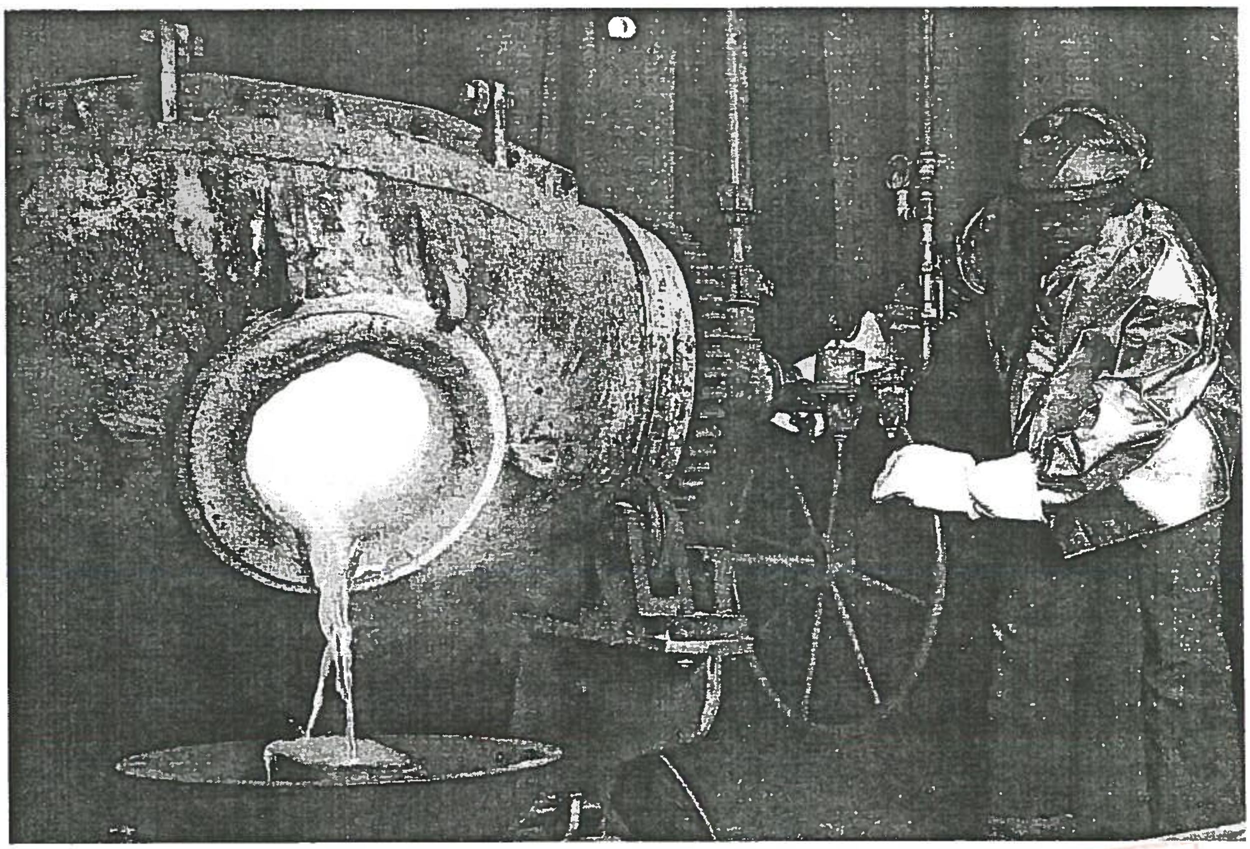
ECHO BAY MINES LTD.

LUPIN OPERATION

GENERAL INFORMATION



APRIL 2000

HISTORY

PORT RADIUM

The history of Echo Bay Mines Ltd. began in 1964 at Port Radium, located about 40 kilometres south of the Arctic Circle on the shores of Great Bear Lake in the Northwest Territories. Port Radium itself came into existence in the early 1930s when pitchblende was discovered there and mined by Eldorado Nuclear Ltd., initially for its radium content and then for uranium. Eldorado stopped mining in 1961 when the uranium ore was depleted.

Echo Bay was formed by a group of investors in the early 1960s. The company leased the former Eldorado property along with the adjoining Cominco property, which was known to have silver and copper ore within its boundaries. The Eldorado facilities were resurrected and the mining of silver from the Cominco lease commenced in 1964. By 1976, the silver ore reserves from the initial site were depleted and the old Eldorado Mine was reopened and mined for its silver and copper ore. During this period until closure in 1982, mill production totaled 35.5 million ounces of silver and 10 million pounds of copper. Reclamation of the site was completed in 1985 when the Port Radium Mine was completely restored to its natural condition.

LUPIN

The Lupin gold deposit was discovered in 1960 as a result of reconnaissance sampling and mapping programs conducted by Canadian Nickel Company Limited, a subsidiary of Inco Limited. Lupin is situated on the west shore of Contwoyto Lake in Nunavut, 400 kilometres northeast of Yellowknife and 80 kilometres south of the Arctic Circle. Between 1961 and 1964 Canadian Nickel Company Limited conducted exploration in the Lupin area which included geological mapping, geophysical surveying, trenching, stripping and channel sampling. In February 1979, Echo Bay obtained an option on the Lupin property from Inco and proceeded with an underground exploration program in 1979 and 1980. This program consisted of driving a decline at -15% grade to the 110-metre level and conducting extensive diamond drilling down to the 200 metre level, as well as a single deep hole to the 470 metre level. Geological information obtained from this program indicated enough ore reserves to provide for six years production, with a mill designed to process 1,000 tons per day. The single deep hole to the 470-metre level indicated a continuation of ore at depth and the potential to significantly extend the mine life. In August 1980, the decision was made to proceed with development and construction of what became the Lupin Mine.

