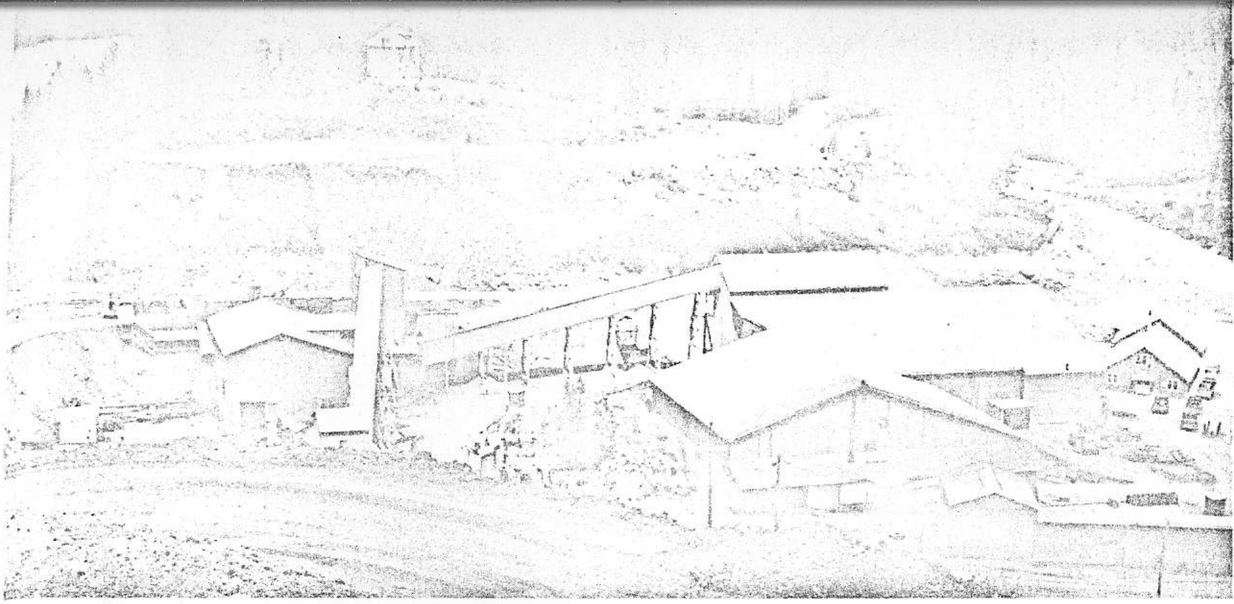


Phoenix: crushing plant (left), mill, offices

Phoenix: himself

Phoenix

where it all started — and still goes

When the copper deposits at Phoenix were discovered in 1891 they were found to be decidedly low grade. The Rossland and Slocan booms were on, there were few trails in the country, and the nearest railroad was 75 miles away; under these conditions very little attention was paid to the new discoveries.

It was soon found that the Phoenix ores were self-fluxing; ie, they required only the addition of coke for direct smelting, and hence could be treated cheaply. Development began in 1896, and by 1900 Granby had built a 700 ton-per-day smelter in Grand Forks and had begun shipping ore via the CPR which had reached Phoenix that same year. In 1904 the Great Northern built a line into Phoenix, and both mine and smelter capacity were rapidly increased to 4500 tons per day.

The smelter was designed and built by ABW Hodges, who became the first superintendent. For many years this was the largest non-ferrous smelter in the British Empire and the second largest in the world.

Underground mining at Phoenix began using the 'square-set' method but by 1901 the method had been changed to 'open stope and pillar' with very considerable savings in costs. At one time there was on display a stope 80 ft high, 105 ft wide, and 400 ft long, completely unsupported.

In 1903 there were three small steam shovels at work in the surface quarries, handling about one-half of the mine production. This was one of the earliest attempts at open-pit mining in the province.

Operating costs, including mining, freight, smelting, converting, and general, were reduced from $4.77 per ton in 1901 to $2.39 per ton in 1913. Labour and material shortages caused by the outbreak of World War I resulted in cost increases in later years.

