OF 55-45

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

PRELIMINARY REPORT ON PART OF THE OAT HILL QUICKSILVER MINE MAYACMAS DISTRICT, NAPA COUNTY CALIFORNIA

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This report is preliminary and has not been edited or reviewed for conformity with Geological Survey standards or nomenclature.

OPEN FILE
1955

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Mayacmas District, Napa County,

California

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ABSTRACT

Oat Hill quicksilver mine, located in the Mayacmas district of northern California, and credited with having produced more than 140,000 flasks of quicksilver, was sampled cooperatively by the Bureau of Mines and Geological Survey during 1944. 28 diamond drill holes totaling 8,120 feet were drilled by the Bureau of Mines in four of the six principal veins to sample virgin low-grade reserves and stope fill, and reserves in the other two veins were estimated from existing underground workings and by inferences from drill holes in nearby veins.

The writer estimates a total of 10,220 flasks of quicksilver in indicated and inferred reserves totaling 320,000 tons.

Indicated reserves minable under 1943 conditions are estimated at 2,960 flasks of quicksilver in 75,000 tons averaging 3.0 lbs. Hg per ton.

Inferred reserves minable under 1943 conditions are estimated at 4,680 flasks of quicksilver in 109,920 tons averaging about 3.2 lbs.

Hg per ton. Inferred reserves believed minable only under economic conditions much more favorable than even those of 1943 are estimated at 2,620 flasks of quicksilver in 135,080 tons averaging a little less than 1.5 lbs. Hg per ton.

About two-thirds of the indicated reserves are accessible in underground workings. All other reserves are estimated approximately without access underground. Several areas not sampled may possibly contain reserves.

INTRODUCTION

Oat Hill quicksilver mine is 9 miles by gravel road southeast of Middletown, Lake County, California. The mine is reputed to rank third among quicksilver mines of the United States, with a total of 160,000 flasks of quicksilver since discovery in 1872 (Ross, 1940, p. 347). It has not been operated on a large scale since 1909.

The mine was discussed briefly by Becker (1888), Forstner (1903), W. W. Bradley (1918), and others. The Geological Survey mapped part of the mine in 1941-44, and this work formed the basis for subsequent sampling by the Bureau of Mines.

HISTORY OF THE MINE

Oat Hill mine is said to have more than 20 miles of underground workings. An old company map shows the Manzanita and Humboldt shafts,

an underground inclined shaft in the Eureka vein, and several miles of workings. It does not show veins or stopes. The known workings, virtually all inaccessible, occupy about one-half square mile (see map). The southwest and central parts of the area have five principal levels (1, 1-5, 2, 2-5, and 3), plus a level 5 said to exist in parts of the Eureka and Escape veins from the underground shaft. The deepest workings in the northern part of the mine were on the 875 level of the Manzanita shaft (Becker, 1888, p. 359).

The mine began to produce on a large scale in 1875. Most of the production was between 1881 and 1910 during the ownership of the Napa Consolidated Quicksilver Mining Company. Prior to about 1885 the Manzanita and Mercury veins, developed from the Manzanita shaft, were mined. After that the Eureka, Escape, Osceola, and Humboldt veins are said to have produced most of the quicksilver until about 1900. At that time the Manzanita shaft was reopened to supplement the dwindling supply of ore. The last high-grade ore body of considerable size is said to have been in the vicinity of Osceola vein between the Humboldt and Eureka veins, and to have been exhausted about 1903. Production then declined steadily despite energetic prospecting, and the company abandoned the mine in 1910.

After 1910 the mine passed through the hands of various owners and lessees until Norman B. Livermore, 716 Pine Street, San Francisco, acquired it about 1925, and leased it to H. W. Gould and Co. of San Francisco in 1927.

The Napa Consolidated Company used two 50-ton Scott furnaces. It is said that their ore probably yielded 15 or more pounds of quicksilver per ton. The Oceanic Quicksilver Company built a smaller Scott furnace during World War I. H. W. Gould and Co. installed a 4 x 60 ft. rotary furnace about 1930.

SCOPE OF THIS REPORT

This report summarizes the quicksilver reserves of Oat Hill mine as far as they could be ascertained by 28 diamond drill holes totaling 8,120 feet that were drilled between December 8, 1943 and December 15, 1944 by the Bureau of Mines with geologic guidance by the Geological Survey.

