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THE BAKER MINE OPERATION

by,

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ABSTRACT

This paper reviews the exploration, development and subsequent production following the serendipitous discovery of high grade epithermal gold-silver mineralization in 1969. This discovery was made in a remote location, during a regional geochemical reconnaissance program designed to search for porphyry copper mineralization in the Cassiar-Omineca Mountains. Exploration and development in the 1971-79 period included geological, geochemical and geophysical surveys; trenching, almost 30,000 ft of surface and underground drilling in about 100 holes and cross-cutting, drifting and raising on the principal gold-silver bearing vein. This led to the delineation of 100,000 tons grading about 0.9 oz gold per ton and 18 oz silver per ton to an average depth of 120 ft below surface.

A production decision in early 1980 led to the establishment of a 100 ton per day mining operation with all supporting infrastructure transported to the site by a Hercules aircraft.

The operation relies on its own Twin Otter aircraft for personnel mobilization and supply of small items. Periodic Hercules campaigns supply major items including fuel.

The mining operation has included both open pit and cut-and-fill methods. The milling operation, reviewed in greater detail in a separate paper, employs a conventional cyanide-leach process with cyanide destruction. The end product is dore bullion.

The fly-in operation, initially structured on a 21-day-in and 7-day-out basis has been modified to a 14-day-in and 7-day-out basis with no loss in efficiency and with a significant increase in employee satisfaction. The operation, which earned the B.C. Small Mines Safety Award in 1982 during its first full year of operation, emphasizes safety and process hazard awareness. It has also carried out its own wildlife studies and shown that industry and wildlife can co-exist in harmony.

Every effort has been made to extend the life of the operation either by discovery of additional on-property ore reserves or by encouraging mining companies exploring nearby properties to consider the potential advantage of utilizing existing infrastructure at the Baker Mine.

INTRODUCTION

The Baker Mine (formerly known as the Chappelle property) is located at an elevation of about 5500 feet in a sub-Alpine environment at the western margin of the Omineca Mountains about 170 miles north of Smithers, BC. The earliest recorded prospecting activity in the area was associated with placer gold mining in the 1930's on the Toodoggone River about five miles north of the mine, near Serem's Lawyers property. Lead-zinc mineralization in skarn, which lies about one mile southwest of Vein A, was also discovered, staked and explored by Cominco during this early period.

In 1968, Kennco Explorations (Western) Limited carried out geochemical reconnaissance surveys in the search for porphyry copper deposits and as a result, staked the original Chappelle block of claims. During follow-up of a molybdenum-silver soil anomaly at the present property in 1969, quartz float aroused the curiosity of the Kennco prospector regarding the precious metal possibilities in the area. One fragment assayed 2.5 oz Au/ton and 65 oz Ag/ton. During the period 1970-72, the balance of the Chappelle claims were staked and soil sampling, hydraulic trenching and rock chip sampling delineated a 10-foot wide mineralized quartz vein grading 1.0 oz/ton Au and 18 oz/ton Ag over a strike length of about 750 feet. Two X-ray diamond drill holes indicated persistence of high grade mineralization to a depth of at least 65 feet. In 1973, Kennco decided that the property should be dealt to outside parties and an agreement was entered into with Conwest Exploration Ltd. During that year, Conwest built a 2800 foot airstrip at Black Lake and a five mile road to the property, drove an adit that crosscut and drifted along Vein A, and completed some surface and underground diamond drilling. The results of the underground program were not particularly encouraging and Conwest terminated its option at the end of 1973.

Early in 1974, Du Pont of Canada Exploration Limited optioned the property and over the next five years completed over 28,500 feet of diamond drilling in 96 holes. In addition, an underground development program resulted in 300 feet of crosscuts and 1200 feet of drifts and raises. At the end of 1977, the mineable reserves of 57,000 tons resulted in a feasibility that showed only a marginal return at prevailing metal prices. However, by 1980 February a production decision was made based on mineable reserves of 100,000 tons of 0.90 oz/ton Au and 19.0 oz/ton Ag and a favourable feasibility at US$350/oz Au and US$11.50/oz Ag. During the period 1969-79, total costs of exploration and development were $2.1 million. In addition, attempts to increase mineable reserves during the last three years have involved about 14,000 ft of surface and underground drilling in 65 holes. Unfortunately, these efforts have been unsuccessful to date.

