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UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES

DISTRICT I

REPORT OF COAL-MINE OUTBURST
BROOKSIDE MINE
KENTUCKY JELLICO COAL COMPANY, INCORPORATED
BROOKSIDE, HARLAN COUNTY, KENTUCKY

April 9, 1963

By

J. L. Gilley
Mining Health and Safety Engineer

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Originating Office - Bureau of Mines
Barbourville, Kentucky
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Barbourville, Kentucky Subdistrict, Health and Safety District I

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INTRODUCTION

This report is based on an investigation made in accordance with provisions of the Federal Coal Mine Safety Act (66 Stat. 692; 30 U.S.C. Secs. 451-483).

A coal-mine outburst (bump) occurred during extraction of the outby portion of the 2 right K-Main barrier pillar in the subject mine at 9:45 p.m., April 9, 1963, resulting in injuries to John Henson, loading-machine operator, Cecil Dozier, utility man, and Isaac Hyde, Jr., shuttle-car operator. Henson received a fractured shoulder bone and contusions and abrasions of the head; Dozier received a hair-line fracture of one bone of the leg and contusions and abrasions of the head; and Hyde received a bruised leg, and, after examination at the hospital, was released and returned to duty without lost-time. John Henson and Cecil Dozier were confined to the hospital for 12 days. The other 6 men on the section were not injured and there was no damage to equipment.

After receiving information regarding the occurrence of the outburst through the Mount Hope Office, District C, and the Norton, Virginia Office, District I, on April 10, 1963, a joint investigation by company, State, and Federal officials was started the same day and was concluded April 12, 1963.

GENERAL INFORMATION

The mine operates through drifts in the high-volatile Harlan coal bed, which averages 42 inches in thickness in the area involved. A total of 55 men was employed underground and produced a daily average of 650 tons of coal on a double shift, 3 to 5 days a week. The coal was loaded with 14 BU Joy loading machines into shuttle cars which discharged the coal into mine cars for transportation to the surface. The mine is classed nongassy.

The mine was developed by a multiple-entry system and pillar extraction follows a room-and-pillar method of development. Entries ranged from 2 to 8 in number. Cross or face entries were projected at 2,000-foot intervals and

the room entries were turned 2 abreast at intervals of 500 feet off the face or cross entries. The K-Main face entries (the section involved in the bump) off Main Butt entry were driven as a group of 3 on 50-foot centers. Entries were 14 to 16 feet in width; the rooms were projected on various centers, ranged from about 35 to 75 feet and 20 to 30 feet in width. Crosscuts were 60 to 90 feet apart.

Pillars in the K-Main face entry section were extracted by single open-end pillar lifts 20 to 30 feet in width from either the room or the crosscut side of the pillars, but alternate lifts were not usually mined simultaneously in the same pillar. The barrier pillars, including the one involved in the bump on the right side of the K-Main face entries, were formed several years previously and they were of various shapes and sizes, as indicated in sketch A. Extensive roof falls and some heaving of the mine floor had occurred in the openings surrounding several of the pillars. Because of extensive falls, a set of 2 entries was driven on 50-foot centers parallel to the 3 original K-Main entries through the right barrier pillars within the last 2 years to reactivate the section and permit mining of the pillars at the top end of the section.

The depth of the cover over the area (2 and 3 right) involved, ranged from about 1,000 to 1,400 feet. The irregular crests of the mountain range on the property have elevations in excess of 3,000 feet. The main roof structure in the area is predominately thick, massive, fine grained sandstone, reportedly ranging up to 60 feet in thickness. Several of the overlying stratum of sandstone, according to logs of boreholes in the Harlan area, indicate thicknesses of 20 to 75 feet. Localized dispositional changes in the structure of the immediate roof occur and in many instances very abruptly; such an abrupt change occurred in the 2 right barrier area. From inspection of the caved material in the mined-out area inby the scene of the bump, the immediate roof was firm sandstone ranging up to more than 10 feet thick. Sandstone contacted the coal over the barrier pillar involved in the bump.

The floor for the first 2 to 6 feet was a hard, dense shale that resisted plastic flow but heaved extensively under abnormal pressures and was affected by water. The immediate floor structure was underlain by a comparatively thick sandstone formation.

