Province of British Columbia
Ministry of Energy, Mines and
Petroleum Resources
Hon. Anne Edwards, Minister

MINERAL RESOURCES DIVISION
Geological Survey Branch

EXPLORATION IN BRITISH COLUMBIA 1991

Part A - Overview of Exploration Activity
Part B - Geological Descriptions of Properties

The following format is recommended when referencing manuscripts in this publication:

Cook, S.J., Jackaman, W. and Matysek, P.F. (1992): Follow-Up Investigation of Anomalous RGS Stream-Sediment Sites in Southeastern British Columbia: Guide to Potential Discoveries (82E, F, G, J, K, L); *in* Exploration in British Columbia 1991, *B.C. Ministry of Energy, Mines and Petroleum Resources,* pages 51 - 59.

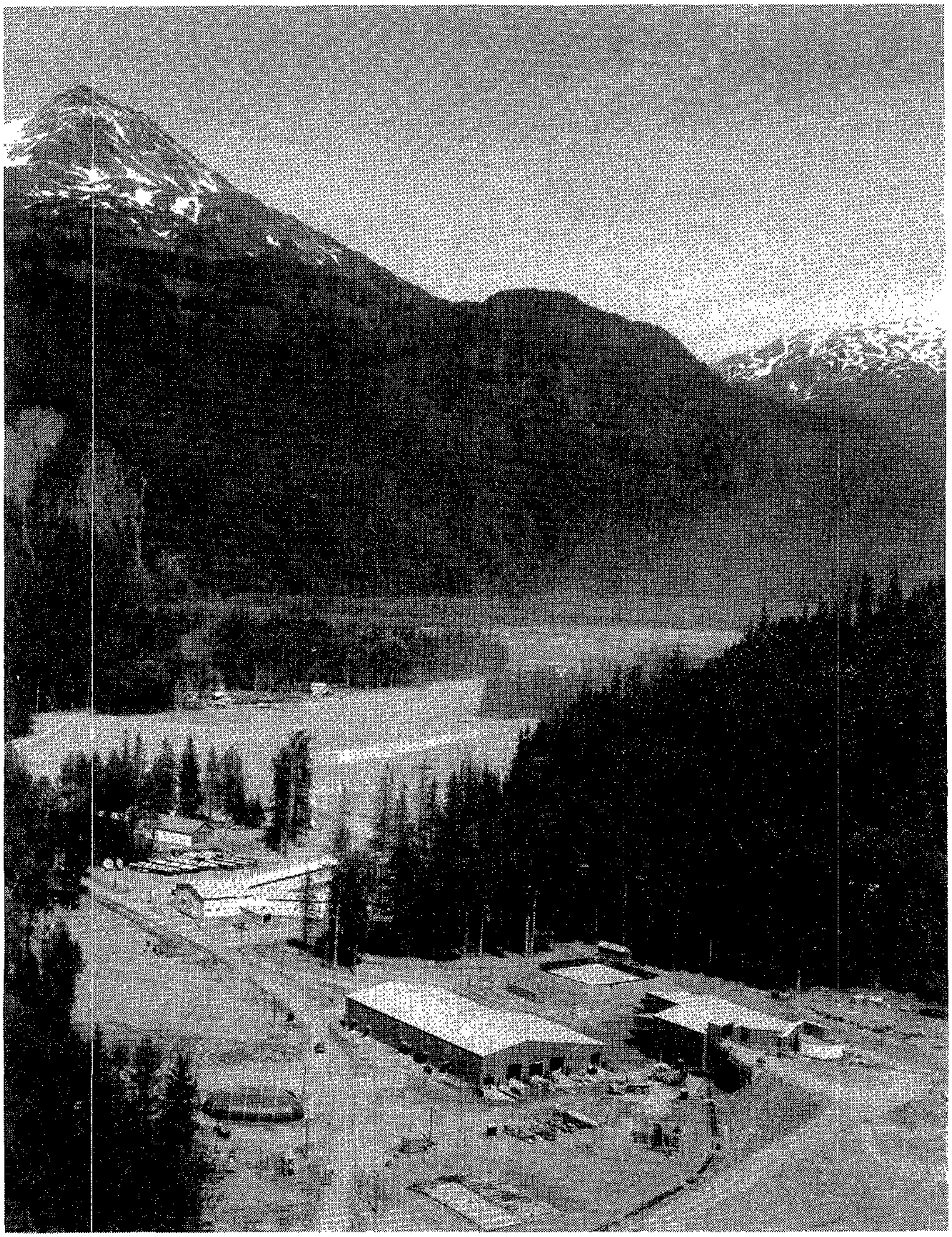
British Columbia Cataloguing in Publication Data
Main entry under title:
Exploration in British Columbia - 1975-
Annual.
With: Geology in British Columbia, ISSN 0823-1257; and, *Mining in British Columbia*, ISSN 0823-1265, *continues: Geology*, exploration, and mining in British Columbia, ISSN 0085-1027.
1979 published in 1983.
Issuing body varies: 1975-1976, Ministry of Mines and Petroleum Resources; 1977-1985; Ministry of Energy, Mines and Petroleum Resources; 1986-, Geological Survey Branch.
ISSN 0823-2059 - Exploration in British Columbia.

1. Prospecting - British Columbia - Periodicals. 2. Geology, Economic - British Columbia - Periodicals. I. British Columbia. Ministry of Energy, Mines and Petroleum Resources. II. British Columbia. Ministry of Energy, Mines and Petroleum Resources. III. British Columbia. Geological Survey Branch.

TN270.E96 622.1'09711
Rev. April 1987

VICTORIA
BRITISH COLUMBIA
CANADA

AUGUST 1992



The Snip Mine, in Northwestern British Columbia, was opened in July 1991. It is owned by Cominco Ltd. and Prime Resources Group Inc. Bronson airstrip is visible in the background. (Photo courtesy of Cominco Ltd.)

FOREWORD

During 1991 the mineral exploration and mining industry in British Columbia experienced a significant decrease in activity. This, in part, reflects depressed international metal markets, increasing competition and regulation, and lack of risk financing. Notwithstanding these difficulties three new metal mines opened in 1991. The Snip gold mine opened in July and the Goldstream copper-zinc mine was reopened the same month. In March, Westmin Resources Limited announced a production decision for the Au-Ag-Cu-Pb-Zn Facecut-35 zone on the SB property which is adjacent to the Premier Gold mine. Important developments in the province include significant progress on the Kemess and Fish Lake porphyry deposits, development approval for the Stronsay Zn-Pb-Ag project, and the discovery of the Gibraltar North zone of approximately 30 to 40 million tonnes.

The serious downturn in exploration in British Columbia is reflected in a drop of 41 per cent in claim staking activity, 58 174 units in 1991 versus 100 484 units the previous year. Exploration expenditures were $87 million, a drop of 60.8 per cent from the $143 million expenditure of 1990. Activity centred mainly on porphyry gold-copper targets and base metal targets in established exploration camps.

The British Columbia Geological Survey Branch had an active program of fieldwork in 1991 with projects in regional mapping, mineral deposits, surficial geology and regional geochemistry. The results of these surveys were published in Geological Fieldwork 1991, Paper 1992-1.

W.R. Smyth
Chief Geologist

PART A
OVERVIEW OF EXPLORATION ACTIVITIES

TABLE OF CONTENTS

PART B
GEOLOGICAL DESCRIPTIONS OF SELECTED PROPERTIES

PART A

OVERVIEW OF EXPLORATION ACTIVITIES

BRITISH COLUMBIA EXPLORATION AND DEVELOPMENT HIGHLIGHTS FOR 1991

By V.A. Preto,
Manager, District Geology and Coal Resources

INTRODUCTION

The year 1991 was again one of significant developments in British Columbia, but also of severely decreased exploration activity, particularly by junior companies and individual prospectors. These proven mine finders struggled against a lack of investor confidence, softening base and precious metal prices, rising costs, increased concern over land alienation, and mounting offshore competition.

In spite of these difficulties, British Columbia's mineral resources proved worthy of the challenge, and the junior sector confirmed its resilience, innovation and effectiveness by making significant progress on two major, large-tonnage copper-gold projects, **Fish Lake** and **Kemess**. These, and others, are the subject of this Review.

Exploration expenditures in 1991 are estimated at $87 million, a significant decrease from the $143 million in 1990. Activity was primarily in the central and northern parts of the province, in pursuit of precious and base metal targets.

New mineral claim units recorded for the year are 58 174, a drop of 41 per cent from the 100 484 in 1990.

Preliminary surveys estimate the total value of British Columbia solid mineral production (metals, industrial minerals, structural materials and coal) for 1991 at $2.78 billion compared to $2.97 billion of the previous year. Coal continues at the top of the mineral production list with an anticipated output of 25 million tonnes (metallurgical and thermal) valued at $949 million. Copper remains

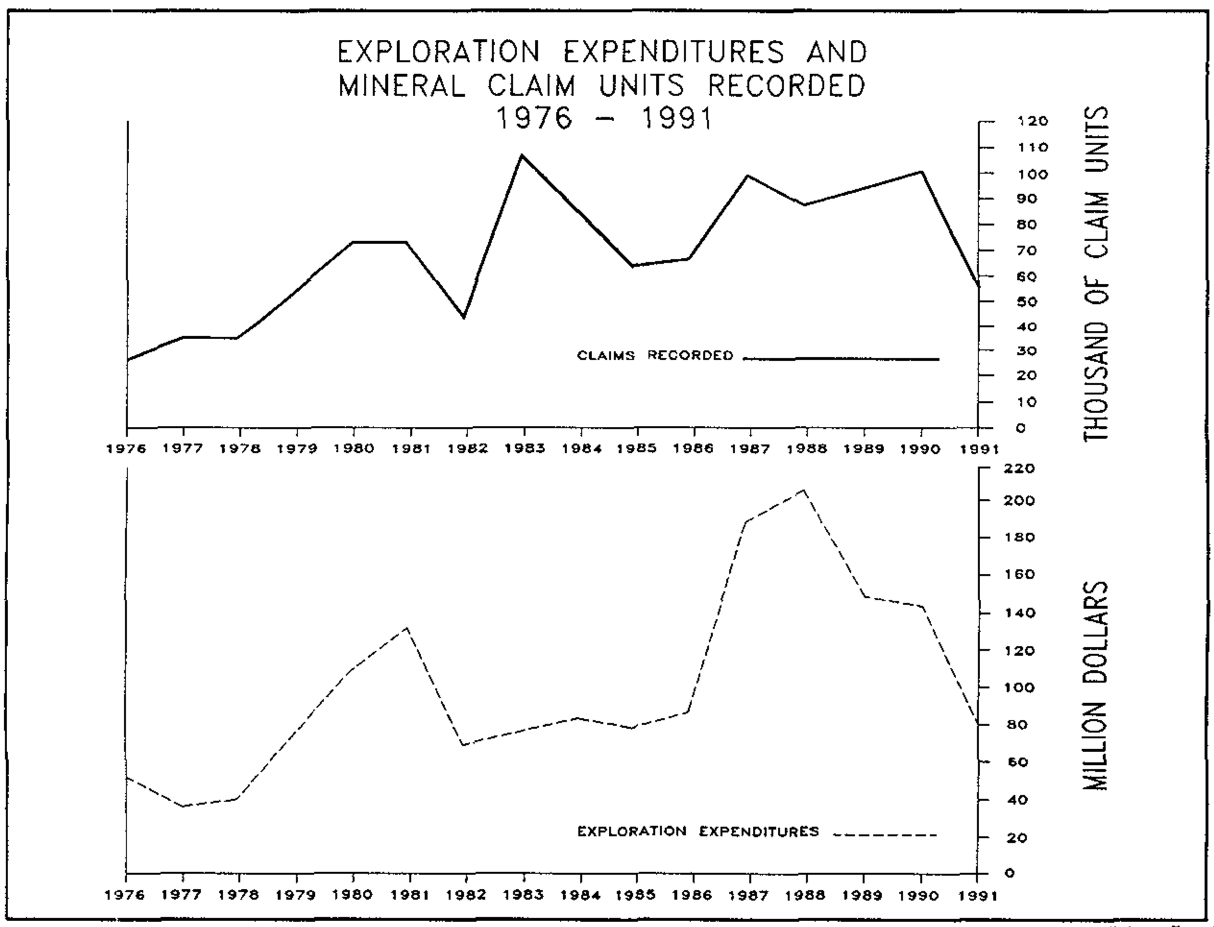


Figure A-1

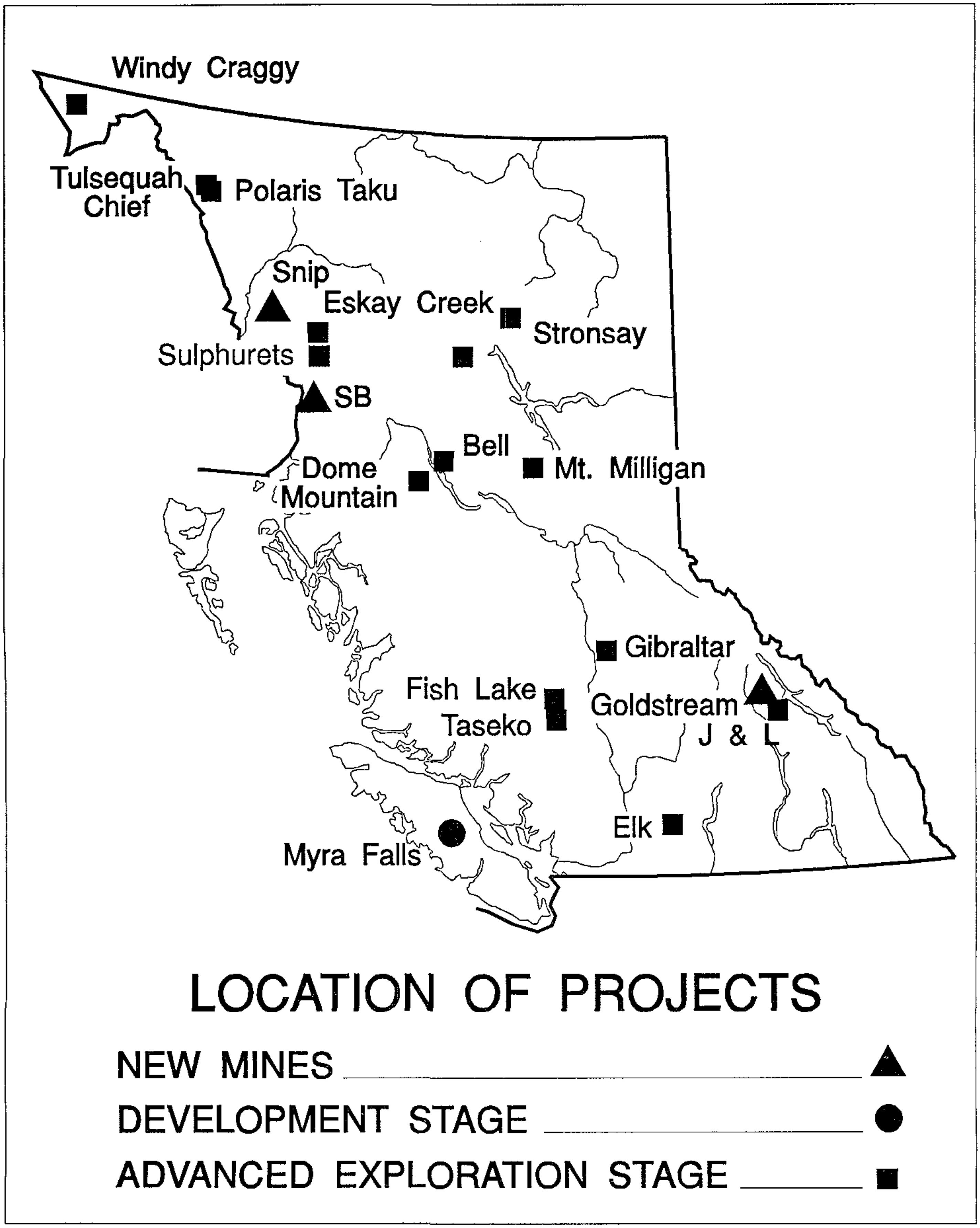

Windy Craggy
Tulsequah Chief
Polaris Taku
Snip
Eskay Creek
Stronsay
Sulphurets
SB
Bell
Dome Mountain
Mt. Milligan
Gibraltar
Fish Lake
Taseko
Goldstream
J & L
Elk
Myra Falls
LOCATION OF PROJECTS
NEW MINES
DEVELOPMENT STAGE
ADVANCED EXPLORATION STAGE

Figure A-2

the most important metal by far, with preliminary production statistics of 348 618 tonnes, worth in excess of 896 million. Gold production is estimated at 17.7 million grams (568 943 ounces) valued at $245 million compared to 16.4 million grams (527 280 ounces) in 1990. This represents an increase of 1.3 million grams (41 787 ounces), or 7.9 per cent, due primarily to the opening of the Snip mine which was, in part, offset by the closing of the Blackdome mine. Silver production was down 23 per cent to 483 million grams (15.53 million ounces) valued at $73 million; a drop of 37 per cent.

Three new metal mines opened in 1991. The official opening of the $65-million **Snip** mine (60% – Cominco Ltd. and 40% – Prime Resources Group Inc.) was on July 25, 1991, although production actually began six months earlier, on January 25, 1991 with the commissioning of the mill. The plant had been designed for a production rate of 300 tonnes per day and this was achieved six days after start up. From February 1 to March 15 the mill processed an average of 320 tonnes per day with an overall mill recovery of 91 per cent. Diluted ore reserves at start up were 940 000 tonnes grading 28.5 grams per tonne gold, allowing for a projected mine life of 10 years with an annual output of 2.9 million grams (93 000 ounces). During the first six months of life, Snip operated 10 to 20 per cent above design capacity and within projected costs.

The official re-opening of the **Goldstream** copper-zinc mine, (50% – Bethlehem Resources Corporation, 50% – Goldnev Resources Inc.) was on July 9, 1991. The 1350-tonne-per-day concentrator and mine were built in 1983 by Noranda Inc. at a cost of $72 million and operated for 11 months to April, 1984. Closure was due to low copper prices. Upon re-opening, the deposit contained 1.86 million tonnes, grading 4.81 per cent copper and 3.06 per cent zinc, sufficient for five years of operation. From June 1st to July 31, 1991, a total of 69 505 tonnes was milled, grading 4.11 per cent copper and yielding 2 567 191 kilograms (5 654 607 pounds) of copper for a recovery rate of 89.9 per cent. The rehabilitation of the mine was completed ahead of schedule and under budget, at a cost of $4.4 million.

On March 5, 1991, Westmin Resources Limited announced it would go to production from the **Facecut-35** zone on the SB property of Tenajon Resource Corporation which is adjacent to the **Premier Gold** mine. At the time of the announcement, diluted proven and probable geological reserves for the Facecut-35 zone were 96 209 tonnes grading 9.91 grams per tonne gold, 65.9 grams per tonne silver, 0.32 per cent copper, 0.67 per cent lead and 3.85 per cent zinc. Mill and tailings facilities of the nearby Premier Gold mine are being used to process the ore which was expected to be sufficient for six months of operation.

ADVANCED PROJECTS AND IMPORTANT DEVELOPMENTS

Several projects at the advanced exploration, preproduction or production stage, reached important milestones.

In the extreme northwest corner of the province the **Windy Craggy** copper-gold-cobalt project of Geddes Resources Ltd. continued in the Mine Development Review Process with submission of a revised mine plan late in 1990. This was an addendum to the original Stage 1 submission.

International Corona Corporation had spectacular results from a significant underground drilling and development program, and carried out engineering and environmental studies at its rich **Eskay Creek** gold-silver deposit. In mid-September Placer Dome Inc. and International Corona entered into a joint venture agreement with a view to bringing the project to production by early 1994. Each company would own 50 per cent of the deposit, with Placer funding all exploration, development and construction costs to a total of $240 million. On December 16, Placer Dome announced that, following completion of its property review, it did not intend to proceed to the exploration and feasibility study stage as provided in the September agreement. Reserves at Eskay Creek currently stand at 1.8 million tonnes grading 50.40 grams per tonne gold and 1913 grams per tonne silver, at a cutoff grade of 8.57 grams per tonne gold. There are additional significant base metal values. Most important for this project, and several others in the region, construction of the 37-kilometre access road from Bob Quinn Lake to the confluence of Volcano Creeek and Iskut River is well underway.

Approval of the *Mine Development Certificate* for the **Stronsay** (formally **Cirque**) zinc-lead-silver project was announced September 24, 1991. The deposit, owned 70 per cent by Curragh Resources Inc. and 30 per cent by Asturiana de Zinc of Spain, is located 280 kilometres north of MacKenzie, the nearest railhead. It has total reserves of 52.2 million tonnes grading 8 per cent zinc, 2 per cent lead and 47 grams per tonne silver. Construction is planned to start in 1992 on this $140-million project. It is expected to process 3500 tonnes of ore per day and employ 200 during construction and more then 300 for the expected 15 years plus of mine life.

Work continued through the year on optimizing reserves, grades, plant design and mining plan for the large **Mount Milligan** copper-gold project of Continental Gold Corporation, a wholly owned subsidiary of Placer Dome Inc. This vast alkalic porphyry system, hosted by Late Triassic to Early Jurassic volcanic rocks of the Takla Group and high-level intrusive rocks, has been under continuous exploration by Continental Gold Corporation and BP Resources Canada Inc. since 1986. In November

1991
EXPLORATION HIGHLIGHTS

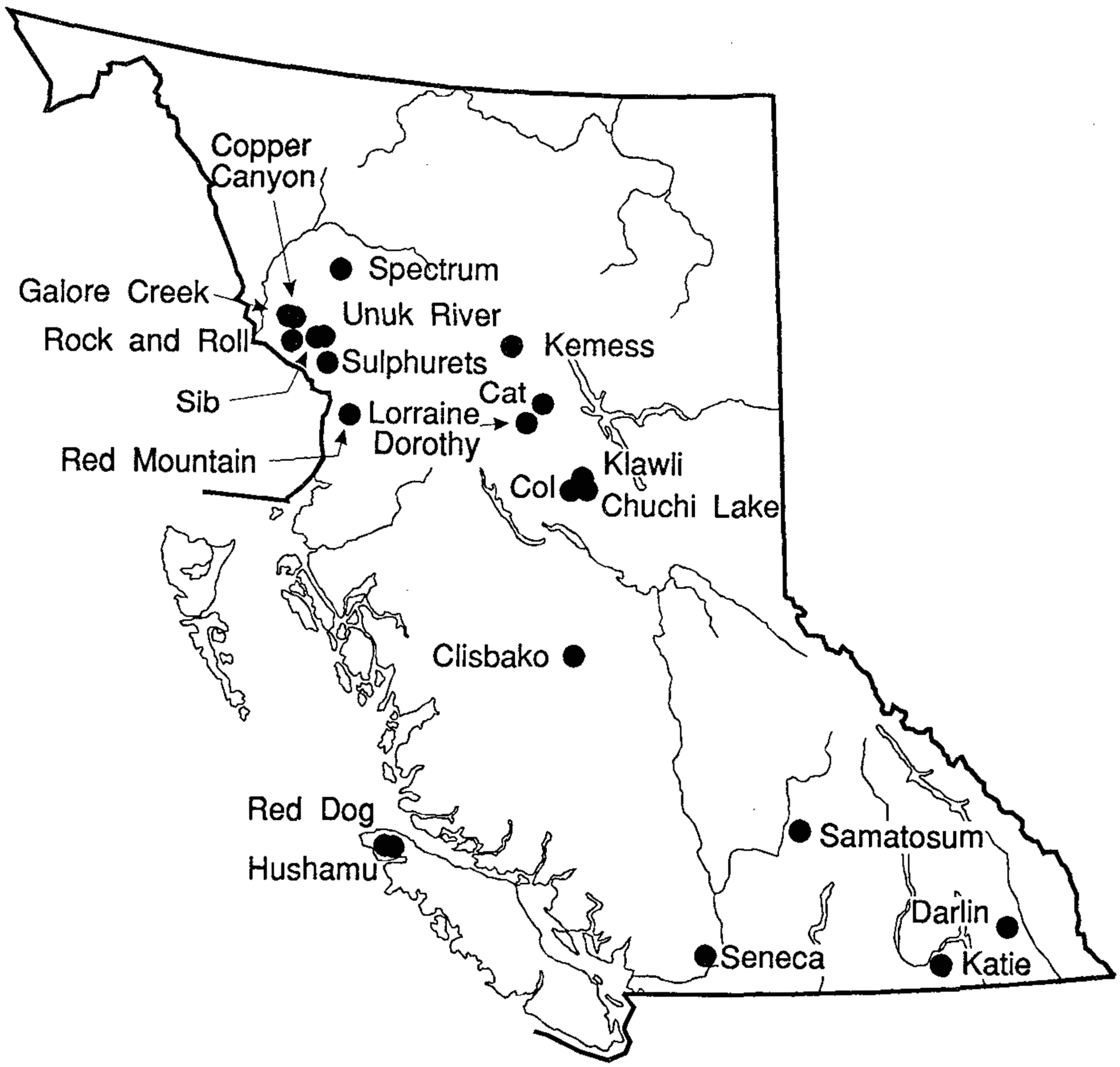


Figure A-3

1990 it was purchased by Placer Dome Inc. The project is at Stage 1 in the Mine Development Review Process. Work during 1991 included extensive large-diameter drilling for better delineation of reserves, metallurgical research, preparation of mill and dump sites, and a feasibility study. A final decision on whether or not to proceed with this large project is expected early in 1992.

A number of other significant developments occurred at five producing mines. The **Golden Bear** gold mine, of North American Metals Corporation and Homestake Mining (B.C.) Ltd., has solved most of its production and milling problems, and the resulting high production costs. As a result, the project had a fair year with a final projected production of at least 1500 kilograms (52 000 ounces). It is also significant that Homestake increased its interest in the project by buying the Chevron Minerals' interest.

The **Bell Copper** mine of Noranda Inc. successfully completed a major drilling program, started in 1990, at the perimeter of the pit. Significant new ore reserves, which could extend mine life by as much as 20 years, were indicated by this program. Access to these reserves, however, will require a large capital investment to push back the pit walls. A decision on this investment is expected early in 1992 since without it the mine has effectively reached the end of its life. Other possible sources of ore could be nearby properties such as Granisle, Morrison and Hearne Hill. The mine is also experimenting with leaching its extensive waste dumps, a technique that has been successfully used at the **Gibraltar** copper mine and produced copper at a cost of 79 cents per kilogram (36 cents per pound).

The discovery of the **Gibraltar North** zone by Gibraltar Mines Ltd. and Newcoast Silver Mines Ltd. was the direct result of their investment in geological modelling and a subsequent drilling program. This completely blind orebody of approximately 30 to 40 million tonnes, better than run-of-mine grade and with significant gold and silver credits, may well be the faulted extension of the **Gibraltar West** zone.

A similar success, again due to good geological modelling followed by drilling, was achieved by Westmin Resources Limited at its Myra Falls Cu-Pb-Zn-Ag-Au mine with the discovery, in May, of the **Gap zone**. This new, blind orebody is located between the Lynx and H-W mines, in upper H-W stratigraphy, thus defining a new exploration target. It is considerably better than run-of-mine grade, particularly for gold, and has been tested over a strike length of 250 metres. A decision to proceed with the development of the Gap zone was announced August 5 and the access drift from the existing H-W 18-level workings is well under way.

Underground development started earlier in the year at the **Samatosum** open-pit Pb-Zn-Ag-Au mine of Minnova Inc. and Rea Gold Corporation, and underground drilling discovered a new gold zone in April. The new zone is about 50 metres below current development and strikes almost parallel to the main ore horizon. Although severely depressed silver prices have been threatening an earlier than planned mine closure in October 1992, the new discovery may well extend the life of the mine.

EXPLORATION HIGHLIGHTS

Following the trend that began in 1988-89, exploration interest continued for multi-element deposits of large size, such as porphyry copper-gold deposits, or those with high unit values, such as volcanogenic massive sulphide and high-quality precious metal deposits. The main targets of exploration are summarized below:

Porphyry Copper – Gold Deposits

Porphyry Cu-Au systems in Late Triassic to Early Jurassic and younger volcanic sequences in the Intermontane Belt continue to be the most popular exploration target in the province. Exploration using this model was responsible for sustained activity in the Quesnel trough, particularly from Fort St. James to the Toodoggone area, in the Stewart–Stikine region, on the Cariboo plateau southwest of Williams Lake, in the Nelson–Salmo area and on northern Vancouver Island.

In the Stikine region, Kennecott Canada Inc. and Hudson Bay Mining and Smelting Co. Ltd. completed a major drilling program, an extensive re-assaying program, and air and ground geophysics on and around the main **Galore Creek** deposit. Their objective was to extend reserves and better define smaller but much richer deposits which ring the main deposit. The Galore Creek deposit, discovered in the 1950s, is in a Late Triassic alkalic porphyry system hosted by coeval and cogenetic volcanic rocks. It has drill-indicated reserves of 113 million tonnes grading 1.06 per cent copper, 0.445 gram per tonne gold and 8.57 grams per tonne silver.

Ten kilometres east of Galore Creek, Consolidated Rhodes Resources Ltd. completed a trenching program on the **Copper Canyon** and **Copper Penny** properties, old prospects drilled by Amax in the late 1950s. This is another porphyry system similar in age and setting to Galore Creek. A 1990 drilling program by Consolidated Rhodes Resources Ltd. on three zones produced drill-indicated reserves of 32.5 million tonnes grading 0.75 per cent copper, 1.16 grams per tonne gold and 17.1 grams per tonne silver. A 0.5 per cent copper-equivalent cut-off grade gives a geological potential for an additional 90 million tonnes along the strike extensions of the three known zones.

Newhawk Gold Mines Ltd. and Granduc Gold Mines Ltd. carried out an extensive surface exploration pro-

Table A-1
New Mines, Development and Advanced Exploration Projects

Company Name	Project Name	Commodity	Estimated Tonnes (000s)	Estimated Grade	Estimated Employment
New Mines					
Cominco Ltd., Prime Resources Group Inc.	Snip	Au	940	28.5 g/t Au	150
Bethlehem Resources Corp. Goldnev Resources Inc.	Goldstream	Cu, Zn	1650	4.81% Cu, 3.06% Zn	100
Westmin Resources Ltd. Tenajon Resources Corp.	SB	Au, Ag, Cu, Pb, Zn	96.2	9.91g/t Au, 65.9 g/t Ag, 0.32% Cu, 0.67% Pb, 3.85% Zn	30
Development (Production Decision Announced)					
Westmin Resources Ltd.	Gap Zone/Myra Falls	Cu, Pb, Zn, Ag, Au	217	2.7% Cu, 1.1% Pb, 16.6% Zn, 213 g/t Ag, 3.4 g/t Au	568
Advanced Exploration					
Geddes Resources Ltd.	Windy Craggy	Cu, Au, Ag, Co	297 440	1.38% Cu, 0.2 g/t Au, 3.83 g/t Ag, 0.069% Co	600
International Corona Corp. Prime Resources Group Inc. Placer Dome Inc.	Eskay Creek	Au, Ag	1810.9	50.40 g/t Au, 1913 g/t Ag	200+
Curragh Resources Inc. Asturiana de Zinc	Stronsay (Cirque)	Zn, Pb, Ag	52 200	8% Zn, 2% Pb, 47 g/t Ag	300+
Placer Dome Inc	Mt. Milligan	Cu, Au	284 000	0.2% Cu, 0.58 g/t Au	350+
Noranda Inc.	Bell	Cu, Au	150 000		
Gibraltar Mines Ltd. Newcoast Silver Mines Ltd.	Gibraltar North	Cu	40 000	0.4% Cu	
Cominco Ltd. Redfern Resources Ltd.	Tulsequah Chief	Cu, Pb, Zn, Au, Ag	7800	1.6% Cu, 1.18% Pb, 6.47% Zn 2.74 g/t Au, 109.72 g/t Ag	
Newhawk Gold Mines Ltd. Granduc Gold Mines Ltd.	Sulphurets	Au, Ag	749.7	15.39 g/t Au, 648 g/t Ag	50 - 60
Canarc Resources Corp. Suntac Minerals Corp.	Polaris-Taku	Au	2018.5	14.84 g/t Au	
Hapsburg Resources Inc. Timmins Nickel Inc.	Dome Mountain	Au, Ag	294.5	12.17 g/t Au, 80.22 g/t Ag	55
Equinox Resources Ltd. Cheni Gold Mines Inc.	J & L / Main Zone	Zn, Pb, Au, Ag	4770	4.3% Zn, 2.7% Pb, 7.2 g/t Au, 72 g/t Ag	80 - 90
	Yellow Jacket Zone	Zn, Pb, Ag	910	7.4% Zn, 2.6% Pb, 55 g/t Ag	
Fairfield Minerals Ltd.	Elk	Au	308.4	22.18 g/t Au, 24.68 g/t Ag	
Westpine Metals Ltd.	Taseko	Cu, Au	6763.2	0.73% Cu, 0.82 g/t Au, 1.7 g/t Ag	
Taseko Mines Ltd	Fish Lake	Cu, Au	545 000	0.32% Cu, 0.548 g/t Au	

gram, including prospecting, geological mapping, sampling and diamond drilling on their **Sulphurets** property, located 65 kilometres northwest of Stewart. Newhawk's extensive holdings include at least four large Cu±Au±Mo zones hosted by intensely altered Lower to Middle Jurassic volcanic and sedimentary rocks of the Stewart Complex. These are intruded by structurally controlled, alkalic to subalkalic plutons of similar age.

Less than 50 kilometres southeast of the Toodoggone precious metals camp, El Condor Resources Ltd. carried out an extensive and very successful diamond drilling program on its **Kemess** copper-gold project as a follow-up to an equally successful 1990 drilling program. This large property consists of at least four prophyry copper-gold zones hosted by Late Triassic to Lower Jurassic, high-level calcalkalic intrusions and associated volcanic rocks. The property is strategically located close to the Cheni Gold Mines access road and possible rail transportation. Drilling to date on the **Kemess South** deposit (60% – El Condor Resources Ltd., 40% – St. Philips Resources Inc.) has indicated reserves of 229 million tonnes grading 0.23 per cent copper and 0.651 gram per tonne gold in a continuous, tabular deposit open to expansion and including an upper, supergene-enriched blanket containing native copper and chalcocite.

Drilling results from the **Kemess North** deposit (100% – El Condor Resources Ltd.) have indicated reserves of 116.3 million tonnes grading 0.19 per cent copper and 0.377 gram per tonne gold. This deposit is located 6 kilometres north of the South deposit and is within a larger zone enriched in sulphides. The Kemess project is about to enter the Mine Development Review Process.

Farther to the south, along more than 250 kilometres of the same Late Triassic to Early Jurassic volcanic belt known as the Quesnel trough, work was done on several other similar projects and most included drilling. Notable amongst these are **Lorraine** and **Dorothy** of Kennecott Canada, **Cat** of BP Resources Canada Inc. and Lysander Gold Corporation, **Klawli** of Rio Algom Exploration Inc., **Chuchi Lake** of BP Resources Canada Inc. and **Col** of Kookaburra Gold Corp.

Approximately 130 kilometres southwest of Williams Lake, outside the Quesnel trough, Taseko Mines Ltd. carried out a 10-hole, large-diameter drilling program at its **Fish Lake** porphyry copper-gold project. This drilling achieved excellent core recovery and was successful in significantly upgrading continuity and grade of mineralization to a depth of 800 metres. This program, and 168 other drill holes completed by previous operators, confirmed an initial reserve block of 545 million tonnes grading 0.32 per cent copper and 0.548 gram per tonne gold. The Fish Lake deposit is associated with a Late Cretaceous calcalkalic quartz diorite stock and dike complex which cuts coeval, and probably cogenetic, volcanic rocks. The deposit was first discovered by two prospectors in the early 1930s, and since 1962 has been drilled by several companies, large and small, with mixed success.

On northern Vancouver Island, Moraga Resources Ltd. carried out further drilling on the **Hushamu** zone of the **Expo** property. It was optioned from BHP-Utah Ltd. which operates the nearby **Island Copper** mine. Current reserves at Hushamu are estimated at 118 million tonnes grading 0.28 per cent copper, 0.01 per cent molybdenum and 0.342 gram per tonne gold. Moraga and Crew Natural Resources Ltd. also carried out a preliminary mineral inventory and optimized pit study on their nearby **Red Dog** zone which yielded a reserve of 41.1 million tonnes grading 0.26 per cent copper, 0.006 per cent molybdenum and 0.342 gram per tonne gold. Both deposits are viewed as potential sources of ore for the Island Copper mine where reserves will be depleted in 1997. Moraga Resources Ltd. was acquired by Jordex Resources Inc. in August.

Near Salmo, within the Rossland volcanic belt, Noranda Exploration Company Limited and Hemlo Gold Mines Inc. drilled the **Katie** property which is held under option from Yellowjack Resources Ltd. This property is a large porphyry copper-gold system associated with Early Jurassic diorite and volcanic rocks of the Rossland Group. Drill holes cut mineralized sections from 60 to 139 metres in length, grading from 0.36 to 0.24 per cent copper and from 0.308 to 0.240 gram per tonne gold.

Volcanogenic and Sediment-hosted Massive Sulphide Deposits

Volcanogenic massive sulphide targets in Paleozoic and Mesozoic submarine volcanic sequences continued to be the focus of exploration because of their relatively high unit value and multi-element nature.

Cominco Ltd. and Redfern Resources Ltd. completed another very successful drilling program at their **Tulsequah Chief** property, confirming and extending favourable drilling results obtained in 1990. Preliminary reserves at Tulsequah Chief have been increased to 7.80 million tonnes grading 1.65 per cent copper, 1.18 per cent lead, 6.47 per cent zinc, 2.74 grams per tonne gold and 109.72 grams per tonne silver.

American Fibre Corporation and Silver Butte Resources Ltd. completed a major diamond drilling program on the **Sib** deposit. Mineralization at Sib is similar in character and geologic setting, and only 5 kilometres southwest of Eskay's 21B zone.

Granges Inc., in joint venture with Springer Resources Ltd. and Cove Resources Corp., completed a drilling program and obtained significant intersections of gold and silver mineralization on the **Unuk River** project.

Table A-2
1991 Exploration Highlights

Company Name	Project Name	Commodity	Estimated Tonnes (000s)	Estimated Grade	Exploration Expenditures ($ Millions)
Kennecott Canada Inc., Hudson Bay Mining and Smelting Co. Ltd.	Galore Creek	Cu, Au, Ag	113 000	1.06% Cu, 0.445 g/t Au 8.57 g/t Ag	3.35
Consolidated Rhodes Resources Ltd.	Copper Canyon	Cu, Au, Ag	32 450	0.75% Cu, 1.16 g/t Au, 17.1g/t Ag	<1
Newhawk Gold Mines Ltd., Granduc Gold Mines Ltd.	Sulphurets	Cu, Au	n/a	n/a	1.5
El Condor Resources Ltd., St Philips Resources Inc.	Kemess South	Cu, Au	229 090	0.23% Cu, 0.651 g/t Au	2.9 (incl. Kemess North)
El Condor Resources Ltd.	Kemess North	Cu, Au	116 363	0.19% Cu, 0.377 g/t Au	
Kennco Canada Inc.	Lorraine/ Dorothy	Cu, Au	n/a	n/a	0.675
BP Resources Canada Inc., Lysander Gold Corporation	Cat	Cu, Au	n/a	n/a	0.4
Rio Algom Exploration Inc.	Klawli	Cu, Au	n/a	n/a	0.13
Jordex Resources Inc.	Hushamu	Cu, Au, Mo	118 000	0.28% Cu, 0.342 g/t Au 0.01% Mo	0.11
Jordex Resources Inc., Crew Natural Resources Ltd.	Red Dog	Cu, Au, Mo	41 136	0.26% Cu, 0.342 g/t Au, 0.006% Mo	0.17
Yellowjack Resources Ltd.	Katie	Cu, Au	n/a	n/a	0.9
American Fibre Corporation, Silver Butte Resources Ltd.	Sib	Au, Ag	n/a	n/a	3.75
Granges Inc, Springer Resources Ltd., Cove Resources Corp.	Unuk River	Au, Ag	n/a	n/a	n/a
Eurus Resources Corp., Thios Resources Inc.	Rock and Roll	Zn, Pb, Cu, Au, Ag	582	3.08% Zn, 0.79% Pb, 0.64% Cu 2.47g/t Au, 336g/t Ag	1.5
Minnova Inc.	Seneca	Zn, Cu, Au, Ag	1509.5	3.7% Zn, 0.63% Cu, 0.823g/t Au, 41.14g/t Ag	0.5
Chapleau Resources Ltd., Barkhor Resources Inc., Kokanee Explorations Ltd.	Darlin	Pb, Zn	n/a	n/a	0.3
Lac Minerals Inc,	Red Mountian	Au	840	12.68 g/t Au	1.5
Columbia Gold Mines Ltd., Eurus Resources Corp.	Spectrum	Au	275	15.77g/t Au	1
Minnova Inc., Eighty-Eight Resources Ltd.	Clisbako	Au	n/a	n/a	n/a

This property is only 5 kilometres south of the Eskay Creek deposit and in a similar geologic setting.

Approximately 40 kilometres west of Eskay Creek, along the Iskut River, Eurus Resource Corporation and Thios Resources Inc. completed a program of diamond drilling, air and ground geophysics and geochemistry on the **Rock and Roll** project, a volcanogenic massive sulphide target hosted by Triassic tuffs and argillites. Preliminary reserves for the **Black Dog** and **SRV** zones of this project are 582 000 tonnes grading 3.08 per cent zinc, 0.79 per cent lead, 0.64 per cent copper, 2.47 grams per tonne gold and 336 grams per tonne silver over a 700-metre strike length.

Along the Fraser Valley near Harrison Lake, Minnova Inc. continued detailed geological studies, followed by drilling on the **Seneca** project. Work to date has been rewarded by the discovery of the **Vent** and the **Fleetwood** zones in addition to the original Seneca deposit. These massive sulphide deposits are hosted by Jura-Cretaceous felsic volcanic rocks of the Harrison Lake Formation. Reserves at the Seneca are estimated at 1 509 500 tonnes grading 3.7 per cent zinc, 0.63 per cent copper, 0.823 gram per tonne gold and 41. 1 grams per tonne silver.

In the southeastern corner of the province, 8 kilometres south of the Cominco Ltd. **Sullivan** mine, Chapleau Resources Ltd., Barkhor Resources Inc. and Kokanee Explorations Ltd. (as operator), carried out a drilling program on the **Darlin** project. They encountered five massive sulphide beds from 15 to 60 centimetres thick in stratigraphy similar to that which hosts the Sullivan orebody. Late in the year, Minnova Inc. optioned the contiguous **Horn** property from Kokanee Explorations Ltd.

Vein and Transitional Deposits

Epithermal and mesothermal veins and deposits that formed in a setting transitional between the classic epithermal environment and the deeper seated porphyry environment are other important targets. Some of these deposits, such as the mesothermal veins of the **Snip** gold mine and parts of the **Sulphurets** (Brucejack Lake zone) property of Newhawk Gold Mines Ltd. and Granduc Gold Mines Ltd. are in British Columbia's Golden Triangle. At Sulphurets work in 1991 was focused mostly on porphyry copper-gold zones with bulk mineable potential.

Canarc Resource Corporation and Suntac Minerals Corporaton carried out a diamond drilling program at their **Polaris-Taku** property, approximately 100 kilometres south of Atlin, and across the Taku river from the **Tulsequah Chief** massive sulphide deposits. This program was successful in extending the known limits of mineralization. At the start of the 1991 program total geological reserves stood at 1 454 500 tonnes grading 15.43 grams per tonne gold for a total of 20 412 kilograms (720 000 ounces) in the C-vein. The 1991 program was successful in boosting geological reserves to 2 018 500 tonnes grading 14.84 grams per tonne gold.

Twenty-six kilometres west of the Stewart-Cassiar highway near the village of Iskut, Columbia Gold Mines Ltd. and Eurus Resource Corporation carried out a major diamond-drilling program on the **Spectrum** project. The objective was to test for high-grade, structurally controlled gold zones and low-grade disseminated gold-copper mineralization hosted by intensely altered andesitic volcanic rocks intruded by a Jura-Cretaceous quartz monozonite. Preliminary reserve estimates for the higher grade zones are 275 000 tonnes grading 15.77 grams per tonne gold, using a 10.28 grams per tonne gold cut-off grade. Bulk tonnage estimates, including high-grade reserves, are 8.393 million tonnes grading 1.268 grams per tonne gold and 0.18 per cent copper.

Lac Minerals Inc. completed a diamond-drilling program on its **Red Mountain** gold property located 15 kilometres east of Stewart. This is a newly discovered, structurally controlled, mesothermal vein system related to a porphyry environment. A preliminary reserve of 840 000 tonnes grading 12.68 grams per tonne gold has been established for the MARC zone.

Forty kilometres east of Smithers, Hapsburg Resources Inc. (formerly Teeshin Resources Ltd.) and Timmins Nickel Inc., carried out a program of surface and underground drilling and drifting on the **Dome Mountain** project under a joint venture agreement. Bulk samples were sent to the Equity Silver mine and to the Premier Gold mine for a custom milling test. Ore reserves are calculated at 294 500 tonnes grading 12.17 grams per tonne gold and 80.22 grams per tonne silver.

Approximately 100 kilometres west of Quesnel, Minnova Inc. carried out an extensive program of surface trenching and diamond drilling on the **Clisbako** gold-silver prospect under option from Eighty-eight Resources Ltd. This new discovery, in a previously under-explored area, is in a structurally controlled epithermal system hosted by Tertiary acid volcanics.

A short distance by road north of Revelstoke, Equinox Resources Ltd. and Cheni Gold Mines Inc. completed a major program of diamond drilling and underground development on their **J&L** project, a stratabound polymetallic vein system. Current probable and possible reserves in the **Main** zone are estimated at 4.77 million tonnes grading 4.3 per cent zinc, 2.7 per cent lead, 7.2 grams per tonne gold, 72 grams per tonne silver and 4.5 per cent arsenic. Additional reserves in the newly discovered **Yellowjacket** zone are 910 000 tonnes grading 7.4 per cent zinc, 2.6 per cent lead and 55 grams per tonne silver.

In the south-central part of the province, 40 kilometres southeast of Merritt, Fairfield Minerals Ltd. completed an additional 37 diamond-drill holes on the Elk property, a quartz-sulphide mesothermal vein system of possible Tertiary age, hosted by the Jurassic Pennask granodiorite. A total of 107 holes drilled on this property since 1989 has traced the vein system over a strike length of 915 metres and 300 metres down dip. Drilling previous to the 1991 program indicated reserves of 212 730 tonnes grading 21.7 grams per tonne gold and 21.9 grams per tonne silver using a cut-off grade of 10.3 grams per tonne gold across a 2-metre width. Work completed in 1991 boosted this figure to 308 400 tonnes grading 22.18 grams per tonne gold and 24.68 grams per tonne silver.

Near Taseko Lake, 250 kilometres north of Vancouver, Westpine Metals Ltd. continued drilling on their **Taseko** copper-gold property. At least three zones of mineralization have been identified in Cretaceous volcanic rocks with intense argillic and silica alteration, and in the border phase of intrusive rocks of the Coast Range batholith. Mineable reserves for an open-pit operation have recently been calculated to be 6 763 200 tonnes grading 0.73 per cent copper and 0.82 gram per tonne gold and 1.7 grams per tonne silver.

SUMMARY AND A LOOK AT 1992

The year 1991 was one of significantly decreased exploration activity, but also one of important new developments. Junior companies and individual prospectors faced the brunt of hard times and struggled to carry on. The greatest obstacle was the shortage of risk capital. Notwithstanding this, British Columbia's exploration industry and world-class mineral endowment, proved their worth with significant progress in two major, large tonnage copper-gold projects, Fish Lake and Kemess and in the discovery of new prospects such as the **Clisbako.**

In short, British Columbia is still a good place to explore and discover mines!

NOTE: Grade and tonnage cited in this publication is from information released by operators; monetary figures are in Canadian dollars.

TABLE A-3

Property (Operator)	MINFILE Number	Mining Division	NTS	Commodity	Deposit Type	Work Done
NORTHWESTERN DISTRICT						
Ala 9 (Ashworth Expln. Ltd.)		Atlin	104K/11W, 12E	Au, Ag, Zn, Pb, Cu		2 ddh, 304.8 m; air & grd geophys; pspg;geol
Barytex (Noranda Expl. Co. Ltd.)		Liard	104B/10E	Au	Vein	2 dhh, 213.4 m, geophys; geochem; geol
Bend (Tenajon Res. Corp.)	104B 132	Skeena	104B/1E	Au, Ag	Shear-hosted vein	10 ddh, 300 m
Big Onion (Varitech Res. Ltd.)	93L124	Omineca	93L/15W	Cu ,Mo	Porphyry	8 ddh, 1700 m
Bine - Lake (Noranda Expl. Co. Ltd.)	93M 003	Omineca	93L/16E, 93M/1	Au, Ag, Cu, Mo	Porphyry	13 ddh, 1261.9 m; air & grd geophys; geochem; geol; trenching
Bornagain (Eurus Res. Corp./ Thios Res. Inc./ Bel-Air Res.)	?	Liard	104B/11E	Au, Ag, Cu, Pb, Zn		5 dhh, 400 m; air & grd geophys; pspg; trenching; geol
Burbridge Lake (D. Groot Logging Ltd.)	93L 223	Omineca	93L/10	Cu, Mo, Au, Ag, Zn	Porphyry	11 ddh, 1716 m
Chance (AIC Int'l. Res. Corp.)	93L 251	Omineca	93L/10E	Ag, Au, Cu, Zn, Pb	Mesothermal vein	2 ddh, 264 m; geophys
CL 6215 (Berube, C.)	104G 030	Liard	104P/6W	Au, Ag	Vein/Skarn	3 ddh, approx. 600 m; pspg
Dome Mountain (Timmins Nickel Inc.)	93L 276	Omineca	93L/10E, 15E	Au, Ag, Zn, Cu, Pb	Vein	drifting; bulk smplg;
Eric-Mako (Equity Silver Mines Ltd.)		Omineca	93L/2E	Cu, Ag		13 ddh, 1024 m; trenching, 57 m; OB drilling, 1376 m
Erickson (Total Erickson/Total Energold)	104P 029	Liard	104P/4E, 5E	Au	Mesothermal vein	20 ddh, 3896 m
Eskay Creek (Int. Corona Corp.)	104B 008	Skeena	104B/9W	Au, Ag, Cu, Pb, Zn	VMS	u/g dvlp, 553 m; 95 u/g ddh, 3793 m; 12 sfc ddh, 2800 m; geophys;geochem
Fireweed (Mansfield Mins. Inc.)	93M 151	Omineca	93L/15, 16 93M/1, 2	Ag, Zn, Pb, Cu, Au	Vein/Bx/Rpl	18 ddh, 2982 m; geophys
Forgold (Gold Fields Cdn. Mining Ltd.)		Liard	104B/15E	Cu, Au		5 ddh, 935.7 m; geophys; geochem; geol
Galore Creek (Kennecott Canada Inc.)	104G 090	Liard	104G/3W, 4E	Cu, Au, Ag	Porphyry	49 ddh, 13830 m; air & grd geophys; geochem;geol
GNC (Int'l Corona Corp.)		Skeena	104B/9W	Au, Ag, Pb, Zn, Cu	Massive Sulphide	4 ddh, 900 m; sfc and down-hole geophys; geol.
Golden Bear mine (Golden Bear Operating Co. Ltd.)	104K 079	Atlin	104K/1	Au	Shear-hosted/ Rpl/Skarn	14 ddh, 3870 m; 7 u/g ddh, 608 m; 40 m u/g dvlp; pspg; geol;geochem
GOZ-RDN (Noranda Expl. Co. Ltd.)		Liard	104B/15E 104G/2E	Au, Ag, Cu, Pb, Zn	Vein	10 ddh, 1403.6 m; geophys; geochem; geol
Haida-Catspaw	104B 288	Skeena	104B/8E	Au, Ag	Vein	3 ddh, 289.9 m;

Property (Operator)	MINFILE Number	Mining Division	NTS	Commodity	Deposit Type	Work Done
(Omega Services)						trenching
Hearne (Chapman, Dave)	93M 006	Omineca	93M/1W	Cu, Au	Breccia pipe	7 ddh
Independence (Armeno Res. Inc.)	104A 038	Skeena	104A/4W	Au, Ag, Cu	Vein	11 ddh, 1338.5 m; pspg; geol
Indian (Westmin Res. Ltd.)	104B 031	Skeena	104A/4W 104B/1E	Ag, Au	Vein	3 ddh, 378 m
Inel (Gulf Int'l. Min. Ltd.)	104B 113	Liard	104B/10W	Au, Ag, Cu, Pb, Zn	Vein/SMS/BX	u/g & sfc geol; trenching, 35.4 m; pspg
Kemess North (El Condor Res. Ltd.)	94E 021	Omineca	94E/2	Cu, Au	Porphyry	18 ddh, 4613 m; geophys; geol
Kemess South (El Condor Res. Ltd.)	94E 094	Omineca	94E/2 94D/15	Au, Cu	Porphyry	45 ddh, 8784 m; geochem; geol; geophys
Knipple Lake (Noranda Expl. Co. Ltd.)		Skeena	104A/5W	Cu, Pb, Zn, Ag, Au	Vein	6 ddh, 346.6 m; geophys; geochem; geol
Lakewater (OreQuest Consultants Ltd.)		Skeena	104B/9W, 10E	Au, Ag, Pb, Zn, Cu	Massive sulphide	7 ddh
Lawyers (Cheni Gold Mines Inc.)	94E 067	Omineca	94E/6E	Au, Ag	Epithermal vein	40 to 50 ddh, 7000 m; mining lease survey geophys
Lucifer (Noranda Expl. Co. Ltd.)		Liard	104G/2E	Au		2 ddh, 493.3 m; geophys; geochem; geol
Metla (Galico Res. Inc.)		Atlin	104K/7E	Au, Ag		10 ddh
Midnight (Equity Silver Mines Ltd.)	93E 029	Omineca	93E/6	Au, Ag	Vein	12 ddh, 1365 m; trenching, 600 m; geol; geochem
MM 100 Group (KRL Res. Corp.)	104A 053	Skeena	104A/4W	Au	Vein	14 ddh, 1848 m; geophys; geochem
Moose (Porphyry Pearl) (Golden Rule Res. Ltd./ Manson Creek Res. Ltd.)	94E 084	Omineca	94E/6E	Au, Cu	Porphyry	7 ddh, 1100 m
More Creek (Noranda Expl. Co. Ltd.)		Liard	104G/1W, 2E	Au, Ag		1 ddh, 250 m
Mount McKendrick (Habsburg Res. Inc.)	93L 286	Omineca	93L/15	Pb, Zn, Au, Ag, Cu	Vein	3 ddh, 140.8 m
MR (Equity Silver Mines Ltd.)		Omineca	93M/2E	Ag, Cu, Au	Epithermal	6 ddh, 457 m; trenching, 1202 m
New Nanik (New Canamin Res. Ltd.)	93E 055	Omineca	93E/12E 13E	Cu, Mo, Au, Ag	Porphyry	5 ddh, 500 m
Nor 2-12 (Rio Algom Expl. Inc.)		Omineca	94D/15 94E/2W	Cu, Au	Porphyry	15 ddh, 1957 m; geophys; geochem; geol
OP-Pup (Consol. Goldwest Res. Ltd.)	104G 069	Liard	104G/3W, 4E	Cu, Au, Pb, Zn	Porphyry/Shear zones	2 ddh, 306.3 m geol; pspg
Outlaw (Glider Developments Inc.	104K 083	Atlin	104K/7, 10	Au, Ag, Pb, Zn, Cu	Vein/Skarn	2 ddh

Property (Operator)	MINFILE Number	Mining Division	NTS	Commodity	Deposit Type	Work Done
Paydirt (Pacific Century Explns. Ltd./ Ticker Tape Res. Ltd.)	104G 108	Liard	104G/3W 4E	Au, Cu	Shear-hosted vein/Porphyry	3 ddh, 271 m; geol; pspg
Phiz (Adrian Res. Ltd.)		Liard	104B/11E	Au, Cu, Pb	Vein	25 ddh, 2803 m; air & sfc geophys; geochem; geol; pspg
Pictou-Scarab (Internova Res. Ltd.)	104N 044	Atlin	104N/12E	Au, Ag	Vein	4 ddh, 470.8 m
Polaris-Taku (Suntac Minerals Corp.)	104K 003	Atlin	104K/12E	Au	Vein/Rpl	11 ddh, 3657.6 m
Poplar (New Canamin Res. Ltd.)	93L 239	Omineca	93E/15 93L/2, 3	Cu, Mo, Ag, Au	Porphyry	13 ddh, 1300 m; geochem
Q.C. (Quash Creek) (Dryden Res. Corp.)	104G 033	Liard	104G/9W 16W	Cu, Au, Zn, Ag	Porphyry/Vein	5 ddh, 721.9 m; geochem; geophys; geol
Red Mountain (Bond Gold Canada Inc.)	103P 086	Skeena	104A/4 103P/13	Au, Ag, Pb, Zn	Transitional	11 ddh, 2628 m; geol; pet; struct. study; geochem; geophys
Reg (Skyline Gold Corp.)	104B 107	Liard	104B/11E	Au, Ag	Mesothermal vein/VMS	8 ddh, 703 m; trenching, 240 m; geochem; geol
Rhub-Barb (Equity Silver Mines Ltd.)		Omineca	93F/11, 12	Au, Ag	Epithermal vein	5 ddh, 942.7 m
Rocher Déboule (Int'l Okengate Ventures Inc./ Trans Arctic)	93M 071	Omineca	93M/4E	Cu, Au, Ag, Co	Vein	u/g review and smplg;mine rehab; mtllg testing; pre-feas. study
Rock and Roll (Thios Res. Inc./ Eurus Res. Corp.)		Liard	104B/11	Au, Ag, Pb, Zn, Cu	VMS	90 ddh; air & grd geophys; geochem; geol; OB drilling
Rok (Cons. Carina Res. Corp./ Manchester Res. Corp.)	104H 001	Liard	104H/13W	Cu, Au	Porphyry	5 ddh, 716 m; geophys; geochem; geol; trenching, 1110 m
Shasta (Sable Res. Ltd./ Int'l Shasta Res. Ltd.	94E 050	Omineca	94E/2W, 7W, 3, 6E	Au, Ag	Vein	10 ddh, 900 m
Sheslay (Golden Ring Res. Ltd.)	104J 005	Atlin	104J/4, 5	Cu, Au, Ag, Pb, Zn		870 line km. air geophys; grd geophys; geochem; geol; pspg
Sib (American Fibre Corp.)		Skeena	104B/9W, 10E	Au, Ag	Massive sulphide/Vein	64 ddh, 6097.5 m; geol; lithogeochem; pspg
Silbak Premier - Premier Gold (Westmin Mines Ltd.)	104B 054	Skeena	104A/4W 104B/1E	Au, Ag	Vein/Porphyry	7 ddh, 1150 m; trenching
Sky Creek (Adrian Res. Ltd.)	104B 263	Liard	104B/11E	Au, Ag, Zn, Pb, Cu	VMS	15 ddh, 1250 m; air & grd geophys; geol; geochem; pspg; OB drill; trench
Snip Mine (Cominco Ltd.)	104B 250	Liard	104B/11E	Au	Mesothermal vein	80 line km geophys; geol
Snippaker Mtn. (Solomon Res. Ltd.)	104B 299	Liard	104B/10W 11E	Au, Ag, Zn, Pb	Vein-shear controlled	6 ddh, 601.37 m; trenching; geol; pspg; geochem

Property (Operator)	MINFILE Number	Mining Division	NTS	Commodity	Deposit Type	Work Done
Snow Creek (Homestake Canada Ltd.) (Pacific Rim Mining Corp.)	93L 297	Omineca	93L/12E	Au, Ag, Zn, Cu, Pb	Vein	5 ddh 4 ddh
Snowfields (Westmin Res. Ltd.)	104B 048	Skeena	104B/1E	Au	Vein	10 ddh, 1235 m; trenching; geol; air geophys
Spectrum (Columbia Gold Mines Ltd.)	104G 036	Liard	104G/9W, 10E	Au, Cu	Vein/Porphyry/ Bx	24 ddh, 3987 m; geol; pspg
Strike (Navarre Res. Corp.)	104A 061	Skeena	104A/4W	Ag, Pb, Zn, Cu, Au	Vein	156 trenches; geophys
Sulphurets - Bruceside (Newhawk Gold Mines Ltd.)	104B 193	Skeena	104B/8E, 9E	Ag, Au	Epithermal vein	6 ddh; air geophys; geochem; geol; pspg; trenching
Sulphurets - Sulphside (Newhawk Gold Mines Ltd.)	104B 184	Skeena	104B/8, 9	Au, Cu	Porphyry	13 ddh; lithogeochem; geol;air geophys; pspg
Summit (Homestake Canada Ltd.)	104B 133	Skeena	104B/1E, 8E	Au, Ag	Vein	7 ddh, 1258 m
Teryl Option Project (Tymar Res. Inc./ Cons. Goldwest Res. Ltd.)		Liard	104B/11E			1 ddh;geochem; air & grd geophys; pspg
Treaty Creek (Tantalus Res. Ltd.)	104B 078	Skeena	104B/9	Au, Cu, Ag	Vein	5 ddh
Tulsequah Chief (Cominco Ltd.)	104K 002	Atlin	104K/11, 12	Ag, Au, Pb, Zn, Cu	VMS - Kuroko type	6 u/g ddh, 3109 m
Unuk River (Granges Inc.)	104B 083	Skeena	104B/8, 9 10	Au, Ag, Zn,	Massive Sulphide	30 ddh, 4910 m; geophys; geochem; trenching
Whiting Creek (Kennecott Canada Inc.)	93E 112	Omineca	93E/11, 14	Cu, Mo	Porphyry	2 ddh, 109.7 m
Windy Craggy (Geddes Res. Ltd.)	114P 002	Atlin	114P/12E,W	Cu, Co, Au, Ag, Zn	VMS	AMD wild life, water quality, weather, glaciology studies

CENTRAL DISTRICT - MAJOR PROJECTS

Property (Operator)	MINFILE Number	Mining Division	NTS	Commodity	Deposit Type	Work Done
AA (Wind River Res. Ltd.)		Skeena	92M/15E	Graphite	Sedimentary, vein	ddh; geochem; metallurgical; geol
AOK (Takla Star Res. Ltd.)		Omineca	93N/1	Au, Cu	Alkali porphyry	ddh; geochem; geophys; geol
Ahbau (Appian Res. Ltd./ Valerie Gold Res. Ltd.)	93G 007	Cariboo	93G/1W	Au, Cu, Zn, Pb, Ag	Vein, porphyry	3 ddh, 300 m
Ahdatay Lake (BP Res. Canada Ltd.)	93N 085	Omineca	93N/7W	Au, Cu	Alkali porphyry	4 ddh, 548 m; geophys
Alpha-Beta (Noranda Exploration Co. Ltd.)		Cariboo	93J/13	Au, Cu	Alkali porphyry	geol; geochem; geophys
Angela (Jade West Res. Ltd.)	93N 165	Omineca	93N/13W	Jade		10 ddh; 20 pdh trenching
Anom (BP Res. Canada Ltd.)	93N 099	Omineca	93N/1W	Au, Cu	Alkali porphyry	geol; geophys
Beekeeper (Eastfield Res. Ltd.)	93A 155	Cariboo	93A/6W	Cu, Au, Hg	Porphyry, related	geol; geochem; airborne geophys

Property (Operator)	MINFILE Number	Mining Division	NTS	Commodity	Deposit Type	Work Done
Bio (Rio Algom Expln. Inc.)	93K 004	Omineca	93K/16	Au, Cu	Alkali porphyry	2 ddh, 244 m; geophys; trenching, 580 m; test pits
CH Claims (Placer Dome Inc.)		Omineca	93F/7E	Au, Ag	Epithermal	geol; geochem; geophys
Camp (Mutual Res. Ltd.)	93N 081	Omineca	93N/2E	Au, Cu	Alkali porphyry	7 ddh, 891 m; road, 11 km
Cantin Creek (Phelps Dodge Corp. of Canada Ltd.)	93B 027	Cariboo	93B/16E	Cu, Au	Alkali porphyry	12 ddh, 1800 m
Cat (BP Res. Canada Ltd.)	94C 069	Omineca	94C/3W	Au, Cu	Alkali porphyry	15 ddh, 2209 m; geol; geochem; geophys; test pits; road
Chuchi (BP Res. Canada Ltd.)	93N 159	Omineca	93N/1W, 2E	Au, Cu	Alkali porphyry	28 ddh, 4595 m; geol; geochem; geophys; road
Chuchi East (BP Res. Canada Ltd.)	93N 123	Omineca	93N/1W	Au, Cu	Alkali porphyry	4 ddh, 585 m; geol; geochem; geophys; road
Cirque (Stronsay Corp.)	94F 008	Omineca	94F/6E 11E	Pb, Zn, Ag	Sedex	86 u/g ddh, 4973 m; geol; bulk sampling
Clisbako (Minnova Inc.)		Cariboo	93C/9E	Au, Ag	Epithermal	19 ddh, 3017 m; geol; geochem; trenching, 2000 m; road
Col (Kookaburra Gold Corp.)	93N 101	Omineca	93N/2	Au, Cu	Porphyry	11 ddh, 1524 m; geol; geochem; geophys; road
Dem Lake (Noranda Expln. Co. Ltd.)		Omineca	93K/9W, 16W	Au, Cu	Alkali porphyry	geol; geochem; geophys
Dorothy (Kennecott Canada Inc.)	93N 007	Omineca	93N/14	Au, Cu	Alkali porphyry	6 ddh, 1000 m; geol; geophys; road
Duckling Creek (BP Res. Canada Ltd.)	93N 005	Omineca	93N/14	Au, Cu	Alkali porphyry	4 ddh, 352 m; geol; geochem; geophys
Eagle (Noranda Expln. Co. Ltd.)	93N 092 091	Omineca	93N/2W	Au, Cu	Alkali porphyry	17 ddh, 1483 m, geol; geochem; geophys; road
Ferguson (Int'l. Impala Res. Ltd.)	94C 002	Omineca	94C/11	Pb, Zn, Ag	Manto	4 ddh, 279 m; geophys
Fish Lake (Taseko Mines Ltd.)	920 041	Clinton	920/5E	Au, Cu	Porphyry	10 ddh, 7500 m; geochem; metallurgical
Frasergold (Eureka Res. Inc.)	93A 150	Cariboo	93A/7E	Au	Phyllite-hosted	111 rcdh, 11 458 m; bulk sampling; pilot milling;road
GR (BP Res. Canada Ltd.)	93N 123	Omineca	93N/1W, 8W	Au, Cu	Alkali porphyry	1 ddh, 156 m; geol; geochem; geophys
Gibraltar (Gibraltar Mines Ltd.)	93B 007	Cariboo	93B/9W	Cu, Au, Zn, Ag	Shear, replacement	33 ddh, 8433 m; metallurgical
Heath (Teck Corp.)	93N 071 072	Omineca	93N/6E	Au, Cu	Porphyry, vein	10 ddh, 969 m; geophys
Heidi Lake (BP Res. Canada Ltd.)	93N 194	Omineca	93N/1E	Au, Cu	Alkali porphyry	12 ddh, 1675 m; road
KL (Noranda Expln. Co. Ltd.)	93N 032	Omineca	93N/7W	Au, Cu	Alkali porphyry	geol; geochem; geophys
Klaw - Norn (BP Res. Canada Ltd.)		Omineca	93N/1W, 2E	Au, Cu	Alkali porphyry	1 ddh, 122 m; geol; geophys
Klawli (Rio Algom Expln. Inc.)		Omineca	93N/7E, 8W	Au, Cu	Alkali porphyry	9 ddh, 1052 m; road

Property (Operator)	MINFILE Number	Mining Division	NTS	Commodity	Deposit Type	Work Done
Kwanika/Valleau (Westmin Resources Ltd.)		Omineca	93N/6E, 7W	Au, Cu	Porphyry	trenching, 2.4 km; geol; geochem; geophys
Lake (Placer Dome Inc.)		Omineca	93O/4W	Au, Cu	Alkali porphyry	geol; geochem; geophys
Lip (BP Res. Canada Ltd.)		Omineca	93N/1E, 4W	Au, Cu	Alkali porphyry	4 ddh; road
Lorraine (Kennecott Canada Inc.)	93N 002	Omineca	93N/14W	Au, Cu	Alkali porphyry	12 ddh, 2000 m; geol; geophys
Lustdust (Alpha Gold Corp.)	93N 009	Omineca	93N/11	Ag, Pb, Zn, Au, Sb, Cu	Vein, replacement	ddh, road
Mass (Rio Algom Expln. Inc.)		Cariboo	93A/11,14	Au, Cu	Massive sulphide	geol; geochem; airborne geophys, 400 km
Max (Rio Algom Expln. Inc.)	93K 020	Omineca	93K/16	Au, Cu	Alkali porphyry	geol; geochem; geophys
Mine (Sanfred Res. Ltd.)		Omineca	93N/1	Au, Cu	Alkali porphyry	geol; geochem; geophys; airborne geophys
Mitzi (Noranda Expln. Co. Ltd.)	93N 096	Omineca	93N/1W	Au, Cu	Alkali porphyry	3 ddh, 344 m; geol; geochem; geophys
Mount Milligan (Placer Dome Inc.)	93N 194	Omineca	93N/1E	Au, Cu	Alkali porphyry	19 ddh, 5059 m; geol; geochem; geophys; trenching, 1150 m; road
Mount Sidney Williams (Ursula Mowat)	93K 043 072	Omineca	93K/14W	Au	Listwanite	5 ddh, 511 m; geochem; geophys
Mount Skinner (Ottarasko/Northair Mines Ltd.)		Clinton	92N/9W	Au	Vein	6 ddh, 260 m; geol; geochem; geophys; trenching, 120m; road
Mount Tom (Inco Ltd.)		Clinton	92O/6	Au	Epithermal	geol; geochem; geophys
Mouse Mountain (Teck Corp.)	93G 005	Cariboo	93G/1W	Au, Cu	Alkali porphyry	9 ddh, 914 m; geol; geophys
Nell (Placer Dome Inc.)		Omineca	93N/11	Au, Cu	Alkali porphyry	geol; geochem; geophys
Newmac (Noranda Expln. Co. Ltd.)	92N 030	Clinton	92N/10,15	Au, Cu	Porphyry related	7 ddh, 1338 m; geochem; geophys; test pits
Newton (Rea Gold Corp.)		Clinton	92O/13E	Au, Cu	Porphyry related	geochem; trenching; road
PM-Klein (Noranda Expln. Col Ltd.)		Cariboo	93J/13	Au, Cu	Alkali porphyry	geol; geochem; geophys
Pan (Cominco Ltd.)		Cariboo	93G/6	Au, Cu	Alkali porphyry	1 ddh, 150 m
Par (Cominco Ltd.)	94C 024 080	Omineca	94C/3E, 2W	Pb, Zn, Ag	Sedex	geol; geochem; geophys; trenching, 300 m; test pits; road
Patenaude (Cominco Ltd.)		Cariboo	93A/6	Au, Cu	Porphyry	7 ddh, 740 m; geol; geochem; geophys
Perkins Peak (Hunter Point Expln. Ltd.)	92N 010 012	Cariboo	92N/14	Au, Ag	Epithermal/vein	Drifting, 88 m
Porphyry Creek (Teck Corp.)	94C 007	Omineca	94C/5, 94D	Au, Cu, Mo	Porphyry, vein	3 ddh, 457 m; geol; geochem; geophys

Property (Operator)	MINFILE Number	Mining Division	NTS	Commodity	Deposit Type	Work Done
Prince (Cominco Ltd.)		Cariboo	93G/15	Au, Cu	Alkali porphyry	1 ddh, 150 m; geol; geochem; geophys
QR (Rea Gold Corp.)	93A 121	Cariboo	93A/12	Au	Alkali porphyry	40 ddh, 2000 m
Rain (BP Res. Canada Ltd.)		Omineca	93N/1E	Au, Cu	Alkali porphyry	1 ddh, 151 m
Redgold (Phelps Dodge Corp of Canada Ltd.)	93A 058	Cariboo	93A/6	Au, Cu	Alkali porphyry	12 ddh, 5000 m
Skook (BP Res. Canada Ltd.)	93N 140 141	Omineca	93N/1W, 2E	Au, Cu	Alkali porphyry	11 ddh, 1243 m; geol; geochem; geophys; road
Sowchea (Cominco Ltd.)	93K 036	Omineca	93K/8, 7	Au	Listwanite	geol; geochem; geophys; trenching, 250 m
Swan (Candela Res. Ltd.)	93N 073	Omineca	93N/6,11	Au, Cu	Porphyry related	4 ddh, 549 m; road
Tak (Placer Dome Inc.)		Omineca	93N/11E	Cu, Au	Alkali porphyry	3 ddh, 453 m; geol; geochem; geophys
Takla-Rainbow (Eastfield Res. Ltd.)	93N 082	Omineca	93N/11E,11	Au, Cu	Porphyry, related	geol; geophys; geochem
Taseko (Alpine Expln. Corp.)	92O 038	Clinton	92O/3W	Au, Cu	Porphyry, transitional	14 ddh, 3800 m; road
Tchentlo (Westmin Res. Ltd.)		Omineca	93N/2	Au, Cu	Alkali porphyry	geol; geochem; geophys
Trail-Philip Lakes (BP Res. Canada Ltd.)		Omineca	93N/1, 93O/4	Au, Cu	Alkali porphyry	2 ddh, 304 m; geol; geochem; geophys
Tsil (Noranda Expln. Co. Ltd.)		Cariboo	93K/16W	Au, Cu	Alkali porphyry	geol; geochem; geophys
Valley Girl (Westmin Res. Ltd.)	93N 053 111	Omineca	93N/7W,10W	Au, Cu	Alkali porphyry	geol; geochem, test pits
Webb (Moondust Ventures Ltd.)		Omineca	93N/1W	Au, Cu	Alkali porphyry	5 ddh, road
Weedon (Placer Dome Inc.)		Cariboo	93J/10W,11	Au, Cu	Porphyry	geochem; geophys
Williams Creek (Williams Creek Expln. Ltd.)	93H 079	Cariboo	93H/4E	Au	Vein	5 ddh, 800 m; geol; geochem; geophys
Windy (Lorne E. Ross)	93J 024	Cariboo	93J/13W	Au, Cu	Porphyry related?	24 pcdh, 1600 m
Witch (Rio Algom Expln. Inc.)	93N 164 084	Omineca	93N/1W, 2E	Au, Cu	Alkali porphyry	9 ddh, 1327 m; trenching 600 m
Wudleau (Westmin Res. Ltd.)		Omineca	93N/6E, 7, 1	Au, Cu	Alkali porphyry	geochem; geol