The geologic setting and mineralization of the Baker Mine gold-silver deposit was described in a paper published in the 1978 February CIM Bulletin and because of time limitations, will not be discussed in any detail in this presentation.

DEVELOPMENT

The paramount item to be addressed in the development of the Baker Mine was the determination of the most cost-effective method of access to such a remote location. The small, high-grade nature of the deposit supported a decision to proceed with a totally aircraft-supported operation following the government's decision not to proceed with extension of the Omenica road into the Baker Mine area. During 1979-80 the 5330 foot gravel Sturdee Valley airstrip was constructed by Du Pont and the Ministry of Energy Mines & Petroleum Resources and was equipped with radio, beacon, lighting facilities and a weather observer. The construction period necessitated over 200 flights with PWA C-130 Hercules aircraft in order to transport heavy equipment, camp/mill components and supplies. Over 250 flights with a company-based Navajo Chieftain were required for personnel and small freight transportation. In addition, Du Pont purchased a Twin Otter in late 1980 that has been used almost exclusively for support of the Baker Mine operations while logging over 120 flights to Sturdee during the pre-production phase and almost 1000 flights during the production phase. This aircraft is based out of a modern company owned hangar in Smithers and is operated and maintained by an excellent 5-man crew contracted from Innotech Aviation. Heavy freight and fuel are marshalled in Smithers for restocking via a Hercules campaign every three to four months.

In order to bring the mine into production, over 25 permits were required, concerning most notably the environment, water pollution control and the mining plan. Fortunately, as early as 1976, Du Pont had initiated an environmental base-line study primarily concerned with water quality. In addition, environmental/reclamation and wildlife studies were started during the pre-production period, with special emphasis on a large herd of Osborne caribou nearby. These monitoring programs have continued during the production phase and have shown that wildlife and industry can live in harmony.

Since the mine is located in a sub-alpine environment at the head of a creek system in an area of moderate precipitation, a particular concern during development of the project was an adequate water supply for pottable purposes and mill requirements. The water system that evolved includes both a 5500 foot Sclaircore polyethylene water line to a cirque at the head of the creek system and a small dam on the creek near the camp.

Although the construction phase of the Baker Mine presented many challenges typical of remote mine developments, the breadth of this paper allows time for only the more significant items. It is sufficient to point out that within 400 days of the production decision, the first dore bar was poured at Baker after airlifting over ten million pounds of freight, and transporting over 1300 passengers between Smithers and the Sturdee airstrip. Pre-production capital costs for the project were about $18 million, with an additional $3/4 million in post production capital cost due to additions and modifications to the project.

MINING OPERATIONS

The mining operation has involved both an open pit and an underground mine. During 1980, ore for initial mill feed was developed by the contractor (Dillingham) in a small open pit using an airtrac drill, a front-end loader, a dozer and two trucks. The steeply dipping ore vein, which varies from 5-20 feet in width, tends to be very strong but cut by numerous cross joints and faults. However, the wall rock is relatively incompetent and as a result, the segregation of ore and waste was initially recognized as a significant problem during open pit mining and has continued to be a problem underground. The weak wall rock and complex faulting indicated that shrinkage stoping was not feasible. Therefore, all underground mining has been by cut and fill using upholes in good ground and breasting in less competent areas. Fill consists of waste rock from the open pit mining operation. Fasloc resin rock bolts and timbering are used for stability as required.

The Baker Mine is a trackless operation with a single 2 yd^3 scooptram capable of handling the daily output of 100 tons of ore. Mine access is based on two adits at elevations of 5538 feet and 5420 feet. Initial underground mine development included raises between the two main levels and between the upper level and surface for ventilation, escapeways and fill. Ventilation and heating of mine air are accomplished with a fan and oil-fired heater as required. Compressed air is supplied by two 750 cfm compressors and mine water is collected from old diamond drill holes and pumped throughout the mine.

