

Bureau of Mines
Special Publication

LIST OF BUREAU OF MINES
PUBLICATIONS AND ARTICLES

January 1, 1960, to December 31, 1964

With Subject and Author Index

By Rita D. Sylvester



UNITED STATES DEPARTMENT OF THE INTERIOR
Stewart L. Udall, Secretary

BUREAU OF MINES
Walter R. Hibbard, Jr., Director

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Rita D. Sylvester¹

Introduction

THE BUREAU OF MINES was established in the public interest to conduct inquiries and scientific and technologic investigations concerning mining and the preparation, treatment, and utilization of mineral substances; to promote health and safety in the mineral industries; to conserve mineral resources and prevent their waste; to further economic development; to increase efficiency in the mining, metallurgical, quarrying, and other mineral industries; and to inquire into the economic conditions affecting these industries. The organic act of the Bureau, as amended by Congress and approved February 25, 1913, made it the province and duty of the Bureau to "disseminate information concerning these subjects in such manner as will best carry out the purposes of this Act."

In accordance with that directive, the Bureau reports the findings of its research and investigations in its own series of publications and also in articles that appear in scientific, technical, and trade journals; in proceedings of conven-

tions and seminars; in reference books; and in other non-Bureau sources. The number of these reports, the wide range of subjects they cover, and the variety of mediums in which they appear make the kind of list and index presented in this special publication both necessary and valuable. This issue describes Bureau reports and articles published during the period January 1, 1960 to December 31, 1964. It supplements the 50-year list of Bureau publications issued from July 1, 1910, to January 1, 1960,² and the 50-year list of articles by Bureau authors published outside the Bureau from July 1, 1910, to January 1, 1960.³ It supersedes the annual lists of Bureau publications and articles from January 1 to December 31, 1960,⁴ from January 1 to December 31, 1961,⁵ from January 1 to December 31, 1962,⁶ and from January 1 to December 31, 1963.⁷ The leading general and technical libraries of the United States maintain files of the Bureau's publications. A list of these libraries appears immediately following this introduction.

BUREAU PUBLICATIONS

Because some series of Bureau reports contain both free and sales publications, and because the cost of sales publications varies, prices are indicated in the individual listings of all publications for which charges are made.

¹ Editor, Division of Publication Services, Bureau of Mines, Washington, D.C.

² Obtainable from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402. (Price, \$4.25.)

Sales publications of the Bureau of Mines can be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402, to whom orders should be sent direct. Remittances for such publica-

³ See footnote 2. (Price, \$1.75.)

⁴ See footnote 2. (Price 60 cents.)

⁵ See footnote 2. (Price, 60 cents.)

⁶ See footnote 2. (Price 60 cents.)

⁷ See footnote 2. (Price, 60 cents.)

tions may be by money order or check or by coupons, sold in sets of 20 for \$1 and good until used. Do not send postage stamps. Remittances from foreign countries should be made by international money order, or draft on an American bank, payable to the Superintendent of Documents.

Free publications of the Bureau of Mines can be obtained from the Publications Distribution Section, Bureau of Mines, 4800 Forbes Avenue, Pittsburgh, Pa., 15213. (*Because of the limited editions, only one copy of any free publication can be sent to the person applying and only a few different publications to any one applicant.*) The following series or types of publications are listed in this directory:

Bulletins describe major Bureau investigations or studies that are considered to have permanent value. Usually a Bulletin describes research that has been completed, but sometimes one is issued on completion of a significant part of the research.

Special Publications include comprehensive lists of Bureau publications and lists of articles published outside the Bureau.

Handbooks are special manuals issued as guides to practices recommended by the Bureau in promoting safety and efficiency in the mineral industries and in the use of mineral products.

Miners' Circulars are safety publications prepared primarily for miners but also valuable for supervisory officials. They describe methods of preventing accidents, safe use of equipment and materials, first-aid and mine rescue procedures, protective measures against mine gases, and prevention of disease.

Mineral Yearbooks—annual statistical volumes of the Bureau—review the mineral industries in the United States and foreign countries; contain official Government statistics on metals, minerals, and mineral products; and include factual accounts of economic and technologic developments and trends. Published in four volumes, any of which, as well as preprints of individual chapters, may be obtained from the Superintendent of Documents at the prices quoted.

Schedules describe the procedures and methods followed by the Bureau in testing materials and equipment to determine their permissibility for use by the mineral industries.

Cooperative publications describe research work conducted cooperatively with State departments of geology or mines, universities and colleges, industries, or other recognized organizations and are issued by the cooperating agency. The list should be consulted regarding

prices and the method of procuring such reports.

Annual Report of the Director is first printed in the Annual Report of the Department, which is submitted by the Secretary of the Interior to the President. It summarizes the overall program of the Bureau during the fiscal year covered and indicates future plans.

Reports of Investigations describe the principal features and results of minor investigations or phases of major investigations, thus keeping the mineral industries and the public advised on the progress of original research.

Information Circulars are easily understood digests designed primarily for compilations, reviews, abstracts, and discussion of virtually all activities and developments in the minerals industries. One of their important uses is to provide concise information for replies to inquiries received by the Bureau.

Mineral Industry Surveys cover a wide variety of timely statistical and economic reports designed to keep the public, particularly the business community, and Government agencies regularly informed of trends in the production, distribution, stocks, and consumption of approximately 100 different mineral commodities, including the several mineral fuels. These surveys, prepared by various commodity specialists, are issued at weekly, monthly, quarterly, or at other regular intervals, depending on the need for current data. In 1962 Mineral Market Reports (MRS), Petroleum Products Surveys (PPS), Health and Safety Surveys (HSS), and certain Information Circulars dealing with the mineral fuel industry were combined with this series.

Foreign Mineral Reports are issued to assist domestic producers and consumers to keep abreast of developments in the mineral industries and markets abroad and to provide a summary or brief inventory of significant information from U.S. Foreign Service offices and other sources, which may otherwise not be available to the general public.

Although the material in the categories that follow is not published by the Bureau of Mines, it is listed in this publication as a service to those interested:

Open-File Reports are unpublished reports that are available for reference at certain Bureau offices and libraries. See the list of reports for information on where they are available.

Outside Publications are articles by Bureau authors that are published in the technical press, in proceedings of meetings, and in books.

Patents issued to Bureau personnel since January 1, 1960, are listed, with instructions on how to apply for permission to use such patents.

LIBRARIES

Under provisions of the law, certain libraries are designated by Congress as depositories for printed publications issued by the Government agencies. Through them, various documents printed by the Government Printing Office are made available to residents of every State. Distribution of printed publications is made by the Superintendent of Documents.

Many of these depository libraries and other general and technical libraries also receive multilithed publications of the Bureau of Mines, particularly the Reports of Investigations and the Information Circulars, which are distributed mainly by the Bureau.

Libraries maintaining a file of Bureau of Mines publications are the best sources for reports published by the Bureau when the publications are out of print or copies no longer

are available from the Superintendent of Documents or the Bureau.

In the United States some libraries maintain complete files of Bureau reports; others carry only selected series or classes. The following list contains the names and locations of the depository libraries (indicated by D in parentheses) and some other libraries receiving various series of reports and documents issued by the Bureau of Mines. The figures in parentheses, following the names of the libraries, indicate the type of Bureau publications generally received on a regular basis by each library. They are:

- (1) Reports of Investigations and Information Circulars.
- (2) Bulletins.
- (3) Minerals Yearbooks.

State	City	Library ⁸
Alabama	Auburn	Auburn University. (D, 1)
	Birmingham	Birmingham Public. (D, 1)
	Mobile	Southern Research Institute. (1)
Alaska	University	Mobile Public. (D, 1, 2)
	College	University of Alabama. (D, 1, 2)
Arizona	Juneau	University of Alaska. (D, 1)
	Phoenix	Alaska State. (3)
Arkansas	Tempe	Department of Library and Archives. (D, 1)
	Tucson	Phoenix Public. (D, 1)
	Fayetteville	Arizona State University, Matthews Library. (D, 1)
California	Bakersfield	University of Arizona. (D, 1)
	Belmont	University of Arkansas. (D, 1)
	Berkeley	Kern County Free. (D, 1)
	Fresno	San Mateo County Free. (3)
	La Jolla	University of California. (D, 1, 3)
	Long Beach	Fresno State College. (D, 1)
	Los Angeles	University of California at La Jolla. (D, 1, 2, 3)
		Long Beach Public. (D, 1)
		Los Angeles Public. (D, 1, 2)
		Pacific Institute of Earth Sciences. (1)
		University of California at Los Angeles. (D, 1)
		University of Southern California. (D, 1)
		Marysville City. (3)
		Department of the Interior, Geological Survey. (D, 1, 2)
		Stanford Research Institute, Government Publications. (1)
	Oakland Public. (D, 1)	
	Pasadena	California Institute of Technology. (D, 1)
	Pomona	Pasadena Public. (D, 1, 3)
	Sacramento	Pomona Public. (D, 1, 2, 3)
		California State. (D, 1)
		Sacramento City Free. (D, 1)
		Sacramento State College. (D, 3)
	San Diego	San Diego Public. (D, 1)
		University of California. (2, 3)
	San Francisco	California State Division of Mines and Geology. (1, 2, 3)
		San Francisco Public. (D, 1)
	Stanford	Stanford University. (D, 1, 3)
	Stockton	San Joaquin and Stockton Free Public. (D, 3)

⁸ See types of publications received by libraries, immediately preceding this list (p. 3).

State	City	Library ⁸
Colorado	Boulder	University of Colorado. (D, 1, 2)
	Colorado Springs	Colorado College, Coburn Library. (D, 1)
	Denver	Bureau of Mines, U.S. Department of the Interior. (1, 2, 3) Colorado State. (D, 1) Denver Public. (D, 1)
Connecticut	Golden	Colorado School of Mines. (D, 1, 2)
	Bridgeport	Bridgeport Public. (D, 1)
	Hartford	Connecticut State. (D, 1)
District of Columbia	Storrs	University of Connecticut. (D, 1)
Delaware	Washington	U.S. Department of the Interior. (D, 1)
	Newark	University of Delaware. (D, 1)
Florida	Wilmington	Wilmington Institute Free. (D, 1)
	Coral Gables	University of Miami. (D, 1)
	Gainesville	University of Florida. (D, 1)
Georgia	Miami	University of Miami, Marine Laboratory. (2)
	Tallahassee	Florida Geological Survey. (1, 2)
	Tampa	University of South Florida. (D, 3)
Hawaii	Atlanta	Atlanta Public. (D, 1)
	Honolulu	Georgia Institute of Technology. (1) University of Hawaii. (D, 1, 3)
Idaho	Boise	Boise Public. (D, 1)
	Lewiston	Lewis-Clark Normal School. (3)
	Moscow	University of Idaho. (D, 1)
Illinois	Pocatello	Idaho State University. (D, 1)
	Chicago	Chicago Public. (D, 1) Illinois Institute of Technology. (1, 2) John Crerar. (D, 1, 2) University of Chicago. (D, 1) University of Illinois. (D, 1, 2)
	Eureka	Eureka College. (3)
Indiana	Evanston	Northwestern University. (D, 1)
	Normal	Illinois State Normal University. (D, 1)
	Peoria	Peoria Public. (D, 1)
Iowa	Springfield	Illinois State. (D, 1)
	Urbana	Illinois State Geological Survey. (1, 2) University of Illinois. (D, 1)
	Bloomington	Indiana University. (D, 1)
Kansas	Evansville	Evansville Public. (D, 1)
	Fort Wayne	Fort Wayne Public. (D, 1)
	Indianapolis	Indiana State. (D, 1) Indianapolis Public. (D, 1) Purdue University. (D, 1)
Kentucky	Lafayette	University of Notre Dame. (D, 1)
	Notre Dame	Iowa State University of Science and Technology. (D, 1)
	Ames	Des Moines Public. (D, 1)
Louisiana	Des Moines	State University of Iowa. (D, 1)
	Iowa City	Fort Hays Kansas State College, Forsyth Library. (D, 1)
	Hays	University of Kansas. (D, 1)
Maine	Lawrence	Kansas State University. (D, 1)
	Manhattan	Kansas State Library. (D, 1)
	Topeka	University of Kentucky. (D, 1)
Maryland	Lexington	Louisville Free Public. (D, 1)
	Louisville	Louisiana State University. (D, 1)
	Baton Rouge	New Orleans Public. (D, 1)
Massachusetts	New Orleans	Tulane University, Howard Tilton Memorial Library. (D, 1)
	Orono	University of Maine. (D, 1)
	Portland	Portland Public. (D, 1)
Michigan	Baltimore	Enoch Pratt Free. (D, 1) Johns Hopkins University. (D, 1)
	College Park	Bureau of Mines, U.S. Department of the Interior. (1, 2, 3)
	Boston	Boston Public. (D, 1)
New York	Cambridge	Harvard Geological. (1, 2) Massachusetts Institute of Technology. (D, 1)
	Ann Arbor	University of Michigan. (D, 1)
	Detroit	Detroit Public. (D, 1) Wayne State University. (D, 1)
Ohio	East Lansing	Michigan State University. (D, 1)
	Houghton	Michigan College of Mining and Technology. (D, 1)
	Lansing	Michigan State. (D, 1)
Pennsylvania	Saginaw	Hoyt Public. (D, 1)

⁸ See types of publications received by libraries, immediately preceding this list (p. 3).

State	City	Library ⁸	
Minnesota	Duluth	Duluth Public. (D, 1)	
	Minneapolis	Bureau of Mines, U.S. Department of the Interior. (1, 2, 3) Minneapolis Public. (D, 1) University of Minnesota. (D, 1, 2)	
	Northfield	St. Olaf College. (D, 1)	
	St. Paul	James Jerome Hill Reference. (1, 2, 3) St. Paul Public. (D, 1)	
Mississippi	State College	Mississippi State University, Mitchell Memorial Library. (D, 1)	
Missouri	Columbia	University of Missouri. (D, 1, 2)	
	Kansas City	Kansas City Public. (D, 1) University of Missouri at Kansas City. (D, 1)	
	Rolla	Bureau of Mines, U.S. Department of the Interior. (1, 2, 3) University of Missouri at Rolla. (D, 1)	
	St. Louis	St. Louis Public. (D, 1) Washington University. (D, 1)	
Montana	Bozeman	Montana State College. (D, 1)	
	Butte	Montana School of Mines. (D, 1)	
	Missoula	State University of Montana. (D, 1)	
Nebraska	Blair	Dana College. (D, 1)	
	Chadron	Nebraska State Teachers' College. (3)	
	Lincoln	Nebraska Geological Survey. (1) University of Nebraska. (D, 1, 3) University of Nevada. (D, 1, 3)	
Nevada	Reno	University of Nevada. (D, 1, 3)	
New Hampshire	Durham	University of New Hampshire. (D, 1)	
	Hanover	Dartmouth College. (D, 1, 3)	
New Jersey	Elizabeth	Elizabeth Public. (D, 1)	
	Hoboken	Stevens Institute of Technology. (1, 2, 3)	
	New Brunswick	Rutgers University. (D, 1)	
	Newark	Newark Public. (D, 1)	
	Princeton	Princeton University. (D, 1)	
New Mexico	Albuquerque	University of New Mexico. (D, 1)	
	Socorro	New Mexico Bureau of Mines and Mineral Resources. (1) New Mexico Institute of Mining and Technology. (1, 2) New Mexico School of Mines. (3)	
	University Park	New Mexico College of Agriculture and Mechanical Arts. (1)	
New York	Albany	New York State. (D, 1)	
	Alfred	State University of New York, College of Ceramics. (2)	
	Brooklyn	Brooklyn Public. (D, 1) Pratt Institute. (D, 1)	
	Buffalo	Buffalo and Erie County Public. (D, 1)	
	Ithaca	Cornell University. (D, 1, 3)	
	Jamaica	Queens Borough Public. (D, 1)	
	New York	College of the City of New York. (D, 1) Columbia University. (D, 1, 2, 3) Engineering Societies. (1, 2, 3) New York Public. (D, 1) New York University, University Heights Library. (D, 1) United Nations. (3)	
	Rochester	Rochester Public. (D, 1)	
	Schenectady	Union College. (D, 1)	
	Syracuse	Syracuse Public. (1, 3)	
	Troy	Rensselaer Polytechnic Institute. (1, 3)	
	North Carolina	Chapel Hill	University of North Carolina. (D, 1)
		Durham	Duke University. (D, 1)
		Raleigh	North Carolina State. (D, 1)
		Salisbury	Catawba College. (D, 1)
North Dakota	Bismarck	North Dakota Historical Library. (D, 1)	
	Fargo	North Dakota State University. (D, 1)	
	Grand Forks	University of North Dakota. (D, 1)	
Ohio	Cincinnati	Cincinnati Public. (D, 1) University of Cincinnati. (D, 2)	
	Cleveland	Cleveland Public. (D, 1) Fenn College. (1)	
	Columbus	Ohio State University. (D, 1, 3)	
	Dayton	Dayton Public. (D, 1)	
	Marietta	Marietta College. (D, 1)	
	Toledo	Toledo Public. (D, 1) University of Toledo. (1)	
	Wilberforce	Wilberforce University, Carnegie Library. (3)	

⁸See types of publications received by libraries, immediately preceding this list (p. 3).

State	City	Library ⁸
Oklahoma	Bartlesville	Bureau of Mines, U.S. Department of the Interior. (D, 1, 2, 3)
	Durant	Southeastern State Teachers College. (D, 1)
	Lawton	Cameron State Agricultural College. (1)
	Norman	Oklahoma Geological Survey. (1, 2)
	Oklahoma City	Oklahoma City Public. (1, 2, 3)
	Stillwater	Oklahoma State. (D, 1)
	Tulsa	Oklahoma State University. (D, 1)
Oregon	Tulsa	Tulsa City-County. (D, 1, 2)
	Tulsa	Tulsa Public. (1, 3)
	Tulsa	University of Tulsa. (D, 1)
	Albany	Bureau of Mines, U.S. Department of the Interior. (2, 3)
	Corvallis	Oregon State University. (D, 1)
Pennsylvania	Eugene	University of Oregon. (D, 1)
	Portland	Library Association of Portland. (D, 1)
	Portland	Oregon State Department of Geology and Mineral Industries (2)
	Salem	Oregon State Library. (D, 1)
Pennsylvania	Bethlehem	Lehigh University. (D, 1)
	Harrisburg	Pennsylvania State Library. (D, 1)
	Philadelphia	Franklin Institute. (1, 2, 3)
	Philadelphia	Free Library of Philadelphia. (D, 1)
	Philadelphia	University of Pennsylvania. (D, 1)
	Pittsburgh	Carnegie. (D, 1)
	Pittsburgh	Mellon Institute. (1, 3)
	Pittsburgh	Bureau of Mines, U.S. Department of the Interior. (2, 3)
	Reading	Reading Public. (D, 1)
	Scranton	Scranton Public. (D, 1)
Rhode Island	University Park	Pennsylvania State University. (D, 1, 2)
	Kingston	University of Rhode Island. (D, 1)
South Carolina	Providence	Brown University. (D, 1)
	Columbia	University of South Carolina. (D, 1)
South Dakota	Brookings	South Dakota State University, Lincoln Memorial Library. (D, 1)
Tennessee	Huron	Huron College. (3)
	Rapid City	South Dakota School of Mines and Technology. (D, 2)
	Vermillion	University of South Dakota. (D, 1)
	Knoxville	University of Tennessee. (D, 1)
Texas	Memphis	Cossitt. (D, 1)
	Nashville	Joint University Libraries. (D, 1)
	Amarillo	Bureau of Mines, U.S. Department of the Interior. (1, 2, 3)
	Arlington	Arlington State College. (D, 1, 2)
	Austin	Texas State. (D, 1)
	Austin	University of Texas. (D, 1)
	Beaumont	Lamar State College of Technology. (D, 1)
	College Station	Texas A & M University. (D, 1, 2)
	Dallas	Dallas Public. (D, 1)
	Dallas	Southern Methodist University. (D, 1)
Texas	El Paso	El Paso Public. (D, 1)
	El Paso	Texas Western College. (1, 2)
	Fort Worth	Fort Worth Public. (D, 1)
	Fort Worth	Texas Christian University. (D, 1)
	Houston	Houston Public. (D, 1)
	Houston	Rice University. (1)
	Houston	University of Houston. (D, 1)
	Lubbock	Texas Technological College. (D, 1)
	Midland	Midland County. (1)
	San Antonio	San Antonio Public. (D, 1)
Utah	Waco	Baylor University. (D, 1)
	Provo	Brigham Young University. (D, 1)
	Salt Lake City	Salt Lake City Public. (2, 3)
Vermont	Salt Lake City	University of Utah. (D, 1)
	Middlebury	Middlebury College, Egbert Starr Library. (D, 1)
Virginia	Arlington	Central Arlington. (3)
	Blacksburg	Virginia Polytechnic Institute. (D, 1)
	Charlottesville	University of Virginia, Alderman Library. (1)
	Richmond	Virginia State. (D, 1)
Washington	Olympia	Washington State. (D, 1)
	Pullman	Washington State University. (D, 1, 2)
	Seattle	Seattle Public. (D, 1)
	Seattle	University of Washington. (D, 1)
	Spokane	Spokane Public. (D, 1)
Washington	Tacoma	Tacoma Public. (D, 1)

See types of publications received by libraries, immediately preceding this list (p. 3).

State	City	Library ^a
West Virginia	Charleston	West Virginia State. (D, 1)
	Huntington	Marshall University. (D, 1)
Wisconsin	Morgantown	West Virginia University. (D, 1)
	Madison	University of Wisconsin. (D, 1)
	Milwaukee	Milwaukee Public. (D, 1)
	Platteville	Wisconsin State College and Institute of Technology, Karmann Library. (1, 2, 3)
Wyoming	Racine	Racine Public. (D, 1)
	Cheyenne	Wyoming State Library. (D, 1)
	Laramie	Geological Survey of Wyoming. (D, 1, 3) Bureau of Mines, U.S. Department of the Interior. (3) University of Wyoming. (D, 1, 2, 3)

^a See types of publications received by libraries immediately preceding this list (p. 3).

BULLETINS

- B 581. Index of Selected Gasification Patents (in Three Parts). I. United States Patents, compiled by Simon Klosky. 1960. 265 pp. 439 figs. Includes abstracts of more than 500 patents issued between 1867 and 1955 on coal-gasification processes. Part II includes United Kingdom and other patents and part III, European patents. \$1.25.
- B 581. Index of Selected Gasification Patents (in Three Parts). II. United Kingdom, Australian, and South African Patents, compiled by Simon Klosky and Zane E. Murphy. 1962. 576 pp. 433 figs. Includes abstracts of patents issued in these countries between 1917 and 1956 on coal-gasification processes. Part I includes U.S. patents, and part III European patents. \$3.
- B 581. Index of Selected Gasification Patents (in Three Parts). III. Belgian, French, German, Italian, and Swedish Patents, compiled by Simon Klosky and Zane E. Murphy. 1964. 197 pp. Includes abstracts of patents issued in these countries between 1914 and 1955. Part I includes U.S. patents; part II includes United Kingdom, Australian, and South African patents. \$1.
- B 582. Petroleum and Natural Gas Fields in Wyoming, by Paul Biggs and Ralph H. Espach. 1960. 538 pp. 171 figs. Study contains individual reports on 271 oil and gas fields, including all the fields covered in B 418 of the same title, issued in 1941. Discusses briefly the geology of the fields and surface formations; records history of discovery and development of each field; and tabulates amounts of oil and gas produced in each field by years. Includes 418 analyses of crude-oil, 183 natural gas, and 334 oilfield-water samples. Work done in cooperation with University of Wyoming. Data originally collected for a report submitted to the Missouri Basin Field Committee, U.S. Department of the Interior. \$4.25.
- B 583. A Glossary of the Diamond-Drilling Industry, by Albert E. Long. 1960. 98 pp. Presents the meaning of terms as used by diamond-drilling industry and furnishes descriptive information regarding the use of diamond-drilling equipment and processes in garnering physical data needed by mining, civil, petroleum, and other professional engineering groups. 35 cents.
- †B 584. Contributions to the Data on Theoretical Metallurgy. XIII. High-Temperature Heat-Content, Heat-Capacity, and Entropy Data for the Elements and Inorganic Compounds, by K. K. Kelley. 1960. 232 pp. This publication, a revision and extension of B 476 of the same main title, issued in 1949, reviews available heat content data for the elements and inorganic compounds and gives tables and algebraic expressions for their representation.
- B 585. Mineral Facts and Problems, by the staff of the Bureau of Mines. 1960. 1016 pp. 69 figs. A new edition of a valuable reference volume, which first appeared in 1956 as B 556, on metal, non-metals, and mineral fuels and the industries that produce them is republished with new statistics and other up-to-date information. \$6.00 (cloth).
- B 586. Historical Summary of Coal-Mine Explosions in the United States, 1810-1958, by H. B. Humphrey. 1960. 280 pp. 188 figs. Describes major explosions covering more than a century, reviews growth of explosion hazards with the increased number and size of coal mines and the changing mining methods, and discusses causes of explosions during each period of years to show progress or its lack in controlling or eliminating different causes. Originally issued as IC 7900 in 1959. \$1.75.
- B 587. Design of Underground Openings in Competent Rock, by Leonard Obert, Wilbur I. Duvall, and Robert H. Merrill. 1960. 36 pp. 27 figs. Presents methods and principles useful in designing underground mine openings and pillars in competent rock formations—massive and bedded. 30 cents.
- B 588. Safety at Gas-Processing Plants, compiled by G. M. Kintz and Frances C. Hill. 1960. 98 pp. 54 figs. An up-to-date version of Technical Paper 462, Safety at Natural-Gasoline Plants, issued in 1929, publication describes design, construction, operation, and maintenance of natural gasoline and gas-processing plants, emphasizing procedures and practices that will promote maximum safety for workers in such installations. Work done in cooperation with Natural Gasoline Association of America. 50 cents.
- †B 589. Introduction to Mine Ventilating Principles and Practices, by D. S. Kingery. 1960. 54 pp. 32 figs. Explains in layman's language basic laws and fundamentals of mine airflow and their application to the solution of common ventilating problems; reduces complex and difficult formulas to simple fundamentals. 40 cents.
- B 590. Control of Fires in Inactive Coal Formations in the United States, by F. E. Griffith, M. O. Magnuson, and G. J. R. Toothman. 1960. 105 pp. 61 figs. Presents history and description of Bureau activities in controlling fires in inactive coal formations and provides mining industry and public with information concerning methods of controlling these fires. 60 cents.
- B 591. Identification of Distillable Tar Acids and Tar Bases From a Low-Temperature Bituminous Coal Tar, by Clarence Karr, Jr., Patricia A. Estep, Ta-Chuang Lo Chang, and Joseph R. Comberati. 1961. 228 pp. 213 figs. Approximately 130 individual compounds are identified, generally with respect to their isomers; most of the compounds are determined or estimated. \$1.25.
- B 592. Contributions to the Data on Theoretical Metallurgy. XIV. Entropies of the Elements and Inorganic Compounds, by K. K. Kelley and E. G. King. 1961. 149 pp. Provides the available entropy values at 298.15° K. for the elements and explains methods of measuring and calculating entropies. Represents an elaboration and revision of four earlier bulletins—B 350, 394, 434, and 477—and covers work through September 1959. 75 cents.
- B 593. Composition of Shale-Oil Naphtha, by G. U. Dinneen, R. A. Van Meter, J. R. Smith, C. W. Bailey, G. L. Cook, C. S. Allbright, and John S. Ball. 1961. 74 pp. 41 figs. Describes the analysis of shale-oil naphthas and discusses their composition. Presents quantitative data on the occurrence of individual compounds and groups of related compounds. Work

† Out of print.

- done in cooperation with University of Wyoming. 45 cents.
- B 594. Synthetic Cordierite, by M. E. Tyrrel, G. V. Gibbs, and H. R. Shell. 1961. 41 pp. 17 figs. Describes exploratory studies, crystallochemical properties of synthetic cordierite, electric furnace synthesis, and fabrication of dense cordierite ceramics. Indicates that a vitreous ceramic body can be produced, using fused synthetic cordierite frit that is composed of 15 to 17 percent MgO, 31 percent Al_2O_3 , and 52 to 54 percent SiO_2 . Work done in cooperation with Office of Naval Research, U.S. Department of the Navy. 20 cents.
- B 595. The Chemical Thermodynamic Properties of Hydrocarbons and Related Substances. Properties of 100 Linear Alkane Thiols, Sulfides, and Symmetrical Disulfides in the Ideal Gas State From 0° to 1,000° K., by Donald W. Scott and John P. McCullough. 1961. 68 pp. First of a series of Bulletins presenting the Bureau's work in petroleum thermodynamics. 45 cents.
- B 596. The Chemical Thermodynamic Properties of Hydrocarbons and Related Substances. The Use of *n*-Heptane as a Reference Substance for Low Temperature Calorimetry, by John P. McCullough and John F. Messerly. 1961. 15 pp. 2 figs. Presents results of five investigations of *n*-heptane. Certain values of the low-temperature thermal properties are tabulated, and comparisons with results obtained in other laboratories are made. 20 cents.
- B 597. Pilot-Plant Studies of the Hot-Carbonate Process for Removing Carbon Dioxide and Hydrogen Sulfide, by J. H. Field, H. E. Benson, G. E. Johnson, J. S. Tosh, and A. J. Forney, 1962. 44 pp. 26 figs. Describes improved process for removing carbon dioxide and hydrogen sulfide from synthesis gas. Specifies optimum operating conditions for several purification tests. 30 cents.
- B 598. Kinetics of the Reactions of Carbon Dioxide and Steam With Coke, by Sabri Ergun. 1962. 38 pp. 34 figs. Presents a comprehensive kinetic analysis of the reactions of a metallurgical coke with carbon dioxide and with steam between 900° and 1,200° C. at atmospheric pressure. Provides theories on the mechanisms of both reactions, and reveals a close analogy between them. 30 cents.
- B 599. Relative Permeability Studies: Gas-Oil and Water-Oil Systems, by A. G. Loomis and D. C. Crowell. 1962. 39 pp. 25 figs. Methods for measuring relative permeability as a valid function of saturation were compared, using core samples from representative oil-productive California formation, Bartlesville sand in Oklahoma, and synthetic samples. Measurements for gas-oil systems were made by steady-state dynamic, unsteady-state displacement, and two stationary-phase methods, and for water-oil systems by the unsteady-state displacement method. 30 cents.
- B 600. The Chemistry and Catalytic Properties of Cobalt and Iron Carbonyls, by Irving Wender, Heinz W. Sternberg, Robert A. Friedel, Sol J. Metlin, and Raymond E. Markby. 1962. 83 pp. 17 figs. Study of metal carbonyls and their catalytic action has revealed existence of a new chemistry. Study resulted in discovery of the catalytic action of the hydrocarbonyls of cobalt and iron, probably a consequence of the unusual structure of these compounds. These fundamental studies on the mechanism of catalytic action are divided into three parts: structure and properties of metal carbonyls, reactions catalyzed by cobalt carbonyls, and some catalytic properties of iron carbonyls. 50 cents.
- B 601. Contributions to the Data on Theoretical Metallurgy, XV. A Reprint of Bulletins 383, 384, 393, and 406, by K. K. Kelley. 1962. 525 pp. Makes available in a single volume four Bulletins published between 1935 and 1937 that have long been out of print. The bulletins are: B 383, III. The Free Energies of Vaporization and Vapor Pressures of Inorganic Substances; B 384, IV. Metal Carbonates—Correlations and Applications of Thermodynamic Properties; B 393, V. Heats of Fusion of Inorganic Substances; and B 406, VII. The Thermodynamic Properties of Sulfur and Its Inorganic Compounds.
- B 602. Oxidation of Aromatic Compounds by Bacteria, by Martin H. Rogoff and Irving Wender. 1962. 14 pp. 7 figs. Discusses the oxidation of polynuclear aromatic hydrocarbons by strains of soil bacteria in relation to recent findings. Appendix contains information about some of the techniques in the study of bacterial oxidation of hydrocarbons. 20 cents.
- †B 603. Electrostatic Separation of Granular Materials, by F. Fraas. 1962. 155 pp. 76 figs. Describes the development of the electrostatic method of particle separation. Includes chapters on design of equipment; probability and selectivity in electrostatic separation; effect of dielectric constant; surface cleaning and flming; effects of humidity, temperature, and impurities; size limits, classification, and separation of fine powders; and a review of U.S. patents on electrostatic-separation processes. 75 cents.
- B 604. Structure and Propagation of Turbulent Bunsen Flames, by David Burgess. 1962. 42 pp. 40 figs. Evaluates experimental work by the Bureau of Mines on turbulent flames from 1954 to 1959. Delineates the experimental conditions under which the wrinkled flame is real and shows evidence that the scale of turbulence, or at least the burner dimension, is of importance. 30 cents.
- B 605. Thermodynamic Properties of 65 Elements—Their Oxides, Halides, Carbides, and Nitrides, by C. E. Wicks and F. E. Block. 1963. 146 pp. 67 figs. Compiles in readily usable form data on the heat content, heat of formation, and free energy of formation of 65 common elements and their respective oxides, halides, carbides, and nitrides. Data are presented by means of tables, equations, and graphs. \$1.
- B 606. Properties of Compounds in Coal-Carbonization Products, by H. C. Anderson and W. R. K. Wu. 1963. 834 pp. Gives data for 832 compounds that have been found in the products of coal carbonization. Data for each compound include values for frequently used properties, as well as molecular formula, structural formula, and molecular weight. Data are indexed by compound name, boiling point, melting point, molecular formula, and molecular weight. Includes author index for the 1,525-item list of references. \$4.50.
- B 607. West Virginia Oilfields Discovered Before 1940, by Charles E. Whieldon, Jr., and William E. Eckard. 1963. 187 pp. 87 figs. Contains comprehensive petroleum data for 79 oilfields, including maps, location, discovery date, size, formation, reservoir content and rock characteristics, secondary-recovery methods, and bibliography. Appendix presents routine crude oil analyses by the Bureau. Work done in cooperation with West Virginia Geological and Economic Survey. \$1.
- B 608. Catalytic Oxidation of Hydrocarbons. Tests of Single Oxides and Supported Catalysts in a Microcatalytic Reactor, by K. C. Stein, J. J. Feenan, L. J. E. Hofer, and R. B. Anderson. 1962. 19 pp. 6 figs. Provides information on the activity of catalytic materials in oxidizing different C_2 and C_6 hydrocarbons. A series of essentially pure metal oxides was tested with eight hydrocarbons, and a

† Out of print.

- series of metals supported on spheres of high surface area γ -alumina was examined with four hydrocarbons. Appendix describes similar experiments on the catalytic oxidation of methane. Work done in cooperation with Public Health Service, Department of Health, Education, and Welfare. 20 cents.
- B 609. Determination of Phenols in Coal Tars and Hydroxyl Groups in Coal by Forming Trimethylsilyl Ethers, by Sidney Friedman, Charles Zahn, Marvin Kaufman, and Irving Wender. 1963. 27 pp. 9 figs. Describes new methods for determining phenols in coal tar oils and the hydroxyl content of coal, based on the conversion of the hydroxyl group to the trimethylsilyl ether group by hexamethyl-disilazane. Gives low-ionizing voltage mass spectrometric analyses of high-boiling phenols before and after their conversion to trimethylsilyl ethers and gas-liquid chromatographic analyses of the trimethylsilyl ethers of lower boiling phenols. Hydroxyl oxygen content of 29 coals and 10 vitrains is reported. 25 cents.
- B 610. Plastic, Agglutinating, and Free-Swelling Properties of American Coals, by J. G. Walters, W. H. Ode, and L. Spinetti. 1963. 87 pp. Presents, in collected and tabulated form, Bureau of Mines data on the plastic, agglutinating, and free-swelling characteristics of U.S. coals. 50 cents.
- B 611. Oil-Shale Mining, Rifle, Colo., 1944-56, by J. H. East, Jr. and E. D. Gardner. 1964. 163 pp. 103 figs. Gives data on the Bureau of Mines oil-shale mining research project at Rifle, Colo. The mining organization successfully performed its three functions; namely, (1) to furnish oil shale of selected characteristics for the experimental reports, (2) to devise a mining method whereby oil shale could be produced safely by underground methods at a very low cost per ton, and (3) to demonstrate by actual sustained test runs that the estimated mining costs could be attained. The data, techniques, and equipment developed in the mining research should be very helpful to industry when oil-shale mining on a commercial basis is begun. \$1.25.
- B 612. Carbides, Nitrides, and Carbonitrides of Iron as Catalysts in the Fischer-Tropsch Synthesis, by J. F. Shultz, L. J. E. Hofer, K. C. Stein, and R. B. Anderson. 1963. 70 pp. 36 figs. Iron catalysts converted to carbides, nitrides, and carbonitrides were investigated in the Fischer-Tropsch synthesis. Three iron carbides—Hägg carbide, hexagonal carbide, and cementite—were considered. Reduced, fused-iron catalysts, converted to Hägg iron carbide by treatment with either CO or $1H_2+4CO$ gas and converted to cementite by direct carburization or by thermal reaction of Hägg iron carbide and iron, were tested in the Fischer-Tropsch synthesis with gas at pressures from 7.8 to 21.4 atmospheres. Phase changes in the catalysts were determined by thermomagnetic analysis and X-ray diffraction. Synthesis tests were made on catalysts converted to nitrides and carbonitrides. Structural changes occurring in fused and precipitated iron catalysts during pretreatment, oxidation, and synthesis were determined. 45 cents.
- B 613. X-Ray Powder Diffraction Patterns of Solid Hydrocarbons, Derivatives of Hydrocarbons, Phenols, and Organic Bases, by L. J. E. Hofer, W. C. Peebles, and E. H. Bean. 1963. 59 pp. 3 figs. Deals with compounds of interest in research involving fuels, coal tar dyes, plastics, pharmaceutical, agricultural chemicals, carcinogens, air pollutants, and other public health problems. Presents 178 X-ray powder diffraction patterns of aromatic hydrocarbons, 2,4,7-trinitro-9-fluorenone derivatives of aromatic hydrocarbons, phenols, and organic bases for positive identification of solid organic compounds. Contains convenient indexes to permit maximum use of these patterns, discusses X-ray powder diffraction analysis, and describes methods and instruments developed to implement the data. 40 cents.
- B 614. Kinetics of the Fisher-Tropsch Synthesis on Iron Catalysts, by R. B. Anderson, F. S. Karn, and J. F. Shultz. 1964. 45 pp. 35 figs. Nitrided catalysts were studied at 21.4 atmospheres using feed gases ranging from $2H_2+1CO$ to $0.25H_2+1CO$, and at 7.8 to 21.4 atmospheres using $1H_2+1CO$ gas. The overall apparent activation energy increased with increasing CO content of the feed gas from 19.5 kcal/mole for $2H_2+1CO$ to 23.7 for $0.7H_2+1CO$. The rate of synthesis with $1H_2+1CO$ increased linearly with operating pressure from 7.8 to 21.4 atmospheres. A semifundamental rate equation was shown to fit the data satisfactorily. In another group of experiments, H_2O , CO_2 , A, and CH_4 were added to $1H_2+1CO$ feed to a nitrided catalyst. Important factors of catalyst geometry in determining rate were found to be particle size and extent of reduction. The appendix presents a group of synthesis experiments at pressures of 21.4 to 103 atmospheres. 35 cents.
- B 616. Historical Documentation of Major Coal-Mine Disasters in the United States Not Classified as Explosions of Gas or Dust: 1846-1962, by Charles M. Keenan. 1963. 90 pp. Lists and provides brief accounts of disasters causing five or more deaths that have occurred in the United States since 1846. This publication is a sequel to and supplements Bulletin 586, Historical Summary of Coal-Mine Explosions in the United States, 1810-1958, issued in 1960. The two bulletins provide information on all the known major coal-mine disasters in the Nation's history. 50 cents.
- B 617. Helium-Bearing Natural Gases of the United States: Analyses. Second Supplement to Bulletin 486, by R. D. Munnerlyn and R. D. Miller. 1963. 93 pp. 1 fig. Presents analyses of 1,444 samples from oil and gas wells and natural-gas pipelines collected from 23 States from May 1956 to January 1961 as part of the Bureau's continuous helium-survey program. Since May 1956, helium was found in natural gas from several new areas, principally in Arizona, Colorado, New Mexico, and Utah. None of the new areas contain helium resources comparable to those known previously. Supplements Bulletins 486 and 576. 50 cents.
- B 618. Measurement and Significance of the Flow Properties of Coal-Ash Slag, by Richard C. Corey. 1964. 64 pp. 32 figs. Consolidates the essential features of all the research reports published by the Bureau of Mines on the flow properties of coal-ash slag, with emphasis on both the experimental procedures employed and the interpretation of the experimental results. Contains a bibliography and index. 40 cents.
- B 619. Corrosion Properties of Titanium and Its Alloys, by David Schlain. 1964. 228 pp. 102 figs. Correlates and evaluates data, obtained by the Bureau of Mines and other organizations, on the corrosion properties of titanium and its alloys. Most of the data presented concern the corrosion characteristics of titanium in aqueous solutions and organic solutions and compounds although some information is also given on the corrosion of titanium in other environments, such as gases at elevated temperatures. \$1.25.
- B 626. Storage Stability of Gasoline. Fundamentals of Gum Formation, Including a Discussion of Radiotracer Techniques, by Frank G. Schwartz, M. L. Whisman, C. S. Allbright, and C. C. Ward. 1964.

44 pp. 13 figs. Variables of composition and environment that affect storage stability of gasoline-type fuels were studied. Change in gasoline composition brought about by aging were determined and correlated with gum formation. The amounts of reaction of selected gasoline components, measured by radioactive tracers, were determined in a

gasoline-type blend and in a mixture of 17 pure gasoline components. Data show that compounds that contribute to gum-forming reactions are sulfur compounds, nitrogen compounds, olefins, and polycyclic compounds in the presence of oxygen. Work done under an agreement with the Research Division, Army Materiel Command. 30 cents.

SPECIAL PUBLICATIONS

- SP 1. List of Publications Issued by the Bureau of Mines From July 1, 1910, to January 1, 1960, With Subject and Author Index, by Hazel J. Stratton. 1960. 826 pp. Contains more than 7,500 listings of virtually all scientific and technical publications. \$4.25.
- SP 2. List of Journal Articles by Bureau of Mines Authors Published July 1, 1910, to January 1, 1960, With Subject Index, compiled by Mae W. Hardison and Opal V. Weaver. 1960. 295 pp. Contains nearly 9,000 articles, written by Bureau personnel and published in scientific and technical journals, the trade press, convention proceedings, and other non-Bureau publications. \$1.75.
- SP 3. List of Bureau of Mines Publications and Articles, January 1 to December 31, 1960, With Subject and Author Index. 1961. 66 pp. Describes Bureau publications and papers written by its personnel that have appeared in outside publications. It supplements the 50-year lists of Bureau publications and articles issued from 1910 to 1960. 60 cents.
- †SP 4. List of Bureau of Mines Publications and Articles, January 1 to December 31, 1961, With Subject and Author Index. 1962. 62 pp. Describes

Bureau publications and papers written by its personnel that have appeared in outside publications. It supplements the 50-year lists of Bureau publications and articles issued from 1910 to 1960, and the annual list of Bureau publications and articles issued in 1960. 60 cents.

- SP 5. List of Bureau of Mines Publications and Articles, January 1 to December 31, 1962, With Subject and Author Index. 1963. 87 pp. Describes Bureau publications and papers written by its personnel that have appeared in outside publications. It supplements the 50-year lists of Bureau publications and articles issued from 1910 to 1960, and the annual lists of Bureau publications and articles issued in 1960 and 1961. 60 cents.

- SP 6. List of Bureau of Mines Publications and Articles, January 1 to December 31, 1963, With Subject and Author Index. 1964. 78 pp. Describes Bureau publications and papers written by its personnel that have appeared in outside publications. It supplements the 50-year lists of Bureau publications and articles issued from 1910 to 1960, and the annual lists of Bureau publications and articles issued in 1960, 1961, and 1962. 60 cents.

HANDBOOKS

- BAH. Mine Rescue Apparatus and Auxiliary Equipment, by Alexander E. Morrow, William M. Demkowicz, and Gordon W. Chastain. 1961. 287 pp. 42 figs. (Revision, in part, of Self-Contained Oxygen Breathing Apparatus, by D. J. Parker, G. S. McCaa, and E. H. Denny, issued in 1923 and revised in 1929, 1934, and 1940.) Includes information on design, construction, and operation of five new types of self-contained breathing apparatus, two types of gas masks, and lifeline telephone. \$1.25.
- BWH. Questions and Answers on Boiler-Feedwater

Conditioning, by A. A. Berk. 103 pp. (Revision of Handbook 3, Questions and Answers on Boiler Feed-Water Conditioning, by J. F. Barkley, issued in 1936 and revised in 1943.) Attempts to give information about boiler feedwater to boiler operators who have not studied chemistry. Shows harmful effects of impurities in boiler water, causes of boiler pitting or corrosion, methods of preventing undesirable sludge, and chemicals used for conditioning feedwater. Includes a useful table of chemical compounds. 35 cents.

MINERS' CIRCULARS

- MC 51. Injury Statistics as an Aid in Preventing Accidents in Metal and Nonmetallic Mines. Metal and Nonmetallic-Mine Accident Prevention Course—Section I. (Revised March 1958), by Roy G. Stott. 1960. 42 pp. 10 figs. One in a series of miners' circulars being revised to include improve-

ments in an accident-prevention course inaugurated by the Bureau of Mines in 1942. Shows how accident-injury records can help in planning, carrying out, and evaluating accident-prevention programs. Presents statistics on past accident experience. 40 cents.

† Out of print.

MINERALS YEARBOOKS

- The Minerals Yearbook 1959, published in three volumes, provides a record of performance of the Nation's mineral industries during the year. The complete volumes, covering all mineral commodities, are obtainable from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. All chapters for which prices are given are also obtainable from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402.
- Volume I, Metals and Minerals (Except Fuels), prepared by the staff of the Bureau of Mines, Division of Minerals. 79 chapters. 1271 pp. 62 figs. Covers the metals and minerals other than fuels. \$4.50.
- Volume II, Fuels, prepared by the staff of the Bureau of Mines, Division of Petroleum, Division of Bituminous Coal, Division of Anthracite and Assistant Director—Helium. 13 chapters. 483 pp. 43 figs. Covers the mineral fuels. \$2.50.
- Volume III, Area Reports prepared by the staff of the Bureau of Mines, Division of Minerals. 53 chapters. 1134 pp. 60 figs. Contains geographic chapters for each State, as well as the island possessions and the Canal Zone. \$4.25.
- The Minerals Yearbook 1960, published in three volumes, provides a record of performance of the Nation's mineral industries during the year. The complete volumes, covering all mineral commodities, are obtainable from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. All chapters for which prices are given are also obtainable from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C.
- Volume I, Metals and Minerals (Except Fuels), prepared by the staff of the Bureau of Mines, Division of Minerals. 79 chapters. 1294 pp. 56 figs. Covers the metals and minerals other than fuels. \$4.50.
- Volume II, Fuels, prepared by the staff of the Bureau of Mines, Division of Bituminous Coal, Division of Petroleum, Division of Anthracite, and Assistant Director—Helium. 13 chapters. 509 pp. 44 figs. Covers the mineral fuels. \$2.50.
- Volume III, Area Reports, prepared by the staff of the Bureau of Mines, Division of Minerals. 53 chapters. 1161 pp. 58 figs. Contains geographic chapters for each State, as well as the island possessions and the Canal Zone. \$4.25.
- The Minerals Yearbook 1961, published in three volumes, provides a record of performance of the Nation's mineral industries during the year. The complete volumes, covering all mineral commodities, are obtainable from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. All chapters for which prices are given are also obtainable from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.
- Volume I, Metals and Minerals (Except Fuels), prepared by the staff of the Bureau of Mines, Division of Minerals. 80 chapters. 1418 pp. 50 figs. Covers the metals and minerals other than fuels. \$4.75.
- Volume II, Fuels, prepared by the staff of the Bureau of Mines, Division of Bituminous Coal, Division of
- The Minerals Yearbook 1961—Continued
- Volume II—Continued
Petroleum, Division of Anthracite, and Assistant Director—Helium. 13 chapters. 499 pp. 44 figs. Covers the mineral fuels. \$2.50.
- Volume III, Area Reports, prepared by the staff of the Bureau of Mines, Division of Minerals. 53 chapters. 1173 pp. 59 figs. Contains geographic chapters for each State, as well as the island possessions and the Canal Zone. \$4.25.
- The Minerals Yearbook 1962, published in three volumes, provides a record of performance of the Nation's mineral industries during the year. The complete volumes, covering all mineral commodities, are obtainable from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. All chapters for which prices are given are also obtainable from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.
- Volume I, Metals and Minerals (Except Fuels), prepared by the staff of the Bureau of Mines, Division of Minerals, 78 chapters. 1410 pp. 54 figs. Covers the metals and minerals other than fuels. \$4.75.
- Volume II, Fuels, prepared by the staff of the Bureau of Mines, Division of Petroleum, Division of Bituminous Coal, Division of Anthracite, and Assistant Director—Helium. 12 chapters. 531 pp. 47 figs. Covers the mineral fuels. \$2.50.
- Volume III, Area Reports, prepared by the field staffs of the Division of Mineral Resources of the Bureau of Mines. 53 chapters. 1206 pp. 59 figs. Contains geographic chapters for each State, as well as the island possessions and Canal Zone. \$4.25.
- The Minerals Yearbook 1963, published for the first time in four volumes, provides a record of performance of the Nation's mineral industries during the year and a review of world mineral production, consumption, and trade on a country-by-country basis. The complete volumes are obtainable from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402. All of the chapters in the first three volumes have been pre-printed separately and are available from the Superintendent of Documents at the prices indicated. Reprints of individual chapters of volume IV will be available in 1965. For prices consult the monthly list of Bureau of Mines New Publications or the Superintendent of Documents.
- Volume I, Metals and Minerals (Except Fuels). Prepared by the staff of the Bureau of Mines, Division of Minerals. 78 chapters. 1307 pp. 47 figs. Covers the metals and minerals other than fuels. \$4.50.
- Foreword, by Marling J. Ankeny. 1 p.
- Acknowledgments, by Charles W. Merrill. 2 pp.
- General Reviews:
- Employment and Injuries in the Metal and Nonmetal Industries, by Forrest T. Moyer. 9 pp. 10 cents.
- Review of Metallurgical Technology, by Kenneth B. Higbie and Rollien R. Wells. 14 pp. 10 cents.
- Review of the Mineral Industries (Metals and Nonmetals Except Fuels), by Kung-Lee Wang and Edward E. Johnson. 64 pp. 25 cents.
- Review of Mining Technology, by James E. Hill. 12 pp. 10 cents.

The Minerals Yearbook 1963—Continued

General reviews—Continued

Statistical Summary, by Kathleen J. D'Amico.⁹ 47 pp. 20 cents.

Technologic Trends in the Mineral Industries (Metals and Nonmetals Except Fuels), by Frank L. Wideman. 38 pp. 2 figs. 15 cents.

Commodity reviews:

Abrasive Materials, by Paul M. Ambrose. 20 pp. 15 cents.

Aluminum, by John W. Stamper. 28 pp. 15 cents.

Antimony, by D. E. Moulds. 10 pp. 10 cents.

Arsenic, by Arnold M. Lansche. 5 pp. 5 cents.

Asbestos, by Timothy C. May. 15 pp. 10 cents.

Barite, by Harold J. Drake. 12 pp. 10 cents.

Bauxite, by Lloyd R. Williams and John W. Stamper. 21 pp. 2 figs. 15 cents.

Beryllium, by Donald E. Eilertsen. 9 pp. 10 cents.

Bismuth, by Donald E. Moulds. 5 pp. 5 cents.

Boron, by William C. Miller. 9 pp. 10 cents.

Bromine, by William C. Miller. 6 pp. 5 cents.

Cadmium, by H. J. Schroeder. 8 pp. 1 fig. 10 cents.

Calcium and Calcium Compounds, by Clarence O. Babcock. 6 pp. 5 cents.

Cement, by William R. Barton. 32 pp. 2 figs. 15 cents.

Chromium, by R. W. Holliday. 14 pp. 10 cents.

Clays, by James D. Cooper. 26 pp. 3 figs. 15 cents.

Cobalt, by Glen C. Ware. 10 pp. 10 cents.

Columbium and Tantalum, by Gilbert L. DeHuff and Richard F. Stevens, Jr. 13 pp. 10 cents.

Copper, by F. L. Wideman. 46 pp. 1 fig. 20 cents.

Diatomite, by Benjamin Petkof. 5 pp. 1 fig. 5 cents.

Feldspar, Nepheline Syenite, and Aplite, by James D. Cooper. 9 pp. 10 cents.

Ferroalloys, by Gilbert L. DeHuff. 14 pp. 10 cents.

Fluorspar and Cryolite, by Paul M. Ambrose. 18 pp. 10 cents.

Gem Stones, by Benjamin Petkof. 12 pp. 10 cents.

Gold, by J. P. Ryan. 24 pp. 3 figs. 15 cents.

Graphite, by Harold J. Drake. 9 pp. 10 cents.

Gypsum, by William R. Barton. 12 pp. 10 cents.

Iodine, by William C. Miller. 5 pp. 5 cents.

Iron and Steel, by Robert A. Whitman. 30 pp. 1 fig. 15 cents.

Iron and Steel Scrap, by Robert A. Whitman. 25 pp. 15 cents.

Iron Ore, by Harold T. Reno. 31 pp. 1 fig. 15 cents.

Iron Oxide Pigments, by Horace T. Reno. 5 pp. 5 cents.

Kyanite and Related Minerals, by James D. Cooper. 5 pp. 5 cents.

Lead, by Donald E. Moulds. 35 pp. 1 fig. 15 cents.

Lime, by Perry G. Cotter. 14 pp. 1 fig. 10 cents.

Lithium, by Donald E. Eilertsen. 5 pp. 5 cents.

Magnesium, by Lloyd R. Williams and John W. Stamper. 10 pp. 1 fig. 10 cents.

Magnesium Compounds, by Lloyd R. Williams and John W. Stamper. 12 pp. 1 fig. 10 cents.

Manganese, by Gilbert L. DeHuff. 22 pp. 1 fig. 15 cents.

Mercury, by John E. Shelton. 12 pp. 1 fig. 10 cents.

Mica, by Benjamin Petkof. 17 pp. 10 cents.

Minor Metals and Minerals, by Staff, Division of Minerals. 25 pp. 15 cents.

Molybdenum, by R. W. Holliday. 11 pp. 1 fig. 10 cents.

Nickel, by Glen C. Ware. 15 pp. 10 cents.

Nitrogen, by Richard W. Lewis. 14 pp. 10 cents.

Perlite by Timothy C. May. 4 pp. 5 cents.

⁹ Same chapter in volume III.

The Minerals Yearbook 1963—Continued

Commodity reviews—Continued

Phosphate Rock, by Richard W. Lewis. 22 pp. 1 fig. 15 cents.

Platinum-Group Metals, by Glen C. Ware. 13 pp. 10 cents.

Potash, by Richard W. Lewis. 15 pp. 1 fig. 10 cents.

Pumice, by Timothy C. May. 7 pp. 2 figs. 10 cents.

Quartz Crystal, Electronic-Grade, by Benjamin Petkof. 5 pp. 5 cents.

Rare-Earth Minerals and Metals, by John G. Parker. 10 pp. 10 cents.

Salt, by William H. Kerns. 14 pp. 10 cents.

Sand and Gravel, by Perry G. Cotter. 26 pp. 2 figs. 15 cents.

Silicon, by Gilbert L. DeHuff. 7 pp. 10 cents.

Silver, by J. P. Ryan. 24 pp. 3 figs. 15 cents.

Slag, Iron-Blast-Furnace, by Perry G. Cotter. 9 pp. 2 figs. 10 cents.

Sodium and Sodium Compounds, by Robert T. MacMillan. 9 pp. 10 cents.

Stone, by Perry G. Cotter. 25 pp. 1 fig. 15 cents.

Strontium, by Clarence O. Babcock. 3 pp. 5 cents.

Sulfur and Pyrites, by Clarence O. Babcock. 22 pp. 2 figs. 15 cents.

Talc, Soapstone and Pyrophyllite, by James D. Cooper. 8 pp. 10 cents.

Thorium, by Charles T. Baroch. 6 pp. 5 cents.

Tin, by John E. Shelton. 22 pp. 15 cents.

Titanium, by John W. Stamper. 22 pp. 2 figs. 15 cents.

Tungsten, by Richard F. Stevens, Jr. 14 pp. 1 fig. 10 cents.

Uranium, by Charles T. Baroch. 25 pp. 15 cents.

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Vermiculite, by Timothy C. May. 5 pp. 5 cents.

Water, by William H. Kerns. 12 pp. 10 cents.

Zinc, by H. J. Schroeder. 38 pp. 2 figs. 15 cents.

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Volume II, Fuels. Prepared by the staff of the Bureau of Mines, Division of Anthracite, Division of Bituminous Coal, Division of Petroleum, Division of Statistics, Division of Economic Analysis, Division of Accident Prevention and Health, and Assistant Director—Helium. 12 chapters. 531 pp. 47 figs. Covers the mineral fuels. \$2.50.

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Appendix: Tables of Measurement.

Volume III, Area Reports: Domestic. Prepared by the staffs of the field offices of the Divisions of Mineral Resources of the Bureau of Mines. 53 chapters. 1235 pp. 54 figs. Contains geographic chapters for each State, as well as the island possessions and Canal Zone. \$4.25.

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¹⁰ Same chapter in volume I.

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Louisiana, by Peter Grandone, Owen W. Jones, and Leo W. Hough. Prepared in cooperation with the Louisiana Geological Survey. 33 pp. 1 fig. 15 cents.

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Puerto Rico, the Panama Canal Zone, the Virgin Islands, and Pacific Island Possessions, by Harry F. Robertson, José F. Cadilla, Leovigildo Vásquez, and Roy Y. Ashizawa. Puerto Rico section prepared in cooperation with the Mineralogy and Geology Section, Industrial Research, Economic Development Administration, Commonwealth of Puerto Rico. 8 pp. 10 cents.

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- Volume IV, Area Reports: International.¹¹ Prepared by the staff of the Bureau of Mines, Division of International Activities. 127 chapters. 1505 pp. 1 fig. Contains geographic chapters presenting the latest available mineral statistics for more than 130 foreign countries and areas. \$5.00.
- Foreword, by Marling J. Ankeny.
- Acknowledgments, by Virgil L. Barr.
- Minerals in the World Economy, by Stephen C. Brown.
- The mineral industry of—
- Afghanistan, by L. Nahai.
- Albania, by Bernadette C. Michalski and K. P. Wang.
- Algeria, by Thomas G. Murdock.
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¹¹ Reprints of individual chapters will be available in 1965 at prices ranging from 10 to 35 cents. Obtainable from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402.

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 Yugoslavia, by Roman V. Sondermayer.

SCHEDULES¹²

- S 1H. Explosives and Related Articles: Tests for Permissibility and Suitability. Federal Register, v. 26, No. 39, Mar. 1, 1961, 4 pp. (Supersedes S 1G.)
 S 16E. Multiple-Shot Blasting Units: Tests for Permissibility; Fees. Federal Register, v. 25, No. 103, May 26, 1960, 3 pp. (Supersedes S 16D.)
 S 25B. Dust Collectors for Use in Connection with Rock Drilling in Coal Mines: Tests for Permissibility and Suitability; Fees. Federal Register, v. 25, No. 133, July 9, 1960, 4 pp. Supersedes S 25A)
 Amendments to S 25B. Dust Collectors for Use in Connection with Rock Drilling in Coal Mines: Tests for Permissibility and Suitability; Fees. Federal Register, v. 26, No. 58, Mar. 28, 1961, 1 p.
 S 31. Mobile Diesel-Powered Transportation Equipment for Gassy Noncoal Mines and Tunnels: Tests for Permissibility and Suitability; Fees. Federal Register, v. 26, No. 14, Jan. 24, 1961, 7 pp.
 S 32. Methane-Monitoring Systems: Tests for Permissibility; Fees. Federal Register, v. 26, No. 226, Nov. 23, 1961, 4 pp.

COOPERATIVE PUBLICATIONS

The following reports, resulting from investigations conducted cooperatively by the Bureau of Mines and the agencies noted, have been written in part by members of the Bureau and published by the cooperating agency.

WITH THE BONNEVILLE POWER ADMINISTRATION, U.S. DEPARTMENT OF THE INTERIOR¹³

BPA. The Titanium Industries and Their Relation to the Pacific Northwest, by Frank B. Fulkerson and Jerry J. Gray. Pacific Northwest Economic Base Study for Power Markets. V. 2. part 7G. 46 pp. 6 figs. Includes a history of the industry, a study of raw material sources and requirements, a consideration of markets, and a study of the competitive position of Pacific Northwest producers. Work done in cooperation with the Bonneville Power Administration.

WITH THE GEOLOGICAL SURVEY OF ALABAMA, DIVISION OF ECONOMIC GEOLOGY¹⁴

AGS. LaMont, W. E., and E. L. Hastings. Resource and Beneficiation Studies of Copper-Bearing Pyrite Ore, Pyriton, Clay County, Alabama. Alabama Geol. Survey Circ. 27, 1964. 26 pp. 8 figs.

WITH THE MARYLAND DEPARTMENT OF GEOLOGY, MINES, AND WATER RESOURCES AND THE GEOLOGICAL SURVEY, U.S. DEPARTMENT OF THE INTERIOR¹⁵

MNR. Physical Properties of Nonmarine Cretaceous Clays in the Maryland Coastal Plain, by Maxwell M. Knechtel, Howard P. Hamlin, John W. Hosterman, and Dorothy Carroll. Maryland Dept. of Geology, Mines, and Water Resources, Bull. 23, 1961. 11 pp. 7 figs.

WITH THE PUBLIC HEALTH SERVICE, U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

† PHS. Uranium Miners: Your Ounce of Prevention, by the Public Health Service and the Bureau of Mines. Public Health Service Pub. 708, 1959.

WITH THE VIRGINIA DEPARTMENT OF CONSERVATION AND ECONOMIC DEVELOPMENT, DIVISION OF MINERAL RESOURCES¹⁶

VMR. Analyses of Clay, Shale, and Related Materials—Northern Counties, by James L. Calver, Howard P. Hamlin, and Robert S. Wood. Virginia Divi-

¹² Schedules and amendments to schedules are printed in the Federal Register.

¹³ May be obtained only from Chief, Branch of Power Marketing, Bonneville Power Administration, P.O. Box 3621, Portland, Oreg. 97208.

¹⁴ Obtainable only from the Geological Survey of Alabama, University, Ala. 35486.

¹⁵ May be obtained only from Director, Department of Geology, Mines, and Water Resources, 102 Latrobe Hall, Johns Hopkins University, Baltimore, Md. 21218.

¹⁶ May be obtained only from the State Geologist, Division of Mineral Resources, Box 3667, University Station, Charlottesville, Va. 22901.

† Out of print.

sion of Mineral Resources, Min. Res. Rept. 2, 1961. 194 pp., 28 figs.

MONOGRAPH

A monograph is a detailed report of a cooperative investigation of a special subject in which the Bureau of Mines and another organization are mutually interested and usually relates to a study of problems encountered in production, distribution, or utilization of mineral fuels.

M 11. Using Foaming Agents to Remove Liquids From Gas Wells, by H. N. Dunning, J. L. Eakin, and C. J. Walker. 1961. 38 pp. 16 figs. Discusses principles of foam formation, properties of foaming agents, and methods of laboratory and field testing. Presents results from more than 60 field tests. Work done in cooperation with Pipeline Research Committee of the American Gas Association and the State of Oklahoma. (May be obtained only from the American Gas Association, 605 Third Avenue, New York, N.Y., 10016. Price \$2.00).

ANNUAL REPORT OF THE DIRECTOR, BUREAU OF MINES¹⁷

DAR 1960. Annual Report of the Director of the Bureau of Mines to the Secretary of the Interior, for the Fiscal Year Ended June 30, 1960. Marling J. Ankeny, Director. (Reprinted from the Annual Report of the Secretary of the Interior for the Fiscal Year Ended June 30, 1960. pp. 139-174.)

DAR 1961. Annual Report of the Director of the Bureau of Mines to the Secretary of the Interior, for the Fiscal Year Ended June 30, 1961. Marling J. Ankeny, Director. (Reprinted from the Annual

Report of the Secretary of the Interior for the Fiscal Year Ended June 30, 1961, pp. 223-262.)

DAR 1962. Annual Report of the Director of the Bureau of Mines to the Secretary of the Interior, for the Fiscal Year Ended June 30, 1962. Marling J. Ankeny, Director. (Reprinted from the Annual Report of the Secretary of the Interior for the Fiscal Year Ended June 30, 1962, pp. 363-403.)

DAR 1963. Annual Report of the Director of the Bureau of Mines to the Secretary of the Interior, for the Fiscal Year Ended June 30, 1963. Marling J. Ankeny, Director. (Reprinted from the Annual Report of the Secretary of the Interior for the Fiscal Year Ended June 30, 1963, pp. 401-441.)

¹⁷ Obtainable from the Publications Distribution Section, Bureau of Mines, 4800 Forbes Avenue, Pittsburgh, Pa., 15213.

REPORTS OF INVESTIGATIONS¹⁸

- RI 5529. Heats of Combustion and Formation of Molybdenum Subnitride and Chromium Subnitride, by Alla D. Mah. 1960. 7 pp. Measures heats of combustion of molybdenum and chromium subnitride, combines data with previous determinations of the heats of formation of molybdenum trioxide and chromium sesquioxide to obtain heats of formation of the two subnitrides from the elements at 298.15° K.; and compares heat data with those of nine other nitrides. 15 cents.
- RI 5530. Manganese Deposits of the Olympic Peninsula, Wash., by E. A. Magill. 1960. 82 pp. 54 figs. Describes 67 manganese deposits in Clallam, Jefferson, Mason, and Grays Harbor Counties. Twelve deposits have produced manganese ore and more than 95 percent of the total Olympic Peninsula manganese production has come from the Crescent mine in Clallam County. 50 cents.
- RI 5545. Bureau of Mines Gas-Combustion Retort for Oil Shale: A Study of the Effects of Process Variables, by Raymond O. Dannenberg and Arthur Matzick. 1960. 73 pp. 21 figs. Presents results of a series of experiments on a 6-ton-per-day gas-combustion pilot retort. The experiments were designed to gain information concerning the effects of the process variables on operational characteristics, product yields, and product properties.
- RI 5548. Frictional Ignition of Gas During a Roof Fall, by John Nagy and Edward M. Kawenski. 1960. 11 pp. 2 figs. Sandstone, shale, and other materials encountered in coal mines can cause frictional sparks that can ignite methane, an explosive gas usually found in such mines, according to this publication describing tests on frictional ignition.
- RI 5549. Metallurgical Laboratory Data on Reduction and Refining of Cerium Oxide and Cerous Fluoride to Cerium Ingot, by E. Morrice, J. Darrah, E. Brown, C. Wyche, W. Headrick, R. Williams, and R. G. Knickerbocker. 1960. 36 pp. 2 figs. Presents data on reduction and refining of cerium.
- RI 5550. Recovering Iron Concentrates From the Pea Ridge Deposit, Central Missouri, by D. W. Frommer and M. M. Fine. 1960. 14 pp. 3 figs. Describes mineral dressing research on three samples of iron ore from the Pea Ridge deposit. Work done in cooperation with St. Joseph Lead Co.
- RI 5552. Tungsten Resources of Montana: Deposits of the Mount Torrey Batholith, Beaverhead County, by Eldon C. Pattee. 1960. 41 pp. 36 figs. Contains assays and other data obtained in Bureau study of 22 tungsten properties in and near the Mount Torrey batholith, southwestern Montana. Most deposits are in Lost Creek, Utopia, and Bald Mountain mining districts and are contact metamorphic or quartz-fissure-vein type. The Brown's Lake mine, major producer, has yielded more than 625,000 tons of ore. \$1.25.
- RI 5555. Molybdenum Casting Development, by E. D. Calvert, S. L. Ausmus, S. A. O'Hare, and A. H. Roberson. 1960. 16 pp. 10 figs. Describes the successful arc casting of molybdenum into static or centrifugal molds.
- RI 5556. Anthracite Gas-Producer Tests at a Brick Plant, by R. F. Tenney, J. D. Clendenin, and W. S. Sanner. 1960. 25 pp. 5 figs. Presents results of an investigation on production and use of anthracite producer gas for industrial-process and brick-kiln heating; describes producer and periodic-kiln equipment, operating procedures, and labor requirements.
- RI 5558. A Cost Study of Pumping Versus Flowing Oil Production From Appalachian Waterfloods, by Robert L. Rough and Paul T. Bail. 1960. 63 pp. 31 figs. Presents results of an investigation of water-injection projects in the northwestern Pennsylvania and southwestern New York area, where oil-producing wells have been converted from pumping to flowing; includes cost data of waterflooding properties so converted.
- RI 5559. Gasification of Pulverized Coal at Atmospheric Pressure: Discussion of Pilot-Plant Development, Study of Process Variables, and Relative Gasification Characteristics of Coals of Different Rank, by G. R. Strimbeck, J. H. Holden, F. Bonar, K. D. Plants, C. D. Pears, and L. L. Hirst. 1960. 68 pp. 40 figs. Describes atmospheric-pressure pilot plant for gasifying coal in producing synthesis gas and the operating performance of the pilot plant.
- RI 5560. Survey of Face Ventilation Practices in Coal Mines, by R. W. Stahl and F. F. Kapsch. 1960. 13 pp. 13 figs. Describes problems encountered in maintaining adequate ventilation of coal-mine workings while using continuous-mining machines.
- DI 5561. Geologic Factors Related to Block Caving at San Manuel Copper Mine, Pinal County, Ariz. 2. Progress Report, April 1956-March 1958, by E. D. Wilson. 1960. 43 pp. 27 figs. Results of study show that the principal geologic factors that affect block caving at the San Manuel mine are structure, rock types, alteration, mineralization, oxidation, and presence of water; main structural feature is fracturing.
- RI 5562. The Analysis of Kinetics by the Method of Constant Compositions, by Sabri Ergun and Morris Mentser. 1960. 9 pp. 3 figs. The method of constant compositions, used heretofore in evaluating the energy of activation only, involves the determination of the time required for the attainment of a given conversion at various temperatures. In this study a method is developed that makes possible the evaluation of the functional dependence upon composition and frequency factor in addition to the energy of activation.
- RI 5563. Experiments in Crushing Green River Oil Shale, by Arthur Matzick, R. O. Dannenberg, and Boyd Guthrie. 1960. 64 pp. 37 figs. Presents Bureau of Mines data on crushing experiments, physical properties, and related information on Colorado oil shale.
- RI 5564. Beneficiating a Complex Sulfide-Oxide Lead-Zinc Ore from Missouri, by H. E. Powell. 1960. 10 pp. Presents results of tests made to recover lead and zinc from sulfide-oxide lead-zinc ore.
- RI 5565. High-Temperature Heat Contents and Entropies of Aluminates and Ferrites of Lithium and Sodium, and of Lithium Titanate, by A. U. Christensen, K. C. Conway, and K. K. Kelley. 1960. 7

¹⁸ Free publications are obtainable from the Publication Distribution Section, Bureau of Mines, 4800 Forbes Avenue, Pittsburgh, Pa. 15213.

- pp. 3 figs. Gives Bureau-determined experimental heat content values above 298.15° K for these interoxidic compounds. Heat content results are presented both as tables and as algebraic equations for use in conducting thermodynamic calculations at temperatures ranging from 298° to 2,000° K. 15 cents.
- RI 5566. Experimental Treatment of Base-Metal Ores From California and Nevada, by A. L. Engel and H. J. Heinen. 1960. 9 pp. Describes experimental treatment of six base-metal ores from Inyo, Imperial, and Shasta Counties in California and Lincoln and Washoe Counties in Nevada.
- RI 5567. Electronegativities of the Rare-Earth Elements, by R. L. Montgomery. 1960. 11 pp. 6 figs. Gives revised electronegativity values for the more electropositive elements, including the rare-earth metals; compares estimates of unknown heats of formation made from electronegativities with other estimates.
- RI 5568. Application of Buckley-Leverett Techniques in Oil-Reservoir Analysis, by R. V. Higgins. 1960. 21 pp. 7 figs. Outlines procedures in proposed methods for quickly (1) determining the saturation at breakthrough, (2) approximating relative permeabilities of cores, and (3) evaluating the preferential wettability of a core to oil and water.
- RI 5569. Washability Characteristics of Mammoth and Holmes Vein Anthracites, by D. E. Ingersoll and J. W. Eckerd. 1960. 12 pp. 1 fig. Describes preparation characteristics of anthracite from the Mammoth and Holmes veins as determined by Bureau's laboratory separations at specific gravities of 1.50 to 1.90.
- RI 5570. Liquid-Liquid Extraction of Rare-Earth Elements, by D. J. Bauer, A. C. Rice, and J. B. Berber. 1960. 10 pp. 5 figs. Presents results of investigation by Bureau of liquid-liquid extraction techniques for the fractionation of rare-earth solutions.
- RI 5571. Low-Temperature Heat Capacities and Entropies at 298.15° K. of the Zirconates of Calcium, Strontium, and Barium, by E. G. King and W. W. Weller. 1960. 3 pp. 1 fig. Presents data obtained at a Bureau laboratory by heating mixtures of alkaline-earth metals and pure zirconia. Also gives entropies of formation from the constituent oxides. 5 cents.
- RI 5572. Preparation Characteristics of Coal From Monongalia County, W. Va., by T. E. Gray and E. R. Palowitch. 1960. 42 pp. 3 figs. Describes washability studies to determine whether coals in Monongalia County can be upgraded to metallurgical quality. Samples came from Pittsburgh, Redstone, Upper Freeport, Sewickley, Upper Kittanning, and Waynesburg beds.
- RI 5573. Operation of Pressure-Gasification Pilot Plant Utilizing Pulverized Coal and Oxygen. A Progress Report, by J. H. Holden, G. R. Strimbeck, J. P. McGee, L. F. Willmott, and L. L. Hirst. 1960. 56 pp. 33 figs. Covers experimental results of operating a pilot plant designed for gasifying pulverized coal, using oxygen and steam, at pressures up to 300 psig and describes alterations to the basic pilot plant described in an earlier report.
- RI 5574. Hydrogenating Shale Oil and Catalytic Cracking of Hydrogenated Stocks, by C. M. Frost, H. C. Carpenter, C. B. Hopkins, Jr., S. S. Tihen, and P. L. Cottingham. 1960. 17 pp. 5 figs. Purpose of present work was to study recycle hydrogenation of gas-combustion shale oil at 3,000 psi pressure as a means of preparing a 700° F end-point catalytic cracking stock and to study yields and properties of gasoline obtainable by catalytically cracking this stock. Work done in cooperation with University of Wyoming.
- RI 5575. Experimental Smelting of Aluminum Silicates to Produce Aluminum-Silicon Alloys, by Oliver C. Fursman and Lloyd H. Banning. 1960. 23 pp. 4 figs. Describes work conducted to determine the feasibility of producing aluminum-silicon alloys in a pit-type, three-phase electric-arc furnace.
- RI 5576. Utilization Studies on Chromite From Seiad Creek, Calif., by W. L. Hunter and G. V. Sullivan. 1960. 37 pp. 9 figs. Describes results of beneficiation and smelting studies conducted by Bureau on chromite samples from the Emma Belle and Seiad Creek prospects.
- RI 5577. Examination of Ilmenite-Bearing Sands in Otter Creek Valley, Kiowa and Tillman Counties, Okla., by A. D. Hahn and M. M. Fine. 1960. 77 pp. 24 figs. Describes Bureau examination of the ilmenite-bearing placer sand deposits in the 24-mile-long valley of Otter Creek. The deposits were sampled by drilling 330 holes, aggregating 13,025 feet of bore, and taking 1,218 samples of cuttings from the holes.
- RI 5578. Crushing Chestnut-Size Anthracite to Produce Buckwheat No. 1 and Rice Sizes, by J. W. Eckert, W. S. Sanner, and A. F. Baker. 1960. 20 pp. 7 figs. Gives results of Bureau study of the crushing of chestnut-size Pennsylvania anthracite in four commercial crushers—impact, jaw, hammer-mill, and gyratory types—to determine which could produce the largest proportions of buckwheat Nos. 1 and 2 sizes.
- RI 5579. Reconnaissance of California Manganese Deposits, by Russell R. Trengrove. 1960. 46 pp. 8 figs. Gives results of Bureau survey to determine California's potential manganese reserves, listing characteristics, location, and last-known owners of most important deposits, and reporting outcome of metallurgical tests. 35 cents.
- RI 5580. Quick, Nongraphical, Noniterative Method for Gas-Drive Predictions—Short Turner, by R. V. Higgins and A. J. Leighton. 1960. 18 pp. 1 fig. A fast, accurate technique for calculating oil recovery by expansion of dissolved gas, with or without pressure maintenance. The Bureau's system, derived from the short Turner method, eliminates need for plotting calculated data and enables petroleum engineers to predict oil recovery quickly and precisely. Report shows how to make necessary calculations under various operating conditions and how to minimize the listing of intermediate calculations to determine recovery of oil for pressure decrements more rapidly.
- RI 5581. Electrorefining Beryllium. Preliminary Studies by M. M. Wong, F. R. Cattoir, and D. H. Baker, Jr. 1960. 9 pp. 3 figs. Presents results of preliminary experiments in which thin platelike crystals of beryllium metal were produced by electrolyzing technical-grade beryllium beads.
- RI 5582. Rapid Method for Determining Lime, Magnesia, and Titania in Blast-Furnace Slags and Other Calcareous Materials, by David J. Kusler, Elizabeth A. Hattmann, Glenn R. Zellars, and Richard H. Jefferson. 1960. 12 pp. Gives details of method developed in a Bureau laboratory and already applied satisfactorily to routine analysis of blast-furnace slags and similar materials; lists equipment and reagents required.
- RI 5583. Expansion of Coal: Bench-Scale Tester, by J. E. Wilson and B. W. Naugle. 1960. 11 pp. 6 figs. Describes development and operation of small laboratory device that utilizes a 71-gram coal sample to determine effects of such variables as oxidation, blending, bulk density, inerts, size consist, petrographic differences, and rate of heating.

- RI 5584. Use of High-Speed Camera in Blasting Studies, by Byron E. Blair. 1960. 32 pp. 18 figs. Exposing supersensitive film at speeds up to 3,200 frames per second, this camera faithfully records blasting phenomena that occur in fractions of a second. Report gives detailed descriptions of the photographic equipment employed by the Bureau and step-by-step instructions on its use.
- RI 5585. Effects of Temperature Variations on Contact Angles for Coal and Related Substances, by J. B. Gayle and A. G. Smelley. 1960. 16 pp. 9 figs. Details of an investigation indicating that variations in temperature between 1° and 60° C influence markedly and in a complex manner the contact angles for coals and similar substances. Results also suggest that normal temperature variations may affect both quantity and quality of coal and other minerals recovered by flotation processes. Work done in cooperation with University of Alabama.
- RI 5586. Effect of Antimony on Tensile Properties of Titanium, by J. D. Ramsdell and W. H. Lenz. 1960. 11 pp. 12 figs. Results of experiments in which alloys, based on several grades of titanium metal containing up to 10 percent antimony, were arc-melted and processed to sheet by hot and cold rolling. Although Bureau was unable to confirm improved ductility reported by other researchers, tests showed that, for the same hardness level, titanium-antimony alloys have adequate ductility and higher yield strengths than unalloyed titanium. Materials and experimental procedure are described in detail.
- RI 5587. Properties of Petroleum From the Four Corners Area of Arizona, Colorado, New Mexico, and Utah, by W. J. Wenger and B. W. Reid. 1960. 25 pp. 3 figs. Presents and compares 34 analyses of crude oils from fields in the Four Corners Area. Work done in cooperation with University of Wyoming. 25 cents.
- RI 5588. Preparation of High-Purity Yttrium by Metallic Reduction of Yttrium Trichloride, by F. E. Block, T. T. Campbell, R. E. Mussler, and G. B. Robidart. 1960. 22 pp. 17 figs. Describes experiments in which yttrium trichloride was reduced to extremely pure metal by reacting it with hot lithium or sodium metal in a crucible filled with inert gas. Study showed that high-purity yttrium is ductile enough to be worked into a promising structural metal. Work done under a cooperative agreement with Atomic Energy Commission under Contract No. AT(11-1)-599.
- RI 5589. High-Purity Chromium by Electrolysis, by P. C. Good, D. H. Yee, and F. E. Block. 1960. 17 pp. 5 figs. Results of a series of experiments in which chromium metal was deposited in ultra-pure form by passing an electric current through a hot solution of chromium trioxide. Bureau found that the chromium obtained could be processed to sheets and wire and had superior ability to withstand effects of high temperatures.
- RI 5590. Low-Temperature Heat Capacities and Entropies at 298.15° K. of Strontium Sulfide and Barium Sulfide, by E. G. King and W. W. Weller. 1960. 5 pp. 1 fig. Reports results of heat capacity measurements of strontium sulfide and barium sulfide in the temperature range 50° to 298° K. 15 cents.
- RI 5591. Properties of Titanium-Vanadium Cobalt Alloys, by J. D. Ramsdell and E. D. Hull. 1960. 13 pp. 14 figs. Studies of 16 titanium alloys containing 4 to 16 percent vanadium and 0 to 4 percent cobalt.
- RI 5592. Studies of Coke Oven Width, Flue Temperature, and Coking Rate. Critical Survey of Literature; Carbonizing Tests With Tuscaloosa Oven, by J. B. Gayle and W. H. Eddy. 1960. 35 pp. 18 figs. Discusses tests of five coals and blends in an experimental coke oven adapted to permit operating at three different widths. Results indicated that moderate changes in oven width and flue temperature have little effect on coke properties when coking rates are kept constant. Work done in cooperation with University of Alabama.
- RI 5593. Flotation Characteristics of Goethite, by I. Iwasaki, S. R. B. Cooke, and A. F. Colombo. 1960. 25 pp. 17 figs. Vacuum flotation, contact angle, measurement, and simplified flotation tests with a modified Hallimond tube were tried experimentally and data were correlated with the electrokinetic properties of goethite. Results were applied in interpreting batch flotation tests on an artificial mixture of quartz and goethite.
- RI 5594. Gasification of Bone Anthracite, by J. W. Eckerd, J. D. Clendenin, W. S. Sanner, and R. E. Morgan. 1960. 24 pp. 9 figs. Describes tests made to determine technical feasibility of making producer gas from chestnut-size bone anthracite in a conventional, commercial-size, rotating grate, dry-ash-removal type gas producer.
- RI 5595. Analysis of 42 Crude Oils From Mexico, by C. M. McKinney and E. L. Garton. 1960. 26 pp. 1 fig. Gives source and general characteristics of each crude-oil sample and summarizes analytical and computed data. All samples were analyzed by Bureau of Mines routine method.
- RI 5596. Reducing Titanium Tetrachloride With High-Surface Sodium, by D. C. Fleck, M. M. Wong, and D. H. Baker, Jr. 1960. 10 pp. 1 fig. Describes experiments made as part of a continuing Bureau program to improve the extractive metallurgy of titanium. Includes information on construction and operation of a vertical reactor and analyses of products obtained.
- RI 5597. Studies of Several Flocculants to Improve Hydraulic Backfill Characteristics, by John D. Bardill and Donald L. Cenis. 1960. 19 pp. Preliminary laboratory tests with 18 reagents made to determine effects on settling rates of fine-size tailings and comparative percolation rates of unflocculated and flocculated tailings slurries. Work done under a fellowship agreement cosponsored by Bureau and Montana School of Mines.
- RI 5598. Flotation of Low-Grade Mercury Ores, by J. W. Town, R. S. McClain, and W. A. Stickney. 1960. 34 pp. Results of studies with five ore types, varying from simple siliceous to almost completely opalescent and from unaltered siliceous to decomposed siliceous. Tests showed that recovery of mercury by flotation was directly related to grade of ore. A spectrographic method that gave rapid, accurate mercury determinations is described.
- RI 5599. Technology of Bastnasite, by J. S. Berber, V. E. Shaw, A. C. Rice, R. E. Lindstrom, and D. J. Bauer. 1960. 20 pp. 11 figs. Discusses development of suitable methods for separating and purifying bastnasite rare-earth elements. Techniques employed included classical chemical, ion exchange, and solvent extraction.
- RI 5600. Thermodynamic Properties of Manganese and Its Compounds, by Alla D. Mah. 1960. 34 pp. 3 figs. Summarizes basic metallurgical thermodynamic data for manganese metal and its inorganic compounds; contains metallurgical reactions of manganese compounds; and presents basic thermodynamic data for other elements and compounds involved in metallurgical reactions of manganese and its compounds. 30 cents.

- RI 5601. Secondary Recovery of Oil by Waterflooding in Big Injun Sand, Roane County, W. Va., by W. M. Nabors, N. A. Caspero, Joseph Pasini III, and C. E. Whieldon, Jr. 1960. 49 pp. 23 figs. Discusses methods employed by three oil companies on leases in the Walton and Clover Rush Run pools. Although waterflooding could not be termed successful for the projects studied, results were not so unfavorable as to rule out future attempts on other projects. Numerous maps and graphs supplement the text.
- RI 5602. Separation of Chloride Vapors During Ilmenite Chlorination, by V. A. Nieberlein. 1960. 11 pp. 3 figs. Presents results of research undertaken to recover titanium and columbium by low-temperature chlorination of low-grade columbium-bearing ilmenite concentrates and to simultaneously remove chlorinated impurities from the volatile chlorides without distillation.
- RI 5603. The Fischer-Tropsch Synthesis in the Oil-Circulation Process: Experiments With a Nitrided Fused-Iron Catalyst, by D. Bienstock, J. H. Field, A. J. Forney, J. G. Myers, and H. E. Benson. 1960. 32 pp. 12 figs. Describes investigation made by Bureau of the Fischer-Tropsch reaction in the oil-circulation process to study activity and durability of a nitrided fused iron in the process and to prepare enough products to determine yield and quality of a finished synthetic gasoline rich in alcohols.
- RI 5604. Properties of Titanium-Vanadium-Zirconium Alloys, by Jack D. Ramsdell and Ernest D. Hull. 1960. 12 pp. 11 figs. Presents results of investigation made to evaluate hardness, hot workability, and room-temperature tensile properties of arc-melted titanium-vanadium-zirconium alloys.
- RI 5605. Simulated Underground Gasification of Coal and Electrolinking-Carbonization Method of Preparing Path in a Coalbed, by Marvin W. Wilson, Lester L. Hirst, James L. Elder, John P. Capp, and Joseph J. Gentile. 1960. 61 pp. 46 figs. Describes experiments conducted by Bureau in a horizontal, rectangular retort to investigate the process of gasifying coal underground; also describes tests made to investigate properties of coal and other factors affecting the electrolinking-carbonization method of preparing a path through a coalbed before gasification.
- RI 5606. Back-Pressure Tests on Gas-Storage Projects, by C. J. Walker, J. S. Miller, and H. N. Dunning. 1960. 30 pp. 13 figs. Presents results of back-pressure tests on groups of wells in six gas-storage projects and one gasfield. Work done in cooperation with State of Oklahoma and American Gas Association.
- RI 5607. Performance of Small Industrial-Type Anthracite-Burning Stokers: ASME Code Tests, by R. F. Tenney and J. W. Eckerd. 1960. 57 pp. 14 figs. Presents results of tests by the Bureau of the performance of four anthracite stokers—Hazleton, Skelly, Losch, and E.F.M.—under identical 74-hp steam boilers. Fifty runs of 12 and 24 hours' duration were made in accordance with the ASME test code.
- RI 5608. Computer Programs for Turner Calculations of Gas-Drive Oil Recovery by Analytical or Iterative Method, by R. V. Higgins and A. J. Leighton. 1960. 12 pp. 3 figs. Presents two schematic programs—analytic and iterative—for calculating performance of gas-drive reservoirs by electronic computers.
- RI 5609. Preparation Characteristics of Coal From Butler County, Pa., by T. E. Gray and E. R. Palowitch. 1960. 49 pp. 3 figs. Describes washability studies to determine whether coals in Butler County can be upgraded to metallurgical grade. Samples came from Upper and Lower Freeport, Middle and Lower Kittanning, Clarion, and Brookville beds.
- RI 5610. Flammability Limits of Methane and Ethane in Chlorine at Ambient and Elevated Temperatures and Pressures, by A. Bartkowiak and M. G. Zabetakis. 1960. 6 pp. 3 figs. Presents results of study made to determine limits of flammability of methane and ethane in chloride at pressures of 1, 100, and 200 psig and temperatures of 28°, 100°, and 200° C. Work done in cooperation with the Ethyl Corporation.
- RI 5611. Leonardite: A Lignite Byproduct, by Walter W. Fowkes and Clyde M. Frost. 1960. 12 pp. 7 figs. Leonardite, a soft coallike substance associated with lignite, can be produced in a laboratory under controlled conditions. Report gives results of proximate and elemental analyses of leonardite as found in North Dakota and Texas and as produced in the laboratory.
- RI 5612. Tungsten Resources of Montana: Deposits of the Philipsburg Batholith, Granite and Deer Lodge Counties, by D. D. Walker. 1960. 55 pp. 32 figs. Second in a series on Montana tungsten, report contains assays and other data obtained in Bureau study of 43 tungsten deposits of the Philipsburg batholith in west-central Montana. The deposits are in Black Pine-Henderson, Philipsburg, Silver Lake, and Foster Creek areas. RI 5552, Tungsten Resources of Montana: Deposits of the Mount Torrey Batholith, Beaverhead County, is the first report in series.
- RI 5613. Hazards of Cutoff Explosive Charges in Multiple Blasting of Coal, by John Nagy, Irving Hartmann, Edward M. Kawenski, and Robert W. Van Dolah. 1960. 23 pp. 5 figs. Presents results of a study of the gas-ignition hazard of a cutoff charge and of single charges of explosives fired in coal.
- RI 5614. Oil Yields of Sections of Green River Oil Shale in Colorado, 1954-57, by K. E. Stanfield, J. W. Smith, H. N. Smith, and W. A. Robb. 1960. 186 pp. 68 figs. Presents oil yields of cores drilled during 1954-57 in the Green River formation in Colorado that may be used for future reserve estimates of oil shale in the United States. Supplements RI 5081, Oil Yields of Sections of Green River Oil Shale in Colorado, Utah, and Wyoming, 1945-52, and 5321, Oil Yields of Sections of Green River Oil Shale in Colorado, 1952-54, issued in 1954 and 1957, respectively.
- RI 5615. Analyses of Tipple and Delivered Samples of Coal (Collected During the Fiscal Year 1959), by S. J. Aresco, C. P. Haller, and R. F. Abernethy. 1960. 59 pp. Tenth in a series, report contains analytical data showing composition and quality of tipple and delivered samples of coal from mines in 24 States, including Alaska. 40 cents.
- RI 5616. Safety With Mobile Diesel-Powered Equipment Underground, by John C. Holtz. 1960. 87 pp. 29 figs. Describes Bureau research on diesel engines. Gives precautions recommended by Bureau in using diesel-powered equipment underground in noncoal mines and tunnels.
- RI 5617. Use of Sonic Techniques in Exploring Coal-Mine Roof Strata: A Progress Report, by Charles E. Mongan, Jr., and Thomas C. Miller. 1960. 15 pp. 11 figs. Evaluates progress by Bureau in its investigation to determine whether sonic techniques can be applied successfully to determine hidden unconformities common to coal-mine roof.
- RI 5618. Waterflood Performance in Stratified Reservoirs. Recovery as Influenced by Relative Permeability Curves and by Continuously Changing Saturation, by R. V. Higgins and A. J. Leighton.

1960. 19 pp. 8 figs. Describes Bureau study made to evaluate the effect of layers of different permeability on recovery as a function of the water-oil ratio to ascertain in advance the potential oil recovery.
- RI 5619. Plant Performance Tests of the Tromp Dense-Medium Coal-Cleaning Process, by M. R. Geer, Michael Sokaski, and H. F. Yancey. 1960. 34 pp. 6 figs. One of a series describing investigations by the Bureau of the performance of various types of coal-cleaning equipment, report deals with three plants using the Tromp dense-medium process. The plants are of the Old Ben Coal Corp., Roslyn-Cascade Coal Co., and Usibelli Coal Mine, Inc. Work done in cooperation with the School of Mineral Engineering, University of Washington.
- RI 5620. Field Test for Beryllium Minerals: The Morin Fluorescence Method, by T. N. McVay. 1960. 10 pp. 1 fig. Describes a modified method that provides a fast, dependable field test for beryllium minerals containing as little as 0.2 percent beryl or its equivalent. Work done in cooperation with the University of Alabama.
- RI 5621. Use of Natural Gas in an Experimental Blast Furnace, by Norwood B. Melcher, J. P. Morris, E. J. Ostrowski, and P. L. Woolf. 1960. 15 pp. 3 figs. Natural gas injected through auxiliary tuyeres into the smelting zone of the Bureau's experimental blast furnace reduced the consumption of coke, according to this publication describing tests on the use of natural gas in a blast furnace.
- RI 5622. Equilibrium Pressures of Hydrogen Sulfide and Carbon Dioxide Over Solutions of Potassium Carbonate, by J. S. Tosh, J. H. Field, H. E. Benson, and R. B. Anderson. 1960. 25 pp. 19 figs. Describes study made to obtain equilibrium data for evaluating the feasibility of using solutions of hot potassium carbonate for removing hydrogen sulfide from gas mixtures.
- RI 5623. Concentrating Argillaceous Surface Iron Ore of Tuscaloosa County, Ala., by Washing, by I. L. Feld, R. E. Perry, and W. E. Lamont. 1960. 15 pp. 5 figs. Describes the development of a simple method of producing low-phosphorus hematite concentrates from submarginal southeastern iron ores. Work done in cooperation with the United States Pipe & Foundry Co. and the University of Alabama.
- RI 5624. Laboratory Equipment and Test Procedures for Evaluating Explosibility of Dusts, by Henry G. Dorsett, Jr., Murray Jacobson, John Nagy, and Roger P. Williams. 1960. 21 pp. 9 figs. Describes equipment and test procedures used by the Bureau in its studies on the explosibility of dusts. Ignition temperatures, minimum explosive concentration, electrical energy for ignition, explosion pressure, and rates of pressure rise are covered.
- RI 5625. Correlations Involving Different Screen Indexes for a Given Size Distribution of Coke, by J. B. Gayle. 1960. 7 pp. Results of a study of size-distribution data for hypothetical and coke screen analyses show that the different screen indexes derived from any given set of screening data are inherently correlated. Includes equations developed for estimating the extent of these inherent correlations in terms of computed correlation coefficients. Work done in cooperation with University of Alabama.
- RI 5626. Sulfur in Lignite: Form and Transformations on Thermal Treatment, by Walter W. Fowkes and Jerome J. Hoepfner. 1960. 15 pp. Describes an investigation on the form and reactions of sulfur in North Dakota lignite, which influence processing procedures in low-temperature carbonization or gasification of low-rank coal.
- RI 5627. Ignition by Hot Gases, by M. Vanpée and H. G. Wolfhard. 1960. 12 pp. 8 figs. Discusses processes that determine ignition when hot gases have a common boundary with cold explosive mixtures. Work sponsored in part by Project SQUID, which is supported by the Office of Naval Research. Presented at Conference of Directors of Safety in Mines Research, Pittsburgh, Pa., September 28-October 2, 1959.
- RI 5628. Carbonizing Properties of Boone County, W. Va., Coals, by D. E. Wolfson, G. W. Birge, and J. H. Lynch. 1960. 14 pp. 3 figs. Gives results of an investigation of the carbonizing properties of coals from nine beds—No. 5 Block, Stockton-Lewiston, Coalburg, Winifrede, Chilton, Hershaw, Cedar Grove, Alma, and No. 2 Gas beds—by the standard BM-AGA carbonization tests. This method permits comparison of results on different coals.
- RI 5629. Acid Leaching of Oxidized Copper Ores By Downward Percolation, by W. A. McKinney and Carl Rampacek. 1960. 16 pp. 5 figs. Describes investigation made to obtain operating data pertaining to the treatment of wholly oxidized copper ores by downward percolation leaching.
- RI 5630. Fused-Salt Electrorefining of Vanadium, by F. R. Cattoir and D. H. Baker, Jr. 1960. 11 pp. 4 figs. Describes investigation undertaken to ascertain the feasibility of using the fused-salt technique to produce a metal of greater purity than the present commercial vanadium metal.
- RI 5631. Extracting Final Stump in Pillars and Pillar Lifts With Continuous Miners, by R. W. Stahl. 1960. 13 pp. 11 figs. Describes survey conducted by Bureau to ascertain how safe and successful pillaring, especially the removal of final stumps in lifts or the final stump of a pillar, is accomplished in some coal mines, while others have considerable difficulty under similar conditions.
- RI 5632. Controlling Mine Fires With High-Expansion Foam, by John Nagy, Edwin M. Murphy, and Donald W. Mitchell. 1960. 28 pp. 17 figs. Summarizes results of tests conducted by Bureau since 1958 at its Experimental Coal Mine of the practicability of the foam-plug technique for controlling coal-mine fires under American mining conditions; suggests procedures for applying the methods to fire control in mines.
- RI 5633. Bimetallic Reduction of Hafnium Tetrachloride, by Gerald W. Elger. 1960. 17 pp. 7 figs. Describes investigation conducted to determine if higher purity hafnium metal could be produced by bimetallic reduction of hafnium tetrachloride rather than by the conventional magnesium-reduction technique. Work done in cooperation with Atomic Energy Commission and the Bureau of Ships, U.S. Department of the Navy.
- RI 5634. Vapor Pressures of Liquid Manganese and Liquid Silver, by P. L. Woolf, G. R. Zellars, E. Foerster, and J. P. Morris. 1960. 10 pp. 2 figs. Describes equipment and procedure for measuring vapor pressures of liquid manganese and silver. Measurements of vapor pressure can be used to determine thermodynamic activities of the components of metallic solutions.
- RI 5635. Determining the Safety Characteristics of Unsymmetrical Dimethylhydrazine, by Joseph A. Herickes, Glenn H. Damon, and Michael G. Zabetakis. 1960. 12 pp. 7 figs. Describes Bureau investigation of the flammability and explosibility of unsymmetrical dimethylhydrazine to evaluate hazards associated with commercial application of this material as a missile fuel. Work done in co-

- operation with Westvaco Chlor-Alkali Division, Food Machinery and Chemical Corp.
- RI 5636. X-Ray Crystallography of Boron, by Raymond L. Carpenter and Haruo Kato. 1960. 8 pp. Describes powder X-ray diffraction techniques used to determine the crystal structure of samples prepared from fused boron.
- RI 5637. Use of Membrane Filters for Determining the Size of Dust Agglomerates as They Actually Exist in a Gas Stream, by L. J. Kane, H. C. Wright, and C. C. Shale. 1960. 30 pp. 11 figs. Presents results of an investigation conducted by the Bureau to develop methods for determining size of dust agglomerates suspended in a gas stream.
- RI 5638. Producing Nickel-Bearing Iron From Cuban Ores in a Batch Rotary Kiln, by Warren M. Mahan. 1960. 21 pp. 1 fig. Describes a rotary-kiln process developed by the Bureau to produce an iron product containing from 3 to 7 percent nickel.
- RI 5639. Methods for Analyzing Titanium Metal for Tin, by T. A. Sullivan, R. W. Lewis, L. Carpenter, and B. J. Boyle. 1960. 14 pp. 2 figs. Presents results of investigative work on chemical-iron reduction and lead reduction—optical emission spectrochemical, and fluorescent X-ray spectrographic methods for analyzing titanium metal for tin.
- RI 5640. Smelting Unfired Iron Ore Pellets in an Experimental Blast Furnace, by Norwood B. Melcher and Miles B. Royer. 1960. 9 pp. 2 figs. Describes tests of the feasibility of direct smelting of green pellets in Bureau's experimental blast furnace at Pittsburgh, Pa. Work done in cooperation with Applied Research Laboratory, United States Steel Corp.
- RI 5641. Laboratory Treatment of California and Nevada Manganese Ores by Sulfation-Reduction and Other Methods, by A. I. Engel and H. J. Heinen. 1960. 10 pp. Presents results of treating low-grade or refractory manganese ores, using sawdust or lignin-sulfonates as reducing agents. Three samples of ores from California and one from Nevada were treated.
- RI 5642. Oil Recovery and Formation Damage in Permafrost, Umiat Field, Alaska, by Oren C. Baptist. 1960. 22 pp. 7 figs. Presents results of studies of the reservoir sand in the Umiat field made to determine cause of plugging in the wells drilled with rotary drills in the Umiat field and to estimate oil recovery from frozen sand by depletion drive when the oil is gas saturated at low pressures.
- RI 5643. Hyatt Ranch Pegmatite, Larimer County, Colo., by M. M. Gilkey. 1960. 18 pp. 5 figs. Describes investigation by Bureau of the Hyatt Ranch pegmatite. Work included driving an adit 272 feet long, diamond drilling four holes, totaling 297.5 feet, and constructing and operating a sorting plant to investigate the feasibility of hand concentration of the beryl and mica.
- RI 5644. Determining Trace Impurities in Grade-A Helium, by C. G. Kirkland, L. W. Brandt, and W. M. Deaton. 1960. 12 pp. 3 figs. Describes apparatus and its operation for determining trace impurities in Grade-A helium by mass spectrometer methods.
- RI 5645. Explosion of Dephlegmator at Cities Service Oil Company Refinery, Ponca City, Okla., 1959, by M. G. Zabetakis. 1960. 16 pp. 11 figs. Describes investigation conducted by the Bureau regarding the cause of an explosion of a dephlegmator or fractionating column.
- RI 5646. Flotation of Pacific Northwest Chromite Ores, by G. V. Sullivan and W. A. Stickney. 1960. 14 pp. Describes an investigation by the Bureau of flotation techniques for recovering chromite from fine-grained disseminated ores. Tests were made on seven samples of chromite ores.
- RI 5647. Laboratory Beneficiation of East Texas Limonite-Siderite Iron Ores, by H. E. Powell and W. M. Dressel. 1960. 14 pp. 3 figs. Describes a mineral-dressing investigation by Bureau on four limonitic and four sideritic iron ores from the North Basin. This investigation was conducted to devise a mineral-dressing method to increase the yield from mined iron ores in eastern Texas and to extend such treatment to include the lower grade ferruginous materials that are not amenable to beneficiation by simple washing.
- RI 5648. Injecting Solid Fuels Into Smelting Zone of an Experimental Blast Furnace, by E. J. Ostrowski, M. B. Royer, and L. J. Ropelewski. 1960. 14 pp. 4 figs. Describes investigation made to determine maximum amount of anthracite fines that could be injected into the smelting zone of Bureau's experimental blast furnace as a replacement for the coke in the stock column and to study effect of the solid-fuel injection on furnace performance, furnace driving rate, slag volumes, and the chemistry of the pig metal. Work done in cooperation with United States Steel Corp.
- RI 5649. Evaluating Anchorage Testing Methods for Expansion-Type Mine Roof Bolts, by A. J. Barry and J. A. McCormick. 1960. 19 pp. 9 figs. Covers a series of tests to ascertain whether two anchorage testing methods used in industry are acceptable for determining anchorage characteristics of any expansion-type bolt and shell assembly.
- RI 5650. Tungsten Deposits of Cochise, Pima, and Santa Cruz Counties, Ariz., by V. B. Dale, L. A. Stewart, and W. A. McKinney. 1960. 132 pp. 48 figs. One of a series on mineral resources by the Bureau, report describes most of the tungsten deposits in the three counties. 65 cents.
- RI 5651. Barite Deposits of Arizona, by L. A. Stewart and A. J. Pfister. 1960. 89 pp. 23 figs. Examines all known deposits (75 in 9 of the 14 counties). Discusses history, ownership, production, and geologic setting of most of the deposits; briefly considers uses and specifications of product grades of barite. 50 cents.
- RI 5652. Refractory-Clay Deposits of Wyoming, by Joel N. Van Sant. 1961. 105 pp. 31 figs. Forty-two clay samples were collected, and tests showed that 14 were refractory to a certain degree. Five clays were sub-low-duty grade, eight were low-duty refractory, and one was high-duty grade. The one high-duty grade clay, found near the Utah border, might be economically shipped to Utah clay-products plants.
- RI 5653. Preparation Characteristics of Coal From Marion County, W. Va., by T. E. Gray and E. R. Palowitch. 1960. 29 pp. 3 figs. Describes washability studies to determine whether coals in Marion County can be upgraded to metallurgical grade. Samples came from Waynesburg, Sewickley, and Pittsburgh beds.
- RI 5654. Nitric Acid Oxidation Rates for Selected Coals and Related Substances, by J. B. Gayle and A. G. Smelley. 1960. 12 pp. 9 figs. Presents results of coal, cokes carbonized at temperatures 520° to 1,180 C, and synthetic polymers oxidized by the standard method, that is, by boiling in 8-normal nitric acid. Work done in cooperation with University of Alabama.
- RI 5655. The Fischer-Tropsch Synthesis Using Gas Recycle Cooling (Simulated Hot-Gas-Recycle Process), by D. Bienstock, R. M. Jameson, J. H. Field, and H. E. Benson. 1960. 25 pp. 16 figs. Describes tests using a recycle of cooled and then reheated gas with catalyst beds of lathe turnings and par-

- allel-plate assemblies for the Fischer-Tropsch synthesis.
- RI 5656. Characteristics of Cold-Rolled and Annealed Titanium, by Jack D. Ramsdell and Ernest D. Hull. 1960. 15 pp. 18 figs. Presents results of investigation of electrorefined, magnesium-reduced, and sodium-reduced titanium. These titanium samples were evaluated for recrystallization behavior, effect of cold rolling on tensile properties, and bend ductility.
- RI 5657. Rapid Evaluation of Spodumene and Kyanite Samples by Heavy Liquid Separation, by James S. Browning and John B. Gayle. 1960. 5 pp. 3 figs. Presents results of investigation conducted to determine the applicability of heavy liquid mineral separation to the evaluation of certain spodumene and kyanite ores, prepared mixtures, and plant products. Work done in cooperation with University of Alabama.
- RI 5658. Infrared Spectra of Organic Compounds in the Region 15-35 Microns: Thirteen Organic Oxygen, Nitrogen, Sulfur, and Silicon Compounds, by C. A. Frenzel, D. W. Scott, and J. P. McCullough. 1960. 17 pp. 13 figs. Presents infrared spectra of 13 organic compounds. Work done in part in cooperation with American Petroleum Institute and under contract with Air Force Office of Scientific Research.
- RI 5659. Heat of Formation of Yttrium Chloride, by R. L. Montgomery and T. D. Hubert. 1960. 10 pp. Presents measurements of heats of solution of yttrium chloride and oxide in hydrochloric acid.
- RI 5660. Removing Hydrogen Sulfide by Hot Potassium Carbonate Absorption, by J. H. Field, G. E. Johnson, H. E. Benson, and J. S. Tosh. 1960. 19 pp. Presents results of studies by Bureau on a pilot-plant scale for removing hydrogen sulfide and carbonyl sulfide from gas mixtures by the hot carbonate system.
- RI 5661. Mechanism of Sodium Reduction of Titanium Chlorides in Fused Salts, by T. A. Henrie and D. H. Baker, Jr. 1960. 33 pp. 20 figs. Presents theoretical and experimental evidence which shows that sodium reduction of titanium tetrachloride occurs by two reaction stages; describes mechanism of sodium reduction of titanium subchlorides in fused sodium chloride.
- RI 5662. Composition of a Shale-Oil Naphtha, by H. H. Heady, L. G. Adams, and G. U. Dinneen. 1960. 12 pp. Presents results obtained by two methods in the determination of the hydrocarbon-group composition of naphtha. The two methods are by summing the results obtained in 105 individual fractions and by direct chromatographic analysis of the original naphtha. Work done in cooperation with University of Wyoming.
- RI 5663. Dual-Inlet System for a Mass Spectrometer, by G. L. Cook, R. A. Meyer, and D. G. Earnshaw. 1960. 8 pp. 3 figs. Describes design of a dual-inlet system for a Consolidated model 21-103C mass spectrometer. The system permits both high-mass and low-mass samples to be run by using a single instrument. Work done in cooperation with University of Wyoming.
- RI 5664. Thermodynamics of Some Oxides of Molybdenum and Tungsten, by E. G. King, W. W. Weller, and A. U. Christensen. 1960. 29 pp. 4 figs. Presents work on new low-temperature heat capacity data of tungsten dioxide and tungsten trioxide and high-temperature heat contents of molybdenum dioxide, molybdenum trioxide, tungsten dioxide, and tungsten trioxide. Includes heats of fusion of the two trioxides.
- RI 5665. Methods for Improving Quality of Titanium Sponge Produced by the Kroll Process, by W. M. Mark, S. Yih, C. L. Lo, and D. H. Baker, Jr. 1960. 29 pp. 6 figs. Describes investigation conducted to develop methods to improve the quality of titanium sponge produced by the Bureau of Mines modification of the Kroll magnesium reduction process.
- RI 5666. Underground Gasification of Coal: Hydraulic Fracturing as Method of Preparing a Coal-bed, by J. P. Capp, J. L. Elder, C. D. Pears, R. W. Lowe, K. D. Plants, and M. H. Fies. 1960. 50 pp. 23 figs. Describes tests in hydraulic fracturing conducted to determine applicability and effectiveness of the technique, extent and horizon of the fracture, and physical and chemical effect of the fracturing fluid. Work done in cooperation with the Alabama Power Co., the Pan American Petroleum Corp., and the Halliburton Oil Well Cementing Co.
- RI 5667. Effect of Isomorphous Substitutions on Properties of Fluormica Ceramics, by H. R. Shell. 1960. 40 pp. 3 figs. Tells how numerous substituted fluormicas were synthesized by the Bureau and how the properties of the hot-pressed products made therefrom were determined.
- RI 5668. Thermodynamic Properties of the Combustion Products of Graphite and Oxygen in Idealized Dust Flames, by Robert W. Smith, Jr., Edwin B. Cook, and Hans M. Cassel. 1960. 12 pp. Provides examples, at atmospheric pressure and room temperature, of composition profiles in an idealized oxygen-dust flame, with mass and enthalpy preserved. Research sponsored in part by the Office of Ordnance Research.
- RI 5669. Particle Statistics of Infinite Populations as Applied to Mine Sampling, by R. M. Becker and Scott W. Hazen, Jr. 1961. 79 pp. 23 figs. Presents a study of the application of statistical practice to mine and mineral sampling. Provides theoretical and practical data. 45 cents.
- RI 5670. Lake Superior Iron Resources: Preliminary Sampling and Metallurgical Evaluation of Mesabi Range Nonmagnetic Taconites, by R. L. Marovelli, D. W. Frommer, F. W. Wessel, L. F. Heising, P. A. Wasson, and R. E. Lubker. 1961. 35 pp. 7 figs. Describes part of work of a long-range program to sample, classify, and evaluate important occurrences of nonmagnetic taconite on the Mesabi range. Discusses geology, history, and potential of the Mesabi range district and mining industry and includes a more detailed presentation of the sampling and metallurgical evaluation of nonmagnetic taconite deposits. 30 cents.
- RI 5671. Minimum Ignition-Energy Concept and Its Application to Safety Engineering, by E. L. Litchfield. 1960. 10 pp. 3 figs. Surveys the significance of minimum ignition-energy concept and presents recent data pertaining to the safety problem associated with ignition of combustible gases by electrical discharges.
- RI 5672. Ceramic Fibers for Filtering Dust From Hot Gases, by L. J. Kane, G. E. Chidester, and C. C. Shale. 1960. 18 pp. 17 figs. Presents results of tests made with an aluminum silicate filter to develop methods for removing dust from hot gases at 1,800°C.
- RI 5673. Hydrogenating Coal in a Pilot Plant With a Molybdenum Catalyst, by Henry H. Ginsberg, Sam Friedman, Paul S. Lewis, M. D. Schlesinger, Arthur J. Stewart, and Raymond W. Hiteshue. 1960. 35 pp. 20 figs. Presents results of an investigation conducted to determine the feasibility of continuous hydrogenation of coal to hydrocarbon fuels at 8,000 psig with 0.01 pct molybdenum (as ammonium molybdate) on moisture- and ash-free coal.

- RI 5674. Producing Heavy Fuel Oil by Hydrogenating Bituminous Coal, by Henry H. Ginsberg, Paul S. Lewis, Robert B. Anderson, and Raymond W. Hiteshew. 1960. 57 pp. 32 figs. Presents results of three studies of the process requirements necessary to produce heavy fuel oil by the liquid-phase hydrogenation of bituminous coal.
- †RI 5675. Field Test for Cesium and Rubidium, by K. C. Dean and I. L. Nichols. 1960. 9 pp. Describes a simple and inexpensive field test developed by the Bureau of Mines for testing cesium and rubidium in rocks, clays, and mineral waters. Includes a list of selected references.
- RI 5676. Heats of Formation of Cerium Sesquioxide and Bismuth Sesquioxide by Combustion Calorimetry, by Alla D. Mah. 1961. 7 pp. Measures the heats of combustion of cerium sesquioxide and bismuth metal. Calculates the free energy of formation for bismuth sesquioxide and estimates it for cerium sesquioxide.
- RI 5677. Solvent Extraction of Coals by Abietic Acid at Atmospheric Pressure, by E. C. Tarpley and H. C. Howard. 1960. 8 pp. 1 fig. Presents results of work on the solvent extraction of coal by abietic acid conducted to recover commercially useful products and to characterize coals and obtain information on their structure.
- RI 5678. Structural Phases in Lime-Soda Sinters for Alumina Recovery: A Progress Report, by R. V. Lundquist and Lloyd Carpenter. 1960. 12 pp. Outlines initial results from an X-ray investigation on the lime-soda sinter process.
- RI 5679. Cebolla Creek Titaniferous Iron Deposits, Gunnison County, Colo., by Charles K. Rose and Spencer S. Shannon, Jr. 1960. 30 pp. 11 figs. Presents results of an investigation of the Cebolla Creek titaniferous iron deposits by the Bureau. Work comprised mineral-dressing studies to test the feasibility of recovering iron and titanium products and diamond drilling three holes, totaling 1,868 feet.
- RI 5680. Flammability Limits of Methyl Ethyl Ketone and Methyl Isobutyl Ketone in Bromochloromethane-Air Mixtures, by M. G. Zabetakis, P. M. Gussey, and G. S. Scott. 1960. 12 pp. 3 figs. Presents limits of flammability data for the systems methyl ethyl ketone-bromochloromethane and methyl isobutyl ketone-bromochloromethane and for two complex mixtures in air at ambient temperatures and pressures. Work done in cooperation with Philadelphia Naval Shipyard, U.S. Department of the Navy.
- RI 5681. Combustion of North Dakota Lignite in Domestic Heaters, by W. H. Oppelt, W. R. Kube, R. B. Porter, T. W. Kamps, O. C. Ongstad, and E. F. Golob. 1960. 52 pp. 21 figs. Investigates combustion of lignite in domestic heating equipment to obtain information on equipment performance and to evaluate testing procedures.
- RI 5682. Electrorefining Chromium, by F. R. Cattoir and D. H. Baker, Jr. 1960. 15 pp. 6 figs. Presents results of fused-salt electrorefining of chromium; 4- and 12-inch electrorefining cells were employed in the tests.
- RI 5683. Reducing the Incendivity of Permissible Explosives by Sodium Chloride, by N. E. Hanna, G. H. Damon, and R. W. Van Dolah. 1960. 19 pp. 11 figs. Describes studies by Bureau on effect of varying proportions of fine and coarse salt to reduce the incendivity of permissible explosives to fire-damp atmosphere. Work done in cooperation with Institute of Makers of Explosives.
- RI 5684. A Method for Evaluating Viscosity Data From Lime Soda Sinter Slurries, by R. V. Lundquist and E. L. Singleton. 1960. 14 pp. 6 figs. Presents method developed by Bureau for evaluating viscosity data from slurries obtained in leaching sinters from the lime soda sinter process for extracting alumina from aluminous silicates.
- RI 5685. Acid Curing and Countercurrent Decantation Washing of an Oxidized Copper Ore From Pinal County, Ariz., by W. A. McKinney and Carl Rampacek. 1960. 10 pp. 2 figs. Presents results of laboratory and continuous pilot plant tests made on a sample of oxidized ore with the acid cure procedure.
- RI 5686. Casting Technology for Titanium, Zirconium, and Hafnium, by S. L. Ausmus, F. W. Wood, and R. A. Beall. 1960. 31 pp. 19 figs. Indicates improvements in the skull-casting method for casting reactive metals, such as titanium, zirconium, and hafnium.
- RI 5687. Volumetric Determination of Uranium in the Presence of High Concentrations of Iron, by Thomas J. Blalock. 1960. 9 pp. Reveals that the use of a double precipitation procedure permits the essentially quantitative separation of uranium tetrfluoride as low as 0.1 to 0.2 mg of uranium per 100 ml of solution. A suitable carrier must be present and ammonium chloride must be added to prevent peptization. Work done in cooperation with U.S. Atomic Energy Commission.
- RI 5688. Zirconium-Dysprosium Equilibrium Diagram, by J. Croeni, C. E. Armantrout, and H. Kato. 1960. 12 pp. 8 figs. Covers investigation of the zirconium-dysprosium system by melting point, thermal analysis, resistivity, X-ray, and metallographic methods. Project sponsored by Pittsburgh Naval Reactor Operations Office of the Atomic Energy Commission for the Bureau of Ships, U.S. Department of the Navy.
- RI 5689. Applications of Radioisotopes in Metallurgical Research, by H. L. Gibbs, C. H. Schack, and J. B. Clemmer. 1960. 12 pp. 4 figs. First of a series of reports describing application of radioisotopes and radioactivity techniques in extractive metallurgy. Includes discussion of licensing and safety requirements, description of laboratory and methods used, definition of nature and scope of the research program, and synopsis of the more important problems.
- RI 5690. Reactions of Iron and Iron Compounds With Hydrogen and Hydrogen Sulfide, by Walter Kawa, Raymond W. Hiteshew, Robert B. Anderson, and Harold Greenfield. 1960. 16 pp. The reactions of iron and iron compounds described in this report were studied to facilitate the qualitative prediction of the chemical state of iron catalysts during coal hydrogenation experiments in batch autoclaves.
- RI 5691. Selectivities of Laboratory Flotation and Float-Sink Separations of Coal, by J. B. Gayle and A. G. Smedley. 1960. 19 pp. 14 figs. Compares selectivities of three diverse flotation reagents and also flotation and float-sink methods of separation. Seven samples of high- to medium-volatile coking coal are tested. Work done in cooperation with University of Alabama.
- RI 5692. Recovering Manganese From Mill Rejects, by W. A. Stickney and C. W. Sanders. 1960. 11 pp. Describes four mill rejects—three from Montana and one from Peru—and results obtained from laboratory beneficiation of these samples. The oil-emulsion scheme to recover manganese from certain fine-grained, complex mineral sources is determined to be technically feasible.
- RI 5693. Fersmite: A Rare Calcium-Columbate Mineral From Montana, by H. D. Hess. 1960. 9 pp. 2 figs. Describes second recorded occurrence (first in North America) of this rare calcium-columbate

† Out of print.

- mineral. Presents X-ray diffraction data and specific optical information.
- RI 5694. Shallow Lead Diggings, Grant and Lafayette Counties, Wis., by W. A. Grosh. 1960. 59 pp. 18 figs. Presents brief history and description of the Wisconsin portion of the Upper Mississippi Valley lead-zinc field; considers representative deposits and digging areas selected for investigation; and concentrates on analysis of samples by several methods.
- RI 5695. International System for Classifying Brown Coals and Lignites and Its Application to American Coals, by W. H. Ode and F. H. Gibson. 1960. 20 pp. 2 figs. Reviews the proposed system of classification, describes its application to American coals, and compares the properties of the lower rank coals of various countries by analyses and tests of the exchange samples.
- RI 5696. Evaluating One-Half Million Pounds of Zirconium Sponge, by M. D. Carver and H. Kato. 1960. 14 pp. 5 figs. Describes development of quality evaluation procedure for certifying the adequacy of production lots of Kroll process zirconium sponge produced for reactor applications.
- RI 5697. Paper-Coating Clay From Coarse Georgia Kaolins by a New Attrition-Grinding Process, by I. L. Feld, T. N. McVay, H. L. Gilmore, and B. H. Clemmons. 1960. 20 pp. 11 figs. Describes process and equipment for grinding coarse kaolins to the 2-micron particle-size range.
- RI 5698. Fine-Screening of Coal: Testing of the Sieve Bend, by M. R. Geer, A. W. Deurbrouck, and H. F. Yancey. 1960. 20 pp. 6 figs. Investigates this radically different type of screen used in the cleaning of fine coal. Work done in cooperation with School of Mineral Engineering, University of Washington.
- RI 5699. The Role of Fluidity in Coal Carbonization, by G. H. Martindill and M. J. Kovalik. 1960. 23 pp. 17 figs. Gives results of investigation by Bureau of the influence of the maximum fluidity attained by the charge on physical quality of the coke or char produced.
- RI 5700. Heats of Formation of Three Sodium Vanadates, by Mary F. Koehler. 1960. 10 pp. Presents thermodynamic study of three vanadates of sodium—metavanadate, pyrovanadate, and orthovanadate. 15 cents.
- RI 5701. Effects of Impurities on Mechanical Properties of Electrolytic Titanium, by J. D. Ramsdell and D. R. Matthews. 1960. 12 pp. 12 figs. Describes effects of oxygen, nitrogen, carbon, and iron (in low percentages) on mechanical properties of electrolytic titanium.
- RI 5702. Metallic Reduction of Thorium Tetrachloride, by P. C. Good and F. E. Block. 1960. 12 pp. 4 figs. Presents a method for preparing thorium metal by reduction of thorium tetrachloride; furnishes data on hardness values of magnesium- and sodium-reduced thorium metal.
- RI 5703. Removing Volatile Metals From Lead and Tin by Vacuum Distillation, by H. S. Caldwell, Jr., M. J. Spendlove, and H. W. St. Clair. 1960. 12 pp. 1 fig. Summarizes work on removal of more volatile metals, such as cadmium, zinc, and magnesium, from lead and tin.
- RI 5704. Laboratory-Scale Gasification of Coal-Water Slurries in a Metallic Tube Coil, by J. L. Konchesky, R. F. Stewart, and J. J. S. Sebastian. 1960. 20 pp. 14 figs. Describes steam-coal gasification process, including study of effects of temperature, residence time, rank of coal, and steam concentration on gasification of coal; presents data on operating conditions for gasifying coal slurries. Work done in cooperation with University of West Virginia.
- RI 5705. Extracting Tar Acids With Monoethanolamine, by James Stuckey. 1960. 27 pp. 9 figs. Describes method to extract tar acid from coal tar distillates derived from a subbituminous and a lignite coal. Contains basic information on low-temperature tars and distillates and a bibliography.
- RI 5706. Well Productivity Related to Drilling Muds: Umiat Field, Naval Petroleum Reserve No. 4, Alaska, by George L. Gates and Hodge Caraway. 1960. 21 pp. 7 figs. Evaluates effect of clay-water, brine, and oil-base drilling fluids on the productivity of test wells drilled on the Umiat anticline; also gives data on production and drilling at Umiat field.
- RI 5707. Research on the Hazards Associated With the Production and Handling of Liquid Hydrogen, by M. G. Zabetakis and D. S. Burgess. 1961. 50 pp. 40 figs. Describes the hazards of producing and storing liquid hydrogen and safer ways for handling this high-energy fuel. Includes what is believed to be the first stored quantity-safe distance table.
- RI 5708. Design Criteria for Portable Seismographs, by Wilbur I. Duvall. 1961. 6 pp. 2 figs. Describes some of the possible rigid-body motions of tripod supported seismographs; presents three basic design criteria for constructing a three-point supported portable instrument.
- RI 5709. High-Temperature Heat Content of Uranium Tetrafluoride, by E. G. King and A. U. Christensen. 1961. 4 pp. 1 fig. Presents measurements of the heat content of uranium tetrafluoride conducted from 298° to 1,350° K. Indicates melting point and heat of fusion.
- RI 5710. High-Temperature Heat Content and Entropies of Crystalline and Glassy Germanium Dioxide, by K. K. Kelley and A. U. Christensen. 1961. 5 pp. 1 fig. Contains experimentally determined heat content values for hexagonal crystalline germanium dioxide between 298.15° and 1,350° K and for germanium dioxide glass between 298.15° and 1,800° K. Presents heat content and corresponding entropy-increment data in tabular form and by equations. Estimates free energy of formation values for germanium dioxide glass at 298.15° and 1,800° K.
- RI 5711. Heats and Free Energies of Formation of Ferrites and Aluminates of Calcium, Magnesium, Sodium, and Lithium, by M. F. Koehler, R. Barany, and K. K. Kelley. 1961. 14 pp. Contains results of new experimental work for obtaining heats of formation of five ferrites and one aluminate and a review and revision of previous similar work of the Bureau on five aluminates.
- RI 5712. Titanium-Bearing Deposits in South Texas, by A. D. Hahn, W. C. Miller, and M. M. Fine. 1961. 84 pp. 22 figs. Summarizes studies and tests to determine methods of recovering ilmenite and other heavy minerals. Includes bibliography.
- RI 5713. Effects of Hydraulic Fracturing in Oklahoma Waterflood Wells, by John P. Powell and Kenneth H. Johnston. 1961. 21 pp. 12 figs. Presents results of a comprehensive study of the effects of hydraulically fracturing waterflood wells in Oklahoma. Analyzes some of the factors governing results of fracture treatment on waterflood properties.
- RI 5714. Reconnaissance of Titanium Resources, Kemper County, Miss., by A. D. Hahn. 1961. 16 pp. 3 figs. Considers the ilmenite, rutile, and associated heavy-mineral content of black-sand-bearing Eocene deltaic formations. As more than 60 percent of the titanium dioxide in the samples tested occurs in particles too small to be separated by gravity-concentration methods, the formations are not classified as potential titanium resources.
- RI 5715. Low-Temperature Heat Capacities and En-

- tropies at 298.15° K. of Three Sodium Vanadates, by E. G. King and W. W. Weller. 1961. 5 pp. 1 fig. First of a series on entropies of vanadates, tungstates, and molybdates. Presents low-temperature heat capacity data and entropy values.
- RI 5716. Thermodynamic Properties of Aluminum Nitride, by Alla D. Mah, E. G. King, W. W. Weller, and A. U. Christensen. 1961. 8 pp. 2 figs. Provides thermodynamic data pertinent to the calculations regarding thermal stability and reactivity of aluminum nitride.
- RI 5717. Susceptibility of Organic Compounds to Tritium Exchange Labeling by Marvin L. Whisman, F. G. Schwartz, and B. H. Eccleston. 1961. 18 pp. 6 figs. Describes preparation of tritium-labeled organic compounds to be used by the Bureau in studying the role of certain gasoline constituents in gas-forming mechanisms.
- †RI 5718. Three Chemosynthetic Autotrophic Bacteria Important to Leaching Operations at Arizona Copper Mines, by John D. Corrick and Joseph A. Sutton. 1961. 8 pp. Covers studies on isolating and identifying chemosynthetic iron- and sulfur-oxidizing autotrophic bacteria in water samples from five mines.
- †RI 5719. Development and Operations of a Pilot Plant for Feeding Bituminous Coal Slurry to a Pressure Gasifier, by W. R. Huff and L. F. Wilmott. 1961. 36 pp. 19 figs. Study concerns bituminous coal-in-water suspensions as a source of preheated coal and superheated steam in pressure gasification of coal with oxygen.
- RI 5720. Spectrophotometric Determination of Trace Amounts of Copper in Tungsten Metal Powder, by A. S. Prokopovitch and T. E. Green. 1961. 7 pp. 1 fig. Describes a spectrophotometric method using the principle of solvent extraction. Includes bibliography.
- RI 5721. Preparation Characteristics of Coal From Preston County, W. Va., by T. E. Gray and E. R. Palowitch. 1961. 37 pp. 3 figs. One of a series discussing suitability of various coals for producing metallurgical coke, either as mined or after beneficiation. Describes preparation characteristics of significant coalbeds in Preston County.
- RI 5722. Metallothermic Reduction of Vanadium Chlorides, by F. E. Block, R. R. Brown, and M. J. Ferrante. 1961. 17 pp. 8 figs. Describes process for preparing metallic vanadium of uniformly high purity by methods adaptable to large-scale plant operation.
- RI 5723. Characteristics of Petroleum From the Powder River Basin, Wyo., by W. J. Wenger and B. W. Reid. 1961. 123 pp. 3 figs. Presents analyses of 108 crude oils. Indicates best refining uses for the oils and predicts characteristics of oils that may be discovered in the Basin. Work done in cooperation with University of Wyoming.
- RI 5724. Smelting Taconite in the Bureau of Mines Experimental Blast Furnace, by Miles B. Royer, Norwood B. Melcher, and W. O. Philbrook. 1961. 15 pp. 2 figs. Crude Minnesota taconite was charged in Bureau's experimental blast furnace so that smelting characteristics of such highly siliceous raw materials could be studied and smelting costs could be compared with those of a standard Mesabi ore.
- RI 5725. Ultimate Composition of Organic Material in Green River Oil Shale, by John Ward Smith. 1961. 16 pp. 1 fig. Describes and evaluates method used to determine ultimate composition of organic material in 10 samples of oil shale from the Mahogany zone of the Green River Formation in Colorado and Utah.
- RI 5726. Laboratory-Scale Casting Furnace for High-Melting-Point Metals, by P. G. Clites and E. D. Calvert. 1961. 13 pp. 7 figs. Describes laboratory furnace developed for a study of interrelationships among variables associated with skull melting and casting high-temperature metals. Many casting characteristics of metals and alloys can be determined on equipment of this size.
- RI 5727. Rapid Determination of Aluminum, Iron, Copper, Cadmium, and Lead in Zinc-Base Alloys, by R. J. Gajan and D. M. Geehan. 1961. 10 pp. 5 figs. Describes a fast method for determining aluminum, iron, copper, cadmium, and lead in zinc-base alloys. The new method is intended for use by trained technicians in laboratories with inexpensive equipment.
- RI 5728. Beneficiating Manganese Oxide Ores From the Butte-Phillipsburgh Federal Stockpile, by G. V. Sullivan, W. A. Stickney, and R. C. Bush. 1961. 19 pp. 9 figs. Summarizes Bureau metallurgical investigations of manganese oxide ore averaging 23 to 25 percent manganese.
- RI 5729. Beneficiating Spodumene From Pegmatites of Gaston County, N.C., by James Browning and Thomas L. McVay. 1961. 12 pp. 4 figs. Describes a dependable method for recovering spodumene and mica from certain pegmatites that represent a major part of the nation's lithium reserves. Work done in cooperation with Lincoln-National Concentrates Corp. and University of Alabama.
- RI 5730. Removing Acid Gas by Agitated Absorption, by A. S. Moore and C. C. Shale. 1961. 26 pp. 8 figs. Discusses process developed by Bureau for producing synthesis gas directly from coal.
- RI 5731. Carbonizing Properties of Wyoming Coals, by W. S. Landers, V. F. Parry, Manuel Gomez, E. O. Wagner, J. B. Goodman, and C. R. Nelson. 1961. 74 pp. 17 figs. Describes Bureau study of technical factors related to producing special carbon and tar from selected Wyoming coals. Work done in cooperation with Columbia-Geneva Division of United States Steel Corp., Kemmerer Coal Co., and State of Wyoming Natural Resource Board.
- RI 5732. Performance of Dense-Medium Cyclone in Cleaning Fine Coal, by M. R. Geer, Michael Sokaski, P. Stanley Jacobsen, and H. F. Yancey. 1961. 22 pp. 3 figs. Describes a cyclone able to provide relatively high recovery efficiencies in making separations that would be impossible with other fine-coal cleaning devices. Work done in cooperation with the University of Washington.
- †RI 5733. Radioactive Inert Gases as Tracers for Petroleum Reservoir Studies, by F. E. Armstrong, W. D. Howell, and J. Wade Watkins. 1961. 15 pp. 8 figs. Covers development and application by the Bureau of techniques and instruments for using these tracers to determine flow paths through petroleum reservoir. Includes bibliography. Work done in cooperation with Southland Royalty Co.
- RI 5734. Production of Bimetal-Reduced Hafnium, by Dale W. Richardson. 1961. 21 pp. 10 figs. Describes method employed by Bureau for producing high-purity sponge by using sodium magnesium for bimetal reduction of anhydrous hafnium tetrachloride. Work done in cooperation with Bureau of Ships, U.S. Department of the Navy.
- RI 5735. Process Development in Removing Sulfur Dioxide From Hot Flue Gases (in Four Parts). 1. Bench-Scale Experimentation, by D. Bienstock, J. H. Field, and J. G. Myers. 1961. 29 pp. 16 figs. Discusses bench-scale experiments in which sulfur dioxide in 0.3-percent concentration was removed completely from simulated flue gas without cooling the gas with solids at flue gas temperatures. Part 2, RI 6307, published in 1963, describes the design

† Out of print.

