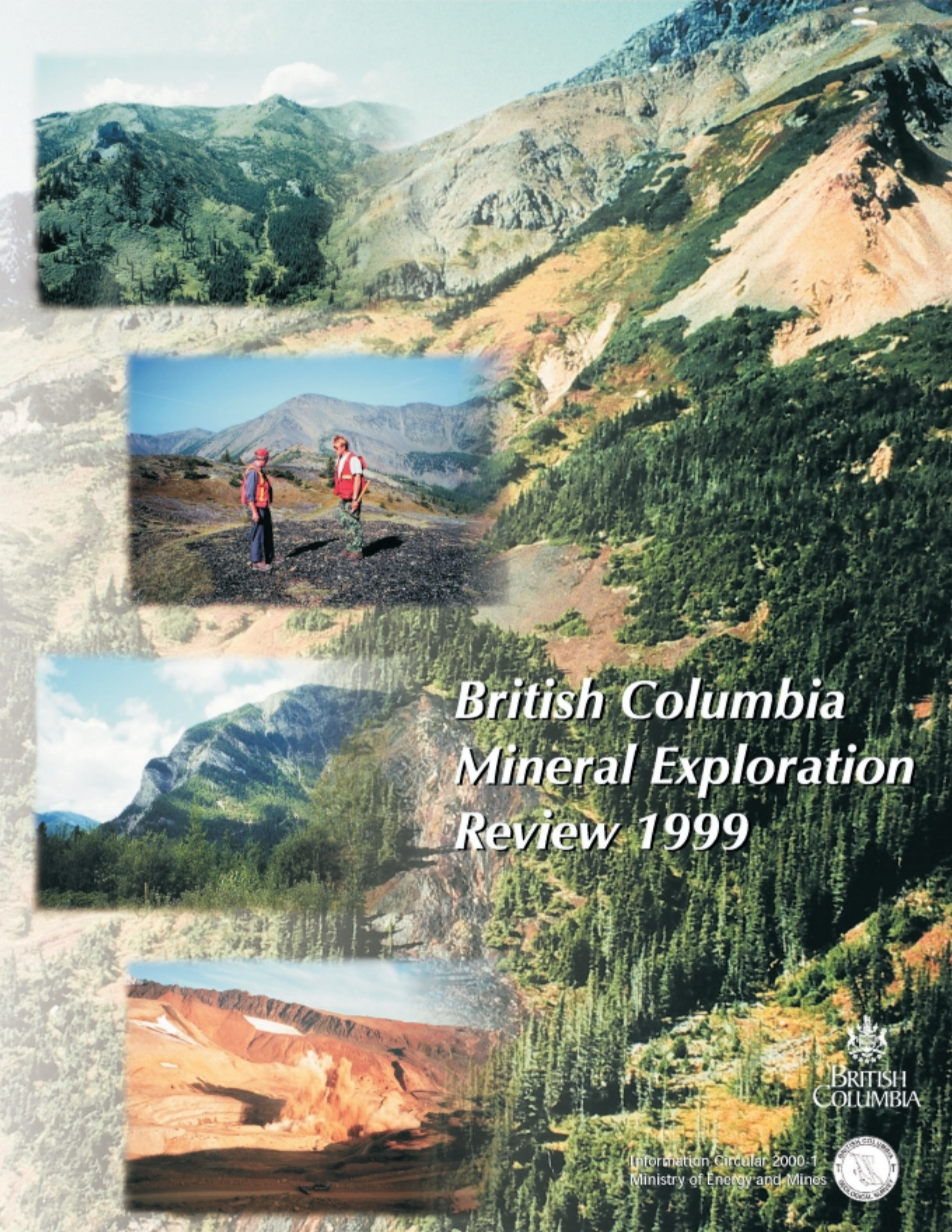

# British Columbia Mineral Exploration Review 1999

BRITISH COLUMBIA

Information Circular 2000-1
Ministry of Energy and Mines

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# PHOTOS

***Background:*** Looking west over ferricrete adjacent to the Jungle anomaly, RDN project. Photo courtesy of Rimfire Minerals Corp.

***Top:*** Looking west toward Trachyte Ridge, Crowsnest project. 1999 drilling around "The Fortress". Photo courtesy of Phelps Dodge of Canada Corp.

***Top Centre:*** Tourmalinite Ridge, Findlay North project. Photo by T.G. Schroeter.

***Bottom Centre:*** Looking northwest across Cayoosh Creek valley toward Ample/Goldmax gold project. 1999 drilling in shallow-dipping shear zone marked by break in slope. Bridge River Group greenstones above and Cayoosh Assemblage argillites below. Photo by T.G. Schroeter.

***Bottom:*** Looking northeast over Ursa Zone pit and Totem Creek leach pad, Golden Bear mine. Photo courtesy of Wheaton River Minerals Ltd.

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# BRITISH COLUMBIA
# 1999 MINERAL EXPLORATION REVIEW

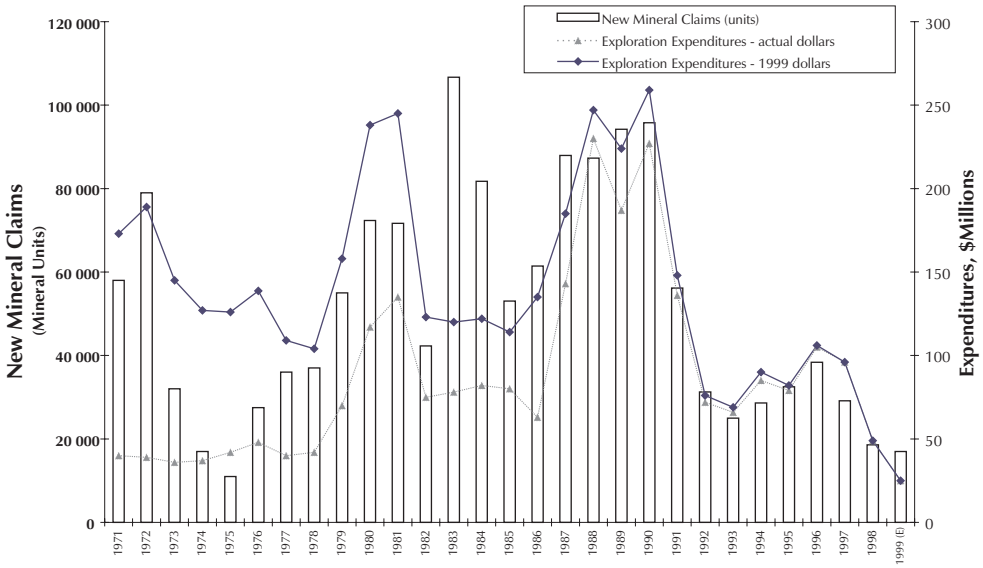
British Columbia Ministry of Energy and Mines

## INTRODUCTION

The exploration highlight for 1999 in British Columbia is the continuing interest, by major and junior mining companies alike, in British Columbia's base metal potential, particularly for Proterozoic and Paleozoic stratiform zinc-lead-silver deposits and Paleozoic–Mesozoic precious-metal-enriched massive sulphide deposits. This is best exemplified by the sustained commitment of Rio Algom Ltd., Kennecott Canada Inc. and Billiton Metals Canada Inc., together with a number of junior companies, to locating the elusive successor to the world-class **Sullivan** zinc-lead-silver orebody in southeastern BC. Three aggressive drilling programs have identified new sulphide-rich hydrothermal vents, and exploration on several other prospects has defined new drilling targets (*e.g.*, **Pakk, North Findlay, South Findlay, Greenland Creek, Irishman Creek, Pyramid Peak, Yahk, Car, Cruz** and **Smoker**). This was the most active exploration area in 1999 and is expected to be so again next year.

An outstanding drill intersection by Peruvian Gold Ltd. and Imperial Metals Corp. on the **Silvertip** silver-lead-zinc manto prospect in northern British Columbia prompted re-activation of underground exploration. They believe that the drill hole intersected a chimney deposit which is considered to have better tonnage potential and have more attractive mining characteristics than the existing manto resource on the property. Underground drilling from the dewatered exploration decline is planned during the first quarter of 2000.

*Figure 1...*

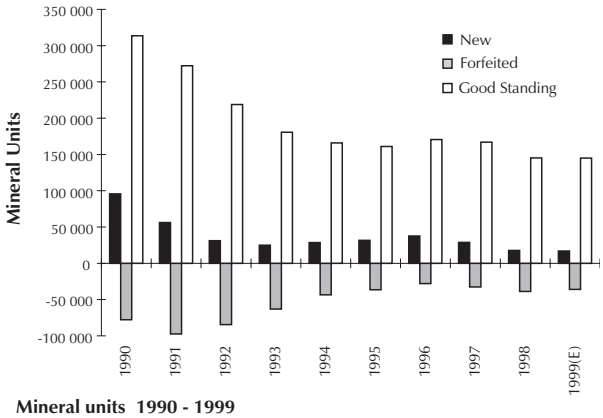



**Mineral Exploration Expenditures and Number of New Mineral Claims Recorded in B.C. 1971 - 1999**

*(Data source: MEM, Minerals, Oil and Gas Branch and Mineral Titles Branch).*

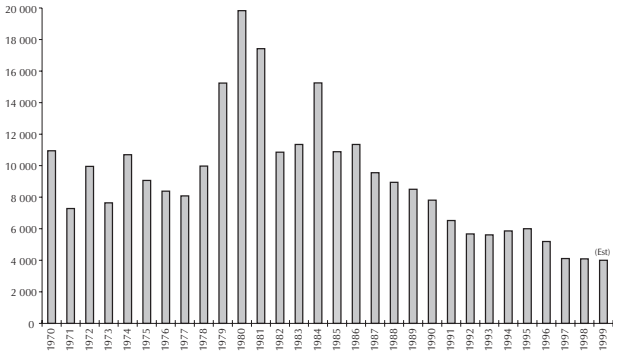
*As in past years information contained in this review, including tonnages and grades, are from data released by the individual owners or operators. The Ministry of Energy and Mines makes every effort to ensure accuracy in the information presented, however the Ministry is not responsible for any errors or omissions. Monetary figures are in Canadian dollars. Readers should conduct their own inquiries and verify the information contained for themselves.*

*Figure 2 ...*




**Mineral units 1990 - 1999**

*Figure 3 ...*




**Free Miner Certificates 1970 to 1999**

Late in 1999, Hudson Bay Exploration and Development Co. Ltd. optioned a large tract of land encompassing the newly discovered **Bow** and **Lottie** volcanogenic massive sulphide prospects, north of Wells.

On the mining scene, the **Eskay Creek** precious metal mine, owned by Homestake Canada Inc., continues to shine. The mine produced an estimated 9990 kilograms (321 200 oz) of gold and 432 340 kilograms (13.9 million oz) of silver in 1999. Due to successful exploration since start up, the mine now has a higher reserve base than at mine opening in 1995.

Northgate Exploration Ltd. is the new owner of the large **Kemess** porphyry gold-copper mine, following restructuring of the insolvent Royal Oak Mines Inc. late in 1999. The mine has been operated by the receiver, Pricewaterhouse-Coopers Inc., since April. Improvements in mining and mill recoveries resulted in an estimated production of 6620 kilograms (200 000 oz) of gold and 22 700 tonnes (50 million lbs) of copper in 1999.

**Golden Bear**, the province's only heap-leach gold mine, is noteable for its economic success despite operating at high altitude on a short summer seasonal basis. The mine produced 2227 kilograms (71 600 oz) of gold at a cost of US$159 per ounce. Critical factors contributing to the mine's performance are uncommonly rapid leaching and high recovery of gold, which is amongst the best in the world for this type of operation.

## *Noteworthy grassroots exploration programs*

- the northwest (Eskay Creek) area for precious-metal rich subaqueous hot-spring deposits;
- the Toodoggone (Kemess) area for porphyry gold-copper deposits;
- the area north of Wells for polymetallic massive sulphide deposits;
- the area north of Revelstoke for polymetallic massive sulphide deposits;
- the area northeast of Kamloops for intrusion-hosted *(e.g.* Fort Knox, Pogo*)* gold deposits;
- numerous areas throughout the province in the search for industrial minerals; and,
- new mineral discoveries reported throughout the province in 1999, most made by prospectors taking advantage of new access (*see* Table page 19).

## *Statistics*

Exploration expenditures in 1999 are estimated to be approximately $25 million, included in this total are approximately 48 exploration projects (versus 70 in 1998), with budgets in excess of $100 000. The number of mineral claim units recorded in 1999 is forecast at 17 500, compared to 17 753 in 1998. Figure 1 presents the trends in exploration expenditures and recordings of mineral claim units between 1971 and 1999. Figure 2 illustrates the number of new, forfeited and good standing mineral units in the province between 1990 and 1999 and shows that the total number of mineral claims in good standing has been relatively constant since 1994. Similarly, the number of Free Miner Certificates issued each year (Fig. 3), has been steady since 1997. Drilling in British Columbia during 1999 is estimated to total approximately 140 000 metres (versus 170 000 in 1998); of this, approximately 99 000 metres and 41 000 metres were for metals and coal, respectively.

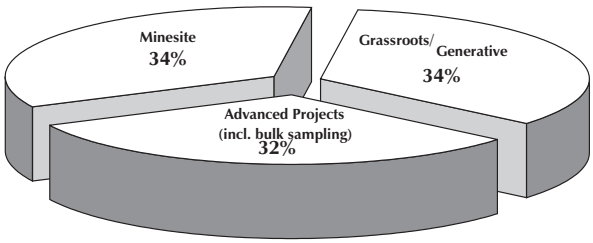
During 1999, approximately 34% of exploration expenditure was around minesites; 7% of this was in and around coal mines. An estimated 32% of exploration expenditure was on properties with a recent or on-going work history, and 34% of expenditures were on grassroots programs (Fig. 4). Exploration has focused increasingly on grassroots programs rather than advanced projects. Minesite exploration expenditures were dominated by programs at **Eskay Creek** (10.5%) and **Myra Falls** (14.6%).