Many factors contributed to the Company's liability to achieve such low unit costs. In addition to the economies of operating on a large scale the Company pursued a policy of mechanization and electrification wherever possible, and the operating staff developed many cost-saving improvements.

Probably the best-known development to originate at Phoenix was the self-dumping Granby car. Although based on an earlier wooden car, the Granby car in its present form was first introduced in 1905 when twenty 10-ton steel cars were built for use on the main haulage levels.

Another early improvement was the invention of a drill-sharpening machine which eliminated the need for many blacksmiths and forges.

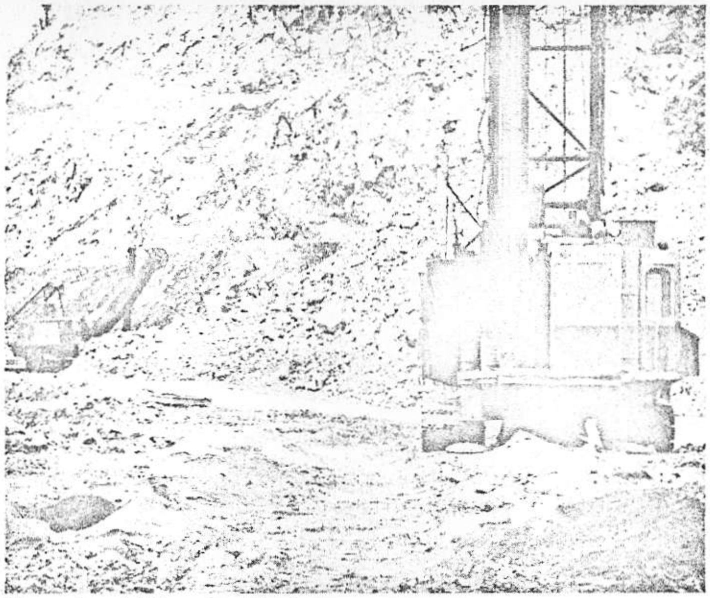
At the smelter, Mr Hodges invented an automatic furnace charger which greatly reduced the time and manual labour for this operation.

Much of the heavy equipment used in the mine was manufactured locally and well-equipped machine shops could make or repair almost any part or machinery required.

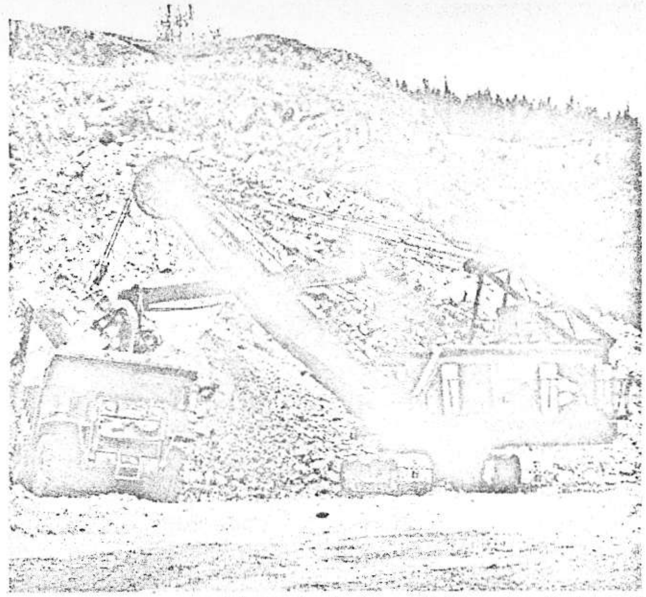
An extended strike in the coal fields forced a suspension of operations in 1919. With the ore reserves almost exhausted, and with a need for experienced men at Anyox, it was decided to close the mine and smelter permanently. During its twenty years of operation at Phoenix, Granby had the distinction of having mined, at a profit, lower grade ores than had been mined anywhere up to that time.

The success of the operations at Phoenix can, to a large degree, be attributed to the efforts of many highly competent men and women at all levels of the organization and it would be fitting to pay tribute to a few of these at this time.

CM Campbell, engineer and superintendent from 1904 to 1919, who went on to manage the Cassidy coal mine for Granby until 1924. The Swanson brothers, John and Steve, and John McLaughlin, all experts in large-scale mining; John Swanson later became superintendent at Anyox and McLaughlin became superintendent at Copper Mountain. Ned Nelson, engineer at Phoenix and Anyox for many years, now lives in retirement in the States.