- and operation of a laboratory-scale, pulverized-coal-fired furnace.
- RI 5736. Chemical Analysis and Electrical Resistivity of Selected California Oilfield Waters, by David M. Gullikson, W. Hodge Caraway, and George L. Gates. 1961. 21 pp. 1 fig. Contains first published analyses of California oilfield waters in which determinations for potassium, strontium, bromide, iodide, boron, and naphthenates were made. Thirty-eight samples from oil- and gas-producing formations in 12 fields in Ventura, Kern, Glenn, and Colusa Counties were analyzed by the Bureau to supply needed information on the composition of waters in areas of current drilling activity.
- RI 5737. Applying Modern Instrumental Techniques to Oilfield Water Analysis, by David M. Gullikson, W. Hodge Caraway, and George L. Gates. 1961. 45 pp. 15 figs. Summarizes fundamentals of flame photometry and describes spectrophotometric, potentiometric, and colorimetric analytical techniques that were applied. Includes bibliography.
- †RI 5738. High-Temperature Furnaces for X-ray Diffractometers, by William J. Campbell, Stephan Stecura, and Clark Grain. 1961. 30 pp. 16 figs. Summarizes development in the field of high-temperature X-ray diffractometers through 1959, evaluates various furnace designs, and describes Bureau's X-ray diffraction facilities.
- RI 5739. Fluorescent X-Ray Spectrograph for Dynamic Selective Oxidation Rate Studies: Design and Principles, by William J. Campbell and Melvin Leon. 1961. 21pp. 12 figs. Discusses design and operation of the high-temperature X-ray spectrograph, basic principles of the proposed X-ray methods, and results of preliminary studies.
- RI 5740. Recovering Cobalt and Nickel From Complex Sulfide Ores of Southeastern Missouri, by K. K. Kershner and F. W. Hoertel. 1961. 16 pp. 4 figs. Includes information on salt roasting followed by steam treatment and leaching.
- RI 5741. Using a Centrifuge for Float-and-Sink Testing Fine Coal, by E. R. Palowitch and T. M. Nasiatka. 1961. 14 pp. 2 figs. Describes test procedure developed by Bureau to reduce time for gravimetric separation of coals finer than 14-mesh from 24 hours to less than 1 hour.
- RI 5742. Extracting Neutral Low-Temperature Lig-nite Tar Fractions With Dipropionitrile Solvents, by Paul L. Campbell and James M. Stuckey. 1961. 36 pp. 9 figs. Describes Bureau method of upgrading low-temperature tar. Includes bibliography.
- RI 5743. Determining Phosphorus in Coal and Coke: Evaluation of Volumetric, Colorimetric, and Gravimetric Methods, by F. H. Gibson and W. H. Ode. 1961. 21 pp. Presents results of phosphorus determinations in 14 ash samples. Indicates that the ASTM and British volumetric methods are equally suitable.
- RI 5744. Carbonizing Tests With Tuscaloosa Oven: Factors Influencing Apparent Specific Gravity, by J. B. Gayle and W. H. Eddy. 1961. 18 pp. 4 figs. Study of various factors considered as possible contributors to apparent specific gravities of experimental and commercial cokes. Work done in cooperation with University of Alabama.
- RI 5745. Downward-Flowing Granular Solids as Pressure Seals in Vertical Standpipes, by J. J. Demeter and W. P. Haynes. 1961. 30 pp. 17 figs. A study of behavior of standpipe pressure seals using finely divided iron oxide.
- RI 5746. Determining the In-Place Support of Mine Roof With Rock Bolts, White Pine Copper Mine, Michigan, by Robert H. Merrill, Thomas A. Morgan, and C. J. Stehlik. 1961. 28 pp. 17 figs. Discusses method used in upper shale beds of Nonesuch formation.
- RI 5747. Extraction of Zirconium From Nigerian High-Hafnium Concentrate, by S. L. May, A. W. Henderson, and J. L. Tews. 1961. 28 pp. 4 figs. Indicates that hafnium and zirconium compounds of acceptable purity can be extracted from Nigerian zircon concentrates. Work done in cooperation with U.S. Atomic Energy Commission.
- RI 5748. Caustic Sulfide Leaching of Mercury Products, by J. W. Town, R. F. Link, and W. A. Stickney. 1961. 39 pp. 6 figs. Summarizes laboratory investigations to obtain hydrometallurgical information on dissolution of mercury sulfides from ores, flotation concentrates, and pure mercuric sulfides.
- RI 5749. Discharge Behavior in Vacuum Arc Melting, by F. W. Wood and R. R. Lowery. 1961. 32 pp. 18 figs. Investigation of anomalies in electrical-discharge behavior during consumable-electrode arc melting of titanium and the effects of these irregularities on arc-furnace explosions. Includes experimental survey of arc behavior and a qualitative definition of discharge behavior. Work done in cooperation with Titanium-Zirconium Melting Safety Committee.
- RI 5750. Beneficiating North Carolina Spodumene-Beryl Ores, by J. S. Browning, B. H. Clemmons, and T. L. McVay. 1961. 20 pp. 2 figs. Describes new and improved method for separating and recovering spodumene, mica, and beryl from Kings Mountain area ores.
- RI 5751. Experimental Treatment of Nevada and California Fluorspar Ores, by A. L. Engel and H. J. Heinen. 1961. 11 pp. Covers experiments by Bureau of Mines on low- and medium-grade fluorspar ores to aid in developing domestic resources. Includes list of references.
- RI 5752. Relative Wetting Tendencies of Crude Oils by Capillarimetric Method, by R. T. Johansen and H. N. Dunning. 1961. 11 pp. 3 figs. Indicates that wetting tendencies of crude oils differ widely and may be a major factor in determining wettability of reservoir surfaces. Work done in cooperations with State of Oklahoma.
- RI 5753. Explosibility of Agricultural Dusts, by Murray Jacobson, John Nagy, Austin R. Cooper, and Frank J. Ball. 1961. 23 pp. 2 figs. Presents data on dust-explosion hazard in air for 220 samples of agricultural products. (See also RI 5971, 6516, and 6597.)
- RI 5754. Removing Quartz and Other Impurities From Refractory Clays by Mineral Dressing Methods, by W. A. Calhoun and H. E. Powell. 1961. 22 pp. 2 figs. Describes investigation to develop economical mineral-dressing processes for removing objectionable quantities of impurities, such as quartz and pyrite, from refractory clay deposits in east-central Missouri.
- RI 5755. Solution-Flame Photometric Determination of Lithium in Lithium Minerals, by V. M. Benson, J. L. Kassner, E. E. Creitz, and H. A. Ice. 1961. 10 pp. 3 figs. Describes simple, routine method for determining lithium in lithium-bearing rock. Work done in cooperation with University of Alabama and University of Alabama Research Council.
- RI 5756. Recovering Tin From Hardhead by Selective Oxidation of Iron, by D. A. Wilson and P. M. Sullivan. 1961. 17 pp. 8 figs. To permit recovery of tin from hardhead, several systems for

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- selectively oxidizing the iron were investigated. A method was developed and successfully tested on melts of 2,000 grams.
- RI 5757. Thermal Expansion of Alpha Alumina, by William J. Campbell and Clark Grain. 1961. 16 pp., 6 figs. Indicates accurate thermal expansion coefficients for alpha alumina and critically evaluates these coefficients with other published values.
- RI 5758. Electrorefining Zirconium, by D. H. Baker, Jr., J. R. Nettle, and H. Knudsen. 1961. 12 pp. 4 figs. Presents investigations conducted to determine feasibility of molten-salt electrorefining of zirconium scrap, offgrade sponge, and alloys. Studies resulted from a contract between U.S. Atomic Energy Commission and Bureau of Mines.
- RI 5759. Production of Zirconium by the Semicontinuous Reactor Process, by James E. Mauser, 1961. 17 pp. 6 figs. Presents method to develop an inexpensive and continuous process for producing pure zirconium. Includes bibliography. Work done in cooperation with U.S. Atomic Energy Commission.
- RI 5760. Statistical Analysis of Gallery Variables Affecting the Probability of Ignition by Explosives, by R. L. Grant and R. W. Van Dolah. 1961. 27 pp. 8 figs. Discusses data developed in testing 102 explosives for permissibility.
- RI 5761. Thermal Behavior of Manganese Minerals in Controlled Atmospheres, by W. M. Dressel and H. Kenworthy. 1961. 35 pp. 16 figs. Presents, for the first time, results of differential thermal analysis of manganese minerals in reducing atmospheres as well as in neutral and oxidizing atmospheres. Provides differential thermal analysis data as an aid in controlling thermal treatments in extracting manganese from ores.
- RI 5762. Effect of Particle Size Upon the Crushing Strength of Iron Oxide Pellets, by R. P. Jewett, C. E. Wood, and J. P. Hansen. 1961. 15 pp. 9 figs. Correlates crushing strength of green pellets prepared from magnetite and specular and earthy hematite with particle size of these respective raw materials. Work done in cooperation with Michigan College of Mining and Technology.
- RI 5763. Chlorination of an Idaho Ilmenite, by E. C. Perkins, H. Dolezal, and R. S. Lang. 1961. 16 pp. 4 figs. Covers research aimed at using ilmenite from domestic deposits for producing titanium tetrachloride.
- RI 5764. Gas-Fired Vacuum Retort for Distilling Metals, by H. S. Caldwell, Jr., H. W. St. Clair, J. H. Bilbrey, Jr., and M. J. Spendlove. 1961. 11 pp. 6 figs. Describes investigation undertaken to develop and test a retort for laboratory use embodying many features required for practical commercial-scale vacuum distillation.
- RI 5765. Selective Flotation of Fine-Grained Lead-Zinc Sulfides From Idaho and Washington, by A. E. J. Gallagher, W. A. Stickney, J. E. Shelton, and F. W. Wessel. 1961. 20 pp. 3 figs. Studies of six deposits indicate that flotation can be effectively applied to selective recovery of very fine lead and zinc sulfide minerals.
- RI 5766. Significance of Experimental Operations to Industrial Blast-Furnace Practice, by Miles B. Royer and Warren M. Mahan. 1961. 8 pp. 1 fig. Indicates that the experimental blast furnace is a practical tool for obtaining preliminary information on raw materials of unknown smelting characteristics under operating conditions that might deviate considerably from normal industrial practice. Work done in cooperation with Raw Materials Engineering Division, Applied Research Laboratory, United States Steel Corp.
- RI 5767. Flotation of Beryl From Northeastern Pegmatites: A Progress Report, by John E. Shelton. 1961. 10 pp. Part of Bureau's continuing effort to develop an economical recovery process for beryl ores, report describes flotation research on samples of beryl-bearing pegmatites from a mine in Connecticut and one in New Hampshire.
- RI 5768. Gas-Liquid Chromatography of Basic Nitrogen Compounds, by A. W. Decora and G. U. Dineen. 1961. 23 pp. 11 figs. Discusses Bureau's investigation of adapting gas-liquid chromatography to analyzing tar bases. Includes list of references. Work done in cooperation with University of Wyoming.
- RI 5769. Physical and Mechanical Properties of Electrorefined Vanadium, by J. D. Ramsdell, W. L. O'Brien, J. S. Winston, and D. R. Schuyler II. 1961. 21 pp. 17 figs. Evaluates workability and recrystallization characteristics of high-purity electrorefined vanadium. Includes list of references.
- RI 5770. Preparing Zirconium Diboride Directly From Zircon, by Perry G. Cotter. 1961. 9 pp. 2 figs. Describes method of synthesis and some of the results of that synthesis.
- RI 5771. Laboratory Concentration of Seven Titanium-Bearing Ores of the Pacific Northwest, by J. W. Town and C. W. Sanders. 1961. 12 pp. 1 fig. Recoveries from tabling placer samples were about 50 percent at grades of 30 percent titanium dioxide. Flotation was the most effective method for concentrating the fine ilmenite in clay samples; recoveries of approximately 50 percent at 35-percent grades were obtained. Magnetic and electrostatic separation methods were used on the coarse-grained sand samples to improve concentrate grade.
- RI 5772. Physical and Mechanical Properties of Sodium-Reduced and Electrorefined Titanium, by C. N. Adams and E. D. Hull. 1961. 12 pp. 13 figs. Indicates that the metal can be cold-worked easily and that work hardening is not excessive. The effects of cold work can be removed by annealing at 700° C for 30 minutes.
- RI 5773. Refining Crude Aluminum by the Subhalide Reaction, by Leland A. Yerkes and Oliver C. Fursman. 1961. 19 pp. 7 figs. Discusses method of producing aluminum by means other than electrolysis of its oxide.
- RI 5774. A Boron-Base Refractory, by Perry G. Cotter. 1961. 7 pp. Describes study conducted to synthesize and investigate properties of a high-temperature refractory material combining boron, silica, and magnesium.
- RI 5775. Electric Smelting of Montana Chromite Concentrates, by W. L. Hunter and Lloyd H. Banning. 1961. 30 pp. 3 figs. Study centered on feasibility of producing ferrochromium of varying silicon and carbon contents from Mouat chromite.
- RI 5776. Electric Smelting Titaniferous Magnetite Ore, Iron Mountain, Wyo., by H. C. Fuller and V. E. Edlund. 1961. 11 p. 1 fig. Describes tests on feasibility of smelting titaniferous iron ore containing about 20 percent titanium dioxide (TiO₂).
- RI 5777. Recovering Aluminum and Fluorine Compounds From Aluminum Plant Residues, by R. S. McClain, G. V. Sullivan, and W. A. Stickney. 1961. 16 pp. Residues from aluminum plants were studied to determine if carbon could be removed by flotation while fluorine and aluminum compounds were recovered for recycling to the reduction process. Samples representing three types of plant waste products were studied.
- RI 5778. Vacuum Melting of Low-Alloy Steel, by Beverly W. Dunning, Jr. 1961. 14 pp. 6 figs. Tells of effect of vacuum melting to eliminate gases and nonmetallic inclusions in six low-alloy steels. Analyzes and compares differences in gas content

- and inclusions in air-melted and vacuum-melted steel.
- RI 5779. Beneficiation of Red Iron Ore Fines From Pyne Mine, Bessemer, Ala., by W. E. Lamont, I. L. Feld, and B. H. Clemmons. 1961. 16 pp. 1 fig. Discusses Bureau's method of beneficiating the minus ¼-inch fraction of mine-run ore. Work done in cooperation with University of Alabama and Woodward Iron Co.
- RI 5780. Correlation of Fischer-Schrader Assay and BM-AGA Carbonization Yields, by J. G. Walters. 1961. 38 pp. 1 fig. Presents data on standard test for evaluating carbonizing properties of coal. Includes bibliography.
- RI 5781. Using Molten Zinc to Extract Aluminum From Aluminum-Silicon Alloys: A Progress Report, by H. S. Caldwell, Jr., and M. J. Spendlove. 1961. 15 pp. 6 figs. Describes how molten zinc was used to leach aluminum from an aluminum-silicon alloy made by carbothermic reduction of siliceous aluminum ores.
- RI 5782. Oxidation of Anthracite With Concentrated Nitric Acid, by M. A. Hammer, G. A. Brady, and J. W. Eckerd. 1961. 19 pp. 13 figs. Covers Bureau's investigation for determining chemical structure of anthracite. Includes list of references.
- RI 5783. Radiochemical Precipitation Studies of Rare-Earth Oxalates, by Kenneth G. Broadhead and Howard H. Heady. 1961. 8 pp. Summarizes study to determine what effect could be attributed to the several variables—temperature; digestion time; acid, rare-earth, and oxalic acid concentrations; stirring; and rare-earth ions. Includes list of references.
- RI 5784. Stress-Corrosion Cracking Susceptibility of Zirconium in Ferric Chloride Solution, by J. T. Dunham and H. Kato. 1961. 29 pp. 20 figs. Discusses results of particular environments where zirconium has poor corrosion resistance. Includes bibliography. Work done in cooperation with Oregon State College.
- RI 5785. Performance of Partly Depleted Oil Reservoirs During Complete Gas Repressuring and Gas Cycling, by Alton B. Cook, R. H. Coulter, Jr., G. B. Spencer, and F. Sam Johnson. 1961. 24 pp. 6 figs. Presents laboratory and field data to explain reservoir performance during complete gas repressuring. Concludes that the conversion of partly depleted oil reservoirs for gas storage may be more practical in many areas than using partly depleted gas reservoirs.
- RI 5786. Experimental Extraction of Strategic Components From S-816 Alloy Scrap, by H. Kenworthy, V. A. Nieberlein, and A. G. Starliper. 1961. 27 pp. 8 figs. Describes study undertaken to develop methods for recovering simple master alloys or single metal components from discarded and scrapped S-816 alloy.
- RI 5787. Computed Compositions and Thermodynamic Properties of Deuterium-Air Flames, by Erwin B. Cook and Robert W. Smith, Jr. 1961. 22 pp. Presents results of study of flame and combustion. Contains tables giving thermodynamic properties of air flames.
- RI 5788. Oil-Well Logging With Model Equipment: Tests on Noninvaded Thin Beds With Shielded Electrodes, by C. I. Pierce, R. B. Lowe, and J. Pasini III. 1961. 19 pp. 11 figs. Indicates response of shielded electrodes of different dimensions in thin, noninvaded beds. Recommends use of focused-type logging devices in certain Appalachian oilfields.
- RI 5789. High-Temperature Heat Contents and Entropies of Cerium Dioxide and Columbium Dioxide, by E. G. King and A. U. Christensen. 1961. 6 pp. 1 fig. Gives data on two metallic elements in temperature range from 298° to 1,800° K. Work done in cooperation with Office of Naval Research, U.S. Department of the Navy.
- †RI 5790. Experimental Extraction of Gold and Silver From California and Nevada Ores, by A. L. Engel and H. J. Heinen. 1961. 30 pp. Describes results of laboratory-scale experimental treatment of mine ores containing gold and silver.
- RI 5791. Low-Temperature Heat Capacities and Entropies at 298.15° K. of Monotungstates of Sodium, Magnesium, and Calcium, by E. G. King and W. W. Weller. 1961. 6 pp. 1 fig. Heat capacity measurements were conducted between 51° and 298°. The entropies at 298° K were evaluated and then combined with entropy data for the elements and oxides to obtain entropies of formation. This information is needed for thermodynamic appraisals of chemical reactions of these substances. No similar data for any tungstate have yet been published.
- †RI 5792. Analyses of Tipple and Delivered Samples of Coal (Collected During the Fiscal Year 1960), by S. J. Aresco, C. P. Haller, and R. F. Abenethy. 1961. 44 pp. One of a series on coal analyses. Furnishes data on composition and quality of hundreds of samples of coal from 21 States.
- †RI 5793. Flotation Studies on Copper-Nickel Sulfide Ores From Deposits Near Rockport, Maine, by John E. Shelton. 1961. 17 pp. 1 fig. Describes tests on two ore samples from the Harriman area. Work done in cooperation with Roland F. Beers, Inc.
- RI 5794. Cleaning Trials on Subbituminous Coal Containing Bentonitic Clay From Lewis and Thurston Counties, Wash., by H. F. Yancey and M. R. Geer. 1961. 21 pp. 2 figs. As the number of Pacific Northwest hydroelectric sites capable of providing low-cost power continues to decline, power companies and public utilities have expressed increasing interest in establishing reserves of coal. This report on subbituminous coal from Lewis and Thurston Counties covers sampling, float-and-sink tests, cleaning trials with jig and with dense-medium pilot plant, and chemical analyses and grindability determinations. Work done in cooperation with University of Washington.
- †RI 5795. Electrowinning Molybdenum: Preliminary Studies, by H. J. Heinen and J. B. Zadra. 1961. 8 pp. 3 figs. Summarizes practical method of electrowinning molybdenum directly from pure or impure molybdenum trioxide.
- RI 5796. Titanium-Gadolinium Phase Diagram, by J. G. Croeni, S. C. Rhoads, C. E. Armantrout, and H. Kato. 1961. 14 pp. 12 figs. Discusses feasibility of alloying titanium with rare-earth metals. Includes bibliography.
- RI 5797. Comparative Studies of Explosives in Marble, by Thomas C. Atchison and Julius Roth. 1961. 20 pp. 7 figs. Six explosives were tested for their strain-producing abilities in a dolomitic marble. Tests indicated that the performance of one explosive could be predicted from the known performance of another explosive, either in the marble or in any rock type for which the characteristic impedance is known.
- RI 5798. Effects of Polar Components of a Petroleum Distillate Fuel on Storage Stability, by J. W. Davis, F. G. Schwartz, and C. C. Ward. 1961. 11 pp. 3 figs. Discusses a chromatographic method developed to separate those compounds that have strong polar characteristics from a catalytically cracked distillate. Presents data on the effect of these materials upon the stability of the stored fuel.

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- Work done in cooperation with Bureau of Ships, U.S. Department of the Navy.
- RI 5799. Some Thermodynamic Values for Four Titanium Halides, by E. G. King, W. W. Weller, A. U. Christensen, and K. K. Kelley. 1961. 20 pp. 4 figs. Contains results of low-temperature heat-capacity measurements and high-temperature heat-content measurements of four halides—trichloride, tribromide, tetrabromide, and tetraiodide. Work done in cooperation with Office of Naval Research, U.S. Department of the Navy.
- RI 5800. Subsurface Saline Water Sources for Waterflooding in North Texas, by Frank Parrish, Jr., and Thomas M. Garland. 1961. 59 pp. 52 figs. Outlines the occurrence, quantity, and quality of water available for flooding in North Texas, discusses aquifers containing large quantities of saline water, and describes areas where considerable water is available from alluvial deposits, streams, lakes, and irrigation canals. Work done in cooperation with North Texas Oil and Gas Association.
- RI 5801. Reproducibility of Tritium Analysis of Organic Compounds Using A Liquid Scintillation Spectrometer, by Marvin L. Whisman, Barton L. Eccleston, and F. E. Armstrong. 1961. 14 pp. 4 figs. Presents data on Bureau's study and evaluates some variables in liquid scintillation counting. Includes bibliography. Work done in cooperation with U.S. Department of the Army.
- RI 5802. Flotation of Unoxidized Manganiferous Material From the Cuyuna Range, Minn., by F. W. Wessel, P. A. Wasson, and D. W. Frommer. 1961. 14 pp. 4 figs. Describes laboratory research on froth flotation for beneficiating manganiferous-ferruginous carbonate slates. Includes bibliography.
- RI 5803. Performance of a Gas-Synthesis Demonstration Plant for Producing Liquid Fuels From Coal, by R. G. Dressler and L. L. Hirst. 1961. 25 pp. 9 figs. Describes a demonstration plant designed to produce gasoline and diesel oil from coal by a modified Fisher-Tropsch gas-synthesis process. Includes description of the plant and process and discussion of coal and coke gasification, synthesis-gas purification, and synthesis and refining of liquid products.
- RI 5804. Low-Temperature Carbonization of Lignite and Subbituminous Coal: Effect of Hydrogen Atmosphere to 1,000 Pounds Pressure, by R. B. Porter, W. H. Oppelt, and W. R. Kube. 1961. 25 pp. 14 figs. Considers bench-scale tests performed to determine the influence of pressure on the carbonization of normally noncaking coals. Indicates distribution of gaseous, liquid, and solid products as a function of processing pressure.
- †RI 5805. Development of a 10,000-Ampere Cell for Electrorefining Titanium, by F. P. Haver and D. H. Baker, Jr. 1961. 42 pp. 19 figs. Describes development of a 10,000-ampere cell constructed to determine economic feasibility of producing high-purity electrolytic titanium from mill scrap or off-grade sponge. Furnishes studies of costs, operating variables, and material handling procedures. Work done in cooperation with General Services Administration.
- RI 5806. Infrared Spectra of Hydroxy-Aromatic Organic Compounds (Supplement to R.I. 5505), by W. Beckering and W. W. Fowkes. 1961. 34 pp. 32 figs. Presents the spectra of 32 compounds, largely phenolic materials.
- RI 5807. Carbonizing Tests With Tuscaloosa Oven: Studies of Pushing Pressures, by J. B. Gayle and W. H. Eddy. 1961. 14 pp. Correlates results of previous investigations of pushing pressures. Describes knowledge obtained from 10 years of experiments with a slot-type oven. Work done in cooperation with University of Alabama.
- †RI 5808. Underground Gasification of Coal: Second Experiment in Preparing a Path Through a Coalbed by Hydraulic Fracturing, by J. P. Capp, K. D. Plants, M. H. Fies, C. D. Pears, and L. L. Hirst. 1961. 32 pp. 19 figs. Involves the use of hydraulic fracturing to increase air acceptance of a coalbed for the introduction of combustion air and the removal of product gases.
- RI 5809. Defluorination of Siliceous Fluorspars at Elevated Temperatures, by Arden D. Fugate and Lloyd H. Banning. 1961. 23 pp. 9 figs. Furnishes studies on solid-state and molten defluorination of siliceous fluorspars. Tests were made to develop a pyrohydrolytic process for liberating fluorine from offgrade fluorspars.
- RI 5810. Low-Temperature Heat and Entropies at 298.15° K. of Diaspore, Kaolinite, Dickite, and Halloysite, by E. G. King and W. W. Weller. 1961. 6 pp. 1 fig. Indicates that diaspore has an unusually low heat capacity and entropy compared with boehmite (another mineral of the same composition). Shows that entropy is not the most significant factor for differences in the thermal stability of three clay minerals.
- RI 5811. Volatilization of Tin Chlorides From Bolivian Low-Grade Ores and Concentrates, by K. K. Kershner, F. W. Hoertel, and A. A. Cochran. 1961. 16 pp. 9 figs. A low-temperature chloride volatilization process was used to remove tin from slimes, concentrates, and mine-run ores. Tests indicated that more than 95 percent of the total tin in Bolivian mine-run ores could be volatilized and recovered as tin chloride between 520° and 565° C. Equally high recoveries of tin could be obtained from low-grade Bolivian concentrates between 565° and 600° C.
- RI 5812. Problems in Recovering Thermal Energy From Molten Salts, by T. A. Henrie, R. A. Renner, R. L. Olson, O. Q. Leone, and D. H. Baker, Jr. 1961. 27 pp. 1 fig. Describes study undertaken to determine problems involved in recovery of thermal energy from molten salts and to assist in planning experimental programs for the Gnome project.
- RI 5813. An Examination of a Low-Temperature Tar From a North Dakota Lignite, by W. W. Fowkes, C. M. Frost, J. J. Hoepfner, W. Beckering, P. G. Freeman, and R. W. Youngs. 1961. 27 pp. 4 figs. Examines a low-temperature tar obtained from a small-scale commercial unit for carbonizing North Dakota lignite for products that might be important to the economic processing of the tar.
- RI 5814. Spectrochemical Analysis of High-Purity Tungsten, by R. W. Lewis, C. F. Earl, J. L. Potter, and J. R. Wells. 1961. 12 pp. 4 figs. Describes experiments undertaken to develop a spectrochemical method for determining concentrations of impurities in high-purity tungsten. Presents a procedure, developed by these experiments, for determining 19 impurities in high-purity tungsten.
- RI 5815. Explosibility of Coal Dust in an Atmosphere Containing a Low Percentage of Methane, by John Nagy and William N. Portman. 1961. 16 pp. 10 figs. Presents investigations of the effect of low percentages of methane (0 to 5 percent) in an air atmosphere on spark-initiated explosions of coal dust.
- RI 5816. Infrared Spectra and Analytical Correlations of 24 Alkylthiophenes, by Dorothy M. Richardson, Norman G. Foster, Barton H. Eccleston, and Cecil C. Ward. 1961. 22 pp. 29 figs. Expands knowledge range of one family of sulfur compounds. Includes bibliography.

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- RI 5817. Experimental Smelting of Utah and Wyoming Iron Ores, by Nick Derick and J. P. Riott. 1961. 10 pp. 1 fig. Recent development of economical techniques for concentrating and agglomerating taconites has focused attention on low-grade magnetite deposits near Atlantic City, Wyo., as potentially important sources of iron ore for blast furnace smelting. Tests indicate that (1) substitution of Atlantic City pellets for part of the Utah ore now being used increases iron production and (2) that the quality of coke is a significant limiting factor affecting the furnace productivity of Utah ore.
- RI 5818. Preparation Characteristics of Coal From Harrison County, W. Va., by T. E. Gray and E. R. Palowich. 1961. 31 pp. 3 figs. While considering current production rates and estimated minable reserves, this report indicates the feasibility of using coal from the Pittsburgh and Redstone beds for the production of metallurgical coke. Float-and-sink tests of the samples collected showed that the coal could not be upgraded to a metallurgical fuel under the established production and reserves standards, even after intensive preparation.
- RI 5819. Methods of Analyzing Oilfield Waters: Iodides, Bromides, Alkalinity, Acidity, Borate Boron, Total Boron, Organic Boron, Potassium, Calcium, Magnesium, Iron, Fluorides, and Arsenic, by A. Gene Collins, Cynthia Pearson, Dave H. Ataway, and J. Wade Watkins. 1961. 39 pp. 8 figs. Describes method of determining major, minor, and trace constituents of oilfield brine. Includes bibliography.
- RI 5820. Aluminum Fluoride From Wet Hydrogen Fluoride Offgas, by Robert K. Koch and Henry E. Blake, Jr. 1961. 11 pp. 5 figs. Indicates that an aluminum fluoride reactor operating at maximum efficiency can retain 96 percent of the fluorine contained in offgases generated by pyrohydrolysis of siliceous fluorspar. The requirements are a reactor temperature of 200° C and a reactor entrance gas containing 5 mole-percent hydrogen fluoride.
- RI 5821. Energy Production and Consumption in the United States: An Analytical Study Based on 1954 Data, by Perry D. Teitelbaum. 1961. 145 pp. 6 figs. Presents energy balance sheet and analyzes Nation's fuel economy. Includes charts. Work done in cooperation with Resources for the Future, Inc.
- RI 5822. Chemical Analyses of Automobile Exhaust Gases for Oxygenates, by C. F. Ellis. 1961. 35 pp. 5 figs. Presents analytical techniques used and results of determinations. Includes list of references. Work done in cooperation with Public Health Service, U.S. Department of Health, Education, and Welfare.
- RI 5823. Low-Temperature Phase Equilibria of Helium-Bearing Natural Gases: Cliffside Gas, by Lowell Stroud, John E. Miller and L. Warren Brandt. 1961. 19 pp. 11 figs. Describes technology of extraction. Contains data in both graphic and tabular forms. Includes bibliography.
- RI 5824. Particle-Size Reduction of Coal by Attrition in a Tube, by J. L. Konchesky, P. G. Salgado, and R. F. Stewart. 1961. 16 pp. 7 figs. Discusses operating variables and suggests mechanism for pulverizing coal.
- RI 5825. Heats and Free Energies of Formation of Gibbsite, Kaolinite, Halloysite, and Dickite, by R. Barany and K. K. Kelley. 1961. 13 pp. Using hydrofluoric acid solution calorimetry, heat of formation values are derived from the elements and oxides for the four substances, and the data are combined with known entropy values to obtain the corresponding free energies of formation.
- RI 5826. Copper Recovery From Segregation-Flotation Concentrates by Ammoniacal-Ammonium Carbonate Leaching, by M. H. Stanczyk and P. A. Bloom. 1961. 6 pp. 3 figs. Bench-scale laboratory tests were made on a segregation-flotation concentrate, assaying 20.43 percent copper, to determine the influence of various ratios and concentrations of ammonia and carbon dioxide on copper extraction. A recovery of 96.3 percent of the copper was obtained from a feed assaying about 20 percent copper; only 0.12 pound of ammonia was lost per pound of copper recovered. Resegregation and flotation of leach residues recovered additional copper.
- RI 5827. Recovery of Zinc From Dross and Tin From Hardhead by Amalgam Electrolysis, by P. M. Sullivan and D. H. Chambers. 1961. 18 pp. 7 figs. Presents methods of processing to produce high-purity base metals. Includes bibliography.
- RI 5828. Preparation of Tungsten and its Alloys by Bomb Reduction, by P. C. Good, D. H. Yee, and F. E. Block. 1961. 10 pp. 5 figs. Covers new approaches for preparing tungsten in high-purity form. Includes statistical data.
- RI 5829. A Simple Chemical Method for Estimating Phosphorus Pentoxide Content of Sedimentary Phosphate Ores and Concentrates, by C. P. Mabie and H. D. Hess. 1961. 6 pp. 2 figs. Considers a method for estimating the phosphorus pentoxide content of finely ground sedimentary phosphate ores and beneficiated products. The method involves acid decomposition of the ore or product, filtration, addition of ammonium molybdate reagent to the filtrate, and centrifugation and measurement of the volume of yellow ammonium phosphomolybdate precipitate produced.
- RI 5830. Underground Gasification of Coal: Operation of Multiple-Path System, by John P. Capp, Robert W. Lowe, and Everett F. House. 1961. 13 pp. 1 fig. Indicates the feasibility of simultaneously burning several paths through a coalbed to develop a multiple-path underground gasification system.
- RI 5831. Using Radiant Heat to Reduce Coal Filter-Cake Moisture: Results of Pilot Plant Tests, by E. R. Palowitch. 1961. 16 pp. 4 figs. Considers the possibility of reducing coal filter-cake moisture by applying radiant heat directly to the filter cake while it is under vacuum during the drying phase of the filter cycle. Indicates that this procedure can increase the effectiveness of vacuum filtration by about 6 percentage points.
- RI 5832. Construction, Calibration, and Operation of Ice Calorimeters, by Donald F. Smith, Charles E. Kaylor, George E. Walden, Arthur R. Taylor, Jr., and John B. Gayle. 1961. 20 pp. 5 figs. Includes results of high-temperature heat content measurements on rubidium fluoride, hafnium tetrafluoride, cesium chloride, and cesium iodide. Work done in cooperation with University of Alabama.
- RI 5833. Electric-Furnace Synthesis of Spinel in Dusting Slags, by M. E. Tyrrell and N. A. Pace. 1961. 38 pp. 6 figs. Discusses method of producing spinel synthetically from inexpensive raw materials. Includes bibliography.
- RI 5834. Determination of Oxygen in Titanium, by T. A. Sullivan, B. J. Boyle, A. J. Mackie, and R. A. Plott. 1961. 30 pp. 6 figs. Considers techniques for determining oxygen content of titanium and titanium alloys. Discusses two vacuum fusion methods and one inert-gas fusion method.
- RI 5835. Statistical Analysis of Sample Data for Estimating Ore, by Scott W. Hazen, Jr. 1961. 27 pp. 8 figs. Covers sampling methods and adaptation of techniques of statistical analyses to mine sampling.

- RI 5836. Effect of Methyltrichlorosilane on Permeability of Sandstone Cores to Gas and Water, by W. L. Schmidt and C. J. Walker. 1961. 16 pp. Discusses feasibility of using silane to retard influx of water into natural-gas storage wells. Includes bibliography. Work done in cooperation with American Gas Association.
- RI 5837. Electron Diffraction Study of Garnierite, by Charles W. Huggins. 1961. 10 pp. 6 figs. Electron diffraction and electron microscopy are used to determine the unit cell parameters of garnierite and to examine its crystal habit.
- RI 5838. Rapid Determination of Particle-Size Distribution of Pulverized Coal Sedimentation, by R. F. Stewart, P. G. Salgado, and J. L. Konchesky. 1961. 15 pp. 8 figs. Evaluates the Palo-Travis method for determining size distribution of coal. Includes bibliography.
- RI 5839. Bacteria in Mining and Metallurgy: Leaching Selected Ores and Minerals; Experiments With *Thiobacillus Thiooxidans*, by Joseph A. Sutton and John D. Corrick. 1961. 16 pp. 7 figs. Summarizes studies made to determine if this sulfur-oxidizing bacterium could use sulfur compounds to produce sulfuric acid for leaching metals from low-grade ores.
- RI 5840. Preparation of High-Purity Nickel, by K. K. Kershner, F. W. Hoertel, and J. C. Stahl. 1961. 15 pp. 6 figs. Outlines procedures for purifying nickel solutions by precipitating and filtering impurities. Gives details for using the purified solutions as electrolytes in depositing high-purity nickel.
- RI 5841. Pilot Plant Development of the Hot-Gas-Recycle Process for the Synthesis of High-B.t.u. Gas, by D. Bienstock, J. H. Field, A. J. Forney, and R. J. Demski. 1961. 27 pp. 11 figs. Indicates that a high-Btu gas can be synthesized by the catalytic methanation of a mixture of 2.5 to 3 parts of hydrogen to 1 part of carbon monoxide, obtained in the gasification of coal, using a steel catalyst and then Raney nickel in the hot-gas-recycle system.
- RI 5842. Porous Stainless Steel Filters for Removing Dust From Hot Gases, by L. J. Kane, G. E. Chidester, E. Takach, and C. C. Shale. 1961. 18 pp. 11 figs. Describes tests made with three porosities of stainless steel filter materials at specified gas flow rates, temperatures, and dust loadings.
- RI 5843. Agglomerating Anthracite for Metallurgical Fuel, by W. S. Sanner, R. E. McKeever, and J. W. Eckerd. 1961. 42 pp. 24 figs. Considers experiments conducted to provide an adequate technology for the use of anthracite by the metallurgical industry.
- RI 5844. Chromatographic Resolution of Petroleum Porphyrin Aggregates, by L. R. Fisher and H. N. Dunning. 1961. 19 pp. 7 figs. Describes a rapid method for determining quantitatively the porphyrin-carboxylic acid content of a particular crude-oil porphyrin aggregate and a procedure for isolating porphyrins in the crystalline state from crude-oil porphyrin aggregates. Work done in cooperation with State of Oklahoma.
- RI 5845. Compressibility Factors for Helium and Helium-Nitrogen Mixtures, by J. E. Miller, L. W. Brandt, and L. Stroud. 1961. 11 pp. 4 figs. Reports experimental determinations of compressibility factors to 4,000 pounds per square inch absolute for helium at temperatures from -10° to 130° F and for 16 helium-nitrogen mixtures at 70° F.
- RI 5846. Practical Aspects of Controlling an Underground Fire on a Mining Machine, by Donald W. Mitchell, Edwin M. Murphy, John Nagy, and Florence P. Christofel. 1961. 20 pp. 15 figs. Evaluates effectiveness of a few extinguishing agents and techniques for controlling a fire on a simulated mining machine.
- RI 5847. Thermal Expansion and Phase Inversion of Rare-Earth Oxides, by Stephan Stecura and William J. Campbell. 1961. 47 pp. 18 figs. Contains thermal expansion and phase inversion measurements up to $1,350^{\circ}$ C on oxides of scandium, yttrium, lanthanum, and 12 lanthanide series elements.
- RI 5848. Dissolution of Zinc From Sphalerite at Elevated Temperatures and Pressures, by Martin H. Stanczyk and Carl Rampacek. 1961. 23 pp. 9 figs. Considers the direct dissolution of a typical zinc sulfide flotation concentrate by leaching. Complete dissolution of the mineral required vigorous and intimate mixing of the gaseous, liquid, and solid phases. Work done in cooperation with University of Arizona.
- RI 5849. Photographic Observation of Quarry Blasting, by Benjamin Petkof, Thomas G. Atchison, and Wilbur I. Duvall. 1961. 14 pp. 6 figs. Describes tests conducted in three rock types to determine how rock breakage occurs in quarry blasting in which long cylindrical charges break to two or more free surfaces.
- RI 5850. Zirconium-Gadolinium Equilibrium Diagram, by M. I. Copeland, C. E. Armantrout, and H. Kato. 1961. 13 pp. 8 figs. Describes part of a program, undertaken by the Bureau of Mines and sponsored by the U.S. Atomic Energy Commission, to investigate rare-earth alloys for use as nuclear reactor control materials.
- RI 5851. Hafnium Electrorefining, by J. R. Nettle, J. M. Hiegel, and D. H. Baker, Jr. 1961. 18 pp. 8 figs. Indicates feasibility of refining low-grade hafnium by an inert-gas-shielded molten-salt electrorefining technique to produce a hafnium metal meeting reactor specifications. Technique was adapted from that used for titanium electrorefining. Work done in cooperation with U.S. Atomic Energy Commission.
- RI 5852. Laboratory Investigation of the Effect of Temperature on Coal Flotation, by J. B. Gayle and W. H. Eddy. 1961. 11 pp. 10 figs. Indicates the effects of changes in pulp temperature on coal flotation recovery and on the selectivity of separation possible with different reagents. Work done in cooperation with University of Alabama.
- RI 5853. Fatigue Properties of Manganese-Copper Damping Alloys, by J. W. Jensen, A. E. Schwaneke, and D. F. Walsh. 1961. 14 pp. 9 figs. Describes results of fatigue tests on alloys of four compositions. Indicates that the general rule that vibration-dampening manganese-copper alloys are comparable to mild steel in hardness and strength may be extended to include fatigue strength.
- RI 5854. Experimental Tertiary Amine Flotation of Zinc Silicate (Hemmorhite) from Missouri, by W. M. Dressel and W. A. Calhoun. 1961. 7 pp. 2 figs. Indicates a mineral-dressing procedure suitable for concentrating zinc silicate minerals from certain deposits in southwestern Missouri.
- RI 5855. Low-Temperature Heat Capacities and Entropies at 298.15° K. of Some Sodium- and Calcium-Aluminum Silicates, by E. G. King and W. W. Weller. 1961. 8 pp. 2 figs. Summarizes data on measured heat capacities used to derive entropy values for four minerals at 298° K.
- RI 5856. Hafnium Content of Domestic and Foreign Zirconium Minerals, by H. D. Hess. 1962. 62 pp. Gives data on the hafnium content of 147 samples of foreign and domestic zirconium minerals that were evaluated in an effort to locate commercial sources of high-hafnium ores. Each sample also was analyzed for combined zirconium-hafnium

- oxide, silica, uranium, thorium, yttrium, and cerium. Work was conducted under joint sponsorship of U.S. Atomic Energy Commission and Bureau of Ships, U.S. Department of the Navy.
- RI 5857. Thermodynamic Data for Lanthanum Sesquioxide, by E. G. King, W. W. Weller, and L. B. Pankratz. 1961. 6 pp. 2 figs. Presents results of low-temperature heat capacity and high-temperature heat content measurements of lanthanum sesquioxide.
- †RI 5858. Heats and Free Energies of Formation of Oxides of Vanadium, by Alla D. Mah and K. K. Kelley. 1961. 11 pp. Reports new heat of formation data for four oxides of vanadium (VO, V₂O₃, VO₂, and V₂O₅).
- RI 5859. High-Temperature Heat Contents and Entropies of Bismuth Chloride and Cerous Chloride, by G. E. Walden and Donald F. Smith. 1961. 4 pp. Presents data on heat contents of two chlorides measured through temperature ranges of 370° to 630° K and 370° to 1,200° K, respectively. Work done in cooperation with University of Alabama.
- RI 5860. Reconnaissance of Titaniferous Sandstone Deposits of Utah, Wyoming, New Mexico, and Colorado, by V. T. Dow and J. Vance Batty. 1961. 52 pp. 28 figs. Summarizes study of 82 deposits in four States. Includes bibliography.
- RI 5861. Preparation of Tungsten by Reduction of Tungsten Hexachloride, by P. C. Good and F. E. Block. 1961. 9 pp. 4 figs. Describes the purification of tungsten hexachloride by distillation and its reduction with sodium, magnesium, or hydrogen. The metal thus prepared is of very high purity after arc melting.
- RI 5862. Separation of Tantalum From Columbium by the Hydrofluoric Acid-Sulfuric Acid-Methyl Isobutyl Ketone System, by S. L. May, J. L. Tews, and T. N. Goff. 1961. 31 pp. 6 figs. Describes a process for separating columbium from tantalum and for severing the two metals from other metallic impurities normally extracted with them from ores and concentrates.
- RI 5863. Relative Efficacy of Stemming Materials in Reducing Incendivity of Permissible Explosives, by R. W. Van Dolah, N. E. Hanna, and R. L. Grant. 1961. 8 pp. 4 figs. Discusses relative efficacy of water and several other stemming materials in reducing the incendivity of the gallery-cannon shot in firedamp.
- RI 5864. Iron Mountain Titaniferous Magnetite Deposits, Fremont County, Colo., by R. M. Becker, S. S. Shannon, Jr., and C. K. Rose. 1961. 18 pp. 17 figs. Presents information obtained from magnetic, gravity, and geologic surveys undertaken to permit an estimate of the extent and magnitude of the deposit. Work done in cooperation with Colorado School of Mines.
- RI 5865. Effects of Aluminum, Nitrogen, Manganese, and Copper Impurities on Hot Water and Steam Corrosion Rates of Zircaloy-3, by M. D. Carver, R. F. Link, and H. Kato. 1961. 15 pp. Describes effects of variations in content (near the residual level) of the impurities of the four elements on corrosion rate in pressurized hot water and in pressurized steam of zircaloy-3, a zirconium-base alloy of 0.25 percent tin and 0.25 percent iron.
- RI 5866. The Foam-Drive Process for Increasing the Recovery of Oil, by A. N. Fried. 1961. 65 pp. 28 figs. Laboratory tests have revealed an entirely new oil-displacement mechanism, which can greatly reduce the amount of oil unrecovered by conventional secondary-recovery methods. Outside the laboratory, the application of foam injection to reservoirs will require the development of methods and equipment for generating and injecting foams.
- RI 5867. Factors Influencing the Incendivity of Permissible Explosives: Ammonium Nitrate and Carbonaceous Material, by N. E. Hanna, R. L. Grant, and R. W. Van Dolah. 1961. 11 pp. 3 figs. Describes a statistically designed experiment for studying effects of the particle size of ammonium nitrate and the type of carbonaceous materials used on the incendivity of permissible explosives.
- RI 5868. Electrowinning Cerium-Group and Yttrium-Group Metals, by E. Morrice, B. Porter, E. A. Brown, C. Wyche, and R. G. Knickerbocker. 1961. 39 pp. 4 figs. Describes laboratory procedure and the requisite equipment for electrowinning ingot (liquid) cerium metal from a fused-fluoride bath. Considers bath properties and electrochemistry and a speculative model of the mechanisms involved.
- RI 5869. Froth Flotation and Chemical Processing of Colorado Ferberite Ores, by K. C. Dean and I. L. Nichols. 1961. 15 pp. 1 fig. Presents the combination of flotation and chemical processing methods used to treat typically low-grade ores from the Boulder County, Colo., area. The treatment produced specification-grade synthetic scheelite.
- RI 5870. Purification of Hafnium Tetrachloride by Alkali-Chloride Fusion, by A. Adams and H. O. Poppleton. 1961. 13 pp. 5 figs. Describes an attempt to produce a higher purity hafnium metal than that currently obtained by the Kroll process.
- RI 5871. Further Studies of the Fischer-Tropsch Synthesis Using Gas Recycle Cooling (Hot-Gas-Recycle Process), by J. H. Field, D. Bienstock, A. J. Forney, and R. J. Demski. 1961. 32 pp. 8 figs. Indicates that the system is operable and presents optimum conditions for gasoline production.
- RI 5872. Effects of Interstitial Impurity Levels on Mechanical Properties of Columbium at Low Temperatures, by M. D. Carver, J. T. Dunham, and H. Kato. 1961. 14 pp. 8 figs. Results showed the almost pure metal to be ductile at minus 194° C, the lower limit of the range used. Ductility of less pure columbium appeared to depend on the interstitial element content.
- RI 5873. Continuous Analysis of Helium in Natural Gas by Chromatography, by C. L. Klingman and J. D. Marshall. 1961. 17 pp. 8 figs. Describes an analyzer able to record automatically, at 5-minute intervals, the helium content of inlet or discharge gases from helium-extraction plants.
- RI 5874. Disposal of Liquid Wastes in the Durango-Type Uranium Milling Flowsheet, by K. E. Tame, E. G. Valdez, and J. B. Rosenbaum. 1961. 12 pp. 3 figs. Report is first of a series describing research by the Bureau on modifications in conventional uranium ore milling circuits that will confine and permit controlled disposal of radioactive wastes. A bench-scale simulation of the uranium mill flowsheet of the Durango, Colo., plant of the Vanadium Corporation of America was used to examine the possibility of reusing waste solutions—in effect to erase the need for disposal of the liquid waste. See also RI 6011, 6045, and 6114.
- RI 5875. Flotation of Bertrandite and Phenacite From Mount Wheeler, Nev., Beryllium Ore, by Richard Havens, W. I. Nissen, and J. B. Rosenbaum. 1961. 14 pp. Summarizes procedure developed and results obtained in bench-scale flotation tests.
- RI 5876. Forced Convection Heating of Steel Scrap in a Fuel-Fired Vertical Furnace, by R. J. Leary, W. O. Philbrook, and B. J. Mitchel. 1961. 32 pp. 16 figs. Presents study on design and operation of furnaces using steel scrap in arc furnace steel-making.

† Out of print.

- RI 5877. Flammability and Detonability Studies of Hydrogen Peroxide Systems Containing Organic Substances, by J. M. Kuchta, G. H. Martindill, M. G. Zabetakis, and G. H. Damon. 1961. 20 pp. 9 figs. Summarizes study on hazards created by presence of combustibles in peroxide liquid and vapor during such a process. Work done in cooperation with Solvay Process Division of Allied Chemical Corp. and Columbia Southern Chemical Corp.
- RI 5878. Determination of Oxide Solubility in Molten Fluorides, by Bernard Porter and E. A. Brown. 1961. 8 pp. 2 figs. Describes method used to prepare high-purity reactive metals. Includes bibliography.
- RI 5879. Effect of Temperature in Ion-Exchange Separation of Rare-Earth Elements and Recovery of EDTA From Effluent Solutions, by R. E. Lindstrom, J. O. Winget, and J. S. Berber. 1961. 16 pp. 11 figs. Presents one phase of a research program designed to assist technology of separating and purifying elements. Includes bibliography.
- RI 5880. Preparation and Metallic Reduction of Rare-Earth Halides and Oxides, by T. T. Campbell, F. E. Block, R. E. Mussler, and G. B. Robidart. 1961. 29 pp. 10 figs. Traces the development of techniques for the preparation of high-purity rare-earth metals. The metals were prepared by converting their oxides to anhydrous chlorides or fluorides and reducing the rare-earth halides with active metals such as lithium or calcium.
- RI 5881. Deformation of a Borehole in Rock, by Robert H. Merrill and Jon R. Peterson. 1961. 32 pp. 20 figs. Describes first phase of investigation to determine direction and magnitude of stresses in rocks surrounding an underground opening. Includes bibliography.
- RI 5882. Seismic Methods of Detecting and Delineating Subsurface Subsidence, by Leonard Obert and Wilbur I. Duvall. 1961. 28 pp. 19 figs. Discusses principal features and instrumentation for the travel-time, microseismic, travelttime difference, and seismic reflection methods.
- RI 5883. Comparison of Methods for Detecting and Analyzing Fumes From Explosives, by Edward J. Murphy. 1961. 13 pp. 2 figs. Presents a comparative study of several analytical methods for determining carbon monoxide and nitrogen oxides in toxic gases produced by detonation of explosives.
- RI 5884. Beneficiation of Uranium Ores, by K. E. Tame and J. B. Rosenbaum. 1961. 28 pp. 7 figs. Presents history of physical beneficiation of uranium ores. Reviews current conditions. Considers concentration of uranium ores by attrition grinding.
- RI 5885. Preparation of Ultrathin Sections of Coal, by J. T. McCartney, R. E. Walline, and Sabri Ergun. 1961. 5 pp. 3 figs. Describes the cutting of ultrathin sections of coals ranging in rank from lignite to anthracite. These sections are about 1 mm in area and 500 to 2,000 Å thick, about 1/100 of the thickness obtained by the earlier methods.
- RI 5886. Simulated Nuclear Reactor System for High-Temperature Process Heat: 1,000-Hour Demonstration Run at 2,500° F., by N. H. Coates, J. P. McGee, and G. E. Fasching. 1961. 15 pp. 16 figs. Explains part of the joint program of AEC and Bureau of Mines to supply process heat by the use of nuclear energy. Indicates that construction of a 250-psig helium-recycle system to operate with gas temperatures as high as 2,500° F appears feasible.
- RI 5887. Evaluating Cuyuna Manganese Resources by Sulfatizing, by Charles Prasky, R. L. Marovelli, and F. E. Joyce, Jr. 1961. 27 pp. 7 figs. Describes part of a continuing investigation of Cuyuna iron range manganese deposits in Crow Wing County, Minn. Reveals response to sulfatization of diverse low-grade manganese materials in the iron formation of Cuyuna district.
- RI 5888. In Situ Determination of the Dynamic Elastic Constants of Rock, by Harry R. Nicholls. 1961. 13 pp. 7 figs. Describes an economical method for determining the in situ longitudinal and shear velocities in rock from which elastic constants can be calculated. Work done in cooperation with U.S. Atomic Energy Commission.
- RI 5889. Isolation and Colorimetric Determination of Rhenium, by H. E. Peterson, J. S. MacDuff, and M. W. Hovey. 1961. 32 pp. 6 figs. Reveals a method for detecting and measuring minute quantities of the metal. Includes bibliography.
- RI 5890. Effects of Ultrasonics on Electrolytic Deposition of Copper and Zinc From Sulfate and Cyanide Electrolytes, by Charles B. Kenahan and David Schlain. 1961. 53 pp. 33 figs. Shows that ultrasonic radiation with frequencies of 20, 26, and 38 kilocycles per second permits the electrodeposition of copper in adherent, well-consolidated form from a copper sulfate-sulfuric acid solution at higher current densities (up to 300 amperes per square foot) and lower cell voltages.
- RI 5891. Recovery of Germanium, Cadmium, and Lead as Sulfides From Zinc Concentrates by Batch and Fluid-Solids Roasting, by A. G. Starliper, H. Kenworthy, and P. T. Gain. 1961. 21 pp. 6 figs. Both methods give satisfactory metallurgical recoveries, but the second process, which is continuous, is recommended because of inherent advantages. Final products are enriched fractions that can be treated by conventional methods for producing metallic germanium, cadmium, and lead.
- RI 5892. Thermochemistry of Erbium, by R. L. Montgomery and J. M. Stuve. 1961. 10 pp. Reveals heats of solution of erbium chloride in water and in hydrochloric acid and of erbium oxide in hydrochloric acid.
- RI 5893. Preparing Boron by Fused-Salt Electrolysis: A Preliminary Study, by D. Z. Hobbs, T. T. Campbell, and F. E. Block. 1961. 17 pp. 3 figs. Describes investigations directed toward the development of techniques for the preparation of pure boron by fused-salt electrolysis.
- RI 5894. Chloridizing the Sulfides of Lead, Zinc, and Copper, by K. K. Kershner and J. G. Donaldson. 1961. 19 pp. 15 figs. Considers a study designed to provide background data for extending and improving applications of chlorine metallurgy in extracting metals from ores.
- RI 5895. Producing and Ladle-Treating Medium-Carbon Alloy Steels With Rare-Earth Metals and Oxides, by R. J. Leary, E. J. Ostrowski, and N. Derick. 1961. 50 pp. 14 figs. Investigates effect of ladle additions of small quantities of rare-earth metals or their oxides in wrought and in cast plain carbon and alloy mechanical steels containing approximately 0.35 percent carbon. Work done in cooperation with Ordnance Corps, Watertown Arsenal, U.S. Department of the Army.
- RI 5896. Combustion at Elevated Pressures in a Spherical Vessel, by Joseph Grumer, Edwin B. Cook, J. Kenneth Richmond, and Theodore A. Kubala. 1961. 19 pp. 7 figs. Describes an instrumented vessel for determining burning velocities of ethylene-air mixtures with initial pressures as high as 20 atm.
- RI 5897. Ferrochromium From Western Metallurgical-Grade Chromite, by Willard L. Hunter and Gary A. Kingston. 1961. 9 pp. Samples of chromite ore and concentrate are smelted in a submerged-arc furnace to establish smelting conditions and the energy requirement to produce high-carbon ferrochromium.

- RI 5898. Field Test for Columbium, by T. N. McVay and Annie G. Smelley. 1962. 9 pp. Discusses mineralogy of columbium-tantalum minerals and the sensitivity and reliability of the test. Work done in cooperation with University of Alabama.
- RI 5899. Electric Smelting and Gaseous Refining of Cement-Copper Precipitate, by F. E. Brantley, R. G. Peterson, and J. B. Clemmer. 1961. 14 pp. 8 figs. Discusses research made to delineate problems of smelting and refining the element to commercial-grade products.
- RI 5900. Heats and Free Energies of Formation of Some Hydrated and Anhydrous Sodium- and Calcium-Aluminum Silicates, by R. Barany. 1961. 17 pp. Gives results of experiment conducted to obtain heats of formation at 298.15° K of analcite, lawsonite, anorthite, and leonhardtite.
- RI 5901. Heats and Free Energies of Formation of Anhydrous Silicates, by K. K. Kelley. 1961. 32 pp. Presents up-to-date data on temperatures above 298.15° K. Contains tables for 51 substances. Includes bibliography.
- RI 5902. Synthetic Fuel From Coal for Supersonic Aircraft, by M. D. Schlesinger and R. W. Hiteshue. 1961. 19 pp. 5 figs. Describes a fuel, prepared from low-temperature tar, that meets most of the specifications for a thermally stable jet fuel.
- RI 5903. Semiquantitative Spectrographic Analysis of Tungsten, by M. J. Peterson and C. L. Chaney. 1961. 17 pp. 11 figs. Presents a spectrographic procedure applicable to the semiquantitative determination of 29 elements in tungsten. The method is designed to give estimates of impurity concentrations up to 500 ppm. Limits of detectability range from 0.3 to 100 ppm.
- RI 5904. Low-Temperature Carbonization Assays of Coals and Relation of Yields to Analyses, by W. S. Landers, J. B. Goodman, and D. J. Donaven. 1961. 41 pp. 3 figs. Summarizes results of 220 carbonization assays conducted on selected coals from 12 States and 9 foreign countries.
- RI 5905. Washability Examinations of Coals From the Rocky Mountain and Pacific Coast States, by M. R. Geer and H. F. Yancey. 1961. 34 pp. Compares results of examinations made on coals from Oregon, Idaho, Wyoming, Utah, and Washington. Includes specific gravity data on each bed. Work done in cooperation with University of Washington.
- RI 5906. Lightweight Aggregates: Expansion Properties of Clays, Shales, and Precambrian Rocks of Wisconsin, by W. A. Cole, G. F. Hanson, and W. T. Westbrook. 1961. 26 pp. 1 fig. Covers preliminary phase of investigation to determine feasibility of processing lightweight aggregates in Wisconsin.
- RI 5907. Field Test for Germanium, by W. M. Dressel. 1962. 4 pp. Describes a simple test for detecting the metallic element in rocks, coals, and flue dust. The test can be used by persons who are not highly trained in analytical chemistry. Amounts as small as 0.001 percent can be detected by this method. 10 cents.
- RI 5908. Hydrogenation of Coal at Short Retention Times, by Paul S. Lewis, Henry H. Ginsburg, and Raymond W. Hiteshue. 1961. 14 pp. 9 figs. Bench-scale experiments show the gross effect of retention times from 0.1 to 14.5 minutes on the conversion of high-volatile C bituminous coal to liquids and gases.
- RI 5909. Preparation Characteristics of Coal From Boone County, W. Va., by T. E. Gray and E. R. Palowitch. 1961. 39 pp. 3 figs. Describes preparation characteristics of the significant coalbeds in Boone County, W. Va. Indicates the coals suitable for producing metallurgical coke, either as mined or after beneficiation.
- RI 5910. Extraction and Separation of Yttrium and Rare-Earth Elements Found in Euxenite, by William G. Gruzensky. 1961. 22 pp. 2 figs. A separation factor of 10.92 was obtained between yttrium and cerium from a single-stage extraction, and a factor of 1.78 was obtained between yttrium and erbium from a multi-stage system. Study included extraction from euxenite concentrate, separation by solvent extraction, fractional precipitation studies, chelate fractionations, fractionation by thermal decomposition, rare-earth extractions with nonaqueous systems, and separation by aliphatic amines.
- †RI 5911. Production of Synthesis Gas and Hydrogen by the Steam-Iron Process: Pilot Plant Study of Fluidized and Free-Falling Beds, by S. J. Gasior, A. J. Forney, J. H. Field, Daniel Bienstock, and H. E. Benson. 1961. 49 pp. 31 figs. A mixture of iron and iron oxide from 20- to 100-mesh was partially reduced with a simulated producer gas and then oxidized with steam and/or carbon dioxide. Results showed the effects of pressure, temperature, bed height, gas-to-solids ratio, type of iron oxide, and composition of gas on the gas and solids conversions during reduction and oxidation.
- RI 5912. Carbonizing Tests With Tuscaloosa Oven: Hardness of Cokes From Blends Containing Added Inerts, by J. B. Gayle and W. H. Eddy. 1961. 22 pp. 5 figs. Presents results of testing with wider range of inerts and determines applicability of conclusions using sole-heated oven. Work done in cooperation with University of Alabama.
- RI 5913. Calculated Equilibrium Gas Composition of Water-Carbon Dioxide Mixtures Over Iron at Pressures of 1 to 30 Atmospheres and Temperatures of 800° to 1,300° K., by W. P. Haynes and R. W. Smith, Jr. 1961. 40 pp. 55 figs. Discusses a modified steam-iron process for producing hydrogen; a fluidized bed is used instead of the conventional cyclic, fixed-bed system. Goals sought include improved thermal efficiency, the production of synthesis gas (hydrogen plus carbon monoxide), and possibly the production of a high-Btu gas starting with coal-derived producer gas.
- †RI 5914. Engineering Study of Water Injection in 14 Oil Reservoirs of North Louisiana, by Paul Meadows, M. E. Hawkins, L. K. Weaver, and O. W. Jones. 1962. 143 pp. 63 figs. Describes 14 water-injection projects and discusses 9 of the 14 fully. Work done in cooperation with Louisiana Department of Conservation.
- RI 5915. Hydraulic Coal Mining Research: Equipment and Preliminary Tests, by J. J. Wallace, G. C. Price, and M. J. Ackerman. 1961. 25 pp. 13 figs. Describes initial phase of research and outlines proposed future research. Tests were conducted in the comparatively flat-lying Pittsburgh coalbed. RI 6276, published in 1963, describes further tests of hydraulic mining methods in a steeply pitching coalbed, Roslyn No. 5 in the State of Washington.
- RI 5916. Recovery of Thorium From Ores in Colorado, Idaho, and Montana, by S. R. Borrowman and J. B. Rosenbaum. 1962. 35 pp. 14 figs. Summarizes results of procedures to recover thorium and finds that thorite ores are amenable to treatment by an acid-leach solvent extraction process, analogous to that employed by some uranium mills.
- RI 5917. Recovery of Thorium From a Wyoming Ore, by S. R. Borrowman and J. B. Rosenbaum. 1962. 8 pp. 1 fig. Discusses method of extracting thorium oxide from monazite concentrate by sulfuric acid leach-amine solvent extraction process and recovering rare-earth products from the raffinate.

† Out of print.

- RI 5918. Separating Tantalum and Columbium by Solvent Extraction: HF-HCl-Diethyl Ketone System, by Willard L. Hunter and Kenneth B. Higbie. 1962. 10 pp. 3 figs. Summarizes method used for extracting, separating, and reducing these elements to metal.
- RI 5919. Calcium Fluoride Additions to Chlorination Reactions, by A. W. Henderson and F. E. Block. 1962. 19 pp. 9 figs. Presents study of chlorination reactions in presence of fluorine donor and shows that recovery of tantalum and columbium or hafnium and zirconium is increased.
- RI 5920. Effect on Cricondenbar and Other Phase-Boundary Pressures of Adding Light Hydrocarbons, Nitrogen, and Carbon Dioxide to Oils and Gas-Condensate Fluids, by L. M. Burman, Byron A. Baker, and C. Kenneth Eilerts. 1962. 41 pp. 13 figs. Indicates a procedure for calculating the effect on phase-boundary properties produced by adding light components to reservoir fluids, using certain correlations of critical temperature, critical pressure, and cricondenbar pressure. Nitrogen, carbon dioxide, the light hydrocarbons, and a natural hydrocarbon gas were added to a reservoir oil and to three gas-condensate fluids in 100 different concentrations. The results demonstrate how changes in composition affect phase-boundary pressure.
- RI 5921. A Method of Predicting Performance of Five-Spot Waterfloods in Stratified Reservoirs Using Streamlines, by R. V. Higgins and A. J. Leighton. 1962. 23 pp. 21 figs. Presents a method of calculating the performance of a waterflood starting in either the primary or secondary phase of recovery.
- RI 5922. Beneficiating and Smelting Carter Creek, Mont., Iron Ore, by Wesley T. Holmes II, W. Floyd Holbrook, and Lloyd H. Banning. 1962. 21 pp. 7 figs. Discusses laboratory-scale beneficiation tests made on handpicked and bulk samples, an agglomeration test on the concentrates, and smelting tests on fine magnetic concentrates.
- RI 5923. Amines in Liquid-Liquid Extraction of Rare-Earth Elements, by A. C. Rice and C. A. Stone. 1962. 15 pp. 8 figs. Describes part of a research program to implement technology of separation and purification of rare-earth elements.
- RI 5924. Leaching Michigan Copper Ore and Mill Tailings With Acidified Ferric Sulfate, by A. F. Colombo and D. W. Frommer. 1962. 12 pp. 6 figs. Discusses technical feasibility of leaching system including effects of roasting before leaching and long-residence leaching.
- RI 5925. Iron-Gadolinium Phase Diagram, by M. I. Copeland, M. Krug, C. E. Armantrout, and H. Kato. 1962. 16 pp. 10 figs. The iron-gadolinium phase diagram was investigated by careful techniques, including melting-point determinations, thermal analyses, metallographic examination, and X-ray diffraction analyses. Investigation is part of a program sponsored by U.S. Atomic Energy Commission to investigate rare-earth alloys.
- RI 5926. Carbonizing Properties of Perry County, Ky., Coals, by G. W. Birge and D. E. Wolfson. 1962. 15 pp. 3 figs. Gives results of an investigation of the carbonizing properties of seven samples from the Hindman, Flag, Haddix, and Fire Clay beds.
- RI 5927. Carbonizing Properties of Butler County, Pa., Coals, by G. W. Birge and D. E. Wolfson. 1962. 12 pp. 3 figs. Gives results of investigation on carbonizing properties of eight samples from Upper Freeport, Lower Freeport, Upper Kittanning, Middle Kittanning, Lower Kittanning, Clarion, and Brookville beds in Pennsylvania by the standard method BM-AGA carbonization test.
- RI 5928. A Rapid Twist Test for Determining Hot-Forming Temperatures of Steels, by C. S. Tout, Jr., and Lloyd H. Banning. 1962. 22 pp. 18 figs. Discusses a simple test for evaluating the formability of low-nickel austenitic stainless steels. These tests can be made in a newly developed twist-test machine in a few minutes. Includes turn-to-failure data and a list of references.
- RI 5929. Return-Line Corrosion in Federal Heating Systems, by A. A. Berk and G. L. Hopps. 1962. 42 pp. 8 figs. Summarizes current practices for controlling corrosion in Government-operated steam heating plants. Contains analytical methods that were developed for investigating filming treatment.
- RI 5930. Thermodynamic Functions for Internal Rotations That Involve Rotational Isomerism, by D. W. Scott and J. P. McCullough. 1962. 27 pp. 6 figs. Presents tables of contributions for two potential functions.
- RI 5931. Effect of Sulfur Retention on Determined Ash in Lower Rank Coals, by W. H. Ode and F. H. Gibson. 1962. 11 pp. Describes results of an investigation for determining sulfur content in ash of 2 German brown coals and 22 American lignites, and also some simple modifications of the ashing procedure to minimize retention.
- RI 5932. Analytical Method for Study of Thermal Degradation of Oil Shale, by John Ward Smith. 1962. 17 pp. 2 figs. Presents an analytical method designed to provide for control of retorting conditions, precise direct gravimetric measurement of the thermal degradation products, samples of all products, determination of the identities and amounts of gaseous compounds produced, elemental analysis and gross heating value of all products, and the determination of the distribution in the retorting products of the elements in the original samples.
- RI 5933. Quality of Zirconium Prepared by Different Reductants, by Gerald W. Elger. 1962. 20 pp. 10 figs. Compares quality of the metal prepared by batch reduction of zirconium tetrachloride by sodium, magnesium, and mixtures of sodium and magnesium at temperatures of 700° to 850° C. Work done in cooperation with U.S. Atomic Energy Commission.
- RI 5934. Production of Molybdenum Metal by Magnesium Reduction of Molybdenum Oxides, by T. T. Campbell, F. E. Block, and E. R. Anderson. 1962. 22 pp. 13 figs. Describes procedures for preparing high-purity ductile molybdenum of uniform quality by bomb-reduction techniques. Discusses experimental results and properties of bomb-reduced molybdenum trioxide.
- RI 5935. Structural and Optical Data on Synthetic Asbestiform Materials: Potassium-lead Silicate and Lead-Aluminum Silicate, by Gerald V. Gibbs, Irving L. Turner, and F. Donald Bloss. 1962. 11 pp. 3 figs. Provides crystallographic data for synthetic isotypic compounds $K_2 \cdot Pb_4 \cdot Si_8 \cdot O_{24}$ and $Pb_2 \cdot Pb_4 \cdot Al_3 \cdot Si_8 \cdot O_{24}$. Includes powder data, accurate cell edges, unit cell contents, optical properties, and provisionally assumed space group symmetry.
- RI 5936. Properties of Arc-Melted Iron-Chromium Alloys, by G. Asai and H. Kato. 1962. 14 pp. 12 figs. Determines properties for arc-melted binary alloys having chromium contents ranging from 12 to 50 weight-percent. Discusses experimental work and results.
- RI 5937. Preparing Metal-Grade Vanadium Oxide From Red Cake and Mill Solutions, by C. J. Chindgren, L. C. Bauerle, and J. B. Rosenbaum. 1962. 14 pp. Describes methods for upgrading commercial red cake and for manufacturing metal-grade oxide directly from uranium mill solutions.

- RI 5938. Studies of the MnO-SiO₂ Binary System, by E. L. Singleton, L. Carpenter, and R. V. Lundquist. 1962. 31 pp. 8 figs. Considers the chemical and physical characteristics of the condensed MnO-SiO₂ system; contains fundamental data which should permit a better understanding of the more complex slag systems.
- RI 5939. Sintering and Smelting Manganese Concentrates From Maggie Canyon Ore, Artillery Mountains Area, Ariz., by V. E. Edlund and R. S. Lang. 1962. 27 pp. 5 figs. Deals with pyrometallurgical treatment of flotation concentrate and manganese precipitate, prepared by the standard ferromanganese method. Discusses plant-scale sintering and smelting process for recovering manganese from the ore.
- RI 5940. Concentration of Pollucite Ores, by K. C. Dean and I. L. Nichols. 1962. 10 pp. Describes cationic froth flotation method used to recover pollucite from ores taken from Maine, Southern Rhodesia, and Canada. Discusses separation of cesium and rubidium.
- RI 5941. Solvent Extraction of Beryllium From Sulfate Solutions by Alkylphosphoric Acids, by R. O. Dannenberg, D. W. Bridges, and J. B. Rosenbaum. 1962. 16 pp. 3 figs. Presents experiments and reviews theoretical aspects of the use of organophosphate solvent extraction for recovering beryllium from sulfate leach liquors. Discusses procedures and experimental and supplemental results.
- RI 5942. Foam Concentration of Scandium by D. J. Bauer. 1952. 15 pp. 17 figs. Describes apparatus and experiments made to assess the technical feasibility of concentrating scandium from dilute solutions by foam fractionation techniques; discusses analytical procedure.
- RI 5943. Electrochemical Reduction of Coal, by Heinz W. Sternberg and Irving Wender. 1962. 10 pp. Reviews the literature on electrochemical treatment of coal and evaluates possible paths of future research. Considers electrolytic reduction of coal in amines, reduction of coal by electrolytically generated free-radical anions, reduction potentials of aromatic structure in coal, introduction of carboxyl groups into coals, and the mechanism of hydrogen addition to condensed aromatic structures.
- RI 5944. Refractory Properties of Magnesia Spinel Recovered From Dusting Slags, by M. E. Tyrrell. 1962. 8 pp. 4 figs. Three types of refractory bricks were studied: Dense, lightweight bubble, and insulating. Test specimens were fabricated by dry pressing, fired to 1,675° C, and tested by common industrial procedures. The concentrates produced a refractory with satisfactory density and mechanical strength.
- RI 5945. Corrosion of Zirconium in Cupric and Ferric Chlorides, by D. J. Stoops, M. D. Carver, and H. Kato. 1962. 11 pp. 7 figs. Discusses the effect of metallurgical and surface treatments on the corrosion behavior of arc-melted reactor-grade zirconium in cupric or ferric chloride solutions. An apparatus was constructed, and specimens with various metallurgical conditions and surface treatments were tested for 6 days at 35° C, with aeration.
- RI 5946. The Performance and Operating Characteristics of an Image Furnace Having 60-Inch Double Paraboloid Mirrors, by Edwin E. Maust, Jr., and Wilbert E. Warnke. 1962. 48 pp. 6 figs. Indicates the limitations and characteristics of the furnace. Considers the quantitative determination of the energy available at the image, the control of this energy by a 60-inch iris diaphragm, and its variation with position and time relative to the heat source.
- RI 5947. Tests of Additives To Control Soot Deposition in Oil-Fired Boilers, by G. L. Hopps, A. A. Berk, and J. F. Barkley. 1962. 19 pp. 4 figs. Various chemicals, including compounds of copper and lead, were added to a mixture of No. 2 and No. 6 fuel oils that was fired in an experimental furnace. Tests were made to determine the effectiveness of these chemicals in removing soot deposits on probes devised to stimulate heat-transfer surfaces in boilers and the effectiveness of the chemicals in preventing the deposition of soot on the probe surface.
- RI 5948. Mount Eddy and Shasta View Asbestos Deposits, Siskiyou County, Calif., by Kevin Malone, W. T. Benson, and A. L. Engel. 1962. 29 pp. 9 figs. Gives drill-log data for core drills from four drill holes on the Mount Eddy property and two drill holes on the Shasta View property. Results of mineral-dressing tests, pilot plant test for recovery of asbestos, and a summary of cost of the investigation are included.
- RI 5949. Effects of Hafnium Additions on Properties of Vanadium, by R. L. Lincoln and H. Kato. 1962. 17 pp. 2 figs. Additions of small amounts of hafnium resulted in lessened as-cast hardness, decreased electrical resistivity, impaired rollability, increased oxidation resistance, and greater tensile strength. Larger amounts of hafnium caused greater as-cast hardness, increased electrical resistivity, further impaired rollability, a continued increase in oxidation resistance, and lessened tensile strength.
- RI 5950. Bituminous Coal Deposits of the Matanuska Coalfield, Alaska: Central and Western Parts, Wishbone District, by Robert S. Warfield. 1962. 190 pp. 11 figs. Describes the program conducted by the Bureau from 1949 through 1958. This study proved the existence of the Jonesville coal group in the vicinity of the Buffalo mine, provided additional information on the synclinal structure (including a more accurate location of the axis), and determined the character and quality of the coal over a much larger area than previously explored.
- RI 5951. Chemical Reactions in the Electric Arc: Reactive Metal Carbides, by E. D. Calvert, M. M. Kirk, and R. A. Beall. 1962. 13 pp. 7 figs. Examines the preparation of refractory metal carbides in the controlled atmosphere electric-arc furnace. Describes a new technique for producing pure carbides which uses the intense heat of the arc to volatilize the carbides.
- RI 5952. Computing Ore Reserves by the Polygonal Method Using a Medium-Size Digital Computer, by Richard F. Hewlett. 1962. 31 pp. 12 figs. Describes a program, which is limited to using vertical drill-hole data, that computes ore reserves for a low-grade deposit. Modifications needed for computing other types of deposits are explained.
- RI 5953. Flotation of Titanium Minerals From the Roseland Anorthosite, Near Roseland, Nelson County, Va., by V. F. Swanson and J. E. Shelton. 1962. 21 pp. 5 figs. Samples of altered rock (saproilite) and unaltered rock were tested for amenability to beneficiation by flotation. The study showed that it is possible to produce a bulk concentrate of mixed titanium minerals (ilmenite, rutile, leucocoxene, and sphene) from the Roseland anorthosite.
- RI 5954. Low-Temperature Heat Capacities and Entropies at 298.15° K. of Three Calcium Vanadates, by E. G. King and W. W. Weller. 1961. 6 pp. 1 fig. Gives analogous data for calcium metavanadate (CaV₂O₆), calcium pyrovanadate (Ca₂V₂O₇), and calcium orthovanadate (Ca₃V₂O₈).

- RI 5955. A Study of Copper Reverberatory Slags From White Pine, Mich., by L. M. Irwin, R. E. Lubker, and R. A. Marsyla. 1962. 23 pp. 19 figs. Slag fluidity and refractive indices varied directly with the iron content and inversely with silica, lime, and alumina. There was no apparent correlation between slag fluidity and its copper content.
- †RI 5956. Operating a Pressure-Gasification Pilot Plant Using Pulverized Coal and Oxygen: Effect of Heat Loss on Economy, by J. H. Holden, K. D. Plants, G. R. Strimbeck, and L. F. Willmott. 1962. 32 pp. 15 figs. Indicates the direction and magnitude of the changes to be expected in the dependent variables of the pressure-gasification process when any of several interdependent factors such as pressure, coal-feed rate, oxygen-to-coal ratio, steam-to-coal ratio, and heat loss is varied.
- RI 5957. Effects of Impurities on Sintered Mullite, by M. E. Tyrrell. 1962. 15 pp. 8 figs. To promote greater use of abundant domestic raw materials in manufacturing synthetic mullite, the Bureau has investigated the effects of the impurity oxides TiO_2 , Fe_2O_3 , and alkali on physical properties of sintered mullite-forming mixtures. Laboratory results indicate that refractories of sintered mullite based on domestic siliceous bauxite may be substituted for imported kyanite with little or no sacrifice in performance.
- RI 5958. Bureau of Mines Coal-Fired Gas Turbine Research Project: Redesign and Assembly of Turbine, by J. P. McGee, J. Smith, R. W. Cargill, and D. C. Strimbeck. 1962. 19 pp. 21 figs. Describes redesigning of the turbine blading by the Bureau of Mines in an effort to solve the problem of blade erosion and the progress made by the Bureau in assembling a coal-fired gas turbine plant at Morgantown, W. Va. Work done in cooperation with Bituminous Coal Research, Inc.
- RI 5959. Electrorefining Beryllium. Studies of Operating Variables, by M. M. Wong, R. E. Campbell, and D. H. Baker, Jr. 1962. 14 pp. 4 figs. Presents a study of the electrorefining of beryllium in electrolytes composed of $LiCl-KCl$ eutectic mixture plus varying amounts of $BeCl_2$. Results showed a 99-percent or better reduction of oxygen and magnesium and a substantial reduction of other minor metallic impurities.
- RI 5960. Precipitation and Electrodeposition of Mercury in Caustic Solutions, by J. W. Town, R. F. Link, and W. A. Stickney. 1962. 19 pp. 1 fig. Summarizes the results of laboratory investigations of the recovery of mercury from caustic sulfide solutions by aluminum precipitation and electrodeposition. Statistical methods were used to design the experiments and to evaluate the resulting data.
- RI 5961. Behavior of Clays Associated With Low-Rank Coals in Coal-Cleaning Processes, by H. F. Yancey and M. R. Geer. 1962. 10 pp. 2 figs. The pronounced tendencies of these clays to disintegrate in water, to form plastic masses, and to swell with resulting decrease in density have definite implications for the design and operation of preparation plants. First, water classification will be difficult and costly, involving extra filter capacity or settling ponds. Second, this clay cannot be removed in washing as completely as the usual shales. Third, the jig offers certain advantages.
- RI 5962. Titaniferous Magnetite Deposits, Los Angeles County, Calif., by W. T. Benson, A. L. Engel, and H. J. Heinen. 1962. 40 pp. 16 figs. Discusses field work undertaken in 1956-58 to determine the extent and character of the deposits in the western San Gabriel Mountains. Summarizes earlier work in the area by the Bureau and others.
- RI 5963. Experiments in Purifying Solutions From Lime-Sintered Beryl Concentrates, by J. M. Riley. 1962. 10 pp. 1 fig. Summarizes experiments in purifying sulfate leach liquors prepared from low-tenor beryl concentrates by modifying the Degussa process. These experiments emphasized the problems inherent in purifying grossly contaminated beryllium leach liquor, but they did not delineate feasible means for surmounting the difficulties.
- RI 5964. High-Temperature Heat Contents and Entropies of Zirconium Fluoride and Zirconium Sulfate, by D. F. Smith, W. C. Miller, and A. R. Taylor, Jr. 1962. 3 pp. 1 fig. Reports experimental heat content values determined for these two zirconium salts between 273° and $1,200^\circ$ K. No crystalline transformations were found in the two compounds, and neither melted over the temperature range studied. Work done in cooperation with the University of Alabama.
- RI 5965. Heats and Free Energies of Formation of Gallium Sesquioxide and Scandium Sesquioxide, by Alla D. Mah. 1962. 6 pp. Reports newly determined values of the heats of formation at 298.15° K (obtained by combustion calorimetry) and the corresponding free energies of formation (derived from heat and entropy data).
- RI 5966. Fluorescent X-Ray Spectrography: Determination of Trace Elements, by William J. Campbell and John W. Thatcher. 1962. 29 pp. 5 figs. Considers the status of this technique in studies involving trace elements. Fluorescent X-ray spectrography can be used to obtain absolute values (by preparation of standard samples) or relative values based on standards analyzed by other means. Since X-ray techniques are nondestructive, both standards and unknowns are conserved for use in other evaluation procedures.
- RI 5967. Thermodynamic Properties of Strontium Bromide and Strontium Nitrate, by A. R. Taylor, Jr., and D. F. Smith. 1962. 12 pp. 2 figs. The heat capacities of these two alkaline earth compounds were measured between 60° and 300° K in an adiabatic calorimeter and between 300° and $1,200^\circ$ K in a Bunsen ice calorimeter. The resulting data were extrapolated to 0° K, and smooth values of heat capacity, entropy, enthalpy function, and free energy function were calculated and tabulated at 10-degree intervals. Work done in cooperation with the University of Alabama.
- RI 5968. Review of Criteria for Estimating Damage to Residences From Blasting Vibrations, by Wilbur I. Duvall and David E. Fogelson. 1962. 19 pp. 6 figs. Advocates that consideration should be given to the measurement of particle velocity versus time rather than to displacement or acceleration. Recommends that vibration levels near residential structures be maintained below a peak particle velocity of 2 inches per second.
- RI 5969. Radiation Hazards Encountered in Arc Melting Thorium, by R. R. Lowery. 1962. 22 pp. 11 figs. A general air-sampling analysis was made to determine the separation, concentration, and distribution of thorium daughter products throughout arc-melting, machining, and forging processes of a thorium-handling facility. Lists precautions necessary when arc melting thorium. Work done in cooperation with the U.S. Atomic Energy Commission.
- RI 5970. A Computer Program for Calculating Coordinates and Elevations of Survey Stations Located by Intersection, by F. L. Wideman and T. E. Caldwell. 1962. 37 pp. 6 figs. Describes a computer program used to calculate coordinates and elevations of subsidence survey pins located by in-

† Out of print.

- tersection. Includes a description of the survey, an explanation of the computer program, a brief discussion of possible applications of the program, and the complete coded program.
- RI 5971. Explosibility of Dusts Used in the Plastics Industry, by Murray Jacobson, John Nagy, and Austin R. Cooper. 1962. 30 pp. 1 fig. Considers the dust-explosion hazard in air of materials used in the plastics industry. Information, based on studies of 313 samples, is given on ignition temperature of dust clouds and layers, minimum explosive concentration, minimum energy required for ignition, explosion pressure and rates of pressure rise, and amount of inert dust required to prevent ignition and flame propagation. (See also RI 5753, 6516, and 6597.)
- RI 5972. Heats and Free Energies of Formation of Antimony Sesquioxide and Tetroxide, by Alla D. Mah. 1962. 5 pp. Gives heats of formation obtained by combustion-bomb calorimetry and free energies of formation obtained by combination of heat and entropy data. The new values are believed to substantially improve the accuracy of thermodynamic considerations involving these oxides.
- RI 5973. Heats of Formation of Sodium Molybdates and Tungstates, by Mary F. Koehler, L. B. Pankrat, and R. Barany. 1962. 13 pp. Contains values of the heats of formation of two sodium molybdates—sodium monomolybdate and sodium dimolybdate—and three sodium tungstates—sodium monotungstate, sodium ditungstate, and sodium tetratungstate. The experimental method was solution calorimetry. The solution medium was sodium hydroxide solution, except that hydrofluoric acid solution was used for sodium tetratungstate.
- RI 5974. Concentration, Calibration, and Operation of a Low-Temperature Adiabatic Calorimeter, by A. R. Taylor, Jr., and D. F. Smith. 1962. 17 pp. 1 fig. Describes a calorimeter for measuring heat capacities of solids or liquids from 60° to 300° K. Briefly considers the basic theory of chemical thermodynamics and the problems involved in obtaining accurate experimental data. Work done in cooperation with the University of Alabama.
- RI 5975. Some Properties of Vanadium, by R. Lincoln, G. Asai, and H. Kato. 1962. 33 pp. 3 figs. A surplus of vanadium has resulted from the tremendous output of uranium, of which vanadium is a byproduct, but the metal's physical and mechanical properties must be better understood before its utilization can be substantially increased. This report considers some of these properties.
- RI 5976. Determination of Alcohols by Their Trimethylsilyl Ethers, by Charles Zahn, A. G. Sharkey, Jr., and Irving Wender. 1962. 33 pp. 3 figs. Reviews Bureau investigations of the mass spectrometric and gas-liquid chromatographic behavior of trimethylsilyl ethers, the development of methods for analyzing alcohols by their trimethylsilyl ethers, and the preparation and properties of the trimethylsilyl ethers of alcohols.
- RI 5977. Removing Methane (Degasification) From the Pittsburgh Coalbed in Northern West Virginia, by W. M. Merritts, W. N. Poundstone, and B. A. Licht. 1962. 39 pp. 22 figs. Describes the equipment, procedure, and results of an experiment in removing methane before and during mining.
- RI 5978. Borehole Deformation Gage for Determining the Stress in Mine Rock, by Leonard Obert, Robert H. Merrill, and Thomas A. Morgan. 1962. 11 pp. 5 figs. Describes a gage that will measure the borehole deformation resulting from strain relief. Use of the borehole deformation data will permit the calculation of the magnitude and direction of the principal stresses in a plane normal to the axis of the borehole. The design considerations, mechanical construction, sensitivity, and stability of the gage are discussed.
- RI 5979. Corrosion Study of the Hot-Carbonate System, by D. Bienstock, J. H. Field, and J. G. Myers. 1962. 20 pp. 7 figs. Indicates the corrosion rates of steel in boiling solutions of potassium carbonate saturated with carbon dioxide and hydrogen sulfide. Examines the effectiveness of various inhibitors.
- RI 5980. Use of Radioactive Tracers in Beryllium Extractive Metallurgy Research, by A. M. Poston, Jr., J. V. Batty, and H. L. Gibbs. 1962. 10 pp. Discusses the problems encountered and resolved in using radioactive tracers and radiometric methods, defines the conditions and techniques for their effective use, and delineates the limitations and flexibility inherent in applying such methods in laboratory-scale beryllium research.
- RI 5981. Melting Temperatures of Fluoricas and Related Compounds, by John K. Alley and H. R. Shell. 1962. 32 pp. 4 figs. The melting temperature of fluorphlogopite was found to be between 1,382° and 1,384° C. This temperature was determined by studying single crystals, the heating behavior of glass of fluorphlogopite composition, and the crystallization of fluorphlogopite from a melt that had been heated above 1,430° C.
- RI 5982. Thermal Expansion and Phase Inversion of Six Refractory Oxides, by Clark F. Grain and William J. Campbell. 1962. 21 pp. 10 figs. Considers thermal expansion and phase inversion measurements, obtained by high-temperature X-ray diffractometry, on the principal oxides of beryllium, calcium, titanium, zirconium, hafnium, and thorium. All are high-purity commercially available oxides.
- RI 5983. Chlorination of Titaniferous Slags: A Study of the Moving Bed Technique, by E. C. Perkins, H. Dolezal, H. Leitch, and R. S. Lang. 1962. 17 pp. 4 figs. Discusses the feasibility of producing titanium tetrachloride by chlorinating titaniferous slags produced from domestic deposits.
- RI 5984. Low-Temperature Heat Capacity and Entropy at 298.15° K. of Scandium, by W. W. Weller and K. K. Kelley. 1962. 3 pp. 1 fig. Reports heat capacity data for scandium metal between 50° and 298° K and the entropy value at 298.15° K.
- RI 5985. Pulse-Forming Circuitry for Explosives Research, by M. L. Bowser and F. C. Gibson. 1962. 8 pp. 10 figs. Covers ionization probes, counter-chronograph input circuitry, multiple-channel pulse generator for rate of propagation measurements using oscilloscope recording, and use of the multiple-channel pulse generator.
- RI 5986. Reconnaissance Studies of Alaskan Beach Sands, Eastern Gulf of Alaska, by Bruce I. Thomas and Robert V. Berryhill. 1962. 38 pp. 13 figs. Includes analyses of sands from 201 auger-hole and 33 shovel samples collected along 247 miles of Gulf of Alaska coast between Kiklukh River and Icy Point.
- RI 5987. Columbium-Vanadium Binary Alloys for High-Temperature Service, by H. R. Babitzke, G. Asai, and H. Kato. 1962. 13 pp. 10 figs. Covers tests of 13 different columbium-vanadium alloys to develop one for use at high temperatures and for nuclear applications.
- RI 5988. Underground Blasting Accident Involving an Air-Placed Ammonium Nitrate-Fuel Oil Mixture, by R. W. Van Dolah, G. M. Kintz, and W. Marion Baker. 1962. 13 pp. 3 figs. Reports on the premature detonation of an explosive charge in an underground salt mine in Louisiana in January 1961. The fatality that resulted was the first to be reported to the Bureau in connection with

- the use of ammonium nitrate-fuel oil blasting agents in underground mines in the United States.
- RI 5989. Effects of Selected Operating Variables on Continuous-Cell Flotation of Coal: A Laboratory Study, by J. B. Gayle and W. H. Eddy. 1962. 18 pp. 8 figs. The variables considered include particle size of the feed, composition of the feed, percentage of solids in the feed, emulsifying reagents, feed rate, cell depth, impeller speed, and the gas used for aeration.
- RI 5990. Chemical and Galvanic Corrosion Properties of High-Purity Vanadium, by Charles B. Kenahan, David Schlain, and Walter L. Acherman. 1962. 22 pp. 10 figs. Presents data on chemical and galvanic corrosion properties of high-purity vanadium in substitute ocean water, tapwater, 3-percent sodium chloride and 10-percent sodium hydroxide solutions, 20-percent ferric chloride and cupric chloride solutions, and various other organic and inorganic acids.
- RI 5991. Investigation of Mercury-Antimony Deposits Near Flat, Yukon River Region, Alaska, by R. P. Maloney. 1962. 44 pp. 8 figs. Describes an investigation of mercury-antimony deposits in the Iditarod mining district. Bedrock was exposed in over 10,000 linear feet of bulldozer trenches from which 83 channel samples were taken; 307 soil samples were taken over selected areas. Summarizes surface- and trench-sampling data and gives logs of 33 trenches.
- RI 5992. Flammability and Autoignition of Hydrocarbon Fuels Under Static and Dynamic Conditions, by Joseph M. Kuchta, Sotirios Lambiris, and Michael G. Zabetakis. 1962. 21 pp. 10 figs. Gives limits of flammability and autoignition temperatures of 12 hydrocarbon fuels that can be used to predict fire and explosion hazards associated with the use of these fuels.
- RI 5993. Purification of Electrolytes for the Deposition of High-Purity Nickel, by J. G. Donaldson, K. K. Kershner, and W. L. Falke. 1962. 13 pp. 4 figs. Describes the deposition of high-purity nickel from electrolytes purified by passing a nickel amine solution through a column of an ion-exchange resin. Results of experiments to purify solid nickel salts by some refining are also reported.
- RI 5994. Effect of Ionizing Radiation on the Chlorination of Mixtures of Rutile, Carbon, and Various Catalysts, by A. A. Cochran and P. W. Martin. 1962. 24 pp. 8 figs. Describes theoretical and practical aspects of using ionizing radiation to promote chemical reactions that are of interest to metallurgists, including a radiation study of a suitable reaction.
- RI 5995. The Frequency Spectrum of a Square Lattice, by R. Barany. 1962. 27 pp. 5 figs. Closed expressions are obtained for the frequency spectrum of a Born-Karman square lattice in terms of elliptic and hyperelliptic integrals.
- RI 5996. Gasification of Coal by Hot Recycled Helium in a Laboratory-Scale Exchanger-Type Gasifier, by R. L. Gall, R. F. Stewart, and J. P. McGee. 1962. 17 pp. 13 figs. Describes Bureau experiments in gasifying preheated coal in a helium-heated tube-coil reactor.
- RI 5997. Methods for Producing Alumina From Clay: An Evaluation of the Sulfurous Acid-Caustic Purification Process, by Frank A. Peters, Paul W. Johnson, and Ralph C. Kirby. 1962. 21 pp. 6 figs. First of a series concerning various known methods of extracting alumina from low-grade aluminous materials which was undertaken to permit comparison with other processes. Evaluates the sulfurous acid method and estimates the cost of producing crude alumina.
- RI 5998. Electrorefining of Selected Titanium Tertiary Alloys, by J. R. Nettle, T. E. Hill, Jr., and D. H. Baker, Jr. 1962. 14 pp. 1 fig. Presents data on the transfer characteristics of 10 alloys composed of 95 percent titanium plus 2.5 weight-percent each of two alloying elements.
- RI 5999. Changes in Stress Concentration Created by Undercutting in Block Caving, by Robert H. Merrill. 1962. 14 pp. 8 figs. Summarizes one phase of the investigation of design methods for size and shape of mine openings used in block-caving mining methods.
- RI 6000. The Suspended Specimen Method for Determining the Rate of Steam-Carbon Reaction, by W. T. Abel and J. H. Holden. 1962. 22 pp. 14 figs. Gives data on the rate of steam-carbon reaction determined by passing steam over graphite specimens suspended in an electrically heated tube at 1,900° to 2,400° F and at steam-feed rates of 0.1 to 0.2 mole of steam per mole of carbon per minute.
- RI 6001. Low-Temperature Heat Capacity and Entropy at 298.15° K. of Red Mercuric Sulfide, by E. G. King and W. W. Weller. 1962. 4 pp. 1 fig. Presents data obtained at a Bureau laboratory of the measurements of the low-temperature heat capacity of red mercuric sulfide and the entropy value at 298.15° K derived therefrom.
- RI 6002. Some Nonmetallic Mineral Resources for Alaska's Construction Industry, by R. S. Warfield. 1962. 25 pp. 10 figs. Satisfactory lightweight aggregate, mineral wool, and cement were produced from samples of limestone and shale deposits adjacent to the Alaska Railroad. Research is part of Bureau program to assist in stabilizing Alaskan economy by developing local resources.
- RI 6003. Metallurgical Testing of Hawaiian Ferruginous Bauxites, by W. A. Calhoun and T. E. Hill, Jr. 1962. 43 pp. 17 figs. Samples of Hawaiian bauxite from the islands of Kauai, Maui, and Hawaii were tested to determine if alumina could be extracted. Results were encouraging.
- RI 6004. Radioisotopes as Tracers in Volatilization Studies of Selenium and Tellurium, by J. V. Batty, A. M. Poston, Jr., and H. L. Gibbs. 1962. 9 pp. 2 figs. Radioisotopes of selenium and tellurium were successfully employed by the Bureau as tracers in metallurgical research on volatilizing these elements from low-tenor raw materials.
- RI 6005. Methods for Determining Microquantities of Impurities in Tungsten, by J. G. Haymes and Albert Ollar. 1962. 22 pp. Evaluates spectrophotometric, spectrographic, polarographic, conductometric, and vacuum-fusion methods for quantitatively determining impurities in high-purity tungsten.
- RI 6006. Field Test for Tellurium and Selenium, by Philip E. Niebuhr and Allan H. Macmillan. 1962. 6 pp. Procedure is given for a field test for tellurium and selenium that can be performed by nonanalytical personnel. If test material is taken from same sample, a fair estimate of the amount of each of the two elements present can be made. Material that also contains carbon, tannins, organic compounds of iron, and mercury can be successfully tested by this means. 15 cents.
- RI 6007. Carbon Formation in Very Rich Hydrocarbon-Air Flames, by Joseph M. Singer and Joseph Grumer. 1962. 80 pp. 36 figs. Gives results of studies, based on tests with ethylene and propane, made to identify the smoke limits of gaseous fuel-air mixtures and to evaluate basic chemical information on the formation of smoke in very rich flames near the smoke limit. Work done in cooperation with the American Gas Association.

- RI 6008. Low-Temperature Phase Equilibria of Helium-Bearing Natural Gases: Exell Gas, by W. J. Boone, Jr., Will E. DeVaney, and John E. Miller. 1962. 20 pp. 14 figs. Gives phase-equilibrium data obtained for conditions from -50° to -275° F and 100 to 500 psia.
- RI 6009. Calibration Studies of Three Portable Seismographs, by David E. Fogelson and Charles F. Johnson. 1962. 21 pp. 21 figs. Gives results of calibration on a shaking table of three different makes of portable displacement seismographs.
- RI 6010. Pyrometallurgical Beneficiation of Off-grade Chromite and Production of Ferrochromium, by Willard L. Hunter and Lloyd H. Banning. 1962. 16 pp. 1 fig. The chromium-iron ratio of offgrade chromite can be improved to more than 3:1, either by selective reduction in an electric furnace or by chlorination. Chromium recoveries were about 85 percent with selective reduction smelting and over 90 percent with the chlorination method. Satisfactory high-carbon ferrochromium was smelted from the products of each type of beneficiation.
- RI 6011. Disposal of Radioactive Waste in the Vitro-Type Uranium Milling Flowsheet, by K. E. Tame, E. G. Valdez, and J. B. Rosenbaum. 1962. 10 pp. 1 fig. Second of a series, report shows that reuse of barren raffinate in the mill circuit appears feasible, resulting in a 75-percent reduction in the discard of dissolved radionuclides. RI 5874, 6045, and 6117 describe radioactive waste disposal by the Durango-, Shiprock-, and resin-in-pulp-type processes.
- RI 6012. Small-Scale Blasting in Mortar, by J. Burlin Johnson. 1962. 22 pp. 16 figs. Gives data on results of small-scale blasting experiments in the Bureau laboratory that indicate that results obtained should be useful in predicting large-scale blasting effects.
- †RI 6013. Inyo Beryl Deposit, Inyo County, Calif., by W. T. Benson. 1962. 8 pp. 2 figs. Describes investigation of a beryl deposit near Lone Pine, Calif., in which 207 samples were taken from 1,100 feet of trenches.
- RI 6014. Composition and Mechanical Properties of Selected Cold-Mold and Skull-Cast Titanium Alloys, by E. D. Calvert, P. C. Magnusson, M. D. Carver, and R. A. Beall. 1962. 26 pp. 22 figs. Physical properties of four titanium-base alloys melted and forged under varying conditions were examined for variations in the resulting products.
- RI 6015. Fire and Explosion in a Blasting Agent Mix Building, Norton, Va., by Robert W. Van Dolah and Joseph S. Malesky. 1962. 12 pp. 8 figs. On December 27, 1961, a fire and explosion destroyed the blasting agent mixing plant and an attached storage barn of the Whitaker-Atlas Supply Co., near Norton, Wise County, Va. This incident is noteworthy because of the widespread practice of mixing fuel oil with ammonium nitrate to prepare low-cost blasting agents, often under conditions similar to those presented in this publication.
- RI 6016. A Preferential Stain for Beryl, by Sarkis G. Ampian. 1962. 4 pp. Describes method for identifying fine particles of beryl by preferential staining. Sample is subjected to a heated sodium hydroxide solution to etch the beryl particles which are subsequently stained an intense blue color in boiling alkaline solution of quinalizarin.
- RI 6017. Washability of Coals From the Matanuska Valley and Beluga River Fields, Alaska, by M. R. Geer and F. D. Fennessy. 1962. 33 pp. Contains all available washability data on the coals of these two fields. Indicates the quality of coals that can be supplied and the proper preparation techniques.
- RI 6018. Lead-Silver Deposits in the Omilak Area, Seward Peninsula, Alaska, by John J. Mulligan. 1962. 44 pp. 13 figs. Lead-silver deposits on the western slopes of the Darby Mountains were investigated as part of the Department of the Interior's continuing program for the development of Alaska's resources. Gives results of trenching and diamond-drill-hole data.
- RI 6019. An Experimental Mine-Sampling Project Designed for Statistical Analysis, by Scott W. Hazen, Jr., and R. D. Berkenkotter. 1962. 111 pp. 31 figs. Describes an experimental, underground, diamond-drill sampling project, designed specifically for statistical analysis. One of a series of studies on application of statistical methods to mine and mineral sampling. Work done in cooperation with Climax Molybdenum Co., Division of American Metals-Climax, Inc.
- RI 6020. Electron Micrographs of Some Unusual Inorganic Fibers, by Charles W. Huggins. 1962. 27 pp. 20 figs. Presents a series of electron micrographs showing the important morphological differences exhibited by potassium-lead silicate, lead-aluminum silicate, chrysotile, wollastonite, silicon nitride, potassium titanate, cobalt chrysotile, magnesium-fluor-richterite, fluor-richterite, refractory oxide fiber, silicon carbide, massive serpentine, and palygorskite.
- RI 6021. Relative Activity of Impregnated and Mixed Molybdenum Catalysts for Coal Hydrogenation, by M. D. Schlesinger, L. V. Frank, and R. W. Hiteshue. 1962. 12 pp. 5 figs. Presents experimental data to show that when a vehicle oil produced from coal is present, coal is hydrogenated to the same high conversion whether molybdenum catalyst is impregnated on the coal or intimately mixed with the slurry. Hydrogenation conditions were in the range of 8,500 to 10,000 psi and 400° to 500° C.
- RI 6022. Hydrogenation of Irradiated Coal, by Paul S. Lewis, Walter Kawa, and Raymond W. Hiteshue. 1962. 12 pp. 1 fig. Discusses results of hydrogenating coals of different ranks that had been irradiated with either X-rays or gamma rays. Comparison with unirradiated specimens showed that the radiation had no beneficial effect on the coals.
- RI 6023. Removing Hydrogen Sulfide From Synthesis Gas With Iron Oxide at Elevated Pressure, by G. E. Johnson, J. H. Field, W. A. Decker, and R. M. Jameson. 1962. 27 pp. 16 figs. Describes how purification of synthesis gas using wood chips impregnated with iron oxide can reduce the hydrogen sulfide content below the limits of 0.02 and 0.10 grain per 100 cubic feet for nickel methanation and Fischer-Tropsch catalyst, respectively. Operating pressures and temperatures, bed depth, and moisture content of the impregnated wood shavings are important factors in the design and operation of iron oxide units for purifying gas.
- RI 6024. Reconnaissance of Titanium Resources on Ship Island, Harrison County, Miss., by A. D. Hahn. 1962. 24 pp. 7 figs. Describes investigation of ilmenite, rutile, and associated heavy-mineral content of black-sand-bearing beach sands of Ship Island in the Gulf of Mexico. Western part of the island is a potential source of titanium.
- RI 6025. Experimental Production of Lightweight Basic Refractories, by M. E. Tyrrell. 1962. 16 pp. 5 figs. Describes development of lightweight basic refractories suitable for use in some section of the all-basic furnace. Potential advantages of such refractories are lower weight, improved resistance to thermal shock, and less tendency to spall off the working face.

† Out of print.

- RI 6026. Calibration Study of a Peak-Reading Accelerograph, by Alfred V. C. Meyer and Wilbur I. Duvall. 1962. 6 pp. 6 figs. Describes calibration study of a portable seismograph on the Bureau's shaking table, conducted as part of the research program on vibrations from quarry blasting. Instrument provides a meter reading and permanent record to enable operator to keep blasting vibrations within safe limits.
- RI 6027. Hydrogenation of Coal to Gaseous Hydrocarbons, by Raymond W. Hiteshue, Sam Friedman, and Robert Madden. 1962. 25 pp. 13 figs. Describes experiments conducted at temperatures of 480° to 800° C and hydrogen pressure of 6,000 psig to determine the effect of coal residence time on the conversion of a high-volatile bituminous C coal to liquid and gaseous products, using a semicontinuous apparatus designed for rapid heating and cooling of reactants.
- RI 6028. Ice Calorimeter for the Precise Measurement of Heat Content From 0° to 1,500° K., by J. R. Welty and C. E. Wicks. 1962. 13 pp. 4 figs. Describes a high-temperature calorimeter designed and constructed by the Bureau in cooperation with Oregon State University. Accurate heat content data may be obtained for elements and compounds.
- RI 6029. Pyrolysis of Five Salts of Yttrium, Lanthanum, and Cerium, by Louis P. Domingues, Roy L. Wilfong, and LeRoy R. Furlong. 1962. 19 pp. 12 figs. Gives the thermogravimetric analysis of five salts each of yttrium, lanthanum, and cerium. The temperature ranged from room temperature to 1,500° C.
- RI 6030. Problems in Substituting Titanium for Manganese in Steel, by P. G. Barnard, D. F. Walsh, and J. A. Rowland. 1962. 27 pp. 17 figs. Presents data that show that titanium has little potential as a substitute for manganese in steelmaking.
- RI 6031. Defluorination of Fluorspar: Preparation of Aluminum Fluoride From Siliceous Fluorspar, by Henry E. Blake, Jr., and Robert K. Koch. 1962. 17 pp. 2 figs. Low-grade siliceous fluorspars can be successfully defluorinated, either in a solid or a molten state, in a gas-fired rotary kiln by water vapor. The water produced by combustion of propane was sufficient to yield defluorinations of 75 to 85 percent. The liberated hydrogen fluoride offgas can be recovered as aluminum fluoride.
- RI 6032. Defluorination of Fluorspar: Pyrohydrolysis at 1,500° C., by Robert K. Koch and Henry E. Blake, Jr. 1962. 14 pp. 5 figs. Gives data on laboratory-scale studies on defluorination of natural and synthetic fluorspars made to determine the feasibility of developing a process for producing hydrogen fluoride from siliceous fluorspars. The reaction at 1,500° C is not promising for process development because an offgas with only 6 percent hydrogen fluoride was generated. A lower temperature process is considered a better method for producing hydrogen fluoride.
- RI 6033. High-Temperature Heat Contents and Entropies of Sesquioxides of Europium, Gadolinium, Neodymium, Samarium, and Yttrium, by L. B. Pankratz, E. G. King, and K. K. Kelley. 1962. 13 pp. 5 figs. Reports the results of high-temperature heat content measurements of the sesquioxides of four rare-earth elements—europium gadolinium, neodymium, and samarium—and of the closely related element, yttrium. Includes the original heat content data and smooth values, entropy increment data above 298.15° K, and equations representing the heat content results. Work done in cooperation with the Office of Naval Research, U.S. Department of the Navy.
- RI 6034. Heats and Free Energies of Formation of Germanium Dioxide, by Alla D. Mah and L. H. Adami. 1962. 7 pp. Reports new experimental values of the heats of formation at 298.15° K of the hexagonal crystalline variety of germanium dioxide and germanium dioxide glass. These newly measured data were used with previously known entropy and heat content values to obtain heats and free energies of formation of germanium dioxide from 298.15° to 2,000° K.
- RI 6035. Hydrogen as an Oxidation Retardant in Gas-Cooled Systems, by Robert F. Stewart and William T. Abel. 1962. 12 pp. 8 figs. In experimental equipment for gasifying coal with heat transferred by helium, oxidation of graphite and metals by trace impurities in the coolant helium was virtually eliminated by adding 0.1 to 1.0 percent hydrogen. Method has been tested successfully on pilot plant scale for 1 year at 250 psig and 2,400° F.
- RI 6036. Application of Rapid Methods for Analyzing Coal Ash and Related Materials, by F. H. Gibson and W. H. Ode. 1962. 23 pp. 1 fig. Reviews and applies new physicochemical techniques for analyzing coal ash and related materials. The procedures include spectrophotometric methods for SiO₂, Al₂O₃, Fe₂O₃, TiO₂, and P₂O₅; chelatometric titration for CaO and MgO; and flame photometry for Na₂O and K₂O. The methods are rapid and direct, are suitable for analyzing a group of samples at the same time in production work, and give results with almost the same accuracy as classical procedures. With these new methods, complete analyses in duplicate can be obtained at a rate of two to three times that of conventional methods.
- RI 6037. Studies of Anhydrous Methods for Extracting Beryllium From Low-Grade Ores, by Joan T. May and C. L. Hoatson. 1962. 19 pp. Studies show that fluorination and carbide-chlorination are practicable methods for the extraction of beryllium from low-grade ores. Treatment of concentrate-carbon mixtures with anhydrous hydrogen fluoride extracted 99 percent of the beryllium in the concentrate; the soluble fluoride product, converted to an oxide, contained 7 percent BeO. Chlorination of beryllium-silicon carbide, prepared from low-grade concentrates, extracted beryllium into the volatile chloride product.
- RI 6038. Recovery of Zinc From Ammoniacal-Ammonium Sulfate Leach Solutions, by Martin H. Stanczyk and Carl Rampacek. 1962. 12 pp. 3 figs. Investigates two methods—distillation and electrolysis—of recovering zinc from zinc-ammonia complex solutions. The distillation method recovered about 98 percent of the zinc in a product analyzing 97 percent zinc. Electrolysis of the solutions at a cathode current density of 25 amp per sq ft yielded zinc deposits assaying in excess of 99.9 percent zinc. Work done in cooperation with the University of Arizona.
- RI 6039. Quantitative Determination of Trace Metals in Crude Oils by X-Ray Spectrography, by C. W. Dwiggins, Jr. 1962. 21 pp. 2 figs. Describes the development, theory, and application of techniques and instruments for quantitatively determining nickel, vanadium, and iron in oils, using direct, X-ray emission spectrographic methods. The methods developed apply to petroleum and other oils as well as to some specific fraction of oils.
- RI 6040. Low-Temperature Heat Capacities and Entropies at 298.15° K. of Antimony and Indium Sulfides, by E. G. King and W. W. Weller. 1962. 5 pp. 1 fig. Reports low-temperature heat capacity measurements and entropy evaluations at 298.15° K of antimony sesquisulfide of stoichiometric composition and of indium sesquisulfide which was somewhat deficient in sulfur. The data for the latter substance were adjusted to correspond to the

- stoichiometric composition. Indium sesquisulfide has a lower entropy at 298.15° K than either antimony sesquisulfide or cerium sesquisulfide, which is in line with the higher atomic density of the indium compound.
- RI 6041. Comparative Studies of Explosives in Salt, by Harry R. Nicholls and Verne E. Hooker. 1962. 46 pp. 31 figs. Results of an investigation show that the ratios of characteristic impedances of explosive to those of rocks are of primary importance in the selection of an explosive for use in a particular rock type. Explosives having characteristic impedances more closely matching those of the rock generate higher peak strain amplitudes, crush more rock, and transmit higher percentages of the explosive energy to the rock. Results also show that explosive performance cannot be predicted from the standard acoustic impedance equation, thus indicating that shock wave phenomena exist at the boundary between explosive and rock. Investigation was supported by U.S. Atomic Energy Commission.
- RI 6042. Underground Gasification of Coal With Oxygen-Enriched Air, by J. P. Capp and K. D. Plants. 1962. 14 pp. 7 figs. Describes tests with oxygen-enriched air conducted in an Alabama coalfield. During the best gasification period, which extended for 2½ days, 780,000 std cu ft of 124-Btu gas was produced. In other periods the heating value at times was almost 300 Btu per std cu ft, but sustained production of such gas was not achieved. Approximately 12 million Btu per foot of nominal path was recovered at the surface. Work done in cooperation with the Alabama Power Co.
- RI 6043. Recovery of Mineral Values in Cupriferous and Nickeliferous Pyrrhotite, by Oliver C. Fursman. 1962. 24 pp. 3 figs. Describes investigations conducted to determine conditions for recovery of nickel and copper from Funtar Bay, Alaska, sulfide ore and recovery of nickel from nickel-silicate ore, Nickel Mountain, Riddle, Oreg. Samples of Funtar Bay cupriferous and nickeliferous pyrrhotite ore were treated by beneficiation, roasting, and electric smelting of roasted ore for matte production, chlorination, leaching, and sulfatizing roasting with subsequent leaching. Funtar Bay and Nickel Mountain ores were smelted together to produce matte.
- RI 6044. Use of Various salts as Copper-Volatilizing Agents in the Segregation Process, by W. A. McKinney and P. T. Waddleton. 1962. 7 pp. Results of tests show that sodium chloride is the most effective volatilizing agent in the segregation of copper from crushed oxidized or mixed oxide-sulfide copper ores.
- RI 6045. Radioactive Waste Disposal in the Shiprock-Type Uranium Milling Flowsheet, by K. E. Tame, E. G. Valdez, and J. B. Rosenbaum. 1962. 9 pp. 2 figs. Third of a series, report shows that reuse of raffinate in the Shiprock process appears feasible for obtaining a 75-percent decrease in the contaminated solution discarded from the mill. RI 5874, 6011, and 6114 describe radioactive waste disposal by the Durango-, Vitro-, and resin-in-pulp-type processes.
- RI 6046. Differential Sulfatization of a Georgia Manganiferous Iron Ore, by H. P. LeVan and R. B. Bauder. 1962. 9 pp. 4 figs. Demonstrates by laboratory research that low-grade Georgia umber ore can be differentially sulfatized with sulfur dioxide-air mixtures. The sulfatization reaction occurs rapidly and can be carried out in the absence of atmospheric oxygen. A high yield of manganese sulfate with a good manganese-to-iron ratio can be obtained. Work done in cooperation with University of Alabama.
- RI 6047. Methods of Analyzing Oilfield Waters: Flame-Spectrophotometric Determination of Potassium, Lithium, Strontium, Barium, and Manganese, by A. Gene Collins. 1962. 18 pp. 1 fig. Describes details of sensitive and accurate flame-spectrophotometric methods developed for determining potassium, lithium, strontium, barium, and manganese present in oilfield brines. Potassium, lithium, and strontium were determined by a standard-addition technique in ethyl alcohol solutions. Barium and manganese were determined in ethyl alcohol and normal propyl solutions, respectively, after interfering substances were removed.
- RI 6048. Flammability in Air of Solvent Mixtures Containing Methyl Ethyl Ketone and Tetrahydrofuran, by Michael G. Zabetakis, John C. Cooper, and Aldo L. Furno. 1962. 14 pp. 8 figs. Gives determination of lower limits of flammability of a number of mixtures containing methyl ethyl ketone, tetrahydrofuran, toluene, ethyl alcohol, and ethyl acetate in dry air at atmospheric pressure and temperatures between 16° and 200° C. The experimental values were found to be in good agreement with those predicted by Le Chatelier's law; variations with temperature were in fair agreement with those predicted by a modified Burgess-Wheeler law. Work done in cooperation with E. I. du Pont de Nemours and Co.
- RI 6049. Heats and Free Energies of Formation of Calcium and Magnesium Vanadates, by E. G. King, Mary F. Koehler, and L. H. Adami. 1962. 11 pp. Reports the heats of formation of three calcium vanadates and two magnesium vanadates. The experimental method was hydrochloric acid solution calorimetry, using calorimetric reaction schemes involving the vanadates and their component oxides. The results were expressed as heats of formation from the component oxides and from the elements. Corresponding free energy of formation values were calculated. The data show that the calcium and magnesium vanadates are stable with respect to all possible decompositions in which vanadium remains pentavalent.
- RI 6050. Oxygen Analysis of Mixed Fluoride Salts, by J. L. Potter, James E. Murphy, and Howard H. Heady. 1962. 14 pp. 2 figs. Describes an inert-gas fusion technique for quantitatively determining oxygen in mixed fluoride salts. Also included is a thermodynamic and experimental study of reaction temperatures.
- RI 6051. Explosion Hazards of Diethyl Ether, by Michael G. Zabetakis, Marjorie P. Benoy, and Patricia M. Gussey. 1962. 16 pp. 5 figs. Discusses conditions under which spillage of liquid diethyl ether could result in flammable vapor-air mixtures, with special reference to hospitals. Work done in cooperation with Public Health Service, U.S. Department of Health, Education and Welfare.
- RI 6052. Chloridization of Certain Mineral Sulfides, by J. G. Donaldson and K. K. Kershner. 1962. 18 pp. 12 figs. Gives optimum conditions for chloridizing pyrite, marcasite, chalcopyrite, arsenopyrite, stibnite, and covellite with chlorine gas.
- RI 6053. Effects of Stress Relief and Other Changes in Stress on the Physical Properties of Rock, by Leonard Obert. 1962. 8 pp. 9 figs. Presents evidence indicating that rock, stress-relieved during mining or in drilling a core, may be altered or damaged to the extent that the physical properties of the stress-relieved specimen are not the same as those of the in situ rock.
- RI 6054. Performance of Tables in Cleaning Alaska Coals, by M. R. Geer, Michael Sokaski, and P. S. Jacobsen. 1962. 26 pp. 2 figs. Gives results of 12 performance tests of coal-cleaning equipment in 2 Alaska plants. The five Alaska coals cleaned represent a wide range of washability. Work done in

- cooperation with School of Mineral Engineering, University of Washington.
- RI 6055. Metallurgical Studies of Rhodonite Ores, Silverton District, Colorado (in Three Parts). 1. Beneficiation Tests To Produce Manganese Concentrates, by W. W. Agey, C. H. Schack, and J. B. Clemmer. 16 pp. 12 figs. Describes mineral-dressing studies on seven samples of different grades and types of rhodonite ore. Demonstrates that higher recoveries were obtained by dry magnetic separation than by gravity or flotation methods. Part 2, RI 6062, published in 1962, demonstrates the technical feasibility of producing silicomanganese from a rhodonitic concentrate by electric smelting methods; part 3, RI 6442, published in 1964, evaluates the melt-quench-leach process for treating the rhodonitic concentrate and an electrolytic process for recovery of manganese from solution.
- RI 6056. Measuring Changes in Pillar Strain During Pillar Recovery: Experiments in a New Mexico Uranium Mine, by W. L. Dare. 1962. 17 pp. 12 figs. Summarizes the instrumentation, data, and results of a study on changes in magnitude and direction of three-dimensional strain in mine pillars during final pillar recovery. Work done in cooperation with the Hidden Splendor Mining Co.
- RI 6057. Transfer of Heat From Helium at High Temperatures: Physical Characteristics of Ceramic Heat Exchangers, by John J. S. Sebastian and Stanley C. Browning. 1962. 23 pp. 10 figs. Investigates basic problems of operating a ceramic heat exchanger at high temperatures. Gives technical data on transfer of heat from helium to air in a single-tube vitreous-alumina heat exchanger. Work done in cooperation with U.S. Atomic Energy Commission.
- RI 6058. Safety Characteristics of Normal Propyl Nitrate, by Michael G. Zabetakis, Charles M. Mason, and Robert W. Van Dolah. 1962. 26 pp. 15 figs. Gives information on limits of flammability of normal propyl nitrate at ambient and elevated temperatures and at pressures from 0 to 4,000 psig. Measures flame speeds and detonation susceptibility of NPN vapor. Work done in cooperation with Bureau of Ordnance, U.S. Department of the Navy.
- RI 6059. Washability Characteristics of the Lower Hartshorne (Spadra) Coalbed Near Clarksville, Ark., by E. R. Palowich and T. E. Gray. 1962. 13 pp. Gives results of washability tests of both raw coal and machine-cut coal from this coalbed.
- RI 6060. Thermal Decomposition of Five Salts of Praseodymium, Neodymium, and Samarium, by Roy L. Wilfong, Louis P. Domingues, and LeRoy R. Furlong. 1962. 18 pp. 14 figs. Gives data on the temperature limits for the various stages of decomposition and values for loss on ignition for five salts of praseodymium, neodymium, and samarium.
- RI 6061. Resources for Making Expanded Aggregate in Western Washington and Oregon, by Henry M. Harris, Karle G. Strandberg, and Hal J. Kelly. 1962. 41 pp. 8 figs. Gives information on suitability as raw material for expanded aggregate of low-carbon shales from 65 deposits and 11 sources of coal-mine waste. Samples from nine low-carbon shale deposits and three coal-mine waste sources were selected for more extensive bloating tests and for examination of the expanded aggregates in concrete shapes. Work done in cooperation with School of Mineral Engineering, University of Washington.
- RI 6062. Metallurgical Studies of Rhodonite Ores, Silverton District, Colorado (in Three Parts). 2. Producing Silicomanganese by Electric Furnace Smelting, by H. C. Fuller and V. E. Edlund. 1962. 12 pp. 1 fig. Demonstrates the technical feasibility of producing silicomanganese from a rhodonitic concentrate by electric smelting methods. Part 1, RI 6055, published in 1962, describes beneficiation tests to produce manganese concentrates; part 3, RI 6442, published in 1964, evaluates the melt-quench-leach process for treating the rhodonitic concentrate and an electrolytic process for recovery of manganese from solution.
- RI 6063. Metallurgical Investigations of Philippine Nickeliferous Ores, by L. H. Banning, W. E. Anable, R. B. Quicho, H. D. Hess, and P. C. Good. 1962. 71 pp. 23 figs. Gives results of laboratory and pilot plant tests undertaken to obtain information necessary for the design and operation of a plant for recovering metallic values from nickeliferous laterite and serpentine of the Philippine Islands. Tests included mineralogical studies and preliminary mineral-dressing tests; electric smelting of the ores, upgrading of ferronickel by blowing with oxygen, smelting laterite slag to produce crude iron, and the production of mild steel; and nickel and cobalt recovery from upgraded ferronickel. Results indicate that it should be feasible to recover nickel, iron, and possibly cobalt products. Work done in cooperation with the International Cooperation Administration. 45 cents.
- RI 6064. Reconnaissance of Scandium Sources and Recovery of Scandium From Uranium Mill Solutions, by J. R. Ross and J. B. Rosenbaum. 1962. 16 pp. 3 figs. Describes analysis of a large number of minerals for scandium content and evaluates several methods for recovering scandium from uranium mill solutions.
- RI 6065. Factors Influencing the Design of Hydraulic Backfill Systems (in Two Parts). 1. Friction-Head Losses of Sand Slurries During Pipeline Transport, by William R. Wayment, George L. Wilhelm, and John D. Bardill. 1962. 43 pp. 21 figs. Gives information on friction-head losses of sand slurries during their transport in pipelines, and includes data on degradation, changed percolation characteristics, and critical velocities of the slurries. Work is based upon research partly performed under a fellowship agreement cosponsored by the Bureau of Mines and the Montana School of Mines.
- RI 6066. Factors Influencing the Design of Hydraulic Backfill Systems (in Two Parts). 2. Friction-Head Losses of Barite and Limestone Slurries During Pipeline Transport, by John D. Bardill, Donald R. Corson, and William R. Wayment. 1962. 33 pp. 10 figs. Presents results of extensive tests on friction-head losses of sand slurries composed of materials of different specific gravities and under varying transport systems. Work is based upon research partly performed under a fellowship agreement cosponsored by the Bureau of Mines and the Montana School of Mines. Part 1, RI 6065, covers friction-head losses of sand slurries.
- RI 6067. A Method of Determining Dynamic Tensile Strength of Rock at Minimum Loading, by L. O. Bacon. 1962. 22 pp. 18 figs. Presents curves and results of the dynamic tensile measurements for 6 basalt cores with a pendulum-impacting method and for 11 sandstone cores with the pellet-impacting method. Work done in cooperation with Institute of Minerals Research, Michigan College of Mining and Technology.
- RI 6068. Experiments in Extinguishing Liquid-Fuel Flames With High-Expansion Foams, by Eugene L. Grumer and David Burgess. 1962. 10 pp. 5 figs. Presents results of application of high-expansion foams to six fuels burning in 1-foot-diameter

- trays. Flames of three hydrocarbon fuels were more readily extinguished than the flames of methanol, acetone, or unsymmetrical dimethyl hydrazine.
- RI 6069. Resource Investigation and Leaching Study of Manganiferous Schists, Kings Mountain District, North and South Carolina, by J. F. O'Neill and R. B. Bauder. 1962. 12 pp. 1 fig. Concludes that there is a large quantity of manganiferous schist associated with the Battleground Schist. Manganese oxide is amenable to sulfur dioxide leaching, but more research is needed on methods of recovering the silicate manganese. Work done in cooperation with University of Alabama.
- RI 6070. Flotation of Spodumene From Pegmatites of Cleveland County, N.C., by Thomas L. McVay and James S. Browning. 1962. 6 pp. 1 fig. Gives results of continuous flotation tests that indicated that commercial-grade spodumene could be produced from these pegmatites. Work done in cooperation with the Lithium Corporation of America and the University of Alabama.
- RI 6071. Properties of Palygorskite, an Asbestiform Mineral, by Charles W. Huggins, M. V. Denny, and H. R. Shell. 1962. 17 pp. 8 figs. Gives X-ray diffraction data, chemical analyses, differential thermal analysis, thermal gravimetric analysis and optical data for palygorskite.
- RI 6072. Performance of Waterfloods in Wichita County, Tex., by Thomas M. Garland. 1962. 135 pp. 75 figs. Presents data on 36 waterflood projects in Wichita County, Tex., and analyzes some of the factors affecting the results obtained. Work done in cooperation with North Texas Oil and Gas Association.
- RI 6073. Effects of Ultrasonics on Electrolytic Deposition of Manganese and Manganese Dioxide From Sulfate Electrolyte, by Charles B. Kenahan and David Schlain. 1962. 26 pp. 17 figs. Gives information on effects of ultrasonic vibrations of 26, 38, and 400 kilocycles per second at acoustical intensities of 0.25 to 1.25 watts per square centimeter in two separate electrodeposition processes.
- RI 6074. Effects of In-the-Mill Drying on Pulverizing Characteristics of Lignite, by R. C. Ellman, J. W. Belter, and L. Dockter. 1962. 18 pp. 11 figs. Gives results of comparative tests on lignites from five mine sources and shows significant advantages from high degrees of in-the-mill drying.
- RI 6075. Electrowinning Molten Lanthanum From Lanthanum Oxide, by E. Morrice, C. Wyche, and T. A. Henrie. 1962. 9 pp. 3 figs. Describes electrowinning of molten high-purity lanthanum from lanthanum oxide dissolved in a fluoride electrolyte in an internally heated cell.
- RI 6076. MgO-MgF₂-SiO₂ System at Two Levels of Li₂O and Na₂O, by H. R. Shell. 1962. 16 pp. 5 figs. Gives results of investigations by solid-state reactions in the systems MgO-MgF₂-SiO₂ at 2 and 4 weight-percent Li₂O and 3.8 and 7.7 weight-percent Na₂O. Summarizes results in four ternary diagrams.
- RI 6077. Synthetic Mica From Low Cost Raw Materials, by H. R. Shell and Wilbur Warwick. 1962. 19 pp. 2 figs. Describes methods of synthesizing fluorphlogopite mica from impure materials such as olivine, clay, and feldspar (plus K₂SiF₆ and Al₂O₃ as needed) that yielded 95 to 98 percent mica suitable for metallurgical uses. Because highly dispersed minute ferroalloy particles were present, the mica was not suitable for electrical or electronic uses.
- RI 6078. Studies of Magnesium Alloys for Use at Moderate Temperatures, by R. L. Crosby and K. A. Fowler. 1962. 28 pp. 16 figs. Presents data on the mechanical properties of wrought magnesium alloys containing rare-earth elements at temperatures up to 300° C. Discusses solid solubility of cerium and zirconium in magnesium.
- RI 6079. Titanium-Iridium Phase Diagram, by J. G. Croeni, C. E. Armantrout, and H. Kato. 1962. 15 pp. 12 figs. The titanium-iridium phase diagram was investigated by careful techniques, involving melting point, thermal analyses, X-ray diffraction, dilatometry, electrical resistivity, and metallography. Work done in cooperation with U.S. Atomic Energy Commission under contract.
- RI 6080. Preparation of Columbium and Tantalum by Metallic Reduction of Their Chlorides, by T. T. Campbell, F. E. Block, G. B. Robidart, and J. L. Schaller. 1962. 20 pp. 7 figs. Describes experimental work that demonstrates the feasibility of preparing columbium and tantalum metals by application of Kroll-process techniques.
- RI 6081. Lake Superior Iron Resources: Metallurgical Evaluation and Classification of Nonmagnetic Taconite Drill Cores From the West Central Mesabi Range, by P. A. Wasson, D. W. Frommer, L. F. Heising, R. E. Lubker, and R. L. Blake. 1962. 62 pp. 17 figs. Presents data developed from a study of drill cores from 15 holes that was designed to provide a better understanding of the nature and character of low-grade iron ore occurrences.
- RI 6082. Flotation of Siegenite in a Complex Sulfide Table Middling From Southeast Missouri, by W. A. Calhoun and T. E. Hill, Jr. 1963. 13 pp. 4 figs. Describes a mineral-dressing procedure developed by the Bureau for concentrating this nickel-cobalt-bearing mineral from a table middling occurring in mill operations in the southeast Missouri "lead belt." The procedure also includes recovering commercial-grade concentrates of copper and lead; a low-grade zinc concentrate, a potential coproduct, was also made.
- RI 6083. Incinerator for Solid Combustible Wastes Containing Low-Level Radioactivity, by R. C. Corey and C. H. Schwartz. 1962. 38 pp. 25 figs. Gives specifications and performance data for an incinerator for combustible low-level radioactive wastes. Incinerator reduces waste to one-tenth to one-twentieth of its original volume.
- RI 6084. Beryllium-Bearing Tuff From Spor Mountain, Utah: Its Chemical, Mineralogical, and Physical Properties, by J. W. Montoya, R. Havens, and D. W. Bridges. 1962. 15 pp. Describes laboratory research on general physical properties of berylliferous tuff from Spor Mountain. Possibility of separating beryllium minerals from the tuff by physical methods appears remote.
- RI 6085. Design and Initial Operation of a Slagging, Fixed-Bed, Pressure Gasification Pilot Plant, by G. H. Gronhovd, A. E. Harak, W. R. Kube, and W. H. Oppelt. 1962. 50 pp. 25 figs. Describes a pilot plant designed for eventual operation at pressures ranging from 400 to 600 psig. For the preliminary test reported here, the gasifier was fitted with a low-pressure slagging section and operated at atmospheric pressure and at 80 psig. The gasifier was designed to gasify lignite or other low-rank non-caking coals; however, a bituminous coal char was used in most of the tests included in this report.
- †RI 6086. Analyses of Tipple and Delivered Samples of Coal (Collected During the Fiscal Year 1961), by S. J. Aresco, C. P. Haller, and R. F. Abernethy. 1962. 41 pp. Presents the results of analyses of 7,603 samples collected in connection with Government coal purchases. Heating value and proximate analyses are given for all the samples; ash-softening temperature, free-swelling index, and the Hardgrove grindability index are also shown for many samples.

