

# BC Mineral Exploration Review 1996

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## **Introduction**

Three large, open-pit, porphyry-type deposits (**Kemess South**, **Huckleberry** and **Mount Polley**) are in the construction phases, with estimated capital costs totalling approximately \$650 million. The three mines, scheduled to be in production in 1998, collectively will create approximately 700 new, full-time jobs and an estimated 1500 indirect jobs.

The historic **Bralorne** gold mine is scheduled to re-open in 1997. The **Golden Bear** mine is poised to go back into production in the summer of 1997 as a bulk-mineable, heap leaching gold operation. After a hiatus in exploration in 1995, the **Red Mountain**gold project had the largest expenditure at approximately \$8 million in 1996.

Exploration expenditures in 1996 are estimated to be approximately \$100 million. The number of projects in 1996 with budgets in excess of \$100 000 are estimated at approximately 210, a 13% decrease from 1995. Drilling in the province in 1996 is estimated to total approximately 500 000 metres, with approximately 40% of the meterage having being done in the northwest region. Targets included many of the classic deposit types for which British Columbia is known. Individual deposit examples include: **Specogna** (**Cinola**), **Prosperity** (**Fish Lake**), **Polaris-Taku**, **Red Mountain**, **Taurus**, **Golden Bear**, **Telkwa Coal**, **Tsable River**, **Akie**, **Ladner Creek** (**Carolin**), **Cariboo Gold Quartz**, **Giant Copper**, **Tsacha**, and porphyries in the **Babine Lake** area.

Lower metal prices, a stronger Canadian dollar, and lower production due to mine closures have led to decreased value of output (approximately 12%) at existing mines. The total metals output by value is down approximately 24% from the 1995 estimate. Four metal mines closed during the year: **Nickel Plate**, **Similco**, **Premier** and **Goldstream**. However, gold and silver production increased significantly at the **Eskay Creek** mine, where exploration has also been very successful in adding to the reserve base.

Clean coal production in 1996 is expected to increase by 12% over 1995. Exploration at coal mines and off leases increased by about 8%, the latter was led by expenditures at **Telkwa**, **Tsable River** and **Willow Creek**. Predictions are for strong thermal coal markets. Although estimated expenditures for industrial minerals are down, there is strong interest in the wide variety of such commodities produced in British Columbia.

The number of claim units (approximately 38 380) recorded in 1996 indicates an increase of about 15% in the level of activity over 1995; however, there is still a very significant number of claim units forfeited (approximately 28 800). The number of Free Miner Certificates recorded for 1996 is estimated at 5460, down approximately 9% from 1995.

Several bulk sampling projects were carried out (*e.g.* **Brett**, **Pellaire**, **Telkwa Coal** . A number of advanced projects in the Environmental Assessment Process are in the feasibility stage (*e.g.* **Tulsequah Chief**, **Red Mountain**, **Telkwa Coal**, **Bronson Slope**, **Golden Bear**, and **Red Chris**). The Mining Association of British Columbia estimates that approximately \$1.7 billion worth of new projects are in the approval process and these projects have the potential to create 2400 new, high-paying jobs. Some projects (*e.g.* **Mt. Milligan** and **Cirque**) have received Mine Development Certificates and await production decisions. Of real concern, however, is the very low level (*i.e.* 12%) of grassroots or generative expenditures.

In 1996 the Geological Survey Branch released regional geochemical survey (RGS) data for the **Cry Lake** (NTS 104 I) map sheet; this resulted in the staking of several new claims. The Survey also completed sampling in the **Toodoggone River** (NTS 94E) and **McConnell Creek** (NTS 94D) map sheets and will release the data in 1997. The survey also released airborne geophysical data from the **East Kootenay** project which led to new claims staking. It also completed the final block of the survey and will release the results in 1997. The British Columbia government allocated approximately \$500 000 for exploration under its **Prospectors Assistance** program. Positive and encouraging results have been reported.

Table 3 New Mines, Closures, Development And Advanced Exploration Projects In British Columbia, 1996

Company Name	Project Name	Commodity	Estimate d Tonnes (000s)	Estimated Grade	Reference
<b>Development</b>					
Imperial Metals Corp.	Mount Polley	Cu, Au	82 300	0.3% Cu, 0.417 g/t Au	Imperial Metals, 1996
Royal Oak Mines Inc.	Kemess South	Cu, Au	200 400	0.22% Cu, 0.63 g/t Au	Royal Oak, 1996
Huckleberry Mines Ltd.	Huckleberry	Cu			
	Main Zone		26 820	0.48% Cu, 0.07 g/t Au, 2.17 g/t Ag, 0.013% Mo	Huckleberry, 1995
	East Zone		72 710	0.52% Cu, 0.06 g/t Au, 3.1 g/t Ag, 0.014% Mo	
Polar Res. Ltd.	Serpentine Lk.	Jade			
<b>Closures</b>					
Bethlehem Resources Corporation	Goldstream	Cu, Zn, Ag			
Homestake Canada Inc	Nickel Plate	Au, Ag			
Westmin Resources Limited	Premier	Au, Ag			
Candorado	Hedley Tailings	Au			
Similco Mines Ltd.	Similco	Cu,Au			
<b>Advanced Exploration</b>					
<i>Porphyry (and related) Deposits</i>					
Taseko Mines Ltd.	Prosperity (Fish Lake)	Cu, Au	675 000	0.236% Cu, 0.435 g/t Au	Taseko Mines, 1995
Placer Dome Inc.	Mt. Milligan	Cu, Au	298 400	0.22% Cu, 0.45 g/t Au	Placer Dome, 1993
American Bullion Minerals Ltd.	Red Chris	Cu, Au	494 000	0.323% Cu, 0.254g/t Au	Amer. Bullion, 1995
Princeton Mining	Similco - all zones	Cu, Au	123 742	0.393% Cu, 0.155 g/t Au, 1.576 g/t Ag.	Princeton, 1996
	- Ingerbelle(Phase 2)		7 800	0.31% Cu	
	- Alabama		26 300	0.352% Cu, 0.17g/t Au.	
	- Oriole		2 630	0.44% Cu	
	- Pit2		35 400	0.33% Cu, 0.12 g/t Au.	
	- Pit3		53 500	0.48% Cu	
Gibraltar Mines Ltd.	Gibraltar (total)	Cu	162 300	0.297% Cu, 0.009% Mo.	Gibraltar, 1995
	- Gib North (est.)		40 000	0.4% Cu	
	- Pollyanna (CM)		48 000	0.32% Cu, 0.009% Mo.	
	- Granite Lake		73 765	0.305% Cu	
	- Connector		1 100	0.372% Cu (leachable), 0.281% Cu, 0.008% Mo.	
	- Gibraltar East		44 625		
Royal Oak Mines Inc.	Red Mountain	Au, Ag	1 920	9.8 g/t Au	Royal Oak, 1996

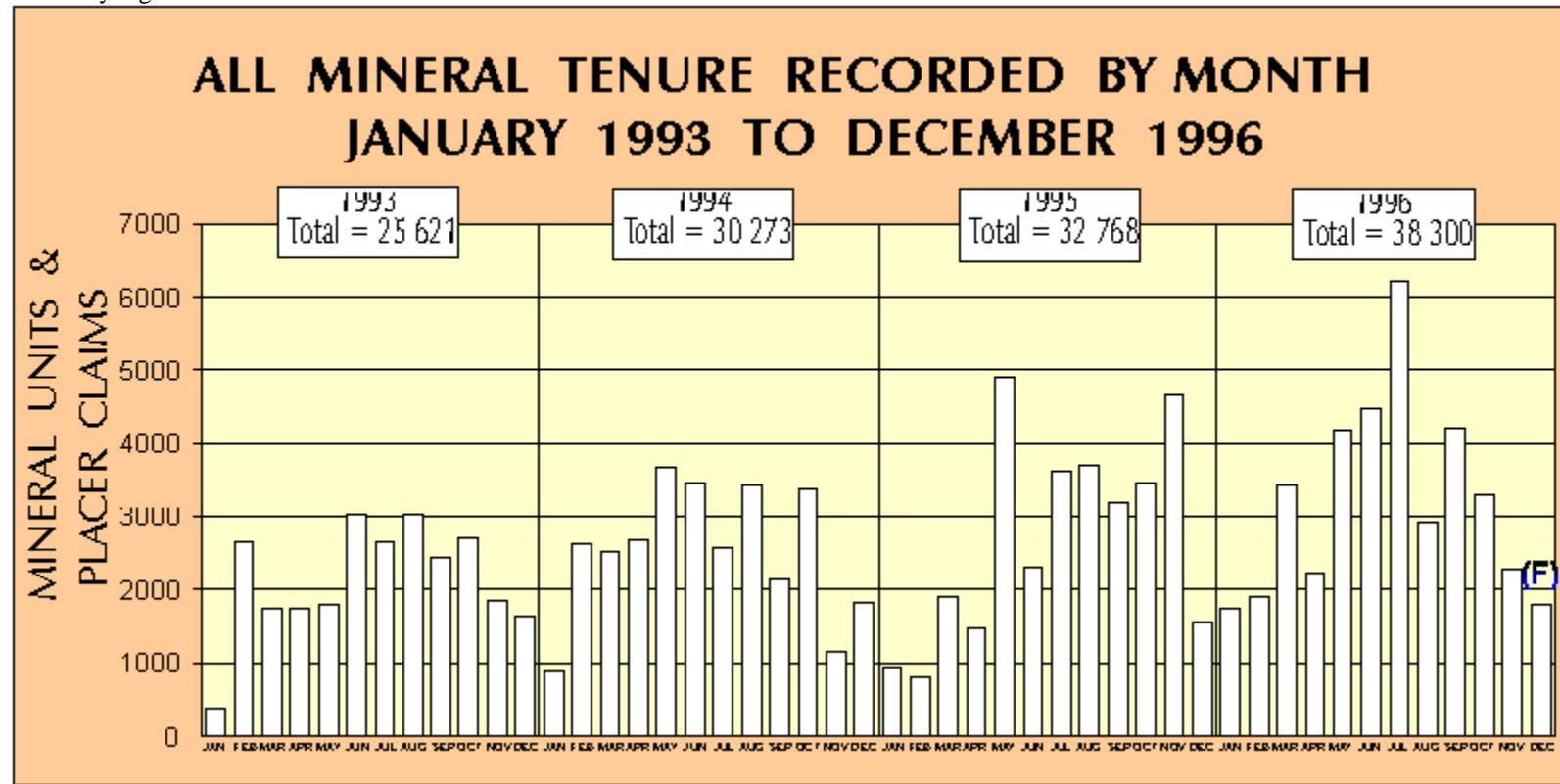
International Skyline Gold Corp.	Bronson Slope	Cu, Au, Ag	97 920	0.57 g/t Au, 0.2 % Cu, 2.65 g/t Ag	International Skyline, 1996
Britannia Gold Corp./	Lexington	Cu, Au	162	8.9 g/t Au	Bren-Mar, 1995
Bren-Mar Res. Ltd.				0.96% Cu	
Getchell Res./Teck Corp	Galaxy	Cu, Au	3200	0.65% Cu, 0.34 g/t Au	Getchell, 1995
Getchell Res./Teck Corp.	Rainbow (Kamloops)	Cu, Au	14 100	0.5% Cu	Teck, 1995
Imperial Metals Corp.	Giant Copper (AM)	Cu, Au	29 500	0.65% Cu, 0.38 g/t Au, 12.34 g/t Ag.	Imperial Metals, 1996
<i>Massive Sulphide Deposits</i>					
Prime Res. Gp. Inc.	Eskay Creek	Au, Ag			Prime, 1996
	- 21B (prov. + prob.)		97	130.6 g/t Au equiv.	
	- 109 (prov.+ prob.)		123.3	22.97 g/t Au equiv.	
	- NEX (dil. geol.)		82.5	46.28 g/t Au equiv.	
Redfern Res. Ltd.	Tulsequah Chief Big Bull	Cu, Pb, Zn, Au, Ag	7910	1.27% Cu, 1.18% Pb, 6.35 % Zn, 2.42 g/t Au, 100.9 g/t Ag	Redfern, 1995
Inmet Mining Corp./ Ecstall Mining Corp.	Akie	Zn, Pb, Ag	12	8.6 % Zn, 1.5 % Pb, 17.1 g/t Ag.	Inmet, 1996
<i>Vein Deposits</i>					
Wheaton River Minerals Ltd./ North American Minerals Ltd.	Golden Bear - Ursa	Au, Au	511	7.0 g/t Au	Wheaton R., 1996
	- Kodiak A	Au	824	3.3 g/t Au	
	- Kodiak B	Au	278	8.6 g/t Au	
	- Kodiak C	Au	276	7.8 g/t Au	
	- East Low Grade Stockpile	Au	2.45	1.3 g/t Au	
	- Grizzly	Au	153	20.5 g/t Au	
Bralorne-Pioneer Gold	Bralorne	Au, Ag			Bralorne-Pioneer, 1995
Mines Ltd./	Above 1000 level		432.5	10.6 g/t Au	
Avino Mines and Res. Ltd.	Below 1000 level		673	8.2 g/t Au	
	51 vein		110.7	12.7 g/t Au	
	Loco veins		363	17.14 g/t Au	
Huntington Res. Ltd.	Brett Bonanza Zone R.W. vein	Au	12	39.1 g/t Au	Huntington, 1993
Golden Angus Mines Ltd..	Polaris-Taku	Au	3170	14.1 g/t Au	Canarc, 1995
Athabaska Gold Res. Ltd.	Ladner Creek - Idaho	Au	1630	4.46 g/t Au	Athabaska, 1996
	- Tailings	Au	660	1.75 g/t Au	
Fairfield Minerals Ltd.	Elk (Siwash North)	Au	121	25.4 g/t Au, 35.3 g/t Ag	Fairfield, 1996
Hera Res. Inc./	Taurus	Au, Ag			Hera, 1995
International Taurus Res. Ltd./	88 Hill Zone				
Cusac Industries Ltd.	(inferred)		13 725	1.01 g/t Au	
	(indicated)		25 134	0.67 g/t Au	

Misty Mountain Gold Ltd.	Specogna (Cinola)	Au, Ag	31 300	2.2 g/t Au	Misty Mtn., 1995
Claimstaker Res. Ltd.	Blackdome	Au, Ag	159.6	16.11 g/t Au, 37.0 g/t Ag	Claimstaker, 1995
Prime Resources Gp.Inc.	Snip-Twin West	Au	32	24 g/t Au	Prime, 1996
Westmin Res. Ltd.	Premier (proven + probable)	Au,Ag	261151	7.9 g/t Au, 35.3 g/t Ag.	Westmin, 1996
	(possible)			8.6 g/t Au, 30.9 g/t Ag.	
Cusac Gold Mines Ltd.	Table Mountain - Vollaug	Au	39.4	15.43 g/t Au	Cusac, 1996
<i>Coal and Industrial Mineral Deposits</i>					
Mountain Minerals Co. Ltd.	Ranchlands	zeolite			Mountain Minerals, 1995
Canmark Int'l Res. Ltd.	Sunday Creek	zeolite			Canmark, 1995
Highland Talc Minerals Ltd.	Goldbridge	talc			Highland Talc, 1995
Okanagan Opal Inc.	Klinker	fire opal			Okanagan, 1995
Quinto Mining Corp. Ltd.	Lumby	graphite, sericite			Quinto, 1995
New Global Res. Ltd.	Monteith Bay	silica, pyrophyllite			New Global, 1995
Super Twins Res. Ltd.	Isk	wollastonite	2000	80%	Super Twins, 1995
Manalta Coal Ltd.	Telkwa	coal	46 000	thermal	Manalta, 1996
Globaltex Industries Ltd.	Willow Creek	coal		thermal	Globaltex, 1995
Quinsam Coal Corp.	Tsable R.	coal	38 478	thermal	Quinsam, 1996
Line Creek Res.	Mount Michael	coal			Line Ck., 1996
IMP Ind.Min. Park	Black Crystal	graphite	27 000		IMP, 1995
Cassiar Coal Ltd.	Stitt Creek	garnet			Cassiar, 1995
Anglo Swiss Ind. Ltd.	Blu Starr	sapphire			Anglo Swiss, 1995
B.C. Chrysolite Corp.	Cassiar	asbestos			B.C. Chrysotile, 1995
Quest Int'l Res. Corp.	Ice	diamond			Quest, 1995
Ava Res. Ltd.	Wishaw	quartzite			Ava, 1995

*Note: Estimated Tonnes and Grade are "Resources".*

Figure 5. All Mineral Tenure Recorded By Month; 1993 To 1996.

Note: High value for July reflects releases of a Regional Geochemical Survey for the Cry Lake (NTS 104I) map sheet, and of geophysical data from the East Kootenay region.



## Regional Trends

Preliminary estimates indicate that total expenditures on exploration and development projects in British Columbia during 1996 have been approximately \$100 million, an increase of about 20% over 1995. Much of this significant increase is attributed to increased spending at active mines in search of new resources, the advancement of many projects which are either in the Environmental Assessment Process or are close to entering it, and the government release of geochemical and geophysical survey data in the Cry Lake and East Kootenay areas respectively. As in previous years, approximately 45% of total expenditures was spent in the northwest part of the province. The very low level of expenditures on grassroots or generative projects (*i.e.* 12%) is of concern. All regional Ministry offices recorded increases in exploration spending in their respective areas in 1996: Smithers (+29%), Prince George (+14%), Kamloops (+44%), Cranbrook (+12%), and Vancouver (+25%).

Figure 1 illustrates the fluctuation of exploration expenditures in British Columbia compared to the rest of Canada over the past decade. Included are comments, along with the average annual prices for copper and gold, which influenced the increase or decrease in expenditures over that period. The peak year 1988, with expenditures of \$230 million, coincided with the height of flow-through funding. In subsequent years, expenditures show a steady decline to a low of \$66 million in 1993. Although slight increases have occurred since then, annual expenditures in the \$130 million to \$140 million range are considered necessary by industry to sustain a healthy, viable mining industry in British Columbia. For the same ten-year period, the pattern of exploration spending is broadly similar to changes in the total value of solid mineral production (Figure 2); the latter indicates a much more dramatic increase in 1995, followed by a 12% decline in 1996.

Exploration targets are varied and include: vein deposits (epithermal and mesothermal) massive sulphide deposits (volcanogenic, sedex and seafloor hydrothermal), porphyry and related deposits, skarn deposits, industrial minerals deposits, coal deposits, placer deposits and others (*e.g.* magmatic) (Figure 3a). Porphyry and related deposits continue to be the most significant target (41.5%), followed by veins (32.5%).

Approximately 15% of exploration expenditures (including 3.6% at coal mines) were at minesites and 73% on advanced projects, including bulk sampling and environmental programs. An estimated, very low level of 12% was spent on less advanced or grassroots/generative exploration programs (Figure 3b).

In total, there were approximately 210 projects with budgets in excess of \$100 000, down about 13% from 1995. Approximately 50.5% of expenditures were in the \$100 000 to \$200 000 range. Those projects (27) with budgets over \$1 million accounted for approximately 58% of the total; those (20) in the range \$500 000 to \$1 million accounted for an additional 12.8% of the total, thus collectively accounting for approximately 71% of the total expenditures. Figures 4a and 4b show the number of projects with expenditures in excess of \$100 000. The largest program was by Royal Oak Mines Inc. on the **Red Mountain** gold project, southeast of Stewart, estimated at \$8 million. Expenditures in excess of one million dollars were also directed at re-evaluation of advanced projects such as: **Specogna (Cinola)**, **Prosperity (Fish Lake)**, **Telkwa Coal**, **Golden Bear**, **Premier**, **Similco**, **Cariboo Gold Quartz**, **Taurus**, **Akie**, **Ladner Creek** and **Red Chris**. The discovery of the **Clone** gold prospect, south of Red Mountain, in late 1995 led to increased exploration in the area in 1996.

