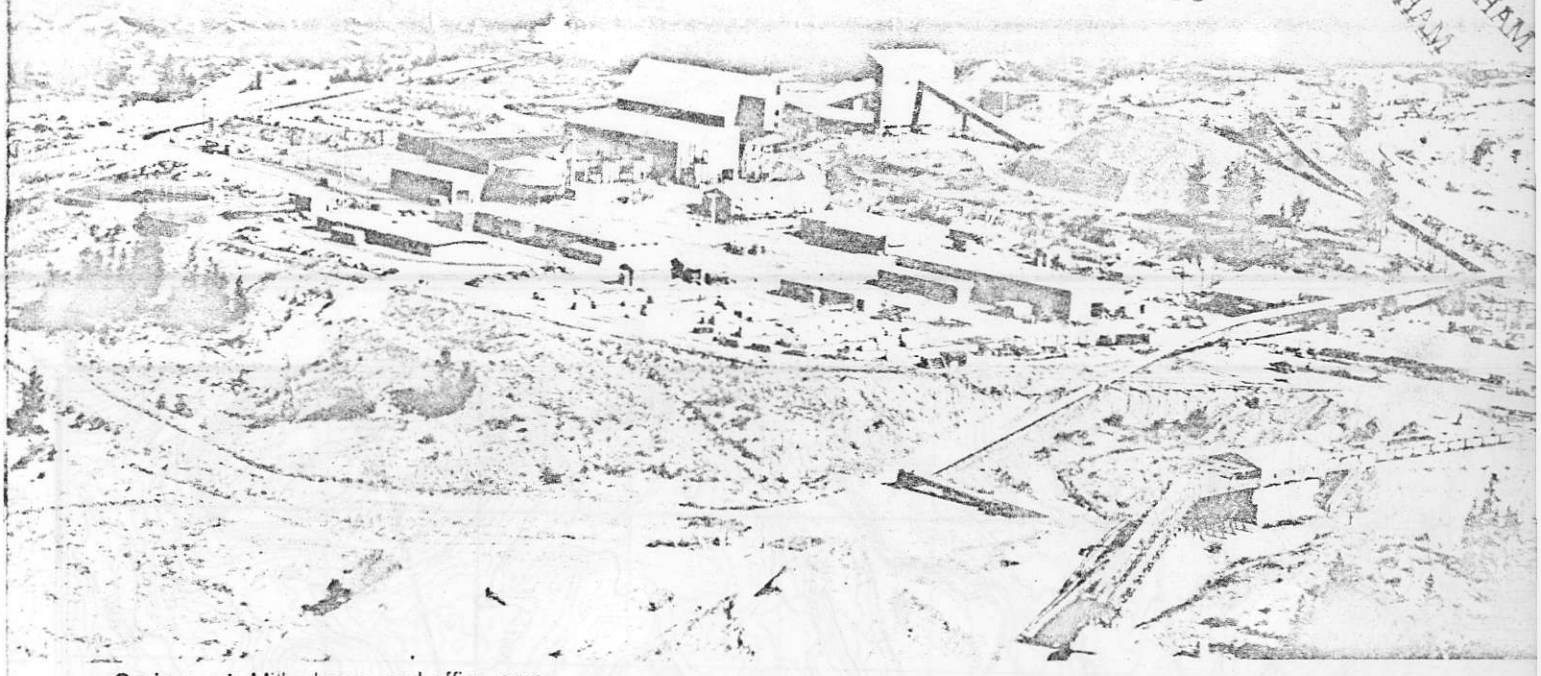


Craigmont: Mill, shops, and office area

Craigmont

Starting as an open pit operation, the Craigmont mine, in south-central British Columbia, now produces copper ore from underground. The mine has developed interesting techniques and equipment to deal with the particular problems of the mining activity

The Craigmont property in south-central British Columbia is about ten miles from Merritt and 120 miles northeast of Vancouver. Elevations range from 1850ft at the Nicola River, 2400ft at the plant site, 4450ft at the west end of the open pit area, to 5600ft at the top of Promontory Hill. The area is dry, with annual precipitation of about 13in (higher in the upper slopes); temperatures range from about −30C to 39C.

The chalcopyrite magnetite-specularite orebodies have a combined strike length of about 2800ft and extend over a vertical distance of 2000ft. The orebodies lie in steeply south-dipping Triassic Nicola Group rocks which parallel the east-west contact of the south end of the Jurassic Guichon Batholith. Near the mine, outcrop exposure is about 10%. None of the orebodies were exposed at surface, but were covered either by a thin layer of glacial till or Cretaceous Kingsvale Volcanic rocks.