† Out of print.

- RI 6087. Methods of Analyzing Oilfield Waters. Metallics: Copper, Nickel, Lead, Iron, Manganese, Zinc, and Cadmium, by A. Gene Collins, Cynthia Pearson, Dave H. Attaway, and Thomas G. Elbrey. 1962. 24 pp. 7 figs. Presents detailed description of the methods of analyzing oilfield brines for certain trace and minor constituents.
- RI 6088. Linearization of Adsorption Data, by Foster Fraas. 1962. 20 pp. 12 figs. A method is presented for the linear evaluation of adsorption data using two equations. The equations are applicable to electronic and salt equilibria.
- RI 6089. An Economic Evaluation of Hydrogen Production by the Continuous Steam-Iron Process at 7 Atmospheres, by Sidney Katell, John H. Faber, and Paul Wellman. 1962. 13 pp. 4 figs. The estimated capital requirement for a plant producing 30 million std cu ft per day of 99.8-percent purity hydrogen at a discharge pressure of 450 psig is \$13,100,000, using January 1961 equipment cost data. The operating cost before profit and taxes with coal at \$4 per ton is estimated to be \$0.38 per M std cu ft.
- RI 6090. Some Characteristics of Iron in the Lime Soda Sinter Process for Recovering Alumina From Anorthosite, by R. V. Lundquist and E. L. Singleton. 1962. 13 pp. 5 figs. Indicates that the iron content of sinters influences the recovery of alumina and soda. The approximate Fe_2O_3 appears to inhibit gelation; and 15.5 percent Fe_2O_3 produces effects similar to those produced by 1 percent sucrose.
- RI 6091. Spectrographic Analysis of Cerium by a Carrier Distillation Technique, by A. B. Whitehead and Howard H. Heady. 1962. 24 pp. 9 figs. A spectrographic method for the determination of 18 impurities in cerium is presented. The carrier distillation technique is utilized to separate the spectra of impurities from the complex spectrum of cerium.
- RI 6092. Alkyl-Dithiocarbamic Acid Amine Salts as Flotation Collectors for Sulfide Lead Slime, by H. E. Powell, W. A. Calhoun, and T. E. Hill, Jr. 1962. 18 pp. 11 figs. Dithiocarbamate-type reagents as prepared and evaluated in this study are shown to be collectors for finely divided partly oxidized galena. Reasonable recoveries made from a mill tailing already stripped of most of its lead values indicate the effectiveness of the collectors.
- RI 6093. Physical Properties and Clay Mineral Contents Affecting Susceptibility of Oil Sands to Water Damage, Powder River Basin, Wyo., by Elliot J. White, Oren C. Baptist, and Carlton S. Land. 1962. 20 pp. 4 figs. Gives data on interrelationships among permeability, restored water saturation, clay content, and bulk swelling capacity of cores from 100 wells in the major oil-producing formations in the Powder River basin. Results were used to estimate the susceptibility of the formations to water damage.
- RI 6094. Titanium Resources of Nelson and Amherst Counties, Va. (in Two Parts) 1. Sapolite Ores, by George E. Fish, Jr. 1962. 44 pp. 27 figs. Describes investigations conducted by the Bureau in the Roseland anorthosite-titanium belt of Nelson and Amherst Counties. Sapolite ore bodies investigated contain titanium minerals in quantity and are large enough to warrant consideration by industry for economic development. Part 2, RI 6429, published in 1964, is an investigation of nelsonite deposits.
- RI 6095. Cemented Tungsten Carbide With Titanium Diboride Additions, by M. E. Tyrrell and Gilbert M. Farrior. 1962. 12 pp. 5 figs. Gives data on the properties of cemented tungsten carbide modified by the addition of 1, 2, and 5 percent of titanium diboride and compares the properties of these mixtures when sintered, hot-pressed, and flash-welded.
- RI 6096. A Microhydrogenation Technique for Identifying Organic Sulfur, Nitrogen, Oxygen, and Halogen Compounds, by C. J. Thompson, H. J. Coleman, R. L. Hopkins, and H. T. Rall. 1962. 28 pp. 11 figs. Describes a micromethod for catalytically removing sulfur from sulfur compounds to yield hydrocarbons for which standard compounds are available. Shows how this method was applied with equal success to various classes of oxygen, nitrogen, and halogen compounds.
- RI 6097. Ion-Exchange Separation and Instrumental Analysis of Impurities in Rare-Earth Metals, by H. J. Seim, Joseph L. Johnson, K. R. Stever, and Howard H. Heady. 1962. 19 pp. 6 figs. An ion-exchange instrumental analysis technique is described for analyzing impurities at 1 to 1,000 parts per million in rare-earth metals. A cation-exchange flame-photometric method is used for the alkali and alkaline earth groups of metals, and an anion-exchange procedure is used with polarographic and X-ray fluorescence techniques for selected transition elements.
- RI 6098. Rapid Determination of Permeability in Porous Rock, by Jerry B. F. Champlin. 1962. 9 pp. 3 figs. Describes a method and apparatus, developed by the Bureau, that use the principle of specific-volume permeametry to determine permeabilities of porous solids rapidly and accurately.
- RI 6099. Fire and Explosion Hazards Associated with Liquefied Natural Gas, by David Burgess and Michael G. Zabetakis. 1962. 33 pp. 21 figs. Discusses factors to be considered in an evaluation of the fire and explosion hazards connected with any fuel and describes the experiments conducted to evaluate the hazards associated with liquefied natural gas.
- RI 6100. The Desilication of Caustic Leach Liquors Containing Alumina, by R. V. Lundquist and N. Chardoul. 1962. 18 pp. 4 figs. Describes results of tests on the desilication of solutions resulting from the leaching of lime-soda sinters. Presents the experimental data obtained when desilication was accomplished by heating solutions in an autoclave under select conditions of temperature and pressure.
- RI 6101. Columbium-Hafnium Binary Alloys for Elevated Temperature Service, by H. R. Babbitzke, G. Asai, and H. Kato. 1962. 17 pp. 9 figs. Gives results of tests of the machinability, hardness, workability, tensile strength, and oxidation resistance of 10 ingots ranging from 100 percent columbium to 70 atomic percent hafnium. For the alloy series tested, strength and hardness values increased with increasing hafnium content, with maximum values at 50 atomic percent hafnium. Oxidation resistance improved with increasing hafnium content through 70 atomic percent. Eight of the ten ingots were fabricable at room temperature; those with 5 and 10 atomic percent hafnium required hot working.
- RI 6102. Bacterial Leaching of Manganese Ores, by E. C. Perkins and Frank Novelli. 1962. 11 pp. Reports preliminary experiments in utilizing bacteria to leach manganese from a variety of domestic low-grade manganiferous materials.
- RI 6103. Flotation and Sintering Studies on Manganese Ores Stockpiled at Deming, N. Mex., and Wenden, Ariz., by W. W. Agey and V. E. Edlund. 1962. 13 pp. Summarizes results of bench-scale metallurgical studies on three composite samples representative of the low-grade manganese ores stockpiled at the Deming and Wenden depots.

- RI 6104. Lake Superior Iron Resources: Further Metallurgical Evaluation of Mesabi Range Nonmagnetic Taconites (Reduction Roasting and Magnetic Separation), by D. W. Frommer and P. A. Wasson. 1963. 47 pp. 4 figs. Evaluates 159 composite samples of nonmagnetic taconite, in terms of responsiveness to a process of commercial significance, by a technique of reduction roasting, fine grinding, and magnetic separation.
- RI 6105. Spectrochemical Analysis of High-Purity Titanium, by J. Robert Wells and Lloyd Carpenter. 1962. 23 pp. 7 figs. Describes a spectrochemical procedure for determining 19 impurity elements in high-purity titanium metal, titanium oxides, and titanium halides in which all samples are converted to titanium dioxide.
- RI 6106. Estimating Daily Exposures of Underground Uranium Miners to Airborne Radon-Daughter Products, by R. C. Bates and R. L. Rock. 1962. 22 pp. 5 figs. Recommends the spot-check method for use by mining companies, Government agencies, and others who wish to evaluate the radon-daughter exposures of uranium mine workers. If the sampler correctly evaluates the variables involved, the spot-check method is simple and fast and gives a reasonably accurate estimate of the full-shift exposure.
- RI 6107. Recovery of Tin, Tungsten, and Other Metals From Tin Smelter Wastes, by A. G. Starliper and H. Kenworthy. 1962. 17 pp. 1 fig. Covers studies on the removal of metallic values in two waste products from the Longhorn tin smelter, Texas City, Tex. Describes the treatment of a slag containing tin, tungsten, and other metals and a spent acid solution also containing tin, tungsten, and other metals.
- RI 6108. Spectrochemical Analysis of High-Purity Beryllium, by R. W. Lewis, C. F. Earl, J. L. Potter, and R. Fehler. 1962. 15 pp. 5 figs. Describes spectrochemical procedures that were developed, using dc arc excitation, to determine 18 impurity elements in electrorefined beryllium and high-purity beryllium oxide.
- RI 6109. Performance of a Screw-Type, Classifier-Cyclone Combination: A Laboratory Evaluation, by P. S. Jacobsen, Michael Sokaski, and M. R. Geer. 1962. 16 pp. 3 figs. Tested the improvement in recovery when a cyclone was added to the classifier circuit and discovered that addition of the cyclone greatly improved the overall recovery of solids. Work done in cooperation with the School of Mineral Engineering, University of Washington.
- RI 6110. Underground Borate Mining, Kern County, Calif., by Leonard Obert and Albert E. Long. 1962. 64 pp. 45 figs. Documents the underground mining methods employed in the Kramer district before 1957. Gives detailed geology of four mine sites and describes factors that affect the structural characteristics of the mines.
- RI 6111. Design, Construction, and Evaluation of an Electron Probe X-Ray Spectrograph, by J. D. Brown, J. W. Thatcher, and W. J. Campbell. 1962. 30 pp. 19 figs. Describes the design and construction of the Bureau's electron probe X-ray spectrograph. Mentions two applications of the spectrograph and describes in detail the analysis of a sample of a uranium-iron-nickel alloy to illustrate the calculation of composition from measured X-ray intensities.
- RI 6112. Autoignition of Lubricants at Elevated Pressures, by Michael G. Zabetakis, George S. Scott, and Robert E. Kennedy. 1962. 10 pp. 7 figs. Gives data on the autoignition temperatures of natural and synthetic lubricants at elevated pressures and temperatures showing that the phosphate esters have higher autoignition temperatures than the mineral oils at any pressure between 1 and 200 atmospheres.
- RI 6113. Deoxidation of Blister Copper by Gaseous Reduction, by F. E. Brantley and C. H. Schack. 1962. 12 pp. 3 figs. Describes the successful laboratory-scale deoxidation of blister copper with any of a variety of reducing gases. Estimates that process on a commercial scale would be cheaper and more efficient than poling.
- RI 6114. Disposal of Liquid Waste in the Resin-In-Pulp-Type Uranium Milling Flowsheet, by K. E. Tame and J. B. Rosenbaum. 1962. 11 pp. 2 figs. Fourth in a series, report explains that the benefits expected from reuse of barren solution in the washing circuit are (1) reduction in the quantity of dissolved radium 226 and thorium 230 discharged from the mill, (2) reduction in the amount of uranium in discarded solution, and (3) savings on fresh water requirements for the mill. A disadvantage is the cost of recovering clear barren solution for return to the wash circuit. RI 5874, 6011, and 6045 describe radioactive waste disposal by the Durango, Vitro-, and Shiprock-type processes.
- RI 6115. Thermal Expansion of Magnesium Oxide: An Interlaboratory Study, by William J. Campbell. 1962. 50 pp. 10 figs. Thermal expansion characteristics of a high-purity polycrystalline magnesium oxide were determined by 21 cooperating laboratories. Comparison of results within methods showed the least variance for X-ray camera results; dilatometer and X-ray diffractometer results have about the same variance. The average deviations, in percent, between observed and calculated expansion values among methods were approximately 10 percent from 100° to 300° C, 5 percent from 300° to 500° C, and 2 percent from 500° to 1,400° C. Maximum deviations were approximately twice as large in most instances.
- RI 6116. Vibration Damping Capacity of Various Magnesium Alloys, by D. F. Walsh, J. W. Jensen, and J. A. Rowland. 1962. 16 pp. 11 figs. Studies the damping capacities of a number of magnesium-base alloys and establishes a correlation between damping capacity and composition.
- RI 6117. Gasification of Bituminous Coal With Oxygen in a Pilot Plant Equipped for Slurry Feeding, by L. F. Willmott, K. D. Plants, W. R. Huff, and J. H. Holden. 1962. 10 pp. 4 figs. Finds that the slurry system offers a satisfactory means of feeding pulverized coal to a pressure gasifier, although further work is required to develop an economical process.
- RI 6118. Sampling of Lynch Creek Beryllium-Tungsten Prospect, Lander County, Nev., by Robert Hall. 1962. 10 pp. 5 figs. Gives data on 40 samples from this prospect that were analyzed by the Bureau.
- RI 6119. Investigation of Manganese Deposits, Hodgdon and Linneus Townships, Southern District, Aroostook County, Maine, by Kenneth M. Earl and N. A. Eilertsen. 1962. 47 pp. 11 figs. Describes the results of a field study made by the Bureau during 1956 and 1957 on manganese- and iron-bearing mineral deposits in the southern district of Aroostook County, Maine. Over 50 magnetic anomalies were mapped in the Westford Hill-Daggett Hill area, Hodgdon Township. The largest anomaly indicates a deposit 3,200 feet long, with a maximum width of 350 feet. Of several magnetic anomalies outlined on the Stewart prospects in Linneus Township, three indicate manganese deposits of appreciable size. Core analyses show that the deposits average less than 7 percent manganese.
- RI 6120. Electric Furnace Smelting of Offgrade Domestic Manganese Ores and Concentrates, by F. B. Peterman and R. S. Lang. 1962. 21 pp. 1

- fig. Describes smelting of offgrade manganese ore and sintered concentrate to specification-grade ferromanganese.
- RI 6121. Extraction of Manganese From Low-Grade Dolomitic Materials by a Roast-Leach Process, by G. V. Sullivan, L. L. Brown, and R. G. Petersen. 1962. 24 pp. 8 figs. Summarizes the results of a preliminary study of manganese extraction from low-grade dolomitic materials from the Philipsburg district in Montana by the Deante ammonium carbamate process.
- RI 6122. Autoradiography of Carbon and Sulfur in Titanium Steels, by A. A. Cochran and J. W. Jensen. 1962. 17 pp. 8 figs. Describes the preparation of small heats of steel containing radioisotopes and the use of stripping film autoradiography to detect and study the carbide and sulfide phases in titanium-bearing steels.
- RI 6123. Flotation of Northeast Birmingham, Ala., Hematite Ores, by R. E. Perry, W. E. Lamont, I. L. Feld, and B. H. Clemmons. 1962. 14 pp. 2 figs. Shows that improved flotation methods can produce concentrates containing 49 to 51 percent iron from low-grade red iron ores. Study included several hundred batch flotation tests and about 50 pilot plant tests. Work done in cooperation with the University of Alabama and the United States Pipe and Foundry Co.
- RI 6124. Hydrogenation of Pitch From Low-Temperature Carbonization of Coal, by Richard D. Graves, Walter Kawa, and Raymond W. Hiteshue. 1962. 15 pp. 7 figs. Describes the production of low-molecular-weight oils and tar acids from pitch from low-temperature carbonization of bituminous coal hydrogenated at cracking conditions in a continuous bench-scale unit.
- RI 6125. Hydrogasification of Bituminous Coals, Lignite, Anthracite, and Char, by Raymond W. Hiteshue, Sam Friedman, and Robert Madden. 1962. 15 pp. 8 figs. Gives data on the amenability of various coals and a char to hydrogasification at 800° C and 6,000 psig, using a molybdenum catalyst.
- RI 6126. Use of a Large-Diameter Reactor in Synthesizing Pipeline Gas and Gasoline by the Hot-Gas-Recycle Process, by A. J. Forney, D. Bienstock, and R. J. Demski. 1962. 30 pp. 18 figs. A 12-inch-diameter reactor was operated successfully in the synthesis of gaseous and liquid fuels. When high-Btu gas was synthesized in two stages, parallel-plate assemblies of Raney nickel were almost as active as granular Raney nickel in the second reactor. The pressure drop through the second reactor, however, was reduced 90 percent by the use of these assemblies. Work done in cooperation with Consolidated Natural Gas Co.
- RI 6127. Biological Formation of Flammable Atmospheres, by Michael G. Zabetakis. 1962. 7 pp. 1 fig. Discusses six cases of hazardous conditions created by the action of bacteria on organic matter and analyzes the gases obtained in the investigations.
- RI 6128. Biaxial Device for Determining the Modulus of Elasticity of Stress-Relief Cores, by John Fitzpatrick. 1962. 13 pp. 9 figs. Describes an apparatus and procedure that permit determination of the modulus of elasticity of cores obtained in the process of making in situ stress measurements. Apparatus is sufficiently portable to permit field use.
- RI 6129. Laboratory Studies of Variables in Rotary Drilling, by James A. Whelan. 1962. 35 pp. 27 figs. Covers some preliminary studies of rock failure during rotary drilling and effect of bit design. Considered were (1) the penetration of a wedge into rock, (2) the effect of thrust on penetration rate, (3) the effect of rotary speed on penetration rate, (4) the relationship between torque and bit diameter, (5) the effect of reamer or pilot drilling on torque, and (6) the forces acting on a cutting tool during drilling. The applications of the results of these studies to drilling practice and to bit design are considered. Experimental work was done under Bureau-sponsored fellowships at the University of Minnesota.
- RI 6130. Low-Temperature Heat Capacities and Entropies at 298.15° K. of Magnesium Metavanadate and Magnesium Pyrovanadate, by W. W. Weller and E. G. King. 1962. 5 pp. 1 fig. Completes low-temperature measurements planned for alkaline-earth vanadates. No similar data for these compounds have been published previously. Free energy of formation values at 298.15° K were derived by combination of the present entropy values with heat of formation data.
- RI 6131. Hydrogen as a Retaining Ion for Rare-Earth Separation by Ion Exchange With EDTA and DCTA, by R. E. Lindstrom and J. O. Winget. 1962. 18 pp. 11 figs. Shows that the use of hydrogen as a retaining ion at 200° F with ethylenediaminetetraacetic acid (EDTA) eluant gives effective separation and permits EDTA and water, collected before rare-earth breakthrough, to be recycled without extensive processing. Finds that separation with 1,2-diaminocyclohexanetetraacetic acid (DCTA) eluant increases markedly on increasing temperature from ambient to 250° F, but DCTA does not compare favorably with EDTA on the basis of separation efficiency.
- RI 6132. Spectrochemical Determination of Beryllium in Mineral Beneficiation Products, by M. J. Peterson and J. B. Zink. 1962. 19 pp. 9 figs. Spectrochemical methods were developed to determine beryllium in the concentration range 0.0015 to 4.0 percent in siliceous mineral beneficiation products. Two methods are described. They are a fusion-pellet-spark procedure (spark method) and a sustaining alternating-current arc procedure (arc method). Beryllium determinations show deviations from accepted chemical values of approximately 5 and 8 percent for the spark and arc methods, respectively. Analyses can be made more rapidly by the arc procedure with a sacrifice in precision and accuracy. Either method can be applied to the determination of beryllium in silicate rocks.
- RI 6133. Methods for Producing Alumina From Clay. An Evaluation of Five Hydrochloric Acid Processes, by Frank A. Peters, Paul W. Johnson, and Ralph C. Kirby. 1962. 68 pp. 23 figs. The processes considered are designed to extract alumina as aluminum chloride from calcined clay with 20 percent hydrochloric acid and to remove the silica residue by filtration. Operating and capital costs for each of the five processes are estimated. Report is second of a series describing and analyzing various known processes for producing alumina; the first report, RI 5997, described sulfurous acid leaching of alumina from clay.
- RI 6134. Petroleum-Engineering Study of the Hall-Gurney Oilfield, Russell County, Kans., by C. H. Riggs, Larman J. Heath, Don C. Ward, and Ray V. Huff. 1963. 86 pp. 45 figs. Describes the development, oil recovery, and potentialities of productive formations in the Hall-Gurney field. Presented as part of a general program to aid and promote increased recovery from petroleum reservoirs, report is based on studies of well logs, drill cuttings, and oil- and water-production histories of individual wells and leases. Work done in cooperation with the Kansas State Board of Health. \$1.25.
- RI 6135. Use of a Large-Diameter Auger in Mining Pitching Anthracite Beds, by J. T. Schimmel, W. H.

- Tavener, and Donald Markle, Jr. 1962. 24 pp. 14 figs. Shows that augering eliminates exposure to the hazards encountered in driving chutework by conventional methods and provides adequate circular ventilation openings, which are strong in self support and are adaptable to reaming when required. Work done in cooperation with Raven Run Coal Co.
- RI 6136. Preparation Characteristics of Coal From Nicholas County, W. Va., by T. E. Gray. 1962. 32 pp. 3 figs. This report is one in a series describing coals suitable for producing metallurgical coke, either as mined or after beneficiation. The Lower Kittanning bed at one location, the Coalburg, the Peerless, and the Eagle beds at two locations, and the Sewell bed at three locations are of metallurgical quality as mined. Upgrading the Lower Kittanning, the Winifrede, and the Eagle beds at one location each to metallurgical quality presents a simple washing problem.
- RI 6137. Determination of Stresses Around an Underground Opening, Climax Molybdenum Mine, Colorado, by Stephen Utter. 1962. 26 pp. 22 figs. Presents the following results: (1) The maximum principal stresses were compressive and ranged from 690 to 4,870 psi, (2) the directions of the maximum principal stresses ranged from about 26° to 175° from the right horizontal axis, (3) the stresses computed from surface strain measurements were less than those computed from measurements farther in the rock, (4) stresses computed from theory ranged from 3,200 to 4,500 psi, depending on the depth of overburden, (5) anisotropy was not significant, and (6) the stress field was influenced either by the topography or by tectonic forces, or by both.
- RI 6138. The Effect of Suspension in Bolting Bedded Mine Roof, by Louis A. Panek. 1962. 59 pp. 11 figs. Explains the general principles of behavior of bolted roof beds by an approximate theory. Validates the theory with model test data and obtains an expression for the "suspension efficiency."
- RI 6139. The Combined Effects of Friction and Suspension in Bolting Bedded Mine Roof, by Louis A. Panek. 1962. 31 pp. 9 figs. Gives mathematical formulas for the change in maximum roof bending stress and for the change of roof deflection due to the combined friction and suspension effects. Findings are based on theory and on tests of mine-roof models in a centrifuge.
- RI 6140. Test Operation of a Pneumatic Vibrating-Blade Planer in Phosphate and Coal: A Progress Report on Planer-Mining Research, 1958-60, by Webster S. Anderson. 1962. 21 pp. 13 figs. Third in a series describing progress in research with the pneumatic vibrating-blade planer, report describes tests with the planer conducted in the Arickaree phosphate mine in Utah and in the Roslyn No. 9 coal mine in Washington. After the Arickaree mine tests, the bit design was improved, and tests were conducted in the Roslyn No. 9 mine to check the modifications. The redesigned cutting tool was an improvement, and the possibility of planing coal as well as phosphate was proved.
- RI 6141. Trenching and Sampling of the Rhyolite Mercury Prospect, Kuskokwim River Basin, Alaska, by Raymond P. Maloney. 1962. 43 pp. 11 figs. Shows that bulldozer trenching to bedrock at intervals, in a 2,000- by 3,000-foot area where previous prospecting had disclosed abundant float and several in-place stringers containing cinnabar, indicated that the mercury mineralization in the area investigated was confined to erratically distributed short stringers and to small lenses, occurring in discontinuous zones in silica-carbonate dikes and sills or along their altered contacts with sedimentary rocks. The geology of the prospect is similar to that existing at several other mercury mines and prospects in the Kuskokwim region.
- RI 6142. Beneficiation of Refractory Clay, by H. E. Powell, W. A. Calhoun, and C. K. Miller. 46 pp. 14 figs. 1963. Diverse mineral-dressing tests were used to beneficiate samples from the east-central Missouri fire clay district. Marginal and submarginal clays containing impurities were effectively beneficiated by both wet-cyclone and wet-table treatment, but the wet-cyclone treatment was cheaper.
- RI 6143. Heats and Free Energies of Formation of Calcium Tungstate, Calcium Molybdate, and Magnesium Molybdate, by R. Barany. 1962. 11 pp. The heats of formation at 298.15° K for the three compounds were determined by solution calorimetry. Combining these data with related entropy values gave the free energies of formation at 298.15° K.
- RI 6144. Performance of a Losch Anthracite Stoker in Building-Heating Service, by R. F. Tenney and J. W. Eckard. 1963. 45 pp. 12 figs. Presents additional data on the performance of a small industrial-type stoker burning rice-size anthracite. Observations were made, during a 4-month winter-spring season, on a stoker in actual building-heating service.
- RI 6145. Low-Temperature Phase Equilibria of Helium-Bearing Natural Cases: Hansford Gas, by Lowell Stroud, John E. Miller, and Will E. Devaney. 1963. 20 pp. 11 figs. Offers information on a natural gas with 0.75 mole-percent helium content which is to be processed by the Bureau. A windowed-cell apparatus was used to obtain 218 samples of equilibrium vapor and liquid phases at 73 experimental conditions ranging in temperature from -100° F to -275° F and in pressure from 100 to 500 psi. From the phase data, the condensation characteristics, helium solubility, and equilibrium-vaporization-coefficient data for helium, nitrogen, and methane were evaluated.
- RI 6146. Heat of Solution of Cerium Metal in Hydrochloric Acid, by R. L. Montgomery. 1962. 9 pp. Gives new determination of the heat of solution of cerium in hydrochloric acid, based on pure, thoroughly analyzed cerium produced by the Bureau.
- RI 6147. Low-Temperature Heat Capacities and Entropies at 298.15° K of Monomolybdates of Sodium, Magnesium, and Calcium, by W. W. Weller and E. G. King. 1963. 6 pp. 1 fig. Presents low-temperature heat capacity data for the monomolybdates of sodium, magnesium, and calcium. No previous similar data have been published for molybdates.
- RI 6148. Methods for Analyzing Tungsten Ores and Concentrates, by H. E. Peterson, W. L. Anderson, and M. R. Howcroft. 1963. 30 pp. Describes gravimetric and colorimetric methods currently used for the determination of tungsten in ores, mill tailings, and concentrates. Presents methods for the analysis of impurity elements that are encountered in tungsten concentrates including molybdenum, tin, copper, arsenic, antimony, bismuth, phosphorous, sulfur, lead, zinc, silica, calcium, magnesium, and iron. This publication is a revision of RI 3709, Determination of Tungsten in Low-Grade Ores, published in 1943.
- RI 6149. An Inclined-Piston Deadweight Pressure Gage, by D. R. Douslin and J. P. McCullough. 1963. 11 pp. 5 figs. Describes an inclined-piston pressure gage that operates from a zero-pressure datum level. Gage is adaptable to accurate vapor-pressure measurements in the low and intermediate pressure range, 0.01 to 40 mm (mercury). Work

- done in cooperation with the American Petroleum Institute and under contract with the Air Force Office of Scientific Research.
- RI 6150. Fuel-Oil Injection in an Experimental Blast Furnace, by P. L. Woolf and W. M. Mahan. 23 pp. 10 figs. 1963. Describes successful injection of fuel oil into tuyeres of Bureau of Mines experimental blast furnace and gives results of tests at minimum and maximum oil-injection rates. Oil-to-coke replacement ratios have been calculated for various conditions, and oil is compared with natural gas and moisture. A study of the effect of variations in slag volume and basicity on the sulfur content of the metal at high sulfur loads is included. Work done in cooperation with United States Steel Corp. and Esso Research and Engineering Co.
- RI 6151. Vibrations From Instantaneous and Millisecond-Delayed Quarry Blasts, by Wilbur I. Duvall, Charles F. Johnson, Alfred V. C. Meyer, and James F. Devine. 1963. 34 pp. 15 figs. Describes the test site, equipment, and experimental procedures used in performing these factorial designed blasting tests and presents the data derived together with an analysis and conclusions.
- RI 6152. Prerduced Iron Ore Pellets: A New Blast Furnace Raw Material, by M. M. Fine, J. P. Hansen, and Norwood B. Melcher. 1962. 19 pp. 16 figs. Describes a technical feasibility study of simultaneous reduction and induration of pelletized iron to make a product with superior qualities as blast furnace feed.
- RI 6153. Treating Beryl-Spodumene Concentrates Containing 10 to 30 Percent Beryl by the Fluosilicate Process, by R. O. Dannenberg, D. W. Bridges, and J. B. Rosenbaum. 1963. 18 pp. 2 figs. Shows that fluosilicate sinter-water leach processes appear applicable for treating beryl-spodumene concentrates containing 10 to 30 percent beryl. Recovery decreased and flux requirements increased when treating concentrates containing less beryl.
- RI 6154. Experiments in Fused-Salt Electrolysis of Tungsten, by F. R. Cattoir. 1963. 10 pp. 2 figs. Presents results of preliminary studies for the evaluation of some fused-salt electrolytes for refining tungsten metal and describes the equipment used. Some impurities could be eliminated with electrolytes composed of sodium chloride, sodium iodide, or sodium tetraborate in combination with tungsten oxide or sodium tungstate. No electrolyte tested yielded a product pure in all respects.
- RI 6155. Thermodynamic Properties of Yttrium Metal and Iron Pentacarbonyl at High Temperatures, by James R. Welty, Charles E. Wicks, and Herbert O. Boren. 1963. 10 pp. 3 figs. Gives experimentally determined heat content values for yttrium metal between temperatures of 400° and 1,300° K and for iron carbonyl between 301° and 380° K. A revised technique for determining heat content values from calorimetric data is described. Work done in cooperation with Oregon State University.
- RI 6156. Recovery of Beryllium From Utah Ore by the Fluosilicate Process, by R. O. Dannenberg, D. W. Bridges, and J. B. Rosenbaum. 1963. 12 pp. 4 figs. Gives results of exploratory research to ascertain the feasibility of recovering beryllium from Spor Mountain ore by the sodium fluosilicate method used industrially for processing beryl. The quality of beryllia from Spor Mountain ore is comparable to that prepared commercially from beryl, but the reagent requirements are considerably greater and the beryllium recovery is appreciably lower than in treating industrial-grade beryl concentrate.
- RI 6157. Thermodynamic Properties of Cesium Chloride and Cesium Iodide From 0° to 300° K, by A. R. Taylor, Jr., T. Estelle Gardner, and D. F. Smith. 1963. 7 pp. 1 fig. Gives low-temperature heat capacities of cesium chloride from 7° to 300° K and cesium iodide from 13° to 300° K, measured with an adiabatic calorimeter. Heat capacity measurements were analyzed graphically to determine smooth values of heat capacity, entropy, enthalpy, function, and free energy function at 10° K intervals and at 273.15° and 298.15° K. Work done in cooperation with the University of Alabama.
- RI 6158. Design and Applications of Some Mathematical Models for Mine-Systems Analysis, by Richard F. Hewlett and D. E. Redmon. 1963. 51 pp. 15 figs. Constitutes an introduction to work being done by Bureau concerning mine-systems analysis. Discussion of computational details are avoided; the major effort is concentrated on illustrating easily understood and representative applications of potentially valuable methods of solving the mine-operating problems.
- RI 6159. Separation and Recovery of Cobalt and Nickel by Solvent Extraction and Electrorefining, by P. T. Brooks and J. B. Rosenbaum. 1963. 30 pp. 12 figs. Describes a novel method for separating nickel and cobalt. Laboratory-scale studies demonstrated the technical feasibility of producing high-quality nickel and cobalt metals from impure nickel oxide containing 1 part of cobalt per 100 parts of nickel by a combination solvent extraction-electrolytic process.
- RI 6160. Differential Sulfatizing Process for the Recovery of Ferrograde Manganese, by Charles Prasky, F. E. Joyce, Jr., and W. S. Swanson. 1963. 30 pp. 6 figs. Describes and appraises recent progress in the development of a differential sulfatizing process for recovering a ferrograde manganese oxide from low-grade manganese ferruginous materials from the Cuyuna range deposits in Crow Wing County, Minn. Individual process steps were carried out successfully.
- RI 6161. Electrolytic Methods of Preparing Cell Feed for Electrorefining Titanium, by M. M. Wong, R. E. Campbell, D. C. Fleck, and D. H. Baker, Jr. 1963. 22 pp. 5 figs. Gives results of investigative work by the Bureau on fused-salt electrolysis of titanium carbide and a commercial material termed "titanium cyanonitride." Problems associated with the preparation of crude metal by fused-salt electrolysis are discussed. Work done in cooperation with the General Services Administration.
- RI 6162. Reaction Rate of Titanium and Titanium Subchlorides in Molten Sodium Chloride, by T. A. Henrie, E. K. Kleespies, and D. H. Baker, Jr. 1963. 20 pp. 8 figs. Describes an experimental technique devised for measuring the kinetics of heterogeneous reactions between molten salts containing multivalent ions and reactive metals that was then applied to the reaction between high-purity titanium metal and titanium trichloride dissolved in molten sodium chloride in the temperature range of 800° to 890° C. Experimental technique should have wide application in studying reactions involved in electrolytic and rate-controlled metallothermic reductions in molten salts containing multivalent species.
- RI 6163. Chemical and Physical Beneficiation of Florida Phosphate Slimes, by James H. Gary, I. L. Feld, and Edward G. Davis. 1963. 35 pp. 19 figs. Presents data on the composition and physical properties of Florida land-pebble phosphate-waste slime and discusses the feasibility of dewatering and beneficiating the slime by several different methods. Work done in cooperation with the University of Alabama.

- RI 6164. Design and Development of Precast Concrete Mine Supports: A Progress Report, by G. T. Krempasky and R. C. Cowles. 1963. 50 pp. 14 figs. Describes an attempt to develop a suitable precast concrete support for underground use, in which two different models of a five-piece concrete set were designed, fabricated, and tested under adverse loading conditions. Discusses test results and details of designs. First in a series on precast concrete mine supports.
- RI 6165. Noise From Pneumatic Rock Drills. Measurement and Significance, by William C. Miller. 1963. 30 pp. 19 figs. Describes investigations by the Bureau of Mines designed to establish the noise level and spectrum of various types of pneumatic rock drills and to furnish information that would be useful in conducting sound measurements in mining environments and in reducing the noise generated in pneumatic drilling.
- RI 6166. Oxidation of Colorado Oil Shale, by W. E. Robinson, D. L. Lawlor, J. J. Cummins, and J. I. Fester. 1963. 33 pp. 2 figs. Gives new information about the chemical structure of organic kerogen in oil shale, obtained by oxidizing samples of raw oil shale and kerogen concentrates by alkaline potassium permanganate, air, nitric acid, oxygen, and ozone. Work done in cooperation with the University of Wyoming.
- RI 6167. Analyses of Brines From Oil-Productive Formations in Mississippi and Alabama, by M. E. Hawkins, O. W. Jones, and C. Pearson. 1963. 22 pp. 6 figs. Presents in tabular form mineral analysis and electrical resistivity measurements of 324 representative samples of oilfield brines from 24 oil-productive counties in Mississippi and Alabama. Chemical analysis of formation waters is helpful to operators having water problems associated with petroleum recovery. Electrical resistivity values are helpful in making interpretations from logs. Work done in cooperation with the Mississippi State Oil and Gas Board.
- RI 6168. An Improved Gravimetric Method for Analyzing Blast Furnace Top Gas, by David J. Kusler. 1963. 21 pp. 10 figs. Describes a gravimetric method for determining carbon dioxide, carbon monoxide, hydrogen, methane, and oxygen in blast furnace top gas. Nitrogen may be determined directly by volume measurement or by difference. Method is direct, permits continuous sampling, and provides an averaged analysis over a selected range of sampling intervals from one-half to 24 hours or more. Does not require expensive equipment or specialized equipment, and results compare favorably with those of established methods.
- RI 6169. Investigations of Stresses in a Drill Bit and Rock Under Static Loads, by Albert J. Rambosek and James B. Williams, Jr. 1963. 21 pp. 17 figs. Presents the results of a study of the stress conditions existing in a drill bit-point area and in the underlying rock, when the bit was in full but nonpenetrative contact with the rock. The photoelastic technique of experimental stress analysis was the principal method used to obtain the data.
- RI 6170. Effect of Indium on the Solid Solubility of Calcium and of Silicon in Magnesium, by R. L. Crosby and K. A. Fowler. 1963. 11 pp. 4 figs. Gives data on the solid solubility of calcium and of silicon in magnesium, using metallographic, X-ray diffraction, and electrical resistivity techniques. Adding 2 weight-percent or more of indium reduced the solid solubility of calcium in magnesium by forming a compound containing indium and calcium, but indium additions have no perceptible effect on the solid solubility of silicon in magnesium.
- RI 6171. Heats and Free Energies of Formation of Barium Oxide and Strontium Oxide, by Alla D. Mah. 1963. 8 pp. Combustion energies of barium and strontium were measured by means of the combustion calorimeter. Tables containing heats and free energies of formation from 298.15° to 2,000° K were prepared.
- RI 6172. Flotation of Ilmenite From Virginia Sapolite and Unweathered Diorite Ores, by Vernon F. Swanson. 1963. 8 pp. Describes an investigation of flotation procedures to recover ilmenite from a diorite deposit located in Amherst County, Va. Flotation of the ilmenite from the unaltered sample was successful in producing commercial-grade concentrate at good recovery.
- RI 6173. Recovery of Beryllium From Spor Mountain, Utah, Ore by Solvent Extraction and Caustic Stripping, by Laird Crocker, R. O. Dannenberg, D. W. Bridges, and J. B. Rosenbaum. 1963. 27 pp. 6 figs. Describes a study of beryllium recovery from sulfate leach liquor by di-2-ethylhexyl phosphate solvent extraction in conjunction with caustic stripping. Over 90 percent of the beryllium contained in the leach liquor was recovered as beryllia.
- RI 6174. Pressure Forming of Aluminum Oxide, by Sara Janes Boles and Edwin E. Maust, Jr. 1963. 14 pp. 4 figs. Gives data on the effect of liquid content on the apparent porosity and bulk density of compacts pressed from high-purity fused aluminum oxide and studies the actual mechanism by which the liquid content affects the bulk density. Water content varied from 7 percent to 25 percent, and data gathered indicated a well-defined optimum water content for obtaining minimum apparent porosity and maximum bulk density.
- RI 6175. High-Temperature Heat Contents and Entropies of the Sesquioxides of Erbium, Holmium, Thulium, and Ytterbium, by L. B. Pankratz and E. G. King. 1963. 8 pp. 2 figs. Gives measurements of the heat contents of the sesquioxides of erbium, holmium, thulium, and ytterbium in the cubic crystalline form over the temperature range from 298° to 1,800° K. The heat content results are presented in both tabular form (at 100° K intervals) and in algebraic form. Entropy increments, corresponding to the heat content results, also are listed.
- RI 6176. Computing Ore Reserves by the Triangular Method Using a Medium-Size Digital Computer, by Richard F. Hewlett. 1963. 30 pp. 3 figs. The computer program was written for the IBM 650, augmented with floating-point arithmetic, index registers, core storage, and an online 407 printer. Appendix provides charts of program.
- RI 6177. Heats and Free Energies of Formation of Vanadium Nitride and Vanadium Carbide, by Alla D. Mah. 1963. 8 pp. Reports new experimental values of the heats of formation of vanadium nitride and vanadium carbide. Data have greatly reduced the uncertainties and will result in greatly improved thermodynamic calculations involving nitride and carbide of vanadium.
- RI 6178. Vapor-Liquid Equilibria for a Helium-Nitrogen-Methane System, by W. J. Boone, Jr., Will E. DeVaney, and Lowell Stroud. 1963. 19 pp. 9 figs. Reports experimental determinations of vapor-liquid equilibria data for a helium-nitrogen-methane system. The mixture composition approximates the crude helium that eventually will be further refined to obtain pure helium. The experimental data presented in this report supplement the information available for the binary systems.

- RI 6179. Iron-Catalyzed Hydrogenation of Phenyl Ether, Benzyl Ether, and Phenyl Sulfide, by Walter Kawa and Raymond W. Hiteshue. 1963. 17 pp. 1 fig. Gives results of studies of hydrogenation of phenyl ether, benzyl ether, and phenyl sulfide in the presence of iron catalysts which was undertaken to gain a better understanding of the role of iron catalysts in the hydrogenation of coal. Experiments were made in batch autoclaves for 4 hours; hydrogen was at a pressure of 540 atmospheres.
- RI 6180. Thermal Expansion of the Oxides of Yttrium, Cerium, Samarium, Europium, and Dysprosium, by Roy L. Wilfong, Louis P. Domingues, LeRoy R. Furlong, and Joseph A. Finlayson. 1963. 25 pp. 11 figs. Gives the linear expansion of high-purity oxides of yttrium, cerium, samarium, europium, and dysprosium determined by the interferometric method for the temperature range 25° to 1,000° C. Investigation of the interferometric technique showed the interferometer to be a precision tool, but only when adequate precautions, which are described, were taken.
- RI 6181. A Replica Electron Microscopic Method for Measuring Knoop Hardness Indentations, by Charles W. Huggins and C. W. Houck. 1963. 15 pp. 16 figs. Gives results of a study of Knoop hardness indentations on TiB₂, HfC, and AlB₂ crystals. The indentations, replicated with collodion and Faxfilm, were studied and measured with the electron microscope. Resulting data showed excellent agreement between the measurements made on the replicas with the electron microscope and those made with the optical microscope.
- RI 6182. Analysis of High-Purity Vanadium by Optical Emission Spectrography, by Lloyd Carpenter and Kathleen Hazen. 1963. 16 pp. 4 figs. Gives determination of 18 elements in vanadium metal and its compounds by an optical emission spectrographic procedure. Average precision of method was 15.6 percent relative standard deviation and relative error was 4.4 percent.
- RI 6183. Experiments in Using an Electrochemical Cell to Analyze High-Purity Iron, by H. W. Kilau and J. P. Hansen. 1963. 11 pp. 5 figs. Explores the feasibility of an electrochemical technique for the analysis of high-purity iron. Some degree of success was achieved with a high-temperature cell having a molten-salt electrolyte composed of 0.5 percent of FeCl₂ and eutectic mixture of KCl-LiCl. The electrodes were composed of 99.4910 and 99.4016 percent iron.
- RI 6184. Physical Structure of Green River Oil Shale From Colorado, by P. R. Tisot and W. I. R. Murphy. 1963. 24 pp. 6 figs. Analyzes oil shale in regard to distribution of organic carbon, grade limits, particle designation, surface area and pore volume of particles, surface area and pore volume of mineral constituents, amount of organic matter in contact with mineral constituents, and other factors. Work done in cooperation with the University of Wyoming.
- RI 6185. Gas Explosion Hazards Associated With the Bulk Storage of Molten Sulfur, by Aldo L. Furno, George H. Martindill, and Michael G. Zabetakis. 1963. 11 pp. 7 figs. Shows that sufficient quantities of combustible vapors are released by some molten sulfurs to produce flammable atmospheres during prolonged storage. Hydrogen sulfide and carbon disulfide appear to be the principal flammable constituents in the vapor space above molten sulfur. If sufficient carbon disulfide is present, ignition of the vapor-air mixtures can occur spontaneously on contact with the heated surfaces found within storage tanks. Work done in cooperation with the Texas Gulf Sulphur Co.
- RI 6186. Recovery of Low-Silica Cryolite From Siliceous Fluoride Offgases, by Arden D. Fugate and Robert K. Koch. 1963. 14 pp. 4 figs. Gives results of a study to determine a feasible process for converting siliceous fluoride offgases to a commercially usable product. An electrolytic-grade cryolite was recovered, a product containing 97 to 100 percent of the fluorine was obtained, and 94 to 99 percent of the theoretical yield was realized.
- RI 6187. Selective Flotation of Barite-Fluorspar Ores From Kentucky, by James S. Browning, W. H. Eddy, and Thomas L. McVay. 1963. 15 pp. 2 figs. Describes laboratory batch and continuous pilot plant tests made to demonstrate the feasibility of recovering high-grade barite and fluorspar concentrates from two deposits. The fluorspar concentrates were of acid-grade quality; the barite met the specifications for material used to increase the density of oil-well-drilling muds. Work done in cooperation with the University of Alabama.
- RI 6188. Effects of Mechanical Properties of Material on Cratering: A Laboratory Study, by J. Burlin Johnson and R. L. Fischer. 1963. 24 pp. 11 figs. Describes an investigation of the relationship between crater dimensions formed in laboratory blasting experiments and the mechanical properties of the material cratered. Scaled field data have been included when available. The results show that tensile strength and possibly other properties may be useful in predicting maximum crater dimensions.
- RI 6189. Effect of Ions Common to Natural Water on Flotation of Limestone, by W. W. Agey, H. B. Salisbury, and P. L. Placek. 1963. 25 pp. Describes the fundamental research undertaken to define and measure the adverse and/or beneficial effects of different concentrations and combinations of several common ions and cations when oleic acid is used to froth-float limestone from a pulp of quartz and limestone. A satisfactory test procedure was developed by which significant factors could be controlled and reproducible results achieved.
- RI 6190. Flammability of Trichloroethylene, by G. S. Scott. 1963. 5 pp. 1 fig. Gives determination of the flammability of trichloroethylene vapors in air in a 7-inch cylindrical vessel. Saturated flammable mixtures were formed with air at atmospheric pressure between 30° and 82° C; the trichloroethylene concentrations were 12.5 and 90 volume-percent, respectively.
- RI 6191. Low-Temperature Heat Capacities and Entropies at 298.15° K of Sodium Dimolybdate and Sodium Ditungstate, by W. W. Weller and K. K. Kelley. 1963. 5 pp. 1 fig. Heat capacities were measured over the temperature range from 51° to 298° K. The entropies were calculated from the heat capacity values and were used, in conjunction with other entropy data, to evaluate the entropies of formation of the compounds from their constituent elements and oxides.
- RI 6192. Supercompressibility Factors for Helium-Nitrogen Mixtures, by John E. Miller and Lowell Stroud. 1963. 242 pp. Tabulates supercompressibility factors derived from experimental compressibility data for five helium-nitrogen mixtures containing from 50 to 100 percent helium.
- RI 6193. Oxidation Leaching of Copper Sulfides in Acidic Pulp at Elevated Temperatures and Pressures, by Martin H. Stanczyk and Carl Rampacek. 1963. 15 pp. 3 figs. Gives results of laboratory investigation of acid leaching of selected copper sulfide minerals, impure copper sulfide flotation concentrates, and a cement copper precipitate at elevated temperatures and pressures. Copper extractions of 97 to 99 percent were obtained by leaching chalcopyrite and the flotation concentrates with wa-

- ter under oxidizing conditions at 200° C for 30 to 60 minutes. In tests with bornite, chalcocite, and cement copper, addition of sulfuric acid or pyrite to the autoclave was required to obtain similar copper extractions.
- RI 6194. Fischer-Tropsch Oil-Circulation Process: Experiments With a Massive-Iron Catalyst, by D. Bienstock, A. J. Forney, and J. H. Field. 1963. 20 pp. 7 figs. Describes a massive-iron catalyst resistant to oxidation and spalling and having a 6-month catalyst life. This rugged catalyst was developed to withstand the hydraulic attrition resulting from the oil-circulation process for synthesizing liquid fuels.
- RI 6195. Radiotracer Applications in Electrometallurgical Processing, by Kenneth G. Broadhead and Howard H. Heady. 1963. 14 pp. 2 figs. Describes four radiotracer applications to special metallurgical research problems. The solutions of these problems were generally of an analytical nature. However, in electrowinning tungsten, the feasibility of using a tracer technique as a control method was also demonstrated. The procedures and techniques developed were both rapid and accurate, and provided data that would have been difficult, or impossible, to obtain by conventional methods.
- RI 6196. Reservoir Oil Characteristics, Greater Aneth Area, Utah. Unusual Saturation-Pressure Variations, by R. F. Zaffarano, C. Q. Cupps, and J. Fry. 1963. 61 pp. 10 figs. Gives data on the characteristics of the reservoir oil in this area of the Paradox basin, results of a study made to detect variation in oil characteristics within the reservoir and to determine its relation to age of accumulation and fluid equilibrium. Presents individual subsurface sample analyses not previously published and a consolidated analysis of the reservoir oil in the greater Aneth area.
- RI 6197. Heats and Free Energies of Formation of Vanadates of Lead and Manganese, by K. K. Kelley, L. H. Adami, and E. G. King. 1963. 9 pp. Gives the heats of formation of two lead vanadates and manganese vanadate determined by hydrochloric acid solution calorimetry, which supplement previous Bureau measurements of the vanadates of calcium, magnesium, and sodium. Heat and free energy for 11 vanadates were assembled on a common basis. The stability of comparable vanadates (with respect to the oxides) increases in the following order: Magnesium, manganese, lead, calcium, sodium.
- RI 6198. Thermodynamic Data for Gallium and Scandium Sesquioxides, by L. B. Pankratz and K. K. Kelley. 1963. 7 pp. 2 figs. High-temperature heat content values of these sesquioxides were obtained over the temperature range from 298° to 1,800° K. No similar data existed previously. These values were combined with heats and entropies of formation to obtain free energies of formation of the sesquioxides to 2,000° K. The thermodynamic stabilities of the sesquioxides of aluminum, gallium, scandium, and yttrium were compared.
- RI 6199. Anionic Flotation of Silica From Goethitic Iron-Bearing Materials, Cuyuna Range, Minn., by P. A. Wasson, R. T. Sorensen, and D. W. Frommer, 1963. 11 pp. Gives results of batch laboratory tests made on four goethitic iron-bearing samples from the Cuyuna range that showed that the anionic method for silica flotation could be used to concentrate these materials. Iron recoveries ranged from about 71 to 85 percent, but recoveries as high as 94 percent could be obtained by reclaiming iron in the middlings.
- RI 6200. Thermoelectric Properties of Enargite-Type Compounds, by Raymond L. Carpenter, John S. Murray, and Thomas D. Roberts. 1963. 8 pp. 2 figs. Gives data on the thermal conductivity, electrical resistivity, and Seebeck coefficient for nine compounds, based on the formula for enargite Cu_3AsS_5 , which were measured in a search for efficient materials to be used in thermoelectric generators or refrigerators. Results indicate that the compound Cu_3SbSe_5 has thermoelectric properties approaching those of bismuth telluride.
- RI 6201. Determination of Tellurium, by W. L. Anderson and H. E. Peterson. 1963. 9 pp. Describes modification of standard tellurium analytical procedures to obtain greater sensitivity. Resulting volumetric and spectrophotometric methods for determining tellurium in all types of tellurium-containing materials are described.
- RI 6202. Infrared Studies of Oleic Acid and Sodium Oleate Adsorption on Fluorite, Barite, and Calcite, by A. S. Peck. 1963. 16 pp. 10 figs. Define the mechanism involved in the adsorption of oleic acid and sodium oleate on fluorite, calcite, and barite, using an infrared spectrophotometer for identifying and measuring the adsorbed reagents and reaction products. Work done in cooperation with the University of Utah.
- RI 6203. Studies on the Bullet Sensitivity of Ammonium Nitrate-Fuel Oil Mixtures, by C. M. Mason, J. Ribovich, and R. W. Van Dolan. 1963. 22 pp. 13 figs. For the three rifles used, the order of efficiency in initiating detonation in AN-FO mixtures was 220 Swift >300 Weatherby Magnum >30-'06. The velocity of the bullet was found to be a decisive factor in the initiation. The sensitivity of various materials studied increased as follows: Clay-coated prills with 4 percent oil <fresh surfactant-coated prills with 4 or 6 percent oil <surfactant-coated prills with 4 or 6 percent oil and aged 270 days <crushed prills with 6 percent oil <very-low-density, surfactant-coated prills (micronized), with 4 percent oil.
- RI 6204. Measurements of Surface Subsidence, San Manuel Mine, Pinal County, Ariz., by George H. Johnson and John H. Soulé. 1963. 36 pp. 26 figs. Summarizes the results of an investigation of surface subsidence above caving blocks at the San Manuel mine in order to obtain quantitative information on subsidence and ground movement caused by mining large volumes of ore. Angles of break varied from 53° to 95° (a reverse angle), and angles of subsidence range from 64° to 95°. Ratio of volume of material mined to the volume of the surface subsidence is about 1.44 to 1. This investigation is part of an overall study of rock mechanics undertaken by the Bureau.
- RI 6205. Chelating Agents in Separation of Rare-Earth Compounds by Solvent Extraction With Amines, by A. C. Rice. 1963. 16 pp. 11 figs. Separation factors between rare-earth elements obtained by solvent extraction with amines are enhanced by the addition of aminopolyacetic chelating agents. Adding EDTA or DCTA to the extraction improves separation factors for elements in both the cerium and yttrium groups. HEDTA is effective for improving separation factors in the cerium group elements.
- RI 6206. Pine Flat and Diamond Flat Nickel-Bearing Laterite Deposits, Del Norte County, Calif., by W. T. Benson. 1963. 19 pp. 3 figs. Describes an investigation of the nickel-bearing laterite deposits in the Pine Flat and Diamond Flat areas and the response of the ores to metallurgical treatment. Results indicate that the deposits are comparatively small and marginal or submarginal in grade; metallurgical tests showed that no separation of cobalt from nickel and iron was made by sizing, but a large portion of the chromium was

- separated. Work was done in cooperation with the California-Oregon Power Co.
- RI 6207. An Electrical Method for the Continuous Measurement of Propagation Velocities in Explosives and Propellants, by F. C. Gibson, M. L. Bowser, C. R. Summers, and F. H. Scott. 1963. 8 pp. 8 figs. Describes an electrical method for the continuous determination of propagation velocities in opaque, confined explosives and propellants. The method is applicable to both solids and liquids.
- RI 6208. A Mobile Spectroscopic Laboratory for Reconnaissance and Exploration, by E. C. Pattee and R. D. Weldin. 1963. 22 pp. 8 figs. A mobile laboratory provides rapid and inexpensive means of field testing samples for beryllium and other associated metals of possible commercial importance.
- RI 6209. Design and Construction of a Laboratory-Scale Fluidized-Bed Reactor, by B. K. Shibley and D. A. Martin. 1963. 15 pp. 9 figs. A highly flexible laboratory-scale fluidized-bed reactor was designed, constructed, and successfully operated continuously at temperatures up to 1,300° C during an investigation of thermal methods for decomposing gypsum.
- RI 6210. Effects of Water Injection on Oil Recovery in Cooke and Grayson Counties, Tex., by Frank Parrish, Jr. 1963. 82 pp. 59 figs. Presents the history and the performance data of 17 water-injection projects in the Strawn and Canyon sands. The purpose was to study and compare operating practices and oil-recovery techniques. Work done in cooperation with the North Texas Oil and Gas Association.
- RI 6211. Physical and Chemical Properties of Some Pacific Northwest Halloysitic Clays, by Hal J. Kelly, George J. Carter, and Thomas R. Rehm. 1963. 32 pp. 19 figs. Investigates problems that developed in processing halloysitic clays from eastern Washington and northern Idaho. Compares the deflocculating effect of tetra sodium pyrophosphate with that of several other compounds and explains the advantages of sodium pyrophosphate. The adsorption of the sodium ion was established by a radiotracer technique, and the deflocculating action of sodium pyrophosphate was postulated. These clays and a kaolinite clay sample were disaggregated effectively by high-pressure liquid extrusion and slightly less effectively by plastic extrusion and/or ball milling.
- RI 6212. A Metal Diaphragm Apparatus for Measuring Vapor Pressures. Vapor Pressure of Arsenic (III) Oxide, by F. D. Stevenson and C. E. Wicks. 1963. 19 pp. 19 figs. A metal diaphragm pressure relay system was constructed to measure vapor pressures of the metal halides, oxyhalides, and other substances at temperatures up to 700° or 800° C. The vapor pressure of arsenic (III) oxide was determined to verify the reliability of the apparatus for such measurements. Work done in cooperation with Oregon State University.
- RI 6213. Flotation Concentration of a Complex Barite-Fluorspar Ore, by P. A. Bloom, W. A. McKinney, and L. G. Evans. 1963. 16 pp. 3 figs. Demonstrates the feasibility of the lignin-fluoride-cetyl sulfate method for selective flotation of fluorspar and barite from a complex Arizona ore containing 24.8 percent fluorspar and 24.3 percent barite. The products met specifications for acid-grade fluorspar and drilling-mud-type barite.
- RI 6214. Reconnaissance of Beach Sands, Bristol Bay, Alaska, by Robert V. Berryhill. 1963. 48 pp. 15 figs. Gives data on spot samples from some beaches along the shores of the Alaska Peninsula that indicated small deposits containing up to 10 percent recoverable titaniferous magnetite. Some larger deposits were indicated to contain from 1 to 2 percent total heavy metal, principally as titaniferous magnetite. Significant amounts of other commercial minerals were not detected.
- RI 6215. Segregation of Copper Ores by Direct-Firing Methods, by W. A. McKinney and L. G. Evans. 1963. 15 pp. 7 figs. Describes a new method of segregating copper ores by using a direct-fired, refractory-lined rotary kiln instead of the more complicated indirect-fired stainless steel kiln. Batch trials of the new technique yielded flotation concentrates containing from 17 to 45 percent copper, representing 84 to 94 percent recovery.
- RI 6216. Statistical Analysis of Churn-Drill and Diamond-Drill Sample Data From the San Manuel Copper Mine, Arizona, by Scott W. Hazen, Jr. 1963. 124 pp. 56 figs. Presents results of a study and statistical analysis of part of the initial exploration churn-drill sampling and some of the subsequent underground diamond-drill-core sampling in the North ore body at the San Manuel copper mine, Arizona. Investigates the feasibility of using the techniques of statistical analysis in evaluating sample and assay data and computing grade and tonnage of ore from porphyry-type copper deposits.
- RI 6217. Examination of an Experimental Iron Blast Furnace After Quenching With Nitrogen, by J. P. Morris and P. L. Woolf. 1963. 36 pp. 17 figs. Gives analyses of 500 samples taken from the stack, bosh, and hearth when the experimental furnace in normal operation was quenched by substituting cold nitrogen for the hot blast air. Makes deductions as to the patterns of burden movement and gas flow, the reduction of iron oxides, and the behavior of sulfur above the smelting zone. Data upon which the report is based were obtained during a cooperative project with the United States Steel Corp.
- RI 6218. Mount Gran Coal Deposits, Victoria Land, Antarctica, by John J. Mulligan and Others. 1963. 66 pp. 38 figs. Presents data on Antarctic deposits of anthracites or semianthracites. This is the first of a series of Bureau reports on Antarctic coal. The project was sponsored by the National Science Foundation and laboratory work was done by the Geological Survey and the Bureau of Mines.
- RI 6219. Beneficiation of Aluminum Plant Residues, by R. S. McClain and G. V. Sullivan. 1963. 17 pp. 3 figs. Presents results of continuous-circuit flotation and batch-scale precipitation tests made to determine rejection of carbon residues. Gasoline and turpentine were satisfactory for floating carbon from both fresh water and saturated solution systems. Soluble fluorine and aluminum compounds were recovered by precipitation with sodium aluminate and carbon dioxide. Results show that a flotation-precipitation method for treating aluminum reduction plant residue is potentially feasible for industrial application.
- RI 6220. Synthesis of Fibrous Silicon Carbide by Thermal Reduction of Silicates and Silicon Compounds, by John K. Alley, Robert C. Johnson, Charles Huggins, and H. R. Shell. 1963. 19 pp. 9 figs. Describes the production of fibrous silicon carbide by thermal decomposition of certain silicates contained in graphite crucibles. Induction heating was used to produce the necessary temperature and thermal gradients.
- RI 6221. Effects of Hydraulic Fluids in Spontaneous Heating of Coal, by Allan F. Smith, Henry P. Barthe, and Samuel P. Polack. 1963. 16 pp. 10 figs. Gives results of the measurement of temperature increases produced in coal-hydraulic fluid mixtures that were heated to a temperature sufficient

- for the initiation of self-heating. Compares results with those of similar tests made on as-received coal samples and water-coal mixtures. Data provide a basis for predicting the possible effects in gob or carbonaceous refuse of coal mines.
- RI 6222. Vapor Phase Oxidation for Hydrocarbons in Low-Temperature Coal Tar, by John S. Berber and Arthur L. Hiser. 1963. 15 pp. 4 figs. Describes research on the production of phthalic anhydride by vapor phase oxidation of hydrocarbons. Of six catalysts tested, vanadium pentoxide proved to be the most effective from the point of conversion yield and catalytic life.
- RI 6223. Concentration of Fine Mica, by James S. Browning and Thomas L. McVay. 1963. 7 pp. 1 fig. Gives results of laboratory and pilot plant flotation studies that demonstrated the feasibility of producing a mica concentrate from crushing and screening tailings that contained 17 percent mica. Products containing about 98 percent mica were obtained by flotation, whereas wet-tabling and agglomeration-tabling methods yielded a product containing about 95 percent mica. Work done in cooperation with the University of Alabama and Dixie Mines, Inc., Heflin, Ala.
- RI 6224. Magnetic Susceptibility of Siderite, by H. E. Powell and C. K. Miller. 1963. 19 pp. 3 figs. Describes a laboratory investigation to study the magnetic characteristics and to measure the magnetic susceptibility of the mineral siderite. Gives susceptibility measurements, made by the Gouy method on powdered samples at room temperature, of siderite from 15 foreign and domestic sources. Discusses the relation of magnetic susceptibility to mineral composition.
- RI 6225. Two-Stage Electric Furnace Smelting of High-Iron Manganiferous Materials for Producing Ferromanganese, by F. B. Peterman and R. S. Lang. 1963. 10 pp. 1 fig. Gives results of two-stage electric smelting tests on high-iron manganiferous materials from the Pioche district, Nevada, and the Cuyuna range, Minnesota. Ferromanganese produced was high in silicon but otherwise met specifications. The overall recovery of manganese was about 70 percent from the Pioche concentrate and about 50 percent from the Cuyuna concentrate.
- RI 6226. Electrowinning Uranium Oxide, by D. G. Kesterke, L. W. Schramm, R. G. Knickerbocker, and T. A. Henrie. 1963. 10 pp. 3 figs. Describes research on the electrolytic reduction of uranium dioxide to molten uranium in fluoride baths at approximately 1,200°C. Over 1,000 grams of metal of 99.8-percent purity was made in some tests. Effects of cell design, geometry, and bath composition were investigated. Work done in cooperation with U.S. Atomic Energy Commission.
- RI 6227. Preparation Characteristics of Coal From Mercer County, W. Va., by Albert W. Deurbrouck. 1963. 23 pp. 3 figs. Describes the preparation characteristics of the significant coalbeds in Mercer county. Of the six samples collected from the three producing coalbeds—Pocahontas Nos. 3, 6, and 11—four were of metallurgical quality as mined and two could be upgraded by washing at suitable specific gravities.
- RI 6228. Lead and Barium Disilic Fluormicas, by John L. Miller, Jr., I. L. Turner, and H. R. Shell. 1963. 9 pp. Describes the synthesis of lead and barium disilic fluormicas and gives data on their properties including unit-cell parameters from X-ray diffraction, optical data, chemical composition, density, melting points, and chemical and dielectric properties. Both the lead and barium micas yielded polycrystalline machinable ceramics with excellent mechanical and dielectric properties.
- RI 6229. Methods for Producing Alumina From Clay. An Evaluation of Three Sulfuric Acid Processes, by Frank A. Peters, Paul W. Johnson, and Ralph C. Kirby. 1963. 57 pp. 24 figs. Evaluates three processes designed to leach alumina as aluminum sulfate from calcined clay with sulfuric acid and purify the filtrate from the leaching by (1) an electrolytic iron-removal process, (2) a chemical iron-removal process, or (3) an ethanol purification process. Gives estimated capital and operating costs and recommendations for additional research and development to improve the processes and to lower their costs.
- RI 6230. Reclaiming S-816 High-Temperature Alloy Scrap, by L. W. Higley, Jr. 1963. 12 pp. 8 figs. Gives results of tests that show that a cobalt-base, multicomponent, high-temperature alloy, such as S-816, can be successfully melted from scrap and its specified chemical composition can be retained. The scrap material, after melting, forging, and heat treatment, was equivalent in room-temperature tensile strength, in high-temperature creep and stress-rupture properties, and in chemical composition to commercially produced S-816 alloy made from virgin material.
- RI 6231. High-Temperature Corrosion Studies. Nickel and Cobalt in Air and Oxygen, by Robert M. Doerr. 1963. 20 pp. 7 figs. Isothermal oxidation kinetics were determined for three grades of nickel and one grade of cobalt in air from 800° to 1,200° C. The oxidation reactions followed approximately the parabolic rate law. Volumetric and quartz-helix gravimetric methods were used.
- RI 6232. An Introduction to Statistical Design of Experiments in Metallurgical Research, by S. J. Hüssey, P. L. Placek, and C. H. Schack. 1963. 111 pp. 10 figs. Presents a discussion of the statistical approach to the design of experiments in extractive metallurgy and indicates, by concrete examples, how and when statistical design is essential for obtaining meaningful data with a minimum number of experiments. The principles involved in using factorial, fractional factorial, composite, randomized, and nested designs are described and illustrated by means of typical examples.
- RI 6233. Developing a Thermochemical Model for the Iron Blast Furnace. Model of Ideal Furnace at Equilibrium, by Hillary W. St.Clair. 1963. 38 pp. 12 figs. First progress report on a theoretical study of the iron blast furnace intended to develop a thermochemical model to simulate mathematically a real furnace. Analysis is made of a hypothetical furnace, operating adiabatically on pure ferric oxide, graphitic carbon, and dry air; analyses are made for two contrasting types of gas flow, nonturbulent (having no vertical mixing) and turbulent.
- RI 6234. Statistical Analysis of Diamond-Drill Sample Data from the Cebolla Creek Titaniferous Iron Deposit, Gunnison County, Colo., by R. D. Berkenkotter and Scott W. Hazen, Jr. 1963. 59 pp. 8 figs. Titanium and iron assays obtained from cores of three diamond-drill holes from the Cebolla Creek titaniferous iron deposit were evaluated by statistical techniques to obtain information concerning the mineral characteristics of the deposit and to make a preliminary determination of sampling requirements for the deposit.
- RI 6235. Water-Swelling Synthetic Fluormicas and Fluormontmorillonoids, by Robert C. Johnson and Haskiel R. Shell. 1963. 57 pp. 12 figs. Describes water-swelling fluormicas and fluormontmorillonoids which were shown by electron microscopy, X-ray diffraction, and chemical analysis to be typically two-silica-layer platy compounds. The work was performed, in part, under a cooperative agreement with the General Services Administration.

- RI 6236. Sulfuric Acid From Sulfur Dioxide by Autoxidation in Mechanical Cells, by Carl Rampacek and J. B. Clenner. 1963. 24 pp. 7 figs. Describes investigation of the conversion of dilute sulfur dioxide gas into sulfuric acid by autoxidation in mechanical cells of the flotation or gas absorber type. Batch and continuous tests demonstrated the technical feasibility of producing dilute sulfuric acid by autoxidation of sulfur dioxide gas in mechanical cells when converting pyrite roaster or waste smelter gases.
- RI 6237. Hydrocracking Low-Temperature Tar From a North Dakota Lignite, by H. C. Carpenter, P. L. Cottingham, C. M. Frost, and W. W. Fowkes. 1963. 13 pp. 1 fig. Describes hydrocracking of lignite tar from a North Dakota lignite in a single-pass, fixed-bed operation at 3,000 psi over cobalt molybdate catalyst to produce gasoline and, at the same pressure, over zinc chromite catalysts to crack the high-boiling phenolic compounds to low-boiling phenolics. Work done in cooperation with the University of Wyoming.
- RI 6238. Investigation of a Subbituminous Coal Deposit Suitable for Opencut Mining, Beluga River Coalfield, Alaska, by Robert S. Warfield. 1963. 100 pp. 8 figs. Describes investigation of a geologically favorable area in the Beluga River coalfield to determine minable coal reserves to meet the projected thermal power needs of the Anchorage area. Diamond core drilling indicated reserves of more than 20 million tons of coal that could be mined by opencut methods. A coal sample, with 4 volume-percent of clay partings eliminated, contained 24.4 percent moisture and 16.8 percent ash and had a calorific value of 7,162 Btu per pound. Studies indicated that mechanical cleaning would be of doubtful value.
- RI 6239. Performance Characteristics of Coal-Washing Equipment: Concentrating Tables, by A. W. Deurbrouck and E. R. Palowitch. 1963. 26 pp. 4 figs. Gives results of tests in five preparation plants using concentrating tables for washing $\frac{3}{8}$ -inch to 0 raw coal. The concentrating table is an effective fine-coal cleaner even when operating at 40 percent over the recommended 10-ton-per-hour feed rate. Recovery efficiencies for the $\frac{3}{8}$ -inch to 200-mesh size fraction ranged from 97.3 to 99.3 percent.
- RI 6240. Thermodynamic Properties of Beryllium Sulfate From 0° to 900° K, by A. R. Taylor, Jr., T. Estelle Gardner, and D. F. Smith. 1963. 8 pp. 2 figs. Gives low-temperature heat capacity and enthalpy values of beryllium sulfate from 10° to 300° K, measured with an adiabatic calorimeter, and high-temperature values from 350° to 900° K, measured with a Bunsen-type ice calorimeter. Heat capacity, entropy, enthalpy function, and free energy function values were calculated at 10-degree intervals between 0° and 300° K, and heat capacity, entropy, enthalpy function, and free energy function values at 50-degree intervals between 300° and 900° K. Work done in cooperation with the University of Alabama.
- RI 6241. High-Temperature Heat-Content and Entropy Data for Vanadium Silicide (V_5Si), by L. B. Pankratz and K. K. Kelley. 1963. 5 pp. 1 fig. Gives determination of heat content above 298.15° K for crystalline vanadium silicide. Presents original heat content data and lists smooth values of heat content and corresponding entropy increments for temperature range from 298.15° to 1,500° K. Equations representing heat content values and derived heat capacities are also included.
- RI 6242. Yttrium Behavior in Rare-Earth-Amine Extraction Systems and Effect of Sequestrants, by D. J. Bauer and A. C. Rice. 1963. 16 pp. 15 figs. Single-stage separatory funnel tests indicate the feasibility of yttrium separation from rare-earth subgroups by judicious selection of operating conditions when Primene 81-R is used as an extractant. EDTA and DTPA are of value in separating yttrium from heavy group rare-earth elements. Yttrium-ytterbium separation is more effective with EDTA, whereas yttrium-dysprosium separation is more effectively increased with DTPA.
- RI 6243. Effect of Lead Deposits on Activity of Automotive Exhaust Catalysts, by L. J. E. Hofer, J. F. Shultz, and J. J. Feenan. 1963. 22 pp. 6 figs. Describes nature and extent of poisoning of oxidation catalysts by lead deposits derived from compounds formed when leaded gasoline is used as engine fuel. These catalysts are used to control emission of pollutants in automotive exhaust gases. Work done in cooperation with the Public Health Service, U.S. Department of Health, Education, and Welfare.
- RI 6244. Carbonizing Properties of Kanawha County, W. Va., Coals, by G. W. Birge, D. E. Wolfson, and J. H. Lynch, Jr. 1963. 21 pp. 3 figs. Investigates the carbonizing properties of 29 samples from the Pittsburgh, Lower Kittanning, Stockton-Lewis, Coalburg, Winifrede, Cedar Grove, Peerless, No. 2 Gas, Powellton, and Eagle beds in West Virginia by the standard method BM-AGA test. Expanding properties of 22 of the coals were determined in the Bureau of Mines sole-heated oven.
- RI 6245. Low-Temperature Heat Capacities and Entropies at 298.15° K of the Sesquioxides of Scandium and Cerium, by W. W. Weller and E. G. King. 1963. 6 pp. 1 fig. Gives data on low-temperature heat capacities of scandium sesquioxide and a mixture of cerium sesquioxide and cerium dioxide over the temperature range from 50° to 298° K. Entropy of scandium sesquioxide was evaluated directly and that of cerium sesquioxide was extracted by combining the heat capacity data for the mixture with those from pure cerium dioxide.
- RI 6246. Sources and Recovery Methods for Rhenium, by P. E. Churchward and J. B. Rosenbaum. 1963. 16 pp. 1 fig. The only significant rhenium resource appears to be about 28,000 pounds of rhenium contained in the annual domestic output of approximately 20,000 tons of byproduct molybdenite concentrates from porphyry copper operations. A procedure was developed in the laboratory for recovering rhenium in the form of electrolytic flake by electrowinning metal from a solvent extraction strip solution.
- †RI 6247. Oxidation of Coal Mine Pyrites, by Walter C. Lorenz and Edward C. Tarpley. 1963. 13 pp. 6 figs. Gives results of a study of samples of materials containing pyrite from various coal mines and coalbeds to compare their compositions and oxidizing characteristics. The oxidation of pyrite in solutions of ferric and ferrous sulfate and in the presence of an iron-oxidizing bacterium, *Ferrobacillus ferrooxidans*, was studied.
- RI 6248. High-Temperature Heat Contents and Entropies of Sesquioxides of Lutetium, Dysprosium, and Cerium, by L. B. Pankratz and K. K. Kelley. 1963. 8 pp. 1 fig. High-temperature heat content values of pure lutetium sesquioxide and dysprosium sesquioxide were measured over the temperature range 298° to 1,800° K. Similar data for cerium sesquioxide were calculated from measurements of a mixture of cerium sesquioxide and dioxide and

†Out of print.

- known values for cerium dioxide. The original heat content data are reported, and smooth values of heat content and the corresponding increments are tabulated. Equations were derived to represent the heat content values.
- RI 6249. Studies on the Spectrochemical Analysis of Solutions: Use of Carrier-Precipitation and a Filter Electrode, by C. L. Chaney and M. J. Peterson. 1963. 18 pp. 12 figs. Describes a filter-electrode technique in which a porous-cup graphite electrode is used to collect the precipitate and to serve as the sample-containing electrode in the subsequent spectrographic analysis. Gallium hydroxide was used as a carrier-precipitant to concentrate metallic ions. Analytical curves are given for antimony, arsenic, beryllium, and zinc; and sensitivities of detection are given for 13 elements.
- RI 6250. Design and Development of a Rock Bolt Anchored by Explosive Forming: A Progress Report, by Edward W. Parsons. 1963. 29 pp. 11 figs. Describes the design of an explosive-anchored rock bolt, laboratory tests, and preliminary anchorage tests in mines; also presents an evaluation of test results.
- RI 6251. Heats of Formation of Gehlenite and Talc, by R. Barany. 1963. 9 pp. Gives results of experimental work conducted by the Bureau of Mines to obtain the heats of formation at 298.15° K of gehlenite and talc. Data are reported both in terms of the constituent oxides and in terms of the constituent elements.
- RI 6252. Identification of 2,2,5-Trimethylthiacyclopentane and 2,2,5,5-Tetramethylthiacyclopentane in Wilmington, Calif., Crude Oil, by C. J. Thompson, H. J. Coleman, R. L. Hopkins, and H. T. Rall. 1963. 11 pp. 6 figs. Two sulfur compounds—the 2,2,5-trimethyl- and 2,2,5,5-tetramethyl derivatives of thiacyclopentane—were identified in Wilmington, Calif., crude oil, using microdesulfurization and gas-liquid chromatography techniques. Work sponsored jointly by the Bureau of Mines and the American Petroleum Institute. Presented at Oklahoma Tetra-sectional Meeting, American Chemical Society, Stillwater, Okla., March 3, 1962.
- RI 6253. Installation and Evaluation of Precast Mine Supports: A Progress Report, by G. T. Krem-pasky. 1963. 32 pp. 26 figs. Describes the installation and evaluation of 18 reinforced concrete sets in the Coeur d'Alene mining district, Shoshone County, Idaho, and is the second of a series to investigate the feasibility of a more permanent type of mine support. Results tend to confirm opinion that precast mine supports could be used to advantage in openings that require support and must have long life, especially where decay of timber is an important factor. The first report, RI 6164, covered the design and development of the supports.
- RI 6254. Vacuum Arc Melting and Casting of Copper, by P. G. Clites. 1963. 15 pp. 12 figs. Presents results of studies made on ingots and castings from electrolytic tough pitch copper, electrolytic cathode copper, and oxygen-free copper to determine the effect of consumable-electrode vacuum arc melting on the removal of impurities from the copper and on its physical properties.
- RI 6255. Experiments With Solid-in-Gas Suspensions as Heat Transport Mediums, by W. T. Abel, J. P. O'Leary, D. E. Bluman, and J. P. McGee. 1963. 18 pp. 11 figs. Describes laboratory tests with a closed recycling system to evaluate the effectiveness of solid-in-gas suspensions as heat transport mediums. At low flowrates and light graphite loadings, slightly less power was required to transport a given amount of heat with suspensions than with helium alone, but heat transfer effectiveness decreased at higher solids concentration.
- RI 6256. Radiotracer Studies of Cerium and Sulfur Distribution in Steel, by A. A. Cochran and V. R. Miller. 1963. 21 pp. 6 figs. Gives data on the final distribution of cerium additions to steel, their effects on sulfide inclusions, and the usefulness of radiotracer methods in investigating steel problems. Radiotracer methods were found to be versatile and highly sensitive.
- RI 6257. Oxidizing Pittsburgh-Bed Coal: Effect of Processing Temperature and Time, by M. J. Kovalik and W. H. Oppelt. 1963. 30 pp. 20 figs. Gives results of a study of the effect of oxidation by air at temperatures ranging from 200° to 300° C on chemical and physical properties of Pittsburgh-bed coal as a function of processing time and temperature. Goal was to prepare a nonagglomerating fuel from a strongly coking coal for use in continuous carbonizing processes and in fixed-bed gasifiers. Results indicate that oxidation at a temperature slightly above the lower limit of the plastic temperature range would be good because of the short processing time required to destroy the coking properties and because of the moderate processing losses.
- RI 6258. Sulfatization of Manganiferous Carbonate Slates in a Fluidized Bed Reactor, by Charles Prasky and G. P. Howard. 1963. 16 pp. 5 figs. Describes fluidized-bed techniques for differentially sulfatizing the manganese in two samples of low-grade manganiferous ferruginous carbonate slates from the Cuyuna range, Minnesota. Two treatments were used, single or two-stage, and both converted approximately 80 percent of the manganese to sulfate. The two-stage treatment made more efficient use of the sulfur dioxide.
- RI 6259. Metallothermic Reduction of Yttrium Halides, By R. E. Mussler, T. T. Campbell, F. E. Block, and G. B. Robidart. 1963. 21 pp. 9 figs. Gives results of a study of new methods of preparing high-purity yttrium metal. Yttrium halides, purified by vacuum distillation, were reduced by alkali or alkaline-earth metals. Lithium and sodium proved to be the best reductants from the standpoint of yield, and the sponge metal produced was consolidated readily by cold-mold, arc-melting procedures. Mechanical tests showed that yttrium can be forged, extruded, rolled, spot welded, and deep drawn. Work done in cooperation with the U.S. Atomic Energy Commission under Contract No. AT(11-1)-559.
- RI 6260. Heats of Formation of Two Crystalline Hydrates of Ferrous Sulfate, by L. H. Adami and K. K. Kelley. 1963. 7 pp. Presents results of solution calorimetry conducted to obtain the heats of formation of crystalline $\text{FeSO}_4 \cdot 6.952\text{H}_2\text{O}$ and $\text{FeSO}_4 \cdot 1.008\text{H}_2\text{O}$, from which values were derived for the stoichiometric compounds $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ and $\text{FeSO}_4 \cdot \text{H}_2\text{O}$. Also included are derived values of the free energies of formation and dehydration.
- RI 6261. Carbonizing Properties of Coals From Elk, Clarion, Jefferson, Clearfield, and Centre Counties, Pa., by G. W. Birge, D. E. Wolfson, and J. H. Lynch, Jr. 1963. 22 pp. 3 figs. Gives results of an investigation of the carbonizing properties of coals from six beds—Upper Freeport, Lower Freeport, Upper Kitanning, Middle Kitanning, Lower Kitanning, and Brookville—in Pennsylvania by the standard BM-AGA carbonization test. Expansion or contraction of the majority of the samples was measured in the Bureau's sole-heated oven.
- RI 6262. Metallic Binders for Zirconium Diboride: Iron, Cobalt, and Nickel, by M. E. Tyrrell and C. W. Houck. 1963. 17 pp. 8 figs. To evaluate their usefulness as binders for zirconium diboride, mixtures of zirconium diboride and iron, cobalt, or nickel were resistance sintered to high-density com-

- pects using modified electric welding equipment. Each of the zirconium diboride-metal mixtures produced brittle cermets, but the hardness was generally satisfactory. The sintered compacts were examined in polished section and tested for crushing strength, hardness, microhardness, oxidation rate, and resistance to mechanical shock.
- RI 6263. Recovery of Lead and Zinc From Slimes, by J. G. Donaldson. 1963. 15 pp. 3 figs. Describes a bench-scale method for recovering lead and zinc from slimes and mill tailings from the Tri-State district of Missouri, Oklahoma, and Kansas. Up to 98 percent of the lead was recovered in an electrodeposit assaying approximately 85 percent lead. Zinc recovers up to 90 percent of the total were attained in a precipitate assaying approximately 40 percent zinc.
- RI 6264. Flash Irradiation of Coal, by C. O. Hawk, M. D. Schlesinger, and R. W. Hiteshue. 1963. 7 pp. 1 fig. Describes experiments on fast heating of finely ground coal by irradiation with a flash of high-intensity light, produced by an electrical discharge at high voltage through a xenon-filled tube. Flashes lasted from 2 to 3 milliseconds; reaction took place in 0.5-inch-diameter by 4-inch-long tubes; amount of coal charged was 0.1 gram; and average particle size was 20 microns. All products obtained in quantity were characteristic of high-temperature pyrolysis. This is good evidence of a short heating period to very high temperatures (well above 1,000° C) followed by rapid quenching.
- RI 6265. A Small Alumina Reduction Cell, by David Schlain, Charles B. Kenahan, and Joseph H. Swift. 1963. 41 pp. 16 figs. Describes a cell developed for studying the reactions which occur in the reduction of alumina by the Hall-Heroult process. Operating conditions in the cell such as temperature, time, current density, electrolyte composition, and electrode materials could be varied easily. Aluminum was produced in the cell at a current efficiency of about 75 percent and a cell voltage of 2.7 volts.
- RI 6266. Analyses of Crude Oils From the Gulf Coast Area of Louisiana and Texas, by C. M. McKinney and Edward P. Ferrero. 1963. 173 pp. Contains analyses of 291 samples of crude petroleum. Included are 65 analyses from 51 Louisiana fields and 226 analyses from 116 Texas fields. The analyses represent fields that produce 1,000 or more barrels of oil per day. The most effective method of using the data is to compare analyses of recently discovered oils with similar analyses of oils for which refining data are available.
- RI 6267. Application of the Burnett Method of Compressibility Determinations to Multiphase Fluid Mixtures, by Earle S. Burnett. 1963. 15 pp. 4 figs. Outlines the experimental procedures for using a Burnett apparatus to obtain compressibility coefficients for multiphase, multicomponent fluid mixtures.
- RI 6268. Flotation of Kyanite-Quartzite Rock, Graves Mountain, Lincoln County, Ga., by Thomas L. McVay and James S. Browning. 1963. 9 pp. 1 fig. Gives results of laboratory batch and pilot plant flotation tests made to determine the feasibility of recovering commercial-grade kyanite from a kyanite-quartzite rock. Acid leaching of the flotation concentrate gave a product analyzing 59.7 percent Al₂O₃ and about 0.1 percent Fe₂O₃. As the result of this research, a commercial kyanite flotation plant was completed in September 1962. Work done in cooperation with the University of Alabama and Aluminum Silicates, Inc.
- RI 6269. Use of Calcined Anthracite in Foundry Cupolas, by A. F. Baker, R. F. Tenney, and J. W. Eckard. 1963. 13 pp. Summarizes results of testing calcined anthracite in commercial-size iron-melting cupolas. For comparison purposes, tests were made using fuels other than calcined anthracite. Owing to its smaller size range, calcined anthracite requires a higher wind-box pressure than cupola fuel to provide an adequate air-input rate. Consequently, blowers, rather than centrifugal fans, are necessary for use with calcined anthracite.
- RI 6270. Vibrations From Blasting at Iowa Limestone Quarries, by Wilbur L. Duvall, James F. Devine, Charles F. Johnson, and Alfred V. C. Meyer. 1963. 28 pp. 18 figs. Gives results of tests of 12-millisecond-delayed blasts in four quarries that were instrumented with arrays of vertical velocity gages to determine if the direction of propagation through the rock or the method of initiation of the blasts had any effect upon the level of vibration. Direction of propagation is shown to have affected the value of the exponent *n* (the parameter determined from the experimental data) in a power-law equation. The method of initiating the blasts had a strong effect on the level of vibration and the spread in the data from one shot to another.
- RI 6271. Tallahatta Diatomite, Choctaw and Clarke Counties, Ala., by Earl L. Hastings and T. N. McVay. 1963. 12 pp. 3 figs. Gives information on the Tallahatta Formation in southwestern Alabama which is composed principally of diatomaceous earth with accompanying beds of sand, clay, and sandstone. Because of the opal content, Tallahatta diatomite may have pozzolanic properties in concrete. More detailed studies could reveal other uses of this diatomite, such as filter aids, fillers, polishing powders, and refractory products. Work done in cooperation with the University of Alabama and the Geological Survey of Alabama.
- RI 6272. Centrifugal Compressor for High-Temperature Helium. Performance Characteristics, by N. H. Coates, S. G. Nordlinger, and J. P. McGee. 1963. 17 pp. 8 figs. Gives data on a small compressor developed to circulate 60 pounds of helium per hour at 1,000° F and 250 psig. Performance characteristics were determined at helium flows of 2,000 to 18,000 std cu ft per hour, pressures of 100 to 250 psig, and temperatures of 100° to 1,000° F. Work done in cooperation with the U.S. Atomic Energy Commission.
- RI 6273. Study of the Calorimetric Method of Purity Measurement Using IUPAC Samples of Benzene, by J. F. Messerly, S. S. Todd, G. B. Guthrie, and J. P. McCullough. 1963. 19 pp. 9 figs. Gives data on the purity of three specially prepared samples of benzene determined with an adiabatic, low-temperature calorimeter with automatic control of shield temperature. Extensive measurements were made on each sample to determine how variations in operating procedures affect melting point and freezing point as well as purity data obtained by the calorimetric method.
- RI 6274. Cleaning Unsized Fine Coal in a Dense-Medium Cyclone Pilot Plant, by Michael Sokaski and M. R. Geer. 1963. 25 pp. 4 figs. Describes a pilot plant that does not require the removal of extremely fine material from the feed. The plant is capable of high recovery efficiencies even with refractory feeds and of making sharp separation. For medium recovery, a combination of sieve bend screens, classifying cones, and magnetic separators is used. Tests of the plant are described in this report. The work upon which the report is based was done in cooperation with the School of Mineral Engineering, University of Washington.
- RI 6275. The Hydrocyclone in Clay Beneficiation, by H. E. Powell and W. A. Calhoun. 1963. 20 pp. 4 figs. Shows that the hydrocyclone technique is

applicable to clays ranging from plastic to flint. Under proper conditions use of this technique will result in good separation of quartz sand and good recovery of a useful clay mineral concentrate. Rejection of quartz from the clays investigated ranged from a low of 82.4 percent, with an alumina recovery of 71.2 percent, to a high of 99.0 percent, with an alumina recovery of 85.6 percent. Estimates are furnished for installation and direct operating costs of hydrocyclones used in such separations.

- RI 6276. Hydraulic Coal Mining Research, Tests in a Steeply Pitching Coalbed, Roslyn, Wash., by Thomas M. Nasiatka and Frank Badda. 1963. 16 pp. 10 figs. Tests showed that the hydraulic method was more productive than the conventional method in pillar mining. In development mining of a solid coal face, the productivity of hydraulic mining depended primarily on the hardness of the coal; compared with conventional methods, hydraulic mining was less productive where the coal was relatively hard and equally as productive where the coal was relatively soft. This report is the second in a series on hydraulic coal mining research; the first report, RI 5915, published in 1962, gave preliminary results of mining in a flat-lying bituminous coalbed in Pennsylvania. Work done in cooperation with the Northern Pacific Railway.
- RI 6277. Determination of Copper in Tungsten Metal and Tungstic Oxide, by Thomas E. Green. 1963. 7 pp. Describes a combined solvent extraction-spectrophotometric method for determining as little as 1 ppm of copper in tungsten metal or tungstic oxide. Precision at the 2-ppm level is better than 0.1 ppm.
- RI 6278. Low-Temperature Phase Equilibria of Helium-Bearing Natural Gases: Hogback Gas, by Lowell Stroud, Will E. DeVaney, and John E. Miller. 1963. 16 pp. 3 figs. A windowed-cell phase equilibrium apparatus was used to obtain equilibrium vapor-liquid data for the gas at temperatures from -100° to -250° F and pressures to 500 psi. Anomalous phase behavior resulting in the formation of two stable liquid phases occurred at temperatures below -200° F and pressures above 200 psia. This is the first substantiated evidence of vapor-liquid-liquid equilibria in a helium-containing natural gas.
- RI 6279. Materials in Coal Inhibitory to the Growth of Microorganisms, by Martin H. Rogoff and Irving Wender. 1963. 13 p. 4 figs. Describes methods for extracting biologically active organic compounds (antibiotics) from coal with polar organic solvents and concentrating them by using aqueous sodium hydroxide. Mass spectrometry of the extracts indicated 6-ring compounds in the region of mass 324 to 392. Ultraviolet analysis showed a predominance of 3-ring aromatic systems. The activity of the hydroxide-soluble material decreased markedly when the phenolic hydroxyl groups were transformed into trimethylsilyl ethers. Hydrolysis of the ethers yielded a product with the same activity as the original material, which indicates that phenolic compounds are largely responsible for the antibiotic activity observed.
- RI 6280. Extraction of Alumina From Ferruginous Bauxite by a Double-Leach Process, by W. F. Holbrook and L. A. Yerkes. 1963. 20 pp. 6 figs. Describes a process which recovers a greater proportion of alumina from high-silica ores than the conventional single-leach method. This recovery is accomplished by calcining the ore, removing reactive silica in a preliminary dilute caustic soda leach, and then applying a second leach to dissolve alumina. Eighty percent alumina extraction is demonstrated with Oregon ores containing up to 15 percent SiO_2 , 35 percent Al_2O_3 , and 30 percent Fe_2O_3 . This process is capable of providing millions of tons of alumina from Oregon ferruginous bauxite, when and if such low-grade raw material needs to be utilized.
- RI 6281. Low-Temperature Heat Capacity and Entropy at 298.15° K of Muscovite, by W. W. Weller and E. G. King. 1963. 4 pp. 1 fig. Heat capacity measurements were made in the range of 50° to 298° K. The entropy at 298.15° K was evaluated as $S^{\circ}_{298.15} = 69.0 \pm 0.7$ cal/deg mole.
- RI 6282. Analyses of Brines From Oil-Productive Formations in South Arkansas and North Louisiana, by M. E. Hawkins, W. D. Dietzman, and J. M. Seward. 1963. 28 pp. 3 figs. Describes major physical and chemical properties of brines from all the important petroleum-productive formations in south Arkansas and north Louisiana. Data presented offer a correlation check for future chemical analyses and resistivity measurements that may be obtained. Work done in cooperation with the Arkansas Oil and Gas Commission and the Louisiana Department of Conservation.
- RI 6283. Densimetric Method in Studying Coal and Coke Structure, by W. R. K. Wu. 1963. 71 pp. 8 figs. Reports on studies of the structure of coal and coke using the graphical, statistical densimetric method based on the relation between the molecular volume per carbon atom and the atomic hydrogen-carbon ratio.
- RI 6284. Modifications in Bomb Reduction of Vanadium Oxide, by C. J. Chindgren, L. C. Bauerle, and J. B. Rosenbaum. 1963. 14 pp. Describes attempts to make the conventional method of preparing ductile vanadium metal more economical. The most promising modification appeared to be bomb refining, using calcium to purify vanadium metal—of low aluminum but high oxygen content—prepared by open-vessel aluminothermic reduction of vanadium pentoxide.
- RI 6285. Use of Depleted Uranium for Cathodic Protection, by F. W. Hoertel. 1963. 13 pp. 9 figs. Gives results of an investigation of depleted uranium as a sacrificial anode for the cathodic protection of submerged and underground structures of iron, steel, and copper. Uranium remained anodic to iron, steel, and copper in simulated marine environments and under simulated boiler service if the electrolyte was oxygen-free water. Uranium appeared to offer limited protection to iron, low-carbon steel, copper, and zinc in the simulated underground tests. Work done in cooperation with the U.S. Atomic Energy Commission.
- RI 6286. Decomposition of Gypsum in a Fluidized-Bed Reactor, by D. A. Martin, F. E. Brantley, and D. M. Yergensen. 1963. 15 pp. 5 figs. Deals with fluidized-bed roasting as a means of decomposing gypsum and gypsum mixtures to produce a gas rich in sulfur dioxide and a lime or portland cement. Ninety-eight percent desulfurization of gypsum was achieved at an operating temperature between $1,200^{\circ}$ and $1,225^{\circ}$ C. A cement-type residue was obtained but had to be refired at $1,450^{\circ}$ C before mortar prepared from it met physical specifications for cement.
- RI 6287. Low-Temperature Heat Capacity and High-Temperature Heat Content of Mullite, by L. B. Pankratz, W. W. Weller, and K. K. Kelley. 1963. 7 pp. 2 figs. Gives measurements of the high-temperature heat content of mullite ($\text{Al}_6\text{Si}_2\text{O}_{13}$) in the temperature range from 298.15° to $1,800^{\circ}$ K and evaluates the entropy at 298.15° K as 60.8 cal/deg mole. The entropy of formation of mullite from

- corundum and quartz is 4.3 cal/deg mole at 298.15° K and 2.9 cal/deg mole at 1,750° K.
- RI 6288. Recovery of Alumina From Anorthosite, San Gabriel Mountains, California, Using the Lime Soda Sinter Process, by R. V. Lundquist, with section on geology by Gordon B. Oakeshott. 1963. 12 pp. 4 figs. Gives results of tests made on anorthosite rock from the San Gabriel Mountains, Los Angeles County, for its response to lime-soda-sinter processing to recover alumina. More than 88 percent of the alumina in the anorthosite was extracted at a mole ratio of CaO to SiO₂ of 1.94 and Na₂O to Al₂O₃ of 1.19. Work done in cooperation with the California Division of Mines and Geology.
- RI 6289. Coking-Rate Study on a Commercial Blend of Western Coals, by W. S. Landers, Manuel Gomez, and E. O. Wagner. 1963. 26 pp. 10 figs. Describes a study of the effect of coking rates of a special Columbia-Geneva six-coal blend on its coke properties. Increase in the coking rate decreased the size of the coke. The stability factor decreased after the coking rate reached more than 1.0 in/hr, and specific gravity increased to a maximum value at rates approaching 1.1 in/hr. Work done in cooperation with the Columbia-Geneva Steel Division of the United States Steel Corp., the Kaiser Steel Corp., the Colorado Fuel and Iron Corp., and the Colorado School of Mines Research Foundation.
- RI 6290. Methods for Producing Alumina From Clay. An Evaluation of a Potassium Alum Process, by Frank A. Peters, Paul W. Johnson, and Ralph C. Kirby. 1963. 27 pp. 9 figs. Evaluates a process for extracting alumina as potassium alum from clay using sulfuric acid and potassium sulfate. The process design is based on published results of pilot plant and laboratory work and not on present experimental work. Gives estimated capital and operating costs. Process is not competitive, under current economic conditions, with production of alumina from bauxite by the Bayer process. Improvement in leaching, basic alum decomposition, and washing could reduce the costs and improve the product, which contains some potassium.
- RI 6291. Longwall Mining With a German Coal Planer. Pocahontas No. 3 Coalbed, Keystone, W. Va., by D. S. Harper and C. O. Carman. 1963. 18 pp. 11 figs. Gives data on the operation of a German coal planer in the Keystone mine of the Eastern Associated Coal Corp. Almost one-half million tons of coal has been mined from four panels since August 1960, and an 11-man crew handles the complete planer operation and produces an average of 500 tons of clean coal per shift.
- RI 6292. A Basic Computer Program for Computing Grade and Tonnage of Ore Using Statistical and Polygonal Methods, by Richard F. Hewlett. 1963. 20 pp. 2 figs. Gives a computer program for use in mineral-deposit evaluation using either a statistical or polygonal method. Program has been written to provide a minimum of restrictions, and any grade class interval, uneven assay-interval lengths, varying tonnage factors, different composite assay-interval lengths, and pit bottom elevation can be used. Work done in cooperation with the Bear Creek Mining Co. and the College of Mines, University of Arizona.
- RI 6293. The Ignition of Combustible Mixtures by Laminar Jets of Hot Gases, by Marcel Vanpée and Arthur E. Bruszak. 1963. 84 pp. 66 figs. Describes a method of studying reaction kinetics under conditions similar to those which prevail in flame propagation. Two well defined types of ignition processes have been observed: 1. The pre-ignition zone is a luminous zone of reaction in which the heat generated by the reaction plays a critical role in the process of ignition. 2. The preignition zone is not luminous and no heat generation is observed until the very last moment of the onset of explosion. Research sponsored in part by Project Squid, Office of Naval Research, Department of the Navy, under Contract Nonr 1858(25) NR-098-038.
- RI 6294. Solubility Characteristics of Monocalcium Aluminate, by R. V. Lundquist and H. Leitch. 1963. 9 pp. 2 figs. Na₂CO₃ solutions containing NaOH must be used for the leach extraction of alumina. A deficiency of NaOH allows rapid precipitation of bayerite, and an excess of NaOH tends to convert one third of the alumina to insoluble Ca₂[Al(OH)₆]₂ where the extent of conversion depends on the carbonate concentration present. About 98 percent extraction of alumina from the aluminate occurred in Na₂CO₃ solutions containing 10 to 12 percent NaOH.
- RI 6295. Thermodynamic Data for Magnesium Oxide (Periclase), by L. B. Pankratz and K. K. Kelley. 1963. 5 pp. Gives heat content of magnesium oxide (periclase) from 298° to 1,800° K. Results were combined with other thermodynamic data for magnesium oxide and its constituent elements to obtain improved values of the heat and free energy of formation at temperatures between 298° and 2,000° K. Periclase behaves better in the calorimeter than corundum, and it is strongly suggested that periclase is a better substance for this purpose.
- RI 6296. Preparation Characteristics of Coal From Kanawha County, W. Va., by T. E. Gray and A. W. Deurbrouck. 1963. 53 pp. 3 figs. Float-and-sink tests of the samples collected from Eagle A, Peerless, Cedar Grove, Winifrede, and No. 2 Gas beds show that these coals at one location each are suitable for metallurgical use without washing. Lower Kittanning bed at four locations, Pittsburgh, Stockton-Lewinston, and No. Gas beds at two locations each, and Coalburg, Powellton, Winifrede, Peerless, Upper Kittanning, and Cedar Grove beds at one location each can be upgraded to metallurgical quality by mechanical cleaning.
- RI 6297. Preparation Characteristics of Coal From Tazewell County, Va., by Albert W. Deurbrouck. 1963. 31 pp. 3 figs. Describes the preparation characteristics of samples from the Raven, Jawbone, Upper Seaboard, and Pocahontas Nos. 3, 4, and 5 beds. Only the Jawbone sample required upgrading to be of metallurgical quality. The coals ranked from high-volatile A to low-volatile bituminous. Significant increases in recovery of the Pocahontas coals at 1.30 specific gravity could be effected by reducing the top size of the samples from 1½ inches to ¾ inch.
- RI 6298. Separation and Characterization of Polar Material in Distillate Fuel, by J. W. Davis, D. E. Hirsch, Norman G. Foster, and F. G. Schwartz. 1963. 18 pp. 4 figs. Identifies nitrogen, oxygen, and sulfur compounds found in catalytically cracked distillate fuel. Naphthalene and its homologs, phenanthrene and its homologs, and other compounds such as methyl indene, C₂ quinolines, phenyl indan, and the benzothiophenes, appeared in the benzene extracts. Quinolines were the major components of the lower boiling fraction of the ether extract, although carbazoles, acridans, and indoles were present in some concentration. Elemental and functional group analyses of the alcohol fraction indicated 10 percent of the distillate portion was nonhydrocarbon, and in this portion the average molecule contained more than one nonhydrocarbon element.

- RI 6299. Comparison of Oil Yields From Core and Drill-Cutting Sampling of Green River Oil Shales, by J. W. Smith, L. G. Trudell and K. E. Stanfield. 1963. 35 pp. 8 figs. Average oil yields of single sets of mud cuttings from hydraulic rotary drilling in Colorado and gas cutting from pneumatic rotary drilling in Utah were compared statistically with yields of core samples taken from adjacent holes. Oil yields from gas cuttings were identical with oil yields from core samples. Mud cuttings appeared to represent a section of the formation conservatively, the deficiencies increasing with increasing richness of sample. Work done in cooperation with the University of Wyoming.
- RI 6300. Analyses of Tipple and Delivered Samples of Coal (Collected During the Fiscal Year 1962), by S. J. Aresco, J. B. Janus, and F. E. Walker. 1963. 46 pp. Presents results of analyses of 7,114 samples collected in connection with Government coal purchases. Heating value and proximate analyses are given for all the samples; ash-softening temperature, free-swelling index, and the Hardgrove grindability index are also shown for many samples.
- RI 6301. Electrodeposition of Zinc, by Glen C. Ware. 1963. 24 pp. 17 figs. Reports on work undertaken to determine the factors involved in the corrosion of starting sheets used in the production of electrolytic zinc. Zinc starting sheets could be made as reliable as aluminum and could be continued in residence for periods up to 39 days. Periods as long as a week were feasible under conditions similar to those found in commercial practice. A test of zirconium as a starting sheet material showed promise, but titanium was found to be unsuitable.
- RI 6302. Laboratory Test Method for Unsteady-State Gas Flow in Consolidated Porous Media, by J. S. Miller and C. J. Walker. 1963. 29 pp. 3 figs. Describes an attempt to find a simple solution to the problem of simultaneously changing terminal rate and terminal pressure under conditions of unsteady-state flow in porous media. Although the original aim was not realized, a method for encasing a sandstone core that would permit high-pressure flow tests and the use of electronic equipment to measure pressures at points along the core during unsteady-state gas depletion was found to be feasible. Work done in cooperation with the American Gas Association.
- RI 6303. Electrodeposition Studies of Molybdenum, Tungsten, and Vanadium in Organic Solvents, by Robert E. Meredith and Thomas T. Campbell. 1963. 15 pp. 7 figs. Gives results of studies of the feasibility of employing low-temperature nonaqueous baths for electrodepositing some of the refractory metals of the ferroalloy group. No successful metallic deposits were obtained with any of the systems examined.
- RI 6304. Preparation and Evaluation of Fused Hafnium Carbide, by R. P. Adams and R. A. Beall. 1963. 17 pp. 14 figs. Describes a method of melting and casting specimens of hafnium carbide. Includes evaluation of the cast specimens according to their carbon content for melting point, density, microhardness, electrical resistivity, and oxidation resistance. Work done in cooperation with the U.S. Atomic Energy Commission and the University of California Lawrence Radiation Laboratory.
- †RI 6305. Principles and Computer Techniques for Calculating Performance of a Five-Spot Waterflood—Two-Phase Flow, by R. V. Higgins and A. J. Lighton. 1963. 71 pp. 12 figs. Presents a computer program to calculate the reservoir performance of waterfloods of complicated well-spacing patterns. Many steps are explained in detail, both for the fluid mechanics and the directions for the computer. Program has been presented in such a way that it may be used as given to calculate performance of two-phase flow in odd-shaped geometry.
- RI 6306. Performance of Baum Jigs in Treating Rocky Mountain Coals, by Michael Sokaski, P. S. Jacobsen, and M. R. Geer. 1963. 40 pp. 6 figs. Evaluates the performance of two Baum jigs for cleaning Rocky Mountain coals. The sharpness of separation for these jigs is characterized by error areas of 73 and 75 which compare favorably with values reported by other investigators. Detailed comparison of these data and other information is included in the report. Work done in cooperation with the School of Mineral Engineering, University of Washington.
- RI 6307. Process Development in Removing Sulfur Dioxide From Hot Flue Gases (in Four Parts). 2. Laboratory-Scale Pulverized-Coal-Fired Furnace, by R. C. Kurtzrock, D. Bienstock, and J. H. Field. 1963. 37 pp. 25 figs. Describes the design and operation of a laboratory-scale, pulverized-coal-fired furnace to furnish small quantities of flue gas for an air-pollution investigation. This report is the second in a series of four publications on the engineering development of a process for removing sulfur dioxide from flue gases. The first report, issued as RI 5735, in 1961, discussed bench-scale experiments for the removal of low concentrations of sulfur dioxide from simulated flue gas.
- RI 6308. Determination of Cobalt and Nickel in Tungsten by a Combined Ion-Exchange X-Ray Spectrographic Method, by E. F. Spano, T. E. Green, and W. J. Campbell. 1963. 20 pp. 7 figs. Describes a quantitative method developed for determining parts per million of cobalt and nickel in high-purity tungsten trioxide. All results agreed to within 10 percent of the amount present.
- RI 6309. Hazards in Using Liquid Hydrogen in Bubble Chambers, by Michael G. Zabetakis, Aldo L. Furno, and Henry E. Perlee. 1963. 39 pp. 27 figs. Reports results of a study to determine the hazards associated with the use of liquid hydrogen as an ionizing particle detector in bubble chambers. Work done in cooperation with the Health and Safety Laboratory, U.S. Atomic Energy Commission.
- RI 6310. Chloridization of Galena and Sphalerite by Contact With Certain Chlorides, by J. G. Donaldson and K. K. Kershner. 1963. 16 pp. 7 figs. Describes optimum conditions for chloridizing metal sulfides. Salt-roasting galena at 450° C for 8 hours chloridized 75 per cent of the lead; in an equal time of treatment at 750° C, the process chloridized 42 percent of the zinc in sphalerite. Hydrogen chloride at 500° C completely chloridized galena in 15 minutes, and at 600° C converted all the zinc in sphalerite to the chloride in 4 hours.
- RI 6311. Use of a Sieve Bend and a Scalping Deck With a Vibrating Screen in Dewatering and Draining Dense Medium From Fine Coal, by Michael Sokaski, P. F. Sands, and M. R. Geer. 1963. 13 pp. 6 figs. Determines that, in dewatering, use of either the sieve bend or the scalping deck increases the capacity of the vibrating screen tenfold and the recovery of coal finer than 0.5 mm threefold, with no sacrifice in the moisture content of the oversize product. In dense-medium drainage, the scalping deck is superior. Additional advantages of the scalping deck are lower cost and a substantial saving in headroom. Work done in cooperation with the University of Washington.

†Out of print.

- RI 6312. A Method for Determining Stress in Rock, by Thomas A. Morgan and Louis A. Panek. 1963. 7 pp. 5 figs. Describes a method for determining stress in rock based on a requirement for static equilibrium; namely, that the total load on a sufficiently large area must remain constant even after a drift or stope is mined in the area.
- RI 6313. Lightweight Aggregates. Expansion Properties of Clays, Shales, and Argillites of Minnesota, by W. A. Grosh and H. P. Hamlin. 1963. 30 pp. 5 figs. Gives results of preliminary bench-scale tests for bloating properties made on samples of clays, shales, and argillites from 21 locations; several were tested for ceramic properties. Decorah Shale from one area made a suitable material for lightweight aggregate; however, the limestone layers in the formation must be eliminated or the resulting activated lime must be controlled by quenching.
- RI 6314. Fluorine Analyses. Control Method for Various Compounds, by Henry E. Blake, Jr. 1963. 29 pp. 6 figs. Describes a new analytical-control method for analyzing fluorides from low-grade sources using a sulfuric-phosphoric acid solution of a sodium carbonate fusion of the sample material with distillation temperature maintained at about 155° C. Method is more reliable and rapid than other techniques for the analytical control of unknown sample materials.
- RI 6315. Sintering of Pyrrhotite Calcine, by W. E. Lamont, I. L. Feld, and R. E. Perry. 1963. 17 pp. 4 figs. Gives results of tests to determine the conditions required to sinter a pyrrhotite calcine into a commercially acceptable iron-blast-furnace feed. Batch and continuous sinter tests showed that minus ¼-inch pellets prepared from a mixture of the calcine with coke, dolomite, and water gave sinter cakes analyzing 57 to 61 percent iron and 0.05 to 0.02 percent sulfur. Work done in cooperation with the University of Alabama and the United States Pipe and Foundry Co.
- RI 6316. Thermodynamic Properties of Strontium Chloride and Strontium Fluoride From 0° to 300° K, by D. F. Smith, T. E. Gardner, B. B. Letson, and A. R. Taylor, Jr. 1963. 8 pp. 1 fig. Presents heat content values for strontium chloride from 7° to 300° K and for strontium fluoride from 11° to 300° K that were determined with an adiabatic calorimeter. Smooth values are given at 10-degree intervals and at 273.15° and 273.15° K. Work done in cooperation with the University of Alabama.
- RI 6317. Fluidized-Bed Chlorination of Titaniferous Slags and Ores, by E. C. Perkins, H. Dolezal, D. M. Taylor, and R. S. Lang. 1963. 13 pp. 2 figs. Describes the successful chlorination of titaniferous slags and domestic mineral concentrates in a 6-inch-diameter fluid-bed chlorinator. Ilmenites from Idaho, South Carolina, Florida, and New York, and a titaniferous magnetite from Wyoming were used in preparing the slags. An ilmenite concentrate from Idaho and a rutile from Arkansas were tested.
- RI 6318. Advances in Coal Spectrometry. Mass Spectrometry, by A. G. Sharkey, Jr., J. F. Shultz, and R. A. Friedel. 1963. 32 pp. 21 figs. Gives results of a study of pyrolysis products and extracts of coal and also whole coal. Mass spectrometric techniques are shown to be useful in studying the chemical structure of coal and various high-molecular-weight materials derived from coal.
- RI 6319. Titanium Placer Deposits of Idaho, by R. H. Storch and D. C. Holt. 1963. 69 pp. 20 figs. Gives results of an investigation of more than 300 stream areas in Idaho to determine the potential value of ilmenite in black-sand placer deposits. Data indicate a good potential for large, low-grade deposits containing ilmenite, monazite, columbite, euxenite, uranothorite, and other radioactive black minerals and accessory black-sand minerals. The data also indicate most deposits will be economic only if several component minerals can be recovered as coproducts.
- RI 6320. Underground Combustion Oil-Recovery Experiment in the Venango First Sand, Warren County, Pa., by N. A. Caspero, W. T. Wertman, and W. E. Eckard. 1963. 39 pp. 20 figs. Gives results of a thermal oil-recovery experiment conducted in the Venango First sand, of the Goodwill Hill oil-field near Titusville, Pa. The well pattern for the experiment consisted of five producing wells, enclosing an area of 1.28 acres, and a central ignition-injection well. Ignition of an air-natural gas mixture in the ignition well was followed by injection of air and natural gas at various rates. The experiment was suspended when it became evident that economic oil production could not be achieved. Work done in cooperation with the Quaker State Oil Refining Corp.
- RI 6321. Selective Adsorption and Recovery of Sulfur Dioxide From Industrial Gases by Using Synthetic Zeolites, by D. A. Martin and F. E. Brantley. 1963. 15 pp. 8 figs. Describes tests conducted with synthetic zeolites as selective adsorbents for recovering sulfur dioxide from synthetic gases and gases produced from gypsum decomposition. Regeneration studies showed that over 90 percent of the sulfur dioxide desorbed from the loaded beds was of sufficient purity for direct liquefaction. Good adsorption of sulfur dioxide from gases produced by the decomposition of gypsum was attained, despite small amounts of hydrogen sulfide in the offgas.
- RI 6322. Acid Leaching of Beryllium Ore From Spor Mountain, Utah, by L. Crocker, R. O. Dannenberg, and D. W. Bridges. 1963. 15 pp. 3 figs. Describes how 95 percent of the beryllium was dissolved from most ore samples by agitation leaching with 600 pounds of H₂SO₄ per ton of ore for 24 hours at 65° C and 35 percent solids. Settling of the leached pulp required 0.6 to 0.8 pound of polyacrylic flocculant per ton of ore leached. Terminal density of the settled pulp was about 28 percent solids. Experiments with 800 pounds of H₂SO₄ per ton of ore are also described.
- RI 6323. Removal of Hydrocarbons and Carbon Monoxide From Automotive Exhaust, Using a Promoted Uranium Catalyst, by D. Bienstock, R. C. Kurtzrock, E. R. Bauer, Jr., and J. H. Field. 1963. 18 pp. 10 figs. Describes tests made with leaded and unleaded gasolines in a reactor in place of a truck muffler. Conversion of 98 percent of the hydrocarbons and 100 percent of the carbon monoxide was achieved with the engine idling, and conversion of 75 percent of the hydrocarbons was obtained at cruising speeds of 30 mph. Identical activity was obtained initially in switching to a leaded gasoline; however, there was a gradual loss of activity thereafter. The levels of radioactive materials in the exhaust of the reactor and the radiation in the vehicle were negligible. Work done in cooperation with the U.S. Atomic Energy Commission.
- RI 6324. Drillability Studies. Diamond Drilling, by James Paone and W. E. Bruce. 1963. 32 pp. 7 figs. Presents experimental drillability curves from AX-size diamond core bit performance in eight different rocks ranging from dense hard taconite to soft limestones. Results show that in small-bore diamond drilling, compressive strength and possibly other rock properties may be a useful parameter in predicting drilling rates.

- RI 6325. Feasibility of Electrical Precipitation at High Temperatures and Pressures, by C. C. Shale, W. S. Bowie, J. H. Holden, and G. R. Strimbeck. 1963. 20 pp. 9 figs. Electrical characteristics are presented for air in a 2-inch pipe-type electrostatic precipitator operating under dynamic conditions at temperatures of 600° to 1,500° F and pressures of 0 to 80 psig using a negative discharge electrode. Results of this one-geometry study show that current-voltage relationships are a function of air pressure and temperature and indicate that precipitators can be used at any temperature through about 1,350° F over the full range of pressure. Corona starting voltage and sparkover voltage vary directly with pressure and inversely with temperature. Experimental results are interpreted in terms of a theory presented.
- RI 6326. Removing Methane (Degasification) From the Pocahontas No. 4 Coalbed in Southern West Virginia, by W. M. Merritts, C. R. Waine, L. P. Mokwa, and M. J. Ackerman. 1963. 39 pp. 23 figs. Describes tests conducted in the Pocahontas No. 4 coalbed to determine if degasification techniques could be effective in removing methane from gaseous coals. Tests showed that methane emissions from free-flow bleeder holes were as much as 131 cfm. The methane content in the main return-air currents after water infusion was reduced more than 86 percent. Work done in cooperation with the Olga Coal Co., Coalwood, W. Va.
- RI 6327. Continuous Attrition Grinding of Coarse Kaolin (in Two Parts). 1. Open-Circuit Tests, by Martin H. Stanczyk and I. L. Feld. 1963. 14 pp. 5 figs. To obtain paper-coating clay, commercial kaolin containing about 11 percent minus-2-micron equivalent-spherical-diameter (esd) material was ground in a 10-inch-diameter grinder using continuous single- and multiple-stage grinding circuits. The feed rates varied from 10 to 480 pounds per hour. Multiple-stage grinding proved superior to single-stage treatment at equivalent feed rates. The best product was an 80-percent minus-2-micron esd paper-coating clay obtained when grinding 60 pounds of raw clay per hour using a three-stage circuit. Work done in cooperation with the University of Alabama.
- RI 6328. Lithology and Reservoir Properties of the Big Lime, Keener, Big Injun, Weir, and Berea Horizons, Spruce Creek Oilfield, Ritchie County, W. Va., by Wallace R. McCord and William E. Eckard. 1963. 16 pp. 3 figs. Presents a detailed lithologic description of important oil- and gas-producing horizons from a 4-inch-diameter well. Well logs and results of core analyses are also included. Commercial oil production was obtained by the well owner after the Big Injun horizon was successfully hydraulically fractured. Work done in cooperation with the West Virginia Geological and Economic Survey.
- RI 6329. Some Generalized Probability Distributions With Special Reference to the Mineral Industries (in Five Parts). 1. Sampling to n Items per Sample, by Robert M. Becker, 1964. 53 pp. 1 fig. First of a five-part investigation that extends the theory of sample reliability from a sample consisting of a fixed number of items to a sample consisting of a fixed amount of items. The extension of the theory is confirmed by experimental laboratory sampling using standard procedures.
- RI 6330. Bovill Clay and Sand Deposit, Latah County, Idaho. Geology, Mineralogy, and Beneficiation Tests, by Hal J. Kelly, George J. Carter, and George H. Todd. 1963. 56 pp. 16 figs. Drill-hole samples from the deposit were evaluated and beneficiated. Tests of the beneficiated products showed that a filler-grade clay having an apparent spectral reflectance of 78 percent can be made by bleaching and by removing some of the submicron-size particles. A quartz product suitable for the manufacture of glass containers can also be made. Work done in cooperation with J. R. Simplot Co., Boise, Idaho, and the School of Mineral Engineering, University of Washington.
- RI 6331. Willett Range Coal Deposits, Mackay Glacier Area, Victoria Land, Antarctica, by John J. Mulligan and Others. 1963. 67 pp. 35 figs. Presents data on Antarctic medium-volatile bituminous and semianthracite coal. Although the coal could be used for space heating and to generate electric power, economic exploitation is not practical at present. This is the second published report of the Bureau of Mines on Antarctic coals; RI 6218 was the first. The project was sponsored by the National Science Foundation, and laboratory work was done by the Geological Survey and the Bureau.
- RI 6332. An Inexpensive Triaxial Apparatus for Testing Mine Rock, by Leonard Obert. 1963. 10 pp. 8 figs. Describes an inexpensive apparatus for testing rock cylinders subjected to loading conditions comparable to those encountered in underground mining. The mechanical parts were relatively easy to machine and fabricate, and their cost, exclusive of labor, was approximately \$1,000.
- RI 6333. Effect of Decoupling on Explosion-Generated Strain Pulses in Rock, by Thomas C. Atchison, Wilbur I. Duvall, and Joseph M. Pugliese. 1964. 47 pp. 17 ills. Short cylindrical charges were detonated in drill holes in rock to determine the effects that decoupling (defined as the ratio of the radius of the hole to the radius of the charge) has on the strain-generating abilities of explosions in rock. The amplitude and period of the strain pulses produced in the rock were studied as a function of distance, size of charge, and decoupling. These studies show that, for a given distance and size of charge, the amplitude of the strain pulse decreases as decoupling increases and the period of the strain pulse decreases at first and then increases as decoupling increases. A simplified theory of decoupling is presented that satisfactorily explains the experimental results and makes it possible to predict the effect of decoupling on explosion-generated strain pulses in rock, thus helping the explosives user evaluate the effect of decoupling on his blasting.
- RI 6334. Tungsten Resources of Western Montana. Miscellaneous Deposits, by David B. Walker. 1963. 60 pp. 27 figs. Describes and appraises 64 tungsten deposits in western Montana. Report is the third of three describing tungsten resources in this area and supplements RI 5552 and 5612, published in 1960.
- RI 6335. Two Hydrated Calcium Aluminates Encountered in the Lime-Soda-Sinter Process, by R. V. Lundquist and H. Leitch. 1963. 9 pp. 2 figs. Gives the results of chemical and X-ray analysis of $\text{Ca}_3[\text{Al}(\text{OH})_2]_2$ and $3\text{CaO}\cdot\text{Al}_2\text{O}_3\cdot(8-12)\text{H}_2\text{O}$ formed in the leaching and desilication step of the lime-soda process. $\text{Ca}_3[\text{Al}(\text{OH})_2]_2$, which was found as a precipitate in leach solutions, contributed to lower alumina recoveries.
- RI 6336. Laboratory Smelting of Copper Precipitator Dust, by L. Mark Irwin and R. A. Marsyla. 1963. 9 pp. Presents results of a laboratory investigation to develop a matte-smelting process for the recovery of copper from industrial smelter dusts. Best results were obtained from smelting moist self-fluxing pellets; these yielded furnace slags with an average copper content as low as 0.15 percent copper, which is well below that of industrial copper reverberatory slags.

