GEOLOGY OF THE BRENDA LAKE AREA

Regional Geology:

The rounded, timber-covered mountains in the area are composed of stratified tuffs, tuff breccias, argillites, and limestones of the Nicola Group (Upper Triassic). The Nicola Group is intruded by a zoned and composite quartz diorite termed the Brenda Stock. Other units ranging from quartz diorite to quartz monzonite also intrude the Nicola Group. These intrusives are all Jurassic in age.

The Brenda Stock is composed of four north-south trending gradational units of quartz diorite and a related, partly discordant fifth unit. From west to east, the units are:

1. Medium Quartz Diorite - 500 to 1500 feet wide; contacts with the Nicola Group are sharp, irregular, and unchilled.
2. Speckled Quartz Diorite - host rock of the Brenda orebody; 800 to 2000 feet wide.
3. Uniform Quartz Diorite - grades into (2) within one or two hundred feet.
4. Porphyritic Quartz Diorite.
5. Fine Quartz Diorite - discordant to other units.

Mine Geology:

The orebody occurs approximately 1500 feet east of the Nicola Group - Brenda Stock contact and is almost wholly confined to the Speckled Quartz Diorite unit which has been strongly fractured and faulted. The ore minerals, chalcopyrite and molybdenite, occur as fillings within the fractures and faults. Four types of ore fractures have been identified, based on the filling material:

1. Quartz - potash feldspar - chalcopyrite - molybdenite.
2. Biotite - chalcopyrite.
3. Quartz - molybdenite - pyrite.
4. Epidote - magnetite - molybdenite.

The bulk of the mineralization in the Brenda deposit is contained in type (1) fractures. These veins have a predominant N 60-75 degrees strike and 55 degrees S to 80 degrees N dip. A later system of vuggy type (1) veins strike N 0-25 degrees W and dip 80-85 degrees W.

The biotite veins occupy narrow fractures up to 1/8 inch and they cut the type (1) veins. Minor amounts of molybdenite and potash feldspar occur in these veins. The majority of the biotite veins strike N 10-25 degrees W and dip 70 degrees E to 35 W.

The quartz veins occur near shear zones and are 1½ to 8 inches thick. They strike N 80 degrees E and dip 75 degrees S to vertical.

The epidote veins, although not abundant, occur throughout the deposit. They stripe N 55 degrees W and dip vertically.

The grade of the orebody at any point is wholly dependent upon the intensity of the fracturing. The orebody is elongated in a north-easterly direction and is approximately 2800 feet long, up to 1300 feet wide, and 900 feet deep. In plan, the grade of the orebody decreases outwards from the centre. Weak mineralization continues beyond the economic cut-off point but the orebody does not appear to have a pyrite halo.

Alteration within the ore zone consists of hydrothermal biotite, argillic shear zones from a few inches to 30 feet in width, and a weak and irregular propylitic alteration. The argillic alteration is characterized by clay and sericite and the propylitic by chloritization of the mafics.

Small granitic dykes varying in texture from splitic to pegmatitic strike N 50-65 degrees W and dip 60-66 degrees W. Andesite dykes up to 2 feet in width strike northwesterly with vertical to steep southerly dips.

The Brenda orebody is estimated to contain 177 million tons grading 0.184% copper and 0.049% molybdenum. This includes a "core" or 26 million tons at 0.212% copper and 0.063% molybdenum.

OPEN PIT STRIPPING OPERATION

Pit Design:

Three alternative 3-year pits, (1A, 1B and 2) and three final pits, (3, 4 and 5) were compared by computer methods to arrive at an ultimate pit design and mining sequence. It was found that the optimum rate of return would be realized from the following mining plan:

(a) Mining Pit 1A during the tax-free period (3 year)
(b) Expanding to Pit 3 at year 3
(c) Expanding to Pit 4 at year 10

During the mining of Pits 1A and 3, material containing 0.3% to 0.4% equivalent copper will be stockpiled for milling at a later date while material grading 0.4% equivalent Cu or better will be fed directly to the mill. Following expansion to Pit 4, all material grading 0.3% equivalent Cu or better will be fed directly to the mill.