## MINING HIGHLIGHTS

Production details for the 1999 operating mines will be included in the forthcoming annual publication, *Exploration and Mining in British Columbia*.

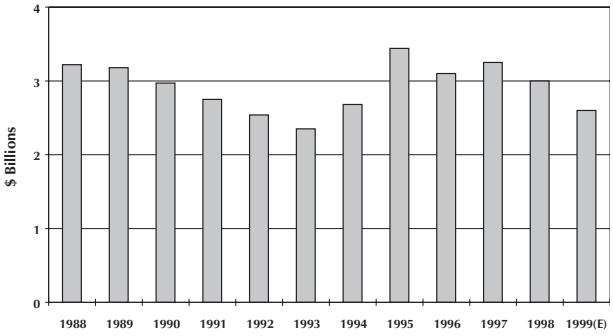
- The value of solid mineral production for 1999 is estimated at $2.6 billion and the industry employs a workforce of about 9000 (*see* Table page 4; Figure 5; Figure 6). Lower commodity prices, particularly for coal, copper and gold, the closure of the **Snip** mine, and temporary closures at **Highland Valley Copper**, **Myra Falls**, and several **coal** mines in the southeast, resulted in the 13% decrease in value from 1998.
- Highlights of metal mine developments were the very successful seasonal heap-leach operation at the **Golden Bear** gold mine in the northwest, and operational improvements at the **Kemess** gold-copper mine in the Toodoggone district. The **Eskay Creek** mine achieved record production of gold. The **Snip** gold and the **Parson** gypsum mines closed in 1999 due to the depletion of reserves. The **Blackdome** gold mine also closed, due to low gold prices. The locations of the twelve metal, eight coal, eleven industrial mineral mines and one tailings project that were in operation in 1999 are indicated on Figure 7.
- Copper represents 15.7% of total production value, at a projected $410.9 million, a 43% decrease from 1998. This decrease is principally the result of lower copper production at the **Highland Valley Copper** and **Myra Falls** mines, which were affected by labour and rehabilitation shut downs respectively, and the closure of the **Gibraltar** copper-molybdenum mine in late 1998.
- Gold production is forecast to be 25.5 million grams (819 840 oz), up by about 27% from 1998, and valued at about $338.8 million. This increase is due mainly to increased gold production at the **Eskay Creek**, **Kemess** and **Golden Bear** mines.
- Silver output is forecast at 524 million grams (16.8 million oz), the same as in 1998, and valued at $132.3 million, almost all of which comes from the Eskay Creek mine [432 340 kg (13.9 million oz)]. Temporary closures

*Figure 4 ...*



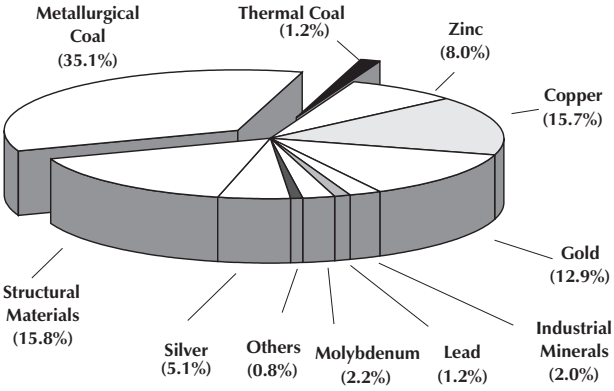

**Exploration expenditures 1999; by level or category of program**

*Figure 5 ...*



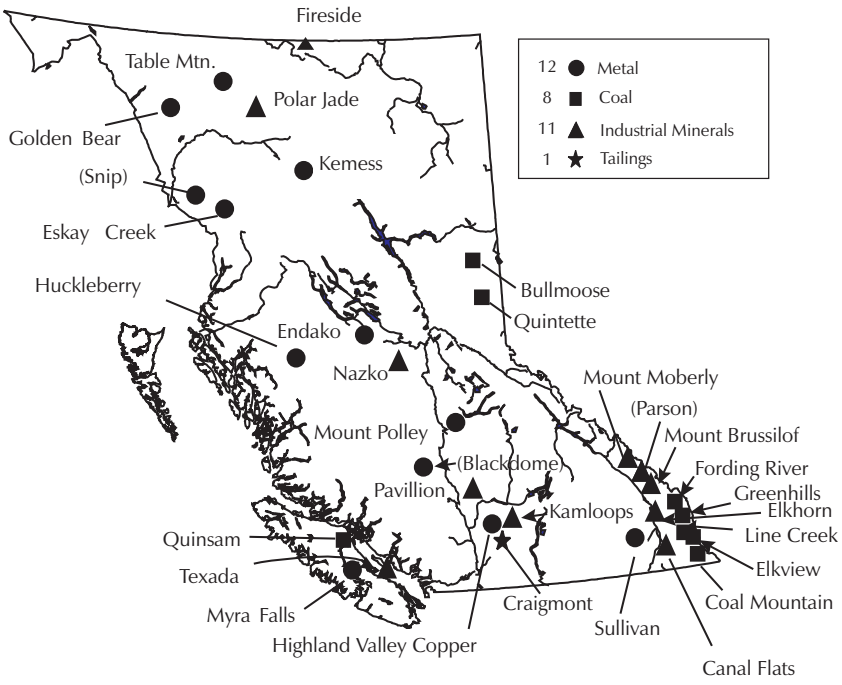

**Solid mineral production value in British Columbia: 1988 to 1999.**

*Figure 6 ...*




**Forecast value of solid mineral production in British Columbia; by percentage of total value - 1999**

*Figure 7 ...*




**Operating Mines in British Columbia - 1999**

at **Myra Falls** and **Highland Valley Copper** reduced their silver production.

- Zinc production in 1999 is forecast to be 120.4 million kilograms worth $210.1 million, and lead output is forecast to be 39.8 million kilograms valued at $30.2 million. This is a 27% decrease in production for zinc, and a 40% increase for lead. The decrease in zinc production is primarily due to the temporary closure of the **Myra Falls** mine.
- Metallurgical coal, produced from five mines in the southeast, two in the northeast and one on Vancouver Island, is the most important mineral commodity to the British Columbia economy. Clean coal production in 1999 is expected to total about 24.6 million tonnes, with a forecast value of approximately $950.6 million, or approximately 35.1% of the total solid mineral production. The reported value is at the mine portal and does not include rail and port costs, which are paid by the customer.
- The forecast value of structural materials at approximately $416.4 million, and of industrial minerals at approximately $51.4 million, represents the status quo for the former and an 11% increase over 1998 for the latter. There are approximately 1100 construction aggregate operations and 40 industrial minerals mines in the province. Limited mining and/or processing was conducted at the **Fireside**, **Monteith Bay**, **Cassiar**, **Willow Creek**, **Pellaire** and **Jubilee Mountain** projects.

## *OPERATIONS*

### *Metal Mines*

The **Eskay Creek** massive sulphide, underground gold-silver mine, owned and operated by Homestake Canada Inc., is the fifth largest silver producer in the world and one of the highest grade gold and silver deposits. Direct shipping ore is blended on site (approximately 265 tonnes/day), trucked to load-out facilities at Stewart and Kitwanga for shipping to smelters in Japan and Quebec. In addition, the gravity flotation mill, with throughput between 165 to 235 tonnes/day, produces precious metals in high-grade concentrates, with approximately 62% recovered in the gravity circuit and 38% by flotation. The mill was commissioned on January 1, 1998 to process lower grade ore from the NEX and 109 zones, which carry less deleterious elements than the 21B zone. Production for 1999 is forecast by the company to be approximately 9990 kilograms (321 200 oz) of gold and 432 340 kilograms (13.9 million oz) of silver, at a total cash cost of US$130 per ounce of gold equivalent. Proven and probable reserves, estimated

**1999 FORECAST VALUE OF SOLID MINERAL PRODUCTION IN B.C.**

| Commodity | Quantity (millions) | C$ Value (millions) | Percentage of Total Value |
|---|---|---|---|
| **METALS** | | | |
| Gold | 25.5 g | 338.8 | 12.9% |
| Silver | 524 g | 132.3 | 5.1% |
| Copper | 117.7 kg | 410.9 | 15.7% |
| Lead | 39.8 kg | 30.2 | 1.2% |
| Zinc | 120.4 kg | 210.1 | 8.0% |
| Molybdenum | 6.8 kg | 58.5 | 2.2% |
| Other Metals | | 20.0 | 0.8% |
| **Total: Metals** | | **1200.8** | 45.9% |
| **COAL** | | | |
| Metallurgical Coal | 23.25 t | 919.8 | 35.1 |
| Thermal Coal | 1.34 t | 30.8 | 1.2 |
| **Total: Coal** | **24.6 t** | **950.6** | 36.3% |
| **OTHER** | | | |
| Industrial Minerals | | 51.4 | 2.0% |
| Structural Materials | | 416.4 | 15.8% |
| **Total: Solid Minerals** | | 2619.2 | 100.0% |

Note: Prices are F.O.B. for metals and **ex-minesite for coal**.
Source: MEM Stats. & NRCan.

by the company as of January 1, 1999, were 1 355 965 tonnes grading 57.5 g/t Au and 2493 g/t Ag. The total of past production, reserves and resources at Eskay Creek is about 7 million ounces of gold equivalent.

During 1999, over 14 000 metres of exploration drilling was completed at the minesite. Targets included the 21C zone (in-fill), the West Limb area on the Kay claims (down-dip potential), the East Limb area, 21A zone (in-fill), and the down-plunge potential to the north of the NEX and HW zones. Development of the 21C footwall rhyolite zone will lead to increased production of milling ore in 2000 and justify expansion of mill capacity from 165 to 250 tonnes per day. Exploration has increased the size of the HW, Mud and Rhyolite zones; the mine currently has a higher reserve base than at mine opening.

Reserves in the mesothermal gold vein at the **Snip** mine, owned and operated by Homestake Canada Inc., were exhausted in 1999 and the mine closed permanently in the second quarter. Reclamation was expected to be completed by the end of the year, with a small amount of residual production during final clean-up. In November, 1998, the mine produced its one millionth ounce (31 103 kilograms) of gold since start up in 1991. At an average daily mill throughput of 400 to 500 tonnes, the average grade of ore mined over the life of the mine was about 25 g/t Au; total operating cash costs over the last couple of years were around US$200 per ounce gold. Under an agreement with Homestake, International Skyline Gold Corp. and Royal Gold Inc., the Snip mine workings were extended onto the High claims prior to mine closure. Subsequent drilling for an extension of the Twin vein was unsuccessful.

The **Highland Valley Copper** porphyry copper-molybdenum mine, a partnership among Cominco Ltd. (50%), Rio Algom Limited (33.6%), Teck Corporation (13.9%) and Highmont Mining Company (2.5%), is one of the largest operations in the world, ranking fourth or fifth on the basis of daily mill throughput of about 135 000 tonnes. Since the start of the partnership in 1986, over 625 million tonnes of ore have been milled. In 1998, the mine produced 170 000 tonnes of copper and 1800 tonnes of molybdenum in concentrates, at a cash production cost of US$0.68 per pound of copper. Unfortunately, due to low copper prices, the mine was temporarily closed from mid-May until October, 1999. The mine employs nearly 1000 people and, in late August, unionized employees ratified an innovative five-year, risk-sharing labour agreement that ties wages to the price of copper. Reserves, as of January 1, 1999, were estimated by the company at 416 800 000 tonnes grading 0.42% Cu and 0.0087% Mo. [1999 production forecast is 100 000 tonnes (2.2 billion pounds) of copper and 1400 tonnes (3.1 million pounds) of molybdenum in concentrate]

The **Myra Falls** underground mine, located within Strathcona Park on Vancouver Island, has been in production since 1966. It has produced in excess of 21 million tonnes of massive sulphide, copper-zinc-gold-silver ore from a number of separate orebodies along a 6-kilometre northwest trend. As of January 1, 1999, Boliden-Westmin Limited estimated proven and probable reserves at 6 785 000 tonnes grading 1.5% Cu, 7.9% Zn, 0.5% Pb, 1.5 g/t Au and 36.8 g/t Ag, sufficient for approximately eight more years of production. In addition, measured and indicated reserves stood at 5.3 million tonnes grading 7.7% Zn, 1.6% Cu, 0.7% Pb, 2 g/t Au and 56 g/t Ag. Average annual production is projected at 66 000 tonnes of zinc in concentrate; the mine also produces concentrates containing approximately 18 000 tonnes of copper and 700 kilograms of gold. Production for 1999 is forecast at 840 000 tonnes grading 6.5% Zn, 1.5% Cu, 1.32 g/t Au and 25.02 g/t Ag. Average cash costs are expected to be US$0.435 per pound of zinc, net of byproduct credits valued at US$0.258 per pound. The mine was shut down for rehabilitation and underground development for three months; at an estimated cost of US$10 million. Total employment stands at 450 persons; daily mill capacity is 4000 tonnes. As in 1998, exploration expenditures at Myra Falls in 1999 were the largest in the province, and included over 14 000 metres of underground drilling. The main target is the Marshall zone, situated on the H-W horizon, west of the Battle zone. Boliden also tested a target just east of the H-W deposit, the Battle North and Ridge zones of the Battle–Gap mine. Longer term exploration targets include the SW Frontier zone, west of the Lynx deposit, and the South Flank area, just south of the mined-out Myra deposit. Future work will require opening up the Lynx mine to allow drifting and drilling from the 15 level. Boliden has opened an exploration office in Campbell River and is examining mining opportunities on Vancouver Island.

