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UNITED STATES
DEPARTMENT OF THE INTERIOR
J. A. KRUG, SECRETARY

BUREAU OF MINES
R. R. SAYERS, DIRECTOR

REPORT OF INVESTIGATIONS

EXPLORATION OF THE GOLD, SILVER, LEAD, AND ZINC PROPERTIES, EUREKA CORPORATION EUREKA COUNTY, NEVADA

BY

E. O. BINYON

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By E. O. Binyon[2]

CONTENTS

INTRODUCTION

In 1937 the Eureka Corporation, Ltd., of Canada obtained a lease on the mining property of the Richmond-Eureka Mining Co. in the Eureka mining district, Eureka County, Nevada. In 1910 the Richmond-Eureka Co. suspended all operations except small-scale leasing, but company and other geologists contended that the El Dorado dolomite would also carry ore in its continuation in a fault block north and northeast of the productive old workings. The company began to explore the fault block in 1923 by diamond drilling from the 900 level of the Locan shaft, but for various reasons the hole was drilled to a depth of only 725 feet and was then abandoned.

The Eureka Corporation, Ltd., planned an extensive diamond-drilling program, which included four deep diamond-drill holes, one (designated "A", fig. 1) to be drilled from the surface, and three (designated "B", "C", and "D", figs. 1 and 2) to be drilled from the 900 level of the Locan shaft. Of these, only B and C were completed by the company. Hole C was a continuation of the hole started by the Richmond-Eureka Co.

1/ The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from Bureau of Mines Report of Investigations 3949."

2/ Mining engineer, Reno Division, Mining Branch.

The site for hole D (figs. 1 and 2) was prepared, but the hole was not drilled. Both B anc C holes penetrated sulfide ore carrying good percentages of zinc, lead, gold, and silver. The ore bodies were 40 feet thick and were found approximately 1,400 feet below the 900 level of Locan shaft.

On the basis of the very favorable results obtained from the drilling program, the Eureka Corporation planned extensive development of the property and in 1942 commenced sinking the Fad shaft (figs. 1 and 2). The shortage of equipment and materials brought on by the war and difficulties with water in the shaft greatly hindered progress. However, early in 1943 the Eureka Corporation, Ltd., of Canada submitted to the War Production Board a proposal for developing the mine and milling 500 tons of zinc-lead ore a day. The proposal involved an expenditure of $2,890,750.

Before acting on the corporation's proposal, the War Production Board concluded that further exploration was necessary and requested the Bureau of Mines to examine the property and recommend a plan to explore the ore bodies more fully. R. A. Elgin, an engineer of the Bureau examined the property in April 1943 and recommended that four vertical diamond-drill holes, to total approximately 6,800 feet, be drilled from the 900 level of the Locan shaft. These holes, spaced about 200 feet from one or the other of those drilled by the company, formed an irregular, five-sided polygon, which enclosed an area approximately 350 to 300 feet, as shown on figure 2. Also recommended were two flat holes for draining the Fad shaft, but these were to be drilled only if the results of the vertical holes warranted and if sufficient funds were available. Work was to begin at the earliest possible date.

On September 20, 1943, the author arrived in Eureka to start the work preparatory to drilling.

Actual project work did not begin until October 13, 1943. The Eureka Corporation assisted the Bureau by lending, moving, and setting up equipment with which they had been sinking the Fad shaft; they also made some minor repairs to the equipment and to the Locan shaft. The interval between September 20 and October 13, 1943, was taken up by this work.

ACKNOWLEDGMENTS

In its program of exploration of mineral deposits, the Bureau of Mines has as its primary objective the more effective utilization of our mineral resources to the end that they make the greatest possible contribution to national security and economy. It is the policy of the Bureau to publish the facts developed by each exploratory project as soon as practicable after its conclusion. The Mining Branch, Lowell B. Moon, chief, conducts preliminary examinations, performs the actual exploratory work, and prepares the final report. The Metallurgical Branch, R. G. Knickerbocker, chief, analyses samples and performs beneficiation tests. Both these branches are under the supervision of Dr. R. S. Dean, assistant director.

Special acknowledgment is made to William Sharp, superintendent of the Eureka Corporation at Eureka, for his cooperation and valuable assistance; to S. R. Zimmerley, regional engineer, Bureau of Mines, Salt Lake City, and the Metallurgical staff for analyzing the samples and performing beneficiation tests; and, to Glenn L. Allen, district engineer, Bureau of Mines, Reno, Nev.