CONSTRUCTION

In the summer of 1980, prior to a production commitment, a 5,000-foot gravel landing strip capable of handling a C130 Hercules was prepared. Plant design was based on being able to air freight all the components to site. Mine site construction started in August 1980 and was completed on schedule in March 1982 when pre-production commissioning began. The transportation of personnel to the site was accomplished with a Convair 640, which also carried a total of 7 million pounds of supplies such as perishables and repair parts during construction.

During the twenty-month construction period, the Hercules aircraft made some 1,100 flights, carrying 25 tons of construction material per trip. This material included all the contained machinery and construction equipment, 2,200 tons of structural steel and the cement required to mix 9,500 cubic yards of concrete. The floor area of the main complex was 100,000 square feet. During peak periods, the construction crew numbered up to 400 people on site.

Engineering, procurement and construction management of the surface facilities was contracted to Bechtel Canada Limited, while the contract for mine development and underground construction was awarded to J.S. Redpath Limited. The Lupin Mine was constructed and commissioned for a total cost of $135 million dollars.

EXPANSION

During 1983, a construction program was completed to expand the capacity of the mill from the original 1,000 tons per day, to a new nominal capacity of 1,200 tons per day. This construction phase included the installation of a rod mill in the grinding circuit, an additional 1,000-ton fine ore storage bin, additional filters and an extension to the maintenance bay.

From 1983 to 1993, the Lupin Mine has undergone a number of other expansions and operational changes to increase milling capacity to a nominal 2,300 tons per day. The main production shaft has been deepened on two separate occasions to a final depth of 1,210 metres below surface and the old sinking compartment has been converted into a cage compartment.

Since bringing Lupin into production, Echo Bay has added three other currently operating gold mines: two open pit mines in Nevada (Round Mountain and McCoy/Cove) and one underground operation in Washington (Kettle River). Echo Bay is also active in the pursuit of exploration and development opportunities, with North America being the Company's principal focus.

CURRENT STATUS

In January 1998 the Lupin mine was placed on care-and-maintenance status. Lower gold prices and the prospect of this becoming a prolonged reality prompted the Company to review the cost structure for Lupin and operating practices generally.

Mothballing of the mine site was carried out to ensure that the future start-up could proceed with as few unanticipated problems as possible. Production from the mine ceased immediately after the January announcement and the mill was shut down after the last of the contained feed was processed. The mothball process was completed by the end of March 1998.

Thirty-four key employees representing all departments were responsible for keeping the Lupin infrastructure at an acceptable level of readiness and to comply with ongoing regulatory requirements.

An intensive in-house re-engineering study was also carried out during the shutdown. A number of operating changes were identified that would enable cash operating costs to be reduced. Consulting engineering and geological contracting firms were hired to provide an independent assessment of this study. They agreed that the design and operating strategies described in the study were achievable.

In 1999, Lupin ore reserves were re-evaluated to reflect changes in the US/Canada exchange rate and projected costs based on the re-engineered mine plan. Year-end reserves amounted to 1.9 million tons of material grading 0.268 ounces of gold per ton, for a total of 518,000 contained ounces. Other mineralization includes 808,000 tons averaging 0.332 oz/ton containing 268,000 ounces. The current life of mine plan calls for an average of 150,000 ounces of gold to be mined from Lupin for an initial five year production period. Underground exploration completed early in 1999 has confirmed the continuation of a recently discovered zone (McPherson Zone) from 930 down to the 1,400 metre level. The Centre, West and McPherson Zones are all open at depth.

In November 1999, Echo Bay decided to re-open the Lupin Mine. Start-up activities began in December 1999 and production resumed in April 2000 at a rate of 1,830 tons per day.

ULU

The Ulu project was purchased from BHP Minerals in November 1995. The property is located 125 kilometres north of Lupin by air, or 171 kilometres by winter road. An exploration camp has been constructed including a landing strip, accommodations, maintenance facility and fuel storage. Underground development via an underground ramp from surface began in 1996. To date, 1,760 metres of underground ramping and drifting have been completed to a depth of 155 metres. 16.000 metres of diamond drilling has also been completed. The geological work completed to date indicates an inferred geological resource of 1.5 million tons of material, grading 0.374 ounces of gold per ton. The Ulu operation was temporarily suspended in August of 1997, pending a return to higher gold prices.

All necessary permits are in place to mine up to 600 tons per day from Ulu, with the broken ore to be trucked over a winter road for processing at the Lupin mill. It is likely that work will continue at Ulu once production is underway again at Lupin.

An Inuit Impact and Benefits Agreement was negotiated between Echo Bay and the Kitikmeot Inuit Association pertaining to the Ulu project, and signed on September 17, 1996. This agreement establishes the framework for providing employment, training and other economic benefits to the aboriginal people in the West Kitikmeot Region of Nunavut. This agreement is the first of its kind signed under the Nunavut Land Claims Agreement.

