1947

The Park City Consolidated Mine Madison County, Missouri

Charles Donald Geiger

THE PARK CITY CONSOLIDATED MINE

MADISON COUNTY, MISSOURI

BY

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THESIS

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Approved by J. D. Forrester
Professor of Mining Engineering

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The helpful suggestions and assistance of the staff and faculty of Missouri School of Mines and Metallurgy can only be rewarded by the author's sincere appreciation.

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INTRODUCTION

The purpose of this study is the application of the principles of mining geology to a search for additional ore in one of Missouri's lead mines and to provide in the literature a general analysis of a type of lead deposit found in Southeast Missouri whereby future prospecting and development work on similar deposits may be more efficiently carried on.

The study consists of a thorough consideration of the geology and operation of the mine being worked by the Park City Consolidated Mines Company, Missouri Division, at Fredericktown, Madison County, Missouri.

The field work was conducted during the months of June and July 1947. This included a Brunton and tape traverse of the mine workings and a thorough familiarization with the mining method.

LOCATION

The property leased by Park City Consolidated Mines Company is located two and one-half miles south of Fredericktown, Madison County, Missouri (Map 1). The mine is located in the northeast corner of Federal Land Survey number 350, Township 35 north, Range 7 east and is known locally as the Ruth mine.

PHYSICAL FEATURES

The Ruth mine is in the southeast foothills of the St. Francois Mountains. In the vicinity of the mine a rolling terrain exists which is well adapted to light farming and hence, though lead mining is the principal industry of the area, farming also is an important industry.

Adequate supplies of water have been provided for mining and milling purposes through dewatering of the mine. An additional supply could be easily obtained by pumping from any of the exploration churn drill holes on the property. Large stands of native oak and pine exist nearby and all lumber and timber needed for mining can be purchased locally. Several small sawmills in the region do custon sawing for the mines.

The Sho-Me Rural Electrification Administration Cooperative provides electrical power for the mine. The power is brought onto the property at 33,000 volts. A sub-station at the mine reduces this voltage to 220 and 440 for power and light use.

A branch line of the Missouri Pacific Railroad passes through Fredericktown and affords freight service to and from St. Louis, Missouri. Fredericktown is located on United States highways 67 and 61 and on Missouri state highway 70. United States highway 61, south of the town, passes within one-half mile of the mine.

HISTORY

Lead was first mined in the Fredericktown area in 1700 at Mine La Motte, four miles north of the town. This mine is presently in operation as a subsidiary of the St. Joe Lead Company.

The Missouri Cobalt Company was organized during World War I and began extensive operations on a property in the southeast outskirts of Fredericktown. The company constructed a 1000 ton daily capacity mill for the recovery of lead, nickel, copper and cobalt. The mine was abandoned and the mill closed at the end of the war. The St. Louis Smelting and Refining Company, a subsidiary of the National Lead Company, in 1927, leased the mine that had been worked by the Missouri Cobalt

Company and is operating it at the present time. This company conducted an extensive exploration campaign over the district and thereby extended the limits of their orebody and added greatly to the knowledge of the geology of the locality.

The land, known as the Ruth farm, now leased by Park City Consolidated Mines Company was leased and drilled by the St. Louis Smelting and Refining Company but was never developed by them because of the low price of lead during the decade preceeding World War II. The Ruth Farm has been leased for prospecting purposes by several companies and individuals since 1900. A total of approximately 180 churn drill and diamond drill holes have been put down on it in an effort to locate and delimit the ore. A Mr. Green leased the mineral rights in 1937 and began sinking a shaft in the orebody. He encountered economic difficulties and abandoned the shaft after sinking it 210 feet. It was leased to the Park City Consolidated Mines Company in 1941, at which time they put down 21 churn drill holes to check information gained by previous drilling and on which the records were insufficient or doubtful. They reopened the abandoned shaft in August 1942 and continued sinking it to the ore. The shaft was completed, a 500 ton mill constructed, and mining commenced in December 1943.

GEOLOGY

Stratigraphy

The accompanying geologic column (Plate 1) shows the stratigraphic relationship of the formations exposed in the mine. The age relationships shown for the formations is that adopted by the Missouri Bureau of Geology and Mines.