- RI 6337. Heats of Combustion and Formation of Carbides of Tungsten and Molybdenum, by Alla D. Mah, 1963. 9 pp. Reports new values of the heats of formation of carbides of tungsten and molybdenum. The energies of combustion of two carbides of tungsten and two carbides of molybdenum were measured, and the corresponding standard heats of combustion were derived. The heats of formation were obtained by combining the combustion heats with the heats of formation of the corresponding metal trioxides and carbon dioxide.
- RI 6338. Experimental Conversion of Hematite to Magnetite With Solid Reductants, by P. A. Wasson and M. M. Fine. 1963. 13 pp. 1 fig. Gives results of reductive roasting research using various solid reductants for converting nonmagnetic iron ore to a magnetic type. Recoveries of over 90 percent of the iron in magnetic concentrates were achieved at 650° C, using one or more of the following reductants: Lignite, lignite chars, a high-volatile bituminous coal, peat, and pyrite.
- RI 6339. Compressive Strength Versus Length-Diameter Ratios of Potash Specimens, by Robert T. Beckman. 1963. 15 pp. 9 figs. Summarizes results of a preliminary investigation made to evaluate a laboratory method for obtaining estimates of the strength of potash pillars in the Carlsbad area in New Mexico during robbing operations and to determine the reliability of the data.
- RI 6340. Effect of Natural Gas Concentration on Ignitibility of Gallery Atmospheres, by R. W. Van Dolah, N. E. Hanna, and R. L. Grant. 1963. 15 pp. 10 figs. Describes an experimental investigation of the relation between natural gas concentration and ignitibility of the gallery atmosphere. Both the gas concentration representing maximum ignitibility and the relationship between certain properties of the explosives and their incendivity are discussed. Was first presented at the 11th International Conference of Directors of Safety in Mines Research, Aix-les-Bains, France, July 2-5, 1963.
- RI 6341. A System for Electron-Beam Melting, by F. W. Wood, J. L. Hoffman, W. E. Anable, and R. A. Beall. 1964. 35 pp. 14 figs. Describes two electron-beam furnaces constructed and operated on the principle of high-powered vacuum diodes to melt and purify reactive and refractory metals. It was necessary to design the vacuum and electrical systems, mechanical features, and operating procedures to cope with dynamic conditions. The furnaces have been used to melt button specimens weighing several hundred grams and small ingots weighing several kilograms. Hafnium is among the metals that can be purified. Work done under cooperative agreement AT (11-1)-599 with the U.S. Atomic Energy Commission.
- RI 6342. Preparation Characteristics of Coal From Russell County, Va., by Albert W. Deurbrouck. 1963. 32 pp. 3 figs. Describes the preparation characteristics of the significant coalbeds in Russell County, Va.—Upper and Lower Banner, Kennedy, Raven, Jawbone, Tiller, and Burtons Ford beds. Most Russell County coal requires some cleaning to reduce the ash content. Report is one of a series covering preparation characteristics of U.S. coals on a county basis.
- RI 6343. Low-Temperature Heat Capacities and Entropies at 298.15° K of Akermanite, Cordierite, Gehlenite, and Merwinite, by W. W. Weller and K. K. Kelley. 1963. 7 pp. 1 fig. Presents low-temperature heat capacity data and entropies at 298.15° K of akermanite, cordierite, gehlenite, and merwinite. No similar data for the four compounds concerned in the report have been published previously.
- RI 6344. Experimental Coal-Dust and Gas Explosions, by John Nagy and Donald W. Mitchell. 1963. 27 pp. 26 figs. Summarizes observations made on coking of coal, deposition of soot, dust transport, flame, violence, and related phenomena following experimental coal-dust explosions. Data are given on gas explosion pressure, flame length, flame velocity, and variations of these parameters with concentration. Conclusions from these observations are useful in preventing similar occurrences in operating mines and serve as a guide in improving safety.
- RI 6345. Noise From Pneumatic Rock Drills. Analogy Studies of Muffler Designs, by R. T. DeWoody, J. W. Chester, and W. C. Miller. 1964. 24 pp. 21 figs. Describes the development of a relatively efficient reactive muffler for quieting the exhaust noise of a rock drill. Information obtained from analogous electrical circuits was used to design the muffler, and results of actual muffler tests are in essential agreement with the electrical analogies.
- RI 6346. Radioactivity in Alkaline Leach Milling Processes, by K. E. Tame. 1964. 8 pp. 1 fig. Gives results of laboratory investigation of buildup of radium in barren solutions recycled to the washing circuit in carbonate leaching mills. Finds that over 95 percent of the radium 226 precipitates with the uranium, and there is no buildup of radium in the pregnant solution when the barren solution is recycled to the washing circuit.
- RI 6347. Developing a Lock-Hopper Feeder for Hydraulic Hoisting of Coal, by H. A. Dierks, and H. B. Link. 1964. 27 pp. 8 figs. Describes the design, assembly, and testing of a practical feeder apparatus to introduce comparatively large pieces of coal and similar material into a pipeline under pressure in connection with hydraulic hoisting. The experimental lock-hopper feed apparatus demonstrated a hoisting capacity of 36 tons per hour of anthracite in a mixture containing coal up to a top size of 3 inches.
- RI 6348. Formation and Flammability of Stratified Methane-Air Mixtures, by Henry E. Perlee, Israel Liebman, and Michael G. Zabetakis. 1964. 23 pp. 17 figs. Describes flammability studies conducted on stratified methane-air and pentane-air mixtures in air, indicating that location and extent of a flammable layer are affected by molecular diffusion, gas motion, and propagation of flame.
- RI 6349. Experimental Upgrading of Artificial Magnetite Concentrates by Flotation, by D. W. Frommer and A. F. Colombo. 1964. 13 pp. 1 fig. Gives results of tests made to determine the applicability of flotation as a means of upgrading magnetic concentrates prepared from reductively roasted iron ores. Seven concentrates, containing from 6.7 to 13.7 percent SiO₂, were improved by the flotation treatment, yielding final concentrates containing less than 6.0 percent SiO₂. Cationic flotation methods were studied on four of the seven samples; of this group only one sample yielded better results by cationic flotation than by the anionic method.
- RI 6350. Reconnaissance of Tellurium Resources in Arizona, Colorado, New Mexico, and Utah. Including Selected Data From Other Western States and Mexico, by F. D. Everett. 1964. 38 pp. 4 figs. Presents Bureau analyses of more than 200 samples of mineral-bearing deposits for determination of tellurium content that came from the areas listed. Also includes the results of tellurium determinations by private companies on more than 500 samples from a wide variety of mineral-bearing deposits. About 40 minerals containing tellurium have been reported, mainly tellurides of gold, silver, bismuth, mercury, lead, copper, iron, and nickel.
- RI 6351. Abatement of Noise From Explosives Testing, by R. W. Van Dolah, F. C. Gibson, and

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- N. E. Hanna. 1964. 23 pp. 16 figs. Describes measures that were taken to eliminate noise resulting from explosives work at the Bureau of Mines facility at Bruceton, Pa. A method of monitoring sound transmission characteristics of the atmosphere and controlling the explosives testing partially controlled the noise. The noise problem was entirely eliminated when the explosives work was done in closed facilities.
- RI 6352. Cadmium Refining by Amalgam Electrolysis, by Arnold M. Lansche and D. H. Chambers. 1964. 17 pp. 5 figs. An acid rinse and zinc displacement technique was developed to amalgamate air-oxidized cadmium sponge. Zinc was completely removed from amalgamated sponge by selective oxidation with air. Zinc-free cadmium amalgam was circulated by an electromagnetic pump through an electrolytic cell where cadmium 99.9-percent purity was electrodeposited onto a rotating aluminum cathode.
- RI 6353. An Apparatus for Detecting Helium Leaks, by C. L. Klingman and J. C. Meeks. 1964. 17 pp. 7 figs. An instrument that is sensitive, portable, safe in explosive atmospheres, and low in cost was developed for detecting helium leaks by comparing the thermal conductivity and flow rate of the atmosphere around a suspected leak against a reference of helium-free air.
- RI 6354. Comparison of Properties of Coke Produced by BM-AGA and Industrial Methods, by D. E. Wolfson, G. W. Birge, and J. G. Walters. 1964. 19 pp. 5 figs. Seventeen samples were carbonized by the BM-AGA pilot-plant method and in industrial ovens. The industrial plants carbonizing these samples represent about 30 percent of total 1959 U.S. capacity. Chemical and physical properties of the samples were determined, and the physical properties of the cokes prepared by the two methods were compared.
- RI 6355. Carbonizing Properties of Coals From Buchanan, Dickenson, Russell, Tazewell, and Wise Counties, Va., by G. W. Birge, D. E. Wolfson, and J. H. Lynch, Jr. 1964. 22 pp. 2 figs. Thirty-one channel samples from the principal beds were carbonized at 900° C. Most of the samples proved chemically suitable for metallurgical use in coking blends. Ash content exceeded 10 percent in only three samples, and none of the coals contained more than 1.5 percent sulfur. Dry, mineral-matter-free fixed-carbon content ranged from 62.1 to 77.5 percent. Expansion behavior varied widely. Samples came from Clintwood, Hagy, Splash Dam, Upper and Lower Banner, Kennedy, Raven, Jawbone, Tiller, Upper Seaboard, Pocahontas Nos. 3 and 5, Taggart, Norton, Pittsburgh, and Beckley beds.
- RI 6356. Heat and Free Energy of Formation of Muscovite, by R. Barany. 1964. 6 pp. Describes experimental work to obtain heat of formation at 298.15° K of muscovite by solution calorimetry. The value obtained for the heat of formation from the elements was $-1,421.2 \pm 1.3$ kcal/mole, and the value for the heat of formation from the oxides was -55.9 ± 1.3 kcal/mole.
- RI 6357. Low-Temperature Heat Capacities and Entropies at 298.15° K of Lead Molybdate and Lead Tungstate, by W. W. Weller and K. K. Kelley. 1964. 5 pp. 1 fig. Presents heat capacity measurements of lead molybdate and lead tungstate over the temperature range from 51° to 298° K. The entropy values at 298.15° K fill an important gap in the data necessary for deriving the free energies of formation of the compounds and evaluating their chemical and thermal stabilities.
- RI 6358. A Penetrometer for Measuring the Absolute Viscosity of Glass, by John E. Kelley, Thomas D. Roberts, and Henry M. Harris. 1964. 11 pp. 4 figs. Describes a penetrometer which was developed to measure viscosity of glass at temperatures up to 1,450° C to be used in establishing the viscosity coefficients required for high-temperature forming of ceramic materials. The penetrometer was tested using a standard viscosity sample of soda-lime-silica glass obtained from the National Bureau of Standards. Values obtained at several temperatures agreed within 10 percent with comparable data calculated from the Fulcher equation derived by NBS for this glass. Equivalent accuracy was obtained with other glasses used to evaluate the apparatus.
- RI 6359. High-Temperature Corrosion Studies. A Sensitive Volumetric Apparatus for Determining Gas-Solid Reaction Kinetics, by Robert M. Doerr and Charles C. Myers. 1964. 13 pp. 3 figs. Describes an apparatus for determining the kinetics of gas-solid reactions at high temperatures by measuring the volume of gas consumed with respect to time. Gives a detailed description of the precision-bore tube, reaction chamber, reservoir, and associated equipment.
- RI 6360. Methods for Producing Titanium Lower Chlorides, by V. E. Homme and M. M. Wong. 1964. 16 pp. 3 figs. Describes methods of preparing melts consisting of sodium chloride-titanium lower chlorides by reducing $TiCl_4$ with sodium and with scrap titanium metal in sodium chloride.
- RI 6361. Hydrometallurgical Recovery of Manganese From Manganiferous Slimes and Limestones, by W. L. Falke. 1964. 14 pp. 10 figs. Describes recovery of manganese by treating slimes and limestones with sulfur dioxide; manganese (II) hydroxide is precipitated and leached with ammonium carbamate solution, and manganese carbonate is separated by warming the leach solution. Concludes that manganese can be recovered simultaneously from both manganiferous slime and limestone by blending the materials in suitable ratios before reduction. This procedure lowers the cost without reducing the overall recovery of manganese.
- RI 6362. Continuous Electrowinning of Cerium Metal From Cerium Oxides, by E. S. Shedd, J. D. Marchant, and T. A. Henrie. 1964. 12 pp. 3 figs. Twenty-seven pounds of 99.8-percent-pure metal was produced at a rate of 3 pounds per hour and tapped from the cell. Stable cerous oxide reacted more uniformly at the anode surface than ceric oxide. The purity of the metal collected in an electrolyte skull was greater than the purity of that collected on a molybdenum metal hearth. Cell design proved to be an important factor in the continuous cell operation.
- RI 6363. Gasification of Coal in the Presence of Gamma Rays, by Paul S. Lewis, Henry H. Ginsberg, and Raymond W. Hiteshue. 1964. 12 pp. 4 figs. Shows that irradiation with 3.57 million roentgens has no gross effect on the gasification rate or on the yield and distribution of methane and hydrogen. Concludes that gamma-ray irradiation produces no improvement in the technology or economics of coal gasification.
- RI 6364. Gasification of Bituminous Coal With Oxygen in a Pilot Plant Equipped for Steam-Pickup Feeding, by K. D. Plants, J. H. Holden, and L. F. Willmott. 1964. 9 pp. 4 figs. The pressure-gasification pilot plant operated satisfactorily at relatively high steam-to-coal ratios, but these could not be reduced much below 0.5 lb/lb without condensation of steam or softening of the coal. Carbon gasified, gas composition, and coal and oxygen requirements were essentially the same as for a pilot plant equipped with a fluidized-

- coal feeder. Average results from the pilot plant equipped for steam-pickup feeding were coal requirement, 37.3 lb/M (1,000) scf of CO + H₂ produced; oxygen requirement, 358 scf/M scf CO + H₂ produced; and carbon gasified, 87.7 percent.
- RI 6365. Titanium Placer Resources in Western Montana, by Dean C. Holt. 1964. 39 pp. 15 figs. Appraises the potential of titanium minerals in known titanium-bearing placer deposits and potential titanium-bearing placer areas in western Montana. Reconnaissance studies were made of more than 225 stream areas. Sampling results from 8 deposits indicate areas containing more than 10 pounds of ilmenite and other titanium-bearing black-sand minerals per cubic yard. Chief source for constituents of the black sands appears to be the Idaho batholith, and highest concentrations are generally found near the source. Testing methods included gravity and magnetic separation, and visual microscopic, chemical, and radiometric analyses on deposits sampled in detail.
- RI 6366. Rigid Foam for Mines, by Donald W. Mitchell, John Nagy, and Edwin M. Murphy. 1964. 37 pp. 19 figs. Describes the Bureau's work in developing chemical formulation, spraying equipment, and application procedures for safe and effective use of urethane foam in mining. Research and experience indicates that rigid foam will improve safety and productivity.
- RI 6367. Vapor Pressure of Tungsten (VI) Chloride and Hafnium (IV) Iodide by a Metal Diaphragm Technique, by F. D. Stevenson, C. E. Wicks, and F. E. Block. 1964. 32 pp. 13 figs. Describes vapor pressure measurements of tungsten (VI) chloride and hafnium (IV) iodide with a metal diaphragm vapor pressure apparatus. Heats of vaporization, sublimation, fusion, and transition are calculated for the two systems by means of the Clausius-Clapeyron equation. Comparisons are made with results of earlier investigators that differ considerably and are discussed in detail.
- RI 6368. Ammoniacal-Ammonium Carbonate Leaching of Manganiferous Materials From the Southern District, Aroostook County, Maine, by Theodore L. Turner and Joseph H. Swift. 1964. 33 pp. 10 figs. Gives results of a laboratory-scale study of ammoniacal-ammonium carbonate batch leaching of manganese from low-grade manganiferous materials from three deposits in Aroostook County. These materials were partially reduced at 500° to 700° C with H₂ or CO₂ and leached with solution of NH₃ and CO₂ dissolved in water. Extractions of 80 to 90 percent Mn were obtained from some sample materials, but 10 to 34 percent of the Fe was also extracted, indicating that post-leaching treatment would be necessary to obtain a commercial-grade product.
- RI 6369. Ignition of Coal Dust-Methane-Air Mixtures by Hot-Turbulent-Gas Jets, by Joseph M. Singer. 1964. 24 pp. 14 figs. Presents the results of an investigation of the ignition of hybrid coal dust-methane-air mixtures by hot-turbulent-pulsed-gas jets generated by explosions in a primary chamber of stoichiometric mixtures of methane, oxygen, and nitrogen. This paper reports that ignitability was influenced by the dimension of communicating channel between a primary explosion and a hybrid mixture, coal-dust particle size in the hybrid mixture, addition of inhibitor to the hybrid mixture, temperature of hot igniting jet, and concentration of methane and coal dust.
- RI 6370. High-Temperature Heat Contents and Entropies of Andalusite, Kyanite, and Sillimanite, by L. B. Pankratz and K. K. Kelley. 1964. 7 pp. 1 fig. Gives results of heat content measurements above 298.15° K for three crystalline varieties of Al₂SiO₅. A combination of entropy data with a free energy of formation value for mullite led to the conclusion that the heats of formation of andalusite, kyanite, and sillimanite from corundum and cristobalite at 1,600° K are less negative than -6.0 kcal/mole.
- RI 6371. High-Temperature Heat Contents and Entropies of Muscovite and Dehydrated Muscovite, by L. B. Pankratz. 1964. 6 pp. 1 fig. Reports new experimental values for the high-temperature heat content of muscovite in the range from 298° to 900° K and for dehydrated muscovite in the range from 298° to 1,200° K. The apparent heat content of the water in muscovite was extracted from the data and compared with similar information regarding water in hydrated minerals.
- RI 6372. Mine Roof Rock Bolt Behavior Resulting From Nearby Blasts, by Charles J. Stehlik. 1964. 33 pp. 16 figs. Describes the effects of blasting on mine roof bolts and roof rock in the upper shale production headings at the White Pine Copper Co. mine, White Pine, Mich. Tests indicate that roof bolt tension change and roof deterioration were caused by the effects of blasting.
- RI 6373. Use of Tritium Tracer Techniques in Studies of Gasoline Storage Stability, by Charles S. Allbright, Marvin L. Whisman, and Frank G. Schwartz. 1964. 17 pp. 5 figs. Describes the use of radioactive tracer techniques in studying compounds that cause the formation of gasoline gum. About 70 compounds were studied. Information derived should be helpful in developing a method for predicting storage stability of gasoline. Work done in cooperation with Research Division of the Army Materiel Command.
- RI 6374. Reducing Vanadium Compounds in Bomb Reactors, by T. T. Campbell, F. E. Block, and E. R. Andersen. 1964. 26 pp. 10 figs. Describes methods for increasing the yields and purity of vanadium. Concludes that yields of 85 to 90 percent can be effected by the calcium reduction of V₂O₅ in reactors measuring as much as 14 inches in diameter and 60 inches in height. Purity of the vanadium produced in large reactors varied from 99.5 to 99.8 percent. Estimates that pure ductile vanadium can be produced for \$20 per pound at a production rate of 100 tons per year.
- RI 6375. Some Physical Properties of Ceria Powders Derived From Five Salts, by Louis P. Domingues, Roy L. Wilfong, and LeRoy R. Furlong. 1964. 10 pp. Describes studies of the variation of the bulk and apparent densities, particle size, and surface area of ceria powders derived from the ammonium sulfate, carbonate, nitrate, oxalate, and sulfate salts and heated at 950° to 1,500° C for 1 to 24 hours. These observations will help the researcher to predict the optimum conditions for the commercial production of ceria powders.
- RI 6376. Hydrogasification of a High-Volatile A Bituminous Coal, by Raymond W. Hiteshue, Sam Friedman, and Robert Madden. 1964. 31 pp. 20 figs. Discusses the hydrogenation of hvab coal and char to high-Btu gas at pressures of 50 to 1,000 psig and 800° to 1,200° C and presents some of the problems of hydrogenating such coal on a continuous basis.
- RI 6377. Developing a Thermochemical Model for the Iron Blast Furnace. Rate of Reduction of an Oxide Sphere in a Stream of Reducing Gas, by Hillary W. St. Clair. 1964. 22 pp. 4 figs. Develops an equation for the rate of reaction of a sphere of metal oxide in a restricted enclosure through which a reducing gas is flowing. The equation

represents a theoretical basis for predicting the course of reduction of a particle of metal oxide in a shaft furnace.

- RI 6378. Experimental Longwall Mining in a Pennsylvania Anthracite Mine (in Two Parts). 1. Use of Yielding Steel Props, by Robert J. Brennan, John W. Buch, and Edward R. Navrocky. 1964. 27 pp. 17 figs. Describes the Bureau's efforts to establish a productive mechanized mining system for anthracite beds pitching between 10° and 20°, using a drum cutter loader and friction-type yielding steel roof supports. The project was discontinued when the yielding steel props proved to be unsatisfactory for the existing anthracite mining conditions. Work done in cooperation with the Glen Alden Corp. (now Glen Alden Coal Co.).
- RI 6379. Linear Correlation of Magnetic Susceptibility With the Composition of Minerals, by Foster Fraas. 1964. 13 pp. 5 figs. Presents a review of the literature on solid solutions and discloses that the relation between composition and magnetic susceptibility is not linear. Recalculation using a transformation of composition values to parameter values provides for a linear relation with the magnetic susceptibility to the one-half power. Application to minerals is illustrated by the olivine and enstatite series.
- RI 6380. Accuracy in Estimating Metal Content and Tonnage of An Ore Body From Diamond-Drill-Hole Data, by George S. Koch, Jr., and Richard F. Link. 1964. 24 pp. 10 figs. Estimates the metal content and tonnage of an ore body by statistical methods, using data from 18 diamond-drill holes, and compares the results with actual values established with data from 1,829 drift samples. It is concluded that useful estimates can be made from 18 drill holes provided that reasonable assumptions are made and certain risks accepted. The ore body investigated is the Don Tomas vein of the Frisco mine, San Francisco del Oro, Chihuahua, Mexico. Work done in cooperation with the Department of Statistics, Oregon State University.
- RI 6381. Metathesis of Bastnasite and Solvent Extraction of Cerium, by D. J. Bauer and V. E. Shaw. 1964. 15 pp. 13 figs. Gives results of processing bastnasite concentrate with caustic soda that gave 99-percent conversion to rare-earth hydroxides. A drying step followed by solution in nitric acid produced a cerium fraction amenable to extraction with tri-*n*-butyl phosphate. Single-stage separatory funnel experiments resulted in 90-percent recovery of ceric nitrate at a purity of 99.9 percent and fractional extraction in pressure-bubbler columns resulted in 98.5-percent recovery of 99.5-percent-pure ceric nitrate.
- RI 6382. Preliminary Study of Inorganic Reactions in a High-Gamma Radiation Flux, by J. E. Tress, C. E. Wicks, and F. E. Block. 1964. 17 pp. 2 figs. Investigates the utilization of gamma radiation with various inorganic materials of metallurgical significance. Attempts were made to effect reactions that might be applicable in the extraction and separation of metal values from minerals and ores. Complexing of salts, decomposition of hydrated salts, metal chlorination reactions, leaching of ores and minerals, halogen exchange, and various reducing reactions were studied.
- RI 6383. Anthracite Metallurgical Briquets as Blast Furnace Fuel, by J. W. Eckerd, R. E. McKeever, W. S. Sanner, and P. L. Woolf. 1964. 16 pp. 4 figs. Gives data on the successful use of anthracite metallurgical briquets in the Bureau's experimental blast furnace. Tuyere pressures were higher and more erratic than for operations using coke, and furnace "hangs" occurred more frequently. By using higher hot blast temperatures, the fuel and production rates and slag volumes were comparable to those obtained for all-coke operation. The anthracite metallurgical briquets exhibited excellent mechanical strength and descended through the shaft of the furnace with little breakage or reduction in size.
- RI 6384. Analysis of High-Purity Columbium by Optical Emission Spectrography, by Lloyd Carpenter and James M. Nishi. 1964. 16 pp. Describes spectrochemical determination of 19 elements in high-purity columbium. Method determined impurities in the general range of 0.5 to 1,000 ppm; average precision of the method was 14.2 percent relative standard deviation.
- DI 6385. Flotation of Calcareous Scheelite Ores, by K. C. Dean and C. H. Schack. 1964. 15 pp. Presents results of an investigation to devise and evaluate a flexible flotation method for beneficiating typical tactite types of calcareous scheelite-bearing ores. The flotation process comprised (1) removal of sulfide minerals, (2) conditioning the residual ore pulp with sodium carbonate, quebracho, and trisodium phosphate, and (3) rougher flotation and single-stage cleaning of a scheelite concentrate. Over 91 percent of the tungsten was recovered from ore containing 0.27 percent WO₃, in a concentrate containing 11.2 pct WO₃.
- RI 6386. Laboratory Continuous Flotation of Bertrandite and Phenacite From Mount Wheeler, Nevada, Beryllium Ores, by Richard Havens and William T. Nissen. 1964. 18 pp. 2 figs. Presents results of continuous flotation studies made at a 50-pound-per-hour feed rate to confirm the effectiveness of a batch-scale procedure for concentrating phenacite and bertrandite from berylliferous ores. The principal problem of achieving adequate conditioning to depress calcite and fluoide was described. Concentrates of 12 to 25 percent BeO were achieved. Recoveries, on a BeO basis, ranged from 75 to 88 percent. Losses probably could be lowered in a commercial operation.
- RI 6387. Dissolution and Roasting Techniques for Extracting Cesium From Pollucite Ores, by K. C. Dean, P. H. Johnson, and I. L. Nichols. 1964. 20 pp. 4 figs. Gives results of small-scale tests of methods of extracting cesium and rubidium from Maine, Canadian, and Rhodesian pollucite ores by hydrochloric acid, sulfuric acid, and chloridizing roast-water leaching. Extractions of cesium from ores and flotation products containing over 20 percent cesium were in excess of 97, 93, and 96 percent for the hydrochloric acid, sulfuric acid, and chloridizing roast-water leach processes, respectively.
- RI 6388. Prerefining Pig Iron With a Vortex Cone. Preliminary Experiments, by F. X. Tartaron, R. J. Leary, and W. M. Mahan. 1964. 20 pp. 9 figs. Describes work undertaken to develop a simple, rapid method for prerefining hot metal continuously. The vortex cone is a funnel-shaped device into which a horizontal stream of molten pig iron is directed tangentially, causing the stream to flatten itself upon the wall and flow in a spiral path to the outlet. Oxygen is impinged upon the flowing metal, and reaction is facilitated by the large metal surface exposed and the turbulent flow. The extent of silicon compares with commercial practices in steelmaking and is accomplished in the time interval that it takes to pour metal from one ladle to another.
- RI 6389. Areal Variation in Reservoir Oil Characteristics, Newcastle Sandstone, Greater Clareton Area, Wyo., by C. Q. Cupps, J. Fry, and R. F. Zaffarano. 1964. 34 pp. 5 figs. Presents a study of the reservoir oil characteristics of the Newcastle sandstone in the greater Clareton area. These

- data, correlated with areal location of the wells, show an increase of saturation pressure in a general north-south or downdip direction, which is taken as evidence of updip diffusion of solution gas from a somewhat higher concentration at the bottom of the reservoir, an effect opposite to that previously observed in two prominent high-relief reservoirs in the Rocky Mountain area. The increasingly greater saturation pressures downdip in the greater Clareton area suggest a continuing migration of fluids into the structure. Work done in cooperation with the University of Wyoming.
- RI 6390. Columbium and Tantalum Alloys Suitable for Use at High Temperatures, by H. R. Babitzke, M. D. Carver, and H. Kato. 1964. 25 pp. 9 figs. Gives data on a number of columbium and tantalum alloys that were investigated to determine their suitability for use at elevated temperatures. Columbium-vanadium, tantalum-vanadium, and tantalum-hafnium alloys, and also columbium-10 weight-percent titanium alloys modified with additions of 0.1 to 2 mole-percent ZrO_2 , TiO_2 , ZrB_2 , TiB_2 , ZrC , or TiC were prepared and tested for workability, tensile properties, and oxidation resistance. Of the columbium alloys studied, the columbium-12 atomic percent vanadium exhibited the best properties.
- RI 6391. Effect of Gamma Radiation on Anthracite, by Ralph Husack, G. A. Brady, and J. W. Eckerd. 1964. 28 pp. 13 figs. Discusses the results of tests in which anthracite was exposed to gamma radiation up to 1×10^6 rads. Rate of oxidation of anthracite was increased, and changes were produced in the composition of gases evolved from evacuated anthracite. Although drop-shatter tests indicated that the structure of anthracite was weakened, the evidence was not supported by the results of grindability or particle-size studies.
- RI 6392. Polyethoxylated Amines as Flotation Collectors for Slimed Lead Minerals, by T. E. Hill, Jr., W. A. Calhoun, and H. E. Powell. 1964. 19 pp. 15 figs. Determines the effectiveness of certain cationic flotation collectors, Ethomeens, in recovering fine particles of lead minerals from mill tailings at a grade equal, at least, to that of the mill feed. Best results were obtained with coco amine C/12, soybean amine S/15, tallow amine T/12, and stearyl amine 18/20. In comparative tests, the Ethomeens were more selective than conventional anthate collectors for flotation of slimed lead minerals.
- RI 6393. Lightweight Aggregates: Expansion Properties of Selected Iowa Shales, Clays, and Loess, by John W. Sweeney and Howard P. Hamlin. 1964. 33 pp. 3 figs. Describes preliminary testing and evaluation of shales, clays, and loess in Iowa to determine feasibility of producing lightweight aggregates by commercial rotary-kiln or sintering methods. Three samples made suitable lightweight aggregate by rotary-kiln methods and two by sintering.
- RI 6394. Some Iron Phyllosilicates of the Cuyuna and Mesabi Districts in Minnesota, by Rolland L. Blake. 1964. 33 pp. 7 figs. Examination of 96 thin sections from the thin-bedded facies of the main iron formation of the Cuyuna district indicates that the most abundant minerals are Mn-Mg-siderite, stilpnomelane, and minnesotaite. Reconstitution and recrystallization of minerals have occurred along certain beds, and textures indicate that some minnesotaite apparently formed at the expense of stilpnomelane. The detection of ammonia in stilpnomelane samples is the first such occurrence reported, and its significance is discussed. New mineral data are presented on greenalite and probable septechamosite from the Mesabi district.
- RI 6395. Comparative Studies of Explosives in Limestone, by Thomas C. Atchison and Joseph M. Pugliese. 1964. 25 pp. 11 figs. Gives results of measurements of the strain-producing abilities of six explosives that were detonated in limestone. The data indicated that, at lower values of impedance ratio, the strain intercept is relatively larger than would be expected from the simple elastic theory. The results presented provide a simple method for predicting the relative effectiveness of different explosives in breaking limestone from the detonation pressures and characteristic impedances of the explosives.
- RI 6396. Naphthenic Acid Solvent Extraction of Rare-Earth Sulfates, by D. J. Bauer and R. E. Lindstrom. 1964. 19 pp. 14 figs. Presents results of extraction studies conducted to assess the potential of naphthenic acid as a fractional extractant for rare-earth mixtures and yttrium in sulfate solution. Naphthenic acid was an effective extractant, and separation factors were favorable in the presence of aqueous-phase chelating agents.
- RI 6397. Characteristics of Positive Corona for Electrical Precipitation at High Temperatures and Pressures, by C. C. Shale, W. S. Bowie, J. H. Holden, and G. R. Strimbeck. 1964. 17 pp. 7 figs. Presents electrical characteristics of positive corona for air in a 2-inch-diameter electrostatic precipitator operating under dynamic conditions at temperatures of 600° to $1,500^\circ$ F and pressures of 0 to 80 psig. Results show that current-voltage relationships depend solely on air density. Comparison with data on negative corona demonstrates that positive corona has a higher sparkover voltage and wider range of operability at temperatures above 375° F. Based on the physics of an ion in an electrical field, a theoretical equation is derived to define current-voltage characteristics of positive corona in terms of air density.
- RI 6398. The System Magnesia-Magnesium Fluoride-Germania-Lithium Fluoride. 6.94 Percent Lithium Fluoride, by George McCormick. 1964. 11 pp. 3 figs. Presents data for 69 composition prepared in the system $MgO-MgF_2-GeO_2$ at 6.94 percent LiF. In addition to the expected compounds of germanium, a Ge-fluor-hectorite and a Ge-fluor-chrysoile were synthesized. Protoamphibole was not observed.
- RI 6399. Anionic Flotation of Silica From Western Mesabi and Menominee Range Iron Ores, by D. W. Frommer, M. M. Fine, and L. Bonicatto. 1964. 25 pp. 3 figs. Describes an investigation made to develop an anionic flotation method capable of producing concentrates meeting the exacting chemical specifications for iron-blast-furnace feed and yet permitting the treatment of a wide variety of iron-bearing materials. Work done in cooperation with the Hanna Mining Co.
- RI 6400. Stress Determinations by Flatjack and Borehole-Deformation Methods, by Robert H. Merrill, James V. Williamson, David M. Rapchan, and George H. Kruse. 1964. 39 pp. 30 figs. Describes the sites where the rock stresses were measured, the flatjack and borehole methods of stress determination, and the data and results obtained from 9 flatjack and 157 borehole-deformation measurements. Also discussed are the results of special studies to estimate the stress distribution in the rock caused by pressure in the flatjack.
- RI 6401. Statistical Analysis of Some Sample and Assay Data From Bedded Deposits of the Phosphoria Formation in Idaho, by Scott Hazen, Jr. 1964. 29 pp. 20 figs. Presents the results of a statistical analysis of a limited amount of sample

- and assay data from a production panel in an open-pit phosphate mine. A frequency distribution analysis is shown for the assays, sample interval lengths, and products of assay and sample interval length for the mill-shale, furnace-shale, and main phosphate beds. Correlation techniques were used to show the relationships between assays and sample interval lengths. Simulation methods, using a digital computer, were used to establish assay populations that could be used for estimating grade of ore, cutoff grades, and deposit or bed identification.
- RI 6402. Investigation of Chlorination Reactions Using Carbon 14, by Robert R. Brown, F. E. Block, and A. W. Henderson. 1964. 20 pp. 10 figs. The chlorination of chromic oxide in the presence of carbon with carbon tetrachloride and phosgene chlorinating agents was investigated by employing the radioactive tracer carbon 14. Results showed that each source of carbon reacts significantly with the chromic oxide, that the reactivity of each form of carbon depends on the reaction temperature, and that each form is independent of the other.
- RI 6403. Uranium Alloyed Steels; Their Fabrication and Mechanical Properties, by L. W. Higley, Jr., and K. A. Fowler. 1964. 16 pp. 8 figs. Gives results of a study of an alloying addition of depleted uranium to steels. Uranium additions did not increase tensile strength, and hot-shortness occurred during forging above 1,090° C because of the presence of a low-melting-point constituent of a eutectic type. Although a measurable amount of radioactive contamination resulted from processing, the quantity was never large enough to require the work area to be identified as a radiation area.
- RI 6404. Electrostatic Separation of High-Conductivity Minerals, by Foster Fraas. 1964. 17 pp. 9 figs. Gives results of research on separation of one highly conductive mineral from a second conductive mineral. A new technique involved use of carrier-electrode rolls specially prepared by anodizing and/or oxidizing at high temperatures to form suitable oxide surfaces. Specific oxides included aluminum, copper, and nickel. Separation range was extended in relative mineral conductivity from 10^{-24} to 10^{-21} mhos.
- RI 6405. Melting Pyrophoric Hydrogen-Reduced Iron Powder for Production of Steel, by Lloyd H. Banning and Oliver C. Fursman. 1964. 37 pp. 11 figs. Proves that high-quality steel can be produced readily from high-grade iron powder. Shows that the pyrophoric powder can be handled safely. Melting tests were made in a single-phase, electric-arc furnace to determine inert-gas requirements for preventing powder oxidation. Work done in cooperation with Hydrocarbon Research, Inc.
- RI 6406. Using Unequal Sample Interval Lengths and Weighted Averages in Estimating Grade of Ore for Bedded Deposits, by Scott W. Hazen, Jr., and George W. Gladfelter. 1964. 23 pp. 4 figs. Randomness tests on sample and assay data from the Phosphoria Formation indicate that correlation between assay value and sample interval length apparently has little effect on the independence between successive assays, between successive sample interval lengths, and between the products of assays and sample interval lengths. Therefore, these data can be analyzed statistically as long as the original sample sections have been selected at random for sampling.
- RI 6407. Preparation and Evaluation of the Diborides (Ti, V)B₂, (Ti, Cb)B₂, and (Ti, Ta)B₂, by M. E. Tyrell and J. Koster. 1964. 16 pp. 7 figs. The diborides (Ti, V)B₂, (Ti, Cb)B₂ and (Ti, Ta)B₂ were prepared in a crucible resistance furnace at 2,100° C to determine the feasibility of making mixed diborides of two metals directly from the metal oxides, boron carbide, and carbon. The diboride powders were cold pressed, sintered to 2,300° C, and evaluated for mechanical strength, rate of oxidation, and resistance to molten metals.
- RI 6408. Mineralogical Investigation of Beryllium-Bearing Tuff, Honeycomb Hills, Juab County, Utah, by J. W. Montoya, G. S. Baur, and S. R. Wilson. 1964. 11 pp. 6 figs. Summarizes the results of a limited field and laboratory examination of beryllium deposits in tuff beds similar to the extensive berylliferous tuff at Spor Mountain. The Honeycomb Hills samples showed beta-Be(OH)₂, as well as an amorphous berylliferous substance; in the Spor Mountain tuff the beryllium-bearing minerals are hydrated bertrandite and berylliferous saponite.
- RI 6409. Alkaline Leach Processing of a Subgrade Calcareous Uranium Ore, by K. E. Tame. 1964. 12 pp. 2 figs. Describes tests on recovering uranium from a submarginal 0.1 percent U₃O₈ calcareous carnotite ore. Alkaline leaching recovered 72 percent of the uranium, while recovery by ion exchange was about 95.5 percent. No economic evaluation of the processes was made.
- RI 6410. Activities of Copper and Nickel in Liquid Copper-Nickel Alloys, by C. W. Schultz, G. R. Zellars, S. L. Payne, and E. F. Foerster. 1964. 9 pp. 4 figs. The activity and activity coefficient of copper were calculated over the entire range of alloy composition. These data show a slight positive deviation from ideal behavior. The activity coefficient of copper was highest at 0.05 mole fraction copper and approached unity at concentrations above 0.85 mole fraction copper. The coefficient for nickel was calculated from the copper data. Vapor pressure was also determined for copper.
- RI 6411. Magnetization Delay in the Separation of Minerals, by Foster Fraas. 1964. 13 pp. 7 figs. The magnetic tractive force on particles varies not only in accordance with the static susceptibility but also with respect to magnetization in a preliminary field and time of retention in the tractive field. Adaptation of these variations provides for a greater range of separation selectivity, particularly in the separation of minerals in certain ores that have previously been difficult to separate.
- RI 6412. Infrared Study of the Effect of Fluoride, Sulfate, and Chloride Ions on Adsorption of Oleate on Fluorite and Barite, by Alan S. Peck and Milton E. Wadsworth. 1964. 15 pp. 10 figs. Investigates the effects of fluoride, sulfate, and chloride ions on the adsorption reaction between sodium oleate and water suspensions of synthetic fluorite and barite. Infrared analytical methods permitted identification of chemisorbed oleate and physically adsorbed sodium oleate species, on each mineral, and quantification of the changes induced by different concentrations of the sodium salts.
- RI 6413. Determination of Principal Stress Directions Through an Analysis of Rock Joint and Fracture Orientations, Star Mine, Burke, Idaho, by E. W. Gresseth. 1964. 43 pp. 39 figs. Gives results of a study of the joints and fractures surrounding underground openings in the Star mine to show their orientation and to facilitate their classification into systems. The direction of the principal stresses in the rock were determined in situ by the use of strain ellipsoid techniques. The objective was to discover if the orientation of in situ rock fractures and joints formed a pattern that could be utilized in determining the direction and effect of past and present ground forces in a geologically complex formation. Results indicate at least two periods of rock deformation, the first

- during folding and the most recent associated with stoping.
- RI 6414. Analysis of High-Purity Columbium by Optical Emission Spectrography, by Lloyd Carpenter and James M. Nishi. 1964. 16 pp. Sixteen elements were determined spectrochemically in the general range of 3 to 1,000 ppm in high-purity columbium. The dc arc was used as an excitation source. Average precision of the method was 11.2 percent relative standard deviation.
- RI 6415. Heat of Formation of Aluminum Carbide, by Alla D. Mah. 1964. 4 pp. The heat of combustion of aluminum carbide, obtained directly by combustion calorimetry, was $\Delta H_{298-15} = -1,029.6 \pm 1.9$ kcal/mole. The heat of formation of aluminum carbide corresponding to this value was $\Delta H_{298-15} = -53.4 \pm 2.0$ kcal/mole. Previously existing values of the heat of formation of aluminum carbide varied widely, and the better values were uncertain by ± 10 kcal/mole. The present measurements substantially reduce this uncertainty.
- RI 6416. Carbonizing Properties of Letcher County, Ky., Coals, by G. W. Birge, D. E. Wolfson, and J. H. Lynch, Jr. 1964. 16 pp. 3 figs. Fourteen samples from eight beds were investigated—Flag, Fire Clay, Whitesburg, Amburgy, Upper Elkhorn No. 2, Upper Elkhorn No. 3, Upper Elkhorn No. 1, and Lower Elkhorn beds. The samples were high-volatile A bituminous in rank, with dry, mineral-matter-free fixed-carbon contents ranging from 55.3 to 62.2 percent. Five of the samples, as received, were chemically unsuitable for metallurgical use because of excessive ash and/or sulfur content. Strength indexes of the cokes were low, and all the coals require blending with higher rank coal to constitute satisfactory blast-furnace fuel.
- RI 6417. Recovery of Zinc From Galvanizers' Dross and Zinc-Base Die-Cast Scrap by Filtration, by J. A. Ruppert and P. M. Sullivan. 1964. 19 pp. 11 figs. Describes the recovery of refined zinc from zinc-base die-cast scrap and galvanizers' dross by the formation of solid intermetallic compounds which can be separated easily. The low temperatures employed and the inexpensive equipment requirements make the process commercially attractive.
- RI 6418. Corrosion Resistance of Diborides in the Pseudobinary System TiB_2-CrB_2 , by Gilbert M. Farrior. 1964. 21 pp. 11 figs. Describes tests of resistance to molten metals, to oxidation at elevated temperatures, and to various chemical reagents which were made for a series of compositions in the $(Ti, Cr)B_2$ subsystem. There was no noticeable difference in the reaction of the various compositions in the $(Ti, Cr)B_2$ series with molten metal. Compositions near $Ti_{0.4}Cr_{0.6}B_2$ had the best oxidation resistance. The chromium-rich alloys showed marked superiority to the titanium-rich alloys in resistance to corrosion by the chemical agents investigated.
- RI 6419. Construction and Operation of a Quartz Composite Oscillator, by A. E. Schwaneke. 1964. 20 pp. 8 figs. Plans and specifications are given for constructing a quartz composite oscillator designed to measure friction in metals and alloys. Characteristics of the system are listed, and detailed procedures for its operation are explained. Typical measurements on manganese-copper alloy, on single-crystal magnesium, and on polycrystalline magnesium are shown to illustrate applications of the system.
- RI 6420. Oil Yields of Sections of Green River Oil Shale in Utah, 1952-62, by K. E. Stanfield, J. W. Smith, and L. G. Trudell. 1964. 217 pp. 128 figs. Presents oil-yield data for 40 sets of core samples and 83 sets of drill cuttings from the Uinta basin of eastern Utah. The data indicate that Green River oil shale in the Uinta basin is not as thick or as uniform as that in the Piceance Creek basin of western Colorado. However, it is an important potential source of oil. Estimates that beds 15 feet or more thick and averaging 25 gallons of oil per ton represent at least 120 billion barrels of oil in place are supported by these data. Work done in cooperation with the University of Wyoming.
- RI 6421. A Servomechanical System for Measuring Vapor Pressure of Metal Halides, by L. C. George and J. W. Jensen. 1964. 15 pp. 7 figs. Describes a new system for precisely counterbalancing and measuring vapor pressure. Pressure measurements are accurate to ± 0.003 cm Hg for the range 0 to 200 cm Hg.
- RI 6422. Chemical Analyses and Electrical Resistivities of Oilfield Brines From Fields in East Texas, by M. E. Hawkins, W. D. Dietzman, and C. A. Pearson. 1964. 20 pp. 1 fig. Presents results of chemical analyses and electrical resistivity measurements of 422 samples of brines from 120 east Texas fields in Railroad Commission of Texas districts 5 and 6. These samples represent water from all of the major petroleum-productive formations in the area. These data, presented in tabular form, are useful in the detection of well leaks, identification of water sources, and interpretation of electrical well logs.
- RI 6423. Leaching Copper-Sulfide Minerals With Selected Autotrophic Bacteria, by Joseph A. Sutton and John D. Corrick. 1964. 23 pp. 10 figs. Describes the chemistry involved in the microbial dissolution of iron and copper from such minerals as pyrite, chalcopyrite, chalcocite, covellite, and bornite. The chemical criteria used to evaluate the activity of microorganisms on these minerals were changes in pH, ferric iron produced, and oxygen consumption. The iron-oxidizing bacteria *Ferrobacillus ferrooxidans* and *Thiobacillus ferrooxidans* were capable of bringing about the dissolution of 23.7 percent of the copper from chalcocite, 56.3 percent of the copper from covellite, and 29.8 percent of the copper from bornite by the microbial production of ferric sulfate which reacted with these minerals.
- RI 6424. Pressure Carbonization of a High-Volatile A Bituminous Coal to Produce High-Btu Gas, by Raymond W. Hiteshue, Sam Friedman, Paul Dobransky, and Robert Madden. 1964. 20 pp. 8 figs. Describes carbonization of an hvab coal in a closed system at 600° C and 40 to 1,200 psig to produce a high-Btu gas and char. By retaining the volatiles within the system, it was possible to virtually eliminate production of tars and oils. Yields of combustible gases amounted to 4,000 to 6,000 cubic feet per ton of maf coal, and gross heating values of the gases varied from 830 to 960 Btu per cubic foot. If these results could be translated into an economical process for producing high-Btu gas from coal, the demand for coal could be expanded by 40 to 50 million tons per year.
- RI 6425. Experiments With a Self-Generated Carbon-Expanded Iron Catalyst for Synthesis of Methane, by J. J. Demeter, W. P. Haynes, and A. J. Youngblood. 1964. 37 pp. 13 figs. Synthesis of high-Btu gas, using the Fischer-Tropsch reaction, was investigated in a tube-wall reactor. The catalyst was carbon-expanded iron formed on the walls of a steel reactor by exposing the reactor to 1 H₂O + 1 CO synthesis gas. The catalyst did not operate effectively as a film catalyst under conditions of generation tried in this study. Generally, operation of the 2-inch reactor with the

catalyst was unsatisfactory because of poor reproducibility of the activation step and poor temperature control resulting in high operating temperatures and eventual plugging of the reactor. Tests suggest that the most likely application for the catalyst would be in a moving-bed reactor.

- RI 6426. Evaluation by Filter Methods of the Quality of Waters Injected in Waterfloods, by Kenneth H. Johnston and Joe L. Castagno. 1964. 14 pp. 8 figs. Describes results of membrane-filter tests made as part of a program to develop equipment and procedures to evaluate the quality of waters and to determine the quality of water suitable to efficiently flood oil sands of known permeability. Results indicated that neither the color of the water nor that of the precipitate on a membrane filter is a criterion for determining the quality of injection water. Gives reasons for poor water quality. A good water is required to efficiently flood sands of low permeability, but fair results may be obtained in flooding more permeable sands with poorer quality water. Work done in cooperation with the Oklahoma Corporation Commission and endorsed by the Secondary Recovery and Stripper Well Committee of the Independent Petroleum Association of America.
- RI 6427. Effects of Substituting Cobalt For Nickel on the Tensile Properties and Hardness of Two Types of Stainless Steel, by M. M. Tilman. 1964. 16 pp. 6 figs. Investigates the effects of small amounts of cobalt (up to 2 weight-percent) in nickel on the tensile properties and hardness of type 302 and 309 stainless steels. In type 302 steels, tensile strength and hardness increased with larger percentages of cobalt, percentage elongation and reduction in area decreased, and yield strength showed little change. In type 390 steels, only minor variations were observed for the properties investigated; effects of the relatively small cobalt substitutions and nickel reductions were somewhat reduced by the higher total alloy content.
- RI 6428. X-Ray Diffraction and Optical Microscopic Data on Several Important Phases in the Binary Systems $\text{CaO-Al}_2\text{O}_3$, CaO-SiO_2 , and $\text{Na}_2\text{O-Al}_2\text{O}_3$, by Sarkis G. Ampian. 1964. 53 pp. 12 figs. Compares published optical microscopic and X-ray diffraction characteristics of the following compounds with Bureau of Mines data: Tricalcium aluminate, calcium monoaluminate, dodecacalcium heptaluminate, dicalcium silicate, tricalcium silicate, and sodium aluminate. Presents a recommended set of definitive optical and X-ray diffraction characteristics, the values of which are used to identify products of the lime-soda-sinter process for production of alumina. Reexamines polymorphism of gamma-, beta-, and alpha prime-dicalcium silicate and presents new data on polymorphism of tricalcium silicate and sodium aluminate by high-temperature X-ray diffractometry.
- RI 6429. Titanium Resources of Nelson and Amherst Counties, Va. (in Two Parts) 2. Nelsonite, by George E. Fish, Jr., and Vernon F. Swanson. 1964. 25 pp. 12 figs. Gives results of an investigation of nelsonite deposits of Nelson and Amherst Counties as a source of titanium. The deposits are small but of high grade and due to the proximity of some of the bodies, several might be mined in one operation. Electromagnetic separation on composited samples recovered 83 percent of the TiO_2 as an ilmenite concentrate. Two flotation procedures were developed that produced a recovery of 59.3 and 66.2 percent TiO_2 , respectively. Part 1, RI 6094, published in 1962, is a study of saprolite ores.
- RI 6430. Separation and Determination of Rare Earth Metals in Zirconium-Rare Earth Alloys, by Edward Cogan. 1964. 7 pp. 1 fig. Describes the development of a rapid gravimetric method for determining rare earths in zirconium in which the rare earths are absorbed from sulfuric acid solution of the alloy on a cation-exchange resin. Recovery averaged 97.6 percent on 0.002 μg europium in the rare-earth fraction. Rare earths were determined in the 0.10- to 90-percent range. A tracer technique, using europium 154-152, was used to test the efficiency of the procedure in recovering rare earths at low levels.
- RI 6431. Methods for Producing Alumina From Clay. An Evaluation of a Nitric Acid Process, by Paul W. Johnson, Frank A. Peters, and Ralph C. Kirby. 1964. 25 pp. 9 figs. Evaluates a process for recovering alumina from clay, using 30 percent nitric acid. Gives estimated capital and operating costs and recommendations for additional research. It is the fifth of a series concerning various known methods of extracting alumina from low-grade aluminous materials.
- RI 6432. Observations in the Development of Titanium Refining Cells, by Oliver Q. Leone. 1964. 27 pp. 16 figs. Gives data on three electrorefining cells designed for investigating factors associated with the electrorefining of reject-grade titanium sponge. Electrolyte chambers had capacities ranging from 400 to 3,500 pounds of molten salt. Operation of the cells provided data on cell design and on how design and operating variables affected the quality of the titanium product. One of the cells was in intermittent operation over a 4-year period and produced 2 tons of refined titanium. A product with a hardness of 80 Bhn or less was consistently and easily obtained, and some metal with a hardness of less than 60 Bhn was produced.
- RI 6433. The Mass Spectra and Correlations With Structures for 23 Alkylthiophenes, by Norman G. Foster, D. E. Hirsch, R. F. Kendall, and B. H. Eccleston. 1964. 38 pp. 1 fig. Presents the mass spectra of 23 alkylthiophenes, including 21 that have not been previously reported. A comparison with correlations of earlier workers is made, and predictions are given.
- RI 6434. Comparative Studies of Explosives in Granite: Second Series of Tests, by Thomas C. Atchison and Joseph M. Pugliese. 1964. 26 pp. 10 figs. Gives data on the strain-producing abilities of five explosives tested in granite. Peak strain and scaled radial strain energy per unit area varied with scaled distance. Distance exponents were constants of the rock and did not depend upon explosive. Intercept constants increased with increasing detonation pressure and with increasing energy per unit volume of explosive. Explosives with impedances more nearly matching the impedance of the rock produced higher peak strains and transferred more of their energy to the rock. Results presented provide a method for predicting the relative effectiveness of different explosives for breaking granite.
- RI 6435. Thermodynamic Properties of Sodium Bromide and Sodium Iodide at Low Temperatures, by T. Estelle Gardner and A. R. Taylor, Jr. 1964. 8 pp. 1 fig. Reports low-temperature heat capacity measurements and calculations of thermodynamic functions for sodium bromide and sodium iodide. The thermodynamic data for sodium bromide are original. Work done in cooperation with the University of Alabama.
- RI 6436. Direct Electrolysis of Uranium Dioxide to Uranium Metal in Fluoride Melts, by D. G. Kesterke, D. C. Fleck, and T. A. Henrie. 1964. 12 pp. 5 figs. Describes electrowinning of massive ura-

- nium metal from uranium dioxide in fluoride electrolytes. Product purity of 99.8 percent was attained.
- RI 6437. Transfer of Selected Metals in Titanium Electrorefining, by E. K. Kleespies and T. A. Henrie. 1964. 9 pp. 2 figs. Discusses studies conducted to determine the transfer rates of nickel, tin, copper, bismuth, and manganese from molten titanium anodes to solid titanium cathodes in molten-salt systems.
- RI 6438. Estimated Cost of Exploiting Enriched, Hard Manganese Ore From the Maggie Canyon Deposit, Artillery Mountains Region, Mohave County, Ariz., by D. A. Elkins. 1964. 78 pp. 23 figs. Gives design plans and detailed cost estimates of mining and treating ore from Maggie Canyon deposit by two alternative methods which could be used in the event of a sudden need to exploit this resource. An operation employing oil-emulsion flotation is estimated to cost about \$245 per ton of ferromanganese and an operation using dithionate leaching, about \$284 per ton. Exploitation of the deposit by the techniques studied is not economic today.
- RI 6439. A Method of Obtaining the Ultraviolet and Visible Spectra of Insoluble Materials, Use of a Low-Molecular-Weight Polyethylene as a Matrix Material, by F. R. McDonald and G. L. Cook. 1964. 10 pp. 10 figs. Describes a method of obtaining the ultraviolet and visible spectra of high-molecular-weight materials by using low-molecular-weight polyethylene as a dispersion medium. Work done in cooperation with the University of Wyoming.
- RI 6440. Influence of Certain Processing Variables on the Determination of Moisture in Coal, by R. F. Abernethy, E. C. Tarpley, and R. A. Drogowski. 1964. 12 pp. 2 figs. Compares three frequently used methods (ASTM standard, and the direct and indirect methods proposed by the International Standardization Organization) for the determination of moisture in analysis samples of coal. For most higher rank coals variations between different methods are within the ASTM tolerance permitted for duplicate tests by the same method.
- RI 6441. Determining Mine-Production Schedules by Linear Programming, by D. E. Redmond. 1964. 48 pp. 16 figs. Gives details of data arrangement for solution by linear programming and presents solutions. Purpose of report is to clarify terminology and to illustrate applications of linear programming to simple mining problems. Computational procedures have been simplified, and routine applications require only a basic understanding of algebra in formulating problems. As examples, two mining situations were considered: (1) Producing ore from mine stopes at minimum cost and (2) obtaining maximum value for transporting ore to one mill from uranium mines.
- RI 6442. Metallurgical Studies of Rhodonite Ores, Silverton District, Colorado (in Three Parts). 3. Melting, Quenching, and Acid Leaching of Concentrates and Electrolytic Recovery of Manganese From Solution, by H. C. Fuller, V. E. Edlund, J. W. Sterner, and J. F. McDermaid. 1964. 31 pp. 7 figs. Defines optimum process conditions and determines pertinent engineering data with respect to the requirements of power for melting, the leaching and filtration rates, and the amount of reagents consumed. Investigates the possibility of producing manganese metal from the sulfuric acid leach solution. Part 1, RI 6055, published in 1962, describes beneficiation tests to produce magnesium concentrates; Part 2, RI 6062, published in 1962, demonstrates the technical feasibility of producing silicomanganese from a rhodonitic concentrate by electric smelting methods.
- RI 6443. Synthesis and Properties of Germanium Fluorophlogopite, by John L. Miller, Jr., M. V. Denny, and H. R. Shell. 1964. 13 pp. 5 figs. Gives data on the properties of synthetic germanium fluorophlogopite that was obtained by the isomorphic substitution of germanium for silicon in the synthetic silicon fluorophlogopite structure. The morphology of the germanium isomorph ($K_2 \cdot Mg_4 \cdot Al_2Ge_3 \cdot O_{20}F_4$) is essentially the same as that of synthetic silicon fluorophlogopite.
- RI 6444. Electrodeposition of Molybdenum Metal From Molten Electrolytes, by H. J. Heinen and J. B. Zadra. 1964. 17 pp. Investigates electro-winning of molybdenum from oxide feed materials dissolved in a variety of molten baths. An $NaCl-NaF-Na_2B_4O_7-MoO_3$ system operating at $1,000^\circ C$ in a cell without a protective atmosphere gave the best current efficiency, metal-to-cathode adherence, and purity of electrowon metal. Arc melting molybdenum electrowon from either chemically pure or commercial-grade MoO_3 produced ingots that contained less than 0.1 percent total impurities and had hardness readings of 168 to 200 Vhn.
- RI 6445. Electrochemical Recovery of Cobalt-Nickel Alloy From Superalloy Scrap, by Masami Hayashi, Donald R. Peterson, and D. W. Bridges. 1964. 35 pp. 6 figs. Describes techniques for recovering about 80 percent of the cobalt and nickel contained in superalloy scrap by anodic dissolution of the scrap and simultaneous electrodeposition of a pure cobalt-nickel alloy at the cathodes in an electrolytic cell partitioned by permeable diaphragms into separate anode and cathode compartments. About 80 percent of the contained nickel and cobalt in superalloy scrap can be recovered in a 50 percent nickel-50 percent cobalt alloy.
- RI 6446. Thermodynamic Data for Columbium (Niobium) Carbide, by L. B. Pankratz, W. W. Weller, and K. K. Kelley. 1964. 9 pp. 2 figs. Presents results of measurements of the heat capacity of columbium carbide from 51° to $298^\circ K$. Heat content above $298.15^\circ K$ is measured to $1,800^\circ K$. Heat and free energy of formation values for columbium carbide are calculated for 298.15° to $2,000^\circ K$. Data fill gaps in the basic thermodynamic knowledge of columbium carbide.
- RI 6447. Preparation of Titanium Nitride, by E. K. Kleespies, and T. A. Henrie. 1964. 8 pp. 3 figs. Describes carbon reduction of rutile and ilmenite in nitrogen and ammonia atmospheres as a method of preparing titanium nitride. Ammonia was a better nitriding agent than nitrogen. The contact between the solid reactants, carbon and rutile, was a prime factor in nitrogen atmospheres and was of lesser import in dissociated ammonia. The reduction process for conversion of rutile to the nitride required carbon. The nitriding of ilmenite-carbon mixtures produced titanium nitride and elemental iron.
- RI 6448. Beneficiating Low-Grade Chromites From the Stillwater Complex, Montana, by G. V. Sullivan and G. F. Workentine. 1964. 29 pp. 2 figs. Presents results of beneficiation studies conducted on three low-grade chromite-bearing ore samples from the Mouat, Benbow, and Gish deposits. Tabling, flotation, high-tension electrostatic separation, and combinations of processes were applied to each ore. Most successful technique was treatment of the Mouat sample (9.95 percent Cr_2O_3) by high-tension electrostatic separation, a combination of tabling and high-tension electrostatic separation, and tabling with middling retreatment. The resulting concentrates graded 42.8, 42.0, and 40.7 percent Cr_2O_3 at chromium recoveries of 85, 86, and 84 percent, respectively.

- RI 6449. Production of Lightweight Aggregate From Washery Refuse, by J. W. Myers, J. J. Pfeiffer, and A. A. Orning. 1964. 19 pp. 7 figs. Gives results of a study of the feasibility of using washery refuse to manufacture lightweight aggregates. The aggregate was prepared by pelletizing the refuse and burning out the carbonaceous material on a chain grate in a refractory-lined furnace. A commercial development based upon the results of this study yielded a product which met ASTM specifications for lightweight aggregate, and blocks made from the aggregate were of good color, durable, and light in weight.
- RI 6450. Noise From Pneumatic Rock Drills. Shape and Exit Noise of an Exhaust Muffler, by J. W. Chester, R. T. DeWoody, and W. C. Miller. 1964. 12 pp. 10 figs. Results of tests of mufflers of three different shapes showed that shape is not critical and that a muffler could be incorporated into the shell of the drill. Petal diffusers are beneficial in reducing exit noises, but add another projection to the machine. Increasing the number of exit openings while maintaining the same area of exit openings has a markedly beneficial effect on the exit noise and appears to be the most satisfactory treatment.
- RI 6451. Electro-dewatering Tests of Florida Phosphate Rock Slime, by M. H. Stanczyk and I. L. Feld. 1964. 19 pp. 4 figs. Describes dewatering of typical Florida phosphate rock slime by electro-osmotic techniques to determine if a compacted, plastic solid product could be obtained with simultaneous recovery of the water for reuse. Tests with porous cathodes and rod-type anodes imbedded in dilute slime charges of up to 4 tons in weight showed that the slime could be dewatered to about 35 percent solids. Work done in cooperation with the University of Alabama.
- RI 6452. Manganese Extraction Studies Using Ferrous Sulfate and Pickle Liquor, by H. P. LeVan, E. G. Davis, and L. S. Smith. 1964. 18 pp. 1 fig. Discusses extraction of manganese from ore with either a ferrous sulfate solution or pickle liquor (a ferrous sulfate-sulfuric acid solution), filtration of ore pulps, and the agglomeration of the iron-rich residue. Work done in cooperation with the University of Alabama.
- RI 6453. Sealing a Coal-Mine Passageway Through a Borehole. A Progress Report, by John Nagy, Donald W. Mitchell, and Edwin M. Murphy. 1964. 13 pp. 10 figs. Discusses five methods for remote sealing of mine passageways through boreholes—pneumatic injection of mineral wool and sand, urea-formaldehyde foam, balloons, urethane foam, and caving by blasting. Further research is needed to simplify and improve the techniques involved.
- RI 6454. Preparation of Thick Coatings of Tungsten, by F. X. McCawley, C. B. Kenahan, and David Schlain. 1964. 28 pp. 17 figs. Describes the electrodeposition of protective coatings of tungsten from a sodium and lithium borate-tungstate-tungstic oxide fused-salt electrolyte. Thick deposits of tungsten (up to 26 mils) were made at a temperature of 900° C and a current density of 0.3 to 0.4 ampere per square inch. Coatings of tungsten were made on molybdenum, Carpenter 20 stainless steel, Inconel, and nickel.
- RI 6455. Absorption Corrections for Intensity of X-Rays Scattered by Weakly Absorbing Polycrystalline Materials, by Victor H. Tiensuu, Robert W. Smith, Jr., and Sabri Ergun. 1964. 12 pp. 6 figs. Considers factual geometries for X-ray scattering studies of weakly absorbing materials by both reflection and transmission methods. For polycrystalline carbons the use of idealized geometries leads to several percent error in the corrections to be made; the use of factual geometries substantially reduces this error.
- RI 6456. Methods Used in Preparing Boron, by D. Z. Hobbs, T. T. Campbell, and F. E. Block. 1964. 16 pp. 4 figs. Describes the preparation of boron by metering boron trichloride gas into a crucible containing molten metal reductants. Magnesium and sodium were tested as reductants, but the best results were achieved using lithium or zinc as reductants. Impurities ranged from 0.5 to 5.0 percent. Impure boron (85 to 90 percent) was also prepared by the magnesium reduction of boron trioxide in a thermite-type reaction.
- RI 6457. Solvent Extraction Recovery of Thorium and Yttrium from Siliceous Colorado Ores, by S. R. Borrowman, and D. W. Bridges. 1963. 16 pp. 7 figs. Explains method of recovery of thorium and yttrium oxides from siliceous ores of the Powderhorn, Colo., area by acid curing, subsequent acid baking; leaching; and solvent extraction of thorium, using a primary alkylamine, and yttrium, using di-2-ethylhexyl phosphoric acid. About 95 percent of the contained thorium and yttrium was recovered from ore containing 1.2 percent ThO₂ and 0.5 percent Y₂O₃; the thorium product was 99 percent ThO₂ and the yttria product was 77 percent Y₂O₃.
- RI 6458. Extraction of Sulfides From Petroleum Fractions by Conversion to Sulfonium Salts, by R. L. Hopkins, H. J. Coleman, C. J. Thompson, and H. T. Rall. 1964. 20 pp. 12 figs. Describes two separative procedures, the methyl-p-toluene-sulfonate method and the hydrogen iodide method, used to extract sulfides from petroleum fractions. The methods were evaluated using individual pure sulfur compounds and blends of sulfur compounds and also were applied successfully to separating sulfides from sulfur concentrates derived from petroleum fractions.
- RI 6459. Cost Estimates and Optimum Conditions for Continuous-Circuit Leaching of Mercury, by J. W. Town and W. A. Stickney. 1964. 28 pp. 3 figs. Summarizes results of studies of continuous-circuit leach-aluminum precipitation and leach-electrodeposition of mercury made to determine optimum conditions and cost estimates for recovering mercury from mercury sulfide flotation concentrates.
- RI 6460. Secondary Oil Recovery Possibilities. Cow Run Sand Burning Springs Pool, Wirt County, W. Va., by James A. Wasson, Harry R. Johnson, and Dean W. Boley. 1964. 57 pp. 24 figs. The Cow Run sand was cored and electrical and radioactivity surveys were made in the C. E. Vandevender well 35 in the Burning Springs pool of the Burning Springs oilfield in Wirt County. Laboratory tests, reservoir-fluid analysis, well-log interpretation, and available field data indicate that a substantial quantity of oil may be recovered from this pressure-depleted reservoir by waterflooding. Two other formations were similarly evaluated in the A. E. Mackintosh well 8, Anns Run pool, but were found unsuitable for secondary-recovery operations.
- RI 6461. Analyses of Tipple and Delivered Samples of Coal, Collected During Fiscal Year 1963, by S. J. Aresco, J. B. Janus, and F. E. Walker. 1964. 38 pp. Presents the results of analyses of 6,999 samples collected in connection with Government coal purchases. Heating value and proximate analyses are given for all the samples; ash-softening temperature, free-swelling index, and Hardgrove grindability index are also shown for many samples.
- RI 6462. The Stress Field Within a Core Stub in a Borehole, by Albert J. Rambosek. 1964. 16 pp.

- 11 figs. Gives information on the stress field in a core stub at the bottom of a cored borehole, and whether, and at what distance, in terms of core diameters from the face of the borehole, relief of stresses in the core is complete.
- RI 6463. Preparation Characteristics of Coal From Hancock, Brooke, Ohio, and Marshall Counties, W. Va., by Albert W. Deurbrouck. 1964. 34 pp. 3 figs. Describes the preparation characteristics of the significant coalbeds in Hancock, Brooke, Ohio, and Marshall Counties, W. Va. Twelve coal samples were collected for this study, 11 from the Pittsburgh bed and 1 from the Lower Freeport bed. Two of these samples could be upgraded to produce metallurgical-grade coal. The sulfur content of the Pittsburgh-bed coals was generally excessive—as high as 4.9 percent in the raw coal and 3.19 percent in the float 1.30 specific gravity fraction.
- RI 6464. Vapor Deposition of Tungsten on MERM Rocket Nozzles, by F. W. Hoertel. 1964. 19 pp. 17 figs. Describes laboratory experiments in lining graphite and rhenium-lined graphite nozzles with a coating of tungsten by reduction deposition of tungsten hexafluoride. MERM (Material Evaluation Rocket Motor) nozzles have surface configurations that preclude the conventional fabrication of high-density tungsten liners. Operation at 550° C produced selectively placed uniform coatings of specified thicknesses at near theoretical density on the graphite and rhenium-lined graphite nozzles, but it was not possible to deposit an acceptable coating on a beryllia nozzle. Work done under an agreement between the Bureau of Mines and the Special Projects Office, U.S. Department of the Navy.
- RI 6465. High-Level Gamma-Ray Dosimetry at the Albany Cobalt 60 Facility, by S. D. Hill and F. E. Block. 1964. 16 pp. 10 figs. Describes investigations of techniques by which high-level gamma-radiation intensities can be measured. Procedures have been developed for mapping isodose contours inside various source holders, and the information has been compiled in a form useful to research personnel interested in using the Albany (Oreg.) cobalt 60 facility.
- RI 6466. Continuous Flotation of Beryl From Spodumene Mill Tailing, Foote Mineral Company, Kings Mountain, N. C., by James S. Browning, Thomas L. McVay, and Paul E. Bennett. 1964. 24 pp. 7 figs. Describes continuous 1.0- to 1.5-ton-per-hour pilot plant flotation tests made to determine the technical and economic feasibility of recovering beryl from flotation tailing produced at the spodumene concentrator of the Foote Mineral Co. Best results were obtained when using an acid circuit and amine-type cationic reagents to float a bulk beryl-feldspar concentrate and then selectively floating the beryl away from the feldspar using a petroleum sulfonate collector. About 77 percent of the beryllium in the pilot plant feed was recovered in a concentrate containing 6.42 percent BeO. Work done in cooperation with the Foote Mineral Co. and the University of Alabama.
- RI 6467. Synthesis and Some Properties of Fibrous Silicon Nitride, by Robert C. Johnson, Wilbur H. Warwick, and H. R. Shell. 1964. 25 pp. 8 figs. Gives data on alpha silicon nitride fibers, Si₃N₄, that were successfully grown in graphite crucibles by a new method utilizing silicates and silicon as sources of silicon and using carbon, aluminum, and silicon as reducing agents. A buildup of coatings on the solid raw-material particles hindered the evolution of silicon or silicon monoxide vapor and thereby slowed down further formation of silicon nitride fibers. The fiber widths were generally only a few microns whereas their lengths sometimes reached one-quarter inch or more. Chemical and X-ray analyses indicated that bulk fiber samples were usually 80 to 90 percent Si₃N₄. The fibers had good oxidation resistance to about 1,260° C. Thermal shock resistance was excellent. Electrical resistance was determined.
- RI 6468. Petrographic Study and Classification of Western Phosphate Ores, by C. P. Mabie and H. D. Hess. 1964. 95 pp. 64 figs. Describes in detail the results of petrographic research conducted on 21 phosphate ores representing important deposits in southwestern Montana, southeastern Idaho, and northeastern Utah. On the basis of this investigation, operational methods have been developed for quantitatively describing textural and compositional features that are likely to be significant in determining the response of phosphate ores to conventional beneficiation treatments.
- RI 6469. Expanded Investigation of Beryllium Solvent Extraction of Spor Mountain, Utah, Ore, by R. O. Dannenberg, Laird Crocker, and D. W. Bridges. 1964. 31 pp. 16 figs. Describes studies of beryllium recovery from Spor Mountain, Utah, ore by acid leaching and solvent extraction operations. The resulting beryllia was 98 to 99 percent BeO and was suitable for most nonnuclear uses. The economy of the process has been improved over previously reported work by utilizing less acidic aqueous feed and increasing the specific power input to the mixers.
- RI 6470. Hydrogenation of New Mexico Coal at Short Residence Time and High Temperatures, by Sam Friedman, Raymond W. Hiteshue, and Martin D. Schlesinger. 1964. 28 pp. 12 figs. Describes hydrogenation of New Mexico coal in a bench-scale semicontinuous unit at pressures of 500 to 6,000 psig, at 480° to 1,000° C, and residence times of 1 to 15 minutes. The coal yielded large quantities of gaseous hydrocarbons and small quantities of low-boiling oils, high in single-ring aromatics. Work done in cooperation with the El Paso Natural Gas Co.
- RI 6471. Hydraulic Fracture Treatments in Glade and Clarendon Oil Reservoirs, Warren County, Pa., by Robert L. Rough and William E. Eckard. 1964. 22 pp. 10 figs. Describes hydraulic fracturing in oil wells in Warren County, Pa. Presents methods of well completion for single- and multiple-stage fracturing of old and new wells. Average oil production after fracturing with a sand-carrying liquid is compared with production after fracturing with liquid nitroglycerin.
- RI 6472. A Case Study of the Validity of Scaling Laws for Explosion-Generated Motion, by Harry R. Nicholls. 1964. 14 pp. 7 figs. Gives acceleration data that were recorded underground from a series of chemical explosive shots detonated as part of the pre- and post-shot mine examination at Project Gnome. Data from the series of small tests provided sufficient data to make reliable predictions of acceleration for the large nuclear explosion.
- †RI 6473. A Stainless Steel Fume Hood For Safety in Use of Perchloric Acid, by W. E. Dieter, L. Cohen, and M. E. Kundick. 1964. 12 pp. 7 figs. Describes the major details of design and maintenance of a seamless stainless steel fume hood system, developed by the Bureau. Operating and housekeeping routines are outlined.
- RI 6474. Methods of Analyzing Oilfield Waters: Selenium and Tellurium, by A. Gene Collins, Cathy J. Waters, and Cynthia A. Pearson. 1964. 19 pp. 1 fig. Outlines methods of determining the amount of selenium and tellurium in oilfield water. Less than 0.05 mg/l of selenium 0.1 mg/l of tellurium can be determined.

† Out of print.

- RI 6475. Perfluorocyclobutane: The Thermodynamic Properties of the Real Gas, by R. H. Harrison and D. R. Douslin. 1964. 14 pp. 4 figs. Presents the thermodynamic properties $H - H^\circ$, $(H - H^\circ)/T$, $S - S_{ideal}$, $S - S^\circ$, $F - F_{ideal}$, $F - F^\circ$, $(F - F^\circ)/T$, and activity coefficient Y for perfluorocyclobutane calculated as functions of temperatures (115.22° to 350° C) and molal density (0.75 to 6.5 moles per liter). Describes improved analytical and graphical correlating techniques. Work done under an agreement between the Bureau of Mines and the Office of Scientific Research of the Air Research and Development Command, U.S. Department of the Air Force.
- RI 6476. Infrared Analysis of Gases Produced During Molten-Salt Electrolysis of Metals, by J. L. Johnson, G. H. Cobb, and H. H. Heady. 1964. 11 pp. 3 figs. Describes an infrared absorbance technique for analyzing anodic gases produced during electrowinning of uranium, thorium, and rare-earth metals in molten fluorides. Quantitative determination of CO, CO₂, CF₄, and SiF₄ takes about 20 minutes; qualitative analysis takes about 15 minutes.
- RI 6477. Properties of Hydraulic Backfills and Preliminary Vibratory Compaction Tests, by David E. Nicholson and William R. Wayment. 1964. 31 pp. 15 figs. Covers field sampling on in-place fill densities at four mines and laboratory and underground compaction tests using a standard concrete vibrator. Report is first of a series covering current Bureau of Mines research on hydraulic backfilling.
- RI 6478. Manganese Resources of the Batesville District, Arkansas (in Three Parts). 3. Field Investigations: July 1956 to June 1961, by R. B. Stroud. 1964. 50 pp. 15 figs. Describes and gives results of field investigations by the Bureau of Mines on manganese resources of the Batesville district from July 1956 through June 1961. The work comprised areal reconnaissance, mapping, churn and core drilling, and core sampling. This publication is the final report in a series; RI 5206 and 5411 were the first and second reports, respectively.
- RI 6479. Electrical Dewatering of Dilute Clay Slurries, by Hal J. Kelly and Henry M. Harris. 1964. 21 pp. 11 figs. Shows that dilute clay slurries can be dewatered in the laboratory to approximately 60 percent solids by electrophoresis. A balance between recovery and a balance between yield and solids in the product must be effected for optimum results. When a single cell was used, maximum yield and solids in the product were attained with slurries of high specific gravity. Recovery, however, appeared to be a function of electrical input and to a lesser extent of specific gravity.
- RI 6480. Electrical Resistivity of Cerium Metal From 4° to 300° K, by R. D. Smith and E. Morrice. 1964. 13 pp. 7 figs. Describes thermal expansion and electrical resistance measurements made on cerium metal from 4° to 300° K. Gives a detailed description of the apparatus developed, including a specimen holder and a cryostat system, along with the experimental techniques used in obtaining the measurements.
- RI 6481. Smelting Copper Reverberatory Slags To Recover Iron of Low Copper and Sulfur Content, by V. E. Edlund. 1964. 14 pp. 2 figs. Describes an investigation to determine the feasibility of pyrometallurgical treatments of copper reverberatory slags to recover marketable iron. The product is low in silicon, but otherwise meets specifications for pig iron and melting stock that is to be used to make steel in the basic open hearth furnace.
- RI 6482. Correlation of ASTM and Micum Coke Test Methods, by J. G. Walters, G. W. Birge, and D. E. Wolfson. 1964. 48 pp. 4 figs. Gives determinations of relative strengths of 18 commercially produced cokes by ASTM and Micum tumblers and ASTM shatter tests. The objective was to determine the degree of correlation between ASTM and Micum tumbler data and to develop equations that would enable the conversion of data from one test method for comparison with those determined by the other, and thereby facilitate the international exchange of data.
- RI 6483. X-Ray Spectrographic Analysis for Trace Quantities of Tantalum in Columbium, by P. A. Romans, W. J. Niebuhr, and J. R. Hauger. 1964. 11 pp. 2 figs. Discusses the selection of X-ray spectrographic instrumentation needed to determine as little as 20 ppm tantalum in columbium. Includes a technique for accomplishing this low-level determination of tantalum. An ion-exchange method for separating tantalum from columbium is also described.
- RI 6484. Beneficiation Studies of the Oregon Coastal Dune Sands for Use as Glass Sand, by George J. Carter, Henry M. Harris, and Karle G. Strandberg. 1964. 21 pp. 5 figs. Sands from 13 dune localities between Fort Stevens and Coos Bay were studied. The sands between the Umpqua River and Coos Bay contained fewer impurities and were easiest to beneficiate. Tests on a composite sample from Coos Bay indicated that high-intensity magnetic separation followed by acid leaching would produce a product that could be used in amber and clear container glass batches. Good glass-sand concentrates were also prepared by froth flotation; however, recovery was low and reagent costs excessive. Work done in cooperation with the School of Mineral Engineering, University of Washington.
- RI 6485. An Evaluation of the Western Phosphate Industry and Its Resources (In Five Parts) 1. Introductory Review, by A. L. Service and C. C. Popoff. 1964. 86 pp. 35 figs. Presents background information, including geology, mining, beneficiation, processing, resources, and economics, to provide a comprehensive introduction to a series of four area reports. About 20 percent of the Nation's phosphate comes from Montana, Idaho, Wyoming, and Utah, which have 58 percent of the Nation's phosphate reserves. Continuing development of the Western phosphate industry is assured by these abundant resources and an increasing demand for phosphate products.
- RI 6486. Preparation of Copper Powder From Leach Solutions After Precipitation With Iron, by R. D. Groves. 1964. 23 pp. 4 figs. Describes how high-grade copper powders can be produced under controlled conditions from cement copper products. The technique should enable small producers to prepare a directly marketable product by means other than smelting and electrolytic purification. Treatment of leach solutions from three different sources resulted in copper powder containing 99.2 to 99.8 pct Cu, apparent densities of 1.97 to 2.25 grams per cu cm, good powder flow rates, and a size distribution of 54.9 to 60.1 pct minus 325-mesh material.
- RI 6487. Design Requirements for Instrumentation To Record Vibrations Produced by Blasting, by Wilbur I. Duval. 1964. 7 pp. 1 fig. Discusses the need for better portable velocity seismographs to record building and ground vibration produced by blasting and describes the assembly of such a seismograph from commercially available velocity gages, amplifiers, and recorders.
- RI 6488. A Pilot-Scale Fluidized-Coal Feeder Utilizing Zone Fluidization, by W. R. Huff, J. H. Holden, F. F. Willmott, and G. R. Strimbeck. 1964. 20 pp. 15 figs. Describes equipment developed by the Bureau for the fluidized feeding of approximately 1 ton of pulverized coal per hour to a pilot-scale

- pressure gassifier. Also described is a coal-storage and feeding system based on the fluidized method.
- RI 6489. Electrorefining Beryllium. Operation of a Prototype Cell, by M. M. Wong and J. E. Klosterman. 1964. 17 pp. 7 figs. Describes electrorefining in a prototype cell scaled up from laboratory apparatus. Operations demonstrated that adapting the beryllium electrorefining process to the relatively large prototype cell presented little difficulty in mechanical functions, maintenance of optimum operating conditions, and control of product purity. Work done in cooperation with the U.S. Atomic Energy Commission and the University of California Lawrence Radiation Laboratory.
- RI 6490. Triaxial Method for Determining the Elastic Constants of Stress Relief Cores, by Leonard Obert. 1964. 22 pp. 12 figs. Describes a triaxial procedure for measuring modulus of elasticity and Poisson's ratio of stress relief cores. The appendix considers the problem of the thick-wall cylinder subjected to an internal pressure, an external pressure, and an axial strain.
- RI 6491. Selective Flotation of a Barite-Fluorspar Ore From Tennessee, by W. H. Eddy and James S. Browning. 1964. 8 pp. 1 fig. Describes procedures to further develop lignin sulfonate-sodium fluoride-fatty acid method for flotation of complex barite-fluorspar ores and to adapt it to continuous-scale operations. Material studied was a complex ferruginous barite-fluorspar ore from Tennessee. RI 6187 was the first in this series. Work done in cooperation with University of Alabama.
- RI 6492. Columbium-Hafnium Equilibrium Diagram, by R. E. Siemens, H. R. Babitzke, and H. Kato. 1964. 11 pp. 3 figs. Describes tests made on the columbium-hafnium alloys for use as high-temperature structural materials. The system was investigated between 700° and 2,400° C by melting point, thermal analysis, X-ray diffraction, electrical resistivity, and metallographic techniques. Alloys containing less than 83 atomic percent hafnium may be favorable for high-temperature use.
- RI 6493. Simulating Mineral Deposits Using Monte Carlo Techniques and Mathematical Models, by Richard F. Hewlett. 1964. 27 pp. 18 figs. Presents the computer programming methods and mathematics required to generate either random numbers or normal random numbers to be used for the construction of statistical probability models for simulating mineral deposits by Monte Carlo techniques. Work done in cooperation with Bear Creek Mining Co. and the College of Mines, University of Arizona.
- RI 6494. A Study of the Feasibility of Using Nuclear Explosions To Increase Petroleum Recovery, by Charles H. Atkinson, and Robert T. Johansen. 1964. 18 pp. 4 figs. Reports results obtained to date from a study of the general feasibility of using underground nuclear explosions to increase the recovery of petroleum from reservoirs normally having low productivity. Calculations of the effect on ultimate recovery of increasing temperature with nuclear explosives showed disappointingly small increases, but production increases caused by fracturing of massive low-permeability reservoirs appear economically promising. Work done under an agreement between the Bureau of Mines and the U.S. Atomic Energy Commission.
- RI 6495. Heats and Free Energies of Formation of Sulfides of Manganese, Iron, Zinc, and Cadmium, by L. H. Adami and E. G. King. 1964. 10 pp. The heats of formation of four sulfides—MnS (alabandite), FeS (hexagonal pyrrhotite), ZnS (wurtzite), and CdS (greenockite)—were determined by hydrochloric acid solution calorimetry. The heats of formation from the metals and rhombic sulfur at 298.15° K, are respectively -51.01 ± 0.19 , -23.81 ± 0.24 , -45.86 ± 0.20 , and -35.70 ± 0.30 kcal/mole. The corresponding free energies of formation were calculated from the heats of formation and the pertinent entropy values.
- RI 6496. A Semiquantitative Spectrochemical Method for Analysis of Coal Ash, by M. J. Peterson and J. B. Zink. 1964. 15 pp. Describes semiquantitative spectrochemical methods for determining trace elements in the ash of U.S. coals. The analytical procedure provides for the estimation of 68 major, minor, and trace constituents; 36 trace elements were found in the analysis of 900 samples.
- RI 6497. Electric Smelting of Titaniferous Iron Ores From Alaska, Montana, and Wyoming, by Wesley T. Holmes II and Lloyd H. Banning. 1964. 23 pp. 4 figs. Describes a method for successfully treating titaniferous materials to produce pig iron and enriched titania slag. Pig irons containing less than 0.05 percent phosphorus or sulfur were readily produced; iron recoveries ranged from 92 to 98 percent. The Choteau, Mont., ore was ground to minus 65-mesh to produce a concentrate containing 60 percent or more iron. The steel produced from the titaniferous pig iron was a high-quality product. Work done in cooperation with the General Service Administration.
- RI 6498. Intermetallic Phases in Magnesium-Rich Magnesium-Aluminum-Zirconium Alloys, by R. L. Crosby and L. W. Higley, Jr. 1964. 13 pp. 4 figs. Studies magnesium-rich magnesium-aluminum-zirconium alloys in the cast and in the extruded and heat-treated condition to identify the phases present and to determine phase distribution. $ZrAl_2$ and $Mg_{17}Al_{12}$ were identified.
- RI 6499. Low-Temperature Phase Equilibria of a Natural Gas of Low Helium Content, by Will E. DeVaney, Lowell Stroud, and W. J. Boone, Jr. 1964. 17 pp. 6 figs. This report is the fifth in a series presenting equilibrium vapor-liquid data for helium-bearing natural gases. It covers 0.41-mole-percent-helium natural gas that may be processed in the Department of the Interior's long-range helium conservation program. The first four reports were RI 5823, 6008, 6145, and 6278.
- RI 6500. Electrical Conductivity and Density of Molten Systems of Uranium Tetrafluoride and Thorium Fluoride With Alkali Fluorides, by E. A. Brown and Bernard Porter. 1964. 18 pp. 7 figs. Gives information on electrical conductivities and densities of the $LiF-Uf_4$, $LiF-ThF_4$, $NaF-Uf_4$, and $NaF-ThF_4$ systems when measured as functions of composition and temperature. Molar and equivalent volumes, as well as heats of activation for conductance, were calculated from the experimental data. The data are interpreted on the basis of a semilattice model for the melts.
- RI 6501. Application of Simulation in Evaluating Low-Grade Mineral Deposits, by Richard F. Hewlett. 1964. 62 pp. 74 figs. Presents methods developed for simulation of populations of assays that are representative of a deposit and provide the necessary added data to permit solution of specific evaluation problems. Work done in cooperation with the Bear Creek Mining Co. and the College of Mines, University of Arizona.
- RI 6502. Bulk Density Studies on a Commercial Blend of Western Coking Coals, by W. S. Landers, Manuel Gomez, and D. J. Donaven. 1964. 33 pp. 8 figs. Gives data on a coke-oven plant blend that was studied to obtain bulk density control data that would be directly transferable to plant practice. Samples were tested for effect on bulk density of (1) surface moisture; (2) fine grinding; (3) addition of oil at varying concentrations; (4) storage effects, observed at selected intervals from 0 to 56

- days. Work done in cooperation with the Kaiser Steel Corp., Columbia-Geneva Steel Division of the United States Steel Corp., the Colorado Fuel and Iron Corp., and the Colorado School of Mines Research Foundation, Inc.
- RI 6503. The Chromium-Gadolinium System, by M. I. Copeland, C. E. Armantrout, and H. Kato. 1964. 9 pp. 2 figs. Concludes that the chromium-gadolinium system has extensive liquid immiscibility and one eutectic point. Gadolinium and chromium are the only phases in this system. Work done under an agreement with the U.S. Atomic Energy Commission.
- RI 6504. Solubility Characteristics of Sodium Aluminate, by R. V. Lundquist and H. Leitch. 1964. 19 pp. 6 figs. Deals with determination of some of the properties and characteristics of sodium aluminate in relation to the lime-soda-sinter process and optimum alumina recovery.
- RI 6505. Limits of Flammability of Hydrazine-Hydrocarbon Vapor Mixtures, by Aldo L. Furno, George H. Martindill, and Michael G. Zabetakis. 1964. 7 pp. 4 figs. Discusses an investigation to determine the minimum concentrations of benzene, toluene, *m*-xylene, cumene, and *n*-heptane required to inhibit flame propagation through hydrazine-hydrocarbon vapor mixtures at 125° C and atmospheric pressure. These concentrations can be correlated with either the heat of formation or the heat capacity of the hydrocarbon. More *n*-heptane was required to suppress the flammability of hydrazine vapor than was previously reported. Work done in cooperation with the Food Machinery and Chemical Corp., Princeton, N.J.
- RI 6506. Electrorefining of Columbium, by R. E. Cummings and F. R. Cattoir. 1964. 12 pp. 6 figs. Evaluates electrorefining of columbium metal in a fused-salt electrolyte (Kf-NaF-K₂CbF₇). Excellent results were obtained in lowering the impurity content in a 94-percent columbium anode feed material to produce a 99.8-percent-pure metal.
- RI 6507. Molten-Salt Electrorefining of Uranium, by F. R. Cattoir and T. A. Sullivan. 1964. 44 pp. 19 figs. Describes electrorefining of commercial uranium metal to a high-purity product by using molten-salt electrolytes in an inert-atmosphere cell. Two molten-salt electrolytes were prepared and evaluated: (1) lithium chloride-potassium chloride-uranium trichloride and (2) sodium chloride-potassium chloride-uranium trichloride. Work done in cooperation with the Lawrence Radiation Laboratory, University of California.
- RI 6508. Computer Methods of Fitting Surfaces to Assay and Other Data by Regression Analysis, by Richard F. Link, George S. Koch, Jr., and George W. Gladfelter. 1964. 69 pp. 18 figs. Explains a method of constructing generalized contour maps through a statistical method programed for an electronic computer. One of several available methods is described and explained through examples. An equation is found for quadratic surface corresponding to the elevations (*w* values) for the various points above the *x-y* datum plane. The coefficients of the equation may be used to construct a contour map representing a quadratic equation fitted to the data points. A theoretical discussion is also presented reviewing the relative merits of fitting a quadratic surface and fitting higher order surfaces. Work done in cooperation with the Oregon State University, the National Science Foundation, and the American Philosophical Society.
- RI 6509. Expendable Casting Molds For Reactive Metals, by S. L. Ausmus and R. A. Beall. 1964. 44 pp. 32 figs. Details the experimental work in the development of a completely water-free expendable graphite mold material, useful for casting titanium, zirconium, and hafnium. The primary advantage of this material is its adaptability to standard foundry techniques. Work done under an agreement with the U.S. Atomic Energy Commission.
- RI 6510. Separation of the Lanthanide Series and Yttrium Using Phosphonic and Iminodiacetic Acid Resins, by J. O. Winget. 1964. 15 pp. 8 figs. Describes an investigation of phosphonic acid and iminodiacetic acid chelating resins to assess their potential as selective ion exchangers for separating lanthanide elements and yttrium. The affinity of phosphonic acid resin for lanthanides increases with increasing atomic number, and affinity of iminodiacetic resin for lanthanides increases with atomic number to a maximum for element 62 and then declines with atomic number throughout the remainder of the series. Elution sequences of the elements with mineral acid eluants corresponded favorably with equilibrium data, whereas the elution sequence obtained with chelating eluants was proportional to the relative values of the stability constants of the chelating agents with the lanthanides. Separation of lanthanide mixtures into groups of light and heavy elements with iminodiacetic acid resin appears feasible.
- RI 6511. Low-Temperature Heat Capacities and Entropies at 298.15° K of Sulfides of Arsenic, Germanium, and Nickel, by W. W. Weller and K. K. Kelley. 1964. 7 pp. 1 fig. Gives the heat capacities of four crystalline sulfides—AsS, GeS, NiS, and Ni₃S₂—over the temperature range from 51° to 298.15° K. The results were used to evaluate the entropies of the sulfides at 298.15° K. No previous similar experimental data existed for any of these compounds.
- RI 6512. Electrolytic Extraction of Tungsten From Western Scheelite, by J. M. Gomes, J. B. Zadra, and Don H. Baker, Jr. 1964. 13 pp. 2 figs. Describes a method by which tungsten comparable in purity to commercial hydrogen-reduced tungsten powder can be produced from scheelite in a relatively simple ternary electrolyte composed of sodium pyrophosphate, sodium chloride, and sodium tetraborate. Operating conditions for electrolysis are temperature, 1,000° C; minimum WO₃ concentration in the electrolyte, 2.5 percent; and initial cathode current density of about 110 amperes per square decimeter. Work done in cooperation with the California State Division of Mines and Geology.
- RI 6513. Thermodynamic Properties of Cuprous and Cupric Ferrites, by R. Barany, L. B. Pankratz, and W. W. Weller. 1964. 19 pp. 2 figs. Determines the heat capacity of cuprous ferrite over the temperature range from 50° to 298° K and evaluates the entropy at 298.15° K. The heat contents of cuprous ferrite and cupric ferrite above 298.15° K were measured to 1,500° and 1,100° K, respectively. These thermodynamic values were combined with other pertinent data to obtain heat and free energy of formation values at high temperatures.
- RI 6514. Sulfatization of Manganese Minerals and Gangue Materials, by F. E. Joyce, Jr., and Charles Prasky. 1964. 11 pp. 5 figs. Describes how 14 manganese samples representing oxide, carbonate, and silicate minerals were tested to substantiate thermodynamic predictions and responded to sulfatization but to varying degrees. The gangue materials MgO, MgCO₃, CaO, and CaCO₃ were sulfatized readily in contrast to the iron oxides and the alumina-containing material which were not.
- RI 6515. Effect of Uranium on the Isothermal Transformation and Hardenability of a Low-Alloy Steel, by K. A. Fowler and L. W. Higley, Jr. 1964. 18 pp. 15 figs. Evaluates the effect of uranium on the transformation kinetics and hardenability of low-alloy steel. The addition of 0.15 weight-percent uranium produced a significant shift in the iso-

- thermal transformation curve and caused a related increase in hardenability. These effects diminished rapidly when the uranium content was increased above 0.2 weight-percent. Work done under an agreement with the U.S. Atomic Energy Commission.
- RI 6516. Explosibility of Metal Powders, by Murray Jacobson, Austin R. Cooper, and John Nagy. 1964. 25 pp. 3 figs. Presents data on dust explosion hazards of 313 elemental metals, alloys, catalysts, and ores, comprising 54 separate types of material. Gives information on ignition temperature, spark energy for ignition, minimum explosion concentration, explosion pressure, rate of pressure rise, and admixed inert dust on oxygen concentration in atmosphere required to prevent ignition of dust dispersions. Discusses effects of particle diameter on explosibility and pyrophoricity. Supersedes earlier reports in which limited data on explosibility of metal powders were published. (See also RI 5753, 5971, and 6597.)
- RI 6517. Application of Computers to Heat Flow and Cost Analysis in Furnace Wall Design, by M. J. Lempel, D. Bienstock, and J. H. Field. 1964. 18 pp. 8 figs. Presents a computer program to perform the calculations required for determining the interface temperatures and steady-state heat flow through a furnace wall composed of several refractories in layers. A method is developed that will allow the designer to determine the various thicknesses for each refractory layer to minimize either the total wall thickness or the cost of the wall per unit of area.
- RI 6518. Heats of Formation of Zirconium Carbide and Hafnium Carbide, by Alla D. Mah. 1964. 8 pp. Gives the results of calorimetric measurements to obtain the heats of formation of zirconium carbide and hafnium carbide. The work was conducted as part of the Bureau's program for determining the heats of formation of oxides, carbides, and nitrides by combustion calorimetry.
- RI 6519. An Improved Procedure for the Synthesis of Thiolacetic Acid, by R. L. Hopkins and H. T. Rall. 1964. 6 pp. 1 fig. Describes a continuous method for preparing thiolacetic acid by passing acetic anhydride and hydrogen sulfide concurrently over an amine ion-exchange resin. The acid is flashed continuously from the crude reaction mixture and is purified by fractional distillation. Work done in cooperation with the American Petroleum Institute Research Project 48A.
- RI 6520. Formation Damage Estimated From Water Sensitivity Tests, Patrick Draw Area, Wyoming, by Eliot J. White, Oren C. Bantist, and Carlon S. Land. 1964. 20 pp. 13 figs. Estimates, by laboratory methods, the water sensitivity of oil-gas-producing sandstones in three fields in the Patrick Draw area. Tests used to estimate sensitivity, which is a measure of the loss of well productivity if the producing formation is invaded by fresh water, are porosity; permeability to gas, water, and brines; saturation characteristics with air displacing water from the samples and by mercury injection; and identification of clay minerals by X-ray diffraction. Results indicate that the degree of water sensitivity of the sands in the area vary from moderately sensitive to highly sensitive.
- RI 6521. The Hafnium-Tantalum Equilibrium Diagram, by Laurance L. Oden, D. K. Deardorff, M. I. Copeland, and H. Kato. 1964. 12 pp. 11 figs. Describes a study of the equilibrium relationship of hafnium and tantalum conducted to facilitate alloy and property investigations. The hafnium-tantalum system contains potentially valuable alloys and a thorough investigation of properties is necessary.
- Work done under an agreement with the U.S. Atomic Energy Commission.
- RI 6522. Polynomial Surface Fitting Using Sample Data From an Underground Copper Deposit, by Richard F. Hewlett. 1964. 27 pp. 3 figs. Describes an attempt to fit assay data from an underground copper deposit to a three-dimensional polynomial surface as a means of expressing assay points in terms of their mine coordinates by a mathematical equation. Although the fit obtained by this initial experiment is not considered accurate enough to provide good predictions about the deposit, the methodology is presented in this preliminary report to show the potential usefulness of the technique in mineral-deposit evaluation. Work done in cooperation with the Bear Creek Mining Co. and the College of Mines, University of Arizona.
- RI 6523. Experimental Production and Smelting of Prerduced Iron Ore Pellets, by M. M. Fine, P. L. Woolf, and N. Bernstein. 1964. 28 pp. 8 figs. Describes an experiment conducted to demonstrate the feasibility of simultaneous induration and reduction of magnetic taconite concentrate. The report includes blast furnace tests and pelletizing procedures. Prerduced pellets are suitable for blast furnace smelting, and extremely low coke rates with large gains in productivity will result from their use.
- RI 6524. Preparation of Aluminum Fluoride From Alumina Hydrate and Dilute Fluoride Solutions, by Henry E. Blake and Robert K. Koch. 1964. 17 pp. Shows that dilute HF and NH₄F solutions produced as waste material or byproducts of waste materials can be slurried with alumina hydrate to form hydrated AlF₃ or (NH₄)₂AlF₆ by careful evaporation. These materials can then be converted or upgraded to commercial-grade AlF₃ by thermal decomposition or dehydration by heating to moderate temperatures in a stream of dry air.
- RI 6525. Optical Activity in Oils Derived from Coals, by Charles Zahn, Bernard D. Blaustein, Gus Pantages, and Irving Wender. 1964. 32 pp. 7 figs. Gives results of a study of oils from coal hydrogenation to determine whether optical activity reported in coal would survive catalytic hydrogenation at 450° to 525° C and about 8,000 psig pressure. Oils from carbonization tars were also examined. Optical activity was found in the majority of the distillate fractions of the hydrogenation oils and in almost all distillates from the carbonization tars. No activity was observed in the tar-acid and tar-base fractions examined.
- RI 6526. Application of Statistical Analysis in Evaluating Bedded Deposits of Variable Thickness—Florida Phosphate Data, by R. D. Berkenkotter. 1964. 38 pp. 26 figs. Describes a weighted method for evaluating the mean and variance of assay data from samples of different lengths. The method, which produces unbiased estimates from which valid confidence limits can be computed, is appropriate for bedded deposits of variable bed thickness and for vein deposits of variable vein width. Assay data from the bedded Florida phosphate deposit is used to illustrate the procedure.
- RI 6527. A Process for the Preparation of Thorium by Sodium Reduction of Thorium Tetrachloride, by H. O. Poppleton and F. E. Block. 1964. 20 pp. 19 figs. Demonstrates that high-purity thorium metal in amounts up to 20 kilograms can be prepared by the sodium reduction of thorium tetrachloride. Thorium sponge from the reduction tests was consolidated by consumable electrode arc melting. Metal prepared by this method could be fabricated into bar, rod, or sheet at room temperature.
- RI 6528. Aluminum Extraction Characteristics of Three Calcium Aluminates in Water, Sodium Hy-

- dioxide, and Sodium Carbonate Solutions, by R. V. Lundquist and H. Leitch. 1964. 16 pp. 1 fig. Describes the solubility characteristics of $12\text{CaO}\cdot 7\text{Al}_2\text{O}_3$, $3\text{CaO}\cdot \text{Al}_2\text{O}_3$, and $4\text{CaO}\cdot \text{Al}_2\text{O}_3\cdot \text{Fe}_2\text{O}_3$ in water and in solutions of NaOH and Na_2O_3 to more clearly define their roles in relation to the recovery of aluminum by the lime-sinter and the lime-soda-sinter processes. The rates and extent of aluminum extractions were determined.
- RI 6529. Recovery of Tin From Hardhead by Filtration, by J. A. Ruppert and P. M. Sullivan. 1964. 13 pp. 5 figs. Presents filtration techniques for recovering the major part of tin contained in hardhead. Special small-scale filtering apparatus and a three-stage cyclic process were developed. Eighty-seven percent of the tin contained in an alloy of 82 percent tin and 17 percent iron was recovered as pure metal.
- RI 6530. Cost Estimates of Processes for Separating Mixtures of Methane and Hydrogen, by J. W. Mulvihill, W. P. Haynes, S. Katell, and G. B. Taylor. 1964. 43 pp. 12 figs. Capital and operating costs have been estimated for separating methane and hydrogen in gas-separating plants designed to produce 90 million scf per day of product gas containing a minimum of 90 percent methane. Three different processes—moving-bed adsorption using active carbon, oil absorption, and liquefaction—were chosen for the cost estimates.
- RI 6531. Specific-Gravity to Oil-Yield Relationships for Black Shales of Kentucky's New Albany Formation, by John Ward Smith and Neil B. Young. 1964. 13 pp. 2 figs. Presents specific-gravity to oil-yield relationships for the black shales of the New Albany Formation. Shows that certain linear equations for estimating oil yield from measured specific gravity and for estimating specific gravity from measured oil yield are applicable within small error limits to all the sites tested. Work done in cooperation with the University of Wyoming.
- RI 6532. Flotation Treatment of Experimental Iron Ore Tailing From Champion Mine, Marquette Range, Michigan, by R. T. Sorensen, A. F. Colombo, and D. W. Frommer. 1964. 13 pp. 2 figs. Describes a flotation method for concentrating spiral tailing, using a reagent suite composed of tall oil-fatty acid, fuel oil, sulfuric acid, sodium fluoride, and sodium silicate. Work done in cooperation with North Range Mining Co.
- RI 6533. Modulus of Elasticity of a Rock Determined by Four Different Methods, by Francis X. Cannaday. 1964. 59 pp. 47 figs. Determines the modulus of elasticity of a rock by four different laboratory methods: (1) Deformation of a borehole in a prism subjected to uniaxial stress, (2) deflection of a thin beam of uniform cross section uniformly loaded, (3) sonic-pulse velocity measurements, and (4) strain measurements on a prism under uniaxial stress. Moduli obtained by each of the four methods check one another within the limits of experimental error.
- RI 6534. Feasibility of Inert-Gas Cushions in Gas Storages, by C. J. Walker and Ray V. Huff. 1964. 25 pp. 4 figs. Indicates that molecular diffusion is not of concern under usual conditions of gas-well spacing and pressures, displacement efficiency is of a critical nature, and the tilting of the vertical "interface" between the cushion and working gases brought about by gravitational stratification in essentially horizontal formations is also critical. Close analysis of field and operating conditions would be required to determine the feasibility of using an inert cushion gas. The operation would appear to be tedious and expensive; furthermore, the rate of mixing in the average reservoir is ominous. Work done in cooperation with the American Gas Association.
- RI 6535. Characteristics of Products Obtained by Oxidation of Anthracite With Concentrated Nitric Acid, by M. H. Kersten, Jerry W. Ramsey, and G. A. Bray. 1964. 11 pp. Gives data on anthracite samples oxidized with nitric acid to prepare products representing different stages of oxidation. Mellitic acid was identified in the acid-soluble products from 10 tests. Benzene pentacarboxylic acid was found in some products, but other carboxylic acids were not present in amounts detectable by methods used in this study. The acid-insoluble residue varied significantly in solubility behavior toward different classes of solvents. Organic material separated from the residue by peptization with dimethylformamide contained 1 percent ash, consisting of more than 50 percent zirconium.
- RI 6536. Effect of Impurity Levels on Zircaloy 2 Microstructure, Mechanical Properties, and Corrosion Rates, by H. Kato, D. J. Stoops, and M. D. Carver. 1964. 20 pp. 7 figs. Investigates the effects of the impurity elements silicon, aluminum, copper, nitrogen, and manganese on the microstructure, mechanical properties, and corrosion behavior of the zirconium alloy Zircaloy 2.
- RI 6537. Development of a Rock Stress Monitoring Station Based on the Flat Slot Method of Measuring Existing Rock Stress, by Louis A. Panek and John A. Stock. 1964. 61 pp. 28 figs. Describes in detail apparatus, procedures, and performance data for the installation and operation of a permanent rock stress monitoring station for observing mining-induced stress changes. Flat slot method yields indicated ground stress values that have acceptable accuracy and dispersion if the sensor is located within a specified zone close to the pressure transmitter in the flat slot.
- RI 6538. Washability Studies and Cleaning Trials on Coals From Pierce County, Wash., by M. R. Geer. 1964. 27 pp. Describes washability characteristics of three coals from the Wilkeson Nos. 2, 3, and 7 beds in the Wilkeson-Carbonado district. Because the coals were unusually difficult to clean, washability examinations were supplemented by table tests, tests in dense-medium cleaning units, and flotation tests. Dense-medium treatment provided coal of the desired quality, but with the most difficult coal the recovery efficiency was lower than usual. Work done in cooperation with the School of Mineral Engineering, University of Washington, and the Pacific Coast Co.
- RI 6539. Rolled Molybdenum Single Crystals. Deformation Textures, Recrystallization, and Transition Temperature, by R. Blickensderfer, R. Siemens, G. Asai, and H. Kato. 1964. 34 pp. 26 ills. Gives data on some relationships established among crystallographic orientation, rollability, deformation texture, annealing behavior, slip planes, and ductile-brittle bend transition temperature of molybdenum single crystals, using six large molybdenum single crystals obtained from an ingot melted by electron beam. The specimens were oriented by X-ray diffraction and rolled on crystallographic planes of low indices in a known direction. Work done in cooperation with the Wah Chang Corp.
- RI 6540. Safe Use of Respiratory Protective Equipment in Work in Compressed Air: Detection and Physiological Effects of Gases Encountered, by L. B. Berger, T. F. Curry, H. A. Watson, and S. J. Pearce. 1964. 40 pp. 8 figs. Discusses some of the problems involved and presents information on the following subjects: (1) Physiological effects of gases at elevated pressure; (2) use of respiratory protective equipment in rescue or recovery operation in event of fire or other emergency in pressurized tunnels; (3) effect of elevated pressure on performance of some gas-detecting instruments and interpretation of the results.

- RI 6541. Investigation of In Situ Rock Stresses, Ruth Mining District, Nevada, With Emphasis on Slope Design Problems in Open-Pit Mines, by David W. Wisecarver, Robert H. Merrill, Donald O. Rausch, and S. Jackson Hubbard. 1964. 21 pp. 17 figs. Reports results for stress-relief borehole-deformation measurements made in three underground openings near open-pit mines in the Ruth mining district. A total of 134 deformation measurements made in 8 boreholes determined the regional stresses in the horizons above, below, and at the elevation of nearby open-pit mine floors. Knowledge of these stress conditions is considered essential information relative to certain aspects in the designing of stable pit slopes. Work done in cooperation with the Kennecott Copper Corp., Western Mining Division, Engineering Department, Salt Lake City, Utah.
- RI 6542. Hydrocarbon-Type Relationships of Eastern and Western Hemisphere High-Sulfur Crude Oils, by Harold M. Smith. 1964. 89 pp. 28 figs. Presents a comparison of high-sulfur crude oils based on interpretations of Bureau of Mines routine crude-oil analyses in terms of common commercial products. These analytical interpretations are applied to a group of high-sulfur crude oils from the Near East, Texas, Venezuela, Colombia, California, and other locations, and the resultant data for gasoline, gas oils, lubricating oils, and asphalt are compared. Because the Near East crude oils contain higher quantities of paraffins in the gasoline and gas-oil ranges, they will yield good low-solvency solvents and kerosine, jet fuels, and diesel fuels, but the straight-run gasoline will be inferior to similar products from Texas and Venezuelan high-sulfur oils. The Near East oils should be good sources of lubricating stock, but when used as stock for catalytic cracking or reforming, they are deficient in naphthenes.
- RI 6543. Preventing Ignition of Dust Dispersions by John Nagy, Henry G. Dorsett, Jr., and Murray Jacobson. 1964. 29 pp. 17 figs. Shows that ignition of a dispersed combustible dust in an open vessel may be prevented by adequate inerting. Factors affecting the inerting requirements are dust concentration, spark energy, ignition temperature, composition of inerting substances, fineness of dust, and type of combustible. Oxygen concentration of atmosphere and in some instances the proportion of admixed inert powder and moisture required to prevent ignition are given for 367 dust samples. Variations in inerting requirements with strength of igniting source are discussed.
- RI 6544. A Device for Placing a Borehole Deformation Gage in a Horizontal Hole, by David W. Wisecarver. 1964. 13 pp. 10 figs. Describes a tool to engage or place a Bureau of Mines type gage to measure borehole deformation in a horizontal, 1½-inch-diameter stress-relief borehole. The tool was successfully used at a borehole depth of 105 feet. Practical usage up to borehole depths of 200 feet might be realized. Tool was designed to work inside EX-size (1½-inch ID) diamond-drill drive casings used as drill rod and through which the deformation gage is guided into an EX-size stress-relief borehole.
- RI 6545. An Apparatus for Determining the Helium Content of Gas Mixtures, by E. M. Frost, C. G. Kirkland, and D. E. Emerson. 1964. 18 pp. 7 figs. Describes an apparatus developed by the Bureau for determining the helium content of gases containing 40 percent or more helium. It uses activated coconut charcoal at liquid nitrogen temperatures to absorb constituents other than helium in the mixture. Series of analyses have been run where the mean deviation was less than 0.05 percent helium. Twenty or more analyses can be made in an 8-hour day.
- RI 6546. Theory and Application of Dimensional and Inspectional Analysis to Model Study of Fluid Displacements in Petroleum Reservoirs, by A. G. Loomis and D. C. Crowell. 1964. 37 pp. Develops both dimensional and inspectional analysis from fundamental concepts and derives dimensionless groups which represent the viscous, capillary, and gravitational forces existing in two-phase incompressible flow in petroleum reservoirs. Shows how properly scaled laboratory models may be devised by means of the foregoing groups that faithfully duplicate the behavior of the reservoir on a miniature dimensional and compressed time scale. Report is intended as a review and summary of the application of dimensional analysis to reservoir displacement problems.
- RI 6547. Recrystallization of Vanadium by E. A. Loria, W. D. Ludemann, and E. S. Rowe. 1964. 38 pp. 24 figs. Gives results of a study of the isothermal recrystallization of electrorefined vanadium as a function of annealing time, temperature, and prior deformation. Specimens were cold rolled from 30- to 75-percent reduction in thickness, then annealed from 700° to 1,200° C at time periods ranging from 1 minute to 96 hours. The course of recrystallization was followed by means of hardness, metallographic, and X-ray techniques, and a recrystallization diagram was constructed.
- RI 6548. Vapor-Phase Hydrogenation of Oils Derived From Coal and Oil Shale, by C. O. Hawk, M. D. Schlesinger, H. H. Ginsberg, and R. W. Hiteshue. 1964. 53 pp. 13 figs. Gives results of Bureau of Mines studies of single-step catalytic vapor-phase hydrogenation of oils derived from coal and oil shale. The oils used were middle oil from hydrogenation of bituminous coal, crude shale oil, and coker distillate from shale oil. High nitrogen and sulfur in all three of these raw materials severely poison the usual refining catalysts. Thus, the common objective in these studies was application of poison-resistant catalysts to the problem of reducing nitrogen and sulfur to tolerable levels. Cobalt molybdate was a particularly effective catalyst for sulfur removal.
- RI 6549. Metallic Binders for Zirconium Diboride: Chromium, Molybdenum, and Tungsten, by M. E. Tyrrell and C. W. Houck. 1964. 14 pp. 7 figs. To evaluate their usefulness as binders for zirconium diboride, mixtures of zirconium diboride and chromium, molybdenum, and tungsten were resistance sintered to high-density compacts using modified electric welding equipment. Each of the zirconium diboride-metal mixtures produced brittle cermets having poor oxidation resistance, but the hardness was generally high. Chromium yielded the highest compressive strength, the greatest resistance to mechanical shocks and oxidation, and a satisfactory Rockwell hardness. Molybdenum did not yield a satisfactory cermet. Tungsten yielded compacts having high microhardness but very low mechanical strength. The first report in this series, RI 6262, evaluated iron, cobalt, and nickel as binders.
- RI 6550. Statistical Interpretation of Sample Assay Data From the Mi Vida Uranium Mine, Big Indian District, San Juan County, Utah, by George S. Koch, Jr., Richard F. Link, and Scott W. Hazen, Jr. 1964. 40 pp. 17 figs. Presents a statistical analysis of assays of samples taken from the ore body of the Mi Vida uranium mine that affords an estimate of the grade of the ore body and provides a prediction about the direction of best mineralization beyond the sampled area. Basic data analyzed are assay results for U_3O_8 , V_2O_5 , and CaO from 225 chan-

- nel samples cut at 79 sample points. The statistical methods employed illustrate certain techniques that may be used to analyze assay data from ore deposits in general.
- RI 6551. Some Fundamental Aspects of Dust Flames, by Hans M. Cassel. 1964. 51 pp. 20 figs. Gives the results of research on the physicochemical fundamentals of the mechanism of dust explosions. Describes the equipment, techniques (chiefly photographic), and dusts (chiefly graphite and light metals.) Results are interpreted using thermal theory as accepted for combustible gas mixtures. Radiative transfer across the flame front, as a characteristic of dust flames, is given particular attention. Related studies by other investigators are discussed.
- RI 6552. Some Generalized Probability Distribution With Special Reference to the Mineral Industries (in Five Parts). 2. Sampling to λ Amount of of Items per Sample, by Robert M. Becker. 1964. 101 pp. 2 figs. Presents the mathematical development in extending the theory of sample reliability from a sample consisting of a fixed number of items to a fixed amount of items. Examples of a fixed amount of items per sample are samples consisting of a fixed weight or a fixed volume of unequal size particles. The probability distribution functions are developed from fundamentals. Their distributions are generalized to include some measured characteristic of the items. Infinite population moments are derived from moment-generating functions, while finite population moments are developed from corresponding infinite population moments using the finite probability operator defined in part 1 of this series, RI 6329, Sampling to n Items per Sample.
- RI 6553. Some Effects of Yttrium and Rare-Earth-Metals Additions on Electrorefined Vanadium, by W. L. O'Brien and E. A. Rowe. 1964. 23 pp. 15 figs. Describes the effect on electrorefined vanadium of additions up to 5 weight-percent of yttrium, cerium, lanthanum, praseodymium, neodymium, and samarium. Vanadium and the alloying element were melted to ingots in a nonconsumable electrode arc in a helium atmosphere. The ingots were rolled into strips and evaluated for the effect of the alloying elements on hardness, tensile strength, ductility, recrystallization temperature, and microstructure. Except for samarium, the addition of rare-earth metals and yttrium produced an improvement in workability, a decrease in hardness and strength, and a lower recrystallization temperature.
- RI 6554. Recovery of Lead and Sulfur by Combined Chlorination and Electrolysis of Galena, by A. G. Starliper and H. Kenworthy. 1964. 29 pp. 3 figs. Describes a procedure for separating lead and sulfur in industrial concentrates of galena by using a combination of chlorination and fused-salt electrolysis. An apparatus was designed and constructed to chlorinate galena and to volatilize simultaneously most of the chloridized impurities. By electrolyzing the chlorinated concentrate, a high percentage of lead was recovered. Anodic chlorine was drawn from the cell and used to chlorinate new feed. In many runs, the recovered metal analyzed from 99.8 to 99.9 percent lead.
- RI 6555. High-Temperature Heat Contents and Entropies of Akermanite, Cordierite, Gehlenite, and Merwinite, by L. B. Pankratz and K. K. Kelley. 1964. 7 pp. Gives the heat contents of four silicate minerals—akermanite ($\text{Ca}_2\text{MgSi}_2\text{O}_7$), cordierite ($\text{Mg}_2\text{Al}_2\text{Si}_2\text{O}_{10}$), gehlenite ($\text{Ca}_2\text{Al}_2\text{SiO}_7$), and merwinite ($\text{Ca}_3\text{MgSi}_2\text{O}_8$)—that were measured from 298° to around 1,700° K. Results were compiled into tabular and equation forms suitable for thermodynamic calculations. No previous high-temperature heat content data exist for akermanite, cordierite, and merwinite.
- RI 6556. Low-Temperature Heat Capacities and Entropies at 298.15° K of Crystalline Silicates of Barium and Strontium, by W. W. Weller and K. K. Kelley. 1964. 8 pp. Gives the heat capacity measurements of four crystalline silicates of barium (BaSiO_3 , $\text{Ba}_2\text{Si}_2\text{O}_7$, and BaSi_2O_6) and two crystalline silicates of strontium (SrSiO_3 and Sr_2SiO_6) that were measured over the temperature range from 51° to 298° K. The results were used to evaluate the entropies at 298.15° K. The entropy values were joined with known heats of formation to obtain the free energies of formation of the silicates with respect to their constituent oxides at 298.15° K.
- RI 6557. The Effectiveness of Sodium Tripolyphosphate for Improving Injection Rates of Waterfloods, by R. T. Johansen and R. J. Heemstra. 1964. 15 pp. Discusses the use of sodium tripolyphosphate (STP) in treating injection waters to eliminate or reduce the formation of insoluble precipitates. Gives results of field tests showing the almost immediate effects of using STP. Methods of treatment, solubility of STP in fresh water and brines, and precautions to observe when starting to treat a waterflood with this chemical are given. Laboratory data show that the preferential wettability of a crude oil for reservoir rock can be reversed by adding a small amount of STP to the flooding water. This reversal in wetting tendency should not only decrease the injection pressures but also increase oil recovery by improving the sweep efficiency of a waterflood. Work done in cooperation with the Layton Oil Co., Independence, Kans.
- RI 6558. Development of Columbium and Tantalum Alloys For Elevated-Temperature Service, by H. R. Babitzke, R. E. Siemens, G. Asai, and H. Kato. 1964. 33 pp. 18 figs. Describes an investigation of 69 columbium and tantalum alloys to determine their suitability for use at elevated temperatures. Columbium was alloyed with two or more of the following: hafnium, tungsten, vanadium, titanium, and zirconium. Tantalum was alloyed with vanadium or hafnium or hafnium and carbon. Of the alloys studied, Cb-15Hf-5W, Cb-15Hf-5W-10Ti, Cb-15Hf-10W-10Ti, Cb-10V-5W, Ta-30V, and Ta-20 to 33Hf were easy to fabricate, had good oxidation resistance, and excellent high-temperature strength.
- RI 6559. Effects of Retort-Immersion Depth on Gieseler Plasticity Determination on Western Coals, by R. R. Allen. 1964. 26 pp. 8 figs. Gives results of Gieseler plastometer tests performed on eight western coking coals at retort-immersion depths ranging from 2¼ to 3¾ inches. Increased maximum fluidities were associated with greater retort-immersion depths, the most pronounced increases being observed on highly swelling coals when tested at 3¾ inches. Retort-immersion depth had no significant effect on the temperatures of initial softening, fusion, maximum fluidity, end of fusion, and solidification.
- RI 6560. Electron-Beam Purification of Hafnium, by W. E. Anable and R. A. Beall. 1964. 30 pp. Gives results of a detailed examination of the purification of hafnium by electron-beam melting at moderate energy inputs and at low pressures. Most metallic impurities and hydrogen were removed in the first few minutes of operation; oxygen, carbon, and nitrogen were removed at a slower rate. Samples treated by electron bombardment suffered a small loss of weight and a gradual lowering of hardness. The magnitude of each change varied with the energy input and the duration of the melt. Analysis of the data confirms the loss of oxygen as hafnium monoxide. Approximate

- activity coefficients for other contaminants are given. Work done under an agreement with the U.S. Atomic Energy Commission.
- RI 6561. Pressure Development in Laboratory Dust Explosions, by John Nagy, Austin R. Cooper, and Joseph M. Stupar. 1964. 19 pp. 25 figs. Presents information on the pressure and rate of pressure development during a dust explosion. Data were obtained in laboratory studies in a 75-cubic-inch vessel with mineral, agricultural, and chemical dusts. Factors investigated include dust concentration, oxygen concentration of the atmosphere, admixed inert powder, and admixed moisture. Information is given also on the effects of these factors on the composition of the atmosphere after the explosion.
- RI 6562. A Proposed Modified Percolation-Rate Test for Use in Physical Property Testing of Mine Backfill, by William R. Wayment and David E. Nicholson. 1964. 24 pp. 11 figs. Describes equipment requirements and detailed procedure for a modified percolation-rate test for use in determining flow rates through hydraulic backfill. In contrast to the conventional test, a percolation-rate versus void-ratio relationship is established. The modified test method yields more accurate, realistic, and usable percolation-rate (permeability) data than the conventional test method.
- RI 6563. Production of Coronene From Coal, by R. W. Fridy, W. Kawa, and R. W. Hiteshue. 1964. 18 pp. 6 figs. Investigates the maximum yield of coronene that could be obtained by hydrogenating coal or materials derived from coal. With anthracite, yields of coronene of 0.5 to 0.8 weight-percent of maf coal were obtained at 6,000 to 8,000 psi, 700° to 750° C, and residence time of 30 minutes. With bituminous coal, yields averaging 0.4 weight-percent of maf coal were obtained at 6,000 psi, 800° C, and 30 minutes residence time. With asphaltene and centrifugal residue, yields of less than 0.02 weight-percent of maf coal were obtained at 6,000 psi, 700° C, and 60 minutes residence time. Work done under an agreement with the U.S. Atomic Energy Commission, through their representative, Sandia Corporation, Livermore, Calif.
- RI 6564. Iron Ore Pellet Binders From Lignite Deposits, by M. M. Fine and W. C. Wahl. 1964. 18 pp. 7 figs. Investigates leonardite as a binder for iron ore pellets. Although insoluble in original condition, leonardite forms water-soluble salts with good binding properties when treated with certain alkalis, such as sodium hydroxide. Soluble leonardite imparts excellent dry strength to pellets, but green strength is somewhat lower than that obtainable with bentonite. Green strength can be improved by adding a small amount of calcium hydroxide to the leonardite-concentrate mixture.
- RI 6565. Evaluation of a Combined Ion Exchange X-Ray Spectrographic Exchange X-Ray Spectrographic Method for Determining Trace Metals in Tungsten, by E. F. Spano, T. E. Green, and W. J. Campbell. 1964. 16 pp. 1 fig. Evaluates a combined ion-exchange X-ray spectrographic method for the determination of 11 trace metallic impurities in high-purity tungsten. Copper, nickel, and manganese in the 5- to 100-microgram range (1 to 20 ppm based on 5-gram samples of tungsten), calcium in the 10- to 100-microgram range, and cobalt in the 5- to 20-microgram range can be determined within an accuracy of ± 10 percent of the amount present. The overall method was unsatisfactory for the determination of aluminum, chromium, iron, magnesium, titanium, and zinc in tungsten.
- RI 6566. Nickel-Gadolinium Phase Diagram, by M. I. Copeland, M. Krug, C. E. Armantrout, and H. Kato. 1964. 24 pp. 11 figs. Investigates the nickel-gadolinium phase diagram to determine the alloying behavior of these two metals. The data from melting-point determinations, thermal analyses, metallographic examinations, and X-ray diffraction analyses revealed a phase diagram with three eutectic points and seven intermetallic compounds. Very limited solubility of the phases in each other was observed.
- RI 6567. Reactions Between Manganous Oxide, Graphite, and Manganese Carbide, by E. L. Singleton, A. E. Morris, and R. V. Lundquist. 1964. 22 pp. 10 figs. Describes experimental research performed to determine rate-of-reaction constants on the MnO-C and Mn₂C₃-3MnO systems at 1,100°, 1,150°, and 1,185° C. The system MnO-C followed a linear reaction rate, and experimental results produced an apparent activation energy of 55.8 kcal/mole of MnO. The system Mn₂C₃-RMnO followed a parabolic rate of reaction law and yielded an apparent activation energy of 114.4 kcal/mole for the reaction.
- RI 6568. Studies of the Thickness of the Plastic Layer of Coals. Its Determination and Significance, by M. J. Kovalik, D. E. Wolfson, and F. Fischler. 1964. 20 pp. 12 figs. Plastometric tests were made to determine the maximum thickness of the plastic layer for different U.S. coals. The effect of test variables on the maximum thickness of the plastic layer was studied. The values for the maximum thickness of the plastic layer were found to be related to the Gieseler maximum fluidity, plastic temperature range, free-swelling index, and other plastic properties of coals. Only a general relationship was observed between the plastometric parameters obtained in these tests and the coking properties of coal.
- RI 6569. Beneficiation and Hydrometallurgical Treatment of Complex Mercury Sulfide Products, by J. W. Town and W. A. Stickney. 1964. 35 pp. 5 figs. Gives results of batch and continuous-circuit flotation, leaching, precipitation, and electrodeposition studies made by the Bureau of Mines to determine optimum conditions for treatment of complex mercury-antimony sulfide and mercury-arsenic sulfide ores and concentrates. Methods for recovering mercury and antimony from solution were electrodeposition of mercury followed by electrodeposition of antimony, aluminum precipitation of both mercury and antimony, or antimony precipitation of mercury followed by antimony electrodeposition. The method used in recovering the mercury depended on the mercury-antimony content of the solution being treated. When recovering the mercury and arsenic from solution, either aluminum precipitation of both metals was used, or the mercury was electrodeposited and the arsenic precipitated with aluminum.
- RI 6570. Electrorefining Beryllium. Two-Cycle Electrolysis, by M. M. Wong and D. A. O'Keefe. 1964. 8 pp. 3 figs. Describes a two-cycle electrolytic process designed to obtain beryllium metal of higher purity. Flakes produced from electrorefining scrap metal were used as cell feed for a second cycle of electrorefining at 500° C in an electrolyte composed of 51.7 mole-percent LiCl, 36.9 mole-percent KCl, and 11.4 percent BeCl₂. Metallic impurities in the flakes used as feed totaled more than 108 ppm, and the metallic impurities in the metal obtained from the second cycle of the electrorefining were, with the exception of 35 ppm of calcium, below the spectrographic determination limits.
- RI 6571. Development of a Hydraulic Device for Measuring Relative Pressure Changes in Coal During Mining: A Progress Report, by Thomas C. Miller and Rudolph Sporcic. 1964. 13 pp. 7 figs. Describes

Reports of Investigations

the construction and field testing of a relatively simple and inexpensive encapsulated hydraulic device developed by the Bureau of Mines to facilitate study of coal bumps and to measure pressure changes in a coalbed as it is subjected to roof loading during mining. Preliminary feasibility tests in the laboratory and field indicate that the device responds satisfactorily to pressure changes in coal created by roof loading.

RI 6572. Investigation of Beryllium Deposits in the Northern Virgin Mountains of Clark County, Nev., and Mohave County, Ariz., by George H. Holmes,

Jr. 1964. 30 pp. 11 figs. Gives results of an investigation of beryllium deposits in the northern Virgin Mountains, about 70 miles east of Las Vegas. The investigation indicated a widespread occurrence of beryllium-bearing pegmatites within an extensive belt of mica schist. Several deposits with significant beryllium mineral concentrations were encountered. In ore-dressing tests on a composite sample containing 0.28 percent BeO, 85 percent of the chrysoberyl mineral (70-percent recovery of total BeO) was recovered in a concentrate containing 17.6 percent BeO.

INFORMATION CIRCULARS ¹⁹

- IC 7923. Fusibility of Ash of United States Coals, by Roy F. Abernethy and Elsie M. Cochrane. 1960. 363 pp. Includes all information on fusibility of coal-ash determinations of coal tested from 1921 to 1957. These data are mainly from tipple samples, while B 209 of the same title, issued in 1922, contained information almost exclusively on mine samples. \$1.75.
- IC 7928. Bibliography of Hafnium, by Eleanor Abshire and Sarah Notestine. 1960. 30 pp. Includes 670 references on hafnium, a vital component in atomic power reactors, and its compounds. Includes articles in scientific and technical journals, books, and patents. 25 cents.
- IC 7936. Tungsten Mining and Milling in Boulder County, Colo., by Carl Belser. 1960. 54 pp. 18 figs. Describes mining and milling practices and the tungsten mines operating in Boulder County. Supplements IC 7721, A Study of the Tungsten Potential in Boulder County, Colo., issued in 1955. 40 cents.
- IC 7938. Open-Pit Copper Mining Methods at New Cornelia Branch, Phelps Dodge Corp., Pima County, Ariz., by W. R. Hardwick. 1960. 83 pp. 68 figs. Describes mining methods and practices at the New Cornelia open-pit copper mine and geology of the ore deposit, and outlines methods of sampling and ore estimation. 50 cents.
- †IC 7939. Cost of Tonnage Oxygen, by Sidney Kattell and John H. Faber. 1960. 6 pp. 6 figs. Estimates capital requirements and operating expenses for a theoretical plant, located in the Ohio Valley and producing from 150 to 1,000 tons of high-purity oxygen per day, using low-pressure or split-cycle process. Pressure specifications are 450 psig discharge and power costs \$0.0075 per kilowatt-hour.
- IC 7944. Exploratory Drilling Practices and Costs at Western Uranium Deposits, by D. E. Redmon. 1960. 68 pp. 30 figs. Presents results of studies of several drilling methods being used in the search for uranium deposits in sedimentary formations from surface drill sites. 45 cents.
- IC 7945. Mining Methods and Costs, Black Rock Tungsten Mine, Wah Chang Mining Corp., Mono County, Calif., by A. C. Johnson and N. M. Phillip. 1960. 19 pp. 6 figs. Describes a well-planned program of exploration, development, and exploitation that resulted in a good production record at low cost until mine shut down after suspension of Government tungsten-purchase program. 45 cents.
- †IC 7946. Field Test for Beryllium, by W. M. Dressel and R. A. Ritchey. 1960. 5 pp. 1 fig. A reliable method that can be used by any prospector to detect beryllium in concentrations as low as 0.013 percent. Test was developed by Bureau to spur hunt for beryllium, a promising structural metal for jet aircraft, missiles, and space satellites. Inexpensive chemicals and equipment required are listed. 15 cents.
- IC 7947. Thermal Decomposition of Organic Nitrogen and Sulfur Compounds: A Survey of Chemical Abstracts, 1930 to 1956, by Irven A. Jacobson, Jr. 1960. 99 pp. Consists of references dealing with gaseous-state thermal decomposition reactions of organic nitrogen and sulfur compounds. Part I lists nitrogen compounds; Part II, sulfur compounds; and Part III, compounds containing both nitrogen and sulfur. Work done in cooperation with University of Wyoming. 50 cents.
- IC 7948. Coal Chemicals for World Markets, by Joseph A. DeCarlo, Harry Perry, and Eugene T. Sheridan. 1960. 44 pp. 8 figs. Contains data on production, exports, imports, and consumption of coal-chemical materials in the leading countries of the world, including the United States. 35 cents.
- IC 7949. Training Technical Personnel for the Mineral Industries of the U.S.S.R., by Bernadette C. Michalski. 1960. 20 pp. 4 figs. Discusses educational system utilized by Russia in building a force of scientists, engineers, and technical workers to support expanding mineral production. Based on official Soviet reports and on American appraisals of Communist education programs, publication is an outgrowth of studies Bureau is making to gain knowledge of mineral-resource development behind the Iron Curtain. 20 cents.
- IC 7950. Sources of Refractory Raw Materials and Refractories Markets in South Central United States, by Howard E. Rollman and Harvard Eng. 1960. 54 pp. 10 figs. An economic evaluation of supply and markets and a functional appraisal of resources in the area. Present and potential supplies of raw materials are discussed only as they may be related to market demands. 40 cents.
- †IC 7951. Phosphate Rock (in Two Parts) 2. Processing and Utilization, by William H. Waggaman and E. Robert Ruhlman. 1960. 36 pp. 8 figs. Describes industrial methods for decomposing phosphate rock to obtain such products as elemental phosphorus, phosphoric acid, phosphatic fertilizers, phosphate salts, and other compounds. Presents flowsheets for typical plants, tabulates production statistics for various phosphate-rock products, and discusses industrial outlook. Part I, IC 7814, published in 1958, contains general information on mining, beneficiating, and marketing of phosphate rock.
- IC 7952. An Economic Study of the Hot Carbonate Process for Removing Carbon Dioxide, by Sidney Kattell and John H. Faber. 1960. 10 pp. 3 figs. Presents economics of the hot-carbonate purification process for removing carbon dioxide. 15 cents.
- IC 7953. Bibliography on Metallurgy of High-Purity Tungsten, January 1911 Through February 1959, by Earl T. Hayes and Ruth A. Pritchard. 1960. 46 pp. Includes more than 250 abstracts of articles and patents, foreign and domestic, that concern improving the purity of tungsten—from processing the ore to treating the finished metal. 35 cents.
- IC 7954. High-Temperature Systems for Nuclear Process Heat, by James P. McGee. 1960. 18 pp. 9 figs. Presents discussion of possible applications for nuclear-process heat in the chemical field, describing design and testing of an electrically simulated atomic reactor developed by the Bureau as part of preliminary studies aimed at gasifying coal with nuclear heat. 20 cents.

¹⁹ Free publications are available from the Publications Distribution Section, Bureau of Mines, 4800 Forbes Avenue, Pittsburgh, Pa.

† Out of print.