Ore reserves at the end of 1975 at a cut-off grade of 0.7% were 7,026,000 tons at an average grade of 1.83% copper. This tonnage is sufficient to sustain operations on the present scale for three or four years. On-property exploration over several years has not proven commercial quantities of new ore.

After some early work in or before 1935, Craigmont Mines was incorporated in 1946. After various investigations, diamond drilling in 1957 indicated an extensive zone of copper mineralization. Canadian Exploration Ltd directed and financed exploration from November 1957 to July 1958, when underground development was undertaken by a group, Birkett Creek Mine Operators Ltd, formed by Canadian Exploration, Noranda Mines, and Peerless Oil and Gas Co. Though Birkett was dissolved in 1960, the same interests now operate the mine as Craigmont Mines Ltd under the management of Placer Development, parent of Canadian Exploration (now Canex Placer).

MINE OPERATION

Since start of operations in 1961 to 31 May 1976 the Craigmont concentrator has processed 25,686,000 tons of ore grading 1.41% copper. A total of 1,226,150 tons of copper concentrate, containing over 344,500 tons of copper, has been shipped.

Open pit mining: The open pit operated from March 1961 to March 1967. A contractor handled overburden (11,017,180 tons) and rock (3,451,472 tons), while Craigmont handled 72,989,369 tons of ore and waste for a total of 87,458,021 tons. A total of 6,922,907 tons grading 1.81% copper was hauled directly to the primary crusher.

When the pit was completed, 7,066,090 tons of ore grading 0.77% copper had been stockpiled. This material is blended with underground ore as feed to the concentrator, as required.

Underground mining

Exploration, development, and production started underground while the open pit was operating. Experiments with mining methods were carried out, and ground support proved to be a major problem. In 1965, after studying operations in Sweden, it was decided to adopt sublevel caving methods at Craigmont.

It was decided to use large diesel equipment despite higher mechanical maintenance, ventilation, and drift maintenance, compared with the use of smaller air equipment. Because of the poor ground conditions, installation and maintenance of ore passes are high cost items; shotcreting is used extensively.

Equipment used includes ten ST5 Scooptrams and one 20-ton truck of Craigmont design based on the ST5.

The Craigmont production and maintenance departments are noted for the innovations they have made to equipment to meet local needs. Some of this work was discussed in *Western Miner* (WM July'75 p9-16).

Development jumbos, fan drills, and jumbos for hole cleaning and rebar hole drilling are Gardner-Denver and Atlas Copco units, but several of them modified; for example by mounting on John Deere 440 timber skidders fitted with Deutz engines. The skidders are tough articulated units which have served their logging life but which make a strong base for readily-mobile drill and other equipment.

There are eight custom-built service vehicles consisting of boxes or decks mounted on the JD 440 chassis and fitted with Deutz or Mercedes Benz motors. Three are used for shotcreting and pipefitting, one for development blasting, two with hydraulic lift decks for production blasting, two with hydraulic lift decks for timbering.

There are four Unimog service vehicles and five model H True Gun-all trailers. Some access is by rail on which there operate various locomotives, 32 Granby cars (256ft³) and four cars for sand supplies (90ft³).

Development and production

It is not possible here to give a detailed account of the operating conditions and procedures, though these have been described in an interesting account by the Craigmont staff. Some of the main points are summarized here.

Waste development is 12ft wide in haulage drifts and ramps, 12ft high in ramps, and 14ft high in haulage drifts requiring 36in metal duct. Production drifts are 13ft wide and 11.5ft high. Development work in waste is arched, but production drifts in ore are flat-backed.

Ramps are driven on a maximum of 20%, with 15% favoured particularly on curves. A flat spot is provided at level horizons for turnouts. Maximum radius of curvature on ramps is 40ft inside.

Drilling equipment was modified partly to improve mobility, and to help it cope with tough conditions. With air-motor traction only it was necessary to tow jumbos through the ramp system, often long distances through narrow curved ramps; a rugged mobile unit is much more efficient.

Also, as mining has proceeded, ground conditions generally have deteriorated. Instead of drilling a large number of holes before production (during which many holes may close up and need cleaning or redrilling) the practice in weak areas now is to drill and load, blast, move the drill back in, and so on. In this way holes are not left sitting for a long time and are loaded before they are affected by nearby blasting. The drill unit's mobility helps this operation, and allows it to be moved readily to the shop for necessary maintenance.

Load-haul-dump: After the maintenance procedures became established, the use of the Scooptrams posed no particular problems. Productivity has increased from about 300 tons per manshift over a round trip average distance of 1800ft, to 600 tons per manshift over 1264ft. Good roads have helped, after initial problems caused by the soft ground which tended to hole at turnouts, and drainage problems. Drifts are driven at 3%, and side ditches could not be maintained because the drifts are too narrow.