Below: Ulu camp in summer of 1996

GENERAL DESCRIPTION

INTRODUCTION

Since the start of production in 1982, the Lupin Mine has produced over 2.8 million ounces of gold. Other than the transportation requirement for materials and supplies necessary to sustain the workforce and operations, the Lupin site is completely self-contained. It is comprised of two principal clusters of buildings: the residential complex which consists of accommodations, a kitchen and recreation center, and the industrial complex which houses the mine, mill, powerhouse, maintenance facility, warehouse and offices.

An additional facility located at the Edmonton International Airport consists of a hangar and several other buildings and offices housing transportation, human resources, accounting and purchasing personnel.

Throughout its operation, the Lupin Mine has been an innovator in such areas as:

- remote site construction and operation
- northern transportation infrastructure development
- mining in permafrost conditions
- the implementation of hydraulic drilling technology
- mechanized narrow-vein mining
- creating employment relationships with northern communities
- the introduction of paste fill

Mining people from all over the world have visited the Lupin Mine to gain experience and insight that could be used at their own operations. The discoveries and development of the large diamond projects currently underway in the North, were greatly assisted by the location of the Lupin Mine and its transportation infrastructure.

TRANSPORTATION

In 1975 Echo Bay established its Aviation Department, operating a DC-3 leased from Eldorado Nuclear to service the Port Radium operation. The success of this venture led to the purchase, in 1976, of a Convair 640 complete with freight door. With an option on the Lupin property, Echo Bay's experience in northern aviation proved invaluable. The only practical means of moving materials and personnel to this isolated site was by air. Due to the size and weight of the required construction materials, the only aircraft capable of doing the job was the Lockheed C130 Hercules. Such an aircraft, previously used on the James Bay hydroelectric construction project, was leased in early 1980. All required materials for the $135 million construction project were delivered on time and without incident.

At the completion of initial construction and the start-up of the winter ice road in 1983, there was no longer a requirement for the Hercules. However, an ongoing requirement to efficiently move freight and passengers to the site remained. This exceeded the capability of the Convair 640, so to meet these new transportation needs, a Boeing 727 aircraft was purchased. Between April and late December each year, the only access to the Lupin site is by air. Echo Bay uses the 727 to shuttle both freight and employees on a regular basis between Edmonton and the mine site, with regularly scheduled stops in Yellowknife.

Over the years, Echo Bay has operated other types of aircraft to meet its northern transportation and exploration needs, including a Twin-Otter and a helicopter. The 727 is the only aircraft still owned and operated by the company. Employees residing in either Cambridge Bay or Kugluktuk have more recently made their way to and from the mine site by charter service.

In January 1983, Echo Bay constructed an ice road between Yellowknife and Lupin, a distance of approximately 670 kilometres of which 75% is on frozen lakes. Two maintenance camps, located at Lockhart Lake and Lac de Gras, serve as base camps for the road maintenance crews and rest stops for the truckers on their 24-hour journey from Yellowknife to the mine site. The winter road season is approximately three months long, lasting from early January to late March. Construction of the road takes about three weeks, leaving only nine weeks to move a year's supply of freight and fuel to the mine. A typical annual haul consists of about 31 million pounds of freight and 18 to 20 million litres of fuel. Echo Bay holds a license of occupation for the winter road which allows the Company and other users to haul supplies, while sharing equitably in the cost of operation.

RESIDENTIAL FACILITIES

Lupin has a residential complex which provides a comfortable home away from home for its employees and has the capacity to house a total of 444 people. Approximately 132 rooms are available for single occupancy with integrated bathroom/shower facilities. Most of the remaining rooms are single occupancy as well, but share a bathroom. A new kitchen complex and additional office space were added in 1993. Recreational facilities include:

- sauna
- whirlpool
- racquetball/squash court
- weight room
- gymnasium
- television rooms
- cable television system
- pool tables
- baseball diamond

A recreation committee, selected by the employees, also organizes occasional events such as cribbage or dart tournaments.

An occupational health nurse and specially trained safety personnel are present on site at all times. On the rare occasion when personnel require further medical attention, they are flown to either Yellowknife or Edmonton depending on the circumstances.

SITE AND SERVICES

In addition to the two main complexes there are a variety of materials storage facilities, the largest of which is the tank farm. Erected in this containment area are 34 holding tanks ranging in capacity from 82,000 to 1.64 million litres. Total capacity of all tanks is 22 million litres. A large storage building provides shelter for the cement used with mine pastefill, while other buildings are used to store mill reagents and grinding media. A number of annex buildings house a carpenter's shop, concrete batch plant and miscellaneous maintenance facilities.

A pump house, equipped with three 3-stage vertical turbine pumps, is situated on the shore of Contwoyto Lake to supply fresh water to the complex via an insulated pipeline. Mill tailings and effluent are pumped in slurry form through an 8-inch diameter insulated and heat traced pipeline to the tailings containment area located nine kilometres south of the mine site.

The airstrip adjacent to the mine site has been extended a number of times since its original construction and is now 1.9 kilometres long and equipped with lighting and navigational aids. A weather observation station and radio operator complement the operation of this facility.