Phoenix: drilling for blast



Phoenix: in the pit (the small shovel)

THE RE-OPENING OF PHOENIX

When the original Phoenix operation closed in 1919 it was estimated that approximately 2,500,000 tons of 1% copper ore remained, of which some 500,000 tons were available. There were also approximately 200,000 tons of material grading 0.65% copper which was not considered to be of ore grade. These reserves were contained in pillars or old stopes which had not been completely mined out at the time the mine closed.

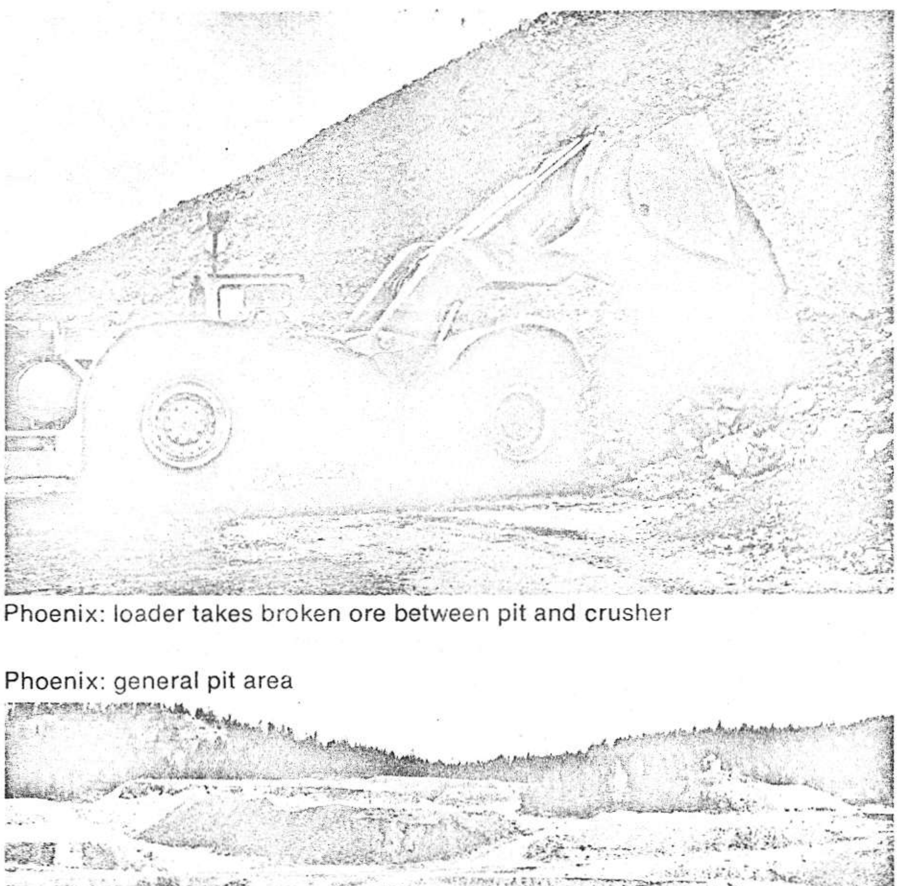
In 1956 Granby began a re-evaluation of the old mine in light of the success of open pit methods at Copper Mountain. Preliminary work indicated that at least 1,300,000 tons of ore were readily available and a 600 ton-per-day concentrator was erected, utilizing equipment from the mill at Allenby. Production began in 1959.

It was soon apparent that a considerably greater tonnage was available and the mill capacity was increased to 900 tons per day the following year. Subsequent exploration added to the reserves and the capacity was increased to 1900 tons per day by 1964 and to its present rated capacity of 2750 tons per day in 1972.

The mining, by open pit methods, of an ore body substantially mined out by underground methods has presented many unique problems.