Pit 1A contains 26,000,000 tons of ore grading 0.212% Cu and 0.063% Mo. (0.105% MoS_2), at 0.4% equivalent Cu cut-off.

Pit 3 contains 86,600,000 tons grading 0.206% Cu and 0.057% Mo. (0.095% MoS_2) at 0.4% equivalent Cu cut-off.

Pit 4 contains 177,000,000 tons grading 0.183% Cy and 0.049% Mo. (0.082% MoS_2) at 0.3% equivalent Cu cut-off.

The mining sequence Pit 1A - Pit 3 - Pit 4 has a projected life of 21 years.

The pit design incorporates the following features:

(a) Bench height - 50'
(b) Overall pit slope - 45^o
(c) Maximum haul road gradients 8%
(d) Minimum haul road width 80

Current Mining Equipment:

1 Bucyrus - Erie 60 R Rotary Drills

2 Gardner-Denver - ATD 3100 Airtracs with Pr 123 machine

1 Gardner-Denver - 900 cfm compressor

1 Gardner-Denver - 600 cfm compressor

3 Marion 182M shovels with 11 cu.yd. buckets

1 Dart DW 600 with 15 cu. yd. bucket

12 Lectra Haul M 100 trucks (100 ton)

2 Caterpillar 769 trucks (35 ton)

1 Caterpillar 824 B rubber-tired dozer

1 Caterpillar D 8 Bulldozer with Straight blade and winch

1 Caterpillar D 8 Bulldozer with U-blade and Ripper

1 Euclid 82-40 Bulldozer with U-blade and Ripper

1 Caterpillar 12 F Grader

1 Caterpillar 14 E Grader

1 Water Tanker - Caterpillar 631 tractor and southwest 10,000 gal. tanker

2 GMC tandem axle 10 ton sand truck with Flink spreader

1 Ford 1 ton hole dewatering truck

1 Ford 45 man bus

2 Ford ½ ton supervisors pick-ups

Current Maintenance Equipment:

1	Dominion 450 Crane (45 ton)
1	GMC Flat deck service truck with Crane
1	GMC Lube Van
1	Clark Fork lift truck with tire manipulator
1	GMC Dump truck
2	Ford ½ Ton pick-ups

Pit Development:

The preproduction plan encompassed the removal of 9,000,000 tons of material from the pit. During this phase, three mining benches were developed to expose the ore.

Primary drilling is done with the 60 R Rotary Drills providing 12¼" diameter holes. These are drilled to a depth of about 58' including 8 feet of subgrade. Drill patterns have varied during the initial period with a 26' x 32' pattern now in use.

Bulk blasting agents supplied by CIL are used. The powder factor is curreotly about 0.5 pounds of explosives per ton of rock. Dry holes are toe loaded with Hydromex M2 slurry and column loaded with ANFO. Prosser electric water pump is used to remove the water from the wet holes. The hole is then toe loaded with Hydromex M2 slurry, a plastic liner is inserted into the hole and the column load of ANFO is placed inside the liner. Dry holes are primed with 3 Procore 1# primers on a downline of Scufflex primacord. The first primer is placed in the M2 slurry, the second at the base of the ANFO, and the third part way up the ANFO column. Wet holes are similarly primed except that 2 Scufflex primacord downlines are required - one for the toe load and a second for the ANFO inside the liner. Holes are tied together with primacord and delayed between rows with 50 ms - delays. Two electric blasting caps are used to initiate the primacord.

The broken muck is loaded by the Marion 182M shovels into 100 ton Lectra Haul trucks. Two shovels and 8 trucks required to move the scheduled tonnage of 18,000 tons per shift - 3 shifts per day - 7 days per week. The third shovel is kept on standby in case of breakdown and for routine maintenaace aad servicing. It is felt that 4 spare trucks will be adequate for truck repairs and maintenance.