Lowell S. Hilpert of the Geological Survey early in 1943 summarized the geology and history of the mine in a report that stated specific reasons for sampling the property. At that time only part of two of the six principal veins, the Osceola and Humboldt, were being mined. About 1,000 flasks of quicksilver per year were being obtained from stope fill and cinnabar-impregnated virgin sandstone in the footwalls, with an average yield of 3.2 lbs. Hg/ton.

The operators were doing little prospecting. Other principal veins were reputed to contain reserves similar to those being mined, but were inaccessible because virtually all underground workings of the mine were caved. The imperative need for adequate reserves of quicksilver led the Government to sample parts of the mine to verify the existence of such reserves.

Oat Hill ground is not ideal for diamond drilling because the ground swells, but other methods seemed less practicable. There are many old stopes of unknown extent. The Franciscan (?) country rock lacks known key beds. Identifying veins and faults in drill holes is difficult because most material between the fault walls is broken country rock. The drill reached to deeper levels, reputed to have been richest, in few places. Despite these handicaps, much reliable information was obtained for estimating the approximate location and grade of reserves in the areas drilled, and also in the Osceola and Humboldt veins below the 1,330-ft stopes because seven oil drill holes reached the equivalent level of the nearby Eureka vein.

GEOLOGY

"The major structure in the southeastern end of the Mayacmas district is a broad, eastward-plunging anticline, the heart of which is composed of Franciscan sandstone and shale.... The Oat Hill mine lies near the crest of the anticline... where the Franciscan sandstone has been broken by normal faults ...." (Hilpert, written communication). Most of the faults strike northwest and dip northeast at moderate angles, but the Osceola strikes east and dips south. About 40,000 flasks of quicksilver have been produced since 1860 from this anticline, chiefly from the Oat Hill, Great Western, Aetna, and Mirabel mines, although the last three named are at the contact of sandstone with serpentine on the southwest flank of the structure.

A butte of Quaternary basalt (Gilpert, personal communication) lies a few hundred yards northwest of the nearest underground workings shown on the old company map (see map). Forstner (1903, p. 91) said the basalt is a dike or plug, and that ore bodies did not exist near it. His words imply that he saw it underground, and there may be extensive underground workings in that area not shown on the map.

Oat Hill veins apparently consisted of cinnabar in brecciated sandstone and shale with some quartz, carbonates, and pyrite with 2 to 20 feet of gouge on the hanging wall side. Irregular porosity in sandstone of the footwalls of the faults resulted in formation of irregular bodies of cinnabar-impregnated sandstone with veinlets of quartz and cinnabar at various angles, and with gradational boundaries. Some of these were mined prior to 1910. Becker (1888, p. 356) described one 50 feet high and 100 feet wide in the Mercury vein. Many of these bodies remained because of their low grade, and now are a very important part of the reserves of the mine.

Width of the stope fill and virgin ore mined in the 1941-44 stope of the Osceola and Humboldt veins ranged from 6 to 50 feet on the stope floors, with very irregular boundaries on the footwall side where the boundary is gradational. It is said that the veins were not very productive above the 1 level, with few exceptions. The Ramsanita vein was richest between the 400 and 500 levels (1888, p. 356). The Eureka, Escape, Osceola, and Humboldt veins are said to have been richest in the vicinity of the 2 and 2-C levels. Virtually nothing is known of the Edna Mabel vein, and the underground workings shown on the map suggest that it was not very productive.

QUICKSILVER RESERVES OF OAT HILL MINE

The writer believes that 7[illegible],000 tons of 3.0 lbs. Hg/ton, or 2,960 flasks of quicksilver are indicated in the Osceola and Humboldt veins between the 2-C level and the 1939-44 stoped area above. This estimate is made on the following basis. W. W. Bradley (1918, p.89) said that the Osceola and Humboldt veins (see Index map) were stoped for a length of 500 feet each. The 1941-44 top-slice stope lengthened with each successive floor, but the lowest floor had a length of only about 500 feet along the strike of the two combined. The lowest floors are believed to have produced about 4,000 or 5,000 tons each, and approximately 12 floors remain unmined down to the 2-C level. This includes the zone of the 2 and 2-C levels that is said to have been most productive. The grade is believed to have been about 3.0 pounds Hg per ton, as the previously-mentioned report by Wilpert stated that the grade was 3.2 to the end of March 1943.