Grassroots programs were carried out in the northern (**Cariboo** area) and southern (**Philip Lakes to Toodoggone** areas) Quesnel Trough areas and the **Babine Lake** region for gold-enriched porphyries, in southeastern (**Sullivan** area) and northeastern (**Gataga** area) parts of the province for sedex deposits, in the **Interior Plateau** region of south-central British Columbia, in the **Toodoggone** region of northwestern British Columbia for bonanza and bulk-mineable epithermal gold, in the **Stewart** camp in the northwest for mesothermal and transitional gold deposits similar to Snip and Red Mountain, in the Cassiar camp for bulk-mineable, heap leachable gold deposits, and in the **Wells-Barkerville-Likely** camps for mesothermal veins and bulk-mineable gold. Two projects targeted porphyry molybdenum potential, the **Salal** and **Crow-Rea** prospects located northwest of Pemberton and Summerland respectively. Exploration expenditures decreased for industrial minerals, but increased significantly for coal.

Figure 1. Mineral Expenditures In British Columbia Relative To Other Canadian Provinces: 1986 To 1996.  
 (Source MEI, Resource Policy Branch, 1996)

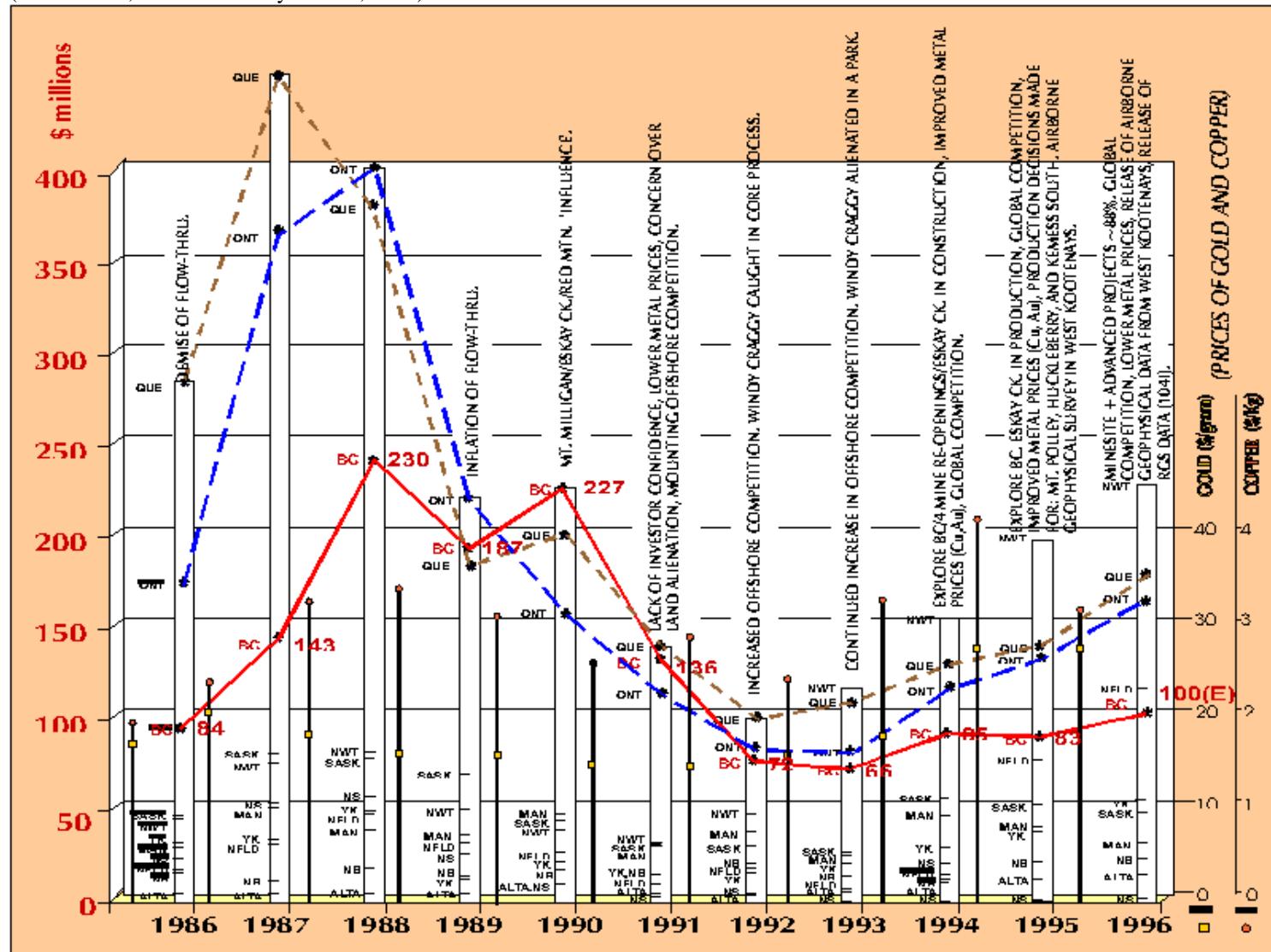


Figure 2. Solid Mineral Production Value In British Columbia: 1986 To 1996.  
(Source MEI, Resource Policy Branch, 1996)

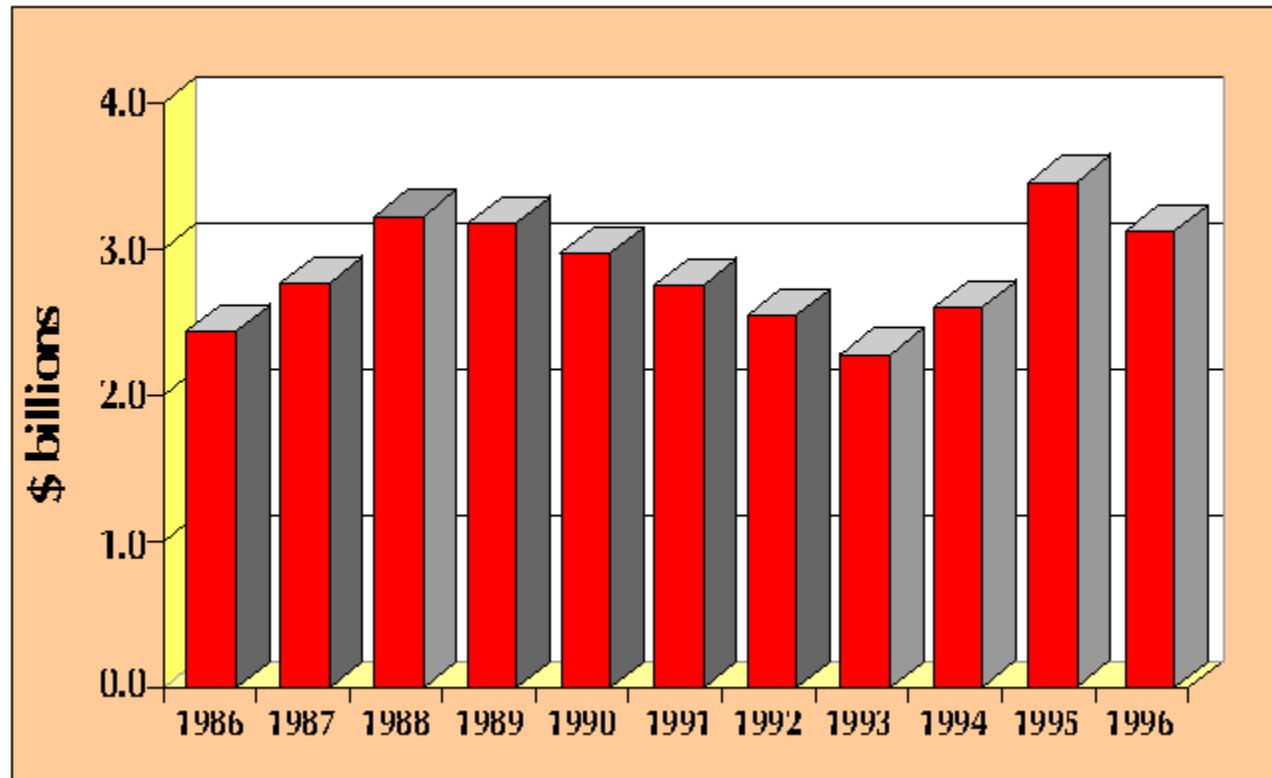
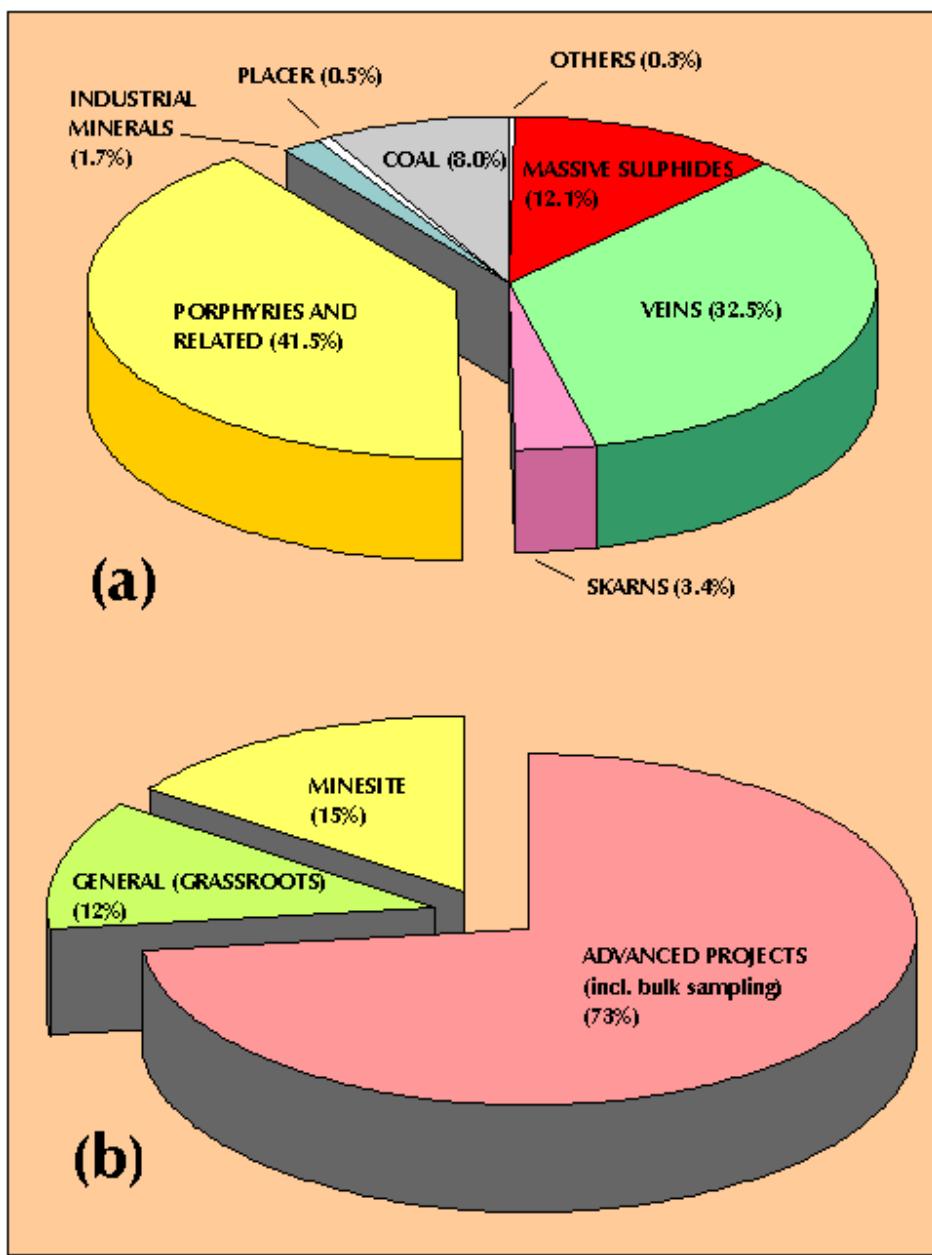


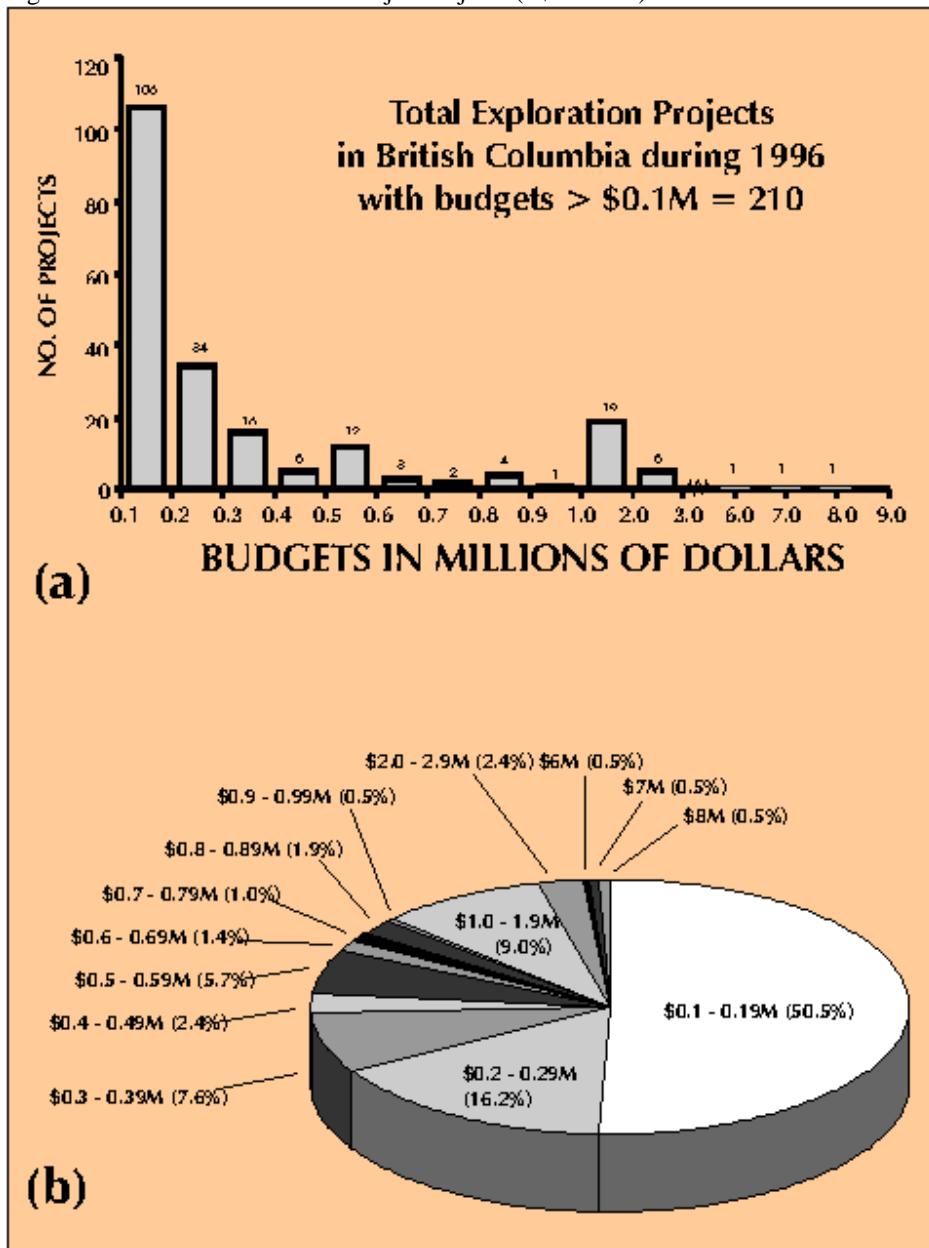
Figure 3. Exploration Targets - 1996



(a) by deposit type (%);

(b) by level or category of program (%)

Figure 4. Estimated Number Of Major Projects (>\$100 000)



- (a) by incremental \$0.1M;  
(b) by percentage of total expended.

## Highlights at Operating Mines

The 14 metal mines operating in British Columbia in 1996 are indicated in Figure 6. There were no new mine openings, and the following four metal mines closed during the year - **Nickel Plate, Similco, Premier** and **Goldstream**. Many mines had significant exploration programs, some with good results. Several small high-grade projects (*e.g.*, Brett) have the potential to produce using custom milling arrangements.

Table 1 Active And Potential Custom Milling Projects

Mill Or Smelter/ Location	Project Name (Potential)	Commodity	Operator
Asarco/Helena, Montana	*Elk	Au	Fairfield Minerals Ltd.
Trail	*Brett	Au	Huntington Res. Ltd.
Trail	*Pellaire	Au	Int'l Jaguar Equities
Trail?	(Skinner)	Au	Ottarasko Mines Ltd.
Kettle/Republic, Washington	(Iron Colt, Evening Star, Midnight)	Au	Pacific Vangold Res. Inc./ Int'l Silver Ridge Res. Inc.
Afton/Kamloops, B.C.	(Alwin)	Cu, Au	Claimstaker Res. Ltd.
Premier/Stewart, B.C.	(Debbie)	Au	White Hawk Ventures Inc.
Premier	(Greens Creek, Alaska)	Au,Cu,Ag,Pb,Zn	Kennecott Corp./Hecla Mining Co./ CSX Energy Corp./Exalas Res.
Premier	(Johnson River)	Au,Cu,Ag,Pb,Zn	Westmin Res. Ltd.
Premier	(Jualin)	Au	Coeur d'Alene Mines Ltd.
Premier	(Red Mtn.)	Au,Ag	Royal Oak Mines Inc.
Premier	*Snip	Au	Prime Resource Group Inc.
Premier	(SB)	Au	Tenajon Res. Ltd./Westmin Res. Ltd.
?	(Engineer)	Au	Ampex Mining
?	(Valentine Mtn.)	Au	Beau Pre Explorations Ltd.
Roberts Mill	(Lexington)	Au	Britannia Gold Corp./Bren-Mar Res.

\* = Active

The number of direct mining employees in British Columbia in 1996 is estimated at approximately 9800 with wages totalling \$565 million.

The forecast value of solid mineral production for 1996 in British Columbia, (Table 2) is \$3.05 billion, a 12% decrease from 1995.

Table 2 1996 Forecast Value Of Mineral Production In B.C.

