CONTACT INFORMATION
Mining Records Curator
Arizona Geological Survey
416 W. Congress St., Suite 100
Tucson, Arizona 85701
602-771-1601
http://www.azgs.az.gov
inquiries@azgs.az.gov

The following file is part of the Grover Heinrichs Mining Collection

ACCESS STATEMENT

These digitized collections are accessible for purposes of education and research. We have indicated what we know about copyright and rights of privacy, publicity, or trademark. Due to the nature of archival collections, we are not always able to identify this information. We are eager to hear from any rights owners, so that we may obtain accurate information. Upon request, we will remove material from public view while we address a rights issue.

CONSTRAINTS STATEMENT

The Arizona Geological Survey does not claim to control all rights for all materials in its collection. These rights include, but are not limited to: copyright, privacy rights, and cultural protection rights. The User hereby assumes all responsibility for obtaining any rights to use the material in excess of "fair use."

The Survey makes no intellectual property claims to the products created by individual authors in the manuscript collections, except when the author deeded those rights to the Survey or when those authors were employed by the State of Arizona and created intellectual products as a function of their official duties. The Survey does maintain property rights to the physical and digital representations of the works.

QUALITY STATEMENT

The Arizona Geological Survey is not responsible for the accuracy of the records, information, or opinions that may be contained in the files. The Survey collects, catalogs, and archives data on mineral properties regardless of its views of the veracity or accuracy of those data.

L. Z. J Wissir (r)

I. C. 7022 JUNE 1938

UNITED STATES
DEPARTMENT OF THE INTERIOR
HAROLD L. ICKES, SECRETARY

BUREAU OF MINES
JOHN W. FINCH, DIRECTOR

INFORMATION CIRCULAR

RECONNAISSANCE OF MINING DISTRICTS IN EUREKA COUNTY, NEVADA

BY

WILLIAM O. VANDERBURG

AFTER THIS REPORT HAS SERVED YOUR PURPOSE AND IF YOU HAVE NO FURTHER NEED FOR IT, PLEASE RETURN IT TO THE BUREAU OF MINES, USING THE OFFICIAL MAILING LABEL ON THE INSIDE OF THE BACK COVER.

I.C. 7022,
June 1938.

INFORMATION CIRCULAR

UNITED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

RECONNAISSANCE OF MINING DISTRICTS IN EUREKA COUNTY, NEVADA[1]

By William O. Vanderburg[2]

CONTENTS

	Page
Introduction	3
Acknowledgments	4
Eureka County	4
Topography	5
Climate and vegetation	5
Water resources	6
Power facilities	6
Transportation facilities	6
History of mining	7
Mineral production	11
Antelope District	17
July group	17
Belmont group	18
Blue Eagle group	18
Beowawe District	19
Red Devil group	19
Buckhorn District	19
Buckhorn Mining Co.	20
Cortez District	22
Cortez Metals Co.	23
Roberts Mining & Milling Co.	26
Turquoise	28
Diamond District	28
Phillips group	28
Wilcox and Fraser claims	29
Silver Bell group	29
Eureka District	31
Early mining and smelting	33
Geology	37
Eureka Corporation, Ltd.	40
Eureka-Croesus Mining Co.	40
Silver Connor Mine	42
Geddes and Bertrand group	43
Eureka Prospect	43

1/ The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from Bureau of Mines Information Circular 7022."

2/ Mining engineer, Metal Mining Methods Section, Mining Division, Bureau of Mines.

Page

Eureka District (Continued)
Windfall mine 44
Gordon group 45
Other mines 46
Slag and speiss dumps 47
Fish Creek District 48
Antelope group 49
Black Rock group 49
Lynn District 49
Beaver Crown Consolidated Mining Co. 50
Placer deposits 50
Turquoise 51
Mineral Hill District 51
Early metallurgy 53
Mineral Hill Consolidated Mining Co. 54
Palisade District 56
Asphaltite 56
Diatomaceous earth 57
Pumicite 58
Iron ore 58
Mount Hope District 58
Universal Exploration Co. 59
Morrison group 59
Safford District 59
Zenoli mine 60
Onondaga mine 61
West iron mine 62
Schroeder District 62
Maggie group 63
Good Hope group 64
Barite 64
Union District 64
Union Mines Co. 65
Williams Salt Marsh 65
Future of mining in Eureka County 66

ILLUSTRATIONS

Fig. Following Page
1. Sketch map of Eureka County, Nevada 4
2. Flow sheet of 80-ton-daily-capacity flotation mill, Buckhorn Mining Co., Buckhorn district, Eureka County, Nevada 20
3. Longitudinal section through no. 1 dike, Cortez mine, Cortez district, Eureka County, Nevada 22
4. Flow sheet of 20-ton-daily-capacity cyanidation mill, Roberts Mining & Milling Co., Cortez district, Eureka County, Nevada 26
5. Longitudinal projection through Ruby Hill mines, Eureka district, Eureka County, Nevada 38
6. Cross section through Ruby Hill mines, Eureka district, Eureka County, Nevada 38

TABLES

Page

1. Net annual production of gold and silver from Eureka County, 1873-1903 12
2. Gold, silver, copper, and lead production from Eureka County, Nevada, 1902-1936, in terms of recovered metal 15
3. Gold, silver, copper, and lead production from Buckhorn district, Eureka County, Nevada, 1910-1936, in terms of recovered metal.. 21
4. Gold, silver, copper, and lead production from Cortez district, Eureka and Lander Counties, Nevada, 1902-1936, in terms of recovered metal 24
5. Gold, silver, copper, and lead production from Eureka district, Eureka County, Nevada, 1902-1936, in terms of recovered metal.. 34
6. Operating costs of the Eureka Consolidated Mining Co., 1871-1874, inclusive, and 1878..... 38

FOREWORD

This is one of a series of circulars dealing with mining and milling operations in various mining districts in the Western States. Data on operating costs, grades of ore treated, wage scales, haulage and trucking rates, were obtained from historical records and from present operators and other local sources during the course of field inspections, and are believed to be substantially correct as of the time when the districts were visited.

Chas. F. Jackson,
Chief engineer, Mining Division.

INTRODUCTION

This report3/ gives the results of a reconnaissance of mining districts in Eureka County, Nevada, made from September 25 to October 20 and from October 27 to November 5, 1937. During this time, virtually all the districts were visited and many data obtained on active and inactive properties. This report covers the locations of the various districts, geological background, ownership and brief descriptions of mines and prospects, information on past and current operations, and other data likely to be useful to those interested in the development of our mineral resources.

From the viewpoint of past production in the county, the silver-lead-gold deposits at Eureka have been the most important, followed by the silver deposits at Cortez and Mineral Hill. The period of greatest activity in the foregoing districts was from 1870 to 1890, when Eureka was one of the principal mining areas in Nevada; the production of lead was sufficient to affect its price in all the commercial centers of the world. Eureka also merits the distinction of being the birthplace of the silver-lead smelting industry in the United States.

3/ Manuscript completed Feb. 24, 1938.

In recent years, mining activity within the county has been largely in the hands of lessees, who ship their ores to smelters in the vicinity of Salt Lake City.

The future production of metals from Eureka County appears to be largely dependent on further exploration in the known mineralized areas and the rehabilitation of old mines to work ores that were too low-grade to be treated in former years. Compared with some of the other counties in the State, the industrial mineral deposits in Eureka County are of minor importance.

ACKNOWLEDGMENTS

The author wishes to thank the owners, lessees, and mine operators, too numerous to mention individually, who wholeheartedly provided information and assistance during the course of the field work.

B. F. Couch, secretary of the Nevada State Bureau of Mines, Reno, Nev., made available to the writer published articles pertaining to the early mining activities in Eureka County. Credit for such published data is given in the text.

Charles White Merrill, of the Mineral Production and Economics Division, Bureau of Mines, compiled the data for the mineral-production tables. The Mackay School of Mines, University of Nevada, at Reno, cooperated in making mineral determinations and assays and in providing the use of its technical library.

EUREKA COUNTY

Eureka County was created and organized March 1, 1873, out of the eastern portion of Lander County. By acts of the State Legislature, approved March 2, 1881, and February 7, 1877, several small strips of land were withdrawn from White Pine and Elko Counties, respectively, and added to the eastern part of Eureka County.[4] Figure 1 is a sketch map of the county.

The county has an area of 4,157 square miles and, according to the report of the county auditor,[5] the population in 1937 was 1,317, of whom 770 were registered voters. Nearly half the population resides in Eureka, the county seat and supply center for mining districts and ranches within a radius of 50 miles. The principal industries are stock raising, farming, and mining.

The assessed value of real property in the county for the fiscal year ended June 30, 1937, was $6,330,480, and the tax rate for the same period was $2.02 per $100, exclusive of special taxes but including the State tax of $0.68 per $100.

4/ Deady, C. L., Biennial Report of the Surveyor-General, 1917-1918, State of Nevada, Carson City, Nev., 1919, pp. 11-12.

5/ Merialdo, Peter, Auditor of the County of Eureka, Annual Report for the Fiscal Year Ended June 30, 1937.

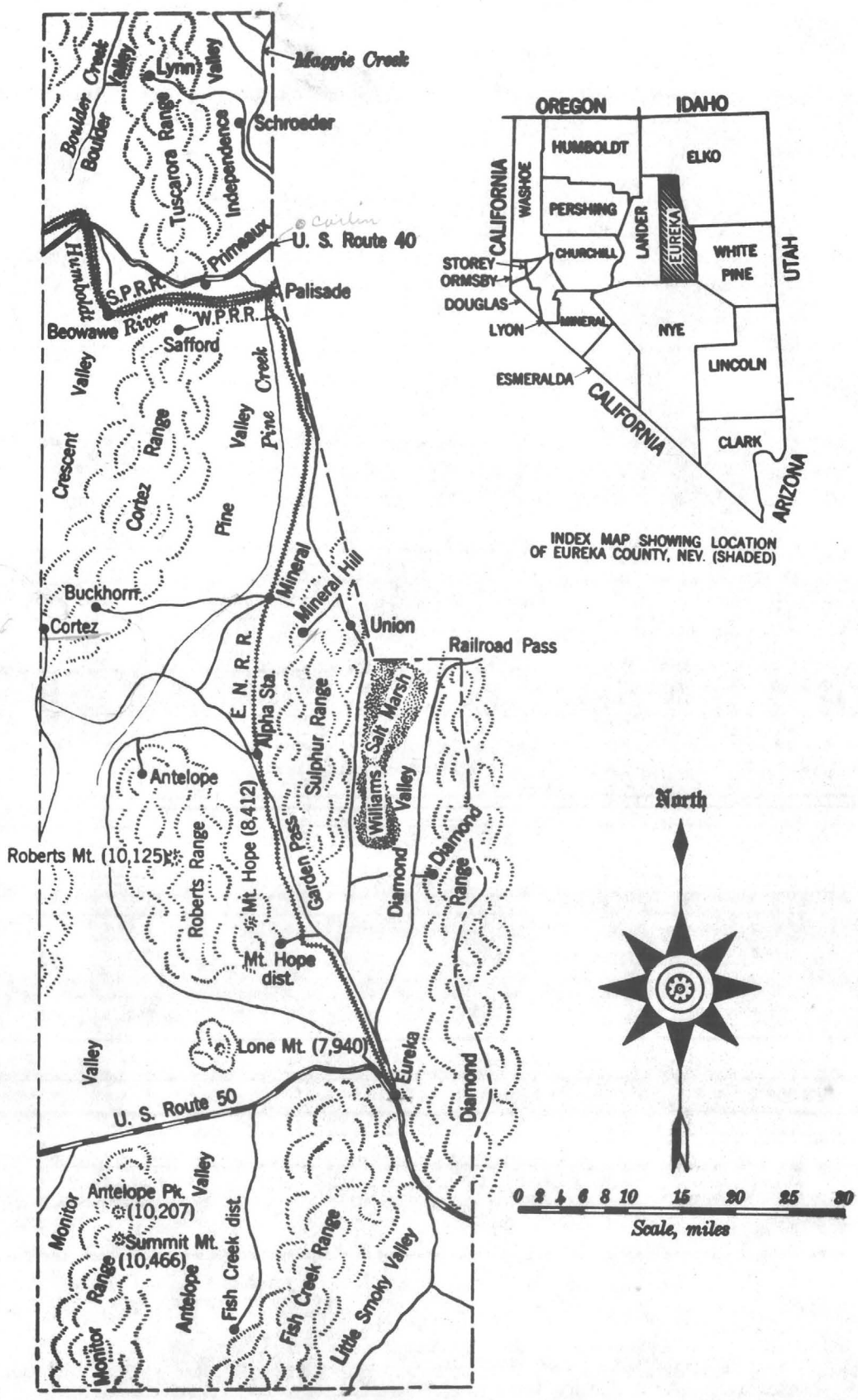

Figure 1.—Sketch map of Eureka County, Nev.

Topography

The topography of Eureka County is typical of the Great Basin region, in which the two prevalent features are the meridional Basin ranges and the intervening valley plains. The altitude of the valleys ranges from 4,500 to 5,000 feet. The mountain ranges are generally long and narrow with serrated peaks and ridges rising from 2,000 to 6,000 feet above the subjacent valley plains.

The principal valleys in Eureka County are Monitor, Antelope, Diamond, Independence, Pine, and Boulder. The principal mountain ranges are Fish Creek, Monitor, Sulphur, Cortez, Roberts, Tuscarora, and Diamond. Some of the higher mountain peaks, with their elevations, are Antelope Peak (10,207 feet) and Summit Mountain (10,466 feet) in the Monitor Range, Prospect Mountain (9,604 feet) in the Diamond Range; Roberts Mountain (10,125 feet) and Mount Hope (8,412 feet) in the Roberts Range; and Lone Mountain (7,940 feet), an isolated mountain in the north end of Antelope Valley. In addition, there are numerous other peaks rising from 7,000 to 9,500 feet above tidewater.

The Humboldt River flows westerly across the northern portion of the county. Maggie Creek from the north and Pine Creek from the south are small tributaries of the Humboldt. Fish Creek rises in the southeastern part of the county and flows eastward into White Pine County, where it sinks.

Climate and Vegetation

No records are available of the annual precipitation in Eureka County, but, judging from other parts of the State with similar climatic conditions, it probably averages between 7 and 10 inches per year. The amount of precipitation, largely in the form of snow, varies according to the altitude, the mountains receiving the most and the valleys the least. In the summer, an occasional cloudburst may occur, which, although of short duration, may be exceptionally severe. A cloudburst that occurred in the vicinity of Eureka in July 1874 destroyed 17 lives and considerable property.

During the summer the days are hot and cloudless, but, since the atmosphere is very dry, the heat is seldom oppressive. The nights are invariably cool. Rigorous winters are the rule.

There is some sort of vegetation, although limited in variety, over the entire county, with the exception of the valley depressions impregnated with alkaline salts. On the mountains, above a general altitude of 7,000 feet, the greater precipitation favors sparse forest growths; dwarf juniper (Junipero occidentalis), mountain mahogany (Cercocarpus laedifolius), and pinon pine (Pinus monophylla) are the most abundant. These trees seldom attain a height greater than 20 feet.

The pine nut, which is obtained from the cone of the pinon pine, constituted the principal food of the aborigines. The nut has a thin,

tender shell and is similar in shape to a small peanut. Its meat is palatable and nutritious, tasting something like that of a hickory nut, with a slight terebinthine flavor.

On the lower elevations, the common sage (Artemesia tridentata) grows vigorously and is most abundant. White sage, bunch grass, and other varieties of nutritious grasses afford pasturage for cattle and sheep.

Water Resources

The principal perennial streams in Eureka County are Pine and Maggie Creeks, tributaries of the Humboldt River, which flow westward across the northern part of the county, and Fish Creek in the southeastern part. The mountain ranges are intersected by numerous canyons, in which small streams are formed during the spring run-off. Such streams disappear either by evaporation or into subterranean channels without accumulating in lakes or other surface drainage basins.

A number of springs occur on the mountain sides and at the edges of the valleys throughout the county. Perhaps the most interesting are Fish Creek Springs on the side of the mountain range of the same name. These springs consist of about 15 pools ranging from 10 to 40 feet in diameter, some of which are of considerable depth and filled with trout, which have been planted, and another species of fish reported to be indigenous to the locality. The pools are surrounded by a turflike sod and are interconnected by subterranean channels. The flow is considerable and constant, and it is conjectured that the original source is the mountain streams which disappear in underground channels to collect in a reservoir that ultimately finds an outlet at these springs.

The only artesian wells in the county are on the Bartine ranch in Antelope Valley, about 24 miles west of Eureka.

Topographical conditions are favorable for the accumulation of underground water, and the alluvial sediments in the valleys absorb a considerable portion of the run-off. If not otherwise available, water for milling and other purposes can generally be developed by sinking wells in the valleys, usually within convenient distances of the districts mentioned in this report.

Power Facilities

There is no public power service in any of the mining districts mentioned in this report; power for mining and milling operations is furnished by Diesel or other types of internal-combustion engines.

Transportation Facilities

The main lines of the Southern Pacific and Western Pacific Railroads traverse the northern part of Eureka County, following the natural route formed by the Humboldt River. The Eureka and Palisade Railroad, a narrow-

gage line, extends from Palisade, on the main line of the aforementioned railroads, to the town of Eureka, a distance of 84.6 miles. This line maintains no regular schedule. The freight rates on ores and concentrates from Eureka to Utah smelters are as follows:

Value of ore, per ton1/	$6.00	$10.00	$15.00	$20.00	$30.00	$40.00
20-ton car minimum, per ton	-	5.90	5.90	7.10	8.00	9.30
40-ton car minimum, per ton	4.30	4.50	5.00	5.60	6.20	6.80
Value of ore, per ton	$50.00	$60.00	$70.00	$80.00	$90.00	$100.00
20-ton car minimum, per ton	10.20	11.30	12.40	13.70	15.00	15.80
40-ton car minimum, per ton	7.40	8.00	8.60	9.20	9.80	10.40

1/ The railroad value per ton is the smelter value less treatment charge, divided by the total number of tons (wet weight) in the shipment. The above rates include the cost of transfer from narrow-gage to standard-gage cars at Palisade. On shipments from Ruby Hill, 15 cents per ton is added to the foregoing rates.

The town of Eureka is on the Lincoln Highway (U. S. Route 50) connecting Salt Lake City, Utah, with Reno, Nev., and the Pacific Coast. The Victory Highway (U. S. Route 40) cuts across the northern part of the county. Both these roads are oiled. All other roads in the county are either gravel or natural, and they afford easy access by automobile to all the districts mentioned in this report.

History of Mining

The region within the present boundaries of Nevada originally comprised part of the territory purchased by the United States from Mexico under the treaty of Guadalupe Hidalgo, consummated in 1848. Prior to its alienation by the Republic of Mexico, it was included in the department of "Alta California." After its acquisition by the United States, it constituted the western part of the Territory of Utah, from which it was separated by an Act of Congress approved March 2, 1861, to form the Territory of Nevada. The territorial status was maintained until October 31, 1864, when, by proclamation of President Lincoln, it was admitted into the Union as the thirty-sixth State.

Before 1848, the only white inhabitants within the limits of Nevada were a few itinerant trappers and traders. The aboriginal Indian tribes, principally Shoshones and Paiutes, numbering perhaps 10,000 to 12,000 people, roamed this vast region, but they were not versed in the art of mining metals. Exploring parties led by Fremont, Stanbury, Beckwith, Simpson, and others, had crossed the State by different routes, but all of these failed to impart any great amount of knowledge concerning the mineral wealth of this area.

The discovery of placer gold in California by James Marshall in 1848 led to the rapid population of California, and the backwash of this horde

of gold seekers was instrumental in developing the mineral resources of Nevada. In 1849 and the years following, pioneers crossed the State; most of them followed the route along the Humboldt River, but they looked upon Nevada as a sterile waste to be crossed as expeditiously as possible, so that up to 1860 the area now included in Eureka County was virtually unexplored.

The first mineral discovery in Eastern Nevada was associated with the establishment of the overland-mail and pony-express route, which crossed Eureka County a little north of the east and west central line.

In May 1862, William H. Talcott, an employee of the Overland Stage Co. stationed at Jacobsville (a stage and pony-express station on Reese River, 7-1/2 miles west of the present site of Austin), discovered a vein of metal-bearing quartz while hauling wood from the hillside in the area now within the limits of Austin, Lander County, soon after the Reese River district was organized. News of the discovery spread rapidly, and the Reese River "excitement" gave extraordinary impetus to prospecting in eastern Nevada. The first mineral discovery of importance in Eureka County was in the Cortez district, organized in 1863 while it was still a part of Lander County. The Diamond district, near the site of the old Diamond Springs stage station, was formed in May 1864, and Eureka was organized as a mining district on September 19 of the same year.

The early history of Eureka County is largely the history of the mines in the Eureka district. The first locations were made here by a party from the Reese River district composed of W. O. Arnold, W. R. and G. T. Tannehill, J. W. Stotts, and Moses Wilson. This party found a species of limestone rock in New York Canyon on the eastern side of Prospect Mountain which differed from any they had seen previously. Pieces of the rock were placed in a fire, with the result that a surprising amount of metal was obtained, subsequently determined to be a combination of lead and silver. They located a number of claims and organized the Eureka mining district. This discovery did not create the usual excitement attending new mineral discoveries, since the ores were not amenable to the amalgamation processes in vogue at that time and, furthermore, the early-day prospectors looked upon ore deposits in limestone with distrust. It is interesting to note that the original discovery never fulfilled the expectations of the locators or subsequent owners.