The rubber-tired dozer is kept on shovel clean-up and one grader is kept on road maintenance on each shift. A track dozer is used on dump maintenance and for other requirements in the pit. Water and sand trucks are available and utilized seasonally as needed. The front-end loader is used for stockpile rehandling, pit cloan-up, snew removel, road developmont, road maintenance, and overburden removal.

CONCENTRATOR OPERATION

The concentrator facilities are designed to treat 24,000 tons per day from the low grade copper-moly ore body. Production is expected to be in the order of 200 tons of copper concentrate grading 22-24% copper, and 24-25 tons of molybdenum concentrate grading 54% molybdenum. All copper concentrate will be shipped to Japan initially, and most of the molybdenum output has been sold to various European companies.

The primary crushing plant consists of a 60" x 89" gyratory crusher with a rated capacity of approximately 2500 tons per hour. The crusher discherge, nominally mious 8 inches, is metered by two 72-inch apron feeders to two 54-inch conveyor belts which, in turn, discharge to two 8' x 20' double deck vibrating screens. The product of both decks is conveyed to a 45,000 tons live load stock pile, and the minus 3/4 - inch undersize from the lower deck is conveyed direetly to the mill bins.

The secondary crushing plant consists of two 7-foot cone crushers set at 1½ inches. The product, which includes the circulating load from the tertiary crushers, ie screened on five 8' x 20' vibrating screens. Again, the product of both decks is combined and returned to the three 7-foot tertiary cone crushers, and the 3/4-inch screen undersize is conveyed to the mill bins at a rate of approximately 1800 tons per hour. Controls in the various crushing areas include closed circuit television, sonic and more conventional level controls in chutes and bins, integrating power demand circuits with an optimum-seeking system to produce maximum through-put in the critical tertiary crusher installation.

The concentrator is designed as four parallel circuits of 6000 tons per day capacity. Each circuit is made up one 13'6" diameter by 18'0" rod mill with a 1900 HP motor, and one 13'6" diameter by 22'0" ball mill equipped with a 2900 HP motor. Each rod mill-ball mill grinding unit will operate in a closed circuit with a cluster of 30-inch cyclone classifiers, and cyclone overflow at approximately 50% minus 200-mesh flows by gravity to the rougher circuit conditioner ahead of flotation.

Rougher, or bulk flotation, continues in four parallel circuits, and each circuit is made up of three 5-cell groups of No. 120 Agitair flotation cells. The bulk concentrate is cleaned in No. 24 Denver DR cells, and cleaned twice more in No. 24 Denver sub-A oells. Finished bulk concentrate is pumped to the 70 foot thickener in the mill building, where sodium sulphide and hear form the first stage of the copper-moly separation.

The moly separation takos place in two 20-cell rows of No. 24 Denver DR cells, and the tailing from these cells becomes the copper concentrate and is pumped to an outdoor 70-foot thickener prior to conventional filtering and truck shipment of the copper concentrate.

The moly rougher concentrate is cleaned in two 10-cell rows of No. 24 Denver Sub-A cells, and the cleaned froth product is pumped to the first stage of re-grinding which is carried out in a 6-foot diameter by 14 foot long hall mill in closed circuit with a cluster of 6-inch cyclones. Reground concentrate is given three additional stages of cleaning in No. 21 Denver Sub-A cells, and the final product is returned to the second stage re-grind unit which is a duplicate of the first stage. Product from this second re-grinding stage undergoes an additional seven stages of cleaning to produce a final molybdenum flotation product.

Flotation alone is unlikely to produce a completely satisfactory product which meets specificetions at all times. For this reason the concentrate will undergo a leaching step in a process developed at the Noranda Research Centre and involving the use of hot calcium and ferric chlorides. The leached product is expected to attain the specifications required by the sales contracts with no difficulty, and it will then be filtered, dried, and packed as required for shipment.

