I. C. 7039

December 1938

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

BUREAU OF MINES
JOHN W. FINCH, DIRECTOR

INFORMATION CIRCULAR

GOLD MINING AND MILLING IN IDAHO COUNTY, IDAHO

BY

S. H. LORAIN

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By S. H. Lorain[2]

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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 7039."

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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 production, operating costs, grades of ore treated, wage scales, haulage and trucking rates, power costs, and smelting charges, 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 paper, which describes lode gold mining in Idaho county, Idaho, is one of a series on western mining districts being published by the Bureau of Mines. It describes mining and milling practices, gives costs, and discusses transportation, climate, power, labor, and other conditions that affect them. The material upon which the paper was based was gathered during a field survey in the summer of 1937.

Idaho County has long been one of the most important placer gold-mining regions of Idaho. Although some lode mining has been in progress for nearly 70 years, the total production from lode mines has been small in comparison with the output from placer mines. Building of roads and the higher price of gold have been responsible for greatly increased activity in the county; lode mining will likely continue to increase as transportation facilities are improved and as the geology of the region is more thoroughly understood.

ACKNOWLEDGMENTS

The author wishes to thank the operators and mine owners of the region for their cooperation in supplying all available information and for freely permitting access to their mines and mills.

During preparation of the paper, frequent reference was made to earlier writings on the region and to various other sources of information, which are acknowledged in the text.

LOCATION

Idaho County (fig. 1), in north-central Idaho, has an area of 8,539 square miles. Most of it lies between latitudes 45° N. and 46° 30' N., and between longitudes 114° 30' W. and 116° 30' W. Grangeville,[3] the county seat and largest town, is on U. S. Highway 95, 79 miles by road southeast of Lewiston, Idaho, and 210 miles by road north of Boise, Idaho.

HISTORY OF LODE MINING

Gold was first discovered in Idaho County early in 1861 by a party of men from the newly discovered placer diggings near Orofino in Clearwater County. This party penetrated the then unknown regions of the South Fork of the Clearwater and discovered placer gold near the present site of Elk City. Discoveries of the placer deposits near Florence, Newsome, Dixie, Warren, and other places followed in quick succession. Most of these camps yielded large returns in placer gold, but it does not appear that much attention was paid to lode mining until the richest placers had been exhausted.

Apparently the small but rich veins at Warren were the first to attract serious attention. Lindgren[4] mentions that, in 1869, the Rescue and other lode mines at Warren produced $35,000. These mines have continued to produce intermittently, in a small way, up to the present time.

3/ Population 1,360 by 1930 census.

4/ Lindgren, Waldemar, The Gold and Silver Veins of the Silver City, De Lamar, and Other Districts in Idaho: 20th Ann. Rept., Geol. Survey, 1899, part III, p. 238.

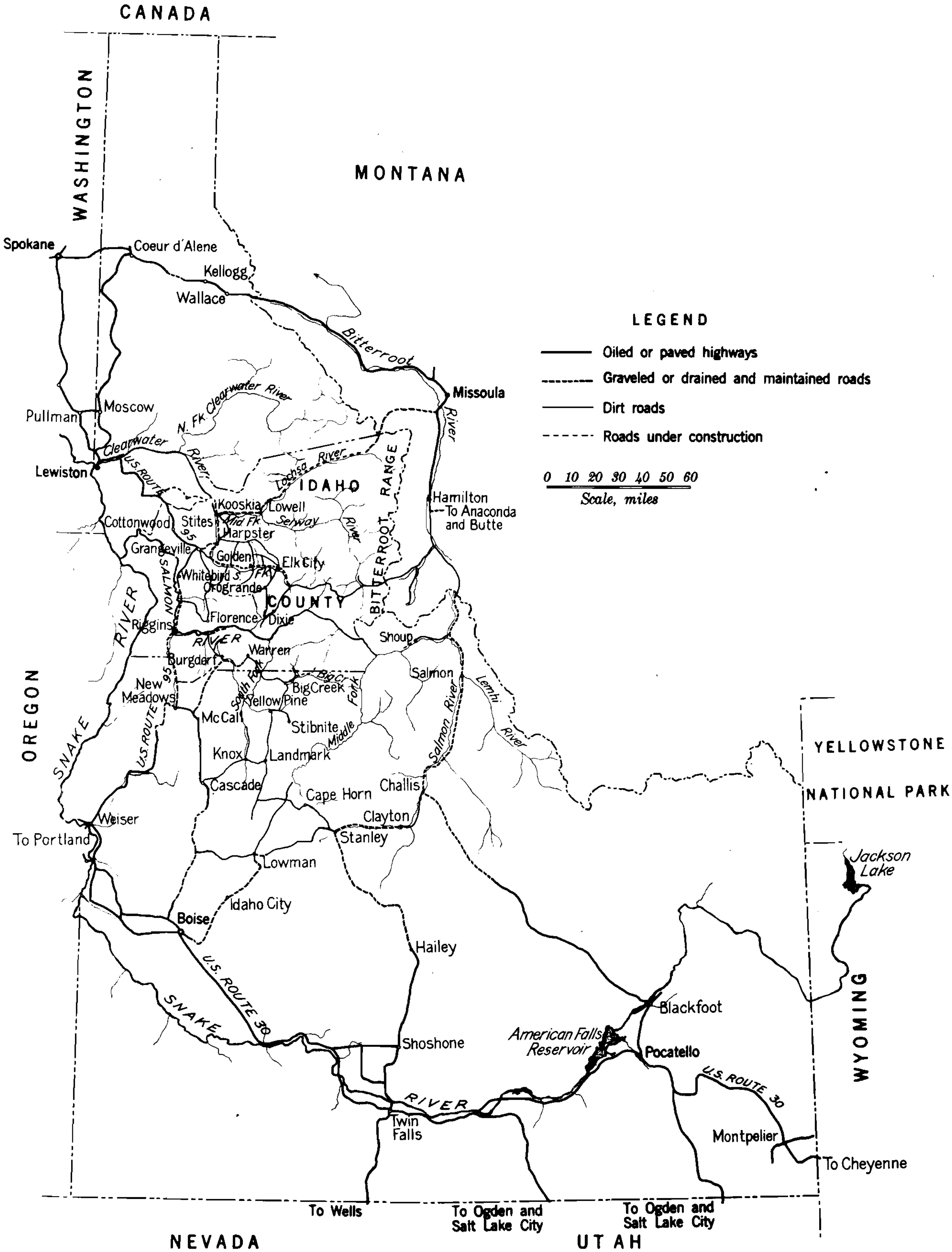


Figure 1.—Key map, Idaho County, Idaho, showing road connections with adjoining territory.

Serious lode mining appears to have begun at Elk City with the discovery of the Buster mine in 1884 and at Dixie with the discovery of the Dillinger, North Star, and South Star veins in 1891. The first great impetus to central Idaho lode mining was, however, given by the Thunder Mountain (Valley County) discoveries in 1896 and the Buffalo Hump discoveries in 1898. Both of these discoveries resulted in feverish lode-mining activity, which lasted for several years and inspired an intense search for other lode deposits throughout the region; before this excitement subsided, the mineralized areas of central Idaho had probably all been outlined by lode discoveries. This does not mean that the region was exhaustively prospected at this time, as is evidenced by the fact that two of the most profitable lode mines in the county were not discovered until many years later and that promising discoveries are still being made.

The collapse of the Thunder Mountain and Buffalo Hump booms was followed by a gradual recession in lode mining; this recession reached its low in 1920, when the recorded lode production of the entire county was less than $700. From 1920 to 1930 lode mining in Idaho County was nearly quiescent.

From the early days until recently, lode mining in Idaho County has been handicapped seriously by poor transportation facilities and short operating seasons. Furthermore, the high-grade veins so far discovered have been small and the large ore deposits very low-grade. Consequently, the development and operation of lode deposits proceeded spasmodically, often under incompetent management, which was unable or unwilling to perceive the frequently insurmountable obstacles that had to be overcome. The economic impossibility of shipping the crude ore of the region resulted in an aggravation of the universal tendency of inexperienced operators to build mills before blocking out adequate ore reserves; this undoubtedly contributed very materially to the number of failures. At present the region is dotted with mills in all stages of dilapidation.

Since the early 1930's, greatly improved transportation, higher gold prices, and better management have permitted a highly successful exploitation of several small mines and the entry of one company into the large-tonnage, low-grade field. Two nationally known mining companies are operating small producing mines in the region.

The road-construction program, begun early in the depression, is continuing with little, if any, abatement, and there is every reason to believe that the resulting improvement in transportation conditions will permit greater development and encourage more intensive prospecting for some time to come.

PRODUCTION

Dependable figures on the early gold production of Idaho County are not available. It has been estimated that the total production of both lode and placer mines prior to 1900 was probably somewhere between $40,000,000 and $60,000,000[5]; there seems to be little question but that at least 95 percent of this was derived from placer gold.

An examination of Lindgren's figures on the early production of the Warren district[6] indicates a yearly production from lode mines in the 1880's of from $10,000 to $18,000. Checking this against the total production claimed for the most productive mines of the district shows that the total lode production of the district prior to 1900 can scarcely have been more than $500,000.

The most optimistic claims for the Buffalo Hump district place the production at $1,000,000; more conservative estimates are about half this figure. Most of the lode production from the Elk City, Golden, Orogrande, Burgdorf, and other districts has been obtained in later years. It therefore seems doubtful if the lode production of Idaho County prior to 1900 was much, if any, in excess of $2,000,000.

Table 1, showing lode production of Idaho County since 1904, was compiled from Mineral Resources of the United States, published by the Geological Survey, and its successor, Minerals Yearbook, published by the Bureau of Mines. The table was verified and corrected by Thos. H. Miller of the Economics and Statistics Branch of the Bureau of Mines.

5/ Lorain, S. H., and Metzger, O. H., A Reconnaissance of Placer Mining Districts in Idaho County, Idaho: Inf. Circ. 7023, Bureau of Mines, 1938, 93 pp.

6/ Lindgren, Waldemar (see footnote 3).

TABLE 1. - Lode production statistics, Idaho County, Idaho.

Year	Number of producing mines	Tons mined	Tons milled	Tons of concentrate produced	Tons of crude ore shipped	Bullion recovery, ounces: By amalgamation		Bullion recovery, ounces: By Cyanidation	
						Gold	Silver	Gold	Silver
1904	10	36,367	36,367	750	-	9,184	6,331	989	-
1905	15	28,181	28,181	238	-	7,276	4,905	280	-
1906	12	18,130	18,130	55	-	4,395	8,332	-	-
1907	17	13,427	13,419	45	8	3,242	1,656	-	-
1908	17	15,778	15,773	395	5	5,506	1,653	-	-
1909	17	25,765	25,765	292	-	5,893	1,089	-	-
1910	20	6,351	6,351	68	-	1,834	535	-	-
1911	24	7,147	7,125	1	22	2,696	941	-	-
1912	18	4,948	4,883	11	65	2,641	687	-	-
1913	32	2,656	2,552	48	104	905	292	9	1
1914	31	4,319	4,240	7	79	755	217	272	108
1915	32	4,155	4,097	22	58	2,794	1,027	217	48
1916	27	6,748	6,725	15	23	4,994	2,125	-	-
1917	24	11,351	11,154	3	197	9,594	4,687	10	1
1918	22	15,567	15,566	1	1	3,459	1,549	279	2,759
1919	9	1,084	1,029	-	55	275	139	65	306
1920	2	34	34	-	-	32	14	-	-
1921	2	600	600	-	-	522	278	-	-
1922	9	487	487	-	-	555	392	-	-
1923	8	621	621	-	-	752	510	-	-
1924	7	2,429	2,429	-	-	1,559	1,005	3	-
1925	8	1,792	1,785	-	6	1,095	754	-	-
1926	5	342	342	-	-	210	140	-	-
1927	9	650	650	-	-	274	176	-	-
1928	8	1,671	1,654	-	7	1,313	793	-	-
1929	6	2,898	2,898	14	-	1,929	1,091	-	-
1930	14	8,293	8,263	24	30	3,343	1,648	-	-
1931	23	2,435	2,345	23	90	1,201	545	-	-
1932	33	8,104	8,060	49	44	3,041	1,315	534	183
1933	38	13,533	13,461	40	72	3,728	1,461	4,030	973
1934	52	27,495	27,397	61	98	3,355	1,440	2,705	1,855
1935	46	71,013	70,883	106	125	4,151	1,803	2,294	1,097
1936	50	121,053	120,978	95	75	8,187	4,042	4,933	2,324
1937	58	97,034	96,894	231	140	7,119	3,394	2,890	1,757
Totals	-	562,458	561,154	2,594	1,304	107,910	56,966	19,510	11,412

TABLE 1. - Lode production statistics, Idaho County, Idaho. (Continued)

Year	Recovery from concentrates				Recovery from crude ore				Total average value per ton	Total value
	Gould, ounces	Silver, ounces	Copper, pounds	Lead, pounds	Gold, ounces	Silver, ounces	Copper, pounds	Lead pounds		
1904	1,524	400	-	-	-	-	-	-	$ 6.75	$ 245,651
1905	698	-	-	-	-	-	-	-	6.16	173,588
1906	508	-	-	-	-	-	-	-	5.90	106,927
1907	146	75	-	-	5	55	3,043	-	5.36	71,935
1908	1,758	6,050	-	-	5	1,865	233	-	9.85	155,356
1909	2,653	6,066	-	-		-	-	-	7.00	180,393
1910	368	1,053	-	-	-	-	-	-	7.30	46,375
1911	4	188	-	-	11	34	312	-	7.93	56,686
1912	29	77	-	82	60	24	-	-	11.50	56,901
1913	223	212	-	-	17	1,403	36,831	-	11.56	30,702
1914	27	36	78	-	78	511	6,379	-	5.73	24,747
1915	147	116	-	64	183	1,779	1,284	11,337	17.17	71,332
1916	148	61	-	-	80	120	739	-	16.25	109,648
1917	20	140	-	-	75	93	7,132	-	18.19	206,497
1918	-	318	-	-	-	319	-	-	5.28	82,210
1919	-	-	-	-	54	83	867	-	8.20	8,891
1920	-	-	-	-	-	-	-	-	19.76	672
1921	-	-	-	-	-	-	-	-	18.45	11,070
1922	-	-	-	-	-	-	-	-	28.59	13,922
1923	-	-	-	-	-	-	-	-	25.72	15,973
1924	-	-	-	-	-	-	-	-	13.57	32,961
1925	-	-	-	-	62	4	-	-	13.65	24,463
1926	-	-	-	-	-	-	-	-	12.95	4,430
1927	-	-	-	-	-	-	-	-	8.86	5,759
1928	-	-	-	-	21	19	-	-	16.78	28,047
1929	105	2,134	75	584	-	-	-	-	15.12	43,829
1930	279	7,577	182	795	11	25	1,113	-	9.51	78,865
1931	174	2,930	713	77	120	320	283	-	14.66	35,703
1932	928	5,635	2,301	8,500	52	87	32	-	11.92	96,636
1933	302	562	437	1,812	118	164	125	403	12.64	171,109
1934	563	3,630	1,114	2,872	193	280	136	398	8.85	243,275
1935	1,590	7,438	1,048	6,125	218	357	24	225	4.18	296,906
1936	2,424	17,443	1,283	7,074	112	213	130	122	4.68	567,040
1937	2,451	26,860	13,406	6,966	236	965	90	-	4.86	471,911
Totals	17,069	89,001	20,637	34,951	1,711	8,720	58,753	12,485	6.70	3,770,410

Summary and Analysis of Idaho County Lode Production Statistics, 1904 to 1937, Inclusive

Total gold production	ounces	146,200
Total silver production	do.	166,099
Total copper production	pounds	61,390
Total lead production	do.	47,436

	Gold, ounces	Silver, ounces	Copper, pounds	Lead, pounds
Average metal recovery per ton from all ore mined	0.26	0.295	0.11	0.084
Average metal recovery per ton from concentrates	6.58	34.31	1.02	13.47
Average metal recovery per ton from crude ore shipments	1.31	6.69	45.05	9.57
	Gold	Silver	Copper	Lead
Percentage of metals recovered by:				
Amalgamation	74	34	--	--
Cyanidation	13	7	--	--
Concentration	12	54	4	74
Direct smelting	1	5	96	26

TOPOGRAPHY[7]

With the exception of a comparatively small area of rolling farm land in the northwestern corner of the county near Grangeville, the region is rugged and mountainous throughout. There are, however, no well-defined mountain ranges; the region may best be described as a deeply dissected plateau. Most of the upland area is from 4,000 to 7,000 feet above sea level; the higher ridges are about 8,000 feet above sea level, and a few peaks reach an elevation of over 9,000 feet. The upland area is characterized by a mature topography and by U-shaped valleys suggestive of glacial action; these valleys are occupied by the smaller streams and the headwaters of the larger streams. The rivers and some of the larger creeks occupy deep, steep-walled canyons that are eroded down to from 3,000 to 1,400 feet above sea level.

The most striking topographic feature of the region is the Salmon River Canyon, which cuts from east to west across the southern part of the county, then turns abruptly northward, and crosses the county from south to north. This canyon is between 4,000 and 5,000 feet deep and has formed an effective barrier to cross-country travel. Other rivers whose canyons cut deeply into the region are the Selway, Lochsa, South Fork of the Salmon, and South Fork of the Clearwater; the Middle Fork of the Salmon forms part of the eastern boundary of the county.

7/ Lorain, S. H., and Metzger, O. H. (see footnote 5).

CLIMATE AND VEGETATION[8]

The lower parts of the deep canyons are characterized by mild winters and excessively hot summers; rainfall is light and vegetation sparse. Water for irrigation is easily obtained, however, and luxuriant truck gardens may be cultivated on the river bars and lower bench land.

The higher parts of the canyon walls and all of the upland area are within the Nez Perce, Idaho, Bitterroot, or Lolo National Forests and is well timbered with Pondorosa pine, Douglas fir, Engleman spruce, tamarack, and lodge-pole pine. The climate at these higher altitudes is cool in summer and cold in winter. Frost or an occasional light snowfall may occur in any of the summer months; the winter snows begin to pile up in November and remain on the ground until May or late June, depending on the elevation.

Weather statistics in the mining districts are not available; the following tables of weather statistics in the larger towns will, however, give some idea of general weather conditions in the surrounding country.

Precipitation[9], [10]

Town Elevation...	Grangeville 3,323		Riggins 1,685		Warren 5,352
Month	Precipitation, inches[1]	Snowfall, inches[2]	Precipitation, inches[1]	Snowfall, inches[3]	Precipitation inches[4]
January.....	2.15	15.8	1.22	4.2	2.45
February....	1.65	10.7	1.36	5.5	2.35
March.......	2.52	11.5	1.43	1.9	2.01
April.......	2.55	4.7	1.55	0.4	1.80
May.........	3.50	1.5	2.13	0	2.01
June........	3.10	T	1.54	0	1.92
July........	.85	0	.47	0	.79
August......	1.09	0	.63	0	1.22
September...	2.07	.1	1.03	0	1.54
October.....	2.34	1.4	1.11	0	1.32
November....	2.13	5.5	1.21	1.1	2.27
December....	1.82	10.6	1.48	2.3	2.93
	25.77	61.8	15.16	15.4	22.61

1/ Average of 20 years observation.
2/ Average of 16 years observation.
3/ Average of 10 years observation.
4/ Average of 12 years observation.

8/ Lorain, S. H., and Metzger, O. H. (see footnote 5).
9/ Official records, United States Weather Bureau.
10/ Work cited (see footnote 5).

Temperatures 11/, 12/

Month	Grangeville (11-year average)				Riggins (15-year average)			
	Mean maximum	Mean minimum	Highest	Lowest	Mean maximum	Mean minimum	Highest	Lowest
January........	34.6	20.3	55	-22	41.9	27.3	61	-3
February.......	39.2	23.3	62	-20	46.7	29.4	69	-12
March..........	44.8	28.0	68	-5	52.8	32.6	76	3
April..........	53.3	34.3	82	21	63.2	37.6	90	23
May............	60.6	40.3	96	28	69.8	42.8	98	28
June...........	68.4	45.7	93	32	76.6	47.2	104	31
July...........	81.5	52.2	104	39	89.0	52.6	107	39
August.........	83.1	51.7	102	37	87.6	52.0	110	40
September......	67.3	42.4	95	27	75.4	45.1	95	28
October........	57.3	36.1	81	13	65.2	38.8	88	22
November.......	46.2	28.0	70	-11	51.1	32.9	77	-13
December.......	37.9	22.8	58	-17	42.6	28.6	63	0
Year...........	56.2	35.4	104	-22	63.5	38.9	110	-13

11/ Official records, United States Weather Bureau.
12/ Work cited (see footnote 5).

The following table lists the monthly snow-stake readings as recorded by the United States Forest Service at three points in the mountains of Idaho County. The Ranger stations at which these observations were taken are all within a few hundred feet, one way or the other, of being 5,000 feet above sea level. Readings are in inches of snow actually on the ground.

Station	Adams						Dixie	Red River
Year.............	1930	1931	1932	1933	1934	1935	1936	1936
Month								
January..........	12	34	42	36	19	30	42	17
February.........	24	25	60	60	19	25	55	54
March............	24	35	60	61	29	36	66	29
April............	24	38	63	54	2	42	56	36
May..............	0	0	30	24	0	15	12	0
October..........	0	0	0	0	0	1/ 0	0	0
November.........	0	4	5	1/ 2	0	1/ 6	1	0
December.........	14	42	15	12	10	1/ 10	18	12

1/ Average of Dixie ranger station and Red River ranger station.

Water and timber for mining purposes

As indicated in the preceeding paragraphs, there is an abundant water supply throughout the region; the entire area is covered by a network of permanent streams, many of which are potential sources of water power (see fig. 2).

Although much of the timber is small, and areas on the steeper mountain slopes and in the lower parts of the Salmon River Canyon are barren of trees, good mining timber is abundant on the gentler slopes and in the more sheltered valleys even at high elevations. Relatively large commercial sawmills are in operation in the largest towns, and there are a few smaller mills in the outlying districts. Rough sawed lumber, suitable for mining purposes, may be obtained from these mills at from $22 to $28 a thousand board feet, delivered, depending on the cost of transportation from mill to mine. At most places in the region it is possible to cut and saw timber at the mines. Some detailed costs of wood supply and sawmill operation at an isolated mining operation are given under the description of the Golden Anchor mine on page 59.

TRANSPORTATION

General discussion

Until recently, the mining districts of Idaho County have been handicapped by lack of roads. Roads from the mining settlements to the railheads at Stites, Grangeville, McCall, or Cascade were little more than wagon trails through the mountains, although some of them could be traversed by automobile during the summer months; in winter the region was almost entirely isolated. Most of the mines were connected with the settlements by pack trails only.

An excellent dirt and gravel forest highway now follows the valley of the South Fork of the Clearwater from Grangeville to Elk City, Red River ranger station, Red River Hot Springs, and thence over the Bitterroot Mountains to Hamilton, Mont. For some time this road has been kept open for winter travel between Grangeville and Elk City, a 2-hour drive by passenger car; in 1937-38 it was kept open to Red River ranger station. Good mountain roads connect the highway with Dixie, Orogrande, and many other points in the area, as shown in figure 2. Since the construction and improvement of the main forest roads, private operators have built a number of short roads to individual mines.

Burgdorf and Warren may be reached over a good forest highway from McCall, or from Riggins by way of French Creek. As is the case north of the Salmon, secondary roads have been built to most of the important mines and mining districts.

The Ramey Ridge district is usually approached from Cascade by way of Big Creek post office, although it may also be reached from Warren over Elk Summit.

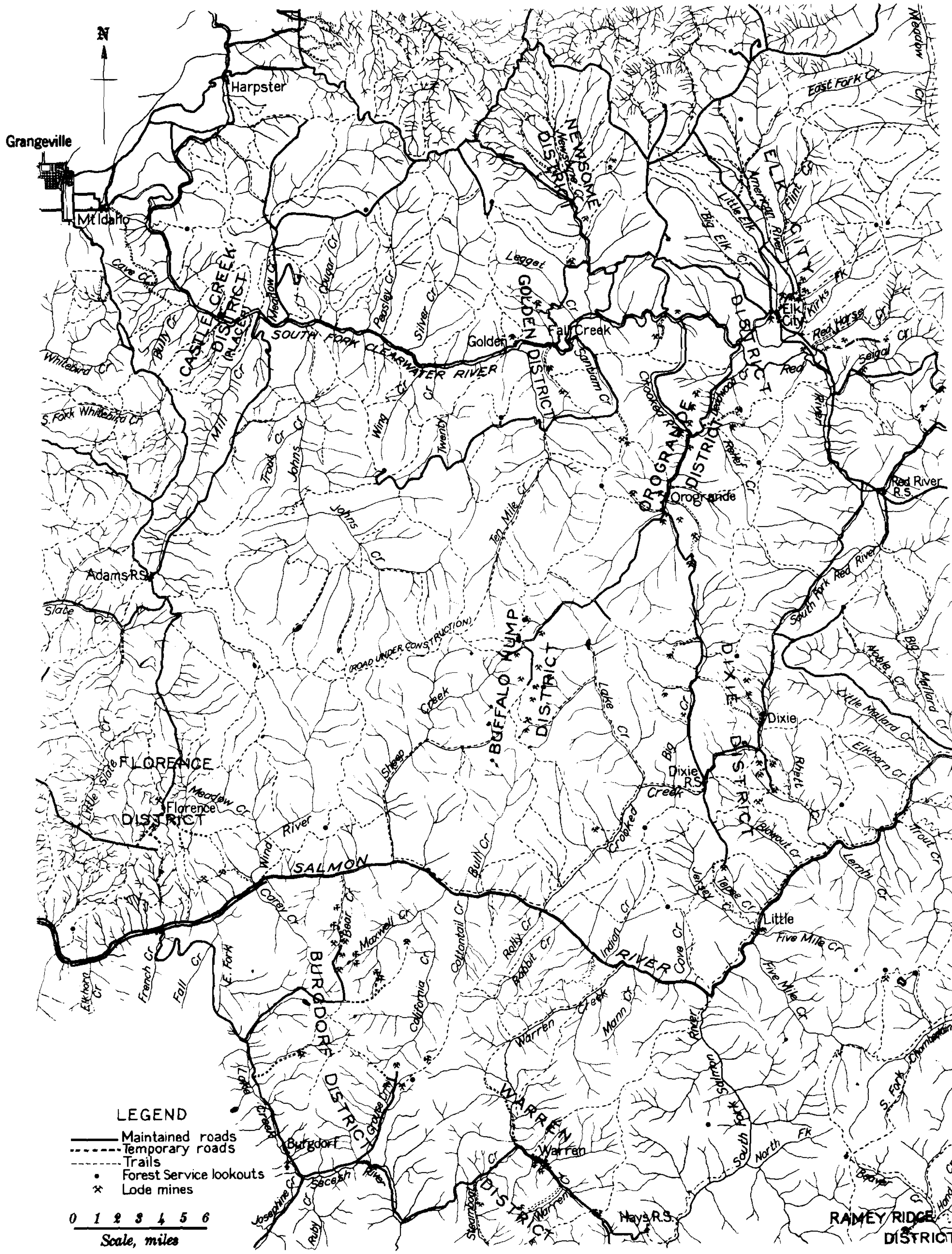


Figure 2.—Gold belt, Idaho County, Idaho, showing roads, trails, and mining districts.

United States Highway 95 (see fig. 1) is kept open for winter travel, but, with the exception of the Grangeville-Elk City and Grangeville-Orogrande roads, the mining districts are closed to wheeled motor transport during the winter months. Supplies and passengers, however, are transported to the principal settlements by tractor-drawn sleds throughout the winter. The roads are usually closed to automobile travel sometime during November, although on some roads travel frequently continues until late in December. Automobile travel usually is resumed sometime during May or June, depending on the elevation of the road.

At present there is no route of travel across or along the Salmon River except on Highway 95. However, a highway is under construction from Riggins to Salmon City along the bottom of the Salmon River Canyon. In 1937, this road had been built to the eastward about 4 miles east of the mouth of French Creek and was entering the heart of the Idaho County mining districts. From Salmon City, the road had been built westward to below Shoup but, at the present rate of construction, will not reach the mining districts of Idaho County for a number of years. This road will be open for travel throughout the year, and the building of feeder roads from the upland areas down tributary valleys will permit north-south travel across the Salmon and afford quicker and easier access to most of the mining districts. This shortening of the routes of approach to many mining districts will also materially lengthen the travel season and in many cases will permit the roads to be kept open for all-year travel at comparatively small expense.

The railhead for districts north of the Salmon is now at Grangeville; for districts south of the Salmon at McCall or Cascade. All of these towns are served by the Union Pacific Railroad Co. There is no railroad connection between Grangeville and McCall; consequently, freight is shipped south from Spokane or Lewiston to Grangeville and north from Boise to Cascade or McCall. The rail distance from Lewiston to Grangeville is 77 miles; from Boise to McCall, 148 miles.

RAILROAD FREIGHT RATES

The following rates on ores and concentrates were quoted in April 1938 by courtesy of the Union Pacific Railroad Co. with the understanding that they are subject to revision at any time.

Grangeville, Idaho, to Bradley, Idaho (Bunker Hill and Sullivan smelter). Rates quoted are on minimum carloads of 40,000 pounds.

			Rate per ton
Value not exceeding	$25.00	per ton............	$5.64
Do.	35.00	do.	5.98
Do.	50.00	do.	6.67
Do.	75.00	do.	7.70
Do.	100.00	do.	8.53

On ore and concentrates exceeding $100 per ton in value, the rates will be determined by adding 20 percent for each $50 per ton increase in valuation about $100 per ton to the rates provided for an ore or concentrates of $100 per ton valuation.

Rates to Salt Lake City, Utah

From -	Value not to exceed -									Minimum
	$20	$30	$40	$50	$60	$70	$80	$90	$100	carload
Cascade....	3.52	4.29	5.06	5.83	6.60	7.37	8.14	----	----	60,000
	4.95	5.50	6.05	6.60	7.15	7.70	8.25	8.80	9.35	40,000
McCall.....	3.52	4.29	5.06	5.83	6.60	7.27	8.14	8.91	9.68	60,000
	5.50	6.05	6.60	7.15	7.70	8.25	8.80	9.35	9.90	40,000

When value exceeds $100 per ton, apply the following percentages of rates applying on ore and concentrate of $100 per ton in value.

					Percent
Value over	$100 per ton,	but not over	$125	per ton...........	109
Do.	125	do.	150	do.	118
Do.	150	do.	175	do.	127
Do.	175	do.	200	do.	135
Do.	200	do.	225	do.	144
Do.	225	do.	250	do.	153
Do.	250	do.	275	do.	162
Do.	275	do.	300	do.	170
Do.	300	do.	350	do.	185
Do.	350	do.	400	do.	200
Do.	400	do.	450	do.	215
Do.	450	do.	500	do.	225

For value in excess of $500, the rate will be made by adding the following to the rate of $500 valuation:

Value over $500 and under $1,000 per ton, add 2 percent of valuation above $500 per ton.
Value over $1,000 and under $1,500 per ton, add 3 percent of valuation above $500 per ton.
Value over $1,500 and under $2,000 per ton, add 4 percent of valuation above $500 per ton.
Value $2,000 and over, add 5 percent of valuation above $500 per ton.

TRUCKING RATES

Freight is trucked into the region north of the Salmon from Grangeville; it is trucked into all but one of the Idaho County districts south of the Salmon, from McCall. The Ramey Ridge district and other territory tributary to Big Creek Post Office gets its freight by way of Cascade. A large portion of the supplies brought into the region is hauled by truck directly from the larger supply centers; most of the concentrate shipped out is trucked to the smelters.

Because of the relatively small freight shipments in or out of central Idaho, rates are not yet well established and tend to vary considerably for hauls of the same length. The following table presents some of the rates paid in the summer of 1937; for the most part these apply chiefly to small or irregular shipments. Where the rate is given in dollars per 100 pounds, it applies to irregular shipments of supplies, usually in less than truck-load lots; when given in dollars per ton, it applies to shipment of heavy freight, such as concentrates.

Between -		Distance, miles	Rate	Rate per ton-mile
Elk City	and Grangeville...	61	$0.40 hundredweight	$0.13
	Lewiston......	138	.70.......do.....	.10
	Spokane.......	253	1.10.......do.....	.087
Dixie	and Elk City......	28	.35.......do.....	.25
	Kellog, Idaho.	237	1/8.50 ton..........	.025
Orogrande	and Grangeville...	66	.50 hundredweight	.15
	Kellog, Idaho.	314	14.00 ton..........	.045
Marshall	and McCall........	48	5.00 ton..........	.10
Lake mining	Do............	48	.50 hundredweight	.21
district 2/	Boise.........	158	10.00 ton..........	.063
or Warren	Do............	158	.90 hundredweight	.112
	Salt Lake City, Utah....	545	26.00 ton..........	.048
Big Creek	and Cascade.......	83	.70 hundredweight	.17
Post Office	Boise.........	162	1.20 .....do......	.15

1/ Cost of supplies and labor only. Hauled 3-1/2 tons of concentrate in 3-ton Chevrolet truck at cost of $15 for gas and oil and 3 days' labor for one man.