Activity in the district between 1864 and 1870 is indicated by the number of claims located - in 1864, 30 claims; 1865, 31 claims; 1866, 15 claims; 1867, 11 claims; 1868, 43 claims; 1869, 354 claims; and in 1870, nearly 3,000.

The rapid growth of Eureka after 1869 was due to a number of factors, among which may be mentioned (1) the demonstration that the ores could be treated successfully by smelting, (2) the completion of the Central Pacific (now Southern Pacific) Railroad across the State in July 1869, and (3) the White Pine "excitement" during the same year. The White Pine "excitement" was one of the most violent of the extraordinary mining booms ever experienced

in Nevada. Thousands of people stampeded to the rich silver discovery at Treasure Hill (Hamilton district, White Pine County, Nev., about 40 miles southeast of Eureka), but the extravagant hopes of many were not realized and a large proportion of the miners, prospectors, and others turned their attention toward Eureka.

An interesting account of the first smelting operations at Eureka is contained in a paper written by Judge S. Hetzel for the Librarian of Congress, in response to an invitation by the President, as an exposition of condition and wealth of the country in the centennial year 1876:6/

> From 1869 dates the first successful treatment of the Eureka ores, and in the train of that success came capital, labor, and increased facilities for transportation. The history of the industrial growth of Eureka is the history of the first successful treatment in America of argentiferous lead ore. The first attempt at smelting this class of ore was made at Oreana, in Humboldt County, and it was unsuccessful. In 1866, Moses Wilson built a furnace in Eureka on the site now occupied by the Roslin furnace, and an attempt at smelting was made. This resulted in a total failure. In 1868, Morris, Monroe and Co., having acquired a large property in the district, employed C. A. Stetefeldt of Austin to erect and conduct a furnace. Having completed the furnace, he commenced operations in May 1869, but each of three attempts made by him resulted in failure. In the meantime, Major W. W. McCoy had acquired the Morris, Monroe and Co. property. Major McCoy attributed Stetefeldt's want of success to an insufficiency of blast, the poor quality of material used for lining, and the incompetency of his subordinates. The last difficulty he overcame by securing the services of R. P. Jones and John Williams, who had had considerable experience in Wales.
>
> In coming to Eureka from White Pine, Jones and Williams discovered on Pancake Mountain an excellent quality of fire rock, and thus the second difficulty was overcome. Major McCoy then inserted in the old Stetefeldt furnace two side tweers (tuyeres) - it previously had but one, and that in the rear - and, the Pancake rock having been procured, Jones and Williams, in July 1869, commenced their first run of ore from the Champion, Buckeye, Grant, and Eureka mines. A deserved success attended their efforts; the practicability of cheaply treating these ores, heretofore regarded as so stubborn, was demonstrated, and the future prosperity of Eureka was assured. Major McCoy continued smelting until November 1869, when he leased the furnace to D. E. Buel and I. C. Bateman, who, about this time, bonded the Champion and Buckeye series of mines and purchased the Monroe town survey. These gentlemen smelted successfully until the termination of their lease in May 1870.

6/ Quoted by Henry R. Whitehill, Biennial Report of State Mineralogist, State of Nevada, 1875-1876, p. 52.

In December 1869, G. C. Robbins commenced operating a draft furnace, which was afterwards converted into a blast furnace. Still another furnace was added to the Robbins reduction works, and all of them were sold in 1876 to a Chicago company. In 1870, Bevan and Wallace built a furnace and engaged in smelting, but their operations proved unsuccessful. In the summer of 1870, Buel and Bateman, having purchased the Buckeye and Champion series of mines, built two furnaces at the lower end of town. They, together with the mines, were subsequently sold to the Eureka Consolidated Mining Co. That company subsequently built three additional furnaces and also constructed a narrow-gage railroad from its reduction works, a distance of 3 miles. About the same time, the Jackson Mining Co. purchased Wilson's furnace site and erected two furnaces, which were run on ore from the Jackson mine. In the summer of 1870, Thomas J. Taylor commenced erecting a furnace, which he subsequently sold to the Phoenix Mining Co., which, in turn, sold it to the Hoosac Co.

In September 1870, J. J. Dunne & Co. purchased of H. P. McNevin an uncompleted furnace at the south end of town, and completed it, and it was subsequently used to run ores from the Richmond mine. In 1871, the Richmond Consolidated Mining Co. of London, purchased the works of Ogden, Dunne & Co. and the Richmond mine.

In 1872, H. Hennemann, having previously purchased the Dunderberg and other mines, built the reduction works, comprising two furnaces, which have since been employed almost constantly in smelting ores from the Dunderberg and Atlas mines. (From January 1 to September 30, 1880, 3,500 tons were hoisted through the Atlas shaft). The Silver West Mining Co. also built a furnace in 1872, which has since been run principally on ores from the K. K. mines. There are now in Eureka (1876) nineteen furnaces, whose daily capacity varies from 40 to 60 tons each. The Lemon Mining & Milling Co. has also erected a mill of 15 stamps.

The last stretch of the transcontinental telegraph line (New York to San Francisco) between Fort Churchill, Nev., and Salt Lake City, Utah, was started on June 24, 1871, when the first pole was placed, and it was completed to Salt Lake City by October 24 of the same year. Considering the fact that all the poles used in the construction of this stretch were hauled, largely by wagon teams, from the Sierras, the completion of the line in so short a time was a remarkable engineering achievement.7/

The Eureka and Palisade Railroad (now Eureka-Nevada Railroad) between Palisade (on the main line of the Central Pacific Railroad) and Eureka was completed in October 1875. By 1878, Eureka had a population of about 9,000, and it attained an importance as a mining center second only to the Comstock.

7/ The line ran from Fort Churchill to Austin, via Westgate, a distance of 138 miles; and from Austin to Salt Lake City, via Ruby Valley, Fish Springs, and Fort Crittenden, an additional 422 miles.

About 1885, with the exhaustion of the bonanza ores, mining passed into the hands of lessees. In 1890, the Richmond Mining Co. ceased smelting and the Eureka Consolidated Mining Co. followed suit the following year. After the abandonment of local smelting, the argentiferous lead ores were shipped to Utah smelters.

From time to time, revivals of mining activity have occurred in the district, but these never attained an importance comparable with the early-day operations.

During the time the Eureka district experienced its greatest prosperity, the Cortez district was also active. Unlike Eureka, the Cortez mines were for many years largely controlled by one man, Simeon Wenban, who was one of the original locators. For several years after the district was organized, Wenban had as a partner George Hearst; the rich ores produced contributed to the founding of the Hearst fortune.

Other mining districts of lesser importance in Eureka County have been active intermittently since the early days. In recent years, mining has been largely in the hands of lessees whose activities are restricted to ores of shipping grade.

The outstanding mining development at present is the exploration work being carried on by the Eureka Corporation, Ltd., in the Ruby Hill sector of the Eureka district.

Mineral Production

Discrepancies occur in the mineral-production statistics for Eureka County collected from various sources between 1869 and 1902, so that it is difficult to obtain an accurate figure on total gross production for this period. The net annual production of gold and silver from 1873 to 1903, as compiled from the quarterly assessment rolls of Eureka County assessors is shown in table 1.8/ By the amended revenue act of 1867, a State tax of 1.25 percent was levied on the net proceeds of gold and silver from mines. To this, a county tax was added, which made the total tax 3 percent. The law provided that the value of the ore was to be estimated on the dump before being milled, and the sum of $18 per ton was allowed, free from tax, for the expense of extraction and reduction of ore treated by the Washoe process (amalgamation without roasting), and $40 per ton for ore treated by the Freiberg process (roasting followed by amalgamation). The Eureka ores were treated by smelting, and it is probable that the latter figure ($40 per ton) was deductible to arrive at the net proceeds; consequently, the gross production would be considerably more than the figures stated in table 1. The value of the lead produced was not recorded.

8/ Stewart, E. E., Nevada's Mineral Resources, State Printing Office, Carson City, Nev., 1909, p. 83.

TABLE 1. - Net annual production of gold and silver from Eureka county, 1873 to 1903

(Compiled from quarterly assessment rolls of the county assessors.)

Year	Tons	Value
1873	49,277	$1,858,413.42
1874	60,534	2,388,724.19
1875	90,217	3,430,904.66
1876	50,326	2,177,070.67
1877	68,085	2,696,420.24
1878	134,382	6,257,225.57
1879	115,277	3,948,723.43
1880	89,291	3,402,828.31
1881	77,005	3,168,543.91
1882	72,587	2,592,680.63
1883	70,510	1,999,414.69
1884	68,657	1,462,246.82
1885	55,352	1,191,771.93
1886	45,302	1,022,993.93
1887	69,347	1,216,547.78
1888	44,361	987,388.83
1889	31,752	1,179,468.66
Total	1,192,262	40,981,367.67

Year	Value of gold	Value of silver	Total
1890	$ 302,000.00	$ 748,000.00	$ 1,050,000.00
1891	308,000.00	751,000.00	1,059,000.00
1892	185,000.00	445,000.00	630,000.00
1893	100,000.00	250,000.00	350,000.00
1894	(no figures given)		
1895	62,000.00	158,500.00	220,500.00
1896	68,650.00	157,300.00	225,950.00
1897	92,058.00	820,292.00	912,350.00
1898	74,097.00	520,563.00	594,660.00
1899	179,100.00	485,660.00	664,760.00
1900	76,800.00	493,265.00	570,065.00
1901	95,456.00	448,948.00	544,404.00
1902	91,189.11	531,930.55	623,119.66
1903	92,198.72	565,333.63	657,532.35
Totals	1,726,548.83	6,375,792.18	8,102,341.01

Tailings

Year	Tons	Value
1887	4,382	$ 33,920.93

Estimates of the value of gold and silver produced in the Eureka district from 1869 to 1883, according to Hague[9], are as follows:

From 1869 to 1873	$10,000,000
From 1873 to 1883	50,000,000
Total	60,000,000

One-third of this amount, according to the best estimates, was gold and two-thirds was silver. In addition, Hague states that the lead production is not so easily determined but that it is not far from 225,000 tons. Assuming an average value of $107 per ton[10] the lead production would be $24,075,000, giving a total value of the mineral production for the Eureka district from 1869 to 1883 of $84,075,000.

The value of the gold-silver production from the Eureka district from 1870 to 1878, compiled from various official reports and generally based on bullion shipments made by the Wells Fargo Express Co., is as follows:

1870	$ 1,200,000
1871	2,173,106
1872	2,495,033
1873	3,907,402
1874	3,655,453
1875	6,100,000
1876	4,003,148
1877	3,898,879
1878	6,981,706
Total	34,414,727

The annual report of the United States Smelting, Refining, & Mining Co. for 1906 states that a compilation from the books of the Eureka Consolidated and Richmond Eureka companies (the principal producers in the district) shows that the gross output of these two properties alone was $76,000,000.

From the foregoing data, the writer estimates that the total gross production of metals from the Eureka district was about $95,000,000 up to 1903.

The Cortez district is also known to have had substantial production in the early days, estimated by several authorities to have been between $10,000,000 and $18,000,000. Probably the lower figure, given by Emmons,[11]

9/ Hague, Arnold, Geology of the Eureka District, Nevada: Geol. Surv. Monograph 20, 1892, pp. 6-7.

10/ The average New York price of lead from 1870 to 1883, as calculated from data contained in Mineral Resources, Geol. Surv., 1896-1897, part 5, p. 254, is 5.36 cents per pound, or nearly $107 per short ton.

11/ Emmons, William H., A Reconnaissance of Some Mining Camps in Elko, Lander, and Eureka Counties, Nev.: Geol. Surv. Bull. 408, 1910, p. 101.

is the best estimate. The production of Mineral Hill district is estimated by the writer to be about $2,500,000, although a production in excess of $6,000,000 is sometimes quoted. A recapitulation of the total production of Eureka County from the earliest mineral discovery up to 1903 is as follows:

Eureka district	$ 95,000,000
Cortez district	10,000,000
Mineral Hill district	2,500,000
Safford and other districts ..	400,000
Total	107,900,000

The production of metals in the county from 1902 to 1936 is shown in table 2.

Other minerals that have been produced in commercial quantities are iron ore for fluxing (about 300,000 tons), barite (about 10,000 tons), salt for metallurgical use in early days (quantity undeterminable), and turquoise for gem purposes (value about $3,000).

During 1937, the writer estimates that an average of 230 men were directly employed in the mineral industries in the county.

TABLE 2. - Gold, silver, copper, and lead production from Eureka County, Nevada, 1902 to 1936, in terms of recovered metal

(Compiled by Charles White Merrill, Mineral Production and Economics Division, Bureau of Mines)

Year	Placer						Lode			
	No. of mines	Gold		Silver		Total value	No. of mines	Ore, short tons	Gold	
		Fine ounces	Value	Fine ounces	Value				Fine ounces	Value
1902	-	-	-	-	-	-	7	4,508	3,742.82	$77,371
1903	-	-	-	-	-	-	14	7,549	4,496.50	92,951
1904	-	-	-	-	-	-	10	8,143	2,142.82	44,296
1905	-	-	-	-	-	-	11	3,640	753.97	15,586
1906	-	-	-	-	-	-	8	12,040	2,462.82	50,911
1907	-	-	-	-	-	-	11	36,358	8,424.36	174,147
1908	2	41.70	$862	4	$2	$864	20	28,198	8,339.66	172,396
1909	6	718.66	14,856	85	44	14,900	23	88,341	20,308.60	419,816
1910	5	247.49	5,116	18	10	5,126	8	11,977	3,694.54	76,373
1911	6	443.12	9,160	30	16	9,176	13	15,634	4,947.49	102,274
1912	9	498.31	10,301	34	21	10,322	22	22,058	5,702.88	117,889
1913	4	73.10	1,511	5	3	1,514	42	2,897	758.08	15,671
1914	12	410.51	8,486	25	14	8,500	33	76,326	14,433.45	298,366
1915	8	449.79	9,298	40	20	9,318	38	109,320	15,709.73	324,749
1916	6	501.79	10,373	44	29	10,402	30	22,082	5,049.33	104,379
1917	5	133.56	2,761	16	13	2,774	40	7,165	1,331.33	27,521
1918	4	80.30	1,660	7	7	1,667	32	4,936	1,648.77	34,083
1919	2	27.57	570	2	2	572	18	3,428	1,066.72	22,051
1920	2	14.13	292	1	1	293	23	8,970	3,070.26	63,468
1921	1	20.03	414	2	2	416	15	9,744	2,439.02	50,419
1922	1	59.99	1,240	4	4	1,244	20	4,441	1,896.20	39,198
1923	2	60.37	1,248	4	3	1,251	15	27,074	4,149.08	85,769
1924	-	-	-	-	-	-	11	20,026	1,511.72	31,250
1925	2	78.95	1,632	5	3	1,635	15	31,050	1,627.77	33,649
1926	1	14.66	303	1	1	304	18	34,968	3,906.62	80,757
1927	2	190.21	3,932	14	8	3,940	11	50,888	2,676.78	55,334
1928	1	22.79	471	2	1	472	7	57,173	2,692.93	55,668
1929	1	62.75	1,297	5	3	1,300	9	49,311	2,334.61	48,261
1930	1	72.85	1,506	5	2	1,508	5	3,521	733.46	15,162
1931	4	257.16	5,316	21	6	5,322	9	2,065	728.34	15,056
1932	10	689.92	14,262	59	17	14,279	9	1,156	637.82	13,185
1933	16	521.50	13,330	44	15	13,345	9	655	230.02	5,879
1934	9	410.50	14,347	36	23	14,370	11	4,505	2,051.01	71,683
1935	8	660.57	23,120	51	37	23,157	23	7,297	3,402.37	119,083
1936	10	603.00	21,105	53	41	21,146	19	18,694	4,255.00	148,925
Total	-	7,365.28	178,769	617	348	179,117	-	796,138	143,356.88	3,103,576

TABLE 2. - Gold, silver, copper, and lead production from Eureka County, Nevada, 1902 to 1936, in terms of recovered metal - Continued.

(Compiled by Charles White Merrill, Mineral Production and Economics Division, Bureau of Mines)

Year	Lode								Total value (lode and placer)
	Silver		Copper		Lead		Total value	Average recoverable value of ore per ton 1/	
	Fine ounces	Value	Pounds	Value	Pounds	Value			
1902	96,287	$51,032	-	-	903,875	$37,059	$165,432	$36.70	$165,432
1903	97,424	52,609	-	-	621,177	16,176	161,736	21.42	161,736
1904	160,724	93,220	13,963	$1,380	513,032	20,404	159,300	19.56	159,300
1905	78,475	47,399	64	10	525,304	24,688	87,683	24.09	87,683
1906	77,552	51,960	6,653	1,283	1,014,244	57,712	161,866	13.44	161,866
1907	252,889	166,907	144,825	28,965	2,992,117	158,582	528,601	14.54	528,601
1908	140,551	74,492	79,985	10,558	2,330,048	97,862	355,308	12.60	356,172
1909	187,625	97,565	101,500	13,195	4,346,535	186,901	717,477	8.12	732,377
1910	36,029	19,456	721	91	672,801	29,603	125,523	10.48	130,649
1911	15,243	8,079	2,617	327	61,136	2,751	113,431	7.26	122,607
1912	28,273	17,388	19,861	3,277	230,710	10,382	148,936	6.75	159,258
1913	56,991	34,423	55,385	8,585	498,104	21,917	80,596	27.82	82,110
1914	164,177	90,790	6,800	904	391,690	15,276	405,336	5.31	413,836
1915	186,543	94,578	15,813	2,767	1,299,085	61,057	483,151	4.42	492,469
1916	143,642	94,516	79,066	19,450	2,804,981	193,544	411,889	18.65	422,291
1917	72,253	59,537	72,841	19,886	1,783,933	153,418	260,362	36.34	263,136
1918	66,970	66,970	67,618	16,702	1,197,292	85,008	202,763	41.08	204,430
1919	69,521	77,864	40,713	7,573	1,179,723	62,525	170,013	49.60	170,585
1920	84,005	91,565	121,029	22,269	2,487,210	198,977	376,279	41.95	376,572
1921	45,902	45,902	206,948	26,696	776,943	34,962	157,979	16.21	158,395
1922	49,862	49,862	69,681	9,407	592,430	32,584	131,051	29.51	132,295
1923	87,455	71,713	646,870	95,090	1,398,929	97,925	350,497	12.95	351,748
1924	49,414	33,107	160,344	21,005	1,776,927	142,154	227,516	11.36	227,516
1925	101,838	70,676	25,955	3,686	4,331,011	376,798	484,809	15.61	486,444
1926	155,424	96,984	67,359	9,430	5,653,705	452,296	639,467	18.29	639,771
1927	619,869	351,466	52,758	6,911	2,440,127	153,728	567,439	11.15	571,379
1928	816,510	477,658	51,199	7,373	1,296,707	75,209	615,908	10.77	616,380
1929	521,605	278,015	41,917	7,377	1,191,478	75,063	408,716	8.29	410,016
1930	61,460	23,662	10,784	1,402	402,977	20,149	60,375	17.15	61,883
1931	5,664	1,643	2,525	233	126,010	4,662	21,594	10.46	26,916
1932	10,074	2,841	1,940	122	124,934	3,748	19,896	17.21	34,175
1933	21,848	7,647	1,990	127	57,220	2,117	15,770	24.08	29,115
1934	21,107	13,645	14,358	1,149	296,738	10,979	97,456	21.63	111,826
1935	46,200	33,206	22,217	1,844	484,662	19,386	173,519	23.78	196,676
1936	79,234	61,367	294,000	13,524	8,000	736	224,552	12.01	245,698
Total	4,708,640	2,909,744	2,500,299	362,598	46,811,795	2,936,338	9,312,256	11.70	9,491,373

1/ Not to be confused with average assay value of ore.

6589

ANTELOPE DISTRICT

The Antelope district is at the north end of the Roberts Range, about 12 miles west of Alpha Station on the Eureka-Nevada Railroad. The town of Eureka is 55 miles south. A number of locations were made in this area from 1900 on, but no important discoveries were made. A 10-stamp mill with 5 vanners was erected in the early days; it operated only a short time. About 400 tons of shipping ore has been produced.

Antimony was discovered in the district by José Villanueva in June 1936, but there has been no production of this metal.

There has been very little activity in this area in recent years.

July Group

The July group of two unpatented claims, owned by Fred Bartine, of Eureka, is on the west fork of Kelly Creek, 4 miles south of Willow Creek ranch and 16 miles westerly from Alpha Station. This property was first located in 1902 by Peter Carletti, former owner of the Willow Creek ranch. Production has been about 350 tons of shipping ore, most of which was produced about 25 years ago. In 1937, Bartine shipped 47 tons of ore from the dumps of the property. Development consists of four short adits and scattered surface workings totaling not more than 300 feet. The main adit is 70 feet long and filled with water. There is no equipment on the property.