POWER GENERATION

Lupin's diesel engine operated powerhouse generates over 72 million kilowatt-hours per year and consumes over 18 million litres of P40 fuel oil. The total installed generator capacity is 18.5 megawatts. This is provided by:

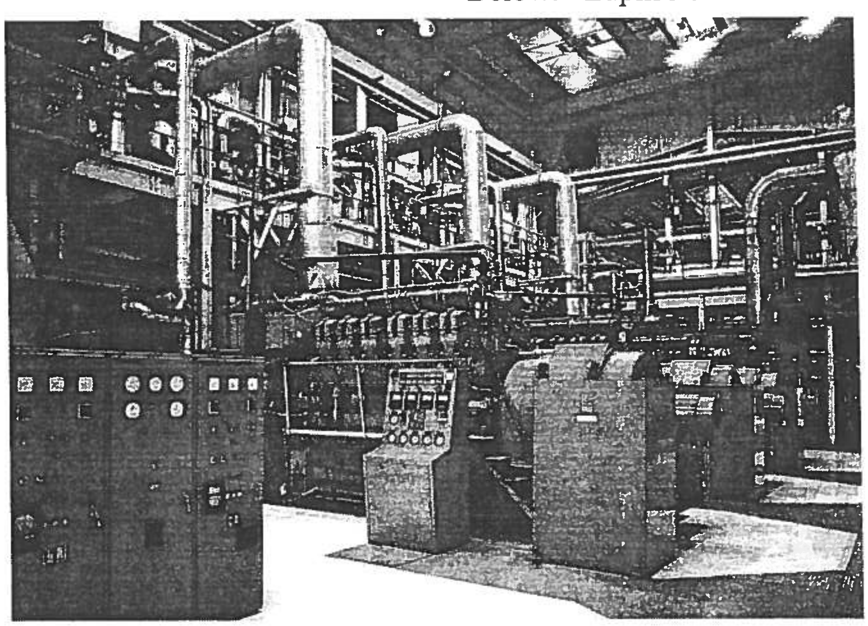
- 3-Ruston RK 12-cylinder, 4-stroke, water cooled diesel generators producing 1.8 megawatts each
- 4-General Motors EMD645E4B 20-cylinder, 2-stroke, water cooled diesel generators producing 2.6 megawatts each
- 1-General Motors EMD710G4B 16-cylinder, 2-stroke, water cooled diesel generator producing 3.0 megawatts

An additional 1.5 megawatts can be produced in emergency situations by utilizing 3-Caterpillar D398 12-cylider, 4-stroke water-cooled diesel generators located in a separate building.

As fuel is an expensive commodity for Lupin, efficient utilization must be achieved. One way this is accomplished is by harnessing all the waste heat possible during the power generation cycle. This is achieved by passing the hot lubricating oil, jacket water and exhaust gases through three separate heat exchangers. A mixture of 50% glycol and 50% water is continually circulated through the heat exchangers. This solution absorbs the conductive waste heat and the heated liquid is then pumped throughout the mine site. In places where heat is required, the water-glycol solution is piped either through unit heaters, simple baseboard heaters, or liquid-air heat exchangers. The fresh air supply to underground, office complex, accommodations, kitchen facility, and domestic hot water are all heated by means of the waste heat recovery system.

The output from the powerhouse is continuously monitored and controlled. Intensive scheduled maintenance is carried out to ensure that the diesel generators operate at their peak efficiency. Due to these measures, the Lupin powerplant generates power at relatively low cost.

Below: Lupin Powerhouse



ORGANIZATION

Approximately 320-325 permanent employees, including contractors, work at the Lupin Mine. At any given time between 175 and 210 employees will be on site. Most employees work either a 2-week in/2-week out or a 1-week in/1-week out rotation. Historically work shifts have been 12 hours in duration, but as of January 2000 the workday was changed to 11 hours. The Lupin Mine runs seven days a week and 365 days a year.

The mine and mill are the two main operating departments and are supported by:

- Administration and Management
- Loss Control and Environmental Affairs
- Engineering
- Geology
- Human Resources
- Accounting
- Purchasing and Warehouse
- Maintenance
- Powerhouse

A number of contractors may be on site at any given time to carry out specialized functions such as food catering, diamond drilling, site services and various mining activities.

