# Industry IN ACTION

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## EXPLORATION

SNIP

### Delaware's Snip Progress

Delaware Resources Corp. and Cominco have rescheduled the agreement governing their respective stakes in the Snip prospect on Johny Mountain in the Cassiar District of British Columbia. The property is 70 km east of the Alaskan town of Wrangell. Under the new agreement, Delaware can increase its interest to 100% by the expenditure of a further $C4 million with the proviso that Cominco can earn back a 60% interest at any stage.

In 1986, the company drilled 13 widely spaced holes, of which only one failed to intersect significant mineralization. Drilling outlined two zones, the Twin zone and the Lamp zone with a further four that could add to the tonnage potential. Both structures are still open along strike and at depth over a possible true thickness of 6-12 m. Drilling results include 3.3 m grading 10.8 g/t gold, 4.5 m at 13.8 g/t, 42 m assaying 7.5 g/t (which included several high grade sub-sections), 1.5 m grading 3.7 g/t, 11.8 m at 9.0 g/t, 2.8 m at 36.3 g/t, 1.9 m grading 5.7 g/t, 3.9 m at 1.3 g/t and 17 m assaying 20 g/t. The drill cores also contained up to 2% copper and some zinc.

Delaware is to fund up to $C3 million for the 1987 programme which should start mid-May. It intends to carry out an extensive step out drilling programme with permanent underground exploration (adits into the mountains) starting in September.

Delaware holds several adjoining properties in that area, in partnership with other companies. These are immediately north of Skyline Explorations' Reg property.

### Geological Help for Philippines

The U.S. Geological Survey and the Geological Survey of Japan are launching a five-year joint programme as from this year, to investigate the presence of chromium and platinum resources in the Philippines, reports the *American Metal Market*. The survey will also attempt to find sources of supply for rare metals. Geological studies will start in Bagio on Luzon Island and in Surigao on Mindanao Island.

### Selco in Kitimat

The Selco division of BP Resources Canada Ltd. has farmed into Laramide Resources Ltd.'s Kitimat gold-base metals prospect near the town of Kitimat in British Columbia by making an initial payment of $C50,000. BP has the right to earn a 50% interest in the property by spending $C1 million on exploration before end-1990. Thereafter Laramide can elect whether to participate in further costs on a 50:50 basis or be reduced to 25% when a production decision has been made or receive a net smelter return royalty that escalates to 3% over five years.

The mineralization has been traced along strike for at least 4 km. It is composed of steeply dipping pyrite and barite bearing rhyolite beds within a sequence of volcanic fragmental rocks. Geochemical rock sampling has identified anomalous concentrations of copper, lead, zinc, gold and silver. Gold values up to 5.1 g/t have been recorded.

### Amir-Glamis Deal

Amir Mines Ltd., wholly-owned by a private firm of exploration consultants called Bema Industries Ltd. of Vancouver, has entered a joint venture agreement with Glamis Gold Ltd., whereby Glamis can earn a 51% interest in the Friday/Buffalo Gulch properties by funding further exploration and bringing them into production. The two properties are situated near Elk City in Idaho.

An extensive drilling programme carried out in 1986 outlined proven-probable reserves of some 4.5-5.5 Mt of oxide material grading 0.9 g/t gold, which includes a higher grade zone of 1.5 Mt grading 1.1 g/t on the Buffalo Gulch claim area. On the North Deadwood zones, the potential is estimated at some 20 Mt of leachable ore. On the Friday property, which Amir holds with Normine Resources (24% and 25% respectively), drill indicated reserves stand at 2.7 Mt grading 1.4 g/t with a further 3 Mt possible. Over the whole belt the companies estimate a total potential of some 45 Mt grading 1.4 g/t.

Initial metallurgical tests on the friable material indicated recoveries of 75% of the gold in 10 days, and 93% over 24 days. Bulk leaching tests on the ore are due to start in April. The oxide zone runs 45 m deep with a 1:1 stripping ratio. As the ore will require no blasting or crushing, the companies have projected operating costs at $US125-195/t as a conservative estimate. Plans are to start production by mid-1988, treating a minimum of 2 Mt/y over an eight-month leaching period, possibly from two or three open pits.

### Nigerian Gold

According to the Nigerian Mining Corp., gold deposits with commercial potential have been discovered in three Nigerian states, in the western Oyo state and in the northern states of Sokoto and Niger. No indication has been given of their size.

### Pacific at North Bend

Pacific Concord Resource Corp. has acquired a 100% interest in a large group of gold-bearing mineral claims near North Bend in Oregon. Under the terms of the agreement, the purchase price is deferred until an independent feasibility study has been completed. The purchase price will then be 10% of the valuation, not exceeding $US44 million.

The company is also negotiating the purchase of certain interests in Mexico.

### Keezhik Lake Drilling

Vancouver-based companies, Severide Resources Inc. and Pure Gold Resources Inc. have announced that the first diamond drill hole on their Keezhik Lake property near Fort Hope in Ontario intersected 2 m grading 12.8 g/t gold and 1 m grading 2.1 g/t gold down to a depth of 68 m. This zone is within a strong IP conductor which exceeds 580 m in length. Follow-up diamond drilling is planned.

Severide has an option to acquire a 100% interest in the property with Pure Gold earning 50% thereof by spending about $C462,000 on exploration by February 1988.

### Platinum in Madagascar?

According to some industry sources, Madagascar's National Military Office for Strategic Industries (OMNIS) is negotiating an exploration contract with France's Bureau de Recherches Geologiques et Minieres (BRGM), which would involve prospecting for platinum in the Andriamena region where chromite is already being mined.

## DEVELOPMENT

### Akjoujt Plans Simmer

Mauritania's Societe Arabe des Mines de l'Inchiri (SAMIN) is reportedly planning to invest $50 million in the development of the Akjoujt copper deposit. The mine will be developed in two phases, the first of which would produce about 500kg/y of gold and 300kg/y of silver, possibly starting in 1988. Operations would subsequently be expanded to produce some 1,000kg/y gold and 65,000t/y of copper concentrates.

### Queenstake's Hopes for Argus

Vancouver-based Queenstake Resources Ltd. has signed an agreement with Childs International Inc., under the terms of which Childs can earn a 60% interest in Queenstake's Argus gold project near Bakersfield in California. Childs must spend $US1 million on the property by 1989.

The property hosts two deposits, the Davenport and the Arondo. Potential tonnage on the Davenport to a depth of 100 m is 1.8 Mt grading 3.0 g/t gold with grades cut to 1.8 g/t. The stripping ratio is approximately 4:1. The East Arondo is of lower grade and tonnage, estimated at 363,000 t grading 1.0 g/t with a stripping ratio of 2.6:1.

The companies are planning an open pit mining operation, heap leaching and carbon-in-column gold recovery. Preliminary metallurgical tests indicate that leaching rates are very rapid and reagent

drilling, including 2625 m of c -spaced in-fill drilling.

In 1995, Cumberland Resources (60%) with Comaplex Minerals (40%) drilled 34 holes (3,862 m) and successfully advanced both Third Portage and Goose Island to a combined 25,038 kg (805,000 oz) Au resource. Baseline environmental and engineering studies for future development were also started at this time. In 1996, a further 63 drillholes (9,443 m) on the project advanced resources to beyond 34,200 kg (1.1 million oz) Au.

In 1997, aggressive drilling (13,609 m in 65 holes) has significantly expanded resources at Third Portage, outlined a new zone (the Bay Zone), and identified new exploration potential beneath ose Island. Detailed surface structural mapping of the Third and North Portage area was also completed. Cumberland Resources acquired a 100% interest in the Meadowbank project from Comaplex Minerals, becoming the sole owner/operator.

### Reference

KERSWILL, J.A. (1993) Model for iron formation hosted gol deposits. *In* Mineral Deposit Modelling (R.V. Kirkham, W.D. Sinclair, R.I. Thorpe & J.M. Duke, eds.). *Geol. Assoc. Can. Special Paper* **40**, 171-199.

## 8. PIERINA, PERU - *see section II. - 5.*

## 9. FAULTS AND FOOTWALL VEINS AT THE SNIP GOLD MINE

**Bruce Coates**

*Prime Resources Group Inc. – Homestake Canada Inc., Snip Mine, British Columbia*

### Introduction

The Snip mine is in northwestern British Columbia, on the south side of the Iskut River, 100 km north of Stewart, and is accessible only by air. The 420 t.p.d. Au mine is owned by Prime Resources Group Inc. (100%) and is operated by Homestake Canada Inc.

### History

At the turn of the century, three crown grants were placed to cover a gossanous cliff face known as the "Red Bluff", and at the bottom of the cliff two adits were driven into the porphyry copper prospect. The first Snip vein showing was discovered in 1965 by accident as Cominco Ltd. geologists, returning from an examination at the top of the Red Bluff porphyry copper prospect, slid down a creek gully and came face to face with the vein. This showing is near the eastern limit of the deposit, where vein continuity, faults, and lamprophyre dykes are indefinite, so that initial trenching yielded limited success and the property was allowed to lapse. Government introduction of "flow-through share financing" in the early 1980s helped provide the incentive for Cominco Ltd. to reacquire the property and option it to Delaware Resources (subsequently bought out by Prime). During 1986 to 1988, surface drilling outlined a resource of 1,370,000 t grading 22.8 g/t Au on the basis of 50-m centers. During 1989-1990, underground development, infill drilling on 12.5-m centers, and bulk sampling was completed. With the new database of 64 km of drilling in 750 holes, reserves were revised to 940,000 t at 28.2 g/t Au (amongst other refinements some apparently marginal stringer ore was removed); because of this extensive effort, few surprises were encountered on production startup in January of 1991.

### Geological setting

The Snip Au deposit lies just east of the Coast Plutonic complex within the Stikine Terrane. Hosting the vein is a thick, northwest-dipping, homogeneous sequence of turbiditic feldspathic greywackes. Intruding the sediments, about 0.5-1 km into the footwall of the vein, is the Red Bluff porphyry. This quartz monzonite stock is K-feldspar megacrystic, and is elongate parallel to its strong foliation at 120°. Its date of 195 Ma suggests a relationship to rocks in the Eskay, Sulphurets, Red Mountain, and other Au camps. The Red Bluff porphyry also exhibits a typical porphyry-copper zonation of metals (Mo > Cu, Au > Pb,Zn,Ag) and alteration (sericitic > propylitic), and also hosts the Cu-Au-Mo resource owned by International Skyline Gold Corp. Sediments hosting the Snip vein are strongly foliated parallel to the porphyry, and have strong potassic (mainly biotite) alteration, about 5% disseminated pyrite, and are anomalous in both Cu (40-400 ppm) and Au (40-400 ppb).

Ore at startup was entirely contained in a single shear vein called the Twin Zone, which dips 30-60° SW, strikes 120°, and rakes about 35° SW. Overall dimensions are 250 m strike length by 600 m updip, and widths are up to 13 m, averaging 3 m. Mineralogy in the Twin Zone is primarily laterally zoned, although pyrrhotite is more common at depth. One of two end-member ore types, called *pink and green ore*, is predominant on the western side of the deposit near the west-boundary fault. This ore has a low sulfide content (typically <5% pyrite), and contains no chalcopyrite, but has a high Mo content as molybdenite. The pinkish color is derived from pervasive hydrothermal red-brown biotite alteration, with subsequent carbonate alteration, whereas the green color is from chlorite. Textures vary from laminated to brecciated. The other end-member ore type, *massive sufide ore*, is predominant on the eastern side of the twin zone, at which the vein thins or ramifies to numerous pyrite-pyrrhotite stringers or extenuation veins within intense biotite alteration (*i.e.*, "pyrite - pyrrhotite - biotite zone"). Chalcopyrite is abundant in this zone, and molybdenite is almost absent. The most common ore type is streaky ore, which is spatially and compositionally between the two end-members. Streaky ore consists of laminations of any combination of biotite, quartz-carbonate, chlorite, orthoclase-altered greywacke, and sulfides. Sheath veining occurs within some of the streaky ore in 5-25 m, southwest-plunging lenses. These veins are filled with either massive pyrite or a "crackled quartz". An unmineralized biotite-spotted basic dyke was intruded along this vein, commonly splitting the ore; thus the name Twin Zone.