At the **Golden Bear** mine, a Carlin-type deposit, Wheaton River Minerals Limited and North American Metals Corporation completed a very successful third year of seasonal heap-leaching (approximately three summer months). The mine employs 65 persons. Production during 1999 was 2227 kilograms (71 600 oz) of gold, at a cash cost of US$159 per ounce. A total of 390 434 tonnes grading 5.63 g/t Au was mined from the Ursa zone pit and stacked on the Totem Creek heap-leach pad. In addition, 155 551 tonnes grading 3.10 g/t Au, previously stockpiled from the Kodiak A deposit, were also stacked on the Totem Creek pad. The Fleece Bowl leach pad contributed 57 kilograms (1831 oz) to production. Recoveries of gold from the Totem Creek and Fleece Bowl leach facilities were 78.3% and 92.4%, respectively. During 1999, an eight-hole, 1200-metre drilling program tested three target areas: the northerly extension of the Ursa deposit along the projected trace of the Ursa fault, the South Zone, and the 1700-metre

level below the Kodiak A zone, at the same level as the Kodiak B and Ursa deposits. Plans for the year 2000 include mining and leaching of the approximately 300 000 tonnes of ore remaining in the Ursa zone, and further leaching of about 35 000 tonnes of lower grade Kodiak A ore on the Totem Creek pad. Underground work will begin on the Kodiak B deposit, which is expected to yield about 183 900 tonnes of refractory ore grading 8.7 g/t Au over the next two years.

Royal Oak Mines Inc. commenced commercial production at its **Kemess** porphyry gold-copper mine, 300 kilometres northwest of McKenzie, in October, 1998. The mine employs approximately 400 workers. The capital cost of the project was $490 million (US$325 million), including a new 230-kilovolt transmission line from Mackenzie to the minesite. Resources at start-up were estimated at 200.4 million tonnes grading 0.22 % Cu and 0.63 g/t Au. After being unable to restructure a debt of more than $600 million, Royal Oak was placed in receivership in April, 1999. In October, Northgate Exploration Ltd. reached an agreement with PricewaterhouseCoopers, the interim receiver, to purchase the Kemess mine for about US$180 million. Closing of the transaction is expected by January 2000 and is conditional on court approval. Financing for the deal is expected to be arranged by Trilon Financial Corp. Resources estimated by Royal Oak as of January 1, 1999 were 192 918 000 tonnes, grading 0.22% Cu and 0.63 g/t Au. Four different ore types (leached cap, supergene, transitional and hypogene) are mined separately from a starter pit developed on the Kemess South orebody. Milling treats each ore type individually, in batches, to maximize metal recoveries. Since the spring, operational efficiencies have improved significantly, especially in the mill. Production for 1999 is forecast around 6220 kilograms (200 000 oz) of gold and 22 700 tonnes (50 million pounds) of copper.

The **Mount Polley** porphyry gold-copper mine, owned and operated by Imperial Metals Corporation (52.5%) and SC Minerals Canada Ltd. (47.5%), a wholly owned subsidiary of Sumitomo Corporation of Japan, operated at a daily milling rate of 19 000 tonnes. Production for 1999 is forecast at 3110 kilograms (100 000 oz) of gold and 16 000 tonnes (35 million pounds) of copper. Resources as of January 1, 1999 were estimated by Imperial at 76 470 300 tonnes grading 0.3% Cu and 0.47 g/t Au. During the first nine months of 1999, the grade of feed from the Cariboo and Bell pits averaged 0. 339% Cu and 0.603 g/t Au. Metal recoveries for the same period averaged 67.4% for copper and 76.5% for gold, both up significantly from 1998 levels because of a lower than anticipated oxide/sulphide ratio of ore mined and increased mill efficiencies. During 1999 Imperial Metals conducted exploration drilling north and east of the Bell pit and at depth within and immediately south of the Cariboo pit. Several holes intersected ore-grade mineralization and additional drilling is planned.

At the **Huckleberry** porphyry copper-molybdenum open-pit mine, Huckleberry Mines Ltd., which is owned by Princeton Mining Corporation (50%) and a consortium for Mitsubishi Materials Corporation, Dowa Mining Company Ltd., Furakawa Company Ltd. and Marubeni Corporation (50%), milled approximately 20 300 tonnes of ore daily. Mill feed from the East zone pit averaged 0.602% Cu and 0.019% Mo; recoveries for copper and molybdenum were 90.99% and 39.65%, respectively. Later in 1999, mining ceased in the East zone pit and began in the Main zone pit. At start-up (October, 1997), the mine was forecast to produce 28 740 tonnes of copper, 180.4 kilograms (5800 oz) of gold, 9390 kilograms (302 000 oz) of silver and 545 tonnes of molybdenum annually, over a mine life of 16 years. Cash costs, net of byproduct credits, were projected to be US$0.65 per pound of copper. Resources estimated by Imperial Metals as of January 1, 1999 were 80 754 000 tonnes grading 0.5% Cu, 0.014% Mo, 0.06 g/t Au and 2.73 g/t Ag.

At the **Table Mountain** gold mine, owned by Cusac Gold Mines Ltd., shipments from the recently discovered East Bear mesothermal vein totalled approximately 21 700 grams (698 oz) of gold. Ore from development of this vein on the east side of the Erickson fault, was stockpiled during late 1998 and processed in early 1999. The mill suspended operations in the spring; no further mining or exploration was conducted. A pre-feasibility study completed by Cusac in 1998 estimated that the "old" tailings pond (1989 to 1992) contains 700 880 tonnes grading 1.25 g/t Au. Also, late in 1998, Cusac optioned the adjacent Taurus gold property from International Taurus Resources Inc. The company estimates that it contains a resource of 13.9 million tonnes grading 1.01 g/t Au. During 1999, Cusac completed a trenching and sampling program east of the 88 Hill zone in an attempt to define higher grade veins.

Cominco Ltd.'s **Sullivan** sedimentary exhalative, zinc-lead-silver mine is expected to maintain its current rate of production to the mine's closure at around the end of 2001. Sullivan supplies 40% of the zinc concentrate and 80% of the lead concentrate treated in the Trail metallurgical complex; the remainder comes from Cominco's Red Dog mine in Alaska and a number of smaller operations in North America. Since 1923, when the Sullivan concentrator started treating ore, approximately 146 million tonnes of ore grading 6.2% Pb and 5.6% Zn have been milled; about 11 million tonnes of lead concentrate and 13.8 million tonnes of zinc concentrate have been produced and sold to Trail. At today's metal prices, production to the end of 1998 from Sullivan represents a total value in excess of $18 billion. These last years of mine life have focused on pillar recovery and ore remnants after 89 years of production. Resources estimated by the company as of January 1, 1999 were 6 100 000 tonnes grading 6.6% Zn, 3.7% Pb and 20 g/t Ag. During 1999, underground drilling continued to evaluate the

remaining resources, and the feasibility of recovering a small zone of mineralization in the open pit was tested.

At the **Endako** porphyry molybdenum mine, Thompson Creek Metal Company (75%) and Nissho Iwai (25%) continue milling at a rate of approximately 25 500 tonnes per day, with feed blended from pit material grading 0.078% Mo and stockpiled material grading 0.056% Mo. Pit ore is mined from the upper benches at the northeast corner of the Endako pit. Endako was shut down for one month, as a means of cutting costs and reducing market supply. In early 2000, pit ore is expected to come from the long-inactive Denak West pit. Work on the installation of the in-pit crusher, bought from the Island Copper mine in 1998, and the conveyor ramp continues. During 1998, approximately 5120 tonnes of molybdenum were produced from 9.8 million tonnes of ore. Mine life is estimated at eleven years.

Claimstaker Resources Ltd. (50%) and Jipangu Inc. (50%) commenced commercial production at their **Blackdome** gold mine on October 10, 1998. Between 1986 and 1991 this epithermal vein system produced 6975 kilograms (224 234 oz) of gold and 2370 kilograms (76 242 oz) of silver from 305 615 tonnes of ore. Claimstaker acquired the mine in 1993; Jipangu became involved in 1998. In late 1998, the mine produced approximately 41.3 kilograms (1327 oz) of gold and 134 kilograms (4308 oz) of silver. Unfortunately, the mine was closed in May, 1999 due to the drop in gold prices.

During 1999, Taseko Mines Ltd. completed its acquisition of the temporarily-closed, **Gibraltar** porphyry copper-molybdenum mine from Boliden Limited. Taseko intends to keep the 37 000 tonne-per-day open-pit operation on standby until copper prices improve. The company also believes that the acquisition will enhance the development prospects for its Prosperity porphyry gold-copper deposit. Resources estimated by Gibraltar Mines as of January 1, 1999 were 148 685 000 tonnes grading 0.305% Cu and 0.010% Mo, sufficient to sustain mining for another twelve years. Since 1972, annual production at Gibraltar averaged 34 050 tonnes of copper in a 28% concentrate, 2270 tonnes of copper cathode from solvent extraction - electrowinning, and 318 tonnes of molybdenum in concentrate. An exploration drilling program, originally planned for late 1999, has been deferred until 2000.

Kinross Gold Corporation's **QR** skarn gold mine was placed on a care and maintenance program on March 1, 1998, primarily due to low gold prices and high operating costs. An estimated 3980 kilograms (128 000 oz) of gold were recovered from 1 063 000 tonnes of both underground and open pit ore between June, 1995 and April, 1998. Reserves estimated by the company as of January 1, 1999 were 320 000 tonnes grading 5.08 g/t Au. During 1999, Bigh Valley Resources Inc. conducted negotiations with Kinross to buy the mine.

### *Coal Mines*

Total production of clean coal from eight operations in 1999 is estimated at about 24.6 million tonnes, approximately 23.25 million tonnes metallurgical and 1.34 million tonnes thermal. The value of production (ex-minesite) is estimated at $919.8 and $30.8 million respectively, and accounts for approximately 36.3% of British Columbia's total solid mineral production. About 48% of the total metallurgical coal exports go to Japan and the rest to over twenty other countries. After nearly two years of decreasing GDP, the Japanese economy is projected to grow 0 to 0.5% in 1999. Coal tonnage imported by the steel mills has decreased since 1997, but more importantly the mix has changed. In 1997, 48% of Japan's coal imports were semi-soft coking coal (*i.e.* lower price and quality); in 1999 this percentage is over 55%. The Canadian mines rely on exporting the higher priced, prime coking coal to Japan to maintain the highest possible average price for all their exports. The export market is affected by an oversupply of premium coking coals, but also by increased shipments from China. In previous years, the quality of the Chinese product was poor and most steel mills mixed small percentages with their own high quality coke. Recently, despite old technology, the quality has improved, in part as a result of excess coke-oven capacity, which permitted longer coking times. The average price of coal sold FOB out of British Columbia in 1999 is estimated at C$56 per tonne; this price is biased by prices from the northeast which have not fallen as far as world prices. Total expenditures on exploration at existing coal mines are forecast to be approximately $1.57 million in 1999, a 57% decrease from 1998. Most expenditures (92.4%) were on in-pit drilling to improve short-term mine plans; the remainder was spent on exploration outside mine leases.

At the **Quinsam** mine on Vancouver Island, Quinsam Coal Corporation expects to produce about 0.39 million tonnes of thermal coal in 1999. This tonnage is sold to local cement plants. In 1998, the mine sold 0.71 million tonnes, but with the collapse of thermal coal prices it was not able to compete in the international market. The mine has drastically reduced the work force to 30 people, from 240 two years ago. The mine is profitable, operating with the reduced tonnage and work force, but carries a large debt as a result of improvement projects. It is under court protection from its creditors until the end of February, 2000.

In the Elk Valley, **East Kootenay** region, approximately 2000 people are employed at five operating mines, with a gross payroll of $150 million per year. The mines provide an estimated 6000 direct and indirect high-paying jobs.

The **Fording River** mine, operated by Fording Coal Limited, is the largest coal mine in British Columbia. Despite the difficult market, the tonnage shipped in 1999 is expected to be similar to 1998, at about 8.3 million tonnes. Mining is concentrated in the Eagle Mountain and Henretta pits. In-pit exploration drilling totalled about 2000 metres. There was a three-week shutdown in the summer, but no permanent change to the labour force.

At the **Greenhills** mine, Fording Coal Limited expects to ship approximately 4.2 million tonnes in 1999, slightly more than in 1998. There was a three-week shut down in the summer but no permanent changes to the work force. In-pit exploration drilling totalled 3032 metres. In one month a record of 453 000 tonnes of clean coal were produced; this represents a productivity of slightly over 10 000 tonnes per man year.

The **Coal Mountain** mine, operated by Fording, is expected to produce 2.1 million tonnes in 1999, an increase from 1.88 million tonnes in 1998. Approximately 0.45 million tonnes of the total is thermal coal, mostly sold to Kepco on a spot sale. About 170 people are employed on a five day week. In-pit exploration drilling totalled 10 463 metres. Another 4100 metres of drilling was completed on the company's **Loop Ridge** property north of the mine and adjacent to the McGillvray pit.

In 1999, Luscar Ltd. bought the assets of Manalta Coal Ltd. and now operates the **Line Creek** mine. The mine expects to sell 2 million tonnes and 0.5 million tonnes of metallurgical and thermal coal respectively. As a result of the reduced tonnage, the plant is not operating full time. Most of the mining is now concentrated in the North pit with the original South pit largely mined out, except for the possibility of some additional reserves along its eastern edge. The new Horseshoe Ridge pit is now active on a year-round basis. In the summer, the labour force was reduced by 80 unionized workers and 15 staff in a move to improve mining costs and as a reflection of reduced sales. Since then there has been some improvement and 15 union personnel have been rehired. In-pit exploration drilling totalled 9000 metres.

