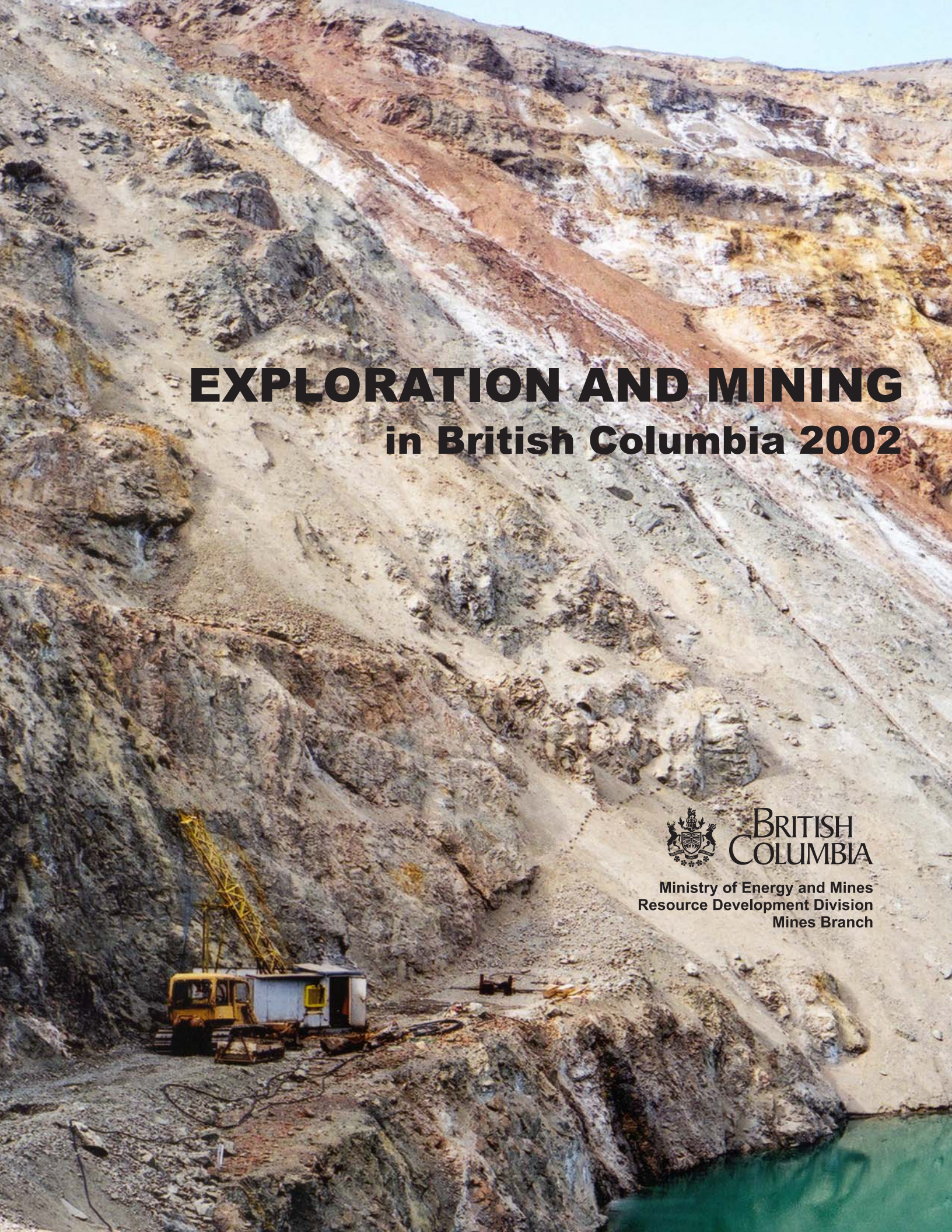

EXPLORATION AND MINING
in British Columbia 2002

BRITISH COLUMBIA

Ministry of Energy and Mines
Resource Development Division
Mines Branch

FOREWORD

The year 2002 was another challenging one for the mineral exploration industry in British Columbia. Companies continued to experience difficulty in securing financing for projects and prices for most metals remained depressed. Gold was one bright spot. The price of the yellow precious metal rose steadily from just below US$280 at the beginning of the year to almost US$350 by the end of 2002, and surged even higher in early 2003. Deposits containing gold, and gold in combination with other metals, were the target of a majority of exploration projects. This renewed interest in gold helped spur exploration spending in the province to near the $40 million, up by about $10 million over 2001, and the third successive increase in annual exploration spending since the all-time low set in 1999.

In 2002 there were 75 exploration projects with expenditures in excess of $100 000 in the province, up from 58 in 2001. The number of mineral claims recorded in British Columbia during the year was 27 542, an increase of 6% over 2001; the number forfeited was 21 012, down from 24 228 in 2001. The number of Free Miners Certificates increased 7% to 4375 in 2002. Total 2002 drilling in British Columbia on more than 90 projects is estimated to total 215 000 metres. Of this, 160 500 were on metals projects, 44 000 on coal projects (down sharply from 2001), and 10 500 on industrial minerals projects.

Noteworthy new discoveries were made in the province. Roca Mines Inc. located a stratabound mineralized zone on their Foremore property in the Iskut district which may be the source of polymetallic boulders that attracted explorers to the area. Barrick Gold Corporation found a wide zone of gold mineralization in the 22 Zone, 1.5 kilometres south of the Eskay Creek mine. Also in the Eskay Creek camp, Heritage Resources assembled a significant land position, completed a comprehensive digital compilation of historical data for the area, and followed it up with a successful drill program. Drilling by Northgate Exploration Inc. tested the Nugget Zone, approximately 1 kilometre west of the Kemess North deposit. The drilling intersected porphyry gold-copper mineralization similar in nature to the Kemess North deposit. While carrying out fieldwork, a British Columbia Geological Survey mapping crew discovered the Joss'alun high-grade copper sulphide prospect southeast of Atlin. After the discovery was announced, several companies acquired claims in the area. Late in the year Chapleau Resources Ltd. assembled a large land position to cover many gold prospects in the Cranbrook area. Initial drilling on their Bar gold project intersected significant gold mineralization in an area of historical trenching that had not been previously drill-tested.

Important exploration programs continued on a number of advanced level projects. Sultan Minerals Inc. further explored their Kena intrusion-related gold project near Nelson and in the fall, concluded an option agreement on the project with Kinross Gold Corporation. Another high-profile acquisition by a major was Noranda's option from Seabridge Resources Inc. of the Kerr-Sulphside porphyry Cu-Au project in the Iskut district. The largest exploration program in the province was carried out by Northgate Exploration Inc. on its Kemess North porphyry Cu-Au deposit. A large drill program was carried out by DRC Resources Inc. on their Afton porphyry Cu-Au-Ag-Pd project. They traced mineralization to the southwest of the past-producing pit area. After infill and geotechnical drilling on the southeast zone, Doublestar Resources Ltd, in partnership with Northgate Exploration Ltd. and Procon Mining and Tunnelling Ltd, undertook a feasibility study of the Sustut volcanic redbed copper project, approximately 65 kilometres south of the Kemess South mine. International Wayside Gold Mines Ltd. continued to explore the Cariboo Gold Quartz property in the Wells-Barkerville camp, focusing on mesothermal vein and pyrite replacement-style mineralization at both the Bonanza Ledge Zone and on the adjacent Myrtle property. In mid-December Redfern Resources Ltd. received a Project Approval Certificate for the underground development of its Tulsequah Chief polymetallic massive sulphide deposit, located southwest of Atlin, and for construction of a 162-kilometre access road. In the Harrison Lake area Leader Mining International Inc. carried out a definition drill program and accelerated its feasibility study of the Cogburn magnesium metal project.

At year-end there were six operating metal mines, seven operating coal mines, and approximately forty active industrial mineral operations in British Columbia. The value of solid mineral production in the province is estimated to be $2.84 billion for 2002, a decrease of 5% from 2001 levels. The most valuable commodities were metallurgical coal (36%), copper (21.3%), structural materials (17%), gold (11.2%), silver (5.3%), molybdenum (2.9%), and zinc (2.4%). Industrial minerals, lead, thermal coal and other commodities each contributed less than 2%. The Myra Falls Cu-Zn-Pb-Ag-Au mine on Vancouver Island, operated by Boliden-Westmin (Canada) Ltd., reopened in March after a four-month shutdown. Subsequently, the mine increased gold and silver production and reduced operating costs. The Eskay Creek Au-Ag mine in the Iskut River area increased production slightly in 2002 to offset the effects of mining lower grade material. The Kemess South Cu-Au mine improved its operating efficiency by increasing production and attaining higher gold and copper recoveries. At the Huckleberry porphyry Cu deposit, mining of the main pit was completed and expansion of the east pit initiated. The Endako porphyry Mo mine benefited from higher prices for molybdenum in 2002. The Highland Valley Copper mine southwest of Kamloops confirmed plans to maintain production until 2009.

Coal exploration expenditures were down sharply in 2002. Tthe Fording Canadian Coal Trust a new investment vehicle will combine all the metallurgical coal assets of Fording, Luscar, and TeckCominco (all the Elk Valley mines) as well as the export terminals owned by Luscar and Westshore Terminals.

Exploratory drilling for coal bed methane was carried out in the Peace River coalfield and interior basins.

As a result of reorganization and downsizing, staff in the Ministry of Energy and Mines regional offices in Cranbrook, Kamloops, Prince George, and Smithers will be reduced; the Nanaimo office will be closed. Jacques Houle is now returning to the exploration sector, after spending the last three years as the Regional Geologist for the Southwest Region based in Nanaimo. We wish him well. Jacques has done an excellent job of promoting mineral exploration in the Southwest Region, has taken on the task of overseeing the publication of this volume for the past two years, and was responsible for setting up the Vancouver Island Exploration (VIX) Group, based in Nanaimo.

The year 2003 has begun with a progressive strengthening of the gold price and prices of other metals are beginning to inch up. Early indications are that the ability of exploration companies to raise money to finance projects has improved. These factors, combined with positive key exploration indicators for the province, bode well for the mineral industry's prospects in the year ahead.

Part A of this publication contains summary papers of exploration and mining highlights for each of the five regions and are authored by the Regional Geologists in Nanaimo, Kamloops, Cranbrook, Prince George and Smithers. Part B comprises papers authored by a combination of government and industry geoscientists which focus on specific projects. Once again thanks are extended to Bill McMillan of Victoria who critically reviewed all the papers, and to Janet Holland of the Geological Survey who handled the desktop publishing of the volume.

David A. Terry, PhD, PGeo.
Regional Geologist, Cranbrook

TABLE OF CONTENTS

Aluminous Alteration at the Briton Hematite Prospect, Chilcotin Ranges

PART A

REVIEW OF EXPLORATION AND MINING ACTIVITY

PART B

NORTHWEST BRITISH COLUMBIA

Paul Wojdak, PGeo
Regional Geologist, Smithers

SUMMARY

The year 2002 showed improvement for the mining industry although activity remains at less than historic levels. Exploration spending in the Northwest was $10.2 million, compared with $7.2 million in 2001 (*see* Figure 1). Exploration drilling, which is an indicator of work on advanced properties, increased substantially from 37 932 metres to 57 252 metres in 2002 (*see* Figure 2). Clearly the most promising statistic is the increase in the number of mineral claims in the region. The number of units staked rose sharply to 10 735 while the number of units lapsed or forfeited declined for the fourth successive year to 3588 (Figure 3). The net increase of 7147 claim units show that optimism has returned at the grassroots level of the industry. The Stewart-Iskut "Golden Triangle" led the way in new activity (the Skeena and Liard mining divisions). New and expired claim units in the Atlin and Omineca mining divisions approximately balanced in 2002.

Production of gold and silver from the Eskay Creek mine increased slightly due to an increased mining rate, but at Endako and Huckleberry mines, the output of molybdenum and copper declined slightly due primarily to the mining of lower grade ores. Mine data, including production and reserves, is shown in Table 1. At Eskay Creek, Barrick Gold Corporation was successful in following up a single drill intercept from late 2001 and defining new reserves, the 44 zone, in 2002. Endako mine benefited from a short-lived spike in the molybdenum price that enabled them to reactivate stripping of waste, which will expose ore and alleviate a slope stability problem. Huckleberry copper mine finished mining the Main pit and started expansion of the East pit.

Exploration in the Stewart - Iskut district was led by Barrick Gold Corp., Heritage Explorations Ltd. and Teck Cominco Ltd. Each spent more than $1 million dollars on drilling programs in search of a gold-silver deposit similar to Eskay Creek. Barrick found a wide zone of gold mineralization in the 22 zone, 1.5 kilometres south of the mine. Follow up drilling next year may show the drill intersection to be the most promising exploration result in 2002. Heritage (formed by merger with St Andrew Goldfields Ltd.) evaluated its enormous claim consolidation surrounding Eskay Creek but focused its effort on the long-inactive SIB property where it confirmed the presence of high-grade gold-silver mineralization in the Lulu zone. Teck Cominco worked southeast of Stewart on Homestake Ridge. In the Babine district, Pacific Booker Minerals Inc. concluded re-drilling

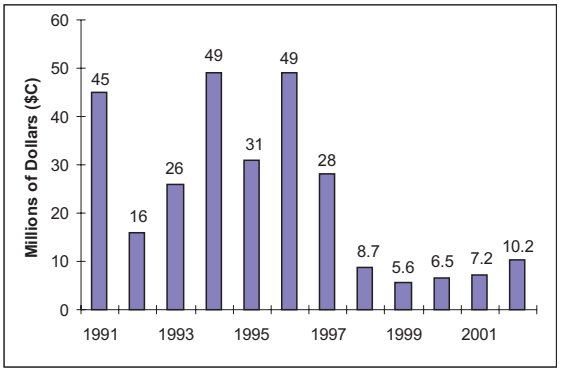

Figure 1. Exploration Expenditures in Northwest British Columbia.

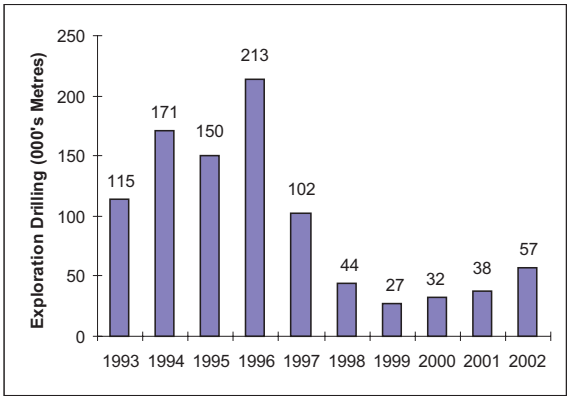

Figure 2. Exploration Drilling in Northwest British Columbia.

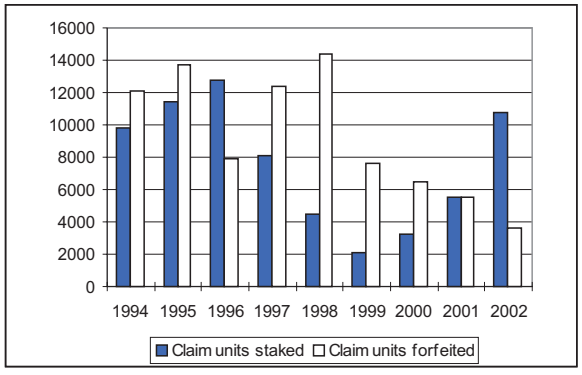

Figure 3. Claim Activity Summary in Northwest British Columbia.

TABLE 1
MINE PRODUCTION AND RESERVES

Mine	Operator	Employment	Production (2002)	Reserves	Reference for Reserves
Endako	Thompson Creek Mining, Ltd. & Nissho Iwai Moly Resources Inc.	222	5 239 tonnes Mo	Endako Pit, 46.5 million tonnes at 0.072% Mo Denak Pit, 10.5 million tonnes at 0.075% Mo Stockpile, 26.4 million tonnes at 0.047% Mo (on Oct 1, 2002)	Alan Morrish, pers. comm., Dec 10, 2002
Eskay Creek	Barrick Gold Corporation	316	11 157 kg (358 718 oz) Au, 552 487 kg Ag	Shipping ore, 494 907 tonnes at 51.81 g/t Au, 2604 g/t Ag Milling ore, 805 343 tonnes at 23.38 g/t Au, 918 g/t Ag (on Dec. 31, 2002)	J. Rogers, pers. comm. Feb. 11, 2003
Golden Bear	Wheaton River Minerals Ltd.	21 (seasonal)	70.6 kg (2271 oz)	Closed, undergoing reclamation	
Huckleberry	Imperial Metals Corporation	235	35 032 670 kg Cu, 507 400 kg Mo, 8393 kg Ag, 341 kg Au	36 365 000 tonnes at 0.496% Cu, 0.014% Mo, (on Dec. 31, 2002)	G. Frost, pers. comm. Feb 11, 2003
Fireside	Fireside Minerals Inc.	20 (seasonal)	5 000 tonnes of barite	Not available	

Table Notes: Employment includes all employees and contractors as of December, 2002.

TABLE 2
MAJOR EXPLORATION PROJECTS, 2002

Property	Operator	MINFILE	NTS	Commodity	Deposit Type	Work Done
Albert Creek	Logan Resources Ltd.		104P/13	Ag, Zn, Pb	Manto, sedex	Mag, 2.5 km; Drill access, 1.3 km; 1 ddh, 556 m
BX	Parkside 2000 Resources Corp. & Goldrea Resource Corp.	104B 291	104B/10W	Au, Ag, Cu	Porphyry, skarn	Geol; Prosp; 9 ddh, 198 m
Del Norte	Teuton Resources Corp.	104A new	104A/4E	Au, Ag, Zn	Vein	Prosp; 7ddh, 365 m
Eskay Creek	Barrick Gold Corporation	104B 008	104B/9W	Au, Ag, Zn, Cu	Epithermal VMS	37 sfc ddh, 13 990 m; U/g ddh, 20 000 m; U/g definition ddh, 10 000 m
Foremore	Roca Mines Inc.	104G 148	104G/2W	Cu, Zn, Ag, Au	VMS	Geol; Prosp; Contour soil geochem; Rock trenching
Homestake Ridge	Teck Cominco Ltd.	103P 016, 047, 091, 210	103P/12E	Au, Ag, Cu, Zn	Epithermal VMS	Geol; Mini-excavator trenching; 21 ddh, 4375 m
Morrison	Pacific Booker Minerals Inc.	093M 007	93M/1W	Cu, Au	Porphyry	20 ddh, 5578 m
Praxis West	Northgate Exploration Ltd.	103O new	103O/9E, 103P/12W	Cu, Zn, Au, Ag	VMS	5 ddh, 1945 m
RDN	Barrick Gold Corporation	104G 144	104B/15E, 104G/2E	Au, Ag	Epithermal VMS	8 ddh, 1126 m; Camp reclamation
SIB	Heritage Explorations Limited	104B 376	104B/9, 10	Au, Ag	Epithermal VMS	Geol; Geochem, 560 bulk silts; Re-log core; 8 ddh, 3071 m
Table Mountain	Cusac Gold Mines Ltd.	104P 070	104P/4	Au	Orogenic gold vein	11 ddh, 2395 m
Thorn	First Au Strategies Corp.	104K 031	104K/10W	Au, Ag, Cu	High sulphidation epithermal vein	Geol; Prosp; 7 ddh, 472 m
Turnagain	Canadian Metals Exploration Ltd.	104I 014	104I/7W	Ni, PGE	Magmatic	IP, 30 km; Drill access trail, 1 km; 7 ddh, 1683 m
William's Gold	Stikine Gold Corp.	94E 092, 150, 182, 183	94E/13	Au	Intrusion-related Gold	Three dimensional IP, 27 km

of the Morrison porphyry copper deposit that enabled a better resource estimate to be made. These and other exploration projects with expenditure exceeding $100,000 are listed in Table 2 and their locations shown in Figure 4.

Four other discoveries contributed to a level of excitement in the region. At Foremore in the Iskut district, Roca Mines Inc. located a stratabound mineralized zone that may be the previously undiscovered source of polymetallic boulders that attracted previous explorers. Teuton Resources Corp. found a precious metal vein breccia on its Del Norte property that prompted staking of a 40 kilometer-long belt east of Stewart. Discovery of the Joss'alun high grade copper showing, by a B.C. Geological Survey field party working southeast of Atlin, caused three companies to stake claims. Also southeast of Atlin, Rimfire Minerals Corp. and First Au Strategies Corp. discovered silver-gold mineralization in the Oban zone on the Thorn property.

Several prospects with large undeveloped resources came under new ownership. Noranda Inc. acquired the Kerr-Sulphurets copper and gold deposits, Fortune Minerals bought the Klappan coal property, Silver Standard Resources Inc. purchased the Silvertip silver-lead-zinc deposit, and the Red Mountain gold deposit was bought by Seabridge Resources Inc. Exploration and/or development activity is anticipated in 2003 on some of these properties, others will be dormant pending higher commodity prices and/or improved infrastructure. Considered a bellwether decision, the Government of British Columbia overturned a legal challenge and restored a Project Approval Certificate to the Tulsequah Chief project owned by Redfern Resources Ltd.

METAL MINES

The **Eskay Creek** underground gold-silver mine (Photo 1), owned by Barrick Gold Corporation, increased the mining rate to 670 tonnes per day (tpd) to increase precious metal output and offset the mining of slightly lower grade ore (*see* Table 1). The deposit consists of clastic sulphosalt-sulphide beds in the Contact Mudstone (Photo 2), and lower grade stringer ore in the underlying footwall rhyolite. Overlying basalt is unmineralized but intercalated mudstone, above the first basalt flow, contains sulphide and barite-rich gold-bearing horizons which are referred to as hangingwall ore. The orebody is on the west limb of the

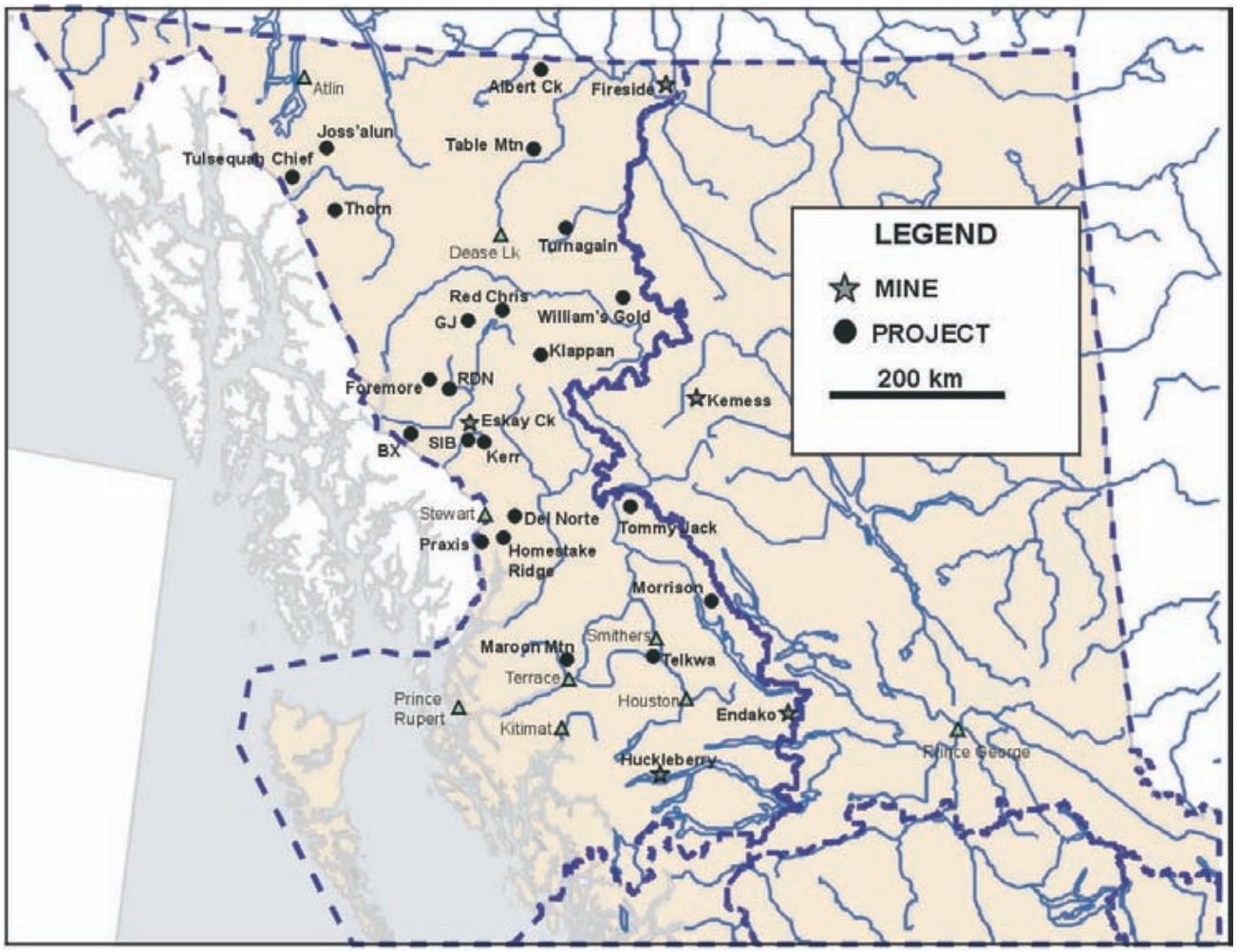

Figure 4. Location map, Mines and Exploration Projects in Northwest British Columbia, 2002

Photo 1. Workers at the portal of the Eskay Creek gold-silver mine

Photo 2. Eskay Creek ore, fine sulphosalt-sulphide beds in mudstone

Eskay anticline and continues into the fold nose. Mudstone-hosted ore contains problematic levels of mercury, antimony and arsenic so that high-grade ore is treated off-site at smelters in Japan and Quebec. Mudstone-hosted ore at the north end of the deposit, the NEX area, and footwall ore contain much lower levels of these toxic elements and are acceptable for treatment in an on-site flotation mill. Smelter ore is custom-blended to minimize treatment penalties at each smelter. A six month-long (and continuing) strike at the Horne smelter in Quebec necessitated an approximate 10% reduction in the 340-tpd rate of mining of smelter ore. Mining of ore with the highest content of precious metals and deleterious elements was deferred because Eskay Creek mine has no ore storage capacity. The mine compensated by increased production of mill ore, such that the mill operated at 10% above its scheduled rate of 330 tpd. By year-end, adjustments were made so that planned mining rates were resumed. Cut-off grades are 12 to 15 g/t gold equivalent for ore to the mill, depending on mining characteristics, and 30 g/t gold equivalent for smelter ore. Gold production cost, net of silver credits, was $US 42 per ounce (to end of third quarter). In 2002, Eskay Creek produced 116 581 tonnes of smelter ore containing 74.36 g/t Au and 3515 g/t Ag, and 116 013 tonnes of mill ore containing 28.5 g/t Au and 1430 g/t Ag.

Surface facilities at Eskay Creek were expanded and improved once again. Cramped working conditions were alleviated by enlarging the office and warehouse facilities. Flotation cells were added to the mill. Problems at the subaqueous outfall of the new tailings pipeline, described in EMBC 2001, were corrected by divers in MacKay Lake and the system now operates as designed. Additions to staff include two more grade control/ exploration geologists (bringing geologic complement to eleven) and a geotechnical engineer. These additions reflect the close grade control supervision that is required by geological complexity, and the added importance of effectively dealing with difficult ground conditions as the production rate increases.

Development of the north-plunging NEX zone continued with a 1300 metre advance of a spiral ramp system which includes a northerly 460 metre hangingwall drift. The drift afforded drill positioning to follow up on the exceptional intercept in the last hole of the 2001 surface exploration program which returned 50 g/t Au equivalent over 17 meters (*see* EMBC 2001, page 4). The 2002 underground drilling delineated a new resource, named the 44 zone, that could add several months to the mine life. The area is structurally complex, lying within closely faulted and tightly folded mudstone and rhyolite in the hinge of the Eskay anticline. Continued exploration of deep footwall targets, for example the intersection of the Pumphouse fault with an amygdaloidal horizon at the top of the footwall dacite (EMBC 2001, p. 4), awaits additional development of the ramp. This drilling is anticipated 2003.

The mine was also successful in delineating additional reserves west of the main stoping area within the 800 metre-long 21C zone. At the beginning of the year, reserves were estimated to be 112 000 tonnes at 19.4 g/t Au and 403 g/t Ag, within a larger resource of 237 000 tonnes grading 17.1 g/t Au and 520 g/t Ag. Mineralization is controlled by a northerly fault that cuts the mine sequence, possibly a splay of the graben-bounding Andesite Creek fault. Ore is developed in footwall rhyolite adjacent to the fault and, in overlying horizons, as a stacked series of stratabound zones that extend away from the fault (I. Dunlop, J. Rogers, pers. comm., 2002). The 21C Contact mudstone, 21C barite and 21C hangingwall mudstone ore zones portray an intriguing, smaller-scale replica of the 21B orebody, and demonstrate the interaction of structural and lithologic ore controls at Eskay Creek. With respect to mining, the company is optimistic that it will be more successful in overcoming difficult ground conditions in 21C South reserve block than it was in its trial mining last year in the 21C North block.

North of the 21C zone, deposit appraisal drilling in the Water Tower zone converted a geologic resource of 87 000 tonnes grading 20.8 g/t Au and 500 g/t Ag into a mining re-

serve. The Water Tower zone was discovered and the resource was estimated in 2001 but results of 2002 drilling are not yet available. Mineralization is proximal to the same fault as the 21C zone. Gold occurs in the footwall rhyolite along the contact of a thin mafic body that is rooted against the fault, but it is uncertain if the mafic unit is a volcanic flow or a dike.

Exploration expenditure at Eskay Creek made it the largest project in the region once again. Exploration drilling is conducted from underground on a year-round basis and from surface on a seasonal basis. Promising areas are quickly taken to the next stage of appraisal, resource definition and detailed drilling for mining (eg. Water Tower, 44 and 21C zones). The total of all drilling at Eskay Creek amounted to 45 000 metres in 2002, of which 33 990 metres is classed as exploration and included in Figure 2. Target areas drilled from surface include the NEX trend ("deep Adrian" area), the east limb of the Eskay anticline, the MacKay zone and the historic 22 zone. In the NEX area, two promising intersections were obtained north and west of 44 zone. The 22 zone is 1.5 kilometres south of the mine site in an area of historic trenching and shallow underground development (the Emma adit driven by Tom MacKay in 1932). One of two holes drilled late in the season returned 64.1 g/t Au equivalent over 4.7 metres, within a wider zone that assayed 6.2 g/t Au equivalent over 80.1 metres (I. Dunlop, pers. comm., 2002). Dunlop states that the intersection appears to be analogous to the 21C and Water Tower zones, consisting of steeply west-dipping, structurally controlled stibnite-sphalerite-electrum-pyrite mineralization in the rhyolite. A considerable portion of the 2003 drilling program will continue to test the 22 zone and similar targets to the south. The property boundary with the SIB claims is 3 kilometres south.

Endako is a porphyry molybdenum deposit within an early Cretaceous granite batholith. The Endako open pit mine has operated for 32 years and is a low-cost producer. The pit is elongated west-northwest, it measures 650 metres by 230 metres, and is 250 metres deep (Photo 3). The mill normally processes 28 000 tonnes per day, the total for the year was 9 593 303 tonnes of ore containing 0.0726% Mo. Molybdenum production amounted to 5 239 101 kilograms, an average recovery of 75.6%. Ninety-five percent of the flotation concentrate is converted to molybdic oxide in an on-site roaster. The balance is upgraded and sold as 'ultrapure' (a trademarked product containing 99.15% molybdenum sulphide). In 2002, Endako began roasting concentrate from the Los Pelambres and Highland Valley Copper mines on a toll basis. Endako benefited from a sharp increase in molybdenum price in June. The price gradually declined but by year-end molybdenum was still trading above $3 per pound, appreciably higher than during the past three years when Endako was compelled to introduce many cost-cutting measures, including an in-pit crusher and deferral of stripping, to remain in operation.

Photo 3. Endako open pit, showing the ore conveyor from the in-pit crusher and the area of instability on the south pit wall.

Slope instability on the south wall of the Endako pit, which began in 2000, expanded in extent during 2002. A 3.8 million tonne project to strip material from the upper benches was initiated to unload the South Basalt fault, the primary cause of the stability problem. Ultimately, an additional 15.5 million tonnes of waste rock must be removed from the south wall to provide access to the 46.5 million tonnes of reserves remaining in the Endako pit. Minor pit wall instability results from an east-northeast striking fault (one of a set spaced 300 metres apart that transect the Endako pit obliquely) that dips north at such an angle that it undercuts benches on the south wall. The fault is intersected by a closely-spaced joint set sub-parallel to the south wall that dips steep east to northeast, toward the pit, resulting in a wedge failure zone. More extensive instability is related to the South Basalt fault, the structure that marks the hangingwall of the orebody. The South Basalt fault strikes east-west, dips steeply south and tracks across the south wall of the pit, about one third of the distance above the pit floor. Flat to gently dipping molybdenite-bearing gouge zones below the fault provide detachment surfaces at the base of the south wall. Impermeable kaolinite alteration in the fault zone impounds groundwater and adds to the driving force (A.V. Chance, private report for Endako Mines Ltd., 2002). Movement caused by this block-sliding mechanism temporarily disrupted mining over a 300 metre horizontal distance within the pit in 2002 (photo 3).

Two exploration holes 1.5 kilometres northeast of the Endako pit were drilled late in 2001 and found strong argillic alteration overprinted on a weak quartz-molybdenite stockwork. Follow-up work is warranted but was postponed.

Huckleberry is a porphyry copper deposit related to the late Cretaceous Bulkley intrusions. Copper mineralization, which occurs in two zones one kilometre apart, is developed within a granodiorite stock and related dike, and also in adjacent hornfelsed and fractured volcanic rocks. The mill processed 7 421 715 tonnes grading 0.534% Cu and 0.014% Mo, recovering 88.4% of the copper and 47.5 of the molybdenum. Concentrate is trucked to the port of Stewart for shipment to Japan. Mining of the Main zone ended in early May, somewhat abruptly, when the combined effects of high spring run-off and pit wall failure caused the mine to abandon the remaining one-half million

tonnes of ore in the bottom of the pit. The second mining phase in the East pit required increased capacity to remove waste rock and 150-ton haul trucks were acquired. Waste rock with potential to generate acidic runoff is dumped into the Main Pit which will be flooded upon closure. The East pit expanded east of the 150 fault. The trend of the ore zone is 110° and the 150 fault caused more than 100 metres of right lateral oblique displacement. Mining encountered a greater depth of oxide copper than was anticipated from exploration data. However, mill losses due to oxide copper minerals were more than offset by mining of ore of better grade than anticipated from the upper benches, 0.5 to 0.6% copper rather than 0.4% copper. Differences from the exploration model resulted because dissolution of gypsum-filled fractures near the surface caused poor exploration core recovery from the highly broken rock.

Wheaton River Minerals Ltd. continued reclamation of the **Golden Bear** mine site. Rinsing of the Totem heap leach pad resulted in recovery of 70.6 kg of gold, raising total recovery from the pad to 91.6%.

MINERAL EXPLORATION

SMITHERS-HOUSTON-BABINE AREA

Pacific Booker Minerals Inc. completed its three year program of 60-metre grid drilling of the **Morrison** porphyry copper deposit (93M 007) and subsequently released an open pit resource calculation. This Babine district deposit is centred on an Eocene biotite-feldspar porphyritic granodiorite stock. The stock was emplaced into mid-Jurassic sedimentary rocks of the Bowser Lake Group along the graben-bounding Morrison fault. Based on 82 holes (22 824 metres of drilling) and using a 0.3% copper cut off, an independent consultant estimates the Morrison deposit contains:

- A measured plus indicated resource of 62 121 000 tonnes at 0.46% Cu and 0.22 g/t Au, and
- An inferred resource of 8 937 000 tonnes at 0.52% Cu and 0.21 g/t Au.

The total estimate, 71.0 million tonnes grading 0.47% Cu and 0.22 g/t Au, is at a 1.15:1 strip ratio. The Morrison resource estimate is very similar to the life-of-mine production from the Bell deposit, which was 77.2 million tonnes of 0.47% Cu and 0.26 g/t Au, but the strip ratio is higher, that at Bell was 0.75:1.

Telkwa Gold Corporation drilled six holes on their **Del Santo** property (93L 025) southeast of Smithers, to test EM anomalies for VMS mineralization. The property is underlain by the Nilkitkwa Formation of the Hazelton Group. The holes, collared north and west of holes drilled in 1998, penetrated magnetic and amygdaloidal mafic volcanic rocks that are variably altered to epidote, calcite and hematite. An intercalated layer of aphanitic felsic volcanic rocks containing disseminated pyrite was cut in one hole. On nearby Dome Mountain, Consolidated Rich Resources Inc. agreed to explore the Dome claims of Guardsmen Resources Inc., but were unable to fund proposed trenching of the Gem and Eagle showings (93L 284, 285).

Separately owned claim groups on the **Tommy Jack** (94D 031) gold prospect 95 km north of Hazelton were optioned by International Kodiak Resources Inc. (from Lorne Warren) and Gold City Industries Ltd. (from Alan Raven). Gold and silver occur in sulphide veins, containing galena, sphalerite, chalcopyrite, pyrrhotite, pyrite, tetrahedrite and ruby silver. The veins are adjacent to fine grained dikes and sills, thought to be derived from an unexposed Bulkley granodiorite pluton that intrudes sandstone and shale of the Bowser Lake Group. Noranda drilled 35 holes (2452 metres) at Tommy Jack in 1986 and 1987 targeting, in part, gold-silver-lead soil anomalies. Soil anomalies may be derived from a shallow blanket of glacial till, and not be a primary dispersion from bedrock. The direction of ice transport is uncertain because the property is at the intersection of north-south and east-west valleys. Gold City discovered a new vein occurrence by hand-trenching a self-potential anomaly (due to graphite in the veins) identified by Alan Raven with the assistance of a Prospector Assistance grant several years ago. International Kodiak compiled geologic data but deferred exploration.

Tenajon Resources Ltd. commenced exploration of the Sleeper silver showing on the **Silver Streak** property acquired from Ed and Jerry Westgarde and Barry Hofsink. Tetrahedrite, minor galena and sphalerite, but negligible pyrite, accompany vuggy calcite and quartz in a crackle-brecciated zone exposed along a forest service road south of Houston. The host rock is feldspathic tuff of the Telkwa Formation. Sampling by Tenajon of the vendors' hand trench returned 191 g/t Ag, 0.26% Cu, 0.30% Pb and 0.15% Zn over 16.7 metres. Late in the year, Tenajon undertook excavator trenching based on an interpreted northeast trend to the mineralized zone but results are not yet available. Equity Silver Mines Ltd. explored the Sleeper showing from 1990 to 1992, when it was named the Eric property, and drilled 19 holes. Drilling results are poorly known because the work was not filed for assessment. Equity had limited success in extending the zone based on an assumed shallow southwest dip (D. Hanson, pers. comm., 1992) but Tenajon interprets a different structural trend.

Several prospectors undertook drilling on their own properties. Wes Moll completed one hole on both the **Crow-Raven** porphyry copper prospect south of Houston and the **Harry Davis** copper-zinc-silver prospect north of Houston. Gary Thompson performed a 12-kilometre vertical loop EM survey and drilled two holes on his **Rox** claims 80 kilometres south of Houston. The target is fault-controlled gold-silver vein mineralization. Fifty kilometres west of Smithers, near Mulwain Creek, Regis Plante drilled two holes targeting a copper vein on the **Regis** claims.

TERRACE-KITIMAT AREA

Seymour Exploration Corp. explored the auriferous Bear quartz vein (103I 029) on **Maroon Mountain**, 35 km north of Terrace. Historic sampling returned gold grades between 0.2 and 106 g/t over vein widths between 0.3 and 1.5 metres. Two holes were drilled by Seymour. The first

cut 0.6 metres of quartz-pyrite-sphalerite-galena vein that assayed 26 g/t Au but the second hole did not intersect the vein and may not have been drilled far enough. The quartz vein, or a family of veins in similar structures, extends west to the Black Wolf showing (103I 030) and east to Gold Cap (103I 028) for a total strike extent of 1500 metres. Over that distance, the vein(s) follow a bedding-parallel fracture located 15 to 50 metres below a distinctive 35-75 metre thick cobble conglomerate. The host rocks are turbidite greywacke of the Bowser Lake Group that are folded, penetratively deformed and metamorphosed to biotite-andalusite grade. The vein(s) contain sporadic scheelite and are associated with a narrow aplite dike, implying derivation from a nearby Tertiary pluton.

At the **Morningstar** prospect (103P 034), a Bulkley granodiorite stock with porphyry molybdenum mineralization intrudes Bowser Lake Group sedimentary rocks. Dwight Herbison and Larry Noble drilled a single hole to test auriferous arsenopyrite veins peripheral to the stock.

Southern Rio Resources Ltd. acquired the **Dani** claims on Hawkesbury Island in the Ecstall volcanosedimentary belt from prospectors Shawn Turford and Ralph Keefe. Southern Rio contracted Equity Engineering to do a brief geological appraisal. Also in the Ecstall belt, CSS Exploration Inc. conducted a limited geochemical program on the **Iuxta** property, acquired immediately prior to the RGS release in 2001.

STEWART DISTRICT

Mineral claims owned by Teck Cominco Limited in the upper Kitsault and Illiance River area comprise the **Homestake Ridge** and **Big Bulk** properties. A detailed geological mapping program in 2001 at Homestake Ridge (103P 091, 210, 214) identified drill targets for a precious metal enriched VMS deposit analogous to Eskay Creek. Precious and base metal veins on Homestake Ridge lie on the inverted limb of an anticline that is overturned to the south. Twenty-one holes were drilled (Photo 4), mainly from aphyric flow-banded rhyolite in the structural hanging wall through a sequence containing graphitic mudstone and siltstone with tuffaceous rhyolite interbeds into a volcaniclastic basalt debris flow. High-level intrusions of hornblende-feldspar porphyry andesite, with rare K-feldspar phenocrysts, grade into quartz-phyric felsite bodies that invade the section up to, and including the basal portion of the basalt unit. Pyrite, sphalerite, arsenopyrite and galena intersected in the basal 15 metres of the mudstone and, less commonly, near the top of the rhyolite, are interpreted to be early diagenetic (G. Evans, pers. comm., 2002).

Teck Cominco optioned the Big Bulk property to Canadian Empire Exploration Corp. The 351 claim unit property covers a felsic volcanic unit within the Betty Creek Formation that hosts a series of mineral occurrences including Leftover (103P 047), a high-silver massive sulphide prospect, and the Big Bulk subvolcanic intrusion (103P 016). Surface chip samples at Big Bulk by Prism Resources Limited in 1980 returned 0.715% Cu and 1.75 g/t Au over 13 metres. Canadian Empire plans a drilling program in 2003.

Photo 4. Graeme Evans (centre) showing drill core from the Homestake Ridge project to Mines Branch personnel Bruce Graff and Doug Flynn

Praxis Goldfields Inc., a private company, optioned the western portion of its **Praxis** property 25 km south of Stewart to Northgate Exploration Limited. Northgate drilled five holes in the Section Ridge area, to test strong electromagnetic anomalies within Salmon River Formation mudstone for volcanogenic mineralization. The mudstone overlies pillow basalt, a stratigraphic setting correlative with the Anyox copper massive sulphide district. Northgate's second drill hole intersected 0.67% lead and 0.39% zinc over one metre near the top of the volcanic sequence, but the strong EM response is attributed to graphite seams parallel to bedding in the overlying mudstone (D. Kuran, pers. comm., 2002).

Praxis Goldfields Inc. retained the eastern portion of its Praxis claims, the Rhyolite Ridge area south of Ashwood Lake. Two holes were drilled to explore the geochemically anomalous contact between the mudstone and overlying rhyolite. The rhyolite, of similar mid-Jurassic age to the Eskay Creek rhyolite, is comprised of various flow-banded, brecciated and altered phases. One hole intersected a narrow zone of disseminated sphalerite, the other was stopped where the favourable stratigraphy is truncated by younger intrusive rocks (D. Kuran, pers. comm., 2002).

On its **Del Norte** property, Teuton Resources Corporation discovered a quartz-cemented breccia, mineralized with coarse sphalerite and galena and containing appreciable gold and silver. The new showing is located at the margin of a wasting icefield on the ridge between Nelson and

Del Norte creeks, about 500 metres southeast of the LG showing (104A 161). The breccia zone lies along the contact of a granitic dike emplaced into pyritic black mudstone of the Salmon River Formation. The weighted average of three closely-spaced drill intercepts across the 10 metre-wide zone is 5.07 g/t Au and 210 g/t Ag, compared to the outcrop sample that returned 6.14 g/t Au and 631 g/t Ag.

Seabridge Resources Inc. purchased the **Red Mountain** gold deposit (103P 086) from Wheaton River Minerals Ltd. During its ownership of the property, Wheaton River relogged drill core and studied ore controls leading to a resource estimation of:

1.26 million tonnes grading 8.01 g/t Au (measured)

340 000 tonnes grading 7.04 g/t Au (indicated)

350 000 tonnes grading 7.45 g/t Au (inferred).

ISKUT DISTRICT

Heritage Explorations Ltd. became the operating company to explore a 2200 unit claim consolidation in the Iskut district. St. Andrew Goldfields Ltd. and Zebrex Holdings Inc. hold a controlling interest in Heritage. The property largely surrounds the Eskay Creek holdings of Barrick Gold Corp. and covers favourable folded stratigraphy from the McKay syncline eastward to the McTag anticlinorium, including the Treaty Creek and Bonsai prospects optioned from Teuton Resources Corp. Heritage undertook an ambitious digital compilation to build a comprehensive topographic, geological, geochemical and geophysical model to explore for, in particular, Eskay Creek-type precious metal mineralization. Some 300 assessment reports spanning decades of previous exploration were digitized and studied by a team of geologists. Consultant Peter Lewis helped to rationalize stratigraphic nomenclature that has evolved over time. From their study of the Eskay Creek area, Heritage concluded that the primary control of mineralization is structural, and that lithology, such as receptive mudstone, is a secondary factor (interestingly, there is now greater recognition of the importance of structural ore controls at Eskay Creek). Heritage Resources identified two parallel, northeasterly mineralized corridors. The field program, partly funded by Kinross Gold Corp., included a property-wide stream geochemical program and detailed work on the SIB claims.

The **SIB** claims of Heritage Explorations lie on the west limb of the Eskay anticline and cover the southern half of a nine kilometre chain of gossanous mineralized zones associated with the Eskay Creek rhyolite. The most notable target is the Lulu zone (104B 376) where a Heritage drill hole cut 19.5 g/t Au and 1602.9 g/t Ag across 11.7 metres, closely matching the intersection in a nearby 1990 drill hole. Mineralization in the Lulu zone consists of pyrite, stibnite and sphalerite with minor gold, pyrargyrite and arsenopyrite within an intra-rhyolite mudstone unit. Other mudstone horizons, including one at the base of the rhyolite (the McKay mudstone) are also known to contain gold-silver mineralization. However, the Contact Mudstone, the unit that hosts the Eskay Creek deposit at the top of the rhyolite, is not well developed. Two other targets, North SIB (the MacKay adit area) and Battleship Knoll, are in an area in which alternating claims are owned by Barrick Gold and Heritage Resources. A single hole at Battleship Knoll encountered 8.24 g/t Au and 16.8 g/t Ag over 1.4 metres. Four holes at North SIB targeted an anticline in the McKay mudstone where it is cut by a thrust fault. This was regarded as the favourable structural site intersected by a 1990 drill hole that returned 41 g/t Au over 3.0 metres but no significant mineralization was found. More work is planned on these targets and the TV, AP, Lance, Bonsai, Tarn, Jeff and Noot prospects.