Ore occurs in bunches along the bedding planes of limestone adjacent basalt dikes. The limestone strikes nearly north and south and dips about 30° to the east. The ore is sulphide in character, containing sphalerite and argentiferous galena. The gangue is silicified limestone, which contains a considerable amount of barite. The smelter returns on the shipment of ore, made in August 1937 by Fred Bartine to the U. S. Smelting, Refining, & Mining Co., furnished the following data:

Metal quotations:	Lead	6.5 cents per pound.
	Zinc	7.125 cents per pound.
		Ounce per ton
Settlement assay:	Silver	0.8
		Percent
	Lead	9.6
	Insoluble	16.4
	Iron	0.3
	Zinc	39.8
	Sulphur	21.5
	Lime	3.0

	Pounds
Wet weight	95,200
Moisture, 1 percent,	952
Dry weight	94,248 , or 47.124 tons.

Metal payment:	Lead	$6.48		
	Zinc	18.67		
	Gross value	25.15		
	Treatment charge	2.88		
	Net value	22.27	47.124 tons at $22.27	$1,049.45
Deductions:	Freight, $6.20 per ton			295.12
			Net proceeds	754.33

Belmont Group

The Belmont group of claims, owned by Mrs. M. Wilson of Tonopah, Nev., is in Dry Creek Canyon 6 miles southeast of Willow Creek ranch and 11 miles westerly from Alpha Station. The property was originally located in 1912 by Dan G. Kelly of Eureka, who sold it to Byron Wilson of Tonopah, Nev., and associates. In 1931 it was under bond and lease to the F. W. Bradley interests of San Francisco, who did a small amount of prospecting and then relinquished the option. A small amount of ore was shipped from the property in 1923. Development consists of a shaft 50 feet deep and other shallow workings totaling little more than 100 feet.

Ore occurs in bunches along bedding planes of limestone in proximity to basalt dikes. The principal ore minerals are sphalerite and argentiferous galena in a gangue composed largely of barite and siliceous limestone.

Blue Eagle Group

The Blue Eagle group of four antimony claims owned by José Villanueva of Eureka is at the upper end of Meadow Canyon on the west slope of the Roberts Range, about 6 miles east of the Three-Bar Ranch. Property is accessible by automobile from Eureka, which is 42 miles southeast via Roberts Creek Ranch. The last 2 miles to the property must be traversed on foot, although a road up Meadow Canyon could be built with little difficulty. Alpha Station, on the Eureka-Nevada Railroad, is 20 miles northeast and the nearest shipping point. The only work done on the claims consists of an open cut 12 feet long, 6 feet wide, and several feet deep, and a shaft 7 feet deep.

The antimony occurs in at least two parallel veins in quartzite. From surface indications, the veins range from 2 to 6 feet in width and the predominant antimony mineral is stibnite with a minor amount of antimony oxide. The veins are traceable on the surface for a length of several hundred feet. According to Villanueva, two large samples yielded 38 and 42 percent metallic antimony. No copper, lead, or zinc were present in the samples. Several masses up to 50 pounds in weight, composed of nearly pure stibnite, were observed on the dump near the shaft.

BEOWAWE DISTRICT

Beowawe[12] is a small ranching settlement and station on the Southern Pacific and Western Pacific Railroads in northern Eureka County. Cinnabar was discovered in the low hills about 1 mile south of Beowawe in 1924 by R. S. Harris and C. M. Wilkinson. In 1928, the Red Devil group of claims located by the discoverers was acquired by the Nevada-Mexico Mining Corporation, a subsidiary of the Compania de Mineral de Jalisco of Mexico. This company erected a Diesel power plant, a 30-ton rotary furnace, and a condensing system, and did some development work. In September 1929, the property closed down, and later the equipment was dismantled and sold. The production has been about 132 flasks of mercury. In recent years the property has been idle.

Red Devil Group

The Red Devil group comprises three unpatented claims owned by R. S. Harris and Mrs. Clara Sullivan of Beowawe, Nev. Development consists of two adits, a shaft 42 feet deep, and subsidiary workings totaling about 1,400 feet.

The cinnabar occurs in fractures in rhyolite and rhyolite breccia. Near the surface, the rhyolite is flinty in character; at depth it is altered to a soft kaolinized material. The ore bodies are small and irregular and the ore mined has been taken from five small stopes, none of which are more than 60 feet from the surface.

BUCKHORN DISTRICT

The Buckhorn district is in the south end of the Cortez Range, 22 miles west from Mineral, a station on the Eureka-Nevada Railroad and the nearest shipping point. It is accessible by automobile over fair desert roads, either from Palisade, about 55 miles northeast, or Eureka, 75 miles southeast. The history of the district is largely the history of the Buckhorn mine, discovered in the winter of 1908-1909 by Joe Lynn, W. S. McCrea, William Ebbert, and John Swan. In 1910, the discoverers sold a group of 14 claims and several fractions for $90,000 to George Wingfield and associates, who organized the Buckhorn Mines Co. The company did considerable development work and blocked out a body of low-grade gold-silver ore and, in 1913, erected at the mine an all-slime cyanidation plant designed for a daily capacity of 300 tons. In the same year, a 700-horsepower steam power plant with electric generators was built at Beowawe with a 35-mile, 33,000-volt transmission line to the mine. The mill operated from January 1914 to the early part of 1916, following which the equipment was dismantled and sold. Operations were confined to the exploitation of the oxidized ores mined by the glory-hole method. Except for a small amount of leasing in 1931 and 1932, the district remained virtually inactive until 1936, when the Buckhorn Mining Co. installed an 80-ton-daily-capacity

12/ An Indian word meaning "gate", probably given because the opening in the nearby hills resembles a gateway to the canyon beyond.

flotation mill at the mine to work the known, though limited, bodies of sulphide ore that were not amenable to the cyanide process formerly employed. This plant operated from November 1936 to December 1937, when the mine closed down and the equipment was offered for sale.

Production from the district from 1910 to 1936, inclusive, is shown in table 3.

Buckhorn Mining Co.

The Buckhorn Mining Co., owned by the Pardners Mines Corporation, John Baragwanath, president, Chrysler Bldg., New York City, comprises a group of 10 patented and 4 unpatented claims. Development consists of a main haulage adit 1,750 feet long, an inclined shaft several hundred feet deep, and subsidiary workings totaling about 4 miles. The deepest working is 300 feet from the surface, but no ore was encountered below about 180 feet.

The Buckhorn Mining Co. employed the top-slicing system of mining, since the ground is very heavy. Each top-slicing cut was 10 feet high and 6 feet wide; round posts with square caps were used for support. Because of the softness of the ore, hand augers were used for drilling. For September 1937 the total mining cost was $5 per ton, which included $3.50 for stoping and $1.50 per ton for maintenance of workings.

The flotation flow sheet (fig. 2) employed is unusual in that no primary crushing was necessary. In the tube mill, the only grinding medium consisted of siliceous pebbles occurring in the ore. Concentration ratio was 4-1/2 to 1. Water for milling was pumped from a well sunk in the flat about 5 miles south of the mine by a Worthington duplex pump driven by a Caterpillar Deisel engine; the lift was 1,000 feet. Electric power for mining and milling was generated by two Caterpillar Deisel engines rated at 100 and 150 horsepower, respectively. Cost of milling for September 1937 was $1.66 per ton.

The Buckhorn ore body is a soft, kaolinized mass of brecciated material carrying gold-silver values. The best ore occurs along a regional fault striking N. 3° W. and dipping nearly vertical. The country rock consists of alternating layers of basalt and volcanic scoria dipping towards the fault. Away from the fault the values gradually diminish, until the material is too low in grade to constitute ore. The zone of oxidation extends to a depth of about 100 feet and the sulphide ore to a depth of 180 feet. The sulphide ore mined was confined to an area 300 feet long and a maximum width of 100 feet; it consisted of fine pyrite desseminated in talcy material.

Although the best ore has been mined, it is reported that there remains an appreciable tonnage of mixed oxide and sulphide ore, too low-grade to be treated economically by the methods previously employed; direct cyanidation is not applicable, and with flotation the ratio of concentration is low. The resulting concentrate can not be directly cyanided, and the expense involved in shipping the low-grade product to a distant smelter is prohibitive.

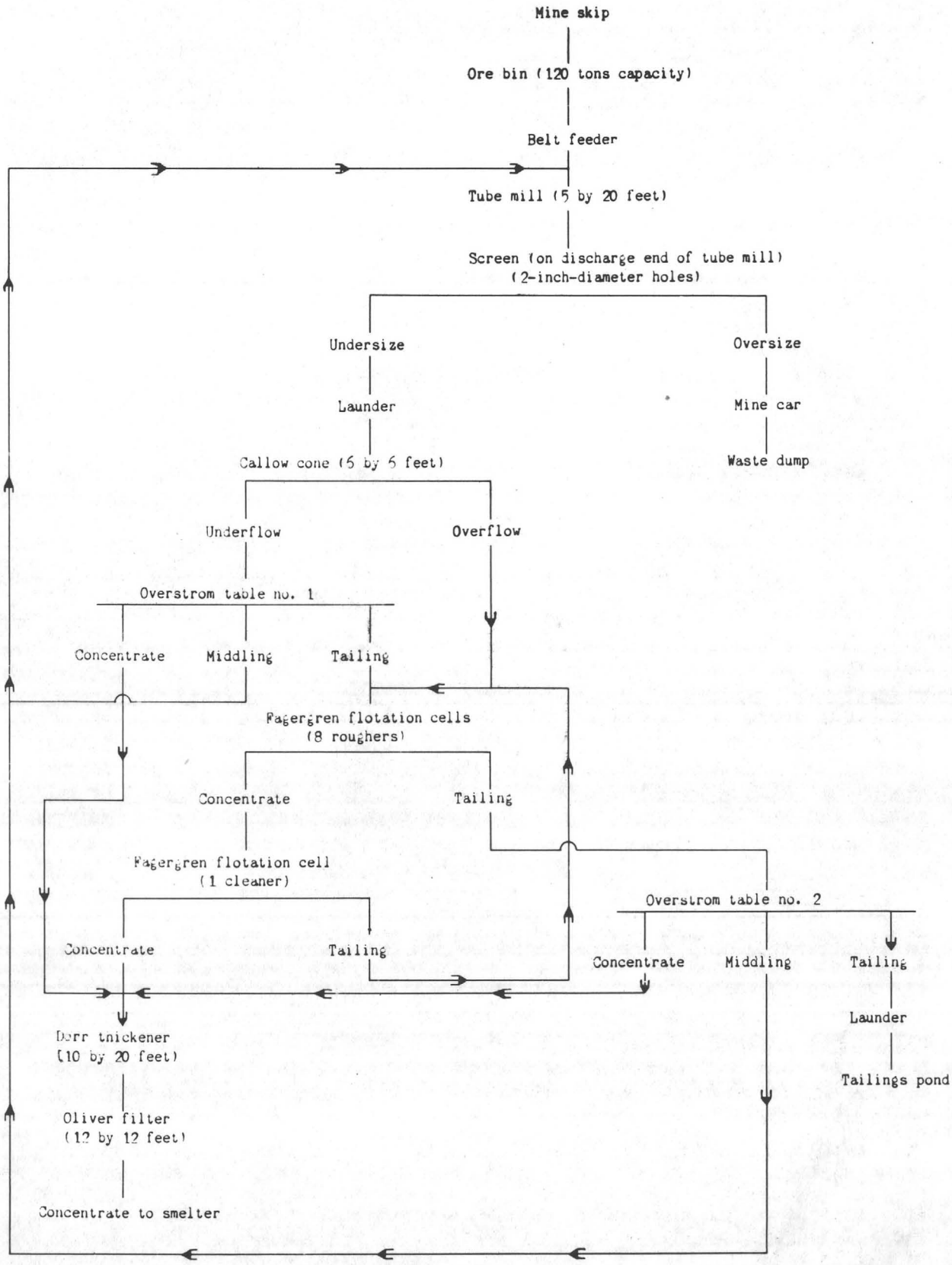

Figure 2.- Flow sheet of 80-ton-daily-capacity flotation mill, Buckhorn Mining Co., Buckhorn district, Eureka County, Nev.

TABLE 3. - Gold, silver, copper, and lead production from the Buckhorn district, Eureka County, Nevada, 1910 - 1936, in terms of recovered metal.
(Compiled by Charles White Merrill, Mineral Production and Economics Division, Bureau of Mines.)

Year	No. of mines	Lode								
		Ore, short tons	Gold		Silver		Copper		Total value	Average recoverable value of ore per ton 1/
			Fine ounces	Value	Fine ounces	Value	Pounds	Value		
1910	1	54	282.31	$5,836	2,660	$1,447	19	$2	$7,285	134.91
1911-13	-	-	-	-	-	-	-	-	-	-
1914	1	73,000	13,485.00	278,760	107,248	59,308	-	-	338,068	4.63
1915	1	103,528	14,026.00	289,943	106,081	53,783	-	-	343,726	3.32
1916	1	15,000	2,702.68	56,014	24,327	16,007	-	-	72,021	4.80
1917-30	-	-	-	-	-	-	-	-	-	-
1931	1	164	132.21	2,733	978	284	-	-	3,017	18.40
1932	1	2/	2/	2/	2/	2/	-	-	2/	2/
1933-35	-	-	-	-	-	-	-	-	-	-
1936	2	2/	2/	2/	2/	2/	-	-	2/	2/
Total	-	195,010	31,289.79	655,429	246,643	134,735	19	2	790,166	4.05

1/ Not to be confused with average assay value of ore.
2/ Bureau of Mines not at liberty to publish figures, but concealed figures included in totals.

31000) 247000 (7.9
217
300

CORTEZ DISTRICT

The Cortez district is in the vicinity of Mt. Tenabo (elevation 9,240 feet), at the south end of the Cortez Range, and near the middle of the boundary line between Eureka and Lander Counties. It is accessible by automobile from Beowawe, a station on the Southern Pacific and Western Pacific Railroads 36 miles north. The district includes Mill Canyon, 4 miles north.

In the early '60s, prospectors from Austin found Indians gathering silver float in the gulches southwest of Mt. Tenabo, and by tracing the float to the cliffs above found the St. Louis lode. A number of locations were made in 1863 and, shortly after, Simeon Wenban, one of the original locators, sold half his holdings to George Hearst. Operating under the name of the Tenabo Mill and Mines Co., Wenban and Hearst acquired the principal properties, including the Garrison, St. Louis, Mt. Tenabo, Fitzgerald, and Arctic mines, embracing 690 acres of mineral land and 520 acres of mill sites and water rights. Wenban purchased Hearst's interest in 1867, and the profit realized by Hearst on this sale is said to have been an important factor in the founding of the hearst fortune. At first, the rich ore was hauled 60 miles by pack train to Austin for treatment, but in 1869 an 8-stamp mill in Mill Canyon was acquired, which was later enlarged to 16 stamps and 4 roasting furnaces.

In 1886, a new mill was constructed near the Garrison mine; the treatment process involved a chloridizing roast followed by leaching with sodium hyposulphite solution (Russell process). This mill was a model installation at that time, and the extraction of silver ranged from 85 to 90 percent. From 1889 to 1892, the Tenabo Mill and Mines Co. was operated under the name of Cortez Mines, Ltd., by the Bewick-Moering Syndicate of England; the property reverted to Wenban in 1892. Following Wenban's death in 1895, his heirs continued operations until 1903, after which a small amount of mining was done by lessees up to 1919, when the property was acquired by the Consolidated Cortez Silver Mines Co. The Garrison tailings dump, reported to contain 125,000 tons, was retreated by cyanidation from 1908 to 1915.

The Consolidated Cortez Silver Mines Co. erected a 125-ton-daily-capacity cyanide plant at Cortez in 1923, which operated continuously until the latter part of 1927, when the mill was remodeled and converted into a 150-ton flotation plant. Operations were continued until January 1930, when the mill closed down because of the low price for silver and depletion of the ore reserves. Subsequently, the company went into the hands of a receiver. In September 1937, the receivership of the properties was terminated and the receiver, John F. Coleman of New York, was instructed to accept an offer tendered by the Cortez Metal Co., a Nevada corporation, whereby 900,000 shares of the 2,000,000 shares (par value 5 cents per share) of the Cortez Metal Co. was distributed to the creditors of the old company.

In recent years the only activity at Cortez has been small-scale leasing operations.

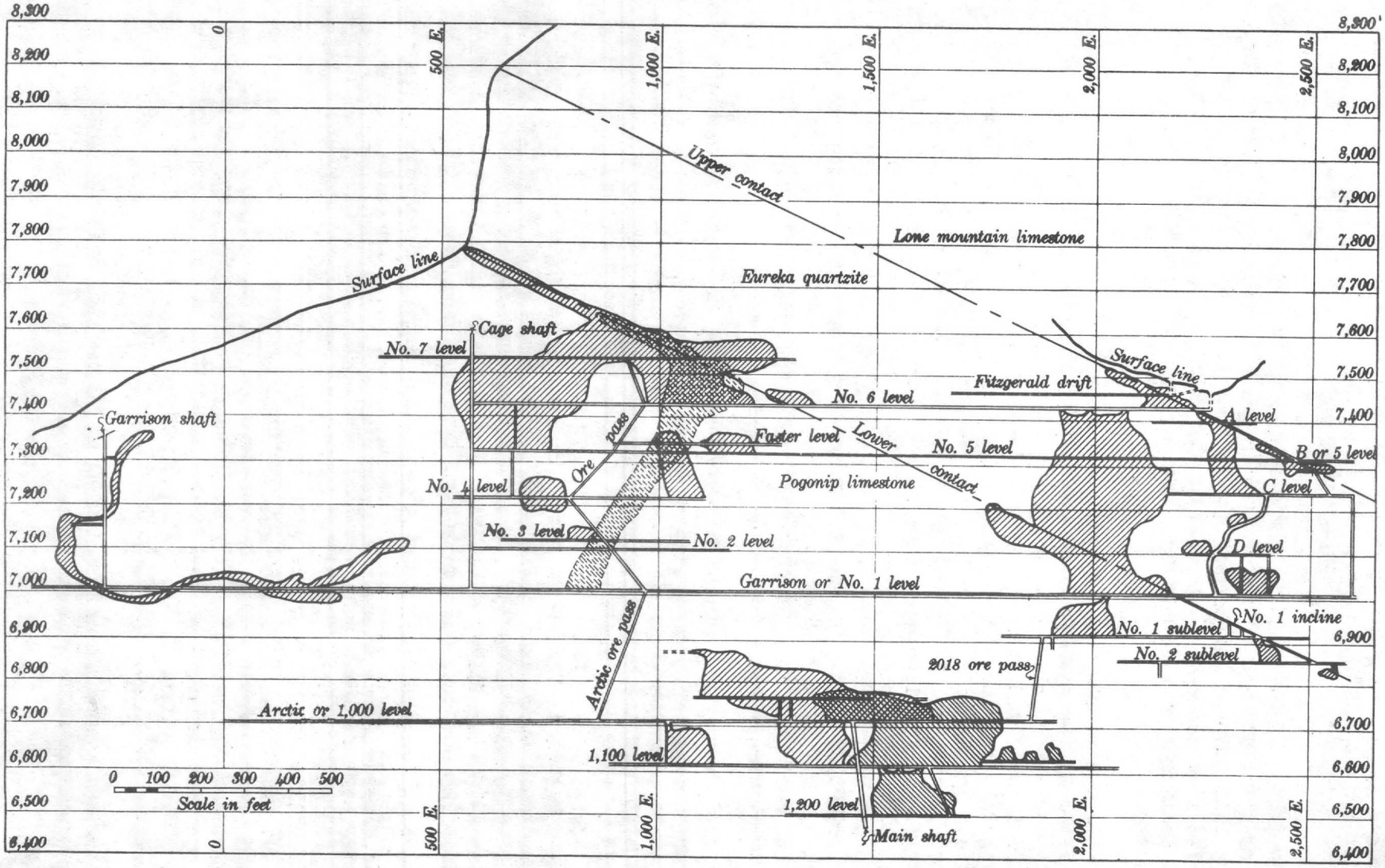

Figure 3.- Longitudinal sections through No. 1 dike, Cortez mine, Cortez district, Eureka County, Nev.

Mill Canyon, about 4 miles north of Cortez, is generally considered part of the Cortez district. A number of properties have been intermittently active in this area since the early days, but, compared with the Cortez mines, production has been small. The principal properties are owned by the Roberts Mining and Milling Co. This company erected a 25-ton cyanide plant in 1937, which started operation in August the same year. In the early part of 1938 the property closed down because of litigation.

Several deposits of turquoise in the vicinity of Cortez have been worked intermittently in former years, but the production has been small.

The production of the Cortez district from 1863 to 1903, according to the old company records, was in excess of 7,400,000 ounces of silver and $500,000 in gold, but this does not include many unrecorded shipments. The gross value of the production for this period is probably about $10,000,000. The production of the district from 1902 to 1936 is shown in table 4.

Cortez Metals Co.

The Cortez Metals Co. owns 44 mining claims (33 patented) and 520 acres of millsites and water rights. This group comprises the properties formerly owned by the Tenabo Mill & Mines Co.

The property has been developed extensively by a number of adits, shafts, and lateral workings totaling approximately 20 miles. Entry to the lower portion of the mine is made by two adits, each about 4,000 feet long, and one inclined shaft sunk from the lowest adit. The portal of the Garrison, or upper, adit is at an altitude of 7,055 feet. The underground shaft, from the Arctic level, has an inclination of 73° and extends 240 feet vertically below the level. From this shaft, two levels have been established, respectively, 98 and 217 feet vertically below the collar. A longitudinal section of the principal workings is shown in figure 3.

