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Cyaniding Clayey Ore at the Buckhorn Mine, Nevada

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*The ore deposit of the Buckhorn Mines Co., Buckhorn, Nevada, is peculiar as it occurs as a shallow kaolinized mass of material with basalt walls, having apparently no direct connection with any of the usual gold-bearing rocks. The ore generally contains 16% water of hydration, and the cyaniding of this hydrous clayey material offered unusual difficulties when compared with the typical gold-quartz ores of Nevada. The orebody was thoroughly developed. Then the mill was built according to the latest cyanide practice, embodying changes necessitated by the peculiar nature of this ore; but on starting the mill, the ore proved more difficult to treat than had been anticipated.

Considerable trouble was experienced in mining the sticky ore and getting it to the treatment plant. The next problem was to get the ore out of the mill-bin and to crush it. The bin was an ordinary circular steel type, with natural earth bottom and side gate. This ore would not run from the bin. The mill was designed to treat 300 tons per day, but even with one man in the ore-bin and two at the crusher, it was impossible to get more than 150 tons through in 24 hours. In crushing, the large kaolin lumps gave the most trouble.

The jaw-crusher was discarded in favor of high-speed toothed rolls that gave the desired crushing capacity. The rolls are well adapted for sticky ores. To dispense with a man on each shift shoveling ore out of the bin, a 36-in. conveyor-belt was installed to feed the crusher. The opening in the bottom of the bin over the belt was 2 ft. wide, extending clear across the bin. It was closed by means of short pieces of mine rails that could be removed as desired to allow the ore to be drawn out.

The 45 by 15-in. Anaconda-type rolls with smooth shells would clear themselves fairly well if one of the shells had a channel 1 in. wide by ½ in. deep machined in it, but it was troublesome to keep a groove in the shells as they wore down.

One 6-ft. Hardinge ball-mill was intended to reduce the whole tonnage. After plastering the balls to the side of the mill with clay a few times, the mill-men learned by the sound of the mill when it was beginning to choke; feed was then cut off.

Another ball-mill made it possible to keep the rest of the plant going while grinding out the mills, one at a time, and allowed the rolls being set coarser on sticky ore. With clean ore 300 tons per day was sometimes put through one mill.

The ball-mill discharge was classified in two 36-in. Akins classifiers, the oversize fed to two 5 by 18-ft. tube-mills with Komata liners. The tube-mill discharge was classified in a home-made drag-classifier. The small quantity of material requiring re-grinding included fragments of basalt 'nigger-heads.' This material was almost as hard as the pebbles themselves and of low assay-value. Occasionally enough accumulated in the circuit to be troublesome and was thrown out. A small amount was thought to help grinding. About 80% of the product delivered to the cyanide plant would pass a 150-mesh screen.

Of the mill-head value 80% was dissolved in the crushing-plant. Only small additional extraction could be obtained in the rest of the plant. The real trouble was to remove the dissolved value from the clayey pulp. Accordingly the three 32 by 14-ft. Dorr agitators were changed to thickeners. These settled 300 tons daily of 1 to 10 pulp, as delivered from the crushing-plant, to a specific gravity of 1.15. The 8 sq. ft. of settling area provided per ton of this ore settled in 24 hr. would be sufficient to settle an average Nevada quartz ore to a specific gravity of 1.33. The overflow was precipitated, and the underflow mixed with the barren solution and fed to six 36 by 12-ft. Dorr thickeners, delivering a 1.23 specific gravity underflow to the filters. The 20 sq. ft. of settling area per ton settled in 24 hr. is three times the area required to settle an average Nevada ore to a specific gravity of 1.33. Primary thickeners were held with 2 ft. of clear solution; the secondary thickeners with 6 in. It was impossible to settle the raw Buckhorn ore beyond a specific gravity of 1.26, either in the mill or experimentally.

The maximum capacity of each of the four 14-ft. diam. by 12-ft. face Oliver filters was 50 tons per day, about one-half their capacity on average Nevada ore. An additional filter, 24-ft., had to be installed to filter 300 tons per day.

A sample of Buckhorn ore, dried carefully at a temperature below 110°C., had a specific gravity of 1.9. A higher temperature gave an additional loss of 16% in weight, and entirely changed the physical properties of the ore. The dehydrated sample had a specific gravity of 2.4, and settled and filtered almost as well as a quartz ore. Dehydrating also removed the sticky qualities. Both samples, however, gave the same extraction with cyanide. The temperature of a laboratory electric hot-plate was sufficient to dehydrate a sample nicely. As CO_2, etc., would not be driven off at this temperature, this loss in weight must be due to water of hydration. With cheap fuel, dehydration before milling would be the best treatment for this class of material. The ore would mill and classify easier, the thickeners and filters would have normal capacity, and dissolved metals would be more completely removed. The temperature of a commercial drier would dehydrate the ore with about the same fuel consumption (100 lb. of coal per ton of ore) as in removing the 18% H_2O if it existed in the form of moisture. The high price of fuel delivered at Buckhorn prevented the adoption of dehydration at this mill. The ore was treated raw at the cost of $1.59 per ton; total costs were $2.55 per ton. Power cost $8 per hp. month.

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