TAILINGS DAM CONSTRUCTION & OPERATION

The tailings disposal area is situated on MacDonald Creek about two miles east of the Concentrator. This area is the closest available for economic handling of the tailings and for the return of process water from the slime pond.

The tailings system was designed to provide for sufficient tailings disposal space for the life of the mine and to ensure the stability of the mass of waste into the future.

An additional and very important requirement was that nearly all water must be recovered and returned to the mill for re-use and no water be allowed to pass the dams and so add to the pollution of Okanagan Lake.

Construction:

The basic principle of the dam is the construction over a period of time of a huge sand-filled dam behind which the slimes will be impounded.

The first step in the development is the construction of the Upper and Lower Main Dams. These dams will form the upper and lower toes of the main sand-filled dam. The Upper Main Dam is built of waste rock from the open pit with an impervious blanket of glacial till on the upstream face. The Lower Main Dam is built entirely of waste rock from the open pit. A total of 2.5 million tons of waste was trucked over the 5 mile haul road from the pit to the tailings site.

A small impervious dam called the Water Reclaim Dam was built downstream of the Lower Main Dam. The Water Reclaim Dam will catch any water that percolates through or around the Main Dam.

At start-up of production the situation was as shown in Figure 5. The Upper and Lower Main Dams and the Water Reclaim Dam were completed and the Tailings Lines, Cyclone Station, Water Reclaim line and pump stations were installed. The pond will continue to build up behind the Upper Main Dam and the pump barge is in position on it.

Operation:

Tailings from the Concentrator runs by gravity in the form of a slurry containing 2/3 by weight of water. The slurry is transported in a 30" diameter wood stave pipe to the Cyclone Station where it is split into sand and slime fractions on a 50-50 basis.

The sand fraction and sufficient water for transportation flows through two 12" diameter pipelines in parallel to the crests of both the Upper and Lower Main Dams. The sands spill, first from the Lower Dam and then from the Upper Dam, continually alternating from one to the other to ultimately fill the space between the dams as shown in Figure 6.

The water used to transport and place the sands percolates through the free-draining sand fill to the base of the dam where it is picked up in four specially constructed course rock finger drains and directed under the Lower Main Dam to the Water Reclaim Dam. The water collected by the Water Reclaim Dam is pumped back around the Main Dam into the slime pond thus ensuring a completely closed circuit.

The slime fraction and most of the water is transported in a 20" diameter steel pipe to the top of the Upper Main Dam. There, the slimes spill down the upstream face of the dam and into the pond where the slimes slowly settle out as the water migrates toward the pump barge which is located as far away as possible from the slime spill point. The water, thus clarified, is pumped in a 24" diameter steel pipeline back up to the Water Reclaim Tank near the Concentrator, a vertical lift of nearly 700 feet.

The 50-50 sand-slime split allows the sands in the Main Dam to be built up ahead of the accumulation of slimes so that the slime pond will always be impounded behind the main sand-fill dam which is sealed on the upstream face by slimes from the pond. In this way the huge sand fill with the slimes impounded behind it will reach its ultimate height of nearly 400' above the valley floor and ultimate length from one abutement to the other of nearly one and one-quarter miles.

Water Requirements:

Approximately 11,000 gallons of water per minute will be required to convey the tailings from the Concentrator to the Tailings Dam at a milling rate of 24,000 tons per day. Approximately 10,000 gallons per minute are reclaimed and recirculated. The remaining quantity (1,000 gallons per minute) will be lost through retention in the slimes and evaporation into the air from the pond surface. The lost water will be made up from the fresh water reservoir at Peachland Lake (approximately 800 gals. per minute) and the natural run-off which flows into the tailings basin.

During the summer of 1968 Brenda Mines Ltd. constructed a 100' high dam at Peachland Lake. This dam is designed to raise the lake level by some 50 feet above the top of Peachland Irrigation District's old dam to provide a reservoir of some 10,000 acre feet capacity. Water will be pumped over 900 feet vertical lift from the reservoir to the Fresh Water Tank near the Concentrator through a 10' diameter concrete lined steel pipe.