Commodity	Quantity (Millions)	C\$ Value (Millions)	Percent Of Total Value
Metals			
Copper	230 kg	700	23.00%
Gold	18.5 g	320	10.50%
Zinc	140 kg	206	6.80%
Lead	45 kg	50	1.60%
Molybdenum	8 kg	96	3.10%
Silver	450 g	105	3.40%
Other		10	0.30%
Total Metals		1 487	48.70%
Coal			
Metallurgical Coal	22.20 t	1 061	34.70%
Thermal Coal	2.25 t	69	2.30%
Total Coal		1 130	37.00%
Total Others		435	14.30%
(Includes Structural Materials & Industrial Minerals)			
Total Solid Minerals		3 052	100%
<i>Source: MEI Resource Policy Branch</i>			

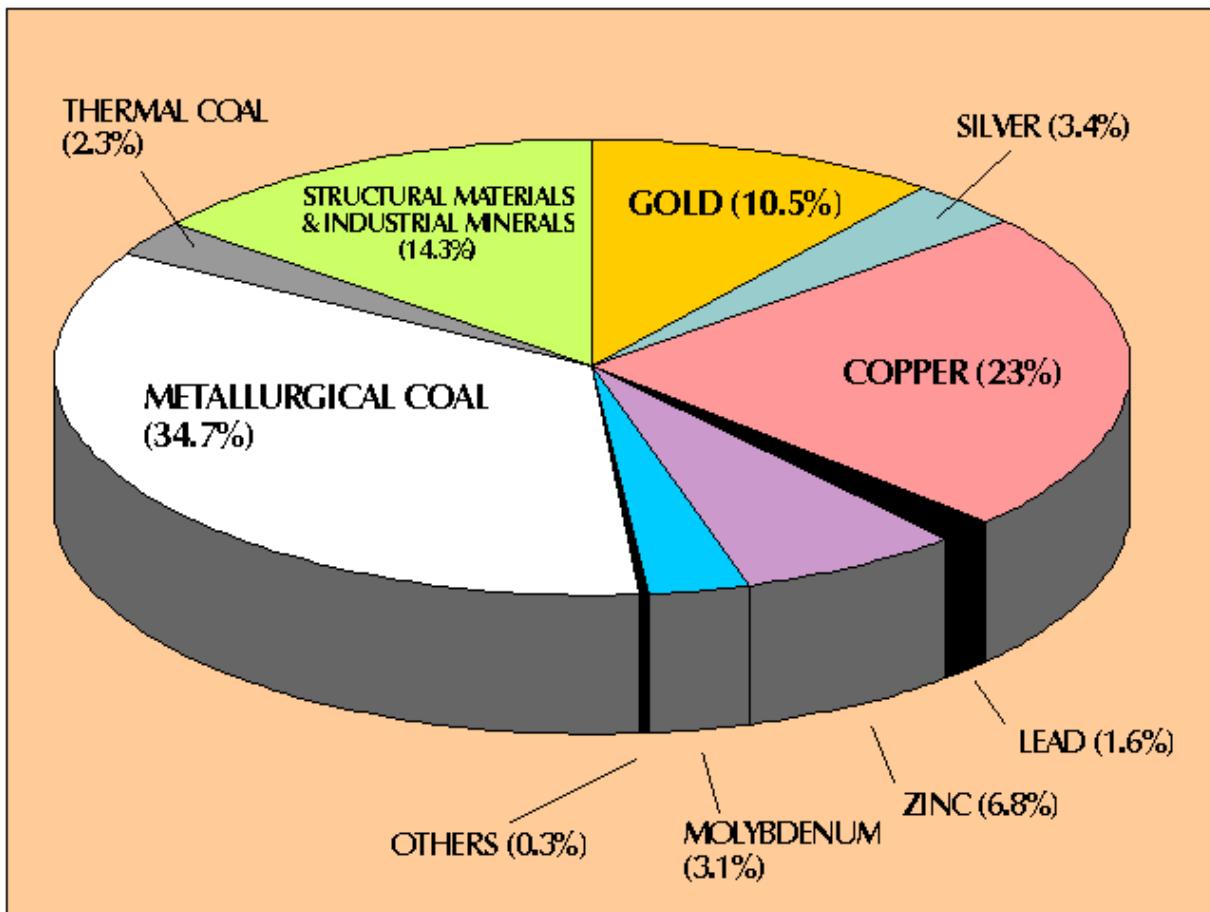


Figure 7. Forecast Of Value Of Mineral Production In BC - 1996.

Coal represents 37%, at a projected value of approximately \$1.13 billion, a 12% increase from 1995. Copper represents 23%, at a projected value of approximately \$700 million. These decreases in copper production reflect the closure of the Island Copper mine at the end of 1995, the closure of the Similco mine in November, 1996, the closure of the Goldstream mine in January, 1996, and the lower production volumes achieved at the Highland Valley Copper operation. During 1996 copper prices fell by approximately 34%.

The production of gold is forecast to be 18.5 million grams (575 400 oz) valued at \$320 million, down slightly from 19.8 million grams (636 000 oz) last year, primarily due to lower production from Nickel Plate (closed, Oct. '96), closure of the Island Copper mine at the end of 1995, closure of the Premier mine in April, 1996 and less output from smaller, high-grade custom-milling operations.

Increases in gold production are expected from the **Eskay Creek**, **QR** and **Table Mountain** gold mines. Silver output is forecast at 450 million grams (14 million oz) valued at \$105 million, up about 12% from 1995 due to increased production at the **Eskay Creek** mine. Zinc production in 1996 is forecast to be 140 kilograms worth \$206 million and lead output is forecast to be 45 million kilograms valued at \$50 million; both represent slight increases from 1995. The total metals value is down approximately 28% from the 1995 estimate. The value of production from industrial minerals and structural materials is forecast to be approximately \$435 million in 1996, down very slightly from 1995.

## Operations

### Metal Mines

Production during 1995 at the **Eskay Creek** gold-silver mine, operated by Homestake Canada Inc., through 50.6% - owned Prime Resources Group Inc., at a mining rate of 275 tonnes per day, totalled 6113 kilograms (196 550 oz) of gold and 309 480 kilograms (9.95 million oz) of silver from 100 470 tonnes of ore milled. This equates to a gold equivalent production of 10 300 kilograms (331 300) ounces; total cash costs were US\$185 per gold equivalent ounce.

Eskay Creek is the sixth largest silver producer in the world, and one of the highest grade gold and silver deposits (\$1800 to \$2200 per tonne of ore) ever discovered in North America. Ore is being blended on site, trucked to load-out facilities at Stewart and Kitwanga, and shipped directly to smelters in Japan and Quebec, by ship and rail, respectively.

In 1996 operations continued to exceed expectations; the tonnage shipped is expected to be over 99 770 tonnes with a total production target of 11 800 kilograms (380 000 oz) of gold equivalent, a 13% increase from 1995. Cash costs through the first three quarters of 1996 are estimated at US\$170 per ounce gold equivalent, down from 1995. The increase in production is attributed to higher productivity, reduced underground development, and increased metal production (higher grades and metal prices). Silver production to the end of the third quarter had increased by 23.5% and gold by 5% from 1995. Reserves in the 21B deposit estimated by Prime at January 1, 1996 were 1 019 468 tonnes grading 64.46 g/t Au, 2859.4 g/t Ag, 0.86% Cu, 3.07% Pb and 5.43% Zn, good enough for a 10-year mine life.

In-mine (30 000m) and surface (6280m) exploration drilling during 1996 have added 302 938 tonnes containing 19 346 kilograms (622 000 0z) of gold equivalent to Eskay Creek's ore reserves and resources (*i.e.* an 18.5% increase). These included proven and probable reserve additions of 220 000 tonnes grading 70.28 g/t Au in the 21B and 109 zones, and diluted geological resources of 82 537 tonnes grading 46.28 g/t Au equivalent in the NEX zone. A cut-off grade of 13.7 g/t Au equivalent was used. Although numerous drill intersections of high-grade mineralization were encountered in the HW zone, no new resources have yet been calculated. These high-grade gold-silver zones, significantly base-metal enriched (up to 30% combined lead and zinc) and uniformly low in deleterious elements, occur at the base of the hangingwall andesite unit and are interpreted as the stratigraphic extension of the northeast end of the main 21B zone, with a 45° plunge to the north-northeast.

As a result of positive exploration and metallurgical results, Prime has decided to proceed with permitting and design of a mill facility to be located at the Eskay Creek minesite. The underground drilling program is continuing at the north end of the mine to extend and upgrade the NEX and HW zones.

Production during 1995 at the **QR** gold mine, at an average milling rate of 1100 tonnes per day, totalled 659 850 grams (21 215 oz) of gold from 194 318 tonnes of ore milled. Reserves estimated by Kinross Gold Corporation at January 1, 1996 were 1 287 239 tonnes grading 4.35 g/t Au. During 1996 Kinross increased the milling rate to 1200 tonnes per day, 400 tonnes over design capacity, in order to meet its production target of 1 244 000 grams (40 000 oz) of gold. Cash operating costs during the first three quarters of 1996 were US\$272 per ounce gold, slightly less than in 1995. Overall gold recovery is estimated at 91%, with 20 to 25% of the gold coming from gravity separation. Overall silver recovery is estimated at 30% or less. In 1996 mining took place in the Main zone; resources there are expected to be exhausted by August 1997. Early in 1996, Kinross mined approximately 32 000 tonnes (nearly double that which was previously outlined by drilling) at an estimated grade of 5.6 g/t Au from two benches in the West zone. This material has been stockpiled for winter milling. Mining in the West zone will resume later in 1997. The decline being driven parallel to the Midwest zone will enable the company to drill-test the grade continuity of the zone, prior to mining in early 1997. Surface exploration drilling was carried out in several areas on the property in 1996. Drilling on the margins of the West zone has been successful in outlining approximately 8 months of additional millfeed.

On April 30, 1996 Prime Resources Group Inc. purchased Cominco Ltd.'s 60% interest in the **Snip** gold mine for \$55 million, thereby giving Prime 100% ownership in the mine. Homestake Canada Inc. was appointed as operator of the mine under a managerial agreement similar to that for Prime's Eskay Creek mine. Since start-up in January, 1991, to the end of 1995, the Snip mine has produced 20 800 kilograms (669 000 oz) of gold at an average cost of US\$165 per ounce gold. During 1995 the Snip mine produced 4000 kilograms (128 275 oz) of gold from 169 525 tonnes of ore milled. Mining was at a rate of 460 tonnes per day with a 12 g/t Au cut-off and operation costs are estimated at US\$175 per ounce gold. Proven and probable reserves estimated by Cominco at January 1, 1996 were

347 775 tonnes grading 26.74 g/t Au containing 9 250 kilograms (297 500 oz) of gold. In addition, possible reserve of 132 875 tonnes grading 23.66 g/t Au have been identified. During 1996 there were increases in production, depreciation and exploration expenditures. Lower productivity and lower production during the first half of the year were attributed to the mine's increasing reliance on narrow-vein mining methods and the uncertainty associated with the sale of the mine. In the second half, a refocusing of the mining effort has led to increased underground efficiencies which in conjunction with high grades, has put Snip back on track to achieve its 1996 production goals.

Cash costs during the first three quarters averaged US\$175/oz gold (cf. US\$174 in 1995). Recoveries for gold are approximately 35% by gravity circuit and 56% by flotation, for an overall 91% recovery. Concentrate has been shipped to the Premier mill near Stewart for further processing; however, Westmin has declined to accept shipments due to changing metallurgical characteristics in the concentrate resulting in a poorer gold recovery. Later in the year, concentrate was being "piggybacked" with Eskay Creek shipments to the Dowa smelter in Japan.

Exploration drilling of the Twin West (T-West) zone at 20m spacing gave inconclusive results. Homestake Canada plans to submit a mine plan to the British Columbia government to extract 36 000 tonnes of ore from this narrow (up to 1 meter) vein system which lies immediately to the north and west of the tailings pond. It hopes to be able to mine a high-grade ore shoot with a cut-off grade of 12 to 15 g/t Au.

The **Highland Valley Copper** mine, a partnership among Cominco Ltd. (50%), Rio Algom Limited (33.6%), Teck Corporation (13.9%) and Highmont Mining Company (2.5%), milled 45 521 000 tonnes during 1995 at an average daily throughput of 124 715 tonnes. Some 270 000 tonnes of ore and waste are mined daily. Production totalled 157 980 tonnes of copper contained in concentrate, 58 790 kilograms (1.89 million oz) of silver, 396.5 kilograms (12 745 oz) of gold and 1566.4 tonnes of molybdenum. Annual capital expenditures at the mine average \$25 to \$30 million while revenues amount to approximately \$400 million per annum. The mine is one of the largest operations in the world, ranking third on the basis of tonnage milled, and employs about 1100 people. Reserves estimated by the partnership, as of January 1, 1996, were 504 million tonnes grading 0.42% Cu, 4.8 g/t Ag, 0.032 g/t Au and 0.0076% Mo. Currently, 95% of millfeed is from the Valley orebody, 5% from Lornex. Mining cut-off grade averaged 0.25% copper equivalent (or approximately 0.2% Cu). In order to reach the credit limit for gold production, small amounts of gold from the Snip mine were added to the concentrate. The molybdenum content can account for up to 1% to 3% of the profit with molybdenum concentrate grades between 45% to 55% Mo. To facilitate mining in the Valley pit, in-put crushers (biggest in the world) were re-positioned as the east and northeast walls of the pit were being pushed back as part of the long-term expansion plan. Current mine plans call for mining another 200 m in depth in the Valley pit to the year 2008. In addition, the partnership may consider mining the remaining 120 million tonnes grading 0.33% Cu estimated to exist in the Lornex pit. Exploration in 1996 consisted of confirming mineralization in the JA orebody, which is covered by extensive overburden, and follow-up drill testing of geophysical anomalies in the east wall of the Valley pit and easterly across the Lornex fault. Also, exploration in 1995 identified a possible resource of 200 million tonnes grading 0.4% Cu at depth, below the current designed depth of the Valley pit. This resource was further examined in 1996 and resulted in the identification of an indicated resource of 350 million tonnes grading 0.384% Cu, which could extend the life of the operation by about 7.5 years.

During 1995 the Westmin Resources Limited **Myra Falls** mine produced 21 770 tonnes of copper, 26 780 tonnes of zinc, 17 000 kilograms (546 570 oz) of silver and 819 kilograms (26 330 oz) of gold from 1 197 000 tonnes of ore, milled at a daily throughput of 3650 tonnes. Proven and probable mineable reserves estimated by the company as of January 1, 1996 were 11 150 400 tonnes grading 1.6% Cu, 0.3% Pb, 6.1% Zn, 1.5 g/t Au and 27.5 g/t Ag. Geological reserves in the Battle zone, which is currently being developed and mined, are 2.5 million tonnes grading 2.0% Cu, 10.6% Zn, 1.0 g/t Au and 20.3 g/t Ag.

There are two other high-grade zinc zones closely associated with the Battle: The Gopher and Gnu, which together total about 700 000 tonnes. Exploration underground in 1996 increased the size of the Gopher zone substantially, while providing development ore to the mill. Westmin continued to increase its zinc production, largely from the Gopher/Battle zones, while maintaining historic levels of copper production, largely from the H-W deposit. It hopes to further increase zinc production once full production is achieved from the Battle zone and the Main 24 Level haulage route is fully operational. Westmin also completed construction of a cross-cut in the Price Mine area, designed to provide access for an additional drilling program on the Trumpeter zone in the fall or winter. Westmin postponed a deep drilling program (2-3 holes) on Phillips Ridge designed to test stratigraphy in the northwestern

part of the property where it hopes to be able to gain access via a new 750m cross-cut in the Lynx underground mine to the newly-discovered Marshall zone.

At the Gibraltar Mines Limited **Gibraltar** (McLeese Lake) mine, production during 1995 totalled 27 795 tonnes of copper in concentrate and 2600 tonnes of cathode copper and 30.4 tonnes of molybdenum, from milling of 13 852 610 tonnes of ore at a daily throughput of 37 950 tonnes. Reserves estimated by the company at January 1, 1996 were 162 302 200 tonnes grading 0.297% Cu and 0.009% Mo. The mine life is estimated at 12 years, not including resources in the Gib North, GM or Sawmill zones. Current mining is from Phase 3 of the Gibraltar East pit; the cut-off milling grade is 0.2% Cu. This operation with 275 employees, is highly efficient and one of the lowest grade (if not the lowest) copper mines in North America. Total operating costs for 1996 are estimated at US\$0.93 per pound copper. The molybdenum circuit was also in operation in 1996. The SX-EW plant accounts for approximately one seventh of copper production, with four active dumps providing the copper solution. Exploration in 1996 consisted of a small (2440m) diamond drilling program on the Sawmill skarn zone to the south of the mine, plus bulk sampling and metallurgical testing of surface oxide material from the Connector zone which is expected to add at least another 1.2 million tonnes of reserves to the mine. Over the next few years, an aggressive exploration and development program is planned, including the Pollyana pit expansion to the north-northeast to develop reserves in the GM zone and pit expansion in the Granite Lake zone. In mid-October, Westmin Resources Ltd., through its subsidiary WRL Acquisition Corp., effectively took over control of Gibraltar Mines Ltd., including the McLeese Lake mine.

During 1995 the Princeton Mining Corporation **Similco (Copper Mountain)** mine produced 17 113 tonnes of copper, 736.5 kilograms (23 680 oz) of gold, and 2970 kilograms (95 565 oz) of silver from 7 371 190 tonnes of ore milled at a daily throughput of 19 140 tonnes. Reserves estimated by the company at January 1, 1996 were 123 742 000 tonnes grading 0.393 % Cu, 0.155 g/t Au and 1.576 g/t Ag. During 1996 mining of approximately 14 million tonnes with an average grade of 0.32% Cu occurred in the Ingerbelle East pit; mining ceased in early November. Phase 2 expansion of the Ingerbelle East zone, involving a push back of the West wall and mining of a potential 20 million tonnes of ore eastwards down towards the Similkameen River, was cancelled. During 1996 Princeton conducted an aggressive three phase, diamond drilling (12 190m) exploration program on the east side of the Similkameen River, designed to establish sufficient low-cost reserves (*i.e.* in excess of 100 million tonnes grading 0.45% Cu at a strip ratio of 1.5:1 or less) for a 10-year mine plan. The primary (Phase I) target area, called the SP zone, encompasses existing reserves in the formerly producing Pit 2 and Pit 3 areas as well as extensions of known mineralization that occur between the two pits. Drilling also tested the Oronoco zone, which is located along the Virginia-Alabama mineralized trend, 910 metres to the west of the Alabama zone. Initial results from both the SP and Oronoco target areas were encouraging. Also, following some positive results from Phase I drilling on the Alabama zone, a Phase III drilling program will test for continuity of higher grade zones.

The Homestake Canada Inc. **Nickel Plate** open pit gold mine produced 2842 kilograms (91 365 oz) of gold from 1 461 780 tonnes of ore milled in 1995, at a daily throughput of 3635 tonnes. Total cash costs were (CDN \$379 per ounce gold). Reserves estimated by the company at January 1, 1996 were 696 655 tonnes grading 2.84 g/t Au. Mining, at a cut-off of 1.2 g/t Au, ceased in mid-July in the North pit. The entire operation over the past 9 years has produced approximately 24 880 kilograms (800 000 oz) of gold. Although the open-pit mineable reserves were exhausted, mineralization continues downdip to the west on to adjacent properties; future development might come from a decline from the bottom of the North pit on the north wall.

Production at the Westmin Resources Limited **Premier** gold mine during 1995 totalled 580 kilograms (18 665 oz) of gold and 6235 kilograms (200 495 oz) of silver from 179 500 tonnes of ore milled at a daily throughput of 490 tonnes. In addition, custom treatment of Snip mine concentrates during early 1996, yielded additional gold and silver. Later in the year, Premier ceased treatment of Snip concentrate. Reserves estimated by the company at January 1, 1996 were 260 000 tonnes grading 4.65 g/t Au and 68.0 g/t Ag. During 1996 millfeed came from the Glory Hole and other underground areas. Underground mining was suspended on April 12, 1996 due to poor grades in the developed zones and dwindling reserves. Fifty of the seventy-five employees were laid off. A compilation in early 1996 by the company identified a possible underground resource of approximately 1 million tonnes grading 7.9 g/t Au. Metallurgical testing examined the feasibility of producing a zinc concentrate. Westmin also conducted an aggressive, two-phase exploration surface and underground diamond drilling program, estimated to total approximately 12 800m, testing for mineralization between the No. 4 and No. 6 levels of the mine and also for deeper mineralization in the Martha Ellen zone on the Big Missouri deposit to the north. The overall target is to

identify enough reserves for three years of production. Preliminary results are very encouraging; a new mine plan is being developed with the potential for re-opening in the near future.

