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BRETZ MERCURY OPERATION
ARENTZ-COMSTOCK MINING VENTURE

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The conventional process for the recovery of mercury from its ores consists of feeding coarsely crushed, mine-run ore directly to a furnace or retort equipped with a suitable condensing system for the recovery of mercury from the furnace gas. The process is simple, efficient and relatively low in cost. It was with some hesitation that we chose to use flotation ahead of furnacing at the Bretz Operation. The factors considered in the selection of the metallurgical process employed and the results attained will be discussed after a brief review of the history and geology of the Bretz Mine.

The Bretz Mine is situated in the Opalite Mining District, Malheur County, Oregon, three miles north of the Nevada State line and ten miles west of McDermitt, Nevada. The Opalite District includes the Cordero and Opalite Mines, and has reportedly produced over 70,000 flasks of mercury. The Cordero Mine, operated by the Sun Oil Company, has been a major producer for over fifteen years and is currently one of the country's largest mercury operations. The Opalite Mine has not been operated since 1944, but produced a substantial amount of quicksilver during the period 1927 to 1944.

The Bretz Mine was discovered in 1931 by William S. Bretz. The property was leased to the Bradley Mining Company and was operated in conjunction with that company's Opalite Mine during the period 1931 to 1936, and again from 1940 to 1944. The ore was mined from open pits by a small power shovel and was trucked to a 4' x 70' Gould furnace at the Opalite property. A total of 10,309 flasks of mercury were recovered from approximately 40,000 tons of Bretz ore for an

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average of 18.8 pounds of mercury per ton. The Opalite and Bretz Operations were stopped in 1944 when the price of mercury dropped below the cost of production and the Bretz claims were abandoned.

John Ruiz, a McDermitt rancher, relocated the Bretz claims in 1954. In 1955, Jay A. Carpenter obtained a lease on the claims on behalf of the U. S. Mercury Corporation and started exploring the property with drill holes. The U. S. Mercury Corporation was subsequently merged into the Shawano Development Corporation and the exploration program started by Mr. Carpenter was continued under the direction of J. P. Hart. The exploration was successful in delineating an ore body on the extension of an area formerly mined by the Bradley Mining Company. Arentz-Comstock completed an agreement with the Shawano Corporation covering the construction of a plant and the operation of the property in April, 1956. The plant was placed in operation on December 1, 1956 and to March 1, 1958, has processed 45,000 tons of ore.

The geology of the Opalite District has been described by Schuette (1938) and by Yates (1942), and reference has been made to their papers in the following summary of the geology in the area of the Bretz Mine.

The Opalite District is covered by several thousand feet of Miocene lavas overlain by several hundred feet of upper Miocene lake beds. The lavas range from basalt to rhyolite in composition and the lake beds consist of tuffs, shales and sandstones, the particles of which are predominately of volcanic origin. The Miocene rocks are cut by a series of steeply dipping normal faults which strike north to northwest in the vicinity of the Bretz Mine. Some of these faults served as channels for the mineralizing solutions.

Along the fault zones there has been extensive silicification of both the lavas and the lake beds forming large irregular masses of "Opalite". Adjacent to the "Opalite" the lake beds have been altered to form kaolin and related clay minerals. Most of the Bretz ore occurs in these altered areas in fracture zones in the hanging wall of major faults.

Finely disseminated pyrite has been deposited in the mineralized area and is much more widespread than the cinnabar mineralization. The oxidized pyrite in the upper portions of the orebodies gives a typical limonite coloration which, with the silicification, serves as a guide to exploration. The oxidation of the iron extends from thirty to over one hundred feet below the surface. Gangue minerals include pyrite, opalite, various clay minerals and occassionally some chalcopyrite.

A truck mounted Mayhew "1000" drill has been used for exploration and development. Cuttings are blown from the holes with air and are caught in a small cyclone for sampling. Some difficulty has been experienced from drilling into silicified areas, but in the unsilicified lake beds, drilling is rapid and relatively inexpensive. Maximum depth of holes is approximately 200 feet, but is dependent upon the dryness of the formation drilled. Deeper holes can be drilled with the equipment by circulating water or mud instead of air.

When Arentz-Comstock completed an agreement covering the Bretz Mine in April, 1956, exploratory drilling indicated an ore body approximately 40' wide by 200' long by 25' thick with an average overburden of 30' of waste. There was indication that a narrow extension continued for 350' to the north and that continued exploration would find additional ore. Our initial work consisted of stripping the waste from a portion of the ore body to check on the grade indicated by the drill holes and to provide representative samples for metallurgical test work.