Total past production and current diluted reserves at June 30, 1997 were 1.33 Mt at 27.04 g/t Au in all categories. Additional reserves since startup have almost exclusively been located within the mine by underground drilling (101 km of drilling in 1,420 holes). Some of this work, combined with test mining, in the eastern "pyrite-pyrrhotite-biotite zone" led to putting much of this stringer zone back into reserves at an early date. In addition, three new veins were delineated in the footwall, all narrower and with steeper dips, thus converging toward the Twin Zone up-dip. The mineralogical variation present in the Twin Zone is less pronounced or absent in these footwall veins, although pyrrhotite is more common at depth. First into the footwall is the 150 Vein, named for its strike orientation, which leads to convergence with the Twin Vein toward the east. The 150 Vein averages 0.5-1.0 m in width, and ore-bearing portions are confined to about 200 m dip and 200 m strike length. Next into the footwall is the 150-FW Vein, which has an orientation similar to that of the Twin Zone, resulting in it joining the 150 Vein on the west. About 75 m farther into the footwall of this intersection is the 130 Vein, which strikes parallel to the 150-FW Vein and has similar widths of 0.1-0.4 m. Surface work, including extensive soil geochemistry, ground geophysics of all types, and 53 km of surface drilling in 225 holes has had little success. In one area about a kilometer away, a small indicated reserve called the "Twin West" is currently being explored from a new portal by subdrifting, raising, and mining.

# 10. GEOLOGICAL RELATIONSHIPS IN THE VOISEY'S BAY DEPOSIT, REID BROOK INTRUSIVE COMPLEX, LABRADOR

**Peter C. Lightfoot**
*Inco Exploration, Copper Cliff, Ontario*

## INTRODUCTION

Drilling at Voisey's Bay has produced a remarkable resource of drill core which records geological relationships of paramount importance to unravelling the origin and evolution of the troctolitic rocks and the associated Ni, Cu, and Co magmatic sulfide mineralization, and which has established the groundwork for empirical exploration criteria that can be applied to other troctolite-anorthosite complexes worldwide. The sequence of rock types and their relationships are described for the Ovoid, Eastern Deeps, and the Western Extension sheet in the Reid Brook intrusive complex (Naldrett *et al.* 1996; Lightfoot, this Volume).

The Ni-Cu-Co ores at Voisey's Bay are associated with a 1.34-Ga troctolitic complex that belongs to the Nain plutonic suite (Ryan *et al.* 1995). Hosting the mineralization is the Reid Brook intrusive complex (RBIC), which lies on an E–W trend across the N–S suture between the Nain Province to the east and the Churchill Province to the west. To the east, the RBIC is a gabbroic and troctolitic sheet, ~1 km thick, that hosts the Eastern Deeps deposit. To the west, the RBIC consists of gabbro, troctolite, and breccia in a subvertical sheet that contains the Ovoid and the Western Extension deposits. The mineralized segments of the RBIC are described below.

# MEETINGS, WORKSHOPS & FIELDTRIPS

### January 1998

28 - 30 **Exploration Methods 98 - *Pathways to Discovery.*** Hotel Vancouver, Vanc. BC. Sponsored by the BC&YCM, SEG, BCGSB and GSC. Special version of **Cordilleran Roundup**. Contact: BC & Yukon Chamber of Mines, Tel: 604-681-5328; FAX: 604-681-2363; Visit Pathways98 on the web: http://www.eos.ubc.ca/pathways98

31 - Feb 7 **The California Gold Rush Fieldtrip**. Mother Lode District & Southern California Desert. Sponsored by MDD-SEG-BCYCM. Contact: Dani Alldrick, MDD Fieldtrip Coordinator, Tel: 250-952-0412; FAX: 250-952-0381; Email: dalldrick@galaxy.gov.bc.ca.

### March 1998

8 - 11 **Prospectors & Developers Annual Meeting**. Toronto, Ont.

15 - April 8 **Australia-Tasmania Fieldtrip**. Sponsored by MDD-SEG-BCYCM. Tour organizers John Thompson, Dick Hutchinson & Dani Alldrick. Contact: D. Alldrick, MDD Fieldtrip Coordinator, Tel: 250-952-0412; FAX: 250-952-0381; Email: dalldrick@gems6.gov.bc.ca.

### April 1998

13 - 17 **7th International Kimberlite Conference.** Cape Town, SA. Pre & Post field trips. Contact: James Gurney, 71KC, Dept Geological Sciences, Univ. of Cape Town, PB, Rondebosch 7700, South Africa. FAX: +27-21-650-3783; E-mail: 71KC@geology.uct.ac.za; Visit the website at: http://www.uct.ac.za/depts/geolsci/71KC/

### May 1998

18 - 20 **Mineralized Porphyry-Skarn Systems - Short Course.** Quebec City, PQ. Immediately prior to GAC/MAC Annual Meeting. Contact: Dave Lentz, NB Geological Survey, Box 50, Bathurst, NB, E2A 3Z1. Tel: 506-547-2070; FAX: 506-547-7694; E-mail: dlentz@gov.nb.ca.

### June 1998

June 29 - July 2 **IAGOD/CODMUR 8th International Platinum Symposium.** Johannesburg, SA. Field excursions and technical meeting. Contact: Dr C.A. Lee, PO Box 68108, Bryanston 2021, South Africa. Tel: +1-2711-411-2253; FAX: +1-2711-692-3693.

### August 1998

**10th Auadriennial IAGOD Symposium,** Broken Hill, Australia. Contact: Prof I. Plimer, Dept of Geology, Univ of Melbourne, Parkville, Vic 3052, Australia. Tel: +61-3-344-6520; FAX: +61-3-344-7761; E-mail: ian_plimer@muwayf.unimelb.edu.au

### September 1998

22-25 **International Meeting Of Gold Exploration And Mining In Nw Spain**. Facultad de Geologia, Oviedo, Spain. Contact: Secretary Daniel Arias Prieto, Facultad de Geología. Universidad de Oviedo, C/ Arias de Velasco s/n, 33005 Oviedo, Spain. FAX 34-8-5103087; Email: darias@asturias.geol.uniovi.es

### April 1999

11 - 16 **19th International Geochemical Exploration Symposium.** Hotel Vancouver, Vancouver, BC. Contact: Venue West Conference Services Ltd., Tel: 604-681-5226; FAX: 604-681-2503; E-mail: congress@venuewest.com.

### Future GAC/MAC Meetings:

May 18 - 20, 1998 **Quebec 98** - Quebec Congress Centre, Quebec City. Contact: Mme Agathe Morin, Laval University, Sainte-Foy, PQ, Tel: 418-656-2193; FAX: 418-656-7339; E-mail: quebec1998@ggl.ulaval.ca; WWW: http://www.ggl.ulaval.ca/ quebec1998.html.

May 1999 **GAC/MAC 1999** - Sudbury

May 2000 **GAC/MAC 2000** - Calgary

## Further Discussion Re Gold-Pyrrhotite Veins, by D. Alldrick, T. Hoy (Gangue #55, Feb' 97) and D. Rhys (Gangue #56, may 97)

*By Andris Kikauka, GeoFatts (AKA Geofacts), Sooke, BC*

Actually, GeoFatts is a typographical error which appeared on correspondence from Revenue Canada, but the name is catchy and I enjoy billiards.

With reference to the article, replies and discussions on Rossland, Stewart and Iskut mesothermal Au veins in recent issues of Gangue, I wish to commend all of the authors for their contributions to a better understanding of high-grade gold vein systems in BC. I would like to add some additional comments:

**Johnny Mountain's** Zephrin Zone is a NW trending, steeply dipping fault containing abundant K-feldspar, crushed remnants of sub-vertical dipping quartz-carbonate-sulphide veins and post-ore horizontal quartz-sulphide veinlets. The Zephrin Zone offsets the NE trending, steeply dipping "Discovery and 16" Cu-Au-Ag-Pb-Zn-As-Bi bearing quartz-sulphide veins. The notable feature of the Zephrin Fault is that gold occurs in silicified zones with increased K-spar adjacent to and within ore zones. K-spar staining indicates that higher grades of gold correlate directly with increased K-spar. A positive indicator for higher precious metal grades in the quartz-carbonate-sulphide veins are coarse blebs (2-5 mm) of chalcopyrite. It is worthy to note that several Pb-ZN-Ag showings occur in close proximity to the Au bearing veins.

There is very little surface outcrop exposing the **Snip** Twin Zone, but the original Cominco showing was examined in 1984 (3 years before any drilling took place), and the consensus, of those who looked at the showing, was that the high grade portion of the vein system was narrow. Clues suggesting that the vein had a 1000-metre strike length and could be traced 250 metres down dip were: the presence of an air photo lineament along the surface trace of the vein system; the presence of moderate to strong carbonate and K-spar alteration; and, the implied genetic relationship to the nearby Red Bluff Cu-Au-Ag alkalic prophyry. Drilling by Delaware Resources in 1987 quickly put the Snip deposit on the map.

Examination of airborne magnetometer data flown in the vicinity of **Scottie Gold** shows a variety of high and low anomalous readings in the area of the mine. The generally complex magnetic response lends itself to the fact that there are numerous faults and alteration zones within this area and suggests that geophysical surveys such as mag or EM, require specific individual interpretation for each target. A good example of this is a mag high located southwest of Scottie Gold, which was drilled and produced a thick, visually impressive intersection of massive and sem-massive pyrrhotite. However, base and precious metal values were low.

Exploration of the **Inel** Au-Ag-Cu-Pb-Zn prospect located 3 km SE of Johnny Mtn. initially concentrated on the main gossan known as the "central zone", which consisting of an en echelon swarm of gold bearing sphalerite-pyrite-chalcopyrite hosted in quartz-carbonate fissure veins. These veins rarely exceeded one metre width and 0.3 opt Au. About 700 metres north of the central zone, a Au-Ag-Cu bearing quartz-sulphide vein system returned 1 opt Au across several metres. The AK zone was located along the margin of a steeply dipping, NW trending syenite dike.

The above examples illustrate the necessity to treat each project with an open perspective. In order to evaluate high grade Au vein deposits, an inventory of geological, geochemical and geophysical data should be compiled and interpreted to apply procedures which lead to deposit definition.

Jan. '98

# SNIP MINE — AN UPDATE

**Mark J. Brown**

Cominco Ltd., Snip Operations, Bag 9000, Smithers, B.C. V0J 2N0

The Snip mine, which is operated by Cominco on behalf of a joint venture between Cominco Ltd. and Prime Resources Group Inc., is in northwest British Columbia on the Iskut/Stikine River system 80 km east of Wrangell, Alaska. Snip is a high-grade underground gold mine producing 470 tonnes per day, and employing 135 people on a fly-in (28 days), fly-out (14 days) basis. Labour-intensive mining methods include conventional jackleg cut-and-fill, mechanized cut-and-fill, as well as some shrinkage stoping. The metallurgical plant is a straightforward gravity/flotation operation producing doré metal and a pyrite-gold concentrate which is treated off site. The operation is faced with many challenges, including operating on the banks of a major salmon-spawning river system, and constraining costs in a remote location. Difficulties in transportation logistics are met by use of freighter hovercraft, supplemented by aircraft support.

## INTRODUCTION

Exploration of the area dates back to the late 1920s, although intensive exploration of the Snip claims only began in 1986. The name is derived from the nearby prominent Snippaker Mountain. At the end of 1989, the decision was made to develop the high-grade, narrow-vein, underground deposit, with construction of the conventional gravity/flotation concentrator and other facilities commencing in June 1990. Mine production by cut-and-fill methods began the following January at the initial design rate of 300 tpd, increasing to the present rate of 470 tpd.

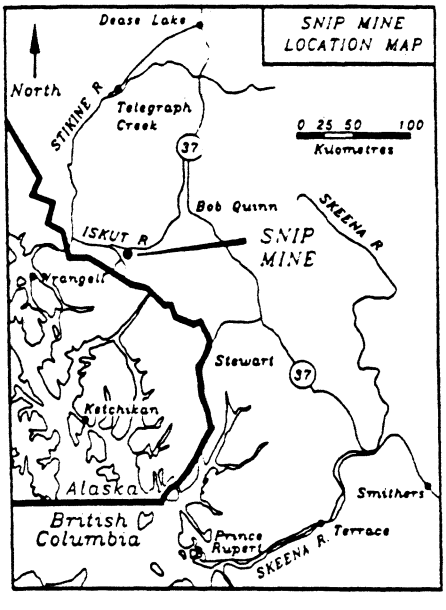
Snip has approximately four years of production remaining in the presently delineated ore zones. The 15,000 kg (500,000 oz) production milestone was recently achieved. An active underground exploration program continues to add mineable tonnage to reserves, while surface programs seek to discover new orebodies.

## GEOLOGY AND EXPLORATION

The Snip property is underlain by a sequence of Triassic feldspathic greywackes, siltstones, and mafic tuffs. The main orebody, called the Twin Zone, is a 0.5- to 15-m-thick shear structure filled with quartz-carbonate-sulfides, within the greywacke unit. Gold primarily occurs as finely disseminated grains along pyrite grain boundaries. Other sulfides within the Twin Zone include pyrrhotite, chalcopyrite, and sphalerite, with traces of arsenopyrite.

The vein structure has been traced over a strike length of 1,000 m, has a known vertical extent of 500 m, strikes at 120°, and dips southwest at 40° to 60°. For most of its length the vein occurs in two parts, separated by a post-mineralization fine-grained basic dyke, hence the name "twin."