Barrick Gold Corporation acquired the **RDN** property (104G 144), 40 km north of Eskay Creek mine, after Newmont Exploration of Canada terminated its agreement with Rimfire Minerals Corp. The property is underlain by similar rocks with a comparable geochemical signature to those that host the Eskay Creek deposit (*see* EMBC-2001, page 65-71). Barrick encountered difficult drilling conditions and were able to complete only two of eight holes. The other holes terminated short of their target depth and drilling was postponed until 2003 when the work will resume with a modified procedure. The Jungle anomaly, a prime target, remains untested. Surface work was carried out in other areas and additional claims were staked along the projection of favourable stratigraphy.

Roca Mines Inc. made significant progress in solving the enigma of polymetallic sulphide boulders on the **Foremore** property (104G 148). The More glacier, which is two kilometres wide and ten kilometre long, divides into two snouts 5 kilometres apart, each marked by an extensive outwash morraine containing a variety of mineralized boulders. Roca's prospecting program tested a new interpretation by glaciologist Wayne Savigny that the boulders came from a collapsed lateral morraine from a side glacier. The property is underlain mainly by deformed Paleozoic mafic to felsic volcanic rocks, siliclastic sedimentary rocks and limestone. Intrusive rocks of Paleozoic and Mesozoic ages are also present. Lorne Warren discovered a pyrite-sphalerite-galena-arsenopyrite stringer zone that is stratabound over a 100-metre length within sericite-altered intermediate volcanic rocks (Photo 5). The zone lies on the

Photo 5. Geologists examine stratabound mineralized zone discovered on the Foremore property by Lorne Warren, top left.

margin of a 50-metre wide snow-filled gully and trends toward an EM anomaly. Channel sampling and other follow-up work will take place in 2003.

Northgate Exploration Limited carried out a brief geological examination of its newly acquired **Rest** claims, located along the long-lived Forrest Kerr fault. Major accumulations of Salmon River Formation pillow basalt along the fault to the north on the RDN claims and south on the PBR property, suggest the Forrest Kerr structure was a rift fault and therefore prospective for Eskay Creek-type mineralization.

On the **BX** claims, Parkside 2000 Resources Corp. explored gold-bearing vein, stockwork and magnetite skarn occurrences (104B 290, 291, 362, 364) associated with the early Jurassic Lehto stock 6 kilometres southeast of the former Snip gold mine. The pluton is the same age as the Red Bluff stock and the ore deposit setting on the BX property may be comparable to the Twin vein at Snip and porphyry copper-gold mineralization at Bronson Slope. Parkside, under an earn-in agreement with Goldrea Resources Corporation, undertook a drilling program but were unable to complete their holes due to broken rock.

A number of property acquisitions point to new exploration projects in 2003. Noranda Exploration Inc. optioned the **Kerr-Sulphside** property from Seabridge Resources Inc. Placer Dome Inc. estimated the Kerr deposit to contain 140.8 million tonnes grading 0.75% Cu and 0.36 g/t Au and Sulphurets to contain 54.8 million tonnes grading 1.02 g/t Au (total of measured, indicated and inferred resources in both deposits). Noranda will begin a property-wide exploration program in 2003. Rimfire Minerals Corp. staked the **Adam** property on widespread copper-gold mineralization (104B 079, 209) in a fault-controlled monzonite dike near the confluence of the Unuk and South Unuk rivers. Rimfire conducted a brief field program, to assess work by previous explorers who reported a chip sample grading 0.60% Cu and 1.28 g/t Au across 18.9 metres within a 1.5 kilometre long copper-gold soil anomaly. Newcastle Minerals Ltd. acquired claims on the **Phiz** (104B 165) and **Snip North** (104B 312) gold occurrences located 5 km west and 4 km north respectively of the Snip gold mine. Between 1988 and 1991, some 97 holes totaling 9565 metres were drilled at Snip North and 25 holes were completed at Phiz, but the work was not filed for assessment. Newcastle located core and drill records, and is compiling the data in search of untested targets. And finally, Hathor Exploration Ltd. acquired some 1280 claim units by staking in the Eskay-Granduc area.

TURNAGAIN-STIKINE AREA

After a three-year hiatus on the **Turnagain** project, exploration resumed for a bulk-tonnage nickel-cobalt-platinum-palladium deposit (104I 014) in the Turnagain ultramafic complex. Canadian Metals Exploration completed an induced polarization survey and seven core holes, bringing the total to 26 holes drilled on the property since 1996. Complete assay data for three holes was available at the time of writing and had similar results. For example, hole 7 averaged 0.26% Ni, 0.02% Co, 0.03% Cu and 39 ppb platinum plus palladium over 414 metres. Higher grades were encountered over shorter intervals, beginning at 302 metres in the third hole 16 metres of 0.71% Ni, 0.017% Co, 0.13% Cu and 183 ppb platinum plus palladium were cut. The Turnagain intrusion is characterized as a zoned (Alaskan type) body by the B.C. Geological Survey and is located adjacent the Turnagain River, 110 kilometres east of Dease Lake.

Stikine Gold Corporation, a private company, entered into an option agreement to acquire 70% of the **William's Gold** property (94E 092) from Rimfire Minerals Corp. Formerly known as the Bill (*see* EMBC, 2001), the property is located 290 km north of Smithers. Auriferous arsenopyrite-pyrite-quartz veins with bulk tonnage potential are likely related to a buried intrusion, evidenced by structural and magnetic data. Stikine Gold performed a three-dimensional induced polarization survey. This new technique provided targets for a drill program anticipated in 2003. The company also plans to expand the IP survey northward over an area of gold-bearing float.

West of Kinaskan Lake on the **GJ** property (104G 034), International Curator Resources Ltd. performed an induced polarization survey between two previously explored areas. Porphyry copper showings one kilometre apart lie at the west end of the Groat (alkalic) monzodiorite stock. Work between 1970 and 1990 included several phases of mapping, geochemistry, geophysics, and 52 diamond drill holes, with a best intercept of 0.70% Cu and 1.9 g/t Au over 68 metres. The Groat stock and attendant porphyry copper mineralization belongs to the same plutonic suite as the Red stock at the Red Chris copper-gold deposit. North and east of GJ on the Kinaskan plateau, some 528 units were staked by Viceroy Resource Corp. as the **QC** claims, and subsequently transferred to Royal County Minerals Corp. Work in 2002 focused on two of seventeen mineral occurrences identified by previous exploration of the claim area. New areas of gold-silver-copper-zinc mineralization were discovered in quartz veined intrusive rocks west and southeast of the Gordon Vein (A. Travis, pers. comm., 2002). Rock sampling within the Horn East soil gold anomaly located quartz-veined float with up to 6.95 g/t Au.

Dissident shareholders of American Bullion Minerals Ltd., owner of the inactive **Red Chris** deposit (104H 005), ousted company management on December 30 and began formation of a new management group. Red Chris is estimated to contain 522.7 million tonnes at 0.35% Cu and 0.27 g/t Au with a higher grade core of 118.9 million tonnes grading 0.58% Cu and 0.47 g/t Au. The new group is not in favour of a draft agreement, negotiated by previous management, to sell 70% of the Red Chris deposit and are investigating whether the proposal is binding.

John Poloni staked new mineral claims over the lapsed **Eaglehead** porphyry copper system (104I 008). The Camp, Pass and Bornite zones are strung out over a 3 kilometre distance. Based on work carried out between 1972 and 1982 various operators estimated resources in these deposits as 2.7 million tonnes at 0.45% Cu, 11.8 million tonnes at 0.52% Cu and 16 million tonnes at 0.65% Cu respectively.

Significantly, a 6.3 metre intercept grading 7.13% Cu at the eastern extremity of the drilled area, has yet to be followed up. Poloni re-logged drill core stored on the claims and re-established a grid to facilitate further exploration.

Eagle Plains Resources optioned the mineral claims 65 kilometres southwest of Telegraph Creek that were newly staked over lapsed claims that covered part of the **Copper Canyon** alkalic porphyry copper-gold deposit (104G 017). Exploration in 1990 identified an inferred resource of 32.4 million tonnes grading 0.75% Cu, 1.17 g/t Au and 17.1 g/t Ag in the Central zone at Copper Canyon. Silver Standard Resources Inc. and Stikine Copper Limited continue to hold claims over part of the deposit.

CASSIAR AREA

At the **Table Mountain** gold mine, Cusac Gold Mines Ltd. reactivated exploration of the Bain vein, east of where it was mined. Between 1993 and 1995 the Bain vein produced about 55 000 tonnes of ore with a recovery grade of 14 g/t gold. From west to east, the Katherine, Bonanza and Bain veins represent faulted segments of a single structure (M. Glover, pers. comm., 2002). The Eileen fault displaces the eastern continuation of the Bain vein some 300 metres, termed the 'Bain Gap'. Drilling and concurrent modeling confirmed the fault gap and improved the resource estimate in the eastern extension of the Bain vein to a mining reserve of 22 000 tonnes containing 33.78 g/t gold. Vein width averages 1.45 metres. Exploration drilling 300 to 400 metres further east failed to intersect the Bain vein, results suggest there may be another vein gap caused by similar style displacement on the Lily fault. Cusac proposes to contract mine the East Bain reserve and continue exploration in 2003. In the same district, Navasota Resources Ltd. signed a letter of intent with International Taurus Resources to earn a 70% interest in the **Taurus** gold property (104P 010, 012). The agreement is scheduled for completion in early 2003.

Logan Resources Ltd. drilled a single hole on its **Albert Creek** property, to test a coincident strong magnetic and silver-lead-zinc silt and soil geochemical anomalies. Geophysical modeling indicated a large, conformable magnetic body. The target was a manto or sedex deposit at the inferred contact between McDame Group limestone and Earn Group clastic sedimentary rocks. The geochemical anomaly was identified by a government Regional Geochemical Survey (RGS) some 20 years ago but not explained, despite exploration programs by Falconbridge Nickel Mines Limited and Total Erickson Resources Ltd. The hole by Logan Resources intersected carbonaceous and pyritic mudstone and limestone to 527 metres, then serpentinite, the cause of the magnetic response.

Silver Standard Resources Inc. obtained the **Silvertip** silver-lead-zinc prospect (104O 038) from Imperial Metals Corporation in exchange for a combination of cash and shares. Silver Standard will continue to hold the property on a care and maintenance basis until commodity prices improve.

ATLIN AREA

The **Tulsequah Chief** project, owned by Redfern Resources, received a Project Approval Certificate from the Minister of Energy and Mines and the Minister of Sustainable Resource Management. The approval allows for development of a 2250 tonne per day underground copper, lead, zinc, gold and silver mine, and construction of a 162 km access road from Atlin.

First Au Strategies Corp. funded a drilling program on the **Thorn** gold-silver prospect (104K 031) under an agreement with Rimfire Minerals Corporation. High sulphidation enargite-tetrahedrite-tennantite-pyrite mineralization is associated with intense sericite-clay alteration and a Cretaceous biotite-quartz-feldspar porphyry that intrudes coeval volcanic rocks. Drilling was directed at some of the numerous high-grade veins on the property. Two holes on each of the I and Tamdhu zones delineated steeply south-dipping structures but with lower grade than those found on surface; the best intercept was 3.05 g/t Au, 454 g/t Ag and 3.65% Cu over 1.65 metres in the Tamdhu zone. Another drill target was the newly discovered Oban breccia zone which is 300 metres in diameter. Although three shallow drill holes returned only elevated metal values, it remains a prime target for continued drilling in 2003 because of its tonnage potential.

The B.C. Geological Survey mapping project led by Mitch Mihalynuk in the Nakina area discovered a new high-grade copper showing at the head of Horsefeed Creek, 75 km southwest of Atlin. Named **Joss'alun**, semi-massive chalcopyrite and pyrite is conformable within mafic volcaniclastic rocks of the Cache Creek Group. Chip samples assayed 7.33% Cu across 0.35 metres and 3.35% Cu across 0.9 metres. Copper Ridge Explorations Inc., Imperial Metals Corporation and Tenajon Reources Corp. acquired claims soon after the discovery was announced.

Stirrup Creek Gold Ltd. expanded its claim holdings over the **Adanac** molybdenum deposit at the head of Boulder Creek, 25 kilometres east of Atlin, and re-formulated geologic data to assess potential for a plutonic-related gold deposit. The company carried out rock and soil sampling and a magnetic survey.

On the outskirts of Atlin, Gary Lee excavated trenches on the **Beavis** (104N 007) prospect to extend epithermal gold veins. At **Yellow Jacket** (104N 043) on Pine Creek in the Atlin placer district, Lenard Diduck excavated 245 metres of trenches in search of lode gold. Results are not available.

The **Golden Eagle** property of Marksmen Resources Ltd. comprises two claim groups located east and west of Tutshi Lake. East of the lake, the Carbonate and Camp zones (104M 071) are areas of anomalous gold and copper in rock and sediment samples in carbonate and chlorite-altered mafic volcanic rocks of the Stuhini Group. The target is a VMS deposit or an epigenetic deposit related to the Llewellyn fault. West of the lake, the Tannis zone contains Cretaceous intrusive-hosted vein-type gold mineralization (104M 074, 075). In addition, work by the B.C. Geological Survey indicates Jurassic felsic volcanic rocks have poten-

tial to host VMS mineralization. Marksmen performed IP and limited magnetic and geochemical surveys.

INDUSTRIAL MINERALS AND GEMSTONES

Fireside Minerals Limited mined 6500 tonnes of barite ore from the Bear East pit on the **Fireside** property (94M 003), which is 125 km east of Watson Lake. Barite that remained from 2001 was ground and bagged at the company's plant in Watson Lake and sold to finance startup. Due to a weak market, only 1500 tonnes of barite mined this year was processed, the balance was stockpiled at the mine site. Jigs at the mine, normally used to upgrade the barite, were not operated.

Nephrite jade was produced from two properties in the Turnagain River area east of Dease Lake. Jedway Enterprises Ltd. was contracted by Polar Gemstones to mine and ship 60 tonnes from **Polar Jade**. Jedway shipped 40 tonnes of jade that had been mined in prior years from the **Blue J** property near Kutcho Creek. Jedway also mined and shipped about 22 tonnes of jade recovered from the Cassiar waste dump, under agreement with **Cassiar** Mines & Metals Inc. The Jade West Group markets the jade, mainly to Chinese and Korean buyers.

There was little activity on precious opal projects in the region. Cantec Ventures Inc. terminated its option of the **Firestorm** opal property 20 km west of Burns Lake. Operator status reverted to the Schaefer family who reclaimed the access trail and exploration trenches. No work was conducted on the **Whitesail** opal property south of Huckleberry mine although the owners continue to market previously mined material.

Pacific Ridge Exploration Ltd. announced recovery of a microdiamond from a kimberlitic diatreme dike on its **Xeno** property (94L 017) located near the Turnagain River about 140 kilometres east of Dease Lake. The diamond measures 0.38 by 0.30 by 0.25 mm and was obtained by caustic fusion of a 32 kg sample collected in 2001 during investigation of occurrences of rare earth elements. The diatreme occurs in a complex of Paleozoic alkalic rocks and carbonatite 15 kilometres west of the Rocky Mountain Trench, an area underlain by continental crust. Pacific Ridge intends to deal the project to a diamond exploration company.

PLACER MINING

Placer gold mining in the Atlin and Dease Lake areas continued at a reduced level for the third year. Many operators remain idled by the low gold price, high cost of fuel, and scarcity of shallow paydirt. There were 24 mining projects in the region, similar in number to last year, and 34 exploration projects, an increase from 2001. There were two reclamation projects in 2002.

In the Atlin district, **Ruby Creek** continued to be the main area of activity with about 40 workers at three operations. Attracted by the success of Ruby Gold Ltd., two other companies began mining through Quaternary basalt, 30 to 50 metres thick, in search of rich placer gravel underneath. The basalt comprises three columnar-jointed flows locally separated by a red scoria horizon. Stripping of basalt waste rock requires conventional mine equipment; tank drills, loaders and 35 to 50 tonne haul trucks. Sisters Resources excavated a 50 metre wide strip along the left (east) bank of Ruby Creek upstream from the Ruby Gold pit. About 15 000 cubic metres of gravel was washed, one-half the expected quantity. The centre of the paleo-channel containing more gold is thought to be further into the bank. There was not enough time in the field season for Sisters Resources to complete another stripping cycle, so they moved their mining equipment to Otter Creek. Further upstream on Ruby Creek, a joint venture between West Coast Paving Co. Ltd. and Westrail Construction Ltd. excavated a 50 metre deep test pit based on the results of a fence of five exploration holes. The paychannel is indicated to be 55 metres wide and 9 metres thick. Pelly Construction Ltd. took over as operator of the Ruby Gold joint venture and did a 7-metre setback of the pit high wall.

There was increased mining on **Thibert Creek** in the Cassiar district, and encouraging test work to suggest that mining will continue for many years. Operating a floating wash plant, Taiga Ventures sluiced about 60 000 cubic metres of gravel on lower Thibert Creek. Angel Jade Mines Ltd. outlined a large area of paygravel in the alluvial fan at the mouth of the creek, near the north end of Dease Lake. Testing indicates acceptable gold grade and favourable opearating costs, so that a large operation is planned. Historic and recent testing suggest recovery of platinum group elements (palladium, platinum and osmiridium) may contribute substantially to the proceeds. Wesley Gwilliam and Trio Gold Ltd. tested further upstream on Thibert Creek and along its tributaries, Vowell and Cache creeks. Michael Swenson continued to mine on **Dease Creek** and is investigating the amount of platinum group elements in his concentrate.

COAL AND ENERGY PROJECTS

Fortune Minerals Limited acquired the immense **Klappan** anthracite coal property from Conoco Canada. Measured and indicated resources are 260 million tonnes primarily in the Lost-Fox deposit. Inferred and speculative resources total an additional 2.54 billion tonnes in four deposits. Fortune Minerals contemplates a mining rate of a one-half to two million tonnes per annum, marketing premium coals for water purification, cooking briquettes and metallurgical applications. A more direct road link to Stewart than the existing 410 km route and a local market for thermal power generated from high ash fine coal would be of particular assistance to project economics. The nearby Red Chris deposit might provide such an opportunity.

ACKNOWLEDGEMENTS

I sincerely thank prospectors, geologists and engineers, and mine staff for their hospitality while visiting their exploration projects and mines. This report would not be possible if they did not share information and their input is gratefully acknowledged. I also greatly appreciate the help of co-workers in the Mines office, Daryl Hanson, Doug Flynn and Bruce Graff.

NORTHEAST-CENTRAL BRITISH COLUMBIA

Bob Lane, PGeo
Regional Geologist, Prince George

SUMMARY

Mineral exploration activity in the Northeast-Central region increased significantly in 2002. Exploration expenditures jumped 50% to an estimated $10.9 million and the amount of diamond drilling increased roughly 40% to approximately 70 000 metres. The number of major exploration projects increased from 14 to 22. The largest drilling program took place at the Kemess North porphyry gold-copper prospect. Other major exploration projects sought mainly gold-enriched porphyry, skarn, vein and coal deposits – many generated very encouraging assay results. Activity in the Peace River Coal Fields slowed somewhat, but several advanced stage projects are moving towards feasibility and development.

Two mines operated during the year. The Kemess South mine continued to improve its operating efficiency by increasing both throughput and gold and copper recoveries. Higher average gold prices contributed to the success of the operation. The Bullmoose mine was on pace for record production as the waste rock: coal ratio diminished in the South Fork pit. However reserves are nearly exhausted and the metallurgical coal mine will close in April, 2003.

METAL MINES

KEMESS SOUTH

In 2002, Northgate Exploration Ltd. made several key improvements at its **Kemess South** mine (Photo 1), a 48 000 tpd open pit gold-copper operation in the Toodoggone, about 300 kilometres northwest of Mackenzie. The changes increased mine efficiency and reduced the overall cost of producing an ounce of gold. Two new column flotation cells were added to the mill circuit mid-year and resulted in a significant increase in both gold and copper recoveries. For the year these averaged 70% and 81% respectively. The average gold and copper grades of the concentrate were also increased. The concentrate haulage fleet was increased to 22 triple-axel units, in part to deal with concentrate that accumulated at the mine following transportation delays caused by the washout of a bridge along the route to the load-out in Mackenzie. A cyclone sand operation, designed to recover clean tailings (i.e. non-ARD generating), was constructed at the dam and trials were conducted late in the year. The clean sand will be used in dam construction and will reduce the need to transport waste rock from the pit to the dam. A new 32 cubic yard P&H cable shovel was commissioned in October and will further enhance production in the pit. Reserves as of December 31, 2001, stood at 132.6 million tonnes grading 0.704 g/t Au and 0.233% Cu. Production for 2002 totaled 8781 kg (282 300 oz) of gold and 33 070 tonnes (72.9 million lbs) of copper from milling 17.3 million tonnes of ore. Average mill throughput for the year was 47 420 tonnes per day.

OTHER MINES

The **Gibraltar**, **Mount Polley** and **QR** mines, all located in the Cariboo, are currently on 'care-and-maintenance' status. The economics of each operation is re-evaluated on a regular basis while alternatives to traditional milling and metal recovery, such as hydrometallurgical processing, and measures that would result in lower overall mining costs, are investigated.

COAL MINES

BULLMOOSE

The **Bullmoose** mine (Photo 2), owned by partners Teck Cominco Limited (61%), BHP-Billiton (29%) and Nissho Iwai (Canada) Ltd. (10%), is the only major operating coal mine in the region. It is located near the town of Tumbler Ridge and produces medium-volatile bituminous coal from the Lower Cretaceous Gates Formation. Production in 2002 increased substantially to an estimated 2.1 million tonnes of clean coal as the stripping ratio shrunk dramatically. The work force at the mine also declined through the year and by the end of 2002 totaled 220. Teck Cominco announced its plans to close the mine in early April, 2003.

Photo 1. View of the Kemess South mine looking east.

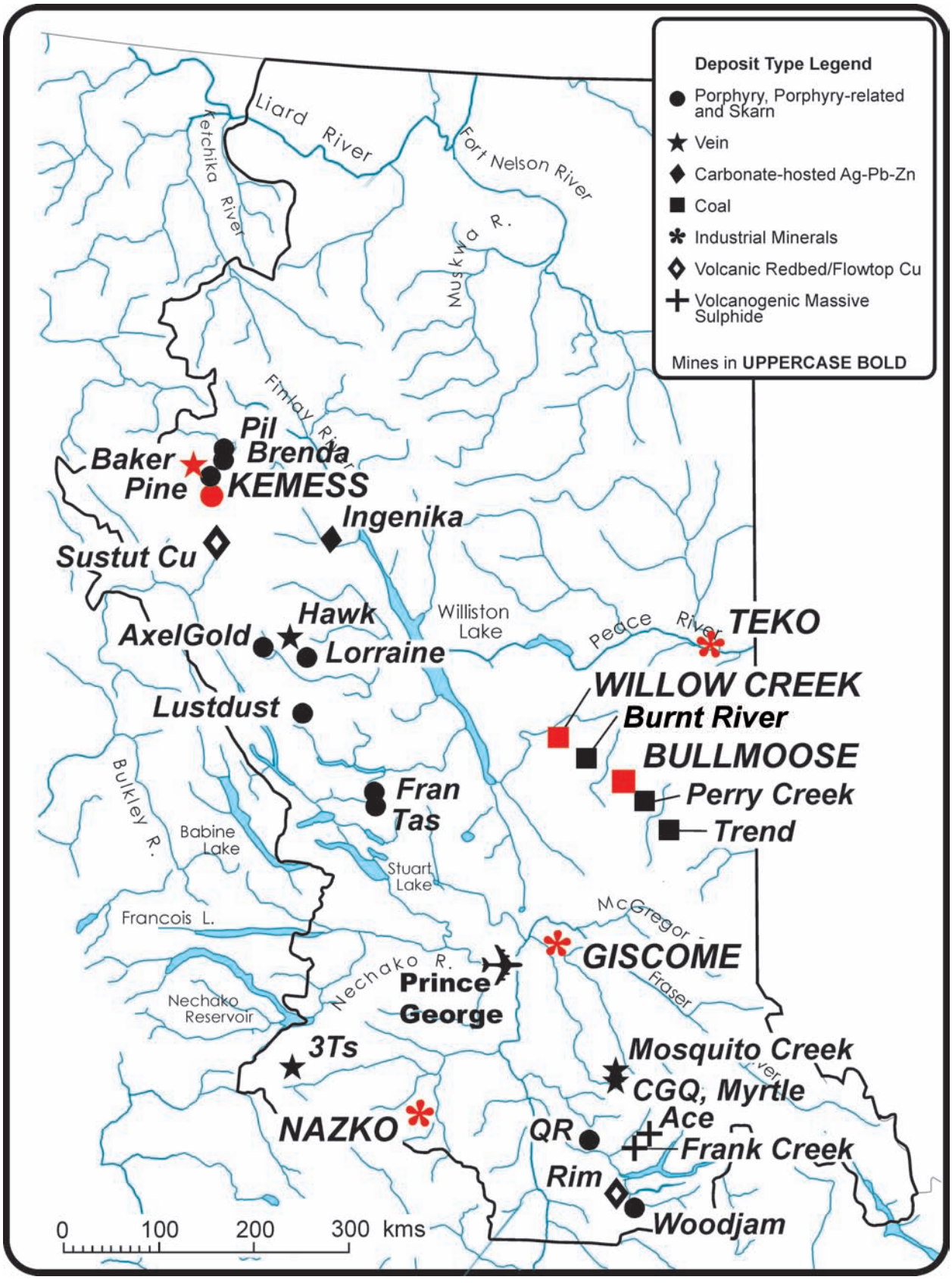

Figure 1. Operating mines and selected exploration projects, northeast-central British Columbia - 2002.

Photo 2. Aerial view of the South Fork pit at the Bullmoose mine near Tumbler Ridge.

Reclamation of the mine site has been ongoing for several years, but will become a higher priority upon closure, and is expected to continue for at least 2 to 3 years. The Bullmoose mine, which opened in 1983, has produced and shipped approximately 32 million tonnes of metallurgical coal to Japan.

WILLOW CREEK

The **Willow Creek** property, 45 kilometres west of Chetwynd, is owned by Globaltex Industries Inc. (67%) and Mitsui Matsushima Canada Ltd. (33%). Late in 2001 and early in 2002, the operator, Pine Valley Coal Ltd., mined and shipped a total of 84 400 tonnes of coal to Japan. Coal came mainly from a single pit developed on the '7' seam, but a subordinate tonnage was excavated from the thinner '6' seam that occurs up-section. The coal measures at Willow Creek occur within the Cretaceous Gething Formation on the east limb of the Peace River anticline. They are low-volatile bituminous in rank and are suitable for the Pulverized Coal Injection (PCI) market, a partial replacement for coke in the steel-making process. Current established mineable reserves for the property total 12.3 million tonnes. A new feasibility study, completed in September, 2002, estimated initial capital costs of about $24.1 million to upgrade the site for annual production of 950 000 tonnes per year over a 14-year mine life.

INDUSTRIAL MINERAL MINES

Canada Pumice Corporation produced 23 000 cubic metres of screened and sized tephra from its **Nazko** quarry west of Quesnel. The material is used for landscaping, sporting facilities, growing and filtration media and lightweight aggregate applications. Shipments have been transported by rail as far east as Toronto. The company is continuing to develop new markets, particularly along the west coast of North America. Canada Pumice has also studied options for a significant expansion of its quarry operation to meet increasing demands for its products.

The **Giscome** limestone quarry of Pacific Lime Products Ltd., near the community of Giscome east of Prince George, produced small quantities of crushed limestone for use in local pulp mills.

The **Teko** pit, 4 kilometres west of Taylor near Fort St. John, is a joint Ministry of Transportation and Highways, British Columbia Assets and Lands Corporation, and British Columbia Railway venture. It was a major aggregate crushing operation in 2001 and was reactivated for an 8 to 10 week period in the fall of 2002. During that time an estimated 320 000 tonnes of product was generated for use as road construction material mainly for the oil and gas sector in northeast British Columbia.

EXPLORATION TRENDS

An estimated $10.9 million was spent on exploration in the region (Figure 2) during 2002. This figure represents more than a 50% increase over last year's total ($7.2 million) and marks the third consecutive increase in annual exploration expenditures for the region. The amount of exploration drilling also increased for the third consecutive year.

TABLE 1
2001 MINE PRODUCTION AND RESERVES, NORTHEAST-CENTRAL REGION

Mine (Operator)	**Employment**	**Production (approx.)**	**Reserves (Jan. 1, 2002)**
Kemess South (Northgate Exploration Ltd.)	440	8781 kg (282 300 oz) Au, 33 070 tonnes (72.9 M lbs) Cu	132.6 million tonnes grading 0.704 g/t Au and 0.233% Cu
Bullmoose (Teck Cominco Ltd.)	220	2.1 million tonnes of metallurgical coal	Mine to close in April, 2003; reserves exhausted
Willow Creek (Pine Valley Coal Ltd.)		84,400 tonnes PCI coal	12.3 million tonnes
Nazko (Canada Pumice Corp.)	4	23 000 m^3 tephra	

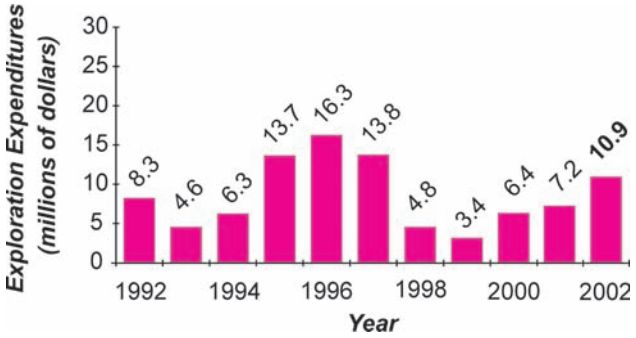

Figure 2. Annual Exploration Expenditures, Northeast-Central Region.

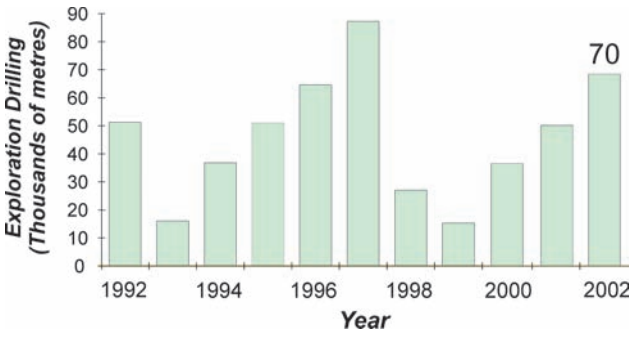

Figure 3. Annual Exploration Drilling, Northeast-Central Region.

It totaled 70 000 metres in 2002, up more than 20 000 metres from last year (Figure 3). Approximately 23 000 metres of the drilling represents deposit appraisal and the remainder is considered to be exploration drilling (advanced and early-stage). The total number of Notice of Work (NoW) applications received for projects in the region was 472, down more than 14% relative to 2001 (Table 2). This was due primarily to the subdued level of placer activity. There were 22 major exploration projects (those that involved mechanical disturbance and expenditures in excess of $100 000), eight more than in 2001 (Table 3). A number of 2002 projects produced very encouraging results and bode well for future exploration successes.

Recovery and stabilization of the price of gold at well above the US$300 mark heavily influenced exploration in the region in 2002. The search for gold-bearing mineral deposits accounted for about 84% (or $9.2 million) of the exploration dollars spent in the region. Porphyry copper systems, in particular those with potential for significant gold enrichment, continue to be the most sought after targets in the region, and accounted for 59% of total exploration spending. Seven of the twenty-two major exploration projects, including AxelGold, Brenda, Fran, Kemess North, Lorraine, Tas and Woodjam, focused on gold-enriched porphyry systems. Five major metallic mineral projects keyed on epithermal or mesothermal gold deposits; three others, Lustdust, Pine (VIP) and QR, targeted auriferous skarn mineralization; two explored polymetallic volcanogenic massive sulphide targets; and the last two examined volcanic redbed copper deposits. Most of these projects generated encouraging drill assay results. There were three major coal projects, Burnt River, Perry Creek and Trend. Each major project is reviewed in the Exploration Summary section following.

EXPLORATION SUMMARY

TOODOGGONE CAMP

There was a revival of exploration in the Toodoggone camp in 2002. Exploration was focused primarily on bulk tonnage deposits associated with Early Jurassic calc-alkalic intrusions. Companies carried out four major exploration programs and completed several smaller, early stage projects that may lead to more advanced work in the coming years.

The largest exploration program in the region was conducted by Northgate Exploration Ltd. on its **Kemess North** (094E 021) porphyry gold-copper deposit (Photo 3) located about 5.5 kilometres north of the Kemess South open pit. Northgate fought thick accumulations of snow during the initial stage of the project that began in early June. The company re-conditioned and upgraded a former exploration trail to provide low cost access for the expanded drilling program. A total of 44 additional core holes further evaluated Kemess North. Drilling completed in 2000 and

TABLE 2
NOTICE OF WORK (NOW) SUBMITTALS FOR PROJECTS IN THE NORTHEAST-CENTRAL REGION

Type of NoW	Year							
	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Mineral	221	184	164	115	86	112	109	93
Placer	498	440	415	403	393	422	397	320
Coal	3	4	5	5	2	1	9	8
Other	67	58	57	56	42	33	34	51
Total NoW	**789**	**686**	**641**	**579**	**523**	**568**	**549**	**472**

2001 identified a resource of 442 million tonnes grading 0.40 g/t Au and 0.23% Cu for the deposit. Northgate also tested the Nugget (12 holes) and Kemess East (4 holes) targets. These lie to the west and southeast of Kemess North, respectively, and had received only limited attention in the past.

Results at Kemess North were generally encouraging and expanded the dimensions of the higher-grade 'porphyry dome' core of the deposit to 700 metres by 400 metres. The central portion of the deposit is up to 370 metres thick and is characterized by intense silica-flooding that is accompanied by magnetite-pyrite and lesser chalcopyrite as disseminations, patchy networks and narrow semi-massive to massive bands. This zone of replacement occurs along the contact between a quartz monzodiorite sill and overlying intermediate volcanics of the Takla Group. Based on the results of this year's drilling the company is proceeding directly to pre-feasibility.

Drilling at Nugget intersected a porphyry system with characteristics similar to those of Kemess North. Three subhorizontal quartz monzodiorite bodies were intersected in hole KN-02-23. The hangingwall contact of each monzodiorite interval displayed intense silica-replacement with associated magnetite, pyrite and chalcopyrite mineralization. Both the intrusive material and host intermediate volcanic flows are altered and mineralized (Photo 4), but these diminish in intensity away from the contacts, where a series of weakly mineralized sheeted quartz veinlets are developed. Each zone corresponds with significant gold and copper assays (e.g. 62.0 metres grading 0.55 g/t Au and 0.134% Cu). This setting is likely a narrower version of the 'porphyry dome' core of the Kemess North deposit, where virtually all textures are obliterated. The best intersection at Nugget averaged 0.455 g/t Au and 0.191% Cu over 115.6 metres. Hole KN-02-55, collared approximately 300 metres west of the edge of the proposed Kemess North pit, intersected two significant intervals of gold-copper mineralization. There remains an untested area roughly 700 metres long between this hole and the Nugget zone. Two of the four Kemess East holes intersected narrow intervals of gold mineralization and will be followed up in 2003.

Stealth Minerals Ltd. evaluated several gold prospects on its vast **Pine** property that straddles the Finlay River,

Photo 3. Drilling in the East Cirque, Kemess North project.

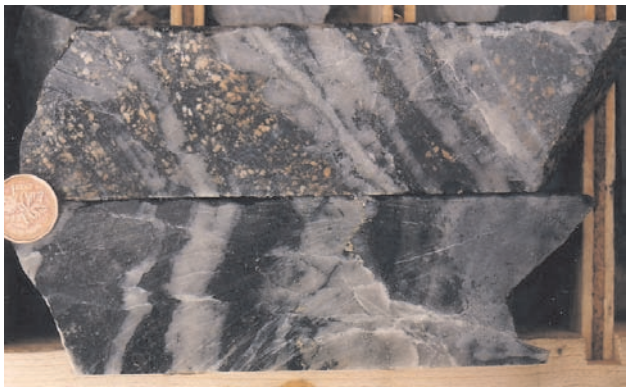

Photo 4. Sheeted veins cutting silicified quartz monzodiorite (above) and andesite (below), Nugget zone.

about 20 kilometres north of the Kemess South mine. Trenching on the **Wrich Hill** (094E 047, 048) epithermal gold prospect, located south of the river within view of the Kemess North drills, exposed a 150-metre wide zone of silica and clay-altered dacitic tuff of the Toodoggone Formation that lies immediately east of the northwest-trending Wrich fault. Two sub-parallel zones, 20 to 50 metres in width, are characterized by chalcedonic-quartz stockworks, brecciation and silica-flooding. Pyrite occurs in trace amounts as fine wispy disseminations. Earthy hematite, limonite and manganese oxide are locally abundant. Assay results from 4 excavated trenches and surface sampling define the zone along its north-northwest strike for more than 150 metres, although mineralized float occurs over a length of 1.2 kilometres. Trench 2 cut a zone of silicified dilational breccia that averaged 2.04 g/t Au and 10 g/t Ag over 48 metres, including a 2-metre interval that graded 17.33 g/t Au. Sampling of the nearby **Goat** prospect generated some spectacular assay results, including a 40-centimetre chip sample from the Black quartz-carbonate vein that graded 165.8 g/t Au and 397 g/t Ag.

North of the Finlay River, Stealth completed bedrock mapping, geochemical and geophysical surveys, and trenching on its **VIP** (094E 082) skarn system (Photo 5). Chalcopyrite-bearing, mainly garnet-actinolite-epidote-calcite-magnetite skarn, developed along the con-

Photo 5. Trench dug on the VIP auriferous skarn occurrence, Pine property.

tact between a screen of limy volcanic-sedimentary rocks of the Pennsylvanian-Permian Asitka Group and granodiorite of the Early Jurassic Black Lake intrusive suite. A total of 17 trenches were dug to examine several east-northeast trending bands of gold-silver-copper skarn mineralization, that range from 10 to 20 metres wide, on the West, North and East zones. Most of the trenching occurred on the East zone where the favourable horizon was traced for more than 500 metres along strike. The best trench assay from the East zone averaged 1.41% Cu, 32.6 g/t Ag and 5.81 g/t Au over 6 metres. The most encouraging trench assay from the West zone averaged 2.77 g/t Au and 0.22% Cu over 24 metres; this interval included 6 metres grading 9.4 g/t Au, 22.75 g/t Ag and 0.72% Cu that is hosted within a crowded feldpsar porphyry dyke.

In July, 2002, Northgate Exploration optioned the **Brenda** (094E 147) porphyry gold-copper property, 25 kilometres northwest of the Kemess South mine, from Canasil Resources Inc. Northgate evaluated the property with high resolution magnetic, radiometric and satellite imaging surveys and produced a number of drill targets. Four holes totaling 1649 metres were drilled in the general vicinity of the White Pass zone, an area marked by intense alunite alteration. Previous drilling had intersected significant gold+/-copper mineralization at shallow depths. Northgate's program targeted the porphyry system at greater depths and encountered mineralization associated with potassic alteration and silicification of intermediate flows of the Triassic Takla Group. The setting is similar to that at Kemess North. The best assay from the 2002 drilling was 25.7 metres grading 0.417 g/t Au and 0.028% Cu from a down-hole depth of 296.1 metres in hole BR-02-02. Northgate plans to continue drilling in 2003.

Further north, owner/operator Sable Resources Ltd. explored its **Chappelle** property, which surrounds the Baker (094E 026) mine, for both high-grade gold and bulk tonnage gold+/-copper mineralization. Nine drill holes and two trenches evaluated a 300 metre by 1000 metre gold soil geochemical anomaly in the Black Gossan area, where oxidized pyritic andesite of the Triassic Takla Group forms a prominent gossan. Five holes targeted I.P. resistivity lows east and west of the B zone, a high-grade gold vein that has been mined on a seasonal basis. Results from the work have not been disclosed.

Finlay Minerals Ltd. identified seven coincident geochemical-geophysical (I.P. and Mag) anomalies on its **Pil North** property, centered approximately 35 kilometres north of the Kemess South mine. The zones are underlain by phases of the Early Jurassic Black Lake intrusive suite, and are characterized by propylitic to phyllic alteration and pronounced gossans. The East and Milky zones have a polymetallic geochemical signature characterized by highly anomalous gold and silver values, and inconsistent copper and zinc values. At the East zone, hand trenching exposed diorite that is brecciated and flooded with silica and small amounts of barite, galena and sphalerite. At the Milky zone, a 10-metre interval of Potassic feldspar-magnetite-quartz stockwork, associated with phyllic alteration in monzonite, averaged 0.52 g/t Au. Both zones are priority targets for 2003.

Doublestar Resources Ltd., in partnership with Northgate Exploration Ltd. and Procon Mining and Tunnelling Ltd. conducted an infill and definition drilling program on the Southeast zone at the **Sustut** (094D 063) volcanic redbed copper deposit, which is located approximately 65 kilometres south of the Kemess South mine. The Southeast zone is a gently dipping tabular body that has an estimated resource of 5.937 million tonnes grading 1.87% Cu and 6.11 g/t Ag, based on a copper cut-off grade of 0.70%. The 2002 drilling provided the data required to calculate a 'measured mineral resource' that is consistent with National Instrument 43-101 (NI 43-101) standards. Baseline environmental, geotechnical and metallurgical studies were also conducted. Mineralization consists of disseminated chalcocite, bornite, chalcopyrite and native copper in volcanic conglomerates, grits and sandstones of the Upper Triassic Moosevale Formation of the Takla Group. In November, Doublestar announced that a full feasibility study on the project would be completed in the first quarter of 2003. The project will require development of an 11 kilometre access road that would branch off from the existing Omineca Mine Access Road (OMAR).

OMINECA MOUNTAINS

Activity in the Omineca Mountains region increased in 2002 with major diamond drilling programs at several properties including Hawk, AxelGold, Lustdust and Lorraine.

On the **Hawk** (094C 138-140) property (Photo 6), located 70 kilometres northwest of Germansen Landing, mesothermal gold veins were the target of a mapping, geochemical sampling and diamond drilling program by Redcorp Ventures Ltd. The property is underlain by the Duckling Creek syenite complex, one of several components of the Late Triassic to Early Cretaceous Hogem Intrusive Suite. Previous work by Amoco and UMEX in the 1970s, focused on the copper-molybdenum potential of the property. Exploration by Cyprus (Gold) Canada and

Photo 6. Bob Carmichael of Redcorp Ventures examining the Radio North vein, Hawk property.

TABLE 3
MAJOR EXPLORATION PROJECTS IN NORTHEAST-CENTRAL BRITISH COLUMBIA.

Property (Operator)	MINFILE	NTS	Commodity	Deposit Type	Work Done
Ace (Barker Minerals Ltd.)	093A 142	93A/11W	Cu, Pb, Zn, Au, Ag	vms	5 ddh, 646 m; geophys; geol
AxelGold (Rubicon Minerals Ltd.)	093N 196	93N/13W	Au, Cu	porphyry	10 ddh, 1250 m
Baker / Chappelle (Sable Resources Ltd.)	094E 026	94E/06E	Au, Ag	epithermal vein	14 ddh, 734 m; trench
Brenda (Northgate Exploration Ltd.)	094E 147	94E/07E	Au, Cu	porphyry	4 ddh, 1649 m; airborne geophys
Burnt River (Western Coal Corp.)	093P 007-008	93P/05W	coal	sedimentary	28 rdh, 1323 m; spot coring
Cariboo Gold Quartz [Bonanza Ledge, BC Vein] (International Wayside Gold Mines Ltd.)	093H 019	93H/04E	Au	pyrite replacement, mesothermal vein	18 ddh, 3394 m; trail constr;
Fran (Navasota Resources Ltd.)	093N 207	93N/16W	Au, Cu	porphyry	27 ddh, 4105 m; geophys
Frank Creek (Barker Minerals Ltd.)	093A 152	93A/11W	Cu, Pb, Zn, Au, Ag	vms	6 ddh, 813 m; trench; geophys; geol
Hawk (Redcorp Ventures Ltd.)	094C 138-140	94C/04E	Au, Ag	mesothermal vein	12 ddh, 1534 m; grid
Kemess North (Northgate Exploration Ltd.)	094E 021	94E/02E	Au, Cu	porphyry	60 ddh, 34380 m; airborne geophys
Lorraine (Eastfield Resouces Ltd.)	093N 002	93N/14W	Au, Cu, PGE	magmatic-porphyry	6 ddh, 1105 m; geol
Lustdust (Alpha Gold Corp.)	093N 009	93N/11W	Au, Ag, Zn, Cu, Pb	skarn, manto, porphyry	19 ddh, 7790 m; geol
Mosquito Creek Gold (Island Mountain Gold Mines Ltd.)	093H 010	93H/04E	Au	pyrite replacement, mesothermal vein	4 ddh, 402 m; trench; prosp; geochem
Perry Creek (Western Coal Corp.)	093P 015	93P/3W	coal	sedimentary	40 rdh, 1500 m; spot coring; bulk sample
Pine [VIP, Wrich Hill] (Stealth Minerals Ltd.)	094E 047-048, 094E 082	94E/02E	Au, Ag, Cu	epithermal vein (Wrich Hill) skarn (VIP)	grid; IP; mag; trench; geochem
QR (Cross Lake Minerals Ltd.)	093A 121	93A/12W	Au	skarn (propyllite)	19 ddh, 1692 m; trench; geochem
Rim (Phelps Dodge Corp. of Canada Ltd.)	-	93A/05E	Cu, Ag	volcanic redbed copper	grid; IP; Mag/VLF-EM; 5 ddh, 806 m
Sustut Copper (Doublestar Resources Ltd.)	094D 063	94D/10E	Cu, Ag	volcanic redbed copper	27 ddh, 2289 m infill & geotech program
Tas (Navasota Resources Ltd.)	093K 080	93K/16W	Au, Cu	porphyry	7 ddh, 1270 m
Trend [Roman Mtn.] (Consolidated Goldbank Ventures Ltd.)	-	93I/15W	coal	sedimentary	9 rdh, 525 m; trench
Tsacha-Tam-Taken (Southern Rio Resources Ltd.)	093F 055, 068	93F/02W, 03E	Au, Ag	epithermal vein	11 ddh, 1313 m; resistivity
Woodjam (Wildrose Resources Ltd.)	093A 078	93A/6W	Au, Cu	porphyry	5 ddh, 1009 m

Castleford Resources in the 1990s focused on high-grade gold veins and identified the Radio North, Radio South, SW and AD veins. In 2002, Redcorp extended the strike length of the Radio North and Radio South veins and linked them up to the SW vein, generating an overall strike length to the zone of more than 3 kilometres. These narrow, sub-vertical veins have a west-northwest trend and occur in weakly altered, pale pink syenite. Veins are consist of quartz with pyrite and chalcopyrite with or without visible gold. Surface samples produced assays of up to 123 g/t Au. Five drill holes encountered discrete veins over 1300 metres of strike length; the best intersection assayed 18.79 g/t Au over an estimated true width of 0.2 metre. However, the most encouraging drill results were obtained from the AD vein, which crops out about 1.5 kilometres to the north. The AD vein is associated with sericitic alteration in granite and includes stockwork and breccia zones that result in more significant widths. Veins are generally steeply dipping and

trend westerly. The best intersection from two holes drilled on the AD assayed 4.66 g/t Au, 25.06 g/t Ag and 0.48% Cu over a true width of 5.0 metres (including 8.6 g/t Au, 35.4 g/t Ag and 1% Cu over a true width of 1.6 m).