At the **Elkview** mine, Teck Corporation expected to ship approximately 3 million tonnes of product. As a result of poor sales prospects in the first part of the year, the company and union initiated a plan of reduced work weeks and a number of one-week shutdowns. However, with improved sales, shutdowns were cancelled. The present work force is 495. Approximately 7000 metres of in-pit exploration drilling were completed in 66 holes.

In the **Northeast**, Teck Corporation is supplying metallurgical coal exclusively to Japan from the Quintette and Bullmoose open-pit mines near Tumbler Ridge, under an

## Mine Production and Reserves 1999

| | Mine | Operator | Deposit Type | Forecast Production | Reserves (Jan. 1, 1999) |
|---|---|---|---|---|---|
| **Metals** | | | | | |
| | Endako | Thompson Creek Mining, Ltd. & Nissho Iwai Moly Resources Inc. | Porphyry molybdenum | 3 975 000 kg Mo | |
| | Eskay Creek | Homestake Canada Inc. | Epithermal VMS | 9990 kg (321 200 oz) Au, 432 340 kg (13.9 million oz) Ag | 1 355 965 tonnes at 57.5 g/t Au, 2493 g/t Ag |
| | Golden Bear | Wheaton River Minerals Ltd. | Carlin | 2227 kg (71 600 oz) Au | 703 000 tonnes at 7.4 g/t Au |
| | Huckleberry | Huckleberry Mines Ltd. | Porphyry copper | 36 000 000 kg Cu, 400 000 kg Mo | 80.7 million tonnes at 0.501% Cu, 0.014% Mo, 0.061 g/t Au, 2.7 g/t Ag |
| | Kemess | Northgate Exploration Ltd. | Porphyry gold-copper | 6620 kg (200 000 oz) Au, 22 700 tonnes (50 million lbs) Cu | 192.9 million tonnes at 0.63 g/t Au and 0.22% Cu |
| | Mount Polley | Imperial Metals Corporation | Porphyry gold-copper | 3110 kg (100 000 oz) Au, 16 000 tonnes (35 million lbs) Cu | 76.5 million tonnes at 0.47 g/t Au and 0.3% Cu |
| | Snip | Homestake Canada Inc. | Mesothermal shear vein | 1350 kg (43 390 oz) Au | Reserves exhausted, closed May '99 |
| | Table Mountain | Cusac Gold Mines Ltd. | Vein | 21.7 kg (698 oz) Au | Shut down |
| | Sullivan | Cominco Ltd. | Sedex | approx. 2 million tonnes | 6.1 million tonnes @ 6.6% Zn, 3.7% Pb, 20 g/t Ag |
| **Industrial Mineral Deposits** | | | | | |
| | Fireside | Fireside Minerals Inc. | Vein | 23 000 tonnes of barite | |
| | Giscome | Pacific Lime Products Ltd. | Limestone | 10 000 tonnes | |
| | Nazko | Canada Pumice Corporation | Volcanic cinder | 10 000 tonnes | est. 45 million tonnes |
| | Mount Brussilof | Baymag Mines Co. Ltd. | Replacement | ~ 200 000 tonnes magnesite | |
| | Elkhorn | Westroc Inc. | Evaporite | 500 000 tonnes gypsum | |
| **Coal** | | | | | |
| | Bullmoose | Bullmoose Operating Corp. | Metallurgical coal | 1.3 million tonnes | |
| | Quintette | Quintette Operating Corp. | Metallurgical coal | 2.8 million tonnes | |
| | Coal Mountain | Fording Coal Ltd. | Coal | 2.1 million tonnes | |
| | Elkview | Elkview Coal Corporation | Coal | 3.0 million tonnes | |
| | Fording River | Fording Coal Ltd. | Coal | 8.5 million tonnes | |
| | Greenhills | Fording Coal Ltd. | Coal | 4.2 million tonnes | |
| | Line Creek | Luscar Ltd. | Coal | 2.5 million tonnes | |

## MINE CLOSURES, DEVELOPMENT AND ADVANCED EXPLORATION PROJECTS - 1999

| Company Name | Project | Commodity | Estimated Tonnes (000s) | Estimated Grade | Reference |
|---|---|---|---|---|---|
| **CLOSURES** | | | | | |
| Homestake Canada Inc. | Snip | Au | | | |
| Claimstaker Res. Ltd./ Jipangu Ltd. | Blackdome | Au | | | |
| Highwood Res. Ltd. | Parson | Barite | | | |
| **DEVELOPMENT** | | | | | |
| Monteith Bay Res. | Monteith Bay | Silica | | | Monteith Bay, 1999 |
| Cassiar Mining and Metals Inc. | Cassiar | Asbestos | | | Cassiar, 1999 |
| W.W.C. Consulting Ltd. | Jubilee Mtn. | Barite | | | W.W.C., 1999 |
| Cassiar Coal Company Ltd. | Stitt Creek | Garnet | | | Cassiar Coal, 1977 |
| IG Machine & Fibres Ltd. | Ashcroft | Basalt | | | IG Machine, 1999 |
| IG Machine & Fibres Ltd. | Slesse | Limestone | | | IG Machine, 1999 |
| $C_2C$ Mining Corp. | Ranchlands (Z-2) | Zeolite | | | $C_2$2 Mining, 1999 |
| Continental Lime Ltd. | Var | Limestone | | | Continental, 1998 |
| Pacific West Coal Ltd. | Tulameen | Coal | | | Pacific West, 1999 |
| **ADVANCED PROJECTS** | | | | | |
| **Porphyry (and related) Deposits** | | | | | |
| Taseko Mines Ltd. | Prosperity | Cu, Au | 633 000 | 0.253% Cu<br>0.466 g/t Au | Taseko Mines, 1998 |
| American Bullion Minerals Ltd. | Red Chris | Cu, Au | 118 900 | 0.584% Cu,<br>0.47g/t Au | American Bullion, 1998 |
| **Massive Sulphide Deposits** | | | | | |
| Redfern Res. Ltd. | Tulsequah Chief | Cu, Pb, Zn Au, Ag | 7910 | 1.27% Cu<br>6.35% Zn<br>1.18% Pb<br>2.42 g/t Au<br>100.9 g/t Ag | Redfern, 1996 |
| **Vein Deposits** | | | | | |
| North American Metals Corp. | Red Mt | Au | 1922 | 9.8 g/t Au | Royal Oak, 1996 |
| Misty Mountain Gold Ltd. | Specogna | Au | 33 500 | 2.11 g/t Au | Misty Mt, 1998 |
| International Wayside Gold Mines Ltd. | Cariboo Gold Quartz | Au | 3109 | 3.5 g/t Au | Int'l Wayside, 1998 |
| Canarc Res. Corp. | Polaris-Taku | Au | 3270 | 13.7 g/t Au | Canarc, 1997 |
| Int'l Taurus Res Inc./ Cusac Gold Mines Ltd. | Taurus | Au | 13 900 | 1.01 g/t Au | Int'l Taurus, 1996 |
| Doublestar Res Ltd | Fandora | Au | 180 | 10.3 g/t Au | Doublestar, 1999 |
| Bul River Mineral Corp | Bull River | Cu, Ag, Au | | | |
| **Skarn/Manto Deposits** | | | | | |
| Imperial Metals Corp./ Peruvian Gold Corp. | Silvertip (Midway) | Zn, Pb, Ag, Au | 2570 | 8.8% Zn<br>6.4% Pb<br>325 g/t Ag<br>0.63 g/t Au | Imperial Metals, 1998 |
| Int'l Jaguar Equities Inc. | Pellaire | Au | bulk sample | | Int'l Jaguar, 1998 |
| **Industrial Mineral Deposits** | | | | | |
| Ava Res. Ltd. | Wishaw | Quartzite | | | Ava, 1995 |
| Int'l Minerals Res. Ltd. | Superior | Graphite | | | Int'l Mineral, 1999 |
| Westroc Inc | Kootenay West | Gypsum | | | Westroc, 1999 |
| **Coal Deposits** | | | | | |
| Luscar Ltd. | Telkwa | Coal | 50 000 | thermal | Manalta, 1997 |
| Pine Valley Coal Ltd. | Willow Creek | Coal | 15 600 | metallurgical | Pine Valley, 1997 |
| Western Canadian Coal Corp. | Belcourt | Coal | 103 200 | metallurgical | Western Coal, 1998 |

agreement with a consortium of eight Japanese steel mills, until March 2003. The agreement calls for 3 million tonnes and 1.55 million tonnes annually from the Quintette and Bullmoose mines respectively.

The **Bullmoose** mine (Teck Corporation, 60.9%; Rio Algom Limited, 29.1%; Nissho Iwai Coal Development Canada Ltd., 10%), operated by Bullmoose Operating Corp., produced approximately 1.3 million tonnes from the South Fork pit in 1999. In response to lower sales, the mine has reduced its labour force to about 245.

The **Quintette** mine, operated by Quintette Operating Corp. and managed by Teck Corporation, is forecast to ship approximately 2.8 million tonnes in 1999. The workforce has been reduced to about 500 people, after layoffs in the summer. Geotechnical drilling in the phase 1 Mesa pit and in the Babcock area totalled 5417 metres.

### *Industrial Minerals Mines*

British Columbia is producing a wide variety of industrial minerals from more than 40 mines or quarries and interest is increasing steadily. Operations are located mainly in the southern half of the province, close to existing infrastructure and markets. The most economically significant industrial minerals produced are sulphur, magnesite, gypsum, white calcium carbonate, limestone, silica, dimension stone and construction aggregate. Commodities produced in lesser quantities include magnetite, dolomite, barite, volcanic cinder, pumice, clay, fuller's earth and zeolites. Nephrite jade (British Columbia's mineral emblem and a semiprecious stone), fire opal, star sapphire and several other precious minerals are also produced in limited quantities. The annual value of production of all industrial minerals (excluding sand and gravel and crushed rock) is in the order of $51.4 million, accounting for about 2% of the forecast value of solid mineral production in the province in 1999.

**Sulphur**, a byproduct of natural gas, is produced at a number of processing plants in the northeast of the province by West Coast Energy Inc., Petro-Canada Inc., Trans Canada Midstream and Amoco Canada Petroleum Company Ltd. Liquified $SO_2$ and sulphuric acid are also produced at the Trail smelter.

In the Rocky Mountains, Westroc Inc. is producing approximately 500 000 tonnes of gypsum from its **Elkhorn** I and II quarries near Windermere. Reserves are expected to last approximately ten years. During 1999, Westroc conducted a modest exploration program on its **Kootenay West (Koot)** gypsum property, northeast of Canal Flats. Georgia Pacific Canada Inc. is mining **gypsum** from its **Four J** quarry southeast of Canal Flats. During 1999, Georgia Pacific conducted a close-spaced definition drilling program to test the viability of a proposed expansion of its existing quarry. Both Westroc and Georgia Pacific also operate wallboard plants in the Vancouver area; these plants appear largely dependent on imported materials and supplement their raw gypsum needs with recycled gypsum. Lafarge Canada Inc. mines a small quantity of gypsum from its **Falkland** pit for use in its own cement plant near Kamloops.

Baymag Mines Company Limited continued to mine **magnesite** at **Mount Brussilof** at a rate of about 200 000 tonnes annually. Over the last ten years improvements in grade control and systematic blending of magnesite from different parts of the mine resulted in very consistent feed for the sintering plant. The company has two plant sites at Exshaw, Alberta; one produces sintered magnesia, the other comprises a 50 000-tonne capacity, multiple hearth furnace, vertical-kiln and electrofusing installation, which is dedicated to specialty calcined MgO and which produces refractory-grade fused magnesia. Most of the production reaches the market as calcined magnesia; however, a portion of production is further processed to produce high quality fused magnesia, used in refractories.

The **Mount Moberly** and **Horse Creek silica** mines, in the Golden area, account for most of high-grade silica production in British Columbia. The Silica Division of Highwood Resources Ltd. produces approximately 120 000 tonnes at Moberly, for shipment to Springfield, Oregon, Lavington, B.C. and other destinations. The company has developed technology to reprocess some coarse silica waste. Bert Miller Contracting Ltd. mined between 30 000 and 60 000 tonnes from the **Horse Creek** silica mine which is owned by Silicon Metaltech of Seattle. This mine closed down in 1999 as a consequence of the shutdown of the Wenatchee metallurgical grade silicon and ferrosilicon plant. It may reopen later next year. In 1999, Monteith Bay Resources Limited supplied 37 000 tonnes of silica to the Tilbury Cement Ltd. plant in Delta, from its quarry at **Monteith Bay** on western Vancouver Island.

**Limestone** is processed by three cement plants and two lime plants in British Columbia. Although the majority of pulp and paper mills produce their own lime from nearby limestone quarries, some purchase raw material from other sources. The largest production centre is **Texada Island**, where two quarries, the **Gillies Bay** (Texada Quarrying Ltd.) and **Blubber Bay** (Ashgrove Cement) ship some 5 million tonnes annually to customers in British Columbia, Washington, Oregon and California, mainly for cement, chemical and agricultural use. Over a million tonnes of aggregate-grade crushed rock is sold annually as construction aggregate. The Continental Lime Ltd. **Pavilion Lake** plant produces about 200 000 tonnes of lime per year from limestone quarried on site, and the **Kamloops** cement plant of Lafarge Canada Inc. produces about 40 000 tonnes of ce-

ment annually from locally quarried limestone (**Harper Ranch** quarry). Lafarge modernized its plant in Richmond, increasing the capacity to 1 million tonnes of cement. It is expected to take some time before it increases sales sufficiently to operate near the designed capacity of the plant. It is using limestone from Texada Island, coal from Quinsam coal mine and silica mainly from Fraser River sands. Pacific Lime Products Ltd. at Giscome, near Prince George, sells small quantities of limestone to pulp mills in the region.