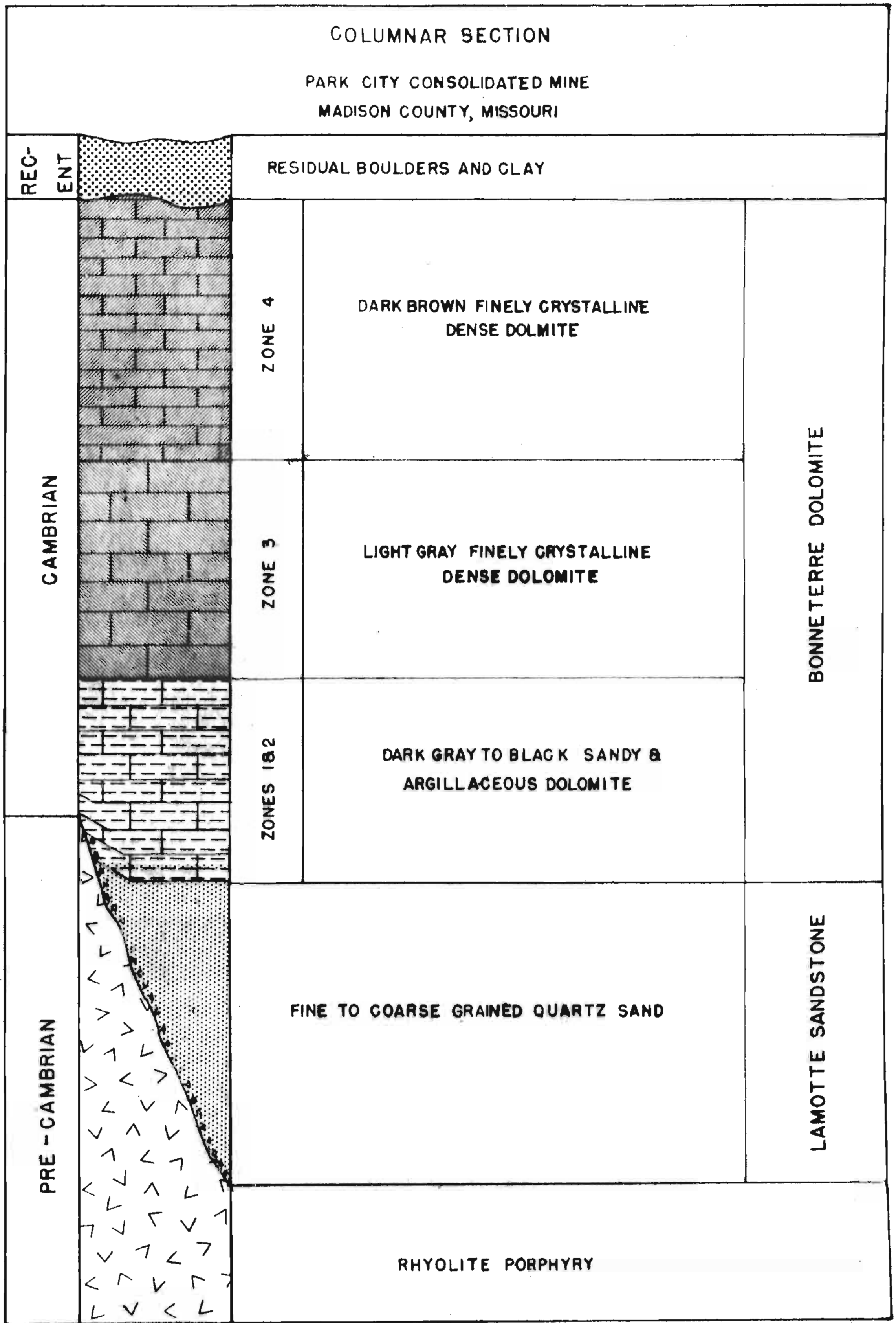
COLUMNAR SECTION
PARK CITY CONSOLIDATED MINE
MADISON COUNTY, MISSOURI
REC-ENT
RESIDUAL BOULDERS AND CLAY
CAMBRIAN
ZONE 4
DARK BROWN FINELY CRYSTALLINE DENSE DOLMITE
ZONE 3
LIGHT GRAY FINELY CRYSTALLINE DENSE DOLOMITE
ZONES 1&2
DARK GRAY TO BLACK SANDY & ARGILLACEOUS DOLOMITE
BONNETERRE DOLOMITE
PRE-CAMBRIAN
FINE TO COARSE GRAINED QUARTZ SAND
LAMOTTE SANDSTONE
RHYOLITE PORPHYRY

PLATE I

Pre-Cambrian: The oldest rock exposed in the mine is rhyolite porphyry that is a member of the crystalline basement rocks of the Ozark uplift. It presents a fresh, unweathered appearance wherever exposed in the workings except where it is overlain by conglomerate beds. In such zones it is partially decomposed, probably as a result of the weathering action of ground water percolating through the permeable conglomerate. The porphyry is comprised of a dense, non-crystalline, dark red ground mass in which have developed scattered phenocrysts of clear quartz and pink feldspar. The feldspar phenocrysts are, by far, the most prominent as the quartz crystals are small and relatively rare.

The porphyry apparently represents a buried hill of the pre-Cambrian land surface against which the sedimentary rocks lap with unconformity. (Map 3a-3e) The surface of the porphyry is very irregular and preserves the ridges and valleys of the ancient topography.

Lamotte Sandstone: The Lamotte sandstone consists of fine to coarse grains of quartz sand. Its color varies from almost white to dark brown with local areas dark gray to black due to dark argillaceous inclusions. It is poorly exposed in the mine and prospect drilling has not penetrated it to depth as the mineralization is confined to the overlying rock.

The Lamotte sandstone rests unconformably on the pre-Cambrian erosion surface and laps up on the flanks of the porphyry hill. Near the porphyry contact it carries many weathered fragments of the igneous rock, the fragments ranging in size from pebbles of a fraction of an inch in diameter up to boulders of a foot or more in diameter. Its contact with the overlying Bonneterre dolomite is a conformable one, indicating almost continuous deposition during the transition from the deposition of sand to that of dolomite. The contact is marked by the interbedding of shale lenses in the sandstone and dolomite. The shale ranges from sandy to calcaerous in composition but is always dark grey to black.

The Lamotte sandstone is considered to be of Upper Cambrian age.

Bonneterre dolomite: The Bonneterre formation has been divided, on the basis of lithology, into four zones by McQueen[1/].

1/ McQueen, H. S., Occurrence of dolomite in the Fredericktown area, Madison County, Missouri. Mo. Bur. Geol. and Mines, Appendix II, 62nd Biennial Report, 1943. p. 8.

Zone 1 is the transition zone from the Lamotte sandstone to the overlying Bonneterre dolomite. It consists of dark grey to black, fine-grained dolomite with sandy and argillaceous zones. Its maximum thickness is 35 feet but it is much thinner where it laps over the porphyry ridge in the mine. A high organic content accounts for the dark color and offers an explanation for the solid hydrocarbon that fills vugs in the rock. The lower portion of this zone laps unconformably by initial dip against the porphyry ridge whereas the upper section reflects the old, buried porphyry hill by warping upward and extending over the intrusive roof. The basal portion is the ore bearing horizon at the Park City mine.

