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BRIDGE RIVER MINING CAMP GEOLOGY AND MINERAL DEPOSITS

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SUMMARY

The Bridge River mining camp encompasses five former mines including two large gold producers, Bralorne and Pioneer; three small producers, Wayside, Minto and Congress; and more than 60 surrounding mineral prospects. This study re-evaluates the geology of the camp, fits the numerous mineral occurrences to modern geological interpretations and provides a synthesis of mineral potential and a framework for further exploration.

The rocks of the Bridge River mining camp comprise a variety of Paleozoic, Mesozoic and Tertiary volcanic and sedimentary strata and igneous intrusions. The Bralorne intrusions and Pioneer volcanic rocks are the most consistently mineralized rocks in the area and the granitic rocks of the Coast Plutonic Complex appear to have been the principal source of mineralizing solutions.

The geology of the camp records repeated cycles of deformation. The oldest rocks are strongly fragmented and intricately folded; spilitic greenschist metamorphism is common. Numerous slices and wedges of Cadwallader and Bridge River metamorphic rocks are found throughout the area testifying to a complicated tectonic history. The youngest units are weakly metamorphosed and block faulted.

It is believed that the imbrication of rocks from Cadwallader (Stikinia) and Bridge River (Cache Creek) terranes occurred at the time of plate collision. Faults and folds disrupt all the units and the general lack of stratigraphic markers makes it difficult to fully evaluate the structures. Although current studies allow tentative restoration of the ancient terranes the details remain controversial.

The present map pattern mainly reflects Cretaceous and Tertiary tectonic activity. A relatively young 'slice fabric' dominates the region. This consists of panels of diverse rocks (including ramped blocks of older rocks) bounded by major northwest and north-trending faults of the Cadwallader and Yalakom fault systems, that mark the boundaries of the principal structural domains that have persisted through the emplacement of the Late Cretaceous to Early Tertiary granitic plutons.

That parts of the Cadwallader and Bridge River suites were deposited penecontemporaneously in adjacent terranes, is suggested by similar fossil assemblages and similar geochemical signatures of the volcanic rocks. These volcanic rocks are MORB-like tholeiites generated from rising mantle diapirs, possibly in a back-arc setting.

The Bralorne intrusions are small gabbro and diorite stocks mostly aligned along the Cadwallader break. Zircon from a coarse-grained phase near Gold Bridge yields a U-Pb date of 293±13 Ma, indicating that the intrusions are among the oldest rocks in the area. These rocks have a silica content in the range 45 to 55% (averaging 50.8%), similar to the Pioneer volcanics, but relatively high in magnesia and low in titania and iron oxides. The geochemistry is similar to that of rocks of ophiolitic affinity in the Thetford area of Quebec and in a general way to that of magmas of oceanic arc tholeiite association.

The Bridge River mining camp is known principally for gold-quartz vein mineralization. An intricate system of fractures is thought to have controlled the movement of the ore-solutions; the most profound crustal breaks being the main solution channelways.

Mineralizing solutions in the Bridge River camp were originally considered to be magmatic; the result of differentiation of Bralorne gabbro and diorite that produced the soda granite (plagiogranite). However, it is now known that the Bralorne intrusions and associated ophiolite complex are Paleozoic and much older than the ore veins. Indeed, the age of mineralization at the Bralorne mine, determined by K-Ar dating of wallrock alteration, is 85.1 Ma. This is similar to the age of the nearby Gwyneth Lake satellitic stock, dated 85.9 Ma, and within the 69.5 to 98.4 Ma-zircon-dating age range of the adjacent Bendor pluton.

It is speculated that the stresses caused by the intrusion of these granitic plutons resulted in shearing and the development of fissure veins. It is believed that an important part of this movement is manifest in reactivation of the Cadwallader fault zone, a pre-existing major break. The evidence suggests that emplacement of the Coast Plutonic Complex provided both the structural controls and the necessary thermal engine to drive the mineralizing solutions, which were of mixed connate and juvenile origin.

Frontispiece: Relics of a golden mining era; Pioneer Headframe and mill (sketch by Margaret Hanna, 1987).

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CHAPTER 1
INTRODUCTION

"Nay if I understand anything, greater wealth now lies hidden beneath the ground in the mountainous parts of your territory than is visible and apparent above ground."

—— *Agricola (1556)*

The Bridge River mining camp is located 180 kilometres north of Vancouver. It covers approximately 1500 square kilometres of mountainous terrain in the Bridge River watershed and is bounded by the Coast Range on the west and southwest and the Shulaps Range on the northeast (Photo 1.1). The camp has more than 60 mineral localities including the Bralorne-Pioneer mining complex which with an output of 129 tonnes of gold is the foremost gold producer in British Columbia and sixth largest in Canada.

Regional mapping and property evaluations in the camp, covering parts of the Bralorne, Noaxe and Birkenhead map sheets, were initiated by the British Columbia Ministry of Energy, Mines and Petroleum Resources in 1986 in response to mineral exploration activity stimulated by flow-through tax incentives. The mapping was completed on a 1:20 000 and 1:50 000 base during the summers of 1986, 1987 and the early part of the 1988 season (Church and MacLean, 1987a; Church *et al.*, 1988); mineral studies and detailed mapping on mining properties continued through 1988 (Church 1986a, 1987a,b; Church and MacLean, 1987b and c; Gaba and Church, 1988; Gaba *et al.*, 1988; Hanna *et al.*, 1988; Church *et al.*, 1988-1989). The area is underlain by 14 mappable units consisting of bedded volcanic and sedimentary assemblages and a variety of intrusive rocks ranging from Paleozoic to Tertiary age. These units are faulted and invaded by veins which are mineralized with gold, silver, tungsten, antimony, molybdenum and mercury.

The object of this study was to re-evaluate the geology and style of mineralization in the camp in the light of new road access and renewed mining exploration activity in the area. The regional mapping fits the numerous mineral occurrences into a modern geological framework (Figure 1A, in pocket). The study presents revised lithological and structural interpretations of the region providing a mineral potential rationale and targets for further exploration. Control of the regional mapping is based on approximately 200 traverses and 2500 geological stations scattered across the area (Figure 1B, in pocket). A summary of selected traverses is appended to this report. Lithology is determined by microscope and microprobe examination of more than 300 thin sections, mineralogical determinations of 64 rocks by x-ray diffraction analyses, and silicate analyses (major and minor elements) of 84 samples collected across the area. The age of units was further defined by 25 new fossil locations and 16 radiometric determinations of igneous and metamorphic rocks. Structures are detailed by numerous measurements of fractures, bedding attitudes, fold axes, and vein orienta-

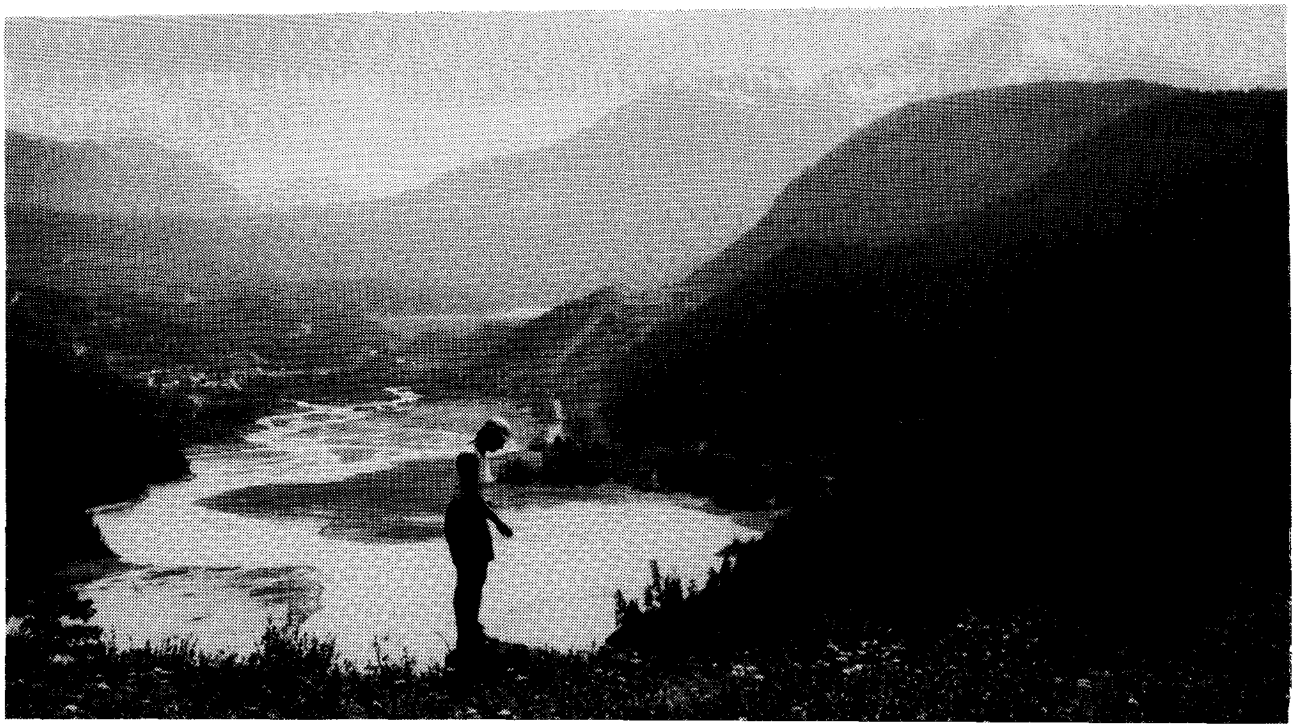


Photo 1.1 View of Gold Bridge area looking southwest to the Coast Range, from Slim Creek logging road.

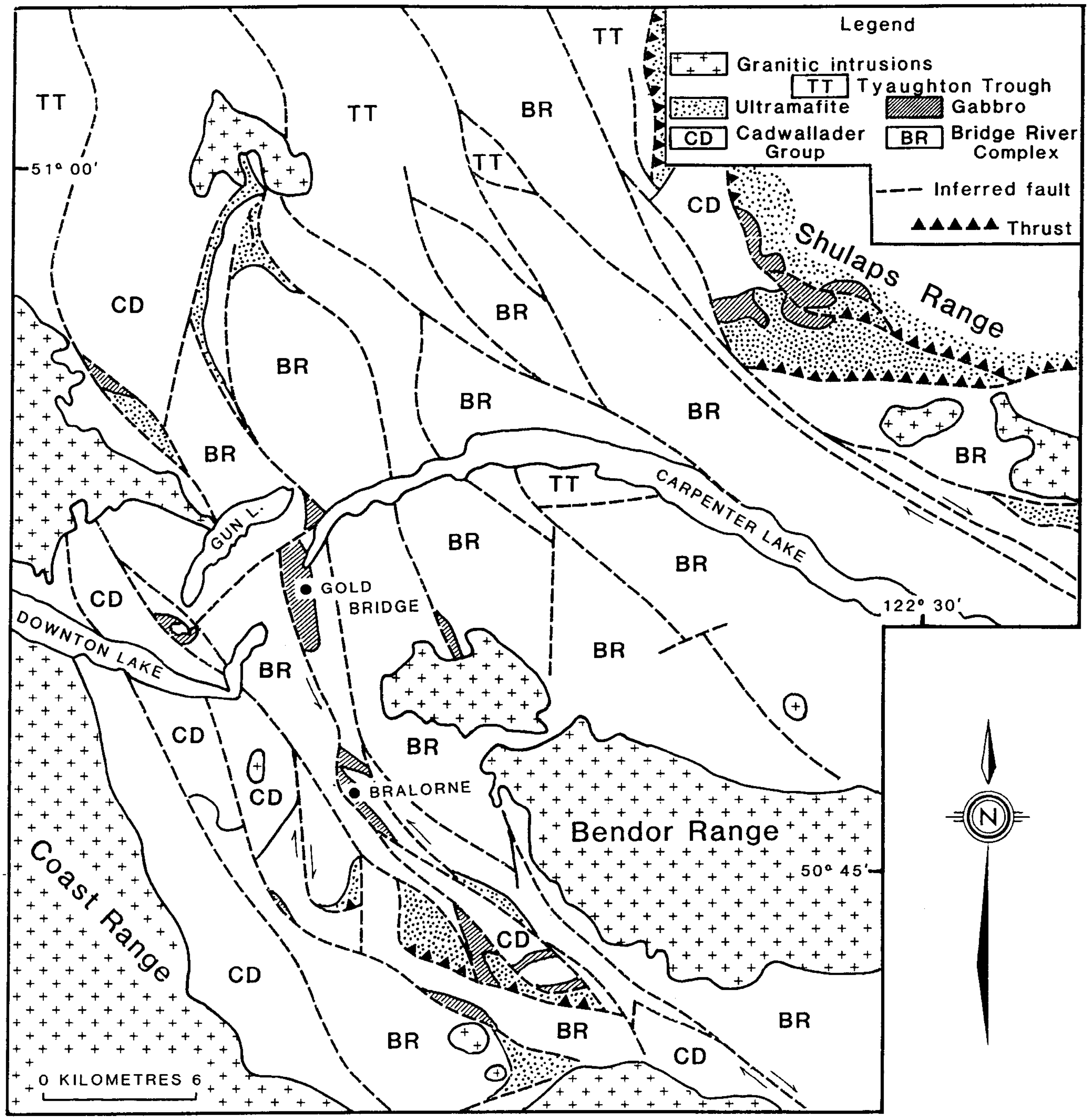


Figure 1.1 Generalized geological map of the Bridge River area.

tions. A synthesis of the mineral potential of the camp is given at the end of Chapter 5.

PHYSIOGRAPHY, GLACIATION AND RECENT DEPOSITS

The Bridge River mining camp encompasses an area extending from the snow-clad peaks and serrated ridges of the Coast Mountains, west of the towns of Bralorne and Gold Bridge, to the less rugged varicoloured Shulaps and Chilcotin ranges north of Carpenter Lake. Elevations decrease from a maximum of 2880 metres at the summit of Mount Truax to the local base level of 650 metres on Carpenter Lake (Figure 1.1). The history of uplift and erosion in the region can be interpreted in part from the disposition of concordant summits in the Coast Mountains and upland surfaces in the Chilcotin Range. The evidence from buried erosion surfaces is more fragmented and difficult to interpret, nevertheless, the mesa-forming 'plateau basalts' on Mount Noel (elev. 2400 m) correlate with the basalts of the Chilcotin Group (Miocene), at roughly the same elevation on Castle Peak and Cardtable Mountain, 40 kilometres to the north. These outliers are at considerably higher elevations than equivalent lavas exposed in the Interior Plateau

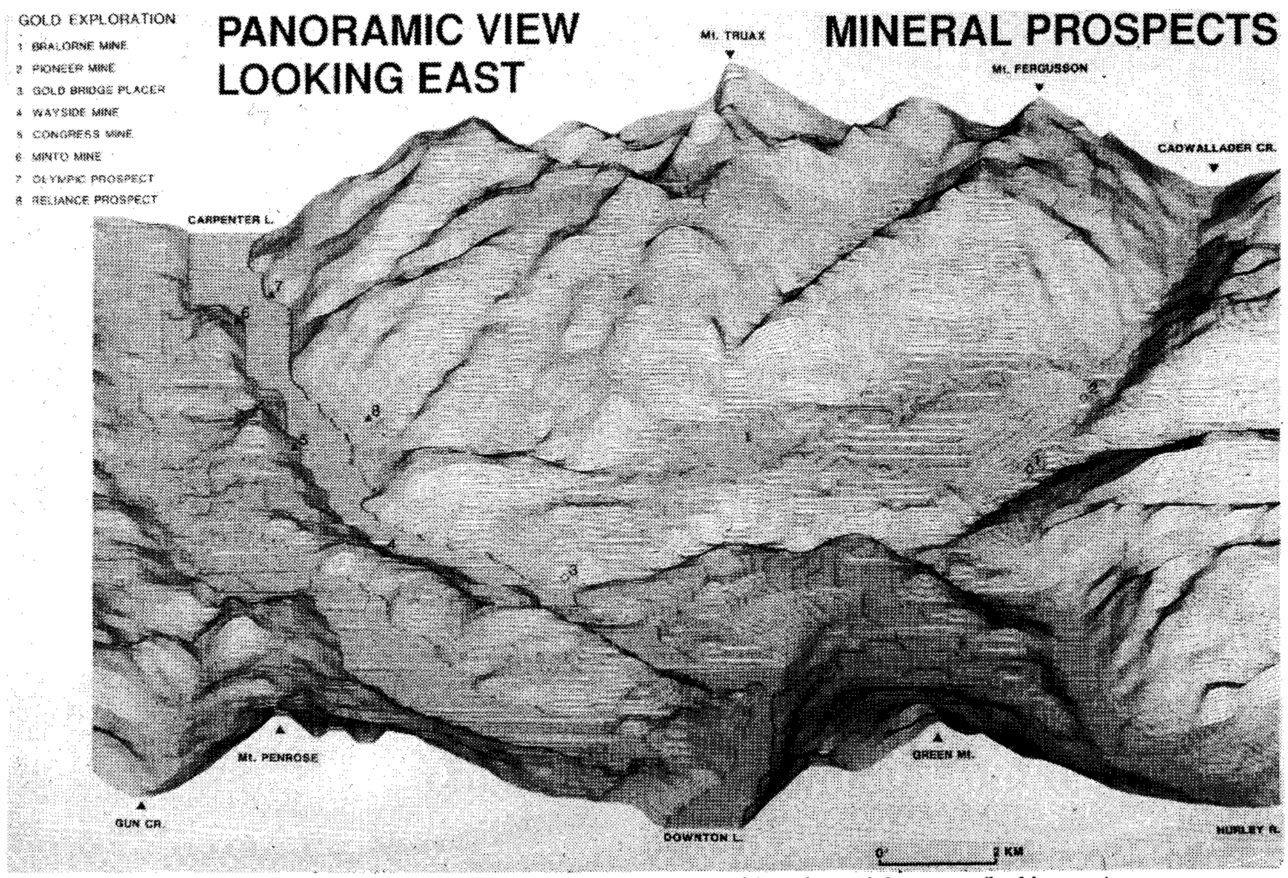


Figure 1.2. Panoramic view (computer generated) of the Bridge River mining camp (looking east).

to the east, suggesting relative uplift of more than 1500 metres in the Coast Mountains since the eruption of the basalt during the Miocene (Mathews, 1990).

The area has been markedly sculptured by Pleistocene glaciation (Evans, 1990). The principal features are the deep, broad and straight or gently curving main valleys now occupied by Downton Lake and Carpenter Lake and, at somewhat higher elevation, the broad flat-floored tributary valley of the Hurley River. Towards the end of the last glacial episode the melting ice lobes drained easterly to the Fraser River, depositing large volumes of sand and gravel such as presently found near the mouth of the Yalakom River. This meltwater also carved the canyon section along the lower course of the Bridge River. With further ablation and retreat of the Hurley valley lobe, ice blockage in the main valley was removed from the area near the present west end of Carpenter Lake. Drainage was restored to the antecedent course of the Bridge River from a temporary route through Gun Lake and Pearson Pond. The thick gravel beds deposited along this temporary channel were subsequently breached by Gun Creek which was draining meltwater from the northwest. It is suspected that these gravels were the source of the placer gold on Gun Creek reported in 1859.

A large accumulation of outwash gravel on the south side of Carpenter Lake, 7 kilometres east of the mouth of Gun Creek, was formed by a cascade of meltwater discharging from a large northerly flowing glacier occupying the valley of Truax Creek. The present lower course of Truax Creek has been deflected by a sill of chert and greenstone near the north end of the hanging valley, into a V-shaped gorge which enters Carpenter Lake a few kilometres east of the outwash deposit.

In the late Pleistocene, the broad section of Cadwallader valley above the Pioneer mine was filled with melting ice. This drained northwest, depositing much sand and gravel along the course of Cadwallader Creek, the Hurley River and antecedent channels. The meltwater deeply incised the lower section of the Hurley River valley and deposited gold placers at Haylmore at the mouth of the river near Gold Bridge.

The Bridge River ash, which has been deposited across a large area over glacial colluvium, is about 30 centimetres thick just south of Pearson Pond near Gun Creek (Photo 1.2). The ash is a distinctive light coloured rhyodacite dated ~2350 B.P. (Nasmith *et al.*, 1967; Mathewes and Westgate, 1980). The source of the ash is believed to be a volcanic vent on Plinth Mountain about 50 kilometres to the west in the upper Lillooet River valley. Accumulation of the ash is variable throughout the region and appears to be thickest near Downton Lake. Mountain tops and ridges above treeline are generally washed free of the ash.

MINING HISTORY

Gold was first discovered in the Bridge River valley by placer miners on Gun Creek in 1859 and along the lower section of Tyaughton Creek by 1866. It was not until 1882 that the Haylmore placer gravels were found at the mouth of the Hurley River near the present town of Gold Bridge, and in 1886 on Cadwallader Creek (Bancroft, 1887; Pater-

Photo 1.2. Bridge River ash, above Gun Creek.

son, 1979). Total recovery from the Haylmore placer is estimated to be "over 1000 ounces" (31 100 grams) of coarse gold (MINFILE 092JNE026). It is also reported that many nuggets were in the 31 to 156 gram range, the largest weighing 404 grams.

Most of the lode gold occurrences were located from 1896 to 1915, although discoveries and desultory development continued until construction of the Terzaghi Dam in 1959 and rerouting the main road to the north shore of the B.C. Hydro reservoir that now forms Carpenter Lake.

The Pioneer mine began production in 1928 followed by the Bralorne mine in 1932. These operations were amalgamated in 1959 and soon became the primary gold producer in British Columbia. The mines closed in 1971. Combined operations from 160 kilometres of tunnels attained a total ore output of 7.2 million tonnes yielding, on average, 17.9 grams per tonne gold and 3.9 grams per tonne silver.

Other past-producing properties include the Wayside, Congress and Minto mines north of Carpenter Lake. At these mines most development occurred from 1933 to 1940. The Minto mine was the most important with an output of 80 650 tonnes of ore that yielded 6.8 grams per tonne gold and 19.5 grams per tonne silver. The Wayside mine produced 39 094 tonnes yielding 4.2 grams per tonne gold and 0.67 grams per tonne silver, and the Congress mine 943 tonnes yielding 2.7 grams per tonne gold and 1.4 grams per tonne silver (Harrop and Sinclair, 1985).

Additional information on the history of individual mines and prospects is provided in Chapter 5 of this report.

ACKNOWLEDGMENTS

The courtesies and support of the residents of the communities of Bralorne and Gold Bridge are gratefully acknowledged including Frank Whiting, Carol and Frank Bethune and Tom Illidge.

Assistance rendered by mining and exploration personnel is also acknowledged. Special thanks are owing Jan Kristofferson, Paul Johannes and Jim Miller Tait of Levon Resources Limited, Mark Tindall of Mascot Gold Mines Limited, Bill Howell and Sandra McAllister of Chevron Canada Resources Limited, Brad Cooke and Tim Sandburg of Cooke Geological Consultants Limited, Charles Boitard and Lawrence Sookochoff of Menika Mining Limited, Tom Carpenter of Azimuth Geological Consultants Limited, Jim Dawson of Kerr, Dawson and Associates and Pilgrim Holdings Limited, Robert Miller of Westmin Resources Limited, John Tancowney of Anvil Resources Limited, Bob Seraphim (consultant), Peter Friesen (consultant), Chris Sampson (consultant), Bill Atkinson and Bob Holt of Caribou Chilcotin Helicopters Limited.

Officers of the Geological Survey of Canada including Ken Dawson, Glen Woodsworth and Margaret Rusmore have provided scientific information for this study. Fossil identifications and related data were supplied by Terry Poulton, Jim Haggart, Mike Orchard and Jim Monger.

Joe Harakal, Don Murphy and Janet Gabites of The University of British Columbia have provided K-Ar and U-Pb zircon radiometric age determinations. Information was also exchanged with Craig Leitch of the University of British Columbia, and John Garver and Paul Umhoefer of the University of Washington and Pierre Maheux of the University of Alberta.

Advice and technical assistance has been supplied by Ministry colleagues including Verna Vilkos (chemical analyses), Mac Chaudry (x-ray diffraction), Paul Matysek (geochemical sampling), Dick Player (lapidary and photography) and field assistants Mary MacLean, Margaret Hanna, Robert Gaba, Debbie James and Kim Safton, and Aaron Pettipas (fieldwork and research). Field trips were conducted jointly with Paul Schiarizza and Rick Meyers.

Much appreciation is owing to Vic Preto, Paul Schiarizza and other staff members of the British Columbia Geological Survey Branch for technical and scientific editing and to external reviewers Craig Leitch (Geological Survey of Canada), Ted Grove (consultant) and Jarda Dostal (Saint Mary's University) for their advice.

CHAPTER 2
GENERAL GEOLOGY

"But geology has never been a dull subject, and the review of post-1955 developments indicates that the magnificent two-sided argument may degenerate into a barroom brawl among rival groups of petrologists and geochemists; this augurs well for new discoveries as each group strives to persuade the others."

— P.J. Wyllie (1967)

The first contributions to the geology of the area were by the Geological Survey of Canada, mainly by Drysdale (1915), McCann (1922), Cairnes (1937, 1943) and later by Roddick and Hutchison (1973) and Woodsworth (1977). Recent detailed mapping in parts of the area has been completed by post-graduate students of the University of Washington, including Potter (1983), Rusmore (1985) and Garver *et al.* (1989), and by the British Columbia Geological Survey Branch including Church (1987a), Church and MacLean (1987a), Church *et al.* (1988), Glover *et al.* (1988a, b), Church and Pettipas (1989), Schiarizza *et al.* (1990), Schiarizza *et al.*, (in preparation), and Garver (1992).

The rocks of the Bridge River mining camp comprise a variety of Paleozoic, Mesozoic and Tertiary sedimentary and volcanic rocks and igneous intrusions (Tables 2.1, 2.2 and 2.3). The oldest rocks are deformed and fragmented; greenschist grade metamorphism is common throughout the area. The younger cover beds are locally folded and tilted by block faulting and exhibit significant metamorphism only near the contact with major intrusions.

The bedded rocks range in age from mid-upper Paleozoic to mid-Tertiary (Figure 2.1). The oldest rocks are assigned to the Fergusson Group (Cairnes, 1943; Roddick and Hutchison, 1973). This unit is a Paleozoic ocean-floor as-

TABLE 2.1
TABLE OF FORMATIONS

Age	Units / Lithology / Structural History		
	- block faulting -		
Neogene	Chilcotin Gp. plateau basalt lavas; 100-150 m.		
	- strike = slip faulting -		
Paleogene	Rexmount porphyry (~47.5 Ma)		quartz - feldspar porphyry and equivalent volcanic rocks ~500 m and some coal-bearing sedimentary rocks ~50 m.
	- thrusting -		
U. Cretaceous	Coast Plutonic Complex (60-110 Ma)		biotite hornblende granodiorite plutons, minor diorite and granite.
	- Tyaughton trough -		
M. Cretaceous	Taylor Creek Gp.	cyclic polymictic conglomerate beds with minor sandstone and shales.	
L. Cretaceous/ U. Jurassic	Relay Mountain Gp.	*Buchia* beds of varying lithologies, mostly grey shales with minor conglomerate, ~650 m.	
	- terrane docking (imbrication) -		
L. Jurassic/ U. Triassic	Stikine Terrane/ Cadwallader Gp. Hurley sandstones, mudstones, limestones ~700 m; Noel black argillite ~350 m; Pioneer spilitic basalts ~300 m		Cache Creek Terrane/ Bridge River Complex/ Ophiolitic rocks ultramafics, ribbon chert, schists, minor limestones, greenstone with chlorite, prehnite, epidote and epidote Fergusson Gp. + 1000 m.
Permo-Carboniferous	Bralorne intrusions (260-293 Ma) px-hb diorite, gabbro and anorthositic gabbro; soda granite		

TABLE 2.2
RADIOMETRIC K-Ar DATES FOR THE BRIDGE RIVER AREA

No.	EASTING	NORTHING	SOURCE	MATERIAL	K Wt.%	Ar^{40}	Ar^{40} %	DATE (Ma)	LAB	REFERENCE
1	509600	5618900	BASALT	WHOLE ROCK	0.444 ± 0.006	0.324	52.7	18.7 ± 0.7	UBC	CHURCH, THIS PUBLICATION
2	532000	5645000	ALTERED DIORITE	WHOLE ROCK	0.121 ± 0.005	0.205	60.4	43.2 ± 1.8	UBC	CHURCH, THIS PUBLICATION
3	547500	5633200	PORPHYRY	BIOTITE	0.000 ± 0.000	0	69.7	44.7 ± 2.4	GSC	WANLESS *ET AL*., 1975
4	517800	5638600	VEIN	WHITE MICA	0.000 ± 0.000	0	0	45.4 ± 1.1	UBC	PEARSON 1977
5	531200	5654100	PORPHYRY	WHOLE ROCK	0.190 ± 0.020	2.744	810500	58.4 ± 2	UBC	CHURCH *ET AL*., 1989
6	619400	5613300	ALTERED ROCK	WHOLE ROCK	0.326 ± 0.005	0.781	70.4	60.6 ± 2.1	UBC	CHURCH, THIS PUBLICATION
7	511900	5631400	GRANITIC ROCK	WHITE MICA	0.000 ± 0.000	0	0	62.5 ± 1.8	UBC	PEARSON 1977
8	523000	5621500	GRANITIC ROCK	BIOTITE	7.260 ± 0.070	18.205	83.9	63.4 ± 2.2	UBC	CHURCH *ET AL*., 1989
9	521100	5628000	SCHIST	BIOTITE	4.720 ± 0.020	12.01	90.4	64.3 ± 2.3	UBC	CHURCH *ET AL*., 1989
10	514400	5653100	BASALT	WHOLE ROCK	1.370 ± 0.010	3.623	92.5	66.8 ± 2.3	UBC	CHURCH, THIS PUBLICATION
11	517800	5638600	DIKE	WHOLE ROCK	0.000 ± 0.000	0	0	67.7 ± 2.4	UBC	PEARSON 1977
12	517900	5614800	DIKE	WHITE MICA	2.630 ± 0.020	7.616	78.3	73 ± 2.6	UBC	CHURCH, THIS PUBLICATION
13	534900	5619600	ALTERED BRECCIA	WHOLE ROCK	0.467 ± 0.005	1.385	87	74.7 ± 2.6	UBC	CHURCH, THIS PUBLICATION
14	513400	5647500	SANDSTONE	WHITE MICA	0.673 ± 0.001	2.158	80.8	80.7 ± 2.8	UBC	CHURCH, THIS PUBLICATION
15	513600	5626300	ALTERED DIORITE	WHOLE ROCK	0.198 ± 0.001	0.671	61.9	85.1 ± 3	UBC	CHURCH, 1990
16	509800	5625700	GRANITIC ROCK	BIOTITE	6.340 ± 0.030	21.671	90.9	85.9 ± 3	UBC	CHURCH, 1990
17	507200	5638700	GABBRO	WHOLE ROCK	0.089 ± 0.005	0.312	41.2	88.3 ± 4.9	UBC	CHURCH, THIS PUBLICATION
18	521300	5637200	GRANITIC BOULDER	MAFIC CONC.	0.516 ± 0.001	2.475	82.9	119 ± 4	UBC	CHURCH, 1990
19	510600	5633500	DIORITE	AMPHIBOLE	0.087 ± 0.006	1.053	74.5	287 ± 20	UBC	ARMSTRONG, UNPUBLISHED

TABLE 2.3
MICROFOSSIL DETERMINATIONS FROM LIMESTONES OF THE CADWALLADER GROUP AND BRIDGE RIVER COMPLEX

MAP NO	GSC CAT. NO.	UTM COORDINATES EASTING	NORTHING	TAXA	CAI	TERRANE	AGE
1	C-117567	527350	5640200	*Epigondolella triangularis, Neogondolella navicula Huckriede*	3-4	BR	E. NORIAN
2	C-117572	520630	5648150	*Epigondolella sp.*	~4	CD	NORIAN
3	C-117575	532850	5640320	Ichthyolith			INDETERMINATE
4	C-117578	506250	5628950	*Neogondolella navicula, Epigondolella triangularis (Budurov)*	~3	CD	E. NORIAN
5	C-117582	537400	5631550	*Metapolygathus sp.*	6-7	BR	CARNIAN
6	C-117583	536680	5631600	*Neocavitella? sp.*			INDETERMINATE
7	C-117586	508500	5653500	*Neocavitella? sp., Metapolygnathus nodus (Hayashi)*	~4	CD	L. CARNIAN
8	C-117588	510250	5653158	Radiolaria: Canoptum? sp.		CD	L. TRIASSIC - E. JURASSIC
9	C-117596	537410	5632600	*Epigondolella sp.*	2-3	BR	E. NORIAN
10	C-117618	509200	5626600	*Epigondolella triangularis, Neogondolella sp.*	5	CD	E. NORIAN
11	C-117619	510000	5624600	Ichthyolith			INDETERMINATE
12	C-154005	506800	4643000	Ichthyolith			MESOZOIC ?
13	C-154006	505900	5647100	*Epigondolella bidentata*	2-3	CD	M. - L.NORIAN
14	C-154009	532936	5629045	platform fragments	6-7		INDETERMINATE
15	C-154014	511287	5631085	*Metapolygnathus? sp., ramiform elements*	5-5+	CD	L. TRIASSIC
16	C-154015	525940	5642752	*Epigondolella abneptis subsp.Huckriede*	2-3	BR	E.(?) NORIAN
17	C-154018	544112	5633545	ramiform elements	~6	BR	L. PALEOZOIC - TRIASSIC
18	C-154019	543714	5632121	*Metapolygnathus? sp.*	6.5-8	CD	L. TRIASSIC
19	C-158864	503600	5646100	Ichthyolith			INDETERMINATE
20	C-158871	513320	5632500	*Neogondolella hallstattensis, Epigondolella triangularis, spatulata*	6-7	BR	E. NORIAN
21	C-158872	506500	5642800	*Metapolygnathus primitius*	2-3	CD	L. CARNIAN - E. NORIAN
22	C-158873	506600	5643000	Ichthyolith			INDETERMINATE
23	C-158874	505820	5648200	*Epigondolella sp., Neostraptognathodus sp.*	2-3	CD	E. - M. NORIAN
24	C-158875	504900	5645400	Ichthyolith			INDETERMINATE
25	C-158880	503900	5649800	Forams			INDETERMINATE

Samples collected by B.N. Church; determinations by M.J. Orchard, Geological Survey of Canada; CAI - conodont colour alteration index; CD - Cadwallader terrane; BR - Bridge River terrane; GSC CAT No. - catalogue number of the Geological Survey of Canada.

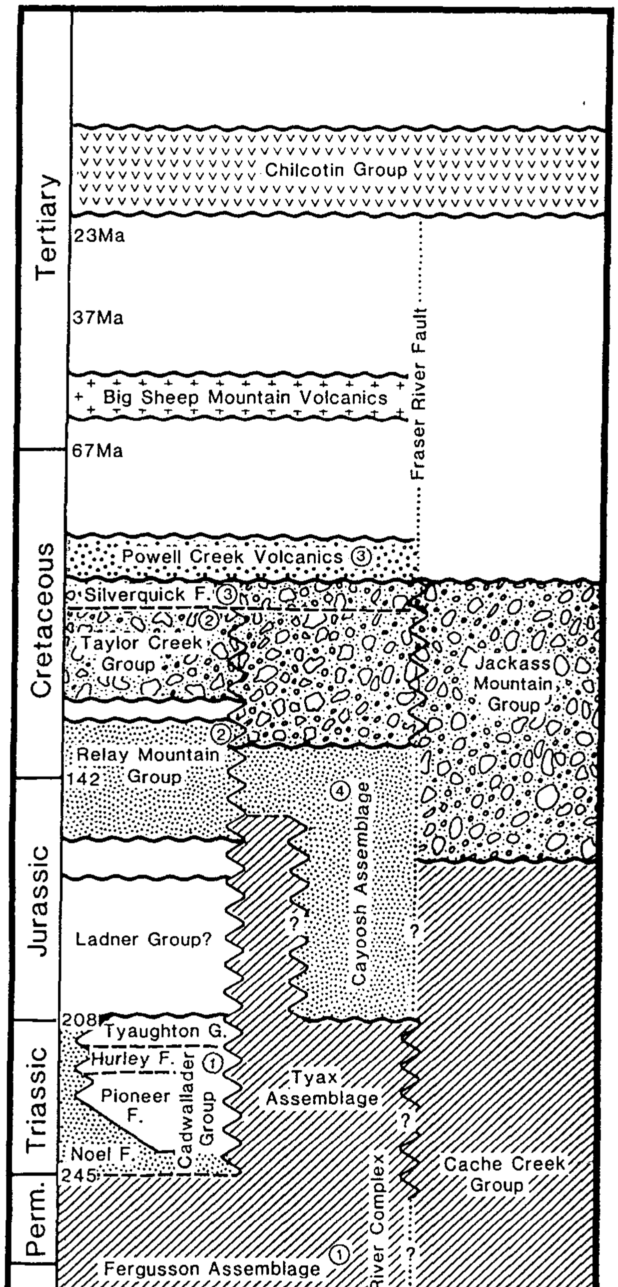


Figure 2.1. Tectonostratigraphic units of the Bridge River area modified after (1) Cairnes, 1937; (2) Jeletzky and Tipper, 1968; (3) Schiarizza *et al.* (1989); and (4) Journeay and Mahoney (1994).

semblage that forms part of a metamorphic terrain referred to by Potter (1986) as the Bridge River Complex. The Triassic Cadwallader Group is thought to be an arc assemblage (Stikinia) accreted to the Bridge River Complex (Rusmore, 1987). The Jurassic and Cretaceous Relay Mountain and Talyor Creek Groups were deposited in a seaway known as the Tyaughton trough that was developed on the Bridge River - Cadwallader basement (Jeletzky and Tipper, 1968; Kleinspehn, 1984; Garver, 1992).

Outlying Tertiary beds (Eocene) are preserved as downfaulted blocks, mainly along the Marshall Lake fault. The youngest Tertiary rocks occur as small remnants of Miocene basalt (Chilcotin Group) uplifted in the Coast Range.

Intrusive rocks span about the same age range as the bedded units. The oldest intrusions are the Permo-Carboniferous Bralorne gabbro/diorite (Armstrong, R.L., 1981, personal communication; Leitch and Godwin, 1988; this study). These rocks occur along many of the major faults, accompanied by ultramafites and small granitic stocks. The principal ultramafic bodies are the Shulaps Complex and the 'President Intrusions'. These may be part of a disrupted ophiolite complex of about the same age as the Bralorne intrusions although there is no sheeted dike system such as associated with the classic ophiolitic rocks of Cyprus (Cairnes, 1937; Leech, 1953; Wright *et al.*, 1982; Potter, 1983; Calon *et al.*, 1990).

The Coast Plutonic Complex comprises an assortment of Late Cretaceous to Early Tertiary granite to diorite plutons and smaller satellitic stocks scattered along the axis of the Coast Range Mountains (Roddick and Hutchison, 1973; Woodsworth *et al.*, 1977).

The Middle Eocene Rexmount porphyry is the youngest of the major intrusions. A variety of basic to felsic dikes related to the Rexmount porphyry and to volcanic rocks of several ages are found throughout the area.

The following descriptions of the geological units vary in amount of detail depending on the importance of the rock types as related to the mineral deposits. The Bralorne intrusions (Unit A), the Pioneer volcanics (Unit 2) and the Coast Plutonic Complex (Unit C) are described at length because the former are the most consistently mineralized units in the area and the latter unit is believed to be the principal source of mineralizing fluids.

BEDDED ROCKS

The names Fergusson, Cadwallader, Relay Mountain, Taylor Creek and Chilcotin are retained in this report for the principal stratigraphic assemblages although knowledge of some of the constituent units is incomplete. For example the lithology of the Paleozoic Fergusson assemblage is not readily distinguished from younger ocean-floor rocks in the area. Also, there is some uncertainty regarding the constitution and structural relations of many of the other major units. Paul Schiarizza of the British Columbia Geological Survey and Murray Journeay of the Geological Survey of Canada, are currently working to resolve outstanding regional structural and paleontological problems (Schiarizza, *et al.*, in-preparation).

BRIDGE RIVER COMPLEX

The term 'Bridge River Complex' was proposed by Potter (1983) in reference to deformed metamorphic rocks in the Shulaps - Mission Ridge area. This name replaces

'Bridge River Series' of Drysdale (1915) and McCann (1922) and 'Bridge River Group' of Roddick and Hutchison (1973) - although 'Bridge River Group' continues to be used by some authors (Coleman, 1989; Coleman and Parrish, 1991). The stratigraphic sense implied by 'series' and 'group' has been lost by the inclusion of beds of widely different ages. For example, Cameron and Monger (1971), Cordey (1986) and Church and MacLean (1987b) discovered relatively young Triassic and Jurassic fossils along Carpenter Lake in areas mapped by McCann as Permian (Bridge River Series). A wholly Middle to Lower Jurassic age was proposed by Schiarizza *et al.* (1989), however, major elements of the Bridge River Complex are now firmly established as Permian. This has expanded the age range of the Bridge River Complex to more than 100 million years; a time interval that greatly exceeds the usual age limits assigned to 'series' or 'groups'.

The terminology 'Bridge River Terrane' is a relatively new conceptual expression of broad time-stratigraphic and regional tectonic significance (Monger and Berg, 1984). 'Bridge River terrane' is roughly equivalent to the Cache Creek and Hozameen terranes of interior British Columbia. These are allochthonous oceanic rocks that were apparently accreted to the North American plate in the Jurassic (Price *at al.*, 1985). It has been suggested that separation of Bridge River, Cache Creek and Hozameen from a single terrane occurred during the Cretaceous and Tertiary as a result of major episodes of transcurrent movement along the Yalakom and Fraser River faults (Monger, 1985; Rusmore and Woodsworth, 1991). However, it may be that only part of the Bridge River (and Hozameen) terrane is equivalent to Cache Creek that contains Tethyan fauna and no major Permo-Triassic unconformity (Danner, 1992). In the Bralorne area the Upper Permian/Lower Triassic boundary has not yet been delineated and Tethyan fauna have not been found.

FERGUSSON ASSEMBLAGE

In this study 'Fergusson assemblage' (Unit 1a and 1d) is an adaptation of the term 'Fergusson Group' that was introduced by Cairnes (1943) for deformed strata in the Bridge River mining camp, believed to be Paleozoic age. These rocks are mainly ribbon cherts (Photo 2.1) laced with quartz veinlets and intercalated with argillite, greenstone and thin recrystallized limestone bands. The thin limestone bands are the only known stratigraphic markers in the succession. The antiquity of the Fergusson rocks is established by various lines of evidence including a few microfossil determinations, metamorphism, crosscutting relationships of igneous intrusions and stratigraphic superposition.

The beds are locally intricately folded and in some places cataclasis has reduced bedding laminations to detached cherty lenses in pelitic schist. In some instances these intensely fragmented and milled rocks resemble pebbly conglomerate.

The unit attains a thickness of more than 1000 metres where best developed on Mount Fergusson, although the base is nowhere visible (Cairnes, 1937). The beds consist mostly of thin ribbons of light and medium grey metachert, 1 to 4 centimetres thick, interlayered with thin seams of dark grey graphitic pelite (Photo 2.2). The ribbons are crisscrossed by numerous small quartz veinlets normal to the bedding planes. In thin section the rock is a mosaic of recrystallized deformed quartz grains (0.1 to 1.0 mm across)

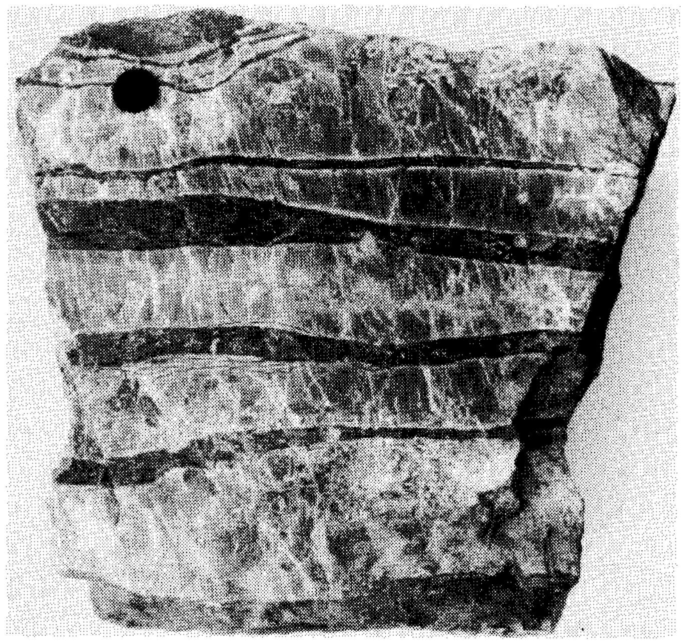


Photo 2.1. Fergusson chert interlayered with thin bands of argillite, Mount Fergusson (black marker = 1 cm).

Photo 2.2. Contorted biotite-bearing metamorphosed ribbon chert of the Fergusson assemblage.

with occasional subcircular pellet structures or shell remnants and concentrations of micaeous minerals and opaques. Analysis of a sample of moderately pure grey chert from the Lajoie Lake area by Cairnes (1937) returned 97.74% silica.

The results of x-ray diffraction analyses of 30 samples of pelitic rocks and schist from localities across the map area (Table 2.4) show a mixture of quartz, albite, chlorite and muscovite accompanied by accessory amounts of amphibole and opaque minerals such as magnetite, pyrite and pyrrhotite in some samples. Biotite, potassium feldspar and carbonates were found in a few samples.

Near the contact of the major granitic intrusions the cherty rocks and pelites are transformed to garnetiferous biotite-quartz gneiss and andalusite-bearing schists (Photos 2.3 and 2.4) and the volcanic rocks metamorphosed to amphibolitic hornfels.

The Fergusson rocks are assumed to be Paleozoic in age because of lithological similarities with Cache Creek and Hozameen assemblages (Cairnes, 1937; Haugerud, 1985), some sparse fossil evidence and crosscutting relationships with plutonic rocks such as the Permian Bralorne intrusions. The preservation of fossils in Fergusson and Bridge River rocks is rare because of cataclasis and recrystallization. The first microfossils with a Paleozoic range were determined by M.J. Orchard (*see* Church, 1989; Cordey and Schiarizza, 1993).

SCHIST FACIES

A schist facies (Unit 1b on Figure 1A) of the Bridge River complex was described by McCann (1922). These mostly chloritic and quartz-mica schists are a possible facies of the Fergusson assemblage occurring in a zone up to a kilometre wide trending along the contact of the Bendor intrusion. On the south side of the intrusion where the zone is widest most of the rocks are biotite schists with lenses of chert, marble, amphibolite and some strongly deformed coarse clastic sedimentary rocks. This lithology is similar to the 2400 metres thick Paleozoic(?) Whitecap schist series noted by Drysdale (1916). An equally thick section of steeply dipping schists crops out on the ridge at the headwaters of the east fork of Noel Creek and Copp Creek at the contact of the Coast Plutonic Complex.

The age of metamorphism of the schist in the headwaters of Truax Creek is 64.3±2.3 Ma and essentially the same

TABLE 2.4
X-RAY DIFFRACTION RESULTS FOR BRIDGE RIVER CHERTY ARGILLITE

LAB NO.	UTM LOCATION EASTING	NORTHING	DESCRIPTION MINERALOGY (from most to least abundant)
39156	507700	5628700	Quartz, muscovite, chlorite; minor amphibole, pyrite
39157	526100	5618000	Biotite, plagioclase, chlorite, muscovite, amphibole, K-spar.
39158	525500	5618500	Quartz, biotite, chlorite, albite, muscovite?
39159	539600	5641000	Chlorite, quartz, calcite, muscovite, orthoclase, albite.
39160	519400	5613400	Magnesio-hornblende, albite; trace quartz, muscovite
39161	511900	5622600	Quartz, chlorite, albite, muscovite; trace magnetite
39162	512000	5622800	Quartz; minor muscovite, chlorite
39163	511700	5624700	Quartz, chlorite, albite, muscovite, orthoclase.
39164	518300	5623400	Quartz, biotite, chlorite, amphibole, albite, muscovite?
39165	515400	5654500	Albite, quartz, chlorite, muscovite, amorphous material?
39166	517700	5615000	Quartz, albite, chlorite, muscovite, orthoclase.
39167	504300	5629700	Albite, andalusite, chlorite, muscovite; minor pyrrhotite, magnetite
39173	521200	5620500	Plagioclase, quartz, biotite, chlorite, K-spar; minor pyrrhotite, amphibole
39174	524800	5618700	Biotite, hornblende, albite, orthoclase?
39175	525000	5618200	Albite, quartz, biotite, hornblende, calcite, almandine?; trace chlorite
39176	525800	5618100	Hornblende, albite, orthoclase, calcite, augite?
39177	525900	5617900	Albite, hornblende, quartz, orthoclase?
39178	522200	5628100	Quartz, albite, muscovite, amphibole, calcite, magnesite.
39179	521900	5628900	Quartz, biotite, hornblende, chlorite, anthophyllite, albite, pyrophyllite.
39180	521400	5630700	Quartz, plagioclase, chlorite; trace pyrrhotite, orthoclase?
39181	519500	5612700	Quartz, muscovite, chlorite, plagioclase, K-spar, magnetite, biotite?, diopside?
39182	519500	5612800	Calcite, quartz, albite, augite, trace amphibole, chlorite
39183	519500	5612900	Muscovite, chlorite, quartz, plagioclase, anhydrite?
39184	526000	5641100	Calcite, quartz, plagioclase, chlorite.
39185	525000	5618600	Quartz, biotite, albite, calcite, magnetite.
39186	527300	5639200	Chlorite, albite, calcite, dolomite?, quartz.
39187	512100	5621800	Quartz, tremolite/actinolite, chlorite, muscovite.
39188	533500	5635500	Quartz, calcite, albite, chlorite, muscovite, trace pyrrhotite, amphibole, pyrite
39189	523600	5614600	Quartz, albite, chlorite, muscovite, K-spar, apatite?
39190	519800	5616800	Quartz, chlorite, albite, muscovite, siderite? trace amphibole, orthoclase, illite

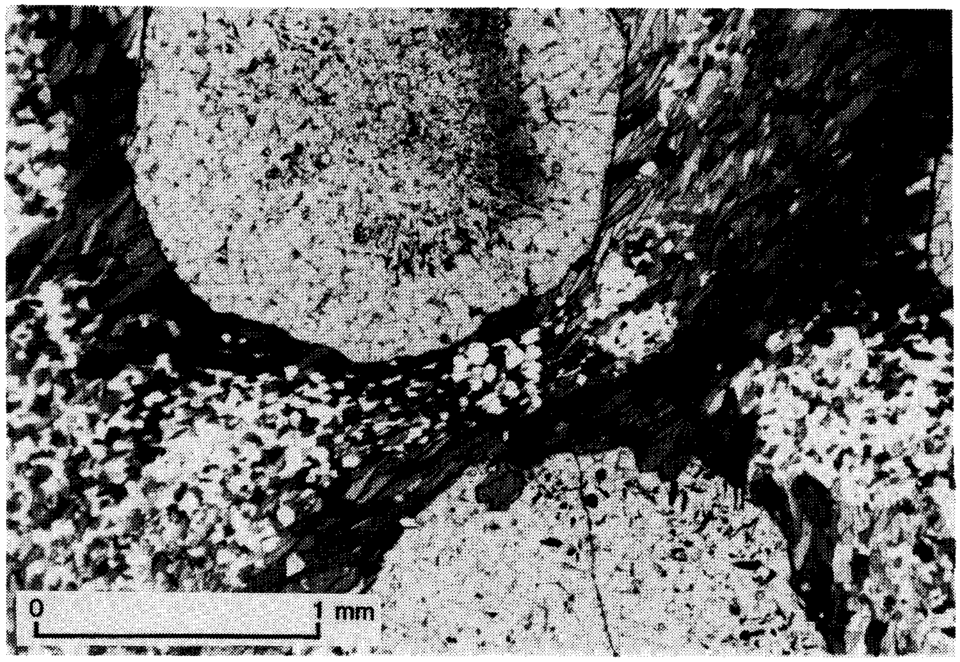


Photo 2.3. Garnet-biotite schist, metamorphic aureole of Coast Plutonic Complex.

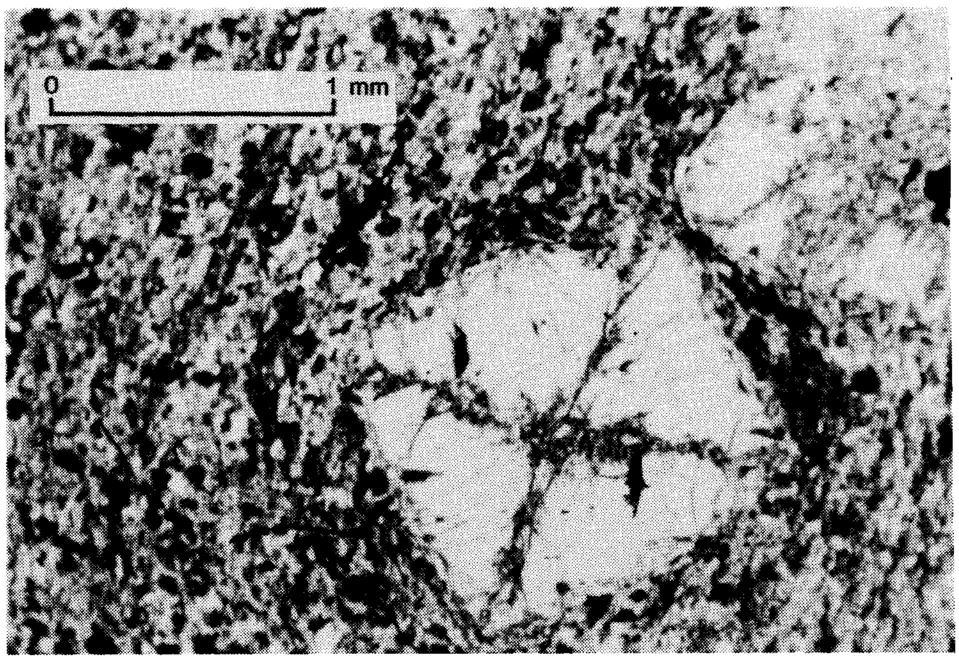


Photo 2.4. Photomicrograph of andalusite-bearing argillites, Noel Formation.

as the age of the final stage of emplacement of the Bendor intrusion (Table 2.2, Nos. 8 and 9).

The only fossil evidence for the age of the schist protolith is a late Paleozoic conodont (*Idioprioniodus* sp.) obtained from a limestone lens in a band of phyllite above Big Horn Creek on Mission Ridge in the northeast part of the map area (Table 2.3, No. 17). These rocks adjoin the Bridge River schists northeast of the Marshall Creek fault described by Potter (1983) and a band of phyllites to the northwest, just south of the Shulaps Ultramafic Complex.

The Chisholm Creek schists of Rusmore (1985) coincide with the broad zone of faulting along Cadwallader Creek. In this report the zone includes sheared Fergusson rocks and deformed clastic beds of the Cadwallader Group and the Noel argillites exposed on Downton Lake and in the Cadwallader - Noel Creek area.

A relic of low-temperature high-pressure mineralogy ('blue phyllite') was discovered on North Cinnabar Ridge by Mary MacLean in 1986. This is the 'blue schist' of Garver *et al.*, (1989), also noted by Church and Pettipas (1989) and determined to be the result of Triassic metamorphism by Archibald *et al.* (1989).

Detailed analysis of the rock shows that it is a metamorphosed basalt and contains an abundance of sodic amphibole, lawsonite, phengite and minor graphite (Church *et al.*, 1994). The chemical and optical properties of the amphibole suggest glaucophane. After normalizing microprobe analyses to 15 cations exclusive of K (cf. Robinson *et al.*, 1982), the amphibole is seen to be devoid of alkalies in the A-site, has a Na/(Na+Ca) ratio of 0.9, and a $Fe^{3+}/(Fe+Al^{vi})$ ratio of 0.1-0.7. X_{Fe2+} ranges between 0.45-0.50. According to Leake's (1978) classification, the amphibole is a ferro-glaucophane to crossite. Because of the normalization dependence of the classification scheme for alkali amphiboles (notably the determination of Fe^{3}) and the importance of amphibole compositions to metamorphic facies identification, the same sample was also analyzed by x-ray diffraction, which confirms the presence of ferro-glaucophane. The presence of glaucophanic amphibole+lawsonite indicates that this sample was metamorphosed under blueschist facies conditions (Evans and Brown, 1986). The presence of prehnite-pumpellyite to greenschist facies assemblages in affiliated rocks along the lower course of the Bridge River (Potter, 1983) is not inconsistent with the local preservation of blueschists, particularly given the sensitivity of low to very low-grade mineral assemblages to the composition of the metamorphic fluid phase (Zen, 1961) as well as their thermal history.

TYAX ASSEMBLAGE

The term 'Tyax assemblage' (Unit 1) is used informally in this report for the Triassic and Jurassic ocean-floor volcanic and sedimentary facies of the Bridge River Complex. This unit comprises ribbon chert with argillaceous interbeds, basaltic lavas, sills and dikes and some thin limestones. The unit is weakly to moderately metamorphosed but otherwise it is not readily distinguished from Fergusson beds.

Microfossils were obtained by Cameron and Monger (1971) from limestone samples from an outcrop at the mouth of Tyaughton Creek on the north shore of Carpenter Lake above the highway. The limestone is part of a band of limestone lenses 5 kilometres long, traced northwesterly to Liza Creek. Conodonts from this locality indicate a Ladinian to Carnian age.

The extent of the Tyax assemblage includes the area along Carpenter Lake from the Minto mine to the Marshall Creek fault. Nine fossil localities reported by Cordey (1986) from the ribbon cherts of this area contain a rich collection of radiolarians ranging in age from Middle Triassic to Early Jurassic. To the west and north of this belt the Tyax assemblage and older rocks appear to be imbricated in a series of thrust faults that also involve Cadwallader rocks, the Fergusson assemblage and the Bralorne intrusions.

CADWALLADER GROUP

The name Cadwallader Group used by Roddick and Hutchison (1973) is an adaptation of the Cadwallader 'Series' (Upper Triassic) of McCann (1922). The group comprises the Pioneer, Noel and Hurley formations. This is a sequence of volcanic and sedimentary rocks, several hundred to a few thousand metres thick, occurring on the east flank of the Coast Plutonic Complex. Within the map area these rocks are exposed along the Hurley River and Cadwallader Creek, the Eldorado basin, Downton Lake, northeast and west of Lisa Lake, and north of Carpenter Lake along the Slim Creek logging road. Beyond the map area similar rocks have been traced to the Mount Waddington area, 150 kilometres to the northwest (Tipper, 1969). Together these outliers form what is believed to be the southern extension of the Stikine Terrane (Rusmore and Woodsworth, 1991).

That parts of the Cadwallader and Bridge River suites were deposited penecontemporaneously in separate, perhaps adjacent terranes, is suggested by different lithologies but similar fossil dates (Figure 2.2). Sampling limestones for conodonts has generally confirmed the Late Triassic age previously assigned to the Cadwallader Group (Table 2.3). These data coincide with the age of the Bridge River Complex determined by Cameron and Monger (1971) and Cordey (1986).

The Cadwallader Group represents in parts island-arc deposition (Rusmore, 1985) while Bridge River rocks represent a more distal ocean-basin environment (Potter, 1983). Common elements in these adjacent packages may be the Pioneer and Noel formations as first suggested by Cairnes (1937) and proposed again by Dostal and Church (1992 and 1994).

PIONEER VOLCANICS

The Pioneer Formation (Unit 2) occurs in the lower part of the Cadwallader Group and consists primarily of basaltic volcanic rocks and feeder intrusions. The unit is well developed at the California mine on the Hurley River and at the Pioneer mine on Cadwallader Creek. The only sedimentary

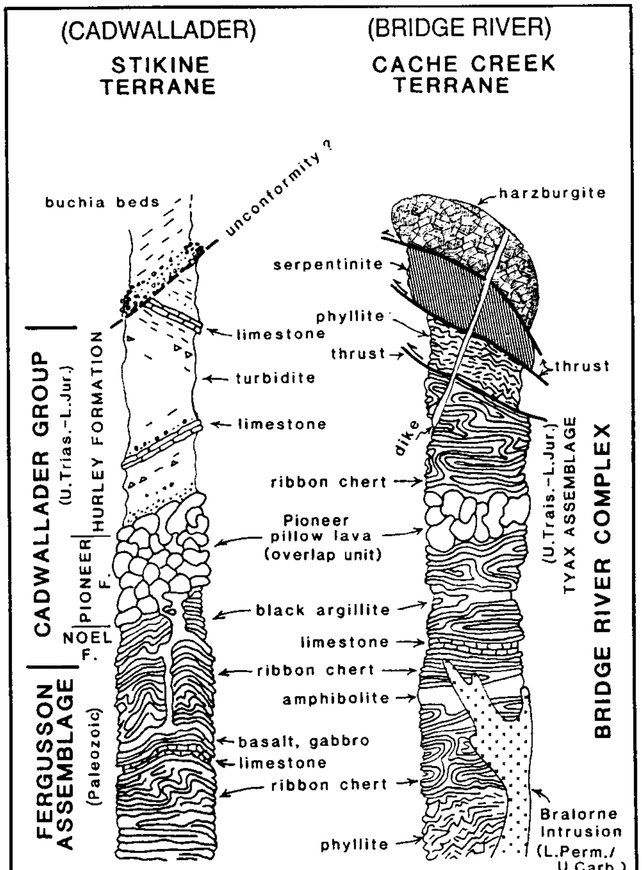


Figure 2.2. Schematic stratigraphy of the Cadwallader and Bridge River terranes in the Bridge River area.

rocks assigned to the formation are a few small lenses of limestone and thin tephra beds. In the type area along the Cadwallader valley the basalts attain a thickness in excess of 300 metres (Cairnes, 1937).

In this study the name Pioneer volcanics refers to significant thicknesses of basalt of Late Triassic and older age in both the Cadwallader Group and the Bridge River Complex. The upper contact of the Pioneer volcanics within the Cadwallader Group is gradational with the Upper Triassic Hurley Formation (Roddick and Hutchison, 1973; Rusmore, 1985). The relationships are less clear at the base of the volcanics. In places the pillow lavas seem to rest on Fergusson cherts but elsewhere similar volcanic rocks are intercalated with Noel argillite, or Tyax argillites and cherts of the Bridge River Complex. A clear understanding of the contact relationships is further complicated by the lack of diagnostic fossils that would help in assigning the units underlying the lavas to either Fergusson Assemblage or Bridge River Complex.

The Pioneer volcanics are characterized by an abundance of pillow lavas, volcanic breccias and massive lava flows and sills. Large thicknesses of basalt occur on both sides of Cadwallader Creek, on the BRX property east of the Hurley River, in the Gwyneth Lake area, south of the Eldorado basin and near the west end, and along the south shore of Carpenter Lake.

Pillow lava sequences are especially well displayed in the Eldorado basin, at McDonald Lake and on the Congress, Reliance and Olympic properties toward the west end of Carpenter Lake. The pillows are grey, green or brown bun-like structures ranging in size from several centimetres to more than a metre in diameter (Photo 2.5). They are commonly flattened or elongated subparallel to the plane of bedding. Downward-pointing cusps at the base of the pillows point away from flow tops, although single observations of these structures are not always reliable for top determination. The interstices between the pillows may contain aquagene breccia, chlorite from pillow selvages or carbonate minerals. Joints, cracks and amygdules are commonly filled with calcite.

Volcanic breccia occurs throughout the sequence as significant accumulations of basaltic debris or thin layers between lava flows and intercalations in normal sedimentary sequences. In the Eldorado basin the Pioneer pillow lava and volcanic fragmental deposits show every gradation into the overlying Hurley sedimentary rocks. In the areas west of Gwyneth Lake and northeast of Bralorne, aquagene breccias are locally well developed (Photo 2.6). Elsewhere, such as on the south shore of Carpenter Lake near Keary Creek, the volcanic breccias form a chaotic mass intermixed locally with limestone blocks derived from submarine slumping (Photo 2.7).

Massive lava flows are exposed throughout the area. Except for differences in grain size and abundance of amygdules, lava flows are not always readily distinguished from sills and feeder dikes. In drill core and underground workings individual lava flows can be seen to range from less than a metre to a few tens of metres thick. The thick

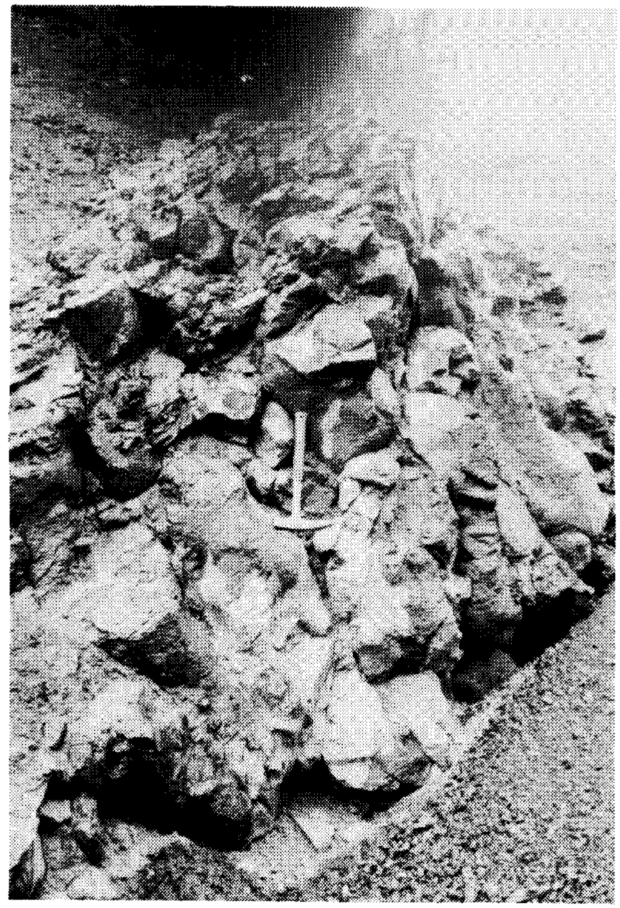


Photo 2.5. Pioneer pillow basalts, Congress area.

flows, dikes and sills are least affected by cataclasis and primary megastructures are generally well preserved.

The Pioneer volcanic assemblage has undergone greenschist and subgreenschist grade regional metamorphism. This has changed the mineralogy although relicts of igneous textures are commonly seen under the microscope. In thin section the lavas consist of randomly oriented or subparallel laths of feldspar 0.2 to 1.0 millimetre long, with interstitial chlorite and abundant magnetite dust. In some flows amphibole is also present and may contain pyroxene cores. Amygdules are filled with quartz, calcite and epidote. Calcic feldspar has been largely altered to albite, and chlorite generally replaces the primary ferromagnesian minerals. Primary magnetite grains may have survived the effects of regional metamorphism, however, much of the iron is contained in very fine grained masses of opaque dust associated with decomposition of the original mineral and vitreous components (Photo 2.8).

Table 2.5 gives the results of x-ray diffraction analyses of 19 basaltic rocks from across the map area. The most common minerals in order of decreasing abundance are albite, quartz, chlorite, calcite and magnetite; pyroxene, amphibole, epidote, biotite and pyrite are significant constituents in some of the rocks.

The chemical composition of the basalts is given in Table 2.6. For comparative purposes the major components are normalized to 100 % (H_2O-CO_2 free). The principal

Photo 2.6. Pioneer aquagene breccia, Bralorne area.

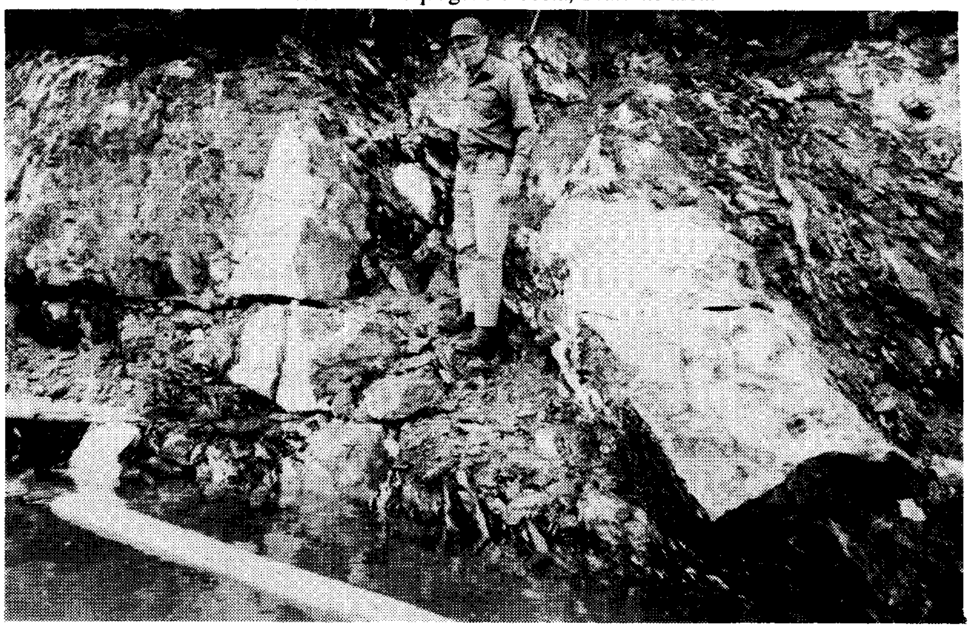


Photo 2.7. Olistostrome of limestone blocks and volcanic breccia, south shore of Carpenter Lake.

characteristics of the suite are silica content in the range 45 to 55% averaging 51% and colour index approximately 40%. The FM plot and the magnesium oxide content indicates an intermediate tholeiitic composition (Figure 2.3).

The high loss on ignition values (LOI) for some of the samples, ranging to 7.94%, may be attributable low-grade metamorphism or the interaction of the lavas with sea water. On the TiO_2-K_2O-P_2O_5 ternary diagram (Pearce *et al.*, 1975) the spread of points beyond the ocean-floor basalt field towards the K_2O pole (Figure 2.4) suggests potassium metasomatism perhaps originating in the Coast Plutonic Complex. This fits with the observed occurrence of biotite in the metabasalts in the vicinity of the granitic plutons.

The tectonic setting of these volcanics is interpreted from minor element plots (Wilson, 1989). The ternary diagram MnO-TiO_2-P_2O_5 discriminates between several major lithotectonic environments (Mullen, 1983). For the analyzed Pioneer basalts (Figure 2.5) the plot shows relatively constant titania (TiO_2) but some dispersion between ocean-island basalt (OIB) and mid-ocean-ridge basalt (MORB) fields (Figure 2.6; Dostal and Church, 1992) - no analyses fall in the calcalkaline field (CAB). The MORB characteristics are detailed on the Th-Hf-Ta plot (Wood, 1980).

TABLE 2.5
X-RAY DIFFRACTION RESULTS FOR PIONEER BASALT

	UTM LOCATION		DESCRIPTION
LAB NO.	EASTING	NORTHING	MINERALOGY (from most to least abundant)
32574	508388	5627664	Albite, quartz, chlorite, muscovite, epidote, amphibole, magnetite.
32581	516967	5638798	Albite, augite, chlorite, calcite, biotite?
34123	515500	5636000	Albite, quartz, calcite, chlorite, hematite, pyrite.
34124	519200	5633600	Albite, quartz, hematite, chlorite, calcite, pyroxene, biotie?
34125	519300	5635000	Albite, quartz, chlorite, hematite, calcite, pyrite, pyroxene.
34127	526500	5649400	Albite, hematite, pyroxene, chlorite.
35408	518900	5648000	Albite, chlorite, diopside, hematite, quartz, minor: calcite
35409	511900	5636800	Albite, quartz, chlorite, calcite, diopside?
35410	539400	5630900	Albite, quartz, chlorite, diopside, calcite, magnetite?, pumpellyite?
35411	517800	5631900	Albite, amphibole (hastingsite?), chlorite, K-spar?
35412	517300	5633400	Albite, chlorite, quartz, epidote, diopside, magnetite, calcite, amphibole, pyrite, muscovite.
35413	517400	5632200	Albite, amphibole, chlorite, augite/diopside, mica, magnetite.
35416	524700	5630500	Quartz, albite, chlorite, calcite, clinozoisite/epidote.
35595	535600	5634300	Calcite, albite, quartz, hematite/maghemite, chlorite.
35603	521900	5645557	Albite, calcite, hematite/maghemite, quartz, dolomite?
35604	523300	5642700	Albite, quartz, hornblende, chlorite, clinozoisite, calcite, magnetite, muscovite?
35606	529400	5627100	Albite, amphibole (edenite?), chlorite.
35624	515500	5636000	Albite, quartz, chlorite, calcite, augite/diopside, pyrite?
38653	513685	5645854	Glaucophane, lawsonite; minor chlorite

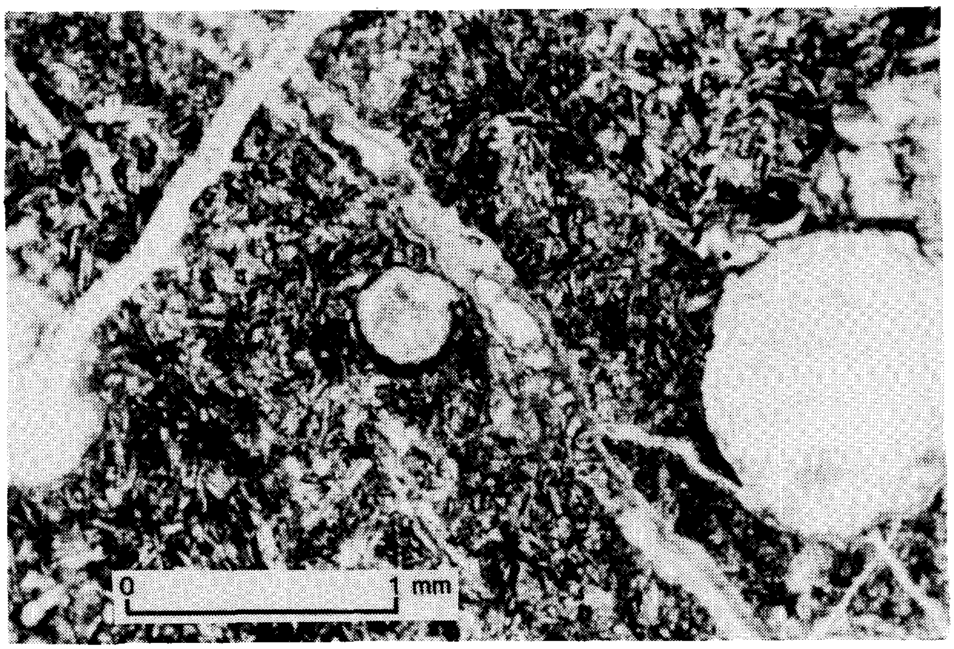


Photo 2.8. Photomicrograph of metabasalt showing relict primary textures and veinlets.

TABLE 2.6
ANALYSES OF PIONEER VOLCANIC ROCKS

No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Oxides recalculated to 100:																				
SiO_2	45.61	48.22	48.34	49.19	49.37	49.38	49.72	49.96	49.97	50.42	50.50	50.86	51.12	51.62	52.65	52.91	53.55	54.16	54.84	55.14
TiO_2	2.74	2.76	2.06	2.05	2.12	1.47	2.08	2.99	0.93	1.58	1.92	1.95	2.17	1.17	1.98	2.39	1.84	1.89	1.16	2.05
Al_2O_3	14.46	15.23	15.33	15.47	15.68	18.72	15.06	16.13	16.45	14.12	14.65	13.67	14.66	16.46	14.77	17.83	16.86	14.97	15.80	17.22
Fe_2O_3	14.59	4.36	3.70	2.70	11.39	2.04	5.60	2.82	2.51	9.32	3.47	3.56	3.79	2.77	4.15	4.02	3.44	3.46	2.77	3.63
FeO	1.53	8.41	7.45	6.98	0.00	6.46	8.47	9.57	7.93	1.89	8.04	8.57	9.65	7.68	8.12	8.63	7.98	10.42	7.47	6.87
MnO	0.20	0.18	0.16	0.15	0.19	0.13	0.22	0.18	0.19	0.14	0.15	0.21	0.19	0.17	0.16	0.15	0.14	0.26	0.32	0.08
MgO	2.55	7.09	6.42	7.87	7.76	6.42	5.73	6.46	10.19	2.63	7.47	4.97	6.39	8.82	6.28	2.79	4.71	5.68	6.52	1.80
CaO	14.00	10.72	13.30	11.74	9.86	12.49	9.41	7.72	8.28	14.74	10.16	12.33	7.39	6.07	7.43	5.26	5.17	5.48	6.53	8.02
Na_2O	3.09	2.93	3.19	3.35	3.21	2.59	2.83	2.43	3.31	4.64	3.36	3.59	3.72	4.93	3.55	4.87	4.61	2.95	4.21	4.69
K_2O	1.32	0.10	0.05	0.50	0.40	0.30	0.88	1.74	0.24	0.52	0.28	0.29	0.92	0.31	0.91	1.15	1.70	0.73	0.38	0.50
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Oxides as determined																				
LOI	7.94	4.96	6.69	2.94	6.63	1.26	3.10	2.37	3.86	8.98	1.99	5.62	5.56	5.45	4.71	6.32	4.66	5.67	5.40	3.90
H_2O	—	—	—	0.17	—	—	—	0.14	—	—	—	—	—	—	—	—	—	—	—	—
CO_2	4.08	0.28	—	1.04	—	0.10	1.05	0.14	0.10	7.08	0.10	3.83	—	—	0.64	—	0.14	—	0.51	—
P_2O_5	0.32	0.28	0.23	0.23	0.22	0.19	0.19	0.39	0.04	0.23	0.23	0.17	0.17	0.05	0.26	0.46	0.32	0.41	0.06	0.30
S	0.02	0.09	—	0.04	—	0.02	0.01	0.01	0.02	0.01	0.01	0.02	—	—	0.03	—	0.01	—	0.02	—
Minor element determinations (ppm)																				
Ba	92	74	—	—	109	77	104	—	38	59	168	72	—	—	—	—	259	101	132	—
Cr	48	283	—	—	207	320	121	—	307	141	161	170	—	—	—	—	593	89	49	—
Nb	34	25	—	—	16	17	10	—	6	14	20	14	—	—	—	—	12	25	9	—
Ni	28	183	—	—	85	119	45	—	184	95	124	46	—	—	76	—	195	10	24	—
Sr	186	307	—	—	225	306	77	—	180	265	326	157	—	—	—	—	125	62	235	—
V	391	279	—	—	273	218	363	—	204	224	213	365	—	—	—	—	270	252	312	—
Y	34	28	—	—	35	22	40	—	27	25	29	43	—	—	—	—	32	81	25	—
Zr	182	160	—	—	145	107	114	—	55	103	120	123	—	—	—	—	89	256	53	—
Molecular Norms																				
Qz	0.00	0.00	0.00	0.00	0.00	0.00	2.30	0.60	0.00	0.00	0.00	0.00	0.00	0.00	2.70	1.40	0.00	8.00	2.70	6.20
Or	7.60	0.60	0.30	2.90	0.00	1.80	5.30	10.50	1.40	3.10	1.60	1.70	5.50	1.80	5.50	6.90	10.10	4.40	2.30	3.00
Ab	28.00	26.70	28.90	30.30	0.00	23.30	26.00	22.10	29.30	42.40	30.30	32.80	33.80	43.50	32.10	44.20	41.40	27.10	37.70	42.60
An	22.40	28.50	27.60	25.60	0.00	38.50	26.20	28.50	29.00	16.40	24.20	20.60	20.80	21.40	21.90	23.70	20.30	26.00	23.10	24.80
Wo	19.80	10.20	15.60	13.00	0.00	9.30	8.50	4.20	4.60	23.10	10.10	16.60	6.50	3.20	6.10	1.10	2.10	0.70	3.70	6.20
En	5.30	18.20	8.50	6.50	0.00	13.60	16.20	18.10	12.70	1.10	17.30	12.90	15.60	4.80	17.50	7.80	11.50	16.00	18.00	5.00
Fs	0.00	5.70	2.90	1.80	0.00	5.00	6.50	8.80	4.20	0.00	6.20	7.60	8.20	1.60	7.00	7.30	6.60	11.30	9.00	5.30
Fo	1.60	1.20	7.00	11.40	0.00	3.10	0.00	0.00	11.30	4.70	2.60	0.80	1.60	14.30	0.00	0.00	1.10	0.00	0.00	0.00
Fa	0.00	0.40	2.40	3.20	0.00	1.20	0.00	0.00	3.70	0.00	0.90	0.50	0.90	4.90	0.00	0.00	0.60	0.00	0.00	0.00
Il	4.00	3.90	2.90	2.80	0.00	2.00	3.00	4.20	1.30	2.20	2.70	2.80	3.00	1.60	2.80	3.40	2.60	2.70	1.60	2.90
Mt	1.00	4.60	3.90	2.80	0.00	2.20	6.00	3.00	2.60	1.10	3.60	3.80	4.00	2.80	4.40	4.20	3.60	3.70	2.90	3.80
He	10.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Key:

No.	LAB.#	STN.#	ROCK TYPE	EASTING	NORTHING	LOCATION
1	035603	GBB 219	BASALT	521900	5645557	W. LIZA LAKE
2	035410	BBC 464	BASALT	539400	5630900	JONES CREEK
3	033128	BBC GSC	BASALT	514300	5637400	SLIM CK. RD.
4	032581	BRC 180	BASALT	516967	5638798	MINTO
5	035624	BBC 358	BASALT	515500	5636000	MENIKA CORE
6	035606	GBB 364	BASALT	529400	5627100	MT. BOBB
7	035604	GBB 307	BASALT	523300	5632700	MT. WILLIAMS
8	032574	BRC 30	BASALT	508388	5627664	N. GREEN MTN.
9	035411	BBC 483	BASALT	517800	5631900	STEEP CREEK
10	035595	GBB 494	BASALT	535600	5634300	SUMMIT RDG.

No.	LAB.#	STN.#	ROCK TYPE	EASTING	NORTHING	LOCATION
11	035413	BBC 486	BASALT	517400	5632200	RANGER
12	035412	BBC 491	BASALT	517300	5633400	RANGER
13	034125	BBC 248	BASALT	519300	5635000	N. MT. TRUAX
14	034127	BBC 349	BASALT	526500	5649400	LIZA CREEK
15	038653	BRM111	BASALT	513675	5645854	N. CINNIBAR RDG.
16	034123	BBC 775	BASALT	515500	5636000	RELIANCE
17	035408	BBC 725	ANDESITIC	518900	5648000	NOAXE LOG. RD.
18	035416	BBC 498	ANDESITIC	524700	5630500	MT. WILLIAMS
19	035409	BBC 522	ANDESITIC	511900	5636800	WAYSIDE AREA N.
20	034124	BBC 238	ANDESITIC	519200	5633600	GIRL CREEK

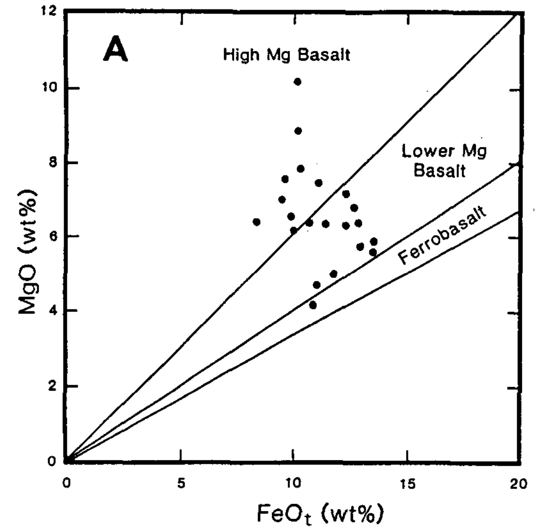


Figure 2.3A. MgO - FeO_t plot (LOI-free) for Pioneer basalts showing the fractionation trend and compositional range. The basalt fields are after Wood (1980).

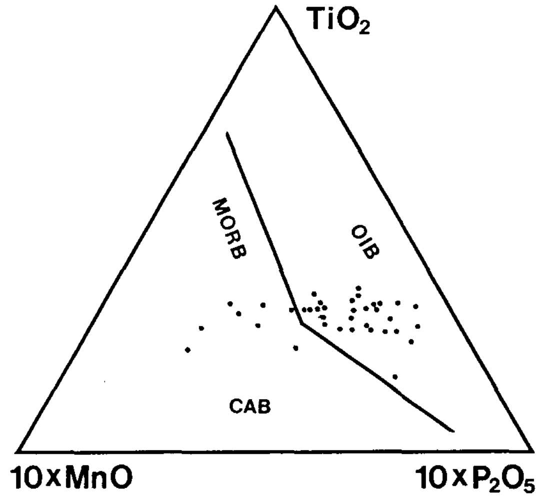


Figure 2.5. Plot of Pioneer basalt compositions on Mullen's (1983) ternary diagram showing lithotectonic fields.

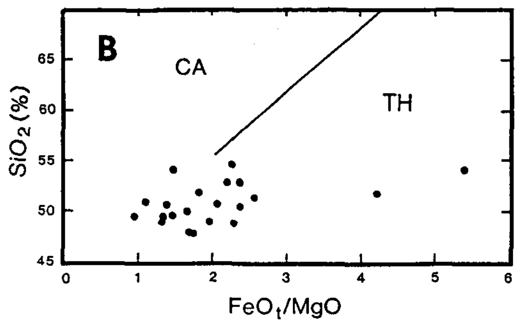


Figure 2.3B. SiO_2 - (FeO_t/MgO) diagram of Miyashiro (1974) for the Pioneer volcanics (LOI-free). CA - calc-alkali field, TH - tholeiitic field.

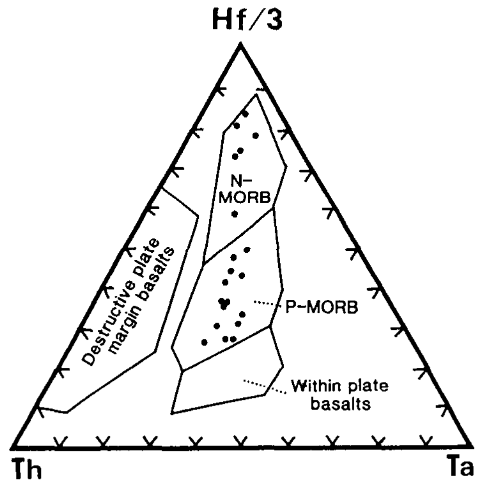


Figure 2.6. Th-Ta-Hf/3 discrimination diagram of Wood (1980) for Pioneer basaltic rocks showing a spread of compositions from N-MORB to P-MORB fields.

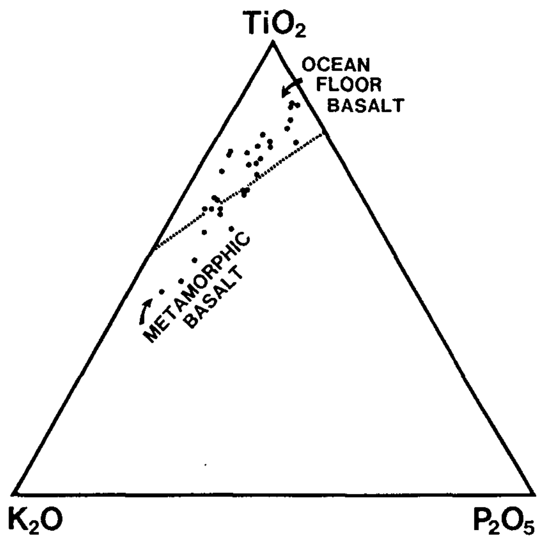


Figure 2.4. Plot of Pioneer basalts on ternary diagram (Pearce *et al.*, 1975) showing potassium enrichment.

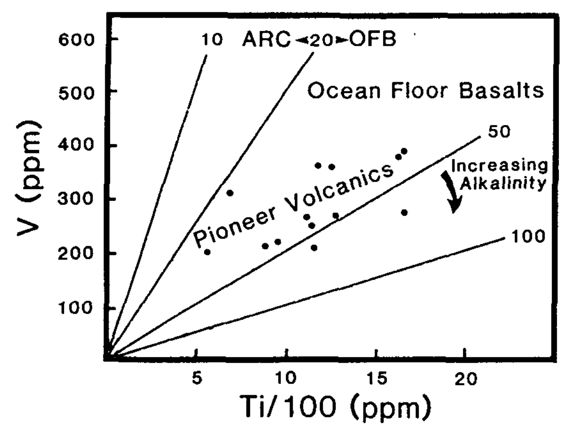


Figure 2.7. TiO_2-V diagram for Pioneer basalts; fields after Shervais (1982).

Figure 2.6 shows as scatter of points that stretch from the normal N-type MORB to the P-type MORB field of typical basalts enriched in light rare earth elements (LREE) - none plot in the 'within-plate' or 'destructive plate margin' fields.

The relatively immobile elements titanium, zirconium, yttrium, chromium and vanadium are particularly useful as discriminants for metamorphosed volcanics. The Ti/V ratio plot (Shervais, 1982) separates arc, ocean-floor and alkalic suites. Figure 2.7 shows that the majority of Pioneer basalts have a Ti/V ratio between 20 and 50, characteristic of back-arc suites - titanium and vanadium values are somewhat less than plots for mid-ocean-ridge or typical island-arc basalts.

The Thompson spider diagram method characterizes lithotectonic environments by comparing incompatible element patterns (Thompson *et al.*, 1984). With some exceptions a plot for the Pioneer lavas shows a systematic concave-downward curve with a culmination at niobium (Nb), typical of ocean-island basalt trends (OIB), and with neither niobium nor tantalum negative anomalies the pattern is characteristically unlike subduction-related basalts.

Detailed analyses by Dostal and Church (1994) shows that the basalts can be subdivided into three compositionally distinct groups, well-defined by the slope of their chondrite-normalized REE patterns (Figure 2.8). The first group exhibits a distinct light REE (LREE) enrichment and fractionation of heavy REE (HREE) with $(La/Yb)_n > 1$ (n-chondrite-normalized) and resemble P-type MORB or OIB. These rocks have the highest abundances of incompatible trace elements. The second group with approximately flat REE patterns, has $(LaYb)_n$ around 1 and lower abundances of compatible trace elements than the first group. The third group with $(La/Yb)_n < 1$, displays flat HREE patterns with abundances of HREE about ten times that of chondrites, and a distinct depletion of LREE (Pattern shapes typical of N-type MORB). These rocks have low abundances of other strongly incompatible trace elements such as Th, Zr and Nb.

The Bridge River basalts located east of the map area are described by Potter (1983), on the basis of few analyses, as intermediate between spreading-ridge ocean-floor tholeiites and somewhat alkalic ocean-island basalts. Clastic rocks interbedded with the volcanic rocks and ribbon chert are believed to have been derived from a nearby ocean-island and/or arc assemblage such as the 'Cadwallader volcanics' and associated sedimentary rocks described by Rusmore and Woodsworth (1991). The setting of the Bridge River lavas, like the Pioneer volcanics is interpreted to be a back-arc basin. Although geochemical criteria alone are not considered sufficient to distinguish the Pioneer volcanics from mid- ocean-ridge basalts (Hawkins, 1980; Hawkins *et al.*, 1990). The low initial strontium isotope ratios of these volcanics (~0.703, Leitch *et al.*, 1991) indicates back-arc basin conditions rather than mid-ocean-ridge environment for their emplacement. The compositional variations of the basalts are attributed to dynamic partial melting of source rocks that are believed to have been part of the rising mantle diapir. According to this model, after initial melting in the garnet stability field, the mantle diapir rose up to the spinel stability field where it underwent subsequent melting. The reconstructed stratigraphy of the Bridge River area may be interpreted in terms of an oceanic plate moving over a mantle plume and into a trench where offscraping preserved tectonic lenses of the subducting plate in an accretionary prism.

NOEL FORMATION

The Noel Formation (Unit 3) is a sequence of mostly thinly bedded, fine-grained sedimentary rocks and a few conglomeratic beds exposed in the southwest part of the map area. The unit is best developed in a belt extending from the Hurley River to Bralorne and then southeasterly, south of Cadwallader Creek, to McGillivray pass. A second belt begins on the north shore of Downton Lake and trends southeasterly to Mount Noel along the east flank of the Coast

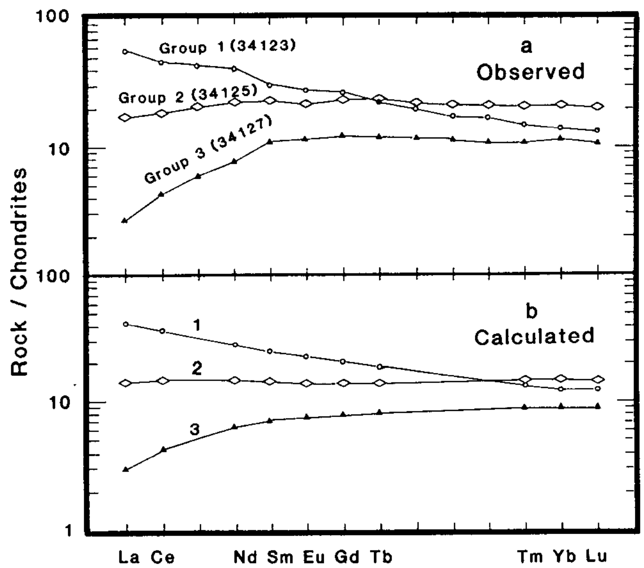


Figure 2.8. (a) Chondrite-normalized REE abundances of the basaltic rocks of the Pioneer Formation (Group 1 with $[La/Yb]_n > 1$: sample no. 34123, Group 2 with $[La/Yb]_n \sim 1$; sample no. 34125, Group 3 with $[La/Yb]_n < 1$; sample no. 34127). Normalizing values after Sun (1982). (b) Chondrite-normalized REE concentrations of the melts produced by dynamic melting of peridotite which contained 3 x chondrite abundances. 1 - liquid produced by initial melting (6%) of garnet peridotite (parent: olivine 0.50, orthopyroxene 0.25, clinopyroxene 0.20 and garnet 0.05; orthopyroxene 0.25, clinopyroxene 0.20 and garnet 0.05; melt: olivine 0.10, orthopyroxene 0.17, clinopyroxene 0.33 and garnet 0.40); 2 - liquid generated by 10% melting of the residue of the initial source (with 2% liquid remaining in the residue) (parent and melt: olivine 0.54, orthopyroxene 0.25; clinopyroxene 0.21); 3 - melt produced by the fourth 2% melting increment of the residue left after an extraction of melt 2 with 2% irremovable liquid always remaining in the residue. 18% of the initial source has been melted to produce liquid 3. The mineral proportions of the source and the melting proportions of the source mineral liquids are the same as for melt 2. The parameters including partition coefficients used are those of Wood (1979). For given partition coefficients, the degree of melting and the fraction of liquid remaining in the residue have the greatest effect on the trace element concentrations in the melts. The source with chondritic REE distribution rather than a MORB source was chosen since the derivation of the LREE-enriched patterns from the LREE-depleted MORB source would require an unreasonably small degree of melting.