2/ The Marshall Lake mining district is about 17 miles by road north of Burgdorf Post Office. Rates to Burgdorf should be slightly lower.

COST OF PACKING

The cost of pack-train transportation seemed to be fairly well established at a contract price of $0.01 a pound on reasonably good trails for any distance that could be covered regularly in one day, with return on the next; the maximum distance that could be covered in this way was considered to be about 15 miles. The rate was about the same for shorter distances unless the distance was so short that a round trip per day could be made easily. In other words, the charge is about $2 per day per animal, including a packer for a string of 7 or 8 mules.

AIRPLANE TRANSPORTATION

Several established air transport lines are engaged in carrying freight and passengers from Cascade, McCall, Grangeville, or Lewiston to points in central Idaho where landing fields are available. Regularly used fields are established at Warren, Stibnite, Big Creek, Chamberlain Basin, and Mackay Bar, and there are numerous other points where landings may be made. Freight rates are based on the cost per trip rather than on an unvariable cost per pound; that is, the cost per pound for a full load is less than for a partial load. The cost also appears to vary somewhat according to flying and landing conditions.

In the summer of 1937 mining supplies were being carried into the Salmon River canyon south of Dixie for from $0.03 to $0.05 per pound from McCall or Cascade; the air-line distance from these towns is about 40 and 60 miles, respectively.

POWER

At present (1937) no plants are selling power in the region except at Warren, where the hydroelectric power plant of the Unity Gold Production Co. is supplying power to dredges operating there. In 1936 this plant generated 1,789,000 kw.-hrs., of which 1,100,000 kw.-hrs. were sold and the remainder used by the Unity mine; at present this plant has only a very small surplus capacity.

A 500-horsepower hydroelectric power plant is being installed on the Salmon River at the mouth of the South Fork for the use of placer operations in that vicinity. Hydroelectric plants are in use also at the Lone Pine mine, the Orogrande-Frisco mine, and the Snowshoe mine. Other mines in the region are using locally generated Diesel, gasoline, or steam power.

Diesel oil costs from $0.10 to $0.12 a gallon delivered to points accessible to heavy trucks. Gasoline at retail costs from $0.25 to $0.33 a gallon delivered; from this price, a State tax of $0.05 a gallon is deductable for gasoline not used for road transport. The cost of operating a small Diesel-electric plant in Idaho County is given under the description of the Golden Anchor mine (p.59).

A number of the smaller plants burn wood. In this region, wood is very economical for small consumers or temporary installations and is usually contracted for at from $2.25 to $4.00 a cord. Large consumers would, however, find the cost mounting rapidly as nearby supplies became exhausted. Examples of the cost of generating power with wood are given under descriptions of the Robinson mine (p.53), the Una mine (p. 47), the North Star mine (p. 58), the Golden Hand mine (p. 81), and the Hinkson and Bishop mine (p. 72).

LABOR AND WAGES

The supply of skilled and semiskilled mine labor is usually sufficient for the small demands so far created. The attractiveness of the region as a field for prospecting has built up a considerable resident population and causes a small annual influx of the better class of prospector-miners, some of whom are usually available for underground work. If at any time a larger demand is created, Spokane and the northern Idaho mining camps probably would supply an adequate number of experienced men.

At present there is no standardized wage scale in the region. Wages are generally lower than in the northern Idaho mines, but this difference is largely compensated for by cheaper living and pleasanter working conditions. In 1937 common labor in the Idaho County mines received $4 to $5 per day, miners $4.50 to $5.00 per day, millmen $5.00 to $5.75 per day, and other labor in proportion. The wage scale at the Golden Anchor mine (p. 67) is representative of the higher wages being paid in 1937.

SMELTERS AND SMELTING SCHEDULES

At present most shipments of ore and concentrates from north of the Salmon River are sent to the Bunker Hill and Sullivan smelter at Kellog (Bradley), Idaho; most shipments from south of the Salmon River are sent to one of the smelters in the vicinity of Salt Lake City, Utah.13/ A few shipments are sent to the smelter at Tacoma, Wash.

The following smelter schedules were abstracted from a Bureau of Mines Information Circular14/ that contains an outline of smelter schedules in the Western States and presents a general discussion of smelting practice.

13/ For distance and shipping rates, see section on "Transportation", pp. 14-18.

14/ Gardner, E. D., and Allsman, Paul T., Open Schedules for Gold and Silver Ores and Concentrates at Western Custom Smelters: Inf. Circ. 6926, Bureau of Mines, 1936, 25 pp.

COPPER SMELTERS

	Garfield[1]	Midvale	Tooele[2]	Tooele[3]
Payments				
Gold:				
Minimum paid for ounces per ton....	0.03	0.02	0.02	0.02
Rate per ounce for ore valued at ..	0 to 3 oz./ton $31.81825 per oz	0 to 5 oz./ ton $31.81825 per oz.	All ore $31.85 per oz.	0 to 3 oz./ton $31.85 per oz.
Do..................	over 3 oz./ton $32.31825 per oz	Over 5 oz./ton[4]	-	3 to 6 oz./ton $32.20 per oz.
Do..................	-	-	-	6 to 10 oz./ton $32.90 per oz.
Do..................	-	-	-	Over 10 oz./ton $33.25 per oz.
Silver:[5]				
Minimum paid for ounces per ton ...	1.0	1.0	1.0	1.0
Minimum deduction do	.5	.5	-	-
Percent paid for	95	95	95	95
Copper:[6]				
Deductions:				
Pounds per ton[7]	15	[8] 15	15	15
Cents per pound..................	2.5	3.0	2.775	2.775
Percent of quotation after deduction	100	90	100	100
Lead:[9]				
Deductions:				
Cents per pound	3.5	-	3.525	3.525
Percent of quotation after deduction	[10] 50		[10] 50	[10] 50
Deductions				
Treatment charge:				
Base per ton......................	$3.50	$5.00	$4.00	$4.00
For excess gross value per ton over	$20	$30	$25	$25
Add to base charge percent	10	10	10	10
Maximum treatment charge per ton ..	$5.50	$7.00	$6.00	$6.00

COPPER SMELTERS (Continued)

	Garfield 1/	Midvale	Tooele 2/	Tooele 3/
Deductions (Continued)				
Penalties:				
Zinc:				
Units free	6	6	-	-
Charge per unit for excess.........	$0.30	$0.30	0	0
Arsenic and antimony:				
Units free	2	-	-	-
Charge per unit for excess	$0.50	0	0	0

1/ Siliceous ore, open schedule.
2/ Dry-ore rate.
3/ Gold-concentrate rate.
4/ On direct smelting ore containing over 5 ounces gold per ton, the price per ounce for the excess will be to the mutual agreement between the buyer and shipper.
5/ Payments on silver are based on the mint price for American mined ore.
6/ Payments on copper are based on the Engineering and Mining Journal quotations.
7/ When assay is less than the deduction, the shipper is charged with the deficiency, except as further noted.
8/ Minimum deduction.
9/ Payments on lead are based on the New York quotations for common desilverized lead.
10/ Nothing paid for lead less than 2 percent by wet assay.

LEAD SMELTERS

	Murray	Midvale	Kellog 1/	Kellog 2/
Payments				
Gold:				
Minimum paid for ounce per ton........	0.02	0.02	0.05	0.05
Payments:				
Classes of ore......	All	0 to 5 : over 5	0 to 5 : 5 to 10	over 10
Dollars per ounce ..	31.81825	31.81825: 3/	31.81825:32.17431	32.53037
Silver 4/				
Minimum paid for ounce per ton	1.0	1.0	1.0	1.0
Minimum deductions ounces per ton.......	.5	.5	-	-
Percent paid for	95	95	5/95	5/95
Lead: 6/				
Deductions:				
Units..............	1.5	1.5	1.25	-
Cents per pound.....	1.5	1.5	0	-
Percent of quotation after deduction....	7/90	8/90	7/90	-
Copper: 9/				
Deductions:				
Pounds per ton......	15	10/15	20	20
Cents per pound.....	5.5	5.5	8.0	8.0
Percent of quotation after deduction....	100	90	11/100	11/100
Iron and lime...........	12/Iron 13/Lime	14/Iron	-	-
Deductions				
Treatment charge:				
Gross value..........	14/	15/	16/ :0 to 20	17/
Base per ton..........	2.50	2.50	12.00: 6.50	
Maximum...............	-	-	-	9.00
Panalties:				
Insoluble:				
Charge per unit.....	$0.10	$0.10	-	-
Zinc:				
Units free..........	6	6	5	5
Penalty per unit for excess............	$0.30	$0.30	$0.30	$0.30
Arsenic, antimony, tin				
Element of combination..............	As plus Sb	-	As, Sb	As, Sb
Units free..........	2	-	-	-
Penalty per unit for excess............	$0.50	-	$1.00	$1.00
Bismuth:				
Units free..........	-	18/	-	-
Penalty per unit for excess............	-	-	$2.50	$2.50

LEAD SMELTERS (Continued)

	Murray	Midvale	Kellog1/	Kellog2/
Deductions (Continued)				
Penalties (Continued)				
Sulphur:				
Units free..........	2	2	4	4
Penalty per unit for excess............	$0.25	$0.25	19/$0.25	$0.25
Maximum penalty.....	2.50	2.50	2.00	.20
Moisture:				
Units free..........	-	-	6	6
Penalty per unit for excess............	-	-	$0.20	$0.20
Maximum penalty.....	-	-	2.00	2.00

1/ Lead ore open schedule.

2/ Siliceous ore open schedule; ores containing no lead or under 5 percent for which no payment is made (lead determined by wet method less a deduction of 1-1/4 units).

3/ On direct smelting ores containing over 5 ounces gold per ton, the price per ounce for the excess will be to the mutual agreement between buyer and seller.

4/ Payments on silver are based on the mint price for New American-mined ore.

5/ Ore over 35 ounces per ton, deduct 2 cents per ounce.

6/ Payments on lead are based on the New York quotations for common desilverized lead.

7/ Nothing paid for lead less than 5 percent wet assay.

8/ No payment for lead under 3 percent dry assay.

9/ Payments on copper are based on the Engineering and Mining Journal quotations.

10/ Minimum deduction.

11/ No payment for copper under 1 percent when quotation is 8 cents per pound or less.

12/ Pay for all at 6 cents per unit.

13/ Pay for all at 5 cents per unit if 5 percent or over.

14/ Add 10 cents to base charge for each unit of lead under 30 percent and deduct 10 cents for each unit of lead over 30 percent.

15/ Based on 30 percent dry lead assay. Debit 10 cents for each unit of lead under 30 percent and credit 10 cents for each unit of lead over 30 percent.

16/ Based on 50 percent lead. Add 10 cents per unit when over 50 percent and deduct 10 cents per unit when under 50 percent.

17/ Between $20 and $35, $7.00 per ton; between $35 and $50, $7.50 per ton; between $50 and $75, $8.00 per ton; between $75 and $100, $8.50 per ton; over $100, $9.00 per ton.

18/ The Midvale smelter reserves the right to reject any shipment containing in excess of 0.1 percent bismuth.

19/ Penalty only applies to ore under 20 percent lead; no penalty for ore 20 percent lead or over.

GENERAL GEOLOGY

A great deal has been written about the geology of some parts of Idaho County; very little about other parts. The northern part of the gold belt was described by Lindgren[15] in 1904 and by Shenon and Reed[16] in 1934; the Warren district was described by Lindgren[17] in 1900 and by Reed[18] in 1938. Papers describing the geology of certain parts of the region have also been published from time to time in the technical press. To date the Dixie, Florence, and Burgdorf districts have not been described in detail by Government or State publications; the Dixie and Florence districts, however, have been geologically mapped and it is believed that reports are in preparation. A description of the geology of the Ramey Ridge district and the adjoining territory north to the Salmon River is included in a report by Shenon and Ross.[19]

Although there may be great variations in detail from place to place, the broader relations of areal and historical geology are similar throughout the region; therefore, the following outline, abstracted chiefly from United States Geological Survey Circular 9,[20] may be considered applicable to the entire region.

The oldest rocks in the area comprise a thick series of gneisses, schists, quartzites, and limestones that appear to belong to the Belt series (pre-Cambrian).

The most abundant rocks in the area are the granodiorite and monzonite of the Idaho batholith, which intruded and profoundly altered the older rocks. The intrusion of this batholith has been assigned by some writers to the late Jurassic or early Cretaceous; others have assigned it to the late Cretaceous or early Eocene.

Subsequent to the intrusion of the batholith, central Idaho was deeply eroded to a region of low relief, and the thick covering of Beltian rocks was removed to expose granitic rocks over large areas. This surface was then uplifted and greatly dissected by erosion, but parts of the surface remain to the present day; in places, these remaining parts stand at elevations of 7,000 to 8,000 feet or more.

15/ Lindgren, Waldemar, A Geological Reconnaissance Across the Bitterroot Range and Clearwater Mountains in Montana and Idaho: Geol. Survey Prof. Paper 27, 1904, 123 pp.

16/ Shenon, P. J., and Reed, J. C., Geology and Ore Deposits of the Elk City, Orogrande, Buffalo Hump, and Ten-mile Districts, Idaho County, Idaho: Geol. Survey Circ. 9, 1934, 89 leaves (mimeographed).

17/ Lindgren, Waldemar, work cited (see footnote 4).

18/ Reed, J. C., Geology and Ore Deposits of the Warren Mining District, Idaho County, Idaho: Idaho Bureau of Mines and Geology, Pamphlet 45, Moscow, Idaho, 1938.

19/ Shenon, P. J., and Ross, C. P., Geology and Ore Deposits Near Edwardsburg and Thunder Mountain, Idaho: Idaho Bureau of Mines and Geology, Pamphlet 44, Moscow, Idaho, 1936.

20/ Work cited (see footnote 16).

In Tertiary time, the Columbia River lava and its interbedded sediments were deposited over the lower part of the region. Since then, possibly in part during the period of lava extrusion, faulting and possibly warping formed certain basinlike depressions such as those of Elk and Newsome Creeks. These basins were partly filled with gravel, sand, and clay.

The drainage was again rejuvenated, and before the late Miocene, the Salmon, Clearwater, and other trunk streams had cut deep canyons well below the base of the Columbia River lava, while erosion was proceeding headward along the valleys of their tributaries.

In the late Miocene stage, the higher parts of the region were extensively glaciated.

Numerous gold and silver bearing veins were formed after the solidification of the batholith and before the deposition of the unconsolidated Tertiary sediments; the placer deposits of the region were formed by the weathering of these veins and the subsequent concentration and reconcentration of the gold derived from them.

GENERAL DISCUSSION OF MINERALIZATION AND ORE DEPOSITS

Virtually all the developed ore deposits of the region occur within a northeasterly striking belt (see fig. 2) about 35 miles wide by about 50 miles long. Some mineralization is known to exist along the Bitterroot Range in eastern Idaho County and in the southeastern part of the county between Big Creek and the Salmon River; there is also some weak mineralization in other parts of the county. So far, however, the only mine developed outside of the region mapped in figure 2 is situated in the eastern end of the Ramey Ridge district (see fig. 23).

Within the area covered by figure 2 the mineralization is remarkably uniform in its general characteristics. Gold and silver are the only metals found in commercial concentrations; of the two, gold has nearly always been the more important. Nevertheless, there is a noticeable variation in the ratio of silver to gold in different parts of the region; for example, most ores of the Warren region contain an exceptionally high proportion of silver, whereas most ores of the Elk City district contain relatively little silver. In exceptional cases, however, veins with a high silver-gold ratio may occur in close proximity to veins with a low silver-gold ratio. Noticeable amounts of stibnite are nearly always found in veins having an exceptionally high ratio of silver to gold.

Sulphide mineralization throughout the region consists chiefly of pyrite, galena, sphalerite, tetrahedrite, stibnite, and chalcopyrite; the last-named is of little importance in the majority of veins but occurs in commercial concentrations at the Snowshoe mine in the Ramey Ridge district and could be observed at a few other mines. Pyrite is the most widely distributed sulphide; in disseminated deposits it usually constitutes the only ore mineral except free gold; on the other hand, it is almost entirely lacking in some of the high-grade quartz veins. Galena is usually an indication of comparatively high gold values and was abundant in all of the higher-grade veins observed by the writer.

As indicated by table 1 on page 9, a high percentage of the gold found in the Idaho County veins is free. This percentage is, normally, highest in the oxidized zones and in the high-grade veins.

Although the mineralization may vary slightly from district to district or from vein to vein, it appears to maintain its general characteristics over a wide vertical range. This is particularly noticeable in the Bear Creek or Marshall Lake district near Burgdorf, where the erosion of the Salmon River canyon has exposed veins of almost identical mineral characteristics over a vertical range of about 4,000 feet; similar veins could also be observed in the bottom of the Salmon River Canyon some miles east of Bear Creek and about 6,000 feet lower than the highest outcrops in the Bear Creek district.

The ore deposits of the region may be classified, broadly, into vein deposits and disseminated deposits. Vein deposits are more numerous and more widely distributed; because of their higher gold content they have been the object of most mining operations to date. The majority of the quartz veins are found in fractures formed by direct tensional movements or in fractures of such small longitudinal displacement that the development of shearing or fault breccia along the ore shoots has been very slight; it is probable that many of these lightly sheared faults could be classified properly as torsion joints. Such veins are very widely distributed throughout the region and are frequently high-grade; they are, however, usually narrow and of short lateral extent. They commonly have a general east-west strike and are usually closely associated with north-south shearing, which, in turn, is often controlled by a granite-gneiss contact or marked by a band of dikes. In a few places, however, where tensional movement has taken place uniformly along a broad front, these tension veins have formed ore bodies of considerable length and value, as at the Lone Pine (p. 30), the Golden Anchor (p. 59), and some of the veins in the Warren district. The tension veins form most readily along pre-existing planes of weakness, such as contacts, or in the harder rocks, such as granodiorite or quarzite, but are seldom, if ever, strongly developed in the softer rocks, such as gneiss or schist.

At some places in the region wide zones of brecciation are found in granitic rocks or quartzites; these zones usually are marked by intense silicification and sometimes, by development of numerous short, closely spaced gash veins, as at the Surprise mine (p. 55). In one or two places the brecciation has been so intense as to permit the formation of large disseminated ore bodies, as at the "Dixie Dike" described on p. 53.

Quartz veins formed in strong shear zones are found in the Elk City and Buffalo Hump districts and at scattered points throughout the region. The strongest veins of this type sometimes attain widths of 10 to 15 feet and, until the development of the Golden Anchor and Lone Pine mines, had been the most productive vein deposits of the region. In some cases, as at the Madre d'Oro (p. 29) quartz is lacking and the ore consists of highly mineralized gouge and shear material. At the Big Buffalo mine, in the Buffalo Hump district, it is said that in addition to a wide quartz vein a zone of sheared wall rock 18 feet wide constituted good ore. The oreshoots so far developed in deposits of this type, though often wide, are comparatively short and lenticular in shape.

In the Orogrande district, a broad band of shearing and fracturing containing both veins and disseminated deposits extends, with some interruptions, from near the South Fork of the Clearwater along Crooked River and Deadwood Creek to the forks of Crooked River about a mile south of Orogrande. Deposits of similar type also occur near Dixie, Elk City, and at one or two places along the South Fork of the Clearwater. The movement in any one direction along these zones has seldom been strong enough to form strong, persistent vein fractures; nevertheless, there are numerous short quartz lenses striking either north-south along the zones or east-west across them. Some of these lenses have been productive in a small way, but they are seldom persistent in either dip or strike; however, at various points, mineralization of the disseminated type has been strong enough to form very large bodies of low-grade ore. The extent and value of these ore bodies has not been determined, although considerable work has been done on them near the mouth of Crooked River, along the ridge west of Deadwood Creek, at the mouth of Relief Creek, at Orogrande, on two properties a short distance south of Orogrande, and at properties near Elk City and Dixie, but only the deposit at Orogrande has been mined in a large way; this deposit is described in more detail on page 37.

The Orogrande type of disseminated deposit is formed chiefly along contact zones between the Beltian rocks and the granitic intrusives; at Orogrande the mineralization seems to be most strongly developed in the gneiss or schist; on the other hand, disseminated deposits of the Dixie Dike type are entirely within the batholithic rocks. Such differences as exist between these deposits may be accounted for largely by the difference in the physical character of the enclosing rock.

Throughout the region there is a broad though definite similarity in the structural relations between the different types of ore deposits; if allowance is made for minor local variations, this fact suggests a close relationship between the vein-forming movements. Such a relation, of course, could only be verified by a more careful study of the fracture system than has yet been undertaken. Shenon and Reed[21], however, have pointed out that in the area mapped by them the general structural trend is slightly west of north and that the linear and planar foliations of

21/ Shenon, P. J., and Reed, J. C., work cited, pp. 19-21 (see footnote 16).

the rock minerals are both orientated in a northwesterly-southeasterly direction; they suggest that this may indicate a regional "stretching" or "flow" in that direction. Such a regional movement, with local variations, might be expected to develop the broad bands of northwest to northeast shearing, especially along contacts, and to develop tensional and torsional fractures across the direction of stretching. Local resistance to the north-south stretching could develop the strong east-west rotational shearing found in a few districts.

MINES AND MILLS

The following pages will contain brief technical descriptions of most of the lode-mining operations that were active in the later summer of 1937. It would have been impossible, in the time available, to visit and describe each of the hundreds or perhaps thousands of lode prospects and claims in the region. The properties described are those that happened to be the most active at the time of visit or that it was thought desirable to include in order to present some data of general interest. The object has been to present a cross-section of the various types of ore deposits, mining conditions, and of the technical methods in use.

Geological descriptions of numerous important mining properties not mentioned in this paper may be found in the various geological reports on the region.

ELK CITY DISTRICT

General Discussion

The Elk City district (fig. 3) is usually considered to include the veins along Seigal Creek and other tributaries of Red River as well as the veins in the immediate vicinity of Elk City. Many of these veins appear to belong to a fairly well-defined system, which was mapped and described in some detail by Shenon and Reed.[22]

The most productive vein so far developed in the district is the Buster, which, between 1907 and 1909, is said to have produced about $300,000 from gold ore averaging about $15 a ton. According to Thomson and Ballard,[23] the vein averaged 15 feet wide for a maximum distance of about 450 feet along the strike, but was said to have pinched out a short distance above a fault on the 370-foot level. It is claimed, locally, that legal entanglements have prevented a determined search for possible extensions of this oreshoot.

22/ Shenon, P. J., and Reed, J. C., The Geology of the Elk City Mining District, Idaho, With Special Reference to the Structural Setting of the Veins: Am. Inst. Min. and Met. Engr., Tech. Pub. 562, 1934, 22 pp.

23/ Thomson, Francis A., and Ballard, Samuel M., Geology and Gold Resources of North Central Idaho: Idaho Bureau of Mines and Geology, Bull. 7, Moscow, Idaho, 1924.

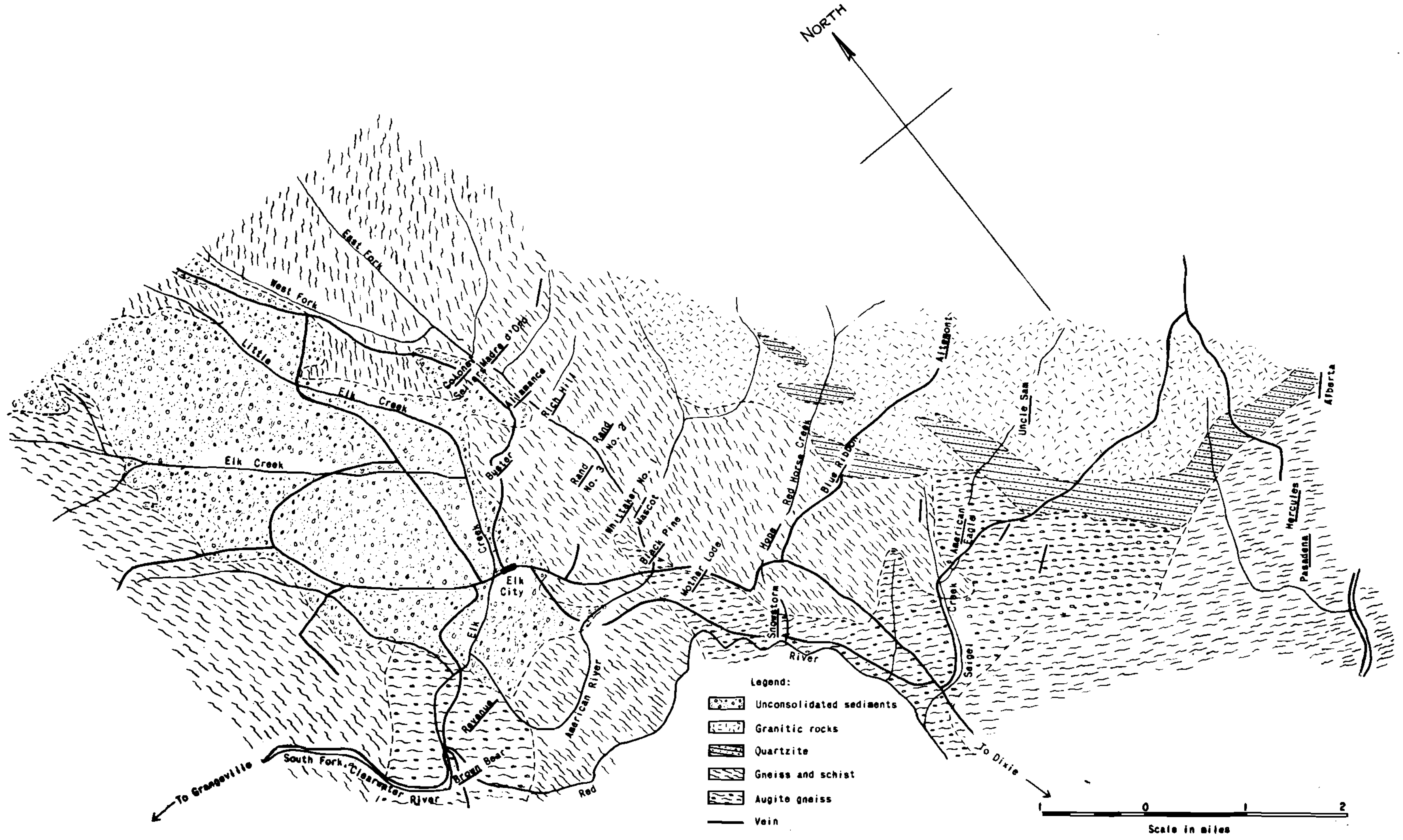


Figure 3.- Geological sketch, Elk City district (after Shenon and Reed).

The American Eagle mine, on Seigal Creek, has probably been the second highest producer in the district. According to Bureau of Mines records, this mine produced 5,223 ounces of gold and 1,830 ounces of silver from 9,931 tons of ore between 1903 and 1927; it was active early in 1937 but suspended operations later in the season.

The Madre d'Oro produced some gold in 1937, and small-scale development or ore-testing work was in progress at the Mother Lode, Colonel Sellers, Rich Hill, and a few other properties.

Madre d'Oro mine

The Madre d'Oro mine, owned and operated by S. W. Litchfield, is situated on American River 2.7 miles by road north of Elk City at an altitude of approximately 4,100 feet above sea level. The property comprises three patented and four unpatented claims.

The ore occurs in a shear zone 40 to 60 feet wide in a dark-colored hornblende gneiss. The shear zone strikes approximately east and west and dips steeply to the north. The ore is a bluish gouge from a few inches to 4 feet or more wide, which occurs near the middle of the shear zone; this gouge is strongly mineralized with auriferous pyrite and carries some free gold. One stope about 50 feet long had been mined to a height of four sets above the drift; the stope faces showed 4 to 5 feet of ore. It was said that 300 tons of $23 ore was mined during the current season.

The mine was worked through an adit drift which, at the active stope, was about 150 feet below the surface. The ground, particularly in the ore shoots, was soft; it was easily drilled by hand methods and required square sets for support. The ore slacked quickly upon exposure to the air and consequently required no primary crushing at the mill.

Two 1,000-pound stamps crushed 10 tons of ore per 24 hours; a 30-mesh screen was used. The pulp then passed over a corduroy table consisting of four sections, each 4 feet 6 inches wide and 28 inches long with a 2-inch drop between; the slope was 1-3/4 inches to the foot. Concentrates from the blanket tables were amalgamated in an amalgam barrel; the tailings were stored for retreatment. A 20-percent recovery was made by amalgamation.

It was planned to install a small tube mill for regrinding a 1/4-mesh stamp product; this would be followed by a hydraulic classifier gold trap for recovery of free gold and a flotation machine for concentration of the sulphides.

The stamp mill was driven directly from a 7-foot 10-inch-diameter Pelton-type water wheel turning at 35 r.p.m.; this wheel was made from an old gear wheel to which buckets had been bolted. For four months of the year water was brought in a ditch from Queens Creek and delivered under a 190-foot head; a high head of water was also available from Whittaker Creek. To provide for year-round operation, a ditch was under construction that would deliver water from American River, under a 35-foot head, to a 250-horsepower turbine generator plant to be installed about 600 feet from the mill. The mine was equipped with a small sawmill.

GOLDEN AND NEWSOME DISTRICTS

General Discussion

The Golden district, 20 miles by road west of Elk City, and the Newsome district, which adjoins it on the north (see figs. 2 and 4), have been the scene of considerable intermittent mining activity since the early days of mining in Idaho County. According to Jellum,[24] the Iron Crown mine, northeast of the old town of Newsome, was the first dividend-paying quartz mine in northern Idaho County; he states that it operated from 1888 to about 1900 and produced $70,000 or more. The South Fork mine has been credited with producing $200,000 to $250,000 prior to 1916.[25]

Lode mining in the Newsome district has been practically dormant for many years. On the other hand, the Golden district has been one of the most active districts in the county for a number of years.

In 1937, two mines, the Lone Pine and New York, were producing regularly; a number of other properties were producing intermittently, and a large number of claims were being developed actively. Descriptions of the Lone Pine and the New York, which were the largest recent producers in the Golden district, follow.

Lone Pine Mine

The Lone Pine mine is situated on the north side of the South Fork of the Clearwater River at Golden. When visited, the mine was owned and operated by F. O. Müller of Clarkston, Wash., and his son S. O. Müller, who was in active charge of operations. Later in 1937, operating rights were said to have been acquired by new interests.

The historical data, and many of the operating data, contained in this description were first published in the Proceedings of the Idaho Mining Association.[26]

24/ Jellum, S. P., Some Central Idaho Mining Districts: Published by Northwest Mining News, Spokane, Wash., 1909.
25/ Shenon, P. J., and Reed, J. C., work cited (see footnote 16).
26/ Müller, S. O., Development and Operation of the Lone Pine Group: 1936 Convention of the Idaho Mining Association, Apr. 24-26, 1936.