The Zulu and Rainbow veins, discovered in 2002, were also evaluated. These veins occur between the Radio-SW and AD zones. The Zulu vein was traced on surface for more than 450 metres. It was tested by five holes over a 60-metre strike length and to a depth of 100 metres. The best assay from Zulu came in hole HK02-011 that averaged 4.43 g/t Au over an estimated true width of 1.8 metres. In contrast to other veins on the property, the Rainbow vein has a shallow dip to the north—an orientation previously unrecognized on the property. Redcorp is expected to further evaluate the high-grade, mesothermal gold vein potential of the property in 2003.

Wheaton River Minerals Ltd. optioned the **AxelGold** (093N 196) alkalic porphyry prospect, 55 kilometres north of Takla Landing, from operator Rubicon Minerals Corporation. The property lies west of the Pinchi fault and is underlain by a multi-phase syenite intrusion of uncertain age that cuts sediments of the Paleozoic Cache Creek Group and volcanics of the Triassic Takla Group. It has potential for both bulk mineable low-grade gold and structurally-controlled high-grade gold deposits. Rubicon completed an 8-hole, 1250-metre drilling program designed to test strong gold-in-soil anomalies in the Gossan Hill area of the property. Previous drilling and trenching tested pyritized syenite porphyry cut by narrow calcite-fluorite-quartz stringers containing trace amounts of tetrahedrite, stibnite and molybdenite. Diamond drilling conducted by Imperial Metals in 1987 intersected a mineralized intrusion that assayed 2496 ppb Au over 7.3 metres (in hole AX87-3) and 352 ppb Au over 36.6 metres (in hole AX87-5). Unfortunately, the 2002 program did not produce any significant results and Wheaton River relinquished its interest in the property.

Eastfield Resources Ltd. conducted two modest phases of diamond drilling on its **Lorraine** (093N 002) copper-gold porphyry system, located about 190 kilometres northwest of Fort St. James in the Swannell Ranges. The Lorraine property is underlain entirely by the Hogem intrusive suite, a Late Triassic to Middle Jurassic multiphase intrusion of calcalkaline to alkaline composition that is intruded by Early Cretaceous granites. The highest and most continuous grades of mineralization occur in syenitic phases and, locally, in biotite pyroxenites. Mineralization typically consists of fine to coarse-grained disseminations of chalcopyrite and bornite, however net-textured sulphides in pyroxenite have also been noted. Drilling was successful in extending the Lower Main zone further to the southwest. Hole 2002-62, collared 87 metres southwest of hole 2001-48, intersected 51 metres grading 0.89% Cu and 0.61 g/t Au within a 149-metre interval that averaged 0.57% Cu and 0.38 g/t Au. In addition to drilling, 11.6 line-kilometres of IP were completed on several targets including the All Alone Dome, where a 500-metre by 500-metre chargeability high, that coincides with a large copper soil anomaly was outlined. The present geological resource estimate for the property is 32 million tonnes grading 0.66% Cu, 0.17 g/t Au and 4.7 g/t Ag. Drilling is expected to continue at Lorraine in 2003.

Owner/operator Alpha Gold Corp. conducted another aggressive diamond drilling campaign in 2002 on its **Lustdust** (093N 009) polymetallic prospect, located 210 kilometres north-northwest of Prince George. The property lies 2 kilometres west of the Pinchi fault and is underlain by deformed oceanic rocks of the Cache Creek Terrane that have been intruded and altered by the Eocene Glover stock, an elongate body of monzonite, and also a series of related feldspar megacrystic dikes and sills. The company drilled 19 holes for an aggregate length of approximately 7790 metres. The drilling program was focused on extending the strike and down dip potential of previously identified auriferous skarn mineralization in the vicinity of Canyon Creek. The 'Canyon Creek' skarn is a north-northwest trending garnet-dominated body that lies immediately east of the Glover stock. Skarn mineralization occurs on the limbs and in the core of a north-northwest striking, tightly folded sequence of phyllites, argillites, cherts, mafic volcanics and carbonates.

Skarn mineralization is best developed within a geochemically receptive calcareous mafic tuff unit (Photo 7) that has been traced for more than 500 metres along strike and ranges in width from 3 metres to more than 110 metres. The highest gold-copper grades occur at the contact between the marble and altered tuff where skarn bodies with local massive sulphide replacements have developed. Hole 02-09 cut a 90-metre thick skarn assemblage within which a 9.7 metre intersection of semi-massive sulphide assayed 36.7 g/t Au, 182.6 g/t Ag and 2.89% Cu. The mineralization is within a continuous auriferous polymetallic vein, manto, skarn and porphyry system that occurs over a strike length of approximately 3 kilometres. A follow-up diamond drilling program is being planned for 2003.

In the Manson Creek area, Angel Jade Mines Ltd. trenched and sampled a number of mesothermal veins, in-

Photo 7. Exposure of weakly altered, non-mineralized calcareous mafic tuff, Lustdust property.

cluding one on the **Rainbow** property. The vein occurs near the McCorkell stone monument and is likely part of the Fairview mineral occurrence (093N 023) that has produced free gold. The showing consists of a 6-metre wide anastomosing quartz-carbonate vein within altered mafic volcanics that are part of the Manson Lake ultramafic complex. Mineralization consists of tetrahedrite, chalcopyrite and pyrite. The property was optioned to Seymour Exploration Corporation who intends to conduct a small drilling program in 2003.

Cross Lake Minerals Ltd. completed 4 drill holes totaling 491 metres on its contiguous **Ingenika** and **Swannell** lead-zinc-silver properties, located southwest of Ingenika Arm. The intent of the program was to identify silver-rich lead-zinc mineralization similar to that discovered at the former I*n*genika mine and nearby Onward prospects. Both occurrences are semi-massive to massive lead zinc silver veins and/or mantos hosted by silicified dolostone of Cambrian age. Three holes that were drilled to test a large base metal soil anomaly on the Swannell property, did not intersect mineralization. The fourth hole targeted a suspected extension to the Swannell base-metal showing and intersected a zone of brecciated limestone carrying coarse-grained sphalerite and traces of galena that graded 4.6 g/t Ag, 1.90% Zn and 0.37% Pb over 2.1 metres.

The **Fran** property (Photo 8), located near Inzana Lake approximately 70 kilometres northeast of Fort St. James, was explored by Navasota Resources Ltd. The property covers a high-level porphyry gold-copper system that is associated with an Early Jurassic granodiorite-quartz diorite stock and thermally altered fine-grained volcanic sediments and cherty argillites of the Upper Triassic Inzana Lake succession. Mineralization consists of disseminations and weak stockworks and veinlets of pyrite-chalcopyrite within pyrrhotite-bearing biotite hornfels, brecciated zones of the intrusion and in shear zones. The company conducted a major diamond drill program within a 1500-metre long northwest-trending gold geochemical anomaly (the 'Bullion Alley' trend) where several showings had been previously identified. Several holes intersected narrow quartz-pyrite-chalcopyrite veins carrying visible gold within a plagioclase porphyry phase of the intrusion and produced high-grade gold assays. The best intersection graded 33.12 g/t Au over 2.0 metres. Navasota concluded that the system lacked significant lateral extent and dropped its option on the property late in the year.

Photo 8. Winter drilling on the Fran property.

Navasota optioned the nearby **Tas** property from Derry Halleran and proceeded to drill 7 holes to test the West zone and a strong gold geochemical anomaly. The property is mainly underlain by augite-phyric intermediate flows of the Triassic Takla Group and covers numerous gold showings. One such showing, the Ridge zone, was the site of a small bulk sampling program in 1993 that yielded close to 1100 grams of gold from milling 32.4 tonnes of massive sulphide vein material. Drill holes that tested the gold geochemical anomaly encountered a swarm of plagioclase porphyry dykes and intrusion breccia locally carrying disseminated to semi-massive and massive pyrite, pyrrhotite, lesser chalcopyrite and traces of arsenopyrite. Hole TS-066 cut 12.45 metres of semi-massive to massive pyrrhotite-pyrite-chalcopyrite grading 2.3 g/t Au and 0.23% Cu. Further drilling is planned early in 2003.

Nation River Resources Ltd. drilled one hole and deepened an existing hole on its **Skook** property immediately north of Chuchi Lake. The program evaluated the porphyry copper-gold potential of part of the 'Skook Halo' (093N 140) where disseminated pyrite, pyrrhotite, and minor chalcopyrite and bornite occur in bleached and altered tuffaceous sediments of the Chuchi Lake succession near its contact with the Hogem intrusive suite. Results from the drilling program have not been announced.

ROCKY MOUNTAIN FOOTHILLS

The **Prophet River** property of Strategic Metals Ltd. covers the Cay (094G 017) occurrence, a Mississippi Valley-type germanium-gallium-zinc prospect. The 14-unit property, which lies 55 kilometres west of the Alaska Highway between the Prophet and Muskwa rivers, and is underlain mainly by dolomite and limestone of the Devonian Stone and Dunedin formations. In 2002, Strategic dug a series of hand trenches and test pits to evaluate a 2.5-kilometre zinc soil geochemical anomaly. A bulk sample taken in 1987 reportedly assayed 6.28% zinc, 0.36% lead, 400 g/t germanium and 30 g/t gallium. Sphalerite, galena, pyrite and pyrobitumen occur in the hinge, and to a lesser extent in the limbs, of an anticline within silicified and/or brecciated limestone. Assays results have yet to be received by the company.

PEACE RIVER COAL FIELDS

Advanced exploration and deposit appraisal of several key coal properties in the Peace River Coal Fields continued in 2002.

Western Canadian Coal Corp. completed a 28-hole, 1323–metre rotary and core drilling program on its **Burnt River** coal property, located 50 kilometres south of Chetwynd. The program was part of a study to evaluate the feasibility of a 750 000 tonne per year mining operation. Drilling successfully evaluated coal measures along the northwest trend of the Dillon Anticline. However, geological mapping and two holes that tested the structure to the

southeast identified the potential for additional low strip ratio coal. The company's short-term objective is to outline 8 million tonnes of low strip ratio coal within an existing 33 million tonne high strip ratio coal resource. The coal measures at Burnt River are classified as low volatile bituminous/semi-anthracite and are suitable for PCI markets. In some cases low volatile coal with minimal rheology can be added to coke oven blends in small quantities to improve yield without deteriorating coke quality or increasing coke oven pressure.

Western Canadian Coal Corp. conducted a rotary and core drilling program on its **Perry Creek** metallurgical coal property located between the Quintette and Bullmoose mines near Tumbler Ridge. The deposit occurs in a broad syncline with gently dipping limbs. The deposit occurs in a broad syncline with gently dipping limbs. The coal measures occur in the Lower Cretaceous Gates Formation, have a rank of medium-volatile bituminous and are of metallurgical quality. Approximately 25 six-inch diameter core holes were drilled on the 'J' seam in order to provide a 3.5 to 4.0 tonne bulk sample for a pilot-scale testing. The shallow northeast-dipping coal measures are beautifully exposed at a site proposed for development of an adit (Photo 9). The upper part of 'J' seam, the J1 and J2 splits, has a thickness of more than 6 metres. A 1.5 to 1.75 metre thick siltstone bed separates J2 from the 2-metre thick J3 seam. Exploration rotary drilling took place in three areas of the property to establish the locations of potential starter pits within a larger open pittable deposit.

The **Trend (Roman Mountain)** property is located immediately south of Babcock Falls and was last explored in 1974 (Dennison) and 1985 (Quintette Operating Company). In 2002 Consolidated Goldbank Ventures Ltd. conducted a trenching and rotary drilling program on the north-facing flank of Roman Mountain, where the steeply northeast dipping limb of a syncline exposes the Middle Gates Member and five coal seams. Seams D, E, F, G/I and J have a combined thickness of more than 15 metres. A narrow bed of pebble conglomerate is a consistent marker for the immediate hangingwall of D seam. Limited test pitting was conducted to accurately locate the position of the seams and nine rotary drill holes were completed. The program provided information on five of the seams and confirmed their thicknesses along strike to the northwest and southeast of previously drilled areas.

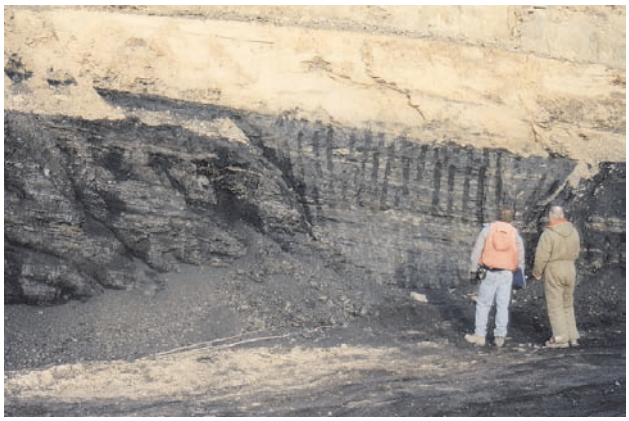

Photo 9. Upper part of the 'J' seam exposed at proposed adit site, Perry Creek property.

In addition to coal exploration, interest in the coalbed methane (CBM) potential of the Peace River coalfield also continued in 2002. The coal measures in the belt contain an estimated 60 trillion cubic feet (Tcf) of methane. A total of 5 wells were drilled in 2002. The number of holes is considerably less than those drilled for coal, but the total expenditure was probably greater because of depth and use of larger drilling equipment. Two of these wells in the Hudson Hope area were permitted as test holes (maximum depth 600 metres and no production allowed). Three holes were permitted as experimental schemes. These holes were drilled in the Highhat Mountain, Wolverine and Flatbed Creek areas. Data from these wells is confidential, but at this time none are in production.

NECHAKO PLATEAU

Exploration activity in the Nechako Plateau region consisted of one major drill program (3Ts) and several smaller projects. Grassroots prospecting was conducted by a number of individuals who sought to take advantage of an ever-increasing network of logging roads that have been built to access vast areas of trees infested with Mountain Pine Beetle, particularly east of Tweedsmuir Park.

Southern Rio Resources Ltd. carried out a very successful exploration drilling program on its **3Ts** property located in the Nechako Plateau approximately 120 kilometres south of Vanderhoof. The 3Ts property hosts numerous northerly-trending epithermal gold-silver quartz veins and includes the Tsacha (093F 055), Tam (093F 068) and Taken claim groups. On the Tsacha portion of the property, drilled and trenched by Teck Exploration Ltd. in the mid to late 1990s, two holes intersected the main Tommy vein at 200 metre and 400 metre step-outs, and extended the known strike length of the structure to more than one kilometre. Both holes cut the sub-vertical vein beneath a flat-lying micro-diorite intrusion. The intersections were weakly mineralized, but expand the potential for new well-mineralized shoots in this previously unexplored segment of the vein system. A revised resource estimate was calculated in, compliance with NI 43-101, for the main Tommy vein above the sill. The 'inferred resource', calculated using a cut-off grade of 4.0 g/t Au, totaled 470 000 tonnes averaging 7.4 g/t Au and 65.22 g/t Ag.

On the Tam property three holes intersected the Ted vein. They were collared at 50-metre intervals along strike from a core hole drilled in 1996 by Phelps Dodge and trace the vein structure for at least 250 metres along strike. The widest intersection of vein material was 26.9 m grading 1.29 g/t Au and 237 g/t Ag. The best assays were from sections of the vein that were composed of semi-massive bands of fine-grained sulphides and sulphosalts. Hole TT-10 (Photo 10) averaged 1.94 g/t Au and 357.9 g/t Ag over 13.2 metres; and hole TT-11 averaged 3.28 g/t Au and 1117 g/t Ag over 3.0 metres. The company plans to conduct a follow-up drill program early in 2003.

Photo 10. Close-up of core from Ted vein (hole TT-10) showing banded, fine-grained sulphides and sulphosalts.

Further north, Nation River Resources explored its **Cabin** (093F 038) property located about 22 kilometres southwest of Fraser Lake. Mineralization consists of northerly and northwesterly trending polymetallic quartz veins and intensely silicified linear zones associated with argillic to phyllic-alteration in granodiorite of the Topley intrusions. Re-examination of the East vein produced multigram assays. The company drilled one hole on an EM16 conductor in an area of previous trenching and percussion drilling by Nithi Exploration Ltd. Assay results have not yet been made public.

Elsewhere in the Nechako Plateau, Navasota Resources staked the **Yellow Moose** epithermal prospect (093F 058), located 140 kilometres southwest of Vanderhoof, and carried out a preliminary investigation of all known showings on the property. Adam Travis acquired the **Chili** epithermal gold prospect (093C 011), 180 kilometres west of Williams Lake, and re-examined quartz vein and stockwork showings with anomalous gold and silver values.

CARIBOO – WELLS-BARKERVILLE AREA

Lode exploration in Wells-Barkerville area continued to be focused almost exclusively on gold-bearing mesothermal quartz vein and auriferous pyrite replacement mineralization. Host rocks for both deposit types are metasedimentary rocks of the Hadrynian to Paleozoic Snowshoe Group.

Drilling near the former **Mosquito Creek Gold** mine (093H 010) by Island Mountain Gold Mines Ltd. targeted high-grade mesothermal gold veins within the Rainbow unit. Narrow high-grade intersections include 0.3 metres grading 29.04 g/t Au in hole IGM02-02 and 1.8 metres grading 6.96 g/t Au in hole IGM02-04. Trenching of a broad gold geochemical anomaly later in the season uncovered several west-trending quartz veins containing pyrite, arsenopyrite and galena within a pyritic quartzite. Grab samples from these structures graded up to 10.9 g/t Au. Drill pads were constructed late in the year in advance of an early 2003 drilling program.

International Wayside Gold Mines Ltd. continued to explore its **Cariboo Gold Quartz** property (093H 019), located immediately south of Jack of Clubs Lake, for both mesothermal vein and 'Bonanza Ledge-style' replacement mineralization. Drilling of the **Bonanza Ledge** zone produced moderate to high-grade gold intersections. As in other recent programs, drill holes were oriented to intersect projections of both the BC vein and the Bonanza Ledge zone where possible. The best assay came from hole BC02-03 that intersected the BC vein about 180 metres north of the BC Shaft; it averaged 22.97 g/t Au over 15.8 metres and included a 1.15 metre interval that graded 108.25 g/t Au. Approximately 120 metres further north, hole BC02-02 intersected a 4.7 metre segment of the BC vein that averaged 13.16 g/t Au.

Late in 2002, International Wayside announced resource estimates for the Bonanza Ledge and BC Vein zones. The indicated resource for Bonanza Ledge is 337 500 tonnes grading 8.12 g/t Au. The indicated resource for the BC Vein is 296 000 tonnes grading 5.31 g/t Au. In both cases a cut-off grade of 0.7 g/t Au (0.02 ounces/ton) was used. Existing open pit resources for the Cow Mountain (Sanders-Pinkerton-Rainbow zones) total about 6.014 million tonnes averaging 2.23 g/t Au. A revised mining proposal, yet to be formally submitted to the British Columbia Environmental Assessment Office, incorporates the resources from all three zones. The company envisages a 1500 tonne per day mill complex on Barkerville Mountain, a rock dump in upper Lowhee Creek, and a tailings impoundment southwest of Jack of Clubs Lake.

International Wayside optioned the **Myrtle** claim group, located immediately northeast of the Bonanza Ledge zone, from Gold City Industries Ltd. A five-hole diamond drilling program targeted two I.P. chargeability anomalies, outlined in a previous survey by Gold City across the prospective contact between the Baker and Rainbow units. The best assay from results released so far was a 17.68-metre intersection of multiple quartz-pyrite veins (Photo 11) that averaged 9.12 g/t Au. The veins are orthogonal to the BC vein and are a significant high-grade gold target with excellent strike and down-dip potential.

Golden Cariboo Resources Ltd. conducted prospecting and geochemical sampling on its **Grouse Creek** project along strike to the southeast of the Bonanza Ledge discovery.

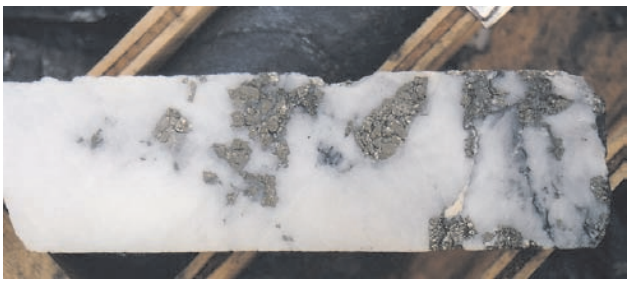

Photo 11. Quartz-pyrite vein mineralization from the Myrtle property.

Further southeast along the trend, Consolidated Pacific Bay Minerals Ltd. drilled two mesothermal gold vein occurrences and trenched several other prospective vein targets on its **Nugget Mountain** property. The veins carry pyrite and arsenopyrite with lesser galena and tetrahedrite in a gangue of quartz. They are generally subvertical, have a northwest strike, and are associated with marked iron-carbonate alteration of the host metasedimentary rock package. Exploration in the 1970's and early 1980's consisted of underground development and bulk sampling of the Skarn (093A 090) prospect, and diamond drilling, surface stripping and trenching of the B zone, Jewelry Shop and Hibernian (093A 051) occurrences. The property was optioned from Mike Danroth, who died tragically during the summer while en route to the claims. Two holes intersected the B zone, with a best assay of 21.1 g/t Au over an estimated true width of 1.35 metres, that further confirmed the high-grade potential of the prospect. Results from two holes drilled on the Jewelry Shop vein system include 2.1 g/t Au over a true width of 5.2 metres.

Ray Maltais drilled 1 hole on his **Beaver** mesothermal vein property, east of Alice Creek, but did not generate encouraging results.

Mark Heinzelman and partners drilled four short holes near the Rainbow adit on their **Mountain** property, located about 1 kilometre east of Williams Creek. Underground development took place in 1937 and included approximately 36 metres of drifting and crosscutting to expose auriferous quartz-pyrite veins that reach thicknesses of 1.5 metres. Drilling did not intersect any veins.

CARIBOO - LIKELY AND HORSEFLY AREAS

Exploration in the Cariboo also targeted alkalic intrusion-related gold-copper deposits within the Late Triassic to Early Jurassic volcano-plutonic arc of the Southern Quesnel Trough, but also volcanogenic massive sulphides within metasedimentary rocks of the older Snowshoe Group.

Cross Lake Minerals Ltd. optioned the dormant **QR** (093A 121) gold mine, located 58 kilometres southeast of Quesnel, from owner Kinross Gold Corporation. Cross Lake joined forces with Gold Giant Ventures Inc. to fund exploration at both QR and the adjoining Cariboo (Most Likely) properties. Traditionally, the best gold grades at QR occurred in propylitically altered, epidote-rich basaltic tuffs and fragmental volcanic rocks (Nicola Group) marginal to the Early Jurassic QR diorite stock. These receptive units produce tabular bodies of mineralization with sulphide content ranging from 1% to 15%, and pyrite far more abundant than chalcopyrite. Mining previously took place from the Main, Midwest and West zones where a total of 120 030 ounces of gold were recovered.

After conducting a review of known mineralized zones on the property, operator Cross Lake conducted a 19-hole, 1692-metre diamond drilling program. One hole was drilled to test the deep North zone target (north of the Main zone pit), 13 holes targeted the near surface Northwest zone, and 5 holes evaluated the West zone between the small North Lobe and South Lobe open pits. The North zone hole intersected four significant mineralized intervals of propylitically altered basalt; the best intersection returned 3.87 g/t Au across 9.0 metres at a down-hole depth of 240.5 metres. The open pit potential of the Northwest zone was confirmed by several intersections, including 16.7 m grading 4.71 g/t Au in hole CL-02-2007. Assays from West zone drilling are not yet available. The companies intend to complete data compilation, engineering studies and continue with field exploration that will likely include trenching and additional diamond drilling.

On the **Cariboo** (093A 062) property, Cross Lake targeted epithermal gold mineralization with a modest trenching program in the vicinity of diamond drill hole 89-6, completed by Corona Gold Corporation in 1989. The drill hole intersected 5.26 g/t gold over an 8.5 metre interval. Results from the trenching program have not been released.

Fjordland Exploration Inc. funded a modest drill program (Photo 12) on the **Woodjam** (093A 078) gold-enriched alkalic porphyry prospect, near Horsefly, to follow up on two large chargeability anomalies that were outlined in 2001. The property was optioned from Wildrose Resources Ltd. who remain operator. They returned to the property in 2002 to conduct a modest drill program (Photo 12). The property is underlain by intermediate flows of the Nicola Group that have been intruded, altered and locally mineralized by phases of the Early Jurassic Takomkane batholith. The property includes the Megabuck prospect, first identified and later drilled in the mid 1970s. Megabuck yielded drill intersections as high as 1.39 g/t Au and 0.13% Cu over 58 metres. This main zone continues to be the focus of exploration drilling. It is outlined by a northeast-trending coincident magnetic and chargeability anomaly. Mineralization consists of chalcopyrite with subordinate pyrite in fractures and in veinlets with quartz+/-magnetite. Narrow, epidote-rich propylitic alteration zones typically envelope the veins. The best intersection from the five holes drilled in 2002 assayed 0.52 g/t Au and 0.11% Cu over 54 metres. A follow-up program is planned for 2003.

Rudy Durfeld discovered a new showing near the Northeast zone while prospecting on his **Redgold** (093A 058) property, centred 3 kilometres south of Quesnel Lake. The property covers the Shiko stock and hosts several

Photo 12. Drilling on the Woodjam porphyry gold-copper property near Horsefly.

alkalic porphyry gold-copper prospects that coincide with chargeability, magnetic and soil geochemical anomalies. Past drilling has generated encouraging assay results over narrow intervals, for example 12 metres grading 985 ppb Au and 1873 ppm Cu, but none of the targets have been thoroughly evaluated.

Late in the year, Phelps Dodge Corporation of Canada Ltd. optioned the **Rim (Dot Com)** property, located just west of Horsefly, from Herb Wahl and Jack Brown-John. The company conducted several line-kilometres of IP and Mag/VLF-EM survey and drilled five holes. The property is underlain by basalt, analcite-bearing amygdaloidal flows, breccias and clastics of the Late Triassic to Early Jurassic Nicola Group. Mineralization consists of disseminations and narrow stringers of native copper, and lesser bornite and chalcocite. Results from the drilling program were not available at the time of writing.

Barker Minerals Ltd. conducted trenching and drilling on its **Frank Creek** (093A 152) volcanogenic massive sulphide (VMS) prospect, located immediately south of Cariboo Lake. The work was successful in tracing the F1 mineralization over a strike length of more than 400 metres. The F1 showing is one of several VMS occurrences hosted within metasedimentary rocks of the Harvey's Ridge Succession (Hadrynian to Paleozoic Snowshoe Group). Four holes tested the footwall rocks and two holes were drilled in hanging wall siliciclastics. The latter two holes encountered several narrow massive sulphide lenses within iron-carbonate altered quartz-sericite phyllite that contains common porphyroblastic pyrite and ilmenite, and variable amounts of chrome mica. Assays graded up to 89 g/t Ag and 2.08% Cu over 0.45 metres. Gold values were sporadic and lead and zinc values ranged up to 0.54% and 3.42%, respectively. Further exploration has been proposed for 2003.

Barker Minerals also drilled its **Ace** property (093A 142), centered approximately 20 kilometres east of the Frank Creek prospect. Five holes tested a prospective felsite unit within meta-sediments and volcanics of the Downey succession (Hoy and Ferri, 1998). It includes a suspected exhalite that typically contains up to 6 to 8% disseminated sulphide, mainly pyrrhotite-pyrite, with local narrow massive sulphide bands comprised of sphalerite-chalcopyrite+/-galena. Two holes that intersected the mineralized horizon were anomalous in copper, zinc, lead and, locally, gold. The company will continue to explore the prospective 'felsite' unit along its multi-kilometre strike length.

PLACER MINING AND EXPLORATION HIGHLIGHTS

By Ken MacDonald, P.Geo.

INTRODUCTION

The placer sector in northeast-central British Columbia again experienced a decline from the previous year. Although 2002 saw increased gold prices and relatively stable fuel costs, these market improvements did not translate into increased levels of activity for the placer sector. However, unlike last year, operators were emboldened by rising gold prices and optimistic that 2003 will reverse downward trends experienced over the past several years.

One large and eight medium-sized (where volume of washed paydirt exceeded 2000 m^3) programs were conducted in the region this year, which reversed the trend toward smaller testing programs during the last several years. Overall, levels of activity in 2002 followed the overall general decline of the past several years. Accurate estimates of expenditures on exploration and testing are unavailable but are roughly estimated at between $1.5 and $2.1 million. Many operators continued modest testing programs for assessment purposes.

TRENDS

The total area within the region held under placer tenure (excluding crown grants) remained at about the same level as a year earlier. The number of placer leases (production) held in the region remained steady at 446, and the number of placer claims (exploration) increased slightly to 1783. The area held under placer lease totaled about 24 000 hectares, or about 0.07% of the total area of the region. The area held under placer claim totaled just less than 64 000 hectares, or about 0.2% of the region.

The reduction in placer mining activity is reflected in the relatively low number of Notice of Work (NoW) applications submitted to the Prince George Mines Branch office. A total of 327 placer NoWs were filed, compared to 397 in 2001. Of the total, 132 NoWs were for mechanical testing, and 195 comprised handwork. This corresponds to a general shift over time from mechanical testing, when commodity prices and fuel costs were more favorable, to the situation today when relatively few operators are inclined to run expensive testing equipment or engage in large-scale production.

To date 102 or roughly 32% of the operators have responded with a Notice of Completion (NoC) report. However, it is believed that many of the planned programs were not completed due to a variety of factors. Thus the relatively low overall response rate is more reflective of canceled programs than failure to respond. Of particular interest are 71 mechanical programs for which reasonably accurate completion data is available. The responses received represent the majority of mechanical operations on which a planned program was executed. Based on 71 NoCs received to date, all but nine programs consisted of modest exploration testing, and most programs tended to be smaller than originally planned. The programs ranged from 100 m^3 to over 160 00 m^3 of paydirt washed. The total volume of production planned was about 80 500 m^3, while actual recorded production amounted to about 22 000 m^3, a decline of 73%.

As mentioned, in 2002 nine programs achieved placer production of more than 2000 m^3 of paydirt, compared to only one in 2001. No information is available on the quantity of gold recovered, or the grade of material washed. In terms of testing and size: five programs washed between

1000 and 2000 m^3 of paydirt; nineteen programs washed between 100 and 1000 m^3 of paydirt; and forty one programs completed only minimal testing, washing less than 100 m^3 of paydirt each. It is expected that the remainder of the mechanical operators from which no NoC has been received either completed hand testing or paid cash in lieu of assessment work to maintain tenure. Operators have given a variety of reasons for canceling programs, including low gold prices; lack of capital for equipment, parts, or fuel; inability to raise reclamation security; health issues; or employment in other sectors during the seasonal months.

Using the Mineral Titles' *Guide to the Evaluation of Physical Work for Assessment Purposes*, and the limited information provided by the operator on the NoC reports, exploration expenditures can be roughly calculated. Using two methods described in Information Letter 19 (BCMEM Mineral Titles Information Letters), the first based on the sum of labour, supply and machinery costs, and the second based on $50 per cubic metre of gravel processed, exploration spending in the region is estimated to have been between $1.5 and $2.1 million, down slightly from last years' estimate of between $1.49 and $2.24 million. Most small operators spent the bulk of the money on supply and machinery/equipment costs, including fuel, repairs, parts, and maintenance. However, for several larger programs with hired help, the labour component can be considerable, perhaps as much as 25% of the overall expense.

PRINCIPAL AREAS OF ACTIVITY

As in past years, the focus of activity followed the well-established pattern. The Cariboo (including sub-areas) was the principal center of activity followed by the Omineca and Hixon areas. A total of 52 programs were conducted in the Cariboo, subdivided into the Lightning Creek area, the Quesnel River area, the Wells-Barkerville area and the Likely-Keithley Creek area. Major drainages in the Cariboo that saw activity included Cottonwood River, Fraser River, Quesnel River, Cariboo River, Lightning Creek, Ketchum Creek, Snowshoe Creek, Maude Creek and Antler Creek. A total of 19 programs were conducted in the Omineca area, with Slate Creek and Manson Creek the most active drainages. The Hixon area was relatively quiet, with only two significant programs conducted.

OMINECA

The largest program, and only property from which large-scale production was recorded in the District, was in the Omineca region. J.M. Thomas of Angel Jade Mining completed bulk testing from one main mine pit identified from the previous years' testing. A total of about 16 000 m^3 of paydirt was washed. Gold was recovered from gravels believed to represent a buried paleochannel confined to the modern creek valley. Angel Jade designed and implemented a non-conventional floating processing plant (Photo 13). The plant was fed by excavator with oversize removed by conveyor and loader. The program is effectively a mobile placer mine with concurrent reclamation. This design provides better environmental safeguards, and lower operating costs than a conventional stationary design. The operation employed four workers for a period of 10 weeks. A larger program is proposed for the coming field season, and promises to be the largest production mine in the region for 2003. Angel Jade has also proposed development and production from three other sites in the Omineca, and plans to test about 10 other sites.

Vladimir Pogorevc tested about 1800 m^3 of gravel from McConnell Creek, over a period of 16 weeks. Groundwater hampered the operation, but focused digging and a well-designed processing plant made the operation a success. Fine-grained gold is recovered from a buried paleochannel adjacent to the modern alluvial channel. Local variability in depth to bedrock has made definition of the lateral extent of the buried channel difficult. Close attention to processing controls appears to have improved recovery rates compared to a conventional sluice or trommel operation.

CARIBOO (WELLS-BARKERVILLE-QUESNEL)

Mining was active on a small tributary to Summit Creek, northeast of Wells. Harry Robinson and partners mined 2500 m^3 of paydirt from a shallow pit that may represent a buried-channel gravel deposit adjacent to a modern alluvial channel. The operation processed paydirt over a nine-week period.

Further southwest Frank Nestle continued mining on his large lease on Summit Creek (Photo 14), near the confluence with Eight Mile Lake Creek. The operation processed 2000 m^3 of paydirt from one large, deep pit dug to exploit a buried bedrock channel. Depth of pay and groundwater seepage made mining difficult. The lateral extent of the channel is unknown and may be discontinuous due to recent erosion. The deposit is interpreted to be a buried channel in a modern valley system.

Vern Weirs mined approximately 2000 m^3 of paydirt on his lease on Lightning Creek. Production came from one main mining pit, and several test pits located on a low terrace on the north side of the river. The site likely represents a postglacial reconcentration of fluvial and glaciofluvial deposits.

Photo 13. Mobile processing plant in use on Manson Creek, Angel Jade Mining.

Photo 14. Large pit excavated in search of buried bedrock channel on Summit Creek, F. Nestle.

Jack and brother Tim Kleman revisited the Hannador property, previously worked by Gallery Resources Ltd. The brothers anticipated good results from testing on the southwest edge of the property beyond the limits of the previous mining. The site is located on the south side of Lightning Creek in a presumed buried paleochannel adjacent to the modern alluvial channel. Gravel on bedrock did yield gold as anticipated, but the size of the channel remnant did not justify large-scale production. The operation washed about 1300 m^3 of paydirt over a 3-week period.

CARIBOO (LIKELY-KEITHLEY CREEK)

Al Bruce continued his seasonal operation on two claims on the Cariboo River, near Likely. This site is located on a low terrace directly downstream from Quesnel Forks. The deposit is interpreted as a glacial and/or glaciofluvial placer deposit. The historical record identifies many terraces along the Cariboo River that have supported productive mining operations, including exploitation by large dragline/dredge methods. Al washed 3000 m^3 of paydirt from reworked dredge tailings and several test pits.

Edwin Gordon mined about 2000 m^3 of paydirt from one main pit and three test pits. His site is located on the south bank of the Cariboo River, near the confluence of Spanish Creek. The site is similar in setting to larger mines located nearby that exploited large fluvial and glaciofluvial deposits on intermediate to high-level terraces. Placer gold has been recovered from several stratigraphic horizons in the local area, including glaciofluvial gravels overlying till. It's possible that the gold was derived from upstream placer deposits.

Noble Metals were active on their large lease near Likely. The deposit represents a buried paleochannel that roughly parallels the present course of Keithley Creek. The company was unable to complete plans for a major stripping program on its Keithley Creek lease, and settled for limited production of about 2000 m^3 of paydirt from their main mine pit. Thick overburden and subsurface drainage hampered development. By necessity work focused on dewatering the pit face, and benching the face in anticipation of larger production in 2003. The lowermost gravel on bedrock has typically produced the most gold. Progressive reclamation was continued, including the remediation of a road from the pit area to Snowshoe Creek.

The Rasmussen brothers continued development of the Golden Horn property on Cedar Creek. This site has experienced several large-scale mining programs over the years, and continues to produce gold. Recent work has focused on post-glacial gravels and testing for buried bedrock channels that were missed by earlier mining. A total of 2000 m^3 of paydirt was processed over an extensive 28-week season.

Operator/owner Sam Vizi washed about 1000 m^3 of paydirt on his claim located immediately upstream of Quesnel Forks, on the south side of the Cariboo River. This site has been tested repeatedly, over the last several decades, targeting low level terraces. Gold enrichment has been reported from abandoned channel courses and channel junctions, and coarse gravel lags on channel scours are common targets.

HIXON

Len Kozak was again active on his lease on Government Creek, near Hixon. Production focused on a paleoplacer believed to be buried-channel gravel adjacent (and presumably below) the modern stream. Steep topography and groundwater posed a significant challenge to mining gravels that are close to the watercourse. Len processed 3500 m^3 of paydirt in six weeks.

RECLAMATION

Don Carter of Calverson Int. Ltd was recommended for the placer reclamation citation given annually by the Technical and Research Committee for Reclamation in British Columbia. Mr. Carter was nominated in recognition of the outstanding reclamation completed on the Yeates Lake Placer lease located near Lightening Creek. The three-hectare site was last worked in the mid 1990's. Reclamation work was contracted and paid for from a seized reclamation security. Reclamation consisted of extensive earthmoving, demolition of a large camp, removal of scrap and equipment, and recovery of non-combustible waste materials. Pits and trenches were backfilled and re-contoured; topsoil was spread and all areas seeded with forestry mix.

CONCLUSION

Placer activity during 2002 again decreased from the level witnessed in the previous year. Following a trend that has developed over the past several seasons the average size of an operation and the total exploration expenditures continued to decrease. However, unlike recent years, the reason may be less related to depressed gold prices and more to other factors, such as rising fuel costs. The price of gold rose above the US$300 benchmark, and at the time of writing has risen briefly above US$350. It is anticipated that several large programs will be executed in 2003, and the activity levels for small-scale mining and testing will increase, to reverse the general downward trend of previous

years. The largest programs are expected to be conducted in the Manson Creek area. As in the past, the majority of the activity will occur on the streams and creeks in the Wells-Barkerville, Likely, Hixon and Omineca placer gold camps.

OUTLOOK FOR 2003

The improved price of gold will continue to drive grassroots and advanced exploration for both high-grade gold and bulk tonnage gold-copper deposits throughout the Northeast-Central Region. This may result in the re-opening of one or more mines currently on 'care-and-maintenance' status. The level of placer gold testing and mining will increase in each of the region's traditional placer camps. Peace River coal properties will continue to be advanced towards full feasibility and production.

ACKNOWLEDGEMENTS

The author gratefully acknowledges the many contributions provided by mine staff, exploration geologists and prospectors working throughout the region. Without their cooperation compilation of this report would not be possible. The manuscript benefited from many constructive suggestions from co-workers Ken MacDonald and Ed Beswick and external editor Bill McMillan.

REFERENCES

Levson, V.M. and Giles, T.R. (1993): Geology of Tertiary and Quaternary Gold-bearing Placers in the Cariboo Region, British Columbia (93A, B, G, H), *B.C. Ministry of Energy and Mines*, Bulletin 89, 202 pp.

MacDonald, K. (2002): Placer Reclamation Project, Mines Branch, Northeast-Central Region, *B.C. Ministry of Energy and Mines*, Unpublished Report, 19 pp.

SOUTHWEST REGION

Jacques Houle, PEng
Regional Geologist, Nanaimo

SUMMARY

The Southwest Region of British Columbia holds some of the greatest challenges and opportunities for exploration and mining in Canada. Many portions of the region are covered by dense vegetation, carved by rugged coastlines, virtually unmapped and inaccessible; other portions are blessed with an excellent infrastructure network of logging roads, highways and communities connecting numerous MINFILE occurrences hosted by highly favourable and well documented geology. It has been a source of great joy to be able to re-discover some of the geological wonders of the Southwest Region over the past three years as Regional Geologist based in Nanaimo. As a result of downsizing within the Mining Division of the Ministry of Energy and Mines, the Nanaimo Office will close and the position of Regional Geologist, Southwest Region will no longer exist as of April 2003. All regional functions and selected personnel will be relocated to the Victoria Office.

The year 2002 brought a tremendous increase in the diversity of target commodities being sought by explorationists in the Region. Several exploration projects stand out as possible candidates for new mining and quarrying operations in the next few years. Leader Mining International Ltd.'s Cogburn Magnesium project near Hope may well become the province's next metal mine. SYMC Resources Ltd.'s Dauntless and Macktush Cu-Ag-Au projects near Port Alberni made considerable progress towards advanced exploration status. Staking campaigns targeting magmatic Ni-Cu-Co-PGE deposits, and grass roots exploration projects by both Emerald Field Resource Ltd. near Port Renfrew and Garex International Exploration and funding partners near Harrison Lake helped breath new life into the local exploration communities. Exploration funding was very difficult to find in 2002, but the best projects always seemed to find a way to get funding.

Mining operations in the region continued to display economic stability for their owners, employees, suppliers and shareholders, in the case of public company owners, during 2002. Boliden-Westmin (Canada) Ltd.'s Myra Falls Operation established modest profitability after a difficult period. Together with Hillsborough Resources Ltd.'s improving Quinsam Mine, the two operations generated positive spin-off benefits felt in the shared primary service community of Campbell River. At Texada Island, strong growth in the export limestone market helped Texada Quarrying Ltd.'s Gillies Bay Quarry and Ash Grove Cement Ltd.'s Blubber Bay Quarry increase production in 2002 by almost one third. Dimension Stone producers were also successful in helping to meet growing domestic markets in residential construction. Mining is a cornerstone industry in British Columbia, and will always be important in the Southwest Region.

EXPLORATION TRENDS

In 2002, there were eight major (>$100 000) exploration projects undertaken in the Southwest Region (Table 1) the same as in the previous year. These major projects targeted a wide variety of commodities and deposit models, and consisted of grass roots to bulk sampling projects. They are dominated, however, by exploration projects targeting ultramafic-hosted magmatic deposits containing either Mg or Ni-Cu-Co-PGE's, which together account for about two-thirds of total exploration expenditures in the region. Exploration projects targeting metallic hydrothermal deposits containing Au, Cu and Ag in veins, skarns and porphyries also increased dramatically in 2002. Exploration and development for industrial minerals such as limestone, silica, kaolin, wollastonite, garnet and dolomite, as well as for dimension stone, also increased. In contrast, traditionally significant massive sulphide and coal exploration project expenditures were negligible in 2002. Figure 1 illustrates exploration expenditures by target deposit type in the Southwest Region in 2002. Several mineral exploration projects were funded through the new Super Flow-through

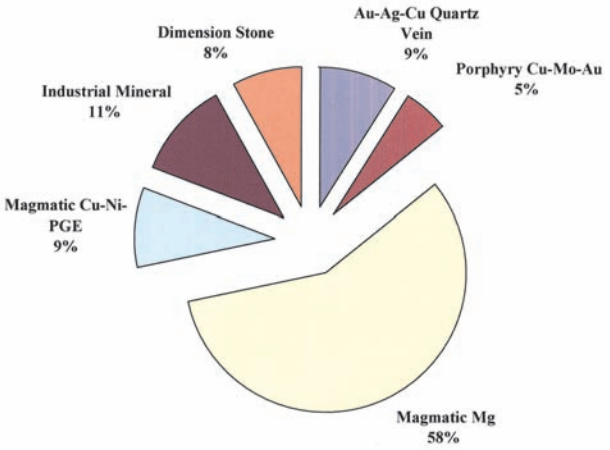

Figure 1. Exploration expenditures by target deposit type in the Southwest Region, 2002.

TABLE 1
MAJOR EXPLORATION PROJECTS, SOUTHWEST REGION - 2002

Property	Operator	MINFILE	NTS	Commodity	Deposit Type	Work Done
Valentine Mountain	Beau Pre Explorations Ltd.	092B012, -075	092B12W	Au, Ag	Au Quartz Veins	Prospecting, Trenching
Pearson	Emerald Field Resources Ltd.	092C025,-68,-91, -92,-141,-142,-147	092C050, -59,-68,-9	Ni, Cu, Co, PGE	Magmatic Ni-Cu-PGE	Staking, Geochemistry Petrography
Dauntless	SYMC Resources Ltd.	092F155,-168,-383	092F02W	Cu, Ag, Au	Cu-Ag Quartz Veins	Access,Trenching
Mineral Hill	Clearview Mineral Resource Corp.	092GNW052,-53	092G12W	Wollast., Garn., Dol.	Wollastonite Skarn	D. Drilling (5h., 705m.)
Whistler Area Properties	Huckleberry Stone Supply Ltd.		092G14E, 092J03E	Dimension Stone	Volcanic (basalt)	Access, Bulk Sampling
Cogburn	Leader Mining International Ltd.	092HSW041,-81	092H05E, -12E	Magnesium	Ultramafic-hosted Mg	Access, D.D. (38h.,2152m.)
Harrison Lake	Int'l. Millennium Mining Inc. / Garex	092HSW076	092H05, -12,-13	Ni, Cu, Co, PGE	Magmatic Ni-Cu-PGE	Geol., Geoch. Geophysics
Apple Bay	Electra Gold Ltd. /Ash Grove Cement Ltd. / Homegold	092L087,-88,-89, -150,-269,-308	092L12	Silica, Kaolin	Hydrothermal Alt'n. Clays Al-Si	D.D. (550m.), Enviro. Work

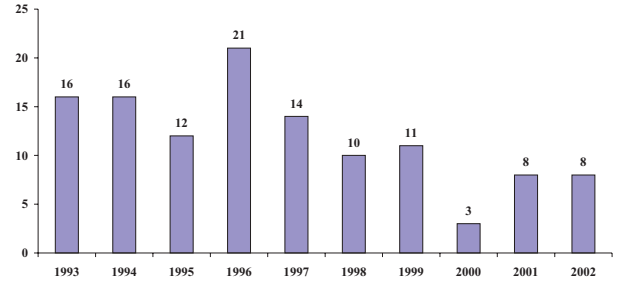

Figure 2. Annual number of major exploration projects in the Southwest Region

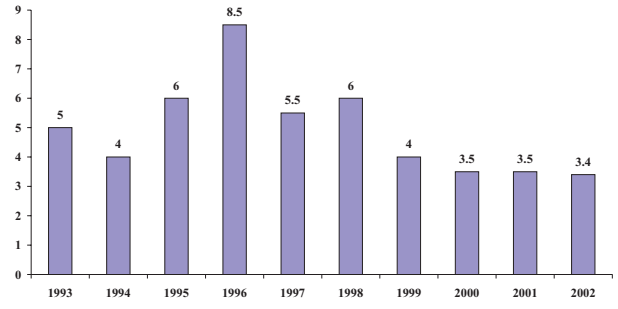

Figure 3. Annual exploration expenditures in the Southwest Region (in C$ millions).

Share program initiated by the British Columbia government in late 2000, primarily through private placements.