**White calcium carbonate** is produced from deposits on **Texada Island** (**Vananda** and **Gillies Bay**), **Benson Lake** on Vancouver Island and **Lost Creek** near Salmo. A small limestone producer at **Dahl Lake**, west of Prince George, has been processing old waste rock into decorative aggregate at a rate of 20 000 tonnes per year.

In 1999, Highwood Resources Ltd. completed underground mining and closed the **Parson** mine, one of two British Columbia **barite** producers. In 1998 and 1999, Fireside Minerals Ltd. reactivated open cuts and conducted seasonal mining on the Moose and Bear deposits at its **Fireside barite** quarry, east of Watson Lake. During the year the company processed approximately 18 300 tonnes of ore at its plant in Watson Lake. The products were shipped mainly to Alberta, or used in British Columbia.

Clayburn Industries Ltd. of Abbotsford is processing **fireclay** from **Sumas Mountain** into a variety of refractory bricks and castable refractory products. Small quantities of **flueline pipe** and ornamental and **facing brick** are produced near Abbotsford by Sumas Clay Products Ltd. Western Industrial Clay Products Ltd. in Kamloops supplies approximately half of the **kitty litter** market (and other domestic and industrial absorbents) in western Canada, principally from its **Red Lake diatomaceous earth** property near Kamloops. The company is shipping part of its production overseas. It plans to further diversify its product line into the horticulture market.

**Granite** and **marble** are produced by several companies. Stone-processing plants are operated by Westcoast Granite Manufacturing Inc. in Delta, Margranite Industries in Surrey, Matrix Marble Corporation in Duncan and Garibaldi Granite Group Inc. in Squamish. Margranite is processing nine granite varieties from three quarry sites that are located in the East Anderson River, Beaverdell and Skagit Valley areas. It has doubled its plant capacity by adding a wire saw and hydraulic splitter, and is further expanding its operation to include two state-of-the-art gangsaws. Garibaldi Granite owns a state-of-the art processing plant in Squamish and is processing three granite varieties from four quarry sites in the **Squamish** area. It also produces some specialty products from columnar basalt and rhyolite. San Pedro Stone Inc., a subsidiary of Garibaldi Granite, operates black granite and pink granite quarries in **Grand Forks**. The operations at Squamish and Grand Forks are part of a joint venture with Pender Capital Corp. Westcoast Granite Manufacturing installed a second gangsaw a few years ago, doubling its plant capacity. Quadra Stone Ltd. started production of Cascade Coral blocks from a new quarry near **Beaverdell**. Other active quarry sites include: Tsitika Stone Industries on northern Vancouver Island (grey granite); Yoho National Stone Inc. near Sayward; and, Adrea Natural Stone Supplies Ltd. on Granite Island near Sechelt. Matrix Marble Ltd. was developing a new site near the old **Tahsis Inlet** quarry and owns a marble quarry near Cowichan Lake; however, there was no mining activity in 1999.

**Flagstone** has traditionally been quarried by Revelstoke Flagstone quarries and Begbie Flagstone Ltd., together producing approximately 200 tonnes of mica schist flagstone. Kootenay Stone Centre, in Salmo, is producing a similar quantity of **quartzite flagstone**. One local company produces flaggy sandstone on a small scale near **Port Renfrew** on Vancouver Island. Buff-tan dacitic ash, sold as **flagstone**, ashlar, landscape rock and boulders are produced by L and D Petch Contracting Ltd. on a small scale in the Kelowna area, including **Nipple Mountain**. Since November 1998, the company has mined about 4000 tonnes, and much of it is sold in Washington and Oregon.

**Dolomite** is quarried by IMASCO Minerals Ltd. at Crawford Bay on Kootenay Lake and by Mighty White Dolomite Ltd. near **Rock Creek**. Dolomite is used for soil conditioning, white ornamental aggregate, stucco and roofing, fine aggregate and synthetic marble products.

**Jade** (nephrite) production is currently concentrated in the **Kutcho Creek** and **Serpentine Lake** areas, east of Dease Lake. In 1999, Jade West Resources Ltd. and its affiliated company, Polar Gemstones Ltd. and Frank Plut were the most active producers in that region. Total production was about 200 tonnes. Jade West Resources Ltd. also operates a jade processing facility in south Surrey. The company is currently looking for partners to set up a facility to produce nephrite tiles. In the past, nephrite was also recovered from the old Cassiar Asbestos mine waste dumps (traditionally 50 to 100 tonnes) and sawn for sale on site by Jedway Enterprises, however only a few blocks were recovered in 1998 and sold this year.

Canada Pumice Corporation produced red and black **volcanic cinder** from its **Nazko** quarry west of Quesnel, for markets in the Lower Mainland. Current production is at a rate of about 10 000 tonnes annually. The property hosts a total resource of approximately 45 million tonnes of tephra, tuff breccia and basalt, suitable for processing into marketable products. In 1999, the company bought the former Crownite plant site, adjacent to a rail siding in Quesnel, and

plans to modify it for the processing and bagging of its products. The materials from Nazko are used for landscaping, sporting facilities and growing media. On a small scale, Great Pacific Pumice Ltd. is shipping **pumice** from its **Pum** property on Mount Meager, north of Pemberton.

Limeco Products Division of Highwood Resources Ltd. continues to develop its market, in a variety of agricultural applications in Alberta, for **zeolite** from the **Ranchlands Z-1** quarry near Cache Creek. There was no mining in 1999 as the company relied on stockpiled ore. In 1998, control of the **Z-2** deposit was acquired by $C_2C$ Mining Corporation and by early 1999 zeolite sales began from its Ashcroft processing and packaging plant.

M-Seven Industries Inc. produces about 60 000 tonnes per year of **magnetite** for industrial applications by processing the **Craigmont** tailings on an intermittent basis. The company is supplying most coal mines in western Canada with material for heavy media coal upgrading.

**Pacific Abrasives & Supply Inc.** is producing and processing slag from Grand Forks dumps for a variety of applications but mainly for sandblasting purposes in major shipyards and for roofing granules. Some slag was also shipped from **Anyox** by Tru-Grit Abrasives for use in the cement industry, mainly in the Vancouver area, for roofing granules and some abrasive applications. Cominco is also a major slag producer from operations at its **Trail** smelter. It markets its products mainly for cement production and abrasive applications. The company is converting one of the old furnaces into its second fuming furnace. The use of two furnaces will double the fuming time and result in substantially lower base metal levels in the slag, thereby improving its competitive edge. Slag is also recovered in the Greenwood area and used as one of the raw materials in the production of mineral wool by the **Enertek** plant in **Grand Forks**.

## EXPLORATION HIGHLIGHTS

### *METALS*

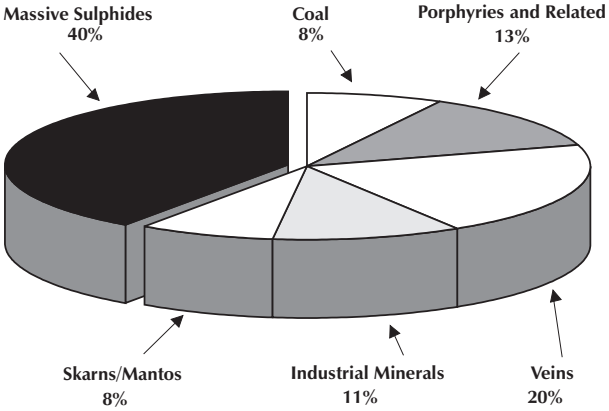
Exploration targets in 1999 were varied (Fig. 8) but, as in 1998, there was a continued emphasis on polymetallic massive sulphide deposits. Exploration for massive sulphides, which include volcanogenic, sedex and subaqueous hot-spring types, accounted for about 40% of expenditures. Mesothermal and epithermal vein targets attracted about 20% of exploration spending. During 1999, advanced and grassroots projects accounted for 32% and 34% of total exploration expenditures, respectively (Figures 3, 4, 9, 10).

The most active area in the province was the southeast, where numerous companies and prospectors explored for sedex deposits. Sedex targets in the vicinity of the Sullivan mine attracted over $2 million in exploration spending, and resulted in over 7500 metres of drilling (*e.g.* **Pakk**, **North Findlay**, **South Findlay**, **Greenland Creek**, **Irishman Creek**, **Pyramid Peak**, **Yahk**, **Car**, **Cruz** and **Smoker**).

Several bulk-sampling projects were carried out (*e.g.* **Jubilee Mountain**, **Mountain Boy**, **Pellaire**, **Fandora** and **Cassiar**). A number of advanced projects are in the Environmental Assessment Process, {*e.g.* **Silvertip** (Midway), **Red Mountain**, **Red Chris**, **Prosperity** and **Bronson Slope**} and Project Certificates are in place for **Mt. Milligan** and **Tulsequah Chief**.

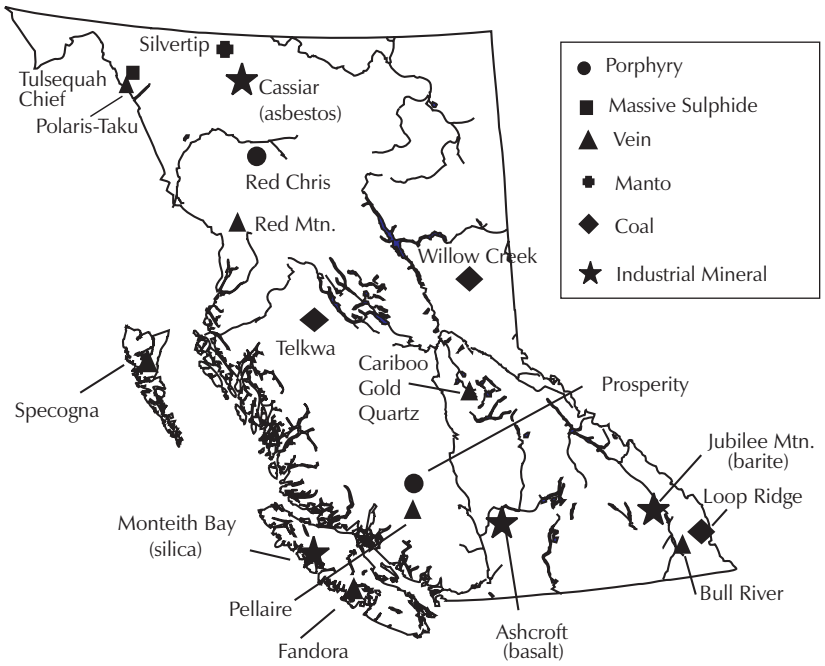
Several major companies renewed or established an exploration presence in the province in 1999. Hudson Bay Exploration and Development Co. Ltd. drilled a number of properties in the **Babine** area to test airborne geophysical anomalies identified in 1997. Late in 1999, it also optioned a large tract of land in the Cariboo where several promising VMS float occurrences have been discovered. Homestake Canada Inc. carried out both detailed and regional exploration programs around the **Eskay Creek** mine. It also examined other areas in the northwest for Eskay Creek style mineralization. Freeport Copper Ltd. (a subsidiary of Freeport-McMoran) optioned the **Zymo** porphyry target west of Smithers and drilled six short holes. Billiton Metals Canada Inc. opened an office in Vancouver and took an interest in the Sullivan camp. Phelps Dodge Corporation of Canada established an office in Vancouver and started fieldwork in 1999. BHP Minerals also re-established one of its three major, world-wide offices in Vancouver.

*Figure 8 ...*




**Exploration targets by deposit type (%) 1999**

*Figure 9 ...*




# Advanced projects, 1999

By *Letter of Intent* dated September 30, 1999, Doublestar Resources Ltd. has agreed to acquire substantially all of Falconbridge Limited's mineral property interests in British Columbia. These include a number of significant resources, for example, **Sustut**, **Catface**, **Ruddock Creek**, **Robb Lake**, **Scotia**, **Hiller** and **Baldwin/McVicar**. Exploration programs on a number of these properties are expected for 2000.

### *Massive Sulphide Deposits*

Base and precious metal rich (sedex, volcanogenic and subaqueous hot-spring) massive sulphide deposits were the most important exploration targets in 1999. The discoveries at **Myra Falls**, **Eskay Creek** and **Tulsequah Chief** in past years testify to the excellent potential for these deposit types. The discoveries and developments at the **Wolverine** and **Kudz Ze Kaya** deposits in Yukon-Tanana Terrane in the Yukon, and the recent success at the **Greens Creek** mine west of Juneau, Alaska, are particularly important because rocks which host these deposits extend into British Columbia.

In March 1998, Redfern Resources Ltd. received a Project Certificate for its **Tulsequah Chief** polymetallic volcanogenic massive sulphide deposit in northwestern British Columbia, northeast of Juneau, Alaska (Fig. 9). Reserves estimated by the company are 7.9 million tonnes grading 6.35% Zn, 1.23% Cu, 1.18% Pb, 2.42 g/t Au and 100.91 g/t Ag. At full production, milling 900 000 tonnes per year, the mine is forecast to produce 52 620 tonnes of zinc, 10 450 tonnes of copper, 4940 tonnes of lead, 81 000 kilograms (2.6 million oz) of silver and 1910 kilograms (61 400 oz) of gold annually, over a minimum mine life of ten years. The capital cost of the project is estimated at $160 million and the operation would employ about 260 persons. Access is proposed via a 160-kilometre restricted road from Atlin. Redfern worked on its SUP (Special Use Permit) for road construction, conducted ongoing site studies and is seeking project financing.