The main cross faults are used as the boundaries of the stopes since the strike slip component of the offset can be up to 30 feet and as sudden changes in vein width are often associated with the main faults. In areas where stopes have been carried through major cross faults, caving has lead to high dilution from wall rock. Ground stability problems in stopes near surface resulted in the need to take a small 50 foot thick crown pillar from surface using the Du Pont Sequential Blasting System of non-electric delay decking. De-coupled charges for pre-shear and cushion blasting were used to control overbreak and hence minimize dilution. The final strip ratio in this part of the operation was about 6:1.

Despite the high grade nature of the vein, no visible free gold has been detected. Gold is mostly associated with fine-grained electrum while the predominant silver mineral is acanthite. Experience has shown that the best grades are generally concentrated along the hangingwall of the vein and the recognition of chalcopyrite and sphalerite in the ore is generally a reliable indication of high-grade mineralization. The ore values occur as shoots within the vein that generally plunge at a low angle. The combination of these low angle ore shoots with fault offsets makes it very difficult to mine the ore and waste portions of the vein separately. An additional contributing factor to high dilution is the fact that miners and even the geologist have difficulty in predicting grades based on visual inspection. These Baker Mine problems have lead to detailed sampling of stope backs, the use of percussion test holes and detailed stockpile sampling. In fact, the grade

control program has evolved to the point that a "laydown pad" has been established where each 15 ton truck load is sampled. Assays are turned around in twenty-four hours to allow stope backs and stockpiles to be designated as ore, sub-ore, or waste depending on the prevailing metal prices/operating cost impact on cut-off grade.

MILLING OPERATION

The milling operation at Baker Mine came on-stream in April 1981. The initial period of operation was plagued with throughput bottlenecks, as the single-stage dewatering section, utilizing a belt filter could not adequately process the finely-ground ore. Conversion to a two stage dewatering process with the addition of a drum filter in the third quarter of 1981 followed by process development, concentrating on grinding and gold/silver dissolution, increased throughput to design levels by the fourth quarter of 1981. Recoveries above 94% for gold and 87% for silver have been demonstrated in the mill when mill feed calculated heads reach design levels. The milling operation has operated very steadily through 1982 and 1983 with very good mechanical utility. Two recent process development improvements have been put in place. The belt-filter capacity and efficiency has been increased significantly with the installation of a specially designed needle felt cloth manufactured by Albarie Canada Ltd. Barrie. And, the tailings cyanide destruction system has been converted from alkaline chlorination to the Inco SO_2/air process with a significant improvement in safety, cost and performance.

Overall, the milling operation has performed very well. The Baker Mine milling operation is the topic of a separate paper being presented later this morning.

ECONOMIC VIABILITY

The economic viability of the Baker Mine operation has been affected by several factors, of which the most significant are:

(1) Tonnage dilution
(2) Grade dilution
(3) Operating costs

(1) Tonnage dilution

Two separate economic studies which influenced the production decision considered that the geologic reserve would be diluted 20 percent with waste material containing no gold or silver values, to produce the mineable reserve. In practice, ore dilution has averaged about 65 percent, because of the extensive faulting and other reasons previously discussed.

In the first two years of the operation, the average mill grades were above the cut-off of 0.3 gold equivalent. By 1983 as operations moved to lower grade portions of the mine, it became necessary to employ an full-time mine technologist on grade control. Each 15 ton truckload of broken ore was assayed and segregated according to gold equivalent grade. Although the program has contributed significantly to cash margin in 1983, it has also resulted in removal of part of the original reserve.

(2) Grade Dilution

The Baker Mine production decison ore reserve was based on 24 blocks, all within 200 feet of surface, and an extremely detailed surface sampling program of the vein which was essentially duplicated by drilling results. Over 60% of the ore blocks contained reference intercepts of plus 0.8 oz gold/ton with high silver values, i.e., in the range of 20:1 silver:gold ratios.

Experience has shown that apart from tonnage dilution, the calculated head values for mill feed determined from solution values and dore bullion measured in the mill represent only 70% of the gold and silver ounces predicted in the deposit in the ore reserve calculations. When the mining and grade dilution experience was applied to some of the lower grade ore blocks, the probability of producing mill feed from these blocks, above the economic cut-off was considered remote, and accordingly, they were removed from the reserve.

Mill feed cut-off at Baker Mine has ranged from about 0.30-0.45 oz/t gold equivalent, depending on gold and silver prices.

