

types recognized at the Valley Mine are silicic, potassic, phyllic, argillic, propylitic and post-mineral veining.

The principal sulphides in the Valley Mine are bornite and chalcopyrite with minor amounts of molybdenite, pyrite, pyrrhotite, digenite, covellite, enargite, sphalerite and galena. Most of the copper mineralization occurs in areas with abundant sericitic (phyllic) vein alteration and associated quartz veinlets. Molybdenite occurs as disseminations in flaky sericitic veinlets, as an infilling along fractures and shear zones, and in late phase quartz veins associated with gouge zones.

The five major deposits in the Highland Valley camp are now owned by the Highland Valley Copper partnership. About eighty per cent of current ore production is from the Valley Mine and the remainder is from the Lornex pit. Combined reserves in the Valley and Lornex deposits are 627 millions tonnes at .43% copper and .007% molybdenum. Daily mill throughput averages 125,000 tonnes at a 1.1:1 strip ratio.

#### **Paper No. 14 — 2:45**

*Porphyry Copper-Gold-Molybdenum Mineralization in the Island Copper Cluster, Vancouver Island*

J.A. PERELL, Minera BHP de Chile Inc., J.A. FLEMING, BHP Minerals Canada Ltd., Island Copper Mine, K.P. O'KANE, Minera Escondida Ltda., P.D. BURT, BHP Minerals Canada Ltd., G.A. CLARKE, BHP Minerals Canada Ltd., Island Copper Mine, M.D. HIMES, Ok Tedi Mining Ltd. and A.T. REEVES, BHP Minerals Canada Ltd., Island Copper Mine

The Island Copper Cluster (ICC), situated at the northern end of Vancouver Island, consists of five porphyry copper-gold-molybdenum systems genetically associated with stock and dyke-like rhyodacitic porphyries of Jurassic age (approximately 180Ma) that intruded the island arc, calc-alkaline basalts, andesites and pyroclastic rocks of the comagmatic Bonanza group. The systems (Island Copper, Bay Lake, G Zone, Red Island and Rupert Inlet) are coincident with a series of northwest-trending magnetic highs and regional faults aligned for more than 10 kilometres. They all share many similarities in the alteration-mineralization geometries but vary largely in size and grades. Copper-bearing skarn and vein-type mineralization also constitutes an integral part of the porphyry systems.

The only economic deposit of the cluster is the Island Copper Mine controlled and operated by BHP Minerals Canada Ltd., which had initial estimated reserves of 257 million tonnes at 0.52 per cent copper and 0.017 per cent molybdenum at a 0.3 per cent copper cutoff grade. Gold production from Island Copper since production started in 1971 through to the end of 1993 is over 32,000 kilograms, and annually amounts to 1,200 to 1,500 kilograms. This renders Island Copper one of the largest current gold producers, and historically the seventh largest lode gold producer, in British Columbia. Historical average head-grade of the deposit is about 0.19ppm gold but includes large volumes having assayed more than 0.40ppm gold.

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Only about 50 per cent of the gold is recovered in the copper concentrate, which has averaged about 24 per cent copper, 7ppm gold and 60ppm silver.

The bulk of the copper mineralization at Island Copper was introduced during the Early Stage in feldspar-stable, K-silicate conditions, to be followed by a main episode of molybdenum in a feldspar-destructive, sericitic environment. All of the recovered copper occurs as chalcopyrite, predominantly hosted by biotite-altered Bonanza volcanic rocks. Similar alteration-mineralization geometries characterize the other members of the ICC although hydrothermal pyroxene is conspicuous in the quartz-amphibole-magnetite stockworked core at Bay Lake.

Certain features such as the positive correlation between gold and copper, the association of gold with the potassic, biotite-rich alteration, and the high content of magnetite in the system (>8 vol. per cent) are characteristic of gold-rich porphyry copper deposits from elsewhere. The spatial arrangement of the ore zones (biotite-chalcopyrite around a copper-barren, quartz-magnetite core) is, however, considered to be unique among porphyry deposits, because copper-gold ore normally accompanies the quartz-magnetite stockwork veinlets (e.g., Philippine porphyry deposits).

#### **3:15 - 3:45 Coffee**

#### **Paper No. 15 — 3:45**

*Regional Setting and Styles of Porphyry Copper Mineralization, Babine Lake Area, British Columbia*

N.C. CARTER, Consulting Geologist, GAVIN E. DIROM, Consulting Geological Engineer and PETER L. OGRYZLO, Consultant

While porphyry mineralization in the Babine Lake district is known to be associated with three distinct ages of intrusive activity including early to mid-Jurassic (176Ma) and late Cretaceous (77Ma), the most significant deposits and occurrences are temporally and spatially related to Tertiary (50Ma) Babine intrusions. These host more than a dozen deposits and occurrences in addition to the past producing Bell and Granisle open-pit mines which processed 132 million tonnes with average recovered grades of 0.39% copper, 0.15g/t gold and 0.73g/t silver between 1966 and 1991.