Plutonic Complex (Cairnes, 1937, 1943). In the type locality, near the confluence of Cadwallader Creek and Noel Creek, the unit is more than 350 metres thick, consisting of grey siltstone and finely laminated black argillite containing a few thin lenses of dark grey limestone. In thin section the sandy and conglomeratic facies consist of angular to subrounded volcanic clasts, quartz, chert, plagioclase and lithic clasts of mixed provenance in a fine-grained impure matrix (Photo 2.9). Metamorphic overprinting manifest by the development of biotite, garnet and andalusite is evident near the contact of the Coast Plutonic Complex in the Mount Sloan - Green Mountain area (Photo 2.4). On the north shore of Downton Lake the principal exposures are steeply dipping, dark grey and greenish grey pyritiferous argillite and tuffaceous argillite not more than 750 metres thick.

The nature of the upper and lower contacts of the unit are uncertain. Stevenson (1958) reported a transition from mainly cherty Fergusson rocks to cherty argillite and platy argillite of the Noel Formation in the area south of the confluence of the Hurley River and Cadwallader Creek. A similar transition occurs at the east end of Downton Lake. Elsewhere the unit appears to directly overlie Fergusson rocks (Cairnes, 1937) and chert pebbles in conglomeratic facies of the Noel Formation on the ridge south of the Standard mine were probably derived from adjacent Fergusson terrain. However, on the Slim Creek logging road northeast of the Wayside mine, banded black and grey argillite resembling typical Noel Formation overlie Pioneer volcanic rocks and are overlain in turn by Hurley sandstone and conglomerate. These varying relationships suggest that the age of the Noel may be long ranging, like the chert of the Bridge River Complex, from Paleozoic to Mesozoic. Rusmore (1985) considered the Noel a facies of the Hurley Formation and Journeay (1993) and Journeay and Mahoney (1994) includes the Noel in the 'Cayoosh assemblage' that they believe to be the upward Jurassic continuation of the 'Bridge River ocean'. However, few fossils have been found and the age of these rocks remains uncertain. Nevertheless, the unit is sufficiently distinctive and important, having local concentrations of andalusite, to be mapped separately (Simandl *et al.*, 1995).

HURLEY FORMATION

The best development of the Hurley Formation (Unit 4) is in the type area along the Hurley River, upstream from Cadwallader Creek (Cairnes, 1937) and in Eldorado Creek basin in the northwest part of the map area (Cairnes, 1943; Rusmore, 1985). Other major areas of exposure are along Cadwallader Creek, on Downton Lake and in the Lisa Lake areas. Similar rocks have been reported in the Pemberton and Tenquille Lake area 30 to 80 kilometres south of the Bridge River camp (Riddell, 1991) and to the north in the Hanceville area (Rusmore and Woodsworth, 1991).

The total thickness of the Hurley Formation in the Eldorado basin is estimated to be at least 700 metres (Rusmore, 1985). These rocks are dominantly soft, green, brown and black argillite and harder siliceous argillite. They are intercalated with gritty siltstone, sandstone, conglomerates and fossiliferous limestone lenses. Thick sequences of alternating sand, silt and mudstone bands display grading, loading and flame structures typical of turbidites (Photo 2.10). There is little chert in the Hurley and the beds are notably more limy than the Noel Formation. Volcanic breccia and tephra occur throughout and are particularly abundant in the lower part of the sequence where the unit appears to be locally gradational into the Pioneer Formation. Pillow lavas up to several metres thick, intercalated with volcanic breccias and

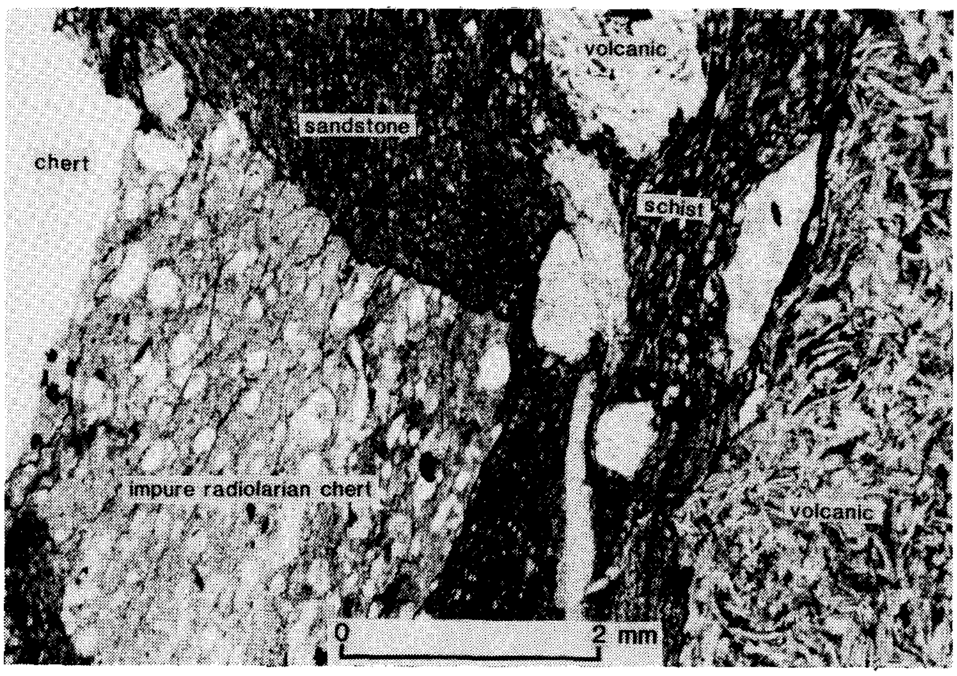


Photo 2.9. Photomicrograph of Noel polymictic conglomerate.

sedimentary rocks, are exposed locally on the ridges in the north and south parts of the Eldorado basin.

In thin section the Hurley sandstones are mostly wackes of mixed provenance. Typically these rocks consist of closely packed volcanic rock fragments interspersed with accessory amounts of quartz, feldspar, chert, limestone and opaque minerals in a yellow-brown chloritic matrix. The volcanic clasts comprise a large variety of microporphyritic rocks of basaltic or andesitic composition and glassy fragments replaced by chlorite and iron oxide dust. The quartz occurs as discreet angular clasts, usually less than 10 %, and in lithic fragments representing a variety of porphyritic rocks, composite quartz grains and fine-grained recrystallized chert and schist. The feldspar consists of, angular, solitary, twinned and untwinned plagioclase crystal fragments and subparallel or randomly oriented laths in subrounded porphyritic grains. Limestone is interspersed sparingly among the other clasts, mostly as composite grains of calcite that may represent fossil fragments.

Conglomerate beds occur throughout the sequence and are as diverse in composition as the sandstones. The clasts are mostly well rounded grey and greenish porphyritic and fine-grained volcanic and cherty rocks of mixed local and distal provenance. Conglomerates composed almost entirely of limestone boulders and pebbles (Photo 2.11) are less common but widely distributed and are especially well developed on strike with massive limestone lenses in the Eldorado basin. Light coloured clasts of felsic rock with feldspar and/or quartz phenocrysts are a common accessory and predominate in a few places where the source appears to be local, such as the rhyolite/dacite lens near the divide south of Windy Pass in the headwater basin of Eldorado Creek.

The age of the Hurley Formation is Triassic according to Cairnes (1943). Recent determinations by M.J. Orchard of the Geological Survey of Canada give late Carnian-early Norian ages based on conodont fossils collected by Rusmore (1985) from the Eldorado basin and similar collections made during this study from elsewhere in the camp (Table 2.3).

RELAY MOUNTAIN GROUP

The Relay Mountain Group (Unit 5), originally described by Jeletzky and Tipper (1968), is mostly a monotonous sequence of *Buchia*-bearing shales, siltstones and greywackes of Late Jurassic to Early Cretaceous age. These strata are up to 650 metres thick and occur along the southeasterly trending axis of the Tyaughton trough.

The main exposures of the group in the Bridge River camp are west of Spruce Lake, south of the type section, and near Truax Creek where the unit is underlain by the Bridge River Complex (Roddick and Hutchison, 1973; Woodsworth, 1977; Garver, 1992). These widely separated areas suggest that the unit was deposited continuously across the structural quilt of the older terranes. At Spruce

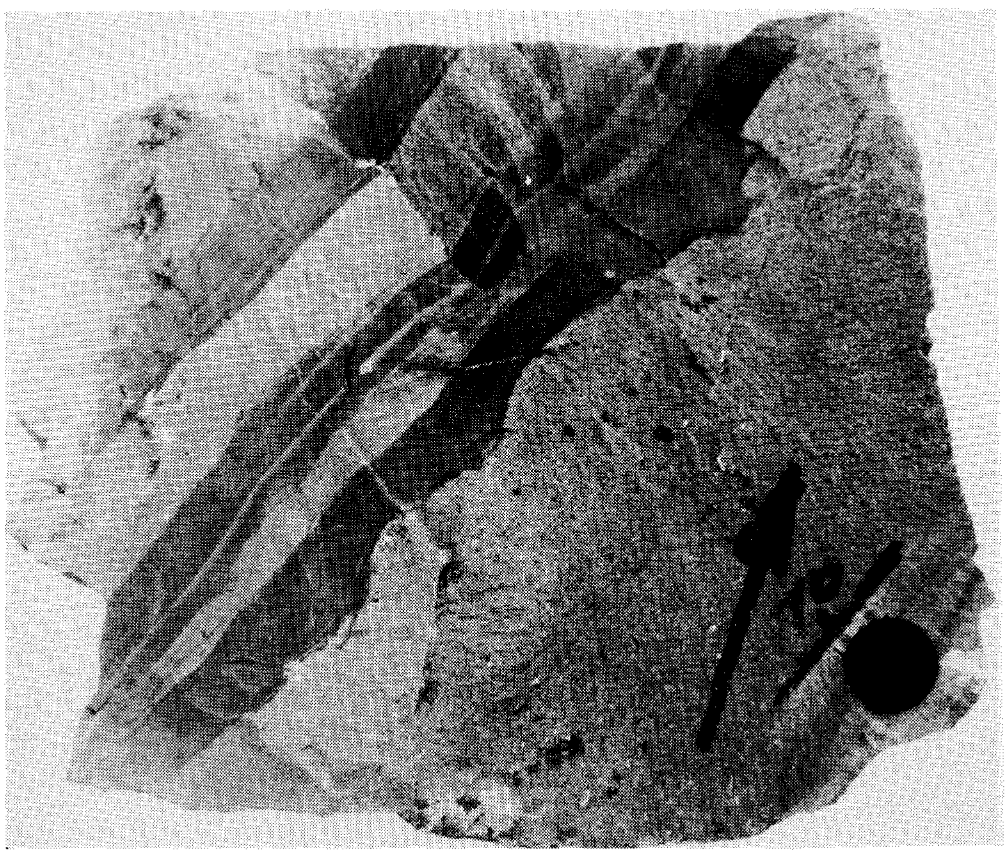


Photo 2.10. Micro-crossbedding and flame structures in Hurley greywacke (black marker = 1 cm).

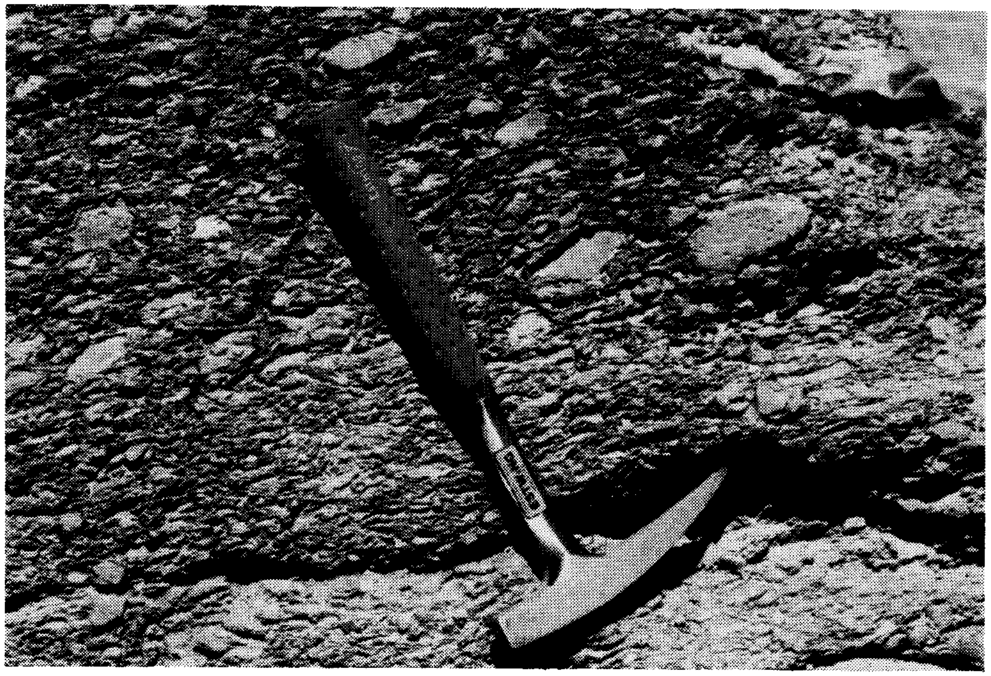


Photo 2.11. Limestone-pebble conglomerate, Hurley Formation, Downton Lake area.

Lake the outcrops include steeply dipping *Buchia* and ammonite-bearing beds (Photo 2.12a and b) in thick sandstones. In the Truax area, *Buchia* beds (Photo 2.12c) of latest Jurassic or Early Cretaceous age are associated with conglomerate in a down-faulted block (Church and MacLean, 1987a).

At the Truax Creek locality the group consists of several hundred metres of grey shales and siltstones underlain by polymictic conglomerate with accessory granitic clasts. The westerly provenance of the clasts fits the paleogeographic setting of the deposit. The unit marks the first uplift of the Coast Mountains giving an earlier age for the development of the southwest margin of the Tyaughton basin than the mid-Cretaceous age proposed by Kleinspehn (1984).

TAYLOR CREEK GROUP

The name 'Taylor Group' of Cairnes (1943) was expanded to 'Taylor Creek Group' by Jeletzky and Tipper (1968) in reference to what is believed to be partly the marine equivalent of the (Albian) Jackass Mountain Group exposed east of the Yalakom fault (Garver, 1992)

The Taylor Creek Group (Unit 6) comprises a distinct sequence, with few erosional unconformities, that forms a broad sedimentary wedge filling what appears to be a taphrobasin. The south bounding "headwall" fault of the basin, exposed on North Cinnabar Ridge, marks the limit of the unit in the map area (Figure 1A).

Major downward displacement here is balanced by major uplift in the source area to the southwest that is underlain by Bridge River chert, greenstone and blueschist. In the Bridge River mining camp these rocks extend easterly and northeasterly from Eldorado Mountain to Tyaughton Creek. The beds are mainly westerly dipping pebble and boulder conglomerate with minor intercalations of siltstone and shale (Photo 2.13). Well preserved shell fossils are rare (Garver *et al.*, 1989) but fossillized wood fragments are found throughout the unit. Paleocurrent indicators such as crossbedding and other fluvial structures are rarely seen, nevertheless, the source of the clasts is believed to be from both the northeast and southwest (Jeletzky and Tipper, 1968; Garver 1992). Recent workers (Schiarizza *et al.*, 1990; Garver, 1992) have postulated overturning of these beds on the basis of reverse grading contrary to Cairnes' (1945) earlier work. Turbidites in sandstone - conglomerate units may show reverse and normal grading (Allen, 1984). No conclusive evidence of overturning was found during the course of the present study and this writer, therefore prefers to retain Cairnes (1945) and Jeletsky and Tipper (1968) earlier interpretations that the beds are upright.

In the type area, between Tyaughton Creek and Taylor basin, the group is mostly clast-supported coarse conglomerate, 3000 metres thick (Photo 2.14). The base and middle of the unit is a sequence of polymictic pebble and boulder conglomerate, in beds 10 to 15 metres thick, separated by siltstone seams, 1 to 2 metres thick. Above this are sandstones, 600 metres thick, with silty and conglomeratic interlayers that include a dark grey shale marker zone (Unit 6a).

The clasts in the conglomerate are mostly rounded chert and greenstone from the Bridge River Complex and a few cobbles of sandstone and shale reworked from older Taylor Creek or Relay Mountain units. Accessory plutonic fragments are mostly diorite resembling various facies of the Bralorne intrusions. Although no large ultramafic fragments were discovered, trace amounts of chromite (and pyroxene) seen in thin sections of the sandstone appear to have been derived from unroofed ultramafic bodies - possibly the nearby Shulaps Complex. Yellow limonitic clasts, conspicuous in some of the upper pebble-conglomerate members,

Photo 2.12a. *Buchia pacifica* (middle Valanginian) from Relay Mountain Group near Spruce Lake collected by M.J. Hanna and identified by T.P. Poulton (G.S.C. cat. no. C154002).

Photo 2.12b. Homolsomites (early Cretaceous) from Buchia beds west of Spruce Lake, collected by M.J. Hanna and identified by J.W. Haggart (G.S.C. cat. no. C154001).

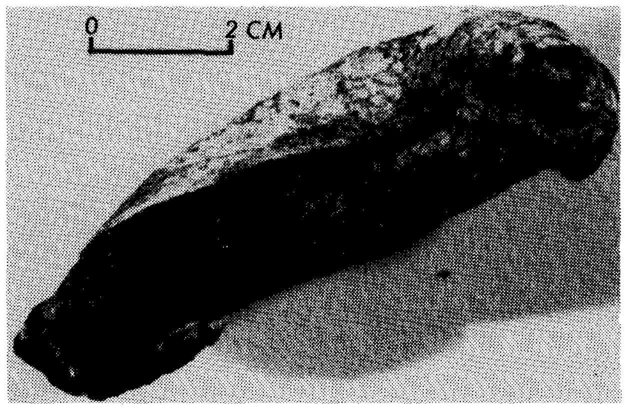


Photo 2.12c. *Buchia* sp. (Volgian?) from Relay Mountain Group, thin shale bed in conglomerate from road cut on Gray Rock road, collected by M.E. MacLean and identified by T.P. Poulton (G.S.C. cat. no. C117551).

may have a volcanic or basic intrusive source. The source of white mica and chloritized biotite seen in thin sections of some sandstone interbeds (Photo 2.15) is thought to be felsic plutonic rocks, although clasts of these rocks are not seen.

The Silverquick conglomerate is a coarsely bedded unit, more than 1000 metres thick, split off from the Taylor Creek Group by Garver *et al.* (1989) and Garver (1992). These rocks are poorly constrained in age and appear to rest directly on Bridge River Complex in some places and on the Taylor Creek Group elsewhere. The clasts are mostly Bridge River chert, as in the Taylor Creek Group, with ancillary sedimentary, volcanic and metamorphic components. As shown on Figure 2.1 and generally accepted, the Taylor Creek Group and Silverquick conglomerate are coeval with the upper Jackass Mountain Group in Cache Creek Terrane east of the Yalakom Fault. Given, however, the difference in provenance, Bridge River Complex sources for Taylor Creek (and Silverquick beds) and Cache Creek Terrane and granitic stock sources for Jackass Mountain beds, the names of these units should not be used interchangeably.

BIG SHEEP MOUNTAIN VOLCANICS

"Big Sheep Mountain volcanics" (Unit 7) is an informal name applied to a few small scattered outliers of Tertiary felsic lava and breccia in the northern part of the map area. The largest of these is a down-faulted northerly trending panel on Big Sheep Mountain (Photo 2.16) and a narrow northwesterly trending belt along the southwest side of the Marshall Creek fault from north of the mouth of Marshall Creek to the east boundary of the map area. On Big Sheep Mountain these rocks are more than 500 metres thick and consist of westerly dipping, brightly weathered rhyolite and dacite lavas, pyroclastics and sedimentary rocks. Felsic feeder dikes and sills intrude Taylor Creek conglomerate and Shulaps ultramafic rocks at the base of the formation. A similar thickness of rhyolite and dacite tuff-breccia forms a series of light-coloured hoodoo bluffs along the Marshall

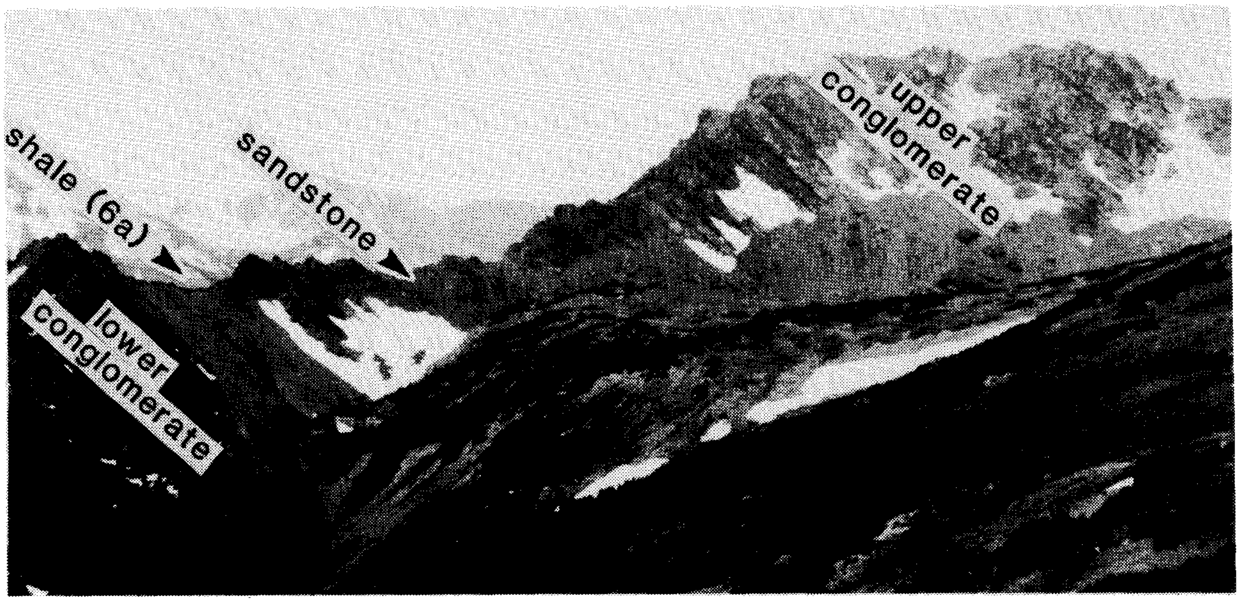


Photo 2.13. Mid-Cretaceous section above Taylor Creek on Eldorado Mountain looking southerly.

Photo 2.14. Taylor Creek clast-supported conglomerate, fragments consisting mostly of chert and greenstone.

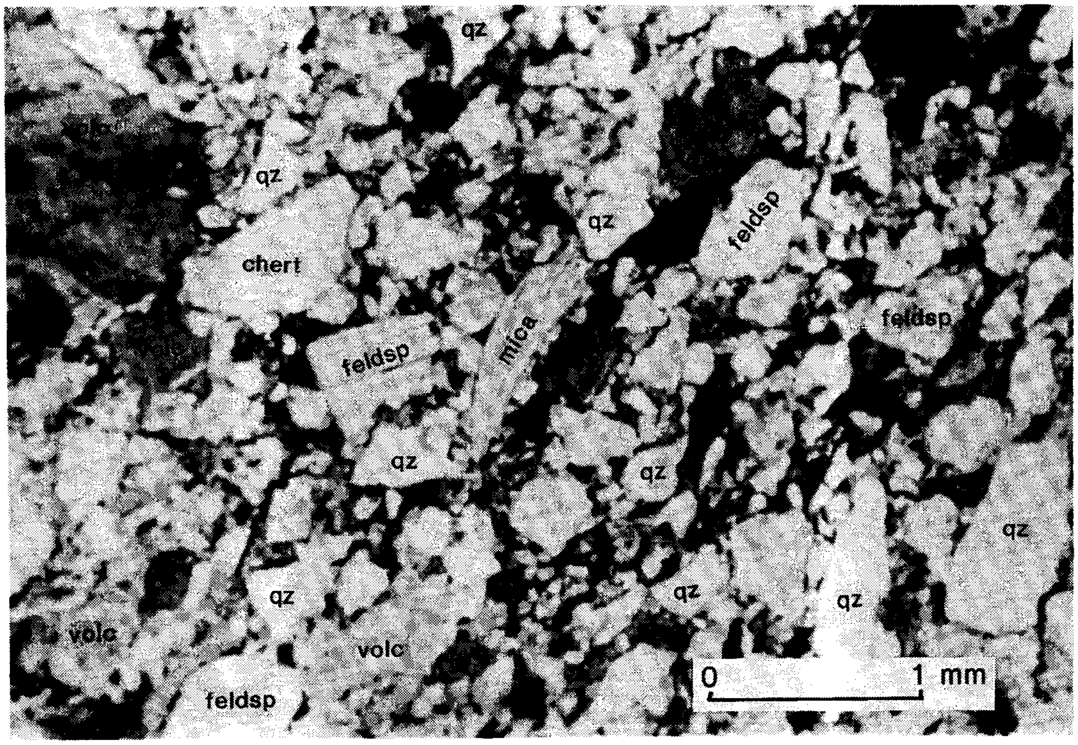


Photo 2.15. Photomicrograph of mica-bearing quartz-feldspar wacke, upper clastic unit of Taylor Creek Group.

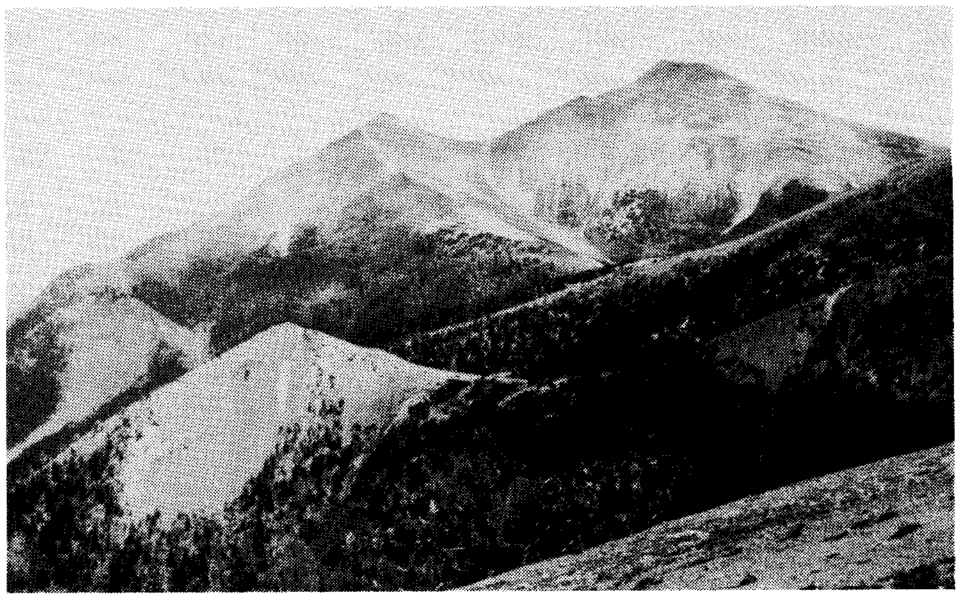


Photo 2.16. Felsic volcanics on Big Sheep Mountain with alteration zones related to epithermal mineralization.

Creek fault (Photo 2.17). These volcanic rocks are the extrusive equivalent of the adjacent Rexmount porphyry (Unit D, McCann, 1922). The beds dip 40° to 45° northeast against the fault and are underlain by conglomerate and sandstone and shale with thin lignite seams.

CHILCOTIN GROUP

Small remnants of 'plateau lava' (Unit 8) occur at high elevations on the north and south spurs of Noel Mountain (Photo 2.18). These are horizontally layered basalts 100 to 150 metres thick, dated 18.7 Ma (Table 2.2, No.1), similar to the tiered and occasionally columnar lava flows that form the summit of Cardtable Mountain and on Castle Peak in the Noaxe Creek area to the north. These basalts are outliers of the Chilcotin Group (Mathews, 1990). Equivalent formations near the Fraser River and on the Interior Plateau to the east occur at considerably lower elevations suggesting uplift of the Coast Mountains in post-Miocene time.

The lavas are medium to dark grey and commonly fine grained and brittle with some conchoidal fracturing. Porphyritic varieties include distinctive flows crowded with

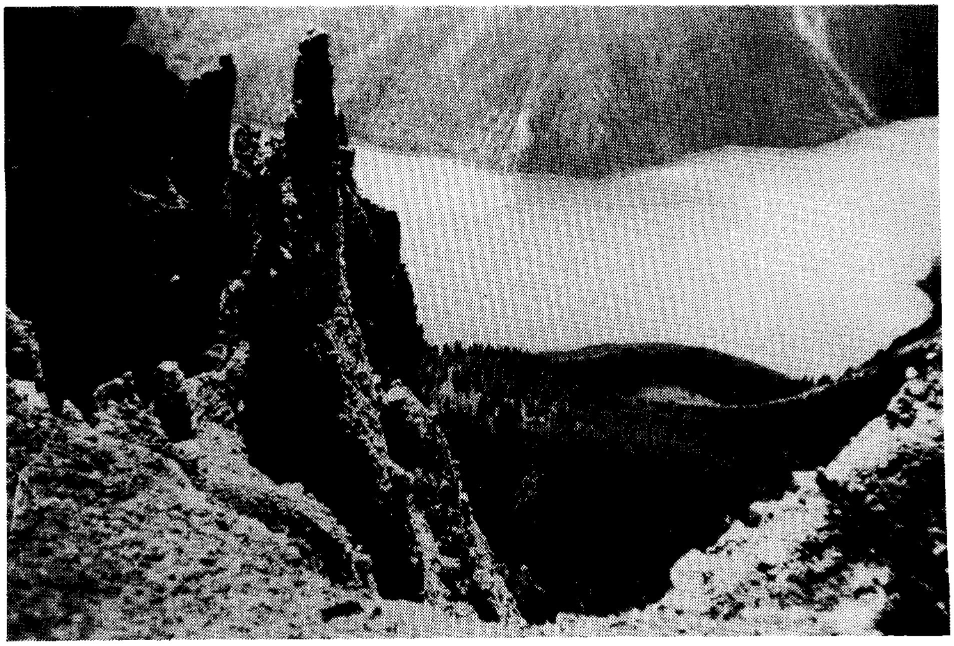


Photo 2.17. Hoodoos in Tertiary pryoclastic beds overlooking Carpenter Lake.

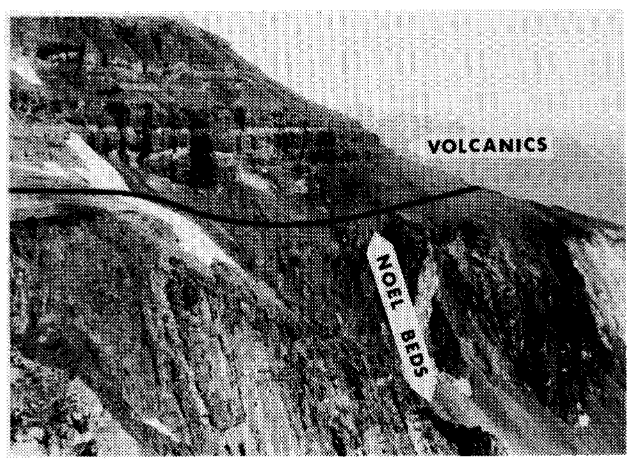


Photo 2.18. Chilcotin basalt (Miocene) resting unconformably on the steeply dipping Noel argillite beds, of Mount Noel.

feldspar and some lava flows with only a few scattered olivine phenocrysts. In thin section the rocks mostly consist of randomly oriented plagioclase laths, 1 to 10 millimetres in length, mixed with olivine euhedra, often replaced by iddingsite, in a groundmass enriched in pyroxene grains and magnetite dust. Chemical analyses of these rocks give a range of 52 to 53% silica with normative feldspar from 65 to 73% and pyroxene in the range 20 to 27% (Table 2.7). Accordingly, these are alkali olivine basalts typical of the Chilcotin Group.

INTRUSIVE ROCKS

"There has been a debate for the past 35 years between the field geologist and the laboratory investigator on how ultramafic rocks are emplaced. The field man has invariably drawn the conclusion that they appear to have been very fluid at the time of injection. Repeatedly the laboratory investigator has ruled out each new suggestion as to how such materials could be magmas at any reasonable temperature."

——— *H.H. Hess (in Wyllie, 1967)*

In this report 'intrusions' and 'intrusive rocks'refers to molten or partly molten emplacements and plastic or ductile rocks that have been injected or forced upward or laterally into pre-existing hostrocks. The main intrusions in the Bralorne camp are the Paleozoic Bralorne intrusions, the Shulaps ultramafic rocks, including the 'President Intrusions', and a variety of granitic bodies that comprise the Mesozoic Coast Plutonic Complex. In addition there are many small felsic to basic Mesozoic and Tertiary stocks, sills and dikes scattered across the map area.

BRALORNE INTRUSIONS

Cairnes (1937) mapped several small stocks occurring mostly along the Cadwallader break in the Bralorne-Pioneer belt. These included gabbro, augite diorite, hornblende diorite, amphibolite, soda granite and aplite which Cairnes believed to be phases in a magmatic series. However, their relationships were not fully understood other than it was recognized from crosscutting structures that the granite and aplite were younger than the gabbro and diorite. This author observed the intrusive relationship of those plutonic rocks with older formations, in underground workings and drill core at the Bralorne mine where, apophyses of the gabbro invade Fergusson chert and argillite (Church, 1992).

TABLE 2.7
ANALYSES OF CHILCOTIN BASALTS

No.	1	2	3	4
Oxides recalculated to 100:				
SiO_2	48.65	49.39	51.50	48.77
TiO_2	1.72	1.56	1.39	1.55
Al_2O_3	16.86	17.31	18.04	17.33
Fe_2O_3	5.70	3.36	0.00	4.33
FeO	3.58	5.80	8.31	4.97
MnO	0.23	0.17	0.14	0.17
MgO	5.04	6.38	3.56	6.47
CaO	8.92	9.15	8.21	8.97
Na_2O	3.06	3.39	3.48	3.20
K_2O	1.11	0.54	1.62	0.49
TOTAL	100.00	100.00	100.00	100.00
Oxides as determined				
LOI	4.07	1.59	3.13	2.78
CO_2	<0.10	0.28	<0.10	<0.10
P_2O_5	0.37	0.24	0.33	0.23
S	<0.01	<0.01	<0.01	<0.01
Minor elements (ppm)				
Ba	391	123	653	117
Cr	67	75	38	76
Nb	41	44	12	47
Ni	11	9	3	10
Sr	561	534	820	517
V	28	28	28	29
Y	217	181	231	179
Zr	0	157	170	156
Molecular Norms				
Qz	3.30	0.00	0.00	0.90
Or	7.00	3.30	10.00	3.00
Ab	29.20	31.30	32.60	29.80
An	30.80	31.30	30.10	32.70
Wo	6.50	6.20	5.00	5.40
En	14.80	16.30	7.40	18.60
Fs	0.00	4.10	8.30	2.60
Fo	0.00	1.40	2.10	0.00
Fa	0.00	0.40	2.40	0.00
Il	2.50	2.20	2.00	2.20
Mt	5.00	3.60	0.00	4.70
He	0.90	0.00	0.00	0.00
C	0.00	0.00	0.00	0.00

Key:

No.	LAB.#	EASTING	NORTHING	DESCRIPTION
1	35529	509600	5619000	FELDSPAR PORPH.
2	35530	509600	5619000	MICROPORPHYRY
3	35531	509600	5619000	COLUMNAR BASALT
4	35532	509600	5619000	MESA BASALT

In the present study and Church *et al.* (1995), Bralorne intrusions (Unit A) is the name applied to the diorite and gabbro bodies (Figure 2.9) found at Bralorne and a number of outlying areas such as LaJoie Lake, Sumner Creek and Steep Creek that are similar to the ophiolitic gabbros of the Shulaps Range (Figure 1A). These are the pyroxene and hornblende diorites of Bateman (1914), McCann (1922) and Cockfield and Walker (1933) that are the prime hostrocks for gold veins in the camp. The elongated outline of individual intrusions and the linear arrangement of these bodies suggests emplacement on major fracture systems.

The age of the Bralorne intrusions is now known to be Permo-Carboniferous from radiometric dating. Zircon obtained from a pegmatitic phase of diorite at the B.C. Hydro quarry north of Gold Bridge has yielded a U-Pb date of 293±13Ma (Table 2.8, No.1). This is close to 287±20Ma, the K-Ar result obtained by Armstrong 1981, on amphibole from similar rocks in the same area and a U-Pb date on zircon (270±5Ma) minimum age from the Bralorne intrusion at the Bralorne mine (Leitch *et al.*, 1988).

Typically these rocks are mottled greenish grey, medium grained and characterized by a reticulate pattern of light coloured veinlets of prehnite, clinozoisite, epidote and carbonate minerals. Slips are coated with glossy, dark green chlorite superficially resembling serpentine. In contrast, gabbroic feeders to younger basaltic volcanics in the area are generally fresh, even grained, homogeneous and distinguished by a light rust weathering surface.

Locally these rocks grade into medium and coarse-grained massive amphibolite such as exposed on the bluffs on the east side of the lower section of the Hurley River and at the Arizona and Wayside mines (Stevenson, 1958). Fine-grained phases may be the result of comminution of igneous textures by cataclasis such as seen in the vicinity of the Cadwallader fault at the Pioneer mine (Stanley, 1960).

The results of x-ray diffraction analyses of 15 Bralorne intrusive rocks from various parts of the map area are given

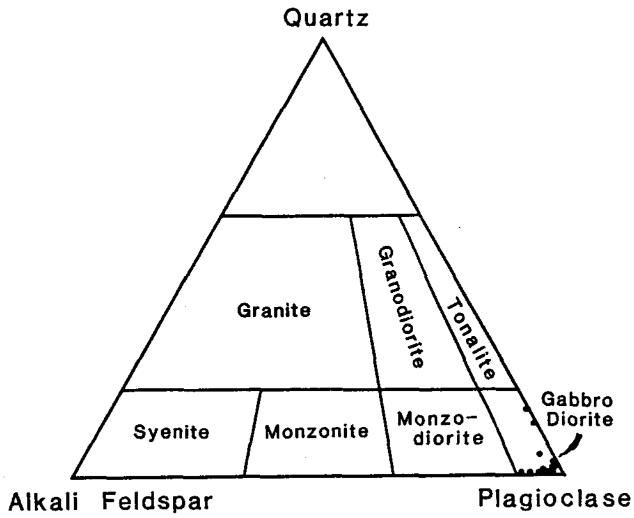


Figure 2.9. Classification of the Bralorne Intrusions using Streckeisen's system (1976).

TABLE 2.8
NEW U-Pb ZIRCON DATA
FROM THE BRIDGE RIVER AREA

SAMPLE NO.	WEIGHT (mg)	Concentration Observed (ppm) U	Pb	Atomic Ratios $^{206}Pb/^{204}Pb$	$^{206}Pb/^{238}U$	$^{207}Pb/^{235}U$	$^{207}Pb/^{206}Pb$	Model Ages (Ma) $^{206}Pb/^{238}U$	$^{207}Pb/^{235}U$	$^{207}Pb/^{206}Pb$	Assumed Lower Concordia Intercepts
BER-001*	0.2	474.60	20.11	2354.00	0.03971 ± 0.00020	0.28570 ± 0.00151	0.05219 ± 0.00015	251.0 ± 1.2	255.2 ± 1.2	293.6 ± 6.5	293 ± 13 Ma
50° 51.2'											
122° 50.8'											
-200 µm	0.6	253.00	19.55	83.00	0.04060 ± 0.00035	0.27911 ± 0.01610	0.04985 ± 0.00269	256.6 ± 2.2	249.9 ± 12.7	188.2 ± 12.1	
(abraded)											
+200 µm											
BBC-422**	0.5	363.70	4.37	291.00	0.01084 ± 0.00004	0.07217 ± 0.00093	0.04830 ± 0.00056	69.5 ± 0.2	70.8 ± 0.9	114 ± 27	
50° 49'	0.2	186.90	1.98	354.00	0.01026 ± 0.00004	0.06706 ± 0.00108	0.04740 ± 0.0007	65.8 ± 0.2	65.9 ± 1.0	69.6 ± 35	73.5 ± 36 Ma
122° 46.4'											
-74 µm	0.9	363.60	3.48	635.50	0.00917 ± 0.00016	0.06008 ± 0.00130	0.04753 ± 0.0006	58.8 ± 1.0	59.2 ± 1.2	76.2 ± 30	(computed)
-74+44 µm											
-74 µm											
(abraded)											
-74+149 µm	0.5	899.20	13.02	1212.00	0.01512 ± 0.00006	0.10178 ± 0.00053	0.04881 ± 0.00016	96.8 ± 0.4	98.4 ± 0.5	138.7 ± 7.5	(anomalous)
-44 µm	0.1	150.00	7.79	31.70	0.01016 ± 0.00010	0.06726 ± 0.01030	0.04801 ± 0.00070	65.2 ± 0.6	66.1 ± 9.7	99.7 ± 35	

Note: Samples submitted by B.N. Church, analyses performed by J. Gabites* and J.Gabites / D. Murphy**
Sample BER-001 from the Bralorne Intrusion at the B.C. Hydro quarry near Gold Bridge.
Sample BER-422 from the west lobe of the Bendon pluton on Fergusson Creek.

in Table 2.9. The most common minerals, in decreasing order of abundance, are plagioclase, amphibole, augite and chlorite; prehnite, clinozoisite and pumpellyite are also important constituents in 10% of the samples. In hand specimen a few samples show layered or banded structures suggesting crystal accumulation, however, typically the feldspar and ferromagnesian minerals show interlocking granoblastic and ophitic textures characteristic of igneous intrusions (Photo 2.19a to c). In thin section, samples consist of (55 to 80%) subhedral to euhedral clusters of calcic plagioclase and lesser amounts of ferromagnesian minerals, mostly green hornblende, some actinolite, diopsidic augite, altered olivine and magnetite. Plagioclase/ferromagnesian ratios are highly variable and melanogabbro to anorthositic rocks occur throughout the area. In the severely altered rocks plagioclase is commonly replaced by a fine mixture of sodic feldspar, white mica, clay and carbonates. The ferromagnesian minerals are replaced by chlorite, talc, iron oxide dust and carbonates.

Microprobe analyses of the principal primary minerals is shown in Figure 2.10 (after Pettipas *et al.*, 1992). Figure 2.11, based on the chromium and magnesium versus iron ratio of clinopyroxene, shows the oceanic gabbro magmatic affinity of the Bralorne intrusions (Hebert and Laurent, 1989).

The range in chemical composition of the Bralorne intrusions is given in Table 2.10. Major oxides are normalized to 100% (LOI free) for comparative purposes; the relatively high LOI values (1.84 to 11.48%) reflect the significant amphibole content and presence of hydrous alteration and low-grade metamorphic minerals. The main characteristics of these rocks are silica in the range of 45 to 55%, averaging 50.8%, similar to the Pioneer volcanics, but AFM values average 15/30/55, indicating comparatively high magnesium and low iron content. The low iron content is also reflected in the low magnetic susceptibility of these rocks (Church and James, 1988).

Figure 2.12 shows good discrimination between the Bralorne gabbroic rocks and the Pioneer basalts on a titania versus felsic index (Qz+Or+Ab) plot - the major variable in the index being sodic feldspar (Ab). The Bralorne rocks are relatively impoverished in titania but clearly more basic in overall composition than the Pioneer volcanics. In addition the Bralorne rocks manifest a strong anorthositic to mafic cumulate trend (Figure 2.13) not shown by the Pioneer rocks.

The gabbros have primitive compositions as indicated by Mg# (=Mg/(Mg+Fe_t), atomic which varies between 0.78 and 0.60, and display a positive correlation of FeO, and TiO_2 with FeO_t/MgO ratios, a trend typical of tholeiitic series. Compared to MORB, they are depeleted in Ti, P, and incompatible trace elements. They have low Ti/V ratios of 6-17 (Fig. 2.14), and are depeleted in Ti and Y relative to Cr. These features as well as their Ni vs Ti/Cr relations are characteristic of island arc tholeiites (IAT; Beccaluva *et al.*, 1979; Pearce, 1975; Shervais, 1982).

Samples with elevated Al_2O_3 ($\leq$22%) and Sr show a small, positive Eu anomaly with Eu/Eu* = up to 1.5 (Fig. 2.15A). These features qualitatively correlate positively with the modal proportions of plagioclase, and suggest that these rocks are plagioclase cumulates. Compared to typical IAT (Woodhead, 1989), the gabbros have high contents of Ni and Cr. This suggests that pyroxenes and olivine also are cumulus phases in these samples.

The REE abundances of the gabbroic rocks are comparable to those of mafic plutonic rocks of ophiolitic complexes (Montigny *et al.*, 1973; Kay and Senechal, 1976;

TABLE 2.9
X-RAY DIFFRACTION RESULTS FOR BRALORNE GABBRO

LAB NO.	UTM LOCATION EASTING	NORTHING	DESCRIPTION MINERALOGY (from most to least abundant)
32572	510700	5633500	Plagioclase, hornblende, augite, chlorite, prehnite; minor pyrite?, K-spar?
35398	511800	5636300	Plagioclase, hornblende, augite, pumpellyite? minor chlorite, muscovite
35399	517400	5631900	Plagioclase, hornblende, chlorite, clinozoisite, augite?
35400	517100	5632300	Plagioclase, chlorite, augite, hornblende; minor prehnite, K-spar?
35401	512100	5636400	Amphibole, prehnite; minor quartz, pyrite?
35402	512200	5636300	Plagioclase, hornblende, augite, chlorite, prehnite; minor quartz, muscovite, magnetite
35404	529800	5644200	Plagioclase, hornblende, chlorite, augite, pumpellyite.
35522	510300	5620800	Hornblende, plagioclase, chlorite, clinozoisite.
35523	530600	5645000	Chlorite, albite, pumpellyite; minor amphibole
35526	532000	5644000	Plagioclase, hornblende, clinozoisite, chlorite; minor epidote?
35602	528200	5644100	Plagioclase, hornblende, chlorite, prehnite, pumpellyite?
35616	517300	5616800	Quartz, albite, clinozoisite, chlorite; minor magnetite?
35617	529600	5647400	Plagioclase, quartz, augite, chlorite, prehnite, amphibole.
35620	521800	5617000	Albite, hornblende, chlotite, clinozoisite, augite?, calcite; minor quartz, titanite
38663	513200	5626200	Hornblende, plagioclase, chlorite, prehnite; minor quartz?, K-spar?

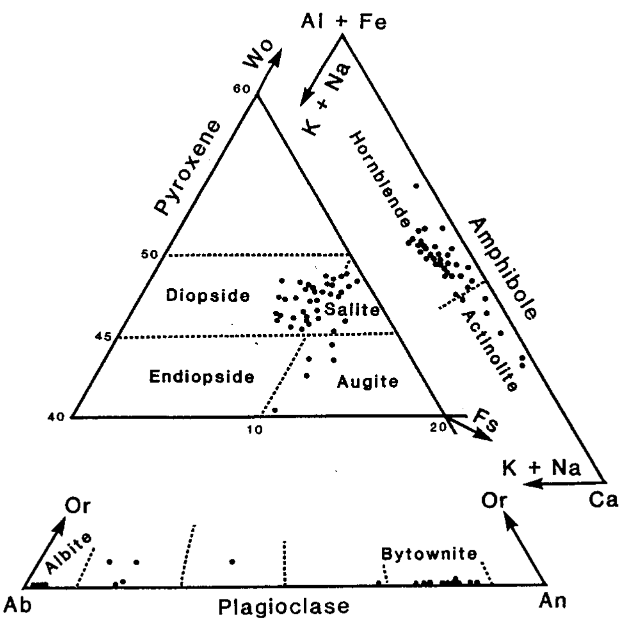


Figure 2.10. Microprobe results for the major minerals comprising the Bralorne Intrusions.

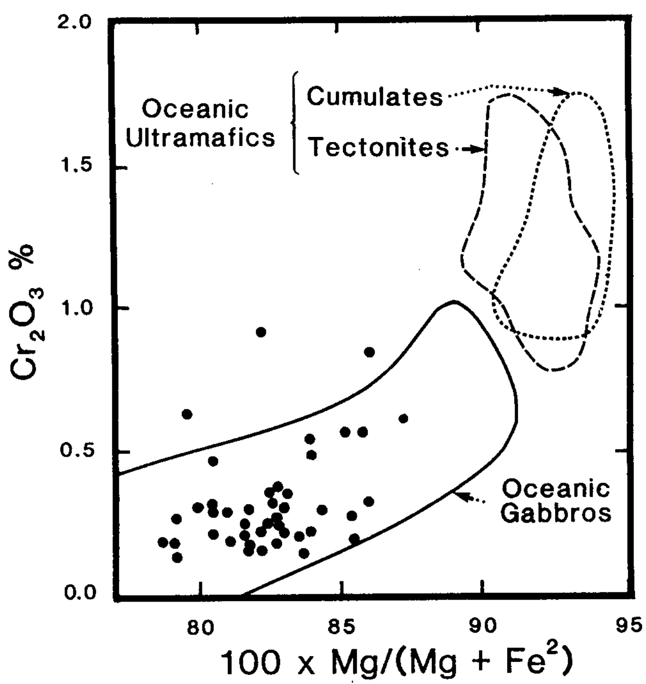


Figure 2.11. The composition of clinopyroxenes from the Bralorne (full circles) and Shulaps (open circles) gabbros. Fields for clinopyroxenes from oceanic mafic and ultramafic plutonic rocks defined by Hebert and Laurent (1989).

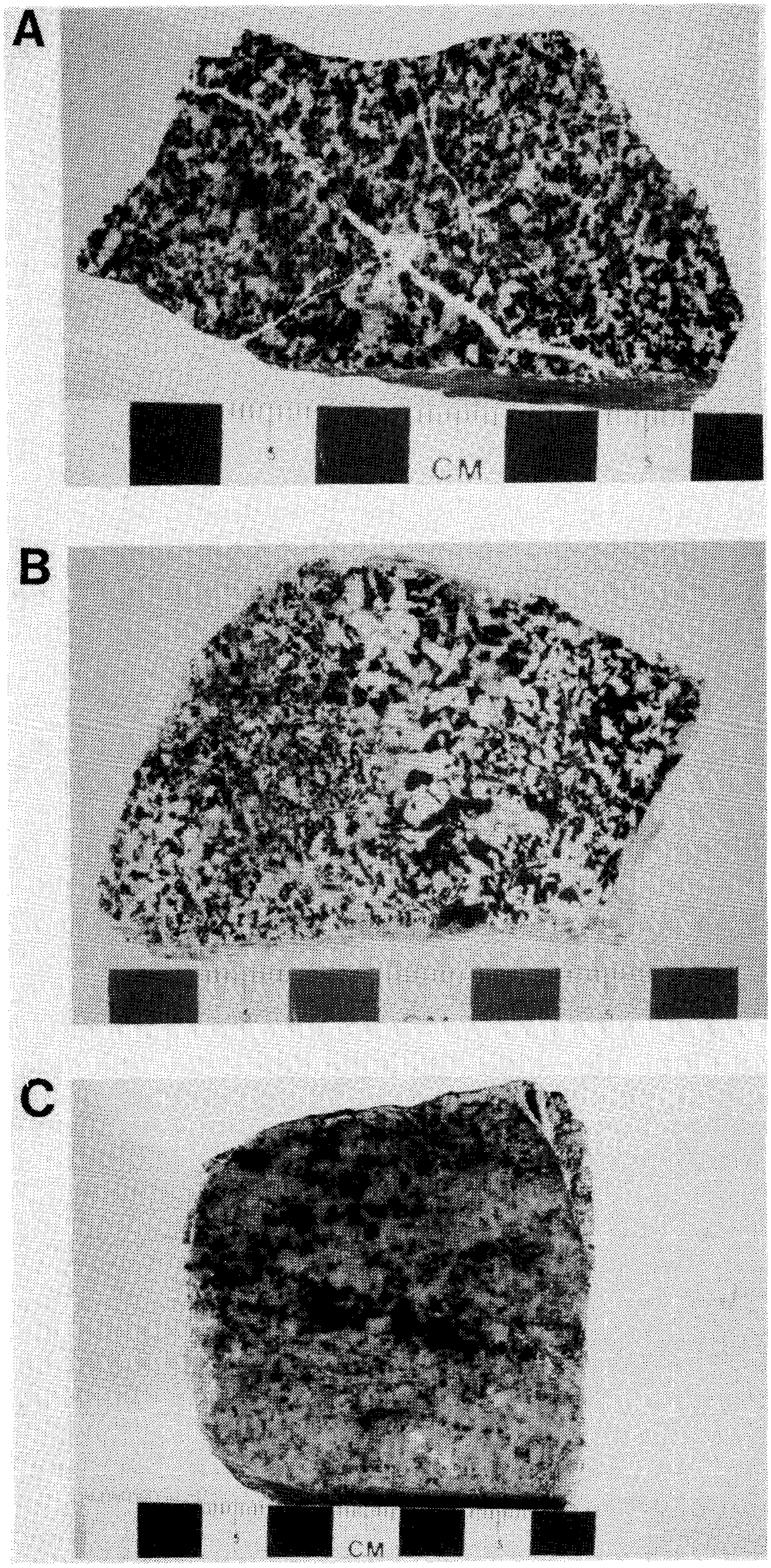


Photo 2.19. Textures of Bralorne (A-B) and Shulaps (C) gabbros; A - Ophitic intergrowth of plagioclase - pyroxene and amphibole; B - Pegmatitic sweats in medium to fine grained matrix; C- Pseudolayering of ferromagnesian minerals in altered gabbro.

TABLE 2.10
ANALYSES OF BRALORNE GABBROIC ROCKS

No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Oxides recalculated to 100:															
SiO_2	45.66	47.71	49.19	49.27	50.45	50.75	50.79	50.82	51.15	51.32	51.86	52.08	53.74	53.81	54.04
TiO_2	0.04	0.17	0.16	0.27	0.29	0.30	0.36	0.19	0.30	0.08	0.82	0.40	0.35	0.10	0.49
Al_2O_3	23.87	21.89	18.86	19.53	16.90	16.27	22.80	12.37	17.34	17.32	15.65	13.48	15.02	17.72	16.44
Fe_2O_3	1.06	1.66	1.64	0.92	1.78	2.07	4.17	1.68	1.79	1.11	2.30	7.68	1.17	1.52	1.75
FeO	4.56	2.78	3.82	3.92	3.19	5.91	2.61	3.78	5.63	4.13	7.13	1.80	4.61	3.88	4.82
MnO	0.09	0.07	0.10	0.10	0.11	0.15	0.13	0.13	0.15	0.12	0.19	0.17	0.12	0.09	0.11
MgO	9.32	8.60	10.74	9.67	9.36	10.83	2.33	10.10	10.30	10.63	7.64	10.91	8.34	7.19	8.24
CaO	12.50	13.16	11.64	14.26	14.89	11.26	15.41	20.20	9.27	13.59	9.76	10.94	13.22	12.27	10.16
Na_2O	2.03	1.46	2.11	1.62	2.32	2.18	1.32	0.07	3.21	1.67	3.51	2.27	3.40	3.38	3.68
K_2O	0.77	1.04	0.56	0.44	0.12	0.28	0.08	0.02	0.37	0.03	0.15	0.27	0.03	0.04	0.26
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Oxides as determined															
LOI	6.05	3.28	11.48	2.55	4.07	3.09	2.89	3.73	3.72	4.86	2.05	2.53	2.84	1.84	2.45
H_2O	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CO_2	0.10	0.43	0.42	0.35	0.01	0.57	0.70	0.90	0.14	0.10	0.21	0.15	0.56	0.10	0.87
P_2O_5	0.00	0.01	0.00	0.00	0.00	0.00	0.03	0.00	0.01	0.00	0.01	0.04	0.00	0.00	0.04
S	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.03	0.01	0.01	0.02	0.03	0.01	0.02	0.01
Minor element determinations (ppm)															
Ba	131	73	135	—	39	56	68	19	61	14	33	75	15	13	59
Cr	52	363	412	—	446	462	23	420	567	168	201	468	580	109	125
Ni	110	144	214	—	120	156	5	125	123	79	50	78	107	67	113
Sr	127	665	472	—	70	215	589	44	638	75	238	238	76	137	179
Nb	8	2	2	—	5	6	4	9	5	5	2	—	5	5	4
V	37	96	98	—	123	189	261	126	116	108	277	—	144	85	176
Y	8	9	8	—	10	10	13	10	13	3	31	—	12	6	13
Zr	11	20	13	—	13	15	27	15	32	7	62	—	15	12	36
Molecular Norms															
Qz	0.00	0.00	0.00	0.00	0.00	0.00	9.80	3.70	0.00	0.00	0.00	4.00	0.00	0.40	0.00
Or	4.40	6.10	3.30	2.50	0.70	1.60	0.50	0.10	2.20	0.20	0.90	1.60	0.20	0.20	1.50
Ab	12.60	12.90	18.60	14.30	20.60	19.30	12.10	0.70	28.20	14.70	31.50	20.30	30.00	30.00	32.40
An	52.70	49.30	39.60	43.80	34.90	33.30	57.20	33.70	31.70	39.00	26.60	25.80	25.20	32.60	27.10
Wo	3.10	6.00	6.80	10.20	15.20	8.70	8.30	27.00	5.30	10.90	8.80	11.30	15.70	10.90	9.00
En	0.00	11.80	13.20	14.60	16.30	22.60	6.60	28.10	13.20	27.70	18.00	30.00	18.70	19.50	21.30
Fs	0.00	2.10	2.30	2.80	2.20	5.50	0.60	4.60	3.40	5.20	7.20	0.00	4.70	4.70	5.20
Fo	18.80	8.70	12.00	8.80	6.90	5.20	0.00	0.00	11.00	0.90	2.40	0.00	3.00	0.00	0.80
Fa	8.30	1.60	2.10	1.70	0.90	1.30	0.00	0.00	2.80	0.20	1.00	0.00	0.80	0.00	0.20
Il	0.10	0.20	0.20	0.40	0.40	0.40	0.50	0.30	0.40	0.10	1.10	0.60	0.50	0.10	0.70
Mt	0.00	1.30	1.90	0.90	1.90	2.10	4.40	1.80	1.80	1.10	2.50	3.30	1.20	1.60	1.80
He	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.10	0.00	0.00	0.00
C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Key:

No.	LAB. #	STN. #	ROCKTYPE	EASTING	NORTHING	LOCATION
1	035523	BBC 181	ANORTHOSITE	530600	5645000	SHULAPS RIDGE
2	035398	BBC 525	ANORTHOSITE	511800	5636300	WAYSIDE-GUN L.
3	035402	MJB 262	ANORTH-GAB	512200	5636300	WAYSIDE
4	032572	BRC 26	ANORTH-GAB	510700	5633500	B.C. HYDRO PIT
5	035404	BBC 600	GABBRO	529800	5644200	SHULAPS
6	035522	BBC 381	GABBRO	510300	5620800	NOEL PK.
7	035616	GBB 221	GABBRO	517300	5616800	PRESIDENT
8	035401	MJB 261	GABBRO	512100	5636400	WAYSIDE
9	035400	BBC 488	GABBRO	517100	5632300	TRUAX AREA
10	035617	GBB 179	PYROXENITE	529600	5647400	NW. SHULAPS PK.
11	035399	BBC 485	GABBRO	517400	5631900	RANGER
12	038663	BERTAIT	MICRODIORITE	513200	5626200	LOVE OIL ADIT
13	035602	GBB 524	PYROXENITE	528200	5644100	E. LIZA CK
14	035526	BBC 169	GABBRO	532000	5645000	SHULAPS
15	035620	GBB 342	GABBRO	521800	5617000	RED HAWK

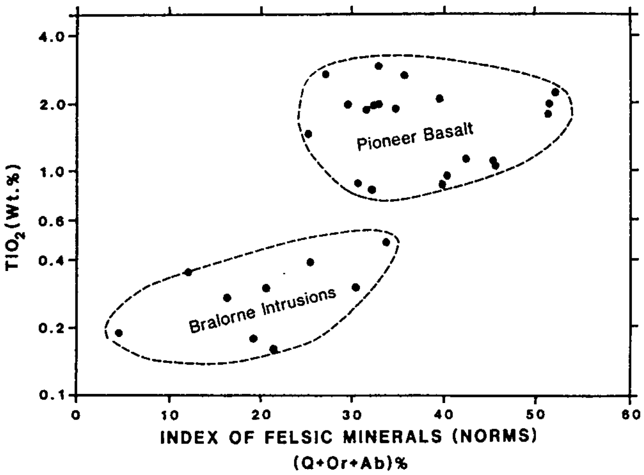


Figure 2.12. Major oxide plot discriminating Bralorne Intrusions and Pioneer basalts.

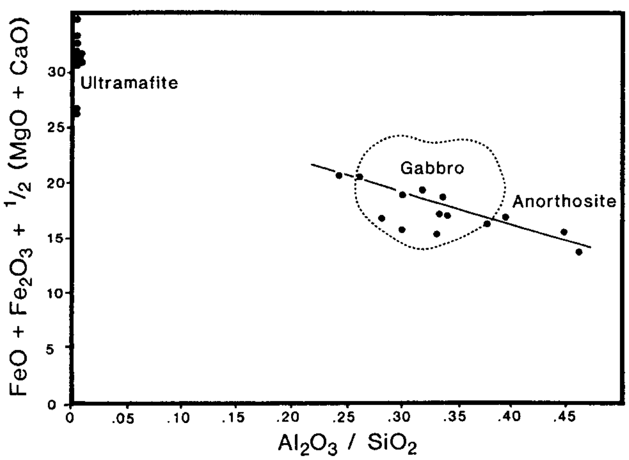


Figure 2.13. Major oxide trend for Bralorne Intrusions showing compositional discontinuity with the principal ultramafic rocks in the area.

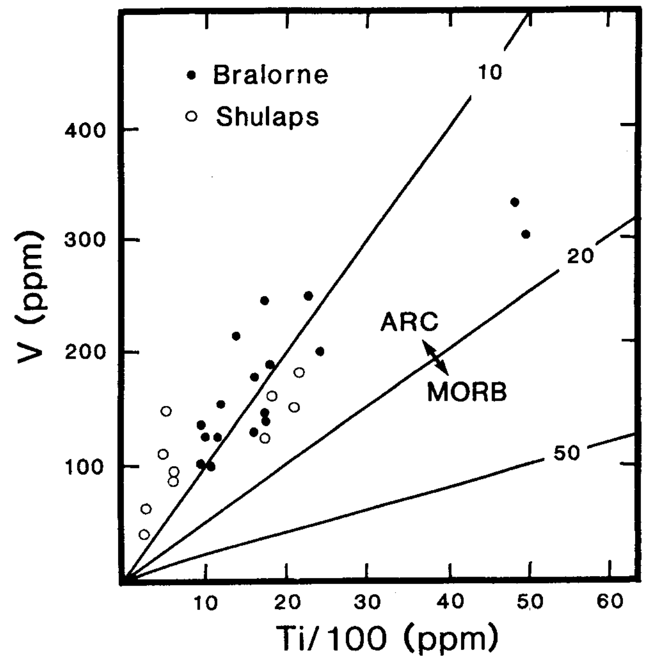


Figure 2.14. Variations of Ti/100 (ppm) vs. V (ppm) in gabbroic rocks of the Bralorne intrusions (filled circles) and the Shulaps ophiolites (open circles); dividing line between ARC (IAT) and MORB fields is after Shervais.

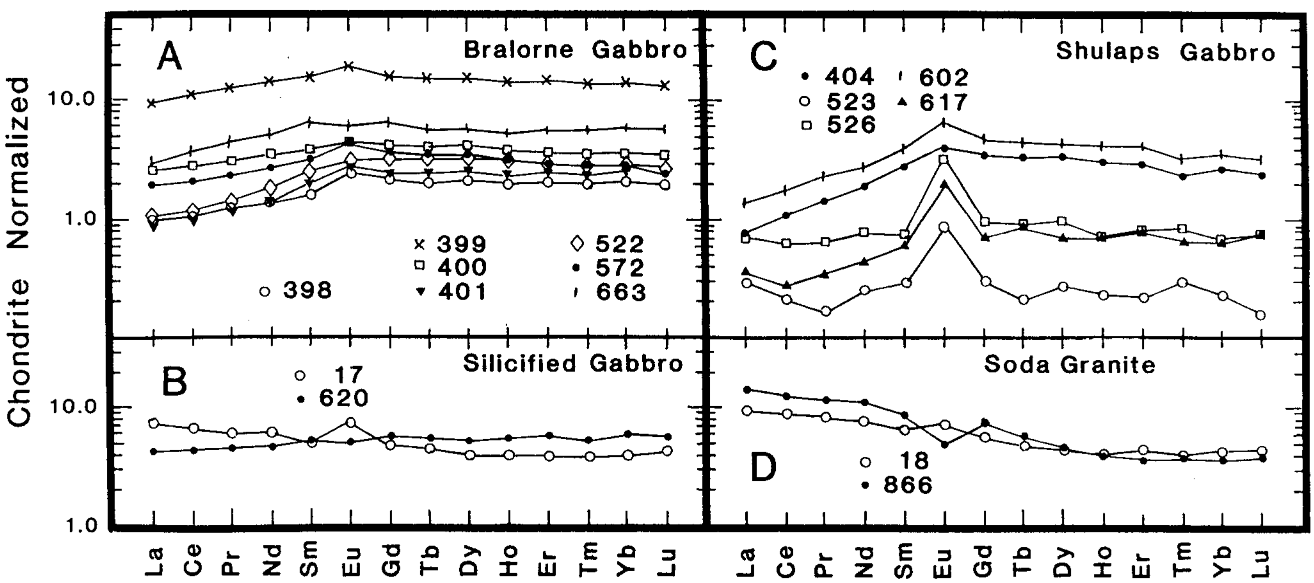


Figure 2.15A. Chondrite-normalized REE abundances in the Bralorne gabbros (A), strongly altered Bralorne gabbros (B), gabbros of the Shulaps ophiolites (C) and felsic rocks of the Bralorne bodies (D) Normalizing values after Sun (1982).

Suen *et al.*, 1979; Coish and Rogers, 1987; Harnois and Morency, 1989). The gabbros have REE patterns that are slightly depleted in light REE (LREE) relative to heavy REE (HREE) but the overall abundance of REE varies by a factor of almost 10 between the most primitive and most evolved samples (Fig. 2.15A). Their chondrite-normalized La/Yb and La/Sm ratios typically are <0.7. The similarity in the REE patterns supports the interpretation based on geological and petrologic evidence that the Bralorne gabbros represent a cogenetic suite. The absolute REE abundances correlate primarily with the degree of differentiation of the rocks, as monitored by Mg#. Alteration effects include slight LREE enrichment, which characterizes two highly silicified samples (17, 620; Fig. 2.15A).

MORB-normalized plots (Fig. 2.16) are flat and show slight enrichment of large-ion-lithophile-elements (LILE; *e.g.*, Th, U, Ba, Rb) relative to LREE with negative Nb and Ti and positive Sr and Eu anomalies. These patterns are typical of a primitive oceanic island arc environment. Relative enrichment of Sr and Eu is consistent with the variable accumulation of plagioclase.

The Shulaps gabbros are compositionally similar to the cumulate gabbros of ophiolitic complexes (Harnois and Morency, 1989). They are also grossly comparable to the Bralorne gabbros although they have lower abundances of most incompatible trace elements, including HFSE and REE. Despite similarities in their REE patterns, the Shulaps gabbros display a wider range of REE fractionation than the Bralorne intrusions: La/Yb, ranges between 0.25 and 1.25, and La/Sm, <1 (Fig. 2.15A).

Discrimination of Bralorne and Shulaps gabbros achieved on a Sr-Zr plot (Fig. 2.16) is similar to the pattern obtained with Sr-Ti suggesting some inherent differences in these rocks and some mobility of Sr due to metamorphism.

Petrographically and geochemically, the Shulaps rocks also have a relatively distinctly cumulitic character. Their REE patterns can be explained by the fractional crystallization of partial melts derived from a MORB-type mantle source and the accumulation of crystallizing phases, notably plagioclase and clinopyroxene.

The magnitude of the Eu anomaly decreases with the increase of the overall REE abundances. Samples with elevated REE concentrations have higher modal clinopyroxene. These rocks seem to have had a lower proportion of intercumulus liquid than the Bralorne gabbros. Their MORB-normalized trace element patterns display an enrichment in Th and small negative Nb depletion (Fig. 2.17). This is consistent with their Ti/Cr *vs* Ni, Ti *vs* V and Ti *vs* Cr relationships, which also indicate the island arc affinities of the sequence.

Modelling calculations of batch partial melting and fractional crystallization (Shaw, 1970; Hanson, 1980) show that the REE composition of the Bralorne gabbros can be derived from a single LREE-depleted peridotitic MORB-type mantle source (Wood *et al.*, 1979) by about 20% partial melting and subsequent fractional crystallization/accumulation of various combinations of olivine, pyroxenes and plagioclase (Fig. 2.15B). The fractional crystallization/ accumulation process also accounts for the positive Eu anomalies displayed by these rocks (Fig. 2.15B). On the one hand, these calculations demonstrate that the sodic granites cannot be derived from the gabbros by fractional crystallization. On the other hand, parental melts of the Shulaps gabbros could have been derived from a MORB-type source similar to that envisaged for the Bralorne gabbros. The Shulaps gabbros are cumulates containing various proportions of accumulated plagioclase, pyroxenes and probably also olivine.

The mineralogical and chemical evidence supports a partly magmatic source for the Bralorne gabbros whereas the Shulaps gabbros have distinct cumulate character with relatively small amounts of intercumulate liquid.

ULTRABASIC ROCKS

There is an abundance of ultrabasic rocks (Unit B) in the Bridge River mining camp. These rocks consist of an assortment of small serpentinite and talc-carbonate lenses

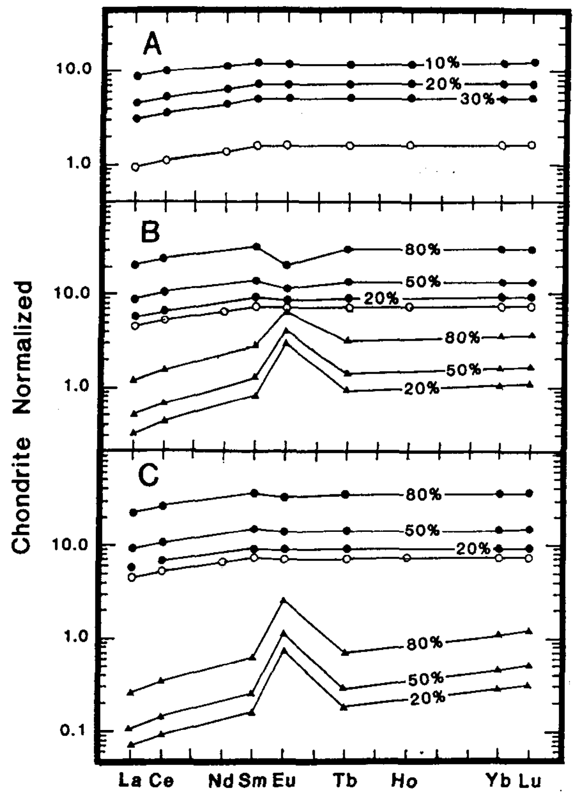


Figure 2.15B. A: Calculated REE abundances in liquids (solid circles) produced by melting of a MORB-type source (open circles; Wood *et al.*, 1979). Modal composition of the source (olivine 50%, orthopyroxene 35%, clinopyroxene 15%) and melt proportions (clinopyroxene 50%, orthopyroxene 35%, olivine 15%) after Harnois and Morency (1989). Partition coefficients after Frey *et al.* (1978). Percentages (10, 20 and 30%) reflect degrees of partial melting of MORB-type source. B and C: Calculated REE abundances in residual liquids (solid circles) and crystallizing mineral assemblages (solid triangles) produced by fractional crystallization of 20% partial melt (open circles) of a MORB-type source (pattern 20 in A). Degrees of crystallization are 20%, 50% and 80%. Mineral proportions in B are plagioclase 55% and clinopyroxene 45% and in C olivine 70%, orthopyroxene 15%, clinopyroxene 5% and plagioclase 10%. They were taken from modal composition of the gabbros.

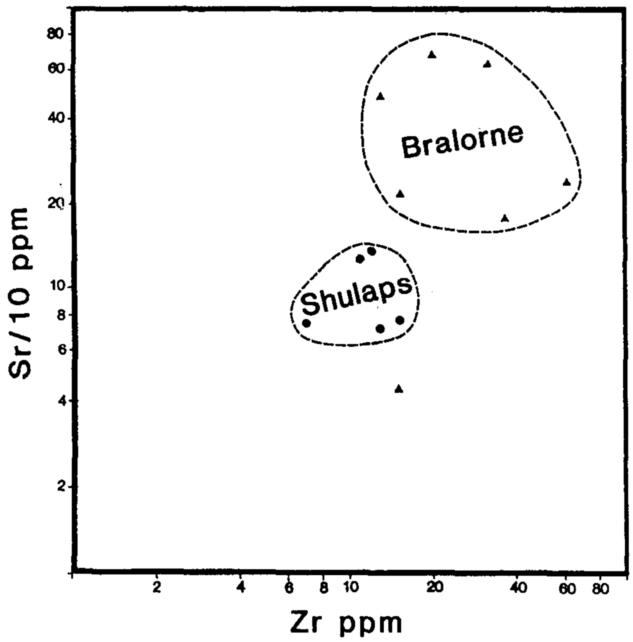


Figure 2.16. Sr vs Zr plot distinguishing Bralorne and Shulaps gabbroic rocks.

and larger bodies of dunite, pyroxenite and peridotite that occur in steeply dipping fault zones and imbricated thrust sheets. The largest bodies comprising 180 km^2 are in the Shulaps Ultramafic Complex underlying the Shulaps Range in the northeast part of the camp, and smaller but similar bodies on Sunshine Mountain, (Photo 2.20) and the 'President Intrusions' along the Cadwallader break.

The principal ultramafic bodies in the Shulaps Range and on Sunshine Mountain have been variously interpreted as 'alpine type' by Leech (1953) and more recently as

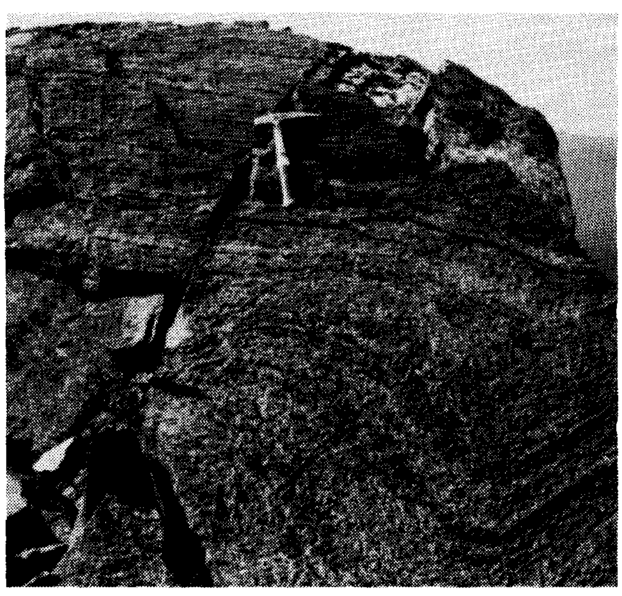


Photo 2.20. Layered structure in ultramafic rocks, Sunshine Mountain.

'ophiolitic' by Nagel (1979), Wright *et al.* (1982) and Calon *et al.* (1990). These latter workers consider the ultramafic rocks, together with the Bridge River ribbon cherts and spilites, to be the principal elements characteristic of ophiolitic complexes as described by Amstutz (1980). This model assumes that the Bridge River hostrocks are the same age as the ultramafic rocks and includes the Permo-Triassic gabbroic rocks and pillow lavas with the ultramafic rocks in the ophiolitic package. The difficulty is the petrogenetic link between the ultramafic rocks, gabbros and the basalts is not established and a common source for all these rocks seems unlikely (Dostal and Church, 1992).

Leitch (1989) indicates that some of the ultramafic rocks may be pre-Permian age. This is tentatively supported by the occurrence of xenoliths of ultramafic rocks in the Bralorne gabbro-diorite such as seen in the B.C. Hydro quarry north of Gold Bridge. A minimum age for the emplacement of the ultramafic bodies is offered by the presence of chromite in the sedimentary record, assuming that the ultramafic rocks were the only readily available source of chromite. Potter (1986) suggests that the obduction of the major ultramafic bodies was Cretaceous - much younger than the gabbros and pillow basalts of the area. The occurrence of chromite in late Lower Jurassic beds was noted by Leech (1953), in Upper Jurassic beds by Roddick and Hutchison (1973) and in middle Cretaceous beds by this study. This suggests that exposure of ultramafic rocks at surface began at least as early as the Jurassic and has continued episodically since that time.

The composition of selected ultramafic rocks from widely scattered parts of the study area is given in Table 2.11. Normative calculations show that the main mineral components are forsterite 1.3 to 85.0%, enstatite 5.9 to 51.9%, and wollastonite, 0.9 to 31.0%. This represents a variety of rock types including dunite, harzburgite and websterite. Silica is lowest in dunite (38.27%) and highest in pyroxene-rich rocks (52.88%).

Harzburgite, the most common ultramafic rock (Leech, 1953; Wright, 1974), is readily identified in the field by rust-brown weathering on a warty surface. The 'warts' are pyroxene grains randomly distributed in layers in a fine-textured, recessively weathered groundmass. In thin section the ratio of pyroxene to olivine is usually less than 1:4. Pyroxene, mostly enstatite, is present as clusters or individual subhedral crystals, 0.4 to 3 millimetres across, surrounded by olivine. Diopsidic augite is a minor constituent, less that 10%, occurring interstitially and as exsolution lamellae in enstatite. In most samples enstatite and diopsidic augite are notably less serpentinized than olivine. Chromite is present mostly as dark brown translucent grains with black rims, forming small inclusions in olivine and pyroxene.

Dunite is variably interlayered with harzburgite and forms irregular massive bodies characterized by smooth, tan weathered surfaces. Where freshly broken, surfaces are typically brittle and dark coloured. In thin section the rock is even textured and fine to medium grained. Commonly the olivine is crisscrossed by numerous veinlets of serpentine. Chromite is the principal accessory mineral and occurs as

TABLE 2.11
ANALYSES OF ULTRAMAFIC ROCKS

No.	1	2	3	4	5	6	7	8	9	10	11	12
Oxides recalculated to 100:												
SiO_2	38.27	40.37	43.23	43.68	45.19	45.32	45.97	46.15	46.22	46.75	51.37	52.88
TiO_2	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.03	0.06	0.07
Al_2O_3	1.13	0.34	0.75	1.65	0.79	1.23	1.46	0.53	0.67	1.54	1.51	2.18
Fe_2O_3	6.89	7.05	9.73	7.61	6.96	3.09	4.13	3.67	3.71	4.14	2.07	1.38
FeO	4.91	4.09	1.12	3.34	3.00	6.06	5.87	5.44	6.06	5.90	4.28	6.65
MnO	0.15	0.19	0.18	0.15	0.07	0.15	0.16	0.14	0.09	0.15	0.10	0.16
MgO	48.42	47.89	44.50	43.50	43.90	43.00	40.74	43.32	42.61	40.61	25.54	19.66
CaO	0.22	0.05	0.48	0.03	0.08	1.14	1.65	0.67	0.63	0.88	15.07	16.98
Na_2O	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.04
K_2O	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Oxides as determined												
LOI	8.37	15.85	13.66	12.17	12.13	11.25	5.18	5.67	12.68	10.63	4.92	2.15
H_2O	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.12
CO_2	0.87	6.94	0.91	0.14	0.44	6.08	0.14	0.21	1.27	0.40	0.10	0.56
P_2O_5	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
S	0.01	0.14	0.02	0.02	0.07	0.30	0.01	0.01	0.02	0.28	0.02	0.02
Minor element determinations (ppm)												
Ba	—	<56	—	—	—	—	—	<56	—	—	38	<56
Cr	6821	4482	3058	3296	2200	1717	3169	2297	926	3011	1669	1242
Sr	3	7	3	3	3	28	3	10	12	6	7	22
Nb	4	—	4	6	1	2	3	—	1	6	6	—
Ni	2500	1739	2000	2000	1700	1500	1800	1969	2300	1900	499	319
V	40	—	45	50	34	39	78	—	27	50	124	—
Y	2	—	1	2	2	2	2	—	2	3	6	—
Zr	5	—	5	3	7	4	7	—	5	3	8	—
Molecular Norms												
Qz	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Or	0.00	0.10	0.00	0.10	0.00	0.00	0.00	0.10	0.00	0.00	0.30	0.00
Ab	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.40	0.00	0.00	0.50	0.40
An	1.00	0.20	1.80	0.20	0.40	3.00	3.70	1.00	1.70	3.90	3.60	5.70
Wo	0.00	0.00	0.10	0.00	0.00	0.90	1.50	0.80	0.50	0.10	27.30	31.00
En	5.90	13.90	30.80	37.30	41.50	38.30	44.30	35.70	45.30	49.90	45.60	51.90
Fs	0.00	0.10	0.00	0.00	0.00	0.00	0.00	1.60	0.00	0.00	3.00	8.10
Fo	85.00	78.30	60.40	53.80	51.20	52.00	44.10	54.60	46.30	39.60	16.60	1.30
Fa	0.00	0.80	0.00	0.00	0.00	0.00	0.00	2.50	0.00	0.00	1.10	0.20
Il	0.00	0.01	0.01	0.00	0.01	0.01	0.03	0.01	0.01	0.00	0.10	0.10
Mt	7.40	0.04	6.90	6.90	6.30	5.80	6.40	3.30	6.20	6.50	1.90	1.30
He	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C	0.70	0.20	0.00	1.50	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Key:

No.	LAB.#	STN.#	ROCKTYPE	EASTING	NORTHING	LOCATION
1	038933	GBB 195	DUNITE	533100	5648700	PERIDOTITE CK.
2	032578	BRC 98	DUNITE	515449	5623164	PIONEER MINE
3	038934	GBB 276	HARTZBURGITE	516800	5618700	SUNSHINE MTN.
4	038926	BRC 339	SERPENTINE	509661	5647385	TAYLOR BASIN
5	038935	BER 634	AMPHIBOLITE	544793	5634322	SPOKANE AREA
6	038927	BRC 539	SERPENTINE	509098	5646860	ELDORADO TAYLOR
7	038929	BBC 346	HARTZBURGITE	526900	5650400	LIZA CK.
8	032586	BRC 217	WEBSTERITE	502800	5638900	MT. PENROSE
9	038928	BBC 290	SERPENTINE	512300	5619200	NOEL RIDGE
10	038930	BBC 415	HARTZBURGITE	526800	5617400	MT. ROYAL
11	035534	BBC 171	HARTZBURGITE	531800	5645200	SHULAPS PK.
12	032573	BRC 27	SERPENTINE	510600	5634200	B.C. HYDRO QUAR RY

embayed dark-fringed individual grains and clusters surrounded by serpophite - a colloidal variety of serpentine and chlorite(?) (Photo 2.21).

The largest known concentration of chromite is on a steep hillside at elevation 1675 metres between Marshall Lake and Brett Creek on the southwest flank of the Shulaps Range (MINFILE 092JNE099). This is a chromite-rich zone several metres long consisting of a few narrow pods of chromitite in sheared serpentine. According to Leech (1953), hand picked chromite from this location assayed 57.43 % Cr_2O_3, 7.44 % Al_2O_3, 5.08 % Fe_2O_3 and 12.09 % FeO. Analyses (this study) of a sample taken at the same locality assayed 41% Cr_2O_3, 6 ppb gold, 4 ppb palladium, 1 ppb platinum, 900 ppm nickel, 100 ppm sulphur, 10 ppm copper and 0.1 ppm selenium.

Serpentine and serpentinized ultramafic rocks occur throughout the camp and broad bands of serpentinite are found along the faulted margins of the major ultramafic bodies (Wright *et al.*, 1982; Calon *et al.*, 1990). The southwest side of the Shulaps body is marked by a thrust zone of sheared serpentinite and a mélange tectonite that includes a mixture of serpentine and exotic blocks of chert, greenstone and gabbro with some garnetiferous alteration (Nagel, 1979). On the east side of the Shulaps body and at many other localities in the camp, serpentinite is associated with steeply dipping faults (Stevenson, 1958).

In outcrop serpentinite is commonly strongly sheared and jointed resulting in wedge and elliptical shapes resembling pillows that are, however, wholly structural in origin and not true volcanic features as suggested by McCann (1922). Strongly fractured faces and cuts tend to slough, forming talus slopes composed of glossy green lens-shaped fragments. If broken across foliation the rock is dull black, fine grained and massive. A porphyritic variety of serpentinite seen locally near the Lucky Strike mine and in the Bralorne-Pioneer belt appears to be the replacement equivalent of warty harzburgite - the pyroxenes being replaced by books of glistening bastite.

In thin section, sheared serpentinite is traversed by numerous irregularly spaced veinlets that weave and converge around and between thin lenses and wedges of feathery antigorite, and less commonly tremolite and chlorite, that replace the original silicates. The veinlets are carbonate with small opaque granules of iron oxide at the centre. Patches of antigorite replacing orthopyroxene are typically charged with tiny aligned and subparallel rods of iron oxide replicating, after a fashion, the schiller texture of the original grains.

Jade has been found in small lenses in association with chert and greenstone knockers in the serpentine and talc-carbonate mélange zones flanking the main ultramafic bodies in the Jim Creek and Noel Creek areas (MINFILE 092JNE111 and 092JNE118) and as boulders along the lower section of Marshall Creek (Holland, 1962). The jade is a dark green nephritic variety composed mainly of a semitransluscent microscopic intergrowth of tremolite with chlorite, magnetite and/or chromite impurities. Several tonnes of jade from the Noel Creek prospect were quarried and sold in 1969.

Talc occurs as an alteration phase within the serpentinite (MacLean, 1988). It is particularly abundant in the Bralorne-Pioneer belt in the workings of the Pioneer Extension mine (MINFILE 092JNE009), on the Red Hawk property (MINFILE 092JNE012), above the Pioneer mine (MINFILE 092JNE113) and along the margin of the President ultramafic body (MINFILE 092JNE137). Generally talc concentrations are associated with the iron and magnesium carbonates that are a byproduct of the serpentinization process. In the Pioneer Extension mine, a shaft penetrates 30 metres of talcose rocks containing exotic blocks of chert and argillite and intruded by albitic dikes. Analyses of the

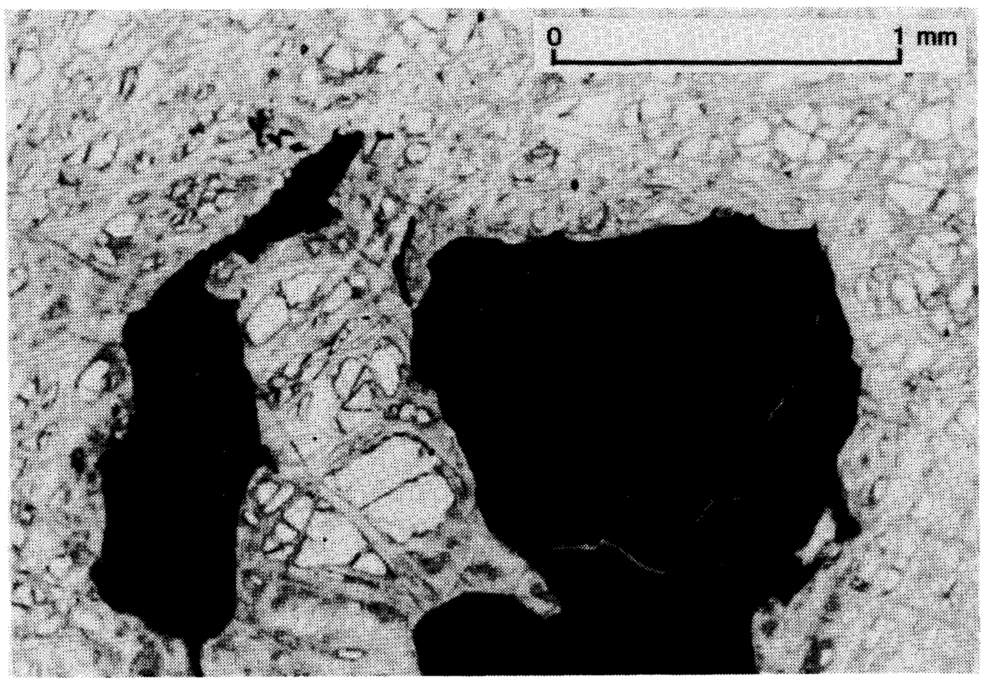


Photo 2.21. Photomicrograph of chromite in dunite, Shulaps Range.

talc concentrate from this location indicate approximately 12 % impurities that consist mostly of alumina and iron oxide (MacLean, 1988). On the south contact of the Sunshine Mountain ultramafite, talc-carbonate-chlorite schist is developed between the serpentinite and the surrounding country rocks.

The association of listwanites (Kemp, 1927) and serpentinite in belts of ultramafic rocks is a feature of the Bridge River camp similar to the Mother Lode area of California and the Cassiar and Greenwood mining camps of interior British Columbia (Church *et al.*, 1988). By reaction, serpentine plus carbon dioxide yields talc plus magnesite and water. The listwanites are light orange-buff with patches of bright green fuchsite/mariposite occurring along the boundaries of some ultramafic bodies. The main zones of listwanite development in the Bridge River district are in the Eldorado and Taylor Creek basins, Steep Creek, Tyaughton Creek and Liza Lake areas. The listwanites are locally cut by reticulating veinlets of calcedonic quartz. At the Tungsten King and Tungsten Queen prospects (MINFILE 092OSE020; 092OSE022) in the Tyaughton Creek area, scheelite is associated with quartz veins in listwanite (33 tonnes of scheelite ore was mined). Magnesite prospects in listwanites occur along the margins of the Marshall Lake fault zone in the Liza Lake area. The largest magnesite prospect, 250 by 60 metres (MINFILE 092JNE018) has been found immediately southeast of Liza Lake; another 16 by 15 metres (MINFILE 092JNE019), is northwest of the lake. The composition of these deposits ranges from 28.14 to 43.42 % MgO (Grant, 1987). Analyses of listwanites from the Tyaughton Lake, Steep Creek and Taylor basin areas (Table 2.12) report a similar range of MgO from samples containing 70 to 95 % magnesite.

GRANITIC INTRUSIONS

Granitic intrusions underlie about 15 % of the map area (Unit C) and range in age from late Paleozoic to mid-Tertiary. Plutonism occurred episodically within this interval, coinciding with major tectonic and mineralizing events.

Granitic plutonism began in the early Permian. The soda granite bodies of the Bralorne-Pioneer belt were intruded at this time (Leitch and Godwin, 1988) marking the culmination of mantle-derived igneous activity. Triassic granitic rocks, mainly quartz feldspar porphyry clasts in the Hurley conglomerate, appear to be related to island-arc evolution (Rusmore and Woodsworth, 1991). Granitic clasts in *Buchia* beds of the Relay Mountain Group (Church and MacLean, 1987b), are the first evidence in this area of the up-lift and unroofing of the Coast Plutonic Complex and development of the western rim of the Tyaughton trough in Late Jurassic - Early Cretaceous time. The full emplacement of the Coast Plutonic Complex occurred in the Late Cretaceous and coincides with the major period of mineralization in the area (Leitch, 1990; Woodsworth *et al.*, 1977). Final granitic plutonism, manifest here by the Eocene Rexmount porphyry marks the beginning of extension tectonics and major volcanism in the interior of British Columbia (Armstrong, 1988).

The classification of granitic rocks in this report follows the method of Streckeisen (1976) and other petrological and geochemical systems designed to distinguish between the various granite series and to show progressive changes in the orogenic cycle (Batchelor and Bowden, 1985). The classifications of Peacock (1931), Shand (1951), White and Chappell (1977) and Didier *et al.* (1982) have genetic and

TABLE 2.12
ANALYSES OF LISTWANITES

No.	1	2	3
Oxides recalculated to 100:			
SiO_2	36.47	43.19	49.80
TiO_2	0.01	0.01	0.01
Al_2O_3	0.81	0.87	1.62
Fe_2O_3	4.93	1.98	1.32
FeO	6.36	9.24	8.68
MnO	0.25	0.09	0.14
MgO	50.58	43.34	32.96
CaO	0.55	1.25	5.28
Na_2O	0.00	0.00	0.10
K_2O	0.04	0.03	0.09
TOTAL	100.00	100.00	100.00
Oxides as determined			
LOI	30.48	34.04	30.33
H_2O	0.00	0.00	0.25
CO_2	25.55	33.59	29.29
S	0.02	0.08	0.03
Minor elements (ppm)			
Ba	-	-	127
Cr	1877	1983	2691
Ni	1400	1500	1555
Sr	24	23	52
V	25	35	-
Molecular Norms			
Qz	0.00	0.00	0.00
Or	0.20	0.20	0.50
Ab	0.00	0.00	0.90
An	1.80	2.00	3.50
Wo	0.20	1.40	8.50
En	0.00	30.20	46.10
Fs	0.00	0.00	5.80
Fo	89.10	59.10	29.80
Fa	0.00	0.00	3.70
Il	0.02	0.00	0.02
Mt	8.90	7.10	1.20
He	0.00	0.00	0.00
C	0.00	0.00	0.00

Key:

No.	LAB.#	EASTING	NORTHING
1	038925	516175	5642502
2	038932	517200	5633700
3	032592	510060	5646670

tectonic connotations. These methods assume that 'calcalkaline' I-type granites are typical of Cordilleran post-orogenic uplift igneous regimes, that 'alkaline' (A-type) magmas typically represent within-plate late orogenic domains. 'Aluminous' (S-type) granitic rocks result from the anatexis of sedimentary rocks during continental collision events and plagiogranites are derived from the mantle.

SODA GRANITE

Small masses of 'soda granite' of Unit Cc, associated with the Bralorne gabbro-diorite bodies, are exposed on the Bralorne, Pioneer and Pioneer Extension properties and in the workings of the Arizona and Wayside mines (Cairnes, 1937; Stevenson, 1958; Leitch, 1990; Church *et al.*, 1995). Cairnes believed that the soda granite was the result of differentiation of the Bralorne diorite. Zircon dating of the diorite and soda granite at Bralorne by Leitch *et al.* (1991) gives 270±5 Ma for both rocks and tends to confirm a comagmatic relationship, although the albitite dikes dated 91.4±1.4 Ma, formerly believed to be apophyses of the soda granite, are clearly cogenetic with the much younger Coast Plutonic Complex.

The soda granite at Bralorne-Pioneer is the largest body, in the region measuring 2400 by 300 metres. This is a northwest-southeast elongated lens-like intrusion bounded by gabbro-diorite on the southwest and greenstones on the northeast. The contact with the Bralorne diorite is irregular, up to 100 metres wide and consists of numerous granitic tongues and dike-like offshoots cutting the country rocks (Leitch, 1990). The northeast contact, in contrast, is relatively straight and steeply dipping. The sharp nature of this contact and evidence of shearing suggests that emplacement may have been along a fault zone or possibly that the granite was truncated by faulting subsequent to intrusion.