(3) Costs

The operating costs at $200 per ton in 1983 are about 40% higher, on a constant dollar basis, than predicted at the feasibility stage. Contributing factors included higher costs for reagents, especially the calcium hypochlorite required in the mill process and for diesel fuel as a result of spiralling Canadian crude oil prices. The feasibility study did not provide adequate coverage for the mine organization to meet its requirements for reliability and safety. Du Pont also decided to purchase its own Twin Otter aircraft rather than rely on charters.

The impact of the higher operating costs was compounded by the assumption in the feasibility that over the life of Baker Mine, the precious metal prices would increase to offset inflation. This has not happened. In fact, the average gold/silver prices over the life of Baker are just about equal to the feasibility values at US$350/oz gold and $11/oz silver. The average annual inflation over the same period was 13%.

When comparing the operating cost performance of Baker Mine, it is well to remember that the "remoteness" component of operating cost is significant. Our studies have shown that up to 15% of the $200/ton operating cost is directly related to remoteness.

POSITIVE EXPERIENCE

But not to leave the Baker story on a down-note, what positive experiences have been recorded by the operations.

- Safety: It is absolutely essential that in a remote, air-supported operation like Baker Mine, safety of personnel be made the #1 priority. We have done this at Baker and have been successful. In 1982, Baker Mine was awarded the British Columbia Small Mines Safety Award plaque presented by the West Kootenay Mine Safety Association. In 1983, to date, no injury has resulted in lost work days and the mill has recently passed its 820th day without a lost work day injury. The employees at Baker Mine are to be recognized for their improving performance in the area of safety, --- if all employees would believe all accidents are preventable, and apply common-sense in conjunction with training and audit feedback provided by the organization, safety performance would improve. Baker Mine has shown it can be done - safety frequency to date in 1983 is 2.75 injuries per 200,000 exposure hours, and severity is 11.0 days per 200,000 exposure hours. In addition, the Baker operation has been further enhanced in that air operations service provided by INNOTECH, has had an incident-free record since service started out of Smithers in 1980.

- Environment: As previously discussed, it has been shown that a mining operation like Baker can co-exist with nature. Most importantly, in our remote wilderness area, Baker Mine has shown to be ideally located to minimize the impact on water quality and wildlife. Like safety, environment is a "must" management priority, rating equally as important as production. Our experience has emphasized the importance of thorough "environmental design" at the feasibility stage and of thorough measurement and testing through construction and start-up. Baker has operated through the period in gold mining history where the technology of tailings treatment has finally met the needs of the environment. There is no question, the involvement of experienced site management personnel in the feasibility and construction phases of any new mining operation will help identify and deflect any potential environmental problems.

PERSONNEL/PRODUCTIVITY

At the peak of operation, the complement on site was 47, made up of 44 company and 3 contract personnel. Two company and 5 contract personnel at Smithers provided purchasing, receiving and flight operations coverage.

The initial rotation allowed for a 21-day-in and 7-day-out schedule but was modified in 1982 to a 14-day-in and 7-day-out basis, primarily at the suggestion of employees. Efficiency was not affected, productivity was improved by approximately 12% and employee satisfaction solidified.

Recreation on the site centres around a satellite receiving dish that brings in four TV and radio channels. A VCR compliments the system that is distributed throughout the bunkhouse to each individual room. Radio controlled model airplanes have been known to take off and radio controlled boats to sink. A workout room and sauna are available for all to challenge the calories put up in quantity and quality by Calvan Catering, or to warm-up after a cool day on the ski-trail or snow-shoeing.

Overall, an excellent working and living climate has been developed at Baker.

CONCLUSION

Although the Baker production decision did not rely on development of additional reserves in order to increase the original three-year life of the operation, it was hoped that additional exploration would achieve this objective. Unfortunately, this has not happened. Thus, as a result of the reduction of the original reserves due to dilution and cost, Baker Mine will be forced to cease operations in 1983 December.