- IC 7955. Methods and Costs of Sinking a Circular Concrete-Lined Ventilation Shaft, by Lloyd Williams. 1960. 31 pp. 16 figs. Describes methods used in sinking a 1,700-foot concrete-lined ventilation shaft, designed to handle 500,000 cubic feet of air a minute, at an Alabama mine. 25 cents.
- IC 7956. Mining Methods and Costs at Crystal-Victory and Minerva No. 1 Fluorspar Mines of Minerva Oil Co., Hardin County, Ill., by Gill Montgomery, J. J. Daly, and Frank J. Mysliński. 1960. 45 pp. 21 figs. Describes exploration, development, and mining practices at two fluorspar mines. 50 cents.
- IC 7957. Permissible Mine Equipment Approved During 1957-58, by E. J. Gleim and F. R. Lee. 1960. 27 pp. Lists equipment Bureau approved during 1957 and 1958 as permissible for use in underground mines. Supplements B 543, Permissible Mine Equipment Approved to January 1, 1953, issued in 1954; IC 7722, Permissible Mine Equipment Approved During the Calendar Years 1953-54, issued in 1955; and IC 7840. Permissible Mine Equipment Approved During the Calendar Years 1955-56, issued in 1958. 25 cents.
- IC 7958. Bibliography of Thermal Methods of Oil Recovery, by W. T. Wertman, N. A. Caspero, and T. E. Sterner. 1960. 13 pp. Includes nearly 250 references to U.S. patents and published literature relating to thermal processes of oil recovery from 1899 through 1959. 20 cents.
- †IC 7959. Applications of a Small Electronic Digital Computer to Pyrometallurgical Research, by R. J. Leary, R. W. Smith, Jr., and B. J. Mitchel. 1960. 26 pp. 7 figs. Tells how a small automatic electronic computer employing punched cards is used to perform calculations required in pyrometallurgical research.
- IC 7960. The National Safety Competitions of 1948-58, by John C. Machisak and Elizabeth K. Elsner. 1960. 195 pp. The National Safety Competition, sponsored and conducted annually by the Bureau, promotes safety in the mineral industries and encourages development of more effective accident-prevention programs. Presents results of 11 annual contests for the period 1948-58; includes statistical information on injury experience of individual mines and quarries enrolled in the annual contests. \$1.00.
- †IC 7961. Methods and Costs of Shaft Sinking in the Coeur d'Alene District, Shoshone County, Idaho, by John R. McWilliams and Eric G. Erickson. 1960. 49 pp. 14 figs. This report, based on data and information made available by several operators of the Coeur d'Alene mining district, describes shaft-sinking practices in the district, including methods and procedures employed in 13 shaft-sinking projects at 10 mines. Gold, silver, copper, lead, and zinc are produced in the district.
- IC 7962. Recommended Standards for Alternating Current in Coal Mines, by Bureau of Mines Health and Safety Staff. 1960. 25 pp. 11 figs. Discusses advantages of ac systems and gives examples of practical installations in coal mines.
- †IC 7963. Mining Methods and Costs. Schwartzwalder Uranium Mine, Jefferson County, Colo., by J. H. Soulé. 1960. 24 pp. 13 figs. One of a series on methods and costs at various mining operations, report describes activities at the Schwartzwalder mine, an important source of uranium ore in the Front Range.
- IC 7964. Methods and Costs of Driving Drifts, Crosscuts, and Raises in the Coeur d'Alene Mining District, Shoshone County, Idaho, by George T. Krempasky. 1960. 45 pp. 26 figs. One of a series dealing with mining methods and costs throughout the United States. Describes operations at several mines. 35 cents.
- IC 7965. Possibilities of Using Nuclear Energy for Gasifying Coal, by James P. McGee and Sidney Katell. 1960. 11 pp. 4 figs. Describes a conceptual design of a system to utilize nuclear heat for coal gasification and apparatus built to simulate operation of a high-temperature nuclear system. 15 cents.
- †IC 7966. Bibliography of Investment and Operating Costs for Chemical and Petroleum Plants, January-December 1959, by Sidney Katell, John H. Faber, and John W. Douglas. 1960. 68 pp. To aid plant managers estimating investment and operating costs of petroleum refining and chemical processes, bibliography contains nearly 300 abstracts of publications. Indexed by subjects and authors. Work done in cooperation with American Association of Cost Engineers.
- IC 7967. Coal-Mine Fires and Gas and/or Dust Ignitions Since Enactment of the 1952 Federal Coal Mine Safety Act, by C. M. Keenan. 1960. 9 pp. Publication points out that 26 major disasters, which caused the deaths of 491 persons, occurred during the 7 years immediately preceding enactment of the Federal Coal Mine Safety Act, while in the next 7½ years under the act 12 major disasters, which caused the deaths of 148, occurred.
- IC 7968. Constitution of Oil-Shale Kerogen: Bibliography and Notes on Bureau of Mines Research, by W. E. Robinson and K. E. Stanfield. 1960. 79 pp. Contains nearly 250 references and abstracts of literature published from 1905 through 1957 on the constitution of kerogen. 45 cents.
- IC 7969. Four Waterflooding Projects in Greenwood County, Kans., 1960, by Kenneth H. Johnston. 1960. 36 pp. 14 figs. Discusses four waterflooding projects—George Sheehan Ellis Unit project, Sinclair Oil and Gas Co. Browning Unit project, Cities Service Oil Co. Teter Unit project, and Wood Oil Co. Wiggins project. Gives history, methods employed, and results obtained from the waterflooding. Work done in cooperation with Kansas State Board of Health. 30 cents.
- IC 7970. Research and Technologic Work on Coal and Related Investigations, 1958, by Staff, Division of Bituminous Coal. 1960. 89 pp. 10 figs. Twenty-third in a series, this report summarizes Bureau research and technologic work on coal, which was directed toward promoting conservation of coal resources through improved production and utilization during the year. 50 cents.
- IC 7971. Iron Mining Methods and Costs, Greenwood Mine, Ishpeming, Mich., by R. C. Annear and W. A. Cole. 1960. 36 pp. 9 figs. Describes open, sublevel, and shrinkage stoping at the Greenwood mine—one of three active hard-ore mines on the Marquette range; presents mining methods and costs and labor, power, and supply records. 30 cents.
- IC 7972. Survey of Oil Production in West Virginia by Waterflooding, 1959 (in Three Parts). 1. Cow Run Sand, St. Mary's Field, Pleasants County, by Charles E. Whieldon, Jr., and Robert M. Meddles. 1960. 14 pp. 7 figs. First in a series describing secondary recovery of oil by waterflooding in various counties in West Virginia, report describes waterflooding operation of Dearborn Oil & Gas Corp. in the Cow Run sand near Calcutta. Part 2, IC 7982, published in 1961, discusses waterflooding in Wetzel County; part 3, IC 8036, published in 1961, discusses waterflooding in Lincoln County. 20 cents.
- IC 7973. Iron and Steel Scrap in California and Nevada, by George C. Branner. 1960. 89 pp. 30 figs. Presents information on the origin, collection,

† Out of print.

- movement, and consumption of iron and steel scrap. 50 cents.
- IC 7974. Administration of the Federal Coal-Mine Safety Act, 1952-59, by James Westfield, H. F. Weaver, and C. M. Keenan. 1960. 70 pp. Covers seventh year of operations under Federal Coal-Mine Safety Act and reviews activities of the Bureau's Division of Coal-Mine Inspection.
- IC 7975. Injury Experience in Quarrying, 1957, by John C. Machisak, Naomi W. Kearney, and Zelda S. Glidden. 1960. 55 pp. Presents statistical data on fatal and nonfatal injuries and related employment at all quarries by States. 40 cents.
- †IC 7976. Injury Experience in Coal Mining, 1955-56. Analysis of Mine Safety Factors, Related Employment, and Production Data, by John C. Machisak, Virginia E. Wrenn, Nina L. Jones, Elizabeth J. Reid, and Dora D. Rice. 1960. 116 pp. 2 figs. Presents data on fatal and nonfatal injuries in bituminous coal and Pennsylvania anthracite mines for 1955 and 1956 and by States for the 2 years. Includes historical data on coal-mine fatality rates for the United States for 1870-1956. 60 cents.
- IC 7977. Injury experience in the Metal Industries, 1956 and 1957, by John C. Machisak, Naomi W. Kearney, and Elizabeth B. Dixon. 1960. 82 pp. Presents data on fatal and nonfatal injuries and employment in the metal mines by States, including Alaska. 50 cents.
- IC 7978. Mechanical Mining In Some Bituminous Coal Mines. Progress Report 9: Face Haulage, by J. J. Shields and J. J. Dowd. 1960. 106 pp. 37 figs. Ninth in a series on mechanical mining in bituminous coal mines, report presents results of studies made of different methods of face haulage used at 13 mines in Pennsylvania, West Virginia, Ohio, and Illinois. 55 cents.
- †IC 7979. Injury Experience in the Nonmetal Industries (Except Stone and Coal), 1956 and 1957, by John C. Machisak, Naomi W. Kearney, and Hazel M. Keener. 1960. 78 pp. Presents injury and employment data for nonmetal mines and mills by States, type of mining, and principal nonmetallic mineral extracted, such as abrasives, asbestos, asphalt, barite, clay, feldspar-mica-quartz, fluorspar, gypsum, magnesite, phosphate rock, potash, pumice, salt, sulfur, talc and soapstone, and other minor nonmetals.
- IC 7980. Lecture and Demonstration on Flame Propagation and Permissible and Explosion-Proof Electrical Equipment, by Hal H. Engel and W. M. Merritts. 1960. 13 pp. 3 figs. Demonstration, one of several safety education features presented by Bureau and developed in connection with its accident-prevention work, shows that regardless of how expensive explosion-proof and permissible enclosures are or how carefully they are installed only a false sense of security exists unless the equipment is properly maintained.
- IC 7981. Development of a Simulated High-Temperature Nuclear Loop, by J. P. McGee, N. H. Coates, and G. E. Fasching. 1960. 17 pp. 11 figs. The nuclear loop described in this report has been operated for more than 1,800 hours at 100 psig; includes discussion of equipment performance. Work done in cooperation with U.S. Atomic Energy Commission. 20 cents.
- IC 7982. Oil Production in West Virginia by Waterflooding, 1959 (in Three Parts). 2. Maxton Sand, Burton Field, Wetzel County, by Charles E. Wheldon, Jr. 1961. 14 pp. 8 figs. Second in a series describing secondary recovery of oil by waterflooding in various counties in West Virginia. This report describes the Barron Kidd Oil Co.'s Santee waterflood project in Wetzel County. Part 1, IC 7972, published in 1960, describes waterflooding in Pleasants County, W. Va.; Part 3, IC 8036, published in 1961, describes waterflooding in Lincoln County. 20 cents.
- IC 7983. Methods and Costs of Producing Brown Iron Ore at Two Small Southern Missouri Mines, by H. D. Kline. 1960. 18 pp. 8 figs. One of a series on mining and milling costs in various districts, report describes methods of mining and washing brown iron ore employed at the Sawyer and Fore mines. 20 cents.
- IC 7984. Fluorspar Mining Methods and Costs, Ozark-Mahoning Co., Hardin County, Ill., by Harold Bailie, E. Powell, William Melcher, and F. J. Myslinski. 1960. 33 pp. 22 figs. Provides information on mining practices applied to flat-bedded fluorspar deposits in southern Illinois. Presents new and improved operating procedures and specialized techniques applicable to deposits of this type. 30 cents.
- IC 7985. Open-Pit Copper Mining Methods and Practices, Copper Cities Division, Miami Copper Co., Gila County, Ariz., by W. R. Hardwick and M. M. Stover. 1960. 51 pp. 35 figs. One of series by the Bureau of Mines on mining methods, practices, and costs at various mining operations, report contains a brief history of the district and describes the Copper Cities deposit. 35 cents.
- †IC 7986. Mining Methods and Costs, Regal Asbestos Mine, Jaquays Mining Corp., Gila County, Ariz., by L. A. Stewart. 1961. 53 pp. 36 figs. Discusses the highly selective mining methods used at the Regal asbestos mine, 45 road miles northeast of Globe, Ariz. Discusses the milling method and tabulates the extraction ratios of the various grades of fiber. The proposed flowsheet of a mill under construction is shown.
- †IC 7987. Injury Experience in Coal Mining, 1957, by John C. Machisak, Virginia E. Wrenn, Nina L. Jones, Elizabeth J. Reid, and Dora D. Rice. 1960. 72 pp. 2 figs. Presents data on fatal and nonfatal injuries in bituminous coal and Pennsylvania anthracite mines in 1957 and by States for the year. Includes historical data on coal-mine fatality rates for the United States for 1870-1957 and injury experience, employment, and production data for 1957. 45 cents.
- †IC 7988. Tentative Safety Recommendations for Field-Mixed Ammonium Nitrate Blasting Agents, by Staff, Bureau of Mines. 1960. 12 pp. Presents safety recommendations covering the preparation, storage, transportation, and use of field-mixed ammonium nitrate blasting agents. (Revised and issued as IC 8179.)
- IC 7989. National First-Aid and Mine Rescue Contest, Buffalo, N.Y., October 5-7, 1959, by H. F. Weaver and D. M. Alden. 1960. 97 pp. 5 figs. Describes the National First-Aid and Mine Rescue Contest, the fifth after a lapse of 21 years, held in the Memorial Auditorium in Buffalo, under auspices of Bureau and Joseph A. Holmes Safety Association. Nine teams from 4 States participated in the mine rescue contest, and 43 teams from 8 States in the first-aid contest. Six teams entered as combination teams, participating in both mine rescue and first-aid contests.
- IC 7990. Manganese Deposits of Eastern Arizona, by L. L. Farnham, L. A. Stewart, and C. W. DeLong. 1961. 178 pp. 24 figs. Briefly describes most of the known manganese deposits of eastern Arizona. The distribution of the deposits by counties is as follows: Cochise, 45; Gila, 37; Pinal, 25; Pima, 13; Greenlee, 13; Santa Cruz, 12; Graham, 4; Navajo,

† Out of print.

Information Circulars

- 1; and Apache, 1. Discusses history, production, ownership, geologic setting, and mining methods.
- IC 7991. Peat Producers in the United States That Reported Production in 1959, by Eugene T. Sheridan and Virginia C. Berté. 1960. 10 pp. 1 fig. Twenty-sixth annual survey by the Bureau of Mines showed that 104 procedures in 19 states reported commercial production of peat in 1959. 15 cents.
- IC 7992. Fuel-Briquetting and Packaged Fuel Plants in the United States That Reported Production in 1959, by Eugene T. Sheridan and Virginia C. Berté. 1960. 5 pp. Survey shows that 15 fuel briquet plants were operating in 8 states and 21 packaged-fuel plants in 7 states in 1959. 15 cents.
- IC 7993. Catalog of Recorded Exploration Drilling and Mine Workings, Tri-State Zinc-Lead District—Missouri, Kansas, and Oklahoma, by Louis C. Brichta. 1960. 13 pp. 8 figs. Summarizes progress made by Bureau in assembling and compiling a catalog of available logs of drill holes and maps of mine developments in the Tri-State district. 60 cents.
- IC 7994. Gasfreeing of Cargo Tanks, by Michael G. Zabetakis. 1961. 10 pp. 6 figs. Outlines a study of gas explosion hazards likely to be encountered while gasfreeing a vessel compartment. Reviews terminology used in gas-explosions work.
- IC 7995. Testing and Splicing Electric Cables and Frame-Grounding Pit Equipment, Tecumseh Coal-Strip Mine, Boonville, Ind., by Sanford J. Douglas. 1960. 17 pp. 4 figs. Describes study by Bureau of devices and methods used for testing and splicing 4,160-volt and 440-volt cables and for providing ground-fault protection for 440-volt circuits at the Tecumseh coal mine, an open-pit operation.
- IC 7996. Coke Plants in the United States on December 31, 1959, by Joseph A. DeCarlo and Maxine M. Otero. 1960. 20 pp. Includes data on number and capacity of beehive and slot-type ovens on December 31, 1959. 20 cents.
- IC 7997. Occurrence, Properties, and Uses of Some Natural Bitumens, by E. P. Carman and F. S. Bayes. 1961. 42 pp. 1 fig. Emphasizes the less common solid and semisolid bitumens, particularly those occurring or used in the United States.
- IC 7998. Research and Technologic Work on Explosives, Explosions, and Flames: Fiscal Years 1955 and 1956, by Ruth F. Brinkley and R. W. Van Dolah. 1961. 31 pp. 10 figs. A biennial report issued to acquaint the reader with the work in explosives and related studies. 30 cents.
- IC 7999. Research and Technologic Work on Explosives, Explosions, and Flames, Fiscal Years 1957 and 1958, by Ruth F. Brinkley and R. W. Van Dolah. 1961. 30 pp. 12 figs. Reviews the activities in these fields during 1957 and 1958 and presents in abstract form the publications prepared by the Bureau that appeared during the period. 25 cents.
- IC 8000. Research and Technologic Work on Explosives, Explosions, and Flames: Fiscal Year 1959, by Ruth F. Brinkley and Robert W. Van Dolah. 1961. 35 pp. 14 figs. Explains mechanisms associated with the combustion and explosion of flammable gases and volatile liquids and provides information on the flammability and explosibility of individual gases and vapors, especially those of industrial and military interest. 30 cents.
- IC 8001. American Standard Practice for Rock-Dusting Underground Bituminous Coal and Lignite Mines to Prevent Coal-Dust Explosions (ASA Standard M13.1-1960, UDC 622.81), sponsored by Bureau of Mines. 1960. 5 pp. Publication is a revision of American Recommended Practice for Rock-Dusting Coal Mines to Prevent Coal-Dust Explosions, M13, sponsored by American Institute of Mining, Metallurgical, and Petroleum Engineers, approved in 1925 and reaffirmed in 1942. Contains recommended practices for the use of rock dust and definitions of the terms employed.
- IC 8002. Methods of Producing Secondary Copper, by Max J. Spendlove. 1961. 41 pp. 14 figs. Consolidates information on secondary copper in one publication. Covers preparation of scrap, smelting low-grade copper scrap and wastes, melting and alloying intermediate-grade copper scrap, refining high-grade copper scrap, and fire refining a specific type of copper scrap.
- †IC 8003. Possible Uses for Bacteria in Metallurgical Operations, by Joseph A. Sutton and John D. Corrick. 1961. 8 pp. Elements of bacteriology and metallurgy are discussed in relation to possible areas where biological science might be applied in extractive metallurgy.
- †IC 8004. Mining Methods and Techniques Used at the Random Longwall Operation, Hecla Mining Co., San Juan County, Utah, by W. L. Dare and P. M. Lindstrom. 1961. 54 pp. 27 figs. Discusses location and physical features, history and production, labor and living conditions, general geology and description of the deposit, exploration, development and mining, the surface plants, production rates, ventilation, and shaft-sinking data.
- IC 8005. Flammable Materials: A Lecture Demonstration, by M. G. Zabetakis and H. H. Engel. 1961. 17 pp. 14 figs. Describes fire and explosion hazards of flammable liquids and solids, oxidizing materials, corrosive liquids, and compressed gases.
- IC 8006. Natural-Gasoline and Cycling Plants in the United States, January 1, 1960, by Ivan F. Avery. 1961. 17 pp. Presents data on the design productive capacity of such plants. Provides tables showing the number of plants by States, the capacity by States and type of natural gas liquid products and plants, the summary by years, 1932-60, and a list of natural-gasoline and cycling plants. 20 cents.
- IC 8007. Heavy Liquids and Procedures for Laboratory Separation of Minerals, by J. S. Browning. 1961. 14 pp. 7 figs. Gives information on the properties of different liquids for separating high-specific-gravity minerals; also discusses sink-float techniques. Work done in cooperation with University of Alabama.
- IC 8008. Coal Research Organizations: Their Activities and Publications, by Mary S. Esfandiary. 1961. 64 pp. Lists government, university, private, and commercial organizations that conduct research and development programs on coal. Areas of investigation include analysis and constitution, mining and geology, preparation, combustion, briquetting, high- and low-temperature carbonization, gasification, hydrogenation, Fischer-Tropsch synthesis, and health and safety.
- †IC 8009. Petroleum Refineries, Including Cracking Plants, in the United States, January 1, 1960, by C. E. Hennig. 1960. 13 pp. Summarizes refinery capacity by years from 1930 to 1960 and by districts and States on January 1, 1960, and cracking plant capacity by years from 1930 to 1960, by types from 1941 to 1960, and by districts and States on January 1, 1960; also lists changes in crude-oil capacity by districts during 1959. 20 cents.
- IC 8010. Comparative Evaluation of Coking Properties of Four Coals, by Staff, Division of Bituminous Coal. 1961. 22 pp. 6 figs. Presents results of tests made by three Bureau laboratories on four coals used industrially for coke production. Covers the collection and analyses of samples, carbonization

† Out of print.

- data and coke properties, the BM-AGA carbonizing apparatus, the 50-pound, 10-inch circular retort, the Bureau's Denver 500-pound experimental slot oven, and the Tuscaloosa 17-inch slot-type experimental coke oven. 25 cents.
- IC 8011. Uranium Mining in the Lukachukai Mountains, Apache County, Ariz., Kerr-McGee Oil Industries, Inc., by W. L. Dare. 1961. 30 pp. 18 figs. One of a series describing methods and costs of mining uranium on the Colorado Plateau. The Navajo Uranium Division of Kerr-McGee Oil Industries, Inc., mines uranium from several deposits of carnotite-type ores, which lie buried in the Lukachukai Mountains on the Navajo Indian Reservation, Apache County.
- IC 8012. Mining, Milling, and Water-Control Methods, Rosiclare Fluorspar Works, Aluminum Co. of America, by Ronald W. Schaefer, William H. Harrison, and Frank J. Myslinski. 1961. 52 pp. 23 figs. Describes operations at the Hardin County, Ill., site. Provides information on methods and procedures employed in mining steeply dipping fluorspar veins, 3 to 20 feet wide. Covers exploration, development, mining and milling practices, and mine-drainage problems.
- IC 8013. Reconnaissance of Selected Pegmatite Districts in North-Central New Mexico, by D. E. Redmon. 1961. 79 pp. 19 figs. Reveals the locations and general features of 90 pegmatites found in this area.
- IC 8014. Tungsten Deposits in Utah, by F. D. Everett. 1961. 44 pp. 11 figs. Describes mineral areas, inferred reserves, and production practices and problems. Includes bibliography.
- IC 8015. Uranium Mining Methods and Costs at Several Mines on the Colorado Plateau, by W. L. Dare. 1961. 48 pp. 19 figs. Considers information gathered between 1955 and 1958 on the following eight small mines: Vanura, Smith-Lucas, Jack Rabbitt, Ringtail, Frisco, Veta Mad, La Salle on Club Mesa, and La Salle on Beaver Mesa. The data should permit estimates of future costs at similar deposits. 45 cents.
- IC 8016. Mining Methods and Practices, Hurricane Creek Bauxite Mine, Reynolds Mining Corp., Saline County, Ark., by Raymond G. Travis. 1961. 19 pp. 13 figs. A relatively high recovery of bauxite is obtained at this mine despite unconsolidated water-bearing overburden and an unstable clay floor. Controlled caving, timbered stope walls, and efficient drainage systems on the surface and underground have minimized the problems and raised ore recovery to about 25 percent more than that formerly obtained. Report includes history, description of deposit, development methods, mining, ventilation, mine drainage, ore recovery, and safety and health summary.
- †IC 8017. Summary of Mining and Petroleum Laws of the World, by Northcutt Ely. 1961. 215 pp. Summarizes the mining and petroleum laws of the countries of the world; primary attention is given to the requirements that must be met within the country for the acquisition of concessions or other forms of tenure to permit the development of its mineral resources. \$1.
- IC 8018. Helium Production at the Bureau of Mines Keyes, Okla., Plant, by M. M. Deaton and R. D. Hayes. 1961. 16 pp. 9 figs. Presents pertinent, technical, and detailed information on operation and production costs of the Bureau of Mines helium extraction plant.
- IC 8019. Use of the High-Expansion Foam on a Pennsylvania Coal-Mine Fire, by T. J. McDonald. 1961. 7 pp. 2 figs. Reviews methods used and results obtained with high-expansion foam in an operating mine. Represents first instance where foam was applied extensively to a fire under actual mining conditions.
- IC 8020. Estimated Costs of Gasifying Coal in Place: A Study Based on Electrolinking and Hydraulic Fracturing Experiments of the Bureau of Mines, by Sidney Katell and John H. Faber. 1961. 12 pp. 2 figs. Presents an economic analysis of underground gasification of coal and indicates the cost of producing a gas for use in a powerplant. Major factors influencing operating costs are height of overburden, power costs, thermal efficiency, and the gasification air inlet pressure.
- IC 8021. Dust Control in Mining, Tunneling, and Quarrying in the United States, 1955 Through 1957, by Floyd G. Anderson and R. L. Evans. 1961. 25 pp. Summarizes the control measures applicable to these conditions that were studied in 1955, 1956, and 1957. Includes pneumonconiosis statistics; dust prevention and suppression practices; airborne dust sampling, measurement, and analysis; use of respiratory protective equipment; education and training of personnel; legislation; and research.
- IC 8022. The National Safety Competition of 1959, by John C. Machisak, Virginia E. Wrenn, and Elizabeth K. Elsner. 1961. 39 pp. Reviews the accomplishments of participants in the 1959 National Safety Competition, a contest conducted annually by the Bureau of Mines in cooperation with The Explosives Engineer magazine. A Sentinels of Safety trophy is awarded annually to the winning participant in each of the following six groups: Anthracite, bituminous coal, metal, nonmetal, open-pit, and quarry.
- IC 8023. The Soviet Seven-Year Plan (1959-65) for Oil, by Donald J. Frenzdel. 1961. 17 pp. 1 fig. Tells of expansion plan for the Soviet petroleum industry. Based on U.S.S.R. reports. Includes maps and list of references.
- IC 8024. Costs of Mining Under Bolted Roof and Timbered Roof in Bituminous Coal Mines, by M. J. Ackerman and J. J. Wallace. 1961. 21 pp. Describes studies made at 14 mines to compare the costs of the two methods.
- †IC 8025. Free-Swelling and Grindability Indexes of United States Coals, by Roy F. Abernethy and E. M. Cochrane. 1961. 83 pp. 4 figs. Contains the free-swelling indexes for 2,812 samples received from January 1948 to July 1957 and the Hardgrove grindability indexes for 2,339 samples received from June 1947 to July 1957. 50 cents.
- IC 8026. Injury Experience in Coal Mining, 1958, by John C. Machisak, Virginia E. Wrenn, Nina L. Jones, Elizabeth J. Reid, and Dora D. Rice. 1961. 67 pp. 2 figs. Presents injury experience data, with related employment statistics, in United States.
- †IC 8027. Drill-Dust Collectors and Drilling Equipment With Integral Dust-Collecting Systems Approved by the Bureau of Mines as of January 31, 1961, by Floyd G. Anderson and R. L. Evans. 1961. 28 pp. 18 figs. Discusses requirements and procedure for obtaining certificates of performance and lists equipment certified as permissible under Schedule 25.
- IC 8028. Mining and Milling Methods and Costs, Madison Mine, National Lead Co., St. Louis Smelting and Refining Division, Madison County, Mo., by H. D. Kline, W. A. Calhoun, and B. M. Reynolds. 1961. 26 pp. 13 figs. One of a series on methods, practices, and costs of mining and millings in the United States. Indicates that commercial quantities of sulfides of copper, nickel, and cobalt occur with lead sulfide.

† Out of print.

- †IC 8029. Sinking a Large-Diameter, Concrete-Lined Access Shaft: Harold D. Roberts Tunnel, Colorado, by R. L. Bolmer. 1961. 70 pp. 48 figs. Describes applications of modern methods and equipment used in sinking heavy access shafts that can be adaptable to mine development.
- IC 8030. Manganese Deposits of New Mexico, by Lloyd L. Farnham. 1961. 176 pp. 27 figs. Includes the location, history, production, ownership, geologic setting, and mining methods for most of the known manganese deposits in New Mexico. The counties that contain all the known manganese deposits are Catron, Dona Ana, Grant, Hidalgo, Luna, Rio Arriba, Sandoval, Santa Fe, Sierra, Socorro, San Juan, and Taos. \$1.
- IC 8031. Recommended Procedures for Mine Hoist and Shaft Installation, Inspection, and Maintenance., by W. Dan Walker, Jr., and R. W. Stahl. 1961. 16 pp. 6 figs. Indicates the essential elements pertaining to safe installation and maintenance of hoisting equipment.
- IC 8032. Pulverizing Lignite in a North Dakota Powerplant, by R. C. Ellman and J. W. Belter. 1961. 31 pp. 9 figs. Describes two series of tests on lignite pulverization with in-the-mill drying. Represents an attempt to determine power consumption, fineness and moisture content of product, and other detailed operating characteristics of the lignite pulverizing unit. The primary variable in the tests was lignite feed rate, and the operating characteristics were determined at feed rates ranging from 6,500 to 10,000 lb/hr.
- †IC 8033. Mining and Furnacing Mercury Ore at the New Idria Mine, San Benito County, Calif., by R. K. Linn and W. F. Dietrich. 1961. 35 pp. 14 figs. Discusses exploration, development, and conservation methods of the mine.
- IC 8034. Bibliography of Bureau of Mines Articles on Thermodynamics of Petroleum Constituents and Related Compounds: January 1, 1944–December 31, 1960, by J. P. McCullough. 1961. 49 pp. This report, prepared in response to many requests, presents abstracts of 95 papers published in the outside press. Besides providing new thermodynamic data, these papers describe advances in experimental techniques and new theoretical developments. They cover the Bureau's long-range research on the thermodynamics of hydrocarbons and hydrocarbon derivatives containing sulfur, nitrogen, fluorine, and metals.
- †IC 8035. Bibliography of Investment and Operating Costs for Chemical and Petroleum Plants, January–December 1960, by Sidney Katell, John H. Faber, and Mary Jo Williams. 1961. 96 pp. The abstracted articles are concerned with all facets of cost engineering in petroleum and chemical plants and related facilities. The bibliography contains references to construction and operating costs and to cost estimating methods and theory. Work done in cooperation with American Association of Cost Engineers. 50 cents.
- IC 8036. Oil Production in West Virginia by Waterflooding, 1959 (in Three Parts). 3. Berea Sand, Griffithsville Field, by Charles E. Whieldon, Jr. 1961. 12 pp. 7 figs. Third in a series describing secondary recovery of oil by waterflooding in various counties in West Virginia. This report describes South Penn. Oil Co. Yawkey waterflood project in Lincoln County. Part 1, IC 7972, published in 1960, considers waterflooding in Pleasant County; Part 2, IC 7982, published in 1961, discusses waterflooding in Wetzel County.
- IC 8037. Magnetite and Ilmenite Resources, Iron Mountain Area, Albany County, Wyo., by V. T. Dow. 1961. 133 pp. 30 figs. Summarizes exploration of the area's titaniferous iron deposits, by the Bureau of Mines and Union Pacific Railroad, and beneficiation work on the magnetite-ilmenite, by the Bureau of Mines.
- IC 8038. Developments in Waterflooding and Pressure Maintenance in Osage County, Okla.. Oilfields, 1961, by Kenneth H. Johnston and Joe L. Castagno. 1961. 38 pp. 17 figs. Information on each project covered in this report includes the early history, methods used to complete wells, source and treatment of water, description of automatic custody-transfer systems, oil-production-decline curves, mineral analyses of waters, typical electrical logs and core analyses, development maps, and results of waterflooding. Prepared in cooperation with the Oklahoma Corporation Commission, State of Oklahoma.
- IC 8039. Spectrochemical Analysis of High-Purity Metals: A Review and Bibliography of Recent Literature, by Maurice J. Peterson. 1961. 47 pp. Considers optical spectrochemical methods of analysis for determining trace impurities in metals. Includes a bibliography containing abstracts of recent methods. 35 cents.
- IC 8040. Kyanite. A Material Survey, by T. A. Klinefelter and James D. Cooper, with a chapter on Resources, by G. H. Espenshade. 1961. 55 pp. 5 figs. Covers properties, uses, resources, technology, supply distribution, and development of the mineral. Survey was prepared for the Office of the Civil and Defense Mobilization. Includes bibliography. 40 cents.
- IC 8041. Peat Producers in the United States in 1960, by Eugene T. Sheridan and Virginia C. Berté. 1961. 11 pp. 1 fig. Lists all producers that reported commercial production to the Bureau for 1960 and presents data on individual plants.
- †IC 8042. Administration of the Federal Coal-Mine Safety Act, 1952–60, by James Westfield, H. F. Weaver, and C. M. Keenan. 1961. 68 pp. Covers a report of the Bureau's Division of Coal-Mine Inspection for the calendar years 1952–60, as transmitted annually to the Congress by the Secretary of the Interior, pursuant to the requirements of the Federal Coal-Mine Safety Act.
- IC 8043. Recent Development in Fire-Resistant Hydraulic Fluids for Underground Use, by Samuel P. Polack, Allen F. Smith, and Henry P. Barthe. 1961. 32 pp. 9 figs. Discusses fire hazards occurring in coal mines when flammable petroleum hydraulic oils are used to actuate mining equipment and summarizes research on fire-resistant hydraulic fluids.
- IC 8044. Cost Accounting and Control at Calumet Division, Calumet & Hecla, Inc., Calumet, Mich., by B. C. Peterson, E. R. Nelson, and William A. Beck. 1962. 37 pp. 23 figs. Describes the successful use of cost accounting. Indicates that the constant control of cost in modern mining operations is essential if the increase in fixed costs relative to the cost of metal continues. 30 cents.
- †IC 8045. Trends in Alaska's Mineral Industry, by Alvin Kaufman. 1961. 43 pp. 6 figs. Delineates the problems and forecasts the growth of the mineral industries in Alaska.
- IC 8046. Trends and Outlook in the Pacific Northwest Aluminum Industry, by Frank B. Fulkerson. 1962. 42 pp. Aluminum production in the Pacific Northwest has a potential for expansion and increased stability of operation. This potential results from greater availability of power, lower freight rates on alumina and aluminum, good market prospects, and the possibility of developing bauxite deposits and other mineral resources in the Pacific Basin. 30 cents.

† Out of print.

- IC 8047. Methods in Driving the 5490 Railroad Tunnel, Kennecott Copper Corp., Salt Lake City, Utah, by V. T. Dow, F. D. Everett, and S. R. Wilson. 1962. 40 pp. 34 figs. Describes construction details and methods used in driving the tunnel that will provide railroad access to the world-famous open-pit copper mine at Bingham, Utah. Includes a description of the operating cycle, equipment, engineering practices, and performance data.
- IC 8048. Bibliography of Zirconium: Supplement to Information Circulars 7771 and 7830, by Eleanor Abshire. 1962. 99 pp. This bibliography is the third in a series that covers current technical literature on metallurgy of zirconium. It is the result of a cooperative project by the Bureau of Ships, U.S. Department of the Navy, and the Bureau of Mines to accumulate literature for interested research organizations or libraries in the Zirconium Information Center at the Bureau's Albany, Oreg., station. Includes 780 literature references and 107 U.S. and foreign patents. 50 cents.
- IC 8049. Bibliography of Bureau of Mines Investigations of Coal and Its Products, 1910-60, by Staff, Division of Bituminous Coal. 1962. 161 pp. Lists more than 5,000 reports by members of the Bureau (including those published by the Bureau, by journals of various societies, and by the technical and trade press). Replaces earlier Bureau bibliographies that appeared as B 528, IC 7825, and Technical Papers 576, 639, and 698. \$1.
- IC 8050. The Pacific Northwest Ferroalloy Industry, by Gary A. Kingston. 1962. 26 pp. 23 figs. Considers the status and potential of the ferroalloy industry in the Pacific Northwest. Includes information from operating alloy plants in Oregon, Washington, Idaho, and Montana; from published materials; and from consumers of ferroalloys. 25 cents.
- IC 8051. Mining Methods of the Fort Dodge Limestone Company, Inc., Fort Dodge, Iowa, by L. G. Marshall. 1962. 13 pp. 6 figs. Describes mining methods and performance at the underground operations of Limestone Mine No. 1. 20 cents.
- IC 8052. Fuel-Briquet and Packaged-Fuel Plants in the United States in 1960, by Eugene T. Sheridan and Virginia C. Berté. 1961. 5 pp. Lists all producers that reported commercial production to the Bureau for 1960 and furnishes annual capacity and production data.
- IC 8053. Lithium. A Materials Survey, by Albert E. Schreck. 1961. 81 pp. 6 figs. Discusses uses, properties, resources, technology, supply, research, and development of the mineral. Survey was prepared for the Office of Civil and Defense Mobilization. 50 cents.
- IC 8054. Hydrogenation of Low-Temperature Coal Tar and Related Materials: A Summary of the Literature, by Howard W. Wainright. 1961. 85 pp. Summarizes information presented during the past 25 years on the hydrogenation of low-temperature tars and related substances. Published articles and patents not abstracted in the main body of this report are included in a bibliography at the end. 50 cents.
- IC 8055. India's Iron and Steel Industry, by Lot-follah Nahai. 1961. 40 pp. 10 figs. Covers India's third 5-year plan for expanding steel production. Presents structure of the industry, principal producers, method of financing three new Government-owned plants, and plant details. Includes bibliography. 50 cents.
- †IC 8056. Yieldable Steel Arches and Yieldable Steel Ring Supports in Metal Mines, by N. A. Ellertsen. 1962. 55 pp. 64 figs. Presents results of study of artificial support for stabilizing openings in weak or incompetent rock in metal mines. Describes yieldable arch and ring supports and cost of installing yieldable steel sets.
- IC 8057. A Method of Analyzing Demand for Mineral Commodities: A Case Study of Salt, by Richard S. Watt. 1962. 35 pp. 10 figs. Presents one of the methods developed by the Bureau for analyzing the demand for any industrial new material and illustrates the method with a case study of salt demand.
- IC 8058. Waterborne Wastes and Water Use by Metal-Processing Industries in the Missouri River Basin, Kansas and Missouri, by Harvard Eng and H. Kenworthy. 1961. 26 pp. 1 fig. Results of a survey show that considerable quantities of waterborne wastes originate from metal-processing industries. Conclusions and recommendations regarding a solution are based on data obtained from plant interviews. (See also IC 8108.) 25 cents.
- IC 8059. Bureau of Mines Publication on Coal Preparation, 1910-60, by Albert W. Deurbrouck. 1961. 29 pp. Lists 150 technical and scientific publications that document the Nation's progress in fuel technology. Includes index.
- IC 8060. Vanadium. A Materials Survey, by Philip M. Busch, with chapters on Geochemistry and Geology of Vanadium, and Resources, by R. P. Fischer. 1961. 95 pp. 21 figs. Summarizes the supply-demand position of the United States. Includes chapters on properties, products, and uses; historical background; geochemistry and geology; resources; technology; supply and distribution; structure of vanadium industry; research and development; and legislation and Government controls. \$1.
- IC 8061. Coke Plants in the United States on December 31, 1960, by Joseph A. DeCarlo and Maxine M. Otero. 1961. 20 pp. Presents data for 1960 on all oven-coke plants in existence at yearend; also includes information on beehive plants on which reports were submitted to the Bureau. 20 cents.
- †IC 8062. Petroleum Refineries, Including Cracking Plants, in the United States, January 1, 1961, by C. E. Hennig. 1961. 12 pp. Contains data on crude oil capacity and cracked and reformed gasoline capacity in the United States. 15 cents.
- IC 8063. Foreign Literature on Coal: A Guide to Abstracts and Translations, by Mary S. Esfandiary. 1961. 46 pp. Describes sources available used to obtain information on foreign coal technology.
- IC 8064. Copper, Lead, and Zinc in Three Recessions Following World War II, by Staff, Office of Chief Economist. 1961. 79 pp. 78 figs. Relates the status of the base-metals industries to the shifts in the United States economy since World War II. Covers production, consumption, employment, stocks, prices, average weekly hours, and average hourly earnings.
- †IC 8065. Conversion of Coal to Fluid Fuels: Abstracts of Selected German Patent Applications, by Ignaz Lichtig. 1961. 112 pp. German patents have been particularly useful in this field because both processes for the complete conversion of coal to fluid fuels originated in Germany and were thoroughly investigated there because of the shortage of indigenous fluid fuels. Patents cover chemical processes and apparatus, furnace installations, gas production by degasification of fuels, wet methods of producing fuel gas, production of fuel gas by carbureting, and purification of distillation gas and of acetylene.
- IC 8066. Instruction Handbook: Fundamentals of Accident Prevention for Coal-Mine Supervisors, by W. H. Tomlinson. 1962. 140 pp. 84 figs. Presents

† Out of print.

- the basic text for a 20-hour accident-prevention training course developed for supervisors by the Bureau. During the past 2 years, the course has been used by the Bureau to teach more than 300 groups of coal-mine supervisors—men whose responsibility is to manage production and maintenance phases of coal mining and to guide their men regarding safe procedures.
- IC 8067. Injury Experience in Coal Mining, 1959. Analysis of Mine Safety Factors, Related Employment and Production Data, by John C. Machisak, Virginia E. Wrenn, Nina L. Jones, Elizabeth J. Reid, and Dora D. Rice. 1961. 61 pp. 3 figs. Discusses general and selected injury data, injury experience by States, major disasters, and historical coal-mine-fatality experience.
- IC 8068. Mining and Milling Methods and Costs, Vermont Asbestos Mines, The Ruberoid Co., Hyde Park, Vt., by H. L. Burmeister and I. E. Matthews. 1962. 43 pp. 33 figs. Describes all phases of mining and milling practices at an open-pit asbestos mine. Methods employed in exploration, sampling, and estimation of tonnage and grade are outlined. Breakdown of costs is given.
- IC 8069. An Economic Analysis of Underground Gasification of Coal, by G. D. Bakulev; translated by A. Kahane; edited by J. L. Elder. 1962. 94 pp. Represents a translation of a Soviet publication. The objective of the work described was to investigate the present and future economic problems involved in the underground gasification process. Briefly discusses the history and early development of the process.
- IC 8070. Permissible Mine Equipment Approved by the Bureau of Mines During 1959-60, With Appended Lists of Manufacturers of Flame-Resistant Trailing Cables and Fire-Resistant Conveyor Belts and Holders of Permits, by R. A. Kearns and F. R. Lee. 1961. 20 pp. Lists permissible mine equipment that supplements B 543, IC 7722, 7840, and 7957. Also includes equipment meeting Bureau of Mines standards that have been revised since IC 7957 was issued. Appendixes list manufacturers of flame-resistant trailing cables and fire-resistant belts.
- IC 8071. Quadratic Functions for Copper Radiation, 0° to $180^\circ 2\theta$, by Gerald V. Gibbs and Ronald M. Lewis. 1961. 43 pp. Quadratic functions, $Q(hkl)$, are given to six places in increments of 0.01 for 2θ from 0° to 90° for $CuK\alpha$ and from 25° to 180° for $CuK\alpha_1$.
- IC 8072. Quadratic Functions for Iron Radiation, 0° to $180^\circ 2\theta$, by Ronald M. Lewis and Gerald V. Gibbs. 1961. 43 pp. Quadratic functions, $Q(hkl)$, are given to six places in increments of 0.01° for 2θ from 0° to 90° for $FeK\alpha$ and from 25° to 180° for $FeK\alpha_1$.
- IC 8073. The Pacific Northwest Steel Industry, by Gary A. Kingston and Frank B. Fulkerson. 1962. 45 pp. 13 figs. Discusses production, costs, and markets for steel produced in Washington and Oregon. Forecasts future production and consumption of steel in these two States. 35 cents.
- IC 8074. Methods and Practices for Producing Crushed Granite, Columbia Operation, Palmetto Quarries Co., Columbia, S.C., by N. A. Pace, H. J. Schroeder, and H. L. Riley. 1962. 19 pp. 7 figs. Presents method of mining and preparing crushed stone for market requirements. Development, mining, processing, maintenance and repairs, auxiliary operations, and power distribution are of particular interest.
- IC 8075. Microbiology of Coal, by Martin H. Rogoff, Irving Wender, and Robert B. Anderson. 1962. 85 pp. 7 figs. Combines critical review of the literature of microbiology of coal with an introduction to those areas of microbiology related to studies of coal as a biological material. Role of microorganisms in coalification is explored.
- IC 8076. Processes for Recovering Sulfur From Secondary Source Materials, by B. K. Shibley and M. W. Hovey. 1962. 62 pp. Summarizes results of a literature survey and describes the more important processes that have been used or suggested for recovering sulfur and sulfur compounds from all non-Frasch sources. Includes a bibliography of available English language literature through 1958. 40 cents.
- IC 8077. Injury Experience in Quarrying, 1958, by John C. Machisak, Virginia E. Wrenn, Naomi W. Kearney, and Zeldia S. Glidden. 1962. 58 pp. Gives data on the number of injuries, injury frequency rates, work location, accident agency, and degree of injury for employees of the quarrying industry.
- †IC 8078. Tungsten Deposits of Gila, Yavapai, and Mohave Counties, Ariz., by V. B. Dale. 1961. 104 pp. 40 figs. Describes most of the known tungsten deposits in the three counties. Production figures are given for each deposit, where known, and for each county. Ore reserve estimates are made for each county.
- IC 8079. Physical Properties of Aromatic Ethers: A Literature Survey of 1,024 Compounds, by Clarence Karr, Jr. 1962. 75 pp. Presents the results of an investigation of the ether constituents of low-temperature tar. Lists the physical properties of 1,024 aromatic ethers. The compounds are divided in to 37 groups, ranging in complexity from the alkoxybenzenes to dibenzopyrans.
- IC 8080. Progress in Controlling Acid Mine Water: A Literature Review, by Walter C. Lorenz. 1962. 40 pp. 11 figs. Summarizes research reports written on the problems of controlling acid mine water, which have been studied for the past 40 years. Measures to prevent pollution included neutralization of acid mine water from underground and strip mines, sealing of underground mines, segregation and sealing of acid-forming material, and drainage control.
- IC 8081. Proposed Standardization of Coal Mine Examination Records, by Harry A. Schreengost. 1962. 16 pp. Describes forms designed to provide clarity, accuracy, and uniformity. These forms will aid mine officials in recording the results of examinations made by preshift examiners (fire bosses), assistant foremen, (section foremen, shift foremen, and face bosses), mine foremen (mine managers), weekly mine examiners, air measurers, and examiners of fans, shafts, and hoisting equipment.
- IC 8082. Rare-Earth Compounds as High-Temperature Refractories: A Bibliography, by Sara Jane Boles. 1962. 70 pp. Prepared for use of ceramic industry as a guide for locating and utilizing scattered and fragmentary information available, report includes more than 200 abstracts. Temperature of $1,500^\circ C$ is the lower limit for reported data on thermal properties.
- IC 8083. Lead. A Materials Survey, by H. M. Callaway. 1962. 194 pp. 32 figs. Presents all available data pertinent to supply-demand situation; gives statistics on production consumption, reserves, and capacities; and discusses technology of mining, processing, and fabrication. Includes chapters on research and development, legislation and Government programs, and strategic factors relating to lead. This revised survey, originally published in 1951, was prepared with the cooperation

† Out of print.

- of the Geological Survey for the Office of Civil and Defense Mobilization. \$1.25.
- †IC 8084. Methods and Costs of Mining and Crushing Limestone at Three Quarries, Anderson-Oxandale Rock Co., Kansas, by H. D. Kline. 1962. 15 pp. 12 figs. Describes the Bosse quarry, Pottawatomie County; Hansen quarry, Morris County; and Huston quarry, Dickinson County. Includes information on the deposits, exploration, stripping, drilling and blasting, loading and hauling, crushing and stockpiling, and on costs.
- IC 8085. Equipment, Accessories, and Procedure for Fighting Mine Fires With High-Expansion Foam, by R. Ward Stahl. 1962. 36 pp. 27 figs. Considers foam generators, examines a procedure adopted by some companies in event of fire, and suggest procedures for mock fire drills.
- IC 8086. Sinking Methods and Costs for a Small Vertical Shaft With Steel Supports: Keystone Mine, Crested Butte, Colo., by R. L. Bolmer. 1962. 25 pp. 19 figs. Describes methods and costs of sinking a mine shaft in massive sandstone. Direct sinking cost is given in detail in dollars and in units of labor, power, material, and supplies.
- IC 8087. Active List of Permissible Explosives and Blasting Devices Approved Before February 28, 1961, by N. E. Hanna. 1962. 10 pp. Gives all permissible explosives (gelatinous and nongelatinous) and permissible blasting devices on the active list as of February 28, 1961.
- IC 8088. Coal-Mine Hazards Caused by Electrolysis, by Clyde L. Brown. 1962. 12 pp. 5 figs. Discusses some of the electrolysis hazards in the coal-mining industry and outlines corrective measures that may be taken to alleviate them.
- IC 8089. Proceedings: Tenth International Conference of Directors of Safety in Mines Research, compiled by Ruth F. Brinkley and Robert W. Van Dolah. 1962. 216 pp. 6 figs. Comprises summaries and discussions of 70 papers presented at eight technical sessions of the International Conference held at Pittsburgh, Pa., in 1959. Papers dealt with safety of coal mine explosives and explosion hazards, ignition, and fires in mines. Representatives from Belgium, Canada, Colombia, France, Germany, Great Britain, Indonesia, Japan, Korea, Mexico, the Netherlands, Poland, and the United States were present.
- IC 8090. Prevailing Practices in Splicing Electric Trailing Cables in Coal Mines, by Fred A. Williams and William R. Devett. 1962. 19 pp. Gives data on 232 splices that revealed that only 3 percent had all the characteristics desirable in splicing techniques. Shows the need of higher standards of cable repair and care.
- IC 8091. A Study of Mine Examination Techniques for Detecting and Identifying Underground Nuclear Explosions, by the Staff, Bureau of Mines. 1962. 73 pp. 39 figs. Presents a study of mine-examining techniques that might aid in the detection and identification of underground nuclear explosions. Reviews previous work, evaluates suggested techniques and clues, recommends additional methods, and determines the feasibility of detection by onsite mine inspection based on existing knowledge.
- IC 8092. Sand and Gravel Operations and Costs, Construction Aggregates Corp., Ferrysburg, Mich., by William A. Beck. 1962. 26 pp. 21 figs. Describes the mining and processing of sand in an efficient, fully mechanized plant. Covers history; geology; prospecting and reserves; stripping; excavation and transportation; safety methods; labor organization; fire protection; power, rail transportation, and plant property; and performance.
- IC 8093. Evaluation of Washery Performance, by M. R. Geer and H. F. Yancey. 1962. 19 pp. 7 figs. Gives details of criteria for performance of coal-cleaning equipment that are dependent on or independent of the nature of the raw coal and describes how these criteria may be used to predict cleaning results. Work done in cooperation with School of Mineral Engineering, University of Washington.
- IC 8094. Sulfur Production and Consumption in Eight Western States: Arizona, Colorado, Nebraska, New Mexico, North Dakota, South Dakota, Utah, and Wyoming, by F. J. Kelly. 1962. 85 pp. 49 figs. Survey was made of the resources, production, consumption, and economic future of the sulfur and sulfuric acid industry in eight Western States. Purpose of survey was to review the demand for sulfur and primary sulfur compounds that draws upon the natural resources of the region, to discover opportunities for better use of these resources, and to analyze and evaluate the patterns of consumption, sources of supply, and other factors that affect the demand for these mineral products.
- IC 8095. Methods and Costs of Mining and Washing Manganese Ore, Batesville District, Arkansas, by H. D. Kline. 1962. 22 pp. 11 figs. Discusses methods and costs of mining and washing manganese ore produced by three operators in Independence County, Ark., whose mining and ore-recovery methods may be considered typical of the local manganese producers of the Batesville district.
- IC 8096. Changing Trends in the Use of Coke in the United States, by Harry Perry, Eugene T. Sheridan, and Joseph A. DeCarlo. 1962. 31 pp. 6 figs. Reviews the history of the coke industry and the changes that have occurred in the use of coke. Evaluates the potential effects of innovations in blast-furnace operations and forecasts requirements for metallurgical coke.
- IC 8097. Industrial Engineering Practice at Selected Metal Mines in Western States, by Donald E. Redmon. 1962. 81 pp. 23 figs. Presents information based on experiences of relatively new and successful industrial engineering departments at selected Western mines. Emphasis is placed on time-study practice, collection of work-measurement data, analysis of data, and desirability of standard-time data. A proposed standard-symbol nomenclature for time study of mining operations is presented. 50 cents.
- IC 8098. Bureau of Mines Research and Technologic Work on Coal, 1959, by the Staff, Bureau of Mines. 1962. 119 pp. 39 figs. Presents highlights of the Bureau's work during the year, details of which have been or will be published as separate reports. Report is 24th in a series summarizing research on coal and related investigations directed toward promoting conservation of coal resources through improved production and utilization.
- IC 8099. Use of High-Speed Data Reduction and Processing in the Mineral Industry, by Richard F. Hewlett. 1962. 82 pp. 4 figs. Indicates techniques that can be applied by industry. Reviews existing computer programs or processing methods, including calculation times and costs. 50 cents.
- IC 8100. Minerals in Japan's Industrial Economy, By K. P. Wang. 1962. 37 pp. 2 figs. Reviews the mineral industry of Japan from the point of view of raw-material supply, mineral-processing capacity, domestic and foreign markets, management and capital, technology, role of Government, and future outlook. 30 cents.
- IC 8101. The National Safety Competition of 1960, by John C. Machisak, Virginia E. Wrenn, and Elizabeth K. Elsner. 1962. 44 pp. Lists mines and quarries that ranked first through fifth in their

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Information Circulars

- competitive groups (anthracite, bituminous coal, metal, nonmetal, open-pit, and quarry) and summarizes achievements in preventing disabling injuries at all of the 675 mines and quarries that participated in the 36th annual competition.
- IC 8102. Injury Experience in the Metal Industries, 1958, by John C. Machisak, Virginia E. Wrenn, Naomi W. Kearney, and Elizabeth B. Dixon. 1962. 75 pp. Presents data on injury experience and employment at metal mines and metallurgical plants in the United States, including Alaska, for the calendar year 1958, and historical injury experience in the metal mining industry during 1951-58.
- IC 8103. Cobalt. A Materials Survey, by Joseph H. Bilbrey, Jr. 1962. 140 pp. 19 figs. Summarizes the supply-demand position of the United States. Includes chapters on forms and uses, history, resources, technology, structure of the industry, research and development, and legislation and Government controls. This revised survey, originally published in 1952, was prepared for the Office of Civil and Defense Mobilization. \$1.
- IC 8104. Mining, Milling, and Smelting Methods, San Manuel Copper Corp., Pinal County, Ariz., by V. B. Dale. 1962. 145 pp. 102 figs. Discusses a modern block-caving operation producing 33,000 tons per day. Cost cutting at this underground mine is imperative because the ore averages only 0.78 percent copper; the important cost-cutting practices are discussed in detail. \$1.50.
- IC 8105. Predicting Suitability of Variable-Composition Liquefied Petroleum Gases for Use in Appliances, by Joseph Grumer. 1962. 12 pp. 3 figs. Calculations are made establishing minimum concentrations of butane in liquefied petroleum gas (butane) cylinders for good flexibility in performance of existing appliances. Nearly pure butane is the minimum composition needed for adjustment of butane-burning appliances. Appliances should be able to burn either propane or butane properly when adjusted with either of the two fuels. When only one of the fuels is available, either fuel can be made equivalent to the other for burner adjustment purposes by making a suitable change in gasline pressure. 20 cents.
- IC 8106. Research and Technologic Work on Explosives, Explosions, and Flames: Fiscal Year 1960, by Ruth F. Brinkley and Robert W. Van Dolah. 1962. 39 pp. 24 figs. Reviews the activities in these fields during the fiscal year and presents in abstract form the publications that appeared during the report period. 30 cents.
- IC 8107. Platinum Expansion Values for Thermal Calibration of High-Temperature X-Ray Diffraction Cameras and Diffractometers, by William J. Campbell. 1962. 9 pp. 1 fig. Evaluates accuracy of temperature measurements based on expansion of platinum added as an internal standard; presents tabular expansion values for platinum from 26° to 1,700° C in 2-degree intervals. 15 cents.
- IC 8108. Waterborne Mineral Wastes and Water Uses of Various Industries in the Lower Missouri River Basin, by Roy F. Waters and H. Kenworthy. 1962. 36 pp. Gives results of an inventory made of wastes of mineral origin, water requirements, treatment of wastes, and water treatment practices of 163 industrial installations. Report is second in a survey conducted in cooperation with the Missouri Basin Field Committee of the U.S. Department of the Interior as part of the Missouri basin project. The first report, issued as IC 8058 in 1961, covered most of the metal-processing industries. 30 cents.
- IC 8109. Mining and Furnacing Methods and Costs, Abbott Mine, COG Minerals Corp., Lake County, Calif., by A. C. Johnson and F. D. Hanson. 1962. 35 pp. 14 figs. Describes the entire operation from initial exploration to actual production of mercury at a mine that operates on a high-cost, comparatively small-scale basis. 60 cents.
- IC 8110. Uses and Properties of Magnesia as a Superrefractory for Temperatures Above 1,500° C.: A Bibliography, by Sara Jane Boles. 1962. 41 pp. Contains nearly 150 references, most of which cover magnesium in a pure state. However, several discuss the effect of minor impurities on the properties of magnesia. A few references to articles on forming techniques are also included.
- IC 8111. Water as an Inert for Neutralizing the Coal Dust Explosion Hazard, by Donald W. Mitchell and John Nagy. 1962. 12 pp. 12 figs. Summarizes current knowledge on the use of water as an inert in U.S. coal mines, with particular regard to its use as a supplement to and substitute for generalized rock dusting.
- IC 8112. Industrial Silica Deposits of the Pacific Northwest, by George J. Carter, Hal J. Kelly, and E. W. Parsons. 1962. 57 pp. 11 figs. Gives results of investigation of 82 known silica deposits. Of 37 deposits found to be of high quality, 16 were large enough to be classified as industrial silica resources. 40 cents.
- IC 8113. Survey of Practices in Controlling Roof at Intersections and Junctions in Underground Coal Mines, by R. Ward Stahl. 1962. 13 pp. 13 figs. Surveys the junction-support systems in use in the United States and recommends procedures to protect these critical areas in mines; although the exposed roof at intersections rarely exceeds 15 percent of the total exposed, 30 percent of the fatalities occur at these points.
- IC 8114. Safety Practices in Shaft Sinking and Tunneling: West Delaware Aqueduct, by William Rachunis, Arthur A. Sinicrope, and James A. Moore. 1962. 35 pp. 12 figs. Describes construction of 43.64 miles of underground tunnel, known as the West Delaware aqueduct. At the request of State and company officials, the Bureau initiated a safety training program; the safety and progress results are accepted as a record.
- IC 8115. Mine Water Control Program, Anthracite Region of Pennsylvania: July 1955-December 1961, by H. A. Dierks, W. L. Eaton, R. H. Whaiter, and F. T. Moyer. 1962. 63 pp. 58 figs. Covers 29 mine flood control projects. Gives essential engineering and cost details for each project. Evaluates the effect that the installed facilities have on the mine-water problem as it concerns individual mines and the anthracite industry as a whole.
- IC 8116. Economic Analysis of the Production of Ferronickel and Steel From Philippine Nickeliferous Ores, by Sidney Katell, John H. Faber, T. J. Joyce, and Paul Wellman. 1962. 45 pp. 3 figs. Discusses relationship of estimated capital requirements and probable returns on an electric furnace operation to process Philippine laterite and serpentine ores. Both ferronickel and steel could be produced.
- IC 8117. Bibliography of Investment and Operating Costs for Chemical and Petroleum Plants, January-December 1961, by Sidney Katell, John H. Faber, and J. Douglas Machesney. 1962. 68 pp. Contains abstracts of 307 articles on cost engineering in the field of chemical and petroleum plants published in 1961. Work done in cooperation with American Association of Cost Engineers. 40 cents.
- IC 8118. Thickness of Bituminous Coal and Lignite Seams Mined in 1960, by W. H. Young and R. L. Anderson. 1962. 19 pp. 1 fig. Includes data on productivity and average thickness of bituminous coal and lignite seams mined in the United States in 1920, 1945, 1950, 1955, and 1960.

- IC 8119. Bureau of Mines Research and Technologic Work on Coal, 1960, by Bureau of Mines Staff. 1962. 121 pp. 45 figs. Twenty-fifth in a series, report reviews briefly work in progress during 1960 and furnishes references to publications by Bureau personnel during the year.
- IC 8120. Columbium and Tantalum. A Materials Survey, by William R. Barton. 1962. 110 pp. 24 figs. Summarizes the demand-supply position in the United States and includes information on production, imports, consumption, exports, capacity, interchangeability, substitutes, and history. Describes properties of the commodity, principal compounds and alloys, domestic and foreign resources and reserves, the structure of the industry, pertinent laws and taxation policies, tariffs, Government controls, and history of wartime control experiences. Survey was prepared for the Office of Civil and Defense Mobilization. 60 cents.
- IC 8121. Bibliography of Bureau of Mines Health and Safety Publications, July 1, 1955, Through June 30, 1961, by G. G. Morgis. 1962. 46 pp. Describes health and safety reports published for the period July 1, 1955, through June 30, 1961; includes a subject index and an author index. Supplements B 558 issued in 1956 and Technical Paper 705 issued in 1948.
- IC 8122. Evaluating Raw Materials for Rotary-Kiln Production Of Lightweight Aggregate, by Howard P. Hamlin and George Templin. 1962. 23 pp. 9 figs. Shows that laboratory data can be used to guide rotary-kiln testing, and an appraisal of a raw material for lightweight aggregate concrete can be made in 3 days by the methods described in this report. 25 cents.
- IC 8123. Aluminum Fabrication in the Pacific Northwest: An Economic Survey, by Frank B. Fulkerson. 1962. 29 pp. A survey of 100 companies processing aluminum into finished products was made in 1961. The principal consumers and the finished products were identified. The market areas and the factors that encourage and discourage growth were studied. 25 cents.
- IC 8124. Technological and Economic Problems of Rare-Earth-Metal and Thorium Resources in Colorado, New Mexico, and Wyoming, by Francis J. Kelly. 1962. 38 pp. 1 fig. Presents facts concerning the production and marketing of rare-earth metals and thorium in the Central and Southern Rocky Mountains and reviews the current demand for these elements in the United States.
- IC 8125. Mica. A Materials Survey, by Milford L. Skow. 1962. 241 pp. 27 figs. Summarizes the demand-supply position in the United States and includes information on production, imports, consumption, exports, substitutes, and history. Discusses properties, mining, and processing methods, domestic and foreign resources and reserves, the structure of the industry, pertinent legislation, and Government wartime controls. Survey was prepared with the cooperation of the Geological Survey for the Office of Civil and Defense Mobilization. \$1.75.
- IC 8126. Blasting Stumps in Coal Mines, by R. W. Stahl. 1962. 7 pp. 3 figs. Summarizes recent findings published by the Bureau of Mines and recommends safer methods.
- IC 8127. Escaneways and Other Emergency Measures in Coal Mines, by R. W. Stahl. 1962. 13 pp. 3 figs. Describes escape procedures used by several mining companies.
- IC 8128. Bibliography of Tar Bases. Analysis, Production, Synthesis, and Utilization, by Howard W. Wainwright. 1962. 99 pp. Consists of over 1,000 literature and patent references from about 1945 to 1961.
- IC 8129. Open-Pit Operations at the Tripp Pit, Consolidated Coppermines Corp., Kimberly, Nev., by M. Clair Smith and A. C. Johnson. 1962. 16 pp. 3 figs. Describes exploration, development, equipment, and mining by open-pit methods the remainder of an ore body that had been previously worked by underground methods.
- †IC 8130. Dust Control in Mining, Tunneling, and Quarrying in the United States, 1958 Through 1960, by Floyd G. Anderson, R. L. Evans, and R. G. Peluso. 1962. 23 pp. Reviews and summarizes information on prevention and suppression of dust in mining, tunneling, and quarrying published in the United States during the years 1958 through 1960. Unpublished pertinent data developed or assembled by the Bureau of Mines during this period also are included.
- IC 8131. Mercury Occurrences in Alaska, by Kevin Malone. 1962. 57 pp. 22 figs. Describes principal mercury occurrences in Alaska and gives mining methods and costs for the Red Devil mine.
- IC 8132. National First-Aid and Mine Rescue Contest, Charleston, W. Va., October 2-4, 1961, by H. F. Weaver and D. M. Alden. 1962. 48 pp. 4 figs. Describes the 19th National First-Aid and Mine Rescue Contest, which was held in the Civic Center, Charleston, W. Va., October 2-4, 1961, sponsored by the Bureau and the Joseph A. Holmes Safety Association. Eleven teams from 4 States participated in the 1961 mine rescue contest, and 43 teams from 7 States competed in the first-aid contest. Five teams entered the combination contest, thus participating in both the mine rescue and first-aid events.
- IC 8133. Administration of the Federal Coal-Mine Safety Act, 1952-61, by James Westfield, H. F. Weaver, and C. M. Keenan. 1962. 56 pp. Presents a brief history of Bureau of Mines Division of Coal-Mine Inspection activities that have favorably affected health and safety and reduced injuries at coal mines.
- IC 8134. Injury Experience in the Nonmetal Industries (Except Stone and Coal), 1958, by John C. Machisak, Virginia E. Wrenn, Naomi K. Kearney, and Hazel M. Keener. 1962. 84 pp. Presents injury and employment data for nonmetal mines and mills by States, type of mining, and principal nonmetallic mineral extracted, such as abrasives, asbestos, asphalt, barite, clay, feldspar-mica-quartz, fluorspar, gypsum, magnesite, phosphate rock, potash, pumice, salt, sulfur, talc, and soapstone, and other minor nonmetals.
- IC 8135. Methods for Producing Dimension Stone, Crab Orchard Stone Co., Inc., Cumberland County, Tenn., by Harold L. Riley and H. J. Schroeder. 1962. 18 pp. 9 figs. Describes methods and practices used at the Peck quarry of the Crab Orchard Stone Co., Inc., one of the leading producers of dimension stone in the Crossville area.
- IC 8136. Vacuum Melting of Steel, by James R. Kerr. 1962. 32 pp. 8 figs. Describes vacuum melting processes and their application to the steel industry. Vacuum melting technology is discussed in general terms. 25 cents.
- IC 8137. Review of Fire and Explosion Hazard of Flight Vehicle Combustibles, by Robert W. Van Dolah, Michael G. Zabetakis, David S. Burgess, and George S. Scott. 1963. 80 pp. 52 figs. Compiles the available characteristics data for a series of combustibles of current interest. Presents vapor-pressure data for fluorine, oxygen, chlorine trifluoride, nitrogen tetroxide, nitric acid, hydrogen peroxide, ethylene oxide, hydrogen, ammonia, pentaborane, unsymmetrical dimethylhydrazine, mono-

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- methylhydrazine, hydrazine, and a series of hydrocarbons including decalin, tetralin, bicyclohexyl, and other high-density fuels. In addition, flammability characteristics diagrams are included for each of the fuels in contact with air and, where available, other oxidants. Includes a section on combustion and detonation definitions and theory.
- IC 8138. Review of Major Proposed Processes for Recovering Manganese From United States Resources (in Three Parts). 1. Pyrometallurgical Processes, by Lindsay D. Norman and Ralph C. Kirby. 1962. 30 pp. 12 figs. Describes 11 major pyrometallurgical processes and operations suggested for recovering manganese from domestic resources. Part 2, IC 8160, published in 1963, describes four chloride and seven fixed nitrogen processes.
- IC 8139. Metallurgical Application of Solvent Extraction: Fundamentals of the Process, by D. W. Bridges and J. B. Rosenbaum. 1962. 45 pp. 10 figs. Deals with the status of solvent extraction in metallurgy, as well as with the rudiments and terminology of the unit operation.
- IC 8140. Survey of Research on Thermal Stability of Petroleum Jet Fuels, by F. G. Schwartz and B. H. Eccleston. 1962. 116 pp. Summarizes information found in nearly 100 reports concerning the thermal stability of jet fuels. Includes information gained from interviews with representatives of over 35 companies or agencies actively engaged in research in this field. Work done in cooperation with National Petroleum Refiners Association.
- IC 8141. Injury Experience in Coal Mining, 1960. Analysis of Mine Safety Factors, Related Employment, and Production Data, by John C. Machisak, Virginia E. Wrenn, Nina L. Jones, and Dora D. Rice. 1962. 76 pp. 3 figs. Presents injury data and related employment statistics under the following topics: General injury experience, selected injury experience, injury experience by States, major distasters, and historical coal-mine-fatality experience.
- IC 8142. Mining and Milling Methods and Costs, Eastern Magnesia Talc Co., Johnson Mine, Johnson, Vt., by H. L. Burmeister. 1963. 42 pp. 31 figs. Describes mining and milling practices at the Johnson talc mine. Contains a description of the local geology and all available information on cost and performance data. One of a series of reports by the Bureau on mining and milling various ores in the United States.
- IC 8143. Secondary Nonferrous Metals Industry in California, With Data on Nevada and Hawaii, by George C. Branner. 1962. 115 pp. 31 figs. Gives data on the generation, collection, preparation, and consumption of eight nonferrous scrap metals in California; includes brief references to Nevada and Hawaii. Scrap metals of major importance, copper, lead, aluminum, and zinc, make up about 95 percent of the total value; the remaining four, antimony, magnesium, nickel, and tin, make up the remaining 5 percent. 60 cents.
- IC 8144. Manganese Mining and Milling Methods and Costs, Mohave Mining and Milling Co., Maricopa County, Ariz., by P. V. Fillo. 1963. 29 pp. 12 figs. Gives a brief history of the Black Rock Mine; describes the general geology of its ore deposit; and outlines methods of exploring, sampling, developing, and mining. Milling and sintering operations and mining and milling costs are discussed.
- IC 8145. Velocity of Sound in Petroleum Reservoir Rocks and Other Mediums: A Bibliography, by C. A. Komar. 1963. 51 pp. Covers material obtained from a literature search of past and present uses of sound. Compiled as part of a Bureau investigation of possible applications of acoustic energy at sonic and ultrasonic frequencies in petroleum production. Includes 143 references and subject and author indexes.
- IC 8146. Ultrasonic Phenomena and Methods of Measurement: A Bibliography, by C. A. Komar and J. Pasini III. 1963. 31 pp. Contains literature references and U.S. patents pertaining to ultrasonic phenomena, measurement techniques, and scientific and industrial applications. Has subject and author index. Literature search was conducted to review the uses that have been made of acoustic energy in the petroleum industry and to select procedures and techniques that could be applied to the solution of petroleum production problems.
- IC 8147. List of References to Metal-Halide Vapor Pressures With Bibliography, by F. D. Stevenson and S. D. Hill. 1963. 35 pp. Provides a ready reference to experimental vapor-pressure data of metal halides and oxyhalides. The material is divided into two parts, a tabulation of vapor-pressure references for each of the metal halides (listed by metal) for which actual experimental data are reported and a bibliography of the citations.
- IC 8148. Paraffin and Other Blocking Agents That Interfere With Petroleum Production: A Bibliography, by J. Pasini III. 1963. 34 pp. Contains 140 summarized references relating to paraffin deposition, inorganic deposits, emulsion or waterblocks, detrital material in the well, solids that block flow channels, and well work-over equipment and methods. Includes subject and author indexes.
- IC 8149. The Federal Coal Mine Safety Act and Federal Mine Safety Codes: Interpretations and Applications, by the Staff, Health and Safety Activity. 1963. 26 pp. Presents interpretations of those provisions that may be misinterpreted or misapplied. Interpretations and practical applications of the Codes are published for the first time.
- IC 8150. Float Dust Deposits in Return Airways in American Coal Mines, by Edward M. Kawenski, Edwin M. Murphy, and R. Ward Stahl. 1963. 20 pp. 14 figs. Gives determination of the mean quantities of coal and incombustible content in 711 dust samples collected from 50 mines in the major coal fields of the United States. Data from limited samples indicate that belt entries present a serious dust-explosion hazard when judged from the existing criterion of 65 percent incombustible content without considering the special hazard arising when surficial coal exists.
- IC 8151. Mining Practices at Four Uranium Properties in the Gas Hills, Wyoming, by F. D. Everett. 1963. 83 pp. 57 figs. Describes the geology, exploration, open-pit development and mining, and shaft sinking in the Gas Hills uranium district of Wyoming. Cost and performance data are presented as made available by the four mining companies. One of a series on mining methods and costs in the development of our mineral resources.
- IC 8152. The National Safety Competition of 1961, by John C. Machisak, Virginia E. Wrenn, and Elizabeth K. Elsner. 1963. 49 pp. Gives results of the National Safety Competition of 1961, a contest sponsored and conducted annually by the Bureau to promote safety in the mineral industries and encourage development of more effective accident-prevention programs. Lists anthracite, bituminous-coal, metal, nonmetal, and open-pit mines and quarries that ranked first through fifth in their respective groups and gives data on injury experience of all 868 contestants in the 37th competition.
- IC 8153. Open-Pit Copper Mining and Concentrating Methods and Costs, Silver Bell Unit, American Smelting and Refining Co., Pima County, Ariz., by W. R. Hardwick. 1963. 72 pp. 41 figs. Contin-

- ues the series on representative mining operations in the United States. Percentage distribution of mining, concentrating, and direct operating costs is given.
- IC 8154. Mining Methods and Costs, Inspiration Consolidated Copper Co. Open-Pit Mine, Gila County, Ariz., by W. R. Hardwick. 1963. 65 pp. 42 figs. Describes operating and engineering practices at a completely integrated open-pit mine that was formerly a block-caving operation. Emphasis is given to the physical, economic, engineering, and management factors that have affected the choice of mining method and equipment. 70 cents.
- IC 8155. Production of Mineral Fuels and Hydropower in the United States Since 1800, by R. M. Gooding. 1963. 33 pp. 18 figs. Presents a short history of the production and utilization of the mineral fuels and hydropower and discusses the competition and interchangeability of the fuels. Brings together basic data for the production of coal, crude petroleum, natural gas liquids, and natural gas. 30 cents.
- IC 8156. A Survey of Methods for Desulfurizing Residual Fuel Oils, by H. C. Carpenter and P. L. Cottingham. 1963. 29 pp. 4 figs. Presents a literature study of the types of sulfur compounds in residual fuels and possible methods of desulfurizing these fuels, sponsored by the Public Health Service, U.S. Department of Health, Education, and Welfare. Hydrodesulfurization appears to be the most promising method. Work done in cooperation with the University of Wyoming.
- IC 8157. Sand and Gravel Operations and Costs, Minneapolis-St. Paul Area, Minn., by L. G. Marshall. 1963. 66 pp. 29 figs. Presents a cross section of the sand and gravel operations in the Minneapolis-St. Paul area. Covers nine individual operations, economic problems peculiar to the industry, glacial geology of the area and its effect upon the grades and types of products, and population trends and their effect upon the industry. One of a series published by the Bureau on mining methods, beneficiation methods, and costs at mining operations throughout the United States.
- IC 8158. Beryllium Investigations in California and Nevada, 1959-62, by George H. Holmes, Jr. 1963. 19 pp. 2 figs. Beryllium was found to be concentrated along a wide belt in eastern Nevada extending from the Ruby Mountains, Elko County, south through the Fish Creek Range, Eureka County, the Snake Range, White Pine County, to the Virgin Mountains in Clark County, Nev., and Mohave County, Ariz. There are sporadic occurrences of beryllium in central and southern Nevada, and in the pegmatite dikes of San Bernardino, Riverside, and San Diego Counties, Calif., and in the granite masses of the southern Inyo Mountains, Inyo County, Calif.
- IC 8159. Methods and Costs of Rock Drilling at the Silver Summit Mine, Hecla Mining Co., Shoshone County, Idaho, by D'Arcy Banister and H. R. Wellman. 1963. 19 pp. 12 figs. Describes drilling practices at the Silver Summit mine in Shoshone County and the steps taken to increase drilling efficiency in the 1952-58 operating period. Outlines mining and development methods and discusses drilling equipment and practice. Gives cost and performance data.
- IC 8160. Review of Major Proposed Processes for Recovering Manganese From United States Resources (in Three Parts). 2. Chloride and Fixed Nitrogen Processes, by Lindsay D. Norman and Ralph C. Kirby. 1963. 35 pp. 12 figs. Describes four chloride and seven fixed-nitrogen processes for recovering manganese from domestic resources. The 11 processes include HCl leach, HCl chloridization, HCl chloride volatilization, CaCl_2 chloride volatilization, NO_2 leach, HNO_3 leach, $\text{HNO}_3\text{-NO}_2$ leach, $\text{NH}_3\text{-CO}_2\text{-H}_2\text{O}$ system leach, $(\text{NH}_4)_2\text{SO}_4$ leach, $(\text{NH}_4)_2\text{SO}_4$ roast and ammonium salt roast. Part I, IC 8138, published in 1962, reviews the pyrometallurgical processes.
- IC 8161. Ventilation of Continuous-Miner Places in Coal Mines, by Donald P. Schlick and Robert W. Dalzell. 1963. 18 pp. 9 figs. Discusses a representative cross section of methods successfully used to ventilate continuous-miner places as well as the factors that should be considered when selecting ventilating equipment. Line brattice can direct fresh air to the active face reasonably well, but if adequate area for installation is not available, other methods of auxiliary ventilation have been developed and are discussed in this study.
- IC 8162. Water Requirements and Uses in Arizona Mineral Industries, by M. M. Gilkey and Robert T. Beckman. 1963. 97 pp. 51 figs. Describes the effects of water shortage on Arizona's mineral industries. Covers all of the State's concentrators and smelters and all metal mines using substantial quantities of water. Cost figures for water are included. 50 cents.
- IC 8163. Rare Elements in Coal, by R. F. Abernathy and F. H. Gibson. 1963. 69 pp. Summarizes published information available on the occurrence of rare elements in U.S. coals and pertinent information concerning the coals of other countries. Includes nearly 400 references. Contains data on the occurrence of chlorine, phosphorus, titanium, and manganese. Publication is a revision of Technical Paper 669, Rare and Uncommon Chemical Elements in Coal, issued in 1944.
- IC 8164. Technology and Use of Lignite Proceedings: Bureau of Mines-University of North Dakota Symposium, Grand Forks, N. Dak., April 1961, compiled by James L. Elder and Wayne R. Kube. 1963. 113 pp. 33 figs. Gives the text of papers presented at the 1961 Lignite Symposium. Technical developments in lignite research were presented, and lignite resources and market trends were evaluated by representatives of government and private industry from the United States and Canada.
- IC 8165. Aqueous Slurries of Coal and Granular Materials: A Bibliography, by L. F. Willmott, W. R. Huff, and W. E. Crockett. 1963. 88 pp. Presents a compilation of material collected from an extensive literature search into the technology of aqueous slurries in order to establish design criteria for a pilot-plant-scale continuous integrated coal-water slurry system for feeding coal to a pressure gasifier, and to correlate various phases of the work with that of other investigators. Aqueous slurries of granular materials cover a broad spectrum of industrial materials, including hydraulic cements and mortars, drilling muds, clay slips for ceramics, etc.
- IC 8166. X-Ray Mass Absorption Coefficients. A Literature Survey, by Howard M. Stainer. 1963. 124 pp. 6 figs. Gives X-ray mass absorption coefficients, compiled from 28 sources, for 87 elements in tabular form, with both experimental and calculated points included. Discusses the methods used by the authors of the references for determining these values and the results obtained.
- IC 8167. Bureau of Mines Research and Technologic Work on Coal, 1961, by the Staff, Bureau of Mines. 1963. 121 pp. 34 figs. Summarizes Bureau of Mines research and technologic work on coal and related investigations during 1961, details of which have been or will be published as separate reports. Report is 26th in a series.

Information Circulars

- IC 8168. Injury Experience in Quarrying, 1959, by John C. Machisak, Virginia E. Wrenn, Naomi W. Kearney, and Zelda S. Glidden. 1963. 56 pp. Gives data on the number of injuries, injury frequency rates, work location, accident agency, and degree of injury for employees of the quarrying industry.
- IC 8169. Injury Experience in the Metal Industries, 1959, by John C. Machisak, Virginia E. Wrenn, Naomi W. Kearney, and Elizabeth B. Dixon. 1963. 81 pp. Gives data on injury experience and employment at metal mines and metallurgical plants in the United States, including Alaska, for the calendar year 1959.
- IC 8170. Injury Experience in the Nonmetal Industries (Except Stone and Coal), 1959, by John C. Machisak, Virginia E. Wrenn, Naomi W. Kearney, and Hazel M. Keener. 1963. 91 pp. Presents injury and employment data on 2,525 nonmetal mines and 1,006 mills by States, type of mining, principal mineral extracted, and other pertinent categories.
- IC 8171. Injury Experience in Quarrying, 1960, by John C. Machisak, Naomi W. Kearney, and Zelda S. Glidden. 1963. 57 pp. Gives data on the number of injuries, injury frequency rates, work location, accident agency, and degree of injury for employees of the quarrying industry.
- IC 8172. Injury Experiences in the Metal Industries, 1960, by John C. Machisak, Virginia E. Wrenn, Naomi W. Kearney, and Elizabeth B. Dixon. 1963. 85 pp. Presents data on injury experience and employment at metal mines and metallurgical plants in the United States, including Alaska, for the calendar year 1960 and historical injury experience in the metal mining industry during 1931-60.
- IC 8173. Injury Experience in the Nonmetal Industries (Except Stone and Coal), 1960, by John C. Machisak, Virginia E. Wrenn, Naomi W. Kearney, and Hazel M. Keener. 1963. 93 pp. Presents injury experience and employment data for the non-metal mines and mills by States, type of mining, and principal nonmetallic mineral extracted, such as abrasives, asbestos, barite, clay, feldspar, fluor-spar, gypsum, magnesite, mica, phosphate rock, potash, pumice, salt, sulfur, talc and soapstone, and other miscellaneous nonmetals.
- IC 8174. Mining Methods and Costs, Deep Creek Zinc-Lead Mine, Goldfield Consolidated Mines Co., Stevens County, Wash., by Galen G. Waddell. 1963. 39 pp. 12 figs. Describes a relatively small underground operation that approached large, highly mechanized mines in the low level of mining costs. Details the exploration program, stope development, stoping procedures, and pillar removal. Mining and milling costs are included.
- IC 8175. The Application of Hydraulic Fracturing in the Recovery of Oil by Waterflooding; A Summary, by James A. Wasson. 1963. 10 pp. Summarizes the results and conclusions reached by various investigators who have attempted to determine the extent to which hydraulic fracturing will affect the secondary recovery of crude oil by waterflooding. Also explains advantages and disadvantages of fracturing.
- IC 8176. Bureau of Mines Boiler-Water Service, by A. A. Berk. 1963. 8 pp. Describes the nature of the service which the Bureau provides for other Federal agencies in solving boiler-feedwater problems.
- IC 8177. Oil Recovery by Miscible-Phase Displacement: A Bibliography, by L. K. Weaver, W. D. Dietzman, and M. E. Hawkins. 1963. 27 pp. Bibliography includes more than 250 references to U.S. patents, foreign patents, and published literature relating to miscible-phase displacement processes of oil recovery. Was compiled as a preliminary part of an engineering study of oil recovery by miscible-phase displacement started by the Bureau.
- IC 8178. Three Waterflooding Projects and a Pressure-Maintenance Project in Butler and Cowley Counties, Kans., by Kenneth H. Johnston and Joe L. Castagno. 1963. 43 pp. 16 figs. Describes in detail three waterflooding projects and a pressure-maintenance project in Kansas where approximately 3 million barrels of oil was gained from the injection of about 39 million barrels of water into five formations. Discussion of each project includes information on early history, source and treatment of injection fluids, oil production-decline curves, and results of water injection on oil production. Work done in cooperation with the Division of Sanitation, Kansas State Board of Health.
- IC 8179. Safety Recommendations for Sensitized Ammonium Nitrate Blasting Agents, by the Staff, Bureau of Mines. 1963. 15 pp. Presents 84 safety recommendations for sensitized ammonium nitrate blasting agents. The ammonium nitrate-based fuel oil mixtures have partly or wholly displaced explosives such as dynamite in many applications. Attempts to summarize knowledge of the hazards of ammonium nitrate-based blasting agents and to give practical ways to cope with the dangers. Is a revision of IC 7988, published in 1960.
- IC 8180. Bibliography of Investment and Operating Costs for Chemical and Petroleum Plants, January-December 1962, by Sidney Katell, John H. Faber, and William C. Morel. 1963. 93 pp. Contains abstracts of 472 articles on all facets of cost engineering in the field of chemical and petroleum plants and related facilities published in 1962, with subject and author index. Work done in cooperation with American Association of Cost Engineers. 35 cents.
- IC 8181. Open-Pit Iron Mining, Milling, and Costs, Groveland Mine, The Hanna Mining Co., Dickinson County, Mich., by Leonard F. Heising. 1963. 37 pp. 18 figs. One of a series on mining and milling practices and costs in the United States. Describes how iron is selectively mined by open-pit methods and concentrated by means of spirals and flotation at the Groveland mine. Mining and milling costs are given in percent of total cost. 30 cents.
- IC 8182. Sandstone as Dimension Stone, by Oliver Bowles and William R. Barton. 1963. 30 pp. Presents general information about dimension sandstone and describes its properties, composition, production history, uses, marketing, distribution of deposits, quarrying methods, and recent advances in technology.
- IC 8183. Mobile Diesel-Powered Equipment for Noncoal Mines Approved by the Bureau of Mines, 1951-62, by Rogers F. Davis, Joseph J. Seman, George A. Hindman, and William E. O'Neill. 1963. 20 pp. Describes 59 diesel-powered machines approved under Bureau of Mines Schedule 24. The operating limitations of the machines, which include locomotives, shuttle cars, tractors, and trucks, are given. Briefly describes 24 diesel engine sub-assemblies certified under the same schedule.
- IC 8184. Traprock, by Oliver Bowles and Roger L. Williams. 1963. 19 pp. 3 figs. Presents general information about traprock; describes its properties, geology, distribution of deposits, history of production, quarrying and milling methods, and uses.
- IC 8185. Computing Value of Helium in Cylindrical Steel Containers, by H. S. Kalman. 1963. 102 pp. 3 figs. Presents a table of factors for rapid accurate calculation of the volume of pure helium in cylindrical steel containers. From the table the volume of helium in a container can be calculated

- from observed pressure and temperature of the helium and the known internal volume of the container, using base conditions of 14.7 psia and 70° F. Table covers a pressure range from 0 to 4,500 psia in 10 psi increments and a temperature range from 0° to 120° F in 2-degree increments.
- IC 8186. Research and Technologic Work on Alabama Coals: An Annotated Bibliography, by R. Q. Shotts and J. B. Gayle. 1963. 102 pp. 1 fig. References are arranged in order of subject matter. Geology, preparation, and carbonization of coal are emphasized. This bibliography is especially of interest to those in areas where thinner and less regular coalbeds must be exploited. This report, which includes author and areal indexes, was prepared in cooperation with the University of Alabama.
- IC 8187. Compressor and Related Explosions, by Henry E. Perlee and Michael G. Zabetakis. 1963. 11 pp. 5 figs. Discusses the nature of the combustible involved in compressor explosions, the methods of ignition, and the preventive measures that could be used to eliminate such explosions. Includes a literature survey.
- IC 8188. Administration of the Federal Coal-Mine Safety Act, 1952-62, by James Westfield, H. F. Weaver, and C. M. Keenan. 1963. 53 pp. Covers the 10th complete calendar year of coal-mine inspections under the Federal Coal-Mine Safety Act and the 21st calendar year since Federal coal-mine inspections were begun. Background information and data from 1952 are given, including up-to-date statistics for the calendar year 1962. During that year approximately 9,704 coal mines were active in the United States, and the Bureau made 12,810 regular inspections.
- IC 8189. Bureau of Mines Research and Technologic Work on Coal, 1962, by the Staff, Bureau of Mines. 1963. 112 pp. 27 figs. Twenty-seventh in a series, the report reviews work in progress in 1962 and gives references to publications by Bureau personnel during the year. Certain work first reported here will be covered in greater detail in later publications.
- IC 8190. Reconnaissance of Iron Resources in New Mexico, by C. M. Harrer and F. J. Kelly. 1963. 112 pp. 25 figs. Describes the location, features, qualities, and potential of iron occurrences and some associative resources—limestone and dolomite, coal, petroleum and natural gas, power, and water—in New Mexico. Discusses the economic feasibility of utilizing these resources.
- IC 8191. Research and Technologic Work on Explosives, Explosions, and Flames: Fiscal Year 1961, by Ruth F. Brinkley and Robert W. Van Dolah. 1963. 38 pp. 18 figs. Summarizes the research conducted by the Bureau's Explosives Research Laboratory from July 1, 1960, to June 30, 1961. Covers studies on ignition, structure, and behavior of flames; explosion and combustion processes; fundamental detonation problems; new explosive formulations; and the safety and performance of commercial explosives.
- IC 8192. Safety Organization and Activities of Award-Wining Companies in Metal and Nonmetal Mining Industries, by R. W. Stahl and Robert T. Davis. 1963. 37 pp. 5 figs. Gives results of a Bureau study of safety practices of 41 companies that had won awards between 1957 and 1961. Summarizes outstanding features of safety programs and gives detailed accounts of the safety organizations of four large companies.
- IC 8193. Underground Gasification of Coal, 1945-60: A Bibliography, by John P. Capp, Robert W. Lowe, and Dorothy W. Simon. 1963. 233 pp. Provides a comprehensive list of more than 800 references on the underground gasification of coal from 1945 to 1960, including patents.
- IC 8194. Methods and Practices in Clay Mining, Processing, and Utilization, Kraftile Co., Fremont, Calif., by Alfred Wild and Wallace W. Key. 1963. 44 pp. 19 figs. Presents technologic information on problems encountered in processing clay from the raw material to a finished product of glazed structural tile. Describes the prospecting, exploration, and test methods used to locate raw-material sources and covers processing methods, cost factors, and trends. Should assist potential clay suppliers in evaluating and marketing raw clay for use in tile manufacturing.
- IC 8195. Methods and Costs of Shaft Sinking, U.S. Atomic Energy Commission Project Gnome, Near Carlsbad, N. Mex., by Merwin H. Howes. 1963. 49 pp. 23 figs. Describes the design and sinking of Gnome shaft, a 10-foot-diameter shaft which was sunk through about 709 feet of rock and 506 feet of salt, and the driving of a 1,100-foot drift on the 1,200-foot level. Includes details of methods used for sealing an aquifer in the rock section. Work done in cooperation with the U.S. Atomic Energy Commission. 35 cents.
- IC 8196. Mineral Resources of the Malagasy Republic, by Thomas G. Murdock. 1963. 147 pp. 32 figs. Presents essential data from which a preliminary appraisal of mineral development potentials can be made and includes minerals not of primary interest to investors. Information in this survey was derived from published literature supplemented by field observations and data from other sources. Work done in cooperation with the U.S. Agency for International Development and the Malagasy Republic. 75 cents.
- IC 8197. Methods and Costs of Exploration and Pilot Plant Testing of Ilmenite-Bearing Sands, Lakehurst Mine, The Glidden Co., Ocean County, N.J., by Richard Quirk and N. A. Eilertsen. 1963. 68 pp. 35 figs. Describes methods used in exploring a sand deposit to determine ore reserve potential and the feasibility of mining and of establishing a milling plant on the property for producing ilmenite concentrate.
- IC 8198. Crushed Limestone Operations, Watauga Quarry, Watauga Stone Co., Carter County, Tenn., by H. L. Riley and H. J. Schroeder. 1963. 21 pp. 7 figs. Describes the methods and equipment used by the Watauga Stone Co. to drill and blast limestone in a two-floor quarry and to crush, screen, blend, and load this stone. Power requirements per ton of stone produced are reported. The personnel requirements for individual phases of the operation are tabulated in man-hours per ton of stone produced.
- IC 8199. Mining and Beneficiating Methods and Costs at Two Crushed-Limestone Operations, Madison County, Iowa, by L. G. Marshall. 1963. 18 pp. 13 figs. Describes the geology, method of mining and beneficiating, types of products, and costs, in terms of percent of total costs and of labor, power, and supplies for two crushed-limestone operations.
- IC 8200. Industrial Diamond. A Materials Survey, by Henry P. Chandler. 1964. 149 pp. 20 figs. A worldwide study describing forms, properties, uses, and substitutes; manufacture; history; geology; deposits; reserves; technology; production, consumption, and trade; industrial structure; marketing; research and development; and strategic factors. Cutoff date for statistics is yearend 1961. Includes appendixes on (1) Government wartime orders, (2) U.S. patents on industrial diamond and (3) glossary. Survey was prepared with the cooperation of the Geological Survey for the Office

- of Emergency Planning (formerly Office of Civil and Defense Mobilization). 75 cents.
- IC 8201. Magnesium and Magnesium Compounds. A Materials Survey, by Hazel B. Comstock. 1963. 128 pp. 24 figs. This report is a comprehensive summary of fundamental information on uses, production, consumption, imports, exports, and reserves of the strategic metal magnesium and its compounds. Survey was prepared for the Office of Emergency Planning (formerly Office of Civil and Defense Mobilization). 65 cents.
- IC 8202. Sand and Gravel Operation and Costs, Concrete Materials and Construction Division, Martin Marietta Corp., West Des Moines, Iowa, by L. G. Marshall. 1963. 14 pp. 7 figs. Describes dredging and processing of sand and gravel from a glacial-fluvial deposit in Raccoon River valley near West Des Moines, Iowa—including preliminary cleaning and separation at dredge site, subsequent transferral to separate plants, and production and disposal of various grades of aggregate. Tabulates costs in units of labor, power, and supplies.
- IC 8203. The Petroleum Industry of Iran, by L. Nahai and C. L. Kimbell. 1963. 112 pp. 33 figs. Gives a summary of Iran's petroleum industry, the oldest in the Near East. Includes a brief survey of the geology, oil reservoirs, technology, laws, economy, refineries, and storage and distribution facilities \$1.
- IC 8204. Mining Methods and Costs, Moat Mine, American Chrome Co., Stillwater County, Mont., by Paul M. Price. 1963. 58 pp. 27 figs. Describes mining methods and cost data for the Moat mine, Nye, Mont., which was operated from 1953 to 1961 under a Defense Minerals Production Administration contract. Although costs were reduced 47 percent, the chrome-to-iron ratio of the ore became too low to meet industry specifications, and operations were terminated in 1961 after completion of the contract.
- IC 8205. A Study of Dust-Control Methods for Continuous Mining of Coal. 1963. 14 pp. 3 figs. Studies the effectiveness of dust-control methods employed in connection with continuous-mining operations. Summarizes conditions required for control of dust exposure of workmen and dust loadings of return air.
- IC 8206. Marketing Ores and Concentrates of Gold, Silver, Copper, Lead, and Zinc in the United States, by Melford H. Salsbury, William H. Kerns, Frank B. Fulkerson, and George C. Branner. 1964. 150 pp. 9 figs. Presents data that the producer, especially the small mine operator, can use to survey available markets and make a preliminary estimate of the net return to be expected from an ore, on the basis of typical mill, smelter, and freight schedules. Recent production statistics are given, marketing facilities are discussed, and locations of principal mining districts, custom mills, and smelters are shown. Explanations of treatment processes, ore types, treatment charges, payments for metals, and deductions are given. Published rail and truck freight rates for mine products, based on marketing patterns developed over many years are explained. \$1.25.
- IC 8207. Economic Aspects of Silver Production in the Coeur d'Alene Mining Region, Shoshone County, Idaho, by Frank B. Fulkerson. 1964. 20 pp. 4 figs. Gives results of a study made to determine the economic factors governing silver production in the Coeur d'Alene mining region, Shoshone County, Idaho. Production and other statistics were analyzed. Concludes that higher silver prices could lead to new discoveries, increased capacity, and an upward trend in production at silver mines, but that even if lead and zinc prices rise substantially, output of byproduct silver from lead-zinc mining is unlikely to increase.
- IC 8208. Loading and Transportation at Zinc-Lead Mines, The Eagle-Picher Co., Jo Daviess County, Ill., and Lafayette County, Wis., by William A. Beck. 1964. 31 pp. 18 figs. Describes and illustrates the diesel-powered, rubber-tired loading and haulage equipment and analyzes the materials-handling system. The costs per ton of the various components of mechanical loading, underground haulage, underground crushing, and hoisting are tabulated for fiscal year 1960.
- IC 8209. Survey of Burning Coal-Mine Refuse Banks, by R. W. Stahl. 1964. 39 pp. 20 figs. Presents a survey of all such refuse banks in the United States. Location, distance from nearest town, condition and stage of the fire, surrounding topography, and size of 495 banks in 15 States are given. Ways of controlling fires were reviewed, the compacting and sealing method proving most satisfactory. Methods for preventing refuse-bank fires by proper construction of banks are described. Work done in cooperation with the Public Health Service, U.S. Department of Health, Education, and Welfare.
- IC 8210. Injury Experience in Coal Mining, 1961. Analysis of Mine Safety Factors, Related Employment, and Production Data, by Forrester T. Moyer, Virginia E. Wrenn, and Nina L. Jones. 1963. 77 pp. 3 figs. Presents injury data and related employment statistics under the following topics: General injury experience, selected injury experience, injury experience by States, major disasters, and historical coal-mine-fatality experience.
- IC 8211. Bureau of Mines Chromium Supplied for Research, July 1953 to July 1961, Including Names of Recipients and Nature of Studies, by G. Asai and H. Kato. 1964. 15 pp. Presents a tabulation of the distribution of chromium samples by the Bureau. The samples were used for such studies as the following: Mechanical properties, vaporized metal and vaporization, physical properties, corrosion and oxidation, chemical, and medical. The samples were used in medical research to determine the suitability of a radioactive chromium isotope in the radiotherapy of cancer.
- IC 8212. Subsurface Disposal of Industrial Wastes in the United States, by Erle C. Donaldson. 1964. 34 pp. 3 figs. Reviews current industrial practices for subsurface disposal of liquid wastes. Gives details on more than 30 wells ranging in depth from 30 to 12,000 feet that are used for industrial waste disposal into subsurface formations which include unconsolidated sand, sandstone, vugular limestone, and fractured gneiss.
- IC 8213. Refractory-Clay Deposits of Utah, by Joel Van Sant. 1964. 179 pp. 48 figs. Gives results of an investigation of Utah clay resources that could be used for the manufacture of refractories and light or buff-burning heavy-clay products. More than 400 samples were tested; of 60 refractory-clay samples tested, 10 were superduty, 11 high duty, 5 intermediate duty, 16 low duty, and 18 sub-low duty types.
- IC 8214. Mining Methods and Costs, Kimballton Limestone Mine, Standard Lime and Cement Co., Giles County, Va., by N. A. Eilertsen. 1964. 50 pp. 28 figs. Describes procedures for drilling and blasting limestone at the Kimballton Mine in Giles County, Va. Operating features include underground air compression, electric-eye control of curtained doorways, use of a single jumbo drill rig for all drilling, an effective plan for maintenance of equipment, and an outstanding program.
- IC 8215. Unconventional Methods of Hydrogenating Coal, by Walter Kawa, and Raymond W.

- Hiteshue. 1964. 29 pp. Discusses the economics of the conventional methods and presents a review of unconventional methods of hydrogenating coal. Contains annotated bibliography.
- IC 8216. Oil Shale Technology: A Review, by H. M. Thorne, K. E. Stanfield, G. U. Dinneen, and W. I. R. Murphy. 1964. 24 pp. Discusses the occurrence and estimated reserves of oil-shale deposits throughout the world, the compositions of the shales, and the devices that have been developed to utilize them. Covers oil shale throughout the world, but emphasizes the oil shale and technology of the United States. Work done in cooperation with the University of Wyoming.
- IC 8217. Bibliography of Investment and Operating Costs for Chemical and Petroleum Plants, January-December 1963. by Sidney Katell and W. C. Morel. 1964. 126 pp. Contains abstracts of 687 articles on all facets of cost engineering of chemical and petroleum plants and related facilities published in 1963, with subject and author index. Work done in cooperation with the American Association of Cost Engineers. 65 cents.
- IC 8218. Research and Technologic Work on Explosives, Explosions, and Flames: Fiscal Year 1962, by the Staff, Explosives Research Laboratory 1964. 36 pp. 13 figs. Describes the principal activities of the Explosives Research Laboratory from July 1, 1961, to June 30, 1962. Gives short abstracts of publications that appeared during fiscal year 1962; in general, the research reported in these publications antedates the report period. Gives the results of an investigation which, although too limited to warrant separate publication, merits presentation in some detail because of current interest in ammonium nitrate-fuel oil compositions.
- IC 8219. Potential of Nuclear Explosives for Producing Hydrocarbons From Deposits of Oil, Natural Gas, Oil Shale, and Tar Sands in the United States, by J. Wade Watkins and C. C. Anderson. 1964. 17 pp. Presents a theoretical study of the feasibility of using nuclear explosives to stimulate production of liquid or gaseous hydrocarbons from essentially nonproducing formations. Additional information is needed on the effects of pressure, heat, and radioactivity on the solids and fluids of hydrocarbon deposits; nature and extent of fracturing in different rock media; and the confining or removal of radioactive contaminants. Final technical feasibility can only be determined by a field test. Work done in cooperation with the U.S. Atomic Energy Commission.
- IC 8220. Permissible Mine Equipment Approved by the Bureau of Mines During 1953-62. A Supplement to Bulletin 543, by F. R. Lee and R. L. Evans. 1964. 39 pp. Consolidates lists of permissible mining equipment issued by the Bureau from 1953 through 1962. With the Bureau's Bulletin 543, it provides complete coverage of approved mining equipment. 30 cents.
- IC 8221. Analyses of Natural Gases of the United States, 1961, by Richard D. Miller and Geraldine P. Norrell. 1964. 148 pp. 1 fig. Contains routine analyses and related source data for 434 gas samples from 16 States, collected during calendar year 1961 as part of the continuous survey for the occurrence of helium in natural gas conducted by the Bureau. Gas samples were obtained from gas and oil wells and from pipelines; analyses were made with mass spectrometer and Frost helium apparatus. This circular is the first of a new series and supplements the three Bulletins on helium-bearing gases of the United States; Bulletin 486, published in 1951; Bulletin 576, published in 1958; and Bulletin 617, published in 1963. 70 cents.
- IC 8222. Sulfur Resources and Production in Texas, Louisiana, Missouri, Oklahoma, Arkansas, Kansas, and Mississippi and Markets for the Sulfur, by F. F. Netzeband, Thomas R. Early, J. P. Ryan, and W. C. Miller. 1964. 77 pp. 28 figs. Gives information on the types, location, and size of the sulfur resources of the area included in these seven States and relates this information to the domestic sulfur industry and to world developments that could possibly affect existing relationships. Economic factors and relationship affecting the area's production and consumption of sulfur are analyzed. 45 cents.
- IC 8223. Titanium in the Southeastern United States, by Fred P. Giese, Lawrence E. Shirley, and James L. Vallely. 1964. 30 pp. 6 figs. Shows that reserves of titanium ores in the Southeast are large, widespread, and ample for anticipated demand. The leading titanium industries are mining and beneficiating sand deposits, principally in Florida, and manufacturing titanium pigments. Most of the mineral output is consumed by the producers themselves. In 1962, 20 percent of the national titanium pigment capacity was in the Southeast.
- IC 8224. Safety Organization and Activities of Award-Wining Companies in the Coal-Mining Industry, by Robert T. Davis and R. W. Stahl. 1964. 26 pp. 1 fig. Gives results of a Bureau study of safety practices of companies that had won awards between 1957 and 1961. Summarizes outstanding features of safety programs and gives detailed accounts of the safety organizations of three companies.
- IC 8226. Application of the Method of Least Squares to PVT Data on Gases, by B. J. Dalton. 1964. 18 pp. Presents briefly a method of treating pressure-volume-temperature data on gases that consists of expressing the isothermal variation of the pressure-volume product of a gas in terms of a power series in either the pressure or the density and of evaluating the so-called virial coefficients by least squares solution. This report presents the method of least squares and its application to rational integral functions of one to four degrees, without going into any details of the mathematical without going into any details of the mathematical lems of curve fitting.
- IC 8227. American Standard Safety Rules for Installing and Using Electrical Equipment in and About Coal Mines (M2.1). (Revision of American Standard Safety Code for Installing and Using Electrical Equipment in Coal Mines, M2.1, 1952), by American Standards Association. Sponsors, American Mining Congress and U.S. Bureau of Mines. 1964. 27 pp. 8 figs. Gives revision of safety rules for installing and using electrical equipment in and about coal mines, superseding those published in Bulletin 514 in 1952. 25 cents.
- IC 8228. Examining and Testing Clay From Hartford County, Conn., for Lightweight Aggregate Use. The Clark Brick Co. Deposit at South Windsor, by W. T. Millar, and H. P. Hamlin. 1964. 21 pp. 7 figs. Describes laboratory tests on clay from South Windsor, Hartford County, Conn., to determine whether it is suitable for lightweight-aggregate raw material. The clay will make an acceptable lightweight aggregate if kiln temperature and kiln feed sizes are carefully controlled.
- IC 8229. Mineral Resources of Upper Missouri River Basin, Mont. Fort Peck Reservoir to Morony Dam, by C. R. Hubbard, R. N. Roby, W. C. Henkes,

Information Circulars

- and P. Biggs. 1964. 60 pp. 5 figs. Gives results of studies of the mineral resources of the Upper Missouri River Basin from Fort Peck Reservoir to Morony Dam. Evaluates future economic development of mineral resources. Oil and gas have been produced from several fields in the area; total value exceeds \$45 million. Coal-bearing formations cover approximately 45 percent of the study area, and total production of coal since 1880 has been between 40 and 50 million tons, exceeding \$75 million in value. Total metal production has been about \$52.5 million.
- IC 8230. Geothermal Power. An Economic Evaluation, by Alvin Kaufman. 1964. 24 pp. 4 figs. Evaluates the economic potential of geothermal power and its relationship to other sources of energy. Geothermal plants are competitive with conventional units, and potential for thermal power exists in the Western United States, Alaska, and possibly Hawaii. 25 cents.
- IC 8231. The National Safety Competition of 1962, by Forrest T. Moyer, Virginia E. Wrenn, and Elizabeth K. Elsner. 1964. 51 pp. Reviews the accomplishments of participants in the 1962 National Safety Competition, which was the 38th annual contest sponsored by the Bureau of Mines. Of the record 910 mines and quarries enrolled, 415 achieved injury-free operations for the year, the largest number of perfect records in the history of the contest. The participating operations also achieved a lower injury-frequency rate than in 1961.
- IC 8232. Injury Experience in Coal Mining, 1962, by Forrest T. Moyer, Nina L. Jones, Mary B. McNair, and Virginia C. Berté. 1964. 82 pp. 3 figs. Presents injury data and related employment statistics under the following topics: General injury experience, selected injury experience, injury experience by States, major disasters, and historical coal-mine-fatality experience.
- IC 8233. Expanded Clay and Shale Lightweight Aggregate Industry in the South-Central United States, by W. G. Diamond, Thomas R. Early, and Harry F. Robertson. 1964. 50 pp. 10 figs. Studies production, transportation, and consumption patterns and problems to determine economic and technologic factors affecting the development of the lightweight aggregate industry in the South-Central United States.
- IC 8234. Technology and Use of Lignite. Proceedings: Bureau of Mines-University of North Dakota Symposium, Grand Forks, N. Dak., April-May 1963, by Wayne R. Kube and James L. Elder. 1964. 128 pp. 50 figs. Gives the texts of the papers presented at the 1963 Lignite Symposium. Technical developments in lignite research were presented, and lignite resources and market trends were evaluated by representatives of Government and industry.
- IC 8235. A Review of Well Stimulation and Techniques to Prevent Formation Damage in Oil and Gas Production, by J. L. Eakin, J. S. Miller, and V. Vern Hutchison. 1964. 84 pp. Summarizes the works and opinions of experts on stimulative work in petroleum and natural gas wells exclusive of the generally applied pressure-maintenance and secondary-recovery methods. Purpose of the report is to review recent and available material on well-stimulation methods and techniques. Work done in cooperation with the Pipeline Research Committee, American Gas Association.
- IC 8236. Reconnaissance of Iron Resources in Arizona, by C. M. Harrer. 1964. 204 pp. 58 figs. Gives results of reconnaissance investigations of 129 iron occurrences in Arizona to determine their extent, attitude, and potential. Discusses the location, features, qualities, extent, and potential of iron occurrences and some associative resources—limestone and dolomite, coal, petroleum and natural gas, power, and water. The common iron minerals are magnetite and hematite. Higher grade deposits range from 30 to 60 percent iron content. Extensive low-grade deposits of great potential are present as taconite to semitaconite-like formations of magnetite-hematite.
- IC 8237. Bureau of Mines Research and Technologic Work on Coal, 1963, by Bureau of Mines Staff. 1964. 128 pp. 43 figs. Twenty-eighth in a series, the report reviews work in progress in 1963 and gives references to publications by Bureau personnel during the year. Certain work first reported here will be covered in greater detail in later publications.
- IC 8238. An In Situ Combustion Project and Three Waterflood Projects in Allen, Anderson, and Wilson Counties, Kans., 1964, by Kenneth H. Johnston. 1964. 30 pp. 16 figs. Describes an in situ combustion project and three waterflood projects in Allen, Anderson, and Wilson Counties. Among the unique features of the projects are (1) the movement of heavy crude oil through the reservoir and into the wellbore with energy furnished by burning a portion of the crude oil therein and (2) the simultaneous injection of CO₂ and water, through separate tubing into input wells during early development, to increase injectivity at moderate pressure. Work done under an agreement with the Division of Sanitation, Kansas State Board of Health.
- IC 8239. Analyses of Natural Gases of the United States, 1962, by Richard D. Miller and Geraldine P. Norrell. 1964. 121 pp. 1 fig. Contain routine analyses and related source data for 350 gas samples from 19 States, collected during calendar year 1962 as part of the continuous survey for the occurrence of helium in natural gas conducted by the Bureau. This circular is the second of a new series and supplements the three bulletins on helium-bearing gases of the United States: B 486, published in 1951; B 576, published in 1958; and B 617, published in 1963. IC 8221 is the first in the new series. 60 cents.
- IC 8240. Selected List of Bureau of Mines Publications on Petroleum and Natural Gas, 1910-62, by V. Vern Hutchison. 1964. 98 pp. Lists publications issued by the Bureau of Mines concerned with investigations on petroleum and natural gas. The items are chosen for their continuing interest and value. With subject and author index. Work done in cooperation with the State of Oklahoma.
- IC 8242. Summary Energy Balances For the United States: Selected Years 1947-62, by Warren E. Morrison. 1964. 32 pp. 11 figs. Presents annual energy balances prepared for 8 selected years between 1947 and 1962, using official data available from the Bureau of Mines and other official sources. These balances, covering a recent historical period, should be useful for general analysis of the energy economy and for projecting or forecasting the country's future energy position.
- IC 8243. Iron and Steel Scrap in the Pacific Northwest, by Gary A. Kingston. 1964. 50 pp. 8 figs. Examines Pacific Northwest ferrous scrap-industry operations and points out factors influencing the supply and consumption of scrap materials, such as the complete dependence of steel ingot producers in these States on scrap as a metal raw material and the sizable quantity of scrap exported from Seattle and Portland to Japan. 35 cents.

IC 8246. Methane-Oxidizing Bacteria. A Review of the Literature, by Melvin P. Silverman. 1964. 37 pp. 2 figs. Reviews the literature on methane-oxidizing bacteria with emphasis on the utilization of these organisms for the removal of methane from coal mines as well as other purposes. Discusses present practical applications and future research and possible applications.

IC 8247. Electronic Monitoring of Mine Fans, by John C. Hartley and C. D. McMaster. 1964. 18 pp. 9 figs. Describes three systems that monitor ventilating fans. These electronic monitoring systems automatically perform most of the operations required to conform with the provisions of the Federal Mine Safety Code in the event of fan failure or slowdown.

MINERAL INDUSTRY SURVEYS ²⁰

In 1960 the Bureau of Mines was publishing several series of processed reports: Periodic Reports contained statistical and economic data on a number of important mineral commodities, including some information on foreign petroleum, petroleum products, and coal. These reports were issued weekly, monthly, quarterly, or annually. Mineral Market Reports (MMR), issued annually in a numbered series, contained information on the production, consumption, and markets for certain mineral commodities. This material was later published in permanent form in the Minerals Yearbook. Health and Safety Surveys (HSS) contained summary statistics, by States, for fatal and nonfatal injuries and man-hours worked in the mineral industries. Petroleum Products Surveys (PPS), issued annually, presented information on the properties of burner fuel oils, diesel fuel oils, motor fuel oils, and aviation fuels produced during the previous year. Mineral Trade Notes, issued monthly, provided current data on foreign mineral production and trade not otherwise readily available. Mineral Trade Notes Supplements, issued at irregular intervals, treated the mineral industry of a specific country or a specific mineral commodity.

In 1962 all periodic reports, Mineral Market Reports, Health and Safety Surveys, and Petroleum Products Surveys were combined into the Mineral Industry Series. Some fuel industry reports that had formerly been published as Information Circulars were also added to the series. Mineral Trade Notes and all other foreign mineral reports were combined into the Foreign Mineral Report series.

The following list shows the Mineral Industry Surveys, including recent changes in the series:

WEEKLY

Bituminous Coal and Lignite.
Crude Oil Stocks.²¹
Pennsylvania Anthracite.

MONTHLY

Aluminum, Primary.
Aluminum Scrap and Secondary Ingot.

²⁰ Mineral Industry Surveys, except District V Petroleum Demand Reports and District V Petroleum Statements, are obtainable from the Publications Distribution Section, Bureau of Mines, 4800 Forbes Avenue, Pittsburgh, Pa., 15213. District V Petroleum Demand Reports and District V Petroleum Statements are obtainable only from Area VI Mineral Resource Office, Bureau of Mines, 450 Golden Gate Avenue, San Francisco, Calif. 94102.

²¹ Discontinued in 1964.

Brass Mill.
Carbon Black.
Cement.
Chromium.
Coal-Mine Fatalities.
Coal-Mine Injuries and Employment.
Cobalt.
Coke and Coal Chemicals.
Copper.
Copper Scrap Consumers.
Copper Sulfate.
District V Petroleum Demand.
District V Petroleum Statement.
Gold.
Iron and Steel.²²
Iron and Steel Scrap
Iron Ore.
Lead Industry.
Lead-Mine Production.
Lime.
Manganese.
Molybdenum.
Natural Gas.
Natural Gas Liquids.
Nickel.
Pennsylvania Anthracite.
Petroleum Forecast.
Petroleum Statement.
Silver.
Sulfur.
Tin.
Tungsten.
Vanadium.
Zinc, Secondary.
Zinc Industry.
Zinc Mine Production.
Zinc Oxide.

QUARTERLY

Antimony, Primary.
Bauxite.
Bismuth.
Bituminous Coal and Lignite Distribution.
Cadmium.
Ferrosilicon.
Fluorspar.
Gypsum.
Magnesium, Primary.
Mercury.
Natural Gas.
Platinum-Group Metals.
Selenium.
Silicon, High-Purity.²³
Titanium.

ANNUALLY

Abrasive Materials.
Aluminum and Bauxite.
Aluminum, Secondary.
Antimony.
Arsenic.
Asbestos.

²² Discontinued with May 1964 issue.

²³ The quarterly report on high-purity silicon was discontinued in 1963.

Asphalt Shipments.
 Aviation Fuels (Petroleum Products Survey 34).²⁴
 Barite.
 Beryllium.
 Bismuth.
 Boron.
 Brass Ingot Consumption.
 Bromine.
 Burner Fuel Oils. (Petroleum Products Survey 36.)²⁵
 Byproduct Sulfuric Acid.
 Cadmium.
 Calcium and Calcium Compounds.
 Carbon Black.
 Cement.
 Cesium, Rubidium, Gadolinium, Lithium, and Scandium.
 Chromium.
 Clay.
 Cobalt.
 Coke and Coal Chemicals.
 Coke Distributors.
 Coke Plant Injuries. (Formerly Health and Safety Survey.)
 Coke Producers.
 Columbium and Tantalum.
 Commodity Data Summaries. Preliminary data, in summary form, for most metals, nonmetals, and fuels.
 Copper.
 Copper Industry.
 Copper Scrap Consumers.
 Crude Oil and Refined Products Pipeline Mileage in the United States. (Formerly issued as Information Circulars. The last listing in this series was IC 7942.)
 Diesel Fuel Oils (Petroleum Products Survey 38).²⁶
 Dimension Stone.
 Explosives.
 Feldspar.
 Ferroalloys.
 Fluorspar.
 Fuel Briquets and Packaged Fuel.
 Fuel Briquets and Packaged Fuel Producers. (Formerly issued as Information Circulars. The last listing in this series was IC 8052.)
 Fuel Oil Shipments.
 Germanium.
 Gold.
 Graphite.
 Gypsum.
 Injuries at Iron-Blast-Furnace Plants. (Formerly Health and Safety Survey.)
 Injuries at Sand and Gravel Plants. (Formerly Health and Safety Survey.)
 Iodine.
 Iron and Steel.
 Iron and Steel Scrap.
 Iron-Blast-Furnace Slag.
 Iron Ore.
 Iron Oxide Pigments.
 Kyanite.

²⁴ These reports on the properties of aviation gasolines and aviation turbine fuels are done in cooperation with the American Petroleum Institute. Other aviation fuel surveys published in the last 5 years include PPS 14 (1960), PPS 19 (1961), PPS 24 (1962), and PPS 29 (1963).

²⁵ These reports on the properties of burner fuel oils produced in the United States are done in cooperation with the American Petroleum Institute. Burner fuel oil surveys published in the last 5 years include PPS 16 (1960), PPS 21 (1961), PPS 26 (1962), and PPS 31 (1963).

²⁶ These reports on the properties of diesel fuel oils produced in the United States are done in cooperation with the American Petroleum Institute. Diesel fuel oil surveys published in the last 5 years include PPS 13 (1960), PPS 18 (1961), PPS (1962), and PPS 28 (1963).

Lead and Zinc Pigments and Zinc Salts.
 Liquefied Petroleum Gas Shipments.
 Magnesium.
 Magnesium Compounds.
 Manganese.
 Mercury.
 Mica.
 Molybdenum.
 Motor Gasolines, Summer (Petroleum Products Survey 37.)²⁷
 Motor Gasolines, Winter (Petroleum Products Survey 35.)²⁸
 Natural Gas.
 Natural Gas Processing Plants in the United States. (Formerly issued as Information Circulars. The last listing in this series was IC 8006.)
 Nickel.
 Oil and Gas Injuries. (Formerly Health and Safety Survey.)
 Peat Producers. (Formerly issued as Information Circulars. The last listing in this series was IC 8041.)
 Pennsylvania Anthracite.
 Pennsylvania Anthracite Fatalities. (Formerly Health and Safety Survey.)
 Perlite.
 Petroleum Refineries in the United States. (Formerly issued as Information Circulars. The last listing in this series was IC 8062.)
 Phosphate Rock.
 Platinum-Group Metals.
 Potash.
 Pumice.
 Quartz Crystal, Electronic-Grade.
 Rhenium.
 Roof-Fall Fatalities. (Formerly Health and Safety Survey.)
 Safety Competition, National Crushed Stone Association. (Formerly Health and Safety Survey.)
 Safety Competition, National Lime Institute. (Formerly Health and Safety Survey.)
 Safety Competition, National Sand and Gravel. (Formerly Health and Safety Survey.)
 Safety Competition, National Slag Association. (Formerly Health and Safety Survey.)
 Safety in Mineral Industries. (Formerly Health and Safety Survey.)
 Salt.
 Sand and Gravel.
 Silver.
 Sodium.
 Stone.
 Sulfur.
 Talc.
 Tin.
 Tin, Secondary.
 Titanium.
 Tungsten.
 Uranium.
 Vanadium.
 Vermiculite.
 World Mineral Production.
 Zinc.
 Zinc, Secondary.
 Zirconium and Hafnium.

²⁷ Analytical data on the properties of motor fuels sold through service stations in the United States. Work done in cooperation with the American Petroleum Institute. Summer gasoline surveys published since 1960 include PPS 12 (1960), PPS 17 (1960), PPS 22 (1962), PPS 27 (1963), and PPS 33 (1964).

²⁸ Analytical data on the properties of motor fuels sold through service stations in the United States. Work done in cooperation with the American Petroleum Institute. Winter gasoline surveys published since 1960 include PPS 15 (1960), PPS 20 (1961), PPS 25 (1962), and PPS 30 (1963).

FOREIGN MINERAL REPORTS²⁹

Foreign mineral reports are issued to assist domestic producers and consumers of mineral commodities to keep abreast of developments in the mineral industries and markets abroad and provide a brief summary of significant information from U.S. Foreign Service offices and other sources, which may otherwise not be made available to the general public. Recent changes in this series are noted beside each entry.

International Coal Trade. Issued monthly; summarizes the latest salient statistical and economic data on worldwide coal trade.

International Petroleum Quarterly.³⁰ (Replaces International Petroleum Trade, World Petroleum Statistics, and World Retail Prices and Taxes on Gasoline, Kerosine, and Motor Lubricants.) Provides data for nearly all countries outside the Soviet bloc on production, imports, and exports, showing countries of origin and destination; refinery runs of crude oil; calculated demand for

major refined products; and world retail prices and taxes for refined petroleum products.

International Petroleum Trade. Monthly. (Replaced

by International Petroleum Quarterly, July 1964.)

Mineral Trade Notes. Issued monthly; provides selected news note and brief economic information on a variety of mineral commodities (except fuels) throughout the world.

Mineral Trade Notes Supplements. Special numbered supplements to Mineral Trade Notes, published at irregular intervals, relate to minerals in a specific country or to a specific mineral commodity. (Publication was suspended in 1960.)

MTN 58. The Foreign Mineral Trade of the U.S.S.R. in 1958, by Alexander Gakner. 1960. 36 pp.

MTN 59. Rich Mineral Resources Spur Communist China's Bid for Industrial Power, by K. P. Wang. 1960. 35 pp. 11 figs.

MTN 60. The Foreign Mineral Trade of the U.S.S.R. in 1959, by Alexander Gakner. 1960. 36 pp.

World Petroleum Statistics. Quarterly. (Replaced by International Petroleum Quarterly, July 1964.)

World Retail Prices and Taxes on Gasoline, Kerosine, and Motor Lubricating Oils. Annual. (Replaced by International Petroleum Quarterly, July 1964.)

²⁹ Obtainable from Publications Distribution Section, Bureau of Mines, 4800 Forbes Avenue, Pittsburgh, Pa. 15213.

³⁰ Date of first issue, July 1964.

OPEN-FILE REPORTS

These are reports that have not been published because the research they report is of limited interest, has been reported elsewhere, or is too voluminous to be published in a convenient form. However, the Bureau of Mines has made these reports available as reference material at certain libraries and Bureau offices, as specified for each report in the listing that follows:

- OFR 1. Berryhill, Robert V. Reconnaissance Sampling of Beach and River-Mouth Deposits, Norton Bay and Kotzebue Sound, Seward Peninsula, Alaska. 1962. Gives information on the location, accessibility, physical features, climate, and geology of the region and notes that only trace quantities of heavy minerals were found in samples analyzed by the Bureau. Available at the Department of the Interior Library, Washington, D.C., and at the Bureau of Mines offices in Juneau and Anchorage, Alaska, and at Albany, Ore.
- OFR 2. Bloom, Philip A. Percolation Leaching of Oxidized Copper Ores from the Mineral Hills Deposit, Yuma County, Ariz. 1961. Describes Bureau of Mines Tucson Metallurgy Research Laboratory tests which indicate that copper ore from the Mineral Hill deposits in Yuma County, Ariz., can be leached effectively with dilute sulfuric acid. Available at the Tucson Metallurgy Research Laboratory, Tucson, Ariz., the Salt Lake City Metallurgy Research Center, Salt Lake City, Utah; and the Department of the Interior Library, Washington, D.C.
- OFR 3. Branner, George C., and John W. Padan. High-Temperature Alloy Scrap in California and Nevada. 1962. Describes the high-temperature alloy scrap metal industry of California and Nevada, including information on the origin, collection, movement, and consumption of the scrap. Available at the Department of the Interior Library, Washington, D.C., and at the Bureau of Mines office in San Francisco, Calif.
- OFR 4. Bureau of Mines. Bush A-6 Test Well. 1961. Gives details regarding a well drilled for the Bureau of Mines in the Cliffside field of Texas. Includes electrical and radiation logs and analyses of core samples and cuttings. Available at the office of the General Manager, Helium Operations, Bureau of Mines, Amarillo, Tex.
- OFR 5. ———. Composition and Characteristics of Lignite Ash. 1964. Describes lignite and lignite ash from eight North Dakota and Montana mines. Includes proximate and ultimate analyses of the lignite samples, their heating values, and fusion temperatures and chemical analyses of the ash. Also gives composition of ash taken from various locations within lignite-fired boilers at the Minot Air Force Base and the Heskett Power Station in North Dakota. Available at Department of the Interior Library, Washington, D.C., Grand Forks Lignite Research Laboratory, Grand Forks, N. Dak., and the library of the Pittsburgh Coal Research Center, Pittsburgh, Pa.
- OFR 6. Bureau of Mines. Information on the Cost and Operation of the Bureau of Mines Excell and Keyes Helium Plants. 1960. Gives costs of building and operating the Bureau of Mines' two largest helium plants at Excell, Tex., and Keyes, Okla. The report is designed to aid possible private producers in estimating costs of constructing new plants to process helium-bearing natural gases. Available at the Bureau's Amarillo, Tex., helium plant; in the office of the General Manager, Helium Operations, Bureau of Mines, Amarillo; and in the office of the Assistant Director—Helium, Washington, D.C.
- OFR 7. ———. Logs on Gas and Water Wells. 1960. Includes well logs used to guide Bureau of Mines operations in the Cliffside, Tex., and Rattlesnake, N. Mex., gasfields, and electrical logs of one test water well and four wells that supply water for the Bureau's new helium plant at Keyes, Okla. Available at the Office of the Assistant Director — Helium, Bureau of Mines, Washington, D.C., and at the office of the General Manager, Helium Operations, Bureau of Mines, Amarillo, Tex.
- OFR 8. ———. Logs on Three Wells Drilled in Cliffside Gasfield, Amarillo, Tex. 1963. Gives electrical and radiation well logs, core analysis reports, and test data for three wells — Bivins A-8R, Bush A-7, and Bush A-8—in Cliffside Gasfield near Amarillo, Tex. Available at the Office of the Assistant Director — Helium, Bureau of Mines, Washington, D.C., and at the Office of the General Manager, Helium Operations, Bureau of Mines, Amarillo, Tex.
- OFR 9. ———. The Most Hydrogenation Works in Czechoslovakia. 1960. Describes operation both before and after World War II of the coal hydrogenation plant at Most, Czechoslovakia, which was modified after the war to use tars as raw materials. The information was obtained by the Bureau as part of research on low-temperature coal tars. Available at the Department of the Interior Library, Washington, D.C., and at the Bureau of Mines libraries in Pittsburgh, Pa., Morgantown, W. Va., Grand Forks, N.D., Denver, Colo., and Minneapolis, Minn.
- OFR 10. ———. Nickel Content of Individual Samples Included in Composition of Enriched Zone Material. 1960. Gives tables of percentages of nickel in deposits in Puerto Rico as a supplement to RI 5532, Nickel-Cobalt-Iron-Bearing Deposits in Puerto Rico. Available in the Department of the Interior Library, Washington, D.C., and at the Bureau of Mines in Bartlesville, Okla.
- OFR 11. ———. Properties of Some Australian, Japanese, and Soviet Coals. 1964. Describes tests on samples of coals from Japan, Australia, and the Soviet Union, giving information on proximate and ultimate analyses, calorific values, chlorine and phosphorous contents, forms of sulfur, and free-swelling and Hardgrove grindability indexes. Available at the Department of the Interior Library, Washington, D.C., and at the Bureau of Mines Research Center Library, Pittsburgh, Pa.