Zone 2 consists of a fine-grained argillaceous dolomite ranging in color from dark brown to black. It has a maximum thickness of 65 feet. The contact between zones 1 and 2 is difficult to pick out on churn drill logs and hence the two zones are not separated on the cross sections. (Maps 3a-3e)

Zone 3 consists of a hard compact finely crystalline dolomite ranging from white to gray in color. Its maximum thickness is 150 feet.

Zone 4 consists of a hard dense dolomite of a very dark brown color. Its maximum thickness is 150 feet but recent erosion has removed much of it.

The Bonneterre dolomite is considered to be of Upper Cambrian age.

Residum: A mantle of residual clay overlies Zone 4 of the Bonneterre formation. The clay is a characteristic chocolate brown in color and contains pebbles of chert left after the complete weathering and erosion of formerly overlying formations. Its thickness ranges from 0 to 35 feet.

Structure

The regional structure of the area is controlled by a sedimentary basin rimmed on the west and southwest by high hills and ridges of igneous rock. The contour of the floor of the basin follows the ridges and valleys of the pre-Cambrian topography. The Cambrian sea, during its encroachment over the land, deposited sand which partially filled the valleys. Deposition of dolomite began after the sea had flooded the land and continued until the highest of the porphyry ridges was buried beneath the sediments.

The irregular dip imposed on the sedimentary formations where they lap against the hills of the pre-Cambrian surface has been described and analyzed by Bridge and Dake[2/]. This structure is readily observable throughout the St. Francois Mountains where the peaks of granite or porphyry hills have been denuded of part of the overlying sediments and the remaining sediments dip steeply away from the igneous rock.

2/ Bridge, Josiah and Dake, C. L. Initial dips peripheral to resurrected hills. Mo. Bur. Geol. and Mines, Biennial Report, 1929, pp. 93-99.

The initial dip of the formations overlying the porphyry in the Park City mine is the most impressive structural feature in the underground workings. The beds that carry the ore dip away from the porphyry as much as 35 degrees at the contact but rapidly flatten out and become horizontal within 200 feet.

The initial dip of the formations influenced the mineralization inasmuch as the ore is confined to the portion of the beds that dips away from the porphyry. It was also an important consideration in selecting a method of mining for the deposit as will be pointed out below.

There is no evidence of diastrophism within the mine. All irregularities in the strike and dip of the strata appear to be related to depositional activity as influenced by the porphyry surface. The bedding shows minor "rolls" which, at first examination, appear to be a result of folding but on close study indicate their depositional nature by a close relation to irregularities in the surface of the porphyry and the lenticular nature of the strata.

Faulting is a very minor structural feature in the mine. Although some of the peripheral fractures have a small amount of displacement parallel to the fracture plane and thus are classed as faults, the displacement is so small as to be, in the writer's opinion, inconsequental with regard to the implacement of the ore or to the mining practice.

The joint system in the mine is composed of three major joint sets as shown on the geologic map. (Map 2) One set of joints strikes northeast; the second set is peripheral to the buried ridge and dips into the porphyry and the third set is, likewise peripheral to the buried ridge but dips away from the porphyry.

The joint set which strikes northeast is a member of the regional joint system and has no apparent relation to the mineralization. It is characterized by a large amount of solution activity and individual joints in it have been enlarged by solution to form openings in the rock as much as 2 feet in diameter and extending for several hundred feet toward the surface.

The peripheral joint set which dips into the porphyry is the outstanding structural feature in the mine. It is made up of a series of joints that strike parallel to the outline of the buried ridge. The individual joints of the set reflect minor changes in the outline but at major salients or recesses they pass out into the country rock or die out against the porphyry and are replaced by one which parallels the new direction of the contact. This set is so well developed that the tract in which it occurs, from 10 to 50 feet in width, resembles a breccia. The average dip of these joints where they die out against the porphyry near the Lamotte-Bonneterre contact is 45 degrees.

The peripheral joint set that dips away from the porphyry is less well developed than the peripheral set described above. This second set, as exposed in the mine, occurs in a poorly defined band from 150 to 200 feet away from the porphyry contact. It reflects major changes in the outline of the buried ridge but is little affected by minor changes. The joints in this set dip steeply, 80 to 85 degrees, away from the porphyry.

Mineralization

Galena is the only mineral of economic importance in the orebody. Other sulfide minerals which are present in amounts too small to be economically recoverable include, chalcopyrite, pyrite, marcasite, siegenite (a complex cobalt-nickel sulfide of variable composition) and millerite (the sulfide of nickel). Non-sulfide minerals include calcite, dolomite and the oxidization products of the sulfide minerals.

The galena occurs in three forms; as disseminated crystals, as fracture fillings, and as bedded material.

The disseminated ore is of the same type as that mined in the "lead-belt" district of Southeast Missouri. In this mode of occurrence the galena exists as small isolated crystals dispersed in the country rock.

The galena that occurs as fracture fillings exists as small crystals coating the surfaces of joints. Most of the ore of this type is associated with the peripheral joints described above.

The bedded galena is found as thin beds or lenses in the inter-bedded shales of the Lamotte-Bonneterre contact zone described above. The beds of galena are made up of an aggregate of crystals which form a solid layer of the mineral. Beds of marcasite commonly occur within or adjacent to the galena.

The occurrence and distribution of all classes of sulphide minerals is largely confined to a mineralized tract bounded in its lower extent by the upper surface of the underlying Lamotte sandstone and laterally and above by the intersecting peripheral joint systems. The ore, in general, is found in the lower 15 to 20 feet of this tract. The relation of the peripheral joints to the mineralization leads to the conclusion that they acted as passageways for the mineral-bearing solutions.