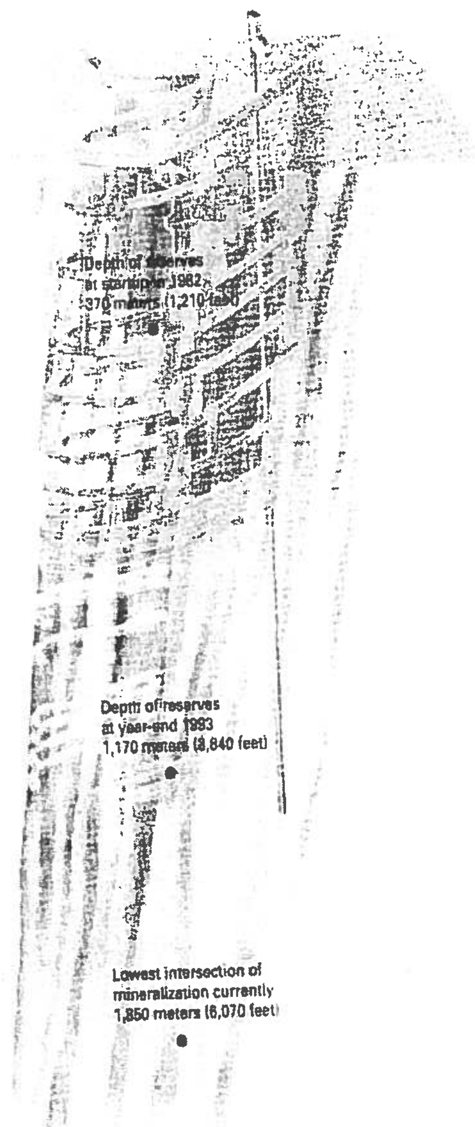
MINE

GENERAL GEOLOGY

Gold mineralization at Lupin is confined to a folded and metamorphosed iron formation and the mineralization may be termed "stratabound". The iron formation horizons consist of both silicate facies and sulphide facies metamorphosed to an amphibolite + quartz rich rock. Regional deformation of the iron formation horizon along with associated quartzites and fine-grained sediments has resulted in steeply dipping strata and tight folds. The gold bearing iron formation occurs as a Z-shaped structure made up of three zones: the West Zone, Centre Zone and East Zone. The West and Centre Zones dip steeply to the east at 75-90 degrees, while the East Zone dips at 75-90 degrees to the west. Total strike length of the three zones is in excess of 900 metres.

Gold is found primarily within a sulphide rich iron formation. The ore at Lupin consists of amphibole, quartz, garnet, pyrrhotite, arsenopyrite, minor pyrite and traces of chalcopyrite. The gold is fine grained (generally less than 100 microns in diameter) and is associated mainly with pyrrhotite and arsenopyrite. Although not common, visible gold is sometimes found and is usually in close proximity to quartz veining.

As of December 31, 1999 proven and probable gold reserves calculated to the 1,340-metre level consist of 1.93 million tons @ 0.268 oz/ton for 518,000 ounces of gold. Other mineralization includes 808,000 tons of material averaging 0.332 ounces per ton, containing 268,000 ounces of gold.



MAIN SHAFT

Shaft sinking began in 1982 to an original depth of 370 metres below the surface collar. The shaft has been deepened twice since then, first to the 780-metre elevation during 1984-86 and the second time to its final depth of 1,210 metres during 1988-90. The 2-drum ASEA production hoist, originally installed in 1987, was upgraded to 1,720 horsepower in 1992. This allowed 10-ton capacity skips to be hoisted in the two skipping compartments. Further upgrades allowed hoisting speed to be increased to the present rate of 1,825 feet per minute.

In 1992, to improve the efficiency of shaft operations, the manway compartment above the 250-metre level and the sinking compartment below the 250-metre level were converted to a cage compartment. The hoistroom was modified to accommodate a fully automated cage hoist, so mine personnel can now be moved without causing interruption to the skipping operations. The service cage is relatively small (double-deck 16 man total), however it adequately meets the needs of the mine.

TECHNICAL DATA – SHAFT AND HOISTS

- Three compartment from surface to 250 level: 2 skip, 1 cage
- Four compartment from 250 level to bottom: 2 skip, 1 cage, 1 manway and services
- Shaft dimensions: 2.7 m x 7.2 m x 1,210 m depth (9 ft x 23.75 ft x 3,970 ft)
- 2.44m x 6.94m (8.0 ft x 22.75 ft) outside steel set dimensions.
- Steel sets spaced at 4.57 m (15 ft)
- No. Levels: 12
- Shaft Guides: 5.5 in x 7.5 in B. C. Douglas Fir

Cage Hoist: G. L. Tiley 2.32m dia. x 1.71m face width, single drum.

- Cage Hoist Motor: 500 HP, 850 RPM, DC
- Cage: GL&V double deck
- Cage Tare: 1.36 tonnes (3,000 lb.)
- Cage Capacity: 2.19 tonnes (personnel) or 2.72 tonnes (material)
- Cage Speed: 6.1 m/s (1,200 fpm) up; 5.2 m/s (1,025 fpm) down
- Cage Rope Dia.: 25.4 mm (1 inch)

Skip Hoist: ASEA Brown Bovari HTVD, double drum

- Skip Hoist Size: 3.05m dia. x 1.98m wide (10.0 ft x 6.5 ft)
- Skip Hoist Motor: 2 x 860 HP ASEA Type DMG
- Skips: GL&V bottom dump
- Skip Tare: 4.68 tonnes (10,300 lb.)
- Skip Capacity: 9.06 tonnes (20,000 lb.)
- Skip Speed: 9.3 m/s (1,825 fpm)
- Skip Rope Dia.: 38.1 mm (1.5 inch)

MINING METHODS AND EQUIPMENT

RAMP

The Lupin Mine is also serviced by an access ramp, which extends from surface to the bottom of the mine. For the most part, the ramp is a closed spiral and is located under the plunging south nose of the ore body. The 5m wide x 3.5m high ramp grades at -15% over its entire length. The present ramp face is just below the 1,340m level. The ramp provides for movement of men and materials within the mine and allows efficient deployment of resources as required. The main access ramp is essential for the highly mechanized mining methods being used.