Secondary narrow high-grade footwall vein structures at a strike of about 150° have been discovered by mine development and infill drilling over much of the mine area. Mine planning is complicated by cross-cutting faults which offset the veins. The orebody subcrops to surface over half of its strike length. An inferred ore reserve of 940,000 tonnes grading 28.5 g/t Au, inclusive of an assumed 20% mining dilution factor, was used for feasibility-study purposes in late 1989.



## MINING

predominant method used at Snip, but a few stopes dip steeply enough to permit
wider parts of the orebody, an electric–hydraulic single-boom jumbo drills flat
uck the ore to an orepass on the level. Stope cleanup is done with a 1-yd³ LHD
Generally, development waste is hauled into the stope for backfill and then
voids. A cap is poured, providing a level surface for mining the next lift.
rebody, conventional hand-held drills are used to drill flat breasts or uppers.
stopes is slushed to bolted section steel mill holes, which are raised along with
uring hydraulic sandfill for the next lift. The first, or undercut lift of both
is backfilled with a reinforced cemented fill, called a sill mat, which permits
ed as the stope below approaches the sill mat.
rately good although the highly jointed basalt dyke in the middle of the orebody
mechanized areas, cable bolts and 6-m super Swellex bolts are used to pre-
g is done with 2.4- or 3-m split-set bolts installed with either a scissor bolter

occasionally be well-defined, but usually the presence of small stringer veinlets
y boundary between ore and waste. Stope limits in a horizontal sense are also
nder geological control, although occasionally stopes can be fault-bounded.
logists, both on day and night shifts, which has resulted in overall mining
e pre-production estimate of 20%.
footwall of the orebody direct these materials to Norcast chutes on the 180-m
km down to the 130 portal, and then 0.5 km to the ore-dump grizzly at the
cks haul waste as required to the mill for the production of supplementary

iston diaphragm pump on the 180-m level takes a flow of hydraulic sandfill
np located at the concentrator and lifts it to the 440-m level.
s at the 130-m portal, and travels up the main spiral ramp, from which it is
ust-air raises at the end of mining levels discharge to the two primary exhaust
with two 100-HP fans, and the other at 420 m is equipped with two 75-HP
d with 6 million BTU/h diesel-fired heaters required for temperatures below

## CONCENTRATOR

sts performed on ore samples taken early in the exploration program indicated
g. The initial flowsheet called for a conventional cyanidation/Merrill-Crowe
ing about 96% overall recovery. However, the proximity of the plant to the
reated considerable difficulty in designing safeguards to contain the cyanide. In
le compromise to eliminate the possibility of cyanide escape and accept an
using the more benign gravity/flotation gold-milling process. In addition to the
concentrate haulage by aircraft and hovercraft costs an incremental $1 million
t capital costs were reduced by elimination of the cyanide circuit, the cyanide
d containment facilities.
concentrator was purchased as the nucleus of the mill. It had been designed as
fabricated, truck-size, process-equipment pods: these were hauled to a remote
Northwest Territories, and were assembled and commissioned in about a two-
er throughput rate at Snip, a new 24" × 36" jaw crusher, 4¼′ SH cone crusher,
to the front end of the mill. Some of the modularized concept was retained,
section, whereas the balance of the used equipment, consisting of gravity tables,

flotation banks, regrind mills, cyclones, doré furnace, thickener, filter, and pumps, was designed into a new 540-$m^2$ building shell.

The finely disseminated gold ore requires a fine grind (80% minus 200 mesh) for acceptable flotation recovery, and consequently only about 30% of total throughput is coarse enough to make acceptable hydraulic sandfill for the mine. A separate circuit was installed in the concentrator, using the original 7′ × 7′ ball mill, to grind and classify waste rock to provide supplementary sandfill as required by underground stoping cycles. The sandfill plant incorporates a 750-tonne sand-storage bin and a 150-HP, 900-psi GEHO piston diaphragm pump which moves 31 $m^3$ per hour of slurry at 65% solids 1,500 m horizontally and 65 m vertically to a relay station within the mine.

As throughput increased from 350 to 470 tpd, the disc filter lacked capacity to produce concentrate of acceptable moisture content; thus, a used Larox filter was added to make a product with a 7 to 8% moisture content. Other fine tuning has increased the gravity-circuit recovery by nearly a half to 35%, which combines with a flotation recovery of 56%, for an overall 91% recovery. This is based on a throughput rate of 470 tpd, at a grade of just under 30 g/t for 1993. The very clean concentrate typically grades 320 g/t Au and 150 g/t Ag.

Tailings are pumped 2.2 km to an 11-ha tailings pond at the head of a valley located below the mine workings in the mountainside. The pipeline enters one portal of the mine and exits another to avoid an avalanche/rockslide area on surface. Tailings water, along with run-off into the pond, is seasonally decanted directly into a small water course, called the Monsoon Creek/Lake system, which discharges into the Iskut River. During summer, evaporation and pond seepage are greater than in-flow. Discharge-water quality limits are set very conservatively, are monitored frequently, and have not been exceeded since startup.

## SUPPORT FACILITIES

A four-bay maintenance shop with separate electrical, hydraulic rebuild, and machine-shop areas is located in a multipurpose building alongside the warehouse, change-room facilities, and assay lab. Administration and technical offices are located on the second floor.

A four-unit, 3.4-mW diesel-generating plant is located in the concentrator building. An attached cooling system heat-recovery plant is able to heat the mill, service building, and the 170-person accommodation complex except on the coldest winter days, when supplementary boiler heat is added to the glycol delivery system. All buildings are completely sprinklered, that system being fed from a 3,375,000-L water bladder by a stand-alone high-pressure pump which starts automatically when a drop in pressure is sensed.

## TRANSPORT

A 1350-m gravel airstrip was constructed in 1988, 0.5 kilometre from the present Snip plant site. It served as the base for over a dozen different exploration projects in those active years up to 1990, and accommodates planes up to the size of a Lockheed C-130 Hercules. Snip construction in 1990 required three one-week Hercules mobilizations for earth-moving equipment and construction materials.

Rugged mountainous terrain and sporadic foul weather combine to produce a uniquely hostile operating environment for aircraft. The airstrip can be approached only in daylight visual conditions; winter fogs have prevented landings for periods of up to five and occasionally seven days.

An amphibious hovercraft was purchased in 1990, and was converted from its 77-passenger configuration to an open-deck freighter with a rated capacity of 10 tonnes under sea-going conditions with up to 2-m waves. The Iskut River is a braided system with many separate channels which change with rapid erosion effects and blockages by snags and trees. It is not navigable even by an outboard motor boat with conventional propeller, but the hovercraft is capable of flying over gravel bars, shallow water, and ice and snow. Its practically undetectable impact on the environment had been well-demonstrated at various places in the world, including the heavily populated Isle of Wight region in the United Kingdom, the environmentally sensitive Gold Coast and Brisbane areas in Australia, and the Canadian Arctic coastline along the Beaufort Sea. The Canadian Coast Guard uses the same make and model of hovercraft on the St. Lawrence River and its tributaries, as well as smaller units on the west coast.

This mode of transport was judged to create a much smaller impact on the environment than the other option of constructing an 80-km Class 5 logging road from Bob Quinn on Highway 37. Given the relatively small projected annual concentrate production of around 6,000 tonnes, and the fact that a used hovercraft was immediately available for moving the larger concentrator modules during the construction period, the decision to purchase the hovercraft made economic sense as well. The hovercraft can carry 20 passengers and has been used for crew rotations when planes are grounded, as well as the occasional medevac to Wrangell.

At present, the hovercraft operating season is from March to November, making two round trips per day to Wrangell, or four to a staging area on the navigable Stikine River. In winter, short daylight hours and difficult ice conditions make the hovercraft uncompetitive compared to a charter DC4 for freight hauls.

## ORGANIZATION, PERSONNEL

The 135-person operation is self-contained, with procurement, accounting, and personnel services on site. All employees work a rotation of 28 days on site, followed by 14 days at home, with transportation provided to any airport in British Columbia, as well as Calgary and Edmonton, Alberta and Whitehorse. Yukon Territory. Weekly charters provide service directly from Vancouver, Smithers, and Dease Lake/Telegraph Creek.

Work schedules are 10 hours per day, 7 days per week. The standard 2- to 4-week annual vacations enable employees to add to the 2 weeks "out" for substantial holidays. The operation runs through Christmas, with somewhat reduced crews. Those employees scheduled to work during this period are encouraged to bring spouses and children to the site at company expense for what is generally regarded as a very special week. A number of cabins used during the exploration phase were modernized to self-contained guest cottages, which employees are able to use during the summer for visiting family who are offered partly subsidized air tickets.

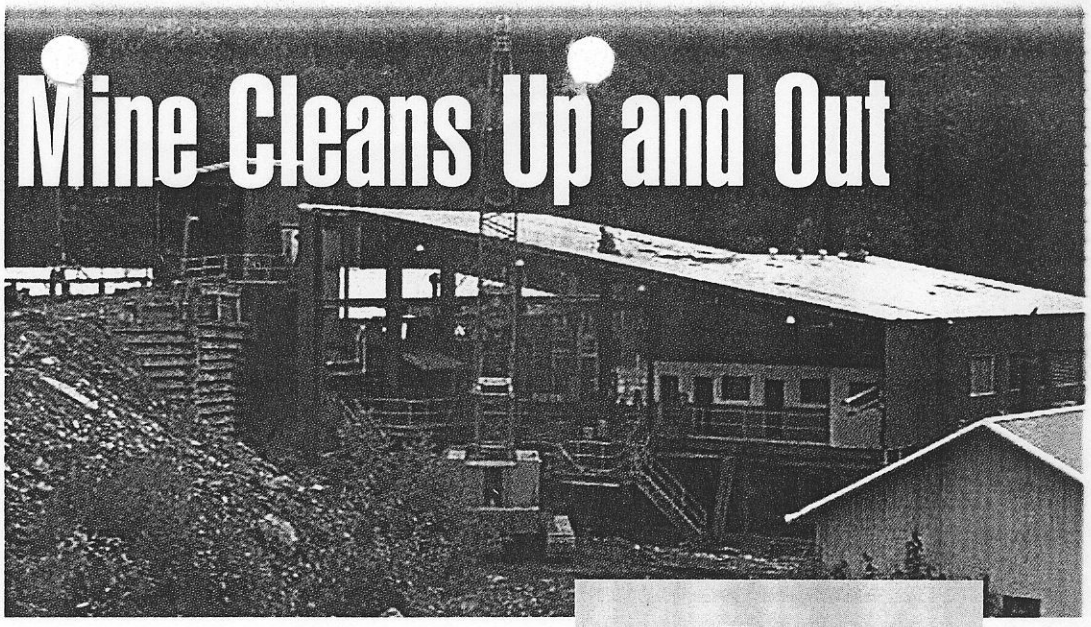
Primary accommodation is in a two-floor complex centred around kitchen/dining room with TV and reading rooms on the second floor. The two bedroom wings have a total of 170 small single rooms and adequate common washroom and laundry facilities on each floor of each wing. A selection of satellite TV stations is available, and most employees have their own TV and personal phone in their rooms. A separate building 50 m from the accommodation complex includes a well-equipped exercise and weight-training gym, hot tub, games rooms, and a bar/lounge area which is used for a variety of social activities as well as occasional company meetings. The Bronson Creek Social Club, with a membership of 135, operates the bar at a modest profit from which some of the social club furnishings, as well as outdoor-games facilities and a nicely equipped woodworking/hobby shop were funded. Highly skilled volunteer labour is readily available for such after-hour projects such as building an outboard jet-pump-driven aluminum fishing boat.

The mine was set up as a non-union operation, with hourly-rated employees being offered a benefits package comparable to the staff package. The nominal work year is about 2,400 hours; standard overtime rates are paid because the underlying philosophy is to make the jobs attractive to high-calibre employees who are willing to give up normal home life for a few years in return for significant earnings. Employee turnover since startup, including company inter-operation transfer, has averaged 12% per year.

# Snip Gold Mine Cleans Up and Out

## Reclamation right on schedule for fall exit

by Grace Golightly



After nine years of high-grade gold production, the Snip Mine is undergoing a speedy, perhaps even record-breaking, demolition and reclamation project.

During production, Snip Gold Mine was one of B.C.'s highest-grade mines, averaging 400-500 metric tons per day.

"The end result came out around 25 grams a ton (0.8 opt) for the life of the mine," mine manager Tom Colbourne reports.

"In the early years, the grade was typically above an ounce per ton. Even right up till the end, we were still maintaining around three-quarters of an ounce."

The mill used a flotation process to remove most of the finer gold and some of the sulphides, and an on-site gravity circuit enabled the company to pour bullion to recover the remaining 40 per cent of the gold.

"The concentrate was around 20-25 tons a day of flotation con that was flown either by aircraft or by hovercraft out to Wrangell, Alaska, our nearest ocean port.