The adopted standard roof-support plan for this mine required permanent timbers to be set on 4-foot centers along each side of the haulage roads and maintained to within 8 feet of the working faces. Additional timbers or 3-piece timber sets were provided if conditions warranted; safety posts were required at the working face. Roof bolts were installed at several locations along haulage roads.

Mining in the K-Main face entry section at the time of the outburst consisted of the extraction of the right and left barrier pillars and the entry chain pillars. The extent of development and the limit of pillaring the K-Main face section on the day of the bump are indicated in sketches A and B. It will also be noted from sketch A that the K-Main entry section is flanked on the right side by old workings of an abandoned mine. Rooms had been driven into the intervening barrier toward the old mine workings at several locations and had intersected the old mine workings. From sketch A it will be noted that the left and right barrier pillars were being extracted simultaneously. The 2 right barrier pillar was originally polygonal (pentagon) in shape and was 300 feet in length, 180 feet in width at the outby end, 240 feet wide at the thickest part (apex) and 160 feet in width at the inby end. However, on the date of the outburst, this barrier pillar had been reduced to a comparatively long and narrow rectangular pillar, as indicated in sketch B. The left barrier was rectangular and was 320 feet in length and 220 feet in width, but had been reduced to about one-third the original dimensions at the time of the outburst.

The plan for development and extraction of these barrier pillars was very similar to the plan used at this mine over a long period of years. One or two rooms, projected on about 30- to 35-foot centers and 20 to 28 feet wide were driven in succession across the inby ends of the barrier pillars and in sequence so that they would not be abreast. Crosscuts between the rooms are made at intervals of 15 to 35 feet. The thin pillars (yield pillars) are recovered after the rooms are completed where conditions permit.

Blasting after undercutting pillars is seldom done in the K-Main section because most of the coal falls or is dislodged during cutting operations. However, after the loose coal is loaded, the practice had been for the loading-machine operators to continue to dig coal from the pillar faces or ribs of pillars with the loading machines as long as the pillars continued to "work".

The sequence of events immediately preceding and at the time of the outburst was obtained from statements of witnesses and by a detailed examination of the area involved. Persons interrogated and who furnished information during the investigation include:

Lee Wilson	Superintendent
Robert Jackson	Night-Shift Section Foreman
John Henson, Jr.	Cutting-Machine Operator
Robert Collett	Cutting-Machine Helper
Isaac Hyde, Jr.	Shuttle-Car Operator
Hillary Miracle	Section Foreman (Day Shift)

The investigating committee consisted of:

Kentucky Jellico Coal Company, Incorporated

Lee Wilson	Mine Superintendent
Hillary Miracle	Section Foreman

Harlan County Coal Operators' Association

Rufus Bailey	Safety Director

Kentucky Department of Mines and Minerals

Henry Hamblin	Principal Inspector
Grant Hall	Mine Inspector

United States Bureau of Mines

J. L. Gilley	Mining Health and Safety Engineer
Charles H. Sample	Federal Coal-Mine Inspector

The preceding Federal inspection was completed December 14, 1962.

DESCRIPTION OF OCCURRENCE

On the day of occurrence, the night-shift crew comprised of 9 men, including the section foreman, entered the mine at 3:30 p.m., and arrived on the K-Main section about 3:50 p.m. After receiving their instructions, the workmen proceeded with their assignments of delivering supplies, timbering and moving equipment nearer the working faces in the right and left barrier places. The cutting-machine crew then undercut the face of the No. 5 room in the left barrier while several shuttle cars of coal that had been left by the day-shift in the right barrier place was being loaded. After the undercut was completed in No. 5 room in the left barrier and the place in the right barrier was cleaned up, the cutting machine, which is equipped with a hydraulically-operated hand-held drill, was trammed into right barrier where the section foreman supervised the drilling, charging, and firing of 8 holes spaced about 6 feet apart in the inby portion of the pillar. (After rooms 5 to 7 were completed, blasting in lieu of undercutting the coal was utilized in the right barrier.) After the coal from this round of shots was loaded, the section foreman had 10 holes drilled, spaced as before, about 6 to 7 feet apart in the inby portion of the pillar (see sketch A), and then each hole was charged with 3 or 4 cartridges of permissible explosives. While Henson and Dozier charged the holes, the cutting machine was trammed out of the place to the K-Main haulageway. A loading machine and 2 shuttle cars were moved and parked along the right barrier roadway, as indicated in