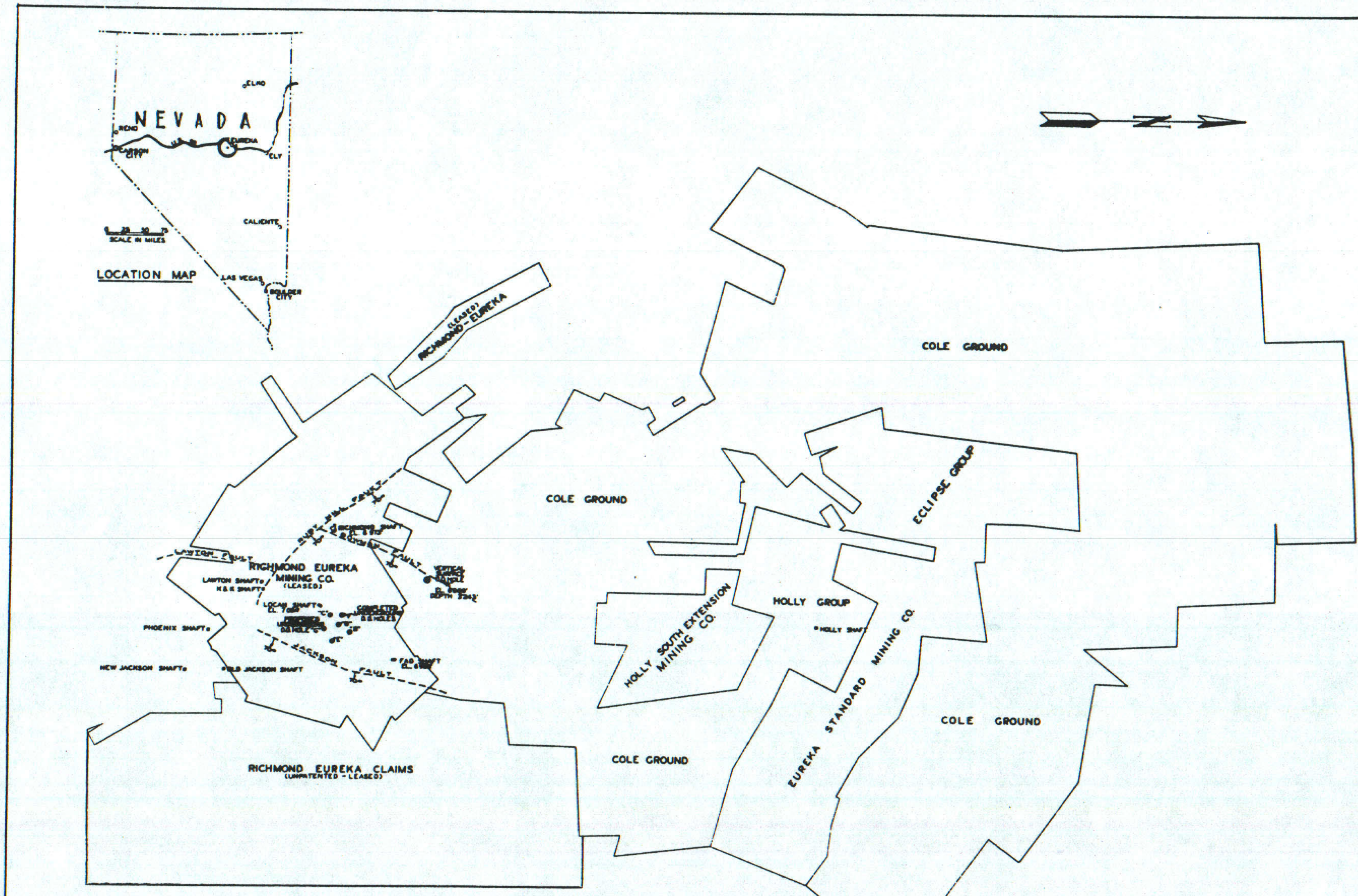


Fig. 1.- PROPERTY MAP SHOWING MINING AREA OF THE EUREKA CORPORATION LIMITED, EUREKA, NEVADA

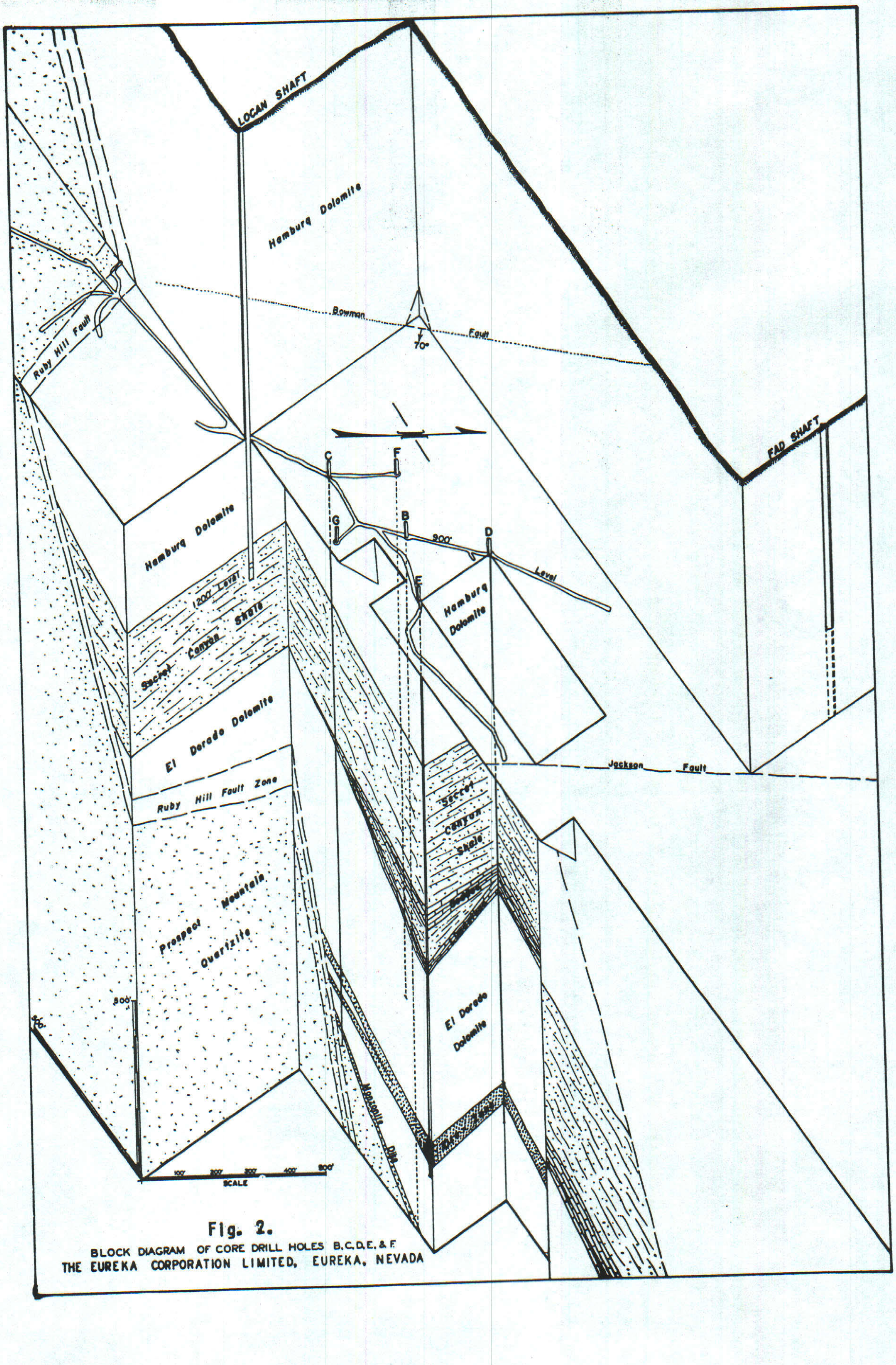


Fig. 2.

BLOCK DIAGRAM OF CORE DRILL HOLES B, C, D, E, & F
THE EUREKA CORPORATION LIMITED, EUREKA, NEVADA

OWNERSHIP

In 1905, the properties of the Richmond Mining Co. and the Eureka Consolidated Mining Co., including the famous Richmond and Eureka mines, were combined under the control of the Richmond-Eureka Mining Co.

The United States Smelting, Refining, & Mining Co., of 75 Federal Street, Boston, Mass., owns a controlling interest in the Richmond-Eureka Mining Co. These properties (fig. 1) were leased by the Richmond-Eureka Mining Co. to the Eureka Corp., Ltd.

The Eureka Corp., Ltd., is incorporated under the laws of Nova Scotia, Canada. George W. Tower is president of the corporation, W. B. Malone is secretary, and Thayer Lindsley is director. The main office of Eureka Corp., Ltd., is at 25 King Street, West Toronto, Ontario, Canada. George W. Mitchell is the resident manager for the corporation at Eureka, Nev.

The lease agreement includes 70 patented and 4 unpatented claims and 18 city lots and 2 city blocks in the Eureka townsite. Under a purchase agreement with the owners of the Cole-Wittenberg group (fig. 1), the corporation has also acquired 28 patented and 84 unpatented claims. The Holly group (fig. 1), consisting of three patented and five unpatented claims, likewise has been obtained under purchase agreement with the owner. All lease and purchase agreements are of record in the County Recorder's office in Eureka, Nev.

HISTORY AND PRODUCTION

Ore was first discovered in the district in September 1864. A group of prospectors from Austin found an outcrop of silver-lead ore in New York Canyon near the "76" claim, about 2 miles south of the present townsite. The following year the Champion and Buckeye claims were taken up on the southwest side of what is now known as Ruby Hill. Only a small amount of ore was mined, and operations virtually ceased after a small smelter, erected in 1866, failed to treat the ores effectively, and little was done thereafter until 1869. Since their discovery in 1864, these mines are reported to have produced 1,250,000 tons of oxide ore containing gold, silver, and lead, valued at approximately $90,000,000. Both companies smelted the ores locally until depletion of ore reserves forced them into leasing remnants of the larger ore bodies for small-scale production. Ore mined by lessees was shipped to the Selby smelter in California and to various smelters in the Salt Lake City area.

In 1869 ore from the Champion and Buckeye claims was successfully smelted, which encouraged mining activity in the district. San Francisco interests organized the Eureka Consolidated Mining Co., which controlled the ground on the northeast side of Ruby Hill; in 1871 an English company, the Richmond Mining Co., bought the adjoining claims to the west. Both companies immediately started to build smelters, and in 1872 mining and smelting operations had reached a high of about 160 tons per day. These two companies, the largest in the district, continued to treat ores from their mines, as well as custom ores, until 1891, when the smelters were shut down. Mining continued, however, under a leasing or "tributing" system until 1905, the ore being shipped to either Selby or Salt Lake City smelters for treatment.

In 1905 the Richmond-Eureka Mining Co., a subsidiary of the United States Smelting, Refining & Mining Co., acquired the combined holdings of the two companies, and, after a year or two of rehabilitory work, mining operations under a leasing system were resumed.

Lessees shipped approximately 200 tons per day to the smelter in the Salt Lake City area until the Eureka-Palisade Railroad was washed out in 1910. From that year until 1937, only small-scale leasing was done. The company, however, did some exploratory work in 1923 and started to drill hole C in the area to the north and on the hanging-wall side of the Ruby Hill fault; but for various reasons the hole was abandoned after reaching a depth of 725 feet, and drilling stopped.

In 1937, the Eureka Corp., Ltd., obtained a lease on the Richmond-Eureka holdings, and although 29,000 tons of ore was shipped between 1937 and 1940, the major objective of the corporation was exploration of the area north of the Ruby Hill fault. The diamond-drill program of Eureka Corp., Ltd., was started in September 1937 with diamond drill hole A (fig. 1) and was completed in 1941 with diamond-drill hole B. Total production from the Richmond-Eureka property to date is approximately 1,250,000 tons of ore with a gross value of approximately $90,000,000, the greater part of which represented gold and silver. Lead produced amounted to approximately 200,000 tons, or about one-third the value of the ore.

LOCATION AND COMMUNICATIONS

The properties of the Eureka Corporation, Ltd., in the Eureka Mining district are 2-1/2 miles west of Eureka, which is the business center of the district and the county seat of Eureka County, Nevada. The lands are in secs. 10, 11, 14, 15, 22, and 23, T. 19 N., R. 53 E. The Public Land Survey has not been completed over the entire district, but the sections mentioned will include virtually all of the claims held by the corporation.