Discussion of Maps

Platting of the geology and structure in the mine presented a problem of depicting a three-dimensional subject on a two-dimensional map. The mine workings follow the dip of the formations as shown by the cross sections (Maps 3a-3e and 4) and to plat the geology at breast height would lead to a distorted picture of the exposures. To avoid this situation the author projected the geology to a horizontal plane at breast height in the drift and it is thus shown on the geologic map (Map 2).

The cross sections were constructed on the basis of churn drill logs and the geology exposed in the mine.

MINING PRACTICE

Exploration

The land leased by Park City Consolidated Mines Company has been prospected, as before noted, by several companies during the past 50 years. At least 180 drill holes have been put down on the property but records are now available for only 129. This total is comprised of 108 holes sunk by the St. Louis Smelting and Refining Company, and of 21 driven by the Park City Company.

The drilling was done by contract, with an engineer representing the company present during all drilling operations to take samples and plot the drill log. Samples were taken during each five foot drill run. Where mineralization was encountered the samples were assayed and the results entered on the drill log.

All drill holes were put down into the porphyry or, if sand was encountered in the hole, to a minimum of 20 feet into the sandstone.

Shaft Sinking

A single compartment vertical shaft, 7 by 9 feet in cross section and 375 feet deep, opens up the deposit. The Park City Consolidated

Mines Company sunk the last 165 feet after reopening the abandoned shaft formerly driven by Green.

A serious water problem was the only unusual difficulty encountered during the shaft sinking operation. Each fracture in the rock acted as a channel to carry the ground water into the shaft. To dewater the shaft a 40 hp. Ingersoll-Rand single-stage "Built-On" pump was operated continuously and a 50 hp. Byron Jackson centrifugal pump kept on a stand-by basis. As the shaft neared its ultimate depth the operation of both pumps was required.

Development

The deposit was opened by a cross cut from the shaft to the orebody and then by driving a drift in the outer or down-dip margin of the ore. The drift was advanced in both directions from the cross cut to develop the deposit as rapidly as possible.

The drift was driven with a cross section of 6 by 7 feet. Slab rounds are used to bring down the back to the height of the ore and to widen the drift to provide space for double track in the haulage way, for tugger stations at each stope entry, and for storage of supplies.

Government restrictions on development work during the war required some modification of this practice. To open up ground in advance of stoping and thereby insure adequate reserves of ore for capacity production the drift was widened to 20 feet and advanced as a wide heading.

Two drillers, working on a contract basis, drill out and blast a drift round in one shift. The second shift mucks out the broken rock, lays track and advances the water and air lines as needed.

A drift round consists of 30 holes, which are drilled and loaded according to the character of the ground. The rock to be pulled in a single round may include sandstone, shale, dense dolomite and highly fractured dolomite, hence each round is a special problem in drilling and blasting.

Cleveland HC-10 drills mounted on post type drill columns are used to drill the round.

In advancing the drift an average of 5 feet is pulled per round although this figure may be increased to as much as 10 or 12 feet where solution channels parallel the drift or where the ground is highly fractured.

Stoping

Stope entries are opened from the drift at intervals of approximately 100 feet. The ore is mined by the room-and-pillar method commonly used in bedded deposits. Pillars are turned every 25 to 50 feet, their spacing being dependent upon the character of the back.

Where the ore zone is too thick to be drilled from columns a heading 8 to 10 feet in height is carried in the top of the ore and the remainder broken by down holes drilled from a drill board.

Holes are drilled to depths of from 4 to 14 feet with not more than 4 feet of burden. They are loaded with Gelamite No. 2 and fired electrically at the end of the shift.

The ore breaks well and little secondary blasting is necessary.

Underground Loading and Haulage

The structure of the deposit and the method of mining have led to a particularly efficient loading method for the ore broken in the stopes. The loading installation for a stope includes an electric tugger mounted in the side of the drift opposite the stope and a ramp constructed from heavy timbers in such manner that the broken ore can be scraped up on it and loaded directly into the ore cans. (Map 4) Double or triple drum 20 hp. electric tuggers pulling 42 inch scrapers are used. A variation of this practice calls for mounting the tugger on a heavy frame built on a standard mine car, thus enabling the tugger to be easily moved from one loading place to another.

The drift is mucked out with an Eimco Number 12-B Rocker-Shovel.

Haulage and hoisting follow the "Joplin" method in which a 1300 pound capacity can is loaded at the face, trammed to the shaft, hoisted and dumped in the headframe.

The ore cans are trammed to the shaft in 10-can trains by a Mancha Mule battery locomotive.

Hoisting is accomplished by means of a 100 hp. single drum Rogers Iron Works hoist mounted in the headframe. A five-eighths inch non-spinning hoisting cable is used. The cans are hoisted at the rate of 1660 feet per minute, the cycle of hoisting, dumping and returning the empty can to the foot of the shaft requiring approximately one minute.

Sampling

Hand samples are taken to indicate the grade of the ore mined from each working place. As each can of ore is loaded a grab sample weighing approximately one-half pound is taken from it and added to the samples taken from every other can loaded from that stope or heading during the shift. These samples are delivered to the assay laboratory for analysis at the end of the shift.

A daily report showing the amount and grade of ore loaded at each working place during each shift is submitted to the mine office.

Pumping

The mine makes an average of 450 gpm. of water, as much as 700 gpm. in the wet season of the spring and fall. The ground water flows freely into the workings through the fractures in the rock and through churn drill prospect holes which have been broken into, hence every working place is extremely wet.