sketch B. The section foreman stated that as he was completing his examinations and tests of the face area, Henson and Dozier had charged the 10 holes according to plan and were connecting the shots preparatory to firing them simultaneously. The foreman then proceeded to the K-Main haulageway to supervise the 2 shuttle-car operators and the motorman in rearranging and connecting the trailing cables of the various equipment. While these operations were in progress, the section foreman and the men nearby heard Henson and Dozier give warning that they were preparing to fire the shots. Shortly thereafter, according to the foremen and the 3 workmen nearest him, there was an unusually loud report accompanied by a strong stress wave which threw them to the mine floor and stunned them momentarily. A very dense cloud of dust was thrown into suspension, and reportedly, the roof "worked" extensively throughout the right barrier area. After the dust settled to permit visibility, the foreman and 7 of his men, including the cutting-machine crew and the left barrier loading-machine operator, who had been setting timbers and otherwise preparing the left barrier place for undercutting, proceeded to the right barrier pillar place to locate Henson and Dozier and found them lying near the loading machine and a shuttle car, as indicated in sketch A. After ascertaining that the men had sustained various injuries and were conscious, they were moved to a safe location outby while first-aid equipment was procured from the loading terminal. After the men were given first-aid, they were transported to the surface where they were examined by a doctor then were taken to a hospital.

The K-Main day- and night-shift section foreman stated that coal had bumped from the rib of the inby portion of the pillar during their respective preceding shift. On the evening of the outburst, 33 cars, or a total of about 110 tons of coal, had been loaded; 22 cars, or about 80 tons of coal, had been loaded from the right barrier pillar and the remainder from the left barrier.

The outburst was violent in nature and extensive in that 4 pillars, in addition to the one involved, were affected to various degrees. Coal was expelled violently from the front and back sides of the right barrier pillar; the back of the pillar was affected for 110 feet along the face and for as much as 25 feet over the top of the pillar. Coal was expelled or shaken from along the entire length of the front side (entry side) of the pillar, and for a distance of about 80 feet, the 2 right empty-track entry was practically filled with coal (see sketch B). Effects of the force extended 10 feet over the top of this side of the pillar. It was estimated that 350 tons of coal were expelled and shaken from the right barrier pillar. A stratum of thin laminated sandstone roof overlying the coal was fractured for several feet along the back of the pillar and 2 pieces of this roof were detached and thrown down in the face areas. Tension cracks opened in the roof at a set of widely spaced jointing planes radiating from the pillar into the mined-out area, as indicated in sketch B. A roof fall, reportedly,

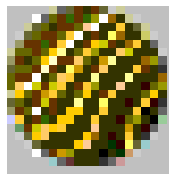
occurred over a small portion of the mined-out area about 30 minutes after the outburst. Several timbers were broken in the area and the floor heaved by forces of the bump in the vicinity of the outby end of the pillar. Equipment was not damaged, but, reportedly, the shuttle car parked farthest from the loading machine was moved outward about 3 feet by the stress wave. Prior to firing the shots, the men got behind the loading machine and a shuttle car for protection from flying coal during blasting. Their position placed them about 18 feet from the coal pillar and undoubtedly, the equipment deflected a considerable amount of the released stress which probably minimized the severity of their injuries.

During the development and extraction of the right barrier pillar, an area of very fragile thinly laminated sandstone roof was encountered. Because of this condition and subsequent falls of roof, rooms No. 4, 5, and 6 were not completed, as projected. Consequently, about a month prior to the April 9, outburst, mining in the right barrier had progressed to the extent shown in sketch C. Because of the roof falls in the Nos. 4, 5, and 6 rooms, the mine officials decided to drive No. 7 room a sufficient distance to permit the 3 incompleted rooms to be picked up and completed through No. 7 room. Development and most of the extraction of the coal in Nos. 4, 5, and 6 rooms was completed on April 5,and on Monday, April 8, mining of the remainder of the right barrier pillar remnant was started by mining successive open-ended lifts along the inby end of the pillar.