Eureka is in the southeastern corner of Eureka County, on the Lincoln Highway (U. S. Highway 50), 77 miles west of Ely and 248 miles east of Reno. The nearest rail connection is at East Ely, Nev., which is the southern terminus of the Nevada Northern Railway. Ely is the main distribution point for White Pine and Eureka Counties. The Nevada Northern Railway connects with the Western Pacific Railroad at Shafter and with the Southern Pacific Railroad at Cobre. Palisade, 90 miles north of Eureka, is on the main lines of the Southern Pacific and Western Pacific Railroads. The road to Palisade, although graveled for about 60 miles, is not serviceable the year around, and little freight is brought in from this rail point. This road is now being improved by the Federal Government, and application has been made to convert it into a hard-surfaced highway. At present, the greater part of supplies and freight destined for the Eureka district is hauled from Ely and Reno by Hickey Stages, and rates from these two points are high. If the road between Eureka and Palisade should be hard-surfaced, this would be the most direct and feasible route for shipment of large quantities of freight or express.

The road from Eureka to the properties of the Eureka Corporation is a graded dirt road that needs considerable improvement. Although the grades are not excessive and the road is maintained in fair condition during summer and fall, it will not stand up under heavy traffic in winter and spring. Applications have been made to the Government for an oiled, hard-surfaced road.

A branch telephne line connects Eureka and small outlying communities with Ely, where connections are available with the main lines of the Bell system. Indirect telegraph connections are maintained by the Bell Telephone Company. Messages are transmitted over the party-line telephone connecting with Ely, and from there are sent out over the main lines of the company's telegraph system.

PHYSICAL FEATURES

The most prominent surface feature in the district is Prospect Mountain, a north-south trending spur from the west slope of the Diamond Range. The ridgelike Prospect Mountain is some 7 miles long and 1 to 1-1/2 miles wide. From Prospect Peak, the highest point of the ridge, which has an altitude of 9,600 feet, the south and west sides slope steeply into Fish Creek and Spring Valley, respectively. The east slope is rough, being broken into numerous ridges and canyons, which trend northeast and join the main canyon in which Eureka townsite is situated.

To the north the slope is fairly regular but steep to Mineral Hill, the altitude of which is 7,740 feet. From this hill northward the mountain ridge is broken into three unimposing hills, on which the greater part of the corporation's claims are located. Ruby Hill, the most southern and the highest of the three hills, with an altitude of 7,300 feet, is separated from Adams Hill by a narrow gulch, which joins Spring Valley on the west. On Ruby Hill are located the "lava beds" and the underground workings of the Richmond-Eureka mines.

Adams Hill, altitude 6,950 feet, is a long, flat-topped elevation with gentle slopes into Austin Canyon on the east and into Spring Valley on the west. To the north it slopes gradually into Mineral Point, which is really a part of Adams Hill. Mineral Point merges into Diamond Valley and is the northernmost part of Prospect Mountain Ridge. The altitude of Diamond Valley here is 6,350 feet, or about 600 feet below the collar of the Fad shaft, which is on the east rim of Adams Hill at altitude of 6,950 feet. The location and altitude of all shafts are shown on figures 1 and 2.

The climate permits year-around operation. Throughout the winter months, however, long periods of subzero weather are not unusual, making the protection of all water pipe lines imperative and insulation of buildings and houses advisable. Snow, although on the ground from 4 to 5 months, does not seriously interfere with highway traffic but does occasionally block the roads to the property and the outlying communities.

All fuel for domestic purposes is hauled in on order by a local merchant and trucking firm. Wood for fuel is brought in from a distance of about 40 miles, and coal is hauled from Ely. The Shell Oil Co. and the Standard Oil Co. of California have wholesale plants in Eureka for bulk sales of gasoline, Diesel fuel, stove oil, and all types of lubricants. No fuel or lumber company is in Eureka. Lumber and timber for mining purposes are obtained from Ely, Reno, or Fallon.

Water for mine and domestic use at the property is purchased from the Ruby Hill Water Works. A. C. Florio, the owner, also owns the Eureka Water Works, which supplies the Eureka townsite. These companies hold the water rights on several springs in the mountains about 5 miles southeast of the Richmond-Eureka mine. These springs are the only developed water within a reasonable distance of the property. The supply from them, is ample for present needs.

Little is known of the volume of water that flows or is pumped from the wells in Spring and Diamond Valleys. These wells, which are 75 to 110 feet deep, were sunk by stockmen, and no attempt was made to obtain a greater flow than was needed. It is reasonable to expect that a good volume of water can be obtained from deeper wells, as artesian water is found farther north in Diamond Valley.

There is little doubt that the mine will make enough water for all mining and milling uses, at least for a time. The water level in the Locan shaft is 206 feet below the 900 level, or at elevation of 6,157 feet. In diamond-drill holes D, E, and F water stood 64 feet below the collars, or at elevation of 6,350 feet. The Fad shaft makes about 50 gallons per minute, and this water was struck 252 feet below collar, or at an elevation of 6,698 feet. The Fad shaft will be sunk at least 3,000 feet to an elevation of 3,950 feet. This indicates an unlimited supply, as the Fad shaft and the workings from the shaft will open a large area of virgin ground some 2,500 feet thick in which water-bearing formations are known to be present. Whether or not continuous pumping will exhaust the supply is not known, but it is entirely probable that with some control of the flow into the mine, sufficient volume for mining and milling can be pumped throughout the life of the property. It would seem advisable, however, to obtain more definite data on the water in the valleys, as it is possible that water from this source might be required.

LABOR AND CAMP ACCOMMODATIONS

At present there is an acute shortage of all classes of labor in the district, and no immediate relief is in sight. In fact, the shortage will become more acute as mining operations increase. The 25 or 30 men now employed by the corporation represent virtually the entire supply of local labor. The requirements for skilled and unskilled labor, in addition to that now available, are expected to rise to a peak of approximately 300, and arrangements must be made to import that number of men in order to maintain development and production.

No living accommodations are available at the mine. All employees live in Eureka, and at present the town does not have housing facilities for even a few more workers. For the employees necessary for installation of equipment and in the preliminary stages of development, trailer houses can be used until permanent housing is available.

The county hospital in Eureka is not equipped to care for more than 15 patients, nor can it care for major surgical cases. With the growth of the community, hospital facilities will have to be increased and the local doctor will need assistance.