Estimated total exploration expenditures in the region are $3.4 million, just slightly less than in each of the two previous years. Estimated total exploration drilling in 2002 is 4 360 meters, a reduction of 81% from 2001 drilling. This is primarily due to the lack of mine site exploration drilling at both the Myra Falls Operation and the Quinsam Mine; traditionally these dominate regional statistics. Figures 2, 3 and 4 show key exploration indicators for the region over the past ten years: annual major exploration projects, annual exploration projects, and annual exploration drilling. These indicators clearly show that exploration activity in the Southwest Region reached a low point in 2000 and recovery is still pending after three lean years. Increases in exploration activity during the past two years in the northern regions have not yet been felt in this region. With the wide diversity of exploration projects and increasing commodity prices for Au,

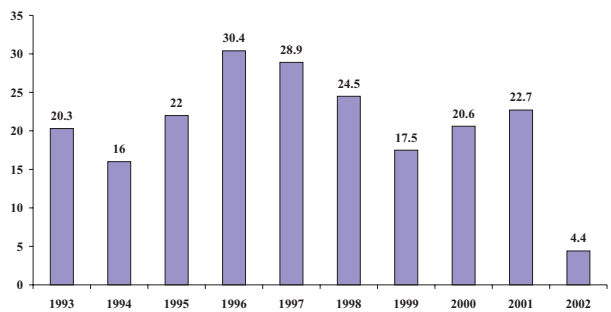

Figure 4. Annual exploration drilling in the Southwest Region (in thousands of metres).

Cu, and Ni, which are being targeted by many of those projects, it is expected that the recovery of exploration activity in the Southwest Region will finally begin in 2003.

MINES AND QUARRIES

The same nine major mines and quarries (>100 000 tonnes annual production) operated in the Southwest Region in 2002 as in the previous year. At the request of the owners, two industrial mineral quarries (Sumas Mountain and Clayburn) shown separately in 2001 are reported as a combined operation in 2002. Figure 5 illustrates names, locations, owners, and commodities produced by these mines and quarries. There are also many large sand and gravel operations in the region, plus several small dimension stone and industrial mineral producers. In general, both tonnages and values of 2002 mineral production from mining operations in the region increased significantly relative to 2001. In particular, limestone producers increased limestone and crushed aggregate production tonnages by about one third. These products are exported from quarries on Texada Island to U.S. west coast markets. Major mines and quarries, major exploration projects (Figure 6) and new discoveries (Figure 7) demonstrate the diversity of mineral deposit types and potential, as well as the innovation of operators and explorationists working in the region.

MYRA FALLS OPERATION

The Myra Falls Operation, located on central Vancouver Island west of Campbell River, is owned and operated by Boliden-Westmin (Canada) Ltd. This underground metal mine is centered on a large, geologically complex cluster of volcanogenic massive sulphide deposits hosted in a northwest-trending horst of the Paleozoic Sicker Group. These deposits include MINFILE's Lynx 092F071, Myra 092F072, Price 092F073 and H-W 092F330. Since production began in 1966, over 22 million tonnes of Cu-Zn-Pb-Ag-Au ore have been mined and milled. As of January 1, 2002, Myra Falls had a mining reserve of 8.40 million tonnes at 1.28% Cu, 6.99% Zn, 0.54% Pb, 1.4 g/t Au, 45.5 g/t Ag and 2.17% Ba. Geological resources as of January 1, 2002 are 4.73 million tonnes at 1.33% Cu, 7.40% Zn, 0.68% Pb, 1.80 g/t Au, 64.4 g/t Ag and 2.92% Ba.

Mining and milling operations were resumed in late March 2002 after a four-month shutdown that began in late November 2002. Since April 2002, the mine has employed 380 people and operated at a nominal milling rate of 2925 tonnes per day. Both are substantially less than levels of recent years, which are part of Boliden's action plan to improve operating efficiency. Total estimated production for the year was 773 858 tonnes at 1.22% Cu, 0.45% Pb, 7.29% Zn, 1.49g/t Au and 46.55g/t Ag, reflecting relatively higher grades of Zn and Ag in the ores mined and milled. These were primarily from the 43 Block and Gap Zones. Selected long-term capital projects were completed through the shutdown period and through 2002, including the production ramp from 18th to 22nd Levels, and maintenance of the hoist and crushers. The paste tailings fill plant project was started during the shutdown as well and continued through 2002; completion is expected in 2003.

During the shutdown period and through 2002, all exploration activity including mine site exploration drilling was curtailed, and Boliden Exploration Geologists based at Myra Falls left the company. In 2002, definition diamond drilling at the mine totaled 23 000 meters, down from 51 000 meters in 2001. The future of the Myra Falls Operation remains uncertain, with commodity prices for Zn and Ag at historically low levels. However, Boliden Ltd., the parent company of the current owner, removed Myra Falls from the selling block and implemented its aggressive action plan because it values the operation as high-grade ore producer. A modest resumption of exploration activity is planned at Myra Falls in 2003. Possibilities for increasing future revenues include establishment of high-grade sulphide mill feed from external sources, and improving mill recovery for precious metals. Reduced costs could be achieved by connecting the operation to the provincial electrical power grid, thereby reducing dependence on costly diesel generators for supplementary power. Such improvements, combined with a recovery of base metal prices and continued exploration success, would keep the Myra Falls Operation viable for decades to come.

Photo 1. Lynx pit and underground portal at Boliden-Westmin (Canada) Ltd.'s Myra.

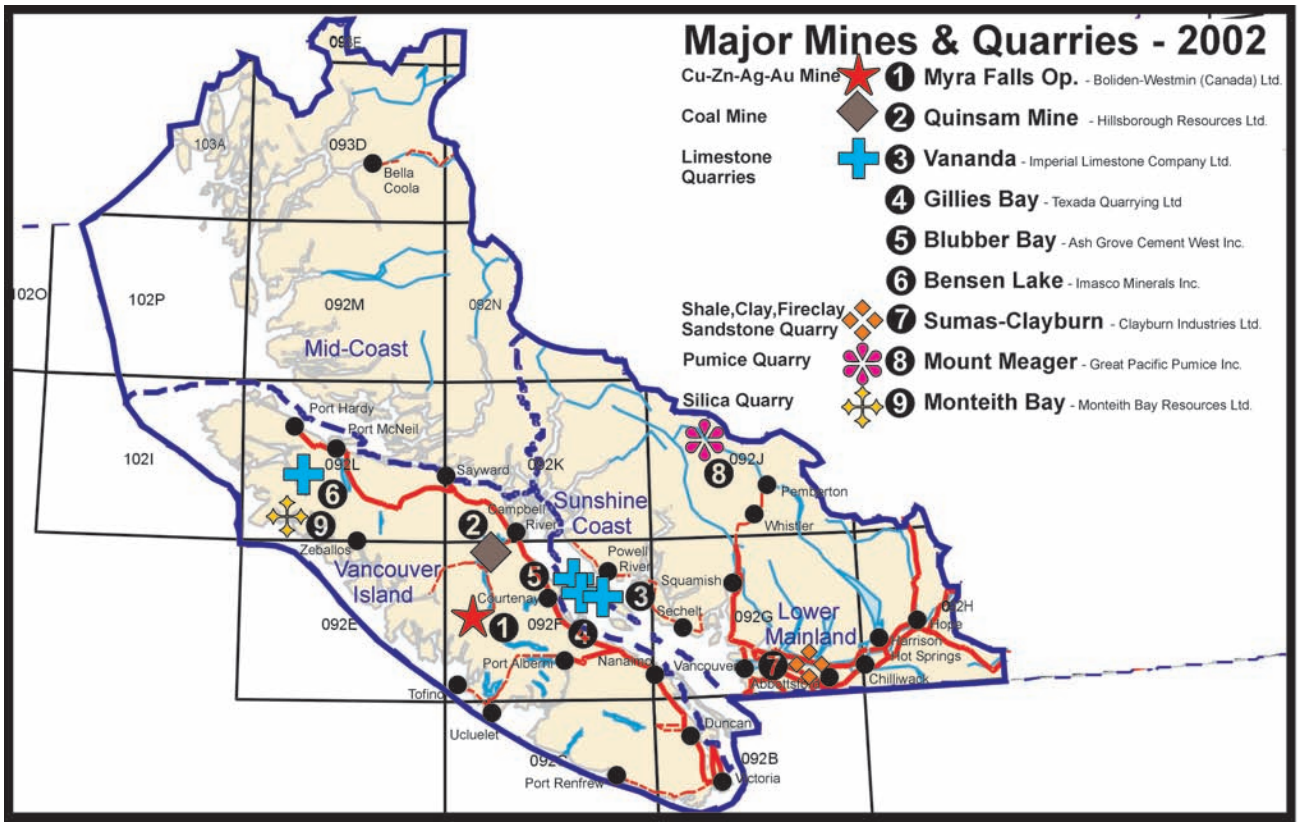

Figure 5. Major mines and quarries (>10 000 tonnes) in the Southwest Region, 2002.

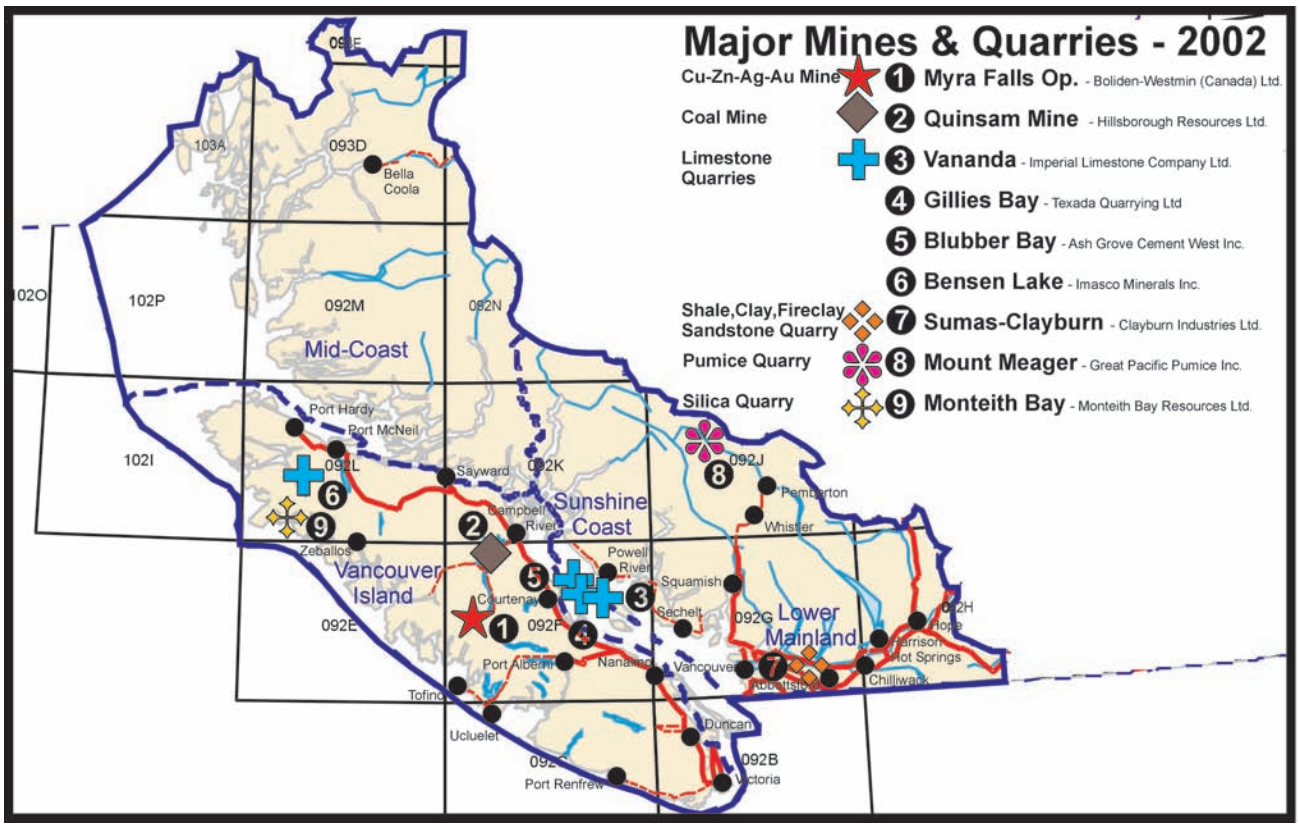

Figure 6. Major exploration projects (>$100 000) in the Southwest Region, 2002.

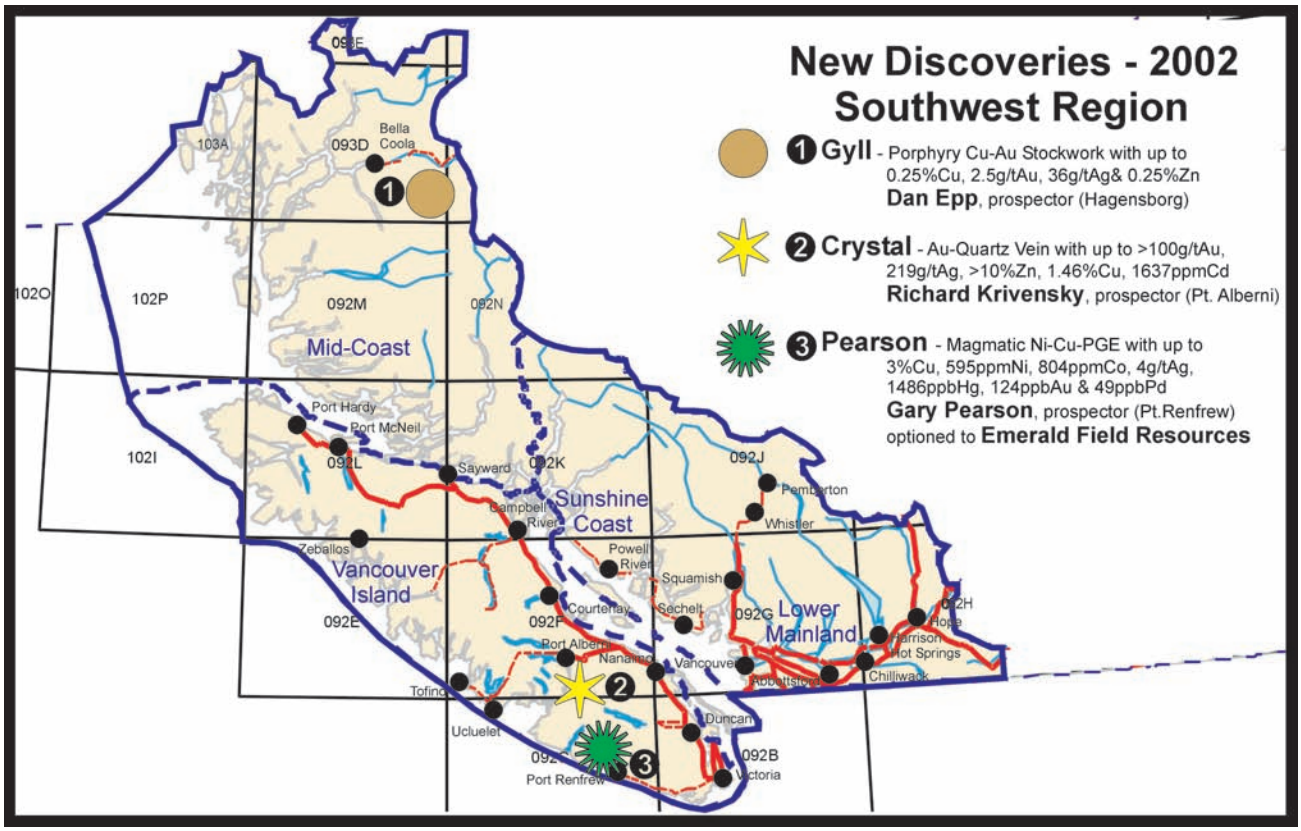

Figure 7. New discoveries in the Southwest Region, 2002.

QUINSAM COAL MINE

Hillsborough Resources Ltd. owns 100% of Quinsam Coal Corporation, which in turn owns and operates the underground Quinsam Coal Mine near Campbell River on central Vancouver Island near Campbell River. Coal at the Quinsam Mine is hosted in numerous, shallow, flat-lying seams within Cretaceous Nanaimo Group sedimentary rocks. The seams are accessed by ramps from surface. Proven and probable reserves at Quinsam are 30 million tonnes. During 2002, the mine increased personnel to 52 to operate multiple shifts. They produced 341 432 tonnes of clean bituminous grade thermal coal for markets in the western North America. Relative to 2001, revenues from the mining operations for Hillsborough at Quinsam increased by about 60% through the first 9 months of 2002, due primarily to the sale of 240 000 tonnes in four shipments to AMCI of Pennsylvania, a new customer.

During 2002, a trial burn of thermal coal from the Quinsam Mine was successfully completed at the nearby Elk Falls Pulp Mill at Campbell River; this could increase future sales. Hillsborough also completed a joint venture with Texas Canadian Ventures (TCV) of Texas for evaluating the coal bed methane resource on all of its freehold and lease deposits in the Campbell River area. Also in 2002, Hillsborough Resources Ltd. and Weldwood of Canada Ltd. were unsuccessful in renegotiating their agreement for the T'Sable River Coal project and allowed the agreement to lapse. Hillsborough applied for a permit for a 49.9 mega-watt coal-fired power plant at the Quinsam Mine under the provincial government's Customer Generation Program. However, the permit application was not approved; it will be re-submitted in 2003.

LIMESTONE QUARRIES

Extensive flat-lying exposures of the Triassic Quatsino Formation, a prime source of limestone, underlie much of northern Vancouver Island and several of the northern islands in Georgia Strait in the Southwest Region. On northern Texada Island, three operators quarry this unit, and two of these are the largest suppliers of cement-grade limestone in western North America. In 2002 Lafarge Canada Inc. (through Texada Quarrying Ltd.) shipped 4.19 million tonnes from its Gillies Bay Quarry, and Ash Grove Cement Corporation shipped 1.83 million tonnes from its Blubber Bay Quarry, representing increases of about one third over 2001 levels for each operation. Imperial Limestone Company Ltd. shipped 223 188 tonnes of limestone from its Gillies Bay Quarry on Texada Island, an increase of 23% from 2001.

Chemical-grade limestone was also shipped from a portion of Lafarge's production at Gillies Bay. Lafarge invested $10 million in an aggregate crushing plant in 2002, to help increase its total production and maintain its rank in the top five quarries in Canada. Proximity of the Texada Island quarries to sheltered ports on Georgia Strait enables highly efficient and inexpensive barge transportation of their products, which helps these operations ship to as far away as southern California. On northern Vancouver Is-

land, International Marble and Stone Company Ltd. (IMASCO) produced 28 970 tonnes of chemical grade limestone from its Benson Lake Quarry near Port Hardy, an increase of 3% from 2001.

INDUSTRIAL MINERAL QUARRIES

The wide variety of industrial minerals in the Southwest Region continually opens new opportunities for exploration and exploitation by innovative operators. Producers of both natural and crushed aggregate in the region are too numerous and poorly documented to report, but provide essential products for construction, particularly near major urban areas. Seven major (>10 000 tonne per year) non-aggregate quarries continued operations in 2002. The Sumas Mountain & Clayburn Quarry near Abbottsford is centered on altered sediments of the Eocene Huntington Formation. Lafarge Canada Inc., Lehigh Norwest Cement Ltd. (formerly Tilbury Cement Ltd.) and Clayburn Industries Ltd. together produced 535 910 tonnes of shale, sandstone and fireclay from the quarry in 2002. The products were used for cement, aggregate, refractory bricks, flue line pipes, and both ornamental and facing bricks.

In remote parts of the region, summer quarrying operations extract and transport specialty resources. On northwest Vancouver Island, Monteith Bay Resources Ltd. (an affiliate of Lehigh Northwest Cement Ltd.) produced and barged 43 199 tonnes of hotspring silica from its Monteith Bay Quarry to its Delta cement plant during 2002. This operation, which mines a paleo-hotspring replacement silica, or chalky geyserite deposit in Jurassic Bonanza Group volcanics, is located along tidewater. On the mainland northwest of Pemberton, Great Pacific Pumice Ltd. produced and trucked 13 000 cubic meters (10 500 tonnes) of volcanic pumice from its Mount Meager Quarry to processing and sorting yards near Meager Creek Hotsprings and Squamish. The material is used for lightweight concrete, as stone washing media and for cosmetics. The operation exploits a stratified deposit of rhyodacitic breccia and ash of the Pliocene to Recent Garibaldi Group volcanics.

DIMENSION STONE QUARRIES

Several small (<10 000 tonne per year), seasonal dimension stone quarries operate in the Southwest Region, providing a wide variety of mainly granitic and volcanic products for dimension stone processors in the lower mainland and on Vancouver Island. Stone processing plants are operated by Westcoast Manufacturing Inc. in Delta, Margranite Industry Ltd. in Surrey, Garibaldi Granite Group Inc. in Squamish, Mountain High Properties Ltd. in Pemberton and Matrix Marble Ltd. in Duncan. These operations market products to local and international markets. The new Mountain High plant in Pemberton was constructed and began producing primarily local basalt in 2002, focusing on fast-growing markets in the nearby resort community of Whistler as well as in Vancouver.

Market conditions for dimension stone improved dramatically as new housing developments increased in 2002. There was a strong demand for natural stone products for

Photo 2. Palletized basalt column segments and gang saw at Mountain High Properties Inc.'s dimension stone plant, Pemberton.

Photo 3. Gang saw cutting granite slabs at Garibaldi Granite Group Inc.'s dimension stone plant, Squamish.

Photo 4. Beau Pre Exploration Ltd.'s consultant Andris Kikauka at Valentine Mountain project Discovery Zone, Victoria area.

both interior and exterior applications. Hardy Island Granite Quarries Ltd. produced 3700 tonnes of light grey granodiorite from its Hardy Island Quarry in Jervis Inlet near Powell River. In the Squamish and Whistler areas, Huckleberry Stone Supply Ltd. produced a total of 6700 tonnes of basalt from five quarries on its Spumoni, Cabin, Freeman, Rubble and Huckleberry claims. Nearby, Garibaldi Granite Group Inc. produced about 3000 tonnes of granitic and volcanic dimension stone products from its Squamish, Ashlu River and Leo quarries. Mountain High Properties Ltd. produced about 900 tonnes of basalt and 140 tonnes of phyllite from the Spike and Gunsight Quarries respectively in the Whistler area, and about 30 tonnes of slate from the Brian Quarry near Jervis Inlet. Matrix Marble Ltd. produced 120 tonnes of limestone from its Hisnet Quarry near Tahsis on western Vancouver Island.

Photo 5. Quartz-pyrite-arsenopyrite-gold vein at Valentine Mountain Discovery Zone.

EXPLORATION ACTIVITY

VANCOUVER ISLAND

VALENTINE MOUNTAIN (MINFILE NOS. 092B012,-075,-111)

Beau Pre Exploration Ltd.'s Valentine Mountain project near Victoria has been active intermittently for over twenty-five years; the year 2002 saw a renewed effort on two fronts. Joint venture partner First American Scientific Corp. continued modifications to the KDS Micronex dry gravity milling machine in preparation for its proposed installation at Valentine Mountain near the Discovery Zone. This Zone hosts an indicated mineral resource of 30 660 tonnes at 14.7 g/t Au. Beau Pre Exploration continued to explore the Discovery Zone West and Log Dam West Zones on the project. Chip sample results from new trenches yielded up to 100 g/t Au across 0.5 metres and at 32.0 g/t Au across 0.4 meters, from the respective zones.

The Valentine Mountain project consists of 261 mineral claim units and covers several clustered zones of narrow, locally high-grade Au-Ag quartz veins hosted in highly metamorphosed sedimentary-volcanic rocks of the Cretaceous Leech River Formation. Mineralization may be related to Tertiary intrusive activity associated with tectonic plate subduction. Beau Pre Exploration Ltd. owns 100% of the Valentine Mountain project, and is actively seeking an additional joint venture partner to fund both installation of the KDS plant including test mining/milling at the Discovery Zone, and further exploration trenching, mapping and drilling throughout the property planned for 2003.

PEARSON (MINFILE NOS. 092C025,-068,-091,-094,-110,-141, -142,-146)

Gary Pearson prospected for Au quartz veins and dimension stone marble for several years in the Port Renfrew area but more recently he has focused on magmatic Cu-Ni-PGE (platinum group element) deposits. In 2002 he staked claims to cover several lapsed Cu and/or Fe Skarn MINFILE occurrences in the Westcoast Intrusive Complex of southern Wrangellia just north of Port Renfrew. Through prospecting and sampling, he subsequently discovered anomalous PGE values in the skarns. During a property visit in May, 2002 the Regional Geologist collected grab samples of outcropping skarn and/or magmatic sulphide mineralization on Mr. Pearson's claims. Samples located near the Sirdar (MINFILE 092C025) and Reko 3 (MINFILE 092C090) showings yielded anomalous values in Cu, Ni, Co, Mn, Fe, Ag, Au, Hg, and Pd. Although the potentially significant PGE mineralization was discovered on existing MINFILE occurrences, it is regarded as a new discovery for 2002.

Also in 2002, Gary Pearson secured an option agreement with private company Emerald Field Resource Corporation of Kenora Ontario to fund exploration in the Port Renfrew area. Emerald Field subsequently staked additional claims in two blocks that, together with Mr. Pearson's previous claims, total 685 mineral claim units as of November 2002. The smaller 64-unit claim block just north of the village of River Jordan, which is underlain by rocks of the Eocene Metchosin Volcanics and Sooke Gab-

Photo 6. Massive pyrrhotite-chalcopyrite pods at Emerald Field Resource Corporation's Pearson project, Port Renfrew area.

bros of the Crescent Terrain, covers the Wolf (MINFILE 092C094) occurrence. The larger 621-unit claim block is located just north of Port Renfrew and covers the remaining MINFILE occurrences listed in the paragraph header. Soil and rock sampling, geochemical sampling and petrographic work were conducted during 2002. An airborne geophysical survey planned for late in the year was deferred until 2003.

DAUNTLESS
(MINFILE NOS. 092F155,-168,-383,-549,-551)

SYMC Resources Ltd. has explored and gradually increased its land position south of Port Alberni and along the west shore of Alberni Inlet for almost twenty years. SYMC has targeted multiple occurrences and styles of porphyry copper-molybdenum-gold-silver and related vein mineralization that occur within and adjacent to northwest trending stocks and dikes of the Jurassic Island Plutonic Suite granodiorite that intrude Triassic Karmutsen Formation basalt flows. Exploration continued in 2002 primarily at the Dauntless project, where historic mine workings on several clusters of parallel, steeply dipping, north-east trending Cu-rich sulphide-quartz-calcite veins cut altered basalt. The showings were relocated, trenched and sampled by SYMC. Dauntless, which is contiguous to and located ten kilometers north of SYMC's Macktush (MINFILE 092F012) project, is immediately above tidewater. Interim access to some of the occurrences at Dauntless was established by using a barge from Port Alberni to move the heavy equipment that was used for access trail construction and trenching.

In 2002, SYMC submitted notice of work applications for extensive bulk sampling programs centered on its two project areas at Macktush and Dauntless. Neither was completed as the programs were deferred to 2003. In order to process the bulk samples, SYMC also plans to install a small gravity and sulphide flotation milling plant between the Dauntless site and Port Alberni. It may be possible to ship some of the high-grade chalcopyrite/bornite mineralization from Dauntless directly to smelters. In 2003, continued prospecting, trenching and diamond drilling is planned on various MINFILE occurrences on the property, including Holk 092F155, Bell 092F383, Stamp 092F549 and Devil's Den 092F551, and work will continue on Dauntless 092F068.

APPLE BAY
(MINFILE NOS. 092L150,-269,-308)

South of Port Hardy along the north shore of Holberg Inlet, Homegold Resources Ltd., with funding from Ash Grove Cement Ltd. and Electra Gold Ltd., completed 550 meters of diamond drilling to further test its Apple Bay project for silica and kaolin potential. Environmental and product testing of the material was also completed. Ash Grove is targeting the silica as cement feedstock, and Electra is targeting the kaolin for applications in the pulp, paper, paint and ceramics industries.

The Apple Bay project is centred on a series of ten or more intense zones of acid sulphate and advanced argillic

Photo 7. SYMC Resources Ltd. president Herb McMaster at c.100 year old adit on Dauntless project, Port Alberni area.

alteration developed within a northwest trending flow banded and pyroclastic rhyolite unit of the Jurassic Bonanza Group. Two areas in one of the zones (Pem 100) contain geological resources of four and one million tonnes respectively, averaging 83.3% SiO_2, 12.9% Al_2O_3 and 0.08% SO_3. The region and property also hold potential for porphyry and related Cu-Mo-Au-Ag deposits similar to the nearby past producing Island Copper mine (MINFILE 092L158) and Hushamu (MINFILE 092L240) and Red Dog (MINFILE 092L200) developed prospects. There is also potential for high sulphidation epithermal deposits, like the Knob Hill prospect (MINFILE 102I005) further to the northwest.

OTHER EXPLORATION ACTIVITY

During 2002, several prospectors and mining companies either resumed dormant projects or started new ones that could easily become major projects in the region next year. In contrast to prior years, only about 30% of explora-

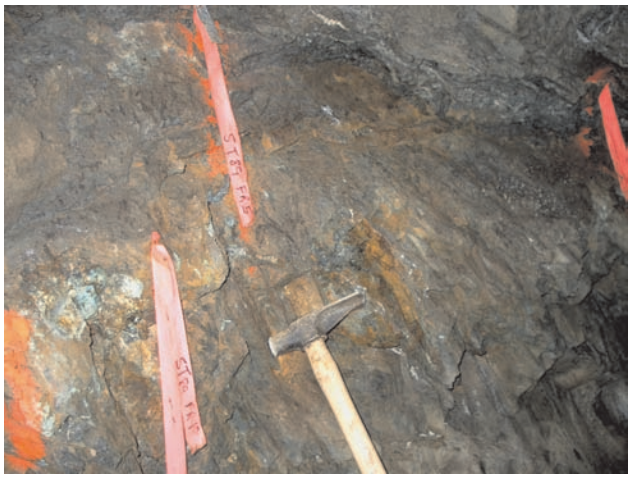

Photo 8. Massive chalcopyrite-pyrrhotite-bornite vein in adit on SYMC's Dauntless project, Port Alberni area.

tion projects and expenditures in the Southwest Region occurred on Vancouver Island. In order to help stimulate mineral exploration interest on Vancouver Island, the Regional Geologist started the Vancouver Island Exploration (VIX) Group. At the inaugural meeting on October 30, 2002 at Malaspina University College in Nanaimo, Jacques Houle gave a presentation on the Mineral Deposits of Vancouver Island that was attended by about 30 people. The VIX Group met again on December 4, 2002 for technical presentations by Ray Lett and Dani Alldrick of the B.C. Geological Survey. Membership in the VIX grew to about 50 by year-end; meetings are scheduled every month or so in 2003.

On southern Vancouver Island near Port Renfrew, Tim Henneberry mapped, sampled and successfully optioned the Hemm project to Southern Pacific Development Corp., who planned but failed to complete diamond drilling and bulk sampling in 2002. They are targeting $CaCO_3$ in marbles of the Paleozoic to Jurassic Westcoast Complex for specialty aggregates. Both the Hemm project and several large claim blocks staked by partners Norman Rooke, Robin Rooke and Ray Oshust are completely surrounded by claims of Emerald Field's Pearson project described previously. East of Alberni Inlet along Corrigan Creek, Richard Krivensky staked claims near the Crystal project to cover the Rodeo Cu-Ag Quartz vein (MINFILE 092F217). In 2002 the Regional Geologist grab sampled a narrow quartz-sulphide vein in Triassic Karmutsen volcanics in a roadcut near the Rodeo. The sample yielded >100g/t Au, 219 g/t Ag, >10% Zn, 1.46% Cu and anomalous Pb, Cd, Co, Bi and Hg; this is considered a new discovery in the Southwest Region.

On central Vancouver Island east of Port Alberni, numerous MINFILE occurrences occur within the largest exposure of the metal-rich Paleozoic Sicker Group volcano-sedimentary rocks. Three groups looking for polymetallic deposits have targeted this area. In 2002, Michael Becherer successfully completed prolonged negotiations with Boliden-Westmin (Canada) Ltd. to acquire an interest in the Debbie project, which covers MINFILE's Linda 092F079, Grizzly 092F152, 900 092F343, Debbie 3 092F445 and Pat 3 092F458 showings. Barry Hanslit staked several properties covering MINFILE's Regina 092F078, Bank Group 092F167, Lizard Lake 092F285, McQuillan 092F444 and Debeaux Creek 092F565 occurrences. Herb McMaster, on behalf of SYMC Resources Ltd., staked the Cameron Creek project that covers MINFILE's High Grade 092F143, Monkey 092F544, Spring 092F552 and Peak Lake 092F564 showings. All three groups plan exploration work in 2003.

In the Cretaceous Nanaimo Group Sedimentary Basin of eastern Vancouver Island between Nanaimo and Port Hardy, several groups acquired new coal licenses in 2002. These cover developed coal prospects and presumably target coal bed methane potential. Among these Trent River Coal acquired the Hamilton Lake occurrence (MINFILE 092F313) near Cumberland, 634284 B.C. Ltd. acquired the Anderson Lake prospect (MINFILE 092F317) near Courtenay, Briden Holdings Inc. acquired the Chute Creek property (MINFILE 092F316) near Campbell River, and Priority Ventures Ltd. acquired the Suquash prospect (MINFILE 092L067) near Port McNeil. As well, both Hillsborough Resources Ltd. and Priority Ventures Ltd. were active in acquiring new coal licenses near their existing projects. Exploration plans for 2003 are not known.

On northern Vancouver Island near Campbell River, Better Resources Ltd. completed a 255-meter drilling program on the Blue Grouse project (MINFILE 092F358), which they optioned from private company Minland Resource Inc. The second and last hole yielded an intercept of 1.5 meters at 3.33% Cu, 0.356 g/t Au and 10.7 g/t Ag in Cu Skarn mineralization developed within Triassic Karmutsen basalt associated with Jurassic Island intrusives. Near Sayward, Hillsborough Resources Ltd. acquired an interest in the Iron Ross project, which covers the Iron Mike (MINFILE 092K043) Fe Skarn, from Homegold Resources Ltd. They completed trenching, a 454-meter drilling program, and a 160 tonne bulk sampling program. Hillsborough is seeking a source of local magnetite for coal processing at its nearby Quinsam Coal Mine. Near Zeballos, Adolf Aichmeier continued minor underground exploration work at the Privateer Au-Ag Quartz Vein project (MINFILE 092L012 and others) on behalf of Newmex Minerals Ltd., which underwent a change in management in 2002. Mr. Aichmeier also staked two large claim groups in the area, one of which covers several MINFILE occurrences, including the King Midas No.1 Au-Ag Quartz vein 092F020. Graymont Western Canada Inc. completed geological work at the Var (MINFILE 092L044) Limestone project on Rupert Inlet near Port Hardy.

HARRISON LAKE - HOPE AREA

COGBURN (NEAR 092HSW081)

In 2002, Leader Mining International Inc. accelerated its production feasibility study and expanded exploration of the Cogburn Mg project area. It was the dominant exploration project by far in the Southwest Region. The 2002 diamond drilling program of 2152 meters in 38 holes helped

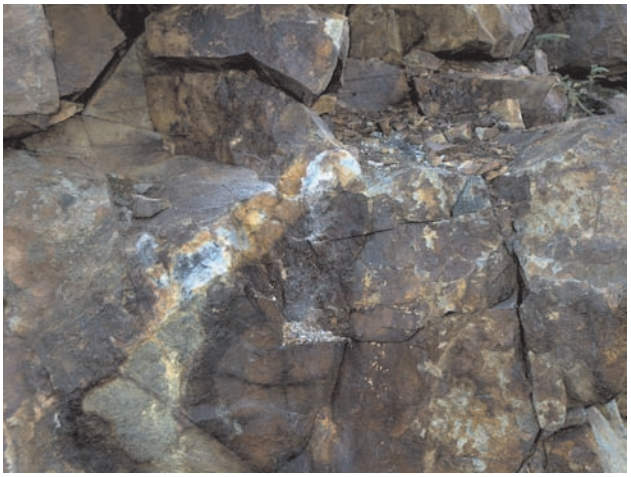

Photo 9. Gold-sulphide vein at Richard Krivenski's Crystal project near Rodeo showing, Port Alberni area.

define a measured mineral resource of 25.5 million tonnes at 40.5% MgO within a portion of the Emory Zone, with measured ore reserve status pending completion of the feasibility study by March 2003. This resource is considered adequate to support a mine life of 37 years at an annual production rate of 120,000 metric tonnes of Mg metal. The Emory Zone is within a 2 km by 10 km body of serpentinized ultramafic intrusives (peridotite or dunite) of probable Paleozoic-Mesozoic age assigned to the Bridge River Terrain. The Zone contains consistently high values of Mg (25 to 30%, that is 40 to 50% MgO) and Ni (2000 to 2500 ppm) in silicates, as well as consistently low values of deleterious elements such as sulphur and boron. If successful, the Cogburn project will lead to a new open pit Mg metal mine and plant near the town of Hope by 2004, and a potential showcase operation for the British Columbia mining industry within a two hour drive of downtown Vancouver.

Photo 10. Leader Mining International Ltd.'s consultants David Makepeace and Craig Payne at Cogburn project drill site on Emory Zone, Hope area.

HARRISON LAKE
(MINFILE 092HNW040, -045, -076)

Garex International Exploration continued its exploration activities in the Harrison Lake to Hope area. In early 2002, Garex optioned its extensive 1396 mineral claim unit property position to four separate companies: International Millennium Mining Ltd. (964 units), Stellar Pacific Ventures Inc. (355 units), Goldnev Resources Inc. (47 units), and Harrison Holdings (30 units). Garex, an exploration consulting company operated by Nicholson and Associates, continued to manage exploration work on all the properties on behalf of the optionees throughout 2002. Grass roots prospecting, geological mapping, geochemical sampling and ground geophysics were completed, and target areas selected for airborne geophysics planned for early 2003. Garex targeted magmatic Ni-Cu-Co-PGE sulphide mineralization associated with discontinuous and deformed exposures of ultramafic rocks of probable Paleozoic-Mesozoic age. They explored the property around the AL (092HNW040), Settler Creek (092HNW045), Jason (092HSW076) and Swede (092HSW082) MINFILE showings. They also checked areas proximal to Murray McClaren's Sable (092HNW077) showing immediately to the northwest, and Barrick Gold Corporation's past producing Giant Nickel Mine immediately to the southeast. At Giant Nickel, production of Ni-Cu-Cr-Co-Au-Ag-PGE ore came from the Pride of Emory (092HSW004), Star of Emory (092HSW093) and Giant Mascot (092HSW125) deposits.

OTHER EXPLORATION ACTIVITY

Also in the Harrison Lake to Hope area in 2002, Eagle Plains Resources Ltd. successfully optioned its Harrison Gold (Abo) project, covering MINFILE 092HSW092, to Northern Continental Resources Inc. The Harrison Gold (Abo) property hosts several quartz diorite stocks of Tertiary age that locally contain zones of sheeted, gold-bearing quartz-sulphide veins and stockworks that have bulk open pit potential. Northern Continental is planning a surface drilling program in early 2003 to delineate and augment some of the five known gold zones. One zone in the Jenner Stock contains an inferred resource of 2.2 million tonnes at 3.2 g/t Au. Along the Chilliwack River south of Harrison Lake, I.G. Machine and Fiber Ltd. and Homegold Resources Ltd. completed a 5000 tonne bulk sample on its Slesse Limestone project, near MINFILE occurrences 092HSW088 and 092HSW089.

COASTAL MAINLAND AREA

MINERAL HILL (092GNW052, -053, -066)

Tri-Sil Minerals Inc. successfully secured a 50/50 joint venture agreement with Clearview Mineral Resource Corporation for its Mineral Hill Wollastonite-Garnet Skarn project near Sechelt. Clearview funded a 5 hole, 705 meter drilling program on the Snake Bay Deposit (MINFILE 092GNW052) in early 2002. The drilling program intersected mineralization in every hole; the second hole cut 66.5 meters at 50% wollastonite and 50% garnet within an

Photo 11. Wollastonite-garnet skarn at Snake Bay deposit on Mineral Hill J.V. project of Clearview Mineral Resource Corp. and Tri-Sil Minerals Inc., Sechelt area.

area with a mineral inventory of 560 000 tonnes at 52% wollastonite. Both Snake Bay and the Wormy Lake occurrence (MINFILE 092GNW053) 2 kilometers to the northwest may be segments of an exoskarn that was offset by the NW-trending Wormy Lake Fault. The exoskarns formed within roof pendants of probable Triassic Quatsino Formation limestone within Jurassic plutons of granodiorite to gabbro composition.

The Mineral Hill project also has significant potential for dolomite, limestone and marble as well as other industrial minerals. Gabbro associated with Sechelt Granite occurrence (MINFILE 092GNW066) has dimension stone potential. Clearview intends to pursue further development of the property and marketing research in 2003. Also in 2002, Tri-Sil Minerals Inc. undertook minor exploration work at its contiguous Sechelt Carbonate project centered on MINFILE occurrence 092GSW031, and also covering the MC (MINFILE 092GSW035) and SN (MINFILE 092GSW048) showings. Tri-Sil is targeting Porphyry Cu-Mo-Au and related Cu Skarn and Zn Skarn mineralization, as well as sedimentary dolomite and limestone. Homegold Resources Ltd. also undertook minor exploration work in 2002 in the Alexis project area, adjacent to and east of Tri-Sil's Sechelt Carbonate project.

OTHER EXPLORATION ACTIVITY

The rocks of the Jurassic to Tertiary Coast Plutonic Complex largely underlie the Coastal Mainland portion of the Southwest Region, which covers the Sunshine Coast and Mid-Coast Forest Districts. The area saw a dramatic increased in exploration activity in 2002. Selected precious metal rich porphyry and related metallic mineral projects were reactivated, as the prices of Au and Cu increased. One new metallic mineral discovery was made in the Bella Coola area.

At the Jon project north Pemberton, International Silver Ridge Resources Ltd. completed a 4 hole, 242 meter drilling program in 2002. The program targeted gold rich Porphyry Cu-Mo-Au and related skarn or other intrusive related mineralization proximal to MINFILE's Texas 092JSE002, Sylvan 092JSE020, Lizard 092JSE029 and Bank 092JSE031 showings. North of Powell River, Bob Meikle and Jon Stewart undertook exploration work at the OK Porphyry Cu-Mo-Ag-Rhenium (Re) project (MINFILES 092K008 and 092K057), previously held under option by Canquest Resource Corp.

Along the east side of the Klinaklini River north of Knight Inlet, Saxony Explorations Ltd. completed preliminary exploration late in 2002 on their Redbreast project, acquired early in the year. Saxony targeted gold rich Porphyry Cu-Mo-Au and related mineralization in three claim blocks

Photo 12. Dan Epp and Bob Lenci at Milica project on Bella Coola Chief showing, Bella Coola area.

covering MINFILE's Hannah 8-10-11 092N028, Hoodoo North 092N029, Lancers Mountain 092N051 and Darlene 092N063 occurrences. Chip sample results from trenches on the Saffron claim block near the Hannah prospect yielded up to 12.41 g/t Au, 10.3 g/t Ag and 1.5% Cu.

East of Bella Coola along the west shore of the Talchako River, Dan Epp and Robert Lenci, two of the few active prospectors working in the area, staked and discovered new quartz-sulphide stockwork mineralization possibly of the Porphyry Cu-Mo-Au type at the Gyll project. A grab sample of a roadcut taken by the Regional Geologist while visiting the property yielded 0.25% Cu, 0.254% Zn, 36.2 g/t Ag, 2.5 g/t Au and 145 ppm Cr. The B.C. Geological Survey released results of a Regional Geochemical Survey for the Bella Coola area on August 14, 2002. The survey covered NTS sheets 093D and portions of 093C and 103A. The B.C. Geological Survey and the Geological Survey of Canada collaborated on the second and final year of fieldwork at the Bella Coola regional mapping project, led in part by Larry Diakow of the B.C. Geological Survey.

ACKNOWLEDGEMENTS

The author gratefully acknowledges the contributions of the dedicated and skilled prospectors, explorationists, and the personnel of the British Columbia Geological Survey and the Southwest Region Mines Branch to this report. Editing by Bill McMillan improved this paper, and his sharing of skill and expertise with all the contributors to this publication is greatly appreciated. Desktop publishing efforts by Janet Holland are gratefully acknowledged.

SOUTH-CENTRAL REGION

Michael S. Cathro, PGeo
Regional Geologist, Kamloops

HIGHLIGHTS

- Exploration indicators continued their gradual upward trend to the **highest levels in five years.**
- An aquifer-dewatering plan approved at the **Highland Valley Copper** mine, will help the mine operate until mid-2009.
- Approval was granted for a doubling of production at the **Ashcroft** quarry and roofing granule plant.
- A coal washing plant was purchased for the **Basin Coal** project near Princeton, and small-scale mining and processing began.
- Drilling tested the potential for coalbed methane at **Princeton**, and oil and gas rights were subsequently sold for $2.07 million to three Alberta-based companies.
- Good progress was made at several advanced exploration projects including Afton (Cu-Au), Elk (Au-Ag) and Fir (Ta-Nb-P).

EXPLORATION TRENDS

Exploration activity in the South-Central region continued a gradual upward trend to its highest level in five years. Exploration spending for the year is estimated at $6.0 million (Figure 1) while drilling activity increased to about 37 000 metres (Figure 2). There were twelve major projects (Figure 3; Table 1), defined as those involving drilling or trenching with more than $100 000 in spending.

4715 claim units were staked in the region by year-end, down by nearly 24% from the previous year (Figure 4). A total of 5780 claim units forfeited during the year, down about 9.5% from 2001. In terms of location, most of the major projects (Figure 5) were located in the Kamloops-Princeton corridor, with a few others scattered to the north and west. Grassroots projects accounted for about 60 per cent of spending with the remainder split evenly between minesite and advanced projects. As was the case last year, the **Afton** mine project was by far the largest drilling program. Junior companies and individuals funded most of the exploration; major companies were responsible for less than 5% of spending.

The most popular exploration targets were copper-gold-molybdenum porphyries (with about 40% of spending), coal and coalbed methane (20%), precious-metal veins (15%) and industrial minerals (10%). The remainder was split between stratiform base metal,

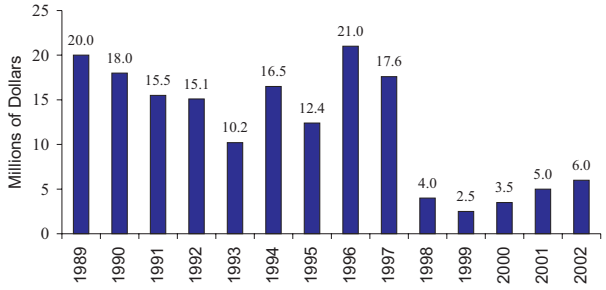

Figure 1. Annual exploration spending, in million of dollars, South-Central Region.

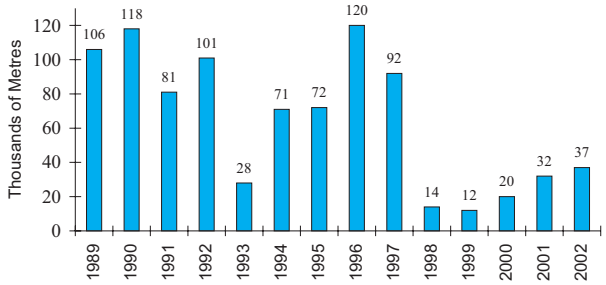

Figure 2. Annual exploration and development drilling, in thousands of metres, South-Central Region.

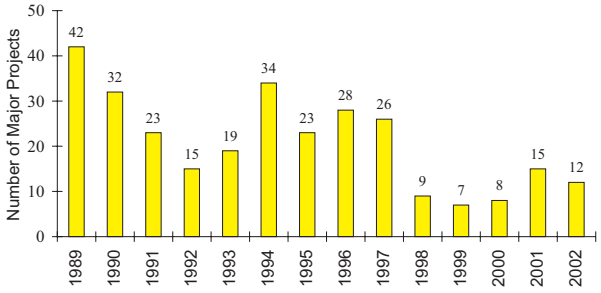

Figure 3. Number of major exploration projects per year, South Central Region. Major projects are defined as those with trenching or drilling and expenditures exceeding $100 000.