SOUTH CENTRAL DISTRICT

Allenby (Princeton Ind. Min.)	92HSE139	Similkameen	92H/7E	Zeolites	bulk sample	
Axe (Cominco Ltd.)	92HNE142 143	Similkameen	92H/9W,1	Cu, Au	Porphyry	11 pcddh, 200.1 m; geochem
Beaton (C. Boitard)		Kamloops	92I/10E	Cu, Au	Porphyry	6 ddh, 565.5 m; EM, 9.6 km;IP, 2 km

Property (Operator)	MINFILE Number	Mining Division	NTS	Commodity	Deposit Type	Work Done
Bend (Cominco Ltd.)	83DSE001	Golden	83D/1W	Pb-Zn	Massive sulphide	3 ddh, 1069 m
Birk Creek (Falconbridge Ltd.)	82MSW219	Kamloops	82M/5W	Cu, Pb, Zn, Ag, Au	Massive sulphide	8 ddh, 2426 m; pulse EM, 1970 m; geochem, 116 whole rock,496 assay
Blue Jay (Edward Peacher)		Vernon	82L/11E	Coal	Sedimentary	1 ddh, 15 m
Bogg (Placer Dome Inc.)		Kamloops	92P/10E	Cu, Au	Porphyry	4 trenches, 1420 m; geochem, 1684 soil
Bromley Creek (Felix Reyes)		Similkameen	92H/7E	Zeolites		bulk sample
Camp #1 (L. Mear)		Kamloops	92I/9E	Au, Cu	Porphyry	1 ddh, 70 m
Chip (Kennecott Canada Inc.)		Lillooet	92J/10W	Cu, Pb, Zn, Au, Ag	Massive sulphide	EM, 25 km; mag, 57 km; geochem, 741 soil
Chu Chua (Minnova Inc.)	92PSE140	Kamloops	92P/8E	Cu, Ag, Au	Massive sulphide	9 ddh, 4950 m; down-hole pulse EM
Craigmont (Craigmont Mines Ltd.)	92ISE034 036	Nicola	92I/2W	Magnetite tailings		30 ddh
Deanna (T. Kirk Kilo Gold Mines Ltd.)	82ESW047 048	Osoyoos	82E/5W	Au	Skarn	6 ddh, 150 m
Deer (A. Bartlett)		Kamloops	92I/7E	Cu, Au	Porphyry	1 ddh
Dill (Placer Dome Inc/ Fairfield Minerals Ltd.)	92HNE055 124	Similkameen	92H/9W;1	Cu, Au	Porphyry/Vein	11 ddh, 2030 m; IP, 4.4 km; geochem
Drop (Andrew Babiy)		Kamloops	92I/8W	Au, Ag	Vein	1 pcdh, 50 m
Elk (Fairfield Minerals Ltd.)	92HNE134 137	Similkameen	92H/16W	Au, Ag	Vein	37 ddh, 6600 m; trenching, 50 m
Fairview (Oliver Gold Corp.)	82ESW007 008	Osoyoos	82E/4E	Au, Ag	Vein	6 ddh, 540 m
French Bar (R. Clark)		Clinton	92O/1W	Au	Vein	14 pcddh, 300 m; 12 trenches, 200 m; geochem, 400 samples
Gold Ridge (D. Cardinal)	92ISW055 056, 063, 064, 065	Kamloops	92I/4E	talc-magnesite		8 ddh, 747 m
Goldstream (OreQuest Consultants Inc.)	82MSE141	Revelstoke	82M/8, 9	Cu, Zn	Massive sulphide	35 ddh, 8000 m
Griz (Minnova Inc.)	82MSW049	Kamloops	82M/5	Ag, Cu, Pb, Zn, Au	Massive sulphide	2 ddh, 287 m; 1P, 7 km; mag, 10 km; geochem, 400 soils
Hit and Miss (Vanco Expl. Ltd.)	92HNE157	Similkameen	92H/1E	Cu, Pb, Zn	Porphyry	3 ddh, trenching
Iron Mask (Eureka Res. Inc.)	92INE031 054	Kamloops	92I/15E	Cu, Au	Porphyry	pcdh
J & J (A. Ismay Assoc. Inc.)	92HNW047	Kamloops	92H/13E	Talc	Metamorphic	13 ddh, 1130 m
J & L (Equinox Res. Ltd.)	82MSE003	Revelstoke	82M/8E	Au, Cu, Zn, Pb	Stratabound/Vein	27 ddh, (u/g), 5605 m; 50 ddh, (surface), 8272 m;

Property (Operator)	MINFILE Number	Mining Division	NTS	Commodity	Deposit Type	Work Done
Kamad (Homestake Canada Ltd.)	82MSW020	Kamloops	82M/4W	Au, Ag, Cu, Pb, Zn	Massive sulphide	3 trenches; geochem 4 ddh, 2313 m; pulse EM, 1000 m; geochem
Log (Cominco Ltd.)	92HNE115 118, 131	Similkameen	92H/15E	Cu, Au	Porphyry	15 pcdh, 1067 m; road, 1120 m; geochem
Love Oil (Avino Mines and Res. Ltd.)	92JNE001 002, 003, 004, 007	Lillooet	92J/15W	Au, Ag	Vein	drifting, ddh; rehab
Lumby (Quinto Mining Corp.)	*82LSE006*	*Vernon*	*82L/7W*	*Au, Ag*	*Vein*	*pcdh (u/g)*
M & R (Afton Operating Corp.)	92INE067	Kamloops	92H/10E	Cu, Au	Porphyry	6 rcdh, 250 m; geochem, 64 soil, 18 rock
MGM (Teck Corp.)		Golden	83D/1E	Pb, Zn, Ag	Shale-hosted Massive sulphide	4 ddh, 1874 m; trenching mag, 7.4 km; UTEM, 1092 m; geochem, 232 soil
Mastadon (Teck Expl. Ltd.)	*82MSE005* 094	*Revelstoke*	*82M/1E*	*Zn, Pb, Cd*	*Massive sulphide*	*7 ddh, 685 m;* trenching, 40 m
Mila (Goldbank Ventures Inc.)	82MNW151 152	Kamloops	82M/12E	Ag, Cu, Zn, Pb, Au	Massive sulphide	7 ddh, 1408 m; mag, 12.7 km
Mosquito King (Plateau) (Minnova Inc.)	82MSW016 129, 138	Kamloops	82M/4E	Au, Cu, Pb, Zn, Ag	Massive sulphide	16 ddh, 2100 m; IP, VLF, mag, 55 km; goechem, 1000 soil; 400 rock
Murphy (Murphy-Shewchuk)		Similkameen	92H/7E	Cu, Au	Porphyry	1 ddh; trenching
Ranchlands (Mountain Minerals Ltd.)		Kamloops	92I/14	Zeolite		bulk sample
Raven (Reese River Res. Corp.)		Lillooet	92J/9	Au	Vein	10 hand ddh; geol
Reg-Byr (Afton Operating Corp.)		Kamloops	92I/9W	Cu, Au, Mo	Porphyry	8 pcdh, 684.3 m; geochem, 211 rock
Samatosum (Minnova Inc.)	82MSW244	Kamloops	82M/4W	Ag, Cu, Zn, Pb, Au	Vein/Massive sulphide	147 ddh (121 u/g, 26 surface), 9074 m; drifting
Second (Cyprus Gold Canada Ltd.)		Clinton	92O/1E	Au	Vein	10 ddh, 548 m; trenching
Snowflake (Quilchena Res. Ltd.)		Nicola	92H/15E	Cu, Au	Porphyry	3 ddh; trenching
Stmp 1 & 2 (L. Mear)		Kamloops	92I/8W	Au, Cu	Porphyry	1 ddh, 107 m
Tim 1 (Andrew Babiy)		Kamloops	92I/9W	Ag, Au	Vein	1 pcdh
Tor (E. Wedekind)		Similkameen	92H/7E	Au, PGE		2 ddh, 333 m;
Twin (Homestake Canada Ltd.)	82MSW025	Kamloops	82M/4W	Au, Ag, Pb, Zn	Massive sulphide	6 ddh, 4417 m; pulse EM, 2000 m; geochem
Vicars 1-4 (L. Mear)		Kamloops	92I/9E	Au, Cu	Porphyry	1 ddh, 107 m

Property (Operator)	MINFILE Number	Mining Division	NTS	Commodity	Deposit Type	Work Done
Vin (Fairfield Minerals Ltd.)		Similkameen	92H/15E	Cu	Porphyry	geochem, 5231 soils (262 km)
Wayside (Carpenter Lake Res. Ltd.)	92JNE030 121, 124	Lillooet	92J/15W	Au	Vein /Massive sulphide	4 ddh, 884 m
Whipsaw (Phelps Dodge Corp. Canada Ltd.)	92ISW102	Similkameen	92H/7E	Cu, Au, Mo	Porphyry	10 ddh, 1221 m; 12 pcdh, 845 m; road, 500 m
Wye (Apollo Developments Inc.)	82ESW136	Greenwood	82E/6E	Ag, Au, Pb, Zn	Vein	5 ddh; geophys (IP), 5.9 km
Zig (Minequest Expln. Assoc. Ltd.)	92HNE090 151	Nicola	92H/15E	Cu, Au	Porphyry	11 rcdh, 651 m; geochem

KOOTENAY DISTRICT

Property (Operator)	MINFILE Number	Mining Division	NTS	Commodity	Deposit Type	Work Done
Athelstan-Jackpot (Minnova Inc.)	82ESE047	Greenwood	82E/2E	Au, Ag, Cu	Listwanite	7 ddh, 946 m; geochem
Bluebell (Canamax Res. Inc.)	82ESE188	Greenwood	82E/2E	Au, Cu	Skarn	6 ddh, 970 m; geochem; geophys
Bull River (R.H. Stanfield)	82GNW002	Fort Steele	82G/11W	Au, Ag, Cu, Pb, Zn, Cd	Vein	7 ddh, 4689 m; 5 rdh, 247.8 m; trenching; airborne geophys, 1206 km
Canam (Cominco Ltd.)		Fort Steele	82G/4W	Pb, Zn, Ag	Sedex	3 ddh, 869 m; trenching; geochem; geophys, 75 km
Castle Mountain, North Face (Fording Coal Ltd.)	82JSE011	Fort Steele	82J/2W	Coal	Sedimentary	22 rdh, 4095.7 m
Clubine (Yellowjack Res. Ltd.)	82FSW200	Nelson	82F/3W	Au, Pb, Zn, Ag	Vein	6 ddh, 743 m
Corbin - South Mine Extension (Byron Creek Collieries)	82GSE052	Fort Steele	82G/7E	Coal	Sedimentary	15 kt bulk sample
Cottonwood Pitt (Noramco Mining Corp.)	82FSW237	Nelson	82F/6E, 6W	Au, Cu	Porphyry	1 ddh, 486 m; geophys; geochem
Darlin (Kokanee Expln. Ltd.)		Fort Steele	82F/9E	Pb, Zn, Ag, Au	Sedex	13 ddh, 3025.8 m; geochem; geophys
David/Lew (Dragoon Res./Greenstone Res.)		Fort Steele	82F/8E	Au	Shear/vein	27 ddh, 2539.5 m; geophys
Duncan (Cominco Ltd.)	82KSE023	Slocan	82K/7W	Zn, Pb	Remob. stratabound	2 ddh, 1069 m
Elkhorn Barite (Dynamic Drilling Fluids Ltd.)	82JSW002	Golden	82J/5W	Barite	Vein, breccia	49 ddh; 1432 m
Estella (Cominco Ltd.)	82GNW008	Fort Steele	82G/13E	Zn, Pb, Ag, Cd	Vein	1 ddh, 708 m; geochem; geophys
Evergreen, Silverhawk (Teck Corp.)	82FSW230	Nelson	82F/6W	Pb, Zn	Vein	4 ddh, 350 m; geophys; geochem
Greenhills (Westar Mining Ltd.)	82JSE007	Fort Steele	82J/2W	Coal	Sedimentary	9 rdh, 1669 m; 6 ddh, 2270 m
Katie (Noranda Expln./ Yellowjack Res.)	82FSW291	Nelson	82F/3W	Cu, Au	Porphyry	27 ddh, 6772.5 m
Kena (Noramco Mining Corp.)	82FSW237	Nelson	82F/6W	Au, Cu	Porphyry	2 ddh, 588 m; geophys; geochem
Kenville Mine (Coral Industries Ltd.)	82FSW086	Nelson	82F/6W	Au, Ag	Vein	exploration drifting

Property (Operator)	MINFILE Number	Mining Division	NTS	Commodity	Deposit Type	Work Done
Lapointe Creek (Dragoon Res. Ltd.)		Fort Steele	82F/15E	Zn, Pb, Ag	Vein sedex	1 ddh
Line Creek (Manalta Coal/Crowsnest Res.)	82GNE020	Fort Steele	82G/15W, J/02	Coal	Sedimentary	104 rdh, 17 250.7 m; 39 trenches, 777 m
Lower Henretta (Fording Coal Ltd.)	82JSE012	Fort Steele	82J/2W	Coal	Sedimentary	33 rdh, 3483.7 m
Mt. Mahon (Minnova Inc.)		Fort Steele	82G/4W	Pb, Zn, Ag	Sedex	3 ddh, 1256 m
North Belt (Vangold Res./Antelope Res.)	82FSW100	Trail Creek	82F/4W	Au, Cu	Vein	16 ddh, approx. 1585 m; u/g drifting and drilling; geophys:geochem
Ore Hill-Sumit (Yellowjack Res. Ltd.)	82FSW053	Nelson	82F/3E	Au, Ag, Pb, Zn	Replacement/ vein	8 ddh, 1049 m; geochem
Outback (Inco Ltd.)		Greenwood	8E/9W	Au, Ag	Epithermal	6 ddh, 807.1 m
Paul-Mike (Dia Met Minerals Ltd.)		Fort Steele	82G/13E	Pb, Zn	Sedex	2 ddh, 60 m
Phoenix (Battle Mountain (Canada) Inc.)	82ESE025	Greenwood	82E/2E	Au, Ag, Cu	Skarn	approx. 10 ddh, 915 m; geophys
Rainbow-Tam O'Shanter (Minnova Inc.)	82ESE130	Greenwood	82E/2W	Au, Ag, Cu, Mo	Porphyry/ skarn/vein	19 ddh, 25945 m; geophys; geochem
Royal Canadian (Nevada) (Hibernian Properties Ltd.)	82FSW088	Nelson	82F/6W	Au, Ag	Vein	exploration drifting
Star (Kokanee Expln. Ltd.)	82FSE089	Nelson	82F/1E	Pb, Zn, Ag	Vein, sedex	3 ddh, 1480.5 m; geochem
Stoney (Minnova Inc.)		Fort Steele	82G/4W	Pb, Zn, Ag	Sedex	1 ddh, 285.6 m
Sullivan Mine (Cominco Ltd.)	82FNE052	Fort Steele	82F/9E, G/12	Pb, Zn, Ag	Sedex	diamond drilling, trenching
Surelock (Mountain Minerals Co. Ltd.)		Golden	82K/9W	Barite	Vein	drifting, 30.5 m
Tillicum Mountain (Columbia Gold Mines Ltd.)	82FNW234	Slocan	82F/13E	Au	Skarn	approx. 1 kt bulk sample for metallurgical testing
Torrent (Bonny) (Mountain Minerals Co. Ltd.)	82GNW065	Fort Steele	82G/13W	Barite (Ag, Au, Cu)	Vein, Breccia	10 ddh, 65.5 m
Vine (Kokanee Expln. Ltd.)	82GSW035	Fort Steele	82G/5W	Pb, Zn, Cu	Vein	diamond drilling
Vulcan (Ascot Res. Ltd.)	82FNE093	Fort Steele	82F/16W	Pb, Zn, Ag	Sedex	5 ddh, 1000 m
Whitewater (Highland Surprise) (CSA Res. Mgmt./Goldcorp)	82KSW033	Slocan	82K/3E	Ag, Pb, Zn, Au	Vein, replacement	6 ddh, 405.6 m
Wildrose Claim Group (Randsburg Gold/Minnova Inc.)		Greenwood	82E/2E	Au, Cu, Mo	Skarn/porphyry/ epithermal	13 ddh, 824 m; trenching; geophys; geochem

SOUTHWEST DISTRICT - 1991 MAJOR PROJECTS

Property (Operator)	MINFILE Number	Mining Division	NTS	Commodity	Deposit Type	Work Done
Avalanche (Teck Expln. Ltd.)		Lillooet	92J/10W	Au	Shear, vein	10 ddh, 1914 m; geochem; geophys
Deer/Sep (Dual Res./Antelope Res.		Alberni	92F/4E, 5E	Cu, Zn	Porphyry/skarn	4 ddh, 633 m

Property (Operator)	MINFILE Number	Mining Division	NTS	Commodity	Deposit Type	Work Done
Expo (Hushamu) (Jordex Res. Inc.)	92L 240	Nanaimo	92L/12W	Cu, Mo, Au	Porphyry	8 ddh, 2857.35 m
HPH/Holberg Inlet (Cameco Corp.)	92L 069	Nanaimo	92L/12W	Pb, Zn, Cu, Ag, Au	Skarn, manto	6 ddh, approx. 731.2 m; geochem; geophys
Ladner Creek/Emancipation (Anglo Swiss Mining Corp.)	92HSW034	New Westminster	92H/11W	Au, Ag	Vein	3 u/g ddh, 122 m
Lang Bay (Lang Bay Res. Ltd.)		Vancouver	92F/16W	Kaolin	Residual	rotary drilling; mill tests
Leo D' or (Leo D' or Mining Inc.)		Nanaimo	92L/7W	Marble	Metamorphic	bulk sampling, diamond drilling
Madhat (Pan Orvana Res. Inc.)		Nanaimo	92L/5E	Cu, Au	Porphyry/ epithermal	3 ddh, 486 m; geophys; geochem
Merry Widow (Taywin Res. Ltd.)	92L 043	Nanaimo	92L/6E, W	Au, Ag, Cu	Skarn, manto	2 ddh, 193 m
Murex (North Slope Minerals Inc.)	92F 206	Nanaimo	92F/14E	Au, Ag, Cu	Epithermal veins, breccias	diamond drilling
Myra Falls (Wesmin Res. Ltd.)	92F 071	Alberni	92F/12E	Cu, Zn, Pb, Au, Ag	VMS	u/g drifting and drilling; surface diamond drilling
Red Dog (Moraga Res. Ltd.)	92L 200	Nanaimo	92L/12W	Cu, Mo, Ag	Porphyry	8 ddh, 1240 m
Seneca (Agassiz-Weaver) (Minnova Inc.)	92H 013	New Westminster	92H/5W	Zn, Cu, Pb, Ag, Au	VMS	20 ddh, 5360 m; trenching; geophys geochem
Southeaster (Clear Creek Res. Ltd.)	103G 004	Skeena	103F/8E, G/5W	Au, Ag	Epithermal veins, breccias	14 ddh, 533 m; 13 trenches
Sumas Mountain (Pegasus Earth Sensing Corp.)	92G 037	New Westminster	92G/1E	Feldspar	Intrusive	9 ddh, 182 m; beneficiation tests
Tay Gold (Dalmation Res. Ltd.)	92F 212	Alberni	92F/6W	Au	Vein, breccia	6 ddh, 891 m
Tsable River Coal (Western Canadian Mining Corp.)	92F 333	Nanaimo	92F/7W, 10W	Coal	Sedimentary	20 ddh, approx. 3300 m; geophys
Vananda Gold (Vananda Gold Ltd.)	92F 271	Nanaimo	92F/10E, 15E	Au, Cu	Skarn	5 ddh, approx. 1370 m; trenching, geophys; drilling continuing
Wellington Shale Quarry (IEC Investments Ltd.)		Nanaimo	92F/1E, G/4W	Shale	Sedimentary	9 ddh, approx. 310 m
Win (Essex Res. Corp.)	92L 181	Nanaimo	92L/12W	Zn, Pb, Ag, Au	Skarn	3 ddh, 320 m; geophys; geochem

NORTHWESTERN DISTRICT

By M.L.Malott and J. Crux-Prosser
District Geology, Smithers

INTRODUCTION

In 1991, northwestern British Columbia continued to be one of the most active mineral exploration areas in the country (Figure A-1 and A-2). Expenditures in the district were in excess of $45 million, down 60 per cent from 1990; 52 per cent of the $87 million provincial total. A total of 381 Mineral Notices of Work were submitted during the year. Fourteen million dollars were spent on continuing exploration at and within the vicinity of Eskay Creek. The major portion of the exploration expenditure, $27 million, was spent in the Stewart to Galore Creek region. However, after four years of relatively high mineral exploration expenditures, economic conditions deteriorated sharply in 1991 and numerous programs were reduced or cancelled.

Although Eskay Creek remains a focus, exploration activity this year began to broaden within a prospective belt stretching from Stewart northwest to the Tulsequah River. Nearly 60 per cent (42) of the 73 major exploration programs were conducted within this belt (Figure A-3). In addition to precious metal targets, polymetallic porphyry and volcanogenic massive sulphide deposits were sought by increasing numbers of companies.

The advanced projects - Windy Craggy, Sulphurets and Eskay Creek, remained active and studies associated with the Mine Development Assessment Process (formerly the Mine Development Review Process) and mine feasibility continued. Four other advanced projects proceeded through development to mining: Silver Butte, Al, Chappelle (B vein) and Dome Mountain. All ore is being processed at existing mills.

Eight mines were in production during 1991. One mine, Shasta, temporarily shut down in November. Cassiar (McDame), Golden Bear, Cheni Gold, Snip, Premier Gold, Bell and Equity Silver mines continued operations throughout the year. Snip gold mine has been operating efficiently since it began production in January. Equity will close in 1992 and possibly Bell as well. Golden Bear and Premier Gold, although beset by difficulties since start-up, are currently giving a positive cash flow. Cassiar (McDame) and Cheni Gold have been particularly hard hit by production difficulties and the economic downturn. Their future is uncertain.

HIGHLIGHTS

- Snip mine began production on January 15 and to the end of October 1991 milled 98 426 tonnes of ore and produced 2716 kilograms (87 338 oz) of gold.
- Drilling continued through the winter of 1990 and into the spring of 1991 on the new volcanogenic massive sulphide target, Rock and Roll, 12 kilometres west of Bronson airstrip.
- Underground operations were discontinued at the Golden Bear mine and production is now entirely from the open pit.
- The Iskut Road has been advanced 37 kilometres westward from the Bob Quinn area to the confluence of the Iskut River and Volcano Creek (Plate A-1).
- Aggressive exploration by El Condor Resources Ltd. on the South Kemess property is proving up a sizeable porphyry copper-gold deposit in the south Toodoggone with 127.0 million tons grading 0.23 per cent copper and 0.58 gram per tonne gold and still open to extension.
- Massive sulphides were discovered in a road-cut on the Sky property between the Snip and Johnny Mountain mines.
- Major litigation proceedings regarding the Eskay Creek area were settled. The staking ban was lifted in early September and a staking rush ensued.
- International Corona Corporation and Placer Dome Inc. initially struck a 50/50 agreement to bring Eskay Creek to production. After a review of the deposit Placer announced in December that it would not proceed with the exploration and feasibility studies. Placer determined its financial objectives would not be met by the terms of agreement.
- For the first time since the late 1970s and early 1980s, respectively, drilling programs were carried out on the Big Onion and Poplar porphyry copper-gold deposits.
- Equity Silver Mines Limited posted a $37.5 million bond to cover reclamation costs after mine closure (Plate A-2).
- The McDame mine of Cassiar Mining Corporation has been beset by start-up problems and required additional capital to continue. This was not available and the mine closed in February, 1992.

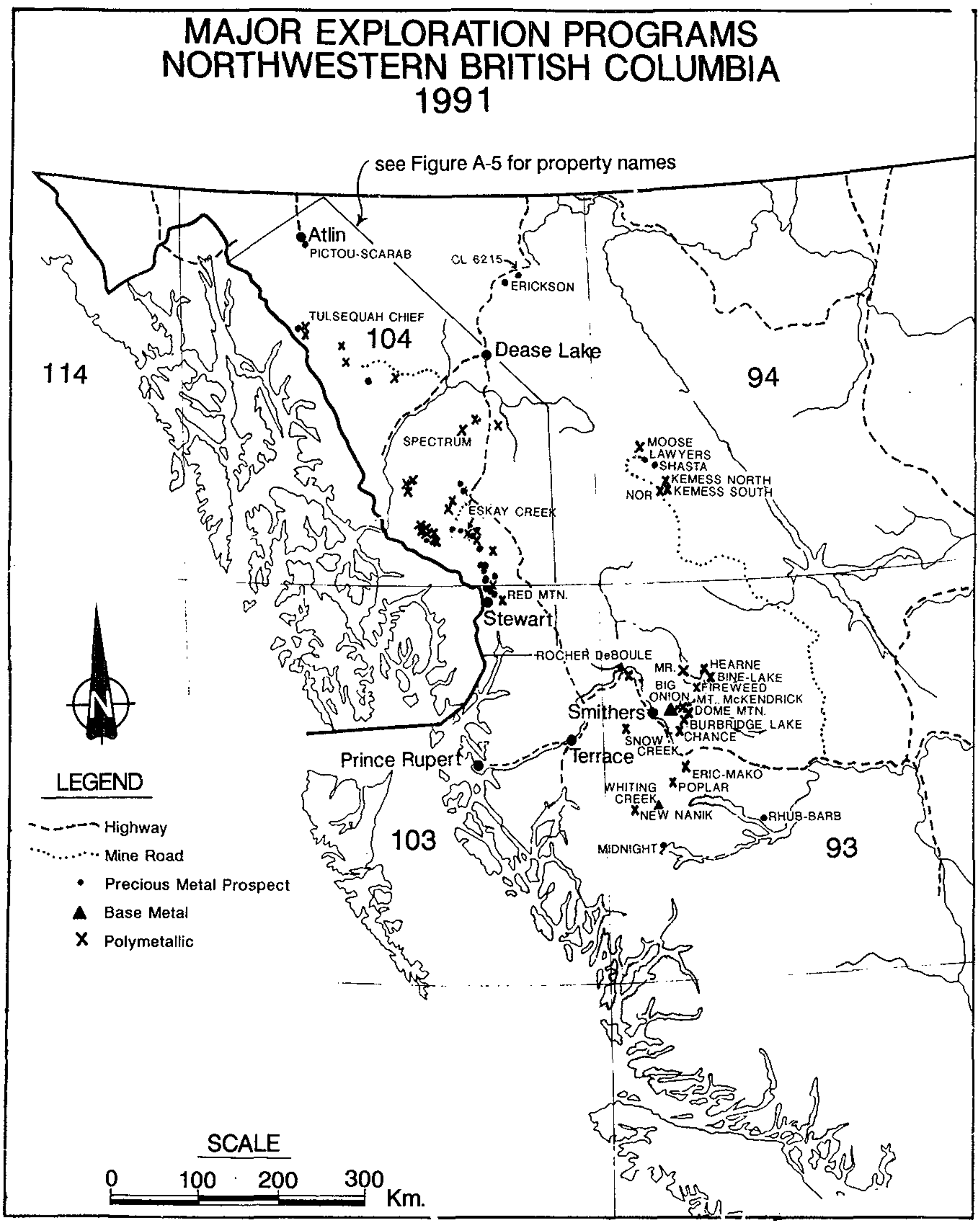

MAJOR EXPLORATION PROGRAMS
NORTHWESTERN BRITISH COLUMBIA
1991
see Figure A-5 for property names
Atlin
PICTOU-SCARAB
CL 6215
ERICKSON
TULSEQUAH CHIEF
104
Dease Lake
114
94
SPECTRUM
MOOSE
LAWYERS
SHASTA
KEMESS NORTH
NOR
KEMESS SOUTH
ESKAY CREEK
RED MTN.
Stewart
ROCHER DeBOULE
MR.
HEARNE
BINE-LAKE
BIG
FIREWEED
ONION
MT. McKENDRICK
Smithers
DOME MTN.
BURBRIDGE LAKE
SNOW CREEK
CHANCE
Prince Rupert
Terrace
ERIC-MAKO
WHITING CREEK
POPLAR
NEW NANIK
RHUB-BARB
103
MIDNIGHT
93
N
LEGEND
Highway
Mine Road
Precious Metal Prospect
Base Metal
Polymetallic
SCALE
0
100
200
300
Km.

Figure A-4

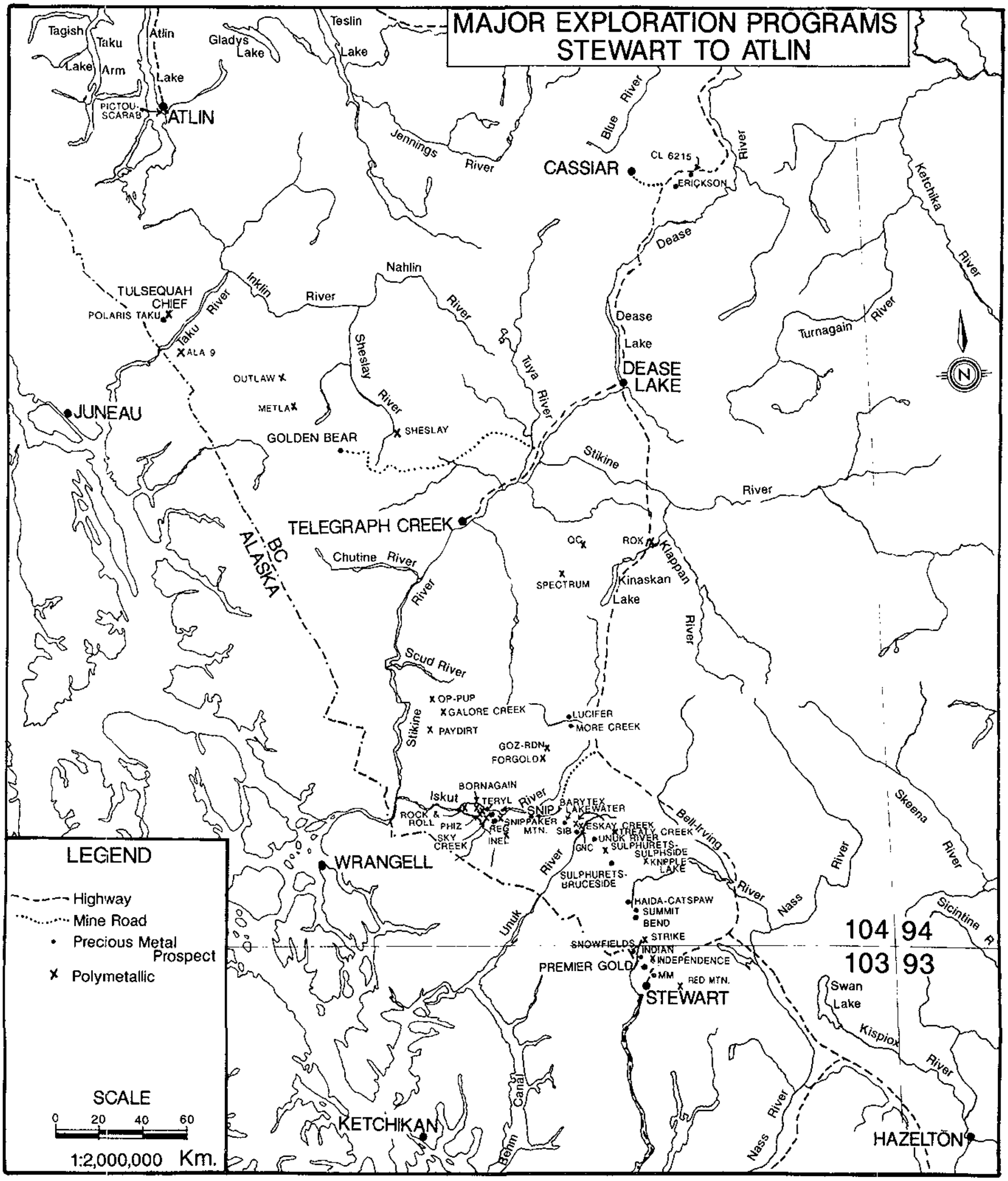

MAJOR EXPLORATION PROGRAMS
STEWART TO ATLIN
LEGEND
Highway
Mine Road
Precious Metal Prospect
Polymetallic
SCALE
0 20 40 60
1:2,000,000 Km.
ATLIN
JUNEAU
CASSIAR
DEASE LAKE
TELEGRAPH CREEK
WRANGELL
STEWART
KETCHIKAN
HAZELTON
BC
ALASKA
PICTOU-SCARAB
TULSEQUAH CHIEF
POLARIS TAKU
ALA 9
OUTLAW
METLA
GOLDEN BEAR
SHESLAY
CL 6215
ERICKSON
QC
ROX
SPECTRUM
OP-PUP
GALORE CREEK
PAYDIRT
LUCIFER
MORE CREEK
GOZ-RDN
FORGOLD
BORNAGAIN
TERYL
SNIP
BARYTEX
LAKEWATER
ROCK & ROLL
PHIZ
SKY CREEK
REG
INEL
SNIPPAKER MTN.
SIB
ESKAY CREEK
TREATY CREEK
UNUK RIVER
GNC
SULPHURETS
SULPHSIDE
KNIPPLE LAKE
SULPHURETS-BRUCESIDE
HAIDA-CATSPAW
SUMMIT
BEND
STRIKE
SNOWFIELDS
INDIAN
INDEPENDENCE
PREMIER GOLD
MM
RED MTN.
104 94
103 93
Tagish Lake
Taku Arm
Atlin Lake
Gladys Lake
Teslin Lake
Jennings River
Blue River
Dease River
Ketchika River
Nahlin River
Inklin River
Taku River
Sheslay River
Tuya River
Dease Lake
Turnagain River
Stikine River
Chutine River
Klappan River
Kinaskan Lake
Scud River
Iskut River
Unuk River
Bell-Irving River
Nass River
Skeena River
Sicintine R.
Swan Lake
Kispiox River
Behm Canal

Figure A-5

Plate A-1. Logging equipment is shown clearing the right of way on the Iskut Road. Beginning several kilometres south of Bob Quinn, the Iskut Road has been taken 37 kilometres to the west to the confluence of Volcano Creek with the Iskut River.

Plate A-2. Equity Silver Mines Limited is recontouring waste piles, adding a compacted till layer and top soil, then seeding, in an effort to reduce water infiltration by as much as 70%. Reducing the amount of water requiring treatment may ultimately lower the large reclamation bond ($37.5 million) which the company has posted.

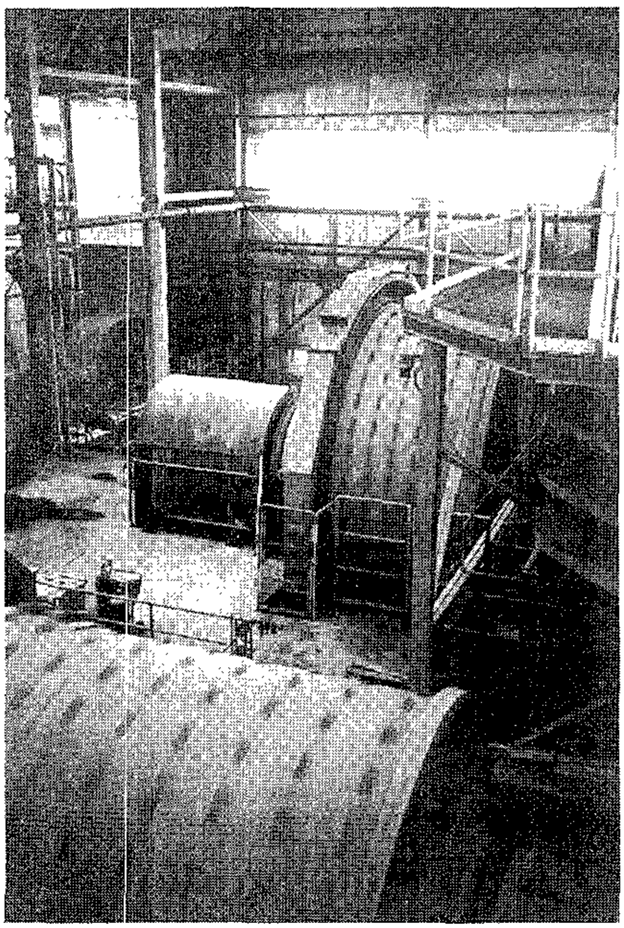
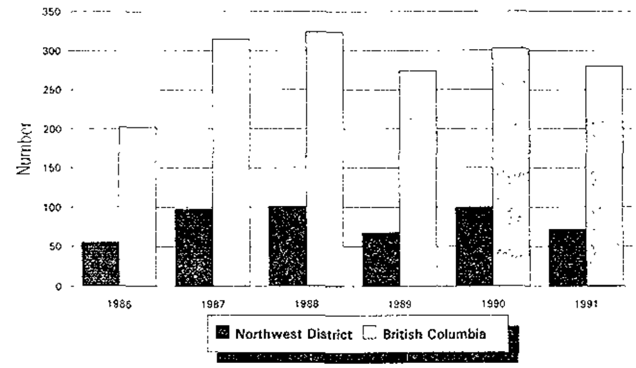


Plate A-3. Ball mills in the Premier Gold mill process up to 2000 tonnes per day. In addition to ore from the Premier Silback and Big Missouri deposits, Westmin has milled Silver Butte and Dome Mountain ore. Westmin is actively looking for custom milling arrangements.

Figure A-6

MAJOR EXPLORATION PROGRAMS



Major indicating drilling, underground work or very extensive surveys.

Figure A-7

MINERAL NOTICES OF WORK
Northwestern British Columbia

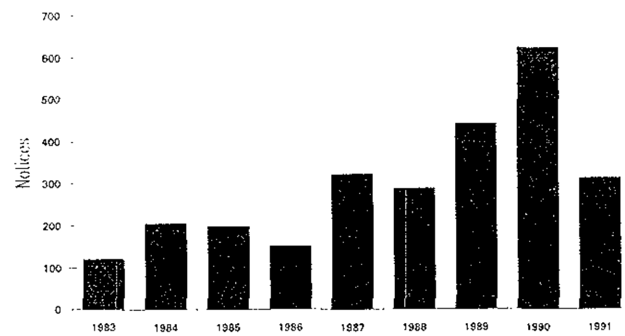
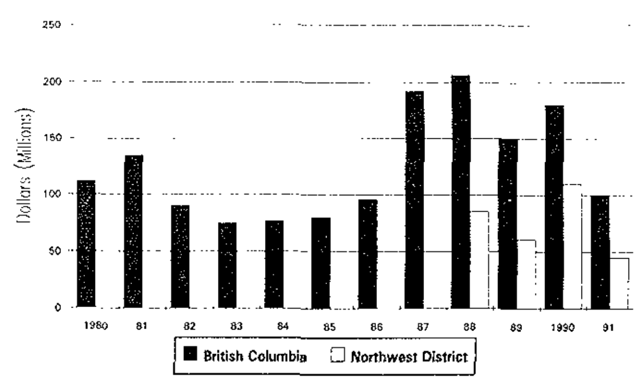


Figure A-8

Mineral Exploration Expenditures



Provincial figures for 1981 to 1989 provided by British Columbia and Yukon Chamber of Mines 1990 and 1991 figures from District Geologists.

TABLE A-4
1991 RESEARCH PROGRAMS IN NORTHWESTERN B.C.

RESEARCHER	LOCATION AND TYPE OF RESEARCH
B.C. Ministry of Energy, Mines and Petroleum Resources (M.E.M.P.R.)	
Derek Brown	Regional mapping in the Stikine River area west of Telegraph Creek
Vic Levson	Evaluation of placer gold deposits in the Atlin area
Jim Logan	Regional mapping in the north Iskut River, More Creek area
Mitch Mihalynuk	Regional mapping between Atlin Lake and the old Tulsequah minesite
Barry Ryan	Compilation studies of numerous coal deposit localities in northwestern B.C.
Geological Survey of Canada (G.S.C.)	
Bob Anderson	Regional mapping as the basis of detailed biochronologic geochronometric and geochemical studies contributing to unravelling the tectonic history of the Iskut map area
Wanda Bentkowski	Heat-flow measurements (Premier, Eskay, Tulsequah) to better establish the heat-flow regime across northern B.C.
Hugh Gabrielse	Selected detailed studies in the Sylvester Group
Carol Evenchik	Mapping structural styles and sedimentary facies in Bowser Lake Group rocks along the east margin of the Bowser Basin, Toodoggone River map sheet
Jack & Mariette Henderson Rod Kirkham Bruce Ballantyne Jim Harris Tom Wright (US. Nat. Sci. Fd)	Detailed mapping and structural analysis in the Sulphurets region to establish a geological framework for geochemical studies on alteration zones and mineralogy
Carmen Lowe Dave Seeman	Regional gravity survey extending across the western margin of the Bowser Basin (56°-57°), Iskut map area
Brian Ricketts	Stratigraphic analysis of the Bowser Basin sediments (Bowser Lake Group and Spatsizi Group) to elucidate basin initiation and evolution
Tom Vandall	Paleomagnetism of Toarcian Hazelton Group rocks in the Yehiniko Lake area (104G/11, 12)
Mineral Deposit Research Unit (MDRU)	
Roland Bartsch (RB) David Bridge (DB) Art Ettlinger (AE) Colin Godwin (CG) Peter Lewis (PL) James Macdonald (JM) Bruce Miller (BM) David Rhys (DB) Tina Roth (TR) Alistair Sinclair (AS) Lori Snyder (LS) John Thompson (JT)	Regional mapping concentrating on the Prout Plateau Eskay area (PL, RB, BM) Site Studies: Snip (AS, DR, AE, CG); Johnny Mountain (AE); Eskay Creek (AE, TR, CG); Kerr (DB, CG); Sulphurets (JM); Treaty Creek (JT, PL); Forgold (JM); E & L (AE, LS); Inel (JM)
University Theses	
Charlie Grieg Univ. of Ariz	Mapping, stratigraphic and structural studies in the Oweegee Dome and Kinskuch Lake areas
Mike Gunning Univ. W. Ont.	Mapping, biostratigraphic and stratigraphic studies of the Paleozoic Stikine assemblage in the Iskut and S.W. Telegraph Creek map areas
Julie Hunt UBC	A study of Cretaceous stratigraphy of the Nazco Basin
Bill McClelland Univ. Southern Califormia Santa Barbara	A study of Yukon-Tanana-type rocks as they extend from S.E. Alaska into the Iskut map area
Scott Porter Univ. of Calgary	Amphibolite-grade metamorphic rocks in the Elbow Mountain area
Genga Nadaraju, UBC Paul Smith, UBC.	Paleontological studies in the Eskay Creek, John Peaks, Sulphurets and Snippaker Mtn. areas
Harrison Cookenboo, UBC Mark Bustin, UBC	Upper Jurassic and Cretaceous stratigraphy of the Bowser Basin

- Cheni Gold Mines Inc. mined approximately 60 000 tonnes from the Al deposit and milled it at Lawyers; International Shasta Resources Ltd. mined 11 014 tonnes from the Chappelle (B vein) milling it at the old Baker mill site; Westmin Resources Limited milled 74 300 tonnes from the Silver Butte property, between May and October, processing it at the Premier Gold mill (Plate A-3).
- Timmins Nickel Inc. has developed the Dome Mountain property and full production began in early January, 1992. Dome ore is being milled at Equity Silver mine.
- Noranda Minerals Inc. has concluded that the stripping ratio at Bell mine is too high to develop reserves of 120 million tonnes of 0.45 per cent copper. The mine is to close in 1992 or 1993, depending on the method of final ore extraction.
- Kennecott Canada Inc. spent $3.3 million on an extensive exploration program at Galore Creek which included assaying 15 000 samples from old core.

TRENDS

A strong economic downturn hit the mineral industry in 1991. For the northwestern district this resulted in:

- 50 per cent fewer Notices of Work were submitted (Figure A-7).
- 27 per cent fewer major programs than 1990 (Figure A-4).
- Mineral exploration expenditure was $45 million, 40 per cent of the previous year's total (Figure A-5).
- Program budgets were smaller and correspondingly, a shorter time was spent in the field.
- Very few grassroots exploration programs.
- Most of the mines were hit hard by both the economic downturn and continuing soft precious metal prices.
- Prime Equities Inc. was involved with a large proportion of the exploration programs.
- Land-use concerns continued to increase dramatically.

In February, staff from the Ministries of Energy, Mines and Petroleum Resources; Parks; and Forests were involved in a province-wide series of public meetings presenting Parks and Wilderness for the 90s. The public were asked to comment on the process of Park and Wilderness determinations. It is increasingly apparent that the mineral industry will face more and more constraints on how exploration and mining can be carried out.

OPPORTUNITIES

The Northwestern District still has numerous areas with open exploration potential. Attractive targets are porphyry copper-gold deposits in the Stikine and Quesnel terranes, volcanogenic massive sulphide deposits in the Alexander and Stikine terranes and mesothermal gold deposits in the Alexander Terrane.

Although the focus is broadening northward from the Quesnel trough and spreading within the northern Stikine Terrane, large tracts of ground still remain prospective for porphyry copper-gold deposits such as Galore Creek or Bell Copper. The southern part of Stikinia, northeast to southwest of Smithers, has good potential.

Exploration for volcanogenic massive sulphide deposits increased significantly in 1991. The discoveries in the Bronson Creek area (Rock and Roll, Sky Creek) have spurred interest in that region. The Windy Craggy, Tulsequah and Ecstall River areas have massive sulphide potential. Mineral potential in the Middle Jurassic submarine strata of the Stikine Terrane is promising.

Mineral exploration remains very quiet in the North Coast region despite very good potential for finding major mesothermal gold veins.

RESEARCH

The Northwestern District encompasses a large and geologically diverse region noted for its mineral deposits. The number and diversity of research projects undertaken in the district is correspondingly large. Table A-4 outlines research programs which were active in the field in 1991.

EXPLORATION PROJECTS

Tatshenshini River Area To Atlin

There was no active geological exploration at the Windy Craggy project in the extreme northwestern corner of the province. However $1.5 million was spent completing a number of baseline studies for the Mine Development Assessment Process. Geddes Resources Ltd. announced a reserve estimate by Montgomery Consultants Limited which added 110 million tonnes giving a total of 297 439 000 tonnes at an average grade of 1.38 per cent copper using a cut-off grade of 0.5 per cent (George Cross Newsletter, 1991, No. 227).

The only major exploration program in the Atlin area was on the Pictou-Scarab property. Internova Resources Ltd. drilled four holes to test for gold and silver mineralization associated with listwanite alteration around an ultrabasic-andesite contact.

Cassiar

In the Cassiar mining camp Total Energold Corporation conducted a 20-hole diamond drilling program early in the year on the Erickson (Cusac) property. There are more than 20 high-grade gold-quartz veins on the Cusac site and drilling was on the Bain vein cutting basalts close to a contact with argillites and a listwanitic alteration zone. The mineralization is in two blocks over 450 metres length. The Erickson has estimated possible and probable reserves of 199 585 tonnes with an average grade of 22.97 grams per tonne gold (George Cross Newsletter, 1991, No. 243)

TULSEQUAH RIVER - TATSAMENIE LAKE AREA

The Tulsequah chief volcanogenic massive sulphide deposit is located 65 kilometres northeast of Juneau, Alaska. Cominco Ltd. and Redfern Resources Ltd. conducted a six-hole infill drilling program to confirm the continuity of both the AB and H lenses. Results show that the H lens extends from the deeper levels upwards through the full 670-metre vertical extent of the deposit.

Several kilometres southeast, across the Tulsequah River, Suntac Minerals Corporation completed 11 diamond-drill holes. Auriferous quartz veins occur in carbonate-altered wallrock adjacent to three major structures. All of the 1991 drill holes intersected significant mineralization while testing the C and Y veins. The ten best holes are reported to average 18.5 grams per tonne gold over 3.2 metres.

Ashworth Exploration Ltd. tested a massive sulphide target by ground and aerial magnetic surveys plus a two-hole drilling program on Sittakanay Mountain to the southeast of the Tulsequah and Taku rivers confluence.

Drilling programs were carried out in the Trapper Lake area by Glider Developments Inc. and Galico Resources Inc. No significant mineralized intercepts were encountered on the gold and polymetallic targets.

At the Golden Bear mine an exploration program to outline additional reserves included fourteen surface and seven underground diamond-drill holes in addition to reconnaissance work, geochemical surveys and geological mapping.

Along the Sheslay River to the east of the Golden Bear mine, Golden Ring Resources Ltd. undertook an 870 line-kilometre airborne magnetic - electromagnetic survey over the central portion of its Sheslay project.

MOUNT EDZIZA - KINISKAN LAKE AREA

During the 1960s and 1970s exploration identified a number of porphyry copper-gold and precious metal shear-vein systems on the Klastine Plateau. A number of these systems are being re-examined.

Twenty-five kilometres southwest of the village of Iskut, on the east side of Mount Edziza, Columbia Gold Mines Ltd. drilled 24 closely spaced holes along a 215-metre strike length in the northern portion of the QC and Porphyry zones. These intensely altered structural zones are associated with a granodiorite intrusion into Upper Triassic sediments and volcanics. Core contains visible gold and assay values from the holes include intercepts of 3.43 grams per tonne gold over 53.6 metres and 16.8 grams per tonne over 11.8 metres. Mineral inventory calculations indicate the property has a bulk tonnage inventory of 8.38 million tonnes of 0.18 per cent copper and a high-grade potential of 274 300 tonnes of 15.8 grams per tonne gold (George Cross Newsletter, 1991, No. 211).

Drilling results from the porphyry target on the QC property, 15 kilometres west of the village of Iskut, gave results such as 0.14 per cent copper over 125.2 metres and 0.25 per cent copper over 84.5 metres. Dryden Resource Corporation also tested a gold-quartz vein system and assays ranged up to 18.85 grams per tonne gold, 186.5 grams per tonne silver, 2.87 per cent copper and 4.98 per cent zinc over 3.8 metres.

Manchester Resources Corporation drilled and trenched the Rok property, 7 kilometres southeast of the village of Iskut. Seven of the eighteen trenches exposed encouraging copper-gold grades. One trench averaged 0.45 per cent copper and 0.34 gram per tonne gold over 114 metres.

MORE CREEK AND FORREST KERR AREA

Boulders and boulder trains of massive sulphide float in the More creek area have spurred considerable interest over the past several seasons. In 1991 numerous small programs were conducted in the area in addition to the following major projects.

Noranda Exploration Company Limited was active on three properties. Two diamond-drill holes on the Lucifer property tested a large pyritic alteration zone with an associated strong gold soil anomaly and weak mineralization. On More Creek, altered pyritic rocks with elevated mercury, antimony and arsenic values were drill tested with poor results. Altered Hazelton volcanics show widespread mineralization on the GOZ-RDN project. Only erratic, narrow structures were intersected in the ten holes drilled although some interesting assays were obtained, for example: 24.03 grams per tonne gold, 7.03 grams per tonne silver, 0.436 per cent copper, 0.014 per cent lead and 0.048 per cent zinc over 11.6 metres and 8.22 grams per tonne gold, 20.74 grams per tonne silver, 0.45 per cent copper, 0.75 per cent lead, and 0.285 per cent zinc over 2.0 metres.

GALORE CREEK AREA

Activity in this area has focused on the Galore Creek porphyry copper-gold deposit. The deposit is estimated to contain 113.4 million tonnes grading 1 per cent copper and 0.41 gram per tonne gold (Northern Miner,Oct. 28, 1991). Mingold Resources Inc. conducted a program in 1990 and in 1991 Kennecott Canada Inc. undertook a 49-hole diamond drilling program, geochemical, induced polarization and airborne geochemical surveys together with relogging of old core. This effort was to delineate new reserves of copper-gold mineralization and more reliably define gold grades. Copper mineralization on the property occurs in ten incompletely defined zones. The 1991 program successfully delineated the dimensions of the Southwest zone, determined the strike potential of the North Junction zone and discovered a new zone in the Middle Creek area.

Other porphyry copper-gold prospects were explored in the Galore Creek area. Coincident copper-gold soil anomalies and geophysical conductors were drilled on the OP-PUP property of Consolidated Goldwest Resources Ltd. and the Paydirt property of Pacific Century Explorations Ltd. and Ticker Tape Resources Ltd., both with disappointing results.

Iskut River Area

At Bronson Creek, Cominco Ltd. brought the Snip mine into production in January 1991. It continued exploration of the property conducting magnetic and EM surveys as well as geological mapping.

In June 1991, massive sulphide mineralization, the SMC zone of the Sky Creek property, was discovered adjacent to the roadway connecting the Snip and Johnny Mountain minesites. Adrian Resources Ltd. concentrated on the SMC zone with a 15-hole diamond drilling program which returned assay results such as 2.16 grams per tonne gold, 20.9 grams per tonne silver, 0.89 per cent lead, 1.93 per cent zinc and 0.08 per cent copper over 5.6 metres; 4.56 grams per tonne gold, 32.2 grams per tonne silver, 0.17 per cent lead, 5.74 per cent zinc and 0.13 per cent copper over 14.8 metres.

Solomon Resources Limited drilled and trenched the Snippaker prospect which has widespread sulphide mineralization associated with discordant shear zones cutting Upper Triassic strata. Chip sampling and drilling on both the south and north slopes of Snippaker Mountain, indicated the base and precious metal mineralization is erratic, discontinuous and narrow.

On the Reg property of Skyline Gold Corporation, 2.5 kilometres north of the Johnny Mountain mine, volcanogenic massive sulphides, predominately sphalerite and pyrrhotite, were discovered on the south flank of the Bronson Creek valley. The zone was mapped over a strike length of 700 metres. Trenching, drilling and geochemical surveys were completed.

On the south side of the Iskut River, 10 kilometres west of the Snip mine, Eurus Resource Corp. and Thios Resources Inc. completed a geological, geochemical and geophysical evaluation of the Rock and Roll property. The exploration focus was to define the Black Dog horizon, a volcanogenic massive sulphide target. Ninety diamond-drill holes delineated a favourable unit 25 metres thick with numerous semimassive to massive sulphide lenses up to 10 metres wide. A preliminary geological reserve is calculated as 580 600 tonnes grading 2.47 grams per tonne gold, 336.0 grams per tonne silver, 0.79 per cent lead, 3.08 per cent zinc and 0.64 per cent copper (George Cross Newsletter, 1991, No. 202). Drilling programs were also completed on three properties that lie within a few kilometres of the Rock and Roll: the Bornagain, Phiz and Teryl. Results were not encouraging.

Gulf International Minerals Ltd. was active on the Inel property east of Bronson Creek. During underground mapping a stockwork zone in potassium-altered sediments was defined in the south Discovery adit. It contains veinlets of pyrite, chalcopyrite and significant gold. A new zinc-rich structure with some gold content was defined in the AK adit.

To the east of the Snip mine Noranda Exploration Company Limited drilled the Barytex prospect. Narrow, erratic quartz-sulphide-gold veins were intersected. These are structurally controlled and may be related to intrusive activity in the area.

Eskay Creek Area

Expenditures at the Eskay Creek project were $9 million, again the largest exploration and development program in British Columbia. International Corona Corporation completed a surface program of 12 diamond-drill holes and downhole geophysics to assess geologic potential in areas away from the 21 zone. Ninety-five underground diamond-drill holes were completed, confirming grade and ore continuity in the "Main Contact Lens" orebody, formerly termed the 21B zone.

International Corona also drilled four holes on the GNC property which brackets the Eskay Creek project on the east and west. Geochemically anomalous results came from various targets.

American Fibre Corporation conducted a 64-hole drilling program and mapped the entire Sib property at 1:2000 scale. Targets included the Lulu zone, a folded mudstone bed within rhyolite flows and breccias of the Mount Dillworth Formation. Several drill holes intersected a massive and laminated stibnite-barite lens containing pyrargyrite and native gold. Assay results from these intersections included: 10.63 grams per tonne gold, 802.3 grams per tonne silver over 8.0 metres and 20.33 grams per tonne gold, 969.6 grams per tonne silver over 4.6 metres.

Near Eskay Creek, Tymar Resources Inc. drilled the Lakewater property. The target was the interpreted extension of the Lulu horizon on the Sib property.

Five kilometres southeast of the Eskay Creek project Granges Inc. undertook a 30-hole drilling program on the Unuk River property. Gold and silver mineralization was encountered in sulphide-enriched zones hosted in felsic volcanics and argillites. The mineralization is thought to be volcanogenic and conformable to stratigraphy. Assay results have included: 6.24 grams per tonne gold, 155.66 grams per tonne silver over 4.9 metres and 2.66 grams per tonne gold, 52.8 grams per tonne silver over 0.98 metre.

Inclement weather shortened the drilling program on the Treaty Creek property. The AW and Mama Susu zones were tested by five holes with the AW mineralization averaging 5.45 grams per tonne gold, 237.9 grams per tonne silver, 4.45 per cent lead, 1.37 per cent copper and 0.55 per cent zinc over 4.7 metres.

SULPHURETS CREEK AREA

Newhawk Gold Mines Ltd. divided the focus of its exploration program on the Sulphurets property between the Sulphside copper-gold bulk-tonnage targets in the western part of the property and the Bruceside high-grade gold-silver targets to the southeast. An airborne magnetic, EM and radiometric survey was flown over the entire 85 square kilometre property.

Results from the 12-hole drilling program on five zones in the Sulphside area were encouraging. They demonstrated the potential for copper-gold deposits extending north from the adjacent Kerr deposit. Examples of assay returns are: from the Sulphurets Gold zone; 0.42 per cent copper, 0.55 gram per tonne gold over 114.2 metres and from the Main Copper zone 0.54 per cent copper, 0.38 gram per tonne gold over 34.1 metres.

The Bruceside program included regional surveys to identify additional high-grade targets which could augment reserves defined in the West zone. Fifteen gold-silver-bearing structures have been outlined in the Golden Marmot, Gossan Hill and Electrum zones. Six holes were drilled on the Shore zone to test the continuity and grade in its southern extension. All six holes intersected extensive quartz-carbonate veining, breccia and stockwork. Assay results included: 13.06 grams per tonne gold, 210.91 grams per tonne silver over 4.9 metres and 8.71 grams per tonne gold, 25.03 grams per tonne silver over 1.8 metres.

Ten kilometres east of the Sulphurets project, Noranda Exploration Company Limited undertook geochemical and IP surveys as well as drilling. The program was an attempt to locate the source of mineralized float on the Knipple Lake property which lies over prospective Hazelton Group volcanics.

STEWART MINING CAMP

North of Stewart, near the former Scottie Gold mine, three drilling programs tested vein and stockwork mineralization. Near the Tide Lake airstrip, on the Haida-Catspaw property of Teuton Resources Corp and Silver Standard Resources Inc. interbedded sediments and volcanics were tested in areas of quartz, epidote, calcite and sericite alteration. At the Bend property, Tenajon Resources Corp. drilled ten holes on a shear-hosted vein system. Homestake Canada Ltd. drill-tested the Summit property, previously the Scottie Gold mine. A zone with sericitic alteration and intense quartz-pyrite stockwork is hosted by andesites of the Unuk River Formation. It was intersected in all the holes, between 75 and 125 metres below the surface, and remains open in all directions.

Navarre Resources Corp. undertook extensive trenching on the Strike property situated to the east of Long Lake near the Big Missouri deposit. The mineralization is related to the contact between a mudstone and unconformably overlying rhyolite and dacite. The polymetallic mineralization is in a quartz-carbonate gangue concentrated along the axial plane of an anticline.

Westmin Resources Limited explored several properties in the vicinity of the Premier Gold mine. On the Premier site seven holes from underground tested IP and geochemical anomalies in the Northern Lights zone. Sections of disseminated pyrite were intersected adjacent to Premier porphyry but assay results were not encouraging. At the Snowfields project, ten drill holes, trenching and mapping returned no significant results for tests on geochemical anomalies and a gossanous showing. Drilling of the Myrtle and R&R veins on the old Indian minesite intersected siliceous and graphitic argillites and siltstones carrying silver and gold-bearing base metal sulphides in quartz; however no reserves were delineated.

In the Mount Shorty Stevenson area, Armeno Resources Inc. drilled eleven holes on the Independence property attempting to define gold-silver vein mineralization. Five kilometres north of Stewart, to the west of the old Dunwell mine, KRL Resource Corp concentrated its drilling on the newly discovered Hill Top zone in silicified argillites, andesites and intrusives.

Bond Gold Canada Inc. conducted structural, petrographic and geochemical studies in addition to drilling on the Red Mountain project. There are four target areas for precious and base metal mineralization, the Marc zone being the most promising. All are related to a Lower Jurassic volcanic-plutonic island arc system cut by Tertiary intrusives.

TOODOGGONE RIVER AREA

With the discovery of the Kemess deposit in the south Toodoggone district, the exploration trend in the area has turned from gold-silver epithermal veins to porphyry copper-gold targets.

Golden Rule Resources Ltd. and Manson Creek Resources Ltd. drill-tested the Moose (Porphyry Pearl) property which lies to the north of the Cheni mine. The target was a broad zone of elevated copper and gold values in an intensely altered quartz monzonite to granodiorite.

Fifty-five kilometres southeast of the Cheni mine, El Condor Resources Ltd. conducted a large program split between the North and South Kemess properties. Drilling on the North Kemess has delineated a resource of 139.7 million tonnes of 0.17 per cent copper and 0.34 gram per tonne gold (El Condor press release, November 6, 1991). Mineralization on this part of the property occurs as pyrite and chalcopyrite in Takla volcanics that have been intruded by a quartz monzonite stock. On the South Kemess, sulphides are found within a near-surface, flat-lying porphyritic quartz monzonite that averages 105.2 metres in thickness and is underlain by Takla volcanics and sediments. Enriched in gold and copper, the upper 30.5 metres of the deposit is supergene mineralization characterized by native copper and chalcocite. The lower 74.7 metres is a strong zone of hypogene chalcopyrite and pyrite mineralization. Covered by a blanket of friable Tertiary sediments that averages 20 metres, but ranges up to 100 metres thick, the South Kemess deposit has drill-indicated resources of 127 million tonnes of 0.23 per cent copper and 0.58 gram per tonne gold (El Condor press release, November 6, 1991).

Adjacent to the Kemess project to the southwest, the Nor property of Rio Algom Exploration Inc. was drilled to test Takla Group volcanics and monzonitic to monzodioritic plutons. Both rock types are intensely sericitized and potassium metasomatized with sulphide content, predominately pyrite, averaging 5 per cent.

Cheni Gold Mines Inc. has been experiencing difficulties with the Lawyers epithermal gold-silver deposit. Low ore grades have been a problem since depletion of the AGB zone and commencing extraction on the Cliff Creek zone. Drilling to test the Cliff Creek structure proved disappointing when the grade of mineralization was less than anticipated.

Southeast of the Cheni mine Sable Resources Ltd. has been mining the Shasta deposit. Gold-silver mineralization occurs within feldspar quartz crystal-lapilli tuffs of the Toodoggone formation. A drilling program immediately adjacent to the orebody was unsuccessful in adding to reserves.

HAZELTON - SMITHERS - BABINE LAKE AREA

There has been increased activity in the Smithers - Hazelton district, particularly around Babine Lake. Targets included porphyry and volcanogenic massive sulphides.

Five kilometres southwest of Hazelton, International Kengate Ventures Inc. and Trans Arctic Explorations Ltd. conducted a multifaceted review, sampling and rehabilitation program at the former Rocher de Boulé mine. A 90-kilogram sample over an average 1.4 metres mining width was taken on the #2 vein, from four areas on two levels. This sampling returned assays of 5.8 grams per tonne gold, 365.5 grams per tonne silver and 5.38 per cent copper. From drill and drift sampling the vein is estimated to contain 55 000 tonnes (D. Clark, personal communication 1991).

In the Serb Creek area, 40 kilometres southwest of Smithers, the Snow Creek property was drilled by Pacific Rim Mining Corp. and Homestake Canada Ltd. in two separate programs. One hole, by Pacific Rim Mining, intersected up to 10 per cent disseminated and stockwork pyrite, chalcopyrite, sphalerite and galena over 6 metres in volcanic hostrocks.

International Resources Corp. drilled an IP anomaly on the Chance property 30 kilometres southeast of Smithers, to test porphyry copper potential. Drilling also tested a vein system cutting several high-grade intercepts over narrow widths. Ten kilometres to the north, on the Burbridge Lake property, D. Groot Logging Ltd. encountered low-grade mineralization while drilling a porphyry target and magnetic anomalies in a chloritic altered porphyry and foliated diorite.

Timmins Nickel Inc. took a 5080-tonne bulk sample from the Dome Mountain property, sending 1450 tonnes to Equity Silver mine and 3630 tonnes to Premier Gold mine for custom milling. On Mount McKendrick, Habsburg Resources Inc. drilled vein targets and intersected mineralization consisting of arsenopyrite, tetrahedrite, sphalerite and galena.

In the southwest corner of the Babine Mountain Recreation Area, 5 kilometres east of Smithers, Varitech Resources Ltd. began a program to delineate reserves on the Big Onion property. This porphyry copper-gold deposit was outlined in the 1970s, and estimated to contain approximately 85 million tonnes grading 0.42 per cent copper and 0.02 per cent molybdenum. This year's drilling program tested a zone of supergene copper mineralization that averaged 0.52 per cent copper over 80.7 metres in four holes.

Near Babine Lake, on the Fireweed property, Mansfield Minerals Inc. drilled eight IP targets on strike from known mineralization, four in the Far East zone and four in the Far West zone. There were no significant results and other holes drilled in areas of known mineralization on the Jan, West, East and South zones were unsuccessful in increasing the known mineral inventory. Also along the west side of Babine Lake, to the northwest of the Fireweed project, Equity Silver Mines Ltd. trenched and drilled the MR property. An iron carbonate altered zone with copper-silver mineralization was exposed over a 300 by 40 metre area. Drilling on the zone intersected weakly disseminated tetrahedrite or tennantite mineralization to a depth of 70 metres.

Noranda Exploration Company Limited was active on the Bine (Lake) claims on the east shore of Babine

Lake near the Bell mine. Fifteen targets from previous aerial, magnetic and IP surveys were mapped and geochemically sampled. These were narrowed to eight targets that returned discouraging results when drilled. To the north, on the Hearne Hill property, the owner, Dave Chapman drilled seven holes on a copper-gold-bearing breccia pipe.

Houston - Whitesail Area

Activity in the Houston-Whitesail area had two foci: epithermal gold-silver vein mineralization and porphyry copper or molybdenum mineralization with precious metal content.

Equity Silver Mines Ltd. pursued epithermal targets. Twenty kilometres south of Houston, the company conducted trenching, overburden (reverse circulation) and diamond drilling on the Eric property. Results defined a mineralized zone 40 metres wide with an unknown strike length. Pyrite, tetrahedrite, galena, chalcopyrite and sphalerite occur as disseminations in the matrix of a lapilli tuff and an argillite breccia, as well as in quartz-carbonate veinlets. Assay results included, from DDH 91-01, 5.24 metres of 119 grams per tonne silver, 0.17 per cent copper and 10.46 metres of 99 grams per tonne silver, 0.11 per cent copper. East of Ootsa Lake/Intata Reach, Equity Silver drilled five holes on the Rhub-Barb property. In a 900 by 150 metre IP anomaly drilling intersected argillically altered volcanics. These contain silicified zones of chalcedonic and amethystine quartz that are geochemically anomalous in arsenic and gold with silver spot highs to 75 grams per tonne. On the Midnight property, within Tweedsmuir Recreation Area, Equity Silver intersected arsenopyrite, pyrite and galena mineralization carrying gold values, while drilling silicified sediments intruded by a feldspar pyroxene porphyry plug.

New Canamin Resources Ltd. assessed the potential of two porphyry deposits delineated in the 1960s to early 1980s. The Poplar property contains 250 million tonnes of 0.357 per cent copper (Geroge Cross Newsletter, 1991, No. 202). Drilling in 1991 focused on the China Creek zone where a propylitic alteration zone contains chalcopyrite and molybdenite mineralization and the Canyon Creek zone where it was confirmed that a higher grade annular zone surrounds a low-grade core. Geological reserves wee substantially increased. The New Nanik deposit, 18 kilometres northeast of Kemano, has geological reserves of 20 million tonnes 0.43 per cent copper, 0.2 gram per tonne gold, 3.5 grams per tonne silver and 0.009 per cent molybdenum (Ministry of Energy, Mines and Petroleum Resources, Assessment Report 18656). Drilling by New Canamin Resources did not significantly add to these reserves.

Kennecott Canada Inc. had no significant results from its drilling of the Whiting Creek porphyry copper-molybdenum prospect.

Coal

There was no exploration activity on coal properties. Crows Nest Resources Limited continued with studies for Mine Development Assessment reports on the Telkwa project and late in the year announced its intent to sell the property.

Placer

Placer activity increased by 20 per cent from the preceeding year, to 76 Notices of Work for the Northwestern District. Atlin was the busiest Mining Division recording 38 notices. Liard was next with 33. The Skeena and Omineca areas were very quiet with only three and two notices respectively.

DEVELOPMENT PROJECTS

A number of projects were involved in the provincial Mine Development Assessment Process. Active programs were Windy Craggy, Sulphurets, Eskay Creek and Telkwa Coal. The Silver Butte, Al, Chappelle and Dome Mountain properties proceeded through the review process

Geddes Resources Limited continued with studies for the Mine Development Assessment Process. Glaciology studies were continued in order to maintain mass balance and glacier movement databases. The revised mine plan submitted for the assessment process remains under review.

A prospectus was filed, in 1990, for the Eskay Creek property and International Corona Corporation has continued with studies required for filing an application with the Mine Development Assessment Process. Mine feasibility studies were undertaken in 1991 and 553 metres of development drifting was completed. Transporation to the project is by air only. In April 1991 the provincial government announced that the Iskut Road would be built. Construction began in the summer and the road was advanced from the Bob Quinn area westward for 37 kilometres to the confluence of the Iskut River and Volcano Creek. In December, Placer Dome Inc. announced it would not increase its interest in the property to 50 per cent and International Corona proceeded alone until further agreements with Placer Dome and Homestake were announced in early 1992.

Newhawk Gold Mines Ltd. and Granduc Mines Ltd. have defined a proven and probable reserve on the West zone, in the Bruceside area of the Sulphurets property, of 749 710 tonnes averaging 15.1 grams per tonne gold and 648.0 grams per tonne silver (Northern Miner, September

TABLE A-5
ACTIVE MINES IN THE NORTHWEST DISTRICT, 1991

MINE NAME (OWNER)	TONNES MILLED (000's)	RATED CAPACITY (TPD)	%ANNUAL RATED CAPACITY	DEPOSIT TYPE	PRODUCTION (to Oct.31,1991)
Cassiar/McDame (Princeton Mining Corporation)	689 938	4 000	92	Ultramafic asbestos	49 855 tonnes
Golden Bear (North American Metals Corp., Chevron Minerals)	77 097	350	73	Vein Au	1 447 kgs Au to Sept. 30/91
Snip (Cominco Ltd., Prime Resources Group Inc.)	98 426	370	95	Mesothermal Vein Au	2 717 kgs Au
Lawyers (Cheni Gold Mines Inc.)	142 850	500	98	Epithermal Vein Au-Ag	4 157 kg Au, 83 902 kg Ag to Sept 30/91
Al (Cheni Gold Mines Inc.)	42 549 mined total			Epithermal Vein Au-Ag	
Shasta (Homestake Mining; International Shasta Resouces Ltd.)	106 330	181	104	Epithermal Vein Au-Ag	477 kg Au 26,575 kg Ag (Total Production)
Chappelle (Multinational Resources Inc.)	9 992.1	154.2	90	Epithermal Vein Au-Ag	146 kg Au 701 kg Ag (Total Production)
Premier Gold (Westmin Resources Ltd., Pioneer Metals Corporation)	1 591 600	2 000	75	Epithermal Vein Au-Ag	2 950 kg Au, 34 907 kg Ag
Silver Butte (Tenajon Resources Corp. Westmin Resources Ltd.	74 300			Epithermal Vein Au-Ag	577 kg Au, 2 100 kg Ag
Bell Mine (Noranda Minerals Inc.)	4 161 922	15 876	96	Porphyry Cu-Au	21 354 204 kg Cu, 853 kg Au, 2 990 kg Ag
Equity Silver (Equity Silver Mines Ltd.)	2 774 700	9 500	96	Transitional Au-Ag-Cu	151 355 kg Ag, 1 462 kg Au 4 136 800 kg Cu

16, 1991). A feasibility study by Fluor Daniel Wright Engineers Ltd., released late in 1990, determined the project was not economic at then current metal prices. In 1991 the companies continued with an exploration program on this portion of the property with the intent of adding additional reserves. The property has been involved with the Mine Development Assessment Process and has proceeded through a Stage 1 report, with addendum, that has been given Approval in Principle. Property sale negotiations were on-going and early in 1992 Placer Dome Inc. purchased portions of the property other than the Bruceside.

OPERATING MINES

During 1991 there were eight mines operating in the Northwestern District providing employment for 1385 people (Table A-5). Additionally there were four deposits mined and the ore milled at existing facilities. All of the mines have been hard hit by one or more difficulties: start-up problems, declining reserves or low dollar return with relatively high operating costs. The Snip mine of

Cominco was the only new producer in 1991. The Shasta mine, operated by Sable Resources Limited, shut down in October. By year's end slow-downs or closures were imminent at a number other mines.

In Cassiar, the McDame asbestos deposit mined by Cassiar Mining Corporation has proven reserves of 19.94 million tonnes at an average recovered grade of 6.21 per cent asbestos fibre fully diluted (personal communication, mine staff, November 1991). The mine has been beset by start-up difficulties and closed in February of 1992.

The Golden Bear mine has struggled with start-up problems which by mid-year had been worked through and the mine was meeting costs. Underground operations shut down on March 4, 1991 with the plan being to operate solely from the open pit. By August enough ore had been broken to carry the mill through the winter. There is potential for additional reserves in the area and a $1.2 million exploration program was undertaken.