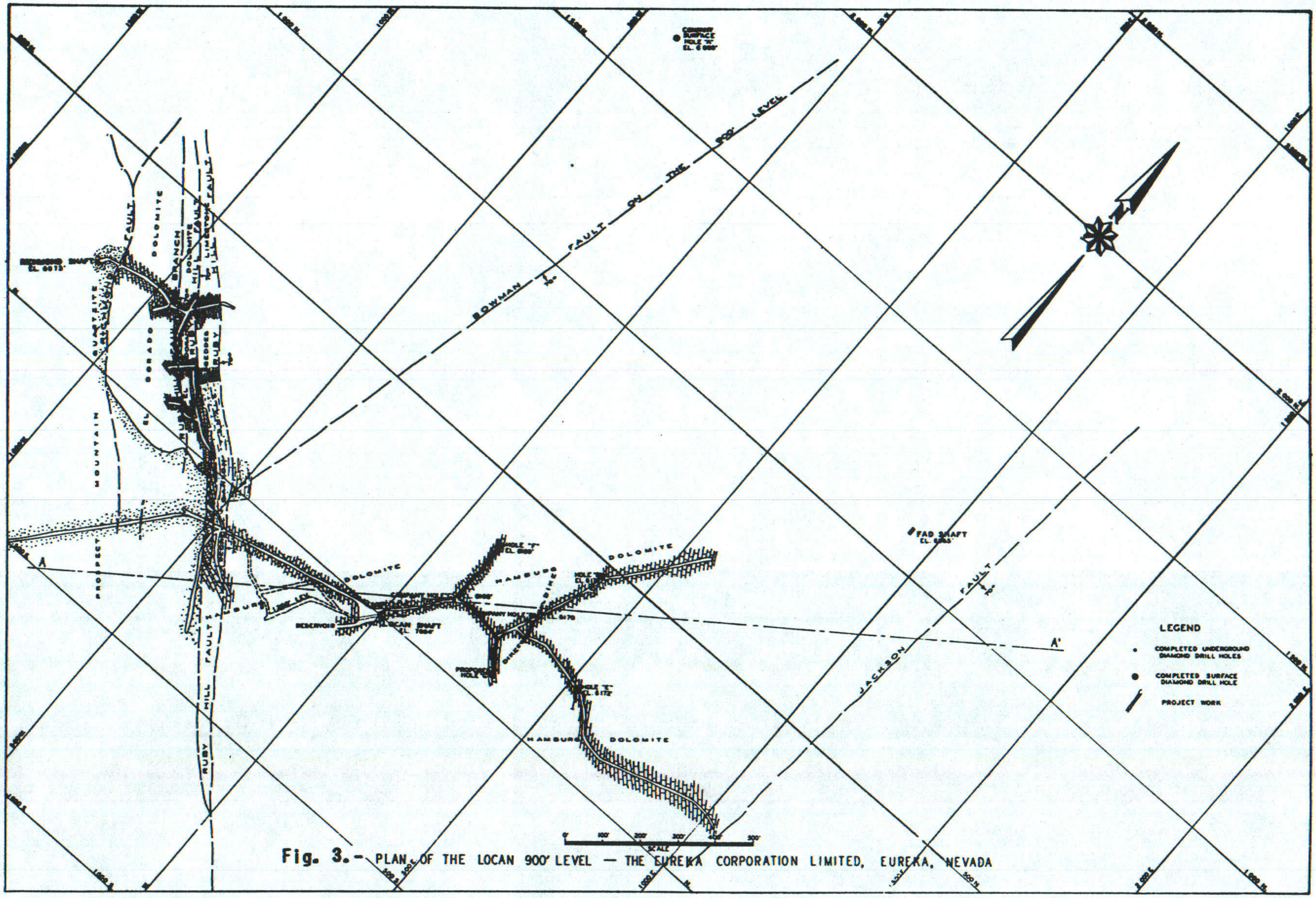


Fig. 3.- PLAN OF THE LOGAN 900' LEVEL — THE EUREKA CORPORATION LIMITED, EUREKA, NEVADA

PLAN OF THE PROJECT

For further exploration of the property, the Bureau proposed a diamond-drilling program, which included four vertical holes totaling 6,800 feet of drilling and two flat drainage holes totaling 2,000 feet, a total of 8,800 feet. The two flat holes, which were to drain the Fad shaft to approximately the 900 level, were to be drilled only if the results from the vertical holes warranted sinking the Fad shaft and funds were available.

Before drilling could begin, a certain amount of preparatory work was necessary; equipment such as hoist, compressors, and other accessory equipment had to be moved from the Fad shaft to the Locan shaft. Locan shaft required minor repairs, and all track and pipe had to be replaced on the 900-level before beginning raises and stations for holes E, F, and G.

The vertical holes, designated D, E F, and G, were to be collared from the 900 level of the Locan shaft and with holes B and C, which had been put down by the corporation, were to form a pattern enclosing an area approximately 350 by 300 feet, as shown on figure 2. Holes D and E were located to take advantage of all work done by the Eureka Corporation in preparation for its drilling program. The drifts and crosscut to holes D and E had been driven, and at D hole the raise and station had been completed, whereas at hole E only the riase and station were to be completed to make it ready for the drill. The locations of holes F and G were such that crosscuts had to be driven and raises and drill stations had to be cut. Total footage of crosscuts, as planned, amounted to 280 feet. Also, the three raises would require 135 feet of rock work with timbering and installation of sheave supports. The stations were to be 10 by 15 by 8 feet, or for the three holes, E, F, and G, a total of 133 cubic yards was to be excavated.

ORE DEPOSITS

The geology of the Eureka district has been fully described by Hague[3] and Curtis.[4] Walcott[5] and Resser[6] wrote several reports covering the fauna found in the Cambrian formation, in which virtually all of the ore deposits occur. Through the work of Wheeler and Lemmon,[7] a stratigraphic sequence with

3/ Hague, Arnold, Abstract of the Report on the Geology of the Eureka District, Nev.: In 3d. Am. Rept., U. S. Geol. Surv., 1881-82, 1883, pp. 237-290. Also, Geology of the Eureka District, [Nev]: Geol. Surv. Mono. 20, 1892, 419 pp.

4/ Curtis, J. S., Silver-lead deposits of Eureka, Nev.: Geol. Surv. Mono. 7, 1884, 200 pp.

5/ Walcott, C. D., Paleontology of Eureka District Nev. : Geol. Surv. Mono. 8, 1884, 298 pp.

6/ Resser, C. E., Nomenclature of Some Cambrian Trilobites: Smithsonian Misc. Coll., vol. 93, No. 5, 1935, 46 pp.
Second Contribution to Nomenclature of Some Cambrian Trilobites: Smithsonian Misc. Coll., vol. 95, No. 4, 1936, pp. 1-29.
Third Contribution to Nomenclature of Some Cambrian Trilobites: Smithsonian Misc. Coll., vol. 95, No. 22, 1937, pp. 1-29.

7/ Wheeler, Harry E., and Lemmon, Dwight M., Cambrian Formations of the Eureka and Pioche Districts, Nev.: Geol. and Min. Surv. No. 31, vol. 33, No. 3, 1939, pp. 13-32.

accurately measured strata was made. The name "Geddes" was proposed for the bed of flaggey limestone which lay conformably on top of the El Dorado dolomite, of which it was formerly considered a part. It was designated as a separate formation. Faunas were reallocated, which, according to Wheeler and Lemmon, would aid in distinguishing and properly placing the formations in their true sequence and would also lead a better understanding of certain structural fractures that had been either misinterpreted or entirely overlooked.

The oxide and sulfide ore bodies containing gold, silver, and lead, and gold, silver, lead, zinc, and cadmium, respectively, occur as typical replacement deposits in the El Dorado dolomite, a member of the Paleozoic sediments that are widespread through the Great Basin area. The age of the El Dorado has been designated as of the Lower and Middle Cambrian period of the Paleozoic era.

Some relatively small oxide-ore bodies have been found in the upper beds of dolomite and limestone (the Hamburg and Pogonip). The more important deposits, however, are confined almost entirely to the El Dorado dolomite. This stratum, 2,000 feet in thickness, is composed of a secondary dolomitic limestone in which dolomite predominates. The color ranges from light gray to black. Bedding has been virtually obliterated by faulting; apparently the entire bed has been crushed and recemented with calcite.

The stratigraphic sequence of Cambrian formation in the district, as determined by Wheeler and Lemmon, is:

"Pogonip" limestone	425	Lower portion	)
Dunderburg shale	340		)Upper Cambrian
Hamburg dolomite	900		)
Secret Canyon shale	1,035		)
Geddes limestone	335		)Middle Cambrian
El Dorado dolomite	2,000		Middle and Lower Cambrian
	5,035		
Prospect Mountain quartzite	1,600		Lower Cambrian
	6,635		

Although the total thickness of strata is 6,635, this does not represent the thickness which it will be necessary to penetrate to reach the sulfide deposits, as they were found 500 feet from the top of the El Dorado dolomite.

The deposits of oxidized ore on Ruby Hill were confined to a segment of the El Dorado dolomite, which apparently is an upthrust fault block on the footwall of the Ruby Hill fault. This fault, with the parallel branches or secondary fissures, is thought to be the main channel for the mineralizing solutions that result from igneous intrusions. Although it is generally accepted that the mineralizing action was of igneous origin and that either the granite, monzonite, or rhyolite found in the area might have been the source of the solution, a definite genesis has not been determined.

As stated, the deposits are of the replacement type, and, judging from the analyses of the ores from the upper segment, the ascending mineralizing solution completely replaced the El Dorado dolomite. Few, if any, inclusions of unreplaced dolomite were found in the ore deposits. The ore bodies of Ruby

Hill seem to have no definite pattern either as to position or size and shape. The physical condition of the dolomite and the main structural features, the Ruby Hill and other faults, are certainly the most important factors in the formation and distribution of the ore bodies. The chemical composition of the rock (that is, whether dolomite or limestone) apparently had little if any bearing on the formation of the ore bodies, as they occurred neither in any particular horizon nor with any definite pattern. No criteria have been found from which either the size or shape, dip or strike, or position of occurrence of ore bodies can be predicted. Dip and strike varied with the individual ore bodies; some were flat and seemed to follow the direction of the thrust faults; others conformed to the strike and dip of the normal faults; still others occurred as isolated bodies with unrelated strike or dip.