"The mine made money, right from the beginning to the last brick we poured here. Costs over the last couple of years were around $200 US per ounce – which is pretty good considering it's a fly-in operation."

Situated about 30 km above the confluence of the Stikine and Iskut Rivers, and 100 air miles northwest of Stewart, B.C., the mine was built and run without road access.

A hovercraft was employed from 1990 to 1996 during the years Cominco ran the mine, to move heavy freight, like structural steel, and to remove concentrate.

Colbourne explains that a road was considered at various times during the life of the mine, but was considered uneconomic for the amount of ore.

While a road would certainly speed up the shut-down process, he acknowledges, reclamation is still moving at a respectable rate, and so far is right on schedule.

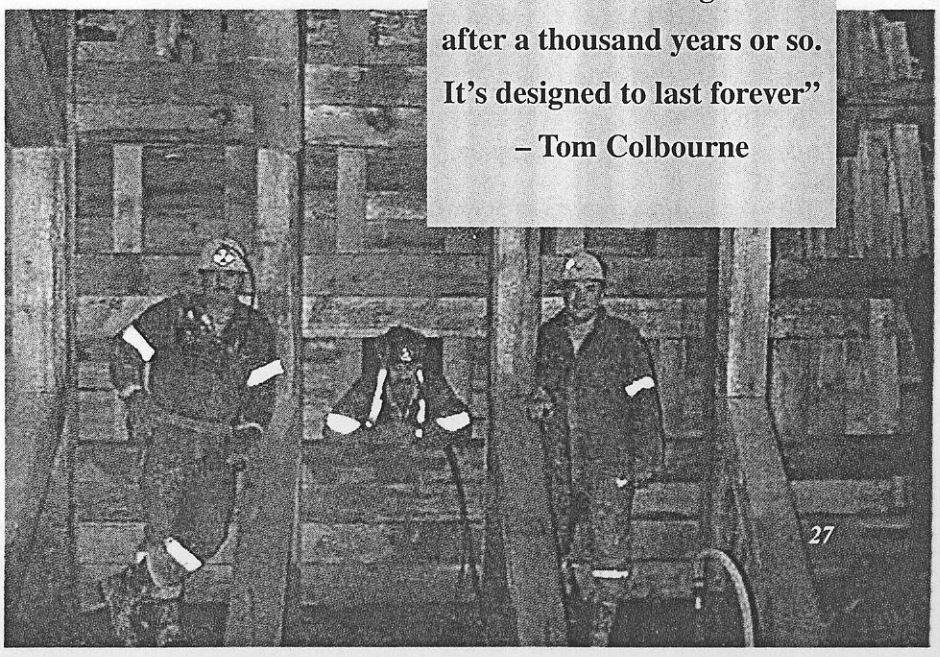
The mill, which was working up till June 14, was torn down within just two months, and Colbourne hopes to have everything else torn down, demobbed and resloped within four months.

"The speed at which we're moving is a little more than most companies would use," he says. "We have a time constraint based on getting this stuff out by air, before the weather gets iffy in early October."

**"The speed at which we're moving is a little more than most companies would use."**

Without a hovercraft, remaining structural steel will be buried on the site. But most of the large items can be moved out on the giant Hercules aircraft. The aircraft can carry up to 45,000 pounds – big enough to man-

**"There's nothing to rust after a thousand years or so. It's designed to last forever" – Tom Colbourne**



age the articulated trucks required for earth-moving.

"Sourcing the trucks and getting them here in one piece was an interesting project," Colbourne recalls.

Only Volvo trucks could fit in the aircraft, they found. But special wheels made in Sault Ste. Marie were needed, so the trucks could be driven right onto the plane.

Closing up the mine has also required some ingenuity, since 90 per cent of it is underground and it ascends the side of Johnny Mountain.

"The workings are all from 180 metres to about 600 metres up in the side of the mountain," Colbourne says, while the camp itself is only about 110 metres above sea level.

Consequently, only about half the mine can be flooded. Plans call for the insertion of concrete plugs to limit air flow.

"We've done one already, it's about 20 feet of concrete," he adds. "It's a special mix that's sulphate-resistant and shrink-resistant. There's no steel in it, so there's nothing to rust after a thousand years or so. It's designed to last forever."

Colbourne says there's some concern that the backfill and some of the exposed surfaces could potentially generate acid, but ongoing tests show no indication of this occurring in the near future.

"In the meantime, we're going to flood as much of the workings as we can. The plugs will flood the lower level – from 130 metres up to 300 metres. Above that will still be open, but we're plugging all the portals. We've also done work on the surrounding wall rocks to ensure that the seepage around the plugs is within the limits that we can tolerate," he adds.

The tailings pond, which holds about a million tons of tailings in an 11-hectare area, will be covered with an inert rock liner.

While testing has shown the tailings themselves are not currently acid-generating, sulphur levels suggest the potential could exist at some point in the future.

"We're providing a saturated environment for the tailings, below the rock cap, and it's designed so the tailings will remain saturated even though there won't be any water in the pond itself," Colbourne says. "So no oxygen will be available for oxydization to happen."

Two tailings dams are being "beefed up" to ensure they'll hold in case of a one-in-a-thousand-years design earthquake.

Once demolitions are completed, covered with earth and seeded with grass, and natural vegetation has time to encroach, Colbourne says the only visible evidence of the mine from the air will be the flat surface of the 800-metre by 130-metre tailings pond, and the air strip.

"That's about all that will remain. Everything else is going to be recontoured and planted.

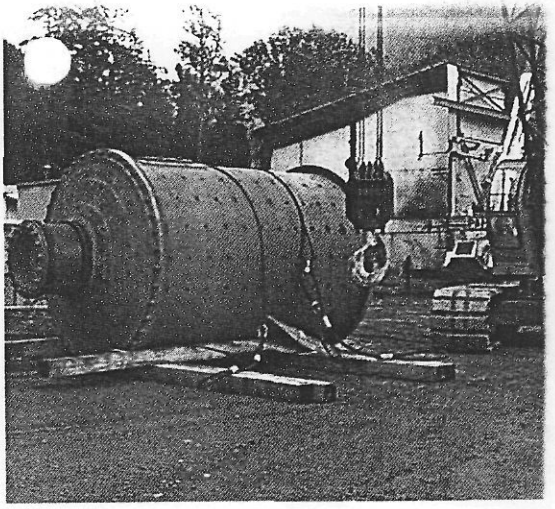
Local growth is quite prolific – we're down pretty low and get lots of rain, so it doesn't take long for the natural vegetation to take hold."

The company is applying for a permit to leave the mile-long air strip as an emergency landing strip. Colbourne doesn't foresee a problem, since the nearby Eskay Creek mine is still in operation, and the Snip mine itself will also require periodic checking.

"We'll be monitoring groundwater, water exiting the mine, water running through the tailings and pond, if there is any, other creeks in the area – the receiving waters will be monitored," he says. "And also the vegetation and growth. We'll be monitoring for several years after we're gone."

Colbourne is optimistic that reclamation will be complete by mid-October, largely thanks to a smooth permitting process.

"We've had excellent cooperation from all the ministries involved, as well as the Tahltan Nation and the other stakeholders in the area, to let us get going so quickly."



## Reply to Discussion by David Rhys

→ SNIP

*by Dani Alldrick and Trygve Hoy, BC Geological Survey*

David Rhys completed his M.Sc. study of the Snip mine in 1993. His professional career has been particularly focused on intrusion-related gold deposits, including work as an exploration geologist at the large Red Mountain deposit and as a consulting geologist at the Johnny Mountain mine and at properties within the Rossland mining camp. His comments reflect extensive experience with this deposit type and we welcome these contributions. His willingness to share important proprietary company data is particularly appreciated.

The typical pattern of debate generated by development of new ore deposit models - a general agreement on the geological features, but strongly divergent interpretations - is reversed here. Rhys acknowledges a general agreement with the deposit classification and with the interpreted genetic association with a highly specific, localized, and time-constrained geologic setting, but points out inaccuracies with a number of facts used to develop the interpretive model. These differences are in part due to the hasty preparation of our report; additional figures would have done much to ensure clearer communication.

Some of the apparently contradictory evidence presented in these two articles derive from observations made during different periods. BCGS studies of the Scottie Gold, Johnny Mountain and Snip mines were completed between 1982 and 1989. During this period Scottie Gold mine opened and closed (1981-1985), Johnny Mountain mine went from surface trenching (1982) to production (1988-90), and Snip mine evolved from an exploration target to underground exploration developments for pre-production feasibility studies. David Rhys' work on these deposits began in 1991, shortly after the opening of the Snip mine.

In 1989, the deposits at the producing Johnny Mountain mine consisted of four veins plus the Zephrin zone, a mineralized fault zone. The Victoria vein, then known from two drill intersections, was little more than a gleam in Paul Metcalfe's eye. Changes to names of mineral zones is an unusual problem that is also related to the different periods of our sequential studies. At Johnny Mountain mine, the term "Zephrin" has changed in name, character and location over the life of the mine. Discovered during a 1987 surface drilling program designed to located an offset vein, drill core recovered a highly disrupted, foliated and mineralized fault zone - the fault which offset the two parts of the vein. At this time, and up to initial underground development and production from the zone (1989), this mineralized and relithified fault material was termed the Zephrin zone. As Rhys indicates, it was subsequently discovered that the eastward continuation of the vein was a relatively small fault-bounded block, and the term "Zephrin" was then re-defined, re-located and re-applied to this adjacent fault-bounded vein segment, the Zephrin vein.

Geologists should be familiar with, and should be prepared to make allowances for, the variability in textures, mineralogy and modal abundances for observations and samples acquired in different parts of an ore deposit. There are unavoidable limitations to mapping and sampling within a 'mined-out' deposit, and the reported differences in the abundance of pyrite in the quartz veins at Johnny Mountain mine may be an important indication of an inverse relationship between pyrite and gold abundance, since the higher pyrite contents reported by Rhys were documented after the mine ceased production.

Johnny Mountain hosts: two "Intrusion-Related Gold ± Copper" vein systems or sets (Johnny Mountain and Snip mines); a recently discovered, large porphyry copper-gold deposit (Bronson Slope); and a small but significant molybdenite-bearing skarn. Rhys correctly points out that no hotspring-type deposits are known on the mountain. However, the regionally distributed continuation of the distinctive felsic volcanic package that underlies the Eskay Creek ore deposits ("shallow exhalative" or "shallow subaqueous hotspring" deposits) are exposed at higher elevations on Johnny Mountain. Given the geological setting of intermediate to proximal facies volcanic rocks and their coeval subvolcanic pluton documented at Johnny Mountain, and the presence of this regionally prospective felsic volcanic horizon - and recognizing that exploration programs are sometimes designed to target a single deposit type - we repeat our recommendation that "the exploration focus must be expanded to include the search for porphyry, epithermal, skarn and hotspring deposit types" in any exploration program conducted on Johnny Mountain.

A cross-sectional sketch or clearer description from us would have eliminated the need for a discussion that derives from the unusual form of the Twin vein at the Snip mine. We failed to indicate the scale over which gradational changes in vein mineralogy occur. The Twin vein, dipping at an average of 50° and split lengthwise down the middle by a post-ore dyke, has "upper" (shallower mine levels) and "lower" (deeper mine levels) parts when viewed on the large scale (entire mine scale), but also has "upper" (hangingwall vein segment) and "lower" (footwall vein segment) parts when viewed on the small scale (individual mine level scale). The large scale geometrical relationships and the quartz versus sulphide distributions which vary strongly over the full extent of the vein (Alldrick and Hoy), are not evident on a smaller scale as Rhys indicates.

Rhys' observation that the highest gold grades at the Snip mine have come from well-sheared calcite+quartz+chlorite+biotite+pyrite veins is followed by a comment that the Twin vein has a potassic alteration envelope and the implication that propylitic alteration is absent. A further evaluation of these concepts could be useful.

Everyone interested in understanding and exploring for these deposits needs to know why magnetometer surveys over the pyrrhotite-rich parts of both the Johnny Mountain and Snip mines yield no discernible magnetic signature if the pyrrhotite is strongly magnetic. The recent discovery of important early magnetometer surveys of the Rossland Camp is described as information which has been established in exploration for over forty years. Since these maps have been stored in the archives of Cominco Limited for decades, they could also be described as "long-forgotten" with equal accuracy.

We thank David Rhys for his thorough review and comments on our article, and hope that readers are better informed about this new deposit model because of the time and effort he has invested in preparing his discussion. We extend our invitation to work together to prepare a joint paper which will be more comprehensive and satisfactory to both readers and authors.

# Comment on "Intrusion-Related Gold-Pyrrhotite Veins" by Dani Alldrick and Trygve Hoy, The Gangue, Issue 55, February 1997

*by David A. Rhys, Pantera Geoservices Inc., Surrey BC*

The recent article by Alldrick and Hoy discusses a small, although economically significant, group of gold deposits in British Columbia that are of similar age and character. Although I agree with the classification of these deposits as a distinctive group, and with the general conclusion that they are spatially and genetically associated with subvolcanic Eary Jurassic intrusions, there are numerous errors in the deposit descriptions which could have adverse affects on explortion. The discussion presented here is intended to correct only factual errors, and does not attempt to address further fundamental theoretical problems with the structural geologic setting and style of the deposits that are proposed in the article.