The Cominco Ltd. mill at the Snip mine started production at full capacity on January 25, 1991. Having been refitted from the Terra mine, in the Northwest Territories, at a cost of $4 million, the mill is designed to process 300 tonnes per day for a mine life of between 9 and 10 years. Gold is recovered by two methods. A gravity circuit recovers 20 per cent which is refined and poured as doré bars on site. The remaining 80 per cent is recovered as a sulphide-rich flotation concentrate shipped to Japan. Cominco calculated proven and probable reserves of 940 000 tonnes with an average grade of 28.5 grams per tonne gold (Cominco Annual Report, 1990) based on drilling at 12.5-metre centres. The result has been a mine that has operated throughout the year trouble free and reached a 91.5% recovery rate.

The Premier Gold Project of Westmin Resources Limited, continued to have difficulties. Westmin continued to explore and examine known showings within the area and is considering the feasibility of mining underground on the Northern Lights zone. Custom milling business was pursued and ore from the Timmins Nickel, Dome Mountain project was processed. A 50/50 joint venture was struck with Tenajon Resources Corp. to mine and mill the 35 zone on the nearby Silver Butte property. The endeavour was very successful and between July 9 to November 14, 102 556 tonnes were processed in the Premier mill. Westmin did not receive a contract to mill the Dome Mountain ore but did commit to running the mill over the winter.

On the Lawyers property in the Toodoggone, Cheni Gold Mines Inc. mined out on the AGB zone in late spring and began production from the Cliff Creek zone. Unfortunately the orebody on the latter zone is not as continuous as anticipated. Reserves were revised downwards twice, leaving a proven reserve on the Cliff Creek zone of 139 430 tonnes averaging 6.9 grams per tonne gold and 198.9 grams per tonne silver. Cheni Gold Mines has purchased the Al property situated to the north of the Lawyers deposit from Energex Minerals Ltd. After completion of a 24-kilometre road off the Cheni mine road 42 550 tonnes were mined from the BV zone on the Al property and trucked to the Cheni mill for processing. Cheni Mines is investigating other sources of ore in the area.

At the Shasta deposit, 25 kilometres southeast of the Cheni mine, Sable Resources Ltd. mined until late summer when reserves were depleted. Milling continued through to the end of October at the old Baker mine with additional ore feed from the B vein on the Chappelle deposit (Baker mne). A total of 9992.1 tonnes of ore at an average head grade of 16.63 grams per tonne gold and 85.03 grams per tonne silver was processed.

Bell mine, 65 kilometres northeast of Smithers, continued production from the main pit and initiated a heap leach study. This was to assess the feasibility of leaching and electrowinning copper while stripping was in progress for a pit expansion. Exploration drilling in 1990 indicated a potential reserve of 108.86 million tonnes of 0.4 per cent copper (personal communication, mine staff, November, 1991) at depth outside the main pit. Unfortunately the stripping ratio is too high for mining to be feasible. At the end of November proven reserves were 8.4 million tonnes (personal communication, mine staff, November, 1991). This included 4.2 million tonnes from a "rob-cut" which would over-steepen the walls at the base of the main pit thereby extracting otherwise inaccessible ore. Noranda Minerals Inc. indicated that without the rob-cut the mine would close in early 1992. Although the cut began late in the year, problems with stability stopped it in March 1992. Mine closure was announced for June.

At Equity Silver mine, 25 kilometres southeast of Houston, production continued at an average rate of 9127 tonnes per day with an average head grade of 87.7 grams per tonne silver, 0.87 gram per tonne gold and 0.22 per cent copper. Mining was on both the Main and the Waterline orebodies. The Main Zone pit has reached the deepest workable level and an extra rob-cut was taken on the south berm using a remotely controlled loader. Equity Silver Mines Ltd. struck an agreement with Timmins Nickel to custom mill Dome Mountain ore. This mill feed together with ore potentially available from a proposed underground operation off the northern end of the Waterline orebody may extend the mine life, at a reduced production rate, past projected closure in the fall of 1992.

CENTRAL DISTRICT

By E.L. Faulkner and B.E. Madu
District Geology, Prince George

INTRODUCTION

Precious metals in all types of deposit once again dominated exploration targets in the Central District. Despite being another very busy year, especially in the Omineca, exploration activity was down from 1990 levels and some 20 per cent of exploration projects were either scaled down from planned levels or were cancelled due to funding problems.

Mineral Notices of Work totalled 240, down 16 per cent from 1990. Figure A-9 illustrates the strong interest in porphyry copper-gold targets in the Omineca and shows a decline in activity in the Cariboo. Activity in other mining divisions was low.

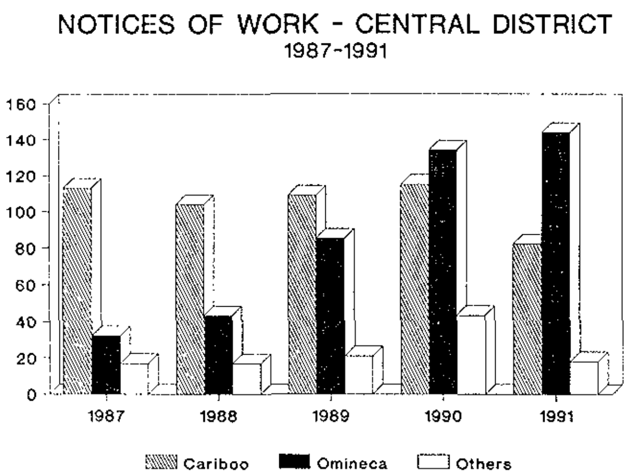


Figure A-9

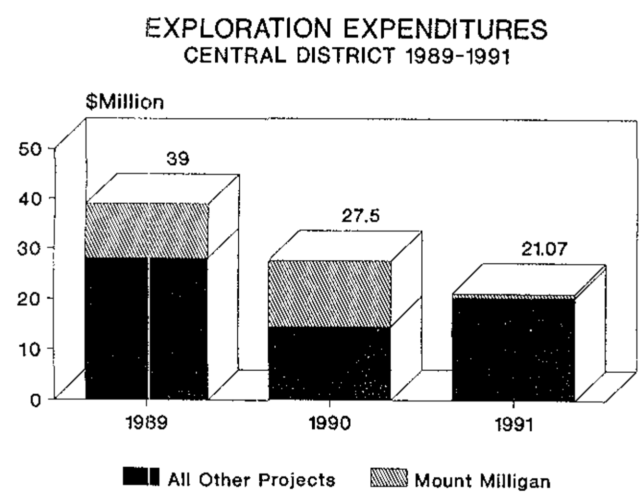


Figure A-10

Mineral exploration expenditures were down again, but as Figure A-10 shows, if the major spending at the Mount Milligan project is allowed for, there was actually an increase in spending on other projects, most notably in the Omineca.

Interest in base metal/silver targets continued at modest but steady levels while interest in industrial minerals and stone was low. Placer operations increased this year, with Placer Notices of Work, at 401, up 12 per cent from 1990.

The four operating mines in the district produced at near historic levels, but no mining development decisions were forthcoming from the five projects in the Mine Development Review process.

Details of selected major exploration projects in the district are given in Table A-1 and the locations of these projects are shown in Figure A-11.

NORTHERN QUESNEL TROUGH

SUMMARY

Most of the activity in the district was again concentrated in the northern Quesnel trough. The general lack of outcrop and heavy drift cover in much of the area continue to make exploration difficult and comparatively expensive. Despite road access to much of the area, logistics costs in some parts are still high. Although there has been a high level of exploration in much of the area for more than four years, there has been a lack of exploration results that can be considered exciting. This, together with reduced exploration budgets of major companies and shortage of risk capital available to juniors, makes it unlikely that interest in the area will be sustained.

TRENDS

Drilling of targets that have been outlined by induced polarization surveys, continues to be the exploration technique of choice, but results are commonly disappointing or enigmatic. Many companies are paying increased attention to surficial geology in an attempt to improve planning and interpretation of geophysical and especially soil geochemical surveys.

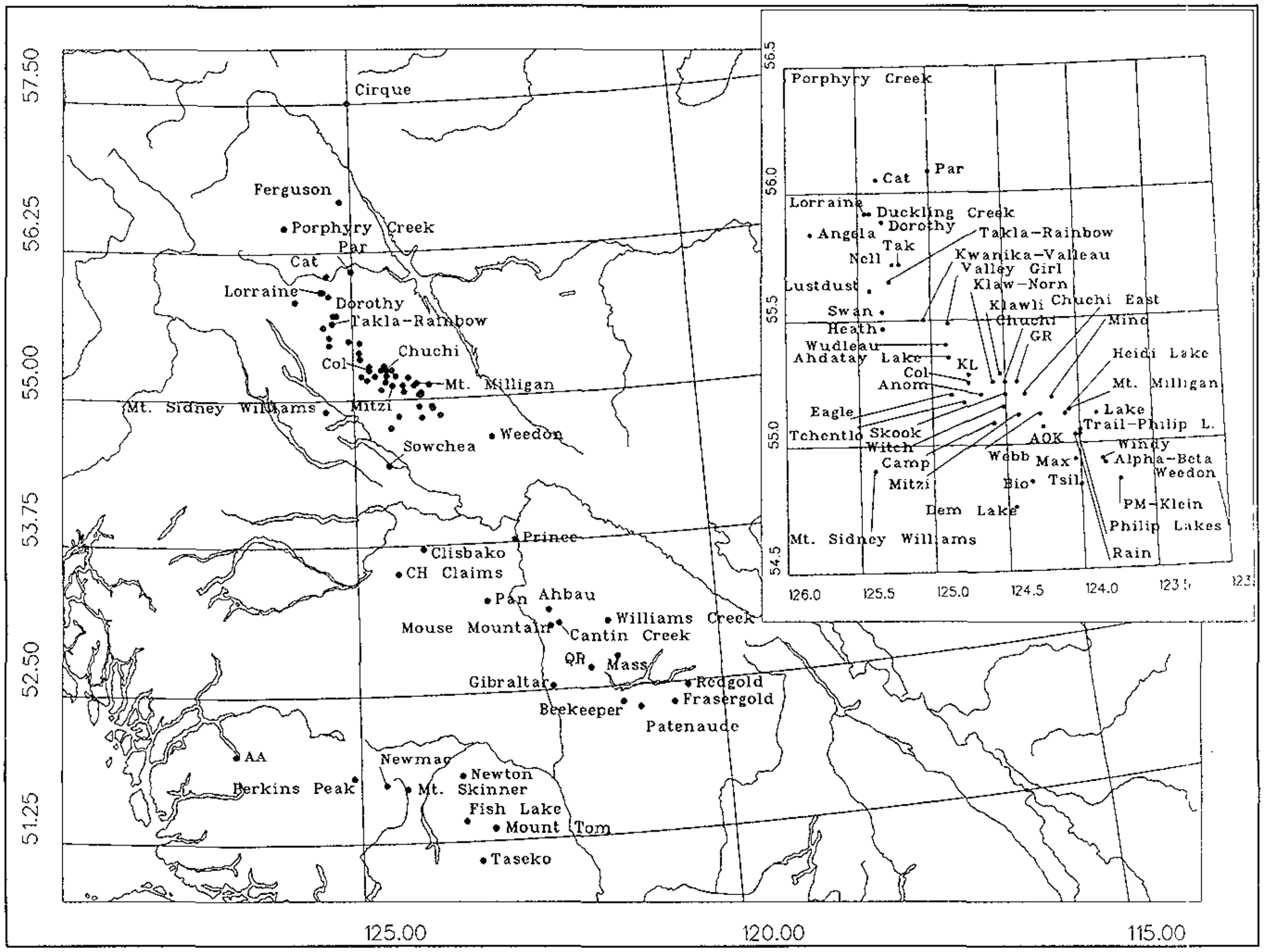


Figure A-11. Major exploration projects - Central District. Inset: Northern Quesnel Trough Area.

Alkali porphyry copper-gold targets continued to dominate, but an increasing proportion of calcalkaline porphyry targets, mostly in the margin of or immediately adjacent to the Hogem batholith, are being examined. This has resulted in a shift of interest away from the Mount Milligan area to the northern part of the trough. In general, the mineralization, structure and alteration patterns of calcalkaline porphyry targets tested to date are much as expected from models developed elsewhere, but with the advantage for exploration that mineralization is more confined to the intrusive, and grades, while low, appear to be more uniform and consistent than has been the case with alkali porphyry targets. In the Kemess camp, the Kemess South deposit of El Condor Resources Ltd. joint venture has been the most notable example to date, and the potential for substantial increases in tonnages at several targets in this camp is excellent.

Two other trends are of note. At several properties, the geology of the contact zone of the Hogem batholith is complex, with a variety of intrusive border phases of uncertain provenance. Some mafic border phases, typically pyroxenites or mafic diorites, may have been derived from remelted Takla volcanics, with the consequence that associated gold and copper mineralization may not fit a porphyry model.

Gold mineralization has also been found in sheared Takla volcanics that does not appear to be of the vein or shear zone type sometimes found peripheral to an alkali porphyry system, as is the case at Mount Milligan, for example. It differs in that the gold is associated with pyrrhotite or pyrite, there is little or no associated copper or minor base metal sulphides, alteration is typically chloritic and the shearing has a regional pattern rather than a radial pattern around a nearby intrusive centre. Examples occur at the Takla Rainbow property, and have been reported from the Chuchi Lake area. This type of mineralization may prove to be more widespread, and, as has been found at the Chuchi property of BP Resources Canada Limited, it may have large tonnage potential.

Exploration

In the northern part of the trough, Teck Corporation continued its evaluation of the large Porphyry Creek property with a modest drilling program on selected tar-

Plate A-4. Drill core at Taseko Mines Ltd., Fish Lake property.

gets. More follow-up work will be needed. Kennecott Canada Inc. reported mixed results from drilling 18 holes on another large property, the Lorraine/Dorothy.

Farther south, BP Resources Canada Ltd. drilled a number of previously untested targets at the Cat property, with disappointing results, and the option was dropped. Placer Dome Inc. subsequently optioned ground immediately to the north from Lysander Gold Corporation.

In the Chuchi Lake area, BP, Placer Dome, Rio Algom Exploration Inc., Noranda Exploration Company Ltd., Westmin Resources Limited and several junior companies were active. Results reported were generally mixed to disappointing. The area hosts a large number of mineralized porphyry-related systems, but grades are generally well below economic levels. BP reported a geological reserve of some 45 million tonnes with copper grades of 0.2 to 0.4 per cent and gold grades of 0.22 to 0.44 gram per tonne in a broad shear zone on the Chuchi property.

In the Mount Milligan area, both BP and Placer Dome were active with drilling programs on several targets in the Mount Milligan intrusive complex, while further to the south, Rio Algom reported encouraging results from drilling on the Max property, but negative results from the Bio property.

SOUTHERN QUESNEL TROUGH

The number of projects in the southern Quesnel trough declined more than 30 per cent this year. Ground is coming open at an increasing rate and the area may be coming to the end of a major exploration cycle. Unfortunately, to date, no new mines have resulted. There were only a few major projects in the area this year. Most notable were Eureka Resources Inc. surface and underground exploration of the Frasergold basal phyllite-hosted gold property. Here the pronounced nugget effect continued to cause problems. Attempts to show that pilot mill head grades were consistently higher than grades calculated from drill results were inconclusive.

At Cantin Creek, Phelps Dodge Corp. of Canada Ltd. reported disappointing results, despite strong indications of another system similar to the nearby QR deposit. Farther north on the same trend, Teck reported encouraging results from drilling targets on the southern part of the Mouse Mountain property.

COAST RANGE MARGINAL BELT AND FRASER PLATEAU

Significant exploration took place on a variety of targets in this area. The re-examination of the Fish Lake calcalkaline porphyry copper-gold deposit by Taseko Mines Ltd. has prompted staking by a number of companies, mostly in the belt of Kingsvale volcanics north of Fish Lake. This has already been followed by some initial-stage exploration programs.

At the Fish Lake deposit (Plate A-4), deep drilling has greatly increased the tonnage of the deposit and resulted in increases in both copper and gold grades. Reserves are now given as 478 million tonnes grading 0.2 per cent copper and 0.34 gram per tonne gold at a cut off grade of 0.2 per cent copper equivalent and a strip ratio of 0.7:1. A major program of step-out and infill drilling is planned for 1992.

Westpine Metals Ltd. remained the only company with a major program on transitional replacement copper-gold targets along the margin of the Coast Range batholith, at its Taseko property. Drilling concentrated on targets peripheral to and distant from the main mineralization established at the Empress zone. Extensions to the Empress zone were found to the north and east, but results on more distant targets were mixed.

There were a few programs on epithermal targets, either in veins associated with intrusive centres, or in alteration zones in Ootsa volcanics, with some encouraging results reported by Minnova Inc. at the Clisbako property. Here a number of high-level fault-related epithermal quartz veins and breccia zones have been found in silicified and argillically altered Ootsa Lake volcanics, with gold grades in the low gram per tonne range and silver grades up to 170 grams-per-tonne. The potential of this region is still largely unexplored.

OTHER AREAS AND ACTIVITY

Base Metal/Silver Targets

There was continued but modest interest in sedex and base metal/silver vein targets, with mixed results reported. In the Muskwa Ranges, Stronsay Corporation's preproduction program at the Stronsay (fomerly Cirque) deposit, plus the fact that the area now has road access, has so far failed to renew much interest in the area. There were no other major projects in the area and most of those announced were not funded.

In the Swannell Ranges, generally disappointing results were reported. Cominco Ltd. however, reported the discovery of significant shale-hosted base metal sedex mineralization in a surface mapping and trenching program at its Par property. Additional staking of shale sequences in the adjacent area was completed.

Placer

It was another difficult year for placer operators, as the price of gold declined again in real terms, while costs continued to increase. Most affected were the medium and large-sized mechanized operations. The increase in the number of placer operations reflects a trend seen during a downturn in the economy, with people who would normally be employed in other endeavours turning to placer mining. An ambitious project by Gold Ridge Resources Inc. to mine the rich buried placers at Wingdam by means of a decline, was slowed by a series of technical problems and funding difficulties.

PRODUCING MINES

There were important developments at two of the district's four operating mines: Teck Corporation assumed operational control of the Quintette coal mine after lengthy negotiations, and late in the year a debt restructuring package was agreed to. Plans to trim the workforce to 1000 people and reduce costs were implemented, and initial indications are that the mine has returned to profitability.

Deep drilling based on a geological model at Gibraltar mine resulted in the discovery of the Gibraltar North orebody, the faulted extension of the Gibraltar West orebody. The ore occurs in a wide shear zone, hosted by chlorite schists. Copper grades range from 0.25 to 1.29 per cent at depths of 80 to 220 metres. Molybdenum is virtually absent, but zinc and silver values are high compared to current ore grades. Despite the depth, it is expected to provide a new Stage 1 pit of 30 to 35 million tonnes of reserves, with a significantly higher copper grade than current mill feed. The other two operating mines in the district - Bullmoose (coal) and Endako (molybdenum) continued production at historic levels.

MINE DEVELOPMENT ASSESSMENT PROCESS

As of the year's end there were still five projects in the assessment process, but unfortunately no production decisions were made during the year on any of them. Stronsay Corporation was restructuring and was unable to secure production funding for the Cirque deposit. The generally low tenor of the ore caused problems at the three porphyry properties in the review process.

Placer Dome Inc., after several delays, took a write down of $230.6 million on the Mount Milligan project, citing high capital cost projections, lower gold grades and harder ore than expected. Placer continues to work toward a Mine Development Certificate for the property however.

Imperial Metals Corporation was unable to secure financing to put the Mount Polley deposit into production and late in the year was seeking a buyer for the property. Rea Gold Corporation was not satisfied with results from additional drilling and its reassessment of the QR deposit and has delayed construction plans.

OUTLOOK

Although another busy year is expected in 1992, the number of projects and expenditures will be down from 1991 levels. Most major companies reporting expect to have reduced exploration budgets this year, and it appears unlikely that junior companies not involved in joint ventures with majors will be able to do much more than property maintenance, if that.

In moves that reflect the difficult economics of the times, BP announced it was planning to sell or option its properties in the district, Noranda greatly reduced the size of its Prince George office and Asarco Exploration Co. of Canada dropped all its options on properties in the district. Prospectors have already reported that many of their options were dropped in 1991 and the trend is expected to continue. There is uncertainty at all levels in the industry.

SOUTH CENTRAL DISTRICT

By R.E. Meyers and R.L. Arksey
District Geology, Kamloops

INTRODUCTION

The exploration and mining industry in south-central British Columbia was forced to refocus priorities during 1991 in order to survive the economic downturn brought about by such factors as the high Canadian dollar, unpredictable or depressed metal prices, increased operating costs and smelter charges and the increase in off-shore competition for exploration dollars. The trend is perhaps best illustrated by a contrasting shift in industry investment; where expenditures on exploration projects in the district dropped by about 19 per cent, the decrease is more than off-set by a remarkable 64 per cent increase in development expenditures at operating mines.

Exploration expenditures on all projects during 1991 are estimated at $14.5 million, down from $18 million in 1990 (Table A-6). The total breaks down to $10.9 million for "general" exploration, plus $3.6 million for exploration carried out at the producing mines (Figure A-13).

A total of $30.4 million was expended on development, expansion and construction projects at operating mines in the district; a significant increase over the 1990 figure of $18.5 million. This accounts for a total estimated "E & D" investment in the region of $44.9 million and translates into a net increase of 23 per cent from 1990.

HIGHLIGHTS, TRENDS AND LOWLIGHTS

MAJOR EXPLORATION FOCUS

Mineral exploration in south-central British Columbia focused primarily in three main areas during 1991; the **Revelstoke** and **Adams Lake** regions in the Omineca Belt, and the **Siwash-Princeton** region in the Intermontane Belt (Figure A-14). These three areas account for about 80 per cent of the total exploration dollars spent in the region. Exploration continued in other parts of the district, but at considerably lower levels (Figure A-15).

"E & D" INCREASED BY 23 PER CENT DUE TO MINE DEVELOPMENT

The 19 per cent drop in exploration dollars is more than offset by major increases in development expenditures at operating mines, from $18.5 million to $30.4 million. Expenditures at **Highland Valley Copper** increased slightly from 1990 and account for about 55 per cent of the total, but the main increases were at International Corona Corporation's **Nickel Plate mine** and for the rehabilitation and development at the newly reopened **Goldstream copper-zinc mine.**

THREE OF FOUR MAJOR PROJECTS OPERATED BY JUNIORS

Three of the four largest exploration projects in the region are operated by junior mining companies. The **J & L** gold-zinc-lead-silver project, operated by Equinox Resources Ltd. and Cheni Gold Mines Inc., is the largest single project in the district. Bethlehem Resources Corporation and Goldnev Resources Inc. completed extensive exploration on and adjacent to the **Goldstream** property prior to going into production. Reserves at the Fairfield Minerals Ltd. **Siwash North** gold project on the **Elk** property were expanded significantly and this promises to be one of the major underground programs in 1992.

MAIN TARGETS

Massive sulphide deposits (sedex and volcanic-hosted) and porphyry copper-gold deposits continue to be the leading exploration targets. Although the Elk and Samatosum projects represent major exploration and development efforts for epigenetic precious metal veins, they are generally atypical of the main exploration targets currently sought after in the region.

MAJOR SET-BACKS FOR COPPER-GOLD PRODUCERS

The porphyry copper industry in the region experienced major setbacks during 1991. Afton Operating Corporation's **Ajax** mine was shut down (temporarily) for economic reasons: high production costs, the high Canadian dollar, low copper prices and high smelter charges. The Similco Mines **Ltd. Copper Mountain** operations were suspended for 4.5 months due to a strike.

SAMATOSUM PROJECT SCHEDULES PREMATURE SHUTDOWN

Minnova Inc.'s Samatosum mine has weathered a continuous downward trend in silver prices since opening in 1989, resulting in a substantially increased cut-off grade, drastic reductions in underground ore reserves and a premature depletion and shutdown schedule. The

South Central District

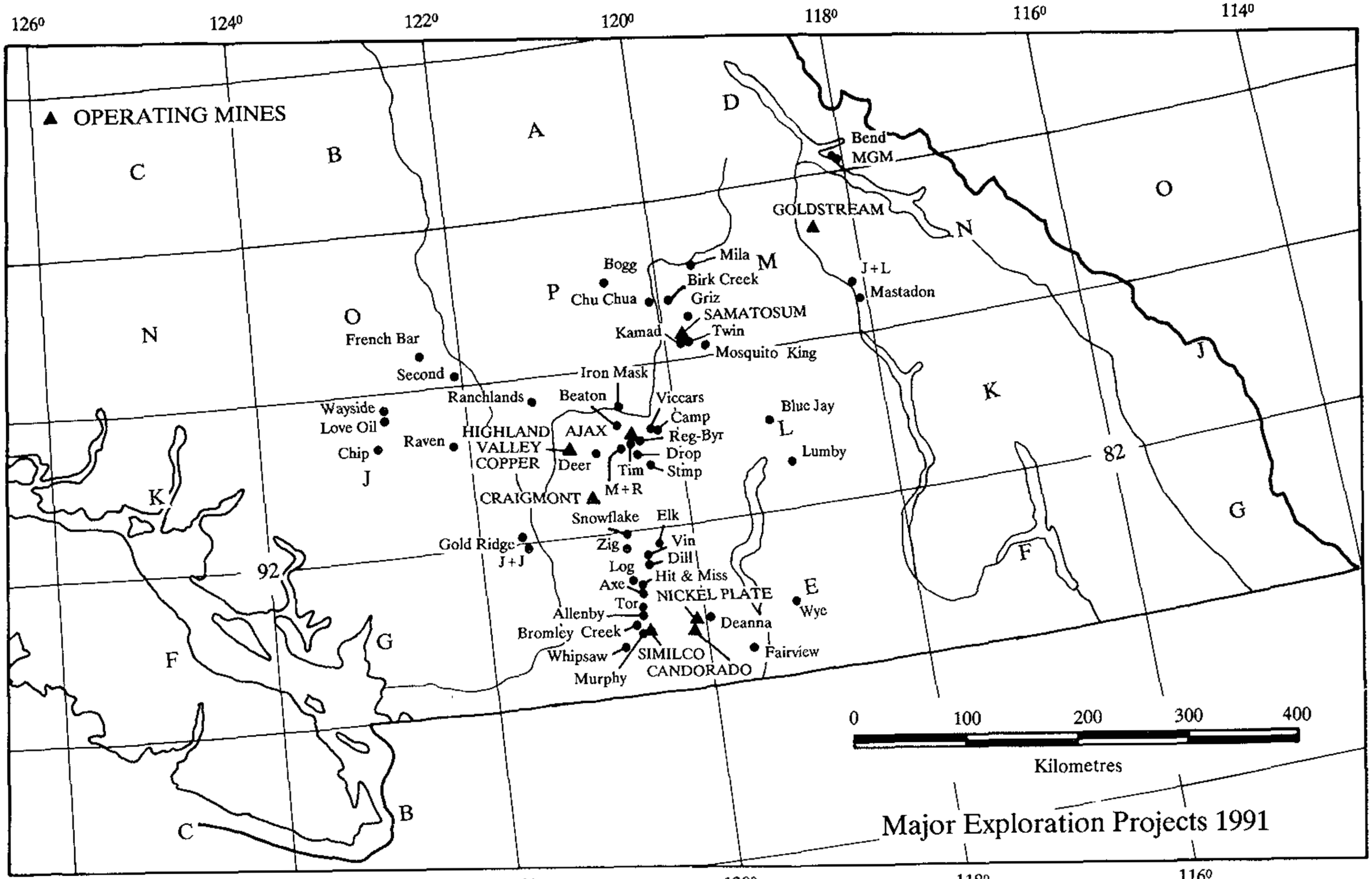


Figure A-12

Exploration & Development Expenditures
South Central BC - 1991

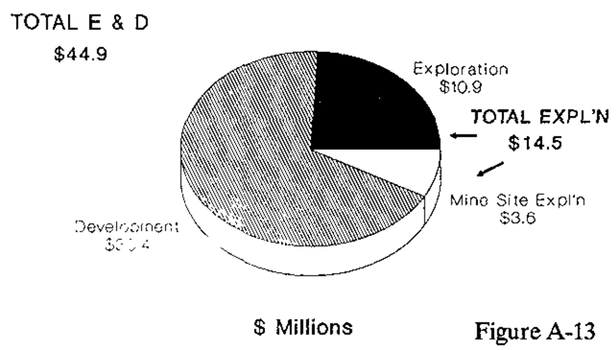


Figure A-13

TABLE A-6
Summary of Exploration & Development Expenditures
South Central District - 1991
($Millions)

	1991	1990	1989
Exploration (all projects)	$14.5	$18.01	$20.0
Development (operating mines)	$30.4	$18.50	$50.0
Total	$44.9	$36.51	$70.0

Exploration Projects - South Central B.C.
(Based on Mineral Notices of Work)

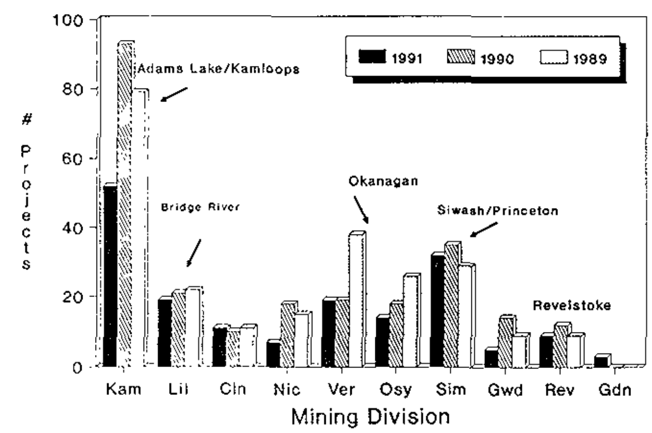


Figure A-14

TABLE A-7
SOUTH CENTRAL BC
OPERATING MINES SUMMARY

HIGHLAND VALLEY COPPER
* $ 16.6 million spent on development
* Production 133 000 tpd
* 16 years of reserves remain
* Teck targets Chile next

GOLDSTREAM
* BC's newest mine
* Copper grades maintained at 4.81% Cu
* Zinc circuit yet to start-up
* New ore potential down-dip

SIMILCO (Copper Mtn)
* Production set-back by 4.5 month strike
* Profitability marginal

CRAIGMONT
* Magnetite tailings recovery project to supply coal industry
* Feasibility study completed

NICKEL PLATE
* Re-evaluated geology extends reserves/production potential to 1995 if Phase 4 proceeds
* Canty reserves increased
* Major pit expansions in 91/92

SAMATOSUM
* Underground mining phase on stream
* New gold zone discovered
* Low silver prices mean early depletion/shutdown - Sept/92

AFTON/AJAX
* High-cost producer
* High $CDN, high smelter costs and low Cu prices result in temporary (?) shutdown

CANDORADO
* Hedley gold tailings recovery
* Plans to expand reserves
* Plans to expand reserves leach solutions recirculated

Mineral Exploration Expenditures 1991
South Central B.C.

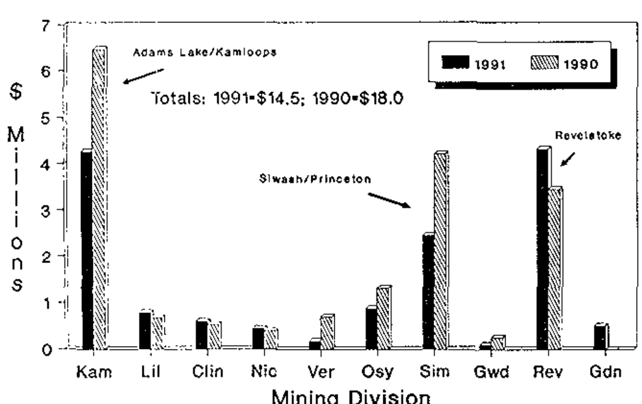


Figure A-15

discovery of a new, albeit small, gold zone could potentially extend the mine life if it proves to be economic.

Land-use Issues

The main land-use issues in south-central British Columbia during the year were: the **Provincial Parks/Wilderness for the '90s** program; **Resources Management Area** plans (Forests initiative); the **Crystal Peak Garnet** project, near Apex Mountain. Crystal Peak has been one of the region's most controversial land-use disputes; the project received overwhelming rejection at a public meeting in Penticton held by the Mine Development Assessment Branch.

MAJOR EXPLORATION ACTIVITY

This section focuses on the major exploration projects carried out in the three main areas of interest: The Revelstoke, Siwash - Aspen Grove and Adams Lake - Kamloops regions.

REVELSTOKE

There has been a modest but steady increase in exploration activity in the Revelstoke and Golden areas during the past two years. The work has been stimulated, in part, by the successful reopening of the Goldstream copper-zinc mine and by recent announcements of newly expanded reserves and potential at the J & L project.

In the northern part of the area, east of McNaughton Lake, Teck Explorations Ltd. and Cominco Ltd. have identified a zinc-lead-silver-bearing massive pyritic sulphide horizon that has been traced for approximately 5 kilometres along strike on two adjacent properties. The horizon transects the **Bend** claims operated by Cominco and the **MGM** property optioned by Teck Explorations from White Knight Resources Ltd. Mineralization occurs in silicified dolomite, at a regional "shale-out" facies change between the Kinbasket (limestone) and Tsar Creek (metapelite) formations of the Cambrian Chancellor Group. Both properties were drilled during 1991.

At the newly reopened **Goldstream** mine, exploration work carried out early in the year by Goldnev Resources Inc. and Bethlehem Resources Corporation, in association with Prime Resources Group Inc., discovered additional mineralization to the northeast and down-dip from the main orebody. Drilling results included a 2.62-metre intersection of chalcopyrite, pyrrhotite and sphalerite grading 6.35 per cent copper, 3.17 per cent zinc, 0.6 per cent lead and 25.2 grams per tonne silver. This work extends the down-dip potential of the ore zone in the order of 400 metres beyond its previously known limit. On the adjacent **Jenkins** and **Brew** properties, work by the same companies outlined stratiform zinc-lead mineralization by drilling geochemical and geophysical targets identified in 1990 surveys.

The **J & L** property, operated by Equinox Resources Ltd. and funded by Cheni Gold Mines Inc., underwent a fast-tracked exploration program early in 1991. The program, which began late in 1990, quickly led to the discovery of the zinc-lead-silver-rich **Yellowjacket zone**, some 40 metres into the hangingwall of the Main zone. Drilling in the two zones over the summer significantly redefined the potential of the property; Yellowjacket reserves were estimated to be 613 000 tonnes grading 7.3 per cent zinc, 2.6 per cent lead and 55 grams per tonne silver; Main zone reserves were effectively tripled with 1.7 million tonnes of probable ore, grading 7.4 grams per tonne gold, 76 grams per tonne silver, 2.5 per cent lead and 4.4 per cent zinc; and possible reserves of 3.07 million tonnes of similar grade material. The overall arsenic content of the Main zone is about 4.5 per cent. The program budget was originally set at $3.4 million but was reduced to $2.5 million due to cash-flow problems experienced by the operators.

In addition to the underground and surface drilling programs, a 35-tonne bulk sample of arsenical ore, extracted from the Main zone, was shipped to France to confirm previous metallurgical work.

Immediately south of the J & L property, Teck Explorations Ltd. completed a seven-hole drilling program on the **Mastadon** property, where zinc-lead mineralization occurs in Lower Cambrian Lardeau Group and Badshot Formation sediments. During the 1950s this deposit produced some 30 800 tonnes grading about 10 per cent zinc, 0.3 per cent lead, 0.04 per cent cadmium and minor barite.

Siwash-Aspen Grove

The interest in this area has continued to grow since the 1989 discovery of the Siwash North gold-quartz vein on the Elk property. The area is also recognized for its porphyry copper-gold potential associated with altered dioritic rocks in the Late Triassic Nicola volcanic belt.

Fairfield Minerals Ltd.'s main 1991 objective for the **Elk** property was to increase gold reserves in the **Siwash North zone**. After 7000 metres of drilling in 37 diamond-drill holes were completed and evaluated, reserves were increased by about 50 per cent to 308 400 tonnes grading 22.18 grams per tonne gold and 24.68 grams per tonne silver. The deposit occurs in Late Jurassic Osprey Lake granodiorite, at its contact with Late Triassic Nicola Group volcanic rocks. Geological work to date suggests that the main easterly trending veins occur in dilational structures developed at the west end, near the Nicola contact, thicken in the central part and subsequently, horsetail toward the east end of the deposit. Late in 1991, Fairfield announced that, subject to financing, an underground exploration program on the Siwash North deposit is planned for 1992.

Southwest of the Elk property, Fairfield and Placer Dome Inc. operate the **Dill** property, a porphyry copper-gold prospect in Nicola Group volcanic rocks and coeval diorites.

Pyrite-chalcopyrite mineralization occurs as quartz-carbonate-sulphide veins within phyllically altered diorite; and associated with propylitic alteration in intermediate Nicola volcanic rocks. A 2000-metre drilling program tested coincident geochemical and geophysical anomalies and intersected encouraging copper and gold values over significant widths.

To the west, adjacent to the Summers Creek fault, several copper and gold prospects associated with subsidiary shears and well-developed carbonate alteration zones were explored. North of Aspen Grove, Quilchena Resources Ltd. drilled the **Snowflake** property, which includes the Blue Jay copper prospect. To the south, MineQuest Exploration Associates Ltd. drilled a number of induced polarization anomalies associated with copper-bearing sulphides on the **Zig** claims. Cominco Ltd. obtained variable, but significant gold and copper values in percussion-drilling programs on the **Log** and **Axe** properties. In the same area, Vanco Explorations Ltd. completed a trenching and drilling program on the **Hit and Miss** claims. Targets on this property are gold-bearing quartz veins within an extensive, carbonate-altered north-striking shear zone.

Adams Lake Area

Exploration activity in the Adams Lake area decreased significantly in 1991 (Figure A-14). For the past several years the area has been most prominent in the number of projects and the amount of money spent. Although some major projects have continued, exploration expenditures in the area have fallen considerably (Figure A-15); a trend, due in part, to the scarcity of junior company financing and to a shift of focus to porphyry targets.

The prime attraction of the area has been the recognized potential of the Paleozoic Eagle Bay assemblage and Fennell Formation to host polymetallic mineralization, such as the Samatosum deposit, and volcanogenic massive sulphide deposits such as the Chu Chua and Rea Gold deposits.

In 1991 Minnova Inc. discovered two new zones of gold mineralization on the **Samatosum** property; the first and most important is below the main Samatosum deposit, encountered during definition drilling of reserves for the underground phase of mining. The second is a small zone of gold-quartz vein mineralization located about 2 kilometres northwest of the mine. The underground gold zone has a 50-metre strike length and averages 2 to 4 metres thick. Notably, however, the discovery hole intersected approximately 11 metres (not true width) of 0.43 per cent copper, 2 per cent lead, 3.23 per cent zinc, 67 grams per tonne silver and 7.29 grams per tonne gold. Sulphide minerization is disseminated to massive, pyritic and associated with strong silicification.

To the southeast of the Samatosum mine, Homestake Mining Canada Ltd. completed more than 7700 metres of drilling on the **Kamad** and **Twin** properties during 1991. The two projects focused on southeastern extensions of the "Sam" and "Rea" horizons, where drilling programs during the past four years have led to the discovery of two small massive sulphide lenses on the Rea horizon. Both horizons were intersected during the 1991 drilling, with the "Sam" or Silver zone returning the most encouraging results in precious metals, although neither zone was of economic dimensions.

To the west of North Barriere Lake, Falconbridge Limited continued with a second phase of diamond drilling on the **Birk Creek** property. Encouraging sulphide mineralization was intersected on the "central trend", with grades averaging 11.95 per cent zinc, 3.83 per cent lead, 1.24 per cent copper and 140.5 grams per tonne silver over significant widths.

At the **Chu Chua** property, Minnova Inc. completed a 4000-metre drilling program and a down-hole pulse EM survey to further define the mineralized horizon. Geophysical anomalies and the distribution of alteration suggest that the best potential for extending the existing deposit is at depth and to the north. A small sulphide lens was discovered at depth in the hangingwall of the main zone during the 1991 drilling. Overall, the zone graded 0.97 per cent copper, 5.4 grams per tonne silver and 0.84 gram per tonne gold over 14.9 metres (not necessarily true width). The zone included higher grade sections over narrower widths. Pacific Cassiar Ltd., Quinterra Resources Inc. and International Vestor Resources Ltd. are Minnova's co-owners in the project.

On the **Mila** property, east of Clearwater, Goldbank Ventures Ltd. and International Suneva Resources Ltd. went to the second phase of drilling to intersect two parallel zones of disseminated to massive sulphides in Eagle Bay rocks. The two zones collectively total about 30 metres in thickness, with copper grades averaging in the order of 0.2 per cent.

East of Adams Lake, Minnova Inc. carried out drilling programs to test geophysical anomalies on three widely separated areas collectively known as the Plateau project. The **Mosquito King, Spar and Boler Creek** showings are all "sedex-type" massive sulphide occurrences hosted in calcsilicate metasedimentary rocks of the Eagle Bay assemblage and all are zinc, lead and silver prospects.

TABLE A-8
MINE PRODUCTION AND RESERVES
1990-1991
SOUTH CENTRAL DISTRICT

	PRODUCTION				RESERVES (End 1991)	
MINE	1991 TONNES (000's)	GRADE	1990 TONNES (000's)	GRADE	TONNES (000's)	GRADE
Highland Valley Copper	47 500	0.43 % Cu 0.008% Mo	47 090	0.429% Cu 0.007% Mo	748 500	0.41% Cu 0.007% Mo
Similco	3 960	0.47 % Cu	6 194	0.495% Cu	32 700	0.44 % Cu
Samatosum	174.5	812 g/t Ag 0.95% Cu, 1.21% Pb 2.24% Zn 1.4 g/t Au	164.7	830 g/t Ag 0.9% Cu 1.0% Pb 1.6% Zn 1.0 g/t Au	94.7	582 g/t Ag 0.64% Cu 0.94% Pb 1.42% Zn 0.91 g/t Au
Afton/Ajax	2 009	0.49% Cu 0.34 g/tAu	2 676	0.55% Cu 0.39 g/t Au	18 735	0.45% Cu 0.34 g/t Au
Nickel Plate	1 261	2.64 g/tAu	1 141	2.502 g/tAu	1 598	2.61 g/t Au
Brenda	-----	---- ---	4 282	0.14% Cu 0.029% Mo	----	----
Highland Bell	----	----	36.3	311 g/t Ag	----	----
Candorado	0000	0000	372	0.79 g/t Au	510	0.79 g/t Au
Goldstream	275	4.00% Cu 2.52% Zn	----	----	1'650	4.81% Cu 3.06% Zn

MINING OPERATIONS

There are currently five producing mines and two metal recovery operations in south-central British Columbia (Table A-7). One former producer, the Goldstream copper-zinc mine was reopened in June of 1991 to become the province's newest massive sulphide producer. On the down side, Afton Operating Corporation was forced to suspend operations at the Ajax mine temporarily, due to marginal profitability, until copper prices stabilize at $US1.15, or higher, per pound. Table A-7 lists a summary of highlights at the operating mines and 1990-1991 production and year-end reserves are shown in Table A-8.

DISTRICT ACTIVITIES AND RESEARCH

The **Kamloops Exploration Group (KEG)** was reactivated in 1988 following an extended period of dormancy. The main objective of the organization has been to encourage and facilitate open and enthusiastic discussion of regional geology, mineral exploration and mining projects carried out in southern British Columbia and the U.S. Pacific Northwest.

The Annual Kamloops Exploration Conference has been an important new event in the region, with an established attendance that has grown from 135 in 1988 to over 270 in 1992. The Fifth Annual KEG Conference, held on April 14-15, 1992, included a session on exploration projects and a symposium which addressed developments, research highlights and challenges confronting the mineral exploration industry. The Sixth Annual Kamloops Exploration Conference is scheduled for April, 1993.

RESEARCH

In 1991 the Mineral Deposit Research Unit (MDRU) initiated a study of porphyry copper-gold systems. The project includes mapping and analytical work on the Iron Mask batholith, the Ajax and Python deposits, and a study of the Copper Mountain deposits at Princeton. MDRU has also proposed a study of volcanogenic massive sulphide deposits, which holds promise of providing new insight for explorationists working on the Paleozoic deposits of the Columbia River and Shuswap regions of the district.

ACKNOWLEDGMENTS

The Kamloops District Geology office acknowledges the contributions of data to this article by the mineral exploration and mining community operating in south-central British Columbia.

Editor's Note:

Information for the Kootenay and Southwest districts was not available at the time of publication of this issue of *Exploration in British Columbia*.

PART B

GEOLOGICAL DESCRIPTIONS OF PROPERTIES

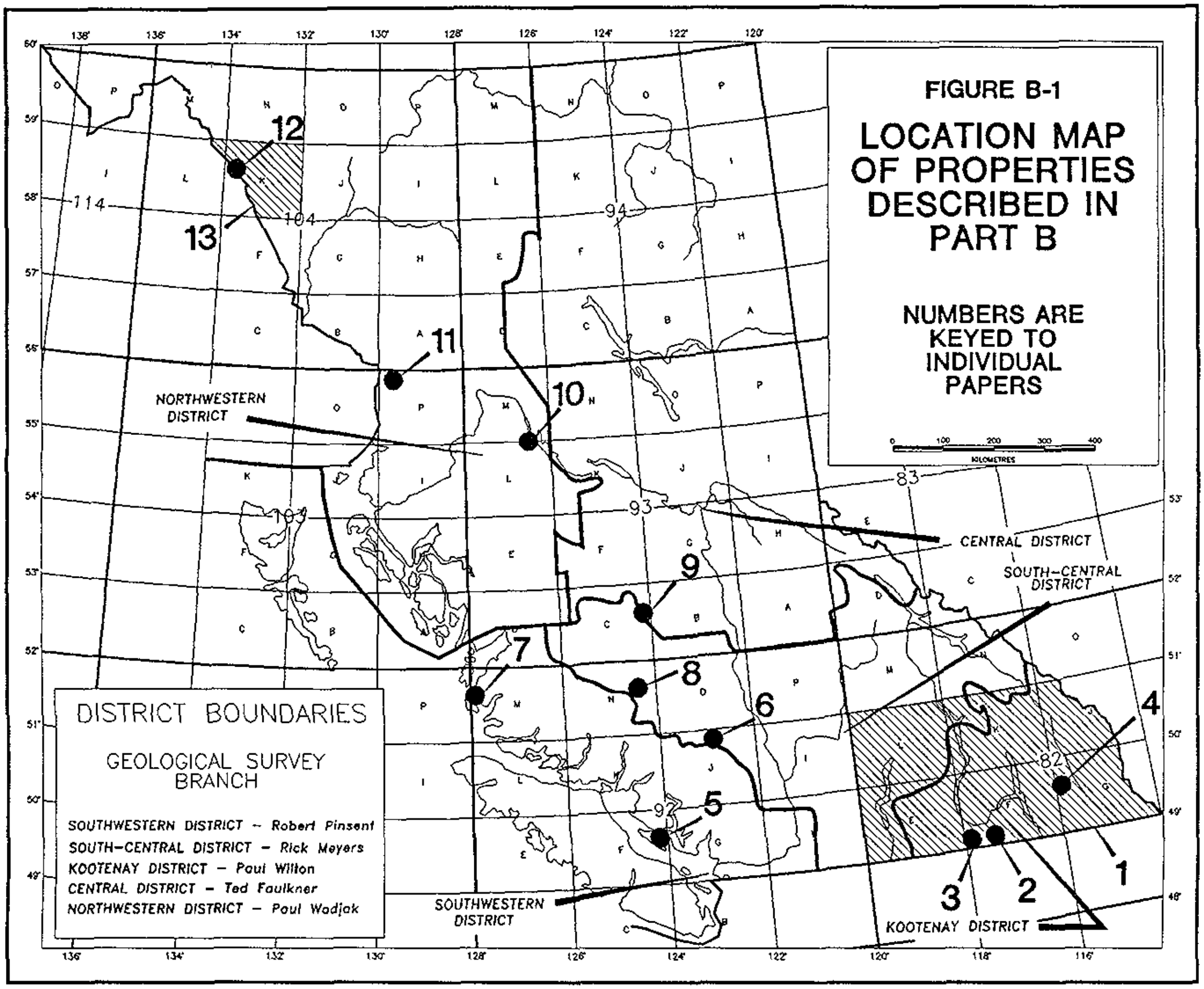


FIGURE B-1
LOCATION MAP OF PROPERTIES DESCRIBED IN PART B
NUMBERS ARE KEYED TO INDIVIDUAL PAPERS
KILOMETRES
DISTRICT BOUNDARIES
GEOLOGICAL SURVEY BRANCH
SOUTHWESTERN DISTRICT – Robert Pinsent
SOUTH–CENTRAL DISTRICT – Rick Meyers
KOOTENAY DISTRICT – Paul Wilton
CENTRAL DISTRICT – Ted Faulkner
NORTHWESTERN DISTRICT – Paul Wodjak
NORTHWESTERN DISTRICT
CENTRAL DISTRICT
SOUTH–CENTRAL DISTRICT
SOUTHWESTERN DISTRICT
KOOTENAY DISTRICT

FOLLOW-UP INVESTIGATION OF ANOMALOUS RGS STREAM-SEDIMENT SITES IN SOUTHEASTERN BRITISH COLUMBIA: GUIDE TO POTENTIAL DISCOVERIES

(Fig. B1, No. 1)

By S.J. Cook, W. Jackaman and P.F. Matysek

INTRODUCTION

Multi-element data for seven 1:250 000-scale Regional Geochemical Surveys (RGS) covering 100 000 square kilometres in southeastern British Columbia were released in 1991 (Figure B-1-1). Over 300 000 analytical determinations were made from 8060 stream-sediment sites in NTS map sheets Fernie (82G) and Kananaskis Lakes (82J), sampled in 1990, and NTS map sheets Penticton (82E), Nelson (82F), Lardeau (82K), Vernon (82L) and Seymour Arm (82M), initially sampled in 1976 and 1977 and recently reanalyzed for gold and numerous other elements. Systematic evaluation of such large multi-element geochemical databases presents a considerable challenge to explorationists. This study outlines a simple methodology to evaluate 1991 RGS data and identifies sites on which no mineral claims have been staked. Several anomalous watersheds are resampled to verify original RGS anomalies and identify possible sources and exploration targets. The methodology can be applied to the remainder of the RGS database, available on diskette, which consists of more than a million analytical determinations at almost 35 000 sites covering more than 65 per cent of the province.

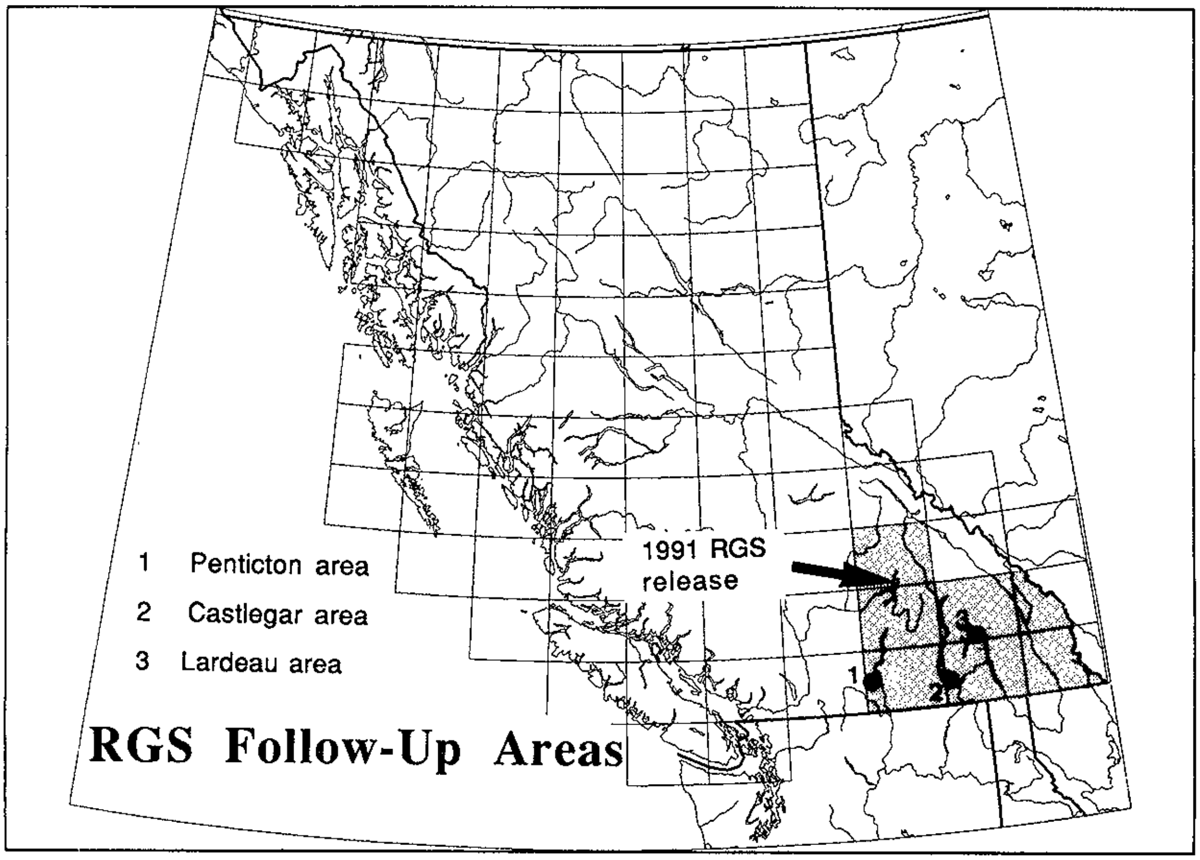


Figure B-1-1. 1991 RGS release areas, and locations of RGS follow-up sites in southeastern British Columbia.

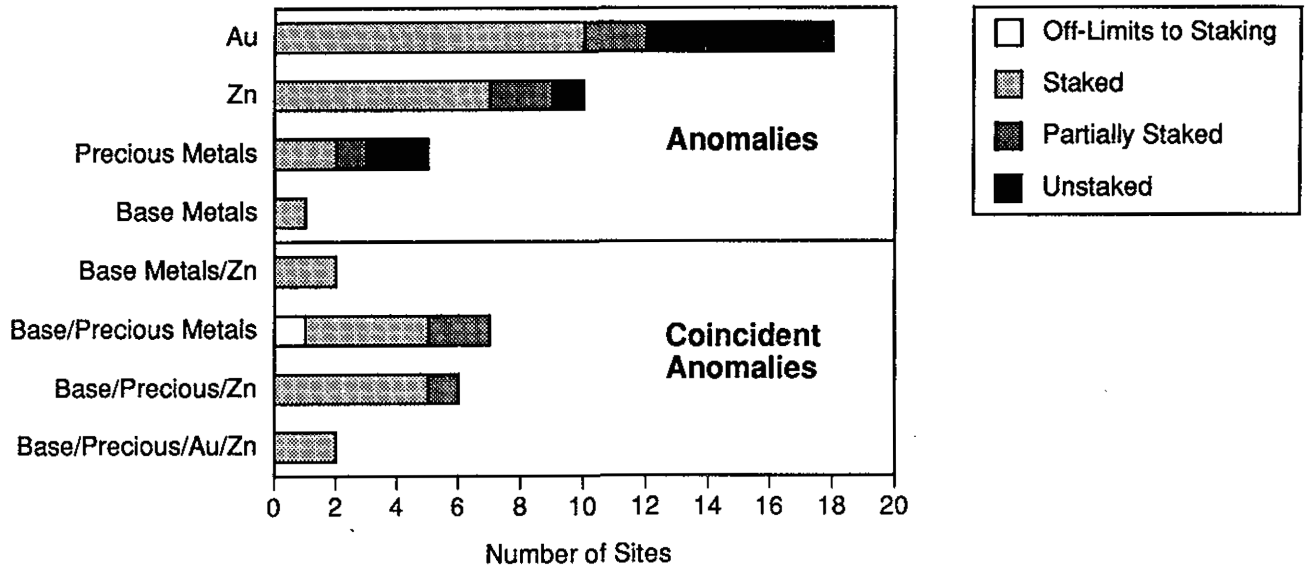


Figure B-1-2. Anomalous stream-sediment sites according to anomaly type and mineral claim status (as of mid October, 1991).

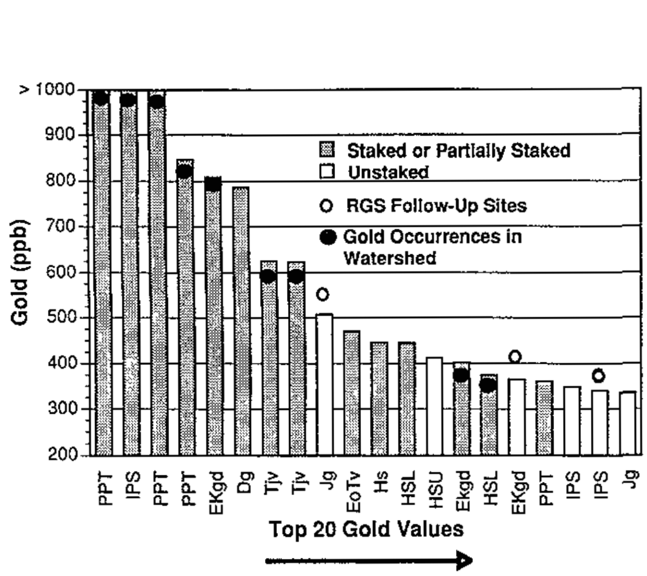


Figure B-1-3. Top 20 RGS gold concentrations in the 1991 RGS release, showing mineral claim status of watersheds (as of mid-October, 1991), underlying geological unit, and relation to known gold occurrences. The three follow-up sites are neither staked nor contain known gold occurrences. Geological units, from Okulitch and Woodsworth (1977) are:
EoTv: Tertiary basalt, andesite, volcaniclastic and flow rocks, minor sediments; Tjv: Triassic-Jurassic greenstone, tuff, sediments; PPT: Carboniferous - Permian argillite, quartzite, greenstone, limestone, conglomerate; IPS: lower Paleozoic argillite, limestone, schist, phyllite, greenstone; Hs: Proterozoic (Hadrynian) sandstone, conglomerate, limestone, volcanic rocks; HSU: Proterozoic (Helikian) quartzite, argillite, dolomite, limestone, siltstone; HSL: Proterozoic (Helikian) quartzite, argillite, siltstone; EKgd: Cretaceous granodiorite, quartz diorite; Jg: Jurassic granodiorite, quartz diorite; Dg: Devonian gneissic granitic rocks.

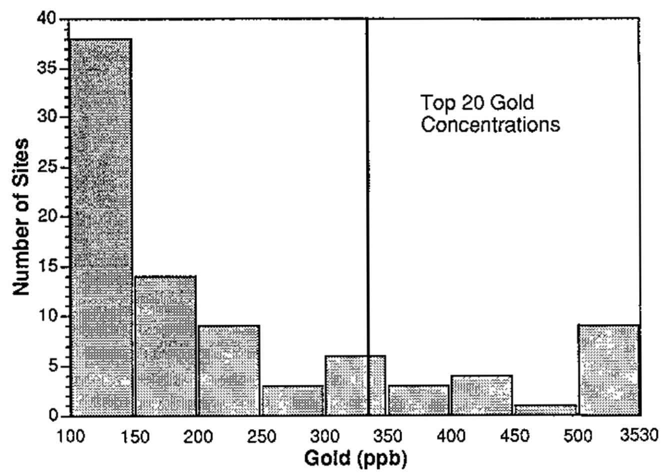


Figure B-1-4. Distribution of sites in 1991 RGS release with at least 100 ppb gold (N=87).

IDENTIFICATION OF ANOMALOUS SITES

An interpretive technique developed by RGS staff rates the anomalous nature of individual samples in the combined survey areas and identifies those sites characterized by multi-element signatures. Briefly, the method consists of calculating 90th, 95th and 98th percentile thresholds for each metal in each geological unit containing ten or more sample sites in the adjoining survey areas; and then assigning metal anomaly ratings to individual samples exceeding these thresholds. Those samples exceeding the 98th percentile for any given geological unit are assigned an anomaly rating of 3. Those samples having concentrations between the 95th and 98th percentiles for a geological unit are assigned an anomaly rating of 2, while those between the 90th and 95th percentiles are assigned a rating of 1. Element ratings for base metal (Cu-Pb-Zn-Ag) and precious metal (Au-Sb-As-Ag) associations are summed for each site, and anomalous samples are deemed to be those with a top rating of at least 10 of a possible 12 in either association. Threshold tables and evaluation charts for anomalous samples are provided in data booklets for individual 1991 RGS releases.

Eighteen top-rated base metal (Cu-Pb-Zn-Ag) and twenty precious metal (Au-As-Sb-Ag) multi-element anomalies were identified in southeastern B.C. (Jackaman *et al.*, 1992). In addition, gold and zinc concentrations were ranked and the top twenty of each identified. Upon elimination of coincident anomalies, 51 sites were identified as anomalous (Jackaman *et al.*, 1992). Two of the ten highest anomalies of gold and zinc were staked following the 1991 RGS release, but a large number remain open for staking. Stream watersheds of 17 such sites, primarily single-element gold anomalies, were either unstaked or partially staked as of October 1991 (Figure B-1-2). In particular, stream sediments with somewhat lower gold concentrations appear to have been overlooked by explorationists. Although watersheds of all but one of the ten highest gold concentrations (470-3530 ppb) have been staked, seven of the next ten (335-446 ppb) were either unstaked or only partially staked (Figure B-1-3). Most of these watersheds contain no known mineral occurrences, suggesting that anomalous metal concentrations may reflect the presence of undiscovered mineralization. These are only a small number of the 87 drainages in the 1991 RGS release containing at least 100 ppb gold (Figure B-1-4). For comparison, background gold concentrations in stream sediments, as expressed by median values, are in the range of 2-4 ppb for most geological units.

FOLLOW-UP OF ANOMALOUS SITES

In order to assess the mineral potential of the anomalous drainages, follow-up surveys were conducted at three sites (Figure B-1-1) in early December, 1991:

- Shingle Creek, Penticton area (NTS 82E/12 765111)
- Cayuse Creek, Castlegar area (NTS 82F/5 777049)
- Davis Creek, Lardeau area (NTS 82K/2 773132)

SAMPLING METHODOLOGY

The drainages are single-element gold anomalies and were selected on the basis of mineral claim status, different geological settings, absence of known mineral occurrences and good road access. The original RGS site was resampled in each drainage, but the extent of follow-up sampling in each varied from detailed survey to single-site verification. A total of seventeen follow-up sites were sampled: thirteen in the Skulaow-Riddle Creeks watershed, three from the watersheds of Cayuse Creek and two bounding creeks, and one from Davis Creek. Most of the major stream confluences in the Shingle Creek watershed were sampled.

A bulk 10 to 20-kilogram sediment sample and, where possible, a moss-mat sediment sample were collected from the active channel at each site. Generally, moss-mat sediments were more readily available at the Castlegar and Lardeau sites than at the Penticton site, where heavy snow cover impeded sampling. The coarsest grained stream sediment, however, was found at the Lardeau site. Field duplicates of sediments and moss mats were collected at two sites in the Skulaow-Riddle and Cayuse watersheds. Pan concentrates were made at some sites in an attempt to find visible gold.

PREPARATION AND ANALYTICAL METHODOLOGY

Sample preparation was done at Rossbacher Laboratory, Burnaby. Stream sediments were dried and the -12-millimetre fraction riffle split into two equal portions. One of the splits, typically 4 to 10 kilograms, was dry-sieved to -180 microns (-80 mesh), and the second was retained for later use. Preparation of moss mats was carried out according to standard RGS procedure (Gravel and Matysek, 1989). Fine sediment is disaggregated from moss fronds by gentle pounding and passed through an 850 micron (20 mesh) screen prior to sieving to 180 microns. On the median, -180 micron particles constituted 58.57 per cent of moss-mat sediments but only 5.04 per cent of stream sediments. Two 30-gram subsamples of the -180 micron fraction of each stream sediment and moss-mat sediment were taken with a small splitter, for a total of four subsamples from each field site.

Two identical sample suites were submitted to two analytical laboratories. One suite was analyzed for gold by lead fire assay with an inductively coupled plasma spectrometry (ICP) finish, and for a 32-element ICP suite following partial digestion in hot aqua regia (hydrochloric:nitric acids), at Acme Analytical Laboratories, Vancouver. The second suite was analyzed for gold and 34 other elements by instrumental neutron activation analysis (INAA) at Activation Laboratories Ltd., Ancaster, Ontario. Stated detection limits for gold are 1 ppb at Acme and 2 ppb at Activation Laboratories.

Field and analytical duplicates were included in the analytical suite, together with an appropriate range of gold-bearing reference standards. Results of three reference standards indicate an acceptable level of analytical accuracy of gold determinations (Figure B-1-5).

TABLE B-1-1
SUMMARY OF GOLD CONCENRATIONS (PPB) AT RGS FOLLOW-UP SITES IN SOUTHEASTERN BRITISH COLUMBIA

Area	RGS Sample Number	Original RGS Gold Value	Analytical Method	Gold in Stream Sediments: Initial Sample	Gold in Stream Sediments: Field Duplicate	Gold in Stream Sediments: Analytical Duplicate	Gold in Moss mat Sediments: Initial Sample	Gold in Moss mat Sediments: Field Duplicate	Gold in Moss mat Sediments: Analytical Duplicate
Penticton	82E12 765111	**507**	Pb FA	**3**	-	**422**	**408**	-	-
			INAA	**<2**	-	**5**	**29**	-	-
Castlegar	82F05 777049	**365**	Pb FA	**2**	**653**	**4**	**324**	**9**	**19, 58**
			INAA	**23**	**22**	**<2**	**108**	**5**	**20, 29**
Lardeau	82K02 773132	**340**	Pb FA	**2**	-	**9**	**287**	-	-
			INAA	**8**	-	**<2**	**230**	-	-

TABLE B-1-2
SELECTED ANALYTICAL DATA FOR THE -80 MESH FRACTION OF STREAM AND MOSS-MAT SEDIMENTS AT THREE RGS FOLLOW-UP SITES IN SOUTHEASTERN BRITISH COLUMBIA

			FIRE ASSAY		INAA																						
Media	Area	Sample	Au-1 ppb	Au-2 ppb	Au-1 ppb	Au-2 ppb	Mo ppm	Cu ppm	Pb ppm	Zn ppm	Ag ppm	Ni ppm	Co ppm	Mn ppm	Fe %	As ppm	Sr ppm	Cd ppm	Sb ppm	Bi ppm	V ppm	Cr ppm	Mg %	Ba ppm	Ti %	Al %	W ppm
	Penticton	S-91-002	3	422	<2	5	1	18	244	234	1.2	27	11	443	11.58	84	73	1.3	5	2	255	52	0.19	65	0.13	0.37	1
		S-91-003	29	-	<2	-	1	29	13	72	0.2	19	10	427	9.71	26	67	0.2	2	2	205	38	0.22	76	0.12	0.47	1
		S-91-004	5	5	<2	<2	1	15	6	53	0.1	14	7	404	3.55	11	153	0.3	2	2	86	20	0.32	170	0.11	0.64	1
		S-91-005	6	-	<2	-	1	17	2	56	0.1	14	8	466	4.11	4	163	0.2	2	2	94	21	0.33	186	0.11	0.75	1
		S-91-006	5	-	<2	-	1	20	2	51	0.1	14	7	456	3.47	12	105	0.2	2	2	73	20	0.31	164	0.11	0.83	1
		S-91-008	4	-	<2	-	1	13	18	64	0.1	16	7	618	4.43	29	69	0.2	2	2	81	21	0.31	127	0.12	0.88	1
		S-91-009	*3*	-	*6*	-	*1*	*21*	*3*	*71*	*0.1*	*22*	*9*	*834*	*4.97*	*2*	*163*	*0.5*	*2*	*2*	*94*	*27*	*0.29*	*242*	*0.13*	*0.98*	*1*
		S-91-010	2	7	<2	<2	1	24	2	56	0.2	19	9	635	3.77	5	252	0.3	2	2	81	24	0.36	321	0.12	0.96	1
Stream Sediment		S-91-011	3	3	<2	4	1	32	7	54	0.2	15	7	276	2.25	8	301	0.2	2	2	50	16	0.40	299	0.09	1.18	1
		S-91-012	1	-	5	-	4	20	6	55	0.1	15	10	1170	5.38	2	221	0.2	2	2	105	22	0.35	228	0.11	1.06	1
		S-91-013	3	-	3	-	1	53	4	69	0.2	24	10	978	3.57	5	688	0.3	2	2	68	25	0.55	820	0.11	1.68	1
		S-91-014	2	-	16	-	1	34	15	61	0.1	24	9	485	4.22	2	217	0.3	2	2	96	31	0.36	213	0.19	1.01	1
		S-91-016	121	-	<2	-	1	16	2	68	0.1	22	10	460	8.30	2	97	0.2	2	2	161	37	0.23	98	0.14	0.45	1
		S-91-017	5	-	<2	-	1	17	9	86	0.1	26	12	540	7.95	2	174	0.2	2	2	187	44	0.28	161	0.17	0.67	1
	Castlegar	S-91-018	2	4	23	<2	1	29	3	58	0.1	18	10	362	3.66	2	63	0.2	2	16	79	39	0.82	130	0.16	1.34	6
		S-91-019	653	-	22	-	1	29	11	58	0.1	19	10	363	3.86	5	62	0.2	2	2	83	42	0.80	130	0.16	1.29	15
		S-91-020	17	2	103	65	1	16	9	51	0.1	14	9	420	4.47	3	41	0.4	2	2	85	43	0.55	89	0.12	0.96	1
		S-91-022	2	-	2	-	1	29	24	71	0.1	161	18	445	3.45	8	103	0.8	2	2	47	78	1.92	194	0.10	1.03	1
	Lardeau	S-91-023	2	9	8	<2	1	57	20	81	0.2	61	21	693	4.73	8	85	0.6	2	2	35	56	1.21	60	0.08	1.68	1
	Penticton	M-91-002	408	-	29	-	1	12	7	60	0.2	15	9	413	9.30	2	70	0.2	2	2	202	38	0.20	64	0.11	0.36	1
		M-91-003	1	-	53	-	1	13	6	71	0.1	18	11	512	11.57	2	65	0.2	5	2	237	42	0.18	85	0.12	0.33	1
		M-91-004	1	2	6	<2	1	14	11	54	0.1	11	7	436	3.70	2	163	0.2	2	2	86	19	0.31	179	0.10	0.65	1
		M-91-006	1	-	<2	-	1	9	7	44	0.1	10	5	562	2.26	2	88	0.3	2	2	51	13	0.24	139	0.08	0.59	1
		M-91-008	3	-	9	-	1	18	5	78	0.2	10	8	1085	3.08	2	101	0.2	2	2	49	11	0.37	225	0.08	1.31	1
Moss Mat Sediment	Castlegar	M-91-018	324	19	108	20	1	26	2	49	0.2	16	9	339	3.71	2	56	0.4	2	2	74	36	0.68	104	0.13	0.99	16
		M-91-019	9	58	5	29	1	33	6	51	0.1	16	9	326	3.62	3	56	0.2	2	2	72	37	0.67	103	0.13	0.96	25
		M-91-020	780	165	1300	202	1	14	17	49	0.1	12	8	391	5.54	2	39	0.2	2	2	96	49	0.46	80	0.11	0.77	1
		M-91-022	2	-	6	-	1	22	19	65	0.1	154	17	415	4.14	2	83	0.2	2	2	55	72	1.97	147	0.08	0.67	1
	Lardeau	M-91-023	287	-	230	-	1	59	22	70	0.4	62	30	585	6.11	14	73	0.2	2	2	37	56	0.94	60	0.06	1.17	1

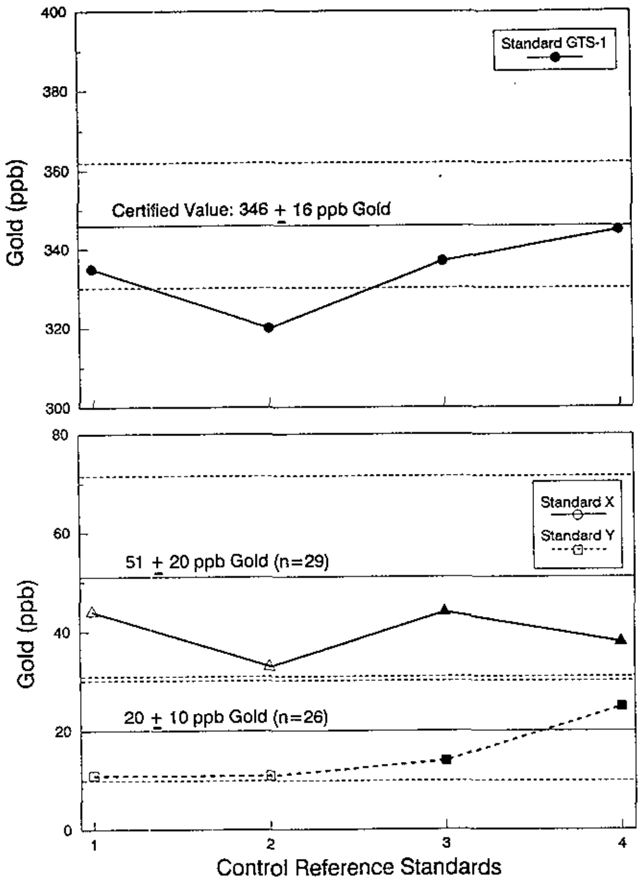


Figure B-1-5. Gold analytical results for multiple insertions of control reference standards GTS-1 (CANMET), X (GSB) and Y (GSB) relative to certified or accepted values (Mean±1s). Open symbols indicate results obtained by lead fire assay; closed symbols indicate results obtained by instrumental neutron activation analysis (INAA).

RESULTS AND INTERPRETATION

Distribution of gold concentrations in stream sediments and moss mats at the resampled RGS sites is shown in Table B-1-1. Concentrations of gold (fire assay and INAA) and selected other elements (aqua regia digestion) at each follow-up site are shown in Table B-1-2. RGS gold anomalies at each of the three sites are verified by follow-up sampling, particularly with moss-mat sediments. This attests to the high quality of sampling during the initial federal-provincial surveys conducted in 1976 and 1977.

For purposes of comparison, percentile threshold concentrations for selected elements and relevent geological units are given in Table B-1-3.