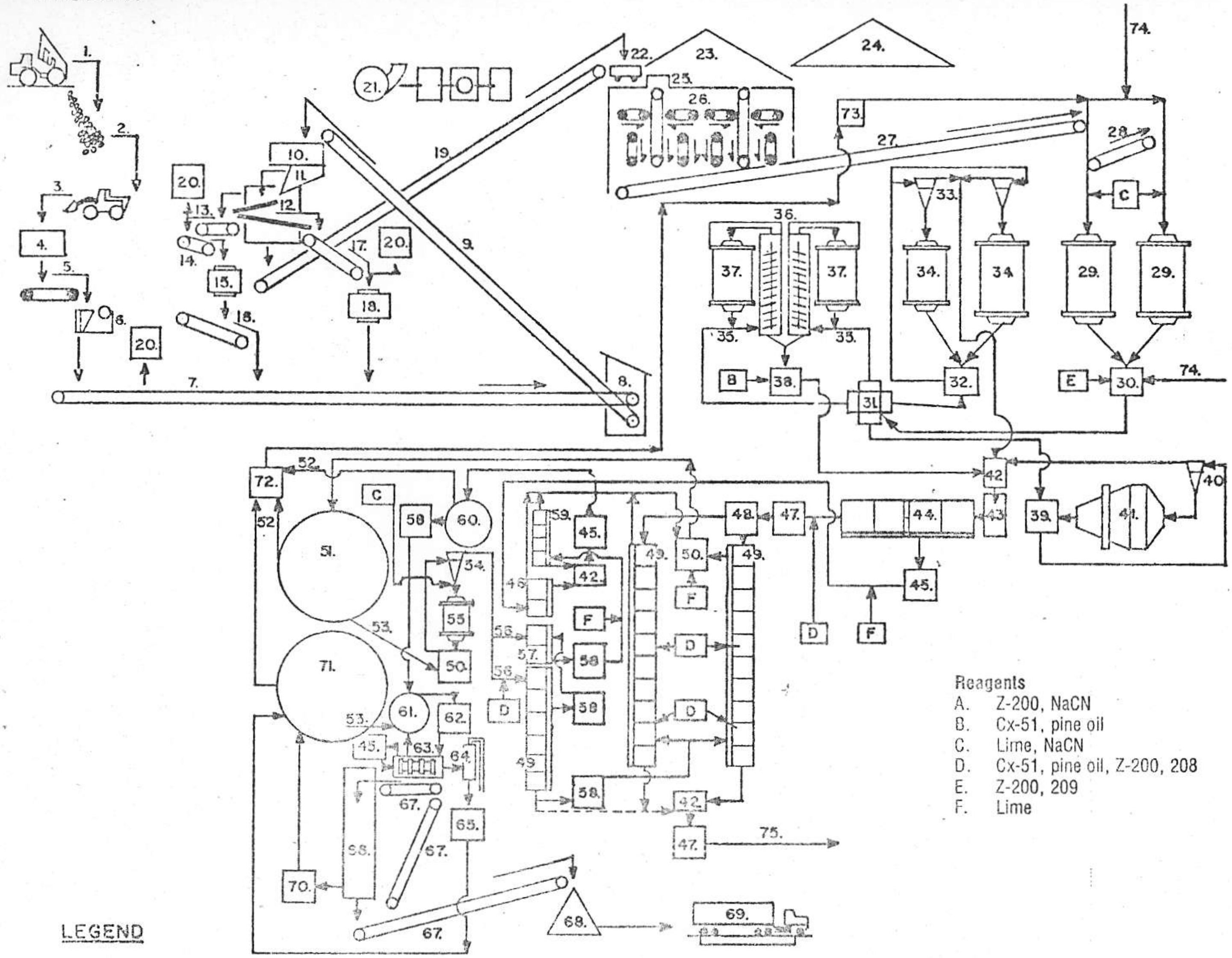
It has always been impossible to calculate 'proven' ore reserves and over the years an empirical method of estimating 'indicated' ore reserves has been developed, based on plans and sections drawn up prior to 1919.