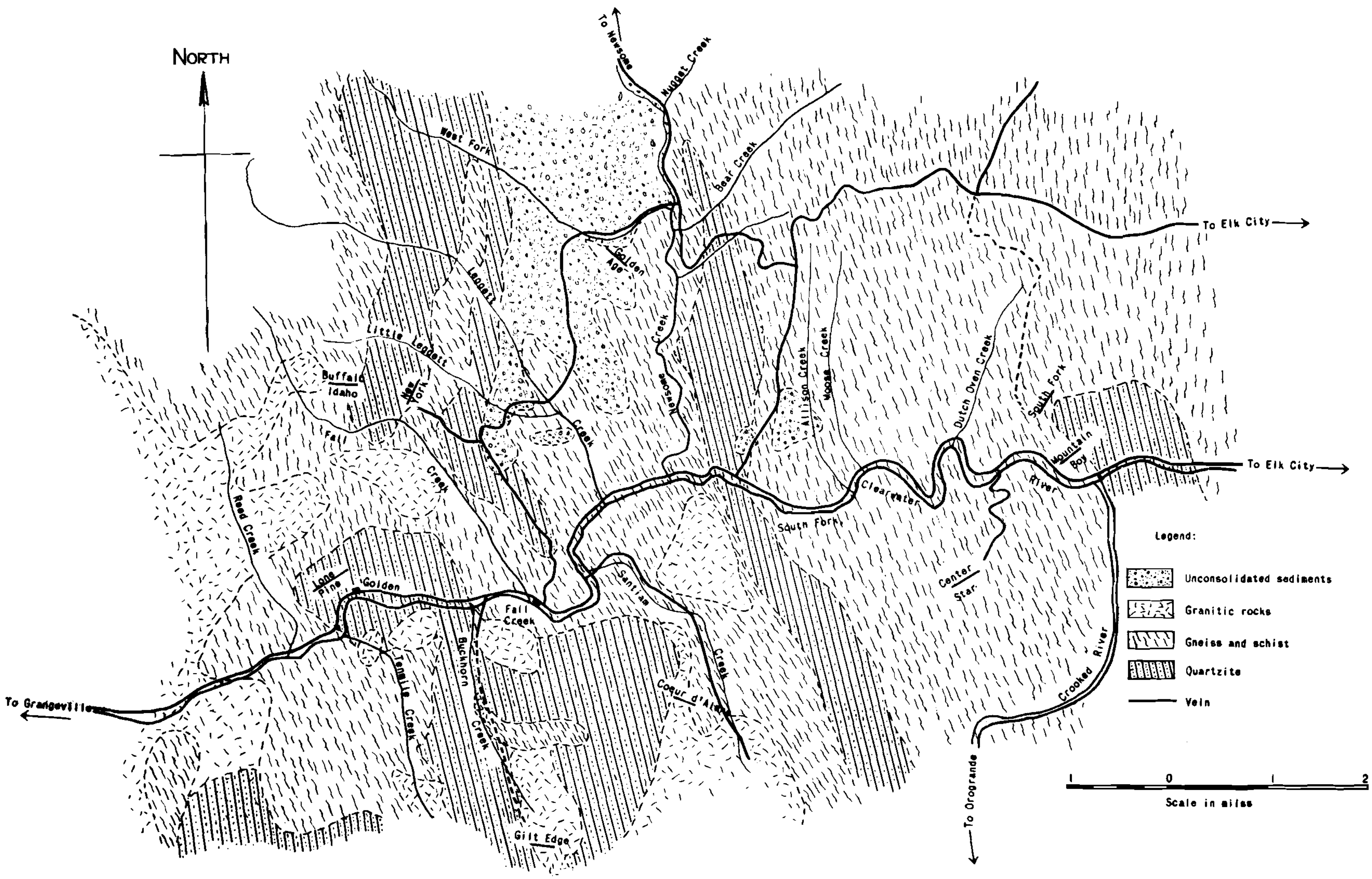


Figure 4.- Geological sketch, Golden district (after Shenon and Reed)

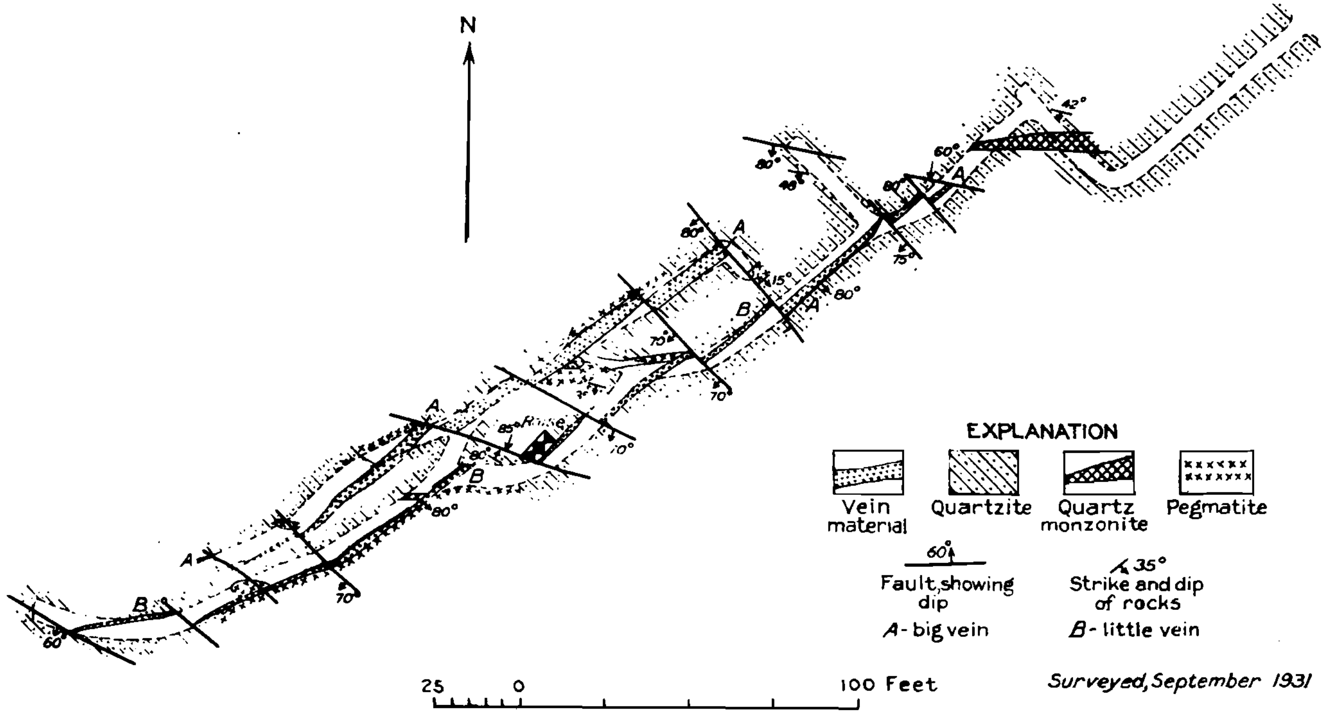


Figure 5.- Geologic map of main level of the Lone Pine mine (after P. J. Shenon and J. C. Reed).

History

The mine was discovered by Jack Harmon in 1909; for several years it was known as the Harmon-Morrow property. In 1915, F. O. Müller purchased the Harmon interest and installed a two-stamp mill, which was operated for a few weeks only. A small amount of development work was done intermittently until 1923, when Müller purchased the other half-interest. Further exploratory work done by Müller resulted in developing a new system, in which present operations are centered.

The two-stamp mill was operated by water power from 1928 to 1932, during periods of high water, and approximately $50,000 was recovered from 2,500 tons of ore. The proceeds of the stamp mill made possible an extensive development program and the installation of modern equipment, including a 40-ton mill and a hydroelectric power plant.

Since 1932, mining has been virtually continuous, although milling operations usually have been suspended during the winter months. An average crew of about 30 men is employed during the producing season. Up to the end of 1935, approximately $240,000 is said to have been produced from 20,000 tons of ore.

Geology

The ore occurs in a series of parallel quartz veins in white, generally massive, quartzite. The veins strike about north 60° east and dip about 80° to the southeast (see fig. 5); they are cut by a series of southeasterly-trending faults, which dip steeply to the southwest. Although there is little or no gouge in the quartz veins, the southeast faults are filled with gouge. In addition to the three veins of the "Müller system" there is also another vein, known as the "Huston", lying to the north of the Müller system; the veins vary in thickness from small stringers to widths of 1-1/2 to 4 feet.

Sulphide mineralization consists chiefly of galena, sphalerite, and pyrite. Gold and silver occur in the ratio of 1 : 1 to 1 : 2.

Mining

Development

The mine has been opened by three adit levels, 80 to 115 feet apart, and by a 250-foot inclined shaft from which a level has been driven at the 200-foot level. The shaft measures 4 by 8 feet inside the timbers; it is divided into a 4- by 4-foot hoisting compartment and a 3-1/2- by 4-foot manway-and-pipe compartment. A 16-cubic-foot skip is hoisted by a 15-horsepower, single-drum, electrically driven hoist; this skip loads from a measuring pocket below two 20-ton storage pockets on the 200-foot level.

An average of 75 gallons of water per minute is pumped from the shaft by a 25-horsepower electrically driven centrifugal pump.

Stoping

The ore is mined in flat-back, cut-and-fill stopes by resuing. Cribbed or stulled and lagged stope raises are carried up with the stopes at 20-foot intervals. On the upper levels, stopes were started directly from the back of drifts; on the 200-foot level, however, a 15-foot pillar was left over the drift; chutes and manway raises were driven through the pillar and connected by a temporary sublevel, which was floored with overlapping lagging; mining was then carried upward in the usual manner.

Stope rounds are drilled by hand-rotated stopers with 1-inch quarter-octagon steel; holes 24 to 30 inches deep are spaced 12 inches apart.

Tramming

On the main, or haulage, level the ore is trammed in trains of ten 20-cubic-foot cars pulled by a 1-1/2-ton Mancha storage-battery locomotive. A motorman and helper can handle about 90 cars a day and transport the necessary supplies into the mine; the average haul is about 1,200 feet; the cost of tramming 4,350 cars was 14 cents a car.

Milling

In 1932, a 40-ton amalgamation mill was built with an unusual flow sheet; it is reported that up to 97 percent of the total gold was recovered when ore from the upper levels was treated. In 1937, with an increasing percentage of unoxidized ore from the lowest level, it was said that recovery by straight amalgamation was falling off and that it would be necessary to install flotation equipment. This description, however, necessarily will be confined to straight amalgamation as practiced in 1936. The flow sheet is shown in figure 6.

Ore from the mine is received in a 150-ton coarse-ore bin, from which it passes over a grizzly to a 7- by 10-inch jaw crusher, thence through a 4- by 5-foot trommel punched with 3/4-inch holes. Trommel oversize is further crushed in an 8- by 10-inch crusher and stored, together with trommel undersize, in a 100-ton fine-ore bin.

A plunger-type feeder delivers ore from the fine-ore bin to a 4-1/2-foot by 32-inch conical ball mill. Mercury and caustic soda are fed by hand directly to the ball mill at 15-minute intervals; the amount of mercury to be fed is determined by panning. A 20-mesh trommel on the discharge trunion of the ball mill delivers an oversize product direct to an elevator boot for return to the grinding circuit, and an undersize product goes to a 12-spigot hydraulic classifier used as a gold amalgam trap.

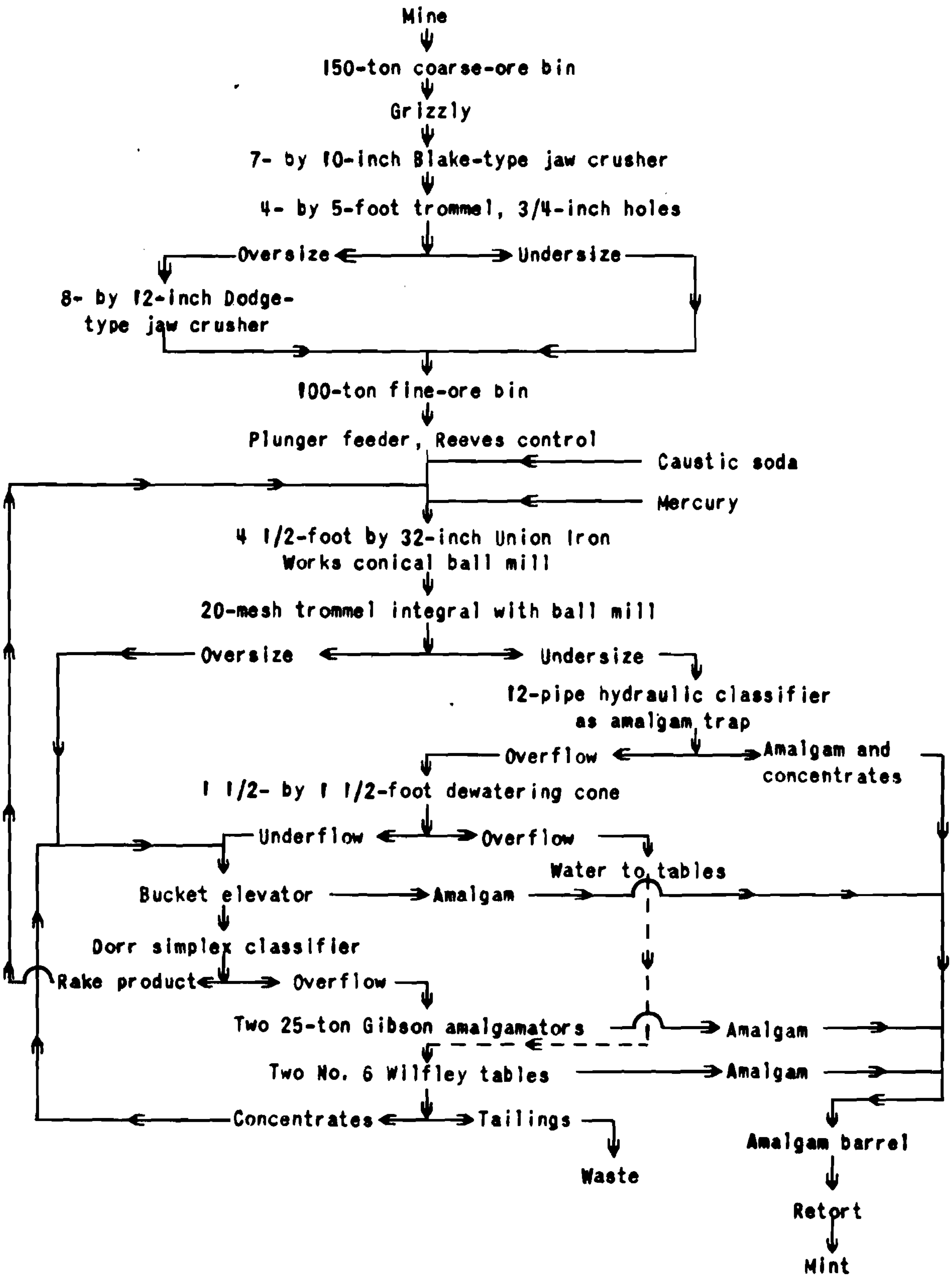


Figure 6.- Flow sheet, Lone Pine mill.

Tailings from the gold trap are thickened slightly in a small dewatering cone and elevated to a Dorr simplex classifier in closed circuit with the ball mill. Dorr classifier overflow, at about 100 percent through 40 mesh, passes directly to two Wilfley tables, on each of which a 25-ton Gibson amalgamator is mounted.

Wilfley tailings go to waste; concentrates go to the elevator for return to the grinding circuit.

The greater part of the amalgam is recovered from the gold trap; additional amalgam is recovered from the ball mill and elevator boot at clean-up time, and from the Gibson amalgamator and table decks. The Gibson amalgamators are cleaned up at about 2-week intervals; amalgam, which has built up on the table decks, is scraped off about once a season; and the ball mill, elevator, and auxiliary traps are cleaned up when the ball mill is relined.

All clean-up material is ground with caustic soda and mercury in an amalgam barrel; the amalgam is retorted and the bullion is melted and shipped to the mint.

The following metallurgical data were obtained during one clean-up period; that is during the period between two relinings of the ball mill.

Number of operating days	98
Total tons of ore ground	4,268
Average tons per 24 hours	43.5

Ball and liner consumption:	Pounds	Pounds per ton of ore
Cast iron balls	17,878	4.19
Liners	5,275	1.24
Total	23,153	5.43

	Ounces	Ounce per ton of ore
Mercury fed to ball mills	3,559.5	0.834
Mercury recovered	3,109.0	
Total mercury loss	450.5	.106

Mercury loss in retorting..............260 ounces in ten retorts, or 26 ounces per retort.

Mercury loss in mill circuit.......450.5 less 260 equals 190.5 ounces, or 0.045 ounce per ton of ore.

Caustic soda fed to ball mill..........................500 pounds per month.

Bullion recovered:	Ounces	Percent
From hydraulic trap and Gibson amalgamator	1,055.35	74.7
From elevator	172.00	12.2
From ball mill	122.25	8.6
From table decks	63.00	4.5
Total	1,412.60	100.0

The mill operating crew consisted of one operator per shift (three operators per 24 hours) and a crusher man on one shift.

Power

The total connected power for operation of both mine and mill is as follows:

		Horsepower
Mine:		
Compressors:		
One 158-cubic-feet-per-minute	25	
One 200-cubic-feet-per-minute	40	
Mine hoist	15	
Mine pump	25	
Blower	3	
Charger	3	
Total mine		111
Mill:		
Crushers	25	
Ball mill	35	
Elevator	5	
Tables	6	
Miscellaneous	3	
Total mill		74
Total mine and mill		185

The peak demand load for both mine and mill at full capacity is approximately 190 horsepower; the usual running load is approximately 135 horsepower.

Power is generated by a hydroelectric power plant a short distance from the mine and by a Diesel-generating plant in the mill building. The hydroelectric plant consists of a 250-horsepower Francis-Pelton turbine direct-connected to a 137-1/2-kv-a generator; the Diesel plant consists of a 110-horsepower Diesel engine connected by V-belt to a 100-kilowatt generator. Each unit of mine and mill is driven by an individual motor.

Operating Costs

The following direct operating costs were obtained during September 1936. During this period 962 tons were mined and milled.

Mining

Item	Cost per ton	Total cost per ton
Labor and explosives........	$ 2.88	
Tramming....................	.09	
Timber......................	.16	
Power1/.....................	.066	
	3.196	$3.196
Milling		
Labor.......................	0.608	
Balls.......................	.117	
Liners......................	.062	
Caustic soda................	.023	
Grease......................	.005	
Power1/.....................	.065	
Welding.....................	.012	
Miscellaneous...............	.026	
	0.918	.918
Total direct operating2/....		4.114

1/ Includes only the cost of an operator (divided between mining and milling). No interest or depreciation included. During 1937 no operator was kept at the power plant; hence, power costs were lower.

2/ Does not include supervision, engineering, bookkeeping, etc., taken care of by owner-operator.

Shamrock (New York) Mine

The New York, now known as the Shamrock, mine is situated on the north side of Fall Creek 4.7 miles by road from Fall Creek settlement. The elevation at the mine is approximately 5,000 feet, or 1,200 feet higher than the South Clearwater River at Fall Creek settlement. When visited in August 1937, the mine was being operated by the owner, H. W. White.

Development

The mine has been developed by a number of adit crosscuts and drifts for about 400 feet on the dip of the vein. Earlier operators had mined a considerable amount of ore from the upper workings; according to Shenon and Reed,27/ the mine had produced $40,000 to $45,000 prior to 1933. Current mining operations are limited to a stope 50 to 100 feet long which had been mined to a height of about 100 feet above the lowest, or mill, adit.

27/ Work cited (see footnote 16).

Geology

The vein, which, in the face of the stope, averaged about 4 feet wide, occurred in massive white quartzite, which frequently was hard to distinguish from vein quartz. The strike of the vein was north 30° east; the dip about 35° southeasterly; the walls were practically free from gouge but showed evidence of slight shearing. At the northeast end of the oreshoot well-developed faulting strikes north to north 30° east and dips 30° to 60° northeasterly. Metallic mineralization consists chiefly of pyrite, arsenopyrite, galena, and free gold; there is also an unidentified mineral that resembles galena in color and luster but has a less perfect cleavage. Oxidation has been strong throughout the developed part of the vein.

Stoping

An overhand cut-and-fill method of stoping was used. Auxiliary support was afforded by stulls spaced approximately at 5-foot centers. Stope filling consisted of waste or low-grade ore from which a higher-grade mill feed had been sorted. It was stated that ore assaying less than $7 a ton was gobbed. Apparently the sorting operations provided enough low grade to fill the stopes without the necessity of breaking additional rock for filling.

Milling

Ore was trammed to the mill by hand and dumped onto a 1-1/2-inch grizzly. Grizzly oversize was crushed in an 8- by 12-inch jaw crusher and joined the grizzly undersize in a 50-ton ore bin. A Challenge feeder regulated the flow of ore from the bin to five 1,200-pound stamps set for a 7-inch drop at the rate of 98 drops to the minute. These stamps crushed 8 to 10 tons of ore per 24 hours to go through a 35-mesh screen.

Stamp-mill discharge passed over two 4- by 5-foot amalgam plates followed by a 4- by 6-foot corduroy table; plates and table were set on a slope of 1-1/2 inches to the foot. It was said that recovery by amalgamation was about 85 percent and that tailings averaged about $0.80. The corduroy table was said to produce about 10 pounds of concentrate per ton of ore.

Power

The mill and a 152-cubic-foot capacity air compressor were driven during the spring and early summer by a 4-foot Pelton water wheel, which received water under a 250-foot head. In 1937, the water supply lasted until about August 5, after which date power was supplied by a six-cylinder automobile engine.

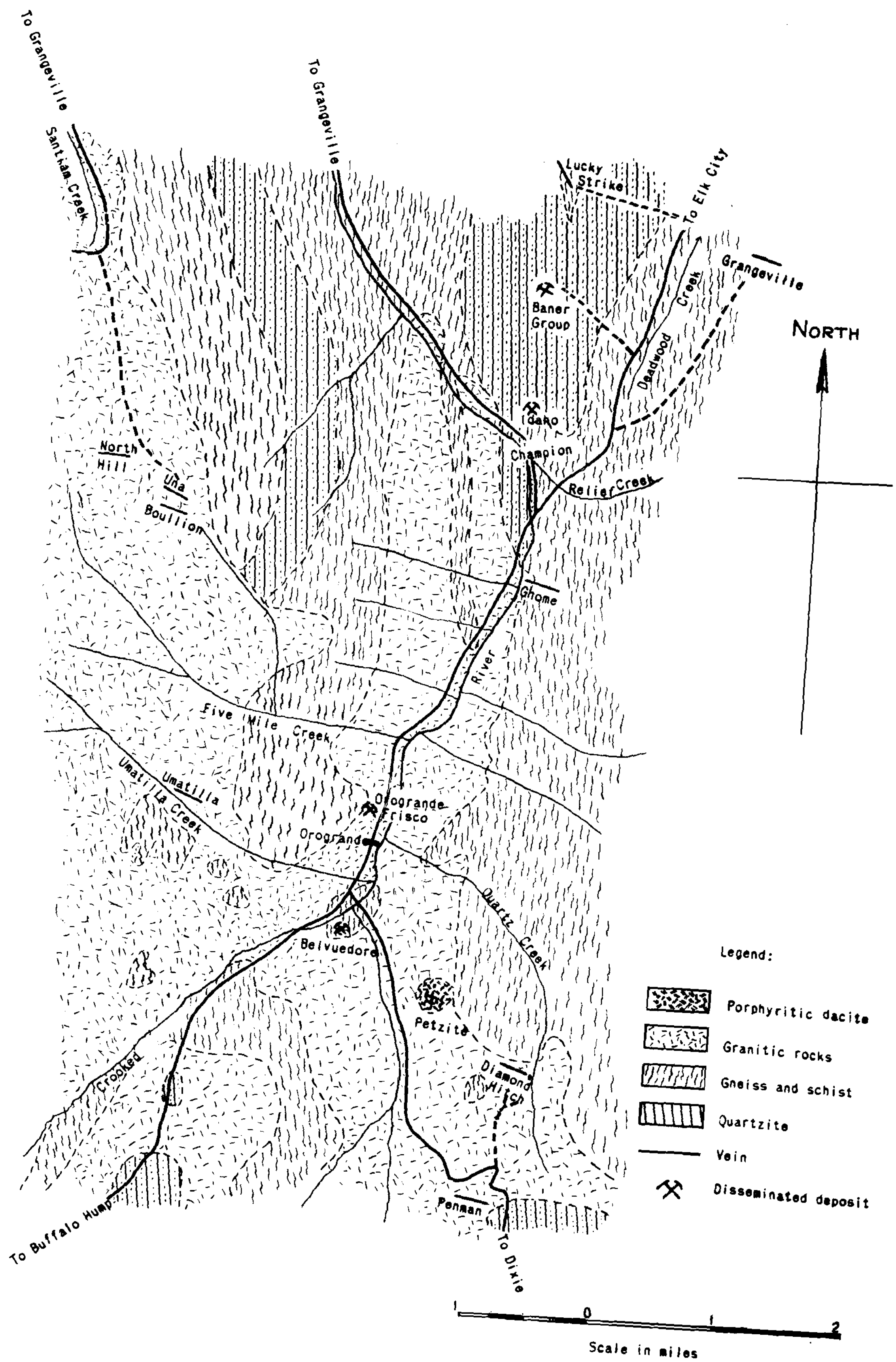


Figure 7.- Geological sketch, Orogrande district.

Labor

Mine and mill were operated by two miners on day shift, two miners on night shift, three millmen, and two bosses, one of whom was the owner.

OROGRANDE DISTRICT

General Discussion

The Orogrande district (fig. 7), mainly from the low-grade deposit of the Orogrande-Frisco mine, has produced the largest tonnage of gold ore of any district in Idaho County; the district has been relatively unimportant as a producer of placer gold.

The large deposits of low-grade ore, which occur as stockworks and disseminations locally known as "dikes", are found in a number of places in Idaho County but apparently are most strongly developed in the Orogrande district at intervals along the entire course of Crooked River. A large amount of work has been done on these deposits at various places from the Mountain Boy group, opposite the mouth of Crooked River, to the Petzite group, about 2 miles south of Orogrande Post Office. In 1937 some active development work was being done at the Mountain Boy (see fig. 4), the Baner group on Deadwood Creek, the Idaho Champion at the mouth of Relief Creek, and the Belvuedore south of Orogrande. The Orogrande-Frisco, at Orogrande, was mining and milling about 600 tons of ore per day.

There are also numerous vein deposits in the district. Of these, the most productive has been the Gnome mine, which was apparently exhausted early in 1937. The Diamond Hitch, on Quartz Creek south of Orogrande, produced some gold in 1937, and the Center Star near the mouth of Crooked River (see fig. 4), the Una, northwest of Orogrande, and the Grangeville, on the ridge north of Relief Creek, were conducting development work. A number of other claims were being developed on a smaller scale.

Orogrande-Frisco Mine

The Orogrande-Frisco mine is situated on the west side of Crooked River at Orogrande (fig. 7). This property, known originally as the Hogan mine and later as the Butte and Orogrande, has been operated for several years by the Orogrande-Frisco Gold Mines, Inc., of which J. R. Moore is the president and general manager.

History

The mine was first brought into production in 1902, when a 20-stamp mill was built. A few years later a cyanide plant was added and the mine was operated nearly every year from 1902 to 1909 and, again, from 1914 to 1920. During this period (1902 to 1920) 42,491 tons of ore was mined and 2,927 ounces of gold and 309 ounces of silver recovered. Production was resumed in 1934, when 5,600 tons was mined; by 1936 production had increased to 90,000 tons for the year, and in 1937 production was further increased to 128,671 tons.

Geology

The ore occurs as disseminations in the wide zone of shearing and fracturing that extends in a northerly-southerly direction along Crooked River. The country rock is a highly silicified, dark, grayish-green schist that contains much pegmatitic material. Sulphide mineralization, which consists chiefly of pyrite, is more intense in the schist than in the pegmatite, although both pegmatite and schist have been mineralized. The ore near the surface has been almost completely oxidized except for occasional stringers of sulphides. Up to the summer of 1937, all production had come from the zone of oxidation; at present, however, the proportion of unaltered sulphides appears to be increasing rapidly as depth is being attained.

The approximate extent and gold content of the ore body, so far as has been determined by diamond drilling and trenching, is indicated in figure 8, which, together with the following drill-hole records, accompanied a recently published report.28/

Drill hole number	Depth in feet	Gold value per ton
1	400	$ 1.40
2	325	1.40
3	316	1.08
4	240	1.70
8	258	2.00
9	200	1.60

Mining

The ore is mined by a power shovel from an open-cut into the hillside over 400 feet in diameter and 250 feet deep at the deepest point.

Holes 18 to 20 feet deep are drilled with hand-held 75-pound jackhammers. The usual round consists of four holes drilled into the face of the pit at an angle of about 15° below the horizontal; three of these holes are "lifters" drilled from the pit bottom and one is a "cut" drilled from a small bench on the pit face directly above the center lifter. The holes are spaced from 15 to 40 feet apart, depending on conditions. Each hole is "sprung" with 25 pounds of 40-percent gelatin and then loaded for blasting with bag powder; all holes are blasted simultaneously. An average of 0.125 pounds of Coyote bag powder is used per ton of ore mined.

28/ Northwest Mining: Published by the Northwest Mining Association, Spokane, Wash., Feb. 17, 1938, p. 9.

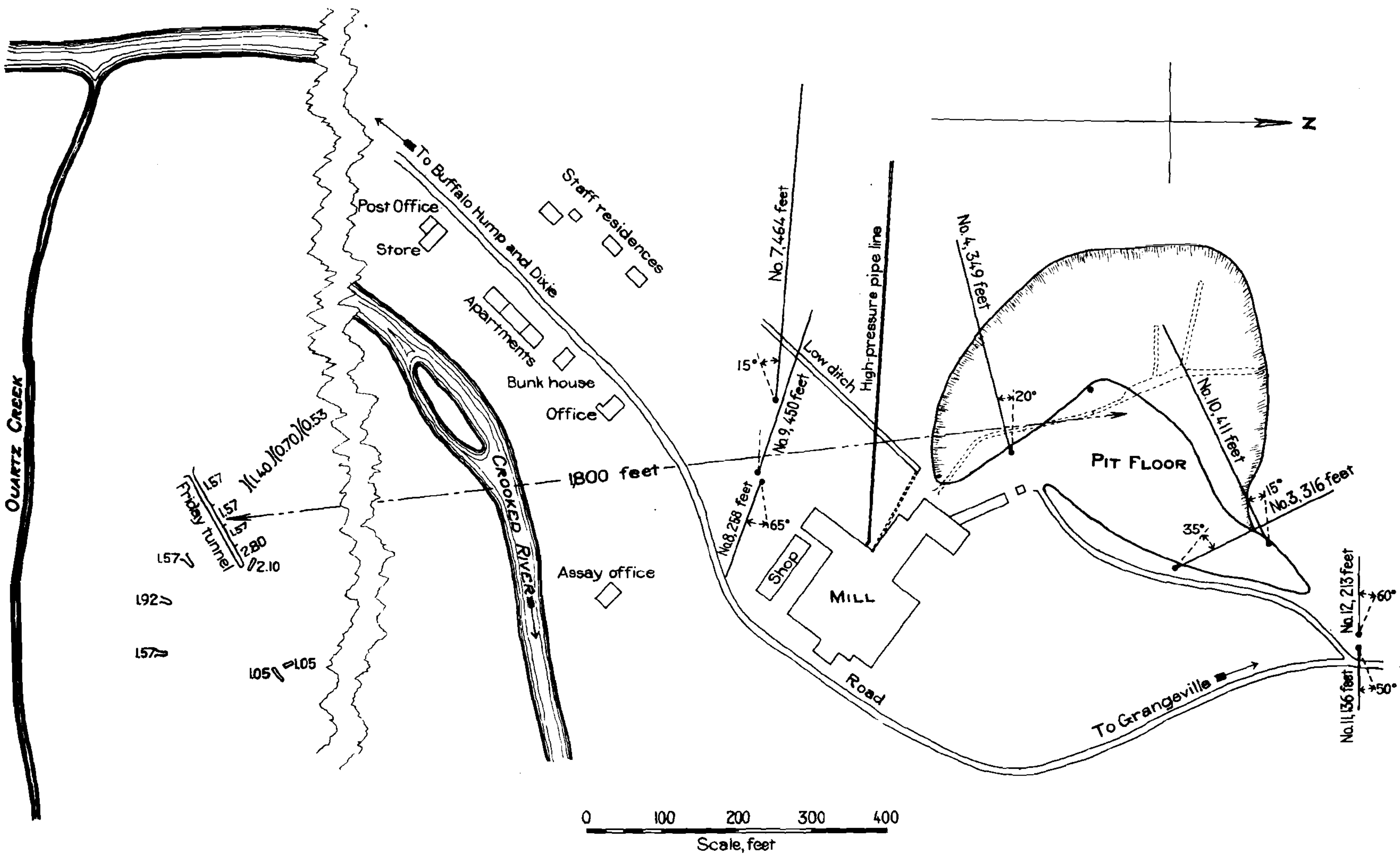


Figure 8.—Plan of main workings and plant, Orogrande-Frisco Gold Mines, Inc., showing drill holes and trenches.