Open-File Reports

- OFR 12. Bureau of Mines. Report of the Seismic Survey of Cliffside Gasfield. 1961. Interprets results of a survey of the extensive Cliffside natural gas field in northern Texas and includes copies of all related seismic records of the field. Available at the office of the General Manager, Helium Operations, Bureau of Mines, Amarillo, Tex.
- OFR 13. ———. Reports on Helium-Bearing Natural Gases. 1960. Describe phase-equilibrium characteristics of nine helium-bearing natural gases from various fields in the United States. One report provides complete information about a typical low helium-content gas (0.4 percent) and the other describes eight gases with helium contents ranging from 0.75 to 7.80 percent. Available at the office of the Assistant Director—Helium, Bureau of Mines, Washington, D.C., and at the Helium Operations Office, Bureau of Mines, Amarillo, Tex.
- OFR 14. ———. Selected Bibliography of Foreign Research on Brown Coal and Lignite, 1950-1960. 1962. Presents nearly 400 bibliographical items indicating the scope and direction of research on brown coal, lignite, and their products in many foreign countries. Available at the Department of the Interior Library, Washington, D.C., the Bureau of Mines Library, Denver, Colo.; Grand Forks Lignite Research Laboratory, Grand Forks, N. Dak.; and the Pittsburgh Coal Research Center, Pittsburgh, Pa.
- OFR 15. ———. Tocito No. 1 Well. 1961. Gives drilling reports, geologic and engineering information, electric logs, well-testing reports, and facts about the plugging and abandonment of Tocito No. 1 well in San Juan County, N. Mex. Available at the office of the General Manager, Helium Operations, Bureau of Mines, Amarillo, Tex.
- OFR 16. Calhoun, W. A., and T. E. Hill, Jr. Extraction of Alumina from Submarginal High-Silica Arkansas Bauxite Ores. 1963. Supplements RI 5042, "Investigation of Low-Grade Bauxites as Potential Sources of Alumina," which described attempts to recover raw material for aluminum production from Arkansas ores containing high percentages of silica. Available at the Department of the Interior Library, Washington, D.C., and at the Rolla Metallurgy Research Center, Rolla, Mo.
- OFR 17. Chindgren, C. J., and L. C. Bauerle. Open-Vessel Reduction of Vanadium Pentoxide and Refining of Aluminothermic Metal as Methods for Preparing Ductile Vanadium. 1963. Discusses Bureau of Mines research on reducing vanadium pentoxide in an open vessel to obtain ductile vanadium metal. Available at the Department of the Interior Library, Washington, D.C., and at the Salt Lake City Metallurgy Research Center, Salt Lake City, Utah.
- OFR 18. Cooper, Franklin D., and Kung-Lee Wang. Process Analysis of the U.S. Coal Industry in 1958. 1964. Gives the known or developed costs of operating supplies and maintenance and repair materials used by the U.S. coal mining industry in 1958. Report may be seen at the Pittsburgh Research Center, Pittsburgh, Pa., and the Central Library, Department of the Interior, Washington, D.C.
- OFR 19. Engel, A. L. Experiments to Recover Lithium and Borax from California Borax Tailing. 1960. Describes laboratory-scale experiments in recovering lithium and borax from tailings of a Kern County, Calif., borax mine. Available at the Department of the Interior Library and in the Bureau of Mines' Division of Minerals, both in Washington, D.C.; at the Bureau's Region II headquarters, San Francisco, Calif.; and at the Reno Metallurgy Research Center, Reno, Nev.
- OFR 20. Gilkey, M. M. Titanium-Bearing Deposits in Five Western States. 1962. Gives descriptions of more than a hundred significant occurrences of titanium minerals in Arizona, Colorado, New Mexico, Wyoming, and Utah. Available at the Department of the Interior Library, Washington, D.C.; Salt Lake City Metallurgy Research Center, Salt Lake City, Utah; and the Bureau of Mines Library, Denver, Colo.
- OFR 21. Herickes, J. A., and J. Ribovich. Stability of Nitroparaffins. 1960. Discusses Bureau of Mines research which included a comprehensive study of the sensitivity characteristics of nitromethane, a nitroparaffin that has received considerable attention as a commercial solvent. Available at the Department of the Interior Library, Washington, D.C., and the Bureau of Mines office, Pittsburgh, Pa.
- OFR 22. Hess, H. D., and Harold W. Lynde, Jr. Preliminary Studies on Photoelastic Stress Analysis of Rocks. 1962. Describes a Bureau of Mines study of the feasibility of a method of stress analysis in which a photoelastic is strongly bonded to rock specimens, then observed by polarized light as specimens are subjected to controlled compression. Available at the Department of the Interior Library, Washington, D. C., and at the Bureau of Mines offices in Albany, Oreg., Spokane, Wash., and Minneapolis, Minn.
- OFR 23. Hickman, R. C. Jet Drilling a Florida Dune Deposit. 1964. Gives results of jet drilling a Florida dune deposit and of sink-float analyses of the sand from each hole. Visual inspection of the heavy-mineral sink products showed the presence of garnet, ilmenite, leucoxene, staurolite, rutile, and zircon, but the deposit was low grade. Available at the Department of the Interior Library, Washington, D.C., the library of the Florida Geological Survey, Tallahassee, Fla., and the Area II Mineral Resource Office, Knoxville, Tenn.
- OFR 24. Iilsley, E. R. Carpenter, and H. Kato. Thermoelectric Measurements on Natural and Artificial Bornite and Related Compounds. 1961. Describes research leading to the conclusion that synthetic bornite and bornite-type materials of the highest purity now obtainable show no advantages over the natural crystalline compound of copper, iron, and sulfur for thermoelectric and semiconductor applications. Available in the Department of the Interior Library, Washington, D.C., and at the Bureau of Mines office in Albany, Oreg.
- OFR 25. Knudsen, H., and D. E. Couch. Construction Details of 4- and 8-inch Diameter Inert Atmosphere Molten Salt Electrolysis Cells. 1964. Gives construction details of inert-atmosphere molten-salt electrolysis cells 4- and 8-inch diameters. Cells are light in weight, have interchangeable parts, and meet such requirements as high vacuum, sublimation control, and efficiency in heating. Detail drawings of various units and parts are shown. Available at the Department of the Interior Library, Washington, D.C., and the Reno Metallurgy Research Center, Reno, Nev.
- OFR 26. Konselman, A. S. Report on the Energy Situation and Relation of Fuels to Hydroelectric Power in the Rocky Mountain Area (Region III). 1962. Analyzes present and future energy requirements in Arizona, Colorado, North and South Dakota, Nebraska, New Mexico, Utah, and Wyoming. Also lists existing powerplant installations, indicates possible future sources of electrical energy, describes existing and projected water requirements, and gives sources and costs of electrical energy now generated in the states. Available at the Department of the Interior Library, Washington, D.C.; at the Bureau of Mines offices in Denver,

- Colo., Tucson, Ariz., Laramie, Wyo., Salt Lake City, Utah, Socorro, N. M., San Francisco, Calif., and Albany, Oreg.; and at the Denver Coal Research Laboratory, Denver, Colo.
- OFR 27. Leary, R. J., and E. J. Ostrowski. Pneumatic Lance Injection of Solid Recarburizers for Recarburizing Open-Hearth Metals. 1963. Available at the Department of the Interior Library, Washington, D.C., and at the Minneapolis Metallurgy Research Center, Minneapolis, Minn.
- OFR 28. Lee, F. W., Guy E. Dent, and Hugo E. Kuehn. Geophysical Investigation Relating to Tin Deposits in Coosa County, Ala. 1961. This report was written in the early 1940's on geophysical prospecting of tin-bearing deposits in Coosa County, Alabama. The studies showed that electrical resistivity methods can be used successfully to indicate the location of tin-bearing dikes where covered by soil or detrital material. Available at the Department of the Interior Library, Washington, D.C., and at the Tuscaloosa Metallurgy Research Center, Tuscaloosa, Ala.
- OFR 29. Magill, Elwin A., and J. C. Schlagel. Copper Deposits in the Silver Creek Mining District, Snohomish County, Washington. 1962. Provides information helpful to prospectors or mining companies interested in the area as a source of either copper or zinc. Available at the Department of the Interior Library, Washington, D.C.; at the Bureau of Mines offices in Seattle and Spokane, Wash.; and Albany, Oreg.; and at the office of the Washington State Division of Mines and Geology, Olympia, Wash.
- OFR 30. McDermid, A. J. Secondary Base Metals Processing Technology. 1962. Describes methods used in the scrap industry and by other metal processors in the United States to recover copper, lead, and zinc from scrap metal. Available at the Department of the Interior Library, Washington, D.C.
- OFR 31. Myers, James W. Control of Fires in Coal-Mine Refuse Piles. 1960. Describes methods devised by the Bureau of Mines for controlling fires in bituminous coal refuse piles. Covers studies which demonstrated the effectiveness of applications of layers of fine-coal wastes to inhibit the flow of air through heaps of refuse. Available at the Department of the Interior Library, Washington, D.C., and at the Pittsburgh Coal Research Center, Pittsburgh, Pa.
- OFR 32. Ouchi, Koji. Magnetochemical Studies of Coals and Their Related Substances (Part 2) — On Carbonization and Graphitization. 1960. This English translation of a Japanese coal-research report, originally published as No. 31 of the Resources Research Institute of Japan, discusses structural changes of coal and related substances during carbonization and graphitization. Available at the Department of Interior Library, Washington, D.C.; and the Bureau of Mines Libraries in Denver, Colo., and Pittsburgh, Pa.
- OFR 33. Padan, John W. Bucket-Drilling the Cooperstown Extension of the Ione Clay Deposits, Stanislaus County, Calif. 1964. Gives results of a preliminary mineral investigation of clays in the Cooperstown area in cooperation with the California Division of Mines and Geology. Tests show good potential for commercial use. An unusual feature of the investigation was the use of what is known as a "bucket" drill in obtaining samples. The Bureau's experience proves that this type of equipment excels in recovering fairly undisturbed samples of unconsolidated materials from depths as great as 200 feet. Available at the Department of the Interior Library, Washington, D.C., Area IV Mineral Resource Office, San Francisco, Calif., and the California Division of Mines and Geology, San Francisco and Los Angeles, Calif.
- OFR 34. Padan, John W. Investigation of the Indian Diggings Limestone Deposit. El Dorado County, Calif. 1964. Diamond drilling of the Indian Diggings limestone deposit in El Dorado County, undertaken jointly by the Bureau of Mines and the California Division of Mines and Geology, disclosed a substantial deposit of uniform high-quality limestone suitable for most industrial applications. Report may be seen at the Bureau's Area VI Mineral Resource Office, San Francisco, Calif.; the California Division of Mines and Geology offices at San Francisco, Los Angeles, Sacramento, and Redding, Calif.; and the Department of the Interior Library, Washington, D.C.
- OFR 35. Perry, R. E., B. H. Clemmons, H. P. Levan, and J. P. Gayle. Desulfurization of San Pedro and Palacio Mexican Iron Ores. 1961. Describes results achieved by the Bureau of Mines in desulfurizing iron ore from two mines near Tatatila, Vera Cruz, Mexico. Available at the Department of the Interior Library, Washington, D.C., and at the Tuscaloosa Research Center of the Bureau of Mines, University, Ala.
- OFR 36. Shaw, Van E., and Roderick A. Falk. Conversion of Depleted Uranium Hexafluoride to Uranium Trioxide. 1961. Describes laboratory studies by the Bureau of Mines in converting hazardous depleted uranium hexafluoride to a relatively safe uranium trioxide which then provides a convenient starting material in preparing other uranium compounds. Available at the Department of the Interior Library, Washington, D.C., and at the Bureau of Mines offices in Reno, Nev., and San Francisco, Calif.
- OFR 37. Sullivan, P. M. Method for Separating Insulation from Scrap Aluminum and Copper Wire. 1963. Describes a new method for reclaiming scrap metal from small-diameter insulated wire. The insulation is removed in a hammer mill and a spiral separator is used to sort the two materials. Available at the Department of the Interior Library, Washington, D.C., and at the College Park Research Center, College Park, Md.
- OFR 38. Tame, K. E. Radioactive Waste Disposal in Acid Leach Column-Ion Exchange Milling Flowsheets. 1964. Recycling of barren solutions to the leaching and washing circuits in two uranium mills resulted in an 80-percent reduction in the discard of solubilized uranium 226. Available at the Department of the Interior Library, Washington, D.C., and the Salt Lake City Metallurgy Research Center, Salt Lake City, Utah.
- OFR 39. Thomas, Bruce I. Galena-Bearing Gossans, Beaver Creek, Ruby District, Yukon Region, West-Central Alaska. 1964. Discusses the history and geography of the area, with a detailed description of the size, shape, and concentration of various metals in the deposit. Available at the Department of the Interior Library, Washington, D.C., and the Bureau of Mines offices in Juneau and Fairbanks, Alaska.
- OFR 40. Thomas, C., G. Asai, and H. Kato. Effect of Rare-Earth Metal Additions on the Properties of Tungsten. 1964. Gives results of Bureau of Mines studies to determine the effects of adding rare-earth metals to tungsten by arc-melting. Available at the Department of the Interior Library, Washington, D.C., and at the Albany Metallurgy Research Center, Albany, Oreg.
- OFR 41. Vaughn, G. E., Jr., J. Wade Watkins, Bruce G. Bray, and H. F. Coffer. Geological and Engineering Data for the Circle Ridge Oil Field, Fremont County, Wyo. 1964. Presents data on

Open-File Reports

- geology, reservoir rock, reservoir fluid, and production history, as well as some special tests involving irradiation and oxidation of the crude oil and fusibility of the reservoir rock. Available at the Department of the Interior Library, Washington, D.C., Laramie Petroleum Research Center, Laramie, Wyo., Morgantown Petroleum Research Laboratory, Morgantown, W. Va., and San Francisco Petroleum Research Laboratory, San Francisco, Calif.
- OFR 42. Warfield, Robert S. Examination of Coal Deposits, Sitkinak Island, Alaska. 1963. Describes a 1962 Bureau of Mines investigation of coal deposits on Sitkinak Island, Alaska. Available at the Department of the Interior Library, Washington, D.C. at the Bureau of Mines offices in Anchorage and Juneau, Alaska, and Albany, Oreg., and at the Seattle Coal Research Laboratory, Seattle, Wash.
- OFR 43. Warfield, Robert S. Investigations of Sub-bituminous Coal Deposits in the Beluga River Coalfield, Alaska. 1961. Gives results of exploratory drilling by the Bureau of Mines in Alaska's Beluga River area. Available in the office of the Director of Coal Research, Bureau of Mines, Washington, D.C., and at the Bureau of Mines offices in Anchorage and Juneau, Alaska, Seattle, Wash., and Albany, Oreg.

ARTICLES IN OUTSIDE PUBLICATIONS

Articles describing results of the Bureau's research and investigations are published in scientific and technical and trade journals, convention proceedings, books, and other outside publications. In the following list, the position of each article is determined by the alphabetical sequence listing of the senior author.

Duplicates of many journal articles can be obtained from the Photoduplication Service, Library of Congress, Washington, D.C., 20540, by paying the usual photostat or duplicating fee.

- OP 1. Abernethy, R. F., and Theodore Christos. Solid and Gaseous Fuels. *Anal. Chem., Anal. Rev.*, v. 35, No. 5, April 1963, pp. 78R-88R. Consists of a technical literature survey on methods of analysis of solid and gaseous fuels for the 2-year period September 1960 through September 1962.
- OP 2. Ackerman, M. J., and J. J. Wallace. Costs of Mining Under Bolted Roof and Timbered Roof in Bituminous Coal Mines. *Min. Equipment*, v. 12, November 1961, pp. 15-16. Results of studies made at 14 mines in Pennsylvania, eastern Ohio, and West Virginia indicated that productivity increased and costs decreased in bolted sections. Total savings included lower maintenance in cleaning falls, elimination of retimbering, reduction in the amount of rejects at the preparation plant, or a reduction in the labor force. Under bolted roof, especially in thin coalbeds, high-productivity equipment can be maneuvered more efficiently.
- OP 3. Allsman, Paul T. Analysis of Explosive Action in Breaking Rock. *Trans. AIME, Mining*, v. 217, 1960, pp. 468-478. Engineering of blast designs—as for green-pitting or blanket blasting—will contribute significantly to lower breaking and related costs by improving fragmentation, control of throw, and choice and placement of the explosive.
- OP 4. ———. Conservation in Metal Mining. *Colorado Sch. Mines Quart.*, v. 57, No. 4, October 1962, pp. 87-95. Discusses technology and costs with respect to the problems of conservation. The necessity for continued improvement in the use of manpower, materials, energy, and equipment calls for a greater investment of effort and money in scientific and technologic research on mineral resources, mining, and metallurgy.
- OP 5. ———. Mining: Metals and Minerals. *Britannica Book of the Year. Encyclopaedia Britannica, Inc., Chicago, 1964*, pp. 569-571. Summarizes mineral production and mining technology and research in the United States and Canada in 1963.
- OP 6. ———. Status of Mining. *Britannica Book of the Year. Encyclopaedia Britannica, Inc., Chicago, 1963*, p. 559. Summarizes productivity, mining methods, and research in the mining industry in the United States in 1962.
- OP 7. ———. U.S. Bureau of Mines Completes Organization for Mining Research. *Min. Eng.*, v. 12, No. 7, July 1960, pp. 675, 675A. Lists the eight research stations established by the Bureau of Mines to reemphasize mining research as an important Bureau function. Explains objectives and programs of each station.
- OP 8. Allsman, Paul T., and Justin B. Gowen. Neuzzeitliche Entwicklung im amerikanischen Bergbau [Recent Developments in American Mining]. *Proc. Special Min. Cong.*, Sept. 12-18, 1962, Leoben, Austria, pp. 455-464. Summarizes recent progress in greater safety, better and simpler methods, cost savings, annual production increases of 8 to 14 percent, and increases in mechanization. Challenges to the industry, such as the necessity of delving deeper for poorer resources, are also indicated.
- OP 9. Ampian, Sarkis G. Preferential Stain of Beryl. *Abs. in Am. Mineral.*, v. 45, Nos. 11 and 12, 1960.
- OP 10. Anderson, C. C. Petroleum and Natural Gas in the Caribbean Area. *The Caribbean: Natural Resources*, Univ. of Florida Press, Gainesville, Fla., ser. 1, v. 9, 1959, pp. 96-119. Gives data on the proved reserves, production of crude oil, refining capacity, and exports from this area, which produced 18.2 percent of the world's crude oil in 1957. The area has substantial reserves of natural gas and produced nearly 1.5 billion cubic feet in 1957. Reviews prospecting licenses and concessions in the area.
- OP 11. ———. Petroleum and Natural Gas in the United States—Relations of Economic and Technologic Trends. *Proc. World Power Conf., 12th Sect. Meeting, Montreal, Canada, 1958*, Gen. Repts. and Papers, v. 3, pp. 1127-1145. Gives data on production, technology, and consumption of petroleum in the United States between 1948 and 1955. Demand for petroleum products increased 46 percent and consumption of natural gas rose 83 percent in these 8 years. Operating costs rose, but unit operating costs were reduced somewhat by using automation, applying other technologic improvements, and operating more efficiently. Daily refinery crude-oil charging capacity increased 34 percent, and cracking capacity 62 percent.
- OP 12. ———. Underground Nuclear Explosions: Awesome Recovery Promise. *Petroleum Eng., Management ed.*, v. 31, No. 9, August 1959, pp. B-28 to B-31. Discusses possible use of nuclear explosives in the production of petroleum and in recovering oil from shale. Describes results of using underground nuclear explosives. Gives a cost estimate for producing shale oil in a hypothetical case, using a 300-kiloton nuclear device.
- OP 13. ———. Utilization of Nuclear Explosives in Oil-Shale and Petroleum Deposits. *Minutes of 108th Meeting, Missouri Basin Inter-Agency Committee, Helena, Mont., Aug. 13, 1959*, Appendix "D" pp. 1-12. Reviews experiments with underground nuclear explosions and discusses possible application of nuclear reactions in recovery of oil from oil shale and petroleum deposits. Presents data for an experiment in oil shale, including preliminary cost figures for the experiment and "order of magnitude" costs that might be expected in a large commercial operation of this type.
- OP 14. Anderson, C. C., and T. W. Hunter. Methods for Evaluating Sources and Requirements for

- Solid and Liquid Fuels in the United States. World Power Conf., Sec. Meeting, Madrid, Spain, June 5-9, 1960, v. 1, pp. 117-133. Explains the classification of coal as to quality and the techniques employed in estimating reserves of solid and liquid fuels. Describes methods used to estimate productive capacity and those employed to forecast the long-range requirements for total energy and the role solid and liquid fuels may have in future domestic markets.
- OP 15. Anderson, Floyd G. A Technique for Counting and Sizing Dust Samples With a Microprojector. *Am. Ind. Hyg. Assoc. J.*, v. 23, No. 4, July-August 1962, pp. 330-336. Describes use of a microprojector for counting and sizing airborne dust. Particle-size determinations are conveniently made at 10,000X. Advantages are greater speed and ease of counting, making possible sustained accuracy over a full workday.
- OP 16. Anderson, R. B. Pore Distributions from Desorption Isotherms. *J. Catalysis*, v. 3, No. 1, February 1964, pp. 50-56. Describes an improved method for computing a pore distribution curve from the nitrogen desorption isotherm at -195° C based on the basic assumptions of Barret, Joyner, and Halenda and Wheeler. Satisfactory agreement was obtained between surface areas computed by the present method and the BET equation.
- OP 17. ———. Review of "On Physical Adsorption," by Sydney Ross and James P. Olivier. *Science*, v. 146, No. 3650, Dec. 11, 1964, p. 1454.
- OP 18. ———. A Theorem Regarding the Poisoning of Fixed Catalyst Beds. *J. Catalysis*, v. 1, No. 4, August 1962, pp. 393-394. For poisoning of a fixed bed of catalyst by a component of the feed, if the distribution of poison in the catalyst as a function of bed length follows the same type of equation as poisoning proceeds, the relative activity of the catalyst will decrease linearly with average poison concentration of the catalyst as long as the concentration in the catalyst at the outlet of the bed is zero.
- OP 19. ———. Graphical Differentiation in Ammonia Synthesis Kinetics. *Ind. and Eng. Chem.*, v. 52, No. 1, January 1960, pp. 89-91. Examines a simple method of graphical differentiation. Uses published data for the ammonia synthesis on iron catalysts.
- OP 20. Anderson, R. B. and L. J. E. Hofer. Studies of the Fischer-Tropsch Synthesis: Application of Wheeler Equation to Synthesis Data. *J. Chem. and Eng. Data*, v. 5, No. 4, October 1960, pp. 511-513. Equations of Wheeler are applied to data on Fischer-Tropsch Synthesis. Diffusivities calculated from this equation are about the same as diffusivities of H_2 and CO in liquid hydrocarbons, confirming the observation that pores of catalyst are filled with oil during synthesis.
- OP 21. Anderson, R. B., L. J. E. Hofer, and J. Bayer. Surface Area of Coal (letter to editor). *Fuel*, v. 41, No. 6, November 1962, pp. 559-560. Is a critique of method for determining surface areas of coal by gas adsorption. Data presented suggest that reliable surface areas may be obtained from carbon dioxide isotherms at -78° C.
- OP 22. Anderson, R. B., and Fred S. Karn. A Rate Equation for the Fischer-Tropsch Synthesis on Iron Catalysts. *J. Phys. Chem.*, v. 64, No. 5, June 1960, pp. 805-808. Develops a rate equation in terms of fractional coverages of the surface by reactants and products. Approximates these surface coverages by Freundlich isotherms. Approximation has been shown to be valid in several systems.
- OP 23. Anderson, R. B., K. C. Stein, J. J. Feenan, and L. J. E. Hofer. Catalytic Oxidation of Methane. *Ind. and Eng. Chem.*, v. 53, No. 10, October, 1961, pp. 809-822. The activity of catalysts for the total oxidation of methane was determined as part of a program for developing devices to monitor methane concentration in coal mine atmospheres. For this purpose a number of catalysts were tested in a microcatalytic reactor. This device facilitates screening of catalysts and provides information on the kinetics of oxidation.
- OP 24. Anderson, R. B., and A. M. Whitehouse. Poisoning in Fixed Beds of Catalysts. *Ind. and Eng. Chem.*, v. 53, No. 12, December 1961, pp. 1011-1014. Considers poisoning in fixed catalyst beds for several types of poison concentration gradients along bed length and several functions relating activity to poison concentration.
- OP 25. Anderson, R. L. Productivity of Continuous and Conventional Mining Equipment. *Min. Cong. J.*, v. 46, No. 5, 1960, pp. 38-43. Relates data on the productivity at underground bituminous coal and lignite mines in the United States to year, location, and method of mining and loading. Shows that production by continuous mining increased from 3 percent of the total underground production that was mechanically loaded in 1952 to an estimated 29 percent in 1959.
- OP 26. ———. A Statistical Study of Continuous and Conventional Mining Machine Productivity. *Min. Cong. J.*, v. 48, No. 5, May 1962, pp. 56-62. Gives data on the production of coal by conventional and continuous mining methods. In 1960 the highest average production was 14.72 tons per man per day in 81 mines with 100 percent continuous mining, and the lowest average production was 5.90 tons per man per day in 4,826 mines with 100 percent conventional mining and hand loading only.
- OP 27. Anderson, S. M., and Horace T. Reno. Iron Ore in South America. *Min. World*, v. 22, No. 6, May 1960, pp. 32-34; *Skullings' Min. Rev.*, v. 48, No. 48, Feb. 27, 1960, pp. 8-10, 26; No. 49, Mar. 5, 1960, pp. 1, 4-5, 15; *World Min.*, v. 13, No. 6, 1960, pp. 41-42, 44-45. Review of status in 1959 of the iron-ore industry of South America and evaluation of the industry's future.
- OP 28. Ankeny, Marling J. Automatic Safety Devices Needed. *United Mine Workers J.*, v. 74, No. 4, Feb. 15, 1963, pp. 5, 6. Discusses the major disasters and fatal and nonfatal injury experience; makes suggestions, for improving mine safety.
- OP 29. ———. The Bureau of Mines—A Small Federal Agency With a Big Job. *Sperryscope*, v. 16, No. 2, 1962, pp. 20-23. Gives a brief summary of the Bureau's activities.
- OP 30. ———. A Look at Coal's Future Markets. *Min. Congress J.*, v. 48, No. 6, June 1962, pp. 51-54; *Coal Age News*, No. 175, June 1962, pp. 1-3. Describes significant new advances in coal transportation, coal use, and mining productivity. Forecasts an improvement in coal's position in the Nation's energy market.
- OP 31. ———. 1962 Safety Record of the Coal Mining Industry. *United Mine Workers J.*, v. 74, No. 4, Feb. 15, 1963, pp. 4, 10. Reviews safety record for coal mines in 1962. Had an explosion not killed 37 miners in December of that year, a new safety record might have been set. The major causes of death in mining accidents were roof fall and explosion.
- OP 32. ———. Progress in Strata Control in the United States. *Proc. 3d Internat. Conf. on Strata Control*, Paris, May 16-20, 1960, pp. 719-726. Points out the magnitude of the roof-fall problem in the United States and explains the character of the Bureau of Mines and its leadership in roof-control methods. Research and investigations relating to

- roof-control programs of the Bureau of Mines are discussed.
- OP 33. Ankeny, Marling J. Safety Record of Coal Industry. *United Mine Workers J.*, v. 75, No. 3, Feb. 1, 1964, pp. 4, 10. Reviews safety record for coal mines in 1963. Roof falls and explosions remain the greatest hazards. The Bureau is devoting considerable time to roof-control and methane-monitoring research.
- OP 34. ———. Thoughts for Better Mine Safety in 1963. *Mechanization*, v. 27, No. 1, January 1963, p. 27. Summarizes the principal hazards in coal mines and recommends procedures for allaying them.
- OP 35. ———. Trends in Productivity in the Coal Industry of the United States. *Proc. Internat. Coal Conf.*, Tokyo, Japan, 1963, paper 6, 1963, pp. 115-122. Discusses changes in the coal-mining industry between 1950 and 1962. Overall productivity rose to nearly 15 tons per man-day, and the average price of bituminous coal declined to \$4.54 per ton. Increasing mechanization is expected to further lower the price of coal and raise output per man-day to 30 tons by 1980. Improvements in coal transportation methods and greater use of coal for electric power generation are expected to improve the market for coal.
- OP 36. Armstrong, F. E. Battery Powered Portable Scaler. *Electronics*, v. 33, No. 19, May 6, 1960, pp. 74-75. Describes a simple battery-operated scaler designed for quantitative measurements in field radioactive-tracer studies. Elimination of frills improves reliability and reduces cost and weight.
- OP 37. ———. Field Use of Radioactive Gas Tracers. *Petrol. Eng.*, v. 32, No. 13, December 1960, pp. B-34 to B-36. Discusses a simple, effective, and economical system for applying radioactive gas tracers to oil-production problems.
- OP 38. Armstrong, F. E., and Keith Lovelace. A Study of Core Invasion by Water-Base Mud Filtrate Using Tracer Techniques. *API Drilling and Production Practice* (1961), 1962, pp. 104-113. Gives a method of measuring water-base mud-filtrate invasion in cores, using tritiated water as a tracer, that has been developed and tested in the field.
- OP 39. Atchison, Thomas C., and Wilbur I. Duvall. Effect of Decoupling on Explosion-Generated Strain Pulses in Rock. *Rock Mechanics, Proc. 5th Symp.*, 1962, ed. by C. Fairhurst, Pergamon Press, New York, 1963, pp. 313-326. Describes results of detonating small cylindrical charges of several diameters in variously sized holes in granite rock and recording the resulting strain pulses at distances ranging from 5 to 100 feet. The amplitude and period of the strain pulses were studied as functions of the decoupling (defined as the ratio of the diameter of the hole to the diameter of the charge). The amplitude and the period of the strain pulse produced in the rock decrease as the decoupling increases. A satisfactory explanation of the experimental results is derived from simple theoretical considerations.
- OP 40. Atchison, Thomas C., Wilbur I. Duvall, and Benjamin Petkof. Rock Breakage in Quarry Blasting. *Proc. 4th Symp. on Rock Mechanics, Pennsylvania State Univ., Bull. Miner. Ind. Exp. Sta.*, v. 76, November 1961, pp. 163-169. Gives results of rock breakage in quarry blasting made by taking high-speed motion pictures of the quarry face in front of one shothole of a production round and measuring the strain produced in the rock at a distance equal to the burden. (Also published under title "How Rock Breaks." *Rock Products*, v. 65, No. 2, February 1962, pp. 73-81, 118.
- OP 44. Atkinson, Charles H., and Mitchell A. Lekas. Atomic-Age Fracturing May Soon Open Up Stubborn Reservoirs. *Oil and Gas J.*, v. 61, No. 48, Dec. 2, 1963, pp. 154-156. Research on the application of nuclear explosives indicates (1) the tremendous amount of energy released during a nuclear explosion may be used to create a multiple fracture system to improve production from reservoirs having low permeability; (2) heat generated by the explosion will contribute little toward increasing ultimate recovery; and (3) radioactivity is not a serious problem.
- OP 42. Ausmus, S. L., F. W. Wood, and R. A. Beall. Casting Technology for Titanium, Zirconium, and Hafnium. *Metals Ind.*, v. 98, No. 12, Mar. 24, 1961, pp. 223-227; No. 13, Mar. 31, 1961, pp. 243-245; No. 14, Apr. 7, 1961, pp. 271-273 (reprint of Rept. of investigations 5686). Describes work on furnace design and control, mold materials, alloying metals, and production of shapes in various reactive metals.
- OP 43. Baber, Kenneth D. The New Bureau of Mines Research Center. *Minnesota Eng.*, v. 12, No. 8, September 1961, pp. 6-10. Describes the new Minneapolis Research Center and the activities carried on by the units housed therein: Mining Research Center, Metallurgy Research Center, and Office of Mineral Resources.
- OP 44. Baker, Don H., Jr. Electrowinning Molybdenum and Tungsten. *J. Metals*, v. 16, No. 11, November 1964, pp. 873-876. Describes a method of extracting molybdenum and tungsten from mineral concentrates by molten-salt electrolysis that has been shown to be technically feasible. Both metals have been produced with purities in excess of 99.9 percent.
- OP 45. ———. Refining: Electrorefining. Section of ch. 4 in *The Metallurgy of Hafnium*, ed. by D. E. Thomas and E. T. Hayes, pub. by Naval Reactors, Div. of Reactor Development, AEC, 1960, pp. 119-125. Indicates applicability of fused-salt electrorefining technique to the refining of hafnium scrap. Indicates that the degree of purification and the optimum electrolyte and the operational techniques still must be determined.
- OP 46. Baker, D. H., Jr., and T. A. Henrie. Electrolytic Preparation of Pure Metals. Ch. in *Ultra-High Purity Metals*, American Society for Metals, Metals Park, Ohio, 1962, pp. 36-54. Reviews theoretical and practical conditions for the preparation of high-purity reactive metal. The electrorefining procedures to produce high-purity beryllium, titanium, vanadium, chromium, and molybdenum from molten chloride baths are described. The operational factors involved in electrowinning molybdenum and tungsten from their oxide concentrates in molten oxide baths and the rare-earth metals from their respective oxides in fluoride melts are discussed.
- OP 47. ———. Electrorefining in Molten Salts. *Encyclopedia of Electrochemistry*. Reinhold Publishing Corp., New York, 1964, pp. 568-572. Describes the cell design and requirements for the general technique of electrorefining reactive and refractory metals in molten salts. Theoretical and practical considerations for the purification of this class of metals are delineated.
- OP 48. Baker, D. H., Jr., and J. D. Ramsdell. Electrolytic Vanadium and Its Properties. *J. Electrochem. Soc.*, v. 107, No. 12, December 1960, pp. 985-989. Successful application of the molten-salt electrorefining technique to the purification of vanadium and the testing of selected properties of the purified vanadium are described. Oxygen and nitrogen impurities were reduced by two-thirds of the amount contained in the feed material by elec-

- trolysis in an electrolyte consisting of molten sodium chloride containing 3 to 6 percent vanadium as vanadium dichloride. Reduction of these impurities produced major hardness reductions, permitted in excess of 90 percent cold reduction, and improved elongation. Strength and resistivity decreased with increasing purity.
- OP 49. Baker, F. D. Modern Communication System for Mine Rescue and Recovery Operations. *Coal Age*, v. 64, August 1959, pp. 112-114; *Proc. 49th Conv., Mine Inspectors' Inst. of America, Terre Haute, Ind.*, 1959, pp. 95-97. Explains four basic component parts of the transistor-type modern communication system and procedures for assembling the equipment. Describes application of the equipment and benefits to be derived when the system is used during rescue and recovery work.
- OP 50. Ball, John S. Nitrogen Compounds in Petroleum. *Proc. API*, v. 42, sec. 8, 1962, pp. 27-30. Summarizes the occurrence of nitrogen in petroleum, including the total nitrogen in various crude oils, the distribution of nitrogen according to boiling range, and the types of nitrogen compounds that have been identified.
- OP 51. ———. Rev. of "Organic Geochemistry," ed. by I. A. Breger. *Chem. and Eng. News*, v. 42, No. 27, July 6, 1964, p. 64.
- OP 52. ———. Rev. of "Zone Refining and Allied Techniques," by N. L. Parr. *Ind. and Eng. Chem.*, v. 53, No. 8, August 1961, p. A63.
- OP 53. Ball, John S., W. E. Haines, and R. V. Helm. Minor Constituents of a California Petroleum. *Proc. 5th World Petrol. Cong.*, v. 5, 1960, pp. 175-189. Presents a comprehensive examination of a California crude oil containing considerable quantities of nitrogen, sulfur, and oxygen compounds and trace amounts of porphyrins and metals.
- OP 54. Ball, John S., and H. T. Rall. Nonhydrocarbon Components of a California Petroleum. *Proc. API*, v. 42, sec. 3, 1962, pp. 128-145. Reviews the available knowledge on nonhydrocarbon constituents of California petroleum, including sulfur, nitrogen, oxygen, and metal compounds. A comparison of knowledge on California oils with that of all other oils was made.
- OP 55. Ball, John S., W. J. Wenger, Harold J. Hyden, C. A. Horr, and A. T. Myers. Metal Content of Twenty-Four Petroleums. *J. Chem. and Eng. Data*, v. 5, No. 4, October 1960, pp. 553-557. Compares results of trace metal analyses on 24 petroleums with properties of organic portion of crude oils. Limited data suggest that predictable relationships exist between the metal content and the nature of the organic constituents in petroleum.
- OP 56. Banning, Lloyd H., and Wallace E. Anable. Effect of Temperature on the Carbon Content of High-Silicon Alloys. *Proc. Elec. Furnace Conf., AIME*, 1961, v. 19, 1962, pp. 345-353. Describes a technique by which the carbon content of a ferrochromium-silicon or a ferrochromium-manganese-silicon alloy containing 30 percent or more silicon can be reduced to 0.50 percent or less by refining under a slag at near the liquidus temperature of the alloy; the carbon content of silicomanganese can also be reduced by the same technique.
- OP 57. ———. Utilization of Nickeliferous Serpentine. Ch. in *Extractive Metallurgy of Copper, Nickel, and Cobalt*, ed. by Paul Queneau. Interscience Publishers, New York, 1961, pp. 301-313. Gives results of electric-smelting tests on Cuban and Philippine ores. Shows that a high percentage of the nickel and most of the cobalt can be recovered easily in a ferronickel product. Either dried or calcined material can be smelted satisfactorily when using a mixture of bagasse and coke for the reductant.
- OP 58. Banning, Lloyd H., and William A. Stickney. Beneficiation of Domestic Chromium Ores. *Proc. Elec. Furnace Conf., AIME*, 1959, v. 17, 1960, pp. 157-174. Gives background information on consumption and uses of chromium ores and concentrates; summarizes history of chromite production in the United States; reviews beneficiation research by the Bureau and others; describes two domestic commercial beneficiation plants; and proposes a method for evaluating chromite concentrates.
- OP 59. Baptist, Oren C. Cable Tools Aid in Arctic Drilling. *Drilling*, v. 22, No. 4, February 1961, p. 65. Bureau of Mines study for the U.S. Navy resulted in the use of cable tools to overcome well plugging caused by increased water saturation in the permafrost.
- OP 60. Barry, A. J., Résumé of Roof Support Methods Used in Coal Mines. *Proc. Coal Min. Inst. America, Pittsburgh, Pa.*, 1961, pp. 95-105; *Mechanization*, v. 27, No. 1, January 1963, pp. 37-40. Summarizes the various roof-control methods including conventional supports, the mining shield, yielding-type supports, roof bolting, yielding arches, and mine roof stabilization by injecting a chemical bonding agent into the mine roof.
- OP 61. ———. Roof Control in United States Mines. *J. Mines, Metals, & Fuels*, v. 10, Special Issue, *Proc. Mechanization of Mines in India Symp.*, 1962, pp. 345-353. Describes several roof-control methods being used in coal and noncoal mines of the United States, including conventional timbering, a mining shield, yielding steel props, yielding steel arches and rings, liner plate, and hydraulic filling. Bureau research regarding roof control is discussed, including coal bursts or bumps, roof bolting, and rock bonding, and sonic techniques for exploring coal-mine roof strata.
- OP 62. Barton, William R. Bureau of Mines Studies of Beryllium Resources in New England. *Oxford County Mineral and Gem Association Yearbook 1962*, No. 15, 1963, pp. 21-22. Discusses the Bureau's studies of the beryllium resources in the New England States and mentions some good locations for collecting mineral specimens.
- OP 63. Bayer, J., K. C. Stein, L. J. E. Hofer, and R. B. Anderson. Effect of Preadsorbed Sulfur Compounds on Chemisorption of CO and CO₂ on Iron Catalysts. *J. Catalysis*, v. 3, No. 2, April 1964, pp. 145-155. The effects of the chemisorption of H₂S, SO₂, CS₂, COS, C₂H₅SH, and thiophene on the nitrogen isotherm at -195° C, the carbon monoxide chemisorption at -195° C, the carbon dioxide chemisorption at -78° C were determined on synthetic ammonia catalysts promoted with MgO, MgO-K₂O, Al₂O₃, and Al₂O₃-K₂O. In general, the poisoning did not affect the surface area, but it did decrease both the metallic iron and alkali surfaces.
- OP 64. Beall, R. A. Consolidation of Refractory Metals by Casting. *High Temperature Materials*, v. 2, ed. by Ault, Barclay, and Munger. Interscience Publishers, Inc., New York, 1963, pp. 533-544. Presents melting and casting techniques used for molybdenum, tungsten, and tantalum. Existing capabilities are indicated for each material.
- OP 65. Becker, Robert M., and Scott W. Hazen, Jr. Probability in Estimating the Grade of Ore. *Proc. 9th Annual Drilling Symposium, Pennsylvania State Univ., Minn. Ind. Experiment Station Bull.* 72, March 1960, pp. 39-49. Declares that two requirements must be met in order to utilize probability as an aid in estimating the grade of ore. First, the samples should be of the same size;

- second, the data must be random or satisfy certain relations. Indicates that a probability statement of accuracy is worthless and misleading if the data do not conform to random laws.
- OP 66. Beckering, Willis. Intramolecular Hydrogen Bonding of π -Electrons in Ortho-Substituted Phenols. *J. Phys. Chem.*, v. 65, No. 2, February 1961, pp. 206-208. Intramolecular hydrogen bonds between hydroxyl groups and aromatic π -electrons were examined in phenols that had an aromatic group attached to the ortho-position. The strength of the hydrogen to π -electron bond was varied by placing different substituents on the primed aromatic ring. Strength of the intramolecular bond was related to the planarity of the two aromatic rings in a biphenyl system.
- OP 67. Beckering, Willis, C. M. Frost, and W. W. Fowkes. Infrared Examination of Carbon-Hydrogen Stretching Frequency in Pyrocatechols, Guaiacols, and Phenols. *Anal. Chem.*, v. 36, No. 13, December 1964, pp. 2412-2414. Gives determination of the infrared spectra of a series of alkyl-substituted phenols, catechols, and guaiacols that were measured in a carbon tetrachloride solution in the 2,800 to 3,000 cm^{-1} region. The origin and the frequency variation of several of the vibrations are discussed. The spectra are presented in a bar-type diagram and should be useful in the characterization of unknown pure phenols.
- OP 68. Bennett, James A. Résumé of the Bureau of Mines Nontechnical Accident-Prevention Course for Metal and Nonmetal Mine Personnel. Abs. in *Trans. of Nat. Safety Cong., Cement, Quarry, and Mineral Aggregates*, v. 4, 1963, p. 11.
- OP 69. Benson, H. E., and J. H. Field. New Data for Hot Carbonate Process. *Petrol. Refiner*, v. 39, No. 4, April 1960, pp. 127-132. Describes various flow systems for operating a hot carbonate purification; compares steam requirements for the pilot plant and commercial plants; and describes a method of decreasing steam consumption by the use of ejectors. Gives data to show the degree of removal of hydrogen sulfide and carbon dioxide from feed gases containing both these components.
- OP 70. Berg, W. T., D. W. Scott, W. N. Hubbard, S. S. Todd, J. F. Messerly, I. A. Hossenlopp, Ann Osborn, D. R. Douslin, and J. P. McCullough. The Chemical Thermodynamic Properties of Cyclopentanethiol. *J. Phys. Chem.*, v. 65, 1961, p. 1425-1430. The chemical thermodynamic properties of cyclopentanethiol (cyclopentyl mercaptan) in the ideal gas state were calculated by using calorimetric, spectroscopic, and molecular structure information. Pseudorotation of the five-membered ring was demonstrated. Experimental studies provide values of heat capacity for two crystalline forms of the solid, for the liquid, and for the vapor; the triple-point temperatures; the heats of fusion; thermodynamic functions for the solid and liquid (0° to 370° K); heat of vaporization (360° to 405° K); parameters of the equation of state; vapor pressure (353° to 446° K); and the standard heat of formation at 298.15° K.
- OP 71. Bienstock, D., and J. H. Field. Bench-Scale Investigation on Removing Sulfur Dioxide From Flue Gases. *J. Air Pollution Control Assoc.*, v. 10, 1960, pp. 121-125. Reports results of a bench-scale investigation on the removal of sulfur dioxide with metallic oxides as absorbents, adsorbents, and oxidation catalysts from a simulated flue gas at temperatures of 265° and 625° F; reviews methods of regeneration.
- OP 72. ———. Corrosion Inhibitors for Hot Carbonate Systems. *Corrosion*, v. 17, No. 12, December 1961, pp. 571t-574t. Evaluates the effectiveness of various inorganic reagents as inhibitors in the corrosion of steel in boiling solutions of potassium carbonate saturated with carbon dioxide and hydrogen sulfide. Reagents tested were potassium chromate, potassium nitrite, sodium metavanadate, vanadium pentoxide, *n*-alkyl trimethylene diamines, and sodium metasilicate.
- OP 73. Bienstock, D., and J. H. Field. Corrosion of Steels in Boiling Potassium Carbonate Saturated With Carbon Dioxide and Hydrogen Sulfide. *Corrosion*, v. 17, No. 7, July 1961, pp. 337-339. Corrosion rates of carbon and stainless steels were determined in boiling solutions of potassium carbonate saturated with carbon dioxide and hydrogen sulfide. Solutions saturated with carbon dioxide were highly corrosive to carbon steel and slightly corrosive to types 304 and 347 stainless. Type 410 stainless behaved similarly to carbon steel. Monel was even more resistant to attack. The addition of only 0.3 percent of hydrogen sulfide to the carbon dioxide reduced the corrosion rate of the carbon steel by 96 percent. Boiling solutions of carbonate saturated with hydrogen sulfide were noncorrosive.
- OP 74. Bienstock, D., J. H. Field, A. J. Forney, and H. E. Benson. High Btu Gas Synthesis. *Am. Gas J.*, v. 189, No. 3, March 1963, pp. 47-60. High-Btu gas can be synthesized by catalytic methanation of a mixture of 2.5 to 3 parts of hydrogen to 1 part of carbon monoxide, obtained in gasification of coal, using a steel catalyst followed by Raney nickel in a hot-gas recycle system. Conversion of 99 percent of $\text{H}_2 + \text{CO}$ yields a fuel gas with heating value of 983 to 1,130 Btu per cubic foot, containing 78 to 96 percent methane, no carbon monoxide, and very small amounts of unsaturates. With the steel catalyst alone, conversions were 85 to 90 percent, giving fuel gas of 810 to 868 Btu per cubic foot.
- OP 75. Bienstock, D., J. H. Field, and J. G. Myers. Removal of Sulfur Oxides from Flue Gas with Alkalized Alumina at Elevated Temperatures. *J. Eng. Power*, v. 86, No. 3, 1964, pp. 353-360. Describes a cyclic process for removing the oxides of sulfur from flue gas by absorption at 625° F and then converting the oxides to elemental sulfur by reduction of the spend absorbent. Pilot-plant experiments are reported in which a solid absorbent of alkalized alumina in free and baffled fall is used to remove SO_2 and SO_3 from the combustion gas of a pulverized-coal-fired furnace. The absorbent is then regenerated by heating with hydrogen or with steam-reformed natural gas.
- OP 76. Bilbrey, J. H., Jr. Nickel. *Min. Cong. J.*, v. 47, No. 2, February 1961, pp. 116-117, 121. Free world production of nickel, which increased 7 percent, reached a record high in 1960. Although consumption in the United States dropped slightly below the 1959 level, greatly increased European consumption more than made up the difference. More nickel will be used in electric heating for homes, nickel-cadmium batteries, and special purpose alloys.
- OP 77. Bird, J. Howard. Maintenance—Its Relation to Safety. *Proc. 59th Meeting of Rocky Mountain Coal Min. Inst.*, 1963, pp. 34-40. Discusses some features of accident prevention that depend on good maintenance of a mine and its equipment.
- OP 78. Blade, O. C. Petroleum Products Survey No. 16 Is Study of Burner-Fueloils 1960. *Fueloil & Oil Heat*, v. 19, No. 11, November 1960, pp. 60-61. Samples of burner fuel oil, typical of those manufactured during the early part of 1960, were analyzed by the refiners, and the results were transmitted to the Bureau of Mines for study and compilation. Data obtained on 415 samples submitted by 45 petroleum refining companies.

- OP 79. Blaustein, Bernard D., and Gary M. Feldman. Peak Width vs. Retention Time in Gas Liquid Chromatography on Packed Columns. *Anal. Chem.*, v. 36, No. 1, January 1964, pp. 65-70. Quantitative analyses were made on mixtures whose chromatograms had overlapping peaks, estimating the half height from the half height-retention time curve where its direct measurement was not possible.
- OP 80. Blaustein, Bernard D., Irving Wender, and R. B. Anderson. Ethyl Branching in the Fischer-Tropsch Synthesis. *Nature*, v. 189, No. 4760, January 1961, pp. 224-225. Describes part of a larger project on the analysis of Fischer-Tropsch synthesis products through the C_7 compounds. Reports the identification of 3-ethylpentane in a hydrogenated Fischer-Tropsch synthesis product.
- OP 81. Blaustein, Bernard B., Charles Zahn, and Gus Pantages. Temperature as a Factor in Determining Order of Elution in Gas-Liquid Chromatography of Some C_7 - C_8 Hydrocarbons. *J. Chromatography*, v. 12, 1963, pp. 104-106. Discusses the reversal in their order of elution of several pairs of hydrocarbons over the temperature range 40° to 80° C and the implications of this reversal in regard to the gas-chromatographic analysis of complex mixtures.
- OP 82. Block, F. E., and T. T. Campbell. Rare-Earth and Yttrium Halides for Metal Production—Chlorides, Bromides and Iodides. *The Rare Earths*, John Wiley & Sons, New York, 1961, pp. 89-101. Gives a survey and evaluation of published methods for preparing rare earth and yttrium halides (chlorides, bromides, and iodides). Methods are discussed in relation to ease of formation, methods of purification, and quality of product.
- OP 83. Block, F. E., and M. J. Ferrante. Vanadium by Metallic Reduction of Vanadium Trichloride. *J. Electrochem. Soc.*, v. 108, No. 5, May 1961, pp. 464-468. Vanadium tetrachloride was made by chlorinating vanadium oxide with chlorine in the presence of carbon. By refluxing, vanadium tetrachloride was decomposed to nonvolatile vanadium trichloride, allowing volatile oxychlorides to be separated. The trichloride was reduced with magnesium or magnesium-sodium mixtures under inert atmosphere. Excess reductant and byproduct salts were removed from the vanadium sponge by vacuum distillation. Arc-melted vanadium containing only 0.2 percent impurities, which could be cold-rolled to thin sheets, was prepared.
- OP 84. Bloss, F. Donald. Choosing Precession Screen Settings. *Am. Mineral.*, v. 47, May-June 1962, pp. 802-804. Gives a nomogram that is simpler to use than those given by Tavora and Evans and others. It permits selection of the largest value of μ that can be used with a particular value of d^* .
- OP 85. Bloss, F. Donald, and G. V. Gibbs. Nomograms for Determining 2θ From Precession Photographs. *Am. Mineral.*, v. 46, January-February 1961, pp. 26-31. Two nomograms are presented that permit 2θ to be evaluated from diffraction spot locations on precession photographs. By means of the first nomogram, 2θ for the wavelength used to produce the precession photograph was obtained. The second permitted 2θ ($CuK\alpha$) to be determined from precession spots produced by molybdenum ($K\alpha$) radiation. The accuracy was usually sufficient to allow, in conjunction with observed intensities, unequivocal indexing of the more intense powder diffraction lines of crystalline materials.
- OP 86. Bloss, F. Donald, Gerald V. Gibbs, and David Cummings. Polymorphism and Twinning in Synthetic Fluorophlogopite. *J. Geol.*, v. 71, No. 5, September 1963, pp. 537-547. Gives results of optical and X-ray studies of large clear flakes of synthetic fluorophlogopite which revealed that approximately 29 percent are not single crystals as had been previously assumed. Gives detailed information on the polymorphs found in these anomalous fluormica crystals and gives a possible explanation.
- OP 87. Bolen, R. J., E. A. Pavelka, J. R. Lindley, and C. W. Dwiggin, Jr. Precise Collimation and Alignment Mechanism for the Spincro Model E Ultra-centrifuge. *Rev. Sci. Instr.*, v. 32, No. 1, January 1961, pp. 94-95. Collimation of light for schlieren optics in the Spincro model E ultra-centrifuge was facilitated by precise alinement of the light-source slip. This article describes a simple, effective collimation and alinement mechanism devised to facilitate precise alinement.
- OP 88. Boley, Dean W., Harry R. Johnson, and John R. Duda. Predicted Oil Recovery from a Pilot Waterflood in the Kane Oilfield, Elk County, Pa. *Producers Monthly*, v. 28, No. 8, August 1964, pp. 10-16. Predicts the performance of a waterflood in the Kane oilfield, located in Elk, Forest, and McKean Counties, that was made to determine secondary-recovery possibilities by waterflooding the Kane sand. This sand exhibits the characteristics of a preferentially oil-wet formation. Gas saturation is estimated to be about 20 percent. Maximum recovery is predicted to be about 52 barrels per acre-foot.
- OP 89. Bomberger, D. R., and M. Deul. Study of Fine Coal Cleaning Process by Automatic Microscopy. *Trans. AIME, Mining*, v. 229, March 1964, pp. 65-69. Gives results of a study of pyrite sizes in fine coal. Pyrite size distribution, rather than simple consideration of density separation, may be more significant in predicting sulfur reduction by a cleaning process. A scheme of size measurement of pyrite by an automated microscope and mathematical treatment of the data are described.
- OP 90. Boyd, William T. Hydraulic Mining of Coal in the U.S.S.R. *Proc. 8th Conf. Coal Research, Inc.*, 1959, pp. 11-22. Summarizes briefly the techniques and equipment used in the U.S.S.R. to extract and transport coal hydraulically from underground mines. Includes some statistical data showing the increased productivity and decreased mining costs obtained by using this mining method in steeply dipping coalbeds.
- OP 91. Boyd, William T., and Harry Perry. Degasification of Coal Beds in Advance of Mining. *Trans. Nat. Safety Cong., Coal Mining*, v. 7, 1959, pp. 21-31. Reviews the origin, release, and extraction of methane from the coalbeds in the United States, Great Britain, France, Germany, and Japan. Presents data regarding methods for economic extraction and utilization of methane being used in European countries and briefly outlines a proposed investigation by the Bureau.
- OP 92. Brandenburg, C. F., D. R. Latham, G. L. Cook, and W. E. Haines. The Identification of a Cycloalkyl Ketone in Wilmington Petroleum through Use of Chromatography and Spectroscopy. *Chem. and Eng. Data*, v. 9, No. 3, July 1964, pp. 463-466. Describes the identification in Wilmington, Calif., petroleum of an acetyl-isopropyl-methyl cyclopentane, the first cycloalkyl ketone to be found in petroleum. The cycloalkyl ketone was isolated from the virgin petroleum by a combination of distillation, liquid-solid chromatography, and gas-liquid chromatography. The compound was identified by interpretation of medium and high resolution mass, infrared, and nuclear magnetic resonance spectra.
- OP 93. Brandt, L. Warren, Lowell Stroud, and John E. Miller. Phase Equilibria in Natural Gas

- Systems. *J., Chem. and Eng. Data*, v. 6, No. 1, January 1961, p. 6. Contains previously unavailable information on the phase equilibria of helium-bearing natural gas. Considers the solubility of helium in the equilibrium liquid phases, the percentage of helium condensed, and equilibrium coefficient data for methane, nitrogen, and helium.
- OP 94. Broadhead, Kenneth G. and Howard H. Heady. Radiochemical Precipitation Studies of Rare-Earth Oxalates. *Anal. Chem.*, v. 32, No. 12, November 1960, pp. 1603-1606. Radiochemical techniques are used to determine quantitatively the effect of temperature, digestion time, pH, rare-earth concentration, oxalic acid concentration, stirring, and the presence of other rare earth ions on the oxalate precipitation of lanthanum, samarium, and yttrium. A Latin square experimental design is used to evaluate some of the variables statistically.
- OP 95. Brown J. D. Limitation of the Linear Intensity-Concentration Approximation in Electron Probe Microanalysis. *Advances in X-Ray Analysis* (Proc. 12th Ann. Conf. on Applications of X-Ray Analysis). Plenum Press, New York, v. 7, 1964, pp. 340-352. Evaluates the various factors that lead to deviations from linearity and gives methods for correctly interpreting X-ray intensity data on a qualitative and semiquantitative basis.
- OP 96. Brown, J. D., J. W. Thatcher, and W. J. Campbell. Electron Probe X-Ray Spectrograph: Design, Evaluation, and Application. *Ch. in Advances in X-Ray Analysis*, ed. by W. Mueller. Plenum Press, New York, v. 5, 1962, pp. 527-537. Describes design and operational characteristics of the Bureau's electron probe X-ray spectrograph. Applications of this instrument to several types of samples are summarized.
- OP 97. ———. X-Ray Optics for Electron Probe Microanalysis. *Norelco Reporter*, v. 10, No. 3, July-September, 1963, pp. 85-88. Compares transmission and reflection curved-crystal spectrometers for intensity, line width, and spectral range. A mathematical relationship of X-ray angle to Bragg angle is derived. Analytical errors resulting from use of an incorrect takeoff angle in calculating concentration are briefly considered.
- OP 98. Browning, James S. Flotation of North Carolina Spodumene-Beryl Ores. *Abs. in Min. Eng.*, v. 12, No. 12, December 1960, p. 1244.
- OP 99. Browning, James S., and Carl Rampacek. Flotation of Complex Barite-Fluorspar Ore. *Proc. 7th Internat. Min. Processing Cong.*, 1964. Gordon and Breach Science Publishers, New York, 1964, pp. 221-226. Discusses the Bureau of Mines lignin sulfonate-sodium fluoride method for treating complex ores to recover barite as well as fluorspar as high-grade products. Presents the results of batch and continuous flotation tests made of barite-fluorspar ores from Illinois, Kentucky, and Tennessee. The tests demonstrated the feasibility of producing acid-grade fluorspar from two of the ores and barite products meeting specifications for well-drilling muds from all three ores.
- OP 100. Browning, Stanley C., and John J. S. Sebastian. Ceramic Heat Exchangers for High-Temperature Heat Transfer From Helium. *Ind. and Eng. Chem.*, v. 53, No. 3, March 1961, pp. 191-196. Ceramic heat exchangers show considerable promise at higher temperatures but are limited to low pressures. Their technical feasibility depends on developing reliable gastight seals and eliminating high-thermal stresses.
- OP 101. Bruszak, Arthur E., David S. Burgess, and Elton L. Litchfield. Pressure Measurement Within Borosilicate Glass Systems by Externally Mounted Strain Gauges. *Rev. Sci. Instr.*, v. 34, No. 7, July 1963, p. 814. Describes a system for measuring the pressure at constant volume and temperatures of 200° to 300° C of the corrosive decomposition products of ammonium nitrate. Essentially this consisted in cementing a Constantan foil strain gage to the flat bottom of a Pyrex Florence flask.
- OP 102. Bruszak, Arthur E., D. S. Burgess, and H. J. Wijnen. Reaction Kinetics in Hot-Gas Ignition of Ethane-Air. *Combustion and Flame*, v. 7, No. 3, September 1963, pp. 245-251. Gives results of studies of heat balances in a jet of heated nitrogen issuing into cool ethane-air. Rates of heat production were obtained for the oxidation of ethane at low concentration near the axis of the jet. Assuming the course of the reaction to be unchanged at all the temperatures (800° to 875° C) and fuel concentrations used, the order of reaction is unity with respect to fuel and 0.25 with respect to oxygen. The activation energy is about 49 kcal/mole.
- OP 103. Buch, J. W. The Hydraulic Mining of Anthracite. *Institut National de l'Industrie Charbonnière, Liège, Belgium, Sec. E6*, October 1963, pp. 1-10. Describes full-scale experiments by the Bureau on hydraulic mining of anthracite. Gives information on installation, equipment, loading and transporting of coal, roof support, safety, and operating performance.
- OP 104. Buch, John W., and Ivor L. Williams. Hydraulic Mining of Anthracite—Experiments at the Sugar Notch Mine, Wilkes-Barre, Pa. *Min. Cong. J.*, v. 48, No. 7, July 1962, pp. 22-28. Bureau of Mines, working cooperatively with the Glen Alden Coal Co., has successfully mined anthracite hydraulically using 300 gpm of water at 5,000 psi. Describes equipment used, which is of special design or which has been modified to meet the requirements; highlights safety features; explains operating procedures; and presents results of the hydraulic cutting tests.
- OP 105. Bureau of Mines. Anthracite Program of the Bureau of Mines. *Coal Age*, v. 68, No. 6, June 1963, pp. 82-84. Summarizes the Bureau's research on anthracite in three broad areas of technology: mining, preparation, and utilization.
- OP 106. ———. Appalachian Region Oilfield Reservoir Investigations. *Producers Monthly*, v. 25, No. 5, May 1961, pp. 14-16. Presents part of an investigation to determine the susceptibility of selected Appalachian region oil reservoirs to more intensive oil-recovery methods. Describes a study made of the Cow Run sand, Burnings Springs oilfield, Clay district, Wirt County, W. Va.
- OP 107. ———. Appalachian Region Oilfield Reservoir Investigations, Big Lime Formation and Keener, Big Injun, Weir, and Berea Sands, Spruce Creek Field, Union District, Ritchie County, West Virginia. *Producers Monthly*, v. 26, No. 4, April 1962, pp. 12-13. Gives basic data resulting from the coring of five formations, analyses of the cores, and a complement of well logs, including electrical, acoustical, and radiation logs. No evaluation of the data is made nor are any conclusions drawn. One of a series on the Bureau's evaluation of oilfield reservoirs.
- OP 108. ———. Appalachian Region Oilfield Reservoir Investigations, Clinton Sand, North Logan Field, Falls Gore Township, Hocking County, Ohio. *Producers Monthly*, v. 26, No. 7, July 1962, pp. 10-13. Mentions geology and early development of the North Logan oilfield. Gives basic data resulting from the coring of the Clinton sand, analyses of the core, and a complement of well logs, including electrical, acoustical, and radiation logs. No evaluation of the data is made and no conclusions are drawn. One of a series on oilfield reservoir evaluation.

- OP 109. Bureau of Mines. Appalachian Region Oilfield Reservoir Investigations, Glade Sand, Youngsville-Five Points Field, Sugar Grove, Farmington, and Brokenstraw Townships, Warren County, Pa. *Producers Monthly*, v. 26, No. 10, October 1962, pp. 8-10. Gives basic data resulting from the coring of the Glade sand, analyses of the core and a complement of well logs, including electrical, acoustical, and radiation logs. No evaluation of the data is made, nor are any conclusions drawn. One of a series on the Bureau's evaluation of oilfield reservoirs.
- OP 110. ———. Appalachian Region Oilfield Reservoir Investigations, Kane Sand, Kane Field, Highland Twp., Elk County, Pa. *Producers Monthly*, v. 28, No. 4, April 1964, pp. 12-14. Presents core analysis, well logs, geology, and development and production history of Kane sand, Kane oilfield, Highland Township, Elk County, Pa.
- OP 111. ———. Appalachian Region Oilfield Reservoir Investigations, Keener Sand, Loyalhanna Lime, and Big Injun and Squaw Sands, Bonds Creek Field, Lafayette District, Pleasants County, W. Va. *Producers Monthly*, v. 27, No. 11, November 1963, pp. 8-10. Gives basic data resulting from the coring of the Keener sand, Loyalhanna Lime, and Big Injun and Squaw sands; analyses of the core; and a complement of well logs, including electrical, acoustical, and radiation logs. No evaluation of the data is made nor are conclusions drawn.
- OP 112. ———. Appalachian Region Oilfield Reservoir Investigations, Venango Group First Sand, Goodwill Hill-Grand Valley Field, Southwest Township, Warren County, Pa. *Producers Monthly*, v. 25, No. 7, July 1961, pp. 2-5. Describes part of a study to determine the susceptibility of certain Appalachian region oil reservoirs to more intensive oil-recovery methods. Covers general geology of the area, general oil production history, reservoir rock analysis and well logs, and an appraisal of first sand.
- OP 113. ———. Appalachian Region Oilfield Reservoir Investigations, Venango Group Second Sand, Foster-Reno Oil City Field, Reno Pool, Sugar Creek Township, Venango County, Pa. *Producers Monthly*, v. 28, No. 5, May 1964, pp. 12-15. Gives general information on the early history and geology of an oil reservoir formation near Reno, Venango County, Pa. Field, lease, and well-location maps, oil-production data, core analysis, and well logs are presented.
- OP 114. ———. Bituminous Research. 1. The Bureau of Mines Program in Coal Mining, Coal Preparation. *Coal Age*, v. 68, No. 2, February 1963, pp. 118-121, 123; 2. The Bureau of Mines Program in Coal Utilization, No. 3, March 1963, pp. 124-129, 132, 134. Summarizes the research program of the Bureau's Division of Bituminous Coal. Discusses the Bureau's work in mining methods, determination of coal reserves, studies of the preparation characteristics and carbonizing properties of coals, degasification of coalbeds, acid mine water, gasification of coal, conversion of coal to special products, and use of coal for heat and power generation.
- OP 115. ———. BuMines Detects Trace Impurities in Grade-A Helium. *Chem. and Eng. News*, v. 38, No. 51, Dec. 19, 1960, p. 51. Describes an improved method for identifying trace impurities in helium and measuring their concentration within a tolerance of 1 ppm. The new method uses a cold trap to freeze out impurities and concentrate them for analysis in a mass spectrometer.
- OP 116. ———. Coal Research at the Bureau of Mines. *Mechanization*, v. 23, No. 12, December 1959, pp. 65-66. Summarizes coal research activities of the three branches and eight research laboratories of the Division of Bituminous Coal.
- OP 117. Bureau of Mines. Coal Research—At Home and Abroad. *Min. Cong. J.*, v. 47, No. 2, February 1961, pp. 65-67. Reviews coal research in the United States and abroad by type of research, amount of money made available, and aims and objectives of the research.
- OP 118. ———. Oil and Gas Producing Sands of the Allegheny Series, Anns Run Pool, Burning Springs Field, Spring Creek District, Wirt County, W. Va. *Producers Monthly*, v. 26, No. 10, October 1963, pp. 14-16. Gives data on two oil sands, known locally as the First and Second Cow Run sands. The sands were cored and well logs run in A. E. Mackintosh well 8 in the Anns Run pool, Burning Springs field. The work was done to evaluate the possibilities of increasing ultimate recovery by secondary recovery methods. Rock properties and fluid saturations were found to be unfavorable for primary or secondary recovery of oil.
- OP 119. ———. Progress on 3 API Research Projects Reported by the Bureau of Mines. *Oil Daily*, Nov. 14, 1960, p. 52. American Petroleum Institute's Research Projects 48A, 52B, and 52C, conducted at Bureau of Mines installations, represent attempts to decrease waste and increase efficiency in the production, manufacture, and use of petroleum and petroleum products. As a result of API Project 48, definite progress has been made in obtaining data on the properties of sulfur compounds found in petroleum and in isolating and identifying sulfur compounds present in characteristic crude oils. Projects 52B and 52C have provided information on the separation of nitrogen compounds from crude oil and the preparation of highly purified nitrogen compounds for calibration standards and measurements of the thermodynamic properties of pure nitrogen compounds.
- OP 120. ———. Review of Gold and Silver Mining Industry for the United States, Calendar Year 1958. Annual Rept. of the Director of the Mint, Fiscal Year Ended June 30, 1959, Treasury Dept. Doc. 3214, 1960, pp. 12-15. Presents a review of the United States gold and silver mining industry prepared from more detailed presentations in the Bureau's Minerals Yearbook (specifically, the chapters on Gold and Silver in Volume I and the chapters on mineral production by States in Volume III). Indicates a continued decline in gold and silver production.
- OP 121. Burgess, David. Rev. of "Combustion, Flames, and Explosions of Gases," by Bernard Lewis and Guenther von Elbe. *J. Chem. Education*, v. 39, No. 4, April 1962, p. A 312. Evaluates the second edition of a book that is the most comprehensive treatment of the basic aspects of combustion. Subject matter is organized according to chemistry and kinetics of oxidation reactions, propagation of combustion waves and detonation waves, state of the burned gas, and problems in technical combustion processes.
- OP 122. Burgess, David, and J. Grumer. Comments on "The Burning Rate of Liquid Fuels From Open Trays by Natural Convection," by D. B. Spalding. *Fire Res. Abs. and Rev.*, v. 4, No. 3, September 1962, pp. 236-238. Discusses Spalding's convection theory and compares some experimental burning-rate values with those predicted from Spalding equations.
- OP 123. Burgess, D. S., Joseph Grumer, and H. G. Wolfhard. Burning Rates of Liquid Fuels in Large and Small Open Trays. *Internat. Symposium on the Use of Models in Fire Res.*, *Nat. Acad. Sci.—Nat. Res. Council Pub.* 786, June 1961, pp. 68-75; abs. in *Fire Res. Abs. and Rev.*, v. 2, 1960, pp. 10-11. Reveals measurements of the consumption rates of six single-component liquid fuels when

- burned in open trays. Results with butane, *n*-hexane, benzene, and methanol are similar to those reported by Blinov and Khudiakov for gasoline and less volatile blended hydrocarbons. Burning rates of liquid hydrogen and of unsymmetrical dimethylhydrazine are consistent with, although too meager to confirm, the same trends. Demonstrates the usefulness of Hottel's semiquantitative analysis of heat transfer with new data on burning rates; heat transfer is predominantly radiative in most cases. When burning rates are extrapolated to large tray dimensions, these extrapolated values are inversely proportional to the fraction of the flame's heat of combustion which is fed back to the liquid to maintain a steady evaporation rate.
- OP 124. Burgess, David, A. Strasser, and J. Grumer. Diffusive Burning of Liquid Fuels in Open Trays. *Fire Res. Abs. and Rec.*, v. 3, No. 3, September 1961, pp. 177-192. Gives data on the burning rate of several hydrocarbon blends contained in shallow trays. Describes the effect of fuel temperature and of wind on burning rate. Fuels were methanol, liquefied natural gas, liquid hydrogen, two amine fuels, and four typical hydrocarbons.
- OP 125. Callaway, H. M. Productivity in the Lead-Zinc Mining Industry. *Min. Eng.*, v. 13, No. 11, November 1961, pp. 1222-1224. Discusses trend of productivity in the industry as it is affected by grade of ore, technology, and current market value.
- OP 126. Campbell, G. G., W. T. Wertman, T. E. Sterner, and E. L. Burwell. Progress Report on Underground Combustion Oil-Recovery Tests in Venango County, Pa. *Producers Monthly*, v. 28, No. 12, December 1964, pp. 12-16. Describes two underground combustion oil-recovery experiments conducted in the Reno oilfield to determine the feasibility of recovering oil from the Second Venango sand by the underground combustion process. There was no conclusive evidence that a self-sustained combustion wave was established in either of the experiments. The slight increase in oil production was attributed to the air drive established prior to and following ignition rather than to combustion advance.
- OP 127. Campbell, William J. Analytical Applications of K, L, and M Spectral Lines. *Encyclopedia of X-Rays and Gamma Rays*, ed. by George L. Clark. Reinhold Publishing Corp., New York, 1963, pp. 1016-1018. Presents rules for selecting the optimum X-ray spectral line for a variety of analytical problems.
- OP 128. ———. Apparatus for Continuous Fluorescent X-Ray Spectrographic Analysis of Solutions. *Applied Spectroscopy*, v. 14, No. 1, 1960, p. 26. Discusses a continuous solution analyzer. Represents an extension of a previous investigation on fluorescent X-ray spectrographic analysis of solutions.
- OP 129. ———. Fluorescent X-Ray Spectrographic Analysis of Trace Elements. Including Thin Films. *Symposium on X-Ray and Electron Probe Analysis*. American Society for Testing Materials, 1963, pp. 48-69. Discusses present status of X-ray spectrography in determining trace elements in metal, powder, and solution samples. Limits of detectability range from 0.1 to 100 ppm, depending on the element being determined, sample composition, and the complexity of the X-ray spectra. Limits of detectability range from 0.01 to 10 μg for elements that have been preconcentrated chemically in a form suitable for X-ray spectrographic determination.
- OP 130. ———. Intensities of the K, L, and M Spectral Lines for the Elements Atomic Numbers 19 to 92. *Advances in X-Ray Analysis*, ed. by W. Mueller. Plenum Press, New York, v. 3, 1959, pp. 109-129. Describes study in which line intensity and background measurements were made on the K lines for the elements with atomic numbers 16 to 60, L lines for the elements above atomic number 42, and M lines for elements above atomic number 80. Three classes of samples—indefinitely thick, microgram deposits, and thin layers—were investigated.
- OP 131. Campbell, William J., and James D. Brown. X-Ray Absorption and Emission. *Anal. Chem.*, v. 36, No. 5, April 1964, pp. 312R-328R. Surveys the literature on X-ray absorption and emission, with emphasis on the fundamental advances achieved in X-ray spectrography and electron-probe microanalysis. Covers the period from December 1961 to November 1963.
- OP 132. Campbell, William J., and Clark F. Grain. Thermal Expansion of Alpha-Alumina. Ch. in *Advances in X-Ray Analysis*, ed. by W. Mueller. Plenum Press, New York, v. 5, 1962, pp. 244-256. 256. Thermal expansion characteristics of alpha alumina were obtained by high-temperature X-ray diffractometer techniques. Bureau values and published values were critically evaluated.
- OP 133. Campbell, W. J., and J. W. Thatcher. Determination of Calcium in Wolframite Concentrates by Fluorescent X-Ray Spectrography. *Proc. 7th Ann. Conf. on Ind. Application of X-Ray Analysis*, University of Denver Press, 1958, pp. 313-332. Describes investigation to develop a rapid, accurate method of analysis for small amounts of calcium in wolframite concentrates by fluorescent X-ray spectrography.
- OP 134. Capp, J. P. Research Program Seeks New Uses for Fly Ash. *Elec. Light and Power*, v. 42, No. 10, October 1964, pp. 36-38. Discusses possible commercial uses of fly ash with emphasis on methods of developing processes for sintering fly ash into lightweight aggregates.
- OP 135. Cargill, R. W., J. Smith, and J. P. McGee. Coal-Fired Gas Turbine Completes Run With New Blades. *Power Eng.*, v. 68, No. 5, May 1964, pp. 47-48. Describes tests of the coal-fired gas turbine using blades of a new design.
- OP 136. Cargill, R. W., Jack Smith, D. C. Strimbeck, and H. R. Bankhead. Feeding Coal to a Gas Turbine—Operation of LCD Coal-Feeding Equipment. *Combustion*, v. 34, No. 10, April 1963, pp. 48-52. Describes the operation of a coal pump and a rotary attrition-type coal pulverizer in one of the coal-feeding systems for the Bureau's experimental coal-fired gas turbine plant. This article is the third in a series.
- OP 137. Caspero, N. A., W. T. Wertman, and Q. E. Wood. Thermal Oil Recovery Experiment in the Pennsylvania Middle District Producing Areas. *Producers Monthly*, v. 25, No. 2, February 1961, pp. 27-28. Bureau of Mines engineers have studied the feasibility of the underground combustion method for recovering Pennsylvania Grade crude oil. Although laboratory work has not been completed, results indicated that a combustion wave could be propagated through a high-gravity, oil-saturated sand at about 700° F. The site of the experiment was the Quaker State Oil Refining Corp. Hunter lease in the Goodwill Hill-Grand Valley field, Southwest district, Warren County, Pa.
- OP 138. Cassel, H. M., and I. Liebman. Combustion of Magnesium Particles. I. Combustion and Flame, v. 6, No. 3, September 1962, pp. 153-156. Evaluation of measurements of the lifetimes of magnesium particles (50- to 120-micron-diameter) burning in oxygen, air, $2\text{O}_2 + 8\text{A}$, and $2\text{O}_2 + 8\text{He}$ strongly supports the conclusion that the overall reaction is governed by diffusion, predominantly of oxygen atoms in the first three gases but of oxygen

- molecules at the lower temperature in the helium mixture.
- OP 139. Cassel, H. M., and I. Liebman. Combustion of Magnesium Particles. II. Ignition Temperatures and Thermal Conductivities of Ambient Atmospheres. *Combustion and Flame*, v. 7, No. 1, March 1963, pp. 79-81. Experimentally determined ignition temperatures of individual magnesium particles (20- to 120-micron-diameter) rise with diminishing particle size and with increasing thermal conductivity of the ambient atmospheres: $2O_2 + 8A < \text{air} < 2O_2 + 8He$. Data are consistent with the thermal theory of ignition here advanced, and thermal conductivity values derived from ignition temperature measurements agree well within theoretical expectation.
- OP 140. ———. Note on the Sublimation of Ammonium Perchlorate. *J. Chem. Phys.*, v. 34, No. 1, January 1961, p. 343. On subliming NH_4ClO_4 in vacuo at $300^\circ C$, a precipitate of liquid droplets is observed on the cool wall of the receptacle. Infrared analysis of the collected condensate indicates about 60 percent HNO_3 , 28 percent HCl and 12 percent $HClO_4$.
- OP 141. Cattell, R. A. Disc. of "Recent Improvements and Development Work Concerning Oil Shale Processing at Kvarntrop, Sweden," by Edmund K. B. Schjanberg and Ake R. L. Brandberg, and of "Oil Shale—Energy for the Future," by Fred L. Hartley and Claude S. Brinegar. *Proc. 5th World Petroleum Cong.*, Sec. 2, June 1959, pp. 390-393.
- OP 142. Cazell, Gabriel F. *Basic Minerals*. *Chem. and Eng. News*, v. 41, Sept. 2, 1963, pp. 91-101. Presents forecast of refined minerals production for the year 1963, based on actual data for the first quarter of the year and on a general forecast of industrial and business activity for the year as a whole.
- OP 143. Champlin, J. B. F. Research on Field Problems on Injecting Solutions Into Permeable Rocks. *Proc. 2d Ground Disposal of Radioactive Wastes Conf.*, Chalk River, Canada, Sept. 26-29, 1961, TID 7628, 1962, pp. 324-343. Describes research on one proposed means of disposal of radioactive wastes, that of injection into geologic formations at depth. Nuclear production plant wastes were simulated and injected into samples of sedimentary rock obtained from outcrops, quarries, and deep wells. Changes in the chemico-physical characteristics of the rocks are discussed. Tests show that injectivity can be maintained over a longer period of waste injection by monitoring the ionic balance and particle-size distribution of the waste stream.
- OP 144. Champlin, J. B. F., and H. N. A. Dunning. Geochemical Investigation of the Athabasca Bituminous Sands. *Econ. Geol.*, v. 55, 1960, pp. 797-804. Furnishes quantitative determination of the metal-porphyrin and porphyrin aggregate contents of the Athabasca oil formations. Subdivides these fractions by alcohol extraction and extensive chromatography. The correlations of the vanadium, nickel, and porphyrin contents of the Athabasca oil and other asphaltic oils, which are unweathered, show that the Athabasca oil has not been subjected to extensive weathering despite its present thin overburden.
- OP 145. Champlin, J. B. F., R. D. Thomas, and A. D. Brownlow. Techniques of Outcrop Rock Sampling. *Oil and Gas J.*, v. 61, No. 38, Sept. 23, 1963, pp. 274-277. Describes two rock drills which are used for sampling outcrops for general areal studies and laboratory research on the physical and chemical characteristics of natural permeable porous media. One drill is hand held and is powered by a small battery pack; the other is mechanically braced and powered by a truck-mounted generator.
- OP 146. Chang, Ta Chuang Lo, and Clarence Karr, Jr. Gas-Liquid Chromatographic Analysis of Aromatic Hydrocarbons Boiling Between 202° and 280° in a Low-Temperature Coal Tar. *Anal. Chim. Acta*, v. 24, April 1961, pp. 343-356. Employment of the effective combination of gas-liquid chromatography and spectrophotometry permits the identification of 43 compounds. Of the identified compounds, 20 are alkylnaphthalenes, including all isomeric dimethylnaphthalenes except the 1-8 isomers. The rest of the identified compounds include methylated indans, tetralins, indenenes and biphenyls, and some oxygenated aromatic hydrocarbons. Cyclohexylbenzene and 2a, 3, 4, 5-tetrahydro acenaphthene, which had never been reported in any low-temperature tar, were also found. Quantitative determinations were made on nearly all of the compounds.
- OP 147. ———. Gas-Liquid Chromatographic Analysis of C_{10} - C_{16} n-Paraffins, Isoparaffins, and α -Olefins in a Low-Temperature Coal Tar. *Anal. Chim. Acta*, v. 26, No. 5, May 1962, pp. 410-418. Describes the identification, by means of gas-liquid chromatography, of 21 organic compounds contained in a low-temperature bituminous coal tar, including 14 paraffins and 7 alpha-olefins. Quantitative determinations were made on all of these constituents.
- OP 148. Churchward, P. E., and J. B. Rosenbaum. Rhenium Recovery by Solvent Extraction and Electrodeposition. *J. Metals*, September 1963, pp. 648-650. Describes a procedure developed by the Bureau to recover rhenium in the form of electrolytic flakes by electrowinning the metal from a solvent-extraction strip solution. The recovered rhenium contains only about 1 percent molybdenum and spectrographic traces of other impurities, such as copper, aluminum, calcium, chromium, iron, platinum, and silicon. Uses and properties of rhenium are discussed, and conventional recovery methods are reviewed.
- OP 149. Clites, P. G., and E. D. Calvert. Laboratory Casting High-Temperature Metals. *J. Metals*, v. 13, No. 2, February 1961, pp. 136-138. A furnace, developed as a laboratory tool for studying the application of skull-casting techniques to high-temperature metals, has been used to produce small castings of various reactive and refractory metals. Because of its small size the apparatus has been useful in studying the casting characteristics of costly and hard-to-melt metals.
- OP 150. Cochran, A. A., and V. R. Miller. Radioisotopes as Aids to Metallography. *J. Metals*, v. 15, No. 12, December 1963, pp. 914-917. Describes a variety of radiotracer techniques for the determination of cerium, sulfur, and carbon distribution in steels and for the identification of steel inclusions.
- OP 151. Cogan, Edward, Controlled-Atmosphere Quartz Ignition Furnace. *Chemist-Analyst*, v. 51, October 1962, p. 84. Describes a furnace in which ignitions can be performed in a reducing or inert-gas atmosphere.
- OP 152. ———. Determination of Trace Bromine. *Anal. Chem.*, v. 34, May 1962, p. 716. Describes a method for quantitative spectrophotometric determination of bromine.
- OP 153. ———. Separation of Cobalt From Its Alloys and Ores With 1-Nitroso-2-Naphthol. *Anal. Chem.*, v. 32, No. 8, July 1960, pp. 973-975. Cobalt is separated from its alloys and ores with 1-nitroso-2-naphthol and subsequently is determined colorimetrically with nitroso-R salt. The cobalt 1-nitroso-2-naphthate is extracted with chloroform; the chloroform is evaporated; the residue is ashed with perchloric and sulfuric acids; and the cobalt salt

- is taken up in water and determined with nitroso-R salt.
- OP 154. Cogan, Edward, Harry Freund, and Peter Romans. Modification of Beckman DK-2 Spectrophotometer Circuitry and Operation. *Anal. Chim. Acta*, v. 23, 1960, pp. 294-295. Reveals modifications of the procedure and circuitry of the Beckman DK-2 automatic recording spectrophotometer which improve the spectrophotometric determination or detection of ions having low molar absorptivities (such as rare earths).
- OP 155. Colbassani, P. J. A Method of Mounting Small Samples for Diffractometer Analyses. *Norelco Reporter*, v. 10, No. 3, July-September 1963, p. 93. Describes a method of mounting small samples for diffractometer analyses; describes the preparation and use of soluble starch wafers for backing samples too small to fill the cavity of the holder.
- OP 156. Colby, Donald. Recent Changes in Bureau of Mines Petroleum Statistics. *Oil Daily*, Nov. 15, 1960, p. 35. Enumerates changes and additions to petroleum statistics that were made as of January 1, 1960.
- OP 157. Colby, Donald S. and Warren E. Morrison. The Role of the Bureau of Mines in Petroleum Economics and Statistics. Document of United Nations Economic Commission for Asia and the Far East, No. 1 & NR/Sub. 3/60, April 20, 1960. This short paper on the general background and purposes of the petroleum reporting program of the Bureau of Mines is designed to familiarize countries with emerging petroleum industries with the techniques and procedures used by the United States Government in this field.
- OP 158. Coleman, H. J., C. J. Thompson, R. L. Hopkins, N. G. Foster, M. L. Whisman, and D. M. Richardson. Identification of Benzo (b) thiophene and Its 2- and 3-Methyl Homologs in Wason, Texas, Crude Oil. *Chem. Eng. Data*, v. 6, No. 3, July 1961, pp. 464-468. Reports the identification of benzo (b)-thiophene (thianaphthene) and two of its homologs (2- and 3-methylbenzol (b) thiophene) in sulfur concentrates obtained from Wason crude oil distillates.
- OP 159. Coleman, H. J., C. J. Thompson, R. L. Hopkins, and H. T. Rall. Gas-Liquid Chromatography. *Proc. API*, v. 42, sec. 8, 1962, pp. 76-80. Discusses past, present, and future gas-chromatographic techniques applicable to sulfur and nitrogen compound separations and identifications conducted by the Bureau of Mines in cooperation with API Projects 48 and 52.
- OP 160. Collins, A. Gene. Eh and pH of Oilfield Waters. *Producers Monthly*, v. 28, No. 9, September 1964, pp. 11-12. Describes and illustrates an apparatus for determining Eh and pH of oilfield waters. Discusses applications of Eh and pH measurements of oilfield waters.
- OP 161. ———. Flame Spectrophotometric Determination of Barium in Oilfield Brines. *Producers Monthly*, v. 27, No. 2, February 1963, pp. 2-6. Describes development of a flame spectrophotometric method for determining barium in oilfield brines. The determinations were made on ethanol solutions of barium concentrates which were separated from the brines by precipitation as chromate. A Farnsworth 6836/FW118 photomultiplier tube was used in the detection system and the emission intensities were measured at 873 m μ .
- OP 162. ———. Flame Spectrophotometric Determination of Cesium and Rubidium in Oil Field Waters. *Anal. Chem.*, v. 35, No. 9, August 1963, pp. 1258-1261. Describes development of a flame spectrophotometric method for determining cesium and rubidium in oilfield waters, with a sensitivity permitting detection of less than 0.05 mg. per liter. Nitroethane was selected and used for the extractions and flame spectrophotometric determinations, and radiotracer methods using cesium 137 and rubidium 86 were used to estimate the extraction efficiency.
- OP 163. Collins, A. Gene. Flame Spectrophotometric Determination of Lithium in Oilfield Brines by an Internal-Standard Method. *Vapor Pressure*, v. 30, No. 3, March 1960, p. 62. Describes an internal-standard flame spectrophotometric method that meets the need for a rapid, sensitive, and precise method of determining lithium in oilfield brines.
- OP 164. ———. Flame Spectrophotometric Determination of Manganese in Oilfield Brines. *Producers Monthly*, v. 26, No. 7, July 1962, pp. 22-23. Describes a flame spectrophotometric method for determining manganese in oilfield brines. Normal propanol was used to increase the emissivity after an extraction of the manganese 8-hydroxyquinoline complex with chloroform.
- OP 165. ———. Flame Spectrophotometric Determination of Potassium in Oilfield Brines. *Producers Monthly*, v. 26, No. 9, September 1962, pp. 28-29. A flame spectrophotometric method for determining potassium in oilfield brines was developed. A red-sensitive multiplier phototube was used to determine potassium by a standard-addition technique at 768 m μ .
- OP 166. ———. Flame Spectrophotometric Determination of Strontium in Oilfield Brines. *Producers Monthly*, v. 26, No. 12, December 1962, pp. 24-25. Describes the development of a standard-addition flame spectrophotometric method to determine strontium in oilfield brines. Ethyl alcohol was used to increase the emissivity of strontium at 680 m μ . Oilfield brines from several formations were found to contain strontium.
- OP 167. Collins, A. Gene, and Thomas G. Ebrey. Spectrophotometric Determination of Zinc in Oilfield Brines. *Producers Monthly*, v. 26, No. 7, July 1962, pp. 29-31. Gives a procedure for determining zinc in oilfield brines by spectrophotometric methods. Dithizone was used to separate the zinc from most interferences, and Zincon was used to form a colored zinc complex.
- OP 168. Collins, A. Gene, and Cynthia A. Pearson. Chelatometric Determination of Calcium and Magnesium in Oilfield Brines. *Producers Monthly*, v. 26, No. 10, October 1963, pp. 18-21. Describes a rapid and accurate chelatometric method of analyzing oilfield waters for calcium and magnesium. Interference from barium and strontium is eliminated by their precipitation as chromates.
- OP 169. ———. Emission Spectrometric Determination of Beryllium in Oilfield Waters Using Plasma Arc. *Anal. Chem.*, v. 36, No. 4, April 1964, pp. 787-789. Gives details of an emission spectrometric method utilizing plasma arc that was developed for determining beryllium in oilfield waters. Detection limit is less than 1 part per billion.
- OP 170. Collins, A. Gene, and J. Wade Watkins. Determination of Potassium in Oilfield Brines. *Pet. Eng.*, v. 31, No. 12, November 1959, pp. B94, B98, B102. Describe a sensitive and relatively simple procedure for determining potassium in oilfield brines. The brine sample is acidized and boiled to remove ammonium ions, and sodium tetraphenylboron solution is added to precipitate the potassium as potassium tetraphenylboron. The precipitate is filtered, dried, weighed, and results reported as parts per million of potassium. Precision and accuracy of the method were found to be within acceptable limits.

- OP 171. Collins, A. Gene, and J. Wade Watkins. Potentiometric Determination of pH, Alkalinity, Acidity, Borate Boron, Total Boron, and Organic Boron in Oilfield Brines. *Producers Monthly*, v. 4, No. 3, January 1960, pp. 32-34. Presents a potentiometric method for determining pH, alkalinity, acidity, borate boron, total boron, and organic boron successively in oilfield brines without preliminary separations. The procedure is sensitive, simple, and relatively free from interference.
- OP 172. Cook, Alton B. Disc. of "The Pickton Field—Review of a Successful Gas Project," by J. H. McGraw and R. E. Lohec. *J. Petrol. Technol.*, v. 16, No. 4, April 1964, pp. 399-405.
- OP 173. Cook, Glenn L. The Mass Spectrometry of Organic Nitrogen Compounds. *Proc. API*, v. 42, sec. 8, 1962, pp. 73-74. Reviews the present status of the mass spectrometry of nitrogen compounds, with emphasis on those found in high-boiling fractions of petroleum. Nitrogen compounds in petroleum identified by mass spectrometry have included pyrroles, inoles, pyridines, quinolines, and carbazoles. The reference compounds are not in the molecular weight range of interest so that an extrapolation is required for their spectra to be useful.
- OP 174. Cook, Glenn L., and N. G. Foster. Relation of Molecular Structure to Fragmentation of Some Sulfur Compounds in the Mass Spectrometer. *Proc. API*, 1961, v. 41, sec. 3, 1962, pp. 199-214. Gives mass-spectral molecular-structure correlations for thiophenes, sulfides, thiols, and disulfides. The thiophenes are discussed in terms of a ring expansion hypothesis. Cyclic intermediates are proposed to explain ion formation in the mass spectra of thiols and sulfides. The ions in the disulfide spectra are formed in a straightforward manner from the parent ions. Some unusual electronic structures, involved in the formation of some of the ions, are discussed in terms of a 10-electron outer shell in the sulfur atom.
- OP 175. Copeland, Mark, and Haruo Kato. Gadolinium Alloys of Iron, Chromium, Nickel, and Stainless Steel. Ch. in *Rare Earth Research*, Gordon and Breach, New York, 1962, pp. 133-141. Phase diagrams of the binary alloys of iron-gadolinium, nickel-gadolinium, and iron-chromium were determined by melting point determinations, thermal analyses, X-ray diffraction, and fluorescent analyses. The stainless steel-gadolinium pseudo binary diagram as observed at this time is presented.
- OP 176. Corey, Richard C. Disc. of "Corrosion of Superheaters and Reheaters of Pulverized Coal-Fired Boilers," by Wharton Nelson and Carl Cain, Jr. *Trans. ASME, J. Eng. for Power*, July 1960, pp. 194-204.
- OP 177. ———. Disc. of "External Corrosion of Superheaters in Boilers Firing High-Alkali Coals," by E. K. Diehl and D. H. Barnhart. *Trans. ASME, J. Eng. for Power*, July 1960, pp. 181-193.
- OP 178. ———. *Fuels and Their Utilization*. Ch. in *Riegel's Industrial Chemistry*. Reinhold Publishing Co., New York, N.Y., rev. ed. by J. A. Kent, 1962, pp. 36-65. Reviews the statistics, mining or recovery, processing, properties, and utilization of coal, petroleum, and natural gas.
- OP 179. ———. Process Variable Study of Incineration Using Tangential Overfire Air. U.S. Atomic Energy Commission, Wash-149. Air Cleaning Seminar, Ames Laboratory, September 15-17, 1952, published May 1962, pp. 154-169. Describes experiments in a cylindrical incinerator employing 100 percent tangential overfire air. Efficient combustion obtained at about 40 percent excess air.
- OP 180. Corgan, Joseph A. Anthracite. *Min. Cong. J.*, v. 47, No. 2, February 1961, pp. 95-97. The available economic barometers indicated that 1960 was a poor year for the anthracite industry. One of the more serious problems was satisfying fully an expanding market for the low-priced fine sizes while the search continued for new uses and markets for the larger coals.
- OP 181. Coryell, R. L., and W. H. Ode. Progress Report on International Standardization Relating to Coal and Coke. *Min. Cong. J.*, v. 49, No. 12, December 1963, pp. 49-51. Reviews progress in developing international standards for sampling, analysis, and testing of coal and coke.
- OP 182. Cotter, Perry G. Stone and Stone Products. McGraw-Hill Yearbook of Science and Technology. McGraw-Hill Book Company, Inc., New York, 1963, pp. 534-536. Discusses present uses and demand for stone and stone products.
- OP 183. Crawford, John E. Bureau of Mines Will Have Versatile Co⁶⁰ Installation. *Nucleonics*, v. 20, No. 5, May 1962, pp. 100-103. Describes the Bureau's 132,000-curie Co⁶⁰ irradiation facility at the Albany (Oreg.) Metallurgy Research Center.
- OP 184. Crentz, William L. Coal Preparation Technology and Trends in the United States. Symp. on Coal, Zonguldak, Turkey, December 1961, Office of U.S. Coordinator for CENTO Affairs, 1962, pp. 282-290. Discusses the meaning of "coal preparation," as the term is used in the United States, and describes mechanical coal-cleaning methods, including coarse-coal cleaning, fine-coal cleaning, froth flotation, and thermal drying.
- OP 185. ———. Federal Coal Research in 1962. *Min. Cong. J.*, v. 49, No. 2, February 1963, pp. 64-66, 69. Gives brief discussion of 1963 Bureau coal research in hydraulic mining methods, rigid foam for roof control and ventilation improvement, sulfur reduction in prepared coal, pipeline transportation of coarse coal, injection of coal into the blast furnace, and other areas.
- OP 186. Crentz, William L., and A. W. Deurbrock. A Review of Coal Preparation Advances Abroad. *Min. Cong. J.*, v. 49, No. 10, October 1963, pp. 88-92. Discusses coal preparation technology in foreign countries, including fine coal washing, ash control, desulfurization, dewatering, electrical crushing, and thermal drying. Reviews the Bureau's investigations of new ideas for possible application in the United States.
- OP 187. Cuffe, S. T., R. W. Gerstle, A. A. Orning, and C. H. Schwartz. Air Pollutant Emissions From Coal-Fired Power Plants: Report No. 1. *J. Air Pollution Control Assoc.*, v. 14, No. 9, September 1964, pp. 353-362. Presents the results of a study of air pollutant emissions from two types of coal-burning powerplant furnaces. Gives data on oxides of sulfur, oxides of nitrogen, solid particulate, polynuclear hydrocarbons, organic acids, and trace gaseous components.
- OP 188. Cummins, J. J., and W. E. Robinson. Normal and Isoprenoid Hydrocarbons Isolated from Oil-Shale Bitumen. *J. Chem. and Eng. Data*, v. 9, No. 2, 1964, pp. 304-307. Gives information on normal and isoprenoid paraffins which were identified in a bitumen from Colorado oil shale. Odd carbon numbered *n*-paraffins were present in greater quantity than even carbon numbered *n*-paraffins and five isoprenoid compounds were identified.
- OP 189. Dalzell, R. Carson, and James P. McGee. Indirect Cycle Nuclear Reactor System To Furnish Process Heat. *Chem. Eng. Prog., Symp. ser.*, v. 55, No. 22, 1959, pp. 111-118. Describes a theoretical process heat reactor which would provide energy for supplying chemical process heat. Considers the use of nuclear process heat for coal gasification.
- OP 190. Dalzell, R. W., and D. S. Kingery. Ventilation Problems and Possible Corrective Measures

- in Operating Continuous Mining Machines in Low Coal Seams. *Trans. 47th Nat. Safety Cong.*, v. 7, 1959, pp. 42-46; abs. in *Coal Age*, v. 64, No. 12, December 1959, p. 139. Describes tests demonstrating the feasibility of utilizing a diffuser-assisted line brattice for ventilation of full face continuous-mining equipment. Tests show that this equipment can reduce the methane concentrations outby the miner head to a maximum of about 2 percent for face liberations of methane up to 15 cubic feet per minute.
- OP 191. Damon, Glenn H. Low Cost Blasting Agents. *J. Mines, Metals, & Fuels*, v. 10, Special Issue, 1962, pp. 305-313. Discusses use of a stoichiometric mixture of ammonium nitrate and fuel oil that has given the mining industry a low-cost blasting agent which has proved surprisingly efficient in a wide range of applications. With careful control of composition and application, substantially equivalent breakage can be obtained at notable saving over the cost of dynamite and similar fixed explosives for many opencast mining and quarry operations.
- OP 192. ———. Safety and Efficiency in Hole Loading and Blasting with AN-FO. *Pit and Quarry*, v. 56, No. 6, December 1963, pp. 89-94. Discusses methods of handling ammonium nitrate blasting agents and shows that operations believed to represent maximum safety will also result in the best performance.
- OP 193. D'Andrea, D. V., R. L. Fischer, and D. E. Fogelson. Prediction of Compressive Strength From Other Rock Properties. *Colorado Sch. Mines Quart.*, v. 59, No. 4, October 1964, pp. 623-640. Gives determinations of 9 rock properties for rocks from 49 locations having a wide range of compressive strengths. Eight of the properties with some of their squares and cross products were used as independent variables in a stepwise multiple linear regression analysis to obtain several equations for predicting compressive strength. The prediction equations had multiple correlation coefficients ranging from 0.947 for an equation with 1 variable (point load tensile strength) to 0.986 for an equation with 25 variables.
- OP 194. Dean, K. C., D. A. Elkins, and B. H. Clemmons. An Evaluation of Thermic Production Methods for Magnesium. *J. Metals*, v. 16, No. 7, July 1964, pp. 564-568. Reports preliminary technological and cost evaluation studies of thermic magnesium production methods and describes two hypothetical plants used in the studies—one based on carbothermic techniques, the other on metallothermic techniques.
- OP 195. DeCarlo, J. A., and Harry Perry. Coal Chemicals for World Markets. *Proc. Blast Furnace, Coke Oven, and Raw Materials Conf., AIME*, v. 18, 1959, pp. 292-309. Tabulates production and consumption of crude tar, light oil, ammonia, and their principal derivatives for the United States and 16 other nations. Shows that the international demand for these chemicals is outstripping the capacity of the coke industry, which obtains them as incidental products in carbonizing bituminous coal at high temperatures to make blast-furnace fuel. Although chemicals obtained in processing natural gas and petroleum will be needed to augment those from coal in the immediate future, coal may ultimately regain its position as the principal supplier of chemical raw materials as new methods for extracting coal chemicals become economic.
- OP 196. Decora, Andrew W., and G. U. Dinneen. Gas-Liquid Chromatography of Pyridines Using a New Solid Support. *Anal. Chem.*, v. 32, No. 2, February 1960, pp. 164-169. Describes a solid support developed for the gas-liquid chromatography of pyridines; it is superior to Chromosorb or Celite 545. The support was used to study the selectivity of several nonpolar and slightly polar liquid substrates. The study was used to select two columns employed in series to separate a test mixture of 14 pyridines.
- OP 197. Decora, Andrew W., and G. U. Dinneen. A Solid Support for the Gas Liquid Chromatography of Strongly Basic Nitrogen Compounds. Ch. in *Gas Chromatography*. Academic Press, Inc., New York, 1961, pp. 33-38; *Proc. Instr. Soc. America*, v. 2, 1959, pp. 12-15. Describes a solid support developed for the gas-liquid chromatography of nitrogen compounds of pKa range 6-11. The support was obtained by depositing 10 grams of potassium hydroxide on 100 grams of a solid support recently developed by the authors for analyzing pyridines. The modified support gave symmetric peaks for 13 nitrogen compounds in the pKa range studies when nonpolar liquid substrates were used. This support allows the use of nonpolar liquid substrates for the analysis of basic compounds.
- OP 198. Deul, Maurice. Methane Drainage From Coalbeds: A Program of Applied Research. *Proc. 60th Meeting, Rocky Mountain Coal Mining Inst.*, June 30-July 1, 1964, Colorado, 1964, pp. 54-60. Discusses research in degasification of coalbeds in the United States. The current research has these objectives: Predicting methane concentrations in coalbeds; establishing the geological conditions that contribute to abnormal methane concentrations in coalbeds; assessing the physical properties of coal and adjacent strata that influence the retention and emission of methane; studying the effect of coal extraction on the emission of methane; and devising and testing methods for effectively draining methane from coalbeds prior to mining.
- OP 199. Deurbrouck, Albert W., and Eugene R. Palowitch. Cleaning Fine Coal on Concentrating Tables. *Proc. 4th Internat. Coal Preparation Cong.* 1962. Published 1963, pp. 181-192. Describes a study of the use of wet concentrating tables for cleaning fine coal. Performance of the table products by size fractions indicates tabling efficiency decreases below 48 mesh. Feed to the tables during these tests included a low-volatile Pocahontas coal, a medium-volatile Elkhorn coal, and a high-volatile Pittsburgh coal.
- OP 200. DeVaney, Will E., J. B. Dalton, and James C. Meeks, Jr. Vapor-Liquid Equilibria of the Helium-Nitrogen System. *J. Chem. and Eng. Data*, v. 8, No. 4, 1963, pp. 473-478. Presents extensive experimental data on the helium-nitrogen system, compares the results with those reported by other investigators, and tabulates this information in useful form for engineering calculations. A windowed phase-equilibrium apparatus was employed to obtain phase equilibria data for temperatures from 76.5° to 120° K and pressures from 200 to 2,000 psia. A compilation of experimental vapor-liquid values and equilibrium constants, *K*, for helium and nitrogen are included.
- OP 201. Devine, James F. Vibration Levels From Multiple Holes per Delay Quarry Blasts. *Earthquake Notes*, v. 33, September 1962, pp. 32-39. Gives data on 12 tests conducted by the Bureau in 4 quarries in Iowa to determine if the method of blast initiation has an effect upon the level of vibration from quarry blasts employing more than 1 hole per delay. Three of the more common levels of blast initiation were studied.
- OP 202. Dinneen, Gerald U. Sulfur and Nitrogen Compounds in Shale Oil. *Proc. API*, v. 42, sec. 8, 1962, pp. 41-44. Summarizes present knowledge of the sulfur and nitrogen compounds in shale oil. The contents of these elements in shale oils from

- different sources are given. The individual thiophenes and pyridines identified from a Colorado shale-oil naphtha are discussed.
- OP 203. Douglas, Sanford J. Electrical Safety in Mining. *Mechanization*, v. 27, No. 8, August 1963, pp. 28-30. Reviews advances in electrical-equipment safety requirements with special reference to trailing cables.
- OP 204. Douslin, D. R. Pressure-Volume-Temperature Relations and Intermolecular Potentials for Methane and Tetrafluoromethane. Ch. in *Progress in International Research on Thermodynamic and Transport Properties*. ASME, New York, 1962, pp. 135-146. Gives second, third, and fourth virial coefficients of methane and tetrafluoromethane, determined from measured P-V-T properties. Results were used to test five theoretical potential functions.
- OP 205. Douslin, D. R., R. H. Harrison, R. T. Moore, and J. P. McCullough. P-V-T Relations for Methane. *J. Chem. and Eng. Data*, v. 9, No. 3, July 1964, pp. 358-363. Measurements of the gas compressibility of methane were made in the region 0-350°, 16-400 atm, and 0.75-12.5 mole liter⁻¹. From these results, values were derived for the compressibility factor Z-PV/RT (th.); second, third, and fourth virial coefficients, B, C, and D, respectively, in the equation PV-RT(th.) (1+B/V+C/V²+D/V³+...); and parameters of the Beattie-Bridgeman and Benedict-Webb-Rubin equations of state.
- OP 206. ———. Tetrafluoromethane: P-V-T and Intermolecular Potential Energy Relations. *J. Chem. Phys.*, v. 35, No. 4, October 1961, pp. 1357-1366. Measurements of the gas compressibility of tetrafluoromethane were made in the region, 0°-350°, 15-394 atm. From these results, values of the compressibility factor Z-PV/RT, the second, third, and fourth virial coefficients, and the parameters of the Beattie-Bridgeman and Benedict-Webb-Rubin equations of state were derived. The virial coefficients were correlated by the Lennard-Jones, Stokmayer, and Kihara intermolecular potential energy functions, and numerical values for the molecular parameters were obtained. One of the first tests of the theoretical fourth virial coefficient of the Lennard-Jones potential was made using the experimental fourth virial coefficients of tetrafluoromethane.
- OP 207. Dozois, C. L., R. W. Hurn, and R. L. Mills. Graphic Cam Programmer is Easily Changed. *Control Eng.*, v. 10, No. 7, July 1963, p. 131. Describes an automatic controller to accomplish close control of repetitive engine test cycles. The heart of each control channel is a programmer that translates the radial contour of a graphic cam into a dc control signal.
- OP 208. Dunning, H. N., J. L. Eakin, W. N. Reinhardt, and C. J. Walker. Foaming Agents: Cure for Waterlogged Gas Wells. *Petroleum Eng.*, v. 31, No. 12, November 1959, pp. B28-B33. Discusses the removal of water from gas wells with foaming agents, with special application to marginal wells. Finds that it can be done at a cost of about \$5 per treatment.
- OP 209. Dunning, H. N., J. L. Eakin, and J. J. Walker. The Foam Method for Removal of Liquids From Gas Wells. *Am. Chem. Soc. Div. of Petroleum Chem.*, Cleveland, Ohio, April 5-14, 1960, v. 5, No. 2, pp. A-19 to A-25. An inexpensive, new method for removing water from gas wells, by the use of foaming agents, has been developed. The value of the foam method, for periodic removal of water from gas wells, has been established by more than 50 field tests. Recent field tests show that the method also is applicable for the continuous removal of water and the periodic removal of hydrocarbons from gas wells.
- OP 210. Dunning, H. N., and G. J. A. Janzen. Standard Dynamic Foam Test. *J. Phys. Chem.*, v. 24, No. 6, April 1960, p. 31. Describes a new, inexpensive method for removing liquids from gas wells by the use of foaming agents. The procedure was developed by the Bureau of Mines in cooperation with the American Gas Association. Explains the test procedure and indicates the results.
- OP 211. Dunning, H. N., J. W. Moore, Herman Bieber, and R. B. Williams. Porphyrin, Nickel, Vanadium, and Nitrogen in Petroleum. *J. Chem. and Eng. Data*, v. 5, No. 4, October 1960, pp. 546-549. Reveals the vanadium, nickel, and porphyrin contents of a variety of crude oils. Shows that 3 to 10 percent of the vanadium in most vanadium-rich oils is present as vanadium-porphyrin complexes.
- OP 212. Dupuy, Leon W. Acid Mine Water. *Proc. Interstate Commission on the Potomac River Basin*, October 1962, pp. 36-38. Discusses briefly the problems of acid mine water control, the Bureau's research, and problems of rehabilitating mined-out areas.
- OP 213. Duvall, Wilbur I. Vibration Levels From One Hole Per Delay Quarry Blasts. *Earthquake Notes*, v. 33, No. 3, September 1962, pp. 24-31. Describes a factorial designed experiment to determine if the number of delay intervals or the length of delay interval in a quarry blast has a significant effect on the vibration level. A statistical analysis of the data was performed, and the results show that over the range of the variables tested neither the number of delay periods nor the length of the delay interval has a significant effect upon the level of vibration from quarry blasting.
- OP 214. Duvall, Wilbur I., and David E. Fogelson. Review of Criteria for Estimating Damage to Residences From Blasting Vibrations. *Abs. in Earthquake Notes*, v. 22, September-December 1961, p. 24. Deduces from a review of the literature that if vibration levels in the vicinity of residential structures are maintained below a peak particle velocity of 2 in/sec, there is a low probability of causing any damage to structures.
- OP 215. Dwiggs, C. W., Jr. Automated Determination of Elements in Organic Samples Using X-Ray Emission Spectrometry. *Anal. Chem.*, v. 36, No. 8, July 1964, pp. 1577-1582. Describes new automated X-ray methods for determining elements in organic materials, including petroleum and petrochemicals, using both X-ray emission and scatter methods. Methods for matrix effect and background corrections suitable for automated analyses were investigated in detail. Direct-reading analyses for some of the more routine determinations were achieved. The use of the new correction methods and techniques speeds analyses and requires much less operator attention for both routine and special analyses.
- OP 216. ———. Carbon and Hydrogen Determination Using Intensity Ratios of Coherent to Incoherent Scattering of X-Rays. *Encyclopedia of X-Rays and Gamma Rays*, ed. by G. L. Clark. Reinhold Publishing Corp., New York, 1963, pp. 113-115. Describes methods for the rapid quantitative determination of carbon and hydrogen using scattered X-rays. The methods are applicable to petroleum and other organic chemical analyses.
- OP 217. ———. Quantitative Determination of Low Atomic Number Elements Using Intensity Ratio of Coherent to Incoherent Scattering of X-Rays. *Determination of Hydrogen and Carbon*. *Anal. Chem.*, v. 33, No. 1, January 1961, pp. 67-70. A new method based on the intensity ratio of co-

- herent to incoherent scattering of X-rays has been developed for the determination of low atomic elements and been used to determine hydrogen and carbon in hydrocarbons, particularly petroleum, and in a matrix containing additional elements. Corrections for the sulfur and nitrogen content have been developed. Carbon and hydrogen may be determined in quadruplicate in 20 minutes or less. Conventional X-ray spectrographic equipment may be used without modification. The precision and accuracy of the method appear to equal or surpass those of conventional microcombustion methods for many types of samples.
- OP 218. Dwiggins, C. W., Jr. Trace Metals Determination in Petroleum by X-Ray Spectrometry: Standardization and Correction Techniques. *Encyclopedia of X-Rays and Gamma Rays*, ed. by G. L. Clark. Reinhold Publishing Corp., New York, 1963, pp. 1071-1073. Describes X-ray methods for determining nickel, vanadium, and iron in petroleum. Several methods for standardization and correction of experimental results are compared.
- OP 219. Dwiggins, C. W., Jr., and R. J. Bolen. Ultracentrifugal Determination of the Micellar Character of Non-Ionic Detergent Solutions, II. *J. Phys. Chem.*, v. 65, No. 10, October 1961, pp. 1787-1788. An analytical ultracentrifuge was used to determine the temperature dependence of the anhydrous, weight-average, micellar molecular weight of a poly-oxyethylated nonylphenol in aqueous solutions. Micellar molecular weights were determined several times under different conditions at each temperature. Partial specific volumes were determined at each temperature. The micellar molecular weight of this detergent increased at a rate of 2.217 (± 66) molecular weight units per degree in the temperature range of 10.5° to 35.0°.
- OP 220. ———. Ultracentrifugal Determination of the Micellar Character of Non-Ionic Detergent Solutions, III. *J. Phys. Chem.*, v. 66, No. 3, March 1962, pp. 574-575. Ultracentrifuge methods were used to study the effect of ethylene oxide chain length on micellar molecular weights of polyoxyethylated nonylphenol nonionic detergent in aqueous solutions.
- OP 221. Dwiggins, C. W., Jr., R. J. Bolen, and H. N. Dunning. Ultracentrifugal Determination of the Micellar Character of Non-Ionic Detergent Solutions. *J. Phys. Chem.*, v. 64, No. 9, September 1960, pp. 1175-1178. Describes analytical ultracentrifuge used to determine the micellar molecular weights of micelles in four aqueous nonionic detergent solutions at 25°. Uses transient state methods extensively and utilizes capillary synthetic boundary cells to determine relative optical concentrations. Determines molecular weights for various times and concentrations to insure accuracy. Indicates that three polyoxyethylated phenols formed micelles containing 100 to 300 molecules, whereas Pluronic L-64, a high molecular weight condensate of ethylene and propylene oxides, did not exhibit micelle formation.
- OP 222. Dwiggins, C. W., Jr., and H. N. Dunning. Quantitative Determination of Traces of Vanadium, Iron, and Nickel in Oils by X-ray Spectrography. *Anal. Chem.*, v. 32, No. 9, August 1960, pp. 1137-1141. Describes an accurate X-ray internal standard developed for the determination of vanadium, iron, and nickel in oils and an emission-absorption method devised for special cases in which an internal standard may not be used. Compares several X-ray methods of trace metal determination.
- OP 223. ———. Separation of Waxes From Petroleum by Ultracentrifugation. *J. Phys. Chem.*, v. 64, No. 3, March 1960, pp. 377-378. Tests indicate that the sediment obtained from ultracentrifugation of petroleum often contains relatively large amounts of wax. These waxes must be recognized during interpretation of ultracentrifuge data based on the sediment that is obtained. Because the centrifugal forces used are in the range of supercentrifuges, the centrifugal method may prove commercially applicable for clarification of crude oils or refinery stocks and for the preparation of high molecular weight waxes.
- OP 224. Eakin, J. L., A. D. Hopkins, and H. N. Dunning. Foam Removes Brine From Deep Texas Wells. *Oil and Gas J.*, v. 58, No. 33, Aug. 15, 1960, pp. 162-163. Foam method of liquid removal from gas wells is put to a severe test in two high-temperature wells in west Texas. Ellenburger lime production was stimulated at a depth of 15,000 feet, where bottom-hole temperatures reached 208° F.
- OP 225. Eakin, J. L., R. T. Johansen, A. D. Hopkins, and R. W. Taliaferro. How Chemical Treatment Gets Rid of Gas-Well Water Blocks. *Oil and Gas J.*, v. 60, No. 48, Nov. 26, 1962, pp. 85-89. Describes inexpensive method of removing water blocks from gas wells by injecting alcohol containing small percentages of surface-active detergents. Method has been used successfully in actual field tests, in some cases doubling the capacity of producing wells.
- OP 226. Eakin, J. L., and R. W. Taliaferro. Selecting Agents To Foam Those Heavy Brines. *Oil and Gas J.*, v. 60, No. 49, Dec. 3, 1962, pp. 131-134. Gives results of field and laboratory tests to find the best foamers for brines with high concentrations of sodium and calcium chloride.
- OP 227. Earnshaw, D. G., G. L. Cook, and G. U. Dinneen. A Study of Selected Ions in the Mass Spectra of Benzenethiol and Deuterated Benzenethiol. *J. Phys. Chem.*, v. 68, No. 2, February 1964, pp. 296-300. Presents partial mass spectra for benzenethiol and deuterated benzenethiol. The change in ion intensities that result from deuterium labeling were studied to determine the structure of the parent ion before fragmentation. A seven-membered ring structure for the parent ion is proposed as precursor for some of the ions studied, whereas the six-membered ring structure for the parent is proposed as precursor for the other ions.
- OP 228. Eckard, W. E. Evaluation of Appalachian Area Reservoirs for Increased Oil Recovery. *Producers Monthly*, v. 27, No. 3, March 1963, pp. 14-20. Preliminary results of a detailed study of a core from a Cow Run sand well (Burning Springs field, Clay district, Wirt County, W. Va.) indicate the possibility of successful secondary recovery of oil by waterflooding.
- OP 229. Ellerts, C. Kenneth, Nora Potts, and Byron A. Baker. Relationship of Vapor-Liquid Equilibrium Ratios at Dewpoint Pressure to Compressibility Factors and Composition of Gas-Condensate Fluids. *Proc. 5th World Petroleum Cong.*, sec. 2, 1959, 357-369. Describes two methods for calculating vapor-liquid equilibrium ratios of components of gas-condensate fluids at dewpoint temperatures in the range of 70° to 310° F when only composition of the fluid is known. Measured equilibrium ratios for relatively low pressures may be extrapolated to measured dewpoint pressure at the temperature of interest.
- OP 230. Ellertsen, Donald E. Beryllium. *California, Div. Mines and Geology, Miner. Inf. Service*, v. 15, No. 2, February 1962, pp. 12-18. Describes briefly mineralogy, mining, reserves, Government programs, industry, marketing, prices, uses, and research.
- OP 231. Elder, James L. The Underground Gasi-
fication of Coal. Ch. 21 in *Chemistry of Coal Utili-*

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- zation: Supplementary Volume, ed. by H. H. Lowry. John Wiley & Sons, Inc., New York, pp. 1023-1040. Discusses the research in underground gasification of coal; the gasification processes tested since 1951; and industrial plants for underground gasification of coal, which have been installed only in the U.S.S.R.
- OP 232. Eldib, I. A., and R. J. Bolen. Ultracentrifugation and Viscosities of Crude Oils. Abs. of Papers, 136th Meeting, Am. Chem. Soc., Div. of Colloid Chem., Atlantic City, N.J., September 1959, p. 19-1. Gives results of the investigation of the viscosities of crude oils and their extracts in various solvents at several temperatures. Purpose of the study was to select solvents that will cause little denaturation of crude oils which are to be centrifuged.
- OP 233. Eldib, I. A., H. N. Dunning, and R. J. Bolen. Nature of Colloidal Materials in Petroleum. *J. Chem. and Eng. Data*, v. 5, No. 4, October 1960, pp. 550-553. Investigates the chemical properties of the colloidal particles of petroleum.
- OP 234. Ellis, C. F. A Suggested Procedure for Converting NO in Low Concentrations to NO₂. *Int. J. Air and Water Pollution*, v. 8, No. 5, May 1964, pp. 297-299. Describes a modification of the Saltzman method that has been found useful in analyzing gases containing low concentrations of NO and NO₂. Such an analysis of gases is frequently required in studies of atmospheric contaminants.
- OP 235. Elliott, William C., Jr. Waterflooding Conglomerate Reservoirs in North Texas. *Mines*, v. 51, January 1961, pp. 29-33. Describes three water-flooding projects in Jack and Montague Counties, Tex. Wells were completed either by setting pipe on top of the formation and drilling through the productive zones or by setting pipe through the productive zones and perforating the casing. Many of the wells were hydraulically fractured, either at completion or during workovers. The primary producing mechanism was either solution gas expansion or solution gas expansion with some effect from a gas cap. High gas-oil ratios developed early in the producing life of the reservoirs and pressures declined steadily. The primary recoveries from the reservoirs studied were low, ranging from 9 to 20 percent of the original oil in place; most recoveries were below 15 percent.
- OP 236. Ellman, R. C., J. W. Belter, and L. Dockter. Pulverizing Lignite in a Pilot-Plant Test Unit. Proc. American Power Conference. Illinois Institute of Technology, 1963, pp. 513-524. Gives results of tests on 10 North Dakota lignites. Power requirements significantly decrease as degree of in-the-mill drying is intensified, but pulverizing characteristics vary with mine source.
- OP 237. Elsner, Elizabeth K., and Mary B. McNair. Awards Announced for 1959 National Crushed Stone Association Safety Contest. *Nat. Crushed Stone J.*, v. 15, No. 3, September 1960, pp. 3-6. Indicates that a record number of awards (59) were presented as a result of the 1959 competition. The winners are listed.
- OP 238. Eng, Harvard, and H. Kenworthy. Waterborne Wastes and Water Usage of Metal-Processing Industries in Missouri River Basin Areas of Kansas and Missouri. Missouri Basin Preliminary Rept. 132, September 1960, 28 pp. A plant-by-plant survey was made of the metal-processing industries generating waterborne wastes of mineral origin. The geographical area covered by the survey consisted of the areas in Kansas and Missouri drained by the Missouri River. The objectives of the survey were (1) to collect data on the quantities and types of industrial wastes, (2) to study the water requirements of these industries, and (3) to study their water usage. Information was gathered, evaluated, and tabulated for reference according to industrial classification.
- OP 239. Ergun, Sabri, and Leroy E. Alexander. Crystalline Forms of Carbon: A Possible Hexagonal Polymorph of Diamond. *Nature*, v. 195, August 25, 1962, pp. 765-767. Gives data to show that the hexagonal form may exist in diamonds, causing what are termed layer faults and growth faults.
- OP 240. Ergun, Sabri, and W. F. Donaldson. The Breit-Dirac Correction to Compton Scattering of Carbon. Proc. 5th Conf. on Carbon, Pergamon Press, New York, v. 2, 1963, pp. 517-518. In comparing experimental scattering results with those predicted for materials of known molecular structure or for assumed structures likely to be present in various forms of carbon, correct conversion of recorded intensities into electron units is necessary. Using MoK α radiation it was observed that Breit-Dirac correction to Compton scattering becomes important for this conversion.
- OP 241. Ergun, Sabri, W. F. Donaldson, and I. A. Breger. Some Physical and Chemical Properties of Vitreous Associated With Uranium. *Fuel*, v. 39, January 1960, pp. 71-77. Presents studies of the chemical composition, density, reflectances, and X-ray scattering of nine samples of coalified wood containing uranium.
- OP 242. Ergun, Sabri, and J. T. McCartney. Absorption by Graphite Single Crystals in the Ultraviolet and Visible Spectrum. Proc. 5th Conf. on Carbon, Pergamon Press, New York, v. 2, 1963, pp. 167-173. Gives determination of refractive and absorptive indexes and thicknesses of ultrathin fragments of graphite at a wavelength of 5460 Å by direct transmission and phase retardation measurements. A graphical procedure has been developed for this calculation.
- OP 243. ———. Electron Diffraction From Coals. *Science*, v. 134, Nov. 17, 1961, pp. 1620-1621. Electron diffraction patterns have been obtained for coals of different rank by transmission through ultrathin sections 500 to 2,000 angstroms thick. Analysis of these patterns for the distribution of atoms in coals by Debye radial distribution functions should furnish information complementary to that derived from X-ray studies, considering the differences in wavelength of the radiation involved and the different mechanisms governing the diffraction.
- OP 244. ———. Reflectance of Coals, Graphite, and Diamond. *Fuel*, v. 39, November 1960, pp. 449-454. The reflectance of coals, graphite, and diamond in the visible spectrum has been determined microscopically. The ratios and reflectance in air to density of the vitrinites ranged between those of graphite and diamond, in order of decreasing rank. The reflectance-density ratios of the vitrinites at 5460 Å were found to be linearly related to the hydrogen/carbon ratio, and the linear relation was extended to the reflectance of graphite. It appears that the increase in reflectance of coals with rank is caused partly by increase in density and, probably to a greater extent, by their becoming more graphite-like.
- OPOP 245. Ergun, Sabri, James T. McCartney, and Robert E. Walline. Adsorption of Ultraviolet and Visible Light by Ultrathin Sections of Coal. *Fuel*, v. 40, March 1961, pp. 109-117. Extinction coefficients of ultrathin sections 500 to 2,000 Å thick of vitrinites from eight coals and of graphite have been determined in the wavelength region of 2,330

- to 6,400 A. The rank of the coals ranged from lignite to anthracite.
- OP 246. Ergun, Sabri, James T. McCartney, and Robert E. Walline. Absorption of Ultraviolet and Visible Light by Ultrathin Sections of Vitrinite From a High-Volatile Bituminous Coal. *Nature*, vol. 187, No. 4742, Sept. 17, 1960, pp. 1014-1015. Investigates the theory that the extinction coefficients of a high-volatile A bituminous vitrinite in ultraviolet and visible light are too low to admit an appreciable content of condensed aromatic structures. Study was made possible when success was achieved in cutting ultrathin section of coals of various ranks and in accurately measuring their thickness and refractive index by interferometry.
- OP 247. Ergun, Sabri, Morris Mentser, and H. J. O'Donnell. Three-Dimensional X-Ray Reflections From Anthracite and Meta-Anthracite. *Science*, v. 132, No. 3436, Nov. 4, 1960, pp. 1314-1316. Careful analysis of X-ray scattering intensities of demineralized meta-anthracites and high-rank anthracites formed during the Pennsylvanian geological period has revealed three-dimensional (hkl) reflections of graphite, demonstrating unequivocally that coals graphitize with metamorphism.
- OP 248. Ergun, Sabri, and I. Wender. X-Ray Scattering Intensities of Coals Treated With Lithium in Ethylenediamine. *J. Appl. Chem.*, v. 10, May 1960, pp. 189-192. Presents X-ray scattering intensities for seven vitrinites of different rank and a natural graphite before and after treatment with lithium in ethylenediamine.
- OP 249. Erickson, Victor. *Basic Minerals*, 1961. *Chem. and Eng. News*, v. 39, No. 36, 1961, pp. 99-106. Presents forecast of refined mineral production for the year 1961, based on actual data for the first quarter of the year and on a general forecast of industrial and business activity for the year as a whole.
- OP 250. ———. *Basic Minerals*, 1962. *Chem. and Eng. News*, v. 40, No. 36, 1962, pp. 51-57. Presents forecast of refined minerals production for 1962, based on actual data for the first quarter of the year and on a general forecast of industrial and business activity for the year as a whole.
- OP 251. Espenshade, Gilbert H., and Howard P. Hamlin. Slate From the Greenville Quadrangle, Maine, as Potential Lightweight Aggregate Material. *Geological Survey Research* 1961, Prof. Paper 424-C, pp. C-18 to C-20. Concludes that slate from this quadrangle would be suitable for bloated lightweight aggregate when fired in a rotary kiln under closely controlled conditions.
- OP 252. Estep, Patricia A., and Clarence Karr, Jr. A Liquid Ultramicrocavity Cell Holder for Use With an Infrared Beam Condenser. *Appl. Spectroscopy*, v. 16, No. 5, 1962, pp. 167-168. Describes a cell holder that was developed to provide a rapid technique for obtaining spectra of microsamples of coal chemicals in solution.
- OP 253. ———. Quantitative Infrared Microanalysis of High-Boiling Aliphatic Neutral Oil Fractions. *Anal. Chem.*, v. 36, No. 11, October 1964, pp. 2215-2218. Describes a procedure for quantitative infrared microanalysis of undiluted samples of aliphatics with a variety of both saturate and olefin types in the C_{15} to C_{20} range from low-temperature coal tars.
- OP 254. Feenan, J. J., R. B. Anderson, H. W. Swan, and L. J. E. Hofer. Chromium Catalysts for Oxidizing Automotive Exhaust. *J. Air Pollution Control Assoc.*, v. 14, No. 4, April 1964, pp. 113-117. Reports on the study of chromia-on-alumina catalysts for the oxidation of carbon monoxide and hydrocarbons represented by isopentane in a continuous-flow system. This study is part of the Bureau program to investigate the feasibility of using various metals and metal oxides as catalysts for the removal of noxious components of automotive exhaust gases.
- OP 255. Ferrante, M. J., P. C. Good, F. E. Block, and D. H. Yee. High-Purity Electrolytic Chromium. *J. Metals*, v. 12, No. 11, November 1960, pp. 861-865. Shows how massive chromium was electrodeposited at elevated temperatures from aqueous chromic acid electrolytes containing the sulfate ion, fluoride ion, or silico-fluoride ion as a catalyst. Metal from sulfate baths was deposited at 13 percent current efficiencies and was shown to contain 50 ppm oxygen, <20 ppm nitrogen, and trace amounts of metallic impurities. Arc-melted metal was hot worked into wire ductile at 25° C. Metal from fluoride or silicofluoride baths was deposited at 37 and 43 percent current efficiencies, respectively, and contained the same impurity levels as chromium prepared from sulfate baths, except that oxygen and tin levels were slightly increased.
- OP 256. Ferrin, C. R., J. O. Chase, and R. W. Hurn. Analysis of Complex Hydrocarbon Mixtures Using an Unsaturate-Discriminating Gas Chromatograph. Ch. 28 in *Biochemical Applications of Gas Chromatography*, ed. by H. P. Burchfield and E. E. Storrs. Academic Press, Inc., New York, 1962, pp. 423-429. Describes a method of obtaining qualitative and quantitative hydrocarbon analyses of automotive engine exhausts using a flame ionization gas-liquid chromatograph. Method can determine individually at least 25 of the C_1 to C_6 hydrocarbons and as groups the C_6 through C_8 saturates, the C_6 through C_8 olefins and acetylenes, the C_6 and heavier saturates, and the aromatics.
- OP 257. Fester, J. I., and W. E. Robinson. Method for Determining Carboxyl Content of Insoluble Carbonaceous Materials. *Anal. Chem.*, v. 36, No. 5, June 1964, pp. 1392-1394. Describes a steam distillation method used to determine carboxyl groups in the kerogen from Green River oil shale.
- OP 258. Field, J. H., H. E. Benson and R. B. Anderson. Synthetic Liquid Fuels by Fischer-Tropsch Process. *Chem. Eng. Progr.*, v. 56, No. 4, April 1960, pp. 44-48. Summarizes recent commercial development and the current status of the coal gasification, gas purification, and catalytic synthesis steps.
- OP 259. Field, J. H., J. J. Demeter, A. J. Forney, and D. Bienstock. Development of Catalysts and Reactor Systems for Methanation. *I&EC Product Res. and Development*, v. 3, No. 2, June 1964, pp. 150-153. Describes effective catalytic conversion of synthesis gas to methane using a hot gas-recycle reactor and a tube-wall reactor. Both offer excellent heat removal and temperature control although the hot gas-recycle system has been developed to a larger scale.
- OP 260. Fine, M. M. A Process for Simultaneous Agglomeration and Reduction of Iron Ores. *Proc. 8th Biennial Conf., Internat. Briquetting Assoc.*, December 1963, pp. 49-60. Shows that green iron ore pellets can be simultaneously reduced and indurated by heating with solid reductants at 1,150° C.
- OP 260A. Fine, M. M., J. A. DeCarlo, and E. T. Sheridan. Substitutes for Coking Coals in the Blast Furnace. *United Nations Interregional Symposium on the Application of Modern Technical Practices in the Iron and Steel Industry to Developing Countries*, Nov. 11-26, 1963. *Tech. Paper A.18*, 13 pp. Discusses substitutes for coking coals in the blast furnace either by reducing the amount of coke used or by substituting another fuel for part of the coke. Prerduced burdens could eliminate up to 50 percent of the coking coal currently consumed in ironmaking. Other fuels may be used.