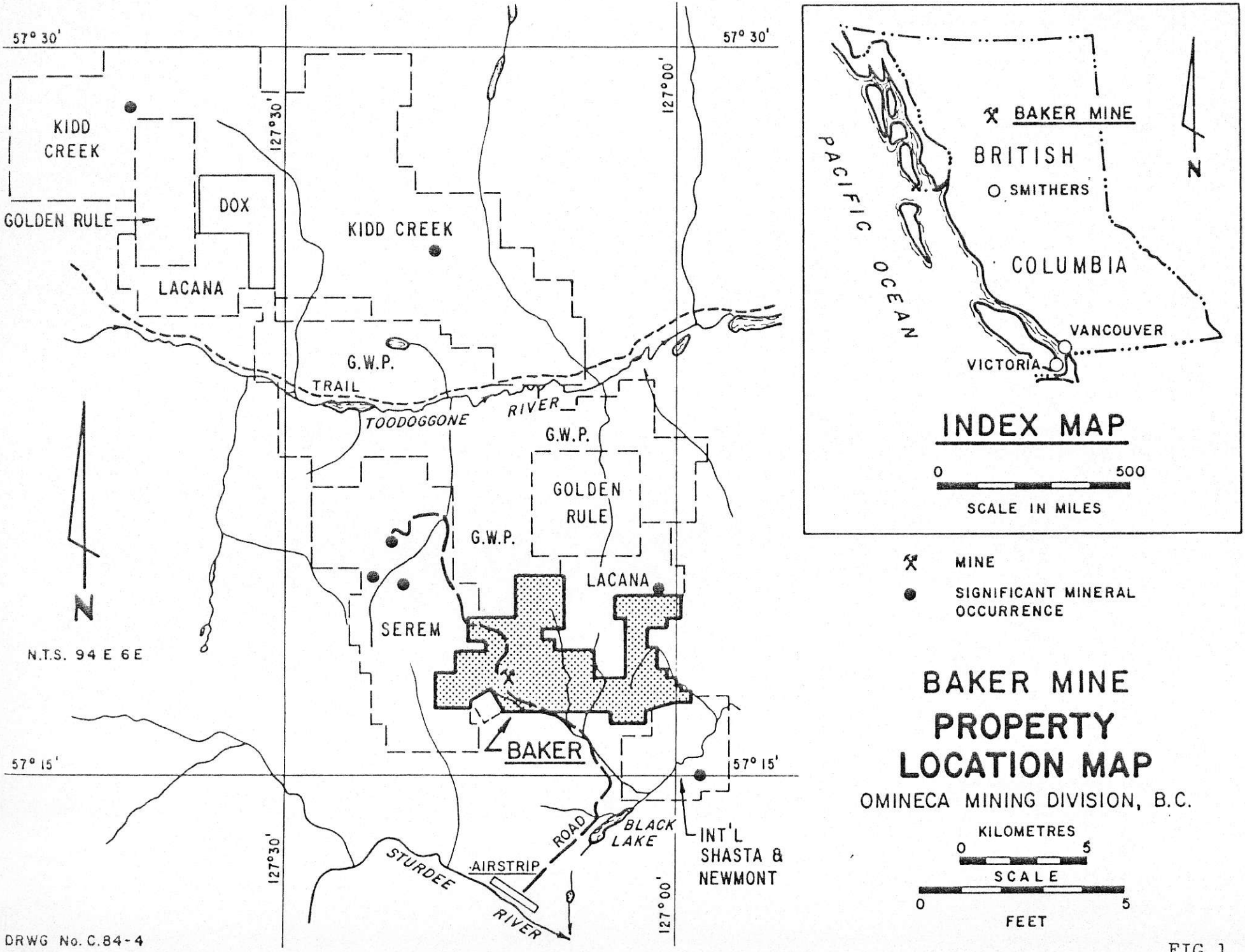
But we don't think this is the end for Baker!

Other mining companies in the area have had some encouragement, although insufficient reserves have yet been delineated for production decisions. The Baker Mine infrastructure, if it can be used by others in the nearby area, would significantly reduce the risk factor in a new development because of the lower capital cost, and the reduced construction and run-in periods.

In addition, our preliminary engineering studies have shown that with minimal investment, the mill throughput can be doubled and the unit cost lowered by 15-20%.

For these reasons, we believe that if the Toodoggone area has a future, then Baker has a future. The existing infrastructure will be left intact and mothballed - but not forgotten.