At the Afton Operating Corporation **Ajax** copper-gold mine production in 1995 from the Ajax East pit totalled 10 586 tonnes of copper, 747.5 kilograms (24 033 oz) of gold and 1450 kilograms (46 620 oz) of silver from 3 110 000 tonnes milled at a daily throughput of 8770 tonnes. Reserves for the Ajax West deposit estimated by the company at January 1, 1996 were 3 613 700 tonnes grading 0.48% Cu, 0.38 g/t Au and 0.86 g/t Ag. During 1996 mining took place in the Ajax West pit; much of the Ajax East pit has been backfilled with waste from the West pit. Afton has decided to close the mine in June 1997 due to higher operating costs and lower metal prices; layoffs began in December 1996. Teck Corporation carried out a large exploration program over the entire Iron Mask Batholith in 1996, including drilling programs on the Rainbow, Galaxy, Audra (between DM and Crescent zones), Coquihala East and West (south-southeast of Pothook zone), Supergene (north of Afton pit), and Galaxy North. (*see Advanced Exploration and Development Projects*). In addition, an estimated 3 million tonnes grading 1.5% Cu exists in the southwest wall of the Afton pit.

At the **Endako** molybdenum mine, Placer Dome Canada Limited produced 6536 tonnes of molybdenum in 1995, from 10 430 000 tonnes of ore milled at a daily throughput of 29 100 tonnes. Proven and probable ore reserves estimated by the company were 104 843 000 tonnes grading 0.077% Mo at January 1, 1996. Mining in 1996 took place in the Main zone pit; mine life is estimated at 10 years at an average grade of 0.126% MoS<sub>2</sub> and a cut-off of 0.07% MoS<sub>2</sub>. A relatively small (6-hole) diamond drilling program was also carried out; a much larger program is planned to test much of the property in 1997. Also, the mine supported a thesis study at the University of Alberta, designed to examined the structural controls of the ore zones and the temperatures of formation of the alteration and ore minerals.

Cominco Ltd. production at the **Sullivan** underground zinc-lead-silver mine in 1995 was 58 356 tonnes of lead, 113 024 tonnes of zinc and 21 118 kilograms (678 970 oz) of silver, from 1 616 000 tonnes of ore milled at a daily throughput of 6900 tonnes. Zinc concentrate production was the highest level achieved in the last 30. Reserves estimated by the company at January 31, 1996 were 11 435 200 tonnes grading 25.0 g/t Ag, 4.5% Pb and 8.0% Zn, sufficient for about another five years. Sullivan supplies 40% of Trail's zinc concentrates and 80% of its lead concentrates. Since 1923 when the concentrator started treating ore, approximately 140 million tonnes of ore grading 6.2% Pb and 5.6% Zn have been milled. In total, about 13.6 million tonnes of zinc concentrates (at an average grade of 48% Zn and 68.6 g/t Ag) and 10.9 million tonnes of lead concentrates (grading 66% Pb and 720 g/t Ag) have been produced and sold to Trail. At today's metal prices, that represents an estimated value of production of about \$6 billion.

In 1996 Cominco completed a deep (2600m) diamond drill hole in the Mark Creek area northwest of the mine to further evaluate a dislocated piece of the Sullivan deposit. It also conducted down-hole geophysics and a surface UTEM geophysical survey.

At the **Table Mountain**, Cusac Gold Mines Ltd. produced 411 kilograms (13 220 oz) of gold in 1995 from approximately 21 500 tonnes of ore averaging 19.2 g/t Au, milled intermittently at a daily throughput of 275 tonnes. Mining during 1996 came mainly from the Lily vein, which forms part of the northeast extension of the Michelle high-grade zone, where a decline was driven to the 13 level. Further exploration/development drilling continued to test the vein for additional reserves, especially to the east and to depth. This vein is the richest vein discovered on the property, with widths up to 3.66m and grades in excess of 68.6 g/t Au over a strike length of approximately 30m. Milling was carried out intermittently at a daily rate of between 60 and 70 tonnes, with an estimated head grade of 51.4 g/t Au. A limited amount of mining was also carried out on the previously-mined Vollaug vein; surface drilling also intersected significant values in 9 holes. The vein is estimated to contain proven, probable and possible reserves of 39 360 tonnes grading 15.43 g/t Au, raising total reserves, as of October 1, 1996, to 131 100 tonnes grading 12.69 g/t Au. Additional underground drilling continues on both the Lily and Vollaug veins. The company's target production for 1996 was approximately 653 kilograms (21 000 oz) of gold at a cash cost of US\$217 per ounce gold. Elsewhere on the property, an 1800m surface diamond drilling program tested a number of other targets.

Underground drilling led to the discovery of a new vein, the Melissa vein, located to the north of the Michelle zone. This new vein has been delineated by drilling over a 70m strike length and 20m downdip. Drifting towards this new

vein is in progress and mining is expected to start in early 1997. Cusac plans completion of the 10-portal in 1997, a major underground development project to improve access to the ore zones and, ultimately, to increase production. At the **Goldstream** mine, Bethlehem Resources Corporation produced 10 220 tonnes of copper and 1043 tonnes of zinc from 302 835 tonnes of ore at a daily throughput of 1100 tonnes. Reserves estimated by the company were approximately 22 000 tonnes grading 3.5% Cu and 2.15% Zn as of January 1, 1996. Mining and milling operations were terminated on January 31, 1996. During the mine's 4.5 year life, 1.8 million tonnes were milled yielding 65 600 tonnes of copper and 28 635 tonnes of zinc in concentrate. In March 1996, Imperial Metals Corporation's wholly owned subsidiary Bethlehem Resource (1966) Corporation entered into a purchase agreement with Goldnev Resources Ltd. to increase its interest in the mine, production facilities and tailings dam disposal area from 50% to 100%. Most of the Goldstream facility will be maintained on a stand-by-basis, pending the outcome of exploration programs on properties in the area of the Goldstream mine (*e.g.* Rain and Cottonbelt; *i.e.* custom milling potential).

The **Island Copper** mine produced 38 777 tonnes of copper, 1400 tonnes of molybdenum, 10 900 kilograms (350 800 oz) of silver and 661 100 grams (21 255 oz) of gold from 16 474 700 tonnes of ore milled at a daily throughput of 45 510 tonnes in 1995. Mining and milling operations ceased at the end of 1995. During its operating life from 1971 to 1995 inclusive, the mine produced concentrate yielding approximately 1.27 million tonnes of copper, 34 2114 kilograms (1.1 million oz) of gold 360 800 kilograms (11.6 million oz) of silver, 31 560 tonnes of molybdenum and 28.2 tonnes of rhenium. An estimated \$900 million was paid out in salaries and in excess of \$3 billion was added to the provincial economy. Mine reclamation in May 1996 involved the flooding of the pit, which had reached a maximum depth of 402 metres below sea level (the lowest man-made pit open to air on the earth's surface), to create a lake.

### **Coal Mines**

Total clean coal production in 1996 is estimated at about 26 million tonnes, approximately 23.1 million tonnes metallurgical and 2.7 million tonnes thermal, for a total forecast value of approximately \$1.13 billion. This represents an increase of approximately \$144 million (12%) over 1995. Most of the major plant expansions are complete so that the total capital expenditure at the mines is down, however, with equipment replacement it is still estimated at in excess of \$20 million for all the mines. Most mines are fine tuning long-term mine plans and two mines in the southeast (Line Creek and Greenhills) conducted exploration programs, outside their mine leases, aimed at better defining long-term reserves, which at the moment are not part of their mining plans. Total expenditure on exploration and development at existing coal mines is forecast to be approximately \$3.6 million in 1996, a slight decrease from 1995.

At the **Quinsam** mine on Vancouver Island, Quinsam Coal Corporation reached the design capacity of 100 000 tonnes of clean coal per month, one year ahead of schedule, and is on target to produce 1 million tonnes of clean coal in 1996. The company plans to further increase production to about 1.2 million tonnes annually or 17% above design capacity. This would almost double the output in 1996, with approximately 225 employees. Mining is from five sections underground. The company bulk sampled and began developing the "242" block at the south end of the coal lease. It also drilled the "4S" area for structural control ahead of development in the 2N area for additional resources. The "4S" and "242" blocks are providing millfeed; the "2S" block closed in late 1996. Total onsite exploration expenditures are estimated at \$210 000. The construction at the Middle Point loadout, north of Campbell River, is finished and the facility can now store 12 000 tonnes of coal and load at the rate of 1800 tonnes per hour. Quinsam also completed a major exploration program on the Tsable River property (*see* Advanced Exploration).

The **Fording River** mine, operated by Fording Coal Corporation, expects to ship approximately 7.3 million tonnes in 1996, a small increase over the 1995 production of 7 million tonnes. Major drilling programs on the mine lease were completed at Castle Mountain (10 holes totalling 6000 metres) and Henretta Ridge (30 holes totalling 4580 metres). Total exploration expenditures are estimated at \$1.2 million. At the **Greenhills** mine, Fording Coal expected to sell 4.2 million tonnes of coal in 1996, of which approximately 500 000 tonnes was thermal coal. This production was achieved with a workforce of approximately 360 persons, making the Greenhills mine one of the most productive surface coal mines in the world. The 1995 production was 3.8 million tonnes; 1997 production is projected to increase to 4.3 million tonnes. Exploration programs were completed on the mine lease and in areas adjacent to the lease. In-pit drilling (65 holes totalling 8500 metres) was estimated to have cost approximately \$350 000. Pit development work on the mine lease cost an additional \$60 000 (4 holes totalling 1200 metres). Two, off-site exploration drilling programs were conducted in the Burnt Ridge Extension area (Crow area) (16 holes totalling

2900 metres) at an estimated cost of \$200 000, and on Burnt Ridge (16 holes totalling 5000 metres), costing \$300 000. Mine plans call for the development of the West Spoil area for 12 years of mine life and the development of the Crow area to replace the Raven pit, where reserves will be exhausted in late 1997. The British Columbia Geological Survey Branch is conducting a study of the distribution of phosphorous, germanium, and selenium, at the Fording River and Greenhills mines.

**Coal Mountain** Operations, owned by Fording Coal Corporation, has increased production from 1.2 to 2.3 million tonnes and hopes to further increase production to 2.5 million tonnes in 1997. Manpower has increased to about 180 persons. Production is split approximately into 20% thermal, 40% PCI and 40% weak coking coal. Most of the plant expansion construction has been completed, although work is continuing on a new breaker site. Exploration continued in the pit 7 area (24 holes), south of the present pits, and in the Middle Mountain area (3 holes) to the north. Exploration drilling of approximately 6000 metres is estimated to have cost \$350 000.

At the **Line Creek** mine, Line Creek Resources Ltd. expects to ship 2.6 million tonnes of metallurgical coal and 740 000 tonnes of thermal coal in 1996; production in 1997 is planned to be about the same level. The access road to the new mining area (Horseshoe Ridge) was completed and mining of a small tonnage of thermal coal was scheduled to commence in late 1996. Construction of a 10-kilometre long conveyor was completed and it is undergoing commissioning trials.

At the **Elkview** mine, Teck Corporation increased production from 2.8 to 3.1 million tonnes; furthermore, it plans to increase production to 3.2 million tonnes in 1997. Most of the coal produced is metallurgical, although two varieties of weak coking coal are also sold. Mining is planned to start in the Natal Ridge area (*i.e.* large highwall pushback) in 1997 and mine plans are being developed for the Baldy Ridge area. Exploration associated with the new mine plans is estimated to have cost \$400 000, including the drilling of 80 holes totalling over 10 000 metres.

In the northeast, the **Bullmoose** mine (Teck Corporation, 60.9%; Rio Algom Limited, 29.1%; Nissho Iwai Coal Development (Canada) Ltd., 10%) is on target to ship 2 million tonnes at \$94 per tonne. A small exploration program, consisting of 30 drill holes totalling 3000 metres at a cost of \$75 000, was conducted in 1996. Three new 190-tonne trucks were purchased and will be commissioned before the end of the year. Existing data on the West Fork area is being re-evaluated in preparation for future exploration in this area which will probably supply coal past 1998.

The **Quintette** mine, operated by Quintette Coal Limited and managed by Teck Corporation, expects to ship 4.3 million tonnes of metallurgical coal in 1996 at \$89 per tonne. The company has negotiated an extension of its contract with Japanese steel mills by 6 months to September 30, 1998. The Shikano pit will be mined out over the next year. Development work is proceeding in the Babcock area and \$500 000 was spent on engineering studies. The company plans to mine about 500 000 tonnes from the Little Windy pit (Babcock Ridge) and continue development of other pits in the area in 1997. Three new 240-tonne trucks have been purchased to help achieve this target.

### **Industrial Minerals Mines**

British Columbia is producing a wide variety of industrial minerals and interest is on a steady increase. There are nine major mines and more than thirty smaller quarries. These operations are located mainly in the southern half of the province, close to existing infrastructure. The most economically significant industrial minerals produced are sulphur, magnesite, gypsum, white calcium carbonate, silica, barite, limestone and construction aggregate. The lesser quantities produced include jade, diatomite, magnetite, dolomite, dimension stone, pyrophyllite, volcanic cinder, clay, fuller's earth and zeolites. The annual value of production is in the order of \$60 million, with structural minerals (principally sand and gravel) accounting for another \$375 million.

**Sulphur**, which is a by-product of natural gas, is produced at five processing plants in the northeast part of the province. Some sulphur is also produced at the Trail smelter. Total annual production in British Columbia is between 600 000 and 650 000 tonnes.

In the Rocky Mountains, Westroc Industries Limited is producing approximately 460 000 tonnes of **gypsum** from its **Elkhorn** 1 and Elkhorn 11 quarries. After a two-year hiatus, the new owner (Georgia Pacific) of the **Canal Flats** operation began operating the Coyote Creek quarry. Its 100<math><math>000</math> tonne captive market is supplied from a stockpile, usually mined in one year of a three-year program.

Baymag Mines Company Limited continued to mine **magnesite** at **Mount Brussilof** at an annual rate of 180 000 tonnes. The magnesite is processed in Exshaw, Alberta into 15 000 tonnes of fused product and the remaining part as caustic magnesia. The company is gearing to shift its production from an existing rotary kiln into a newly-built shaft kiln. This will not only increase efficiency, but will also significantly increase the processing capacity.

The **Mount Moberly and Horse Creek** mines in the Golden area account for all high-grade **silica** production in British Columbia. Mountain Minerals Company Ltd. is producing approximately 140 000 tonnes annually at Moberly, for shipment to Springfield, Oregon, Lavington, B.C. and other destinations. Nugget Contracting Ltd. is producing 70<N>000 tonnes annually of which 50 000 tonnes is shipped to Wenatchee, Washington.

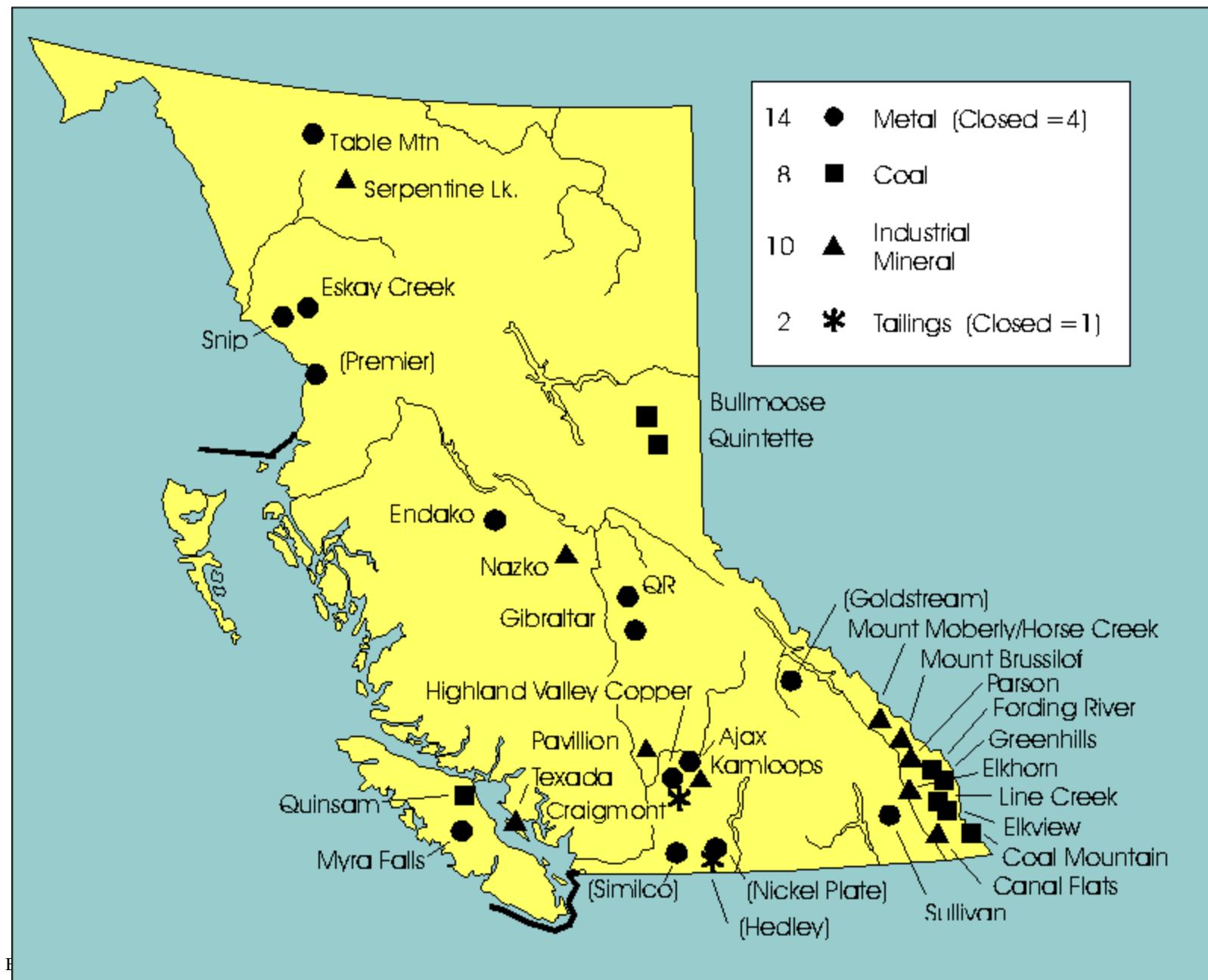
**Limestone** is processed in British Columbia by three cement plants and two lime plants. The majority of pulp and paper mills produce their own lime from nearby limestone quarries. The largest production centre is **Texada Island**, where two quarries, the **Gillies Bay (Holnam West)** and **Blubber Bay (Ashgrove Cement)**, ship some 5 million tonnes annually to customers in British Columbia, Alaska, Washington, Oregon and California. About 1 million tonnes of waste rock is sold annually from Texada Island as construction aggregate. The Continental Lime Ltd. **Pavilion Lake** plant produces up to 200 000 tonnes of lime per year from limestone quarried on the site, and the **Kamloops** cement plant of Lafarge Canada Inc. is producing up to 200 000 tonnes of cement annually from locally-quarried limestone. In Richmond, Lafarges' proposed \$130 million upgrade to its cement plant has gone through the Environmental Assessment Office review process; approval was recommended. The upgrade will allow the plant to produce 1.0 million tonnes of cement using limestone from Texada Island, coal from Quinsam coal mine and silica mainly from Fraser River sands. Near Prince George, Kode-Jerrat Quarries Ltd. at **Giscome** sells about 30 000 tonnes 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 at a rate of 160 000 tonnes annually. A small limestone producer at **Dahl Lake**, west of Prince George, has in recent years been processing old waste rock into decorative aggregate at the rate of some 20 000 tonnes per year.