DEVELOPMENT

All lateral and ramp development is mechanized at Lupin using electric-hydraulic drills and diesel scooptrams. A fleet of three Tamrock Maximatic HS205M twin-boom jumbos and 4 Tamrock Micromatic H102 single-boom jumbos accommodates the drilling requirements. Muck removal in the large drift and ramp headings is done with Wagner ST-6C and JCI 600M scooptrams. Ground support requirements are met with four mechanized bolting rigs (2 MEM 914's and 2 Secoma Pluton models). A DUX scissor truck is also available for miscellaneous jobs.

Standard drift sizes are as follows:
Ramp: 5.0m wide x 3.5m high, -15%
Access Drifts: 4.6m wide x 3.5m high
CZ Ore Drifts: 4.0m wide x 3.5m high
+2% grade
WZ Ore Drifts: 2.0m wide x 3.2m high
+2% grade

Raises up to 20m in length (stope slots, millholes, vent raise extensions) are driven with conventional open raising methods. Depending on the circumstances, one of the longhole drills will be used to take a drop raise instead. Longer raises are driven with an Alimak.

The Lupin mine does a relatively large amount of development to support its mining methods. A typical year would call for 700-800m of ramping, 4,500-5,000m of lateral drifting and 1,400-1,500m of raising.

PRODUCTION

Mining at Lupin began with sublevel longhole open stoping in the Centre and East Zones. Stope heights were typically 80m and were as long as the strike of the ore body. Every fourth sublevel was developed as an extraction horizon complete with a haulageway, drawpoints, ore pass and waste pass. All of the mining above 810m in these two zones was done by this method. The West Zone is the narrowest zone at Lupin. It was first mined by shrinkage and later by a "Raise Platform Mining" method, which involved driving closely spaced raises and then breasting between them from an Alimak raise climber. This method was in turn replaced with sublevel longhole stoping similar to the Centre Zone but utilizing much smaller equipment.

As mining progressed to greater depths and the accumulated volume of stope excavation increased, rock stress and ground control issues became an increasing concern. The stoping method has been modified to integrate paste backfill into the mining cycle. Stope dimensions have been decreased in both height and strike length as one technique used to control dilution. Now termed "sub-level retreat over consolidated fill" (SROCF), the method involves mining 20m high panels over a relatively short strike length (20m maximum in the Centre Zone and 15m in the West Zone), remote mucking the stope empty, then filling with paste before mining the adjacent panel.

A Centre Zone stope, which varies in width from four to 12 metres, is developed by first drifting in the ore zone on 20-metre vertical intervals. Sampling and definition drilling on 5m centres provide the information to generate ore and mining limit contours and the ore reserve block model. The ore drifts are then slashed to the design limits of the ore. Longhole drilling in the Centre Zone is carried out with two Tamrock H831RF and one Tamrock H665RTS Solo longhole drills, which drill parallel rings of 64mm (2.5in) diameter blastholes from one sublevel to the next. The drill rings are a maximum of 1.5m apart and the toe spacing is a maximum of 1.8m.

The West Zone is similarly developed, but because of the narrower widths, slashing is not usually required. Back sampling for ore reserve definition is done at 2.5m intervals along the strike of the ore drift. Production drilling is carried out by three Tamrock H506RTS Solo longhole drills, drilling 10m up and down holes from each sublevel. The holes are also 64 mm (2.5 in) diameter and are nominally drilled in a 3-2 pattern, with the burden between lines being 0.75m. Toe spacing is kept to a maximum of 1.5m. Experimenting with full-length downholes and alternative hole layouts is ongoing in the West Zone in an effort to improve on wall dilution.

With this mining method, much of the stope muck is recovered by mucking remotely. Six 2 cubic yard and five 6 cubic yard scooptrams are equipped with radio remote control to move production muck. Each stope panel has a safety bay from which the scooptram operator can safely manoeuvre the unit in and out of the stope.

PASTE BACKFILL

After other methods were considered, consolidated paste fill was selected as the backfill of choice for the Lupin Mine. The paste backfill plant was commissioned in October 1994 and was one of the first such systems operating in Canada at that time. The process involves taking the filter cake from the second stage filters in the mill (tailings), conveying it to the paste plant where it is mixed in a pan mixer with cement and water to create the paste. The paste is pumped to the shaft utilizing a positive placement pump. Once delivered to the shaft, it flows by gravity through the 6-inch diameter fill line and is distributed throughout the mine. The paste system has a design capacity of 120 short tons per hour. Between January 1995 and December 1997, over 1 million tons of paste backfill was placed in the underground stopes.

UNDERGROUND MINE SERVICES

VENTILATION

A 1,000 horsepower, 84-inch diameter Joy axivane fan mounted on surface, supplies fresh air to the mine via a fresh-air raise system. The fan has a rated capacity of 300,000 CFM at 12.5 in water gauge static pressure. A similarly sized Joy fan, rated at 250,000 CFM at 11.7 in water gauge static pressure is also mounted on surface and helps exhaust contaminated air from the mine.