Several sedex targets were explored in the search for a Sullivan-type deposit in the Purcell Basin of southeastern British Columbia. At the **North Findlay** project 40 kilometres north of Sullivan, Billiton Exploration Canada Ltd., under an option agreement with Eagle Plains Resources Ltd., completed a six-hole, approximately 1700-metre diamond drilling program. The drilling was conducted in the area around Tourmalinite Ridge, where a drill hole completed by Kennecott Canada Exploration Inc. in 1998 intersected alteration and lead-silver enrichment over 105.2 metres. Within this interval, 46 thin, stratabound mineralized horizons were encountered, all believed to be within the upper part of the Aldridge Formation. Three of the six holes drilled in 1999 intersected similar mineralization along strike from the 1998 intersection. At the adjoining **South Findlay** project, Rio Algom Exploration Inc., under an option agreement with Eagle Plains Resources Ltd., completed geological mapping in preparation for a diamond drilling program next year. At the **Greenland Creek** project, which adjoins the South Findlay property on the southwest, Kennecott Canada Exploration Inc., also under a joint venture agreement with Eagle Plains Resources Ltd., conducted comprehensive stream sediment, soil geochemical surveys and geological mapping. Work on the latter two projects is focused on the Lower-Middle Aldridge (LMC) or "Sullivan horizon". At the **Pyramid Peak** property, approximately 20 kilometres west of Sullivan, Rio Algom Exploration Inc., under an option agreement with Abitibi Mining Corp., completed one deep diamond-drill hole to test the LMC Sullivan-horizon. At the **Pakk** property, approximately 35 kilometres southeast of Sullivan, Chapleau Resources Ltd., under an option agreement with Super Group Holdings Ltd., conducted a modest diamond drilling program. Short holes were drilled on the Upper Jack, Lower Jack, Polly and

Sinclair Vent sedex showings, all targeting the LMC Sullivan-horizon.

A number of targets with zinc potential were examined in the Kootenay Arc during 1999. Indo Metals Ltd., under an option agreement with Cominco Ltd., engaged Lakefield Research Limited of Ontario to evaluate potential techniques for treatment of zinc oxide minerals from the **Oxide** property. Zinc and lead oxide mineralization has been traced for a minimum strike length of 1.4 kilometres. Geological mapping and sampling was undertaken in preparation for drilling.

During 1999, Rimfire Minerals Corp. completed a nine-hole, 574-metre diamond drilling program on its 21-kilometre-long **RDN** property, approximately 40 kilometres north-northwest of the Eskay Creek mine. The drilling targeted two styles of mineralization: Eskay Creek style stratiform massive sulphides at the Jungle anomaly and Marcasite gossan, and structurally controlled, quartz-sulphide veins at the Main/Club showings, Baseline vein and Waterfall vein. The property is underlain by Early to Middle Jurassic stratigraphy, similar to that hosting the Eskay Creek Au-Ag deposit. Drilling on the Upper and Lower Marcasite gossans confirmed that the stratigraphic section is conformable and upright. Although no significant gold intercepts were encountered in these holes, the presence of trace elements (*i.e.* As, Hg, Sb) and a stratigraphic setting similar to that at Eskay Creek is encouraging.

The **Lottie** VMS float prospect, 15 kilometres north of Wells, was discovered by prospecting in 1998. Eureka Resources Inc. conducted a limited exploration program in the area of the discovery and located many angular blocks of massive sulphide material grading up to 24% copper. Andesitic volcanics and cherty sediments of the Antler Formation (Slide Mountain Terrane) underlie the area. Late in 1999, the property, which also includes the Bow and Tow VMS float prospects to the north, was optioned to Hudson Bay Exploration and Development Co. Ltd.

Barker Minerals Ltd. discovered a new volcanogenic massive sulphide occurrence on its **Frank Creek** property, southeast of Cariboo Lake. The lens of massive sulphide, comprised mainly of fine-grained pyrite with subordinate chalcopyrite, sphalerite and galena, is spatially associated with phyllites and felsic pyroclastic rocks of the Snowshoe Group (Barkerville Terrane).

Hudson Bay Exploration and Development Co. Ltd. drilled geophysical anomalies identified by an airborne survey in 1997 on the **Len** and **Ful** claims in the Babine district.

### *Precious Metal Bearing Veins and Bulk-mineable Deposits*

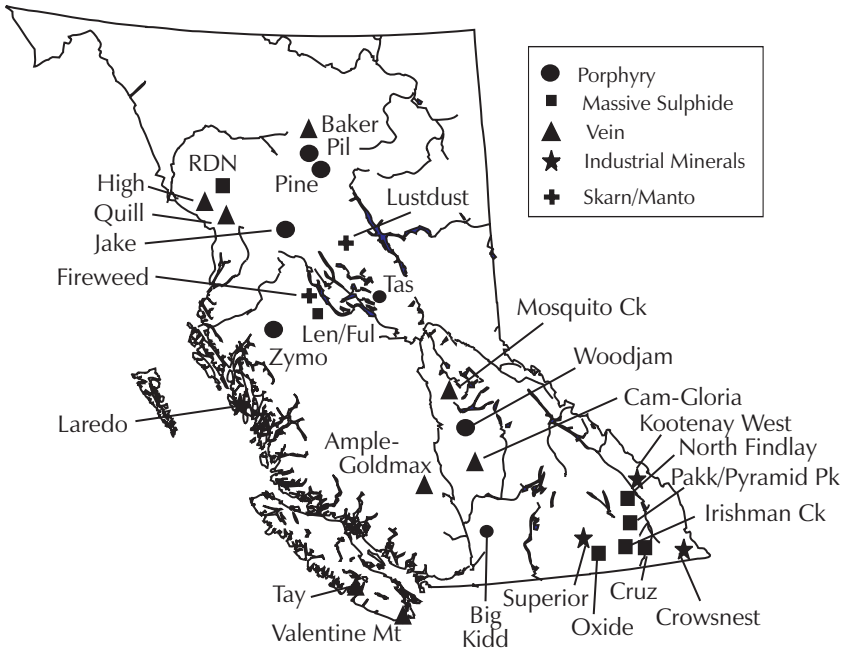
Near the town of Wells, famous for both its lode and placer gold production, International Wayside Gold Mines Ltd. continued to explore the auriferous mesothermal vein system on the former **Cariboo Gold Quartz** mine. During 1999, the company completed 18 diamond-drill holes on the BC vein, for a total of 31 holes over a strike length of approximately 520 metres. The northwesterly trending, steeply northeast-dipping auriferous quartz-pyrite vein has an average width of approximately 2 metres. A preliminary mineral inventory for the zone west of the BC shaft to the Goldfinch fault, and a portion of the American extension, has recently been completed by the company. It estimates a total resource of 55 825 tonnes grading 9.84 g/t Au over a length of 230 metres on the BC vein. In July 1997, the company estimated a mineral resource of approximately 3 million tonnes grading 3.5 g/t Au, at a cut-off grade of 1 g/t Au, above the 1200 level of the mine in the Pinkerton, Sanders and Rainbow zones. International Wayside planned to make an application under the B.C. Environmental Assessment Act in December for a proposed 2720-tonne-per-day open-pit and underground operation, with a projected capital cost of $60 million. At the nearby **Mosquito Creek** gold mine, Island Mountain Gold Mines Ltd., under an option agreement with International Wayside Gold Mines Ltd., carried out partial rehabilitation of the 4400 level, as well as a limited underground and surface diamond drilling program testing for both replacement and vein mineralization.

At its **Baker** mine in the Toodoggone district, Sable Resources Ltd. identified five new alteration zones on the Ridge Zone, located northeast of the mined out A vein. Geophysical and geochemical surveys, extensive backhoe trenching and follow-up diamond drilling were conducted in an attempt to locate the source of high-grade gold and silver-bearing quartz float, found in 1998. Late in 1999, the Beck vein was exposed by trenching. Further drilling is planned for 2000.

During the fall of 1999, Teck Exploration Ltd., under an option agreement with Camille Berube, completed a seven-hole, 836-metre diamond drilling program on the **Cam-Gloria** gold-quartz vein prospect hosted in mid-Cretaceous rocks, west of Adams Lake. Trenching, drilling, mapping and geophysical surveys on this possible pluton-related gold target have traced the quartz veins and alteration over a strike length of 700 metres and a width of 40 metres.

At the **Ample-Goldmax** meso- thermal vein-gold property 8 kilometres west of Lillooet, Gold-Ore Resources Ltd. completed a nine-hole, 907-metre diamond drilling program testing for extensions of high-grade gold mineralization intersected by Homestake Canada Inc. during drilling

*Figure 10 ...*




**Major Exploration Projects - 1999**

in 1996 and 1997. The combined results of all drilling indicate a moderate to high-grade, northeast-plunging zone, 50 to 100 metres wide, 1.5 to 8 metres thick and at least 200 metres long, occurring at the thrust-faulted contact between Cayoosh assemblage phyllitic sediments (footwall) and greenstones of the Bridge River Group (hangingwall). Nearby, Gold-Ore also carried out trenching on Gary Polischuck's newly discovered **Aumax** high-grade silver-gold prospect.

At the **Pellaire** (formerly Lord River) gold telluride deposit in the Taseko Lakes area, International Jaguar Equities Inc. conducted a bulk-sampling program and additional metallurgical test work. Approximately 1400 tonnes of material was extracted from veins 3, 4 and 5 for eventual shipment to the Trail smelter. To the northwest, International Jaguar completed three diamond-drill holes totalling 667 metres on its newly discovered **Northwest Copper** Cu-Ag target.

Petra Resources Corp. explored an auriferous quartz vein, similar to veins at the Snip mine, on the **Quill** property in the Iskut district.

As part of the Royal Oak Mines Inc. receivership proceedings in late 1999, PricewaterhouseCoopers reached a tentative agreement with North American Metals Corp. to purchase the **Red Mountain** gold project, 15 kilometres east of Stewart, for the sum of $413 360. This project has been inactive for several years; however, under new ownership it is expected to be reactivated in 2000.

The **Bull River property** encompasses the site of the old copper-silver-gold Bull River (Dalton) mine that was worked by the Placid Oil Company in two open pits from 1971 to 1974. The mine produced 471 899 tonnes of ore which yielded 7 256 050 kilograms of copper, 6354 kilograms of silver, and 126 kilograms of gold. This is equivalent to a mill recovered grade of 1.54% Cu, 13.46 g/t Ag (0.43 oz/ton) and 0.27 g/t Au (0.008 oz/ton). The Stanfield Mining Group (Gallowai Metal Mining Corporation and Bul River Mineral Corporation) acquired the Dalton mine in 1976 and has been conducting extensive surface and underground exploration since then. In 1996 it began a 5.5 x 4.5 metre, 16% decline to test the underground potential. By December 1999 the decline had advanced approximately 3800 metres to the -900-foot level from surface. The company reported it spent $11.5 million in 1999 on underground development, bulk sampling and analytical work. This included extending the decline by 554 metres, 1424 metres of level development, 11 169 metres of underground drilling, 1741 metres of surface drilling and a 306 metre raise. Mineralization is hosted by quartz-carbonate sulphide veins up to 6 metres wide. The principle sulphides are chalcopyrite, pyrite and pyrrhotite, with minor galena and arsenopyrite. In 1999 Ministry publications quoted the Company's 1998 resource estimate for the deposit as a "measured and indicated mineral resource" of 5.3 million tonnes containing 2.25% copper, 1.06 oz/ton (36g/t) silver and 0.35 oz/ton (12g/t) gold (source: Precious and General Metals, December 1998). Ministry geologists visited the site in June 1999 and took ten splits of mineralized vein material from three diamond-drill holes and five rock chip samples from veins exposed in the underground workings at the -300 and -500 levels for independent assay. The Ministry samples were assayed by standard fire assay-atomic absorption spectrometry finish and cross checked by thermal neutron activation analysis. The median gold grade returned by fire assay from ten mineralized core samples was 0.28 gram/tonne with the best intersect being 4.77 grams/tonne over 1.1 metres. The neutron activation results were in close agreement with those by fire assay. These gold values are in the same order of magnitude as those recovered during the mining life of the deposit in the early 1970s. The Ministry's limited sampling did not bear out the gold grade reported by the company and quoted in