The soda granite on the Pioneer Extension property is more than 700 metres long and less than 100 metres wide. It is sheared and in contact with serpentinite, gabbroic and metavolcanic rocks along splays of the Cadwallader fault. A similar but smaller intrusion, 600 metres long and 50 metres wide, is exposed in the main workings of the Arizona mine. This body is elongated north-south subparallel to the elongation of the gabbroic hostrocks.

On the Wayside property a number of small granitic lenses, up to 200 metres in length, occur in gabbroic rocks. Two of these bodies are centred 200 metres north of the Paxton adit and another two 850 metres to the north. Also, a small ganitic body outcrops adjacent the 3T adit, 300 metres south of the Paxton adit and another in a highway cut 500 metres northwest of the town of Gold Bridge. In the highway cut, aplitic stringers and irregular masses of granite pervade brecciated gabbro, suggesting forceful intrusion (Photo 2.22).

The granite is light coloured, fine to medium grained and distinguished by quartz content that ranges up to 50%. The mineralogy fits Streckeisen's quartz diorite or tonalite classification. In thin section the rocks are composed of interlocking quartz and sodic feldspar grains, 2 to 5 millimetres in diameter, with interstitial ferromagnesian minerals. The quartz is usually subhederal, equant and crisscrossed by tiny bubble trains. The plagioclase is relatively unzoned, twinned and variably altered to fine micas, clay minerals and carbonates. Potassium feldspar is not usually present except as an accessory and, in a few samples, as micrographic intergrowths with quartz. The ferromagnesian minerals are mostly biotite altered to chlorite and magnetite.

Chemical analyses of these rocks are given in Table 2.13. Characteristically the granites have high Na_2O and low K_2O. They also have rather low abundances of incompatible trace elements including HFSE and LILE. The high SiO_2 and Na_2O contents of felsic rocks of the ophiolitic bodies have been attributed to metasomatism or seawater alteration (Gilluly, 1933; Brown *et al.*, 1979; Vallier and Batiza, 1978). However, the petrography of the rocks, low contents of K_2O and the shape of the REE patterns show that the chemical composition is similar to keratophyres, dacites and low-K_2O island arc plutonic rocks (Tomblin, 1979; Gerlach *et al.*, 1981) indicating that these features are magmatic characteristics.

The MORB-normalized incompatible trace element patterns of the sodic granites are characterized by an enrichment of LILE including Rb, Ba and Th relative to REE and HFSE and a depletion of Nb (Fig. 2.17). These patterns are typical of arc rocks. The distinct positive Sr and small Eu anomalies suggest that accumulation of plagioclase played a role in their genesis.

The REE patterns of the sodic granites (Fig. 2.15A) differ from those of the associated gabbros and from felsic dif-

Photo 2.22. Apophysis of soda granite with xenoliths of country rock.

TABLE 2.13
ANALYSES OF SODA GRANITES

No.	1	2	3	4	5	6
Oxides recalculated to 100:						
SiO_2	63.13	75.05	75.19	72.03	68.06	75.17
TiO_2	0.14	0.26	0.14	0.31	0.20	0.19
Al_2O_3	16.74	12.94	13.14	12.61	14.69	13.59
Fe_2O_3	1.09	0.77	0.62	0.67	4.88	2.46
FeO	2.81	2.20	2.00	2.06	-	-
MnO	0.06	0.06	-	-	0.09	0.08
MgO	1.78	7.05	1.30	0.11	1.66	0.45
CaO	9.98	2.92	1.14	1.61	4.12	2.03
Na_2O	3.23	4.46	5.38	5.14	8.18	5.33
K_2O	1.04	0.29	0.37	0.46	0.12	0.70
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00
Oxides as determined						
LOI	4.35	1.50	-	-	2.30	2.47
H_2O	0.18	0.10	1.21	0.31	-	-
CO_2	3.19	0.07	1.32	0.47	0.00	-
P_2O_5	0.06	0.03	0.07	0.28	0.11	0.05
S	0.69	0.04	0.61	0.26	0.42	0.08
Minor elements (ppm)						
Ba	63	56	-	-	120	102
Cr	10	10	-	-	26	10
Nb	-	0	-	-	0	2
Ni	7	10	-	-	4	3
Rb	-	0	-	-	3	14
Sr	327	124	-	-	235	80
Molecular Norms						
Qz	17.90	36.50	34.90	38.00	16.90	32.20
Or	6.30	1.70	2.20	2.80	0.70	4.20
Ab	29.20	40.50	48.40	46.60	55.00	48.00
An	28.30	14.60	5.70	8.10	11.90	10.10
Wo	8.60	0.00	0.00	0.00	3.30	0.00
En	4.90	2.80	3.60	0.30	4.50	1.20
Fs	3.40	2.50	2.50	2.30	7.20	3.60
Il	0.20	0.40	0.20	0.40	0.30	0.30
Mt	1.10	0.80	0.60	0.70	0.00	0.00
He	0.00	0.00	0.00	0.00	0.00	0.00
C	0.00	0.00	2.00	0.80	0.00	0.40

Key:

No.	LOCATION	EASTING/	NORTHING	REFERENCE
1	PIONEER EXTEN.	517700	5621900	THIS STUDY, Lab# 32570
2	WAYSIDE MINE	511100	5633400	THIS STUDY, Lab# 32567
3	EMPIRE MINE			CAIRNES, 1937, p.26
4	PIONEER MINE			CAIRNES, 1967, p.26
5	BRALORNE MINE			LEITCH, 1990, p.57
6	BRALORNE MINE			LEITCH, 1990, p.57

ferentiates such as plagiogranites, commonly found in ophilites. Plagiogranites typically have REE patterns similar to those of underlying cumulates but significantly higher abundances of REE and other incompatible trace elements such as Zr, P, Nb and Y and a prominent Eu anomaly (Coleman and Donato, 1979; Pallister and Knight, 1981, Gerlach *et al.*, 1981).

Compared with the REE signatures of the Bralorne gabbros, the sodic granites are slightly enriched in LREE with $(La/Yb)_n \sim 2 - 3.5$ and $(La/Sm)_n \sim 1.3 - 1.5$. The contrast in REE patterns, LREE-enriched compared to the LREE-depleted patterns of the gabbros, suggests that the granites are

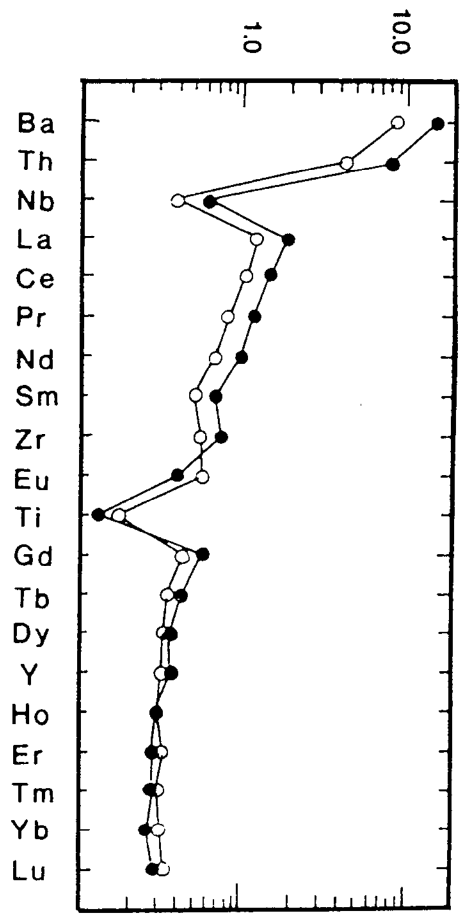


Figure 2.17. MORB-normalized incompatible trace element abundances of soda granite. Normalizing values after Sun and McDonough (1989).

not related to the gabbro sequence by crystal fractionation processes. The relatively low abundances of incompatible trace elements in the granites, their enrichment in Sr and Eu, and the lack of compositionally-intermediate rock-types are inconsistent with continuous fractional crystallization during magma evolution.

The occurrence of the IAT rocks is consistent with a primitive island arc or back-arc setting in early Permian time. Such an environment is compatible with the presence of the sodic granites, which are difficult to explain in a mid-ocean ridge setting (Gerlach *et al.*, 1981).

COAST PLUTONIC COMPLEX

The Coast Plutonic Complex, Unit Ca comprises the contiguous granitic terrain that marks the southwest edge of the Bridge River mining camp. The complex also includes the outlying and somewhat younger, Bendor and Eldorado plutons, Unit Cb and many smaller, related plugs and dikes scattered throughout the region. According to Armstrong (1988) the main magmatic events occurred from 110 to 95 Ma at a time of convergence between the North American and the Pacific Plates. Diminished plutonism continued along the east flank of the complex until about 60 Ma.

The composition of these rocks ranges from diorite to granodiorite, monzodiorite, granite and aplite - biotite hornblende granodiorite being the most common rock type. The rocks are generally well exposed, fresh, light to medium grey and medium grained. Gently inclined sheeting fractures combined with sets of widely spaced vertical joints, give a blocky aspect to large outcrops in alpine areas. The rocks are usually massive and unfoliated. Contacts are generally sharp but irregular locally because of numerous apophyses. Metamorphism of the intruded formation extends laterally to a kilometre or more from the contact of the batholith. Pyritiferous skarns, amphibolitic hornfels and a variety of biotite, garnet and andalusite schists are found in the contact zones.

In thin section the rocks are equigranular or, more commonly, porphyritic. A typical sample contains rectangular plates of zoned plagioclase ranging to 6 millimetres in length, that are set in an interlocking groundmass of smaller plagioclase crystals (40 to 55%), quartz (7 to 20%), amphibole (5 to 15%), biotite (5 to 10%) and accessory potassium feldspar, magnetite, sphene and apatite. Quartz also occurs interstitially and forms inclusions in other minerals. Potassium feldspar, usually microperthite, is interstitial to quartz and plagioclase and, less commonly, forms large poikilitic crystals. Amphibole is generally more abundant than biotite and forms ragged fringes on pyroxene, occurs as solitary crystals with numerous inclusions or in concentrations of small crystals associated with magnetite and biotite.

Chemical analyses of these granitic rocks are given in Table 2.14. Comparing analyses of the Bendor stock (Nos.1 to 7) and the main body of the Coast Plutonic Complex (Nos.8 to 14), silica ranges to lower values in the Bendor suite (57%) and to higher values (more than 77%) in the Coast intrusions - otherwise, major and minor element variations are similar. A plot of Na_2O plus K_2O and CaO against SiO_2, Peacock's alkali-lime index, shows good continuity over the full range of SiO_2 for all samples, including satellitic stocks, and indicates a 'calcic' composition for the complete suite (Figure 2.18). The satellitic Eldorado stock (Table 2.14, No.16) is similar to the Bendor sample (No.2) and the Gwyneth intrusion (No.15), and the Coast sample (No.8).

The multicationic R1-R2 plot is also a useful indicator of major element characteristics (Figure 2.19). On this diagram the granitic rocks form a typical Group 2 'series trend' that, according to the interpretation of Batchelor and Bowden (1985), may be the result of plate-margin consumption early in the orogenic cycle.

Xenoliths form a small part of the granitic intrusions. These are generally rounded or elliptical, dark grey bodies commonly ranging from a few centimetres to less than a metre in diameter. Compared to the hostrocks, xenoliths are more variable in composition and almost always rich in ferromagnesian minerals, especially magnetite, amphibole and biotite. The chemical compositions of three xenoliths from the Bendor intrusion (Table 2.15) show relatively high values for potash, iron oxide, magnesia and lime. Among the minor elements chromium and nickel are anomalously high. The xenolith compositions do not compare with the host granitic rocks and, therefore, are considered to be fragments of stoped wallrock.

The age of the granitic intrusions determined by radiometric methods is given in Tables 2.2 and 2.8. The youngest date is 63.4±2.2 Ma by K-Ar methods on biotite from a sample of granite from the south side of the Bendor intrusion in the Hawthorne Creek area (Table 2.2, No.8). This is similar to a K-Ar date of 64.3 Ma on biotite from schist near the Gray Rock mine in the thermal aureole north of the Bendor intrusion (Table 2.2, No.9) and 63.7 Ma on biotite from the Eldorado granitic stock (K. Dawson, Geological Survey of Canada, personal communication, 1987). An uncorrected K-Ar date of 62.5 Ma was obtained by Pearson (1977) on mica from 'trondhjemite' at the Arizona mine. These relatively young dates are believed to reflect the last pulse of Coast plutonism (Armstrong, 1988).

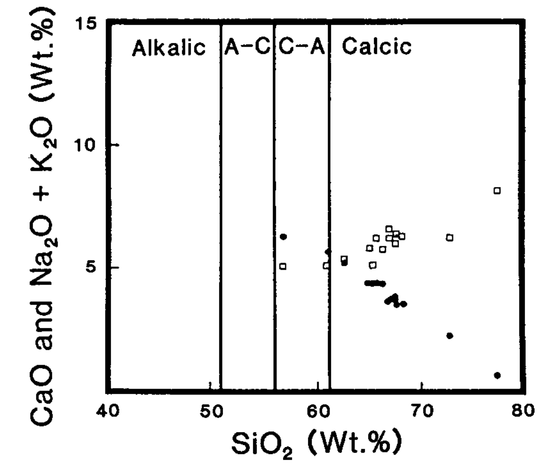


Figure 2.18. Peacock alkali/lime index classification of granitic rocks, Coast Plutonic Complex.

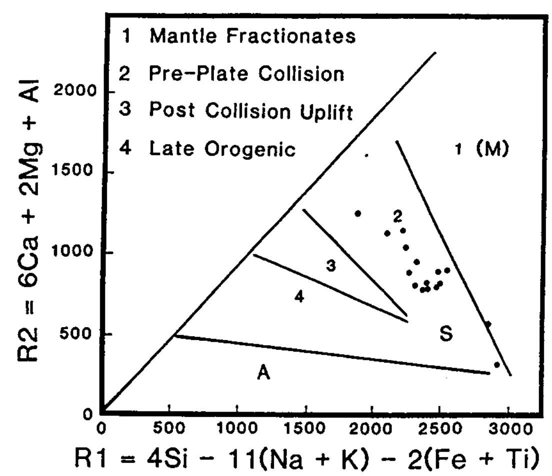


Figure 2.19. Batchelor-Bowden R1-R2 multicationic diagram for granitic rocks, Coast Plutonic Complex; fields after Batchelor and Bowden (1985); R1 = 4Si - 11(Na + K) - 2(Fe + Ti); R2 = 6Ca + 2Mg + A1. 1 = mantle fractionates; 2 = destructive plate margin (pre-plate collision); 3 = post-plate collision ("permitted" plutons); 4 = late orogenic (sub-alkaline); 5=- anorogenic (alkaline-peralkaline); 6 = syn-orogenic (anatectic); 7 = post-orogenic.

TABLE 2.14
ANALYSES OF LATE CRETACEOUS GRANITIC ROCKS

	BENDOR INTRUSION							COAST INTRUSIONS							OTHER STOCKS	
		EAST				WEST										
No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Oxides recalculated to 100:																
SiO_2	56.98	65.70	67.01	67.65	67.09	67.64	68.26	61.14	61.17	65.30	66.28	67.43	72.90	77.50	62.71	64.98
TiO_2	0.93	0.60	0.54	0.61	0.65	0.57	0.67	0.68	0.75	0.61	0.54	0.48	0.21	0.07	0.58	0.73
Al_2O_3	18.77	16.26	16.06	16.59	16.11	16.17	15.65	17.28	16.73	16.76	15.89	15.58	15.46	12.81	18.32	16.37
Fe_2O_3	2.11	2.02	1.03	1.07	1.00	0.00	1.24	1.65	1.07	1.38	1.31	1.22	0.62	0.22	2.25	0.14
FeO	5.44	2.50	2.94	2.59	2.95	3.77	2.00	4.61	4.79	4.03	3.21	2.95	1.20	0.42	2.86	3.89
MnO	0.15	0.08	0.06	0.04	0.06	0.05	0.06	0.12	0.10	0.10	0.07	0.08	0.40	0.00	0.09	0.07
MgO	4.08	2.11	1.97	1.45	2.00	1.67	2.05	3.25	3.81	2.24	2.43	2.34	0.51	0.07	2.45	3.38
CaO	6.41	4.40	3.73	3.66	3.79	3.59	3.64	6.05	5.77	4.38	4.36	3.75	2.33	0.67	5.29	4.46
Na_2O	4.05	4.08	3.94	4.17	3.82	4.06	3.82	3.68	3.70	3.48	3.43	3.56	3.87	2.55	4.24	3.92
K_2O	1.08	2.25	2.72	2.17	2.53	2.48	2.61	1.54	2.11	1.72	2.48	2.61	2.50	5.69	1.21	2.06
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Oxides as determined																
LOI	1.45	0.32	1.01	0.42	1.10	0.50	0.53	0.54	0.66	1.27	0.65	0.80	0.65	0.37	0.86	1.14
H_2O	0.00	0.00	0.00	0.00	0.15	0.00	0.10	0.00	0.09	0.00	0.08	0.00	0.00	0.07	0.08	—
CO_2	0.10	0.10	0.50	0.10	0.69	0.10	0.07	0.10	0.14	0.10	0.14	0.29	0.10	0.28	0.14	0.17
P_2O_5	0.24	0.14	0.12	0.14	0.13	0.11	0.14	0.15	0.13	0.13	0.10	0.09	0.03	0.00	0.18	0.69
S	0.02	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Minor element determinations																
Ba	391	658	612	706	713	797	720	671	704	709	852	794	698	257	692	614
Cr	40	29	28	14	42	29	45	43	78	28	32	46	9	10	16	104
Ni	23	10	13	6	22	10	45	19	38	10	20	18	6	6	15	48
Sn	5	5	5	3	—	5	—	5	—	5	—	1	5	—	—	—
Sr	773	564	477	579	431	453	414	552	512	415	417	333	303	131	762	495
W	149	174	175	344	—	350	—	228	—	264	—	287	341	—	—	—
Y	20	20	15	11	—	17	—	21	—	20	—	19	13	—	—	—
ZR	67	135	131	121	—	149	—	96	—	139	—	134	75	—	—	—
Molecular Norms																
Qz	6.30	18.70	19.70	22.10	20.70	20.10	21.10	13.10	10.90	21.80	20.60	22.00	32.30	36.80	16.00	16.00
Or	6.40	13.40	16.10	12.90	15.10	14.70	15.50	9.20	12.50	10.30	14.90	15.60	14.90	34.20	7.20	12.20
Ab	36.40	36.90	35.40	37.60	34.40	36.50	34.60	33.30	33.30	31.50	31.10	32.00	35.10	23.30	38.00	35.10
An	29.70	19.50	18.10	18.20	18.90	17.90	17.90	26.10	22.80	21.90	20.70	18.70	11.70	3.40	26.20	20.90
Wo	0.80	1.00	0.20	0.00	0.00	0.00	0.10	1.60	2.30	0.00	0.40	0.00	0.00	0.00	0.00	0.50
En	11.20	5.90	5.50	4.00	5.70	4.60	5.70	9.00	10.50	6.30	6.80	6.50	1.40	0.20	6.80	9.30
Fs	5.70	2.40	3.10	2.40	3.00	5.10	2.80	5.00	5.60	4.50	3.30	3.10	1.20	0.40	2.10	4.90
Fo	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Il	1.30	0.10	0.80	0.90	0.90	0.80	1.00	1.00	1.00	0.90	0.80	0.70	0.30	0.10	0.80	1.00
Mt	2.20	2.10	1.10	1.10	1.10	0.00	1.30	1.70	1.10	1.50	1.40	1.30	0.70	0.20	2.40	0.10
He	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C	0.00	0.00	0.00	0.80	0.20	0.30	0.00	0.00	0.00	1.30	0.00	0.10	2.40	1.40	0.50	0.00

Key:

No.	LAB.#	STN.#	ROCK TYPE	EASTING	NORTHING	LOCATION
1	035547	BBC417	DIORITE	526500	5617700	ROYAL PK.
2	035538	BBC222	GRANODIORITE	526100	5626200	BOBB
3	035540	BBC308	GRANODIORITE	522200	5621700	HAWTHORN
4	035546	GBJ 82	GRANODIORITE	532800	5624500	KEARNS L.
5	032589	BRM 302	GRANODIORITE	519652	5630000	MT. TRUAX
6	035548	BBC420	GRANODIORITE	515600	5629200	FERG. CREEK
7	032588	BRC252	GRANODIORITE	515617	5628445	FERG. RIDGE
8	035544	GBJ 79	DIORITE	508300	5616200	NOEL RIDGE
9	032580	BRM 161	DIORITE	504283	5624574	GREEN MTN.
10	O35545	GBJ 33	GRANODIORITE	506800	5617600	NOEL W. RIDGE
11	032587	BRC 219	GRANODIORITE	503538	5638159	JEWEL MINE
12	035551	BRC 529	GRANODIORITE	508876	5648729	NOEL E. FORK
13	035542	GBJ 31	GRANITE	507500	5617300	NOEL W. RIDGE
14	032590	BRM 341	GRANITE	500918	5639101	DICKSON PK.
15	032575	BRC 78	DIORITE	509916	5625768	GYWNETH LAKE
16	032593	BRC 561	GRANODIORITE	509811	5649937	ELDORADO

TABLE 2.15
XENOLITH ANALYSES

No.	1	2	3
Oxides recalculated to 100:			
SiO_2	57.42	57.45	66.01
TiO_2	0.84	0.86	0.76
Al_2O_3	14.94	14.74	12.58
Fe_2O_3	2.49	2.35	1.39
FeO	5.29	5.83	4.01
MnO	0.16	0.17	0.15
MgO	5.76	5.35	4.86
CaO	6.92	6.72	5.02
Na_2O	3.54	3.52	2.88
K_2O	2.64	3.01	2.34
TOTAL	100.00	100.00	100.00
Oxides as determined			
LOI	0.66	0.89	0.48
CO_2	0.10	0.71	0.10
P_2O_5	0.13	0.17	0.07
S	0.01	0.04	0.01
Minor elements (ppm)			
Ba	658	711	672
Cr	309	257	149
Ni	71	64	66
Sn	5	24	4
Sr	374	378	313
W	241	224	187
Y	21	36	-
Zr	113	132	165
Molecular Norms			
Qz	3.80	3.30	20.80
Or	15.60	17.80	14.00
Ab	31.70	31.50	26.00
An	17.00	15.50	14.60
Wo	6.90	7.20	4.20
En	15.90	14.80	13.60
Fs	5.30	6.20	4.20
Fo	0.00	0.00	0.00
Fa	0.00	0.00	0.00
Il	1.20	1.20	1.10
Mt	2.60	2.50	1.50
He	0.00	0.00	0.00
Cor	0.00	0.00	0.00

Key:

No.	LAB.#	EASTING	NORTHING
1	035552	516000	5629000
2	035549	515800	5629000
3	035539	525800	5626300

Zircon dating of the Bendor intrusion west lobe by U-Pb methods gives an older Cretaceous age range of 69.6 to 114 Ma with a significantly older average age of 73.5 Ma (Table 2.8). This is similar to the 73±2.6 Ma date by K-Ar methods on mica from an apophysis of a small granitic stock 14 kilometres to the south (Table 2.2, No.12).

The oldest samples that can be ascribed to the Coast Plutonic Complex by the Armstrong model are granitic boulders from conglomerate beds exposed on the Gray Rock road near Truax Creek dated at 119±4 Ma by K-Ar methods (Table 2.2, No.18). This is the first evidence of uplift and unroofing of the Coast Plutonic Complex intrusions (Church and Pettipas, 1989). Other dates thought to represent main Coast plutonic events are a 95 Ma zircon date obtained on granitic rocks from the summit of Mount Penrose (R.M. Friedman, personal communication, 1989) and a 85.9±3 Ma K-Ar date on biotite from the Gwyneth Lake granitic stock west of the Bralorne mine (Table 2.2, No.16). This latter date is similar to that on altered rocks associated with the Bralorne vein system (Table 2.2, No.15).

REXMOUNT PORPHYRY

The Rexmount porphyry (Unit D), named by Drysdale (1916) consists of two small stocks exposed on Rex Peak and in the Hog Creek area northeast of Carpenter Lake. These are thought to be a slightly younger phase of the coarser grained Mission Ridge pluton (47.5 Ma) exposed to the southeast (Schiarizza *et al.*, 1990) and the intrusive equivalent of felsic volcanics (Unit 7b) outcropping to the south. The rock is conspicuously light coloured and consists of tabular phenocrysts of plagiocase (20%) intermixed with rounded quartz grains (5%) and a few chloritized biotite flakes in a fine-grained quartzofeldspathic groundmass (Photo 2.23). Chemical analysis of the rock shows high silica composition (71%) and low calcium and ferromagnesians suggesting a rhyolite composition.

MINOR INTRUSIONS

Numerous Mesozoic and Tertiary dikes and sills occur throughout the map area. Dike swarms of basic to intermediate composition, conspicuous in the Fergusson chert assemblage, are thought to be feeders to the Triassic volcanic rocks. They are commonly fine grained, massive and less deformed than the adjacent hostrocks. The Cretaceous and Tertiary dikes and sills are generally fresh and undeformed, although the mostly carbonate, alteration is pronounced in some mineralized zones. The main effusives are light brown feldspar porphyries and fine-grained equivalents, grey and brown hornblende porphyries of andesitic composition and, less commonly, fresh basalt dikes. Some of these rocks form small plugs and volcanic necks. A whole-rock K-Ar determination (Pearson, 1977) on a microdiorite dike adjacent the main ore zone at the Minto mine yielded a Late Cretaceous uncorrected date of 67.7 Ma , within the age range of the Bendor pluton. The composition of a selection of dikes and small intrusions from across the map area (Table 2.16, Nos.1 to 8) is generally similar to the Coast Plutonic Complex.

The Blue Creek porphyries described by Leech (1953) are the best known of these intrusions (Table 2.16, No.7). Two small stocks are well exposed on the Elizabeth-Yalakom property near the centre of the Shulaps Complex. The typical porphyry is medium grey and contains plagioclase and hornblende phenocrysts to 5 millimetres in length

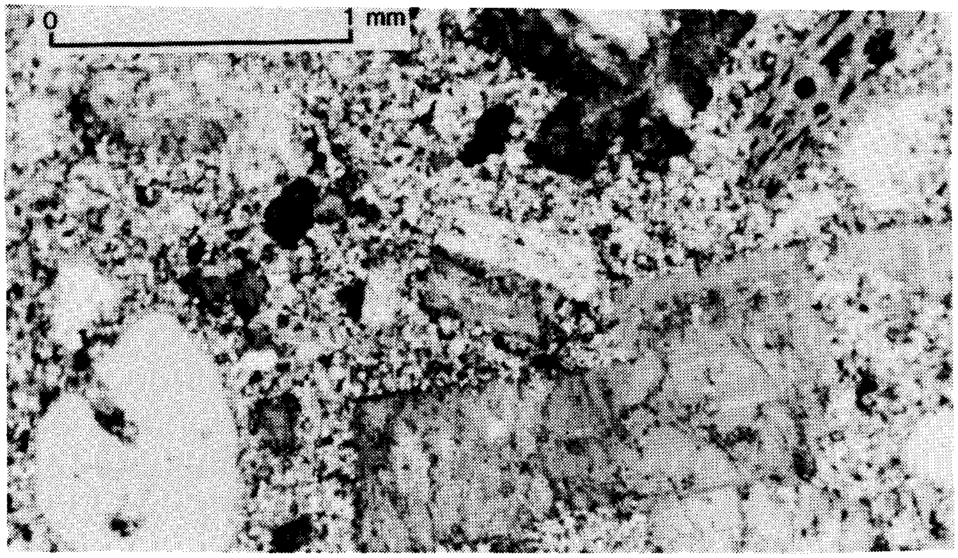


Photo 2.23. Photomicrograph of Rexmount porphyry.

TABLE 2.16
ANALYSES OF FELSIC DIKES AND SMALL STOCKS

No.	1	2	3	4	5	6	7	8	9
Oxides recalculated to 100:									
SiO_2	63.36	62.18	62.90	64.52	63.47	57.71	65.01	65.24	71.06
TiO_2	0.53	0.70	0.70	0.62	0.69	0.87	0.65	0.85	0.22
Al_2O_3	17.11	18.20	17.30	17.65	16.42	15.74	17.16	17.28	16.57
Fe_2O_3	2.88	0.65	2.09	2.96	3.08	1.61	2.19	1.69	0.88
FeO	1.34	5.17	3.22	1.82	2.06	5.48	2.84	5.53	1.00
MnO	0.12	0.06	0.08	0.07	0.07	0.15	0.05	0.10	0.03
MgO	3.22	2.46	3.87	1.85	3.29	6.51	1.80	2.81	0.77
CaO	5.92	5.22	4.50	4.92	3.70	7.67	3.84	1.91	2.37
Na_2O	3.92	4.02	3.84	4.25	4.17	3.04	5.23	2.47	4.83
K_2O	1.59	1.33	1.50	1.33	3.05	1.22	1.24	2.13	2.27
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Oxides as determined									
LOI	2.54	3.98	5.54	4.76	4.68	3.04	1.98	2.80	1.57
CO_2	1.19	1.93	2.50	2.57	1.61	1.81	0.41	1.36	0.09
P_2O_5	0.18	0.20	0.15	0.13	0.21	0.14	0.17	0.11	0.06
S	0.02	1.60	0.01	0.02	0.02	0.41	0.16	0.08	0.01
Minor elements (ppm)									
Ba	682	2105	350	662	-	-	570	627	1265
Cr	90	23	89	27	-	-	18	106	6
Nb	-	-	-	-	-	-	-	9.3	9.2
Ni	63	22	39	20	-	-	21	36	3
Sr	1447	695	521	541	-	-	751	258	721
V	-	-	-	-	-	-	110	166	34
Y	-	-	-	-	-	-	-	25	11
Zr	-	-	-	-	-	-	183	129	78

Key:

No.	LAB.#	EASTING	NORTHING	DESCRIPTION
1	32571	503500	5648300	HB-FELDSP PORPH. DIKE, South of Windy Pass
2	32584	518000	5638800	MICRODIORITE DIKE, Minto Mine area
3	32579	515000	5638000	FELDSP PORPH. DIKE, Congress Mine area
4	32582	516000	5638000	FELDSP PORPH. DIKE, LeJoie road area
5	35536	531900	5645200	FELSIC DIKE, West of Shulaps Peak
6	35622	523600	5632700	BIO-HB PORPH. DIKE, East of Truax Creek
7	34129	531200	5654000	BIO-FELDSP PORPH., Blue Creek porphyry
8	38712	517900	5614800	MUSC-QTZ PORPH., East fork Noel Creek
9	35596	542000	5637700	REXMOUNT PORPHYRY

in a finer grained groundmass of quartz, plagioclase, hornblende and biotite. Accessory minerals are magnetite, apatite and sphene. Pyrite is common in altered samples accompanied by sericite, clay and carbonates, replacing feldspar, and actinolite, chlorite and magnetite pseudomorphic after hornblende. Whole-rock K-Ar analysis of this rock gives a date of 58.4±2 Ma (Table 2.2, No.5) which is judged to be the age of alteration. A somewhat older date of 70.5±6.5 Ma, based on Ar^{39}/Ar^{40} analysis of hornblende from the same porphyry (Archibald *et al.*, 1989) is within the age range of the Coast Plutonic Complex. However, Archibald's dates are questionable in the light of recent studies on the utility of hornblende and biotite, Ar^{39}/Ar^{40} dating (Lee *et al.*, 1991).

CHAPTER 3
STRUCTURAL GEOLOGY

"We must not say, Let us begin by inventing principles whereby we may be able to explain everything; rather must we say, Let us make an exact analysis of the matter, and then we shall try to see, with much diffidence, if it fits any principle."

—— Voltaire (1694-1778)

The geology of the Bridge River mining camp records repeated cycles of deformation which resulted in intricate faulting and folding of the oldest units of the Bridge River Complex. The Cadwallader beds, recording only part of this history, are less deformed, although numerous slices and wedges of these rocks are scattered throughout the map area.

Such mixing of rocks from diverse terranes likely occurred during plate collision. This was achieved by reverse faulting, imbrication and stacking of various oceanic and ocean-margin lithologies with lenses of underlying gabbroic and ultramafic rocks.

A relatively young 'slice fabric' dominates the region. This consists of panels of diverse rocks, including ramped blocks of older rocks, bounded by major northwest and north-trending faults subparallel to the Cadwallader and Yalakom fault systems. The northwest trend is the principal shear direction in a regional stress regime that is linked locally with the tension faults of an extensional strike-slip duplex system; north-trending tension faults separate downward rotated blocks. These are the boundaries of the principal structural domains that have retained their integrity through the emplacement of the Late Cretaceous and Tertiary granitic plutons.

STRUCTURAL SETTING AND HISTORY

The Bridge River mining camp is on the boundary between the Stikine and Cache Creek terranes in the western part of the Intermontane Belt of southwestern British Columbia (Figure 3.1). The structural setting and history of the area has been reviewed by Price *et al.* (1985), Potter (1986), Schiarizza *et al.* (1989), Garver (1991), Rusmore and Woodsworth (1991) and Journeay (1993).

The Intermontane tectonic belt comprises at least four allochthonous oceanic and off-shore island-arc terranes that evolved separately in middle and late Paleozoic and early Mesozoic time and were subsequently accreted to the North American craton. These are Stikinia and the Cache Creek Terrane on the west, Quesnellia and the Slide Mountain Terrane on the east. Although knowledge of the temporal and spacial conditions of accretion is incomplete, it is known that the eastern terranes onlap the continental rocks and that this onlapping (docking) was mostly complete by the middle Mesozoic (Price *et al.*, 1985, Nelson and Mihalynuk, 1993).

In the map area, the Bridge River Complex comprises multiple slabs of oceanic and transitional crust possibly Cache Creek equivalent, partly delaminated from the mantle and lithospheric base and stacked against the continental margin together with units of the Cadwallader Group which is believed to be part of the Stikine Terrane. The middle Jurassic has been proposed by Potter (1986) and Rusmore *et al.* (1988) as the most probable time of accretion of these western terranes (Figure 3.2). However, Schiarizza *et al.* (1989) and Journeay (1993) argue that there are few structures that can be unequivocally assigned to this age or earlier deformation. Nevertheless, it is agreed that by mid-Early Cretaceous no major accretionary sutures remained active between the terranes east of the Coast Plutonic Complex (Armstrong, 1988). The fragmentary evidence of earlier events includes Triassic blueschist metamorphism attributed to the development of a thick accretionary prism (Garver, 1992), and the occurrence of detrital chromite in earliest middle Jurassic beds (Leech, 1953) that gives the first indication of uplift and/or imbrication and unroofing of ultramafic crustal units.

Extensive brecciation of the Bridge River chert beds throughout the area probably occurred during imbrication and stacking at the time of plate collision. A preliminary Ar^{39}/Ar^{40} plateau date of 160 Ma (P. Reynolds, personal communication, 1992) on fuchsite from sheared rocks at the Bralorne mine may be close to the docking event. The general lack of stratigraphic markers together with the absence

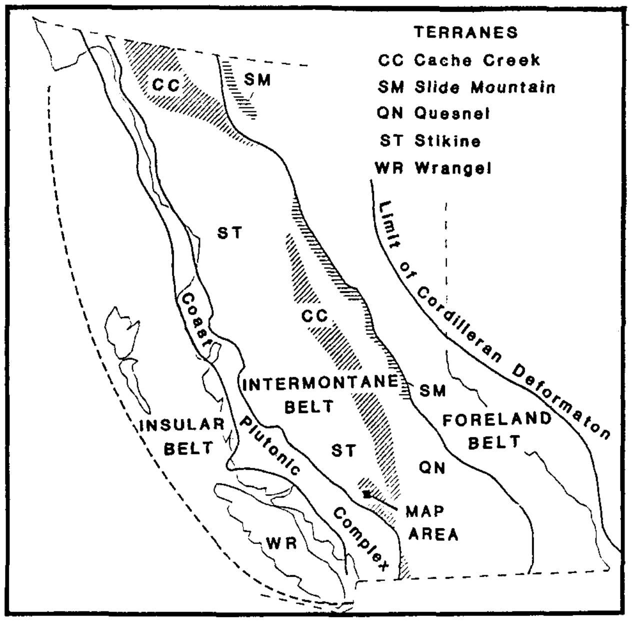


Figure 3.1. Major tectonic belts and terranes in the Canadian Cordillera.

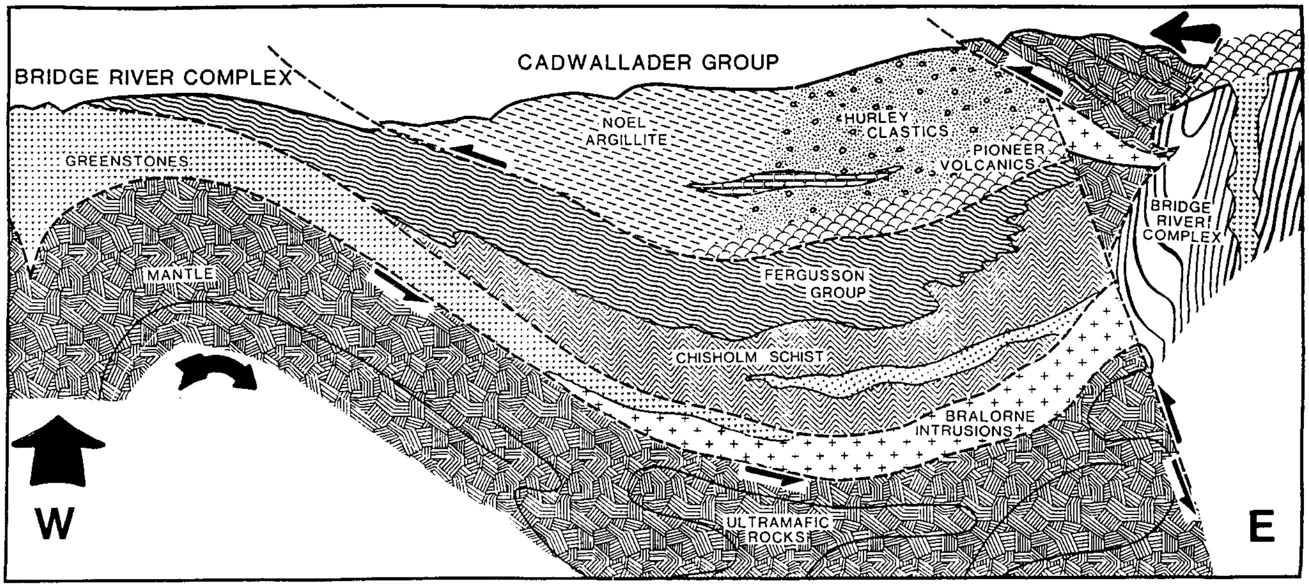


Figure 3.2. Lithofacies variations: Hypothetical cross-section of accreting Bridge River and Cadwallader sequences.

of any apparent consistency in the direction of fold axes across the area (Figure 3.3), makes it difficult to evaluate the extent of imbrication and other structures (Potter, 1983; Church, 1987a).

Post-accretion structures are better understood. The Tyaughton trough is a major subsidence structure that developed from Late Jurassic through middle Cretaceous time near the present boundary between the Coast and Intermontane belts. The trough extended southeast beyond the International Boundary and was limited by intermittently uplifted lands to the northeast and southwest. It began as an open westward-facing marine sedimentary basin and developed to a narrow, enclosed epicontinental seaway into which the Oxfordian-Neocomian Relay Mountain Group was deposited (Jeletzky and Tipper, 1968; Kleinspehn, 1984). Journeay (1993) argues that this seaway is the last remnant of the 'Bridge River ocean' although more fossil evidence and radiometric dating are needed to substantiate this theory. That the trough broadly overlapped the older accreted terranes is proven by the occurrence of *Buchia*-bearing Relay Mountain rocks in the central part of the Bridge River Terrane, 30 kilometres south of the type area of the group (Church and MacLean, 1987b).

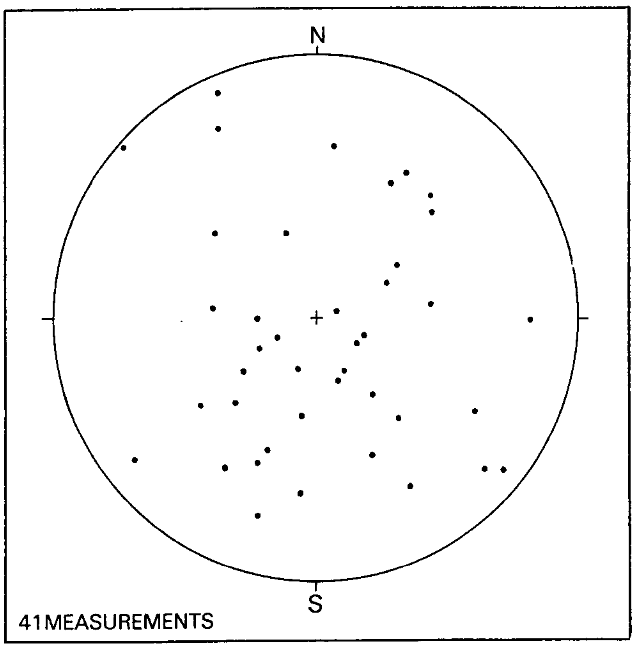


Figure 3.3. Stereographic plot of fold axes for Fergusson chert beds in the Gold Bridge area.

The uplift and erosion of mountains along the west margin of the Tyaughton trough led to unroofing of metamorphic and granitic rocks of the Coast Plutonic Complex during the Early Cretaceous (Neocomian). Continued uplift until mid-Cretaceous time resulted in the dispersion of clasts from the Coast Mountains to form conglomerate beds of the Taylor Creek Group infilling a taphrobasin, a remnant of the Tyaughton trough. The culminating intrusions of the Coast Plutonic Complex occurred in middle Cretaceous time, from 110 to 90 Ma (Armstrong, 1988). After this period the Locus of magmatic activity moved eastward and plutonism continued intermittently until about 45 Ma (Leitch *et al.* 1989).

Late Cretaceous and Tertiary structures are superimposed on older features. The tectonic activity included major uplift, thrusting and transcurrent faulting interspersed with the magmatic events (Schiarizza *et al.*, 1989). The regional fabric is dominated by transpressional deformation, a system of northwest to north-trending faults that combine strike-slip motion and compression. Major dextral strike-slip movement on the Yalakom and Marshall Creek fault systems is at least partly of Tertiary age, and younger than the southwesterly verging thrust emplacement of the Shulaps and President Ultramafic Complexes. The Yalakom fault cuts the Tyaughton trough on the northwest and it is in turn cut by the Late Eocene-Oligocene Fraser River strike-slip fault system on the east. More than 100 kilometres of lateral displacement is estimated on each of these faults (Kleinspehn, 1984).

Block faulting and further magmatism followed initial transcurrent movements, resulting in advantageous emplacement of the Mission Ridge pluton at 47.5 Ma (Coleman and Parrish, 1991) into the existing fracture system and downward rotation of Cretaceous and Early Tertiary beds along the Marshall Creek - Relay Creek fault system. Later step-wise block faulting of a mid-Tertiary erosion surface appears to have caused significant uplift of the Plateau lavas (Chilcotin Group) in the Coast Range relative to similar lavas in the Interior Plateau (Mathews, 1990).

LITHOPROBE RESULTS

Results of the 1988 Lithoprobe Survey were presented by Cook *et al.* (1990; 1991) and Varsek *et al.* (1993). Seismic transect lines 13, 17 and 18 crossed the eastern part of the Coast Mountains. Line 17 traversed the Bridge River camp from Truax Creek along the south shore of Carpenter Lake, through Gold Bridge and along the Hurley Road. The limitations of this survey are several. Mainly because of the deep retrieval design of the survey, shallow structures to a depth of about 4 kilometres were not recorded, thereby precluding close correlation with surface geology. Also, vertical structures tend to be transparent to the induced seismic waves and must be interpolated from discontinuities detected in subhorizontal reflectors. Nevertheless, valuable information was obtained.

The survey area is characterized by east-dipping reflectors and subhorizontal 'ramps' in the upper and lower crust and west-dipping reflectors in the middle and upper crust that appear to cut the former. There seems little doubt that the east-dipping reflectors are similar to the imbricated thrust sheets, reverse faults and foliated shear zones occurring in the Shulaps Range and in the Cadwallader area (Potter, 1983; Wright, 1974). It is assumed that the west-dipping reflectors include faults, such as the west-dipping segments of the Cadwallader fault system that would certainly truncate older westerly vergent thrusts and westerly dipping bedding planes (Figures 3.4 and 1A).

THE CADWALLADER BREAK

The 'Cadwallader break' (Bacon, 1978) is the fault system on which the principal mines of the Bridge River camp are located (Cairnes, 1937). Faulted slivers in the system include Paleozoic and Mesozoic diorite, greenstone, chert and clastic sedimentary rocks. The break is intruded by a variety of Cretaceous and Tertiary dikes, a narrow belt of ultramafic rocks and felsic to basic stocks, the largest of which are the Bralorne gabbro/diorite and younger granitic rocks.

The break trends for more than 50 kilometres from Anderson Lake southeast of the map area, to Gun Creek weaving between major lobes of the Coast Plutonic Complex. Along relatively short segments the break is essentially straight, such as from the Pioneer mine to McGillivray pass and between the Bralorne mine and the Wayside mine. This latter segment is followed by a line of residual magnetic anomalies in the area of relatively low relief and widespread glacial cover between Downton and Carpenter lakes and the lower section of the Hurley River (Figure 3.5). At Bralorne the strike changes abruptly from south to southeast; dips are steep west and southwest. To the north the system is deflected along the valley of Gun Creek (Schiarizza *et al.*, 1990); to the south it extends beyond McGillivray Pass to the south end of Anderson Lake (Journeay *et al.*, 1992).

The history of movement on the Cadwallader break is undoubtedly varied and episodic. This is expressed by Campbell (1975): "The net displacement along the Cadwallader zone is difficult to determine because the zone trends parallel to the surrounding formations; however, Permian formations on the east side of the fault have been thrust over younger formations on the west. In addition, there are numerous indications of normal displacements within the zone. The great lateral extent of the fault, together with its relatively straight strike, its steep dip and the ubiquitous presence in it of serpentinite bodies, are characteristic of a crustal transform fault, along which internal local thrust and normal displacements commonly accompany vertical adjustments during the continuing lateral movement on the break."

The deflection in the trend of the break from northwesterly to northerly induced stresses producing or reactivating a major failure, perhaps a pre-existing thrust or reverse fault known as the Fergusson fault. The Fergusson fault splits off the main Cadwallader break just southeast of Pioneer mine and rejoins it northwest of the Bralorne mine, enclosing a lens of rock 5.5 kilometres long and 0.8 kilometre wide. This wedge-shaped area formed by the bend in the Cadwallader break at Bralorne subtended by the Fergusson fault, contains all of the productive orebodies in the Bralorne-Pioneer area. Within this domain the ore-bearing veins occupy tension fractures and shears that traverse the lens obliquely (Camp-

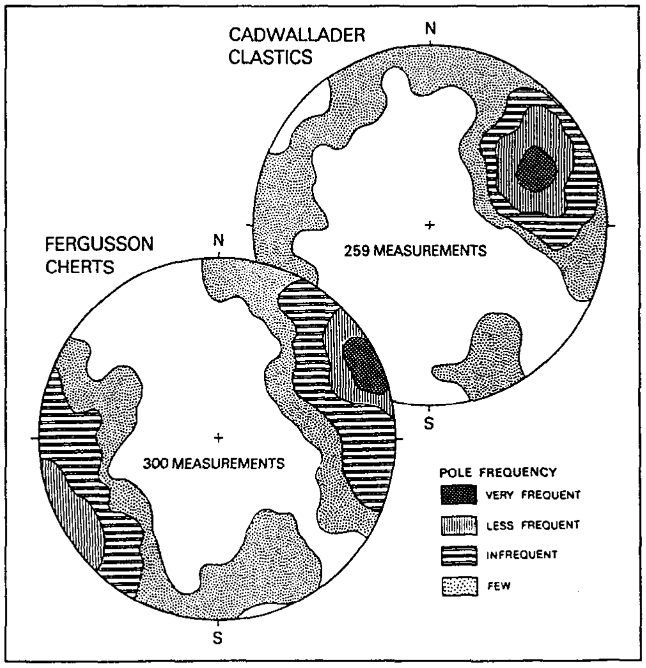


Figure 3.4. Equal area plots of bedding attitudes of Fergusson and Cadwallader rocks in the Gold Bridge area.

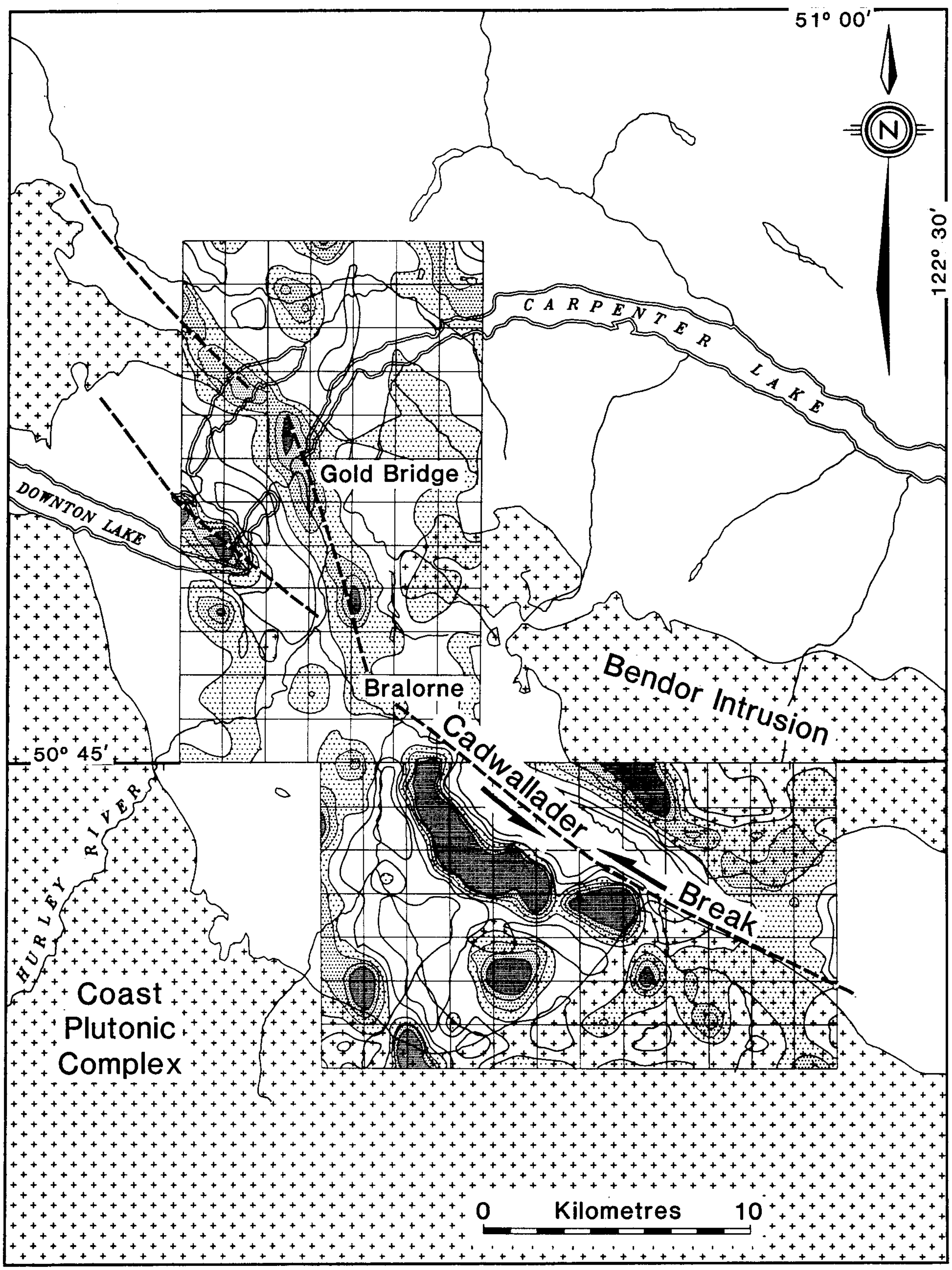


Figure 3.5. Residual magnetic effects along the Cadwallader break (from 6th order polynomial surface - based on Aeromagnetic Map 8552G, Geological Survey of Canada, 1973).

TABLE 3.1
PRINCIPAL VEIN ATTITUDES AT MINES AND PROSPECTS

OCCURRENCE	UTM CO-ORDINATES EASTING	NORTHING	VEIN ATTITUDES		
ALMA (003)	5255	56119	180°/75° E		
BENBOE (098)	5321	56281	025°/50° NW		
BIG (047) *	5238	56533	180°/90°		
BRALORNE					
BLACKBIRD (002)	5143	56241	115°/65° NE	090°/65° N	
CORONATION (007)	5148	56234	110°/65° NE		
EMPIRE (002)	5146	56241	110°/45° NE	105°/80° NE	065°/60° NW
KING (001)	5129	56259	085°/55° N	110°/45° NE	022°/60° NW
BRISTOL (071)	5328	56291	020°/80° SE		
BR JEWEL (135)	5109	56244	060°/55° SE		
BRX					
ARIZONA (024)	5115	56320	135°/50° NE	155°/30° NE	
CALIFORNIA (020)	5126	56298	133°/55° NE		
FORTY THIEVES (023)	5118	56309	130°/45° NE		
WHY NOT (021)	5124	56301	010°/35°E	125°/45° NE	
BUTTE IXL (011)	5242	56173	125°/80° SW		
COMMODORE (124)	5118	56357	160°/50° NE		
CONGRESS (029)	5155	56378	030°/50° NW	010°/85° W	
COSMOPOLITAN (164)	5153	56268	135°/85° NE		
DAN TUCKER (166)	5222	56187	110°/80° SW		
DAUNTLESS (073)	5180	56392	052°/75° NW		
ELIZABETH (012) *	5292	56534	030°/65° NW	010°/75° W	
GOLDEN LEDGE (165)	5190	56283	165°/55° SW	180°/65° W	
GOLDEN GATE (025)	5114	56324	155°/50° NE		
GRAY ROCK (066)	5213	56274	070°/50° SE		
GRULL (017)	5118	56268	025°/80° NW		
HOLLAND (008)	5172	56228	070°/60° NW	150°/80° SW	095°/70° N
HOWARD (132)	5143	56374	165°/50° SW		
JEWELL (108)	5043	56395	070°/65° SE		
LITTLE GEM (068)	5034	56383	095°/75° S		
LAST GOLD (058)	5095	56260	090°/55° N	065°/50° SE	090°/90°
LUCKY JEM (032)	5073	56485	160°/60° E	180°/15° E	160°/80° SW
LUCKY STRIKE (045)	5097	56478	170°/85° SW		
MARY MAC (067)	5220	56339	100°/45° NE	130°/80° NE	
MINTO (075)	5176	56386	180°/75° E		
NORTHERN LIGHT (105)	5089	56489	045°/80° NW		
OLYMPIC					
KELVIN (129)	5175	56374	160°/70° SW		
LECKIE (092)	5182	56375	145°/60° SW	125°/90°	
NO. 1	5196	56372	120°/45° NE		
PEERLESS (076)	5148	56414	045°/65° NW		
PILOT (027)	5078	56357	160°/80° SW	015°/40° SE	
PIONEER (004)	5156	56228	115°/75° NE	075°/52° NW	
PIONEER EX (009)	5173	56223	100°/45° NE		
RANGER (090)	5199	56314	120°/20° SW	150°/80° SW	
RED HAWK (012)	5227	56186	130°/65° SW	135°/40° NE	
RELIANCE (033)	5160	56366	060°/80° NW		
ROBSON (026) *	5082	56520	038°/35° NW	070°/90°	
ROYAL (014)	5251	56167	120°/80° SW	045°/30° SE	
SENATOR (136)	5149	56361	036°/54° NW		
SHORT O'BACON (016)	5113	56246	160°/90°		
SILVERLSIDES (042)	5322	56264	010°/65° W		
SILVERQUICK (017) *	5130	56543	020°/50° NW	020°/20° NW	145°/20° SW
SUMMIT (035)	5176	56266	080°/40° NW	110°/30° NE	130°/75° SW
TRUAX GOLD (060)	5164	56300	110°/10° N		
VERITAS (031)	5063	56318	110°/80° NE		
WAYSIDE (030)	5121	56359	160°/55° NE	130°/50° NE	090°/68° N

* Minfile No. from 920 NTS quadrangle, all others from 92J NE

bell, 1975). The veins mostly strike easterly and southeasterly and dip to the north and northeast. They appear to have formed in a rotating left-lateral shear-couple developed between the Cadwallader and Fergusson faults. Fissures that began as shears became tension fractures and vice versa, explaining brecciated and sheared vein fillings. Rotation on crosscutting faults also explains changes in vein attitude as exemplified by the Empire fault and some of the faults in the King workings (Hedley, 1935; Poole, 1955).

Movement on the fault was interrupted by intrusion of the Coast Plutonic Complex. During this interval faulting was deflected north and around the Penrose pluton (~95 Ma). Stresses caused by the intrusion of contemporaneous and younger phases of the Bendor pluton to the southeast, resulted in left-lateral shearing (Gaba and Church, 1988). The same left-lateral strike-slip regime is linked to the 86-91 Ma period of gold mineralization at Bralorne (Leitch, 1989; Church, 1990a). According to Journeay (1990) movement on the break ended when it was sealed at the south end by intrusion of the Scuzzy pluton (74-88 Ma; Santonian-Campanian). However, this would still allow some movement along the north end of the break, in the order of several tens of kilometres, to accommodate emplacement of younger granitic bodies such as the Bendor pluton. Nevertheless, contrary to reports of Rusmore (1985) and Journeay (1993), identical units of the Cadwallader Group and Bridge River Complex are found locally on both sides of the break (Figure 1A) proving the local rather than regional significance of this fault.

FRACTURE DOMAINS

The Bridge River mining camp is known principally for its gold-quartz vein mineralization. An intricate system of fractures controlled the movement of ore-bearing solutions; the most profound crustal breaks being the main solution channelways and the loci of repeated igneous intrusion. Synoptic diagrams showing local fracture patterns accompany the property descriptions in Chapter 5 of this report.

The principal vein attitudes in the camp are listed in Table 3.1. This shows several clusters in a broad dispersion of orientations. Veins striking southeasterly and dipping moderately and steeply to the northeast are the most common. Among these are Wayside and many of the veins at the Bralorne mine, including the famous 51 and 77 veins. Other important but less common veins strike east to northeasterly and dip northerly, such as the 27 vein at the Pioneer mine. Other significant veins, such as Congress, trend northeast and dip northwesterly, or trend north-south and dip easterly, such as Minto.

CHAPTER 4
GEOCHEMISTRY

"Stones and trees can teach you more than you can learn from the great masters."

— Saint Bernard of Clairvaux (1091-1153)

Exploration geochemistry has been used in British Columbia for many years. Pioneering research in this field was done by Warren and Delavault in the Sixties at The University of British Columbia, and the method was applied successfully by mining companies to locate major copper and molybdenum occurrences in central and northern British Columbia. Later, during the uranium play of the Seventies, the Geological Survey of Canada initiated silt sampling and water testing programs to delineate areas of high uranium background in the southern interior region. More recently, federal and provincial agencies have combined efforts on a regional scale in a systematic geochemical survey with the goal of mapping the entire province, to provide a comprehensive database useful to the mineral industry and in addressing environmental concerns.

SILT GEOCHEMISTRY

A regional geochemical survey of streams in the Pemberton area (NTS 092J), sponsored by the Geological Survey of Canada and the British Columbia Ministry of Energy, Mines and Petroleum Resources, was completed in 1981. Water and silt in the tributary stream system were tested for about a dozen elements, of which arsenic, silver, copper, mercury, molybdenum, lead and zinc in silts showed the most interesting variations. Unfortunately gold was not included although this is locally the most important commodity. A total of 70 sample sites are located in the Bridge River mining camp. The average density of stations is one sample per 16.6 square kilometres, other details of the survey are given in GSC Open File Report 867. The threshold values and location of anomalies are shown on Figure 4.1.

Repeated anomalies on streams draining the Bendor and Eldorado plutons suggest that these intrusions are asso-

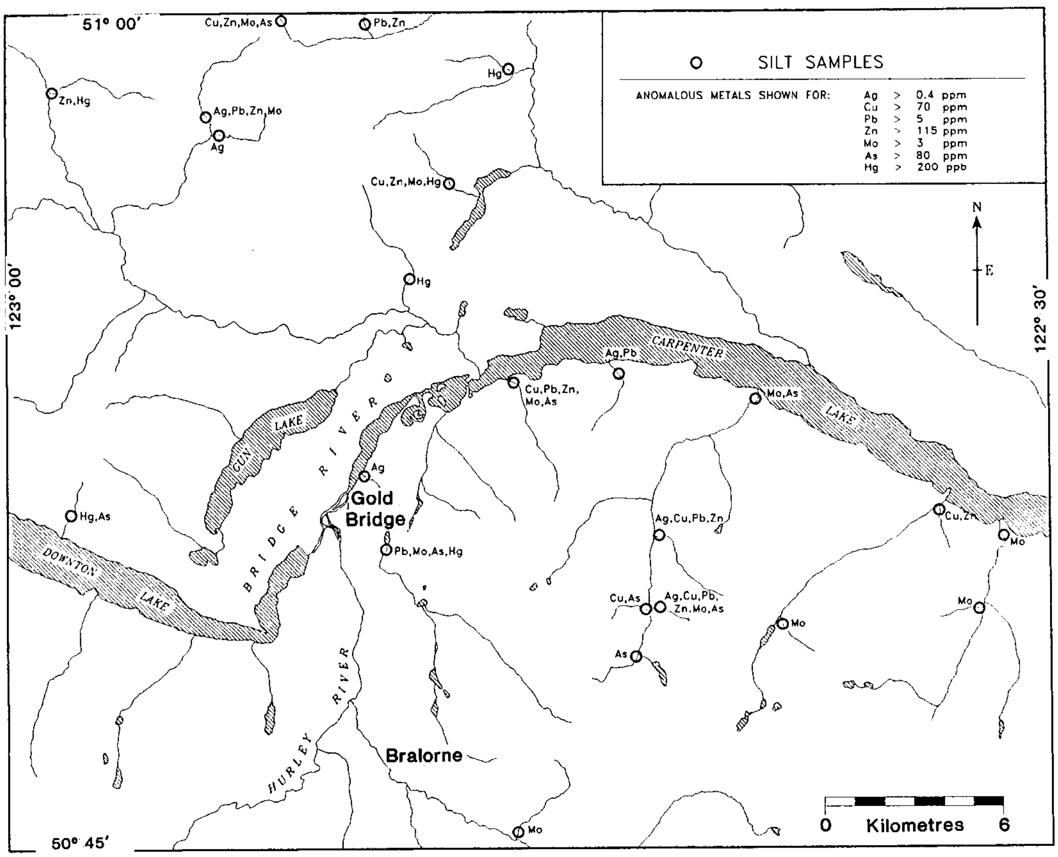


Figure 4.1. RGS anomalies in the Bridge River area.

ciated with mineral deposits. This is supported by the occurrence of a variety of deposits along or near the intrusive contacts. For example the Chalco, Ranger, Gray Rock, Truax and Truax Gold prospects are on or near the contact of the Bendor pluton; similarly, Robson, Lucky Gem and Northern Light occur on the boundary of the Eldorado stock (Figure 1A). Therefore, it is not surprising to find anomalous silts in basins draining the Eldorado stock. The several streams draining the Bendor pluton, such as Bobb Creek which has no known mineral occurrences in its watershed.

MOSS-MAT GEOCHEMISTRY

Moss-mat sampling is a valid prospecting tool, providing a ready means of obtaining geochemical data on stream sediments (Matysek and Day, 1988). It has been shown that moss is an effective collector of silts and concentrator of heavy minerals which can be used to trace the source of base metals and gold.

Moss samples were collected from tributary streams throughout the Bridge River mining camp in the summer of 1988 during a program of regional mapping. A total of 112 samples were obtained along roads and trails and from helicopter-supported overland traverses (Figure 4.2).

SAMPLING PROCEDURE

Moss-mat samples were collected from boulders and logs in stream beds and banks below the high-water level. Care was taken to avoid drainage culverts and other possible sources of contamination due to human action. The samples, weighing up to 1 kilogram, were placed in kraft paper bags and air dried prior to shipping to the ACME laboratory in Vancouver.

The laboratory procedure involved first removal of the dried organic material and then sieving the residual sand and silt to -80 mesh. A 0.5-gram portion of each sample was digested in aqua regia and the elements were determined by induced coupled plasma emission spetrographic (ICP-ES) and fire assay/mass spectrographic (FA/MS) methods. This treatment was for acid-extractable metal only; neither the oxides nor silcate minerals were completely digested. Gold was determined by graphite furnace atomic absorption fol-

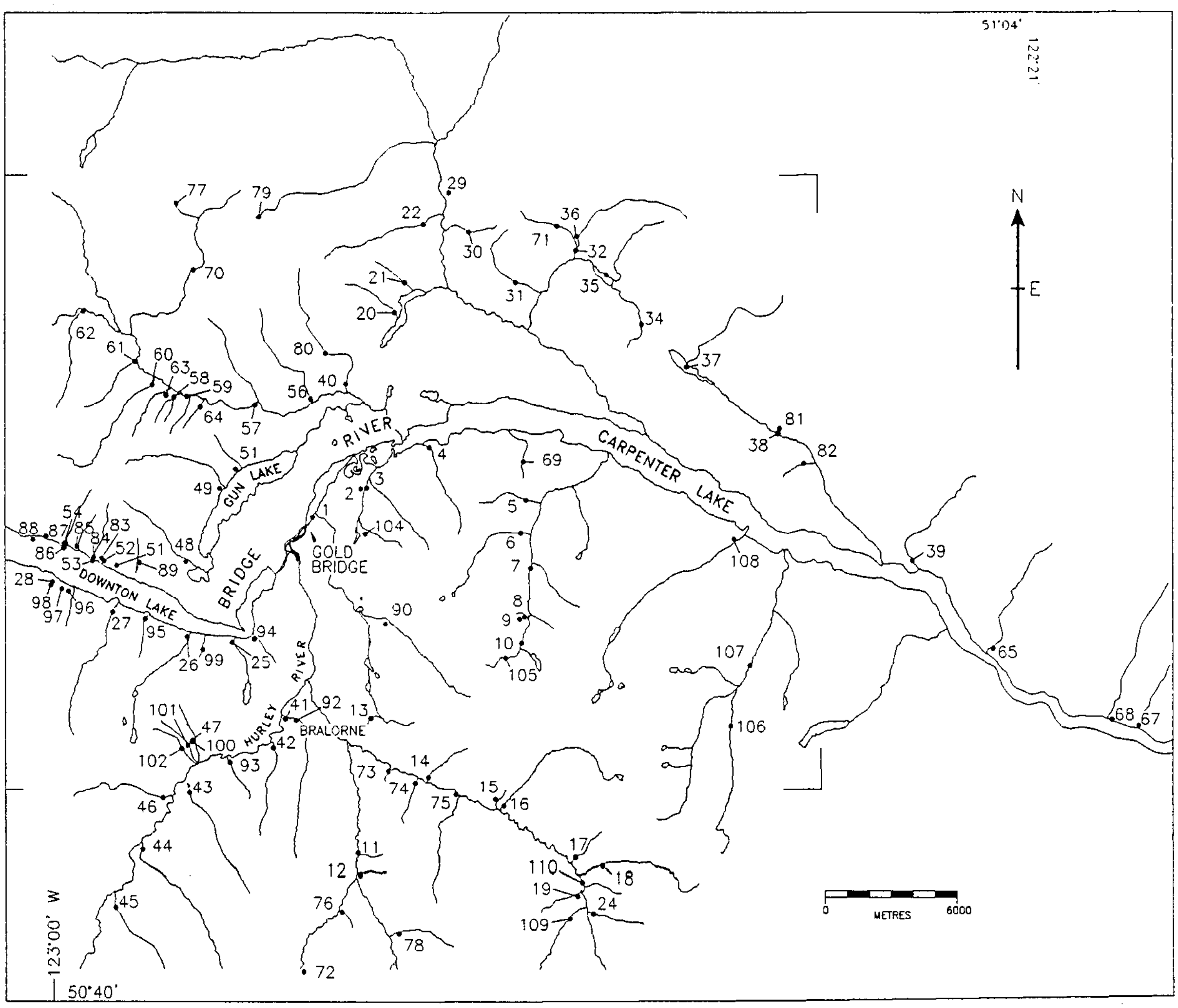


Figure 4.2. Moss-mat stations.

lowing digestion of a 10-gram split with aqua regia and extraction with methylisobutyl ketone.

RESULTS

The results of analyses are listed in Table 4.1. Log probability plots for elements such as lead and zinc, and to a lesser extent arsenic and antimony, show more or less straight-line relationships between cumulative frequency and analytical values close to log normal distributions, suggesting single background populations (Figure 4.3). Surprisingly, there are no very high values for antimony and arsenic that might be the expected mark of the numerous stibnite-arsenopyrite-bearing veins in the area. However, a weak signature for this type of mineralization might be due to low sampling density (Massey and Day, 1989).

The gold results are most important because there are few viable prospects in the area that do not carry gold. Samples with gold values above an arbitrary threshold of 100 ppb are listed in Table 4.1 together with other anomalous elements. From this it appears that gold was derived from at least three sources; (1) polymetallic veins with ancillary lead, antimony, zinc, arsenic and iron, suggesting the presence of galena, stibnite, sphalerite, arsenopyrite and pyrite (samples 1, 2, 3, 4, 8 and 11); (2) veins in ultrabasic rocks with anomalous levels of nickel and chromium (samples 5, 9, 12 and 13); (3) veins with little or no accompanying sulphide mineralization hosted by common igneous or metamorphic country rocks (samples 6, 10, 14 and 15).

TARGETS FOR EXPLORATION

The locations of anomalous gold and base metal samples shown on Figure 4.2. The highest gold analyses, 1103 and 1347 ppb from samples 9 and 10, respectively, were obtained from moss mats in adjacent subparallel streams on the south-facing slope of Mount Penrose, below the contact of the Coast Range batholith with Triassic rocks. Three other samples (18, 19 and 20) from the same general area contain anomalous copper, zinc and iron. Four other samples with anomalous gold values (samples 5, 6, 12, and 13) are aligned and approximately coincident with the Marshall Lake fault between the west branch of Liza Creek and Jones Creek, suggesting a relationship of mineralization to the fault. A platinum anomaly on Pearson Creek (sample 16) is associated with relatively high nickel, chromium and iron values in the moss mat. A second sample (17) from a point higher on the same creek confirms the nickel, chromium and iron anomaly. Ultrabasic rocks exposed in the upper drainage area (Figure 1A) are probably the source of the anomaly.

Two samples (21 and 22) are anomalous in molybdenum, copper, lead and zinc, suggesting possible porphyry mineralization on Mount Fergusson, related to the Bendor granitic stock, and in the Mission Ridge area, related to the Mission Ridge porphyry intrusion. Subsequent mapping by R.G. Gaba of the Geological Survey Branch discovered a new occurrence of stockwork molybdenite in the Mission Ridge porphyry stock (Gaba, 1990).

CONCLUSIONS

The moss from rocks and logs on the banks and beds of streams provides a relatively uniform sampling of silt. From a total of 112 samples obtained during the program, 15 yield values greater than 100 ppb gold. These are widely scattered across the camp and suggest some new exploration targets (Figure 4.2). For example fault zones, such as the Marshall Lake fault lineament, and contacts along the east margin of the Coast Plutonic Complex, appear to be favourable areas for gold and base metal mineralization.

The Bridge River mining camp is known mainly for gold from quartz veins and ancillary production of lead, zinc, antimony, mercury and tungsten. Chromium, nickel and platinum have been found but not in commercial quantities.

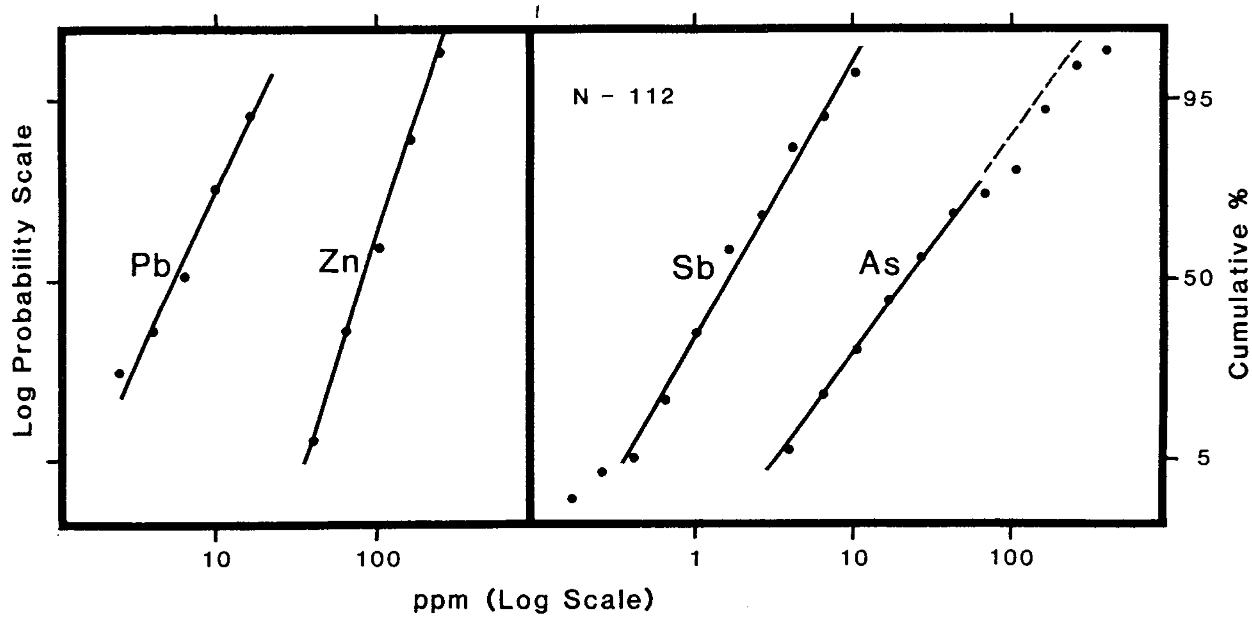


Figure 4.3. Cumulative frequency distribution for selected elements.

TABLE 4.1
MOSS MAT GEOCHEMISTRY

No.	EASTING/NORTHING		Ag PPM	Al %	As PPM	Au PPB	B PPM	Ba PPM	Bi PPM	Ca %	Cd PPM	Co PPM	Cr PPM	Cu PPM	Fe %	Ge PPM	K %
1	511919	5634210	0.1	1.40	179	4	5	100	2	0.62	1	17	73	43	4.81	.2	0.15
2	514143	5635460	0.2	2.08	19	3	17	68	2	1.07	2	20	158	40	3.91	.6	0.08
3	514424	5635507	0.2	1.29	84	212	34	140	2	0.79	1	28	165	92	5.56	.4	0.08
4	517094	5637116	0.4	2.14	140	164	22	351	2	0.83	3	29	168	88	5.85	.3	0.12
5	521640	5634900	0.2	1.78	59	592	22	241	2	0.90	3	21	88	68	5.57	.2	0.11
6	521448	5633331	0.2	1.83	143	6	9	104	3	0.94	1	13	183	43	3.37	.2	0.18
7	521675	5632005	0.2	2.28	32	11	17	81	2	0.85	3	28	229	71	5.35	.4	0.15
8	521602	5629725	0.3	3.92	458	137	4	463	2	1.14	1	31	220	94	5.95	.7	0.87
9	521371	5629626	0.2	1.77	369	28	5	130	2	0.88	1	19	102	137	2.90	.2	0.18
10	521152	5628503	0.2	1.06	98	8	11	125	2	0.53	1	10	80	41	3.65	.3	0.20
11	513992	5619026	0.1	0.19	9	1	79	30	2	4.21	2	4	39	23	0.33	.4	0.14
12	514098	5618074	0.1	1.48	17	2	8	25	2	0.87	1	21	268	36	3.51	.2	0.05
13	514581	5625096	0.2	2.16	152	12	6	374	2	0.51	3	23	93	129	6.78	.2	1.02
14	516893	5622466	0.3	2.62	38	8	8	423	2	0.92	3	18	172	64	3.61	.3	1.11
15	520257	5621430	0.3	1.94	85	4	11	355	2	0.66	2	13	123	52	2.77	.3	1.11
16	520648	5621139	0.1	1.04	61	1	16	151	2	0.44	1	7	70	21	3.26	.3	0.24
17	523925	5618867	0.2	1.33	96	44	4	97	2	0.59	1	8	41	28	2.84	.2	0.13
18	525174	5618512	0.2	1.16	40	54	6	98	2	0.38	1	11	67	32	2.45	.2	0.21
19	524020	5617232	0.1	2.08	107	1	5	74	2	0.60	1	21	182	47	3.77	.2	0.17
20	515500	5643333	0.2	1.24	7	2	34	335	2	1.44	1	13	71	33	3.34	.5	0.10
21	515828	5644553	0.1	0.53	3	2	50	225	2	18.22	3	5	20	27	0.96	.2	0.09
22	517400	5647900	0.2	1.66	16	3	26	179	2	0.68	2	20	82	58	5.13	.4	0.10
23	518000	5050400	0.1	2.14	5	1	42	229	5	1.01	2	19	142	39	4.65	.3	0.11
24	524739	5616489	0.2	1.93	106	1	7	196	2	0.49	1	17	136	39	3.68	.2	0.33
25	508203	5628529	0.1	1.67	25	10	11	85	2	1.04	1	16	89	36	3.40	.6	0.15
26	506166	5628780	0.1	2.27	9	1	7	80	2	0.75	1	17	63	74	4.78	.2	0.30
27	502758	5629917	0.3	2.16	12	2	3	342	4	0.31	2	7	23	56	5.88	.2	0.94
28	500012	5631296	0.1	1.27	29	8	18	90	2	1.88	1	8	43	32	2.20	.5	0.36
29	518171	5648883	0.2	1.79	10	11	51	221	2	2.23	3	28	213	49	5.71	.3	0.15
30	519082	5647085	0.3	1.37	17	68	35	128	2	1.62	1	15	85	37	4.16	.2	0.13
31	521200	5644800	0.1	1.64	3	1	86	410	2	2.12	1	14	51	23	4.14	.2	0.18
32	523759	5646363	-0.0	0.0	0	0	0	0	0	0.0	0	0	0	0	0.0		0.0
33	523642	5646330	0.2	1.34	5	1	24	107	2	0.50	2	32	188	25	4.51	.2	0.07
34	527008	5642938	0.1	1.80	3	204	18	17	2	0.51	1	34	363	56	5.78	.2	0.04
35	525394	5645157	0.1	1.74	5	1	43	81	2	0.74	1	39	558	36	5.35	.2	0.06
36	524007	5646903	0.1	1.53	6	1	31	44	3	0.58	1	37	293	36	5.02	.2	0.04
37	529091	5641100	0.1	1.28	20	2	39	60	2	0.40	1	38	571	46	4.44	.2	0.07
38	533278	5638006	0.2	1.71	20	10	8	25	2	0.54	1	29	274	56	4.87	.2	0.05
39	539420	5632309	0.3	2.12	34	592	14	123	2	1.93	2	21	104	83	5.55	.2	0.13
40	513500	5640180	0.2	2.06	15	8	44	169	2	0.83	1	78	493	74	6.47	.3	0.08
41	510659	5625064	0.3	1.82	21	913	17	49	2	0.50	1	19	145	42	4.99	.3	0.09
42	510099	5623745	0.2	2.67	49	11	8	91	2	0.63	1	26	169	71	5.77	.6	0.18
43	506275	5621695	0.2	2.19	24	2	9	130	2	0.56	1	15	41	49	5.03	.2	0.16
44	504124	5619178	0.1	1.12	7	2	2	104	2	0.51	1	9	88	27	4.44	.2	0.12
45	502876	5616715	0.3	0.97	31	245	5	66	2	0.14	1	11	23	45	4.68	.2	0.13
46	505052	5621467	0.1	1.80	5	1	3	157	3	0.60	1	11	45	46	3.36	.3	0.97
47	506407	5624101	0.1	1.83	9	1	8	105	2	0.79	1	10	38	32	3.04	.3	0.23
48	506109	5632195	0.1	1.05	33	3	48	45	4	1.82	1	11	102	39	2.10	.4	0.07
49	507647	5635700	0.3	1.48	36	14	13	76	2	0.67	1	16	109	47	3.65	.4	0.14
50	508500	5636500	0.1	1.24	3	1	21	67	2	0.86	1	11	109	35	2.21	.3	0.08
51	508400	5636345	0.1	1.51	8	1	35	36	2	3.29	1	9	35	40	2.42	.2	0.09
52	502951	5632028	0.4	3.01	166	3	49	84	2	2.86	1	24	25	108	4.84	.2	0.10
53	502361	5632228	0.0	0.0	0	0	0	0	0	0.0	0	0	0	0	0.0	.2	0.0
54	501895	5632387	0.1	2.38	104	1103	9	77	2	0.80	1	28	218	63	6.13	.2	0.25
55	500551	5633005	0.4	2.45	88	1347	7	85	2	0.91	1	16	43	78	5.59	.3	0.16
56	511600	5639407	0.3	2.13	6	13	29	531	2	0.88	1	23	264	53	4.65	.2	0.12

No.	La PPM	Mg %	Mn PPM	Mo PPM	Na %	Ni PPM	Pb PPM	Pd PPB	Pt PPB	P %	Rh PPB	Sb PPM	Se PPM	Sr PPM	Te PPM	Th PPM	Tl %	U PPM	V PPM	W PPM	Zn PPM
1	6	1.23	1521	3	0.02	119	14	2	1	0.072	6	4	.8	26	.3	2	0.11	5	76	5	57
2	6	2.38	576	1	0.01	155	8	2	1	0.038	2	2	.3	26	.3	1	0.16	5	76	1	62
3	8	2.79	795	3	0.01	271	13	2	2	0.048	2	8	1.6	45	.6	2	0.04	5	50	1	117
4	16	2.61	1474	3	0.01	198	24	2	2	0.069	2	9	2.8	40	.3	2	0.06	5	71	1	147
5	12	1.36	1254	1	0.02	103	18	2	1	0.060	2	5	1.2	35	.3	2	0.17	5	94	1	102
6	8	1.16	513	1	0.08	78	10	2	1	0.075	2	2	.5	79	.3	3	0.09	5	117	3	53
7	13	3.14	1080	2	0.01	246	23	3	1	0.094	2	2	2.4	68	.6	2	0.07	5	72	1	146
8	7	2.93	833	2	0.11	220	20	2	1	0.067	2	9	2.2	69	.5	3	0.18	5	108	1	165
9	7	1.24	329	1	0.07	144	7	2	1	0.110	2	2	.2	59	.3	2	0.09	5	74	2	44
10	9	0.76	272	1	0.03	46	11	2	1	0.119	2	4	.2	32	.3	3	0.09	5	117	1	41
11	2	0.38	312	3	0.01	91	12	2	1	0.114	2	2	.3	102	.3	1	0.01	5	15	1	65
12	6	2.76	531	1	0.01	335	12	2	2	0.056	2	2	1.9	29	.3	1	0.05	5	39	1	62
13	7	1.37	2869	11	0.03	127	13	2	1	0.072	2	6	2.7	51	.6	4	0.12	5	57	3	101
14	7	2.25	494	1	0.04	146	5	2	1	0.076	2	2	2.4	37	.3	3	0.17	5	76	1	90
15	4	1.43	360	2	0.04	128	10	2	1	0.076	2	2	4.3	34	.3	2	0.16	5	65	1	64
16	10	0.77	249	2	0.02	39	9	2	1	0.101	2	2	.2	33	.3	6	0.11	5	76	3	41
17	8	0.80	310	1	0.01	31	12	2	1	0.065	2	2	.5	35	.3	4	0.12	10	67	2	46
18	5	1.27	328	1	0.02	75	7	2	1	0.055	2	2	.2	14	.3	2	0.09	5	44	9	44
19	3	2.58	506	1	0.02	316	8	2	1	0.043	2	2	1.1	26	.5	1	0.11	5	66	1	69
20	10	1.17	592	1	0.02	73	3	2	1	0.074	2	2	1.8	115	.8	1	0.12	5	54	1	83
21	8	0.53	360	1	0.02	35	3	2	1	0.046	2	3	9.4	520	.3	1	0.01	5	14	2	37
22	12	1.22	822	1	0.01	101	7	2	1	0.071	2	2	.3	44	.6	2	0.10	5	73	1	97
23	11	2.08	749	1	0.02	163	7	2	1	0.050	2	2	.6	62	.3	2	0.20	5	86	1	94
24	7	1.80	902	6	0.02	183	4	2	1	0.058	2	2	2.3	23	.3	1	0.10	5	63	4	116
25	5	1.18	1595	1	0.02	73	8	2	1	0.077	2	2	.7	51	.5	1	0.10	5	55	1	99
26	3	1.71	476	1	0.03	40	7	2	1	0.095	2	2	.3	27	.3	6	0.20	5	93	2	77
27	5	0.77	276	3	0.03	12	7	2	1	0.075	2	2	4.6	34	.3	3	0.12	5	95	1	111
28	6	0.58	297	3	0.02	15	2	2	1	0.110	2	2	5.1	125	.6	1	0.05	59	78	1	79
29	16	3.34	939	1	0.02	306	3	2	2	0.056	2	2	1.1	78	.3	2	0.13	5	71	1	117
30	8	1.35	715	1	0.02	103	10	2	1	0.055	2	2	1.9	74	.3	1	0.13	5	74	1	81
31	11	1.39	2082	1	0.02	58	2	2	1	0.054	2	2	2.1	233	.5	1	0.23	5	63	1	167
32	0	0.0	0	0	0.0	0	0	0	0	0.0	0	0		0		0	0.0	0	0	0	0
33	6	7.72	666	1	0.02	560	8	2	3	0.033	2	2	.2	28	.3	3	0.07	5	49	1	66
34	2	7.34	570	1	0.01	477	2	3	3	0.028	2	2	.4	12	.3	1	0.08	5	57	1	60
35	7	8.42	717	1	0.02	619	6	16	3	0.036	2	4	.7	37	.3	1	0.13	5	71	1	72
36	3	8.89	634	1	0.01	603	9	3	2	0.019	3	3	.3	19	.3	1	0.07	5	57	1	60
37	3	10.02	557	1	0.01	676	4	3	4	0.035	2	3	.6	12	.3	1	0.07	5	43	2	49
38	2	3.31	658	1	0.01	262	4	2	1	0.056	2	2	.2	12	.3	1	0.16	5	78	2	49
39	21	2.01	1097	2	0.02	106	9	3	1	0.056	2	2	.6	50	.3	3	0.16	5	77	1	132
40	11	5.13	865	2	0.01	1085	8	5	41	0.058	4	3	1.2	32	.3	2	0.24	5	71	1	143
41	5	2.21	746	1	0.02	141	8	2	1	0.067	2	2	.4	32	.3	5	0.13	26	61	1	100
42	9	2.53	856	1	0.02	155	9	2	1	0.071	2	2	.2	39	.8	2	0.21	5	83	1	126
43	9	0.90	545	1	0.05	37	4	2	1	0.073	2	2	.4	92	.3	2	0.14	5	81	1	115
44	8	0.55	277	1	0.03	21	2	2	1	0.097	2	2	.2	35	.5	20	0.10	5	140	1	41
45	4	0.51	582	1	0.01	9	21	2	1	0.037	2	2	.2	9	.3	1	0.04	5	88	1	173
46	7	1.19	464	1	0.03	20	5	2	1	0.072	2	2	.2	38	.5	5	0.20	5	90	1	74
47	5	0.76	380	1	0.02	26	4	2	1	0.070	2	2	1.4	35	.6	1	0.09	5	65	1	96
48	4	1.43	429	1	0.03	268	2	6	1	0.056	2	3	2.5	44	.3	1	0.05	5	36	1	136
49	4	1.90	413	1	0.05	164	4	2	1	0.053	2	2	1.4	30	.6	1	0.13	5	98	1	66
50	4	1.69	319	1	0.03	172	2	2	1	0.038	2	2	1.4	32	.3	1	0.07	5	43	1	37
51	4	0.88	396	1	0.04	41	5	2	1	0.044	2	3	4.1	76	.4	1	0.09	5	47	1	50
52	2	0.51	370	4	0.02	90	4	2	1	0.082	2	3	5.7	102	.3	1	0.04	5	45	1	152
53	0	0.0	0	0	0.0	0	0	0	0	0.0	0	0	1.0	0	.3	0	0.0	0	0	0	0
54	4	3.19	678	1	0.05	322	9	2	2	0.068	2	4	.2	37	.3	1	0.11	5	87	2	141
55	5	1.06	419	1	0.07	47	7	2	1	0.090	2	3	.7	53	.4	1	0.10	5	117	5	113
56	11	3.53	979	1	0.02	275	2	2	2	0.055	2	2	.4	40	.3	1	0.25	5	74	1	105

TABLE 4.1 Continued

No.	EASTING/	NORTHING	Ag PPM	Al %	As PPM	Au PPB	B PPM	Ba PPM	Bi PPM	Ca %	Cd PPM	Co PPM	Cr PPM	Cu PPM	Fe %	Ge PPM	K %	La PPM	Mg %	Mn PPM	Mo PPM	Na %	Ni PPM	Pb PPM	Pd PPB	Pt PPB	P %	Rh PPB	Sb PPM	Se PPM	Sr PPM	Te PPM	Th PPM	Ti %	U PPM	V PPM	W PPM	Zn PPM
57	509274	5639241	0.2	1.89	9	4	49	477	2	1.09	1	25	248	49	4.74	.2	0.12	10	3.59	947	1	0.02	298	6	2	2	0.057	2	2	.6	36	.4	1	0.24	5	68	1	89
58	505576	5639573	0.2	1.59	23	67	16	106	3	0.62	1	22	101	72	3.71	.2	0.21	6	2.97	598	1	0.04	270	9	2	2	0.055	2	3	.7	32	.4	1	0.12	5	70	2	71
59	506154	5639606	0.2	1.51	10	3	35	72	2	0.77	1	40	282	52	4.74	.2	0.17	5	9.88	774	1	0.03	676	3	3	5	0.042	2	2	.2	19	.4	1	0.12	5	60	1	85
60	504594	5640123	0.1	1.16	24	11	8	81	2	0.72	1	9	40	33	2.61	.2	0.15	7	1.03	251	1	0.05	57	2	2	1	0.095	2	2	.3	39	.3	3	0.10	5	92	1	34
61	503830	5640929	0.1	1.49	15	3	8	147	2	0.73	1	10	34	30	2.60	.3	0.18	8	0.95	416	3	0.03	41	2	2	1	0.060	2	2	.2	62	.3	2	0.14	22	67	3	53
62	501476	5643177	0.1	0.83	5	2	12	76	2	0.57	1	8	68	29	5.30	.2	0.17	11	0.57	301	1	0.02	9	7	2	1	0.111	2	2	.4	22	.3	11	0.10	5	164	2	36
63	505218	5639658	0.1	1.04	15	4	11	63	2	0.54	1	20	125	38	3.45	.3	0.09	5	3.64	498	1	0.02	311	4	2	1	0.046	2	2	5.5	29	.4	1	0.07	5	71	2	47
64	506775	5639147	0.3	1.18	44	28	14	55	3	1.74	1	10	82	240	2.02	.3	0.18	6	1.11	618	2	0.02	146	5	2	1	0.083	2	2	5.5	59	.4	1	0.04	5	47	1	51
65	543125	5628185	0.2	1.57	16	5	29	496	2	0.75	2	20	72	101	5.25	.2	0.16	17	1.47	820	5	0.02	97	15	2	1	0.070	2	2	1.3	38	.3	3	0.11	5	65	1	161
66	549800	5624800	0.3	1.11	17	6	14	732	2	0.55	1	20	29	130	4.49	.2	0.15	15	0.77	749	11	0.02	65	15	3	1	0.060	2	2	1.4	51	.3	4	0.05	5	44	1	169
67	549744	5624876	0.1	3.14	6	1	46	53	2	2.34	1	29	83	82	6.69	.4	0.09	5	2.51	1171	1	0.03	69	7	2	1	0.049	2	2	.2	51	.3	1	0.36	5	132	1	119
68	548564	5625090	0.2	3.24	11	1	75	47	2	2.41	3	29	91	98	6.22	.3	0.08	5	2.48	808	1	0.03	72	3	2	1	0.053	2	2	.2	56	.3	1	0.34	5	136	1	105
69	521600	5637100	0.3	1.46	46	12	74	78	2	3.70	1	18	177	50	2.97	.3	0.15	6	2.84	595	1	0.03	225	11	2	1	0.079	2	6	4.5	91	.5	1	0.06	5	44	1	102
70	506607	5645173	0.2	1.75	64	133	17	159	2	0.56	1	27	172	60	6.08	.2	0.11	8	2.85	994	2	0.03	261	4	3	3	0.054	2	5	.5	37	.3	1	0.06	5	72	1	135
71	523167	5647195	0.1	1.21	6	225	16	83	2	0.45	1	40	227	27	5.34	.2	0.05	5	10.01	786	1	0.01	777	2	2	3	0.036	2	3	.2	23	.3	1	0.06	5	54	1	86
72	511467	5613878	0.1	3.34	5	3	2	229	3	0.45	3	25	136	75	6.24	.2	0.40	9	3.38	1055	3	0.01	125	8	2	1	0.062	2	2	.2	17	.3	2	0.21	5	118	1	122
73	515200	5622690	0.3	1.50	13	20	11	66	2	0.72	1	14	115	38	3.13	.2	0.22	6	1.72	512	1	0.02	162	9	2	1	0.058	2	2	3.1	39	.3	1	0.10	5	47	1	78
74	516498	5622295	0.2	1.24	17	3	10	37	2	0.47	1	24	235	31	3.96	.2	0.10	4	3.55	476	1	0.01	471	2	2	2	0.046	2	2	1.2	20	.3	1	0.08	5	51	1	57
75	518474	5621642	0.1	1.44	11	7	10	44	2	0.38	1	34	368	37	4.04	.2	0.12	4	7.01	540	1	0.02	678	5	2	3	0.049	2	2	2.0	17	.4	1	0.07	5	43	2	57
76	513238	5616525	0.1	1.04	22	5	17	70	2	2.28	1	16	198	40	2.33	.2	0.13	5	1.42	949	2	0.01	350	5	8	1	0.095	2	2	5.1	72	.3	1	0.02	5	32	1	82
77	505811	5648500	0.1	2.76	16	1	6	131	7	0.75	1	29	50	84	6.33	.5	0.10	9	1.93	1243	4	0.04	98	8	3	1	0.052	2	2	2.6	35	.4	1	0.06	5	86	1	206
78	515861	5615561	0.1	2.47	96	5	2	102	2	0.46	1	29	196	78	4.72	.2	0.15	7	2.50	900	2	0.01	207	10	2	1	0.057	2	2	.8	23	.3	2	0.09	5	66	1	108
79	509604	5647730	0.1	1.60	94	7	21	45	3	0.39	1	45	717	30	5.15	.3	0.07	6	8.40	710	1	0.01	759	6	3	5	0.037	2	2	1.2	19	.3	1	0.08	5	56	1	78
80	512500	5641400	0.2	2.61	19	9	31	200	2	0.85	1	72	498	82	5.94	.2	0.08	12	5.95	876	2	0.01	973	11	6	5	0.069	2	2	1.5	33	.3	2	0.21	5	67	1	134
81	533800	5638225	0.1	2.20	32	2	5	91	3	0.96	1	27	249	59	4.49	.4	0.18	9	3.24	695	1	0.01	280	5	4	3	0.065	2	2	.5	51	.3	2	0.09	5	62	1	86
82	534469	5636664	0.1	1.96	38	105	6	68	4	0.53	1	30	361	71	5.84	.6	0.12	9	3.07	704	1	0.01	298	5	2	1	0.073	2	2	1.0	34	.4	2	0.09	5	76	1	92
83	502265	5632354	0.4	4.66	237	3	20	70	4	1.68	2	36	28	111	6.87	.2	0.11	3	0.53	441	5	0.02	110	10	2	1	0.097	2	2	5.2	68	.3	1	0.05	5	52	3	229
84	501838	5632224	0.1	2.47	124	21	7	72	2	0.85	1	29	191	62	5.73	.2	0.19	4	2.90	587	1	0.03	284	2	2	1	0.068	2	2	1.7	41	.3	1	0.08	5	82	1	134
85	501118	5632872	0.1	3.72	51	3	5	108	2	1.03	3	35	28	121	11.55	.3	0.11	4	1.04	689	2	0.05	102	17	2	1	0.086	2	4	4.4	68	.5	1	0.03	5	65	4	230
86	500521	5632799	0.1	2.53	96	13	4	85	3	0.97	1	20	30	76	5.14	.2	0.16	5	1.09	438	1	0.05	53	5	2	1	0.095	2	2	1.0	56	.3	2	0.09	5	106	2	115
87	499704	5633324	0.1	0.95	9	2	9	56	4	1.37	1	7	15	32	2.44	.3	0.12	9	0.40	196	1	0.03	11	3	2	1	0.231	2	2	2.5	42	.3	1	0.07	5	76	10	59
88	499104	5633167	0.1	1.54	25	21	5	85	2	1.31	1	12	31	68	3.99	.3	0.12	10	0.77	374	1	0.05	13	2	2	1	0.258	2	2	1.1	51	.4	3	0.07	5	156	1	93
89	503986	5632149	0.1	0.48	41	1	86	32	2	5.19	1	3	8	31	0.70	.2	0.08	3	0.44	260	1	0.02	6	6	8	1	0.073	2	4	4.3	119	.3	1	0.02	5	32	1	48
90	515262	5629700	0.2	1.50	180	10	3	168	7	0.51	1	24	118	97	6.84	.2	0.32	14	0.92	408	10	0.02	69	19	2	1	0.105	2	16	.6	42	.3	8	0.13	5	179	11	84
91	522300	5642400	1.1	2.01	33	165	11	199	3	0.84	1	20	54	50	5.73	.4	0.09	10	1.43	644	1	0.02	88	9	2	1	0.072	2	2	.8	51	.4	2	0.10	5	85	1	128
92	511141	5625001	0.1	1.85	26	24	8	47	2	0.48	1	22	100	45	4.94	.3	0.09	5	2.01	741	1	0.01	120	8	2	1	0.069	2	2	1.0	32	.3	2	0.11	5	59	1	95
93	507944	5622983	0.1	3.22	40	4	2	99	2	0.75	1	34	120	94	6.58	.2	0.24	8	2.11	890	2	0.02	148	10	2	1	0.105	2	2	3.1	47	.3	1	0.11	5	76	1	213
94	509221	5628678	0.1	0.97	5	1	2	55	2	0.42	1	8	57	23	5.45	.2	0.08	5	0.42	328	1	0.01	23	2	2	1	0.057	2	2	.3	24	.3	5	0.08	5	126	1	59
95	504243	5629601	0.1	2.76	21	1	3	151	2	0.67	1	17	20	75	7.56	.2	0.22	5	0.77	400	2	0.04	21	14	2	1	0.082	2	2	2.6	50	.3	2	0.07	5	84	4	110
96	500735	5630881	0.1	0.51	12	1	27	78	2	3.53	1	3	24	13	0.79	.4	0.17	2	0.40	471	2	0.02	7	5	4	1	0.123	2	2	3.5	175	.3	1	0.03	108	56	1	31
97	500429	5630986	0.1	0.93	14	1	10	73	2	1.50	1	6	27	23	1.98	.3	0.75	5	0.52	239	3	0.02	10	2	2	1	0.132	2	2	3.6	95	.3	1	0.04	49	75	1	64
98	499920	5631155	0.1	0.61	13	1	19	92	2	2.77	1	4	22	26	1.22	.7	0.16	7	0.44	328	3	0.01	8	3	4	1	0.100	2	2	2.7	185	.6	1	0.04	98	53	1	58
99	506869	5628209	0.1	1.13	2	1	2	70	2	0.50	1	7	17	13	2.01	.2	0.06	8	0.36	170	1	0.02	14	2	2	1	0.032	2	2	.3	49	.3	1	0.09	5	47	1	35
100	506386	5623999	0.1	1.75	9	1	2	95	2	0.84	1	10	28	29	3.00	.2	0.20	5	0.71	348	1	0.02	23	2	2	1	0.074	2	2	2.3	36	.3	1	0.08	5	62	1	86
101	506185	5623852	0.1	2.60	9	1	2	131	3	0.45	1	12	27	39	3.78	.6	0.29	6	0.93	350	1	0.02	21	9	2	1	0.051	2	2	1.6	29	.5	2	0.11	5	85	1	85
102	505911	5623695	0.1	2.08	7	1	2	107	3	0.46	1	11	36	36	2.97	.5	0.28	6	0.80	281	1	0.02	35	4	2	1	0.055	2	2	.7	27	.3	1	0.10	5	60	1	61
103	502600	5617700	0.1	2.32	24	16	8	82	3	0.61	1	20	25	50	4.71	.5	0.13	6	1.01	582	1	0.04	34	6	2	1	0.078	2	2	.9	59	.6	2	0.09	5	63	1	97
104	514342	5633441	0.1	2.10	23	5	18	108	2	0.85	1	29	218	75	4.68	.2	0.14	10	3.29	741	3	0.02	294	6	3	1	0.063	2	2	1.6	30	.3	1	0.13	5	70	1	104
105	520719	5627851	0.1	1.06	101	10	4	128	2	0.60	1	10	64	42	3.56	.3	0.20	10	0.81	298	1	0.03	53	3	2	1	0.132	2	3	.5	37	.4	5	0.09	5	109	1	47
106	530900	5624782	0.1	0.94	18	1	2	87	2	0.57	1	8	28	24	2.35	.2	0.27	10	0.72	259	2	0.02	16	2	2	1	0.130	2	2	.2	26	.3	6	0.11	5	55	5	42
107	532000	5627619	0.1	1.02	33	3	6	84	2	0.61	1	9	52	23	3.14	.2	0.21	13	0.78	252	1	0.02	36	2	2	1	0.141	2	2	.4	25	.3	8	0.10	5	76	9	42
108	531500	5633247	0.1	2.73	37	5	33	157	2	1.08	1	28	91	65	6.15	.2	0.22	13	2.31	952	1	0.02	101	5	2	1	0.088	2	2	1.4	34	.3	2	0.28	5	110	1	118
109	523672	5616263	0.1	0.66	10	1	2	63	2	0.33	1	13	41	17	2.82	.2	0.12	10	2.75	297	1	0.01	230	2	4	1	0.102	2	2	.4	14	.3	12	0.05	5	42	1	34
110	524241	5617811	0.1	0.86	12	274	2	73	2	0.40	1	10	46	19	2.78	.6	0.13	9	1.69	291	1	0.01	129	2	2	1	0.101	2	2	.6	17	.6	3	0.06	5	52	1	37
111	538100	5632300	0.1	1.43	17	1	100	194	2	2.82	1	22	107	51	3.64	.2	0.23	8	2.52	759	1	0.02	199	5	2	1	0.093	2	2	3.5	82	.3	1	0.10	5	54	1	79
112	489700	5650700	2.1	1.83	19	24	5	73	9	1.27	8	28	16	414	2.91	.4	0.35	15	0.74	1063	6	0.01	21	108	2	1	0.086	2	2	5.3	57	.4	1	0.04	37	39	2	359

TABLE 4.2
MOSS MAT SAMPLES WITH ANOMALOUS PRECIOUS METAL AND BASE METAL VALUES

No.	UTM Easting	Northing	Mineral Setting	Ag ppm	As ppm	Au ppb	Cr ppm	Cu ppm	Fe %	Mn ppm	Mo ppm	Ni ppm	Pb ppm	Pt ppb	Sb ppm	Zn ppm
1	5147	56356	pmv			212							13		10.3	
2	4173	56373	pmv	0.4	140	164				1474			24		13.2	147
3	5220	56349	pmv	0.3		592				1254			18		9.3	
4	5219	56298	pmv	0.3	458	137			5.95				20		14.4	165
5	5274	56432	ultrabasic			204	363					477				
6	5395	56323	gqv			592				1097						
7	5108	56251	gqv	0.3		913										
8	5028	56167	pmv	0.3		245							21			173
9	5018	56324	ultrabasic		104	1103			6.13			322				
10	5006	56329	gqv	0.4		1347			6.08	994					7.2	
11	5067	56455	pmv			133										
12	5235	56475	ultrabasic			225						777				
13	5350	56368	ultrabasic			105	361									
14	5223	56424	gqv	1.1		165										
15	5242	56178	gqv			274										
16	5132	56402	ultrabasic				493		6.47			1085		41		143
17	5122	56413	ultrabasic				498	82	5.94			973				
18	5023	56323	ic		237			111	6.87							229
19	5011	56329	ic					121	11.55				17			230
20	5079	56230	ic					94	6.58							213
21	5146	56251	porphyry		152			129	6.78	2869	11		13		6.6	
22	5153	56294	porphyry		180			97	6.84		10		19		22.9	
23	5442	56268	porphyry					130			11		15			169
Threshold (plus one standard deviation)			0.3	100	100	250	80	5.9	950	3	320	12	3	4	140	
Detection limit:				0.1	2	1	~8	<10	<0.3	<300	1	~6	2	1	0.2	<30

pmv - polymetalic veins
gqv - gold quartz veins
ic - igneous contact

The lode gold and polymetallic veins and replacements are hosted mostly by the Bralorne intrusions, Pioneer volcanics and porphyry dikes. Complicated systems of deep fractures and shallow subsidiary splays and cross fractures are the principal ore controls. Although no single geological event can explain the numerous mineral deposits, there is a consensus that a magmatic influence is important and that the main period of mineralization ranged from Late Cretaceous to Early Tertiary, bracketing the final emplacement of the Coast Plutonic Complex (Woodsworth *et al.*, 1977; Nesbitt *et al.*, 1987; Leitch *et al.*, 1989).