The water problem is further complicated by the large solution channels which are occasionally penetrated. These usually are filled with water and when tapped release enormous quantities of water into the workings. During the early life of the mine breaking into a "wet" channel meant a complete flooding of the workings. This danger has been almost eliminated through a lowering of the water table as a result of dewatering the mine.

The mine water is collected in a sump of 120,000 gallon capacity and pumped to the surface by two 75 hp. Byron Jackson centrifugal pumps operating in series and two 75 hp. Ingersoll-Rand centrifugal pumps operating in series. The pumps are controlled by automatic electric switches connected to floats in the sump. The discharge is delivered to an 8 inch pipe which reaches the surface through a 10½ inch churn drill hole.

CONCLUSIONS

The orebody of the Ruth Mine that has been worked by the Park City Consolidated Mines Company is practically exhausted and an early abandonment of the property is foreseen. A thorough study of the geologic and structural relationships in the mine indicates the probability that no new ore will be developed.

The large amount of drilling that was necessary to satisfactorily outline the orebody demonstrates a need for the adoption of some other method of prospecting for this type of deposit. It is believed that geophysical methods of prospecting, either gravimetric or magnetic, would outline the features of the buried topography and thus eliminate much "blind drilling". This is because the type of ore deposit described in this paper is genetically associated, as before noted, with the basal zone of the Bonneterre formation where it laps against buried hills of the pre-Cambrian topography.

The mining method used in exploiting this orebody was well chosen and can be practiced as a standard for mining similar deposits.

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LEGEND

FOR MAPS

OF

PARK CITY CONSOLIDATED MINE

RESIDUAL CLAY AND BOULDERS

ZONE 4 OF BONNETERRE FORMATION

ZONE 3 OF BONNETERRE FORMATION

ZONES 1 & 2 OF BONNETERRE FORMATION

LAMOTTE SANDSTONE

RHYOLITE PORPHYRY

JOINTS

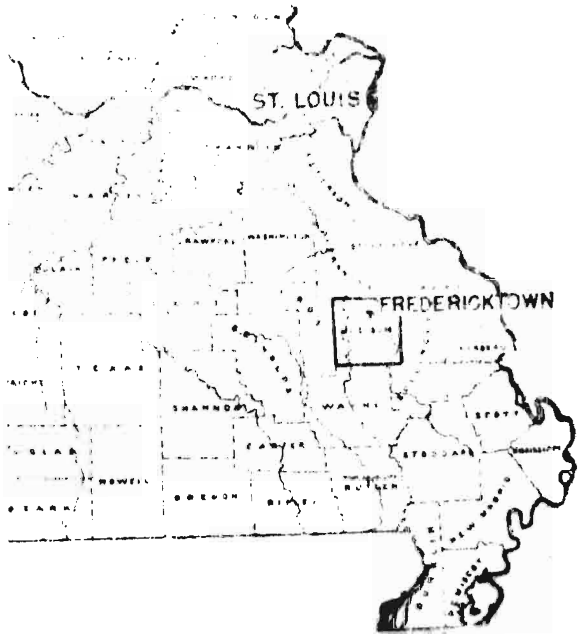
OUTLINE OF BURIED RIDGE AT DRIFT ELEVATION