Equipment includes a 150-ton flotation mill, a complete mining plant, and camp accommodations for 60 men. Power is supplied by two 4-cylinder, Fairbanks-Morse Deisel engines, 200 horsepower each, direct-connected to a 125-kv-a generator, and one 150 horsepower Deisel engine connected to a Sullivan 2-stage compressor. There are also two Chicago pneumatic 2-stage compressors. Haulage equipment includes a 3-1/2 ton storage-battery locomotive.

Water for mining and milling is available from wells sunk in the valley about 3 miles south of Cortez. A description of the mining methods and costs in 1929 (the last year of company operations) is given by Hezzelwood[13].

In 1936 and 1937 a portion of the mine was leased to J. A. Boitano, who shipped 6 carloads of ore averaging about 85 ounces in silver and $1.50 in gold.

13/ Hezzelwood, G. W., Mining Methods and Costs at the Consolidated Cortez Silver Mine, Cortez, Nev.: Information Circular 6327, Bureau of Mines, 1930.

TABLE 4. - Gold, silver, copper, and lead production from Cortez district, Eureka and Lander Counties, Nevada, 1902-1936, in terms of recovered metal.

(Compiled by Charles White Merrill, Mineral Production and Economics Division, Bureau of Mines.)

Year	No. of mines	Lode				
		Ore, short tons	Gold		Silver	
			Fine ounces	Value	Fine ounces	Value
1902	1	6,749	289.28	$5,980	214,094	$113,470
1903	4	9,709	858.46	17,746	149,343	80,645
1904	3	5,561	489.60	10,121	115,902	67,242
1905	2	1,837	96.75	2,000	37,540	22,674
1906	2	144	66.81	1,381	8,792	5,891
1907	1	125	42.33	875	5,000	3,300
1908	2	1,173	73.00	1,509	18,700	9,911
1909	3	898	283.62	5,863	40,459	21,039
1910	-	-	-	-	-	-
1911	5	135	26.99	558	7,712	4,087
1912	2	13,433	294.97	6,098	52,429	32,244
1913	6	12,968	282.36	5,837	54,196	32,734
1914	3	2,946	192.13	3,972	44,185	24,434
1915	6	15,692	816.84	16,886	67,873	34,412
1916	4	5,534	268.42	5,549	42,139	27,727
1917	10	647	161.50	3,339	26,950	22,207
1918	12	456	101.52	2,098	31,578	31,578
1919	2	133	.78	16	11,387	12,753
1920	5	140	21.98	454	7,872	8,580
1921	2	85	11.70	242	8,416	8,416
1922	3	209	35.09	725	39,386	39,386
1923	1	9,250	272.45	5,632	172,466	141,422
1924	1	32,434	713.78	14,755	423,163	283,519
1925	2	40,315	671.68	13,885	366,350	254,247
1926	2	44,482	742.02	15,339	345,381	215,518
1927	2	37,864	304.25	6,289	544,646	308,814
1928	1	51,167	443.22	9,162	785,980	459,798
1929	4	44,322	515.19	10,650	493,766	263,177
1930	2	1,623	39.55	818	44,423	17,103
1931	3	13	13.53	280	618	179
1932	1	2/	2/	2/	2/	2/
1933	3	371	74.42	1,538	18,424	6,448
1934	2	7	6.72	235	341	220
1935	1	44	2.97	104	3,829	2,752
1936	2	2/	2/	2/	2/	2/
Total	-	340,720	8,267.07	171,786	4,195,128	2,564,972

1/ Not to be confused with average assay value of ore.
2/ Bureau of Mines not at liberty to publish figures, but concealed figures included in totals.

6589

83w) 4,200000 (506
41500
50000

8 oz
5 oz
4,000,000

TABLE 4. - Gold, silver, copper, and lead production from Cortez district, Eureka and Lander Counties, Nevada, 1902-1936, in terms of recovered metal - Continued.

(Compiled by Charles White Merrill, Mineral Production and Economics Division, Bureau of Mines.)

Year	Lode					
	Copper		Lead			Average recoverable value of ore per ton 1/
	Pounds	Value	Pounds	Value	Total value	
1902	5,907	$721	12,564	$515	$120,686	$17.88
1903	3,100	391	20,489	550	99,332	10.23
1904	13,963	1,380	16,726	577	79,330	14.26
1905	64	10	56,827	2,670	27,354	14.89
1906	-	-	21,315	1,215	8,487	58.94
1907	-	-	-	-	4,175	33.40
1908	7,773	1,026	9,095	382	12,828	10.94
1909	1,000	130	10,721	461	27,493	30.62
1910	-	-	-	-	-	-
1911	2,022	253	31,970	1,439	6,337	46.94
1912	803	132	46,893	2,110	40,584	3.02
1913	1,581	245	83,791	3,687	42,503	3.28
1914	402	53	179,599	7,004	35,463	12.04
1915	2,543	444	84,068	3,950	55,692	3.55
1916	1,373	338	36,922	2,548	36,162	6.53
1917	7,434	2,029	148,741	12,792	40,367	62.39
1918	4,614	1,140	160,030	11,362	46,178	101.27
1919	780	145	63,358	3,358	16,272	122.35
1920	1,084	199	45,945	3,675	12,908	92.20
1921	368	48	24,959	1,123	9,829	115.64
1922	2,764	373	26,625	1,464	41,948	200.71
1923	2,216	326	30,705	2,149	149,529	161.65
1924	5,021	658	67,041	5,363	304,295	9.38
1925	2,419	344	46,417	4,038	272,514	6.76
1926	3,308	463	38,580	3,086	234,406	5.27
1927	13,770	1,804	176,959	11,148	328,055	8.66
1928	25,031	3,605	364,617	21,148	493,713	9.65
1929	17,990	3,166	435,990	27,467	304,460	6.87
1930	1,768	230	37,252	1,863	20,014	12.33
1931	-	-	1,636	60	519	39.92
1932	2/	2/	2/	2/	2/	2/
1933	1,368	87	25,640	949	9,022	24.32
1934	-	-	240	9	464	66.29
1935	142	12	1,268	51	2,919	66.34
1936	2/	2/	2/	2/.	2/	2/
Total	131,828	19,841	2,311,093	138,364	2,894,963	8.50

1/ Not to be confused with average assay value of ore.
2/ Bureau of Mines not at liberty to publish figures, but concealed figures included in totals.

The geology of the district has been described by Emmons[14].

In the vicinity of Cortez, the prevailing formations are a series of limestone beds and quartzites that have been uplifted by granitic intrusives. The limestone and quartzite dip conformably about 23° S. 80° E. and are cut by a series of eight porphyry dikes, highly altered, striking S. 80° E. and dipping to the north about 75°.

The ore occurs as irregular replacement deposits (1) along bedding planes of the limestone, (2) in limestone and quartzite in and near a dike fissure (only one dike has been explored), and (3) in fissures in limestone approximately parallel to the dikes. The latter type of deposit has been the most productive. The fissure ore bodies dip from 45° to 80° and range from 1 to 20 feet in width, averaging about 7 feet. The vertical range of the ore bodies from the highest point on the surface to the lowest depth mined is about 1,600 feet. The most productive area was between the 5th and 7th levels, or from 100 to 300 feet below the surface. The largest ore body was 630 feet long, 5 to 15 feet wide, with a maximum vertical extent of about 220 feet.

The unoxidized ore minerals are silver-bearing quartz, galena, pyrite, tetrahedrite, sphalerite, chalcopyrite, and stibnite. The oxidized ore is composed of silver chloride, copper carbonates, and iron and manganese oxides. Values are chiefly in silver. As an indicator of the silver values, galena is superseded by tetrahedrite at depth.

Roberts Mining & Milling Co.

The Roberts Mining & Milling Co., Miss Belle McCord Roberts of Long Beach, Calif., president, is a closed corporation organized in 1930. The company's holdings are a consolidation of virtually all the principal groups of claims in Mill Canyon, including the Erwin, Falconer, Bullion Hill, Berlin, Cross Fissure, and Emma E. groups, totaling 48 claims, 9 of which are patented. The first locations in this area were made about the same time the Cortez mines were discovered, or about 1863. A stamp mill was erected in Mill Canyon in 1868, which operated for a number of years principally on ores from the Cortez mines. In 1900, a gravity concentrator was erected in Mill Canyon to treat ores from the Erwin and Falconer properties, but it operated only a short time. About 1928, the Majestic Mines Corporation was organized to work several properties, but only a small amount of development was done and the holdings of the company were acquired by the Roberts Mining & Milling Co. In 1936 and 1937, this company opened a deposit of gold ore on the Emma E. claim and in the latter part of 1937 erected a small cyanide mill, which began operations August 27, 1937, but closed down because of litigation after operating a few months.

The various claims in Mill Canyon have been worked intermittently on a small scale for many years, principally by lessees. The bulk of the production, estimated at $200,000, has been shipping ore.

14/ Emmons, William H., A Reconnaissance of Some Mining Camps in Elko, Lander, and Eureka Counties, Nev.: Geol. Surv. Bull. 408, 1910, pp. 99-110.

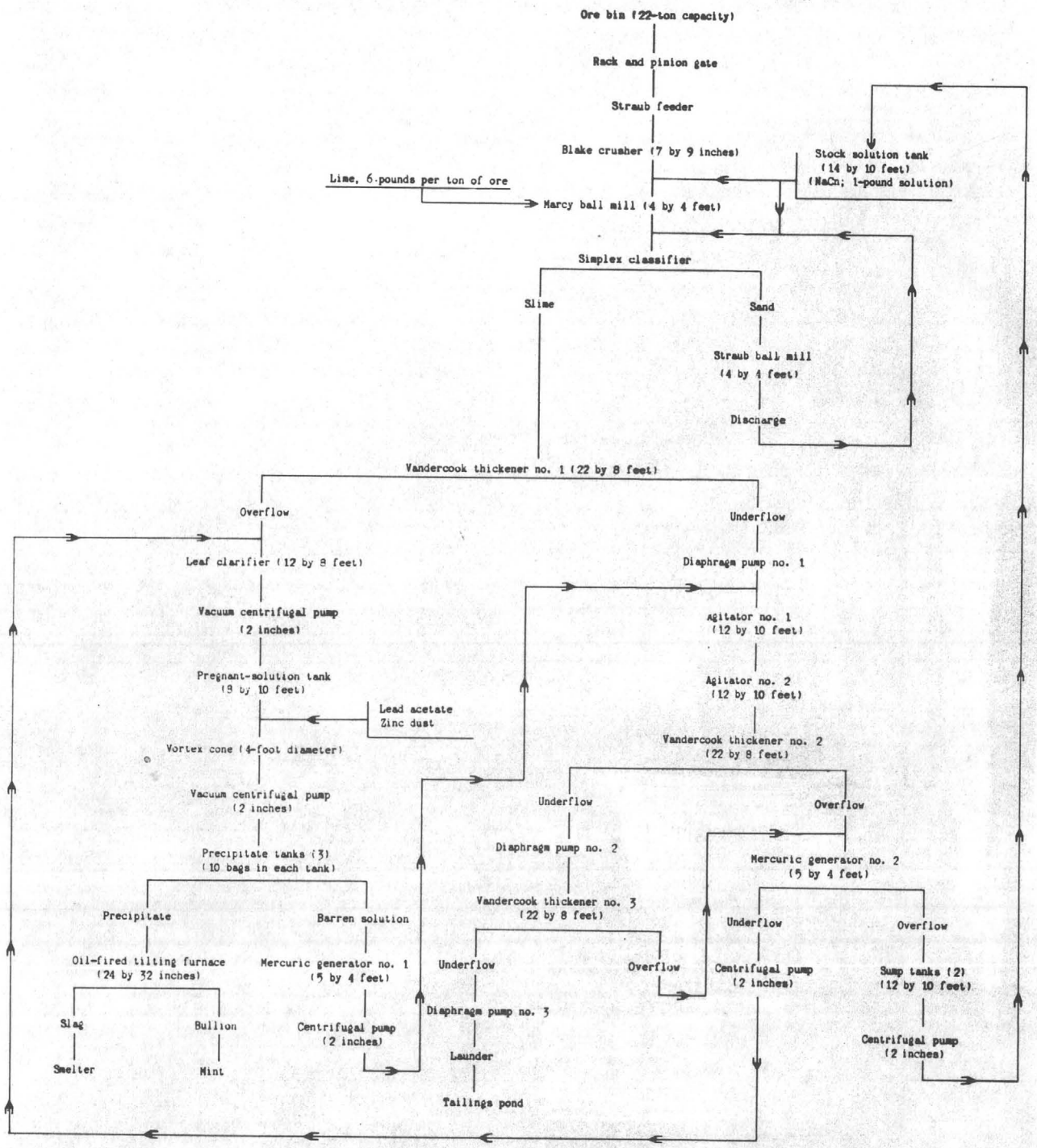

Figure 4.- Flow sheet of 20-ton-daily-capacity cyanidation mill, Roberts Mining & Milling Co., Cortez district, Eureka County, Nev.

Property is developed by a number of scattered adits and other disconnected workings totaling about 5,000 feet. Equipment includes a Sullivan portable compressor; an Ingersoll-Rand, 630-feet-capacity, stationary compressor; Sullivan drill sharpener; rock drills, blacksmith shop; gravity-type tramway, 1,250 feet long; two automobile trucks; a 20-ton cyanide mill; assay office; and camp accommodations for a crew of 30 men. Power for milling is supplied by a 100-horsepower, Fairbanks-Morse, 2-cylinder, Deisel engine direct-connected to a 220-volt, 3-phase, 60-cycle, 75-kv-a generator.

The mill flow sheet is shown in figure 4. The mill was designed for a capacity of 50 tons per day but, due to the limited capacity of the crushing and grinding units, only 20 tons per day could be treated. The only unusual feature of the plant is the installation of the two mercuric generators, the function of which is not understood by the writer. About 1 ounce of mercury is used in the two generators per week. At the time of the writer's visit, the mill heads averaged $40 per ton and the tailings loss was about 90 cents per ton. The milling cost was reported to be $2.50 per ton.

The prevailing formations in the vicinity of Mill Canyon are limestone and granodiorite intrusives. The ore deposits are of three types - (1) fissure veins in granodiorite carrying silver-lead, and gold, (2) silver-lead replacement deposits in limestone, and (3) ferruginous deposits of gold ore in limestone. In former years, the fissure veins were the most productive, the most prominent being the Rhoda and Aurora veins on the Bullion Hill group of claims. These two veins are parallel and about 200 feet apart on the surface, striking nearly north and south, with prevailing steep dips. The portions of the veins economical to mine are generally narrow. The sulphide ore is composed of galena, sphalerite, pyrite, argentite, tetrahedrite, stephanite, stibnite, and gold in a quartz-calcite gangue. The silver values predominate.

The principal silver-lead replacement deposits in limestone occur on the Erwin and Falconer claims. The limestone has a strike of N. 45° W. and an average dip of N. 30° E. On the Erwin ground, the limestone is considerably disturbed by faulting, due to the proximity of granodiorite intrusive. The ore is sulphide in character and occurs along bedding planes and fissures in the limestone.

The principal gold-ore deposit is on the Emma E. claim. Here the values are chiefly in gold, with minor amounts of silver in a gangue composed largely of ferruginous material and calcite. At the time of the writer's visit, an ore body had been opened for a length of 200 feet and approximately 100 feet in depth. The width of the ore ranged from 1 to 18 feet, averaging about 8 feet, and the values ranged from $20 to $60 per ton, chiefly in gold. The ore makes along a fissure, and its continuity is interrupted, both along the strike and dip, by several faults.

Turquoise

The White Horse turquoise deposit is about 3 miles westerly from Cortez. It has been known for many years and a small amount of gem material has been mined. The turquoise occurs in small seams in a decomposed igneous rock, probably rhyolite.

In 1929, J. A. Boitano of Cortez found turquoise in Cortez Canyon, several miles from the camp of Cortez. In 1930 and 1931, Boitano prospected the deposit by several open cuts and during the course of this work produced 600 pounds of crude turquoise that was sold for $5 per pound. Here the turquoise occurs as nodules and seams in thin-bedded limestone striking S. 40° E. and dipping about 20° to the southwest.

DIAMOND DISTRICT

The Diamond, also known as the Phillipsburg, district is on the west slope of the Diamond Range, 21 miles north of Eureka. The first mineral discovery was made here in June 1864, by a man known as Phillips. In 1866, a few tons of ore from the Mammoth claim were hauled to Austin for treatment, after which the district remained virtually abandoned until 1873, when a small smelting furnace was erected at the Champion mine by the Champion Silver Mining Co. This venture was unsuccessful, and later a second furnace was built at the Phillips property. There is no record of production, but from the size of the slag pile, the extent of the underground workings, and reported value of the ore, the district has not produced more than $50,000.

In 1922, the Eureka Silver Mines Co., a Utah corporation, attempted to concentrate, by gravity methods, the dump material at the Phillips property, but the results were discouraging. Subsequently, lessees worked the mine and the dumps with indifferent results. In 1937, the only activity in this area was on the Silver Bell group of claims situated about 1 mile west of the Phillips property.

Phillips Group

This property consists of a group of three patented and one unpatented lode claims owned by H. A. Culloden of Los Angeles, Calif. Development consists of an adit 300 feet long, about 1,000 feet of drifts, and other workings, totaling in all about 1,500 feet. There is no usable equipment on the property.

The prevailing formation is silicified limestone. The Phillips vein, on which most of the work has been done, strikes nearly north and south, has a dip of 35° to 55° to the west, and a width ranging from 1 to 6 feet and averaging 3 feet. Approximately 400 feet of the vein has been stoped above the adit level, but, since the vein outcrops on a gently sloping hill into which the adit has been driven, the stoping distance from the level to the surface is small. In several places the vein has been explored below the adit level.

Values are in lead and silver. The ore consists of argentiferous galena, cerrusite, and stibnite in a gangue composed chiefly of quartz, calcite, and country rock stained with iron and manganese oxides.

A short distance east of the Phillips vein is a parallel vein on which very little work has been done.

Wilcox and Frazer Claims

J. L. Wilcox and the Frazer brothers, Abe and William, of Eureka own 5 unpatented claims, two adjoining the Phillips group on the south and three on the north. These claims are said to be on the extensions of the Phillips vein. Total development on the foregoing claims is about 1,000 feet, most of which has been done on the north claim. There is no equipment on the property and to the writer's knowledge no production has been made.

Silver Bell Group

The Silver Bell group of 13 unpatented claims, owned by C. E. Vance, W. F. Ewald, and associates of Eureka, is in Phillipsburg Canyon 1-1/2 miles easterly from the Phillips property. In the latter part of 1937, the owners of the Silver Bell group had filed an application to incorporate under the name of Summit Mining Co. This group of claims was located in May 1934, although some desultory prospecting had been done in the area as far back as the '90s and several small shipments were made at that time. Development consists of a number of short adits and scattered surface workings totaling about 500 feet. The principal adit has a length of 100 feet. Equipment includes a Baldwin single-stage compressor driven by 4-cylinder Dodge automobile engine, jackhammer, ore bin, and camp accommodations for a crew of 5 men. In the fall of 1937, four men were employed in the production of shipping ore, and the production up to this time amounted to 75 tons averaging $40 per ton.

The prevailing formations are limestone and quartzite, the former trending north and south and dipping 60° to the west. The best showing of ore occurs in fissures and along the bedding planes of the limestone near its contact with the quartzite. Values are in silver, lead, zinc, associated with a little copper in a siliceous gangue. Smelter returns on a shipment of ore made July 10, 1937, to the American Smelting & Refining Co. furnished the following data:

Metal quotations:	Silver	$0.77 per ounce.
	Lead	6 less 1.5 cents per pound.
	Copper	13.65 less 6 cents per pound.
Settlement assay:	Silver	47.0 ounces per ton.
		Percent
	Lead	33.6
	Copper	.95
	Insoluble	29.4
	Zinc	9.0
	Sulphur	1.3
	Arsenic	.4
	Iron	2.5
	Antimony	.3
	Lime	3.9

	Pounds
Wet weight	44,900
Moisture 4.5 percent	2,020
Dry weight	42,880 or 21.44 tons

Smelter charges:	Base treatment charge	$2.00
	Payment for lead over 30 percent	.17
		1.83
	Insoluble (debit)	2.94
	Zinc (debit)	.90
	Labor increase 4/1/37	.81
		6.48
	Iron (credit)	.15
	Treatment charge	6.33 per ton

Metal payment:	Silver, 95 percent at $0.77 per oz.	$34.38	
	Lead, less 1.5 percent, 90 percent at $0.90 per unit (20 lbs.)	26.00	
	Copper, less .75 percent at $1.53 per unit (20 lbs.)	.31	
		60.69	
	Treatment charge	6.33	
	Net value per ton	54.36	
	21.44 tons at $54.36		$1,165.48
Deductions:	Hauling $12.50 per ton		280.63
	Net proceeds		884.85

The ore was hauled to the Murray smelter in Salt Lake Valley, a distance of 336 miles, in a Dodge truck having a capacity of 7 tons per load.