Some of the ore bodies were connected by stringers of iron oxide of varying size, and although some relation apparently existed between ore bodies, there was no definite criterion that could be used for locating them. All the upper ore bodies were almost completely oxidized, the oxide zone extending from surface to 1,200 feet, or slightly below water level.

Results of the diamond-drilling programs of the corporation and of the Bureau were exceptionally favorable. All of the underground holes drilled encountered good thicknesses of sulfide ore and proved beyond doubt that the El Dorado dolomite in the area on the hanging wall of the Ruby Hill fault lying between Jackson fault on the east and the Bowman on the west is in its normal position in the stratigraphic sequence, that it is mineralized, and that the manner of occurrence of these sulfide ore bodies is somewhat similar to that of the upper oxide deposits.

Data obtained from core-drill samples through the deposit in the El Dorado dolomite in the hanging wall of the Ruby Hill fault indicate that in this segment of the dolomite, replacement action of the solutions was also very complete. The analysis shows an extremely low percentage of insoluble and other gangue material.

Although little is known concerning the lateral extent or the shape of these sulfide deposits, results from the diamond-drill holes seem to point to greater uniformity in the dip and strike and a more definite horizon than was found in the oxidized areas, with perhaps less erratic spacing of the ore bodies. The source of mineralization is the same for both the sulfide and oxide ore bodies. The lower ore bodies are mainly sulfides, with only an oxidized shell. An increase in zinc and decrease in lead contents of the sulfide ore indicate a zonal distribution of these metals.

It has been reported that the outlines of the oxide ore bodies were well-defined - that there was a definite line of demarcation between the ore and barren dolomite. This is true also of the sulfide ore bodies. In all the holes drilled by the Bureau and the corporation there was a sharp break between the ore and waste on both the hanging wall and footwall. With the line of demarcation so easily distinguishable, no difficulty whatever will be experienced in determining the limits to which ore can be mined.

Diamond-drill holes A, B, and C (figs. 5 and 6) encountered a monzonite porphyry sill between the El Dorado dolomite and the Prospect Mountain quartzite, considerably below the ore.

Also, in hole E the same rock was encountered at three different depths in the Hamburg dolomite, well above the ore. Although it has not been definitely determined that the monzonite is a source of the mineralizing solutions, it is very probably that it has some bearing on the formation of the deposits.

THE ORE

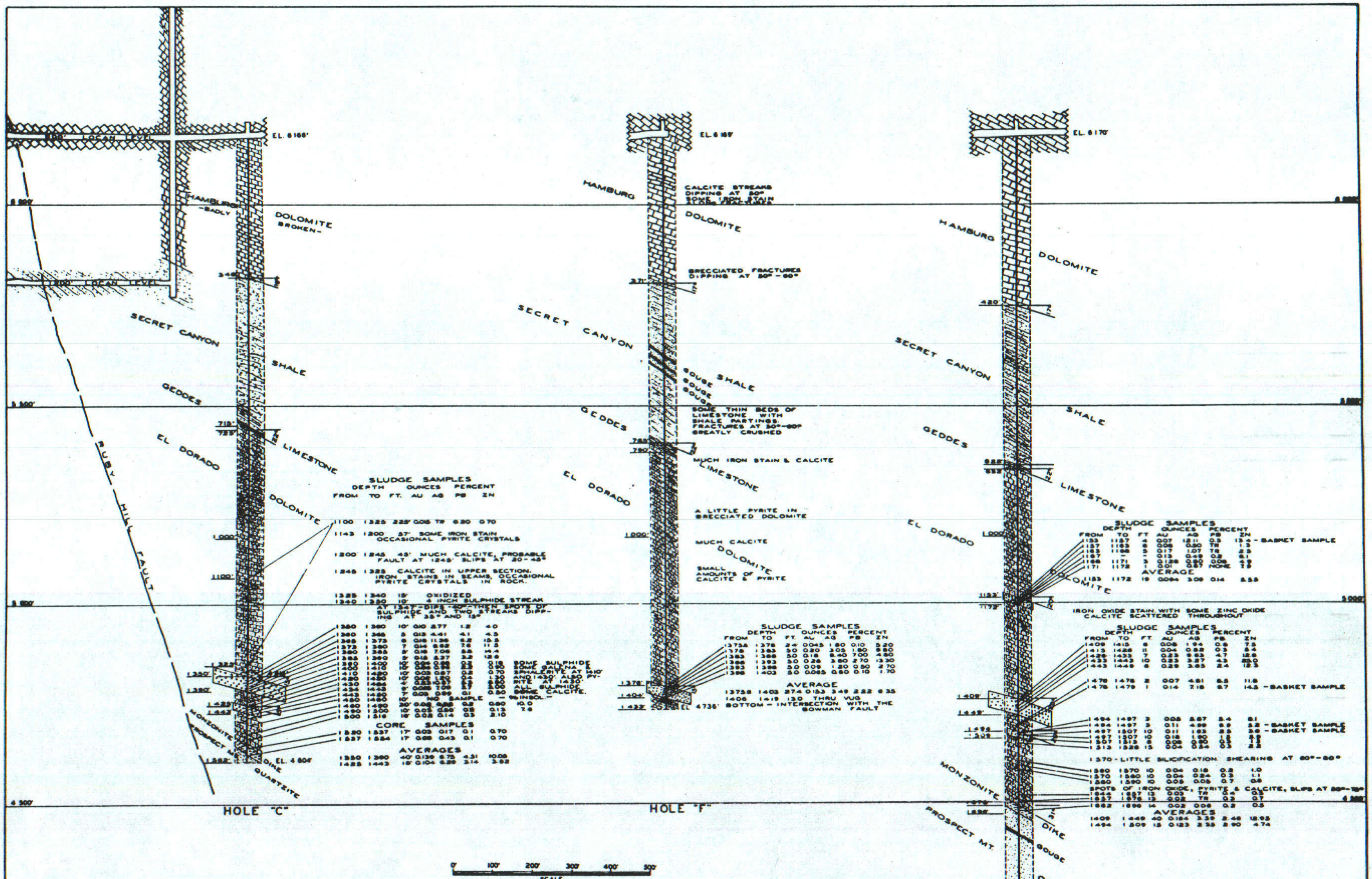
The sulfide ores originally deposited by ascending solution were later completely oxidized and leached to form the typical Ruby hill ores mined in early days south of Ruby Hill fault.

The following analysis (by Fred Claudet of London) of a composite sample of the ores mined in 1878 by the Richmond-Eureka Co. is representative of virtually all the ore mined in Ruby Hill:

	Percent		
Lead oxide	35.65		
Bismuth	-		
Copper oxide	0.15	(Lead	33.12
Iron sesquioxide	34.39	Copper	0.12
Manganese oxide	0.13	Iron	24.07
Arsenic acid	6.34	Zinc	1.89
Sulfuric acid	4.18	Arsenic	4.15
Antimony	0.25	Sulfur	1.67
Chlorine	-	Antimony	0.25)
Silica	2.95		
Alumina	0.64		
Lime	1.14		
Magnesia	0.41		
Water and carbonic acid	10.90		
	99.50		
Au-Ag	0.10		
Ag, oz. per short ton	27.55		
Au, oz. per short ton	1.59		

The value of the ores diminished somewhat in later years, but little change occurred in their chemical composition.

Average ore was composed almost entirely of carbonates and oxides of lead and iron. Predominant lead minerals were cerussite, anglesite, and small amounts of lead occurring as galena in nodules which oxidizing action had not reached. Oxidation was quite complete, and only a very small amount of lead or iron sulfides was found. Extensive oxidation and subsequent leaching produced a very loosely consolidated ore, particularly in the upper portion of the ore bodies. Caves, which occurred in connection with virtually all of the ore bodies, were very probably formed by the shrinkage caused by oxidation and subsequent leaching. Oxidation extended to almost 1,200 feet.



DIAMOND DRILL HOLE SECTIONS C, F, B. — THE EUREKA CORPORATION LIMITED, EUREKA, NEVADA

Fig. 5.

Minerals found in ores from the old workings on Ruby Hill include cerrusite, anglesite, mimetite, galena, pyrite, wulfenite, sphalerite, calamine, smithsonite, arsenopyrite, malachite, azurite, manganese, limonite, siderite, calcite, aragonite, quartz, pyromorphite, leadhillite, molybdenite, and wad. Silver was found as chloride and less often as sulfide and was associated almost entirely with the lead minerals. Gold was associated with the limonite and with silica, and some of the more siliceous ore carried a high gold content.