ORE, 3+% LEAD

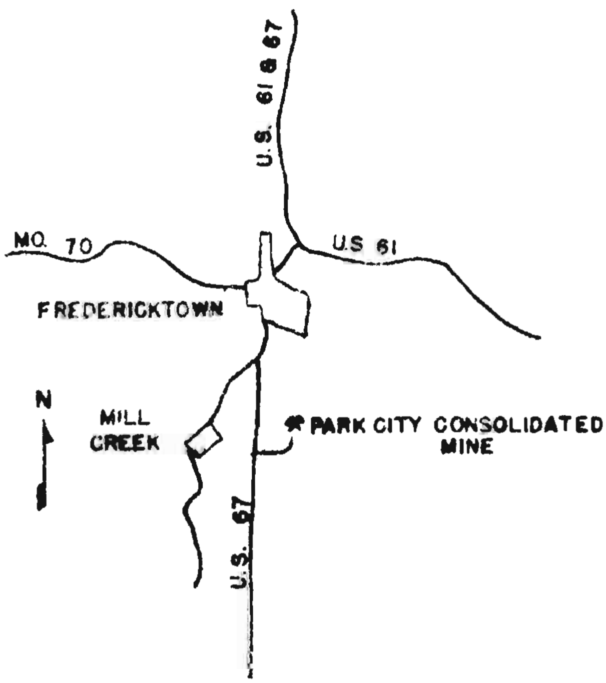
SHINES AND TRACES OF GALENA

W 1 PARK CITY CON MINES CO. PROSPECT CHURN DRILL HOLE

N 1 ST. LOUIS S. & R. CO. PROSPECT CHURN DRILL HOLE



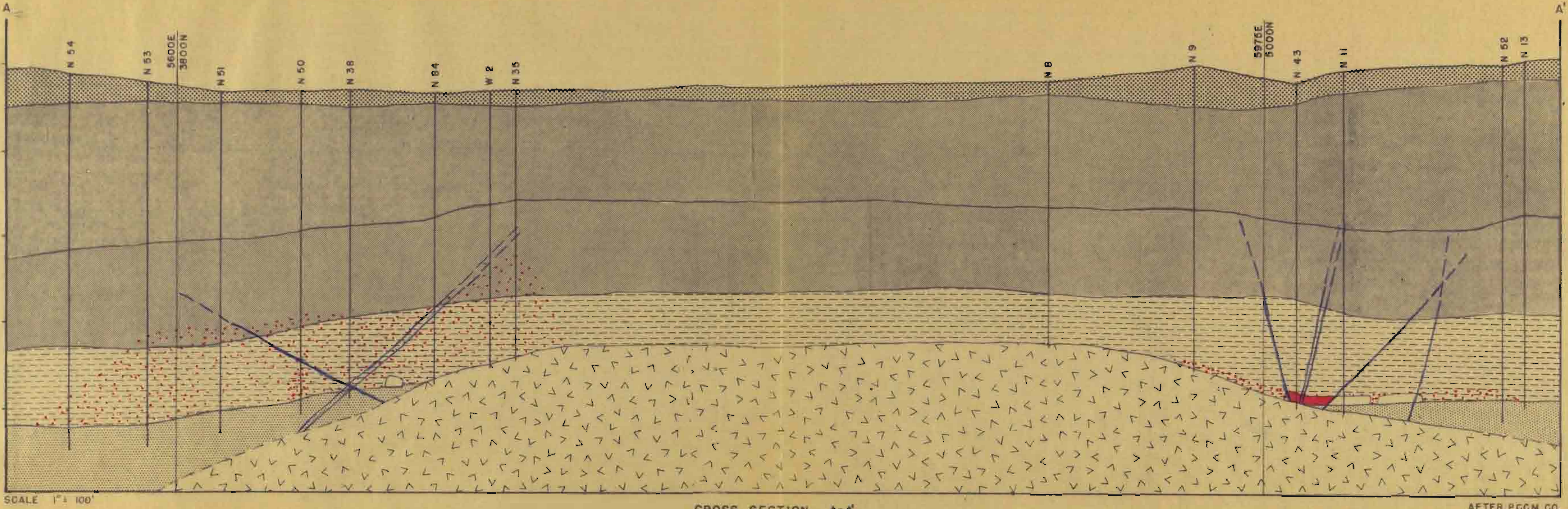
INDEX MAP
SHOWING LOCATION
OF
FREDERICKTOWN
AND
MADISON COUNTY, MISSOURI



MAP
SHOWING LOCATION
OF THE
PARK CITY CONSOLIDATED
MINE

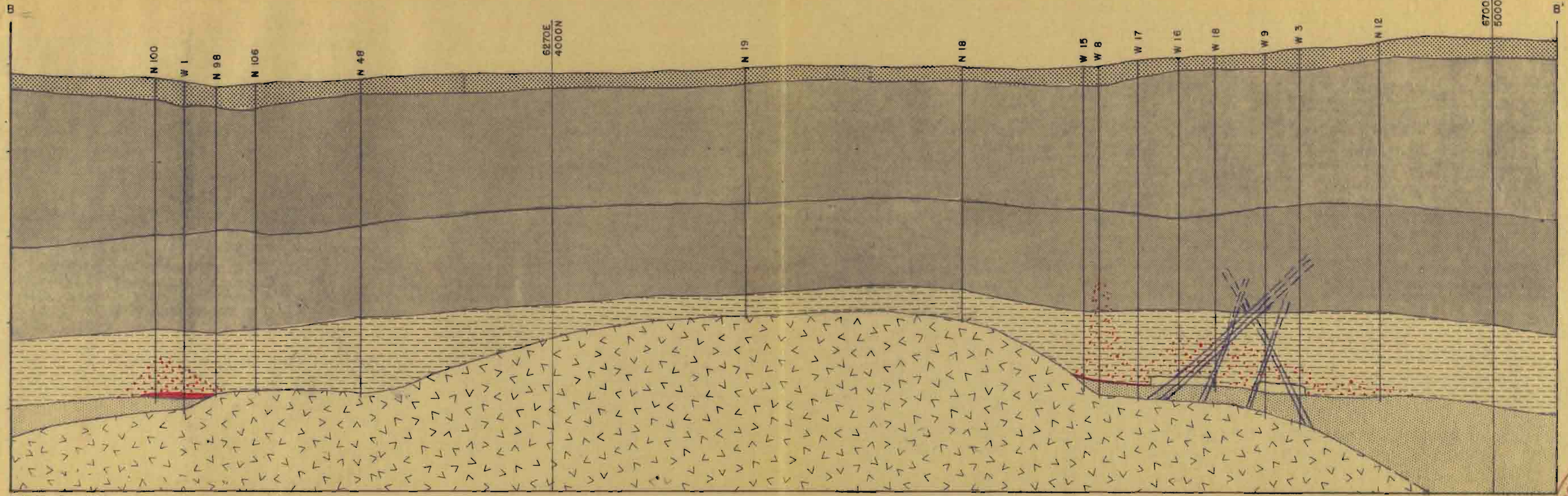
MAP 1


GEOLOGIC MAP
PARK CITY CONSOLIDATED
MINE
MADISON COUNTY
MISSOURI
SCALE: 1" = 100'
BASE MAP BY P. C. C. M. CO.
GEOLOGY BY C.D. GEISER
JULY 1947
MAP 2
5100 E
5300 E
5500 E
5700 E
5900 E
6100 E
6300 E
6500 E
6700 E
6900 E
7100 E
5200 N
5000 N
4800 N
4600 N
4400 N
4200 N
4000 N
3800 N
Drilling on adjacent Property indicates that ore continues along porphyry contact



CROSS SECTION A-A'