Mountain Minerals Ltd. operates the **Parson** mine, British Columbia's only **barite** producer. The reserves are almost depleted; the mine may close by the year 2000, and the company is looking for a new source. The barite is being processed in Lethbridge, Alberta into drilling mud and fillers.

Clayburn Industries Ltd. of Abbotsford is processing locally-mined **fireclay** from Sumas Mountain, **diatomite** from Quesnel and **pyrophyllite** from Princeton into a variety of refractory bricks and castable refractory products. 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** property near Kamloops. Small quantities of **ornamental and facing brick** and **flueline pipe** are produced by Sumas Clay Products Ltd. operated by the Sumas Band near Abbotsford.

**Granite** and **marble** are produced by several companies. Stone-processing plants are operated by Westcoast Granite Manufacturing Inc. in Delta, Margranite Industries Ltd. in Surrey, Matrix Marble Corporation in Duncan and Garibaldi Granite Group in Squamish. Margranite is processing nine granite varieties from five quarry sites, Garibaldi Granite has three granite varieties from two quarry sites and Matrix Marble has two quarry sites with three marble varieties. San Pedro Stone commenced production of black granite blocks from a quarry near Grand Forks for export to Korea; the first shipment left Vancouver on January 30, 1996. Full quarry permits have been received and commercial development is scheduled for 1997. Three additional discoveries in the area include: 1) Imperial No. 1 (greyish-pink granite); 2) Gord No. 1 (blue/pink granite); and 3) Pedro (dark-green granite). Pender Capital Corporation and its 50% owned subsidiary Garibaldi Granite Group constructed a 12 500 square foot production facility in Squamish to supply dimension stone to international markets. The automated equipment began to produce finished products from raw materials extracted from the company's three quarries beginning in August. Pre-marketing efforts have shown promising results. Other active quarry sites include: Tsitika Stone Industries on northern Vancouver Island (grey granite), Granite Creations, north of Harrison Hot Springs (black granite) and Adera Natural Stone Supplies Ltd. on Granite Island near Sechelt. Franz Capital Corporation Ltd. has been delivering stone products from its **Kingfisher marble** quarry near Enderby to landscape and brick retail businesses and construction sites in British Columbia and Alberta. Products manufactured and stockpiled include split stone bricks and marble rock and chips.

Figure 6. Operating Mines In British Columbia - 1996.



**Flagstone** has been produced traditionally by Revelstoke Flagstone Quarries and Begbie Flagstone Ltd., together producing approximately 200 tonnes of mica schist flagstone. Kootenay Stone Centre in Salmo is producing about 4000 tonnes of **quartzite flagstone**. In 1996 two small local companies started to produce slate on a small scale near Port Renfrew on Vancouver Island.

**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, for stucco and roofing, fine aggregate, and synthetic marble products.

**Jade** production is concentrated in the Kutcho Creek area principally at the **Serpentine Lake** property being mined by Polar Gemstones Ltd. A small quantity of jade is also recovered from the old Cassiar Asbestos mine waste dumps by Jedway Enterprises. Jade West Resources Ltd. operates a jade processing facility in Surrey.

Canada Pumice Corporation is producing red **volcanic cinder** from its **Nazko** quarry west of Quesnel, at a rate of 40 tonnes per day. On a smaller scale, Great Pacific Pumice Ltd. started shipping **pumice** from its **Pum** property on Mount Meager, north of Pemberton.

### Tailings

Candorado Operating Company Limited completed mining of the **Mascot Gold** tailings in 1995. Production totalled 94 kilograms (3000 oz) of gold and 10 kilograms (320 oz) of silver from 42 640 tonnes processed. Processing of tailings was completed in October 1996; reclamation is in progress. M. Seven Industries Inc. continues to produce about 60 000 tonnes per year of magnetite by processing the **Craigmont** tailings. The company is supplying most coal mines in Western Canada.

### Advanced Exploration and Development Projects

#### Metals

It is estimated that about 73% of expenditures in 1996 has been for advanced exploration and development projects, including bulk sampling and environmental programs. A number of projects advanced to the development or bulk sampling stage. Three large porphyry deposits (**Kemess South**, **Huckleberry** and **Mount Polley**) are in the construction phase, with combined estimated capital costs totalling approximately \$650 million. The three mines, scheduled to be in production in 1998, collectively will create approximately 700 new, full-time jobs and an estimated 1500 indirect, largely service-oriented, positions. The locations of projects described in this section are shown in Figure 8 and listed, with resources, in Table 3.

The mine life for the Kemess South, Huckleberry and Mount Polley operations is estimated at a minimum of 16 years, 12 to 15 years, and 16 years respectively. Combined annual metal production from the three operations will be approximately 10 885 kilograms (350 000 oz) of gold and 68 540 tonnes (151 million pounds) of copper. Silver will also be produced from each operation as a by-product.

#### Porphyry (and Related) Deposits

Construction at the **Kemess South** project, owned and operated by Kemess Mines Inc., a wholly-owned subsidiary of Royal Oak Mines Inc., began in the summer of 1996, with projected capital costs estimated at \$390 million; it is scheduled to open in the second quarter of 1998. The mine will employ approximately 550 workers during peak construction and create up to 350 new permanent jobs when the operation is running at full production. By late fall 1996 close to 300 workers were on site. Mineable reserves are estimated by the company at 200.4 million tonnes grading 0.63 g/t Au, 0.22% Cu and 0.008% Mo containing 127 525 kilograms (4.1 million oz) of gold and 408 600 tonnes (900 million pounds) of copper. The 45 000-tonne per day milling operation is forecast to produce 7775 kilograms (250 000 oz) of gold and 27 240 tonnes (60 million) pounds of copper annually over its minimum 16 year life. The potential for the discovery of additional resources is good. Several other gold-copper deposits, such as Kemess North, with resources estimated at 175 million tonnes grading 0.18% Cu and 0.37 g/t Au, occur in the immediate area of the mine site on claims owned by Royal Oak Mines. Funding for development of the Kemess South project includes an economic assistance and investment package of up to \$166 million from the British Columbia government negotiated in compensation for the Windy-Craggy decision.

The company constructed an airstrip and mine workers will be flown to and from the property on a rotation basis. Construction of permanent camp facilities, service complex, mill buildings and a tailings dam are well underway. Clearing of the right-of-way for a 380 kilometre, 230 kV electric transmission line to the BC Hydro Kennedy Substation near Mackenzie commenced in November. A 59 kilometre access-controlled private haulage road has been proposed to connect the project to the BC Rail line near Sloane. If constructed it would be used to transport copper-gold concentrate from the mine to the railhead.

The **Mount Polley** gold-copper project, Imperial Metals Corporation (55%) and Sumitomo Corporation of Japan (45%), is in the advanced construction stage, with production scheduled for October, 1997. The mine will be developed by the Mount Polley Operating Company, and Sumitomo Corporation will act as concentrate marketing agent for the partnership. The Mount Polley deposit consists of three zones, named the Cariboo, Bell and Springer, with mineable reserves of 82 300 000 tonnes grading 0.3% Cu and 0.417 g/t Au. Annual production, at a daily mill throughput of 18 000 tonnes, is expected to average 3110 kilograms (100 000 oz) of gold and 11 800 tonnes (26 million pounds) of copper over the 12 to 15 year mine life. The operation will create 170 new, full-time jobs. Development of this \$123.5 million project is ahead of schedule and on budget. The concentrator and crusher buildings have been erected; interior construction will continue throughout the winter. Mined and stockpiled ore (approximately 750 000 tonnes of ore and waste) from the first two benches in the starter (Cariboo) pit will feed the mill at startup. A 69 kV electric transmission line will be extended from McLeese Lake to provide power. Construction of the tailings impoundment will be completed by the end of the year.

On the **Huckleberry** porphyry copper-molybdenum project, Huckleberry Mines Ltd., which is owned by Princeton Mining (60%) and the remainder held by a consortium of Mitsubishi Materials Corporation, Dowa Mining Co. Ltd., Furakawa Co. Ltd. and Marubeni Corporation, began construction on June 3, 1996. The project is scheduled for completion in late 1997 at a budgeted capital cost of \$137 million. Mineable reserves are 26 820 000 tonnes grading 0.48% Cu in the Main zone, and 72 710 000 tonnes grading 0.52% Cu in the East zone. The potential for additional reserves exists locally within the region. By late fall, the company stated that it expected the project to be completed at a cost of \$10 million under budget. The mine will process 16 500 tonnes of ore per day, at an estimated cash operating cost of \$0.65 per pound copper including molybdenum credits. Annual production is projected at 29 500 tonnes (65 million pounds) of copper and 54 tonnes (one million pounds) of molybdenum during a planned 16 year mine life. In addition, the mine will produce 185 kilograms (6000 oz) of gold and 8400 kilograms (270 000 oz) of silver annually.

The site is under construction with the permanent camp nearing completion; mill buildings being erected, a tailings impoundment facility excavated, and soil stockpiled for future reclamation. An eight-kilometre access road has been completed to provide more convenient access to the site via 122 kilometres of road from Houston. A 138 kV power transmission line is proposed to run parallel to the road route. The site will also be serviced by a new airstrip. Up to 300 persons will be involved in the construction phase and the mine will create 180 to 200 permanent full-time jobs during operation.

A detailed pre-feasibility study completed in 1995 on the Taseko Mines Ltd. **Prosperity** (formerly Fish Lake) porphyry gold-copper deposit was based on an open pit "reserve" of 675 000 000 tonnes grading 0.236% Cu and 0.435 g/t Au at a stripping ratio of 1.57:1. The deposit is estimated to contain 292 375 kilograms (9.4 million oz) of gold and 1 589 000 tonnes (3.5 billion pounds) of copper. At a projected 90 000 tonnes per day milling rate, the company forecasts annual production of 11 350 kilograms (365 000 oz) of gold and 69 460 tonnes (153 million pounds) of copper. The mine is projected to have a 21 year life. The capital costs are estimated at US\$430 million, with operating cash costs of US\$0.79/ounce gold, net of copper credits, based on copper at US\$1.00/lb. During the summer of 1996 and continuing through to the spring of 1997, Taseko is carrying out a large (\$13.5 million), in-fill drilling (39 250m in 69 holes) program designed to upgrade previously-drilled holes (*i.e.* preliminary tests in 1995 indicated the potential for an increase of 11% and 4% for gold and copper grades respectively). In addition, 18 holes totalling 3170 m of geotechnical drilling were completed to provide data on pit wall slopes and potential locations for rock dumps, tailings impoundments and other site facilities. Pilot plant metallurgical and process programs, which will include bulk sample testing were also initiated. Other feasibility level engineering studies were underway. The company plans to produce a bankable feasibility study after the completion of the drilling and to enter the Environmental Assessment Process shortly thereafter.

The Placer Dome Inc. **Mt. Milligan** porphyry gold-copper deposit contains resources estimated by the company at 298 400 000 tonnes grading 0.22% Cu and 0.45 g/t Au. Capital costs were projected in the \$500 to \$600 million range in 1993. The company is currently reviewing options to lower this cost; it is developing a revised pre-feasibility study which is scheduled for completion in 1997. It conducted a relatively small program consisting of test pitting and drilling for geotechnical information in the area of the new tailings pond impoundment.

On May 3, 1996 American Bullion Minerals Ltd. (80% interest) presented a pre-feasibility study on its **Red Chris** copper-gold project, to its partner Teck Corporation (20% interest) for Teck's decision to continue, or not, as operator of the project. Teck elected not to complete a final feasibility study. Since 1994 the companies had spent over \$10.5 million on exploration (74 780m of drilling in 244 holes) defining the Red Chris and Yellow Chris deposits. The pre-feasibility study outlined a resource of 494 000 000 tonnes grading 0.323% Cu and 0.254 g/t Au at a stripping ratio of 1.59:1 and based on a \$8.52 per tonne net smelter return. The deposit is estimated to contain approximately 124 400 kilograms (4 million oz) of gold and 1 589 000 tonnes (3.5 billion pounds) of copper. Based on a daily mill throughput of 90 000 tonnes, annual production is forecast at 5256 kilograms (169 000 oz) of gold and 93 980 tonnes (207 million pounds) of copper. The capital cost is estimated at \$541 million; mine life is estimated at 16 years. As an alternative, the companies examined a revised plan with lower daily mill throughput (*i.e.* 20 000 to 30 000 tonnes) and lower capital costs (*i.e.* \$300 to \$350 million), designed to rework the minable reserve at a higher cut-off grade. During the 1996 field season, American Bullion conducted ongoing environmental and socio-economic studies related to its application for a mine development certification.

International Skyline Gold Corporation increased its resource tonnage in 1996 as a result of a 2000m diamond drilling program on its **Bronson Slope** polymetallic porphyry property, located adjacent to the Snip mine. The company estimates a total resource of 97 920 000 tonnes grading 0.2% Cu, 0.5 g/t Au and 2.65 g/t Ag, at a net smelter return of \$8.00/tonne cut-off. Total contained metals include 56 300 kilograms (1 810 000 oz) of gold, 196 240 tonnes (432 252 000 pounds) of copper and 259 710 kilograms (8 350 000 oz) of silver. Metallurgical tests have demonstrated that molybdenum and magnetite are recoverable; these will add to the resource estimates. The company has begun a series of studies leading to a feasibility stage, based on a 12 000-tonne per day milling operation; it is scheduled for completion in 1997. The company also entered into a series of agreements with Prime Resources Group involving the acquisition of land to enhance the development potential of the project.

In January Royal Oak Mines Inc. completed the acquisition of the **Red Mountain** gold-silver project, 10 kilometres east of Stewart, and created a B.C. Division, with headquarters and offices based in Smithers, to carry on exploration, development, construction and administration for the Kemess South and Red Mountain properties. Between 1991 and 1994 previous owners had spent in excess of US\$30 million in exploration at Red Mountain. During 1996, Royal Oak with a project budget of \$8 million, drilled a number of targets utilizing up to 6 drill rigs, three at the Rio Blanco zone testing the JW extension, one on the Cambria zone, one at the Hartley Gulch zone and one underground on the JW zone. Deep drilling tested the plunge extension of the Marc-AV-JW zones; the mineralized zones are now interpreted to plunge more steeply to the northwest of the AV zone thereby potentially making the resource more accessible to mine from the valley bottom. A 300m underground extension was also completed. Surface and underground drilling in 1996 identified a new zone of mineralization (S.F.) located at depth to the northwest of the previously-known mineralized zones. Prior to 1996, Royal Oak estimated a resource of 1 921 680 tonnes grading 9.8 g/t Au. It is working on a revised estimate which is expected to increase the tonnage significantly, but the grade will be lower.

Teck Corporation drill-tested (in excess of 14 000 m) a number of targets in the Iron Mask region principally in the area between the Afton and Ajax deposits. Teck (70%) also continued to drill-test the **Rainbow** No. 2 porphyry copper-gold target, under a joint venture agreement with owner Getchell Resources Inc. (30%). A total of 71 holes have been drilled on the project resulting in geological reserves for the No. 2 zone estimated at 14.1 million tonnes grading 0.5% Cu, plus potential credits in gold and molybdenum to a depth of 300 metres. Drilling in 1996 tested a new zone of copper and gold mineralization discovered while testing the No. 2 zone in late 1995. Teck, Getchell and Afton Operating Corporation are evaluating the data to determine the extent of the next phase of exploration. One alternative involves underground mining, which would require a costly deep-drilling program to define deep, higher grade reserves. If successful, mineralization would be treated at the nearby Afton mill.

Also in January and February of 1996, Teck Corporation, under an option agreement with Getchell Resources Inc., completed a 32-hole diamond drilling program on Getchell's **Galaxy** property, with estimated resources at 3.2

million tonnes grading 0.65% Cu and 0.34 g/t Au. After an evaluation of the results by Afton Operating, Teck decided not to proceed with further exploration or development. For other target areas investigated, *see* Operations Metal Mines.

In the Greenwood camp, Britannia Gold Corporation and Bren-Mar Resources Ltd. completed a production-size, 600-m long decline, and an underground diamond drilling program to define high grade resource, previously estimated at 162 000 tonnes grading 8.9 g/t Au and 0.96% Cu for the **Lexington** Main zone. The decline is being extended a further 235 metres to allow underground diamond drilling of the 'lower' Main zone. Preliminary draft permits have been received to allow mining at 25 000 tonnes per year and processing of the ore at a nearby custom milling facility.

Imperial Metals Corporation completed an airborne geophysical survey over the **Giant Copper** property, and did follow-up diamond drilling on the Invermay zone. Drilling on the AM zone last year was designed to increase the near-surface tonnage, which is estimated to contain an open-pit resource of 29.5 million tonnes grading 0.65% Cu, 0.38 g/t Au and 12.34 g/t Ag. Drilling on the Invermay zone, located 1.5 km northwest of the AM zone, was aimed at establishing a second open-pit resource on the property. Preliminary results from the Invermay zone are very encouraging; the company believes it is testing a porphyry- to-transitional-type deposit, with the mineralization contained within a tourmaline breccia.

Camnor Resources Ltd., under a joint venture agreement with Gold Giant Minerals Inc., completed approximately 1750 metres of surface drilling on the Kiwi, Lower Icefall, Wilby, Wilkie and Edge zones, as well as underground drilling (20 holes totalling 1697 metres) on the North and North-North zones on the **Willoughby** project. The underground adit on the North zone was advanced 40 metres for a total length of 90 metres, as part of the overall \$1.3 million program. The drilling tested the zone along a strike length of 100 metres, a minimum dip length of 75 metres. Widths are variable to 8 metres, grades are highly variable, but high-grade intersections are reported. Drilling on the Wilkie zone tested a 60 metre strike segment at down dip depths of up to 70 metres; widths are variable to 3 metres. In drill testing for the extension to mineralization in the Wilby zone, a new sulphide lens, consisting of extensive pyrite/pyrrhotite mineralization, the Northern Deep, was discovered. Both the Wilby and Northern Deep lenses have been traced for 150 metres along strike with widths variable to 25 metres.

### **Massive Sulphide Deposits**

Redfern Resources Ltd. continued to conduct on-site environmental and socio-economic studies, associated with its application for a project approval certificate for its **Tulsequah Chief** volcanogenic massive sulphide deposit. Metallurgical studies were ongoing with a two-fold objective of reducing the lead in the bulk copper-lead concentrate, and concurrently producing a saleable lead concentrate. Redfern filed a project report under the Environmental Assessment Act in November. Contingent on project financing and government approval, the company could start detailed engineering design and construction on the project in 1997.

In the Gataga district, southeast of the Cirque zinc-lead-silver deposit, Inmet Mining Corporation continued to explore the depth potential of the **Akie** zinc-lead-silver sedex deposit it holds under an option agreement with Ecstall Mining Corporation. The Cardiac Creek zone has been traced by drilling along a strike length of 1400 metres, a thickness ranging from 10 to 30 metres, and to depths of 600 metres. Inmet has estimated a geological resource of 12 million tonnes grading 8.6% Zn, 1.5% Pb and 17.1 g/t Ag over a strike length of 1 kilometre. Due to structural complications encountered in the deep drilling program in 1996, Inmet terminated the program early, after completing one new deep hole and one started in 1995. The new hole completed (A-96-29) was drilled to test for a continuation of massive sulphide mineralization at a point 400 metres downdip of the previous deepest intersection of the Akie deposit made by hole A-95-18 in 1995 which intersected mineralization averaging 9% combined lead and zinc over 9.5 metres. Surface drilling also tested the strike projection to the north and south of the Cardiac Creek zone at 1-km intervals over a distance of approximately 7 kilometres. Encouraging results were reported, particularly from the northern end of the property.