On the date of the outburst, the barrier pillar had been reduced to a long, rectangular-shaped pillar, 209 feet in length, about 54 feet in width at the outby end, and 48 feet wide at the inby end. An opening, 17 feet in width and 25 feet in depth, was driven into the outby end of the pillar to serve, reportedly, as parking or passing space for equipment which further reduced the stability of the front end of the pillar.

Adverse roof conditions, drainage problems and roof falls created difficult mining in most of K-Main, resulting in numerous pillar remnants and some complete pillars being left in the gobs. The roof, with the exception of a few localized falls, had not caved in the mined-out area of the 2 right barrier pillar. The fact that complete caving had not occurred in this area likely caused additional stress on the long, narrow rectangular-shaped barrier pillar remnant. From examination of the mined-out area of 2 right, considerable convergence and cantilevering of the roof were evident.

A coal-mine outburst or bump is a cumulative process which manifests itself in one or more ways, but unfortunately its manifestations are not always recognized in time. It is evident that a combination of natural conditions favorable for outbursts exist in certain areas of this mine. Therefore, where mining is done in the presence of this combination, every precaution



should be taken to avoid, insofar as possible, critical area and circumstances that could induce bumps, through proper mining methods and practices.

CONCLUSION

A violent coal outburst from an over-stressed pillar, which resulted from failure, or inability, to remove the coal according to adopted plan of pillar recovery in combination with other factors discussed above, was the cause of this accident. The outburst was triggered by an imposition of a shock load upon the large pillar by stresses from percussion created by blasting.

RECOMMENDATIONS

The following recommendations are offered in the belief that the hazard from coal outbursts at this mine will be minimized if compliance is obtained:

1. Future mining plans should include a system of development and extraction that will result in the formation of a minimum of critical areas during pillar mining. Critical areas are produced by pillar line points, pillars of various sizes and shapes, pillars not developed sufficiently in advance, and improper sequence in development and extraction.

2. The mining system should require that the coal barrier pillars be developed as nearly uniform in size and shape as practicable. Formations of long rectangular coal pillars should be avoided in areas where conditions are favorable for outbursts.

3. "Hogging" or digging and loading the "loose" coal from the rib lines and faces of pillar lifts in stressed pillars usually results in tight corners outby the extraction line, thus creating a potential bump condition; such practices should not be permitted especially where conditions are favorable or conducive to coal outbursts.

4. Complete extraction should be striven for and pillar remnants that can be mined safely should not be left in the gob to form "island abutments". Where recovery of a pillar remnant is not possible from the safety aspect, its load-carrying capacity should be destroyed.

5. The extraction line should be maintained as uniformly straight as possible. Irregular pillar lines result in excessive pressures on any pillar-line points thus formed.

6. The pillars should be recovered by the open-end lift method; however, where roof conditions present a hazard, a thin wing or fender is permissible. The lifts should be driven so that each lift and adjacent consecutive lifts will be mined along the gob sides of the pillars. Preferably, in areas where conditions are favorable for bumps, only one lift should be mined in a pillar at a time and the lift should be completed before another is started.

7. Pillar lifts or pillar pockets should not be driven at excessive widths into a pillar so as to cause the mining process to evolve into the pillar being literally "pushed out" instead of being extracted by successive open-end lifts, in proper sequence.

8. If slabbing is necessary, other than on the goaf side of a pillar, the passageway (slab) should be kept as narrow as possible. Pillars near the extraction line should not be split.

9. Where pillar recovery is done in areas where natural conditions in combination are favorable for outbursts, every effort should be made to extract the coal pillars in a manner that will permit, insofar as possible, orderly distribution of mining stresses.

10. When shots are being fired in pillars or when "inducer" blasting is being done in pillars, the blasting cable should be long enough in any case to permit the shot firer to get in a safe place away from the pillar in which the shots are to be fired and away from collateral pillars subject to outburst by shock wave from the blasting operation.

ACKNOWLEDGMENT

The courtesy and cooperation of the employees, members of the safety committee, mine officials, and representatives of the Kentucky Department of Mines and Minerals, and Harlan County Coal Operators' Association during this investigation are gratefully acknowledged.