MAP 3A

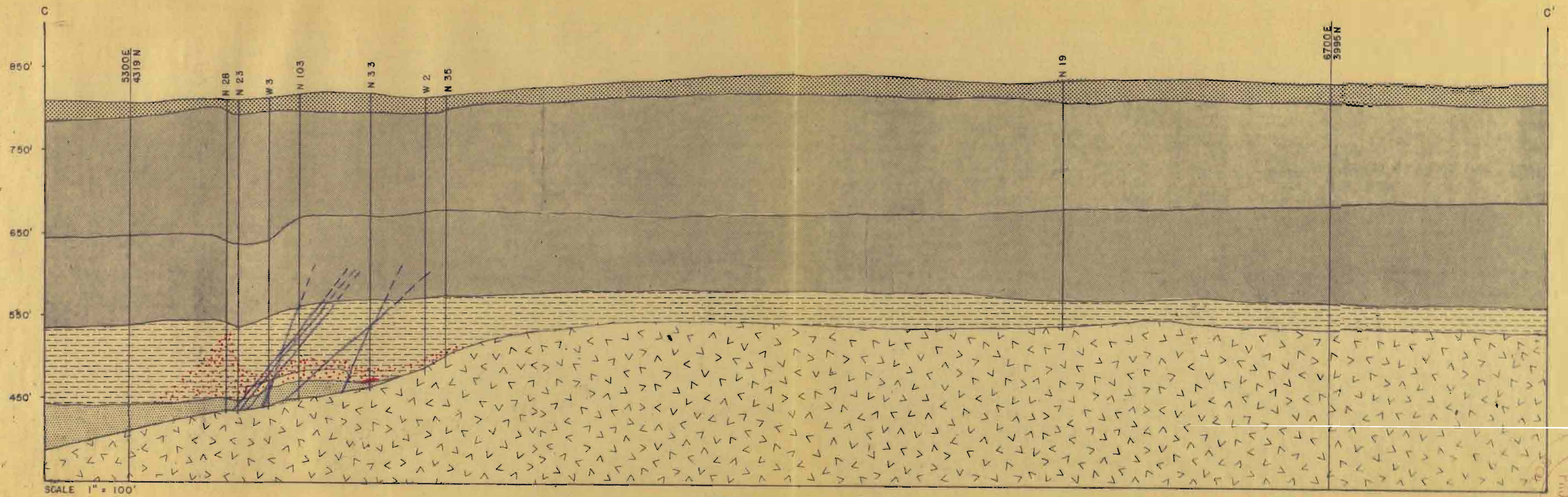


SCALE 1" = 100'

AFTER P.C.G.M.CO

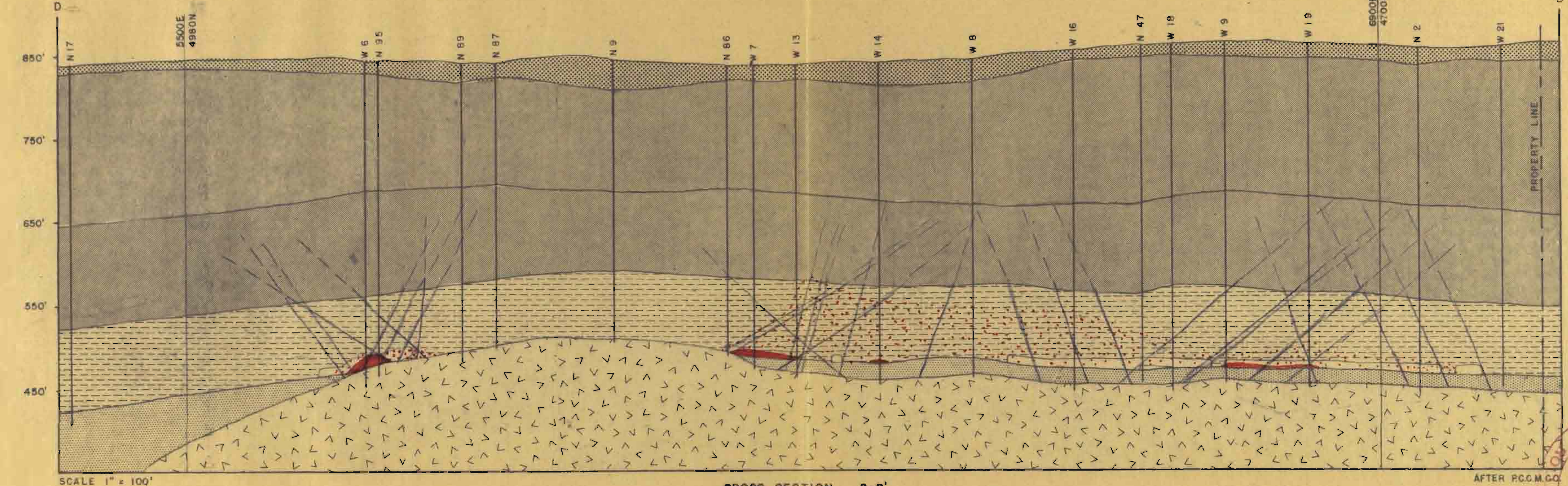
CROSS SECTION B-B'