The reserves indicated in this body were accessible on the 2 level (Gould's 450 level) about 500 feet along the strike of the two veins, and at one time or another were accessible above that level by 10 raises. The reserves between 2 and 2-C levels were inaccessible, but they extend only about 40 feet below the 2 level, and occupy the zone said to have been most productive in these two veins. The equivalent zone was reached in the Eureka vein by several drill holes also, but the basis for indicating this body of reserves derives more on study of the 1941-44 stope than on diamond drilling data.

The writer believes that the inferred reserves of the Eureka, Osceola, Humboldt, and Escape veins, whose locations and inferred geology are shown on the map and sections, may be estimated at approximately 245,000 tons ranging from 3.0 to 1.0 lbs. Hg per ton, or 7,200 flasks of quicksilver. This estimate is based on the diamond drill data and other available information, and the names of veins are quoted from Forstner's map (1903, p. 90).

Eureka Vein

The Eureka vein is reported to have been one of the two most productive of the mine. The presence of cinnabar on a scale comparable with that in the 1341-44 stope of the Osceola and Humboldt veins is suggested by the fact that 15 diamond drill holes totaling 4,295 feet, and 50 to 125 feet apart, yielded more than 200 feet of assays ranging from 1.5 to 4.5 lbs. Hg per ton (21 feet assayed more than 10 lbs. per ton); more than 200 feet of assays ranging from 0.5 to 1.49 lbs. Hg per ton; and more than 2,000 feet estimated by the Bureau of Mines project engineer at about 0.1 lb. Hg per ton.

That the vein was explored and at least partly mined more than 700 feet along the strike, and 400 to perhaps 600 feet down the dip is suggested by the old company map of underground workings, diamond drill data, and other information. The drill encountered on sections 3, 6, and 8 (see map) a larger amount of favorable sandstone than in any other area drilled.

Most of the assays greater than 1.5 lbs. Hg per ton came from this area of 300 or 350 feet along the strike that also contains the inferred fork in the vein. No. 14 hole on section J reached the lowest altitude, and showed not only an assay of 5.4 lbs. Hg per ton 30 feet below the 2-C level, but also found a trace of cinnabar to within about 25 feet of the 3 level.

Diamond drill data provide no information about the vein below the 3 level, and few holes reached the 2 level. It is said that the zone of the 2 and 2-C levels was most productive, and that most of the quicksilver was produced between the 1 and 3 levels. If this is true, the diamond drill data and other available information suggest that reserves may be found chiefly between 1 and 3 levels, with local extensions toward the surface in the vicinity of sections G, C, and F and drill holes 16 and 28. The old company map shows and underground shaft on the 3 level near section F. It is reported that this may have gone to the 5 level, hence there may be some possibility of finding additional reserves below the 3 level.

These inferences, and analogies drawn from the 1941-44 stope in the Osceola and Humboldt veins, lead the writer to believe that the following reserves may be inferred reasonably for the Eureka vein. The total of the three groups listed is 145,000 tons running from 3.87 to 1.4 lbs. Hg per ton, or 4,296 flasks. As a comparison, about 5,000 flasks are

said to have been produced from the 1877-4h stope in the Accels and Humboldt veins that was mined above 1875 feet altitude, and did not even reach the zone said to have been most productive in the two veins. These three groups of inferred reserves of the Eureka vein are as follows:

1. Five bodies of reserves (Nos. 2, 3, 6, 7, and 8) arbitrarily outlined and delimited from some of the more closely grouped assays total 26,140 tons averaging 3.87 lbs. Hg per ton, or 1,035 flasks of quicksilver. All the figures given are very rough approximations based upon inadequate data. It is impossible to determine the very irregular boundaries of such bodies by diamond drill, and these bodies are intended only as a general suggestion of the places that assays and other information from the drill provide a little more information than elsewhere. The boundaries are shown as straight lines conforming only approximately to the assays because of the inherent inaccuracy of drill sampling in this ground and because all underground workings are inaccessible.

The floors of the 1877-4h stope previously mentioned are very irregular, especially on the footwall side where most of the virgin reserves occur. The amount of reserves in the footwall rock at any particular place is controlled by the number of quartz-cinnabar veinlets that dip at various angles and by the degree to which very irregularly porous beds of sandstone were impregnated by cinnabar.