EUREKA DISTRICT

The Eureka mining district is on the west slope of the Diamond Range in southeastern Eureka County. It extends from Secret Canyon on the north to Adams Hill on the south, an area about 8 miles long and 1-1/2 miles wide. In this area a large number of mines and prospects have been opened; the underground workings probably total about 60 miles. The most productive mines are on Ruby Hill (altitude 7,300 feet) 2 miles west of the town of Eureka. Eureka (altitude 6,500 feet) is connected with Palisade, a station on the Southern Pacific and Western Pacific Railroads about 90 miles north, by the Eureka-Nevada (narrow-gage) Railroad.

Although the first location in the district was made in 1866 in New York Canyon, on the east flank of Prospect Mountain, there was very little activity until 1869, when the Ruby Hill deposits were discovered and it was demonstrated that the ores could be reduced successfully by smelting. The first locations on Ruby Hill were the Champion and Buckeye mines, made by Alonzo Monroe, M. G. Clough, and Owen Farrell. These properties formed the nucleus of the famous Eureka Consolidated Mining Co., organized in 1870. In 1871, the Richmond Consolidated Mining Co. purchased the Richmond and other properties adjoining that of the Eureka Consolidated. These two companies, as well as others of lesser note, erected smelters, so that by 1872, 13 furnaces with a combined capacity of 600 tons of ore per day were operating.

With the completion of the Eureka and Palisade Railroad (now Eureka-Nevada Railroad) in October 1875, Eureka became the center of wagon and stage transportation for nearly all the mining camps in eastern Nevada, including Austin, Belmont, Tybo, Ward, Hamilton, and Pioche. The population at this time numbered about 7,000.

The following news item from the Ruby Hill Mining News, dated August 15, 1881, furnishes an idea of the condition of the mining industry at that time:

> There are 50 producing mines in the Eureka district at the present time and thrice that number could be made productive at a very small outlay. Every share of the Eureka Consolidated (50,000 shares) purchased in 1871 has returned a profit of $82 to the stockholders. The Richmond, only 900 feet in depth, has already returned nearly $3,000,000 in profits.
>
> Of the amount invested in the district by outside capitalists, $800,000 has come from England and about $400,000 from the Pacific Coast and other points in the United States. The value of the Eureka mines, as shown by (stock) quotations, is $55,000,000. Ten thousand dollars per month would more than cover the amount paid in prospecting non-dividend-paying mines, and still the district has yielded in gross $68,000,000, has paid over $7,000,000 in dividends, and its bullion production is constantly and rapidly increasing.

The capacity of the smelting works in Eureka is at present 750 tons per day.

Protracted lawsuits between the Eureka Consolidated and Richmond Consolidated started in 1871, and it was the beginning of hard feelings that lasted for many years. It is interesting to note that the first celebrated apex suit in the United States, forerunner of the numerous similar suits, began between the Eureka and Richmond companies in 1877, and was finally adjudicated by the United States Supreme Court in 1881. The point at issue in this case hinged largely on whether or not the Ruby Hill ore deposits constituted a lode within the meaning of the mining statutes. The Richmond company had followed downward, from the Tip-Top claim, an ore shoot that terminated in a bonanza ore body, known as Pott's Chamber, and which lay in ground claimed by both companies. The Richmond company crossed over the compromise plane that had been established in a previous suit and mined ore on the Eureka ground to a reputed value of $2,000,000. The Eureka company claimed this compromise plane as the limit of their ground, but in order to establish their claim it was necessary that they possess a lode within the meaning of the statutes. The Richmond company claimed the whole of Pott's Chamber and the right to follow their body of ore into Eureka ground beyond the limit of the compromise plane as originally established. Both companies proved the existence of a lode apexing on their respective properties and leading into Pott's Chamber.

The court decided that the belt of limestone between the quartzite and shale through Ruby Hill constituted a lode in the sense of the law of 1872, and that therefore the portion of Pott's Chamber lying within the Eureka Company's ground belonged to the Eureka company by virtue of the compromise plane previously established. This decision was upheld by Chief Justice White of the United States Supreme Court.

With the depletion of the bonanza ore bodies, the Richmond smelter closed down in 1890 and the Eureka Company abandoned their smelter the following year. Subsequently, the bulk of the ores from the district was shipped to distant smelters. Contributing factors to the cessation of local reduction of ores were the decline in the price of silver, high operating costs, and the Government edict restricting the cutting of timber for the manufacture of charcoal.

In 1906, a revival of mining activity occurred, when the Richmond and Eureka properties were consolidated and operated by the U. S. Smelting, Refining, & Mining Co. This company rehabilitated the mines and made shipments of ore to their smelter up to 1910. A cloudburst in the latter year washed out the railroad spur to the mine and company operations were suspended. Subsequently, the mines were operated by lessees. From time to time other companies have been active in the district.

The production of the district from 1869 to 1902 is estimated at $95,000,000.15/ The annual production from 1902 to 1936, inclusive, is

15/ See section on mineral production.

shown in table 5. Although Eureka is generally known as a lead producer, more than half of the value has been in gold and silver.

For the amount of capital invested in the Eureka district, it has been one of the best camps in Nevada. The mines did not levy the large assessments that characterized early operations on the Comstock, and the speculative features that attended some other prominent mineral discoveries were not so common.

There is no doubt that there are considerable quantities of low-grade ore in a number of the old mines in the Eureka district, and it is possible that well-planned and executed exploration work may result in the discovery of rich ore bodies. The fact that most of the mines have been idle for many years does not prove their lack of prospective value. In recent years, because of the dearth of new mineral discoveries, the attention of established companies has been focused on a number of the old districts in the State, and, in comparison with other districts of equal prominence, Eureka has not received the attention it merits. The principal drawback to greater activity is the fact that the only outlet for the low-grade or base ores is distant smelters; the metallurgy of such ores by a process other than smelting still awaits a satisfactory solution.

Early Mining and Smelting

The history of the first smelting operations at Eureka is given in this paper in the section "History of Mining." Eureka is generally conceded to be the birthplace of the silver-lead smelting industry in the United States, and from 1869 to 1879 it was the source of a large part of the domestic production of pig lead. In the latter year, its importance as a lead producer was overshadowed by the deposits at Leadville, Colo. The principal reason for the rapid expansion of the smelting industry at Eureka is attributed to the character of the ores; the ores contain the slag-forming constituents iron, lime, and silica to make them largely self-fluxing.

The furnaces used in the district were of the blast type designed after the Piltz and Raschette furnaces used in Europe. The first furnaces had daily capacities of from 20 to 50 tons per day, but later the capacity of individual furnaces was increased to 90 tons. The height of the furnaces was from 10 to 20 feet from the tuyeres to the charging door. Sturtevant fans and Baker and Root blowers were used for the air blast. The number of tuyeres for each furnace varied from 3 to 10. The siphon tap, the greatest contribution Eureka made to lead smelting, was invented by Albert Arentz in 1870. This was a considerable improvement over the tap-holes previously used. Dust- and fume-collecting systems were erected at both the Eureka and Richmond smelters in 1873. Water-cooled furnace jackets were introduced in 1873. In 1878, the Eureka Consolidated company erected an experimental furnace in which air jackets were to take the place of the water jackets, but it proved to be impractical.

TABLE 5. - Gold, silver, copper, and lead production from Eureka district, Eureka County, Nevada, 1902-1936, in terms of recovered metal
(Compiled by Charles White Merrill, Mineral Production and Economics Division, Bureau of Mines)

Year	No. of mines	Lode				
		Ore, short tons	Gold		Silver	
			Fine ounces	Value	Fine ounces	Value
1902	7	4,508	3,742.82	$77,371	96,287	$51,032
1903	10	4,397	3,876.38	80,132	95,596	51,622
1904	7	2,582	1,653.22	34,175	44,772	25,968
1905	7	1,692	651.85	13,475	36,341	21,950
1906	6	11,896	2,396.01	49,530	68,760	46,069
1907	9	35,092	8,370.61	173,036	152,872	100,896
1908	19	28,000	8,337.68	172,355	109,826	58,208
1909	17	87,936	20,306.76	419,778	179,315	93,244
1910	7	11,923	3,412.25	70,537	33,349	18,009
1911	7	15,484	4,920.48	101,715	5,584	2,960
1912	16	20,810	5,642.88	116,649	18,546	11,406
1913	26	1,096	639.83	13,226	24,173	14,601
1914	24	807	892.88	18,457	28,441	15,728
1915	25	1,135	1,092.20	22,578	34,308	17,394
1916	19	3,666	1,873.59	38,731	80,657	53,072
1917	31	3,304	973.85	20,131	39,708	32,720
1918	2	3,804	1,337.23	27,643	51,980	51,980
1919	15	3,283	1,015.29	20,988	66,459	74,434
1920	19	8,825	3,017.85	62,384	78,878	85,977
1921	14	9,644	2,383.92	49,280	45,886	45,886
1922	15	4,236	1,895.02	39,174	44,925	44,925
1923	12	26,937	4,149.02	85,768	84,068	68,936
1924	9	20,006	1,477.76	30,548	48,552	32,530
1925	12	31,004	1,539.12	31,816	101,703	70,582
1926	14	34,816	3,894.40	80,504	153,979	96,083
1927	9	13,024	2,372.55	49,045	75,223	42,652
1928	6	6,006	2,249.70	46,505	30,530	17,860
1929	4	4,981	1,819.42	37,611	27,760	14,796
1930	3	1,898	693.90	14,344	17,037	6,559
1931	4	888	416.47	8,609	4,040	1,172
1932	5	819	452.96	9,364	9,380	2,645
1933	5	283	154.60	3,952	3,408	1,193
1934	6	3,868	1,448.67	50,631	18,094	11,697
1935	16	6,809	2,298.81	80,458	40,972	29,449
1936	11	14,486	3,181.04	111,336	60,830	47,113
Totals	-	429,945	104,581.02	2,261,836	2,012,239	1,361,348

TABLE 5. - Gold, silver, copper, and lead production from Eureka district, Eureka County, Nevada, 1902-1936, in terms of recovered metal - Continued

(Compiled by Charles White Merrill, Mineral Production and Economics Division, Bureau of Mines)

Year	Lode					
	Copper		Lead		Total value	Average recoverable value of ore per ton 1/
	Pounds	Value	Pounds	Value		
1902	-	-	903,875	$37,059	$165,462	$36.70
1903	-	-	577,748	15,311	147,065	33.45
1904	-	-	496,306	19,827	79,970	30.97
1905	-	-	416,308	19,566	54,991	32.50
1906	6,653	$1,283	992,929	56,497	153,379	12.89
1907	115,557	23,111	2,936,672	155,643	452,686	12.90
1908	72,477	9,567	2,310,572	97,044	337,174	12.04
1909	90,100	11,713	4,340,768	186,653	711,388	8.09
1910	702	89	672,801	29,603	118,238	9.92
1911	-	-	27,570	1,240	105,915	6.84
1912	2,394	395	195,036	8,777	137,227	6.59
1913	3,053	473	287,959	12,670	40,970	37.38
1914	2,379	316	194,803	7,597	42,098	52.17
1915	5,653	989	393,526	18,496	59,457	52.39
1916	41,420	10,189	1,290,448	89,041	191,033	52.11
1917	31,771	8,674	693,757	59,663	121,188	36.68
1918	63,517	15,689	1,142,937	81,149	176,461	46.39
1919	40,713	7,573	1,179,723	62,525	165,520	50.42
1920	120,268	22,129	2,457,094	196,568	367,058	41.59
1921	206,948	26,696	776,943	34,962	156,824	16.26
1922	68,450	9,241	501,980	27,609	120,949	28.55
1923	645,715	94,920	1,345,409	94,179	343,803	12.76
1924	160,344	21,005	1,776,927	142,154	226,237	11.31
1925	25,955	3,686	4,326,303	376,388	482,472	15.56
1926	66,194	9,267	5,568,282	445,463	631,317	18.13
1927	38,988	5,107	2,263,168	142,580	239,384	18.38
1928	26,168	3,768	932,090	54,061	122,194	20.35
1929	20,874	3,674	755,488	47,596	103,677	20.81
1930	9,016	1,172	365,725	18,286	40,361	21.27
1931	2,565	233	124,374	4,602	14,616	16.46
1932	1,120	70	122,516	3,675	15,754	19.24
1933	622	40	31,300	1,158	6,343	22.41
1934	13,331	1,067	295,056	10,917	74,312	19.21
1935	20,644	1,713	482,033	19,281	130,901	19.22
1936	5,597	515	283,828	13,056	172,020	11.87
Totals	1,909,188	294,364	41,462,254	2,590,896	6,508,444	15.14

1/ Not to be confused with average assay value of ore.

The average recoveries attained by smelting in 1874 were 81 to 83 percent of the lead and 82 to 85 percent of the gold and silver, based on the assay contents of the ore. The principal losses of precious metals occurred in dust and fumes, 8 to 10 percent, in the speiss 4-1/2 to 5 percent, and in the slag less than 1 percent.

Charcoal was used as fuel and it was the most important related business in the district. Annual consumption reached 1-1/4 million bushels per year, and as many as 800 men were employed in charcoal manufacture. All the mountain ranges within a radius of 60 miles from Eureka were denuded of trees suitable for use in making charcoal, and a number of the pits and kilns can still be seen in various places in the county. Approximately 30 bushels of charcoal were obtained from each cord of nut-pine wood, and the cost ranged from 25 to 33 cents per bushel delivered at Eureka. The average consumption of charcoal per ton of ore ranged from 25 to 35 bushels.

During the first years of smelting operations a number of small companies erected their own plants, but later the operators realized that the smelting rate charged by a large plant was less than the operating cost of a small individually owned one, so that eventually the smelting business reverted to the two major companies, the Eureka Consolidated and Richmond Consolidated. The prices paid for custom ore in 1875, by at least one company, wereas follows:

Assay value of ore	Percent of assay value gold and silver paid.
$ 50	16
60	25
70	35
80	43
90	45
100	50
150	55
200	55
225	60
250	62
300	63

For higher-grade ores, rates were established by special agreement. Lead over 20 percent was paid for at the rate of 40 cents per unit.

Up to 1877, all the base bullion was shipped for refining either to Balbach Refinery in New Jersey or to the Selby Smelting & Lead Co. (established in 1866) at Selby, Calif. In 1877, the Richmond Co. constructed a refinery for desilverizing bullion by the Lucien Rozan process, a modification of the Pattinson method. The lead was refined by successive crystallization in pots, into which steam was admitted. The silver-rich lead obtained in this manner was cupeled twice in wood-fired furnaces holding about 1 ton per charge. The cost of separating lead and silver by this process was about $20 per ton of base bullion. The Eureka company also set up a refinery in 1886 wherein the base bullion was desilverized by means of zinc (Parkes process).

The first ores were easily mined from shallow workings, and the only tools required were picks and shovels. As depth was attained, the square-set system of mining was generally adopted. Data on the cost of mining and smelting are shown in table 6. These costs were compiled from the annual reports of the Eureka Consolidated Mining Co. for 1871 to 1874, inclusive, and 1878. From the data available, the writer estimates that from 1869 to 1891, when the Eureka ores were smelted locally, the cost of mining and smelting averaged between $25 and $30 per ton. Although the cost of smelting decreased in the latter part of this period, this reduction was offset by the lower grade of ore mined, increased cost of mining from greater depths, and the cost of keeping the mines unwatered.

The report of the president of the Richmond Company, made to the directors in 1892,[16] summarizes the operations of the company from 1871 to 1891, and the cost of mining, smelting, transportation of bullion, and miscellaneous expenses averaged $40.50 per ton of ore treated. The ore mined by the company amounted to 465,297 tons, and the company purchased 89,578 tons of custom ore, thus smelting 554,875 tons. The product consisted of 83,183 tons of lead, 362,950 ounces of gold, and 11,022,465 ounces of silver. The gross returns amounted to $28,170,070. The value of the ore mined between 1869 and 1891 ranged between $30 and $300 per ton. It is estimated that the average value of the ore was between $50 and $60 per ton.

In 1878, T. J. Read, superintendent of the Eureka Consolidated, introduced the tribute or leasing system in the district for the purpose of recovering ore unprofitable to mine under company account. Certain portions of the mine were divided into small blocks or "pitches", and the lessees paid a royalty of 10 percent of the assay value of the gold and silver in the ore above $40 per ton. One year later this was increased to 15 percent. In 1881, the schedule of prices paid the lessees was $2.50 for ore assaying $30 per ton and 50 percent of the assay value of the gold and silver above $30 per ton. The leasing system was very successful, and it was generally adopted, so that after 1884 most of the ores were mined by lessees.

Geology

The geology of the Eureka district has been described by Hague[17] and by Curtis[18].

16/ Cited by Chance, H. M., The Silver-Lead Deposits of Eureka, Nev.: Eng. and Min. Jour., vol. 85, 1908. p. 123.

17/ Hague, Arnold, Geology of the Eureka District: Geol. Surv. Monograph 20, 1892.

18/ Curtis, J. S., Silver-Lead Deposits of Eureka, Nev.: Geol. Surv. Monograph 7, 1884.

TABLE 6. - Operating costs of Eureka Consolidated Mining Co., 1871 to 1874, inclusive, and 1878

	1871	1872	1873	1874	1878
Tons ore mined and hauled to furnaces	18,847	32,172	25,692	22,831	72,352
Total cost of mining and hauling to furnace	$104,412.19	$252,274.96	$287,459.44	$312,785.81	$477,548.99
Cost of ore at furnace, per ton.	$5.54	$7.84	$11.19	$13.70	$6.60
Tons ore smelted	18,825	31,069	26,155	22,197	71,352
Total cost of smelting ore	$370,053.68	$569,601.13	$408,527.16	$350,897.36	$824,066.53
Cost of smelting ore, per ton ..	$19.60	$18.33	$15.62	$15.81	$11.55
Total cost of mining, hauling, and smelting ore, per ton	$25.14	$26.17	$26.81	$29.51	$18.15
Tons base bullion produced	3,468	3,570	3,227	3,159	16,342
Tons of ore required to produce 1 ton base bullion	5.43	8.70	8.10	7.03	4.37
Cost of producing base bullion per ton	$135.70	$220.43	$237.36	$210.02	$79.30
Cost of marketing base bullion per ton	---	$78.00	$78.00	1/ $32.10	$75.00

1/ Prior to 1874, bullion refined at Balbach Refinery, N. J.; in 1874, bullion refined in San Francisco.

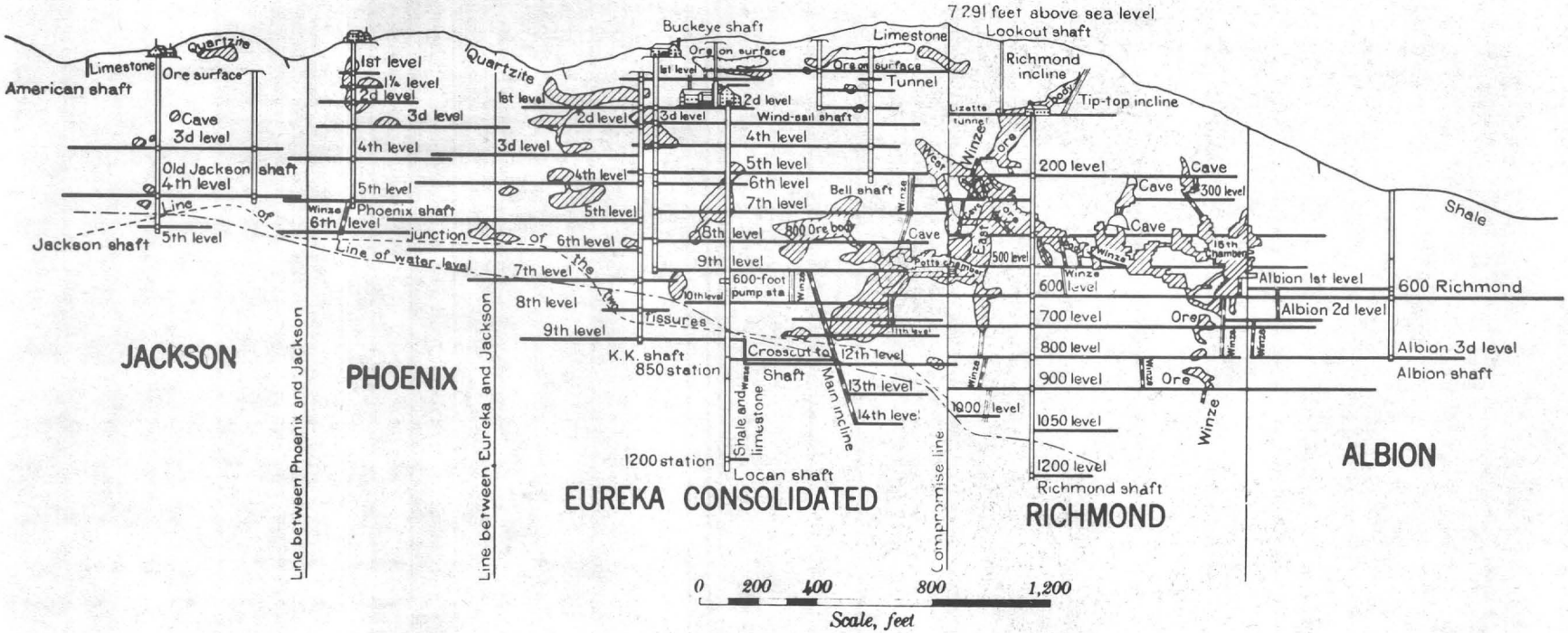

Figure 5.—Longitudinal projection through Ruby Hill mines, Eureka County, Nev. (after Curtis). (Plane of section, northwest-southeast.)