PENTICTON (NTS 82E/12, 5)

The anomalous site (765111) is located on Shingle Creek on the Thompson Plateau (Figure B-1-6), approx-

TABLE B-1-3
PERCENTILE THRESHOLD CONCENTRATIONS FOR SELECTED ELEMENTS AND GEOLOGICAL UNITS IN SOUTHEASTERN BRITISH COLUMBIA
(Geological Units as in Figure B-1-3)

		Au (ppb)			As (ppm)		
		90th	95th	98th	90th	95th	98th
Jg	(n=387)	15	34	120	12	20	30
eoTv	(n=306)	10	27	59	5	6.4	9.4
EKgd	(n=997)	11	16	35	5.5	8.7	14
PPT	(n=275)	37	72	150	13	17	33
lPs	(n=550)	17	25	49	23	29	41

		Pb (ppm)			Zn (ppm)		
		90th	95th	98th	90th	95th	98th
Jg	(n=387)	51	93	175	205	315	560
eoTv	(n=306)	9	12	14	64	72	98
EKgd	(n=997)	19	28	40	84	105	166
PPT	(n=275)	16	26	48	95	124	173
lPs	(n=550)	37	55	118	166	225	465

(from Matysek et al., 1991a,b,c,d,e,f,g)

imately 12 kilometres northwest of Penticton, and is accessible via the Apex Alpine and Shingle Creek roads. There is ranching activity in the watershed, however, and a locked gate on one road prevents public access. The gold concentration at this site (507 ppb) is ranked ninth in the 8060-site combined survey area. The Shingle-Skulaow-Riddle Creek watershed is relatively large (>80 km^2), and is underlain predominantly by granodiorite and related phases of the Jurassic Nelson plutonic suite (Little, 1961; Tempelman-Kluit, 1989). A small Tertiary basin containing Eocene volcanic flows and tuffs (Church, 1982; Morrison, 1990) occurs within the watershed. Predominantly trachyte flows and tuffs of the basin have been variably mapped as Marron Formation (Morrison, 1990) and as Kitley Lake Formation (Tempelman-Kluit, 1989). There are no known gold occurrences within the watershed, although most of the Eocene basin is staked (Vent claims; 10.5 km^2). Hydrothermally altered tuffs of the basin have been the focus of recent gold exploration (Morrison, 1990). Epithermal gold mineralization has been discovered in a similar setting at the Vault deposit near Okanagan Falls (Meyers, 1988).

Resampling confirmed the 1991 RGS gold anomaly, and two anomalous gold values (up to 121 ppb) extend upstream from the original RGS site, in Shingle and Skulaow Creeks. However, no elevated gold concentrations were discovered in sediments in the immediate vicinity of the Tertiary basin (Figures B-1-6 and 7). It should be stated that these results were obtained only with the fire assay suite, as no anomalous gold values were reported for those sample splits analyzed by INAA (Table B-1-2).

Resampling of the original RGS site yielded anomalous concentrations of lead, zinc, silver, cadmium, ar-

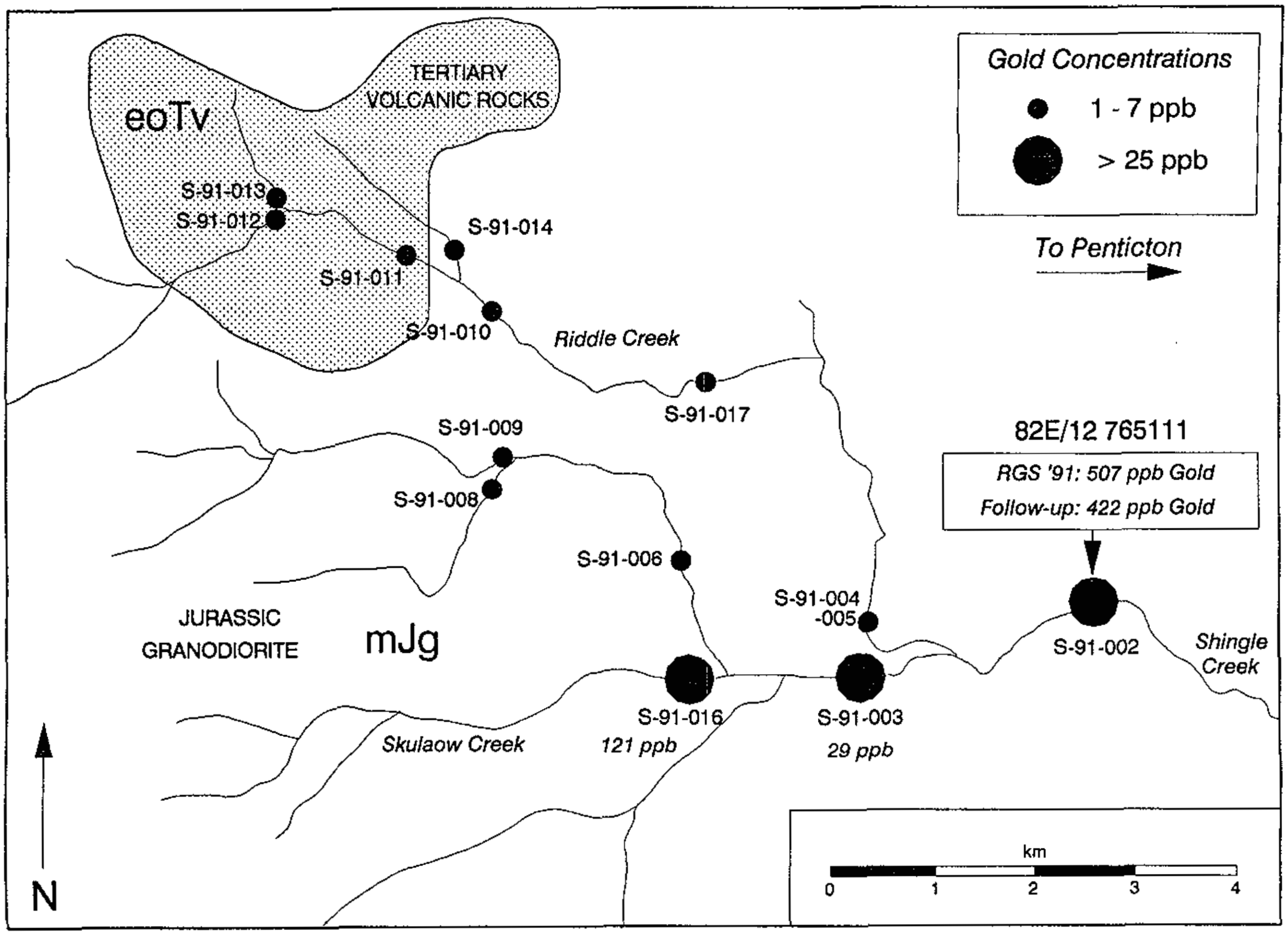


Figure B-1-6. Generalized geology and follow-up sample locations in the Shingle Creek watershed, Penticton area, showing gold concentrations (lead fire assay) of the -180 micron fraction of stream sediments. Complete listings of gold concentrations for both stream and moss-mat sediments are given in Table B-1-2 (geology after Tempelman-Kluit, 1989).

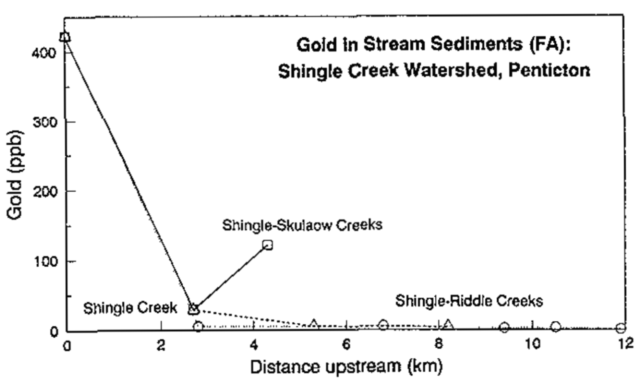


Figure B-1-7. Distribution of arsenic in stream sediments of three tributaries of the Shingle Creek watershed, Penticton area. Both lead fire assay and instrumental neutron activation analysis methods indicate that highest arsenic concentrations occur in Shingle Creek.

senic, antimony and iron, in addition to gold. Most of these elements do not extend upstream in any systematic manner. However anomalous arsenic values, which exceed 80 ppm at the resampled RGS site, extend upstream at three sample sites to the headwaters of Shingle Creek (Figure B-1-8). Elevated lead values at two of the three sites also extend to the same point upstream. A single anomalous molybdenum value (4 ppm; >95th percentile for stream sediments associated with Eocene volcanics) is located immediately downslope of one of the hydrothermally altered tuff units of Morrison (1990).

The distribution of gold in stream sediments of the drainage suggests that anomalous gold values originated in the Skulaow Creek watershed rather than in the Tertiary basin to the north. As well, the suite of anomalous elements at the resampled RGS site does not correspond to those associated with Tertiary epithermal gold mineralization in British Columbia, such as the Vault deposit near Okanagan Falls. Meyers (1988) stated that base metal sulphides, including galena and sphalerite, do not appear to be related to precious metal distribution in the Vault deposit. Thus, while anomalous concentrations of silver, arsenic, antimony and molybdenum in sediments are expected to be associated with epithermal gold mineralization, anomalous concentrations of lead, zinc and iron are not. The suite of anomalous elements is sugges-

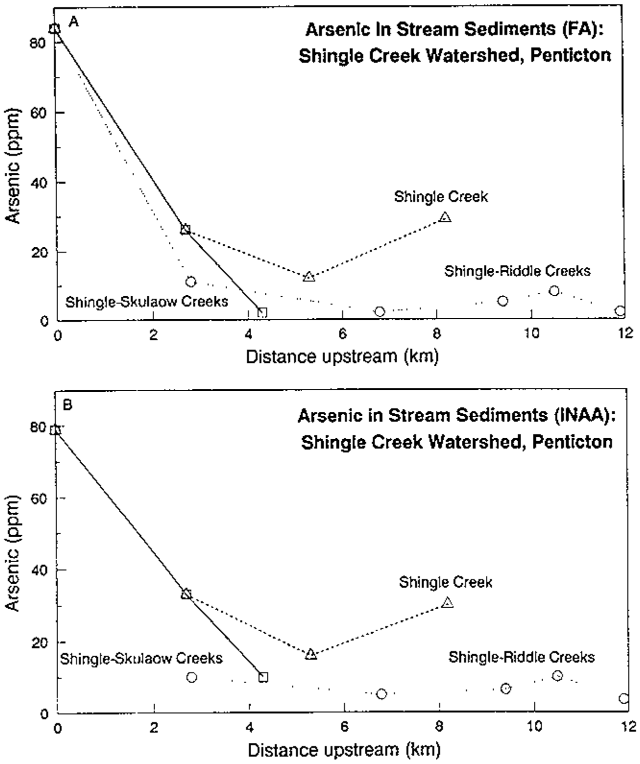


Figure B-1-8. Distribution of arsenic in stream sediments of three tributaries of the Shingle Creek watershed, Penticton area. Both lead fire assay and instrumental neutron activation analysis methods indicate that highest arsenic concentrations occur in Shingle Creek.

tive of intrusive-hosted gold mineralization, such as the Au-Ag-Pb-Zn deposits of the Carmi-Beaverdell camp, or of the Elk property near Kelowna.

Interestingly, the three sites containing the highest gold values are also the same sites containing the highest iron values (8.30-11.58% iron in sediments). These correspond to the top two percentiles of iron above Jurassic granodiorite in the combined survey areas, and may indicate the formation of small-scale placers in this watershed. Fletcher (1990) has documented the occurrence of gold and magnetite concentrations increasing downstream in the Okanagan Plateau near Vernon.

Castlegar (NTS 82F/5, 82E/8)

The anomalous site (777049) is located on Cayuse Creek, about 25 kilometres west of Castlegar, on the northeast side of Lower Arrow Lake (Figure B-1-9). The gold concentration (365 ppb) is the 16th highest in the combined survey areas. The Cayuse Creek watershed is underlain predominantly by middle to late Jurassic Nelson plutonic rocks (Little, 1957, 1960; Andrew *et al.*, 1991), but contains a pendant of Pennsylvanian metasedimentary and metavolcanic rocks of the Mount Roberts Formation. This belt extends eastward from the Deer Park area on Lower Arrow Lake, and comprises southward-dipping crystalline limestone, greenstone and argillaceous quartzite. Local skarn alteration is common (Little, 1960). There are no known gold occurrences within the Cayuse Creek watershed. Only a few scattered mineral claim units, on Cayuse and adjoining creeks, were in existence prior to December 1991. Previous exploration activity appears to have been minimal.

Stream sediments were also collected along the highway from two bounding streams on either side of the RGS site on Cayuse Creek (Figure B-1-9). One, Little Cayuse Creek, also drains Mount Roberts Formation rocks. The second, Tulip Creek, drains only Eocene Paleocene quartz monzonite, formerly referred to as the Valhalla intrusions. Massive magnetite and oxidizing iron sulphides are present in exposed bedrock in this creek.

Resampling confirmed the 1991 RGS gold anomaly on Cayuse Creek, and revealed anomalous bismuth and tungsten values. Strongly anomalous gold concentrations were also discovered in moss-mat sediments of Little Cayuse Creek, immediately to the west of Cayuse Creek (Figure B-1-5). As well, visible gold particles were discovered in a pan concentrate from Little Cayuse Creek.

Both creeks containing strongly anomalous gold values drain the same belt of Mount Roberts Formation strata within the plutonic unit. A third bounding creek (Tulip Creek), which does not drain this belt, contains only background gold concentrations. This may be indicative of previously unknown gold mineralization in this part of the Deer Park belt. The Mount Roberts Formation is lithologically similar to units of the Rossland Group (Little, 1960), both of which are host to lode gold in the Rossland camp (Fyles, 1984). Gold veins also occur in Mount Roberts Formation rocks at Patterson to the south. As well, the area is adjacent to the Valkyr shear (Figure 9). The Slocan Lake fault, which is at places superimposed upon the Valkyr shear, has been linked to silver-lead-zinc veins of the Slocan camp (Beaudoin, 1991).

Lardeau (NTS 82K/2, 3)

The anomalous site (773132) is located on Davis Creek, immediately west of Highway 31 at Lardeau, on the west side of Kootenay Lake. The gold concentration at this site (340 ppb) is the 19th highest in the combined survey areas. Geology of the watershed comprises Lower Paleozoic metasedimentary and metavolcanic rocks, primarily those of the Lardeau Group. Marble and mica schist of the Badshot and Mohican formations, and micaceous quartzite and mica schist of the Marsh Adams Formation (Reesor, 1973; Fyles, 1964) are also exposed near the mouth of Davis Creek.

The headwaters of Davis Creek extend west to the Slocan camp, but there are no known gold occurrences within the watershed. There are no valid mineral claims, although an old adit near the creek mouth attests to previous mining activity. Barren pyritic quartz veins are

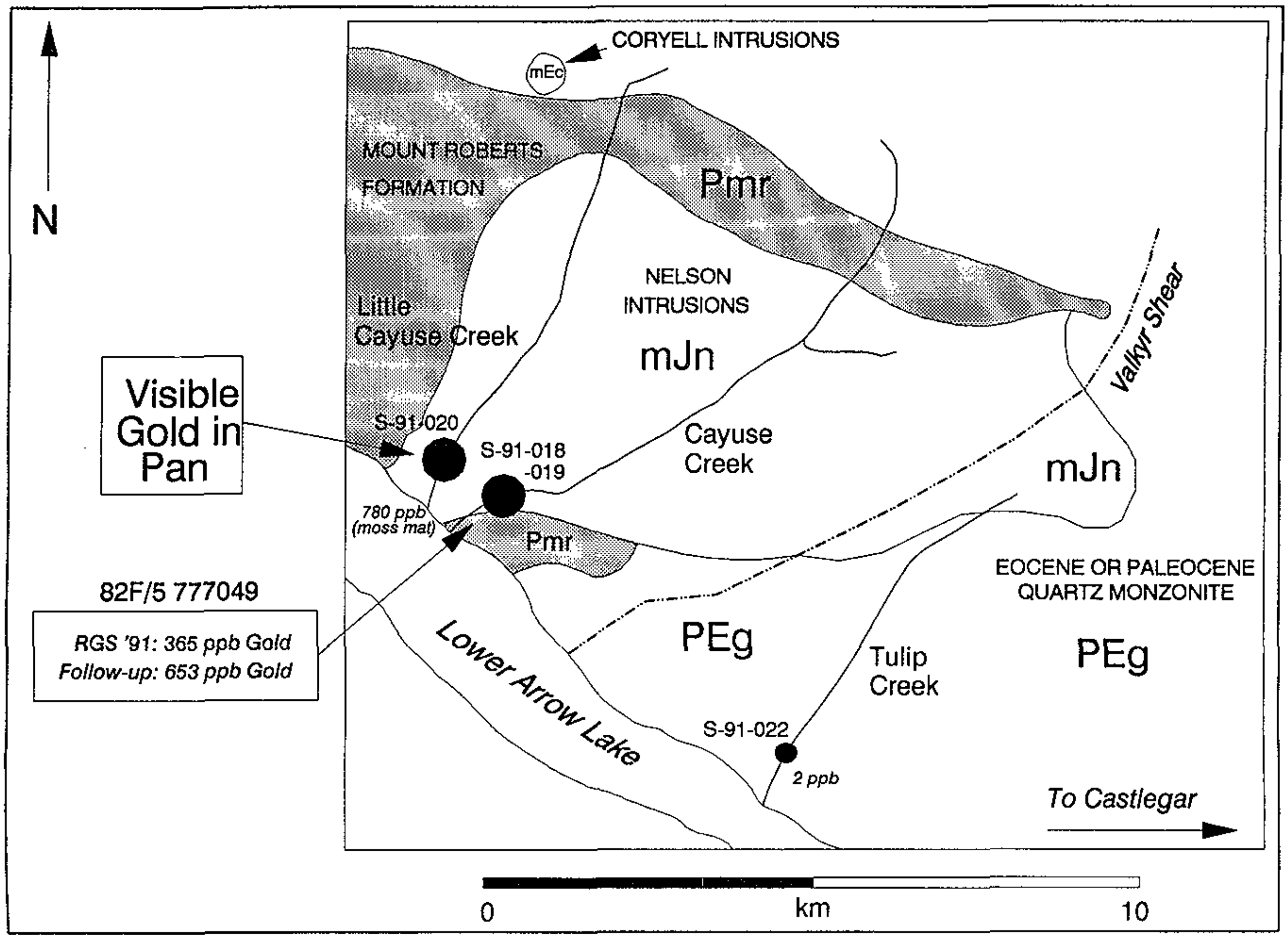


Figure B-1-9. Generalized geology and follow-up sample locations in the Deer Park belt, Castlegar area, showing gold concentrations (lead fire assay) of the -180 micron fraction of selected stream and moss-mat sediments. Complete listings of gold concentrations are given in Table B-1-2, (geology after Andrew *et al.*, 1991; Little, 1957, 1960).

reported to occur 2 kilometres north of Lardeau in siliceous limestone and mica schist (Goldsmith, 1984).

Resampling confirmed the 1991 RGS gold anomaly on Davis Creek in moss-mat sediment, but not in stream sediment (Table B-1-1). Anomalous cobalt [>95th percentile for Lower Paleozoic sedimentary rocks (lPs)] was encountered in moss-mat sediments, but no anomalous concentrations of any additional elements were detected. The irreproducibility of the RGS gold anomaly in stream sediment is attributed to its coarse grain size.

The source of anomalous gold in Davis Creek is not known. However, gold-quartz veins in the Lardeau Group are often associated with bands of chlorite schist (Walker *et al.*, 1929), and chlorite schist of the Jowett Formation is exposed in a Davis Creek tributary a few kilometres upstream from the sample site.

CONCLUSIONS

- RGS gold anomalies at each of the three sites are verified by follow-up sampling. Although gold concentrations in field duplicate and analytical duplicate samples are erratic, they are neverthless repeatable in stream sediments from two of three sites (Penticton and Castlegar), and in moss-mat sediments from all three sites. Moss-mat sediments, where available, provide greater reproducibility than stream sediments in spite of the large stream-sediment sample size collected.
- New and relatively unexplored areas of high gold potential are outlined, showing the effectiveness of the Regional Geochemical Survey program in delineating such areas. Results of the follow-up survey were released at the Cordilleran Roundup, Vancouver, in late January, 1992. Gold anomalies at the Castlegar site attracted considerable interest from the exploration community, and by late May more than 170 claim units had been staked in the Deer Park belt. No staking was recorded at the Penticton or Lardeau sites as of late May, however, and these areas remain open.

- There are many more RGS sites in southeastern British Columbia with anomalous gold concentrations (87 sites with at least 100 ppb) which warrant exploration.

FUTURE RESEARCH

The three follow-up areas were selected largely on the basis of simple, although effective, data ranking. However as stream-sediment geochemistry reflects, to a large degree, the dominant lithologies of the watershed, natural background metal variations of different geological units must be taken into account in order to distinguish more subtle stream-sediment anomalies. Application of more sophisticated methods of anomaly definition to the stream sediment database in southeastern British Columbia is currently in progress.

ACKNOWLEDGMENTS

The authors wish to thank Rick Meyers and Trygve Höy for providing information related to gold deposits of the Penticton and Castlegar areas.

REFERENCES

Andrew, K.P.E., Höy, T. and Simony, P. (1991): Geology of the Trail Map Area, Southeastern British Columbia; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Open File 1991-16.

Beaudoin, G. (1991): The Silver-Lead-Zinc Veins of the Kokanee Range, British Columbia; unpublished Ph.D. thesis, *University of Ottawa*, 168 pages.

Church, B.N. (1982): The Riddle Creek Uranium-Thorium Prospect (82E/12W); *in* Geological Fieldwork 1981, *B.C. Ministry of Energy, Mines and Petroleum Resources*, Paper 1982-1, pages 17-22.

Fletcher, W.K. (1990): Dispersion and Behaviour of Gold in Stream Sediments; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Open File 1990-28, 28 pages.

Fyles, J.T. (1964): Geology of the Duncan Lake Area, Lardeau District, British Columbia; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Bulletin 49, 87 pages.

Fyles, J.T. (1984): Geological Setting of the Rossland Mining Camp; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Bulletin 74, 61 pages.

Goldsmith, L.B. (1984): Geology, Rock and Soil Geochemistry - Deserter Mineral Claim, Slocan Mining Division, Lardeau, B.C. NTS 82K/2W; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Assessment Report 13226, 9 pages.

Gravel, J.L. and Matysek, P.F. (1989): 1988 Regional Geochemical Survey, Northern Vancouver Island and Adjacent Mainland (92E, 92K, 92L, 102I); *in* Geological Fieldwork 1988, *B.C. Ministry of Energy, Mines and Petroleum Resources*, Paper 1989-1, pages 585-591.

Jackaman, W., Matysek, P.F. and Cook, S.J. (1992): The Regional Geochemical Survey Program: Summary of Activities; *in* Geological Fieldwork 1991, Grant, B. and Newell, J.M., Editors, *B.C. Ministry of Energy, Mines and Petroleum Resources*, Paper 1992-1.

Little, H.W. (1957): Kettle River, East Half, British Columbia; *Geological Survey of Canada*, Map 6-1957.

Little, H.W. (1960): Nelson Map-area, West Half, British Columbia (82F W 1/2); *Geological Survey of Canada*, Memoir 308, 205 pages.

Little, H.W. (1961): Kettle River, West Half, British Columbia; *Geological Survey of Canada*, Map 15-1961.

Meyers, R.E. (1988): Preliminary Economic Geology of the Vault Gold Deposit; *in* Exploration in British Columbia 1988, *B.C. Ministry of Energy, Mines and Petroleum Resources*, pages B5-B13.

Morrison, M. (1990): Reverse Circulation Percussion Drilling Assessment Report on the Vent Property, Summerland Area, Osoyoos Mining Division; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Assessment Report 19712, 25 pages.

Okulitch, A.V. and Woodsworth, G.J. (1977): Geology of the Kootenay River Map Sheet; *Geological Survey of Canada*, Open File 481.

Reesor, J.E. (1973): Geology of the Lardeau Map-area, East-Half, British Columbia; *Geological Survey of Canada*, Memoir 369, 129 pages.

Tempelman-Kluit, D. (1989): Geological Map with Mineral Occurrences, Fossil Localities, Radiometric Ages and Gravity Field for Penticton Map Area (NTS 82E), Southern British Columbia; *Geological Survey of Canada*, Open File 1969.

Walker, J.F., Bancroft, M.F. and Gunning, H.C. (1929): Lardeau Map-area, British Columbia; *Geological Survey of Canada*, Memoir 161, 142 pages.

CLUBINE

(Fig. B1, No. 2)

By Kathryn P.E. Dunne,
Trygve Höy and Alex Fraser

LOCATION:	Lat. 49°13'40"-49°15'10" Long. 117°13'40"-117°17'40" (82F/3W) NELSON MINING DIVISION. Approximately 5 kilometres north of Salmo. The area of current exploration lies on the northeast ridge of Keystone Mountain bounded to the south by Key Creek and to the north by Boulder Mill Creek.
CLAIMS:	STEWART #11, MAGGIE, JOCK 1, JOCK 2, JOCK 3, BOULDER 1.
ACCESS:	From Salmo by paved Salmo-Ymir Highway 6 (4 km north), Boulder Mill Creek four-wheel-drive road (1 km northwest), and Key Creek switchback road (2 km west).
OWNERS:	E. Denny, J. Denny, K. Murray.
OPERATOR:	YELLOWJACK RESOURCES LTD.
COMMODITIES:	Lead, silver, zinc, gold.

GEOLOGY AND EXPLORATION OF THE CLUBINE SHOWING, ROSSLAND GROUP, SALMO AREA

INTRODUCTION

Mineralization on the Clubine property includes a number of silver-lead-zinc-(gold) zones in argillite and mafic volcanic rocks near the contact of Lower Jurassic Hall and Elise formations. These zones are exposed in a number of new trenches at the Maggie zone on the northeast ridge of Keystone Mountain and at the past-producing Clubine-Comstock mine about 1 kilometre west of the confluence of Key and Boulder Mill creeks (Figure B-2-1).

EXPLORATION HISTORY

Between 1926 and 1942, work on the Clubine property by Clubine Comstock Gold Mines Ltd. concentrated on the Clubine-Comstock occurrence (MINFILE 082FSW200), a northwest-trending gold-silver-lead-zinc-bearing quartz vein system on Key Creek, 4 kilometres north of Salmo (Figure B-2-1; B.C. Report of the Minister of Mines 1934, page E14). The Clubine-Comstock workings cover five levels; quartz veins in the uppermost level have elevated lead-zinc values whereas the lower levels have higher gold values. Total production from the mine was 3616 tonnes of ore from which 123 293 grams of gold, 239 463 grams of silver and 818 kilograms of zinc were recovered (MINFILE).

During this time other precious and base metal quartz vein deposits in the vicinity of Keystone Mountain (Figure B-2-1) were also in production. These included the Second Chance (MINFILE 082FSW201), Keystone (MINFILE 082FSW202), Gold Hill (MINFILE 082FSW204) and Arlington (MINFILE 082FSW205). The Arlington deposit produced 69 823 tonnes of ore with a recovery of 1 700 339 grams of gold, 4 334 578 grams of silver, 520 420 kilograms of lead and 456 920 kilograms of zinc.

In 1989, diamond drilling by YellowJack Resources Ltd. intersected gold-bearing quartz veins and silicified zones beneath the No. 5 level of the Clubine-Comstock mine (Cooke, 1990; Figure B-2- 2). The Maggie zone, an area of anomalous silver, lead, zinc and copper was discovered in 1990 by YellowJack Resources Ltd. during the course of geophysical and soil geochemical work over the whole Clubine property. Trenching on this zone uncovered significant lead-zinc and silver-bearing quartz-carbonate veins (Figure B-2-2).

REGIONAL SETTING

The Clubine property lies on the eastern limb of the Hall Creek syncline just north of Salmo (Figure B-2-1). The Hall Creek syncline is a tight south-plunging fold that can be traced from north of Hall Creek, in the Nelson area, to Salmo. Near Salmo, it is cut by the Erie Creek fault, a mid-Eocene east-side-down normal fault, but is exposed south of Salmo as an overturned, east-dipping syncline called the Hellroaring Creek syncline (Figure B-2-1). Both Hall and Hellroaring Creek synclines are the earliest structures in the Salmo area. They are along the eastern margin of Quesnellia near its tectonic contact with the Kootenay Terrane.

Compressive deformation in the Hall and Hellroaring Creek synclines has produced slaty cleavage in clastic rocks and a penetrative foliation in volcanic rocks that is parallel to the axial plane of the early folds. A number of faults or shear zones in the volcanic rocks parallel the margins of the synclines (Andrew and Höy, 1991).

East and northeast-dipping normal faults, such as the Erie Creek fault, are the youngest structures in the Club-

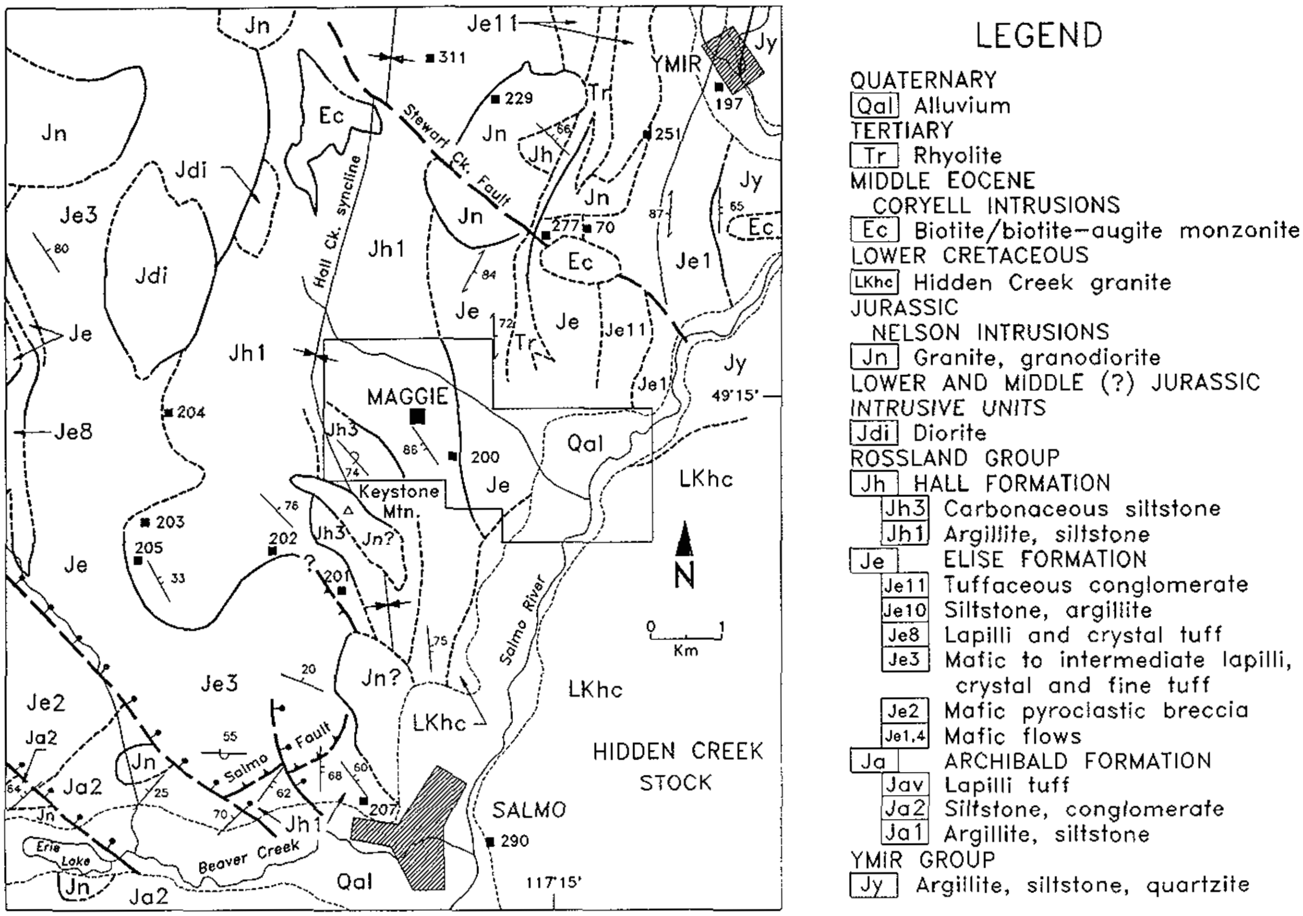


Figure B-2-1. Geology of the Erie Lake area after Höy and Andrew, 1989; 1990; Little, 1960, 1965; Mulligan, 1951, 1952; Fitzpatrick, 1985.

ine area. They may be related to a mid-Eocene extensional event in southeastern British Columbia.

REGIONAL STRATIGRAPHY

The Rossland Group comprises mafic to intermediate flow, pyroclastic, tuffite and epiclastic deposits of the Elise Formation and argillite, siltstone and carbonaceous siltstone of the Hall Formation. The group is Lower Jurassic, bracketed by Sinemurian ammonites in the basal Archibald Formation and early Toarcian ammonites in the Hall Formation (Frebold and Tipper, 1970). The Rossland Group is intruded by Middle Jurassic Nelson intrusions, Lower Cretaceous granitic intrusions such as the Hidden Creek stock (J. Einarsen, personal communication, 1990) and by several Middle Eocene syenite stocks and abundant mafic and felsic dikes (Figure B-2-2).

Elise Formation rocks in the Clubine area correlate well with the Erie-Stewart section (Figure 1-1-3 of Andrew and Höy, 1991), the thickest exposed section of Elise rocks in the Rossland Group. They comprise dominantly mafic lapilli tuff and pyroclastic breccia with minor intermediate crystal tuff and tuffaceous conglomerate (Figure B-2-2).

The Hall Formation conformably overlies the Elise Formation on the east limb of the Hall Creek syncline in the Clubine area but is in fault contact on the west limb (Figure B-2-1; Andrew and Höy, 1991). The exposed thickness of the formation in the Clubine area is 1700 metres (Keystone section: Figure 1-1-6 of Andrew and Höy, 1991). It is divisible into a lower, rusty black siltstone and argillite succession (Jh1) and an upper carbonaceous siltstone unit (Jh3); a central coarse conglomeratic phase (Jh2), seen elsewhere in exposures of the Hall Formation, is missing. Unit Jh3 appears to be laterally discontinuous; it is only recognized in the vicinity of Keystone Mountain. The Hall Formation is interpreted to have been deposited on an irregular paleosurface in a shallow-marine structural basin at the end of a period of explosive pyroclastic volcanism (Andrew and Höy, 1991).

PROPERTY GEOLOGY

The eastern part of the Clubine property (Figure B-2-2) is underlain by mafic volcanic rocks of the Elise Formation; the western part, by the Hall Formation. The Elise Formation comprises augite porphyry flows and lapilli, crystal and fine tuffs. These are characteristically

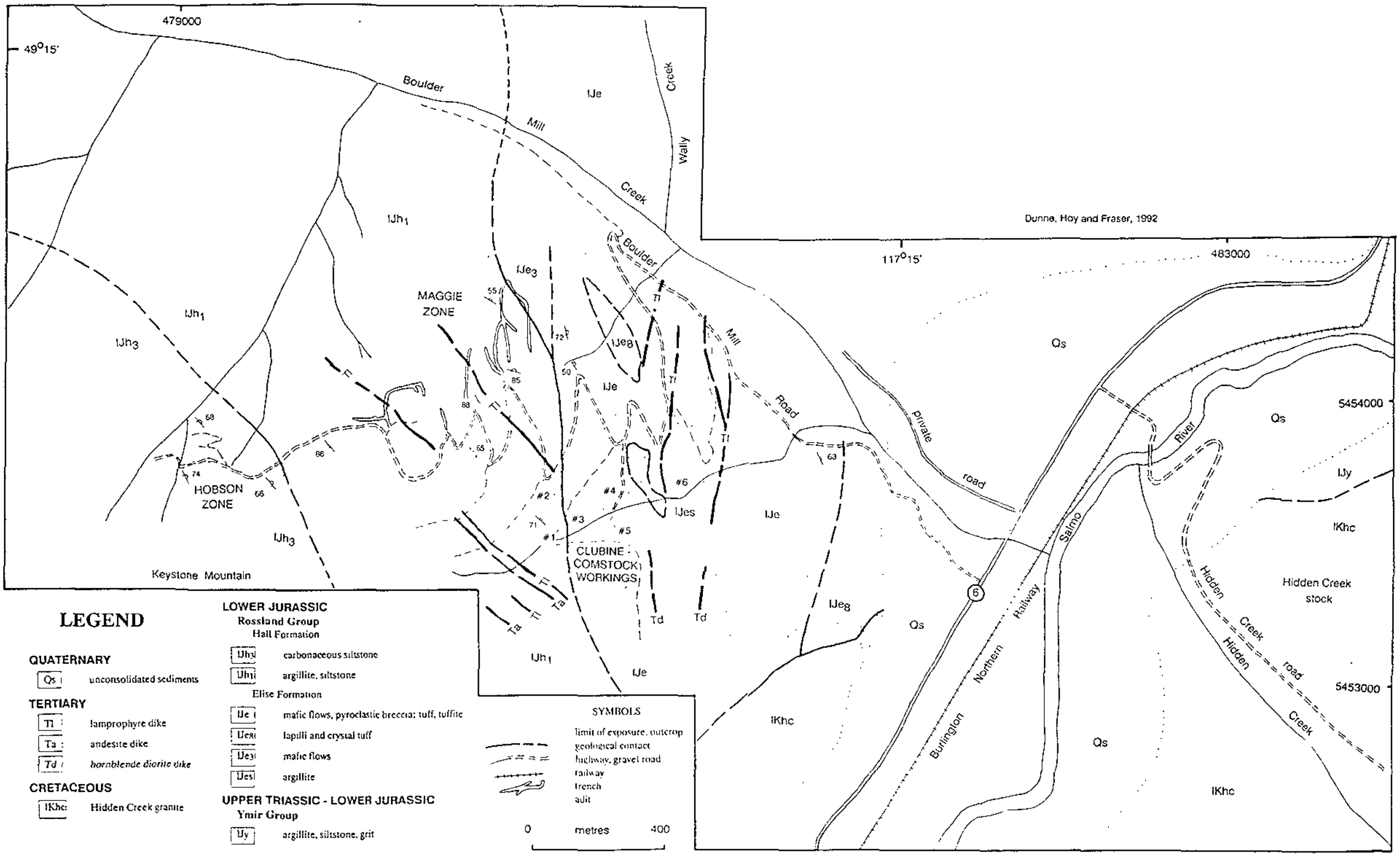


Figure B-2-2. Geology of the Clubine Prospect.

TABLE B-2-1
ANALYSES OF SELECTED SAMPLES FROM THE CLUBINE PROPERTY

Sample 1a No.	Sample Width	Au[2] ppb	Ag[3] ppm	Cu[3] ppm	Pb[3] %	Zn[3] %	Co[3] ppm	Ni[3] ppm	Mo[3] ppm	As[3] ppm	Cr[4] ppm	Ba[4] ppm	Sr[4] ppm
Club6-1	grab	9	6	21	0.23	0.26	16	30	<10	85	102	1375	99
Club6-A	0.20 m	3	7	32	0.24	0.19	49	590	<10	925	1372	177	582
Club4-V	0.20 m	14	8	137	1.47	1.93	44	7	<10	21	36	745	18
352-1	grab	21	372	8600	1.0	1.05	15	44	13	205			
352-6	grab	34	1789	154	49.0	0.38	12	3	11	1400			
352-14	grab	46	57	103	11.3	2.10	39	5	<10	107			
Club4-1	0.20 m	279	2230	3300	73	1.43	2	5	<10	95			
Club4-3	0.15 m	20	6	37	0.49	0.39	48	49	16	75	95	1125	17
Club6-2	grab	4	26	31	0.65	3.03	42	14	<10	95	47	695	254
Club6-3	grab	9	618	312	11.3	3.91	42	18	<10	23			

Sample 1b No.	Sample Width	Au[4] ppm	Ag[4] ppm	Cu[4] ppm	Pb[4] %	Zn[4] %	Co[4] ppm	Ni[4] ppm	Mo[4] ppm	As[4] ppm	Cr[4] ppm	Ba[4] ppm	Sr[4] ppm
	grab	0.03	0.5	13	0.0002	0.0	6	4	3	13	40	145	137
	grab	0.03	1.2	31	0.01	0.45	215	380	42	31	10	599	155
	grab	0.03	0.3	57	0.008	0.0	80	549	2	20	234	120	79
	grab		83.7	783	4.27	0.19	21	27	12	14516	9	85	25
	grab	0.03	13.9	86	0.49	0.09	19	23	10	77	11	91	26
	grab	0.03	17.8	399	0.39	0.13	18	41	8	12167	7	168	97
	grab	0.03	468.6	237	64.25	0.34	8	7	5	3083	2	14	31
	grab	0.03	2	19	0.41	0.0	3	5	2	38	5	30	6
	grab	0.03	8.3	96	0.58	0.30	13	26	2	80	6	48	128
	grab	0.03	21.9	99	0.72	0.46	16	41	8	39	7	48	74
	grab	0.03	211.7	2149	4.51	0.43	15	64	7	868	55	207	151
	grab	0.10	376.2	5853	55.34	0.98	1	10	1	106	2	22	29
	grab	0.13	26.1	124	1.35	0.27	8	31	9	85	19	92	19
	grab	0.03	41.1	94	0.96	0.09	2	12	11	17	5	96	6
	grab	0.13	0.7	88	0.01	0.01	13	6	2	25	6	71	58
	grab	0.03	0.9	11	0.02	0.01	2	5	3	8	4	20	14
	grab	0.03	0.4	7	0.02	0.0	2	12	3	5	9	15	5

Sample 1b No.	Sample Width	Ag[2] ppm	Pb[2] %	Zn[2] %
Tr3-#2	grab	81.4	4.27	0.19
Tr4-#3	grab	1637	54.25	0.34
Tr6-#1	grab	818.7	39.26	5.45
Tr6-#4	0.25 m	1992	55.34	0.98
Tr6-#4	2 m	447.4	16.77	0.40

1a. Analyses by Ministry of Energy, Mines and Petroleum Resources Laboratory
1b. Analyses by Acme Analytical Laboratories Ltd., reported in Cooke (1990)
2. Analyses by fire assay/induction-coupled plasma
3. Analyses by atomic absorption spectrophotometry
4. Analyses by induction coupled plasma

silica undersaturated. Unaltered primary mafic minerals are rare in the augite porphyry flows but relict blue-green amphibole (15-20%) and green biotite (10-15%) can sometimes be distinguished. The mafic minerals are variably altered to chlorite and epidote. Apatite is a common accessory mineral in the flows. Lapilli tuffs contain subrounded to subangular volcanic fragments (up to 5 cm in diameter) which vary from coarse augite porphyry to crystal and fine tuff. The crystal tuffs contain 20 to 25 per cent plagioclase (An_{55-59}) and minor (5 to 10%) albite. Most mafic minerals are variably altered to chlorite and epidote. The volcanic succession is intruded by a lensoid monzogabbro sill near the contact with the Hall Formation north of Key Creek (Figure B-2-2). A number of these monzogabbro-gabbro sills or small stocks occur throughout the exposures of the Elise Formation and are interpreted to be high-level syn-Rossland Group intrusions (Dunne and Höy, 1992).

The contact between the Hall and Elise formations is not exposed on the property. However, discordant bedding attitudes in the Elise and Hall Formations suggest either a disconformable or faulted contact. The lower Hall (Jh1) is typified by fine-bedded, fissile, slightly rusty, dark grey to black silty argillite and massive, black silty argillite. The upper part of the Hall Formation (Jh3), exposed only in the Keystone Mountain area, comprises massive fine-grained carbonaceous siltstone (Figure B-2-1). Occasional rip-up clasts and flame structures indicate facing directions or just tops; more commonly, bedding-cleavage intersections indicate that the property is on the east limb of the Hall Creek syncline.

The Clubine property is intruded by the Early Cretaceous Hidden Creek granite stock in the east (J. Einarsen, personal communication, 1990) and a granite plug south of Keystone Mountain (Figure B-2-2). The Hidden Creek stock comprises 10 to 15 per cent plagioclase (An_{60-86}), 15 to 20 per cent microperthite, 50 to 60 per cent orthoclase, 25 to 30 per cent quartz, up to 2 per cent biotite and 1 to 2 per cent opaques. The age of the Keystone Mountain granite has not been determined; it may be Early Cretaceous similar to the Hidden Creek stock or Middle Jurassic similar to the Nelson intrusive suite. Numerous small dikes, 0.5 to 2.0 metres wide, trend north to northwest across the property (Figure B-2-2). They are of various compositions including lamprophyre, hornblende diorite, quartz porphyry and massive rhyolite, and are interpreted to be Middle Eocene.

MINERALIZATION AND ALTERATION

A number of quartz and quartz-carbonate precious and base-metal vein occurrences occur in the Hall Formation in the Keystone Mountain area within 500 metres of the Elise Formation contact (Figure B-2-1). They generally trend north and include variable amounts of galena, pyrite, chalcopyrite and minor sphalerite, tetrahedrite and pyrrhotite.

The Clubine property has two principal showings; the Clubine-Comstock workings (MINFILE 082F/SW200) and the recently discovered Maggie zone. Although separated by only 600 metres along strike, the tenor and character of mineralization are slightly different.

The Clubine-Comstock, hosted mainly by the Elise Formation, has lenses of quartz and quartz-carbonate up to 0.5 metre wide with variable amounts of pyrite, chalcopyrite, galena and minor sphalerite and pyrrhotite. The lenses or veins of the main workings are commonly brecciated and parallel the footwall of a prominant biotite lamprophyre dike. Anomalous gold values (34.63 g/t over 21.6 m in level No. 2, 14.74 g/t over 8.6 m in level No. 5) occur within the vein quartz and also within broad silicified and pyritic zones (Cooke, 1990). The No. 1 level workings, in the Hall Formation 60 metres west of the main workings, have veins with lower gold but higher lead and zinc values.

The Maggie zone has 12 to 15-centimetre brecciated quartz and quartz-carbonate veins. Microscopically, the veins appear as translucent quartz and rarely carbonate crystals, crosscut by a dense network of wispy

TABLE B-2-2
CORRELATION COEFFICIENTS FOR ELEMENTS FROM THE DATA LISTED IN TABLE B-2-1

Element	Au	Ag[1]	Cu	Pb[1]	Zn	Co	Ni	Mo[1]	As
Au		**0.795**	0.238	0.555	0.279	0.114	0.138	0.233	0.085
Ag			0.278	**0.763**	0.238	0.178	0.193	0.189	0.013
Cu				0.336	0.045	0.176	0.112	0.081	0.045
Pb					0.054	0.222	0.200	0.093	0.065
Zn						0.024	0.123	**0.970**	0.094
Co							0.617	0.003	0.078
Ni								0.077	0.028
Mo									0.061
As									

1. Coefficients in bold type = 99 per cent significance r(0.01, 27)=0.732; r(0.05, 27)=0.671

microfractures defined by tiny (<2μ) fluid inclusions. These textures are commonly observed in veins formed at deep levels in the crust (>4 km). The selvages of the veins are often marked by 2 to 3 centimetres of massive 'steely' galena and/or 8 to 10 centimetres of coarse-grained, euhedral, slightly oxidized galena (90%), pale sphalerite (<3%) and trace pyrite. This zone has high silver and lead but low gold and zinc values (Table B-2-1). A distinctive yellow-green alteration envelope of mica(?) and iron carbonate(?), 5 to 10 centimetres wide, surrounds some of the veins on the Maggie zone.

Analyses of selected vein samples from the Clubine property, not including the Clubine-Comstock workings, are given in Table B-2-1; sample locations are in Figure B-2-3. A correlation matrix, calculated from these sample data, shows a strong positive correlation for gold, silver and lead (Table B-2-2; bold numbers indicate significant correlation). The correlation probably reflects dependence on the actual presence of galena and tetrahedrite. Zinc and molybdenum also reflect a positive correlation; actual concentrations for both these elements are relatively low (Table B-2-1).

Preliminary galena-lead isotope data on veins from both the Clubine-Comstock and Maggie zones are anomalous for lead isotopes in the Canadian Cordillera. They indicate a possible lower crust or upper mantle source for the lead (C.I. Godwin and A. Pickering, personal communication, 1992).

SUMMARY AND DISCUSSION

Gold-silver-lead-zinc-bearing quartz and quartz-carbonate veins on the Clubine property are hosted by mafic volcanic rocks and silty argillite near the contact between the Lower Jurassic Elise and Hall formations. The coincidental stratigraphic position of the deposits may reflect shearing near the sedimentary-volcanic contact at the brittle-ductile transition or may be an expression of disconformity of the Hall-Elise contact in the Keystone Mountain area.

Petrographic evidence indicates that the veins were deposited in a deep structural environment (>4 km) and possibly along pre-existing shears and faults. Tertiary dikes parallel and are adjacent to the mineralized veins and may have been intruded along the same planes of weakness. The age of mineralization is being dated by galena-lead isotope analyses. Preliminary galena-lead data indicate an unusual lead signature for the veins. It is probably associated with intrusion of either the Middle Jurassic Nelson intrusions or the Late Cretaceous Hidden Creek stock. However, it is possible that the veins are Tertiary in age, as they trend north and some are spatially associated with Tertiary dikes.

The variation in composition from gold bearing at the Clubine-Comstock to silver-lead bearing at the Maggie zone may reflect the different hostrocks for these two systems: Elise volcanic rocks versus Hall argillite. However, dominantly gold-bearing quartz veins have been reported elsewhere in the Hall Formation at the Keystone, Canadian King and Arlington deposits. It is possible that the Maggie veins were deposited in the same fracture system as the Clubine-Comstock but at a deeper structural levels.

ACKNOWLEDGMENTS

We appreciate regional field mapping assistance by D. Lindsay, H. Blyth and H. Karam during the 1990 season. Discussions with K. Murray and access to sampling and reports of Yellowjack Resources Ltd. are much appreciated. This report benefited from the editorial comments of J.M. Newell and B. Grant.

REFERENCES

Andrew, K.P.E. and Höy, T. (1991): Geology of the Rossland Group in the Erie Lake Area, with Emphasis of Stratigraphy and Structure of the Hall Formation, Southeastern British Columbia; *in* Geological Fieldwork 1990, *B.C. Ministry of Energy, Mines and Petroleum Resources*, Paper 1991-1, pages 9-20.

Cooke, D.L. (1990): Geological and Geochemical Report, Clubine Property, Nelson M.D.; *YellowJack Resources Ltd.*, private report, September 1990.

Dunne, K.P.E. and Höy, T. (1992): Petrology of Pre- to Syntectonic Lower and Middle Jurassic Intrusions in the Rossland Group, Southeastern British Columbia; *in* Geological Fieldwork 1991, *B.C. Ministry of Energy, Mines and Petroleum Resources*, Paper 1992-1, pages 9-19.

Frebold, H. and Tipper, H.W. (1970): Status of the Jurassic in the Canadian Cordillera of British Columbia, Alberta and Southern Yukon; *Canadian Journal of Earth Sciences*, Volume 7, pages 1-20.

Höy T. and Andrew, K.P.E. (1989): The Rossland Group, Nelson Map Area, Southeastern British Columbia; *in* Geological Fieldwork 1988, *B.C. Ministry of Energy, Mines and Petroleum Resources*, Paper 1989-1, pages 33-43.

Höy, T. and Andrew, K.P.E. (1990): Geology of the Mount Kelly - Hellroaring Creek Area, Southeastern British Columbia; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Open File 1990-8.

Little, H.W. (1960): Nelson Map-area, West Half, British Columbia; *Geological Survey of Canada*, Memoir 308, 205 pages.

Mulligan (1952): Bonnington Map-area, British Columbia; *Geological Survey of Canada*, Paper 52-13, 37 pages.

NANCY GREENE WOLLASTONITE

By A. Legun

(Fig. B1, No. 3)

LOCATION:	Lat. 49°09'30"	Long. 114°10'	(82F/4W)
	TRAIL CREEK MINING DIVISION. On a ridge on the north side of Hanna Creek just east of Highway 3A.		
CLAIMS:	ME3844		
ACCESS:	Access to the claims is by Highway 3A proceeding 12.4 kilometres north of the Rossland post office to a switchback corner. A trail and picketed lines extend from the shoulder of the road to the principal outcrop areas.		
OWNER/OPERATOR:	HORST KLASSEN.		
COMMODITY:	Wollastonite.		

INTRODUCTION TO WOLLASTONITE

The mineral wollastonite, a calcium silicate ($CaSiO_3$), is a comparative newcomer to the industrial mineral market. Large-scale production did not occur until the 1950s. It has a number of applications including semifibrous replacement for asbestos in asbestos cement, bonding agent for ceramic materials, performance filler applications in plastics, and as a metallurgical flux. It is a preferable filler for thermoplastics (such as PVC) and resins (*e.g.* epoxy) due to good electrical insulation properties, low water absorption and reinforcing crystal structure. Its important properties for quality grading are its aspect ratio (ratio of length to width in fibres), brightness, whiteness and purity.

Wollastonite is a new mineral target for prospectors. Its geologic setting is generally constrained to contact zones of intrusions with lime-rich country rock (skarns). Appropriate sites for prospecting can be ascertained by culling the existing geologic literature. Fischl provides a recent compilation (1991). As with any deposit, tonnage is an important factor. Most mineable deposits worldwide contain at least 500 kilotonnes of reserves with a grade of at least 30 per cent wollastonite. In the Rossland area a local market for large volumes (>1 million tonnes) of wollastonite rock may exist in the Trail smelter where it might be used as a flux. High aspect ratio wollastonite however commands a much higher price, particularly after surface chemical treatment (Power 1986).

INTRODUCTION TO PROPERTY

In 1989 Horst Klassen staked a wollastonite occurrence off Highway 3A, 12.4 kilometers north of the Rossland, British Columbia post office. The property, known as ME3844, consists of 16 claims on the eastern boundary of Nancy Greene Recreation Area. The principal outcrop area, consisting of white ridges of wollastonite-rich rock, lies immediately east (100 m) of a switchback corner on Highway 3A. A number of shallow pits have been excavated on the property as well as one vertical shaft (5 m deep) and a decline (10 m long at L110 0+96 north). These workings apparently explored pyrrhotite-bearing quartzitic skarns (for gold?) and ignored the adjacent wollastonite.

The property was visited and mapped over a few days in the summer of 1991. A short walking trail from the highway provides access to a picketed grid. The baseline is oriented 240°. Crosslines are spaced at 10-metre intervals. They are 200 metres long in the eastern half of the grid but are much shorter where the baseline approaches the highway. A skid trail skirts the eastern edge of the grid.

REGIONAL GEOLOGY

The property is located on the east contact of the Coryell batholith, a large body of monzonitic and syenitic rocks of Eocene age. The batholith is bordered extensively on the north by the Carboniferous Mount Roberts Formation. This formation comprises siltstone, argillaceous quartzite and limestone, with lesser chert, greenstone and tuff (Little, 1982). Stocks and plugs of the Jurassic-Cretaceous Nelson Plutonic Suite, largely granodioritic in composition, also intrude the Mount Roberts Formation in the area. The Mount Roberts Formation is variably affected by both regional and contact metamorphism.

LOCAL GEOLOGIC SETTING

Wollastonite on the property is hosted by a carbonate-rich sequence of the Pennsylvanian to Permian Mount Roberts Formation. On the property the formation is represented, east to west, by a band of clastic metasediments, a marble unit and a wollastonite zone. According to Simony (1979) the stratigraphy may be overturned. The wollastonite zone is separated from roadside exposures of intrusive monzonite by an area of drift.

The general area of known wollastonite skarn comprises about 0.85 hectare. Principal exposures of wollastonite occur in a series of white outcrop ridges trending north to north-northwest. In addition there are subcrop

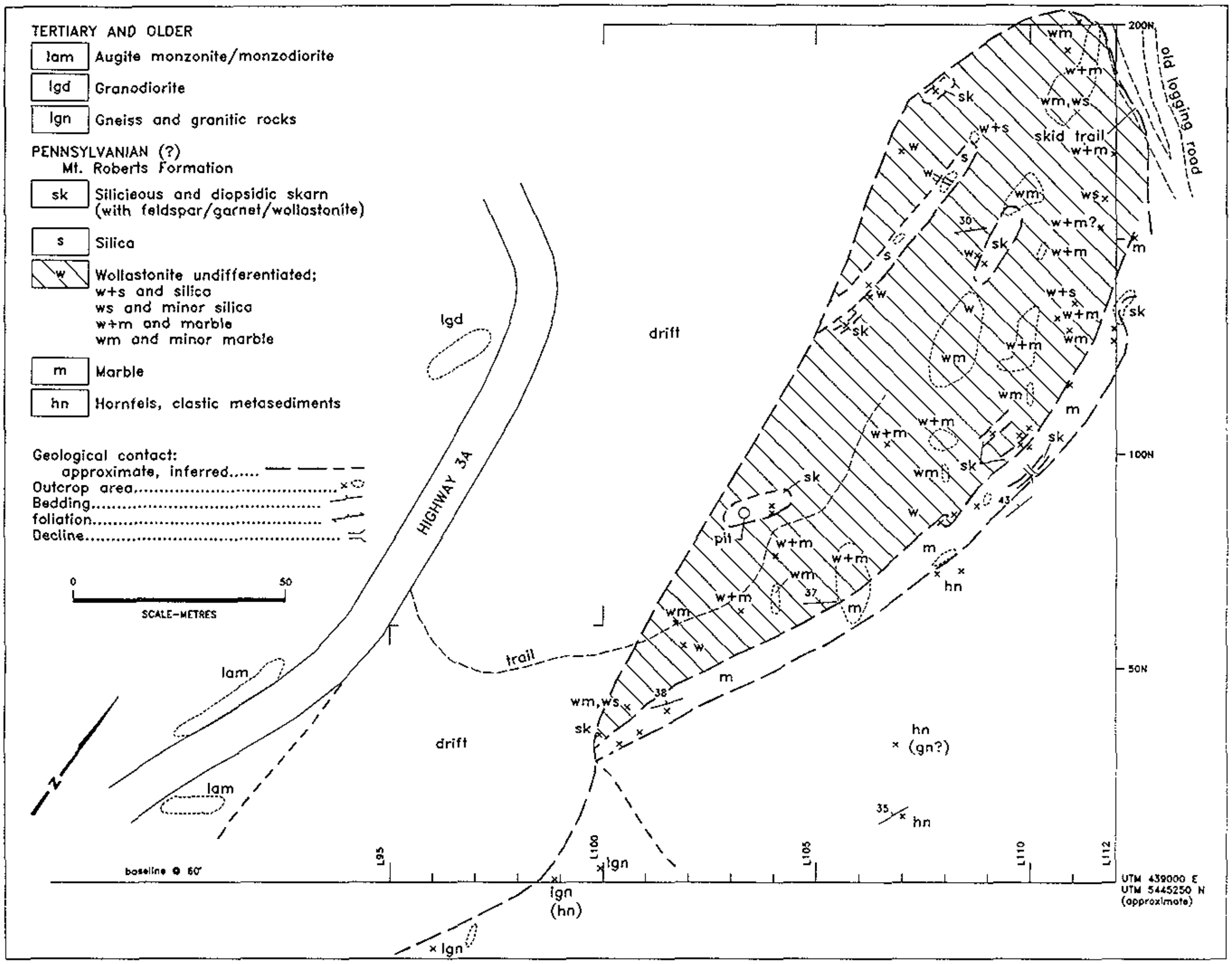


Figure B-3-1.

exposures of wollastonite-bearing rock revealed by probing a hammer through mossy mounds. All outcrops are shown in Figure B-3-1.

The wollastonite zone is up to 60 metres wide in the north. It is open in that direction but the bedrock slopes under overburden and no outcrop is exposed in cuts along the peripheral skid trail. To the south, drift cover progressively overlaps the zone. At the south end only the marble and a few metres of wollastonite, structurally above, are exposed. Monzonite crops out on the other side of the drift area, roughly along strike with the marble and the wollastonite zone. The monzonite-skarn contact must lie under the drift and is probably subparallel to the northerly trend of the drift (*see* Figure B-3-1).

DESCRIPTION OF UNITS

Granitic Intrusions

The intrusive rocks exposed in the area of the property are variable.

Pyroxene monzonite outcrops on both sides of the road at line 91. It consists of an inhomogeneous, interlocking aggregate of plagioclase feldspar (mostly calcic albite), augite, biotite, a few per cent quartz and minor amphibole. To the east biotite granodiorite is exposed on the road, characterized by abundant quartz, albite and biotite. Quartz-rich, micaceous gneisses and granitic rocks outcrop between lines 100 and 97 (*e.g.* L100 0+25 North, L97 0+10 South).

Little mapped the intrusive rocks on the highway as part of the Eocene Coryell batholith.

The Wollastonite Zone

The wollastonite-bearing zone consists of whitish outcrops of wollastonite, wollastonite and marble, and wollastonite and quartz.

In the wollastonite-bearing rock, wollastonite with varying proportions of calcite (marble) is the dominant phase and wollastonite with silica is subordinate, as is wollastonite with both calcite and silica. The dominant mineral phase is indicated on the map. Designation of the dominant phase is uncertain where outcrops are small.

The wollastonite is sometimes crudely interbanded with marble, with fan aggregates of wollastonite crystals normal to possible remnant bedding. Coarse, bladed masses of wollastonite are up to 10 centimetres long and often encrusted with coarse calcite. In several cases blocky wollastonite subcrop suggests calcite veins may have weathered out.

Hand specimens show coarse, tabular, subparallel to subradial, pearly white wollastonite, weathering light tan to light brown, with minor secondary calcite. Thin sections display coarse tabular prisms of wollastonite cut by thin irregular calcite veins, with traces of clinopyroxene as high relief, moderately high birefringent grains and blebs. In general, impurities such as garnet and diopside appear to be restricted to specific skarn units in the wollastonite zone.

SKARNS (Sk)

Greenish quartz-rich skarns carrying pyrrhotite are the most common type of wollastonite-deficient skarn. These rocks often display remnant chert laminations. They are mottled due to calcsilicate reaction fronts. The mineral assemblage includes diopside, feldspar, secondary brown biotite and quartz, chlorite, and actinolite (?).

Diopsidic gneiss is a foliated rock showing schlieren and augen-like aggregates of quartz, feldspar and diopside. Chlorite pseudomorphs after garnet are apparent.

Garnetite is an uncommon massive rock consisting of intergrowths of blastic red garnet and white feldspar. It was observed in outcrop with diopsidic gneiss.

Banded skarns consist of crystalline mineral bands, alternately rich in diopside-hedenbergite, feldspar, wollastonite, quartz, and garnet.

SILICIOUS ZONES (S)

Chert breccia consisting of laminated chert fragments cut by veinlets of quartz and sericite outcrops rarely in the wollastonite zone and is not traceable. Elsewhere minor quartz veining is found associated with the wollastonite or the wollastonite is intergrown with quartz.

A massive quartzite unit several metres thick is traceable in subcrop 40 to 50 metres from the marble unit (L107 0 + 150 North).

PROPORTION OF WOLLASTONITE DEFICIENT ROCK

Traceable units of wollastonite-deficient rock within the wollastonite zone include the unit of clean quartzite and skarns described above. These units appear to be semicontinous layers that are boudined, fractured and veined. They occupy a small proportion of the zone (about 7%). However as bedrock is exposed in less than a third of the zone other areas may be underlain by wollastonite-deficient rock (*e.g.* north of pit in Figure B-3-1) and the true proportion may be closer to 20 per cent.

MARBLE UNIT (M)

The marble band, which is a few metres thick, forms a low step-like ridge that can be traced for 180 metres. The marble displays remnant bedding and contains an interbed of fractured cherty quartzite. The marble band is best exposed at the decline located at L110 0+96 North. It strikes 225° at the south end of the zone and swings to about 180° in the north, dipping 35° to 40°westward. The marble unit may not be present west of Line 100.

UNITS STRUCTURALLY BELOW THE MARBLE

Structurally below the basal marble are outcrops of metasediments including quartzitic sandstone, sandstone and a brownish siltstone. Granoblastic crystalline rocks appear further west. These are quartz rich, faintly foliated gneisses with biotite. Inclusions of metasediments (cherty quartzite) were noted. Some outcrops show granitic material embaying metasediments. There appears to be a transition from dominantly hornfelsed (and granitized?) metasediments to granitic intrusive rock westward.

ORIGIN OF THE SKARN

The wollastonite appears to have formed by metamorphism of a sequence of limestone, cherty limestone, quartz arenite and argillaceous quartzite. The presence of diopside and wollastonite indicates, as a minimum, the upper hornblende hornfels facies of contact metamorphism and low confining pressures (Winkler, 1967)

According to data of Little (1982) the property area lies near the biotite-garnet metamorphic isograd for the Mount Roberts Formation. Contact metamorphic effects may have been superimposed on a (presumed) older regional metamorphism.

OPPORTUNITIES

A drill hole or two in the wider part of the zone, to intersect the marble zone at depth, would provide data on the grade and depth of the wollastonite zone. There may be some stratigraphic control of wollastonite grade. Nothing is known regarding the dip of the wollastonite skarn - intrusive contact. If the skarn is underlain by intrusive rock tonnage it is limited.

Stripping and trenching could determine the true extent of the wollastonite zone and the distribution of skarn and quartzite bands. Stripping of overburden at the north end of the zone has a good chance of uncovering additional resources.

POTENTIAL FOR OTHER WOLLASTONITE SKARNS

The Mount Roberts Formation is extensively exposed in the area. Several factors are relevant in regard to finding other wollastonite prospects:

- Appropriate lithology. Silicious limestones in the Mount Roberts Formation appear to be very suitable hosts for formation of a contact wollastonite skarn. Little (1982) mentions marbles exposed at Strawberry Pass, Mount Crowe and westward to the west border of his map area. They may be associated with wollastonite skarns, as on the claim group.

- Proximity to high-level intrusions. It seems likely that skarns occur elsewhere on the margins of the Coryell batholith. The highway conveniently follows the inside border of the intrusive, providing good access to prospective ground. Enigmatically minimal contact metamorphic effects have been reported for Coryell intrusive rocks invading limestone in the area (Fyles, 1984; Little, 1982). Fractures related to cooling and providing access to fluids or some other local control, such as embayment in the intrusive may be relevant.

- Proximity to plutons other than of the Tertiary Coryell suite. Wollastonite skarns may be found on the margins of stocks or plugs of the Jurassic-Cretaceous Nelson Plutonic Complex. Wider metamorphic aureoles have been ascribed to these intrusions (Little, 1982).

CONCLUSIONS

- There are sizeable outcrop areas on the property where wollastonite grade exceeds the 30 per cent minimum.
- The wollastonite zone is 60 metres thick in the north.
- A stratigraphic control to quality and grade is suspected. Stripping will probably reveal more structure and deformation than is presently apparent.
- Quality, areal extent and proportion of skarn and quartzite bands are the immediate factors to be considered in the evaluation of this prospect.
- The potential for other contact metamorphic wollastonite deposits in the area is high. A significant cumulative tonnage from several pits is quite possible.
- Much more mineralogic work is needed on the deposit, together with description of wollastonite crystal fabric. The deposit provides a good opportunity to study the petrogensis of wollastonite skarn.

REFERENCES

Fischl, P. (1991): Wollastonite and Tremolite Occurrences in British Columbia; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Open File 1991-17.

Fyles, J.T. (1984): Geological Setting of the Rossland Mining Camp; *B.C. Ministry of Energy Mines and Petroleum Resources*, Bulletin 74.

Little, H.W. (1982): Geology of the Rossland-Trail Map-area, British Columbia; *Geological Survey of Canada*, Paper 79-26 and accompanying Map 1504A, Little, H.W. and Thorpe, R.I. (1982).

Power, T. (1986): Wollastonite - Performance Filler Potential; *Industrial Minerals Magazine*, January 1986, pages 19-34.

Simony, P.S. (1979): Pre-Carboniferous Basement near Trail, British Columbia; *Canadian Journal of Earth Sciences*, Volume 16, No. 1, pages 1-11.

Winkler, H.G.F. (1967): Petrogenesis of Metamorphic Rocks; *Springer Verlag*, 237 pages.

MARYSVILLE

(Fig. B1, No. 4)

By Kirk D. Hancock and George J. Simandl

LOCATION:	Lat. 49°36′00″ Long. 115°58′15″ (82G 12/W) FORT STEELE MINING DIVISION. Five kilometres due south of the Marysville subdivision of Kimberley.
CLAIMS:	ATOM, NEUTRON, PROTON, ELECTRON, RADIO, WAVE, HINGS, PACK, SCREEN, ION, CHOKE, RECEIVER, ANTENNA, PENTODE, PLUG, COIL, AUDION and JACK Crown grants.
MINFILE NO.:	082GNW005.
ACCESS:	Access is by all-weather St. Mary River forestry road. At approximately the 8.5 kilometre mark, a narrow, four-wheel-drive road branches south and parallels a low ridge. The showings and workings are on the middle reaches of the ridge.
OWNER:	COMINCO LTD.
COMMODITY:	Magnesite.

GEOLOGY OF THE MARYSVILLE MAGNESITE DEPOSIT, SOUTHEASTERN BRITISH COLUMBIA

The Marysville magnesite deposit is located 5 kilometres south of the Marysville subdivision of Kimberley and 16 kilometres northwest of the town of Cranbrook (Figure B-4-1). The deposit is on the south side of the St. Mary River on the eastern slopes of a low ridge. The showings and workings are on the middle reaches of the ridge. The area was selectively logged about twenty years ago so timber cover is modest with light underbrush. The maximum relief is 600 metres with moderate slopes and a few steep cliffs.

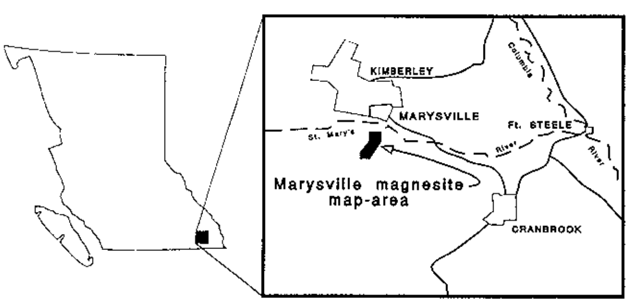


Figure B-4-1. Location of the Marysville magnesite deposit.

HISTORY

Magnesite was first reported in the Marysville area by Cairnes (1932). The showings were staked shortly thereafter and acquired by The Consolidated Mining and Smelting Company of Canada, Limited (now Cominco Ltd). The company has since held the Crown grants that cover all the known showings. The initial exploration done was trenching, test pitting, underground testing, diamond drilling and geological mapping between 1938 and 1941. This work included the mining of a 2700-tonne bulk sample. In 1959, Harbour National Resources did further surface exploration and drilled a few holes south of Lisbon Creek. In 1961 Cominco Ltd. did further surface work and the property has since remained idle (McCammon, 1965). Most of the workings are overgrown but a few trenches and one adit were found during this investigation.

REGIONAL GEOLOGY

The Marysville area is at the eastern edge of the Omineca tectonostratigraphic belt and is underlain by the Proterozoic Purcell (Beltian) Supergroup and Cambrian strata. The Beltian rocks may have been deposited in a marine basin at the margin of the North American craton. Alternatively, Höy (1989) and others have suggested Purcell rocks were deposited in a nonmarine intracratonic basin. The Paleozoic strata are of miogeoclinal affinity (Price, 1964, 1981). The Purcell Supergroup is a thick accumulation of fine to medium-grained clastic and some carbonate material. Reactivation of basement structures created significant thickness variations in late Proterozoic and Paleozoic rocks. Cambrian strata rest unconformably on the Purcell Supergroup and consist of shallow-marine clastics and carbonates deposited on a transgressive, miogeoclinal continental margin (Price, *ibid.*).

The regional stratigraphy is described from oldest to youngest (Figure B-4-2) using the nomenclature of McMechan (1980) and McMechan *et al.* (1980). Use of the term Siyeh Formation, as defined by Schofield (1915), has been discontinued in this map area. Instead the Van Creek through Gateway formation names are used here.

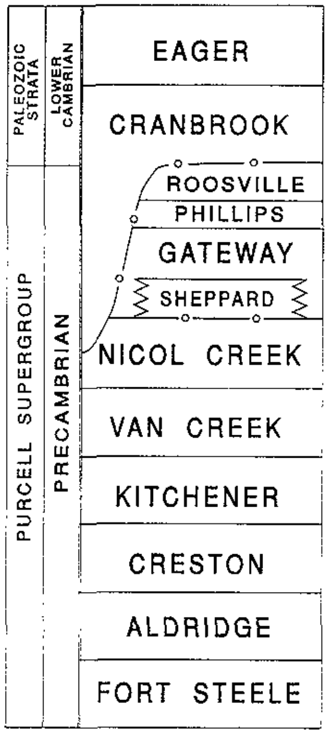


Figure B-4-2. Regional stratigraphic column of the Purcell Supergroup and Lower Paleozoic strata (modified from Höy, in preparation).

The lower Purcell Supergroup is composed of fluvial sediments of the Fort Steele Formation and turbidites of the Aldridge Formation. The upper Purcell rocks are comprised of generally shallow-water sediments, subaerial sediments and minor volcanic rocks.

The Creston Formation rests conformably on the Alldridge Formation. It is composed of fluvial, braided channel and alluvian-fan material. The upper Creston Formation records a marine transgression when argillites and siltstone were deposited.

The Kitchener Formation consists of 2000 metres of silty dolomite, dolomitic argillite, grey limestone and quartz sandstone (Höy and Daikow, 1981; Rice, 1937; Schofield, 1915). It rests conformably on the Creston Formation. Mud cracks, ripple marks, algal traces, oolites, scour marks, rip-up clasts and syneresis cracks are present within the calcareous units (Höy, 1983). This is the first appearance of carbonate in the Purcell Supergroup. It indicates deposition on a shallow-water shoal with periodic subaerial exposure. It also indicates that there was a reduction of clastic sedimentation in the basin (Höy, in preparation).

The Van Creek Formation consists of purple and olive-green interbedded siltstone and shale. Mud cracks and ripple marks are preserved (Rice, 1937). The unit is up to 30 metres thick in the area (Höy, 1985).

The Nicol Creek Formation is also known informally as the Purcell lavas. This is a sequence of purple and green amygdaloidal and vesicular basalt flows interlayered with purple and green tuffs, volcanic breccia and purple volcaniclastic sediments (Höy and Daikow, 1981). The unit ranges from 3 to 420 metres in thickness (Höy, 1985). This distintive package extends throughout most of the basin and separates the lithologically similar underlying Van Creek Formation and overlying Gateway Formation.