Respectfully submitted,

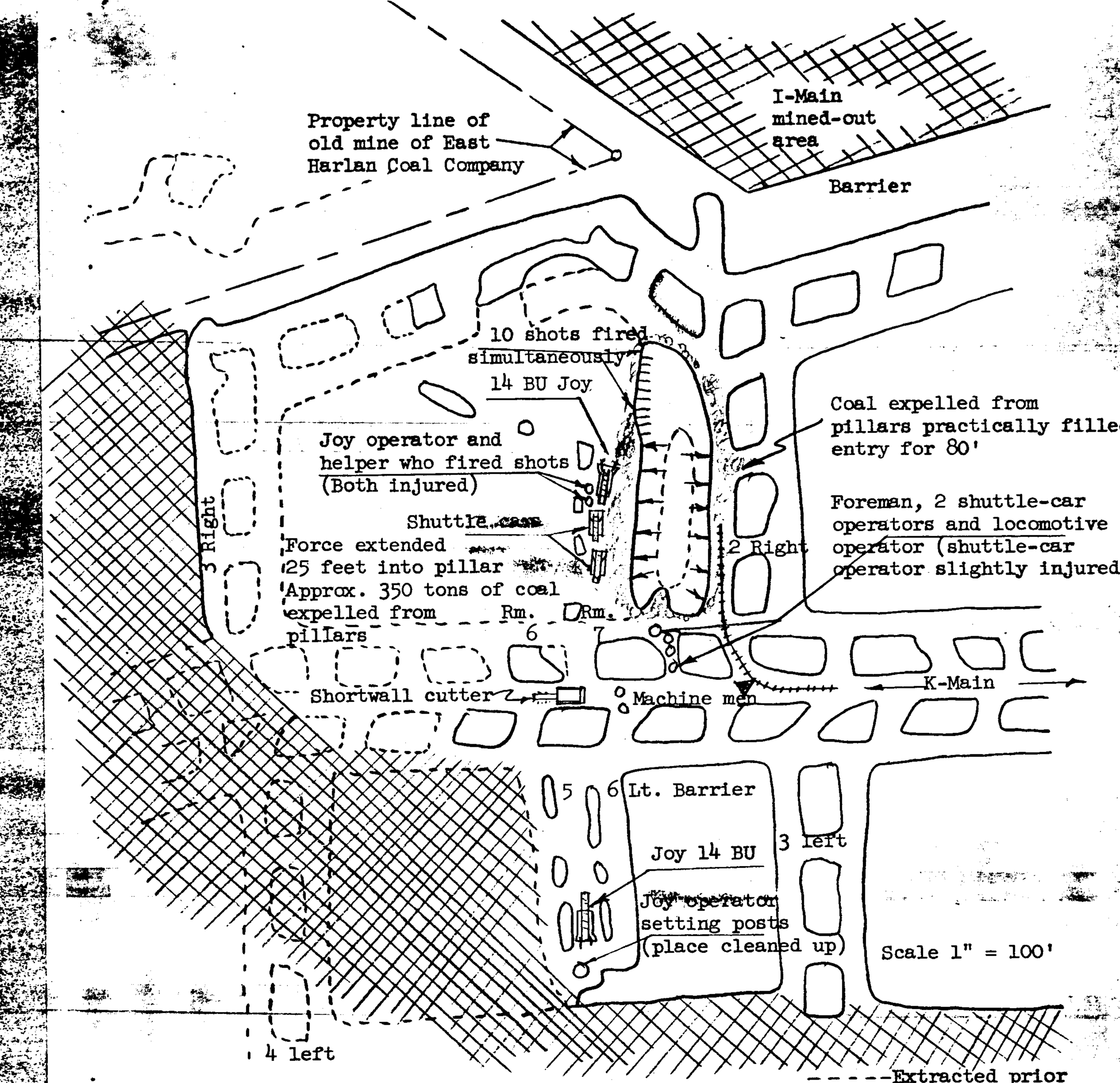
/s/ J. L. Gilley

J. L. Gilley

Approved by:

/s/ G. W. Parry

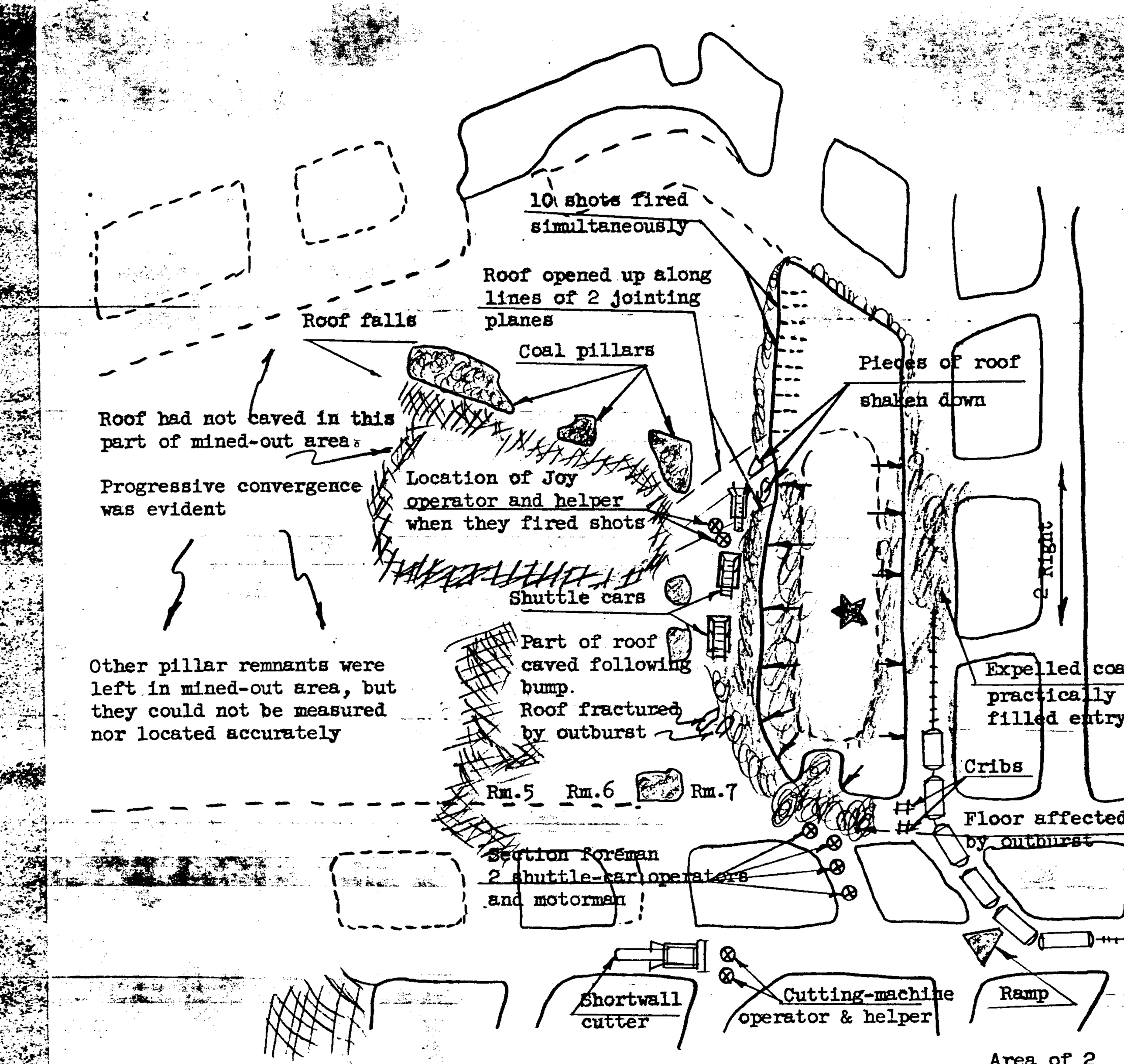
Subdistrict Supervisor, District I



COAL MINE OUTBURST
BROOKSIDE MINE
KENTUCKY JELLICO COAL COMPANY, INCORPORATED
BROOKSIDE, HARLAN COUNTY, KENTUCKY
9:45 p.m., April 9, 1963

(Location of men and equipment)