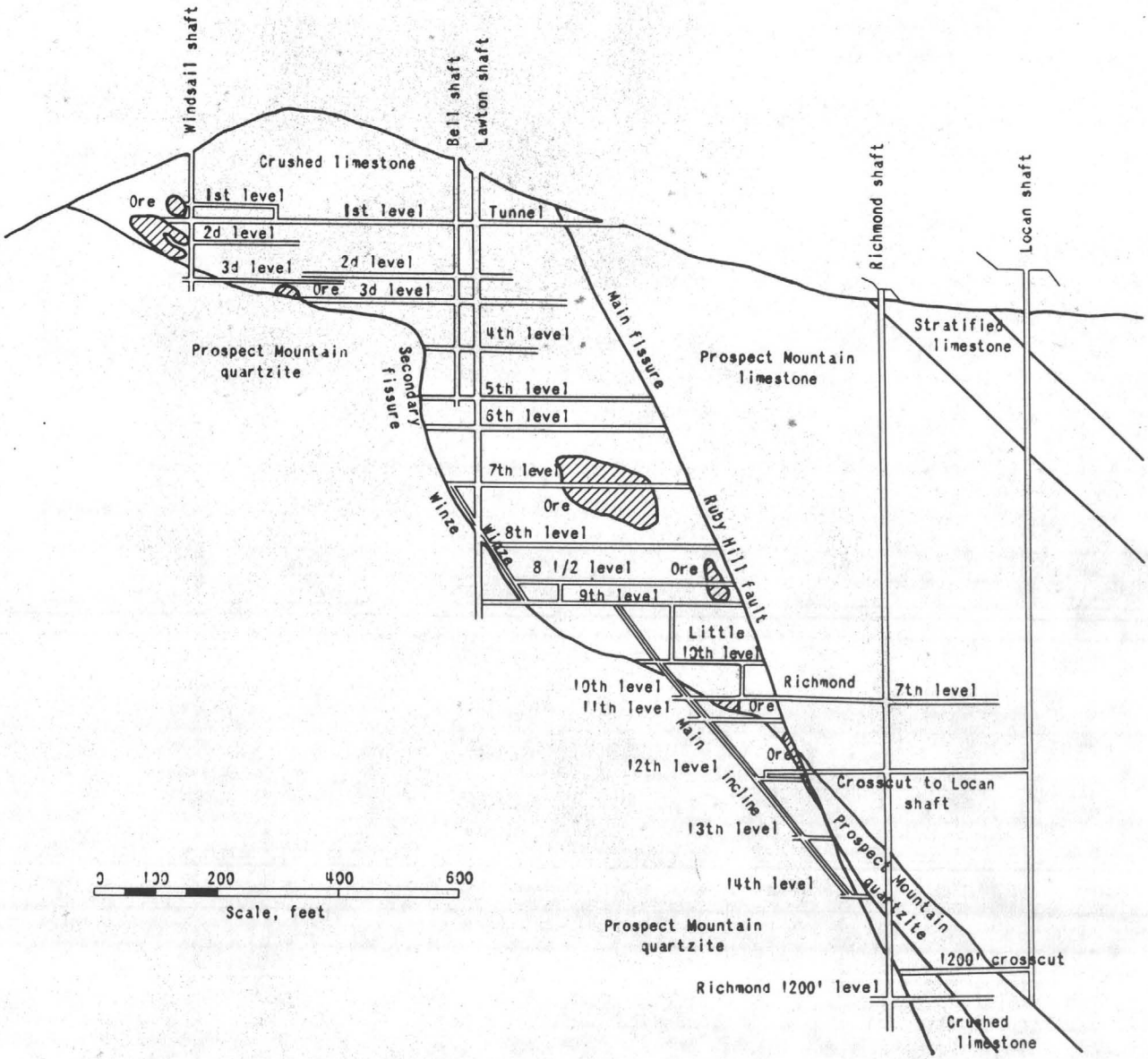

Figure 6.- Cross section through Ruby Hill, Eureka district, Eureka County, Nev. (after Curtis). (Plane of section northeast-southwest.)

The geologic section in the Eureka region is the representative section for eastern Nevada, and, according to Hague[19] and Emmons[20], is as follows:

System	Formation	Thickness (feet)
	(Upper coal measures	500
	(Weber conglomerate	2,000
Carboniferous ..	(Lower coal measures	3,800
	(Diamond Peak quartzite	3,000
	(White Pine shale	2,000
Devonian	(Nevada limestone	6,000
	(Lone Mountain limestone unconformity	1,800
Ordovician	(Eureka quartzite	500
	(Pogonip limestone	2,700
	(Dunderberg shale	350
	(Hamburg limestone	1,200
Cambrian	(Secret Canyon shale	1,600
	(Eldorado limestone	3,050
	(Prospect Mt. quartzite	1,500

Hague[21] states that the Eureka ore deposits extend through a vertical range of over 17,000 feet, but virtually all of those that have proved remunerative to the investor lie within restricted limits, chiefly in the Cambrian strata.

The distribution of the ore has been determined largely by the physical condition of the limestone; wherever the limestone is mineralized it is crushed, fissured, and faulted. The deposits are of the replacement type and include bedded deposits, chimneys, pipe veins, and large and small chambers associated with fissures. As a result of oxidation, caves have been formed above the principal ore bodies; these caves constitute one of the most marked characteristics of the district. Curtis believed that they were formed subsequent to the deposition of the ore, partly by the action of water carrying carbon dioxide and partly by the shrinkage of ore due to its oxidation. Longitudinal and cross sections through Ruby Hill are shown in figures 5 and 6.

The ores consist mainly of argentiferous carbonate of lead interspersed with nodules of galena and a large amount of ferruginous material carrying gold. As a rule the gold decreases and silver increases with the rise in the percentage of lead. The ores, for the most part, were deposited as sulphides and later oxidized by atmospheric agencies. The depth reached by oxidation is about 1,200 feet. The

---

19/ Hague, Arnold, work cited, p. 13.
20/ Emmons, William H., A Reconnaissance of Some Mining Districts in Elko, Lander, and Eureka Counties, Nev.: Geol. Surv. Bull. 408, 1910, p. 16.
21/ Hague, Arnold, work cited, p. 299.

following is an analysis (by Fred Claudet of London) of a composite sample of all the ores smelted for the Richmond Eureka Co. during 1878.

Lead oxide	35.65	(Lead	33.12)
Bismuth	--		
Copper oxide	.15	(Copper	.12)
Iron sesquioxide	34.39	(Iron	24.07)
Zinc oxide	2.37	(Zinc	1.89)
Manganese oxide	.13		
Arsenic acid	6.34	(Arsenic	4.15)
Sulphuric acid	4.18	(Sulphur	1.67)
Antimony	.25	(Antimony	.25)
Chlorine	--		
Silica	2.95		
Alumina	.64		
Lime	1.14		
Magnesia	.41		
Water and carbonic acid	10.90		
	99.50		

Silver	27.55	oz. per short ton.
Gold	1.59	" " " "

The minerals that have been observed in the Eureka ores are cerrusite, anglesite, mimetite (chloro-arsenate of lead), galena, pyrite, wulfenite, sphalerite, calamine, smithsonite, arsenopyrite, malachite, azurite, manganese, limonite, siderite, calcite, aragonite, and quartz.

Eureka Corporation, Ltd.

The Eureka Corporation, Ltd., was organized by Canadian interests in 1937 under the laws of Nova Scotia with a capitalization of 20,000 shares, no par value. The company acquired an extensive mineral acreage in the vicinity of Ruby Hill, including the Richmond-Eureka property owned by the U. S. Smelting & Refining Co., the Jackson mine, and other adjoining properties. In the latter part of 1937, diamond drilling by the E. J. Longyear Co. under contract, was in progress, and a crew of about 25 men was employed in the rehabilitation of some of the old workings on Ruby Hill. Shipments of ore from surface workings were being made to McGill and Salt Lake Valley smelters.

Eureka-Croesus Mining Co.

The Eureka-Croesus Mining Co. controls 18 patented and 16 unpatented claims on Prospect Mountain several miles from Eureka. Included in the holdings are several mines that had their greatest production in the '70s and '80s. According to the records of the county assessor, the Dunderberg and Connolly mines, now in the Eureka-Croesus group of claims, had the following net production:

Mine	Tons ore	Value
Dunderberg	51,268	$1,882,933
Connolly	4,657	166,794
Totals	55, 925	2,049,727

According to the foregoing figures, the average net value of the ore was $36 per ton.

The Eureka-Croesus Mining Co. was organized in 1917, and from 1917 to 1920 the company shipped 4,800 tons of ore having a gross value of $64.67 per ton. Since 1931, the property has been worked under lease by the Cardinelli brothers, J. A. and G. A., and T. J. Frank, who have shipped about 3,500 tons of ore ranging in value from $12 to $40 per ton.

Development consists of about 6 miles of old workings, some of which are inaccessible. The main shafts are the Catlin, 425 feet deep, and the Atlas, 800 feet deep, both vertical. In addition, there are a number of other shafts ranging from 60 to several hundred feet in depth, which were sunk chiefly by lessees.

Equipment includes a double-drum air hoist, one Ingersoll-Rand, type 10, 2-stage, compressor belt connected to a 60-horsepower, Fairbanks-Morse distillate engine, two Chicago-Pneumatic single-stage air compressors, blacksmith shop, and other mining tools.

Ore bodies occur as replacement deposits in limestone along fault fractures, where they are cut by cross-fissures. The ores are largely oxidized and carry gold, silver, and lead; arsenic is present in amounts usually less than 1 percent. The smelter returns on a shipment of ore made on June 13, 1936, to the American Smelting and Refining Co. furnished the following data.

Metal quotations:	Gold	$34.9125 per ounce
	Silver	$.77 per ounce
	Lead	4.8 less 3.725 cents per pound

		Ounce per ton
Settlement assay:	Gold	0.4
	Silver	19.0
		Percent
	Lead	7.5
	Insoluble	43.5
	Zinc	0.5
	Sulphur	2.6
	Arsenic	1.2
	Iron	16.6
	Antimony	None
	Lime	3.5

	Pounds		
Wet weight	89,980		
Moisture 5.5 percent	4,948		
Dry weight	85,032	or 42.516 tons	
Metal payment:	Gold, 100 percent at $31.81825 per ounce	$12.73	
	Silver, 95 percent at $0.77 per ounce	13.90	
	Lead, 50 percent at $0.215 per unit (20 lbs.)	.81	
		27.44	
	Treatment charge	5.22	
	Net value per ton	22.22	
	42.516 tons at $22.22		$944.71
Deductions:	Freight at $6.20 per ton		278.94
	Net proceeds		665.77

Royalty paid by the lessees is 15 percent of the value of the dump ore after freight and smelting charges are deducted.

Silver Connor Mine

The Silver Connor mine comprises 15 claims, 9 of which are patented, and 1 patented millsite, owned by J. B. McNaughton of Eureka. It is on the western slope of Prospect Mountain, 5 miles southwest of Eureka and 2 miles south of Ruby Hill. In the '80s, the property made a net production of $158,900.98 from 4,626 tons of ore, according to the records in the office of the county assessor. About 1910, it was worked by Farmer's Mining Co., controlled by Chicago interests. This company erected a 100-ton-daily-capacity cyanide plant, which was metallurgically unsuccessful. Last activity occurred about 1919, when it was worked for a time by Bulkeley Wells and associates. In the fall of 1937, John S. Baggs of Los Angeles acquired the property under a bond and lease agreement.

Development consists of Prospect Mountain adit, 3,500 feet in length, which intersects the ore zone about 1,000 feet below the collar of the Silver Connor shaft, and subsidiary workings totaling about 4 miles. The underground workings, although largely open, are inaccessible because the ladders have either been removed or are in a decayed condition. There is no water in the workings.

Equipment includes an Ingersoll-Rand compressor, size 10 by 12 inches, belt-driven by 60-horsepower Fairbanks-Morse gasoline engine, and a blacksmith shop.

The ore occurs in a series of irregular cavities or caves in limestone connected by seams and small fissures. The ore bodies have a general northwest course with a slight dip eastward and range in length from 30 to 90 feet and from 10 to 30 feet in width. Values are in gold and silver associated with arsenical compounds. The gangue is largely iron oxides, in places hard and siliceous but generally soft and ochery in character. According to a report on the property made by W. H. Stovell, formerly superintendent of the mine, at least 25,000 tons of ore are available containing an average of 0.361 ounce in gold per ton and 4.02 ounces in silver.

Geddes and Bertrand Group

The Geddes and Bertrand group of 5 claims and 2 mill sites, all patented, owned by Leo Eager, 320 Felt Bldg., Salt Lake City, Utah, is in Secret Canyon, about 14 miles by road south of Eureka. This property was worked in the '70s and '80s by the Bertrand Mining Co., controlled by English capital. From the county assessor's records it appears that this company made a net production of $629,468.40 from 32,081 tons of ore. The gross production was probably a little more than $1,000,000. The ore was probably treated by the chlorination process, as the remains of an old roasting plant are still in evidence. The mine has been inactive for many years.

Development comprises an adit 1,000 feet long and a shaft reported to be 300 feet deep. The shaft is in a caved condition. There is no usable equipment on the property.

The ore bodies occur as irregular masses of ferruginous material along east and west fractures in limestone. Several ore bodies have been stoped to the surface, and a large open stope at the end of the adit is about 100 feet long, 60 feet wide, and 50 feet high. Values are said to have been chiefly in silver. The tailings pile, estimated to contain about 40,000 tons, has been sampled, but the results are not available.

Eureka Prospect

The Eureka Prospect, formerly known as the Diamond mine, comprises a group of 20 patented claims and 4 patented mill sites, owned by the John Hays Hammond estate. In recent years the property has been operated under lease by James A Hogle, of Salt Lake City, and associates.

Development consists of a main adit about 3,000 feet long, three underground shafts, and subsidiary workings totaling 8 miles. The deepest working is 710 feet below the adit level. Property is equipped with a 240-horsepower Deisel engine, two Ingersoll-Rand Deisel operating compressors, 55-horsepower each, two air-operated hoists, blacksmith shop, assay office, camp buildings, a 50-ton cyanide plant, and other equipment.

According to the records in the county assessor's office, from 1873 to 1896 the property made a net production of $1,060,875 from 32,705 tons

of ore. In recent years the property has been a consistent producer, chiefly of shipping ore. In 1935-1936, the company did considerable testing on the ores in an effort to devise a process for treating them locally. The outgrowth of this testing was the construction of a small mill, wherein the ore was subjected to a chloridizing roast and subsequently leached with cyanide solution. After treating about 10,000 tons of ore, the mill closed down, and thereafter the ores were sent to distant smelters.

During 1937, an average of 45 men were employed by the company and the production averaged about 50 tons of ore per day. In the early part of 1938, mining on company account was suspended and the mine was turned over to lessees. The ores are shipped either to McGill smelter or to smelters in Salt Lake Valley, Utah.

The ore deposits occur in irregular masses, pipes, and caves in limestone. The caves constitute one of the marked characteristics of the ore-bearing limestone and may be of large dimension; one cave seen by the writer in the Diamond workings is roughly 401 feet high and 200 by 100 feet in plan. The lower parts of these caves are filled with rubble breccia, below which good ore is invariably found.

The ores are all oxidized and contain values in lead, silver and gold and from 1/2 to 1 percent arsenic.

Windfall Mine

The Windfall group of 10 patented claims owned by E. H. Snyder and associates of Salt Lake City, is about 5 miles southwest of Eureka on a spur of Prospect Mountain. The ground now included in this group was located and relocated by prospectors in the early days, but little more than location work had been done until 1904, when rich gold ore was discovered by Eugene Geraty. A group of claims was located by Geraty, with G. S. Greenwood and Dan Morrison as partners. From 1904 until 1908 the owners are reported to have shipped $30,000 worth of ore, and in the latter year the property was bonded to a group from Goldfield, Nev., who organized the Eureka-Windfall Mining Co. A cyanide leaching plant with a capacity of 150 tons (later increased to 200 tons) per day was erected, which operated from 1909 to 1912, and, judging from the tailings pile, a large tonnage of ore was treated.

About 5 years ago the Snyder interests started to rehabilitate the property, but operations ceased when the mine surface plant was destroyed by fire. In recent years the property has been inactive.

Development consists of a shaft, said to be 540 feet deep, and about 7,000 feet of underground workings. There is no usable equipment on the property.

The mill, erected by George L. Kaeding for the Eureka-Windfall Mining Co., probably holds the record in Nevada for low cost of installation and operation. The plant consisted of a gyratory crusher, a set of rolls (24

by 24 inches), eight leaching tanks (each 20 feet in diameter and 6 feet deep), and a 40-horsepower gas engine. The cost of the completed plant, including some road building, was less than $30,000. Only two men were required per shift, and the extraction by cyanide leaching was over 95 percent on ore ranging between $4 and $7 per ton. The operating costs were 80.4 cents per ton for the first 30,000 tons of ore milled. Later, this cost is said to have been reduced to 65 cents per ton when the plant capacity was increased. Zinc shavings were employed for precipitation. Such efficient results were due to the nature of the ore, which consisted of a soft, friable, sandy material easily crushed and leached. The ore is largely oxidized and siliceous in character. Values are chiefly in gold, with some silver and a little lead. The Windfall ore differs from the bulk of the Eureka ores in that it is amenable to cyanide treatment.

Gordon Group

The Gordon group of 1 patented and 12 unpatented claims, owned by David and Harry Morris, is on the west side of Prospect Mountain, 4-1/2 miles by road from Eureka. This property was located by Harry Morris about 30 years ago.

Development consists of 9 disconnected adits and subsidiary workings, totaling about 5,000 feet. Nearly all of this work has been done by the present owners. The only production has been a number of small lots of shipping ore having a total smelter value of about $10,000. There is no equipment on the property other than tools for hand mining.

Formations in the vicinity are shale, quartzite, and limestone. The ore is oxidized and occurs in fissures and irregular pockets in the limestone. Values are chiefly in gold and silver, with some lead. The smelter returns on a small shipment of ore made on Sept. 19, 1935, to the American Smelting, Refining & Mining Co. supply the following data:

Metal quotations:	Gold	$34.9125 per ounce
	Silver	$0.77 per ounce
	Lead	4.3 less 1.525 cents per pound

		Ounce per ton
Settlement assay:	Gold	0.425
	Silver	24.8
		Percent
	Lead	13.1
	Copper	0.125
	Insoluble	15.85
	Zinc	3.25
	Sulphur	0.7
	Arsenic	1.3
	Iron	22.2
	Antimony	3.7
	Lime	2.6

	Pounds
Wet weight, gross	9,812
Sacks, (122) weight	221
	9,591
Moisture 1.8 percent	173
Dry weight	9,418 or 4.709 tons

Metal payment:	Gold 100 percent at $31.81825 per ounce	$13.52	
	Silver 95 percent at $0.77 per ounce	18.14	
	Lead less 1.5 percent, 90 percent at $0.555 per unit (20 lbs.)	5.79	
		37.45	
	Treatment charge	3.96	
	Net value per ton	33.49	
	4.709 tons at $33.49		157.70
Deductions:	Freight at $5.00 per ton	$24.53	
	Sampling	10.00	
		34.53	34.53
	Net proceeds		123.17

Other Mines

In addition to the aforementioned mines, at least 50 others are known to have made a net production ranging from several thousand to over $800,000 prior to 1900. Some of the more important properties, with their productions, taken from the records of the county assessor, are as follows:

	Tons ore	Net value
Albion Consolidated Mining Co.	7,127	$245,305
Alexander Mining Co.	1,291	54,155
Altoona	526	30,479
Bullwacker	4,118	116,069
Banner	1,277	44,905
Bowman	1,095	51,092
California and Silver King	1,780	40,264
Eureka Tunnel	4,275	192,476
El Dorado	605	59,803
Fraser and Molino	641	26,873
Grant	627	38,913
Industry	539	40,551

	Tons ore	Net value
Idaho	1,319	$41,224
Irish Ambassador	174	29,188
Jackson Consolidated Mining Co.	24,245	834,230
King Lear	488	27,972
Lone Pine	762	26,568
Lord Byron	2,613	118,578
Marguerite	887	32,928
Metamoras	1,479	80,080
Macon City	897	73,407
Members	1,891	31,317
Mountain Boy	354	29,392
Oriental and Belmont	1,434	27,094
Prospect Mountain Tunnel	891	29,791
Paul Pry	742	29,929
Phoenix Mining Co.	4,630	134,078
Silver Lick	4,875	219,349
Williamsburg	2,936	75,112

A large proportion of the foregoing properties are controlled by absentee owners and they have been inactive for many years.

Slag and Speiss Dumps

In the vicinity of Eureka there are a number of slag and speiss dumps containing more than 1,000,000 tons of waste products from former smelting operations.