The Gateway Formation is a thick sequence of light green and grey, laminated to thinly bedded siltstones and fine-grained sandstones. Mud cracks, graded bedding and fining-upward sequences are uncommon but well preserved where seen. Elsewhere mud-chip breccias, ripple marks and distinctive halite prints are reported (Höy, 1983). The Gateway Formation can be up to 1300 metres thick (Höy and Daikow, 1981).

The Sheppard Formation, where present (Figure B-4-2), consists of stromatolitic dolomite, oolitic dolomite, siltstone, argillite, sandstone and quartz arenite. The formation is somewhat enigmatic in that it is not always present throughout the basin. A fluviatile conglomerate forms the base of the formation, indicating an unconformable contact with the Nicol Creek Formation. This unit has previously been included as the basal member of the Gateway Formation by Schofield (1915), Rice (1937) and Höy and Daikow (1981). Höy (in preparation) suggests that it be separated from the Gateway Formation. It is reported to be 100 to 300 metres thick in the Skookumchuk area (Höy, 1985). The stromatolitic and oolitic dolomite members occur in the upper part of the formation and where absent, due to nondeposition or erosion, render the Sheppard Formation indistinguishable from the Gateway Formation (Höy, personal communication, 1992). The Sheppard Formation was not recognized during this study. Re-evaluation of these sections has shown the Sheppard Formation is absent in the deposit area (Höy, personal communication, 1992). However, measured sections 18 and 19 by Höy (1985) describe green sandstone, siltstone and dolomitic sandstone up to 36 metres thick, assigned to the Sheppard Formation.

The Phillips Formation is in gradational contact with the Gateway Formation. It grades upward into thin-bedded maroon and red argillite, siltstone and sandstone. Mud-chip breccias, ripple marks, crosslaminations and graded bedding are reported. The formation is up to 155 metres thick. (Schofield, 1915; Höy and Daikow, 1981; Höy, 1985)

The Roosville Formation rests conformably on the Phillps Formation. It is a thick sequence of green, siliceous argillites with abundant mudcracks. It has been measured to be 305 metres thick (Schofield, 1915) but is somewhat thinner in the Cranbrook area.

A sub-Cambrian unconformity truncates the Purcell Supergroup. Typically this unconformity reaches down to the Gateway Formation but may extend into the Nicol Creek Formation (Figure B-4-2). Paleozoic clastic and carbonate sediments rest on the unconformity. In the Marysville area these sediments are represented by the Lower Cambrian Cranbrook and Eager formations.

The Cranbrook Formation is subdivided into three members, a basal conglomerate, a quartz arenite/sandstone sequence and a carbonate-rich sequence. A polymictic pebble to cobble conglomerate forms much of the base of the formation. In some locations *in situ* rip-up clast breccias are present (Rice, 1937). The clasts are angular to rounded and consist of Gateway to Van Creek formation lithologies. The quartz arenite/sandstone sequence is essentially very thickly bedded, massive, white to pink quartz arenite with some feldspathic quartz wackes. The upper carbonate-rich sequence is a progression of intercalated quartz wacke, carbonate-rich sandstone and siltstone into dolomite, argillaceous dolomite, calcareous argillite and locally, magnesite. There is a distinct lack of fossils in the Cranbrook Formation. The boundary between the Cranbrook and Eager formations is not distinctive lithologically. It is defined paleontologically by the presence of fossils in the overlying Eager Formation and the lack of fossils in the Cranbrook Formation (Höy, 1983; McCammon, 1965: Rice, 1937).

The Eager Formation is in gradational contact with the Cranbrook Formation. It is a thick package of dark to light grey or green siltstone and fine-grained sandstone. The sequence is quite monotonous, broken only by sporadic lenses and beds of calcareous sandstone and argillaceous limestone. It is typically well cleaved and sometimes appears phyllitic. Disseminated pyrite cubes, 1 to 5 millimetres in diameter, are common. The trilobite fauna *Callavia* cf. *navadensis* Walcott, *Wanneria* n.sp ?, *Mesonacis gilberti* Meek, *Wanneria* cf. *walcottanus* (Wanner), *Olenellus* cf. *fremonti* Walcott and *Prototypus senectus* Billings was identified in Eager Formation rocks near Cranbrook (Schofield, 1922). This is an upper Lower Cambrian fauna and diagnostic for the Eager Formation. The formation was measured to be 2000 metres thick by Rice (1937).

REGIONAL STRUCTURE

Several regional structural blocks comprise the Purcell Mountains. This study is within the block bounded by the St. Mary fault to the north, the Moyie fault to the southeast and the Rocky Mountain Trench fault to the east (Figure B-4-3). These and other similar faults have been active during several episodes of tectonic activity since the Proterozoic. The St. Mary fault is known to be very long lived, affecting the deposition of Precambrian Belt-Purcell rocks and continuing into the Late Cretaceous, during the early part of the Laramide orogeny (Höy and van der Heyden, 1988). Episodic reactivation of these structures is reflected by thickness and depositional environment variations within Purcell and overlying Cambrian rocks across the Purcell basin. Following deep to shallow water deposition of sediments in the St. Mary block (Höy, in preparation), uplift and erosion occurred, manifest by the sub-Cambrian unconformity. The immediately overlying Lower Cambrian strata indicate shallow-marine deposition with slow subsidence to the northeast. The net result is that the north margin of the St. Mary block was a topograph high during the Lower Cambrian. All strata are overturned, facing east as part of the eastern limb of an overturned, east vergent, regional antiform. The folding is a result of deformation associated with the early stages of the Laramide orogeny (Höy, 1984; Höy and van der Heyden, 1988).

LOCAL GEOLOGY

The Marysville magnesite deposit occurs in a fault-bounded block (Figure B-4-3). To the north is the St. Mary fault, which is a reverse fault. This fault also has 12 kilometres of apparent dextral movement (Höy, 1983). To the west is the Perry Creek fault which is a thrust fault. An unnamed normal fault forms the southeast boundary. The net result is a graben placing lower Purcell Supergroup rocks against upper Purcell and Cambrian rocks (Figure B-4-3). The stratigraphy in the immediate vicinity of the magnesite deposit includes the Kitchener, Van Creek, Nicol Creek, Gateway, Cranbrook and Eager formations (Figure B-4-4). The strata strike roughly north-northeast dip moderately to steeply west and are overturned. The Sheppard, Phillips and Roosville formations are absent in the study area due to erosion. The Kitchener Formation has been juxtaposed across the northern strike extension of all strata by a normal fault. The formations are described from oldest to youngest.

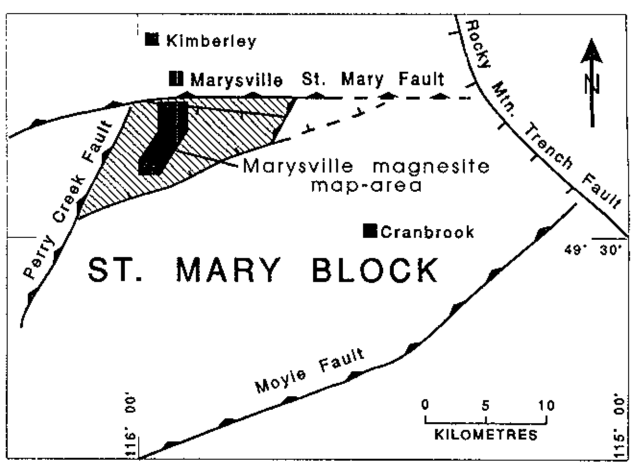


Figure B-4-3. Tectonic and structural setting of the Marysville deposit. Graben hosting the Marysville magnesite map-area is shaded (modified from Höy, in preparation).

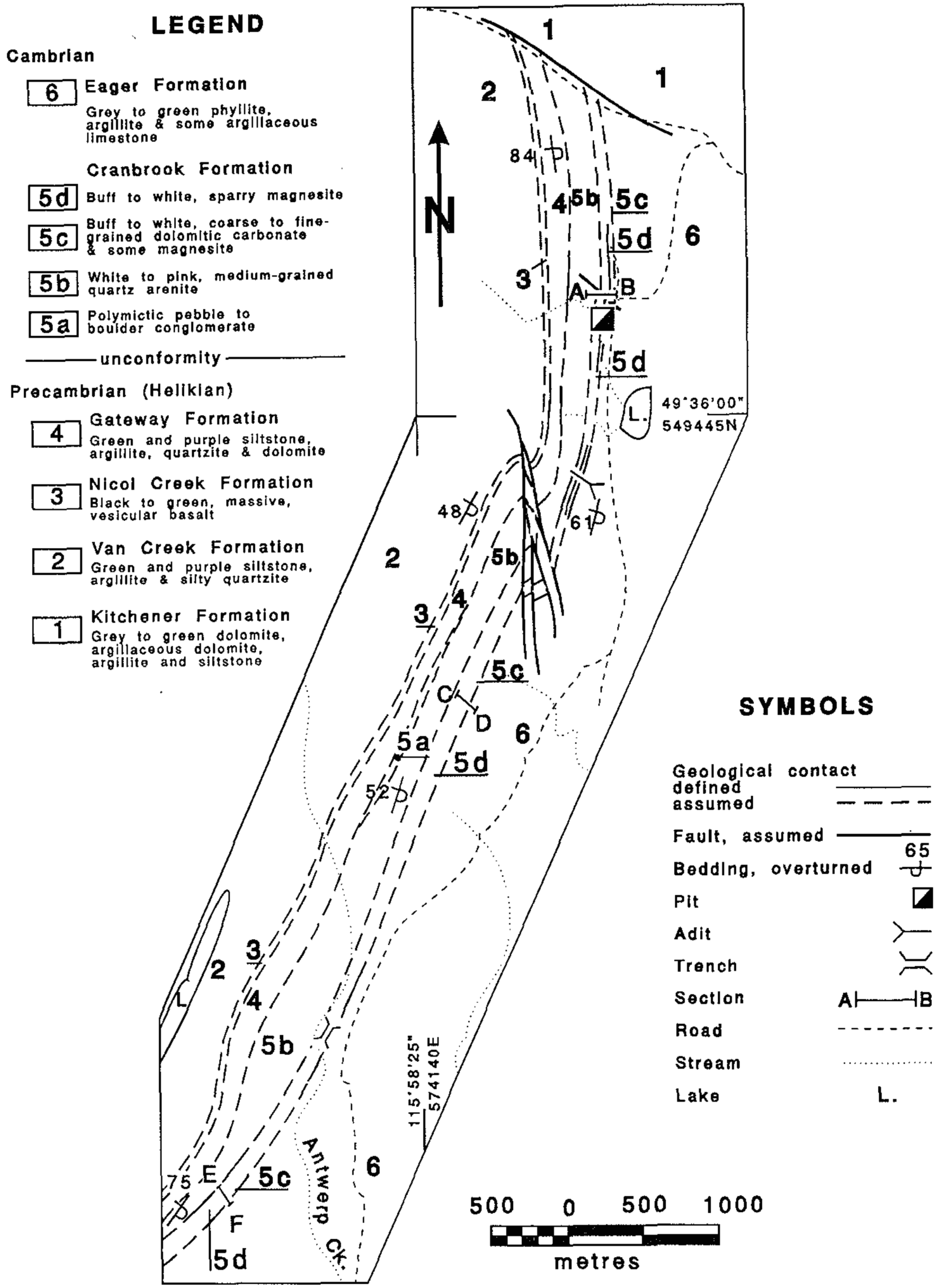


Figure B-4-4. Geology of the Marysville magnesite deposit.

The Kitchener Formation consists of grey, argillaceous dolomite and calcitic dolomite. It is thinly bedded to thickly laminated and has been deformed into minor, open "z" folds.

The Van Creek Formation comprises of medium to dark green siltstone, fine-grained sandstone and shale. It is thinly bedded to thinly laminated. Rare flute casts, syneresis cracks and some dolomitic sandstone have been reported by Höy (1985). Cleavage is moderately well developed and subparallel to bedding Only the uppermost part of the formation was examined in this study.

The Nicol Creek Formation is a thin sequence of amygdaloydal basaltic lava flows. The rocks are medium to dark green, fine grained and massive. Amygdules are 2 to 13 millimetres in diameter, usually somewhat ovoid in shape, flattened parallel to flow contacts and filled with milky quartz. Chlorite spots, usually less than 10 millimetres in diameter, are a common feature. Cleavage is poorly to moderately developed and curves around the amygdules. Mapping indicates a thickness of up to 30 metres.

The Gateway Formation is similar to the Van Creek Formation. It consists of light to dark green, beige, purple and grey siltstone, fine-grained sandstone and some shale. The strata are thinly bedded to laminated. Mud cracks and graded bedding indicate a facing direction to the east. The siltstones commonly show a slaty cleavage, subparallel to bedding, that sometimes has a phyllitic sheen on the cleavage surface.

The Cranbrook Formation rests unconformably on the underlying Gateway Formation. It is divided into three members, a basal conglomerate, a massive quartz arenite/wacke sequence and an upper carbonate sequence.The stratigraphy of the formation in the vicinity of the magnesite showings is typical of the formation as a whole (*see* Regional Geology).

McCammon (1965) reports beds 60 to 120 centimetres thick and in places 5 to 10 centimetres thick with crossbedding frequently present in the quartz arenite/wacke sequence. Near the top of the quartz arenite the sandstone rapidly becomes more impure and the wacke contains less than 2 per cent iron oxides but, when crushed, the rock appears rusty. Thin argillite interbeds are abundant. Clays, feldspar and other detritus give the rock a brownish colour.

The increase in calcite marks the gradational change to the upper carbonate member. The clastic material becomes quite fine. Fine-grained sandstone and siltstone are interbedded with limestone, argillaceous limestone, dolomite, argillaceous dolomite and magnesite. Throughout the carbonate succession, quartz grains are a common impurity. Graded bedding and crossbedding were observed in the clastic beds of the member. A distinctive lenticular bedding is common in the carbonate member. It is usually characterized by lenses of incompetent carbonate bounded by resistant argillite and sandstone. However, sometimes the carbonate exhibits more pinch-and-swell type layering. This is common adjacent to, but not restricted to, the magnesite horizons.

Magnesite units weather a buff to light tan colour and are white to light grey on fresh surfaces. The weathered surface often develops a recessive, crumbly, granola-like texture as individual grains weather out. The magnesite layers vary in thickness up to 24 metres. Massive magnesite may occur at any stratigraphic level in the carbonate sequence. More than one massive layer may be present and continuity along strike is variable. The magnesite is sparry with grain sizes ranging from 0.5 to 15 millimetres, though commonly 1 to 4 millimetres; grains are equant and euhedral. Bedding is rarely preserved in the sparry units; where found, paper thin argillic laminae or layers rich in detrital quartz are spaced 1 to 15 centimetres apart. Disseminated detrital quartz and clay are the most common impurities. The quartz is commonly 0.25 to 0.5 millimetre in diameter, well rounded and present as disseminated grains or discrete beds, making up to 10 per cent of the rock volume. Bedded quartz is usually restricted to the margins of massive magnesite layers and is most common adjacent to lenticularly bedded magnesite-quartz (sub)arkose layers. Clay occurs as thin laminae or small scattered knots forming 1 or 2 per cent of the rock. Typical chemical analyses of the magnesite-bearing rocks are presented in Table B-4-1. The top of the Cranbrook Formation is marked by a thin sequence of calcareous sandstone and siltstone.

DETAILED SECTIONS

Three detailed sections (Figure B-4-5), identified on Figure B-4-4, were measured across magnesite horizons within the Cranbrook Formation. The northernmost section is described in Table B-4-2 as it is most representative of the various lithotypes.

The Eager Formation is in gradational contact with the Cranbrook Formation and the boundary is indistinct lithologically. In the field, it was placed at the top of a fine-grained green sandstone or carbonate-rich siltstone below a thick sequence of black, grey or dark green, well-cleaved, phyllitic argillite. The lithology of the Eager Formation here is the same as described in the regional geology section. Bedding is typically very thin to laminated, especially in the argillite. The bedding-parallel cleavage in the Eager Formation is very well developed and in some places black phyllite is abundant. No trilobites or other fossils were found.

LOCAL STRUCTURE

Strata are overturned and face east in a regional overturned antiform as a result of deformation associated with the Laramide orogeny. Structural measurements

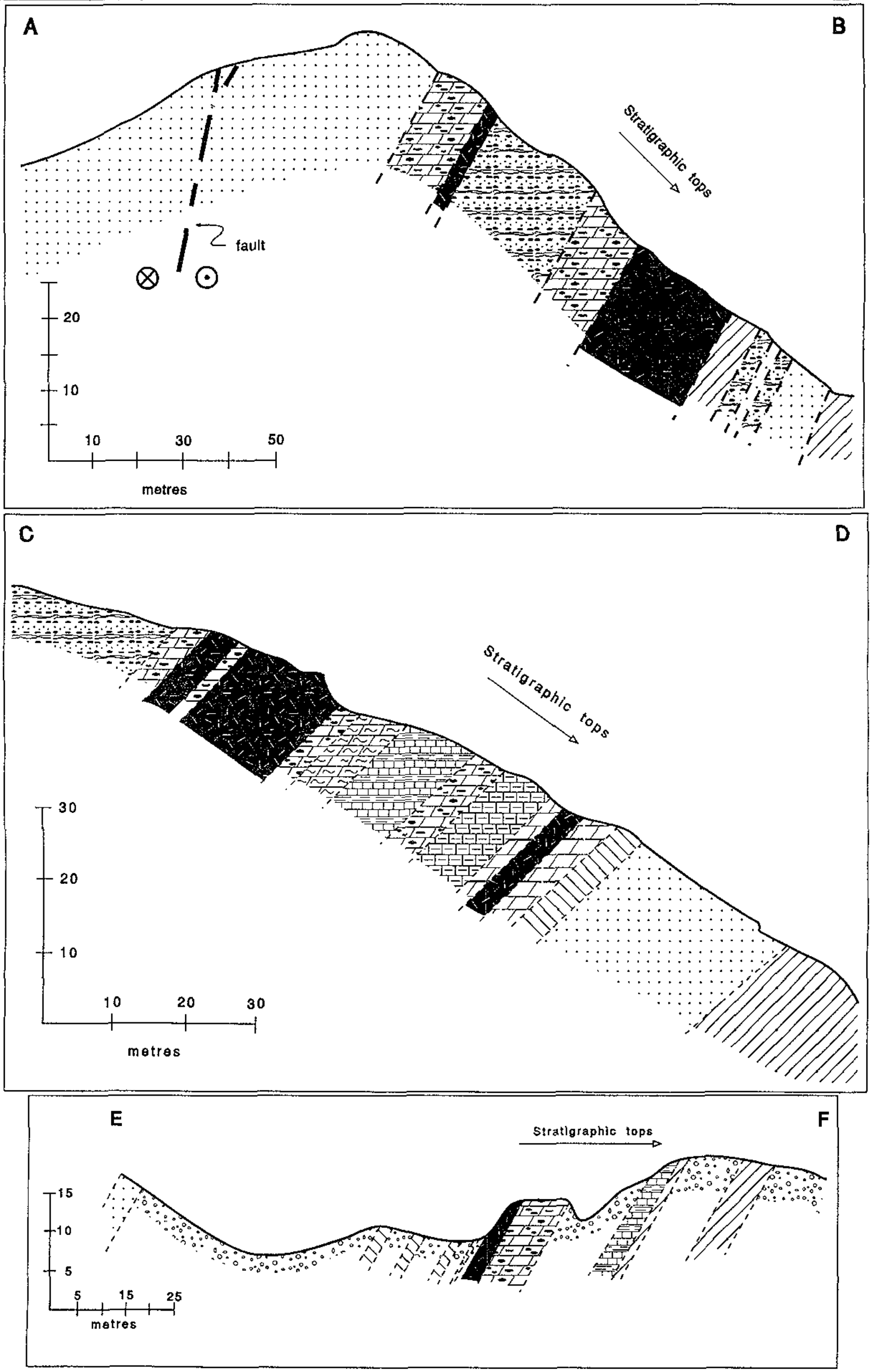
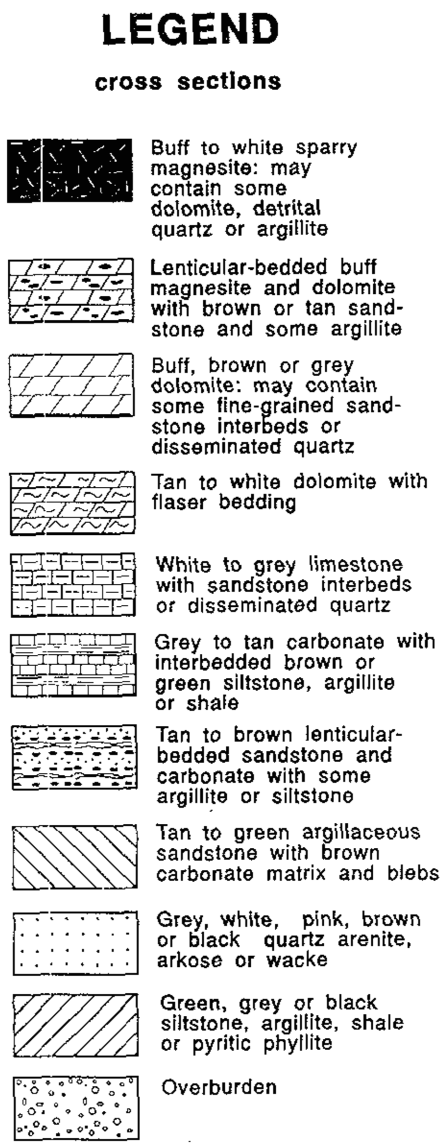


Figure B-4-5. Marysville deposit, looking north. *See* Figure B-4-4 for locations.



were divided into three domains (Figure B-4-6). For each domain bedding showed minimal variation. Average bedding attitudes for each domain are: Domain I: 008°/61°W; Domain II: 029°/48°NW and Domain III: 038°/68°NW. Bedding data from Domains II and III show significant overlap and Domain I is slightly shifted north and east. Some of the apparent variation may be due to the displacement across the fault splay in the north-central part of the map area (Figure B-4-4). The rest is most probably due to warping associated with the formation of the regional antiform. Cleavage is commonly seen in the fine-grained rocks and absent from the coarser varieties. It is parallel or subparallel to bedding and is poorly to well developed. The fault splay in the north-central part of the map area (Figure B-4-4) causes an apparent right-lateral offset of 100 metres across the whole splay. Other minor faults were identified, but their relative offsets appear to be quite small. A normal fault at the northern end of the area places Kitchener Formation rocks against younger rocks. The true displacement or relative motion on this fault has not been determined.

SUMMARY AND CONCLUSIONS

The Marysville magnesite deposit is situated within the St. Mary structural block and coincides with a Cambrian topographic high. Magnesite mineralization is stratabound and restricted to the carbonate sequence of the Cambrian Cranbrook Formation. It occurs as massive sparry layers or as lenticular interbeds in sandy, clastic material. There may be one or more massive, sparry magnesite layers in any given section of the carbonate succession. Magnesite is not restricted to any single part of the carbonate succession. Thickness of the massive magnesite layers is also variable, reaching a maximum

TABLE B-4-1
CHEMICAL COMPOSITION OF SELECTED MAGNESITE SAMPLES

SAMPLE	SiO_2 (%)	TiO_2 (%)	Al_2O_3 (%)	Fe_2O_3 (%)	MnO (%)	MgO (%)	CaO (%)	Na_2O (%)	K_2O (%)	P_2O_5 (%)	LOI (%)	TOTAL (%)
M3/8-2 *	16.49	0.04	0.67	0.80	0.01	38.24	0.64	<0.01	0.01	0.07	42.10	99.08
M5/10G-16	2.59	0.02	0.64	1.71	0.03	46.00	0.92	<0.01	0.01	<0.01	49.50	101.44
M4/2-27	1.92	0.03	0.72	0.89	0.02	46.20	1.04	<0.01	0.02	<0.01	50.06	100.92
M7/5-32	6.83	0.02	0.73	0.92	0.01	42.14	1.03	<0.01	0.03	0.03	47.19	98.94
M7/10-34	4.16	0.06	1.24	1.18	0.03	44.73	1.21	<0.01	0.38	0.18	48.41	101.59
M8/8-46	6.69	0.01	0.62	1.12	0.02	43.56	0.91	<0.01	0.02	0.03	47.42	100.41
MPIT-73	5.90	0.04	0.84	1.12	0.02	43.42	1.09	<0.01	0.03	0.28	47.28	100.03
MPIT-74 *	22.43	0.07	1.16	0.96	0.01	34.53	0.72	<0.01	0.04	0.19	37.94	98.06
M12/SEC-79	4.60	0.05	1.18	0.69	0.01	44.77	0.99	<0.01	0.13	0.11	48.01	100.55
M12/SEC-81	1.99	0.06	1.34	0.94	0.01	47.29	1.00	<0.01	0.01	0.10	49.16	101.91
M12/SEC-83	8.30	0.07	1.25	1.05	0.01	42.47	1.12	<0.01	0.02	0.16	45.79	100.25

*Note: * Silica content is due to quartz arenite or siltstone interbeds and is representative of the lenticular-bedded magnesite. Note that the CaO/MgO ratio remains low regardless of the silica content.*

TABLE B-4-2
DETAILED DESCRIPTION OF SECTION A- B

Section A-B
Cranbrook Formation - Marysville area
Location: about 5 kilometres south of the Marysville subdivision of Kimberley.
Elevation of Unit 1, 1081 m NTS 82G/12W
Measured by G. J. Simandl and K. D. Hancock (1992), Traverse 92GS - M8

UNIT	DESCRIPTION	THICKNESS (metres)
	EAGER FORMATION (?) (3.69 m - incomplete)	
16	Siltstone, dark green, thinly laminated. Cleavage is well developed and parallel to bedding. Disseminated pyrite cubes, 1 to 5 millimetres in diameter, are common.	3.69
	CRANBROOK FORMATION (199.97 m incomplete)	
15	Sandstone, green, thinly bedded, fine grained with rare, thin lenses of recessive weathering carbonate. Cleavage is poory developed and bedding parallel.	9.76
14	Wacke, dark green, very thinly bedded, fine grained. There are abundant carbonate-rich beds and lenses, 1 to 7 centimetres thick. There are vestiges of burrows in some beds.	2.19
13	Wacke, dark green, laminated, very fine to fine grained. Some carbonate lenses, typically 1 by 10 centimetres, are present. Cleavage is poorly developed and is parallel to bedding.	2.31
12	Wacke and siltstone with scattered dolomite lenses, green, thinly interbedded, fine grained, bedding is 1 to 7 centimetres thick. The carbonate lenses are rusty weathering and have a distinct negative relief	3.75
11	Siltstone, grey and white, laminated. Some interlaminated beds of very fine grained wacke.	5.83
10	Magnesite, light grey to buff, massive, sparry. Grains are 1 to 2 millimetres in diameter, blocky and equant. No bedding features are present and the upper and lower contacts are sharp, parallel to adjacent bedding .	24.13
9	Carbonate and sandstone, lenticularly interbedded in approximately equal proportions. The sandstone is light brown to beige, fine to medium-grained, well sorted, silica-cemented subarkose. Layering is 1 to 3 centimetres thick. The interposed carbonate layers and lenses, 30 by 1 to 3 centimetres, are a mixture of buff calcite, dolomite and magnesite. The carbonate-rich portion consists of about 70 per cent carbonate and 30 per cent detrital quartz. The unit has a very distinctive weathering surface of resistant sandstone ribs and labile carbonate lenticular depressions. Bedding thins rapidly and carbonate becomes the dominant part over the uppermost 45 centimetres of the unit.	12.12
8	Arkose, interbedded dark grey and red-brown, fine grained, well sorted. Flattened, very thin lenticular bedding is defined by colour in otherwise similar arkose. It has some calcite cement and the carbonate content increases sharply to approximately 30 per cent at the base. The rock has a prominent red, iron oxide colour when crushed.	24.77
7	Magnesite, light grey to buff, massive, sparry. Grains are average 7.5 millimetres in diameter, are blocky and equant. Magnesite averages 90 per cent and detrital quartz interbeds form the remaining 10 per cent. The interbeds are 1 to 4 millimetres thick, milky white and are sparse in the centre of the unit and abundant near the margins.	2.30
6	Carbonate and sandstone, interbedded in roughly equal proportion. The carbonate consists mostly of magnesite and dolomite with grains up to 1 millimetre. The sandstone is medium grained and subarkosic. Bedding is lenticular and variable in thickness, ranging from thin to medium bedded. Typical rib-and-hollow weathering texture is readily apparent. Some thin interbeds of siltstone.	12.94
Unconformity	It is irregular but essentially parallel to bedding and has a relief of 0.5 metres.	
5	Quartz arenite, light grey and black, lenticular, very thinly bedded, fine to medium grained. Bedding is defined by colour between similar arenites. Sorting is poor with grains up to granule size present. The rock has a prominent red, iron oxide colour when crushed.	10.22
4	Quartz arenite, pink, massive, coarse grained, well sorted.	1.15
3	Arkosic to subarkosic wacke, grey, beige, green or brown, laminated to thinly bedded, very fine to coarse grained, poorly to well sorted.	37.41
2	Siltstone, dark green, massive, fine grained.	0.69
Fault	Strike-slip fault with dextral movement. The exact displacement is unknown.	
1 incomplete	Quartz arenite, light grey to pink, massive, poorly sorted, medium grained. Grains up to pebble size are common.	50.4

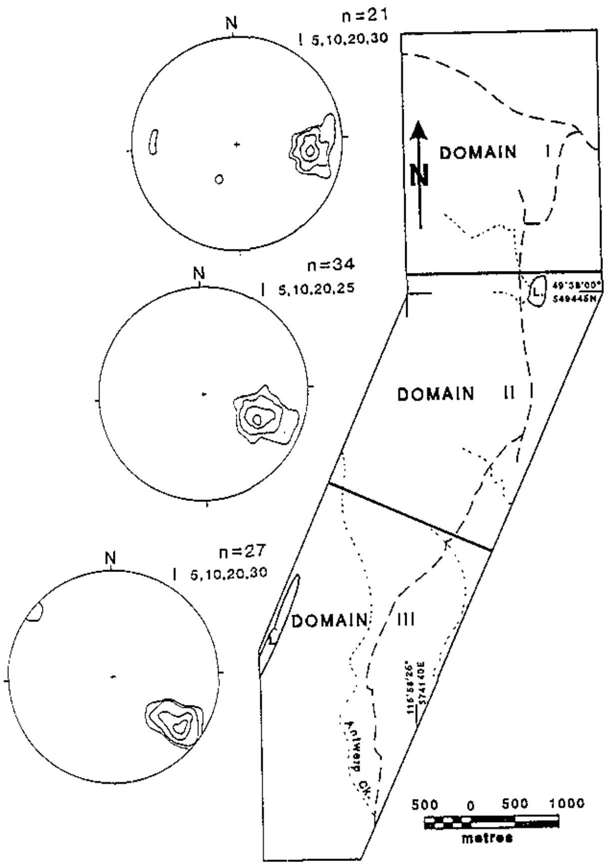


Figure B-4-6. Structural domains and contoured plots of poles to bedding for the Marysville magnesite deposit.

measured thickness of 24 metres, and they may pinch out along strike. The thickest sections of massive, sparry magnesite generally have the least amount of impurities. This type of magnesite may be of economic interest, however it has higher quartz content than deposits in the Brisco and Mount Brussilof areas.

ACKNOWLEDGMENTS

The authors wish to thank Cominco Ltd., D. Anderson, P. Ransom and N. Del Bel Belluze for access to geological information and drill core from the magnesite showings. Trygve Höy provided ample background material on the regional geology of the area. J. Newell edited an earlier version of this paper.

REFERENCES

Cairnes, C.E. (1932): Some Mineral Occurrences in the Vicinity of Cranbrook, British Columbia - Non-metallic Deposits; *Geological Survey of Canada*, Summary Report, 1932, Part A II, pages 101-104.

Höy, T. (1983): Geology in the Vicinity of the Sullivan Deposit, Kimberley, British Columbia, (82F, G); *in* Geological Fieldwork 1982, *B.C. Ministry of Energy, Mines and Petroleum Resources,* Paper 1983-1, pages 9-16.

Höy, T. (1984): Geology of the Cranbrook Sheet and Sullivan Mine Area (N.T.S. 82G/12. 82F/9); *B.C. Ministry of Energy, Mines and Petroleum Resources,* Preliminary Map 54.

Höy, T. (1985): The Purcell Supergroup, Fernie West-half, Southeastern British Columbia, Part A - Stratigraphy - Measured Sections; *B.C. Ministry of Energy, Mines and Petroleum Resources,* Bulletin 76, 79 pages.

Höy (1989): The Age, Geochemistry and Tectonic Setting of the Middle Proterozoic Moyie Sills, Purcell Supergroup, Southeastern British Columbia; *Canadian Journal of Earth Sciences*, Volume 29, pages 2305-2317.

Höy, T. (in preparation): Geology of the Purcell Supergroup in the Fernie West-half Map-area, Southeastern British Columbia; *B.C. Ministry of Energy, Mines and Petroleum Resources,* Bulletin.

Höy, T. and Daikow, L. (1981): Geology of the Moyie Lake Area, Purcell Mountains, Southeastern British Columbia (82G): *in* Geological Fieldwork 1980, *B.C. Ministry of Energy, Mines and Petroleum Resources,* Paper 1981-1, pages 9-14.

Höy T. and van der Heyden, P. (1988): Geochemistry, Geochronology and Tectonic Implications of Two Quartz Monzonite Intrusions, Purcell Mountains, Southeastern British Columbia; *Canadian Journal of Earth Sciences*, Volume 25, Number 1, pages 106-115.

McCammon, J.W. (1965): Marysville Magnesite Belt (49° 115° N.W.); *B.C. Ministry of Energy, Mines and Petroleum Resources,* Annual Report 1964, pages 187-193.

McMechan, M.E. (1980): Stratigraphy, Structure and Tectonic Implications of the Middle Proterozioc Purcell Supergroup in the Mount Fischer Area, Southeastern British Columbia; unpublished Ph.D. thesis, *Queen's University*, Kingston, Ontario, 279 pages.

McMechan, M.E. Höy, T. and Price, R.A. (1980): The Van Creek and Nicol Creek Formations (new): A Revision of the Stratigraphic Nomenclature of the Middle Proterozoic Belt-Purcell Supergroup, Southeastern British Columbia; *Bulletin of Canadian Petroleum Geology*, Volume 28, pages 542-558.

Price, R.A. (1964): The Precambrian Purcell System in the Rocky Mountains of Southern Alberta and British Columbia; *Bulletin of Canadian Petroleum Geology*, Volume 12, pages 399-426.

Price, R.A. (1981): The Cordilleran Foreland Thrust and Fold Belt in the Southern Canadian Cordillera, *in* Thrust and Nappe Tectonics, McClay, K.R. and

Price, N.J., Editors, *Geological Society of London*, Special Publication 9, pages 427-448.

Rice, H.M.A. (1937): Cranbrook Map-area, British Columbia; *Geological Survey of Canada,* Memoir 207, 67 pages.

Schofield, S.J. (1915): Geology of the Cranbrook Map-area, British Columbia; *Geological Survey of Canada*, Memoir 76, 245 pages

Schofield, S.J. (1922): Relationship of the Precambrian (Beltian) Terrain to the Lower Cambrian Strata of Southeastern British Columbia; *Geological Survey of Canada,* Museum Bulletin Number 35, 15 pages.

NELSON ISLAND

By Tom Schroeter
and Bob Lane

(Fig. B1, No. 5)

LOCATION:	UTM Zone: 10U Northing: 5507900 Easting: 419500 (092F/09E) Vancouver Mining Division, 35 kilometres northwest of Sechelt, situated on a north-facing slope south of an unamed creek linking West Lake and Mackechnie Lake located in the centre of Nelson Island.
CLAIMS:	None.
ACCESS:	Approximate 15-minute helicopter flight from Sechelt to the occurrence on Nelson Island. Alternate access is by boat to the foot of logging roads which can be traversed easily to the skarn showing.
OWNER/OPERATOR:	None.
COMMODITIES:	Copper, iron.

A NEW SKARN OCCURRENCE ON NELSON ISLAND, SECHELT AREA

INTRODUCTION

Nelson Island (Figure B-5-1) is situated due east of the historic (and present) Texada Island iron and gold skarn, and limestone quarry operations. The area of interest is a heavily tree covered (second growth) prominent ridge along which recent logging road construction uncovered a previously unknown north-trending band of altered limestone with skarn-type mineralization.

Mining development on the island consists of an abandoned dimension stone operation on Quarry Bay at the south end of the island. There is no record of exploration for metallic minerals on the island.

GEOLOGY

Nelson Island is underlain by intrusive rocks of the Coast Plutonic Complex (Roddick and Woodsworth, 1979). The western two-thirds of the island are predominantly underlain by quartz diorite; exposures of granodiorite occur on the south end of the island at Quarry Bay and at the mouth of Blind Bay at the island's western extremity. The northeast end of the island is underlain by diorite. A belt of Late Triassic Karmutsen Group volcanic rocks trends northwest across the middle of the island (Figure B-5-2).

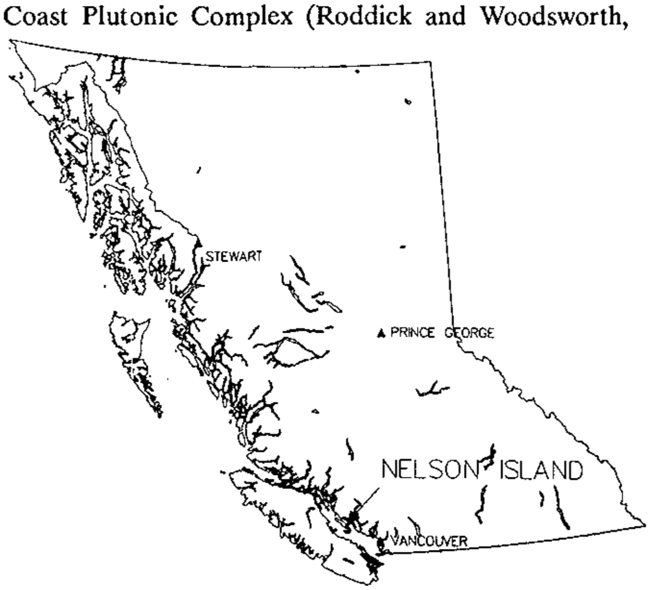


Figure B-5-1. Location of Nelson Island.

Limestone (Triassic Quatsino Formation?) forms a northwest-trending band across the island. At the "road-cut" exposure the limestone band is about 100 metres wide (Figure B-5-3), but it may widen along strike or with depth. It is cut by numerous diorite dikes. Most of the limestone has been metasomatically altered to a combination of marble and skarn. The marble displays wildly contorted banding defined by irregularly alternating plain white and black carbonaceous, pyritic layers. Boundaries between limestone and marble are gradational over tens of centimetres.

Numerous narrow (*e.g.* 0.5 to 3.0 m in width) bands of skarn cut the outcrop. There are three varieties: massive, pale brown garnet skarn; spotted brown garnet and pale green diopside skarn, and pistachio-green spotted (retrograde) epidote skarn. The more intense garnet-bearing skarn varieties are commonly associated with massive sulphide pods up to 0.75 metre across. Magnetite-actinolite zones occur outside the limestone band and within hornfelsed diorite that is exposed at the western limit of the limestone. Diorite is dark grey-green, fine grained and commonly contains 2 to 3 per cent disseminated pyrite. A network of epidote-coated fractures crosscuts the diorite. Medium to coarse-grained equigranular quartz diorite forms the eastern margin of the limestone. The contact zone displays apparent granophyric texture over a width of less than a metre.

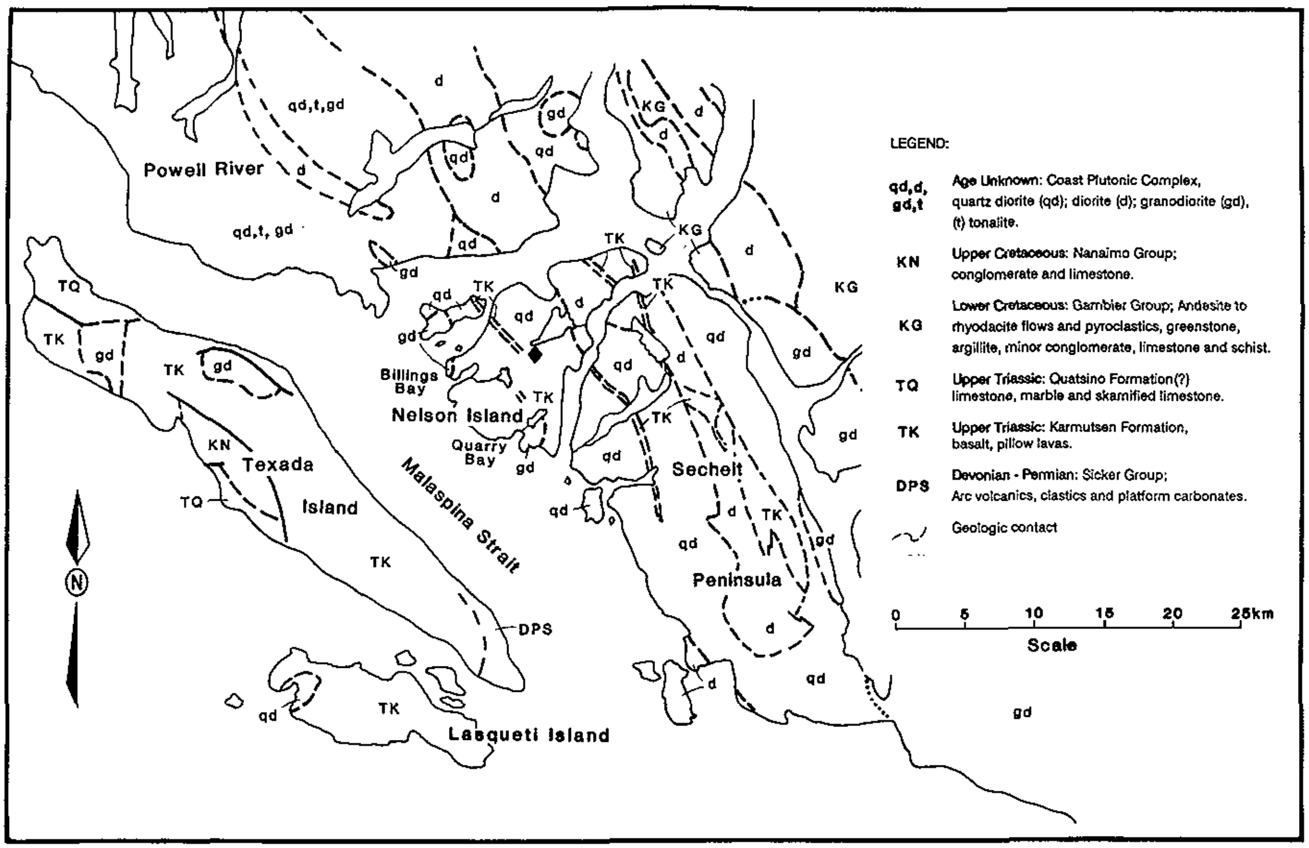


Figure B-5-2. Regional geology (after Roddick and Woodsworth, 1979; Roddick *et al.*, 1979) of Nelson Island and area. The location of the skarn occurrence is shown by the diamond.

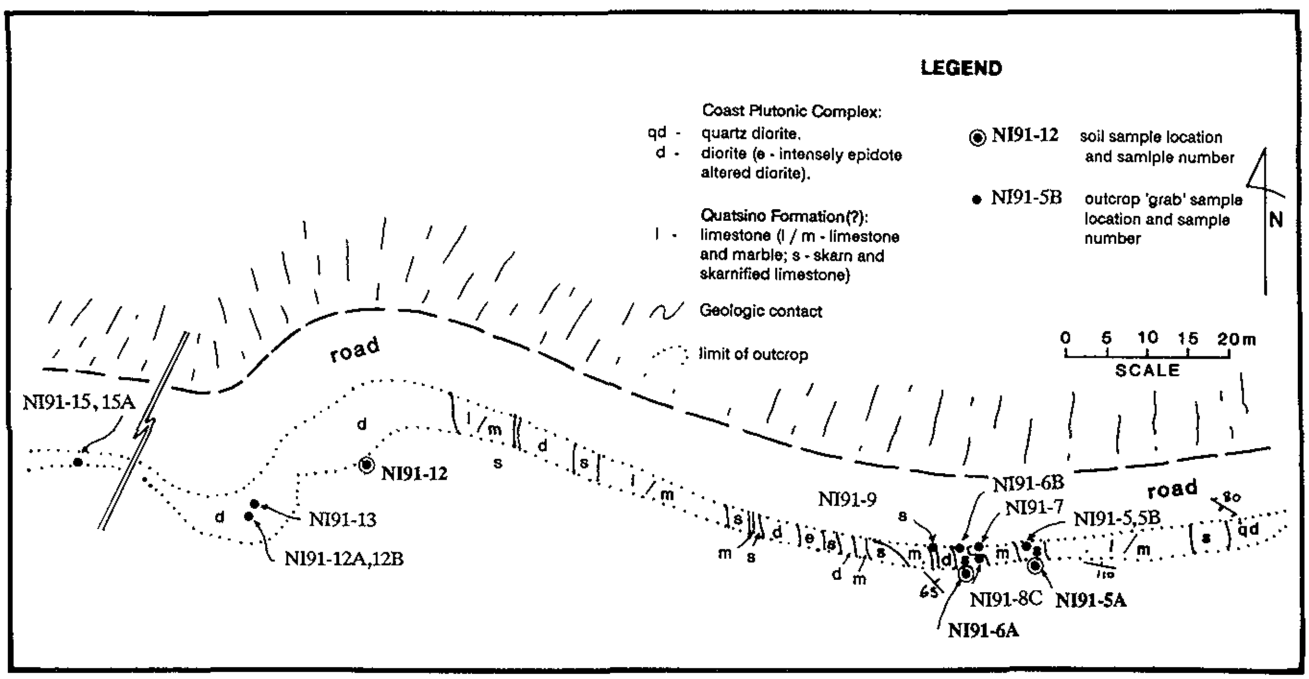


Figure B-5-3. Geological map of skarn occurrence, central Nelson Island. Sample locations are also shown.

TABLE B-5-1
SELECTED SOIL AND ROCK SAMPLES FROM A SKARN OCCURRENCE ON NELSON ISLAND

Sample Number	Cu ppm	Pb ppm	Zn ppm	As ppm	Se ppm	Au ppb	Sample Type	Rock Description
NI91-5A	154	10	284	70	0.83	-	soil	
NI91-6A	135	72	3600	84	0.53	-	soil	
NI91-12	225	14	285	10	0.22	-	soil	
NI91-5B(dup)	282	<6	144	33	4.95	-	grab	py-rich pod in skarn
NI91-6B	18	<6	123	4		-	grab	gar-diop-marble skarn
NI91-5B(dup)	278	<6	112	33	4.95	-	grab	py-rich pod in skarn
NI91-7	5	<6	18	1		-	grab	marble with py-bearing layers
NI91-9	245	8	279	11	0.15	-	grab	ep-rich skarn; mal, tennorite(?)
NI91-12A	75	<6	188	6		-	grab	massive mgt-act skarn
NI91-15	141	<6	137	59	2.50	-	grab	hornfelsed diorite (py±cpy)
NI91-8C	157	<6	27	18	5.30	1	grab	diorite; diss py
NI91-12B	3400	<6	640	6		4	grab	mgt+mal+cpy skarn
NI91-13	132	<6	157	8		6	grab	massive mgt+act skarn
Standard B	281	6	28	5	0.15	27	-	-
NI91-5	237	<6	140	19	5.40	6	0.75m rock chip	py±cpy in skarn
NI91-15A	296	<6	98	94	5.94	4	grab	hornfelsed diorite (py±cpy)

Note:
act = atinolite, cpy = chalcopyrite, diap = diopside, ep = epidote, gar = garnet, mal = malachite, mgt = magnetite, py = pyrite.

Sulphide mineralization consists of disseminated and fracture-controlled pyrite and chalcopyrite. Table B-5-1 briefly describes samples collected and relevant analytical results.

SUMMARY OF ANALYTICAL RESULTS

In recognition of the proximity to the skarn deposits and showings on Texada Island, and the possible genetic and geological similarities, the samples collected were analyzed for copper, lead, zinc, arsenic and gold. In addition, as a result of a request forwarded through the Ministry of Forests, the samples were also analyzed for their selenium content. The preliminary analytical results suggest the following:

1) Sulphide-rich zones are elevated in copper, zinc and perhaps arsenic.
2) Silicate skarn without visible sulphides is low or depleted in all elements analyzed.
3) Marble with or without pyrite is low in all elements analyzed.
4) Skarn with cupriferous minerals is elevated in copper, zinc and perhaps arsenic.
5) Massive magnetite with no visible sulphides is low or depleted in all elements analyzed.
6) Hornfelsed diorite and diorite with sulphides do not appear to be elevated in any metals analyzed.
7) Skarn with magnetite and chalcopyrite, (*i.e.* sample number NI 91-12B) is highly anomalous in copper and zinc. It represents the best target type on the property.
8) Selenium values appear to be higher in rocks that contain sulphide mineralization; otherwise, levels are not anomalous.
9) A high zinc value in soil sample NI 91-6A may reflect an uphill zinc-rich bedrock source or a concentration of zinc derived from the weathering of the underlying bedrock.

Much more sampling would be required to establish the reliability of these suggestions.

EXPLORATION POTENTIAL

This new discovery is evidence of the potential of this area to host skarn mineralization. Similar occurrences may exist in under explored, densely forested areas in the locality.

REFERENCES

Roddick, J.A. and Woodsworth, J.G. (1979): Geology of Vancouver, West Half and Mainland Part of Alberni; *Geological Survey of Canada*, Open File 611.

Roddick, J.A., Muller, J.E. and Okulitch, A.V. (1979): Fraser River Sheet 92 (Bedrock Geology Compilation); *Geological Survey of Canada*, Map 1386A.

LOCO PROPERTY

By B.N. Church

(Fig. B1, No. 6)

LOCATION:	Lat. 50°47'42" Long. 122°47'00" (92J/15W) LILLOOET MINING DIVISION. The property is approximately 1.5 kilometres north of the town of Bralorne and 0.5 kilometre west of Mead Lake.
CLAIMS:	COSMOPOLITAN (Lot 584), NOELTON FR. (Lot 5456), and STAR FR. (Lot 5924) plus 18 additional reverted Crown-granted claims and claim fractions.
ACCESS:	The property is connected directly to Bralorne by a dirt road following the power line on the northeast side of town.
OWNER/OPERATOR:	AVINO MINES AND RESOURCES LTD.
COMMODITY:	Gold.

EXPLORATION OF GOLD QUARTZ MINERALIZATION ON THE LOCO PROPERTY, BRIDGE RIVER MINING CAMP, SOUTHWESTERN BRITISH COLUMBIA

INTRODUCTION

The Loco property, also known as the Cosmopolitan claim group, is adjacent to the King workings of the Bralorne mine in Lillooet Mining Division of southwestern British Columbia. Access is by 1.5 kilometres of dirt road north of Bralorne and 10 kilometres by paved road south of the town of Gold Bridge.

The purpose of this report is to describe ongoing exploration on the Loco property, revise the geological interpretation of the area and provide new isotope and assay data based on discussions with mine geologists and visits to the area up to August 1991.

PREVIOUS WORK

The property has been the target of intermittent exploration since the beginning of the century and several hand-dug trenches and a few adits and shafts from this early period remain. An intensive program of bulldozer trenching and diamond drilling began in 1987, under the direction of Levon Resources Ltd., following the discovery of a gold-enriched arsenopyrite-bearing quartz vein on the Cosmopolitan claim. In 1988 this was followed by development of a crosscut adit (90 m) and drifting on the vein (65 m). In 1991 Avino Mines and Resources Ltd. became the sole owner of the property with the purchase of Levon's holdings and other interests. At about the same time Avino gained control of the Bralorne-Pioneer mine from International Corona Corporation. This led to rehabilitation of access to the King workings on the 800 level and reopening the old crosscuts and drifts on the Cosmopolitan claim. This allowed a review of the underground geology and a diamond-drilling program (totalling about 700 m) to test the vertical continuity of vein mineralization on the Loco property.

GEOLOGICAL SETTING

The Bridge River mining camp is centred about 180 kilometres north of Vancouver. It covers a mountainous area in the Bridge River watershed between the Coast Range on the southwest and Shulaps Range on the northeast.

The rocks of the camp comprise a variety of volcanic and sedimentary beds and igneous intrusions ranging from Paleozoic to Tertiary age. The Bralorne intrusions and Pioneer volcanic rocks (Church, 1990a; Cairnes (1937) are the most consistently mineralized rocks in the area. The granitic intrusions of the Coast Plutonic Complex appear to be an important factor in the mineralizing process, being roughly the same age as the veins.

The geology of the camp records multiple cycles of deformation. The oldest rocks are strongly fractured and folded and greenschist metamorphism is widespread. Numerous outliers and wedges of rocks of Cadwallader and Bridge River terranes occur intermixed throughout the area testifying to a complicated tectonic history (Figure B-6-1). It is believed that interleaving of Cadwallader and Bridge River rocks is the result of imbricate thrusting and stacking of various lithologies in response to plate collision in mid-Jurassic time. The present configuration of major units mainly reflects Cretaceous and Tertiary tectonism.

The 'Cadwallader break' is the fault system on which the principal mines of the Bridge River camp are located, including the Bralorne-Pioneer mine (and the Loco property). Faulted slivers in the system include Paleozoic and

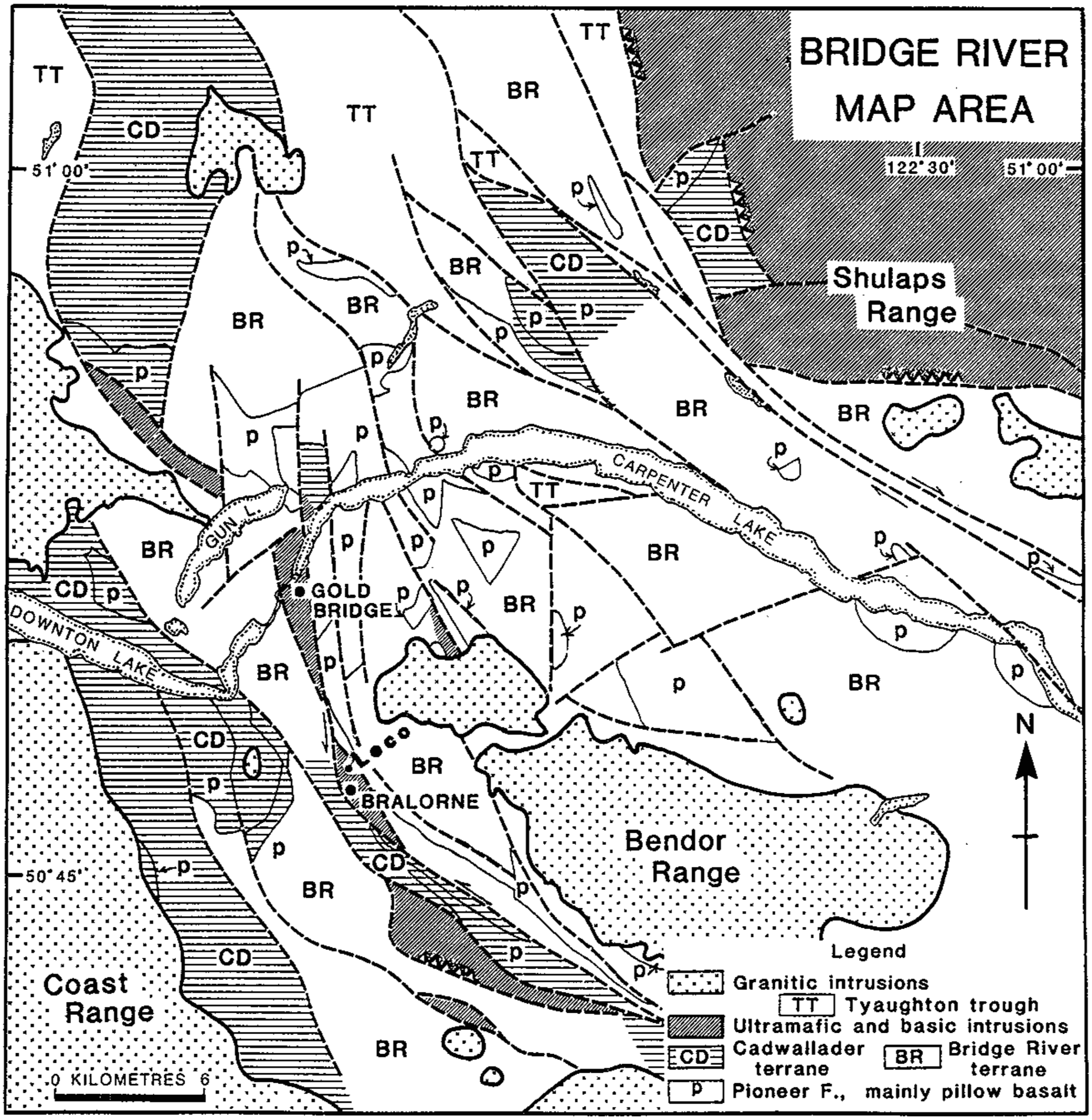


Figure B-6-1. Location of Loco property and generalized geology of the Bridge River mining camp (broken lines are faults; with teeth - thrust faults).

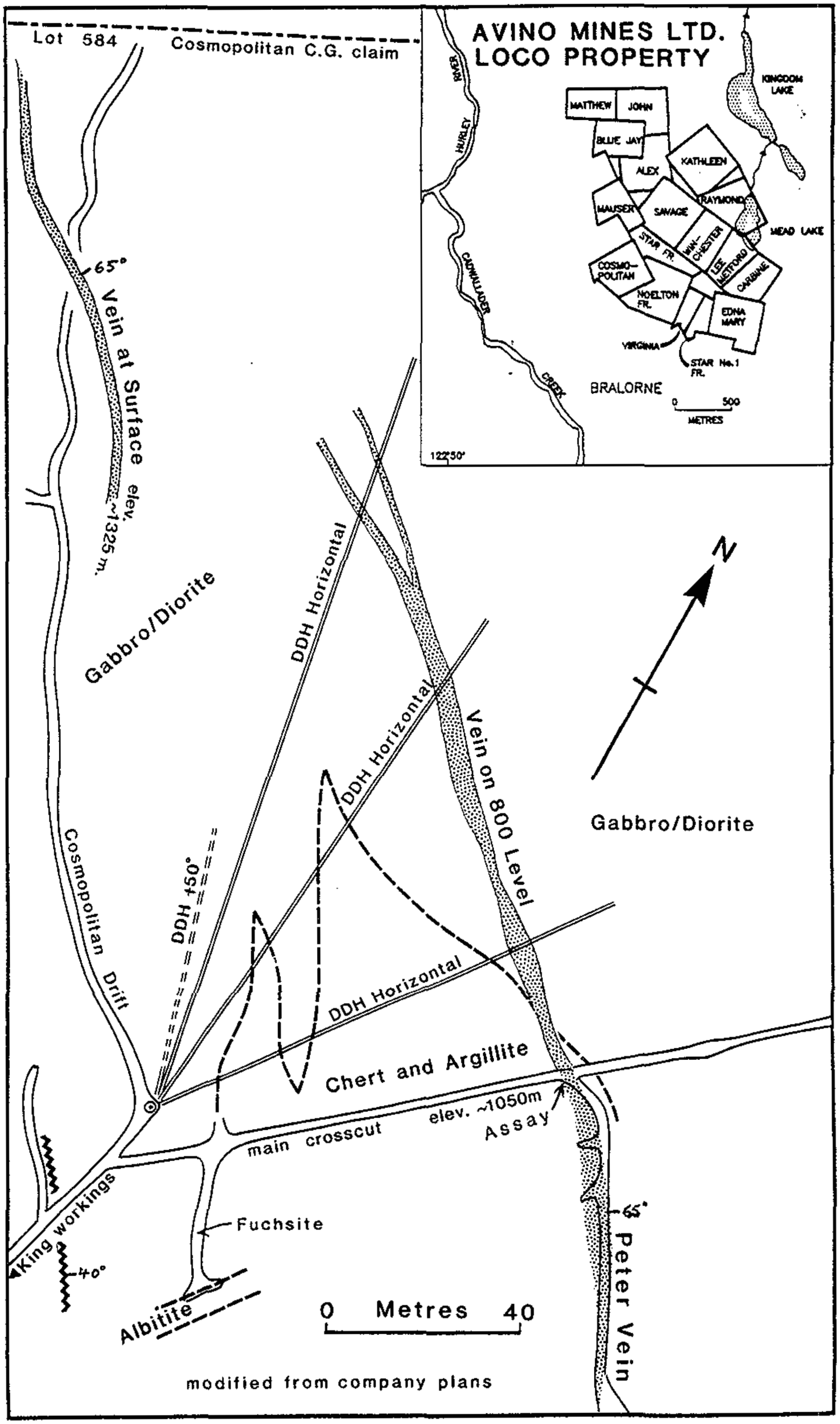


Figure B-6-2. Surface and underground (800 level) projection of Peter vein, Loco property.

Mesozoic diorite, greenstone, chert and clastic sedimentary rocks. A variety of Cretaceous and Tertiary dikes, ultramafic rocks and felsic to basic stocks is emplaced on the break.

The break is essentially straight and uninterrupted for 15 kilometres southeast from the Bralorne mine to McGillivray Pass and 10 kilometres north between Bralorne and Gold Bridge. At Bralorne the strike changes abruptly from northerly to west-northwest. The wedge-shaped area contained by this bend and the Fergusson fault (about 2 km^2) includes all of the productive orebodies in the Bralorne-Pioneer area. Within this area the ore-bearing veins occupy tension fractures and shears that traverse the lens obliquely, dipping mostly north and northeasterly. These fractures appear to have formed in a stress field (left-lateral shear couple) developed between the Cadwallader and Fergusson faults (Church, 1990b). Because of rotation of the stress field fissures that began as shears became tension fractures and vice versa, thus explaining brecciated and sheared vein fillings.

MINERALIZATION

The principal hostrock of vein mineralization on the Loco property is a lobe of the Bralorne intrusion. This is a gabbro/diorite body several hundred metres across. It has been dated 270 to 293 Ma (U-Pb on zircon; Leitch *et al.*, 1991; Church, in preparation), considerably older than the estimated age of vein mineralization (85.9 to 91.4 Ma; Leitch, 1991 *et al.*; Church, 1990b).

The target of exploration on the Loco property is a mineralized quartz vein exposed near the northwest boundary of the Cosmopolitan claim. The vein strikes southeast, dips about 65° northeast, and has been traced for more than 70 metres by surface trenching and drilling. The vein consists of massive and banded white quartz up to 1 metre wide containing screens of wallrock and a few thin lenses of pyrite and arsenopyrite. Company assays average 16 grams per tonne gold, over a width of 1.0 metre, for the length of the vein, ranging to somewhat higher values towards the southeast face.

In the underground workings the Cosmopolitan claim is traversed by a northeast extension of the King crosscut, the Cosmopolitan drift, trending northwest from the bend in the crosscut and a drift extending to the southeast off the crosscut following the 'Peter' vein (Figure B-6-2). Where intersected by the crosscut, the Peter vein is strongly brecciated, irregular in width and consists of dark grey quartz with accessory amounts of pyrite. A company sample here assayed 0.7 gram per tonne gold across 1.5 metres.

An array of three horizontal holes drilled north, northeast and northwest from entry of the Cosmopolitan drift established the irregular intrusive contact of the Bralorne gabbro/diorite with the cherty metasedimentary rocks and proved the lateral extension of the Peter vein in the area northwest of the crosscut. Company assays for intercepts on the Peter vein in the north and northeast-trending diamond-drill holes range up to 3.6 grams and 4.6 grams per tonne gold, respectively, across 1.2 metres. A fourth hole from the same station inclined at +50° intersected what appears to be the same vein suggesting continuity with the discovery vein on surface. Assay results for this hole range to 1.6 grams per tonne gold across 1.4 metres.

A $^{40}Ar/^{39}Ar$ plateau age of 160 Ma on fuchsite from a shear zone off the main crosscut (P. Reynolds, personal communication, 1992) is not believed to be related to the gold-quartz vein mineralization. This age fits best with the Jurassic terrane-collision event and associated imbricate faulting. The nearby Fergussion thrust and interconnected shears may be in part a relict of the these events.

ACKNOWLEDGMENTS

Assistance provided by officers of Levon Resources Ltd. and Avino Mines and Resources Ltd. is much appreciated. Special thanks are owing James Miller Tait for detailed maps, assay results and a guided tour of mine workings and to Peter Reynolds of Dalhousie University for radiometric dating results. Able field help was provided by Aaron Pettipas.

REFERENCES

Cairnes, C.E. (1937): Geology and Mineral Deposits of the Bridge River Mining Camp, British Columbia; *Geological Survey of Canada*, Memoir 213, 140 pages.

Church, B.N. (in preparation): Geology and Mineralization in the Bridge River Mining Camp; *B.C. Ministry of Energy, Mines and Petroleum Resources*.

Church, B.N. (1990a): Tectonamagmatic Setting of the Pioneer Volcanics and Related Greenstones, Bridge River Area, Southwestern B.C.; *Geological Association of Canada*, Annual Meeting, Vancouver, Abstracts Volume, page A24.

Church, B.N. (1990b): Geology of the Cosmopolitan Gold Property; *in* Exploration in British Columbia 1989, *B.C. Ministry of Energy, Mines and Petroleum Resources*, pages 135-140.

Leitch, C.H.B., van Der Heyden, P., Godwin, C.I., Armstrong, R.L. and Harakal, J.E. (1991): Geochronology of the Bridge River Camp, Southwestern British Columbia; *Canadian Journal of Earth Sciences*, Volume 28, pages 195-208.

ARTHUR POINT (Sea Rose) RHODONITE

By Kirk D. Hancock

(Fig. B1, No. 7)

LOCATION:	Lat. 51°31′59″	Long. 127°47′40″	(92M/12W)
	583610E	5709600N	Zone 09
	Skeena Mining Division. Arthur Point is located on the west coast of British Columbia, 185 kilometres southwest of Bella Coola. The showings are in two small bays either side of a penninsula.		
MINFILE NO.:	092M 015.		
CLAIMS:	ROSE 1 - 4		
ACCESS:	Access is by boat or aircraft only and there are no dock facilities. The quarry is a narrow trench in the northern bay and is currently filled with waste to prevent "poaching".		
OWNER/OPERATOR:	Rhode West Resources Ltd.		
COMMODITY:	Rhodonite.		

INTRODUCTION

Rhodonite showings at Arthur Point were found approximately thirty years ago. The Sea Rose claims were staked in 1982 by A.G. Karup of Bella Coola. A few tonnes of rhodonite were extracted at that time. The property is currently owned by Rhode West Resources Ltd., a subsidiary of Jade West Ltd. In 1985, 1989 and 1990 a further 280 tonnes (est.) were removed. A small camp site and access road were cleared during the period of excavation. Since then the property has remained idle. This report is a summary of the investigation of the geological environment of the rhodonite occurrence and possible links with other known rhodonite occurrences in British Columbia.

The rhodonite quarry exposes a zone 1 to 3 metres wide and about 30 metres long. It was mined with light equipment and hand sorted. The quality of rhodonite is considered high as it has a bright pink colour and attractive, black manganese-coated fractures. The material has been sold to carvers in the Lower Mainland - Vancouver Island region of British Columbia as well as overseas to Asian brokers.

REGIONAL GEOLOGY

Arthur Point is situated at the western margin of the Coast Plutonic Complex. This is a long and narrow belt of plutonic rocks with pendants of gneiss, amphibolite and other metasedimentary and metavolcanic rocks. Mesozoic strata and, in a few locations, Paleozoic rocks abut the complex to the east and west. The oldest plutonic rocks within the complex are Jurassic, but clasts of granitic material of unknown age are present. Plutonism continued, became less basic in composition, culminated in the Cretaceous and waned in the Early Tertiary. Some sporadic intrusive events continued into the Miocene. The plutonic complex consists of a wide variety of rock types but the most common are quartz diorite, tonalite, diorite and granodiorite which occupy 90 per cent of the belt. Gabbro, granite, monzodiorite and quartz monzodiorite make up the remainder. Pendants of sedimentary, volcanic and metamorphic rocks are scattered throughout the complex. The pendant ages range from Devonian through Cretaceous (Roddick, 1983). Most are metamorphosed to greenschist or amphibolite grade. However, some are almost pristine and fossiliferous. These rocks, and specifically greenstones, are often associated with dioritic complexes (Roddick, *ibid.*). North of Rivers Inlet and east of Calvert Island is a large basalt and greenstone body which hosts the Arthur Point rhodonite deposit (Figure B-7-1). The greenstone is largely derived from mafic tuffs with some argillite and chert.

LOCAL GEOLOGY

This study was limited to the western end of a large roof pendant where rhodonite mineralization has been discovered. Figure B-7-2 is a map of the area examined. Outcrop is confined to the shore. Mature rain forest and thick salal undergrowth completely blanket everything above the high water mark.

SEDIMENTARY ROCKS

The sedimentary rocks at Arthur Point are part of a roof pendant within the Coast Plutonic Complex. The sediments are greywacke, argillaceous chert, chert and calcareous argillite. Bedding is moderate to steeply dipping and facing direction is to the east. Bedding thicknesses for all rock types are 1 to 15 centimetres; some of the finer grained rocks, such as argillite, are laminated. There is a crude stratigraphic sequence from greywacke through chert into argillaceous chert. The greywacke is dark green to black, composed primarily of quartz, plagioclase and chert fragments and thinly bedded (1 to 10 mm) with some beds reaching 15 centimetres thick. Graded bedding and crossbedding are preserved. Grain

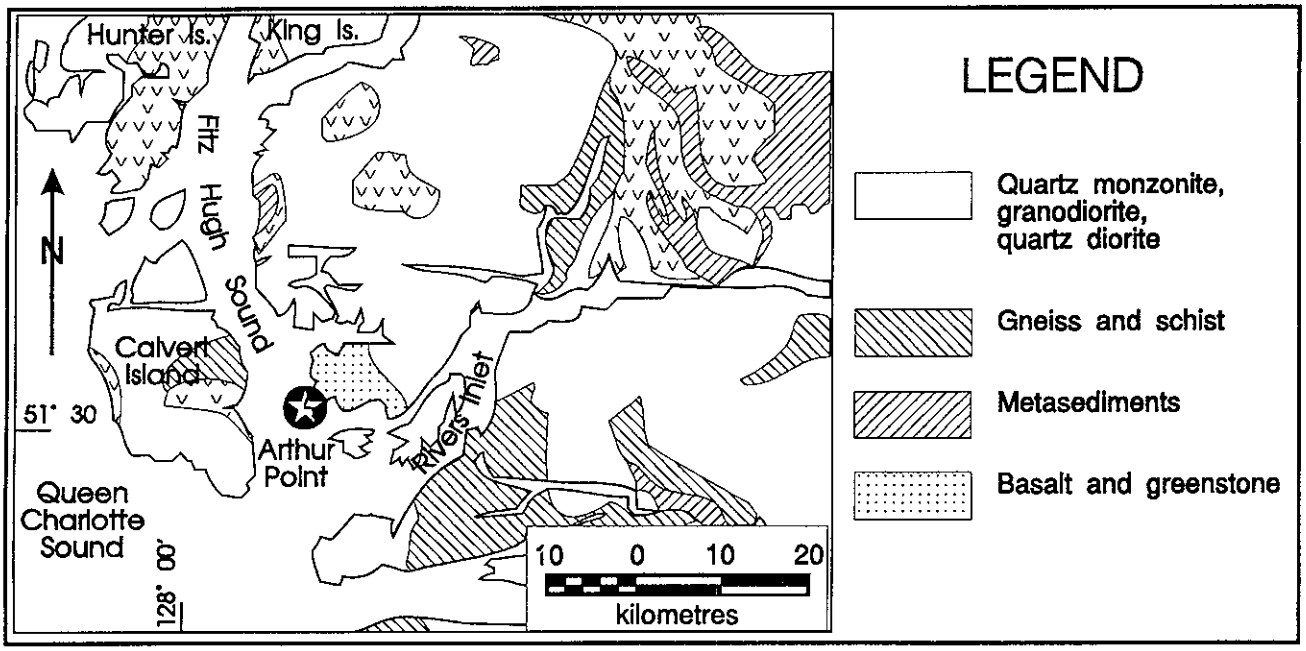


Figure B-7-1. Location of Arthur Point (Sea Rose) rhodonite occurrences and regional geology in the Rivers Inlet area.

size varies from bed to bed. Grains are subangular to subrounded and sorting is good in the fine-grained material and poor in the coarse material. In the coarse wacke, the large fragments are matrix supported.

The chert is dark grey to black and thinly bedded. It has a smooth-weathering, massive appearance in outcrop. In grey chert, quartz grains, 50 to 80 microns in diameter, form 70 to 80 per cent of the rock, with clay-sized minerals forming the rest. Black chert generally comprises quartz and clay-sized material in more equal proportions. In thin section, fining sequences on millimetre scale can be seen but are not visible in hand specimen. Grains are evenly sized and non-equant grains show well developed bedding-parallel orientation. In some thin sections small (125 micron), cored, round grains are seen and may represent partially recrystallized radiolarians. Other exotic grains include garnet and plagioclase.

Argillaceous chert is black and looks similar to the black chert in outcrop. However in hand sample and under the microscope it is somewhat different. Similarities include the thin bedding, with some beds reaching 15 centimetres thick, and the massive appearance. On closer inspection the weathered surface is gritty and argillite laminae are common between the thicker cherty beds. Also, graded bedding and cross-bedding are visible to the naked eye. In the argillaceous chert, clay material is more abundant than quartz. Grains are from 50 to 80 microns in diameter with a clay-sized fraction, less than 39 microns in diameter. Some beds, 5 to 7 centimetres thick, are calcareous, containing up to 50 per cent calcite, as well as a few rounded garnet grains and some lithic fragments.