### **Vein Deposits**

Bralorne-Pioneer Gold Mines Ltd., in a joint venture with International Avino Mines Ltd., purchased a 150 tonne per day milling plant from Zeballos and re-installed it at the **Bralorne** site. Existing geological reserves above the 800 level (main haulage tunnel) are 432 500 tonnes grading 10.63 g/t Au. The resource below the 800 level is

estimated at 549 125 tonnes grading 9.26 g/t Au. Initial production, scheduled for late 1997, will start above the 800 level. Four key zones, Peter, Big Solly, Millchuk and Maddy, discovered over the past several years, offer good potential to increase reserves. Bralorne-Pioneer has proposed mining from the Peter vein on surface to provide early mill feed. The initial capital cost is estimated between \$5 and \$7 million.

At the **Golden Bear** mine site, Wheaton River Minerals Limited and North American Metals Corporation carried out detailed surface diamond drilling on the Kodiak B and Ursula zones, as well as on several coincidental geochemical and geophysical anomalies located west of the Ophir Break (West Wall fault) in the host carbonate complex. A 61-hole reverse circulation drilling program also further tested the East Low Grade Stockpile zone, which had previously calculated resources estimated at 2 470 000 tonnes grading 1.3 g/t Au. The mine was originally built at a capital cost of \$89 million and between 1989 and 1994, 6780 kilograms (218 000 oz) of gold were recovered from underground and open-pit mining on the Bear Main zone refractory ore. The \$1.7 million 1996 exploration program was aimed at defining additional reserves to add to a long-term, heap-leach mining program. An expanded feasibility study, completed in late 1996, involving mining and milling of material from the Kodiak A and Ursula zones, estimated the recovery, by heap leach methods, of approximately 6656 kilograms (214 000 oz) of gold from 1 528 000 tonnes grading 5.1 g/t Au over a six-year period at a total cash cost of US\$232 per ounce. Mineable heap leachable reserves in the Ursula zone are estimated at 511 000 tonnes grading 7.0 g/t Au. Condemnation drilling has allowed for the selection of a preferred site for a second heap leach pad; an amended government permit has been received for the second site. The installation of the soil liner for the Kodiak A zone, with a permitted capacity of 325 000 tonnes and a maximum 21m height, was partially completed in 1996.

Reserves in the Kodiak A zone are estimated at 824 000 tonnes grading 3.3 g/t Au. In addition, a 10-hole, in-fill drilling program on the Kodiak B zone was successful in increasing probable geological reserves to 278 112 tonnes grading 8.6 g/t Au. A new mining plan has placed the reserves into the mineable category and added them to a long-term plan for the Kodiak A heap leach pad. Stacking of the pad with Kodiak A ore is scheduled to commence in June 1997; the first gold pour is scheduled for mid-August 1997. Wheaton forecasts 1997 gold production of 778 kilograms (25 000 oz) of gold.

Testing of several anomalies in the West project resulted in the discovery of three new gold zones, all within the carbonate complex. The C+C zone was located along the 5-km long Limestone Creek fault, located approximately 2-3 kilometres west of the Ophir Break. Other resources have been identified in the Kodiak C and Grizzly zones; these additional resources are estimated at 8615 kilograms (277 000 oz) of gold. Total resources in all categories at Golden Bear are estimated by the company at 15 270 kilograms (491 000 oz) of gold.

At the **Taurus** gold project in the Cassiar camp, Cyprus Canada Inc., under a joint venture agreement with International Taurus Resources Inc. and Cusac Gold Mines Ltd., continued its aggressive exploration program to delineate a large tonnage, low-grade, bulk mineable, potentially heap-leachable deposit in the spring of 1996. This program included surface drilling on several induced polarization targets outside the main zones, plus an extensive trenching and surface mapping program in the proposed starter pit area of the 88 Hill zone. In 1995, a consultant to International Taurus estimated the size of the gold deposit on the Taurus property to be at least 118 million tonnes grading 1.0 g/t Au. Furthermore, International Taurus estimated a potentially mineable resource within the 88 Hill zone of 43 545 kilograms (1.4 million oz) of gold in 45 350 000 tonnes grading 1.05 g/t Au. The early 1996 trenching program by Cyprus on the western half of the zone indicated a potential to increase the resource tonnage and grade. The trenches demonstrated continuity of individual zones up to 100 metres in strike length, within an overall strike length of approximately 1000 metres.

In July 1996, Cyprus relinquished its agreement as the size of the Taurus deposit failed to meet the company's requirements. International Taurus re-acquired a full interest in the property; it also reached an agreement with Cusac to earn up to a 70% interest in claims held by Cusac as part of the Taurus project. International Taurus immediately began an infill reverse circulation drilling program, at 25 metre centres, on the 88 Hill zone. It also completed additional trenching in the 88 Hill zone; this identified mineralization beyond the limits of the trenching program completed earlier in 1996 by Cyprus, and has confirmed a southern mineralized area up to 100 metres in width and several hundred metres in length. International Taurus completed 36 reverse circulation and 4 diamond drill holes in the 88 Hill zone (500m by 200m); drilling extended the zone 300 m to the west. It has calculated a preliminary drill-indicated reserve of 13 725 350 tonnes grading 1.01 g/t Au, and an inferred reserve of 25 134 000 tonnes grading 0.67 g/t Au. This places nearly 31 104 kilograms (1 million oz) of gold in a reserve category.

At the **Specogna** (formerly Cinola) gold deposit, which is part of Misty Mountain Gold Ltd.'s Harmony Gold project on Graham Island, Queen Charlotte Islands, a multi-million dollar diamond drilling program, on a 20 x 20 metre grid, with all holes angled towards the southeast, was conducted in 1996 and will be completed in the first quarter of 1997. Previous work by other operators had defined an open-pit mining resource of 31.3 million tonnes grading 2.2 g/t Au at a stripping ratio of 1.7:1. The drilling was oriented to the southeast at -45°, designed to crosscut at right angles the northeasterly-trending larger veins that dip to the northwest. Previous drilling in late 1995 and early 1996 demonstrated a 24% increase in gold grades in that portion of the deposit tested and the existence of high grade bonanza zones locally. When the drilling is completed in 1997, the deposit will have been tested over its 610m length, 210m width, and over 300m down-dip, and this will enable the company to calculate gold reserves. Mining plans will examine both the bulk-mineable, low-grade and the high-grade, bonanza (underground) potential of the deposit. Metallurgical and environmental studies are underway in preparation for the commencement of feasibility studies. Based on preliminary drilling (holes 95-001 to 96-088), Misty Mountain has calculated a preliminary geological resource estimate in the 62 207 kilograms (2 million oz) of gold range. Since 1995 Misty Mountain has completed more than 33 000m of drilling in over 140 drill holes.

In late 1996, Golden Angus Mines Ltd., a wholly-owned subsidiary of Canarc Resource Corporation, began a multi-million dollar underground exploration and development program on its **Polaris-Taku** project in the Tulsequah area. Drill-indicated geological reserves, contained in the AB, Y and C vein systems, were estimated in 1996 at 3.27 million tonnes grading 13.7 g/t Au at a cut-off grade of 6.86 g/t Au. A base case production model, proposed in 1996, forecasts annual production of 2800 kilograms (90 000 oz) of gold over a minimum 8-year mine life. Capital and cash operating costs are estimated at US\$50 million and US\$220 per ounce of gold respectively. Initial underground work will include rehabilitation, sampling and drilling of the upper workings on the AB and Y vein systems between the Canyon adit and the surface to test for potential open-pit resources, and testing the bottom of the mineralization below the 750 level on the C veins and the possible depth extension of the AB vein system. A recently completed geological review by the company had identified 39 separate drill targets, as well as 35 individual reserve blocks covering every level of the mine workings. The planned 200 drill holes in the 1996-1997 program are designed to increase the contained resource of 44 790 kilograms (1.44 million oz) of gold and to define a minimum of 22 395 kilograms (720 000 oz) of gold as mineable resources, sufficient to complete a bankable feasibility study for production in the spring of 1998. Engineering, environmental, metallurgical studies and permitting have commenced in preparation for an Application under the Environmental Assessment Process.

In 1995 Fairfield Minerals Ltd. sold 118.4 kilograms (3807 oz) of gold and 185 kilograms (3950 oz) of silver, recovered from 1840 tonnes of ore, from its bulk sampling program on the Siwash North vein on the **Elk** property and treated at the Asarco smelter at Helena, Montana. Reserves estimated by the company at January 1, 1996 were 121 350 tonnes grading 25.4 g/t Au and 35.3 g/t Ag. These include a diluted, probable, open-pit resource of 11 340 tonnes grading 58.97 g/t Au, an underground probable resource below the open pit of 20 225 tonnes grading 26.74 g/t Au, and a further possible underground resource of 89 790 tonnes grading 23.66 g/t Au. Past production included 14 620 kilograms (47 000 oz) of gold from open pit mining between 1992 and 1994, and 117 kilograms (3750 oz) of gold from underground test mining in 1994. A total of 994 metres of ramp access and three development levels exist underground. During September, Fairfield shipped all remaining stockpiles of gold mineralization, estimated at 2700 tonnes and grading greater than 12 g/t Au, (*i.e.* contained 283 kilograms (9100 oz) of gold and 358 kilograms (11 500 oz) of silver) to the Asarco smelter.

The 1996 exploration program consisted of 6873m of drilling in 91 holes, to test vein extensions below the underground development from 180m to 275m along a horizontal strike length of 210m, to complete in-fill drilling in the area of the open-pit resource and to test an area approximately 610m east of the current pit. The Siwash North zone has been traced along a 914m strike length and downdip to 245m. In addition, five other promising auriferous vein systems have been identified. In June 1996, Fairfield made an agreement with Almaden Resources Ltd. to take over management of the company. In July, Aurizon Mines Ltd. and Fairfield signed an option agreement, subject to a 60-day due diligence period; however, in September, Aurizon relinquished the option stating that the project did not meet its corporate goals. Fairfield continued with its drilling program, which resulted in the discovery of a new vein (WD vein), 200m north of the Siwash North vein and parallel to it. The drilling emphasis quickly shifted from the underground target to the new discovery; a total of 2630 m in 24 drill holes tested the vein for a 550 m strike length and downdip for 230 m.

In the spring of 1996, Huntington Resources Ltd. completed a 45m bypass tunnel to circumvent a caved portion of the 240 m long adit at the 1205 m level on the Bonanza zone of the **Brett** epithermal gold deposit. Between late 1995 and spring 1996, it mined and stockpiled approximately 1100 tonnes of mineralized rock, with an expected grade of 5.76 g/t Au. A 1992 resource estimate for the Bonanza zone identified approximately 12 000 tonnes grading 39.1 g/t Au. By the end of 1995, approximately 250 tonnes grading 34.18 g/t Au and 63.43 g/t Ag were mined from the surface of the high-grade R.W. vein and stockpiled. This material was trucked to Cominco's Trail smelter in early July for processing and sale. Concurrently, surface mining on the RW vein continued with the aim of stockpiling a further 250 tonnes grading 42.9 g/t Au for later shipment to Trail. The first shipment confirmed a preliminary forecast of 96% recovery of gold, and a silica content in the 80% range plus the logistics of mining, shipping and processing. In December, the company began driving a 27m raise in the hanging wall to mine ore in the Bonanza zone.

At the **Blackdome** gold mine, Claimstaker Resources Ltd. and joint venture partner Petro Plus Ltd., conducted a program of trenching, drilling and underground drifting and raising in search of new reserves on veins identified by previous work. Between 1986 and 1991 production totalled approximately 7000 kilograms (225 000 oz) of gold and 17 100 kilograms (550 000 oz) of silver at an average grade of 21.94 g/t Au and 51.1 g/t Ag. The on-site, 190-tonne per day mill facility is available and could be easily recommissioned with minor changes. A recent study by the company has outlined a resource of 159 600 tonnes grading 16.11 g/t Au and 37.0 g/t Ag, or approximately 233 kilograms (75 000 oz) of contained gold. The initial work was aimed at confirming resources so that a production decision can be made; the base target is 3110 kilograms (100 000 oz) of gold. A trenching program tested a new zone south of the rhyolite zone which appears to parallel the No. 1 and No. 2 vein structures. Follow-up diamond drilling tested the northern extension of the No. 2 vein. A raise was driven 12.8m on the No. 2 vein in the new zone, and 18m of drift advancement was completed on the No. 11 vein on the 1870 level. Encouraging results have been reported.

Athabaska Gold Resources Ltd. continued underground drilling and development on the Idaho zone and surface drilling in the McMaster zone on its past producing **Ladner Creek** (Carolin) gold mine, 18 kilometres northeast of Hope. These turbidite-hosted, mesothermal, epigenetic deposits were mined by underground techniques between 1982 and 1984. The mill, with a daily throughput capacity of 1360 tonnes, remains on site. Drilling in 1996 increased the underground resource by 272 100 tonnes. The current underground resource, estimated by the company, is 1 621 715 tonnes grading 4.42 g/t Au, plus an additional tailings resource 598 620 tonnes grading 1.75 g/t Au, for a cumulative resource of 8 205 kilograms (263 800 oz) of contained gold. A trenching program was aimed at defining an open-pit resource over the surface projection of the main Idaho zone. Bulk sample metallurgical testing was completed and confirmed that gold recoveries will be in the 85% range. The optimum mill process will be a simple flotation-only circuit with the gold-bearing concentrate being shipped to a custom smelter. Work in the first year of operation will consist of reprocessing the tailings; underground mining would follow. Total capital costs to reactivate both the mine and the mill are estimated at \$8.1 million. Average annual production from underground is forecast to be 1 646 kilograms (52 940 oz) of gold, at a cash operating cost of US\$380 per ounce gold. Mine life is currently estimated at 4 years; however, the potential for discovery of additional resources is considered excellent. Also, Athabaska continues to explore for other opportunities on a 15-kilometre long stretch of the Coquihalla Gold Belt along the East Hozameen Fault. In particular, encouraging results were reported from a late fall drilling program on the McMaster zone.

### Industrial Mineral Deposits

In 1996 exploration expenditures are estimated at approximately \$1.7 million, a decrease from the \$4.5 million spent in 1995.

Mountain Minerals Company Ltd. is developing a market for **zeolite**, in a variety of agriculture applications within Alberta, for its product from the **Ranchlands** Z-1 and Z-2 pits near Cache Creek. In 1995, Canmark International Resources Inc. mined a 10 000 -tonne bulk sample from the **Sunday Creek** deposit near Princeton to develop a market in the Lower Mainland. Market tests are continuing.

Quinto Mining Corporation Ltd. and IMP Industrial Mineral Park Mining Corporation continued sampling and evaluation of **graphite/sericite** and **graphite** from their **Lumby** and **Black Crystal** (near Slocan) properties respectively. IMP estimates a resource of flake graphite of over 27 million tonnes in the Black Crystal deposit. The

company stockpiled graphite at the mill which is nearing completion. It processed 5.5 tonnes at Quinto's laboratory in Lumby.

Super Twins Resources Ltd. continued exploration of the **Isk wollastonite** deposit on Zippa Mountain in the Iskut River area. It reported a potential open pit resource of 2 million tonnes of high purity wollastonite from the Cliff zone, one of five known zones. Drilling also tested the Cliff, Bartnick and Bril zones. The Bril deposit, 300m long by 100 m wide, was defined by the company as having the best potential for mining and additional reserves. The company hoped to establish a proven reserve of 18 million tonnes. A mine feasibility study is underway for production targeted to commence in 1997. Simple bench mining, slurry pipeline transport of the crushed wollastonite to the tidal Stikine River and then barging to a suitable port is proposed.

After the discovery of gem-quality **sapphire** in the Slocan Valley (**Blu Starr** property), Anglo Swiss Industries Ltd. continued sampling and evaluating the economic potential of numerous prospects. It also conducted systematic prospecting of alkaline rock occurrences in core gneiss units of the Omineca Crystalline Belt. It is plans to utilize its crushing, milling and laboratory facility located at its Kenville mine property, 30 kilometres by road from the Blu Starr deposit. Other minerals discovered include tourmaline, beryl, topaz, ruby, amethyst, and Japan quartz crystals. Gem-quality **aquamarine** has been found in pegmatitic dikes in the Valhalla Gneiss Complex near **Airey Creek**, west of Slocan Valley. High-quality, black and smoky grey quartz crystals are also common.

The **Klinker fire opal** locality near Vernon, being operated by Okanagan Opal Inc., has sparked some interest and at least two sites were discovered in 1996. Small scale test mining and marketing is ongoing.

Mining companies, as well as individual prospectors, are evaluating new **dimension stone** properties. Rose-pink granite and brown syenite were sampled for testing near Grand Forks, and a **flagstone** property was discovered near Nipple Mountain, east of Kelowna.

A **sodalite** occurrence at Mt. Laussedat, north of Golden, produced several thousand pounds of low-grade sodalite rock in 1996.

A pilot plant to process **Cassiar asbestos** tailings to recover the short fibre has been assembled by B.C. Chrysotile Corporation and processing may commence in 1997.

Quest International Resources Corp. reported the discovery of two new kimberlite pipes and a 1.5 mm gem-quality **diamond** fragment on its **Ice** property near Elkhorn, southeast British Columbia. Five kimberlite pipes were previously identified. A bulk sample of 27 tonnes was taken from each of three kimberlite pipes (Ram 5, Ram 6 and Ram 6.5) and a 4.5 tonne sample was taken from a kimberlite dike exposed in a road cut. A total of 86 tonnes of kimberlite material has been shipped to Fort Collins, Colorado for diamond testing.

Ava Resources Ltd. rehabilitated the access road to its attractive pink, banded **quartzite** deposit (**Wishaw**), east of Prince George, in preparation for test quarrying and sampling.

Dome Creek Structural Slate Company planned to extract blocks of **slate** from its **Dome Creek** property, east of Prince George, for shipment to Wales for testing but development work in 1996 was unsuccessful.

Cassiar Coal Company Ltd. continued development work on its **Stitt Creek placer garnet** property north of Revelstoke.

Highland Talc Ltd. is also active in developing the **Talc** Group claims north of Boston Bar.

## Coal

There were at least seven coal exploration programs in 1996, which were not on existing mine leases. Expenditures are estimated at approximately \$4.5 million, a significant increase from \$1.5 million in 1995. Predictions are for strong thermal coal markets and this has renewed interest in those coal deposits close to existing infrastructure, or in the case of Tsable River, close to tidewater. The outlook for metallurgical coal is for stable markets with a decrease in imports by Japan being offset by increased imports by other Far East countries. There is also a shift from hard

coking coals to weak and semi-soft coking coals. This may offset losses in hard coking coal markets by providing additional markets for some BC coals, albeit at a lower price.

At the **Telkwa** thermal coal project, Manalta Coal Limited conducted an extensive exploration program, including the drilling of 100 holes totalling 15 000 metres. Drilling in the Tenas Creek area, south of the Telkwa River, has proved significant resources in three shallow-dipping coal seams. The property now has four areas with mineable coal reserves. In the early 1980s, an open-pit resource was delineated east of Goathorn Creek (pit No. 3). In the early 1990s, pits (No. 7 and No. 8) were delineated north of the Telkwa River. This year, in addition to drilling, a bulk sample was excavated in the Tenas Creek area to provide coal quality and acid rock data for the Number 1 seam, which constitutes the current resource for this area. The Telkwa deposits are being computer modelled as an initial step towards a mining feasibility study. Preliminary plans call for mining with a plant on the Tenas deposit south of the Telkwa River, followed in later years by mining in the Pit 7/8 area. Manalta plans to enter the Environmental Assessment Process for a project approval certificate. The British Columbia Geological Survey Branch has an ongoing program examining the sulphur distribution in coal samples from the Tenas Creek area.