- instead of coke if one of the so-called direct reduction processes is used. Formed coke may be substituted for metallurgical coke obtained from coking coals. Other fuels may be substituted for metallurgical coke in the blast furnace by injecting them into the combustion zone. Noncaking coals, petroleum products, and natural gas have been substituted successfully.
- OP 261. Fitzpatrick, M., R. Craft, J. W. Warren, F. H. Laird, H. A. Watson, E. J. Harris, R. L. Beatty, and L. D. Scheel. An Industrial Hygiene Survey of Polyurethane Foam Applications in an Underground Mine. *Am. Ind. Hyg. J.*, v. 25, No. 6, November-December 1964, pp. 569-577. Gives the determination of concentrations of toxic airborne isocyanate vapor and particulate matter formed during spray application of polyurethane foam to underground mine surfaces. Study was made to assess possible hazard to workmen.
- OP 262. Fogelson, David E., Thomas C. Atchison, and Wilbur I. Duvall. Propagation of Peak Strain and Strain Energy for Explosion-Generated Strain Pulses in Rock. *Colorado Sch. Mines Quart.*, v. 54, No. 3, July 1959, pp. 271-284. Presents results from a series of linear array strain tests arranged by the Bureau and designed to determine the strain-producing abilities of six explosives when detonated in a granite gneiss.
- OP 263. Forney, Albert J., Richard F. Kenny, Stanley J. Gasior, and Joseph H. Field. Destruction of Caking Properties of Coal by Pretreatment in a Fluidized Bed. *I&EC Product Res. and Development*, v. 3, No. 1, March 1964, pp. 48-53. Treating fine coals at 400° to 425° C with a fluidizing gas composed of either inert gas or steam containing at least 0.2 percent oxygen destroys the caking properties of the coal. The minimum time required to produce a completely nonagglomerating char is about 5 minutes. The chars made may be used as a feed for a fluidized-bed gasification or a hydrogasification process.
- OP 264. Foster, Norman G. Medium- and Low-Resolution Mass Spectrometry for Sulfur Compounds. *Proc. API*, v. 42, sec. 8, 1962, pp. 72-73. Describes and discusses the use of the mass spectrometer as an identification tool and the characterization of higher molecular weight species by low voltage techniques. The correlation of mass spectra and molecular structures of the alkylthiophenes are reviewed in some detail to illustrate the development of fundamental ideas of fragmentation of molecular ions.
- OP 265. Fox, Edward J., and W. A. Jackson. Steam Distillation of Fluorine From Perchloric Acid Solutions of Aluminiferous Ores. *Anal. Chem.*, v. 31, No. 10, October 1959, pp. 1657-1661.
- OP 266. Frantti, G. E. High-Speed Photographic Observations in Taconite and Limestone Blasting. *Proc. 8th Annual Drilling and Blasting Symp. Univ. of Minnesota*, Oct. 2-4, 1958, pp. 60-67. Describes study by Bureau to discover problems in quarry blasting and ultimately to contribute to their solution. A high-speed camera was used to slow down events so that it was possible to observe what actually happened during a blast.
- OP 267. Freeman, G. A., Carl Rampacek, and L. G. Evans. Copper Segregation at the Lake Shore Mine. *J. Metals*, v. 13, No. 5, May 1961, pp. 370-372. Describes a segregation process to concentrate ores not amenable to conventional flotation concentration or sulfuric acid leach treatment. The process involves heating an oxidized or mixed oxide-sulfide copper ore with a halide salt and a carbonaceous material, such as coke or coal, at approximately 1,400° to 1,500° F. Segregation produces fine metallic copper which can be recovered by conventional copper sulfide flotation methods.
- OP 268. Freeman, G. A., Carl Rampacek, and L. G. Evans. Copper Segregation Process Shows Promise at Lake Shore Mine. *Min. Eng.*, October 1961, pp. 1152-1155. Describes a segregation process that involves heating oxidized or mixed oxide-sulfide copper ore with a halide salt and a carbonaceous material, such as coke or coal, at approximately 1,400° to 1,500° F.
- OP 269. Frenzel, Donald J. The Soviet Oil Industry. *Quartermaster Rev.*, v. 40, No. 3, November-December 1960, pp. 28, 147-148. Indicates that the post-World War II expansion of the Soviet petroleum industry has established the U.S.S.R. as a major oil-producing nation and has led to Russian reentry into the international petroleum trade.
- OP 270. Frenzel, Donald J., and Alexander Gakner. Soviet Gas Pipelines. *Pipe Line News*, March 1960, pp. 39-41. Indicates that the Soviet Union, second to the United States in natural gas production, has a natural gas trunk pipeline system of over 10,000 miles in 1959 and is in the midst of an expansion that will boost total mileage to 24,000 by the end of 1965. Discusses Soviet pipeline mechanization, spread layout, welding, use of aluminum and non-metallic pipe, gas reserves, and gas consumption.
- OP 271. Friedel, R. A. Absorption Spectra of Coal, Infrared and Ultraviolet Visible. *Encyclopedia of Spectroscopy*, Reinhold Pub. Co., New York, November 1960, pp. 414-417. Infrared spectra of coal have identified functional groups, the existence of electronic absorption, and the presence of mineral absorption bands, and have permitted the observation of chemical changes in the coal during reactions. Ultraviolet-visible spectra of bituminous coal have shown the lack of specific identification of aromatic groups and have limited the polynuclear aromatic content that may be in bituminous coal.
- OP 272. ———. Infrarotspektren von Dünnschliffen aus Kohlevitrainen [Infrared Spectra of Thin Sections of Coal Vitrains], *Brennstoff-Chemie*, v. 44, No. 1, 1963, pp. 23-24. Thin sections have been used to obtain good quality infrared spectra of lignite, bituminous, and anthracite vitrains. Quantitative data are obtained.
- OP 273. ———. Quantitative Infrared and Ultraviolet Vapor Spectra. *Encyclopedia of Spectroscopy*, Reinhold Pub. Co., New York, 1960, pp. 577-582. Describes an accurate, quantitative, simple-handling technique involving micropipets and spectral sample cells fitted with sintered disks.
- OP 274. ———. Rev. of "Organic Electronic Spectral Data," v. 1, ed. by M. J. Kamlet; v. 2, ed. by H. E. Ungnade. *Spectrochimica Acta*, v. 17, 1961, p. 772.
- OP 275. ———. Spectra and the Constitution of Coal and Derivatives. *Proc. 4th Carbon Conf.*, Univ. of Buffalo, Pergamon Press, London, 1960, pp. 321-336. Infrared spectra, ultraviolet-visible absorption and reflection spectra, magnetic resonance spectra, and mass spectra, are applied to the study of the constitution of coal and carbonaceous materials derived from coal. Intensities of ultraviolet-visible absorption and reflection are shown to be low throughout the spectrum. Explanations for spectrometric data accumulated in the past are presented.
- OP 276. ———. The Use of Infrared Spectra of Chars in Coal Structure. *Appl. Optics*, v. 2, November 1963, pp. 1109-1111. Gives results of indirect studies in the structure of coal and related carbonaceous materials made through spectral studies of chars of model compounds.
- OP 277. ———. Ultraviolet Spectra of Coals and Extracts. *Chem. and Ind.*, No. 15, Apr. 15, 1961,

- pp. 462-463. Indicates that there is no real absorption band at 2,300 Å in the ultraviolet spectra of solid coal or solid pyridine extract and that there is, therefore, no indication of the presence of naphthalene derivatives.
- OP 278. Friedel, R. A., and J. A. Queiser. Ultraviolet Spectroscopy: Aromaticity of Carbonaceous Materials; Absorption Errors. ASTM, Special Tech. Pub. 269, 1960, pp. 218-226. Aromaticities of 84-percent carbon coal and the asphaltene obtained from it by hydrogenation are limited to about 20 percent according to ultraviolet absorption measurements and comparison with ultraviolet data for aromatic compounds. Aromaticity limits for other carbonaceous materials also are determined. Errors due to fluorescence of the sample can produce absorption values in ultraviolet and visible spectra that are too low. Methods of measuring the errors are described.
- OP 279. Friedel, R. A., and H. L. Retcofsky. Carbon-13 Nuclear Resonance Spectra of Olefins and Other Hydrocarbons. J. Am. Chem. Soc., v. 85, May 5, 1963, pp. 1300-1306. The carbon 13 nuclear magnetic resonance method has been applied to the study of organic compounds by means of measurements on naturally occurring carbon 13. Spectra have been obtained principally to illustrate the advantages of the method in the study of carbons containing no hydrogen atoms as in substituted olefins, dienes, allenes, acetylenes, aromatics, and carbonyls.
- OP 280. ———. Spectral Studies of Coal. Proc. 5th Conf. on Carbon, Pergamon Press, New York, v. 2, 1963, pp. 149-165. Describes investigations of coal and derivatives of coal by infrared, ultraviolet-visible, magnetic resonance, and mass spectral methods. Infrared spectral studies of chars have provided further information on the assignment of infrared bands to oxygenated structures. Proton nuclear magnetic resonance studies have been carried out on a variety of coal derivatives. Indirect determinations of aromaticity, ring size, and degree of substitution have been made. The carbon 13 nuclear magnetic resonance technique can be used to study directly the chemical nature of carbon atoms in molecules. The decreased free-radical concentrations in coal vitrains have been investigated by electron paramagnetic resonance after chemical reduction. Considerable decrease of the free-radical content is effected. Ultraviolet-visible absorption and reflectance spectra of polycrystalline graphite have been determined.
- OP 281. Friedel, R. A., and A. G. Sharkey, Jr. Alkanes in Natural and Synthetic Petroleum: Comparison of Calculated and Actual Compositions. Science, v. 139, No. 3560, Mar. 22, 1963, pp. 1203-1205. Gives data on the similarity of the low-molecular-weight alkane isomers in crude oil and Fischer-Tropsch catalytic synthesis products. The composition of the C₄ through C₇ alkane isomers in a crude oil was calculated quantitatively with the equations previously used to calculate the alkane isomers in Fischer-Tropsch product. These results may have significance in the origin of the volatile hydrocarbons in crude oils.
- OP 282. Friedman, Sidney, Marvin L. Kaufman, Waldo A. Steiner, and Irving Wender. Determination of Hydroxyl Content of Vitrains by Formation of Trimethylsilyl Ethers. Fuel, v. 40, No. 1, January 1961, pp. 33-46. Presents a new method for the determination of hydroxyl groups in coal based on the formation of trimethylsilyl ethers [ROSi(CH₃)₃]. These ethers are formed by treating coal with hexamethyldisilazane [(CH₃)₃SiNHSi(CH₃)₃] and trimethylchlorosilene [(CH₃)₃SiCl] in pyridine at about 115° C. The resulting derivatives are analyzed for silicon, and these values are used to calculate the percentage of hydroxyl groups in the coal samples.
- OP 283. Friedman, Sidney, Marvin L. Kaufman, and Irving Wender. Preparation of Trimethylsilyl Ethers of Hindered 2,4,6-Trialkylphenols. J. Organic Chem. v. 27, 1962, pp. 664-665. Reports that dimethylformamide is a solvent which enables very hindered phenols to react with hexamethyldisilazane to form trimethylsilyl ethers which are not formed in other solvents.
- OP 284. Frommer, Donald W. USBM Tests on Selective Iron Ore Flotation Point Way to Greater Recoveries. Min. Eng., v. 16, No. 4, April 1964, pp. 67-71, 80. Describes Bureau studies on the treatment of low-grade hematitic-goethitic jaspers of the Marquette range, Michigan. Selective flocculation and desliming were used for treating these finely ground ore pulps.
- OP 285. Frommer, D. W., M. M. Fine, and L. Bonicatto. Anionic Flotation of Silica—A New Look. Proc. 23d Ann. Min. Symp. and Ann. Meeting, Minnesota Sec., AIME, August 1962, pp. 1-12. Evaluates anionic flotation of silica as a procedure for beneficiating nonmagnetic and semitaconites from the Lake Superior region. Analyses of typical concentrates exceeded 60 percent in iron and showed less than 6 percent SiO₂.
- OP 286. Furno, Aldo L., George H. Martindill, and Michael G. Zabetakis. Limits of Flammability of Hydrazine-Hydrocarbon Vapor Mixtures. J. Chem. and Eng. Data, v. 7, No. 3, July 1962, pp. 375-376. Determines the minimum amount of benzene, toluene, *m*-xylene, and cumene required to suppress flame propagation through hydrazine-hydrocarbon vapor mixtures at atmospheric pressure and various temperatures.
- OP 287. Gakner, Alexander. The Battle for Steel Supremacy—The Soviet Union Leads in Raw Materials. Iron and Steel Eng., v. 36, No. 11, November 1959, pp. 117-124. The Soviet Union, the world's second largest producer of steel, ranked first in 1959 in the production of the principal raw materials needed to produce pig iron and steel—iron ore, manganese ore, chromite, and beehive coke. The U.S.S.R. is also the only large industrial nation with sufficient indigenous resources of these materials to supply all its domestic needs and export sizable amounts; it is also the world's leading exporter of pig iron.
- OP 288. ———. Minerals and Monopoly—Formula for Soviet Strength. Min. Eng., No. 5, June 1960, pp. 557-565. The Soviet Union has large mineral resources. Because the mineral industry and the trading organizations of the U.S.S.R. are monopolies of the Soviet Government, it is possible for that country to use minerals effectively as an economic and political tool.
- OP 289. ———. Sino-Soviet Plans for Petroleum and Natural Gas—What Chance for Success? World Petrol., v. 30, No. 10, September 1959, pp. 60-63. The Sino-Soviet bloc of nations has significant crude oil and natural gas resources and in recent years has set out on a large development program. Production is expanding rapidly, providing for the need of the bloc, and growing annual surpluses are making inroads on free world markets. If the bloc nations meet their 1965 economic development goals, the free world may expect a twofold to threefold increase in exports of crude petroleum and petroleum products from the Sino-Soviet bloc.
- OP 290. Gasior, Stanley J., Albert J. Forney, and Joseph H. Field. Destruction of the Caking Quality of Bituminous Coal in a Fixed Bed. I&EC Product Res. and Development, v. 3, No. 1, March 1964, pp. 43-47. Gives details of a pretreatment process in

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- which a caking coal was converted to a free-flowing char in a fixed bed by heating coal through its plastic range.
- OP 291. Gates, George L., and W. Hodge Caraway. Effect of Completion Fluids on Well Productivity in Permafrost, Umiat Field, Alaska. *J. Petrol. Tech.*, v. 12, No. 10, October 1960, pp. 33-39. From 1944 to 1953, the U.S. Navy extensively explored U.S. Naval Petroleum Reserve No. 4, in Northern Alaska, to determine its oil potential. The Bureau of Mines cooperated in the program to obtain and study the cores and core data and to determine the best completion practice.
- OP 292. Gates, George L., and Harold J. Lechtenberg. Completions—California Style. *Petrol. Eng.*, v. 34, No. 12, November 1962, pp. 108, 110, 113, 116-117, 120. Describes completion practices in California during 1961. Factors described include completion fluids, use of foams, gas drilling, formation evaluation, electrical and mud logging, formation tests, casing programs, cementing, perforating methods, gravel packing, well stimulation, and off-shore drilling methods.
- OP 293. Gayle, John B., and James H. Gary. Mixing of Solids With Horizontal Drum-Type Mixers. *Ind. and Eng. Chem.*, v. 52, No. 5, June 1960, pp. 519-520. Three principal mechanisms for mixing solid particles have been proposed—convective, shear, and diffusive. In this report horizontal drum-type mixers are selected in order to have diffusive mixers predominate.
- OP 294. Geer, M. R., and Michael Sokaski. Coal Preparation. *Min. Cong. J.*, v. 49, No. 2, February 1963, pp. 56-59. Reviews coal preparation methods in use in 1962 and forecasts possible developments in mechanical cleaning methods, depending on the quality of the coal mined, the future markets, and the methods of transporting coal or its energy to the consumer.
- OP 295. Gerard, J. A., Jack Smith, R. W. Cargill, and D. C. Strimbeck. They Subdue Big Sound. *Nat. Safety News*, v. 87, No. 4, April 1963, pp. 30-33. Describes the sound-control and hearing-protection measures adopted by the Bureau for their coal-fired gas turbine project. This is the first of two articles.
- OP 296. Gibbs, Gerald V., and F. Donald Bloss. Indexed Powder Diffraction Data for Scapolite. *Am. Mineral.*, v. 46, November-December 1961, pp. 1493-1497. Presents indexed data for some 40 peaks for scapolites from Arendal, Norway, and from Grenville, Quebec.
- OP 297. Gibbs, Gerald V., F. D. Bloss, and H. R. Shell. Proto-Amphibole, A New Polytype. *Am. Mineral.*, v. 45, September-October 1960, pp. 974-989. Proposes a new structure type for amphibole which is based on the space group Pmnm. The term "proto-amphibole" is used to describe this new polytype, since it appears structurally related to the amphiboles in the same way that protoenstatite is to the pyroxenes.
- OP 298. Gibbs, Gerald V., John L. Miller, and H. R. Shell. Synthetic Fluor-Magnesian-Richterite. *Am. Mineral.*, v. 47, January-February 1962, pp. 75-82. Chemical, physical, optical and X-Ray data are provided for fluor-magnesian-richterite, a fluoramphibole synthesized by melt and by solid-state reactions.
- OP 299. Gibson, Frank C. Reviewer's comment on "Radiation in a Detonation" by I. M. Voskoboinikov. *ARS J.*, v. 32, No. 5, May 1962, p. 809.
- OP 300. Gibson, Frank C., Merle L. Bowser, and Charles M. Mason. Detonation-Temperature Measurements. *Encyclopedia of Spectroscopy*, ed. by G. L. Clark. Reinhold Pub. Co., New York, 1960, pp. 134-138. Describes a method for measuring the detonation temperature in high explosives. A modified grating spectrograph is used to separate the radiation from the detonation into four narrow bands of known wavelengths. The radiation intensity in each band is measured during the detonation by photomultipliers and cathode ray oscillographs. By applying Wein's radiation law, the temperature can be computed. Temperatures are reported for several explosives: EDNA, 5,500° K; PETN, about 5,000° K; nitroglycerin, 4,000° K; and one permissible dynamite, 2,600° K. Indicates that the radiation from at least three of these explosives falls on a black body curve.
- OP 301. Gibson, Frank C., C. R. Summers, C. M. Mason, and R. W. Van Dolah. Initiation and Growth of Detonation in Liquid Explosives. 3d Symposium on Detonation, Princeton, N.J. Sept. 26-28, 1960. *ONR Symp. Rept., ACR-52*, v. 2, 1960, pp. 436-454. An investigation was made on the initiation and growth of detonation in liquid explosives by means of high-speed photographic techniques. Suggests a mechanism for initiation that involves interacting shock waves and cavitation; gives evidence for partial refutation of a current off-end plasma theory.
- OP 302. Gibson, H. G., W. T. Abel, and G. E. Fashing. Meter for Determining Mass Flow of Solids in Multi-Phase Fluids. *Proc. Multi-Phase Flow Symp., ASME*, Philadelphia, Pa., Nov. 17-22, 1963, pp. 49-54. Describes the construction and performance of a mass flowmeter designed by Bureau engineers. A device incorporating the cantilevered-beam force deflection principle detected the flow of solids. Experiments indicate the device, when used in conjunction with a conventional gas flowmeter, will also measure the mass flow of solids in flowing suspensions.
- OP 303. Gomez, Manuel. Pyrolysis of Coal. *Ind. and Eng. Chem.*, v. 52, No. 8, August 1960, pp. 717-720. Presents a summary of the significant developments in coal carbonization, both fundamental and applied.
- OP 304. ———. Pyrolysis of Coal. *Ind. and Eng. Chem., Ann. Rev. Supp.* 1962, pp. 110-114. Reviews worldwide work in coal-pyrolysis technology as reported in the literature during 1961 and through March 1962.
- OP 305. ———. Pyrolysis of Coal and Shale; Pyrolysis of Coal. *Ind. and Eng. Chem.*, v. 53, No. 8, August 1961, pp. 674-676. Reviews the literature on coal pyrolysis published during 1960; includes review of selected journals through March 1961.
- OP 306. Gomez, Manuel, and Charles H. Prien. Pyrolysis of Coal and Shale. *Ind. and Eng. Chem. Ann. Rev. Supp.* 1963, pp. 82-85. Reviews the literature on pyrolysis of coal and shale published during 1962; includes review of selected journals through April 1963.
- OP 307. Good, P. C. Preparation of High Purity Metals. *Min. Cong. J.*, v. 46, No. 9, September 1960, pp. 98-100. Reviews research at the Albany Metallurgy Research Center in the development of processes for recovering unusual metals, such as vanadium, thorium, zirconium, and tantalum, in high-purity form.
- OP 308. Good, W. D. The Heat of Formation of Silica. *J. Phys. Chem.*, v. 66, No. 2, February 1962, p. 380. Summarizes results of rotating-bomb calorimetry of silicon and reports accurate heat of formation of silica, the new value being 4 percent different from previously accepted value for this important mineral.
- OP 309. Good, W. D., D. R. Douslin, and J. P. McCullough. 1,2-Bis-Difluoroamino-4-Methylpentane: Heats of Combustion, Formation, and Vaporization; and Vapor Pressure. *J. Phys. Chem.*, v. 66, May 1962, p. 958. Results of heat of combustion measurements were used to evaluate, for the first time,

- the N-F bond energy in an organic difluoroamino compound.
- OP 310. Good, W. D., D. R. Douslin, and J. P. McCullough. 1,2-Bis-Difluoroamino-4-Methylpentane: Heats of Combustion, Formation, and Vaporization; Vapor Pressure; and N-F Thermochemical Bond Energy. *J. Phys. Chem.*, v. 67, 1963, pp. 1312-1314. In continuing studies of organic fluorine compounds, the Bureau has made accurate thermodynamic measurements in 1,2-bis-difluoroamino-4-methylpentane. Describes development of new techniques developed for combustion calorimetry and vapor pressure measurements on compounds of this class. N-F thermochemical bond energy was found to be about the same as in NF_3 and N_2F_4 , but significantly less than that in perfluoropiperidine.
- OP 311. Good, W. D., J. L. Lacina, B. L. DePrater, and J. P. McCullough. A New Approach to the Combustion Calorimetry of Silicon and Organosilicon Compounds. Heats of Formation of Quartz, Fluorosilicic Acid, and Hexamethyldisiloxane. *J. Phys. Chem.*, v. 68, March 1964, pp. 579-586. Describes a rotating-bomb method that was developed for precision combustion calorimetry of crystalline silicon and organosilicon compounds.
- OP 312. Good, W. D., J. L. Lacina, and J. P. McCullough. Methanethiol and Carbon Disulfide: Heats of Combustion and Formation by Rotating-Bomb Calorimetry. *J. Phys. Chem.*, v. 65, 1961, pp. 2229-2232. Heats of combustion of these highly volatile compounds were measured by rotating-bomb calorimetry, and standard heats of formation were calculated from the results.
- OP 313. ———. Sulfuric Acid: Heat of Formation of Aqueous Solutions by Rotating-Bomb Calorimetry. *J. Am. Chem. Soc.*, v. 82, No. 21, 1960, pp. 5589-5591. Rotating-bomb calorimetry of rhombic sulfur, mixed with hydrocarbon oil in widely varying proportions, led to a more accurate value of the heat of combustion. The heat of formation of aqueous sulfuric acid was calculated from the measured value of the heat of combustion. Discrepancies in previous determinations may have stemmed partly from failure to detect and correct for N_2O in the reaction products.
- OP 314. ———. Tetramethylthiuram Monosulfide and Tetramethylthiuram Disulfide: Heats of Formation by Rotating-Bomb Calorimetry; the S-S Thermochemical Bond Energy. *J. Phys. Chem.*, v. 65, No. 5, May 1961, pp. 860-862. The heats of combustion and formation were determined for tetramethylthiuram monosulfide [bis-(dimethylthiocarbamoyl) sulfide] and tetramethylthiuram disulfide [bis-(dimethylthiocarbamoyl) disulfide]. The S-S thermochemical bond energy in tetramethylthiuram disulfide was shown to be about the same as in normal alkane disulfides and in S_8 . Rotating-bomb combustion calorimetry was found satisfactory for compounds that contain both sulfur and nitrogen.
- OP 315. Good, W. D., J. L. Lacina, D. W. Scott, and J. P. McCullough. Combustion Calorimetry of Organic Fluorine Compounds. The Heats of Combustion and Formation of the Difluorobenzenes, 4-Fluorotoluene and *m*-Trifluorotoluic Acid. *J. Phys. Chem.*, v. 66, No. 8, August 1962, pp. 1529-1532. Describes experimental investigations of the heats of combustion of five organic fluorine compounds. Values of the standard heats of combustion and formation are derived.
- OP 316. Good, W. D., M. Mansson, and J. P. McCullough. Thermochemistry of Boron and Some of Its Compounds. The Heats of Formation of Trimethylamineborane and Orthoboric Acid. *Proc. Symp. on Thermodynamics and Thermochemistry*, Lund, Sweden, July 18-23, 1963, v. 1, pp. 1-9. Gives determination of the heats of combustion of organic boron compounds. The heats of combustion of crystalline boron and trimethylamineborane, $(\text{CH}_3)_3\text{NBH}_2$, were determined. The combustion product was a solution of fluoboric acid in excess aqueous HF. The standard heat of formation of trimethylamineborane is -34.04 ± 0.55 kcal/mole⁻¹. The heat of solution of orthoboric acid in an HF solution chosen to yield the same fluoboric acid solution was determined. The heat of formation of orthoboric acid was calculated as -261.47 ± 0.20 kcal mole⁻¹. Combination of these results with data from the literature permitted calculation of the heats of formation of B_2O_3 and B_2H_6 , referred directly to crystalline boron.
- OP 317. Good, W. D., and D. W. Scott. Combustion in a Bomb of Organic Fluorine Compounds. Ch. 2 in *Experimental Thermochemistry*, ed. by H. A. Skinner. Interscience Publishers, Ltd., London, v. 2, 1962, pp. 15-39. Describes in detail apparatus used by the Bureau of Mines in precise heat of combustion measurements on organic fluorine compounds.
- OP 318. ———. Combustion in a Bomb of Organometallic Compounds. Ch. 4 in *Experimental Thermochemistry*, ed. by H. A. Skinner. Interscience Publishers, Ltd., London, v. 2, 1962, pp. 55-75. Describes in detail apparatus, techniques, and methods of calculation used by the Bureau of Mines in precise heat of combustion measurements on metal organic compounds.
- OP 319. ———. Thermochemistry of Organic Fluorine Compounds and Carbon Compounds of Metals by Rotating-Bomb Calorimetry. *Pure and Appl. Chem.*, v. 2, 1961, pp. 77-82. In recent years the Bureau of Mines has investigated organic fluorine compounds and organometallic compounds and other carbon compounds of metals. Techniques developed for rotating-bomb calorimetry of these two classes of compounds are reviewed.
- OP 320. Good, W. D., S. S. Todd, J. F. Messerly, J. L. Lacina, J. P. Dawson, D. W. Scott, and J. P. McCullough. Piperfluoropiperidine: Entropy, Heat of Formation, and Vapor Pressure; N-F Bond Energy; and Solid-State Transitions. *J. Phys. Chem.*, v. 67, No. 6, June 1963, pp. 1306-1311. Gives results of investigation of thermodynamic properties of perfluoropiperidine including values of heat capacity above 12° K and below 320° K; temperature of two transitions in the solid state; triple-point temperature; heats of transition, fusion, and separation; vapor pressure (302°-355° K); and the standard heats of combustion and formation at 298.15° K. A value for the N-F thermochemical bond energy was calculated from the results.
- OP 321. Grant, R. L., N. E. Hanna, and R. W. Van Dolah. Improved Gap Sensitivity Tests for Permissible Explosives. *Pres. at 11th Internat. Conf. of Directors of Safety in Mines Res.*, Warsaw, Poland, Oct. 16-24, 1961, 7 pp. (preprint). Describes two new gap sensitivity test methods for permissible explosives, although neither method will be adopted for official testing of permissible explosives until further studies are made.
- OP 322. Green, Thomas E. Anti-Bump Device for Use With Small Beakers. *Chemist-Analyst*, v. 53, No. 4, October 1964, pp. 118-119. Describes an antibump device for use with small beakers that can be made in the laboratory from standard aluminum tubing.
- OP 323. Grumer, Joseph, and Margaret E. Harris. Smoke Limits of Bunsen Burner Ethylene-Air Flames. *Ind. and Eng. Chem.*, v. 53, No. 1, January 1961, p. 54 (correspondence). Smoke limits and yellow-tip limits of gaseous fuel-air flames may be correlated by a simple assumption: For a given burner and same total flow for both limits,

- the difference in fuel flow between the value at which yellow first appears in a flame (the yellow-tip limit) and the value at which smoke is first emitted (the smoke limit) is directly proportional to the latter fuel flow.
- OP 324. Grumer, Joseph, Margaret E. Harris, and Valerie R. Rowe. Relations of Fundamental Flashback, Blowoff and Yellow-Tip Limits of Fuel Gas-Air Mixtures to Design Factors of Burners in Gas Appliances. *Am. Gas. Assoc.*, March 1960, 60 pp.; *Am. Gas Assoc. Monthly*, v. 12, April 1960, pp. 12, 31. Attempt to determine the performance characteristics of multiport burners and the effect of flows of ambient air within an appliance on the flames surrounded by this flow.
- OP 325. Grumer, J., A. Strasser, T. A. Kubala, and D. S. Burgess. Uncontrolled Diffusive Burning of Some New Liquid Propellants. *Fire Res. Abs. and Rev.*, v. 3, No. 3, September 1961, pp. 159-176. Reports results of laboratory-scale tests of the behavior of burning MAF fuels. Data obtained should be applicable to other fuel-oxidant systems.
- OP 326. Guthrie, G. B., and J. P. McCullough. Some Observations on Phase Transformations in Molecular Crystals. *J. Phys. Chem. Solids*, v. 13, No. 1, 1961, pp. 53-61. Illustrates the use of calorimetric data in interpreting phase behavior in molecular crystals. Values of entropy of transition are used to estimate the number of distinguishable molecular orientations in a disordered phase, and symmetry and steric considerations are used to find a reasonable description of these orientations.
- OP 327. Haines, W. E. Nitrogen. *Anal. Chem.*, *Ann. Rev.*, pt. 1, v. 35, No. 5, April 1963, pp. 127R-128R, 131R. Reviews the literature on nitrogen published during 1960-62.
- OP 328. ———. Oxygen. *Anal. Chem.*, *Ann. Rev.*, pt. 1, v. 35, No. 5, April 1963, pp. 128R-129R. Reviews the literature on oxygen published during 1960-62.
- OP 329. ———. Some Chemical and Physical Techniques for Separation and Identification of Nitrogen Compounds in Petroleum. *Proc. API*, v. 42, sec. 8, 1962, pp. 51-54. Discusses the techniques and equipment used by API Research Project 52.
- OP 330. ———. Sulfur. *Anal. Chem.*, *Ann. Rev.*, pt. 1, v. 35, No. 5, April 1963, pp. 129R-131R, 141R. Reviews the literature on sulfur published during 1960-61.
- OP 331. Hanna, N. E., R. L. Grant, and R. W. Van Dolah. Factors Influencing the Incendivity of Permissible Explosives: Ammonium Nitrate and Carbonaceous Materials. *Pres. at 11th Internat. Conf. of Directors of Safety in Mines Res.*, Warsaw, Poland, Oct. 16-24, 1961, 8 pp. (preprint). (Pub. as RI 5867.) Describes a statistically designed experiment for studying effects of the particle size of ammonium nitrate and the type of carbonaceous materials used on the incendivity of permissible explosives.
- OP 332. Hansen, J. P. Comments on "Investigation of the Reduction of the Bond Minerals in Iron Ore Agglomerates," by R. L. Rueckl. *Proc. Blast Furnace, Coke Oven, and Raw Materials Conf.*, Detroit, Mich., April 1962, v. 21, 1962, pp. 311-313. Discusses use of a screen series to diminish the variation in size particle range; offers equations to represent the stoichiometry of dicalcium ferrite, monocalcium ferrite, and calcium diferrite.
- OP 333. ———. Disc. on "Combustion Zone in Iron Ore Sintering," by R. Schluter and G. Bitsianes. *Agglomeration*, ed. by W. A. Knepper, Interscience Publishers, Inc., New York, 1962, pp. 637. Comments on the possibility of reducing the combustion rate calculation to a simpler form and suggests possible ways to widen the combustion zone.
- OP 334. Hansen, J. P., Gust Bitsianes, and T. L. Joseph. A Study of the Kinetics of Magnetic Roasting. *Proc. Blast Furnace, Coke Oven, and Raw Materials Conf.*, AIME, v. 19, 1960, pp. 185-205. Pellets of hematite, prepared from Baker's Ferric Oxide and fired at temperatures of 1,250°, 1,325°, and 1,375° C, were reduced to magnetite using a mixture of carbon monoxide, carbon dioxide, and nitrogen. Using a loss of weight method, the movement of the reaction interface was calculated and was found to move at a constant rate from the surface to the center of the pellet. The rate of movement was determined as a function of temperature and gas composition. Rate-controlling steps were hypothesized from the dependence of the reduction rate on the gas composition and its activation energy.
- OP 335. Hansen, J. P., N. B. Melcher, and M. M. Fine. Prerduced Iron-Ore Pellets, Their Experimental Preparation. *J. Metals*, v. 13, April 1961, pp. 314-315. A super blast-furnace feed—hard prerduced pellets—has been the objective of small-scale experimental work by the Bureau of Mines. Results have been sufficiently promising to continue research to develop a continuous production method.
- OP 336. Hansen, J. P., and T. N. Rushton. Experimental Preparation of Prerduced Iron Ore Pellets. *Proc. 23d Ann. Min. Symp. and Ann. Meeting, Minnesota Sec.*, AIME, August 1962, pp. 43-48. Reports the results of laboratory tests and small kiln experiments for simultaneous metallization and hardening of green pellets. The effect of temperature and residence time was determined, and various solid fuels were compared.
- OP 337. Hardwick, W. R. Surface Mining and Mechanization in the Copper Mines of South-Western United States. *J. Mines, Metals & Fuels*, v. 10, Special Issue, 1962, pp. 24-29. Describes methods by which surface copper mines have offset higher labor costs, shortage of experienced labor, and decrease in metal content of ore by increasing productivity through mechanization. Lists initial reserve, estimated life, number of men employed, and production in 1959 for five typical U.S. mines. Describes practices for drilling, loading, and transporting rock and gives the capacity of various machines.
- OP 338. Harris, E. J. The Fluid Network Analyzer as an Aid in Solving Mine Ventilation Distribution Problems. *Trans. AIME*, v. 229, 1963, pp. 391-395. Describes and discusses the direct electrical-analogy method of analyzing mine-ventilation networks, using the Bureau's fluid network analyzer. Changes to represent alternate plans of distribution or different operating features can be made easily and the effects measured rapidly. Comparison of mathematical solutions of complex systems against analog results showed a maximum variance of 3 percent for pressures and 2 percent for quantities.
- OP 339. Harrison, Lawrence H. Bureau Approves the Silicon Diode Method of Frame Grounding. *Coal Min. and Processing*, v. 1, No. 6, June 1964, pp. 33-34. Describes method of frame grounding in which a silicon diode is used to connect the machine frame to the grounded side of the power cable. Gives reasons for Bureau acceptance of this method.
- OP 340. ———. Contributions of American Standards to Mine Safety. *Mag. Standards, A.S.A.*, v. 35, No. 1, January 1964, pp. 14-16. Discusses the promotion of safety within the mining industry by the establishment of appropriate safety standards, including standard practice for rock-dusting, speci-

- fications for roof bolting, rules for installing and using electrical equipment, and others.
- OP 341. Harrison, Lawrence H. Ground-Fault Monitoring on Low Voltage Circuits. *Mechanization*, v. 24, No. 1, January 1960, pp. 72-74. Considers the desirability of monitoring grounding circuits of mining equipment and presents several suggested methods for monitoring the grounding circuits of ac mining equipment.
- OP 342. ———. Silicon Diodes for Frame Grounding—U.S. Bureau of Mines Requirements. *Min. Cong. J.* v. 50, No. 3, March 1964, pp. 53-54. (For summary see OP 339).
- OP 343. Hawk, C. O., M. D. Schlesinger, and R. W. Hiteshue. Addition of Pulverized Coal to Paving Asphalts. *Coal Utilization*, v. 17, No. 5, May 1963, pp. 21-23. Gives results of a study of methods for dispersing coal in asphalt paving. Road strips bound with asphalt containing 10 to 20 percent coal, laid in June 1961, are wearing well.
- OP 344. Hayes, Earl T. Chromium and Vanadium. *Ind. and Eng. Chem.*, v. 53, No. 2, February 1961, pp. 105-107. Indicates the similarities of the metals and then analyzes both separately. The metals are similar, but the closeness of their relationship is not comparable to that of titanium and zirconium or tantalum and niobium.
- OP 345. Haynes, J. G. Impurity Analysis in Tungsten. *Abs. in Conf. on Res. in Progress in Tungsten*, May 20-21, 1959 (pub. by Office of Ordnance Research, U.S. Army, Durham, N.C.), 1959, pp. 3-4. Reports progress made by the Bureau in analyzing tungsten products for impurity content; presents some of the problems encountered during analysis, accuracy of the results obtained, and the range of sensitivity for elements desired.
- OP 346. Haynes, R. D. Operating Experience With Diaphragm-Type Compressor in Helium Service. *Proc. Rotating Machinery for Gas-Cooled Reactor Application Meeting*, Oak Ridge National Laboratory, U.S. Atomic Energy Commission, Oak Ridge, Tenn., April 2-4, 1962. TID-7631. Describes compression of grade A helium from 2,600 to 4,000 psig without contamination by using a metal diaphragm compressor.
- OP 347. Hazen, Scott W., Jr. Disc. of "Effective Pay Limits for Selective Mining," by D. G. Krige. *South African Inst. Min. and Metall.*, v. 63, No. 1, August 1962, pp. 52-53.
- OP 348. ———. Disc. of "Value Contours and Improved Regression Techniques for Ore Reserve Evaluations," by D. G. Krige and H. J. Uechermann. *J. South African Inst. Min. and Metall.*, v. 64, No. 3, October 1963, pp. 117-119.
- OP 349. Heemstra, R. J., J. Wade Watkins, and F. E. Armstrong. Laboratory Evaluations of Nine Water Tracers. *Nucleonics*, v. 19, No. 1, January 1961, pp. 92-96. Radiotracers are needed to follow subsurface flow in the water of petroleum-reservoir materials and stability in brine solutions. To test several likely substances against these standards, laboratory tests for stability and losses from solution when the tracers pass through geological cores have been made. Measurements of radioactivities in both the solution being recycled and the drained core material offer a significant comparison of the different tracers.
- OP 350. Heindl, R. A., and R. C. Wilmot. Bauxite and Alumina. *Document of United Nations Economic Commission for Asia and the Far East*, No. 1 & NR/sub. 3/62, April 19, 1960. Briefly discusses long-term outlook for the bauxite and alumina industries; describes bauxite sources and mining methods; lists raw material requirements for a 20,000-ton-capacity aluminum plant; and suggests five approaches for the commercial utilization of undeveloped bauxite resources.
- OP 351. Heising, L. F., and R. C. Briggs. Sampling for R-N Process Tests. *Preliminary Engineering Studies for Application of the R-N Process to Lake Superior Region Iron Ores*. U.S. Department of Commerce, Area Redevelopment Administration, December 1963, pp. 1-13. Discusses Bureau of Mines program to provide representative samples of Lake Superior iron ores for R-N direct-reduction process feasibility tests in cooperation with the Area Redevelopment Administration. Samples were obtained from the Cuyuna, Mesabi, Gogebic, and Marquette iron ranges.
- OP 352. Helm, R. V., D. R. Latham, C. R. Ferrin, and J. S. Ball. Identification of Carbazole in Wilmington Petroleum Through Use of Gas-Liquid Chromatography and Spectroscopy. *Anal. Chem.*, v. 32, No. 13, December 1960, pp. 1765-1767. Reveals the presence of carbazole in Wilmington, Calif., petroleum—the first nonbasic nitrogen compound isolated from virgin petroleum.
- OP 353. Henderson, A. W. Chlorination of Ores and Concentrates. *J. Metals*, v. 16, No. 2, February 1964, pp. 155-160. Describes the apparatus and procedures for extracting tantalum, columbium, and tungsten chlorides from complex ores by chlorination. The pretreatment of the ores with chlorine in the presence of a reducing agent to convert metal oxides to chlorine salts is discussed. The selective volatilization and condensation of the chlorine salts are also reported.
- OP 354. Henrie, T. A. Disc. of "Equilibrium Between Metals and Their Chlorides," by L. Yang, R. G. Hudson, and C.-Y. Chien. In *Physical Chemistry of Process Metallurgy*, Part 2, ed. by C. R. St. Pierre. Interscience Publishers, Inc., New York and London, v. 8, 1961, pp. 942-943 (AIME, Metallurgical Society Conferences series). Oxide ceramic materials react with the subchlorides of reactive metals in fused chloride melts. To prevent contamination while making equilibrium measurements in the chlorides, only relatively noble metals or other inert materials should contact the melts at temperatures above 400° to 500° C.
- OP 355. ———. Electrowinning Rare-Earth and Uranium Metals From Their Oxides. *J. Metals*, v. 16, No. 12, December 1964, pp. 978-981. Discusses a technique developed by the Bureau of Mines: the electrolysis of a fluoride melt containing the oxide of the metal in question, depositing the molten metal at the cathode, and evolving carbon monoxide at the anode.
- OP 356. Henrie, T. A., and D. H. Baker, Jr. A Theory on the Reduction of Titanium Chlorides by Metallic Sodium. In *Physical Chemistry of Process Metallurgy*, Part 2, ed. by G. R. St. Pierre. Interscience Publishers, Inc., New York and London, v. 8, 1961, pp. 721-744 (AIME, Metallurgical Society Conferences series). The sodium reduction of titanium chlorides in fused sodium chloride was studied by the Bureau of Mines. Researchers found that there were two phases present, one the α -phase, which consisted of dissolved sodium in sodium chloride, and the β -phase, which was titanium subchlorides dissolved in sodium chloride. The mechanism of the principal reaction between the heterogeneous phases is assumed to be electrochemical in nature. The model proposed is a galvanic-type reaction at the interfacial region. Sodium metal is ionized at an anodic site on a metal surface in the α -phase. The electrons produced by this reaction are conducted across the interfacial region through the metal to the β -phase where the titanium species are reduced by a cathodic reaction to produce titanium metal.

- OP 357. Herdlick, J. A. U.S. Bureau of Mines Program in Alaska. *Min Eng.*, v. 13, No. 12, December 1961, pp. 1343-1346. Discusses the Bureau's investigation of ferrous and nonferrous metals, nonmetallic minerals, coal, and petroleum. Considers testing and analysis, sampling and inspection of coal, and analyses of crude oil. Describes the collection and dissemination of mineral production, consumption, accident, and employment statistics; the compilation and publication of general data of special interest to the mineral industry; and studies of the Alaskan mineral economy and its trends.
- OP 358. Higgins, R. V. Quick Methods of Oil Reservoir Analysis. *Petrol. Eng.*, v. 32, No. 5, 1960, pp. B27-B33. Describes the factors involved and outlines the procedures in the proposed quick methods for determining the saturation at breakthrough, approximating relative permeabilities of cores, and evaluating the preferential wettability of a core to oil and water.
- OP 359. Higgins, R. V., and A. J. Leighton. Aids to Forecasting the Performance of Waterfloods. *J. Petrol. Technol.*, v. 16, No. 9, September 1964, pp. 1076-1082. Presents a computer method for obtaining the shape factors and equal cell volumes of channels from a potentiometric model for any well spacing pattern. Results show that the most favorable factors for a successful flood, in order of importance, would be (1) a good oil saturation, (2) a favorable permeability profile, (3) a low oil viscosity, (4) favorable relative permeability curves as those associated with reservoir rocks that are preferentially water-wet, and (5) the well spacing pattern.
- OP 360. ———. A Computer Method to Calculate Two-Phase Flow in Any Irregularly Bounded Porous Medium. *J. Petrol. Technol.*, v. 14, No. 6, June 1962, pp. 679-683. Presents a fast method for calculating thoroughly the performance of two-phase flow in reservoir rock with complex geometry.
- OP 361. ———. Computer Prediction of Water Drive of Oil and Gas Mixtures Through Irregularly Bounded Porous Media—Three-Phase Flow. *J. Petrol. Technol.*, v. 14, No. 9, September 1962, pp. 1048-1054. Presents a method of forecasting three-phase flow in complex geometry, using, as a specific example to explain the details of the method, a five-spot waterflood of a partially depleted stratified reservoir.
- OP 362. ———. Five-Spot and Line-Drive Waterflood Prediction of Oil Recovery With and Without Initial Gas Saturation. *Proc. Permian Basin Oil Recovery Conf.*, AIME, May 9-10, 1963, pp. 48-52. Presents graphs which require only minutes to use that will forecast the waterflood performance of the five-spot and linear patterns with reasonable accuracy using permeability curves and the viscosity of the water and oil in place. The graphs give the performances of waterfloods starting with no gas present in the reservoir before the flood and with gas initially present increasing by increments. Graphs for predicting the performance of multi-layered reservoirs also are presented.
- OP 363. ———. Waterflood Performance in Stratified Reservoirs. *Mines Mag.*, 25th Anniversary Annual Petroleum Number, v. 50, No. 11, November 1960, pp. 50-54. Presents a method that employs saturation changes in evaluating the recovery of oil from a reservoir rock consisting of sand layers having different permeabilities to oil and water. The combined oil rate, water rate, water-oil ratio, and recovery of oil from these layers are calculated; from these data the economic water-oil ratio at which to terminate the production is easily computed.
- OP 364. Higley, L. W. Use of Depleted Uranium in Bearing Metals and Low-Alloy Steels. *OTS Rept. 8212*, November 1962, pp. 00-00. Gives results of tests of binary and ternary alloys of lead, antimony, and copper containing < 33 percent uranium for hardness, compressive strength, wear resistance, and coefficient of friction. The results were compared with known properties of commercial babbitts. Steels containing 0.2 to 1.5 percent uranium were prepared and tested for mechanical properties. No advantage resulted from the uranium addition.
- OP 365. Hiteshue, Raymond W., Robert B. Anderson, and Sam Friedman. Gaseous Hydrocarbons by Hydrogenation of Coals and Chars. *Ind. and Eng. Chem.*, v. 52, July 1960, pp. 577-579. Discusses the amenability of coals and chars to conversion to gaseous hydrocarbons at 6,000 psig and 800° C with higher flows of hydrogen.
- OP 366. Hofer, L. J. E. Rev. of "Catalysis by Metals," by G. C. Bond. *J. Am. Chem. Soc.*, v. 84, No. 23, 1962, pp. 4615-4616.
- OP 367. Hofer, L. J. E., and E. H. Bean. X-Ray Powder Diffraction Patterns of Solid Organic Bases. *Fuel*, v. 40, No. 6, November 1961, pp. 503-509. Presents X-ray powder diffraction patterns of 22 solid organic bases.
- OP 368. Hofer, L. J. E., Patricia Gussey, and R. B. Anderson. Specificity of Catalysts for the Oxidation of Carbon Monoxide-Ethylene Mixtures. *J. Catalysis*, v. 3, No. 5, October 1964, pp. 451-460. Reports the specificity of iron, cobalt, chromium, and copper catalysts for the oxidation of ethylene and carbon monoxide for temperatures from 50° to 600° C.
- OP 369. Hofer, L. J. E., J. F. Shultz, R. D. Panson, and R. B. Anderson. The Nature of the Nickel Boride Formed by the Action of Sodium Borohydride on Nickel Salts. *Inorg. Chem.*, v. 3, No. 12, December 1964, pp. 1783-1785. Finely divided nickel boride useful in catalysts and fuel cell electrode is prepared by the action of solutions of sodium or potassium borohydride on solutions of nickel salts. The study shows that nickel boride prepared in this way is an interstitial compound isomorphous with cementite.
- OP 370. Hofer, L. J. E., and E. W. Toor. Magnetic Balance for Ferromagnetism. *Rev. Sci. Instr.*, v. 33, No. 4, April 1962, pp. 417-422. Describes a Mathieu-type pendulum magnetic balance that employs the Faraday principle for measuring the specific magnetization of ferromagnetic materials.
- OP 371. Howard, Henry C. Pyrolytic Reactions of Coal. Ch. 9 in *Chemistry of Coal Utilization: Supplementary Volume*, ed. by H. H. Lowry. John Wiley & Sons, Inc., New York, 1963, pp. 340-394. Discusses changes occurring in coal below decomposition temperatures, reactions at and above decomposition temperatures, special pyrolytic procedures and apparatus, effects of pretreatment and additives on the pyrolytic process, distribution of the elements among pyrolysis products, general mechanisms of thermal decomposition, kinetic studies of various coals, and pyrolysis of model compounds.
- OP 372. Howard, Thomas E. Metal and Non-Metal Mining Research in the Bureau of Mines. *Min. Eng.* v. 14, No. 1, January 1962, pp. 50-52. Describes the metal and nonmetal mining research in the Bureau and the special phases of the research performed at the five units engaged in the program.
- OP 373. Howell, W. D., F. E. Armstrong, and J. Wade Watkins. Radioactive Gas Tracer Survey Aids Waterflood Planning. *World Oil*, v. 152, Feb. 1, 1961, pp. 41-42, 45. Describes a radioactive gas

- tracer survey used to correlate the directional trend in fractures and to aid in planning a water-injection system in the Spraberry Trend of West Texas. The techniques developed for the Spraberry reservoir are applicable to gas-tracer tests, under varied circumstances, in stimulative projects using gas injection, water injection, miscible-phase displacement, and combustion to increase production.
- OP 374. Hubbard, Arnold B. Oil-Shale Assay Method for Product Balance Studies. *Fuel*, v. 41, No. 1, January 1962, pp. 49-54. Describes a refined assay method for oil shale that was developed to assist in making product balance and evaluation studies of the large oil-shade deposits of Colorado, Utah, and Wyoming.
- OP 375. Hubbard, W. N., F. R. Frow, and Guy Waddington. The Heats of Combustion and Formation of Pyridine and Hippuric Acid. *J. Phys. Chem.* v. 65, 1961, pp. 1326-1328. The heats of combustion of pyridine and hippuric acid were determined by precision oxygen-bomb calorimetry, and these values, in kcal mole⁻¹, are reported for the standard heat of formation, ΔH_f° 298.15, from graphite, and gaseous hydrogen, oxygen, and nitrogen: Pyridine (liq.), 23.89; hippuric acid (c), -145.54. Recommendations are made for methods of determining the amount of reaction in combustion calorimetry. The suitability of hippuric acid as a reference substance for the combustion calorimetry of organic nitrogen compounds is discussed.
- OP 376. Hubbard, Grant L., and Thomas E. Green. Apparatus for Multiple Solvent Extractions. *Chemist-Analyst*, v. 53, No. 4, October 1964, pp. 119-120. Describes an apparatus consisting of a rack for mounting four modified conical flasks on a laboratory shaker, and an adjustable frame on which the rack can be hung for the separation of the phases. The use of two sets of four flasks, each set mounted on a rack, permits manual operations to be performed on one set while the other is being shaken. Eight samples can be processed in little more time and with less effort than is required for two samples.
- OP 377. Huff, W. R., and L. F. Willmott. Metering Density and Flow of Slurries. *Chem. Processing*, v. 24, No. 2, February 1961, pp. 61-62. Describes the evaluation of two density meters and one flowmeter for use with a coal slurry. Both density meters depend upon a measurement of pressure loss in a special pipe section, comparing the loss when pulverized coal and water are being pumped at a 1:1 suspension by weight to the loss when water only is pumped. An evaluation of an electromagnetic-type flowmeter is given, and a combination of meters is suggested for integrating measurement of density and flow.
- OP 378. Huffman, H. M., M. E. Gross, D. W. Scott, and J. P. McCullough. Low Temperature Thermodynamic Properties of Six Isomeric Heptanes. *J. Phys. Chem.* v. 65, 1961, pp. 495-503. Low-temperature thermal measurements were made on the nine isomeric heptanes, but definitive results could be obtained for the following six compounds only: *n*-heptane, 2-methylhexane, 3-ethylpentane, 2,2-dimethylpentane, 2,4-dimethylpentane, and 2,2,3-trimethylbutane. Values of heat capacity in the solid and liquid states and of the latent heats and temperatures of isothermal phase changes were determined for each of these six isomers. Also, the vapor pressure of 2-methylhexane was measured. From the observed data were calculated values of the free energy function, heat content function, heat content, and entropy and heat capacity of the condensed phases at selected temperatures between 10° and 300° K. These results and literature values of heat of formation, heat of vaporization, and vapor pressure were used to compute values of the chemical thermodynamic properties for the liquid and ideal gas states at 298.15° K.
- OP 379. Hughes, K. J., and R. W. Hurn. A Preliminary Survey of Hydrocarbon-Derived Oxygenated Material in Automobile Exhaust Gases. *J. Air Pollution Control Assoc.*, v. 10, No. 5, October 1960, pp. 367-373. Outlines the types and quantities of oxygenates—hydrocarbon-derived oxygenated materials—that might be found in automotive engine exhausts. More than 30 oxygenates in the molecular weight range of ethylene oxide through pentanol have been found in automobile exhaust gases; 14 have been identified positively, and tentative identifications have been established for another 18. The mode of engine operation and the chemical composition of the fuel influences the emission of exhaust gases. The influence is qualitative and quantitative.
- OP 380. Hughes, K. J., R. W. Hurn, and F. G. Edwards. Separation and Identification of Oxygenated Hydrocarbons in Combustion Products From Automotive Engines. Ch. in *Gas Chromatography*. Academic Press, Inc., New York, 1961, pp. 171-182. Gas-liquid partition chromatography has been used to separate and identify oxygenated derivatives of hydrocarbons that are found in the products of combustion of hydrocarbon fuels. A three-stage gas-liquid partition chromatography unit has been used to make a gross separation of hydrocarbons, oxygenated materials, and water; fractions that are unresolved are recovered for reanalysis in a single-stage chromatographic unit. The general range of oxygenated compounds for which the chromatographic equipment can be used covers ethylene oxide through *n*-pentanol.
- OP 391. Hunter, T. W. Bituminous Coal and Lignite Distribution. *Current Coal Trends*, v. 8, No. 12, December 1961, pp. 3-4. Discusses the ways in which Bureau of Mines programs help to advance the position of coal and lignite in the highly competitive energy market.
- OP 382. Hurn, R. W. Comprehensive Analyses of Automotive Exhausts. *Archives of Environmental Health*, v. 5, December 1962, pp. 592-596. Presents a general review of the nature of the gaseous or volatilized components of automotive exhausts and reports on recent work conducted to define more precisely variations in exhaust-gas stream composition.
- OP 383. Hurn, R. W., K. J. Hughes, and J. O. Chase. Application of Gas Chromatography to Analysis of Exhaust Gas. Ch. in *Vehicle Emissions*. Technical Progress Series, Society of Automotive Engineers, v. 6, 1964, pp. 94-101. Provides historical reference to work and findings in the early stages of development of gas-liquid chromatography techniques for separation of the hydrocarbons emitted in exhaust gas.
- OP 384. Irving, Donald R. Improved Methods for Upgrading Clays. *Trans. AIME*, v. 220, 1961, pp. 207-209. Describes various investigations being carried on by the Bureau of Mines.
- OP 385. Iverson, H. G. Bureau of Mines Metallurgical Research. *J. Metals*, v. 13, No. 11, December 1961, pp. 918-920. Describes briefly the Bureau's metallurgical research program, conducted at seven research centers and their associated laboratories.
- OP 386. Iverson, H. G. Role of Metallurgical Pilot Plants in the United States. *Symposium on Pilot Plants in Metallurgical Research and Development*, pub. by The Technical Journals of India, Private Ltd., Calcutta, 1960, pp. 83-90. Metallurgical pilot

- plants insure the success of commercial operations which may ensue. However, pilot plant operations can be expensive; therefore, they must be carefully planned on the basis of adequate prerequisite data in techniques, design, and aim. These prerequisites are described. Once the data indicate the merit for pilot plant studies, the next step is determining the optimum size of the plant. This is usually determined by the minimum size of the equipment which presents the most difficult or severe problems in predicting operational characteristics in the commercial size. Results from more than a dozen Bureau of Mines pilot plants are given.
- OP 387. Jacobson, I. A., Jr., and H. B. Jensen. Thermal Reactions of Organic Nitrogen Compounds. II. 1-*n*-Butylpyrrole. *J. Phys. Chem.*, v. 66, July 1962, pp. 1245-1247. Finds that 1-*n*-butylpyrrole isomerizes by a first-order reaction to 2-*n*-butylpyrrole, which subsequently isomerizes, by an equilibrium reaction, to 3-*n*-butylpyrrole. The 2- and 3-*n*-butylpyrroles decompose to form pyrrole, 2- and 3-methylpyrroles, 2- and 3-ethylpyrroles, 2- and 3-vinylpyrroles, pyridines, and hydrocarbons.
- OP 388. ———. Thermal Reactions of Organic Nitrogen Compounds. III. 1-Isopropylpyrrole. *J. Phys. Chem.*, v. 68, No. 11, October 1964, pp. 3068-3070. Studies the thermal reactions of 1-isopropylpyrrole and finds that 1-isopropylpyrrole isomerized irreversibly to 2-isopropylpyrrole which in turn isomerized reversibly to 3-isopropylpyrrole. The decomposition products from the 1-isopropylpyrrole work consisted of 3-methylpyridine, pyrrole, 2-methylpyrrole, 3-methylpyrrole, 2-ethylpyrrole, 3-ethylpyrrole, and hydrocarbons. Samples of 2-isopropylpyrrole and 3-isopropylpyrrole were also thermally studied.
- OP 389. Jacobson, Murray, and Henry G. Dorsett, Jr. Dust Can Be Dangerous. *Modern Plastics*, May 1962, pp. 134, 137, 215. Presents laboratory findings of dust-explosion hazards for 313 plastic materials. Relative ratings are characterized by empirical indexes. Factors affecting explosibility are described.
- OP 390. Jacobson, Murray, and John Nagy. Recent Research on the Explosiveness of Agricultural Products. *Food Technology*, v. 16, No. 2, February 1962, pp. 32-34. Presents laboratory findings of explosion hazards for 45 agricultural products. Relative ratings are characterized by empirical indexes and effects of particle size are shown.
- OP 391. James, R. S. A Continuous Methane Monitoring System at the Working Face. *Min. Cong. J.*, v. 45, No. 5, June 1959, pp. 44-47. Early in 1958 the Bureau appealed to manufacturers and the coal industry to help in preventing explosion disasters by starting research and development programs to produce a methane detection system that would provide automatic protection against dangerous concentrations of methane. This progress report indicates that the mining industry will have such a system available.
- OP 392. Jensen, James W. Damping Capacity—Cause and Effect. *Light Metal Age*, v. 22, Nos. 11-12, December 1964, pp. 4-8. Discusses vibration damping capacity and gives a substantial amount of data on the damping properties of commercial alloys. Describes a method of assigning a useful "damping index" and uses it to classify the alloys into high, medium, and low damping groups.
- OP 393. Jimeson, Robert M. Census of Federal Coal Research Given at Salt Lake City Meeting. *Min. Eng.*, v. 15, No. 11, November 1963, pp. 51-55. Gives details of some of the Bureau's research programs on coal, including the coal-fired gas turbine, conversion of coal to gaseous and liquid fuels, coal reaction in plasma, use of coal for power generation, production of char from western coals, electrostatic precipitation of dust, and the use of coal as supplemental fuel in blast furnaces.
- OP 394. Johansen, Robert T. How U. S. Government and Industry Teamwork Developed Big Dividend for Flood Operators. *Kansas-Oklahoma Oil Reporter*, v. 4, No. 6, September 1961, pp. 40-44. The development of the use of sodium tripolyphosphate (STP) as an additive to injection water for improving the injection rates in troublesome waterfloods is described. The idea of using STP to improve injection rates and ultimate recovery of crude oil originated at Bartlesville, Okla., when the Bureau of Mines discovered that STP was effective in reversing the tendency of crude oil to wet silica surfaces. Subsequent field tests have indicated the effectiveness of this chemical to improve injection rates in many waterflood projects.
- OP 395. Johansen, Robert T., F. E. Armstrong, and J. Wade Watkins. Shock Induced Transitions. Part II. Encapsulation and Results of Exposing Petroleum Industry Samples. U.S. Atomic Energy Commission Plowshare Program, PNE-112F (Pt. 2), 1964, 42 pp.²¹ Presents a compilation of data including descriptions of fluid and solid samples of petroleum-reservoir and organic materials exposed to the forces of a nuclear explosion in the Gnome event. Discusses the method of containment, fabrication of containers, emplacement of containers in drill holes, conditions of exposure, retrieval of samples, and summary of results. Gives the condition of recovered samples, examples of failure of containers, conclusions, and recommendations for future sample-exposure programs.
- OP 396. Johansen, R. T., R. J. Heemstra, and H. N. Dunning. Continuous Electrophoresis of Petroleum in Nonaqueous Solvents. *Proc. API*, v. 42, sec. 8, 1962, pp. 60-61. Describes the design and construction of a continuous-flow paper-electrophoresis apparatus that makes possible the separation of petroleum into fractions according to the polarity induced on the particles. The instrument is capable of withstanding attack by the variety of solvents anticipated.
- OP 397. Johansen, R. T., R. J. Heemstra, and Loy Hembree. Low-Cost Water-Flood Treatment With Sodium Tripolyphosphate. *Oil & Gas J.*, v. 59, No. 26, 1961, pp. 157-158, 160. Laboratory studies and field tests have shown that the use of sodium tripolyphosphate may be the answer to the problem of improving injection rates in waterfloods resulting from well plugging and corrosion.
- OP 398. Johnson, Charles F. Coupling Small Vibration Gages to Soil. *Earthquake Notes*, v. 33, No. 3, September 1962, pp. 40-41. Establishes criteria for mounts for particle-velocity gages that are part of the instrumentation for measuring vibrations from quarry blasting.
- OP 399. Johnson, Donald R., and John Ward Smith. Glass Filter Paper Suspension of Precipitates for Liquid Scintillation Counting. *Anal. Chem.*, v. 35, No. 12, November 1963, p. 1991. Describes a glass filter paper suspension of radioactive precipitates that provides a simple direct preparation method for scintillation counting. Important features are the speed of preparation and elimination of sample handling steps.
- OP 400. Johnson, Harry R., and Dean W. Roley. Waterflooding Possibilities of the Clinton Sand, Logan Oilfield, Hocking County, Ohio. *Producers Monthly*, v. 27, No. 12, December 1963, pp. 22-26. Presents an evaluation of the Clinton

²¹ Obtainable from the Clearinghouse for Federal Scientific and Technical Information, National Bureau of Standards, U.S. Department of Commerce, Springfield, Va. \$2.

- sand oil reservoir in Hocking County, Ohio, and a predicted waterflood performance. The flood performance was based on an assumed five-spot pattern, considering average spacing existing in the best developed area. The study indicated that the reservoir should be susceptible to waterflooding.
- OP 401. Johnson, J. Burlin. Feasibility of Model Studies in Blasting Research. *Rock Mechanics, Proc. 5th Symp., 1962*, ed. by C. Fairhurst, Pergamon Press, New York, 1963, pp. 263-270. Evaluates laboratory-scale blasting as a tool in mining research. Plots of scaled crater dimensions versus scaled charge depth have yielded curves that are very similar in both shape and magnitude for laboratory and field tests. Laboratory tests in different materials, including rock, have shown that a correlation exists between maximum crater dimensions and certain physical properties of the material cratered.
- OP 402. Johnston, K. H. Study Shows Waterflood Fracturing Pays Off. *Kansas-Oklahoma Oil Reporter*, v. 4, No. 1, April 1961, pp. 28-29. Well-engineered hydraulic fracturing can be of direct and positive benefit to wells under waterflood. The practice of hydraulic fracturing was made available to industry in 1949 by license agreement with Pan American Petroleum Co. However, it was 1953 before the practice was accepted by the waterflood industry. The article discusses the question of when to fracture the wells, the proper size of treatment, and general conclusions.
- OP 403. ———. Waterflood Fracturing Pays Off in Oklahoma. *Producers Monthly*, v. 25, No. 8, August 1961, pp. 2-7. Presents the following conclusions: (1) Hydraulic fracturing has resulted in increased rates and increased ultimate recovery of oil from many waterflood projects; (2) fracturing has been quite effective in improving the performance of partly plugged wells; (3) most fracturing failures have occurred in edge wells that were fractured with a "standard" size treatment, which usually is used in wells with average sand thickness; (4) good results have been obtained in fracturing productive formations above or below water zones by using planned well-completion procedures; (5) correlation of known fracturing techniques with reservoir characteristics, production histories, and well-completion methods is important in selecting the optimum fracture treatments for a particular productive area or field.
- OP 404. Jones, T. S., and H. M. Smith. Relationships of Crude Oil Composition and Stratigraphy in the Permian Basin of West Texas and New Mexico. *Abs. in Bull. Am. Assoc. Petrol. Geologists*, v. 47, No. 12, December 1963, pp. 274-275.
- OP 405. Karn, F. S., J. F. Schultz, and R. B. Anderson. Kinetics of the Fischer-Tropsch Synthesis on Iron Catalysts. Influence of Water Vapor. *Proc. 2d Internat. Cong. on Catalysis, Paris, France, July 1960. Edition Technik, Paris, 1961*, v. 2, pp. 2439-2454. Gives results of a study of the effect of added water vapor on the rate of hydrogenation of carbon monoxide on a nitrided iron catalyst. The production of hydrocarbons decreased more rapidly than the partial pressure of synthesis gas when water was added; however, carbon monoxide was consumed at a constant rate. Methane and argon were shown to be diluents, carbon dioxide a slight inhibitor, and water a strong inhibitor.
- OP 406. ———. Kinetics of the Fischer-Tropsch Synthesis on Iron Catalysts. Pressure Dependence and Selectivity of Nitrided Catalysts. *J. Phys. Chem.*, v. 64, No. 4, April 1960, pp. 446-451. Represents part of the Bureau of Mines investigation of processes for converting coal to liquid fuels. Studies the variations of rate and selectivity of the Fischer-Tropsch synthesis on nitrided fused iron catalysts as a function of operating conditions.
- OP 407. Karn, F. S., J. F. Schultz, R. E. Kelly, and R. B. Anderson. Fischer-Tropsch Synthesis, Poisoning of Iron Catalysts by H_2S in Synthesis Gas. *I&EC Product Res. and Development*, v. 2, No. 1, March 1963, pp. 43-47. Gives results of tests of reduced fused iron oxide and reduced steel turning catalysts with synthesis gas containing 6.9, 23, and 69 mg sulfur as H_2S per cubic centimeter.
- OP 408. ———. Hydrogen Sulfide Poisoning of Nitrided and Carbided Iron Catalysts in the Fischer-Tropsch Synthesis. *I&EC Product Res. and Development*, v. 3, No. 1, March 1964, pp. 33-38. Shows that sulfur poisoning of iron Fischer-Tropsch catalysts converted to Hägg carbide by H_2S in $1H_2 + 1CO$ feed gas was qualitatively similar to the poisoning of the corresponding reduced catalyst. For catalysts converted to epsilon iron nitride, the activity decreased less rapidly with sulfur fed to the catalyst than with reduced or carbided catalysts.
- OP 409. Karr, Clarence, Jr. Chemical Thermodynamic Equilibria and Free Valence Indices as Applied to a Low-Temperature Bituminous Coal Pyrolyzate. *J. Phys. Chem.*, v. 64, No. 4, April 1960, pp. 462-464. Compares the distributions of many isomers in a low-temperature bituminous coal pyrolyzate, or tar, with the thermodynamic chemical equilibrium distributions and the "kinetic" distributions, as obtained from the free valence indices, or numbers. Assumes a free radical mechanism for isomerization. Concludes that the isomeric composition of the tar produced at 500° by fluidized carbonization may be significantly determined by coal structure in addition to thermodynamic and kinetic distributions.
- OP 410. ———. Estimation of Ratio of Isomers in Coal Tar from Free Valence Numbers. *Fuel*, v. 41, No. 3, May 1962, pp. 299-300. Demonstrates by comparing calculated values with experimental values that the ratio of isomers in coal tars may be estimated from free valence numbers.
- OP 411. ———. The Longest Wavelength Band in the Electronic Spectra of Polynuclear Heterocyclic Aromatics for Analytical Use. *Appl. Spectroscopy*, v. 14, No. 5, December 1960, pp. 146-153. A table is presented listing 204 polynuclear heterocyclic aromatics, with 3 or more aromatic rings, according to increasing values in millimicrons of the longest wavelength absorption band. Structural formulas, wavelengths in millimicrons of additional absorption bands, solvents, and literature references through 1958 also are given. This table is supplemental to a previous table listing 408 polycyclic aromatic hydrocarbons, with 3 or more aromatic rings.
- OP 412. ———. Low-Temperature Tar. Ch. 13 in *Chemistry of Coal Utilization: Supplementary Volume*, ed. by H. H. Lowry. John Wiley & Sons, Inc., New York, N.Y., 1963, pp. 539-579. Gives an exposition of modern viewpoints on the composition, processing, utilization, and economics of low-temperature tar.
- OP 413. ———. A Note on Determining the Arrangement of Rings in the Polynuclear Aromatic Compounds of Coal Tar Pitch Fractions. *Fuel*, No. 2, v. 39, March 1960, pp. 119-123. Proposes to show that the arrangement of the aromatic rings can be readily determined from the conventional ring index (total rings/carbon atom) and the atomic hydrogen to carbon ratio.
- OP 414. Karr, Clarence, Jr., and Edward E. Childers. An Improved Siwoloboff Micro Boiling Point Method. *Anal. Chem.* v. 33, No. 4, April 1961, pp. 655-656. While characterizing the components of low-temperature coal tars, the Bureau of Mines has used micro boiling point determinations for small

- samples. The Bureau has developed a method that represents a major improvement of a widely used technique first described by Siwoloboff.
- OP 415. Karr, Clarence, Jr., Edward E. Childers, and William C. Warner. Analysis of Aromatic Hydrocarbon Samples by Liquid Chromatography With Operating Conditions Analogous to Those of Gas Chromatography. *Anal. Chem.*, v. 35, No. 9, August 1963, pp. 1290-1291. Presents some of the results of studies demonstrating that under analogous operating conditions aromatic hydrocarbon samples can be analyzed essentially as well by liquid chromatography as by gas chromatography.
- OP 416. Karr, Clarence, Jr., Edward E. Childers, William C. Warner, and Patricia A. Estep. Analysis of Aromatic Hydrocarbons From Pitch Oils by Liquid Chromatography on Gas Chromatography Analog. *Anal. Chem.*, v. 36, No. 11, October 1964, pp. 2105-2108. Demonstrates that liquid chromatography on the gas chromatography analog is an effective method of analyzing complex natural mixtures of high-boiling aromatic hydrocarbons, including the identification of individual constituents. Pitch oil fractions boiling in the range 290° to 315° C were analyzed by this method and shown to contain about 70 components.
- OP 417. Karr, Clarence, Jr., and Joseph R. Comberiat. Ring Analysis of High Oxygen Content Samples; A Modification of the n-d-M Method. *Anal. Chem.*, v. 33, No. 10, September 1961, pp. 1420-1423. A modification of the n-d-M method makes it possible to obtain acceptable ring analyses of high oxygen content samples. The applicability of this modification is demonstrated with various samples of known ring content consisting of pure oxygen compounds and their mixtures.
- OP 418. Karr, Clarence, Jr., Joseph R. Comberiat, and Patricia Anne Estep. Ring Analysis and Spectral Characterization of Resins From Pitch of Low-Temperature Tar. *Fuel*, v. 41, No. 2, March 1962, pp. 167-176. Describes the results of extensive research in which the physical properties and structure of resins from the pitch of lignite, subbituminous, and bituminous low-temperature coal tars were studied by means of ring analysis, infrared spectra, and ultraviolet spectra.
- OP 419. ———. Structure Determination of Resins From Pitch of Low-Temperature Tar by Combined Pyrolysis and Gas-Liquid Chromatography. *Fuel*, v. 42, No. 3, May 1963, pp. 211-218. Describes how the major liquid pyrolysis products of a subbituminous coal tar resin heated several seconds to a maximum temperature of 528° C were shown by immediate gas-liquid chromatography to be 2,3,4-trimethylpentane, 2,2,4-trimethylpentane, and benzene. Toluene and the three xylenes were also present, but no higher boiling volatile products could be detected.
- OP 420. ———. Thermodynamic and Kinetic Distributions in Relating the Isomers of Low-Temperature Tar to Coal Structure. *Fuel*, v. 39, No. 6, November 1960, pp. 475-478. Shows that tar acids from four low-temperature subbituminous coal tars contain consistently high proportions of the para isomer among the cresols and the ethylphenols. Since the thermodynamic equilibrium distributions and the kinetic distributions at 500° C predict high proportions of the meta and ortho isomers, respectively, a possible relationship may exist between coal structure and the composition of low-temperature tar.
- OP 421. Karr, Clarence, Jr., Joseph R. Comberiat, and William C. Warner. Comparison of Pitch Resins From Different Sources by Combined Pyrolysis and Gas-Liquid Chromatography. *Anal. Chem.*, v. 35, No. 10, September 1963, pp. 1441-1444. Presents the results of studies demonstrating that pitch resins from various sources can be effectively compared by the technique of combined pyrolysis and gas-liquid chromatography.
- OP 422. Karr, Clarence, Jr., Patricia A. Estep, and Lester L. Hirst, Jr. Countercurrent Distribution of High-Boiling Phenols From a Low-Temperature Coal Tar. *Anal. Chem.*, v. 32, No. 4, April 1960, pp. 463-475. Describes the countercurrent distribution of tar acids. Represents the first complete demonstration of the capabilities of this method of fractionation for complex mixtures of high-boiling phenols.
- OP 423. Kassner, James L., Virgil M. Benson, and Ellis E. Creitz. Flame Spectrophotometric Determination of Lithium in Lithium Minerals. *Anal. Chem.*, v. 32, No. 9, August 1960, pp. 1151-1153. The investigation reported was prompted by the need for a method that would be relatively rapid, simple, and easily applicable to the wide range of lithium concentrations encountered in lithium minerals and other materials. A procedure is proposed in which the sample is decomposed with a mixture of nitric, hydrofluoric, and perchloric acids.
- OP 424. Katell, Sidney. Cost Study in Process Research. *Cost Eng.*, v. 4, No. 2, April 1959, pp. 24-26. Presents a description of the various types of cost studies that can be prepared for use in any research organizations and explains the various steps involved in preparing these types of studies.
- OP 425. ———. Process Evaluation in a Research Program. *Cost Eng.*, v. 8, No. 2, April 1963, pp. 4-13. Lists the steps to be taken in a process evaluation of a research project or any part of one, using examples taken from economic evaluations of Bureau research projects.
- OP 426. ———. R&D Aims at Future Gases. *Am. Gas J.*, v. 191, No. 11, September 1964, pp. 41-42. Summarizes the status of research and development, in both Government and private industry, on synthetic gaseous fuels.
- OP 427. Katell, Sidney, and John H. Faber. Estimated Costs of Gasifying Coal in Place. *Gas Age*, Sept. 14, 1961, pp. 40-44. Presents a study based on electrolinking and hydraulic fracturing experiments. Provides an economic analysis. Develops a basic cost formula for any underground gasification system.
- OP 428. ———. New Costs for Hot Carbonate Process. *Petrol. Refiner*, v. 39, No. 3, March 1960, pp. 187-190. Presents the economics of the hot carbonate purification process for removing CO₂. Considers three variations of the process in order to meet the design specifications which call for a feed-gas flow of 10 million standard cubic feet per hour, with CO₂ inlet concentrations of 10, 20, and 30 percent and exit CO₂ values of 5, 2, 1, 0.5, and 0.1 percent. Inlet pressure and temperature are 350 psig and 300 F, respectively.
- OP 429. ———. What Hydrogen from Coal Costs. *Hydrocarbon Processing & Petrol. Refiner*, v. 43, No. 3, March 1964, pp. 143-146. Presents the economics of several processes for producing hydrogen from coal.
- OP 430. Katell, Sidney, John H. Faber, and Marc T. Constantine. The Economic Outlook for Pipeline Gas From Char via the Lurgi Process. *Coal Age*, v. 64, No. 8, August 1959, pp. 92-95. Evaluates a plant designed and built to produce 90 million std cu ft per day of synthetic pipeline gas by Lurgi gasification of bituminous char; includes tables showing estimated capital requirements and estimated annual operating costs.
- OP 431. Katell, Sidney, and Liang-Tseng Fan. How to Estimate Chemical Selling Price. *Petrol*

- Refiner, v. 39, No. 2, February 1960, pp. 153-154. Presents an empirical correlation for determining the approximate selling price of organic chemicals. Describes assumptions used in making the correlation and correlation's applications.
- OP 432. Katell, Sidney, and Thomas J. Joyce. What Pulverizing Costs. *Coal Age*, No. 6, June 1961, pp. 92-93. A Bureau of Mines study develops commercial-scale costs of pulverizing coal to 70 to 90 percent through 200 mesh, using hammer and ball mills, for such applications as production of synthetic liquid fuel and gas, or pipelining. Covers the reduction problem, the coal-handling system, drying air, and economics.
- OP 433. Katell, Sidney, and Paul Wellman. Air Compressor HP, Operating Costs. *Petrol. Refiner*, v. 40, July 1961, pp. 210-214. Describes a quick method for finding the horsepower and costs for centrifugal air compressors operating between 10,000 and 100,000 cfm and 50 to 2,000 psig.
- OP 434. ———. Nomograph Gives Pump Horsepower. *Chem. Eng.*, v. 67, No. 25, Dec. 12, 1960, pp. 176, 178. Presents nomograph for determining pump horsepower for both viscous and nonviscous liquids.
- OP 435. Kaufman, Alvin. Economic Appraisal of Geothermal Power. *Min. Eng.*, v. 16, No. 9, September 1964, pp. 62-66. Discusses the economics of generating electric power from geothermal steam, on the basis of costs for presently operating plants. Concludes that geothermal power could be produced competitively in the Western States.
- OP 436. ———. Economic Aspects of Alaskan Mining. *Min. Eng.*, v. 13, No. 12, December 1961, pp. 1343-1346. High costs, limited transportation facilities, lack of skilled labor, and limited local investment capital plague the development of a mineral industry in Alaska. These difficulties, the article points out, are the usual problems facing mineral producers in undeveloped areas. They are, in the case of Alaska, compounded by climate, location, size, and rugged topography. However, Canada and the Scandinavian countries overcame these problems.
- OP 437. ———. Mineral Industry in Retrospect. *Min. Eng.*, v. 15, No. 2, February 1963, pp. 57-61. Reviews the growth of and changes in the mineral industry since 1946.
- OP 438. Kawenski, Edward M., and Donald W. Mitchell. An Evaluation of Stopping Construction. *Min. Cong. J.*, v. 49, No. 9, September 1963, pp. 57-61. Gives results of air-leakage tests on a variety of test stoppings and of ultimate-strength tests of stoppings subjected to shock pressure.
- OP 439. ———. Rapid and Inexpensive Erection of Stoppings With Rigid Foam. *Proc., 52d Coal Min. Inst. of America*, 1962, pp. 80-87. Describes methods of erecting mine stoppings with rigid foam and discusses the problem of air leakage across a rigid foam stopping due to difference in pressure.
- OP 440. Kaylor, C. E., G. E. Walden, and Donald F. Smith. High Temperature Heat Content and Entropies of Cesium Chloride and Cesium Iodide. *J. Phys. Chem.*, v. 64, February 1960, pp. 276-277. Presents the results of heat content measurements from 273.15° to 1.172° K with calculated entropies for cesium chloride and cesium iodide. The heat of transition for cesium chloride at 742.5° K is measured, and the heats of fusion of cesium chloride and cesium iodide are measured at their respective melting points.
- OP 441. Kenahan, Charles B., and David Schlain. Effects of Ultrasonics on Electrolytic Deposition of Copper From a Cyanide Bath. *Plating*, v. 48, January 1961, pp. 37-41. The application of ultrasonics in the electrolytic deposition of copper from a simple, low-temperature cyanide bath resulted in large increases in anode and cathode current efficiencies and large decreases in cell voltage. The relationship of these effects to current density is discussed, and the effectiveness of ultrasonic vibrations and mechanical agitation are compared. Electrode potential studies indicated that the decrease in cell voltage resulted chiefly from depolarization at the anode.
- OP 442. Kingery, Donald S. The Bureau of Mines Program for Safety in Coal Mines. *Coal Age*, v. 68, No. 5, May 1963, pp. 104-107. Reviews briefly the Bureau's research programs in the fields of roof control, ventilation, coal float-dust inerting, mine fire control, and application of rigid foam to mine use.
- OP 443. ———. Fundamental Principles in Face Ventilation with Auxiliary Fans. *Proc. Coal Min. Inst. of America*, 1959, pp. 32-41. Discusses advantages of the use of auxiliary fans for face ventilation when continuous-mining machines are used. Gives advantages of a combined exhaust and small blower system, describes its component parts, and gives recommendations for its efficient and safe use.
- OP 444. ———. Mining Safety. *McGraw-Hill Yearbook of Science and Technology*. McGraw-Hill Book Co., Inc., New York, 1963, pp. 358-359. States that the accident pattern between July 1961 and July 1962 followed the trend of previous years, although the number of fatal injuries was reduced by about 5 percent. Falls of roof, rib, or pillars continued to be the leading cause of both fatal and nonfatal injuries, accounting for approximately 55 percent. In January 1962, a major gas explosion occurred in a bituminous coal mine, causing 11 deaths. Only one death was charged to coal-mine fires, but there was an increase in hazardous local gas ignitions occurring in face areas.
- OP 445. Kingery, D. S., and D. W. Mitchell. Observation on Control of the Coal Dust Explosion Hazard in European Mines. *Min. Eng.*, v. 16, No. 7, July 1964, pp. 157-160. Discusses present European practices for neutralizing the coal-dust explosion hazard. Emphasis is on rock-dust barriers, their design, application, and location.
- OP 446. Kintz, G. M., and H. F. Browne. What Happens When Gas, Vapor, or Dust Burns or Explodes? *Nat. Safety Cong. Trans., Mining Industry*, v. 18, 1959, pp. 53-55. Describes gas and dust explosions which may occur in a confined space. Although many factors are involved, the most important is the speed with which the flame propagates through the confined space.
- OP 447. Kirkland, C. G., L. W. Brandt, and W. M. Deaton. A Method and Apparatus for Concentrating Trace Impurities in Analyzing Grade-A Helium. *Ch. in Advances in Cryogenic Engineering*. Plenum Press, Inc., New York, v. 6, 1961, pp. 339-405. Describes an apparatus for determining trace impurities in grade A helium that was designed and built by the Bureau. Impurities in the helium are concentrated by freezing them out in a coil-and-trap assembly cooled by liquid helium. Concentrated impurities are analyzed by mass spectrometer methods.
- OP 448. Klingman, C. L. Continuous Analysis of Helium in Natural Gas by Chromatography. *Proc. 6th Annual Symposium on Instrumental Methods of Analysis*, Montreal, Canada, sponsored by Instrument Society of America, Paper C-8, v. 6, 1960, 7 pp. Describes development, testing, and plant use of a gas chromatograph capable of continuously analyzing for helium in a natural gas stream in the range 0.1 percent. The instrument

- uses conventional principles of gas chromatography but contains a few novel solutions to chromatography problems. The analyzer uses commercially available, three-way solenoid valves as column-switching valves; contains a 25-inch column of activated charcoal as a partitioning agent; and uses a hot-wire, thermal-conductivity cell as the detector. In plant application, the instrument has been successful in reducing the loss of helium in outlet gas from helium extraction plants.
- OP 449. Klingman, C. L. Modified Chromatograph to Record Helium Content of Natural Gas Streams. *Rev. Sci. Instr.*, v. 32, No. 7, July 1961, pp. 822-824. Describes the construction and procedure for use of a special-purpose chromatograph designed to analyze small amounts of helium in natural gas streams. The successful use of ordinary solenoid valves for column switching is unique. Mentions automatic-zero circuitry. Shows the instrument to be useful in the reduction of wasted helium in the outlet gas streams from helium extraction plants.
- OP 450. Kloos, Edwin J. History of Respiratory Protection in the Fire Service. *Fire Eng.*, v. 116, No. 7, July 1963, pp. 534-536. Describes and illustrates man's efforts to protect firemen against the inhalation of smoke and irrespirable gases from early times to the present.
- OP 451. ———. Know Your Gas Mask. *Fire Eng.*, v. 117, No. 7, July 1964, pp. 540-541, 559. Written with the fire service in mind, this article explains some of the general misconceptions regarding the use of the universal-type gas mask.
- OP 452. ———. Storage Life of Self-Rescuer Cartridges. *Min. Cong. J.*, v. 49, No. 10, October 1963, pp. 97-99. Based on the tests reported, recommendations are made as to the length of time that self-rescuer cartridges should be kept in service under two conditions: (1) storage in caches and (2) carried on a person or on moving equipment.
- OP 453. Knepper, W. A., P. L. Woolf, and H. R. Sanders. Operation of the Bureau of Mines Experimental Blast Furnace With Fuel-Oil Injection. *Blast Furnace and Steel Plant*, v. 49, No. 12, December 1961, pp. 1189-1196. Describes oil-injection system and results of tests in which oil was injected into the blast furnace. Oil-to-coke replacement ratios are calculated. The use of changes in slag composition and volume to control metal sulfur is also described.
- OP 454. Kuchta, J. M., R. J. Cato, and M. G. Zabetakis. Comparison of Hot Surface and Hot Gas Ignition Temperatures (letter to the editors). *Combustion and Flame*, v. 8, No. 4, December 1964, pp. 348-349. Compares hot-surface and hot-gas ignition temperatures of hydrocarbon combustibles and hydrogen with air at atmospheric pressure.
- OP 455. Kuchta, J. M., Irving Spolan, and Michael G. Zabetakis. Flammability Characteristics of Methylacetylene, Propadiene (Allene), and Propylene Mixtures. *J. Chem. and Eng. Data*, v. 9, No. 3, July 1964, pp. 467-472. Gives results of a study of the flammability characteristics of potentially hazardous mixtures containing methylacetylene, propadiene, and hydrocarbon diluent, such as propylene or propane.
- OP 456. Kurtzrock, R. C. Quick Connector for Multipoint Thermocouple Assemblies. *Rev. Sci. Instr.*, v. 31, No. 4, April 1960, pp. 457-458. Describes a thermocouple connector developed for bench-scale application where frequent assembly and dismantling of equipment are necessary. The connector, incorporated as an integral part of a reactor or vessel, affords ample protection from the disturbances that affect a thermocouple's calibration.
- OP 457. Kurtzrock, R. C., D. Bienstock, and J. H. Field. A Laboratory-Scale Furnace Fired With Pulverized Coal. *J. Inst. Fuel*, v. 36, February 1963, pp. 55-61. Describes the design and operation of a laboratory-scale pulverized-coal-fired furnace burning 1 to 4 pounds of coal per hour and capable of continuous or intermittent operation under constant and reproducible combustion conditions.
- OP 458. Lacina, J. L., W. D. Good, and J. P. McCullough. The Heats of Combustion and Formation of Thiaadamantane. *J. Phys. Chem.*, v. 65, No. 1026, 1961, pp. 1026-1027. The heat of combustion of thiaadamantane, a saturated organic sulfur compound with four fused, six-membered rings forming a cage-like molecule, was measured by rotating-bomb calorimetry. An experimental technique was developed for confining samples of volatile solids in sealed polyester envelopes for precision combustion calorimetry. The heat of formation of thiaadamantane in the solid state at 298.15° K is -34.29 kcal. mole⁻¹, referred to graphite, hydrogen gas, and rhombic sulfur.
- OP 459. Lamb, Frank D. Operation of a Bureau of Mines Metallurgy Research Center. *J. Metals*, v. 14, No. 3, March 1962, pp. 214-217. Describes the operation of the College Park (Md.) Metallurgy Research Center in terms of its direction, capability, and the various studies it conducts.
- OP 460. Landers, W. S. Binderless Briquetting of Indian Lignite. *Proc. Internat. Briquetting Assoc., Univ. of Wyoming Nat. Resources Res. Inst. Inf. Circ.* 10, December 1959, pp. 30-37. Indian lignite containing 56 percent moisture was crushed and dried to about 10 percent moisture in a fluidized dryer, then briquetted without binder in an extrusion press. The briquets were carbonized in a gravity-feed vertical shaft carbonizer. The resultant briquets, containing about 11 percent volatile matter, were easily ignited and proved to be satisfactory fuel for domestic use, burning without smoke or odor.
- OP 461. ———. Metallurgical, Domestic and Industrial Utilization of Low-Rank Coals. U.S. Papers Prepared for the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas. *Natural Resources: Energy, Water, and River Basin Development*, v. 1, 1963, pp. 108-118. Considers the potential uses of low-rank coals, such as are available in many of the less developed areas of the world. The low-rank coals include the lignites, brown coals, and subbituminous coals, all characterized by their high moisture content, low heating value, susceptibility to spontaneous combustion during storage or shipment, and inability to fuse into conventional metallurgical coke. Proper utilization plans should either compensate for undesirable properties or take advantage of desirable ones.
- OP 462. Landers, W. S., and D. J. Donaven. Storage Handling and Transportation. Ch. 7 in *Chemistry of Coal Utilization: Supplementary Volume*, ed. by H. H. Lowry. John Wiley & Sons, Inc., New York, N.Y., 1963, pp. 296-311. Discusses techniques developed for the storage of coal to minimize coal deterioration and spontaneous combustion; problems of handling the discharge of coal from bins, chutes, and pipes; and pneumatic and hydraulic transportation of coal.
- OP 463. Landsberg, Arne. A Simple Remotely Operated Quartz Spring Recording Balance. *J. Sci. Instr.* v. 41, May 1964, pp. 337-338. Describes the construction and operation of a recording balance to operate remotely in high gamma radiation fields. A remotely operated Selsyn motor, coupled through a reduction gear and a sprocket and chain, moves the upper end of a weight-sensing quartz spring.

- The position of the lower end of the spring is accurately determined. The control Selsyn movement necessary to keep the bottom of the spring in position is a measure of the suspended weight.
- OP 464. Langer, S. H., R. A. Friedel, I. Wender, and A. G. Sharkey, Jr. Complex Mixtures of Alcohols and Water: The Fischer-Tropsch Product. *Encyclopedia of Spectroscopy*, ed. by G. L. Clarke. Reinhold Pub. Corp., New York, 1960, pp. 598-602. Describes a new approach for the rapid and accurate determination of alcohols in the presence of paraffins, olefins, and other hydrocarbons. Eliminates the lengthy and relatively complex distillations previously applied to Fischer-Tropsch products.
- OP 465. Langer, Stanley H., and Peter Pantages. A Convenient Safety Shield for Small-Scale Apparatus. *J. Chem. Educ.*, v. 38, December 1961, p. 634. Describes a portable shield for small-scale chemical operations that was constructed from a commercially available face mask adapted to a position-locking swivel mechanism attached to a rod.
- OP 466. ———. Peak-Shift Technique in Gas-Liquid Chromatography: Trimethylsilyl Ether Derivatives of Alcohols. *Nature*, vol. 191, No. 4784, July 8, 1961, pp. 141-142. Discusses identifications and analyses obtained by observing the peak shift resulting from the conversion of volatile materials to volatile derivatives. Considers a hydrogenated Fischer-Tropsch fraction after hydrogenation (110°-115° C, bp) that was obtained from a synthesis using an iron nitride catalyst.
- OP 467. Langer, Stanley H., Charles Zahn, and Gus Pantazoplos. Selective Gas-Liquid Chromatographic Separation of Aromatic Compounds With Tetrahalophthalate Esters. *J. Chromatography*, v. 3, 1960, pp. 154-167. Shows that tetrahalophthalate esters are selective liquid substrates for separating aromatic hydrocarbons by gas chromatography.
- OP 468. Latham, D. R., C. R. Ferrin, and J. S. Ball. Identification of Fluorenones in Wilmington Petroleum by Gas-Liquid Chromatography and Spectrometry. *Anal. Chem.*, v. 34, No. 3, March 1962, pp. 311-313. Describes method of isolating a series of fluorenones from Wilmington, Calif., petroleum. These three-ring compounds containing oxygen were identified through a combination of gas-liquid chromatography and spectroscopy.
- OP 469. Lawlor, D. L., J. I. Fester, and W. E. Robinson. Pyrite Removal From Oil-Shale Concentrates Using Lithium Aluminum Hydride. *Fuel*, v. 42, May 1963, pp. 239-244. Describes a technique developed by the Bureau for removing pyrite from oil-shale concentrates by treatment with lithium aluminum hydride in tetrahydrofuran at reflux temperature. The pyrite content of a carbonate-free oil-shale concentrate was reduced from 5.3 to 0.0 percent with only specific alteration of the organic material (kerogen) as indicated by elemental and infrared analyses. Concentrates obtained by this method will be useful in kerogen structural studies.
- OP 470. Leary, R. J., and R. W. Smith, Jr. Experience With a Small Digital Computer in Pyrometallurgical Research. *Computers in the Mineral Industries*. Stanford Univ. Pub. Geol. Sciences, v. 9, No. 1, 1964, pp. 212-226. Describes the Bureau of Mines electronic digital computer and gives examples of problems that can be solved by the computer.
- OP 471. Leary, R. J., R. W. Smith, Jr., and B. J. Mitchel. Application of a Small Electronic Digital Computer to Pyrometallurgical Research. *Computers in the Mineral Industries*. Stanford Univ. Pub., Geol. Sciences, v. 9, No. 1, 1964, pp. 281-305. Describes the Bureau of Mines electronic digital computer and gives examples of problems that can be solved using the computer.
- OP 472. Lewis, Paul S., and Raymond W. Hiteshue. Hydrogenating Coal in the Entrained State. *Ind. and Eng. Chem.*, v. 52, November 1960, pp. 919-920. Laboratory apparatus was developed to produce hydrocarbon liquids and gases by hydrogenating coal in the entrained state at 800° C; the feeder can be used for any reaction requiring solids feeding at pressures to 6,000 psi.
- OP 473. Lindley, J. R. The Case for Technical Illustration. *Graphic Sci.*, v. 3, No. 2, February 1961, pp. 20-21. Attempts to promote an increased interest in technical illustrations and indicates the importance of teamwork between the author and the draftsman-illustrator. Presents four illustrations; these range from a cartoon approach, showing a statistical trend, to a detailed exploded assembly of a complicated piece of research equipment. Indicates the purpose of each illustration.
- OP 474. Litchfield, E. L. Chronology and Topography of Sparks at Minimum Energy for Ignition. *Combustion and Flame*, vol. 5, No. 3, September 1961, pp. 235-241. Microsecond exposure schlieren observations of ignition kernels and developing flames are reported for a set of minimum energy conditions holding for electrostatic spark ignition of 8.5 percent methane-air mixtures of 0.1 atmosphere initial pressure. Time of appearance of a flame and the extent of influence of the shock wave generated by the electric discharge were determined experimentally. This investigation indicates that the time of appearance of the flame varies inversely with initial pressure and also indicates that only a small portion of the original stored energy is caused to be dissipated outside the ignition kernel as a consequence of the shock-wave.
- OP 475. ———. Freely Expanding Gaseous Detonation Waves Initiated by Electrical Discharges. *Physics of Fluids*, v. 5, No. 1, January 1962, pp. 114-115. Discusses the initiation of freely expanding detonation waves in several gaseous mixtures that had not previously been reported to be amenable to this type of initiation. Work was sponsored in part by Project Squid, which is supported by the Office of Naval Research, U.S. Department of the Navy.
- OP 476. ———. Technique for Microsecond Synchronization of Small, Known Energy Sparks. *Rev. Sci. Instr.*, v. 31, No. 5, May 1960, pp. 572-573. Shows that the factors controlling the application of this synchronization method are the difficulty of forming the spark and the effects of series resistance.
- OP 477. Litchfield, E. L., M. H. Hay, and D. R. Forshey. Direct Electrical Initiation of Freely Expanding Gaseous Detonation Waves. *Proc. 9th Internat. Symp. on Combustion*, Academic Press, Inc., New York, 1963, pp. 282-286. Discusses the initiation of freely expanding detonation waves in mixtures of oxygen with the individual fuels ethylene, hydrogen, and propane. Both spark discharges and exploding wire discharges are discussed as initiation sources. Work was sponsored in part by Project Squid, which is supported by the Office of Naval Research, U.S. Department of the Navy.
- OP 478. Litchfield, E. L., and J. S. Monroe. Ignition of Gaseous Mixtures With Repetitive Sparks (letter to the editor). *Combustion and Flame*, v. 7, No. 4, December 1963, pp. 393-394. It was established experimentally that a flammable (8.5-percent) methane-air mixture can be ignited by a series of repetitive sparks localized in space, each

- spark carrying less energy than would be required for ignition by a single spark, provided that the repetition rate of the spark is of the order of the reciprocal of the thermal relation time. This confirms the fact that ignition by electric discharge is essentially a thermal process. The possibility of repetitive sparking must be taken into account in assessing spark ignition hazards of a procedure involving flammable gases or vapors.
- OP 479. Long, Albert E. Bureau of Mines Investigates Factors Affecting the Stability and Safety of Open-Pit Mine Slopes. *Trans. 52d Nat. Safety Cong., Mining*, v. 16, 1964, pp. 36-42. Discusses the mechanical, physical, and environmental factors that affect the stability of rock slopes in open-pit mines. Slope design criteria developed or being developed through current research will permit engineers to excavate pit slopes to the steepest possible angle as well as to create a safer working environment.
- OP 480. ———. Open Pit Slope Stability Research by the Bureau of Mines. *Min. Cong. J.*, v. 49, No. 6, June 1963, pp. 68-71. Describes the Bureau's slope stability research program: Its objectives and accomplishments to date.
- OP 481. ———. Problems in Designing Stable Open-Pit Mine Slopes. *Canadian Inst. Min. and Met. Bull.*, v. 57, No. 627, July 1964, pp. 741-746. Discusses the general significance and possible effects of the attitude of rock joints and faults, groundwater, overblasting, and the geometry and character of stresses created by previous mining, gravity, or tectonic forces on the steepness and stability of open-pit mine slopes.
- OP 482. Loomis, A. G., and D. C. Crowell. Relative Permeability Studies: III. Comparisons of Gas-Drive and Stationary-Phase Methods. *Producers Monthly*, v. 24, No. 14, December 1960, pp. 22-26. Describes the application of the unsteady-state displacement method to core samples to measure the relative-permeability ratio as a function of saturation in gas-oil systems. Discusses the apparatus and experimental method used to obtain the production curve.
- OP 483. Lorenz, Philip B. Electroosmosis. *Encyclopedia of Electrochemistry*, ed. by C. A. Hampel. Reinhold Publishing Corp., New York, 1964, pp. 536-540. Reviews modern knowledge of electroosmosis under the headings: theory, observed characteristics of electroosmotic permeability, quasi-electroosmotic phenomena, experimental methods, and applications.
- OP 484. ———. The Onsager Coefficient L_{12} in Transport of Binary Electrolytes. *J. Phys. Chem.*, v. 65, No. 4, April 1961, p. 704. Indicates that the slope for a given electrolyte computed from the Debye-Onsager theory depends somewhat on the specific properties, but is almost constant for various electrolytes.
- OP 485. ———. Tortuosity in Porous Media. *Nature*, v. 189, No. 4762, Feb. 4, 1961, pp. 386-387. Interprets the tortuosity of porous media and indicates their relationship to porosity and the formation factor. Presents the interpretations of tortuosity that have been presented by other authors.
- OP 486. Lorenz, Philip B., R. J. Bolen, and H. N. Dunning. Ultracentrifugation and Viscosities of Crude Oils. *J. Colloid Sci.*, v. 16, No. 5, October 1961, pp. 493-496. Viscosities measured at three temperatures on ultracentrifuge fractions of several crude oils are compared with asphaltene content. The same comparison is made for solution of asphaltenes in kerosine, gas, oil, benzene, and decaline. The results indicate that asphaltene particles are solvated strongly in crude oil and only weakly in solvents. Dilution of crude oil desolvates asphaltenes.
- OP 487. Lytle, Farrell W., and Howard H. Heady. X-Ray Emission Spectrographic Analysis of High-Purity Rare Earth Oxides. *Anal. Chem.*, v. 31, No. 5, May 1959, pp. 809-811. Describes detection of impurities in rare-earth oxides by a fluorescent X-ray procedure. The determination of spectral line intensity above background, sample and standard preparation, choice of analytical lines, and utilization of a helium path to increase X-ray intensities are described.
- OP 488. Machisak, John C. The National Safety Competition of 1957. *Explosives Eng.*, v. 36, No. 4, July-August 1958, pp. 103-113. Gives results of 1957 competition in which record lows were achieved in injury-frequency rate and in number of operations recording any disabling work injuries throughout the year.
- OP 489. ———. The National Safety Competition of 1958. *Explosives Eng.*, v. 37, No. 3, May-June 1959, pp. 71-78. Gives results of the National Safety Competition in which a record 675 participants engaged. Injury and severity rates were again low.
- OP 490. ———. The National Safety Competition of 1959. *Explosives Eng.*, v. 38, No. 3, May-June 1960, pp. 71-78. Mine and quarry entrants again establish a new record-low frequency rate of 18.293 disabling work injuries per million man-hours of exposure to the hazard of mineral extraction. The severity rate is third lowest of contest history.
- OP 491. ———. The National Safety Competition of 1960. *Explosives Eng.*, v. 39, No. 4, July-August 1961, pp. 103-113. Gives results of competition in which 675 mines and quarries participated. New record number, 294 participants, operated throughout the contest year without a disabling work injury. Disabling work injury frequency was 18.828 per million man-hours, third lowest since the start of the competition in 1925.
- OP 492. ———. Where Are We Going? *Trans. Nat. Safety Cong., Cement, Quarry, and Mineral Aggregates*, v. 4, 1959, pp. 4-11. Presents 1942-58 data on injury-frequency rates and 1953-58 data on the percentage distribution of four major causes of injury. All figures are broken down according to the subindustry.
- OP 493. Machisak, John C., and Roy G. Stott. Injury Trends and Causes in Non-Coal Mines. *Trans. Nat. Safety Cong.*, v. 18, 1959, pp. 22-28. Discusses disabling injury experience in noncoal mines in the United States through 1957.
- OP 494. Mahan, Warren M., P. L. Woolf, and Norwood B. Melcher. Evaluation of Sinter and Pellets in an Experimental Blast Furnace. *Journées Internationales de Sidérurgie, Luxembourg*, 1963, pp. 235-236. Describes the relative advantages of various kinds of pellets and sinters that have been tested in the Bureau's experimental furnace. Experiments indicate that pelletized iron ore concentrate is a more efficient blast-furnace feed than the same concentrate in sintered form.
- OP 495. Maize, E. R. Progress in Roof Bonding Experiments. *Proc. 55th Meeting Rocky Mountain Coal Mining Inst.*, June 29-July 1, 1959, pp. 47-49. Describes procedure and method of systematically injecting a bonding fluid (epoxy or polyester resin) into bituminous coal-mine roof as a means of adding to its strength and thus reducing the hazard of roof falls.
- OP 496. Marchant, L. C., and J. R. Hamke. Nitrogen in Clear Creek and Charlson Fields, North Dakota 3d Internat. Williston Basin Symp., September 1964, pp. 185-191. Gives data on the volumes of nitrogen gas available in the Minnelusa

- Formation in the Clear Creek and Charlson oil fields and concludes they warrant consideration for production operations.
- OP 497. Marchant, J. D., E. S. Shedd, and T. A. Henrie. Solid-State Electrorefining of Rare-Earth Metals. Ch. in Rare Earth Research, ed. by J. F. Nachman and C. E. Lundin, Gordon and Breach, New York, 1962, pp. 143-150. Describes successful refining of cerium metal with respect to iron, carbon, and copper by passing direct current through a bar at a temperature of 600° C. Iron, carbon, and silicon migrate toward the anode. Molybdenum, magnesium, and calcium were relatively unaffected by the treatment. The concentration of impurity iron at the anode was 100 times that at the cathode. A radiotracer technique was used to follow the iron migration.
- OP 498. Markby, Raymond E., Heinz W. Sternberg, and Irving Wender. Extensive Reduction of Coal by a New Electrochemical Method. *Nature*, v. 199, Sept. 7, 1963, pp. 997-998. Electrochemical reduction of a Pocahontas vitrain resulted in addition of 44 hydrogens per 100 carbon atoms. The advantages of using lithium chloride in ethylenediamine as an electrolyte is probably due to the fact that lithium can act as an electron transfer agent from electrode to coal.
- OP 499. Martindill, C. H., F. W. Lang, and M. G. Zabetakis. Flammability Characteristics of the Vapor System Hydrogen Peroxide-Xylene-Formic Acid-Water. *J. Chem. and Eng. Data*, v. 5, No. 3, July 1960, pp. 355-358. Describes a study undertaken to determine the limits of flammability of organic vapors in hydrogen peroxide-water vapor mixtures. *o*-Xylene and formic acid, representative to two widely varying classes of possible organic substances, were used.
- OP 500. Maurer, R. B. Report of the U.S. Bureau of Mines on Cooperative Mineral Resources and Research Studies in California (Fiscal Year 1960). 57th Rept. of the State Mineralogist—1961, pp. 58-61. Describes the cooperative program of the Federal Bureau of Mines and the California Division of Mines. Gives data on the State's mining industry, including tungsten and molybdenum research, studies on anorthosite utilization, and work on slope stability in open pits.
- OP 501. Maust, E. E., Jr., and W. E. Warnke. A Graphite Resistor Source for Image Furnace Research. *Applied Optics*, v. 2, No. 7, July 1963, pp. 758-759. Describes the design and operation of an electrical resistance element of graphite used as a high-temperature source in a double-paraboloidal mirror-image furnace. The graphite resistor source has been operated continuously for periods exceeding 4 hours at temperatures above 2,000° C with no visible signs of oxidation.
- OP 502. McCann, Charles R., and Arthur A. Orning. A Study of Pulverized Coal Flames. *Abs. in Mech. Eng.*, v. 84, No. 5, May 1962, p. 88. Summarizes study of conditions necessary to produce flames of pulverized coal when recirculation of hot combustion gases into the ignition zone was minimized.
- OP 503. McCartney, J. T., and Sabri Ergun. Refractive Index and Thickness of Ultrathin Sections of Coals and Graphite by Interferometry. *J. Opt. Soc. America*, v. 52, No. 2, 1962, pp. 197-200. Describes method of directly measuring the refractive index of small coal components and simultaneously determining the thickness of these ultrathin sections. Data obtained agreed well with those previously derived from reflectance measurements.
- OP 504. McCartney, J. T., Sabri Ergun, and R. E. Walline. Electron Microscopic Observations of Structure in Ultrathin Sections of Vitrinite in Coal. *Nature*, v. 191, Sept. 30, 1961, pp. 1361-1363. Recently ultrathin sections of soft coals have been cut, using a microtome and a diamond knife. Success in preparing such sections has opened up a very promising field of study involving ultrafine structures in coals such as preserved plant cell components, pores, and possibly structural units or crystallites.
- OP 505. McCullough, J. P. Review of "Estimation of Thermodynamic Properties of Organic Compounds," by G. J. Janz. *J. Colloid Sci.* v. 15, No. 1, 1960, p. 86.
- OP 506. ———. Thermochemistry and Thermodynamic Properties of Substances. *Ann. Rev. Phys. Chem.*, v. 11, 1960. Reviews recent publications on thermochemistry and chemical thermodynamics that were available to the reviewer in the original or as abstracts before December 1, 1959.
- OP 507. ———. Thermodynamic Research Under Projects 48 and 52. *Proc. API*, v. 42, sec. 8, 1962, p. 118. Discusses the objectives of the API thermodynamics work and the approach to the solution of the problems. Gives the status of the work on sulfur and nitrogen compounds completed, in progress, or planned.
- OP 508. ———. Transition Types in Hydrocarbons and Related Substances. *Pure and Appl. Chem.*, v. 2, 1961, pp. 221-230. Presents a brief outline of a systematic classification of the types of transitions that occur in hydrocarbons and related substances. Indicates that seven types of transformations in solid phases could be distinguished phenomenologically. Results for 95 compounds are listed in a table.
- OP 509. McCullough, J. P., H. L. Finke, W. N. Hubbard, S. S. Todd, J. F. Messerly, D. R. Douslin, and Guy Waddington. Thermodynamic Properties of Four Linear Thiaalkanes. *J. Phys. Chem.*, v. 65, May 1961, pp. 784-791. Values of heat capacity, heat of fusion, entropy, and related thermodynamic properties of 2- and 3-thiahexane, 4-thiaheptane, and 5-thianonane were determined by low-temperature calorimetric measurements, 11°-370° K; heats of combustion were determined by rotating-bomb calorimetry. The vapor pressure of 2-thiahexane was measured, 73°-163°. Results were used in calculating values of entropy, heat of formation, free energy of formation, and equilibrium constant of formation in the standard liquid and gas states at 298.15° K. For addition of a methylene group to a normal propyl or larger normal alkyl group in linear thiaalkanes, the increments to the thermodynamic properties were found the same as those in normal alkanes above *n*-heptane.
- OP 510. McCullough, J. P., and W. D. Good. Correlation of Heat of Formation Data for Organic Sulfur Compounds. *J. Phys. Chem.*, v. 65, August 1961, pp. 1430-1432. The method of Allen was used to correlate unpublished and recently published Bureau of Mines data for the heats of formation of organic sulfur compounds. Six parameters were evaluated from data for 25 acyclic alkane thiols, sulfides, and disulfides. By including appropriate strain energies, the results for seven cyclic sulfur compounds also were correlated. For all 32 compounds, the average deviation between calculated and experimental values, 0.17 kcal. mole⁻¹, was less than the average experimental uncertainty, 0.22 kcal. mole⁻¹. The correlation predicts reliable values of heat of formation for many other organic sulfur compounds.
- OP 511. McCullough, J. P., J. F. Messerly, R. T. Moore, and S. S. Todd. Trimethylaluminum: Thermodynamic Functions in the Solid and Liquid States, 0-380° K.; Vapor Pressure, Heat of Va-

- porization, and Entropy in the Ideal Gas State. *J. Phys. Chem.*, v. 67, No. 2, February 1963, pp. 677-679. Describes thermodynamic investigations of trimethylaluminum which were made by the Bureau on selected organic derivatives of elements in the second and third periods. From experimental measurements by low-temperature calorimetry and comparative ebulliometry, the following properties were determined: thermodynamic functions in the solid and liquid states (10° to 380° K); vapor pressure (336° to 400° K); heat of vaporization (298.15° K); and entropy in the ideal gas state (298.15° K).
- OP 512. McCullough, J. P., D. W. Scott, and Guy Waddington. Thermodynamics of Organic Sulfur Compounds. Ch. in *Organic Sulfur Compounds*, ed. by N. Kharasch. Pergamon Press, New York, 1961. pp. 20-30. Thermochemical and thermodynamic studies of organic sulfur compounds are surveyed. A complete listing of thermodynamic data available for 90 sulfur compounds is given with literature references. Contributions of systematic investigations that began in 1948 are emphasized. These investigations proved that values of thermodynamic properties are correlated with molecular weight and structure in two ways: (a) General equations are given for computing thermodynamic properties of any linear 1-alkanethiol, alkane sulfide, or symmetrical alkane disulfide; (b) thermodynamic properties of 30 representative organic sulfur compounds are compared with those of the corresponding hydrocarbons.
- OP 513. McDonald, F. R., and G. L. Cook. Use of Low Molecular Weight Polyethylene in Ultraviolet Spectroscopy. *Appl. Spectroscopy*, v. 15, No. 4, 1961, pp. 110-112. The ultraviolet spectra of high molecular weight materials were obtained by dispersing them in polyethylene, which had a negligible contribution to the spectrum between 2,200 and 4,000 Å. The spectra of reference compounds as well as asphaltenes and polymers are given. The sample is stirred into melted polyethylene, and a portion of the dispersion is pressed between sheets of metal foil in a heated laboratory press to form a film. A circular plate cut from the film and mounted between two metal rings is inserted into the spectrophotometer to obtain a spectrum.
- OP 514. McGann, Paul W. *The Long-Term Outlook for Petroleum*. Commodity Yearbook, 1960. Commodity Research Bureau, Inc., New York, pp. 33-38. Projects total energy consumption by fuel and by use through 1980 in United States; discusses supply of crude petroleum during that period.
- OP 515. McGee, J. P., N. H. Coates, and G. E. Fasching. Development of a Simulated High-Temperature Nuclear Loop. *Franklin Inst. Monograph*, No. 7, May 1960, pp. 236-251. To aid in the feasibility study of nuclear gasification, an induction-heated experimental loop has been constructed and operated to evaluate component performance and indicate areas in which additional development effort is needed. The loop has been operated at temperatures up to 2,500° F, using helium as the heat-transfer medium. Sustained operation has been accomplished between 2,100° and 2,300° F.
- OP 516. McGee, J. P., and Richard C. Corey. Bureau of Mines Coal-Fired Gas Turbine Research Project. *Combustion*, v. 31, No. 10, April 1960, pp. 67-72. Declares that the development of a coal-fired open-cycle gas turbine capable of operating 25,000 to 50,000 hours without excessive forced outages for reblading or other expensive repairs will depend largely on well-conceived and coordinated basic and applied research directed toward minimizing the erosive and corrosive effects of the mineral matter in coal. The principal research efforts must determine the optimum geometry of the blades and gas passages, the best design of the combustor and burners to achieve maximum combustion efficiency and optimum flame temperature, and permissible concentration and size of the particulate matter in the gases entering the turbine.
- OP 517. McGee, J. P., L. L. Hirst, and T. Reed Scollon. Coal-Fired Gas Turbine Research. *Eng. and Boiler House Rev.*, v. 78, No. 1, January 1963, pp. 18-20. Reviews the current work on the Bureau's coal-fired gas turbine, including development of turbine blades that are more resistant to ash erosion, improved equipment for preparing and feeding coal to the turbine, more efficient coal combustion, and better ash separation.
- OP 518. McGee, James P., and Sidney Katell. Nuclear Energy for Gasification of Coal. *Proc. Am. Gas Assoc. Operating Sec.*, 1959, pp. P-209 to P-212. Describes a conceptual design of a system to utilize nuclear heat for coal gasification and an apparatus which has been built to simulate the operation of a high-temperature nuclear system.
- OP 519. Melcher, Norwood B. Bureau of Mines Uses Natural Gas in an Experimental Blast Furnace. *Proc. Blast Furnace, Coke Oven and Raw Materials Comm.*, AIME, 1959, v. 18, pp. 69-74. Describes initial investigations on the use of natural gas as a fuel in the iron blast furnace. Gas was injected into the smelting zone through auxiliary tuyères. Achieved a record low coke rate and an increase of pig iron production with no increase in wind rate. Auxiliary tuyères are of simple construction, could be readily installed in large furnaces, and are also adaptable to the introduction of solid materials.
- OP 520. ———. Iron, Steel, and Ferroalloys Investigated at Bruceton. *J. Metals*, v. 12, No. 5, May 1960, pp. 406-409. Describes the Bureau of Mines Bruceton (Pa.) Pyrometallurgical Laboratory. This report indicates many important advances in iron and steel technology attained at the installation.
- OP 521. ———. Smelting Prereduced Pellets in an Experimental Blast Furnace. *Proc. Minnesota Sec.*, AIME, July 1963, pp. 45-51. Gives results of smelting tests of prereduced iron ore pellets that established that substantial decreases in coke rates and correspondingly higher production rates result from the use of prereduced pellets as compared with conventional unreduced pellets.
- OP 522. ———. Use of Electric Furnaces in Ferroalloy Research. *J. Electrochem. Soc.*, v. 103, No. 12, December 1956, pp. 691-695. Presents a brief review of the Bureau's electric-furnace equipment and typical examples of completed research projects. Processes are tried first in electric furnaces because other types of melting or smelting furnaces must be much larger and more expensive to operate and usually cannot be operated for short periods.
- OP 523. ———. Use of Lignite in Direct Iron Reduction. *Proc. 14th Dominion-Provincial Conf. on Coal*, Winnipeg, Manitoba, 1963, pp. 41-61. Describes a process for simultaneous hardening and reduction of iron-ore concentrates. Moist pelletized concentrate is heated in the presence of a solid reductant at 1,200° C for one-half hour or more. The resulting hardened pellets will contain approximately 80 percent total iron and 60 percent metallic iron.
- OP 524. Melcher, Norwood B., and D. W. Frommer. Flotation of Iron Ores. *Min. Cong. J.*, v. 49, No. 12, December 1963, pp. 29-33. Reviews principal iron flotation methods, present commercial practices, and outlook for future applications. Research by the Bureau on nonmagnetic taconites using anionic

- method for silica flotation is discussed in general terms.
- OP 525. Melcher, Norwood B., Warren M. Mahan, and Philip L. Woolf. Principles of Blast-Furnace Fuel Injection. Proc. British Iron and Steel Inst., Ann. Meeting, London, England, Nov. 29-30, 1961, pp. 47-52. Discusses principles of injection of natural gas, fuel oil, moisture, oxygen, and solid fuel in the tuyères of an experimental blast furnace. Thermal behaviors are related to blast temperature, coke rate, and productivity.
- OP 526. Melcher, Norwood B., and Miles B. Royer. Smelting Unfired Iron Ore Pellets in an Experimental Blast Furnace. Blast Furnace and Steel Plant, v. 48, No. 12, December 1960, pp. 1265-1270. Describes preliminary experiments on the practicability of adding raw pellets of taconite concentrate to blast furnace feeds. Reveals that raw pellets can be successfully smelted in an experimental furnace with no significant change in coke consumption and only a moderate increase in dust losses.
- OP 527. Mentser, Morris. Disc. of "Effect of Cooling Rate From Ms Temperature to Room Temperature on Magnetic Properties of 3.5 Percent Chromium Magnet Steel," by W. L. Hodapp and E. A. Loria. Trans. Am. Soc. Metals, v. 52, 1960, pp. 415-416.
- OP 528. Mentser, Morris, and Sabri Ergun. A Correlation Between Helium Density and Hydrogen Content of Coals (letter to editor). Fuel, v. 39, No. 6, November 1960, pp. 509-510.
- OP 529. Mentser, Morris, H. J. O'Donnell, and Sabri Ergun. Development of Three-Dimensional Crystallinity in Natural Graphitic Materials. Proc. 5th Carbon Conf. Pergamon Press, New York, N.Y., v. 2, 1963, pp. 493-497. Shows that high-rank anthracites and meta-anthracites give rise to three-dimensional (*hkl*) reflections of graphite, indicating that coals graphitize with metamorphism.
- OP 530. ———. X-Ray Scattering Intensities of Anthracite and Meta-Anthracite. Fuel, v. 41, March 1962, pp. 153-161. Gives X-ray diffraction data on six anthracites and four meta-anthracites.
- OP 531. Merrill, Charles W. A Government Viewpoint on Basic Mining Research. Min. Cong. J., v. 48, No. 12, December 1962, pp. 56-57, 63. Discusses the need for and benefit from basic research in mining. The Bureau's mining research is divided into two major areas: (1) Basic research is concerned with fundamental aspects of material and energy mechanisms in mining and the dynamic relationship between the two during the act of mining, and (2) applied research seeks to solve existing mining problems and improve present practices.
- OP 532. ———. The Metal, Mineral and Mineral Fuel Review for 1959. State Geol. J., v. 12, No. 1, April 1960, p. 89. The economic upturn in the United States in 1959 was accompanied by gains in many segments of the mineral industry. The value of United States mineral production rose 2 percent to \$17.1 billion, compared with \$16.5 billion in 1958 and a record \$18.1 billion in 1957. Nonmetal construction materials, crude petroleum, and natural gas contributed most of the increase in total value of minerals. The decline in value of metals output was due largely to strikes in the copper and iron ore industries.
- OP 533. ———. Mineral Obsolescence and Substitution. Min. Eng., v. 16, No. 9, September 1964, pp. 55-59. Discusses mineral commodities that have become obsolescent for particular uses, although general obsolescence among mineral commodities is rare because of the increasing reliance of the economy on minerals for energy and the raw materials of industry. Usually, however, the substitute for an obsolescent mineral commodity is another mineral. Presents causes and results of obsolescence and illustrates them by a number of examples of substitution in the past or now underway.
- OP 534. Merrill, Charles W. The Mineral Research Program of the Bureau of Mines. J. Metals, v. 13, No. 11, pp. 809-811. Describes the Bureau's method of planning, budgeting, and directing metallurgical and mining research.
- OP 535. ———. New Materials for National Strength. Min. Cong. J., v. 49, No. 9, September 1963, pp. 50-55. Discusses both new materials and ways in which old materials find new uses through scientific research, either by synthesis or by improved processing methods.
- OP 536. ———. Programming U.S. Bureau of Mines Multimillion-Dollar Minerals Research. Min. Eng., v. 13, No. 11, November 1961, pp. 1226-1227. Describes the methods by which the Bureau research is programed, both to help assure an adequate and continuing supply of minerals for the people of the United States and to promote the health and safety of workers in mineral industries in this country.
- OP 537. ———. The Role of Mineral Statistics in National Development. Document of United Nations Economic Commission for Asia and the Far East. I&NR/Sub. 3/61, 1960. Minerals are fundamental to all national economies, and their measurement through mineral statistics is essential to effective private and Government planning. Mineral statistics are complex and their collection and interpretation requires that the work be conducted by experts in the earth sciences. Bureau of Mines procedures and statistical publications are presented as patterns for national mineral statistical agencies.
- OP 538. ———. The Shifting Pattern of Mineral Demand. Min. Eng., v. 16, No. 2, February 1964, pp. 60-64. Discusses mineral demand in the past as compared with that expected in future years. Data on copper, aluminum, iron ore, sand and gravel, uranium, beryllium, and diamond are used as specific examples.
- OP 539. ———. Strategic Minerals. Min. Cong. J., v. 48, No. 2, February 1962, pp. 99-102. Summarizes the 1961 demand-supply situation for selected strategic minerals.
- OP 540. ———. United States Mining Industry — 1956. Canadian Min. J., v. 78, No. 2, Feb. 1957, pp. 173-175. Discusses 1956 production of selected metals, nonmetals for construction, other nonmetals, and mineral fuels, including some information on mineral imports.
- OP 541. Merrill, Charles W., and James W. Pennington. The Magnitude and Significance of Flotation in the Mineral Industries of the United States. Ch. 4 in Froth Flotation, 50th Anniversary volume, AIME, New York, N.Y., 1962, pp. 55-90. Reviews the effect of froth flotation on the mineral industry of the United States; in 1960, 198 million tons of material was treated to recover 20 million tons of concentrates containing approximately \$1 billion in recoverable products. Gives data on materials recovered and types of flotation reagents used.
- OP 542. Merrill, Charles W., and Staff, Bureau of Mines. Metal, Mineral and Mineral Fuel Review for 1960. State Geol. J., 13, No. 1, 1961, pp. 86-123. Reviews briefly the output and value of minerals produced in the United States in 1960.
- OP 543. Merrill, Robert H. In Situ Determination of Stress by Relief Techniques. In State of Stress in the Earth's Crust, ed. by W. R. Judd. American Elsevier Publishing Co., New York, 1964, pp. 343-378. Describes relief techniques used by investigators to determine the stresses at various depths from the edge of underground openings. Evaluates

- these techniques and the associated instrumentation, assumptions, and considerations that must be accepted. Two techniques, borehole-deformation and flatjack methods, were used concurrently to test some of the assumed versus the in situ conditions. Results indicate that these methods can give satisfactory results, even though some of the assumptions may not be correct.
- OP 544. Miller, John E., Lowell Stroud, and L. Warren Brandt. Compressibility of Helium-Nitrogen Mixtures. *J. Chem. and Eng. Data*, v. 5, No. 1, January 1960, pp. 6-9. Provides compressibility factors for the helium-nitrogen system that were obtained at 70° F at pressures to 4,000 psia.
- OP 545. Miller, John L., and Robert C. Johnson. The Synthesis and Properties of a Fluormica, Intermediate Between Fluortaeniolite and Fluorhectorite. *Am. Mineral.*, v. 47, September-October 1962, pp. 1049-1054. Gives chemical, physical, optical, and X-ray data for a monoclinic synthetic fluor-mineral which conforms to the hectorite formula but which has the physical characteristics of fluor-micas.
- OP 546. Miller, John S., and J. L. Eakin. Neutron Logs Prove Results of Water-Block Treatment. *Oil and Gas J.*, v. 63, No. 5, Feb. 1, 1965, pp. 81-83. Identification of liquid-saturated gas zones and identification of posttreatment changes in liquid saturation are possible through neutron logging. A field test showed a 52-percent increase in gas production after water-block treatment, and the neutron log indicated a 50-percent drop in the gas zone's water saturation.
- OP 547. Miller, William C. Reduction of Noise at Percussion Drills. *Trans. 50th Nat. Safety Cong., Mining*, v. 16, 1963, pp. 41-44. Describes methods of measuring noise generated by pneumatic rock drills with and without any attached muffling or vibration damping device.
- OP 548. Mitchell, Donald W. Fighting Mine Fires. *Trans. AIME, Mining*, v. 223, June 1962, pp. 218-224. Discusses results of investigations of extinguishing agents and methods for controlling underground fires and suggests ways of reducing the fire hazards.
- OP 549. ———. Rigid Urethane Foam in Mining Applications. *Coal Age*, v. 67, No. 8, August 1962, pp. 64-65, 69. Discusses properties, applications, and costs of rigid foam used in construction of stoppings and sealing of mine roof and ribs.
- OP 550. Mitchell, Donald W., and Edwin M. Murphy. Flammability of Rigid Urethane Foam. *Proc. Foamed Plastic Conf., U.S. Army Natick Laboratories*, Boston, Mass., Apr. 22-23, 1963, Dept. of Commerce, PB 181576, pp. 235-248. Summarizes Bureau of Mines research on rigid urethane foam for use in mines and tunnels.
- OP 551. Mitchell, Donald W., Edwin M. Murphy, John Nagy, and Florence P. Christofel. Practical Aspects of Controlling an Underground Fire on a Mining Machine. *Pres. at 11th Internat. Conf. of Directors of Safety in Mines Res., Warsaw, Poland*, Oct. 16-24, 1961, 27 pp. (preprint). (Pub. as RI 5846.) Evaluates effectiveness of a few extinguishing agents and techniques for controlling a fire on a simulated mining machine.
- OP 552. Mitchell, Donald W., and John Nagy. Water as an Inert for Neutralizing the Coal Dust Explosion Hazard. *Proc. Coal Min. Inst. America*, 1961, 75th Annual Rept. 1962, pp. 43-58. Summarizes current knowledge on the use of water as an inert for American coal mines, with particular regard to its use as a supplement and substitute for generalized rock dusting.
- OP 553. Mitchell, Donald W., John Nagy, Edward M. Kawenski, Edwin M. Murphy, and R. Ward Stahl. The Explosion Hazard of Float Dust Deposits. *Pres. at 11th Internat. Conf. of Directors of Safety in Mines Res., Warsaw, Poland*, Oct. 16-24, 1961, 11 pp. (preprint). Summarizes work done by the Bureau on the explosion hazard of bituminous coal float dust deposits and concludes that for the light deposits found in some American coal mines 80 percent incombustible content maintained in the rib-roof and floor dusts will provide protection against the hazard of explosion, whether the dusts are layered or intimately mixed.
- OP 554. Mongan, Charles E., Jr., and Thomas C. Miller. Exploration of Coal-Mine Roof Strata Through the Use of Sonic Techniques. *Coal Age*, v. 65, No. 12, December 1960, pp. 114-119. Both theory and actual experiments in the Bureau of Mines Experimental Mine indicate the feasibility of exploring coal-mine roof strata through the use of sonic techniques. The term "sonic techniques" refers to the system of generating sonic (sound) waves, shaping and directing them as a beam, introducing them into the mine roof strata, and through observing the reflected waves, discovering separations and other inconsistencies within the strata traversed by them.
- OP 555. ———. Sonar Exploration of Coal-Mine Roof Strata. *Min. Cong. J.*, v. 46, No. 10, October 1960, pp. 35-39. (For summary see OP 554.)
- OP 556. ———. Use of Sonic Techniques in Exploring Coal-Mine Roof Strata. *Coal and Base Minerals of Southern Africa*, v. 8, No. 9, November 1960, pp. 32-40; abs. in *Battelle Tech. Rev.*, v. 9, No. 10, Paper 11436, October 1960, p. 612a; *Trans. Nat. Safety Cong., Coal Min.*, v. 7, 1960, pp. 24-28; *Internat. Symp. Min. Res.*, February 1961, v. 2, 1962, pp. 669-679. (For summary see OP 554.)
- OP 557. Montoya, J. W., and G. S. Baur. Nickeliferous Serpentine, Chlorites, and Related Minerals Found in Two Lateritic Ores. *Am. Mineral.*, v. 48, Nos. 11-12, November-December 1963, pp. 1227-1238. Gives data on nickel-bearing serpentines, chlorites, and related mineral species found in laterite ores from California and New Caledonia. The minerals were identified by detailed mineralogical, optical, chemical, X-ray diffraction, differential thermal, and infrared spectra analyses.
- OP 558. Moore, A. S. Sampling Dust in the Bureau of Mines Coal-Fired Gas Turbine. *Combustion*, v. 35, No. 4, October 1963, pp. 2-4. Describes some of the special equipment and methods the Bureau plans to use for sampling dust in the gases driving the coal-fired gas turbine.
- OP 559. Morgan, R. E., and J. W. Eckerd. Plans and Progress of Anthracite Research at the Bureau of Mines, U.S. Department of the Interior. *Proc. Anthracite Conf.*, October 18-19, 1956, Pennsylvania State Univ., *Miner. Ind. Exp. Sta. Bull.* 70, June 1957, pp. 45-48. Discusses current and future plans of the Bureau of Mines for research on Pennsylvania anthracite to find ways to satisfy an expanding market for fine coal while creating new and profitable uses for the larger sizes.
- OP 560. Morrice, E. and R. G. Knickerhocker. Rare-Earth Electrolytic Metals. *Ch. in Rare Earths*, ed. by F. H. Spedding and A. H. Daane, under auspices of Am. Soc. for Metals in cooperation with Office of Tech. Information, U.S. Atomic Energy Commission. John Wiley & Sons, Inc., New York, 1961, pp. 126-144. A historical review of experiments in electrolytic preparation of the rare-earth and yttrium metals from fused salts is presented. Most efforts at room temperature deposition from aqueous and nonaqueous solutions proved unsuccessful. Commercial misch metal electro-winning practices are described. Analyses and uses of misch metals, didymium, cerium, and lanthanum metals are given.