**Major Exploration Projects, 1999**

| Property | Operator | MINFILE | NTS | Commodities | Deposit Type | Work Done |
|---|---|---|---|---|---|---|
| Ample Goldmax | Gold-Ore Resources Ltd. | 092JNE069, 84, 94 | 92J/09E | Au, Ag | Mesothermal vein | 9 ddh - 907 m; drill access trail |
| Ashcroft quarry | I.G. Machine and Fibers Ltd. | 092INW104 | 92I/11W | Basalt | Industrial mineral | 46 ddh - 1312 m; 9 geotech ddh - 207 m; stripping; road |
| Big Kidd | Christopher James Gold Corp. | 092HNE074 | 92H/15E | Au, Cu | Porphyry, breccia | 4 ddh - ~1000 m |
| Blackdome mine | Claimstaker Resources Ltd. | 092O 053 | 92O/08W | Au, Ag | Epithermal vein | 7 u/g ddh - 1061 m |
| Bull River | R. H. Stanfield Group | 082GNW002 | 82G/11W | Cu, Ag, Au | Mesothermal vein | 1978 m u/g drifting; 45 ddh - 12910 m |
| Cam-Gloria | Teck Exploration Ltd. | 082M 266 | 82M/04E | Au, Ag | Intrusion-hosted vein | 7 ddh - 836 m; trenching; geophys; geochem |
| Car | Chapleau Resources Ltd. | N/A | 82F/1W | Zn, Pb, Ag | Sedex | 6 ddh, 2309 m |
| Cariboo Gold Quartz | International Wayside Gold Mines Ltd. | 093H 019 | 93H/4E | Au | Mesothermal vein | 18 ddh - 1498 m; trenching; geochem |
| Chappelle - Baker mine | Sable Resources Ltd. | 094E 026 | 94E/6E | Au, Ag, Cu | Epithermal vein | 15 ddh - 650 m; trenching; geochem |
| Coal Mt mine | Fording Coal Ltd. | 082GSE052 | 082G/7E, 10E | Coal | Coal | 90 rdh, 10 463 m |
| Crowsnest | Eastfield Resources Ltd. / International Curator Resources Ltd. | 082GSE070 | 82G/2E | Au | Alkalic intrusion - hosted | 10 ddh - 1096 m; geochem; geophys |
| Cruz | Chapleau Resources Ltd. | 082GSW066 | 82G/4W | Zn, Pb, Ag | Sedex | ~1525 m diamond drilling |
| Elkview mine | Elkview Coal Corp. | 082GNE015 | 82G/10W, 15W | Coal | Coal | 66 rdh - 7000 m |
| Eskay Creek mine | Homestake Canada Inc. | 104B 008 | 104B/9 | Au, Ag, Zn, Cu | Epithermal VMS | 64ddh - 14174 m; drill access trail 1 km |
| Fandora | Doublestar Resources Ltd. | 092F 041 | 92F/4E | Au, Ag, Cu | Vein | bulk sample |
| Fireweed | Mansfield Minerals Inc. | 093M 151 | 93M/1 | Ag, Zn, Pb | Stratabound | 6 ddh - 1250 m |
| Fording River mine | Fording Coal Ltd. | 082JSE009, 010, 012 | 82J/2W | Coal | Coal | 8 rdh - 2000 m |
| Golden Bear mine | North American Metals Corp. | 104K 079 | 104K/1 | Au | Carlin | 8 ddh - 1200 m; 100 pdh - 3000 m |
| Greenhills mine | Fording Coal Ltd. | 082JSE007, 001, 005 | 82J/2W | Coal | Coal | 34 rdh - 3032 m |
| Greenland Creek | Kennecott Canada Exploration Inc. | 082FNE107, 089, 112 | 82F/16E | Zn, Pb, Ag | Sedex | geochem; geol |
| High | International Skyline Gold Corp. | 104B 077 | 104B/11 | Au | Mesothermal shear-vein | u/g drift - 198 m; 17 u/g ddh - 1495 m |
| Jake | Teck Exploration Ltd. | 094D 061 | 94D/3W | Au | Epithermal vein | 6 ddh - 696 m; trenching; geochem; geol |
| Jubilee Mountain | WWC Consulting Ltd. | 082KNE079 | 82K/16W | Barite | Vein, breccia | 2 adits; bulk sample; diamond drilling |
| Kootenay West | Westroc Inc. | 082JSW005 | 82J/4E | Gypsum | Evaporite | diamond drilling |
| Laredo | North Pacific Stone Ltd. | 103A 001 | 103A/11 | Limestone | Industrial mineral | 28 ddh - 760 m; geol |
| Len/Ful | Hudson Bay Exploration & Development Co. Ltd. | 093L 213, 242 | 93L/9, 16 | Cu, Zn, Ag, Au | VMS | 7 ddh, 1100 m |
| Line Creek mine | Luscar Ltd. | 082GNE020, 021, 022 | 82G/15W, E | Coal | Coal | 60 rdh - 9000 m |
| Loop Ridge | Fording Coal Ltd. | 082GNE009 | 82G/10W | Coal | Coal | ~8 rdh - 2500 m |
| Lustdust | Alpha Gold Corp. | 093N 009 | 93N/11W | Au, Ag, Zn, Cu, Pb | Skarn, manto | 18 ddh - 3045 m |
| Mosquito Creek | Island Mountain Gold Mines Ltd. | 093H 010 | 93H/4E | Au | Mesothermal vein | Est. 10 ddh, ~900 m; u/g rehab; geochem |
| Mount Polley mine | Imperial Metals Corp. | 093A 008 | 93A/12E | Au, Cu | Porphyry | 14 ddh - 3200 m; geol |
| Myra Falls mine | Boliden Westmin (Canada) Ltd. | 092F 330, 073 | 92F/12E | Cu, Zn, Au, Ag | VMS | 15 to 20 ddh, ~14 000 m |
| North Findlay | Eagle Plains Resources Ltd. / Billiton Exploration Canada Inc. | 082KSE060, 081 | 82K/1E | Pb, Ag, Zn | Sedex | 6 ddh - 1617 m; geochem; geol |
| Northwest Copper | International Jaguar Equities Inc. | 092O 043 | 92O/04E | Cu, Ag | Stockwork, vein | 3 ddh - 667 m; geol |
| Pakk | Chapleau Resources Ltd. | 082FNE074, 062 | 82F/9E, W | Zn, Pb, Ag | Sedex | diamond drilling; geochem; prosp |
| Pellaire | International Jaguar Equities Inc. | 092O 045 | 92O/04E | Au, Ag | Vein | Bulk sample, approx 1400 tonnes |
| Pil | Finlay Minerals Ltd. | 094E 200, 213 | 94E/7W | Au, Cu | Porphyry | IP; geochem; geol |
| Pine | Stealth Mining Corp. | 094E 016 | 94E/2E | Au, Cu | Porphyry | 3 ddh, ~800 m; prospect; geochem |
| Pyramid Peak | Rio Algom Ltd. | N/A | 82F/9E | Zn, Pb, Ag, | Sedex | 1 ddh - 1005 m; geol |
| Quill | Petra Resource Corp. | 104B 231 | 104B/7 | Au, Cu | Mesothermal shear-vein | 7 ddh - 410 m; geol |
| RDN | Rimfire Minerals Corp. | 104G 144 | 104B/15, 104G/2 | Au, Ag | Epithermal VMS | 9 ddh - 574 m; geol; linecutting, 1.9 km |
| Silvertip | Imperial Metals Corp. / Peruvian Gold Ltd. | 104O 038 | 104O/16 | Ag, Zn, Pb | Manto | 3 ddh - 1285 m; u/g rehab; CSAMT, 5.65 km |
| Superior | International Mineral Resources Ltd. | N/A | 82F/12W | Graphite | Metamorphic | diamond drilling, ~2000 m |
| Tas | Omni Resources Inc. | 093K 080, 091 | 93K/16W | Au, Cu | Porphyry | 7 ddh - 653 m |
| Tay | Dalmation Resources Ltd. | 092F 212 | 92F/6W | Fe, Cu, Au | Vein/skarn | 5 ddh - 450 m |
| Valentine Mt | Beau Pre Explorations Ltd. | 092B 108 | 92B/12W | Au, Ag | Vein | 2 ddh - 400 m |
| Woodjam | Phelps Dodge Corp. of Canada Ltd. | 093A 078, 124 | 93A/6W | Au, Cu | Porphyry | 4 ddh - 767 m |
| Zymo | Freeport McMoRan Gold Co. (Canada) Ltd. | 093L 324 (new) | 93L/13 | Cu, Au | Porphyry | 6 ddh - 1600 m |

previous Ministry publications. A more complete Ministry report on the geology and mineralization is published in Geological Fieldwork 1999, Paper 2000-1.

### *Porphyry and Related Deposits*

During 1999 Taseko Mines Ltd. continued to evaluate a recently completed feasibility study of its **Prosperity** porphyry gold-copper deposit. Reserves currently estimated by the company are 633 million tonnes grading 0.253% Cu and 0.466 g/t Au. The project is in the Environmental Assessment Process.

Christopher James Gold Corp. completed four diamond-drill holes, totalling approximately 1000 metres, on the North Breccia target of its **Big Kidd** breccia-hosted, alkalic porphyry gold-copper property, 30 kilometres southeast of Merritt. The drilling stepped out from a 1997 hole which intersected 19.46 metres grading 3.09 g/t Au and 0.11% Cu, included within a broader intersection of 116

metres grading 0.8 g/t Au and 0.12% Cu. Further drilling has been recommended to evaluate the geometry of the gold-copper zones.

In the Flathead region, in the extreme southeastern part of the province, Eastfield Resources Ltd. and International Curator Resources Ltd. completed a ten-hole, 1096-metre diamond drilling program on their **Crowsnest** alkalic intrusion-related gold prospect. The program tested various targets within an area measuring 900 by 600 metres, interpreted to be the source of high-grade gold-bearing syenite boulders found in overburden. A trench dug in this area in 1994, by a previous operator, exposed a section of 16.5 metres grading 8.57 g/t Au, associated with quartz veining within a syenitic intrusion. The companies postulate that a series of stacked syenitic sills, intrusive into a thick sequence of carbonate sediments, has resulted in both porphyry and skarn mineralization. Although only subeconomic gold mineralization were intersected, the companies are conducting a thorough review of the data. Forty kilometres to the southwest, Eastfield Resources Ltd. conducted rock sampling on the **Howell Creek** property optioned from Cominco Ltd. and Placer Dome Limited. Previous work by Cominco, Placer Dome and Phelps Dodge Corporation of Canada Ltd. outlined a large area of gold mineralization related to syenite intrusions into limestones. Previous drilling intersected 58 metres grading 1.23 g/t Au in pyritic silicified limestone. The 1999 exploration program focused on the exploration potential of the numerous diatreme breccias on the property.

In the Toodoggone region, Stealth Mining Corp. drilled three core holes, totalling approximately 800 metres on its porphyry gold-copper **Pine** prospect, 25 kilometres north of the Kemess mine. The company estimates that the Pine zone contains an inferred resource of 70 million tonnes grading 0.57g/t Au and 0.15% Cu. This area lies within an induced polarization anomaly over 4 kilometres long and 1 kilometre wide. Immediately north of the Pine property, Finlay Minerals Ltd. explored its **Pil** porphyry gold-copper property.

Approximately 45 kilometres east of Terrace, Freeport Copper Corp., under an option agreement with Robin Day and Larry Hewitt, drilled six holes totalling approximately 1200 metres on the **Zymo** porphyry copper prospect. This first-pass diamond drilling program tested a 3 by 2-kilometre polymetallic geochemical anomaly.

### *Skarn/Manto Deposits*

In 1999, Peruvian Gold Limited and Imperial Metals Corporation completed a deep-penetrating (CSMAT) geophysical survey and a three-hole diamond drilling program adjacent to the Silver Creek zone on its **Silvertip** carbonate replacement deposit near the B.C. - Yukon border. Imperial Metals previously estimated a resource of 2.57 million tonnes grading 325 g/t Ag, 6.4% Pb, 8.8% Zn and 0.63 g/t Au for the Silver Creek manto zone. It proposed an open-pit and underground mine to feed a 2000 tonne-per-day dense media plant and flotation mill, producing high-value zinc and lead concentrates. The project is currently in the Environmental Assessment Process. The second hole of the 1999 program intersected a 31.4-metre zone grading 318 g/t Ag, 8.65% Zn and 5.53% Pb. Peruvian and Imperial believe that this intersection indicates feeder-style chimney (versus manto-style) mineralization. They plan to test this hypothesis by dewatering 1500 metres of ramp and side drifts at Silvertip to provide access for underground drilling to test the continuity and orientation of this new zone. Dewatering was completed by early December; drilling will begin in January, 2000.

Alpha Gold Corp. completed an 18-hole, 3045-metre diamond drilling program on its **Lustdust** skarn/manto prospect, 150 kilometres northwest of Fort St. James. The property covers multiple zones of gold, silver, zinc, lead and copper mineralization, primarily as structurally controlled, massive sulphide replacements. In addition, tabular calcsilicate skarn zones exist adjacent to a quartz monzonite intrusion. Four parallel, en echelon zones have been identified over a strike length of 2500 metres and a width of 500 metres. The 1999 program tested the size and large-scale zoning of the mineralized system, focusing on tracing the copper skarn and high-grade, zinc-rich sulphide replacements. The Lustdust skarn-replacement system is systematically zoned from copper-skarn to zinc-replacement mantos to silver-lead-zinc replacement veins, and the entire system is auriferous. The company believes that it has explored only the top of the copper-skarn zone; an expanded exploration program is planned for 2000.

The enigmatic **Fireweed** silver-zinc-lead deposit was explored by Mansfield Minerals Inc., in a joint venture with Cedar Capital Corp., by drilling for a western extension of the 1600 zone. Stratabound, epigenetic mineralization has some manto characteristics but does not fit readily into any conventional deposit class.

## *COAL*

During 1999, off-lease coal exploration was undertaken at Belcourt, as well as the Loop Ridge project (Coal Mountain operation). Expenditures are estimated at approximately $130 000, significantly down from the $1.54 million spent in 1998. Luscar Ltd. did not conduct any further exploration at its **Telkwa** project, but still plans to apply for an Environmental Assessment Certificate to allow it to produce between 1.0 and 1.5 million tonnes of thermal coal per year over a 23-year mine life, employing 211 persons.

At the **Willow Creek** project, 45 kilometres west of Chetwynd, Pine Valley Coal Limited (owned jointly by BC Rail, Mitsui-Mitsushima and Globaltex) conducted some in-fill and large-diameter core drilling to provide bulk samples to customers for coal quality testing. Development plans are stalled, although the company has approval for shipping a 50 000-tonne test sample which it hopes to excavate next spring.

Also in the Northeast, Western Canadian Coal Corporation has been active in acquiring coal properties and now holds licenses over the **Belcourt**, **Saxon** and **Burnt River** properties, all previously explored by other coal companies. At Belcourt, besides a small survey program in 1999, work is ongoing on a preliminary feasibility study. The company has found that the low-volatile PCI coal available from the Burnt River property, adjacent to Talisman's Sukunka property, is in demand and may be one of the few classes of coal to experience a price increase in 2000.

Pacific West Coal Limited's plans for a small coal mine at **Tulameen** were derailed by financial problems of the English company (Rackwood) which held an option on the property. The option has now been acquired by a trucking company and a small mine permit is in place. No work was undertaken in 1999.