TABLE 1
MAJOR EXPLORATION PROJECTS, SOUTH-CENTRAL REGION, 2002

Property	Operator	MINFILE	Mining Division	NTS	Commodities	Target Type	Work done
Afton	DRC Resources Corp.	92INE023	Kamloops	92I/10E	Cu, Au, Pd, Ag	Alkalic Porphyry	27 ddh; approx. 15,000 m
Afton Area	Abacus Mining and Exploration Corp.	92INE028	Kamloops	92I/09W	Cu, Au, Ag, Pd	Alkalic Porphyry	10 ddh, approx 3000 m; geol; geochem
Ann North	GWR Resources Inc.	92P 115	Similkameen	92P/14W	Cu, Au	Alkalic Porphyry	6 ddh
AU-Wen-Mal	Lateegra Resources Corp.	92HNE144	Nicola	92H/16W	Au, Ag, Cu	Vein, skarn	6 ddh, approx.500 m; geochem; geol; grid
Elizabeth	J-Pacific Gold Inc.	92O 012	Lillooet	92O/02E	Au, Ag	Mesothermal Vein	16 ddh, 1683 m; geochem; geol
Elk (Siwash North)	Almaden Minerals Ltd.	92HNE096	Similkameen	92H/16W	Au, Ag	Vein	26 ddh, 5012 m; trail
Fir	Commerce Resources Corp.	83D 035	Similkameen	83D/06E	Ta, Nb, Phosphate	Carbonatite	5 ddh, approx. 900 m; mineral processing studies; geol; geochem; prosp
Loco-Cosmopolitan (Peter Vein)	Bralorne Pioneer Gold Mines Ltd.	92JNE164	Kamloops	92J/15W	Au, Ag	Mesothermal Vein	9 ddh, 679 m; 460 m trenching
Panorama Ridge	Goldcliff Resource Corp.	None	Kamloops	82E.031	Au	Skarn	Trenching; geochem
Sadim	Toby Ventures Inc.	92HNE095, 126	Clinton	92H078	Au, Ag, Cu	Vein, Porphyry	12 ddh, 1385 m; geochem
Similkameen	Connaught Energy Corp.	92HSE227, 216, 212, 215, 224	Similkameen	92H/07E	Coal, Coalbed Methane	Sedimentary	3 rdh, 2100 m
Tulameen	Bright Star Ventures Ltd./Cusac Gold Mines Ltd.	92HSE120, 142	Similkameen	92H/07W	Cu, Pt, Pd, Au	Magmatic?	6 ddh, 1024.8 m; road; grid; geophys; geochem; geol

magmatic copper-platinum group metals and gold-copper skarn prospects.

MINES AND QUARRIES

The region's larger operating mines and quarries are shown on Figure 5. The larger mines operate all year round, whereas many of the smaller quarries operate on an intermittent or seasonal basis only.

The large, low-grade **Highland Valley Copper** (HVC) mine (Photo 1) is located southwest of Kamloops and employs about 950 people. The partnership of Teck Cominco Ltd., BHP Billiton Ltd. and Highmont Mining Company own the mine. Production in 2002 was 181 300 tonnes of copper plus by-product molybdenum, gold and silver, down slightly from 2001. Mill throughput for the year was 49 900 000 tonnes, or 136 712 tonnes per day on average, with a head grade of 0.41% Cu and recovery of 88.78% Cu (Teck Cominco Ltd., Fourth Quarter Report, 2002).

During 2002, the Government of British Columbia approved an aquifer dewatering plan that will reduce groundwater inflow into the Valley pit and help the mine continue operating until its scheduled closure in mid-2009. The company is still evaluating a proposal to extend the mine-life by 30 months by deepening the Valley pit. Regionally, the company conducted an IP survey on the **Pimainus** property 8 kilometres southwest of the mine.

Several other moderate to large-sized metal mines and developed prospects remain on care and maintenance status, awaiting higher metal prices or discovery of additional ore. Imperial Metals Corp. owns the **Similco** porphyry copper-gold mine and mill complex at Princeton, and the **Invermay** project near Hope. Similco has a resource of 142 million tonnes grading 0.397% Cu in the area of Pits 2 and 3 on the Copper Mountain side of the property. During 2002,

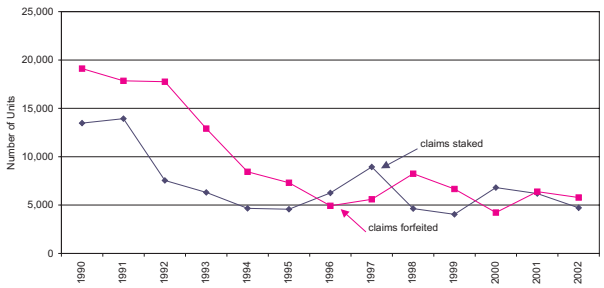

Figure 4. Claim units staked and forfeited, South-Central Region

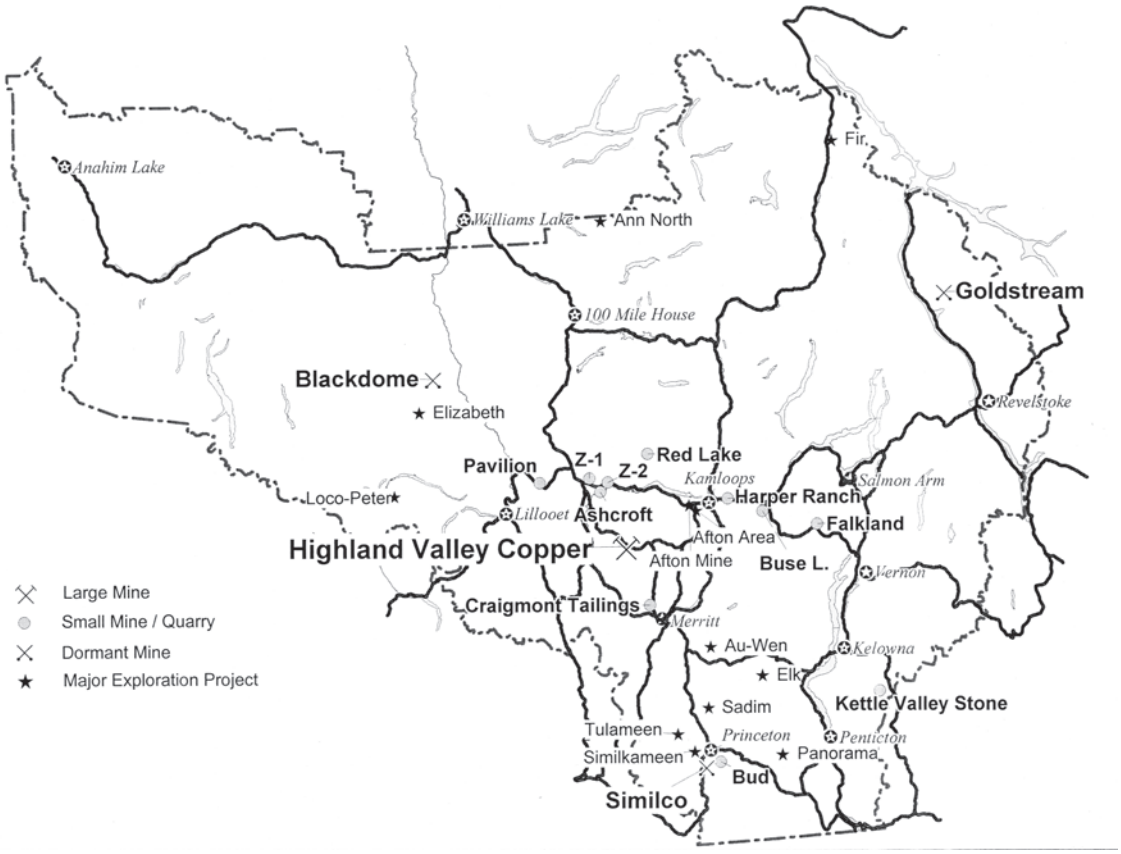

Figure 5. Mines, quarries and major exploration projects, South-Central Region, 2002.

Photo 1. Valley pit, Highland Valley Copper mine. Photo courtesy of Teck Cominco Ltd.

Imperial entered into agreements to sell the Similco mine for $450 000 to an unnamed buyer. The agreement does not include Similco's real estate holdings or its major mining equipment.

The dormant **Blackdome** gold-silver mine of J-Pacific Gold Inc. and Jipangu Inc. also remains on care and maintenance. This underground mine, developed on narrow, high-grade epithermal quartz veins, operated in the 1980's and again briefly from October 1998 to May 1999. The 200 tonne-per-day mill is intact, awaiting a higher gold price and new reserves. An inferred mineral resource stands at 124 120 tonnes grading 12.8 g/t Au and 33.7 g/t Ag. In 2002 J-Pacific drilled 51 holes to test the grade of tailings, and staked a large block of claims south of the mine.

Orphan Boy Resources Inc. now owns the **Goldstream** property north of Revelstoke, including the dormant copper-zinc mine and mill. No exploration work was done in 2002 but the company is examining the feasibility of using the Goldstream mill to process copper-gold ore from the recently purchased **Willa** property located 230 kilometres to the south near the town of Silverton. Orphan Boy also has several other good prospects in the Big Bend area, including the stratiform **Rift** Zn-Pb-Cu deposit, and the recently discovered **Spire** Cu-Zn massive sulphide occurrence that is located seven kilometres southwest of the Goldstream mill.

In 2002, IG Machine and Fiber Ltd., a subsidiary of IKO Industries Ltd. enjoyed a very successful first full year

Photo 2. Ashcroft roofing granule plant of IG Machine and Fibers Ltd.

Photo 3. Basin Coal mine near Coalmont. The stripped but unmined coal seam is in the foreground with screened, raw coal on the pile near the conveyor. Photo courtesy of Eric Beresford, Compliance Energy Corp.

of production from their **Ashcroft** basalt quarry and roofing granule plant (Photo 2). Six distinct colours of granules are produced at the Ashcroft plant for shipment by rail and truck to IKO shingle plants in Calgary, Alberta; Sumas, Washington; and elsewhere in North America.

During the year, the plant operated at about 50 per cent capacity, but was granted government approval to double the quarry production to 500 000 tonnes per year, the rated capacity of the plant. On average about 60% of the basalt fed into the plant becomes roofing granules; the company will try to market the remaining undersized material for other uses, such as road grit. The operation employed about 55 people during the year, not including construction personnel, but this should rise to about 75 when full production is attained. Further along the Thompson River to the northeast, the **McAbee** and **Walhachin** quarries supply railroad ballast for the Canadian National and Canadian Pacific railways respectively. The railroads also have several other quarries in the region.

The Kamloops cement plant and **Harper Ranch** limestone quarry of Lafarge Canada Inc., with an annual capacity of about 220 000 tonnes of cement, operated at about 55 per cent capacity on an intermittent basis during the year (Jeff Colbourne, Personal Communication, January 20, 2003). Lafarge also draws materials from the **Falkland** and **Buse Lake** quarries, which produce gypsum and alumina-silica rock respectively. The company is looking for a new, local source of alumina, which could reduce their dependence on more expensive shale from Sumas Mountain quarry near Abbotsford.

At Pavilion north of Cache Creek, Graymont Western Canada Inc. (formerly Continental Lime Ltd.) operates a limestone quarry and lime kiln. The operation produces about 190 000 tonnes of lime per year, mainly for use in pulp mills.

Craigmont Holdings Ltd. own the **Craigmont magnetite tailings** operation, located near Merritt. Tailings from the old Craigmont copper mine are processed to recover about 70 000 tonnes of magnetite annually. The plant is operated 6 to 8 months per year but product is trucked from the property for 12 months of the year. The magnetite is used in coal washing plants in British Columbia, Alberta and Washington State. There are enough reserves for about six more years of operations and the company is currently evaluating other magnetite sources, both on and off the property, as well as new markets (Eugene Mehr, Personal Communication, January 2003). On **Placer Lease 392136** on the Tulameen River, joint venture partners Firstline Recovery Systems Inc. and Golden Spike Exploration Ltd. produced magnetite (-20 mesh size) for sandblasting purposes. The magnetite content of Tulameen River gravels is quite high and recovery is relatively simple using standard placer mining methods and magnetic separators.

Near Coalmont, partners Compliance Energy Corp. (65%) and Nissho Iwai Canada Ltd. (35%) mined about 10 000 tonnes of thermal coal at the **Basin Coal** project (Photo 3), formerly known as the Tulameen project. The coal, which is high volatile bituminous B and C in rank, is being trucked to a newly constructed wash plant on the Similco site near Princeton, about 45 kilometres away. Clean coal is being marketed to industrial users in the Lower Mainland and southern British Columbia, but the partners are also evaluating export sales opportunities. The project, with measured and indicated resources of 19 million tonnes, has a permit for up to 250 000 tonnes of annual coal production.

At its plant in Kamloops, Western Industrial Clay Products Ltd. manufactures cat litter, barn deodorizer, industrial absorbents, garden mineral supplements and potting soils. The products are mainly prepared from diatomaceous earth mined from the **Red Lake** quarry (Photo 4) northwest of Kamloops, and bentonite mined from the **Bud** quarry at Princeton. Garden supplies are developed from "leonardite" mined at Red Lake, a low-grade coaly material rich in humic acid. In 2002, Western Industrial dug test pits on the **Kitty** claims, adjacent to the Red Lake quarry, in preparation for future mining. North of Cache Creek, Willy Kovacevic sampled bentonite/pozzolan on his **WK Group** property.

The **Z1** (Ranchlands) zeolite quarry near Cache Creek is small-scale, and operates intermittently. The quarry is owned by the Mountain Minerals Division of Highwood Resources Ltd. The ore is shipped to Highwood's plant in

Photo 4. Flat-lying diatomaceous earth deposit, Red Lake quarry, Western Industrial Clay Products Ltd.

Lethbridge, Alberta for processing. The zeolite is used mainly for agricultural purposes.

The nearby **Z2** quarry and a processing plant in Ashcroft are owned by Industrial Mineral Processors of Calgary. The plant produces barn deodorizers, feed binders, cat litter and industrial absorbents. At Princeton, Zeo-Tech Enviro Corp. mined a 4000 tonne bulk sample of zeolite at the **Zeo** (Bromley Vale) quarry. Zeo-Tech and C2C Zeolite Corp. formed a partnership to market the Princeton zeolite as "Zeo-Fume", a cement additive with applications in shotcrete, downhole cementing and other construction purposes. At year-end the partners were arranging to ship 2500 tonnes to the Ashcroft processing plant. In addition, Zeo-Tech continues to develop markets in the aquaculture, horticulture and agriculture fields. Also near Princeton, Canmark International Resources Inc. continues to test markets for zeolite from its **Sun** quarry.

Okanagan Opal Inc. produces attractive fire opal gemstones and jewelry (Photo 5) from the **Klinker** property located west of Vernon. Opal occurs as fracture and vesicle-fillings in andesitic to basaltic laharic breccia of the basal Kamloops Group (Eocene). In 2002 the company conducted small-scale mining and extracted rough opal for processing to meet expanding sales. The company's goal is to introduce the product to the BC and Alberta tourist-retail market and then to other North American jewelry markets as "Okanagan Opal" (Bob Yorke-Hardy, Electronic Communication, January 21, 2003) .

Production of decorative rock and dimension stone continues to grow in the southern interior, due in part to growing markets for natural stone and in part to the success of the **Kettle Valley Stone Company** of Kelowna. Kettle Valley produces flagstone, ashlar, facing stone and landscape rock, which are particularly popular in the Whistler, British Columbia and western United States markets. Dacite ash, granite gneiss and basalt are quarried from the **Nipple Mountain**, **Canyon** and **Gemini** quarries respectively, all located east of Kelowna. Kettle Valley Stone now employs about 25 people.

South of Revelstoke, D.G. Olsson produces small amounts of micaceous quartzite flagstone and facing stone by hand at the **Begbie** quarry. Other small, hand-operated flagstone quarries started up in 2002 near Gosnell in the North Thompson River valley. Grey-green and pinkish white micaceous quartzite was produced from the **M.S. 1** and **North Thompson Pearl** claims (Photo 6), owned by

Photo 5. Ring with fire opal from the Klinker opal mine, west of Vernon. Photo courtesy of Okanagan Opal Corp.

Photo 6. Pallets stacked with micaceous quartzite flagstone from the North Thompson Pearl claim. Photo courtesy of W.B. McEwen.

M.M. Hrytzak and W.B. McEwen. In the same area L.B. Butcher began work on the **BK Mines** property.

Landscaping rock is produced at numerous sites including the **Wing** pit near Princeton (red shale), the **Bailey**, **Leger 2** and **Josh 1** pits south of Vernon (granite), the **Broken Rock Ranch** quarry near Westwold (red lava), the **Pacific Silica** quarry at Oliver (white quartz and pegmatite), and the **Soapy Shale pit** near Armstrong (rusty gneiss). Other prospects being evaluated for small-scale quarrying including the **Barbecue-Landscape** claims near Clinton (red, green and black lava), and the **View** and **Wol** claims near Westwold (lava), to mention just a few.

Near year-end, the inactive **Frenier** perlite quarry was purchased by BBF Resources Inc. who intend to haul a few hundred tonnes of stockpiled material to Ashcroft for process and market tests. The quarry previously operated from 1983 to 1987 and is located south of the Gang Ranch on the west side of the Fraser River. Perlite prospects in British Columbia are few. Inadequate transportation infrastructure hindered marketing of material produced in the past.

DEVELOPMENT PROJECTS

Again the **Afton Mine** porphyry copper-gold-silver-palladium project of DRC Resources Corporation was the largest project in the region in 2002. The company continued definition and exploration drilling beneath and adjacent to the Afton pit, which a subsidiary of Teck Corp. operated between 1977 and 1987. Later production came from the Pothook, Crescent and Ajax pits before Teck closed the operation in 1997.

Located ten kilometres west of Kamloops, the original Afton pit exploited mainly secondary (supergene) mineralization comprised of native copper and chalcocite with lesser bornite and chalcopyrite. Drilling beneath the pit by DRC encountered similar supergene mineralization in what is now called the Northeast Zone. To the southwest, in the Main Zone, however, drilling encountered more typical hypogene mineralization with chalcopyrite being the main sulphide mineral.

DRC has drilled more than 38 000 metres since 2000, including about 15 000 metres in 28 holes in 2002. In 2003 the company will be updating the mineral resource calculation to take into account recent holes, which show extensions of the Main Zone to the southwest, and widening of the Northeast Zone (Figure 6). The mineralization is still open to the southwest and to depth beyond the known strike length of 1000 m and depth of 775 metres (DRC News Releases, 2002). The previous resource calculation, done in late 2001, gives an indicated and inferred resource for the Main Zone of 38.7 million tonnes grading 1.55% Cu, 1.14 g/t Au, 0.125 g/t Pd and 3.42 g/t Ag, plus an additional 1.1 million tonnes of indicated resource at a lower grade for the Northeast Zone. Given current prices, copper accounts for about 60% of the gross metal value with the remainder in precious metals, mainly gold. Given the depth of the mineralization, DRC is evaluating bulk underground mining methods for future production.

Several other projects in the region are on hold pending higher commodity prices, financing and/or permits. The **Bralorne** gold project, a joint venture of Bralorne Pioneer Gold Mines Ltd. (50%), Avino Silver and Gold Mines Ltd. (25%) and Coral Gold Corporation (25%), received a Mine Development Certificate in 1995 but has yet to go into production. A 150 to 200 tonne-per-day mill is on site and reported to be substantially complete. In late 2002 the partners conducted trenching and drilled nine holes on the extension of the **Peter** vein (Loco claims); they reported

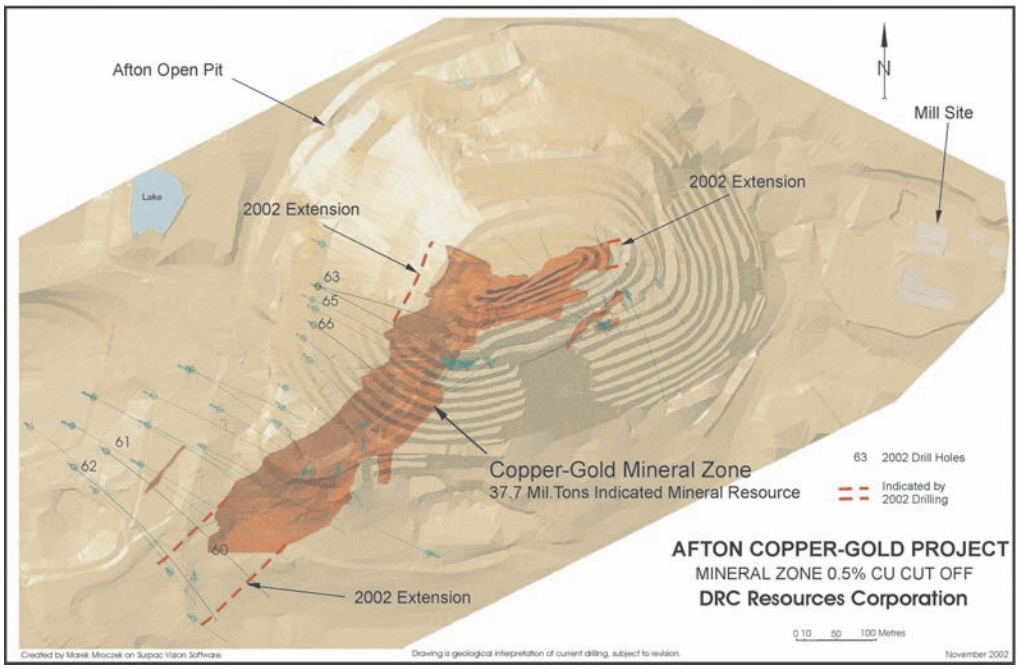

Figure 6. Perspective view (looking north) of the Afton project, courtesy of DRC Resources Corp.

several good intersections, the best being 148.4 g/t Au across 0.46 m.

The largest potential development in the region is the **Prosperity** porphyry gold-copper deposit of Taseko Mines Ltd., located southwest of Williams Lake. The most recent information from the company lists estimated measured and indicated resources at 491 million tonnes grading 0.22% Cu and 0.43 g/t Au, based on a 70 000 tonnes-per-day open pit design.

No work was done at the **Getty North** porphyry copper project of Getty Copper Corporation in 2002, however, assuming financing can be arranged, the company plans drilling and trenching programs, and to establish a pilot SX-EW mill in 2003. Located on the north slope of the Highland Valley, the Getty North deposit is estimated to contain a resource of 72.1 million tonnes grading 0.31% Cu, including 10.0 million tonnes of oxide grading 0.40% Cu.

EXPLORATION PROJECTS

PORPHYRY AND RELATED TARGETS

Abacus Mining and Exploration Corp. optioned seven **Afton Area** properties in the Iron Mask batholith from Teck Cominco Ltd. The properties include the Rainbow, Crescent and DM-Audra alkalic porphyry Cu-Au occurrences, along with the recently closed Ajax West and Ajax East pits. In 2002, Abacus compiled and reviewed the voluminous dataset for the properties, and drilled 10 holes on the **Rainbow** property. Re-sampling of Teck's hole 95-22 returned 57 metres grading 1.06% Cu, 0.27 g/t Au and 1.04 g/t Pd. Abacus' 2002 hole R-02-006 cut 299.2 m grading 0.25 g/t Au, 0.81% Cu and 0.05 g/t Pd, and hole R-02-008 intersected 31.1 m grading 0.045 g/t Au, 1.12% Cu, and 0.94 g/t Pd. The company also reported good precious metal assays from surface samples on several nearby prospects.

G W R Resources Inc. drilled several holes in 2002 on the **Ann** property near Lac La Hache. The holes tested alkalic porphyry-style copper-gold mineralization; however, results have not yet been released.

VEIN TARGETS

The rising price of gold helped rekindle interest in precious-metal bearing vein targets in the region. The high-grade **Elk (Siwash North)** property east of Merritt was the subject of a large exploratory drill program in 2002. Almaden Minerals Ltd., in joint venture with Wheaton River Minerals Ltd., drilled over 5000 m in 26 holes to test the Deep B shoot on the main Siwash North vein, the WD vein, the Gold Creek West vein and the Bullion Creek structure. Mining of the Siwash North vein between 1992 and 1995 produced more than 1440 kilograms (51 000 ounces) of gold, mainly from an open-pit (Photo 7). The Almaden website shows the current Elk resource as 141 962 ounces of gold, however, this figure is currently being updated based on the recent drilling.

Almaden also conducted trenching and pitting on the early-stage **Prospect Valley** epithermal gold-silver prospect, located 50 kilometres west of Merritt. Grab samples of float collected in 2001 assayed up to 43.34 g/t Au with anomalous Ag, As, Sb and Mo in host rocks thought to be volcanics of the Cretaceous Spences Bridge Group.

Photo 7. The Siwash North pit of Almaden Minerals Ltd. People are standing on the footwall of the mined-out vein.

Northwest of Lillooet, J-Pacific Gold Corp drilled several mesothermal vein targets on the **Elizabeth** property (Photo 8). The property is known to have at least six narrow, high-grade veins on which Bralorne Gold Mines Ltd., Bethlehem Resources and Blackdome Mining Corp. drove adits in the 1940s, 1950s and 1990 respectively. Underground sampling (with metallic-screen fire assaying) by J-Pacific confirmed the erratic and locally very high-grade "nuggety" gold distribution in the West vein (Photo 9). For example, a 0.4 m chip channel sample returned 144 g/t Au. The best 2002 hole returned 13.5 g/t Au over 0.55 metres from the West vein (Photo 9). Soil sampling and geological work was also done, and a new area of porphyry-hosted stockwork mineralization discovered. There is potential for near-term, high-grade gold production from this property because it is only 45 kilometres from J-Pacific's **Blackdome** mill, and a road connection may be feasible.

On the **Sadim** property north of Princeton, Toby Ventures Inc. drilled 12 holes in search of vein Au and

Photo 8. Drill at upper portal, Elizabeth property. Photo courtesy of Warner Gruenwald, consultant to J-Pacific Gold Corp.

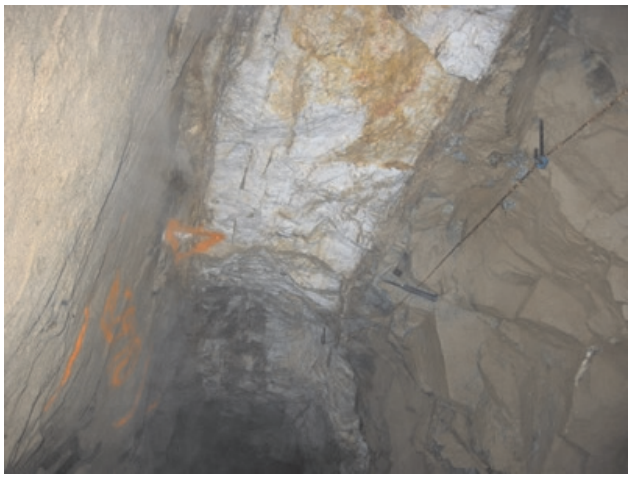

Photo 9. West vein (approximately 60 cm wide), Elizabeth property. Photo courtesy of Warner Gruenwald, consultant to J-Pacific Gold Corp.

stockwork or porphyry Cu-Au mineralization. Nine holes tested the Sadim vein swarm and the best intersection was 15.2 cm grading 48 g/t Au. On the KR showing, the best result was 0.177% Cu and 0.074 g/t Au over a core length of 19.8 m.

Under the direction of geologist Murray Morrison, Doublestar Resources Ltd. drill-tested several areas on the **Gold-Rainbow** property near Venner Meadows, southeast of Okanagan Falls. Au-Ag mineralization occurs in epithermal quartz-calcite veins and silica-clay-pyrite-hematite alteration zones within Tertiary volcanics above an inferred detachment fault. The style of mineralization is somewhat analogous to the former producing **Dusty Mac** gold-silver mine to the northwest, which was optioned during the year by Ecstall Mining Corp.

With the rising price of gold, several other companies optioned high-grade gold-silver vein prospects, and several of these should receive significant work in the near future. In the Princeton-Keromeos area Cassidy Gold Corp. optioned the **Hit** and **Kero**, and Bright Star Ventures Ltd. optioned the **Golden Lode** property. West of Lillooet, Quartz Mountain Resources Ltd. optioned the **Ample-Goldmax** mesothermal gold prospect, and Avino Silver and Gold Mines Ltd. optioned the **Aumax** property. To the northwest near Gold Bridge, Viceroy Resource Corp. staked the **Big Sheep** and **Dash Creek** gold properties; subsequently Royal County Minerals Corp. optioned the properties. Over near Cherryville, Cantech Ventures Inc. optioned the **Mac (Top)** gold prospect. At year end, a deal was rumoured to be close for a company to option the past producing, high-grade **Windpass** gold mine north of Barriere.

SKARN TARGETS

Goldcliff Resources Corporation worked on its **Panorama Ridge** gold skarn property, located a few kilometres east of the past producing Nickel Plate gold mine. Soil and rock chip sampling and trenching were done in several areas, including the Panorama, Epic and Castle targets. At the York prospect (Panorama target) re-sampling of an old Placer Development trench returned 0.59 g/t Au across 86 metres, including 22 m grading 1.258 g/t Au (Photo 10), while at the Tower prospect (Castle target), channel sampling of pyrrhotite-bearing garnet-pyroxene skarn returned 0.418 g/t Au across 27.35 m, including 2 m at 1.735 g/t Au (Goldcliff Resources Corp. News Release, January 17, 2003). Staking was done in the Winters Creek area to cover a new area of anomalous stream sediment samples.

MAGMATIC TARGETS

Bright Star Ventures Ltd. drilled six holes on the **DP** target near Olivine Mountain on their large claim block in the Tulameen ultramafic complex. The DP zone was first identified as a strong magnetic anomaly from a 2001 airborne geophysical survey. Follow-up soil and rock geochemistry identified two significant NNW-trending soil anomalies (with up to 280 ppb Pt, 195 ppb Pd and 4500 ppm Cu) that extend over a combined strike length of 2 kilometres. Mineralization is described as *"disseminated and fracture-controlled pyrite-chalcopyrite mineralization with malachite staining…within magnetite-rich hornblende clinopyroxenite"* (Bright Star Ventures Ltd. News Release, September 20, 2002).

Within a 300 by 200 metre Pd-Pt-Cu-Au lithogeochemical anomaly, a one metre bedrock chip assayed 2.09 g/t PGE and 0.17% Cu. The zones appear to be

Photo 10. Goldcliff Resources Corp. president Len Saleken and consultant Grant Crooker examining gold skarn mineralization in an old Placer Development trench, York prospect, Panorama Ridge property.

broadly parallel to the trend of the mapped lithological units in the complex, however it is not yet clear if mineralization is of magmatic or epigenetic origin. The drill holes tested the easternmost anomaly, and although long intersections of anomalous copper were intersected, the best result were just 0.2% Cu and 0.2 g/t PGE across 8.6 m, and 0.66 g/t PGE across 2.0 m. Nevertheless, the DP mineralization represents a new style of copper-PGE target for the Tulameen complex. The company intends more drilling in 2003 to follow up the western anomaly, which has better surface results but more challenging terrain. In addition, the company has several other targets to evaluate with trenching and drilling.

Five holes were drilled at the **Fir** property north of Blue River in order to define additional reserves of carbonatite-hosted tantalum-niobium-phosphate mineralization (Photo 11). Grades were similar to those in previous drilling. The carbonatite layers are flat lying and average about 40 metres in thickness. Owners Commerce Resource Corp. also conducted metallurgical testwork to determine the best methods of recovery. Resources stated prior to the 2002 drilling totaled 5.2 million tonnes grading 194 g/t Ta_2O_5, 897 g/t Nb_2O_5 and 3.5% P_2O_5. Tantalum and niobium occur in the minerals ferrocolumbite and pyrochlore and phosphate occurs as apatite. In addition, a new prospect was discovered called **Upper Fir**, and it appears to have a higher niobium content than the main Fir deposit. Samples returned up to 6738 ppm Nb_20_5. Commerce also owns the **Verity** deposit, which lies to the north, and has a resource of 3.06 million tonnes grading 196 g/t Ta_2O_5, 646 g/t Nb_2O_5 and 3.2% P_2O_5. No work was done there in 2002.

Targeting coalbed methane, Connaught Energy Corp. of Calgary drilled three holes, totaling 2100 m, in the **Similkameen** (Princeton) coalfield in 2002. The basin includes Tertiary coal beds that were mined by open-pit and underground methods in the first half of the last century. Connaught now holds and has applied for coal licenses to cover more than 21 000 hectares in the Princeton basin. In November 2002, partners Birchill Resources Ltd. (30%), Connaught Energy (Alberta) Corp. (10%) and Petrobank Energy and Resources Ltd. (60%) acquired Petroleum and Natural Gas exploration and development rights from the Province for three parcels in the Princeton area. A total bonus bid of $2.07 million was accepted for the parcels. Petrobank indicated that it plans to shoot up to 100 kilometres of 2D seismic survey lines, and to execute a four-well coalbed methane pilot project (Petrobank Energy and Resources Ltd., 2002 Third Quarter Report).

There is also interest in coalbed methane in other Tertiary basins in the region. The Province is currently re-

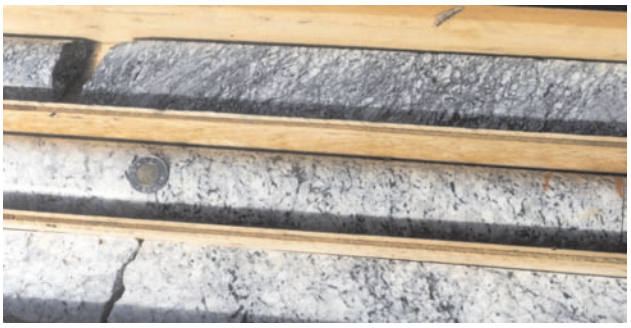

Photo 11. Tantalum, niobium and phosphate-bearing carbonatite in drill core from Commerce Resources' Fir property near Blue River (Hole 2002-7, 67m).

searching both the **Hat Creek** and **Merritt** areas to determine Crown ownership of Petroleum and Natural Gas rights. Disposition of available Crown rights in these basins may occur in 2003.

In the **Merritt** basin, Forum Development Corp. holds 1501 hectares of coal licenses and has an option to gain a 50 per cent interest from Imperial Metals Corp. in a 506-hectare freehold property that contains the Coal Gully Hill, Middlesboro and Coldwater Hill collieries. The properties are reported to contain substantial in-situ resources of high volatile bituminous coal. Seven to eight seams with about 24 metres total thickness occur within a 260 metres section of the Eocene Coldwater Formation. Forum is evaluating the potential for both coal and coalbed methane on these properties, and has submitted a request to the Province to post Petroleum and Natural Gas rights (Forum Development Corp. News Release, August 2, 2002).

At **Hat Creek**, where coal rights are owned by BC Hydro, a Crown oil and gas reserve is currently in place. In 2002, Hydro completed an update of its 1981 feasibility study for a large mine and thermal generating station at Hat Creek, concluding that it would not proceed with development at this time. BC Hydro has stated that it is considering relinquishing its coal rights and other assets in the area.

ACKNOWLEDGEMENTS

This report is made possible by the generosity and cooperation of the region's prospectors, consulting geologists, exploration companies and mine staff. The manuscript was improved by the editorial comments of Bill McMillan.

KOOTENAY REGION

David A. Terry, Ph.D., PGeo
Regional Geologist, Cranbrook

SUMMARY

Exploration expenditures in the Kootenay region during 2002 are estimated at $7.1 million, a decrease of approximately 9% from the $7.8 million spent in 2001 (Figure 1). The 2002 total includes $2.8 million (40%) spent on drilling for coal at, or in the vicinity of, the five producing coal mines in the Elk Valley, a drop of 41% from 2001; $3.7 million (53%) spent on metal exploration; and $0.5 million (7%) spent on industrial mineral exploration (Figure 2). Lowered production levels at several of the mines that resulted from protracted coal contract negotiations in the first half of the year caused the significant drop in exploration by the coal companies. In large measure this was balanced out by the resurgence in metal exploration spending in this area of the province.

An estimated 62 815 metres of drilling was carried out in the region in 2002, in all categories, a decrease of 29% from 2001 levels (Figure 1). Coal companies carried out 38 147 metres of reverse circulation drilling, a significant decrease of 50% from the amount of drilling carried out in 2001. Coal drilling comprised 61% of the total metres of drilling, down from 86% in 2001 (Figure 3). Metal exploration drilling rebounded in 2002 to 18 780 metres in 94 holes, a 161% increase from 2001 levels. It accounted for 30% of the total 2002 drilling, whereas it accounted for only 8% of the total metres drilled in 2001. An estimated 5888 metres of drilling, the remaining 9%, was carried out on industrial minerals projects, up slightly from 2001.

A total of 47 Notices of Work (NoWs) were submitted to the Kootenay Region Mines Branch office in 2002 for exploration programs on metal projects, 5 for industrial minerals projects, 6 for coal exploration programs, and 34 for placer projects. These numbers are similar to 2001 levels. The total number of metal projects worked on last peaked in 1997 at 231, and has declined since then to approximately 50 in each of the past two years (Figure 4). A total of 4445 new mineral claim units were staked in the region during 2002, down slightly from 5329 units in 2001; however, the number of forfeited mineral claims was down to 4396 from 4737 in 2001.

The increase in the price of gold from just below US$280 at the beginning of the year to almost US$350 by the end of 2002 refocused exploration activity toward pre-

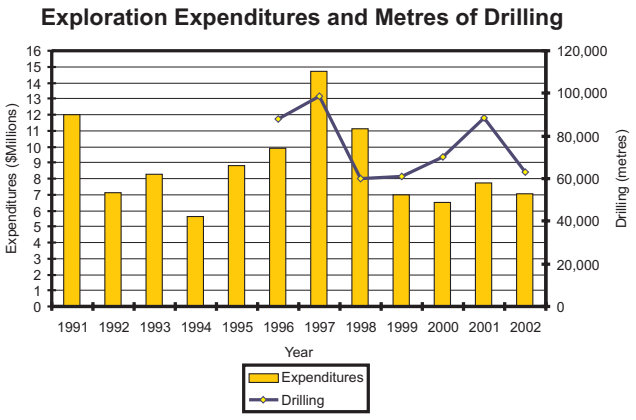

Figure 1. Exploration expenditures and metres of drilling.

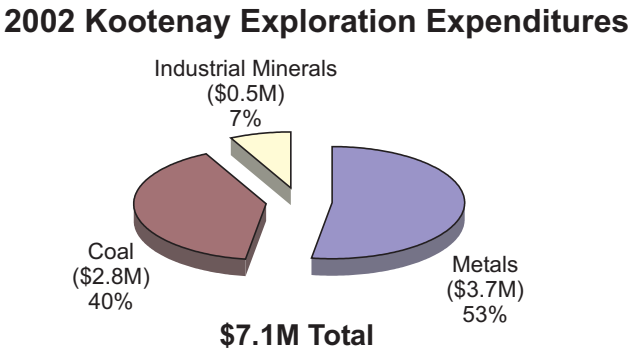

Figure 2. Exploration expenditures by commodity type.

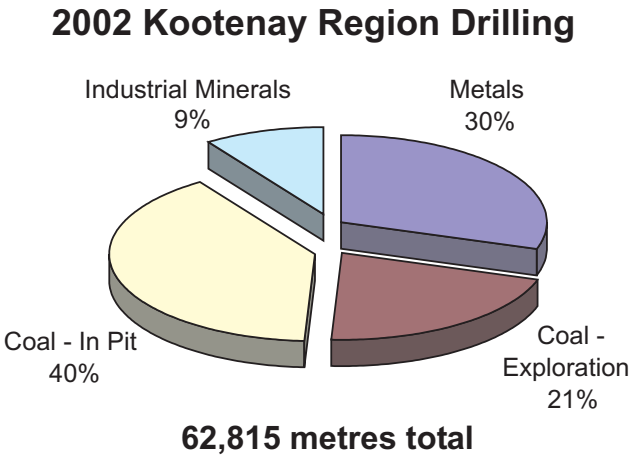

Figure 3. Drilling metres by commodity.

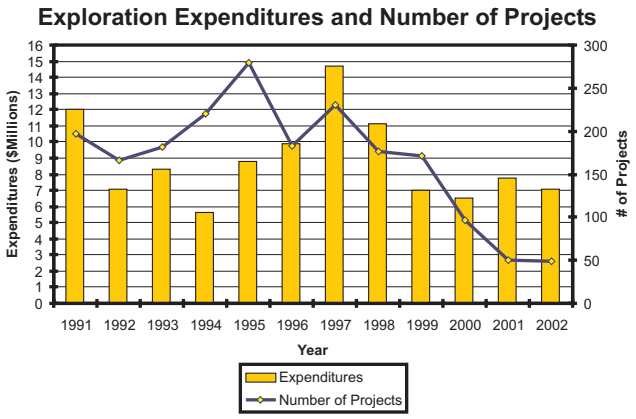

Figure 4. Exploration expenditures and number of projects.

dominantly gold-related targets. This is illustrated by Figure 5, which shows the metal exploration expenditures for the region in 2002 broken down by target deposit type.

In 2002 the Kena intrusion-related gold project in the Nelson area was again the largest metal exploration program in the region. In the fall, Sultan Minerals Inc. concluded a significant option agreement on the project with major gold miner Kinross Gold Corporation. Drilling on the Gold Mountain Zone, located in the northern portion of the Kena property, identified both low grade and high-grade gold mineralization, suggesting the potential for both bulk tonnage and smaller bonanza-grade deposits. In addition to further drilling on the Gold Mountain Zone, several other target areas on the project ground were drill-tested.

In the historical Greenwood mining camp Gold City Industries Ltd. acquired the Lexington-Lonestar and Winnipeg Golden Crown properties through option agreements; both have defined Au-Cu resources. Gold City also acquired a number of adjacent properties with high exploration potential. In addition they now have the rights to the Roberts Mill, near Greenwood, which they plan to use to process bulk samples in the short term and as a small central milling facility in the longer term. Orphan Boy Resources optioned the Willa Au-Cu-Ag deposit near Silverton in

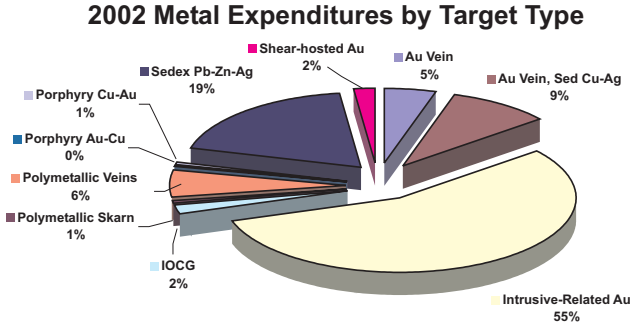

Figure 5. Metal Exploration Expenditures by Target-Type.

2002. The company is aggressively proceeding with a multifaceted feasibility study to examine the viability of underground mining the deposit and trucking the ore to their Goldstream mill complex north of Revelstoke for processing. A digital block model is being constructed, based on the significant amount of work carried out by previous operators, to facilitate mine planning and identification of near surface areas with high exploration potential.

Metal exploration in the East Kootenay area increased significantly during 2002 relative to 2001 levels. A drill program carried out by Golconda Resources Ltd. on the Lone Peak property east of Fort Steele tested for Spar Lake-type Cu-Ag mineralization and gold quartz vein mineralization. Klondike Gold Corporation carried out a campaign of deep drilling to test for Sullivan-type Pb-Zn-Ag targets in the Purcell Basin, as well as evaluating several gold targets. Late in the year Chapleau Resources Ltd. assembled a large land position covering many gold prospects in the Cranbrook area, and initial drilling on their Bar (Lookout) property intersected significant gold mineralization. To the east, in the Flathead River, area Goldrea Resources Ltd. carried out drill programs on their recently optioned Howell and Crowsnest intrusion-related Au properties.

Exploration activity on industrial minerals projects declined in the region during 2002. Crystal Graphite Corporation released results of a new resource calculation for their Black Crystal graphite project in the Slocan Valley. They also applied for a mining permit and continued to fine-tune their on-site pilot plant. Westroc Inc. carried out a drill program on their Elkhorn West project, immediately west of their Elkhorn gypsum mine southeast of Invermere that expanded gypsum resources significantly. Tiger Ridge Resources continued underground development, bulk sampling, and exploration drilling on their Jubilee Mountain barite project west of Spillimacheen.

Since the giant Sullivan Pb-Zn-Ag mine closed in December 2001, after more than a century of continuous production, there have been no operating metal mines in the Kootenay Region. Coal production in the Elk Valley was down from 2001 levels due to protracted contract negotiations during the first half of the year. A hostile takeover bid for the coal giant Fording Inc. was resolved early in 2003 with a plan to merge all of the metallurgical coal mines in the Elk Valley into a single investment vehicle. It will be called the Fording Canadian Coal Trust and will include coal export port facilities in the Vancouver area. All the major industrial mineral mines and quarries operating at the beginning of the year maintained steady production levels throughout the year; no significant change is forecast for 2003. There were no mine closures in the region during the year, and new production came from two industrial mineral quarries, the Rocky Mountain Slate quarry east of Golden, and the Winner diorite quarry in the Greenwood Camp.

EXPLORATION HIGHLIGHTS

The major metals, industrial minerals, and coal exploration projects carried out in the Kootenay Region during

2002 are listed in Table 1. These major projects involved significant levels of expenditures (i.e. >$100,000) on exploration drilling, bulk sampling, or underground exploration work. Locations of these projects, and others that are believed to be regionally significant despite somewhat smaller programs during 2002, are shown on Figure 6. There were a total of 16 projects with reported expenditures of more than $100,000 in the Kootenay Region this year.

METALS

Jonpol Explorations Ltd. optioned the **Ward Cu-Au** property, located approximately 15 kilometres east of Beaverdell, and carried out a two-phase exploration program during 2002. The company targeted quartz sulphide vein showings and bulk tonnage precious-base metal deposits. The property is underlain by metamorphosed volcanics, sediments, and diorite of the Upper Paleozoic Anarchist Group, intruded by quartz diorite and related dykes of the Westkettle Pluton, one of the Middle Jurassic suite of Nelson intrusions. The property contains a number of Minfile occurrences, the best known of which is the Barnato (082ESE109) deposit with historical production from an arsenopyrite-rich quartz-sulphide vein. From 1937 to 1939 and in 1966 and 1967, 296 tonnes with an average grade of 32.8 g/t Au and 13.97 g/t Ag were produced. An initial trenching program was carried out to test areas with elevated Au-As levels in soils and coincident IP chargeability anomalies. This work was followed up in the fall with a 9-hole, 260-metre drill program concentrated on southern part of the claim block (Photo 1) with several holes drilled to the north in the vicinity of the Barnato occurrence.