At the **Tstable River** project, south of Courtenay on Vancouver Island, Quinsam Coal Corporation (63%) and Marubeni Corporation (37%) conducted a large exploration drilling program (planned 27 holes totalling 7000 metres). An underground mine north of Tsable River closed in 1966 after producing a total of 1.8 million tonnes. The 1996 exploration program was south of Tsable River and to the east of the old mine. It was designed to increase the reserves in an area where a previous exploration program conducted in 1991 outlined at least 11 million tonnes of underground mineable coal. The program succeeded in increasing in-situ reserves in all categories to 38 477 900 tonnes, which would be sufficient for a 1 million tonne per year mine if the product is marketable. The company is currently assessing the coal quality and environmental and mine planning studies are in progress. A British Columbia Geological Survey Branch project is under way to measure methane in the core samples. Data will provide information for mine safety and an assessment of coal bed methane resources in the area.

In the northeast at the **Willow Creek** project, a joint venture between Globaltex Industries Inc., Mitsui Matsushima Canada and BCR Ventures conducted an advanced-stage drilling program. The drilling started in June; a total of 240 holes were completed (7500 metres). The drilling concentrated on increasing reserves in the Willow Creek East block and helped to better define the coal quality. Various environmental studies are ongoing and the companies hope to receive approval-in-principle for a 500 000 tonne per year mine in late 1997. Seven low-volatile coal seams with a total thickness of 20 metres have been identified; preliminary resources are estimated at 27 million tonnes of metallurgical coal. A full feasibility study is planned to be completed by late 1996-early 1997; employment during full operation is forecast at 80 to 100 persons.

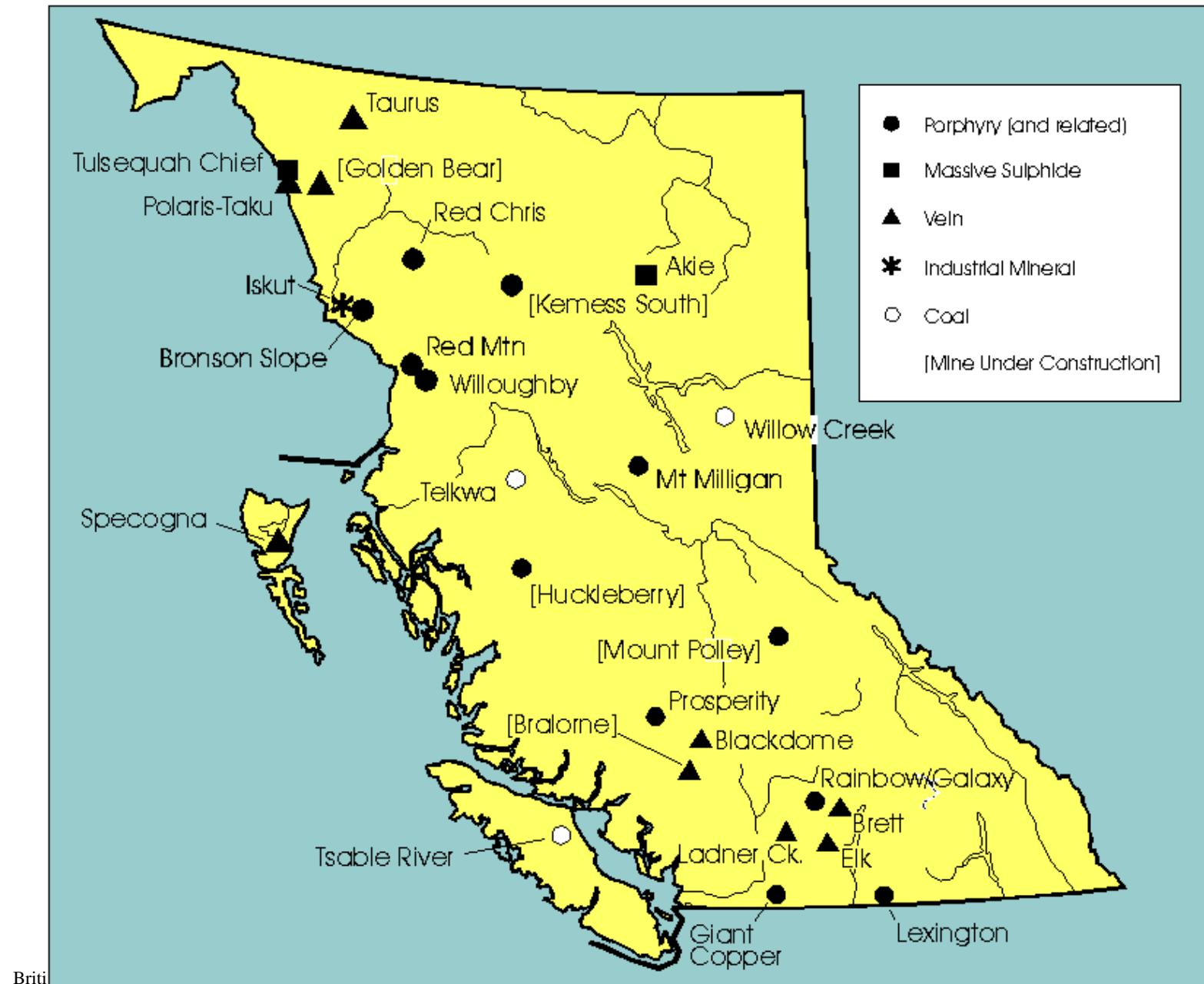
North of the Line Creek mine on **Mount Michael** Ridge, Line Creek Resources Ltd. conducted a helicopter-supported 6-hole drilling program totalling 2500 metres at a cost of about \$500 000. The drilling confirmed earlier interpretations based on surface geology. The British Columbia Geological Survey Branch continues to appraise the coal quality characteristics of the Gething Formation in the northeast.

In the southeast, a small exploration program including a proposed bulk sample test of 2000 to 5000 tonnes was conducted on the **Iron Creek** (formerly Bingay Creek) prospect. There has been no activity on McGillivray Mining Ltd.'s **Loop Ridge** metallurgical coal property in the Crowsnest Pass. The company hopes to negotiate an agreement whereby raw coal can be trucked to either the Coal Mountain or Elkview wash plants.

### **General Exploration highlights**

Gold-enriched porphyry copper ( $\pm$  molybdenum) and porphyry-related gold deposits, polymetallic massive sulphide deposits (volcanogenic, seafloor hydrothermal and sedex), and vein deposits (epithermal and mesothermal) accounted for approximately 86% of 1996 exploration expenditures in British Columbia. The remainder were directed to coal, industrial minerals, skarns and less traditional targets such as ultramafic-hosted nickel and redbed copper. Of the total estimated \$100 million exploration expenditures, only approximately 12% are in the less advanced to grassroots category addressed in this section. Although most of the programs were focused in and around areas with mines, mines under construction or new showings and existing infrastructure, several new, relatively low budget, regional programs were conducted throughout the province. As some claims lapsed, they were restaked by others who plan future work. The diversity of targets, from large, world-class deposits to smaller but

Figure 8. Advanced Exploration and Development Projects In British Columbia - 1996.



profitable targets, and the profitability of these smaller, higher grade deposits such as Eskay Creek and Snip, continue to make British Columbia a good place to explore. The properties reported on are shown on Figure 9 and listed in Table 4, with estimated reserves, where available.

### Porphyry and Porphyry-Related Deposits

The **Babine Camp** was very active in 1996. Booker Gold Explorations Ltd. continued to diamond drill high-chargeability and low-resistivity induced polarization anomalies on its **Hearne Hill** porphyry copper-gold breccia property, 20 km north of the Bell mine. Previously, the Chapman breccia zone had an estimated resource of 180 000 tonnes grading 1.74% Cu. Drilling approximately 200m to the northwest in 1996 located a new zone, the Peter Bland zone. Continued induced polarization surveys identified additional anomalies along a north-northeasterly trending strike length of over 1 kilometre. Individual breccia zones tend to pinch and swell; however, the company hopes that with further work, better continuity between zones can be established. The Peter Bland zone is estimated to be 500 m in length, 200 m in width and at least 460 m in depth. Within this zone, the company has outlined a high-grade core 460 m in length, 45 m in width and 460 m in depth. Till geochemical sampling has been particularly useful in defining drill targets. One such target was identified 80 m to 100 m to the west of the core zone, and may be a parallel system. Drilling confirmed the presence of porphyry -type mineralization in this area. Drilling is planned throughout the winter.

At the **Nak** porphyry copper-gold-molybdenum prospect, 30 km northeast of the Bell mine, Hera Resources Inc. continued drilling later in the season, with a focus on the southern area of the 2.5 km by 1.5 km alteration system. Approximately 5200m of drilling were completed in 27 holes. Encouraging results included the discovery of high-grade copper mineralization associated with a strongly tourmalinized structure. The reconnaissance drill program, with expenditures of over \$2 million to date, has indicated a mineral resource of 45.4 million tonnes grading 0.70% copper equivalent. Hera also completed a program of geological mapping, geochemical and geophysical surveys on its **Trail Peak** porphyry prospect, 55 km northwest of its Nak property. The surveys identified a well-defined, central induced polarization anomaly of 1000 m by 800 m; the overall system is indicated to be over 2 km in length. A comprehensive drill program is planned for early 1997. Teck Corporation conducted follow-up evaluation of a number of anomalies identified from its 1995 airborne survey. The British Columbia Geological Survey Branch conducted a 1:50 000 mapping program, till sampling, surficial mapping and a lake sediment survey in the region as part of the federal-provincial NATMAP program.

Spokane Resources Ltd. entered into an agreement to acquire from Rio Algom Exploration all right, title and interest in the **Mac** molybdenum-copper property, 40 km southeast of the Granisle and Bell mines, for 1.5 million shares. Drilling during the winter of 1995 and 1996 outlined three distinct zones of porphyry molybdenum ± copper mineralization contained within an alteration zone estimated to be 3.5 km long by 2 km wide: the Camp, Peak and Pond zones. Prior to conducting a further \$910 000 diamond drilling program in the fall of 1996, Spokane carried out additional induced polarization surveys, geochemical sampling and detailed geological mapping. The access route was also improved. A total of 4634m were drilled in 34 holes. Drilling targeted the Camp zone which is estimated to be 700 m in length, 300 m in width and at least 150 m in depth. The company estimates the zone has a potential geological resource of approximately 100 million tonnes with an expected average grade of 0.15% MoS<sub>2</sub> and 0.12% Cu. Included within this estimate is the potential for approximately 20 million tonnes with an expected average grade of 0.25% MoS<sub>2</sub> and 0.2% Cu. Drilling in this zone further defined the lateral and vertical extents of mineralization and extended the known mineralization. Drilling on the Peak zone, located 1 km south of the Camp zone, suggests an area of molybdenum-copper mineralization 1 km in length by 500 m in width, with the potential to host in excess of 150 million tonnes of mineralization. Drilling in 1996 indicates that the Peak and Camp zones are part of the same porphyry systems; the Peak zone appears to host more amounts of copper than the Camp zone. The Pond zone, located approximately 1 km north of the Camp zone, is estimated to be approximately 2 km in length and 2 km in width. Several additional targets have been identified. The Mac deposit represents a rather unique metal association, *i.e.* between an Endako molybdenum-type and a Bell copper-type.

At the **Lorraine** copper-gold-silver project, Lysander Gold Corporation expanded its claim holdings north and east to include a contiguous block totalling 250 sq. km., including the PAL claims and the Steelhead, Dorothy, Lorraine and Boote Steele properties. Previous drilling by the company in 1994 and 1995 has indicated significant values in copper and gold (*e.g.* 4.5 million tonnes grading 0.75% Cu and 0.34 g/t Au in the Upper Main zone). The company also believes it has identified a major buried alkalic centre lying immediately to the east of the Lorraine property. A

strong, circular magnetic ring (the Jajay Ring), 10 km in diameter with all known zones of mineralization around its rim has been outlined and will be the focus of a major exploration program in 1997. A modest drilling program of 10 holes in 1996 tested extensions to the Upper Main zone at depth, the southward extension of the Bishop zone by 300m, the potential for higher grade gold mineralization in the Eckland zone and the North Cirque zone. Geochemical sampling in the latter indicated the potential for a large new zone containing copper and gold.

In the northern part of the Highland Valley, southwest of Kamloops, Getty Copper Corporation conducted drilling programs on the **Getty North (Krain)** and nearby targets; the entire property encompasses approximately 100 sq km. At Getty North, Getty estimates indicated resources at 21 million tonnes grading 0.44% Cu, of which approximately 5 million tonnes is oxide material. Recently completed leach testing on a bulk sample resulted in a 82.4% copper recovery over a 120-day period. This material would be further processed using the solvent extraction-electrowinning process. Drilling is continuing throughout the winter. The company has identified the presence of significant supergene mineralization adjacent to the northeast portion of the Getty North deposit, beneath the Tertiary volcanic cover. Drilling is also testing an area approximately 1 km south of the deposit. Getty is evaluating the 1996 results and is planning a property wide program in 1997.

Verdstone Gold Corporation and Molycor Gold Corporation diamond drilled two deep holes on their Climax-Henderson-type **Salal Creek** (Float-Creek zone) molybdenum prospect, 70 km northwest of Pemberton. In addition, extensive surface sampling and mapping was completed in an area 1500 m long by 910 m wide, over the Float Creek zone. Prospecting also located new zones of molybdenum mineralization on Plug Creek, 300 m west of Float Creek, in Hit Creek Canyon, 800 m east of Float Creek and Red Mountain, 2000 m northeast of Float Creek. Previous work by Amax, Cerro, BP Minerals and Utah has outlined a mineralized area measuring approximately 2500 m by 460 m with Float Creek being the centre. The companies plan to continue the deep drilling program in 1997.

During 1996 Big Valley Resources Inc. conducted diamond drilling on the Lloyd 2 deposit on its **Lloyd-Nordik** copper-gold property, 1.5km north of the Mount Polley open pit development. The Lloyd 2 zone mineralization consists of pyrite and chalcopyrite in a monzonitic felsic breccia healed with magnetite. Similar mineralization occurs at the Road showing at Mount Polley which lies immediately to the east. In March 1996 the company reported a preliminary resource estimate for the Lloyd 2 target of 7 190 000 tonnes grading 0.31% Cu and 0.243 g/t Au, based on a copper equivalent cut-off grade of 0.1%. A revised estimate is expected in November. The drilling has also yielded several high-grade intersections of copper and gold. Trenching and drilling has also been conducted on the Lloyd 1, 3, 4, Nordik SE and BV zones. Drilling is continuing throughout the winter. During 1996, Verdstone Gold Corporation and Molycor Gold Corporation completed 8230m of diamond drilling and 2740m of percussion drilling on their **Crow-Rea** porphyry molybdenum prospect located 24 km south of the Brenda mine. The companies have identified a drill-indicated reserve on the Webb site zone of 500 000 tonnes grading 0.32% MoS<sub>2</sub>. Several anomalies remain to be tested.

### Precious Metal Bearing Veins and Bulk-Mineable Deposits

Exploration targets in this category cover a broad spectrum of hydrothermal, epigenetic mineral deposits. They include principally gold-and/or silver-bearing, high-level epithermal and deeper level mesothermal deposits. In the northern Toodoggone district, AGC Americas Gold Corporation completed 59 drill holes totalling approximately 6100 m on the Finn zone on its **JD** polymetallic gold-silver property, 65 kilometres north of the Kemess South project. Geological resources in the Finn zone (Canada Stockwatch, Feb. 4, 1997) were reported at 9 360 000 tonnes grading 1.61 g/t Au. Drilling in 1996 was designed to test known mineralization downdip to the north, below the Finn and Gumbo zones and westerly into the Gumbo zone. Geophysical surveys in the Finn/Gumbo area have outlined an anomaly 1300 m by 2000 m, but drilling has tested an area of about 600 m by 600 m. The Gumbo zone appears to be the up-dip, western extension of the Finn zone. The company now believes they are targeting a structurally-controlled, 600 m by 400 m, east-west trending zone with a central (epithermal-style) brecciated and silicified gold zone, enveloped by a large stockwork zone of quartz-carbonate veining with polymetallic disseminated and massive sulphides. The company postulates that porphyry-style mineralization in the footwall is related to a deep-seated porphyry intrusion, thus suggesting the potential for a much larger, lower grade, bulk mineable deposit. An induced polarization survey completed after this years' drilling defined several new drill targets to both the east and west of the current area of drilling. Further drilling and extensive geophysics is planned

for 1997. Calculation of a mineral inventory is underway using various cut-off grades. Metallurgical testing is also planned.

In the Blackwater River area in the Interior Plateau region of central British Columbia, Teck Corporation completed approximately 3365 m of diamond drilling in 23 holes in 1996 on its **Tsacha** epithermal gold-silver vein target. Drilling focussed on veins other than the Tommy vein which has been traced over a strike length of 640 m, an average width of 4 m and to at least 120 m downdip. The Tommy vein and all other vein systems strike north-south and have near-vertical dips. Trenching was also conducted across 2 kilometres of veins in an east-west direction; at least 8 veins have been identified which have the potential to host bonanza-style gold-silver mineralization of the adularia-sericite type. Drilling also tested the newly discovered Johnny vein (1995), located approximately 600 m west of the Tommy vein, the Barney vein (1996), located east of the Tommy vein near the eastern boundary of the property, and the Larry and Billy veins. In early 1997, Teck released a preliminary resource estimate for the Tommy vein of 478 000 tonnes, grading 8.7 g/t Au and 82.3 g/t Ag using a 3 g/t Au cut off. To the east, Phelps Dodge Corporation of Canada Ltd. drill-tested its **Tam/Taken** gold property. The best results were encountered from the Ted vein, which has been traced along strike for 300 m and over an average width of 10m. There is a good possibility that veins on the Tam/Taken and Tsacha properties are all part of the same mineralizing system. Nearby to the northwest, Lucero Resource Corporation conducted a 9-hole diamond drilling program on its **Wolf** epithermal gold prospect.

In the Likely area, Cyprus Canada Inc. under an option agreement with Consolidated Logan Mines Ltd. and Eastfield Resources Ltd. completed approximately 2700 m of trenching in eight trenches across the long axis of the mineralization plus detailed channel sampling and geological mapping on the **Spanish Mountain** (CPW) bulk-mineable gold target. Trenching suggests three zones of mineralization using a cut-off grade of 0.25 g/t Au. Previous exploration had concentrated on the higher-grade auriferous quartz veins; geological resources were estimated in 1994 at 861 650 tonnes grading 1.92 g/t Au. Cyprus examined the widespread occurrence of gold mineralization associated with a shale-siltstone horizon (*i.e.*, 'stratabound') as part of a sequence including intermediate to felsic volcanic and intrusive rocks. Cyprus terminated its option in the fall, as the property does not fall within its corporate criteria.