Intrusive Rocks

There are two intrusive phases present, an older gabbro with associated basaltic dikes, and a younger granodiorite, both part of the Coast Plutonic Complex. The gabbro forms the western and northern boundaries around the sedimentary roof pendant. It has a narrow chilled margin, usually less than 10 metres across. The contact with the sediments is sharp and irregular with no noticeable hornfels or other contact aureole. The gabbro is quite uniform, massive and dark green in colour and has a characteristic knobby weathered texture. The resistant weathered grains are blocky and range from 1 to 3 millimetres in diameter. Stringers and blebs of epidote and calcite, up to a metre in length, are scattered within the intrusion. No xenoliths were found. The gabbro is strongly altered and the alteration mineral assemblage indicates low-temperature, low-pressure conditions of metamorphism. Basaltic dikes and sills are associated with the gabbro. They are prolific and found throughout the pendant. They range in width from 0.1 to 10 metres. The narrower dikes and sills (<2 m) are aphanitic and black. The wider bodies are dark green, with grain sizes ranging from 1 to 3 millimetres, and have narrow, aphanitic chilled margins. They change strike abruptly, sometimes splitting in an apparent haphazard fashion, and often rolling over to form sills. The dikes have no preferred orientation.

The granodiorite is the latest phase present and marks the southeastern margin of the pendant. It is white to light grey, buff weathering and massive. Grain size is uniform (1 to 2 mm). The rock is essentially unaltered. There is no apparent chilled margin or contact aureole.

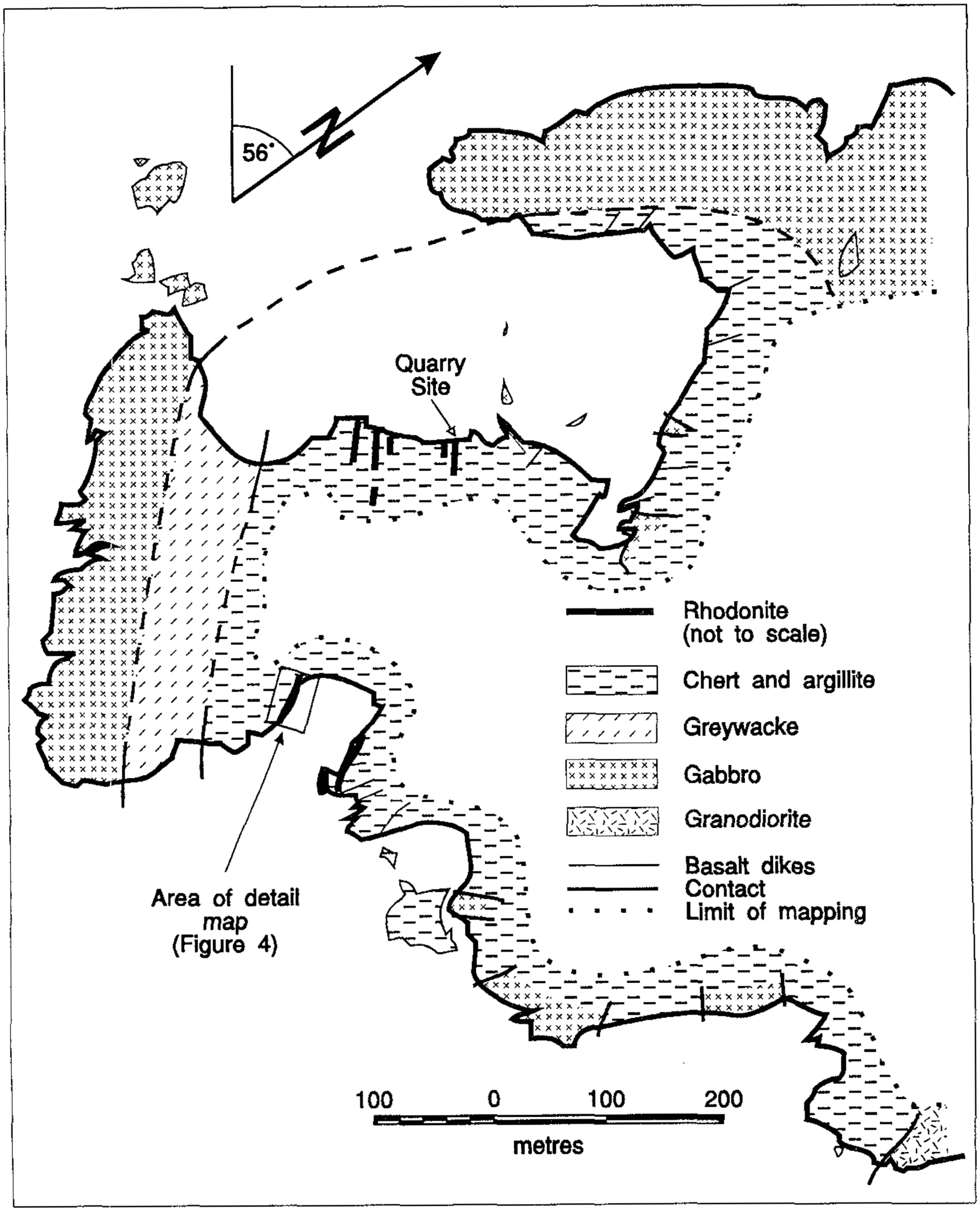


Figure B-7-2. Geology of Arthur Point.

Leucocratic dikes, less than 10 centimetres wide, extend into the adjacent pendant, but no further than 200 metres. The leucocratic dikes crosscut the basaltic dikes.

OXIDE LAYERS

Layers of black oxides, typically less than a centimetre thick, occur within the cherts. In outcrop they are black, massive and have no internal structure. In hand sample they are strongly magnetic and contain abundant octahedrons of magnetite, 1 to 3 millimetres in diameter. The balance of the material is fine grained and massive. X-ray analysis of one sample indicates the prime constituents are plagioclase, muscovite, chlorite, magnetite and hematite. The oxide layers also contain some amorphous minerals which do not give x-ray scattergrams. One sample contained 4670 ppm manganese which may be present as amorphous oxide or complexed in the iron oxides. The oxide layers are similar to oxide pods found within the rhodonite zones.

METAMORPHISM

All rocks except granodiorite show evidence of low-temperature, low-pressure metamorphism. The gabbro and greywackes have the greatest abundance of alteration minerals. Pure chert and the granodiorite contain no secondary minerals. Cherty rocks contain a few percent secondary mica, zoisite and epidote. The more clastic rocks, for example, the feldspathic greywackes, contain chlorite, tremolite/actinolite, zoisite, zeolite and prehnite. Feldspar grains are variably sericitized and some are partly albitized. Within the gabbro, these minerals, together with antigorite, form up to 50 per cent of the rock. Feldspar grains are strongly sericitized. The secondary mineral assemblage indicates low-temperature, low-pressure metamorphism. The conditions that applied were probably within the epidote field of the prehnite-pumpellyite facies; approximately 2 kilobars pressure and 250° to 350°C, (Liou *et al.*, 1983, 1985).

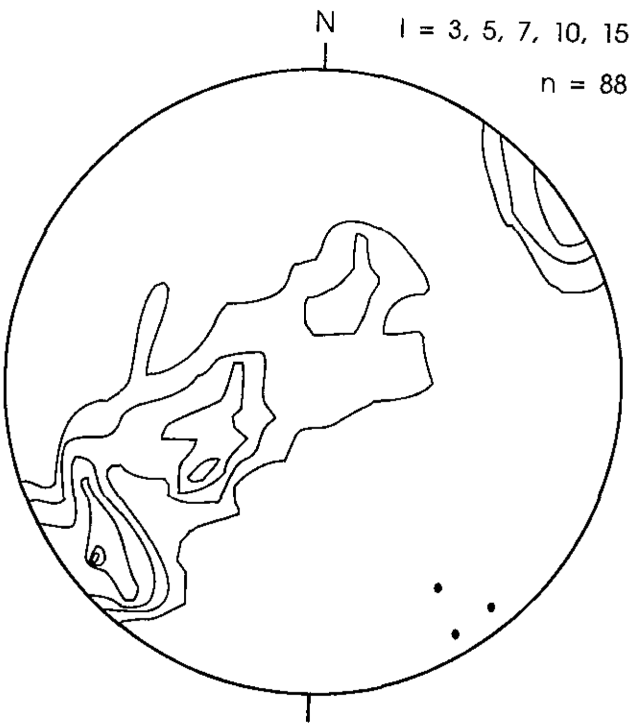


Figure B-7-3. Contour plot of bedding measurements at Arthur Point.

STRUCTURE

The structure of the roof pendant is dominated by a single phase of folding trending northwest with a distinct eastward vergence. Folds are generally tight and subhorizontal although some broad folds and "s" folds were seen. All bedding data were plotted on an equal area stereonet and contoured. They show two distinct clusters, representing the fold limbs and the plunge of the fold (Figure B-7-3). The two limbs are oriented 138°/82°NE and 138°/40°NE and the calculated plunge is 03° towards 140°. No cleavage was seen in the field. Neither intrusion shows evidence of deformation.

RHODONITE OCCURRENCES

Rhodonite occurs as stratabound zones within chert. The mineralized zones have a distinctive, yellow, pockmarked weathering surface. There are five distinct rhodonite layers in the northern bay, including the ore zone, and six layers in the southern bay. No correlation between these layers has been made due to the lack of intermediate outcrops. Figure B-7-4 is a detailed map of the well-exposed southern bay showing. The mineralized layers exhibit a distinct symmetrical zoning which is repeated around each layer. These zones consist of an outermost jasperoid chert, an intermediate pistachio-green zone and a core of rhodonite. Associated minerals include layers of iron and manganese oxides. Hostrocks are black and grey chert.

PERIPHERAL ALTERATION

The outer jasperoid zone has sharp, bedding-parallel contacts with the chert. The jasper consists of quartz grains of 50 to 100 microns in diameter with small (2 to 10 μm) inclusions of hematite. In outcrop, the jasper appears red and layers are 1 to 10 centimetres thick. Bedding features are indistinct and sometimes convolute. The contortions in the jasper are not reflected in the host cherts. Within the jasper zone there are layers of white and grey quartz comprising anastamosing, braided or solitary bands, lenses or strings of blebs which crudely follow bedding. Hematite forms 10 to 20 per cent of the rock. Distribution of hematite is not uniform on a micro-

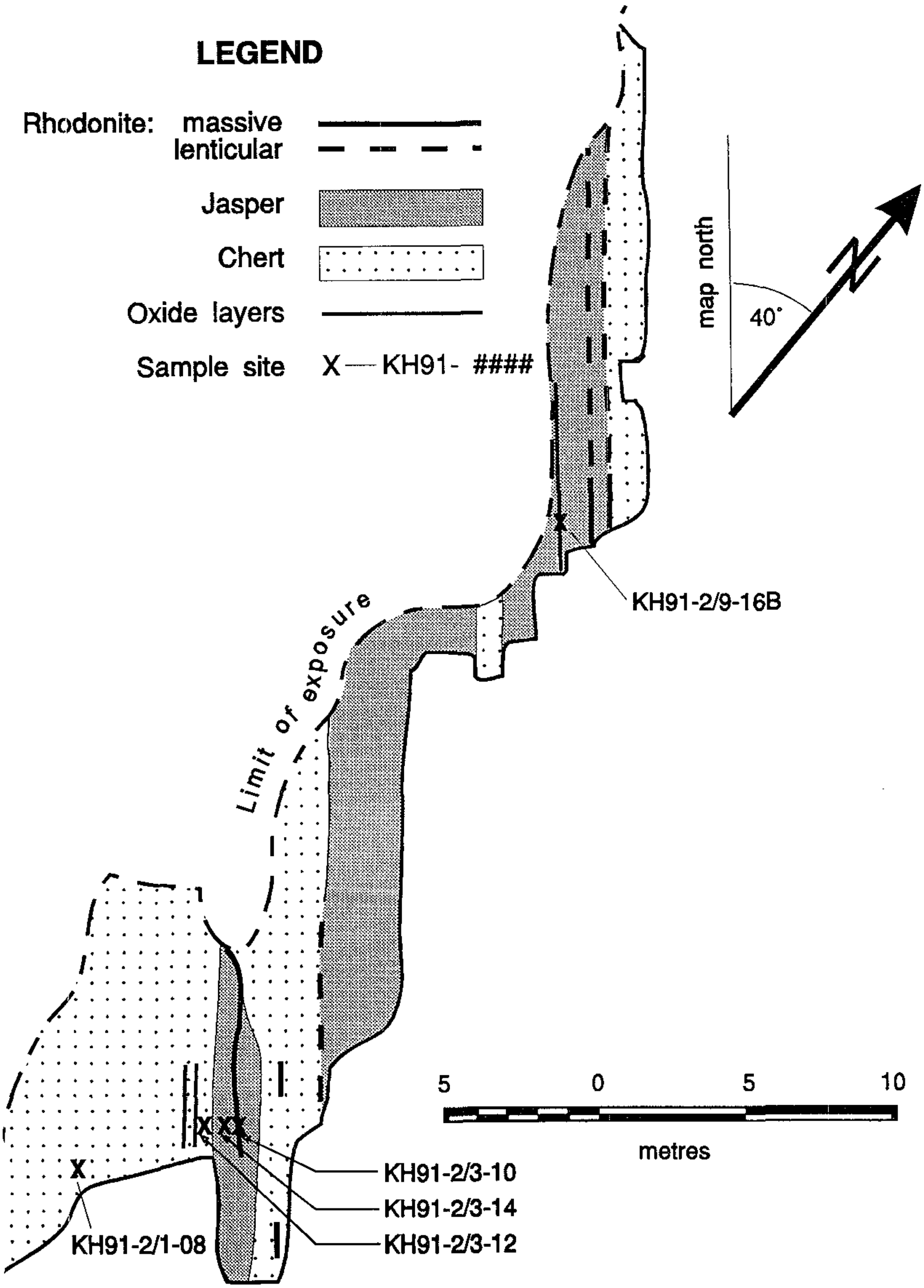


Figure B-7-4. Detail geological map of the rhodonite occurrence in the south bay. Sample locations are for reference with Figure B-7-6.

TABLE B-7-1

Rock type	Minerals	Per cent	Size in microns
Rhodonite	Rhodonite	76	150 - 250
	Garnet	10	10 - 20
	Quartz	7	20 - 150
	Calcite	3	50 - 100
	Epidote (?)	1 - 2	10 - 30
	Tremolite/Actinolite	<1	10
	Chlorite	<1	<10
	Plagioclase	<1	10
Pistachio rock			
Yellow layer	Tremolite/Actinolite	60	10 - 50
	Garnet	30	10 - 50
	Quartz	10	10 - 100
	Calcite	1 - 3	10 - 50
Green layer	Garnet	60	5 - 25
	Tremolite/Actinolite	30	10 - 50
	Quartz	10	10 - 50
Jasper	Quartz	75 - 85	50 - 100
	Opaques (Fe-oxides)	10 - 20	2 - 10
	Garnet	<5	<40
	Calcite	<2	<100
	White mica	<2	<50
	Epidote	<2	20 - 30
	Tremolite/Actinolite	<1	50

scopic scale; it forms dense "islands", several hundred microns across, consisting of aggregates of quartz grains that are 50 to 100 microns in diameter. These aggregates contain about 20 per cent hematite. The surrounding quartz grains are less than 50 microns in size and contain about 10 per cent hematite. The jasper is cut by narrow fractures, typically less than 5 millimetres wide. The fractures are filled by quartz, epidote and calcite with trace amounts of chlorite, zoisite, tremolite/actinolite, white mica, plagioclase and opaque minerals. Data from thin-section analysis of mineralogy are presented in Table B-7-1.

The intermediate zone of pistachio-coloured rock is again mostly chert but also contains a variety of other minerals. The boundary between pistachio rock and jasper is distinct but there are a few jasper layers within the pistachio rock. Compositional layering is defined by colour, typically pistachio green and yellow. The layering varies from 0.1 to 1 centimetre thick and the contacts between layers are diffuse. The layering is often contorted and only generally follows the bedding orientation in the host chert. The green layers may contain one or more of the following minerals, listed in order of relative abundance: quartz, garnet, tremolite/actinolite, epidote, calcite, barite and rhodonite. There are three common mineral assemblages, listed by major components as trace amounts of other minerals are always present: garnet; garnet with minor tremolite/actinolite; and quartz with minor epidote and garnet. In hand sample all green layers appear the same and they can only be distinguished microscopically. The yellow layers are mostly quartz with minor amounts of all the other minerals. A few yellow layers consist of calcite with minor epidote and chlorite. Other layers follow the general pattern of variations in abundances of garnet, tremolite/actinolite, epidote and calcite. There are no hard and fast rules regarding layer compositions and relative mineral abundances. Thin layers of pure quartz, typically less than 5 millimetres across, are scattered within the pistachio rock. The pistachio rock is cut by abundant fractures, typically 100 microns across, but some are up to 2 millimetres wide. The fractures are filled with quartz and small amounts, usually less than a total of 20 per cent, of garnet, opaques, chlorite, zoisite, tremolite/actinolite, epidote, calcite, white mica and plagioclase.

Quartz and garnet grains occur as anhedral grains Sometimes the large garnets appear as skeletal grains. Calcite and tremolite/actinolite show poorly developed cleavage and twinning. Zoisite often forms subhedral to euhedral grains. Within the intermediate zone, the relative abundance of garnet shows a distinct gradation from very little at the jasper margin to pure layers adjacent to the core rhodonite zone (Figure B-7-5). X-ray analysis of garnet shows it to be spessartine. Microprobe analysis of three garnets provides the composition in terms of end members and is listed in Table B-7-2. It is important to note that the jasper and pistachio rock zones are always present but can be extremely telescoped around thin rhodonite layers.

TABLE B-7-2

	#1	#2	#3	Composition
Spessartine	73	92	77	$Mn_3Al_2Si_3O_{12}$
Grossular	14	0	8	$Ca_3Al_2Si_3O_{12}$
Andradite	13	6	4	$Ca_3Fe_2Si_3O_{12}$
Blythite	0	2	0	$Mn_3Mn_2Si_3O_{12}$
Yamatoite	0	0	11	$Mn_3V_2Si_3O_{12}$

Sample compositions are expressed in terms of end members (Harding, 1989).

RHODONITE MINERALIZATION

Rhodonite, when present, occurs at the centre of the jasper and pistachio zones, forming stratabound layers, lenses and strings of blebs. The boundary between rhodonite and the surrounding rock is sharp. Rhodonite is either massive or occurs as layers interbedded with pistachio rock. Massive rhodonite may have margins of interbedded rhodonite but that is not always the case. The massive rhodonite is bright pink to reddish pink on fresh surfaces. The weathered surface is typically a black rind of manganese oxide 1 to 10 millimetres thick. In outcrop the rhodonite is identified as the black material at the centre of the jasper - pistachio rock zone.

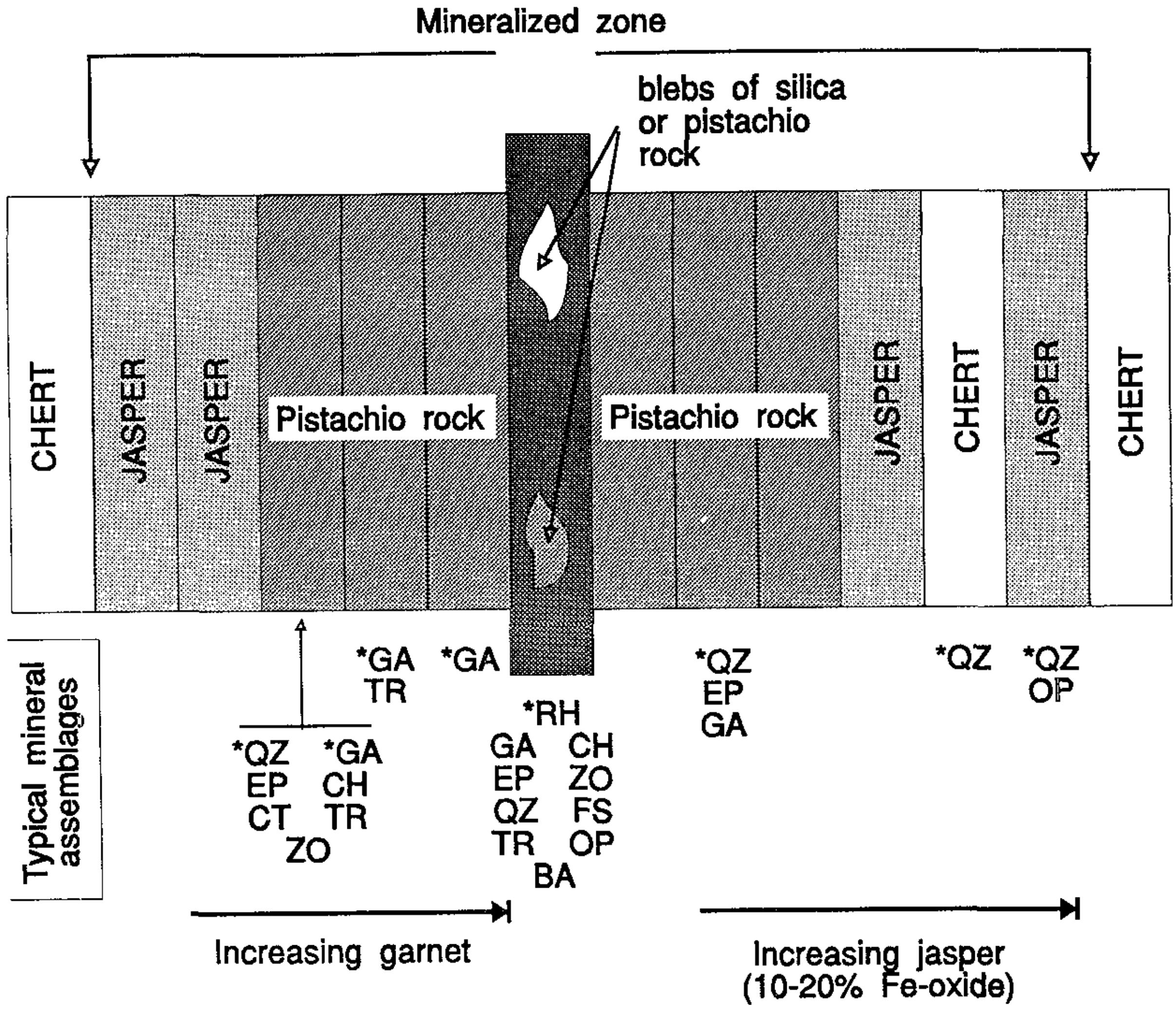


Figure B-7-5. Diagrammatic section of mineralization and associated common mineral assemblages at Arthur Point. Abbreviations are: BA = barite; CH = chlorite; CT = calcite; EP = epidote; FS = feldspar; GA = garnet; QZ = quartz; RH = rhodonite; TR = tremolite/actinolite; ZO = zoisite. * = most abundant mineral(s) present, all others are minor constituents.

Massive rhodonite varies in width from less than a centimetre to about 3 metres. It is typically pink, however, x-ray work by Harding (1989) has determined that there are layers of black rhodonite. Thin rhodonite bands, less than 10 centimetres across, typically pinch out over several metres in outcrop. Rhodonite layers wider than 10 centimetres are continuous for distances in excess of 50 metres. Bedding features are poorly preserved within the massive zones. Layers and lenses of pure quartz, less than 2 millimetres across, are present though not common. Toward the edges of the massive material, there are layers of black rhodonite, grey silica or yellow garnetite. Transverse fractures, filled by black manganese oxide are common. Fractures filled by quartz, calcite, epidote, garnet, chlorite, zoisite, tremolite/actinolote, white mica, plagioclase and opaque minerals are also present. Thin sections show that the massive material consists of 80 to 90 per cent rhodonite grains. The balance of other minerals are interstitial quartz, calcite, epidote, garnet, chlorite, zoisite, tremolite/actinolite, plagioclase and opaque minerals. All the grains are anhedral and rhodonite and calcite sometimes show poorly developed twinning. The mineral assemblage indicates that the temperature of formation was between 400° and 500° C with a pressure range of 500 to 2000 bars (Peters *et al.*, 1973; Candia *et al.*, 1975).

Rhodonite interbedded with yellow garnetite or silica occurs at the margins of some of the thicker massive rhodonite zones or as the cores of the thin (< 10 cm wide) mineralized layers. These layers of rhodonite are typically less than a centimetre across. Mineralogically they are the same as the massive material. The layers are discontinuous and often anastamosing. Layering is parallel to bedding with contortions that are not reflected in the host cherts. The yellow colour greatly diminishes the value of the material.

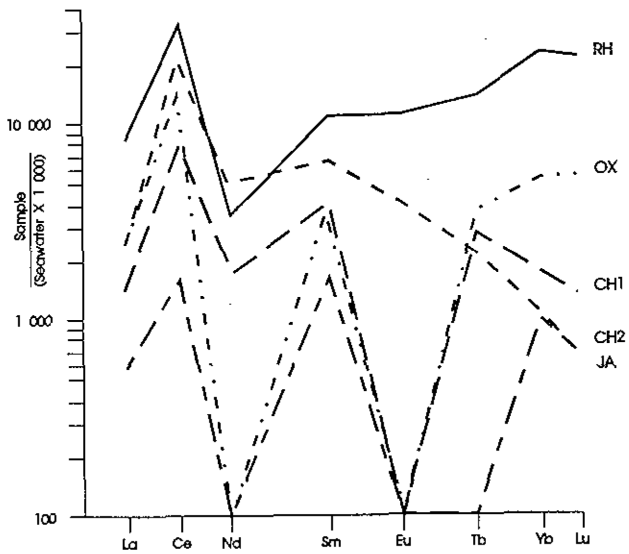


Figure B-7-6. Rare-earth element spidergrams for different rock types at Arthur Point. Abbreviations and references to sample sits on Figure B-6-4 are as follows: RH = rhodonite (KH91-2/3-10); JA = jasper (KH91-2/3-14): CH1 = chert (KH91-2/1-08); CH2 = chert (KH91-2/3-12); OX = oxide layer (KH91-2/9-16B).

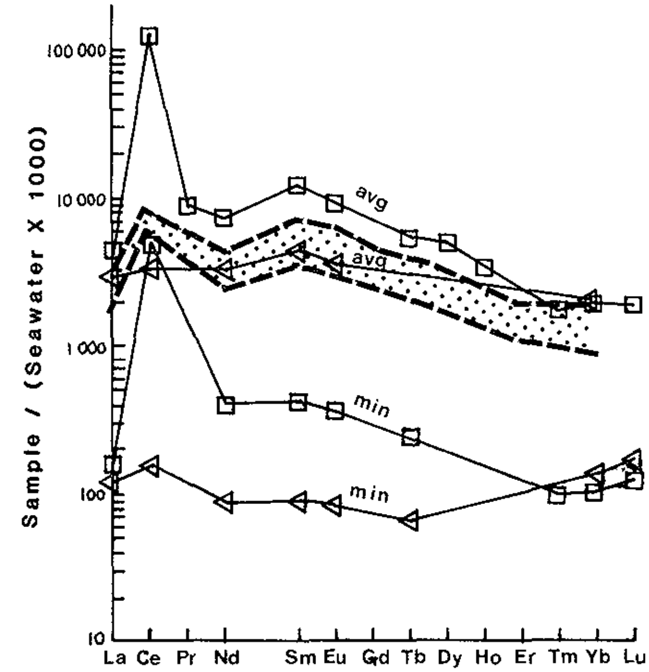


Figure B-7-7. Rare-earth element spidergram signatures of marine manganese-iron deposits. Squares are hydrogenous deposits and triangles are hydrothermal deposits with average and minimum values (after Huebner and Flohr, 1990). Patterned range is for related marine sediments (after Elderfield *et al.*, 1981).

Blebs and lenses of oxides are sometimes present within the rhodonite. This material looks similar to the black rhodonite but has a slightly more metallic appearance and is slightly softer.

Microprobe work by Harding (1989) provided analyses of barite and silica from the rhodonite ore zone. The barite contains 1 to 4 per cent SrO and less than 1 per cent Na_2O and SiO_2. Barite is a minor constituent, much less than 1 per cent. Pods of white or pinkish white material within the rhodonite zone were also examined by Harding. They are pure silica, calcite or manganoan calcite [$(Ca_{0.85}Mn_{0.15})CO_3$].

GEOCHEMISTRY

Samples of the host cherts, mineralized rocks and an oxide layer were analysed for major elements, minor elements and rare earths. Total acid digestion followed by multi-element inductively coupled plasma - atomic emission spectra (ICP-AES) analyses were done by Chemex Labs Ltd. Samples analysed were of host chert away from the mineralization, host chert adjacent to the mineralization, jasperoid chert, pistachio rock, rhodonite and an oxide layer. Trace element abundances are plotted on a logarithmic scale (Figure B-7-6). Rare earths were plotted as seawater-normalized values for comparison with data analysed by Huebner and Flohr (1990; Figure B-7-7). Rare-earth elements were normalized against North Atlantic Deep Water (NADW) by the method of Hogdahl *et al.* (1968).

Comparison of trace element data to the host chert shows the oxide layer is enriched in barium, strontium and vanadium. In a general sense, jasper is depleted and rhodonite is slightly enriched in trace elements with respect to the host chert. Trace element data show all the rock types are anomalously high in cerium. Excluding rhodonite and the oxide layer, the other rock types show flat or slightly decreasing trends in light to heavy rare-earth elements. Both rhodonite and oxide show a positive slope towards the heavy rare-earth elements. There are notable, nonsystematic negative anomalies in neodymium and europium. Jasper shows a notable depletion in rare-earth elements and rhodonite is enriched relative to the host cherts. Trends are not clear due to the neodymium and europium anomalies, but the order of magnitude of rare-earth element values in the oxide layer is within the range of hydrogenous marine manganese-iron deposits defined by Huebner and Flohr (1990). The cerium anomaly, high Ce/La and Ce/Sm ratios are also consistent with that range and rare-earth element pattern. The positive trend toward the heavy rare-earths is also similar to the data of Huebner and Flohr. The range and pattern for the host cherts are the same as those examined by Elderfield *et al.* (1981). The data suggest that the origin of the manganese is deposition on the seafloor from the water column. Hydrothermal and diagenetic processes are the probable cause of the depletion of rare earths in jasper and enrichment in the rhodonite. Enrichment and depletion of rare earths is restricted to the mineralized zone. Mineralization may be isochemical within the zone and so precludes any need to have fluids add or remove material.

SUMMARY AND CONCLUSIONS

Rhodonite mineralization at Arthur Point is stratabound. Hostrocks are black cherts and argillaceous cherts. Rhodonite occurs as massive continuous layers, strings of lenses or blebs within a zone of jasper and garnetite-silica alteration. A zoned alteration envelope, usually symmetrical, is always present around rhodonite but may be extremely telescoped around the thinner layers. The rhodonite is folded with the host cherts. The massive rhodonite underwent brittle deformation, as shown by abundant transverse fractures with minor offsets. The rest of the mineralized zone underwent ductile deformation similar to the host cherts. The mineralized zone is crosscut by basaltic dikes related to a gabbro intrusion.

The age and affinity of host cherts is somewhat enigmatic. Mapping by Roddick (personal communication, 1992) indicates that the greenstone is largely dertived from volcanic tuffs and related material that may be Late Paleozoic or Mesozoic in age. No dates have been determined but four samples of the host cherts have been taken for conodont analysis as part of this project. The Upper Devonian McLaughlin Ridge Formation of the Sicker Group hosts other rhodonite occurrences on Vancouver Island. It is suggested that the rocks at Arthur Point may be correllative with the Sicker Group.

Metamorphism post-dates mineralization. This is based on cross-cutting relationships of fracture mineralogy and interstitial, secondary minerals grains in the rhodonite zone.

The mineralization appears to be metasomatic and is restricted to discrete favourable horizons, probably centred on beds rich in manganese. The geochemical signature suggests that the mineralizing fluids leached some material from the surrounding rock. The jasper was probably formed by the expulsion of iron oxide from the core layer. The pistachio rock then represents the expulsion of the other minor elements into chemically discrete zones.

The oxide layers and the mineralized zones have significantly anomalous quantities of barium, strontium, vanadium and cerium. The high cerium anomaly and the rare earth pattern are similar to hydrogenous manganese-iron deposits as defined by Huebner and Flohr (1990). The elevated levels of barium, strontium and vanadium suggest the source of the oxide layers was hydrothermal vents or black smokers. This could indicate that the layers were distal to either a volcanogenic massive sulphide or "sedex" type environment.

Similar cherts with rhodonite lenses in the Sicker Group are related to a VMS environment. Rhodonite has been reported in cherts of the Fennel Group. Also, rhodonite occurs in cherts within the former Shoemaker Formation in the Keremeos area. Recently, rhodonite was found in Pennsylvanian-Permian cherts in the Cassiar area (Nelson *et al.*, 1990). These other rhodonite occurrences have not yet been closely examined.

ACKNOWLEDGMENTS

The project was proposed by Z.D Hora. I wish to thank Aaron Pettipas for providing able assistance in the field and CAD assistance in the office. Geochemical analyses were provided promptly by Chemex Labs Ltd. and speeded the preparation of this report. I would like to thank Jade West Ltd. for allowing this detailed documentation of its rhodonite deposit. Also A.G. Karup kindly provided a copy of his correspondence with the British Museum (Natural History).

REFERENCES

Candia, M.A.F., Peters, T. and Valarelli, J.V. (1975): The Experimental Investigation of the Reactions $MnCO_3 + SiO_2 = MnSiO_3 + CO_2$ and $MnSiO_3$ $MnCO_3 = Mn_2SiO_4 + CO_2$ in $CO2/H_2O$ Gas-mixtures at a Total Pressure of 500 Bars; *Contributions to Mineralogy and Petrology*, Volume 52, pages 261-266.

Elderfield, H., Hawkesworth, C.J. and Greaves, M.G. (1981): Rare Earth Element Geochemistry of Oceanic Ferromanganese Nodules and Associated Sediments; *Geochemica et Cosmochemica Acta*, Volume 45, pages 513-528.

Harding, R.R. (1989): unpublished private report, *British Museum (Natural History)*, 13 pages.

Hogdahl, O.T., Melsom, S. and Bowen, V.T. (1968): Neutron Activation Analysis of Lanthanide Elements in Seawater; *in* Trace Inorganics in Water, Gould R. F., Editor, *American Chemical Society*, Advances in Chemistry Series 73, pages 308-325.

Huebner, J.S. and Flohr, M.J.K. (1990): Microbanded Manganese Formations: Protoliths in the Franciscan Complex, California; *United States Geological Survey*, Professional Paper 1502, 72 pages.

Liou, J.G., Kim, H.S. and Maruyama, S. (1983): Prehnite - Epidote Equilibria and their Petrologic Applications; *Journal of Petrology*, Volume 24, pages 321-342.

Liou, J.G., Maruyama, S. and Cho, M. (1985): Phase Equilibria and Mineral Paragenesis of Metabasites in Low-grade Metamorphism; *Mineralogical Magazine*, Volume 49, pages 321-333

Nelson, J. Hora, Z.D. and Harvey-Kelly, F. (1990): A New Rhodonite Occurrence in the Cassiar Area, Northern British Columbia; *in* Geological Fieldwork 1989, *B.C. Ministry of Energy, Mines and Petroleum Resources,* pages 347-350.

Peters, T., Schwander, H. and Trommsdorf, V. (1973): Assemblages Among Tephroite, Pyroxmangite, Rhodochrosite, Quartz: Experimental Data and Occurrences in the Rhetic Alps; *Contributions to Mineralogy and Petrology*, Volume 42, pages 325-332.

Roddick, J.A. (1983): Geophysical Review and Composition of the Coast Plutonic Complex, South of Latitude 55°N; *in* Circum-Pacific Terranes, Roddick, J.A., Editor, *Geological Society of America,* Memoir 159, Pages 195-211.

SKINNER MESOTHERMAL VEIN PROSPECT

(Fig. B1, No. 8)

By Tom Schroeter and Bob Lane

LOCATION:	UTM Zone: 10U Northing: 5727600 Easting: 404600 (092N/09W) CLINTON MINING DIVISION, 100 kilometres southwest of Williams Lake, 5 kilometres north of the north end of Tatlayoko Lake on the southwest flank of Mount Skinner.
MINFILE NO.:	092N 039.
CLAIMS:	SK1 - SK7, SKINNER 1 - SKINNER 7 AND LINCOLN 1.
ACCESS:	180 kilometres east along Highway 20 from Williams Lake, then south along logging roads for about 30 kilometres, then west for several kilometres to the property via a four-wheel-drive, private access road.
OWNER/OPERATOR:	Ottarasko Mines Ltd.
COMMODITIES:	Gold.

INTRODUCTION

The Skinner intrusive-hosted mesothermal vein prospect was discovered in June 1990 by local prospector Louis Bernoilles (President, Ottarasko Mines Ltd.). The area is a new mineral locality and may represent a northern extension of the "Taseko" (Chilcotin) mineral belt. The Skinner property is located on the southwest flank of Mount Skinner in the northern part of the rugged Chilcotin Ranges, (Figure B-8-1).

RECENT EXPLORATION

The Skinner property originally consisted of seven two-post claims. These were later surrounded by conventionally staked claims. The main showing, the Victoria vein, was the target of exploration in 1990 and was exposed by hand trenching. The property was optioned to Northair Mines Ltd. in 1991. Northair focused on the Victoria vein and immediate area. Work included the completion of a grid over the area, preliminary bedrock mapping and prospecting, electromagnetic and magnetic surveys, construction of a 4-kilometre access road, mechanized trenching and diamond drilling (Bernoilles, 1991).

The Victoria vein was exposed intermittently over a strike length of 130 metres. It is covered by talus to the west and appears to feather out to the east. Vein width is variable, but it reaches a maximum of 1.4 metres. Grades are variable along the length of the vein. A composite of chip samples taken by Northair across the vein averaged 28.7 grams per tonne gold over a 1.05-metre width and strike length of 59 metres.

A six-hole diamond drilling program totalling 260 metres was completed in October 1991 (Visagie, 1991a). All holes intersected the shear zone that hosts the vein. The best intersections are in Holes 91-3 and 91-4 (0.9 m at 20.85 g/t Au and 1.0 m at 62.40 g/t Au, respectively). The owner has made a preliminary resource estimate for the Victoria vein of 11 300 tonnes grading 20.23 grams per tonne gold (Bernoilles, personal communication, 1992). Due to the suspected limited size potential of the vein Northair terminated its option and turned the property back to the owner.

REGIONAL SETTING

The Skinner property is situated in the Cadwallader Terrane of the Coast crystalline belt between the northwest-trending right-lateral transcurrent Yalokom fault to the west and Tchaikazan fault to the east (Figure B-8-1). The Tchaikazan fault is post Early Tertiary and cuts Late Cretaceous Kingsvale Group volcanic rocks and Late Cretaceous to Early Tertiary granitic rocks (Roddick and Tipper, 1985). The Mount Skinner area is underlain by Early Cretaceous to Late Triassic sedimentary rocks that have been dissected by northwest-trending splays from the major fault systems and intruded by Early Tertiary granodiorite and quartz diorite of the Coast Plutonic Complex.

PROPERTY GEOLOGY

The Skinner prospect is hosted by Early Tertiary(?) quartz diorite that intrudes upper Norian conglomerate, limestone and greywacke and Lower to Middle Jurassic (Hettangian(?), Sinemurian, Bajocian and Callovian) siltstone, shale, grit and conglomerate (Roddick and Tipper, 1985).

Veins discovered to date occur in recessive weathering zones that have, in part, been identified as linear features on aerial photographs. Vein outcrop is almost nonexistant on the property and each prospective gold-bearing target must be trenched. The "discovery zone", the Victoria vein, is up to 1.4 metres wide. It has been traced over a strike length of 130 metres. Vein orientation is 055° to 070° with a 70°N dip (Visagie, 1991b). There are

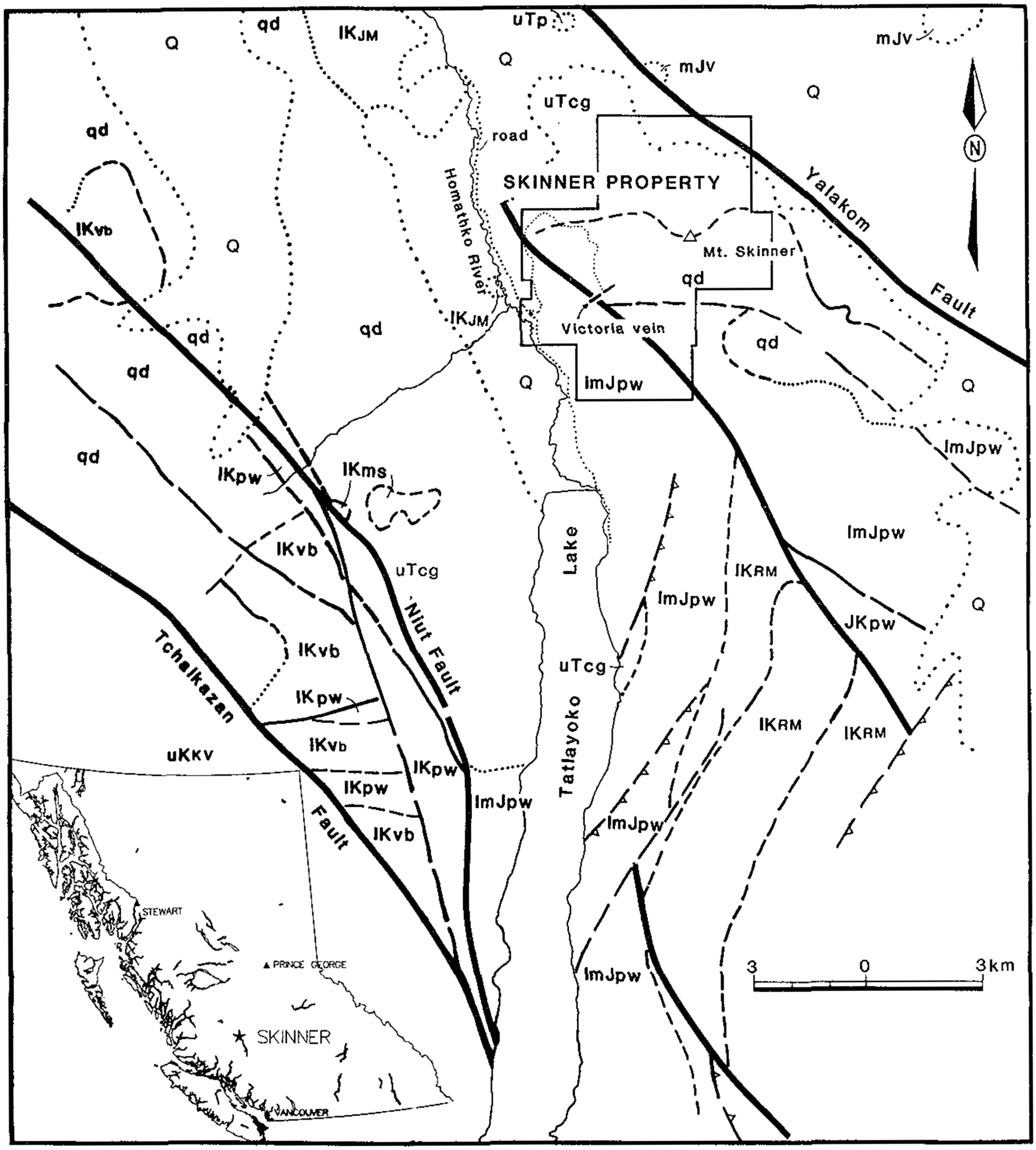


Figure B-8-1. Location of the Skinner property (inset) and regional geology of the Mount Skinner area (after Roddick and Tipper, 1985).

LEGEND

QUATERNARY

Q Till, gravel, sand and alluvium

UPPER CRETACEOUS

uKKv Kingsvale Group; Andesitic and basaltic breccia and tuff

LOWER CRETACEOUS

lKJM Jackass Mountain Group; Greywacke, siltstone and conglomerate

lKvb Andesitic and basaltic breccia and tuff

lKpw siltstone, greywacke and conglomerate, breccia, quartz sandstone and limestone

lKms Metasediments and migmatite

lKRM Relay Mountain Group: Arkose, conglomerate, greywacke, siltstone, coquinoid limestone.

JURASSIC AND CRETACEOUS

JKpw Siltstone, greywacke, conglomerate and arkose

UPPER JURASSIC

uJcg Conglomerate, shale, arkose, greywacke and tuff.

LOWER AND MIDDLE JURASSIC

lmJpw Siltstone, shale, greywacke, grit and conglomerate

mJv Tuff and volcanic breccia; minor conglomerate and shale

UPPER TRIASSIC

uTp Shale, siltstone, greywacke, conglomerate, volcanic breccia and tuff.

uTcg Conglomerate, limestone and greywacke.

COAST PLUTONIC COMPLEX

qd quartz diorite

Geologic contact

Fault

Thrust fault

Limit of outcrop

several parallel vein-bearing structures, but they are relatively narrow. Mineral showings at surface consist of free gold on fractures and within limonitic boxwork. Minor remnant pyrite also occurs. Limonite, hematite and manganese oxide are common fracture coatings, while malachite is rare. At depth gold is associated with pyrite and/or chalcopyrite. Sulphides average less than 1 per cent of the vein material, but locally reach a maximum of 5 per cent.

Wallrock alteration is patchy and generally weak. Where alteration is well developed, chlorite, sericite and clay minerals are common and secondary silica is rare. Sericite occurs in minor amounts as a gangue mineral in the quartz vein.

Fine-grained andesite dikes, typically less than a metre across, are more evident in drill core than in outcrop (Visagie, personal communication, 1991). Dikes are parallel or subparallel to the veins/shears. The relationship between the dikes and the veins is unknown.

EXPLORATION POTENTIAL

The Skinner mesothermal gold prospect, although small, is an interesting new discovery in a generally poorly known and under-explored area of the province. The intrusive-hosted shear-controlled gold vein is a new target in this area of the province.

FUTURE WORK

The owner plans to remove a 200-ton bulk sample for a test mill run in mid-1992. Subsequent underground access may be developed. Interest in the area may increase when results of a B.C. Regional Geochemical Survey for the area (92N) are released in mid-1992.

ACKNOWLEDGMENTS

We would like to thank Dave Visagie of Northair Mines Ltd. and Louis Bernoilles for their invitation and generous hospitality while visiting the property.

REFERENCES

Bernoilles, L.M. (1991): Ottarasko Mines Ltd. Summary Report, 1991.

Roddick, J.A. and Tipper, H.W. (1985): Geology, Mount Waddington (92N) Map Area; *Geological Survey of Canada*, Open File 1163.

Visagie, D. (1991a): Diamond Drilling Report on the Skinner Project; *Northair Mines Ltd.* internal report.

Visagie, D. (1991b): Geochemical Report on the SK Claims; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Assessment Report No. 21, 396.

CLISBAKO

(Fig. B1, No. 9)

By Tom Schroeter and Bob Lane

LOCATION:	UTM Zone: 10U Northing: 5841300 Easting: 429415 (093C/09E) Cariboo Mining Division, 105 kilometres west-southwest of Quesnel and about 40 kilometres southwest of Nazko. The claims are located to the east of Mount Dent.
MINFILE NO.:	093C 016.
CLAIMS:	CLISBAKO 1-15.
ACCESS:	West along Quesnel-Nazko Highway for about 100 kilometres then southwest along Forest Service gravel roads for approximately 55 kilometres to the property. There is road access to all zones.
OWNER:	Eighty-Eight Resources Ltd.
OPERATOR:	MINNOVA INC.
COMMODITIES:	Gold.

INTRODUCTION

The Clisbako epithermal prospect was discovered in June of 1990 by Eighty-Eight Resources Ltd. during a regional exploration program that was designed to locate bulk-tonnage epithermal gold targets in the low, rolling topography of the Nechako Plateau of central British Columbia (Plate B-9-1). Glacial outwash deposits were found to contain abundant epithermal quartz float which was traced back to its sources and led to the discovery of the main zones of mineralization. These are characterized by alteration centres that display an internal zone of intense silicification, with or without brecciation, that are flanked by widespread bleaching and argillic alteration accompanied by a well-developed quartz stockwork. Very fine grained sulphide minerals average less than 1 per cent of the rock and accompany the more intense phases of silicification.

There is no record of previous exploration activity on the property.

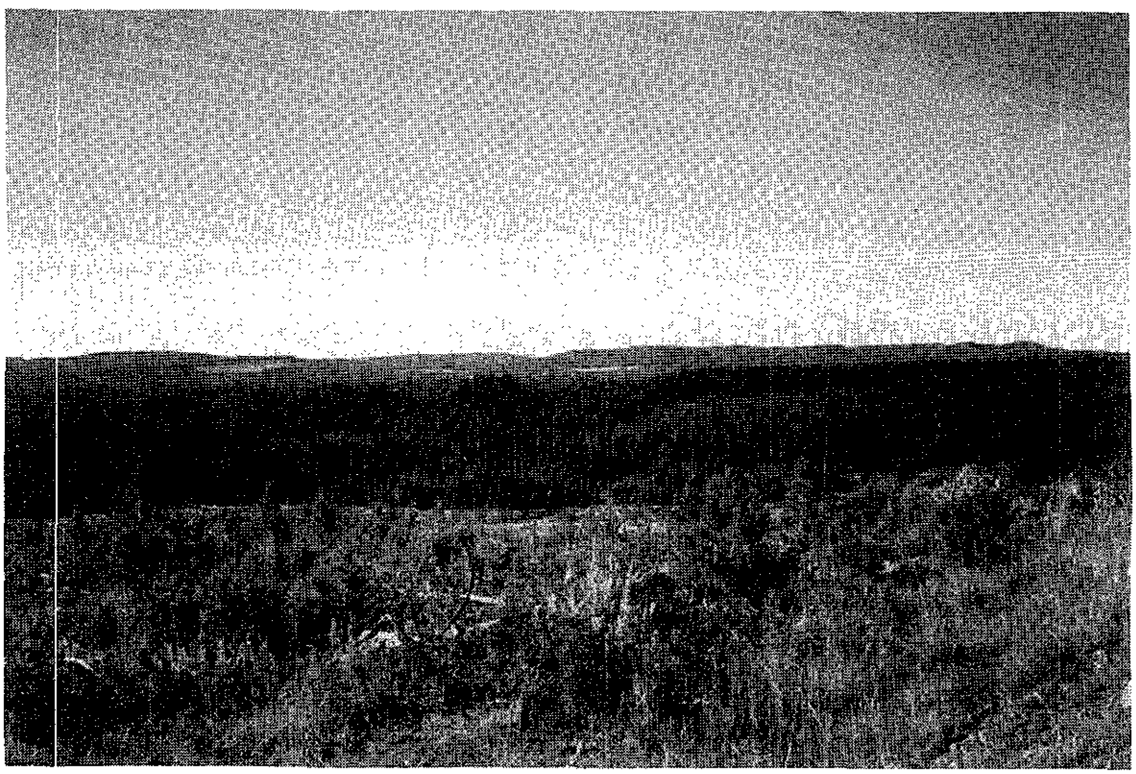


Plate B-9-1. View looking southwest towards the Clisbako property (area of clear cut in upper left background) in typical gently rolling topography of the Nechako Plateau.

RECENT EXPLORATION

A preliminary exploration program carried out in 1990 consisted of prospecting, line cutting, geological mapping, geochemical soil sampling and extensive rock-chip sampling. Minnova Inc. optioned the property in the spring of 1991. The company conducted extensive trenching on three zones and completed a 19-hole diamond-drilling program during the summer.

REGIONAL SETTING

The Clisbako prospect is situated in the south-central part of the Anahim volcanic belt (Souther, 1977), a discontinuous east-trending belt of continental Miocene and younger volcanic rocks 600 kilometres long (Bevier *et al.*, 1979) that extends from Bella Coola to Clearwater (Figure B-9-1). The property lies along an east-west trend defined by three peralkaline shield volcano complexes (Rainbow Range, Ilgachuz Range and Itcha Range) that comprise the western part of the belt.

Figure B-9-1. Location of the Clisbako property (inset) and general geology of the area (from Dawson, 1991).

The oldest rocks in the area are Lower and Middle Jurassic Hazelton Group volcanic rocks which crop out well to the north and southwest of the property. Ootsa Lake Group volcanic rocks are flat lying to gently warped and rest with angular discordance on all older rocks. The assemblage has an estimated maximum thickness of about 500 metres (Tipper, 1971). In the Mount Dent area, Ootsa Lake Group strata are overlain unconformably by remants of rhyolitic tuffs (Oligocene age?) and voluminous Late Miocene and/or Pliocene andesite and basalt flows, breccias and tuffs (Endako Group equivalents?). Intrusive rocks are not known in the area.

A series of steeply west dipping north-northeast-trending normal faults were active during Late Eocene extension. This resulted in the development of numerous tilted blocks that are most apparent in the Eocene volcanic rocks, and to a lesser extent in the Oligocene(?) ash-flow tuffs (Dawson, 1991).

PROPERTY GEOLOGY

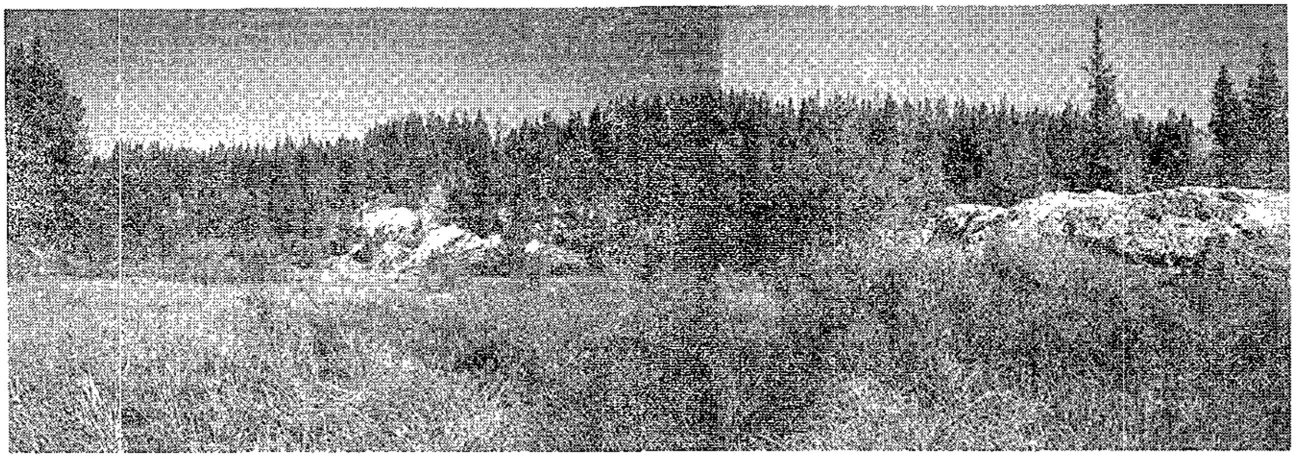
The Clisbako property consists of 15 contiguous, 20-unit claim blocks totalling 7500 hectares (Figure B-9-2). The claims are underlain by a well-differentiated sequence of subaerial tuffs, rhyolite flows and volcanic breccias of the Eocene Ootsa Lake Group (Tipper, 1971). Remants of rhyolitic ash-flow tuff units (Oligocene age?) unconformably overlie the Eocene rocks in the east-central part of the property, but are more prevalent outside the claim boundaries. Flat lying, red scoriaceous, and black vesicular basaltic flows of Oligocene and Miocene age crop out to the north and east of the claim block.

Two recent hot-spring (tufa) deposits occur on the property and may represent the surface expression of the hydrothermal system. They suggest a long-lived, multistage hydrothermal system and indicate that erosion in the area has been limited.

Outcrop accounts for less than 4 per cent of the mapped area. Rock exposures are restricted to gullies, incised drainages and road cuts. Eocene rocks occur in variably tilted blocks and consist of dacitic to andesitic tuffs, rhyolitic ash-flow tuffs, andesitic to basaltic flows, and a mudstone-siltstone unit. They are unconformably overlain by flat-lying to gently dipping, densely welded dacitic tuffs, rhyolitic flows and ash-flow tuffs.

Three well-developed hydrothermal alteration centres, as well as numerous subordinate alteration zones have been identified. The three alteration centres (South, Central and North zones) trend northeast in an "en echelon" pattern over a collective strike length of about 2500 metres. The **South zone** (Plate B-9-2) has been exposed by trenching over a strike length of 250 metres and a width of 150 metres. Hostrocks include interbedded coarse rhyolite breccia (including some flattened fragments) and platey, pale to medium green and maroon fine-grained andesitic tuff and tuffaceous breccia (Plate B-9-3). The **Central zone** was also trenched and appears to be less well defined, but is at least 150 metres in width. White to grey rhyolitic ash-flow tuffs are the principal host of the Central zone. The **North zone,** consisting of pervasive silicification and argillization, was exposed over a strike length of about 450 metres and a width of 350 metres. Hostrocks tend to be relatively flat-lying and include argillically altered tuffs (Plate B-9-4) and an interesting well-bedded lithophysa-bearing unit interbedded with a flow-banded rhyolite.

Two zones of less intense alteration, **Trail** and **Discovery**, are located 750 metres and 1250 metres, respec-



B-9-2. View of South zone looking northeast. Resistant exposures are zones of intense argillic and silicic alteration. Width of photo is about 50 metres.

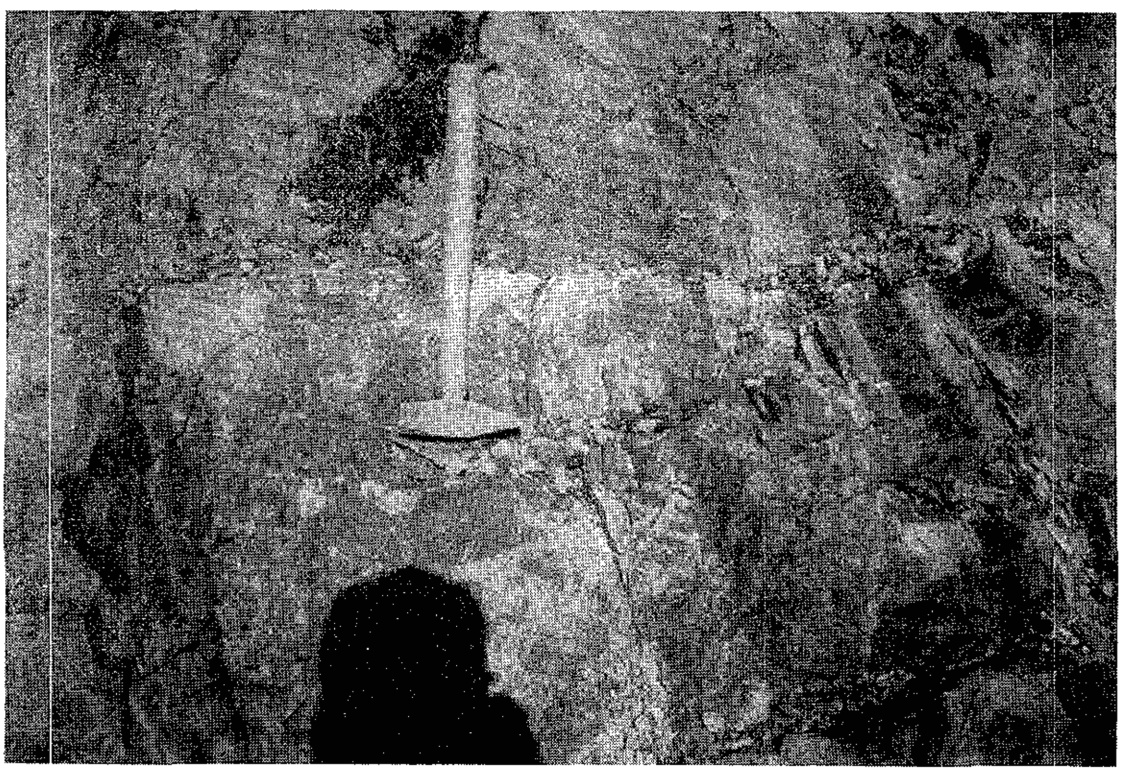


Plate B-9-3. Exposure of thinly interbedded maroon tuff and pale green adesitic tuffs. Beds of tuff breccia, not in view, are also part of this unit that crops out near the South zone.

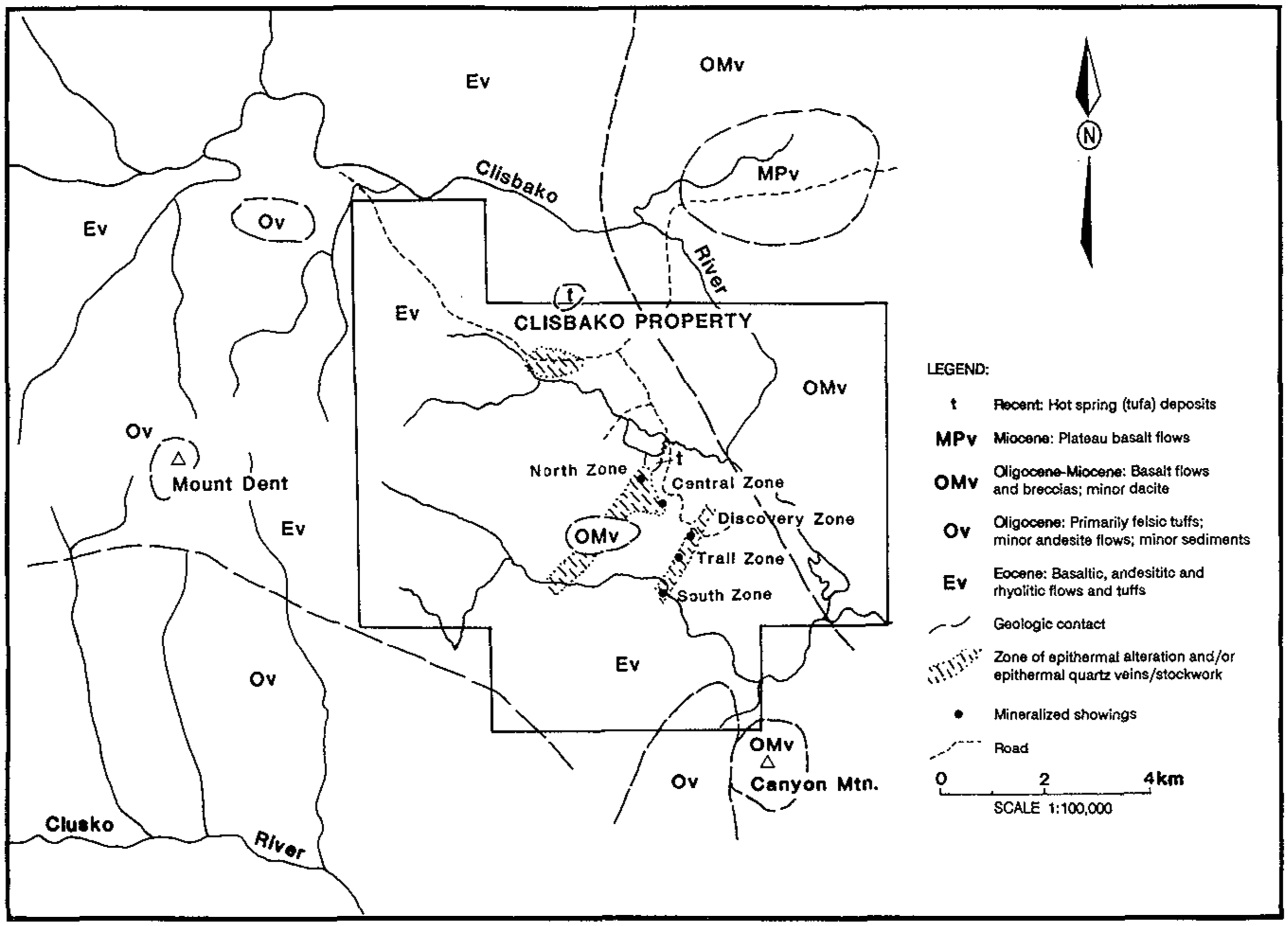


Figure B-9-2. Clisbako property and general geology of the area (from Dawson, 1991).

Plate B-9-4. Sheeted, intensely clay-altered volcanic tuff from the North zone. Note numerous randomly oriented quartz veinlets cutting across the fabric of the rock.

Plate B-9-5. Quartz stockwork in argillically altered volcanic tuffs from the north end of the South zone.

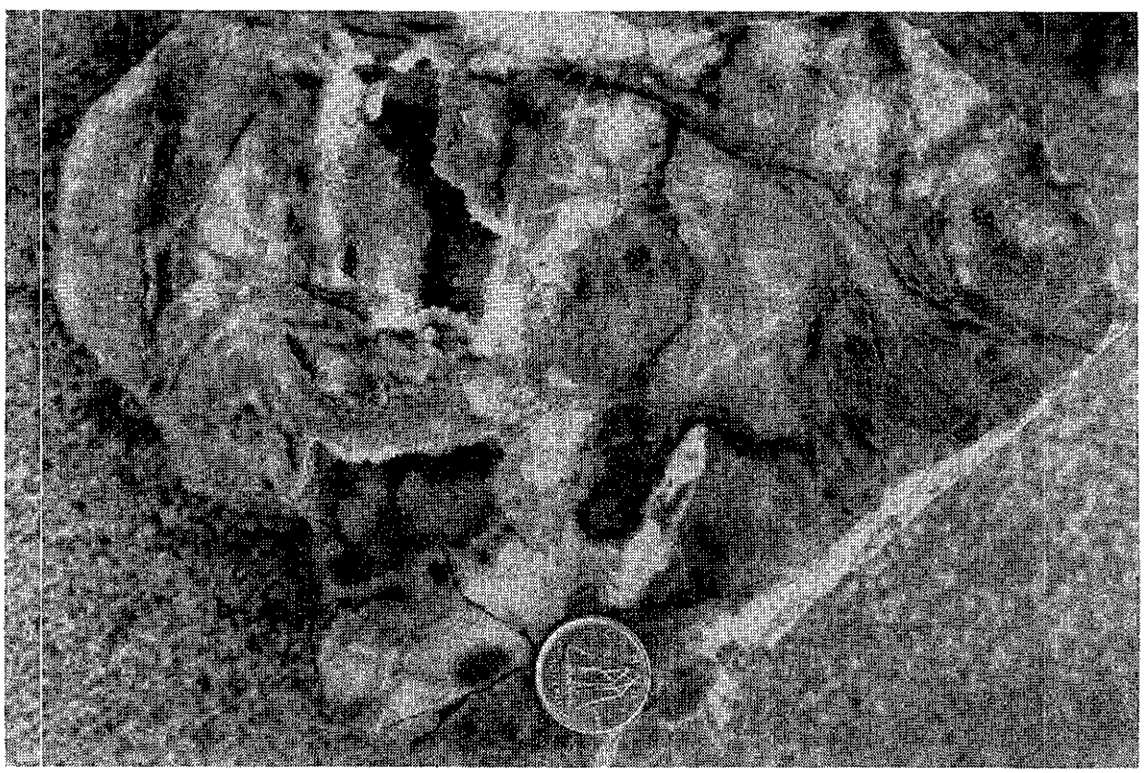


Plate B-9-6. Brecciated and silica-flooded rhyolite(?) from the South zone. Note the 'milky' opaline quartz (top middle) and weak development of colloform banding as well as quartz-lined drusy cavities (lower middle).

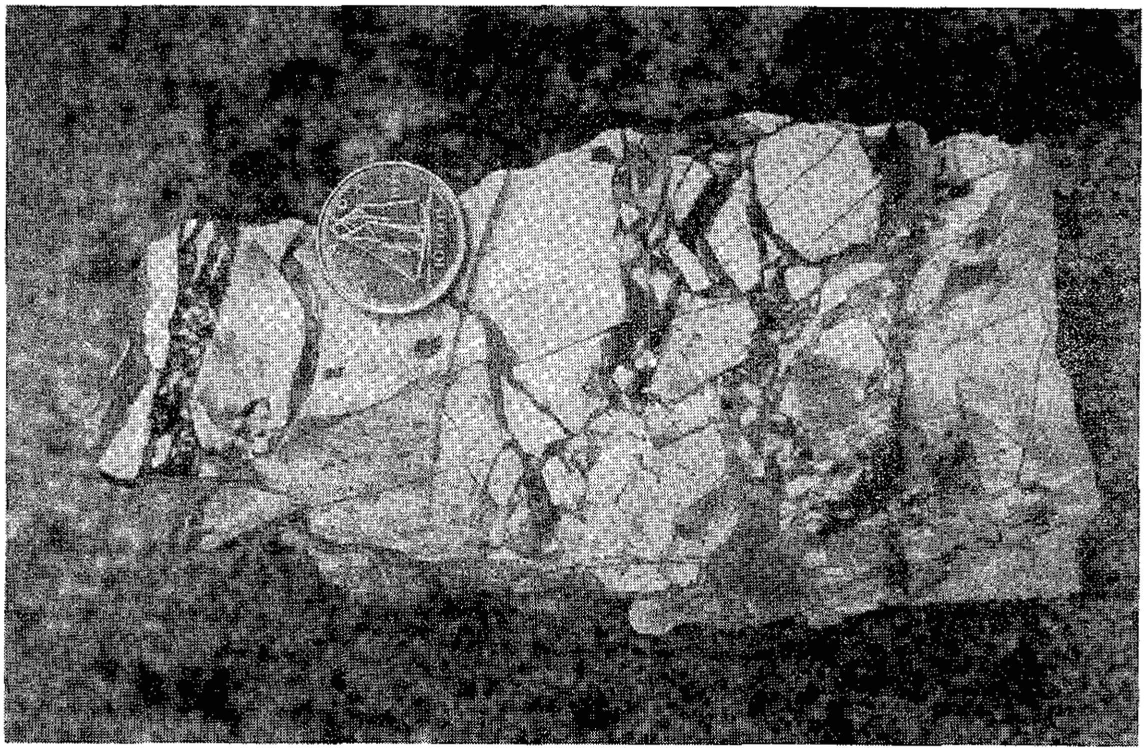


Plate B-9-7. Cut sample of iron oxide stained rhyolite from the South zone displaying subparallel quartz veinlets and subsequant fracturing, brecciation and injection of at least two phases of silica (early, dark chalcedonic quartz and later, clear drusy quartz).

Plate B-9-8. Silicified rhyolite(?) displaying at least three phases of quartz: dark chalcedonic (c), white opaline (o), and clear to iron oxide stained drusy quartz (q). Note the interesting texture of unknown affinity (upper right) and 'filament-texture' (lower right), evidence of possible calcite replacement and boiling.

Plate B-9-9. Cut sample from the South zone displaying pervasive silica replacement of rhyolitic protolith by dark chalcedonic and clear drusy quartz phases. Note quartz pseudomorphs after coarse-bladed calcite,, well-developed comb quartz on margins of sample and crustiform texture. Extremely fine grained pyrite occurs with chalcedonic quartz.

tively, along a northeast trend from the South zone. The Trail zone is exposed in a single trench that exposes argillically altered rhyolite breccia with local weak silicification and poor development of quartz veining and stockwork. Sulphides are rare. The Discovery zone is exposed in several trenches in what is now a clearcut area. It is topographically higher than any of the other zones. Intensely clay-altered and limonitic, fine-grained thinly bedded tuffaceous rocks are strongly contorted and tightly folded.

ALTERATION AND MINERALIZATION

Alteration and mineralization appear to have been localized by a complex of closely spaced subparallel, small-scale faults. In the North and South zones, areas between fault segments are strongly fractured, intensely hydrothermally altered and pervasively silicified (Plate B-9-5). Hydrothermal fluids also migrated along and replaced the more permeable beds in the stratigraphy. This is especially prevalent in the North and Central zones.

The three main mineralized and altered zones are characterized by pronounced bleaching of the hostrocks accompanied by intense argillic and silicic alteration, as well as extensive development of quartz veining, brecciation and stockwork zones. Repeated sealing and fracturing of the system is postulated to have resulted in the local development of zones of intense brecciation and permitted hydothermal fluids to periodically permeate the system. Open space filling textures are common (Plate B-9-6); where small they are typically infilled and display comb, cockade and crustiform textures. Larger drusy cavities are commonly open and display well-developed comb quartz. Banding in silica-flooded zones occurs locally.

Several varieties of quartz (*e.g.* colourless comb quartz, grey to black chalcedonic quartz, white opaline quartz and yellowish vein quartz; Plates B-9-7 and 8) are present, especially in the South zone. Carbonate minerals are uncommon. However, quartz pseudomorphs after coarse bladed calcite (Plate B-9-9) have been noted. They are thought to be evidence of boiling (Drummond and Ohmoto, 1985).

Sulphide minerals constitute less than 1 per cent by volume overall, but locally reach a maximum of about 5 per cent. Low sulphide concentrations are typical of an acid-sulphate epithermal system. Pyrite is the dominant sulphide in the system and typically is extremely fine grained. Pyrite (marcasite?) most commonly occurs as very fine grained disseminations in dark chalcedonic quartz. It also fills quartz-lined cavities. Marcasite and arsenopyrite are locally associated with coarse-grained pyrite. Pyargyrite has been identified in two zones and

TABLE B-9-1
GOLD ASSAY AND PATHFINDER ELEMENT RESULTS FROM THE CLISBAKO PROPERTY

Sample Number	Sample Type	Zone	Au ppb	Ag ppm	As ppm	Hg ppm	Sb* ppm	Sample Description
91TGS-C1	grab	South	760	15.8	460	1000	18	Breccia: 1% diss & fracture controlled py; argillically altered and silicified fragments in sil. matrix; vuggy cavities
91TGS-C2	grab	South	160	8.8	530	1500	57	Breccia: silicified fragments in a sil. matrix with 2% py/marc
91TGS-C4	(dup)	South grab	50	5.5	570	820	34	Breccia: see 91TGS-C4 description
91TGS-C3	grab	South	210	5.0	260	3300	24	Breccia: pale grey, silica flooded, % py, comb quartz veinlets
91TGS-C4	grab	South	50	5.7	570	850	34	breccia: 95% silica, multiple crosscutting phases, 1-2% v. f-gr. py/marc in black chalcedonic quartz

**average of two runns*

TABLE B-9-2
X-RAY DIFFRACTION RESULTS OF CLAY-ALTERED SAMPLES FROM THE CLISBAKO PROPERTY

Sample Number	Sample Type	Zone	Clay Mineralogy	Sample Description
91TGS-C5 ddh	core	South	illite (no quartz)	DDH CL91-5 (95 m): Intensely altered qtz eye rhyolite; vuggy
91TGS-C6	grab	South	illite and quartz	Intensely clay alt. rhyolite(?); qtz stockwork; abdt jarosite staining
91TGS-C7	grab	South	illite and quartz	Intensely clay alt. rhyolite(?); weak qtz stockwork; abdt jarosite staining
91TGS-C8	grab	North	illite-montmorillonite	Intensely clay alt. and oxidized and quartzrhyolite tuff (?); abdt qtz lined vugs
91TGS-C9	grab	North	illite-montmorillonite	Pale green/brown clay alt. rhyolitic and quartz tuff(?) with qtz-carb veinlet

may be the main silver-bearing mineral (Dawson, 1991). Visible gold has not been identified in any of the zones.