Now, crushed and screened diorite is brought in from surface to be used as ballast. This is oversize from the screening plant that provides sand and aggregate for shotcrete. The ballast is distributed on the roadbed by Scooptrams and graded with a Galion grader. A ditch is maintained in the centre, and the sides pack hard with the Scooptram tires. Eight-inch holes are drilled between sublevels for drainage.

Availability of the Scooptrams is about 75%; third and fourth gears have been removed from the transmission. New tire life averages over 1000 hours; tires are mostly Firestone and Bridgestone 18.00x25 24-ply slick-tread with Michelin tubes.

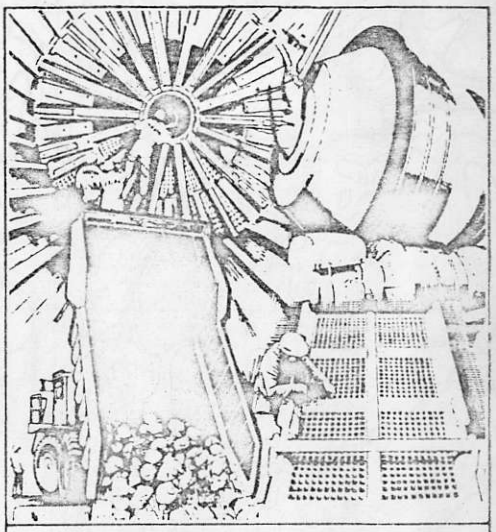
Ground control: Grouted rebar bolts, timber, and steel are now used in various sections of the mine, as well as shotcreting all the headings. Shotcrete is used in 100% of headings; rebars on all production drifts and about half the waste headings; timber on 15% of headings; steel in special areas, usually in turnouts or where headings had to be driven through fault zones.

Craigmont note that control of ground is the 'name of the game'. Other mines may have worse ground, needing more support; at Craigmont the problem is to provide minimum support to satisfy safety and draw control requirements.

The open pit tends to flood, and mud that lies in the bottom of the pit is a serious menace to draw points 200-250ft below. Draw has had to be restricted to try to prevent piping up to the pit floor, resulting in some ore losses.

Ventilation

When sublevel caving was first started, about 150,000ft³/min of air was passed through the mine using one 400hp 73in axial-flow fan in the exhaust drift. Auxiliary ventilation in the sublevels was provided by 32hp fans with 30in flexible



duct. Because of air losses, use of more diesel equipment, and higher standards, it became necessary to provide additional drifts and mechanical ventilation.

Primary ventilation now passes 380,000ft³/min of fresh air using two adits as intakes, each equipped with a two-stage 73in vane-axial direct-driven variable-pitch 500hp 1200rev/min fan (each 190,000ft³/min at 13.5in swg). Fans are in air locks.

Air is exhausted through two routes, one equipped with the original 400hp fan, the other with a 150hp axial fan. Secondary ventilation is by twin 60hp fans through 36in metal duct in the haulage drift, and 30in flexible duct in production drifts.

Installed ventilation capacities are: primary 1450hp, secondary 1750hp.

Production efficiency

The operation was designed for 3000tons/day at three shifts a day, seven days a week, but there was difficulty in reaching this figure. However, in 1972 the mine averaged 4700tons with a peak of 5400tons/day in June, and in 1976 production has averaged over 5500tons/day.

The improvement is attributed largely to: improved ventilation; more working places available (partly because better ventilation allows more units to work in one place); improved maintenance of equipment; improved brows and roads; generally better supervision and operator skills through experience; and improved organization.

Manpower underground totals 226, of which 175 in the mining department, 44 in mechanical, and 7 in electrical. The tons per manshift from underground has increased from 15 to 37.

Recovery has improved from 45% to a cumulative average of 90%; dilution is 39%.

MILLING OPERATIONS

Construction work on the 2400 level mill site started in late 1960, and the Craigmont Mines operation officially opened 15 September 1961, a little over two years from the start of metallurgical assessment of the original ore samples.

Crushing: Underground ore is hauled on the 2400 level in 16-ton side-dump cars to a surge bin (600-ton) ahead of the 48x60in jaw crusher. Crusher discharge at −5in is conveyed to a stockpile. Feed to the 14x84in Hydrocone secondary crusher is screened, as is the discharge from it before entering the 5x84in Hydrocone tertiary crusher.

Fine ore storage is a six-compartment reinforced concrete bin of 8400tons live capacity. Transverse slot feeders deliver ore from three compartments to each of the duplicate grinding sections.