In the Wells-Barkerville area, famous for both its lode and placer gold production, International Wayside Gold Mines Ltd. conducted a large surface and underground diamond and percussion drilling program on its **Cariboo Gold Quartz** mine. The main objective is to outline a zone of gold vein mineralization in the up-plunge projection of the Rainbow zone, which could be mined by open-pit methods. The 1200 level adit was extensively rehabilitated providing access to the Rainbow zone through to the Sanders zone and Pinkerton zone. Drilling tested these zones along a strike length of approximately 730 m and a width of 120 m, for extension to previously known mineralization, particularly targeting the open-pit potential to a goal of 1 million tonnes grading 4.1 g/t Au. The Huestis zone was discovered in 1996 and occurs between the Rainbow and Sanders zones. Surface exploration was also carried out on the B.C. vein. An airborne geophysical survey was completed over the property, and a detailed compilation and evaluation of data was completed. The company received approval, but did not proceed, to extract a 9 900-tonne bulk sample for metallurgical testing, as part of its engineering studies leading to a feasibility study in 1997. Currently, the company is examining a proposal for a 1000 tonne-per-day milling operation from an open pit, including the potential of using a vat (heap) leach system to suit a combination of underground and open pit ore. South of Red Mountain in the Stewart camp, Teuton Resources Corporation and Minvita Enterprises Ltd. conducted a multi-million dollar surface diamond drilling and trenching program on its new **Clone** high-grade gold discovery. Funding was provided by Homestake Canada Inc. and Prime Resources Group; they retain a first right of refusal on the property. Furthermore, Homestake was contracted to provide technical advice. An airborne geophysical survey earlier in the season provided additional targets for drill testing. Diamond drilling in excess of 11 600 m in 95 holes and extensive trenching (140 trenches) tested the main zone and its extension along a 1.5 kilometre strike length and over a width of 60 metres. Two types of high-grade, sub-parallel, shear-controlled (both ductile and brittle deformation types) vein and stockwork complex structures, trending northwesterly and with vertical dips, host gold and gold-cobalt mineralization. The H-type, consisting of pervasive hematite and silica with minor amounts of chalcopyrite, specularite, magnetite and native gold, has a drill-defined strike length of 330 m and depths in excess of 235 metres. Individual veins are up to 7 m wide. The S-type, consisting of pyrite, arsenopyrite, cobalt-bearing mineral(s) and chlorite, have been tested over a strike length of 500 m and depths in excess of 150 metres. Individual veins are up to 6 m. Exploration along strike to the northwest (*i.e.* upslope) identified the Clone Extension, Anderson and Sutton East zones; and along strike to the southeast (*i.e.* downslope) identified a possible

extension of mineralization under the ice. In addition, regional prospecting has identified a one kilometre zone with gold-bearing stringer-type mineralization (Sutton West zone) located three kilometres west-northwest of the core Clone area, along its projected strike. A company preliminary resource calculation for the H-1 zone is expected in early 1997.

In the Lillooet area, Homestake Canada Inc. drilled the **Ample/Goldmax** mesothermal gold vein target, located to the east of the historic Bralorne gold camp. Native gold, arsenopyrite and minor pyrite occur in quartz with minor carbonate veins hosted within a shear zone in Lower Cretaceous Brew Group argillites, sandstones and minor greenstone.

North of Lillooet, Stirrup Creek Gold Ltd. conducted further trenching and diamond drilling on Zone V of its **Watson Bar (Second)** (Carlin-type?) gold target. Zone V was extended to a strike length of 80m, with bonanza grades being reported. It hosts a gently southwest-dipping carbonaceous fault zone(s) and subparallel mineralized quartz veins in Cretaceous sedimentary rocks of the Jackass Mountain Group, intruded by Eocene hornblende diorite. The bulk-mineable potential of the property is also of interest to the company. Immediately along strike to the northwest, First Point Capital Corp. conducted geochemical and geological surveys on the Mad epithermal prospect.

West of Port Hardy, First Choice Industries Ltd. conducted a preliminary 10-hole diamond drilling program on its high-sulphidation, gold-enriched **Knob Hill** prospect. A fine-grained sulphide stockwork in brecciated rhyolite was encountered underlying a 800m by 250m gold-arsenic soil geochemical anomaly. A follow-up geophysical survey was also completed.

### **Polymetallic Massive Sulphide Deposits**

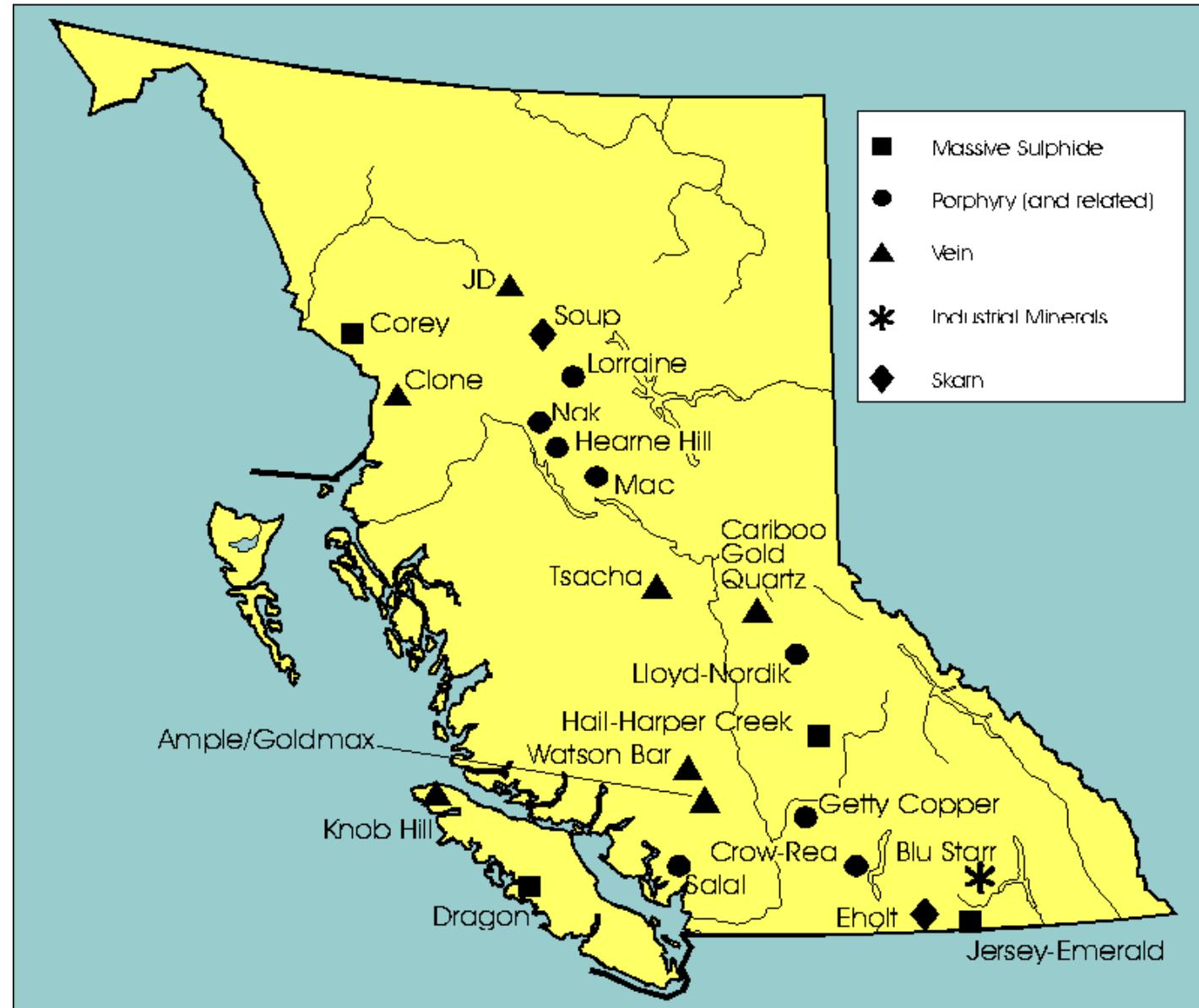
Base and precious metal rich (sedex, volcanogenic and seafloor hydrothermal) massive sulphide deposits were very important targets in 1996. The success of projects at Myra Falls, Tulsequah Chief/Big Bull, Eskay Creek, and Akie over the past few years testifies to the exploration potential for these deposit types. The discoveries and rapid development on the Wolverine and Kudz Ze Kaya deposits in the Yukon, hosted within the Yukon-Tanana Terrane, and the successful re-opening of the Greens Creek mine west of Juneau, Alaska are reminders that the rocks which host the deposits project into British Columbia.

On the **Dragon** polymetallic 'Myra Falls-type' prospect, located near Gold River on Vancouver Island, which Westmin Resources Ltd. holds under an option agreement with Doromin Resources Ltd., the company conducted a two-phase program which included geological mapping, geochemical and geophysical surveys and diamond drilling along a 4-km strike length of favourable Myra Formation volcanic rocks, between Muchalat and Norgate rivers. Drilling tested the Norgate Creek zone area, 3.6 km south of the Dragon zone, and a newly discovered area of potential significant mineralization south of Norgate Creek near Leighton Peak.

At the **Hail-Harper Creek** volcanic-hosted, stratabound copper prospect near Clearwater, American Comstock Exploration Ltd., under agreements with MBI Mining Brokers whereby American Comstock acquired a 100% interest in the project, conducted a 9-hole diamond drilling program designed to increase a previously calculated geologic resource of 96 million tonnes grading 0.41% Cu, 0.045 g/t Au and 2.5g/t Ag. Zones averaging 100 m in thickness with predominantly pyrite and chalcopyrite occur within a quartz-sericite-chlorite alteration zone in rhyolitic rocks of the Eagle Bay Assemblage. The company believes there is good potential to increase resources, particularly downdip to the northwest and along strike to northeast.

At the **Corey** property, 10 kilometres south of the high-grade Eskay Creek gold-silver-zinc-copper mine, Kenrich Mining Corporation drill tested the T.V., Cumberland and Bench zones, during a multi-phase, <N>\$ 1 million exploration program in 1996. A 35-person camp was established on site. In addition, a 1100 km airborne magnetic and radiometric survey was completed. Drilling on the Cumberland prospect identified two zones of massive pyrite, barite and sphalerite, including a new zone of high-grade silver mineralization. The T.V. zone was extensively remapped; drilling located a new silver-rich (pyrargyrite) portion hosted by black shales, extending the zone to the north and east. The company estimates an increase in the mineral inventory of the T.V. zone from approximately 2180 kilograms (70 000 oz) of gold and 31 100 kilograms (1 million oz) of silver to approximately 3920 kilograms (126 000 oz) of gold and 111 000 kilograms (3.57 million oz) of silver. Three drill holes tested the Bench zone.

Figure 9. Major Exploration Projects In British Columbia - 1996.



Regional prospecting resulted in the discovery of several high-grade auriferous quartz veins in the southern portion of the property (*e.g.* Sheellagh Creek showing).

During 1996 Sultan Minerals Inc. conducted a 1610 m surface and 90 m underground drilling program in three zones on its **Jersey-Emerald** stratabound sulphide deposits near Salmo. Underground drilling on the Bismuth gold zone, a flat-lying gold and native bismuth enriched horizon which parallels (and overlies?) the east limb of the Jersey deposit, identified a 9 m intersection of mineralization. Previous drilling suggested that this zone could be greater than 610 m in strike length and up to 18 m in width. Surface drilling on the 2.5 km long Emerald-Leroy gold-tungsten-arsenic anomaly, 1 km along the west limb of the Jersey deposit, identified a second gold-enriched zone over a strike length of 600 m and over narrow widths. Drilling of three surface holes totalling 600 m on the Iron Mountain 2.5 km long by 1.3 km wide copper-zinc-silver soil anomaly, located 1 kilometre east of the Jersey deposit, identified a 160 m thick section of banded, sulphide-rich schist containing pyrite, pyrrhotite, sphalerite and chalcopyrite. The company is examining the large tonnage, open-pit potential of this zone. Regional prospecting and geochemical sampling extended the favourable strike length of mineralization another three kilometres to the south of Iron Mountain in the Wilson Creek area. The company also added significantly to its land package, by acquiring through option agreements, the Tungsten King, Truman Hill, Leroy North, Summit, Boncher and Jumbo No. 2 properties. Preliminary prospecting on these led to some new discoveries.

### **Skarn Deposits**

In the Greenwood camp, Orvana Minerals Corporation and Teck Corporation entered into a 40/60 joint venture agreement to further explore Orvana's **Eholt** copper-gold skarn target. Drilling tested an area to the northwest of the Rambler showing and a 1.5 km long by 200 to 300 m wide northerly-trending anomaly which extends from the Dead Honda showing.

In north-central British Columbia, Vital Pacific Resources Ltd. (74%) and Athlone Resources Ltd. (16%) drilled 9 diamond drill holes on their **Soup** property. Drilling targeted a northwesterly-trending magnetite-rich, auriferous zone containing at least three stratiform lenses near the base of Takla Group volcanic rocks. Locally, the mineralization has been remobilized and is structurally controlled in cross-cutting fault zones. Geochemical, magnetic and radiometric surveys have outlined mineralization over a total strike length of 2.5 kilometres; the main target area (Saddle Gully zone) and anomalies 1 km to the northwest and southeast were tested. Although drilling problems plagued the project, the company intends to further pursue its open pit, bulk mining potential in 1997.

### **Other Targets**

Bren-Mar Resources Ltd. completed an aerial magnetic survey and a preliminary short, 5-hole diamond drilling program on its **Turnagain River** nickel, cobalt and copper ultrabasic-hosted deposit, east of Dease Lake. Gold City Mining Corporation, Phoenix Gold Resources Ltd. and Orion International Minerals Corporation are examining and evaluating the **Old Nick** nickel-cobalt prospect in the Rock Creek area, for its low-grade, bulk tonnage heap-leach potential. The companies believe this unique sulphide deposit, based on historical drilling and trenching, contains approximately 30 million tonnes of near-surface mineral inventory grading 0.22% Ni and 0.015% Co. Previous operators estimated the deposit could contain in excess of 100 million tonnes. During 1996, six diamond drill holes were completed to provide material for a metallurgical testing program, which includes leaching, solvent extraction and electrowinning. In August an option agreement was signed with Canadian Mine Services Ltd., and Monument Mining Corp. whereby the latter two companies have agreed to finance, further exploration and development in return for an eventual 70% joint venture interest in the property. High-grade redbed-type copper prospects were re-examined in the Bear Lake and Driftwood Creek areas, north of Smithers.

Table 4 - 1996 Exploration Highlights

Company Name	Project Name	Commodity	Estimated Tonnes (000s)	Estimated Grade	Reference
<b>Massive Sulphide Deposits</b>					
Doromin Res. Ltd./ Westmin Res. Ltd.	Dragon	Cu, Pb, Zn, Ag, Au			
Kenrich Mining Corp.	Corey	Au, Ag, Zn, Pb			
Sultan Minerals Ltd.	Jersey - Emerald	Au, Ag, Zn, Pb			
American Comstock Ltd.	Harper Ck.	Cu, Au, Ag	96 000	0.41% Cu, 0.045 g/t Au, 2.5 g/t Ag	
<b>Porphyry (and related) Deposits</b>					
Hera Res. Ltd.	Nak	Cu, Mo, Au	45.4	0.70 % Cu equiv.	Hera, 1996
Getty Copper Corp.	Getty North	Cu	21	0.44% Cu	Getty, 1995
Booker Gold Exploration Ltd.	Hearne Hill	Cu, Au	180	1.7% Cu	Prospectus,
Spokane Res. Ltd./ Rio Algom Ltd.	Mac	Mo, Cu	100	0.13% MoS <sub>2</sub>	Spokane, 1997
Lysander Gold Corp./ Kennecott Canada Inc.	Lorraine	Cu, Au	10 000	0.67% Cu, 0.34 g/t Au	Kennecott, 1993
Big Valley Res. Ltd.	Lloyd-Nordik	Cu, Au	7 190	0.31 % Cu, 0.243 g/t Au.	Big Valley, 1996
<b>Skarn Deposits</b>					
Teck Corp.	Eholt	Cu, Au			
Athlone Res. Ltd. / Vital Pacific Ltd.	Soup	Au			
<b>Vein Deposits</b>					
AGC Americas Gold Corp.	JD-Finn	Au	9360	1.61 g/t Au	SW, 1997
Teck Corp.	Tsacha	Au, Ag	478.6	8.7 g/t Au 82.3 g/t Ag	Teck, 1997
Gold City Mining Corp./ International Wayside Mines Ltd./ Mosquito Cons. Gold Mines	Cariboo Gold Quartz -	Au			
	Sanders Zone		690	3.84 g/t Au	
	Rainbow Zone		907	4.53 g/t Au	
Teuton Res. Ltd/ Minvita Enterprises Ltd.	Clone	Au, Ag			

Note: GCNL = George Cross Newsletter; SW=Canada Stockwatch.

## **Initiatives in British Columbia**

Several government programs that influence mineral resource planning, exploration and development in British Columbia were active during 1996.

- The **Prospectors' Assistance Grant Program** is designed to promote grassroots prospecting for new mineral deposits in British Columbia. It contributed up to 75% of eligible costs of an approved project to a maximum of \$10 000. Sixty-eight grants were awarded in 1995 from a budget totalling \$500 000.
- The **Geological Survey Branch** programs focused on regions where significant mineral potential is indicated (Gataga North, Yukon-Tanana Terrane (B.C.), French Range, Toodoggone Southeast-McConnell, Babine, Sitlka, Northern Selkirks, Tatogga Lake, Kootenay Terrane, Bella Coola and East Kootenays). A project was completed examining the metallogeny of the Rossland Camp; a new project was initiated examining the potential for bulk tonnage gold deposits. Several smaller scale projects were carried out on coal and industrial minerals. Results of these programs are expected to encourage base and precious metal exploration in these areas and elsewhere.
- The **Mineral Potential Mapping Initiative** will see completion of 1:250 000 scale mineral potential maps for the province in 1996, with the last area to be completed being the northwest sector. These data are being used in many land-use decisions.
- An inventory of **sand** and **gravel** resources was carried out and will assist the Ministry in managing the aggregate resources in the province.
- The Federal-Provincial **B.C. Geoscience Co-ordinating Committee** continued close liaison regarding the implementation of geoscience programs of the Geological Survey of Canada and the British Columbia Geological Survey Branch.
- A second open file on the "**Mineral Deposit Profiles**" was published. This brings the total to 60 published metallic deposit types. Short courses on parts of the project were delivered at Cordilleran Roundup 1996 (Vancouver) and the Northwest Mining Association Conference 1996 (Spokane, Wa.).
- The **National Geoscience Accord**, which strengthens the federal-provincial geoscience activities in a collaborative manner, was signed in 1996.
- Discussion continued with the **First Nations**, spearheaded through the Treaty Commissions in British Columbia, designed to provide them with a more equitable role in mineral exploration and development decision making within their traditional territories.
- The Nchako Plateau-Babine Porphyry Belt **NATMAP** program by the Geological Survey Branch and the Geological Survey of Canada in the Nchako River (93F), Fort Fraser (93K) and parts of the Smithers (93L) and Prince George (93G) map areas was in full swing, as part of a five-year project.
- The results of the East Kootenay multi-parameter **airborne geophysical survey**, funded by the provincial government covering two blocks surveyed in 1995, were released on July 11, 1996; a third block (Yahk-Creston) was flown in the fall of 1996 and the results will be released in 1997. Several new claims were staked, primarily targeting Sullivan-type targets.
- The release of **Regional Geochemical Survey** (RGS) data of the Cry Lake (104I) map sheet on July 4, 1996 resulted in numerous claims being staked. During the summer of 1996, similar surveys were completed in the Toodoggone River (94E) and McConnell Lakes (94D) map sheets; results will be released in the early summer of 1997.

- The Ministry continued working on a comprehensive review of mineral exploration practices and permitting procedures to develop standards compatible with the Forest Practices Code. The new **Mineral Exploration Code** is expected to be adopted in early 1997.
- The Ministry participated in an interagency study concerning **placer mining** in the province.

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