Our dream is that when the "Price Is Right", the Baker mill will be the pot at the end of the rainbow. Maybe one of you will help make that dream a reality.



BAKER MINE
PROPERTY LOCATION MAP

OMINECA MINING DIVISION, B.C.

KILOMETRES
0 5
SCALE
0 5
FEET

DRWG No. C.84-4

FIG.1

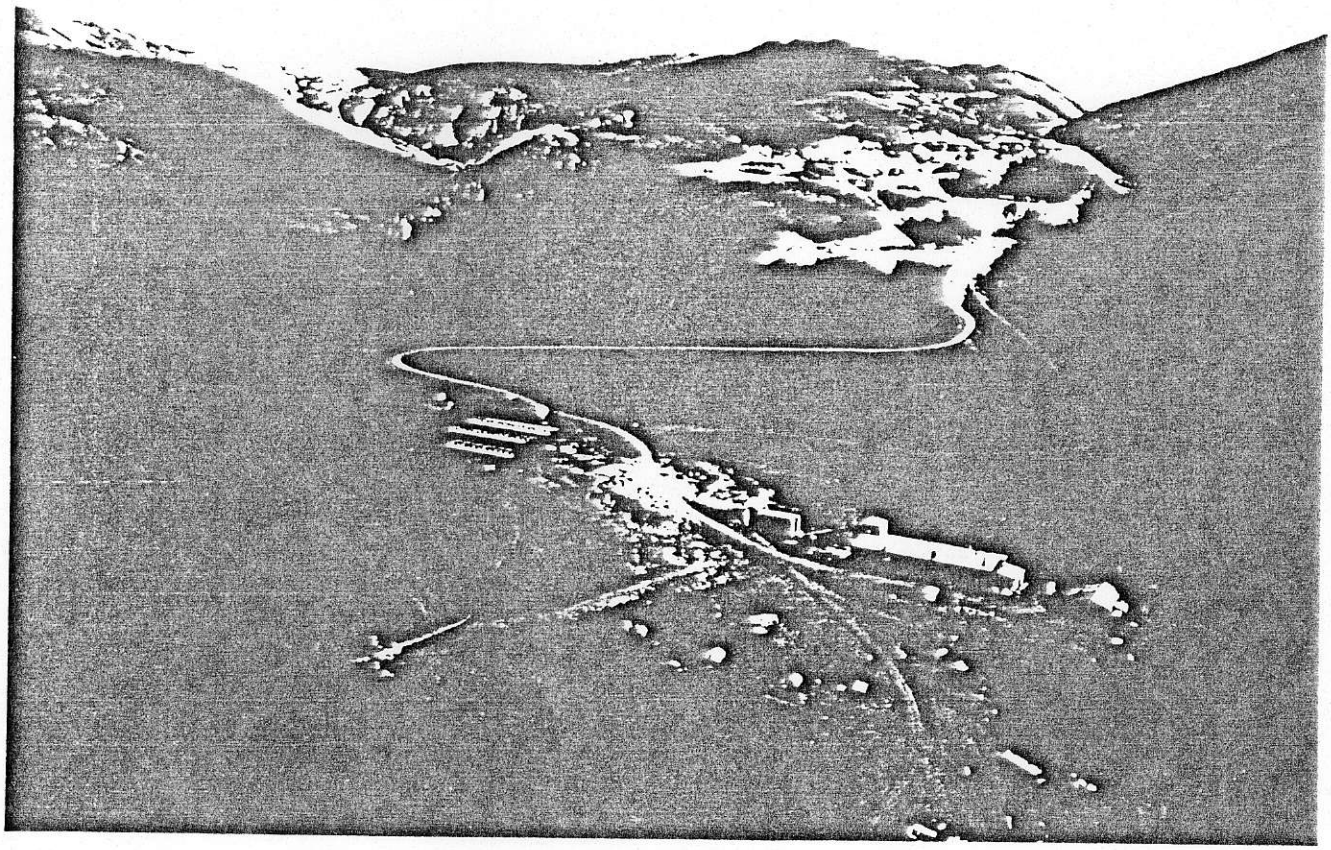


Plate 1 - Baker Mine looking northerly across camp complex, crusher, mill and shop buildings to mine area.