Some of the assays used in body No. 2 came from old workings, and others may possibly have come from old workings if they were not detected

in drilling. It is impossible to locate hanging walls accurately in the old workings, and they are set arbitrarily at the top of loose ground in drill holes. Loose material in the old stopes probably is worthless, and loss is better than the drill represented it. Much of the value of stope fill in the 1941-44 stope occurred as small pieces of high grade ore scattered at random, and the drill cannot give an accurate estimate in such material. It is believed that the recovery of cinnabar from old workings large enough to be stopes is more useful information than are the assay or estimate of grade of the sludge recovered. Recovery of sludge from such material as a rule was poor, and in a number of instances was nil.

These five bodies of inferred reserves, estimated very sketchily as described above, fall in the class of reserves comparable with those of the 1939-44 stope that were mined and are therefore inferred reserves believed minable under 1943 conditions.

Body	Tons	Avg. grade	No. Flasks	Assays of drill holes represented						
2	[illegible]	3.7 lbs.	340	DDH-3	1.0 lbs.	5 ft.;	1.1 lbs.	10 ft.		
				DDH-6	3.4 "	5 "				
				DDH-7	20.3 "	5 "				
3	10,070	3.0 "	420	DDH-3	16.6 "	2 "	;12.3 "	4½ ft.		
					4.3 "	4 "	; 3.9 "	5 ft.		
					2.5 "	5 "				
				DDH-4	1.6 "	5 "	;est. 0.2 lb.	5 ft.		
					2.1 "	10 "				
				DDH-5	2.8 "	5 "	; 1.4 lbs.	5 ft.		
					1.5 "	2 "	; 1.1 "	5 ft.		
					0.6 "	5 "				
6	5,375	3.7 "	681	DDH-11	0.8 "	7 "	; 3.2 "	5 "		
					2.3 "	5 "	;30.5 "	5 "		
					10.7 "	5 "	; 1.7 "	5 "		
					2.4 "	4 "				
7	895	3.4 "	65	DDH-14	3.4 "	6 "				
8	2,280	3.6 "	105	DDH-15	3.2 "	5 "	; 3.9 "	5 "		
					1.6 "	5 "				
	24,160	3.87 lbs.	1,335 flasks							

2. Four bodies of reserves (Nos. 1, 4, 5, and 9) also arbitrarily outlined and estimated under the same conditions mentioned above make a total of 35,080 tons averaging 1.4 lbs. Hg per ton, or 645 flasks of quicksilver. These inferred reserves are somewhat below the grade of ore mined in the 1939-44 stope, and are believed minable only under considerably more favorable economic conditions or grave emergency.

Body	Tons	Avg. grade	No. Flasks	Assays and drill holes represented					
1	15,595	1.3 lbs	265	DDH-3	0.9 lbs.	5 ft.;	1.4 lbs.	5 ft.	
					1.1 "	5 " ;	0.8 "	10 "	
				DDH-7	2.2 "	3 " ;	1.8 "	10 "	
4	905	2.1 "	25	DDH-4	2.1 "	8 " ;			
5	3,655	1.2 "	60	DDH-8	1.4 "	5 " ;	est.0.4 lb. 13 ft.		
					0.7 "	10 "			
9	14,925	1.8 "	295	DDH-14	est.0.3 lb.	7 ft.;	0.2 lb.	12 ft.	
					est.0.3 "	5 " ;	0.9 "	2 "	
					4.1 lbs.	8 ft. (all old working			
				DDH-15	2.2 "	7 " ;	1.3 lbs.	10 ft.	
					1.8 "	6 " ;	3.7 "	10 ft.	
35,080		1.4 lbs.	645 flasks						

Of the nine bodies of inferred reserves listed above, Nos. 6, 7, and 8 are believed to be the best supported by data because they are based upon closely spaced assays, and lie in that zone said to have been the most productive part of the vein. No. 3 has its estimated grade by virtue of high assays at the lower end, and both assays and available geologic information suggest the upper part is too close to the surface to be very good.

The tonnage factor in these calculations is 13.4 cubic feet per ton. This figure was set by the Bureau of Mines project engineer, and is used in this report for uniformity.