The four deposits - Rossland, Snip, Johnny Mountain and Scottie Gold - are described as massive pyrrhotite-pyrite or bull quartz veins, with pyrrhotite as either the dominant mineral or the most abundant sulphide. However, pyrrhotite is rare in economic veins at Johnny Mountain and is subordinate to pyrite (approximately 6:1 pyrite:pyrrhotite) at Snip (Rhys, 1993). Gangue minerals at Snip (calcite, quartz, chlorite, biotite) account for approximately 75% of the veins there, while quartz at Johnny Mountain comprises 20-80% of the veins. Thus, the name proposed for this set of deposits as "gold-pyrrhotite veins" is not accurate for two of the four deposits. Since copper (from chalcopyrite) was an important by-product of the mining at Rossland (approximately 1%) and Johnny Mountain (0.4%), and chalcopyrite is common at Snip, a more suitable name may be "Intrusion-Related Gold ± Copper Veins".

Individual descriptions by Alldrick and Hoy of the veins at Snip and Johnny Mountain convey several inaccuracies, which include:

1. Three, not four, parallel veins occur at Johnny Mountain. These are (i) the 16 vein, and its displaced continuations (the Zephrin and Discovery veins), which together produced 90% of the ore, (ii) the Pickaxe - Gold Rush vein, from which minor production occurred, and (iii) the unmined Victoria vein;
2. Average sulphide (pyrite, with minor chalcopyrite and sphalerite) content in economic veins at Johnny Mountain, although variable along strike, is significantly greater than suggested, and is generally between 15 and 60%;
3. Johnny Mountain is not a "hotspring-type" deposit, although a typographical error at the end of the second paragraph on page 9 alludes to this;
4. Multiple faults displace veins at Johnny Mountain, and displaced segments of vein between faults have been mined, but at no time was any stope developed on lithified fault gouge, as has been suggested by Alldrick and Hoy;
5. At Snip, the "closely overlapping veins" are not different structures, they comprise a single shear vein that is cut down its centre by a post-mineral dike that locally splits the vein into two separate portions, hence its name the "Twin Zone". Another vein, the 150 vein, splays off the footwall of the Twin Zone and has provided about 20% of the ore at Snip, but it was never considered part of the Twin Zone.
6. There is no difference in the ore above and below the dike in the Twin Zone at Snip (their 'upper' and 'lower' veins), as is suggested by Alldrick and Hoy. Ore on both sides is composed of laminated calcite-chlorite-biotite shear veins and subordinate quartz-pyrite ± pyrrhotite veins;
7. Although gold grades are high (commonly >60% g/t) in sulphide-rich veins, the highest gold grades at Snip have come from low sulphide (<2%), chlorite-rich vein material with pink calcite tinted by fine-grained biotite;
8. In reference to the statement in 'Economic Factors' on page 10, Snip is not the largest gold producer in British Columbia; it was surpassed by Eskay Creek two years ago.

Perhaps the most glaring error to exploration geologists is the assertion by Alldrick and Hoy that these veins are characterized by strongly anomalous magnetometer lows due to (i) the ubiquitous presence of non-magnetic pyrrhotite, and (ii) the destruction of magnetite in the propylitic envelopes to the veins.

In actual fact:

1. At Snip, Rossland, and where present at Johnny Mountain, pyrrhotite is *strongly magnetic*.
2. The alteration envelopes to veins at both Snip and Johnny Mountain are potassic, and characterized by the presence of biotite, K-feldspar, and pyrite, and locally disseminated *magnetite*. Magnetite is also present in veins at Snip, Johnny Mountain and Rossland (Drysdale, 1915).
3. Where magnetite surveys have been conducted over veins at Snip, Johnny Mountain and Rossland, veins either have no discernable magnetic signature or produce *positive* magnetometer anomalies; Veins at Rossland and Johnny Mountain also appear as positive linear anomalies with Fraser filtered VLF-EM data.

In closing, a point that was briefly mentioned by Alldrick and Hoy deserves further elaboration, and may provide an important exploration tool. One of the best exploration guides for vein deposits of this type is camp scale metal and alteration zoning. For example, at Snip, vein systems are zoned from Au ± Cu -rich shear veins with potassic alteration envelopes proximal to a porphyry Au-Cu system (the Red Bluff porphyry system) to Zn-Pb enriched veins with phyllic alteration more distal to the porphyry (Rhys, 1993). A similar metal zonation occurs at Rossland, where Zn-Pb enriched veins are also peripheral to the Au-Cu bearing veins (Thorpe, 1967). Individual veins may also display lateral or vertical zonation of metals that mimics that developed at the camp scale (*e.g.*, Johnny Mountain). At both Rossland and in the Snip-Johnny Mountain areas, deposits occur within broad contact metamorphic aureoles comprising widespread, pervasive disseminated bitotite and/or calcsilicate skarn alteration. Composition of associated intrusions may also be genetically important; at all four deposits, associated intrusions range in composition between quartz diorite, monzodiorite and granodiorite.

With so few deposits of this type known, care must be taken when generalizing to distinguish common features from the specific features of each deposit, and not to ignore the latter. A deposit type definition has limited usefulness if it does not accurately portray the characteristics of the deposits that it has been made to represent, and may as a consequence misguide exploration. The four significant deposits of this type that are currently known in British Columbia occur over a broad geographical range, and the abundance of potential host volcanic and intrusive rocks of Early Jurassic age in the Cordillera suggests that other deposits of this type may be found elsewhere in the province.

## Acknowledgments

I thank David Yeager of International Skyline Gold Corp. and Peter Lewis of Lewis Geoscience Services Inc. for their comments and suggestions.

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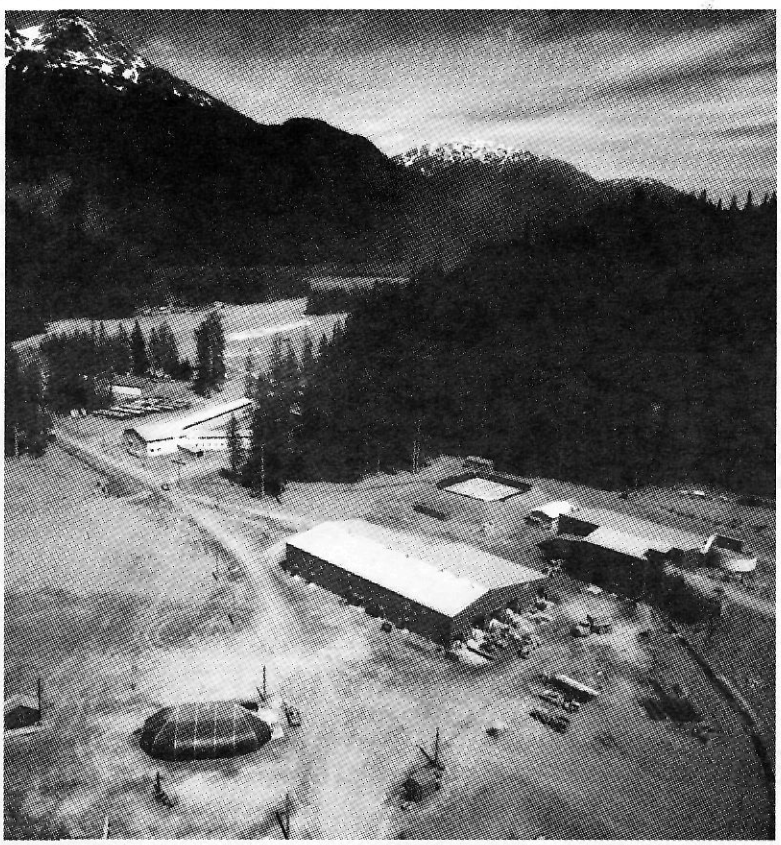
# SNIP SNIP HOORAY!

*Remember the gold mine failures in the 1980's?*

*Well, after a lot of head-scratching Cominco created a success story at Snip.* **By David Scott, P. Eng.**

The Snip mine, with Cominco as operator, produced 149,475 oz. of gold in 1993 at a cash cost of US$152 per oz. (excluding depreciation, amortization and reclamation accruals). Located 100 km northwest of Stewart, in the Iskut River region of British Columbia, the mine is jointly owned by Cominco (60%) and Prime Resources (40%) (Through a 50.6% interest in Prime, Homestake Canada holds a 20.2% direct interest in gold production in the mine.) It's performance has placed it in the upper-tier of low-cost gold producers — a ranking the mine is likely to retain for its remaining life of 4-5 years.



Cominco Ltd.

Iskut Valley isloation.

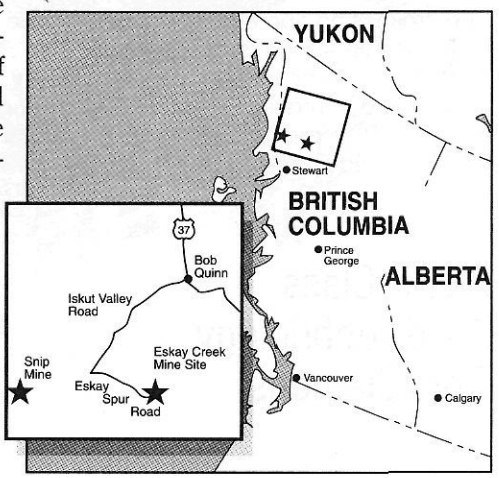
Snip's high-grade outcrop was discovered by Cominco's Ted Muraro in 1965, when gold was trading at US$35 per oz. But it wasn't until the 1980s, when gold was above US$400 that intensive work began. Nevertheless, by 1987, and despite comprehensive diamond drilling, surface trenching and a 300-tonne bulk sample, Cominco still remained uncertain of the validity of its reserve estimates. Proving continuity and establishing grades and tonnages of vein-type deposits is often problematic. As Terry Hodson, Snip's chief geologist told *Canadian Mining Journal* on a recent site visit, "Spectacular gold values are not difficult to find in the Iskut camp."

Reg Davis, one-time president of Skyline Explorations, whose property adjoins Cominco's, said the same thing more colourfully when he quipped, "There's so much of that yellow stuff on Johnny Mountain, even the marmots have gold teeth." Unfortunately there was a second part to Hodson's observation relating to "spectacular values," "...finding sufficient of them close enough together to make an orebody is the problem." The truth of that was proven by Skyline. Gold values faded between one drill hole and the next. Ore reserves projected to be good for five years were depleted in two because continuity of gold mineralization was lacking.

To validate Snip's then indicated ore reserves once and for all, Cominco drilled the orebody off on an unusually tight, 12.5-metre grid in 1989. Reserves were confirmed at 943,000 tonnes grading 28.6 grams gold per tonne (0.92 oz. per tonne) and the decision to go into production was made. Stope development began in 1990, with the mill and camp constructed over a 7-month period. Production started in January, 1991, at a milling rate of 300 tonnes per day (which rose to 468 tonnes in 1993) at a capital cost of $65 million.

A trackless operation, Snip is entered by two adit-ramps, the portals of which are at 130- and 180-metre elevations. Two other portals at 300- and 420-metre elevations serve as ventilation exhausts. The mill and camp are at the 110-metre elevation.

The 180 level was initially considered as the mine's principal access, but the probability of avalanche and hazardous driving conditions in a snow-bound valley in winter pronounced the location unsuitable. An alternative area was found 500 metres from the mill at the 130-metre elevation.



The ramp is driven upgrade at 6%, terminating at the 180-metre level (all level designations are approximate). It transports all men, material and underground sevices and taps the mine's main ore and waste passes. Trucks drive directly from the chutes to the mill.

While the 130 level was being driven, mine development proceeded from the 300 level. A 15%, 4x5-metre-wide ramp opened mining levels at 40-metre vertical intervals. The lowest is 220 and the highest (at present) is a 480 sublevel. Most tonnage mined to date has originated from stoping between the 260 and 420 levels.

All mining is by flat-back, cut-and-fill (C&F) methods. Shrinkage stoping was tried initially but was found unsatisfactory as too much high-grade ore was locked in diverging structures and vein loops which could not be retrieved without unconscionable dilution.

Stoping is carried out in two modes: the first, by "conventional C&F" whereby a stoper-jackleg and slusher are used for flat dips and mining widths of up to 3 metres; the second, by "mechanized C&F" in which a single-boom drill jumbo and load-haul-dump machine are used for widths of 3-12 metres.

The former produces 40% of mill feed; the latter, 60%. There is negligible "development ore."