Plans and sections are continually being revised as further information is obtained through diamond drilling, geological mapping, and experience gained as mining progresses; for example, some of the older stopes had been back filled with low-grade materials



Phoenix: loader takes broken ore between pit and crusher

Phoenix: general pit area



LEGEND

Phoenix: flowsheet legend

Crushing

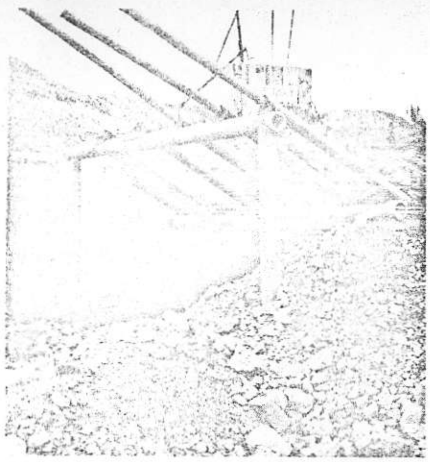
1. 35-ton trucks
2. 100,000-ton stockpile
3. Cat 966 loader
4. 50-ton coarse ore bin
5. Link Belt apron feeder 48in
6. CA-C jaw crusher 36x48in
7. Conveyor 36in (−5in matl)
8. Transfer house
9. Conveyor 36in
10. Surge bin 100-ton
11. Jeffrey vibrating pan feeder 36x72in (2)
12. Dillion double deck screen 48x120in (2)
13. Conveyor 24in (+3.5/−5in matl)
14. Conveyor 24in
15. Symons standard cone crusher 4.25ft
16. Conveyor 24in (−1.5in matl)
17. Conveyor 24in (+0.75/−3.5in matl)
18. Symons shorthead cone crusher 5.5ft
19. Conveyor 24in (−0.75in matl)
20. Electromagnet
21. Wheelabrator dust collector 34,000cu.ft/min

Grinding

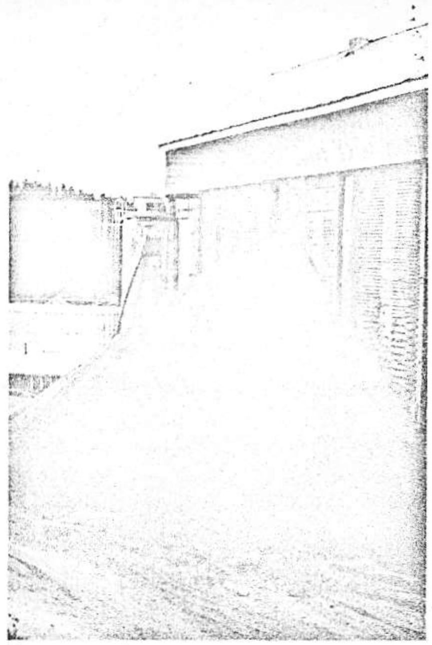
22. Tripper car
23. Fine ore bin 1500-ton
24. Fine ore stockpile 10,000-ton
25. Jeffrey vibrating pan feeders 24x72in (3)
26. Modified slot feeder (8), 20in conveyor (2)
27. Conveyor 24in, Skinner weightometer
28. Conveyor 24in, manual weight
29. CA-C rod mill 8x12ft (2)
30. ASH pump (rod mill) 6x6in
31. Splitter, 4-way
32. ASH pump (ball mill) 6x6in
33. Krebs cyclone 15in (2), Dorrclone 12in (1)
34. Worthington ball mill 7x10ft (1)
    CA-C ball mill 12ft (1)
35. Akins classifier 72x246in (2)
36. Classified sands moved by scoops
37. Worthington ball mill 7x10ft (2)
38. Hydroseal pump (ball mill) 6x6in
39. SRL pump (ball mill) 6x6in
40. Krebs cyclone 15in (1), 20in (1)
41. Hardinge ball mill 9x4ft