3. The writer infers 83,760 tons averaging 3.0 lbs. Hg per ton, or 3,305 flasks of quicksilver in the Eureka vein in addition to the nine bodies of reserves previously listed. The diamond drill data in themselves do not provide all the information required for this estimate, but do provide sufficient specific information in addition to other information that is available. The location of these inferred reserves was discussed above.

Escape Vein

The writer believes that 100,000 tons of 1.5 lbs. Hg per ton, or 1975 flasks of quicksilver, reasonably may be inferred for the Escape vein despite inadequate data. The vein is reported to have been one of the six principal veins, and the old map shows regular levels at least 700 feet along the strike and about 600 feet down the dip, with the possibility of

some exploration between the 3 and 5 levels. Only four holes were drilled in the vein, and two of them failed almost entirely to recover sludge from a zone that might possibly prove to be reserves, but they encountered quite rich workings. Hole 15 obtained a ten-foot sample that assayed 2.5 lbs. Ag per ton, and 11 foot samples from 1.2 to 0.5 lbs. Ag per ton.

[illegible] Areas Investigated by Diamond Drilling

Drill holes 16 and 27 investigated part of what is said to be the Osceola vein between the Humboldt and Eureka veins. They encountered traces of cinnabar with pyrite, quartz, and quartz veinlets, and hole 26 obtained a 5-foot sample that assayed 0.9 lbs. Hg per ton. These data are inadequate for estimating the possible existence of reserves in this area.

Drill holes 17-23 investigated the uppermost part of the area occupied by the Manzanita and Mercury veins, but obtained no data adequate for estimating the possible existence of reserves. No attempt was made to reach the deeper zone said to have been the most productive. Very few samples were taken. No. 17 hole was drilled in search for the three large footwall stopes mentioned by Locher. It yielded a five-foot sample assaying 1.1 lbs. just after the drill passed through the first of three old workings. A five-foot sample assaying 15.9 lbs. was obtained just before the drill passed into the second old workings.

No. 21 hole yielded 3 five-foot samples that assayed 1.0, 1.8, and 0.5 lbs. Hg per ton respectively at depths of 37-42, 105-10, and 147-52 feet.

Little could be learned of the veins from the surface because of the landslide cover.

Recommendations for Future Work

Anyone contemplating a renewed search for reserves in the mine should not forget that the Napa Consolidated Q. M. Co. hunted very intensively with the great advantage of its intimate knowledge of the underground workings and the veins. The reserves discussed in the preceding pages are low grade and are suitable for operation of the mine only under unusually favorable economic conditions.

Three possible directions for search suggest themselves, but in each there is no way to tell how much may already have been done prior to 1910 to exhaust such possibilities. These are: exploration of the Eureka, Escape, Osceola, and Humboldt veins below the 3 level; exploration of adequate depth in the vicinity of the basalt butte; and exploration of the Osceola fault westward toward the serpentine body in which the Corona mine is situated. Neither of these is to be undertaken without great caution. The underground workings shown on the map show that the Osceola fault was followed about 1,000 feet west of the junction with the Humboldt fault.

References cited

Becker, G. F., 1888, Geology of the quicksilver deposits of the Pacific slope: U. S. Geol. Survey Mon. 13, p. 354-8.

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Forstner, William, 1903, The quicksilver resources of California: California State Min. Bur. Bull. 27, p. 89-91.

Ross, C. P., 1940, Quicksilver deposits of the Mayacmas and Sulphur Bank districts, California: U. S. Geol. Survey Bull. 922, p. 347.

From that point it is only [illegible] serpentine outcrop northwest of the Corona mine, but this outcrop has been thoroughly searched by prospectors [illegible] underground. The production of the Corona mine is said to have been only a few thousand flasks also.

APPENDIX

Indicated Reserves

Indicated reserves are defined by the Geological Survey and Bureau of Mines as those "... for which tonnage and grade are computed partly from specific measurements, samples, or production data and partly from projection for a reasonable distance on geologic evidence. The sites available for inspection, measurement, and sampling are too widely or otherwise inappropriately spaced to outline the ore completely or to establish its grade throughout."

Inferred Reserves

Inferred reserves are defined as those "... for which quantitative estimates are based largely on broad knowledge of the geologic character of the deposit, and for which there are few, if any, samples or measurements. The estimates are based on an assumed continuity or repetition for which there is geologic evidence; this evidence may include comparison with deposits of similar type. Bodies that are completely concealed may be included if there is specific geologic evidence of their presence."