## STOPES

Conventional stopes are opened by two crosscuts collared in the 3x4-metre-wide footwall drive. One serves as the mill-hole access for the life of the stope while the other is a short-lived manway that breaks through two manually driven open raises to the level above. These are 1.5x1.5-metre openings. As the dip of the vein is frequently less than 50°, the raises are often driven up the line of full-dip.

A mechanized stope is opened from a minus-20° ramp fanned upwards to keep pace with the mining of each new stope lift. When the ramp reaches an inclination of plus 20°, it is backfilled and abandoned. Stoping is then resumed from a new ramp access started from the footwall-drive at the next highest elevation.

Footwall development is ideal for stope-definition drilling. Cominco attaches considerable importance to drilling; the density of intersections in the Twin zone is now comparable to that resulting from the drilling at 12.5-metre spacings in 1989. The structure's area is much larger than was previously thought, yet intersection density is essentially the same — one intersection per 215-225 sq. metre (in the plane of vein).

Drill data of this order is viewed as the key to clean mining. It may also be the only means of ensuring cost-efficient production from narrow, ramifying, high-grade mineralization.

Most stope-definition drilling is done by the short-hole, relatively portable Bazooka drill. The drill cuts a 21.5-mm core and most holes are fewer than 25 metres long.

In 1993, drilling was carried out about 15,000 metres underground — two-thirds of which was classified as stope-definition, with the remainder being conventional exploration.

The narrowest minable width for conventional C&F is 1.5 metres. A single 2.4-metre lift is drilled off by stoper, blasted, mucked out and backfilled. The cycle is then repeated. Application of small, CAVO-type loaders might seem appropriate (at a small increase in width), but the low dip of the hanging-wall reduces headroom to the minimum. Only scrapers are effective. Most are 1-metre-wide hoes powered by 2- or 3-drum, 10-30-hp air or electric tugger hoists.

Mill holes are circular, 1.1-metre, I.D., custom made from 2-piece segments of reinforced, 7.9-mm steel plate. Heavy-duty construction is necessary. A given mill hole will eventually extend 40 metres or more to the upper lifts of a stope. It will necessarily slope at a low angle and be fitted with one or more more fabricated bends to conform to changes of dip. Abrasion and impact are

**Snip** *Continue[illegible]m p.19*

unusually severe.

There are no mill holes in mechanized stopes. A Tamrock, Minimatic, single-boom, electro-hydraulic jumbo (the mine has two) drills 3-metre flat holes and blasts a 3.5-metre high breast. Depending on the circumstances, a section of the breast adjacent to the hangingwall may be blasted and bolted first, or the full width taken at once. Broken ore is hauled directly to the ore pass via the stope access-ramp.

The mine has five JCI scoops — one 125M, two 250M and two 400M machines (1.25, 2.5 and 4 cu. yds., respectively). One JCI 1504 truck (with a 15-tonne capacity) is used for the routine haul to the mill on the 130 level. A second is in general mine service.

Support in wide stopes is by 2.4- and 3-metre Splitsets, with 3-6-metre Super Swellex bolts used occasionally. High backs are reached by a MacLean scissor-bolter. Elsewhere,

## Snip Snapshot

Triassic greywackes and siltstones underly the Snip property. These are intruded by an early-Jurassic porphyry stock of quartz-diorite composition hosting low-grade copper-molybdenum mineralization.

But it is the genetically associated shear belts that are of interest to the gold miner. The Twin zone is the largest gold orebody discovered to date and is so named because of a 1-2.5-metre lamprophyry dyke which divides the mineralization in two. A shear zone, it ranges in width from 0.5 to 12 metres and averages 3 metres. The unmineralized dyke weaves from wall to wall of the shear and follows the same strike, cutting off values and locally forming blocky ground in areas that are usually strong and competent.

The Twin zone's oreshoot strikes 120°, with a vertical and horizontal extent of about 300 metres, dipping south at 40-60°. The western extremity outcrops on the steep slopes of Johnny Mountain and bottoms near the 220-metre elevation, at which point the shear passes from massive greywackes into a package of thinly layered, greywacke siltstones and fades out.

The shear appears to weaken to the east where there is a change in alteration mineralogy. The area is little-explored and is now the focus of underground diamond drilling.

A number of erratic intersections encountered during drilling of the Twin zone have led to the discovery of the 150 zone. The structure diverges from the Twin zone on strike, dips south at 60-80° and consequently diverges along the dip. Width varies up to 3.5 metres and averages about half that figure.

The 150 zone, as well as several *en echelon* veins in the intervening country, have proved to be significant sources of ore, with reserves replacing 75% of the ore mined to December, 1993, from Twin zone stopes.

Snip's mineralization is anastomotic. Hydrothermal solutions selected particular zones of micro-fracturing within the shear to create a braided, interconnected network of mineralization within the fractured rock mass. Mineralizing solutions also course through secondary fractures, divergent from the average strike, depositing high-grade gold values in *en echelon*

1.8- and 2.4-metre splitsets are common, and mechanical bolts of the same sizes are used in small-dimension jack-leg headings. Shotcrete is used where the Twin zone's internal dyke gives indications of developing loose ground.

As much as 75% of the mine's waste rock remains underground where it is used as backfill for mechanized stopes. Coarse waste is distributed in the stope by load-haul-dump machine and truck, roughly levelled and then saturated with hydraulic fill. Filling is continued until a flat, regular surface, about 0.3 metres thick, forms over the rock fill, while leaving 1.5-metre open spaces between the sand fill and back. The sand cap retains gold cuttings and rapidly compacts into a level working floor.

Surface water is decanted via a drain tower. The 1.2x1.2-metre drain tower is progressively raised, with the fill using 15x15-cm framed lumber. (A small saw mill is operated by the company on the surface.)

The layout and narrow widths of conventional stopes preclude utilization of rock backfill, and 100% hydraulic fill is the rule. Unlike mechanized stopes, fill preparation entails wrapping the drain tower and mill hole with a filter membrane (usually burlap cloth backed by

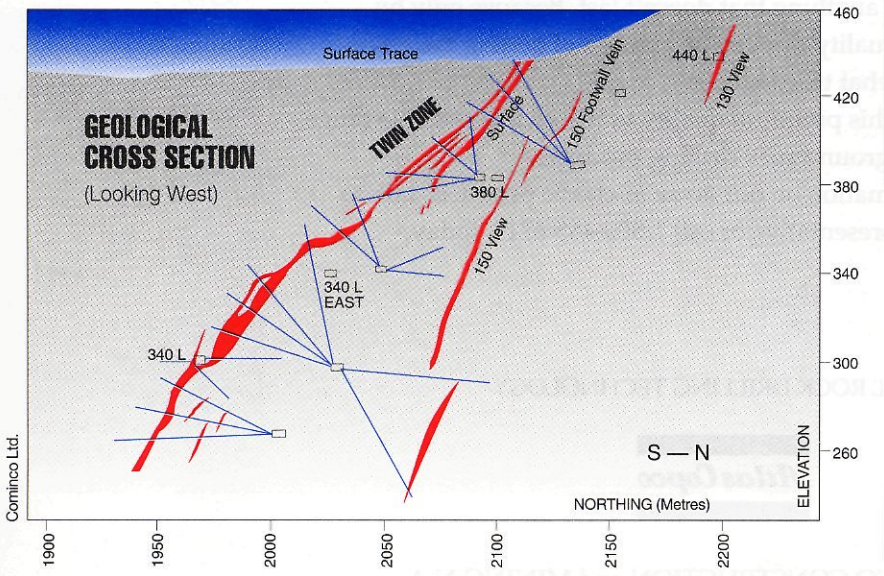
lenses, vein loops and other diverse structures. But beyond the limits of shearing, assay values drop off abruptly.

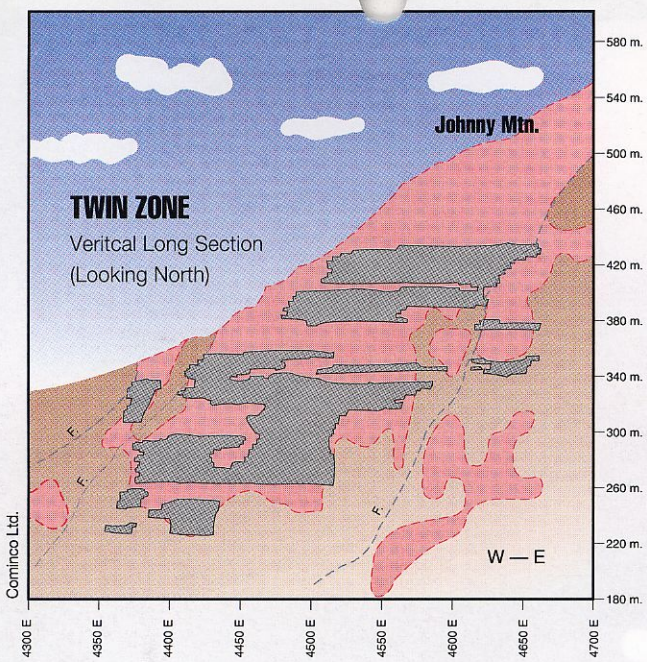
Despite a gold recovery of 40% by gravity concentration, most of the metal is finely divided. In fact, 47% of it is less than 25 microns (500 mesh) in size. On the other hand, observation of the Deister shaking table revealed a fraction as being noticably flat, scaly fragments of metal measuring up to 1 mm and more. The gold-silver ratio for bullion smelted from gravity concentrates is 4-to-1.

Disseminated pyrite and subordinate pyrrhotite occur in a laminated assemblage of calcite, chlorite and biotite, with insignificant zinc and copper sulphides also occuring. Each metal usually returns less than 2% in assays of the bulk flotation concentrate. Massive sulphide and so-called "bull" quartz occur only sporadically in the zone, but diamond drilling indicates they may be more prolific at higher elevations.

Although galena was noted on the Deister table as a narrow strand, it barely registers in the concentrate assays. Wall-rock silicification carries K-felspar alteration and the same earthy minerals minerals as the ore. While the mine rock is acid-consuming because of its carbonate content, it is environmentally benign. **CMJ**

**Reference:** RHYS, D. A. "GEOLOGY OF THE SNIP MINE". M.Sc. THESIS, UBC, VANCOUVER, OCTOBER, 1993.






chicken-wire mesh). Short stopes may be mined without a drain tower, drainage being effected by plastic pipe (sewer tile) laid along the length of the stope.

At the end of the mucking cycle, scraper operators control the amount of fill delivered to the mill hole (plus entrained gold values) by referring to a horizontal datum painted on the stope walls by the mine's surveyors.

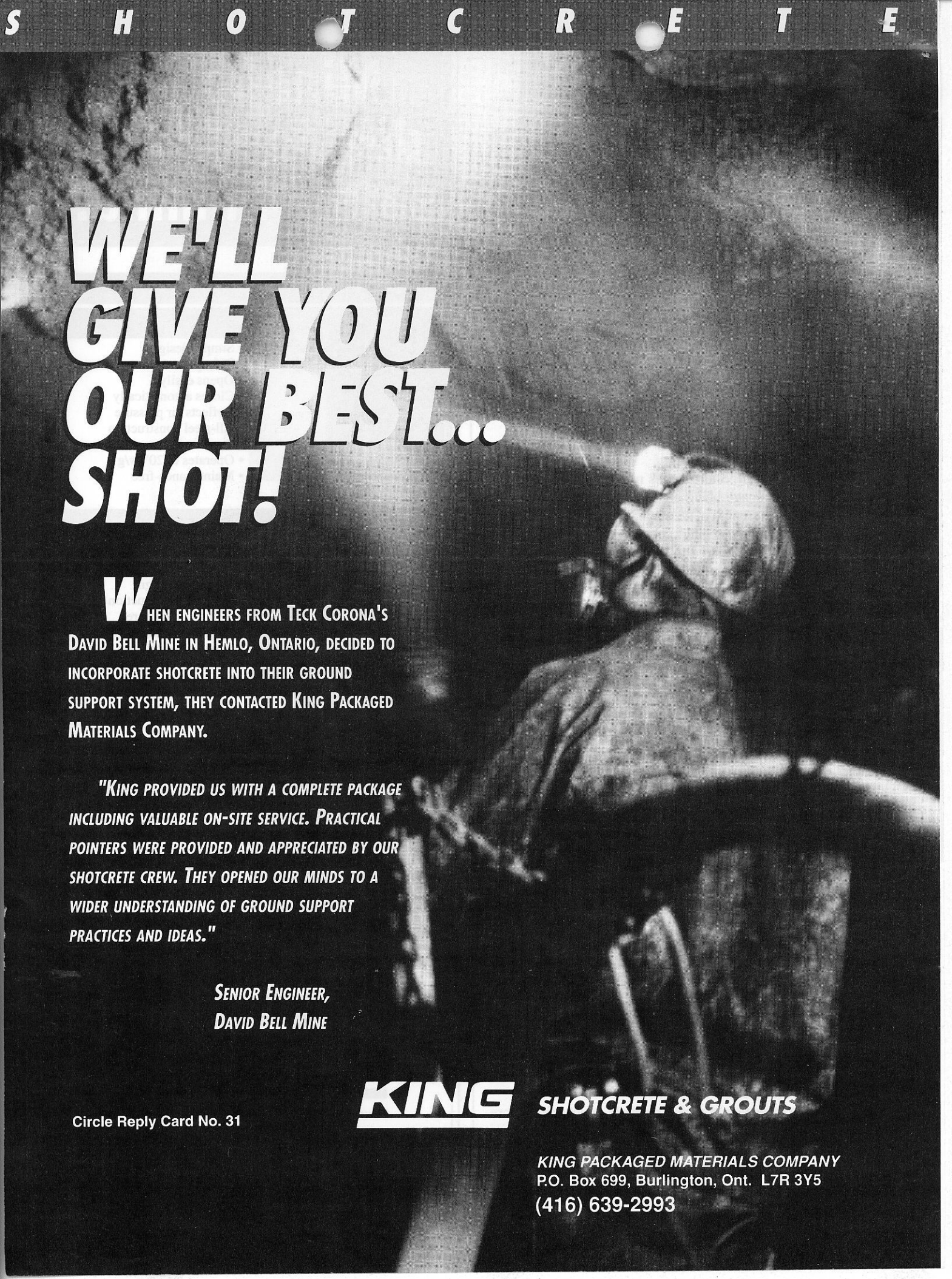
A sill-mat is the first step in stope preparation when a stope is planned to break through into the one above. It comprises a 1.5-metre (or greater) thickness of hydraulic fill bound into concrete-like slab by 6 to 8:1 sand-fill cement mix. The whole is reinforced and tied into the stope walls by a lacing of tensioned wire cable.