CHAPTER 5 ECONOMIC GEOLOGY

"But as for us, though we may not have perfected the whole art of the discovery and preparation of metals, at least we can be of assistance to persons studious in its acquisition."

—Agricola (1550)

MINERAL DEPOSITS

The Bridge River mining camp comprises five former mines, including two large gold producers, Bralorne and Pioneer, and three small producers, Wayside, Minto and Congress (Table 5.1), and more than 60 surrounding mineral prospects (Woodsworth *et al.*, 1977).

The first significant descriptions of the mineral deposits of the area were by the Geological Survey of Canada in the publications of Drysdale (1915, 1916), McCann (1922), Cairnes (1937, 1943) and more recently by Roddick and Hutchison (1973) and Woodsworth (1977). Papers by Joubin (1948), Bacon (1978) and Barr (1980) and company reports by Grove (1974), Campbell (1975), Kelly (1972, 1979) and others give an overview of the camp and specific properties from the viewpoint of company geologists and the mineral industry. The university studies of Harrop and Sinclair (1985); Maheux *et al.* (1987); and Leitch *et al.* (1989) provide new research data and modern interpretations of the mineralization process. Specific details of the history, geology, geochemistry and geophysics of the various properties are recorded in the numerous assessment reports covering the area.

The following descriptions are arranged geographically, beginning with the most important mines and surrounding prospects. The location, access, history, geological setting, mineralogy and chemistry are outlined to the extent of the available data. Figures are based on existing mine plans archived in Ministry files and data gathered in the field during the course of this project. References are consolidated at the end of this report. In some instances access to old mine workings is limited and the work of previous invesigators is the only source of data.

THE BRALORNE MINE AND HURLEY RIVER - TRUAX AREA

The largest concentration of mineral prospects in the Bridge River camp occurs in the area extending from the Bralorne mine to Gold Bridge and eastward to the Bendor pluton. The area includes the northerly trending segment of the Cadwallader fault, that follows the lower course of the Hurley River, and parallel faults on Steep Creek and along the valley of Truax Creek (Figure 1A).

The gold-quartz veins at the Bralorne mine and the BRX prospects are associated mainly with the Bralorne intrusions and Pioneer volcanics. To the east, the Ranger, Gray Rock, and Truax prospects occur in similar rocks near the boundary of Bendor intrusion and are associated with fractures related to emplacement and/or cooling of the pluton. The Lost Gold prospect, west of Bralorne, is probably related to the Gwyneth Lake stock - a small granitic body satellitic to the Coast Plutonic Complex.

BRALORNE (MINFILE 092JNE001, 002, 007)

The Bralorne mine is located on Cadwallader Creek, latitude 50°46′35′, longitude 122°48′12′, at 975 metres (3200 feet) elevation, 8 kilometres south of Gold Bridge (Photo 5.1). Access is by the highway, approximately 100 kilometres west of Lillooet and 10 kilometres south of Gold Bridge. An alternative route is from Pemberton by the Pemberton Meadows Highway and the Hurley River Forestry Road, a distance of 65 kilometres.

The author first visited the Bralorne mine in 1985, courtesy of E & B Explorations Inc., and more recently in August 1991 to examine the underground exploration drilling done by Avino Mines and Resources Limited near the King workings. The surface geology of the property was mapped in 1986 and mapping the Crown and Empire workings 400 and 800 levels was completed in 1988. At the same time, core was examined from 74 holes drilled during 1980 to 1988.

TABLE 5.1
PRODUCTION FROM THE BRIDGE RIVER CAMP

	Tonnes Mined	Tonnes Milled	Gold (kg)	Silver (kg)	Copper (kg)	Lead (kg)	Zinc (kg)
Congress	943	943	2.6	1.3	38	-	-
Wayside	39,094	36,992	166.1	26.1	-	-	-
Minto	80,650	79,073	546.1	1,573.30	9,673	56,435	-
Pioneer	2,313,552	2,240,626	41,476.50	7,612.00	-	59	139
Bralorne	4,981,419	4,954,479	87,643.20	21,969.60	-	-	157

Photo 5.1. Panoramic view of the Bralorne mine and townsite.

History And Development

The Bralorne property is centred on a gold-quartz vein system. The Bralorne mine, comprising the King, Empire and Crown workings, operated continuously from 1932 to 1971. Production during this period and from older operations totals 5.0 million tonnes of ore yielding 87.6 million grams of gold and 22 million grams of silver. The average recovery was 17.6 grams per tonne gold and 4.4 grams per tonne silver (MINFILE 092JNE001).

The property is a consolidation of 133 Crown-granted claims and fractions, many of which were staked in 1897. The staking began after the discovery of gold-bearing quartz veins on the north bank of the lower course of Cadwallader Creek (Cairnes, 1937). Access to the area at that time was 110 kilometres by difficult trail from Lilloet. The original lode claims were explored individually or in small groups (the Lorne and Pioneer groups of claims were staked in 1897) and by 1898 almost all the veins that would be mined had been found. Gold was first recovered by hand crushing and panning the oxidized quartz from surface exposures. Adits were developed on the promising leads and gold was won in quantity from the ore by improvising primitive mills. At Lorne, two 12-foot arrastres were erected, driven by a 28-foot overshot water wheel, to process a few tons of ore per day and in 1900 a 5-stamp mill was set up to increase production. On selling the Pioneer property, Arthur Noel then purchased the Lorne mine from William Sloan and Dan Hurley. Prior to this the Lorne, King and Woodchuck veins had been successfully worked by Mike Gaynor, Nat Coghlan, William Young, John Williams and E.J. Taylor.

In 1910 Lorne Amalgamated Mines Company gained control of the King mine and the adjacent key ground that included the Lorne, Golden King, Woodchuck, Wood Duck, Telephone and Marquis Crown-granted claims. After some shallow surface workings were completed, the No.3 adit-crosscut was driven 335 metres to intersect the King vein. Work on the property was facilitated in 1915 when the Pacific Great Eastern Railway reached Lillooet via the Fraser River. Supplies from the coast were then routed 90 kilometres westward by road following the Bridge River. By 1920 some 900 metres of underground drifts and crosscuts had been developed and about 150 kilograms of gold produced, however, increasing sulphide and arsenic content in the veins at depth made gold recovery by amalgamation too low to pay in this remote area.

In 1928 Lorne Gold Mines Limited (Stobie, Furlong and Company) was incorporated and acquired the Alhambra and Blackbird claims, the Empire mine on the Ida May claim and the Coronation mine workings to the southeast. Proceeds from the sale of stock were spent driving a 900-metre adit 245 metres below the surface showings and by 1929 the principal veins in the King mine were delineated. Underground development was suspended in 1930 because of financial difficulties.

A new mining era began in 1931 when Lorne Gold Mines sold a 60% interest in the property to Austin Taylor and Associates who then organized Bralorne Mines Limited and took control. A 100-ton mill employing blanket concentration and flotation was installed, thus commencing a 40-year period of continuous production. In 1935 milling capacity was increased to 475 tons daily. Reserves were exhausted in the King mine in 1940 and the 51, 55 and 77 veins of the Empire and Crown workings became the chief source of ore.

By 1962 there were three operating internal shafts - the Crown, Queen and Empire; the original Coronation shaft had been abandoned (Mamen, 1962). The Crown shaft connects the No.8 main adit and haulage level to the No.26 level, the Queen shaft connects the No.26 to No.39 and the Empire shaft connects No.3 to No.26. Up until 1961 ore treatment was designed to capture 70-75% of the free gold in jigs and on blanket tables, and to float the remainder with the sulphides. Total recovery was 96% and gold content of the flotation concentrate was about 280 grams per tonne. Cyanidation was introduced at this time to replace flotation and save the $50 per ton cost of shipping and treatment of the sulphide concentrates at the Tacoma smelter.

Bralorne Mines Limited gained control of the adjacent Pioneer mine in 1959. The 30 veins on the combined property were developed by 80 kilometres of tunnelling on 44 levels, the deepest of which traced the vein, to a depth of 1900 metres. Approximately half of the underground drifting on this property was in ore. The Bralorne mine was closed in 1971 because of the combination of high production costs and low gold prices ($41 U.S. per ounce at the time). Limited exploration continued until 1975 when the mine was finally abandoned. The company name was changed in 1969 to Bralorne Can-Fer Resources Limited and again in 1972 to Bralorne Resources Limited.

A joint venture by the E & B Partnership, Geomex Development Inc. and Bralorne Resources Limited was initiated in 1980 to outline additional reserves and to investigate the possibility of renewed production under improving gold prices. The program consisted of diamond drilling, shaft dewatering, underground examination, installation of a hoist plus various engineering and feasibility studies. Expenditures from 1980 to 1985 totalled $8.29 million. In 1986 a 60% interest in the property was optioned by Mascot Gold Mines Limited. Exploration programs financed by this company included surface and underground diamond drilling and drifting following the 51B footwall vein on the No.4 and No.8 levels (400 and 800 levels). Reserve inventory at this time amounted to 898 000 tonnes grading 8.9 grams per tonne gold with a cut off of 4.8 grams per tonne, however, much of this is inaccessible in the old workings (Kilburn, 1992). From 1988 through 1991 under management by Corona Corporation Limited, a program of mine rehabilitation, surface and underground drilling, sampling and mapping was undertaken. This company undertook a program of mine rehabilitation, surface and underground drilling, sampling and mapping. Corona determined the the amount of accessible ore above the 800 level to be 51 245 tonnes grading 11.3 grams per tonne gold at 6.8 grams per tonne cut off.

In November 1991 Avino Mines and Resources Limited acquired the property from E & B Explorations, International Corona, Cathedral Gold and Geomex Development. This combined Avino's discoveries on the Cosmopolitan claims to the north with the Bralorne-Pioneer mine potential. Plans announced then by the company were to re-open the mine at a production rate of 300 to 400 tonnes per day. Calculations based on diamond drilling and surface and underground exposures show a proven and probable reserve above the 1000 level of 292 000 tonnes grading 12 grams per tonne gold. There are also estimated reserves between the 1000 and 2600 level (accessible by dewatering the mine) of 673 000 tonnes grading 8.2 grams per tonne (Avino Mines and Resources Limited Annual Report, October, 1992).

Geological Setting

The Bralorne property is underlain by Fergusson and Cadwallader metasedimentary rocks and greenstones which are cut by a major, steeply dipping, southeasterly striking fault system known as the "Cadwallader break". This break is intruded by a variety of dikes, a narrow belt of steeply dipping ultramafic rocks and felsic to basic stocks, the largest of which is an elongate, 0.7 by 3.3-kilometre body known as the Bralorne 'diorite'. This Permo-Carboniferous stock was succeeded by younger intrusions that include a large body of soda granite flanking the diorite on the northeast side, Late Cretaceous albitite dikes and a few post-vein lamprophyre dikes of Tertiary age.

The principal element of the break, the Cadwallader fault, coincides with the narrow belt of sheared ultramafic rocks, 15 to 60 metres wide, at the southwest contact of the Bralorne intrusion. The ultramafic rocks were named the 'President Intrusives' by Cairnes (1937) because of the steeply dipping, dike-like aspect of these rocks although emplacement was probably by injection of a solid or semi-solid crystal mush rather than intrusion of an ultramafic magma. The ultramafites are partially serpentinized and altered to talc but at the Bralorne and Pioneer mines there is no significant listwanitization. The fault consists of numerous gouge-filled fractures dipping vertically or steeply to the southwest and west. Splays and offshoots from the fault interlace through the Bralorne-Pioneer workings northeast of Cadwallader Creek (Figure 5.1, in pocket).

Campbell (1975) noted that the Cadwallader fault zone is essentially straight and uninterrupted for 13 kilometres southeast from Pioneer and over 11 kilometres north from Bralorne. At Bralorne the strike of the fault zone changes abruptly and the principal economic gold-quartz veins occur at this inflection. The change of direction of the Cadwallader fault produced, or reactivated as, the adjacent Fergusson fault. It appears that stresses set up in the adjacent wallrocks induced fractures which mostly subtend the obtuse angle formed by the bend in the system. The easterly dipping Fergusson fault splits off the Cadwallader shear about 1.5 kilometres southeast of Pioneer and rejoins it 2.4 kilometres north of Bralorne, enclosing a lens of rock 5.5 kilometres in length and 0.8 kilometre in maximum width which, because of diverging dips of the enclosing faults, widens and lengthens with depth. All of the known productive gold-quartz orebodies in the Bridge River area occur within this structural lens. Quartz veins within otherwise favourable rock formations along portions of the zone north and south of Bralorne-Pioneer have all proven to be discontinuous and only locally and sporadically mineralized.

Owing to the varied stresses imposed repeatedly upon the rocks within the Fergusson-Cadwallader fault lens, the enclosed rocks failed further by subsidiary shears which diverged from the main Cadwallader shear at low angles and, trending northwest across the lens, tended to join the Fergusson fault at larger angles. These shear fractures were complimented by northeast-trending tensional fractures which opened as irregular gash veins. It is evident from the many ages of sheared and brecciated quartz that the system of fracture sets was adjusted and reopened repeatedly.

Mineral Deposits

The limits of vein fissuring at Bralorne-Pioneer, as delineated by the mining operations, define a rectangular area 4600 metres long and 550 metres wide. The main producing veins occupy tension fractures and shears that strike generally southeasterly, and dip steeply north, cutting diagonally across the Bralorne intrusion that underlies most of the area between the Fergusson and Cadwallader faults. It is worth noting again that the age of the veins is Late Cretaceous (85-86 Ma) the same as the age of the Gwyneth Lake stock and vein alteration of the Bralorne intrusion (Church, 1990a), that is slightly younger than the albitite dikes (86-91 Ma) at Bralorne (Leitch, 1989; Table 2.2, Nos.15 and 16).

Only 15 of the 30 veins at Bralorne-Pioneer produced significant ore. The principal veins in the King section of the mine are the North, Shaft, King, Alhambra and 'C' veins. The important veins in the Crown and Empire sections of the mine are known as the '51' (Empire, Ida May) and '77' (Coronation) veins, the faulted extensions of these are the '55' (Blackbird) and '53', and the crossover veins the '59', '73', '75' and '79'. The bulk of production came from the '51', '55' and '77' veins at Bralorne and the '27' and 'Main' veins at Pioneer. The '77' vein alone produced 1.9 million tonnes of ore.

Most veins are 0.9 to 1.5 metres wide - ranging up to 6 metres in a few places, and are composed of quartz with minor carbonates, talc, mica, sulphides, scheelite and native gold. The quartz is milky white and usually banded with numerous partings and septa of grey wallrock included in the veins as a result of repetitive hydrothermal events (Sibson *et al.*, 1988). Calcite and ankerite occur as light coloured alteration envelopes in vein walls, especially in areas of fair to good ore development. Sericite is locally common in vein partings and altered wallrock. Talc and fuchsite are found in sheared veins near serpentinite associated with the Cadwallader fault. Local vein brecciation is the result of late movement on the vein structure.

Scheelite is widespread in small amounts, as isolated pale orange crystals or little clusters of crystals. Stevenson (1958) reported the occurrence of shoots of a few hundred tons of scheelite ore that were mined in the 1940s near the east end of the 51 vein, between the 500 and 600 levels, and from the west end of the '73' vein on the 1400 level.

Sulphides average 1 to 3% of the vein material. These are mostly pyrite, arsenopyrite, chalcopyrite, sphalerite and, less commonly, pyrrhotite, galena and tetrahedrite. Pyrite is disseminated throughout the veins and wallrocks. Native gold is commonly associated with arsenopyrite as scattered, discreet grains in white quartz and in dark concentrations of fine-grained pyrite, arsenopyrite and pyrrhotite in vein partings. The gold is 80 to 90% pure; it contains 10 to 20% silver and up to 4% mercury. Copper has not been detected (Knight and McTaggart, 1986). Rare high-grade pockets of ore running as much as 45% gold and weighing more than 400 kilograms, have been reported (Joubin, 1948). According to Poole (1955), sphalerite was a minor constituent but the most consistent indicator of high-grade ore (Photo 5.2). Small inclusions of native gold are observed adjacent to, or within sphalerite. Joubin (quoted in Bacon, 1978) noted the presence of sphalerite was often accompanied by a rise in gold content and the occurrence of scheelite and fuchsite signified the extremity of an ore shoot. The fuchsite is earlier than the gold. Stibnite and marcasite are associated mostly with post-ore fractures.

The ore controls are both regional and local. The main regional control is the Cadwallader fault. Stevenson (1958) indicates that most of the movement was along the northeast contact of the serpentine belt, left-lateral motion is suggested by rotation of veins. At the adjacent Pioneer mine, Cleveland (1938) observed "the vein fissures in several instances are deflected from their normal strike on approaching serpentine contacts. The Pioneer, Footwall and Coronation veins all deflect towards the south near this contact. This might be attributed to structural movements or adjustments which have taken place along the diorite-serpentine contact, since this contact exhibits highly sheared rocks."

It is concluded that the ore veins at Bralorne-Pioneer were emplaced in an array of tension fractures resulting from a left-lateral shear couple developed between the Cadwallader and Fergusson faults. Within the structural lens, between the two faults, veins developed in a variety of rock types, although the principal hosts are Bralorne diorite at the Bralorne mine and greenstone at Pioneer. To the southwest the veins end abruptly against the serpentinite; to the northeast the productive segments extend only marginally into the soda granite and argillite.

Campbell (1975) observed that the Bralorne diorite and Pioneer greenstone have similar mechanical characteristics in that they are both generally competent masses yet varied enough to produce changes in fracture characteristics. Consequently most of the fissures in these rocks are complex structures which opened with the shifting stresses, permitting the passage of hydrothermal solutions and deposition of quartz. In contrast, the other main rock type within the lens, the soda granite, is a far more homogeneous and com-

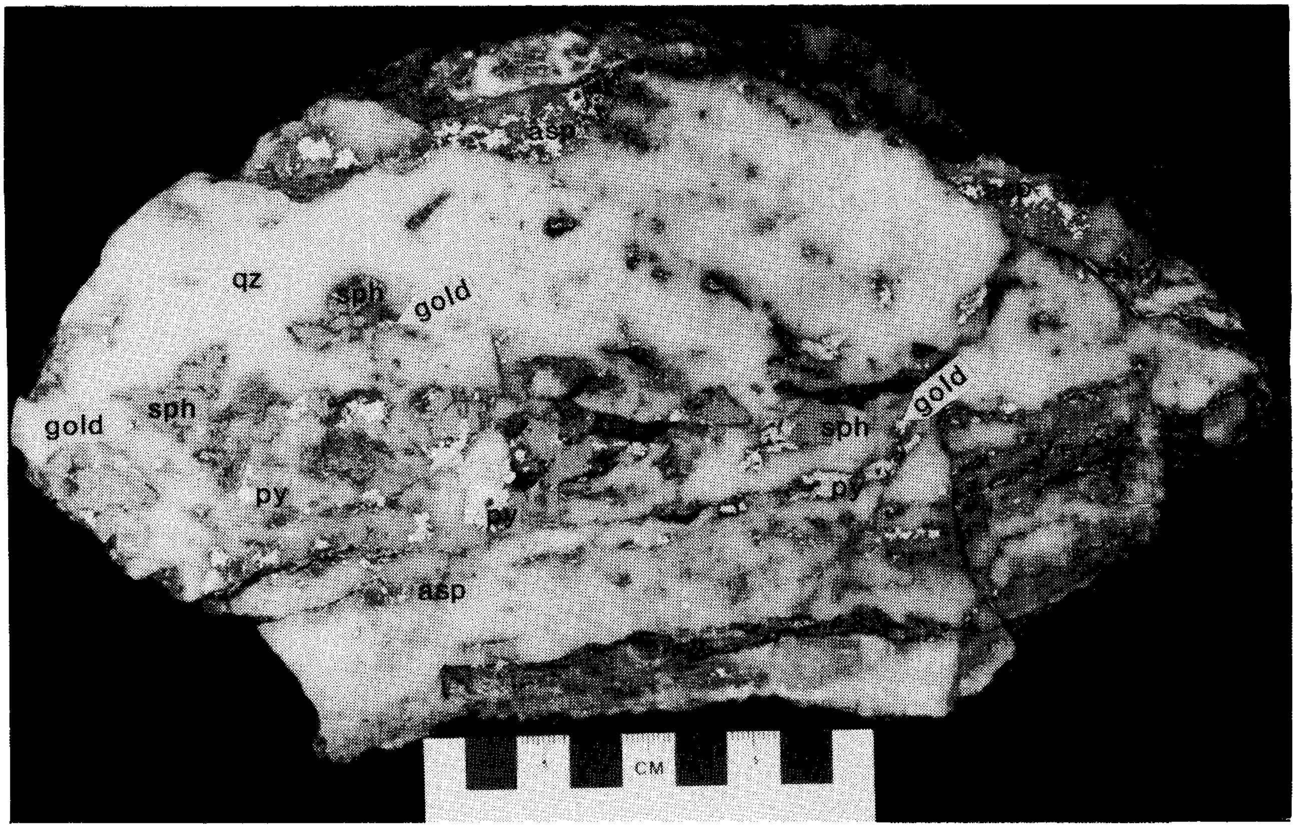


Photo 5.2. Gold and sulphides in quartz, No.51 vein on 400 level, Bralorne mine.

petent rock. It is very brittle and has not sustained single, wide, continuous fissures but rather has failed on tight, braided fractures along which movement in many places has been taken up to some extent on the pre-existing joint system. The quartz veins, such as the '51' vein, tend to become narrow, dispersed and erratic where they traverse the soda granite and gold orebodies are not well developed in this unit.

Abnormal richness in gold was noted by previous workers in veins near the serpentinite belt. It has been suggested by Cleveland (1938) that the serpentine acted as a dam to the mineralizing solutions: "The incompetent rocks, particularly the serpentine, have exerted a strong influence on the distribution of ore merely because the veins died out on entering them. Ore-shoots at the extreme west end of the veins must, therefore, conform on their westerly margins with the trace of the intersections of the vein and serpentine. Thus the west-end ore-shoots of the King vein and of the Pioneer veins rake to the west in part, but there is a definite tendency for an indiviual ore-shoot to pull away from the serpentine with depth and drop vertically down the dip of the vein. A somewhat similar condition exists at the east end of the veins in the centre and west sections of the ore-zone, where the greenstones are somewhat incompetent and do not carry good fissures. A westerly rake of the diorite-greenstone contact is partly responsible for a westerly rake of the ore-shoots" (Cleveland, 1938).

Campbell (1975) also observed that high-grade ore shoots are localized in steeply dipping vein segments: "All of the orebodies on the Bralorne 77 and 79 veins and the Pioneer Main and 27 veins, that is, all of the major orebodies, occur on the steep portions of the veins. Spot checks of a few lesser ore bodies reveal the same relationship. Other structural controls such as branch junctions, segment junctions and lenses also resulted in ore sites in different veins and different parts of veins in the two mines, but these controls are subsidiary to the 'steep and flat' control. This then is the primary control of orebodies at Bralorne and Pioneer and it pertains most commonly where the vein structures have been deflected passing from diorite or greenstone into soda granite, with the steep portions occurring in the former rocks at the contact."

Sulphide zoning is not apparent within the vein system (Joubin, 1948), however, there is a roughly horizontal non-commercial zone in the intermediate levels of the mine, below which grades again improve. Cross-over structures between the veins are developed at or below this zone (Grove, 1974); above it the veins appear to be constricted for an interval. This may have resulted in high-pressure conditions unsuitable for deposition of gold or auriferous sulphides from the ascending hydrothermal solutions.

Post-mineralization faulting consists of reactivation of vein fissures causing brecciation of the veins, shearing of wallrocks and the development of crosscutting fractures that displace the veins. Most post-vein movement appears to be left-lateral on numerous north-trending strike-slip faults. These dip westerly and displace the veins up to tens of metres. They are best developed on the west side of the property in the King and Empire workings (Cleveland, 1938; Joralemon, 1934).

The Empire fault is a significant post-ore fault system that divides the Crown and Empire sections of the mine into east and west blocks. On average the fault srikes 160° and dips 54° west. Matching the veins across this fault has been an ongoing endeavour. Detailed analysis by Poole (1955) shows that it is a reverse fault in which the west block has moved diagonally up the fault to the north resulting in a strike-slip movement of 73 metres and a dip slip of 113 metres. A comparison of facture patterns across the fault (this study) shows a rotation of the principal vein fissures from 118/45NE east of the fault to an average attitude of 105/66NE west of the fault (Figure 5.2). This suggests a rotation between the footwall and hangingwall blocks of about 10°.

It is concluded by Poole (1955) that the 55 and 53 veins in the west (hangingwall) block are faulted extensions of the 51 and 75 veins, respectively, in the (footwall) east block and the 55 vein on the 16th level and below is the faulted equivalent of the 77 vein.

The Ida May or Empire vein, also known as the 51 vein (MINFILE 092JNE002), is one of the largest and in places the most extensively developed veins at Bralorne. The vein extends for a overall length of 1480 metres in the footwall of the Empire fault, striking, on average about 110°, with short deflection to 075°; dips range from 45° northerly to vertical. The vein cuts through soda granite and gabbroic rocks of the Bralorne intrusion; it also follows an albitite dike that is altered to quartz sericite schist. The vein joins the 77 vein at depth (on the 2000 level) on the west and peters out in greenstone at the east end. It is irregular, commonly composed of banded quartz, averaging 0.5 to 2 metres wide and lies within a metre-wide envelope of sheared wallrock. Free gold is associated with arsenopyrite and pyrite intergrowths and locally some fine-grained tetrahedrite. The vein is developed from surface to the 2000 level, a vertical distance of 854 metres. Stevenson (1958) reports production of 0.64 million tonnes of ore containing 13.9 million grams of gold from this vein.

The 51B footwall vein branches from the footwall of the 51 vein and has been followed a few hundred metres on the 400 and 800 levels (Figure 5.3). It is subparallel to the main 51 vein but is locally somewhat flatter in dip, ranging from 25° to 45° north, and the veins converge at depth. The vein 51B consists of both massive and banded quartz ranging from 0.3 to 1.0 metre wide; patches of sulphides and local high grades are the most important features. Over the past several years this vein has been tested by surface drilling and underground drifting. It is one of several partially developed veins on the upper levels with remaining ore potential.

The Blackbird or 55 vein is the faulted extension of the 51 vein, occurring in the hangingwall of the Empire fault (Stevenson, 1958). It strikes easterly, between 085° and 110°, for about 600 metres and dips 65° north to vertical. The vein is principally in diorite although the western 60 metres occurs in talc rock; the southwest end is cut off at the serpentinite. It is well banded and moderately wide, although it narrows to little more than a stringer in altered diorite along the southern side of a sheared albitite dike 40 metres wide. It is a branching vein with a strong hangingwall branch that diverges from the main vein and rejoins again

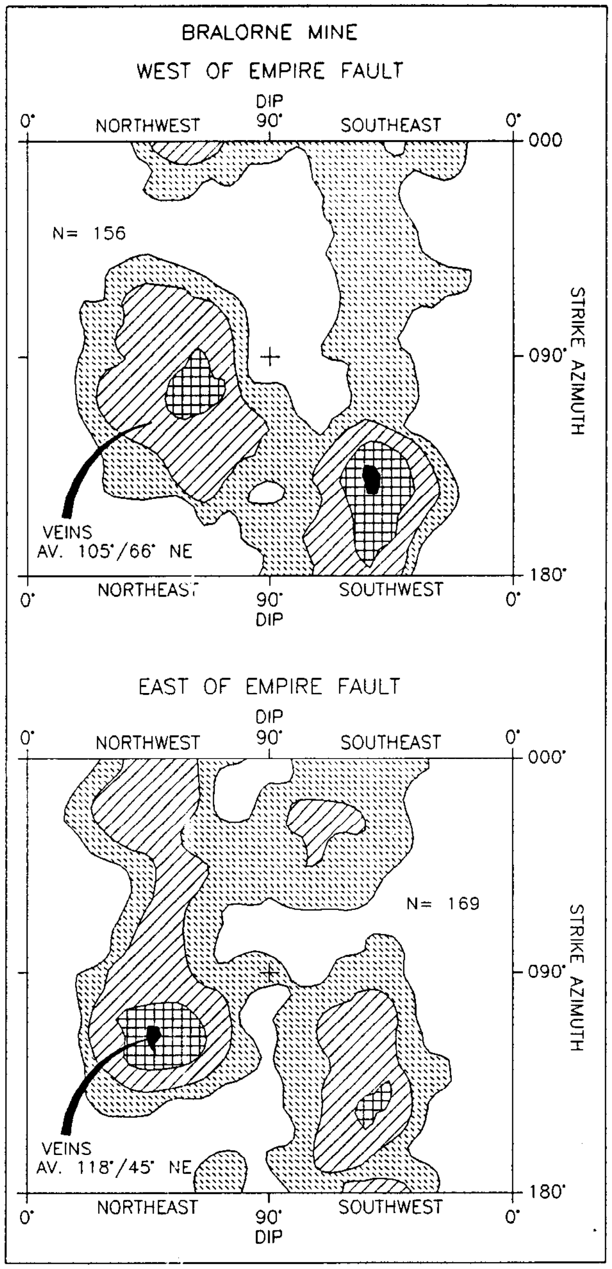


Figure 5.2. Fracture frequency plots for the Bralorne mine.

down dip and along strike. The widest ore shoot occurs where the vein is splayed and several gently dipping branches diverge from the footwall forming east-plunging shoots (Cleveland, 1938). Mining depth on the vein is 396 metres, from surface to the 1400 level. Total production from this vein is 0.27 million tonnes of ore containing 4.9 million grams of gold (Stevenson 1958).

The Little Joe or Coronation vein, also known as the 77 vein (MINFILE 092JNE007),contained the largest and richest orebody in the Bridge River mining camp - 1.9 million tonnes of ore ranging to more than 37 grams per tonne gold. The vein is well banded and varies from a few centimetres to 1.5 metres wide, dips 60° to 70° northerly and is hosted mostly by the Bralorne intrusion. The vein trends east from

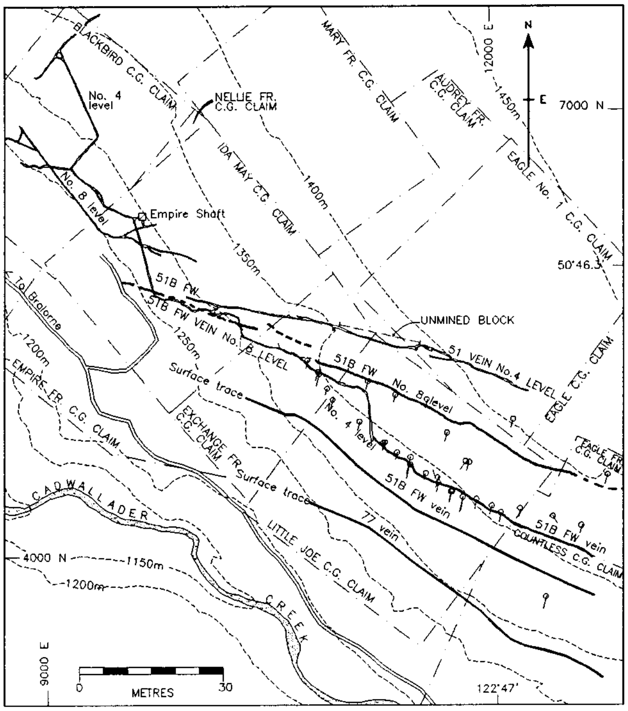


Figure 5.3. Plan of the 51B footwall vein.

the serpentinite where it begins as a weak fracture zone then is deflected sharply near the contact of the greenstone and soda granite and it gradually peters out on the Pioneer ground (Figure 5.1). Below the 1000 level the vein follows an albitite dike 6 metres wide which is altered to quartz sericite schist. The vein is richest and widest where it is steepest and where it approaches the south contact of the soda granite. This ore shoot has been stoped, west of the granite contact, across widths ranging from 3 to 7 metres, over a continuous vertical interval of about 1400 metres, and along strike lengths ranging from 150 to 450 metres. The vein contains quartz, calcite, sericite, ankerite, fuchsite and patches of scheelite. Sulphide minerals include arsenopyrite, pyrite, minor sphalerite, pyrrhotite, chalcopyrite and occasional stibnite, galena and molybdenite. The gold is closely associated with arsenopyrite. The orebody consisted of upper and lower enriched zones and an intervening lean section. At the bottom of the mine, on the 4500 level, the vein averages 38 grams per tonne gold over a width of 2 metres and a strike length of 162 metres (Grove, 1974) - somewhat higher grades than encountered on 3900 and 4100 levels (Figure 5.4). The potential ore reserves below the workings are estimated to be more than 80 000 tonnes at the same grade as on the 4500 level (Grove, 1974; Bacon, 1978).

The 53 vein, the faulted extension of the 77 vein, is described as wide and strong and gradually steepens as it approaches the serpentinite belt. Both the 77 and 53 veins contain numerous branches in the footwall and hangingwall.

The history of vein development at Bralorne was summarized by Joralemon (1934) as follows: "Fracturing of the Bralorne intrusion and adjacent sedimentary and volcanic rocks occurred in grid pattern oriented north and east - the easterly trending fractures predominating. Albitite dikes were intruded along the stronger fractures forming enlarged chimneys, 10 to 15 metres across, at the intersection of the two sets of fractures. Both sets of fractures were then reopened either within or along the margins of the albitite dikes. Early lean quartz, accompanied by small amounts of pyrite and fuchsite, filled the fractures and partially replaced the albitite soon after emplacement of the dikes. This quartz was refractured and refilled with gold-bearing quartz with arsenopyrite and accessory sphalerite, galena and a little tetrahedrite. Significant faulting occurred after vein emplacement. Most of the structural adjustments in the King mine were on the north-trending fractures along the previous veins and aplite dikes in this direction and on new fractures. This resulted in movement of westerly blocks northward and upward."

Joralemon (1934) also concluded that "Field evidence points to the conclusion that the veins are the last step in igneous activity that started with the augite diorite; or perhaps even the peridotite, which was the ancestor of the serpentine. The intrusions from a common source became more acid [by fractional crystallization] through quartz diorite and aplite [albitite], until finally they graded into the more common aqueous solutions that formed the veins."

It is now known (Leitch, 1989), that the albitite dikes are the same age as the Coast Plutonic Complex and not related to the much older Bralorne diorite. Radiometric dating (this study) further constrains the age of mineralization between 81 and 91 Ma indicating that Joralemon was correct in interpreting a close relationship between the albitite dikes and the quartz veins.

COSMOPOLITAN (MINFILE 092JNE164)

The Cosmopolitan property, also known as the Loco property or Taylor claim group, is centred at latitude 50°47′42″ north, longitude 122°48′45″ west, approximately 1.5 kilometres north of the town of Bralorne and 0.5 kilometre west of Mead Lake. Access is from the power-line road which connects the property directly to the town of Bralorne.

Sampling and detailed geological mapping of the property was done by the writer and his field crew in 1987 and 1988. There was a return visit in August 1991 to view rehabilitation of the underground workings on the 800 level and new development work by Avino Mines and Resources Limited near the old Taylor cabin.

History and Development

The property is owned by Avino Mines and Resources Limited and consists of 21 Crown-granted mineral claims and fractions, including the Cosmopolitan claim which is one of the oldest Crown-granted claims in the area. Recent exploration has been focused mainly on the southern part of the property.

The Cosmopolitan claim, which adjoins the King workings of the Bralorne mine, was staked by F.O. Richardson in 1897. Early work consisted of a shaft, several trenches and a short tunnel on a southeasterly striking quartz vein near the northwest boundary of the claim. The vein was re-

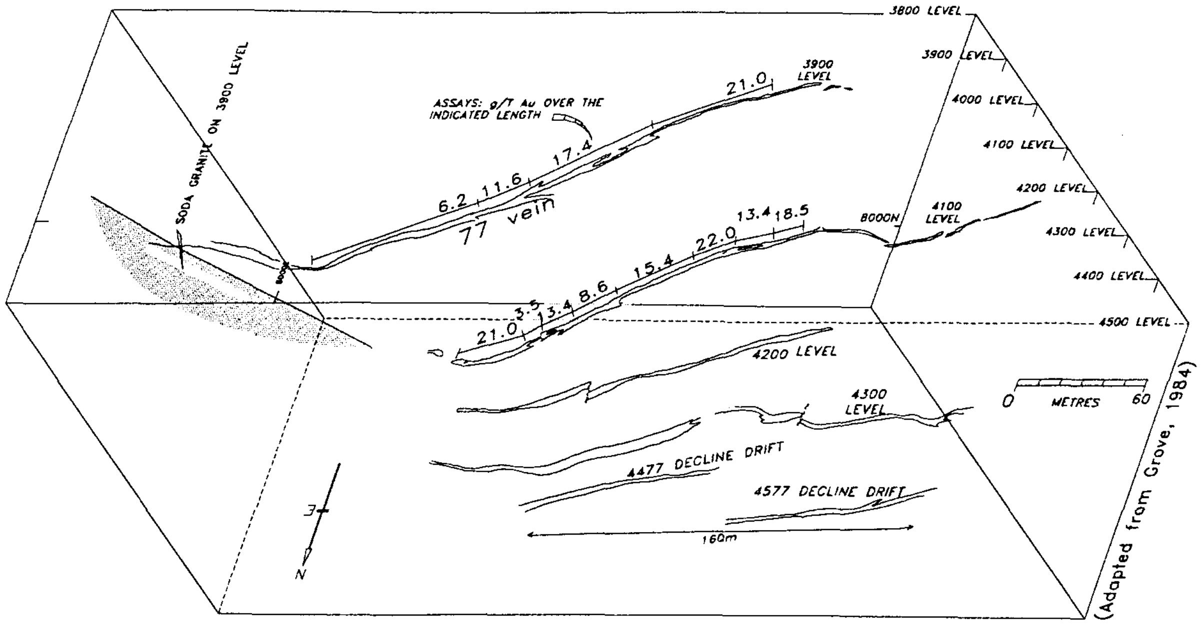


Figure 5.4. Block diagram of the 77 vein on the lower levels of the Bralorne mine.

ported to be steeply dipping and 0.7 metre wide at the shaft and was traced on strike for about 75 metres; an assay of the vein returned approximately 26 grams per tonne gold. A second adit, about 30 metres long, was driven easterly, to intersect a northerly trending mineralized shear zone near the southwest boundary of the claim. Other old workings on the property, now inaccessible but described by Cairnes (1937), include a shaft on a gold-bearing quartz vein close to the southwest corner of the Noelton claim, and two short adits, about 30 metres apart, on the Star No.1.

By 1934 extensive underground development was in progress at the Bralorne mine. A crosscut was extended northward from the King shaft on the No.8 level (800 level) to explore quartz veins on the Cosmopolitan claim. Similar work was later completed on the No.12 level.

The most recent activity began in 1987 with the re-discovery of the Cosmopolitan vein (now believed to be the Peter vein) by the old Taylor cabin in the northwest corner of the Cosmopolitan claim. The discovery was tested by diamond drilling and followed by a broadly based exploration program which included more than 50 trenches and underground development. By October 1988, a crosscut 93 metres long had been driven to a point approximately 20 metres below the discovery trench.

From March to September 1991, access to the vein was completed through the 800 level of the King workings of the Bralorne mine. This required extensive rehabilitation of the main northerly trending crosscut tunnel including the removal of caved material, the installation of new track and air lines. A program of underground diamond drilling on the 800 level was carried out to test continuity of the Peter vein from surface to the northern part of the main crosscut. Drifting on the Peter vein in 1993 proved the continuity suggested by the drilling results.

Geological Setting

The property is located on a smooth glaciated bench (between 1300 and 1375 m elevation) which is bounded on the east by the relatively steep slopes of Mount Fergusson and on the west by the deeply incised post-glacial Hurley River valley. Owing to the extensive glacial drift and till on the property, natural rock outcrops are scarce.

Geologically, much of the property lies between northerly trending splays of the Cadwallader and Fergusson fault systems (Figure 5.5). Subsidiary fractures appear to form boundaries between many of the major lithological units and these may have served as distributary channels for mineralizing solutions.

The bedded rocks on the property comprise the Bridge River Complex, of which the Fergusson chert is the principal rock type, and the Cadwallader Group consisting of three units; the Noel, Pioneer and Hurley formations.

The Fergusson chert is exposed near the northwest and the south boundaries of the claim group. The rocks are medium to dark grey and commonly ribbon banded. The bands are separated by seams of white mica, chlorite and, less commonly, some graphite. Folds are locally well developed but without consistent trend or pattern. Brecciated chert is also common and appears to be the result of widespread dynamic metamorphism of late Paleozoic to early Mesozoic age.

The Noel Formation is exposed in the north-central part of the property and beyond the southwest and southeast boundaries. These sedimentary rocks are characteristically fossil-poor, thinly bedded, dark grey siltstones and argillites. Sheared phases of the Noel Formation are not readily distinguished from the dark, schistose Fergusson rocks, although the latter are typically associated with chert.

The Pioneer Formation crops out on the east side of the property toward Mead Lake (Figures 5.1 and 5.5). It consists of amygdaloidal basaltic lava, volcanic breccia and massive greenstone showing little evidence of primary structures. Well-preserved aquagene breccia, exposed in road cuts south of Mead Lake, appears to be a facies of basaltic pillow lava, a more common rock type in the Pioneer Formation. In thin section these rocks consist of a mixture of amphibole, sodic feldspar, chlorite, magnetite and varying amounts of epidote and calcite.

The Hurley Formation is exposed on the crest of a low ridge immediately north of the property boundary. This is a polymictic conglomerate containing a variety of porphyritic and fine-grained clasts of mainly volcanic derivation. Similar rocks found elsewhere in the region have been assigned a Late Triassic age based on fossil evidence (Church and Pettipas, 1989).

The Permian Bralorne intrusions consist of a relatively large gabbroic body in the Bralorne and Pioneer mine workings and a smaller related body on the Cosmopolitan claims (Cairnes, 1937). The western extremity of the main intrusion, exposed just beyond the south boundary, is a grey rock characterized by numerous criss-crossing light coloured veinlets. In thin section the rock is mostly medium grained and contains abundant chloritized amphibole with pyroxene relicts and altered feldspar accompanied by accessory calcite and epidote. The smaller intrusion is chemically similar (Table 2.10). The primary amphibole and plagioclase are extensively altered to chlorite, clay and sericite. The rock is distinguished from the main intrusion by the presence of accessory quartz and pyrite.

The President Intrusives are discontinuous elongate bodies of serpentinized dunite, peridotite and pyroxenite emplaced along a splay of the Cadwallader fault system near the western margin of the property.

The youngest intrusive rocks in the area consist of a variety of Late Cretaceous to Early Tertiary albitite, feldspar porphyry and lamprophyric dikes. These locally cut across the vein system and can be used for dating the mineralization.

Mineral Deposits

The principal target on the Cosmopolitan property is a pod of the Bralorne intrusion separated from the main body. This detached part is characterized by numerous veins and veinlets, and the development of a locally thick, rusty regolith. This regolith appears to be the result of oxidation of disseminated pyrite resulting in acid leaching and alteration.

The 1987 discovery, located about 70 metres northeast of the Taylor cabin, was exposed by trenching in the oxidized regolith below a cover of glacial gravel and till (Figure 5.5, inset). The vein varies from 90 to 110 centimetres wide and dips 60° northeast to near vertical. It consists of locally banded white quartz with a few discontinous screens of wallrock and some pyrite-arsenopyrite lenses. The vein is accompanied by quartz veinlets in the wallrocks. Contact alteration consists of clay minerals and carbonates. An assay of a sulphide-rich grab sample from the vein returned 332.9 grams per tonne gold, 69 grams per tonne silver, 55 ppm copper, 0.75% lead, 0.45% zinc, 2.40% arsenic and 0.11% antimony.

Cairnes (1937) provides the following description of the geology and mineralization on the 800 level accessed by 1933-34 mine development: "More recent work on this group has been from the No.8 adit level of the King mine. The main crosscut on this level has been extended northerly beyond Bralorne property into the Cosmopolitan claim of the Taylor (Bridge River) property, reaching the boundary of the quartz diorite stock mentioned above. The crosscut continues in this for 450 feet and, 450 feet farther, reaches the more northerly quartz diorite stock and has been continued in this to the face. In the interval between the two stocks several vein-bearing shears were intersected and four of them have been driven on for distances varying from 100 to 800 feet. The rocks in this section are mainly Fergusson sediments, but include towards the south a narrow body of altered, dioritic rock that may be a faulted segment from the more northerly stock. Between this segment and the more southerly stock is a width of 50 to 100 feet of altered rocks of doubtful identity, but probably tuffs or tuffaceous sediments of the Hurley Formation. All of the rocks in this section are fractured and sheared and at intervals there are strong shears up to 15 or more feet wide that are followed by the vein deposits. The shears strike northwesterly and dip northeast. Much of the movement along them is believed to be post-mineral and has resulted in fracturing the quartz deposits and interrupting their continuity. The vein deposits vary up to 6 feet wide, but are mostly much narrower and are discontinuous. In the main northwest drift, 800 feet long, the vein quartz is partly ribboned and sparsely mineralized and is reported to have provided some encouraging assay returns in gold, though average values are low."

The new tunnel on the Cosmopolitan property was collared in an albitite dike and advanced 93 metres northeast along the boundary of the Cosmopolitan claim, in the Bralorne intrusion, intersecting the discovery vein at a point about 250 metres above the same or a similar vein on the 800 level. In fact, the old Cosmopolitan vein, the Peter vein on the 800 level and the recently named Discovery vein found on the surface at the site of the caved Cosmopolitan workings couild be one and the same. Here the tunnel turns southeast and follows the discovery vein 65 metres to the face of the drift. The vein strikes 135°, dips steeply and has a variable width that averages about a metre. It consists mostly of milky quartz, well banded on the margins, with local concentrations of pyrite and arsenopyrite (Photo 5.3). Avino Mines and Resources geologists (personal communication) indicated that the average gold grade of the vein ranges from 13 to 21 grams per tonne. The highest values were obtained between a point midway along the drift and the face (Figure 5.5, inset).

Several veins are intersected by the 800 level crosscut extending north from the King workings. The Peter vein is most conspicuous and ranges up to 3 metres wide. It is strongly sheared and brecciated, consisting of lenses of dark grey quartz with disseminations of pyrite and arsenopyrite.

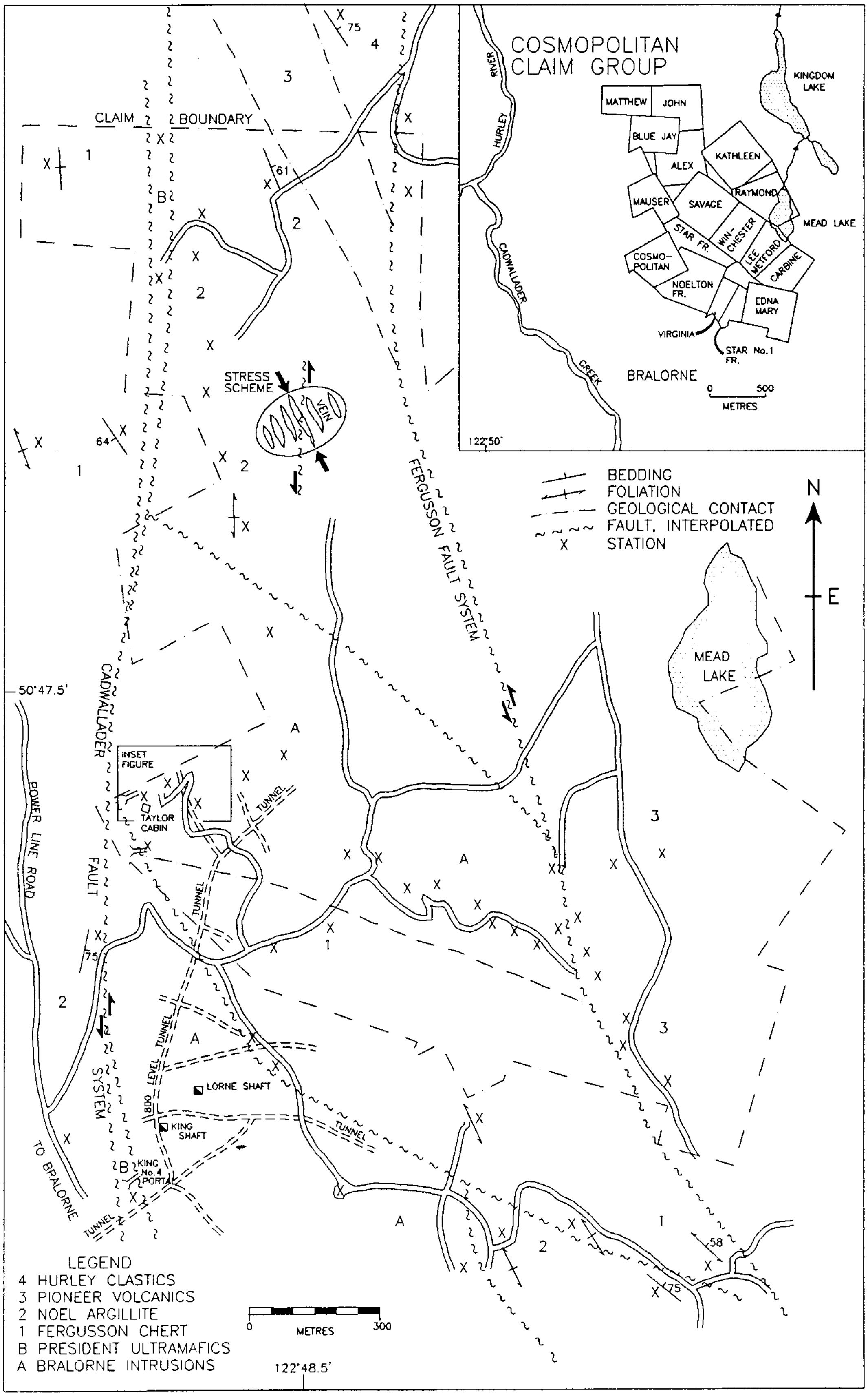
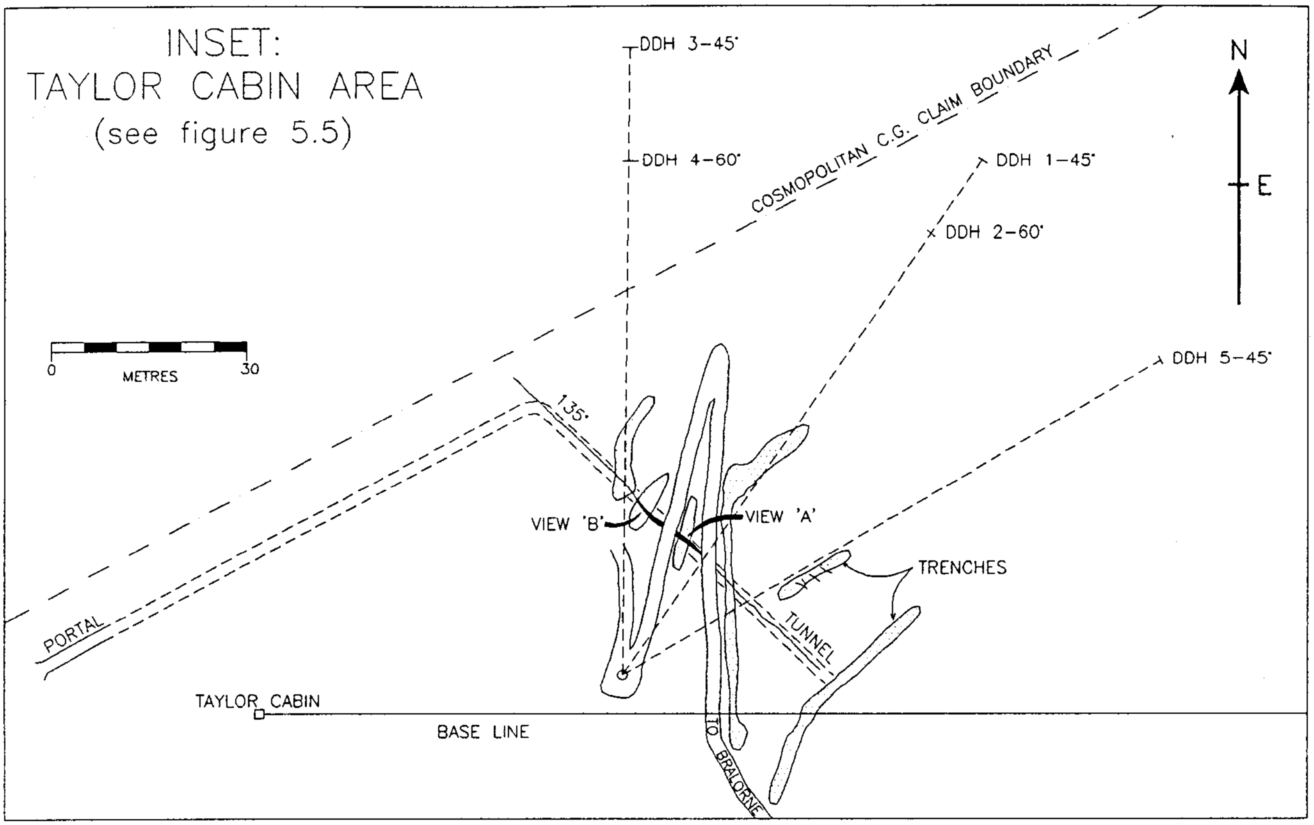
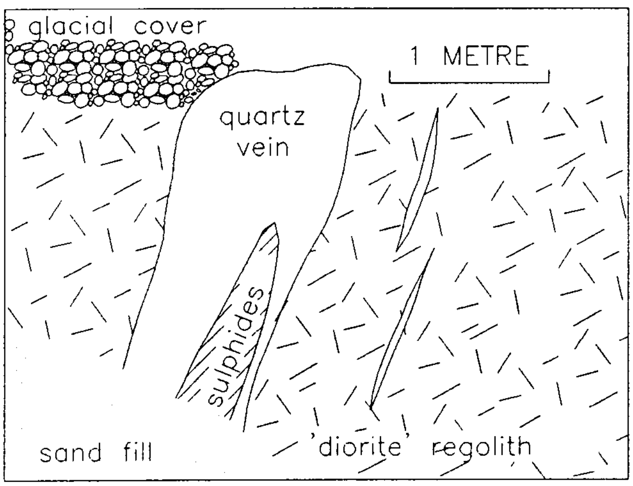
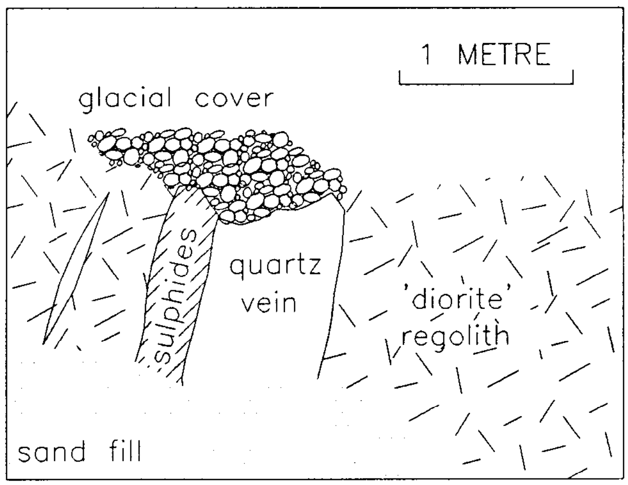


Figure 5.5 Geology of the Cosmopolitan prospect (*see* facing page for details).





View 'A' of trench wall looking S.E.



View 'B' of trench wall looking S.E.

The vein dips 70° northeast and trends southeast along the faulted contact between Noel argillite and Bralorne diorite. A left-lateral shear couple developed between the Fergusson and Cadwallader faults is believed to be responsible for south and southeasterly trending tension fractures in the Bralorne intrusion which controlled vein formation (Church, 1990b).

The age of mineralization is 85.1±3.0 Ma (Late Cretaceous) as determined from a sample of the altered Bralorne intrusion taken from near the Cosmopolitan vein (Table 2.2, No.15). This is well within the age range of the Coast Plutonic Complex from which the mineralizing solutions were probably derived.

ALMA (MINFILE 092JNE003)

The Alma prospect at latitude 50° 47' north, longitude 122°49′54″ west is located on the east Hurley River road, west of Cadwallader Creek, 1 kilometre northwest of Bralorne.

Photo 5.3. Pyrite and arsenopyrite in banded quartz, Cosmopolitan vein.

History and Development

The property was first staked in 1912 and acquired by Grull-Wihksne Gold Mines Limited in 1933. The main development, an adit drift, was completed in 1934. A program of diamond drilling, financed in part by Pinebrayle Gold Mines Limited, was completed in 1946.

Description

The Alma claim and the adjacent area are underlain by Fergusson schist that hosts a body of intensely altered soda granite and associated quartz porphyry and albitite intrusions. The focus of exploration was a weakly mineralized quartz vein and offshoot stringers traced southerly for about 35 metres in the Alma adit. The vein follows the footwall of the small granitic body dipping 75° east, opposite to the dip of the foliation in the schist. The vein varies from several centimetres to 0.5 metre wide and contains silicified fragments of wallrock with disseminated pyrite and scattered fuchsite. Assay results on the vein reportedly range to more than 9.4 grams per tonne gold (McCann, 1922).

NATIVE SON (MINFILE 092JNE006)

The Native Son claims are centred at latitude 50°46′12″ north, longitude 122°48′2″ west, about a kilometre southwest of Bralorne and adjoining the west side of the Bralorne property. Access is southerly about 1.5 kilometres from the east Hurley River road to the main portal (Figure 5.6).

History and Development

The property was first assembled by Native Son Mines Limited in 1933 and consisted of nine Crown-granted claims. A camp, compressor and mining equipment were installed and a road to the portal area was completed at this time. This work coincided with development of a crosscut tunnel (on the Peacock Fraction) driven southwest from the slopes west of Cadwallader Creek at approximately 1200 metres elevation. The tunnel was advanced 180 metres without returning values sufficient to encourage further development.

Pinebrayle Gold Mines Limited was formed in 1945 to consolidate and develop 34 claims centred on the Native Son group. A program of general prospecting, trenching and diamond drilling succeeded in locating a quartz vein on the Native Son No.3 claim, however, assay results were not encouraging. A long drill hole (~380 m), collared just south of the Alma claim (about a kilometre northwest of the Native Son tunnel) and directed to the southwest, passed through cherty and argillaceous sedimentary rocks but found no continuation of the Alma mineralization. A short exploratory adit on the Ogden claim, just above Cadwallader Creek, immediatetly north of Bralorne, failed to locate significant mineralized veins.

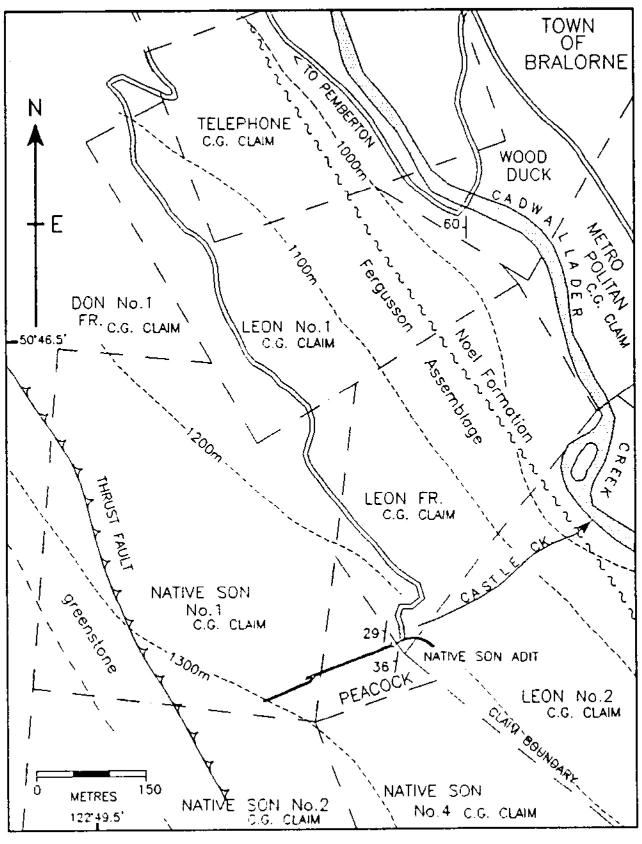


Figure 5.6. Plan of the Native Son claims.

Description

The property is underlain by cherts, argillites, greenstones and serpentinite. The average strike of formations is northerly with beds dipping variably to the west. Noel argillites are well exposed along Cadwallader Creek, Fergusson chert, argillite and greenstones crop out mainly to the west. Contacts between these units are commonly obscured by glacial till and gravel.

Although several quartz veins have been found on the property, Dolmage (1945) reported that none of these are continuous with the veins in the Bralorne mine immediately to the east: "The producing veins [at Bralorne] terminate so far from the Pinebrayle boundary and end so abruptly in the serpentine [on the Cadwallader break] that there seems little likelihood that they extend onto the Pinebrayle property."

He also notes: "The veins consist mainly of quartz with lesser amounts of calcite and ankerite and exceedingly small amounts of pyrite and in these respects they resemble the productive veins. They differ from them in their lack of gold, stibnite, arsenopyrite, chalcopyrite and other metallic minerals."

Dolmage reports further: "The two veins which most closely resemble the productive veins are one just north of Carl Creek [Short O'Bacon showing] and one on the Native Son No.2 claim. The Carl Creek vein occurs at the margin of a body of serpentine and contains, besides quartz, much albite and mariposite, two minerals commonly found in the productive veins. The Native Son vein above referred to is situated several hundred feet [a few hundred metres] south of the Native Son tunnel and has been opened up by a few surface cuts now badly caved. This vein besides being associated with much albite and pyrrhotite contains small amounts of stibnite, arsenopyrite and pyrite. Because of these constituents it more closely resembles the productive veins than any other vein on the Pinebrayle property."

Discontinuous quartz veins to 0.5 metre wide are also exposed above the Native Son adit and the portal area and from the face to midway in the tunnel. They are sparsely mineralized with pyrite, pyrrhotite, arsenopyrite and stibnite. The adit reportedly cuts across siliceous argillites, greenstones, a narrow band of serpentinite and what appears to be granitic apophyses. No ore grade mineralization was found.

SHORT O'BACON (MINFILE 092JNE016)

The Short O'Bacon prospect, at latitude 50°46′36″ north and longitude 122°50′12″ west, is just west of Carl Creek at an elevation of 1175 metres, 1.5 kilometres west-southwest of Bralorne. Access is by 1.5 kilometres of bush road to a well-kept hunting cabin above the falls on Carl Creek, south of the Hurley River (east) road. The Short O'Bacon portal, accessed by a switchback road, is 335 metres southeast and about 100 metres above the cabin. The geology of the property was investigated by the writer in September 1987.

History and Development

The Short O'Bacon adit (now collapsed) was driven by Bridge River Ogden Mines Limited in 1933 at the same time as development work on the adjacent Native Son and Ogden claims. In 1945 the property, consisting of a group of eight claims (the Peru claim group), was acquired by Pinebrayle Gold Mines Limited (controlled by Leitch Gold Mines Limited). This resulted in a program of diamond drilling and surface exploration included trenching south of the Short O' Bacon adit up Carl Creek. In 1947 the option was dropped and there has been little subsequent exploration activity in the area. The prospect was restaked in 1975 as the RE claim that comprises four units corresponding to the Peru Nos.3, 4, and 6 claims and the Dry, Wet, and T claims of subsequent years. The property was then optioned to the B.R. Jewel Syndicate and examined and reported on by Dirom (1979, 1982).

Description

The property is underlain by Pioneer greenstones on the west and faulted slices of Noel argillite and Fergusson chert on the east, the principal formations being separated by a serpentine-carbonate zone that coincides with a major northerly trending shear zone on Carl Creek . The Short O'Bacon vein has been traced southerly (160° azimuth) by underground drifting (20 m) and in surface pits and stripping following a possible splay of the Carl Creek shear. The vein is steeply dipping and ranges from several centimetres to 2 metres wide; It consists of quartz with minor carbonate stringers, pyrite and fuchsite; no significant gold values are reported. Another quartz vein occurs in a wide shear zone at the greenstone-serpentinite contact on the east bank of Carl Creek. This vein is 30 centimetres wide and sparingly mineralized with pyrite and a small amount of gold. The hostrocks are strongly sheared, talcose and enriched in mariposite and pyrite cubes. A third, southeast-striking quartz vein hosted in sheared greenstone is exposed about 200 metres west of the Short O'Bacon adit. It is 1.2 metres wide at the main showing and contains a minor amount of sericite, chlorite, pyrite and low gold values.

BR JEWEL (MINFILE 092JNE135)

The Bridge River Jewel property, consisting of 10 Crown-granted claims (BRJ group), is centred at latitude 50°45′30″ north, longitude 122°50′48″ west two kilometres southwest of Bralorne. The claim group adjoins the west boundary of the RE property and is accessed by an 850-metre extension of the Short O'Bacon road to the BRJ adit southwest of Carl Creek.

History and Development

The property is part of the original Ho Bo group of claims staked in 1934. The only development on the property is a series of trenches and an adit on No.1 vein driven about 120 metres by Pioneer Gold Mines of B.C. Limited in 1938. Olympic Gold Mines Limited acquired an interest in the property in 1946 and drilled four short holes. Results were disappointing and the company relinquished its interest in the property. The property was restaked as the BR Jewel claims and the BR Jewel Syndicate was formed in 1948. The underground drift on the No.1 vein was extended 40 metres at this time and numerous trenches and drill holes were put in. The most recent work on the property by the BR Jewel Syndicate and Carl Creek Resources Limited, in the period 1979 through 1982, consisted of resampling and surveying the trenches and three diamond-drill holes to test the continuity of the No.1 vein.

Description

The BR Jewel prospect consists of weakly mineralized quartz veins in sheared greenstones. The main showing, the No.1 vein, is a well delineated quartz vein, averaging 0.6 metre wide, in a fault zone exposed in a series of trenches and in the Ho Bo adit (Figure 5.7). The vein is mostly massive white quartz surrounded by an envelope of gouge and brecciated wallrocks. It strikes easterly and northeasterly to 060°, dips 45° to 65° southeast and is exposed for a strike length of about 130 metres. The south end of the vein is truncated by a northwesterly trending cross fault. The vein carries a small amount of pyrite, tetrahedrite and arsenopyrite. Assay results on core samples taken from two diamond drill holes gave an average of 22 grams per tonne gold and 60 grams per tonne silver across a width of 0.8 metre (Dirom, 1982). The best assays are reported to occur where the vein is split by the fault. Two other veins, one 61 metres south of No.1 vein and the other 550 metres to the south-southwest are reported barren.

GRULL (MINFILE 092JNE017)

The Grull prospect is centred 2 kilometres northwest of Bralorne and 300 metres northeast of the confluence of Cadwallader Creek and the Hurley River at latitude 50°47′48″ north, longitude 122°49′42″ west. Access is directly from the Gold Bridge - Bralorne highway.

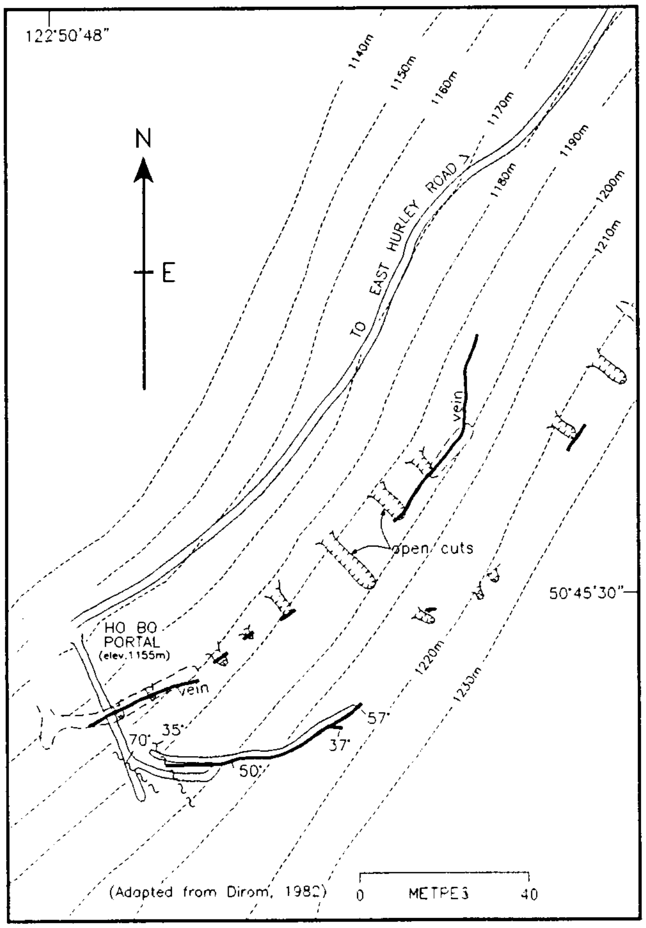


Figure 5.7. Plan of the BR Jewel workings.

In August 1991 the writer traversed the property from the Bralorne Highway to the old power station and suspension bridge on the Hurley River.

History and Development

Work on the original Blue Ribbon claims began in 1912. The property was restaked and the present Silver King Crown-granted claim near the mouth of Cadwallder Creek was subsequently acquired by J. Grull. By 1933 total development consisted of 460 metres of tunnelling in two short adits and a long one. In 1934 Grull-Wihksne Gold Mines Limited took control. A program of tunnelling and diamond drilling was soon suspended because of disappointing results.

Description

Thin cherty beds of the Fergusson group are cut by a felsic dike which is traversed by quartz stringers. Several fissures dip steeply west and strike southwest across the sedimentary rocks. Quartz veins varying from several centimetres to a metre in width are nearly continuous within the fissures for about 75 metres. Shorter, discontinuous quartz bodies also occur. Sulphides in the veins, pyrite and arsenopyrite, are scanty, carrying mostly low gold values, with local highs. Minor gold is associated with arsenopyrite (Figure 5.8).

SUCCESS (MINFILE 092JNE017)

The Success prospect is centred 1 kilometre east at the confluence of Cadwallader Creek and the Hurley River at latitude 50°47′15″ north and longitude 122°49′15′ west.

History and Development

A 46-metre adit, driven by B.C. Cariboo Goldfields Ltd. in 1933 is the only significant development on the property although exploration activity in the area began in 1914. More recent work on adjacent properties includes a small amount of trenching without significant results.

Description

The Success showing consists of irregular and discontinuous gold-bearing quartz veins associated with brecciated Cadwallader Group (Pearson, 1975).

GOLDEN LEDGE (MINFILE 092JNE165)

The Golden Ledge workings are located on both sides of the Hurley River midway between the Bralorne and BRX properties, centred approximately at latitude 50°48′30″ north, longitude 122°49′48″ west, 1350 metres northeast of the confluence of the Hurley River and Cadwallader Creek. Access is from the main Gold Bridge to Bralorne road, 6 kilometres south of Gold Bridge.

History and Development

The property consists of 26 claims including five reverted Crown-granted claims and fractions.

Quartz veins exposed on the walls of the canyon section of the Hurley River were the focus of early exploration. The

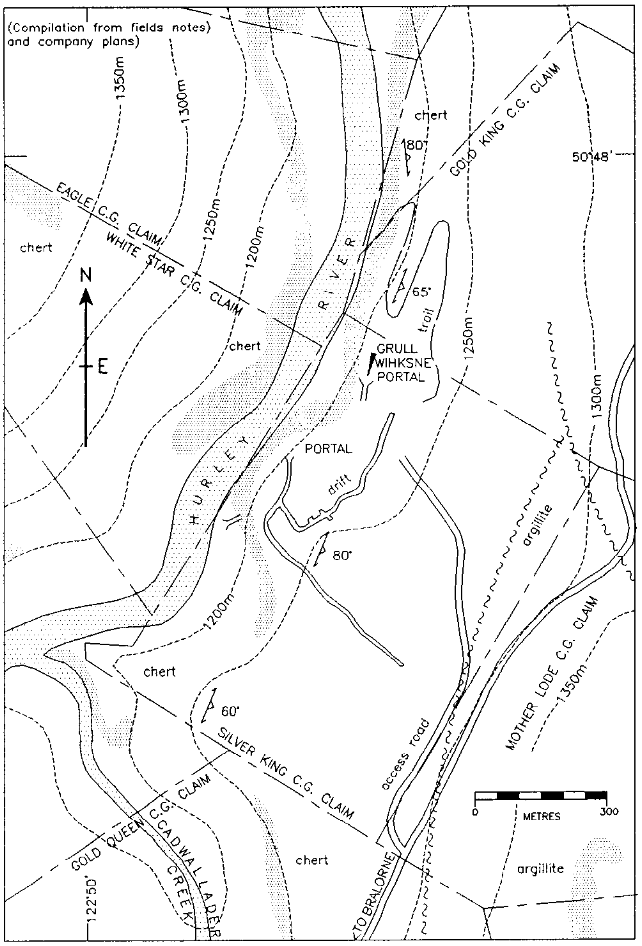


Figure 5.8. Plan of the Grull workings.

first work, completed in the period 1933 to 1934, consisted of several open cuts and two short adits. In 1935 the No.3 adit was begun 100 metres above river level and driven easterly to the Ruth vein (Figure 5.9). Also, at this time, the Jupiter vein, west of the river, was traced 400 metres in a series of open cuts. From 1939 to 1940 the No.4 and No.5 adits were driven to intersect the Jupiter and Ruth veins. In 1951 drifts were extended and a crosscut was driven westerly from the north drift on the No.5 level. A cable crossing was re-established at this time to connect the No.4 workings to the west with the main operations on the east side of the river. In 1952 a total of 250 metres of exploratory tunnelling was completed in the No.4 adit. This work included extension of the existing crosscut and drifting on the Jupiter and Louise veins.

Geological Setting

The principal formations exposed in the workings are greenstones, ribbon chert, black argillite, quartz- carbonate rocks and serpentinite. Lenses of the latter two rocks, up to 9 metres thick, are locally interbanded with chert in the northern part of the property, possibly on a splay of the Cadwallader fault zone. The trend of the formations is northerly, coinciding generally with bedding attitudes observed in the chert. This trend is offset locally by transverse faults.

Mineral Occurrences

Two main veins, the Ruth and Jupiter, and several smaller veins and leads such as the Louise and Jesse Anne were explored. These are described in an unpublished report by Stevenson (1958): "The Ruth vein has been followed by approximately 300 feet [90 m] of drifting in No.3 adit and about 800 feet [240 m] of drifting in No.5 adit. It consists principally of a single quartz lens, 6 inches to 2 feet [15 to 60 cm] wide, in a shear zone 1 to 4 feet [0.3 to 1.2 m] wide. The quartz is usually massive but in places it is ribboned. The mineralization is slight and consists principally of a small amount of fine pyrite. However, where ribboned, the vein contains numerous fine crystals of arsenopyrite in the sericitic partings of the ribbons. Tetrahedrite and even pyrrhotite occur here and there in the vein quartz; chalcopyrite and galena have been reported in small amounts."

Stevenson (1958) also reports that the southern part the Ruth vein is in greenstone and the northern part is in argillaceous chert where it is discontinuous. In the No.3 adit, the north end of the vein at the face is a faulted lens of quartz 1 metre long and 8 centimetres wide. At the south end of the same adit the vein is badly faulted and discontinuous along strike and at the face consists of 2 to 8 centimetres of quartz in 5 to 15 centimetres of shear. In the No.5 adit the northern part of the vein is cut off by a strike-slip fault 35 metres from the face; at the south end there is strong faulting and the vein is narrow and discontinuous as in the No.3 level. The Jupiter vein was first discovered in the bluffs on the west side of the river and traced by stripping for a few hundred metres. It was subsequently intersected by the cross-cut of No.4 adit and followed southerly for 55 metres. Where intersected by the crosscut and for about 30 metres, the vein consists of a stockwork of quartz stringers 1 to 3 centimetres wide. Most of the stringers strike northerly and dip about 50° to the west, however, a set of diagonal stringers in the central part of the stockwork strikes north-northeast and dips 10° to 40° to the northwest. To the south along the drift, the stockwork grades into a single quartz stringer about 30 centimetres wide that narrows to a few centimetres at the face. The Jupiter vein, like the Ruth, follows a strong strike-slip fault containing, in places, 30 centimetres of gouge. The Louise vein was intersected at 68 metres from the No.4 adit portal. It consists of two stringers of quartz ranging from a few centimetres to 0.3 metre wide, dipping 30° to 35° west. The quartz is massive and sparsely mineralized with scattered pyrite, similar to the Jupiter vein. The Jesse Anne adit was driven southerly from a draw on the east bank of the river in the quartz-carbonate zone in the northern part of the property. This adit explores vertical carbonate stringers and veins 2 to 45 centimetres wide. No quartz veins were encountered. A number of other small showings were explored on the property during the early years of prospecting. For example, Stevenson (1958) notes several narrow quartz veins, 2 to 10 centimetres wide and 3 to 30 metres long, that are exposed on the bluffs 150 metres south-southeast of the Jessie Anne adit. Another vein exposure, 90 metres upstream from the No.5 adit, has a strike length of about 75 metres in a chimney near the top of the bluffs on the east side of the river. The vein dips 45° to 60° northwest following a north-northeasterly trending

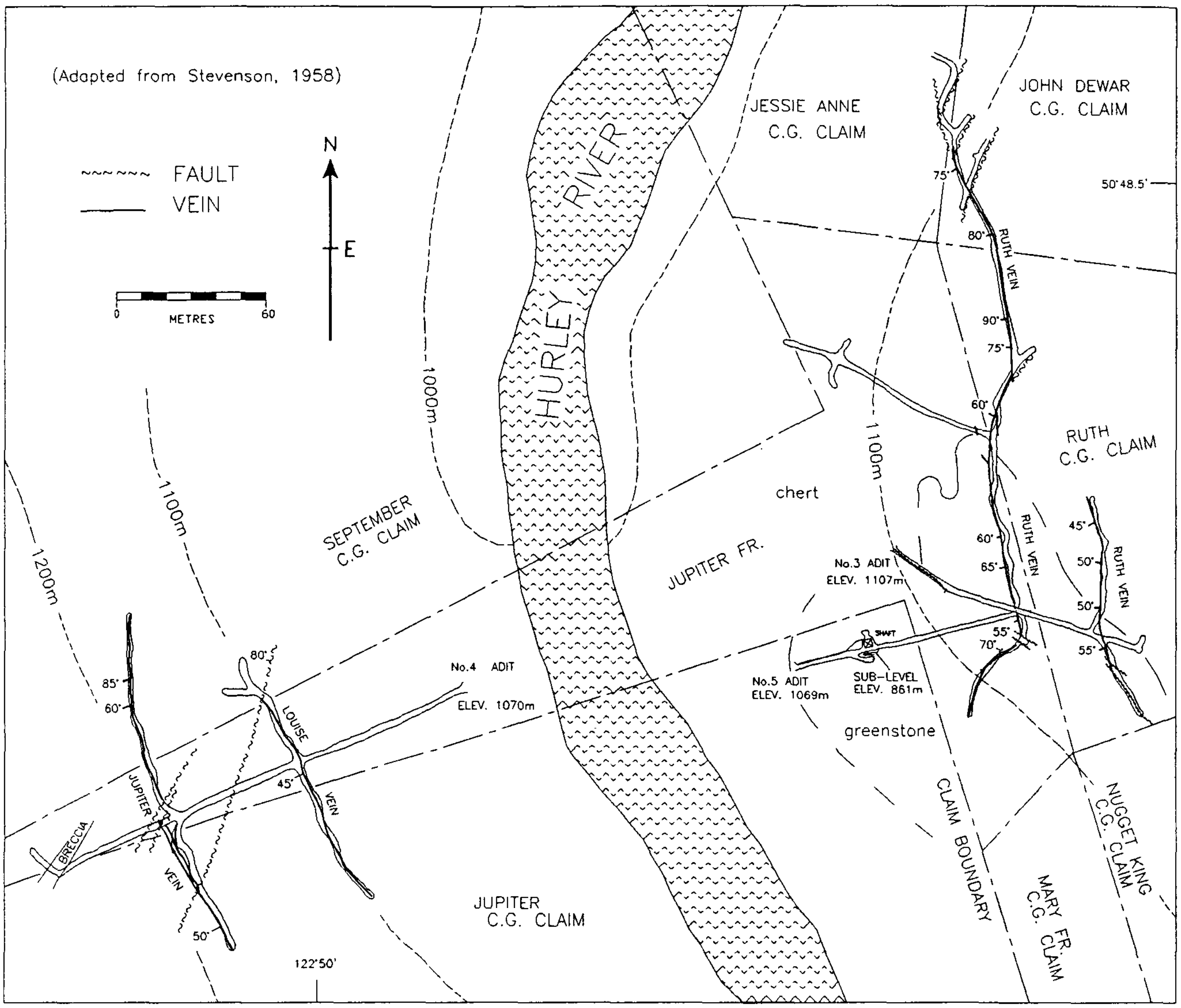


Figure 5.9. Plan of the Golden Ledge workings.

shear zone. Other small, relatively unmineralized quartz veins are exposed above, near the highway to Bralorne.

BRX (MINFILE 092JNE020, 021, 022, 023, 024, 025)

The BRX property comprises a block of 65 units, mostly reverted Crown-granted claims, about 1.5 kilometres wide. The block extends southerly, mostly just east of the Hurley River, from the town of Gold Bridge for 8.5 kilometres to near the north boundary of the Bralorne property. Access to most of the property is from numerous dirt roads branching off the highway between Gold Bridge and Bralorne.

The property was first visited by the writer in July 1986 when the L.O.X. crosscut at the Arizona mine was examined. The Ural, Why Not and California mines were visited in 1987. Because these and the other workings were partially collapsed some of the details for this report are quoted from previous authors.

History and Development

The property consists of several mine workings that together comprise more than 6000 metres of underground tunnelling. The most important developments are on the California and Arizona claims (Figure 5.10).

The Ural, Forty Thieves and Why Not claims were staked in 1896 and 1897 in the canyon section of the Hurley River. Intermittent surface and underground work was attempted on these claims for many years, then the claims came under the ownership of Bridge River Consolidated Mines Limited in 1928. This company drove the No.2 adit crosscut on the Ural claim to intercept the Forty Thieves vein. The present property was assembled in 1931-32 by Bridge River Exploration Limited. In 1932 BRX Consolidated Mines Limited optioned Bridge River Consolidated holdings and drifted on the Forty Thieves vein from the Ural workings. Work also began at this time on the 2900-foot adit at the Arizona mine and No.2 adit on the C-2 level at the California mine (Figure 5.11). In 1933, BRX Gold Mines Limited was formed and work progressed on the No.3 adit (C-3), the main entry connected to the plant at the California mine. In 1934 the No.1 inclined shaft was developed on the California shear down to the No.6 level (C6).

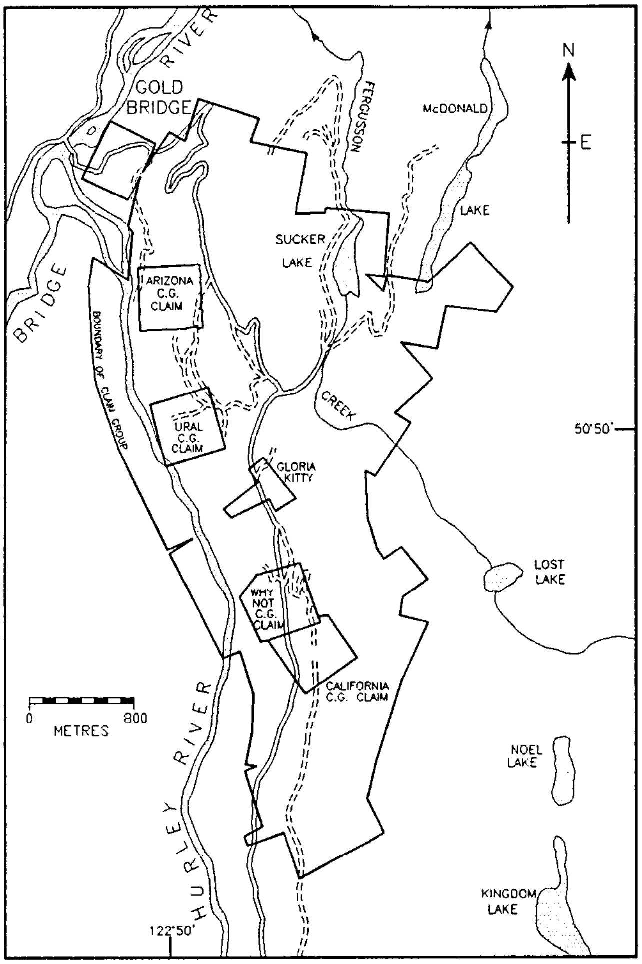


Figure 5.10. Location of the BRX claim group.