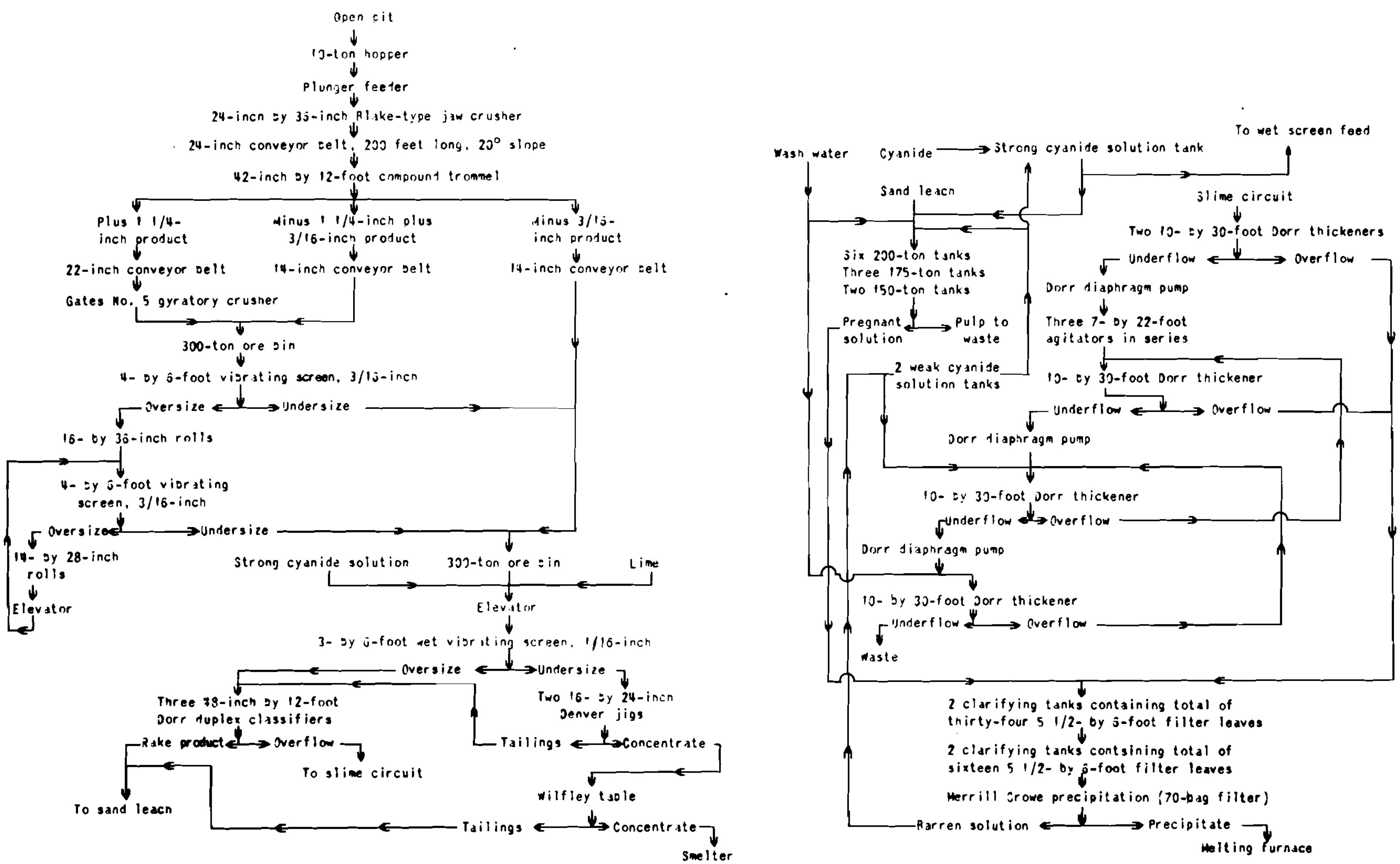


Figure 9.- Flow sheet, Orogrande-Frisco mill.

Drilling and blasting are performed by a crew of two miners, who drill one hole and prepare it for blasting in about 12 hours working time. The broken ore is shoveled by a 1-cubic-yard Diesel-powered shovel and hauled to the primary crusher in 5-ton trucks; two trucks are employed regularly. Overburden comes down with the ore and is removed separately by shovel and truck. All mining is completed in one shift per day.

Milling

The mill building adjoins the open-cut; the receiving hopper for coarse ore is excavated into the pit floor. The ore is treated by straight cyanidation; the sands are leached and the slimes agitated. The fact that the ores are highly oxidized has permitted a fair recovery without fine grinding; up to now it has been found that the savings in cost by the present methods more than offset the higher recoveries that could be obtained with finer grinding. The mill flow sheet is shown in figure 9.

Crushing and classifying

Ore from the pit is received in a hopper of about 10 tons capacity and fed, by a plunger-type feeder, to a 24- by 36-inch Blake-type jaw crusher. The hopper and crushing unit are housed in a small pit excavated below the level of the mine pit in such a way that the trucks deliver on the level without leaving the main pit.

From the primary crusher, ore is conveyed to the mill building on a 24-inch belt conveyor, which discharges into a 42-inch by 12-foot compound trommel drilled with 1-1/4-inch holes in the inner screen and 3/16-inch holes in the outer screen. The minus 3/16-inch product from the trommel is carried by a 14-inch belt conveyor directly to the 300-ton fine-ore bin; the plus 1-1/4-inch trommel product is conveyed to a No. 5 Gates gyratory crusher, where it is crushed to minus 1 inch, and then passes directly to the 300-ton intermediate ore bin, where it is joined by the minus 1-1/4-inch plus 3/16-inch product from the trommel.

Ore from the intermediate bin passes to a 3/16-inch vibrating screen; the screen oversize is crushed in a set of 16- by 36-inch rolls, and then elevated to another 3/16-inch screen operating in closed circuit with a set of 14- by 28-inch rolls. Undersize from both screens joins the minus 3/16-inch trommel product in the fine-ore bin.

Strong cyanide solution and lime are added to the ore as it leaves the fine-ore bin; it is then screened on a 1/16-inch vibrating screen, the oversize sent directly to the Dorr classifier and the undersize to two Denver mineral jigs, which take out a rough concentrate; the concentrate is cleaned on a Wilfley table, which produces a finished concentrate and a tailing.

The jig tailings (with the wet screen oversize) go to three Dorr duplex classifiers arranged in parallel; the classifier rake product and the Wilfley tailings go to the cyanide leaching vats, and the classifier overflow goes to the slime circuit.

Cyaniding

Leaching. - The leaching section of the mill contains six 200-ton tanks, three 175-ton tanks, and two 150-ton tanks. In these tanks the sands are subjected to the following cycle of operations:

	Hours
Strong solution leach	10
Aeration	5
Strong solution leach	10
Drain	6-7
Leach with weak solution and air	10
Drain	10
Water wash	10
Total	61-62

Leaching solutions are of the same strength as solutions in the slime circuit; these strengths and other data are given later.

Slime circuit. - Classifier overflow, which constitutes approximately 20 percent of the total mill feed, is thickened to 30 percent solids in two 10- by 30-foot Dorr thickeners and then agitated in a series of three 7- by 22-foot agitators. The agitators, which were originally thickeners, have been converted to their present use by the addition of paddles and air lifts.

Pulp from the agitators is washed by counter-current decantation in a series of three 10- by 30-foot Dorr thickeners. Weak cyanide solution and wash water are added to the last two thickeners, respectively; pregnant solution is taken from thickeners 1 and 2. The pulp from the last thickener is discharged to waste at about 50 percent solids.

The total time of contact in the slime circuit is estimated at 40 hours.

Clarification. - Pregnant solution from both the sand and slime circuits is filtered in two series of clarifying tanks; the first consists of a series of two tanks with 34 5-1/2- by 6-foot leaves and the second of two tanks with 16 leaves of the same size. The addition of a second tank of 16 leaves to the original tank of 34 leaves was found to result in much more efficient precipitation and in a higher-grade precipitate.

Precipitation. - A drip of lead acetate is added to the pregnant solution from the clarifying tanks; the solutions are then precipitated by the Merrill-Crowe process and the precipitate is collected in two tanks containing, respectively, 42 and 28 bags; each bag has 4 square feet of filter surface. The precipitate is said to assay approximately 50 percent gold.

Melting

Precipitates are given a light roast and are then melted in a standard tilting furnace by means of Dixon J-50 refractory-lined crucibles; the furnace charge has the following composition.

	Percent
Precipitate................	50
Soda.......................	10
CaF_2....................	2.5
MnO_2....................	2.5
Niter......................	15

Metallurgical data

Between 500 to 600 tons are treated per operating day.

Screen analysis of feed to cyanide sections

Mesh	Percent	Percent of total gold
Plus 8.......................	29.2	14.3
Minus 8 plus 20..............	27.6	11.9
Minus 20 plus 40.............	18.6	10.6
Minus 40 plus 60.............	5.3	3.3
Minus 60 plus 100............	6.7	5.8
Minus 100 plus 200...........	4.6	9.3
Minus 200....................	7.8	41.3

Strength of strong cyanide solution.....pounds KCN per ton of solution..	2
Cyanide consumption.....pound KCN per ton of ore..........	.75
Protective alkalinity.....pound CaO per ton of solution...	.4
Lime consumption.......pound CaO per ton of ore...........	.5
Zinc consumption.......pound per ton of ore...............	.244
Total gold recovery................percent................	80 to 83

Labor

The entire plant, mine and mill, exclusive of outside labor on repair, construction, and prospecting, is operated by 29 men on three shifts, distributed as follows:

Mine (day shift only):		
Shovel operator	1	
Miners	2	
Truck drivers	2	
Foreman	1	
		6
Mill:		
Day shift:		
Primary crusher	1	
Secondary crusher and conveyors	2	
Cyanide operators	2	
Foreman	1	6
Afternoon shift:		
Secondary crusher and conveyors	2	
Cyanide operators	3	5
Night shift:		
Secondary crushers and conveyors	2	
Cyanide operators	3	5
Power plant:		
Operators	2	
Ditch walker (day shift)	1	3
General supervision:		
Superintendent	1	
Assayer-metallurgist	1	
Assayer-helper	1	
Bookkeeper	1	4
		29

Power

All power is generated at the mine by either water or Diesel engine, according to the season. Full water power is available about 4 months of the year - from April to July, inclusive. The water is brought in two ditches from the headwaters of Crooked River; a "high ditch" delivers water under a 500-foot head to a Pelton-type wheel, and a "low ditch" delivers water under an 85-foot head to a turbine; both the Pelton wheel and turbine are direct-connected to a 300-kv-a generator.

During the period of low water, the water power is supplemented or replaced by a 240-horsepower Diesel-generator unit.

Air for drilling is supplied by a high-pressure (100 pounds per square inch) 160-cubic-foot compressor driven by a 40-horsepower motor; air for the cyanide plant is supplied by a low-pressure (10 pounds per square inch) 180-cubic-foot compressor driven by a 25-horsepower motor. Peak power load is about 250 horsepower; full running load (for both mine and mill) is slightly under 200 horsepower.

Operating costs

The following operating costs were obtained for the year ended December 31, 1937.

		Per ton
Mining:		
Diamond drilling	$ 5,027.41	
Idaho unemployment tax	730.85	
Federal old-age tax	843.62	
Labor	5,200.77	
Supplies	3,561.31	
Industrial insurance	276.98	
Miscellaneous expense	33.43	
Depreciation	1,589.12	
Total	17,263.49	$0.1340
Steam shovel and dump trucks:		
Labor	4,806.40	
Expense	2,179.62	
Gasoline, oil, grease, etc	944.16	
Total	7,930.18	.0620
Total mining, shoveling, and ore transportation		.1960
Milling:		
Labor	13,657.76	
Supplies	21,882.34	
Industrial insurance	341.29	
Miscellaneous expense	701.23	
Oil, grease, waste	372.84	
Repairs to building	113.25	
Depreciation	3,897.71	
Total	40,966.42	.3181
Assaying	2,684.63	.0210
Power, light and heat	7,433.24	.0578
		.5929

Brought forward		.5929
Transportation:		
Labor	2,315.25	
Expense	3,514.57	
Total	5,829.82	.0453
Total operating cost	82,107.78	.6382
Administration:		
Office and miscellaneous expense	3,604.88	
Capital stock, tax, and license	385.24	
Traveling expenses	996.04	
Accounting and auditing	2,198.91	
Legal	2,775.75	
Stockholders' meeting	36.25	
Insurance	67.17	
Interest paid	94.80	
Total	10,159.04	.0790
Total expenses	92,266.82	.7172

Gnome Mine

The Gnome mine is situated on the east side of Crooked River about 3 miles north of Orogrande Post Office. First brought into production by the Gnome Mining Co. in 1932, it operated almost continuously until the early summer of 1937, when it was shut down and dismantled. During this period, 11,582.12 ounces of gold and 3,165 ounces of silver were produced from 21,981 tons of ore. When visited late in June 1937 the mill was still operating; for a number of years this property was one of the best-known producing lode mines of north central Idaho.

Geology

The Gnome ore occurred in a quartz vein in quartzite and gneiss. The general strike of the vein was north 75° west; the dip varied from 80° southwesterly to vertical. The oreshoots, which were lenticular in shape (see fig. 10), averaged 12 to 14 inches wide in the upper workings and were sufficiently high-grade to supply mill feed averaging over an ounce of gold to the ton for many months. On the lowest (500-foot) level the quartz had widened to 3 or 4 feet and, according to the superintendent, values had dropped to $2.50 to $3.50 to the ton; it was said, however, that one small stringer on the 500-foot level assayed $1,200 a ton. Metallic mineralization consisted chiefly of pyrite and galena, with some chalcopyrite and free gold.

Oreshoots were more or less continuous for a distance of 500 to 700 feet on the strike; the largest single oreshoot or lens had a strike length of 150 to 350 feet. The vein was accompanied throughout by several inches to 1 or 2 feet of gouge and the walls were considerably sheared. This condition necessitated close timbering during mining operations.

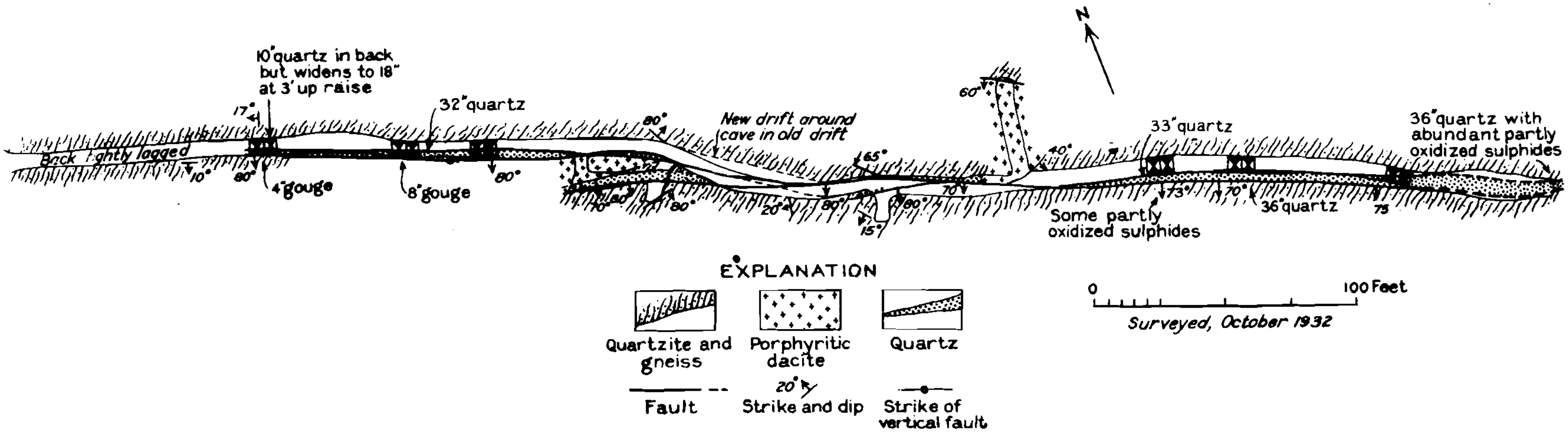


Figure 10.- International tunnel of the Gnome mine (after P. J. Shenon and J. C. Reed).

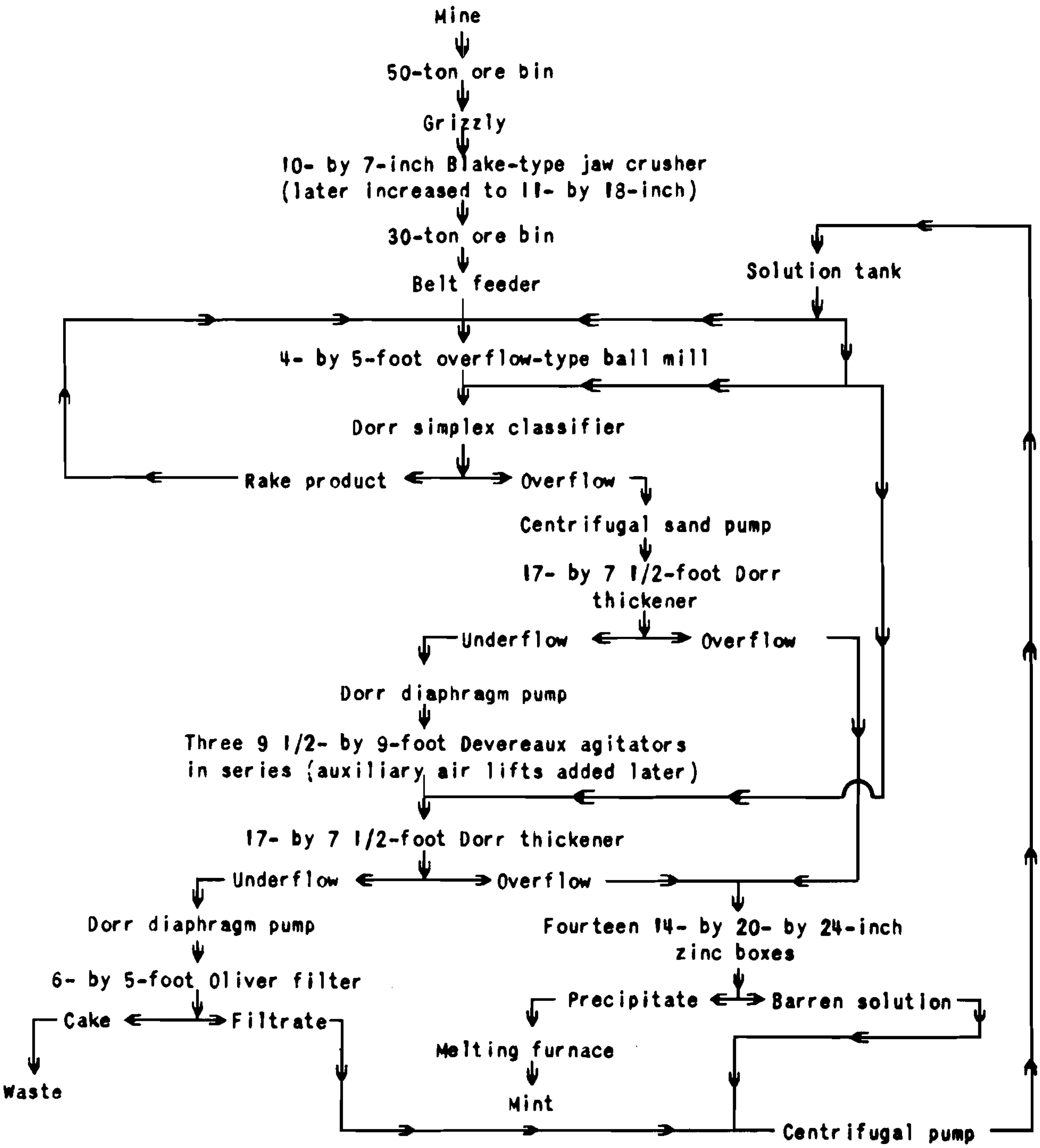


Figure 11.- Flow sheet, Gnome mill.

Mining

The ore was mined by a modified square-set-and-fill system adapted to the narrow vein; caps or stulls were spaced as in square sets, but posts frequently were omitted. For a production of 500 tons a month, 6 miners and about 10 muckers and trammers were required.

Milling

The ore was treated by straight cyanidation in a mill originally designed to treat 25 tons a day. This mill did excellent work on the oxidized ores of the upper levels, but as the proportion of unoxidized sulphides increased with deeper mining, it was found that grinding and classifying capacity was inadequate to liberate gold at the finer meshes required; this introduced other complications, all of which resulted in a very material falling off in both capacity and recovery toward the end of operations.

The original flow sheet is shown in figure 11. As the character of the ores changed, numerous changes were made and various expedients were resorted to to meet changing conditions. Greater crushing capacity was secured by the installation of a larger crusher; air lifts were added to the agitators; thickening ahead of agitation was eliminated when grinding efficiency became so low that the agitators could not handle thick solutions of the comparatively coarse sands produced by the grinding circuit, and finally it was necessary to repulp the filter cake and take off a table concentrate in an attempt to recover unliberated gold. These expedients, however, failed to recover a high percentage of the gold contained in the finer sulphide particles.

Some trouble with precipitation was had from the start; it was believed that the small amount of copper in the ore formed a metallic coating on the zinc shavings. Precipitation trouble was also caused by poor clarification due to the large amount of gouge sometimes present in the ore; the installation of a settling tank ahead of the zinc boxes only partly remedied this difficulty.

Metallurgical data and milling costs

To illustrate more clearly the effect of changes in the character of the ore upon the metallurgy, the results obtained during the winter of 1932-33, shortly after operations started, and the results obtained just prior to closing down can be compared from the following data:

	1932-33	1937
Tons milled per 24 hours.........	19 to 25	10 to 12
Screen analysis classifier overflow..........................	Plus 65 mesh, 0.8 percent; minus 65 plus 200, 50.6 percent; minus 200 mesh, 48.5 percent.	Plus 80 mesh, approximately 33 percent; minus 80 plus 100, approximately 33 percent; minus 100 mesh, approximately 33 percent.
Cyanide strength per ton solution, ... pounds KCN	2.5	2.5
Free lime per ton of solution ....pounds	.34	.5
Cyanide consumption per ton of ore treated, ...pounds	.8	.75
Lime consumption per ton of ore treated, ...pounds	3.0	4.0
Zinc consumption per ton of ore treated, ...pounds	1.25	.6
Heads assay,....ounces gold per ton	1.075	0.3 (Approx.)
Tailings assay,....ounce gold per ton............................	.093	.06 (do.)
Percent extraction...............	91 to 92	80 (do.)
Bullion fineness.................	670 gold; 216 silver	

Mill operating cost, 1932-33:

	Per day	Per ton
Wages:		
1 foreman	$ 6.50	
2 operators....................	9.00	
1 diesel engineer..............	5.00	
1 crusherman...................	3.00	
	23.50	$1.18
Metallurgical supplies:		
NaCN, 16 pounds at $0.13.......	2.08	
Steel balls, 45 pounds at $0.0375......................	1.68	
Zinc shavings, 25 pounds at $0.23........................	5.75	
Lime, 60 pounds at $0.01.......	0.60	
	10.11	.51
Power supplies:		
Diesel oil, 80 gallons at $0.13	10.40	
Lubricating oil, 5 gallons at $0.55	2.75	
	13.15	.66
Supervision:.......................	5.00	
Insurance, taxes, etc..............	2.00	
	7.00	.35
Total mill operating cost......................................		2.70
Depreciation on $25,000[1] distributed over 21,981 tons.........		1.14
Total cost...		$ 3.84

[1] Approximate cost of mill.

(6896)

Power

Power was generated at the plant. In 1937 a 140-horsepower Venn-Severn full Diesel drove a generator that supplied power to the mill and the 40-horsepower mine hoist. A 12- by 14, 12- by 12-inch compressor was driven by a 150-horsepower Fairbanks Morse Diesel.

Una mine

The Una mine is situated at the head of Five Mile Creek about 3.5 miles by trail from Orogrande; however, it is reached by road from the main forest highway at the mouth of Santiam Creek, 6 miles by Forest Service road up Santiam Creek, thence by 3 miles of mine road across Summit Flats. The mine is at an altitude of approximately 5,800 feet above sea level.

The mine is developed by a 1,350-foot adit bearing about north 55° east; this tunnel follows, for 300 to 400 feet, a low-grade vein said to assay $3 to $4 a ton across widths of 4 to 5 feet. At the end of the adit a quartz vein 3 to 4 feet wide and about 100 feet long has been developed; this vein strikes about north 60° west and dips 60° to 70° northeasterly. Near the junction of the two veins is a shattered zone about 40 feet wide said to carry commercial quantities of gold. The wall rock of all the veins is granodiorite with some quartzite.

The mine was equipped with a small sawmill and a 10- by 10- by 12-inch straight-line Gardner compressor driven by steam from a 60-horsepower wood-burning marine boiler, which was said to consume about half a cord of wood in an 8-hour shift. Firewood was cut for $2 a cord.

When the mine was visited in July 1937, seven men were employed on development work.

Bullion Mine

The Bullion mine, owned by D. E. Mulcahy of Orogrande, is situated a few hundred yards south of the Una. The property was in litigation at the time of visit but had recently been equipped with a small mill and had produced some gold.

The ore body is a quartz vein, with a maximum width of about 30 inches, lying alongside an acidic dike about 4 feet wide. The vein, which is nearly vertical, had been developed by a 200-foot adit drift bearing approximately east and west; ore was nearly continuous throughout the length of the drift. A small stope had been started and a raise put through to the surface; it was said that 150 tons of mixed dike material and ore had been milled; from this ore $236 in bullion and two tons of $160 concentrates had been recovered. The tailings were said to have assayed about $0.90 a ton.

The mill was equipped with a 5- by 7-inch jaw crusher driven by a 4-horsepower Stover gas engine, a 70-ton ore bin, a plunger-type feeder that delivered ore from the bin to a 4-foot Denver (high-speed Chilean) quartz mill fitted with 30-mesh screen and revolving at 34 r. p. m., a 52- by 96-inch amalgam plate, and a No. 6 Wilfley table. The Denver mill, feeder, and table were driven by a 6- to 8-horsepower Stover gas engine. Mill capacity had been 12 tons of ore per 24 hours, with a fuel consumption of about 23 gallons of gasoline.

The frame of the mill building was constructed of peeled lodge-pole pine, the roof was corrugated iron, and sides had not yet been put on. It was said that the timber was cut, framed, and the building constructed and machinery installed by 2 to 4 men in about 50 days. The cost of machinery was approximately as follows:

Machinery, initial cost	$ 2,500
Freight, Denver to Grangeville	419
Freight, Grangeville to mine (at $15 per ton)..	90
Total machinery and freight	3,009

Diamond Hitch Mine

The Diamond Hitch mine, owned and operated by D. E. Mulcahy, is situated 4 miles by road south of Orogrande, about 3 miles above the mouth of Quartz Creek. The mill is at an altitude of approximately 6,000 feet above sea level.

The ore so far exposed occurs in a series of nearly parallel quartz veins which strike, in general, about north 70° west and dip 60° to 70° south; these veins intersect a band of acid and basic dikes that strike approximately north and south. The country rock, which consists chiefly of granitic rock associated with gneiss, quartzite, and pegmatite, is highly silicified near the dikes and along the veins. The veins appear to be strongest in the granite or quartzite and near the dikes; the vein walls are devoid of gouge and frequently merge almost imperceptibly into the silicified wall rock. At least three well-defined quartz veins are known, but only one has been developed by underground workings; these veins are mineralized with galena, pyrite, free gold, and probably some tetrahedrite and stibnite. An adit about 600 feet north of the main workings has been driven along some east-west fracturing in quartzite that has been mineralized with pyrite along the fracturing; an assay of $6.30 in gold was obtained from a sample taken across the full face of the adit.

The main workings consist of a lower adit about 100 feet long at an elevation approximately 100 feet higher than the mill and an upper adit about 200 feet long 70 feet vertically above the lower one. An oreshoot 1 to 5 feet wide and about 80 feet long has been developed by the upper level and a 50-foot raise to the surface; the lower adit had not yet been driven under the oreshoot.

Ore mined from the adit, raise, and a small glory hole at the surface has been milled in a small amalgamating-concentrating mill. The ore was lowered to the mill on a 200-foot inclined tram and stored in a 25-ton ore bin. From the bin the ore passed over a 1-inch grizzly to a 4- by 7-inch Blake-type jaw crusher, thence to another 25-ton bin, from which it was fed by a home-made rake feeder to a 4- by 4-foot overflow-type ball mill operating in closed circuit with a Dorr simplex classifier. Classifier overflow, at about minus 60 mesh, passed over a Wilfley table, which produced a concentrate, middling, and tailing. The middling was returned by hand to the ball mill; the tailings passed over an 18-inch by 10-foot corduroy table to the tailings pond. Quicksilver, for amalgamation, was fed to the ball mill. The entire milling unit was driven by a 48-horsepower automobile engine, which consumed 216 gallons of gasoline during a mill run of 57 hours when 50 tons of ore were milled.

A run of 105 tons of ore yielded a 63.44-ounce sponge from amalgamation, with a net smelter return of $1,505.26; and 1,077 pounds of concentrates worth $309. It was estimated that mill recovery was about 75 percent.

A smelter analysis on a 493-pound concentrate shipment was as follows:

	Ounces per ton
Gold	23.19
Silver	75.05
	Percent
Copper	1.8
Lead	5.2
Iron	24.3
Insoluble	39.3
Bismuth	.252
Sulphur	18.2
Zinc	0
Antimony	.1
Arsenic	.2

BUFFALO HUMP DISTRICT

General Discussion

The discovery of the Buffalo Hump district in 1898 was followed by a few years of intense activity and overly optimistic excitement. In spite of the isolation of the district and the extremely poor transportation facilities, several medium-size stamp mills were erected and a large amount of development work was done. The mills, however, were equipped for amalgamation only and, consequently, made a very poor extraction except on the small amount of oxidized ore that was found in a few places. This poor extraction, combined with high operating costs, over-capitalization, and, no doubt, a general disappointment with the size and value of the ore bodies, resulted in an almost complete cessation of operations after a few years. Except for some small leasing operations and one or two short-lived development projects, the camp has been deserted for many years.

The two largest producers were the Big Buffalo, from which about $250,000 is said to have been recovered, and the Jumbo, which is said to have yielded about $225,000. According to Thomson and Ballard,[29] the Big Buffalo ore averaged $14.90 a ton and yielded $8.52 a ton by amalgamation; the bullion contained 711 parts of gold and 285 parts of silver.

The Buffalo Hump veins occur in a series of strong parallel shear zones, some of which may be traced, with interruptions, for a mile or more (see fig. 12). The country rock is chiefly quartz monzonite containing large inclusions of schist; veins are found in both kinds of rock. The veins generally strike 10° to 15° east of north and dip at varying degrees to either east or west. So far as could be learned from surface observations and old records, the ore occurs in strong quartz lenses écheloned along the shear zones. These lenses appeared to vary from 3 to 15 feet in width and were up to 300 feet in length. In places the sheared material along the walls of the veins contained valuable concentrations of gold. For instance, at the Big Buffalo shaft, a well-mineralized quartz vein 6 feet wide and about 30 feet of sheared wall rock are exposed by the caving of the shaft and old stopes; the impression is gained that most of the stoping was in the sheared wall rock, where oxidation was more complete, and that the comparatively fresh quartz had not been touched, although it is said to be high-grade.

Since the collapse of the boom, the principal mining activities at Buffalo Hump have consisted of small-scale cyaniding of the old tailings. The Big Buffalo tailings were worked a number of years ago; according to local reports they assayed about $6 a ton. In 1937, C. H. Whinery and S. A. Spengler were completing several seasons' operation of a small cyanide leaching plant on the Jumbo tailings. Mr. Whinery stated that about 15,000 tons of $3.50 tailings had yielded about $2.50 a ton without regrinding.

Although the district was accessible only by trail for many years, within the last few years the Forest Service has built a road that connects the district with Orogrande. This road is narrow and very steep in places; it rises from an altitude of about 5,000 feet at Orogrande to 7,200 feet at Orogrande Summit in 6 miles; it then drops to 6,400 feet and again rises to 7,800 feet at the old site of Humptown. The total distance is 12 miles from Orogrande and about 80 miles from Grangeville. In 1937 a new road was being built from Humptown to Grangeville by way of Adams Ranger Station (see fig. 2); this road will be in high country nearly all the way but will shorten the road distance to Grangeville to about 50 miles.

As a result of improved transportation conditions, renewed interest is being shown in the district and negotiations are said to be under way for the reopening of several properties.

FLORENCE DISTRICT

General Discussion

The Florence district was famous in the early days for its extraordinarily rich placer deposits; these deposits produced many millions of dollars. The town of Florence, however, has been almost deserted for many years.

29/ Work cited (see footnote 24, p. 49).