SKETCH A



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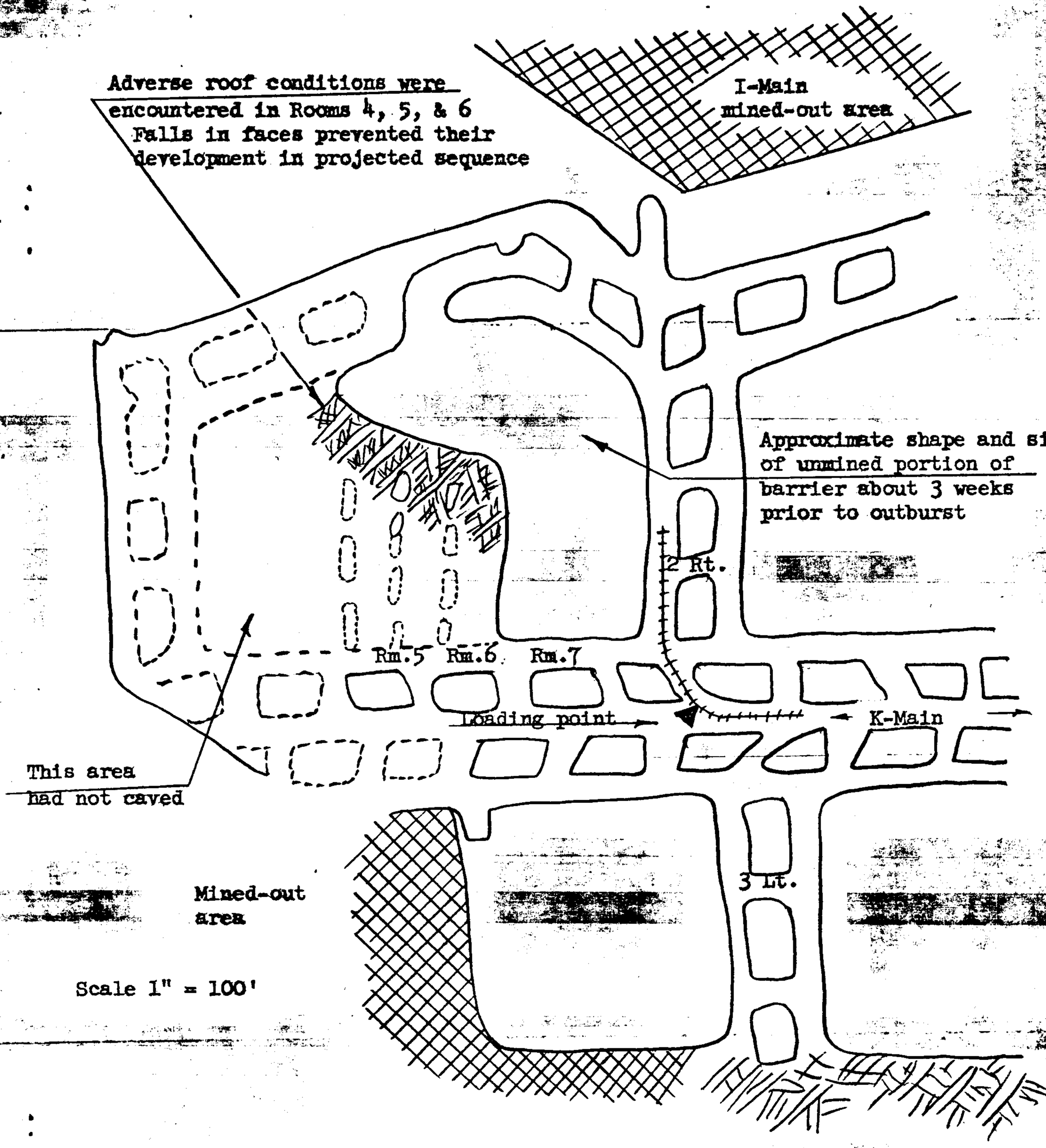
BROOKSIDE, HARLAN COUNTY, KENTUCKY
9:45 p.m., April 9, 1963

Scale: 1"=50'

SKETCH B



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(Showing extent of mining about 3 weeks prior to outburst)

SKETCH C