The Bretz ore is very soft and clay-like, although some of the hard opalite contains scattered cinnabar. The ore as mined contains over 25% moisture and weighs less than 60 pounds per cubic foot when broken. The former furnace plant of the Bradley Mining Company at the Opalite Mine had a reported capacity of 100 tons per day of Opalite ore, but could only treat 45 tons per day of Bretz ore. Fuel consumption increased from 6 gallons per ton on Opalite ore to over 13 gallons per ton on Bretz ore and the volume of furnace gas reached 80,000 cubic feet per ton of Bretz ore.

Preliminary furnace tests on the Bretz ore confirmed the experience reported by the Bradley Company and indicated both capital and operating costs would be unusually high if a conventional furnace plant were used.

In looking for possible alternatives, the work done by Keith Kunze, General Superintendent of Getchell Mine, Inc., on the flotation of cinnabar, came to our attention. Samples of Bretz ore were submitted to Mr. Kunze for testing and the results reported indicated that satisfactory recoveries could be made in a high grade concentrate. Laboratory tests in Salt Lake City confirmed the results reported by Mr. Kunze. Through the co-operation of the U. S. Bureau of Mines, a continuous pilot plant test was made at the experimental station in Albany, Oregon. The pilot plant run further confirmed the laboratory test results. Samples of flotation concentrate were sent to the Pacific Foundry Company in San Francisco to obtain data on the retorting or furnacing equipment required to process the concentrate to elemental mercury.

Cost estimates were prepared on the basis of treating 100 tons of ore per day and amortizing the investment on an estimated ore reserve of 75,000 tons. Because of the high moisture content and the physical characteristics of the Bretz ore, a furnace plant having a nominal capacity of 200 tons of ore per day would be required. Estimated costs included developing a water supply and installing a diesel-electric power plant. Mine development and operation and camp and service facilities would be the same for either plant installation and are not included in the following comparison of estimated costs:

	Furnace Plant	Concentrating Plant
Estimated Capital Cost	$325,000.00	$170,000.00
Amortization per ton	4.33	2.27
Operating Costs - direct	4.45	3.75
Total estimated per ton	$8.78	$6.02

While the furnace plant was estimated to yield slightly higher over-all recovery of mercury, the unusually high gas volume per ton reported by the Bradley Operation when treating Bretz ore indicated that furnace recoveries would be lower than normal for furnace installations. It was not felt that the difference in recovery would offset the higher capital outlay required and the resulting increased cost of a furnace installation. The concentrating plant also offered possible advantages in greater flexibility and possibly greater salvage value as the equipment required is in more general use. The principal problem connected with a flotation plant was an adequate water supply in a desert area. Several of the deeper exploration drill holes indicated a possibility of developing a well on the property and in case of necessity water could be obtained from McDermitt Creek, but only at considerable expense.

With the decision to use flotation concentration followed by retorting of the concentrates, a plant was designed utilizing available reconditioned, used equipment. Construction started late in July, 1956, and the completed plant was placed in operation on December 1, of that year. During the construction period, a water well was completed and a contract was let to Wells Cargo, Inc. for waste removal and mining. Twenty thousand tons of ore averaging four pounds of mercury per ton were salvaged from the stripping operation and stockpiled at the mill site when mining was stopped for the winter in early November.

The capital investment in the completed mill, including a power plant and a water supply, office, laboratory and warehouse, but excluding camp facilities, totalled $166,031.40. After several month's operation, it was found that the retorts were inadequate and that additional flotation cells were required. A new six hearth, 60" I. D. furnace, complete with fans and condensing equipment,was installed and four flotation machines were added to the circuit to bring the total plant cost to $206,601.71.

The mill equipment and flow sheet as revised to date are as follows:

A 15 HP, three drum slusher hoist moves the stockpiled ore to a conveyor belt discharging to a 4' x 8' vibrating screen ahead of a 10" x 20" jaw crusher. The screen undersize and the crusher discharge drop onto a conveyor belt discharging into a circular steel ore bin. The crushed ore is belt fed to a 5' x 5' Eimco ball mill discharging into a 4' x 18' duplex rake classifier. The classifier sands return to the ball mill and the classifier overflow goes to a 5' x 5' conditioning agitator. The conditioned pulp flows to a rougher circuit consisting of four No. 18 Special Denver flotation cells followed by a scavenger circuit consisting of four No. 36 Fagergren flotation cells. The rougher concentrate goes to two No. 18 Special Denver cleaner cells and the scavenger concentrate is returned to the head of the rougher circuit. The cleaner concentrate is pumped to a 10' x 6' thickener and the thickener underflow is pumped to a two leaf, four foot Eimco disc filter. The filter cake discharges into a screw conveyor feeding the hearth furnace.