## A CANADIAN FIRST?

The mine's hydraulic fill system may well be a Canadian first. Fill slurry is pumped uphill. Two identical GEHO pumps in series deliver 20 tonnes per hour at 55%-65% solids. One is in the mill; the other, 1.6 km away at the end of the 180 level. Each is driven by a 112-kW motor developing a maximum pressure of 6,210 kPa (900 lbs. per sq. inch). Vertical head for the mill pump is 60 metres; the size of the underground in-series unit varies according to the stope being serviced. The highest stope is at 420 metres, indicating a static head of 240 metres.

The percolation rate of the cycloned tailings averages 9 cm per hr. Only 25-30% of the tonnage milled is sufficiently coarse to meet these specifications; and to compound the shortfall, stope filling is cyclical. Thus, filling the stope may take a relatively short period of time, but a continuous, heavy flow of fill must be maintained if the stope is to be returned to production quickly. A dedicated waste-grinding circuit makes up the deficiency of coarse sand to an extent, but some delays in the fill cycle are inevitable.

With the exception of a high-recovery gravity circuit, ore processing is conventional. A sulphide concentrate is produced by bulk flotation and assays 200-300 grams per tonne. Concentrate production approximates 5% of tonnage milled



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and is "megabagged" in lots of 1,630 kg. The greater part was shipped to Japanese smelters until recently. Now, a significant tonnage is delivered to Westmin Resources, near Stewart B.C.

The gravity circuit has been modified continually since startup, with recovery having improved from 20% to 40%. The circuit comprises a 2-compartment Yuba jig which delivers a continuous hutch concentrate to two No. 6 Deister tables in parallel. The jig is in closed circuit with the primary mill and cyclones, treating the full ball mill flow. Table concentrate carries about 45% metal, which is smelted and cast on site.

Overall mill recovery, including gold contained in concentrates, is 91-92%.

## TRANSPORT CRITICAL

Snip is a remote operation. Bulk supplies are barged from Seattle, Vancouver or Prince Rupert to Wrangel, Alaska, then trans-shipped the final leg by aircraft (105 km) or hovercraft (120 km). There are 135 on the payroll, as well as 12-17 others employed by catering and surface drilling contractors. They commute by charter aircraft from Vancouver and Smithers on their 4-weeks-in/2-weeks-out schedule.

There is no powerline to the mine. Diesel fuel accounts for 75% of the 5,400 tonnes of annual, inbound freight. Four 12-cylinder Caterpillar 3500s-1,100 kVA generator sets make up the power plant. Waste heat from the diesels is recovered by a glycol system and supplies most of the space and water heating requirements of the mill and camp for all but the coldest months.

Mine ventilating air also requires heating during two of the coldest months. Two indirect air heaters are fired by diesel fuel. Both heaters and the mine's main 134-kW fan are at the 130 portal.

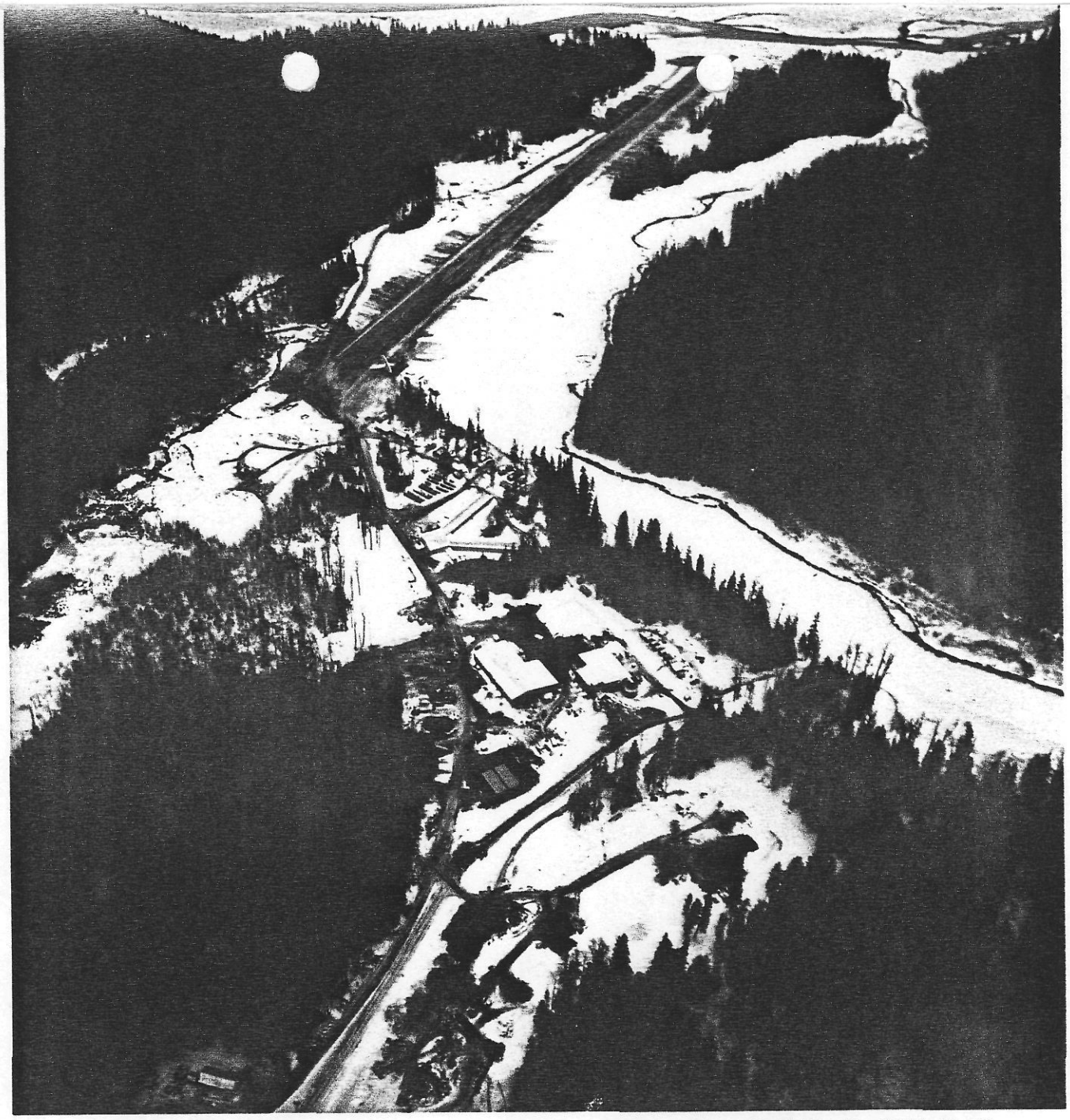
Outbound freight is almost exclusively flotation concentrate and approximates 9,000 net tonnes annually.

One DC-3, a DC-4 and a single AC 188-400 Hovercraft serve the mine. About 45% of the total freight haul is attributable to the Hovercraft.

Cominco originally expected to employ the Hovercraft year-round. However, following trials during the inital winter season, it was concluded that operation of the hovercraft was practical from April through October only. While the Hovercraft can levitate one metre or more above ground-level, abrupt changes in ground topography are difficult to negotiate. Pressure ridges in river-ice and ice build-up on deadhead logs constitute such obstacles and both are commonplace after freeze-up.

Icing of the craft's underbelly was also a problem. The craft measures 24 metres in length, by 9 metres and 1.25 metres greater around the periphery when the skirts are pressurized. Four Deutz Diesels provide power, two for flotation and one for each of the two 3-metre diameter, 1,360-kg thrust aircraft propellers. Under good operating conditions, the trip from the mine to Wrangle can be made in under 2.5 hours, at 52 km per hr.—or, as Hovercraft personnel would prefer, 28 knots. **CMJ**

**References:** PROUDFOOT, R. V. & MORRISON, T. A. "BACKFILLING AT COMINCO'S SNIP MINE, BRITISH COLUMBIA". C.I.M. UNDERGROUND OPERATORS CONFERENCE, SASKATOON, 1993.



# SNIP'S FIRST YEAR IS A SUCCESS

## Cominco's newest gold mine keeps production high and costs low

**Russell A. Carter,** Western Editor

**The airstrip** and Y-shaped bunkhouse dominate this aerial view of the Snip property. The mine's mill and support facilities lie at the foot of Johnny Mountain in northwestern British Columbia.

The blip on the radar screen could have been a rock or a snag. As the vessel veered left and emerged from the fog shrouding the broad river, the contact proved to be a lone Indian fisherman, standing in a small aluminum boat anchored in midchannel. The massive white hovercraft speeding downriver ten yards away barely earned a glance over his shoulder as he tended his nets.

Cominco's Hover Freighter has become a common sight on the lower reaches of British Columbia's Iskut and Stikine rivers as it ferries concentrates from the Snip gold mine to Wrangell, a fishing village on Southeast Alaska's Pacific coast. Snip, a 60:40 venture of Cominco and Prime Resources Group, lies in a narrow mountain valley where Bronson Creek enters the Iskut, 60 mi from Stewart, B.C.

In this rugged area dominated by the Coast Mountains and covered with dense evergreen forest, roads are almost nonexistent. The overcraft and air freighters get the mine's concentrates and bullion to market.

Apart from its remote location, other aspects of the $C65-million Snip operation are notable. It's Cominco's first Canadian underground mine to open since the Polaris mine began operations, and it is the company's first mine in British Columbia since startup of Valley Copper (now Highland Valley Copper). It's an underground mine, but the direction of mining is upward from 180 m above sea level to the upper reaches of the orebody inside Johnny Mountain.

Despite a trend toward lower gold prices during 1991-1992, Cominco reported that its newest mines—Snip and Cominco Resources International Ltd.'s Maria copper mine in Mexico—contributed significantly to earnings and cash flow in 1991, a year in which the company as a whole lost more than $C41 million after posting a profit of $C54.8 million in 1990.

## GATHERING INTEREST

Production at Snip began in January 1991 following decades of intermittent exploration by various parties on and around Johnny Mountain. Cominco staked claims in the area as early as 1929, but the most significant find occurred in 1965 when company geologists discovered the orebody's outcrop on the western slope of the mountain.

Cominco's interest in the find blew hot and cold throughout the 1960s, '70s, and early '80s. Claims were staked, allowed to lapse, and restaked. Cominco even tried unsuccessfully to unload the property in the mid-'80s. Delaware Resources Corp., later acquired by Prime, purchased an option on Snip in 1986 and conducted surface drilling and underground sampling between 1986 and 1988.

Cominco took back the property in 1988 and continued underground exploration. Encouraging results led to expansion of the site's airstrip and further construction of crew facilities to accommodate the area's rising level of activity.

Despite extensive drilling, sampling, and underground development carried out prior to and during 1989, Cominco had concerns about the exact nature of the ore reserves and decided to delay a production decision until more data was available. The deposit, originally diamond-drilled on 25-m centers, was redrilled at 12.5-m spacing; the results of the drilling program prompted Cominco to reduce the ore reserve tonnage figure by more than one-third, yet boosted the average ore grade by 0.29 oz/mt.