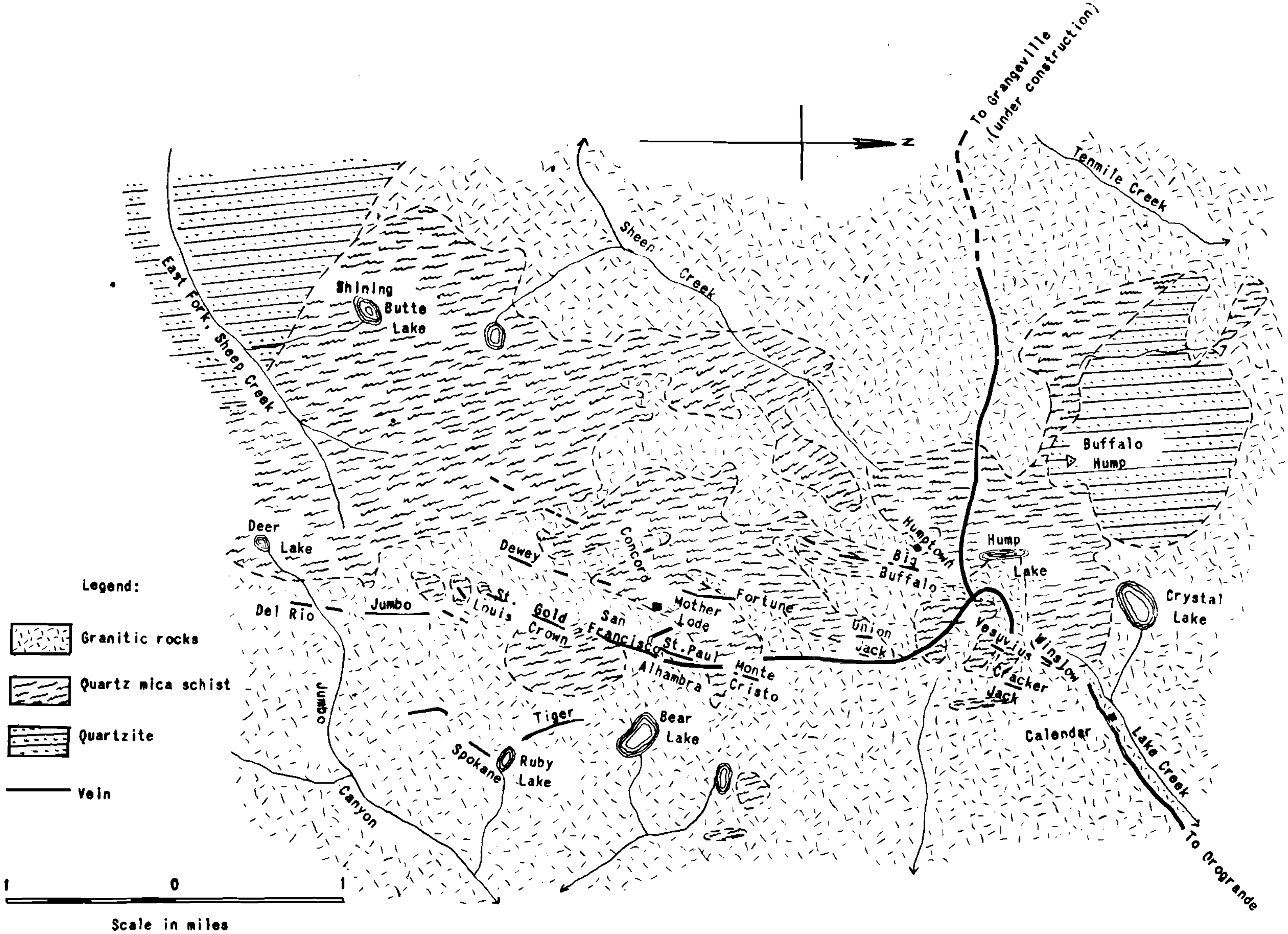


Figure 12.- Geological sketch, Buffalo Hump district (after Shenon and Reed).

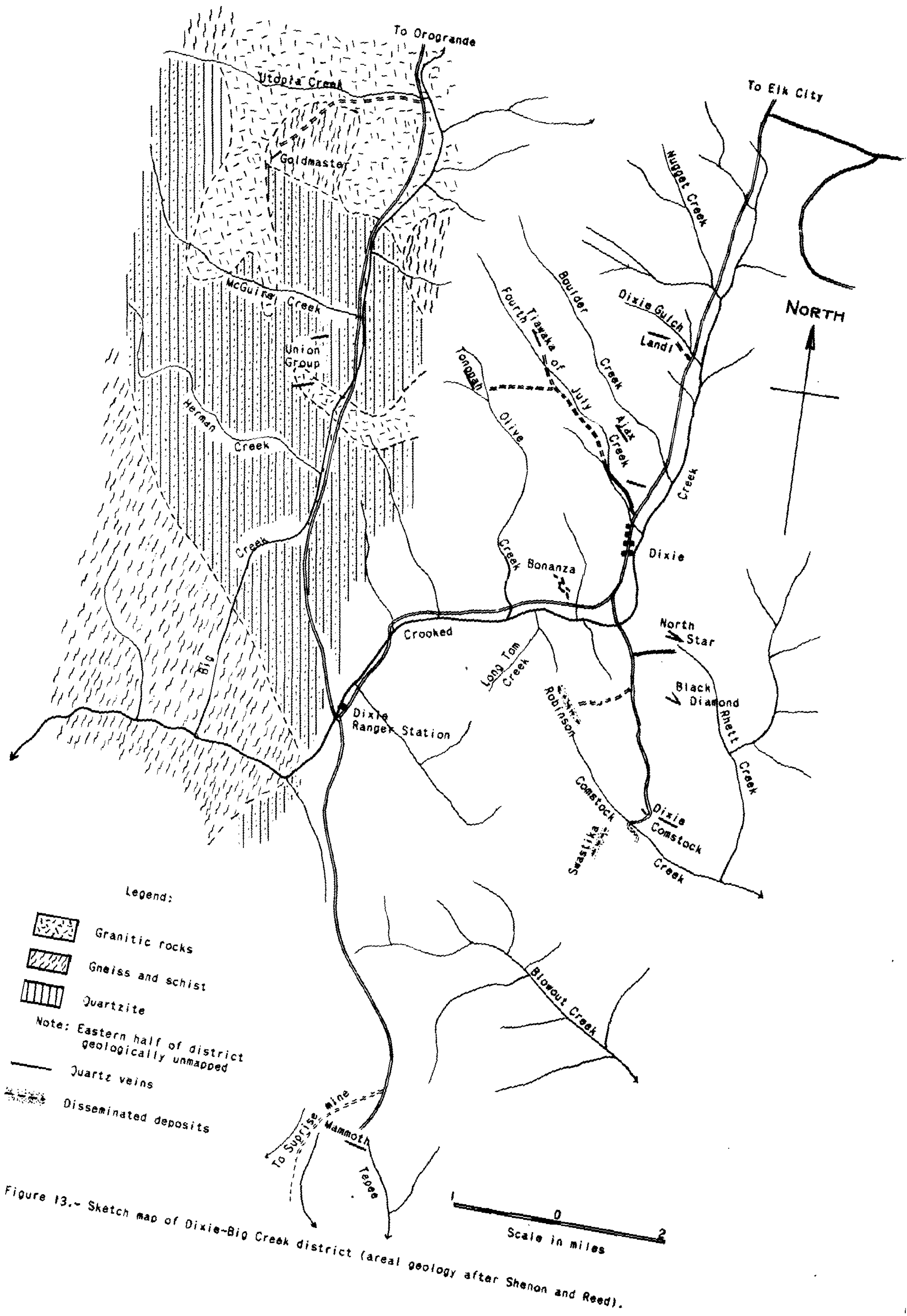


Figure 13.- Sketch map of Dixie-Big Creek district (areal geology after Shenon and Reed).

The placer deposits undoubtedly were derived from the erosion of numerous small quartz veins that traverse the area. So far, no large ore bodies have been discovered in these veins. The few veins disclosed in accessible workings in 1937 occupied small fractures or joint planes in granitic rocks; none of the veins observed were more than a few inches wide. In many cases, however, these narrow veins are exceptionally high-grade, and a high percentage of the gold from the oxidized ore near the surface is easily recoverable by amalgamation.

At one property, the owner, working alone, was reported to have made good wages by hand methods. Selected ore was transported in wheelbarrows to a rod mill built from an old air receiver and driven by a small gasoline engine. The gold was recovered by inside amalgamation, in traps, and on blanket tables. Several other properties were being developed or operated on a correspondingly small scale by owners or leasers.

Strong mineralizations appear to be localized in an area about 2 miles wide by 4 miles long in the immediate vicinity of the old townsite of Florence. This area, although 6,000 feet above sea level, is characterized by low, rounded hills and broad, swampy bottom lands. Consequently, the mantle of soil and vegetation is thick and lode prospecting is correspondingly difficult. There is no certainty that all the veins, or even the strongest ones, have been discovered.

DIXIE DISTRICT

General Discussion

Some small-scale quartz mining has been in progress in the vicinity of Dixie since the early 1890's and a few mines have been profitable in a small way. The district, however, has been one of the least accessible in central Idaho; this has prevented the successful development of low-grade deposits and has greatly retarded the development of the numerous small quartz veins. In recent years transportation has improved greatly; in 1937 the road from Grangeville was maintained for winter travel as far as Red River Ranger Station (see fig. 2). With the completion of a new road now under construction from Red River Ranger Station to Dixie, the town of Dixie will soon be open to year-round automobile travel.

In 1937 lode mining in the Dixie district was more active than at most other camps in the county. The Bunker Hill and Sullivan Mining and Concentrating Company brought the Mammoth mine into small-scale production late in the season; development work at the Robinson mine was meeting with success; the Surprise mine, on the Salmon River, was producing some gold; and development operations were under way at the L and L, Goldmaster, Dixie Comstock, North Star, and several others. The War Eagle, south of the Buffalo Hump district but reached by way of Dixie, was active early in the season but suspended operations about the middle of the summer.

The veins of the Dixie district (see fig. 13) occur in or near granitic rocks of the Idaho batholith; most of them occur in small tension fractures, in small lightly sheared fractures, or as short lenses échelonned along wide zones of fracturing and shearing, as at the Bonanza. In several places, however, such as at the Robinson "dike", the Swastika, and the Surprise, there are large disseminated deposits, some of which may prove to be commercially valuable.

Mammoth Mine

The Mammoth mine, owned by the Mammoth Mine Corporation and operated under lease and bond by the Bunker Hill and Sullivan Mining & Concentrating Co., is situated at the head of Tepee Creek 10 miles by road south of Dixie at an altitude of approximately 6,400 feet.

When visited in August 1937, a large amount of surface trenching and about 2,500 feet of underground exploration and development had been completed. A block of ore about 200 feet long was being prepared for stoping, and a 25-ton flotation mill was under construction; a Diesel power plant was being installed in the mill building where it could be tended by the mill operator.

Geology

The vein, where exposed by drifting, was from 1 to 4 feet wide; the strike was south 75° east and the dip 45° to 60° northerly. The wall rocks were granite and gneiss. Sulphide mineralization consisted chiefly of sphalerite, galena, and pyrite. Although oxidation had taken place along permeable channels to the greatest depth mined, fresh sulphides occurred in the solid quartz to within a short distance of the surface.

Mining

In the highly oxidized vein matter on the main adit level, 5-foot drift rounds could be broken with 12 to 15 holes loaded with about three sticks of 40 percent gelatin dynamite per hole; nearly all drifts required light timbering to prevent sloughing. It was planned to stope by overhand cut-and-fill method.

Milling

The flotation mill was being constructed at the portal of an adit crosscut to the vein; the main floor of the mill is at the level of the mine portal. Ore is trammed from the mine by hand, dumped into a mine ore bin just outside the portal, and hoisted in a small skip to the mill ore bin as indicated on the flow sheet; the hoist and skipway are inclosed in the mill building.

The mill flow sheet is shown in figure 14. A converted Bunker Hill type hydraulic classifier was installed originally in the ball-mill circuit for the purpose of recovering coarse free gold; however, according to information received since operations began, the amount of coarse free gold too heavy to float has been negligible. The efficiency of the flotation circuit in recovering both free gold and partly oxidized sulphides has rendered the use of the gold trap superfluous.

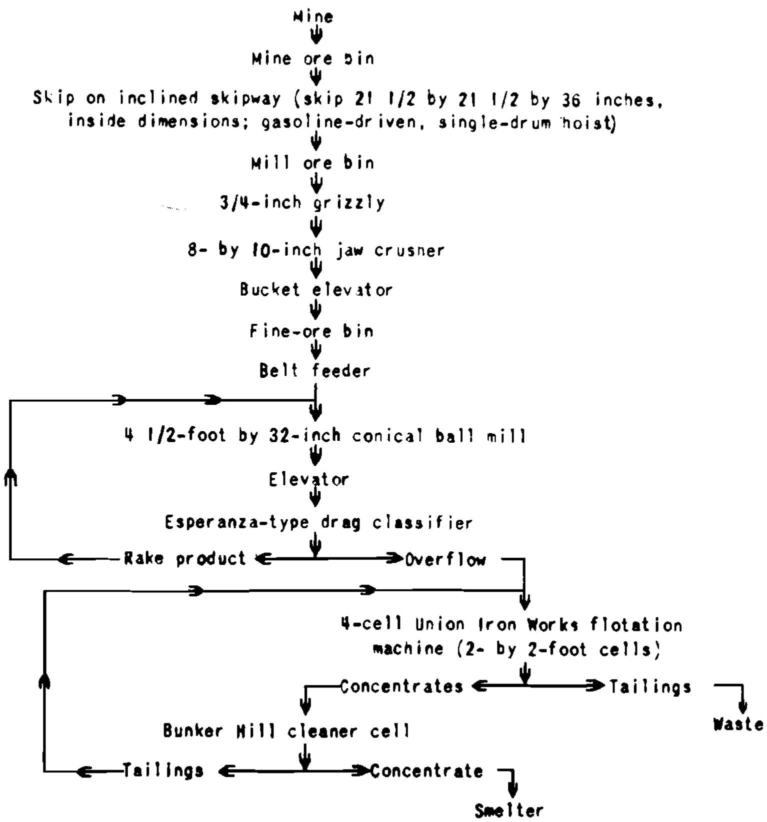


Figure 14.- Flow sheet, Mammoth mill.

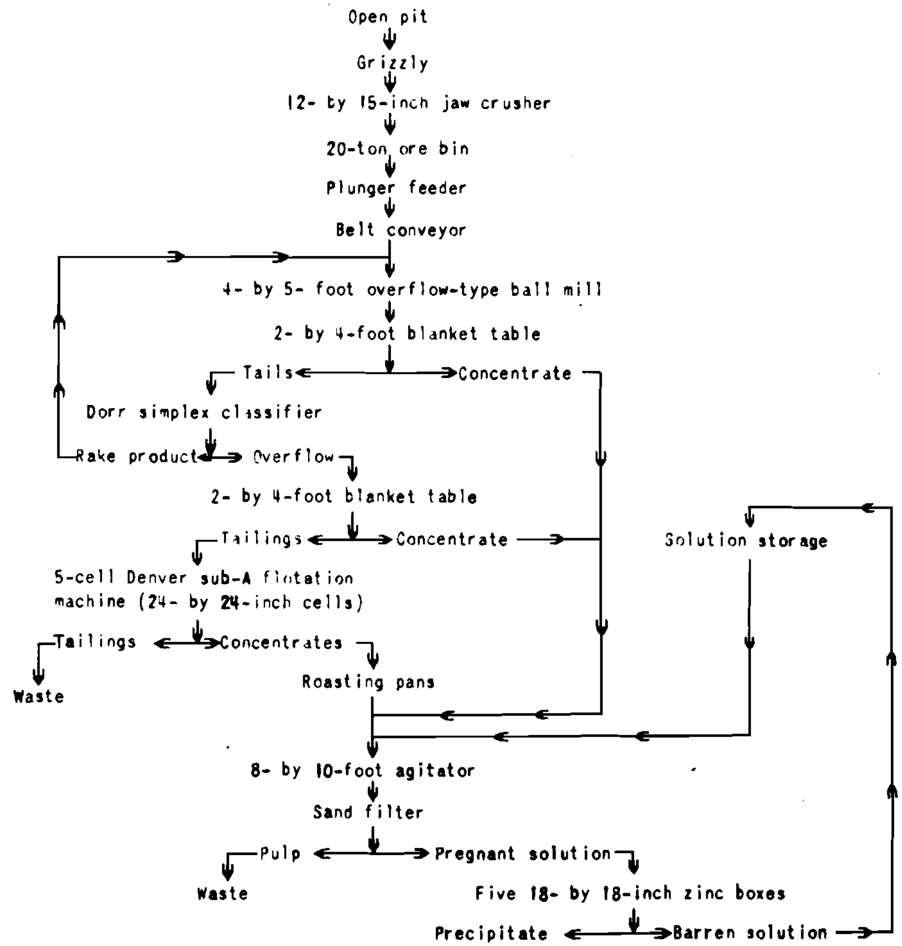


Figure 15.- Flow sheet, Robinson mill.

The following information, supplied by the Bunker Hill & Sullivan Mining Co. early in March 1938, indicates the metallurgical results being obtained at an early stage of operations:

> The ball mill is grinding about 18 tons per 24 hours; the overflow of the classifier is minus 65 mesh in size; tailings occasionally get as low as 0.02 ounce of gold per ton. The general average is 0.04 ounce of gold per ton of feed running from 0.6 to 0.8 ounce of gold.
>
> The reagents in use are a mixture of 90 percent Barretts No. 4 oil and 10 percent pine oil to the ball mill, ethyl xanthate in the head of the flotation roughers, and soap reagent ("tin reagent") in the head of the third cell of the roughers. The exact amount of these reagents in present use is not available to us; the last information indicated 0.2 pound per ton of oil; 0.2 pound per ton of xanthate, and 0.05 pound per ton of soap reagent.

Robinson Mine (Dixie Dike)

The property of the Robinson Mining & Milling Co., locally referred to as the "Dixie Dike" or "Robinson Dike", is situated near the divide between Comstock Creek and Long Tom Creek, 3.4 miles by road south of Dixie at an altitude of approximately 6,000 feet.

History

The first discovery and location on the lode was made by Louis Larsen in 1904; later, additional locations were made by W. N. Robinson and E. A. Cox. By early 1935 A. Robinson and W. N. Robinson had, by purchase and location, acquired full ownership of the claims and incorporated the property as the Robinson Mining & Milling Co. Later the same year, a 50-ton test mill was built and operated on ore from an open pit; during the seasons of 1935 and 1936, a total of approximately 2,000 tons of ore was mined and milled. Milling operations were suspended in 1937 while a crosscut was driven from the open pit diagonally across the ore body.

Geology

The "Dixie Dike" is a wide fractured and mineralized zone in silicified granite or granodiorite; it strikes approximately north 35° west and, according to Livingston[30] dips steeply to the northeast. Although the hanging wall was not visible in the workings visited by the writer, Livingston states that "the hanging wall is a dark, fine-grained dike, probably an andesite." The mineralized zone as exposed by the open pit and crosscut had a width of about 80 feet, measured horizontally perpendicular to the strike; the hanging wall, however, had not been reached. Ore in the open pit and all of the older workings was highly oxidized and considerably decomposed; this material, it was stated, usually assayed from $2 to $5 a ton in gold. The last 40 feet of crosscut had penetrated unoxidized ore; in a hand

30/ Livingston, D. C., Professional report made for the owners, 1934.

specimen it appeared originally to have been granite or granodiorite that had been highly shattered, silicified, and mineralized with fine seams and disseminated pyrite. This material was said to assay about $7 a ton. Whether the marked difference in value between the oxidized and the unoxidized ore was due to primary or secondary agencies had not been definitely determined; however, the fact that the unoxidized ore appeared in the hand specimen to have been much more highly silicified than the oxidized ore indicates that the difference is probably primary.

The length of the commercial mineralized zone had not been proved. The dumps of old workings 700 feet northwest of the open pit showed ore of the same character as that found in the pit. According to Livingston, the outcrop is well mineralized for a distance along the strike of at least 4,500 feet and had an average width of 100 feet or more.

Mining

The only mining had been for purposes of large-scale sampling by a mill run in 1935 and 1936. This ore was mined by hand from an open pit near the mill. Approximately 40 tons per day of partly decomposed ore was mined, trammed, and crushed by a crew of 5 men.

Milling

Although the mill was not operating in 1937, the importance of the deposit warrants a description of results obtained from the test run; the mill flow sheet is shown in figure 15.

Run-of-mine ore was crushed to 3/4-inch size in a 12- by 15-inch jaw crusher, whence it dropped into a 20-ton surge bin. A plunger-type feeder delivered ore from the bin to a short belt conveyor, which delivered to the ball-mill scoop.

A 4- by 5-foot overflow-type ball mill in closed circuit with a small blanket table and a Dorr simplex classifier ground the ore to minus 80 mesh. Classifier overflow passed over another small blanket table to a 5-cell Denver Sub-A flotation machine, which produced a final tailings and a rough concentrate; the flotation reagents used are tabulated under the section on metallurgical data. At the start of operation some difficulty was experienced in floating this highly oxidized ore; the addition of reagent Dixanthogen-6, however, was said to have eliminated this difficulty and resulted in an excellent recovery.

Concentrates from the blanket tables and from all five flotation cells were treated by cyanidation. It was soon found that the oil-coated flotation concentrates gave considerable trouble in the cyanide circuit; this trouble was remedied by a light roast prior to cyanidation. The concentrates in 1-ton batches were agitated in cyanide solution for 16 hours and then washed three times in an 8- by 10-foot Devereaux-type agitator. The pregnant solution was passed through a sand filter and precipitated in zinc boxes.

Metallurgical data:

Tons milled per 24 hours		40
Ball consumption	pound per ton of ore	1/2
Reagents, pound per ton of ore treated:		
Dixanthogen-6		.03
Z-8 xanthate		.2
404		.2
Aerofloat 31		.06
Barrett No. 4		.15
Strength cyanide solution	pounds per ton of solution	2-1/4
Cyanide consumption	pounds per ton of concentrate	3/4
Lime consumption	do	20
Ratio of concentration	(approximately)	100 : 1
Value of concentrate; ounces per ton:		
Gold	do	8
Silver	do	2
Extraction:		
By flotation, percent		92
Flotation tailings assay, per ton		$0.17
By cyanidation (includes blanket concentrate), percent		98

Power

Power was supplied by a 125-horsepower Russell steam engine driven by a 75-horsepower wood-burning boiler. This unit burned 3-1/2 to 4 cords of wood per day at a cost of $15 to $17 for cutting and firing; firewood was cut on contract at $2.25 a cord.

Labor

Operations were conducted under the supervision of the owners by a crew of twelve men, including five miners, five millmen and power-plant operators, and two woodcutters.

Surprise Mine (Painter Group)

The Surprise mine (see fig. 23) is situated at Painters Bar on the main Salmon River 10 miles by airline south of Dixie, or about 4 miles east of the mouth of the South Fork of the Salmon River; the altitude of the mine is approximately 2,000 feet above sea level. Operations were being conducted by the Idaho Newsome Mining Co., J. S. Devenney, president.

In 1937 the mine was accessible by airplane to the mouth of the South Fork, then 4 miles up-river by trail, or by road 10 miles from Dixie to the south rim of the Salmon River Canyon at about 6,500 feet altitude, thence about 5 miles by trail down the side of the canyon. The trail down the canyon had been improved to the extent that it could be traversed downhill by a caterpillar tractor dragging a maximum load of 7 or 8 tons on a wooden sledge; the usual load was 4 to 5 tons.

The ore occurs in an area of 100 acres or more, lying on both sides of the river. This area has been extensively fractured, silicified, and mineralized along the strongest fractures with galena, pyrite, and free gold. The granitic country rock was almost completely silicified in places. Current production was being obtained from a number of short quartz veins from a few inches to 4 or 5 feet wide. Within the same area were some large masses of the more highly silicified country rock, which, by reason of their greater resistance to erosion, stood up in prominent relief. At least part of these quartzitic masses contained considerable disseminated mineralization, which was claimed to be of commercial grade.

Mining was done by hand from short tunnels or in open cuts in the mountain side on the south side of the river. Ore from several openings on different veins was carried to the terminal of a single-cable, aerial, gravity tram, on which it was carried across the river to the mill.

The tramway, which was 1,700 feet long, consisted of a 3/8-inch steel cable and eight buckets each of 200 pounds capacity. The buckets were removed and reclamped at each terminal to permit passage of the cable around the sheave wheel. It was said that the tram had a capacity of 20 tons in 9 hours.

The ore was treated in a 25-ton amalgamating-concentrating mill driven by a 50-horsepower caterpillar Diesel engine. Other equipment on the ground, but not installed, consisted of a 100-horsepower Stroud-Johnson Diesel engine, an 8- by 10-inch Sullivan compressor, a portable road compressor, and Gardner-Denver drifting machines.

Ore from the tramway was received in a 125-ton bin, crushed to 1 inch by a 10- by 12-inch Dodge-type jaw crusher, and carried by belt conveyor to a 50-ton ore bin. The ore was then further reduced in a Gates gyratory crusher and a set of Faust 14- by 8-inch rolls; all three crushers were later replaced by a Patterson gyro-centric crusher, which reduced the feed to 1/2 inch in one operation. The crushers were followed by an 8-1/2-foot Lane Chilean mill operated without screens. Pulp from the Lane mill passed over three 4- by 5-foot amalgam plates arranged in parallel, then over a Wilfley table, followed by a McKeever suction riffle; quicksilver was fed to the Lane mill. Tailings were stored for future treatment.

L and L Mine

The L and L mine, owned and operated by E. G. Wagner and associates, is situated on the divide between Boulder Creek and Dixie Gulch, 2 miles by road north of Dixie, at an altitude of about 6,200 feet.

The mine was located in 1896 by Louis Larsen, who worked it alone in a small way for many years; the ore was treated in an arrastre and the tailings were then roasted and cyanided. In 1937 E. G. Wagner and partner purchased the property and installed a small mill, hoisting equipment, and sawmill.

The ore occurs in quartz veins along a line of fracturing and light shearing in granitic rocks. The fracturing and some mineralization may be observed at intervals for 500 to 1,000 feet in both directions from the present workings. So far, however, all work has been concentrated on an oreshoot that has been developed by a 120-foot shaft and about 300 feet of drifting on each of three levels. The vein strikes approximately east and west; the dip is practically vertical. Where productive, the vein is almost devoid of gouge; it varies from a thin seam to widths of about 14 inches. Past production records indicate an average of over an ounce of gold to the ton; it was stated that ore recently mined had assayed about $75 a ton in gold and $3 in silver.

The ore is mined by hand and hoisted in a sinking bucket by a single-drum, 18-inch-diameter, gasoline-driven hoist. The bucket dumps directly into a car, in which the ore is trammed a short distance to a 50-ton ore bin. Ore from the bin is crushed in a 4- by 6-inch Straub jaw crusher and elevated by a small bucket elevator to the feed scoop of a 20- by 30-inch ball mill, which operates in closed circuit with a small Esperanza-type drag classifier. An amalgamating cylinder is attached to the discharge trunion of the ball mill. Classifier overflow, at minus 60 mesh, passes through a launder lined with corduroy, then to a storage pond, where it is stored for future cyanidation.

The mill had a capacity of 6 tons of partly oxidized ore per 24 hours. It was said that a 70-percent recovery was made by amalgamation. Power for milling was supplied by a gasoline engine, which consumed about 5 gallons of gasoline per 10 hours of operation.

In addition to the mill and mining equipment, the mine was equipped with a sawmill having a capacity of 3,000 board feet of lumber per day; it was said that installation of a new carriage would increase capacity to 8,000 feet per day.

Dixie Comstock Mine

The Dixie Comstock mine is situated on Comstock Creek 3.5 miles by road south of Dixie at an altitude of approximately 5,500 feet. In July 1937 the Dixie Comstock Mining Co. had a small crew of men on exploratory and general repair work.

The ore occurs in quartz veins in gneiss and granite. The main workings have opened the vein through several adits; in the upper workings one oreshoot about 100 feet long was worked out by earlier operators. The lowest adit, in which most of the recent work has been done, follows a small shear or fault in gneiss; several quartz lenses occur at intervals for several hundred feet along this drift. A shaft had been started on the largest lens, which was from a few inches to 18 inches in width. The general strike of the shear was about north 50° west; the strike of the quartz lens at the shaft, however, was north 70° west. Across a small gulch from the main workings an adit had been driven for several hundred feet on a small quartz vein and gouge seam in granite; this adit was approximately on the strike of the main workings.

The mine was equipped with a gasoline-driven compressor, blacksmith shop, dry room, cook and bunk house, three family houses, and a 25-ton flotation mill about half a mile down the creek from the mine. Power for the mill was supplied by a 125-kilowatt generator driven by a 150-horsepower Diesel engine.

North Star Mine

The North Star mine is situated 2 miles by road south of Dixie at an altitude of approximately 6,000 feet. When visited in August 1937, preparations to resume active mining were being made by the Keith Star Mining Co.

The ore occurs in two quartz veins in granitic wall rock; one vein strikes north 80° west, the other north 60° to 70° west. Both veins were from a few inches to 2 feet in width; in the oreshoots the vein walls were virtually free from gouge and in places were highly silicified and mineralized to such an extent that they were said to constitute low-grade ore for several feet beyond the quartz vein filling. The underground workings were all shallow and the ore highly oxidized.

A small mill was being remodeled and put into condition for operating. The mill equipment consisted of a jaw crusher, a 3- by 3-foot ball mill, a very small Straub ball mill for regrind purposes, two Fagergren flotation cells, and a concentrating table.

Motive power was supplied by an 18-horsepower steam engine driven from a 40-horsepower Erie City Economic fire-tube boiler. When last operated, this power plant was said to have consumed half a cord of wood in 8 hours.

BURGDORF DISTRICT

General Discussion

The Burgdorf district is here considered as including all the territory now tributary to Burgdorf Post Office; there are two active mining areas in this district - the Marshall Lake or Bear Creek, 17 miles by road north of Burgdorf (see fig. 2), and the War Eagle Mountain, 6 miles by airline northeast of Burgdorf. Some mineralization occurs between these two areas.

Because of the absence of rich placer deposits in this vicinity, the district was not opened to transportation nor intensively prospected for many years after most other mining districts of Idaho County; consequently, it has come into production only recently. The successful operation of the Golden Anchor mine on Bear Creek has attracted attention to the district, and the high gold content of many of the veins has encouraged vigorous development.

Nearly all the veins of both the Bear Creek (see fig. 16) and War Eagle areas are associated with granitic rocks of the Idaho batholith, although there is a noticeable tendency for them to be stronger and more productive

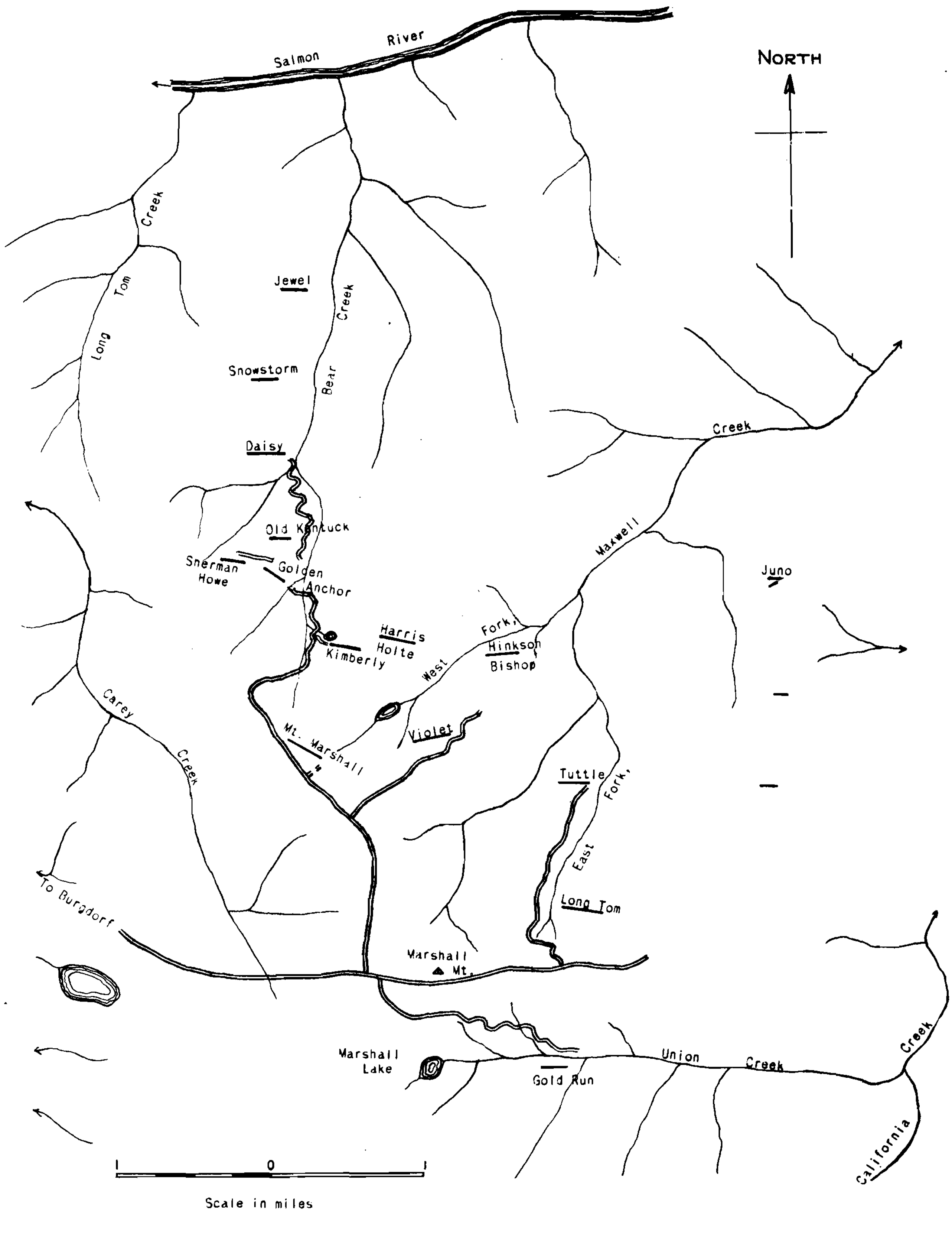


Figure 16.- Sketch showing approximate location and strike of Bear Creek veins, Burgdorf district.

close to the contacts of granitic rocks with one of the numerous bodies of gneiss or schist that appear to be remnants of the pre-Cambrian rocks into which the batholith was intruded. So far, the only ore deposits developed in this district have been of the quartz-vein type.