The question arises whether or not these dumps contain sufficient values to be worth re-treating under present conditions. In early-day smelting operations, the slag losses were relatively small, and this material is too low-grade to be reworked. The following analysis (by Fred Claudet of London) of slag from the Richmond furnaces for 1878 is probably representative of the slag dumps in the district:

	Percent
Silica	23.67
Iron protoxide	58.32
Alumina	1.64
Lead oxide	3.51
Metallic lead	3.26
Bismuth	None
Copper oxide	1.08
Zinc oxide	4.44
Manganese oxide	.23
Molybdenum	.32
Arsenic	.25
Antimony	None
Sulphur	2.19
Lime	4.78
Magnesia	1.27

Silver, 0.58 oz. to the ton of 2,000 pounds; gold, trace.

However, in addition to the slag product, large quantities of speiss (chiefly $FeAs_2$) formed in smelting was a source of considerable trouble to the early-day smelters, as they could not completely extract the values. An analysis (by F. Claudet, London) of the speiss from the Richmond furnaces for 1878 was as follows:

	Percent
Arsenic	32.95
Antimony	.13
Molybdenum	2.31
Sulphur	3.34
Lead	2.18
Copper	1.06
Iron	57.02
Zinc	.07
Lime	.34
Silica	.23
Silver and gold	.029

Silver, per ton of 2,000 pounds, 8.01 ozs; gold, 0.43 oz.

The speiss was formed in proportion of about 1 ton of speiss to each ton of base bullion; with a production of at least 225,000 tons of base bullion, the amount of speiss thrown on the dumps probably originally exceeded 100,000 tons. Some of the speiss was reworked, so that the metal content is less than that given in the analysis. The valuable content of the speiss probably averages 30 percent arsenic, 3 percent lead, 1 percent copper, 2 to 3 ounces in silver, and 0.15 to 0.20 ounce in gold. From 1920 to 1924, the U. S. Smelting, Refining & Mining Co. shipped to their smelter in Salt Lake Valley more than 40,000 tons of speiss. Re-treating this material depends largely on the market for arsenic, as this element constitutes the principal value.

FISH CREEK DISTRICT

The Fish Creek district is at the south end of Antelope Valley, 35 miles by automobile road southwest of Eureka. The first location was made here about 1870 by James Butler, who, 30 years later, attained fame by discovering the rich silver deposits at Tonopah. In 1881, Butler obtained patent on two claims known as the North and the South Antelope. Although considerable development work was done on these claims in the early days, the only production was a few tons of shipping ore. After the death of Butler, the two claims were held by his heirs for a number of years, but they finally reverted to the county for nonpayment of taxes and in 1933 were sold at a tax sale.

Eight miles northerly from the Antelope property, a group of claims was located in 1882 by Angelo Belli, who made several small shipments of silver ore. In 1929, the property was relocated by Stanley Fine of Eureka, who discovered scheelite on the ground. There has been no production of tungsten ore or concentrates.

Antelope Group

The Antelope group of two patented and six unpatented claims is owned by Judge Edgar Eather, Stanley Fine, and Robert C. Kelley of Eureka. Development consists of an adit 350 feet long, a raise 240 feet in length, and a number of shallow shafts, inclines, and other workings totaling about 1,000 feet. Equipment includes a blacksmith shop, a 14-kilowatt generator belt-driven by a model A Ford engine, and a small electric centrifugal pump. The pumping equipment was installed to handle a small flow of water encountered in the lower workings on the North Antelope claim. In the fall of 1937 the property was idle.

The formation is chiefly steeply dipping shaley limestone trending north and south, locally disturbed by minor folds. To the north, the limestone is intruded by granite porphyry. Two fissure veins, known as the North and the South Antelope, ranging from 1 to 5 feet in width, have been prospected. The ore is largely oxidized and contains silver, lead, and zinc. In the lower workings of both veins, bunches of massive sulphides composed of pyrite, galena, and sphalerite are beginning to appear.

Black Rock Group

The Black Rock group of five unpatented claims, owned by Stanley Fine and associates of Eureka, is on the western slope of the Fish Creek Range, 26 miles by road southwest of Eureka. Development consists of four shallow shafts ranging in depth from 10 to 60 feet, an adit 100 feet long, and other workings totaling about 400 feet. There is no equipment on the property and in recent years it has been inactive.

The prevailing formation in this area is dolomitic limestone. The vein varies in width from a few inches to a maximum of 2 feet, and it is traceable on the surface for nearly a mile. At the north end, the vein has a strike nearly east and west with a northerly dip, while at the south end the strike is N. 65° E. with a vertical dip. Scheelite occurs as scattered crystals up to 2 inches in diameter in a gangue composed chiefly of quartz and calcite stained with iron oxides and copper minerals. A little silver and lead are also present.

LYNN DISTRICT

The Lynn district is in the Tuscarora Range, 22 miles by automobile road northwest of Carlin, Nev. Placer gold was discovered here by Joe Lynn in April 1907, and in the same year the Lynn Big Six Mine, the principal lode property, was located by W. E. Barney. The following year a small, short-lived boom ensued. The Lynn Big Six Mining Co. erected a small amalgamating mill at their mine in 1917, in which a small tonnage of ore was treated. There has been a small but consistent annual production of gold from a number of small properties, and up to 1936 the total production, based on incomplete data, has been about $225,000, most of which was derived from the placer deposits. In 1937, lessees worked the Lynn Big Six mine, owned by the Beaver Crown Consolidated Mining Co. (successor to the Lynn Big Six Mining Co.).

Beaver Crown Consolidated Mining Co.

The Beaver Crown Consolidated Mining Co. owns the property formerly known as the Lynn Big Six Mine, consisting of 6 patented and 3 unpatented claims. R. M. Holt, 435 K St., Salt Lake City, is president of the company. In 1937, the property was under lease to George H. Ryan and W. D. Cronin of Salt Lake City and four men were employed. Production of shipping ore in 1935-1936 amounted to $17,000.

Development consists of the Talbot adit, 1,400 feet long; Mill adit, 800 feet long; Bull Moose adit, 700 feet long; a shaft 300 feet deep and inclined 40°, and other workings totaling about 5,000 feet. Equipment on the property consists of tools for hand mining, blacksmith shop, and several camp buildings.

The country rock in the vicinity is bedded rhyolite intruded by andesite, the latter considerably altered. The bedding planes of the rhyolite strike south 30° west and dip about 30° westerly. Values are chiefly in gold, which occurs in a free state along a shear zone in the rhyolite. Principal zone strikes N. 35° E. and dips 40° northwest. The gangue consists chiefly of silicified material and iron oxides. The richest ore is associated with bismuth. A shipment of 25 tons of ore made by Cronin on June 3, 1937, had the following analysis:

	Ounces per ton
Gold	1.16
Silver	0.15
Lead	None
Zinc	Trace
	Percent
Copper	0.1
Insoluble	59.8
Iron	20.0
Sulphur	0.1
Lime	1.7

Placer Deposits

Placer gold deposits have been worked on Lynn, Simon, Rodeo, and Sheep Creeks, which traverse this part of the Tuscarora Range. The Bulldog placer, site of the original placer discovery in this region, has been the largest and most consistent producer. The placers are generally rich but narrow, and the values are confined largely to thin layers of gravel directly above bedrock. A large proportion of the alluvium consists of medium-size subangular boulders. The gold is coarse and rough at the upper ends of the ravines, while lower down it is finer and associated with appreciable amounts of black sand. It is exceptionally pure, ranging in fineness from 920 to 960. Small amounts of bismuth oxide are associated with the placer gold, and its association with the gold in the veins indicates that the placer gold has been derived from a number of small quartz veins and stringers in the vicinity. In general, the coarseness

and roughness of the gold and the frequency with which it is found adhering to gangue material is evidence that it has not traveled far.

The placers have been worked annually since their discovery with small-scale equipment, including power rockers, sluices, and similar equipment, during the spring months when water from melting snow is available. During the summer, dry washers have been employed to some extent. A description of the various types of placer equipment used in the district is contained in a report by Vanderburg[22].

The customary royalty paid by lessees in the district is 10 percent of gross bullion returns.

Turquoise

In recent years, several turquoise claims have been located in the Lynn district on Rodeo Creek; the Black Matrix claim is owned by the American Gem Co., 2113 Delmar Ave., Wilmar, Calif., and two other claims are owned jointly by the American Gem Co. and L. A. Springer.

The turquoise of gem quality occurs in narrow seams in a sedimentary formation. Development work has been superficial in character and there is no record of any production.

MINERAL HILL DISTRICT

The Mineral Hill district is 5 miles southeast of Mineral, a station on the Eureka-Nevada Railroad. It is accessible by automobile over fair desert roads either from Palisade, a station on the Southern and Western Pacific Railroads, 35 miles north, or from Eureka, 55 miles a few degrees east of south. The district derives its name from a detached rounded hill rising to a height of about 700 feet above the subjacent Pine Valley. In 1868, rich silver float was found along the base of this hill by John Spencer, Amos Plummer, and two other men from Austin while searching the hills for a strayed horse. The float was traced to the outcrop along the crest of the hill, and a number of claims were located. The discoverers mined 80 tons of ore from the croppings, which was hauled to the Manhattan Mill at Austin and treated by the Reese River process[23]. The results were

22/ Vanderburg, W. O., Placer Mining in Nevada: University of Nevada Bull., vol. 30, no. 4, 1936, pp. 83-91.

23/ In the early-day milling of silver ores in Nevada, the process most widely used was the Washoe process, named after the Washoe (Comstock) district where it was developed. It consisted of amalgamation in pans heated by steam, using mercury, salt, and copper sulphate for reagents. Essentially it was an adaptation of the Patio process used in Mexico. Ore containing sulphur and other deleterious elements was not amenable to direct amalgamation, and such ores were given a preliminary roast to drive off the volatile elements. Salt was added during the roasting to convert the silver into chlorides, which amalgamate readily. This roasting and subsequent amalgamation constituted the Reese River process. It may be considered a modification of the Freiberg process (roasting followed by amalgamation in barrels) developed in Germany.

so encouraging that a 15-stamp mill and Stetefeldt furnace were erected. After operating several years, it was discovered that a recovery equally as good could be obtained without roasting, and in consequence the ore was subsequently treated by the Washoe process.

In 1870, the property was sold to George D. Roberts and William Lent of San Francisco for $400,000, and in 1871 Isaac C. Bateman, acting as agent, sold it for $1,200,000 to an English syndicate, which organized the Mineral Hill Silver Mining Co., Ltd. This company erected an additional 20-stamp mill, but, failing to develop a sufficient ore supply, the company failed in 1872, following which the mines were worked by the debenture holders of the property. The following extracts from a report[24] prepared by Captain Hoskins in 1872 for the Mineral Hill Silver Mining Co., Ltd. show the condition of the company's affairs at that time:

> In handing you my report on these mines, I am sorry that it does not fall to my lot to notice any decided improvement in them, although we have maintained our weekly results, and increased them to 40 tons per week, still, in the main tunnels and other points where a discovery would be of immense value, our efforts, so far, have been unavailing to meet with a continuation of the rich surface-deposits.***
>
> Queen Tunnel: This tunnel is extended south a distance of 480 feet parallel with the ridge of the hill, and right under the main ore-deposits, and is not communicated to the shaft sunk from the center of the Giant ore-chamber; in all this distance (after the first 120 feet) no trace of ore has been seen, the rock being hard, compact limestone, crossed in many points by fissures which show plainly the action of the water by the carbonate of lime crystalized on the walls, without a trace of mineral.***.
>
> Taylor Tunnel: This tunnel is being extended east by six men and is now in over 229 feet; the ground has been generally hard, but in the last 20 feet we have struck several "vughs" or small cavities, and the rock is mixed with spar, and altogether any change is hopeful, and further extension in the hill may prove something good.***.
>
> We have 60 men employed in the mines, at $4 per day, and have raised during the five months to the end of August, 589 tons of ore of an estimated grade of $71 per ton at a mine's cost, including stores and prospecting, of $35,129. The cost of prospecting in dead ground during the same period was $13,084, a large amount to come out of our very much reduced ore returns. On the question of what is best to be done in the future, my only recommendation is to keep on the Taylor tunnel as fast as possible, with the hope of meeting in depth with a channel of ground more favorable for mineral than that nearer the surface. Nothing having been done in the district deep, we have no guide to give us an idea as to what the probabilities may be of striking ore,

24/ Cited by Raymond, Rossiter W., Report on the Mineral Resources of the States and Territories West of the Rocky Mountains: (1872) Government Printing Office, 1873, pp. 152-153.

but I am sorry to say that, after a careful examination of the hill for many months, I cannot see that there is much chance of meeting ore in depth. The deposit on surface was evidently formed by water from the top, and has no connection whatever with the interior of the hill.

In 1880, the property was acquired by the Barker-Spencer Co., who were operating at the time on the south end of the hill. This company operated intermittently until 1887.

Sporadic mining operations were carried on by lessees and several small companies until 1910, when the Mineral Hill Consolidated Mining Co. was organized. In 1911, this company erected a small cyanide plant and operated until 1913, when operations were suspended. Since 1913, occasional small-scale operations have been carried on by lessees; the last activity was in 1936, when a Los Angeles group made an unsuccessful attempt to treat the tailings dump, estimated to contain about 10,000 tons.

Complete statistics on the production of the Mineral Hill district are not available. It is said to be more than $6,000,000, but this figure appears excessive when one considers the extent of the workings, value of the ore, scattered references on early-day operations, and other factors.

According to Whitehill,25/ the production from 1870 to 1876 was as follows:

Year	Production
1870	$120,000
1871	701,000
1872	590,000
1873	226,000
1874	183,000
1875	140,000
1876	125,000 (estimated)
	2,085,000

Since 1913, the production from the district, according to S. F. Stollenwerck, has been about $25,000. The writer estimates that the total production from the district has been about $2,500,000.

Early Metallurgy

The early metallurgy at Mineral Hill is of interest because better than 90 percent recoveries were obtained by the Reese River and Washoe processes then in vogue. Such recoveries were unusual and they constituted an engineering achievement at that time. The following brief descriptions of milling methods employed is taken from the rare book by Eissler,26/ who at one time was manager of the property.

25/ Whitehill, Henry R., Biennial Report of State Mineralogist, State of Nevada, 1875-1876, p. 27.

26/ Eissler, M. Metallurgy of Silver: New York, 1898, pp. 154-167.

The first mill erected in the district employed the Reese River process, a Stetefeldt furnace being used for roasting. With this process, the ore was first crushed in a Blake-type crusher, after which it was spread out to dry on a floor covered with cast-iron plates 1/2 inch thick. Under the floor was a system of flues connected with a firebox at one end and a stack at the other. The ore was raked constantly, until quite dry, after which it was fed by hand to the stamps, equipped with 40-mesh screens. Since dry-crushing was employed, drying was necessary to prevent clogging of the screens. The screen undersize was delivered by a screw conveyor to a bucket elevator, which transported it to the furnace room.

After being roasted in the Stetefeldt furnace, it was sent to the cooling floor. From the cooling floor it was trammed to the pan room, equipped with four pans and two settlers. Each pan was charged with 1,500 pounds of ore, water was added along with a dipperful of sulphuric acid and, after being stirred for several hours, 300 to 400 pounds of mercury was added to each pan along with 10 to 15 pounds of iron fillings and the pulp was stirred another 6 hours. Amalgamation in this manner resulted in a recovery of as high as 92 to 93 percent of the silver.

It was later discovered that much of the silver was present as chloride, and an extraction equally as good could be obtained without roasting; consequently, the furnace was abandoned and the ore was treated by the Washoe process at a saving of $5,000 per month in operating expenses and with treatment of ore that had previously been considered waste.

With the Washoe process, dry-crushing was also employed to prevent the loss of silver chloride, which would otherwise float away if wet-crushing were used. About 18 tons of ore were treated per day, and the bullion produced averaged 950 fine. It brought a premium at the mint, whereas the bullion from the Reese River process was penalized because of the copper content. The cost of treating the ore by the Washoe process was $12.22 per ton, which was considered efficient milling practice at that time. The tailings from the Reese River process, which have been impounded, averaged 12 ounces silver per ton; and Eissler found that after having been exposed to the weather for several years the sulphides had decomposed, making their retreatment economically feasible. The 20-stamp mill was altered to handle this material, and about 7,000 tons of tailings were treated at the rate of 48 tons per day and at a profit of $20,000. This is the first instance in Nevada of the treatment of tailings from roasted chloridized ore.

During the first 10 years the ores in the Mineral Hill district are said to have averaged, at first, 100 ounces of silver per ton, which decreased to 20 ounces per ton after careful sorting toward the end of the period. In the early days it appears that 20 ounces of silver was the economic low limit for profitable operation.

Mineral Hill Consolidated Mining Co.

The Mineral Hill Consolidated Mining Co. owns 9 patented and 1 unpatented claims covering virtually all of the old workings. The company

is incorporated in Arizona with a capitalization of 1,000,000 shares, par value $1. S. F. Stollenwerck of Palisade is principal owner. Development consists of the Queen tunnel, 700 feet long, Taylor Tunnel about 600 feet long, and other workings totaling about 2,000 feet. Nearly all the usable equipment on the property has been removed. In 1937, the property was idle. A flow of water estimated to be about 10 gallons per minute is available from Cave Canyon, about 1 mile distant. Water can also be developed in nearby Flynn Canyon.

The geology of the district has been described by Emmons.[27] A lengthy report on the property was written in 1914 by T. Poole Maynard for the Mineral Hill Consolidated Mining Co. This report is in the possession of S. F. Stollenwerck.

The prevailing rocks in the vicinity of the ore bodies are dolomitic limestone underlain by carbonaceous shale. The limestone is intruded by several narrow dikes of decomposed igneous rock. The ore occurs as irregular replacement deposits in the limestone along the fracture zone trending north and south for about 1/4 mile and several hundred feet in width. This zone is outlined on the surface by a number of open cuts ranging from 20 to 100 feet in length and 20 to 40 feet in width. The maximum depth of these stopes does not exceed 120 feet. According to Emmons the localization of the ore bodies is due to the intensity of fracturing and sheeting in the ore zone, the larger deposits having formed where there was a maximum amount of shattering. Some work has been done in the shale under the limestone, but no deposits of economic importance were discovered.

The ore bodies are thoroughly silicified and the minerals are quartz, calcite, barite, silver chloride, argentite, gray copper, galena, copper carbonates, zinc-blend, pyromorphite, cerrusite, pyrite, and iron and manganese oxides, according to Emmons. Eissler mentions polybasite and steffanite, molybdenite, and silver bromide as other minerals. Principal values are in silver and a small amount of gold. The smelter returns on a small lot of ore shipped by S. F. Stollenwerck to the United States Smelting, Refining, & Mining Co. on July 7, 1934, furnished the following data:

27/ Emmons, William H., Some Mining Camps in Elko, Lander, and Eureka Counties, Nev.: U. S. Geol. Surv. Bull. 408, 1910, pp. 96-99.

Metal quotations:	Gold	$34.9125 per ounce
	Silver	.64125 " "
		Ounce per ton
Settlement assay:	Gold	0.035
	Silver	52.0
		Percent
	Insoluble	82.8
	Iron	1.2
	Zinc	0.6

	Pounds	
Wet weight	21,540	
Moisture 0.5 percent	108	
Dry weight	21,432	or 10.716 tons

Metal payment:	Gold, 100 percent at $31.8183 per ounce	$1.11	
	Silver, 95 percent at $0.64125 per ounce	31.68	
		32.79	
	Treatment charge	4.98	
	Net value per ton	27.81	
	10.716 tons at $27.81		$298.01
Deductions:	Freight, $6.50 per ton		70.00
	Net proceeds		228.01

PALISADE DISTRICT

Palisade is a station on the Southern Pacific and Western Pacific Railroads at the north end of the Cortez Range. It is also on the Humboldt River, which cuts across the Cortez Range through a narrow, steep-walled canyon known as the Palisades.

Deposits of ashphaltite, pumice and diatomaceous earth occur in this area, but there has been no production of these minerals.

Asphaltite

Asphaltite occurs in the Pinon Range, 15 miles south of Palisade, about 4 miles east of the Yates ranch. It was discovered about 1900, and shortly after this the deposits were prospected by a number of trenches and open cuts, but no production was made. The best showings are covered by six unpatented claims owned by Stanley Fine and associates of Eureka, Nev.

According to Anderson,[28] the asphaltite is of the impsonite variety, resembling coal, except that it is very light, having a specific gravity of

28/ Anderson, R., An Occurrence of Asphaltite in Northeastern Nevada: Geol. Surv. Bull. 380, 1909, pp. 283-285.

less than 2. It occurs in a number of small fissures, striking S 75° E and dipping northerly 50° to 60° within steeply dipping sedimentary strata composed of alternating beds of shale and sandstone. The fissures are in a shear zone about 3 feet wide, and the asphaltite varies from nearly pure to that mixed with sand and clay in which asphaltite is the cementing medium. The largest fissure is 16 inches wide. Asphaltite is also present in the bedding planes of the country rock adjacent the shear zone. Occurrences are also reported 3 miles north and 7 miles south of the foregoing locality.