To distribute fresh air throughout the mine, the main vent raise is broken into on the various working levels. At each such breakthrough, a concrete bulkhead is installed and either a 75 or 50 HP axial flow fan is mounted in the bulkhead to direct the flow of fresh air onto the level through appropriately sized vent tubing. Where development faces are located a far distance from the fresh air raise, booster fans are installed to assist the flow.

The intake airflow is directed over a series of heating coils located inside the fresh air fan building above the main fresh air raise. During winter months, when the temperature of the intake air becomes too low, heat is supplied to the heating coils by means of the powerhouse waste heat recovery system. At extremely low outside air temperatures, this waste heat supply is supplemented by heat generated by diesel fired boilers.

WATER HANDLING

Lupin is a relatively dry mine, having an average water inflow of between 12-25 U.S. gallons per minute. Most of this water seeps into workings below the permafrost level, 500 metres below the surface. The main de-watering system consists of four main sumps located in the 250, 170, 890 and 1,105 shaft stations. The three lower sumps consist of a dirty water side, where slimes are allowed to settle out, and a clear water side in which the pumps are mounted. The sump on 250 is simply a 6,000-gallon transfer tank. On both 1,105 and 890, there are two-40 HP Peerless vertical turbine pumps rated at 100 U.S. gallons per minute under a head of 240 metres. On both 650 and 250, there are two-200 HP horizontally mounted multi-stage Mather & Platt pumps rated at 300 U.S. gallons per minute under a 400-metre head. Pumps are sized for each sump, such that one can do the job leaving the other as a backup. The discharge line is 6 in diameter and is located in the shaft. The mine discharge water is pumped to the sewage lagoon via the mill.

Both drill water and potable water is supplied to the mine via separate pipelines located in the shaft. Also located in the shaft, is a 1.5 in fuel line which allows diesel fuel to be sent to a main storage facility on the 890-metre level.

COMPRESSED AIR AND POWER SUPPLY

Since most of the drilling at Lupin is done with electric-hydraulic equipment, the demand for compressed air is relatively low. Compressed air is still used for drilling in raise development, bolting and other odd jobs. Two Ingersoll Rand 2,500 cubic feet per minute rotary compressors, located in the powerhouse, adequately supply the mine with its compressed air needs.

Power is provided to the mine at 4,160 volts via one of three feeder cables run down the shaft. Transformers lower the voltage to 600 and then more cable distributes the service throughout the mine to virtually every workplace.

UNDERGROUND MOBILE EQUIPMENT MAINTENANCE

The main underground repair shop is located on the 650 metre level, where all repairs and preventive maintenance on approximately 65 pieces of underground equipment are carried out. In addition to the main shop area, separate bays are available for steam cleaning, lubrication, inspections, tire and wheel repair, welding, re-wiring and painting. Hydraulic drifter repairs are conducted in a separate shop on surface. A smaller satellite shop is located on the 1,130-metre level for running repairs and jobs of a smaller magnitude. Also located on the 650 level are three other shops: the electrical shop, the construction shop and the pneumatic drill shop. The bitshop, where drill bits are re-sharpened and distributed, is located in the headframe.

MILLING AND REFINING

The current Lupin milling process incorporates crushing, grinding, pre-aeration, leaching, filtration and recovery.

CRUSHING

The ore from the mine is crushed underground to 5.5 inches by a primary jaw crusher. It is then skipped to a 600-ton coarse-ore bin on surface. A vibrating feeder and conveyor belt transports the ore to a secondary cone crusher. After being reduced to -1.5 inch, the ore passes over a double-deck vibrating screen. The material larger than 5/8 inch is fed into the tertiary cone crusher and re-circulated over the vibrating screen until it passes through the 5/8-inch openings. The ore passing this screen is conveyed to two 1, 000-ton fine ore bins, which feed the grinding circuit. The crushing circuit has a capacity of 240 tons per hour.

GRINDING

Liberation of the gold from the hostrock is done by further reduction of the ore size. This is accomplished with a 9.5-ft. diameter x 12-ft. long rod mill feeding two 8-ft. diameter x 24-ft. long ball mills in parallel. The ore is fed into the rod mill from the fine ore bins via belt feeders and conveyors. The ball mill discharge slurry is pumped to a common ball mill discharge or cyclone feed pump box, then to a cluster of cyclones which classifies the material. Cyclone underflow (+200 mesh material) is fed back into the ball mills with the target-grind being 57% passing -400 mesh.

The cyclone overflow slurry (-200 mesh material) is pumped to the pre-aeration circuit at about 30% solids. The grinding circuit has a capacity of 2,300 tons per day.

PRE-AERATION

The cyclone overflow is fed to the center well of the pre-aeration thickener, a 50-ft diameter shallow settling tank. The thickener overflow solution flows by gravity to the recycle water tank and is recycled back to the grinding circuit. The thickener underflow slurry (60% solids) is pumped to the first of three 82,000 USG pre-aeration tanks. These tanks provide air to oxidize sulfide minerals, which would otherwise consume large amounts of cyanide and oxygen, thus hindering the leaching reaction. The circuit is tuned for efficient mechanical and chemical performance by operating under alkaline conditions (pH 10), adding lead nitrate reagent, and by using primary filtrate to dilute the thickener underflow density to 45% solids.