In 1937 the Golden Anchor mine was producing steadily, and development operations were in progress at a number of other veins in the Bear Creek area; the most aggressive developments are described in this paper.

So far, no oreshoots comparable to the Golden Anchor have been developed in the War Eagle area; consequently, these veins have been worked only on a very small scale by leasers or individual operators. Many of the veins, however, are high-grade and are similar in character to the veins of the Bear Creek area.

The post office at Burgdorf is about 6,000 feet above sea level; at present it is accessible to wheeled transport only from May to November, inclusive. During the winter, mail and supplies are brought from McCall to Burgdorf by tractor-drawn sled, but the mines must depend upon dog teams for such supplies as they import during the winter; however, in an emergency the Golden Anchor Mining Co. has hauled 4,000 pounds per trip from Burgdorf to the mine on a sled pulled by a caterpillar "22" tractor. The roads from the Burgdorf highway to the mines are usually closed until late June or early July. The completion of the new road up the Salmon River and the building of auxiliary roads, however, will greatly shorten the winter haul to the Bear Creek mines.

Golden Anchor Mine

The Golden Anchor mine, operated by the Golden Anchor Mining Co., W. Buford Davis, manager, is situated 17 miles by road north of Burgdorf on the south slope of the main Salmon River Canyon. The mine is at an altitude of 6,500 feet.

The following description is abstracted from a recent paper by Lorain and Davis.[31]

History

The vein was discovered in 1914 by a man named Fox, who sold it to L. T. Holte. Holte drove the adit now known as the 200-foot level, built a camp and mill, and mined the ore above this level; he then sank a shaft to the 300-foot level but ran into financial difficulties. The Golden Anchor Mining Co. was then organized; a 1,600-foot crosscut adit was driven and the vein was cut on the 600-foot level. In 1932 the United Verde Extension Mining Co. purchased a controlling interest and developed the mine intermittently until the summer of 1935, when a 50-ton mill was constructed at the portal of the 600-foot level crosscut. A production of approximately 30 tons a day has been maintained since the completion of the mill.

31/ Lorain, S. H., and Davis, W. Buford, Mining and Milling Methods and Costs of the Golden Anchor Mining Co., Burgdorf, Idaho: Inf. Circ. 7024, Bureau of Mines, 1938, 15 pp.

Geology

The Golden Anchor ore occurs in a quartz vein that has a general strike of north 50° east (fig. 17) and a dip of about 50° southwesterly; however, there are many local variations in strike and dip. The ore-bearing parts of the vein average about 2 feet in width; the width, however, may vary from 8 to 36 inches within a very short distance. Both walls of the vein may be schist, gneiss, or quartzite; in other places one wall may be quartzite and the other wall schist or gneiss. The planes of foliation of the schist and gneiss strike at right angles to the vein and dip 30° to 60° westerly. The vein is always stronger where one wall is schist or gneiss; where both walls are quartzite, the vein often becomes a mere slip plane carrying very low values. Gouge is almost entirely absent along the productive oreshoots.

The vein is cut by a series of faults, most of which strike north 30° to 60° east and dip 30° to 70° northwesterly. These faults displace the vein from a few inches to 50 feet horizontally; most of them are evidently pre-mineral and have had a strong effect on the localization of oreshoots. In many cases the oreshoots have apparently been localized by damming of the mineralizing solution below the intersection of a northeast fault with the vein fracture. It is also noticeable that the strongest ore bodies are formed in those parts of the vein fracture where the fault movement is strongest and nearly at right angles to the vein; on the other hand, there is relatively little ore where the fault movement is weak or forms an acute angle with the vein fracture. Furthermore, the ore usually is cut off abruptly against the right-angle faults but pinches out gradually as it approaches those faults that intersect the vein at more acute angles. These facts suggest the assumption that the vein fracture was formed by the tensional stresses set up by movement along the northeast faults, with the result that the strongest ore bodies are in those parts of the fracture subjected to the least shearing and the greatest direct tensional movement.

Oxidation has been strong near the surface and has continued along certain channels to the lowest workings; the surface ores and precolation channels are often stained with cerargyrite, malachite, and ferrous sulphate. In the lower levels, sulphide mineralization consists of tetrahedrite, galena, sphalerite, molybdenite, and pyrite, with free gold. There is considerable scheelite in the upper workings. The ratio of silver to gold in the upper workings is about 2 : 1; in the lower levels this ratio rises to 4 : 1 and sometimes becomes as high as 20 : 1. It is believed that this erratic distribution of silver is due to solution, and subsequent precipitation, by downward percolating surface waters.

Development and Mining

Development openings

The mine is developed through a 1,600-foot adit crosscut to the vein on the 600-foot level and through several shorter adits on the upper levels.

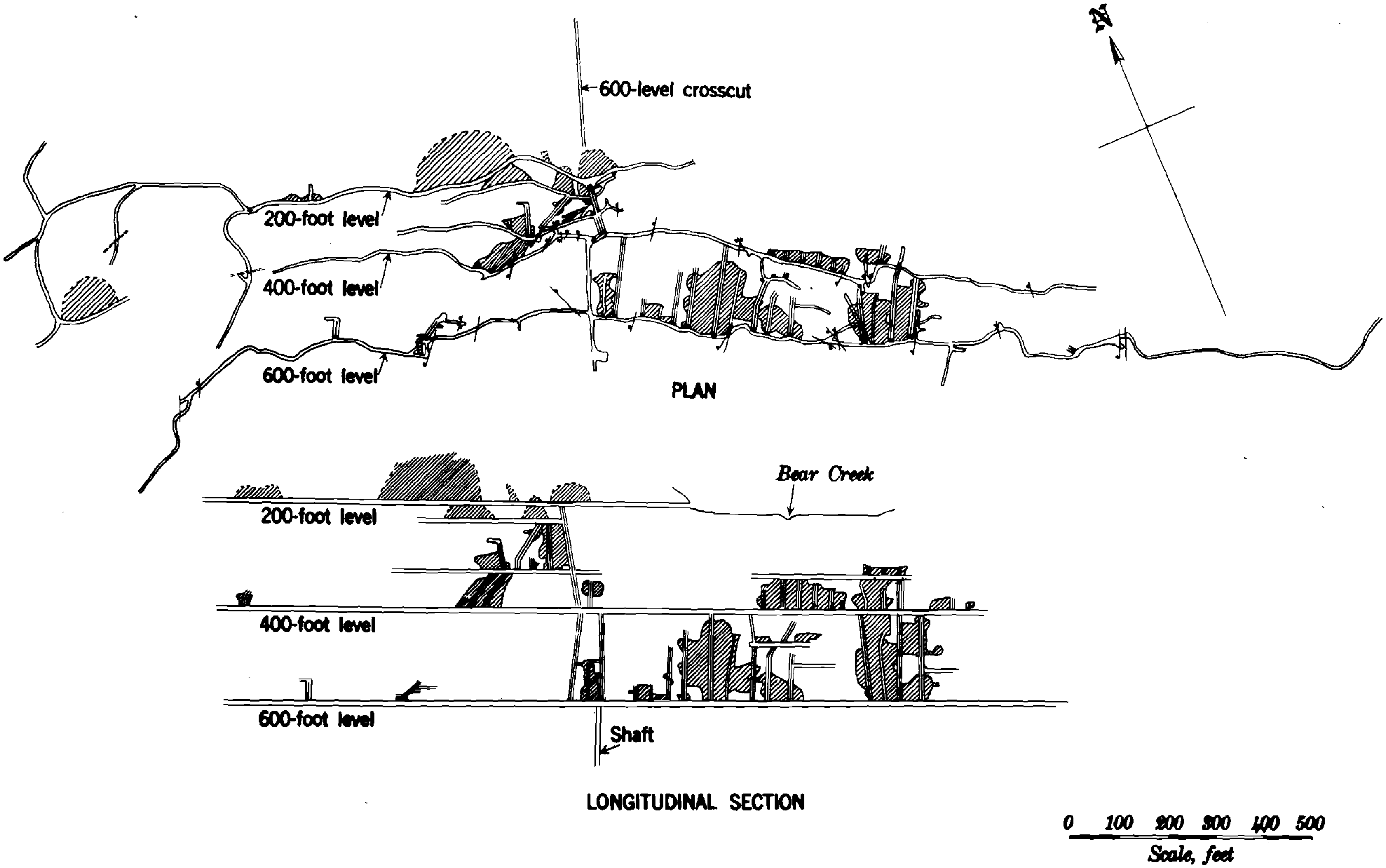
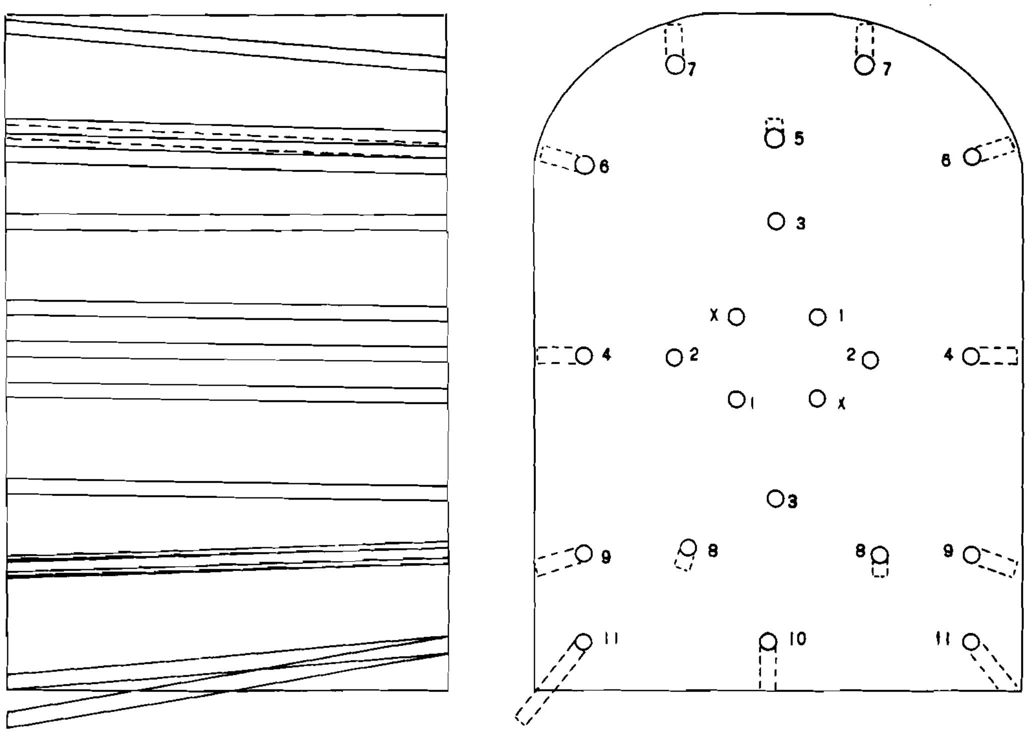
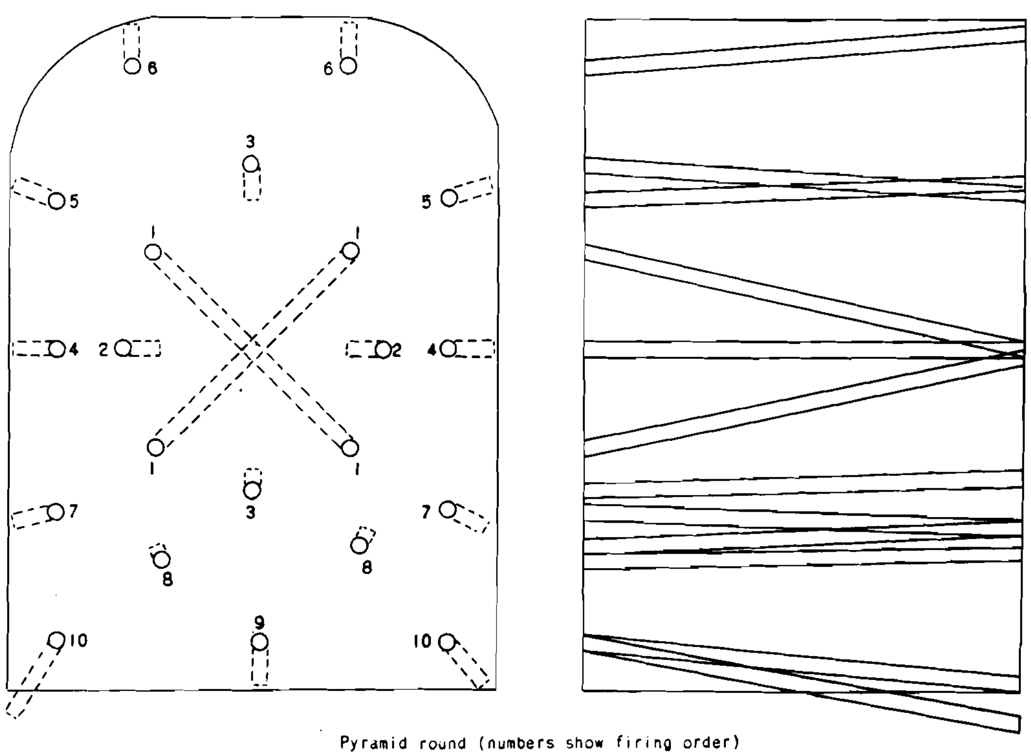


Figure 17.-Underground workings, Golden Anchor mine.



Burn-out round (numbers show firing order)



Pyramid round (numbers show firing order)

0 1 2 3 4
Scale, feet

Figure 18.– Drift rounds at Golden Anchor mine.

On the main or 600-foot level there are 2,400 feet of drifting on the vein in Golden Anchor ground and an additional several hundred feet in adjoining Sherman-Howe ground. Four other levels of varying lengths develop the vein between the 600-foot level and the surface. These levels have been driven at intervals of 45 to 200 feet; on the basis of past experience, it is now planned to drive future levels at 120-foot intervals measured along the vein.

During 1937 a two-compartment vertical shaft was sunk about 200 feet vertically (equivalent to 260 feet on the vein) below the 800-foot level. The shaft cut the vein approximately half-way between the 600- and the 800-foot levels. The skip compartment is 4-1/2- by 5 feet and the manway compartment is 4-1/2 by 3 feet in the clear.

Drifting methods

Drifts and crosscuts are 5 by 7 feet in cross section. Crosscuts are nearly always untimbered; drifts must frequently be timbered with full sets when they are in broken ground, but in ordinary ground they may be untimbered or the back may be supported with an occasional stull. Stope filling usually is supported entirely on stulls.

Ingersoll Rand L-74 drifters using 1-1/8-inch round lugged steel are used for drifting; bit gauges start at 1-7/8-inch and are reduced by 1/8-inch for each change. Rounds are drilled by one miner on day shift and are mucked out by one mucker on night shift; an average of 4.25 feet is broken per round drilled. The average advance per day is 3.75 feet, including all delays. Nearly all drifting is on company account.

The number of holes per round varies from 12 in soft ground to 22 in hard ground in drifts and crosscuts. A "toe" cut is used in soft ground; in hard ground a pyramid cut or burned cut is used. The burned cut is found particularly advantageous in blasting hard ground near timber; the two diagonally opposed holes of a 4-hole cut drilled at the corner of a 9-inch square are each loaded with 8 sticks of 60-percent gelatin and are blasted simultaneously; the other two cut holes are not loaded. The two types of drift round are illustrated in figure 18.

In most drift rounds an average of 5 sticks (1-1/8- by 8-inch) of gelatin dynamite is used per hole; 40-percent strength is used in soft and ordinary ground, 60-percent strength in hard ground.

Raising methods

All raises have two compartments - one is used for a manway and supplies and the other for an ore chute. A few raises in especially favorable ground are stulled and lagged; each compartment is 3 by 4 feet in the clear. All other raises are cribbed with 4-1/2-inch half-round timber; each compartment is 3 by 3 feet in the clear. Although the stulled and lagged raises require less timber, careful cost studies have shown them to be more expensive in over-all costs than the cribbed raises, which require less labor.

Stope raises are carried up with the stope; development and exploratory raises are driven with hand-rotated Ingersoll-Rand N 79 stopers using 1-inch quarter-octagon steel. Because of the isolation of the mine and the consequent difficulty of obtaining spare parts in emergency, the comparative mechanical simplicity of the hand-rotated stoper is considered to outweigh the advantages of the self-rotated stoper.

A 5-foot round is pulled with 15 holes, using a V-cut; the usual powder charge is 5 sticks of 40-percent-strength gelatin dynamite to the hole. One miner and a helper drill and blast one day and timber the next; this results in an average advance of 2-1/2 feet per day.

Sinking methods

Shaft rounds are drilled with Ingersoll-Rand BCRW 430 jackhammers using 7/8-inch hexagon steel in soft ground; in hard ground an L 74 drifter with jackhammer back head is used. Rounds 3-1/2 feet deep are pulled by a round of 24 holes, using a V-cut; the holes are arranged in 8 rows of 2 holes each, the two center rows constituting the cut. The usual powder charge is 90 sticks of 40-percent gelatin dynamite per round; all shaft rounds are fired electrically.

Two miners drill and blast a round on day shift and two muckers clean out the round on night shift; timber sets on 6-foot centers are placed in two shifts. This results in an average advance of approximately 2-1/2 feet per day.

Locally cut Douglas fir is used for shaft timbers; wall plates and posts are 8 by 8 inches and dividers 8 by 6 inches in section.

Stoping methods

Ore is broken by resuing in flat-back cut-and-fill stopes, as illustrated in figure 19. Stopes are started directly from the drifts; the stope fill is supported on 8-inch stulls placed 5 feet apart and covered with 3-inch round or sawed lagging. Another row of stulls, without lagging, is placed 5 feet above the first row for the purpose of arching the fill and relieving the load on the drift timbers; stulls in the second row are staggered with relation to those in the first row.

Two-compartment cribbed raises spaced about 35 feet center to center, or 30 feet from inside to inside of the ore compartment, are carried up with the stope. One compartment is used for ore, the other for men and supplies. Tugger hoists with 3/8-inch steel cables are used to hoist supplies in small steel skips that run on wooden slides in the manway compartment.

Stopes are carried 4 feet wide, measured at right angles to the vein; inasmuch as the vein averages about 2 feet wide, the ore and waste usually are broken alternately by resuing. In 65 to 70 percent of the working faces the ore is first broken onto overlapping steel mucking plates and shoveled into the ore raise; the plates are then taken up and either the hanging or footwall broken and allowed to lie for stope fillings; at the other places

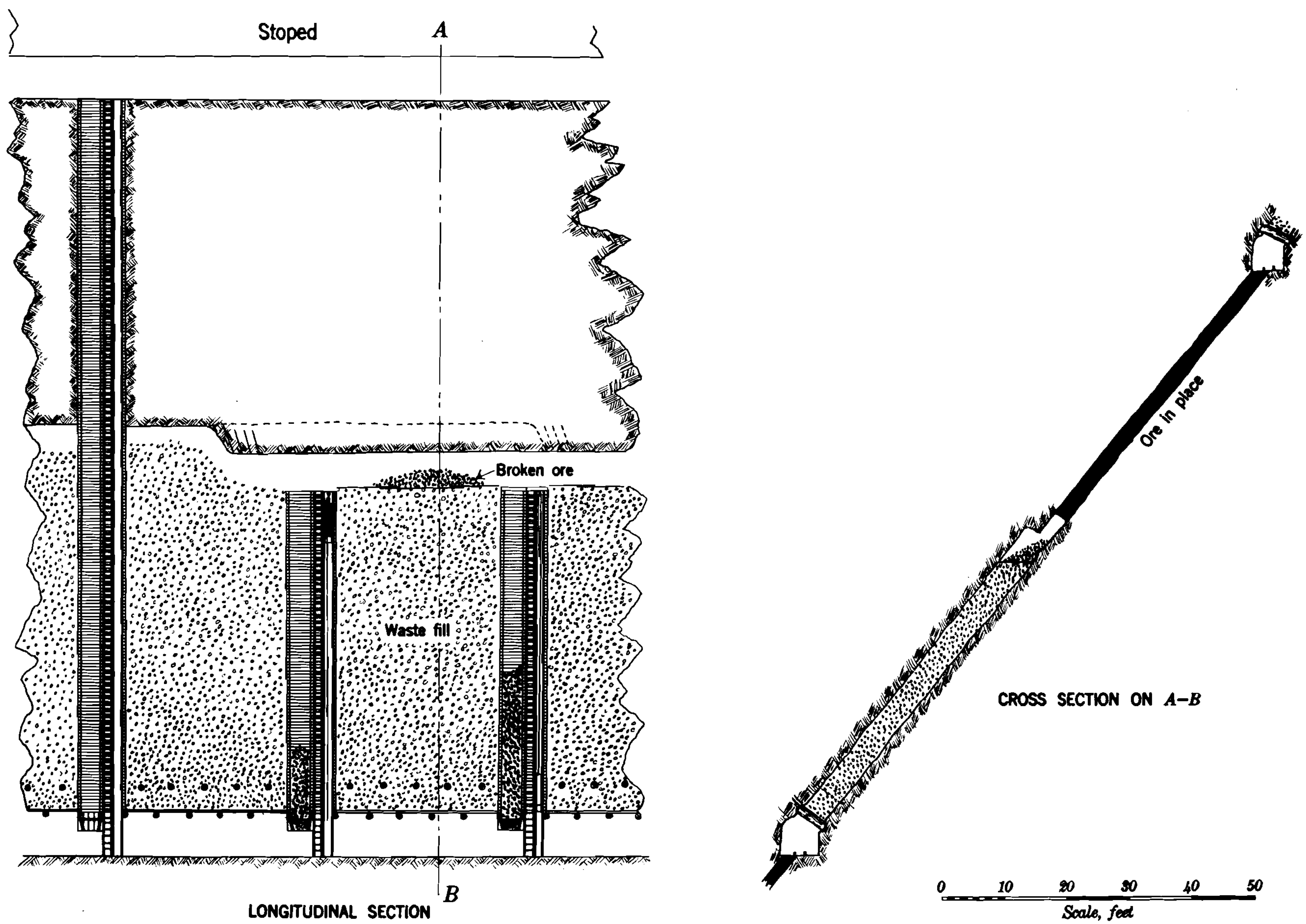


Figure 19.–Stoping method at Golden Anchor mine.

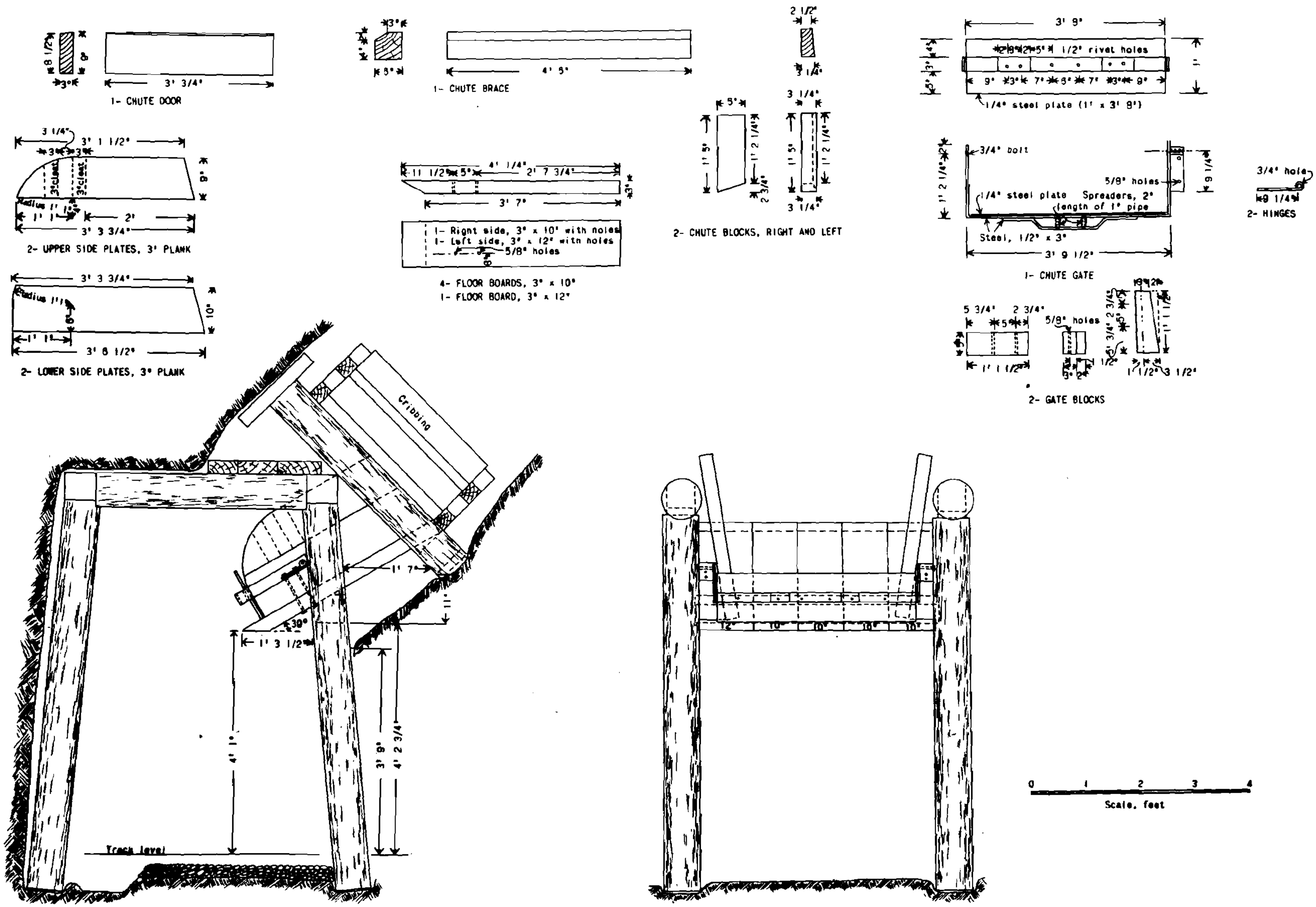


Figure 20.—Details of chute construction, Golden Anchor mine.

the process is reversed by breaking the waste first; ore is carefully sorted in the stopes. Occasionally, where the vein is exceptionally wide, it is necessary to place extra shots in the footwall to fill a stope.

Stope filling is kept within about 6 feet of the face; an occasional stull is required to support weak sections of the hanging wall until a stope is filled. It is seldom, if ever, necessary to draw waste from the stopes, nor is filling brought into stopes from other working places.

Each miner, assisted by a mucker, does all drilling, timbering, and other work required in his working place. Hand-rotated stopers are used, as in raising; an average of eight 4-foot holes is drilled and blasted per machine shift; the usual powder charge is 3 sticks of 40-percent-strength gelatin dynamite per hole. In some working places blasting is done twice a shift; all drilling and blasting is done on day shift. Inasmuch as there is insufficient air to operate all drills at the same time, drilling time is allotted to each miner by the shift boss.

On the main level, steel and other supplies are delivered to the stopes and transfer raises by the motorman. Supplies for the upper levels are hoisted through the transfer raise by the hand trammer and are distributed by him to the stope raises. The main transfer raise is an old stope raise extending to the 400-foot level; this raise has been equipped with a small skip running on a 24-inch gauge track and pulled by an air hoist. Stope miners or muckers take their supplies from the bottom of the stope raises.

Tramming

Ore from the upper levels is trammed to a transfer raise by hand in 20-cubic-foot-capacity cars. On the main or 600-foot level a Mancha "little trammer" pulls a train of 12 cars of 16-cubic-foot capacity each. A maximum of about 50 cars of ore is trammed on day shift and 50 cars of waste on night shift. One motorman on each shift pulls all ore chutes on the main level or trams waste from development and handles all supplies.

Chutes are 3 feet wide at the lip and flare to a width of 4 feet at the back, as illustrated in figure 20; they are built of 3-inch plank throughout. A simple and efficient steel chute gate that may be made by any blacksmith (fig. 20) is safely and quickly operated by the trammer, who stands at one side of the chute and inserts a bar in the handle shown in the sketch.

Sampling

Development faces are sampled at 5-foot intervals by channel samples taken by the manager. Stope faces are sampled only when there is a doubt as to their value. A careful check of the results of channel sampling against actual mill recoveries plus tailings assay indicated a dilution of 7.1 percent by value.

Milling Methods

Ore is treated in a 50-ton amalgamation-flotation mill operated two shifts a day. The flow sheet is shown in figure 21.

Ore from the mine is received in a 50-ton bin covered with an 8-inch grizzly, on which oversize is broken by hand. Two hand-operated gates control the flow of ore from the coarse-ore bin on to a grizzly with a 3/4-inch space between the bars. The oversize is crushed in an 8- by 24-inch Allis Chalmers Blake-type jaw crusher run at 230 r.p.m. and set for 1/2-inch discharge. Crushed ore and grizzly undersize fall into a 50-ton fine-ore bin.

From the fine-ore bin the ore is fed by a 15-inch by 6-foot Denver belt ore feeder traveling at 18 inches per minute to a 4-1/2- by 5-foot open-discharge ball mill loaded with forged-steel balls of 3-inch maximum size. The ball mill is lined with wave-type liners and is operated at 32 r.p.m. through a Texrope drive. It is operated in closed circuit with a 12- by 18-inch Denver mineral jig and an Akins classifier. The jig pulsates at 300 strokes per minute and the classifier rotates at 5-1/2 r.p.m. A jig bed 2 inches deep, composed of 3/8-inch ball bearings, has been found much more satisfactory than the shot bed originally used. About 15 pounds of jig hutch is drawn on each shift, and the jig concentrate is run over a half-size Wilfley table, which produces a tailing, middling, and concentrate; the middling is accumulated and run over the table again, and tailings from the two runs are returned to the classifier. Concentrates from both runs and middling from the second run are amalgamated in the amalgam barrel.

Classifier overflow passes over three 11-inch by 12-foot tables arranged in parallel and covered with rubber matting; tables slope 1-1/4 inches per foot. Concentrates are removed from the matting every two days and amalgamated with the jig concentrates in the amalgam barrel.

The amalgam barrel is operated when sufficient concentrates have accumulated, usually about twice a month. The concentrates are ground for 6 hours with mercury, lye, and about a dozen 4-inch steel balls. The amalgam is retorted and the rejects, which assay about 14 ounces of gold to the ton, are shipped to the smelter.

Tailings from the blanket tables are fed to the second cell of a 6-cell, 15-inch Denver Sub-A flotation machine; this cell is used as a conditioner only. The pulp then goes to the last four cells in series; the concentrates from these cells are returned to the first cell for cleaning. Reagents are added to the feed to the conditioner cell by a Denver reagent feeder in the quantities shown in the table under the section on "Metallurgical data." Soda ash was used formerly but was found definitely to depress gold values; consequently, its use was discontinued; the present flotation circuit is virtually neutral.