Flotation

42. Galigher automatic sampler
43. Stickpicker
44. DR Denver #200 cells (rougher) (2)
45. ASH pump 3x3in
46. DR Denver #24 cells (rougher cleaner) (2)
47. Vacseal pump 6x6in
48. Splitter, 2-way
49. Banks of 10 #30 Denver cells (middling scavenger) (2)
    Bank of 2 #30 Denver cells (retreatment-scavenger) (1)
50. SRL pump 5x4in
51. #1 thickener 40ft
52. Thickener overflow (reclaim)
53. Thickener underflow
54. Dorrclone 12in
55. Regrind mill 5x9ft
56. Retreatment feed
57. #24 Denver cells (6)
58. SRL pump 3x3in
59. #18 Denver cells (retreat cleaner reclean) (4)
60. Concentrate thickener 20ft
61. Agitator tank 10x12ft
62. Hydroseal pump 2in (1); 'Green Giant' pump 3in (1)
63. American filter, 4-disc
64. Vacuum tank with barometric leg
65. Worthington pump (filtrate) 2x2in
66. Rotary drier with screw conveyor feed
67. Conveyor 20in (concentrate filter cake)
68. Final concentrate stockpile 250-ton
69. Truck scale; final product to Vancouver BC
70. Scrubber (SO_2 extraction)
71. #2 thickener 40ft
72. Hydroseal pump 6x4in (thickener overflow)
73. Reclaim water from thickener
74. Reclaim water from tailings storage dam
75. Tailings to storage dam



Phoenix: above the primary crusher



Phoenix: fine ore pile

Phoenix: electrical shop

PHOENIX: Concentrator statistics
Milling data for the 12-month period ending 30 September 1973

Total mill feed: 994,136 tons 0.56% Cu
Concentrate produced: 18,011.9 tons 26.43% Cu
Overall copper recovery: 86.27%
Power consumption (excluding crushing) 13.11 kWh/ton

Material consumption (lb/ton milled)	
Grinding rods (3.5 in)	0.8
Grinding balls (2 in)	0.7

Reagent consumption (lb/ton milled)	
Lime (CaO)	0.966
Collector	
Amyl xanthate	0.011
Z-200	0.017
Aerofloat 208	0.005
Frother (pine oil)	0.016
Flocculant	
(Separan AP-30	0.0001

Mineral processing personnel
(crushing and concentrating)

	Hourly rated	Staff
Operators	21	—
Maintenance	8	—
Crusher lead hand	1	—
Metallurgy/assaying	8	2
Superintendents and assistants	—	3
	38	5

Processing operating costs
Unit costs, c/ton mill feed

Operating labour	13.1
Maintenance labour and supplies	13.8
Power	11.8
Operating supplies	25.5
Metallurgy and assaying	11.0
Supervision	3.8
Total mineral processing operating costs, c/ton milled	79.0

which is ore by today's standards. Arbitrary grades are assigned to 'ore-in-place' and 'ore-in-fill' and revised as necessary to correlate volumes of material mined with actual mill results.

THE MINERAL DEPOSIT

The ores of the Phoenix mine occur as blebs and disseminations of chalcopyrite in a chlorite-epidote skarn rock. The skarn and the copper minerals are localized near the base of an impure limestone sequence in the Brooklyn formation, above a well defined argillite foot-wall. The thickness of mineralization varies from a maximum of about 200 feet to a few feet at the limits of mining. The ore beds have a general inclination to the east, but slopes vary and faulting on north-south lines have produced irregularities. The original outcroppings have been removed and present mining has been carried downward beneath younger Tertiary sediments and volcanics which lie unconformably above the Brooklyn formation and cut off the ore beds in the north-east section.

The thick zone of mineralization, which has constituted the main ore mass, appears to be localized by the fault system and increased limestone impurity and skarn formation. No igneous source rocks for the mineralization are exposed but it is assumed that deep seated granitic intrusions under the mine area have produced the mineral-bearing and skarn-forming emanations conducted by the fault channelways to the favourable facies change in the Brooklyn limestone.