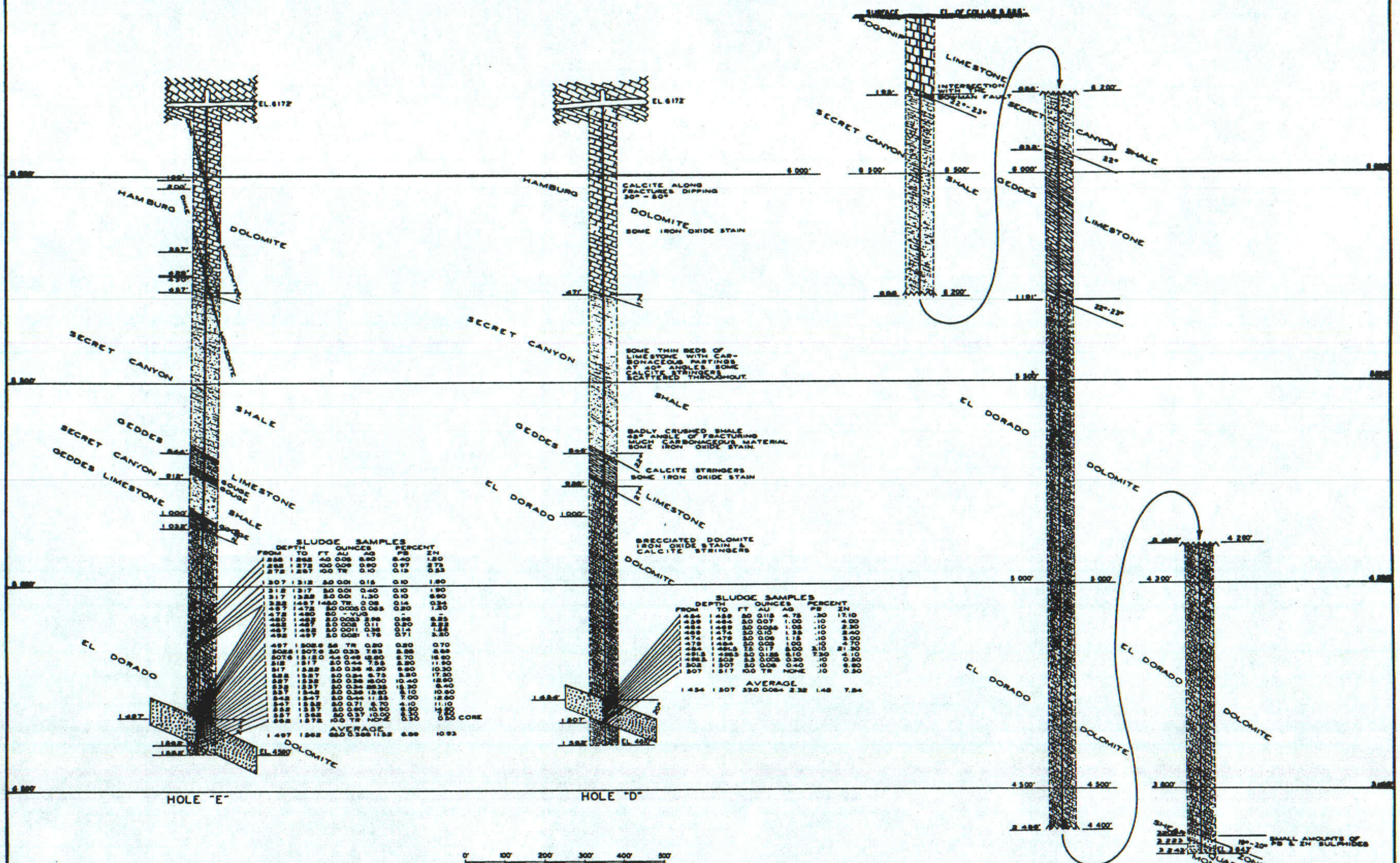
Because of the small quantity of samples recovered, no composite sample was made of ore from diamond-drill holes B, C, D, E, and F. A composite was made at the project, for check purposes, of the samples from hole E, 1,506 to 1,565 feet. Assays are given below. Analyses made by the Bureau of head samples from the ore body cut in hole E also are shown below:

Analyses of hole E composites

	Salt Lake composite, No-18.2 Percent	Project composite Percent
S	38.0	
Insol.	.4	
SiO_2	.1	
Fe	29.35	
CaO	2.1	
Al_2O_3	.35	
Pb(oxide)	.1	
Cu(oxide)	.02	
Zn(oxide)	.1	
Pb	8.0	8.1
Cu	.15	
Zn	10.7	11.6
Cd	.12	
Mn	.1	
As	5.7	
Sb	.16	
Co	.02	
Sn	.08	
Au	0.45 oz./ton	0.445 oz./ton
Ag	14.20 oz./ton	13.65 oz./ton
Specific gravity	4.9	

Though having a higher Au-Ag-Pb-Zn content than the average of the ores from holes B, C, D, or F, this analysis is fairly typical of the ore found in these holes. Sludge samples from D and F holes varied little in physical or chemical character from the E hole composite. Analyses of all samples are shown on figures 5 and 6.

The ore minerals observed in the sulfide ores are sphalerite (variety marmatite), galena, pyrite, arsenopyrite, tetrahedrite, chalcopyrite, and minor quantities of alteration minerals. The concentrates from the sulfide



DIAMOND DRILL HOLE SECTIONS E, D, A, — THE EUREKA CORPORATION LIMITED, EUREKA, NEVADA

Fig. 6.

ores contained valuable amounts (0.5 to 0.6 percent) of cadmium as well as small amounts of cobalt, tin, and antimony. The gangue minerals are calcite and altered feldspars

In holes D, E, and F at the top of the ore bodies some oxide minerals were noted, principally limonite, but only in very small amounts.

The oxide minerals apparently have been formed as lining of the caves or vugs, which occurred at the top of D, E, and F hole ore bodies, or as a casing surrounding the ore bodies.

The outstanding physical characteristic of the ore is its softness and friability. The ore could be observed only as sludge samples. No core was recovered from the ore bodies, and as the ore caved readily during drilling (particularly in E hole) it is believed that it is too soft and loosely consolidated to stand without support over comparatively small openings. The ore is heavy; the specific gravity of the composite sample from E hole is 4.9. This figure, however, is too high for the average of ore from all drill holes, as the ore from E hole was all sulfide with no layers or inclusions of dolomite, and a more nearly accurate average specific gravity for the ore would be 3.8.

MINE WORKINGS AND EQUIPMENT

Development of the ore bodies in Richmond and Eureka mines in the upper segment of the El Dorado dolomite, south of and in the footwall of the Ruby Hill fault, was almost entirely through shafts. The "lava beds" or surface outcrop, containing a few relatively minor ore bodies, was worked through adits and tunnels. Two of the main shafts, the Lawton and Richmond, are inaccessible at present. Access to only a part of the old workings is gained through the Locan shaft. This and the Richmond are the deepest shafts on Ruby Hill, and both are approximately 1,250 feet in depth. The Richmond shaft is caved above the 900 Locan level. The Locan shaft has no ladders below the 900.

Ground subsidence and caving make entrance to most of the old workings either unsafe or impossible. A very clear idea of the old workings can be obtained from the many horizontal and vertical sections made by Curtis.8/ Of the four main vertical shafts, the K-K, Lawton, Richmond, and Locan, only the last is now open. Lawton shaft is in bad condition, and the 1,230-foot Richmond shaft, although affording access to some of the workings of the 600-level, is unsafe and is caved between this point and the 900 Locan level, which connects the Richmond with the Locan shaft. The latter shaft, also sunk to 1,230 feet, has but three levels - the 600 (a pump station), 900, and 1,200 levels. The 1,200 level is under water, and at present only the 900 level is used. In mining the sulfide ore bodies, the Eureka Corporation, Ltd., plans to utilize the Locan, a three-compartment shaft (two hoisting and one manway pipe), as an auxiliary and for ventilating purposes. At present the 900 level of the Locan shaft is being extended to connect with the Fad shaft when it reaches this level.

8/ Work cited in footnote 4.

Development of the ore bodies found by the Corporation and the Bureau in the El Dorado dolomite on the hanging wall of the Ruby Hill fault is to be through the Fad shaft. This new shaft, 1,450 feet northeast of the Locan, has four compartments - three 5-1/2 by 5 feet and one 4-1/2 by 5 feet. It has been sunk 542 feet below the collar and is to be continued, in the first stage of the development, to a depth of 3,000 feet, which will extend it between 600 and 900 feet below the ore bodies in the drill holes. Its location in relation to the more important shafts, is shown on figures 1 and 2.