Flotation concentrates from the first cell are thickened in a 36-inch diameter cone, from which the pulp is discharged by a hand-operated diaphragm

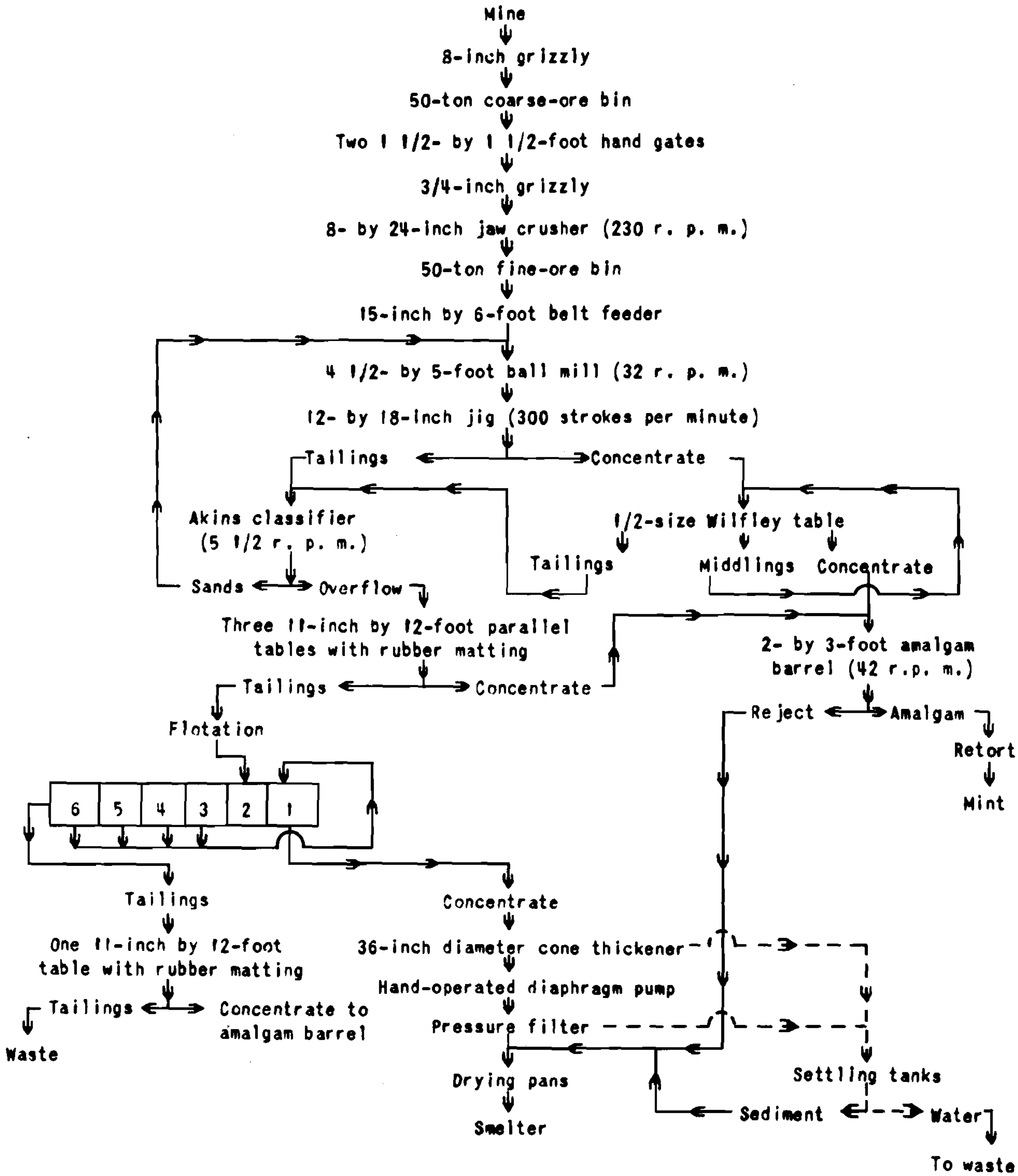


Figure 21.- Flow sheet, Golden Anchor mill.

pump and filtered in a pressure filter of local design and construction. The filter consists, essentially, of a round iron box 18 inches in diameter and 18 inches high, in the bottom of which is a spirally grooved plate covered with filter cloth. The box is nearly filled with concentrate, air pressure is applied, and the moisture is forced out through the spiral grooves. The filtered concentrate contains 10 percent moisture; it is then dried more thoroughly in pans and sacked for shipment in lined sacks with cemented ends and of 100 pounds capacity.

The sacked concentrates are trucked 17 miles to Burgdorf in 3-ton loads; they are then reloaded in 10-ton trucks and hauled the remaining 550 miles to the smelter at Garfield, Utah. The total cost of trucking from the mine to the smelter is $26 per ton of concentrates.

Metallurgical data for 1937:

Head assay........................ ounces per ton gold,	0.711	silver,	2.583
Tailing assay...................... do.	.0488	do.	.670
Tons crushed per hour of crusher operation..............................			7.908
Tons milled per hour of mill operation..................................			2.025
Reagents per ton of ore milled, pound per ton of ore:			
Aerofloat No. 25..			.298
Xanthate Z-3..			.224
Pine oil..			.099
Forged-steel balls..........................pounds per ton of ore			3.55

Sample screen analysis of tailings

Mesh	Percent	Gold	Assay (ounces/ton silver)
On 60......................	0	0	0
Through 60 on 100...........	2.44	Trace	Trace
Through 100 on 200..........	34.10	0.03	1.48
Through 200.................	63.46	.07	2.92

Extraction

	Percent
Gold:	
By amalgamation:	
From jig concentrate....................	73.3
From table concentrate..................	2.34
Total by amalgamation...................	75.64
By flotation................................	17.39
Total.......................................	93.03
Total extraction of gold and silver for the year of 1937:	
Gold....................................	93.03
Silver..................................	80.71
Ratio of concentration......................272.42 to 1	

Sample concentrate assay

		Percent
Gold	ounces per ton	36.45
Silver	do.	537.8
Lead	percent	4.5
Copper	do	1.3
Moisture		5.6

General Operating Data

Labor

Average labor distribution for 1937:

Mining:		
Exploration and development:		
Miners on drifting and raising	4	
Muckers on drifting and raising	4	
Miners in shaft	2	
Muckers in shaft	3	
Hoistmen for shaft	2	
Outside prospecting (hand mining)	4	
Total		19
Stoping (including tramming):		
Miners in stopes	5	
Muckers in stopes	5	
Muckers on general mine labor	3	
Hand trammers (on upper levels)	1	
Motormen	2	
Shift boss	1	
Total		17
Outside labor:		
Blacksmith	1	
Compressor and warehouse man (millman takes care of compressor on night shift)	1	
Timber framer	1	
Power plant operators	3	
General surface labor	2	
Total		8
Milling:		
Crusherman	1	
Mill foreman-operator	1	
Mill operator	1	
Total		3
General supervision:		
Manager	1	
Assayer, engineer, bookkeeper	1	
Total		2
Total on direct operation		49

Wage scale

The following wage scale was in effect in September 1937:

	Per shift
Miners	$5.50
Muckers	5.00
Motormen	5.50
Timber framers	5.00
Shaft miners	5.75
Hoistmen	5.50
Millmen	5.50
Crushermen	5.00
Blacksmith	5.50
Compressormen	5.00
Outside labor	4.40
Power plant operators	5.50

Power

Power requirements:

Connected power:

	Horsepower	
Mine:		
Compressor, single-stage Chicago Pneumatic, 200-cubic-foot capacity	50	
Compressor, two-stage, 8- by 10-inch, 14- by 10-inch, 460-cubic-foot capacity at elevation of mine (6,500 feet)	75	
Underground hoist motor, driving Eimco hoist, 5,000-pound rope pull at 150 feet per minute	25	
Battery-charger	5	
Wedge and cribbing saw	5	
Centrifugal pump	15	
Total mine		175
Outside: Sawmill, driven by take-off from tractor.		
Mill:		
Crusher	25	
Feeder	1/2	
Ball mill and jig	50	
Classifier	1-1/2	
Flotation (three 3-horsepower motors)	9	
Miscellaneous	6	
Total mill		92
Total connected power		267

Power consumption - A metered record of power consumption is not kept. The usual load at the power house is 175 horsepower on day shift, 182 horsepower on afternoon shift, and 112 horsepower on night shift. This gives an approximate daily power consumption of 2,799 kilowatt hours, or about 91.66 kilowatt hours per ton mined and milled. These power requirements are calculated on the basis of operation in late 1937 and include shaft development.

Power supply - Power is obtained from a power plant 4 miles from the mine. This plant was originally built for a neighboring mine but is now leased by the Golden Anchor Mining Co. Power is generated by a Rathbun-Jones Diesel engine direct-connected to a 175-kilowatt generator; the Diesel has a sea-level rating of 250 horsepower; at the elevation of the power plant (6,000 feet) it develops 212 horsepower. Power is transmitted at 2,200 volts and is reduced to 440 volts at the mine.

Cost of power generation - The plant consumes an average of 5,500 gallons of fuel oil per month and requires the attendance of three operators when operating three shifts a day. The following table gives the cost of generating power, in cents per kilowatt hour:

Labor	0.548
Supplies	.045
Fuel oil	.760
Rents	.226
Total	1.579

Timber and firewood

Timber and firewood are cut locally and sawed at the mine; native pine and fir are used for most purposes.

Mine timber is cut in 16-foot lengths with 6-inch tops at a contract price of $5 a cord; the larger pieces are sawed into lumber and the rest cut and framed for various mine purposes.

Sawing and framing are performed in a shed at the mine portal by the timber-framer assisted, when sawing lumber, by an extra man as off-bearer. With the American No. 1 sawmill, driven by the caterpillar tractor, two men can saw 8,000 feet of lumber per day with a fuel consumption of about 10 gallons of gasoline. The direct cost of rough-sawed lumber, therefore, is approximately as follows:

	Per 1,000 board feet
Cut and deliver 1,000 board feet (about 1-1/4 cords at $5 a cord)	$ 6.25
Gasoline, 1.25 gallons at $0.19, delivered	.24
Labor, two men 1/8 day	1.25
Total direct	$ 7.79

Slabs from sawmill operation are used for lagging and cribbing; however, they are not included in the 1,000 board feet on which the above cost is based.

This compares with a cost of $27 a thousand for lumber delivered from the nearest commercial sawmill.

In the fall, 400 cords of mine timber are laid in for the winter's supply. About 50 cords of wood is required to heat the mill during the winter. This wood is cut and delivered on contract in 5-foot lengths at a cost of $5.50 a cord. About 35 cords of wood is required for the cook house during the year; during the same period about 215 cords is required to heat the bunkhouses, 10 family cabins, manager's office, engineering office, and assay office. This wood is cut and delivered in 18-inch lengths at a contract price of $6 a cord.

Cost of freight and general mining supplies

The cost of the principal mining supplies delivered to the mine in 1937 was as follows:

Dynamite, per 100 pounds:	
40-percent strength	$13.54
60-percent strength	15.34
Fuse, per 1,000 feet	6.19
Caps, per 100	1.313
Fuel oil, per gallon	.11
Timber..........(See section on timber and firewood)	

Miscellaneous supplies cost the regular city prices plus a freight charge of $0.90 a hundred from Boise (176 miles); or $0.50 a hundred from McCall (47 miles).

Operating Costs

The following costs are averaged for the year 1937. During this period 9,546.63 tons of ore was mined and milled, 11,245 tons of waste trammed, and 2,933.11 feet of development drifting and raising completed. A shaft was also started and sunk 200 feet; sinking costs are not included in the per-ton costs given below, however. Liability insurance and social security taxes are included in the costs given; other taxes, depreciation, depletion, etc., are not included.

Mining costs per ton of ore mined

Item	Stoping[1/]	Development[1/]	Mine maintenance	Total
Labor	$2.40	$1.83	$0.06	$4.29
Explosives	.20	.24		.44
Timber	.07	.04		.11
Power and air	.31	.27		.58
Other supplies	.37	.37		.74
Liability insurance	.12	.09		.21
Overhead[2/]	.31	.31		.62
Total	$3.78	$3.15	$0.06	$6.99

1/ Includes tramming. 2/ Includes supervision, assaying, engineering, office, and social security taxes.

Milling costs per ton of ore milled

Labor	$ 0.57
Power	.72
Wood for heat	.03
Other supplies	.47
Maintenance	.02
Express and mint (bullion)	.13
Freight and smelter (concentrates)	.15
Overhead[1]	.61
Total	$ 2.70

1/ Includes supervision, assaying, engineering, office, and social security taxes.

Summary of mining and milling costs

	Per ton	
Mining:		
Development	$ 3.15	
Stoping	3.78	
Maintenance	.06	
Total		$ 6.99
Milling		2.70
Total mining and milling		9.69

Cost of sinking per foot[1]

Labor	$ 32.34
Explosives	2.82
Power and air	4.51
Timber	.59
Other supplies	1.92
Liability insurance	1.61
Total	43.79

1/ Based on cost of sinking approximately 160 feet. This does not include cost of equipment or preparation, but does include a heavy pumping cost. Operations were generally handicapped by heavy water flow.

Operating costs in units of labor, power, and supplies

Mining

Item	Development[1]	Stoping	Total
Labor (man-hours per ton):			
Drilling, blasting, and timbering..........	0.89	1.52	2.41
Mucking..................................	.89	1.72	2.61
Tramming.................................	.28	.26	.54
Supervision..............................	.26	.26	.52
General[2]................................	.33	.34	.67
Total....................................	2.65	4.10	6.75
Average tons per man shift................	.467	.723	1.19
Power and supplies:			
Explosives, pounds per ton:			
40-percent strength.................	1.08	1.49	2.57
60-percent strength.................	.26	-	.26
Total....................................	1.34	1.49	2.83
Timber........... board feet per ton......	200	257	457
Power.............. kilowatt hours per ton	[3]22.15	25.10	47.25
Other supplies...... percent of total supplies and power.......................	40.21	38.90	39.5
Total supplies and power...... percent of total cost...........................	29.2	25.1	26.8

1/ Exclusive of sinking.
2/ Includes outside labor directly chargeable to underground operation.
3/ Power consumption for sinking was 14.18 kilowatt hours per ton mined during the period of sinking.

Milling

Labor (man-hour per ton milled):	
Crushing..	0.17
Operating.......................................	.40
General labor...................................	.02
Total...	.59
Power .... kilowatt hours per ton milled	30.23
Reagents..........................pound per ton milled	.621
Steel, pounds per ton milled:	
Balls...	3.55
Liners..	.857
Total...	4.407
Wood for heat.......................... cords per ton..	.0268

Hinkson and Bishop Mine

The Hinkson and Bishop mine, owned and operated by H. R. Hinkson and A. C. Bishop, is situated on the West Fork of Maxwell Creek at an altitude of approximately 6,600 feet; it is reached from Burgdorf by 14 miles of road to a ridge between the headwaters of Carey, Bear, and Maxwell Creeks, thence about 1 mile by trail downhill to the mine.

Geology

The ore is in a quartz vein near a contact between granitic rocks and a basic intrusive. The oreshoot being worked is in the granite close to or actually on the contact; it strikes south 85° west and dips 40° to 60° south. Metallic mineralization consists chiefly of galena, sphalerite, pyrite, and free gold.

Development and Mining

It was stated that 343 tons of ore had been mined and milled from a stope about 80 feet long; this stope had been worked from an adit drift at the mill level; a few inches to several feet of ore were exposed in the stope faces. The ore was broken by resuing in overhand cut-and-fill stopes; all drilling was by hand.

Milling

The mill, which was housed in a 15- by 25-foot log building, consisted of two 850-pound stamps and a 4- by 7-foot amalgam plate. The stamps were set for a 5-inch drop at 90 drops to the minute; they crushed about 6 tons of ore per 24 hours to pass through a 30-mesh screen, or about 4 tons through a 40-mesh screen. Screens were set about 5 inches above the dies.

Tailings from the amalgam plate were carried by launder to another building and passed over a Wilfley table, which produced a $170 concentrate and a final tailing.

A recovery of about 70 percent was made by amalgamation alone; of this, 50 percent was recovered inside the battery and 20 percent on the plates. Tests run by a well-known ore-testing laboratory indicated that the gold was 80 percent free at 150 mesh. The gold is 670 to 680 fine.

The Wilfley table recovered 25 to 35 pounds of concentrate per ton of ore treated; laboratory tests indicated that by grinding to 150 mesh and floating about 75 pounds of concentrate would be recovered per ton of ore treated. A smelter assay of current table concentrate was as follows:

Gold	ounces per ton	5.04
Silver.........	do.	7.40
Lead..................	percent	4.9
Insoluble..............	do.	30
Zinc..................	do.	4.3
Sulphur................	do.	28.8
Arsenic................	do.	.8
Iron...................	do.	24.8
CaO....................	do.	1.8
Antimony...............	do.	.3

Power

Power for the stamps was supplied by a 6-horsepower steam engine and a 7-horsepower boiler; this unit consumed about two-thirds cord of wood in 24 hours' operation.

The table was driven by a 3-horsepower gas engine, which consumed about 4 gallons of gasoline in 24 hours' operation.

Kimberly Mine

The Kimberly mine, operated by the Gold Run Mining Co., Daniel Flotre, manager, is situated on Bear Creek about 1 mile by road south of the Golden Anchor at an altitude of about 7,200 feet.

When visited in September 1937, this property was just getting into production. A new bunkhouse had been built and a small compressor, blacksmith shop, and other mining equipment had been installed. Some ore was being mined in open, overhand stopes and trucked to a neighboring mine for a mill test.

One oreshoot about 270 feet long over all, with an average width of about 12 inches, had been opened through a short adit crosscut and a drift on the vein. The ore is in a quartz vein in silicified granitic rock; the vein strikes south 80° east and dips about 80° south.

Old Kentuck Mine

The Old Kentuck mine, owned and operated by H. H. Hackett, is situated on Bear Creek a short distance north of the Golden Anchor mine.

A lower adit 300 feet long and a shorter upper adit had been driven along a quartz vein, which, in its strongest parts, lay between quartzite and gneiss. The vein strikes approximately west and dips about 60° south.

When visited, the workings were only partly accessible but were being cleaned out preparatory to the beginning of work; an ore bunker was being built, and part of the machinery for a small mill was on the ground ready for installation.

Two Margaret Mine

In September 1937, the Goodenough and Daisy veins were being actively developed by the Two Margaret Mining Co., R. C. Field, superintendent. This mine is situated on the west side of Bear Creek about 1-1/2 miles by road north of the Golden Anchor mine at an altitude of approximately 5,500 feet above sea level. A switchback extension of the Golden Anchor road had recently been completed to the Two Margaret mine, and preparations were being made to truck ore to a neighboring mill for a mill run.

A lower adit drift 85 feet long had been driven on the Daisy vein; another adit drift 160 feet long had been driven on the same vein at an elevation 78 feet above the lower drift. Both of these drifts followed a quartz vein in silicified granite and gneiss. Near the end of the upper tunnel a stope had been started on an oreshoot that had a maximum width of about 36 inches.

The vein strikes approximately west and dips 50° to 60° south; the ore was highly oxidized.

Long Tom Mine

The Long Tom mine, owned and operated by G. E. Hyatt, is situated on the East Fork of Maxwell Creek about 15 miles by road northeast of Burgdorf at an altitude of about 7,500 feet.

The ore occurs in a quartz vein in silicified granite country rock containing tongues of schist and gneiss. The vein has been traced by adits and open-cuts from the creek bottom in an easterly direction for a horizontal distance of about 600 feet to a long open-cut about 400 feet higher than the lowest adit, which is 400 feet long. The vein strikes east to south 80° east and dips 40° to 70° south; it pinches and swells frequently from a mere crack to a width of about 12 inches; in general, the ore "makes" close to or in the gneiss or schist and "pinches" in the granite. Although narrow, the vein is high-grade; the owner stated that nine samples from various points along the strike averaged $97 per ton in gold. For a number of years the owner has been making a grubstake by selective hand mining and then grinding the selected high-grade with a hand morter and pestle.

Although the ore is strongly oxidized in most places where exposed, unaltered grains of galena and sphalerite could be observed.

Gold Run Mine

The Gold Run mine is situated on the south side of Union Creek, a tributary of California Creek, at an altitude of about 7,500 feet above sea level; it is connected with the Burgdorf-Bear Creek road by about 2-1/2 miles of recently constructed switchbacks. The Gold Run Mining Co., Daniel Flotre, manager, had recently mined and sorted about 50 tons of high-grade ore, which it was preparing to ship to a neighboring mill for treatment.

An adit drift had been driven in a westerly direction along a fracture in granitic rocks and gneiss; the strongest ore occurred in lenses 18 inches to 2 feet wide, where the fracture coincided with the contact. A 50-foot shaft had been sunk but was full of water when visited. Metallic mineralization consisted chiefly of pyrite, galena, and sphalerite, and free gold.

A bunkhouse, headframe, and several auxiliary buildings had been completed recently.

Duerdon Mine

The John Duerdon mine was inactive when visited but will be described briefly because of its mineralogical differences from other mines of the district. This mine is situated on Quartz Creek 6.2 miles by road north of Burgdorf at an altitude of about 6,700 feet.

The ore is in a zone of fracturing and light shearing in hydrothermally altered granitic rocks; its strongest exposure is in the face of a 200-foot adit and in an open-cut about 60 feet vertically above the face of the adit. The face of the open-cut shows highly oxidized mineralization across a width of about 14 feet; the face of the drift shows about 6 feet of banded sulphides. Galena, sphalerite, pyrite, pyrrhotite, covellite, bornite, and chalcopyrite have been identified. An assay certificate on one sample showed the following metal content:

Silver............	ounces	4.8
Lead.............	percent	6
Zinc.............	do.	31
Iron.............	do.	20

A sample of wall rock examined at the University of Idaho was reported to contain actinolite, tremolite, diopside, and calcite.

The shearing, which has a nearly vertical dip, strikes north 10° west; it can be traced at intervals across Quartz Creek and up the mountain side; mineralization is evident at several points.

War Eagle Mine

The War Eagle mine is situated near the top of War Eagle mountain about 12 miles by road northeast of Burgdorf at an altitude of about 7,800 feet. The mine, which is owned by the War Eagle Mining & Milling Co., was being operated under lease by Nick Giboy.

The ore is in a number of short, but frequently wide, quartz lenses in a large area of shattered granitic rocks containing large inclusions of gneiss and schist; in some places narrow stringers of high-grade ore are found in the schist. The veins generally strike about south 70° east and dip at varying angles to the south. Development work consists of several open-cuts, a small shaft, and an adit some hundreds of feet long.

Ore from the open-cuts and shaft had been milled in a small plant consisting of a 6- by 8-inch jaw crusher driven by a 5-horsepower Fairbanks Morse gas engine; an Amador mill driven by an 8-horsepower Cushman gas engine; a 22- by 34-inch amalgam plate; and a gold trap; the tailings launder was lined with corduroy blankets. It was said that some of the ore, all of which was strongly oxidized, had yielded $40 a ton by amalgamation.

WARREN DISTRICT

General Discussion

The high gold content and relative persistence of the quartz veins of the Warren district (fig. 22) attracted the attention of quartz miners in the early days of the camp. Several of the veins were worked with profit, even under the adverse conditions then existing. According to Lindgren,[32] the quartz veins of the Warren district produced $125,000 prior to 1871. Operations on some veins were nearly continuous until about 1900 and have been intermittent up to the present time.

Lindgren states that the largest producers were the Little Giant, which produced $178,000 in gold and $16,000 in silver from 1,665 tons of ore between 1883 and 1897; and the Rescue, which produced between $100,000 and $150,000 between 1868 and 1897. He also states that the Charity produced 3,000 tons averaging $15 a ton. Except for recent production from the Unity mine and a few of the smaller operations that have become active in the last few years, lode production of the district after 1900 was relatively unimportant.

The veins of the Warren district all occur within granitic rocks of the Idaho batholith; the large inclusions or roof pendants of gneiss and schist found in most other Idaho County mining districts are generally lacking. The lines of fracturing on which the veins are formed, although often no more prominent than ordinary joint planes, appear to be very persistent and may often be traced, at intervals, for thousands of feet. For instance, the line of fracturing on which the Rescue vein is formed has been productive at various points along a strike distance of about 3/4 mile. The quartz veins, although almost never more than 3 feet wide and usually less than 1 foot or 18 inches wide, are also likely to be very persistent for their width; some of the largest of the oreshoots appear to have been almost continuous in strike and dip for several hundred feet.

The Unity Gold Production Co. has maintained a comparatively large crew of men on exploration work for a number of years; other lode operations in the district are in the hands of individuals or small associations of men doing their own work.

The town of Warren is about 6,000 feet above sea level and, like Burgdorf, is accessible in winter only to airplane or tractor-drawn sled. The mines, being closer to town, are more accessible in winter, however, than the mines of the Burgdorf area.

32/ Lindgren, Waldemar, The Gold and Silver Veins of Silver City, De Lamar, and Other Mining Districts of Idaho: Geol. Survey, 20th Ann. Rept., 1899, part III, pp. 65-256.

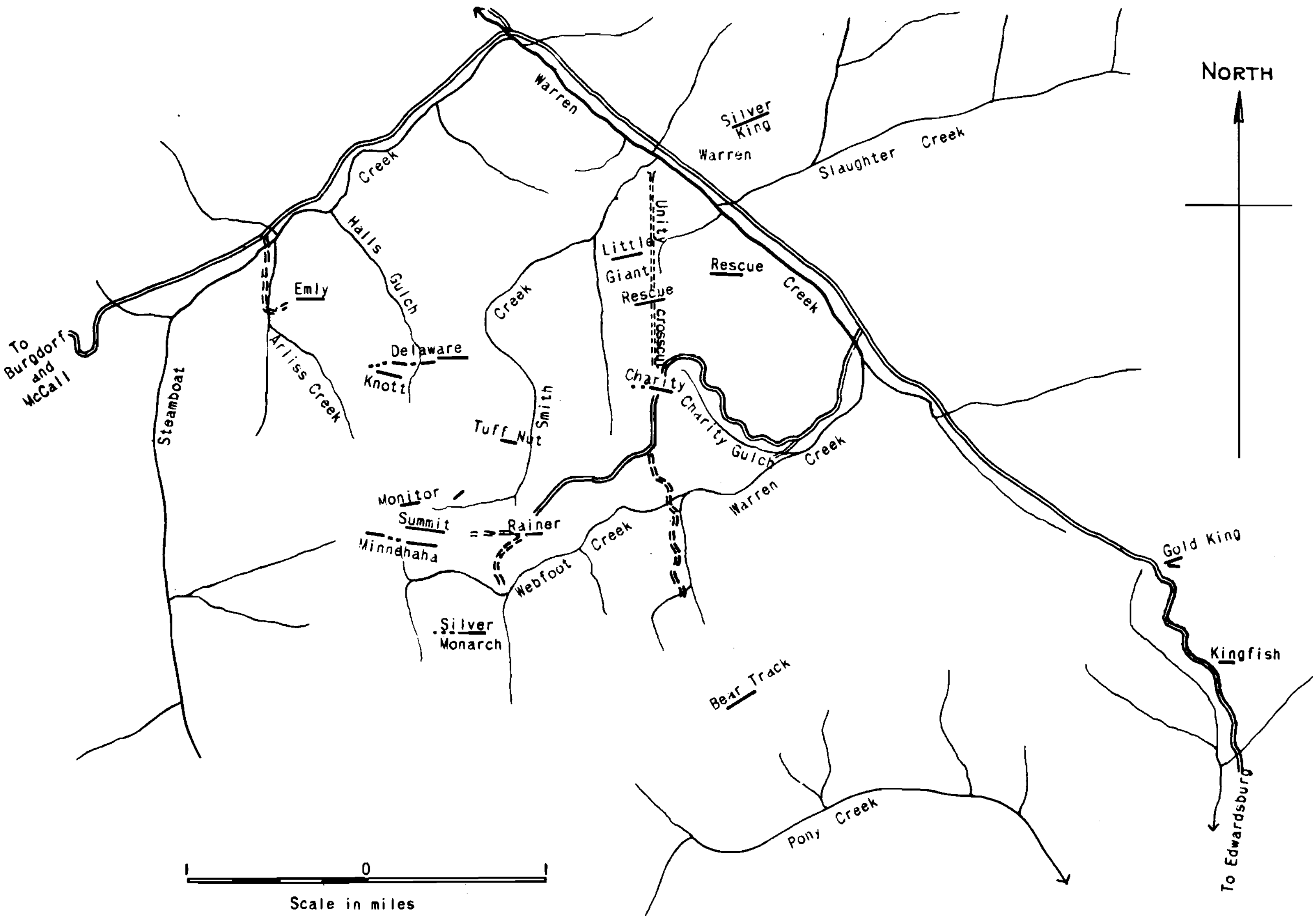


Figure 22.- Sketch showing approximate location and strike of the veins of the Warren district.

Unity Mine

The portal and mill of the Unity mine are situated on the southern edge of the town of Warren. From this point a 5,250-foot crosscut has been driven south at right angles to the general strike of the veins of the district. This crosscut intersects the Little Giant vein at a vertical depth of about 300 feet and the Rescue vein at a vertical depth of about 600 feet; it also cuts several other veins of less importance.

On the Rescue vein stopes averaging 100 to 200 feet long have been worked to the surface and to a depth of about 200 feet below the crosscut; the ore averaged about 8 inches in width. The Rescue vein strikes about north 80° east and dips 60° to 70° south. Some ore has also been obtained from the downward extension of the Little Giant vein, which, although weak where intersected by the Unity workings, is indicated, in a map reproduced by Lindgren,[33] as having a maximum strike length of over 600 feet in the old workings.

The geology and mine workings of the Unity mine have been described and mapped in detail by Reed.[34]

Ore from the Unity workings is treated in a 25-ton amalgamation-flotation mill. The ore is crushed to 1-inch size in a Blake-type jaw crusher and ground to minus 65 mesh in a 3- by 4-foot Marcy-type ball mill operating in closed circuit with a Richards-type pulsator classifier used as a gold trap, and a Dorr simplex classifier.

About 80 percent of the total gold is recovered in the gold trap and amalgamated with mercury and lye in an arrastre-type grinding pan of local construction.

Classifier overflow is pumped to a 9-foot K & K flotation machine, which produces a final tailing and a rough concentrate. The rough concentrate is cleaned in a 6-foot K & K machine, and tailings from the cleaner cell are recirculated to the head of the rougher cell. The total recovery by amalgamation and flotation is from 90 to 93 percent.

Concentrates are settled in a small tank, dried in 300-pound lots on an electrically heated drying pan, and sacked for shipment. The following analysis of a concentrate shipment is fairly typical, although some shipments are much higher-grade; the gold-silver ratio varies greatly from one shipment to another.

33/ Lindgren, Waldemar, work cited (see footnote 32).
34/ Reed, J. C., work cited (see footnote 18).

Gold..............	ounces per ton	4.66
Silver............	do.	85.71
Copper..................	percent	.25
Lead....................	do.	1.6
Zinc....................	do.	.8
Iron....................	do.	22.8
Sulphur.................	do.	24.4
Lime....................	do.	1.0
Insoluble...............	do.	37.6

Rescue Mine

The Rescue mine, situated on the south side of Warren Creek a short distance southeast of the town of Warren, was the earliest producing lode mine of which there is definite record in the Warren district; according to Lindgren,[35] the mine produced $13,000 in 1869. It was worked thereafter for a number of years, and several other mines, notably the Goodenough, West Goodenough, and Unity, have produced ore from apparent continuations of the same vein system.

The original Rescue mine is developed by a 500-foot adit crosscut from which the vein has been drifted on 600 feet or more to the west and 300 feet or more to the east. Stopes have been worked more or less continuously along these drifts, but the old workings are now inaccessible and it is impossible to determine the true size and shape of the old ore bodies. Considerable work was also done for a short distance below the adit level through winzes and shafts now in disrepair. Lindgren stated that the ore from earlier operations averaged about 18 inches wide and assayed $20 to $50 a ton in gold and silver.

In September 1937 W. R. McDowell and Sons were preparing to drive the main-level drift eastward into claims they had located on the same vein. They were also overhauling and preparing to operate a small mill at the portal of the crosscut.

The mill consisted of a 7- by 7-inch Blake-type jaw crusher; a 20-ton ore bin; a 3-1/2-foot Huntington mill fitted with 20-mesh screens; amalgam plates; and a home-made flotation cell. It was stated that on a previous mill run it had been possible to mill 3 tons in 8 hours and obtain an 80-percent extraction on $25 heads; concentrates were said to have assayed $325 a ton. Most of the recovery, however, was obtained by amalgamation in the mill. Power was supplied by a 20-horsepower Fairbanks Morse Diesel engine.

Pickell Mine

Near the head of Warren Creek, 5 miles by road south of Warren, C. H. Pickell and Sons are developing a group of claims traversed by several quartz veins, the most important of which are known as the Rainier, Mohawk, Monitor, and Minnehaha. These veins all strike approximately east and west

35/ Lindgren, Waldemar, work cited (see footnote 32).

and dip at various angles to the south; all are found in fractures in granitic rocks; some fractures exhibit light shearing, others virtually none. Mineralization is generally similar to other veins of the district, although the ratio of silver to gold varies considerably in the different veins. The Rainier, for instnace, is considered to be a gold vein, whereas silver predominates in the Minnehaha.

Current work was centered chiefly on the Rainier vein where a narrow shoot of high-grade ore about 60 feet long had been developed by a short adit crosscut and drift. A sawmill had been set up, lumber cut, and a new mill building erected near the mine portal. Aside from an improvised ball mill for temporary use, no mill machinery had yet been installed.

Some ore had been mined recently from the top of an oreshoot in the Minnehaha vein. The quartz vein at this point was 2 to 5 feet wide, but the selected high-grade ore, said to have assayed 63 ounces of silver and 1-1/2 ounces gold per ton, was obtained from the outer few inches of the vein only. A shaft had been sunk on this showing many years ago but, when visited, was nearly full of water; recent production was from a short drift from the shaft just above water level and virtually at grass roots. This vein, or a succession of veins on the same strike, may be traced by float and surface cuts for several claim lengths.

Emly Mine

The Emly mine, owned and operated by Pete Ashton and R. A. Hughes, is situated on Arlise Creek, a tributary of Steamboat Creek, 4 miles by road southwest of Warren at an altitude of approximately 6,300 feet.

The ore is in a quartz vein along a fracture in granitic rocks. The vein, which is usually a few inches wide in the oreshoots, strikes north 85° east and dips 75° to 80° south. Metallic mineralization consists chiefly of tetrahedrite, galena, sphalerite, and free gold; the ratio of gold to silver is usually about 1 to 15, although the silver content is sometimes proportionately much higher. It was stated that in two years 35 tons of ore yielding $1,500 had been mined and shipped.

The mine was developed by a 730-foot adit drift, near the end of which a stope 70 feet long had been mined to a height of 30 feet; the stope faces were still in ore. Some old workings above the adit portal had been mined out in the early days and were said to have been profitable. Ore was exposed on surface 250 feet vertically above the end of the drift.