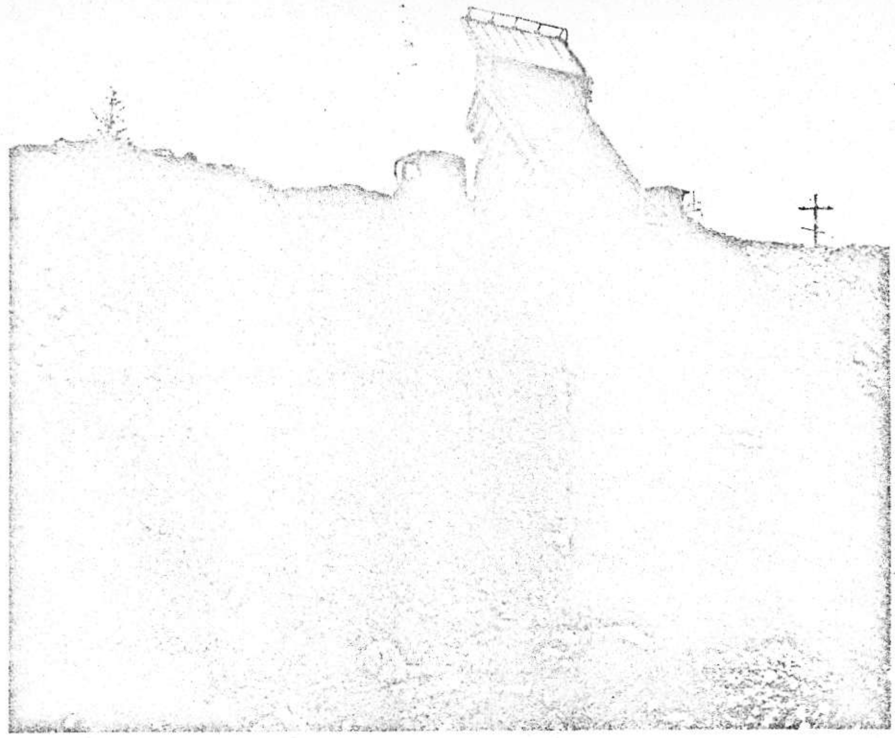
The mine was originally opened as an underground operation and although some surface mining was done it was essentially an underground mine up to the shut-down in 1919. The recent revival of the mine has been entirely as an open pit, which has removed lower grade ores along with floors and back fill and pillars of good ore left for support by the underground miners. The concentrator is located close to the pit at the elevation of 4500 feet above sea level. Mining has been carried out from 600 feet above the concentrator level at the south end to 200 feet below the concentrator level in the deepest part of the pit. The existing pit is about 2500 feet by 1400 feet in surface dimension. Barren waste piles from the relatively high stripping ratio are clustered around the rim of the pit. Concentrator tailings are deposited in a basin created by damming off the head of Twin Creek below the concentrator.

The principal mineral recovered at Phoenix is the copper iron sulphide chalcopyrite. With it important amounts of gold and silver are also saved. The ore reserve estimate at 1 January 1974 is: Ore in place in pit, 1,379,600 tons at 0.80% copper; marginal ore stockpiled, 3,712,000 tons at 0.40% copper.

Crushing and concentrating

The accompanying diagram shows the crushing, grinding and concentrating circuits in the Phoenix plant. Operating statistics are given in the tables.

Ore is delivered from the pit to a jaw crusher set at 5-in, from which the product is conveyed to two double-decked screens to provide a +3.5-in feed for a 4.25-in standard cone crusher in open circuit, and −3.50/+0.75-in feed for a 5.5-in shorthead cone crusher operating



Phoenix: dumping at crusher stockpile

in closed circuit to produce −0.75-in mill feed at a rate of 200 tons/hour.

In the 2800-ton/day concentrator, the grinding circuit comprises two open-circuit rod mills, each with 400-hp motors, discharging to a distributor splitting proportionately to five parallel ball mill circuits operating in closed circuit with cyclone classifiers to produce flotation feed screening about 55% of −200 mesh at a dilution of 38% solids.

Flotation roughing is accomplished in a single bank of 200-cu. ft cells, followed by two parallel banks of 100-cu.ft scavenger cells. Though the flotation circuit is designed to allow a great deal of flexibility in flow, to accomodate variations in the characteristics of the mill feed, rougher concentrates normally receive a single stage of cleaning, whereas scavenger concentrates and cleaner tails are subjected to multi-stage cleaning after thickening and regrinding to 87% of −325 mesh. This particular scheme is depicted in the flowsheet.

The tailings from the middlings retreatment bank may be discarded to waste or recirculated to the scavengers at the option of the operator.

Final concentrates are thickened, filtered, and dried to 7% moisture in the conventional way.

Phoenix: part of dust control plant