The topography of Ruby Hill offered poor opportunity for access to the ore by tunnels or adits. Most of the ore bodies on the hill were opened by shafts, from which drifts were driven to or toward the Ruby Hill fault or to known ore bodies. Ground conditions in the dolomite were good. The quartzite stood fairly well, but some timbering was necessary, especially where water was encountered. The shales required timbering wherever they were opened.

Drifts and shafts through the Hamburg dolomite required little or no timber, and the El Dorado dolomite stood well except in those zones that were badly crushed and fractured. All ground required timbering in and adjacent to the ore bodies or along the quartzite contact.

Virtually all stoping was done by the square-set method. Some fill was used, but only where filling was readily available or ground conditions forced additional support for the timbers. A horizontal cut-and-fill system was tried out for a short time but apparently was either too costly or not suitable, as it was soon discontinued.

Leasing operations used square sets wherever the size of ore bodies required it or the grade of ore would justify the cost. Smaller ore bodies were mined by underhand or overhand open stope, with stull support for heavy ground.

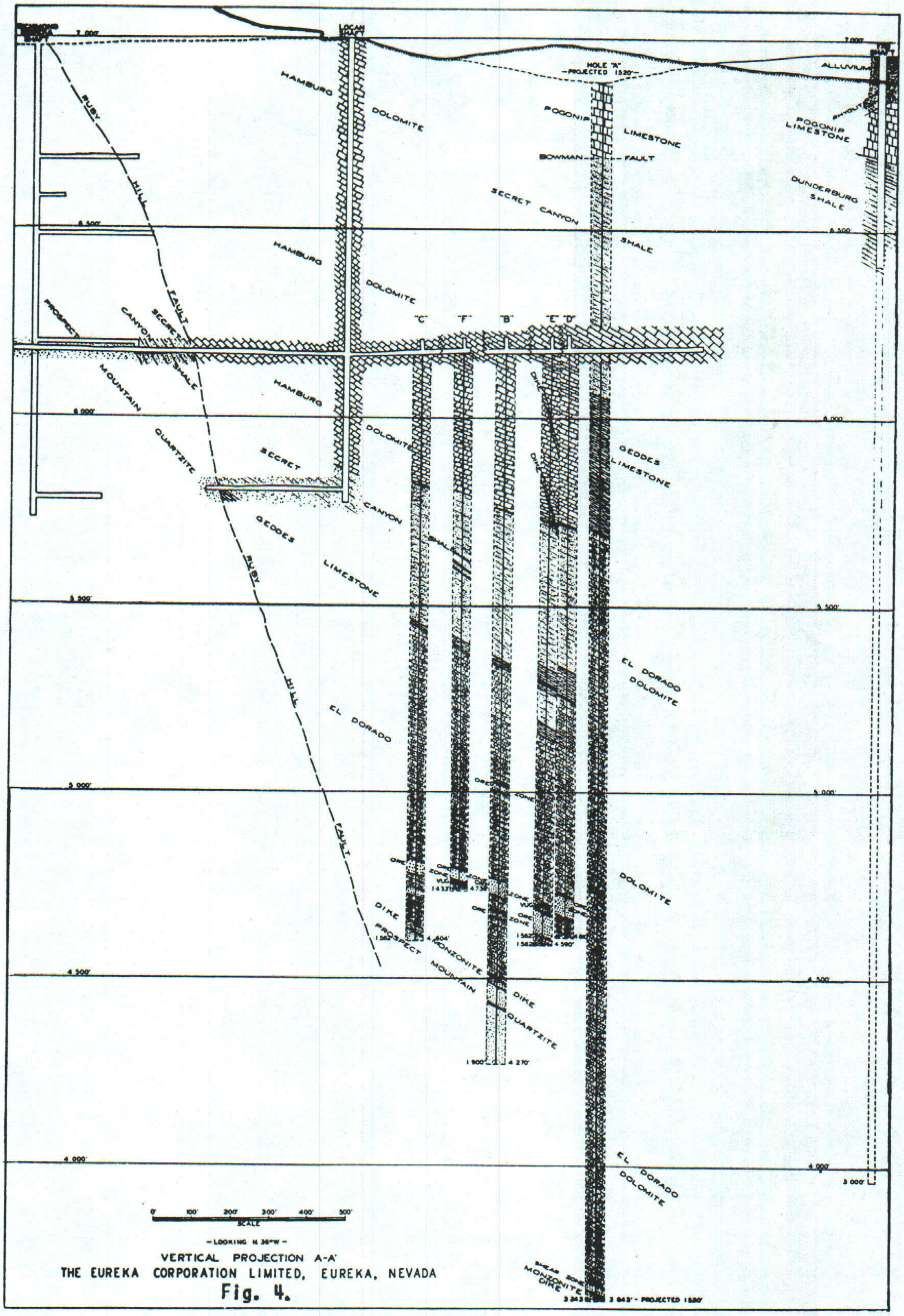
WORK OF THE PROJECT

Core Drilling

Of the four vertical holes (D, E, F, and G) planned, only three (D, E, and F) were completed. Neither of the drainage holes was drilled.

Very poor progress was made on holes D and E owing to the inexperience of crews, poor equipment, and caving ground (particularly in the Secret Canyon shale). Therefore, a third drill, which was set up on hole F, was used solely as a standby to take up some of the slack caused by waiting for cement to set in holes D and E, as well as delays in delivery of supplies and equipment. Excessive cementing, unusual difficulties in the use of cement for catching up caving ground and stopping water loss contributed toward a low footage per drill shift.

Holes E, D, and F were completed on October 30, 1944, December 7, 1944, and January 29, 1945, respectively. A total of 4,577 feet was drilled. Hole E went to a depth of 1,582 feet; hold D to 1,562 feet; and hole F to 1,433 feet below the 900 level. Ore was encountered in all holes. Sections of the individual holes are shown on figures 5 and 6.



VERTICAL PROJECTION A-A'

THE EUREKA CORPORATION LIMITED, EUREKA, NEVADA

Fig. 4.

A total of 58 sludge samples and 13 core samples were taken from the three holes. No core samples were obtained from the main ore bodies; those taken were either from above or below the ore. Approximately 335 pounds of the sludge samples were shipped for analysis and ore-dressing tests to experimental stations of the Bureau in Salt Lake City, Utah, and Reno, Nev.

The work of the project resulted in further proof that mineralization of the El Dorado dolomite continued into the segment that lay on the hanging wall of the Ruby Hill fault between the Jackson and Bowman faults; also, that the ore bodies found by the corporation in holes B and C were not limited to the immediate vicinity of these holes, but were either continuous or relatively closely spaced in the area blocked by the holes.

Ore Dressing

The experimental stations of the Bureau in Salt Lake City and Reno have completed beneficiation tests on four separate composites of sludge samples from core-drilled by the Eureka Corp., Ltd., and the Bureau. Detailed reports of the results of the test work have been made and are recorded at these stations. However, a brief summary of the reports follows.

The following tabulation of analyses (gold, silver, lead, and zinc only) permits comparison of the individual physical composites as well as between the physical composites and the calculated weighted average Au-Ag-Pb-Zn content of the ore.

	Oz./ton		Percent	
	Au	Ag	Pb	Zn
1. Composite of B and C hole rejects sent in by R. A. Elgin..................................	-	-	3.3	9.6
2. Composite of B and C hole rejects, Ne-18.1, sent in by William Sharp............................	0.16	5.3	3.6	9.2
3. E hole composite, Bureau sample) Ne-18.2	.45	14.20	8.0	10.7
) Ne-18.3	.45	14.55	8.8	11.5
4. D, E, and F hole composite, Bureau sample	.235	6.5	4.5	9.2
5. Calculated weighted average content of ore reserves	.241	7.28	4.46	9.84

The first composite sample, sent in by R. A. Elgin, was made up of rejects of sludge samples from holes B and C. The size of the sample, however, limited test work to checking for the grade of concentrate that might be obtained by selective flotation, and no attempt was made to obtain maximum recovery. The results of the tests are shown below.