LEACHING

The liberated gold particles are leached into solution through the reaction of cyanide, oxygen and water. Slurry from the pre-aeration circuit is leached in six consecutive agitated and aerated tanks. Lime is added to the circuit to maintain a constant pH of about 10. These six tanks in series give the circuit 30 hours of retention time. The overflow from Leach Tank No. 6 feeds the cyanidation thickener. Thickener overflow solution is loaded with gold and flows to the pregnant solution tank. The underflow, also containing some gold in solution, is pumped to the filtration circuit.

FILTRATION

A two-stage filtration system separates dissolved gold from the waste solids of the cyanide thickener underflow. Each stage consists of four vacuum drum filters 8 ft. in diameter and 14 ft. long. In the first stage, the cyanidation thickener underflow slurry contacts the outside of the filter unit and the solution is drawn through the filter while the filter cake is washed with barren solution. The solution is returned to the cyanidation thickener or pumped to pre-aeration as dilution water. The filter cake passes through a repulper to a second stage. The second stage filter cake is washed with either barren or raw water and the solution is again returned to the cyanidation thickener. The filter cake is repulped with barren or raw water and flows by gravity to the tailings disposal pump box.

RECOVERY

The pregnant solution from the cyanidation thickener overflow is clarified and de-aerated, precipitated and refined to obtain dore bullion in a conventional Merill-Crowe system. Three pressure clarifiers remove suspended solids from the solution, and then the oxygen is removed prior to precipitation in a de-aeration or Crowe tower. Zinc dust is added to the clarified de-aerated solution and the precipitated gold is collected in precipitation presses. The now barren solution is bled to tailings and recirculated throughout the plant. Once the filter press becomes loaded with precipitate, the feed is transferred to the other presses and the loaded press is emptied. After being mixed with suitable fluxes, the precipitate is smelted in the bullion furnace to produce dore bullion and slag. The slag is returned to the mill to be reprocessed. The bullion contains approximately 85% gold and 12% silver, the balance being base metals. The bullion is delivered to either the Royal Canadian Mint or Johnson Matthey for refining into marketable gold and silver bullion.

TAILINGS DISPOSAL

Tailings are pumped from the mill to a location nine kilometres to the south of the mine site. Tailings are first dumped into a solids retention cell, where the solids settle and the tailings solution drains or is tranferred into Pond No. 1. In Pond No. 1, cyanide undergoes natural degradation due to exposure to sunlight, air and agitation by wind action. Each summer, water from Pond No. 1 is simultaneously siphoned into Pond No. 2 and injected with ferric-sulphate in order to precipitate arsenic. All other contaminants such as heavy metals (Cu, Fe, Ni, Pb, Zn) degrade naturally. Pond No. 2 basically provides more retention time for the above process to take place. When water license criteria are met, water from Pond No. 2 is discharged back to the environment.

The 440 hectare tailings disposal area is adequate for the needs of the Lupin Mine for the foreseeable future. As the mine takes more tailings for pastefill purposes, the demand for tailings disposal space is significantly reduced.

PASTE BACKFILL PLANT

The filter cake that is discharged from the filtration circuit is conveyed to the paste backfill plant and mixed with cement in a pan mixer. Each batch contains approximately five tons of cement and filter cake. The mixture is then diluted with water to obtain the desired slump and when it has been reached, the mixer discharge gate opens allowing the paste to dump into the pump hopper. The paste is then pumped underground continuously by a Schwing positive displacement pump, through a 6in. diameter line. The process is fully automated by a process computer control system.

In the cement building, two-tonne bags of cement are dumped into a screened hopper. which feeds an auger conveyor that in turn dumps the cement into a tanker. Once full, the tanker is pressurized and the cement is pneumatically moved to a cement silo inside the paste plant. The two-tonne bags of cement are stored in an unheated building (32,000 sq.ft.) adjacent to the paste plant. The yearly supply of cement, approximately 5,000 tonnes or 2,500 bags, is trucked to Lupin on the annual winter road.

RECLAMATION

On completion of mining at Lupin and in the absence of any other industrial use for the facility (e.g. custom milling) all buildings, equipment and other structures will be dismantled and removed (if salvageable). Non-salvageable material will be disposed into the mined out workings or will be buried on surface. All raises. the shaft, portal and any other entrance to the mine will be sealed with concrete plugs. Culverts in the roads will be removed and natural watercourses left open. The breakwater and causeway at the water intake will be left in place.

The largest portion of reclamation cost will be for covering the tailings area with esker material. The current provision is for 1.0 to 1.75 metres of cover material. As tailings areas become filled and are no longer required, they will be progressively reclaimed. This will provide some early experience with reclamation and reduce the volume of work required at the end of the mine life.

While the mine is in operation. the waste rock produced will be used as roadbed material, in dams, in the airstrip or as backfill. Any remaining waste rock stockpile will be contoured to match the surrounding landscape. Fuel, oil and chemical storage facilities will be dismantled and disposed of or salvaged. Residual oil and contaminated soil from these storage areas will be dealt with as required. Liner material will be removed and the bermed areas flattened and contoured. Existing garbage dumps will be covered with esker or waste rock and also contoured.

The upper sewage lagoon will require a decant trench to maintain a constant water level. The lower sewage lagoon will also have a decant trench.

The reclaimed site will be contoured to conform to the natural terrain and to minimize ponding of run-off water.