Although there has not been much coal exploration during 1999, there is a lot of interest in coalbed methane in the province. Exploration is taking place in the Southeast and a number of companies are interested in obtaining exploration rights for coal on **Vancouver Island**, especially in the area of the Quinsam Coal mine. There has been a major sale of exploration rights in the Kootenay coalfields and companies have been reviewing information about coal deposits in other parts of the province. The interest reflects, in part, increased success in recovering coalbed methane in the USA and a favourable exchange rate. Also, the spectacular success in recovering economic quantities of methane from shallow low-rank coals in the **Powder River** Basin in Wyoming has stimulated interested in low-rank coal deposits in British Columbia.

## *INDUSTRIAL MINERALS*

In 1999, industrial minerals exploration expenditures are estimated at approximately $2.4 million, up from the $1.5 million spent in 1998. Some noticeable trends are that grassroots exploration for traditional construction materials and lightweight aggregate is gradually expanding from the Lower Mainland up the British Columbia coast. It is expected that over the next ten years, crushed stone from the coast will make significant inroads into the Vancouver area aggregate market. Since the advent of the provincial government's "Power for Jobs" program, sparry magnesite deposits have attracted interest from a number of junior companies that are trying to finance the development of these deposits as potential sources of raw materials for production of energy intensive materials such as magnesia and magnesium metal.

In 1998, an $8-million pilot plant was constructed by Cassiar Mining Inc., a fully owned subsidiary of Cassiar Mines & Metals Inc., to recover short-fibre **asbestos** from the **Cassiar Asbestos** tailings (17 million tonnes). A small shipment was made for market testing late in the year. It used conventional washing (wet milling) technology and was designed to recover relatively inexpensive short fibre. The company was unable to raise money for a full scale plant ($23 million dollars). Instead of concentrating on the processing of tailings, it is now rehabilitating a portion of the dry milling circuit in the old mill, to process approximately 4 million tonnes of ore which was left at several sites on the surface when the original operation closed down in the early 1990s. Anticipated start-up of the operation is January, 2000 at a milling rate of 720 tonnes per day. The long fibre will command a better price and will be more marketable than short fibre from the tailings. Cassiar Mines & Metals Inc. also announced that it signed a memorandum of understanding with Aluminum of Korea Ltd. to recover magnesium metal from the serpentinite tailings; the capital cost is estimated at $733 million. This agreement is subject to the approval of boards of directors of both companies.

IG Machine and Fibres Ltd. (a subsidiary of IKO Industries Ltd.) received a permit for a 250 000 tonnes per year **basalt** quarry and processing plant at **Ashcroft.** The basalt will be crushed, sized and coloured to produce roofing granules for IKO plants in Sumas, Washington and Calgary, Alberta. During 1999, the Barnes Lake road was upgraded, a utility corridor was constructed and the quarry and plant site was stripped. Plant construction is scheduled for next spring. This project is expected to employ 40 to 60 people.

On the **Superior** claims, near Slocan, International Mineral Resources Ltd. drill tested an occurrence of flake **graphite** disseminated in marble and paragneisses of the Valhalla Gneissic Complex.

Anglo Swiss Resources Inc. continued sampling a number of occurrences known to contain **star sapphire** or **corundum** at its **Blu Starr** property in the Slocan Valley. During 1998, Anglo Swiss announced the discovery of **gem-quality garnet and cordierite** (also call iolite or "water sapphire"). Most of the company's efforts in 1999 were concentrated on the **North Rainbow** iolite occurrence. Anglo Swiss sorted and graded a packet of gem garnet for facetting in Sri Lanka.

Follow-up prospecting took place on the Northern Lights precious opal occurrence in the Whitesail Range,

## 1999 Prospecting Highlights & New Discoveries

| Claim/Project Name | Prospector/ Company | Comments |
|---|---|---|
| **Aumax** | Gary Polischuk | High-grade silver-gold veins discovered near Lillooet and optioned to Gold Ore Resources in September, which conducted excavator trenching. (PA, ND) |
| **DI** | Lorne Warren | VMS alteration zone in Sitlika belt (Kutcho correlative) east of Takla Lake, enhances previously known bedded pyrite showing and advances VMS potential. (PA) |
| **Firestorm** | Dennis Schaefer | Precious opal discovery in Tertiary basalt near Burns Lake, may be the best in B.C. (PA, ND) |
| **GQ** | Warner Gruenwald | Several new showings of Au-Cu-Bi-W veins in high-grade metamorphic rocks Northeast of Shuswap Lake. (PA, ND) |
| **McPhee** | Bruce Doyle | Quartz veins discovered containing visible gold (possible Pogo type) near Castlegar. Optioned by Cassidy Gold Corp. (PA, ND) |
| **Talc Creek** | David Haughton | Magmatic Ni-Cu in ultramafic rocks east of Harrison Lake. (PA, ND) |
| **Bizar** | Leo Lindinger | Cassidy Gold Corp drilled 5 holes for gold. (PA) |
| **Ladybug** | Leo Lindinger | Cross Lake Minerals Ltd. Drilled 5 holes for Zn-Ag-Pb-Cu. (PA) |
| **Cam Gloria** | Camille Berube | Teck Corp drilled 7 holes on this gold property. (PA) |
| **Zymo** | Robin Day | Freeport Copper Company drilled 6 holes for Cu-Au. (PA) |
| **Greenland & Findlay Creek** | Tim Termuende | Kennecott Canada, Rio Algom & Billiton Exploration carried out exploration, including drilling for Zn-Pb-Ag. (PA) |
| **Lottie** | Martin Peter | 1998 Cu-Ag-Au discovery optioned to Eureka Res. Inc. Property optioned to Hudson Bay in late 1999. A $400 000 program planned for 2000. (PA) |
| n/a | Gary Pearson | Mesothermal vein gold in Port Renfrew area. (ND) |
| n/a | Efrem Specogna | Magmatic PGEs and gold near Port Renfrew. (ND) |
| **Cache Creek Opal** | Gary Murrel | Fire opal discovery northeast of Cache Creek. (ND) |
| **F13** | Arne Birkeland | VMS Cu-Zn discovery about 10km south of Scotia (ND) |
| **Frank Creek** | Barker Minerals | VMS Cu-Pb-Zn-Au-Ag discovery southeast of Cariboo Lake. (ND) |
| **JC/Nub North** | Stealth Mining | Epithermal vein Au-Ag-Pb-Zn discovery in Toodoggone. (ND) |
| **Lucky Dog** | Ralph Allen | Epithermal vein Au-Ag discovery south of Silverton (ND) |
| **Wadsworth** | Paul Wadsworth | Mesothermal vein gold discovery north of Terrace (ND) |

*Note: PA=funding from Prospectors Assistance Grant Program; ND=new discovery*

south of Houston. Precious opal-bearing boulders or subcrop were discovered on the **Firestorm** property, west of Burns Lake, by Mr. Schaefer of Burns Lake. At least three *in situ* occurrences of precious opal were discovered in the Falkland area by Lloyd Nilsen.

Mining companies, as well as individual prospectors, are evaluating new **dimension stone** properties. Ava Resources Ltd. continued test sampling of its attractive pink, banded **Wishaw** (Kakwa) **quartzite** deposit, east of Prince George.

W.W.C. Consulting Ltd., under an option agreement with prospector Art Louie of Invermere, conducted an underground exploration program on its barite project at **Jubilee Mountain**, west of Spillimacheen. Two short adits were driven on the Heli and Grizzly shear-controlled veins in dolomite. The company mined a bulk sample of barite and transported it to its own mill on Madias Creek, south of Windermere.

In the Chilliwack valley, IG Machine and Fibres Ltd. shipped approximately 25 000 tonnes of **limestone** from its **Slesse** project to its plant in Sumas, Washington, to be used in the making ashphalt shingles.

Continental Lime Ltd. is examining the process for advancing its proposed **Var** quarry, on Rupert Inlet near Port Hardy, into the Environmental Assessment Process. If successful, the quarry will produce 250 000 tonnes of chemical limestone annually.

Orinda Investments and North Pacific Stone propose to develop the **Laredo limestone** deposit on Aristazabal Island, as a source of high-brightness filler for the plastics, paper and paint industries. Drilling on a 50-metre grid, site engineering and environmental studies were conducted.

Cassiar Coal Company Ltd. completed extensive sampling on its **Stitt Creek garnet** property north of Revelstoke in late 1998, and took another significant step towards a future feasibility study. Mammoth Geological Ltd. undertook preliminary sampling at its placer garnet prospect located along **Cupola Creek**, west of Golden.

There is renewed interest by prospectors and some junior companies in **hydromagnesite**, sabkha-type deposits that were known and exploited at the beginning of the 19th century. Stralak Resources Inc. acquired at least three small deposits in the **Atlin** area and conducted preliminary sintering and calcination studies on hydromagnesite samples. There is, however, a small but growing market for natural hydrated magnesia minerals in flame retardants. It remains to be established if British Columbia deposits are competitive in terms of specifications and economics. Near Marysville, Stralak and joint venture partner Magna Precious & Industrial Metals Inc., optioned the **Marysville** sparry magnesite deposit which has an inferred resource of 12.7 million tonnes grading 88% $MgCO_3$, most of it available as underground ore.

## GOVERNMENT INITIATIVES

During 1999, the Government of British Columbia continued with a number of measures introduced in 1998 to assist mineral resource planning, exploration and development. It also continued the successful Prospectors Assistance Program and field programs of the Geological Survey Branch. Highlights are as follows:

- The **British Columbia Mining Exploration Tax Credit Program (METC)** continued in its second year. Expenditures made during 1999 by eligible individuals or corporations conducting grassroots mineral exploration in British Columbia may qualify for a 20% refundable credit.
- **The Prospectors Assistance Grant Program (PA)** is designed to promote grassroots prospecting for new mineral deposits in British Columbia. It contributed up to 75% of eligible costs of approved projects to a maximum of $10 000. Fifty grants were awarded in 1999. Several new discoveries were reported by recipients (see Table page 19). A number of new discoveries made by PA prospectors over the past couple of years were worked on by mining companies under option agreements. The Ministry annually issues grants to seven mining sector organizations to help them deliver training programs to prospectors. The Ministry also provided basic prospector training. The budget of the PA program was $500 000.
- 1235 **Regional Geochemical Survey** samples for the Quesnel Lake area (NTS93A) were re-analyzed for gold and 25 other metals and results released in June by the B.C. Geological Survey. This was part of the ongoing program of enhancing previously released survey results.
- The **Geological Survey Branch** field programs continued to develop the geoscience database. The potential for massive sulphide deposits along the Ancient Pacific Margin (*e.g.* Dorsey Terrane, Big Salmon Complex, Kootenay Terrane and Ingenika area) will be examined over the next five years as part of a new multidisciplinary project with the Geological Survey of Canada and the Yukon Geology Program.
- The potential for **Pogo-type, Carlin-type gold and iron oxide Cu-Au-REE deposits in BC** was investigated, and mineral deposit models and geochemical models are being developed. The **Ecstall and Robb Lake massive sulphide deposit settings** were also examined. Several smaller scale projects were carried out on **coal and industrial minerals**. A number of projects are in the write-up stage (*e.g.* Toodoggone, Nechako NATMAP and Eagle Bay). Results of these programs are expected to encourage exploration.
- The **ARIS** (assessment reports), **MINFILE** and **Map Place** databases continue to be upgraded and made more easily accessible to clients, on the Ministry's website http://www.em.gov.bc.ca/geology.
- Three areas along the central coast were studied, funded under the government's **Corporate Resource Inventory Initiative (CRII)**, as part of the Ministry's contribution to the Central Coast Land and Coastal Resource Management (CCLCRMP) planning process. In each area (Khutze River (NTS 103H), Cape Caution (NTS 092L, 092M), and Bella Coola (NTS 093D), regional geochemical surveys were conducted and the mineral potential was examined. Limited CRII-funded

work was also carried out on the Queen Charlotte Islands (NTS 103 B,C, F and G).

## OUTLOOK FOR 2000

The economic significance of the **Eskay Creek** mine continues to attract province-wide attention to the potential for stratabound, precious metal-enriched subaqueous hot-spring deposits.

The search for zinc-rich sedex deposits in the southeast part of the province is expected to intensify, with follow up work at the **North Findlay**, **South Findlay**, **Greenland Creek**, **Pakk**, **Pyramid Peak**, **McNeil** and **Irishman Creek** properties.

Exploration for Carlin-type gold mineralization is expected to increase throughout the province.

Interest in the potential for discovery of deposits similar to the Pogo and Fort Knox orebodies, currently being exploited in Alaska, will continue in British Columbia, especially in the Kootenay Terrane and Sushwap Metamorphic Complex.

Evaluation of recently discovered volcanogenic massive sulphide prospects in the Cariboo, hosted by Slide Mountain and Barkerville terrane rocks, is expected to revive regional exploration in those belts.

Polymetallic volcanogenic and sedex massive sulphide deposits will also continue to be primary targets. There is good potential for the discovery of Broken Hill-type deposits in the Kootenay Terrane, along a north-trending belt west of Revelstoke.

GTN Copper Technology Ltd., a Sydney, Australia based company, has proposed a $117 million copper processing plant at the former **Island Copper** mine site near Port Hardy, to process copper concentrate from mines in Western Canada, the United States and South America. Detailed marketing and engineering studies and an application for the necessary environmental permits will be the next step. The presence of a copper smelter on the west coast would have a significantly positive impact on the economic viability of many bulk-mineable, copper (-gold) deposits in the province.

The association of nickel and PGEs with mafic to ultramafic rocks in British Columbia is expected to attract attention in 2000.

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