Product	Assay, percent				Distribution, percent	
	Pb	Zn	Cd	Fe	Pb	Zn
Lead concentrate	66.0	6.5	-	3.65	46.2	1.3
Zinc concentrate No. 1	2.2	53.8	0.64	7.4	5.1	36.0
Zinc concentrate No. 2	5.1	50.4	.61	8.5	8.6	24.5
Head sample	3.3	9.6	-	26.4		

The second composite, sent in by William Sharp, of Eureka Corp., Ltd., was made up of 13 assay-sample rejects from holes B and C. Owing to the size of the sample, no test work was done to determine the method of treatment required for recovering the gold in the auriferous pyritic tailings. The zinc cleaner and rougher tailings are composed almost entirely of pyrite containing over 90 percent gold. Complete test data on selective flotation of lead and zinc on this composite follow.

Test No.: Z-18187 Date: 6-29-43

Ore: Eureka Corporation, Ne-18.1 Class: Lead-zinc

Treatment: Selective flotation of lead and zinc

Product	Assay No.	Weight	Percent weight	Assay, percent Pb	Zn	Fe	Insol.	CaO	Cd
Pb cl. conct.	13811	22.6	4.5	63.2	2.7	6.35	0.4	-	-
Pb cl. tail.		11.0	2.2	14.0	7.0	17.5	.4	-	-
Zn recl. conct.	13998	58.9	11.8	.6	52.0	8.5	.2	-	0.60
Zn recl. tail.	13999	18.7	3.8	1.3	36.7	17.0	.2	-	-
Zn cl. tail.		226.2	45.4	.4	2.7	38.0	2.2	-	-
Ro tail.	13815	161.0	32.3	.05	.4	19.6	.8	19.6	-
Head sample		498.4	100.0	3.47	9.16	25.9	1.1	8.6	-
Calc. Zn cl. conct. .			15.6	.9	45.2	10.9	1.2	-	0.45

Product	Assay No.	Oz/ton Ag	Au	Distribution, percent Pb	Zn	Ag	Au
Pb cl. conct.	13811	60.9	0.06	82.0	1.3	56.6	2.1
Pb cl. tail.		17.6	.12	8.9	1.7	8.0	2.1
Zn recl. conct.	13998	4.0	.01	2.0	67.0	9.7	.9
Zn recl. tail.	13999	2.0	.04	1.4	15.2	1.6	1.2
Zn cl. tail.		2.15	.22	5.2	13.4	20.1	78.5
Ro tail.	13815	.6	.06	.5	1.4	4.0	15.2
Head sample		4.85	.127	100.0	100.0	-	-
Calc. Zn cl. conct. .		3.7	.02	3.4	82.2	11.3	2.1

Reagents, pounds per ton

Pebble mill grind, 65-mesh	Pb float	Zn float	Zn cleaning
CaO-2.0	Z-3-0.09	$CuSO_4$ -1.8	Zn Ro. conct. ground in pebble mill with 4.0 lb./ton CaO
$ZnSO_4.H_2O$-6.0	B-23-0.06	Z-3-0.20	
NaCN -0.5		Z-6-0.15 B-23-0.06	

The third series of tests was made on a composite (Ne-18.2) of the sludge samples from hole E, analysis of which follows:

Ne-18.2:	Percent	Ne-18.2:	Percent
S	38.0	Cu	.15
Insol.	.4	Zn	10.7
SiO_2	.1	Cd	.12
Fe	29.35	Mn	.1
CaO	2.1	As	5.7
Al_2O_3	.35	Sb	.16
Pb (oxide)	<.1	Co	.02
Cu (oxide)	<.02	Sn	.08
Zn (oxide)	<.1		Oz./ton
Pb	8.0	Au	0.45
		Ag	14.20

Treatment procedures, as quoted from the report by the Bureau's Salt Lake City experimental station, were:

1. Selective flotation
2. Cyanidation of pyritic rougher tail
3. Cyanidation of roaster rougher tail

The Bureau's Reno experimental station also made many tests to determine the best method of treatment of the pyrite, which makes up the bulk of the tailings. These tailings contained 93.8 percent of the gold. As stated, the results of these tests have been reported by the Metallurgical Branch and no attempt will be made to give the complete reports. Excerpts from the reports are quoted and tables are given, however, in order to compare the results with those on the above tests and one other made on a low-grade composite from D, E, and F holes.

The following excerpts are from a preliminary report by the Salt Lake City experimental station.

> Only fair recoveries of marketable lead and zinc products were obtained by selective flotation. The physical nature of diamond-drill sludge samples was a handicap to good flotation, as an intense tarnish was present on all galena and sphalerite particles. Whether this tarnish is peculiar to the natural deposit or is due to drying of core sludge samples could not be determined with certainty. The gold content of ore is contained in pyrite, and as the bulk of ore is pyrite, the flotation tailing will be a gold concentrate. This gold product was only partly amenable to cyanidation following an oxidizing roast and probably would require smelting for optimum recovery. The cadmium content followed the zinc closely; however, no marked concentration of cobalt, tin, antimony, or arsenic was obtained.

Product	Assay, percent						
	Pb	Zn	Fe	As	Sb	Cd	Co
Pb conct.	61.4	1.8	11.1	5.3	0.61	-	-
Zn conct.	1.0	53.6	9.1	.6	.06	0.53	0.02
Cl. tail.	5.6	10.9	32.7	-	-	-	-
Ro. tail.	.9	1.8	40.8	6.8	-	-	-

Product	Oz/ton		Recovery, percent			
	Au	Ag	Pb	Zn	Au	Ag
Pb conct.	0.22	77.5	74.5	1.4	4.7	60.1
Zn conct.	.04	4.7	2.1	70.6	1.5	6.4
Cl. tail.	.53	11.5	16.1	19.5	27.3	21.0
Ro. tail.	.48	2.6	7.3	8.5	66.5	12.5

The tailings are included in above table, as they are largely auriferous pyrite containing 93.8 percent of the gold and 33.5 percent of silver. Direct cyanidation of the pyrite tailing for recovery of gold was unsuccessful, as less than 1 percent of gold was soluble even with minus 200-mesh grinding. Following an oxidizing roast, reginding, and cyanidation, 70 percent of the gold and 31 percent of the silver was extracted. These recoveries are still too low, and the recommended treatment procedure would be direct smelting of pyrite for precious-metal recovery.

The fourth and last series of tests was made on a composite made up of proportionate parts of the composites from D, E, and F holes. Although last reported as incomplete, the tests had proceeded far enough to show that the results compared favorably to those obtained on the higher-grade ore.

The following is quoted from a report by the Salt Lake laboratory on this work.

> Test work on this sample, which assayed 4.5 percent Pb, 9.2 percent Zn, 24.4 percent Fe, 0.5 percent insol., 0.235 oz. Au, 6.5 oz. Ag, 0.2 percent oxidized lead, and 0.5 percent oxidized zinc, has been underway for some time.
>
> The results obtained thus far are roughly comparable to those obtained in tests on higher-grade ore. The gold content of the ore is so completely locked in pyrite that it cannot be liberated and therefore remains in the pyrite tailings. The selective flotation of the lead and zinc is further complicated by the highly tarnished condition of the surfaces of the lead and zinc sulfide minerals in the sludge samples as submitted. It is possible that this tarnished condition of these minerals has prevented obtaining optimum metallurgical results.
>
> Approximately 73 percent of the lead was recovered in a concentrate assaying 46.3 percent Pb, 4.8 percent Zn, 0.28 oz. Au, and 48.9 oz. Ag. Only 8.3 percent of the gold and 54.5 percent of the silver were recovered in this concentrate. The zinc concentrate

assayed 55.6 percent Zn, 0.8 percent Pb, 7.8 percent Fe, 0.02 oz. Au, and 4.3 oz. Ag, with a recovery of 69.7 percent of the total zinc. Work is being continued on the small amount of composite which remains. However, the quantity of the composite sample will not permit large-scale investigation of the possibility of roasting and the cyaniding the pyrite tailings for the recovery of gold.

The uniform results obtained from the tests indicate that no difficulty will be experienced in making fair recoveries of lead and zinc by standard methods of selective flotation of the ore. The tarnished condition of the samples probably contributed somewhat to the fact that only fair recoveries were made. The ore no doubt will be tarnished less than the samples used for testing, and in actual practice recoveries probably will be higher than the tests indicate.

Some difficulty was experienced in working out an economical method of treatment for recovering gold from the pyritic tailings. The tests made by the Bureau's Reno and Salt Lake experimental stations for determining a method of treatment to recover the gold from these tailings are in a degree inconclusive. The results obtained by both stations indicate than an economical method is yet to be worked out, and it is possible that the tailings may have to be treated by pyrometallurgical methods in order to recover the gold from this product.