The company also encountered delays in obtaining necessary operating permits because of its initial choice of processing methods. Cominco originally planned to use the Merrill-Crowe process to recover 96-97% of the gold values contained in ore, but environmental concerns and the prospect of permitting delays over the use of cyanide in close proximity to major waterways (Bronson Creek empties into the Iskut River, which joins the Stikine River near the coast) eventually forced the company to switch to less controversial gravity separation and flotation techniques. The gold recovery target was subsequently revised downward to 91%.

With these obstacles overcome, the project moved forward rapidly. Construction began in May 1990 and was completed on December 15. The mill was commissioned in mid-January 1991 and achieved its designed production rate of 300 mt/d six days later, fed by several thousand tons of stockpiled development ore.

There were few startup problems, according to Snip operations manager Merlyn Royea; miners found the ore tonnage in the stopes that was predicted by reserve calculations, and the mill has consistently operated at 15-20% above design capacity since June. More importantly, noted Royea, "The mill heads have been within 3% of predictions, and our cash production costs have stayed below $200 per ounce."

Cominco reported early in 1992 that the mill's overall gold recovery averaged 91.1% during its first year of operation, rising to 92.2% in the fourth quarter, and also noted that the project had exceeded planned production rates since startup and had been profitable at current gold prices.

## NO SURPRISES

The absence of unpleasant surprises during mine infancy was a definite plus for Cominco. So was the nature of the orebody—a compact, high-grade vein system that can sustain mining at current rates for 8 to 9 yr. Lack of sufficient ore, among other probems, doomed Snip's nearest neighbor, the 350-st/d Johnny Mountain mine operated by Skyline Exploration, to closure in 1991.

The Snip orebody resides in a sequence of Triassic, feldspathic greywacke, siltstone, and mafic tuffs. Sediments generally strike east to west and dip variably to the north. The property's principal mineralization, the Twin Zone, a sheared quartz-carbonate-sulphide vein that ranges from one-half to 15 m wide. The vein is divided along most of its length by a fine-grained basic dike. The dike, which varies in width, splits the vein from top to bottom and its blocky nature causes occasional ground-control problems.

The Twin Zone has been traced by drilling for 1,000 m, and has a vertical range of 500 m. The vein strikes at 120° and dips southwest at 30° to 90°. Typically, the steeper dip occurs toward the bottom of the orebody, flattening out at the top. Reserves are estimated at 800,000 mt grading 0.83 oz/mt of measured and indicated ore, with an additional 170,000 mt of inferred ore grading 0.77 oz/mt.

The orebody, which remains open at depth and to the east, contains three distinct ore types: streaky quartz ore consisting of quartz, calcite, green biotite, and sulphide laminae within strongly sheared greywacke; crackle quartz, composed of shattered quartz veins infilled with green mica and disseminated sulphides; and massive sulphide veins containing mostly pyrite and pyrrhotite.

The mine was developed by driving adits into Johnny Mountain at the 180- and 300-m levels to intercept the Twin Zone. A 15%-grade, spiral footwall ramp connects the mine's main levels, and drifts are driven at 40-m intervals from the ramp into the ore zone. Two additional adits were developed to facilitate access, the most recent being a 1-km-long, 6% inclined haulageway at the 130-m level which provides a safe, internal truck route to the mill free from the dangers of avalanches and other wintertime hazards. A portal at the 420-m level provides external access to the mechanized stopes in the upper sections of the orebody. The ramp and haulageways are 3 m high and 5 m wide.

Mining methods include conventional shrinkage and cut-and-fill in a half-dozen stopes in the narrow, lower portion of the orebody, while mechanized cut-and-fill is carried out in three stopes in the wider section between the 380 and 440 levels. Stope dimensions in the mechanized mining areas average about 100 m in length and 40 m high.

The underground workforce numbers approximately 40, consisting of three twelve-man mining crews, plus supervisors. The mine operates on a two-shift-per-day basis, with ore haulage and crushing conducted on one shift only. Each miner works a 10-hr shift seven days a week for four weeks, then is given two weeks off and free transportation to and from the remote minesite.

Mechanized mining stopes employ trackless equipment that includes two Tamrock HS-105 single-boom jumbos and two 4-yd³ JCI scoops. Conventional mining areas use handheld jackleg and stoper drills, air and electric-powered slushers, and 2-yd³ scoops.

An ore pass terminating at the 340 level serves the upper mechanized portion of the mine. Another ore pass between the 340 and 180 levels is controlled by pneumatic gates to allow loading of the mine's two 15-mt-capacity JCI trucks, which haul ore from the 180 level down the ramp and out the 130-level portal to the nearby mill.

Rock bolts and Split Set stabilizers in 6- and 8-ft lengths are installed on 1.5-m centers in the back, hanging wall, and footwall as required, with the shorter bolts used in development headings and the longer units in the conventional stopes. Straps and screening are used to control the blocky dike material that splits the vein. Ten-ft-long Split Set stabilizers are installed in the mechanized stopes.

Because of the compact nature of the high-grade orebody, the reserves are divided into a large number of small blocks to avoid leaving massive sill pillars vertically between stopes, and cemented sill mats are built at the bottom of each stope to reduce ore wastage.

Preparation for placement of the sill mat involves stringing cables from the hangingwall to footwall in the wider stopes, or rebar in narrower stopes, followed by welded wire mesh, then cemented fill mixed at a ratio of 6:1. Mat thickness varies from 1 m in narrow stopes to 1.8 m in wider areas. The sill mat is then covered with backfill and topped with a 6-in.-thick cemented cap in a series of lifts as the stope is mined out.

The backfill is composed of classified tailings, pumped back into the mine by 25-mt/hr Geho pumps in the mill and on the 180 level. The mill pump is a constant-speed device and the mine pump is variable-speed. Cement is added to the backfill at a batching station near the mine pump. Both units are designed to pump up to 65% solids by weight and typically operate at a 20-mt/hr rate.

Fine grinding is required to liberate most of the gold particles in the ore, and the resultant tailings are not completely suitable for backfill; after processing, only about 30% of mill feed is of sufficient particle size to allow adequate drainage as backfill. Since the mine's productive capacity depends on how quickly stopes can be put back into production after backfilling, a separate waste-grinding circuit was added in the mill to provide additional material. Waste grinding is carried out as a batch operation when heavy backfill requirements deplete the classified tailings contained in a 450-mt-capacity storage tank. The mill-generated fill is also augmented by placement of development waste rock as additional fill material.

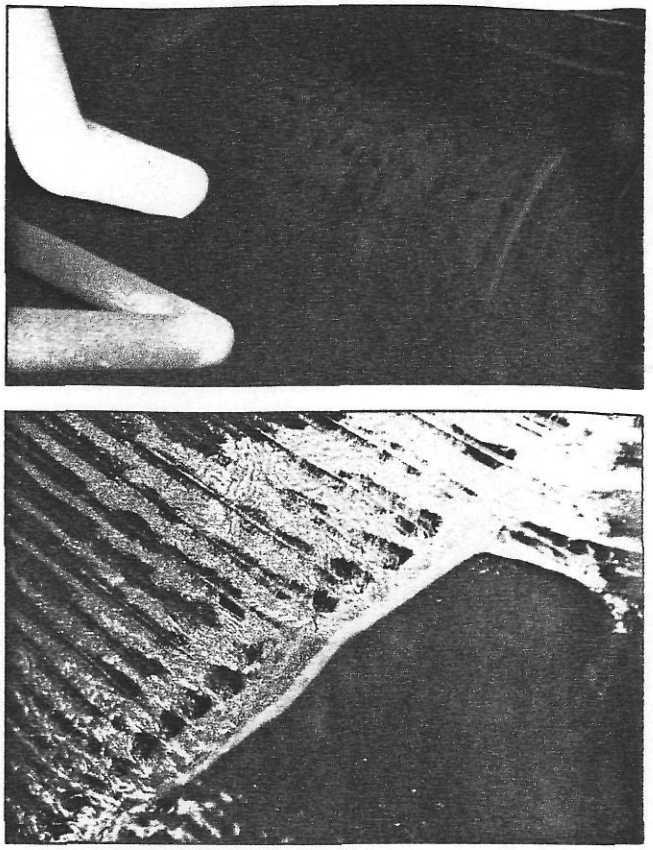
Tailings that are unusable as fill are pumped through a pipeline that runs from the mill, into the 130-level haulage tunnel and out the 180-level portal, then down a culvert to the valley-floor impoundment.

## COMPACT CONCENTRATOR

The Snip concentrator, purchased from a defunct Northwest Territories' mine, is comprised of 14 modules each measuring 10 × 10 × 40 ft. The compact mill, originally rated at 200 mt/hr, included gravity and flotation circuits; Cominco added a larger gravity table and expanded capacity to 350 mt/hr by installing jaw and cone crushers and an 8 × 12-ft ball mill. The modules were erected inside an enclosed structure built by Cominco adjacent to the mine.

The gravity circuit captures about 20% of recoverable gold in the mill feed. The gravity product is processed into doré bullion on site. The flotation section recovers another 70%, producing about 5,000 mt/yr of concentrates. The mill processed 122,600 mt of ore in 1991 and averaged 361 mt/d throughput. Cominco's 60% share of gold in concentrates and bullion amounted to 65,500 oz.

The filtered concentrates are loaded into heavy-duty, synthetic-fiber bags for transport on the cargo deck of the hovercraft during the 60-mi trip downriver to Wrangell, Alaska, then offloaded to a larger ship for delivery to a Japanese refinery via the port of Vancouver.



**An 8 × 12-ft ball mill** (top) and larger gravity table were Cominco's improvements to boost mill capacity to 300 mt/d. The gravity separation circuit (bottom) captures about 20% of recoverable gold.

The hovercraft can carry a payload of 25,000 lb and provides a vital supply service for the mine, carrying diesel fuel and cement on the return trip from Wrangell. The other connection with the outside world is the site's 1,500-m-long airstrip, adequate for air freighters and smaller planes. The strip is the only valley-level facility of its kind in the area and is used to support numerous exploration and mining camps throughout the region.

During winter, when low-water conditions on the Iskut River pose a safety hazard to the hovercraft, concentrate and supplies are shuttled by air, mainly on lumbering, '50s-vintage Bristol transports that bear the marks of previous campaigns dating back to the Berlin airlift.

There is no other access route to the Snip property; although a road is nearing completion which connects an existing provincial highway with the Eskay Creek property 25 mi southeast of Snip, Cominco has determined that the cost of extending the road to Snip—at an estimated $1 million per kilometer—is prohibitive and has no plans at present to complete the link.

The mine's 120 employees work a four-week-on, two-week-off schedule with two-thirds of the workers on site at any given time. Employees are accommodated in a two-story, V-shaped complex that contains 179 single-occupancy rooms, dining facilities, gameroom, and laundry.

Electrical power at the remote site is provided by four diesel generating sets that produce a total of 3.4 MW. Heat recovered from the generating sets' cooling systems provides almost 70% of the energy needed to maintain comfort in the bunkhouse and other mine buildings during the region's long winters. Additional heat is provided by a standby boiler.

SEPT 29/92
CIM/KAMLOOPS

# GEOLOGY OF THE SNIP DEPOSIT

**Terry Hodson**

Located in the Iskut River Valley, 100 km NW of Stewart, B.C., the Snip gold deposit is jointly owned by Cominco Ltd. (60%) and Prime Resources (40%). West side of Johnny Mtn.

Production commenced with the commissioning of the mill in January, 1991 with initial reserves of 940,000 tonnes grading 28.5 grams per tonne.

The property is underlain by Triassic aged feldspathic greywacke, siltstone and mafic tuffs. strike E-W dip N
This sequence has been intruded by two feldspar porphyries, most notably the Red Bluff porphyry. The main zone of mineralization, known as the Twin Zone, lies 1000 metres south of the Red Bluff porphyry. 195 ± 5 Ma
the close

The Twin Zone is a 0.5 to 15 metre wide sheared quartz-carbonate-sulphide vein. Drilling has traced this structure for 1000 metres along strike and 500 metres vertically. Gold within the Twin Zone is hosted by three distinct ore types: vein dips south 30 - 70° strike E-W

1. streaky quartz ore consisting of quartz-calcite-chlorite and sulphide laminae within strongly sheared greywacke
2. crackle quartz ore consisting of shattered quartz vein infilled with chlorite and disseminated sulphides As along Sx grain boundaries & diss in qtz
3. massive sulphide veins, primarily pyrite and pyrrhotite with minor sphalerite and chalcopyrite and rare molybdenite, galena and arsenopyrite.

orig disc. 1965

130 portal - main access to ore

No gold grades in alteration halos
All high grade assays are cut to 15 g/t

A bt (altered) mafic dyke (post min) splits the vein locally. It is foliated & sheared.

(1) & (2) are

crude lateral zonation

py - py-Po-Bt ore (3)

black biotite along selvage of veins
local kspar flooding, rare epidote on
footwall side

Footwall veins occur

riffle table recovers 20% of the Au (gravity)

Con grade 300 - 600 g/t