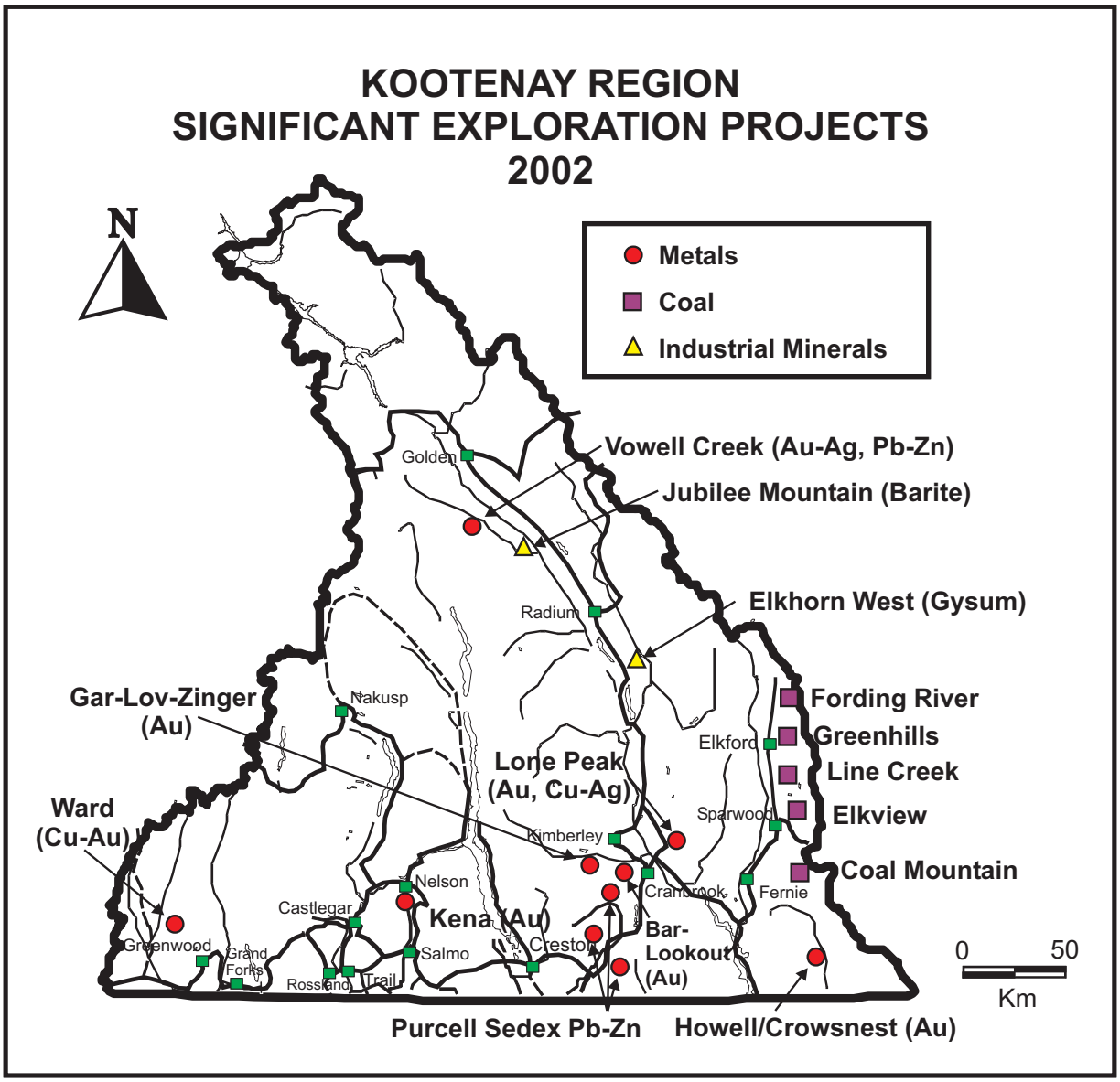

Figure 6. Significant Exploration Projects in the Kootenay Region, 2002.

TABLE 1
MAJOR EXPLORATION PROJECTS, KOOTENAY REGION, 2002

Property	Operator	MINFILE	NTS	Commod.	Deposit Type	Work Done
Bar 19 (Lookout)	Chapleau Resources Ltd.		82G/5W	Au	Intrusive-related	~800m diamond drilling in 2 holes
Coal Mountain Mine	Fording Coal Ltd.	082GSE052	82G/7E, 10E	Coal	Sedimentary	5975m RC drilling in 37 holes
Crowsnest	Goldrea Resources Corp.	082GSE070	82G/2E	Au	Intrusive-related	~610m diamond drilling in 11 holes
DA Vent	Klondike Gold Corp.	082GSW067	82G/5W	Pb, Zn, Ag	Sedex	1171m diamond drilling in 1 hole
Elkhorn West	Westroc Inc.	082JSW028; 082JSW021	82J/5W	Gypsum	Evaporite	3656m diamond drilling in 66 holes
Elkview Mine	Elkview Coal Corp.	082GNE015	82G/10W, 15W	Coal	Sedimentary	4672m RC drilling in 62 holes
Fording River Mine	Fording Coal Ltd.	082JSE009, 10, 12	82J/2W	Coal	Sedimentary	4600m RC drilling in 10 holes
Greenhills Mine	Fording Coal Ltd.	082JSE001, 5, 7	82J/2W	Coal	Sedimentary	4400m RC drilling in 32 holes
Howell	Goldrea Resources Corp.	082GSE037; 082GSE048	82G/02E	Au	Intrusive-related	328m diamond drilling in 3 holes; airborne
Jubilee Mountain	Tiger Ridge Resources	082KNE079	82K/16W	Barite	Veins, Breccias	2086m diamond drilling in 31 holes; 1000 tonne bulk sample; 55m drifting; 22m raising
Kena Gold	Sultan Minerals Inc./Kinross Gold Corp.	082FSW237, 331, 332	82F/6W	Au, Ag, Cu	Intrusive-related	~7870m diamond drilling in 39 holes; trenching; geol; gechem; geophys; airborne
Line Creek Mine	Luscar Ltd.	082GNE020, 21, 22	82G/15W, E	Coal	Sedimentary	18 470 RC drilling in 45 holes
Lone Peak	Golconda Resources Ltd.		82G/12E	Au, Cu, Ag	Veins; Sedimentary Cu-Ag	2054m diamond drilling in 8 holes; geol, pros
Ward	Jonpol Explorations Ltd.	082ESE109; 082ESE244; 082ESE111	082E/7W	Au, Cu	Veins	~460m drilling in 9 holes; trenching
West Moyie Block	Klondike Gold Corp.		82F/8E	Pb, Zn, Ag	Sedex	~1800m diamond drilling in 2 holes (1 extension)
Yahk - Cold Creek	Klondike Gold Corp.		82G/4W	Pb, Zn, Ag	Sedex	775m diamond drilling in one hole extension

Gold City Industries Ltd. completed several significant option agreements in the second half of the year for properties and facilities in the historical Greenwood mining camp. These acquisitions established the framework for their **Greenwood Gold Project**. The first major option deal was for a 100% interest in the **Lexington-Lonestar** property, which includes two deposits, eleven past producing mines, and a number of high potential mineralized zones. The Grenoble/Main Zone has a reported mineral resource of 94 923 tons grading 0.297 oz/ton (10.2 g/t) Au and 1.49% Cu (may not be National Instrument 43-101 compliant) accessed by a 300 metre decline, and the deposit is open down plunge. This mineralization comprises a structurally controlled complex of pyrite-magnetite-chalcopyrite-gold veins closely associated with a serpentinite-dacite contact. Five other zones are known on the property that have similar characteristics to the Grenoble/Main Zone. As well, the Lonestar deposit has disseminated and stockwork Cu-Au mineralization that has supported some past production. A second significant option gained control of the **Winnipeg-Golden Crown** property, 5 kilometres north of Lexington-Lonestar. This property contains a number of Rossland-type veins with pyrrhotite>pyrite>chalcopyrite in a quartz gangue that are hosted by Paleozoic diorite, greenstone, and serpentinite. In 1990 a study indicated the presence of a mineral resource of 37 100 tons grading 0.999 oz/ton (31.07 g/t) Au (uncut) or 0.536 oz/ton (16.67 g/t) Au (cut) and 1.12% Cu (may not be National Instrument

Photo 1. Diamond drilling on the Ward Cu-Au project, Consultant Bob Gale examining core.

43-101 compliant). The mineralization is accessible via a recent 1100 metre adit as well as through historical workings, and surface trenches. Significant potential exists to expand resources in the area both down-dip and along strike, and parallel veins may exist. The company also has completed option agreements to acquire the rights to the adjacent **Zip, JD** and **Century Gold** claims. Further, Gold City acquired the Roberts Mill, located 5 kilometres south of Greenwood, which has been used in the past as a custom mill. After completing rehabilitation work and some modifications to the mill facilities, the company plans to use it to process bulk samples from the Lexington-Lonestar and Winnipeg-Golden Crown properties and, subject to completion of a positive feasibility study, ores from the properties. Gold City plans a significant drill program on the Winnipeg-Golden Crown and surrounding properties for the spring of 2003 to validate and expand known resources.

Sultan Minerals Inc. followed up last year's successful work on the **Kena** project, southwest of Nelson, with another significant exploration program in 2002. One of the year's highlights was the option agreement between Sultan and Kinross Gold Corporation, announced in September. Kinross must fund $1 million of exploration by September 4, 2003 to acquire an option to earn a 60% interest in the property. To maintain and exercise the option Kinross is required to fund further expenditures of $9 million over a five-year period, and make a series of cash payments to Sultan. This deal was particularly significant because it marked the first option of a property in British Columbia by a major metal producer in some time. Exploration was carried out in three phases throughout the year and comprised diamond drilling, IP surveying, an airborne radiometric/magnetometer survey, geological mapping, trenching, and soil sampling. Work programs were carried out on both the core Kena property and adjacent properties optioned by Sultan.

Drilling on the Gold Mountain Zone in 2002 continued to intersect broad intervals of low-grade gold mineralization near the eastern margin of the Silver King Porphyry. Hole 02GM-42 cut 188 metres assaying 0.98 g/t Au, including higher grade intercepts up to 18.21 g/t Au over 2 metres. An extension of hole 01GM-10 from 185.32 metres to 359.05 metres depth (02GM-10 ext.) confirmed that gold mineralization extends to depth; the 94.8 metre interval between 213 metres and 307.8 metres depth assayed 0.95 g/t Au. In this hole the prospective porphyry-volcanic contact was intersected at 333.5 metres hole depth. The Gold Mountain Zone has now been tested along section lines over 1.8 kilometres of strike length along the porphyry-volcanic contact.

Gold mineralization is associated with 2 to 5% disseminated and fracture-filling pyrite found in areas of the Silver King monzonite to diorite plagioclase porphyry that have undergone silicification and strong potassic alteration. Fine-grained visible gold occurs locally in drill core. Some typical assays from 2001 drilling of the low-grade mineralized zone, which locally extends to surface, are 100 metres grading 1.21 g/t Au in hole 01GM-01, 116.05 metres grading 1.87 g/t gold in hole 01GM-03, 130 metres grading 1.14 g/t Au in hole 01GM-05, 160 metres grading 1.15 g/t Au in hole 01GM-08, and 140.38 metres grading 1.10 g/t Au in hole 01GM-28. Several bonanza-grade gold zones internal to the lower-grade areas (for example 172.1 g/t Au over 2 metres in hole 01-GM-08 and 240.1 g/t Au over 1.23 metres in hole 01-GM-03) are spatially related to the porphyry-volcanic contact.

In June Sultan released results of a preliminary study on the Gold Mountain Zone carried out by Snowden Mining Industry Consultants. The study reviewed a number of tonnage and grade scenarios using three types of processing methods at a range of gold prices. The company commissioned the study to determine "order of magnitude" thresholds to be reached in working towards an economic deposit.

Sultan continued to acquire adjacent properties in 2002. They added the **Silver King** claim group and the **Starlight** and **Daylight** properties to the previously acquired **Cariboo, Princess, Cleopatra, Great Western** and **Tough Nut** properties. Drill-testing of several vein systems comprising stockwork and sheeted veins in altered intrusive rocks was carried out on the **Great Western** property, which straddles the western contact of the Silver King Porphyry approximately 1 kilometre west of the Gold Mountain Zone. A soil geochemical survey over the area outlined a strong anomaly measuring 1200 by 300 metres with values of up to 1259 ppb Au. Grab samples of vein material assayed up to 119 g/t Au and 20.9 g/t Ag. Volcanic rocks of the Elise Formation underlie the **Starlight** property, located to the west of the Silver King intrusive. Historical workings are developed along a laterally persistent quartz vein that pinches and swells from 40 centimetres to 2 metres in width (Photo 4). Surface samples of the vein assayed up to 22.5 g/t Au and 150.9 g/t Ag over 1 metre. Three short drill holes were completed to test the Starlight structure, and confirmed the presence of a narrow high-grade vein at depth. It assayed 30.37 g/t Au over 28 centimetres.

No work was carried out during 2002 on the **Silver Lynx** VMS property, located 20 kilometres west of Nelson. Cassidy Gold Corp. entered into an option agreement in

Photo 2. Linda Dandy and Tom Schroeter examining the Starlight Vein, Kena Project

August with Delta Explorations Inc. whereby Delta may earn a 50% to 60% interest in the property, subject to an NSR and a series of cash and equity payments and work commitments. The property is underlain by argillites and siltstones of the middle Jurassic Ymir Group that overlie a package of phyllitic felsic tuffs. The entire sequence appears to have been folded to form a south-plunging antiform. Mineralization appears to be VMS-type, and is apparently stratabound and within 20 metres of the volcanic-sediment contact. Selected grab samples assayed up to 24.59% Zn, 22.35% Pb, 0.21% Cu, and 556.4 g/t Ag. A four-hole drill program in late 2001 intersected disseminated to semi-massive sulphide zones grading up to 6.87% Zn, 1.13% Pb, and 42.5 g/t Ag over 0.6 metres.

As in 2001, no 2002 exploration work was carried out on the **Remac** Zn Oxide project south of Salmo by project operators Redhawk Resources Inc. and joint venture partners ZincOx Resources PLC. Subject to financing, a significant drill program aimed at delineating a resource is currently planned for the spring of 2003.

Orphan Boy Resources Inc. undertook a feasibility study to examine the technical and economic viability of underground mining their **Willa** Au-Cu-Ag deposit near Silverton, which they optioned earlier this year. The company would truck ore to their **Goldstream** mill complex, 75 kilometres north of Revelstoke, for processing. The Willa deposit is hosted by an intrusive breccia pipe within a large roof pendant of metavolcanic rocks in the large Nelson Batholith. The property was explored during the 1980s by joint venture partners Rio Algom Exploration Inc., BP Minerals Ltd. and Northair Mines Limited. During this period 14 300 metres of surface core drilling, 1550 metres of underground development and 15 000 metres of underground drilling were carried out. This work delineated the near surface Main Zone that contains approximately 3.4 million tonnes grading 1.34 g/t Au, 0.32% Cu and 4.8 g/t Ag and the deeper West Zone that contains approximately 1.8 million tonnes grading 2.93 g/t Au, 0.66% Cu and 9.3 g/t Ag. The West Zone contains a higher-grade core of 635 000 tonnes grading 6.03 g/t Au, 0.92% Cu and 13.4 g/t Ag (note these resource numbers may not be National Instrument 43-101 compliant). The company is currently compiling the large amount of drill and sample data from past work on the property into a digital block model that will assist in mine planning and identification of areas with high exploration potential for expansion of near surface resources. Aspects of the feasibility study include: evaluation of the Goldstream mill infrastructure and process layout; assessment of the surface infrastructure requirements related to a 500 metric tonne per day underground mining operation at the Willa property; review and update of underground mine plans for Willa; estimating the cost of trucking Willa ore to the Goldstream mill; and submission of an application for mine development under the Environmental Assessment Act. The company announced acquisition of the adjacent **LH** gold property early in 2003.

Eagle Plains Resources Ltd. carried out further geological mapping and soil sampling on its **Iron Range** property northeast of Creston in 2002 in pursuit of Olympic Dam and sedex-type targets. The Iron Range Fault, which bisects the property, extends for more than 40 kilometres in a north-south direction. It is bordered by strongly albite-altered middle Aldridge clastic sediments intruded by gabbro sills. The fault zone itself is commonly occupied by foliated gabbro with albitic alteration rims. Hematite-magnetite zones occur along the length of the fault zone. In one area a hematite-magnetite breccia zone with a 3-kilometre strike extent has widths of 60 to 150 metres. Work this year identified copper mineralization associated with hematite and magnetite in several of the more northern trenches. Eagle Plains continues to seek a joint venture partner to advance the property.

In 2002 Klondike Gold Corp. continued the campaign to explore its large holdings in the Purcell basin for Sullivan-type Pb-Zn-Ag deposits. Early in the year a drill hole on the **Fran** property, located northeast of Moyie Lake, was completed to a depth of 560.2 metres. In the spring, Klondike Gold optioned the **Davent** property, located along the Lumberton Road southwest of Cranbrook, from SuperGroup Holdings Ltd. and drilled a single hole to a depth of 1171.3 metres. The hole intersected a 19 metre thick argillaceous "Sullivan time horizon" unit at the Lower-Middle Aldridge contact (LMC) with anomalous zinc and lead geochemistry (152 ppm Pb and 350 ppm Zn). Regionally in the Aldridge Basin, the thickness of the Sullivan Horizon varies between 1 and 10 metres. At the Sullivan mine it is approximately 100 metres thick, and in the Davent sub-basin previous drilling indicates that it is up to 86 metres thick and has anomalous base metal sulphide concentrations. Previous drill holes in the Davent area also showed that the sub-basin is 4 kilometres wide. A hole located southwest of the 2002 drill hole, closer to the interpreted axis of the sub-basin, is planned for 2003.

To the southwest of the Davent property, in the **West Moyie Block** area, Klondike Gold extended a 1997 Kennecott drill hole (K97-2) that was originally drilled to test a large gravity anomaly in the Panda-Payday sub-basin. The 1997 hole was stopped before reaching the LMC when it intersected a 190-metre thick gabbro sill. Klondike Gold extended the hole from 762 metres to 1545.4 metres before

reaching the limits of the drill rig. However, based on stratigraphic marker interpretation, the hole is still 200 to 300 metres above Sullivan Time. At the northern end of the Payday Basin Klondike Gold drilled a single hole on the Payday #1 property, approximately 1.5 kilometres southwest of a previously drilled hole (SMC95-1), which intersected a thickened Sullivan Horizon (16.8 metres) with visible sphalerite and pyrrhotite, one of only two holes drilled to the Sullivan Time horizon within this sub-basin.

In the **Cold Creek** area east of Yahk, Klondike Gold extended a hole, previously drilled by Minnova to a depth of 425m (MM-91-01), to a depth of 1200.9 metres. The hole intersected interbedded Ramparts facies quartzites and Lower Aldridge siltstones, suggesting it penetrated the western edge of the basin. A drill hole further to the east to test the basin axis is planned for the spring of 2003.

On the poorly exposed **Thea 17** gold prospect, located along the western edge of the Payday Basin, Klondike Gold excavated a series of trenches, and traced the silicified shear zone for a strike length of at least 250 metres. The prospect was discovered in the late 1990s and exposed in two short trenches in 1999. The shear zone, which strikes northerly and dips steeply, cuts Middle Aldridge Formation siltstones and varies in width from approximately 2 metres to more than 11 metres. Preliminary sampling shows that the zone is anomalous in gold over its entire length. Chip samples of the zone range in grade from 14.5 g/t Au across 4 metres in the central portion of the zone, 0.47 g/t Au over 6 metres in the most northerly trench, and 1.23 g/t Au across 2 metres in the southernmost trench. A grab sample collected along a ridge approximately 90 metres north of the northernmost trench assayed 652 ppb Au. Klondike Gold intends to carry out further trench sampling and diamond drilling on the prospect in 2003.

National Gold Corporation entered into an agreement during the summer with Cranbrook-based private exploration company Supergroup Holdings Ltd., to acquire a 100% interest in all their properties in the Purcell Basin not subject to previous agreements. Subsequent to announcement of the agreement, significant surface work programs were initiated on several precious metal properties, particularly the **Zinger, Gar, Lov,** and **HS** claim groups in the Perry Creek and Hellroaring Creek drainage areas. Perry Creek was a significant placer creek during the East Kootenay gold rush in the later part of the 19th century. The work program included prospecting, stream sediment, soil and rock sampling, geological mapping and further claim staking. A trend of gold mineralization in bedrock extends approximately 10 kilometres on the Zinger property. Gold occurs in Proterozoic sediments of the Purcell Supergroup that are sericitized and silicified with quartz veinlet stockworks, and also in thin siliceous veinlets in Cretaceous quartz monzonite that intrudes the older sediments. More recently, National Gold announced that it intends to merge with Alamos Gold Corporation, their joint venture partner on the large Mulatos gold deposit in Mexico. As a result they terminated their agreement with Supergroup Holdings Ltd.

Late in the year Chapleau Resources Ltd. entered into an option agreement to acquire a 70% interest in the **Bar 19** property, 12 kilometres west of Cranbrook, which includes the Lookout gold prospect. At the Lookout prospect gold mineralization is related to an altered Cretaceous syenitic dyke that occurs along the east-trending Cranbrook fault. The prospect was discovered in the early 1990s at which time soil sampling and a series of trenches traced the mineralization over a strike length of 200 metres. Trench sampling yielded assays as high as 0.132 oz/ton (4.5g/t) Au over 85 feet and grab samples of quartz stockwork in monzonite yielded up to 0.592 oz/ton (20.3 g/t) Au, 3 oz/ton (102.9 g/t) Ag and 1.7% Pb. Chapleau drilled two holes on the Lookout zone prior to the end of 2002 and recommenced the drill program after a Christmas break (Photo 3). Both holes completed in 2002 were drilled to the south from the same setup but at different dips; total length was 797 metres. The holes are collared in altered Creston Formation siltstones and intersect variably altered syenitic intrusives. Significant gold mineralization was encountered over several intervals in both holes; highlights include 1.62 metres grading 15.25 g/t Au and 4.15 metres grading 2.15 g/t Au, including 0.7 metres grading 8.27 g/t Au, from hole B-02-01 and 7.45 metres grading 10.33 g/t Au, including a 3.05 metre interval grading 23.36 g/t Au, from hole B-02-02.

In mid December Chapleau Resources Ltd. announced assembly of a major land position, 734 claim units, in the Cranbrook area through several option agreements and direct claim staking of an additional 592 units. The major option agreement was with Cranbrook-based Supergroup Holdings Ltd. to acquire a 90% interest in many of their gold properties originally the subject of the agreement with National Gold Corporation referred to previously. These properties comprise 610 units and include the **Zinger, Zeus, Hot Sausage, Love, Jackleg, IT,** and **TAC** properties. The large land package hosts numerous known gold occurrences and was laid out to cover two major mineralized trends identified in the Cretaceous Bayonne magmatic belt within the area. With the exception of the Jackleg, TAC, and IT properties, located approximately 35 kilometres northeast of Cranbrook on the eastern side of the Rocky Mountain Trench, the land holdings cover a large

Photo 3. Diamond drilling on the Lookout Zone, Bar property.

area to the west of Cranbrook and are contiguous with the Bar 19 property, which hosts the Lookout Zone.

Late in 2001 Golconda Resources Ltd. optioned the **Lone Peak** property, located east of Fort Steele, from a local claim owner. The property is underlain by rocks of the Creston and Kitchener formations of the Purcell Supergroup. The Spar Lake quartzite unit in the Creston Formation is equivalent to the rocks which host the Spar Lake Cu-Ag deposit, 85 kilometres to the south in Montana. This quartzite is 100 metres thick on the property and can be traced for approximately 3 kilometres along strike. Detailed mapping and prospecting carried out on the property as part of Golconda's due diligence, identified a 300 metre wide anticlinal fold in the Spar Lake unit that contains sheeted quartz veins and stockworks. Assays from select grab samples collected within this zone contain up to 1% Cu, 27 g/t Ag, and 32 g/t Au. Visible gold occurs in sheeted quartz veins up to 10 centimetres in width. Golconda also optioned the **Bri-Lin** and **Sully** claims to the north of Lone Peak. In 2002 the company drilled 8 holes in four separate locations for a total of 2054 metres (Photo 4). Zones of quartz veins with anomalous gold values and calcite veins with disseminated Cu-Pb-Zn sulphides were intersected. The final hole tested the projected extension of the Spar Lake quartzite unit. Disseminated bornite and bornite mineralization in quartz veinlets occur at surface, and the hole intersected quartzite with disseminated malachite. The company is currently evaluating future exploration plans for the property.

Jasper Mining Corporation carried out a surface exploration program on their **Vowell Creek** property, located 30 kilometres southwest of Golden. The property includes the past-producing Ruth Vermont mine, which has a historical indicated mineral resource (drill indicated and probable) of 302 000 tons of vein and replacement type ore averaging 6.8 oz/ton (233 g/t) Ag, 4.8% Pb, and 5.4% Zn (resource may not be compliant with National Instrument 43-101). The property is underlain by folded clastic and carbonate sediments of the Late Proterozoic Horsethief Creek Group, a subdivision of the Windermere Supergroup. The work program this year included soil and rock sampling, geological mapping, and prospecting. Rock and soil sampling demonstrated that significant gold mineralization is associated with the vein system. Selected high-grade grab samples of vein material assayed up to 0.50 oz/ton (17.1 g/t) Au, 66.25 oz/ton (2271g/t) Ag, 39.98% Pb, and 30.63% Zn. Based on this year's work and compilation of previous data, Jasper believes the Ruth Vermont vein system is situated within a larger gold±arsenic±lead±zinc mineralized system that is coincident with a prominent regional structure that hosts numerous mineral occurrences. They think that there is opportunity to extend the vein and replacement-type mineralization on the north side of Vermont Creek as well as in the immediate area of the Ruth Vermont mine. The company is planning an expanded program for 2003 that will include underground and surface drilling.

An agreement was announced in the spring whereby Goldrea Resources Ltd. can earn a 55% interest in one or both of the **Crowsnest** and **Howell** gold properties in the Flathead drainage basin, 30 to 50 kilometres southeast of Fernie, from Eastfield Resources Ltd. Both properties cover large gold anomalies related to Cretaceous alkaline rocks that intrude Paleozoic carbonate-dominant sedimentary sequences. In 1999, trenching on the Crowsnest property exposed a mineralized zone associated with a syenite dyke hosted by limestone that assayed 8.57 g/t Au over 16 metres in trench TK99-1 (Photo 5). In the general area of trenching numerous altered float boulders of various rock types contain anomalous gold concentrations ranging up to 620 g/t Au. In 2002 Goldrea drilled 660 metres in 11 holes in the area around and to the south of TK99-1. The third hole of the program (DDH-02-03), located 200 metres to the south of TK99-1 (Photo 6), intersected a 42.5 metre interval which assayed 0.40 g/t Au, including a 12 metre interval assaying 1.05 g/t Au and a 3 metre interval grading 2.62 g/t Au, in strongly altered monzonite and limestone. This hole was particularly noteworthy as it was the first intersection of significant gold mineralization in a drill hole on the Crowsnest property. Based on the distribution of mineralized rubble, the company believes that the mineral-

Photo 4. Property vendor Brian Kostiuk in front of drill rig, Lone Peak property.

Photo 5. Trench TK99-1, Crowsnest project.

Photo 6. Diamond drilling on the Crowsnest project

ized trend identified in hole DDH-02-03 and trench TK99-1 could continue for up to 2 kilometres. Further exploration work including drilling along the mineralized trend is planned for 2003.

On the **Howell** property, Goldrea conducted an airborne geophysical survey over a portion of the claim group and carried out a 3-hole, 328-metre drill program. Drilling by previous operators on the Howell property intersected 1.23 g/t Au over 58 metres (hole HRC-25) in pyritized and silicified limestone that is intruded by syenite. The three holes drilled this year stepped out to the west up to 200 metres from HRC-25. All three holes intersected wide zones of low-grade gold mineralization in silicified and pyritized limestone intruded by syenitic dykes, sills, and diatreme breccias. Hole DDH-02-01, located 200 metres west of HRC-25, assayed 0.52 g/t Au over 149.4 metres, including 30 metres grading 0.83 g/t Au. DDH-02-03, located 65 metres west of HRC-25, intersected 88.4 metres assaying 0.58 g/t Au, including an interval of 27 metres grading 1.01 g/t Au. A number of magnetic and radiometric anomalies were detected by the airborne survey. These are believed to be caused by multiple areas of alkalic intrusion into the carbonate-dominated stratigraphy that underlies the property. The company plans to carry out additional soil sampling and diamond drilling in 2003.

INDUSTRIAL MINERALS

Crystal Graphite Corporation continued to advance its **Black Crystal** graphite project in the Hoder Creek area of the Slocan Valley. The company submitted an application for a mining permit and proceeded with commissioning of its Koch Creek graphite pilot plant, 25 kilometres to the south of the quarry site. The Black Crystal property is underlain by Paleozoic rocks of the Valhalla Gneiss complex. On the property, calc-silicate gneiss, intruded by pegmatitic dykes, hosts crystalline and flake graphite. The zone of graphite mineralization dips to the southwest. It extends more than 400 metres in an east-west direction, and 300 metres in a north-south direction at the Hoder Creek quarry site. In 2002 the company released results of a new resource calculation carried out by AMEC E&C Services Limited for the Black Crystal graphite project. The resource estimate was based on data collected over the past few years from 64 drill holes, 176 slit trenches, and 1855 metres of linear trench sampling. The weathered Regolith zone was found to host 648 000 tonnes containing 1.82% fixed carbon in the measured and indicated resources category and 516 000 tonnes containing 1.69% fixed carbon in the inferred resources category. The underlying Calc-Silicate Zone was found to host indicated resources of 4 763 000 tonnes containing 1.21% fixed carbon in the indicated category and 4 591 000 tonnes containing 1.24% fixed carbon in the inferred mineral resource category.

Tiger Ridge Resources Ltd. continued underground development and surface exploration drilling on its **Jubilee Mountain** barite project west of Spillimacheen in 2002. The property is underlain by massive dolomite and limestone of the Middle-Upper Cambrian Jubilee Formation. Barite and sulphide mineralization are hosted in solution breccias and related veins in the Jubilee Formation. Approximately 55 metres of drifting and 22 metres of raising were carried out, and a 1000 tonne barite bulk sample was collected. A total of 2086 metres of surface and underground diamond drilling in 31 holes were completed. Surface drilling took place to the northeast of the adits in the "Nose" area. The company made preliminary investigations into the potential for mining barite from underground workings, and the feasibility of recovering it from tailings at the adjacent, past producing Silver Giant mine, which is held as part of the Jubilee Mountain property by Tiger Ridge. A total of 840 000 tonnes of barite-sulphide ore was mined from the deposit in the 1940s and 1950s, and Baroid of Canada produced 180 000 tonnes of barite from the tailings in the 1960s and 1970s. Tiger Ridge intends to continue their work program in 2003.

Westroc Inc. completed 3656 metres of drilling in 66 holes on its **Elkhorn West** gypsum project, 10 kilometres east of Invermere and immediately west of their Elkhorn gypsum quarry operation. The program outlined an undisclosed gypsum resource. The Burnais Formation, a sequence of Devonian carbonates and evaporites, hosts gypsum deposits in the area.

In the fall of 2001, Skeena Resources Limited carried out a short drilling and bulk sampling program on their **Ice** diamond project north of Elkford. Results were released in 2002. Lower Carboniferous to Triassic carbonates and clastic rocks of the Rocky Mountain Fold and Thrust Belt underlie the property. A cluster of four known kimberlite pipes occurs on the property. In 1996, a 20-ton bulk sample, comprising 90 to 95% non-kimberlite material, was collected from the Ram 6 kimberlite. It yielded 3 poor quality macro-diamonds, the two largest stones weighing a combined 0.23 carats. A 1996 bulk sample from the Ram 5 kimberlite yielded 3 good quality macro-diamonds weighing a combined 0.255 carats from 35 tons of surface material of which 95% was reportedly non-kimberlitic. In 2001 a total of 3 diamond drill holes were completed on the RAM 6 kimberlite, one of which intersected a 105.2 metre kimberlitic interval (41.8 to 147.1 metres). Caustic fusion anal-

ysis of 143m of split NQ core from the RAM 6 pipe identified no microdiamonds. Two short drill holes on the RAM 5 kimberlite, 1km to the south, failed to locate any significant kimberlitic material. A 3.8 tonne bulk sample was collected from fresh material at the Bonus kimberlite pipe, 3 kilometres west of RAM 6. Dense media separation analysis to recover diamonds in the +0.5mm to +6.0mm size range was unsuccessful. The company is currently evaluating its options regarding the Ice property.

COAL

Most coal drilling activity in the region took place within or adjacent to existing open pit mining operations. The coal companies carried out a total of 38 147 metres of reverse circulation drilling in 186 holes. Of this, 13 077 metres in 57 holes were classified as "deposit appraisal", and 25 070 metres in 129 holes were classified as "mine development" in-pit drilling. Most of the drilling that was carried out away from existing pits was conducted by the **Line Creek, Elkview** and **Fording River** operations.

At the **Fording River** mine 4630 metres in 10 holes were drilled on the Chauncey Ridge project to the south of the mine. At Fording's **Greenhills** mine, 4400 metres of in-pit drilling were carried out in 32 holes. At the **Coal Mountain** mine, another Fording operation, the company drilled 4975 metres in 21 holes in-pit and 1000 metres in 3 holes on the Leach Ridge project, approximately 12 kilometres west of the mine site. At Teck Comnico's **Elkview** mine, 2695 metres in 36 holes were drilled in producing pits. A total of 1977 metres in 26 holes were drilled outside of operating pits to delineate long-term reserves. At the **Line Creek** mine, owned by Luscar Ltd., a total of 5740 metres in 18 exploration holes were drilled, mainly in the Saddle, MSA North, and North Line Creek areas. In-pit drilling accounted for 129 holes with a cumulative length of 13 000 metres.

PRODUCING MINES AND QUARRIES

The locations of producing mines and quarries in the Kootenay Region for 2002 are shown on Figure 7 and listed on Table 2. Production data is included where it is available.

METALS

The giant **Sullivan** Pb-Zn-Ag mine at Kimberley closed permanently in December 2001 after more than a century of continuous production. Since differential flotation to separate lead and zinc concentrates was initiated at the mine in 1916, the mine produced more than 17 million tonnes of Zn and Pb metal and more than 285 million ounces of Ag. During 2002, decommissioning and reclamation work at the mine site began. There are currently no operating metal mines in the Kootenay Region.

INDUSTRIAL MINERALS

All the major industrial mineral producers in the region maintained production during 2002 at roughly the same

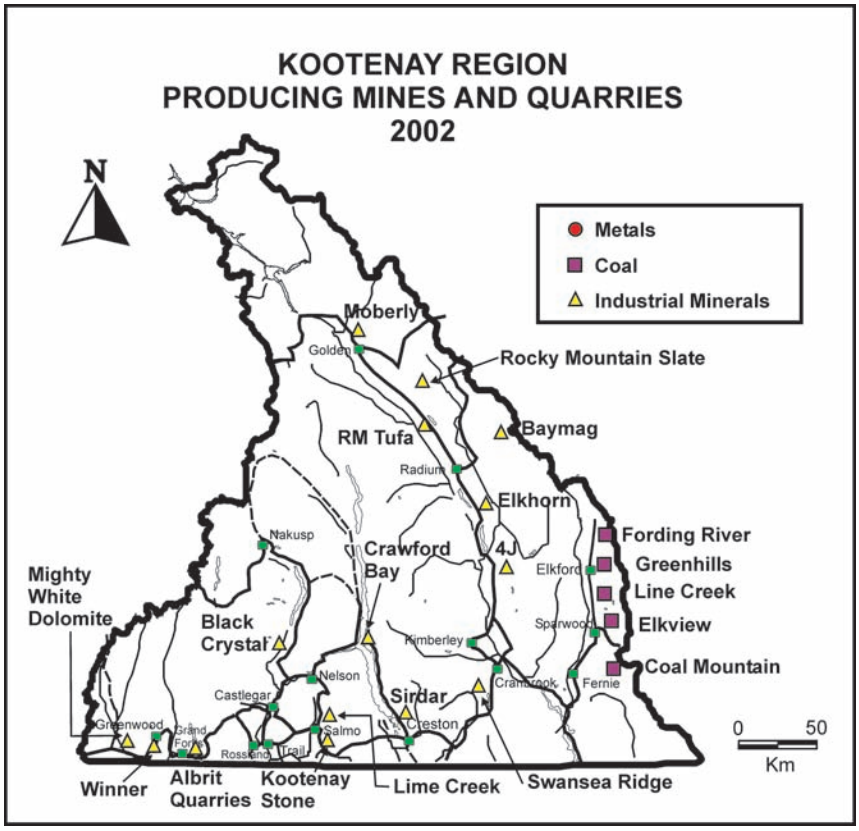

Figure 7. Producing Mines and Quarries, 2002.

TABLE 2
PRODUCING MINES AND QUARRIES, KOOTENAY REGION, 2002

Mine	Operator	Deposit Type	2002 Production
Fording River	Fording Coal Limited	Metallurgical coal	**14 million tonnes combined**
Greenhills	Fording Coal Limited	Metallurgical coal	combined
Coal Mountain	Fording Coal Limited	Metallurgical coal	**13 million tonnes combined**
Elkview	Teck Corporation	Metallurgical coal	5.6 million tonnes
Line Creek	Luscar Ltd.	Metallurgical coal	2.8 million tonnes
Elkhorn	Westroc Inc.	Gypsum	~475,000 tonnes
Mount Brussilof	Baymag Mines Co. Ltd.	Magnesite	~200,000 tonnes
Four J	Georgia Pacific	Gypsum	~175,000 tonnes
Moberly	Highwood Resources Ltd.	Silica sandstone	~80,000 tonnes
Rocky Mountain Tufa	Alan Wolfenden	Tufa	~2,500 tonnes
Winner	Roxul (West) Inc.	Diorite	~50,000 tonnes
Crawford Bay	IMASCO Minerals Inc.	Dolomite	
Kootenay Stone	Kootenay Stone Centre	Flagstone	
Lime Creek	IMASCO Minerals Inc.	Limestone	
Rock Creek	Mighty White Dolomite Ltd.	Dolomite	
Rocky Mountain Slate	Rocky Mountain Slate	Flagstone	
Sirdar	IMASCO Minerals Inc.	Crushed granite	
Swansea Ridge	CPR	Railroad Ballast	

levels as in 2001.Westroc Inc. expects to produce approximately 475 000 tonnes of gypsum from its **Elkhorn** quarries near Windermere in 2002. Discovery of the **Elkhorn West** gypsum resource west of the Elkhorn quarry may extend the life of that operation beyond the projected 2005 exhaustion of current reserves. Georgia Pacific Canada Inc. is expected to produce about 175 000 tonnes from its **Four J** deposit. Typically it ships about 100 000 tonnes of gypsum per year from its Four J quarry near Canal Flats to its wallboard plant near Edmonton, Alberta. Both Westroc and Georgia Pacific operate wallboard plants in the Vancouver area.

Baymag Mines Company Ltd. produces high quality magnesite from the **Mount Brussilof** pit at a rate of approximately 200 000 tonnes annually. The magnesite is transported by truck to Exshaw, Alberta where the company has two plant sites that produce sintered, calcined, and fused magnesia. The Silica Division of Highwood Resources Ltd. expects to ship about 80 000 tonnes of silica from its **Moberly** quarry, near Golden, primarily to Lavington, British Columbia. In the past it shipped to Springfield, Oregon, and other destinations, however, since the collapse of the silicon and ferrosilicon production in the United States, these shipments have stopped.

IMASCO Minerals Inc. processes a variety of specialized industrial mineral products at its plant at Sidar, north of Creston. Raw materials include dolomite from the underground **Crawford Bay** mine near Kootenay Lake, and calcium carbonate from the **Lime Creek** quarry on Lost Creek, south of Salmo. Dolomite is used for soil conditioning, as a white ornamental aggregate, for stucco and roofing, as a fine aggregate, and for synthetic marble products. White calcium carbonate is used as a filler in paper, paint and plastics. The company also produces crushed granite and quartzite products from material mined at **Sidar** and near Crawford Bay. Dolomite is also quarried and processed by Mighty White Dolomite Ltd. at **Rock Creek**.

At the **Winner** quarry, near the past-producing Phoenix mine in the Greenwood mining camp, approximately 50 000 tonnes of diorite was mined and crushed. Half was transported to the insulation and mineral wool manufacturing plant of Roxul (West) Inc. in Grand Forks, for plant feed, the other half was stockpiled for 2003. A further 20 000 tonnes was extracted from the **North Fork** quarry. Canadian Pacific Railway mined, crushed and shipped rail-

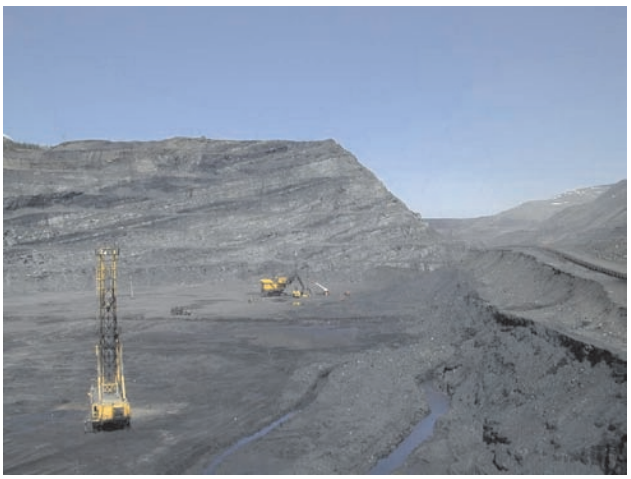

Photo 7. TeckCominco's Elkview Coal Mine.

road ballast from its **Swansea Ridge** gabbro quarry south of Cranbrook.

Kootenay Stone Centre and other small operators quarry flagstone in the West Kootenays. **Rocky Mountain Slate** opened a new slate quarry east of Golden. The blue-gray and beige products are used as flagstone. **Rocky Mountain Tufa** produced about 2500 tonnes of tufa, mainly for landscaping applications.

COAL

The first half of 2002 was marked by very protracted negotiations to establish prices for coking coal being shipped to Japan; contracts were not finalized until July with the Australian producers, and it was even later for the Canadian producers. These negotiations delayed coal shipments in the spring and some companies lost sales as a result. Fording in particular announced several production shutdowns in the later part of the year.

Fording Inc. has not provided individual production tonnage information but the total 2002 production was 14 million tonnes for the **Fording River**, **Greenhills**, and **Coal Mountain** mines combined. This is a decrease of 3.5 million tonnes from the 2001 level. **Line Creek** expects to produce 2.6 million tonnes of coking coal and 0.4 million tonnes of thermal coal. **Elkview's** production is estimated to be between 5.5 and 5.7 million tonnes, similar to that in 2001 (Photo 7).

In October, Sherritt International Corp. and the Ontario Teachers Pension Plan, which already control Luscar Ltd. and therefore the **Line Creek** mine, announced a hostile takeover bid for the assets of Fording Inc., which it planned to roll into an income trust. Fording countered the bid with a plan to merge the Fording assets with the Elkview operation of TeckCominco's and Westshore Terminals port facilities to form an income trust. In January 2003 all of the parties announced a complex new C$1.8 billion agreement, subject to shareholder and regulatory approval, to jointly form the Fording Canadian Coal Trust. This investment vehicle will combine all the metallurgical coal assets of Fording, Luscar, and TeckCominco (all the Elk Valley mines) as well as the export terminals owned by Luscar and Westshore Terminals.

ACKNOWLEDGEMENTS

I would like to thank all of the industry geologists and prospectors who have provided me with data and access to their exploration properties and mines, they made compilation of this paper possible. A great deal of the information relating to industrial minerals in this report came from George Simandl of the Geological Survey Branch, and likewise much of the data on coal was provided by Barry Ryan, now with the Ministry's New Ventures Branch.

Ni-Cu-PGE Deposits in the Pacific Nickel Complex, Southwestern BC; A Profile for Magmatic Ni-Cu-PGE Mineralization in a Transpressional Magmatic Arc

Paul Metcalfe[1], Murray McClaren[2], Janet Gabites[3], and Jacques Houle[4]

ABSTRACT

The Giant Mascot mine remains British Columbia's only historic nickel-copper producer, yielding over 26,500 tonnes of Ni, more than 13,000 tonnes of Cu and more than 140 tonnes of Co from 4,319,976 tonnes of ore processed. Significant values of platinum group elements (PGEs) have also been reported. The economic sulphide mineralization is both massive and disseminated. It is hosted by steeply dipping pipes of varying but distinct ultramafic lithology within the Pacific Nickel Complex, proximal to pipe-like apophyses of diorite of the Spuzzum Intrusion. Previous workers noted that the mineralized pipes lie crudely parallel to a regional, northerly-dipping linear fabric.

The Pacific Nickel Complex is an assemblage of undeformed to weakly deformed ultramafic rocks that are spatially associated with gabbronorite and with the Spuzzum Intrusion. Both intrusions cut rocks of the Cascade terrane at the accreted eastern margin of Wrangellia. Pyroxenitic rocks with sulphide mineralization and microscopic and macroscopic textures identical to those at Giant Mascot occur as far north as Fir Creek, 35 km from the mine. These rocks are interpreted as a single petrologic province with a common magmatic heritage.

The pyroxenites are cumulates with a two-stage history of crystallization. In the first stage, spinel, olivine and clinopyroxene crystallized; spinel compositions overlap those of Noril'sk rift-related intrusions which host a world-class Ni-Cu-PGE deposit. The first-stage phenocrysts are overgrown by a thin rim of clear orthopyroxene and enclosed by anhedral oikocrysts of orthopyroxene, intergrown with clinopyroxene and magmatic pyrrhotite, pentlandite and chalcopyrite. The latest phase of magmatic or deuteric activity comprised replacement of orthopyroxene by hornblende.

The Pacific Nickel Complex intrudes banded paragneisses containing kyanite/sillimanite, staurolite and garnet with a metamorphic closure age of 96+6/-3 to 91.5±2 Ma. The Spuzzum suite of intermediate pyroxene and amphibole-phyric intrusive rocks that cut the Pacific Nickel Complex have a closure age between 96 and 93 Ma, indicating that the two intrusions are penecontemporaneous with the Barrovian stage of metamorphism.

Inclusions of paragneiss within Pacific Nickel Complex pyroxenite are partially or completely assimilated, contaminating the pyroxenite with felsic material. Sulphide mineralization increases next to metamorphic xenoliths. A continuous range of textures and modal compositions exists between the Pacific Nickel pyroxenites, "feldspathic pyroxenites" in the Cogburn Creek area and pyroxene or uralitic hornblende-phyric "gabbronorite" and "diorite". Although the chemical compositions of the intrusive rocks in the Pacific Nickel and Spuzzum intrusions overlap and define a general calc-alkaline trend, their incompatible element ratios preclude generation of the more felsic rocks by crystal fractionation of phases observed in the Pacific Nickel cumulates. The near-contemporaneity of the Pacific Nickel and Spuzzum intrusions and the textural evidence of assimilation strongly suggest that the more felsic rocks in either suite were generated by contamination of an ultramafic cumulate mush with material assimilated from the gneissic wallrocks.

We propose a model for this deposit type that is based upon the model for the Aguablanca Ni-Cu-PGE deposit in Spain. According to the model, a primary Pacific Nickel magma was generated in the mantle by decompression melting facilitated by an extensional window created by regional transpressive tectonics. This magma ponded at intermediate levels in the crust and began fractional crystallization of spinel, olivine and clinopyroxene. Both the intercumulate and supernatent fluids gained substantial amounts of sulphur from assimilated pyritic paragneiss and schist, supersaturating the system in sulphur and triggering nucleation of a sulphide liquid; this process was coeval with second-stage crystallization of orthopyroxene oikocrysts. The Spuzzum intrusive suite may represent a felsic component of this hybrid system. The transpressive stress field persisted and permitted injection of both the mineralized pipes and apophyses of felsic magma. This hypothesis allows for exploitation of linear zones of weakness in the transpressive stress field, either by mechanical (sulphide-silicate crystal mush) or high-temperature hydrothermal emplacement of sulphide mineralization.