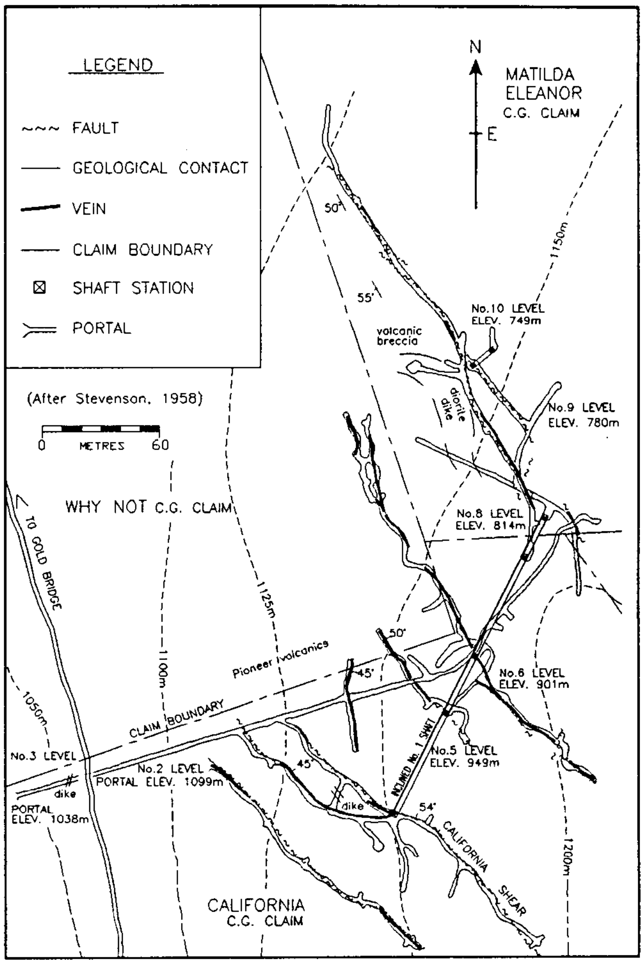


Figure 5.11. Plan of the California mine.

In 1933 and 1934 the Consolidated Mining and Smelting Company of Canada Limited (Cominco) completed surface and underground drilling to test the Why Not vein.

The camp at the Arizona mine was enlarged in 1934 and work started on the main "L.O.X." crosscut to intersect what was thought to be the continuation of the California vein-shear zone (Figure 5.12). In 1935 underground work progressed at the Arizona and the vein-shear zone was intersected 562 metres from the portal and drifted on to the north and south. A winze was sunk from the north drift and drilling completed from short tunnels on a lower level. In 1936 BRX Gold Mines Limited reorganized and BRX (1935) Consolidated Mines Limited was formed. At this time the south drift advanced a total distance of 752 metres. In 1937 the No.2 shaft was sunk 165 metres from a crosscut driven easterly 84 metres. The vein was cut again on the sublevel (500 level) where it was drifted on for another 900 metres north and south. In 1938 a ventilation raise was completed to surface 221 metres from the main level. A mill with a 100-ton daily capacity was built in 1937-38 and a small amount of development ore was treated. A total of 4342 tonnes of ore yielded 425 grams of gold and 28 grams of silver (one brick and one button of doré). In 1939 all mining activities ceased due to financial difficulties.

A minor amount of exporation and mine rehabilitation work was done on the Arizona, California and Gloria-Kitty claims in 1940. There is no record of work done during the period 1941 to 1943. In 1944 a modest drilling program was completed on the Arizona claim and in 1945 equipment was moved from the Arizona to the California property.

BRX Consolidated Mines Limited drove the No.3 crosscut and drift on the Ural claim in 1945-46 based on the results of drilling the Forty Thieves vein in 1945. In 1946 work stopped and the mining plant was dismantled.

At the California mine, in the period 1947 to 1950, the No.1 shaft was completed to the No.9 level (C-9), a total length 282 metres, and development extended along the vein structure on the several levels to this depth. Work on the C-9 north drift to the winze, and No.10 level (Figure 5.11) was completed in 1949-1950.

Bridge River United Mines Limited acquired the property in 1959 after a dormant period. In 1960 and 1961 this company, together with Rayrock Mines Limited, extended the road system to the foot of the Why Not bluffs where a program of diamond drilling was completed. The Ural No.3 adit was reopened giving access to the Forty Thieves vein for sampling and mapping.

Hat Creek Energy Corporation held the property in 1979 and for several years focused on diamond drilling and rehabilitation of the underground workings on the Arizona,

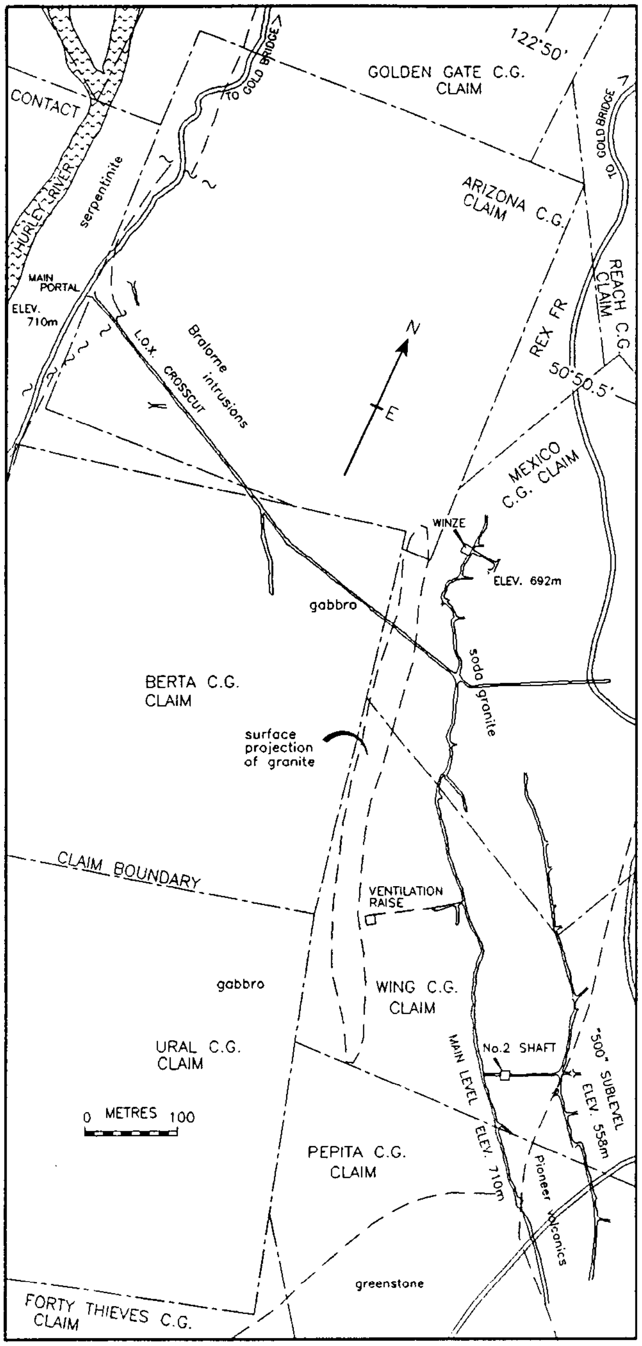


Figure 5.12. Plan of the Arizona mine.

Golden Gate and Gloria-Kitty claims. In 1984, Levon Resources Limited began re-evaluation of the BRX property based on geophysical and geochemical surveys, trenching, and drilling. This program continued until 1988.

Geological Setting

The BRX claims are underlain by a variety of metamorphosed Paleozoic rocks consisting mostly of Fergusson cherts and greenstones, Bralorne intrusions and units of the Triassic Cadwallader Group consisting mostly of Pioneer volcanics and Hurley clastic beds. The rocks are extensively faulted and cut by a variety of small intrusions including numerous fine-grained and porphyritic Cretaceous and Tertiary dikes.

A band of serpentinized peridotite 60 to 180 metres wide, following the lower section of the Hurley River along the western boundary of the property, coincides with a major fault zone that is believed to be the northern continuation of the Cadwallader break (Figure 1A). West of this are mostly steeply dipping Fergusson beds. A complex of greenstones and Bralorne plutonic rocks lie to the east in a zone 5000 metres long and 800 metres wide. The north half of the complex is mostly Bralorne intrusive rocks consisting of gabbro and anorthosite and small patches of soda granite. The south half consists of a mixture of greenstones and Bralorne gabbro. The gabbro in this area is locally comminuted by shearing and so intermixed with the greenstone that the rocks are often indistinguishable.

The Cadwallader rocks are best exposed in the central and eastern parts of the claim group. The Pioneer Formation is the most widespread. The unit consists of volcanic breccia, amygdaloidal lava, and massive sills and dikes. The Hurley Formation occurs north and south of Sucker Lake and consists of argillite, sandstone and conglomerate, including a limestone conglomerate unit 50 metres thick on the May claim.

From previous geological reports it is apparent that the workings of the California mine (now closed) are in massive lava flows and breccia. According to Stevenson (1958) five major breccia horizons can be seen on the north drive of C-8 level and in diamond-drill core. These dip 50° to 60° southwest and appear to be right way up. The volcanics are cut by quartz porphyry and feldspar porphyry dikes which are well exposed on the C-3 level and some of the lower levels of the mine. The largest quartz porphyry dike, about 2.5 metres wide, is located 30 metres northwest (*see* Fig. 5.11) of No.1 shaft on the C-3 level. This is a northerly striking, steeply dipping dike. The rock is light grey with quartz eyes 1 to 5 millimetres in diameter, accompanied by some small rectangular feldspar crystals, set in a fine-grained groundmass. An example of a feldspar porphyry dike is exposed in No.3 adit, about 30 metres from the portal (Fig. 5.11), and in a cut on the main highway to Bralorne above the portal. This porphyry is cream coloured and 1 to 1.5 metres wide. The feldspar phenocrysts, although not always easy to see in hand specimens, can usually be readily recognized in thin section.

The Arizona mine is mostly in gabbro-diorite phases of the Bralorne intrusion (Figure 5.12). This rock is mottled dark greenish grey and medium to fine grained and is best exposed along the entry crosscut and on the nearby bluffs in the Hurley valley. Serpentinite is exposed on the east and west banks of the Hurley River and in the area adjacent to the main portal. These rocks are a continuation of an ultramafic zone that can be traced up the Hurley River to beyond the California claim (Figure 1A). In the main crosscut adit the contact between the serpentinite and the gabbro is a nearly vertical plane of crushing 2 to 3 centimetres wide. On the west bank of the Hurley River the contact between the Fergusson cherts and serpentinized ultramafic rocks is a steeply dipping zone of shearing containing pods of listwanitic rocks. Soda granite is exposed in a relatively small area of the Arizona property, mostly in the north drift and part of the main south drift of the mine and on surface near the boundary of the Wing and on the Berta claim (Stevenson, 1958). Near the intersection of the entry crosscut and the main drift drilling indicates a thickness of 30 metres of granite. The same granite, sampled by Pearson (1977), exposed 250 metres above, near the collar of the ventilation shaft, yielded a K-Ar date of 62.5 Ma.

Mineral Deposits

Several significant veins were discovered on the BRX property in the early years but the most promising proved to be the vein on a prominant northeasterly dipping shear zone in the California mine. According to Stevenson (1958) the length of the California vein from the southern extremities of the California mine through the Why Not, Gloria-Kitty and Ural workings to the north drift of the Arizona mine is 2470 metres; the total vertical depth is in excess of 600 metres. The nature of the vein is quite variable. Along strike it changes markedly in width and composition, from a well-defined quartz vein more than 2 metres wide to a stockwork of quartz stringers with only a small amount of sulphides to simply lenses and pods of suphides in a shear zone.

BRX Consolidated Mines Limited intended to fully develop the California vein by connecting the Arizona and California workings, however, this was never completed. Indeed, the California vein may not be a continuous structure. Kelly (1979) reported that there are two nonaligned vein systems, the true California vein being located about 500 metres southwest of the Arizona workings. Both systems dip about 50° northeast, but one strikes north-northwest subparallel to formational trends and principal shearing and the other is a crosscutting northwest-striking system; the main ore shoots occur at the intersection of these fractures.

The underground workings of the California mine (MINFILE 092JNE020) are shown in Figure 5.11. The mine, centred at approximately latitude 50°49′20″ north, longitude 122°49′12″ west, is developed on a vein structure traced for about 750 metres striking 120°, dipping 45° to 60° northeast. According to Stevenson (1958), in the upper levels of the mine the vein averages about a metre wide and consists of banded quartz or quartz breccia with minor sulphides, mainly pyrite and traces of arsenopyrite, chalcopyrite, galena and sphalerite. Assay results on a segment of the footwall strand of the vein on C3 level show a range from 7 to 14 grams per tonne gold across 1 metre (Joralemon, 1935) and assays on the C6 level are reported to range to 27.43 grams per tonne gold over 2.1 metres on a discontinuous structure. On the lower levels the vein is quite different, consisting of a shear zone up to 3 metres wide containing concentrations of sulphides in lenses several centimetres thick and several metres long, with only a minor amount of vein quartz. The sulphides are mainly pyrite accompanied by some arsenopyrite, chalcopyrite and sphalerite. The schistose hostrocks are glossy dark green or black chlorite with veinlets and small lenses of jasper and quartz. Shearing is not always confined to a narrow zone and may occur as much as 15 metres laterally into the wallrocks. Gently dipping gash fractures associated with the California shear zone suggest reverse fault movement and westerly vergence of the hangingwall. Some of the highest gold assays are reported where sulphides are impregnated in the shear zone, however, overall values obtained to date have been subeconomic.

The Why Not workings (MINFILE 092JNE021) develop the Why Not and Jewess veins; the latter is believed to be a continuation of the California shear (Figure 5.13). The adit portal is about 50 metres below the top of the east bluff in the Hurley River canyon (latitude 50°49′20″ north, longitude 122°49′30″ west). The adit follows the Why Not vein 400 metres northerly, at a point 106 metres from the portal, a drift follows the Jewess vein 100 metres to the southeast. According to Cairnes (1937), the Why Not vein is a poorly mineralized, easterly dipping, quartz-filled fissure ranging from a few centimetres to a few metres wide with inclusions and screens of altered wallrock. The Jewess vein consists of lenses of quartz, often less than a metre wide, separated by long intervals of schist with little or no vein filling. Alteration adjacent the veins consists of bleached greenstone composed mostly of ankeritic carbonate mixed with quartz, feldspar and scattered pyrite. The largest zone of alteration, about 15 metres wide, occurs at

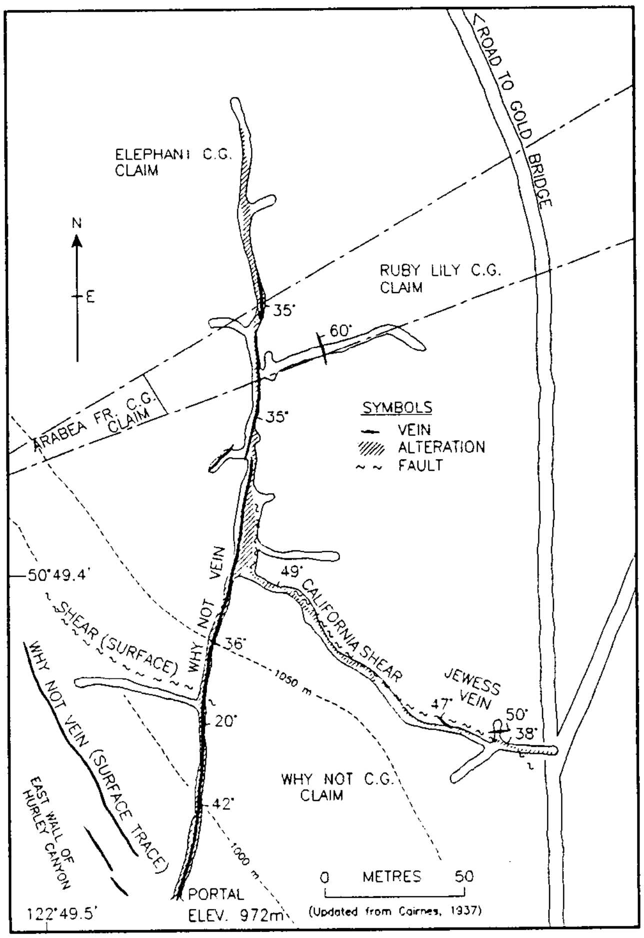


Figure 5.13. Plan of the Why Not workings.

this intersection of the Why Not and Jewess veins. The best mineralization occurs over an interval of 15 metres at a point 60 metres north of this intersection.

The Gloria Kitty workings (MINFILE 092JNE022) are centred about 800 metres north of the California mine (Figure 5.10). They consist of two adits adjacent to the main Gold Bridge to Bralorne road in an area of mixed Bralorne gabbro, greenstones and albitite dikes. The main adit, about 150 metres long, follows a strong southeasterly trending vein-fissure; the second adit collared 24 metres to the south was driven easterly on a weaker vein for about 30 metres. Vein quartz on the fissures is usually narrow and discontinuous, although in a few places lenses of white quartz range up to 0.5 metre wide. Pyrite and arsenopyrite occur sparingly in the vein quartz and more abundantly as concentrations a few centimetres wide on the fissures. Production from these workings is reported to have been 4343 tonnes of low-grade material (Harrop and Sinclair, 1986).

The Forty Thieves vein (MINFILE 092JNE023) follows a northwest-trending shear zone (reverse fault) in a complex of Bralorne plutonic rocks and interfingering fine-grained greenstones. The vein is exposed for a strike length of about 280 metres on the Ural and Forty Thieves claims, 1300 metres northwest of the Why Not vein, in the canyon section of the Hurley River (Figure 5.14). The vein is developed from the main adit (No.3) of the Ural mine which begins at road level near the base of a precipitous bluff, 60 metres above the Hurley River. The entry crosscut trends east and northeasterly from the portal, intersecting the vein at about 145 metres. Drifts extend 150 metres and 160 metres respectively northwest and southeast from the crosscut. The vein is sparsely mineralized with streaks of pyrite, tetrahedrite and minor chalcopyrite in massive and coarsely crystalline white quartz averaging about a half metre wide and dipping 50° to 60° northeast. Except for a few high-grade gold samples most of the vein is subeconomic averaging less than 0.34 gram per tonne gold (Stevenson, 1947a).

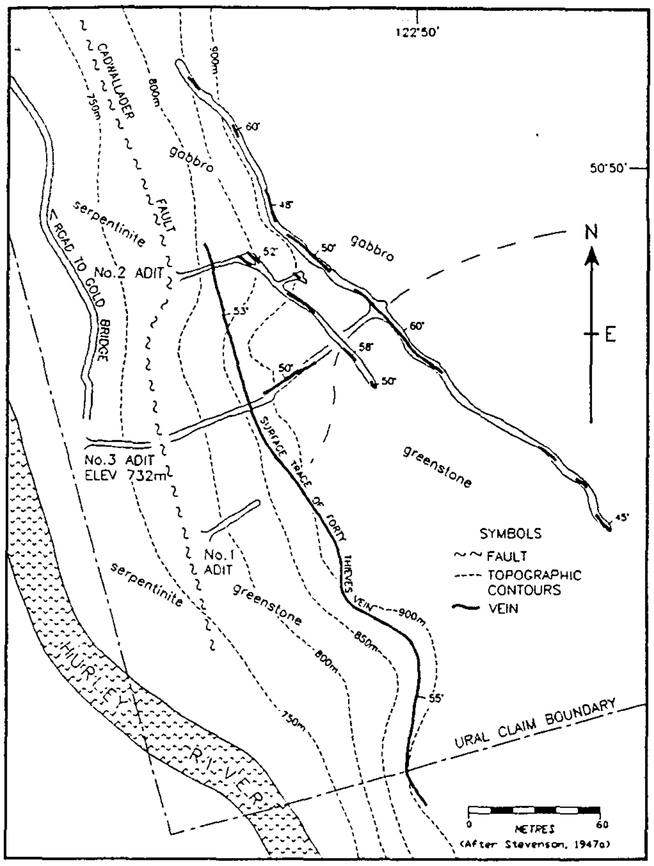


Figure 5.14. Plan of the Forty Thieves vein, Ural mine.

The underground workings of the Arizona mine (MINFILE 092JNE024) are shown in Figure 5.12. The main portal is near the east bank of the Hurley River 1.2 kilometres south of Gold Bridge. Kelly (1979) gave a detailed description of the Arizona mineralization. He noted that the veins range from several centimetres to more than 2 metres wide and extend hundreds of metres on strike. He described the veins as, "principally quartz-calcite fracture fillings which have themselves been subjected to repeated fracturing, reopening and renewed injection of mineralizing solutions. These successive events follow a pattern of decreasing temperature, as evidenced in the suite of minerals deposited in each successive pulse. The initial fracture filling was mostly quartz containing sparse pyrite and scheelite. This is a high-temperature assemblage and implies a nearby parent magma. Further movement re-opened some of the veins and the main deposition of pyrite, arsenopyrite and pyrrhotite occurred, together with calcite and some gold. The next fracturing was followed by the principal stage of free gold deposition, largely deposited in the fractured arsenopyrite. Together with it came calcite and the base metal sulphides, chalcopyrite, tetrahedrite, sphalerite, galena and molybdenite. The final stage, at low to moderate temperature (several hundred degrees Celsius) consisted of some gold, acicular arsenopyrite and finely crystallized pyrite, together with quartz and calcite. Depending on its history of fracturing, a given vein may carry only one of these mineral suites."

Alteration is manifest by the wallrocks being soft and light coloured. The lateral extent of alteration ranges from a few centimetres to several metres from the vein and is more pronounced adjacent to quartz veins as compared to the calcite filled vein. The alteration is predominantly carbonates, mostly ankerite, with some sericite and fuchsite, and disseminated pyrite.

The ore shoots occur at intervals. Kelly describes these as arcuate sections interspersed in otherwise moderately straight, but slightly zig-zag stretches of vein with low gold values. The shoots are usually 150 metres or more in length and bend by as much as 15 metres off strike. They are made up of straight segments, from 3 to 60 metres in length, which represent the two different sets of fractures characteristic of this area, a northerly trending and a southeasterly trending set (120° to 150°), both dipping easterly at about 50°. The intersections of these fractures are the favoured sites of mineral enrichment. Gold values run from 0.7 gram per tonne, typical of the values found in the veins between the ore shoots, to 26 grams per tonne within the shoots.

Molybdenite is reported to occur as grains and streaks in the veins and as disseminations in the soda granite. A quartz-scheelite vein in the soda granite, just below the diorite contact, assayed 0.25% tungsten oxide and 0.72 gram per tonne gold; by comparison a siliceous sheared vein in the diorite above the granite contact yielded lower tungsten values (0.02% WO_3) and higher gold (4.1 g/t Au) values.

Kelly (1979) proposes a granitic source for the mineralizing solutions. He notes, "Early investigators recorded exposures of silicic intrusives at the surface, between 1500 and 2000 feet (450 and 600 metres) east of the intersection of the Arizona adit cross-cut and the main vein. Masses of soda granite and albitite (aplite) were noted and surface work revealed substantial widths of vein quartz carrying gold. These bodies were recognized as favourable host rock for gold-bearing veins. No mention was made, however, of the possibility that they could represent the magmatic source of the mineralized veins in the area."

Furthermore, "The concept of a mineralizing source lying east of the Arizona vein system, emerged from my study of the intersecting vein segments and their values, as entered on the old assay maps. The segment intersections show a pronounced tendency to converge down-dip towards the area of the silicic intrusives and, on the lower level especially, the NNW vein system tends to enter that area on strike."

It then follows, "that the vein systems involved should show progressive changes up dip from that magmatic source from mineralization typical of high temperature deposition to that of lower temperatures as previously described. Those veins which have undergone re-opening and renewed mineralization, may show overlapping of types and superposition of one phase of mineralization on another. These are likely to be the most interesting ones; on the lower level they are in the NNW set, but on the main level, in the NW set."

Kelly concludes, "Close to the invading magma, fracturing of the invaded rock would probably have been most extensive and mineralization of the opening, by freshly released solutions, most intensive. Intensive mineralization, however, may not necessarily be economically exciting, as it might be in the high temperature barren zone. But a vein which has been repeatedly re-opened and re-mineralized, would have received successive solutions of declining temperatures as the igneous sources progressively cooled; it could therefore become the repository of a suite of lower temperature minerals of greater economic interest."

The Golden Gate workings (MINFILE 092JNE025) are east of the Hurley River approximately 450 metres north-northeast of the Arizona portal, and adjacent the access road connecting the property to Gold Bridge. The 50-metre adit explores a wide shear zone trending southeast (155°) and dipping northeast at the contact between the gabbroic Bralorne intrusion and an albitite dike. The shear has slickensides on the margins, and contains small concentrations of needle-like prisms of arsenopyrite with associated gold values.

LOST GOLD (MINFILE 092JNE058)

The Lost Gold prospect, also known as 'Stibnite' and 'Oro', is centred 4 kilometres west of Bralorne and one kilometre south of Gwyneth Lake at latitude 50°46′40″ north, longitude 122°52′25″ west. Access is by trail off of the old Hurley road southwest of the original bridge site on the Hurley River. The property was mapped by the writer in August 1986.

History

The Lost Gold property was first staked in 1946 as the Ann Nos.1 to 8, Mint Nos.1 to 8, and the Cecilia Nos.1 to 8 claims which are now part of the Oro and X-Cal claim groups. Hurley River Mines Limited did some trenching and drilling in 1959. Rayrock Mines Limited optioned the property and continued the drilling program in 1960. New Congress Resouces Limited completed a small amount of geochemical work in 1979 and 1980. The most recent work was line cutting, trenching and soil sampling by Levon Resources Limited in 1984 and 1985.

Description

The prospect is underlain by the Paleozoic Fergusson ribbon chert and schist and the main formations of the Late Triassic Cadwallader Group including Pioneer volcanic breccia, Noel black argillite and Hurley conglomerate and sandstone. The Late Cretaceous Gwyneth Lake granodiorite and a number of basic and intermediate dikes comprise the intrusive rocks (Figure 5.15).

The principal mineral prospects consist of quartz-carbonate veins hosting massive stibnite carrying gold and silver values. The source of the mineralization is believed to be the nearby granodiorite stock.

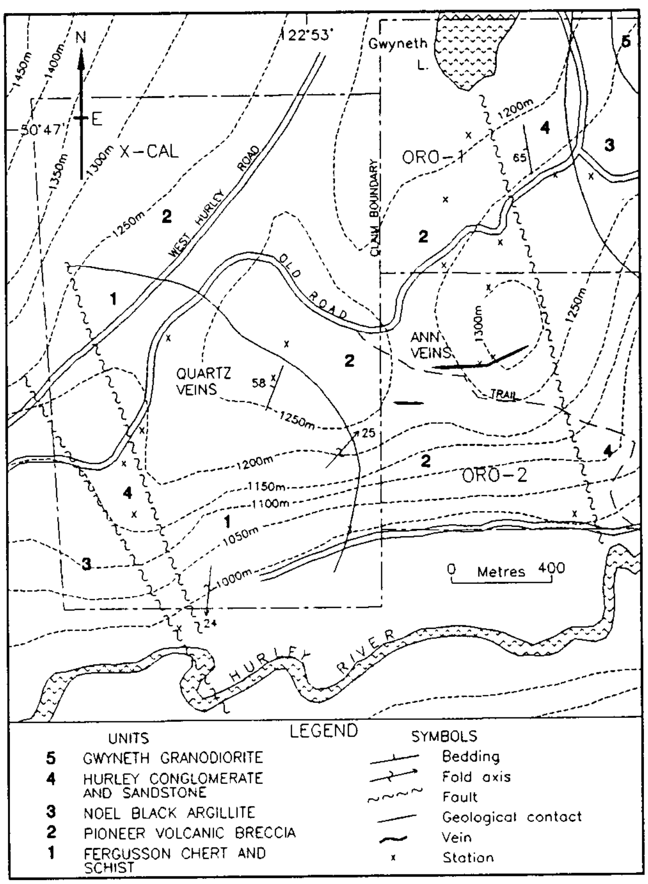


Figure 5.15. Geology of the Lost Gold prospect.

The first description of the mineralization was provided by Stevenson (1947b): "The showings on the Ann group [Oro No.2] consist of a quartz vein and two quartz-stibnite veins. The quartz vein is near the Manson Trail, about 1 mile [2 km] from the bridge over the Hurley River. The vein, about 10 inches [25 cm] wide, extends with a strike of north 65 degrees east and a dip 50° southeastward for a few feet in slightly sheared, fine volcanic breccia.

"The one quartz-stibnite vein is exposed 350 feet [150 m] west of the quartz vein and about 100 feet [30 m] above the Manson Trial. This vein, strike east-west and dip vertical, is exposed in a pit 8 feet [2.4 m] deep and in a stripping that extends 225 feet [70 m] westerly from the pit. The vein consists of both fine-grained and coarsely crystalline stibnite in a lenticular rib of quartz, up to 1 foot [30 cm] in width, that follows a shear zone up to 3 feet [90 cm] in width. A sample taken across a 3-foot [90 cm] width of shear-zone in the east face of the pit assayed: gold nil, silver, nil; antimony, 26.1%.

"The other quartz-stibnite vein is about 200 feet [60 m] south-westerly from the west end of the above stripping and is exposed in a series of four cuts for a strike length of about 70 feet [20 m]. The vein consists of a rib of stibnite and quartz, 4 inches [10 cm] wide, that follows a 6-inch [15 cm] shear, strike east-west and dip 55° northward.

"The rock in these showings is fine volcanic breccia, dark green in colour and massive in structure."

These stibnite showings are hosted in Pioneer volcanics and sediments near a hornblende porphyry dike. Narrow veins in shears are 60 metres long by 25 centimetres wide and contain an average of 8.9% antimony (Cooke, 1986). Northeast of the original showing, also on the Oro No.2 claim, two narrow stibnite-quartz-calcite veins are hosted in quartz diorite near a felsite dike. The veins strike north-northwest, dip steeply north and average 7.5% antimony over 25 centimetres for 15 metres strike length.

On the Oro No.3 claim, three narrow quartz calcite veins containing minor disseminated pyrite, chalcopyrite and stibnite occur in a quartz diorite stock near the contact with Hurley sediments and volcanics. The veins average 30 centimetres wide, strike north-northwest and dip steeply west. Assays yield up to 12.0 grams gold per tonne and 97.4 grams silver per tonne in grab samples (Cooke, 1986a).

The several veins on the Mint claims (X-Cal), also described by Stevenson, are mostly northeast and southeast-trending barren quartz veins in Fergusson chert beds or in basic and intermediate dikes intruding the chert.

TRUAX (MINFILE 092JNE059)

The Truax prospect is located west of Truax Creek, 10 kilometres southeast of Gold Bridge and directly southeast of the summit of Mount Truax at latitude 50°48′37″ north, longitude 122°42′00″ west. Access is from the Gray Rock road near the head of the Truax valley.

History and Development

The first report of showings on the southeast slopes of Mount Truax was by O'Grady (1937d) in his description of the Gray Rock property and the Truax Creek area. In 1959 Hurley River Mines Limited staked 15 claims in the area and completed a program of stripping and diamond drilling. The property was acquired by Dawson Range Mines Limited in 1970. The work completed by this company included trenching and two diamond-drill holes. Levon Resources Limited gained control of the property in 1985 as part of a broader investigation of the Gray Rock mine area.

Description

The property is underlain by metasedimentary rocks of the Bridge River complex near the contact of the west lobe of the Bendor granodiorite intrusion. Three subparallel quartz veins in a shear zone contain stibnite and arsenopyrite with associated gold values. Assays reported by Hurley River Mines Limited ran 5 to 62 grams per tonne gold, 38 grams per tonne silver and 34.25% antimony.

TRUAX GOLD (MINFILE 092JNE060)

The Truax Gold prospect, previously known as the Rock-Roy property, consists of a cluster of mineral showings and gossans centred at latitude 50°49′30″ north and longitude 122°45′40″ west (elevation 2300 to 2600 m), 3 kilometres west of the summit of Mount Truax. Access to the property is by a rough mountain road from the valley of Fergusson Creek via the Lost Lake branch of the Kingdom Lake logging road that joins the Gold Bridge to Bralorne highway. The total driving distance to the property is about 11 kilometres from Gold Bridge

The mineral showings were sampled for petrographic studies and the geology of the property was mapped by the author in August 1988.

History and Development

According to Sampson (1987) the first prospecting on the property was in the 1930s. Prospectors were attracted to the area by high-grade mineralized float scattered accross south and westerly facing talus-covered slopes. Birthday, B.N.M., Commerce and Stewart are the names of some of the original claims in the area. A shipment of 15 tonnes of hand-cobbed antimony-rich ore from the Stewart claim in 1941 is the only recorded production. In 1964 Frobex Limited acquired an interest in the property and subsequently did some bulldozer trenching with disappointing results. For a time Demsey Mines Limited owned the property, then in 1970, Westview Mining Company Limited purchased the Rock claims and staked the adjoining Roy claims. This company completed 13.8 kilometres of magnetic and electromagnetic surveys with no apparent follow-up work and the claims were allowed to lapse. Coral Energy Corporation Limited, later Coral Gold Corporation, subsequently secured the ground and in 1985 began a new program of trenching, sampling and a geochemical soil survey.

Geological Setting

The property covers part of the northwest lobe of the Bendor pluton which intrudes the Fergusson ribbon chert and a variety of metamorphosed rocks including biotite quartz gneiss, garnetiferous schist and amphibolite. The composition of the pluton is mostly biotite hornblende granodiorite, although it ranges locally to granite and diorite. The rocks are predominantly light grey, medium grained and even textured. On average they consist of 10 to 20% quartz, 55 to 65% plagioclase, 5 to 15% amphibole, 5 to 10% biotite and accessory potassium feldspar, magnetite, apatite, sphene and zircon. The rocks are cut locally by quartz veins and a few aplite dikes that are thought to be related to the final cooling stage of the pluton.

The age of the Bendor pluton has been determined by K-Ar analysis of biotite from gneiss (63.4±2.0 Ma) near the Gray Rock mine and from the granodiorite (64.3±3.0 Ma) above Hawthorn Creek by the southern margin (Church and Pettipas, 1989). Determinations of 69.5 to 98.4 Ma on zircon from granodiorite in the Fergusson Creek area give a somewhat older age range than the K-Ar results suggesting a Mesozoic inheritance (Church, 1989).

The rocks of the pluton are normally well jointed due to cooling and post-intrusion stress. From a random survey of outcrops on the property, the main fracture sets are 180/80W and 073/25NW; somewhat weaker sets are at 015/62SE and 045/30NW. The gently northwest-dipping fractures are most commonly mineralized.

Mineral Occurrences

There are many trenches showing evidence of mineralization scattered along the upper section of the main access road as quartz veins and gossans associated with pyrite disseminations in the granodiorite. The most interesting mineral occurrences are exposed in trenches Nos.1 to 6 on the northwest part of the property (Figure 5.16).

Trenches 1A and 1B are on a gossan zone centred 550 metres east of the west end of the main access road. According to Sampson (1987), trench No.1A exposes stibnite, arsenopyrite and "ruby silver" in a quartz vein 3 to 35 centimetres wide, striking 160° and dipping 22° southwest. Trench 1B, 50 metres to the east, exposes the same structure.

Trench No.2 is an east-west cut at the upper western extremity of the access road. This exposes the main showing that consists of clay alteration and silicification developed across a segment of a gently north-dipping sheeting joint set, 100 metres wide, in the granodiorite. Where best developed the structure is about 3 metres thick. Pods and disseminations of stibnite, pyrite, arsenopyrite and sphalerite are associated with the uppermost of three discontinuous, subhorizontal silicified bands, 0.3 to 0.5 metre thick, enclosed in a yellow and white clay-rich envelope (Figure 5.16, inset). Sampling by Logan and Goldsmith (1980) yielded assay results on three chip samples (across 0.5 to 1.5 metres) averaging gold, 3.5 grams per tonne; silver, 1730 grams per tonne; antimony 1.41%; and lead, 7.31%.

Trench No.3 exposes a 12.5-metre section of what appears to be a continuation of the structure in Trench No.2. Sampson (1987a) reported assay results of gold, 0.5 gram per tonne, and silver, 195 grams per tonne, over an average thickness of 0.74 metre.

Trench No.4 exposes a small, weakly mineralized quartz vein in a gossan near the main access road. Trench No.5 is an old hand-dug excavation in a saddle on the ridge to the north and above the main showing. Mineralization there consists of pyrite, stibnite, arsenopyrite and traces of

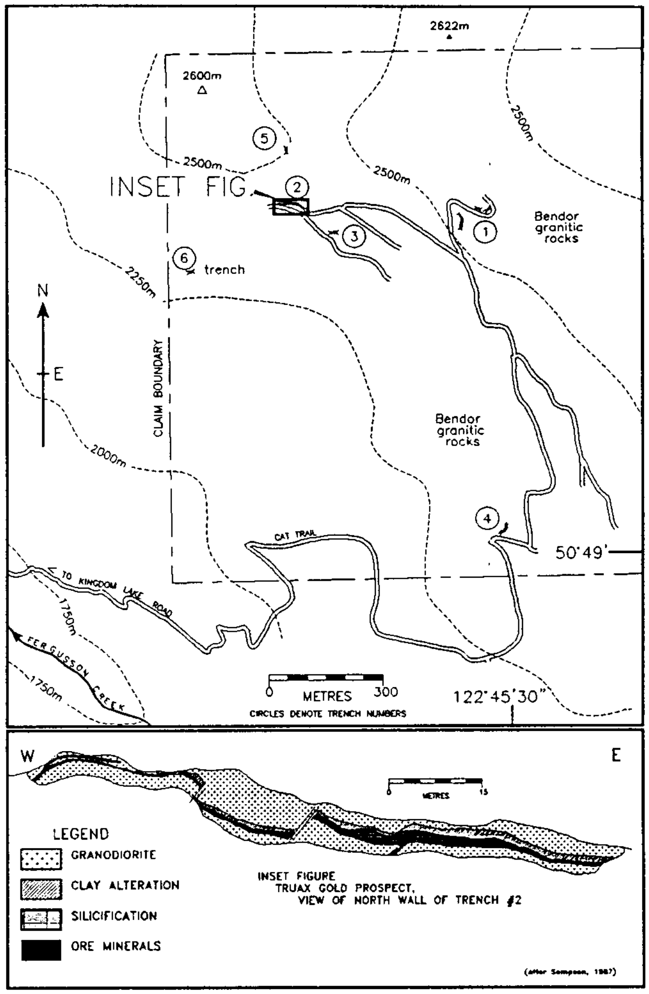


Figure 5.16A. Plan and section of the Truax Gold prospect.

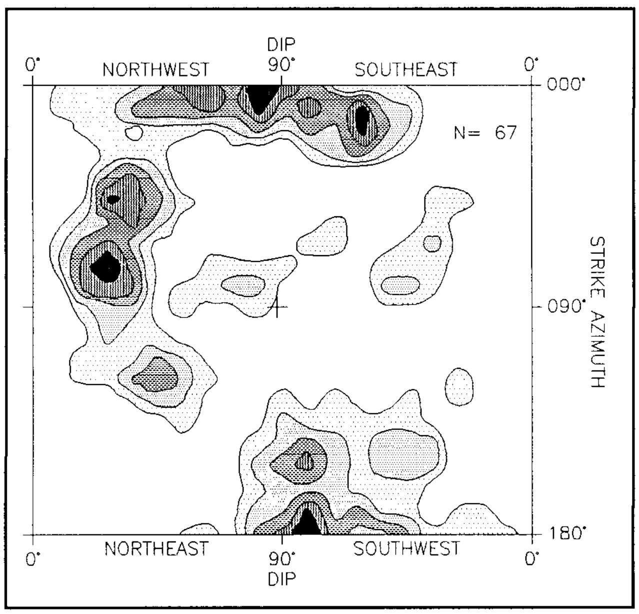


Figure 5.16B. Fracture frequency plot of the Truax Gold prospect

malachite in silicified lenses in a kaolinized and bleached section of the granodiorite.

Trench No.6 is 300 metres southwest of the main showing. Sampson (1987a) describes large pods of sphalerite and spectacular bladed stibnite crystals, together with pyrite, arsenopyrite, chalcopyrite and realgar. This showing is a subhorizontal quartz vein, 0.5 to 1 metre thick, exposed for 16 metres along the length of the trench. An assay he reported from a channel sample across 0.3 metre near the west end of the trench, returned 1.7 grams per tonne gold, 112 grams per tonne silver, 2.7% lead, 3.2% zinc and 1.06% antimony.

A geochemical soil sampling program by Coral Energy Corporation in 1987 revealed coincident precious and base metal anomalies encompassing the area around the main showing and 200 metres beyond to the southwest and southeast (Sampson, 1987a). Similarly, but on a smaller scale, there is a broad metal anomaly around and beyond, Trench No.1. This suggests possible extensions of the mineralized zone to adjacent slide and talus-covered slopes.

GRAY ROCK (MINFILE 092JNE066)

The Gray Rock mine is located just above treeline, between 2000 and 2200 metres elevation at the southern extremity of Truax valley, latitude 50°48′ north, longitude 122°42′ west. The area is characterized by rocky cliffs and extensive talus slopes. Access is by dirt road 29 kilometres from Gold Bridge easterly along the south shore of Carpenter Lake and south to the head of Truax valley. The mine was visited twice by the writer and his crew in July 1987 for geological mapping and sampling.

History and Development

The property consists of a core of 12 claims: MC Nos.1 and 2, Robin Nos.1 to 6 and Roy Nos.1 to 4.

Quartz veins near the headwaters of Truax Creek were first staked by A. Bergenham in 1931. The claims were then acquired by Gray Rock Mining Syndicate in 1936 and the area was restaked by Bellore Mines Limited in 1946. The property was purchased by Gray Rock Mining Company Limited in 1950 and optioned to Bralorne Mines Limited in 1952. From 1953 to the present, exploration has been intermittent; Amalgamated Resources Limited staked additional claims in 1964 and Hydra Explorations Limited and Rayrock Mines Limited completed a joint program of exploration in the period 1967 to 1969. Subsequent work has been mostly geophysics and geochemistry. The most recent investigations were completed by Wesfrob Mines Limited in 1976 and Levon Resources Limited in 1985 and 1988.

Exploration work on the property to the end of 1966 consisted of 427 metres of surface stripping and trenching on the original mineral discovery. Bellore Mines Limited began underground work in 1950 and by 1951 the No.1 (upper) crosscut adit had been driven 126 metres to the main vein. Bralorne Mines Limited continued this work in 1952 extending the No.2 (lower) crosscut adit 303 metres from the portal to intersect the same vein and continue an additional 62 metres to the south. In 1953 drifting on the lower level traced the vein 95 metres to the east and 154 metres west of the crosscut. Other work included two short raises and 230 metres of diamond drilling.

The only recorded production was in 1951 when 7.3 tonnes of hand-sorted ore shipped by Bellore Mines Limited to Antwerp, Belgium, yielded 3765 kilograms of antimony.

Geological Setting

The Gray Rock mine is in a septum of metamorphosed country rock that separates the western lobe of the Bendor pluton from the main body. The metamorphosed rocks consist of westerly to northwesterly striking, steeply dipping, recrystallized chert and chert breccia, siliceous sericitic schist, silicified carbonate lenses and intercalated hornfelsed greenstone composed of varying proportions of amphibole, plagioclase, quartz, biotite and chlorite. These rocks are cut by aplites and granitic dikes that appear to emanate from the Bendor pluton 350 metres south of the portal area. The typical Bendor granite here is composed of 60% plagioclase, 17% quartz, 15% biotite and chlorite and 7% amphibole (Bacon, 1955).

Mineral Occurrences

The mineralized structures at the mine are quartz veins on fractures and shears that strike at 070° and dip 50° to 60° south (Figure 5.17). The main vein (No.1) is developed over a strike length of 230 metres and has been traced about the same distance farther to the southwest beyond the mine workings (O'Grady, 1937d). The vein averages a metre in width and is continuous down dip for at least 123 metres. It has a cumulative offset of about 35 metres on a set of northerly striking, steeply dipping cross fractures. Sulphides occur throughout the vein in a succession of lenticular quartz masses. These are commonly pyrite, sphalerite and galena in milky quartz, however, stibnite is the principal ore mineral locally (Photo 5.4). Stibnite occurs as disseminations and streaks in the quartz gangue and massive layers on the vein walls. Arsenopyrite, tetrahedrite and fuchsite are also identified in a few places. In mineral paragenesis quartz deposition was first accompanied by pyrite and arsenopyrite, then sphalerite, followed by galena and tetrahedrite and finally stibnite (Sebert, 1987). Realgar and orpiment reported by O'Grady (1937d) and Stevenson (1950) appear to have formed in open spaces after shearing and brecciation of the vein.

Assays for No.1 vein average 420 grams per tonne silver, 0.8% lead and 3.0% antimony across 1.5 metres for a strike length of 27 metres for the west ore shoot and 1550 grams per tonne silver, 3.9% lead and 10.7% antimony across 1.1 metres for a strike length of 30.5 metres (Bacon, 1955). Veins Nos.2 and 3, above No.1 vein, are little more than discontinuous lenses of high-grade stibnite.

The chemical signature of No.1 vein has been established by multiple linear regression analysis according to the method outlined by Church (1987c) based on 14 assay results provided by Bacon (1955). This is expressed in terms of the equation: $Log(Au) = -0.028 + 0.19Log(Ag) - 0.003Log(Pb) - 0.19Log(Sb)$.

Proven ore reserves are 17 780 tonnes grading 4.0% antimony, 2.4% lead, and 342.8 grams per tonne silver. Combined with probable and possible reserves, total re-

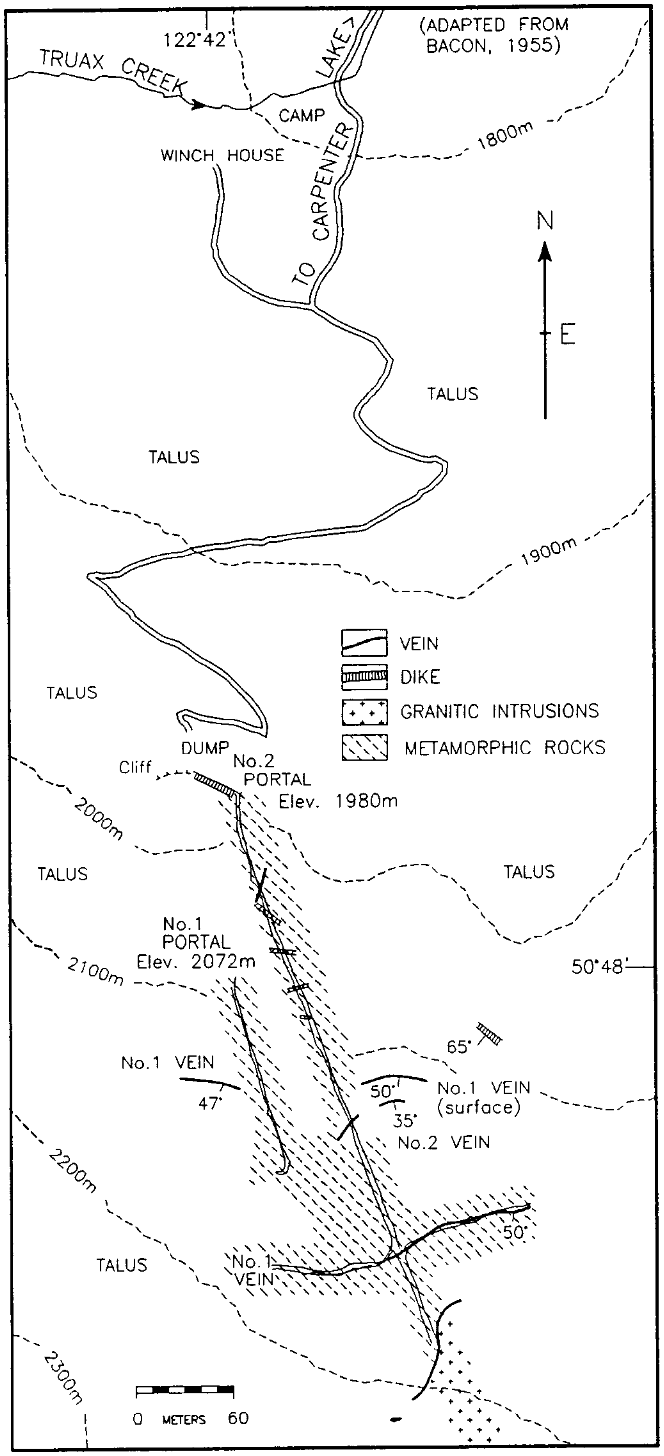


Figure 5.17. Geology of the Gray Rock mine.

serves are 70 500 tonnes of 3% antimony, 2.1% lead and 342.8 grams per tonne silver (Sheppard, 1966). Applying these assays to the above equation would produce an estimated gold content for these reserves of 0.39 grams per tonne, in keeping with values given by Bacon (1955).

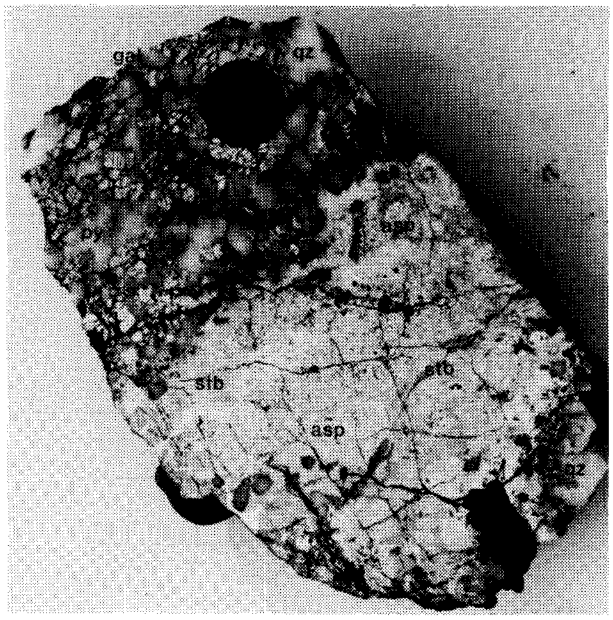


Photo 5.4. Pyrite and stibnite in composite vein. Gray Rock mine (black marker = 1 cm).

MARY MAC (MINFILE 92JNE067, 096)

The Mary Mac mine is located 3.7 kilometres south of Carpenter Lake,and just east of the Gray Rock logging road at latitude 50°51′30″, longitude 122°41′00″ west, near Truax Creek in the 1370 to 1400-metre elevation interval on the lower northwest slopes of Mount Williams. Access to the property is by approximately 20 kilometres of gravel road east of Gold Bridge. The property was visited by the writer and his crew in 1986 and 1987 at which time the showings were sampled and the geology of the surrounding area mapped.

History and Development

Little is known of the early history of this property other than that prospectors arrived by horse trail in the 1930s and drove a few short adits on the banks of Truax Creek (Clothier, 1933). In the 1960s Mr. Harry Street of Gold Bridge built a small mill to recover stibnite from narrow quartz veins. A token production of 3 to 4 tonnes per day of rough stibnite concentrate was realized in 1974. In 1980 Keron Holdings Limited acquired the property and completed a geochemical survey (Gruenwald, 1980). Several zones of anomalously high molybdenum and arsenic values were outlined. Work was continued by Hudson's Bay Oil and Gas Company Limited in 1981, when 4.5 kilometres of bulldozer trenching and additional sampling on Mount Williams were completed (Hall, 1981). The property was then optioned to Andaurex Resources Inc. and by 1983 a total of 1000 metres of diamond drilling had been completed to further delineate the mineralized veins. In 1987 additional trenching and sampling was completed on the HJ claims under an option agreement with Pilgrim Holdings Limited.

Geological Setting

The bedded rocks underlying the HJ claims were assigned to the Bridge River series by McCann (1922) and are here subdivided into the Fergusson Group (Paleozoic?) and the Relay Mountain, Group (Upper Jurassic). These units are intruded by dikes, possibly related to the Bendor stock (Figure 5.18).

The Fergusson beds underlie much of the claim group. They consist mostly of metamorphosed ribbon chert, schist and minor carbonate layers. Near the contact with the dikes they are pyritized, recrystallized and cut by numerous small quartz veins. The beds are locally contorted but generally dip steeply to the southwest.

The Relay Mountain beds are well exposed in road cuts on the northern part of the property, just south of Carpenter Lake. The beds range from massive chert-cobble and boulder conglomerate to *Buchia*-bearing laminated siltstones and argillites resembling similar strata 30 to 40 kilometres to the northwest near Spruce Lake (92O/2) and in the vicinity of Graveyard Creek (92O/3). These rocks are locally downfaulted and dip 45° to 60° to the southwest against the Fergusson basement. The source of the conglomerate appears to be mostly the adjacent Fergusson and Bridge River terrain and intruding granitic plutons. A K-Ar date on a granitic boulder sampled by the writer and analysed by J. Harakal, yielded a date of 119±4.0 Ma.

Mineral Occurrences

The mineral showings occur mainly at the contacts of a northerly dipping hornblende feldspar porphyry dike about 40 metres below the waterfall on Truax Creek, northeast of the mill site. The mineralized zone consists of quartz and carbonate veins 0.5 to 2 metres wide, emplaced on west-northwest trending fractures (Photo 5.5). Coarsely crystalline stibnite is accompanied by small amounts of arsenopyrite, pyrrhotite, chalcopyrite, limonite, tetrahedrite and/or jamesonite (?). On the east side of the creek this zone assays 7.64 grams per tonne gold and 17.1 grams silver across a sampling width of 5 metres. Chloritic alteration is widespread and accompanied locally by sericitization and pyritization. Numerous crosscutting molybdenite-bearing quartz veinlets related to an earlier mineralizing event occur within the porphyry dike (Photo 5.6). Molybdenite is also found in quartz stringers at higher elevations on Mount Williams.

Another mineralized zone, 170 metres northeast of the waterfall, was the chief source of the stibnite ore for the mill. This showing is smaller but higher grade than the main zone and is related to the faulted and serpentinized south contact of another porphyry intrusion. Assays from this site, across 4 to 5-metre widths in stibnite-bearing quartz veins returned gold values in the range 1.7 to 3.4 grams per tonne. The grade of stibnite is reported to be 20% over 2.1 metres, with reserve estimates ranging from 13 000 to 18 000 tonnes (MINFILE 092JNE067). A report for Andaurex Resources Limited gives a larger tonnage estimate based on additional drilling (Kerr, 1983).

The Mary Mac south showing (MINFILE 092JNE096) is hosted by a northerly dipping zone of brecciated andesitic

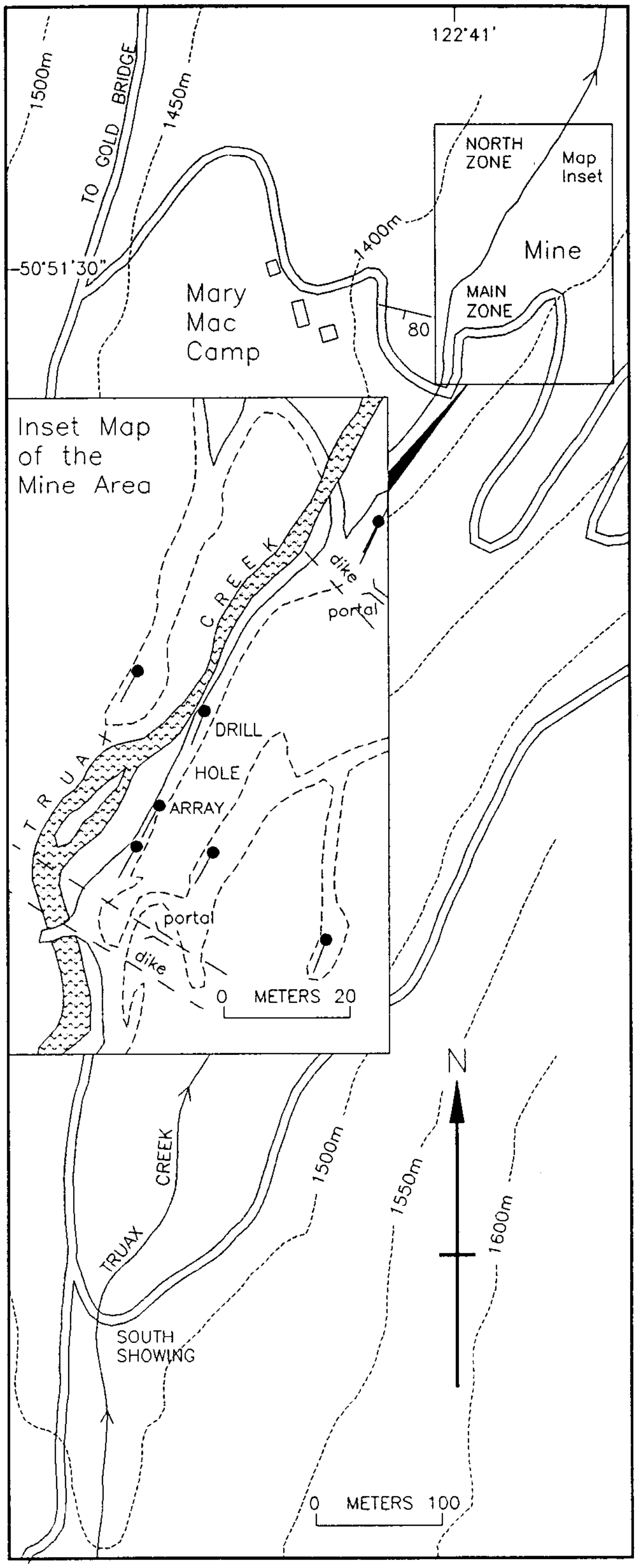


Figure 5.18. Geological setting of the Mary Mac prospect.

metavolcanics, 1 to 6 metres wide, just southeast of the bridge on Truax Creek, about 800 metres south of the main zone. The breccia is cemented by quartz and contains con-

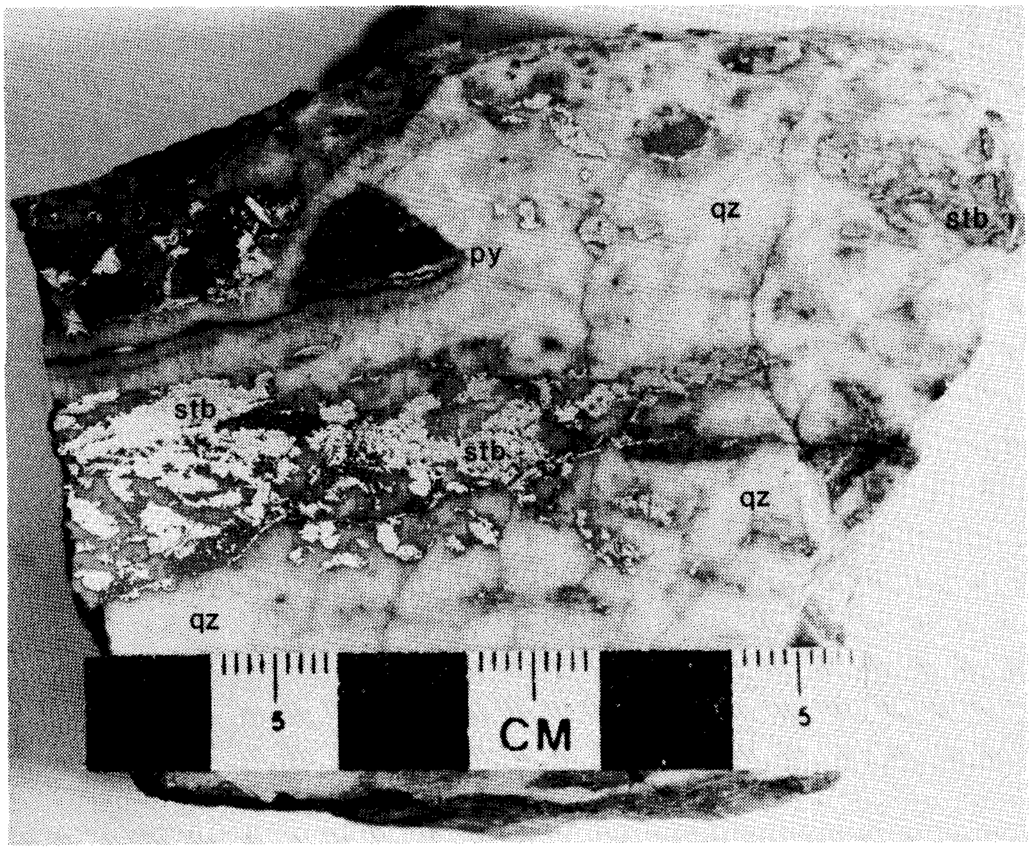


Photo 5.5. Stibnite-bearing quartz vein cutting pyritized hostrock, Mary Mac mine.

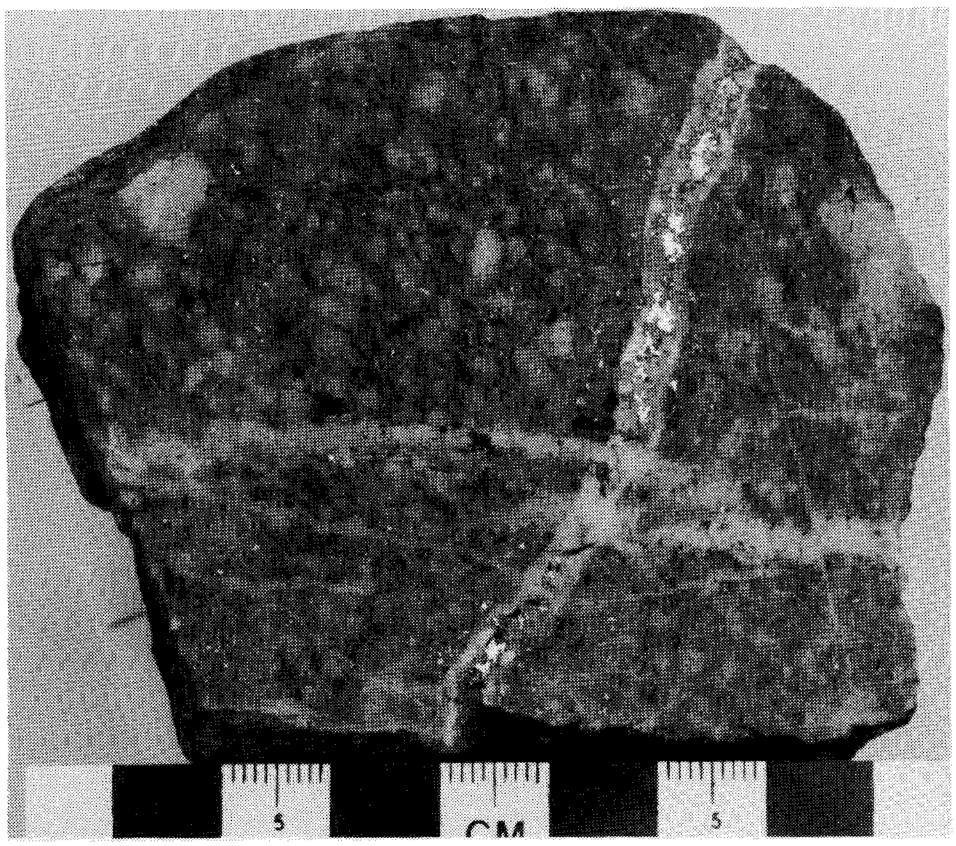


Photo 5.6. Molybdenite-bearing quartz stringers cutting porphyry dike, Mary Mac mine.

centrations of stibnite and pyrite; assays indicate traces of molybdenum and copper. The adjacent, altered Bridge River metasedimentary rocks, containing up to 8% disseminated pyrite, form a 'halo' of mineralization around the base of Mount Williams.

Workings on the south zone consist of surface trenching and three drill holes. Ore estimates calculated in 1983 (Kerr, 1983) are 27 300 tonnes with an average grade of 8.18 grams per tonne gold, over an average width of 2.4 metres (cut-off grade is 3.11 g/t).

RANGER (MINFILE 092JNE090)

The Ranger claims are south of Carpenter Lake, centred at latitude 50°50′05″ north, longitude 122°44′50″ west at 2500 metres elevation, 2.8 kilometres northwest of the summit of Mount Truax and 5 kilometres east of Gold Bridge. Access to the north alpine campsite is by 5.5 kilometres of steep mountain road and horse trail off the MacDonald Lake road. The geology of this property and surrounding area was mapped by the writer and his crew August 1987.

History

The property was first staked in 1944 by D.C. Ault who traced mineralized talus to a high saddle on a ridge at the head of Steep Creek. The property, then known as Ben d'Or, was optioned by Bralorne Mines Limited. Three diamond-drill holes and a short adit, 12 metres long, were completed to test the Ranger vein. The Ashmore Syndicate continued prospecting in 1945 after which the property became dormant. In 1970 it was restaked followed by additional trenching and sampling. In 1980 Rabbit Oil and Gas Limited acquired the ground including the FOXY and BEE claim groups. New showings were discovered by trenching near Steep Creek, 1.6 kilometres northwest of the Ranger adit, and in 1981 magnetic and VLF geophysical surveys were completed. Newmont Exploration of Canada Limited restaked the property in 1983. New work included geological mapping and rock, silt and soil sampling. Tanker Oil and Gas Limited acquired the property in 1985 and together with Levon Resources Limited continued exploration. The North Ridge zone was the focus of trenching, sampling and mapping in 1986.

Geological Setting

The property is underlain by Fergusson chert and schist, and less deformed Pioneer greenstones and a minor amount of Hurley sandstone and conglomerate. These beds are cut by Bralorne gabbro, serpentinite lenses, Bendor granodiorite and feldspar porphyry dikes (Figure 5.19).

The Fergusson chert and schist crop out in the high saddle area near the centre of the property and along the lower and uppermost parts of the Steep Creek access road. The cherts are grey to light brown and laminar bedded with argillaceous partings. In thin section, the chert is seen to consist of fine-grained quartz cut by numerous stringers and veinlets of coarser grained quartz. The argillaceous partings are commonly schistose and comprised of white mica and carbonates.

Cadwallader sedimentary rocks and greenstones are scattered throughout the area. What appears to be Hurley sandstone covers a small area at 1700 metres elevation west of Steep Creek. A patch of dark argillite, tentatively assigned to the Noel Formation, is exposed about 1.7 kilometres west of the high saddle area at the centre of the claim group.

The main areas of greenstone are exposed in the southwest part of the property, in the high saddle area and along the mid-section of the Steep Creek access road. The rock is commonly fine grained and massive. Pillows are seen locally, accompanied by small pods of limestone. In thin section the main minerals are albite, amphibole, chlorite, fine-grained iron oxide and calcite.

Bralorne gabbro occurs as separate detached bodies along and, on the west side of a northwest-trending shear zone that cuts through the high saddle to the headwaters of Steep Creek. The gabbro is mostly grey, medium grained and distinguished by reticulated light coloured veinlets composed of a mixture of sodic feldspar, prehnite and carbonates.

Massive green and black ultrabasic rocks, mostly serpentinite, are found locally at the contact of the Bralorne gabbro and on shears in the north ridge area. On the main shears the serpentine contains numerous veinlets of calcite, magnesite and ankerite. The carbonated serpentinite is transitional to light brown listwanite.

The north edge of the Bendor pluton cuts across the southern part of the property. This intrusion is mostly medium grey biotite hornblende granodiorite. Dense, dark grey hornfels is found locally near the margin of pluton and in small areas southwest of the saddle zone.

Mineral Occurrences

The main showing is a quartz-sulphide vein exposed in the Ranger adit in the central part of the claim group (Figure 5.19, inset). The adit is just south of the high saddle at 2444 metres elevation in a northwesterly trending shear zone 30 metres wide. Information from Stevenson (1947c) and Sebert (1987) indicates that shearing at the Ranger adit is 5 to 30 metres wide and contains small quartz veins - the veins dip westerly and have abundant pyrite, arsenopyrite and minor amounts of tourmaline and late-forming realgar and orpiment. Assay results on two samples across 30 centimetres report 18 and 153 grams per tonne gold, 20 and 257 grams per tonne silver. The host-rocks are sheared chert and argillite. The shear zone containing the vein strikes north-northwest through the high saddle where it is exposed again in the "Moore cut". The brecciated condition of the deposit is evidence of late movement.

A second mineralized vein, 14 metres southwest of the adit, is vertical and subparallel to the westerly wall of the shear zone. It carries arsenopyrite, pyrite, chalcopyrite and a few specks of free gold in quartz. Assay results reported by Stevenson from a sample 30 across centimetres, are 3.8 grams per tonne gold, 65 grams per tonne silver and 0.1% copper.

Several other small, northerly dipping, quartz-sulphide veins occur in the hornfels and cherty argillite rocks 250 metres south of the Ranger adit. Weakly mineralized showings are exposed in the North Ridge area where a north-

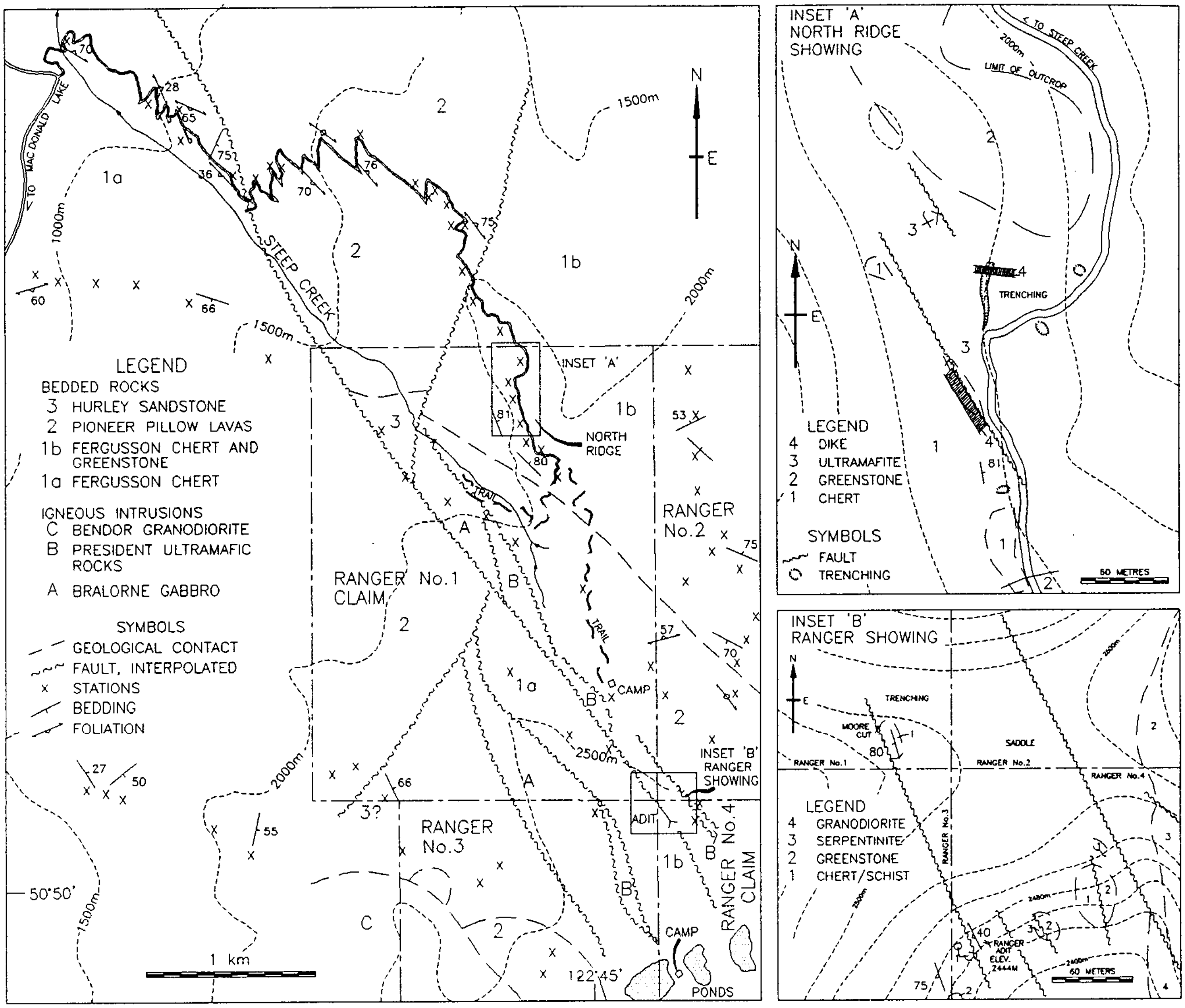


Figure 5.19. Geology of the Ranger property.

northwest-trending zone of sheared serpentinite and a number of feldspar porphyry and fine-grained basic dikes cut the greenstone and chert beds. These are small gossan areas where soil sampling yields up to 1 gram per tonne gold, 5.3 grams per tonne silver and some zinc values (Cooke, 1986b).

THE PIONEER MINE AND CADWALLADER CREEK-PIEBITER AREA

The Pioneer mine and most of the mineral prospects along the east-southeast trending segment of the Cadwallader fault have many of the characteristics of Bralorne. For example the gold-quartz veins at the Pioneer, Pioneer Extension, Dan Tucker, Red Hawk and Royal properties are typically mesothermal, low-sulphide fissure fillings hosted by Bralorne intrusions and Pioneer volcanics adjacent to bands of ultramafic rocks. The veins are probably cogenic with the Coast Plutonic Complex as at Bralorne. The Holland veins are clearly related to the Bendor intrusion as are the Chalco and Bramoose skarns.

PIONEER (MINFILE 092JNE004)

The Pioneer mine is centred at latitude 50°45′35″ north, longitude 122°46′40″ west on the north side of Cadwallader Creek, 3.5 kilometres upstream from Bralorne. Access is by an all-weather gravel road, 11 kilometres southeast from Gold Bridge.

The writer visited the property in early July 1986, and subsequently, finding the veins mostly inaccessible because of the abandoned condition of the mine. Consequently it has been necessary to rely heavily on published descriptions and company plans to compile this report.

History and Development

The Pioneer mine, comprising the original workings on 28 Crown-granted claims and fractions, operated from from

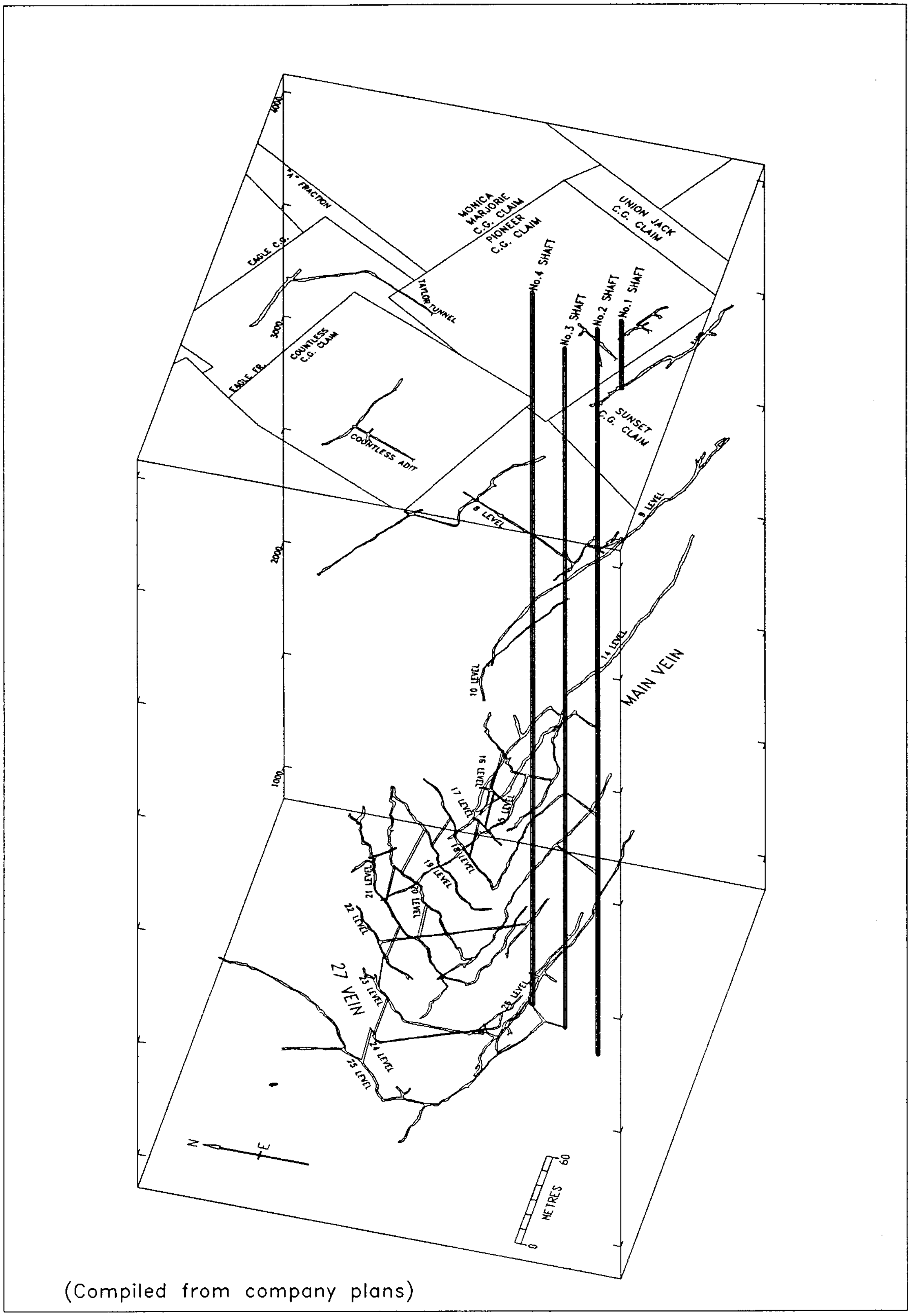


Figure 5.20. Cabinet block diagram of the Pioneer mine, 'Main' vein and '27' vein workings.

1928 to 1962, producing 41.5 million grams of gold and 7.6 million grams of silver from 2.3 million tonnes mined (MINFILE 092JNE004). The mine has been worked from 5 shafts and 29 levels to a depth of more than 1000 metres.

The Pioneer claim was staked in 1897 by Harry Attwood. High gold values were found in a vein. The property was then acquired by hotel owner William Allen of Lillooet and was profitably operated from 1900 to 1911 by Allen's partner Fred Kinder. Production was mainly from an adit entering the north slope from the valley floor 12 metres below the original discovery of gold-bearing quartz. The crosscut adit driven north intersected the discovery vein at 21 metres from the portal and a second vein at a further 9 metres. Two shorter adits were driven above the original level. Kinder built a small mill powered by a water wheel in Cadwallader Creek. This primitive machinery treated about 200 kilograms of ore per day until 1911 when the property was sold to A.F. Noel.

The property was then acquired by a syndicate directed by Peter and Andrew Fergusson, Adolphas Williams and Frank Holden that increased the holdings to seven claims and three fractions. As work continued on Kinder's crosscut, a second adit was driven from a point about 200 metres to the west. In 1914 Pioneer Gold Mines Limited was formed and a small Chilean mill was assembled. By 1917 an inclined shaft had been sunk to about 60 metres below the original crosscut. Mining became difficult and the property was offered for sale. Numerous interested companies examined the workings but there was no significant development during the period 1919 to 1924.

David Sloan leased the property and, with his partner J.D. Babe, renewed operations in July 1924. Mining beyond a pinched section of the Main vein and the milling of broken ore in the old stopes proved successful. Other developments in 1924 included sinking the inclined shaft below the Kinder crosscut. In 1926 work commenced on No.5 level at a depth of 107 metres and in 1927 a vertical shaft was sunk, replacing the old inclined shaft. The old mill had already been replaced by a 100 ton per day cyanide treatment plant which enabled reprocessing of tailings from the previous operation. In 1928 Pioneer Gold Mines of B.C. Limited assumed operational control.

In the early 1930s the Pioneer mine was the leading gold producer in the province. In 1932 the mill capacity was increased to 300 tons per day and the No.3 shaft was completed to the 14th level of the mine. Major development was achieved in 1933 and the largest gold production of any mine in the province was attained in this year. In 1938 the internal No.4 shaft was sunk from the 24 to the 29 level (1067 metres below surface) to access ore blocked out on the Main vein (Figure 5.20). It is significant that in 1939 some ore was produced from the 27 vein on No.18 level. The 27 vein later became the principal producing vein on the property. By 1941 there was more development on the 27 vein and a small amount of drifting on the 28 and 29 veins; further work was curtailed because of wartime conditions that led to labour and material shortages.

Mine development resumed in 1946 and focused on the 27 vein where a rich ore shoot, up to 240 metres in strike length, was traced on the 20, 21 and 25 levels. In 1952 a major diamond-drilling program was completed. The No.5 decline shaft was then sunk to the 29 level following the footwall of the 27 vein. In 1956 an extensive program of diamond drilling and crosscut development was initiated to explore for new ore reserves. A long crosscut was driven from the footwall of the Main vein on the 20 level and another crosscut, 600 metres long, was extended easterly towards the Pacific Eastern workings (Figure 5.1). Drilling from this crosscut further delineated the 89 and 92 veins, however, no significant new vein structures were discovered.

In 1959 the mine was worked from shafts No.2 and No.3 from surface and internal shaft No.5 that was an inclined winze connecting levels 25 to 30. In this year the company was amalgamated with Bralorne Mines Limited to form Bralorne Pioneer Mines Limited, with Franc Joubin as president, and all further investigations were managed by this company. The mine soon closed and has since remained dormant.

Since 1981 the Pioneer property has been jointly owned by International Corona Corporation and Imperial Metals Corporation. In late 1991 Avino Mines and Resources Limited acquired the Corona interest (until 1989 Corona had focused on exploration for new ore reserves in the Bralorne-Pioneer mines area and met with some drilling success). Plans are underway by Bralorne-Pioneer Gold Mines Limited (Avino's wholly owned subsidiary) to continue this exploration with a view to renewed production.

Geological Setting

The veins are hosted mainly by Pioneer greenstone and to a lesser extent in granitic rocks related to the Bralorne intrusions. Granitic rocks (mostly soda granite) comprise a narrow tongue adjacent to the northern margin of the Bralorne intrusion which is the principal hostrock at the Bralorne mine. At Pioneer the Bralorne intrusion is exposed just north and northwest of the mill and pinches out to the southeast between soda granite and the serpentinite belt that follows the Cadwallader fault.

The Pioneer greenstone is commonly fine grained and massive. Except where the lavas are amygdaloidal and intercalated repeatedly with flow-breccia phases the massive lava is difficult to distinguish from feeder dikes and some Bralorne Intrusions. Indeed, the relationship between the Bralorne diorite and the Pioneer greenstone is not entirely clear. At the Bralorne mine, Cairnes (1937) noted the gradational nature of contacts between these rocks, suggesting a cogenetic origin of some phases. Stevenson (1958) indicated that some of the greenstone was dioritized and Stanley (1960) suggested that fine-grained phases of the diorite, such as at the Pioneer mine, are the result of cataclasis. Thin sections examined by the writer confirm Stanley's observations.

The soda granite is medium grained, light coloured and hypidiomorphic granular. The composition and texture is modified locally by alteration and cataclasis. According to Joubin (1948) the contacts between the soda granite and the greenstone are generally sharply defined and sheared. Stevenson (1958) notes that there is no obvious deflection of the veins where they cross the contact, indicating that the shearing predated the emplacement of the quartz veins.

Mineral Occurrences

The veins at the Pioneer mine are in the Pioneer greenstone and the soda granite just northeast of the Cadwallader break. Stevenson (1958) observed that the veins die out towards the west as they pass from the granite into the serpentinite zone on the Cadwallader fault; towards the east the veins diminish in the greenstone some distance before reaching the metasedimentary rocks farther to the northeast.

The principal source of ore at the Pioneer mine was the Main vein up to 1944 and the 27 vein until the end of production in 1962 (Figure 5.20). The veins commonly split forming hangingwall and footwall branches that are also productive.

The Main vein strikes west-northwest and dips steeply north in a shear with some reverse fault movement. For most of its length the vein is in greenstone; it is strongly ribboned, averages a metre in width and splits into a composite system with numerous loops and branches displaced by crossfaulting. Referred to as the Pioneer vein in the early years of the mine it was the source of spectacular museum specimens of gold for which the Pioneer mine is famous. There are four main ore shoots which have been worked to 1074 metres down dip and 1140 metres along strike (Stanley, 1960). The west ore shoot was the original orebody mined to surface. It was immediately adjacent to the serpentinite on the Cadwallader break and extended eastward for about 100 metres and downward more than 300 metres below the level. The second ore shoot is joined with the west shoot above 5 level and mined down to 20 level. The third ore shoot was similar to the second shoot, averaging about 200 metres in strike length, and separated from the second shoot by a narrow unproductive septum. The fourth shoot was mined from the 12 to 29 level in the area west of No.2 and No.3 shafts. This was a narrow discontinuous body with a maxium strike length of 150 metres. Figure 5.21 shows the full extent of stoping on the Main vein.

Four veins (named alphabetically) occurring in the hangingwall of the Main Vein were intersected on the 5 level. The principal one in this group, the Hanging Wall 'B' vein, is a split of the Main vein and lies subparallel to the north. It intersected in a crosscut about 75 metres northeast of the No.3 shaft and drifted on for 285 metres locating a 50-metre-wide zone of gold mineralization. Because of generally low grades there was little stoping in this area.

Other veins occur in the footwall area immediately south of bows in the Main vein. The 'J' vein, the best exposed footwall vein, has been traced from 17 through to 27 level. It dips towards the Main vein (narrowing with depth) and loops around to connect at both ends to the Main vein forming a trough-like structure. The only stope on 'J' vein is along the central part of the trough between 26 and 27 levels.

The 27 vein occupies a tension fracture branching off the hangingwall of the Main vein. It is blind and does not extend much above the 12 level (most of the ore occurring below 18 level). It strikes northeast and dips moderately northwest, averaging 30 to 150 centimetres in width but ranging to 6 metres wide in a few places. The 27 vein has been followed along strike for 570 metres and is distinctive from the Main vein in that it is filled with massive "bull" quartz rather than ribboned. At one point on 25 level, where the drift was slashed for a raise, the vein was 5.2 metres wide and assayed 21 grams per tonne gold. An ore shoot on 25 level having a drift length of 172 metres, a vein width averaging 1.8 metres, averaged 18.8 grams per tonne gold (Stevenson, 1958).

The Countless vein is exposed on the surface on Pioneer ground, and passes northwest onto the Bralorne property where it is correlated with the Coronation vein (*see* Bralorne mine description). The vein is persistent but approaches ore grade (10.3 g/t gold) for only a few intervals of about 30 metres in the adit workings (Stanley, 1960). The 28 vein is small and occurs on 21 level near the 27 vein; it is thought to correlate with the Countless vein although the vertical separation between the veins is about 700 metres.

The Taylor vein is small and subparallel to the east end of Bralorne's 51B footwall vein in the northwest part of the Pioneer property (250 metres north and 29 metres above the No.3 shaft). An adit was begun by the original owner J.M. Taylor and completed after Pioneer acquired the Eagle claim and Eagle fraction. In 1945, at the time of initial development of the vein, pockets of high-grade ore containing 2 to 3 kilograms of gold were discovered on the adit level and good values in the footwall branch of the vein on a sublevel above, however, the overall grades are spotty and the vein is considered to be non-commercial.

The Pioneer veins are composed mainly of quartz gangue with fractures filled with calcite and ankerite. Small shoots of scheelite occur in the Main vein (near the western limit of drifting on the 14 level) and tourmaline is said to occur in cavities in the 27 vein (Cleveland, 1938). The quartz ribbons separate streaks containing chlorite, sericite, mariposite, sulphide gouge and gold. The principal sulphides, arsenopyrite and pyrite, occur as disseminations in massive quartz or in the ribbon partings. Massive arsenopyrite is often associated with free gold. Other sulphides include sphalerite, galena, chalcopyrite, pyrrhotite, marcasite and stibnite. Wallrocks are intensely altered and contain quartz, sericite, mariposite, kaolin, alunite, calcite and arsenopyrite. Low grades of gold are sometimes found in the wallrocks.

The 'Main vein' and '27' vein are the most consistent in attitude of any of the veins in the Pioneer mine . It is clear that the Main vein formed at an acute angle to the (southeast striking) Cadwallader shear zone and that the vein itself became a shear zone, perhaps as the result of a rotating stress field. The 27 vein, that is clearly identified as a tensional fissure, strikes northeast (maximum stress) and towards the Bendor intrusion, the probable source of the mineralizing solutions.

HOLLAND (MINFILE 092JNE008)

The Holland prospect is centred at latitude 50°45′35″ north, longitude 122°45′50″ west on a group of 15 Crown-granted claims and fractions adjoining the northeast bound-

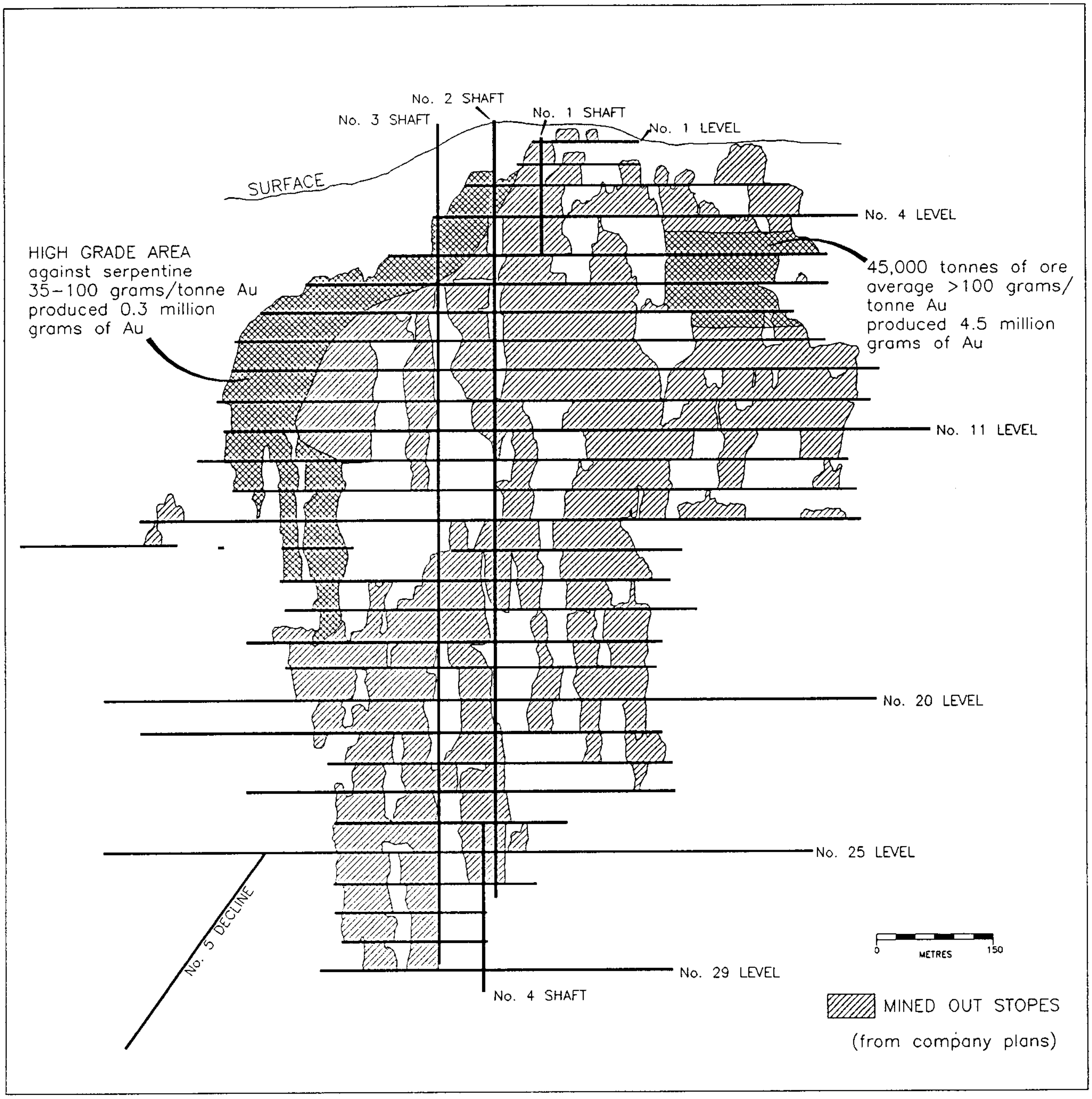


Figure 5.21. Stoped sections of the Main vein, Pioneer mine.

ary of the Pioneer property on the lower slopes of Mount Fergusson. Access is by road 0.5 kilometre east of the old Pioneer townsite and from the Kingdom Lake road, 5 kilometres southeast of Kingdom Lake. At the time of a visit to the property by the author, in July 1992, the portal was totally collapsed. The site of the workings could be located only from the position of the waste rock dump.