Two D 13,000 Caterpillar engines each driving a 100 KVA generator supply 3 phase, 220-440 volt electric power and a deepwell pump mounted in a 600 foot well delivers water to a 40,000 gallon capacity Columbia bolted steel water supply tank. The mill equipment and furnace are housed in a prefabricated steel Butler building and two smaller Butler buildings house the power plant and a laboratory, office and warehouse.

The mill operation has come up to expectations both as to recoveries and operating costs. The original retort installation did not have sufficient capacity and was costly to operate, but the hearth furnace now in use has corrected the problem. The mill tailing assays vary from a low of 0.2 to a high of 0.7 pounds of mercury per ton and average approximately 0.5 pounds per ton. The higher assays are usually due to an increase in the amount of mineralized opalite in the mill feed. Concentrate assays vary from a low of 300 pounds to a high of 1,200 pounds of mercury per ton depending upon the amount of pyrite in the mill feed. The clay-like ore is difficult to handle during wet

weather, particularly in the crushing plant. Plant capacity has averaged in excess of the designed capacity of 100 tons of ore per day, and has reached 140 tons per day. It now appears probable that with a minor change the capacity can be increased to two hundred fifty tons per day. The mill reagents used are as follows:

Palcotan is added at the ball mill and conditioner	0.14# per ton
Copper Sulphate is added at the ball mill	0.16# per ton
Reagent 301 is added at the conditioner and cells	0.54# per ton
Frother 77 is added at the conditioner	0.60# per ton
Separan added to concentrates	0.01# per ton

Mill operating costs are as follows:

	Per Ton
Crushing (including tractor on stockpile)	$ 0.80
Grinding and flotation	0.85
Filtering and drying	0.11
Concentrate roasting	0.19
Mill power	0.50
Reagents	0.36
Flasking (including cost of flasks)	0.20
Mill water	0.10
Assaying	0.12
Total direct expense	$ 3.23

During 1957 exploration and development drilling was continued ahead of mining with fair success. Wells Cargo, Inc. resumed stripping and mining in May and continued to September 1, at which time over forty thousand tons of ore was stockpiled at the mill. While irregular areas of high grade ore containing in excess of 20# of mercury per ton were encountered in mining, the average grade of the deposit is considerably lower than had been indicated by the initial drilling and the ore delivered to the mill has averaged slightly over five pounds per ton.

During the pilot plant test at the U. S. Bureau of Mines station at Albany, Oregon, screen analyses of the ore indicated a marked concentration of cinnabar in the finer sizes after a minimum of grinding. Extensive test work at the plant during the past year confirmed the original observation. The test work indicates that thirty to forty per cent of the mill feed can be rejected

ahead of flotation by discarding the plus 20 mesh fraction of the ball mill discharge. The rejected material will have an average assay of 0.6# mercury per ton of ore and will contain less than 10% of the mercury contained in the mill feed. Since the plus 20 mesh material is the hard, silicious fraction of the ore it is the least amenable to flotation because of ultimate sliming in the grinding circuit and a high proportion of middling product in even the finer sizes. The removal of this material from the grinding circuit will permit increasing mill tonnage to an estimated 250 tons per day from the present capacity of approximately 120 tons per day. The additional equipment required to remove the plus 20 mesh material from the grinding circuit is now being installed and should be in operation during the coming month. Presently developed ore reserves are sufficient to supply the mill at the increased daily tonnage for an estimated 15 months and it is anticipated that continued exploration and development will result in substantially increasing the ore reserve.

The future of the Bretz Operation is, of course, dependent upon our obtaining an adequate price for the mercury produced. The drop in price from $255.00 to $225.00 per flask during the final quarter of 1957 seriously affected our operations and there is every prospect of a further price reduction at the expiration of the present government purchase program. With continually inflated costs for labor and supplies, the domestic mercury mining industry faces the same problems as the other segments of the domestic industry. Unless our government establishes a long-range policy which assures the domestic industry a reasonable proportion of the domestic market, at a price consistent with our inflated costs, we shall have no alternative but to shut down, with a resulting loss in capital, jobs and local industry. Ultimately our domestic consumers will be faced with the problem of procuring an adequate supply of metal at a reasonable price, because without the stabilizing influence of a strong domestic industry, experience indicates that the metal is not available as required and that prices have a tendency to substantially increase.

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