A test of the asphaltite was made by Prof. Walter S. Palmer at the Mackay School of Mines laboratory, Reno, Nev.; it was found that the material carried a small percentage of vanadium. The sample was crushed to 1/4-inch size and, after burning, the resultant ash comprised 2.5 percent of the weight of the original sample. The ash was separated from the impurities, chiefly rock fragments and iron oxides, by screening through a 20-mesh screen; it constituted only 0.64 percent of the weight of the original sample, but it contained virtually all of the vanadium. The assay results of the several products were as follows:

Product	Vanadium pentoxide (V_2O_5) percent
Original sample	0.16
Ash and impurities	6.4
Minus 20-mesh ash	24.8

Three samples of asphaltite were tested by the Union Assay office at Salt Lake City, Utah, with the following results:

Sample 1

Gold	Trace.
Silver	None.
Vanadium pentoxide (V_2O_5)	0.918 percent
Uranium oxide (U_3O_8)	.097 "

Sample 2

Lead	None.
Molybdenum	None.
Vanadium pentoxide (V_2O_5)	None.
Uranium oxide (U_3O_8)	None.

Sample 3

Vanadium pentoxide (V_2O_5)	0.305 percent
Uranium oxide (U_3O_8)	Trace.

Diatomaceous Earth

Diatomaceous earth occurs in the hills several miles north and northwest of Palisade. Two deposits are covered by five unpatented claims owned by Judge Edgar Eather and associates of Eureka, Nev. Very little work has been done, and no tests have been made to determine the value of the material for specific purposes. Judging from the surface showings, the deposits are extensive.

Pumicite

Beds of pumicite occur about 1 mile east of Palisade, between mileposts 527 and 528 on the main line of the Southern Pacific Railroad. The principal deposits, covered by three unpatented claims, are owned jointly by Leo Lucey of Palisade and S. T. Edwards of Winnemucca, Nev., who discovered them several years ago.

The pumicite occurs in stratified beds ranging from 8 to 30 feet in thickness and dipping, on an average, 10° to the northwest. For the most part, the beds are overlain either with detritus or volcanic ash, the latter, in places, tightly cemented. Where the pumicite is exposed, it is composed almost entirely of fine grains of silica that are slightly coherent and uniform in size and texture. Analyses made by Abbott A. Hanks, Inc., of San Francisco, indicate that the material contains 92.4 to 93.6 percent silica.

The pumicite is probably suitable for the manufacture of household cleansers, mechanics soap, or other uses where a mild abrasive is desired. The beds can be mined cheaply, and the transportation facilities are unusually favorable, since the main line of the Southern Pacific runs within a few hundred feet of the principal bed.

Iron Ore

A deposit of iron ore occurs in the east side of the Cortez Range, about 20 miles south of Palisade and 4 miles east of the Goodfellow Ranch. The deposit was discovered by Amos Plummer about 1903 and shortly after it was acquired by M. L. Requa of San Francisco, who held the ground until several years ago under the name of the Amarillo Iron Co. Property consists of seven patented claims now owned by Eureka County for delinquent taxes. Development includes an adit that is caved near the portal. Iron ore has never been produced commercially.

MOUNT HOPE DISTRICT

The Mount Hope district is on the southeast slope of Mount Hope at the south end of the Roberts Range, 23 miles by automobile road northwest of Eureka. Mount Hope station, on the Eureka-Nevada Railroad, is less than 1 mile east of the principal property in this area. Zinc ore was discovered here by charcoal burners in the '70s, but very little prospecting was done until the early '90s, when Thomas Wren, a prominent figure in early-day mining at Austin and Eureka, did considerable development work. The zinc ores could not be exploited profitably at that time, and there is no record of any production. About 4 years ago, the principal claims were prospected and purchased by the Universal Exploration Co. There was no activity in the district in 1937.

Universal Exploration Co.

The Universal Exploration Co., a subsidiary of the United States Steel Corporation, owns 13 patented claims. About 5 years ago the company acquired an option to purchase a group of claims from the Thomas Dixon estate. The ground was prospected by churn and diamond drilling in 1933 and 1934, and the results of this work were sufficiently favorable for the company to purchase the property. Additional claims were acquired by location.

Development consists of several adits, the longest about 900 feet, and other workings totaling about 3,500 feet. There is no usable equipment on the property.

Ore consists chiefly of sphalerite, a little galena, and considerable pyrite occurring as replacement deposits in a sedimentary formation. It is said that the ore contains considerable cadmium.

Morrison Group

A group of six unpatented claims owned by Louis E. Morrison, 420 Sackett Ave., Salida, Colo., adjoins the Universal Exploration Co. property on the west and the south. Development consists of three shallow shafts, the deepest of which is about 50 feet, and other surface workings, totaling in all about 200 feet. This property is in the prospect stage of development.

SAFFORD DISTRICT

The Safford district is in Safford Canyon on the west slope of the Cortez Range, about 10 miles by automobile road westerly from Palisade, Nev. The first discovery of mineral in this area was the West iron deposit, probably found by surveyors employed to map a railroad route from the Mississippi Valley to the Pacific coast.29/ This iron deposit is mentioned by geologists of the Fortieth Parallel Survey.30/

The Onondaga silver mine was discovered by Benjamin Safford, after whom the district was named, in August 1881, and the Zenoli mine by Gabriel Zenoli and Francisco Thoma in 1883. From the viewpoint of past production, the foregoing properties are the principal ones in the district. From time to time a number of other claims have been located in this area, but their development never reached beyond the prospect stage.

The production of iron ore from the West mine for use as a flux in smelting operations in Salt Lake Valley has been about 300,000 tons. The production of other metals, chiefly silver, from the Onondaga and Zenoli mines has been about $200,000. In recent years mining activity in this region has been confined to small-scale operations.

29/ Browne, J. Ross, Mineral Resources of the Pacific Slope: D. Appleton & Co., New York, 1869, p. 225.

30/ Hague, Arnold, and Emmons, S. F., Exploration of Fortieth Parallel: Vol. 2, 1877, pp. 585-586.

Zenoli Mine

The Zenoli mine was relocated in 1930 as the Morning Glory group of 9 patented claims by Nick Mondarelli and sons of Beowawe, Nev. Development comprises four adits, the longest 600 feet, a shaft 90 feet deep, and other workings, totaling 3,000 feet. The main adit is caved at a point 275 feet from the portal. There is no mining equipment on the property other than hand tools.

The prevailing formation is andesite. The main vein strikes north and south and dips to the east 20° near the surface to 45° at the adit level. A second vein (called the lead vein), in the footwall of the main vein, has a similar strike but dips eastward at a steeper angle, intersecting the main vein near the surface. The ore is in shoots ranging from 1 to 6 feet in width. The vein system is disturbed by a number of faults. Values are chiefly in silver, with subordinate amounts of copper and zinc in a gangue of quartz, calcite, and decomposed country rock. The ore in the lead vein contains considerable lead. The smelter returns on a shipment of ore made by Mondarelli on May 5, 1936, to the American Smelting & Refining Co., furnished the following data.

Metal quotations:	Gold	$34.9125 per ounce
	Silver	$.77 per ounce
	Copper	9.15 less 2.525 cents per pound

		Ounce
Settlement assay:	Gold	0.005
	Silver	21.2
	Lead	None
		Percent
	Copper	1.11
	Insoluble	55.8
	Zinc	2.0
	Sulphur	1.3
	Arsenic	0.9
	Iron	12.4
	Antimony	0.8
	Lime	2.0

	Pounds	
Wet weight	42,060	
Moisture 5 percent	2,103	
Dry weight	39,957	or 19.978 tons

Metal payment:	Silver, 95 percent at $0.77 per ounce	$15.51	
	Copper, less 0.75 percent at $1.325 per unit (20 lbs.)	.48	
		15.99	
	Treatment charge	3.50	
	Net value per ton	12.49	
	19.978 tons at $12.49		$249.53
Deductions:	Freight, at $3.50 per ton	75.51	
	Emergency freight, 7 percent	5.30	
		80.81	80.81
	Net proceeds		168.72

Onondaga Mine

The Onondaga property is several hundred yards southeast of the Zenoli mine. The principal production was made from 1881 to 1890. In 1921, the property was relocated by Charles W. Pratt of Palisade, and in 1935 a group of 12 unpatented claims, including the Onondaga mine, was taken over by Salt Lake interests under the name of the Silver Bromide Mining Co., A. E. Tourseen, secretary. In 1937, this company leased the property to H. G. Brown, P. R. Jones, and L. W. Vernom, who drove an adit about 100 feet long but made no production. Development consists of several adits, the longest 700 feet, a shaft 100 feet deep, and other workings, totaling about 2,000 feet. At the time of the writer's visit, the only equipment on the property was a small gasoline-driven compressor.

Formation is chiefly andesite. The ore occurs as shoots in two veins, the principal one striking northwest and southeast, with a steep dip to the southwest. The values are mainly in silver associated with insignificant amounts of lead, copper, and a little gold. The last shipment was made by Charles W. Pratt on September 4, 1933, to the Mammoth Smelter of the U. S. Smelting, Refining, & Mining Co., at Kennett, Calif. The smelter returns on this shipment were as follows:

Metal quotation:	Silver	$0.685 per ounce
		Ounces per ton
Settlement assay:	Silver	45.54
	Gold	0.005
		Percent
	Copper	0.6
	Silica	44.4
	Iron	19.8
	Alumina	6.0
	Lime	0.5

	Pounds	
Wet weight	38,040	
Moisture, 1 percent	380	
Dry weight	37,660	or 18.83 tons

Metal payment:	Silver, 95 percent at $0.685 less $0.03 per ounce	$28.34	
	Treatment charge	6.50	
	Net value per ton	21.84	
	18.83 tons at $21.84		$411.25
Deductions:	Freight, from Palisade $6.20 per ton		117.92
	Net proceeds		293.33

West Iron Mine

The West iron deposit in on section 7, T. 31 N., R. 51 E., M. D. M. and B., at the junction of Safford and Palisade Canyons several hundred yards south of the main lines of the Southern Pacific and Western Pacific Railroads, which pass through Palisade Canyon. It is owned by the Southern Pacific Land Co. From 1907 to 1915, the deposit was worked by the American Smelting, Refining & Mining Co. for fluxing material. After this company relinquished its lease, the property remained idle.

Former operations were confined largely to an open pit approximately 200 feet in diameter and 80 feet deep, which is now filled with water. Below the bottom of the pit is an inclined shaft 180 feet deep, from which two levels, spaced 50 feet apart vertically, have been driven. There is no usable equipment on the property.

According to Jones,[31] the iron occurs probably as a replacement deposit from 60 to 150 feet thick, dipping 40° to the north and east. The country rock is an andesite. The ore is massive and compact hematite, with probably a little magnetite, and contains minor quantities of quartz, fluorapatite, and phlogopite. The following analyses,[32] made by Prof. Walter S. Palmer of the Mackay School of Mines, indicate that the ore is of a uniformly high non-Bessemer quality.

	Upper level	Intermediate level	Lower level
	Percent	Percent	Percent
Insoluble	1.98	1.80	0.45
Ferric oxide (Fe_2O_3)	95.15	89.19	98.44
Ferrous oxide (FeO)	None	None	None
Alumina (Al_2O_3)	1.85	3.52	1.16
Cupric oxide (CuO)	0.43	1.94	Trace
Phosphorous pentoxide (P_2O_5)	Not det.	0.69	Not det.
Ignition loss	0.44	2.53	0.05
Total	99.85	99.67	100.10
Total iron (Fe)	66.54	62.37	68.84

The precious metals contained in the ore are virtually negligible.

SCHROEDER DISTRICT

The Schroeder, also known as the Maggie Creek district, is in the Independence Range, a short distance west of Maggie Canyon and 11 miles northwest of Carlin, Elko County, Nev. The first prospecting was done here in the '70s, but since no important discoveries were made it never became prominent. The Nevada Star Mining Co. operated in this area from 1906 to 1909, but only a small amount of ore was shipped. The total production of metals, chiefly gold and silver with a little lead and copper, has been obtained wholly from shipping ores produced largely by lessees; the value has been about $50,000.

31/ Jones, J. Claude, The Barth Iron Ore Deposit: Econ. Geol., vol. 8, 1913, pp. 247-263.

32/ Jones, J. Claude, work cited, p. 257.

About 1930, barite was discovered on the west ridge of Maggie Canyon, and consistent annual shipments have been made for the past 5 years by the Industrial Mineral & Chemical Co. of Berkeley, Calif.

Maggie Group

The Maggie group comprises three unpatented claims and a patented railroad section (sec. 35, T. 34 N., R. 52 E.) owned by A. H. Berning and A. R. Berg of Carlin, Nev. Gold was found on this property by Berning in 1925, and in 1936 the property was leased to the Cuba Consolidated Mines Co. This company is reported to have shipped six cars of ore in 1936. Development work consists of an open cut, an adit about 40 feet long below the open cut, and other scattered workings, totaling less than 100 feet. In the fall of 1937 the property was inactive. Equipment includes a Sullivan portable compressor, jackhammer, ore bin, and camp accomodations for several men.

The values, chiefly gold, occur in a quartzite formation sheared and stained with iron oxides. There are no pronounced structural features to determine the extent of the mineralization. Probably the ore shipped, reported to average $15 per ton, was largely concentrated mechanically. Smelter returns on a carload of ore shipped July 29, 1936, by the Cuba Consolidated Mines Co. to the American Smelting & Refining Co. furnished the following data:

Metal quotation:	Gold	$34.9125 per ounce	
		Ounce per ton	
Settlement assay:	Gold	0.417	
	Silver	.8825	
	Lead	None	
	Copper	None	
		Pounds	
Wet weight		120,720	
Moisture, 1.15 percent		1,388	
Dry weight		119,332	or 59.666 tons

Metal payment:	Gold 100 percent at $31.81825 per ounce		$13.28
	Treatment charge		3.50
	Net value per ton		9.78
	59.666 tons at $9.78		$583.53
Deductions:	Freight, $2.90 per ton	$175.04	
	Sampling	36.22	
	Assaying	6.00	
		217.26	217.26
			366.27
	Royalty, 10 percent of net smelter returns		36.63
	Net proceeds		329.64

Good Hope Group

The Good Hope group of five patented claims and a patented mill site is owned by A. H. Berning and associates of Carlin, Nev. This property was first located in the '70s and several shipments of ore were made at that time. Development consists of an inclined shaft reported to be 250 feet deep and about 100 feet of lateral workings. Only equipment on the property is a 9-horsepower, Fairbanks-Morse geared hoist.

The prevailing formations are limestone intruded by rhyolite. Values are chiefly in lead and silver with a small amount of gold. The ore occurs in bunches in a vein striking northwest-southeast, dipping 50° northeast, and varying from 3 to 6 feet in width. On the south end of this property, on the Good Hope No. 7 claim, is a vein of barite. This part of the property is under lease to the Industrial Minerals & Chemical Co., which company, in 1935 and 1936, shipped about 300 tons of barite paying a royalty of 50 cents per ton.

Barite

Barite occurs on the E. 1/2 of the E. 1/2 of the NE. 1/4 of Sec. 27, T. 34 N., R. 51 E., M. D. B. and M. This section is one of those included in the original railroad land grant and is owned by the Southern Pacific Land Co. For the past 5 years the barite deposits have been worked under lease by the Industrial Minerals & Chemical Co. of Berkeley, Calif. Development consists of three adits, the longest 700 feet. Equipment for mining comprises an Ingersoll Rand Imperial, type 14, portable compressor and several jackhammers. The barite is mined by open-stope method and it is hauled to Carlin in trucks for rail shipment to the Pacific coast.

The barite occurs in a vein striking S. 30° E. and dipping about 70° easterly. The width of the vein averages about 10 feet. Country rock is shale. The barite is massive, and relatively free from impurities but in places is stained with iron oxide. The deposit has been explored to a depth of about 75 feet.

UNION DISTRICT

The Union district is in Union Canyon in the Sulphur Range, 45 miles by automobile north of Eureka. It can also be reached by automobile from Palisade, about 35 miles north. It is sometimes considered a part of the Mineral Hill district, which is about 7 miles northwest. The first mineral discovery was made by James Lindsay in 1886. In 1887, a small smelting furnace was erected, and, from the size of the slag pile, it is estimated several hundred tons of ore were reduced. After lying idle for many years, the principal claims were acquired by the Union Mines Co. organized by William P. Fairman of Philadelphia, Pa. From 1915 to 1918, this company rehabilitated the mines, did considerable development work, and shipped 7,088 dry tons of ore having a gross value of $175,802, or an average of $24.80 per ton. This ore was hauled to the Union siding on the Eureka-Nevada Railroad by wagon team and shipped to the U. S. Smelting, Refining &

Mining Co. at Midvale, Utah. After the company suspended operations, occasional shipments of ore were made by lessees. The total production from the district has probably been a little more than $200,000.

Union Mines Co.

The Union Mines Co., owned by W. P. Fairman, 225 South 15th St., Philadelphia, Pa., and associates, comprises a group of 12 patented claims. Development consists of four vertical shafts, the depths of which are 200, 250, 300, and 550 feet, respectively. Other workings, consisting of drifts, crosscuts, winzes, and raises, comprise an additional 4,000 feet. The two main shafts, Union and Armstrong, are caved and inaccessible. No water has been encountered in the mine workings. According to W. P. Fairman,[33] approximately $242,000 has been expended by the company for equipment and the development of the property. Equipment includes two Fairbanks-Morse geared gasoline hoists, two Ingersoll-Rand compressors (9 by 8 inches), and camp accommodations for a crew of 12 men.

Prevailing rocks are limestone and quartzite. Ore occurs in irregular replacement deposits in the limestone. Values are in lead and silver. Virtually all the ore shipped was from the zone of oxidation and averaged 25 percent lead, 10 to 12 ounces silver, 10 percent lime, 15 percent iron, and the balance chiefly silica.

WILLIAMS SALT MARSH

Williams Salt Marsh is 40 miles north of Eureka in the north end of Diamond Valley, which parallels the Diamond Range on the west. In the early days, the Marsh was exploited for salt to supply the chlorination mills at Mineral Hill, Hamilton, and other districts in eastern Nevada; with the decline of the chlorination process, salt production became unimportant.

Information on the production of salt from this playa in 1871 is given by Whitehill:[34]

> The marsh contains about 1,000 acres of salt land, from which salt is obtained in incrustations on the surface and from the solution in the waters, which come within 4 feet of the top of the ground. The flat, however, which this marsh drains is 15 miles long and 6 miles wide. Salt was obtained here for a long time by gathering the incrustations, without refining, but it was not very pure. It contained only 60 percent salt. It is obtained now by evaporating the water in shallow iron pans by means of artificial heat. The pans are 10 feet long, 4 feet wide, and 10 inches deep - 22 of which are in use, producing daily 5,000 pounds, working 16 hours. The salt obtained in this manner is 95 percent pure. The waters contain about 12 percent of salt,

---

33/ Private communication.
34/ Whitehill, Henry R., Biennial Report of the State Mineralogist: State of Nevada, 1871-1872, p. 80.

one gallon yielding about 1 pound. It is worth, at the Marsh, about 2 cents per pound.

Williams Salt Marsh is one of the typical desert playas of dry lakes characteristic of the Great Basin region. In this playa the salt occurs in a small portion of the area of greatest depression as a surface incrustation not more than several inches thick. The lowest portion of the playa is saturated with brine, and the salt rises to the surface by capillary attraction so that if the salt layer is removed it is readily restored. Dessication is the normal condition, and the playa is flooded only during times of unusual humidity. The salt and other salines in the playa are derived largely from the evaporation of surface waters draining into the basin.

FUTURE OF MINING IN EUREKA COUNTY

With the present outlook, the future production of metals in Eureka County is largely dependent on further explorations in the known mineralized areas and the rehabilitation of old mines that were prominent producers in the early days. From the viewpoint of past production the outstanding district in the county has been Eureka, and when it is considered that in the palmy days ores less than $40 in value were unprofitable it is likely that considerable ore of milling grade was left behind in pillars and in stope fills. How much of this ore could be mined profitably under present conditions is a question since some of the workings are no doubt badly caved and reopening them for examination is likely to prove costly.

Although several mines in the Eureka district have been developed to a considerable extent there remain a number of properties with large unexplored areas. Past work has demonstrated that some of the deposits persist to a depth of at least 1,000 feet below the surface. Some exploration work has been done in former years to determine the possibility of the occurrence of deposits in the sulphide zone but no information is available on whether or not the results of this work were conclusive.

In conclusion it is possible that with good mining and careful management well-financed companies might be able to bring Eureka again into prominence as a producer of precious metals. The principal drawback to increased activity in the Eureka district other than by lessees is that the only outlet for the bulk of the ores is by shipping to distant smelters; the recovery of the metals in the low grade ores, largely oxidized and base in character, by a process other than smelting still awaits a satisfactory solution.

AFTER THIS REPORT HAS SERVED YOUR PURPOSE AND IF YOU HAVE NO FURTHER NEED FOR IT, PLEASE RETURN IT TO THE BUREAU OF MINES. THE USE OF THIS MAILING LABEL TO DO SO WILL BE OFFICIAL BUSINESS AND NO POSTAGE STAMPS WILL BE REQUIRED.

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES

OFFICIAL BUSINESS

RETURN PENALTY LABEL

THIS LABEL MAY BE USED ONLY FOR RETURNING OFFICIAL PUBLICATIONS. THE ADDRESS MUST NOT BE CHANGED

PENALTY FOR PRIVATE USE TO AVOID PAYMENT OF POSTAGE, $300

BUREAU OF MINES,

WASHINGTON, D. C.