History and Development

The property was originally assembled and developed by Holland Gold Mines Limited beginning in 1933. It was explored by trenching, ground sluicing, diamond drilling and tunnelling. The principal development, completed in 1940, is a 390-metre adit driven northeast at 035° from the Corasand Crown-granted claim on the Pioneer property to the Whistler Crown-granted claim on the Holland ground (Figure 5.22). Two shorter exploratory adits, 36 and 64 metres in length, were completed near the south boundary of the Holland claim. From 1945 to 1947 a 60% interest in the property was optioned by Santiago Gold Mines Limited. This company then assigned the option to Golden Slipper Mines Limited for further work; deep diamond-drilling near the southwest corners of the Langdon claim and the Ruby fraction was unsuccessful in proving ore. There was no further work until acquisition of the ground by Tarbo Resources Limited in 1979. The property was re-evaluated by Texa-

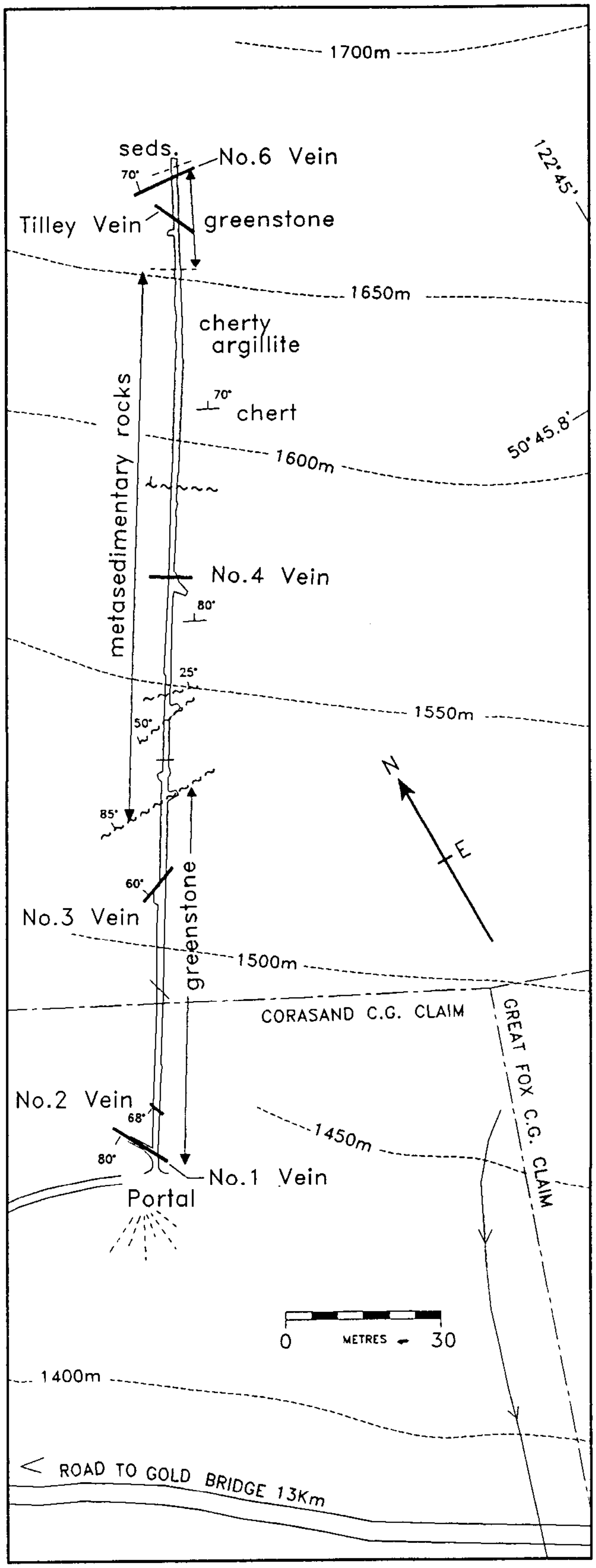


Figure 5.22. Plan of the Holland adit crosscut.

cana Resources Limited in 1981 and ownership was transferred to Unicorn Resources Limited in 1985.

Description

The property is underlain by northeasterly dipping Fergusson metasedimentary rocks and Pioneer greenstones. The Fergusson rocks are mostly thinly bedded cherts, argillites and small lenticular masses of thermally altered greenstone. The main body of greenstone consists of a belt 400 to 600 metres wide, trending diagonally across the claim group. These rocks are intruded by the Bendor granodiorite stock a few kilometres to the east (Figure 1A).

Five veins are reported in the Holland adit. These are quartz-calcite fissure fillings that average 0.6 metre in width and occur mostly in the greenstone and not far from the contact between greenstone and chert near the face (Figure 5.22). In soft sheared argillite the veins are thin and pinch out. Although the veins contain sparse sulphides, the wallrocks are generally heavily charged with disseminated pyrite. Most assay results were low, however, a sample across 0.8 metre of vein material in the northeastern section of the Holland adit assayed 5.8 grams gold per tonne.

Cairnes (1937) concluded: "Mineralization is not certainly related to the Bralorne intrusives and may be connected with the Bendor batholith". The writer agrees with this interpretation. The host-rocks are metamorphosed and similar to facies elsewhere (*i.e.* the Chalco prospect - MINFILE 092JNE043) within the thermal aureole of the Bendor pluton.

PIONEER EXTENSION (MINFILE 92JNE009)

The Pacific Eastern property is centred at latitude 50°45′ north, longitude 122°45′ west, 5.5 kilometres southeast of the Bralorne mine. Access is by gravel road 12.4 kilometres southeast from the town of Gold Bridge. The property was visted in late August 1986 at which time new core drilled by Normine Resources Limited was examined by the writer.

History and Development

The property consists of 88 Crown-granted mineral claims and fractions including the Pioneer Extension, President, Plutus and Dan Tucker claim groups. Recent exploration has been focused mainly on the Pioneer Extension ground.

Pacific Eastern Gold Limited was formed in 1929 to explore the Pioneer Extension claim group and ground adjoining the Pioneer mine to the southeast. This company was succeeded by the Pacific (Eastern) Gold Mines Limited - a subsidiary of Noranda Mines Limited. In addition to much surface work and drilling, extensive underground tunnelling was completed between 1935 and 1937. Mine development during this period included the Pioneer Extension adit, driven 200 metres from the slopes north of Cadwallader Creek and an internal shaft, 160 metres deep, connected to the 520-level crosscut which was driven southerly 1300 metres under the valley of Cadwallader Creek. The 1595 drift system was driven 525 metres easterly from the 520 level crosscut and a winze, 70 metres deep, sunk near the west end to link the 1595 drift with several short tunnels on the

690 level (Figure 5.23). Insufficient ore was delineated by this development and the workings were abandoned and flooded in 1937.

Exploration was resumed in 1945 to 1947. Several new veins were discovered by diamond drilling and subsequently tested by extension of the 1595 drift to the east.

Ownership of the claims subsequently passed from Noranda Mines Limited (1947-1973) to R.J. Barclay (1973-74) and later to J.T.M. Enterprises Limited and B.R.H. Investments Limited of Vancouver. In May 1983 the property was optioned by Normine Resources Limited. Work by Normine Resources confirmed the continuation of lithology and structure from the Bralorne-Pioneer mines through the Pioneer Extension claim group. Three deep diamond-drill holes (to 855, 710 and 762 m respectively) prove the presence of quartz veins and associated carbonate alteration typical of production zones in the nearby mines.

Geological Setting

Exploration on the Pioneer Extension claims has focused on a segment of an east-southeast-trending belt of metasedimentary, metavolcanic and intrusive rocks 2 kilometres wide. The mine workings directed across the belt provide a good view of lithologies and structures (Figure 5.23). The principal lithological units are Fergusson chert and argillite and the main formations of the Cadwallader Group, including Pioneer greenstone and Noel and Hurley clastic sedimentary rocks. Structural relationships are complicated by the emplacement of Bralorne gabbro/diorite bodies, President ultrabasic rocks and younger hornblende and feldspar porphyry dikes. The major intrusions are elongate slices subparallel to the trend of the principal bedded formations and the course of the major faults.

The principal units are exposed in the 520 level crosscut that extends below the valley in a southwesterly direction from a shaft northeast of Cadwallader Creek. Near Cadwallader Creek, Fergusson chert beds are separated from the Cadwallader formations by a steeply dipping ultrabasic body and the Fergusson fault. Repeated intercepts of Triassic greenstones and metasediments suggest that these rocks are tightly folded (Joubin, 1948), although this is not proven by the internal structural relationships.

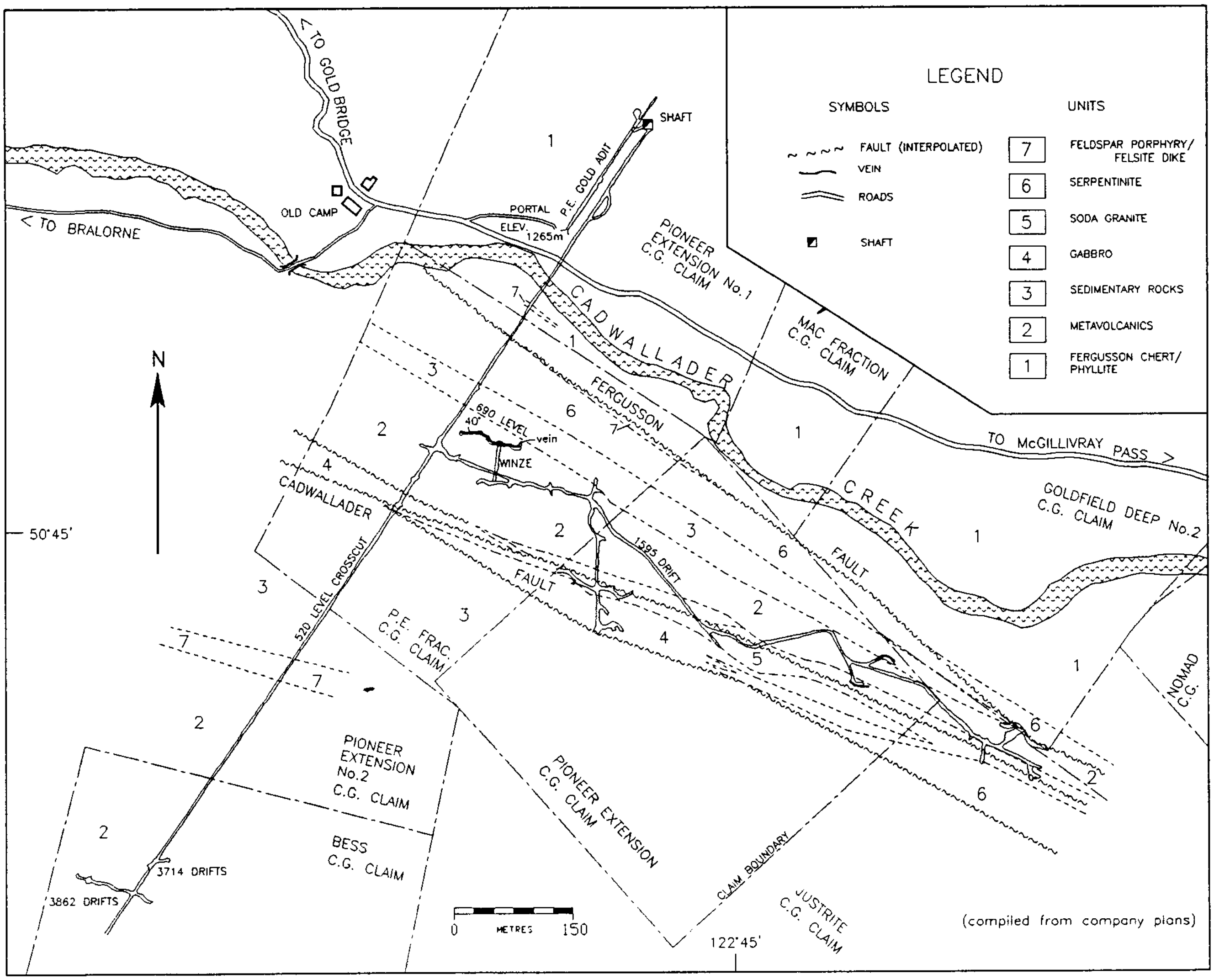


Figure 5.23. Geology of the Pioneer Extension mine (surface projection).

Mineral Occurrences

Two mineralized zones were opened up by the Pacific Eastern underground workings. These are a quartz vein in the west drift (690 level) 370 metres south of the Pioneer Extension portal and two quartz veins intersected by drilling from the 1595 drift near the eastern extremity of the workings, 775 metres southeast of the portal. According to company reports, the vein in the west drift is 29 metres long, 0.3 metre wide and averages 19.8 grams per tonne gold (Nordine, 1983). The veins near the southeast end of the 1595 drift are 1.0 to 1.5 metres wide and contain visible gold; assay results are not available. The veins appear to be en echelon or continuous with two quartz veins, 1.2 and 1.5 metres wide, intersected by diamond-drilling within a wide zone of intense carbonate and biotite alteration. In a few instances late growth of stibnite has been observed in small fissures in the dikes.

The chemical signature of the veins is expressed in terms of the ore-forming elements (gold, silver, arsenic and antimony) according to the method (multiple linear regression) outlined by Church (1987c). The following equation is based on 8 assay results provided by Norman (1986): $Log(Au) = 10.7 + 2.44Log(Ag) - 0.80Log(As) + 0.51Log(Sb)$.

According to Norman (1986), alteration associated with the serpentinite along the Fergusson and Cadwallader faults does not appear to be related to the gold mineralization. This is talc accompanying massive bastite and sheared antigorite or koalinite-montmorillonite and silica-carbonate-fuchsite lenses.

MIX (MINFILE 92JNE005)

The Mix prospect is located 3.6 kilometres southeast of the Pioneer mine just north of the Cadwallader Creek logging road at latitude 50°45′ north, longitude 122°44′ west.

History

The Mix property originally consisted of eight claims located mostly north of Cadwallader Creek, adjoining the Pioneer Extension property on the east between Nomad and Hawthorne creeks. The property was acquired by Mix Gold Mines Limited in 1933. The main development at this time was an adit driven northeast from a point about 60 metres north of Cadwallader Creek. There is no record of further work. The property was subsequently taken over by Pacific Eastern Gold Limited.

Description

The Mix workings are underlain by greenstones and thinly bedded pelitic and cherty metasediments. The main underground development was a 300-metre crosscut, the target being the contact of the metasediments with overlying greenstones to the northeast. For 210 metres the crosscut was in glacial drift. The remainder of the tunnel to the face penetrated mostly Fergusson metasedimentary rocks, and at the midway point, some lenticular greenstone bodies a few metres wide, possibly sills or dikes. Quartz veins occur alongside these 'dikes' where the contacts with the enclosing metasedimentary rocks are sheared and faulted. At the face a southeast-trending drift followed a vein fissure for 54 metres, exposing irregular quartz fillings and replacements with a minor amount of pyrite. Assays of this material are ranged up to 10 grams per tonne (Cairnes, 1937).

BUTTE-IXL (MINFILE 092JNE011)

The Butte I.X.L property is centred on two quartz veins located at latitude 50°42′30″ north, longitude 122°39′40″ west at about 1400 metres elevation, 1 kilometre south of the confluence of Piebiter Creek with Cadwallader Creek. Access is by all-weather dirt road 12 kilometres east of Bralorne. The writer visited the property in late August 1988 taking advantage of a newly constructed bridge and road across Cadwallader Creek. The old mine site was examined and the flume channel was followed to the dam on Copp Creek.

History and Development

Development work on the Butte I.X.L property, consisting originally of 22 claims, was initiated by Butte I.X.L. Gold Mines Limited in 1933 after the discovery of quartz veins exposed by surface stripping. A substantial camp and mine facilities were constructed and a flume was built connecting the mine and compressor site to Copp Creek. By the end of 1934 a shaft was completed on No.1 vein to a depth of 50 metres to connect with 245 metres of drifting from an adit driven from Aggie Creek. Nothing more appears to have been done until the property was acquired by Hillside Energy Corporation in 1980. In 1985 Hudson Bay Exploration and Development Company Limited completed a program of geological mapping and used geochemical sampling to locate several gold anomalies. In 1986 the property was purchased by Armeno Resources Inc.

Description

Noel argillite and Pioneer volcanic rocks underlie much of the area. To the north these units are separated from Fergusson cherty metasedimentary rocks by serpentinized ultramafic rocks (Figure 1A). The main crosscut adit, beginning in Noel argillite, passes into Pioneer greenstone and intersects Bralorne gabbro at 225 metres (Figure 5.24).

The target of the main crosscut was a quartz vein that ranges to 0.6 metre wide. This is heavily mineralized in places with pyrrhotite, chalcopyrite, sphalerite and lesser amounts of pyrite and galena. Another quartz vein on the surface, 60 metres southwest of the portal, strikes northwest and dips steeply southwest in the greenstone. This is reported to carry minor gold values. Brecciated quartz vein material examined on the dump contains less than 1% disseminated sulphides, including chalcopyrite and sphalerite. The sulphides tend to be concentrated along the borders of altered greenstone clasts within bull quartz. Analyses of this material reported 120 ppb gold, 224 ppm lead and greater than 4000 ppm zinc (Melrose and Fairbank, 1982).

RED HAWK (MINFILE 092JNE012)

The Red Hawk prospect is centred 8.5 kilometres southeast of the Pioneer mine at latitude 50°43′10″ north, longitude 122°40′35″ west, on the southwest slope overlooking Cadwallader Creek, between Chisholm Creek and Copp Creek. Access is by trail from the Butte-IXL property adjoining to the east.

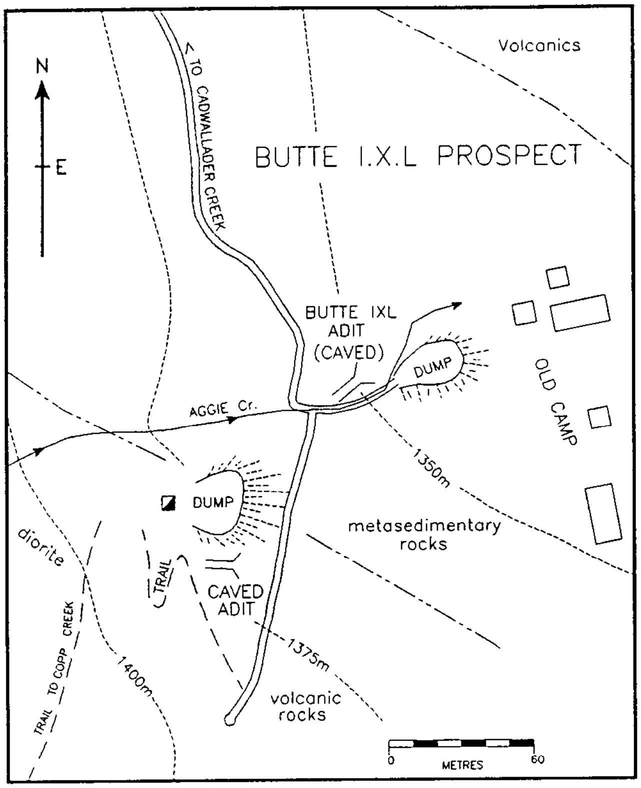


Figure 5.24. Plan of the Butte-I.X.L. workings.

History and Development

The property consists of eleven Red Hawk claims and fractions, and four Premier claims and fractions. The first claims were staked in 1931 and taken over by Red Hawk Gold Mines Limited in 1932. At this time two camps were established to support development on the upper and lower parts of the property. The development consists of five short exploratory tunnels, a number of open cuts and pits and a shaft to test the mineralization. By 1935 the property was dormant. The property was re-examined in 1987 and 1988 by Armeno Resources Inc. (optioned from Trans Atlantic Resources Inc. to earn 50% interest) as part of a large regional exploration program.

Description

The property is underlain by a diversity of rocks. On the lower slopes above Cadwallader Creek, Fergusson cherty argillite, trending northwest parallel to the main valley, is faulted against massive greenstones. On the upper part of the property Pioneer volcanics and some Noel argillite is in contact with Bralorne gabbro and President ultramafic rocks emplaced along a series of imbricated thrusts. The metasedimentary rocks dip 25° to 60° to the southwest. Numerous diabase dikes intrude the volcanics, gabbro and ultramafic rocks.

The principal exporation targets in the three main tunnels were a large irregular mass of quartz in Bralorne gabbro, a metre-wide quartz vein in an albitite dike and quartz lenses in a shear zone. Abundant lenticular quartz veins with minor calcite occur in all the rock types except serpentinite, where veins usually die out. Irregular flat-lying veins that occur along the contact between Noel argillites and a diorite dike contain pyrite, magnetite and chalcopyrite. The main zone of interest trends northwest from the Red Hawk claims onto the Dan Tucker claims, for a distance of about 1200 metres. The zone is a steep southwest-dipping shear, 2.1 metres along a greenstone-gabbro contact. It contains concentrations of pyrite and some free gold. The shear has numerous irregular and diversely oriented quartz veins. Assays are reported to not exceed 0.34 gram per tonne gold (Lees, 1933).

DAN TUCKER (MINFILE 092JNE166)

The Dan Tucker prospect is centred 7.5 kilometres southeast of the Pioneer mine at latitude 50°43′25″ north, longitude 122°41′05″ west, south of Cadwallader Creek. Access is by an old horse-trail from the confluence of Hawthorn and Cadwallader creeks.

History and Development

The property originally consisted of 10 Crown-granted claims and fractions. It appears that the claims were staked in the early 1930s and were shortly thereafter acquired by Pacific Eastern Gold Mines Limited. The principal exploration work at this time was considerable trenching, an exploratory shaft and a crosscut driven southwesterly 150 metres from the main Red Hawk - Butte-I.X.L access trail. The property was dormant from 1937 to 1944 at which time Noranda Mines Limited gained control. In 1973 the property was sold to R.J. Barclay and then to J.T.M. Enterprises Limited and B.R.H. Investments Limited in 1974. Normine Resources Limited optioned the property in 1983 and completed a program of sampling and geological re-evaluation.

Description

A structurally controlled band of serpentinite up to 30 metres wide, trending northwesterly, forms a small side-hill ridge, separating Fergusson cherty metasediments on the north from sheared volcanic rocks and Bralorne gabbro uphill to the south (Figure 5.25). The shear zone has been the target of exploration. It is 3 to 5 metres wide and has been traced on strike for more than 300 metres. The northwest part of the zone is a quartz sericite schist containing local pyrite disseminations and concentrations of 2 to 40%; the zone is locally intruded by felsic dikes with disseminated pyrite and, in the southeast part, calcedonic quartz veining up to 0.5 metre wide. Nordine (1983) reports chip samples of the quartz assayed a maximum of 2.7 grams per tonne and ranged to less than 0.1 gram per tonne gold.

PAYMASTER (MINFILE 092JNE010)

The Paymaster prospect is centred at latitude 50°44′ 10″ north, longitude 122°44′30″ west between Extension Creek and Plutus Creek southwest of Cadwallader Creek 3.7 kilometres southeast of the Pioneer mine. Access is by 2.2 kilometres of trail from the Pioneer-Piebiter road to the campsite on Crazy Creek .

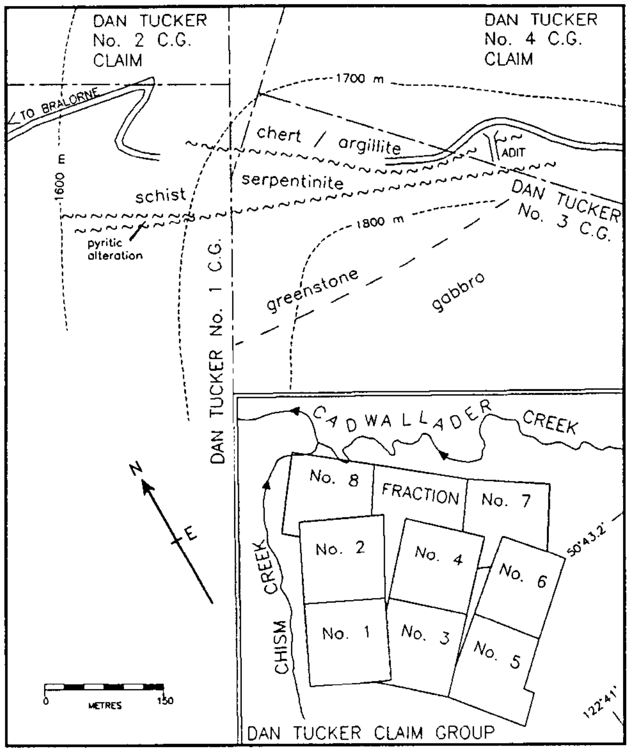


Figure 5.25. Plan of the Dan Tucker prospect.

History and Development

The Paymaster property consists of 24 reverted Crown-granted claims in the Paymaster - Lazy Boy group. Showings were discovered on Crazy Creek in the late 1920s. After a period of considerable prospecting the property was acquired by Paymaster Gold Mines Limited in 1934. Exploration work consisted of open cuts on both sides of Crazy Creek and a short adit east of the creek, 180 metres above the camp site.

Description

A tongue of Bralorne gabbro/diorite and a band of serpentinite cutting Noel argillite is exposed along the upper section of Crazy Creek (Figure 1A). These are the footwall rocks of southwesterly verging thrust sheets that cut diagonally northwest-southeast across the property. The hanging-wall of the thrust on the north side of the property consists of Pioneer volcanics and Hurley sedimentary rocks.

The principal target of exploration was an irregular quartz vein in a felsic dike exposed on the steep valley wall on Crazy Creek, 330 metres southeast of the camp site. The vein contains sparse pyrite and some gold. According to Cairnes (1937) this vein appears to line up or to be closely parallel to a shear zone extending southeasterly for about 1.5 kilometres between Crazy Creek and Plutus Creek.

CHALCO (MINFILE 092JNE043)

The Chalco claims cover several mineral showings in the Piebiter Creek area. The main showing on Lime Creek is centred at latitude 50°43′25″ north, longitude 122°38′40″ west at about 1600 metres elevation. Access is by 11 kilometres of dirt road east from Bralorne to Piebiter Creek, following the north bank Cadwallader Creek, then 1.5 kilometres by steeper road on the north side of Piebiter Creek to the Chalco cabin.

The property was first visted by the writer in late June 1987 at which time the Lime Creek prospect was mapped and the Armeno Resources, Inc. Drill sites on Mount Royal were examined. In late August 1988 there was a return visit to examine a large amount of core drilled the previous autumn and winter by Armeno and Trans Atlantic Resources, Inc.

History and Development

The Chalco property, consisting of nine reverted Crown-granted claims, were staked as the result of exploration by Mrs. C.D. Noel in the period 1945 to 1948. The claims were surveyed in 1956 and W.H. Patmore prepared a geological map in the same year. Mrs. Noel continued to make new discoveries in the area until her death in 1960. In 1962 the ownership of the property was transferred to Bralorne Pioneer Mines Limited. In 1969 Union Carbide Exploration Corporation, by option agreement, completed a major exploration program that included a magnetometer survey, a stream-sediment geochemical program, geological mapping, trenching and stripping, and 670 metres of diamond drilling in 15 holes. Much of this work was completed in the vicinity of Lime Creek on what is now the Chalco No.5 claim. In 1979 Hat Creek Energy Corporation, under a long-term option agreement, explored showings on the Chalco No.12 claim. In the period 1985 to 1988 Armeno Resources Inc. and Trans Atlantic Resources Inc. conducted an extensive exploration program that included geochemical, geological and geophysical surveys and diamond drilling south and west of Piebiter Creek.

Geological Setting

The principal rocks in the area are biotite-quartz schist, amphibolite and marble of the Bridge River Complex, ultramafic rocks and granitic intrusions (Figure 5.26). The schist, marble and amphibolite are believed to be part of the Paleozoic Fergussion assemblage, the protolith of which is a mixture of mostly pelitic rocks, chert, limestone and basalt. These are similar in part to the intensely metamorphosed rocks described by Rusmore (1985) exposed in the Chism Creek area several kilometres to the west. In general, cataclasis has reduced laminated chert and argillite to finely foliated schist, sheared quartz lenses and intensely milled quartz breccias.

The ultramafic rocks consist of pods and bands of harzburgite, dunite, talc, serpentinite and listwanite exposed on the southern part of the Chalco claims on Mount Royal and the area west of Piebiter Creek. These rocks are correlated by Cairnes (1937) to the President ultramafic bodies on Sunshine Mountain and the ridges southwest of Cadwallader Creek.

The Bendor pluton is exposed at the summit of Mount Royal, a short distance southeast of the area illustrated in Figure 5.26, and in the headwaters of Piebiter Creek. This is a Late Cretaceous biotite hornblende granodiorite. The

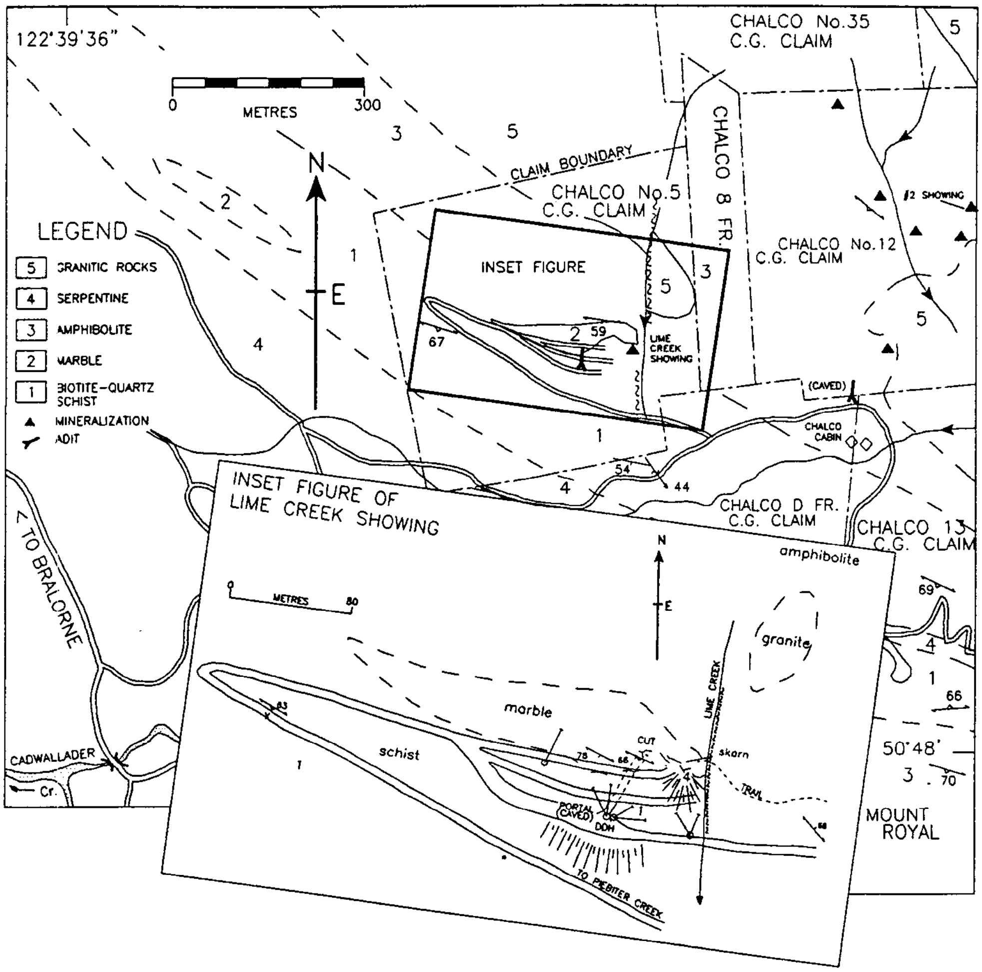


Figure 5.26. Geology of the Chalco prospects.

widespread development of biotite in pelitic schists and skarn minerals in the carbonate and metavolcanic rocks is believed to be caused by this intrusion.

Structural trends in the area are generally east-southeast. This is the direction of bedding attitudes, foliation and major faulting. Folding is not well documented in the area because of poor exposure, however, at one locality west of Piebiter Creek, folding in chert beds plunges about 45 southeast.

Mineral Occurrences

Small garnet-diopside-epidote lenses near the contact of the Bendor intrusion contain copper, molybdenum, tungsten and low-grade gold mineralization. These occurrences are mostly on Chalco No.5, No.12 and No.13 claims in the western part of the claim group. The most important showing was discovered in 1954 just west of Lime Creek at the east end of a large marble body (Figure 5.26, inset). This is a garnet-diopside skarn with pyrite, chalcopyrite (Photo 5.7) and, locally, scheelite. The skarn, exposed in two outcrops 20 metres apart, is bounded by marble on the north and west and a granitic apophysis on the east. The marble body is relatively pure, coarse grained, about 300 metres long, 24 metres thick and dips 65° southwest. Detailed drilling of the skarn in 1969 (a total of 673 metres of drilling in 15 holes) delineated a mineralized zone 50 metres long, 3 to 4 metres wide with grades to 6% copper, 1.8% tungsten, 0.3 gram per tonne gold, and 86 grams per tonne silver. Resource estimates are 33 170 tonnes grading 0.57% WO_3 (Cook, 1970). Reserves calculated for the marble as a potential industrial mineral product are 1.7 million tonnes (Fischl, 1992).

The several skarn showings on the Chalco No.12 claim are all within a few hundred metres of the Bendor granitic intrusion. These are garnet-diopside replacements of limy pods within amphibolitic rocks. The amphibolites are thought to be metamorphosed basaltic lavas and equivalent volcaniclastics. The replacement rocks range from a few centimetres to a several metres thick. The principal showing (No.2 on Figure 5.26) is about 60 metres above the granite contact above the talus slope on the north side of Piebiter Creek. This is described by Stevenson (1949c): "The work on this showing consists of an open cut, 15 feet [4.6 m] wide at the mouth, driven northwesterly for 10 feet [3 m[to a face 10 feet wide and 7 feet [2 m] high. In the cut, numerous masses of chalcopyrite and smaller masses of pyrite and pyrrhotite are associated with blebs of clear, watery vein quartz and light green diopside rock, through all of which are scattered grains and crystals of scheelite. Because of its similar-

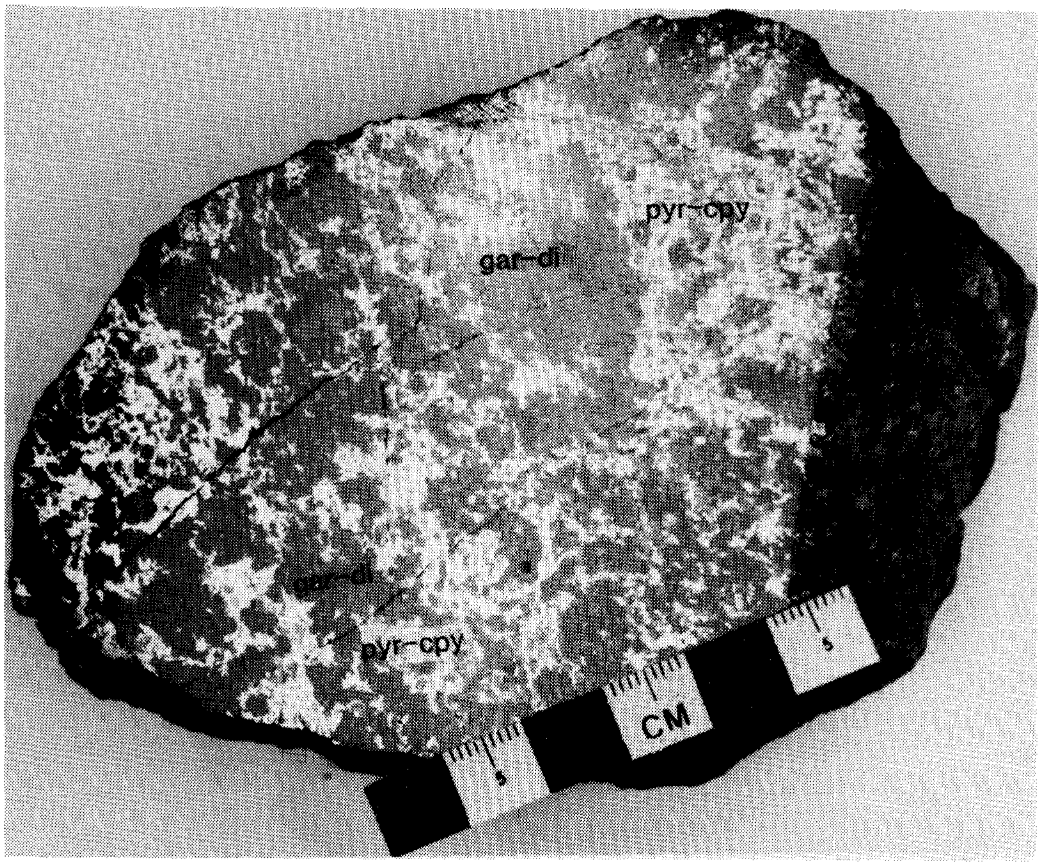


Photo 5.7. Chalcopyrite and pyrrhotite in garnetiferous skarn, Chalco prospect.

ity in colour and lustre to the enclosing silicates, the scheelite is not readily recognizable in ordinary light, but it is clearly recognizable in ultraviolet light. It appears to be most abundant in a vertical 2-foot [0.6 m] zone of light-green diopside-epidote rock, containing a little chalcopyrite, along the northeastern end of the face of the cut. However, more widely scattered grains of scheelite may be seen elsewhere in the lime silicate cut. The lens of lime silicate in the cut extends for 15 feet [4.6 m] northwesterly up the slope beyond the face of the cut before it pinches out and is succeeded along the strike by quartz hornblende schist and extends southeasterly down the hill, narrowing at 36 feet [11 m] from the cut to 3 feet [0.9 m] of lime silicate rock that contains a moderate amount of magnetite and a small amount of chalcopyrite. Farther southeasterly the lime silicate rock is covered with overburden, and the next outcrops, about 100 feet [30 m] distant, along the strike of the formation, are of the unmineralized, laminated schist. The lens of lime silicate rock exposed in the cut is a quartz hornblende schist, strike northwesterly, about 500 feet [150 m] west of the main contact of the batholith —."

Assay results for samples from the face show values to 0.3 gram per tonne gold, 79 grams per tonne silver, 5.2% copper and 1.2% WO_3. More recent estimates of potential are 6100 tonnes per vertical foot based on 12 samples averaging 25 grams per tonne silver, 1.5% copper and 1.18% WO_3 (Sheppard, 1979).

The chemical signature of the mineralization is expressed in terms silver, copper and tungsten (in ppm) by the equation $\mathrm{Log(Ag)} = -7.84 + 1.11\mathrm{Log(Cu)} + 0.002\mathrm{Log(W)}$ where the coefficient of determination is 0.89 and the coefficient of multiple correlation is 0.94, based on 10 assay results provided by Stevenson (1949c).

The area of recent interest on the Chalco No.13 claim is south of Piebiter Creek on the northwest slope of Royal Peak. A geochemical program has outlined a zone of low-grade gold mineralization in quartz biotite schist near a band of ultramafic rocks. The projection of this zone is 36 metres wide and 600 metres long. Diamond drilling in 1977 and 1988 has delineated a mineralized segment of this zone 600 metres long and 36 metres wide with assayed intercepts ranging to 2.2 grams per tonne gold across 9 metres (Carpenter and Haynes, 1988).

The Bramoose showing (MINFILE 092JNE014) is located 1600 metres west by northwest of Piebiter Creek and the Chalco prospect and about 60 metres above the Pioneer-Piebiter road. The main work on the property, by Bramoose Gold Mines Limited in the mid 1930s, was the driving of two short adits, 8.5 metres and 14.6 metres. At the time of visit by the writer in July 1992, both portals were collapsed and the access trail was thoroughly overgrown. The adits investigated skarn mineralization near the contact of Bendor intrusion. A steeply dipping band of marble about a metre wide, striking northwest, is in contact with the southern margin of the Bendor granodiorite stock. The marble is transformed into a lime garnet, epidote skarn locally enriched in sulphides. Low gold values accompany the pyrrhotite and chalcopyrite mineralization (Cairnes, 1937).

ROYAL (MINFILE 92JNE014)

The Royal prospect is on the lower southwest slope of Royal Peak, 11 kilometres southeast of the Pioneer mine, on a small tributary of Cadwallader Creek, just west of Standard Creek at latitude 50°42′05″ north, longitude 122°38′30″ west. Access is by the Cadwallader Creek logging road to Piebiter Creek then 1.5 kilometres on the Standard Creek bush road.

History

Most of the early exploration work on this property was done by Cadwallader Gold Mines Limited in 1932 and 1933. It consisted of ground-sluicing, trenching and a short crosscut adit driven about 45 metres below the road. No further work was recorded on the property until 1980 and 1982 when Hillside Energy Corporation completed a geochemical program. In 1984 the property was acquired by Trans Atlantic Resources Inc. This resulted in completion of several geophysical programs (resistivity, VLF-EM and magnetic surveys) and a drilling program by 1986.

Description

The property is underlain by Fergusson chert, phyllite and schist, dipping 70° to 80° south and southwest. These metasedimentary rocks are cut by Bralorne gabbro and a narrow zone of peridotite. The original discovery was a southeasterly striking quartz vein, about a metre wide, exposed in the Bralorne intrusion on the tributary creek.

Sampling of vein material in the adit below the discovery showing yielded 0.1 gram per tonne gold, 3.5 to 7.0 grams per tonne silver and 0.01 to 0.25% tungsten oxide (Ostler, 1980). Diamond drilling intersected vein quartz with pyrite, minor chalcopyrite and molybdenite; gold assays were disappointing (Carpenter and Haynes, 1988).

STANDARD (MINFILE 92JNE015)

The Standard prospect is near Standard Creek in McGillivray Pass, 14.5 kilometres southeast of the Pioneer mine, latitude 50°41′30″ north, longitude 122°36′08″ west. Access is by the Cadwallader Creek logging road to Piebiter Creek then by bush road and trail. The renovated portal was examined by the writer's crew in August 1987 during the course of a geological traverse of the ridge south of the mine site.

History

The first significant development work on the property was in 1933 by Standard Gold Mines Limited. This included road construction, camp facilities, several trenches and a crosscut adit driven 204 metres northeast (032°) from a point 60 metres north of Standard Creek. There has been no report of subsequent work until recently. The property was held from 1980 to 1982 by Hillside Energy Corporation and was later acquired by Trans Atlantic Resources Inc. In 1984 and 1985 exploration consisted of geochemical and geophysical surveys. In 1985 the Standard adit was reopened and rerouted around a caved area. Sampling and drilling were completed in 1986.

Description

The property appears to straddle a major fault zone (Figure 1A) that continues southeasterly along McGillivray valley dividing Fergusson phyllite and chert on the north from Hurley argillite and clastic sedimentary rocks mainly on the ridge immediately south of the valley. In the area of the workings (Figure 5.27) Fergusson chert and phyllite are interlayered with zones of serpentinite and listwanite.

In the crosscut adit Fergusson beds are exposed from the portal to 123 metres and again at 200 metres near the face. These beds dip 65° northeast and are locally faulted. From 123 to 200 metres the rocks are mainly altered and serpentinized. The face of the tunnel at 204 metres is a listwanitic talc-carbonate rock.

Mineralization is associated with quartz veins and veinlets. These are concentrated in the interval 76 to 84 metres from the portal in the hangingwall of an easterly dipping fault and in quartz lenses up to a metre wide in the altered and serpentinized zone. Pyrite and arsenopyrite are disseminated in the quartz and intervening wallrocks (Cairnes, 1937).

Detailed sampling of the crosscut adit by Trans Atlantic Resources Inc. yielded assays in excess of 2000 ppm arsenic but no correlation of these results with gold. According to Carpenter and Haynes (1988) realgar crystals between 1 and 3% were noted in some of the quartz and pyrite in schistose

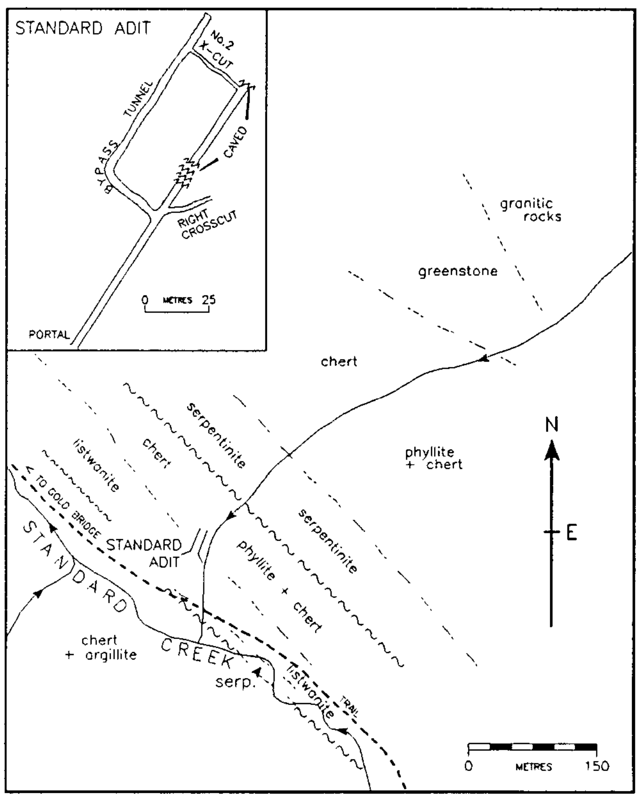


Figure 5.27. Geology of the Standard Creek prospect.

Fergusson rocks, however, the zone between 64 and 85 metres, previously reported to contain gold values to 4.2 grams per tonne, averaged less than 0.1 gram per tonne gold by the new sampling.

WAYSIDE MINE AND MOUNT PENROSE AREA

The mineral occurrences in the Wayside mine, Gun Lake and Mount Penrose area are inter-related structurally and are of similar age. The Wayside mine is situated near the northern extremity of the Cadwallader break; the Veritas and Pilot prospects are associated with segments of this structure dislocated by the intrusion of the Penrose lobe of the Coast Plutonic Complex (Figure 1A). The gold-quartz veins of the Wayside mine are characteristically Bralorne type being hosted by the Bralorne diorite and having an average gold-silver ratio of 6.4 (within the 5.4 to 8.3 range for Bralorne, Harrop and Sinclair, 1986). The Veritas veins are also mesothermal and hosted by Bralorne diorite. The Pilot veins occur in a tongue of the Coast granitic rocks dated 95 Ma; mineralization may be about the same age at Bralorne (85-91 Ma) and related to the cooling phase of the Penrose pluton.

WAYSIDE (MINFILE 092JNE030, 121, 124)

The Wayside mine is located on the north side of Carpenter Lake at latitude 50°52′30″ north, longitude 122°49′40″ west, 3.2 kilometres north of Gold Bridge. Access to the property is by bush roads that connect to thehighway and the Gun Lake road. The property and mine site were visited repeatedly by the writer and crew between 1986 and 1988. The geology of the property was mapped in conjunction with a magnetometer survey and logging of 20 drill cores provided by Chevron Minerals Limited.

History and Development

The history of the Wayside property has been outlined by Cairnes (1937), Kelly (1972) and McAllister *et al.* (1988). Details of the periods of active exploration and development from 1906 to 1937, 1946 to 1953 and 1971 to 1988 are given in the Minister of Mines Annual Reports and subsequent government publications such as Exploration in British Columbia. The property was first staked by J.C. Patterson in 1900. The original claim group, comprising the Wayside, Argon, Radium, Helium and Queen City Fraction, was sold to O. Fergusson and C. Walker six years later. By 1910 three adits had been driven on the Wayside vein system and a sample of pyritic quartz ore was shipped by pack-train for testing. D.C. Paxton then acquired the property and a small mill was in operation by 1915. From 1917 to 1922 there are no reports of activity and the property passed to Messrs. Fergusson and Walker in 1924. This led to a program of sampling and geological mapping and the property was transferred to Wayside Consolidated Gold Mines Limited in 1928. By 1933 complete camp facilities had been installed, including a hydro-electric plant; the Wayside vein system had been exposed on five levels in 300 metres of tunnelling over a vertical interval of 150 metres. From 1915 to 1936 a total of 39 100 thousand tonnes of ore was mined yielding 166.1 kilograms of gold and 26.1 kilograms of silver (MINFILE 092JNE030).

From the end of operations in 1937 until recently, only a small amount of exploration work was done, mainly by the L.A.P. Mining Company Limited (1946 to 1953) and the Ace Mining Company Limited (after 1959). In 1947 the mine was dewatered and rehabilitated with the addition of hoisting equipment; 900 tonnes of ore were recovered for metallurgical testing. A fire at the mine in 1953 curtailed further development. In 1971 Dawson Range Mines Limited (Carpenter Lake Resources Limited) acquired the property and in the following four years completed a number of programs including geological and geophysical surveys, underground rehabilitation and sampling. This led to the discovery of the New Discovery and Commodore zones and the 3T vein. In 1984 the property was optioned to Amazon Petroleum Corporation Limited and many targets were retested by diamond drilling. Early in 1987 the reorganized company, Amazon Petroleum Inc. and Carpenter Lake Resources Limited optioned the property to Chevron Canada Resources Limited. Its exploration activity on the property were based on similarities in geological setting, morphology and style of mineralization between the Wayside mine and the gold-quartz veins at Bralorne, 15 kilometres to the south. A total of 21 diamond-drill holes (3006 m) were completed in Chevron's 1987-88 program to explore for faulted segments of the Wayside veins. The most recent work, in 1992 by Wayside Gold Mines Limited and Brigadier Resources Limited in a 50/50 partnership relationship, has included dewatering of the lower levels of the Wayside mine and resampling the main vein and Notman vein systems.

Geological Setting

The Wayside property is near the northern extremity of the 'Cadwallader break'; a geological setting similar to the Bralorne and Pioneer mines 15 kilometres to the south (Figure 1A). In detail, the property is underlain by faulted segments of the Bralorne intrusion and volcanic and sedimentary rocks of the Cadwallader Group and Bridge River Complex (Figure 5.28). The 'Bralorne diorite', described by Cairnes (1937), is actually a mottled grey-green, medium to fine-grained gabbro and anorthositic gabbro containing granitic apophyses. This is the oldest plutonic rock in the area (Permian) according to radiometric dating by Armstrong (unpublished K-Ar date of 287±20Ma) and this study (Table 2.8, U-Pb zircon date of 293±13Ma). The country rocks along the west contact of the Bralorne intrusion are highly deformed Fergusson cherts and phyllites. This contact is intruded by a dike-like, narrow body of ultramafic rocks. The three principal formations of the Cadwallader Group, the Pioneer volcanics, Noel argillites and Hurley conglomerates and sandstones in this area, are faulted against the Bralorne intrusion on the northeast side. The stratigraphic relationships between these units, shown in Figure 2.1, indicates interdigitation of Noel Formation with Pioneer volcanics and Hurley clastics.

Mineral Occurrences

The main targets of exploration are veins in the Bralorne intrusion, at the Wayside mine, (including the Commodore and 3T veins). The New Discovery zone and Two Bob zone are adjacent the Bralorne intrusion in Bridge

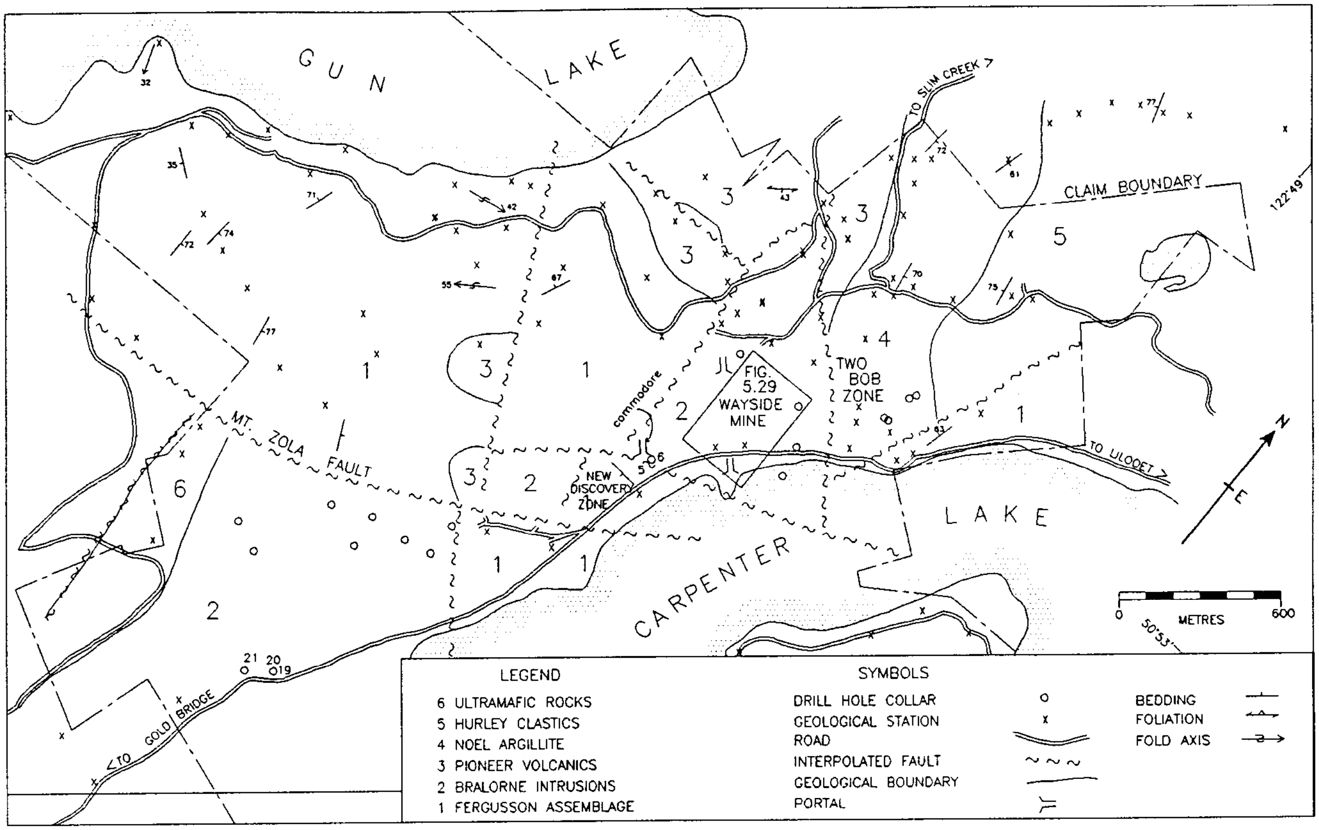


Figure 5.28. Geology of the Wayside property.

River Complex and Cadwallader Group host rocks respectively (Dick *et al.*, 1988).

The Wayside mine, centred on the Wayside Crown-granted claim, consists of seven adit levels and three accessed by winzes levels, developed in a northerly trending shear zone in a faulted segment of the Bralorne intrusion. Gold-quartz mineralization occurs in the main shear zone and branching fissures, known as the footwall veins Nos.1 and 2, and the hangingwall or Notman vein (Figure 5.29). The main shear zone is exposed on every level of the mine, striking 155° to 170° and dipping 45° to 65° easterly. The zone has been traced for a strike length of more than 300 metres and ranges up to 5 metres wide. It consists of carbonate and clay-altered schist cut by numerous quartz-carbonate veinlets. The No.1 and No.2 footwall veins strike subparallel to the main shear zone and, on average, dip flatter (McAllister *et al.*, 1988). These veins are accompanied by carbonate alteration similar to the main zone, however, there is little associated shearing. No.1 vein is exposed on the 0 and 1 levels varying from a composite of quartz stringers 5 centimetres wide, to a solid ribboned quartz vein about a metre wide. No.2 vein is exposed on the 2M, 3, 4W and 5 levels ranging in width from 10 to 60 centimetres. The highest gold value reported by McAllister *et al.* (1988) is 4.35 grams per tonne over 40 centimetres. According to these authors the Notman vein is seen only on the 5 level. This is a continuous vein up to 60 centimetres wide with no obvious accompanying carbonate alteration. The highest assay value, 21.10 grams per tonne gold, was obtained across a width of 10 centimetres.

Much of the main shear contains little mineralization, and the higher grade material is found in branch fissures off the main shear and at shear junctions. The ore minerals include pyrite, arsenopyrite, chalcopyrite, telluride (probably sylvanite), galena, tetrahedrite, sphalerite, stibnite and native gold. Alteration minerals are siderite, mariposite, talc, sericite and chlorite. The main shear is reported by Amazon Petroleum Inc. to carry less than 1.7 grams per tonne gold on average, but drilling in 1984 beneath 9 level intersected a vein assaying 163.2 grams per tonne gold across a 1.6 metres (Arik, 1984). In 1992, Brigadier Resources reported an intersection of 3 metres on the main vein grading 90 grams per tonne gold, 46 metres below the 9 level.

To test the correlation of ore-forming elements, a product moment matrix was computed (Table 5.2) as described by Church (1987c) and using log-transformed values for

TABLE 5.2
PRODUCT MOMENT CORRELATION MATRIX FOR WAYSIDE MINE ASSAYS

	Au	Ag	Cu	Zn	As	Sb
Au	1	0.372	-0.325	-0.094	0.436	0.2
Ag		1	0.404	-0.247	-0.162	0.428
Cu			1	0.063	-0.302	0.612
Zn				1	0.189	0.11
As					1	-0.07
Sb						1

Correlation of r^2 values is based on 20 assay results provided by McAllister *et al*., (1988).

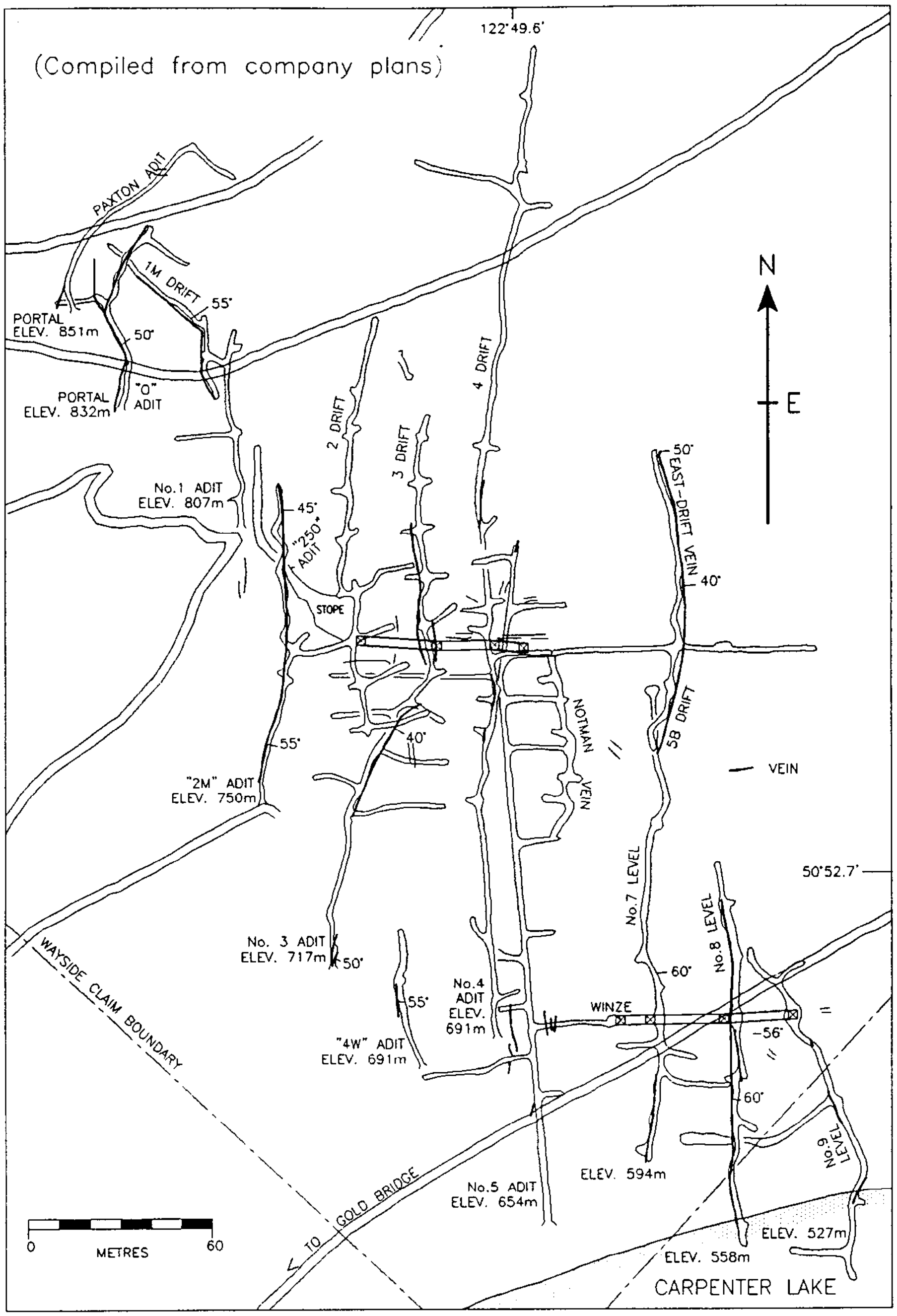


Figure 5.29. Plan of the Wayside mine.

gold, silver, copper, zinc, arsenic and antimony from the assay data reported by McAllister *et al.* (1988). Of the 15 pairs of elements generated in this table Au-Ag, Au-As, Ag-Cu, Ag-Sb and Cu-Sb showed a positive correlation based on 20 assays of vein material from the underground workings of the Wayside mine. The correlation between gold and arsenic is due to the association between gold and arsenopyrite and the three way correlation between silver, antimony and copper suggests the importance of tetrahedrite in the ore. Zinc and lead do not appear to correlate with precious metals.

The chemical signature of this mineralization is expressed in terms of the following equation (based on McAllister's assay results): $\mathrm{Log(Au)} = 0.09 + 0.36\mathrm{Log(Ag)} - 0.44\mathrm{Log(Cu)} + 0.32\mathrm{Log(As)} + 0.29\mathrm{Log(Sb)}$ where the coefficient of determination = 0.66, the coefficient of multiple correlation = 0.81 and the standard error of estimate = 0.50.

The objective of exploration by Chevron Minerals Limited was to locate the faulted segments of the Wayside vein system. In the Wayside area, a northeasterly trending fault, known locally as the Mount Zola fault, appears to have dislocated part of the Bralorne intrusion and the Wayside veins. To understand this dislocation in the search for additional ore, the writer completed a fracture study north and south of the fault in the Bralorne hostrocks; unimodal fracture patterns were found in both areas (Figure 5.30). Assuming a common origin of these fractures, the attitude and rotation on the Mount Zola fault is estimated to be 052/35SE and

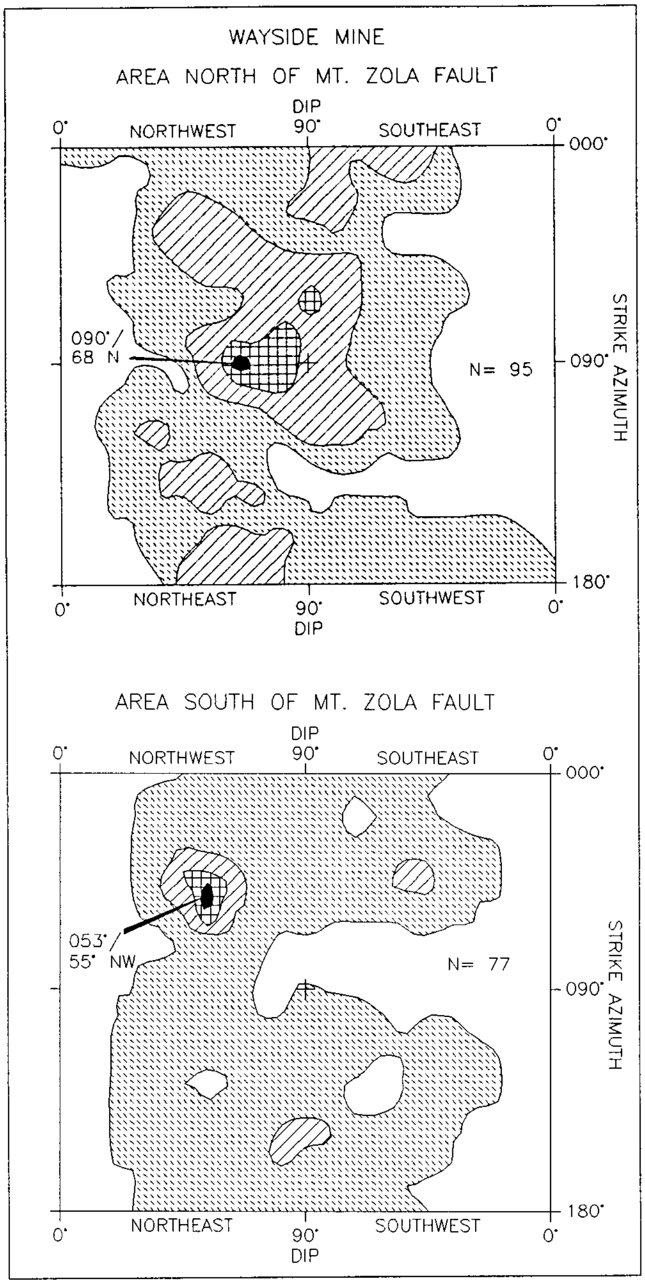


Figure 5.30. Fracture frequency plots for the Wayside property.

35°, respectively; apparent dislocation along the strike of the fault is about 900 metres.

The Commodore prospect (MINFILE 092JNE124) is an auriferous quartz vein near the western margin of Bralorne intrusion, 300 metres southwest of the Wayside mine. Although the vein is poorly exposed at surface it can be traced on strike for at least 10 metres and is up to 1 metre wide. A diamond drilling program by Amazon Petroleum and Carpenter Lake Resources in 1984 showed that the vein dips 45° to 54° northeast, and consists of quartz and albite accompanied by minor amounts of arsenopyrite and pyrite, hosted by carbonate-altered soda granite. Sampling by Lammle (1974) yielded assays as high as 72.5 grams per tonne gold and 56.9 grams per tonne silver. The 3T vein is about 150 metres northeast of the Commodore vein. It has been suggested these veins may coalesce at depth. The 3T adit follows a vein-lead striking northwesterly and dipping about 51° northeast beneath a body of soda granite.

The New Discovery zone (MINFILE 092JNE121) is not related to the Wayside auriferous vein system. It consists of pyritic concentrations within northerly trending and steeply dipping metavolcanic and sedimentary rocks of the Bridge River Complex about 800 metres south of the Wayside mine. This stratiform sulphide body, outlined by more than 1800 metres of diamond drilling in 12 holes, is estimated to be 4.8 metres thick and 140 metres in strike length. The deposit is composed mostly of pyrite with some pyrrhotite, chalcopyrite and sphalerite, and very minor amounts of galena. Weak mineralization on the hangingwall is followed downward locally by massive pyrite and pyrrhotite, mostly near the footwall. Geological reserves estimated by the Amazon Petroleum Corp. from drilling are 150 000 tonnes grading up to 1.76% copper and 3.03% zinc with minor precious metal content (Morris, 1985).

The Two Bob zone is an area of anomalous gold and arsenic determined by sampling from trenches and drilling east of the Bralorne intrusion on the east part of the property. The hostrocks are felsic dikes and listwanite associated with fracturing subparallel to the contact between the Noel argillite beds and Fergusson ribbon cherts - a major fault crossing the highway immediately to the south (Figure 1A).

PILOT (MINFILE 092JNE027)

The Pilot mine is 4 kilometres northwest of Gold Bridge, on the north shore of Gun Lake just east of the mouth of Walker Creek, at latitude 50°52′30″, longitude 122°53′05″ west. Access to the property is by an all-season gravel road that encircles Gun Lake and connects by several routes to the town Gold Bridge. The property was visited twice in July 1986.

History

The property consists of 12 reverted Crown-granted claims, including the Ypres Fraction, Gold Pass 1 and 2, and 9 G.L.C. claims and fractions together with a large number of recently located Pilot claims. The original claims were staked in 1917 on the shore of Gun Lake where several gold-bearing quartz veins were exposed by sluicing. Gun Lake Gold Mines Limited gained control of the property in 1931 and ownership was transferred to Cariboo - Bridge River Gold Properties Limited in 1933. Underground work began from a portal collared 15 metres above lake level; a compressor operated on waterpower derived from nearby Walker Creek. Pilot Gold Mines Limited acquired the property in 1934 and developed approximately 1500 metres of underground workings. In 1936 a two-compartment shaft was sunk 90 metres for exploration purposes. Subsequently the property has been mainly dormant. X-Cal Resources Limited acquired the property in 1984 and has conducted surface exploration mainly on the Pilot Extension claims northwest of the mine. A more thorough examination of the property began in 1991 when the property was optioned to Cogema Canada Limited. Work in 1992 was focused on resampling the Pilot mine and newly discovered mineralization along an 800-metre section of the contact between the Penrose lobe of the Coast Plutonic Complex and metasedimentary rocks on the Pilot Extension claims.

Description

The property is underlain by a granodiorite apophysis of the Coast Plutonic Complex that intrudes Fergusson cherts and Noel argillite. A major zone of Bralorne gabbro and associated ultramafic rocks lies to the east (Figure 5.31).

The Pilot mine is centred on quartz veins and silicified shear zones in the southeast extremity of the granodiorite. The main mineralized zone is on a north-northwest-trending shear zone 80-100 metres west of the main adit. The shear zone is about 3 metres wide and dips 35° to 40° easterly. It contains a number of narrow discontinuous veins accompanied by sericite and clay alteration. A similar zone lies 100 metres farther west. Sebert (1987) reports pyrite and arsenopyrite were deposited coevally with quartz in at least two episodes of mineralization. Assays ranging up to 11.1 grams gold and 56.9 grams silver per tonne are shown on mine plans for 100 metres along this structure - comparison Cairnes (1937) quotes values ranging up to 9.7 grams per tonne gold. Harrop and Sinclair (1985) report an average gold/silver ratio of 0.016 for this prospect.

Several northerly trending, steeply dipping quartz veins in the portal area are relatively continuous, locally enriched with pyrite but with low gold values.

According to Cairnes (1937) the best potential for mineralization is at vein shear zone intersections. Gold appears

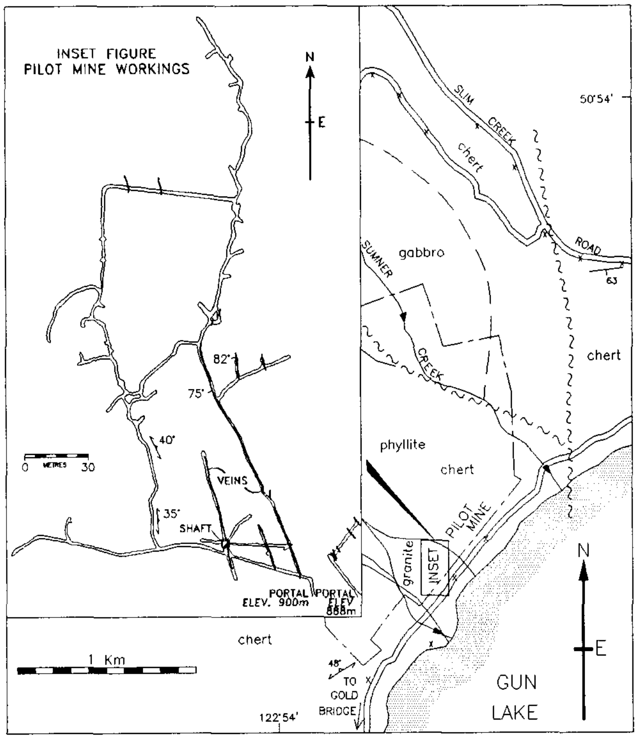


Figure 5.31. Geology of the Pilot prospect and plan of mine workings.

to be associated with arsenopryite. To the northwest on the Pilot Extension claims gold occurs along the east contact of the Penrose granitic stock leaving little doubt that the mineralization is closely related to emplacement of the Coast Plutonic Complex.

VERITAS (MINFILE 092JNE031)

The Veritas prospect is 4.8 kilometres west-southwest from Gold Bridge, on the northwest corner of La Joie Lake, latitude 50°50'30" longitude 122°54'35". Access is by dirt road along the north shore of La Joie Lake from the Gun Lake road. At the time of a visit by the writer in July 1986 the lower portal was collapsed and remainder of the workings were in poor condition.

History

The Veritas prospect was staked about 1908 and was explored intermittently by M. Foster over a period of about 30 years. The property consists of the Veritas, Eve and Ranch reverted Crown-granted claims together with several located claims. Development comprises a number of open cuts and four adits amounting to more than 340 metres of tunnelling (Cooke and Robins, 1986). The No.1 adit follows a vein westerly for about 165 metres from a point 3 metres above the shore of Lajoie Lake. No.2 adit, now collapsed, is 25 metres above No. 1 and driven about 95 metres in the footwall of the vein that is exposed in three crosscuts. No.3 adit, 30 metres above, follows the vein for about 70 metres with a short winze and raise at 12 metres from the portal. No.4 adit is a very short and 25 metres above No.3.

After a long period of dormancy the claims were acquired and re-explored by W. Cook in 1978. Coral Energy Corporation (later Coral Gold Corp.) acquired the property in 1985 and completed geophysical and geochemical surveys in 1986.

Description

The property straddles a major northwesterly trending break along which is emplaced a large lenticular mass of Bralorne gabbro-diorite and serpentinized peridotite. Hurley clastic sedimentary rocks are exposed to the southwest and Fergusson cherts to the northeast (Figure 1A).

The focus of exploration is a quartz vein in Bralorne rocks, subparallel to the contact with the serpentinized peridotite (Figure 5.32). The vein has been traced for about 300 metres along strike (120°) and at least 80 metres vertically through the mine workings. The vein dips steeply to the northeast and ranges from a few centimetres to more than a metre thick. The hangingwall is altered gabbro-diorite with much ankeritic carbonate, disseminated sulphides and a minor amount of talc and green mica. The footwall is a schist and breccia mixture of gabbro-diorite and serpentinite (McCann, 1922). The vein material is massive white quartz with minor calcite and a small amount (1%) of pyrite, arsenopyrite, chalcopyrite and galena and, rarely, specks of free gold. Small masses of pyrite, up to 30 centimetres across, occur in the footwall (Cairnes, 1937).

Sebert (1987) suggests two stages of mineralization. A first stage of emplacement of massive milky quartz with a minor amount of pyrite and arsenopyrite, followed by brecciation, renewed quartz veining and the deposition of the full range of sulphide minerals.

LITTLE GEM - JEWEL (MINFILE 092JNE068, 108)

The Little Gem prospect is centred 9.5 kilometres northwest of Gold Bridge at 1900 metres elevation, below the north spur of Mount Penrose in the headwater basin of Roxey Creek, at latitude 50°53′40″ north, longitude 122°57′10″ west. Access to the property is by 4 kilometres of steep mountain road from Gun Creek and 11.5 kilometres on the Slim Creek logging road that joins the main Gold Bridge to Lillooet road. The property was visited and sampled by the writer in July 1986.

History and Development

The property consists of eight reverted Crown-granted claims, Little Gem 2-18, and the located claims Roxey, Aura and Henabil. The ground was staked by W. Haylmore and W.H. Ball in 1934 and purchased by R.R. Taylor in 1937. The United States Vanadium Corporation optioned the property in 1937 and drove the first adit on the steep mountainside 500 metres southeast of Roxey Creek. During the winter of 1939 the lower adit was begun by contractors. In 1940 the property was optioned briefly by Bralorne Mines Limited at which time the lower adit was extended and two raises were driven. From 1952 to 1953 Estella Mines Limited completed a program of diamond drilling from the lower adit and constructed a switchback road from Gun Creek. Northern Gem Mining Corporation was formed in 1955 and expanded the property from three to eight Crown-granted claims and 26 recorded claims. Work completed included road improvement, construction of a camp site on the east bank of Roxey Creek, installation of a compressor and cable tramway, underground diamond drilling, 125 metres of drifting and crosscutting in the lower (No.2) adit and 154 metres of tunnelling in the upper (No.1) adit. In 1957 No.3 adit was driven 30 metres below No.2 and 140 metres of additional tunnelling was completed (Skerl, 1957). Additional assessment work by this company was done in 1958. There was little activity on the property from 1958 to 1978. Major Resources Limited acquired the property in 1979 and completed geophysical and geochemical surveys. In 1984 Anvil Resources Limited continued exploration under an option agreement. By 1986 a broad program of data compilation, geology, geochemistry, geophysics, trenching and drilling had been completed.

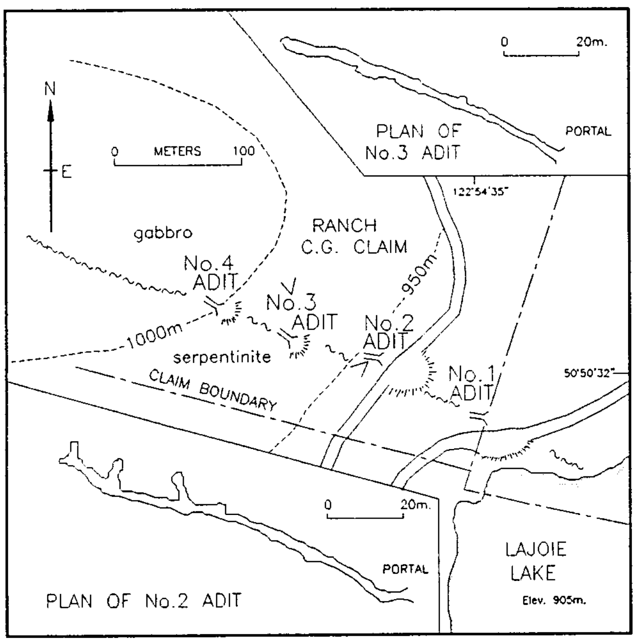


Figure 5.32. Plan of the Veritas workings.

Description

The property is underlain by granitic rocks of the Penrose Stock (Fig. 5.33) which is a lobe of the Coast Plutonic Complex that projects easterly from Dickson Peak to Gun Lake. These rocks consist mostly of biotite hornblende granodiorite and some granitic phases that intrude hornfels, amphibolites, metasedimentary rocks and serpentinized peridotites along the north side of the property.

A northeasterly trending zone of bleached granodiorite, exposed for a strike length of about 200 metres between Roxey Creek and Jewel Creek, can also be traced on the cliffs and through the mine workings for a vertical range of more than 100 metres (Figure 5.33). The zone, containing brownish carbonates and minor quartz, attains a maximum width of about 12 metres on the west where it rises above a talus slope in the valley of Roxey Creek; it narrows to the east where it covered by glacial overburden.

The deposit consists of coarse-grained mineralized lenses and disseminations in a bleached alteration zone. The lenses range from less than a metre to 5 metres long and up to 1.5 metres wide. They occur near the portal of the No.1 and No.2 adits, on surface above the No.1 adit to the north and in several hand-dug trenches 200 metres to the east. The lenses consist mostly of an intergrowth of sulpharsenides and nonmetallic gangue minerals including allanite, apatite, potassium feldspar, quartz, chlorite and calcite (Photo 5.8). A minor amount of pyrite, molybdenite, scheelite and uraninite is also reported. The species of sulpharsenides include arsenopyrite, danaite, loellingite and safflorite (Photo 5.9). The disseminated mineralization is mostly scattered arsenopyrite grains in sericite, clay and quartz.

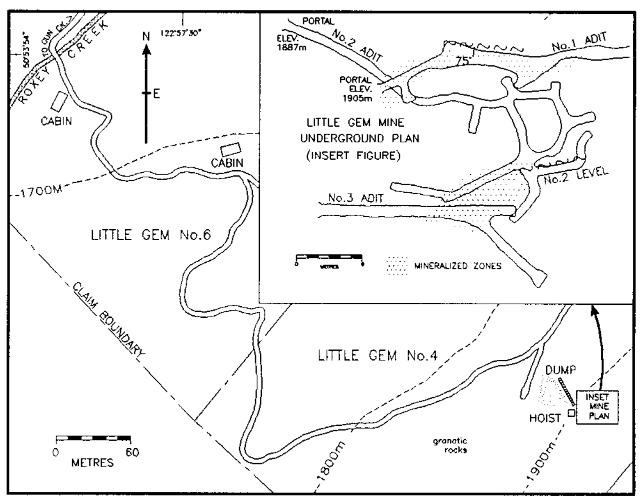


Figure 5.33. Plan of the Little Gem property.

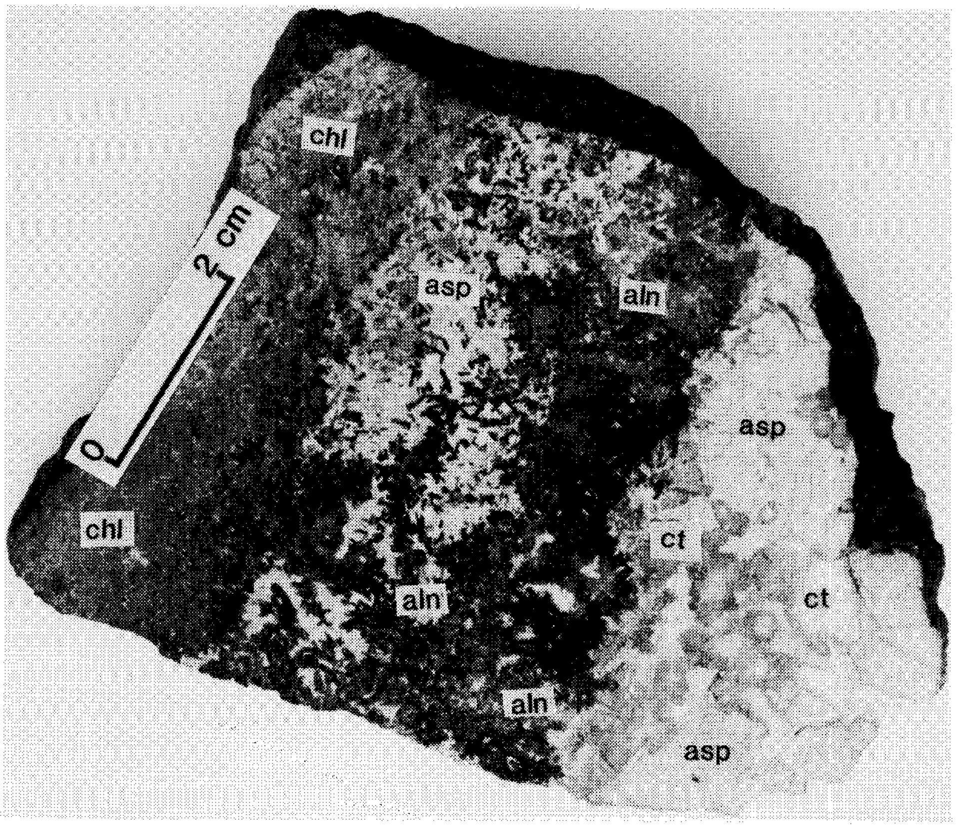


Photo 5.8. Allanite mineralization (small black rods) associated with arsenopyrite (asp), chlorite (chl) and carbonates (ct), Little Gem mine.

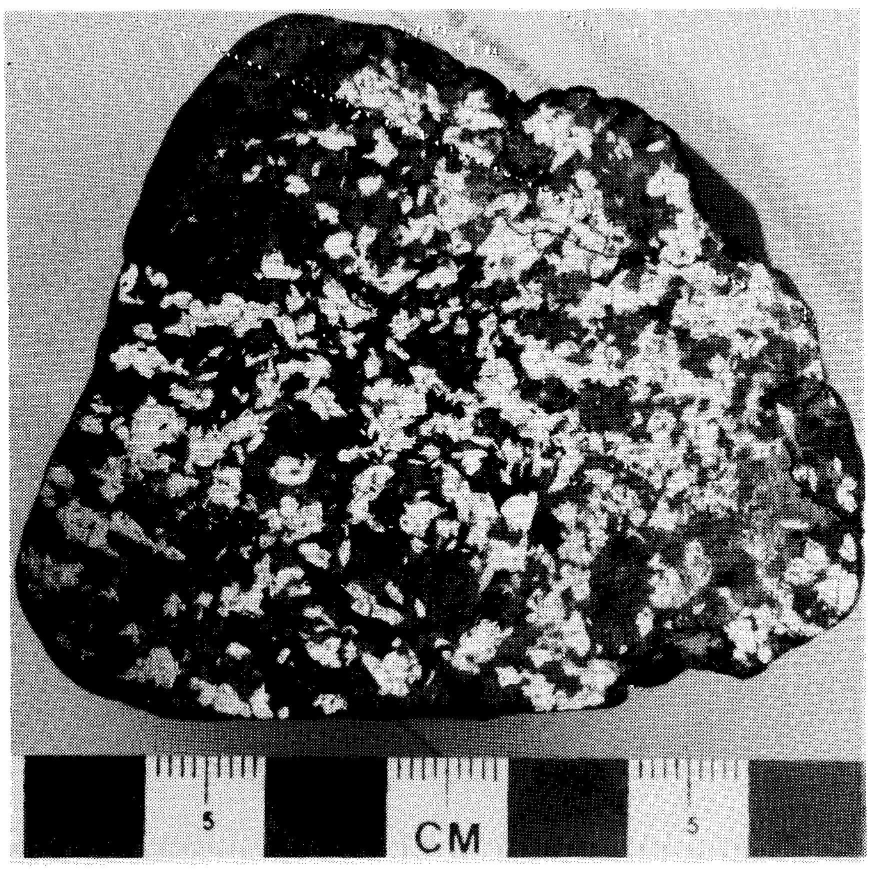


Photo 5.9. Sulpharsenide mineralization, Little Gem mine.

A number of tan-coloured ankeritic carbonate zones associated with shears are conspicuous near the showings. These cut the zone of bleached granodiorite and are believed to be younger than the main period of mineralization. This second, lower temperature event may have caused some leaching and corrosion of the ore minerals noted by Sebert (1987).

Stevenson (1949a) reports that gold, cobalt and uranium are concentrated in the mineralized lenses; the surrounding altered granodiorite carries relatively low values. Gold occurs as discrete grains within or between the sulpharsenides and in the gangue; cobalt is mainly in the sulpharsenides and uranium is in uraninite concentrated locally with the sulpharsenides or gangue minerals. An assay of a typical sample of the "ore" reported by Cairnes (1943) gave 66% arsenic, 22% iron, 5% sulphur, 6% cobalt, and 0.05% nickel. Thirty nine channel samples taken across the mineralized zone by Stevenson (1949a) yielded an average of 27 grams per tonne gold, 2.91% cobalt, 38% arsenic and 0.2% uranium oxide.

The chemical signature of the mineralization is better expressed by multiple linear regression of the principal ore-forming elements where uranium, cobalt, arsenic and sulphur are independent variables and gold is the dependent variable in the following equation: $\mathrm{Log(Au)} = 1.95 - 0.11\ \mathrm{Log(U)} + 1.01\ \mathrm{Log(Co)} - 0.39\ \mathrm{Log(As)} + 0.59\ \mathrm{Log(S)}$, with a coefficient of multiple correlation = 0.74, a coefficient of determination = 0.54 and a standard error of estimate = 0.63. The calculations are based on 10 assay results reported by Stevenson (1949a).

A resource of 9425 tonnes grading 23 grams per tonne gold, 2.97% cobalt and 0.25% uranium was calculated by Allen (1956), assuming continuity of the ore between the upper adit and surface.

The origin of the mineralization is thought to be related to the granodiorite (Cairnes, 1943) and described as pegmatitic and as a high-temperature vein replacement (Stevenson, 1949a). In any case the feldspar porphyry dikes in the underground workings and on the nearby slopes (that appear to be somewhat younger than the granodiorite) cut the ore.

The Jewel prospect (MINFILE 092JNE108) lies directly north of the Little Gem property on the north spur of Mount Penrose, between Roxey Creek and Jewel Creek at elevations 1650 to 1850 metres, latitude 50°54′20″ north, longitude 122°56′20″ west. The workings, visited by the writer in July 1986, consisting of surface trenches, two short shafts and three adits, explore a southerly dipping vein system near the north contact of the Coast Range batholith. At surface the main vein strikes west-southwest for about 200 metres in serpentinized peridotite exposed about 30 metres from the north contact of the batholith. In places the vein branches along the walls of a feldspar porphyry dike and at one location comprises 'drag ore' in a shear zone. Streaks and pods of pyrite, arsenopyrite and chalcopyrite, averaging 15 centimetres wide, occur in sheared siliceous gangue with occasional quartz and calcite streaks. Assays are reported up to 75.4 grams per tonne gold and up to 34.3 grams per tonne silver. From 1938 to 1940, 51 tonnes was milled yielding 3402 grams gold, 3685 grams silver and 199 kilograms copper (MINFILE).

MINTO MINE AND CARPENTER LAKE AREA

The mineral occurrences in the Minto - Carpenter Lake area are mostly base metal enriched veins distal to the Coast Plutonic Complex. They are generally medium to low-temperature deposits with greater amounts of mixed sulphides (characterized by an abundance of antimony) and lower gold to silver ratios than Bralorne-type mineralization. These are the Minto, Olympic, Summit and Peerless deposits. The Congress, Lou, Howard and Reliance-Senator are relatively low temperature deposits containing minor amounts of cinnabar in addition to mixed sulphides (Maheux, 1989). Benboe and Silversides are small prospects in the Tommy Creek area that are genetically related to a small granitic stock satellitic to the Bendor pluton.

MINTO (MINFILE 092JNE073, 075, 077)

The Minto mine is located on the north shore of Carpenter Lake, centred at latitude 50°53′ north, longitude 122°45′ west, east of Gun Creek. Access is directly from the Highway 7 kilometres northeast of Gold Bridge. Examination of this property by the writer, completed in July 1988, included mapping and logging of drill core provided by Avino Mines and Resources Limited.

History and Development

The Minto property is owned by Avino Mines and Resources Limited. The property comprises eight Crown-granted mineral claims (Omega and Omega 1-4, Alpha Fraction, Jack Fraction and Golden Girl); reverted Crown-granted claims, Hillside Extension 1-2, Minto Fraction, Prince, Frank Fraction, Hagmo, Ex Fraction, and Om Fraction, Golden Queen, Helm Fraction, and Juniper (located claim).

The original claims were staked in 1910 but little work was done until the 1930s. The property was optioned to Consolidated Mining and Smelting Company of Canada, Limited (Cominco) by W. Davidson in 1930. Work completed by this company in 1931 and 1932 included the initial development of the River, Hagmo and Warren adits. The option was relinquished in 1933 and property became the asset of the newly formed Minto Gold Mines Limited. This company extended the previous workings, the main adit and a winze from the lowest adit to three deeper levels. A mill was installed in 1934 with a capacity of 50 tons per day; in 1935 capacity was increased and maintained at 125 tons per day until the end of operations in 1937. In 1942 some broken ore was extracted and a few pillars mined. Exploration below the adit levels proved unsuccessful.

Pioneer Gold Mines Limited obtained an option from 1941 to 1942; in 1959 the claims were acquired by Ace Mining Company Limited. Little additional work was done and the property, now under the name of Minto Trading and Development Company, became part of the estate of Marguerite W. Wiles. In 1975 Empire Metals Corporation Limited optioned the property and completed geochemical and geophysical surveys. Avino Mines and Resources Limited purchased the property in 1985 and, up to 1987, had completed geological, geochemical and geophysical surveys which led to trenching and diamond drilling, mostly north of the old mine workings. Since this time the property has been dormant.

The main period of production from the Minto mine was from 1934 to 1940. A total of 80 650 thousand tonnes of ore was mined yielding a total 0.55 million grams of gold, 1.6 million grams of silver, 9673 kilograms of copper and 56 435 kilograms of lead (MINFILE).

Geological Setting

The property is underlain mainly by Fergusson chert and phyllite, serpentinite, greenstone and felsic dikes (Figure 5.34a). Ribbon chert, the most common rock, is locally markedly deformed and brecciated and much of the accompanying greenstone has been transformed to schist. The younger Pioneer pillow basalts occupying the highest terrain, near the northwest boundary of the property, are less deformed and are fed by basaltic intrusions. Feldspar porphyry dikes, exposed in many of the road cuts, follow the principal fracture directions, including mineralized shears.

The fracture pattern in the Minto area is similar to the Congress property (Figure 5.35). The principal fractures dip steeply and trend northerly, subparallel to the attitude of the chert. There are strong cross fractures striking 050° to 080° and dipping 45° to 80° northwest, and several northeasterly dipping faults mapped in the mine workings.

Mineral Occurrences

The Minto vein has been developed for 460 metres on strike and 230 metres down dip. The mine comprises more than 2000 metres of underground development including four adits and lower workings (Figure 5.34b).

The vein closely follows the sheared footwall of a large, Late Cretaceous microdiorite dike (Pearson, 1977). It ranges up to 1.2 metres wide and consists of pinching and swelling bands of quartz, calcite and ankerite with concentrations of medium to coarse-grained pyrite, arsenopyrite, sphalerite, stibnite (Photos 5.10 and 5.11) and smaller amounts of galena, chalcopyrite, tetrahedrite, jamesonite, marcasite, pyrrhotite, bismuthinite and native gold (Friesen, 1988). The main ore shoots occur in the cherts which are relatively unaltered except for shearing, however, the greenstones to the

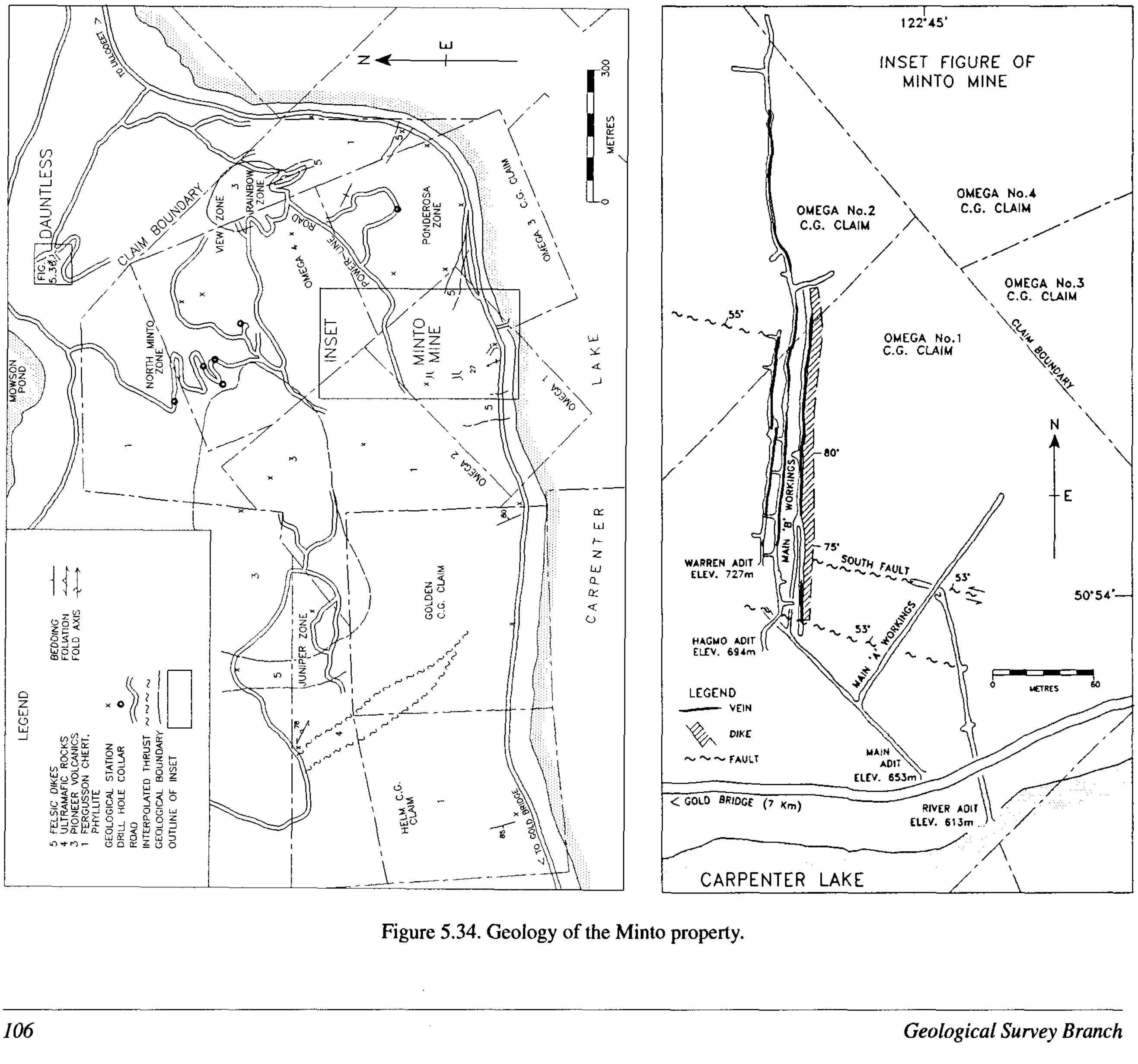


Figure 5.34. Geology of the Minto property.