Babine intrusions occur as small stocks, plugs and dyke swarms emplaced along regional northwest-trending faults developed in arc-derived Mesozoic volcanic and sedimentary assemblages. The intrusions are calc-alkaline in composition but recent trace element work suggests a possible alkaline parentage. The dominant host rock for copper-gold mineralization is a distinctive, fine- to medium-grained, crowded biotite-feldspar porphyry (BFP) of granodiorite composition. Pre-, inter- and post-mineral intrusive phases are evident and extrusive equivalents of these high-level intrusions are locally preserved.

by bacterial action and gives rise to acid mine drainage. The most commonly applied technology for chemical neutralization of acid mine drainage is the use of lime which not only neutralizes the acid but also precipitates metals as their oxides or hydroxides. The processes that have been used to date for lime neutralization include simple neutralization, neutralization with aeration to oxidize iron, and neutralization with aeration and sludge recycle that can produce a sense sludge of more than 20 per cent solids with free drainage properties, which rapidly achieves 40 to 50 per cent solids in the impoundment area. Because of these advantages, this method, otherwise known as the high-density sludge (HDS) process, has been selected for treatment of acid mine drainage at several mining operations in Canada and the United States. The stability of the sludge is naturally high but can be further improved by the addition of a slight lime excess before impoundment.

### 3:15 - 3:45 — Coffee

#### Paper No. 116 — 3:45

*A Closure Plan for Island Copper Mine*

IAN A. HORNE, BHP Minerals Canada Ltd., Island Copper Mine

The Island Copper Mine is owned and operated by BHP Minerals Canada Ltd. The mine is located on the north shore of Rupert Inlet, about 16 kilometres south of Port Hardy, at the northern end of Vancouver Island. The orebody was delineated in 1969 and the first concentrates were produced in September 1971. The mine has been in continuous operation since that time. To June 1994, the mine has produced  $2.44 \times 10^9$  pounds of copper.

Island Copper began its planning for closure in 1988. A commitment was made when seeking approval of the South Wall Pushback Proposal, to extend the mine's life beyond 1992. A Closure Plan was submitted in 1990. Following a review by the Vancouver Island Mine Development Review Committee it was agreed to further develop the plan for submission by December 1994.

There are several key issues related to the closure. They include: (a) acid rock drainage, (b) beach dump marine habitat; and (c) marine environment of Rupert Inlet and connected inlets. The acid rock drainage will be passively treated in the open pit. The pit will be flooded to create a saltwater meromictic lake with an anoxic lower water column. Sulphate reducing bacteria will develop in this environment and the acid rock drainage will be injected into the bottom of the flooded pit. The intertidal zone of the beach dump is being recontoured to encourage the growth of marine organisms. Six embayments will be created in the face of the dump to increase the available habitat. The marine habitat of Rupert Inlet has been extensively monitored for over 23 years. A two year, post-closure monitoring program has been planned to measure the response of the inlet.

SESSION 24 - REGENCY EAST

### Geology V — Exploration Highlights in South America

BOB YOUNG, Minera Teck Chile S.A., Chairperson

#### Paper No. 117 — 1:45

*Exploration Highlights in Peru*

ALBERTO BENAVIDES, Cia de Minas Buenaventura

#### Paper No. 118 — 2:15

*Exploration Highlights in Chile.*

MERWIN BERNSTEIN, Geologo Andes

#### Paper No. 119 — 2:45

*Exploration Highlights in Bolivia*

JAIME VILLALOBOS SANJINES, Exploracion y Promocion Minera Ltda.

### 3:15 - 3:45 — Coffee

#### Paper No. 120 — 3:45

*Gold Potential in Venezuelan Guayana*

RAUL HOMERO CARVAJAL ALFONZO, CVG-TECMIN

The petroleum industry is the main source of currency for Venezuela's economy; however, gold is achieving increasing prominence. In 1885 Venezuela accounted for 5.16 per cent of the world's gold production with recorded sales of 8.19 tonnes. Corresponding projects based on current world production and clearly identified targets suggest that Venezuela can regain or exceed this stature with production of 25 tonnes per year. The Spaniards and Sir Walter Raleigh envisioned El Dorado or Manoa as a mythic golden city in the jungle south of the Orinoco River. The vision of El Dorado is alive again as the rejuvenated mining industry advances.

The greenstone belts of Venezuelan Guayana have clearly demonstrated gold potential. The El Callao district has yielded continuous gold production for more than a century and retains excellent potential for expansion of gold resources in both underground and large scale open pit geometries.

In 1991 CVG was granted by means of the Presidential Decree 1409 and Ministerio de Energia y Minas (MEM) Resolution number 2 the rights to explore, develop and exploit alluvial or vein deposits of gold and/or diamonds in the Guayana region. Attendant with these rights was authority to negotiate and execute exploration and exploitation contracts with qualified third parties. The same year the National Tax Law was amended to reduce taxation of income from mining activities from 60 to 30 per cent. In addition to this supportive legislation, the state advanced the development of the gold industry via supportive government agencies. This is the purpose of the Venezuelan Gold Commission appointed by Dr. Rafael Caldera, President of Venezuela with the order to produce a document with guidelines to speed up the decisions required for gold exploration and mining.