MAP 3B



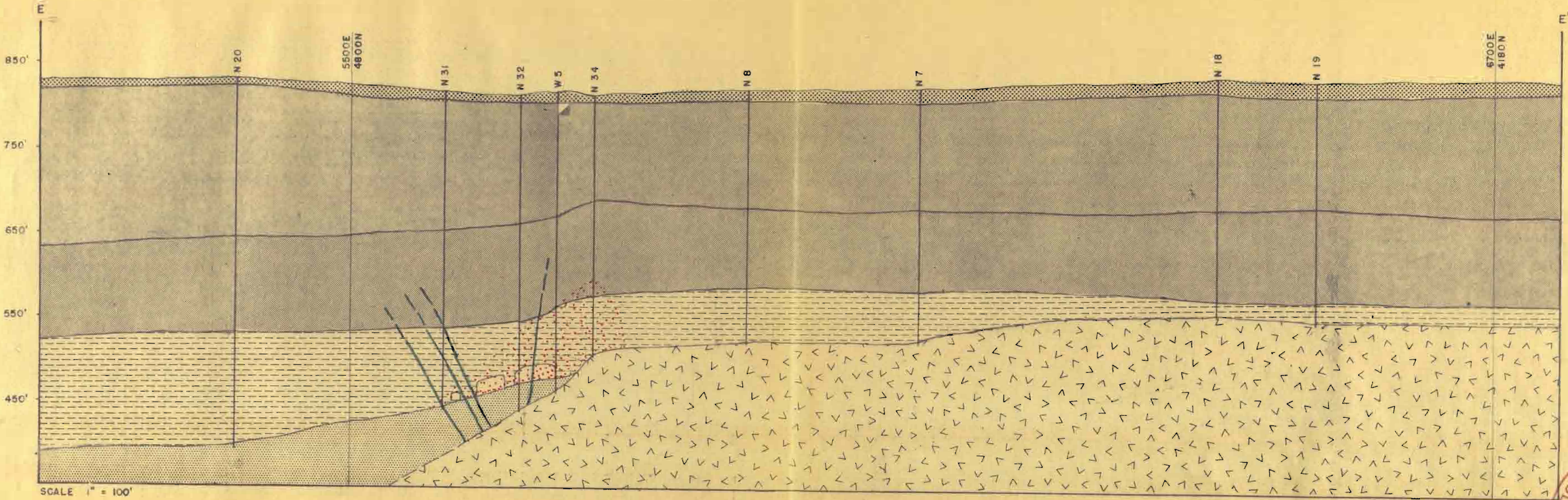
CROSS SECTION C-C'

MAP 3C



CROSS SECTION D-D'

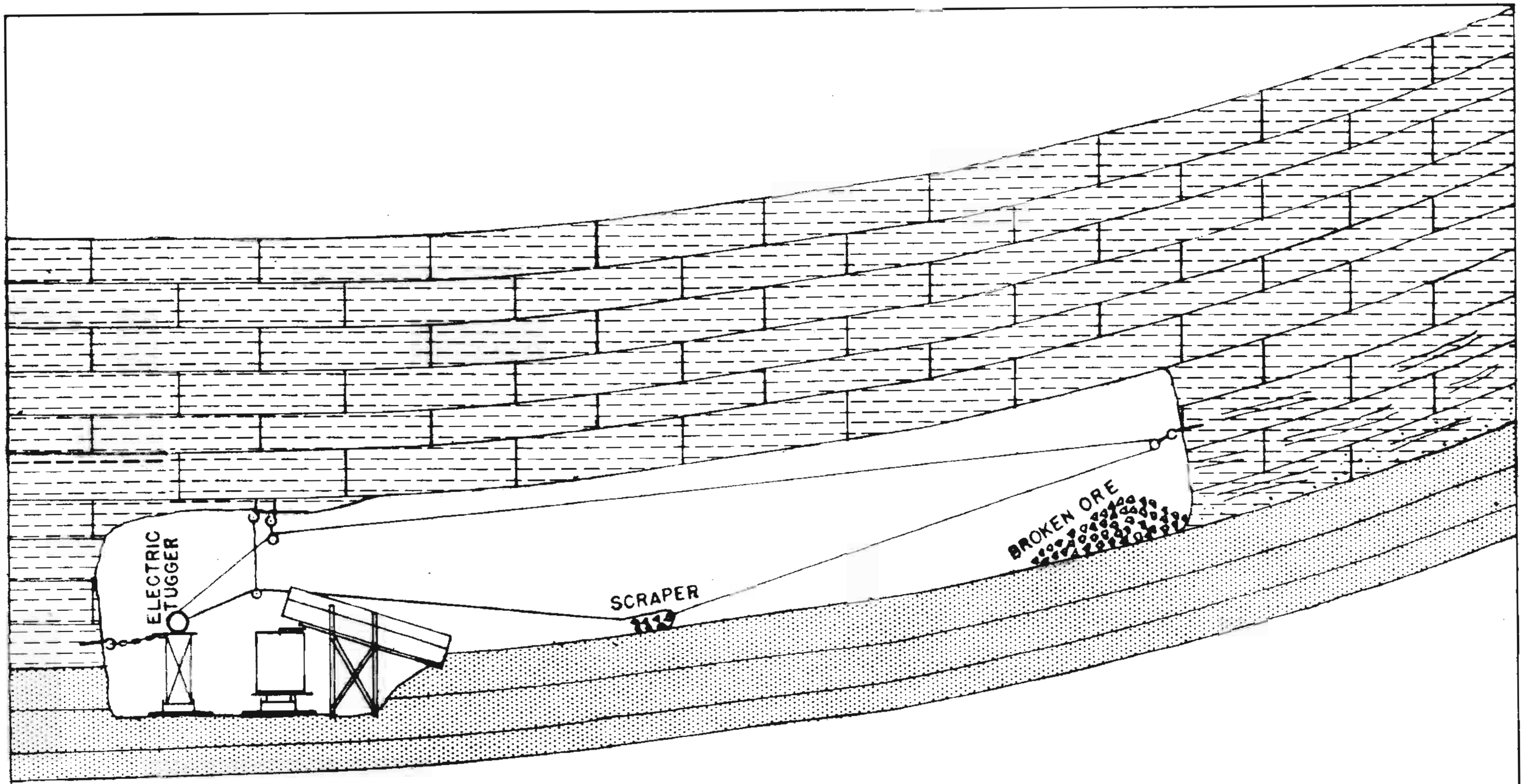
MAP 3D



CROSS SECTION E-E'

MAP 3E

AFTER P.G.G.M.CO.



TYPICAL CROSS SECTION OF MINE WORKINGS

PARK CITY CONSOLIDATED MINE

MAP 4

SCALE: 1" = 10'