Grinding: Rod mill discharge at 80%

solids, 25-30% plus −10 mesh, enters the ball mill — cyclone closed circuit and joins the ball mill discharge (80% solids). The joint stream is fed to one of two Krebs D20 cyclones. Product size is automatically regulated (Autometrics PSM 100) at 56-60% minus −200 mesh. Changes in grinding circuit since start of operations include increased speed of mills and to integral liners in the rod mills.

Flotation: The cyclone overflow passes through one of two 10x8 SRL-C pumps to the rougher feed distributor, and is combined with the scavenger middling return stream. A single pass through six rougher flotation machines produces a final tailing which is sampled by an automatic cutter and then pumped to the iron media recovery plant. Rougher and scavenger concentrates are produced on the rougher flotation machines.

Almost all the copper is present as chalcopyrite; hematite and magnetite are a major constituent (combined assay range 5-40%). Pyrite normally ranges 0.1-0.3%. Concentrate grade varies 28-30% copper depending on the pyrite content of the feed. A concentrate grind of 85-90% −200 mesh at maximum 9.0% water is desirable.

Iron media: A recovery plant started in November 1969 to produce −325 mesh magnetite. The fine magnetite is shipped to coal companies in BC and Alberta for use in their heavy media separation plants. A high level of sales was reached in 1975 as coal activity rose.

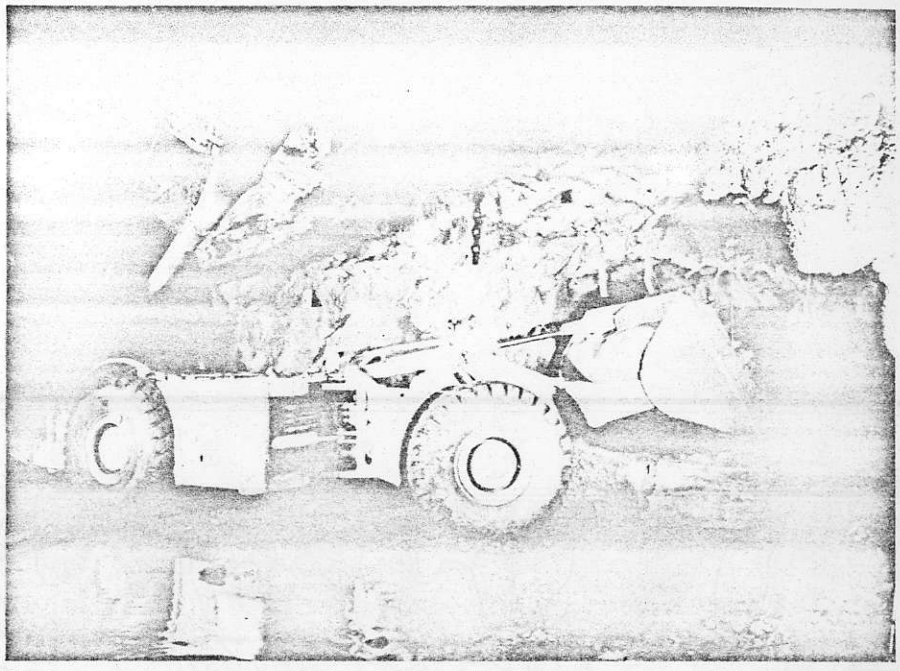
TAILING DISPOSAL

Mill tailing leaves the iron media recovery circuit at about 30% solids and is brought to an average 50% solids in two 125ft thickeners. Tailing is gravity-fed about one mile to be retained behind a 4000ft-long dam across the valley below the plant site; about 230 acres is available for eventual disposal. The dam is built by spigotting behind two-ft high wooden retention fences which are set back 2.5ft with each lift.

Six decant towers were provided for water reclamation from the pond above the dam. Reclaimed water is pumped to the mill head tank.

A two-year program started Oct 1969 to study the growth of vegetation of the tailings dam and waste dumps. The initial plan was to seed and fertilize 14 acres on the face of the dam and 207 acres of pit waste dumps. Useful data were obtained, and the cost of the program was $136/acre. An additional 100 acres of pit waste dumps was treated in 1972 ($58/acre; 3000ft of irrigation pipe was added to the tailings dam sprinkling system in 1973. In 1975 four acres at the 3500 elevation mine portal were seeded, and irrigation continued at the dam.

It is intended, as a future program, to seed the disturbed areas of the mine once the operating activity in various areas ceases. This will involve an additional 574 acres.



Craigmont: Scooptram working underground

Crew strength

At 30 April 1976 there were 398 employees on strength (307 crew and 91 staff): underground 175, mill 57, engineering 13, plant department 122, accounting 17, safety 9, administration and management 5. The operation is on a continuous 6:2 schedule.