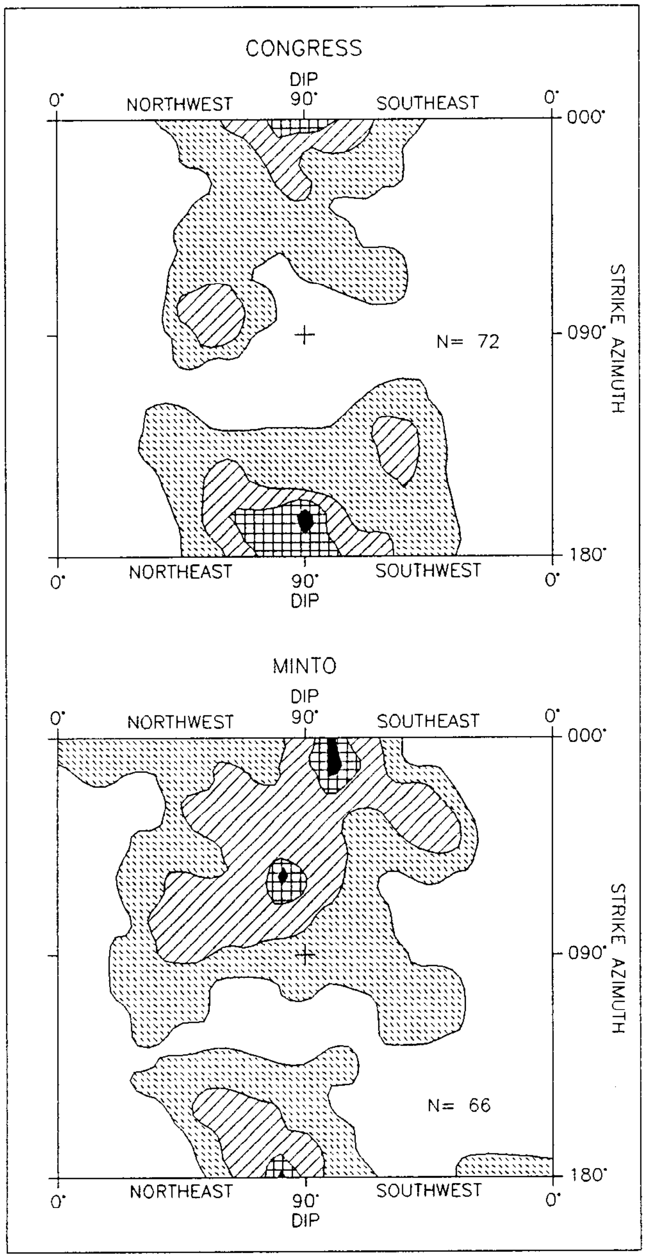


Figure 5.35. Fracture frequency plot for the Congress and Minto areas.

Photo 5.10. Sulphide enrichment (arsenopyrite, stibnite and sphalerite) at margin of quartz vein, Minto mine (black marker = 1 cm).

west are leached, carbonitized and contain minor sericite, fuchsite, kaolinite and disseminated pyrite. Gold was introduced at the final stage of mineralization together with some tellurides (?). The gold occurs free in quartz or as small inclusions and microveinlets in sulphide minerals, especially pyrite, arsenopyrite and galena (Maheux, 1989). The average ore grade for the mine, given by Harrop and Sinclair (1986), is 6.8 grams per tonne gold and 19.5 grams per tonne silver giving a gold/silver ratio of 0.35 (compared to a ratio of 5.4 for Bralorne). A more complete chemical signature is by the sum of the principal ore elements (gold, silver, copper, lead and zinc) formulated by mutilple linear regression analysis *i.e.* Log(Au) = 13.0 + 5.32 Log(Ag) + 0.038 Log(Cu) - 2.71 Log (Pb) - 1.45 (Zn). This equation is based on 6 assay results from Ore Dressing and Metallurgical Investigation No.710, Mines Branch Ottawa (1937), Report 785, pages 43-52.

Recent exploration consists mainly of a series of bulldozer trenches north of the old Minto mine workings. Many of these trenches were dug near the power-line road which passes westerly from the highway; more trenches and diamond-drill holes are located on the high ground in the central part of the property (Sampson, 1988a). Five mineralized zones were located as a result of this program, the Ponder-

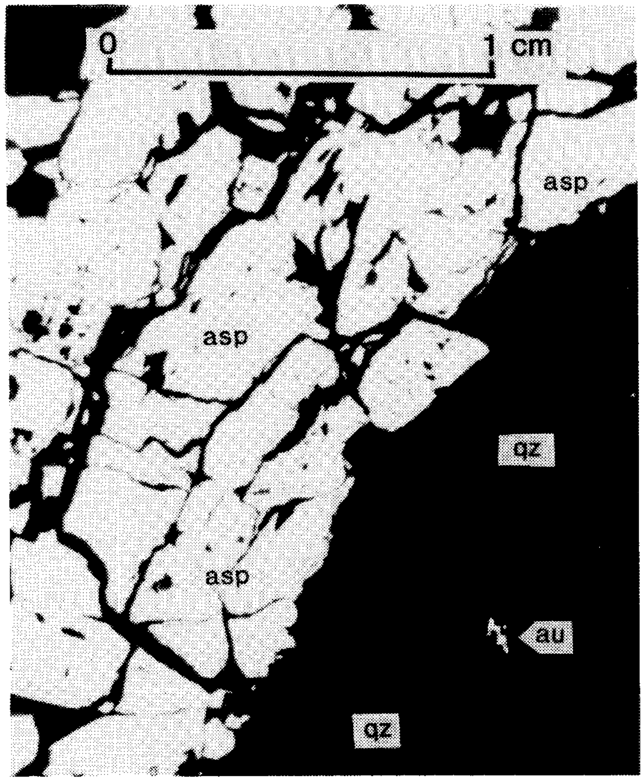


Photo 5.11. Photomicrograph of arsenopyrite accompanied by free gold in vein quartz, Minto mine.

osa, View, Rainbow, Winter and Minto North, the latter two containing ore-grade gold values.

The Minto North zone is approximately aligned with the original Minto orebody, and may be the extension of this structure. Assay results from chip samples across a 1-metre width range up to 10 grams per tonne gold

Work on the adjoining Minto Extension claims by Avino Mines and Resources Limited produced good results. According to company reports trench sampling across widths of 1 to 28 metres returned values in the range 2.3 to 11.4 grams per tonne gold in a zone of anomalous geochemistry 25 metres long.

Northeast and east of the main Minto orebody, within 500 metres, are other mineralized zones. The Ponderosa zone is a wide area of mineralized cherts carrying small arsenopyrite-pyrite veins and lenses. The Rainbow zone is a narrow shear, 200 metres long, with stibnite, arsenopyrite and pyrite veins. The Winter zone includes an old (1934) adit on galena sphalerite-stibnite-arsenopyrite-pyrite veins in a narrow 200 metres long shear structure. The following is the best recent assay obtained by Avino from the Rainbow zone: 7.78 grams gold per tonne over 1.0 metre and 3.5 grams silver per tonne over 1.5 metres.

The Golden group (MINFILE 092JNE077) consists of four claims adjoining the southwest side of the original Minto property. The area is underlain by greenstone and chert cut by a northwesterly trending shear zone occupied by listwanite, serpentinite, feldspar porphyry and fine-grained felsic dikes. The principal workings are centred about 450 metres west of the Minto mine on the Golden claim. These are open cuts, two short adits and a 315 metres long northeasterly trending crosscut adit, driven by Federal Gold Mines Limited in 1935 (Cairnes, 1943).

The focus of development is a wedge of greenstone, 30 to 120 metres wide, between two large converging dikes. Mineralized zones follow northerly trending fractures in the greenstone. Three zones average 60 metres on strike and a few metres wide. The individual veins within the zones, 10 to 50 centimetres wide, contain coarse stibnite and minor amounts of other sulphides and quartz-carbonate gangue. Assays reportedly range to 16.1 grams per tonne gold, 51.8 grams per tonne silver and 3.32% antimony. The screens between the veins contain disseminated pyrite and arsenopyrite. The veins terminate abruptly against the steep walls of the dikes. Cairnes (1943) reports "The deposits are probably all related to one source, which also gave rise to the dikes, and there is therefore a possibility of discovering a more persistent trunk channel of deposition than has been found to date."

A shipment of 12 tonnes of stibnite was made in 1941 from which some gold was reportedly recovered. Subsequent work included geological and geochemical surveys by Empire Metals Corporation (Ikona, 1975) and Avino Mines and Resources, Ltd. (Sampson, 1988a). These investigations focused on a gold geochemical anomaly in soils on the Juniper shear zone north of the old workings.

The Dauntless vein (MINFILE 092JNE073) is exposed at latitude 50°54′25″ north, longitude 122°44′40″ west adjoining the northeast side of the Minto property. The early history of this prospect is reviewed by Sampson (1983). The vein is best exposed at the Dauntless portal on the west side of the small valley between Mowson Pond and Carpenter Lake (Figure 5.36). In 1936 the Reward Mining Company drifted on this lead for 73 metres. The vein is in Bridge River siliceous argillite confined to a shear zone 0.7 to 4.2 metres wide, striking 052° and dipping mostly steeply to the northwest, consisting of breccia and quartz-carbonate lenses with small amounts of pyrite, arsenopyrite, stibnite, sphalerite and trace amounts of tetrahedrite, chalcopyrite and pyrrhotite, Sebert (1987) noted several secondary minerals including limonite, jarosite and stibicondite. Maheux (1989) suggested two episodes of veining. An early stage of fine

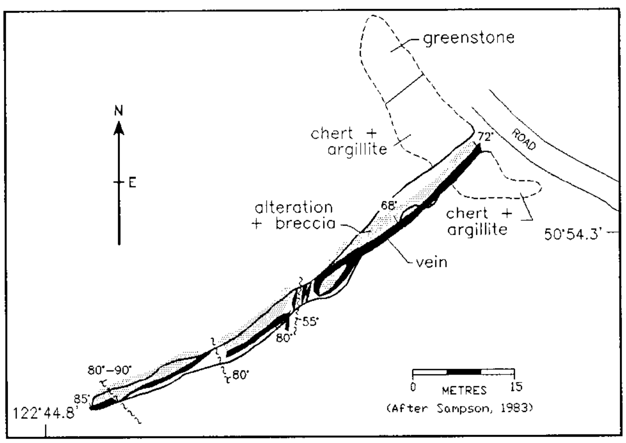


Figure 5.36. Plan of the Dauntless adit.

to medium-grained quartz, interspersed with sericite and chlorite, was brecciated and the fractures filled with euhedral quartz superimposed by crosscutting veinlets of ankerite and calcite. Sullivan (1965) reports assay results across an average of 1.3 metres ranging from 0.3 to 7.9 grams per tonne gold, 6.9 to 8.6 grams per tonne silver, and a trace to 0.9% antimony. Harrop and Sinclair (1985) quote a grade of 5.1 grams per tonne gold and 3.0 grams per tonne silver.

PEERLESS (MINFILE 092JNE076)

The Peerless prospect is approximately 300 metres south of the south end of Tyaughton Lake and 9 kilometres north-northeast of Gold Bridge at latitude 50°55′50″ north, longitude 122°47′30″ west. Access is from a short side-road east of the Tyaughton Lake road, 5 kilometres northwest of the highway.

History and Development

The property was staked in the early Thirties and acquired by Peerless Gold Mines Limited. By 1937 the workings consisted of two adits (the upper adit now collapsed), an inclined shaft 180 metres west of the adits and a number of trenches. Underground tunnelling totals about 85 metres. After a long dormant period, the property was restaked by Thunder Creek Mines Limited in 1974 and again in 1978 by Dawson Logging and Construction Company. Work done in this period was mainly line cutting and some bulldozer trenching. Warstar Resources Inc. acquired control by 1980 and a program of geochemical sampling, a VLF-EM geophysical survey and diamond drilling (four holes totalling 388 m) was completed. Although previous assay results were confirmed, projection of the vein structure significantly beyond the old workings was not proved.

Description

The property is underlain by Fergusson cherty and argillaceous sedimentary rocks, Pioneer volcanics, and feldspar porphyry dikes (Figure 5.37) cut by three major northerly trending shear zones occupied by serpentinite and feldspar porphyry. The main vein is exposed in the lower adit that drifts back and forth across a northeasterly striking shear zone. The shear fissure strikes northeast, like the Dauntless vein, dips 50° to 80° northwest and is filled with seams and lenses of mainly pyrite, sphalerite and a small amount of galena in a gangue of quartz, calcite and ankerite, ranging from a few centimetres to 0.5 metre wide (Photo 5.12). Assays accross the zone (lower adit, 60 metres from portal) were: gold up to 10 grams per tonne, silver 13 to 93 grams per tonne and zinc up to 8.5%, across 0.6 metres (Sampson, 1983). Similar mineralization occurs along the sheared contact between the volcanics and argillite-chert interbeds.

CONGRESS (MINFILE 092JNE029, 131, 132, 133)

The Congress property is centred near the north shore of Carpenter Lake, latitude 50°52′00″ north, longitude 122°43′35″ west, near of the mouth of Gun Creek, 6 kilometres northeast of Gold Bridge on the highway. The property was first visited by the writer in 1985. Geological mapping was completed during several visits to the property in 1986 when the Ace adit was examined and sampled. The Howard adits and Lou decline were mapped in July 1988.

History

The property, consisting of the Congress mine and several nearby mineral prospects, is owned jointly by Levon Resources Limited and Veronex Resources Limited. The claim block includes a number of reverted Crown-granted claims including Stibnite 1-4, Snowflake Fraction, Turner 1, Turner 2, Robert Fraction, David Fraction, Nap 1, 3 to 9 and Ace 17, 18, 20, 22, 23, 28.

The history of the Congress property began about 1910 when the Northstar-University vein was found, following the earlier discovery of placer gold on Gun Creek. The Congress vein was staked by E.J. Taylor and J. Shuster in 1913 and, according to Cooke *et al.*(1986), C.H. Allan and Associates produced a small amount of gold-antimony ore from a short adit. Congress Gold Mines Limited acquired the

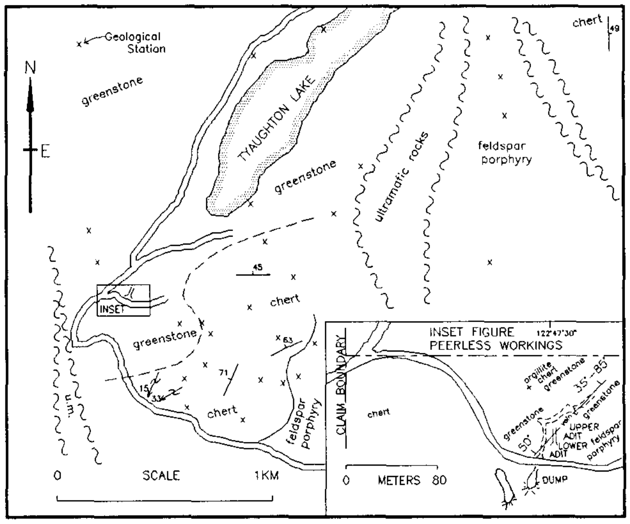


Figure 5.37. Geology of the Peerless property.

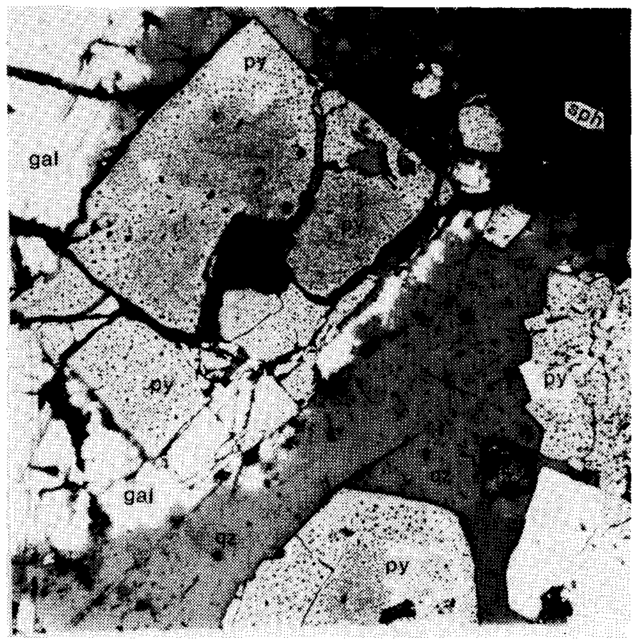


Photo 5.12. Photomicrograph of polymetallic mineralization, Peerless prospect.

property from T. Turner in 1933 and developed three adit levels on the Congress zone between 1934 and 1937. During this period 940 tonnes of ore was tested at the Wayside mill; this yielded 2.58 kilograms of gold, 1.31 kilograms of silver and 38 kilograms of copper.

From 1946 to 1950 Sheep Creek Gold Mines Limited managed the property and developed two additional underground levels at the Congress mine and connected the workings with an inclined shaft. In 1959 the Howard vein was discovered 900 metres west of the mine. Ownership of the property passed to the Ace Mining Company Limited then, under option agreement, to Bralorne Pioneer Mines Limited from 1960 to 1964. In this period Bralorne Pioneer did underground work on the Howard vein and continued drifting at the Congress mine while also carrying out surface and underground drilling programs. The Howard vein was drifted on for about 160 metres at this time and several new mineralized zones were discovered, including the Bluff zone northeast of the Congress mine and the Paul zone on the north side of Gun Creek, 1.5 kilometres north of the previous discoveries. In 1965 the Ace Mining Company drilled the Paul zone and did other prospecting on the property. Additional exploration was undertaken by Rayrock Exploration Limited in 1964, and Alice Arm Mining Limited in 1972. In 1975 Alice Arm was reorganized as New Congress Resources Limited and, over the next five years completed much drilling and drifting on the Howard zone. The property was acquired by Levon Resources Limited in 1982 and, under option agreement, Veronex Resources Limited funded contination of the exploration program. The principal work was diamond drilling and underground development of the Howard and Lou zones in 1984 to 1988, and a bioleaching pilot project in 1988 and 1989. (Due to the overall fine-grained nature of the ore and the association of gold and silver with arsenopyrite and stibnite, a 250 000-litre capacity biological leaching pilot plant was installed in the Plateau Pond area near the west boundary of the property in collaboration with Giant Bay Resources Limited. A 600-tonne test sample for this plant was mined from the Howard and Ace workings of the mine). No further work has been done on the property because of disappointing results at a time of low metal prices.

Description

The Congress property is underlain by a panel of Pioneer pillow lavas and associated feeder dikes and small cogenetic gabbro bodies (Church, 1986a; Cooke, 1986c). These rocks are bounded on the east and west by cataclastic facies of the Fergusson assemblage, including milled ribbon chert, phyllite, graphitic schist, and some marble lenses (Figure 5.38). Feldspar porphyry dikes of Tertiary age are conspicuous in the mine workings as well as areas of fracturing and faulting. The ore is relatively simple consisting mainly of pyrite, arsenopyrite and stibnite in discontinuous northerly trending quartz veins accompanied by carbonate alteration.

The Congress mine (MINFILE 092JNE029) is the oldest and most important development on the property. It consists of 1614 metres of lateral underground development on five levels (three adit levels) through a vertical distance of 200 metres (Figure 5.39). Three steeply plunging ore shoots have been traced on strike (031°) for 550 metres in a northwesterly dipping shear zone cutting bands and blocks of chert, argillite and greenstone intruded by feldspar porphyry dikes. Within the shears, veins several centimetres wide contain massive stibnite and fine-grained pyrite, arsenopyrite and some interstitial kermesite in quartz gangue. Tetrahedrite and cinnabar has been reported in a few places (Stevenson, 1949b). Adjacent to veins and shears the wallrocks are altered to a distance of as much as 5 metres with ankeritic carbonates, sericite, chlorite, minor kaolinite and patches of dense, finely crystalline quartz.

Assay results reported by O'Grady (1937c), from the three main levels of the mine, range from trace to 18.5 grams per tonne gold and 34 grams per tonne silver over widths from 1 to 5.5 metres. Gold appears to be more closely associated with wallrock sulphide disseminations and replacements (fine-grained pyrite, arsenopyrite and rare sphalerite) than with the massive stibnite vein fillings. Also gold values increase with depth as arsenopyrite increases and stibnite decreases. Changes in lithology are an important ore control; for example grades decrease markedly from the tight fissures in the volcanic rocks to the more open fissures in the chert. Stibnite enrichment sometimes occurs at the contact of feldspar porphyry dikes and sheared greenstone.

To test the correlation of the ore-forming elements (gold, silver, lead, zinc, arsenic and antimony) a product moment matrix (Table 5.3) was computed as described by Church (1987c) using log-transformed values from 14 samples vein samples reported by Cooke *et al.* (1986). Of the 15 pairs of elements generated, good correlation was obtained between Au-Ag, Au-As, Ag-Sb and As-Sb. The element associations are attributed to the presence of native gold with silver (electrum), gold in arsenopyrite, and silver associated with stibnite and sulpharsenides. Surprisingly, there is no strong correlation of the precious metals with lead or zinc.

The chemical signature of the veins has been established by multiple linear regression of the coherent elements (gold, silver, arsenic and antimony) from the correlation matrix. The signature is expressed in terms of the equation:

TABLE 5.3
PRODUCT CORRELATION MATRIX FOR CONGRESS MINE ASSAYS

	Au	Ag	Pb	Zn	As	Sb
Au	1	.691	-.129	.163	.855	.507
Ag		1	.010	-.166	.615	.824
Pb			1	.412	-.339	.250
Zn				1	-.121	-.197
As					1	.353
Sb						1

Calculation of r^2 values is based on 15 assay results provided by Cooke (1986)

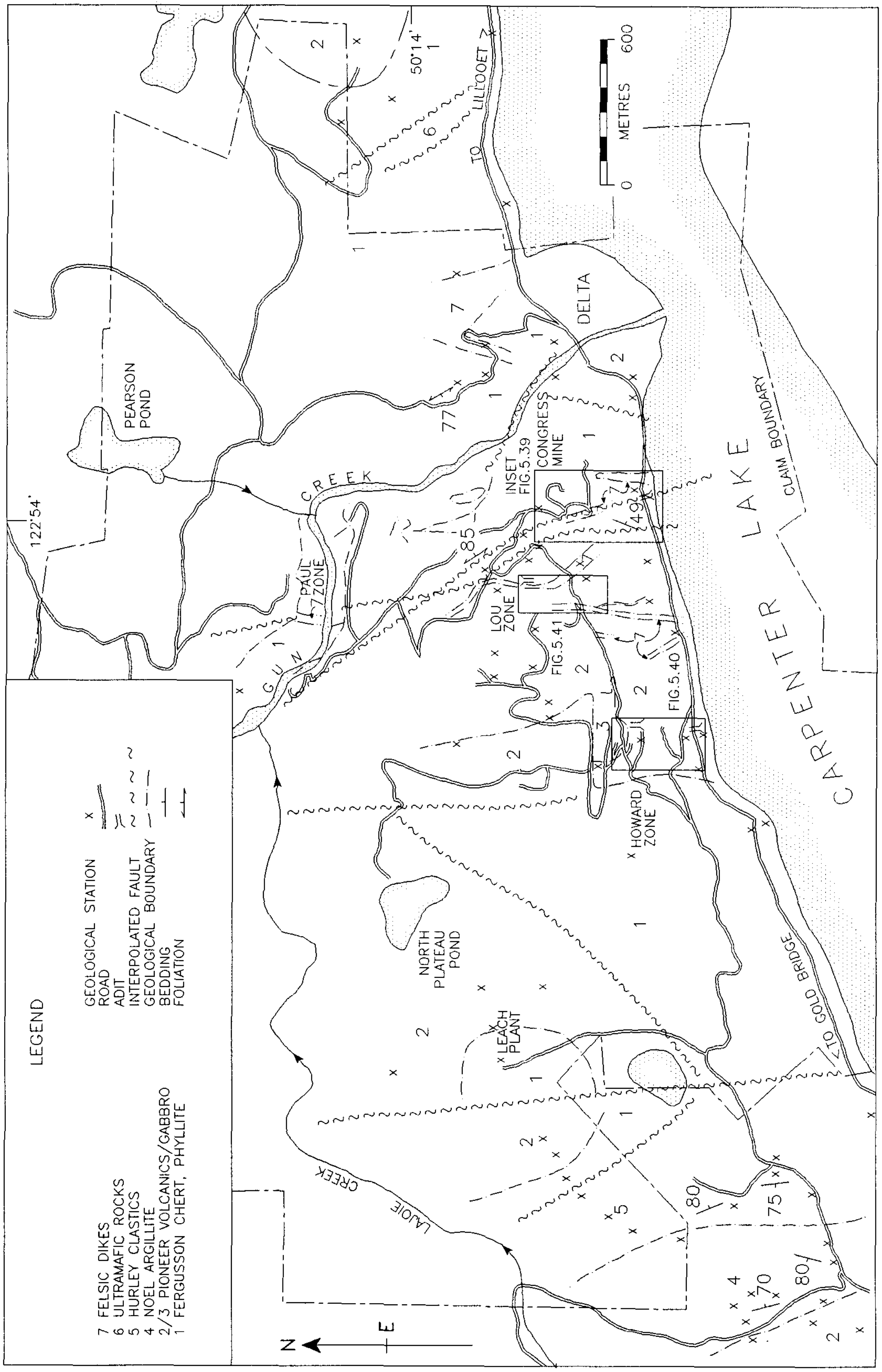


Figure 5.38. Geology of the Congress property.

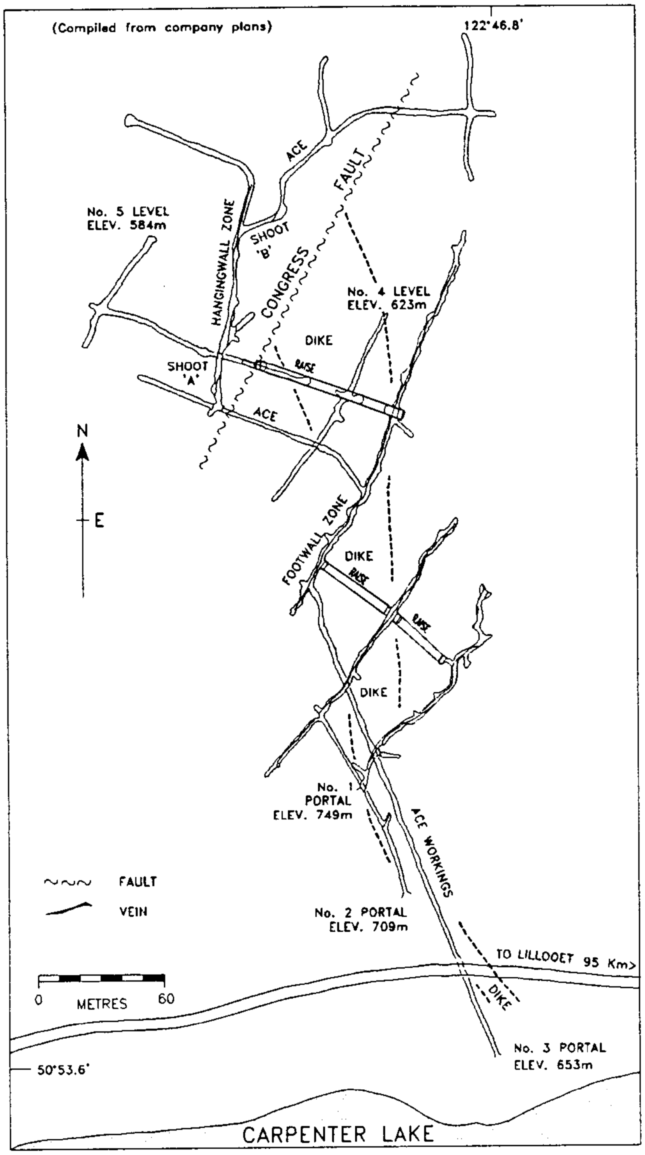


Figure 5.39. Geology of the Congress mine.

$\text{Log(Au)} = -7.65 + 0.18\text{Log(Ag)} + 0.97\text{Log(As)} + 0.075\text{Log(Sb)}$ where the coefficient of determination = 0.78, the coefficient of multiple correlation = 0.88 and the standard error of estimate = 0.50 based on the data of Cooke *et al.* (1986).

The mineralizing episodes recognized by Sebert (1987) include an early event characterized by pyrite and arsenopyrite deposition accompanied by wallrock silicification, followed by a brecciation and late vein-filling by stibnite and milky quartz deposition. Estimates of "ore reserves" in the mine range to 90 000 tonnes grading 7 to 10 grams per tonne gold (Cooke *et al.*, 1986).

The Extension vein, located immediately north of the Congress workings, is believed to be a continuation of the main footwall vein. Other showings in the immediate vicinity include the Contact vein, also known as the North Star - University vein about 200 metres east of the Congress mine. This is a narrow and discontinuous stibnite-rich vein with low gold values.

The Howard zone (MINFILE 092JNE132) is located about 900 metres west of the Congress mine and has been explored by more than 1220 metres of drifts and crosscuts on two adit levels (Figure 5.40). The zone, consisting of subparallel, northerly striking mineralized fractures dipping steeply to the east and west, is exposed for a length of 480 metres cutting mostly Pioneer pillow basalt and feeder gabbroic bodies. The zone has been intruded by Tertiary dikes that are commonly altered and locally mineralized. The veins are discontinuous quartz-carbonate lenses containing stibnite, pyrite, arsenopyrite, and rare free gold, in a light coloured alteration envelope, 2 to 7 metres wide, composed mostly of ankerite, sericite and kaolinite (Photo 5.13). Sebert (1987) reports some galena and rhodochrosite in early fracture-filling quartz. Assays of the zone range from 47.6 grams per tonne gold over 3 metres to 2 grams per tonne gold over a metre with estimated "ore reserves" ranging from 10 000 to 270 000 tonnes grading 11 grams per tonne gold (Cooke, 1986c; Seraphim, 1983).

The Lou zone (MINFILE 092JNE131) is a fracture system 12 metres wide striking north to northwest following a Tertiary porphyry dike which intrudes a major shear zone between the Pioneer pillow basalts to the west and Fergusson metacherts and schists to the east (Figures 1A and 5.41). The geological setting is similar to the Congress mine located 750 metres to the southeast (Cooke *et al.*, 1986). The zone of alteration associated with mineralization has a strike length of 550 metres and ranges up to 3.5 metres wide. Both the basalt and dike rocks in this zone contain narrow high-grade sulphide veins. The veins are concentrated mostly along the brecciated walls of a large northerly trending feldspar porphyry dike; in places lower grade veinlets and sulphide disseminations extend into the central part of the dike. The quartz-calcite veins are accompanied by streaks of coarse stibnite and some fine-grained disseminated arsenopyrite and pyrite (Photo 5.14).

Maheux (1989) identifies three stages of mineralization: an initial stage of silicification of wallrocks accompanied by pyrite and arsenopyrite disseminations; a second, more voluminous stage, characterized by stibnite and minor amounts of pyrite and arsenopyrite with quartz and carbonates in replacements and open-space infillings; and a third stage consisting of a minor amount of sphalerite, tetrahedrite and cinnabar forming coatings on fractures and grain boundaries. Secondary minerals include covellite on tetrahedrite and kermesite on stibnite.

Based on geological extrapolations from trenching and drilling, the zone was estimated to contain 34 000 tonnes grading 2.7 grams per tonne gold (Cooke *et al.*, 1986). However, work on the Lou decline was abandonded in July 1988 after 370 metres of tunnelling because of poor results.

The Paul zone - Slide zone (MINFILE 092JNE133) consists of a number of west-trending veins following shears in greenstones and schists of the Bridge River Complex in an area intruded by crosscutting Tertiary feldspar porphyry dikes on the north side of Gun Creek, about 1.5 kilometres north of the Lou zone. The Slide zone, just northwest of the

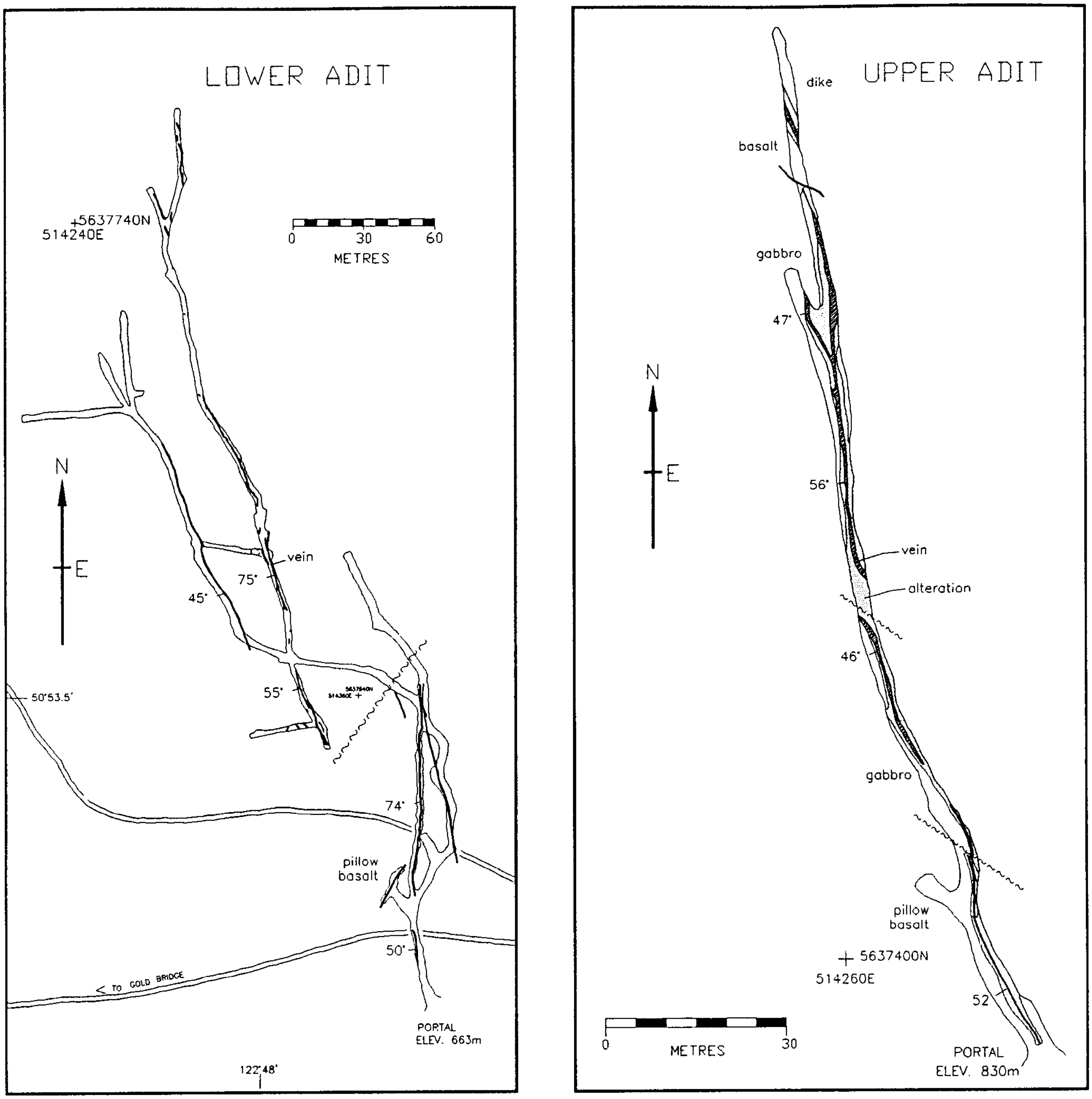


Figure 5.40. Plan of the Howard workings.

Paul zone, follows a sheared contact between greenstones and metasediments west of a porphyry dike. The quartz veins, containing disseminated and massive pyrite, arsenopyrite and stibnite, are in an envelope of ankeritic alteration. The Paul zone contains an estimated 83 000 tonnes grading 9.6 grams per tonne gold (Cooke, 1986c). Drill-hole intersections on the Slide zone give an average grade 11.3 grams per tonne gold across 2 metres (Cooke *et al.*, 1986).

RELIANCE-SENATOR (MINFILE 092JNE033, 136)

The Reliance and Senator prospects are centred at latitude 50°52′ north, longitude 122°47′ west, south of Carpenter Lake, opposite the mouth of Gun Creek. Access is by gravel road along the south shore of the lake, 5 kilometres northeast of Gold Bridge. A road survey and the geology of the property was completed by the writer and his crew in 1987; drill core provided by Menica Mining Limited was examined in July 1988.

History

The property consists of 19 reverted Crown-granted mineral claims and fractions including the Nemo, Omen and Eros claim groups. Its history was noted by Cairnes (1943): "The Reliance is one of the older properties and has been known from the beginning as an antimony prospect. The

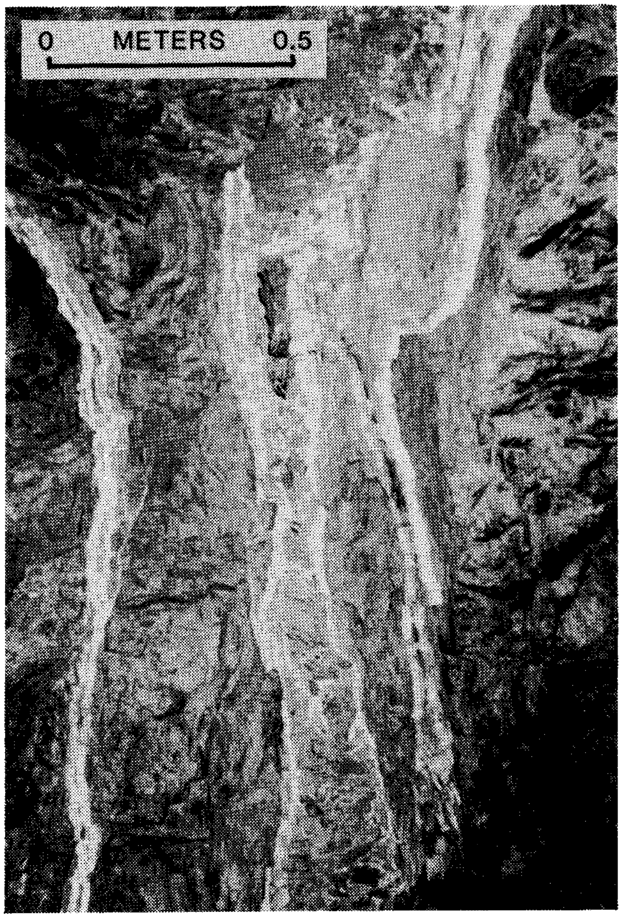


Photo 5.13. Splayed vein, Howard adit, Congress property.

original group of four claims was staked in 1910 by Mr. F.A. Brewer, who relocated the property in 1915. By September 1915, it is reported, four tons of ore had been bagged for shipment, and the richest carried up to 1/2 ounce in gold a ton."

In 1917 there was a shipment of hand-cobbed gold-bearing stibnite; no further records are available for this period.

The property was reorganized by Reliance Gold Mines Limited in 1933 and development work continued until 1937, O'Grady (1937a). This included underground work on several adits and installation of a compressor plant. The mine workings comprised the old Reliance adit (elev. 1100 m) on the Nemo 7 Crown-granted claim, the Fergusson adit (elev. 1023 m) also on Nemo 7, the Turner adit (elev. 830 m) on Omen 1, the River adit (elev. 663 m) on Omen 2, and the Senator adit (elev. ~790 m) on Nemo 1. Short intervals of heavy stibnite mineralization in narrow quartz veins were encountered in the adits.

In 1971, Tri-Con Exploration Survey Limited carried out geotechnical surveys for T.V.I. Mining Limited outlining several electromagnetic conductors coincident with a prominent southeast-trending arsenic-antimony geochemical anomaly near the Senator workings on the west part of the property. There appears to have been no immediate follow-up investigation.

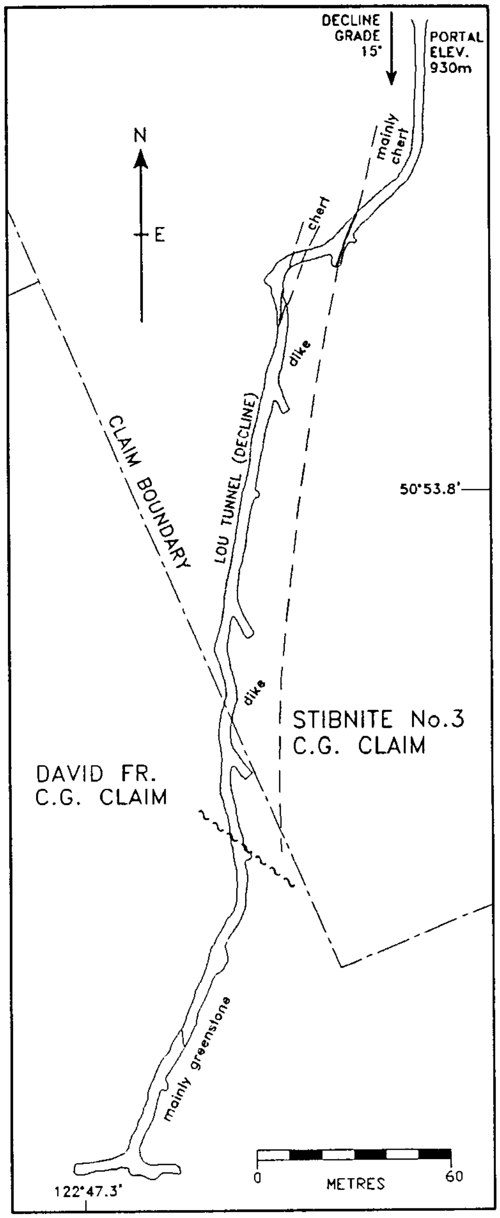


Figure 5.41. Plan of Lou tunnel.

In 1984 the property was acquired by Menika Mining Limited by option agreement from Karl Otting of Lillooet. Subsequent work has been directed toward confirmation of the Tri-Con anomalies and further testing for gold (Sookochoff, 1985). By November 1987, a total of 59 diamond-drill holes had been completed by Menika Mining for a total of 9396 metres (this includes 5 holes in 1985 and 1 hole in 1986).

Description

The geology of the Reliance-Senator claims is similar to the Congress property to the north (Figure 1A). There is a faulted central area of Pioneer pillow lava and massive basaltic lava flows flanked to the east and west by Fergusson chert and phyllite (Hanna *et al.*, 1988). The chert beds are

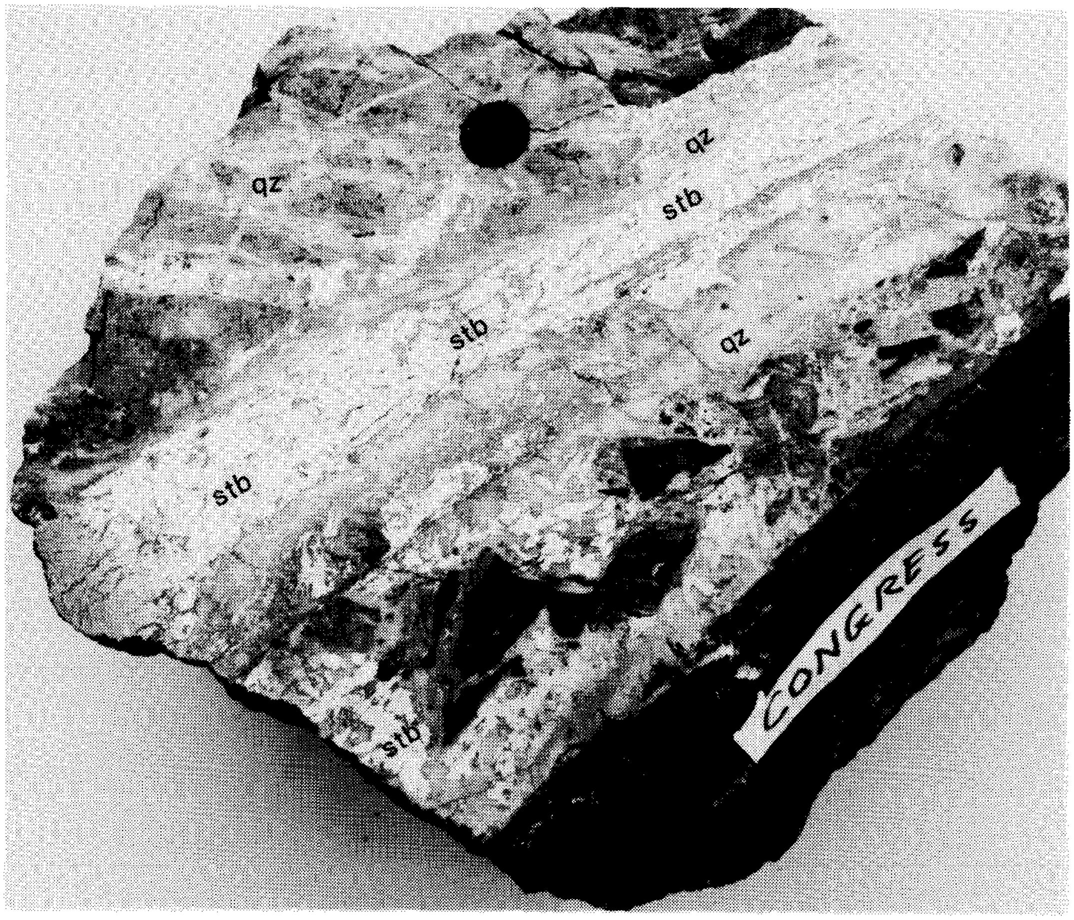


Photo 5.14. Silicified breccia infilled with irregular concentrations of stibnite, Lou zone, Congress property.

intercalated locally with phyllite and deformed showing bedding laminations dipping variously to the northeast and southwest. Mineralization consists mostly of pyrite and stibnite with gold values in quartz-carbonate veins.

On the east side of the property, a northerly striking belt of ribbon chert, about 100 metres wide, traverses the area of the mine workings. The various tunnels follow well-defined shear zones in the intervening greenstones. According to Cairnes (1943) "These zones each carry one or more veins of nearly solid, fine to coarsely crystalline stibnite associated with more or less quartz and calcite gangues."

The Old Reliance adit, the uppermost working, follows a southeasterly striking shear in purplish volcanic rocks, the apparent target being several stringers of stibnite, 2 to 5 centimetres wide, which are exposed in a trench above the tunnel.

Cairnes (1943) also reports on the Fergusson adit which is located below and about 200 metres northwest of the Old Reliance adit. "It runs east-northeast for 80 feet [24 m] in greenstone along a mineralized shear zone 4 feet [1.2 m] wide to a mineralized fault fissure which offsets the first shear 13 feet [4 m] to the southeast. Beyond this offset the drift follows the main shear about 25 feet [8 m] to the face. Between the portal and the fault the shear carries a vein of stibnite up to 6 inches [15 cm] wide with some quartz. Beyond the fault the stibnite vein is 3 to 4 inches [7 - 10 cm] wide and runs off into the foot-wall a few feet from the face of the adit, where, however, other small stringers of stibnite were seen. Above the adit the shear zone has been investigated by a long trench from which a shipment of hand-sorted stibnite is reported to have been extracted in 1917."

The Turner adit is about 375 metres northwest of the Fergusson adit. Cairnes elaborates: "This runs southeast in green and purple volcanic rocks for 85 feet (26 m) to a mineralized shear zone several feet wide striking east-northeast and dipping steeply northwest. This was driven on northeasterly for 55 feet [17 m] and contains veinlets of stibnite in altered and pyritized greenstone. In the opposite direction the shear was followed for only a few feet to a fault striking southeasterly and dipping 50° northeast. Where cut off by the fault the shear zone contained a vein of stibnite is several inches wide. Its probable continuation across the fault appears 6 feet [1.8 m] to the northwest. Such a displacement is similar to that of the fault in the Fergusson adit." The River adit is a crosscut to explore the downward projection of the mineralized zones described above.

On the western part of the Reliance property the Senator workings, located about 1100 metres west of the Fergusson adit, are the only remains of the former development (Figure 5.42). This is the area of most recent exploration. Many of

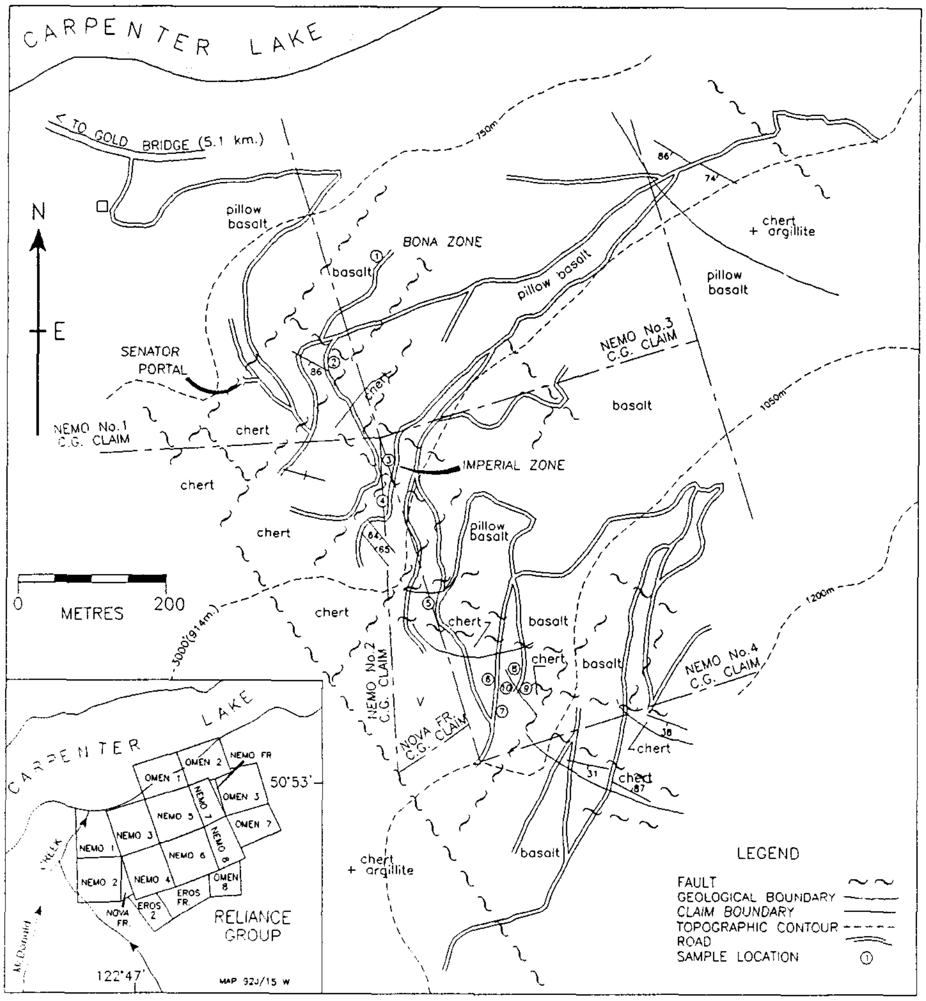


Figure 5.42. Geology of the Reliance-Senator property.

the veins follow the principal shear direction, 036° dipping 54° northwest. The main concentration of mineralized veins is at intervals on a 70-metre section of the southeasterly striking 'Royal shear zone'. A total of 21 test holes were drilled in this area in 1988 with some intersections assaying 15 grams per tonne gold.The Senator vein is on a northeast-trending shear in pyritized and silicified volcanics and ribbon cherts of the Fergusson assemblage. This quartz-calcite vein, 1.4 metres wide, contains up to 15% antimony, up to 5.48 grams per tonne gold and up to 8.57 grams per tonne silver. The wallrock contains disseminated pyrite.

The 'Senator road' showing is about 100 metres southwest of the Senator portal, on a section of the Royal shear zone that coincides with a steep draw. The zone is characterized by dolomitic, limonitic and siliceous alteration of well-fractured greenstone. Quartz-stibnite-limonite veins in this area assayed up to 16.5 grams gold per tonne across a metre width.

The 'Imperial zone', located 200 metres southeast of the Senator portal, is a new discovery. This is an area of northeast-trending stibnite-bearing quartz veins (Photo 5.15) cutting carbonated greenstones and limonitic silicified metasediments. Company assays report 6.34 grams of gold per tonne over 0.3 metre on individual veins and 2.74 grams

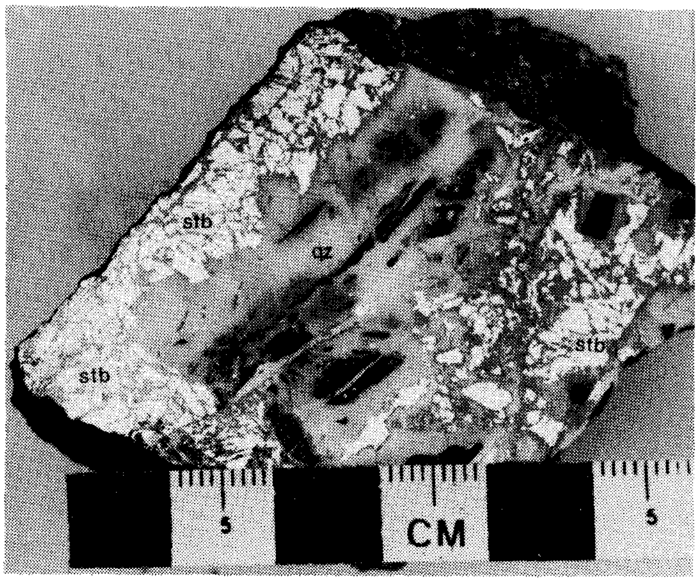


Photo 5.15. Quartz and coarse stibnite filling gash vein, Reliance-Senator prospect.

of gold per tonne across the 12-metre width of the alteration zone. An east-west fence of diamond-drill holes proves similar mineralization to a depth of more than 100 metres. A single grab sample collected by the author from the north part of the zone (Figure 5.42, No.3) returned 13 grams per tonne gold; 11 grams per tonne silver; 0.95% arsenic and 0.80% antimony.

The 'Bona zone', located 200 metres northwest of the Senator portal, is another area of limonitic alteration. Sampling by the author along a 3 metre length of roadcut yielded 12.8 grams per tonne gold and 2.0 grams per tonne silver. Other zones of alteration and mineralization occur intermittently along the Royal shear southwest of the Imperial zone, over an elevation interval of several hundred metres.

Control of the mineralization on the property is governed largely by shear zones. Near the old workings on the east part of the property, Cairnes (1943) records "Two sets of shear zones may be recognized, one striking southeast with steep dips to the northeast and the other trending east-northeast, with steep dips to the northwest. Most of the exploratory work has been done on the latter set."

The same pattern appears to exist in the new exploration area on the west side of the property. The steep draw passing west of the Senator portal and the Imperial zone is evidently a southeasterly trending fault lineament separating mainly ribbon chert to the west and alternating chert and greenstone panels to the east. A series of subparallel northeast striking tensional fractures, separates the panels hosting the veins.

Dikes intruded into the fracture system are mostly premineralization. This is indicated by the strongly altered condition of these rocks caused by migrating hydrothermal solutions. According to Sebert (1987) there were two mineralizing events, separated by an interval of movement on the local fracture system. The first is represented by the deposition of pyrite and arsenopyrite accompanied by grey chalcedonic quartz. This was followed by ankerite cementation of the veins and deposition of stibnite together with a small amount of second generation pyrite and arsenopyrite.

The chemical signature of the veins has been established by multiple linear regression of the ore-forming elements. This is expressed by the equation: $\mathrm{Log(Au)} = -10.8 + 2.43\ \mathrm{Log(Cu)} - 1.31\ \mathrm{Log\ (Zn)} + 0.97\ \mathrm{Log\ (As)} + 0.068\ \mathrm{(Sb)}$; having the following statistical parametres; coefficient of determination = 0.73, coefficient of multiple correltion = 0.85, and standard error of estimate = 1.74. The calculations are based on the 10 assay results listed in Table 5.4.

Coherent element pairs were determined from a product moment correlation matrix using log-transformed values (Table 5.4). Of the 21 pairs of elements generated from the assay data listed in Table 5.5, good correlation was obtained between Au-Ag, Au-As, Au-Sb, Ag-Sb, Ag-Cu, Cu-Zn and As-Sb. These element associations tend to confirm the precious metal association with arsenopyrite, stibnite and possibly tetrahedrite.

Most of the drilling to-date has been confined to the Imperial-Royal area. "Reserves" estimated by Menika are 188 800 tonnes grading 6.45 grams per tonne gold (Morris, 1988, personal communications).

OLYMPIC (MINFILE 092JNE086, 092, 107, 129, 130)

The Olympic property is centred at latitude 50°53′30″ north, longitude 122°44′30″ west between Girl Creek and Marquis Ceek on the south shore of Carpenter Lake. Access to the property is by gravel road 7.8 kilometres northeast of Gold Bridge.

The property was visited on several occasions in 1987 and 1988 by the writer and his field crew to complete a survey of access roads and map the geology of the property.

History and Development

The Olympic property comprises 38 reverted Crown-granted claims covering widely separated mineral prospects including the Leckie-Magee, Kelvin-Alma, Billyo-Manners, No.1 and Moly zones (Friesen, 1988).

Early exploration traced the mineralized belt across Carpenter Lake from the adjoining Minto mine area on a southeast-trending fault (Figure 1A). The first major work on the Olympic property occurred in 1934 when adits were driven on the Leckie and Kelvin zones by Olympic Gold Mines Limited and Mintonia Mining Syndicate, respectively.

The Leckie tunnel (now flooded by Carpenter Lake) was developed near the original level of Bridge River, and the Magee tunnel 60 metres above. The camp, located 300 metres above these workings to the southeast, serviced older work at the Billyo and No.1 adits. In 1935 total underground development comprised 143 metres at the Leckie adit and 85 metres at the Magee.

There was no further exploration in the area until 1945 when a diamond-drilling program was completed around the Leckie adit. In 1946 a winze was sunk 27 metres from near the middle of the Leckie tunnel and a small amount of drifting was completed on a lower level.

The property was acquired by Elizabeth and Donald Ingram in 1977 and in 1980 the claims were optioned to Noranda Exploration Limited. Geological mapping, geochemical soil sampling, magnetometer surveying and diamond drilling were completed. The Noranda program tested a molybdenite occurrence associated with a gossanous felsic dike on Marquis Creek and a suspected replacement sulphide occurrence at the Billyo prospect. Lacana Mining Corporation obtained an option in 1983 and completed geo-

TABLE 5.4
PRODUCT MOMENT CORRELATION MATRIX FOR RELIANCE-SENATOR ASSAYS

	Au	Ag	Cu	Pb	Zn	As	Sb
Au	1	.709	.357	-.206	.191	.830	.612
Ag		1	.618	-.026	.570	.592	.739
Cu			1	.661	.811	.086	.494
Pb				1	.512	-.047	.091
Zn					1	.028	.476
As						1	.623
Sb							1

Calculation of r^2 values is based on assay values in Table 5.5

TABLE 5.5
ASSAY RESULTS FOR THE RELIANCE-SENATOR PROSPECT

STATION NO.	SAMPLE WIDTH (m)	Au ppm	Ag ppm	Cu ppm	Pb ppm	Zn ppm	As ppm	Sb ppm
1	3	12.80	2	85	10	127	424	108
2	3	1.10	1	83	8	267	935	73
3	grab	13.00	11	123	8	400	9500	8000
4	3	1.20	2	119	17	198	1400	3400
5	3	0.06	0.5	84	17	204	40	144
6	4	6.40	2	76	3	110	11300	185
7	grab	0.03	<0.5	29	3	67	232	44
8	grab	11.00	1	57	7	102	2400	455
9	3	0.04	1	85	13	180	80	15
10	3	0.15	1	94	18	148	176	68

Note: ** Analyzed by Analytical Laboratory, B.C. Geological Survey Branch,*
B.C. Ministry of Energy, Mines and Petroleum Resources
Sample locations shown on Figure 5.42

chemical soil sampling and some diamond drilling on the Leckie zone. In 1985 Big I Developments Limited and Redwood Resources Inc. optioned and combined the claims forming the E.D.B. group. The entire property was re-evaluated by mapping and sampling. In 1988 the claims were acquired by Avino Mines Limited and merged with the adjacent Minto mine holdings. Subsequently most of the exploration in the area (predominantly trenching and diamond drilling) was focused on the Leckie zone.

Geological Setting

The Olympic property is underlain by a continuation of the geology found in the Minto area to the northwest that consists mainly of sheared Fergusson chert, phyllite, marble bands and metavolcanics (Figure 1A). Other major features include a fault-bounded wedge of Pioneer lava that covers much of the northwest part of the property and a central belt of ultramafic rocks, basic intrusions and felsic dikes (Figure 5.43). These intrusions are emplaced on sets of southeasterly trending fractures dipping both to the northeast and southwest. These fractures and other cross-fractures striking 022° and dipping 60° northwest control vein mineralization in the area.

Mineral Deposits

Historically the Leckie zone (MINFILE 092JNE092) has received the most attention. The two adits were driven on a broad zone of alteration (ranging to more than 70 m wide) coinciding with sheared ultramafic rocks, gabbro and felsic dikes (Figure 5.43, inset). The following description of the Leckie tunnel (now collapsed and flooded) is from Stevenson (1958). "The Leckie adit was driven to explore a quartz-sulphide vein in a shear that follows an irregular lens of carbonate-silica rock. At 40 feet [12.2 m] from the portal the workings intersected the quartz vein which a slashing in the wall shows to be 4 feet [1.2 m] wide. The vein has been faulted here, but the offset part was picked up 15 feet (4.6 m) farther along the drift and followed for 55 feet [16.8 m] to a point 115 feet [35 m] from the portal where it was cut off sharply by a diagonal fault. From this point the drift follows a barren shear zone and at 145 feet [44.2 m] the zone of shearing becomes a strong fault zone 6 to 12 inches [15 to 30 cm] wide and containing a few stringers of calcite but no quartz. Three crosscuts have been driven southwesterly from the main drift, but although these intersected short quartz-sulphide lenses, from 2 to 12 inches (5 to 30 cm) wide, they failed to intersect anything comparable to the quartz first drifted on.

"The rock in the Leckie adit is principally very fine grained to dense black serpentine that in turn consists principally of fine grained antigorite and numerous scattered grains of chromite. The serpentine along the drift, that is the serpentine followed by the shear and principal quartz vein, has been altered to a grey talc-carbonate and antigorite rock; chromite grains are still present in this altered rock. In the east crosscut to the southeast a body of gabbro, about 30 feet [9 m] wide was intersected and towards the face a felsite dike about 30 feet [9 m] thick was cut; sheared black serpentine was entered at the face. The gabbro is characterized by coarse labradorite plagioclase, and remnant grains of pyroxene; the felsite by a felted intergrowth of plagioclase laths.

"The internal shaft has been sunk 88 feet [27 m] in black massive serpentine, cut occasionally by strong faults. At 75 feet [23 m] down the shaft, a crosscut has been driven 30 feet [9 m] southwesterly and 20 feet [6 m] northeasterly. The southeasterly crosscut, in serpentine, intersects at the face a strong fault zone 5 feet [1.5 m] wide. The crosscut to the northeast, also in serpentine, intersects a strong shear zone; this has been followed by drifts northwesterly for 33 feet [10 m] and southeasterly for 43 feet [13 m].

"A narrow lenticular vein of quartz, to 1 foot [0.3 m] wide, was followed by this drift. This vein has an attitude similar to that on the drift above and it may be the same vein, faulted into its present position by faults, one of which, dip 30° southwest, cuts the vein on the back of the drift. This drift is in a zone of grey altered serpentine, about 8 feet [2.5 m] wide, that follows or has been followed by the shear zone."

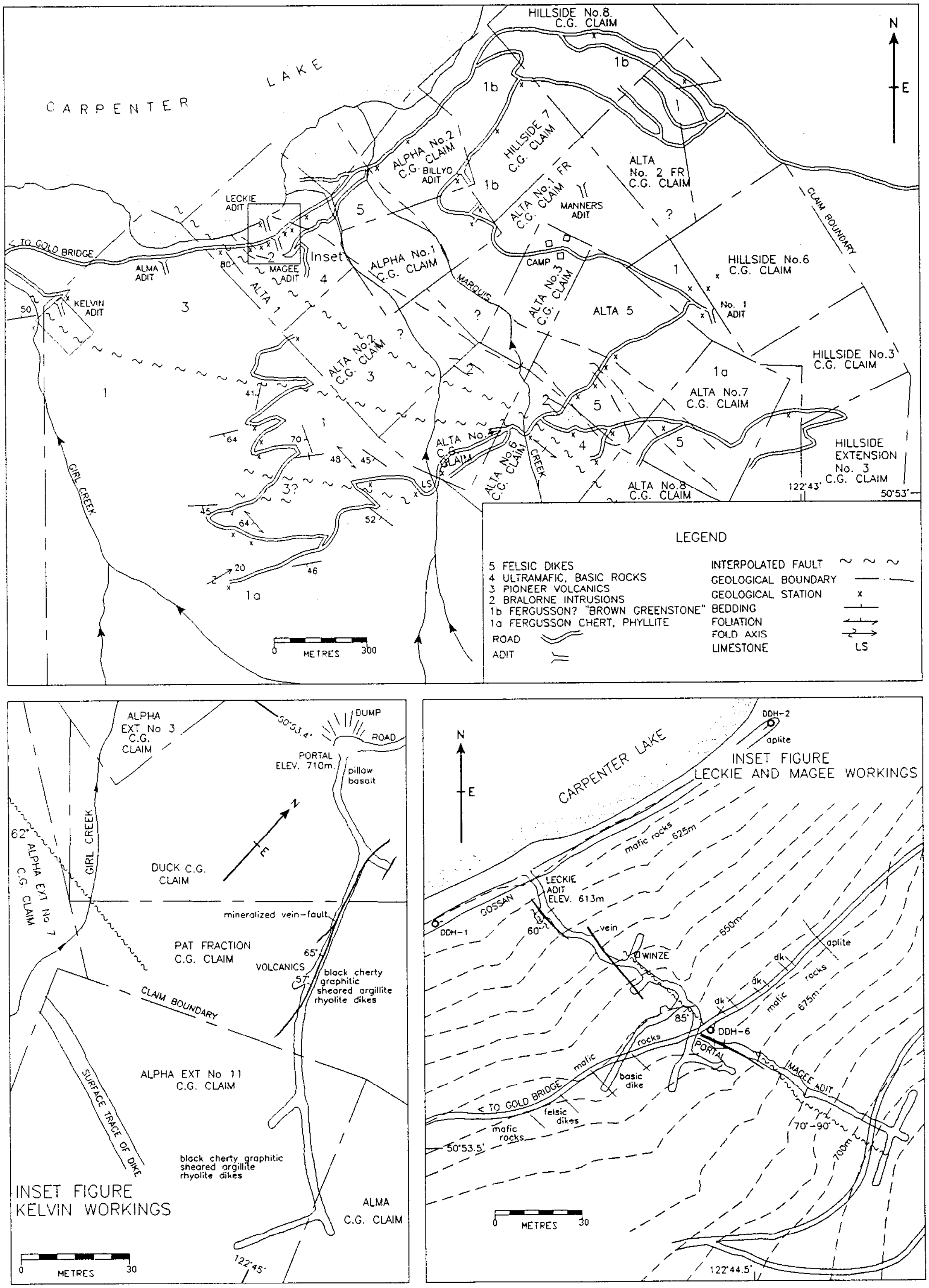


Figure 5.43. Geology of the Olympic property.

Three stages of mineralization are recognized (Sebert, 1987; Maheux, 1989). These consist of an early stage of pyrite and arsenopyrite emplacement accompanied by milky quartz gangue and wallrock alteration consisting of a mixture of quartz, carbonates, epidote, kaolinite and sericite. Refracturing of the vein system was followed by the deposition of pyrite, chalcopyrite, sphalerite and smaller amounts of arsenopyrite, tetrahedrite, pyrrhotite and marcasite. The deposition of galena, jamesonite, magnetite and gold is associated with the waning stages of mineralization - gold occurring mostly as irregular blebs filling corrosion pits in chalcopyrite.

Grades quoted by Harrop and Sinclair (1985) are 3.1 grams per tonne gold and 15.3 grams per tonne silver, giving a Au/Ag ratio of approximately 0.2.

The Magee adit is 53 metres above Leckie and follows the same structure. The portal is also caved and Stevenson's (1958) description remains the most detailed record. "For 70 feet [20 m] from the portal this adit follows a strong quartz-sulphide vein, from 6 to 18 inches [15 to 45 cm] wide, in cream coloured carbonate rock. At 70 feet [20 m] both the vein and carbonate rock have been sliced off by two parallel faults, each about 1 foot [30 cm] wide. From here the drift follows the principal, the footwall fault, to and beyond the cave. The only mineralization along this section of the drift consists of a quartz vein at 75 feet [23 m], 2 to 4 inches [5 to 10 cm] wide, mineralized with quartz, sphalerite, and pyrite, and at 125 feet [38 m] two quartz veins, first 1 foot [30 cm] wide and the second 4 inches [10 cm] wide, both mineralized with pyrite. All these are cut off by the drift fault.

"From the end of the vein the tunnel is in dark coloured serpentine. Greenstone occurs on the hangingwall of the drift fault just before a caved section of the tunnel and gabbro is exposed near the face of a short crosscut to the north."

Assay results by Big 1 Developments Limited and Redwood Resources Limited on this vein quoted by McLeod (1986) include a sampling width of 135 centimetres yielding 0.8 gram per tonne gold, 91 grams per tonne silver, 0.34% copper, 1.5% lead, 1.8% zinc, 0.36% arsenic and 0.058% antimony. This sample consists of a quartz-carbonate vein in chlorite schist with abundant pyrite and arsenopyrite, some chalcopyrite, sphalerite and galena and small aggregates of mariposite, (also *see* Warren and Cummings, 1935).

The Kelvin and Alma adits, located to the west between the Leckie - Magee prospect and Girl Creek (Figure 5.43, inset), are exploration tunnels driven on small westerly dipping suphide-bearing quartz carbonate veins in volcanic and metasedimentary rocks. The Kelvin adit, located above 230 metres southeast of the main road, is collared in pillow lava. At 28 metres from the portal it cuts a mineralized shear zone which was drifted on southerly (160°) following the contact between the volcanics, felsic dikes and black siliceous argillites (O'Grady, 1936a; Cairnes, 1943). The mineralization on the shear consists of quartz stringers, dipping 65° to 70° southwest, containing minor pyrite, chalcopyrite, arsenopyrite and sphalerite. Assay results on grab samples from the main zone range up to 4.48 grams per tonne gold, 8.2 grams per tonne silver, and 1.8% zinc (Price, 1983). The Alma adit was driven by Kelvin Gold Mines Limited, 120 miles west of the boundary of Alta 1 claim just above the present main road level. The adit, now caved, is in volcanic rocks with silica-carbonate alteration and minor sulphides. Price (1983) reports anomalous copper, arsenic and gold values in some soil samples taken from the surrounding area.

The Billyo prospect (MINFILE 092JNE107), located approximately 600 metres to the east and 250 metres above the Leckie portal, is underlain by fine-grained brown-weathering skarn and greenstone in what appears to be Fergusson assemblage. The mineralized zone, traced for more than 100 metres by trenching on surface, consists of lenses and stringers of pyrite, pyrrhotite, chalcopyrite and magnetite. Precious metal values are low.

Stevenson (1958) has described the Billyo adit as follows: "This adit has been driven south 30° east to the face at 150 feet [46 m]; from here one crosscut was driven 30 feet [9.1 m] northeasterly and another 10 feet [3 m] southwesterly. At 23 feet [7 m] from the portal, the adit intersects a 3-inch [8 cm] shear, striking northeasterly and dipping 45° southeastward, that now consists principally of limonite. From this shear for a distance of 40 feet [12 m] southeasterly the working intersects a zone of northeasterly striking, southeastward dipping stringers of pyrite and magnetite. This and the limonite shear, appear to be the only mineralization intersected by the adit. The rock in the adit includes green, actinolite-rich lava, light-brown, dense hornfels, probably a tuff, and between 70 and 110 feet [21 and 33.5 m] from the portal, light brown garnetite. Patches of light green diopside rich rock are also occasionally seen."

McLeod (1986) reports the following assay of a grab sample from the Billyo dump: 3.8 grams per tonne gold; 3.4 grams per tonne silver. Another grab sample from a sulphide lens ran 5.9 grams per tonne gold, 5.14 grams per tonne silver and 0.54% copper; an assay of diamond-drill core of massive sulphide, 30 centimetres across, returned 0.27 gram per tonne gold, 3.43 grams per tonne silver and 632 ppm copper.

The Moly zone, just west of the Billyo adit on Marquis Creek, comprises fracturing and quartz veining adjacent to and within a broad felsic ("aplite") intrusion surrounded by a pyrite-gypsum halo. Mineralization consists of pyrite, arsenopyrite, pyrrhotite (dendritic), molybdenite, ferrimolybdite and manganese staining (Price, 1983).

The Manners prospect (MINFILE 092JNE086) is just to the east of Billyo and may be an extension of the Billyo zone. The hostrocks are siliceous and fine-grained metasedimentary rocks and volcanic rocks of acid and intermediate composition. Contact metamorphism resulting from felsic and dioritic intrusions has produced a quartz-bearing calcsilicate garnet skarn containing minor amounts of magnetite, chalcopyrite and molybdenite. Assays return 0.15 gram per tonne gold, 1.2 grams per tonne silver, 830 ppm copper and 20 ppm molybdenum.

The No.1 Adit (MINFILE 092JNE130) is located 1.2 kilometres east of Leckie and about 300 metres higher in an area of heavy overburden. Stevenson (1958) reports that these workings are on a southeasterly striking contact zone between medium-grained diorite and fine-grained, brownish silicified metasediments and volcanic rocks. He also gives a detailed description of the No.1 Adit; "From the portal to point B [23 m] the working follows a southeasterly striking zone of carbonate silica rock, 10 to 20 feet [3 to 6 m] wide. At B it intersects two strong faults about 6 feet [1.8 m] apart that strike southeasterly and dip 65° northeastward. The hangingwall fault is at the contact between the carbonate zone and diorite. From B the working angles southeasterly across these faults and approaches them again near the face, where a slashing 4 feet [1.2 m] has been made to intersect them; the faults have merged in the slashing. The principal rock in the drift is silica-carbonate rock, but in a few places along the southwest walls, dense black serpentine is encountered, and in the northeast wall at B, diorite was exposed for a couple of feet at the bend."

The mineralization consists of quartz-carbonate stringers in the shear zone, from less than 1 to 8 centimetres wide, containing minor pyrite, arsenopyrite, stibnite and galena. On surface the zone was traced for about 40 metres from the No.1 portal to the 'Elizabeth trench' where a silicified sample several centimetres wide assayed 0.7 gram per tonne gold (McLeod, 1986).

SUMMIT (MINFILE 092JNE035, 085, 123)

The Summit claims are centred on a vein system near the southwest extremity of Marshall Ridge at latitude 50°52′20″ north, longitude 122°31′30″ west, about 22 kilometres east of Gold Bridge. The claims are reached via the Marshall Lake road that links a network of small logging roads to the highway. During brief visits by the writer in 1987 and 1988 the portals were examined and the property was mapped.

History and Development

The first exploration on the Summit claims was in 1907. In 1911 Robertson reported on the occurrence of a number of quartz veins carrying lead and zinc sulphides; also appreciable gold and silver values were obtained near the 1400-metre elevation on the south slope just below the top of the mountain. According to Robertson "There are a number of exposures of the veins on the bluff hillside, slightly developed by open-cuts and pits. About 50 feet [15 m] below one of these outcrops a tunnel has been driven in for some 40 feet [12 m], disclosing a somewhat irregular quartz vein carrying a small quantity of the minerals described."

He reported further that, to the east of this first tunnel, a small upper tunnel has been driven for a short distance. The tunnel was started in the outcrop of a vein striking 040°, but was driven due east for 15 metres, leaving the vein on the left-hand side; at this point the tunnel was swung to the left and continued in a successful attempt to intercept the vein again.

Similar showings were discovered on the ridge above these workings by L.J. Russell in 1944.

The property was acquired by Quinto Mining Corporation in 1977. From 1981 to 1984 the company conducted geophysical and geochemical surveys, geological mapping. trenching and a modest diamond-drilling program (three holes). The property has been owned by R. Polischuck since 1987 and intermittent work by Gold Summit Mines Limited during this time includes a soil geochemical program, mapping, trenching and sampling, mostly on Summit No.2 claim.

Geological Setting

The Summit claims straddle Marshall Ridge between Marshall Creek and Carpenter Lake (Figure 1A). The underlying rocks are mainly ribbon chert and greenstone of the Bridge River Complex (Figure 5.44). The cherts are thinly banded, light to medium grey, and interlaminated with phyllite and chloritic schist. These rocks are intruded and interlayered with amygdaloidal greenstone sills, dikes and lava flows. Limestone lenses, 1 to 20 metres thick, are good local stratigraphic markers traceable on strike several tens of metres to more than a kilometre in some places.

The rocks are markedly deformed having undergone multiple episodes of tectonic disturbance. The dips of the beds are commonly westerly or northerly, although there are many exceptions to this. The small folds often seen in the ribbon chert plunge in many directions with no apparent consistency, possibly as a result of superimposed tectonic and soft sediment deformation. The dynamic effects of metamorphism are manifest by zones of schist alternating with brecciated and imbricated chert bands.

The fracture pattern on the Summit property is similar to that found in the vicinity of the Congress and Minto mines, 18 kilometres to the west (Church and Pettipas, 1989). For example, there is a strong northerly trending, steeply dipping, fracture direction and a number of subsidiary weaker sets. Two fracture sets trending northeast and dipping steeply southeast, appear to control vein mineralization. These fractures are roughly subparallel to a VLF-EM response and a possible fault system trending northerly through the central part of the claim block (Brewer, 1989). A less common fracture direction, striking southeast and dipping southwest, is subparallel to the Marshall Creek fault.

Mineral Occurrences

Mineral showings on the Summit claims consist of the 'Marshall Ridge structures', that are a series of subparallel northeasterly trending fracture zones and related geochemical anomalies near the crest of Marshall Ridge, and the 'Marshall Creek structures' that are related to faulting in the valley of Marshall Creek.

The Marshall Ridge occurrences were described by Bateman (1914): "A basic dike, eight feet [2.2 m] wide, strikes in a northerly direction across a series of quartzites, argillites, and chloritic volcanic rocks. Cutting across this dike are a number of short parallel stringers of quartz containing arsenopyrite and pyrite. The gold content of these stringers is said to be $30 per ton [50 g/t], but they are small and their extent is limited to the width of the dike which is only eight feet. Sufficient stringers are not exposed to justify the working of the dike as a whole.

"Farther up the hill a tunnel was run to intercept an irregular quartz vein containing pyrite, arsenopyrite, galena, and zinc blende, but did not cut it. The vein has been traced on the surface for some distance and was found to vary in width from 2 to 26 inches [5 to 66 cm]. In places there is 16

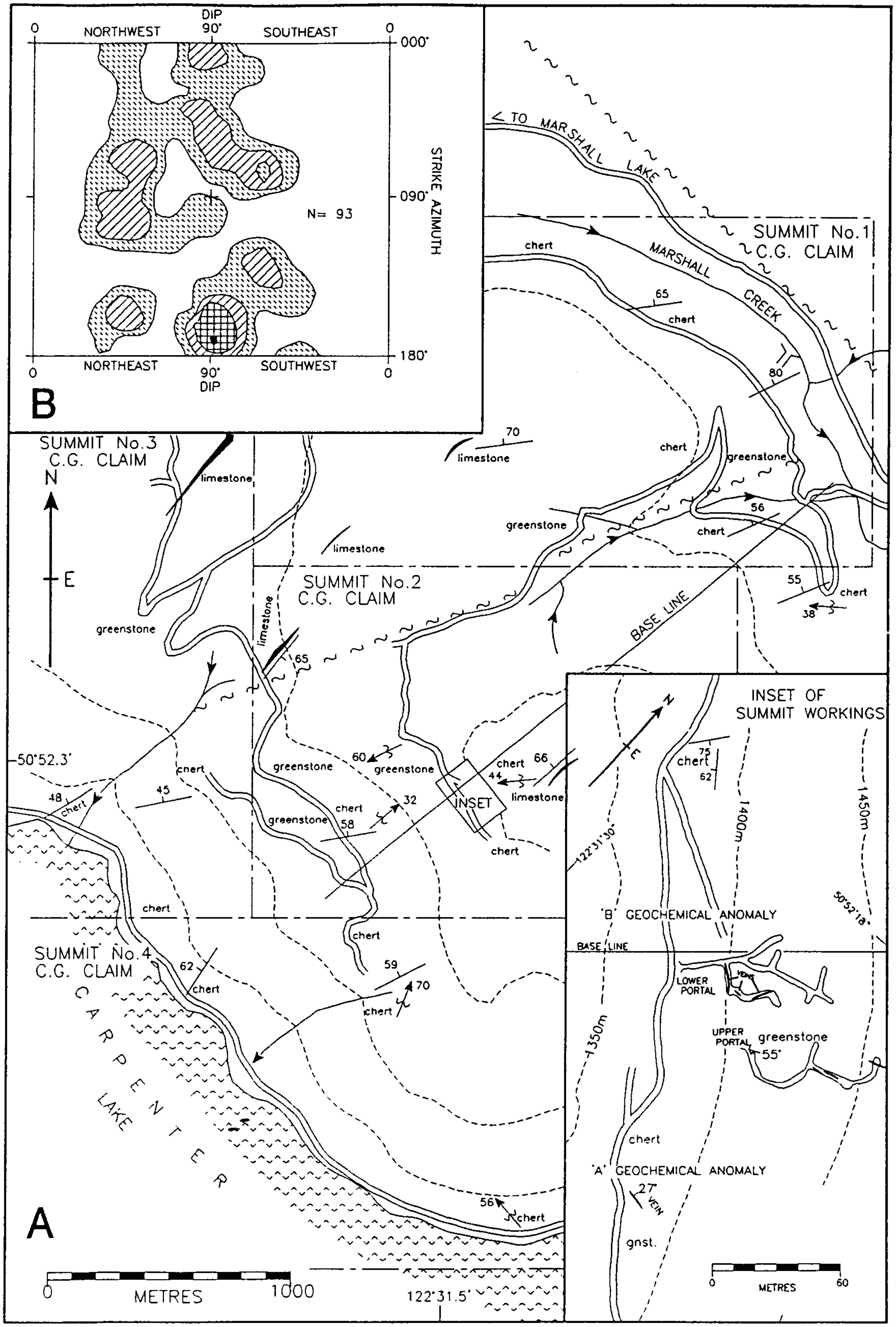


Figure 5.44A. Geology of the Summit prospect.
Figure 5.44B (inset). Fracture frequency plot for the Summit prospect area.

inches (41 cm) of solid sulphide. The deposit, however, is small and extremely irregular."

Figure 5.44 (inset) shows the location and geometry of the tunnels based in part on company plans. The lower tunnel trends northeasterly following the contact between massive greenstone and chlorite schist. An irregular seam of sulphides 10 to 50 centimetres thick is intersected at a point 25 metres from the portal and traced in an easterly and northeasterly direction for 50 metres. According to Landsberg (1981) assays from this drift yielded 3.6 to 14.7 grams per tonne gold, 4.1 to 50 grams per tonne silver and 1.59 to 9.79% zinc

The entrance to the upper tunnel is 50 metres east and 36 metres above the lower portal. These workings are in amygdaloidal and massive metabasalts. The mineralized structures found in the lower tunnel appear to be exposed again about 40 metres northeast of the upper portal (Photo 5.16). Landsberg (1981) reports the following assay results from mineralized pods: up to 3.9 grams per tonne gold, up to 40 grams per tonne silver and up to 8.45% zinc. A sample from another shear at the face of the drift was also assayed and yielded 5.3 grams per tonne gold, 17.8 grams per tonne silver and 0.75% zinc.

The discovery zone which includes the underground workings on Marshall Ridge is subparallel to a geochemical soil anomaly for gold, silver, lead, zinc and arsenic delineated by Sampson (1988b).

Another mineralized Marshall Ridge structure is centred 100 metres southeast of the lower portal. This was discovered by trenching in 1987. It consists of a shallow northerly dipping shear zone 0.5 to 1.0 metre wide containing a minor amount of pyrite, arsenopyrite, sphalerite, galena and chalcopyrite. This coincides generally with a second geochemical anomaly (anomaly A, Fig 5.44). Chip sampling across this shear zone, reported by Sampson, assayed gold, 7.3 to 31 grams per tonne.Another anomaly occurring about 200 metres north of the lower portal coincides with a mineralized shear zone exposed in a trench by Quinto Mining Corporation Limited. An assay on a sample collected by Sampson returned 6.4 grams per tonne gold.

The only mineralized Marshall Creek structure on the Summit claims is exposed in an adit 48 metres long on the south bank of Marshall Creek about 200 metres northwest of the mouth of Hog Creek. The hostrocks are mostly chert with minor amounts of disseminated pyrite on fractures and shears. Only trace amounts of gold and silver have been reported from assays.

The Marshall Ridge limestone occurrence (MINFILE 092JNE123) is 1.7 kilometres northwest of the Summit prospect. Samples collected from this locality were analysed in 1916 and found to contain 96.73% $CaCO_3$, 1.83% $MgCO_3$, 0.46% SiO_2, 0.23% Al_2O_3 and 0.17% Fe_2O_3. This is considered suitable for the production of lime.

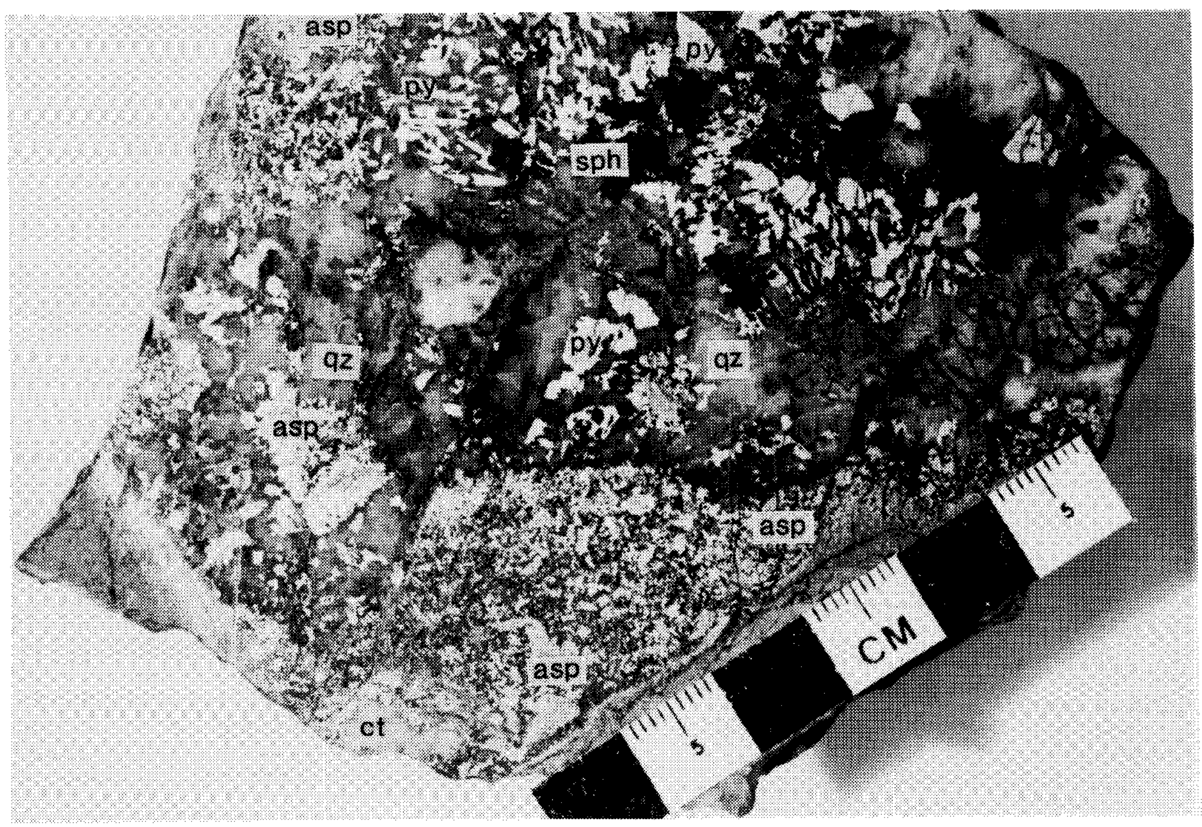


Photo 5.16. Pyrite and sphalerite within envelope of fine-grained arsenopyrite in quartz-carbonate vein, Summit prospect.

BRISTOL (MINFILE 092JNE071)

The Bristol property is centred at latitude 50°48′40″ north, longitude 122°32′00″ west just east of Tommy Creek and about 3.5 kilometres south of Carpenter Lake. Access to the workings is by dirt road from Carpenter Lake, following the west bank of Tommy Creek).

The property was visited by the writer in 1987 during the course of regional geological mapping and again in July 1988 to examine the mine workings.

History and Development

The first exploration activity in the Tommy Creek area was reported by O'Grady (1936b) who described open-cut work on a vein (near what is now the No.1 adit of the Bristol mine) and pack-trail construction. The property consists of a core of 19 Crown granted claims. According to Maconachie (1942) "The claims were located at times between 1934 and 1940. Development work started in 1936. The two upper levels and a short winze below the lower one were driven by hand before machinery was installed in 1941, after a bridge was built over the Bridge River, and the road built to the mine. A rich shoot of gold-tungsten ore found on the No.2 level, and in a winze below, was the reason for the installation of machinery driven by water power, and the subsequent driving of No.3 level under the area of the ore shoot. A raise driven from the No.3 level to the winze in the high-grade ore proved the ore extended downwards about 60 feet [18 m] below No.2 level."

The fact that the ore was not found in the No.3 level below the high grade shoot, together with the supply shortages and difficulties of war time caused the cessation of operations in 1942.

The camp and equipment were left intact. Bristol Mines Limited reopened the underground workings in 1946 and completed 157 metres of drifting and crosscutting. In 1947 a total of 2750 metres of drilling was completed on the No.3 level without significant results. In the period 1980-1981, 20th Century Energy Corporation optioned the property from Columbia Capitals Company Limited and completed an evaluation which included soil sampling, geological mapping and a four-hole diamond drilling program.

The property was optioned to Westmin Resources Limited in 1988. The main work completed by Westmin consisted of 17 diamond-drill holes totalling approximately 2500 metres focussed around the old mine site (Lane, 1989).

Geological Setting

The rocks surrounding the Bristol mine consist of limestone conglomerate, greenstones, chert and phyllite. These lithologies are best exposed on the No.3 level of the mine (Figure 5.45). The crosscut adit begins 9 metres above Tommy Creek and extends 143 metres southeast through a Cadwallader-like assemblage of alternating faulted blocks of massive greenstone, volcaniclastics and limestone beds, to Bridge River schists and chert. The main drift begins here and proceeds southwest for approximately 90 metres in dark coloured schist, then continues southwest and south for another 75 metres in dark and medium grey ribbon chert typical of the Bridge River Complex.

The beds strike north and dip steeply. The most common fractures are northerly trending shears averaging 045/81SE and somewhat weaker set at 020/78SW. The dominant cross fractures trend easterly, averaging 107/78SW. The predominant slickensides in the mine are horizontal or slightly inclined (plunging <35°) and have a mean strike direction of 016° (Figure 5.45, inset).

The only age determination on these rocks is from conodonts obtained from the 'Cadwallader' limestone that are identified as Middle or Upper Triassic.

Mineral Occurrences

The discovery zone at the Bristol mine is a steep southeasterly dipping shear in greenstone. This has been traced northerly by drifting in the No.1 adit for about 60 metres. Calcite and fine-grained sulphide minerals (mostly pyrite) occur as fillings in the shear; pyrite is also present as disseminations in the wallrocks. Sampling by Sargent (1939) returned gold values in the range 2.1 to 7.5 grams per tonnes across a width of 1 metre in the shear.

The No.2 level was driven below No.1 level to test the strike and downward continuity of the lead. Maconachie (1942) reports "Drifting from the crosscut, both to the northeast and southwest, has exposed the shear for a total length of 143 feet [44 m]. At the southwestward face the width of the shear is only 18 inches [45 cm]; to the northeastward it increases to a maximum of 20 feet [6 m] at the crosscut. There may be some additional width of shearing to the northwest of this face but a short crosscut driven to provide this information has exposed only two quartz stringers and no true exposure of shearing. To the northeastward of the crosscut the shear is of such width that it is possible to carry only one wall within the working.

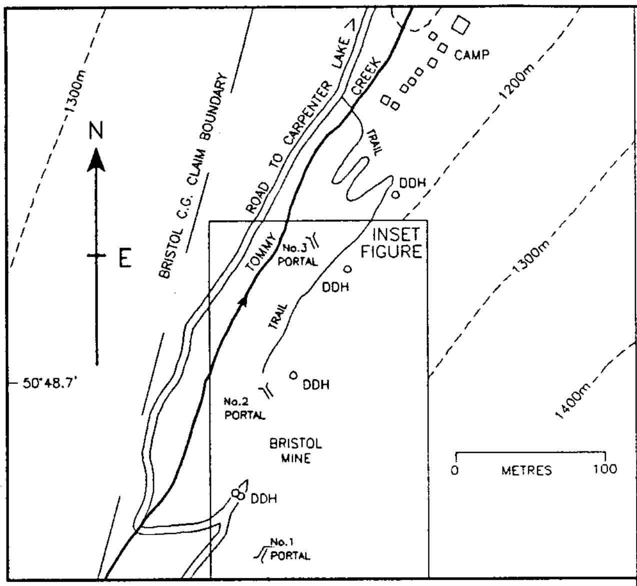
"Drifting was started on the hangingwall and then swung to the footwall side of the shear. At 55 feet [17 m] from the crosscut a winze was sunk to a depth of 25 feet [8 m] below the drift floor.

"At the crosscut there is some scheelite either in or closely associated with the quartz stringers within the first 30 inches [76 cm] on the footwall side of the shearing. The scheelite is not present in great amount, although there are one or two small, attractive concentrations of grains. Where this mineralization does not occur actually within quartz stringers it lies along narrow gouge seams.

"A sample taken across 30 inches [76 cm] from the footwall to represent the best grade of tungsten ore which could be mined selectively from this location, assayed; gold, 0.41 ounces per ton [14 g/t]; silver, nil; oxide of tungsten, 0.6 per cent.