INTRODUCTION

The Giant Mascot mine remains British Columbia's only historic Ni-Cu producer. Between the years 1958 and 1974, 4,319,976 tonnes of ore were mined. This tonnage

[1]*Palatine Geological*
[2]*Crockite Resources*
[3]*The University of British Columbia*
[4]*Mining Division*

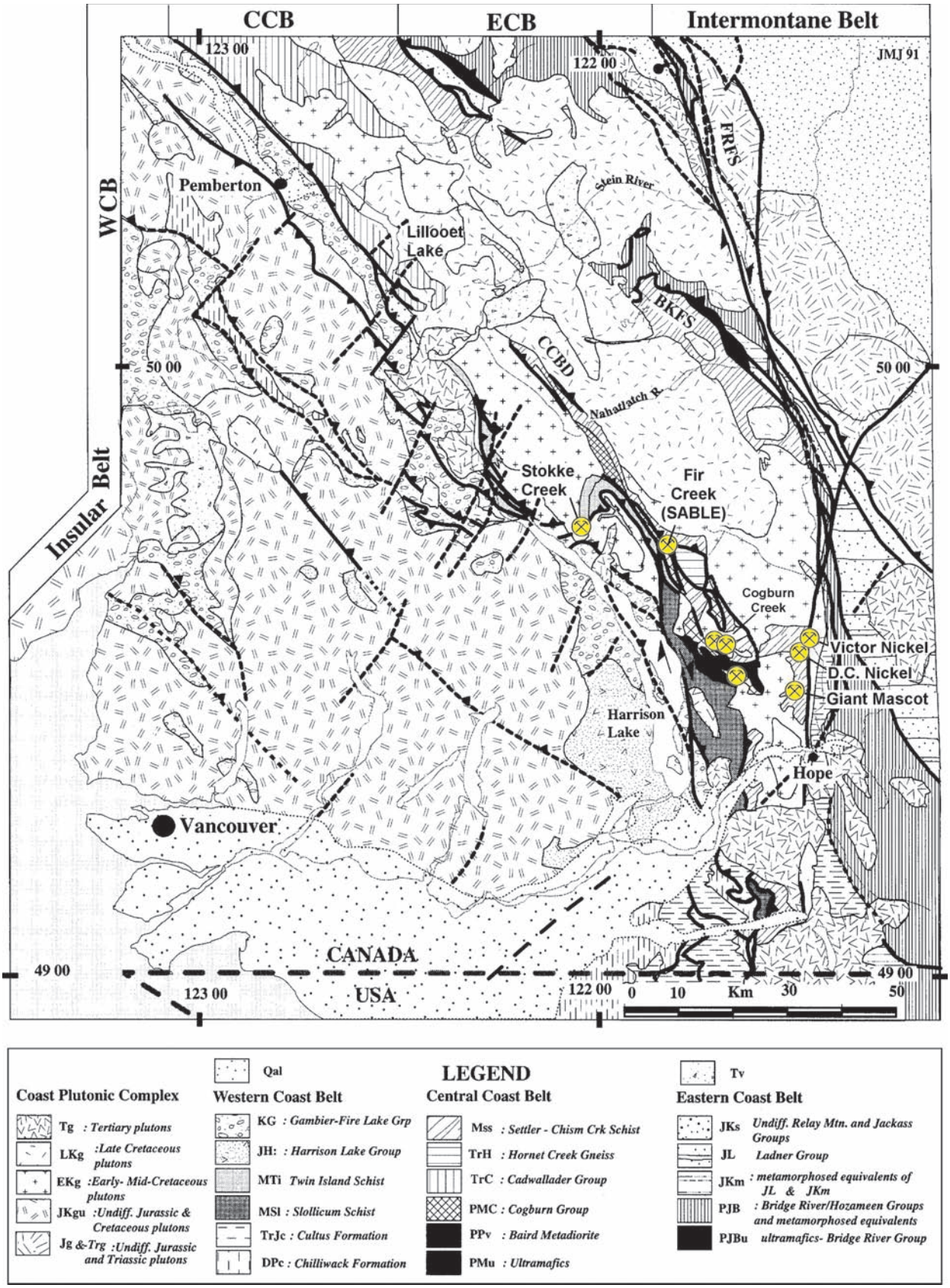

Figure 1. Regional geology of the southern Coast Belt Thrust System adapted from Journeay and Friedman (1993). Abbreviations: Central Coast Belt Detachment (CCBD), Bralorne-Kwoiek Creek Fault System (BKFS), Fraser River Fault System (FRFS). The map shows tectonic belts and the range of occurrences of Ni-Cu occurrences hosted by megacrystic orthopyroxenite (crossed hammers).

yielded: 26,573,090 kg Ni, (reported mean head grade 0.77%), 13,212,770 kg Cu (reported mean head grade 0.34%), 140,700 kg Co, 16,516 gm silver (Ag) and 1,026 gm gold (Au). Platinum values in excess of 1 gram were reported.

The Pacific Nickel Complex, an assemblage of ultramafic and related rocks exposed within the eastern Coast Belt in southwestern British Columbia, hosts the Giant Mascot Ni-Cu deposits (Figure 1). Three main deposits, Choate, Pride of Emory and Star of Emory, were initially staked in 1923 (Cairnes, 1924). The purpose of this paper is to identify characteristics of the lithologies and mineral deposits associated with the Pacific Nickel Complex, and to describe a mineral deposit profile developed for Giant Mascot and other deposits of this general character.

PREVIOUS WORK

Regional studies of the southern Coast Belt, augmented by thesis studies, have been ongoing since 1912. A detailed review of these regional studies is beyond the scope of this paper, which focuses more on the generation and emplacement of the Pacific Nickel Complex and its associated mineralization. The reader is referred to Ash (2002) and Pinsent (2002) for reviews of studies in this area. We adopt the latest structural synthesis of Monger and Journeay (1994) as a framework within which to discuss the origin and setting of the Pacific Nickel Complex.

The Spuzzum Intrusion (Richards and White, 1970; Richards, 1971; Richards and McTaggart, 1976; Vining, 1977) is of relevance to the present study because of its close spatial and temporal association with the Pacific Nickel Complex. The Spuzzum is described as a polyphase intrusion of intermediate composition, with a dioritic core and a tonalitic margin where it intrudes metamorphic country rocks. Its relationship to the Pacific Nickel Complex and its probable significance to the Ni-Cu-PGE metallogeny has been the subject of recent discussion (Ash, 2002; Pinsent, 2002).

The Giant Mascot mineral deposits and host ultramafic rocks have been studied intermittently since their discovery, beginning with the work of Cairnes (1924), Cockfield and Walker (1933) and Horwood (1936). The comprehensive study made by Aho (1954, 1956) remains the latest detailed mapping of the Giant Mascot Mine area. Thesis studies carried out while the mine was in production include those by Muir (1971), King (1972) and McLeod (1975). Government (and other) studies include those by Clarke (1969), Christopher (1974, 1975) and Christopher and Robinson (1975).

Elevated prices of platinum group elements led to the recent exploration interest in nickel-copper occurrences east of Harrison Lake. Consequent studies by Geological Survey Branch personnel include those by Lett and Jackaman (2002), Ash (2002) Pinsent (2002) and Nixon (2003). Our study of an ultramafic rock assemblage 35 km northwest of the Giant Mascot Mine in 2001 (Metcalfe and McClaren, 2002) and other similar occurrences (Metcalfe and McClaren, unpublished data) prompted this paper. The present work is based on the results of exploration in the area and upon publicly available data on the Giant Mascot deposits.

TECTONIC SETTING

The Pacific Nickel Complex lies within the Cascade terrane, which is located on the eastern flank of Wrangellia (Figure 1). The amalgamation of Wrangellia to North America about 100 million years ago contributed to the complex structural development of this terrane. The tectonic evolution of the region during and after accretion (100-40 Ma) is characterized by a series of structural events that culminated in intense Late Cretaceous to early Tertiary (96-47 Ma) intra-plate contraction and dextral transpression, accompanied by metamorphism and granitic intrusion.

The east Harrison Lake area lies within the imbricate zone of the Coast Belt Thrust System. This region is characterized by low-angle thrust faults that envelop high-grade schists and gneisses of the Breakenridge complex (Monger and Journeay, 1994) and Slollicum Schist (Monger, 1986) and by high angle reverse faults that cut these allochthonous sheets (*e.g.* Big Silver Creek and Breakenridge faults). Relative timing relationships between fold and fault structures found associated with the Coast Belt Thrust System indicate a two-stage history of late Cretaceous shortening:

1. Early stage thin-skinned thrusting above a basal décollement accompanied by Alpine-style folding. The age of this event is bracketed by synorogenic plutonic suites with U/Pb zircon ages of 97±1 Ma and 96 +6/-3 Ma (Monger and Journeay, 1994).
2. High angle reverse faulting and out-of-sequence thick-skinned thrusting that caused southwestward telescoping of the metamorphic hinterland over flanking supracrustal arc sequences of the western Coast Mountains. The age of this event is bracketed by late and post kinematic plutonic suites (with U/Pb zircon ages of 96 +6/-3 Ma and 94 +6/-5 Ma (Monger and Journeay, 1994).

Faults within the Harrison Lake Shear Zone include a network of ductile mylonite zones along the east shore of Harrison Lake. These structures cut thrust-related fabrics in metavolcanic rocks as young as 100 Ma. A dextral strike-slip fault that may be part of the Harrison Lake system is the Big Silver Creek fault. Synkinematic muscovite from the Big Silver Creek fault yielded a Rb-Sr date of 93.5±11.4 Ma (Parrish and Monger, 1992). This implies that strike slip faulting may have been at least partly coeval with thrust imbrication.

METAMORPHISM

Two distinct metamorphic events have been identified in the Cascade terrane. The earliest event is bracketed between 96+6/-3 Ma (Journeay and Friedman, 1993) and 91.5±2 Ma (Friedman *et al*.,1992) by syn- and post-kinematic intrusions.

This early metamorphism is linked directly to the imbrication of thin and thick-skinned thrust nappes. It is characterized by a Barrovian sequence of mineral assemblages that range in grade from lower greenschist facies to middle and upper amphibolite facies. These early metamorphic assemblages are best developed in the imbricate and hinterland zones of the Coast Belt Thrust System, and in isolated pendants of gneissic rock within late and post–kinematic intrusions.

The latest metamorphic event is bracketed by crystallization ages of the Mount Mason and Scuzzy-Mount Rohr plutonic suites, which yielded U-Pb dates of 91.5±2 Ma (Friedman *et al*.,1992) and 86 to 84 Ma, respectively (Friedman and Armstrong, 1990; Parrish and Monger, 1992). This metamorphism is post-kinematic with respect to structures and associated fabrics of the Coast Belt Thrust System, and spatially associated with Late Cretaceous intrusions of the Scuzzy-Mount Rohr intrusive suite. Mineral assemblages that characterize this event include late stage overgrowths and porphyroblastic phases of andalusite, sillimanite, garnet and hornblende.

FIELD RELATIONS AND TIMING OF THE PACIFIC NICKEL COMPLEX AND SPUZZUM INTRUSION

K-AR DATA FROM THE VICINITY OF THE GIANT MASCOT MINE

The relative and absolute ages of rock units proximal to the Giant Mascot mineralization have been in dispute since its discovery. Cairnes (1924) described the immediate area of the showings and inferred that the ultramafic rocks intruded the Spuzzum Diorite. Cockfield and Walker (1933) noted that the converse was more probable. This interpretation was later supported by observations made by Horwood (1936). Later, Aho (1954, 1956), in his comprehensive account of the deposits, again concluded that the ultramafic rocks intrude the Spuzzum Intrusion. McLeod (1975) noted that the problem was unresolved. Most recently, Ash (2002) stated from field observations that the Spuzzum Intrusion cuts the ultramafic rocks and, in places, forms intrusive "pipes" subparallel to the ore-bearing peridotite pipes.

McLeod (1975) and McLeod *et al.* (1976) measured the age of the Pacific Nickel Complex using the K-Ar method on hornblende and biotite from eleven samples. McLeod's data are given in Table 1, with the ages recalculated using the modified decay constant of Steiger and Jäger (1977). A range of ages from 122 Ma to 96.4 Ma was ob-

TABLE 1
K-AR DATA FOR THE PACIFIC NICKEL COMPLEX AND SPUZZUM INTRUSION NEAR THE GIANT MASCOT DEPOSITS (FROM MCLEOD, 1975 AND MCLEOD *ET AL*., 1976)

Sample	Location	Longitude	Lithology	Mineral	K wt %	Radiogenic Argon 40Ar* nl/g	Argon %	Age (Ma) (Harakal)	Error (Ma)
Spuzzum	#1, 8 k m W of Hope	121 31 48	Hypersthene hornblende biotite diorite	hornblende	0.654	2.477	86.5	94.9	7
Spuzzum	#1, 8 k m W of Hope	121 31 48	Hypersthene hornblende biotite diorite	biotite	3.70	14.876	83.9	101.0	3
OO4	6.5 mi WSW of Hope	121 34 48	Foliated quartz diorite	biotite	5.73	24.040	82.0	105.0	3
141A	3050 X/C	121 31 20	Feldspathic hornblendite	hornblende	0.258	1.093	64.0	106.0	4
157A-1	3050 X/C	121 31 20	Mineralized hornblendite	hornblende	0.261	1.154	61.4	112.0	4
120A	3050 X/C	121 31 20	Hornblende pyroxenite	hornblende - pyroxene	0.130	0.6357	43.3	121.6	4
#7	Road to Giant Mascot	121 29 35	Tonalite	biotite	5.86	18.808	83.6	80.7	2.5
#7	Road to Giant Mascot	121 29 35	Tonalite	hornblende	0.464	1.600	58.4	86.6	2.8
#8	Several miles S of Giant Mascot 1.8 miles W of Haig, N side of Fraser R.	121 29 30	Hornblende diorite	hornblende	0.536	1.945	58.4	91.0	2.8
#4	Intersection of Lower Haulage and Texas Creek	121 30 05	Hornblende pyroxene diorite (Spuzzum)	hornblende	0.334	1.214	42.7	91.2	3
79A-2	3050 X/C	121 31 20	Hornblendite?	hornblende	0.183	0.7043	63.8	96.4	4

tained from hornblende and biotite from hornblendites and hornblende pyroxenites of the Pacific Nickel Complex collected at the Giant Mascot Mine. A similar range (105 Ma to 80.7 Ma) was obtained for Spuzzum pyroxene diorites adjacent to the pyroxenites.

All analyses were carried out at the University of British Columbia. The ages have been recalculated using the modified decay constants of Steiger and Jäger (1977) and an isotopic abundance (^{40}K/K) of 0.01167 (atomic %). Errors are two standard deviations.

Two factors complicate the interpretation of these K-Ar dates. The first is that argon only starts to accumulate in minerals as the rock cools down below a closure temperature after an intrusive or metamorphic event. The closure temperatures vary for different minerals; for hornblende it is 450-550°C (Harrison, 1981). In a slow-cooling intrusion or deep-seated metamorphic event, the K-Ar dates may be younger than the time of the event.

The second factor is that hornblende is susceptible to retention of excess radiogenic argon (radiogenic ^{40}Ar that is incorporated into the mineral from some source other than the *in situ* decay of ^{40}K) which has the effect of producing conventional dates that are older than the age of the rock. The lower the potassium content, the more pronounced the effect. In a geochemically coherent suite, this problem can be addressed by construction of an isochron diagram of ^{40}K/^{36}Ar *versus* ^{40}Ar/^{36}Ar (Faure, 1977); the technique is used primarily in Rb-Sr, Re-Os, Lu-Hf and Sm-Nd geochronology and in Pearce element ratio analysis.

In the case of McLeod's data, the isotopic ratios were not recorded, but a similar diagram can be constructed by plotting ^{40}Ar *versus* ^{40}K, using data from Table 1. The results are shown on Figure 2. On this diagram, the conventional K-Ar age can be calculated from the slope of the line joining any point to the origin. The presence of excess argon is indicated by non-zero intercepts on the y axis.

Two analyses, a hornblende-biotite pair from tonalite lie on an isochron, a line which passes through the origin and within error of each sample. The line corresponds to an age of 80 Ma, clearly younger than the other samples. These analyses are discarded for present purposes.

The analytical data for biotite and hornblende in all McLeod's diorites lie on a crude line from the origin (Figure 2). This line does not pass through all the error envelopes and is therefore merely a pseudoisochron. Analyses from a coexisting hornblende and biotite pair for a Spuzzum diorite sample taken near Hope (Table 1, Figure 2) permit an isochron to be constructed. The range of possible lines (isochrons) connecting these points to the origin have slopes corresponding to ages between 99 and 96 Ma.

The three hornblende analyses from the diorites (Figure 3) lie on a regression line corresponding to an age of 97 Ma but which intercepts the y axis at a negative value for ^{40}Ar. Possible lines through the origin and the error envelopes (Figure 3) correspond to ages between 95 Ma and 91 Ma; a best-fit line has a slope corresponding to 93 Ma. An age approximating to this last value and to the minimum possible age from the hornblende-biotite pair (96-93 Ma) is our best estimate of the K-Ar closure age of the Spuzzum Intrusion.

Hornblende data from the Pacific Nickel hornblendites are more scattered; one of the samples (79A-2) clearly lies beyond any possible Pacific Nickel isochron (but lies within error of the diorite isochrons). It is impossible to construct an isochron which passes through the origin and within the error envelopes of the three remaining Pacific Nickel samples. A best-fit line, indicating some retention of Ar, gives an estimated K-Ar closure age of between 96 and 95 Ma for the Pacific Nickel Complex.

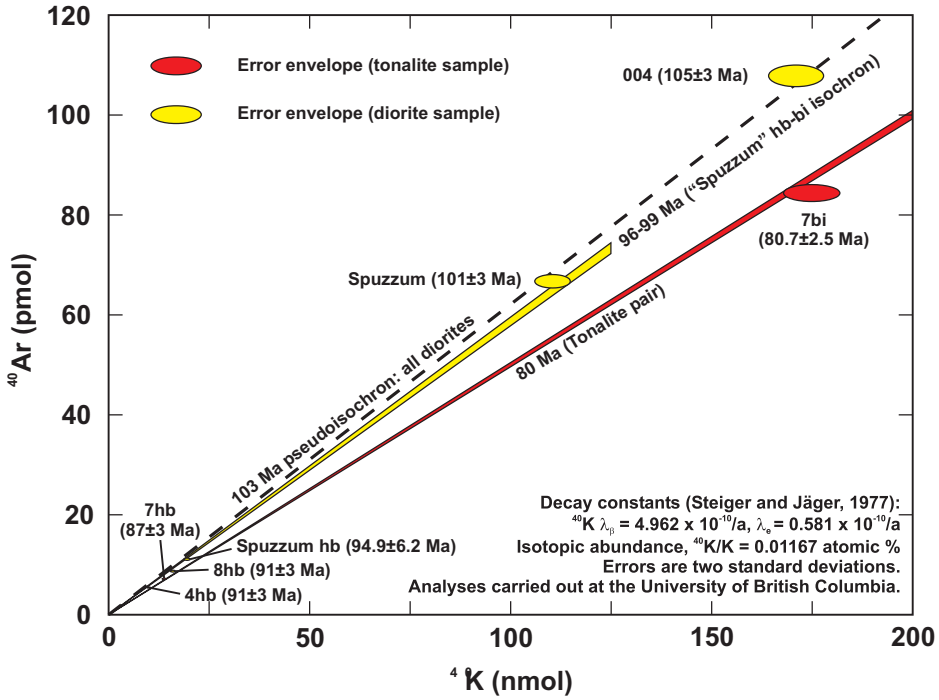

Figure 2. Graph of ^{40}K *versus* ^{40}Ar using data from McLeod (1975) and McLeod *et al.* (1976) for samples taken at or near the Giant Mascot mine. In the absence of recorded errors, the axes of error ellipses are derived using errors of 4% and 2% (2 standard deviations) for ^{40}K and ^{40}Ar, respectively. A hornblende-biotite pair from tonalite define an age of 80 Ma, clearly younger than the other samples. A second hornblende-biotite pair (from diorite) gives a range of possible isochrons corresponding to ages between 96 and 99 Ma (*cf.* Figure 3).

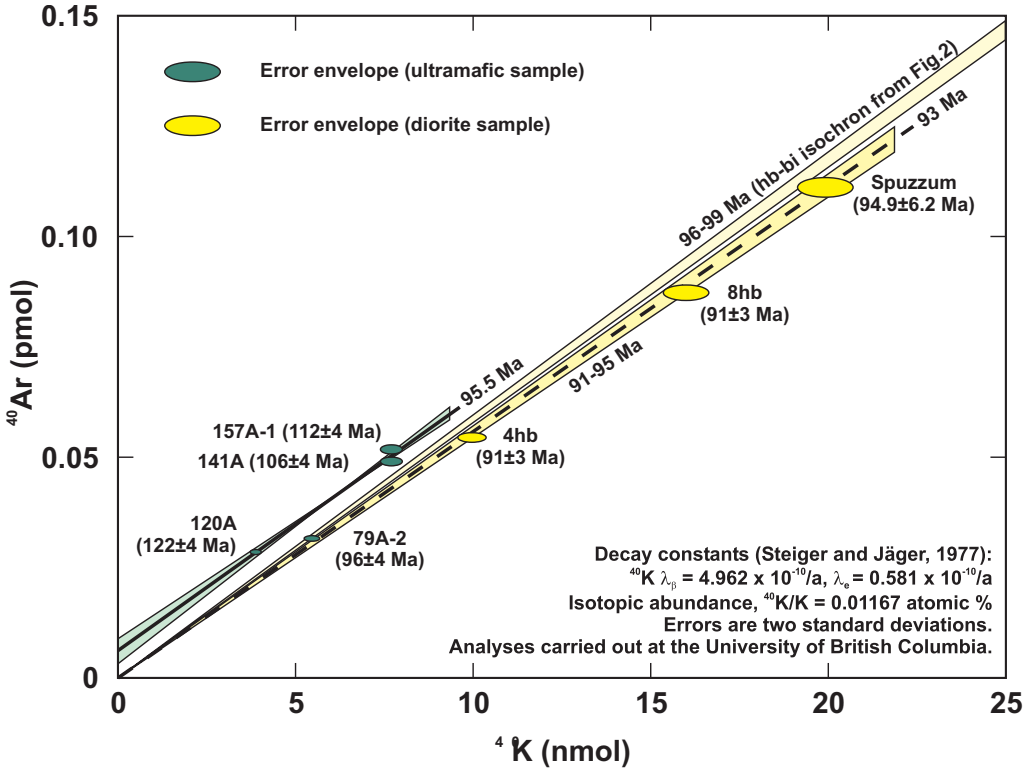

Figure 3. Graph of ^{40}K *versus* ^{40}Ar for hornblende; data and constants as for Figure 2. Hornblende data for the three diorites permit isochrons corresponding to ages between 95 and 91 Ma; the best estimate from these data is 93 Ma (cf. Figure 2). Hornblende data for the ultramafic rocks do not permit construction of an isochron, although one hornblendite sample lies within error of the isochron for the Spuzzum diorites. The remaining samples define a line indicative of argon retention. The best estimate of the age of the ultramafic rocks is 95-96 Ma. These ages are in reasonably good agreement with more recent work using U-Pb and Ar-Ar isotopic methods (Ash, Pinsent, unpubl. data, 2003).

Figures 2 and 3 permit the following comments. Although the relative ages of the two assemblages cannot be resolved within error, it is certain that the same thermal event affected the K-Ar data from not only the three ultramafic samples but also the five Spuzzum hornblende samples and that the thermal event probably took place between 96 and 95 Ma. This range corresponds to the closure date of the U-Pb system given by zircon analyses from the Spuzzum and related intrusions (Journeay and Friedman, 1993). The K-Ar data from the ultramafic rocks indicate a similar age for the Pacific Nickel Complex.

FIELD RELATIONS AT SABLE

Field data collected at Fir Creek, 35 km northwest of the Giant Mascot deposits (Metcalfe and McClaren, 2002) define the relationship between an ultramafic body and enclosing high-grade metamorphic rocks. The metamorphic rocks were assigned to the Settler Schist by Monger (1986, 1989, 1991). In the Fir Creek area (Journeay and Csontos, 1989) and in the Cogburn Creek area to the south (Gabites, 1985; Monger *et al.,* 1990; Journeay and Friedman, 1993), the contact of the Settler Schist with the structurally underlying Cogburn Group is a sharply defined sheared thrust.

On the SABLE mineral claim, near the confluence of Fir Creek with Big Silver Creek, a dyke-like body of pyroxenite and feldspathic pyroxenite intrudes Settler Schist country rock (Metcalfe and McClaren, 2002). The margin of the ultramafic body consists of black hornblendite with a weak to moderate foliation that is oriented parallel to that in the gneiss. The pyroxenite is coarse-grained, unfoliated and oikocrystic. The lack of a penetrative fabric and metamorphic mineral assemblage consistent with that in the wallrock clearly indicates that the mafic intrusion postdates the early Barrovian style metamorphic event. Away from the contact the pyroxenite contains abundant subangular inclusions of a hornblendite that have a planar fabric (Figure 4). The inclusions show rounding and/or plastic deformation, but only minimal resorption. Around the inclusions, the grain size of the enclosing pyroxenites decreases. They are interpreted as fragments of the first-cooled border phase of the mafic intrusion, which were stoped into the magma or crystal mush.

Field observations also permit speculation on the relationship of the pyroxenite to the intermediate intrusive rocks. Angular to subrounded xenoliths of foliated and

Figure 4. Hornblendite xenolith enclosed in coarse-grained oikocrystic pyroxenite. The xenolith is identical in texture to the fine-grained hornblendic margin of the intrusion, moderately foliated and interpreted as a stoped fragment of the intrusive margin.

Figure 5. Angular to subrounded xenolith of Settler Schist included in the pyroxenite. The grain size of the pyroxenite is shown by a reflective cleavage surface in an orthopyroxene oikocryst, upper left. The xenolith is broken and an apopysis of the pyroxenite separates the fragments. Peripheral to the xenolith are areas of very coarse-grained, feldspar-rich intrusive rock with coarse phenocrysts of pyroxene or, more probably, uralitic hornblende of a grain size nearly identical to that of the host pyroxenite.

banded Settler Schist also occur in the pyroxenite (Figure 5). These xenoliths exhibit a complete range in texture from those with clearly defined metamorphic fabrics to those preserved only as areas of felsic melt which have included pyroxene megacrysts from the enclosing pyroxenite. Such areas are pyroxene- or uralitic amphibole-megacrystic gabbronorite (Figure 6), with coarse intersertal plagioclase and sparse anhedral quartz. Locally, the equant, subhedral mafic phenocrysts transect the boundary between the gabbronorite areas and the enclosing pyroxenite. Similar areas of gabbronorite occur as reaction rims at the contacts of unmelted gneissic xenoliths (Figure 5). The textural evidence indicates that contamination of the pyroxenite cumulate mush by anatexis and assimilation of the gneiss produced these feldspar-rich areas. Textures observed in these areas strongly resemble those in phases of the Spuzzum Intrusion.

Both the pyroxenite and the areas of feldspathic pyroxenite are crosscut by thin dykes or sills of pyroxene- or hornblende-bearing, medium grained granodiorite. These in turn are cut by dykes and sills of progressively finer-grained and more leucocratic granodiorite or granophyre (Figure 7). These more leucocratic intrusions are non-porphyritic, allotriomorphic, and contain 10-15% anhedral quartz, and 85-90% anhedral untwinned feldspar. Mafic minerals are scarce to absent. The leucocratic intrusions generally have sharp contacts with the pyroxenite. In places, the volume of granophyre injected was sufficient to brecciate the enclosing pyroxenite and to heal the resultant subangular breccia with a network of anastomosing granophyric "veins" (Figure 8). The intrusive sequence ex-

Figure 6. Feldspathic pyroxenite or gabbronorite in contact with pyroxenite, surrounding and "soaking" subrounded fragments of the pyroxenite.

Figure 7. Fine-grained leucocratic dyke, containing virtually no mafic minerals, cuts both the pyroxenite and a banded hornblendite inclusion shown in Figure 4. These are the latest-formed dykes in the area and form the network or matrix of breccias with subrounded pyroxenite fragments.

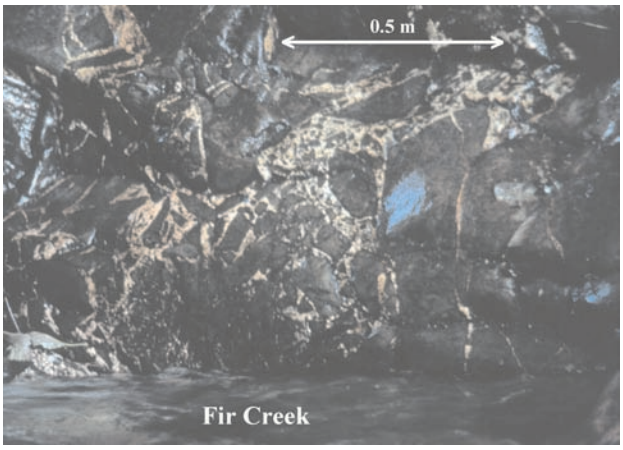

Figure 8. Pyroxenite, brecciated and veined by leucocratic intermediate magma, possibly derived from melting of feldspathic wallrock. Similar textures exist in the mafic ring complex of Ardnamurchan, northwest Scotland (Richey and Thomas, 1930).

posed on the SABLE claim is interpreted to represent partial or complete melting of the metamorphic wallrock.

Barrovian metamorphism waned and Ar retention temperature was reached between 96 +6/-3 and 91.5±2 Ma. As described above, the SABLE ultramafic body clearly postdates the Barrovian metamorphism. The hornblende data suggest that the ages of the mafic and felsic intrusions are much closer than indicated by the individual measurements. Furthermore, field relationships described above suggest that the more felsic intrusions are either hybridized zones in the mafic intrusions, or melts derived from the gneissic country rocks. Further work is required to confirm this relationship.

PETROGRAPHY

The description of the rock units in the Pacific Nickel Complex relies heavily on previous work (Aho, 1954, 1956; McLeod, 1975; Pinsent, 2002). Additional petrographic work has been carried out by Greig (2002) and by Metcalfe and McClaren (2002) in areas to the east of Harrison Lake.

Rocks included in the Pacific Nickel Complex contain both orthopyroxene and clinopyroxene but lack titaniferous augite. The complex is therefore subalkaline. The general lack of deformation and alteration permit identification of magmatic textures. Layering is generally absent within the presently-defined boundaries of the Pacific Nickel Complex.

The Pacific Nickel Complex comprises three main lithologies: peridotites, pyroxenites and feldspathic pyroxenites. This assemblage is characterized by large oikocrysts of pyroxene or uralitic hornblende. Rocks identified with the assemblage are exposed at various locations between Giant Mascot Mine and the eastern shore of Lillooet Lake (Figure 1). Sulphide mineralization is sporadically associated with these lithologies along the entire length of the "belt".

Rocks most commonly observed in the Pacific Nickel Complex are coarse-grained pyroxenites that are black to dark green on fresh surfaces and weather to dark green or rusty brown. The pyroxenites comprise 15-30% euhedral to anhedral primary phenocrysts of olivine and pyroxene, 1-2 mm in size. These phenocrysts are enclosed by 55-70% subhedral to anhedral oikocrysts of bronze-black pyroxene and 15% subhedral to anhedral crystals of jet-black pyroxene. The later-formed pyroxenes are 7-10 mm in size (although they may be as large as 20 mm) and exhibit a mu-

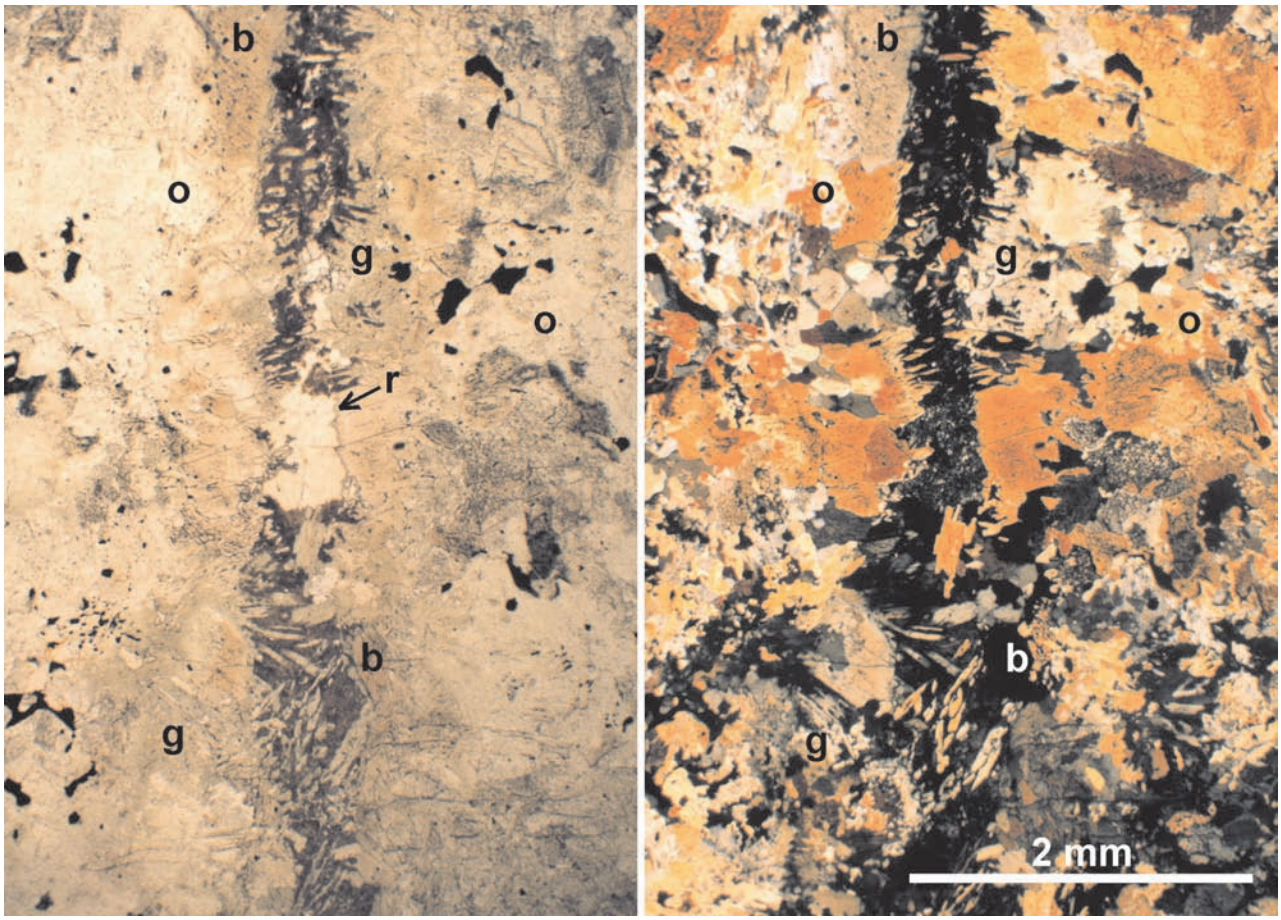

Figure 10. Orthopyroxene oikocrysts (o) altering to brown (b) and green (g) hornblende adjacent to a felsic microveinlet (f) in the pyroxenite sample shown in Figure 9. The hornblende itself shows a reaction rim (r) against the felsic material. Opaque grains are intersertal sulphide minerals, dominantly pyrrhotite. Plane polarized view on right, crossed polars on left.

tually interpenetrant and interlocking texture with 5-15% pyrrhotite, which often contains minor exsolved chalcopyrite.

A photomicrograph of pyroxenite from the SABLE mineral claim, 35 km northwest of the Giant Mascot Mine, is shown in Figure 9. In thin section, the first-formed phenocryst phases are 10-20% euhedral to subhedral clinopyroxene and 5-10% anhedral olivine, 0.5-2 mm in size. Each early phenocryst has a clear, zoned rim of orthopyroxene, 0.01-0.03 mm wide. These composite phenocrysts are enclosed as discrete euhedral to anhedral inclusions in large anhedral pyroxene oikocrysts, which are dominantly orthopyroxene. The orthopyroxene contains numerous opaque microinclusions.

The orthopyroxene oikocrysts in the sample shown in Figure 9 are adjacent to an equant oikocryst of amphibole with a texture identical to that of the orthopyroxene. In addition, felsic material intruded along fine fractures in the pyroxenite is bordered by reaction rims of amphibole which have optical orientations nearly identical to those of the orthopyroxene cores (Figure 10). This replacement is either very late magmatic or very high-temperature hydrothermal. Biotite alteration after amphibole also occurs at the Giant Mascot Mine (Aho, 1956) and in pyroxenites from east of Harrison Lake (Greig, 2002).

Feldspathic pyroxenite has been observed throughout the belt (Pinsent, 2002; Metcalfe and McClaren, 2002). In this petrologic variant (Figure 6), plagioclase is intersertal between mafic phases such as pyroxene and uralitic amphibole, in amounts that vary from traces to as much as 55% of the whole rock. These rocks are sulphide poor and commonly contain accessory quartz. Plagioclase exhibits predominately normal zoning irrespective of core composition (McLeod, 1975).

McLeod (1975) interpreted the pyroxenites at Giant Mascot as sulphide-bearing cumulates based on a mean pyroxene equilibration temperature of 990±50°C. The mineral textures of the pyroxenites record an initial history of normal olivine and clinopyroxene crystallization from a subalkaline melt. The rounded edges of the olivine grains mark a peritectic reaction between magnesian olivine and a silica-saturated liquid (Bowen, 1928). Sodic feldspar and quartz found in some olivine-bearing pyroxenites constitute a metastable assemblage. Pyroxenites with mineral textures like those seen at the Giant Mascot Mine occur on the SABLE mineral claim and at Stokke Creek near the northeast end of Harrison Lake (Figure 1). We conclude that these mafic rocks form part of a single petrologic province, with a similar magmatic heritage, that extends for at least 35 km.

The volume of peridotites in the Pacific Nickel Complex is small and they are generally constrained in pipe-like bodies such as those at the Giant Mascot Mine. They are typically medium to fine-grained, dense, dark greenish grey, lack layering and contain abundant talc, antigorite and subordinate amounts of magnetite. They weather medium grey. At Giant Mascot, olivine in the peridotites is euhedral to subhedral, as coarse as 4 mm and may be supported by nickeliferous pyrrhotite and chalcopyrite in a classic net texture (Aho, 1954, 1956; McLeod, 1975; Pinsent, 2002).

A peridotite sample taken from the SABLE mineral claim, shown in Figure 11, is an altered dunite with relic, fractured olivine surrounded by haloes of alteration products, including antigorite, talc and magnetite. The absence of a pronounced deformational fabric in the alteration products indicates that this alteration took place after regional deformation and metamorphism.

WHOLE ROCK CHEMICAL COMPOSITION AND PETROGENETIC CONSTRAINTS

Chemical analyses that exist in the public domain for rocks of the Pacific Nickel Complex are the whole rock data of Pinsent (2002), and the comprehensive studies of Muir (1971) and McLeod (1975). Richards (1971), McLeod (1975), McLeod *et al*. (1976) and Vining (1977) carried out work on the whole rock composition and age of the Spuzzum Intrusion. Recent work by Pinsent (2002) allows for geochemical classification and limited petrogenetic testing of a diverse suite of rocks within the Cogburn Creek and Giant Mascot mine areas.

The abundance of orthopyroxene indicates that the rocks are subalkaline. Silica concentrations in rocks of the Pacific Nickel Complex have similar ranges to those from Aguablanca, Spain and Las Aguilas, Argentina (Figure 12). In addition, there is an overlap in silica values between rocks identified as diorites (SiO_2 contents range from 45 to 60 wt. %) and those identified as pyroxenites (45 to 53 wt. %). Therefore it is probable that some silica has been introduced by wallrock contamination. Ultramafic rocks of the Pacific Nickel Complex lie along the F-M join on an AFM diagram (Figure 13). The feldspathic pyroxenites of Cogburn Creek and non-ultramafic rocks from both of Pinsent's field areas straddle the boundary between tholeiitic and calc-alkaline fields.

The hornblendites collected by Pinsent have whole rock chemical compositions which lie in the basaltic field of Figure 12. Those collected from Cogburn Creek are somewhat richer in silica than those from the Giant Mascot mine. Anhydrous norms vary from those containing minor amounts of nepheline to those with moderate amounts of hypersthene. Ash (2002) interprets the hornblendites at the contact between Spuzzum Intrusion and Pacific Nickel Complex as products of metasomatism. If instead these compositions are representative of the original composition of a contact phase, then the Pacific Nickel magma was a transitional basalt.

Samples from any comagmatic suite of rocks must have constant ratios of incompatible elements (*i.e.* those excluded from phenocryst phases). Some geochemically similar incompatible elements (*e.g.* K and Rb) in both pyroxenites and feldspathic pyroxenites have generally consistent ratios, but the range of Zr/Ti ratios (Figure 14) indicates that the more felsic rocks of the Pacific Nickel Complex did not evolve solely by a process of fractional crystallization.

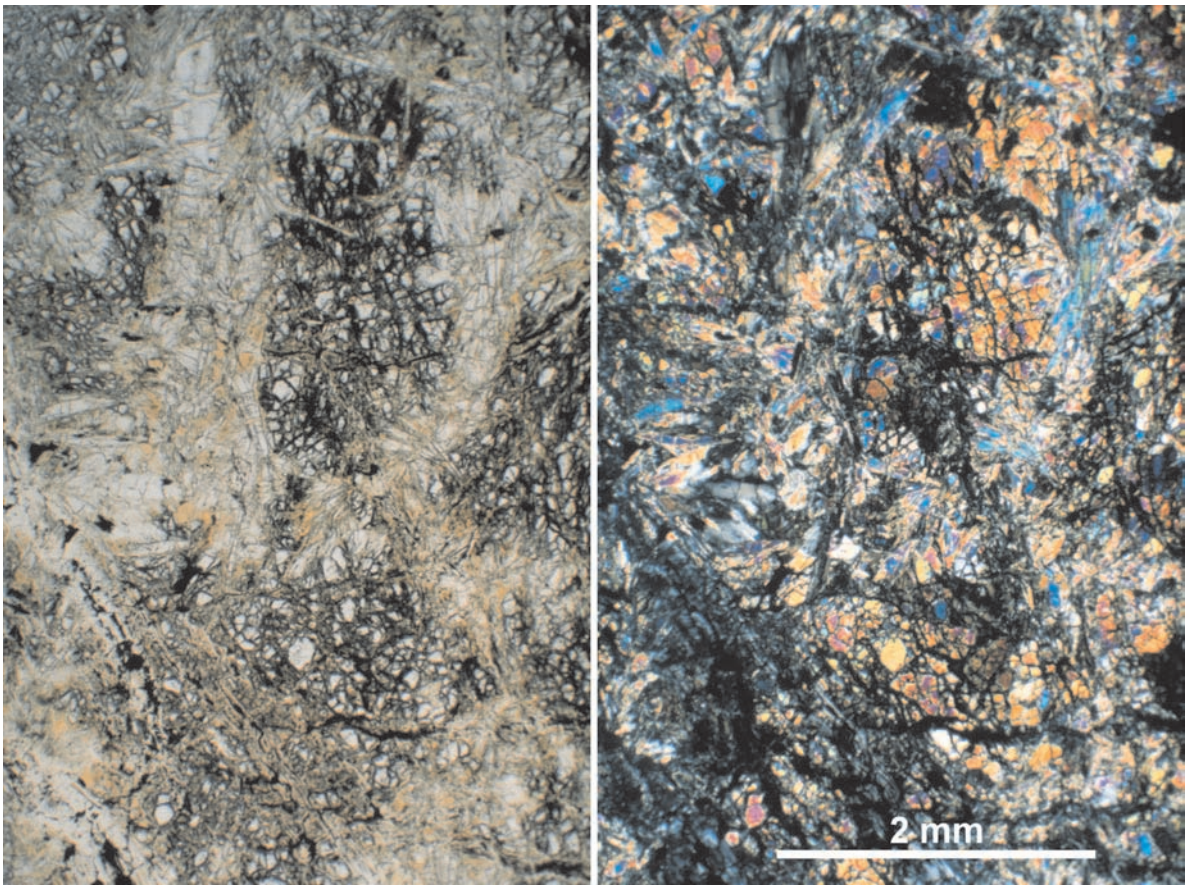

Figure 11. Photomicrograph of an altered peridotite taken from the SABLE mineral claim, 35 km northwest of Giant Mascot. Plane polarized view on right, crossed polars on left. The sample is an altered dunite with relic, fractured olivine surrounded by alteration products, antigorite, talc and magnetite. The absence of a pronounced deformational fabric in alteration products indicates that the alteration was not affected by regional deformation and metamorphism.

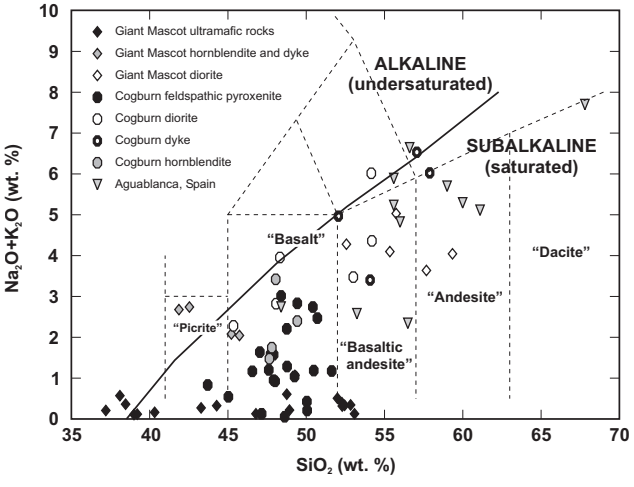

Figure 12. Silica *versus* total alkalies for rocks associated with the Pacific Nickel Complex, including rocks of the Spuzzum Intrusion. Data are from Pinsent (2002). Mafic samples are black, intermediate samples grey, and felsic samples white. Comparative data are from Aguablanca, Spain (Casquet *et al*., 2001).

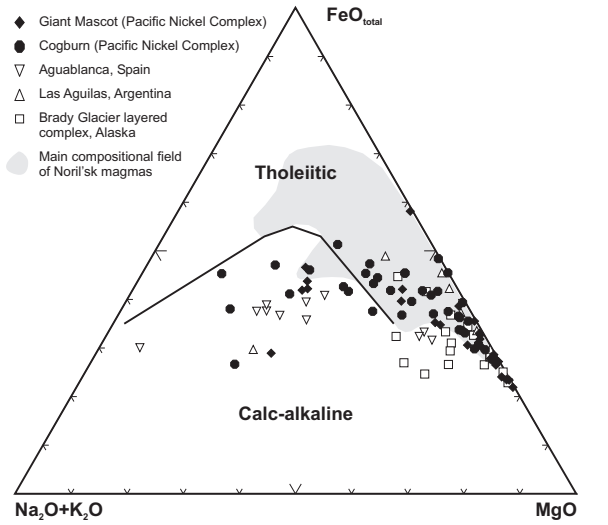

Figure 13. AFM plot (Irvine and Baragar, 1971) for rocks associated with the Pacific Nickel Complex at Giant Mascot and at Cogburn Creek, some 20 km northwest of the mine. Data sources as for Figure 12; additional data are from Las Aguilas, Argentina (Skirrow and Sims, 1999) and from the Brady Glacier layered ultramafic complex (Himmelberg and Loney, 1981). The compositional field of Noril'sk (Lightfoot *et al*., 1993; Hawkesworth *et al*., 1995) is shown in grey.