Gold King Mine

The Gold King mine, owned and operated by A. W. Fisk and Robert Newcomb, is situated alongside the Warren-Big Creek road 4 miles south of Warren at an altitude of approximately 6,900 feet.

The ore occurs in quartz veins in granitic rocks near the intersection of a fracture striking south 85° east with a fracture striking south 72° west; although both fractures contain quartz veins, the high-grade ore is found only on the southwest strike. The high-grade vein averages about 18 inches wide; it dips 35° to 70° south, and is stronger and higher-grade on the steeper dips. The ore, where exposed, is highly oxidized. Smelter shipments of crude ore have yielded as much as $150 in gold and $3 in silver per ton.

A stope about 60 feet long has been mined between a shallow adit drift and grassroots. A crosscut at about 120 feet lower elevation had been driven 270 feet but had not reached the point of expected downward continuation of the oreshoot.

When the mine was visited in September 1937, some ore from the upper workings was being treated in a Gibson "Prospector" mill that had a capacity of about 600 pounds of ore in 8 hours; the mill was driven by a 1-1/2-horsepower gas engine, which used about 1-1/2 gallons of gasoline in 8 hours. It was said that about 80 percent of the gold was recovered by amalgamation in the Gibson mill; the tailings, said to assay about $20 a ton, were stored for further treatment.

Bear Track Mine

The Bear Track mine, owned and operated by Geo. H. Eipp, is situated on the ridge between Pony Creek and the headwaters of Warren Creek at an altitude of approximately 7,300 feet above sea level. From Warren the mine is reached by road 5.2 miles up Warren Creek to the mine camp, thence about 1 mile by trail.

The ore is in quartz lenses in a zone of light shearing that strikes south 60° west and dips 75° southeasterly. An oreshoot about 80 feet long had been developed by a tunnel through the top of a small ridge; ore above the tunnel had been stoped to surface, a distance of about 45 feet; this ore was said to have yielded about $5,000 in gold. A winze 40 feet deep had been sunk from the tunnel and drifts had been driven from the bottom to the ends of the oreshoot; some stoping by overhand cut-and-fill methods had been done above this lower drift.

The ore, which was highly oxidized, was treated by amalgamation in a Straub "Little Giant" ball mill, which was said to crush 2 to 4 tons of ore to pass through a 30-mesh screen in 10 hours.

Power for milling was supplied by an old automobile engine, which consumed about 4 gallons of gasoline in 10 hours' operation.

Kingfish Mine

The Kingfish mine had been discovered recently and was being developed by its owner, R. L. Newcombe; it is situated alongside the Warren-Big Creek road, 5 miles southeast of Warren.

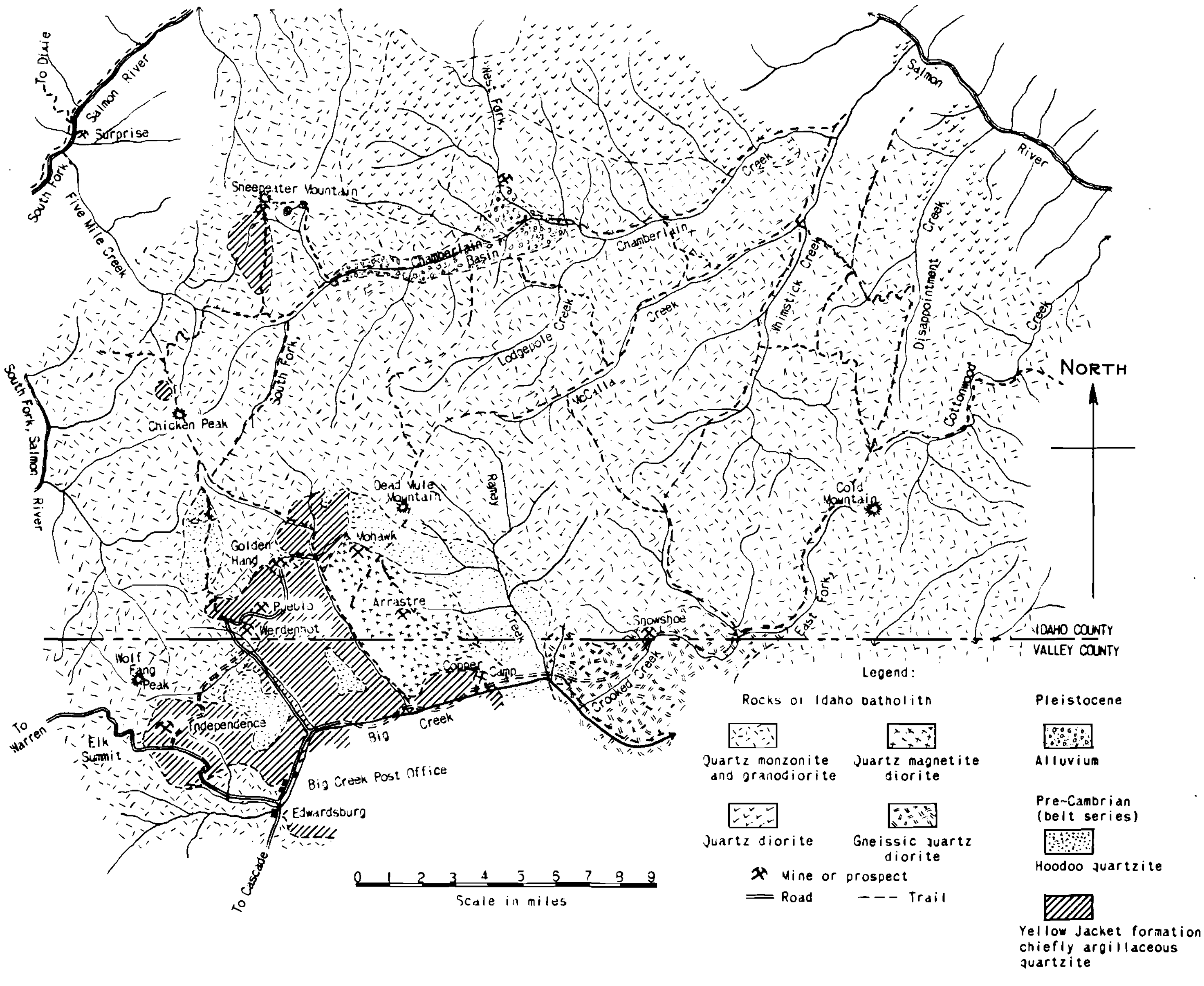


Figure 23.- Geological sketch, Ramey Ridge district and adjacent areas of southeastern Idaho County (after Shenon and Ross).

The ore is in quartz lenses and stringers in a zone of light shearing in granitic rocks. The vein strikes approximately east and dips to the south at varying angles. A short adit drift had been driven on the vein, and between 10 and 20 tons of highly oxidized ore derived from drifting operations had been sorted preparatory to shipment to Warren for milling.

RAMEY RIDGE DISTRICT

General Discussion

The Ramey Ridge district (see fig. 23) is situated near the southern boundary of Idaho County. The small settlement at Big Creek in Valley County is the natural supply point for this district and the region lying between it and the Salmon River to the north. The high, precipitous mountains and steep creek gradients of this region have not been favorable to the accumulation of placer deposits, and few have been found. Furthermore, most of the ores of this region contain less free gold and a higher percentage of sulphides than the ores of the Elk City-Warren belt; in this respect they more nearly resemble the ores of the Valley County mineral belt. Most of the area is accessible only by pack trail. As a large part of the region has been designated by the Forest Service as a so-called "primitive area", it is likely that roads to mines within the areas thus set aside will have to be built by private capital. Until 1933, the only road into the district was by way of Warren over 9,000-foot high Elk Summit; this road was closed to travel from sometime in October to about the middle of July. In 1933, a road was built across Profile Gap from Yellow Pine, thus permitting direct travel to Cascade. Although it crosses several high summits, this road is open from June to November and provides much quicker and cheaper communication with outside points than did the old road. During the winter months, this region is accessible by airplane or by dog team only; the completion of the new road down the Salmon River and the building of auxiliary roads will, however, bring it much closer to year-round transportation.

Although a number of prospects have been located in this area, only a few have been developed aggressively. The Werdenhoff mine, 7-1/2 miles by road north of Big Creek, was developed by about 3,400 feet of drifting about 10 years ago but is now idle. Aside from this, the most extensive operations have been at the Snowshoe, or Jensen, and the Golden Hand mines, which are described in the following pages. In 1937 some active exploration work was in progress on other veins near the Snowshoe mine and on a lead-silver-gold vein near Sheepeater Mountain.

Golden Hand Mine

The Golden Hand mine is situated on Cache Creek, a tributary of Beaver Creek, 14 miles by road north of Big Creek Post Office. The road from Big Creek crosses an 8,000-foot summit; the mine is at an altitude of approximately 6,800 feet above sea level. In 1937, the Golden Hand, Inc., C. W. Mason, president, had a crew of men on exploration and development work; near the end of the season they shipped to the Tacoma smelter 9,800 pounds of ore, from which 15.84 ounces of gold was recovered.

The holdings of the Golden Hand, Inc., consist of about 35 claims covering a large mineralized area on both sides of Cache Creek; several different types of ore deposits are in this area. Beds of schist, argillite, and quartzite, assigned by Shenon and Ross[36] to the Yellowjacket formation (Belt series), have been intruded by granodiorite of the Idaho batholith; the ridges and the north slope of Cache Creek Valley are covered by the Yellowjacket formation, but the granodiorite has been exposed by erosion on the north and east slopes of the valley. Both formations have been fractured, sheared, and mineralized in places with pyrite, galena, sphalerite, tetrahedrite, chalcopyrite, and free gold.

Along the north side of Cache Creek some small quartz veins have been formed along bedding planes in the Yellowjacket formation; one or two of these veins have been mined in a small way for high-grade gold ore. On the south side of the creek a considerable amount of development work was done by the Penn-Idaho Co., shortly after the Thunder Mountain boom (1896), on a zone of fracturing and disseminated mineralization in granodiorite. For several years the principal operations have been concentrated on a comparatively small area at the head of Cache Creek, where a ridgelike exposure of granodiorite passes under arched beds of the Yellowjacket formation. Here, the granodiorite is highly silicified, is traversed by many small veinlets, and contains considerable disseminated metallic minerals. On the west side of the granite ridge is a strong mineralized fracture zone, locally referred to as the "galena vein", on which some drifting has been done; when the mine was visited, however, work was confined to an area near the top of the granite ridge, where a few years ago about $35,000 was produced from high-grade float close to where the granite ridge passes under the Yellowjacket formation; many spectacular specimens containing free gold were obtained from this ore. A considerable amount of exploratory drifting has been done in the granodiorite in this vicinity. In midwinter of 1937-38, it was reported by C. W. Mason that a drift to the north under the Yellowjacket formation had exposed a strong face of ore in a vein striking north and dipping 70° west; some samples of this ore were said to assay over 100 ounces of gold and 32 ounces of silver to the ton; one 85-pound fragment of ore was estimated to contain about $500 in gold.

The mine is fully equipped with cookhouse, men's living quarters, a 310-cubic-foot-capacity Gardner Denver compressor, steel sharpener and miscellaneous mining equipment, a power plant, and a small mill.

The mill is equipped with a jaw crusher, Allis Chalmers ore feeder, five stamps, 30-by 30-inch Union ball mill and simplex classifier, two amalgamating plates, corduroy table, 4-cell Ruth flotation machine, barrel amalgamator, and two settling cones.

The power plant, which is housed in the mill building, consists of three steam boilers, of 15, 30, and 40 horsepower, respectively, and three

36/ Shenon, P. J., and Ross, C. P., Geology and Ore Deposits Near Edwardsburg and Thunder Mountain, Idaho: Idaho Bureau of Mines and Geology, Pamphlet 44, Univ. of Idaho, Moscow, Idaho.

steam engines of 18, 35, and 75 horsepower, respectively. Wood, which is cut locally at $4 a cord, is used for fuel. When the mine was visited, only the compressor was being operated; this required 1 to 1-1/2 cords of wood in 8 hours.

Snowshoe Mine (Jensen group)

The Snowshoe mine, formerly known as the Jensen group, is situated on Crooked Creek, a tributary of Big Creek, about 18 miles by road northeast of Big Creek Post Office. The mine, at an altitude of 5,200 feet, is on the Idaho-Valley County line. In 1937, the mine was reached from Big Creek by about 2 miles of road and about 16 miles of water-grade pack trail. Shortly before the end of the season, however, the trail had been replaced or paralleled by a roughly constructed road. A 25-ton flotation mill, compressor, bunkhouses, tramway, and auxiliary equipment had recently been installed by the Pierce Metals Development Co., and a small tonnage of ore was mined and milled; it was planned to continue operations steadily throughout the winter and to enlarge the milling capacity in 1938.

Geology

The ore is in quartz veins in a formation described by Shenon and Ross[37] as follows:

> The wall rock of the deposit is a somewhat gneissic biotite quartz diorite which, in the general vicinity, contains many highly altered inclusions of sedimentary rocks, mainly schist, white quartzite, and, near the Jensen cabin, limestone. There are also many Tertiary dikes, mainly granophyre.

The vein occurs in a fracture that has a general strike of north 45° west and a dip of about 55° northeast. In the stopes the vein averages about 3 feet in width and was said to have an average gold content of about $20 a ton. Some recent drifting, however, had penetrated an ore body consisting chiefly of what appeared to be highly silicified diorite containing disseminated sulphides. The walls of this ore body were somewhat indefinite, and its size had not yet been determined; it was said, however, that the face of the drift assayed about $7 a ton in gold. Metallic mineralization consists chiefly of pyrite and chalcopyrite with some pyrrhotite and free gold.

Mining and Development

The vein had been developed by a number of adit drifts over a maximum dip length of about 500 feet. The Jensen brothers had made a living for 20 years or more by mining and milling ore from the short upper workings; present operations, however, are confined chiefly to ore lying immediately above the lowest adit. In this adit, 200 to 300 feet of stoping ground had been opened and several stopes started; although interrupted by several

37/ Shenon, P. J., and Ross, C. P., work cited (see footnote 36).

small faults, the oreshoots were closely spaced. The walls are strong and, in the oreshoots, generally free from gouge or shearing; therefore, up to the time of visit, shrinkage stoping had proved very satisfactory.

Milling

Ore from the mine is lowered to the mill in mine cars that operate by gravity on an inclined tramway; there is about 200 feet difference in elevation between the upper and lower terminals. The cars dump automatically into a 50-ton coarse-ore bin, from which the ore is fed to a 7- by 10-inch jaw crusher. The mill flow sheet is shown in figure 24.

Ore from the crusher drops into a 50-ton fine-ore bin, from which it is fed to a 3- by 6-foot overflow-type ball mill operating in closed circuit with a 2-foot Denver Sub-A unit cell and a Dorr simplex classifier; a trommel on the ball-mill discharge trunion screens the unit cell feed to minus 18 mesh.

Classifier overflow at approximately minus 100 mesh goes to a 6-cell Union Iron Works flotation machine. Flotation feed enters the first cell, and a finished concentrate is taken from the first two cells; concentrates from the last four cells return to the first two cells for cleaning; tailings from the last cell go to waste. Reagents used were Z-5 xanthate, pine oil, soda ash, and lime.

It was said that an extraction of 88 to 90 percent was being obtained from $25 to $40 heads; the ratio of concentration varied from 8 : 1 to 12 : 1. Concentrates from the unit cell and the 6-cell machine were dried in pans over wood fires, sacked, packed 15 miles on mules, and trucked about 90 miles to Cascade, then shipped by rail to a smelter at Salt Lake City. The completion of the new road will eliminate the necessity for packing in the future.

Concentrates assayed about $200 gold, $18 silver, and 6 to 10 percent copper per ton.

Power

Power is supplied by a 50-horsepower hydroelectric generator set supplemented by a 25-horsepower Diesel engine.

Water for power purposes was obtained from Crooked Creek. A dam about 16 feet high and 66 feet long had been constructed 3,500 feet upstream from the mill. Abutments on each side of the dam were a concrete shell filled with rock and earth; between the abutments are a series of bents built on 4-foot centers with 6- by 6-inch timbers. The sloping, upstream side of the bents is faced with two layers of 2-inch plank interlined with tar paper. The intake, approximately 12 feet below the surface, connects with a steel pipe line, which carries the water to a 4-foot Pelton-type wheel at the mill, which is 170 feet lower in elevation than the intake. It was said that this arrangement operates the year round without freezing, although there is a very small supply of water during the winter months.

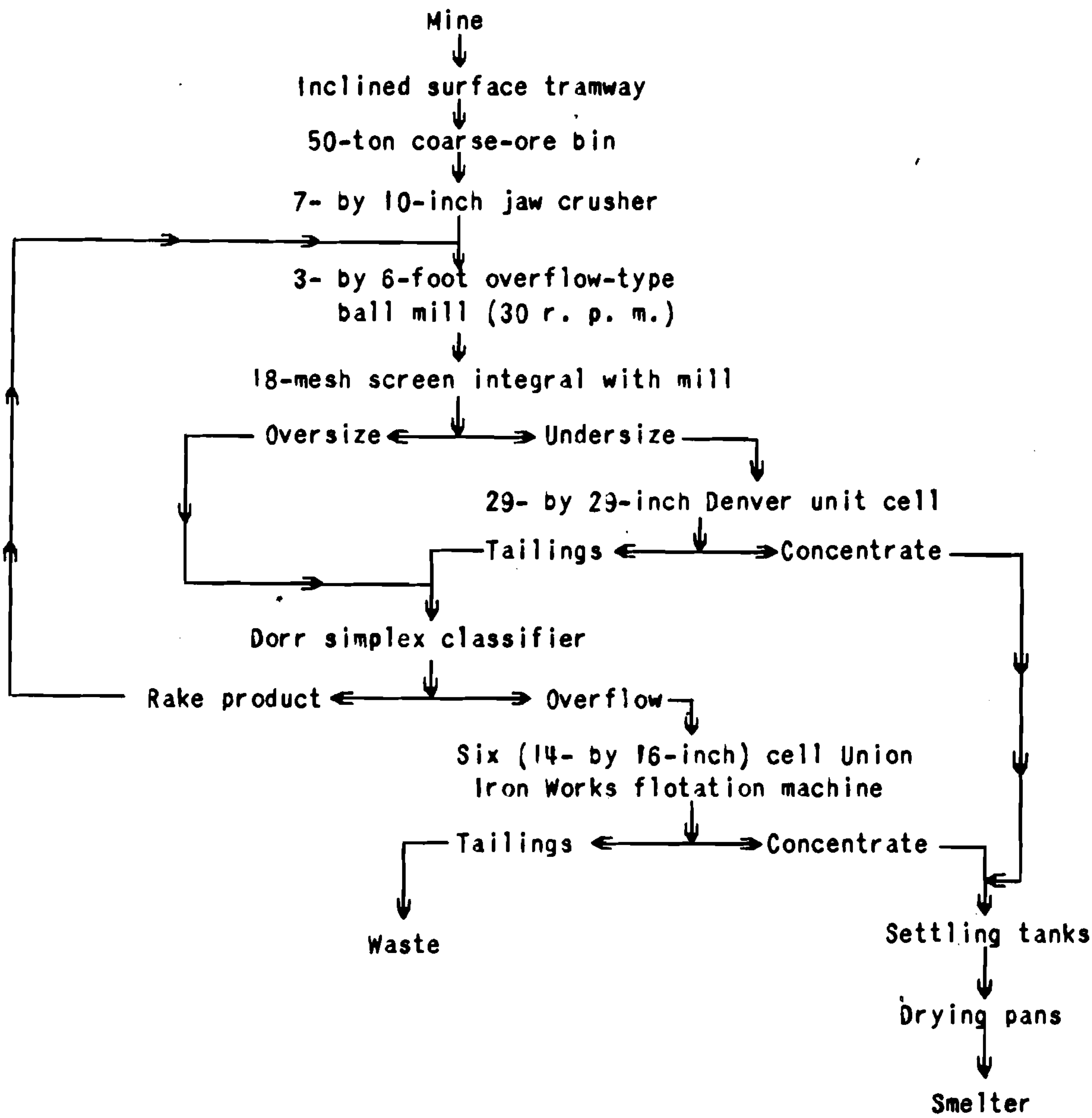


Figure 24.- Flow sheet of the Snowshoe mill.

SUMMARY AND CONCLUSIONS

MINING

Lode mining in Idaho County falls, roughly, into three general classifications according to the type of deposit being mined. Although there is often no definite dividing line between the various types of deposits, they may be discussed most conveniently by considering them as tension or gash veins, shear-zone deposits, and disseminated deposits.

1. The most numerous and widely distributed ore deposits in the region are narrow tension veins or veins in lightly sheared fractures; most of the oreshoots in these veins are comparatively high-grade but small. In mining such veins it is highly important to employ selective stoping methods. Inasmuch as the life of individual mining operations on these small veins is usually short and always uncertain, it is necessary to keep capital outlay at a minimum. Although this is important in almost any type of mining, it is particularly important in these small veins, where capital charges often constitute an exceptionally high proportion of the total cost of gold mined. By clean mining and careful sorting in stopes a minimum of material needs to be trammed, hoisted, and milled, with a consequent saving in equipment required.

Most of the small veins of the region are narrower than minimum requirements for stoping but usually lie between fairly strong walls, which permit the ore to be broken easily by resuing in cut-and-fill stopes, as at the Golden Anchor, Lone Pine, and other successful mines operating on ore bodies of this type. In the few places where these veins are 4 feet or more in width, shrinkage stoping might be possible; with this method, however, dilution is usually higher. Moreover, the veins generally pinch, in which case the method would have to be abandoned. Methods and costs of mining by resuing in cut-and-fill stopes are given in some detail under the description of the Golden Anchor mine and, in less detail, under the description of the Lone Pine mine. The stoping[38/] cost at the Golden Anchor was $3.78 per ton and at the Lone Pine $3.196[39/] per ton. The methods and costs of drifting, raising, and sinking at the Golden Anchor are fairly representative of good practice under the conditions existing throughout most of Idaho County.

2. Quartz lenses are found in strong shear zones at a few places in the county, but none were being actively mined in 1937. The Gnome mine, which operated on a small vein of this type, had recently been shut down, but details of underground operations were not obtainable. The Madre d'Oro, which was mining a deposit of the mineralized shear-zone type, was operating on a very small scale only. It is apparent, however, that deposits in these veins will require close timbering and filling throughout; probably, they will be mined most efficiently by square-setting. Thomson and Ballard[40/]

38/ Not including development and exploration.
39/ Exclusive of supervision, engineering, and office expense.
40/ Thomson, Francis A., and Ballard, Samuel M., work cited (see footnote 24).

state that the cost of mining and milling at the Buster mine (see p. 28) was $7.25 per ton in 1907 to 1909 and that, in 1903, the cost of mining at the Big Buffalo mine (see p. 50) was $3.29 per ton and the cost of milling $1.44 per ton.

The following table is based on actual consumption of labor and supplies at a number of mines using square-set methods on medium-size ore bodies in various parts of the United States, as compiled by Jackson[41] or contained in Bureau of Mines Information Circulars by other authors. The costs are computed on the basis of the cost of labor and supplies in Idaho County in 1937. The unit costs of labor, timber, and explosives are fairly uniform at the various mines using these mining methods. Unit power costs will vary widely according to the depth of hoisting, amount of pumping, drilling efficiency, and other factors, but are usually within the limits given. Other costs vary considerably according to the size of the operation, efficiency of management, and local conditions. In weighing the costs used, some consideration was given to local conditions in Idaho County, with the result that the total cost is somewhat higher than usual. Nevertheless, such a table as this must be considered only as a very rough estimate when applied to individual cases.

Item	Units per ton	Rate	Cost per ton
Labor	4.5 man hours	$0.625 hour	$2.81
Timber...............	3 linear feet (round) 10 board feet (sawed)	.02 foot 1/.012 foot	.18
Explosives	1 pound	-	2/.18
Power	20 to 50 kw.-hours	.02 kw.-hour	3/1.00
Other supplies	40 percent total power and supplies	-	3/.90
Surface and general expense directly chargeable to underground	-	-	.50
Total direct mining cost			$5.57

1/ Locally cut and sawed lumber. Imported lumber would cost about twice this amount.
2/ Includes fuse and detonators.
3/ Maximum.

3. The large disseminated deposits of the Orogrande type have not yet been developed sufficiently to permit an accurate forecast of the average recoverable gold content, the ultimate working methods, or the costs that will be obtainable. So far, only the Orogrande-Frisco Co. has attempted to work these deposits on a large scale; this company has obtained a mining and ore-transportation cost of $0.196 a ton. The portions of these ore deposits that lie near the surface can be mined cheaply in open-cuts, and the ore,

41/ Jackson, Chas. F., Summary of Ore Mining-Cost Data: Inf. Circ. 6785, Bureau of Mines, 1934, 47 pp.

being highly oxidized, can be treated at low cost by cyanidation. Deeper mining will depend upon the results of the pioneering work now being done.

The existence of disseminated deposits, some of which are higher-grade than the Orogrande ore body, is indicated at several places where highly silicified granitic rocks or quartzites have been brecciated and mineralized; this condition appeared to be most strongly developed in the vicinity of Dixie and in the Ramey Ridge district. Although some test work has been done on the Robinson dike near Dixie, no ore bodies have been developed to the stage of large-scale production. The higher-grade ores of this type assayed close to $7 a ton at several mines. Although the higher-grade parts of this type of disseminated deposit will probably prove to be irregular in outline and to occur in smaller bodies than the lower grade ores, it seems probable that some will prove to be of sufficient size to be mined economically by some modification of shrinkage or caving methods.

MILLING

Idaho County ores respond to the same treatment methods that are applicable to semifree-milling gold ores in other districts. The production statistics of Idaho County lode mines show that most gold produced in the past has been recovered by amalgamation. Most of this gold came from the upper, oxidized parts of the veins and was recovered in mills equipped for amalgamation, or for amalgamation and table concentration, only. The old-time type of stamp mill with plate amalgamation can often recover 70 percent or more of the total gold content of highly oxidized ores.[42] As the percentage of unoxidized sulphides increases, recovery by plate amalgamation decreases rapidly; this fact was largely responsible for the closing down of many mines in the early days. The incomplete liberation of the gold from the sulphide particles is largely responsible for poor recovery by amalgamation. The operators of the Lone Pine mine (p. 30) partly solved this problem by inside ball mill amalgamation and recirculation of table concentrates until the sulphides were ground fine enough to pass off with the table tailings. The same problem has been met in a somewhat similar way at the Gold Hill mine in southern Idaho.[43] The Golden Anchor mill (p. 59) and the Unity mill (p. 77) have found it possible to amalgamate as high as 70 to 75 percent of the total gold content of high-grade unoxidized ores by introducing a jig or hydraulic gold trap into the ball mill-classifier circuit and grinding the concentrate thus obtained in an amalgam barrel or grinding pan. Judging from the experience at the mills in the county, amalgamation must be supplemented by either flotation or cyanidation to make a recovery of 90 percent or more of the total gold in unoxidized ores.

The unoxidized sulphides of the region float easily with ordinary reagents and usually produce high-grade concentrates; the ratio of concentration ranges from about 10 : 1 up to over 250 : 1. The most frequent cause of high losses in flotation mills in this region is the failure to recover gold contained in oxidized or partly oxidized minerals that will not float

42/ See descriptions of the Shamrock mine (p.35) and the Hinkson and Bishop mine (p. 72).

43/ Skidmore, Joe H., Gold Mining and Milling Methods and Costs at the Gold Hill Mine of Talache Mines, Inc., Quartzburg, Idaho: Inf. Circ. 6985, Bureau of Mines, 1938, 15 pp.

with ordinary reagents. Any gold amalgamating device preceding flotation usually will overcome this difficulty. Amalgamating plates or corduroy blankets in the ball mill-classifier circuit and at the classifier overflow are frequently satisfactory. Most operators, however, prefer a jig or hydraulic trap in the ball mill-classifier circuit, as already described.

At the Mammoth mine (p. 52) a high recovery has been obtained from the straight flotation of partly oxidized ores by the use of a specially developed soap reagent. The Robinson mine (p. 53) also had good results in floating oxidized ores with the aid of dixanthogen. The elimination of amalgamation results in a considerable simplification of the flow sheet; this would be particularly advantageous if the concentrates are to be cyanided at the mine. However, if concentrates are to be shipped, the savings in freight rates, treatment charges, and gold payments will, in most cases, continue to make it desirable to recover as much of the gold as possible by amalgamation.

Except in the comparatively few mines where the ore contains large amounts of cyanicides (such as copper salts), the Idaho County ores have proved to be easily amenable to cyanidation; in a properly designed and operated plant, it is probable that higher recoveries could be made by this method than by any other. Cyanidation has the further advantage that the gold and silver may be recovered entirely in the form of bullion. However, most cyanide plants that have been erected in this region were originally designed to operate on oxidized ores only; consequently, when unoxidized ores came to be treated it was found that grinding and classifying capacity were inadequate.[44/] Inasmuch as cyanide solutions are only effective on exposed gold surfaces, the recovery of any gold not liberated through the oxidation of the original sulphide particles requires very fine grinding; on unoxidized ores this necessitates larger grinding and classifying equipment than would be required for a flotation plant of the same capacity. Furthermore, the necessary tanks, filters, and other equipment are larger and more expensive, and more technical supervision is required for a small cyanide plant than for a small flotation mill. Continuous-current cyanide plants are not efficient for intermittent operation, which is often so desirable at the small mines of this region. Therefore, it is apparent that the choice between cyanidation and flotation at Idaho County mines should, in most cases, be governed by economic rather than metallurgical considerations.

In some cases it may be found advantageous to cyanide the flotation concentrates, as was done at the Robinson mine. Although the highly oxidized ores at the Robinson mine were cyanided easily without regrinding, concentrates produced from less highly oxidized ores probably will require very fine grinding before cyanidation.

At small mills, costs of $0.918[45/] per ton by straight amalgamation, of $2.70 a ton by amalgamation-flotation, and of $2.70 a ton by straight

44/ See descriptions of Gnome mine (p. 44) and of the Orogrande-Frisco mine (p. 37).

45/ Using hydro-electric power and exclusive of supervision, engineering, and office expense.

cyanidation were obtained at the Lone Pine, Golden Anchor, Gnome mines, respectively. At the 600-ton cyanide mill of the Orogrande-Frisco mine, a cost of $0.3181 a ton was obtained on ores that did not require fine grinding. There are no mills of intermediate size in the region at present.

GENERAL

Idaho County contains some of the few gold-mining districts remaining in the United States that have not been developed intensively. Although some lode mining has been carried on in the county for nearly 70 years, poor transportation facilities and the failure to discover any large bonanza deposits has discouraged intensive exploitation of the numerous ore bodies known to exist and has retarded the search for new ore bodies. It is doubtful if more than a few mines in the county have been entirely exhausted; most known ore bodies have been developed only halfheartedly. The mountainous and relatively inaccessible nature of the area, combined with the thick mantle of topsoil and vegetation with which most of it is covered, has rendered prospecting difficult; consequently, it is probable that more good lode discoveries will be made.

Mining operations in the county are favored by an abundance of timber and water but are handicapped by a short summer season, heavy winter snows, lack of developed power, and by high transportation costs. The last-named handicap has been the greatest but is the one that is being overcome most rapidly by recent and current road-building programs. When transportation is improved, the further development of lode mining will depend largely upon the skill with which the known deposits are operated; so far, no ore bodies of the type that will stand poor management have been discovered.

For the successful operation of the many small veins of the region, it will be necessary first to recognize and admit their limitations. Although often they contain 1/2 to 1 ounce or more of gold per ton, most of them are too small to repay the large prices often asked by owners or the large capital structure often imposed upon them by promoters. Many good veins are not being worked because they are submerged under a load of debt or are being held for exorbitantly high prices. In reviewing the active operations in 1937, it is the writer's opinion that it is much more than a coincidence that most of the small veins were being operated by owners. Many of these small veins will pay good returns to owner-operators or to leasers working on a very small scale, but only in exceptional cases will they stand the overhead necessary for company operation. So far, even the most profitable small veins have not been found to warrant operation on a scale larger than 25 to 40 tons a day.

Some of the stronger quartz veins, such as those at Buffalo Hump and Elk City, may permit operation on a slightly larger scale. Past operations, however, indicate that these ore bodies are in short lenses; consequently, capital investment should be kept at a minimum until it is proved that larger outlays are warranted.

The large disseminated ore bodies present an entirely different problem. Although there is a good chance that some fairly large medium-grade ore bodies of this type may be discovered, the largest disseminated deposits so far developed were too low-grade to be worked successfully when gold was $20.67 an ounce. Higher gold prices and improved transportation have only recently brought these low-grade deposits within possible commercial limits; consequently, this phase of Idaho County lode mining is still definitely in the pioneering stage. If, however, it proves possible to mine these deposits at a profit, some very large tonnages may be available.