Geochemical signatures for the main zones are consistant with an epithermal model (*i.e.* anomalous to highly anomalous As, Sb, Mo and Ba). Gold and silver are also generally anomalous with rock geochemical samples reaching grades of 31 grams per tonne gold and 170 grams per tonne silver in grab samples (Dawson, 1991).

Four samples from outcrop were selected for gold assay and epithermal deposit pathfinder element (Ag, As, Hg and Sb) geochemical analysis. All were anomalous in gold and silver and returned weakly to moderately elevated levels in the other elements. The results are shown in Table B-9-1.

Five rock samples were analyzed for their clay mineralogy using x-ray diffraction techniques. Samples were prepared in Victoria by the Geological Survey Branch Analytical Services Labratory staff and submitted to Dr. Lee Groat, University of British Columbia, for analysis. The results are shown in Table B-9-2. They indicate a low-temperature regime that is consistent with the epithermal setting.

EXPLORATION POTENTIAL

This new discovery is a classic "high-level", volcanic-hosted, acid sulphate, epithermal precious metal system similar to many deposits (*e.g.* Round Mountain, Aurora, Bullfrog) currently being mined in the Great Basin of the western United States. It is further evidence of the potential of this under-explored area of the province (*i.e.* the northwesterly trend from Blackdome to Endako).

FUTURE WORK

The authors intend to continue their investigations of Tertiary metallogenic events in the Interior Plateau region of central British Columbia. Numerous projects in the area are planned by mining companies.

ACKNOWLEDGEMENTS

We would like to thank Jim Dawson of Eighty-Eight Resources Ltd. and Minnova Inc. staff, Alex Davidson and Dave Heberlein, for their cooperation and willingness to share information on the Clisbako property.

REFERENCES

Bevier, M.L., Armstrong, R.L. and Souther, J.G. (1979): Miocene Peralkaline Volcanism in West-central British Columbia - Its Temporal and Plate-tectonics Setting; *Geology*, Volume 7, pages 1141-1166.

Dawson, J.M. (1991): Geological and Geochemical Report on the Clisbako Property; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Assesment Report 20,864.

Drummond, S.E. and Ohmoto, H. (1985): Chemical Evolution and Mineral Deposition in Boiling Hydrothermal Systems; *Economic Geology*, Volume 80, pages 126-147.

Tipper, H.W. (1971): Geology, Anahim Lake (93C) Map Area; *Geological Survey of Canada*, Open File 1202A.

Souther, J.G. (1977): Volcanism and Tectonic Environments in the Canadian Cordillera - A Second Look, *in* Volcanic Regimes in Canada, Barager, W.R.A. *et al.*, Editors; *Geological Association of Canada*, Special Paper 16, pages 3-24.

FIREWEED

By Barry Ryan

(Fig. B1, No. 10)

LOCATION:	UTM Zone: 9 Northing: 6098775 Easting: 661700 (93M/1W, 2E; 93L/16W, 15E) OMINECA MINING DIVISION, 54 kilometres east-northeast of Smithers.
MINFILE NO.:	093M 151.
CLAIMS:	GER 1-4; GRR 1-3; FIREWEED 1-3; FW 1-7; MEG 1-4.
ACCESS:	From Smithers via the Babine Road to Kilometre 58 and then by logging road extending 7 kilometres eastward to the centre of the property.
OWNER:	Mansfield Minerals Inc.
OPERATOR:	MINNOVA INC.
COMMODITY:	Ag, Pb, Zn,Cu, Au.

"COAL" OCCURRENCE AT THE FIREWEED PROPERTY NORTH-CENTRAL BRITISH COLUMBIA 93M/1, 2 and 93L/15, 16

INTRODUCTION

The Fireweed property is located on the south shore of Babine Lake 54 kilometres northeast of Smithers in north-central British Columbia (Figure B-10-1). Claims are centred at latitude 55° 05′ north and longitude 126° 25′ west. The area is flat and almost completely covered by a thick blanket of till. Elevations range from 700 to 1050 metres.

The property was staked in 1987 following the discovery of float with anomalous gold values. Subsequent exploration discovered sulphide mineralization. During an exploration program by Minnova Inc. in 1991, two holes intersected carbonaceous sediments described as coal. There are no outcrops of coal or carboncaeous sediments anywhere in the region. This note documents these intersections and does not deal with the sulphide mineralization.

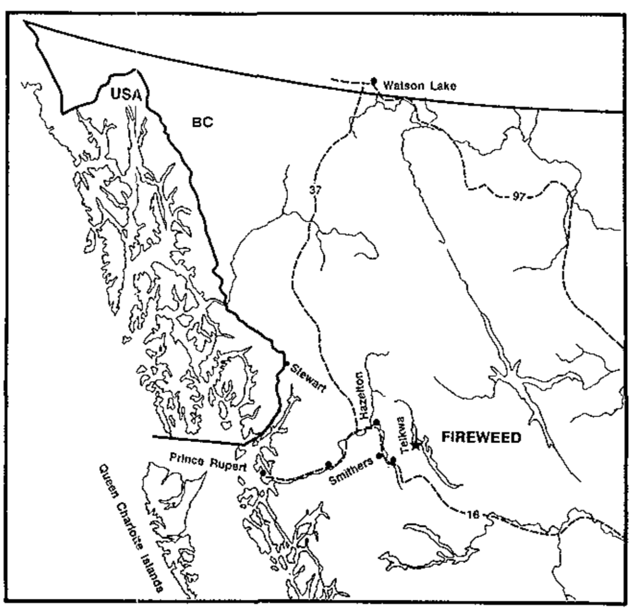


Figure B-10-1. Location map Fireweed property, northwest British Columbia.

The sulphide mineralization on the property has been described by Malott (1989). In 1987 prospectors found mineralized float and two mineralized outcrops but exploration of the property to date has depended mostly on surface geophysics and drilling. A number of IP anomalies have been tested by drilling (Holland, 1988) and a number of types of sulphide mineralization identified. Continued exploration in 1990 identified additional geophysical anomalies west of the existing anomalies. One of these, the Far-west anomaly, was tested in 1991 by four NQ diamond drill holes, two of which intersected coaly rock. Minnova geologists recognized these intersections, sampled them and reported their occurrence to the District Geology Office in Smithers.

GENERAL GEOLOGY

The region has been mapped by Richards (1980) and Tipper (1976). Sediments on the property are assigned to the Skeena Group of Cretaceous Barremian to Albian age. The location represents the most easterly confirmed subcrop of coaly sediments in the Skeena Group. Drill data indicate that the sediments on the property generally trend east-northeast and dip steeply.

Core from three holes that tested the Far-west anomaly were originally described and sampled by Minnova geologists. The author relogged and sampled the holes with Minnova's permission in 1991. Sediments in these holes are feldspathic sandstone, fossiliferous sandstone, conglomerate, mudstone, carbonaceous mudstone and coal; other rocks associated with the sediments consist of debris flows, tuffs and andesitic dikes. Fossils are bivalve fragments and belomnites. These lithologies and fossils support correlating the rocks with the Kitsun Creek Formation as mapped by Richards (1980) and MacIntyre *et al.* (1987).

COAL GEOLOGY, QUALITY AND RANK AND PALYNOLOGY DATA

The locations of the four NQ holes drilled into the Far-west anomaly are given in Table B-10-1 and Figure B-10-2. Carbonaceous mudstone and coal material were intersected in holes FW91 and FW94. Holes FW92 and FW93 did not intersect coal. Simplified down-hole lithology sections for the holes logged are shown in Figure B-10-3. It was not possible to correlate the stratigraphy between the holes.

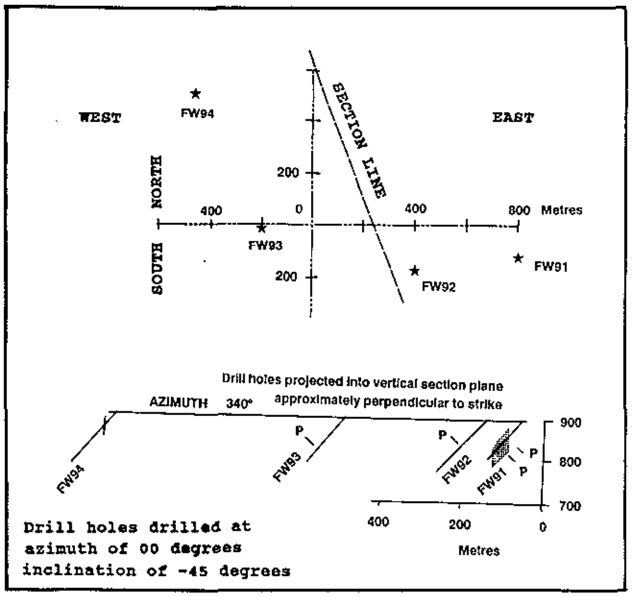


Figure B-10-2. Fireweed Property, Far-west anomaly drill-hole locations on property grid and vertical section.

Hole FW91 intersected coaly material, andesites and sediments over the interval of 45 to 114 metres, 48.6 metres of this was coaly material. Hole FW94 intersected 1.4 metres of coaly material from 33 to 36 metres. Generally the coaly material was extremely fragmented consisting of powder and fragments of carbonaceous mudstone and minor coal less than 5 centimetre in diameter. Often when coal core is recovered in this condition there is a substantial loss of the lighter, cleaner coal. This is exaggerated when the core diameter is small and the core recovery is low. Core recovery of the coaly sections varied from 50 to 100 per cent, therefore it is possible that the core recovered is not very representative of the section drilled. In this situation down-hole geophysical logs are often the only way of estimating coal quality.

A number of samples were collected for coal quality analysis, reflectance measurements and palynological analysis.

The results of the coal quality analyses are reported in Table B-10-2. The raw samples are not coal. The core had been sampled at least twice before the author attempted to take representative samples and the possibility exists that the "coal" sections had been high graded, which would increase the ash content of the samples collected by the author. If the samples are representative then the high ash content may indicate that the samples are a mixture of coal and mudstone, in which case floating the samples at a specific gravity of 1.6 should recover any small amounts of intermixed coal. The ash of the float samples is also high (Table B-10-2) indicating that the samples are predominantly carbonaceous mudstone with very little intermixed coal.

Three measurements of mean maximum reflectance were obtained from samples from holes FW91 and FW94 (Figure B-10-3). Values range from low-volatile bituminous to semi-anthracite. the large variation in reflectance is probably caused by heating due to the andesite intrusions intersected in the holes. The regional rank is probably 1.97 per cent or less.

Four samples were dissolved for palynology (Davies, 1991) but no palynomorphs were found, in part because of the high and variable rank.

TABLE B-10-1
FIREWEED PROPERTY
FAR-WEST ANOMALY, DRILL-HOLE DATA

HOLE	GRID LOCATION		HOLE ORIENTATION			
	NORTH	EAST	ELEV	AZIMUTH	INCL	TD
FW91	120 S	800 E	900	000.00	-47°	125.0
FW92	175 S	400 E	900	000.00	-47°	164.6
FW93	25 S	200 W	900	000.00	-47°	147.3
FW94	515 N	480 W	900	000.00	-47°	169.8

Note: all distances in metres, grid 00.00 east 00.00 north estimated at UTM easting = 661700, northing = 6098775, TD = total hole depth.

TABLE B-10-2
FIREWEED PROPERTY, "COAL" QUALITY

SAMPLE	HOLE	FROM	TO	LENGTH	TRUE THICKNESS
A	FW91	49.4	51.3	1.9	1.36
B	FW91	60.96	70.1	9.14	3.86
C	FW91	104.2	111.35	7.15	5.09

SAMPLE	TYPE	MOISTURE	ASH	VM	FC	S	FSI	CV
A	raw	4.55	65.6	10.2	19.7	/	/	/
A	wash	1.44	23.7	14.9	59.9	/	0	/
B	raw	4.43	69.9	10.4	15.3	/	/	/
B	wash	1.58	36.9	11.1	50.4	/	0	/
C	raw	6.8	69.9	7.5	15.8	1.02	/	/
C	wash	1.76	56.0	9.4	32.9	0.55	0	3164

Oxide analysis sample C wash

SiO_2	Al_2O_3	TiO_2	Fe_2O_3	CaO	MgO	Na_2O	K_2O	P_2O_5	SO_3
59.7	28.8	1.2	1.5	1.5	0.48	2.6	0.85	0.08	0.54

undetermined 2.8 per cent
base/acid ratio = 0.11

Note: Values in metres or per cent samples washed at 1.6 S.G.
CV = calorific value in calories per gram.

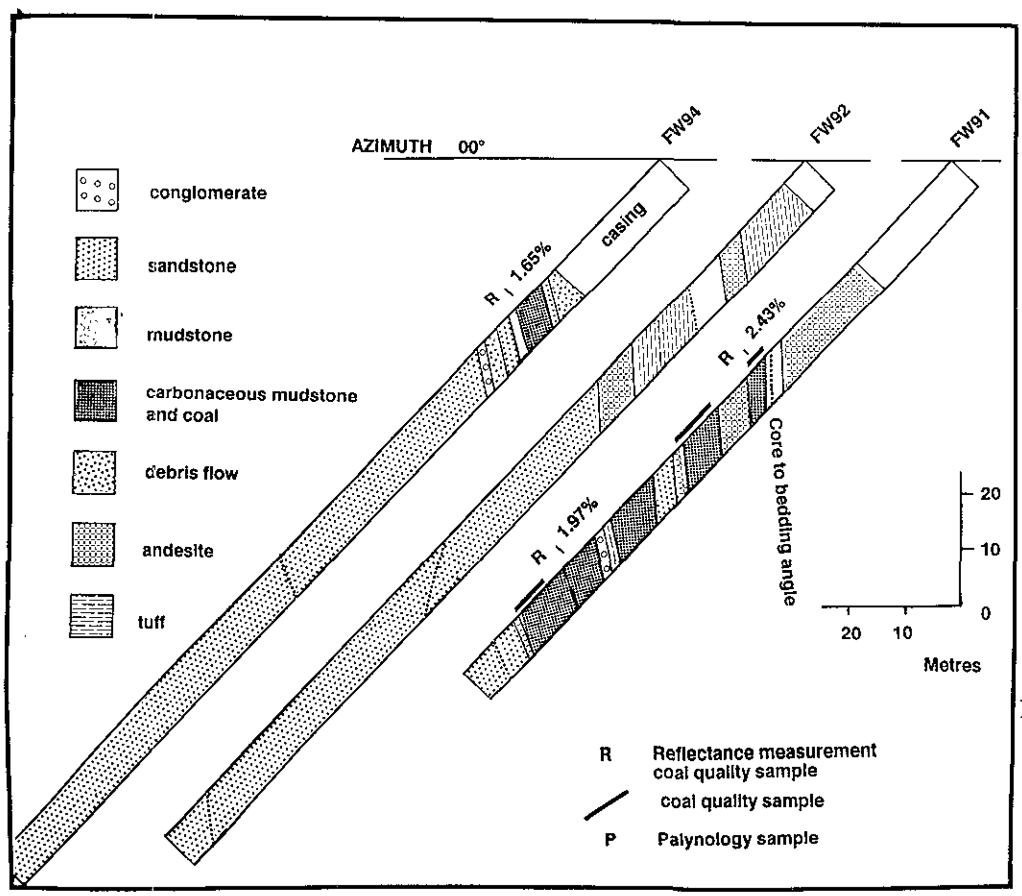


Figure B-10-3. Lithology logs for three holes from the Farwest anomaly (azimuth and inclinations are true but holes are not projected into section).

DISCUSSION

It is unlikely that useful quantities of coal will be found in the vicinity of the Fireweed property. The depositional environment of the sediments appears to have been largely marine and associated with volcanic activity. The carbonaceous mudstone might be associated with near-shore environments inundated with vegetation killed by volcanic activity. The sediments are tentatively identified as Kitsun Creek Formation, although the abundance of volcanic material is unusual for this formation.

ACKNOWLEDGMENTS

Thanks are extended to Jim McDonald of Mansfield Minerals Inc. and Gary Wells of Minnova Inc. for providing information and permitting logging and sampling of the drill core. J.T. Thomas of Smithers provided access to the core and excellent facilities in which to log it.

REFERENCES

Davies, E.H. (1991): Palynological Analysis of 17 Outcrop Samples from Northwestern British Columbia; Report 91-027, Contract number 92-914, Submitted to the *B.C. Ministry of Energy, Mines and Petroleum Resources*, Geological Survey Branch.

Holland, R. (1988): Geological, Geophysical, Geochemical and Trenching Report on the Fireweed Mineral Claim Group; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Assessment Report 17774.

MacIntyre, D.G., Brown, D., Desjardins, P. and Mallett, P. (1987): Babine Project 93l/10, 15); *in* Geological Fieldwork 1986, *B.C. Ministry of Energy, Mines and Petroleum Resources*, Paper 1987-1, pages 201-222.

Malott, M.L. (1989): Fireweed (093M151); *in* Exploration in British Columbia 1988; *B.C. Ministry of Energy, Mines and Petroleum Resources*, pages B127 to B131.

Richards, T. (1980): Hazelton, B.C. 93M; *Geological Survey of Canada*, Open File Map 720.

Tipper, H (1976): Smithers, B.C. 93L; *Geological Survey of Canada*, Open File Map 351.

RED MOUNTAIN

(Fig. B1, No. 11)

By Tom Schroeter, Bob Lane and Adrian Bray

LOCATION:	UTM Zone: 09 Northing: 6202515 Easting: 456645 (103P/13E) Skeena Mining Division, approximately 15 kilometres east of Stewart, between Bromley Glacier and the Cambria Icefield.
MINFILE NO.:	103P 086.
CLAIMS:	ORO 1 TO 6, HROTHGAR.
ACCESS:	Access to the property is by helicopter (15 minutes) from Stewart. An old logging road extends 6.5 kilometres up Bitter Creek valley.
OWNER/OPERATOR:	LAC MINERALS LTD.
COMMODITIES:	Gold, silver, zinc, molybdenum.

GEOLOGIC SETTING AND MINERALIZATION OF THE RED MOUNTAIN MESOTHERMAL GOLD DEPOSIT

INTRODUCTION

The Red Mountain mesothermal gold prospect is located in the historic, and currently active, Stewart mining camp. The area has been explored intermittently since before the end of the last century, principally for placer and lode gold as well as stockwork molybdenum deposits. The Red Mountain area is underlain by some of the most prospective geology in British Columbia, namely volcanic stratigraphy of the Lower to Middle Jurassic Hazelton Group. These rocks host numerous deposits in the Stewart mining camp including long-time gold producers Premier and Big Missouri. Correlative strata host deposits in the Iskut and Sulphurets gold camps, and the recently discovered Eskay Creek precious metal rich massive sulphide deposit.

The Red Mountain property (Plate B-11-1, Figure B-11-1) consists of 97 claims totaling 27 838 hectares. Many areas of the property are extremely rugged to precipitous and required the use of mountaineering geologists for mapping and geochemical sampling. Likewise, innovative methods for the construction of diamond drill pads, including the construction of concrete pylons, were developed to carry out more detailed work (Plate B-11-2).

The claims are more than 50 per cent covered by snow and glacier ice. Bromley Glacier, a north-trending tongue of ice, splits the claim group into east and west sections. The eastern margin of the property is covered by the northwestern fringe of the Cambria Icefield. Glacial downwasting (of about 150 metres, indicated by trimlines in Bromley Glacier valley) and ablation over the past few decades have exposed previously unexplored ground where several showings were recently discovered. The main focus of exploration has been on precious metal occurrences that are exposed east of Bromely Glacier. These are currently being investigated by Lac Minerals Ltd.

RECENT EXPLORATION

The claims that cover Red Mountain were staked by Wotan Resources in 1988 and 1989. Bond Gold Canada Inc. optioned the claims in 1989 and spent approximately $1 million on exploration that year (Vogt, 1989). Bond Gold discovered several gold showings that are spatially related to an Early Jurassic intrusion. These included the

Figure B-11-1. Location of the Red Mountain property.

Plate B-11-1. Red Mountain property looking west-southwest down Goldslide creek. Note Red Mountain summit (far right), exploration camp (centre), Bromley Glacier (centre), Cambria Icefield (far left) and the Marc and Brad zones (far right and centre, respectively).

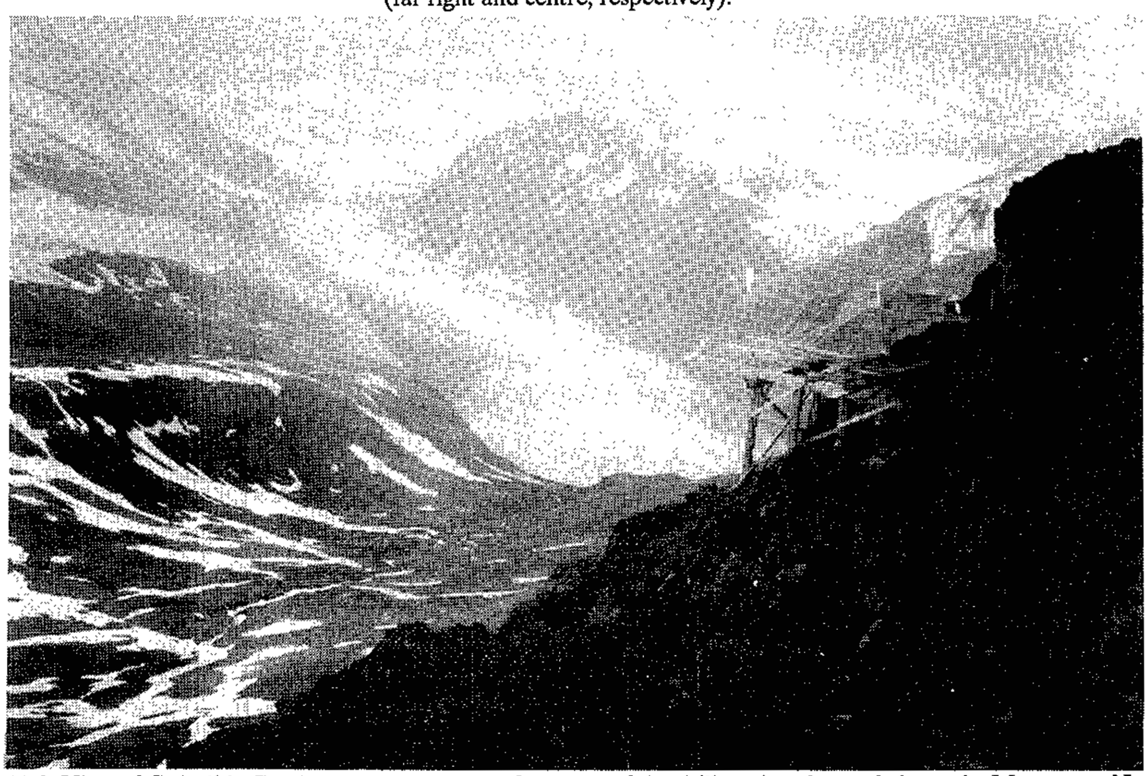


Plate B-11-2. View of Goldslide Creek valley looking west from one of the drill stations located above the Marc zone. Note the use of concrete pilons to support the timbers that formed the base of the drill pad.

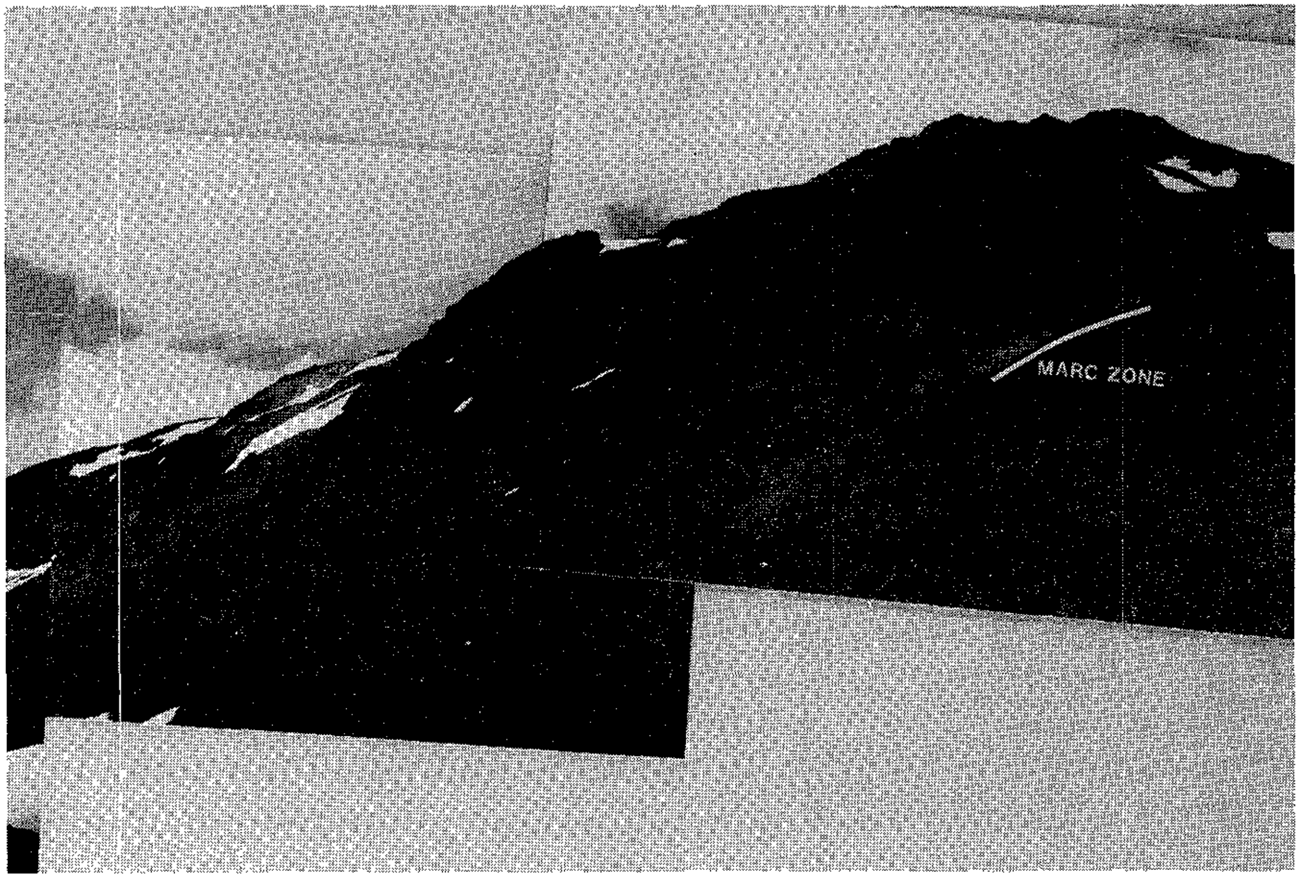


Plate B-11-1. Continued.

Marc and Brad zones which were tested by 21 and 6 diamond-drill holes respectively. The company spent $3.4 million at Red Mountain in 1990. This program included: mapping and sampling; airborne electromagnetic surveys (5000 line km at 200-m spacings) that located several conductors oriented subparallel to stratigraphy; ground VLF and magnetometer surveys that generated additional geophysical targets; 41 diamond-drill holes that defined gold mineralization in the Marc zone over a strike length of about 250 metres; and 13 additional holes that were drilled on geophysical targets elswhere on the property. A preliminary geological resource of 913 725 tonnes grading 12.68 grams per tonne gold and 36.08 grams per tonne silver (using a cut-off grade of 3 grams per tonne gold) was calculated for the Marc zone (Lac Minerals Ltd., 1991 Annual Report).

In 1991 Lac Minerals purchased Bond Gold and continued exploration on the property. The company conducted a large regional-scale mapping program, remapped the area of interest at a property scale, diamond drilled eight new holes and extended three previous holes totalling 2628 metres and sampled many of the gold showings on the surface. Baseline environmental studies were initiated in September, 1990 and are ongoing.

REGIONAL SETTING

The Red Mountain area is part of the Stikine Terrane of the Intermontane Belt. It is at the western margin of a Late Triassic (Stuhini Group) to Middle Jurassic (Hazelton Group) volcanoplutonic arc called the Stewart Complex (Grove, 1986). Tertiary and Jurassic rocks of the Coast Plutonic Complex border the Stewart Complex to the west. Jurassic to Early Cretaceous Bowser Lake Group sedimentary rocks overlie the complex to the east. The prospective area at Red Mountain is defined by a 12 square kilometre gossan that covers what company geologists have mapped as the eastern limb of a prominent north-northwest-trending antiform (Vogt *et al.,* 1992). The same structural feature was described as a syncline by Grove (1986). Its fold axis passes immediately west of the property and extends from Bromley Glacier northward to the Bear River.

Three intrusive events have occurred in the Stewart area: a Lower Jurassic event (Texas Creek Plutonic Complex), an Early Tertiary event (Coast Plutonic Complex and the satellitic Hyder Plutonic Suite), and an Oligocene-Miocene lamprophyre dike suite (Portland Canal swarm). Elements of each are found on the Red Mountain property (*see* Figure B-11-2a).

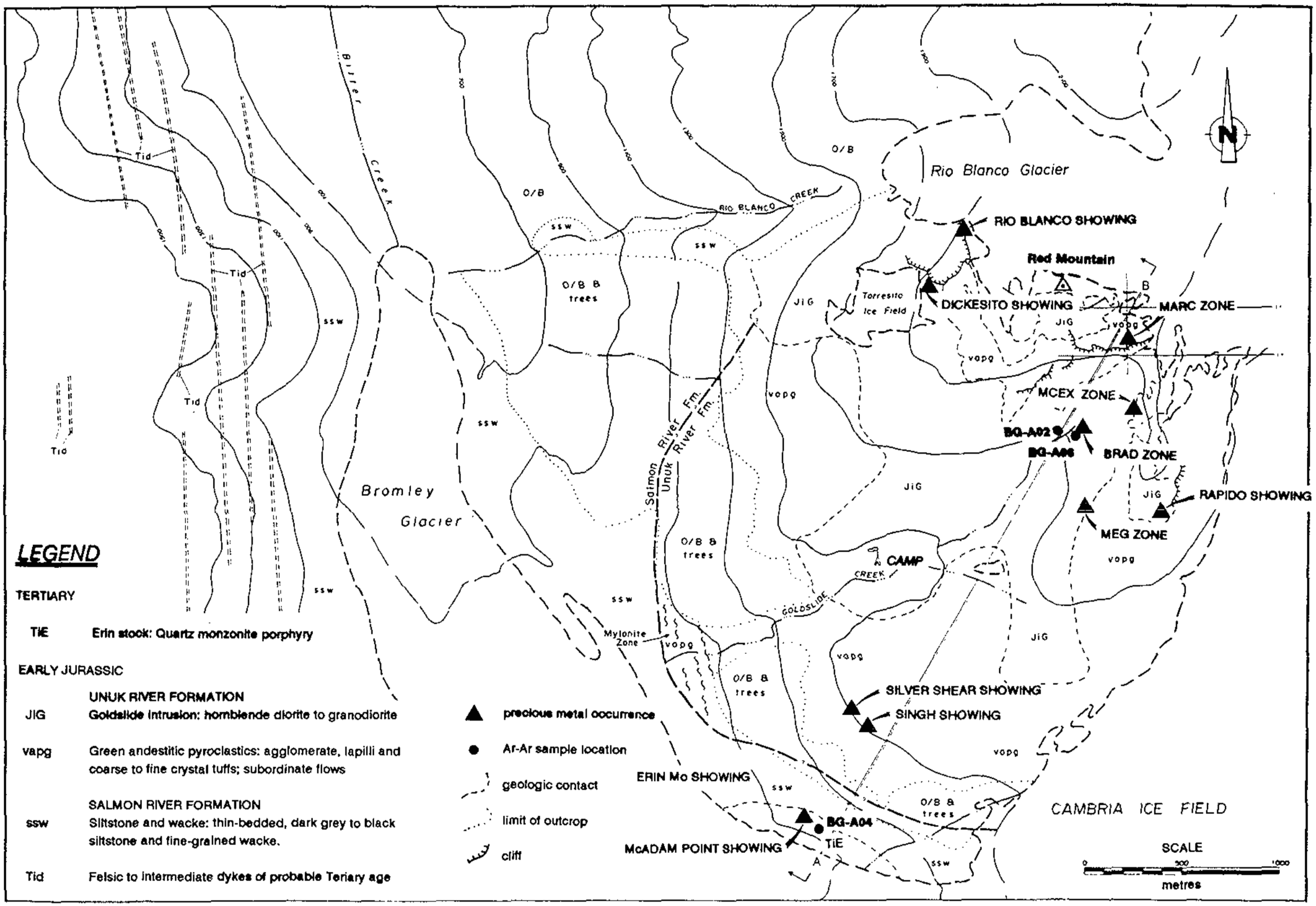


Figure B-11-2b. Simplified bedrock geology of the central part of the Red Mountain property (courtesy of Lac Minerals Ltd.) showing the location of significant precious metal occurrences and location of samples used for Ar-Ar analyses.

TABLE B-11-1
ARGON-ARGON DATA, RED MOUNTAIN PROPERTY

Sample Number	UTM Location Easting	Northing	Name - Lithology	Material Analyzed	Apparent Age (Ma)
BG-A02	456167	6201837	Goldslide intrusion - hornblende porphyry	hornblende	200
BG-A04	455231	6199977	Erin stock - quartz monzonite	biotite	45±2
BG-A06	456498	6202038	Goldslide intrusion - hornblende porphyry	hornblende	160±5

PROPERTY GEOLOGY

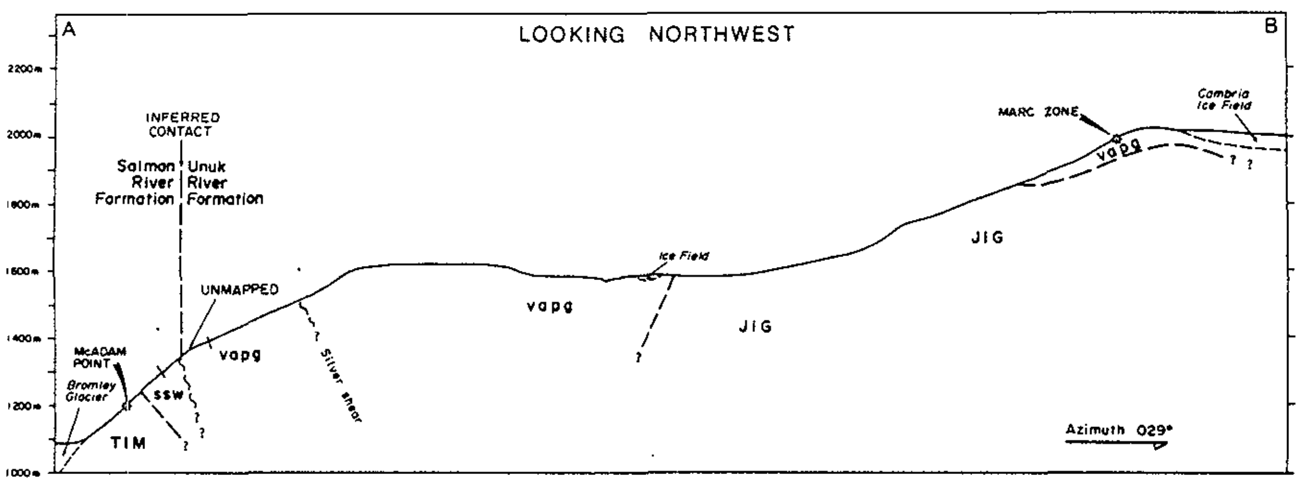
The property is underlain by Jurassic Hazelton Group rocks. Lower and Middle Jurassic Salmon River Formation rocks crop out west of Bromley Glacier. They consist of a sequence of fine to coarse-grained clastic sedimentary rocks and fossiliferous limestones. Lower Jurassic Unuk River Formation underlies much of the property east of Bromley Glacier. These intermediate pyroclastic rocks consist of interbedded ash-dust tuffs (Plate B-11-3), coarse ash tuffs, lapilli tuffs, finely banded argillites and tuffaceous sediments and limestones. The strata generally strike northwest and dip steeply to the southwest. A distinct volcaniclastic unit crops out to the northeast of the Marc zone at the edge of the Cambria Icefield (Figure B-11-2b). It is rusty weathering and is characterized by limestone fragments set in a fine-grained dacitic tuff matrix (Vogt, 1990). There is no evidence of the presence of the Betty Creek and Mount Dilworth formations, which regionally underlie the Salmon River Formation, on the property.

The Goldslide intrusion is a hypabyssal hornblende-plagioclase-porphyritic granodiorite to diorite stock. It is characterized by prismatic hornblende and a green-weathering appearance due to widespread alteration of mafic minerals and plagioclase to chlorite and epidote. The intrusion underlies Goldslide Creek cirque and the west and east slopes of Red Mountain. An argon-argon date of approximately 200 Ma (Table B-11-1) has been determined on a hornblende separate from the intrusion and establishes it as a member of the Texas Creek Plutonic Suite. Emplacement of the Goldslide intrusion resulted in pyritization and sericitization of the surrounding Unuk River Formation.

The margin or "contact zone" of the intrusion is intensely brecciated. The breccia consists of argillite and/or pyroclastic rock fragments set in an intrusive matrix. Locally, the zone is a well-developed quartz stockwork, accompanied by weak to intense silicification, sericitization, propylitization and precious metal mineralization.

Tourmaline is restricted to silicified zones within the Goldslide intrusion (Vogt, 1990). Coarse-grained, bladed purple axinite accompanied by quartz and epidote occurs in fractures that cut the intrusion in the cirque area (Plate B-11-4). These boron-bearing minerals may be associated with precious metal mineralization hosted by the Goldslide intrusion at the Brad zone.

The Erin stock is a granodiorite to quartz monzonite, locally potassium feldspar megacrystic, intrusion. It is exposed on the extreme southern flank of Red Mountain



RED MOUNTAIN CROSS SECTION

Figure B-11-2b. Cross-section looking west through Red Mountain (*see* section line A-B on Figure 2a).

Plate B-11-3. Thinly interbedded intermediate tuffs of theUnuk River Formation exposed near Red Mountain summit.

Plate B-11-4. Hornblende-porphyritic granodiorite of the Goldslide intrusion exposed near the Brad zone. Axinite (ax) veinlets crosscut the granodiorite.

Plate B-11-5. Irregular contact between megacrystic feldspar porphyry and biotite hornfels, McAdam Point.

(Figure B-11-2a), and probably extends beneath Bromley Glacier onto Lost Mountain. An Early Tertiary age of 45±2 Ma has been determined by argon-argon analysis of a biotite separate (Table B-11-1). Widespread development of biotite hornfels in limy sedimentary and pyroclastic rocks occurs along the contact (Plate B-11-5). North-northwest-trending shear zones cut the stock. They host molybdenum and gold mineralization (McAdam Point showing).

MINERAL PROSPECTS

More than ten gold showings (Rio Blanco, Dickesito, Marc, MCEX, Brad, Rapido, Meg, Silver Shear, Singh and MacAdam Point) have been located on the property (Figure B-11-2a). The Marc zone, located just south of the Red Mountain summit, is the most significant gold occurrence discovered on the property to date. The morphology of the Marc zone appears to follow the moderately to steeply south dipping contact margin of the Goldslide intrusion (Vogt, 1990). It has been traced at surface for a minimum of 30 metres and is up to 20 metres wide. The zone is marked by an intense zone of alunite-jarosite alteration that stands out from a distance as an elongate yellow patch against the red-brown gossanous background of Red Mountain (Plate B-11-6).

The Marc Zone consists of three irregularly shaped sulphide-rich lenses (North, Main and East) that are associated with the brecciated margin of the Goldslide intrusion (Vogt, 1990). Mineralization consists mainly of densely disseminated to massive pyrite and stringers of pyrite within a dark grey to black siliceous matrix. Accessory pyrrhotite and sphalerite, and minor chalcopyrite, arsenopyrite, galena, tetrahedrite and various telluride minerals are present. Gold occurs in its native form, in electrum and in numerous telluride minerals--petzite (Ag_3AuTe_2), calavarite ($AuTe_2$), sylvanite ($AuAgTe_4$), and in aurostibnite (AuSb) (Vogt *et al.*, 1992). Telluride minerals are thought to account for a significant percentage of the gold. They are closely associated with native gold and electrum. Rare visible gold has been identified in diamond-drill core (Vogt, 1990).

A continuous mineralized zone, over 150 metres in strike length, has been defined by diamond drilling (70 diamond drill holes totalling over 17 000 m). The zone ranges from 3 to 10 metres in thickness. The most significant diamond-drill hole intercepts were obtained in DDH M90.35 where 55.5 metres returned an average assay of 12.08 grams per tonne gold; and DDH M90.40 which cut a 25.5-metre intersection averaging 36.37 grams per tonne gold. Similar 'Marc-type' mineralization was encountered 100 and 150 metres to the north, effectively extending the known strike length of the zone to over 300 metres. The deposit is open to the north and south and, locally, down dip to the west. Numerous post-mineral faults cut the mineralized zone.

Plate B-11-6. Looking south-southwest over the Marc zone. Cliffs 10 metres high behind the geologists are intensely alunite and jarosite stained. Dashed line marks the surface trace of the mineralizated zone. The exploration camp and Bromley Glacier are in the background.

Veinlets carrying up to 5 per cent by volume of combined argentiferous galena and honey-coloured sphalerite cut the Marc zone and represent a more recent mineralizing event.

The UTEM zone lies 200 metres up-section from the Marc zone. It was discovered by drilling a subsurface geophysical anomaly. The zone appears to be a stratabound, base metal prospect and requires more evaluation. Sphalerite-pyrrhotite-pyrite±chalcopyrite occur within a brecciated sequence of interbedded argillite and tuffs (Vogt *et al.*, 1990). The best diamond-drill intersection to date has been 9 metres averaging 5.6 per cent zinc, 69.2 grams per tonne silver and 0.58 gram per tonne gold.

Four gold-enriched occurrences (MCEX, Brad, Rapido and Meg) located south of the Marc zone lie within the Goldslide intrusion or along its margin (*see* Figure B-11-2a). The Brad Zone is the most significant. A 3.5-metre drill-core intersection assayed 19.84 grams per tonne gold. The Singh and Silver Shear showings, 2.5 kilometres southeast of the Marc zone, have yielded grab samples assaying 5.16 grams per tonne gold and 34.12 grams per tonne gold, respectively. These two occurrences are hosted in andesitic pyroclastic rocks about 500 metres from the contact with the Goldslide intrusion. Galena-lead isotope data for the Meg and Silver Shear occurrences suggest that they are Tertiary in age.

The Rio Blanco showing is about 1000 metres northwest of the Marc zone. Anomalous precious metal values occur near the contact between the Goldslide intrusion and intensely gossanous pyroclastic volcanic rocks. The Dickesito showing, located about 1100 metres west of the Marc zone, occurs within granodiorite, approximately 100 metres from the contact (Plate B-11-7).

The McAdam Point showing is at the southern extremity of Red Mountain and is controlled by several north-northwest-trending shear zones that crosscut the Erin stock. Chip samples taken across the shears have assayed up to 58.0 grams per tonne gold and 191.7 grams per tonne silver across an 0.85-metre interval. The Erin stock also hosts a molybdenum occurrence (Erin showing) that was drilled in the mid-1960s. These two occurrences are related to a mineralizing event and/or events much younger than the occurrences near the contact of the Goldslide intrusion.

SUMMARY

The relationship between Early Jurassic plutonism and precious metal mineralization in the Stewart mining camp has long been recognized. At Red Mountain the 200 Ma. Goldslide intrusion is spatially associated with, and may be genetically related to, several precious metal prospects including the Marc zone. Good potential exists for further discoveries.

ACKNOWLEDGMENTS

We would like to thank Lac Minerals exploration staff for their open discussions, informative surface tours, and hospitality. In particular, we recognize the assistance and enthusiam of Andreas Vogt who died tragically as a result of a bee sting while in the field in August 1991.

REFERENCES

MINFILE 103P, Fischl, P. and Jakobsen, D.E. (1990): Red Mountain, MINFILE 103P 086; *B.C. Ministry of Energy, Mines and Petroleum Resources.* MINFILE data revised February, 1990.

Grove, E.W. (1986): Geology of the Unuk River - Salmon River - Anyox Area; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Bulletin 63.

Vogt, A.H., (1989): 1989 Geological/Geochemical Exploration and Diamond Drilling on the Red Mountain Property; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Assessment Report 20133.

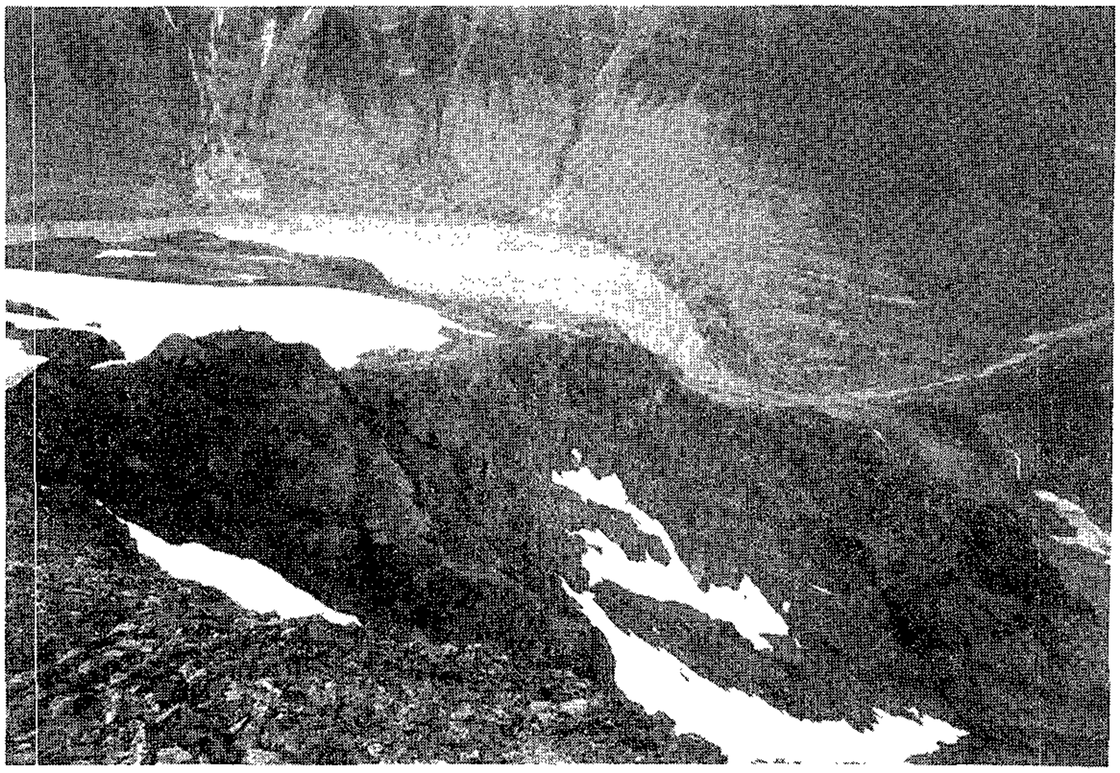


Plate B-11-7. Looking west over lower end of the Rio Blanco zone. Mountaineering geologists were used to map and sample this treacherous area. Bitter Creek (background) exits from the toe of Bromley Glacier. Dikes of probable Tertiary age (Portland Canal swarm?) are exposed beyond the glacier.

Vogt, A.H., (1990): 1990 Diamond Drill Report at the Red Mountain Property; *B.C. Ministry of Energy, Mines, and Petroleum Resources*, Assessment Report 20971.

Vogt, A.H., Bray, A.D. and Bull, K. (1992): Geologic Setting and Mineralization of the Lac Minerals Red Mountain Deposit (Abstract), *British Columbia and Yukon Chamber of Mines*, 1992 Cordilleran Roundup.

POLARIS-TAKU
(Fig. B1, No. 12)

By M.G. Mihalynuk and C.C. Marriott

LOCATION:	Lat. 58°42'01" Long. 133°37'28" (104K/12) Approximately 100 kilometres south of Atlin and 65 kilometres northeast of Juneau, Alaska.
ELEVATION:	40 metres (Polaris portal) to 750 metres.
CLAIM:	61 contiguous Crown grants covering the Polaris-Taku minesite and surrounding areas.
ACCESS:	Aircraft from Atlin or Juneau. A widened road at the minesite functions as a short airstrip that will accommodate small aircraft. A 1200-metre runway 4 kilometres south of the mine will accommodate a DC3. Both are subject to flooding during ephemeral outbursts from lakes dammed by the Tulsequah Glacier.
OWNER:	Rembrant Gold Mines Limited.
OPERATOR:	SUNTAC MINERALS CORPORATION.
COMMODITIES:	Au, Ag, Cu.

THE POLARIS-TAKU DEPOSIT: GEOLOGIC SETTING AND RECENT MINERAL EXPLORATION RESULTS

INTRODUCTION

The Polaris-Taku deposit is a mesothermal arsenical gold vein deposit of replacement origin, hosted by Upper Paleozoic volcanic and sedimentary rocks of the Stikine Terrane. It is located near tidewater approximately 100 kilometres south of Atlin and 65 kilometres northeast of Juneau, Alaska (Figure B-12-1). The property is currently under option by Suntac Minerals Corporation from Rembrandt Gold Mines Limited. Various aspects of the geology and history of the property have been reported on previously (*e.g.* Smith, 1948; Stokes, 1989; MINFILE 104K 003; and various Minister of Mines reports). This report is in part a synopsis of earlier articles. It also encorporates results of mapping near the minesite in the course of a reconnaissance mapping program conducted by the British Columbia Geological Survey Branch in 1991. Detailed property geology of Smith (1938) is placed in a regional framework.

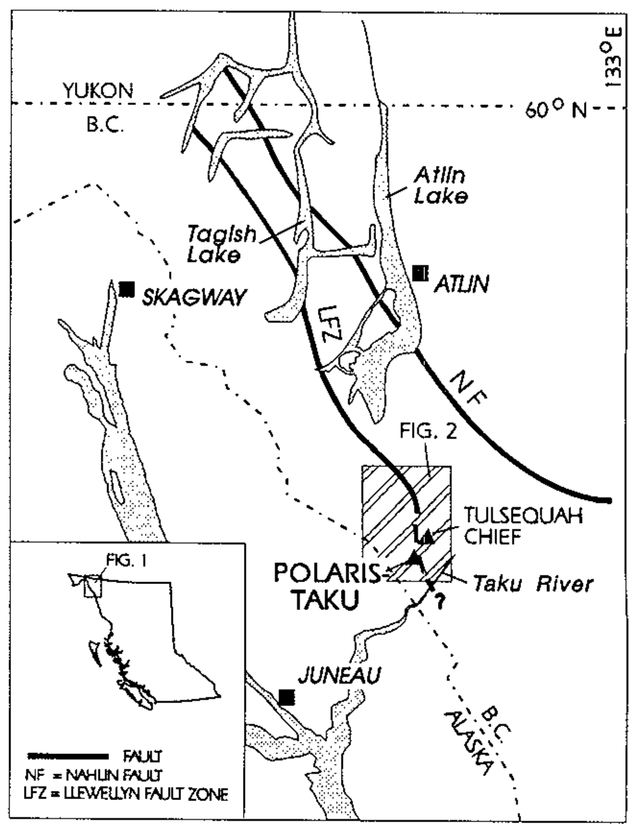


Figure B-12-1. Location map.

HISTORICAL PERSPECTIVE

Gold mineralization was discovered on Whitewater Creek in 1929, 10 kilometres upstream from the confluence of the Taku and Tulsequah rivers. Further exploration work, including underground development in 1933, was conducted by various operators until acquisition of the property by the Polaris-Taku Mining Company in 1936. A mill was built in 1937 and 683 337 tonnes of ore with an average recovered grade of 10.3 grams per tonne were milled during the periods 1938-1942 and 1946-1951. Recorded recovery during these periods was 7 203 579 grams of gold, 365 772 grams of silver and 79 958 kilograms of copper. Increasing operating costs and fixed gold prices forced the closure of the mine in 1951 with an estimated 221 797 tonnes of ore, grading 11.3 grams per tonne gold, remaining in the subsurface.

TABLE B-12-1
EXPLORATORY DRILLING SINCE 1988
(in metres)

1988	1028
1989	4078
1990	2754
1991	3670
Total metres	11530

Extensive drilling has been conducted by Suntac on an annual basis since 1988 (Table B-12-1). A very successful program in 1991 tested the "C" vein system beneath the valley floor and added 4 561 037 grams of gold to the reserves. Drill and geologically indicated reserves currently stand at over 2.02 million tonnes averaging 14.85 grams per tonne (Giroux, 1991).

GEOLOGICAL SETTING

The deposit is situated in the rugged northern Coast Belt, less than 10 kilometres east of the margin of the Coast Plutonic Complex (Figure B-12-2). It occurs within greenchists, thought to be part of the Stikine Terrane, at a zone of intercalation with amphibolite-grade rocks of the Nisling Terrane(?) (Wheeler and McFeely, 1991). Young intrusive rocks that crop out west of the deposit belong dominantly to a belt of Late Eocene (40 Ma)

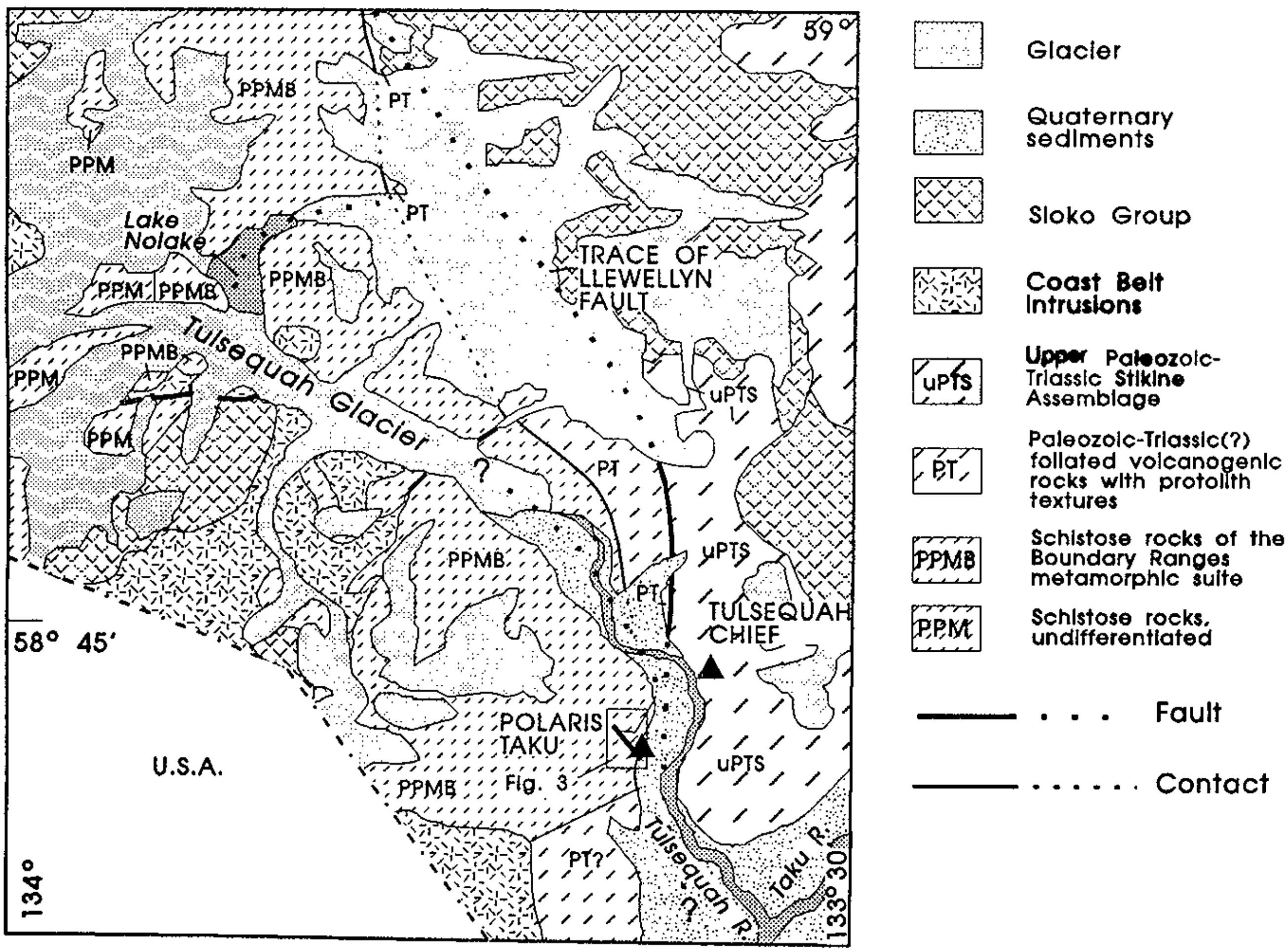
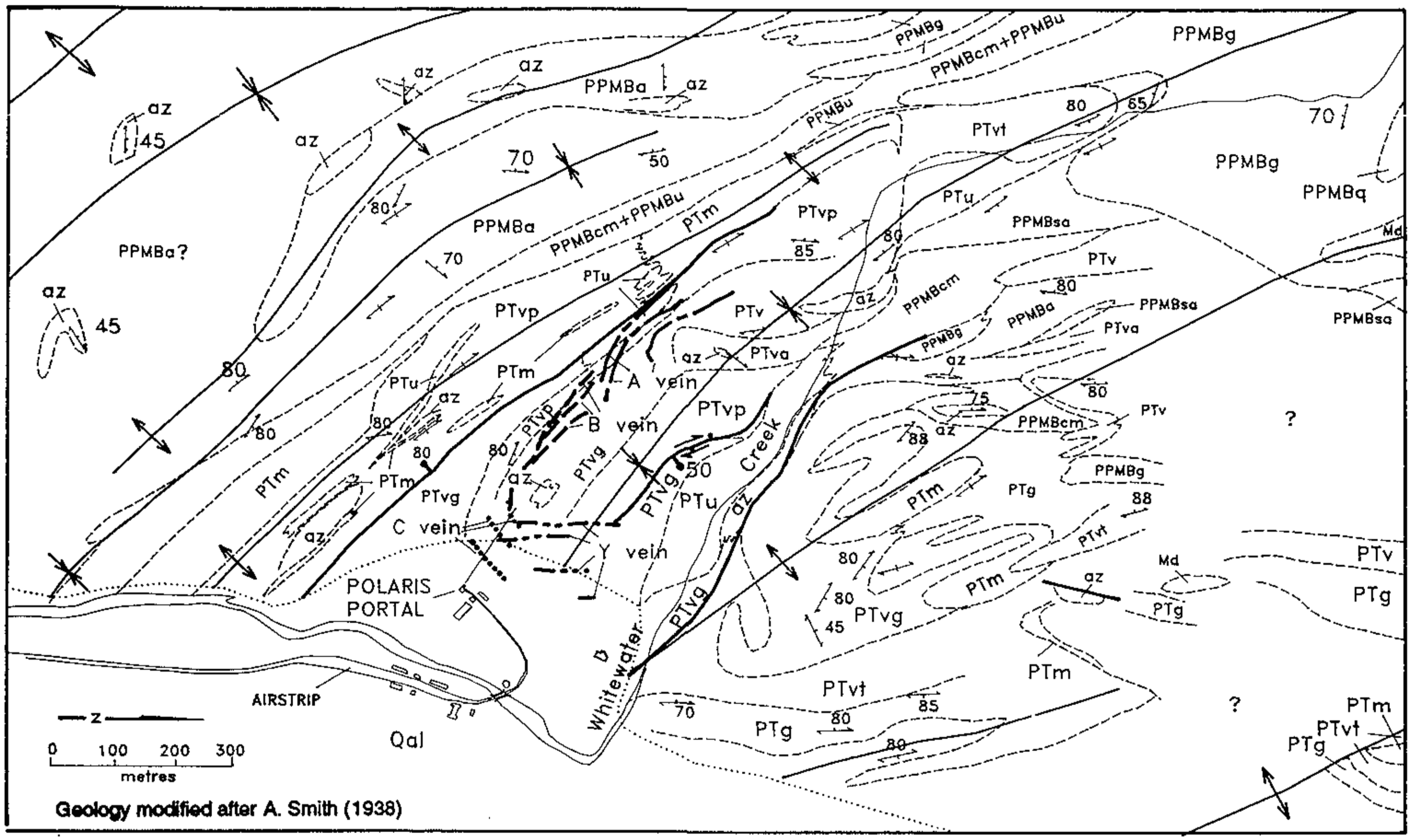


Figure B-12-2. Generalized reconnaissance geology map (Mihalynuk, Smith and others, unpublished) including geology from Nelson and Payne (1984) and Souther (1971). *See* Smith and Mihalynuk (this volume) for an overview of the regional geologic units.



LEGEND

UNITS

Qal	unconsolidated glacial till, alluvium, and fluvial sediments
az	alteration zones
Md	albite diorite of probable post-Jurassic age.
PT	Variably sheared, foliated volcanogenic rocks with relict primary textures. Late Paleozoic to possibly Late Triassic in age.
PTv	Undifferentiated, primarily tuff and flows
PTvt	Intermediate to mafic tuff.
PTvp	Intermediate to mafic pyroclastic deposits.
PTvg	Foliated greenstone (fine-grained tuff protolith?)
PTva	Andesite flows
PTm	Marble
PTg	Gabbro
PTu	Serpentinite and talc schist
PPMB	Schist and gneiss correlated with the Boundary Ranges metamorphic suite of probable early Paleozoic age.
PPMBq	Quartz-rich schist (+feldspar, biotite, muscovite)
PPMBsa	Sericite-albite schist
PPMBg	Dark grey graphitic schist
PPMBu	Pyroxenite and talc schist
PPMBcm	Chlorite-muscovite schist
PPMBa	Actinolite or chlorite-rich schist

SYMBOLS

- Limit of bedrock
- Contact (approximate or assumed)
- High-angle fault
- Anticline (approximate or assumed)
- Syncline (approximate or assumed)
- Foliation (inclined, vertical) 80
- A vein
- B vein
- C vein
- Y vein

Figure B-12-3. Polaris-Taku property geology (modified after Smith, 1938, 1948 and Stokes, 1989).

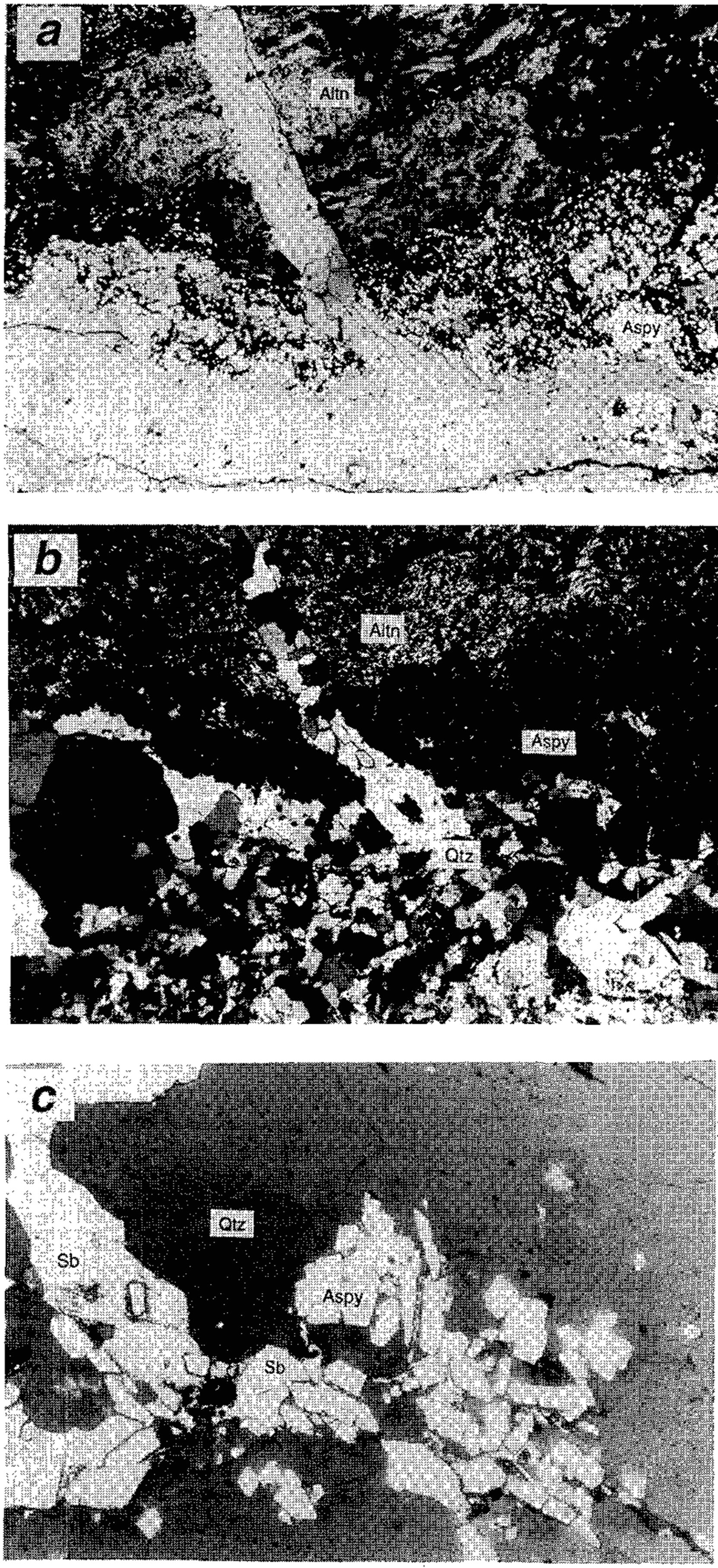


Plate B-12-1.(a) Polished section showing a band of finely disseminated idiomorphic to xenomorphic arsenopyrite (Aspy) that is crosscut by a later quartz vein (Qtz). Field of view is 4.6 millimetres. (b) A cross-polarized, transmitted-light view of a slightly larger field of view than show in (a). Transmitted light shows the fine, polycrystalline nature of the quartz veins as well as the very fine grained sericite-calcite alteration (Altn) halo around the arsenopyrite-rich band. (c) A close-up of idiomorphic arsenopyrite crystals in quartz (Qtz) and stibnite (Sb). Arsenopyrite grain contacts with stibnite are corroded. Field of view is 0.9 millimetre.

stocks (Brew *et al.*, 1988). Hostrocks include variably deformed volcanic and sedimentary lithologies in which relict textures are locally well preserved. The oldest, or at least the most deformed rocks, are restricted to the northwest corner of the property and include quartzites and schists. Commonly, quartzite layers several centimetres thick alternate with thinner argillaceous layers. Structurally higher are chloritic schists which give way to limestone, pyroclastics, andesitic flows and minor intrusives. A conspicuous upper unit includes well laminated, fine to coarse ash tuffs, intermediate agglomerate and minor flows. The succession includes a variety of deformed mafic and ultramafic intrusive bodies including serpentinite, amphibolite, gabbro and diorite.

From a structural standpoint, the Polaris-Taku deposit appears to sit within a synform on the western limb of the Tulsequah synclinorium (Figure B-12-3). The synform displays variable plunges, but is overall quite gently plunging to the southeast where it disappears and is presumably cut off in the Tulsequah River valley. Several large faults are subparallel to the axial surface of the synform. The "AB" vein system is developed in one such fault at the contact between greenstone and schist.

Volcanic and sedimentary rocks hosting the deposit were originally thought to belong to the Upper Triassic Stuhini Group, but are now thought to be much older. Pennsylvanian fossils found in presumably coeval rocks overlying the Tulsequah Chief volcanogenic massive sulphide deposit just across the river (Nelson and Payne, 1984), point to a similar age for hostrocks of the Polaris-Taku. However, recently acquired uranium-lead isotopic data indicate a lower Mississippian age (lower Tournaisian) for strata enclosing the Tulsequah Chief ore (Mortensen, personal communication, 1992). Flattened lapilli tuffs and siliceous sediments enclosing the coeval ore at the Tulsequah Chief closely resemble parts of the succession that hosts the ore at the Polaris-Taku deposit, but further work and dating are required to substantiate this loose correlation.

MINERALIZATION

Vein systems at the deposit were traditionally thought to conform to two dominant trends. The "Y" vein system forms a north trending set whereas the "AB" set trends 310° and dips 70° west. A newly discovered vein set, the "C" vein system, trends 070° (Figure B-12-3). Ore shoots range in size from 15 to 240 metres long and up to 10.7 metres wide (Stokes, 1989).

Gold values are directly proportional to the abundance of arsenopyrite which is disseminated or occurs as rosettes of fine, acicular crystals (Plate B-12-1a). Other vein minerals include pyrite and minor stibnite (Plate B-12-1c), pyrrhotite and gold in a quartz-carbonate-altered host. Fuchsite and albite are locally important alteration products. High-grade ore commonly occurs where fine to coarse ash tuffs are altered to a bile-green colour with grey arsenopyrite-rich patches. Wallrock alteration of this type occurs adjacent to white quartz-carbonate stringers that range from less than a centimetre to decimetres in thickness, but are most commonly 3 to 10 centimetres thick. A recent drill intersection of one such zone penetrated 7.6 metres grading 23.7 grams per tonne gold (4.2 m true thickness) developed adjacent to a quartz-carbonate breccia 1.5 metres wide.

EXPLORATION TRENDS

The focus of future exploration will concentrate on drilling the "C" vein system from surface as the ore shoot is open in all directions. Relatively few problems were encountered with drilling through the overburden on the river flats and consequently discovery costs for the 1991 drilling program were less than 10 cents per gram of gold.

ACKNOWLEDGEMENTS

Moira Smith drafted the figures in this report and has contributed substantially to an understanding of the regional geology.

REFERENCES

Brew, D.A. (1988): Latest Mesozoic and Cenozoic Igneous Rocks of Southeastern Alaska - A Synopsis; *U.S. Geological Survey*, Open-file Report 88-405, 14 pages plus figures.

Giroux, G.H. (1991): Geostatistical Study of the Geological Resource Contained within the Polaris-Taku Gold Deposit; unpublished manuscript, 73 pages.

Nelson, J., and Payne, J.G. (1984): Paleozoic Volcanic Assemblages and Volcanogenic Massive Sulphide Deposits near Tulsequah, British Columbia; *Canadian Journal of Earth Sciences*, Volume 21, pages 379-381.

Smith, A. (1938): Map showing Surface Geology and Topography of Company Claims and Vicinity, scale 1" = 300'; *Polaris-Taku Mining Co. Ltd.*.

Smith, A. (1948): Tulsequah Area; *in* Structural Geology of Canadian Ore Deposits, *Canadian Institute of Mining and Metallurgy*, Jubilee Volume, pages 112-121.

Smith, M.T. and Mihalynuk, M.G. (1992): Geologic Setting of the Maple Leaf Property, Northwestern British Columbia; *in* Exploration in British Columbia 1991, *B.C. Ministry of Energy, Mines and Petroleum Resources*, this volume.

Souther, J.G. (1971): Geology and Mineral Deposits of Tulsequah Map-area, British Columbia; *Geological Survey of Canada*, Memoir 362.

Stokes, W.P. (1989): The Polaris-Taku Gold Mine; unpublished manuscript, 17 pages.

Wheeler, J.O. and McFeely, P. (1991): Tectonic Assemblage Map of the Canadian Cordillera; *Geological Survey of Canada*, Map 1712A.

TULSEQUAH GLACIER: MAPLE LEAF

(Fig. B1, No. 13)

By M.T. Smith and M.G. Mihalynuk

LOCATION: Lat.: 58°56′ Long.: 133°48′ (104K)
ATLIN MINING DIVISION. 75 kilometres northeast of Juneau, Alaska, 70 kilometres south of Atlin, B.C.
ELEVATION: Approximately 1050 metres (3500 feet).
CLAIM: GLACIER LIGHT 1 to 4.
ACCESS: By helicopter from bases in Atlin or Juneau, Alaska.
OWNER/OPERATOR: AMERICAN BULLION MINERALS, LIMITED.
COMMODITIES SEARCHED FOR: Au, Ag, Cu, Pb, Zn.
MINFILE: 104K 117

GEOLOGIC SETTING OF THE MAPLE LEAF PROPERTY, NORTHWESTERN B.C.

INTRODUCTION

The Maple Leaf property is an area of 80 claim units in the north-central Tulsequah Glacier 1:50 000 map area (104K/13; Figures B-13-1, 2). Alteration and mineralization are imposed on structurally complex, greenschist to amphibolite facies rocks of pelitic, quartzofeldspathic, and mafic composition. Alteration types include quartz-pyrite-sericite, quartz-carbonate, and local quartz-carbonate-mariposite. The area had no prior record of mineral investigation until staked in 1990 by American Bullion Minerals, Limited on the basis of aerial reconnaissance and follow-up prospecting. Our mapping and geochemical sampling efforts in 1991 were focused on striking colour anomalies on cliff faces bordering the north side of the Rugulose Glacier northeast of Lake Nolake, at elevations ranging from 950 to 1300 metres (Figure B-13-2). American Bullion (1990) indicated that the claim was in "an identical geologic setting" and on trend with the Tulsequah Chief deposit, located approximately 25 kilometres to the southeast and interpreted to be a Kuroko-type volcanogenic massive sulphide (VMS) deposit. The Tulsequah Chief and nearby Big Bull deposits produced nearly 1 million tonnes of zinc, lead, copper, silver, gold and cadmium ore from 1951 to 1957, with present reserves estimated at over 5 million tonnes with an average grade of 7.03 per cent zinc, 1.6 per cent copper, 1.31 per cent lead, 100.5 grams per tonne silver and 2.74 grams per tonne gold (Höy, 1991). The Polaris-Taku mesothermal gold deposit, which has yielded over 7 200 000 grams of gold is also located in the Tulsequah area. The possible existence of other similar deposits, or fault-displaced slices of the known deposits, prompted this study.