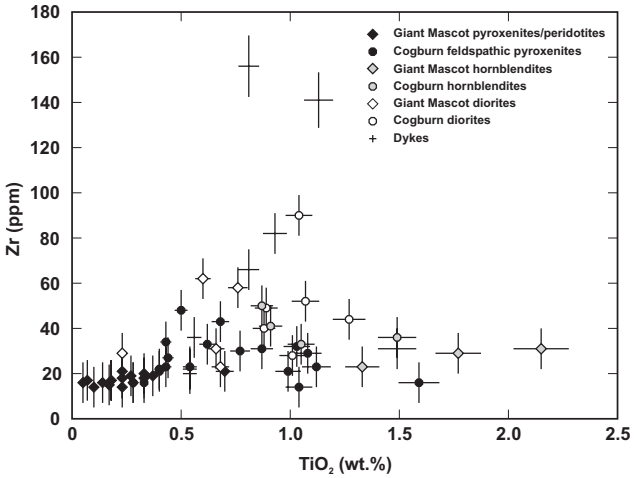

Figure 14. TiO_2 *versus* Zr for rocks associated with the Pacific Nickel Complex. The absence of comprehensive trace element data precludes rigorous testing for an element which is conserved within the suite of rocks. However, the range of incompatible element ratios shown here indicates that the compositional range in rocks of the Pacific Nickel Complex cannot have occurred through simple fractionation of the phenocryst phases observed in the cumulates.

Conserved element ratios in diorites and feldspathic pyroxenites from Pinsent's field areas are variable. However, the range of conserved element ratios measured in diorites is nearly identical to that measured in feldspathic pyroxenites. In addition, each sample of diorite collected proximal to a feldspathic pyroxenite sample in the Cogburn Creek area has an incompatible element ratio similar to that in the feldspathic pyroxenite collected at the same location. These two suites probably reflect variable amounts of contamination of pyroxenitic crystal mush and intercumulus liquid by metamorphic wallrock assimilation. This hypothesis requires further testing by isotopic and trace element methods.

DISCUSSION

The following observations were made during the present study and in previous studies:

1. At the Giant Mascot mine, ultramafic rocks of the Pacific Nickel Complex are undeformed to weakly deformed and contain xenoliths of "crystalline schist" of the Jura-Cretaceous Settler Schist. Some of these inclusions attain the size of screens or pendants (Cockfield and Walker, 1933).
2. Identical contact relationships were observed during the present study on the SABLE claim, 35 km north of the Giant Mascot Mine (Metcalfe and McClaren, 2002). Undeformed pyroxenite cuts intensely deformed and metamorphosed quartzofeldspathic schists and gneisses of the Settler Schist. Xenoliths and screens of Settler Schist are included in the pyroxenite.
3. Barrovian metamorphism in the Harrison Lake area is bracketed by the dates of 96.0+6/-3 to 91.5±2 Ma (102 to 89.5 Ma). Error limits and the K-Ar data of McLeod (1975) and McLeod *et al*. (1976) indicate that the Pacific Nickel Complex can be no younger than 95 Ma. The time of emplacement of the Pacific Nickel Complex is therefore between 102 and 95 Ma, a period of intraplate contraction and dextral transpression.
4. Pinsent (2002) confirmed cumulus textures reported by Cairnes (1924) in rocks of the Pacific Nickel Complex at the Giant Mascot Mine.
5. Pyroxenites 35 km north of Giant Mascot demonstrate a clear progression from initial formation of spinel, olivine and clinopyroxene microphenocrysts to rapid two-pyroxene oikocryst formation dominated by orthopyroxene with coincident precipitation of magmatic sulphide. Adjacent to felsic veinlets, alteration of orthopyroxene to amphibole occurred after crystallization of the pyroxenite and without disturbing its poikilitic texture. The two stages of crystallization evident in the ultramafic rocks suggest a profound change in either the physical or compositional state of the magma. This change is associated with segregation of magmatic sulphide from the silicate magma.
6. Spinel group minerals were the first to crystallize from the primary magma and their compositions are not correlated with those of the sulphides (Horwood, 1936). Nixon (2003) noted that the spinel compositions approximate those of spinels in the tholeiitic rift-related magmas of Noril'sk.
7. Textures in xenoliths of the gneissic wallrock included in the ultramafic rocks demonstrate varying degrees of anatexis, indicating that considerable assimilation of metamorphic wallrock has occurred in the Pacific Nickel Complex. The resultant feldspathic hybrid resembles phases of the Spuzzum Intrusion in mineralogy and texture.
8. The Pacific Nickel Complex is subalkaline with a compositional variation on an AFM diagram towards the calc-alkaline field occupied by rocks of the Spuzzum Intrusion (Pinsent, 2002). There is an overlap in the ranges of major element concentrations in diorites of the Spuzzum Intrusion and those in pyroxenites with intersertal feldspar (feldspathic pyroxenites of Pinsent (2002), assigned to the Pacific Nickel Complex. This compositional continuum ranges from gabbronorite to diorite.
9. Cockfield and Walker (1933) note that: "the diorites to the south (of the Giant Mascot Mine) show a striking relationship to the hornblendites (ultramafic rocks) since both groups carry the same minerals although in different proportions".
10. Ranges of incompatible element ratios in both the Spuzzum diorites and Pacific Nickel feldspathic pyroxenites are inconsistent with igneous systems evolving exclusively by fractional crystallization of the observed phenocryst phases. Chemical variation in the ultramafic cumulate rocks is consistent with the crystallization of olivine, orthopyroxene and clinopyroxene.
11. The hornblendites have the composition of transitional gabbro to subalkaline gabbronorite with norms varying from those containing minor nepheline to those with sig-

nificant orthopyroxene. Their observed chemical variation is minor and is unlikely to have occurred through fractionation of any of the phases observed in cumulates of the Pacific Nickel Complex. Minor variations in Al could be caused by spinel crystallization or by assimilation of aluminous wallrock.

The lack of coherence in ratios of the incompatible elements and the variation in major elements in rocks associated with the Pacific Nickel Complex suggests modification of the original subalkaline mafic magma by a contaminant. The most likely candidates are the surrounding Settler schists and gneisses. Contamination of an ultramafic crystal mush with wallrock rich in intermediate plagioclase feldspar would result in formation of the feldspathic pyroxenites. Progressive anatexis and further contamination with this felsic material would produce progressively more felsic hybrids and may, ultimately, have produced parts of the Spuzzum Intrusion. Detailed trace element, sulphur isotope and radiogenic isotope studies (*cf*. Casquet *et al.*, 2001) are required to test this hypothesis.

Casquet *et al.* (2001) and Tornos *et al.* (2001) recognized a similar geological and tectonic setting for the Aguablanca Ni-Cu-PGE deposit in Spain. Consequently, a mineral deposit profile similar to that developed for the Aguablanca deposit can be applied to the Giant Mascot Ni-Cu-PGE deposit. The Aguablanca deposit is a gabbroic pipe that was emplaced along with its calc-alkaline host, the Santa Ollala plutonic complex, during a period of transpressive tectonics. Petrological work on the Aguablanca stock and associated mineralization (Casquet *et al*., 2001; Tornos *et al*., 2001) clearly indicates that contamination of the magma by sulphide-bearing crustal material was crucial to generation of the deposit.

CONCLUSION

The age, spinel composition, and tectonic setting of the Pacific Nickel Complex indicate that its parent was a primary, mantle-derived tholeiitic magma with characteristics of a continental rift setting but which was generated and emplaced in a convergent continental margin environment. Late Cretaceous to early Tertiary deformation and metamorphism resulted from accretion of Wrangellia to the continental margin of North America (Monger and Journeay, 1994; Monger *et al.*, 1990). This period of accretion was characterized by intraplate contraction and dextral transpression. The Aguablanca deposit in Spain is also a synorogenic, orthomagmatic Ni-Cu-PGE deposit that was emplaced in a transpressional magmatic arc (Casquet *et al.*, 2001; Tornos *et al.*, 2001). A proposed profile for the generation and emplacement of the Pacific Nickel Complex and its mineralization has been adapted from the Aguablanca model.

Our interpretation is that the primary, tholeiitic Pacific Nickel magma was emplaced within the continental crust during the Late Cretaceous. The magma ponded at a depth of approximately 12 km and began crystallization of olivine and clinopyroxene, progressing in composition towards the olivine-liquid-orthopyroxene peritectic (Bowen, 1928). Known mafic-ultramafic exposures with nearly identical petrologic characteristics distributed along a 35-kilometre belt suggest the presence of a large intrusive body.

The metamorphic host rocks of the Pacific Nickel Complex contain mineral assemblages characteristic of intermediate crustal depths. Metamorphosed pyritic host rocks were within 100°C of their wet solidi at the time of intrusion. Assimilation of these aluminous rocks substantially enriched the tholeiitic magma in felsic components and silica, driving the magma composition into the calc-alkaline field and past the peritectic point in the olivine-orthopyroxene-silica system. The enrichment in H_2O derived from breakdown of hydrous metamorphic minerals promoted crystal formation, and the smelted sulphide minerals from the gneisses triggered supersaturation of sulphur in the magma and nucleation of a magmatic sulphide liquid. Segregation of this sulphide liquid resulted in concentration of nickel, copper and platinum group metals.

At Aguablanca orthopyroxene is less abundant in the mafic rocks and the wallrocks are of lower metamorphic grade and different composition (Casquet *et al*., 2001; Tornos *et al*., 2001; Pevida, pers. comm., 2003) from those of the Giant Mascot deposit. The abundance of orthopyroxene at Giant Mascot may be due to the susceptibility of host rock silicate minerals to dissolution that was dependant on host rock composition and temperature at the time of intrusion of the tholeiitic magma.

The Aguablanca deposit model invokes two stages of magma ponding, one at mid-crustal and the other at shallow crustal levels. In our view, a general profile for these magmatic deposits does not require emplacement at shallow crustal levels. Sulphur supersaturation by crustal contamination is considered to be the critical factor in the formation of an immiscible sulphide phase and consequent concentration of the nickel, copper and platinum group metals.

Mobilization of the Ni-Cu sulphide mineralization into pipe-like bodies at Giant Mascot has been ascribed to both mechanical and hydrothermal processes (Aho,1956). At Aguablanca, Tornos *et al*. (2001) stress a dominantly mechanical process of emplacement.

Features that constitute a favourable environment for this particular style of magmatic sulphide deposit include the following:

1. Location on a collisional continental or insular margin;
2. Evidence of a transpressive structural environment during generation and emplacement of the metallogenic melt;
3. An abundant external (wallrock) source of sulphur;
4. Evidence of sulphide smelting in low metamorphic grade wallrock, or wholesale assimilation in a high-grade metamorphic setting.

The ultramafic Pacific Nickel Complex and its related deposits have hitherto been regarded as being of restricted extent. Field observations indicate that this is not the case

and that the Giant Mascot deposit is part of a far more extensive metallogenic event affecting eastern Wrangellia.

ACKNOWLEDGEMENTS

This work could not have been carried out without the quality of data provided by previous workers on Giant Mascot (Aho, 1954, 1956; McLeod *et al.*, 1975, 1976). The paper relies heavily on the observations of Pinsent (2002), of Ash (2002) and upon data published in-house, for which we thank John Versfelt of International Millennium, George Nicholson of Garex and Charlie Greig. We thank Graham Nixon, Robert Pinsent, Chris Ash and Rob MacDonald for several lengthy and rewarding discussions. The advice of Murray Journeay is also gratefully acknowledged. The paper benefited greatly from a thorough review by Bill McMillan and from editing by Brenda Marie Brannström. For the contents of the paper, the authors take full responsibility.

REFERENCES

Aho, A.E. (1954): Geology and ore deposits of the property of Pacific Nickel Mines, near Hope, British Columbia: Ph.D. thesis, *University of California* (Berkeley), 151p.

Aho, A.E. (1956): Geology and genesis of ultrabasic nickel, copper, pyrrhotite deposits at the Pacific Nickel property, southwestern British Columbia; *Economic Geology* 51, pp. 444-481.

Ash, C. (2002): Geology of the East Harrison Lake Belt, SW BC; *In*: Geological Fieldwork 2001, *B.C. Ministry of Energy and Mines*, Paper 2002-1, pp. 197-210.

Bowen, N.L. (1928): The Evolution of the igneous rocks; *Princeton University Press*, 334 p.

Cairnes, C.E. (1924): Nickeliferous mineral deposits, Emory Creek, Yale Mining Division, British Columbia; *Geological Survey of Canada*, Summary Report, pp. 100-106.

Casquet, C., Galindo, C., Torno, F. and Velasco, F. (2001): The Aguablanca Cu-Ni ore deposit Extremadura, Spain, a case of synorogenic orthomagmatic mineralization: Isotope composition of magmas (Sr, Nd) and ore (S); *Ore Geology Reviews* 18, pp. 237-250.

Christopher, P.A. (1974): Giant Mascot mine (92 H/6), British Columbia; *in* Geological Fieldwork, *British Columbia Department of Mines and Petroleum Resources*, pages 17-21.

Christopher, P.A. and Robinson, J.W. (1975): Pride of Emory mine, British Columbia; *British Columbia Department of Energy, Mines and Petroleum Resources*, Geology, Exploration and Mining in British Columbia, pp. 105-113.

Christopher, P.A. (1975): Report on the Giant Mascot Ultrabasic Project. *British Columbia Ministry of Energy, Mines and Petroleum Resources*, Summary Report.

Clarke, W.E. (1969): Giant Mascot Mines Ltd., geology and ore control; *Western Miner*, 42, pp. 40-46.

Cockfield, W.E. and Walker, J.F. (1933): The nickel bearing rocks near Choate, British Columbia; *Geological Survey of Canada*, Summary Report, pp. 62-68.

Faure, G. (1977): Principles of isotope geochemistry; John Wiley & Sons, 464 p.

Friedman, R.N. and Armstrong, R.L. (1990): U-Pb dating , southern Coast Belt, British Columbia; *in* LITHOPROBE: Canadian cordillera Workshop volume, *University of Calgary*, Alberta, pp. 146-155

Friedman R.N., Tyson, T.N. and Journeay, J.M. (1992): U-Pb age of the Mt. Mason pluton in the Cairn Needle area, southern Coast Belt, British Columbia; *in* Current Research. Part A, *Geological Survey of Canada* Paper 1992-1A pp.261-266

Gabites, J.E. (1985): Geology and geochronometry of the Cogburn Creek-Settler Creek area, northeast of Harrison Lake, British Columbia; M.Sc. thesis, *The University of British Columbia*, 153p. plus maps (1:20 000 scale).

Greig, C.J. (2002): Petrography, East Harrison Lake belt; *International Millennium Mining Corporation* internal report, 35 p.

Harrison, T.M. (1981): The diffusion of ^{40}Ar in hornblende; *Contributions to Mineralogy and Petrology* 78, 324-31.

Hawkesworth, C.J., Lightfoot, P.C., Fedorenko, V.A., Blakel, S., Naldrett, A.J., Doherty, W. and Gorbachev, N.S. (1995): Magma differentiation and mineralisation in the Siberian continental flood basalts; *Lithos* 34, pp. 61-88.

Himmelberg, G.R., and Loney, R.A. (1981): Petrology of the Ultramafic and Gabbroic Rocks of The Brady Glacier Nickel-Copper Deposit, Fairweather Range, Southeast Alaska; *U.S. Geological Survey*, Professional Paper 1195, 26p.

Horwood, H.C. (1936): Geology and mineral deposits at the mine of B.C. Nickel Mines Ltd., Yale Mining District; *Geological Survey of Canada*, Memoir 190, 15 p.

Irvine T.N. and Baragar, W.R.A. (1971): A guide to the chemical classification of the common volcanic rocks; *Canadian Journal of Earth Sciences*, 8, pp. 523-548.

Journeay, J.M. and Csontos, L. (1989): Preliminary report on the structural setting along the southeast flank of the Coast Belt, British Columbia; *in*: Report of Activities; *Geological Survey of Canada* Paper 89-1E, pp. 177-187.

Journeay, J.M. and Friedman, R.M. (1993): The Coast Belt thrust system; evidence of Late Cretaceous shortening in southwest British Columbia; *Tectonics*, 12, pp. 756-775.

King, P.N. (1972): Microvariation of nickel in pyrrhotite and pentlandite, Climax ore zone, Giant Mascot Mine, British Columbia; B.Sc. thesis, *The University of British Columbia*.

Lett, R. and Jackaman, W. (2002): PGE Stream sediment geochemistry in British Columbia; *in* Geological Fieldwork 2001, *British Columbia Ministry of Energy and Mines*, Paper 2002-1.

Lightfoot, P.C., Hawkesworth, C.J., Hergt, J., Naldrett, A.J., Gorbachev, N.S. , Fedorenko, V.A. and Doherty, W. (1993): Remobilisation of the continental lithosphere by a mantle plume: major-, trace-element, and Sr-, Nd-, and Pb-isotope evidence from picritic and tholeiitic lavas of the Noril'sk District, Siberian Trap, Russia; *Contributions to Mineralogy and Petrology* 114, pp. 171-188.

McLeod, J.A. (1975): The Giant Mascot ultramafite and its related ores; M.Sc. thesis, *The University of British Columbia*, 123 p.

McLeod, J.A., Vining, M. and McTaggart, K.C. (1976): Note on the age of the Giant Mascot ultramafic body, near Hope, B.C.; *Canadian Journal of Earth Sciences*, 13, pp. 1152-1154.

Metcalfe, P. and McClaren, M. (2002): Preliminary geological and geochemical assessment of the SABLE mineral claim (49°43'21.4"N, 121°50'3.9"W), New Westminster Mining Division, British Columbia; *British Columbia Geological Survey Branch*, Assessment Report 26 748, 29p.

MINFILE (1999): Giant Mascot deposits (092HSW004, 092HSW093, 092HSW125), Settler Creek, Cog, Ni, Daioff (092HSW081, 092HNW045), Jason (092HNW076) Al (92HNW040), D.C. Nickel (092HNW021), Victor Nickel (092HNW039), SABLE (092HNW077).

Monger, J.W.H. (1986): Geology between Harrison Lake and Fraser River, Hope map area, southwestern British Columbia;

in Current Research. Part B, *Geological Survey of Canada* Paper 86-1B, pp. 699-706.

Monger, J.W.H. (1989): Geology and mineral occurrences of the Hope map area; *Geological Survey of Canada*, Map 41-1989.

Monger, J.W.H. (1991): Correlation of Settler Schist with Darrington Phyllite and Shuksan Greenschist and its tectonic implications, Coast and Cascade mountains, British Columbia and Washington; *Canadian Journal of Earth Sciences* 28, pp. 447-458.

Monger, J.W.H. and Journeay, J.M. (1994): Guide to the geology and tectonic evolution of the southern Coast Mountains; *Geological Survey of Canada*, Open File 2490, 77p. plus maps.

Monger, J.W.H., Journeay, J.M., Greig, C.J. and Rublee, J. (1990): Field Trip B6; Structure, Tectonics and Evolution of Coast, Cascade and Southwestern Intermontane Belts, Southwestern British Columbia; *Geological Association of Canada/Mineralogical Association of Canada*, Joint Annual Meeting, Vancouver 1990, Field Trip Guidebook

Muir, J.E. (1971): A preliminary study of the petrology and ore genesis of the giant Mascot 4600 ore body, Hope, British Columbia; M.Sc. thesis, *University of Toronto*, 125p. plus maps.

Nixon, G.T. (2003): Use of spinel in mineral exploration: the enigmatic Giant Mascot deposit - possible ties to Wrangellia and metallogenic significance; *in* Geological Fieldwork 2002, *B.C. Ministry of Energy and Mines*, Paper 2003-1, pp. 115-128.

Parrish, R.R. and Monger, J.W.H. (1992): New U-Pb dates from southwestern British Columbia; *in* Radiogenic Age and Isotopic Studies, Report 5; *Geological Survey of Canada* Paper 91-2, pp. 87-108.

Pinsent, R.H. (2002): Ni-Cu-PGE potential of the Giant Mascot and Cogburn Ultramafic-Mafic Bodies, Harrison-Hope Area, Southwestern British Columbia (092H); *in* Geological Fieldwork 2001, *B.C. Ministry of Energy and Mines*, Paper 2002-1, pp. 211-235

Richey, J.E. and Thomas, H.H. (1930): The geology of Ardnamurchan, north-west Mull and Coll (A description of sheet 51 and part of sheet 52 of the geological map); Memoir of the *Geological Survey of Great Britain* (Scotland) 393p.

Richards, T.A. (1971): Plutonic rocks between Hope, British Columbia, and the 49th parallel; Ph.D. thesis, *The University of British Columbia*, 178p. plus maps (1inch: 1.5-mile scale).

Richards, T.A. and White, W.H. (1970): K-Ar ages of plutonic rocks between Hope, British Columbia and the 49th parallel; *Canadian Journal of Earth Sciences*, 7, pp. 1203-1207.

Richards, T.A. and McTaggart, K.C. (1976): Granitic rocks of the southern Coast Plutonic Complex and northern Cascades of British Columbia; *Geological Society of America*, Bulletin 87, pp. 935-953.

Skirrow, R.G. and Sims, J.P. (1999): Genesis and Setting of Intrusion-hosted Ni-Cu Mineralization at Las Aguilas, San Luis Province, Argentina: Implications for Exploration of an Ordivician Arc; *Exploration and Mining Geology*, 8, pp. 1-20.

Steiger, R.H. and Jäger, E. (1977): Subcommission on geochronology: convention on the use of decay constants in geo- and cosmochronology; *Earth and Planetary Science Letters*, 36, pp. 359-362.

Tornos, F., Casquet, C., Galindo,C., Velasco, F. and Canales, A. (2001): A new style of Ni-Cu mineralization related to magmatic breccia pipes in a transpressional magmatic arc, Aguablanca, Spain; *Mineralium Deposita*, 36, pp. 700-706.

Vining, M.R. (1977): The Spuzzum pluton northwest of Hope, British Columbia; M.Sc. thesis, *The University of British Columbia*, 103 p.

Aluminous Alteration at the Briton Hematite Prospect, Chilcotin Ranges (92N/14E)

Michael S. Cathro, PGeo
Regional Geologist, Kamloops

INTRODUCTION

This article describes unusual aluminous alteration associated with hematite mineralization at the Briton iron prospect (MINFILE 92N 011), Chilcotin Ranges, southwest British Columbia. Massive specular hematite occurs adjacent to argillite in a package of intermediate volcanics. The hematite is closely associated with an alteration assemblage consisting of quartz, pyrophyllite, andalusite, corundum, and nacrite.

Although this iron occurrence is itself of limited economic interest, the associated aluminous alteration assemblage is similar to advanced argillic alteration assemblages that occur around or above porphyry copper deposits, such as El Salvador, Chile, and the Empress and Equity Silver deposits in British Columbia. The potential for porphyry mineralization in the area is also supported by: anomalous Cu, F, Hg, As, Fe, Sb, As, and Co values in a stream sediment sample collected downstream to the east; vague reports of float containing high copper and gold values a few kilometres east of Briton iron at the Pin Cu prospect (92N 053); and Late Cretaceous-Tertiary intrusions that lie a few kilometres to the south. As well, the distinctive pale bluish-grey colour of the corundum-bearing alteration suggests that the potential for gem quality sapphire should be evaluated.

LOCATION, ACCESS AND CLAIM OWNERSHIP

The Briton iron prospect is located on the south side of Perkins Peak in the Chromium Creek valley at an elevation of 2280 metres (7475 feet) (Figure 1). It is 24 kilometres southwest of the village of Kleena Kleene on Highway 20. Four-wheel drive access to the site is possible in late summer and early fall via the Miner Lake Forest Service Road, the Perkins Peak mine road, and a 7-km long, rough spur

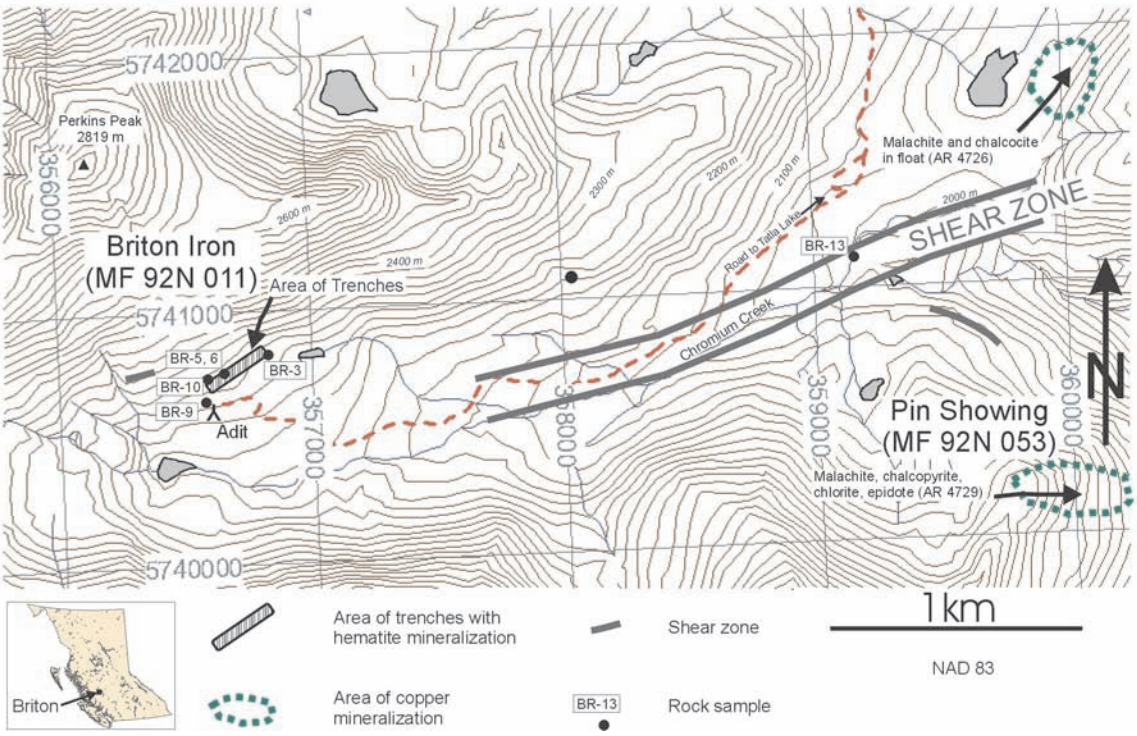

Figure 1. Map showing mineral occurrences and sample locations in the Chromium Creek valley.

TABLE 1
MAJOR AND TRACE ELEMENT ANALYSES OF OCCURRENCES AND SHEAR ZONES IN THE CHROMIUM CREEK AREA

Sample #	Description	SiO2 % LMI	Al2O3 % LMI	Fe2O3 % LMI	MgO % LMI	CaO % LMI	Na2O % LMI	K2O % LMI	TiO2 % LMI	P2O5 % LMI	MnO % LMI	Cr2O3 % LMI	Ba ppm LMI	Sc ppm LMI	LOI % FUS	TOT/C % LCO	TOT/S % LCO	SUM % TOT
BR-3	Blue-grey alteration	61.24	29.9	3.9	0.04	0.39	0.69	0.19	1.03	0.14	< .01	0.003	135	51	2.4	0.01	< .01	99.94
BR-5	Specularite	14.19	1.24	81.69	0.03	0.53	0.01	< .02	0.73	0.42	0.01	0.002	12	5	0.5	< .01	< .01	99.36
BR-6	Blue-grey alteration	67.27	20.72	5.51	0.89	1.09	0.4	0.21	1.06	0.13	0.05	0.004	32	19	2.6	0.03	< .01	99.94
BR-9	Qtz-ser-py schist	61.82	19.71	7.19	0.06	2.13	1.2	0.91	1.2	0.09	< .01	0.003	346	26	5.6	< .01	2.01	99.96
BR-10	Specularite & alteration	61.09	2.76	31.24	0.1	0.39	0.08	< .02	3.21	0.2	0.01	0.002	32	17	0.7	0.01	< .01	99.79
BR-13	Qtz-ser-py schist	73.12	10.42	8.42	0.02	0.1	0.1	0.02	0.67	< .01	< .01	0.002	94	10	7.1	0.02	6.04	100

Sample #	Description	Au ppb LMM	Ag ppm LMM	As ppm LMM	Bi ppm LMM	Cd ppm LMM	Co ppm LMM	Cs ppm LMM	Cu ppm LMM	F ppm ION	Ga ppm LMM	Hf ppm LMM	Hg ppm LMM	Mo ppm LMM	Nb ppm LMM	Ni ppm LMM	Pb ppm LMM	Rb ppm LMM	Sb ppm LMM	Sr ppm LMM	Zn ppm LMM
BR-3	Blue-grey alteration	< .5	< .1	2.7	< .1	< .1	1.3	0.3	6.6	930	16.9	2.4	< .01	0.9	2.1	1.1	1	2.9	0.3	164	5
BR-5	Specularite	< .5	< .1	18.8	0.1	< .1	1.2	< .1	2.5		23.9	2.3	0.01	1.5	1.6	0.1	2.3	< .5	5.6	4.3	4
BR-6	Blue-grey alteration	< .5	< .1	1.8	< .1	< .1	10	1.4	17.6	500	15.7	2.9	< .01	2.1	2.3	3.1	1.3	5	0.3	92.1	22
BR-9	Qtz-ser-py schist	3.3	0.1	2.7	0.1	0.3	6.1	2.8	55.3		13	3.2	0.04	2.4	2.4	2.1	3.1	17	0.4	165.6	7
BR-10	Specularite & alteration	1.1	< .1	14	0.3	0.1	0.9	< .1	14.3	210	22.3	10.6	0.18	1.7	7.4	0.7	1.3	< .5	3.1	25.6	8
BR-13	Qtz-ser-py schist	1.1	0.1	62.3	1.4	0.2	38.3	< .1	60.2	830	9.7	3.2	1.15	5.8	2.3	10.6	10.9	< .5	2.5	48.1	8

Sample #	Description	Y ppm LMM	La ppm LMM	Ce ppm LMM	Pr ppm LMM	Nd ppm LMM	Sm ppm LMM	Eu ppm LMM	Gd ppm LMM	Tb ppm LMM	Dy ppm LMM	Ho ppm LMM	Er ppm LMM	Tm ppm LMM	Yb ppm LMM	Lu ppm LMM	Ta ppm LMM	Th ppm LMM	U ppm LMM	V ppm LMM	W ppm LMM	Zr ppm LMM
BR-3	Blue-grey alteration	5.5	3.1	8.4	1.14	4.8	1.1	0.17	0.92	0.16	1.05	0.23	0.68	0.1	0.71	0.12	0.6	0.5	0.4	160	1	87.2
BR-5	Specularite	2.7	1.8	3.4	0.36	1.5	0.4	0.11	0.49	0.09	0.63	0.14	0.32	0.06	0.34	0.04	< .1	0.3	0.3	3619	0.8	78.2
BR-6	Blue-grey alteration	12.7	6.5	17.1	2.92	17.1	3.2	1.05	2.5	0.4	2.31	0.51	1.44	0.2	1.47	0.23	0.4	0.9	0.5	209	4.2	94.8
BR-9	Qtz-ser-py schist	17	5.2	13.6	1.93	10.9	2.6	0.86	2.61	0.47	2.63	0.6	1.76	0.27	1.99	0.27	0.1	1	0.7	182	3.6	104.4
BR-10	Specularite & alteration	12.9	12.1	29.5	4.51	21.7	4.7	1.03	3.45	0.44	2.3	0.52	1.48	0.24	1.63	0.25	0.4	1.1	1.7	1025	1.8	332.5
BR-13	Qtz-ser-py schist	13.6	4.2	10.8	1.6	7.4	1.9	0.62	1.84	0.36	2.02	0.5	1.7	0.33	2.6	0.38	< .1	0.5	1.9	78	4.3	102.7

Notes:

Preparation: Sample jaw crushed @ GSB & steel milled @ ACME. Quartz wash between each sample milled.

LMI = Lithium metaborate fusion - inductively coupled emission spectrometry

LMM = Lithium metborate fusion - inductively coupled mass spectrometry

LCO = Leco combustion

LOI = Loss on ignition @ 1100^{o}C

ION = Sodium carbonate fusion - spectifc ion electrode

road into the upper Chromium Creek valley. The total distance from Highway 20 to the prospect is 32.6 km.

All prospects in the area are covered by mineral claims belonging to 397470 British Columbia Inc. and Hunter Point Explorations Ltd. Many of the claims have been held for several decades, with the oldest apparently staked in 1964.

EXPLORATION HISTORY

According to the Minister of Mines Annual Report for 1916, the Briton (or Wallace) iron prospect was discovered and staked prior to 1916. About that time the showing was developed by eight open cuts and a 600-foot long adit that apparently failed to intersect the hematite zone. Samples collected at that time by J.D. Galloway, Assistant Provincial Mineralogist, returned up to 47.6 % Fe over 2 feet in the most westerly cut, 48.4 % Fe (average of westerly dump), and 57 % Fe (selected ore from another cut). Sulphur and phosphorus values were reported as nil or trace.

Two dump samples collected in 1921 by W.M. Brewer, Resident Engineer, assayed 48.9 and 57.6 % Fe, trace and 0.24% P, trace sulphur, and 30.7 and 15.5% Si (Minister of Mines Annual Report for 1921). Both government officials remarked that despite the apparent purity of the iron, the commercial value of the deposit was low given its remote location. With the exception of an airborne geophysical survey (Smith, 1970), there is no record of further work being conducted on the Briton iron prospect.

The only recorded work on the Pin copper prospect (MINFILE 92N 053), which is located east of Briton iron, was in 1973 and 1974, when Cities Services Minerals Corp. conducted soil, geological and geophysical surveys over several areas with float boulders that carried high copper and gold values.

North of Perkins Peak, Au-Ag bearing veins and silicified zones at the Mountain Boss prospect (92N 010) were first staked between 1935 and 1938 (Minister of Mines Annual Report for 1938). Eight open cuts and an adit were dug at that time. The Bluebell prospect (92N 012) was first mentioned in 1945, when some tunneling took place. Several other adits have been driven over the years but very little technical information is available.

REGIONAL GEOLOGY

The Perkins Peak area is situated in an area of complex geology between the mid-Cretaceous Coast Belt magmatic arc to the southwest and the Tchaikazan and Yalakom dextral transcurrent faults to the northeast. A three- to eight kilometre-wide imbricate thrust zone affects Upper Triassic arc volcanic and sedimentary rocks of the Mt. Moore and Mosely Formations. These formations are interpreted to be correlative with Stikine Terrane and the thrust zone is interpreted to be part of the East Waddington thrust belt (Mustard *et al*. 1994).

To the north, the Triassic rocks are thrust over clastic sediments and felsic volcanics of the Late Cretaceous Cloud Drifter and Ottarasko Formations respectively, which are part of the Tyaughton Basin. Two kilometres south of the Briton showing, the Triassic rocks are in thrust contact with Late Cretaceous (ca. 96 Ma) tonalite that intrude Cretaceous felsic to intermediate volcanics of the Powell Creek Formation. All of these rocks are intruded by the Late Cretaceous to Tertiary (63-67 Ma) Klinaklini pluton and related stocks and dikes (Mustard *et al*., 1994).

LOCAL GEOLOGY

The Chromium Creek valley is underlain by a stacked series of east-northeast trending, south-dipping pyritic quartz-sericite shear zones that cut intermediate volcaniclastic rocks. Rocks in the immediate area of the hematite showings are mainly medium to dark green and locally maroon-weathering tuffaceous volcanic rocks, and polymictic volcanic breccia. The breccias contain fragments of green and buff volcaniclastics or sediments, dark grey argillite, and intrusive rocks. Minor dark grey argillite that is found locally in trenches and on dumps appears to be intimately associated with the hematite. Greenish intermediate volcanic breccia and tuff are the hosts to mineralization at the Pin copper showings

MINERALIZATION AND ALTERATION

Three types of mineralization are noted in the Chromium Creek valley: massive hematite bodies at the Briton occurrence; chalcopyrite-bearing veins at the Pin prospect and pyrite in quartz-sericite schist. Locations of these occurrences are shown on Figure 1 and analytical values are included in Table 1.

At the **Briton Iron Prospect** (MINFILE 92N 011), on the south slopes of Perkins Peak, massive, dark blue to black-weathering specular hematite occurs in several old trenches and pits extending northeasterly for more than 150 m in the western part of the valley. The workings are badly sloughed-in and the width of the hematite bodies cannot be ascertained, however, when they were open previous workers estimated widths of between two and nine metres. Other rock types on the dumps include dark grey to black siliceous argillite and green andesitic volcanic. In some places, hematite occurs as bands within the dark grey argillite.

Distinctive beige-orange and pale bluish grey alteration assemblages are intimately associated with the hematite in many of the trenches. The beige-orange material is variably soft and hard and fine-grained but contains local radiating masses of pyrophyllite that range up to 1 centimetre in diameter (Photo 1). X-ray diffraction (XRD) studies of this material indicates it is made up of quartz, pyrophyllite ($Al_2Si_4O_{10}(OH)_2$), minor andalusite (Al_2SiO_5) and possibly zussmanite ($K(Fe^{2+},Mg,Mn^{2+})_{13}(Si,Al)_{18}O_{42}(OH)_{14}$). A soft light-coloured material that fills vugs in the massive hematite was identified by XRD as mainly nacrite ($Al_2Si_2O_5(OH_4)$) with possible minor pyrophyllite (J.A. McLeod, Written Communication, November 27, 2002).

The pale bluish grey alteration (Photo 2) is much harder (5 to >7 on Mohs scale) and consists of white, pale

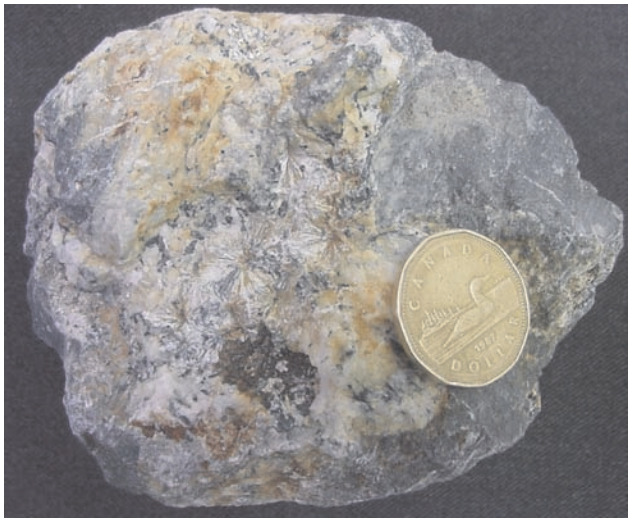

Photo 1. Radiating aggregates, to 1 cm in diameter, of pale buff pyrophyllite and quartz (white) alteration at the Briton iron prospect.

Photo 2. Aluminous alteration at the Briton iron prospect. The upper (beige-orange) layer consists of quartz, pyrophyllite, andalusite and minor nacrite. The lower (grey-blue) layer consists of corundum, quartz, pyrophyllite, andalusite and possibly nacrite.

grey, clear and blue-grey grains up to several millimetres in size, peppered with 1-2 millimetre round black grains, tentatively identified as andalusite. XRD studies indicate that this alteration consists of corundum (Al_2O_3), quartz, pyrophyllite, andalusite, and possibly nacrite. It is not clear from hand specimen examination whether the blue colour is due to corundum or quartz grains. More detailed petrographic work is required to determine the cause of the blue colour; if it is due to corundum, there may be potential for gem quality sapphire.

Other hematite-related alteration minerals noted in hand specimen included buff, hard massive sugary albite(?), and minor chlorite. Epidote occurs locally.

Geochemical analyses (Table 1) of the specular hematite (BR-5 and BR-10) returned up to 81.69% Fe_2O_3, 3.21% TiO_2, and 0.42% P_2O_5, along with anomalous V (3619 ppm), Sb (5.6 ppm) and Ga (23.9 ppm).

Two samples of the pale bluish grey alteration (BR-3 and BR-6) returned 20.72 and 29.9% Al_2O_3 respectively and anomalous amounts of F (500 and 930 ppm).

The **Pin Prospect** (MINFILE 92N 053) was not examined during this study; information provided here is summarized from assessment reports. Located four kilometres east of Perkins Peak, the Pin prospect is reported to consist of copper-bearing float hosted by intermediate volcanic rocks. "Chalcopyrite, chalcocite, bornite and considerable malachite staining is noted in float scattered throughout the property" according to assessment reports submitted by Cities Services Minerals Corp. (Murton, 1973; 1974). The reports also mentioned that the float "contains impressive copper and gold values associated with quartz veins". However, no assay values were reported.

Geological mapping, geochemical sampling and magnetic and IP surveys were done to follow-up on the float discoveries. A prominent quartz-sericite-pyrite shear zone (Figure 1) that dips moderately to the southeast and strikes at 070 degrees, has local malachite staining. Two other major areas of float mineralization were identified: one, comprising malachite and chalcocite, is located east of the small lake in the northeast corner of Figure 1; and the second is in the southeast corner and consists of pyrite, malachite and chalcopyrite associated with epidote and chlorite alteration. These occurrences could represent propylitic alteration and low-grade porphyry copper mineralization.

Prominent **quartz-sericite-pyrite shear zones** and their related gossans occur along a 4 km length of the valley. These were briefly examined and sampled at several locations as part of this study. Fabric in the shear zones dips moderately to the south and generally strikes at about 070 degrees. Pyrite content ranges up to about 10 per cent. Quartz-sericite-pyrite schist is present on the dump at the Briton adit (Sample BR-9) and previous workers reported that it was encountered near the end of the tunnel. This material was also found in outcrop a few hundred metres northwest of the Briton prospect, in a prominent cliff south of Chromium Creek, along the main access road, and at several places in Chromium Creek (BR-13). The outcrops represent a stacked series of shear zones with thicknesses ranging from tens to perhaps hundreds of metres.

Geochemically, one of the two quartz-sericite-pyrite schist samples (BR-13, Table 1) contains anomalous Hg (1.15 ppm) and F (830 ppm), and weakly anomalous Cu (60.2 ppm), As (62.3 ppm), and Co (38.3 ppm).

REGIONAL STREAM GEOCHEMISTRY

A single government stream sediment sample in Chromium Creek, 5 kilometres downstream from the Briton prospect, is anomalous in Fe (4.4%), Cu (225 ppm), Sb (4.1 ppm), As (43 ppm), Co (31 ppm), Hg (220 ppb), Lu (0.70 ppm), Sm (6.5 ppm), Tb (1.6 ppm), Yb (5.4 ppm), F (1100 ppm), F in water (420 ppb), sulphate (86) and pH (4.9). All of these elements are above the 95th percentile for the 92N map sheet, and the F value is the highest on the sheet.

The high values for Fe, Sb, As, Co, Hg, F, sulphate and pH can be readily explained by corresponding anomalous concentrations of Fe, Sb and F in the hematite mineralization and its alteration, and by the anomalous Fe, Sb, As, Co, Hg, F and sulphide contents of the quartz-sericite-pyrite shear zones. The anomalous Cu value could be related to copper mineralization described for the Pin showings, however there may be undiscovered sources.

DISCUSSION AND CONCLUSIONS

Hematite at the Briton iron prospect appears to be of hydrothermal origin due to its intimate association with an unusual aluminous (advanced argillic) alteration assemblage consisting of quartz, pyrophyllite, andalusite, corundum and nacrite. The hematite probably formed by selective replacement of argillite layers within the intermediate volcanic country rocks. Alumina was probably derived from the argillite. Although the source of the hydrothermal fluids is not known, Late Cretaceous to Tertiary intrusions are located a few kilometres to the south.

The aluminous alteration includes a distinctive pale bluish grey assemblage of corundum, quartz, pyrophyllite, and andalusite. The source of the blue colour in this alteration has yet to be determined, but blue corundum is a possibility. Therefore, the potential for gem-quality sapphire should be investigated petrographically and perhaps by panning sediments in Chromium Creek below the iron deposit.

A similar aluminous assemblage has been identified at the Empress (Taseko) Cu-Au-Mo deposit (MINFILE 92O 033) some 140 km southeast of Briton. It contains clear and blue corundum that may be of gem-quality. The Empress deposit is also hosted by Mesozoic volcanic rocks on the northeast margin of the Coast Plutonic Complex, a setting similar to Briton iron. At Empress, porphyry mineralization is associated with alteration assemblages consisting of quartz, quartz-magnetite, quartz-andalusite-pyrophyllite, and plagioclase-quartz-pyrophyllite-andalusite. The latter assemblage also contains minor corundum, magnetite and chlorite (Simandl *et al*., 1997; 1998).

Aluminous alteration has been described from the upper parts of porphyry copper systems, most notably at El Salvador, Chile (Gustafson and Hunt, 1975) where andalusite, pyrophyllite and corundum are present. At the Equity Silver mine in northern British Columbia, Ag-Cu-Au-Sb mineralization occurs in a volcanic breccia matrix and is associated with an aluminous and borosilicate assemblage comprising andalusite, scorzalite, tourmaline, corundum and minor dumortierite. Magnetite occurs in the hangingwall and is associated with, and partially replaced by specularite in the corundum distribution zone (Wojdak and Sinclair, 1984).

Aluminous (advanced argillic) alteration at the Briton iron prospect could represent the upper part of a porphyry environment. Although copper values in the hematite deposit itself are low, several other features show that there is potential for copper mineralization in the broader area. In particular, stream sediments in Chromium Creek are highly anomalous in Cu (220 ppm) and have elevated F, Hg, As, Fe, Sb, As, and Co values; there are vague reports of porphyry-style Cu-Au mineralization at the Pin prospect; and Late Cretaceous-Tertiary intrusive rocks occur a few kilometres to the south. Given that the area has not been explored for nearly 30 years, prospecting and geological mapping are warranted.

ACKNOWLEDGEMENTS

Dave Lefebure and Ray Lett of the Geological Survey Branch are thanked for financial support and technical advice for analytical work. The manuscript benefited from the editorial comments of Bill McMillan.

REFERENCES

Gustafson, L.B. and Hunt, J.P. (1975): The Porphyry Copper Deposit at El Salvador, Chile; *Economic Geology*, Volume 70, pages 564-579.

Murton, J.W. (1973): Geological, Geochemical and Geophysical Report, Pin Claims, Cariboo Mining Division, B.C.; *British Columbia Ministry of Energy, Mines and Petroleum Resources*, Assessment Report 4729, 27 pages.

Murton, J.W. (1974): Geophysical Report on the Pin Claim Group (Pin 1-106) Located Near Tatla Lake, British Columbia in the Cariboo Mining Division; *British Columbia Ministry of Energy, Mines and Petroleum Resources*, Assessment Report 5522, 34 pages.

Mustard, P.S., van der Heyden, P., and Friedman, R. (1994): Preliminary Geologic Map: Tatla Lake - Bussel Creek (East Half), NTS 92N/15, 92N/14 (East Half); *Geological Survey of Canada*, Open File Report 2957, scale 1:50 000.

Simandl, G.J., Hancock, K.D., Hudon, P., Martignole, J. and Osborne, W.W. (1997): The Empress Cu-Au-Mo deposit - Gemstone and Industrial Minerals Potential; *in* Geological Fieldwork 1996, *British Columbia Ministry of Employment and Investment*, Paper 1997-1, pages 339-346.

Simandl, G.J., Jones, P., Osborne, J.W., Payie, G., and McLeod, J. (1998): Use of Heavy Minerals in Exploration for Sapphires, Empress Cu-Au-Mo Deposit, British Columbia; *in* Geological Fieldwork 1997, *British Columbia Ministry of Employment and Investment*, Paper 1998-1, pages 26-1 to 26-12.

Smith, C.L. (1970): Geophysical Report on Apex 1-8, 9-54 Claims and Mineral Lease M-26, Perkins Peak, Cariboo M.D.; *British Columbia Ministry of Energy, Mines and Petroleum Resources*, Assessment Report 2540, 12 pages.

Wojdak, P.J. and Sinclair, A.J. (1984): Equity Silver Ag-Cu-Au Deposit, Alteration and Fluid Inclusion Studies; *Economic Geology*, Volume 79, pages 969-990.