- Recent laboratory developments by the Bureau of Mines in the electrowinning of 99.9 percent cerium metal from ceric dissolved in a fluoride bath are reported. Analysis of the metal obtained is included with cell design and operational data.
- OP 561. Morris, J. C., W. J. Lanum, R. V. Helm, W. E. Haines, G. L. Cook, and John S. Ball. Purification and Properties of Ten Organic Sulfur Compounds. *J. Chem. and Eng. Data.*, v. 5, No. 1, January 1960, pp. 112-116. Presents the third series of compounds that have been prepared by American Petroleum Institute Research Project 48A. This project, cooperatively sponsored by the Bureau of Mines and API, was established to supply fundamental data concerning sulfur compounds that occur in petroleum. This list includes seven thiols and three sulfides.
- OP 562. Morrison, Warren E. *World Petroleum Review*, 1960. U.S. Contributions to 2d Symposium on Development of Petroleum Resources of Asia and the Far East, ECAFFE, Teheran, India, September 1962. Gives statistics covering world petroleum demand, production, refining, transportation and distribution, and exploration in 1960, plus a few salient statistics for the immediately preceding years.
- OP 563. Mudra, Paul J., and Rudolph Sporic. Encapsulated Hydraulic Cells for Measuring Pressure Changes in Coal. *Trans. AIME, Mining*, v. 229, December 1963, pp. 396-401. Describes the design and construction of encapsulated hydraulic cells for measuring pressure changes in coal in situ. Preliminary results from laboratory and field feasibility tests indicate that the cells respond favorably to changes in pressures associated with a coal-mining environment. The ultimate objective is to use these cells to obtain engineering information relating to coal bump or coal outburst phenomena.
- OP 564. Mullins, P. V. Helium — Its Increased Use and Importance. *Gas*, v. 37, No. 1, January 1961, pp. 57-62. Indicates that a broad helium conservation program involving recovery of helium from natural gas for storage underground and subsequent use is needed to guarantee the Nation an adequate supply of helium in the future. Article covers consumers, production process, shipment, technical and cost data, and resources and conservation.
- OP 565. Murdock, Thomas G. Opportunities for Regional Organization in Mineral Resources Development. U.S. Papers Prepared for the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas. *Natural Resources: Minerals and Mining*, v. 2, 1963, pp. 53-69. Experience indicates that similar local conditions and objectives affecting mineral resource utilization within less developed countries of a given geographical area are often such that regional mineral organization can be effectively utilized. Use of regional organizations should be encouraged and expanded; definite programs of active cooperation between countries of a region can accomplish far more than can individual national effort.
- OP 566. Murdock, Thomas G., and L. Nahai. Iran — A Growing Source of Chromite. *World Min.*, v. 13, No. 2, February 1960, pp. 35-37. Reviews chromite mining in Iran; describes principal deposits and mines and factors influencing economics of mining.
- OP 567. Murphy, Edward J. Comparison of Methods for Detecting and Analyzing Fumes From Explosives. Pres. at 11 Internat. Conf. of Directors of Safety in Mines Res., Warsaw, Poland, Oct. 16-24, 1961. 13 pp. (Pub. as RI 5883). Presents a comparative study of several analytical methods for determining carbon monoxide and nitrogen oxides in toxic gases produced by detonation of explosives.
- OP 568. Murphy, Walter I. R. In-Situ Shale-Oil Production Problems. *Proc. 2d Plowshare Symposium*, May 13-15, 1959, San Francisco, Calif., Part IV, Water Resources, Mining, Chemicals, Petroleum, UCRL-5678, February 1960, pp. 80-101. The proposed Plowshare experiment in oil shale consists of two parts: (1) The nuclear phase, in which an atomic device would be detonated in the Green River Formation; and (2) the oil-recovery phase, in which a study would be made of methods for producing oil by in situ combustion of shale broken in the nuclear phase. Discusses some of the problems that may be involved in the second phase and suggests some methods that may be studied for operating an in situ project in oil shale.
- OP 569. Myers, J. W., J. J. Pfeiffer, and A. A. Orning. Using Coal Refuse in Building Materials. *Trans. Soc. Min. Eng.*, v. 223, March 1962, pp. 53-62. Describes method used to process washery refuse for use as a building material aggregate.
- OP 570. Nabors, W. M., C. N. Rosenecker, R. W. Cargill and Jack Smith. Feeding Coal to a Gas Turbine—Operation of Star Wheel Coal-Feeding System. *Combustion*, v. 35, No. 7, January 1964, pp. 41-44. Describes the operation of a star wheel coal-feeding system developed by the Bureau of Mines and adapted for use with the coal-fired gas turbine.
- OP 571. Nagy, John. Controlling Mine Fires. *Newsletter, Min. Sec. Nat. Safety Council*, February 1960, p. 4. Describes experiments conducted by Bureau of Mines with the high-expansion foam plug as a means of controlling fires.
- OP 572. Nagy, John, and Donald W. Mitchell. Coal-Dust Explosions . . . Interpreting the Evidence. *Coal Age*, v. 69, No. 11, November 1964, pp. 102-107. Presents information on how evidence left by a coal-dust explosion can assist in the difficult task of interpreting observations made after an explosion in an operating coal mine when detailed data are collected to establish the cause and factors affecting ignition and propagation.
- OP 573. ———. Gas Explosion Phenomena. *Mechanization*, v. 27, No. 9, September 1963, pp. 39-42. Summarizes data collected at the Experimental Coal Mine involving the ease of ignition and the pressure and flame velocity developed when a body of gas is ignited.
- OP 574. ———. Research on Float Dust Hazards. *Trans. Nat. Safety Cong.*, v. 7, Coal Mining, 1961, pp. 33-36. Describes research on the explosion hazards of float-coal dust deposits.
- OP 575. Nagy, John, Edwin M. Murphy, and Donald W. Mitchell. Controlling Fires in Mines With High-Expansion Foam. *Min. Eng.*, v. 12, September 1960, pp. 993-996. Discusses experiments conducted by the Bureau of Mines to determine the potential value of the foam-plug method for fighting fires in coal or metal mines. Indicates that an incipient fire should be attacked promptly with water, rock dust, or other approved and readily availability extinguishing agents. However, foam may be effective where heat, roof falls, and smoke prevents a direct approach to the fire.
- OP 576. ———. High-Expansion Foam: Use and Method of Application for Bringing Mine Fires Under Control. *Proc. Coal Min. Inst. America*, Pittsburgh, Pa., Dec. 3-4, 1959, pp. 78-91. Describes experiments in controlling underground fires of coal, oil, and wood by using high-expansion foam at attack distances ranging from 155 to 1,010 feet at the Bureau's Experimental Coal Mine. The foam is formed by spraying a dilute solution of foaming agent on a net; air passing through the continuously

- wetted net forms bubbles and produces a honeycomb of foam that fills the passageway. The lightweight plug of foam can be moved, by the pressure of ventilating air or air from a fan incorporated in the foam generating device, through the mine passageways to the fire.
- OP 577. Nahai, L. Brief Review of Some Direct Reduction Methods and Their Evaluation in Relation to Blast Furnace and Electric Furnace Smelting of Iron Ore. Symposium on Iron Ore, Isfahan, Iran, Oct. 2-5, 1963. Office of U.S. Economic Coordinator for CENTO Affairs, pp. 245-276. Discusses reasons for interest in direct-reduction methods, principal methods of direct reduction, types of reduction with gases, recent developments in the blast furnace, and a consideration of electric smelting.
- OP 578. ———. India Expands Ferromanganese Industry. *Eng. and Min. J.*, v. 160, No. 10, October 1959, pp. 112-113, 210. Reviews ferromanganese production and trade in India; describes new plants and examines raw-material situation.
- OP 579. Nahai, L., and K. P. Wang. Basic Concepts of Mineral Trade. Document of United Nations Economic Commission for Asia and the Far East (ECAFE), No. I & NR/Sub. 3/59, April 20, 1960. Examines problems of mineral trade of ECAFE countries and suggests measures which governments of the region, industry, and ECAFE might consider to assure a steady market for mineral products of the countries of the region.
- OP 580. Nasiatka, Thomas M. Hydraulic Pitch Mining — The Roslyn Project. *Coal Age*, v. 67, No. 6, June 1962, pp. 74-76. Describes an experiment in hydraulic mining in the Roslyn No. 5 coalbed, in Washington, which dips approximately 33°. Using one-man monitor and pressures of 3,500 to 4,000 psi, hydraulic pitch mining has increased productivity 50 percent over conventional methods. Better than 17.6 tons per man-shift is achieved with late nozzle designs.
- OP 581. Newman, L. L. The Gas Industry in the U.S.S.R. *Gas*, v. 36, No. 11, November 1960, pp. 59-65. Presents a brief history of the Russian gas industry. Emphasizes Soviet plans to expand the industry.
- OP 582. Nicholls, Harry R. Coupling Explosive Energy to Rock. *Geophysics*, v. 27, No. 3, June 1962, pp. 305-316. Two types of explosive-to-rock coupling were investigated, geometrical and impedance. Strain amplitudes and strain energy in the rock also are shown to be dependent on the properties of the explosive and the medium surrounding the shot-hole. Deviations from acoustic theory are noted.
- OP 583. ———. Disc. of "Recent Techniques for Determination of In Situ Elastic Properties and Measurement of Motion Amplification in Layered Media," by R. J. Swain. *Geophysics*, v. 28, No. 1, February 1963, p. 112.
- OP 584. Nicholls, Harry R., and Wilbur I. Duvall. Effect of Characteristic Impedance on Explosion-Generated Strain Pulses in Rock. *Rock Mechanics, Proc. 5th Symp.*, 1962, ed. by C. Fairhurst. Pergamon Press, New York, 1963, pp. 331-346. Gives data on the effect of the ratio of characteristic impedance on explosion-generated strain amplitudes and strain energies that were investigated theoretically and experimentally. Although the theory postulated is for plane waves, observed data agree with predictions based on shock wave theory. The effect of characteristic impedance was shown to be much greater than acoustic theory predictions.
- OP 585. Niedermeier, William, Ellis E. Creitz, and Howard L. Holley. Trace Metal Composition of Synovial Fluid From Patients With Rheumatoid Arthritis. *Arthritis and Rheumatism*, v. 5, No. 5, October 1962, pp. 439-444; abs. in *Clinical Res.*, v. 10, 1962, p. 53. Gives data on emission spectrographic analysis of synovial fluid and blood serum from patients with rheumatoid arthritis and from subjects free of symptoms of connective tissue disease. Blood serum of arthritic patients contained increased concentrations of copper and rubidium and decreased concentrations of iron, aluminum, and chromium.
- OP 586. Obert, Leonard. In Situ Determination of Stress in Rock. *Min. Eng.*, v. 14 No. 8, August 1962, pp. 51-58. Describes underground research that led to development of a method for determining the absolute magnitude and direction of stress in rock. Work also shows that by making measurements at a distance from the surface of underground openings, the magnitude and direction of the stress field can be ascertained.
- OP 587. ———. Recent Development of Bureau of Mines Investigation of Vibrations from Quarry Blasting. *Crushed Stone J.*, v. 36, No. 1, March 1961, pp. 13-18. Discusses the Bureau of Mines-industry program for studying the seismic effects from quarry blasting in order to guide quarry operators and the various States that are preparing blasting codes. This report evaluates the previous damage criteria studies made by the Bureau of Mines and other investigators; commercially available seismographs of the type used for measuring quarry vibrations; design criteria for portable seismographs; procedures for mounting gages so as to eliminate "ringing"; the relative seismic effects from instantaneous, millisecond, and standard delay shooting; and the accumulation of data for the determination of propagation law.
- OP 588. ———. Seismic Effects From Blasting. *Crushed Stone J.*, v. 35, No. 1, March 1960, pp. 24-27. Presents summary of work accomplished on the vibration problems during the preceding year.
- OP 589. Ode, W. H. *Coal Analysis and Mineral Matter*. Ch. 5 in *Chemistry of Coal Utilization: Supplementary Volume*, ed. by H. H. Lowry. John Wiley & Sons, Inc., New York, 1963, pp. 202-231. Reviews methods for analysis and testing of coal and coke and of the occurrence of major and minor elements in the mineral matter.
- OP 590. Ode, W. H., and Theodore Christos. Solid and Gaseous Fuels. *Anal. Chem.*, v. 33, No. 5, April 1961, pp. 61R-69R. Reviews methods of sampling, analyzing, and testing solid and gaseous fuels during a 2-year period ending in September 1960. The solid fuels section covers sampling, proximate analysis, calorific value, inorganic constituents in coal and coal ash, laboratory coking tests, and standard methods; the gaseous fuels section covers sampling, chemical methods of analysis, calorific value, and standard methods.
- OP 591. Oitto, Richard H. Use of Resin To Stabilize Fractured Ground. *Trans. Nat. Safety Cong.*, v. 16, 1963, pp. 54-57. Describes the experimental application of a polyester-type resin and steel reinforcing bars to stabilize fractured ground in a metal mine. Preliminary test results indicate that resin-rebar supports is effective in repairing certain types of fractured ground where conventional support methods are ineffective or too costly.
- OP 592. Okuno, I., J. C. Morris, and W. E. Haines. Microdetermination of Sulfur by Hydrogenation and Gas Chromatography. *Anal. Chem.*, v. 34, October 1962, pp. 1427-1431. Describes a method for the determination of sulfur in small samples. It consists of hydrogenating the sample to give hydrogen sulfide and determining the hydrogen sulfide by gas-liquid chromatography.
- OP 593. Oppelt, W. H., and G. H. Gronhovd. Design and Preliminary Operation of a Slagging,

- Fixed-Bed Pressure Gasification Pilot Plant. *Trans. AIME, Mining*, v. 220, 1961, pp. 154-160. Complete gasification to produce synthesis gas for manufacture of synthetic chemicals and fuels offers possibilities for utilization of the vast lignite fuel deposits in the United States. The design of a slagging, fixed-bed, pressure gasification pilot plant is described. Results are presented for initial operation of the plant at moderate pressure and using low-temperature char as fuel.
- OP 594. Oppelt, W. H., and W. R. Kube. Bench-Scale Experiments on Low-Temperature Carbonization of Lignite and Subbituminous Coal at Elevated Pressure. *Trans. AIME, Mining*, v. 220, 1961, pp. 126-133. Five low-rank coals, including two lignites, a steam-dried lignite, and two subbituminous coals, were carbonized at 940° F in a bench-scale carbonizer with a nitrogen and hydrogen atmosphere, or both, using pressures from atmospheric to 1,000 psig. Coking characteristics were observed, and yields, composition, and distribution of products from thermal degradation were determined.
- OP 595. Orning, A. A. Disc. of "Corrosion of Superheaters and Reheaters of Pulverized-Coal-Fired Boilers," by W. Nelson and C. Cain, Jr. *Trans. ASME*, v. 82, ser. A, 1960, p. 202.
- OP 596. ———. Disc. of "The Influence of Coal Rank on the Burning Times of Single Captive Particles," by R. H. Essenhigh. *Trans. ASME, series A, J. Eng. Power*, v. 85, No. 3, 1963, p. 189.
- OP 597. Ostrowski, E. J., G. Kesler, and N. B. Melcher. Blast Furnace Enrichment Investigations. *J. Metals*, vol. 132, No. 1, January 1961, pp. 25-30. Reports results of investigation conducted in the Bureau of Mines experimental blast furnace at Bruceton, Pa. Describes the effects of moisture, natural gas, and oxygen injection. Each of these additions required additional blast temperature, and the use of this higher blast temperature resulted in a decreased coke rate and an increased metal production rate. Additional coke savings were realized when the carbon from the natural gas replaced carbon from the coke.
- OP 598. Overbey, William K., Jr. Appalachian Region Oilfield Region Oilfield Reservoir Investigations, Dewdrop, Bradford Third, Lewis Run, and Sartwell Sands, Sartwell Field, Annin Township, McKean County, Pa. *Producers Monthly*, v. 28, No. 11, November 1964, pp. 24-27. Gives production data and core analysis results for the Dewdrop, Bradford Third, and Sartwell sands in the Sartwell oilfield. Discusses development history of the field, geology, lithology, coring, geophysical logging operations, and well completion.
- OP 599. Palowitch, E. R. Coal Preparation, 1959. *Min. Cong. J.*, v. 46, No. 2, February 1960, pp. 54-56. Briefly summarizes progress in the technology of coal preparation in the United States; includes trends, innovations, and practices in the various unit operations included under coal preparation.
- OP 600. ———. Hydraulic Coal Mining in the United States. *Proc. 2d. Internat. Conf. on Rapid Advance in Coal Mining*, Sept. 30-Oct. 5, 1963, Institut de l'Industrie Charbonnière, Liège, Belgium, 1964, E5, pp. 361-367. Describes hydraulic mining methods in the United States as exemplified by Bureau of Mines experimental work in the comparatively flat-lying Pittsburgh coalbed in Pennsylvania and the steeply pitching Roslyn No. 5 coalbed in Washington.
- OP 601. Palowitch, E. R., and A. W. Deurbrouck. New Improvements Shown in Coal Preparation. *Min. Eng.*, v. 16, No. 2, February 1964, pp. 89-90. Summarizes advances made in the field of coal preparation during 1963. New equipment, trends in technology, and latest practices were given for raw-coal treatment, washing, dewatering and drying, and plant control.
- OP 602. Palowitch, E. R., and W. T. Malenka. Hydraulic Mining Research—A Progress Report. *Min. Cong. J.*, v. 50, No. 9, September 1964, pp. 66-73. Describes laboratory studies of the effect of nozzle design and water volume and pressure on the jet performance. Penetration and cutting-rate tests were made on bituminous and anthracite coals to determine the effect of total force, kinetic energy, proximity of the nozzle to the coal, and jetstream traverse speed on the extraction rate of the coal. Field tests were also made in the flatlying Pittsburgh bed, in a 13-foot-thick pitching anthracite coalbed, in the pitching Roslyn No. 5 coalbed, and in the Carbondale, Colo., pitching "A" coalbed.
- OP 603. Panek, Louis A. Design for Bolting Stratified Roof. *Trans. SME*, v. 229, June 1964, pp. 113-119. Brings together results that are pertinent to the design of a bolting system for reinforcing horizontally stratified mine roof with vertical bolts. The design approach is based on the use of bolts to decrease the maximum bending stress within an arbitrary sequence of roof strata in which the only loads are the weights of the individual beds.
- OP 603A. ———. Design Rationale for Bolting Stratified Mine Roof. *Proc. 3d Internat. Min. Cong., Salzburg, Austria*, 1963. Discussion of mechanics of behavior of bolted stratified roof and quantitative evaluation of the reinforcing effect achieved by bolting, based on Bureau of Mines research results.
- OP 604. ———. Measurement of Rock Stresses. *Proc. First Canadian Rock Mechanics Symp. Mines Branch, Dept. of Mines and Tech. Surv. Ottawa, Canada*, 1963, pp. 53-68. Discusses the primary characteristics of the major classes of borehole devices for measuring changes of stress and strain in mine rock. Emphasis is given to the principle that a determination of the response of a device under realistic conditions is a prerequisite for the valid interpretation of gage and instrument readings in terms of actual rock stresses.
- OP 605. ———. Measurement of Rock Pressure With a Hydraulic Cell. *Trans. AIME*, v. 220, 1961, pp. 287-290; *Min. Eng.*, v. 13, No. 3, March 1961, pp. 282-285. Describes an apparatus and technique for direct measurement of existing pressure and change of pressure in mine rock. This relatively simple monitor is reliable for months after being installed. It is used to determine shift of ground pressure created by different sequences of mining, to ascertain the cause of rock failures, and to evaluate the need for artificial support. The technique has been employed to measure pressures in limestone, greywacke, concrete, diabase, and soft iron ore.
- OP 606. ———. Methods for Determining Rock Pressure. *Proc. 4th Symp. on Rock Mechanics, Pennsylvania State Univ.*, 1961, pp. 181-184. Discusses general principles underlying the design and application of sensing devices to make measurements in mines or tunnels, which measurements are for the intended purpose of determining the existing ground stress or the change of ground stress. The several classes of instruments are illustrated by devices that are used by the Bureau.
- OP 607. ———. Use of Vertical Roof Bolts To Reinforce an Arbitrary Sequence of Beds. *Proc. Internat. Symp. on Min. Res., Univ. of Missouri*, v. 2, 1961, pp. 499-508. Discusses certain aspects of the "suspension" and "friction" effects in reinforcing horizontally bedded mine roof by bolting. Major emphasis was on the parametric function denoted the "relative flexural rigidity," which is the main factor underlying the suspension effect.

- OP 608. Panson, A. G., and L. M. Adams. Complete Gas Chromatographic Analysis of Hydrogen in Fixed Gases and Hydrocarbons Using One Detector and Helium as Gas Carrier. *J. Gas Chromatography*, v. 2, No. 5, May 1964, pp. 164-166. Describes a rapid, simple, and accurate method for gas chromatographic analysis of hydrogen in complex gaseous mixtures using one detector and one carrier gas. Method circumvents the difficulties often encountered in determining hydrogen in complex mixtures and can be carried out with standard apparatus.
- OP 609. Pantages, Peter, and Carl Rosa. Quick Disconnect Fittings for Gas Chromatographs. *Hydrocarbon Processing and Petrol. Refiner*, v. 42, No. 4, April 1963, pp. 192, 194. Describes a modified compression fitting that has been developed for use in gas chromatography. It is hand tightened which prolongs thread life, has an effective O-ring seal, and withstands moderate pressure and temperature.
- OP 610. Parisi, C. William, and Donald W. Mitchell. Application of Rigid Foam in the Coal Mining Industry. *Mechanization*, v. 27, No. 3, March 1963, pp. 31-33. Discusses the potential of rigid foams for increasing mine safety and reducing service costs in coal mining. In comparison with current methods for sealing and protecting mine surfaces, rigid foam requires less labor and material handling for its application and makes a stronger bond with unprepared surfaces.
- OP 611. Park, R., and H. N. Dunning. Stable Carbon Isotope Studies of Crude Oils and Their Porphyrin Aggregates. *Geochimica et Cosmo-Chimica Acta*, v. 22, 1961, pp. 99-105. Past research has suggested that petroleum porphyrins arising from bacterial metabolism of the source lipid or petroleum hydrocarbon should have a C^{13}/C^{12} ratio similar to that of the petroleum as a whole. Studies have also indicated that porphyrins arising directly from porphyrins synthesized in the organic source material or from bacterial degradation of the carbohydrate fractions of the source material should have a C^{13}/C^{12} ratio larger than the petroleum hydrocarbon by about 5 per mil. To test these predictions, several petroleum and high purified porphyrin aggregates separated from them were analyzed for their C^{13}/C^{12} ratio.
- OP 612. Parks, Bryan C. Origin, Petrography, and Classification of Coal. Ch. 1 in *Chemistry of Coal Utilization: Supplementary Volume*, ed. by H. H. Lowry. John Wiley & Sons, Inc., New York, 1963, pp. 1-34. Discusses current theories of the origin of coal; developments in the field of coal petrography, including studies of fundamental properties and petrographic components; and international classification of hard coal and brown coal.
- OP 613. ———. The Role of Microconstituents in the Free-Swelling of a High Bituminous Coal, Chilton Bed, Logan County. *Trans. Crystal Cliffs, Nova Scotia, Coal Conf.*, 1962, pp. 195-210. Describes methods and reviews the results of an investigation on the relation between microscopic composition and thermal decomposition of a petrographically heterogeneous high-volatile A bituminous coal from Logan County, W. Va.
- OP 614. Parsons, Edward W. Development and Testing of an Explosive-Anchored Rockbolt. *Min. Cong. J.*, v. 50, No. 6, June 1964, pp. 28-32. Describes a rockbolt anchored by a contained explosive charge, developed by the Bureau of Mines, and tested in nine mines, which will produce better anchorage than conventional rockbolts, especially in soft rock formations.
- OP 615. Pearce, S. J. Do's and Don't's in Using Gas Masks. *Safety Maintenance*, v. 121, No. 3, March 1961, pp. 10-14. Discusses the role of the gas mask in industry. Covers limitations and advantages, performance requirement for Bureau of Mines approval, areas of use, factors in gas-mask use, and common fallacies about the gas mask.
- OP 616. Pearce, S. J. Gas Masks for Industrial Safety. *Modern Sanitation and Building Maintenance*, v. 12, No. 12, December 1960, pp. 11, 39-40. Discusses limitations and advantages of the gas mask.
- OP 617. Perlee, Henry E., Agnes C. Imhof, and Michael G. Zabetakis. Flammability Characteristics of Hydrazine Fuels in Nitrogen Tetroxide Atmospheres. *J. Chem. and Eng. Data*, v. 7, No. 3, July 1962, pp. 377-379. Gives data on the limits of flammability of hydrazine, monomethyl hydrazine, unsymmetrical dimethylhydrazine, and blends containing these liquids in air at various temperatures and pressures. Research was done in an effort to determine the extent of the fire and explosion hazards associated with a flammable liquid in potential accident situations.
- OP 618. Perlee, Henry E., Israel Liebman, and Michael G. Zabetakis. Formation et inflammation de mélanges méthane-air stratifiés [Formation and Flammability of Stratified Methane-Air Mixtures]. *Rev. Ind. Minér.*, v. 46, No. 8, August 1964, pp. 1-5. Summarizes studies of the formation and flammability of stratified methane-air mixtures, in both still and moving atmospheres.
- OP 619. Perry, Harry. Coal Research in the United States. *Proc. 15th Dominion-Provincial Conference on Coal*, Halifax, Nova Scotia, September 1963, pp. 35-43. Discusses some of the major coal research projects under way in the United States. These include removal of methane from coal in advance of mining; possible adaptation of longwall mining methods to U.S. conditions; development of hydraulic mining methods; reduction of acid mine water from both active and abandoned mines; study of the basic properties of coal in place; improvement in coal-preparation equipment; removal of sulfur from coal; safe storage methods for lignite; and developing new uses for coal.
- OP 620. ———. Degasification of Coalbeds in Advance of Mining. *Trans. 47th Nat. Safety Cong.*, v. 7, 1960, pp. 21-34. Describes various methods of extracting methane from coal-bearing formations used in the past and as now practiced. Gives details of methane drainage projects in Europe, Japan, and the United States. Outlines research needed on methane's relation to the physical properties of coal and associated strata and on the development of techniques and equipment for the removal and utilization of methane.
- OP 621. ———. Developments in Coal Utilization Technology (With Emphasis on United States Practice). *Symp. on Coal*, Zonguldak, Turkey, December 1961, Office of U.S. Economic Coordinator for CENTO Affairs, 1962, pp. 261-278. Discusses trends in coal technology that may lead to a higher consumption of coal in the future, including wider use for coal for electric power production, improvements in carbonizing techniques, greater production of synthesis gas and hydrogen, and development of economic processes for producing liquid fuels.
- OP 622. ———. Disc. of "Air Pollution From Power Plants and its Control," by T. T. Frankenburg. *Proc. National Conference on Air Pollution*, Dec. 10-12, 1962, U.S. Department of Health, Education, and Welfare, Public Health Service, Pub. 1022, pp. 101-102; *Combustion*, v. 34, No. 8, February 1963, pp. 31-33.
- OP 623. ———. Make High-Btu Pipe Line Gas From Coal. *Hydrocarbon Processing and Petroleum Ref.*, v. 41, No. 7, July 1962, pp. 89-94. Reviews the processes by which pipeline gas could be economically produced from coal if it were required.

- Significant advances have been made in the technology of making synthesis gas and hydrogen, and several different continuous processes with large throughputs per unit volume of reactor have been developed.
- OP 624. Perry, Harry. Pipeline Transportation of Coal and Its Potentials for the Metallurgical Industry. Proc. 22d Ironmaking Conf., v. 22, 1963, pp. 547-553. At the present time, coal-slurry pipelines apparently do not have potential applications for metallurgical applications except in special cases. On the other hand, should a coal-slurry pipeline designed for other purposes pass close to a metallurgical plant, it may be possible for a part of the coal to be sold to the plant for general use or for supplemental fuel injection into a blast furnace to replace coke. Coarse coal transportation in pipelines, however, may have some application in locations where the coking coal source and the coke plant are close together and where other transportation costs are relatively high.
- OP 625. ———. Remarks on Hydraulic Mining of Coal. Symp. on Coal, Zonguldak, Turkey, December 1961, Office of U.S. Economic Coordinator for CENTO Affairs, 1962, pp. 208-209. Describes briefly the Bureau's experimental work in hydraulic mining of coal in an abandoned coal mine in western Pennsylvania (hard bituminous Pittsburgh bed), in a steeply pitching coal mine in Washington State, and in an operating anthracite mine.
- OP 626. ———. Revolution in Coal Transport. Is It Near? Mechanization, v. 27, No. 5, May 1963, pp. 29-33. Discusses new methods for transportation of bituminous coal that are currently under investigation.
- OP 627. ———. Status of Coal Research in the United States. Coal Age, v. 63, No. 7, July 1963, p. 108. Summarizes coal research in the United States with respect to improved mining and preparation methods and new uses.
- OP 628. ———. Uses for Coal in the Future. Proc. 1st Energy Inst., June 26-July 1, 1960, sponsored by the School of Business Administration, American Univ., Washington, D.C., 1960, pp. 90-97. Indicates that coal supplied 67 percent of the total energy demand of the country in 1920 and only 22 percent in 1959. Discusses the decline of coal and its probable future. Predicts that coal will be able to retain its share of the fuel market during the next 40 years if it can attain its share of scientific advances.
- OP 629. ———. World Coal Trends. Symp. on Coal, Zonguldak, Turkey, December 1961, Office of U.S. Economic Coordinator for CENTO Affairs, 1962, pp. 14-25. Gives data on the world production and consumption of coal and discusses the future of demand for the three fossil fuels.
- OP 630. Perry, Harry, and Carl C. Anderson. Fuel Technology in the United States. J. Inst. Fuel, v. 34, No. 249, October 1961, pp. 421-439. Surveys the entire fossil fuel situation in the United States: history, reserves, technology, and present and future uses of coal, petroleum, and natural gas. While the use of petroleum and natural gas will continue to increase as population and per capita consumption increase, it is believed that coal will claim a larger proportional share of the energy market, particularly in generating electric power.
- OP 631. Perry, Harry, M. A. Elliott, and M. R. Linden. Current Developments in the Conversion of Coal to Fluid Fuels in the United States. Trans. 6th World Power Conf., Melbourne, Australia, Oct. 20-27, 1962, v. 7, pp. 2497-2514. Summarizes the results of research, in the United States, on converting coal to fluid fuels and reviews the pertinent factors relating to the need for supplemental liquid and gaseous fuels produced from coal to meet the increasing demands for fluid fossil fuels.
- OP 632. Perry, Harry, and Richard M. Gooding. Fuels Research in the United States. Mechanization, v. 27, No. 2, February 1963, pp. 39-44. Reviews the research in fuels during the decade 1950-60, with particular emphasis on solid fuels.
- OP 633. Petrick, Alfred. Capital Investment in Mine Plant and Equipment. Met. Min. and Processing, v. 1, No. 8, pp. 32-37. Discusses and evaluates some of the changes in the decisionmaking machinery behind capital expenditures, with particular reference to current practice in the mineral industries.
- OP 634. Pierce, C. I. J. Pasini III, and R. B. Lowe. Laboratory Tests of Shielded-Electrode Logging in Model Oil Wells. Producers Monthly, v. 25, No. 6, June 1961, pp. 20-24. An electrolytic-tank model was used to investigate the response of a shielded-electrode electrical logging device in thin, noninvaded resistive beds of different thickness for various bed-to-borehole-resistivity contrasts. Sandstone disks were used as resistive beds. Each disk had a drill hole along its cylindrical axis. Agar gel or water was used as a conductive bed. The electrical system was an automatically controlled bridge-type circuit that maintained the shield and measuring electrode as equipotential surfaces and also maintained the measuring current at a constant level.
- OP 635. Pipilen, A. P., M. Weintraub, and A. A. Orning. Hydraulic Transport of Broken Coal. Trans. AIME, v. 229, pp. 427-435. Gives results of an investigation of some of the principal factors affecting the economic transport of coal-water mixtures through a pipeline and centrifugal pump. Describes novel techniques for evaluating these factors.
- OP 636. Polack, S. P. Bureau of Mines Evaluates Fire Resistance of Hydraulic Fluids. Iron and Steel Eng., v. 41, No. 8, August 1964, pp. 105-110. Presents brief summation of Bureau activities in the prevention of fires by the use of nonflammable hydraulic fluids.
- OP 637. ———. Fire-Resistant Hydraulic Fluids for Underground Use—Report No. II. Pres. at 11th Internat. Conf. of Directors of Safety in Mines Res., Warsaw, Poland, Oct. 16-24, 1961, 35 pp. (preprint). The second of two reports (first report given at 10th Internat. Conf. of Directors of Safety in Mines Research, Pittsburgh, Pa., Sept. 23-Oct. 2, 1959) on fire-resistant hydraulic fluids for underground use. Gives results of extensive testing of fire-resistant hydraulic fluids.
- OP 638. Porter, Bernard, and E. A. Brown. Melting Points of Inorganic Fluorides. J. Am. Ceram. Soc., v. 45, No. 1, January 1962, p. 49. Melting points were determined to $\pm 5^\circ$ C of pure, inorganic fluorides. The values, in centigrade, are: BaF_2 , $1,354^\circ$; CaF_2 , $1,402^\circ$; CeF_3 , $1,437^\circ$; GdF_3 , $1,228^\circ$; KF , 858° ; LaF_3 , $1,490^\circ$; LiF , 846° ; NaF , 994° ; SrF_2 , $1,463^\circ$; ThF_4 , $1,102^\circ$; and YF_3 , $1,148^\circ$.
- OP 639. Porter, Bernard, E. S. Sheed, C. Wyche, J. D. Marchant, and R. G. Knickerbocker. Higher Purity Ingot Cerium From Molten Salts. J. Metals, v. 12, No. 10, October 1960, pp. 798-801. Presents an evaluation of several critical factors in the electro-winning of cerium from molten salts.
- OP 640. Potter, J. Leon, James E. Murphy, and Howard H. Heady. Determination of Oxygen in Mixed Fluorides by Inert Gas Fusion. Anal. Chem., v. 34, No. 12, November 1962, pp. 1635-1638. Describes an inert-gas fusion procedure for determining oxygen in mixed fluoride electrolytes used in electro-winning uranium and the rare-earth metals.

- Relative error of the method in the 0.05 to 0.5 percent range is about 5 percent.
- OP 641. Powell, John P., and Kenneth H. Johnston. Waterflood Fracturing Pays Off. Independent Petroleum Association of America, October 1960, 9 pp. Provides a major contribution to hydraulic fracturing, particularly as related to waterflood operations.
- OP 642. Prien, Charles H. Pyrolysis of Coal and Shale: Pyrolysis of Oil Shale. *Ind. Eng. Chem.* v. 53, No. 8, August 1961, pp. 676-679. Reviews over 80 technical articles on oil-shale pyrolysis from October 1959 through February 1961 for domestic journals and from February 1959 through February 1961 for foreign journals.
- OP 642A. Prokopovitch, Andrew S. Rev. of "Treatise on Analytical Chemistry. Part II, Analytical Chemistry of the Elements," v. 8, ed. by I. M. Kolthoff and P. J. Elving. *J. Metals*, v. 16, No. 11, November 1964, p. 856.
- OP 643. Pynnönen, R. O., and R. L. Bernard. Supervision in Roof Bolting. *Skilling's Min. Rev.*, v. 50, No. 6, Feb. 11, 1961, pp. 1, 4-5. Discusses need for adequate supervision in roof bolting and cites unsafe conditions or practices that would be avoided with better supervision.
- OP 644. Rall, H. T., R. L. Hopkins, C. J. Thompson, and H. J. Coleman. Some Chemical and Physical Techniques for Separation and Analysis of Sulfur Compounds in Petroleum. *Proc. API*, v. 42, sec. 8, pp. 46-60. Describes some of the physical and chemical methods used by the Bureau in cooperative work with API Research Project 48 in the separation and identification of sulfur compounds in petroleum. Typical data are shown illustrating the results obtained.
- OP 645. Rall, H. T., C. J. Thompson, H. J. Coleman, and R. L. Hopkins. Hydrogenolysis. *Proc. API*, v. sec. 8, 1962, pp. 81-86. Describes a microdesulfurization method applicable to gas-liquid chromatographic fractions as small as 0.000005 ml. The technique is used successfully in the identification of sulfur compounds in petroleum fractions. It is also applied to nitrogen-, oxygen-, and halogen-containing compounds.
- OP 646. ———. Sulfur Compounds in Petroleum. *Proc. API*, v. 42, sec. 8, 1962, pp. 19-27. Discusses the sulfur content of crude oils with relation to geologic origin. Included are data on sulfur compound distribution within the crude oil, classes of sulfur compounds found, and the individual sulfur compounds identified in petroleum. Certain relationships existing between compound structure and abundance are cited.
- OP 647. Raymond, Raphael, Leslie Reggel, Waldo A. Steiner, Sabri Ergun, and Irving Wender. Reduction of Graphite by Lithium-Ethylenediamine. *Nature*, v. 185, No. 4710, Feb. 6, 1960, pp. 379-380. Shows that coals and vitrains containing up to 92 percent carbon can be reduced by the lithium-ethylenediamine system. Hydrogen is added, no carbon-carbon bonds are broken, and the reaction occurs under the mild conditions of 115° C and atmospheric pressure.
- OP 648. Raymond, Raphael, Irving Wender, and Leslie Reggel. Catalytic Dehydrogenation of Coal. *Science*, v. 137, No. 3531, Aug. 31, 1962, pp. 681-682. Reports on first production of significant amounts of molecular hydrogen from coal by catalytic dehydrogenation. Coals were dehydrogenated by treatment with catalysts in high-boiling aromatic and heteroaromatic solvents. Up to 53 percent of the hydrogen was evolved as hydrogen gas.
- OP 649. ———. An Improved Technique for the Soxhlet Extraction of Coal. *Fuel*, v. 43, No. 4, July 1964, pp. 299-301. Certain difficulties commonly encountered in the Soxhlet extraction of coal, which are caused by the swelling action of the solvent upon the coal, can be eliminated by mixing the coal with an inert filler and placing the thimble on a glass pedestal. Potassium chloride and diatomaceous earth are satisfactory as fillers; with the former, there is no reaction with the coal and both residue and extract can be obtained free of any contaminant.
- OP 650. Rees, O. W., and W. H. Ode. International Standardization of Methods for Sampling, Analysis, and Testing of Coal and Coke. *Min. Cong. J.*, v. 46, No. 11, November 1960, pp. 94-96. The development of international standards for sampling, analysis, and testing of coal and coke, under the sponsorship of the International Organization for Standardization, is carried out by a committee representing the national standards bodies of every important coal-producing nation, including the United States. To better acquaint the U.S. coal industry with the activity, the report describes how ISO works, the progress being made, and the benefits accruing from U.S. participation.
- OP 651. Reggel, Leslie, Joseph P. Henry, and Irving Wender. The Lithium-Ethylenediamine System. III. Formation of Imidazole Derivatives and Cleavage of Certain Carbon-Carbon Bonds. *J. Org. Chem.*, v. 26, 1961, pp. 1837-1840. Hydrocarbons such as tetralin and isopropylbenzene, in the presence of *N*-lithioethylenediamine, $H_2NCH_2CH_2NHLi$, catalyze the self-condensation of ethylenediamine to give bis(Δ^2 -2-imidazolynyl), hydrogen, and ammonia. In the presence of *N*-sodioethylenediamine, $H_2NCH_2CH_2NHNa$, a similar reaction occurs and in addition yields an unidentified compound, $C_6H_5N_4$. Stilbene with *N*-lithioethylenediamine gives bis(Δ^2 -2-imidazolynyl), toluene, and 1,2-diphenylethane; under the same conditions, 1,2-diphenylethane is unchanged.
- OP 652. Reggel, Leslie, Milton Orchin, and R. A. Friedel. Synthesis and Ultraviolet Spectra of 1-Methyl- and 1-Phenyl-2-(1'-Naphthyl)-Naphthalene. *J. Chem. and Eng. Data*, v. 8, No. 2, April 1963, p. 279. Describes the synthesis of the two polycyclic aromatic hydrocarbons named in the title. Their ultraviolet absorption spectra are recorded.
- OP 653. Reggel, Leslie, R. Raymond, W. A. Steiner, R. A. Friedel, and Irving Wender. Reduction of Coal by Lithium-Ethylenediamine. Studies on a Series of Vitrains. *Fuel*, v. 40, September 1961, pp. 339-356. A series of vitrains, ranging in maf carbon content from 67.9 to 93.1 percent, and a graphite were reduced with lithium-ethylenediamine. The reduction led to the addition of hydrogen, water, and ethylenediamine to the vitrain. The amount of hydrogen added was highest for a vitrain of 90 percent carbon, which added as much as 55 atoms of hydrogen per 100 carbon atoms. More than half of the carbon atoms in this vitrain appeared to be involved in carbon-carbon double bonds. The hydrogen added increased with decreasing sample size. The reduced vitrains were more soluble in pyridine than the starting materials; however, pyridine solubility did not parallel the extent of hydrogen addition. The reduced vitrains showed changes in their infrared and ultraviolet spectra consistent with addition of hydrogen and reduction of aromatic rings and contained fewer free radicals than the starting vitrains.
- OP 654. Reggel, Leslie, Heinz W. Sternberg, and Irving Wender. Reductive Dimerization of Naphthalene by Sodium-Ethylamine. *Nature*, v. 190, No. 4770, Apr. 1, 1961, pp. 81-82. Because of the authors' interest in the reduction of organic compounds and of coal by metal-amine systems, they have reinvestigated the naphthalene-sodium-ethylamine reaction. The so-called polymeric material

- has been identified as a stereoisomer of 1,2,3,4,1',2',3',4'-octahydro-2,2'-dinaphthyl.
- OP 655. Reggel, Leslie, I. Wender, and R. Raymond. Catalytic Dehydrogenation of Coal II—Reversibility of the Dehydrogenation and Reduction of Coal. *Fuel*, v. 43, No. 3, May 1964, pp. 229-233. Discusses in detail the "reversibility" of the reduction of coal (lithium-ethylenediamine at 110° C) and of the dehydrogenation of coal (palladium as catalyst and phenanthridine as vehicle at 347° C).
- OP 656. ———. Reduction of Coal by Lithium-ethylenediamine. A Re-evaluation of Previous Data (letter to the editor). *Fuel*, v. 43, No. 1, January 1964, pp. 75-77. Experimental data previously reported on the lithium-ethylenediamine reduction of a series of vitrains is re-evaluated in regard to another method of calculation which has recently appeared in the literature. The two methods of calculation are compared and discussed.
- OP 656A. Reno, Horace T. Iron Ore Exploration and Exploitation on a Large Scale. United Nations Interregional Symposium on the Application of Modern Technical Practices in the Iron and Steel Industry to Developing Countries. Nov. 11-26, 1963, Tech. Paper A.3, 26 pp. Describes iron mining on a large scale as exemplified by mining practices on the Mesabi range, Minnesota, which has been the principal source of iron ore in the United States for more than 60 years. Experience in exploiting the Mesabi range iron ores has shown that 5 to 10 years elapse between first interest in an iron resources and construction of a plant to exploit it on a large scale. Careful planning, flexibility in adopting new equipment and methods, a high-quality product, concern for employee well-being, and favorable Government policy are among the elements leading to successful exploitation of an iron ore deposit. Taconite rock, which has been mined commercially only since 1955, is supplanting residual deposits of enriched ore as the major source of iron.
- OP 657. Repley, D. L., J. M., Clingenpeel, and R. W. Hurn. Continuous Determination of Nitrogen Oxides in Air and Exhaust Gases. *Internat. J. Air and Water Pollution*, v. 8, September 1964, pp. 455-463. A solid chemical oxidant has been developed to convert nitric oxide to nitrogen dioxide in a continuous process for the determination of NO in auto exhaust gases.
- OP 658. Richards, Russell L. Evaporite Resources of Pakistan. Symposium on Industrial Rocks and Minerals, Lahore, Pakistan, December 1962, Central Treaty Organization, pp. 267-274. Describes modes of occurrence, methods of exploitation, and future potential of a number of soluble salts which occur naturally in Pakistan. These include common salt, sodium carbonate, sodium nitrate, potassium salts, borax, trona, gypsum, and others.
- OP 659. Richmond, J. K., J. Grumer, and D. S. Burgess. Turbulent Burning Velocities of Core-Zone Flames. 8th Symp. (Internat.) on Combustion. The Williams & Wilkins Co., Baltimore, Md., 1962, pp. 534-542. Gives data on measuring the local luminosities of a turbulent and a laminar flame of identical compositions.
- OP 660. Riggs, C. H., R. V. Huff, and D. C. Ward. Potentialities of the Lansing-Kansas City Formation, Hall-Gurney Field, Russell County, Kans. *Producers Monthly*, v. 24, No. 7, May 1960, pp. 18-25. Emphasizes secondary-recovery potentialities of the Lansing-Kansas City formation and thus encourages a wider application of improved oil-recovery methods. This information is the most prolific of several oil-producing formations in the Hall-Gurney field.
- OP 661. Robinson, W. E., and J. J. Cummins. Composition of Low-Temperature Thermal Extracts From Colorado Oil Shale. *J. Chem. and Eng. Data*, v. 5, No. 1, January 1960, pp. 74-80. Shows that the composition of the extracts depended upon the time and temperature of extraction. At a constant time of extraction, the wax and pentane-insoluble material increased, the percentage of resins decreased with an increase in the temperature of extraction, and the percentage of oil remained nearly constant. At a constant temperature of extraction (350° C), the percentage of pentane-insoluble material decreased, whereas the oil, wax, and resin content increased with an increase in the extraction period.
- OP 662. Robinson, W. E., and D. L. Lawlor. Constitution of Hydrocarbon-Like Materials Derived From Kerogen Oxidation Products. *Fuel*, v. 40, September 1961, pp. 375-388. The organic acids present in a Colorado oil-shale oxidation product were characterized. This was accomplished by reducing the acids to hydrocarbons and fractionating the resulting material. Data from this study indicated that the oxidation product contained *n*-paraffinic, isoparaffinic, aromatic, naphthenic, and heterocyclic acids. The latter two types predominated, suggesting that Colorado oil-shale kerogen contains mostly alicyclic and heterocyclic structures with smaller amounts of straight-chain and aromatic constituents.
- OP 663. Rodriguez, Ernest R. Possibilities of Greater Use of Rock Bolting in Tunnels. *Proc. Construction Eng. Conf.*, 1960, pp. 110-119. Summarizes results achieved in mining with this method of rock support and the relatively limited use in tunneling to point out that greater use of bolting could be made in tunnels. Discusses economic advantage of use of this method of support in place of conventional methods; also discusses critical factors in rock bolting to emphasize the need for anchorage testing, proper design, systematic installation, and close surveillance.
- OP 664. Rogoff, Martin H. Chemistry of Oxidation of Polycyclic Aromatic Hydrocarbons by Soil Pseudomonads. *J. Bacteriology*, v. 83, No. 5, May 1962, pp. 998-1004. The general metabolic pathways by which polynuclear aromatic hydrocarbons undergo bacterial degradation have been studied. Intermediates in these oxidations have been isolated.
- OP 665. ———. Oxidation of Aromatic Compounds by Bacteria. Ch. in *Advances in Applied Microbiology*, ed. by W. W. Umbreit. Academic Press, New York, v. 3, 1961, pp. 193-221. The material dealt with in this chapter is concerned with central paths and means by which bacterial enzymes manipulate and cleave the aromatic ring with the formation of hydroxylated aromatic intermediates, and the further cleavage of these hydroxylated compounds to aliphatic intermediates which, at some stage, can enter the main terminal respiratory cycles of the cell.
- OP 666. ———. The Role of Microbiological Processes in the Formation of Peat and Their Relationship to Coal Genesis. *Abs. in Bull. Geol. Soc. America*, v. 70, No. 12, December 1959, pp. 1663-1664. Discusses microflora of peat and their variations in accord with conditions of acidity and alkalinity and availability of nitrogen and oxygen, resulting in variations in the peat formed. Postulates that anaerobic processes are responsible for the formation of high-rank coals and aerobic oxidate processes produce lignite and brown coals.
- OP 667. Rogoff, Martin H., and Irving Wender. Biologically Active Materials in Coal. *Nature*, v. 192, No. 4800, Oct. 28, 1961, pp. 378-379. Gives

- results obtained when an acetone extract from a high-volatile subbituminous B coal was distilled and separated into its acidic, phenolic, basic, and neutral components, and each component was tested in nutrient broth against *Bacillus subtilis*. The original acetone extract and samples obtained at the various concentration stages were analyzed by mass spectrometry and also examined in the ultraviolet.
- OP 668. Romans, P. A. A Method for Grinding Silver Chloride. *Appl. Spectroscopy*, v. 16, No. 3, May-June 1962, p. 113. Describes a method of pulverizing silver chloride for use as a spectrographic carrier. Pulverizing is done at liquid nitrogen temperature.
- OP 669. Rough, Robert L., and William E. Eckard. Results of Hydraulic Fracturing in Shallow Oil Sands, Warren County, Pa. *Producers Monthly*, v. 27, No. 8, August 1963, pp. 9-15. Describes the history, geology, and reservoir rock characteristics and presents the results of hydraulically fracturing 10 wells in the Glade sand near Sugar Grove, Pa.
- OP 670. Rough, Robert L., and G. E. Rennick. Glass Pipes Used to Study Vertical Flow of Air-Oil Mixtures. *Producers Monthly*, v. 24, No. 13, November 1960, pp. 22-25. Introduces project initiated to investigate the two-phase flow of air-oil mixtures in vertical pipes. The study is limited to steady-state flow conditions at laboratory scale to evaluate design factors for siphon-type flowstrings. The laboratory air-life model well with siphon-type flowstrings is described. The operation of the unit and the measurement of air and oil pressure-volume-temperature values are outlined.
- OP 671. Russell, Paul L. Final Report—Pre- and Post-Shot Mine Survey. U.S. Atomic Energy Commission, Plowshare Program, Project Gnome, Carlsbad, N. Mex., Dec. 10, 1961, PNE-134-F, 1962, 38 pp. Covers a program to measure and assess damage, if such should occur, in the six potash mines located within 30 miles of the detonation point. Results of all tests were negative, and no indication of damage at any of the potash mines was noted. Project Gnome, a part of Plowshare, the Atomic Energy Commission's program for peaceful employment of nuclear energy, was an experiment involving the detonation of a 5-kiloton nuclear device in the salt beds of Eddy County, N. Mex.
- OP 672. Sanner, W. S., R. E. McKeever, J. W. Eckerd. Bench-Scale Experiments in Developing Anthracite Metallurgical Briquets. *Proc. Blast Furnace, Coke Oven and Raw Materials Comm.*, v. 20, 1961, pp. 55-86. Reports on bench-scale experiments to determine the combination of raw materials, briquetting pressures, and calcining temperatures required to produce briquets most resistant to impact and abrasion. Briquets prepared in the laboratory at pressures of 3,000 psi, containing 8 percent coal-tar pitch, 10 percent bituminous coal, 82 percent anthracite, and calcined at 1,750° F were superior to premium furnace and foundry cokes in resistance to impact and abrasion, as determined by the ASTM Tumbler Test for Coke.
- OP 673. Schlain, David, Charles B. Kenahan, and Walter L. Acherman. Corrosion Behavior of High-Purity Vanadium. *Corrosion*, v. 16, No. 2, February 1960, pp. 70t-72t. Presents results of comparative studies of the corrosion of ductile vanadium obtained from several sources.
- OP 674. ———. Corrosion Properties of High-Purity Vanadium. *J. Less-Common Metals*, v. 3, December 1961, pp. 458-467. Discusses results of work on the chemical and galvanic corrosion properties of the metal in various corrodents at 35° and 60° C.
- OP 675. Schlesinger, M. D., S. Nazaruk, and L. Reggel. Laboratory Cylinder-Mill for Small Samples. *J. Chem. Educ.*, v. 40, October 1963, p. 546. Describes a small mill designed by the Bureau's staff to grind small quantities of solid with the advantage of easy recovery. The mill is a rotating thin cylinder in which small rolling cylinders are in contact, causing a differential grinding action.
- OP 676. Schrecengost, H. A. Safety Factors Associated With Thermal Coal Drying. *Min. Cong. J.*, v. 49, No. 7, July 1963, pp. 28-32. Discusses the hazards associated with thermal drying of coal and lists the safety factors to be considered relative to design, installation, and operation of fluidized-bed dryers.
- OP 677. Schwaneke, A. E., and J. W. Jensen. Magnetic Susceptibility and Internal Friction of Tetragonal Manganese-Copper Alloys Containing 70 percent Manganese. *J. Appl. Phys.*, v. 33, No. 3, supp., March 1962, pp. 1350-1351. Presents relationships of structure, magnetic susceptibility, internal friction, and Young's modulus for an alloy containing 70 percent manganese and 30 percent copper.
- OP 678. Schwartz, C. H., S. A., Goldberg, and A. A. Orning. The Use of Visible Light Models for the Study of Radiant Heat Transfer in Furnaces. *Trans. ASME*, v. 84, No. A, October 1962, pp. 358-364. Describes an apparatus for the study of radiant heat transfer in furnaces by means of models using visible light. Flame radiation was simulated by miniature lamps, and strips coated with high-reflectance paint represented partial wall reflection. Tests with models of gas-fired and pulverized-coal-fired furnaces showed the usefulness of the models in the study of such variables as flame position, furnace geometry, and reduction of heat transfer by ash and slag deposits.
- OP 679. Schwartz, Frank G., Marvin L. Whisman, Charles S. Allbright, Barton H. Eccleston, and C. C. Ward. Tritium as a Tracer in Motor Gasoline Stability Studies. *Abs. in Vapor Pressure*, v. 30, No. 3, March 1960, p. 70.
- OP 680. Scollon, T. Reed. Coal Resource Activities of the Bureau of Mines. *Proc. Illinois Coal Min. Inst.*, 71st year, 1963, pp. 34-44. Discusses coal resources program of the Bureau of Mines. Shows Illinois reserves and production and relates them to total reserves and production in the United States. Summarizes trends in the price of coal and coal transportation costs. Gives an example of the work the Bureau is doing to promote coal exports.
- OP 681. ———. Coal Supply and Demand in the Nation's Energy Market. *Mechanization*, v. 25, No. 12, December 1961, pp. 39-44. Presents projections for coal demand and supply based on an evaluation of selected professional estimates of future demands for electric power, steel, and products of other industries. A demand estimate of approximately 670 million tons of coal is indicated for 1975.
- OP 682. ———. Disc. of "Characteristics of Australian Coals and Their Influence on the Pattern of Coal Utilization" by H. R. Brown and P. L. Waters. *Trans. 6th World Power Conf.*, Melbourne, Australia, Oct. 20-27, 1962, v. 12, pp. 4643-4644. Compares American and Australian coal utilization experience.
- OP 683. ———. Hydraulic Mining of Coal. *Proc. 56th Meeting Rocky Mountain Coal Mining Inst.*, Glenwood Springs, Colo., June 26-29, pp. 46-48. States that the technologic feasibility of hydraulically extracting coal from a face has been proved.

- Declares that tests in the near future should indicate whether such a method of extraction will have widespread application.
- OP 684. Scollon, T. Reed. Panel Discussion—Governmental Actions Affecting Energy Resources. Proc. First Energy Institute, June 26–July 1, 1960. Sponsored by the School of Business Administration, American Univ., Washington, D.C., 1960, pp. 159–165.
- OP 685. ———. Le prix du charbon americain [Price Trends of United States Coal]. In The Price of Energy in the Next Ten Years. Seminar of the Economic and Legal Institute of Energy, University of Grenoble, Mar. 25, 1963. Mouton & Co., Paris and The Hague, v. 2, 1964, pp. 20–37. Discusses the price trends of the U.S. coal industry, including the effects of production costs, competition with other fuels, mechanization of underground and open-pit mines, employment, wages, exports, and coal reserves.
- OP 685A. ———. Trends in Utilization of Energy Resources in the United States. 6th World Power Conf., Melbourne, Australia, Oct. 20–27, 1962, v. 1, pp. 264–290. Delineates the changes in utilization of energy resources in the United States during the period 1955–60 and projects the utilization of these resources in 1965, 1970, and 1980. In 1960 coal supplied about 23 percent of total energy consumption; petroleum, almost 45 percent; and natural gas, about 30 percent. Water power supplied slightly less than 4 percent. Nuclear power supplied a negligible amount of energy in 1960, but its share is expected to increase in the next two decades.
- OP 686. Scollon, T. Reed, Harry Perry, Earle P. Shoub, and J. P. McGee. Bureau of Mines Coal-Fired Gas Turbine Research Project. Combustion, v. 33, December 1961, pp. 2–4. Describes progress in the development of a coal-fired gas turbine capable of operating for the long periods of time required for central-station power generation.
- OP 687. Scott, D. W., W. T. Berg, and J. P. McCullough. Chemical Thermodynamic Properties of Methylcyclopentane and 1-*cis*-3-Dimethylcyclopentane. J. Phys. Chem., v. 64, 1960, pp. 906–908. Calculates thermodynamic functions for methylcyclopentane by methods of statistical mechanics and for 1-*cis*-3-dimethylcyclopentane by a refined method of increments. Also determines values of the heat, free energy, and equilibrium constant of formation for both substances.
- OP 688. Scott, D. W., D. R. Douslin, H. L. Finke, W. N. Hubbard, J. F. Messerly, I. A. Hossenlopp, and J. P. McCullough. 2-Methyl-2-Butanethiol: Chemical Thermodynamic Properties and Rotation Isomerism. J. Phys. Chem., v. 66, No. 8, August 1962, pp. 1334–1341. Reports measured thermodynamic data for solid, liquid, and vapor states (12° to 500° K), analysis of molecular spectra and data, and calculated thermodynamic properties (0° to 1,500° K) for 2-methyl-2-butanethiol.
- OP 689. Scott, D. W., W. D. Good, G. B. Guthrie, S. S. Todd, I. A. Hossenlopp, A. G. Osborn, and J. P. McCullough. Chemical Thermodynamic Properties and Internal Rotation of Methylpyridines. II. 3-Methylpyridine. J. Phys. Chem., v. 67, No. 2, February 1963, pp. 685–689. Thermodynamic properties of 3-methylpyridine were measured and the results were correlated by use of spectral and molecular-structure data to obtain values of the chemical thermodynamic properties in the ideal gas state (0° to 1,500° K). Internal rotation of the methyl group was found to be free or nearly so.
- OP 690. Scott, D. W., W. D. Good, S. S. Todd, J. F. Messerly, W. T. Berg, I. A. Hossenlopp, J. L. Lachna, Ann Osborn, and J. P. McCullough. 3,3-Dimethyl-2-Thiabutane: Chemical Thermodynamic Properties and Barriers to Internal Rotation. J. Phys. Chem., v. 36, No. 2, February 1962, pp. 406–411. Chemical thermodynamic properties in the solid, liquid, and vapor states (0°–1,000° K) were determined by experimentation and calculation. Barriers to internal rotation were evaluated.
- OP 691. Scott, D. W., G. B. Guthrie, J. F. Messerly, S. S. Todd, W. T. Berg, I. A. Hossenlopp, and J. P. McCullough. Toluene: Thermodynamic Properties, Molecular Vibrations, and Internal Rotation. J. Phys. Chem., v. 66, No. 5, May 1962, pp. 911–914. New experimental and theoretical studies of toluene led to definitive values of thermodynamic and molecular properties.
- OP 692. Scott, D. W., W. N. Hubbard, J. F. Messerly, S. S. Todd, I. A. Hossenlopp, W. D. Good, D. R. Douslin, and J. P. McCullough. Chemical Thermodynamic Properties and Internal Rotation of Methylpyridines I. 2-Methylpyridine. J. Phys. Chem., v. 67, No. 2, February 1963, pp. 680–685. Thermodynamic properties of 2-methylpyridine were measured, and the results were correlated by use of spectral and molecular-structure data to obtain values of the chemical thermodynamic properties in the ideal gas state (0° to 1,500° K). Internal rotation of the methyl group was found to be free or nearly so.
- OP 693. Scott, D. W., and J. P. McCullough. Vibrational Assignment and Force Constants of S₈ From a Normal Coordinate Treatment. Jour. Molecular Spectroscopy, v. 6, No. 4, 1961, pp. 372–376. Normal-coordinate calculations were made for the S₈ molecule to improve earlier work that had not explicitly included torsional forces about S-S bonds. Inclusion of torsional forces led to a vibrational assignment that is consistent with the spectral and thermodynamic data for S₈.
- OP 694. Scott, D. W., J. P. McCullough, and F. H. Kruse. Vibrational Assignment and Force Constants of S₈ From a Normal-Coordinate Treatment. J. Molecular Spectroscopy, v. 13, No. 3, July 1964, pp. 313–320. Normal-coordinate calculations for the S₈ molecule were revised by use of new far-infrared spectral data and a more elaborate potential function. Digital computer methods were used. Representation of the observed frequencies required that the basic Urey-Bradley field be supplemented with an extra quadratic cross-term between adjacent S-S bonds. The vibrational assignment based on the calculations is consistent with all well established features of the observed spectra.
- OP 695. Scott, D. W., J. F. Messerly, S. S. Todd, G. B. Guthrie, I. A. Hossenlopp, R. T. Moore, Ann Osborn, W. T. Berg, and J. P. McCullough. Hexamethyldisiloxane: Chemical Thermodynamic Properties and Internal Rotation About the Siloxane. J. Phys. Chem., v. 65, No. 8, August 1961, pp. 1320–1326. Thermodynamic, spectroscopic, and molecular structure data were used to show that internal rotation about an Si-O bond in hexamethyldisiloxane is free or nearly so. Thermodynamic functions for hexamethyldisiloxane in the ideal gas state were calculated. Experimental studies provided: Values of heat capacity for the solid, the liquid, and the vapor; the triple-point temperature; the heat of fusion; thermodynamic functions for the solid and liquid (0° to 375° K); heat of vaporization (332° to 412° K); parameters of the equation of state; and vapor pressure (309° to 412° K). Thermodynamic functions also were calculated for the related substance, tetramethylsilane.
- OP 696. Scott, D. W., J. F. Messerly, S. S. Todd, I. A. Hossenlopp, D. R. Douslin, and J. P. McCullough. 4-Fluorotoluene: Chemical Thermodynamic Properties, Vibrational Assignment, and In-

- ternal Rotation. *J. Chem. Phys.*, v. 37, No. 4, August 1962, pp. 867-873. Calorimetric and vapor-pressure data are used to obtain complete tables of thermodynamic properties, a vibrational assignment, and the barrier to internal rotation for 4-fluorotoluene.
- OP 697. Scott, D. W., J. F. Messerly, S. S. Todd, I. A. Hossenlopp, Ann Osborn, and J. P. McCullough. 1,2-Difluorobenzene: Chemical Thermodynamic Properties and Vibrational Assignment. *J. Chem. Phys.*, v. 38, No. 2, January 1963, pp. 532-539. Gives correlation of experimental thermodynamic data for 1,2-difluorobenzene and a vibrational assignment by methods of statistical mechanics to derive thermodynamic properties for the solid, liquid, and gas from 0° to 1,500° K.
- OP 698. Shale, C. C. Bureau of Mines High-Temperature Electrostatic Precipitator. *Combustion*, v. 35, No. 10, April 1964, pp. 42-44. Describes the first semicommercial-size electrostatic precipitator ever designed for operation at high temperature and high pressure, which is now being installed at the Bureau of Mines Morgantown Coal Research Center. Describes a system devised for evaluating the effectiveness of the precipitator for removing dust from hot pressurized gas. The power pack is equipped to permit investigation of the effectiveness of positive and negative corona for cleaning hot gas.
- OP 699. Shale, C. C., and A. S. Moore. Precipitators in New Operating Range. *Combustion*, v. 32, No. 6, December 1960, pp. 42-43. Presents a study on the operating practicability of an electrostatic precipitator for removing fly ash from gas at temperatures and pressures up to 1,500° F and 100 psig, respectively, in conjunction with development of coal-fired gas turbine. Preliminary results show upwards of 98 percent removal efficiency at all pressure levels to 80 psig and temperatures through 1,200° F. Ash used in these tests was 90 to 95 percent less than 10 microns.
- OP 700. Sharkey, A. G., Jr. Mass Spectrometric Analysis Using Low Ionizing Voltage. *Encyclopedia of Spectroscopy*, ed. by G. L. Clark. Reinhold Pub. Co., New York, 1960, pp. 607-613. Discusses briefly the basic limitations of mass spectrometry including resolving power, vapor pressure and stability of the sample, and spectral interferences. Presents the basis of the low-ionizing-voltage method and tells how the use of this method circumvents the limitation of spectral interferences. Describes techniques for operating mass spectrometers at low-ionizing voltages and calibrated data for eight types of phenolic structures. Discusses the application of the method to neutral and tar acid fractions.
- OP 701. Sharkey, A. G. Jr., Janet L. Shultz, and R. A. Friedel. Application of Low-Ionizing Voltage Spectrometry to Oils Derived From Coal. *Fuel*, v. 41, No. 4, July 1962, pp. 359-371. Gives data on carbon number distribution obtained by low-ionizing voltage mass spectrometry for four high-boiling tar acid fractions and three neutral oils (maximum bp, 280° C) from coal. Compound types having up to 22 carbon atoms were determined. Similar analyses cannot be performed by any other analytical technique. Calibration data were obtained at low-ionizing voltage for the major phenolic types.
- OP 702. ———. Comparison of the Mass Spectra of Extracts and Vacuum Pyrolysis Products From Coal. *Fuel*, v. 40, No. 5, September 1961, pp. 423-426. Mass spectra of a vacuum pyrolysis condensate and a methanol-benzene extract of coal indicate that the materials contain similar major constituents. Quantitative analyses were carried out based on structural types found in coal carbonization products. Carbon number distribution data were obtained by mass spectrometry using low-ionizing voltage techniques.
- OP 703. Sharkey, A. G., Jr., Janet L. Shultz, and R. A. Friedel. Comparison of Mass Spectrometric and Gas Chromatographic Analyses of High-Boiling Oils From Coal. *Proc. ASTM Committee E-14 on Mass Spectrometry*, San Francisco, Calif., May 19-24, 1963, pp. 277-238. Naphthalene and anthracene oils from coal were analyzed by high-temperature mass spectrometry. These samples were previously analyzed by 13 European laboratories as part of a cooperative test program investigating the analysis of high-boiling oils. Carbon number distribution data were obtained by mass spectrometry for structural types containing from 8 to 24 carbon atoms. For the majority of the structural types good agreement is shown between gas chromatographic and mass spectrometric results.
- OP 704. ———. Gases From Flash and Laser Irradiation of Coal. *Nature*, v. 202, No. 4936, June 6, 1964, pp. 988-989. Investigates gases from the flash and laser irradiation of Pittsburgh seam (hvab) coal to determine the action of high temperatures on coal. Temperatures in excess of 1,000° C were reached with both types of irradiation, possibly as high as several thousand degrees centigrade with light from the laser source. Gaseous products from the laser and flash irradiations showed 21 percent and 8 percent acetylene, respectively. Diacetylene, vinylacetylene, and other products to molecular weight 130 were indicated in the mass spectrum of gas from the laser study. The results indicate that flash and laser irradiations of coal produce a different distribution of gases from that of high-temperature carbonization.
- OP 705. ———. Mass Spectrometric Determination of the Ratio of Branched to Normal Hydrocarbons Up To C₁₈ in Fischer-Tropsch Product. *Anal. Chem.*, v. 34, June 1962, pp. 826-830. Describes a method for the determination of carbon number distribution and ratio of branched to normal paraffins in mixtures consisting primarily of saturated hydrocarbons.
- OP 706. ———. Mass Spectrometric Investigations of Thermally Treated Extracts From Coal. *Proc. Meeting ASTM Comm. E-14 on Mass Spectrometry*, New Orleans, La., June 3-8, 1962. Gives results of a study of pyridine extracts by mass spectrometric techniques. Materials extractable at room temperature from Pittsburgh seam (hvab), Wyoming subbituminous coal, and North Dakota lignite were examined before and after heating for 4 hours at 450° C. Changes were observed in the carbon number distribution for several aromatic structures.
- OP 707. Shaw, John F. Operations of a Mining Research Center. *Min. Eng.*, v. 14, No. 3, March 1962, pp. 14-16. Describes some of the research done by the Bureau at its Denver (Colo.) Mining Research Center in rock mechanics as applied to ground control and in engineering principles and mathematical techniques as applied to exploration, development, and operational problems in mining.
- OP 708. Shea, G. B., R. V. Higgins, and H. J. Lechtenberg. Decline and Forecast Studies Based on Performances of Selected California Oilfields. *J. Petrol. Technol.*, v. 16, No. 9, September 1964, pp. 959-965. Gives results of a study of production-decline curves of the oil produced from 347 zones in California reservoirs. Presents the results of a computer analysis of the composite effect of factors influencing the decline performance of 347 Cali-

- fornia reservoirs which have been producing virtually at the maximum rate for many years.
- OP 709. Shedd, E. S., and T. A. Henrie. Preparation of Stable Cerous Oxide (3d Rare Earth Conf.). Gordon and Breach, Science Publishers, Ltd., New York, 1964, pp. 21-27. Studies pyrochemical reduction for preparing stable cerous oxide. Carbothermic reduction was effective at 1,250° C at 1 atmosphere absolute pressure. Carbon reduction in CO atmosphere was more effective in producing a stable product than carbon reduction in helium. Hydrogen reduction at temperatures below 1,400° C did not produce stable cerous oxide.
- OP 710. Shell, H. R., and E. J. Fox. Disc. of "Steam Distillation of Fluorine From Perchloric Acid Solutions of Aluminiferous Ores" by E. J. Fox and W. A. Jackson. Anal. Chem., v. 32, October 1960, pp. 1529-1530.
- OP 711. Shultz, J. F. A Small-Scale Recycle Pump. Ind. and Eng. Chem., v. 54, No. 4, April 1962, pp. 34-35. Describes a pump designed by the Bureau to be used in a system to study the kinetics of a catalytic reaction, the hydrogenation of carbon monoxide to methane on a nickel catalyst at 300 psig. All of the component parts are commercially available.
- OP 712. Shultz, J. F., L. J. E. Hofer, F. S. Karn, and R. B. Anderson. Studies of the Fischer-Tropsch Synthesis. Prepoisoning of Iron Catalysts by Sulfur Compounds. J. Phys. Chem., v. 66, March 1962, pp. 501-506. Describes a method of prepoisoning the pretreated catalyst by immersing it in a solution of the sulfur compound in heptane prior to synthesis.
- OP 713. Shultz, J. F., F. S. Karn, and R. B. Anderson. Cylinders for Storing Sulfur-Containing Gases. Ind. and Eng. Chem., v. 54, May 1962, pp. 44-45. Shows by tests on three types of cylinders that the problem of storing sulfur-containing gas can be solved by using different materials for the cylinders and by removing carbonyls from the gas.
- OP 714. Shultz, J. F., F. S. Karn, R. B. Anderson, and L. J. E. Hofer. A New Type of Catalyst—Carbon-Expanded Iron. Fuel, v. 40, May 1961, pp. 181-192. As a part of the Bureau of Mines investigation of converting coal to oil, a new type of Fischer-Tropsch and methanation catalyst—carbon-expanded iron—has been developed. This material is a form of the carbon deposit that often complicates the operation of the conventional catalyst. As observed by electron microscopy these deposits consist of nuclei of iron that are attached filaments, which consist chiefly of carbon but which may contain some finely dispersed iron. This paper presents data to prove that these deposits are catalytically active, but it is not certain which of these structural features are responsible for the catalytic activity.
- OP 715. Shultz, J. F., F. S. Karn, J. Bayer, and R. B. Anderson. Composition Changes of Massive Iron and Fused Iron Oxide Catalysts in the Fischer-Tropsch Synthesis. J. Catalysis, v. 2, No. 3, June 1963, pp. 200-202. Gives determination of changes in composition and surface area of massive iron and fused iron oxide catalysts in the Fischer-Tropsch synthesis. Massive iron catalysts remain in a reduced state during synthesis, but fused iron oxide catalysts oxidize extensively.
- OP 716. Silverman, Melvin P., and Henry L. Ehrlich. Microbial Formation and Degradation of Minerals. Advances in Applied Microbiology, Academic Press, New York. v. 6, 1964, pp. 153-206. Surveys the influence of microorganisms on the geochemical transformation of minerals. Reviews their contributions in the acid mine water problem in desulfurizing coal, and in recovering metals from low-grade ore.
- OP 717. Silverman, Melvin P., Martin H. Rogoff, and Irving Wender. Bacterial Oxidation of Pyritic Materials in Coal. Appl. Microbiology, v. 9, No. 6, November 1961, pp. 491-496. Cells of *Ferrobacillus ferrooxidans* accelerate the oxidation of coal pyrites. The rates of oxidation were increased by reducing the particle size of the pyritic samples.
- OP 718. ———. Removal of Pyritic Sulphur From Coal by Bacterial Action. Fuel, v. 42, No. 2, March 1963, pp. 113-124. Gives data on the removal of up to 80 percent of the pyrite in finely divided coal by bacterial action in 3 to 4 days. The relative ease of desulfurization was bituminous > subbituminous > lignite. Pretreatment with acid increased the susceptibility of all ranks of coal to bacterial action. The action of ferric sulfate further increased the extent of bacterial desulfurization of acid-treated coals.
- OP 719. Singer, Joseph M. Ignitibility of Hybrid Coal Dust-Methane-Air by Hot Gas Jets: A Preliminary Report. Pres. at 11th Internat. Conf. of Directors of Safety in Mines Res., Warsaw, Poland, Oct. 16-24, 1961, 15 pp. (preprint). Gives the results of study of addition of various amounts of coal dust to a methane-air mixture.
- OP 720. ———. Ignition of Mixtures of Coal Dust, Methane, and Air by Hot Laminar Nitrogen Jets. Ninth Internat. Symp. on Combustion. Academic Press, Inc., New York, 1963, pp. 407-414. Gives data on the ignition of hybrid coal dust-methane-air mixtures by hot laminar gas jets.
- OP 721. Smith, Harold M. Effects of Small Amounts of Extraneous Materials on Properties of Petroleum, Petroleum Products, and Related Liquids. Symp. on Major Effects of Minor Constituents on the Properties of Materials. ASTM Special Tech. Pub. 304, 1962, pp. 62-89. Considers the effect of materials such as asphaltenes, hydrocarbons, sulfur and sulfur compounds, nitrogen compounds, porphyrins, metals, antioxidants, anti-knock compounds, gums, metals, various anions and cations in aqueous solution, detergents, bacteria, and water when added to crude oil, gasoline, jet fuels, cracking stock, organic compounds (hydrocarbons, sulfur and nitrogen compounds), and oil-field waters.
- OP 722. ———. Hydrocarbon-Type Relationships of Eastern and Western Hemisphere High-Sulfur Crude Oils. Proc. Second Symposium on the Development of the Petroleum Resources of Asia and the Far East, ECAFE, U.S. Contributions, September 1962, pp. 118-210. (Pub. as RI 6542.) Presents a comparison of high-sulfur crude oils based on interpretations of Bureau of Mines routine crude-oil analyses in terms of common commercial products. Analytical interpretations are applied to a group of high-sulfur crude oils from the Near East, Texas, Colombia, California, and other locations, and the resultant data for gasoline, gas oils, lubricating oils, and asphalt are compared. Because the Near East crude oils contain higher quantities of paraffins in the gasoline and gas-oil ranges, they will yield good low-solvency solvents and kerosine, but the straight-run gasoline will be inferior to similar products from Texas and Venezuela high-sulfur oils. Near East oils should be good sources of lubricating stock but, when used as stock for catalytic cracking or reforming, they are deficient in naphthenes.
- OP 723. ———. The Role of Sulfur and Nitrogen Compounds in Organic Geochemistry. Proc. API, sec. 8, 1962, pp. 132-135. Lists a number of ways in which data on sulfur, sulfur compounds, and porphyrins can assist geochemical studies.

- OP 724. Smith, Harold M. Some Significant Facts Concerning the Composition of Petroleum. Proc. Oil Scientific Sessions, Budapest, Hungary, v. 2, Oct. 8-12, 1962, pp. 474-512. Discusses crude oil variety in composition, gasoline variety in composition, variety in gasoline yield, paraffin-isoparaffin relationships, aromatic content of gasolines, hydrocarbon interrelationships, isoprenoids, naphthenes, high-boiling aromatics, nonhydrocarbons, porphyrins, and metal contents.
- OP 725. Smith, Harold M., H. N. Dunning, H. T. Rall, and J. S. Ball. Keys to the Mystery of Crude Oil. Proc. Am. Petrol. Inst., v. 39, 1959, pp. 433-465. A study and evaluation of recent literature on the composition of crude oil to determine the extent and direction of the findings reported as they may contribute to further understanding of the origin of crude oil. The work of the American Petroleum Institute is particularly stressed. Reviews current theories on the origin of petroleum, then considers studies on the following: nitrogen compounds, porphyrins, trace elements and sulfur compounds; hydrocarbons in the gasoline, middle distillate, and heavy-oil boiling ranges; olefins; aromatics; chromatography; and thermal diffusion. Pertinent facts from various papers in these fields are pointed out insofar as these facts may concern the origin of petroleum.
- OP 726. Smith, Jack, J. P. McGee, and L. L. Hirst. Coal-Fired Gas Turbine Being Developed by Bureau of Mines. Power Eng., v. 67, No. 3, March 1963, pp. 35-38. Discusses the problems encountered in the development of the coal-fired gas turbine.
- OP 727. Smith, Jack, Richard Pill, and Donald C. Strimbeck. Temperature Drop Indicates Plug in Discharge of Ash Separator. Combustion, v. 34, No. 5, November 1962, pp. 30-32. Discusses a method for detecting plugged outlets in separators used to remove ash from combustion gases.
- OP 728. Smith, Jack, and Donald C. Strimbeck. Rotary Valve Transfers Coal in System for Feeding a Gas Turbine. Combustion, v. 33, No. 11, May 1962, pp. 52-53. Describes the adaptation of a commercially available standard rotary valve and tests of its performance in transferring pulverized coal from the cyclone separator to a storage silo.
- OP 729. Smith, John Ward. Stratigraphic Change in Organic Composition Demonstrated by Oil Specific Gravity-Depth Correlation in Tertiary Green River Oil Shales of Colorado. Bull. Am. Soc. Petrol. Geol., v. 47, No. 5, May 1963, pp. 804-813. Demonstrates that organic matter in the Green River Formation changes with depth uniformly both geographically and stratigraphically in the Piceance Creek basin of Colorado.
- OP 730. Smith, John Ward, and L. Warren Higby. Preparation of Organic Concentrate From Green River Oil Shale. Anal. Chem., v. 32, November 1960, p. 1718. Describes a method for concentrating the organic material in an unaltered state in quantities large enough to permit considerable study of the organic material directly.
- OP 731. Smith, John Ward, and Kenneth E. Stanfield. Oil Yields and Properties of Green River Oil Shales in Uinta Basin, Utah. Guidebook to the Geology and Mineral Resources of the Uinta Basin. Intermountain Association of Petroleum Geologists, 1964, pp. 213-221. Evaluates oil-yield data collected on samples from the Green River Formation in the Uinta Basin. Discusses properties of the Uinta Basin's Mahogany-zone oil shales.
- OP 732. ———. Oil Yields of Devonian New Albany Shales, Kentucky. Bull. Am. Assoc. of Petrol. Geol., v. 48, No. 5, May 1964, pp. 712-714. Gives data on oil yields of New Albany Shale from Rockcastle, Pulaski, and Adair Counties, Ky.
- OP 733. Smith, John Ward, Laurence G. Trudell, and Kenneth E. Stanfield. Drill Cutting Sampling for Oil Yields of Green River Oil Shales. Colorado School of Mines Quart., v. 58, No. 4, October 1963, pp. 113-127. Demonstrates that oil yields of the Green River Formation determined on mud drill cuttings represent the actual oil yield of the formation conservatively while those from gas cuttings are equivalent to actual formation yields.
- OP 734. Smith, John Ward, Neil B. Young, and Dale L. Lawlor. Direct Determination of Sulfur Forms in Green River Oil Shale. Anal. Chem., v. 36, No. 3, March 1964, pp. 618-622. Develops and evaluates a new method for determining sulfur forms in Green River oil shale.
- OP 735. Smith, N. K., G. Gorin, W. D. Good, and J. P. McCullough. The Heats of Combustion, Sublimation, and Formation of Four Dihalobiphenyls. J. Phys. Chem., v. 68, No. 4, April, 1964, pp. 940-946. Gives results of investigation of the structure and energetics of dihalobiphenyls by thermochemical methods. Heats of combustion of four dihalobiphenyls were determined by rotating-bomb combustion calorimetry, and the vapor pressure of each was measured by the Knudsen effusion technique.
- OP 736. Smith, N. K., D. W. Scott, and J. P. McCullough. Combustion Calorimetry of Organic Chlorine Compounds. The Heat of Combustion of 2,3,5,6-Tetrachloro-*p*-xylene. J. Phys. Chem., v. 68, No. 4, April 1964, pp. 934-939. A rotating-bomb method was developed for precision combustion calorimetry of organic chlorine compounds. The heat of combustion of 2,3,5,6-tetrachloro-*p*-xylene was determined. Two reducing agents, hydrazine dihydrochloride and arsenious oxide, were used to reduce the free chlorine produced in the combustion reaction to chloride ion. Arsenious oxide proved to be the superior reducing agent.
- OP 737. Smith, Robert W., Jr., and Edwin B. Cook. Calculation of Thermodynamic Properties of Combustion Gases With a Small Punchcard Electronic Computer. Ch. in Kinetics, Equilibria of High Temperature Systems. Butterworth & Co., Ltd., London, 1961, pp. 161-165. Describes how a small punchcard electronic computer is used to solve problems normally reserved for a large or medium-size computer. Discusses problems dealing with the calculation of the thermodynamic properties of combustion gases.
- OP 738. Sohns, Harold W. A Summary of Current Techniques for Processing Green River Oil Shale. Guidebook to the Geology and Mineral Resources of the Uinta Basin. Intermountain Association of Petroleum Geologists, 1964, pp. 223-225. Describes briefly the present state of oil-shale technology in the United States.
- OP 739. Stahl, R. W. Are Coal-Mine Employees and Dollars Protected From Fire as Well as Other Industrial Employees and Dollars? Proc. 49th Conv., Mine Inspectors' Inst. of America, Terre Haute, Ind., 1959, pp. 112-119; Min. Eng., v. 13, No. 1, January 1961, pp. 174-177. Surveys fire protection afforded in the steel, rubber, chemical, aluminum, and other heavy industries compared with that afforded at coal mines. Compares investment in fire-fighting equipment in these industries to the total capital investment. In addition, a small part of a plant is compared with a small part of a mine where activity is concentrated and investment is high to show the difference in value placed on the protection of the investment by the different industries.
- OP 740. ———. Blasting Stumps in Coal Mines. Proc. 52d Conv., Coal Min. Inst. of America, 1962,

- pp. 75-78. Discusses good and poor pillar plans in mines and safe methods of blasting stumps.
- OP 741. Stahl, R. W. Practices in Controlling Roof at Intersections and Junctions. *Mechanization*, v. 27, No. 1, January 1963, pp. 41-45. Shows that 30 percent of roof-fall accidents occur at intersections and junctions. Discusses special roof-control plans for these areas and sag-bolt test results.
- OP 742. Stecura, Stephen, and William J. Campbell. Surface Contamination of La_2O_3 and Nd_2O_3 by B_2O_3 : A Source of Error in X-Ray Diffractometry. *J. Am. Ceram. Soc.*, v. 47, No. 9, 1964, p. 468. Discusses the effect of surface contamination of samples of lanthanum oxide and neodymium oxide by boron oxide. Describes the problem and the methods used to identify the source of the contamination.
- OP 743. Stein, K. C., J. J. Feenan, G. P. Thompson, J. F. Shultz, L. J. E. Hofer, and R. B. Anderson. Catalytic Oxidation of Hydrocarbons. *Ind. and Eng. Chem.*, v. 52, No. 8, August 1960, pp. 671-674. Shows that catalysts based on oxides of cobalt, nickel, manganese, chromium, and iron appear to be good possibilities for the auto smog catalytic muffler.
- OP 744. ———. The Oxidation of Hydrocarbons on Simple Oxide Catalysts. *J. Air Pollution Control Assoc.*, v. 10, 1960, pp. 275-281. Microcatalytic reactor was used to assay effectiveness of variety of pure and supported metal oxides in oxidizing several hydrocarbons.
- OP 745. Stepan, J. B. Promoting an Eye-Protection Program. *Nat. Safety Council, Safety Newsletter*, Min. Sec., October 1961. Discusses ways of promoting the use of safety glasses.
- OP 746. Sternberg, H. W., C. L. Delle Donne, L. Reggel, and I. Wender. Reduction of Coal by Lithium-Ethylenediamine at Room Temperature. *Fuel*, v. 43, No. 2, March 1964, pp. 143-146. Discusses the reduction of four vitrains and a graphite with lithium in ethylenediamine at room temperature. The pattern of hydrogen uptake was the same as that taken up at 90° to 100° C. From the results of the hydrogenation of coronene, it appears that room temperature reduction of condensed aromatic systems can lead to products with isolated double bonds.
- OP 747. Sternberg, H. W., Raymond Markby and Irving Wender. Carboxylation of Diphenylacetylene With $\text{Ni}(\text{CO})_4$ in Alkaline Medium. *J. Am. Chem. Soc.*, v. 82, 1960, pp. 3638-3640. Indicates that treatment of diphenylacetylene with a saturated solution of NaOH in methanol in the presence of excess nickel carbonyl yields α -phenyl-*trans*-cinnamic acid and 1,2,3,4-tetraphenylbutadiene. Shows that a nickel carbonyl anion, $[\text{Ni}_2(\text{CO})_5]^{-2}$, is formed; it is probably the source of carbon monoxide in this reaction.
- OP 748. ———. Electrochemical Reduction of the Benzene Ring. *J. Electrochem. Soc.*, v. 110, No. 5, May 1963, pp. 425-429. Describes reduction of benzene and tetrahydronaphthalene (tetralin) achieved by electrolysis in ethyldiamene saturated with lithium chloride. This reduction could also be carried out with tetrabutylammonium iodide as the supporting electrolyte.
- OP 749. Stever, Keith R., and Howard H. Heady. Rare-Earths: X-Ray Spectrometry. *Encyclopedia of X-Rays and Gamma Rays*, ed. by G. L. Clark, Reinhold Publishing Co. New York, 1963, pp. 913-915. Outlines X-ray fluorescence techniques for analyzing rare earths. Direct qualitative X-ray analysis of rare-earth minerals is feasible, but for quantitative determinations, prior chemical separation of the rare-earth group is necessary. Tabulated data show the most suitable X-ray emission lines for determining the individual elements in a rare-earth oxide mixture.
- OP 750. Stever, Keith R., Joseph L. Johnson, and Howard H. Heady. X-Ray Fluorescence Analysis of Tungsten-Molybdenum Metals and Electrolytes. *Advances in X-Ray Analysis*, v. 4, 1961, pp. 474-487. An X-ray fluorescence method is presented for the analysis of tungsten-molybdenum solutions. The technique is also applied to the analysis of tungsten and molybdenum in fused salts and to the determination of several other impurity elements in these metals. A double detector modification for the General Electric X-ray unit is described. Advantages in specific applications are discussed.
- OP 751. Stewart, Robert F., and W. T. Abel. The Inhibition of Graphite Oxidation by Hydrogen. *Proc. United States-United Kingdom Meeting on the Compatibility Problem of Gas-Cooled Reactors*, Oak Ridge National Laboratory, Tennessee, Feb. 24-26, 1960, v. 2, AEC TID-7597, Mar. 3, 1961, pp. 586-596. While developing a heat exchanger to serve as a coal gasifier utilizing nuclear-derived process heat, it was observed that trace impurities in the high-temperature recycle gas seriously damaged structural materials, such as graphite and metal. Addition of small amounts of hydrogen to the recycle gas greatly retarded the oxidation of these materials. The rate of reaction of hydrogen with graphite is reported at temperatures to 2,800° F and partial pressures to 1 atmosphere. Provided the graphite is more than one-half-inch thick, about 0.5 pound of graphite is consumed per day per square foot exposed to hydrogen at 2,400° F. Experimental apparatus used in this work is described, and the results of applying this method of inhibiting the oxidation of graphite or metals in a recycle system operating at 2,400° F and 250 psia are given. Substitution of the slow graphite-hydrogen reaction for the relatively rapid oxidation reaction promises to extend the operating life of reactors and other process equipment.
- OP 752. Strimbeck, Donald C., David C. Sherren, Jack Smith, and Robert W. Cargill. Big Noise Subdued. *Nat. Safety News*, v. 90, No. 2, August 1964, pp. 24-27. Gives results of the tests of the sound-control and hearing-protection measures adopted by the Bureau for the coal-fired gas turbine. This is the second of two articles.
- OP 753. Strimbeck, Donald C., Jack Smith, Robert W. Cargill, and J. P. McGee. Feeding Coal to a Gas Turbine. *Combustion*, v. 33, No. 9, April 1962, pp. 40-44. Describes two coal-feeding systems for a coal-fired gas turbine, one containing small, non-standard equipment designed to fit into a locomotive and the other including standard commercially available parts.
- OP 754. Stroud, Lowell, W. E. DeVaney, and John E. Miller. Multiple Liquid Phases in a Natural Gas System. *Trans. Soc. Petrol. Eng. AIME*, v. 222, pt. 2, 1961, pp. 137-141. Reviews the published literature on the occurrence of multiple equilibrium liquid phases and presents analytical data for the vapor and two equilibrium liquid phases of the liquefied natural gas at five experimental conditions. In addition, data for 30 conditions of two-phase equilibria are included.
- OP 755. Stroud, Lowell, John E. Miller, and L. Warren Brandt. Compressibility of Helium at -10° to 130° F. and Pressures to 4,000 p.s.i.a. *J. Chem. and Eng. Data*, v. 5, No. 1, January 1960, pp. 51-52. Using a new experimental method, the compressibility of helium was studied at seven temperatures from -10° to 130° F and at pressures to 4,000 psia.

- OP 756. Sutton, Joseph A., and John D. Corrick. Microbial Leaching of Copper Minerals. *Min. Eng.*, v. 15, No. 6, June 1963, pp. 37-40. Discusses Bureau study to determine if pure strains of bacteria *Ferrobacillus ferrooxidans*, *Thiobacillus concretivorus*, and *Thiobacillus ferrooxidans* could utilize iron and sulfur occurring in sulfide minerals to produce appreciable quantities of ferric sulfate and sulfuric acid for dissolving copper and to develop the chemistry involved in the microbial oxidation of sulfide minerals.
- OP 757. Tenney, R. F., and J. W. Eckard. Performance Characteristics of Small Industrial-Type Anthracite Stokers. *Proc. Anthracite Conf.*, Pennsylvania State Univ., Miner. Ind. Exp. Sta. Bull. 75, 1961, pp. 39-62. Four anthracite-burning stokers under identical 74-horsepower boilers were tested in accordance with the ASME Test Code, and the heat efficiencies and other operating characteristics were determined over a wide range of outputs. The daily performance of one of these stoker-boiler units was then determined while it was operated under automatic pressure control in building heating service for 4 months during the winter spring season.
- OP 758. Thatcher, John W., and William J. Campbell. Evaluation of a Demountable X-Ray Tube Vacuum Spectrograph for the Determination of Low-Atomic-Number Elements. *Advances in X-Ray Analysis (Proc. 12th Ann. Conf. on Applications of X-Ray Analysis)*. Plenum Press, New York, v. 7, 1964, pp. 512-522. Reviews the fluorescent excitation of long-wavelength X-ray spectra with respect to X-ray tube target element, inherent filtration, and optimum kilovoltage. A demountable X-ray tube vacuum spectrograph designed for the determination of the light elements is described. Operation of this instrument with both secondary and combined primary-secondary excitation is evaluated. Examples from the literature are cited to show the feasibility of direct electron excitation of long-wavelength spectra.
- OP 759. Thomas, D. E., and E. T. Hayes (eds.). *The Metallurgy of Hafnium*. Naval Reactors, Div. of Reactor Development, AEC, 1960, 384 pp. This book is based largely on the assembly and critical review of information on the development and fabrication work that was performed on hafnium to permit its use in water-cooled reactor cores.
- OP 760. Thomas, Edward. Rock Stabilization Through Bolting. *Second Protective Construction Symp.*, Santa Monica, Calif., Mar. 26, 1959, The Rand Corp., Santa Monica, Calif., 1959, v. 1, pp. 149-168. Summarizes the uses of rock bolting in underground mines throughout the United States. Describes methods for successful use of bolts, type of anchor, correct patterning, and tension maintained between the anchorage point and the bolt head.
- OP 761. Thompson, C. J., H. J. Coleman, R. L. Hopkins, and H. T. Rall. Identification of Alkyl Cycloalkyl Sulfides in Petroleum. *J. Chem. and Eng. Data*, v. 9, No. 2, April 1964, pp. 293-296. Describes the tentative identification of five alkyl cycloalkyl sulfides in Wason, Tex., crude oil. This represents the first known identification of this class of sulfur compounds in petroleum.
- OP 762. ———. Identification of Some Chain Sulfides in a Wason, Texas, Crude Oil Distillate Boiling from 111° to 150° C. *J. Chem. and Eng. Data*, v. 9, No. 3, July 1964, pp. 473-479. Describes a procedure for the concentration and identification of sulfur compounds in petroleum. Application of this procedure resulted in the identification of 22 chain sulfides.
- OP 763. Thompson, C. J., H. J. Coleman, R. L. Hopkins, C. C. Ward, and H. T. Rall. Identification of Oxygen Compounds in Gas-Liquid Chromatographic Fractions by Catalytic Deoxygenation. *Anal. Chem.*, v. 32, No. 13, December 1960, pp. 1762-1765. Considers the catalytic desulfurization of components in gas-liquid chromatographic fractions as applied to a few representative individuals of various oxygen compound classes.
- OP 764. Thompson, C. J., H. J. Coleman, C. C. Ward, and H. T. Rall. Desulfurization as a Method of Identifying Sulfur Compounds. *Anal. Chem.*, v. 32, No. 3, March 1960, pp. 424-430. Describes a micromethod developed for the catalytic removal of sulfur from sulfur compounds to yield hydrocarbons for which standard compounds are available. Presents data showing the desulfurization of typical members of the sulfur compound classes—alkane and cycloalkane thiols, alkane and cyclic sulfides, thiophenes, and benzothiophenes.
- OP 765. ———. Identification of Halogen Compounds by Catalytic Dehalogenation. *Anal. Chem.*, v. 34, No. 1, January 1962, pp. 154-156. Describes a micromethod for rapidly and quantitatively removing the halogen atoms from an organic molecule, leaving a hydrocarbon. Identification of the hydrocarbon will characterize or aid in the characterization of the halogen precursor. Method will handle samples as small as 0.0002 ml.
- OP 766. ———. Identification of Nitrogen Compounds by Catalytic Denitrogenation. *Anal. Chem.*, v. 34, No. 1, January 1962, pp. 151-154. Describes a micromethod for rapidly and quantitatively removing the nitrogen atom from organic nitrogen compounds to produce hydrocarbons. Identification of the produced hydrocarbon identifies or contributes to the identification of the nitrogen compound precursor. Presents data showing the application of this technique to pure compounds and to mixtures of nitrogen compounds of unknown composition.
- OP 767. Thompson, C. J., and W. E. Haines. Methods for the Determination of Sulfur-Based Functional Groups Containing No Elements Other Than Carbon, Hydrogen, and Sulfur. *Handbook of Analytical Chemistry*, ed. by G. Meites. McGraw-Hill Book Company, Inc., New York, 1963, pp. 12-150 through 12-155. Consists of a number of tables pertaining to analytical methods for the determination of sulfur groups containing only carbon, hydrogen, and sulfur.
- OP 768. Thompson, C. J., F. G. Mueller, H. J. Coleman, and H. T. Rall. Continuous Sampling Device for Liquid Thermal Diffusion Separations. *Ind. and Eng. Chem.*, v. 52, No. 2, February 1960, pp. 53A-54A. Describes a continuous sampling device developed, tested, and used to separate selected mixtures by liquid thermal diffusion.
- OP 769. Thorne, Harold M. Bureau of Mines Oil-Shale Research. *Colorado Sch. Mines Quart.*, v. 59, No. 3, July 1964, pp. 77-90. Discusses the Bureau of Mines continuing research program which is intended to encourage and assist private industry in the orderly development of the Nation's oil-shale resources by providing technical information on oil-shale deposits, the characteristics and compositions of shales and their products, and chemical reactions and conversion techniques involved in producing useful fuels and byproducts.
- OP 770. Tiensuu, V. H., S. Ergun, and L. E. Alexander. X-Ray Diffraction From Small Crystallites. *J. Appl. Phys.*, v. 35, 1964, pp. 1718-1720. The classical crystallographic equations used in deducing structure from peak positions, peak widths, and integrated densities of X-ray scattering are facile enough, but they involve assumptions that are not valid for extremely small crystallites. An alterna-

- tive approach more generally valid is to use the Debye interference function. These two different approaches have been compared, using as examples a diamond crystallite containing 3 unit cells on a side ($\sim 10.7 \text{ \AA}$) and one containing 10 unit cells on a side ($\sim 35 \text{ \AA}$).
- OP 771. Tisot, P. R. Properties of Green River Oil Shale, Determined From Nitrogen Adsorption and Desorption Isotherms. *J. Chem. and Eng. Data*, v. 7, No. 3, July 1962, pp. 405-410. Presents information regarding particle size and particle-size distribution of the mineral constituents; surface area, pore structure and pore volume of both oil shale and its mineral constituents; the manner in which the organic matter is distributed within oil shale; and an estimate of the amount of organic matter in direct contact with the mineral constituents. Work done in cooperation with University of Wyoming.
- OP 772. Tisot, P. R., and W. I. R. Murphy. Physicochemical Properties of Green River Oil Shale: Particle Size and Particle-Size Distribution of Inorganic Constituents. *J. Chem. and Eng. Data*, v. 5, No. 4, October 1960, pp. 558-562. Presents information relating to the particle size, particle-size distribution, and size classification of the primary inorganic particles from oil shale taken at two different levels in the Selective mine, Rifle, Colo.; discusses procedure followed to remove the organic matter from the inorganic phase; includes photomicrographs of the larger primary inorganic particles.
- OP 773. Turnbull, Louis A. The Importance of a Central Mines Bureau in Fostering Development of Mineral Resources. U.S. Papers Prepared for the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas, Geneva, February 1963. *Natural Resources: Minerals and Mining, Mapping and Geodetic Control*, v. 2, 1963, pp. 23-31. Gives reasons for the necessity of a central mining bureau, the objectives of a successful bureau, and the organization necessary to ensure efficient operation.
- OP 774. Utter, Stephen. Stress Determinations Around an Underground Mine Opening. *Proc. Internat. Symp. on Mining Research*, February 1961, Pergamon Press, New York, v. 2, 1962, pp. 569-582. Presents results of strain relief measurements around a typical underground mine opening. Instrumentation consisted of electric resistance strain gage rosettes and a portable static strain indicator.
- OP 775. Van Dolah, R. W. Evaluating the Explosive Character of Chemicals. *Trans. Nat. Safety Cong.*, v. 5, 1959, pp. 5-12; *Ind. and Eng. Chem.*, v. 53, No. 7, July 1961, pp. 59A-62A. Discusses the chemicals that are actually explosives or those that are capable of a detonation reaction or a rapid, self-propagating decomposition or oxidation-reduction reaction. Describes various tests for evaluating the explosives characteristics of chemical substances.
- OP 776. ———. Field-Mixed Ammonium Nitrate Blasting Agents. *Nat. Safety Cong. Trans.*, v. 4, 1959, pp. 21-27. Discusses the development of field-mixed blasting agents typically based on fertilizer-grade prilled ammonium nitrate and recommends procedures for the safe utilization of these agents.
- OP 777. ———. Recommended Safe Practices for Field-Mixed Ammonium Nitrate Blasting Agents. In *5th Annual Symposium on Mining Research*, Nov. 19-20, 1959, Univ. of Missouri School of Mines and Metallurgy Bull. 98, 1960, p. 148. Indicates the information program conducted by the Bureau of Mines as a result of its laboratory investigations on the sensitivity and detonation properties of blasting agents based on fertilizer-grade ammonium nitrate.
- OP 778. Van Dolah, R. W. Remarks at Ammonium Nitrate and Public Safety—Symposium. *Proc. 53d Ann. Meeting, Fire Marshals Assoc. of North America*, Atlantic City, N.J., 1959, pp. 9-11. Discusses the problems that are created when a fire starts in or near ammonium nitrate.
- OP 779. ———. Rev. of "Chemistry and Technology of Explosives," by T. Urbanski. *Science*, v. 145, No. 3637, Sept. 11, 1964, p. 1176.
- OP 780. Van Dolah, R. W., N. E. Hanna, and R. L. Grant. Relative Efficacy of Stemming Materials in Reducing Incendivity of Permissible Explosives. *Pres. at 11th Internat. Conf. of Directors of Safety in Mines Res.*, Warsaw, Poland, Oct. 16-24, 1961, 8 pp. (preprint). (Pub. as RI 5863.) Discusses relative efficacy of water and several other stemming materials in reducing the incendivity of the gallery-cannon shot in firedamp.
- OP 781. Van Dolah, R. W., N. E. Hanna, E. J. Murphy, and G. H. Damon. Further Studies on Ammonium Nitrate-Fuel Oil Compositions. In *5th Annual Symposium on Mining Research*, Nov. 19-20, 1959. *Univ. of Missouri School of Mines and Metallurgy Bull.* 98, 1960, pp. 90-101. This paper is the second resulting from a study of the detonation products of ammonium nitrate-fuel oil compositions and especially the production of oxides of nitrogen. In the present investigation, fume production was observed in the laboratory (Crawshaw-Jones technique) and underground in a potash mine. It was found that dry, well-mixed oxygen-balanced AN-FO mixtures, initiated by a strong primer, produce oxides of nitrogen in quantities comparable to certain commercial dynamites. However, the mixtures are sensitive to variations in composition, moisture, and initiation which must be carefully controlled to prevent toxic fume hazards.
- OP 782. Van Dolah, R. W., E. J. Murphy, and N. E. Hanna. Fumes From Ammonium Nitrate-Hydrocarbon Mixtures. Ch. in *Mining Research*, ed. by George B. Clark. Pergamon Press, New York, 1961, pp. 77-89. Gives data on the toxic fumes produced when AN-FO compositions were detonated under laboratory and field conditions simulating underground blasting.
- OP 783. Vogely, William A. Basic Minerals: Mineral Output to Rise Slightly. *Chem. and Eng. News*, v. 38, No. 36, Sept. 5, 1960, pp. 110-117. In September 1959 the chemical industry was still rebounding strongly from the 1958 recession. Business has since continued on the upgrade, but many other problems—higher costs, keener competition, overcapacity, and others—have taken some of the sparkle off the recovery. This article presents a detailed look at what the industry is doing now and where it is likely to go in the months just ahead.
- OP 784. Volk, William, and Lloyd H. Banning. Experimental Production of Steel From Hydrogen-Reduced Iron Powder. *Proc. Electric Furnace Conf.*, v. 20, AIME, 1962, pp. 418-433. Gives results of steelmaking tests conducted in a conventional electric-arc furnace of 1-ton capacity to determine the feasibility of producing steel from hydrogen-reduced iron powder that had been produced from a high-grade hematite iron ore and from titaniferous furnace charges. Work done in cooperation with Hydrocarbon Research, Inc.
- OP 785. Waddington, Guy, J. C. Smith, K. D. Williamson, and D. W. Scott. Carbon Disulfide as a Reference Substance for Vapor-Flow Calorimetry;

- the Chemical Thermodynamic Properties. *J. Phys. Chem.*, v. 66, June 1962, pp. 1074-1077. Reports measurements of heat of vaporization and vapor heat capacity for carbon disulfide, a proposed reference substance for flow calorimetry. Experimental and calculated heat capacity values are compared.
- OP 786. Wallace, J. J. Bureau of Mines Research in Hydraulic Coal Mining. *Min. Cong. J.*, v. 47, No. 1, January 1961, pp. 52-54. After making a literature survey of hydraulic mining in Russia and New Zealand and observing the hydraulic mining of gilsonite, the Bureau of Mines decided to determine if American coalbeds could be mined hydraulically. Experiments were conducted in the hard bituminous Pittsburgh coalbed in Indiana County, Pa. This article describes these tests; it covers such aspects as nozzle size, water pressure, and mining methods.
- OP 787. Wang, K. P. Coal Research and Techniques in Communist China. *Coal Age*, v. 64, No. 10, October 1959, pp. 110-112. Reviews briefly coal research and techniques in Communist China. Highlights developments to enable interested parties to study the problems more thoroughly.
- OP 788. ———. Mineral Wealth and Industrial Power: Communist China's Boasts Begin to Come True. *Min. Eng.*, v. 12, No. 8, August 1960, pp. 901-912. Indicates the industrial progress achieved on the China mainland under the Communist regime. Discusses the country's mineral self-sufficiency, regional factors affecting mineral development, management of the mineral industry, and the present level of mineral technology. Presents individual reviews of the major sectors of Communist China's mineral industry.
- OP 789. ———. Vast Expansion of Aluminum-Alumina Is Planned by Chinese Communists. *Eng. and Min. J.*, v. 160, No. 7, July 1959, pp. 75-77, 123. Describes the growth of Communist China's aluminum industry since its resumption of operations in 1954. Considers the nation's ore-processing procedures and its power resources. Discusses the country's leading aluminum plants and mentions smaller plants.
- OP 790. Ward, C. C. Physical and Chemical Characteristics of Paraffin. *Proc. 2d Ann. Paraffin Control Short Course, Univ. of Oklahoma, 1959*, pp. 11-15. Paraffin accumulates on the face of the producing sand, on the rods, and in the flow lines, thus restricting oil production. The crude paraffin deposits contain not only wax but also crude oil, gums, resins, asphaltenes, water, sand, silt, and mineral salts. The most important constituent of crude paraffin is wax, which acts as a binder for the other materials. The properties of refined wax and the effect of the other constituents on these properties is reviewed. Paraffin deposits can be controlled to some extent by maintaining a back pressure on the well and by keeping the face of the sand covered with oil.
- OP 791. Ward, C. C., and F. G. Schwartz. The Role of Sulfur and Nitrogen Compounds in the Storage and Utilization of Petroleum Products. *Proc. API*, v. 42, sec. 8, 1962, pp. 129-130. Shows that studies of fuel degradation reactions indicate that sulfur and nitrogen compounds promote fuel instability in storage. Additional research is needed to identify the types of sulfur compounds that are responsible and to identify the types of hydrocarbons with which they react.
- OP 793. Wasson, James A. The Application of Hydraulic Fracturing in the Recovery of Oil by Waterflooding: A Summary. *Producers Monthly*, v. 27, No. 7, July 1963, pp. 12-15. Summarizes the results and conclusions reached by various investigators who have attempted to determine the extent to which hydraulic fracturing will affect the secondary recovery of crude oil by waterflooding. Also discusses the most advantageous use of the well-stimulation method in waterflood projects.
- OP 794. Watkins, J. Wade. Properties of Produced Waters. Ch. 21 in *Petroleum Production Handbook*. McGraw-Hill Book Co., Inc., New York, v. 11, 1962, pp. 21-1-to-21-20. Discusses the history and uses of water analyses; origin of interstitial waters; major, minor, and trace constituents of produced waters. Gives ranges of concentrations of ions in waters from numerous oil-productive areas in the United States, Canada, and Venezuela.
- OP 795. Watkins, J. Wade, F. E. Armstrong, and R. J. Heemstra. Feasibility of Radioactive Waste Disposal in Shallow Sedimentary Formations. *Nuclear Sci. and Eng.*, v. 7, No. 2, February 1960, pp. 133-143. One of the pressing problems of the potential nuclear-power industry is the necessity for disposing of radioactive wastes incident to operating reactors and recovering fissionable material from expended fuel elements. The Bureau of Mines has made a detailed analysis of the feasibility of solving this problem in areas where the geology permits by injecting liquid wastes into shallow, permeable, sedimentary rock formations.
- OP 796. Watkins, J. Wade, F. E. Armstrong, and W. D. Howell. Interwell Uses of Radioactive Isotopes in Oilfield Exploitation. *Proc. 2d Symp., on the Development of Petrol. Res. of Asia and the Far East, ECAFE and Dept. of Interior Contributions to ECAFE, September 1962*, pp. 238-270. Discusses Bureau research on techniques and instruments for radiotracer studies in petroleum research. Numerous substances, including krypton 85, tritium-labeled isopropyl alcohol, and tritiated water, are evaluated for use in interwell systems.
- OP 797. Watson, Richard W., and Frank C. Gibson. Jets From Imploding Bubbles. *Nature*, v. 204, No. 4965, Dec. 26, 1964. A hypothesis relating low-velocity detonations in liquid explosives to fluid cavitation is discussed; a photographic study of liquid jets generated by collapsing bubbles suggests micro-jetting as a probable initiation mechanism.
- OP 798. Weaver, H.P. Cause Analysis of Coal Mine Ignitions and Fires. *Coal Age*, v. 65, No. 12, December 1960, pp. 83-84; *Safety Newsletter, Coal Mining Section, National Safety Council, August 1960*, pp. 1-3. During the 8 years after passage of the Federal Coal Mine Safety Act, the Bureau of Mines investigated the fatal and nonfatal injuries resulting from gas and/or dust ignitions and underground mine fires. The main causes of the ignitions in the order of their importance were electricity, sparks from cutting bits, explosives, open flame or smoking, flame safety lamps, and mine fires. The major portion of the fires were caused by electricity, friction heat from belts, spontaneous ignition, explosives, and surface fires that crept underground.
- OP 799. Weaver, Harry F. Coal's Concern. *Mechanization*, v. 26, No. 10, October 1962, pp. 52-53. Discusses the causes of coal-mine fatalities in 1961 and makes suggestions for preventing similar accidents.
- OP 800. ———. What's Up in Coal? *Coal Age*, v. 67, No. 7, July 1962, pp. 89-90. Discusses the rising fatality rate, based on man-hours of exposure. Leading causes of fatalities were falls of roof, electricity, machinery, and fires.
- OP 801. Wei, Anton W. T., and Edgar J. Gealy. Mainland China. *Min. J. (London), Annual Review 1964*, pp. 245-247. Reviews the mineral industry of Communist China and the production of

- coal, petroleum, ferrous and nonferrous metals, cement, asbestos, fertilizers, and salt.
- OP 802. Weintraub, Murray. Chemical Engineering Aspects of Fluid Dynamics. *Ind. and Eng. Chem.*, v. 56, No. 4, April 1964, pp. 43-48. Surveys the literature on fluid dynamics with reference to single-phase flow, meters and controls, fixed beds, fluidized beds, two-fluid phases, solid-fluid transport, solid-fluid separation, and mechanical factors.
- OP 803. ———. Flow of Fluids. *Ind. and Eng. Chem.*, v. 52, No. 3, March 1960, pp. 257-261; v. 53, No. 5, May 1961, pp. 405-408. An annual review and bibliography of the literature of fluid dynamics.
- OP 804. ———. The Practical Aspects of Fluid Mechanics. *Ind. and Eng. Chem., Ann. Rev. Supp.*, v. 54, 1962, pp. 120-123. Surveys recent publications in fluid dynamics. From the voluminous literature, more than 50 references are briefly collated as indicative of the most significant trends in the field.
- OP 805. Weintraub, Murray, S. A. Goldberg, and A. A. Orning. A Study of Sulfur Reactions in Furnace Deposits. *J. Eng. Power*, v. 83, October 1961, pp. 444-450. An experimental study revealed several relationships between coal ash, flue-gas composition, and temperature, which may be related to the causes of fireside deposit formation.
- OP 806. Wellman, Paul, and Sidney Katell. How Pressure and Oxygen/Methane Ratio Affect Partial Oxidation. *Hydrocarbon Processing and Petrol. Ref.*, v. 43, No. 12, December 1964, pp. 106-108. Determining the product gas from the partial oxidation of methane requires the simultaneous solution of the equilibrium equations and a thermal balance. The thermal balanced is based on the oxygen-to-methane ratio, the heats of reactions, and the specific heat of the product gases. A simplified solution involving a computer program is illustrated and the results presented graphically.
- OP 807. ———. How Pressure and Temperature Affect Steam-Methane Reforming. *Hydrocarbon Process and Petrol. Refiner*, v. 42, No. 6, June 1963, pp. 135-138. Determining the product gases evolved during the catalytic steam-methane reaction at various pressures, temperatures, and steam-to-methane ratios requires the simultaneous solutions of the equilibrium equations of the two controlling reactions. A simplified solution involving a computer program is illustrated, and the results are presented graphically.
- OP 808. Wender, Irving. Review of "Organometallic Chemistry," ed. by H. Zeiss. *J. Am. Chem. Soc.*, v. 83, 1961, p. 4111. Recommends the book for all chemists and those interested in catalysis. Although the book does not attempt to be comprehensive, the treatment of the portion of organometallic chemistry covered is uniformly excellent. Gives over 1,700 references, including many published in 1960.
- OP 809. Wenger, W. J., and J. S. Ball. Characteristics of Crude Oils From Utah. *Utah Geol. and Mineral. Surv. Bull.* 54, January 1963, pp. 497-510. Summarizes analyses of 38 crude oils from Utah as determined by the Bureau of Mines method. Geological correlation with properties are described.
- OP 810. Westfield, James. Successful Accident Prevention Program for Bituminous Coal Mines. Part D. Bureau of Mines Accident Prevention Program. *Proc. Mine Inspectors' Inst. of America, Terre Haute, Ind.*, 1959, pp. 50-53. Declares that the education of people in safety is one of the Federal Bureau of Mines primary roles. Considers the Bureau's direct contacts with the coal-mining industry in courses of instruction, inspections, investigations, demonstrations, and publications. Discusses first aid and mine rescue, accident-prevention education, visual aids, permissible equipment, roof-control investigations, and mine ventilation.
- OP 811. Westrum, Edgar F., Jr., and John P. McCullough. Thermodynamics of Crystals. Ch. in *Physics and Chemistry of the Organic Solid States*, ed. by D. Fox, M. M. Labes, and A. Weissberger. Interscience Publishers, Inc., New York, 1963, pp. 1-156. Summarizes the most salient of the theoretical and experimental developments in the thermodynamics of organic crystals.
- OP 812. Wheeler, Henry P. Jr. Helium. *Encyclopaedia of Chemical Technology*, 2d Supplement v., Interscience Publishers, Inc., New York, 1960, pp. 454-459. Reveals the great recent increases in the production and consumption of helium. Explains the new uses that have been found and the new problems that have been encountered.
- OP 812A. ———. The Government's Helium Conservation Program and Its Impact on the Natural Gas Industry. *J. Colloid Sci.*, vol. 16, No. 5, October 1961, pp. 493-496. The demand for helium in 1960 was almost six times greater than that of 1950. The Government plans to offer industry long-term guaranteed purchase contracts for helium extracted from fuel gases. Thus, the Government will acquire the same physical possession and control of the helium as would be obtained with Government plants. If industry should be unwilling to build the necessary plants and sell the helium to the Government at a reasonable price, the Government will build the plants. Regardless, the new helium plants contemplated will cost \$175 to \$200 million. Up to 1,000 new jobs will become available, requiring skills and experiences found in the natural gas industry. The plants will require about 42,000 tons of steel, about 200,000 engine horsepower, and about 35,000 valves.
- OP 813. ———. Helium for Tomorrow. *IEEE Trans. on Aerospace*, v. AS-1, No. 2, August 1963, pp. 1198-1202. Gives a brief summary of the Bureau's work in helium production and outlines the helium-conservation program, which will assure an adequate supply of helium until the year 2000.
- OP 814. ———. Natural Gas Industry's Stake Is Cited in Interior's Helium Conservation Policy. *The Oil Daily*, May 19, 1959, p. 22. Explains the helium-conservation policy announced by the Department of the Interior in May 1958. Explains the importance and probable future of helium.
- OP 815. Whisman, M. L. Preparation of Tritium-Labeled 1-Hexene and 1-Octene. *Anal. Chem.*, v. 33, No. 9, August 1964, pp. 1284-1285. Describes two techniques used by Bureau of Mines personnel to prepare tritium-labeled terminally bonded monoolefins. The first method is more efficient but less versatile, as it requires a specific starting material that may not be readily available. This procedure involves the saturation of one olefin bond in a terminally bonded di-olefin with tritium. The second method combines the Wilzbach exchange labeling with a simple organic synthesis.
- OP 816. Whisman, Marvin L., and Barton H. Eccleston. Gas-Exposure Labeling of Organics With Tritium. *Nucleonics*, v. 20, No. 6, June 1962, pp. 98-102. Reviews state of the art of gas-exposure tritium labeling, including original observations made by Wilzbach, modifications to the original procedure, and problems concerned with purification of labeled materials.
- OP 816A. ———. Purification of Radioactive Organic Compounds: A Noncontaminating Gas Liquid Chromatographic System. *Anal. Chem.*, v. 35, No. 9, August 1963, pp. 1333-1334. Describes a unique and inexpensive modification to conventional gas-liquid chromatographic apparatus that eliminates

- costly decontamination procedures subsequent to processing of organic materials labeled with low-energy beta emitting radioisotopes.
- OP 817. Whisman, Marvin L., Barton H. Eccleston, and F. E. Armstrong. Liquid Scintillation Counting of Tritiated Organic Compounds. *Anal. Chem.*, v. 32, No. 4, April 1960, pp. 484-486. The use of tritium-tagged hydrocarbons in analytical research has made it necessary to evaluate some of the parameters involved in liquid scintillation-counting techniques. From these evaluations, a routine procedure for measuring the radioactivity of tritiated organic compounds and the confidence limits of results has been established. This paper evaluates the more significant variables and sets forth the conditions and procedure adopted by the Bureau of Mines.
- OP 818. Whisman, Marvin L., B. H. Eccleston, F. G. Schwartz, C. S. Albright, and C. C. Ward. The Preparation and Use of Tritiated Organic Compounds for Tracers in Motor Gasoline Stability Studies. *Trans. Am. Nuclear Soc.*, v. 3, No. 1, June 1960, p. 202. Describes a program designed to identify constituents of an unstable gasoline that react to form gum and to postulate and confirm reaction mechanisms that are involved.
- OP 819. Whisman, Marvin L., F. G. Schwartz, and Barton H. Eccleston. Susceptibility of Organic Compounds to Tritium-Exchange Labeling. *Abs. in Vapor Pressure*, v. 30, No. 3, March 1960, p. 70.
- OP 820. Wilfong, Roy L., Louis P. Dominguez, and LeRoy R. Furlong. Thermogravimetric Analysis of Five Salts of Praseodymium, Neodymium, and Samarium. *J. Am. Ceramic Soc.*, v. 47, No. 5, May 1964, pp. 240-241. Describes research to determine the mechanisms of the thermal decomposition of the ammonium sulfate, carbonate, nitrate, oxalate, and sulfate salts of praseodymium, neodymium, and samarium. The pyrolytic sequences were identified, and the temperatures of formation of intermediates and of the sesquioxides were determined.
- OP 821. Williams, Fred A. Trailing Cables and Short-Circuit Protection. *Mechanization*, v. 27, No. 1, January 1963, pp. 59-61. Discusses the protection equipment that can lower the fire hazards resulting from short circuits in trailing cables.
- OP 822. Willmott, L. F. Forced Convection Heating—Its Application to Bituminous Coal-Water Slurries. *Ind. Heating*, v. 29, No. 3, March 1962, pp. 462-464, 466, 548. Describes a forced-convection heater for coal-water slurry designed by the Bureau for use in gasification research.
- OP 823. Winans, G. D. Air Does a Lot of Good in Uranium Mines. *Safety Newsletter*, Mining Section of Nat. Safety Council, September 1960, pp. 1-2. Discusses some selected examples of mines where a small quantity of airflow reduced the concentration of radioactive contaminants.
- OP 824. Woleben, F. D., and J. B. Stepan. "Impact" for Your Eye Protection Program. *Proc. 36th Annual Conf. Lake Superior Mines Safety Council*, May 19-20, 1960, Duluth, Minn., pp. 88-96. Reviews various methods of promoting an eye-protection program and suggested ways and means of adding some "punch" or "impact" to eye-protection promotions. Discusses and demonstrates various specifications and tests for safety lenses and frames; that is, prismatic and refractive power of lens, strength of frames and lenses, and so forth.
- OP 825. Wolfhard, H. G., and A. E. Bruszk. The Passage of Explosions Through Narrow Cylindrical Channels. *Combustion and Flame*, v. 4, No. 2, June 1960, pp. 149-159. Deals with the mechanism by which explosions are transmitted through narrow cylindrical channels. Knowledge of this process is important for understanding flame traps and the flameproofing of electrical equipment in mines.
- OP 826. Wolfson, David E. Disc. of "Use of Coal Plasticity in Coke Plant Coal Blending," by W. G. Schulze and G. C. Soth. *Proc. Blast Furnace, Coke Oven, and Raw Materials Comm., AIME*, Chicago, Ill., April 4-6, 1960, v. 19, pp. 78-80.
- OP 827. Wolfson, D. E., G. W. Birge, and J. G. Walters. Relation of Properties of Coke Produced by BM-AGA and Industrial Method. *Proc. Blast Furnace, Coke Oven, and Raw Materials Comm., AIME*, 1961, v. 20, pp. 387-403. The properties of 17 cokes produced by the BM-AGA and industrial methods were correlated. Since the capacity of the plants from which these samples were obtained is about 30 percent of the 1959 total for the United States, the data given are indicative of the chemical and physical properties of the coal blends used to produce industrial cokes and the acceptable chemical and physical properties of the resultant coke. Of the industrial cokes, 15 were produced in slot-type recovery ovens, 13 for blast furnace use, and 2 for foundry use. Two cokes were from beehive ovens. A high degree of correlation was obtained between the strength indexes of the BM-AGA and industrial cokes.
- OP 828. Wong, M. M., R. E. Campbell, and D. H. Baker, Jr. Fused Salt Electrorefining of Beryllium. *J. Metals*, v. 12, No. 10, October 1960, pp. 786-788. Discusses experimental apparatus, procedure, and results of electrorefining beryllium in fused LiCl-KCl-BeCl₂ baths.
- OP 829. Yarboro, Theodore L., Clarence Karr, Jr., and Patricia A. Estep. Preparation, Properties, and Spectra of Eight Alkylated Indenes. *J. Chem. Eng. Data*, v. 6, No. 3, July 1961, pp. 421-425. The properties and spectra of eight alkylated indenenes, including two not previously reported, are represented in order to aid in the separation and identification of alkyl aromatic hydrocarbons from the neutral oil of a low-temperature bituminous coal tar. The eight indenenes were prepared and purified. Physical properties, including spectra, were determined.
- OP 830. Young, W. H., and R. L. Anderson. 1959 Sales: Coal Mining and Cleaning Equipment. *Coal Age*, v. 65, February 1960, pp. 94-96; *Mining Cong. J.* v. 46, February 1960, pp. 122-125; *Mechanization*, v. 24, February 1960, pp. 95-97. Sales of face equipment increased over those of 1958 but did not reach the 1956-57 level. In terms of capacity, jigs continued to rank first in preparation equipment sales, with two-thirds of all coal cleaning equipment, sold in 1959 being for addition, to, or replacement of, existing facilities.
- OP 831. ———. 1960 Sales: Coal-Mining and Cleaning Equipment. *Coal Age*, v. 66, No. 2, February 1961, pp. 84-86; *Mechanization*, v. 25; No. 2, February 1961, pp. 63-65; *Min. Cong.*, v. 47, No. 2, February 1961, pp. 104-107. Sales of face equipment decreased 3 percent from those of 1959, but preparation equipment sales increased 35 percent. In capacity, dense medium ranked first in cleaning equipment sales; two-third of all preparation equipment sold in 1960 implemented or replaced existing facilities.
- OP 832. ———. 1961 Sales: Coal Mining and Cleaning Equipment. *Coal Age*, v. 67, No. 2, February 1962, pp. 78-80.; *Min. Cong. J.*, v. 48, No. 2, February 1962, pp. 136-139; *Mechanization*, v. 26, No. 2, February 1962, pp. 55-57. Shipments of mechanical-loading equipment for underground use in all coal mines in the United States, in terms of capacity, decreased 14 percent in 1961 from 1960. The capacity of mechanical-cleaning equipment sold

for use at bituminous coal mines also decreased 14 percent during the same period. Sales of coal-cleaning equipment, by type of equipment, in terms of capacity, show that dense medium ranked first, followed by jigs, wet tables, pneumatic, and flotation.

- OP 833. Young, W. H., and R. L. Anderson. 1962 Sales: Coal Mining and Cleaning Equipment. *Coal Age*, v. 68, No. 2, February 1963, pp. 84-85, 87; *Mechanization*, v. 27, No. 2, February 1963, pp. 45-48; *Min. Cong. J.*, v. 49, No. 2, February 1963, pp. 129-132. Shipments of mechanical loading equipment for underground use in all coal mines of the United States, in terms of capacity, increased 31 percent in 1962. Capacity of mechanical cleaning equipment sold for use at bituminous coal mines dropped 3 percent. Sales of coal-cleaning equipment, by type of equipment, in terms of capacity, show that dense medium ranked first, followed by pneumatic, wet tables, flotation, and jigs.
- OP 834. ———. 1963 Sales: Coal-Mining and Cleaning Equipment. *Coal Age*, v. 69, No. 2, February 1964, pp. 86-88; *Min. Cong. J.*, v. 50, No. 2, February 1964, pp. 132-135; *Mechanization*, v. 28, No. 2, February 1964, pp. 25-28; *Coal Min. and Processing*, v. 1, No. 2, February 1964, pp. 28-31. Shipments of mechanical loading equipment for underground use in all coal mines decreased 11 percent in 1963 from 1962. Capacity of mechanical cleaning equipment sold for use at bituminous coal mines increased 16 percent. Production of bituminous coal and lignite increased from 422 million tons in 1962 to an estimated 452 million tons in 1963. The percentage of total production produced by underground mines continued to decrease, while the percentage from strip and auger mines increased.
- OP 835. ———. Thermal Drying of Coal. *Coal Age*, v. 64, June 1959, pp. 114-115. Presents a statistical study of the types of drying equipment used at bituminous-coal preparation plants and the tonnages and sizes handled.
- OP 836. Youngs, Roger W., and Clyde M. Frost. Humic Acids From Leonardite; A Soil Conditioner and Organic Fertilizer. *Proc. North Dakota Acad. Sci.*, v. 17, 1963, pp. 76-82. Presents a simple rapid method for the separation of humic acids from oxidized lignitic coal. This consists of dissolving the humic acid in a solvent mixture composed of acetone-water-hydrochloric acid, separating the insoluble material by settling, and recovering the humic acids by distilling off the acetone. The resulting product is very low in ash content.
- OP 837. Zabetakis, M. G. Hazards in the Handling of Cryogenic Fluids. *Advan. Cryog. Eng.*, v. 8, 1963, pp. 236-241. Reviews the factors to be considered in connection with the hazards that may be encountered in handling cryogenic fluids, such as liquid helium, hydrogen, neon, nitrogen, carbon monoxide, fluorine, argon, oxygen, methane, and krypton.
- OP 838. Zaffarano, Richard F. A Review of Transportation, Liquefaction, and Storage of Natural Gas in the United States. *Proc. of 2d Symp. on the Development of the Petroleum Resources of Asia and the Far East*, Sept. 1-15, 1962, Teheran, Iran, pp. 271-276. Discusses the development of the natural gas industry in the United States including advances made in the storage and liquefaction of natural gas.
- OP 839. Zahn, Charles, Stanley H. Langer, Bernard D. Blaustein, and Irving Wender. Optical Activity in Oils Derived From Coal. *Nature*, v. 200, Oct. 5, 1963, pp. 53-54. Optical activity in coal survives, at least in part, catalytic hydrogenation at 8,000 psig and 450° to 525° C. The active materials isolated from the neutral oils likely are alkylsubstituted naphthenes and hydroaromatics.
- OP 840. Zaverl, Louis J. Are We Prepared? *Safety Newsletter*, Mining Section of Nat. Safety Council, August 1960, pp. 2-3. Emphasizes the importance of first-aid training and the need for refresher courses to keep employees abreast with changes in recommended procedures.
- OP 841. ———. Engineered Protection — Your Hard Hat. *Nat. Safety Council Safety Newsletter*, Min. Sec., March 1962. Describes the construction of the protective hat and how impact and penetration resistance are measured.
- OP 842. ———. From Head Coverings to Hard Hats. *Nat. Safety Council, Safety Newsletter*, Min. Sec., January 1962; *Dock Safety Association Safety Digest*, June 1962. Discusses the development of the protective head covering and the spread of the use of the hard hat to industries other than mining.
- OP 843. ———. Lake Superior Mines Safety Council Produces Results. *Skillings Min. Rev.*, v. 52, No. 21, May 25, 1963, pp. 6-7, 31. Gives brief historical account of mining in the Lake Superior region including the establishment of the Lake Superior Mines Safety Council. Structure and achievements of the council are discussed.
- OP 844. ———. Wearing and Caring for Your Hard Hats. *Nat. Safety Council, Safety Newsletter*, Min. Sec., June 1962; *Industrial Sections of the National Safety Council, Annual Newsletter*, December 1962. Gives directions for wearing and caring for the hard hat to derive the maximum protection that has been built into them.
- OP 845. Zellers, D. H. Developments in Methane Monitoring. *Mechanization*, v. 27, No. 3, March 1963, pp. 41-44. Discusses the problem of methane monitoring and describes the types of methane detection devices including the Bureau-developed monitoring device.
- OP 846. Zinner, Paul. The Noise Level of Science. *Am. Scientist*, v. 51, No. 3, September 1963, pp. 236A-248A. Makes suggestions on ways to improve the quality of published technical literature, and to make existing or projected systems for communicating scientific information more effective.

PATENTS

The following patents were granted to the Bureau of Mines between January 1, 1960, and December 31, 1964. These processes, which can be used by any U.S. citizen or organization without royalty payment, upon authorization by the Department of the Interior, were developed by Bureau scientists. Applications for the use of any of these patents should be made in writing to the Office of the Solicitor, U.S. Department of the Interior, Washington, D.C., 20240.

- P 1. Abel, W. T., and D. M. Bailey. Prevention of Embrittlement of Metals. U.S. Pat. 3,149,006, Sept. 15, 1964.
- P 2. Armstrong, F. E. A Method of Tracing the Flow of Liquids by Use of Post Radioactivation of Tracer Substances. U.S. Pat. 3,002,091. Sept. 26, 1961.
- P 3. Baker, D. H., Jr., and V. E. Homme. Production of High Purity Titanium by Metallic Sodium Reduction of Titanic Halide. U.S. Pat. 3,069,255, Dec. 18, 1962.
- P 4. Benson, H. E., and J. H. Field. Process for Manufacturing Mixtures of Hydrogen, Carbon Monoxide and Methane. U.S. Pat. 3,031,287, Apr. 24, 1962.
- P 5. Bienstock, Daniel, and J. H. Field. Process for the Removal of Sulfur Oxides from Flue Gases. U.S. Pat. 2,992,884, July 18, 1961.
- P 6. ———. Process for Removing Sulfur Dioxide From Gases. U.S. Pat. 3,150,923, Sept. 29, 1964.
- P 7. Bowie, Walter S. High Temperature Electrostatic Precipitator. U.S. Pat. 3,054,243, Sept. 18, 1962.
- P 8. Brandt, L. W., L. Stroud, and W. M. Deaton. Apparatus for Studying Phase Relationships of Gases and Gas Mixtures. U.S. Pat. 3,027,750, Apr. 3, 1962.
- P 9. Browning, J. S., and B. H. Clemmons. Separation of Spodumene and Beryl by Flotation. U.S. Pat. 3,028,008, Apr. 3, 1962.
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- P 11. Cotter, Perry G., and Ralph A. Potter. A Method for Producing Zirconium Diboride. U.S. Pat. 3,088,805, May 7, 1963.
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ABBREVIATIONS

AGS	Geological Survey of Alabama.	MTN	Mineral Trade Notes, Special Supplement.
B	Bulletin.	MY*	Minerals Yearbook.
BAH	Handbook.	OFR	Open-File Report.
BPA	Bonneville Power Administration, U.S. Department of the Interior.	OP	Article in outside publication.
BWH	Questions and Answers on Boiler-Feedwater Conditioning; Handbook.	P	Patent.
DAR	Annual Report of the Director, Bureau of Mines.	PHS	Public Health Service, U.S. Department of Health, Education, and Welfare.
IC	Information Circular.	PPS	Petroleum Products Survey.
M	Monograph.	RI	Report of Investigation.
MC	Miners' Circular.	S	Schedule.
MNR	Maryland Department of Geology, Mines, and Water Resources and the Geological Survey, U.S. Department of the Interior.	SP	Special Publication.
		VMR	Virginia Department of Conservation and Economic Development, Division of Mineral Resources.

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