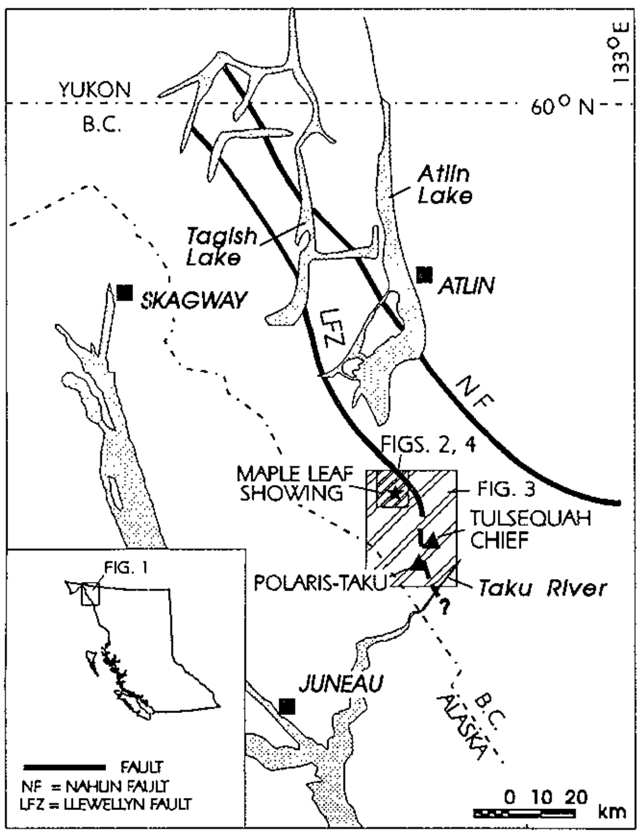


Figure B-13-1. Location of the Maple Leaf property and the Polaris-Taku and Tulsequah Chief mines. The locations of Figures 2, 3 and 4 are also shown.

During the course of this investigation, approximately 30 person-days were spent mapping lithologic contacts, structural elements, and areas of alteration, at a scale of 1:25 000. Geologic relationships are summarized in Figure B-13-2 (geologic map compiled at 1:50 000). Geologic elements mapped at 1:50 000 scale to the north (104M/8; Mihalynuk *et al.*, 1990, and unpublished 1991 BCGS mapping) were extended into the Maple Leaf area

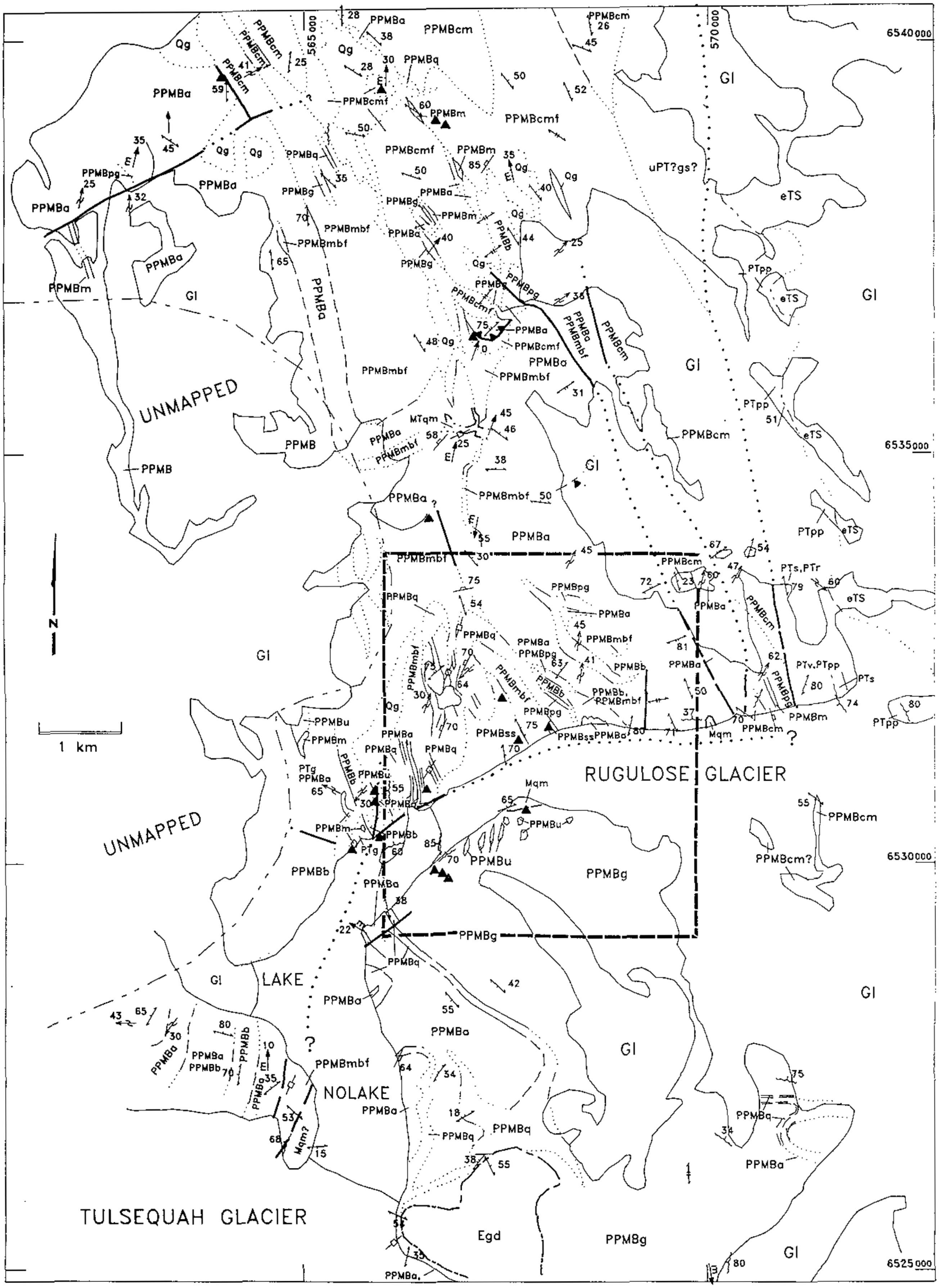


Figure B-13-2. Geologic map of the Maple Leaf area.

LEGEND

LAYERED ROCKS

Qg ***unconsolidated glacial till, outwash and alluvium.***

eTs ***Sloko Group, undifferentiated.*** Intermediate to felsic volcanic flows, breccia, tuff and epiclastic rocks.

PT ***Sheared, foliated rocks with relict primary textures:*** **PTpp**: greenstone with relict pillows, vesicles, pyroxene phenocrysts. **PTv**: mafic to felsic tuff. **PTs**: dark grey phyllite. **PTr:** rhyolite.

uPT?gs ***Greenschist.*** Relatively massive chlorite and actinolite rock. Compositionally layered but not well foliated. No protolith features preserved.

PPMBss ***Quartz±sericite altered schist.*** White to yellow or orange weathering, in part bleached with 1-2% disseminated pyrite. Derived primarily from PPMBq and PPMBcmf.

PPMBg ***Graphitic schist.*** Dark grey to black, schistose or phyllitic, ± spessartine(?).

PPMBu ***Talc-tremolite schist.*** Green to grey, medium to coarse grained. also includes *Pyroxenite.* Coarse to very coarse, dark green to black, locally well-foliated, with interstitial phlogopite ± Po ± Py.

PPMBq ***Quartz-rich schist.*** >80% quartz, ± muscovite, biotite, garnet.

PPMBa ***Actinolite-rich schist and gneiss.*** Ranges from coarse amphibole-feldspar gneiss to fine-grained, massive greenstone.

PPMBb ***Marble.*** Coarse, light grey lenses, generally <2 m thick.

PPMBcm ***Chlorite-muscovite schist.*** Grey-green, usually with strong crenulation cleavage.

PPMBcmf ***Quartz-feldspar-muscovite-chlorite ± garnet schist.*** Unit consists of both primary, chlorite grade rocks or retrograde equivalent of Unit PPMBmbf, with garnets psuedomorphed after chlorite.

PPMBmbf ***Quartz-feldspar-muscovite-biotite ± garnet schist.*** Garnets generally red-brown and unaltered.

PPMBb ***Biotite schist.*** Brown rock with up to 80% medium to coarse-grained biotite ± garnet. Also includes *Biotite-hornblende schist.* Purple-brown, compositionally layered schist and gneiss. Foliation usually flat, with little influence of D_3.

PPMBpg ***Pelitic schist.*** Ranges from medium grey and fine-grained to coarse amphibole-feldspar-biotite rock. All with abundant, 0.5-1.5 cm red-brown garnets.

INTRUSIVE ROCKS

Mqm ***Quartz monzonite.*** Grey to slightly green, locally weakly foliated, brecciated. Hornblende and biotite, generally pyritic, sometimes bleached.

PTg ***K-spar megacrystic orthogneiss.*** Greenish with pink K-spar augen. Interlayered with green, medium-grained amphibolite.

SYMBOLS

- Limit of Quaternary alluvium
- Contact (defined, approximate, assumed
- Unconformable contact (defined, assumed)
- Intrusive contact (defined, approximate assumed)
- High-angle fault (defined, approximate, assumed)
- Thrust fault
- Sample locality (see Figure 4 for sample numbers)
- Property boundary
- Bedding (inclined) 51
- S_1 or S_2 foliation (inclined) 35
- S_3 foliation (inclined, vertical) 31
- Dike (inclined, vertical) 70
- Small shear (inclined, vertical) 37
- Axis of small fold 43
- Lineation (unspecified, M=mineral, S=slickenside, I=intersection) 80

by reconnaissance mapping in order to place the showing within a regional structural and stratigraphic framework. The geologic setting, alteration and mineralization at the Tulsequah Chief and Polaris-Taku mines were also examined in a regional geologic context, for purposes of comparison.

MAJOR ROCK TYPES

The oldest rocks in the map area include schists of variable composition, reflecting a wide variety of protoliths. These are: amphibole-chlorite schist and gneiss (metabasalt or gabbro), biotite-muscovite or chlorite-muscovite schist (metapelite), quartzofeldspathic schist (metamorphosed clastic sediments), and quartz-rich schist or quartzite (metarhyolite or metaquartzite; Figure B-13-2). South of Rugulose Glacier and east of Lake Nolake, rocks are dominantly graphitic schist with intercalated quartz-feldspar-mica schist, chlorite-actinolite schist and minor marble, pyroxenite and talc-carbonate schist. Souther (1971) grouped these rocks as "undifferentiated schist and gneiss of pre-Triassic age". We tentatively assign all rocks in this assemblage to the Precambrian-Paleozoic Boundary Ranges Metamorphic Suite (PPMB of Mihalynuk and Rouse 1988), based on lithologic, structural and metamorphic similarities. These rocks are locally intruded by variably foliated and lineated potassium feldspar megacrystic granodiorite and granite, gabbro and pyroxenite. Several kilometres east of the Maple Leaf property, the Boundary Ranges suite is in fault contact with a sheared package of chlorite-grade, mafic volcanic rocks (PT), within which protolith textures, including pillows, vesicles and pyroxene phenocrysts are partially preserved. The rocks are similar to middle to upper Paleozoic Stikine assemblage strata mapped to the south, and are thus correlated. Schists north and south of the study area are separated from relatively undeformed sedimentary rocks, mafic to intermediate flows and tuff of the Upper Triassic Stuhini Group (uTS) to the east by the probable southern extension of the Llewellyn fault. Within the map area, the preceding units are unconformably overlain by felsic to intermediate volcanic rocks of the early Tertiary Sloko Group (eTS). Swarms of fine-grained, sparsely porphyritic, rhyolitic and intermediate dikes locally cut the deformed rocks and probably represent feeders for the Sloko Group volcanic rocks. These dikes crosscut most structures, but are locally brecciated, bleached and pyritic where disrupted by late northeast-trending faults. Medium-grained monzonite (Mqm) intrusions, generally less than 100 metres in diameter, are exposed northwest of the toe of the Rugulose Glacier and on the southern margin of the glacier. They are locally moderately foliated, pyritic and chloritized.

South of the Maple Leaf showing (Figure B-13-3), the graphitic and quartz-rich schist units extend to beyond the toe of the Tulsequah Glacier. Here they are intruded and thermally metamorphosed by plutons of the Coast Complex, and are cut by numerous small, high-angle, northeast-striking brittle faults. Unit PT also projects southward, where it becomes more heterolithic and variably foliated.

STRUCTURAL STYLE

At least three phases of deformation are evident in the schistose units. Phase 1 deformation (D_1) imparted compositional layering, layer-parallel foliation and intrafolial isoclinal folds of variable orientation. It is difficult to recognize because it is largely coaxial to Phase 2. Phase 2 deformation (D_2) is characterized by greenschist to amphibolite facies metamorphism, and deformation characterized by a strong foliation with regional 340° strike and moderate to steep dip, and decimetre to possibly regional-scale appressed to isoclinal folds with axes that plunge gently and trend roughly 015°. Manifestations of third phase deformation (D_3) include millimetre to decimetre-scale kink and crenulation folds with steep axial planes (locally forming a strong cleavage), and open to tight chevron folds, developed on a metre to kilometre scale. Cleavage and axial planes in both types strike 050° to 090° with steep dips. The effects of D_3 are variable, locally quite strong, and are accompanied by a retrograde, greenschist (chlorite grade) facies metamorphic overprint. Foliated orthogneiss units do not reach amphibolite grade and may be late synkinematic with respect to second phase deformation.

Foliation-parallel ductile faults and small shears are common, although their presence and significance is often difficult to detect and evaluate. A ductile shear zone with dextral-oblique offset that separates the Boundary Ranges Metamorphic Suite (Unit PPMB) from foliated rocks with protolith textures (Unit PT) may be an early strand of the long-lived Llewellyn fault system. The main strand of the Llewellyn fault is concealed by ice and Tertiary volcanic rocks in the vicinity of the Maple Leaf claims, but to the north (NTS map sheet 104N/4) is manifested by a high-angle zone of brittle deformation and hydrothermal alteration ranging from a few to several hundred metres wide, which overprints a zone of ductile shear (Mihalynuk *et al.*, unpublished 1991 mapping).

Brittle to partly ductile faults are very abundant in the region. Common orientations include: high angle and parallel to foliation (340°), parallel to the crenulation cleavage (050° to 090°), and approximately 300°; and thrust faults, locally developed in the hinge areas of large F_3 folds. The faults may be partly coeval with D_3, but most appear to be later. An east-northeast-trending structure of undetermined dip and vergence must extend up the valley occupied by the Rugulose Glacier and Lake

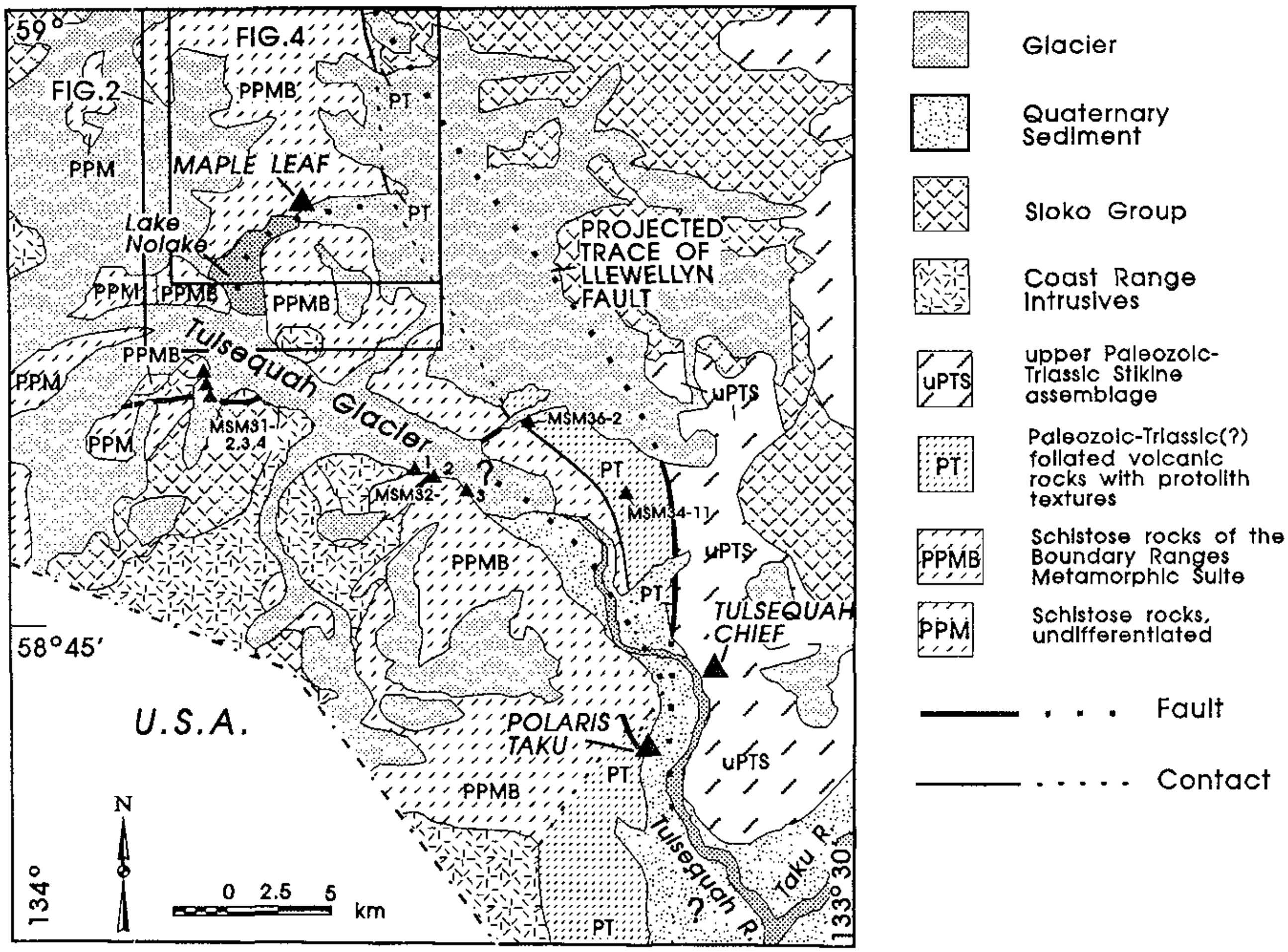


Figure B-13-3. Simplified map of the Tulsequah Glacier and Tulsequah River areas, showing the relationship of the Maple Leaf showing to the Polaris-Taku and Tulsequah Chief deposits (after Souther, 1971; Nelson and Payne, 1984; and Mihalynuk *et al.*, unpublished 1991 mapping).

Nolake, as rocks that project on trend from one side to the other are lithologically distinct.

DESCRIPTIONS OF SHOWINGS AND OTHER SIGNIFICANT ALTERATION ZONES

Several alteration zones were examined and 18 samples were collected for assay. Analytical results are summarized in Table B-13-1. Sample locations and significant alteration zones in the area of Figure B-13-2 are plotted on Figure B-13-4.

Maple Leaf Showing (Area A): Two obvious yellow to orange-red colour anomalies are visible in the cliff face bordering the north side of the Rugulose Glacier.These were the main targets of investigation by American Bullion Minerals, Limited, and interpreted as potential volcanogenic massive sulphide horizons.

The Maple Leaf showing comprises gossanous, bleached, quartz-sericite-pyrite-altered schist. Sericite is coarse and aligned parallel to the fabric in the bounding units. These rocks have invariably been affected by weak to moderate silicification. Disseminated pyrite (up to 10%) is mostly present as euhedral, millimetre-sized crystals, but also forms stringers parallel to foliation. Wide areas of apparently stratabound quartz-sericite alteration and bleaching extend along the cliff face in the vicinity of the two showings, and two prongs extend approximately 1500 metres to the northwest. Hostrocks are primarily quartz-rich quartz-feldspar-muscovite-biotite±chlorite schist. Lateral moraines on the cliff break and talus at the foot of the cliff contain altered boulders with up to 20 per cent sulphides (pyrite, chalcopyrite, sphalerite). Samples of this float material grade to 5.14 grams per tonne gold, 130 grams per tonne silver, 11.25 per cent zinc, 8.22 per cent lead, and 0.15 per cent copper (American Bullion, 1990). These may possibly be derived from massive sulphide layers reported by American Bullion within the altered zones. Three (in place) samples of quartz-sericite-altered schist that were analyzed (JNA25-11, JNA25-12 and JNA25-13) and did not return anomalous precious metal values, although the first contained 1950 ppm zinc and 79 ppb gold.

Field studies suggest that quartz-sericite alteration may be partly imposed on rocks with a pre-existing fabric.

TABLE B-13-1
ANALYTICAL RESULTS FOR 1991 SAMPLES COLLECTED IN THE MAPLE LEAF AREA

SAMPLE #	UTM ZONE 8 easting	UTM ZONE 8 northing	Au ppb	Ag ppm	Zn ppm	As ppm	Sb ppm	Cu ppm	Type
JNA25-11	568100	6531775	79	<5	1950	15	2.8		sericite sch.
JNA25-12	567675	6531500	8	<5	<50	8	<0.2		sericite sch.
JNA25-13	567400	6531750	5	<5	<50	2	<0.2		sericite sch.
MMI21-3-3	567550	6536700	<5	<5	185	3	0.2		bleached act. schist
MMI24-9	567600	6530700	<5	<5	<50	48	3.5		fol. granodiorite
MMI24-11	566700	6531075	8	<5	60	3	0.4		qtz.-ser. schist
MMI25-3	566600	6534250	<5	<5	57	2	5.5		pelitic schist
MMI26-1	566675	6529875	6						listwanite
MMI26-2-1	566500	6529875	<2						listwanite
MMI26-2-2	566475	6529850	12						listwanite
MMI26-5	565800	6528750	67	<5	62	<2	0.4		quartz vein
MSM17-10	566688	6539000	505	<0.4	5	11	2	3	quartz vein
MSM24-2C	566050	6530100	40	<5	109	6	1		qtz/calc. shear
MSM24-3	565950	6530875	7	<5	167	82	2		pyr. greenstone
MSM24-4	565950	6530800	36						pyroxenite
MSM24-8	565700	6530300	242	<5	104	2	0.5		fusch altd carb
MSM31-2	564200	6523850	<5	<5	173	3	0.4		pyr. schist
MSM31-3	564500	6523500	214	26	18 900	16	0.7		sulfide veinlet
MSM31-4	564700	6523175	5	<5	<50	4	0.3		sulfide veinlet
MSM32-1	571350	6519225	9	<5	123	10	0.5		pyr. schist
MSM32-1-2	571675	6519400	9	<5	140	10	0.2		pyr. schist
MSM32-3	572400	6519250	12	<5	223	3	0.3		fault/qtz vein
MSM34-11	578650	6518600	<5	<5	<50	50	1.3		quartz vein
MSM36-2	575900	6522350	360	<5	<50	200	14		qtz vein/intr.
RDU17-5-2	564000	6539688	<5	<0.4	56	1	<0.5	41	quartz vein
RDU17-8	566050	6539500	<5	<0.4	7	2	0.5	3	quartz vein
RDU17-10-2	566750	6538938	<5	<0.4	21	1	0.5	7	quartz vein
RDU24-12	567500	6530575	<5	<5	81	31	<0.2		talc-carb. sch

All sample numbers > 17 were analyzed in INAA

Area B: Red-weathering greenschist and metapsammite exposures that crop out 700 metres west of Area A are cut by gossanous, brittle, northwest-trending shears with weak quartz-sericite alteration, and minor carbonate alteration adjacent to marly units. Carbonate-altered zones locally contain minor pyrite, galena and sphalerite.

Northern Lake Nolake (Area C): Carbonate-altered rocks are exposed on a small point jutting into the northern part of Lake Nolake west of the mouth of Moosetrap Creek. Carbonate alteration is associated with steep, northeast to east-striking brittle shears and breccia zones in massive chlorite-actinolite schist and minor orthogneiss. Altered zones extend for one to several metres into the country rocks adjacent to the shears. Quartz-sericite alteration and quartz and calcite veining locally accompany carbonate alteration. Disseminated pyrite (2 to 5%) is ubiquitous in all rocks on the point. Sample MSM24-2C, a quartz-calcite vein, returned only slightly elevated gold and zinc levels.

Three hundred metres northwest of the point is a brittle fault zone that juxtaposes chlorite-actinolite schist with coarse pyroxenite. Rocks in the metre-wide fault zone contain up to 30 per cent pyrite in veins and as fracture-fillings. Sample MSM24-3 showed slightly elevated zinc and arsenic levels, and MSM24-4 slight gold enrichment. To the south of this zone are two dolomitized carbonate lenses and minor carbonate-altered amphibolite associated with brittle shears. Carbonate-altered rocks contain from 0 to 5 per cent pyrite and locally chrome mica(?). Sample MSM24-8, from the southernmost of the two carbonate lenses contained 242 ppb gold.

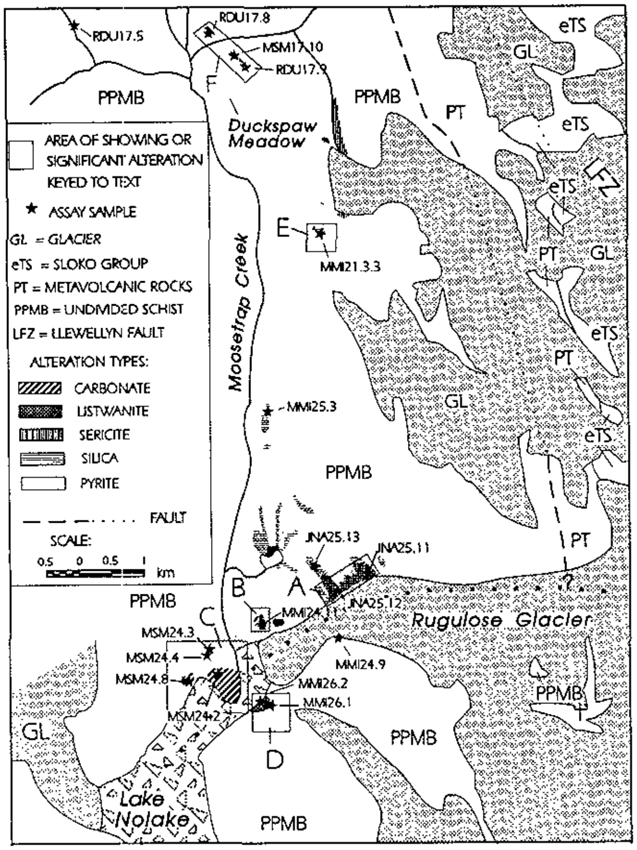


Figure B-13-4. Map showing areas of significant alteration by type, sample locations, and major geologic units in the vicinity of the Maple Leaf property. Areas enclosed by rectangles are discussed in the text.

Listwanite-altered rocks (Area D): Red-weathering outcrops near the toe of the Rugulose Glacier, along the southeastern shore of Lake Nolake, are quartz-carbonate-mariposite-altered, sheared pyroxenite and talc-tremolite schist. Samples MMI26-1, 26-2 and 24-9 were not anomalous, except for slightly elevated arsenic and antimony levels.

Area E is a small, gossanous, glaciated bench at the contact between graphitic micaceous garnet (retrograded to chlorite)-bearing schist and massive actinolite-chlorite metabasite. Metabasite at the contact is bleached, silicified and sericitized, with up to 10 per cent disseminated pyrite as euhedral grains and blebs up to several centimetres in diameter. It is located in the hinge area of an east-trending (D_3) fold with an amplitude of approximately 100 metres. The alteration zone is bounded by the upper fold surface and a low-angle fault. Sample MMI21-3-3 yielded a slightly elevated zinc value.

Duckspaw Meadow (Area F): Alteration includes the east side of a mound in the southern part of Duckspaw meadow, and a small southeast-trending fault zone south of the meadow. Hostrocks are quartz-mica schist that is sheared, quartz-veined and rusty weathering, with minor sericite alteration. Quartz veins range from a few centimetres to several decimetres thick, and are lens-shaped and discontinuous. They are locally brecciated and gossanous, with 5 to 10 per cent interstitial pyrite in fresh samples. Samples RDU17-8 and RDU17-10 returned background metal values, however MSM17-10 contained 505 ppb gold.

Other Areas: Analytical results from samples collected during reconnaissance mapping to the southeast of the Maple Leaf showing are also shown in Table B-13-1 and their locations in Figure B-13-3. Immediately south of the area outlined in Figure B-13-2, elevated gold, silver and zinc values were returned from a sample from a small, ice-cored medial moraine or landslide deposit (MSM31-3). Mineralized boulders from this accumulation contain pyrite, chalcopyrite, and sphalerite veins in a felsic intrusive host (Rizz claim group). The source of this mineralized float has not been pinpointed, however the moraine is located between two cliff faces that contain an east-trending high-angle fault with an altered selvage (Figure B-13-3).

To the southeast along both sides of the Tulsequah Glacier, rocks are thermally metamorphosed, red weathering, and contain up to a few per cent pyrite. Pyritic schist samples do not show elevated values for gold or silver. At the contact between the Boundary Ranges suite and units of the Stikine assemblage, values of 360 ppb gold, 200 ppm arsenic and 14 ppm antimony were obtained from a sample of quartz vein material associated with a late northeast-trending dike with faulted margins (MSM36-2).

$^{40}Ar/^{39}Ar$ Isotopic Studies

Application of the volcanogenic massive sulphide model to the Maple Leaf showing is partly dependent on accurate assessment of the age of alteration relative to the age of the hostrocks. In light of possibly ambiguous field relations, a sample of quartz-sericite-altered schist and a sample of unaltered quartz-feldspar-biotite schist were collected for analysis of sericite and biotite separates (respectively). At time of publication, data for the biotite-bearing sample was unavailable.

Results for the sericite-bearing sample (Figure B-13-5) show a distinct plateau at approximately 172 Ma, and no argon with an apparent age greater than approximately 180 Ma (Figure B-13-5). This mid-Jurassic plateau can be correlated with regional greenschist to amphibolite facies metamorphism of the Boundary Ranges and Florence Ranges metamorphic suites where the age is relatively well-constrained to the north (Wilson *et al.*, 1985; L. Currie, personal communication, 1991). This age provides the only isotopic constraint on the age of metamorphism in the Tulsequah region, and is remarkable in that it shows little post-Jurassic argon loss, expected due

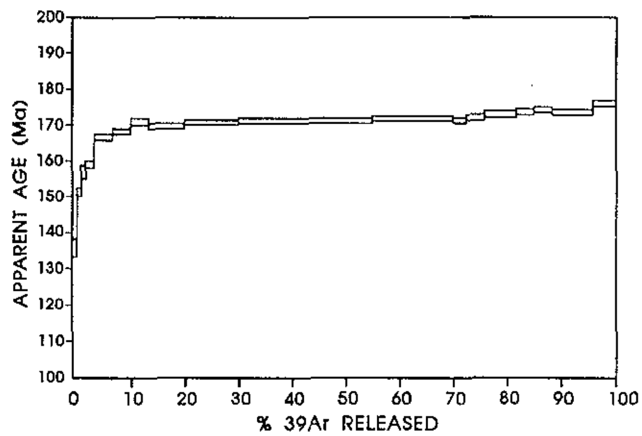


Figure B-13-5. $^{40}Ar/^{39}Ar$ spectrum of dates for sericite separate from the Maple Leaf showing.

to the close proximity of intrusions of the Cretaceous Coast Plutonic Complex.

In terms of metallogenic models, the results can be interpreted two ways: the sericite formed at approximately 172 Ma during regional metamorphism; or the sericite is older, but the argon isotopic system was completely reset during regional metamorphism. Thus, the evidence neither supports or refutes the VMS model. It is interesting to note that the 172 Ma apparent age is exactly the same age as listwanite alteration in the Atlin area (Ash *et al.*, in preparation) temporally associated with intrusion of the *circa* 171 Ma Fourth of July Batholith (Mihalynuk *et al.*, in press).

TULSEQUAH CHIEF AND POLARIS-TAKU DEPOSITS

The Tulsequah Chief is a VMS deposit associated with rhyodacite tuff, agglomerate, interbedded andesite tuff and flows, and minor shale and limestone. It is located 25 kilometres southeast of the Maple Leaf property. The deposit lies to the east of the projected southern extension of the Llewellyn fault, which separates greenschist to amphibolite facies schist on the west from slightly to nonfoliated and weakly metamorphosed rocks to the east. Hostrocks are subgreenschist facies with a local flattening fabric. Protolith textures are commonly well preserved. The age of the volcanic sequence at Tulsequah Chief deposit was first inferred to be Late Triassic by correlation of the rocks with the Stuhini Group (Smith, 1948; Souther, 1971), but later interpreted to be late Paleozoic based on regional correlation with strata of known Penn sylvanian age (Nelson and Payne, 1984). This was recently confirmed by U-Pb dating of rhyodacite flows immediately adjacent to the Tulsequah Chief deposit which yield an Early Mississippian age (J. Mortensen, personal communication, 1992).

Massive, stratabound lenses of fine to medium-grained pyrite, chalcopyrite, galena, sphalerite and tetrahedrite comprise ore-grade material. The underlying rocks are bleached, silicified and sericitized. Massive zinc-lead-copper sulphide deposition, associated with rhyolitic flows and tuff in a volcanic arc setting, as seen at the Tulsequah Chief deposit, most closely resembles the Kuroko model.

The Polaris-Taku deposit is located 5 kilometres south of the Tulsequah Chief. Hostrocks are greenschist facies, range from weakly to strongly foliated, and are thus interpreted to lie to the *west* of the Llewellyn fault, in the belt of deformed rocks with protolith features. Hostrocks include felsic to intermediate ash and lapilli tuff and limestone, with variable preservation of primary textures. The Polaris-Taku is a mesothermal vein gold deposit characterized by quartz-albite(?)-carbonate alteration halos about quartz veins in andesitic metatuff. Ore contains abundant fine-grained, disseminated arsenopyrite (*see* Mihalynuk and Marriot, 1992, this volume).

The Maple Leaf showing has some features in common with both deposits but is distinctly different in other respects. Like rocks hosting the Polaris-Taku deposit, the Maple Leaf hostrocks are foliated and lie to the west of the Llewellyn fault. However, our reconnaissance mapping suggests that the hostrocks for the Polaris-Taku deposit project on a trend several kilometres east of the Maple Leaf showing, and are thus most likely related to rocks correlated with the Stikine assemblage (PT), which grade southward into units of tuffaceous rocks of intermediate and felsic composition, argillite, and limestone (Figure B-13-3). The style of alteration and mineralization at the Polaris-Taku is distinctly different from that at the Maple Leaf showing, but shares some characteristics, such as elevated arsenic and antimony, with carbonate-al tered rocks at Areas B, C, and D. The Maple Leaf showing shares some characteristics with the Tulsequah Chief deposit, including similar hostrock composition (silicic rocks at the Maple Leaf could be metarhyolite) and similarities in the style of alteration (large areas of bleached and quartz-sericite-altered rocks with disseminated pyrite, that may be in part stratabound). The hostrocks at the Maple Leaf showing belong to a suite of relatively high-grade schists that lies several kilometres to the *west* of the Llewellyn fault, and thus appears to represent a distinct package of rocks unrelated to the Tulsequah Chief units. Further mapping is required to substantiate these possibilities.

MINERAL POTENTIAL

Results of reconnaissance mapping and sampling in the Tulsequah Glacier area suggest the following:

- Widespread alteration and disseminated sulphide mineralization are present in an area of several square kilometres centred on the northern end of Lake Nolake and the margins of the lower Rugulose Glacier. Alteration types include extensive areas of quartz-sericite, carbonate and, locally, listwanite alteration. Most rocks in this area (altered and fresh) contain a trace to 2 per cent or more disseminated pyrite.

- Bands of quartz-rich micaceous schist at the Maple Leaf showing may be metarhyolite, consistent with the kuroko-type VMS model developed for the Tulsequah Chief deposit. Hostrocks are high-grade schist, however, and are not directly on trend with those at the Tulsequah Chief. Bleaching and quartz-sericite alteration, consistent with the VMS model, are widespread at the Maple Leaf showing. However, surface expression of massive sulphide layers is restricted to cliff faces, and high metal values are, so far, primarily restricted to float samples.
- Much of the alteration and concentrations of sulphides in other locations within the study area appear to be largely secondary features, localized in the vicinity of late, east-northeast-striking high-angle faults and fold hinges. The highest gold value in this study was obtained from a northwest-trending fault zone, and the next three highest values were from rocks in the vicinity of northeast-trending faults. These and other northeast-trending faults may be worthy of continued exploration.

ACKNOWLEDGMENTS

Thanks are due to Norm Graham of Discovery Helicopters, who managed to find us even in the worst of weather conditions; Jeff Nazarchuk and Rob Dutchak, who assisted in the field; Christian Marriott, who kindly provided us with a dry place out of the rain; and JoAnne Nelson, who shared her ideas about Tulsequah geology. Argon analyses were performed at Dalhousie University. Comments on the manuscript by Wayne Roberts and John Newell are also appreciated.

REFERENCES

American Bullion Minerals, Limited (1990): Maple Leaf Property, A New Volcanogenic Sulphide Discovery; press release.

Ash, C.H., MacDonald, R.W.J., Reynolds, P. and Chaudry, M. (in preparation): Ophiolite-related Mesothermal Lode-gold in British Columbia: A Deposit Model; *B.C. Ministry of Energy, Mines and Petroleum Resources*.

Höy, T. (1991): Volcanogenic Massive Sulphide (VMS) Deposits in British Columbia; *in* Ore Deposits, Tectonics and Metallogeny in the Canadian Cordillera, *B.C. Ministry of Energy, Mines and Petroleum Resources*, Paper 1991-4, pages 89-124.

Mihalynuk, M.G. and Marriot, C. (1992): Geology of the Polaris-Taku Deposit; *in* Exploration in British Columbia 1991, *B.C. Ministry of Energy, Mines and Petroleum Resources*, this volume.

Mihalynuk, M.G., Smith, M.S., Lefebure, D., Gabites, J. and Runkle, D. (in press): Age of Emplacement and Basement Character of the Cache Creek Terrane as Constrained by New Geochemical and Isotopic Data; *Canadian Journal of Earth Sciences*.

Mihalynuk, M.G. and Rouse, J.N. (1988): Preliminary Geology of the Tutshi Lake Area, Northwestern British Columbia (104M/15); *in* Geological Fieldwork 1987, *B.C. Ministry of Energy, Mines and Petroleum Resources*, Paper 1988-1, pages 217-231.

Mihalynuk, M.G., Mountjoy, K.J., Currie, L.D., Lofthouse, D.L. and Winder, N. (1990): Geology and Geochemistry of the Edgar Lake and Fantail Lake Map Area; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Open File 1990-4.

Nelson, J. and Payne, J.G. (1984): Paleozoic Volcanic Assemblages and Volcanogenic Massive Sulphide Deposits near Tulsequah, British Columbia; *Canadian Journal of Earth Sciences*, Volume 21, pages 379-381.

Smith, A. (1948): Tulsequah Area; *in* Structural Geology of Canadian Ore Deposits, *Canadian Institute of Mining and Metallurgy*, Jubilee Volume, pages 112-121.

Souther, J.G. (1971): Geology and Mineral Deposits of the Tulsequah Map-area, British Columbia; *Geological Survey of Canada*, Memoir 362, 84 pages.

Wilson, F.H., Smith, J.G. and Shew, N. (1985): Review of Radiometric Data From the Yukon Crystalline Terrane, Alaska and Yukon Territory; *Canadian Journal of Earth Sciences*, Volume 22, pages 525-537.

MINERAL DEPOSIT LAND-USE MAPS: AN ANALYSIS BASED ON SEVENTEEN YEARS OF EXPLORATION ACTIVITY

(*See* Fig. B1)

By Andrew Legun and Alex Matheson

INTRODUCTION

Compiling mineral potential maps was first attempted by the Geological Branch of the British Columbia Department of Mines and Petroleum Resources in 1969. These maps were of varying formats, in response to requests for mineral resource data from both provincial and local planning agencies.

The Mineral Deposit - Land Use (MDLU) Series was initiated at the end of 1972 and continued through to the beginning of 1977, a period of a little over four years. The maps covered about three-quarters of the province at a scale of 1:250 000. Their development is discussed in McCartney *et al.* (1974).

The map system was conceived as a means of representing mineral potential within the framework of the Canada Land Inventory Series of maps. The Land Inventory Series classified land capability for renewable resources. The purpose of the classification was to provide a measure of the capability of the land to support the resource (agriculture, forestry, recreation, wildlife etc.). The MDLU maps classified areas according to exploration potential and used five categories with 1 highest and 5 the lowest. This classification was based on the number of mineral occurrences and deposits, and the geological environment of the area. The size of the deposits which might be discovered was designated by the letters A, B and C for large (> \$500 x 10^6), medium (\$500 -\$25 x 10^6) and small (\$0.5 - \$25 x 10^6) dollar values. Deposit value was based on the gross value of the metals contained or expected, using 1972 metal prices. The size designations were qualifiers to Categories 1, 2 and 3 and reflected the deposit type expected (porphyries, skarns, veins, etc.). Deposits of coal, industrial minerals, gas and oil wells were shown but rarely categorized for size.

GOAL OF THIS STUDY

The objective of this study was to determine how new discoveries and changing significance of known prospects related to the 1972-1977 MDLU mineral potential classifications. In the discussion 1975 is used for the period 1972-1977. For purposes of clarity a few terms are defined. Key to the definitions is the idea of status or rank of the mineral occurrence.

DEFINITION OF TERMS

showing: occurrence of a minor concentration of *in situ* economic minerals.

prospect: occurrence with documented concentrations of economic minerals which warrants further exploration.

developed prospect: occurrence on which exploration and development has progressed to a stage which allows a reasonable estimate of the amount(s) of one or more of the potentially mineable commodities.

producer: occurrence from which ore containing one or more commodities is being mined for commercial gain or benefit.

past producer: occurrence which is not currently being mined but has recorded production in the past.

deposit of **known** significance: a 1975 term which roughly correlates with developed prospect (particularly at an advanced stage of exploration) or producer.

deposit of **unknown** significance: a 1975 term which correlates roughly with prospect. Might include some developed prospects where drilling is minimal and details of grade or tonnage are sketchy.

new discovery: a mineral occurrence not known or documented in 1975 which is now a deposit of **known** significance.

METHOD

The basic method of the study was to compare current deposit data with 1975 mineral deposit land-use maps. The principal source of current deposit data is the 1992 Minfile database for Map 65, a compilation of producers and potential producers in the province.

The 1:250 000 mineral inventory maps were overlain on 1975 MDLU maps (at the same scale) to see where deposits plotted and whether they were listed as deposits of **known** significance in 1975.

The study was restricted to metals. Industrial minerals were deleted from the Map 65 database. Newly defined orebody extensions to old deposits of known significance (*e.g.* Tulsequah Chief) were also deleted. Some judgement of what constitutes an extension was required here. An orebody such as the H-W was retained. It is on a separate stratigraphic horizon and considered to be detached from nearby stratabound deposits of known significance in 1975.

The records that remained in the database were deposits whose significance had changed from 1975 (from **unknown** to **known**), or represented **new discoveries.**

The remaining records of the Dbase file were loaded into Microsoft Excel. Additional fields relating to location on MDLU maps (yes/no), grades and reserves were added, and formulae used to calculate deposit value and value per tonne. The formula utilized for deposit value was: Resources (kt) x 1000 [13.25 gold + 0.15 silver + 10 (2.75 copper + 6.25 molybdenum + 1.25 zinc + 0.85 lead + 9.2 tungsten oxide + 28.5 cobalt + 2.00 antimony)]. Gold and silver are represented by grades in grams per tonne; all other metals are represented by grades in per cent (%).

Tonnage and grade figures were taken from the Map 65 database. Some deposits have seen production since 1975. In this case an estimate of mined reserves was added to remaining reserves quoted on Map 65. There is admittedly some lack of consistency in reserve category from one deposit to another. As a result reserve comparisons between groups of deposits are more valid than individual comparisons.

Deposit value was calculated according to average Canadian metal prices in 1991. These prices and the corresponding 1972 prices are shown in Table B-14-1.

TABLE B-14-1

1991	Can $	1972 Can $
Gold:	13.25/g	3.52/g
Silver:	.15/g	.07/g
Copper:	2.75/kg	1.10/kg
Molybdenum:	6.25/kg	3.30/kg
Zinc:	1.25/kg	0.33/kg
Lead:	.85/kg	0.33/kg
Tungsten:	9.20/kg	4.74/kg
Cobalt:	28.50/kg	2.20/kg
Antimony:	2.00/kg	1.37/kg

Deposit value is the known resource value based on tonnage, grade and metal prices. It does not represent recoverable value, nor does it take into consideration mining methods (surface, underground), or penalty metals at the smelter (such as arsenic) which decrease the net value. Designation of a value does not mean the deposit is an orebody and can be mined. This number allows comparisons to be made between resources in different mineral potential categories. Value is inflated in very large but very low grade deposits.

X-Y Plots: Value Per Tonne Versus Resource Tonnage

These log-log plots serve to illustrate the size and unit value relationships between various deposits. Such a plot isolates a deposit which has a particularly low or high value per tonne relative to its reserve "peers". A particularly low value suggests that the deposit may need to be re-assessed as a potential producer. A high value suggests economic significance. Value per tonne versus reserve plots are illustrated in a summary plot of all categories (Figure B-14-1). Lines of equal resource value are shown. However, many factors affect economic viability. For example the Canty deposit is a producer even though it is small and has a low value per tonne (*see* Figure B-14-1); it provides ore supplementing that of a much larger, nearby producer (Nickel Plate).

RESULTS

Results of the data analysis are portrayed in a summary table (Table B-14-2) and in pie charts (Figures B-14-2 to 4).

High Potential

There are 63 deposits which contain 49 per cent of total resource tonnage and 57 per cent of the total metal value. Of these, 13 were unknown (unlocated) in 1975. Seven deposits have seen significant production since 1975 (**Goldstream, H-W, Lawyers, Shasta, Scottie Gold, Baker, Canty**). The first four of these were not located on the 1975 MDLU maps. Goldstream, H-W, Lawyers and Canty are currently producing.

An individual plot of log value per tonne versus log resource tonnage shows a uniform distribution with a number of deposits in each size category.

Moderate Potential

There are 55 deposits which contain 49 per cent of total resource tonnage and 35 per cent of total metal value. The **Eskay Creek** deposit falls within this group. Twenty-four deposits were unknown in 1975.

Six of the fifty-five deposits have seen significant production since 1975 (**Samotosum, Snip, Erickson, Cusac, Blackdome and Johnny Mt.**). The first four of these were not located on the 1975 MDLU maps and the first two are currently producing.

The individual plot of log value per tonne versus log resource tonnage shows more dispersal than in the high-potential chart. The distribution across size categories is not uniform (lacking representatives in 3 to 10 million tonne range). The reason for this gap in size representation is not known. The average value per tonne is $16.29. This is significantly less than in high potential areas ($26.76).

Low Potential

There are eight deposits which contain 0.3 per cent of total resource tonnage and 0.7 per cent of metal value. Almost all are new discoveries since 1975. One deposit has produced since 1975 (**Golden Bear**). It was not located in 1975. Most deposits are very small. One deposit

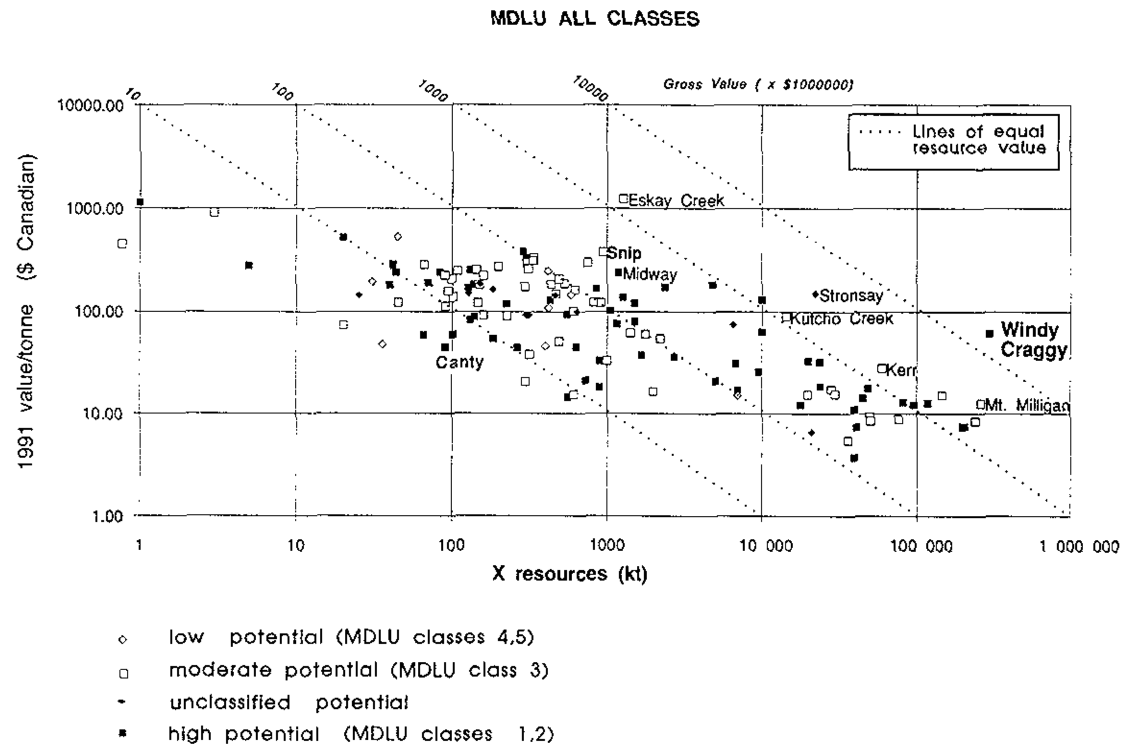


Figure B-14-1.

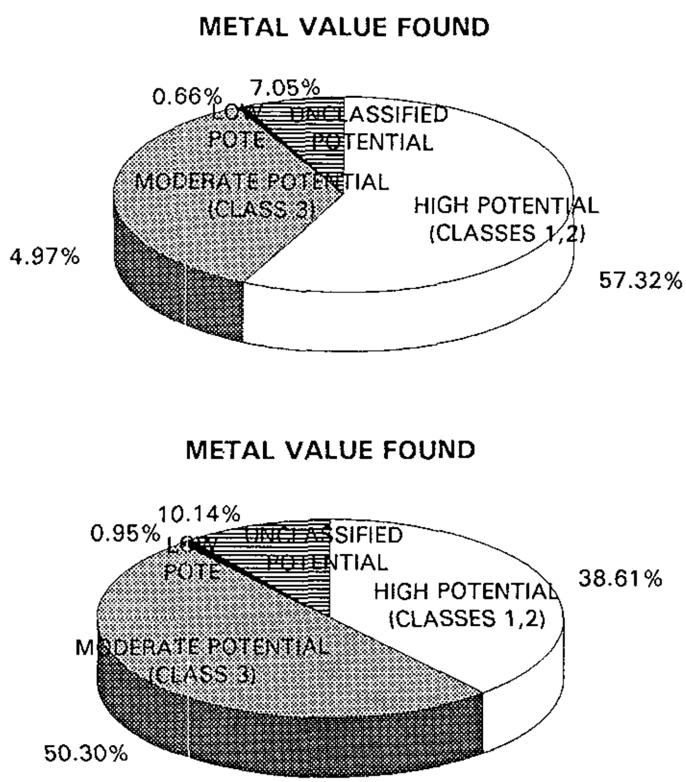


Figure B-14-2. Pie chart of metal value found since "1975" according to mineral potential designation. Bottom chart shows how the analysis is affected by excluding Windy Craggy.

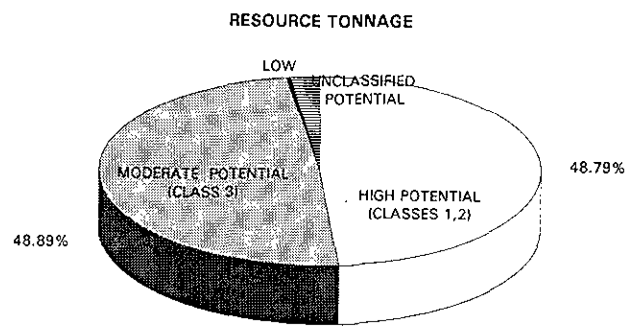


Figure B-14-3.

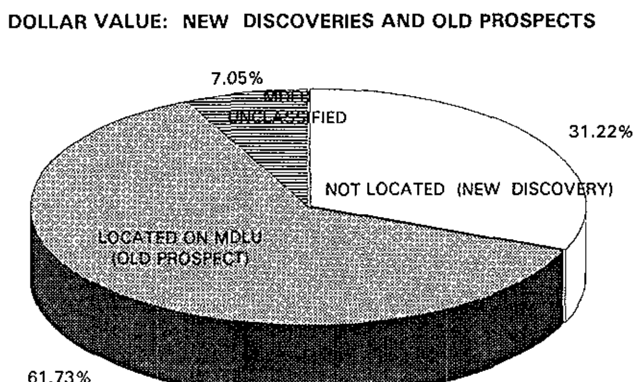


Figure B-14-4.

TABLE B-14-2

DEPOSITS OF KNOWN SIGNIFICANCE SINCE 1975 MDLU (BASED ON MAP 65 DATA)			
DEPOSITS IN HIGH-POTENTIAL AREAS			
LOCATED ON 1975 MDLU AS PROSPECT	VALUE (DOLLARS)	RESOURCES (KT)	VALUE/TONNE ($ CANADIAN)
13 NO	4,146,793,335	222,593	18.63
50 YES	29,884,434,225	1,048,919	28.49
63 TOTAL	34,031,227,560	1,271,512	26.76
DEPOSITS IN MODERATE-POTENTIAL AREAS			
LOCATED ON 1975 MDLU AS PROSPECT	VALUE (DOLLARS)	RESOURCES (KT)	VALUE/TONNE ($ CANADIAN)
24 NO	14,100,155,565	941,958	14.97
31 YES	6,658,919,992	332,104	20.05
55 TOTAL	20,759,075,557	1,274,062	16.29
DEPOSITS IN LOW-POTENTIAL AREAS			
LOCATED ON 1975 MDLU AS PROSPECT	VALUE (DOLLARS)	RESOURCES (KT)	VALUE/TONNE ($ CANADIAN)
7 NO	284,459,488	1,928	147.51
1 YES	105,875,000	7,000	15.13
8 TOTAL.	390,334,488	8,928	43.72
DEPOSITS IN AREAS OF UNCLASSIFIED POTENTIAL			
	VALUE (DOLLARS)	RESOURCES (KT)	VALUE/TONNE ($ CANADIAN)
10 TOTAL	4,184,878,682	51,493	81.27
ALL CATEGORIES			
LOCATED ON 1975 MDLU AS PROSPECT	VALUE (DOLLARS)	RESOURCES (KT)	VALUE/TONNE ($ CANADIAN)
44 NO	18,531,408,388	1,166,479	15.89
82 YES	36,649,229,217	1,388,023	26.40
10 UNCLASSIFIED	4,184,878,682	51,493	81.27
	TOTAL VALUE	***TOTAL RESOURCES***	***AVG. VALUE/TONNE***
136 TOTAL	59,365,516,287	2,605,995	22.78

(**Rock and Roll**) was found in an area classified as having no potential (Class 5 in drift cover).

Unclassified Potential

There are ten deposits which contain 2 per cent of total resource tonnage and 7 per cent of metal value. These are deposits from two diverse areas (northeastern B.C. and the Nelson area in the Kootenays) which were unclassified for different reasons.

RESULTS IN TERMS OF DEPOSITS NOT LOCATED IN 1975 MDLU SERIES (NEW DISCOVERIES)

About 31 per cent of all metal value and 45 per cent of all resource tonnage has been found in new discoveries. This increases to 38 and 47 per cent respectively, if deposits found in areas where no MDLU map was prepared are included. Most of this new metal value is in moderate potential areas. The average value per tonne is less for new discoveries ($18.65 vs. $26.40).

New discoveries comprise 18 per cent of the resource tonnage found in high potential areas and 74 per cent of the resource tonnage found in moderate potential areas.

RESULTS IN TERMS OF AREAL COVERAGE BY EACH MINERAL POTENTIAL CATEGORY

The area covered by the high-potential designation is approximately 10 per cent of that classified as moderate potential. If a comparison is done on the basis of unit area and only new discoveries are considered there is about a 3 to 1 advantage in terms of finding value, and a 2.5 to 1 advantage in finding tonnage in an area designated high potential. The assumption, however, is that the same exploration effort per unit area has been applied to areas of moderate potential as to high. This is probably not true and a more rigorous assessment would result in decreasing the above ratios (the big question is by how much).

The area designated as having low potential is somewhat greater than that of moderate potential. For a rough calculation they can be treated as equal. Again considering only new discoveries and utilizing the figures directly from Table B-14-2 there is an advantage of almost 500:1 in terms of finding value and 50:1 in terms of finding tonnage in a designated moderate potential area. The assumption again is that similar exploration efforts have been made in moderate and low potential designated areas which is not the case.

RESULTS IN TERMS OF THE INFLUENCE OF A SINGLE LARGE DEPOSIT

The Windy Craggy deposit contains 30 per cent of the total metal value found since 1975 (excluding extensions to known orebodies). Figure B-14-2 illustrates its effect on total metal value found as derived from Table B-14-3. Its effect on value per tonne, according to various groupings from Table B-14-3.

TABLE B-14-3

VALUE/TONNE $	WITH WINDY CRAGGY	WITHOUT WINDY CRAGGY
Located in 1975 as prospect	26.40	17.01
Deposits in high pot. areas	26.76	16.36
All categories	22.78	17.88

CONCLUSIONS

The 1975 maps were successful in defining metallic mineral potential. Mineral potential maps have validity.

1. Most of the metal value (and tonnage) added to the database since 1975 is associated with **previously located prospects** in high-potential areas and in **new discoveries** in the moderate-potential areas.
2. High-potential areas remain the best targets for **new discoveries** on a **unit-area comparison** with moderate-potential areas.
3. If the MDLU maps were redone today the principal change would be that some areas previously designated moderate potential would now be designated high potential (*e.g.* areas in NTS 104B represented by Snip, Eskay Creek, Kerr, Johnny Mt. deposits). Such a change was implied in the definition of Class 3 potential on 1975 maps (environment favorable, future exploration likely).
4. The MDLU maps incorporate a strong correlation between high-potential areas and areas with deposits of known significance.
5. Significant deposits (*e.g.* Stronsay) have been found in unclassified areas.
6. Low-potential areas may conceal an economic deposit but the advantage in looking in moderate or high-potential areas is considerable. Surprises are possible in areas of drift cover where the underlying geology is poorly known.
7. A single deposit, Windy Craggy, has a significant influence on the results of the analysis.

RECOMMENDATIONS RELATED TO LAND USE PLANNING

1. Moderate potential areas should be reassessed by the Geological Survey Branch. Additional geologic data (particularly geochemical) has been collected since 1975. More refined techniques of assessment are available (*e.g.* McLaren, 1990).
2. Independent compilations of resource data should be utilized by planners to test the reproducibility of the general results.
3. The level of exploration activity in each mineral potential class in the last 15 to 20 years should be evaluated to determine how activity has affected the discovery rate.
4. The relationship of new industrial mineral discoveries to 1975 mineral potential designations should be evaluated.
5. Other databases can be used to assess 1975 mineral potential designations. For example the maps were constructed without use of regional geochemical data. It would be worthwhile to see how RGS data relates to 1975 mineral potential classifications (perhaps by an assessment of geochemical background levels in each class).
6. Scale must be appreciated. The fact that a single very large deposit can substantially affect the results of a province-wide analysis is a sobering thought for planning.

POSTSCRIPT

There was a strong demand for the MDLU maps in the 1970s and in the early 1980s by provincial land-use planning agencies (G. McLaren, personal communication, 1992). The validity of the maps depends largely on the size and quality of the available database. At that time there were 7000 record cards whereas at present MINFILE has some 10 600 records, half again as much. In addition, the quality of the geological database has been greatly improved. These factors, together with the regional geochemical survey data, should result in improved mineral potential maps.

Copies of the database X-T plots for individual mineral potential categories and a Quikmap file for plotting are available from the authors.

GENERAL REFERENCES

McCartney, W.D., Fyles, J.T. and Matheson, A.H. (1974): Mineral Capability Maps for Land Use Planning in British Columbia; *Western Miner*, July 1974, pages 9-16.

McLaren, G.P. (1990): A Mineral Resource Assessment of the Chilko Lake Planning Area; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Bulletin 81.

ASSESSMENT REPORTS A SOURCE OF VALUABLE CURRENT AND HISTORIC MINERAL EXPLORATION DATA

(*See* Fig. B1)

By T.E. Kalnins and A.F. Wilcox

SUMMARY OF ASSESSMENT WORK, 1991

Results of mineral exploration programs are submitted by the industry to the Ministry in compliance with the Mineral Tenure Act Regulations and provide a valuable record of exploration data in British Columbia.

The number of assessment reports submitted and approved in 1991 totalled 1304 with declared costs of $74, 379 878, a 27 per cent increase in expenditures over year 1990. This mainly pertains to increased exploration activity in the Eskay Creek and Mount Milligan areas of northwestern and central British Columbia (Table B-15-1, Figures B-15-1, 2, 3).

Drilling accounted for 41 per cent of the expenditures, geochemistry 20 per cent, physical work 16 per cent, geophysics 12 per cent, geology and prospecting 11 per cent (Figure B-15- 4).

Although overall exploration in the province decreased from $143 million in 1990 to $80 million in 1991, the decrease is not reflected immediately in assessment work associated with maintenance of mineral claim tenure.

Average exploration project costs by work type are shown in Tables B-15-2 and B-15-3. These values are based on clearly apportioned cost statements declared in 562 selected assessment reports, including labour, consulting, food, accommodation, transport, camp equipment rentals and supplies, laboratory analyses, report preparation, and direct administration and management of the project.

USING THE DATABASE

Assessment reports are the primary and most current source of detailed technical data available in the public domain. Data on exploration may be viewed or copies purchased after expiry of a confidentiality period (usually one year).

The Geological Survey Branch maintains a library of over 22 000 assessment reports dating from 1947. A computer index called ARIS (Assessment Report Indexing System) provides help to users wishing to locate specific information for planning new exploration programs, resource management - land use studies, or geoscience research.

Index maps on microfiche or paper at 1:250 000 scale (1:125 000 in southern B.C.) show the approximate centre of exploration reported. Page-size copies of these maps are included with the index printout. A basic bibliographic index printout is sorted by NTS map sheets. For each report the index provides latitude, longitude, UTM co-ordinates, claim names, operator, author, type of work reported and report year. The same data fields included on the paper index are organized as a series of flat ASCII files on diskettes to facilitate access by a variety of commercial software programs. The index is also available on COMFICHE.

TABLE B-15-1
SUMMARY OF ASSESSMENT WORK, 1991

NTS	No. of Assessment Reports	Value $	Geological (ha)	Geophysical Airborne (km)	Geophysical Ground (km)	Geochem. No. of Samples	Drilling Core (m)	Drilling Non-core (m)	Prospecting (ha)	Trenching (m)	Access Roads (km)	Line/grid (km)	Tunnelling (m)
82/83	267	8 089 958	85 241	6 209	1 577	59 496	32.896	1 495	15 434	7 966	5	957	126
92/102	260	8 323 851	79 722	2 334	1 326	69 704	40 157	7 037	26 698	9 354	34	958	---
93	229	13 285 658	15 645	25 388	3 642	71 537	51 434	12 227	8 531	2 288	70	1 656	422
94	61	2 557 463	30 053	850	398	19 926	3 346	1 460	7 285	3 490	38	224	---
103	53	4 447 837	24 150	10 440	40	11 756	20 169	---	5 448	496	---	12	---
104/114	434	37 675 111	91 211	16 136	2 093	88 086	87 265	160	49 547	12 297	23	1 113	1 132
TOTALS													
1991	1 304	74 379 878	326 022	61 357	9 076	320 505	235 267	22 379	112 943	35 891	170	4 920	1 680
1990	1 199	58 421 502	342 564	36 850	11 020	314 506	185 119	22 359	127 274	39 497	537	5 160	765
1989	1 233	60 856 206	264 373	36 756	10 451	363 152	207 511	34 139	124 516	42 025	222	5 921	3 961

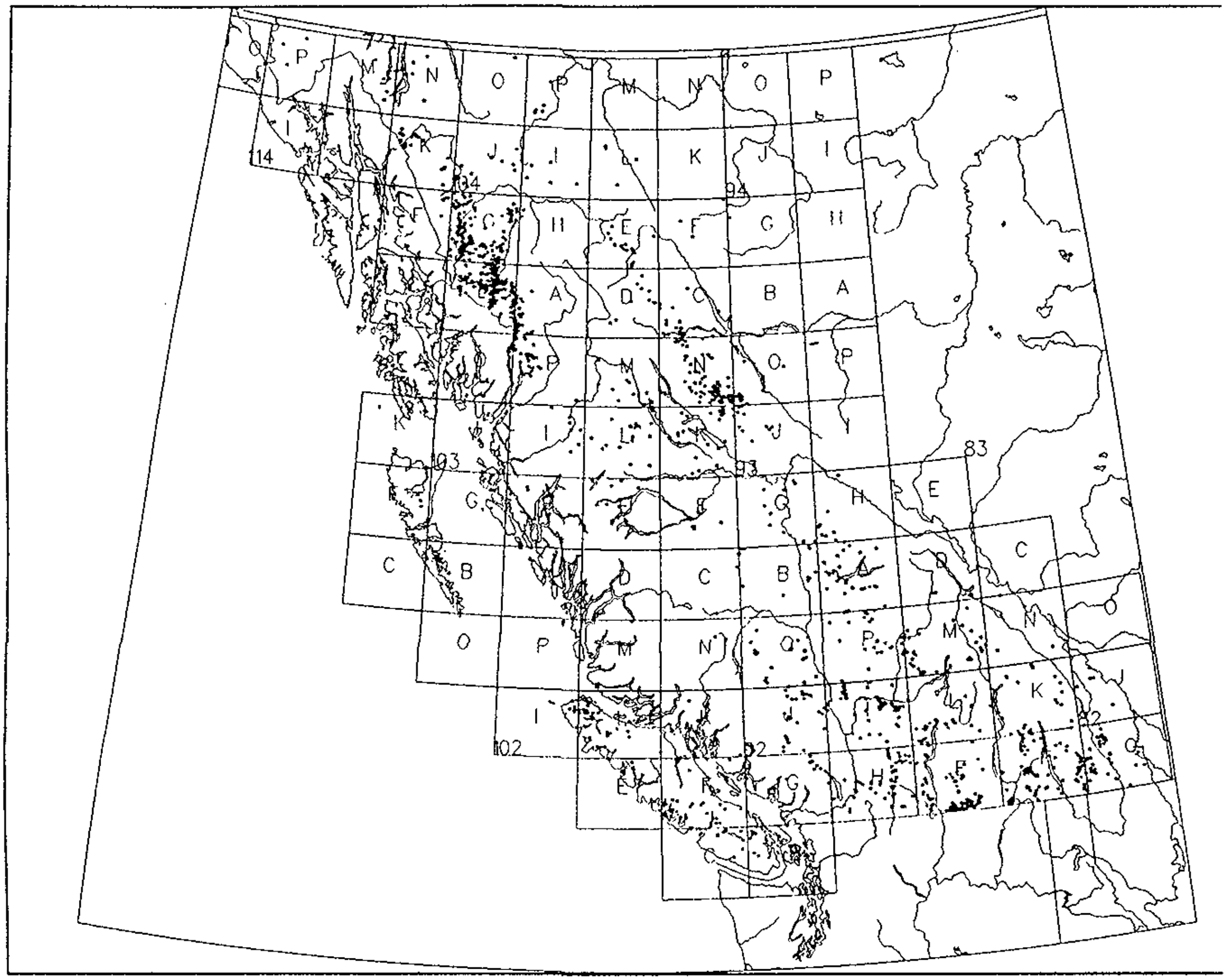


Figure B-15-1. Assessment report distribution in B.C. - 1991.

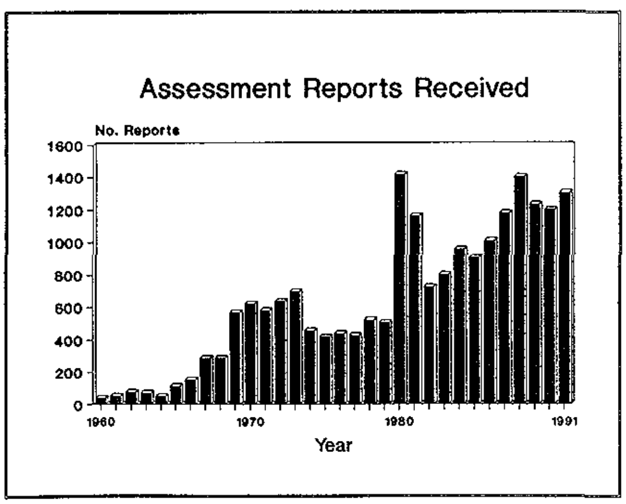


Figure B-15-2.

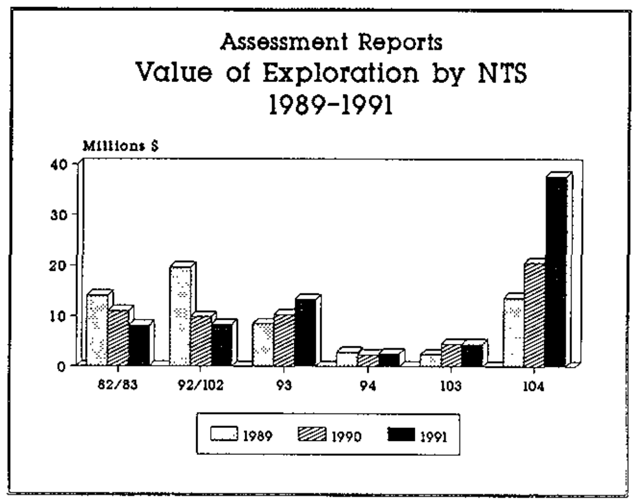


Figure B-15-3.

TABLE B-15-2
EXPLORATION PROJECT COSTS, 1991

TYPE OF WORK	AMOUNT	UNITS	VALUE $	AVERAGE COST $		NO. OF SURVEYS
Geological mapping	197 823	ha	3 597 532	18	per ha	165
Photo interpretation	40 690	ha	59 561	1	per ha	5
Petrography	40	samples	7 180	179	per sample	6
Magnetic, airborne	18 455	km	896 084	49	per km	36
Electromagnetic, airborne	19 039	km	921 743	48	per km	34
Magnetic, ground	2 672	km	369 316	138	per km	71
Electromagnetic, ground	872	km	452 683	519	per km	53
Induced polarization	825	km	1 038 229	1 258	per km	44
Soil sampling	96 603	samples	3 114 186	32	per sample	191
Stream sediments	2 428	samples	184 723	76	per sample	74
Rock chips	15 203	samples	1 088 649	72	per sample	146
Heavy minerals	43	samples	15 062	350	per sample	6
Sampling-assaying	31 780	samples	1 085 740	34	per sample	87
Biogeochemical	139	samples	3 526	25	per sample	3
Core drilling	96 742	metres	10 797 422	128	per metre	76
Non-core drilling	4 646	metres	216 315	47	per metre	9
Prospecting	72 865	ha	719 849	10	per ha	145
Line cutting, grid	2 060	km	841 274	408	per km	80
Road work	93	km	271 514	2 935	per km	17
Trenching	17 609	metres	668 070	38	per metre	37
Topographic (photogrammetric)	23 063	ha	131 686	6	per ha	11

TABLE B-15-3
EXPLORATION PROJECT COSTS, 1989-1991
($ per unit of work)

Type of Work	1989	1990	1991
Geological mapping	12/ha	11/ha	18/ha
Magnetic, ground	242/km	170/km	138/km
Electromagnetic, ground	302/km	285/km	519/km
Mag./E.M., airborne	90/km	80/km	97/km
Induced polarization	1986/km	1329/km	1258/km
Seismic	8978/km	3969/km	---
Soil sampling	23/sample	32/sample	32/sample
Stream sediments	86/sample	115/sample	76/sample
Rock chips	46/sample	79/sample	72/sample
Drilling, core	99/m	109/m	128/m
Drilling, non-core	80/m	70/m	47/m
Prospecting	7/ha	8/ha	10/ha
Line cutting, grid	290/km	396/km	408/km
Topographic (photogrammetric)	---	---	6/ha

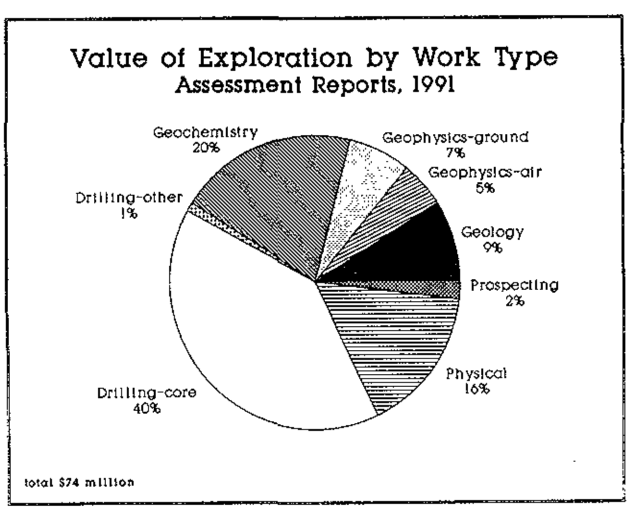


Figure B-15-4.

A new, improved service for obtaining copies of assessment reports and indexes was introduced in Vancouver in December, 1990. These products may now be purchased directly from:

B.C. and Yukon Chamber of Mines Data Centre
844 West Hastings Street
Vancouver, British Columbia
V6C 1C8

Telephone: (604) 688-7571
Fax: (604) 681-2363

A complete library of original assessment reports is located at the Branch's headquarters in Victoria. Partial libraries are located at the District Geologists' offices in Smithers, Prince George, Kamloops and Nelson. Complete libraries of microfiche assessment reports are available in all District Geologists' offices. Partial libraries are maintained in nineteen Gold Commissioners' offices throughout British Columbia. For further information contact:

Geological Survey Branch
Room 201 - 553 Superior Street
Victoria, British Columbia
V8V 1X4

Telephone: (604) 356-2282
Fax: (604) 356-7413