"There are a few scattered grains of scheelite where the northeast drift swings from the hanging to the footwall of the shear but there are none in the rock exposed here on the wall of the drift and below the footwall.

"At 43 feet [13 m] from the crosscut a shallow sideswipe has been taken on the left wall of the drift. This exposes the black, cherty quartzite in which there are quartz stringers, well mineralized by scheelite, behind and parallel



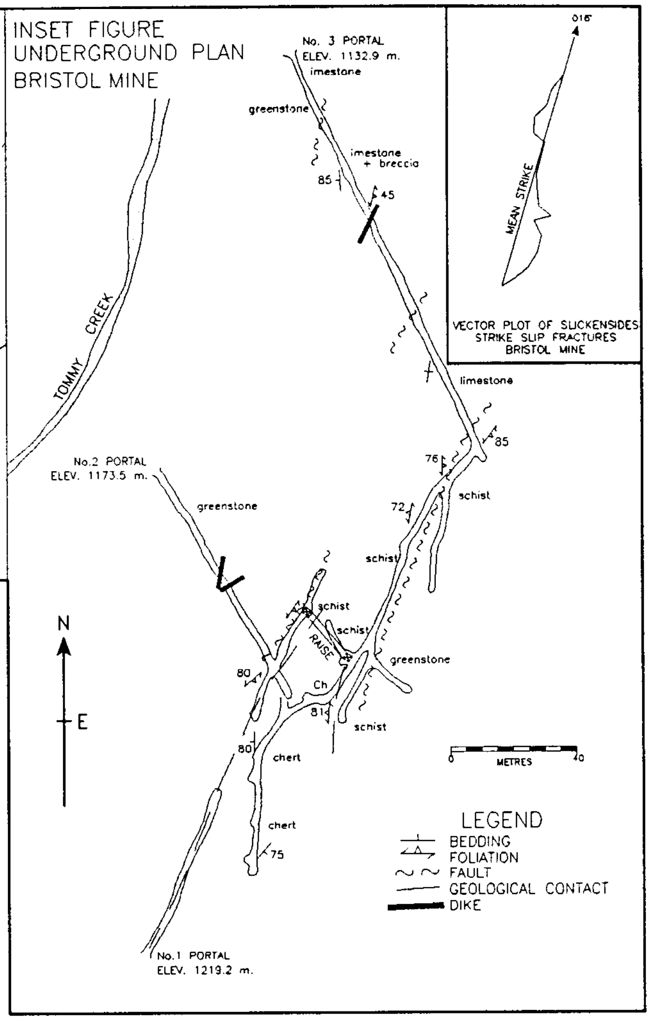


Figure 5.45A. Plan of the Bristol prospects.

to the footwall of the shear. For the first 7 inches [18 cm] behind the wall the quartz presents an almost continuous width and in this width the scheelite is conspicuous, with a tendency to be massive in form. For the succeeding 8 inches [20 cm] into the footwall quartz stringers are separated by quartzite; grains of scheelite are concentrated within the stringers and a lesser amount occurs in the intervening rock. A sample taken across the entire 15 inches [38 cm] assayed: gold, 0.26 ounce per ton [8.9 g/t]; silver, 0.1 ounce per ton [3.5 g/t]; oxide of tungsten, 6.5%.

"The winze was sunk just northeast from where this sample was taken, because exceptionally high gold values were found there in the course of drifting. For a few feet beyond assays showed a progressive rise in gold content until at 48 feet [15 m] from the crosscut and for the next 9 feet [3 m] along the drift across the full 7 feet [2 m] of the back, gold assays maintained an average of better than an ounce per ton [35 g/t]. At 57 feet [17 m] from the crosscut a narrow band of fine grained sulphides cuts across the shear at nearly right angles; beyond this the gold values drop abruptly and the remainder of the working shows no ore. At the time of examination the winze was filled with water and the back above it inaccessible for sampling. A. Stromberg, superintendant, describes the winze as having been sunk 25 feet [8 m] below the drift floor and there abandoned because the flow of water into the workings rendered further advance impractical. From the floor of the winze a drive was driven 8 feet [2.4 m] to the southwestward to give a total length of 20 feet [6 m] exposed along the shear at this horizon; the width of the winze here was just over 11 feet [3.3 m]. With the exception of a felsite dike, which is exposed in the drift on the footwall side of the shear on the floor of the winze in the northwesterly corner, Stromberg describes the total winze workings as being in high grade ore. He reports that a succession of samples was taken carefully around the pe-

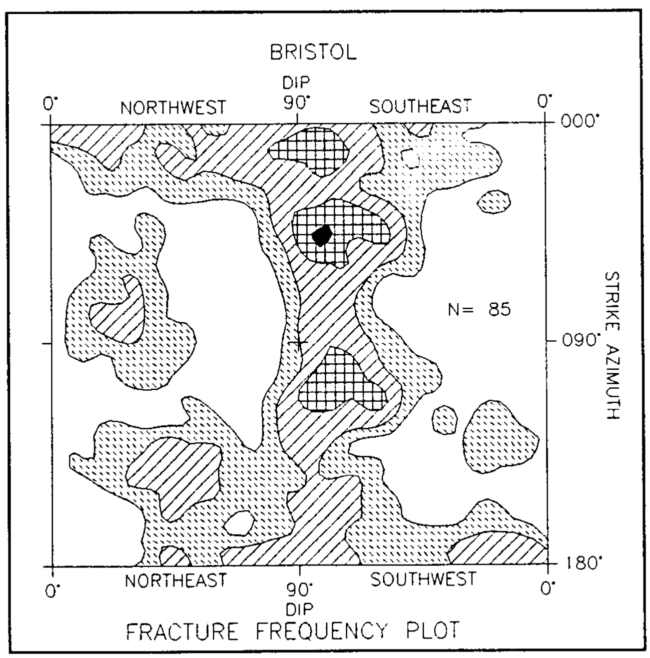


Figure 5.45B. Fracture frequency plot for the Bristol prospect.

rimeter of the working for the entire depth and that gold assays varied from 1.68 to 3.95 ounces per ton [55 to 135 g/t], with the maximum at the floor of the winze. Part of the muck from the winze has been stored underground and from this was taken 50 pound [23 kg] sample which could be regarded as representative. Granular scheelite is scattered through the muck pile but there appears to be very little concentration of it into massive or near massive form. Sulphides are difficult to distinguish even with a hand lens. The rock is hard, compact and black in colour. The sample assayed: gold, 1.04 ounces per ton [36 g/t]; silver, 0.6 ounces per ton [21 g/t]; oxide of tungsten, 0.16 percent.

"There is no obvious explanation for the gold content in the winze. Structural conditions there are similar to those exposed elsewhere in the shear and the rock is not conspicuously different. There are two conditions which are notable. First, the shear filling on either side northeast and southwest of the winze tends to be gougy, while at the winze it is apparently composed of hard, compact quartzite. Second, the defined band of visible sulphide mineralization at the northeastward limit of the high grade ore has only one known counterpart in the mine and this too was present where gold values were considerably higher than usual."

A detailed sudy by Warren and Mathews (1942) confirms that the gold mineralization is concentrated in silicified pockets together with some fine-grained suphides, carbonates and scheelite. The associated sulphides are arsenopyrite, pyrite and marcasite and a small amount of sphalerite, chalcopyrite and galena. Most of the gold appears to be tied up in pyrite and arsenopyrite; assays on concentrates of these minerals show gold in the range 171 to 500 grams per tonne. Free gold is rarely seen.

Scheelite is recognizable with the help of an ultraviolet light in the winze area on No.2 level where it comprises about 1% of the ore samples.

BENBOE (MINFILE 092JNE098)

The Benboe prospect is approximately 21 kilometres east-southeast of Gold Bridge, 200 metres west of Tommy Creek and 4.5 kilometres south of Carpenter Lake at latitude 50°48′50″ north, longitude 122°32′10″ west (Figure 5.46). Access is by trail 800 metres southerly from the bridge on the Bristol mine road 4 kilometres south of Carpenter Lake.

History

The property, consisting of six reverted Crown-granted claims, was staked in 1933 and Benboe Deep Mines Syndicate began development in 1935 (O'Grady, 1938). This work consisted of a short adit (now collapsed) driven northwest to intersect a northereasterly trending structure and a series of open cuts on the structure about 100 metres above Tommy Creek. The property was acquired by Charles W. St. John in 1940 and has been investigated intermittently since that time. In 1985 the property was acquired by G. Polischuck and sold to Fairchild Resources Inc. (formerly Hat Creek Energy Corporation) in 1986. Subsequent work completed by this company consisted of line cutting, geological mapping, geochemical sampling, geophysical surveying and trenching. The company has gone through two further reorganizations since 1988 and is now First International Metals Corporation. The property has been idle during this period.

Description

Cherty sedimentary rocks and greenstones of the Bridge River Complex strike northeast, dip steeply westerly and are intruded by a small granodiorite stock satellitic to the Bendor intrusion (Figures 1A and 5.46). A variety of younger felsic to basic dikes are exposed on the property.

The Benboe vein follows the sheared zone near the contact between greenstone and sedimentary rocks, 175 metres northeast of the eastern extremity of the granodiorite stock. The quartz-carbonate vein is up to a metre in width and is brecciated and vuggy. The vein dips 45° to 55° west and has been traced northerly for 225 metres. The vein filling consists of relatively coarse stibnite interbanded with gangue minerals and fine-grained disseminated pyrite and arsenopyrite carrying gold values of 0.7 to 12 grams per tonne and silver 13.7 to 300 grams per tonne. The best assay obtained is 16.4 grams of gold per tonne across 0.95 metre width (Cooke and Robins, 1986).

Other targets for exploration are gold and arsenic anomalies in soils on the west and south boundaries of the property adjacent the Silverside Extension claims. Also a small quartz veinlet with chalcopyrite was observed by the writer at the western margin of the granodiorite stock near the west boundary of the property.

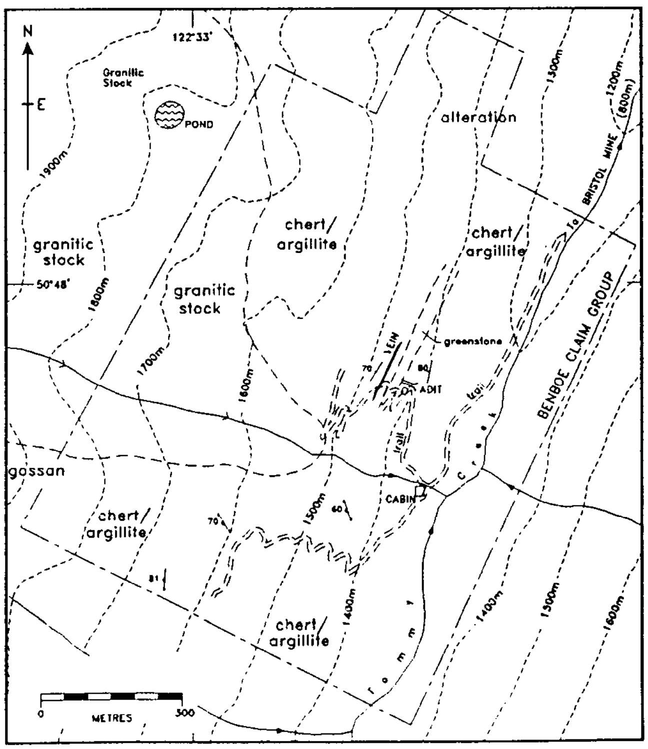


Figure 5.46. Geology of the Benboe prospect.

SILVERSIDES (MINFILE 092JNE042)

The Silverside prospect is centred approximately 19 kilometres east of Gold Bridge, 800 metres northwest of Tommy Creek, 6.5 kilometres south of Carpenter Lake at latitude 50°47′30″ north, longitude 122°34′30″ west. Access is by helicopter from Gold Bridge.

History

The Silverside prospect was 'rediscovered' by Levon Resources Limited in 1985 and has been the focus of intermittent exporation since that time. Evidence of previous work consists of hand diggings on the Silverside vein and a separate sulphide showing, and also a very old, small cabin was found on the property. The work by Levon to date includes a geochemical soil sampling survey, a magnetometer survey and trenching.

Description

The Silverside property is underlain by northerly trending, steeply dipping metasedimentary rocks and greenstones of the Bridge River Complex. These are thinly bedded cherts, cherty and slaty argillites, biotiferous metasediments, and minor recrystallized limestone. The greenstones are interlayered with, and cut across, the sedimentary rocks, mostly in the west and west-central part of the property (Figure 5.47). A thin talc-serpentine band follows a northwesterly striking shear zone that separates the main mass of chert on the east from the greenstones on the west.

The main showing is the Silversides quartz vein located in the west-central part of the property. The vein is exposed intermittantly for about 250 metres, striking northerly and dipping 65° west. It averages less than a metre wide, ranging to 1.5 metres. Quartz is commonly milky white where fresh and slightly limonite stained on weathered surfaces. Cavities lined with clear crystalline quartz occur where the vein has been shattered by subsequent movement. The vein is sparsely mineralized with scattered clots of pyrite, up to 2 centimetres across, and some discontinuous streaks of pyrite, arsenopyrite, stibnite and galena. A grab sample of this material containing up to 7% combined sulphides assayed 0.3 gram per tonne gold and 72 grams per tonne silver (Yorston, 1985).

A second showing is in the greenstone belt 350 metres northwest of Tommy Creek. This is a lens of massive sulphides associated with a minor amount of epidote and carbonates in the greenstone. The lens ranges up to 25 centimetres wide and has been traced on strike several tens of metres into an area of overburden. Assays of this material returned 1 gram per tonne gold, 48 grams per tonne silver, 9.62% copper and 1.77% zinc (Yorston, 1985).

MINERAL PROSPECTS
TAYLOR CREEK AND ELDORADO AREAS

The mineral prospects of the Taylor Creek - Eldorado area are in the thermal aureole of the Eldorado stock (Unit Cb) and are genetically related to this intrusion. The stock cuts Units 1, 4, 6 and B (Figure 1A). The Northern Light and Lucky Jem prospects comprise several quartz and quartz-sulphide veins occurring within the southern lobe of the stock. The Robson prospect consists of quartz-sulphide veins in the Hurley Formation (Unit 4) immediately adjacent to the northwest margin of the stock. The Lucky Strike veins are associated with a porphyritic dike, probably an offshoot of the Eldorado stock. The Silverquick and Lillomer mercury prospects are distal to the stock in the outer mineralized zone.

LUCKY STRIKE (MINFILE 092JNE037, 045, 095, 105)

The Lucky Strike prospect is in the headwater basin of Taylor Creek, 15 kilometres north of Gold Bridge at latitude 50°59′ north, longitude 122°51′35″ west. Access to the property is 10 kilometres westerly from the Tyaughton Creek road that connects with the main Highway, 10 kilometres to the south on the north shore of Carpenter Lake. The property was visited on several occasions by the writer and his crew during the course of regional mapping in 1986 and 1988.

History

The property consists of three reverted Crown-granted claims, Lucky Strike, Lucky Strike fraction and Homestake No.4, and several adjacent blocks of located claims. These blocks include or border on other mineral occurrences including the Northern Light prospect, Lucky Jem and Wide West (Figure 5.48).

The first prospecting reported in the area was in 1909 by Grant White and George Bell who staked the Lucky Jem prospect in the headwater area of the Eldorado basin and drove two short adits. By 1913 the Wide West prospect was located on Taylor Creek by Herb Taylor and at about the same time the Twenty-fourth of May group, now known as the Northern Light claims, were staked covering a gossanous area on the divide between Eldorado and Taylor Creeks. By 1932 the Lucky Strike group was staked. In 1934 Goldside Mines Limited developed two adits on the Northern Light claims and in 1935 this company acquired an option on the Lucky Strike. In 1937 the Lucky Strike Gold Mining Company Limited was formed to consolidate the holdings (O'Grady, 1937b). By 1940 the work completed included 400 metres of tunnelling on two levels and much

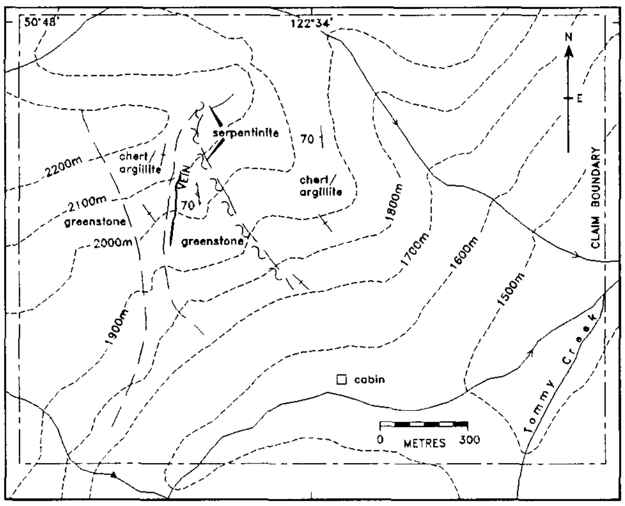


Figure 5.47. Geology of the Silverside prospect.

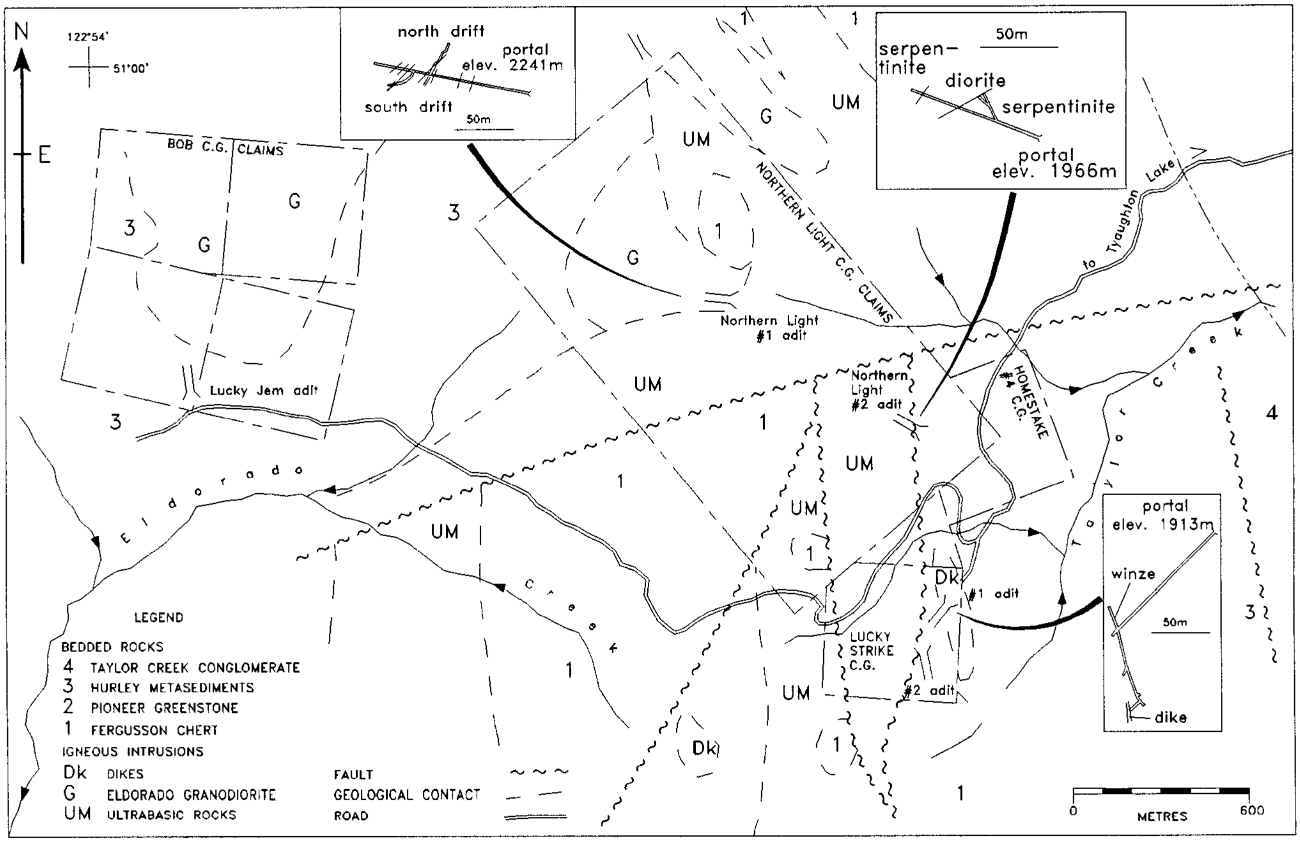


Figure 5.48. Geology of the Taylor basin prospects.

surface stripping and trenching. In 1940 Britannia Mining and Smelting Company Limited optioned much of the ground. This company extended the existing tunnels on the Lucky Jem property by about 90 metres and completed a number of surface cuts and diamond-drill holes. By 1946 Olympic Gold Mines Limited gained majority ownership.

After a long period of dormancy, Bridge River United Mines Limited (International Space Modules, Limited from 1970) acquired the claims in 1967 and undertook a two-year program of geological mapping, geochemical stream-sampling, geophysical surveys and trenching. In 1980 Golden Rule Resources Limited acquired many of the old claims in the area (except for the Northern Light group). The property was optioned to Geomex Canada Resources Limited in 1983 and 1984 and to Can-America Precious Metals Inc. in 1987 and then returned to Golden Rule Resources Limited. The work completed in this interval included geological mapping, lithogeochemical sampling, soil geochemistry and geophysics.

Mineral Occurrences

The Lucky Strike prospect (MINFILE 092JNE045) is located on a low ridge on the east side of the Lucky Strike claim (Lot No.6828) in the central headwater area of the Taylor basin at latitude 50°58′55″ north, longitude 122°51′40″ west. The main focus of exploration is a 110-metre segment of a northerly trending shear zone following the axis of the ridge that coincides approximately with the contact between serpentinite and listwanite rocks on the west and folded chert beds, greenstone and dike rocks on the east (shown as a thrust on Figure 1A). The No.1 adit intersects the mineralized zone 112 metres southwest of the portal (Fox, 1981). Drifts follow the vein 20 metres north and 60 metres south of the crosscut where it is displaced by a cross fault. The vein follows the steeply sheared westerly dipping contact of a porphrytic dike. The mineralization ranges from a few centimetres to more than 1.5 metres thick and consists of pyrite, arsenopyrite, sphalerite and jamesonite in quartz gangue (Photo 5.17). A sample across 1.6 metres at the north end of the drift, near a winze, assayed 25 grams per tonne gold, 95 grams per tonne silver, 4.7% zinc, 4% antimony and 1.15% arsenic (O'Grady, 1936c). The No.2 adit, located 200 metres southwest and about 100 metres above No.1 adit, drives south along a vertically dipping mineralized zone at the contact between a carbonatized hornblende andesite dike and surrounding serpentinite. The adit, which is about 10 metres long, exposes a sulphide-rich vein 10 centimetres wide and associated with quartz-carbonate-fuchsite alteration.

The Northern Light property (MINFILE 092JNE105), is a group of eight reverted Crown-granted claims (latitude 50°59′30″ north, longitude 122°52′10″ west) that extend northwesterly from the Lucky Strike claims to the summit of the ridge dividing the watersheds of Eldorado Creek and Taylor Creek. The principal workings consist of two adits, a few small pits and some ground stripping. The No.1 adit

Photo 5.17. Photomicrograph of jamesonite in quartz vein, Lucky Strike prospect.

and some small excavations are located at approximately 2240 metres elevation near the west side of Northern Lights No.6 claim (Lot No.6836). The adit was driven westerly 127 metres to explore a set of narrow, northeasterly trending mineralized shears and quartz veins in granodiorite. Leads were encountered and followed by drifting at 80 and 94 metres from the portal. The sulphide mineralization consists of some coarse pyrite and arsenopyrite and a minor amount of sphalerite and chalcopyrite. A broad area of fine-grained disseminated sulphides and quartz veinlets was exposed just northwest of the portal. The most common mineralized fractures dip 70° to 86° north and northwest. A test shipment of 2.1 tonnes from an exploration pit 50 metres above No.1 adit assayed 60 grams per tonne gold, 2.1 grams per tonne silver, 44% silica, 19.56% arsenic, 13.9% iron, 6% sulphur, 5.9% alumina, 0.05% copper, trace antimony, nil zinc and calcium (Cairnes, 1943). The No.2 adit is at 1966 metres elevation near the centre of Northern Lights No.1 claim (Lot No. 6831). It was driven 83 metres to the northwest cutting diorite and porphyry dikes and serpentinite. The adit was intended to explore below a large, surface sluice-cut exposing a gossan and veinlets of arsenopyite, however, no significant mineralization was encountered.

The Wide West showing (MINFILE 092JNE037) is located on Taylor Creek (latitude 50°59′20″ north, longitude 122°51′05″ west) approximately 1 kilometre northeast of the main Lucky Strike adit. The prospect consists of a northeast trending skarn-like replacement body at the contact between a diorite intrusion on the northwest and steeply dipping Hurley limestone beds on the southeast. The mineralization consists of massive sulphides, mostly pyrrhotite (up to 60%) and minor chalcopyrite in quartz. Work on the property has been minor since 1913 when sampling gave assay results ranging to 6.8 grams of gold per tonne.

The Lucky Jem prospect (MINFILE 092JNE032), also known as the White and Bell, is at the west end of the Taylor Creek road at the head of the Eldorado Creek basin, 2.7 kilometres west of Lucky Strike (latitude 50°59′30″ north, longitude 122°53′30″ west). The prospect area, about 300 metres square, is underlain by metamorphosed Hurley sedimentary rocks that are intruded by a southerly trending lobe of the Eldorado granodiorite stock (Cairnes, 1943). The workings consist of two short adits (now collapsed), some ground stripping near the adits and a number of pits and trenches on the slopes above. The No.1 adit was driven 11 metres northwest on a gently easterly dipping vein 0.5 to ~1 metre wide and No.2 adit, located 65 metres to the west, follows a set of northerly trending veins. The mineralization consists of brecciated aggregates of pyrite and arsenopyrite (Photo 5.18) accompanied by lesser amounts of chalcopyrite, galena and stibnite. Samples from No.1 adit assayed from a trace up to 34 grams per tonne gold and 21 grams per tonne silver; from No.2, assays range to 1.4 grams per tonne gold and 50 grams per tonne silver. A large area of ground stripping 190 metres west-southwest of No.2 adit exposes a zone of banded, oxidized and decomposed material in Hurley metasedimentary rocks that assayed 4.1 grams per tonne gold and 17.5 grams per tonne silver across 183 centimetres (O'Grady, 1937b). Showings above the adit level are in a deeply oxidized arsenopyrite-filled fracture zone in the granodiorite. Samples here assayed up to 21 grams per tonne gold and 6.9 grams per tonne silver. Harrop and Sinclair (1985) give a gold/silver ratio of 2 for this prospect.

LILLOMER (MINFILE 092JNE041)

The Lillomer prospect is located about 4 kilometres west of the north end of Tyaughton Lake on North Cinnabar Ridge at 2100 metres elevation, just south of the ridge crest, at latitude 50°57′55″ north, longitude 122°49′30″ west. Access is by 6.3 kilometres of four-wheel-drive dirt road from the Tyaughton Creek road that joins with the highway six kilometres to the southeast. The property was traversed by the writer during regional mapping in July, 1986.

History

Cinnabar was discovered in float in the headwaters of Pearson Creek in 1921 and traced to the source on North Cinnabar Ridge. The Marion claims were staked to cover the prospect and in 1928 the property was taken over by Lillooet Mercury Mines (NPL). The principal exploration work by this company was some trenching and a crosscut adit, 28 metres long, driven in a northerly direction below the trenches. The property was restaked in 1936 and explo-

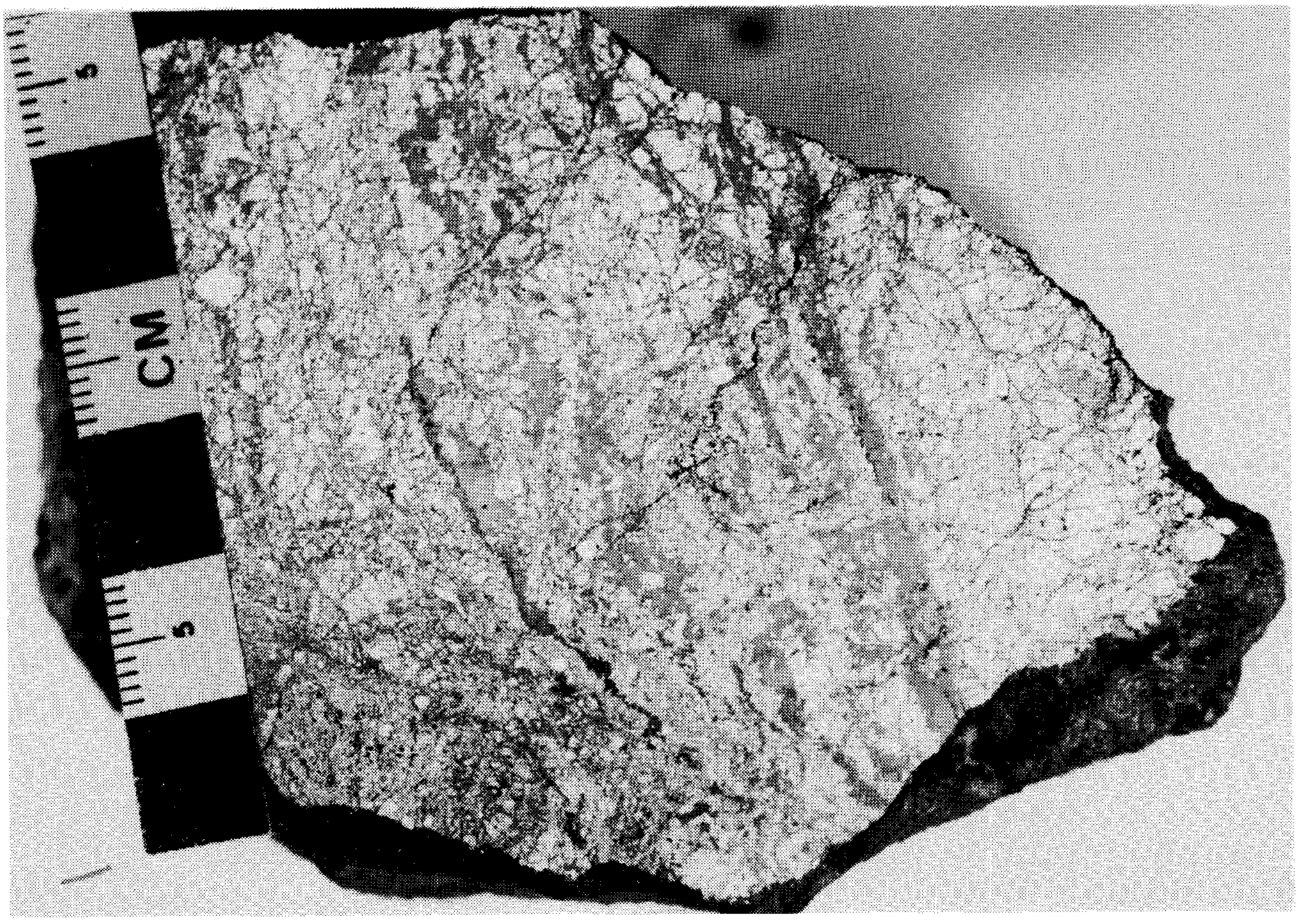


Photo 5.18. Brecciated pyrite and arsenopyrite mineralization, Lucky Jem prospect.

ration was continued by the Conardon Mercury Mines Syndicate. In 1969 Bethlehem Copper Corporation acquired the property and completed geological, geochemical and magnetometer surveys in addition to trenching and four diamond-drill holes.

Description

The property is underlain by greenstone intercalated with grey to red, thinly bedded pelitic chert dipping 30° to 60° southwest. The greenstone consists of massive lava, lenticular sill-like bodies and zones of chlorite schist. The showings are associated with a greenstone lens 35 metres long and 6 metres wide, bounded below by chert and above by phyllite.

Small veinlets and stringers of calcite, dolomite, quartz and pyrite carrying seams (up to 1 cm wide) and disseminations of cinnabar and occasional globules of native mercury are commonly concentrated in fractured greenstone and along the contact between greenstone and underlying chert. Solid masses of cinnabar assay up to 9.5% mercury, whereas averages over 2 metres of branching cinnabar-bearing quartz veins run 0.4% mercury.

SILVERQUICK (MINFILE 092OSE017)

The Silverquick mercury mine is located at latitude 51°03′30″ north, longitude 122°48′55″ west on the northeast slope of Eldorado Mountain, 20 kilometres north of Gold Bridge. Access to the site is about 4.5 kilometres by dirt road south of the bridge on Tyaughton Creek, and 30 kilometres from the Gold Bridge to Lillooet highway via the Tyaughton Lake - Mud Creek logging road. The property was examined by the writer July 21, 1988.

History and Development

Cinnabar was discovered in 1942 on the north slope of Eldorado Mountain above Tyaughton Creek by H.H. "Spud" Huestis of Pioneer Gold Mines of B.C. Limited (McCammon, 1965). The company completed some trenching and stripping in 1943 then the property lay dormant until 1954 when W.C. Sevrens secured the ground. The following year Sevrens set up a retort and produced the first flask of mercury.

Silverquick Development Company Limited optioned the property in 1963 and acquired the Silverquick, Quicksilver and Dot claim groups. Camp construction, an 11-metre adit and a number of open cuts were completed. Also a 9 tonne per day Gould rotary furnace was installed at Mowson Pond, adjacent the access road 15 kilometres southeast of the mine. This operated for a short time with ore trucked from a small open pit. In 1964 the mine produced about 270 tonnes of selected ore that yielded 2516 kilograms of mercury.

During the period 1965 to 1967 several companies held options on the property. In 1965 and 1966 Canex Aerial Exploration Limited completed a geochemical survey followed by 1280 metres of bulldozer trenching and two diamond-drill holes totalling 434 metres. In 1966 and 1967 S.H. Glassmire and Associates completed 2072 metres of trenching, 34 metres of diamond drilling and bulk sampling from an adit 52 metres long.

Silverquick Development continued work on the property in 1967. This resulted in the installation of a 450 tonne mill and a 3.5 tonne per day retort (Photo 5.19). However, in 1969 there was a decrease in the price of mercury and plans for production were postponed indefinitely.

Geological Setting

The geology of the claims is shown on Figure 5.49. The interbedded shales, sandstones and conglomerates in the vicinity of the Silverquick mine were mapped by Cairnes as part of the middle Cretaceous Taylor Creek Group. The conglomerates predominate, underlying 60 to 80% of the area, and consist mainly of well-rounded, grey chert pebbles, cobbles and boulders intermixed with greenstone and a variety of metamorphic rock types in beds 10 to 30 metres thick. The relatively thin shale and sandstone beds weather recessesively and are best exposed in road cuts and trenches. The most detailed information on the composition of these rocks was obtained from thin section analyses of the sandstones.

The sandstones are mostly immature lithic wackes. A petrographic study indicates a mixed provenance of chert, volcanics, metamorphic rocks, granitoids, diorite and gabbro, carbonates and ultramafics. Chert grains comprise 5 to 80% (average 45%) of the sandstone components; these are commonly subrounded, silicified and recrystallized clasts consisting of a mosaic of medium to fine-grained quartz with criss-crossing quartz veinlets. Fossiliferous chert clasts (with recognizable radiolarians) are few. The source of the chert is believed to be the Bridge River Complex that is widely exposed 10 to 15 kilometres south and southeast of the mine.

Lithic fragments of volcanic origin comprise up to 60% (average 25%) of the sandstone. These are a variety of microporphyries with varying amounts of feldspar and ferromagnesian minerals, embayed quartz, chloritized

Photo 5.19. Silverquick millsite, Eldorado Mountain.

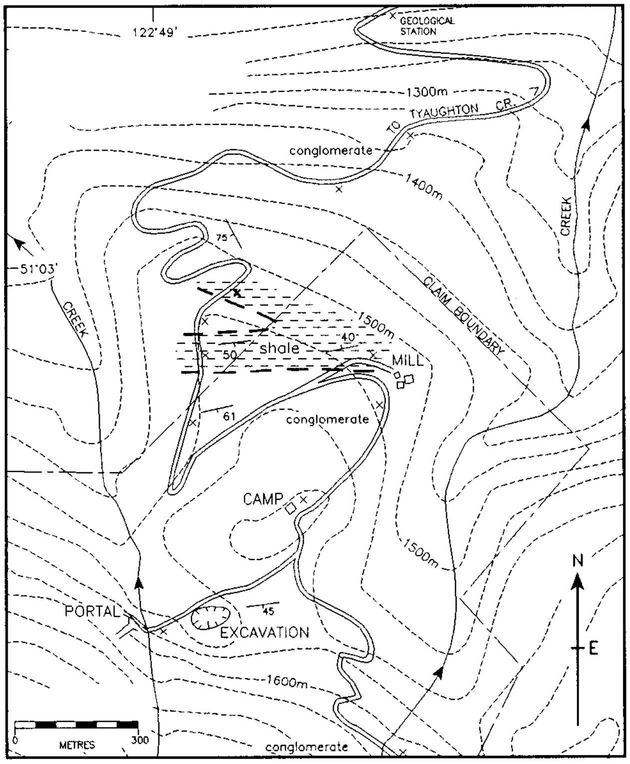


Figure 5.49. Plan of the Silverquick prospect.

amygdaloidal debris and fragments charged with granules of iron oxide. The probable sources of this material are contemporaneous volcanic centres and older lavas, breccias and massive greenstones from the Bridge River and Cadwallader terranes to the south.

Metamorphic rock fragments range up to 30% (average 15%). These clasts are mostly quartz-chlorite schist, micaeous and carbonaceous schist, and metamorphic minerals such as epidote and blue-green amphibole and chlorite. Sources are believed to be mostly the schistose and phyllitic facies of the Bridge River Complex.

Granitic components such as biotite, quartz and feldspar (including some microcline) are as much as 20% of the clasts in some sandstone beds. The source of this material is unknown although granitic cobbles and pebbles found in the older Relay Mountain Group in the Truax area (Church and MacLean, 1987b) are thought to have been derived from unroofing of an early phase of the Coast intrusions. Other accessories in the sandstone include fragments of basic and mafic intrusions, limestone and vein quartz.

The structure of these sedimentary rocks is the result of folding and repeated faulting. In the vicinity of the Silverquick mine the beds strike east and dip 45° to 55° south (Figures 1A and 5.49). These strata appear to be on the north limb of an open, southwesterly plunging syncline. The beds are intruded by the Eldorado granitic stock on Eldorado mountain, 5 kilometres to the southwest, and are downfaulted against the older Hurley sedimentary rocks to the west of the property and the ribbon cherts, schists and greenstones of the Bridge River Complex to the south. The beds are cut by multiple fault slices and juxtaposed similar rocks to the east near Tyaughton Creek. Fractures in the mine area are numerous and multidirectional, the best developed joints and cleavages being roughly perpendicular to bedding.

Mineral Occurrences

A detailed description of the workings of the Silverquick mine was provided by McCammon (1965). "Mineralization on the property consists of cinnabar associated wth quartz, calcite, limonite, and a clay mineral, probably dickite. The cinnabar is present as disseminated grains, streaks, and small lenses in brecciated conglomerate; as smears on slickensided fault surfaces; and in the mud of gouge seams. The best mineralization exposed was in the main open cut at the creek and in the face of the adit".

"At the time of examination the adit had been driven 22 feet [6.7 m] into the hillside on a bearing of south 44° west and then turned to continue for 14 feet [4.3 m] on a bearing of south 16° west. The mineralization seen was near the floor on the west wall near the turn. It was in a wedge of brecciated conglomerate between two intersecting faults with trends of about 20 degrees east of north and northwest dips of 47 and 18°. A channel sample across 11 inches (28 centimetres) between the faults and floor level assayed 2.20 percent mercury".

"Until the middle of August [1964], work had been concentrated on mining out a high-grade oreshoot from an open cut beside the creek. The cut had been excavated from the creek for 90 feet [27 m] northeastward along the steep gully slope and had a maximum face height of 30 feet [9 m]. The ore extended 60 feet [18 m] diagonally across the cut from its southwest corner to the gully edge. Its strike was north 30°east and its dip was 59° northwest. Loose rock covered the band of ore in the floor, and only its vertical trace in the end wall of the cut could be seen. The ore cosisted of brecciated conglomerate mineralized with cinnabar accompanied by quartz, calcite, limonite, and clay. It was 18 inches [46 cm] wide at floor level and pinched out between converging faults about 6 feet [1.8 m] above the floor. A channel sample across 18 inches [46 cm] at floor level on the end wall of the cut assayed 0.56 percent mercury. Besides that in the main ore shoot, cinnabar was conspicuous as smears on slickensided fault surfaces and in thin gouge seams exposed along the walls of the open cut. Numerous fault and joint faces of various orientations were visible, but the cinnabar seems to be restricted chiefly to those surfaces that trended northeastward and dipped moderately northwestward."

A well mineralized sample (Photo 5.20) obtained from a prominant joint surface striking 145° and dipping 19° northeast (approximately perpendicular to fold axis) in the main pit by the creek, returned an analysis of 2.02% mercury, 96 ppb gold, less than 0.4 ppm silver, 56 ppm arsenic, 36 ppm antimony, less than 6 ppm bismuth and 0.7 ppm tellurium.

ROBSON (MINFILE 092OSE026)

Robson, also known as the Eldorado Mountain, Pearson or Bonanza prospect, is 20 kilometres north of Gold Bridge. The main workings are centred at lattitude 51°01′20″ north,

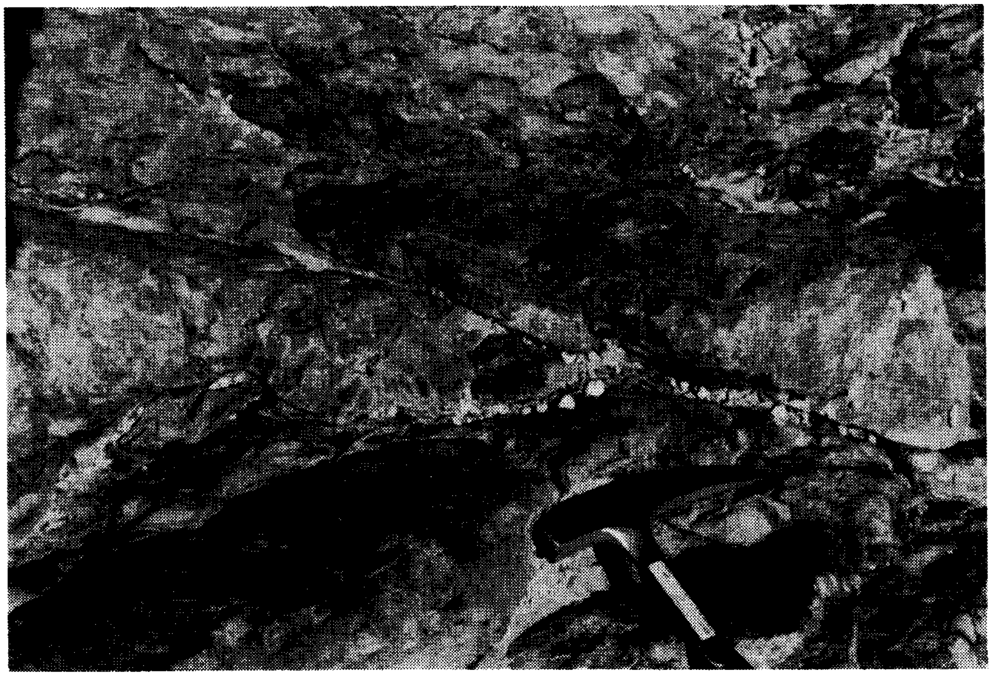


Photo 5.20. Cinnabar mineralization, Silverquick mine.

longitude 122°53′00″ west, in the Bonanza basin. Access is by four-wheel-drive, dirt road 10 kilometres west of the old Silverquick mill site, south of Tyaughton Creek, on an extension of the Tyaughton Creek - Mud Creek logging road. The main showings were examined by the writer on July 13, 1987.

History and Development

The property includes the Nea Fraction, the WG claim and 35 other reverted Crown-granted claims on the northwest side of Eldorado Mountain.

Prospecting in the Bonanza Creek basin began about 1910 and the first claims were staked on some narrow veins by Mr. Pearson in 1912. Mr. Drabble and associates acquired the property about 1933 and continued exploration by sampling and ground sluicing on Hughes Creek. In 1940 the claims were optioned to Bralorne Mines Limited by the J.G. Mining Company Limited. At this time the Robson adit and the West Portal were developed and ore was shipped out on horse back. Total production in 1939 and 1940 amounted to about 31 tonnes that yielded gold, 2.2 kilograms; silver, 18 kilograms; copper, 193 kilograms; and lead, 2645 kilograms.

The property changed ownership several times in the period 1943 to 1979. The most work completed in this interval was geological mapping and soil geochemistry by Chevron Standard Limited in 1975 and 1976.

Mutual Resources Limited gained control of the property in 1979 and proceeded with road building, geological mapping, rock sampling and trenching up until 1981. Personnel of Lacana Mining Corporation conducted a brief examination of the property in 1984 and recommended a geophysical and drilling program which was not implemented. Cinnabar Resources Limited optioned a 50% interest in the property in 1985 and TRM Engineering Limited was contracted for geochemical and geophysical evaluations of previously reported metal anomalies.

Geological Setting

The Robson prospect is hosted by the Hurley Formation near the northwest contact of the Eldorado stock (Figure 5.50). The Hurley Formation is well exposed in rock cuts along the road leading to the mine. Here it consists mostly of thinly bedded, steeply dipping and northerly trending turbidites; mostly grey and brown siltstones and mudstones with some intercalations of dark grey to black limestone. Near the mine the beds are rusted and heavily intruded by dikes. Conodonts obtained from the limestone give a lower Carnian (Upper Triassic) age (No.7, Table 2.3).

The Eldorado stock forms part of the divide between Tyaughton Creek, Eldorado Creek and Taylor Creek. The composition and age of this stock is similar to the Bendor intrusion. The rocks are typically hypidiomorphic granular biotite-hornblende granodiorite. The age of the stock is 63.7 Ma, based on K-Ar dating of biotite (K. Dawson, personal communication, 1987).

Mineral Occurrences

The principal showings are approximately 120 metres southeast of the access road and camp site on Hughes Creek. They are on a shear zone 0.5 metre-wide, striking 038°, dipping 36° northwest and cutting across steeply dipping Hurley beds rocks near the northwestern extremity of the Eldorado stock. This zone was tested by the Robson and West adits (now collapsed) 60 metres and 40 metres long, respectively. The "ore" consists of pyrite, arsenopyrite, stib-

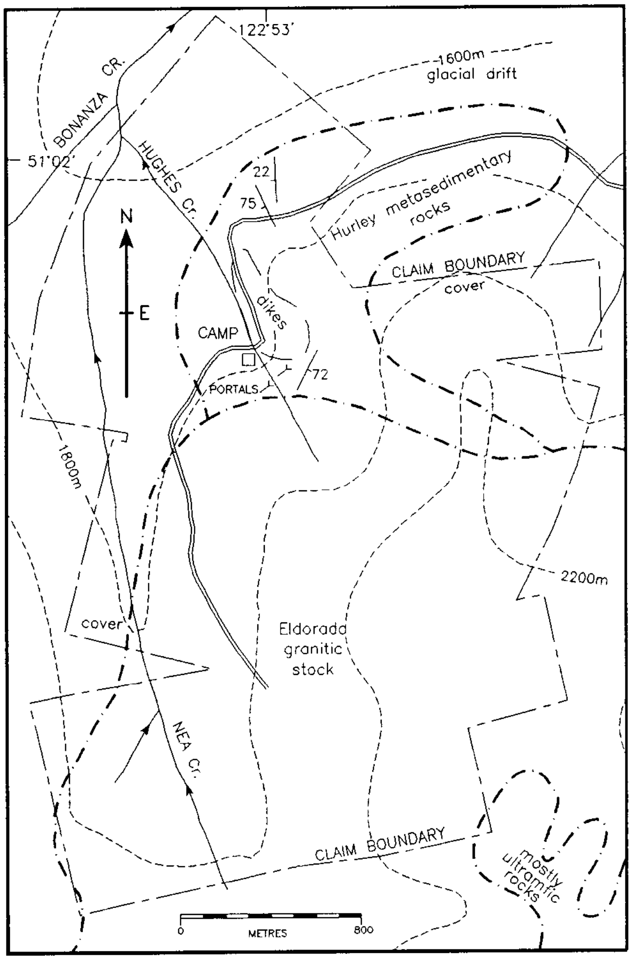


Figure 5.50. Geology of the Robson prospect.

nite, sphalerite (Photo 5.21) and minor jamesonite(?) and cupriferous minerals in quartz. Cairnes (1943) reported assays of representative samples ranging up to 100 grams per tonne gold, high silver and a trace of tin.

Another showing is exposed in the 'Robson trench' 350 metres southeast of the camp site. This is a vein, 0.3 metre wide, that strikes 070° and dips steeply. Christopher (1985) reported assays ranging up to 77 grams per tonne gold and 1000 grams per tonne silver on grab samples. The main 'ore' minerals are arsenopyrite, boulangerite, ruby silver and chalcopyrite.

Other showings are associated with northwesterly trending VLF-EM anomalies aligned subparallel to Hughes Creek. These areas are characterized by light coloured ankeritic carbonate impregnations accompanied by chalcedonic quartz stringers carrying minor amounts of pyrite and arsenopyrite. Anomalous gold values in soils, in the 1250 to 3250 ppb range, occur 2 kilometres southeast of the camp site (Christopher, 1985; Arscott and Ng, 1975, 1976).

Genesis of the prospect is related to emplacement of the Eldorado stock and the subsequent development of a strong northwesterly trending fissure system and cross fractures, at 038° and 070°. The intersection of these fractures coincides with the Robson prospect.

MINERAL PROSPECTS, SHULAPS AREA

The most important mineral prospects in the Shulaps area postdate emplacement of the Shulaps Ultramafic Complex and are related to the final stages in the magmatic evolution of the Coast Plutonic Complex. The gold-quartz veins of the Elizabeth-Yalakom prospect, are intimately related to the Blue Creek granitic porphyry that intrudes the central part of the Shulaps ultramafic body. Epithermal gold-silver mineralization on Big Sheep Mountain and at the Shulaps prospect on Hog Creek is genetically related to the Rexmount porphyry and associated volcanism.

ELIZABETH - YALAKOM (MINFILE 092OSE012)

The Elizabeth-Yalakom property is located 29 kilometres northeast of Gold Bridge near the centre of the Shulaps Range, 6.7 kilometres west of the confluence of Blue Creek and the Yalakom River at latitude 51°02′ north, longitude 122°35′ west. All workings are above treeline (1980 m). A mine road connects the property to the Yalakom River road at a point approximately 23 kilometres north of the highway.

Mapping and sampling of the property was done by the writer and field crew on July 28, 1987 and August 11, 1988. At the time of these visits the underground workings were inaccessible, the upper portal being filled with ice and the others collapsed.

History and Development

Auriferous quartz veins were discovered in the Shulaps Range in 1934, but were not described until several years later (Hedley, 1941). The Elizabeth, Yalakom, Churn and Plateau claims were staked at this time and the property was optioned to Bralorne Mines Ltd. Subsequently a total of 232 metres of diamond drilling at five sites was completed and 534 metres of surface stripping to explore Veins Nos.1, 2, 3 and 4 on the Elizabeth 1 and 2 claims.

Wartime conditions delayed further work until 1947, at which time a portal was collared on the Churn 1 claim (2024 m elev.). A crosscut was driven west toward the Elizabeth 1 claim to test the downward extension of No.1 vein 230 metres below its surface exposure (Figure 5.51). By 1948 this crosscut had been extended a total length of 672 metres. Two quartz veins, the B and C veins, were intersected 490 metres and 641 metres, respectively, from the portal. In addition to 266 metres of diamond drilling, some drifting on the veins was completed. The B and C veins are not exposed on the surface and their relationship to No.1 vein, the intended target, is not known (Merrett and Stevenson, 1950).

The following year a raise was driven up a 1.2-metre-wide section of the B vein to a point 82.5 metres above the level (Merrett, 1951). In addition, a raise was driven 23 metres up the C vein. No significant gold concentrations were encountered during this work. At this time, surface work on the Yalakom 2 claim uncovered a quartz vein 0.6 to 0.9 metre thick and continuous for more than 60 metres, known as the No.9 vein.

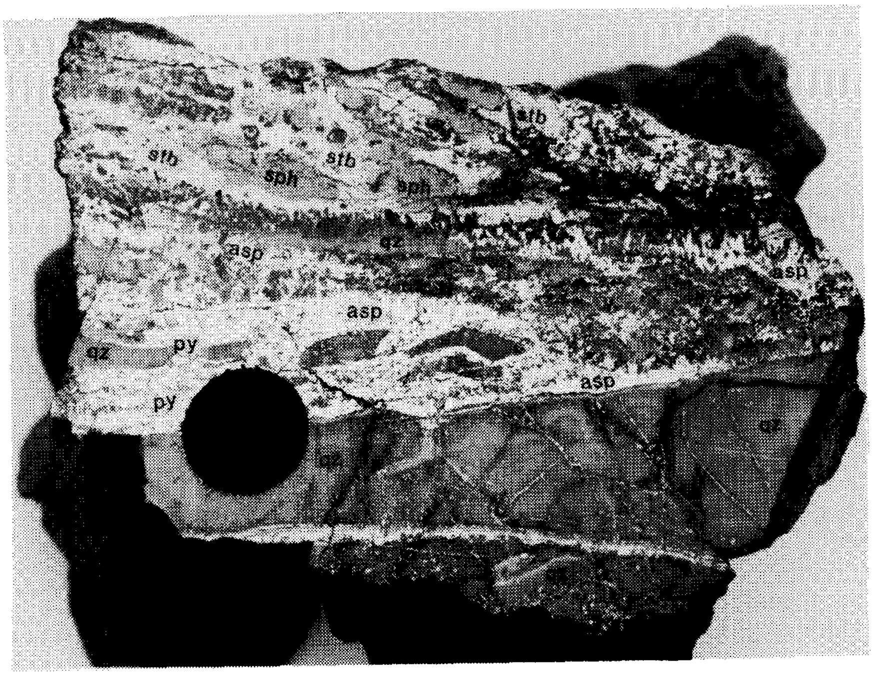


Photo 5.21. Composite pyrite (py), arsenopyrite (asp), stibnite (stb), sphalerite (sph), bearing quartz (qz) vein, Robson prospect (black marker = 1 cm).

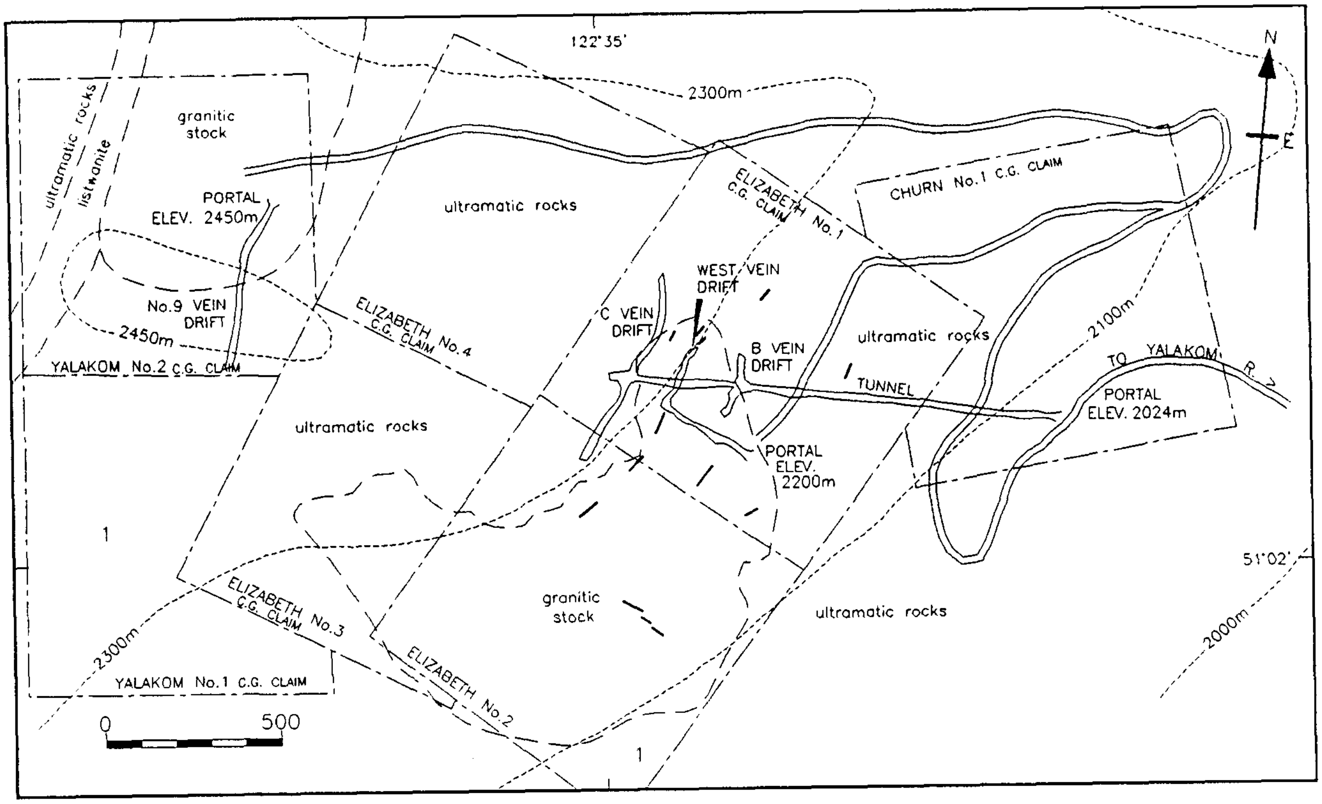


Figure 5.51. Geology of the Elizabeth-Yalakom claims.

During 1951 and 1952 a drift was driven from a portal collared on the Yalakom 2 claim at an elevation of 2298 metres, southward along the No.9 vein for a distance of 246 metres. Gold content of the vein is variable; assays as high as 17.5 grams per tonne gold over a length of 8.5 metres and a thickness of 0.6 metre, and 15.4 grams per tonne gold over a length of 19.8 metres and thickness of 0.8 metre were reported (National Mineral Inventory 920/2-AU2). Surface trenches exposed the No.9 vein in two cuts north of and below the portal. Overall, the thickness of the vein was considered to be too narrow and the gold distribution too erratic to constitute ore (Merrett, 1952, 1953). Bralorne Mines, Ltd. subsequently abandoned the option and its adjacent claims in 1953.

Work was resumed by the owners (T.W. Illidge and W. White) in 1956 and an adit collared on the Elizabeth 1 claim at an elevation of 2204 metres was driven at 1100 for 142 metres to further explore quartz veins exposed on surface. The Main vein and West vein (No.1 vein) were intersected at 33.5 metres and 138.8 metres from the portal, respectively The following year the West vein was followed an additional 97.6 metres. During this time a geological study of surface and underground workings was carried out by R. Thompson of The University of British Columbia, (Thompson, 1957a, b). Nine tons (8.2 tonnes) of rock from the West vein drift was custom processed at Trail, British Columbia and yielded 155 grams of gold, 155 grams of silver, 24 kilograms of lead and 8 kilograms of zinc (King, 1959). No further work has been done on the Elizabeth claims and the portals have subsequently caved.

The claims remained dormant until 1978 when Southern Lights Resources Limited (subsequently reorganized as Balsam Resources Inc.) acquired the Yalakom claims and staked additional ground in the area. In 1983 an option to earn a 40% interest was granted to Cal-Denver Resources Limited (reorganized as Carson Gold Corporation in 1987) and the same year the No.9 drift was rehabilitated and sampled (Culbert and Leighton, 1986). Both drift sampling and drilling from surface yielded encouraging results. In the summer of 1987 a total of 600 metres of diamond-drill core was recovered from four holes drilled from surface to test the down-dip extension of the veins. During a visit by the writer and crew, the No.9 vein portal (Photo 5.22) was being de-iced in preparation for further underground exploration planned for the fall of 1987 in conjunction with Vanguard Mining Exploration Limited. Additional work was suspended because of declining gold prices and the end of "flow-through" financing.

Geological Setting

The geology of the area was first described by McCammon (1947) and Leech (1953); this report is based on the work of Gaba *et al.* (1988) and Church and Pettipas (1989).

The hostrocks for the Elizabeth-Yalakom gold-bearing veins are two adjacent quartz feldspar porphyry bodies (the Blue Creek porphyry; Leech, 1953) intruded into Shulaps ultrabasic rocks. The porphyries are on the Elizabeth Nos.1, 2 and 3 claims and on the Yalakom No.2 claim on the southeast and north slopes of the ridge that forms the main topographic feature in the area (Figure 5.51). It seems probable that the porphyry bodies are connected at depth. Typically the porphyry is a medium grey granodiorite and contains plagioclase and hornblende phenocrysts (2 to 5 mm) in a finer grained groundmass of quartz, plagioclase, hornblende and biotite. Wholerock K-Ar analysis of this rock gives a date of 58.4±2 Ma (Table 2.02, No.5) that is judged to be the age of alteration. A somewhat older date of 70.5±6.5 Ma, based on Ar-Ar analysis of hornblende from the same porphyry (P. Schiarizza, personal communication, 1991) is within the age range of the Coast Plutonic Complex.

The outline of the porphyry is more complex than shown in Figure 5.51. There are numerous apophyses of porphyrytic and equigranular granodiorite and quartz diorite. Light coloured aplite locally intrudes the porphyry along irregular fractures, for example, on the northwest part of the Elizabeth No.1 claim.

Serpentinized harzburgite, typical of the Shulaps ultramafic body, surrounds the porphyry. These rocks are commonly altered, rusted by weathering and partly obscured by glacial debris. The contact along the west side of the porphyry on the Yalakom No.2 claim is a light brown listwanite composed mostly of talc, carbonate, some quartz stringers and a minor amount of green mica. The listwanite (referred to as the 'Bralorne dike' by Leech, 1953) is a rib 9 to 21metres thick trending northerly off of the main ridge. The listwanite is about the same colour as harzburgite on weathered surfaces but more resistant to weathering, especially when laced with quartz veinlets.

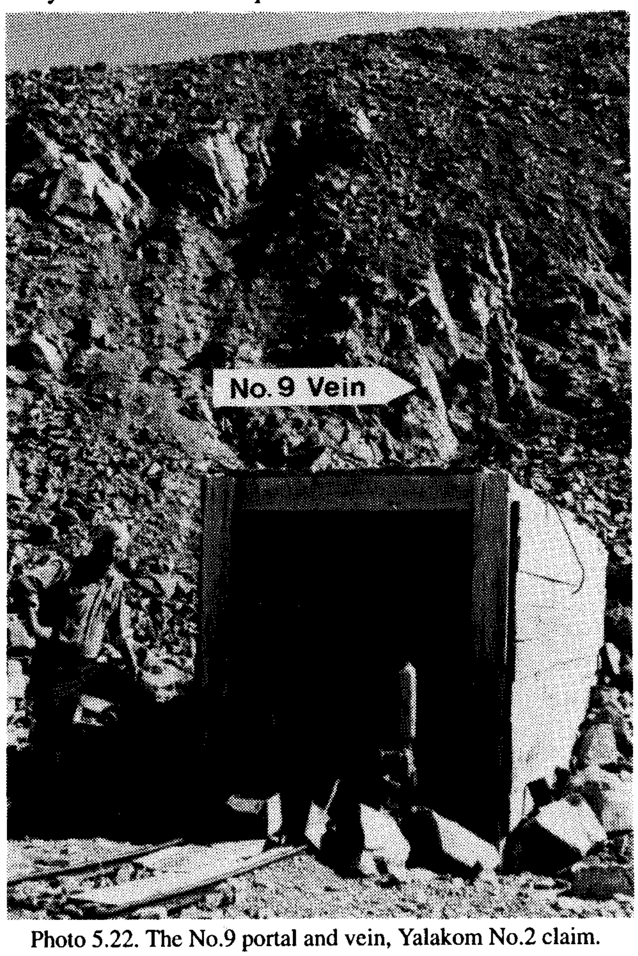


Photo 5.22. The No.9 portal and vein, Yalakom No.2 claim.

A detailed study of the fracture pattern in the porphyry bodies shows a strong unimodal concentration of joints and cleavages striking 034°, dipping 67° northwest (Figure 5.52). This is approximately the average vein direction on the property and coincides roughly with the vein direction at the Blackdome mine to the north that is tentatively related to Tertiary movement on the Fraser River fault system.

Mineral Occurrences

The important gold-bearing quartz veins at the Elizabeth-Yalakom prospect are confined to the porphyry (McCammon,1947) and to some extent along, or adjacent to, the contacts with ultramafic rocks (Leech, 1953; Thompson,1957b). In altered phases of the porphyry, the plagioclase and ferromagnesian minerals are replaced by clay, carbonates, epidote and chlorite. Quartz and disseminated pyrite increase near the vein margins (Leech, 1953).

Auriferous quartz veins include: the Nos.1, 2, 3 and 4 veins and the B and C veins on the Elizabeth Nos.1 and 2 claims and the No.9 vein on the Yalakom No.2 claim. Surface and underground exploration of veins on the Elizabeth claims has resulted in the delineation of gold concentrations considered too erratic and the vein widths too narrow to constitute ore. Currently, the No.9 vein is the only vein with underground workings that are directly accessible for exploration.

The No.9 vein is entirely within the small porphyry body northwest of the main body containing the Elizabeth veins. The vein, exposed along much of the length of the No.9 drift, is actually a system of veins, generally less than 0.5 metre wide and continuous on strike for more than 245 metres. The milky quartz that comprises most of the vein is accompanied by variable amounts of calcite, ankerite and disseminated sulphides. The quartz is ribboned, parallel to the vein walls, with laminations and styolitic partings of chlorite and carbonaceous material. Small fragments of what appears to be altered porphyry wallrocks occur within the ribbons. Concentrations of metallic minerals tend to follow the ribbons.

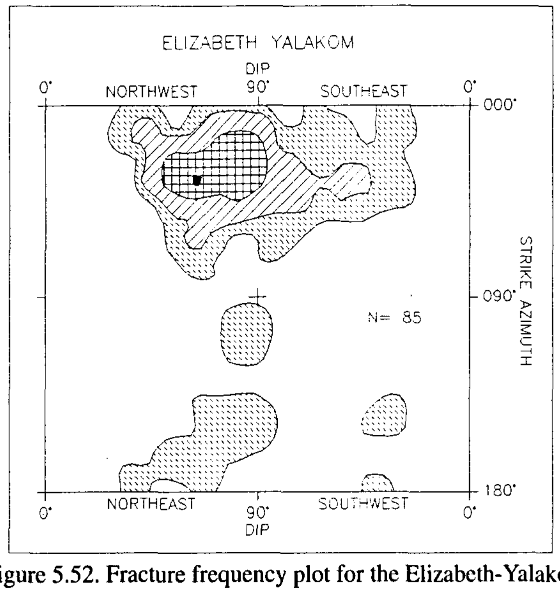


Figure 5.52. Fracture frequency plot for the Elizabeth-Yalakom area.

The concentration of quartz veins in the porphyry bodies suggests that these rocks were relatively brittle compared to the surrounding serpentinized hartzburgite allowing preferential entry of mineralizing solutions into the former unit. The surrounding serpentinite may have acted as an impervious barrier restricting fluid movement and circulation to within the porphyry bodies.

The banded texture of the quartz veins suggests repeated fracturing during emplacement and vein growth, a feature typical of the mesothermal vein systems found throughout the camp. The concentration of metallic minerals and native gold along chloritic carbonaceous ribbons may have resulted from fluid penetration and metal precipitation during vein-fracturing episodes. Inclusions of altered wallrock within ribboned quartz suggest stoping and partial replacement of the adjacent wallrock.

Metallic minerals are mostly arsenopyrite, pyrite, chalcopyrite and minor amounts of galena, sphalerite, pyrrhotite, magnetite and molybdenite. Native gold occurs as visible blebs within, and as thin surface coatings along, chloritic carbonaceous seams (Photo 5.23) and only rarely as isolated blebs within inter-ribbon quartz. Total metallic mineral content of the veins rarely exceeds a few percent.

An underground sampling program carried out in 1983, by Cal-Denver Resources Ltd., along the length of the No.9 drift delineated three auriferous zones. Three diamond-drill holes were subsequently drilled to test the continuity of the zones and intersected numerous gold-bearing quartz veins adjacent to the No.9 vein. Combined drift sampling and diamond drilling indicates "reserves" of 3850 tonnes with an average grade of 41.1 grams per tonne gold.

Four additional diamond-drill holes completed in 1987 and totalling 600 metres, cut intercepts grading 4.94, 4.18 and 3.57 grams per tonne gold over unknown thicknesses. Grab samples taken from the rock dump outside the No.9 portal contain up to 24.5 grams per tonne (Gaba *et al.*, 1988).

SHULAPS COPPER (MINFILE 092JNE028)

The Shulaps Copper prospect is located 2.7 kilometres north of Marshall Lake at latitude 50°57′05″ north, longitude 122°35′35″ west. Access is from the Marshall Lake road via East Liza Creek.

History

The prospect was examined for Lapex Syndicate in 1963 and written off as too small to be of economic interest. There is no known report of more recent exploration activity in the area.

Description

The showing consists of a 0.6 x 2.4 metres exposure of malachite with some bornite and chalcopyrite, with an estimated copper content of 3.0% (Lapex Syndicate, 1963). The occurrence is along a contact between the gabbro-greenstone units in the mélange zone peripheral to the southwest side of the Shulaps Ultramafic Complex.

JIM CREEK (MINFILE 092JNE111)

The Jim Creek prospect is located in the headwater area of Jim Creek, west of Shulaps Peak at latitude 50°56′55″ north and longitude 122°33′15″ west.

History and Development

Leech (1955) noted that the canyon section of Jim Creek was the site of some placer mining.

A small amount of Nephrite occurs along the upper section of Jim Creek.

Description

Botryoidal nephrite occurs as ribbons 30 to 60 centimetres thick in serpentinite. The main showing consists of a cigar-shaped mass of nephrite weighing about 10 tonnes.

SHULAPS (MINFILE 092JNE088)

The Shulaps prospect is on Hog Creek, 25 kilometres east-northeast of Gold Bridge and 2.5 kilometres northeast of the Marshall Creek road at latitude 50°54′05″ north, longitude 122°54′05″ west. Access is from the Marshall Creek road.

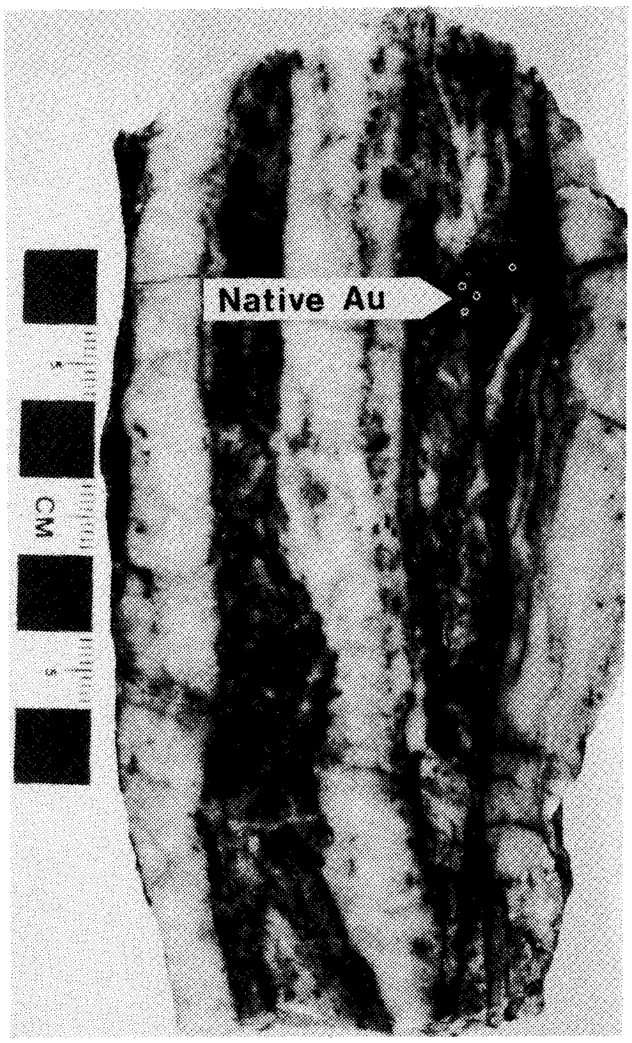


Photo 5.23. Banded gold-quartz vein, Yalakom No.2 claim.

History

The occurrence of placer gold in the creeks of this area has been known for many years. In 1925 panning of stream sediments on Hog Creek, then known as Boulder Creek, led J. Russell and H. Swartz to a vein exposure which was subsequently staked and tested by trenching and driving an 18-metre crosscut adit from the west bank of the creek. Considerable open-cut work was done the following year. There is no further record of activity on the Shulaps prospect until 1982. At this time silt sampling was done on Hog Creek and the property was restaked by Utah Mines Limited (Pollock, 1984). Subsequent work by this company included line cutting, geological mapping, soil and rock sampling.

Description

The Shulaps property is underlain by the Bridge River Complex (Figure 1A). These beds strike about 080°, dip steeply north and are cut by the Rexmount porphyry (west stock) and associated dikes. The rocks in the contact zone of the stock are strongly sheared, silicified and invaded by quartz veins subparallel to the bedding.

The Shulaps prospect is centred on a vein adjacent to an offshoot dike from the Rexmount porphyry in the contact zone of the stock. The sulphide minerals in the vein and wallrocks are mostly pyrite with minor amounts of pyyrhotite, chalcopyrite and arsenopyrite. A sample taken across a 2-metre width where the crosscut meets the vein assayed 27 grams per tonne gold and 70 grams per tonne silver (Nichols, 1926). A second sample taken from an open cut 460 metres from the adit assayed 45 grams per tonne gold and 6.9 grams per tonne silver (Nichols, 1926).

BIG (MINFILE 092OSE097)

The Big gold prospect is centred near the summit of Big Sheep Mountain 23 kilometres northeast of Gold Bridge at latitude 51°01′50² north, longitude 122°39′35″ west. The Big claim group is mostly above treeline between 1800 and 2300 metres elevation. Access is by dirt road and bulldozer trail that follows the valley of Noaxe Creek to Tyaughton Creek. The property was visited by the writer on September 3rd, 1988.

History

A silt-sampling program by Dupont of Canada Exploration Limited first indicated anomalous gold and silver in the vicinity of Big Sheep Mountain. Claims were staked in the summer of 1980 and this was followed by geochemical soil sampling and detailed mapping in 1981 and 1982. This program revealed mineralization associated with the Tertiary volcanic rocks.

Geological Setting

The Big claims are underlain principally by Tertiary volcanics and pre-Tertiary conglomerate, chert, greenstone and ultramafic rocks (Figure 5.53). The youngest rocks form a rhyolite cap 100 to 120 metres thick at the summit of Big Sheep Mountain. This rests on crowded feldspar porphyry dacitic breccias, lava flows and sills that are intercalated locally with volcanic mudstones and coarser clastics. These beds range up to 500 metres thick. The section is block

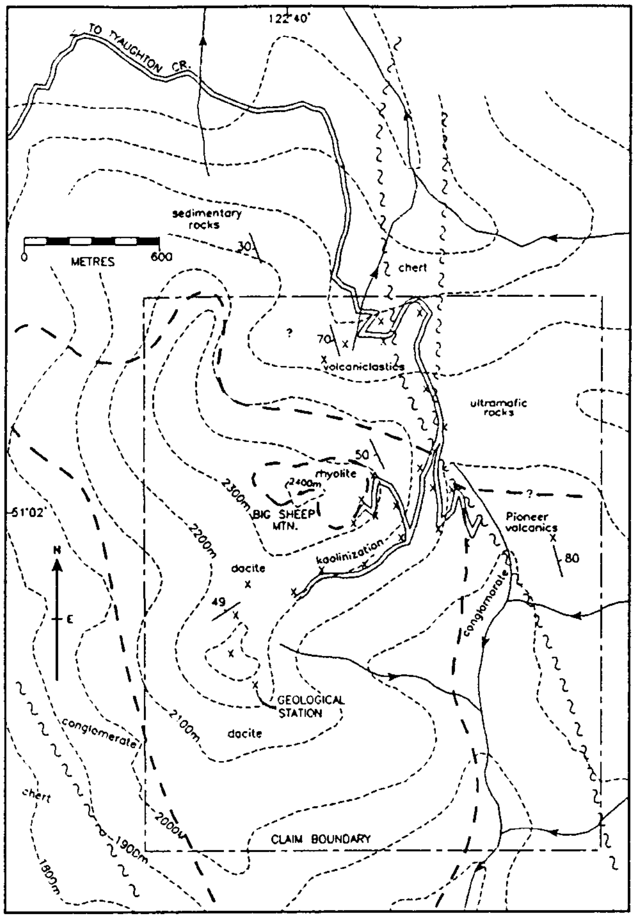


Figure 5.53. Geology of the Big prospect.

faulted and tilted up to 20° westerly. Steep bedding inclinations (up to 50°) reflect the initial angle of repose of the volcanic breccias.

The underlying rocks are polymictic conglomerates of the Tayor Creek Group and older Mesozoic/Paleozoic cherts, greenstones and plutonic rocks. Near the base of the Tertiary pile on the east side of Big Sheep Mountain, a narrow fault slice of ultramafic rock (mostly serpentinite and listwanite) cuts through the conglomerate. Feldspar porphyry dikes, possible feeders to the Tertiary volcanics are common.

Mineral Occurrences

Silt geochemistry in the area returned analyses ranging to a maximum of 10 ppb gold, 39 ppm copper, 50 ppm lead, and 297 ppm zinc. Soil sampling gave much higher results: 2500 ppb gold, 5.4 ppm silver, 130 ppm copper, 452 ppm lead and 2110 ppm zinc (Smith, 1981).

The principal showings are associated with large zones of limonite-stained clay alteration and patchy silicification in the rhyolite near the summit of Big Sheep Mountain. The clay alteration is especially manifest in the rock cuts along the road system on the south and southeast slopes. Quartz occurs locally as small veinlets and as linings in cavities in the altered rocks. Fine-grained sulphides (mostly pyrite and some tetrahedrite; Dawson, 1981) accompany some of the quartz and occasionally replaces small phenocrysts in feldspar porphyries.

Dawson (1982) also reports limonite and manganese stain and pitch, up to 1.5 centimetres thick, coating fractures high on the north cliff area of the mountain. It is concluded that these coatings, quartz veinlets and tetrahedrite mineralization are the source of the anomalous gold and silver values found in silts and soils on the property.

The principal fractures dip steeply and strike in two general directions; to the northeast and northerly. The northerly striking fractures passing through the summit of the mountain appear to be the most important controls for mineralization.

PRIMROSE (MINFILE 092JNE039)

The Primrose prospect is 0.75 kilometre northeast of Marshall Lake - 19.5 kilometres northeast of Gold Bridge at latitude 50°55′55″ north, longitude 122°35′10″. Access is from the Jim Creek road near the junction with the Marshall Creek road, 13.5 kilometres northwest of Gold Bridge.

History and Development

The first reference to the Primrose prospect was by Drysdale (1916) and, according to Cooke and Sandberg (1986), some trenching and two short adits were developed in the 1930s. The property was staked by P. Polischuck in 1985 and subsequently purchased by Coral Energy Corporation. Geophysical and geochemical surveys were conducted in 1986 without much success.

Description

The area is underlain by southwest-dipping cherts, argillites and greenstones at the north boundary of the Marshall Lake fault zone near the southern edge of the Shulaps Ultramafic Complex. Two parallel quartz veins, up to 2 metres wide, trend northwest for 240 metres following a band of listwanite along a chert-greenstone contact. The veins carry minor disseminated pyrite and chalcopyrite. No significant gold values have been found.

DISCUSSION

The Bridge River camp is similar to the Mother Lode camp of California. Campbell (1975) noted "the two camps not only have striking similarities in ore, vein mineralogy, wallrock alterations and wallrocks, but also are remarkably similar in the association of the ore veins with a major fault along a belt of elongate serpentine bodies that flank the margins of granite batholiths."

Cairnes (1937) and Joralemon (1934) believed the source of the mineralizing solutions in the Bridge River camp to be magmatic - a process of differentiation which also produced the soda granite and albitite dikes. The Bralorne gabbro-diorite was thought to be the ultimate source of the ore fluids. However, it is now known that the Bralorne intrusions are Paleozoic and much older than the ore veins in the Bralorne area (Armstrong, 1981, personal communication; Leitch, 1989). Furthermore REE patterns show that the soda granite is not a magmatic differentiate of the gabbro-diorite.

The age of gold-quartz mineralization in the Bralorne area is constrained by dikes dated 43.7 and 91.4 Ma that bracket vein emplacement (Leitch, 1989). The exact timing of this event may be close to the age of the Gwyneth Lake satellitic stock dated 85.9 Ma (Church, 1990a) located just west of Bralorne. This also fits zircon dating giving an age range of 69.5 to 98.4 Ma for the nearby Bendor pluton (Church, 1989) and alteration of the Bralorne intrusion that hosts the gold quartz veins, dated 85.1 Ma (Church, 1990a).

An extensive fracture system in the camp provided abundant channelways for vein-forming solutions. It is speculated that the stresses caused by the intrusion of the granitic plutons resulted in shearing and the development of fissure veins - space was required and the country rocks were pushed aside (Figure 5.54). It is believed that an important part of this movement is manifest in reactivation of the Cadwallader fault zone, a pre-existing major break. The evidence suggests that emplacement of the Coast Plutonic Complex provided the necessary thermal engine driving, the mineralizing solutions and provided the structural setting controlling the channels for these solutions.

Woodsworth *et al.* (1977) described mineral zonation in the Bridge River camp and attributed it to the dispersion of metals outward from the eastern flank of the Coast Plutonic Complex, the probable source of heat and some of the metals. In a belt 35 kilometres wide, a gold zone near the plutons is followed outward by overlapping antimony and mercury zones. The two main types of mineral deposits distinguished within the zonal pattern are represented by the Bralorne-Pioneer-Wayside and the Minto-Congress deposits. The former are characterized by relatively high gold to silver ratios whereas the latter have lower gold to silver ratios, higher antimony content and a greater amount of mixed sulphides . Close to the plutons the quartz veins are typically mesothermal and contain pyrite-arsenopyrite and small amounts of chalcopyrite and scheelite (the Bralorne mine). Farther away, the veins are mixed polymetallic mesothermal and epithermal types with abundant pyrite, stibnite, sphalerite and galena (the Minto mine). Cinnabar prospects are found along the relatively 'cool' northeast fringes of the camp (the Silverquick mine). A summary of mineralization on the various properties comprising the camp is given in Table 5.6. Figure 5.55 is a modification of the Woodsworth model that shows sodium and potassium metasomatism and isotherms around the main plutons.

The actual setting is complicated by local factors such as the superposition of low-temperature mineral assemblages on medium or high-temperature assemblages at the time of cooling of the plutons. This complexity is compounded by the intrusion of dikes into the mineral plumbing system, and later faulting which has resulted in the juxtaposition of blocks exhibiting mesothermal and epithermal levels of mineralization.

The ultimate origin of the hydrothermal solutions is unknown although fluid mixing is suspected. Nesbitt *et al.* (1986) show that deposits formed by deep circulation of fluids in the accreted oceanic or island-arc terranes are characterized by unique chemistry and important isotopic evolution including mixing of primitive mantle-type and more radiogenic leads as shown by Leitch *et al.* (1989).

MINERAL POTENTIAL EVALUATION

Mineral Deposit Land Use (MDLU) maps were developed in the period from 1969 to 1978 at a scale of 1:250 000 to cover most of the province (McCartney *et al.*, 1974). This provided a measure of the capability of the land to support mineral resources and was the first step in estimating mineral potential. The MDLU maps classified areas into categories, according to mineral exploration potential. The classification was based mainly on the frequency of mineral

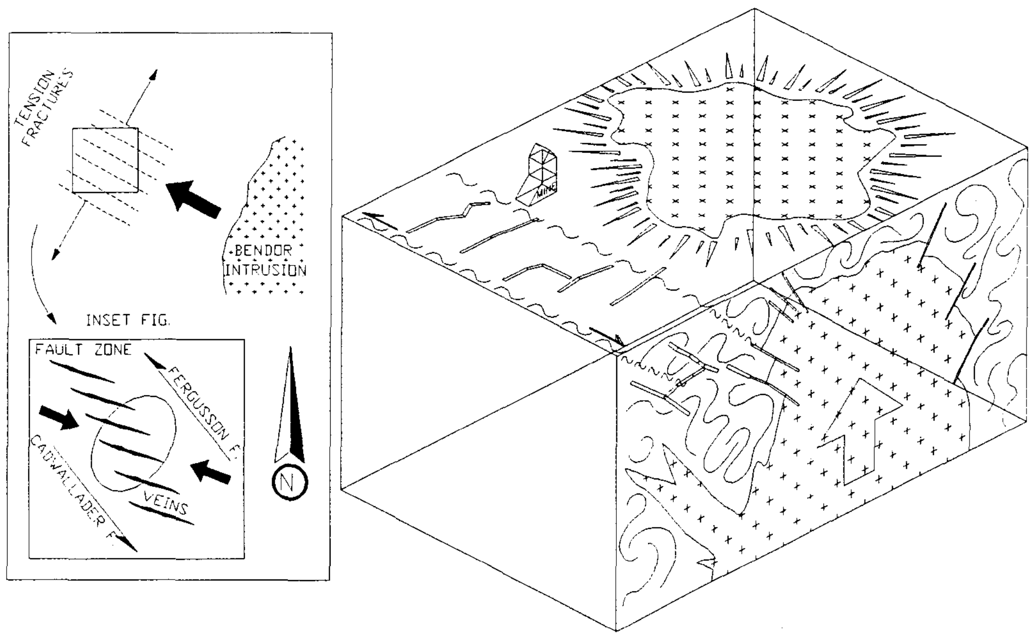


Figure 5.54. Model of the stress regime related to the emplacement of veins during intrusion of the Coast Plutonic Complex.

TABLE 5.6
SUMMARY OF MINERALIZATION IN THE BRIDGE RIVER MINING CAMP

MINFILE NUMBER	DEPOSIT	ORE MINERALIZATION	GANGUE	ALTERATION	COUNTRY/ HOST ROCK
A. Bralorne Mine - Hurley River/Truax Area					
3	Alma '	py., cr-mica	qtz.	carb., silic.	1, Cc
24	Arizona '	py., arspy., chalco., sph., sch.	qtz.	carb.	1, A
1,2,7	Bralorne '	py., arspy.	qtz.	carb.	A, Cc
135	B.R. Jewel ~	py., arspy., tet.	qtz.	gauge, bx.	2
20	California '	py., arspy., sph., chalco.	qtz.	silic., chl.	2, D
	Cosmopolitan '	py., arspy., cr-mica.	qtz.	gossan, ser. clay	A
23	Forty Thieves '	py., chalco., tet.	qtz.	carb.	A, 2
22	Gloria Kitty '	py., arspy.	qtz.	carb.	A, 2
66	Gray Rock ~	py., arspy., sph., gal., stib.	qtz., carb.	carb.	1, 2
17	Grull '	py., arspy.	qtz.	carb.	1, D
25	Golden Gate '	arspy.	qtz.	schist	A, D
	Golden Ledge '	py., arspy., pyrrh.	qtz.	silic., carb.	1
58	Lost Gold ~	stib.	qtz., carb.	carb.	A
67	Mary Mac ~	stib., arspy., chalco., moly	qtz., carb.	chl., ser.	1, D
6	Native Son ~	py., pyrrh., arspy.	qtz., carb.	carb.	1, D
90	Ranger ~	py., arspy., chalco., real., arp.	qtz.	silic., tour.	A,2
16	Short O'Bacon	py.	qtz., carb.	ser., talc., chl., fuch.	A, 2
59	Truax ~	stib., arspy.	qtz.	carb.	1
60	Truax Gold ~	stib., arspy., py., sph.	qtz.	silic., clay	Cb
21	Why Not '	py.	qtz., carb.	qtz., carb.	2
B. Pioneer Mine - Cadwallader/Piebiter Area					
11	Butte - IXL '	py., pyrrh., chalco., sph.,	qtz.	carb.	2, 3
43	Chalco ^	py., pyrrh., chalco., sch., moly	gar., px., ep.	bio., carb.	1, 2
	Dan Tucker =	py.	qtz.	silic., ser.	A, 2
8	Holland '	py.	qtz., carb.	carb.	1, 2
5	Mix '	py.	qtz.	silic.	1, 2
10	Paymaster '	py.	qtz.	carb.	2, D
4	Pioneer '	py., arspy., cr-mica	qtz.	carb., ser., clay, fuch.	2
9	Pioneer Extension '	py., arspy.	qtz.	carb.	A, 2
12	Red Hawk '	py., chalco.	qtz.	silic.	A, D
14	Royal '	py., chalco., moly.	qtz.		A
15	Standard =	py., arspy., realgar	qtz.	talc., carb.	1
C. Wayside Mine - Mt. Penrose Area					
124	Commodore '	py., arspy.	qtz., carb., ab.	carb.	Cc, A
68	Little Gem =	py., arspy., loel., sch.	qtz., ct., all.	ser., clay	Ca
121	New Discovery Zone ¤	py., pyrrh., chalco., sph.		carb., chl.	1
27	Pilot '	py., arspy.	qtz.	silic., ser., clay	Ca
31	Veritas '	py., arspy., chalco., cr-mica	qtz., ct.	carb., talc	A
30	Wayside '	py., arspy., chalco.	qtz.	carb., clay	A
D. Minto Mine - Carpenter Lake Area					
98	Benboe ~	stib., py., arspy.	qtz., carb.	bx.	1
107	Billyo ¤	py., pyrrh., chalco., mt.	act.	limonite	1, 2
71	Bristol =	py., arspy., sch.	ct., qtz.	gouge	1
29	Congress ~	stib., py., arspy., tet.	qtz.	carb., ser., chl., clay	1, 2
73	Dauntless ~	py., arspy., stib., sph.	qtz., carb.	silic., jar., ser.,	1
77	Golden ~	stib., py., arspy.	qtz., carb.	carb.	1, 2
132	Howard ~	stib., py., arspy.	qtz., carb.	carb., ser., clay	2

MINFILE NUMBER	DEPOSIT	ORE MINERALIZATION	GANGUE	ALTERATION	COUNTRY/ HOST ROCK
129	Kelvin "	py., chalco., arspy., sph.	qtz., carb.		2
92	Leckie Zone "	py., chalco., sph.	qtz., carb.	carb., silic., chl., talc	D, A
131	Lou Zone ~	stib., py., arspy.	qtz., carb.	silic.	D
75	Minto ~	py., arspy., cr-mica, sph., stib.	qtz., carb.	carb., ser., clay	1, D
76	Peerless	py., sph., gal.	qtz., carb.	silic.	2
33	Reliance ~	py., stib.	qtz., carb.	silic., carb.	2
136	Senator ~	py., stib.	qtz., carb.	silic., carb.	1, 2
42	Silversides ~	py., arspy., stib., gal.	qtz.	talc., lim., bio.	1
133	Slide Zone ~	py., arspy., stib.	qtz.	carb.	1, D
35	Summit ~	py., arspy., sph., gal.	qtz.	silic., chl.	1, 2
41	Lillomer *	py., cinn.	carb., qtz.	hem.	1, 2
32	Lucky Gem '	py., arspy., chalco.	qtz.	gossan	Ca
45	Lucky Strike ~	py., arspy., sph., jame.	qtz.	carb., qtz., cr-mica	B, D
405	Northern Light '	py., arspy., chalco., sph.,	qtz.	gossan	Ca
26	Robson ~	py., arspy., stib., jame., sph.	qtz.	gossan	Ca, 4
17	Silverquick *	cinn.	qtz., ct	lim., clay	6
37	Wide West ¤	pyrrh., chalco.	qtz.	gossan	Ca, 4
F. Shulaps Area					
47	Big *	py., tet.	qtz.	lim., clay, silic.	7
12	Elizabeth - Yalakom '	py., arspy., chalco., moly	qtz., carb.	carb., clay, chl.	Ca
39	Primrose ~	py., chalco.	qtz.	talc, gossan	1, 2
88	Shulaps ~	py., pyrrh., arspy., chalco.	qtz.	silic., gossan	1
28	Shulaps Copper	chalco., born., mal.	carb.	carb.	A, 2

Key to type of Mineralization:

'	banded mesothermal quartz vein
~	quartz/carbonate vein
*	epithermal fracture filling
¤	skarn and other replacement type mineralization
=	mineralized shears

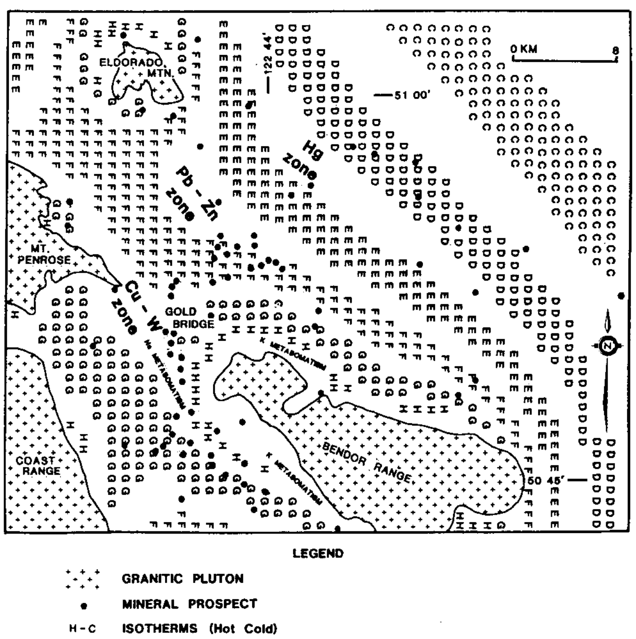


Figure 5.55. Model showing the distribution of mineral occurrences, metal zonation and projected thermal aureole related to the Coast Plutonic Complex.

occurrences. From preliminary evaluations it was clear that the various types of deposits tend to cluster forming mineralized tracts or distinctive mining camps.

The map entitled "Metallic Mineral Potential of British Columbia", produced in 1978 by the British Columbia Ministry of Energy, Mines and Petroleum Resources (at a scale of 1:2 000 000) is a synthesis of this work.

A review of the MDLU program by Legun and Matheson (1991) showed that the maps were quite successful. Indeed, most new discoveries are within the delineated high potential areas; undoubtedly, some deposits remain undetected in glacial drift covered regions. The difficulty with the MDLU maps is the geological controls underlying, and forming the boundaries of the high, medium and low potential areas are not always clear.

In this study the concept of 'geological tracts' is adopted and is the basis for mineral potential evaluations (Church and Kilby, 1994) - a tract being a non-political land unit underlain by an array of variously mineralized formations, having clear geological boundaries such as lithological changes in bedded sequences, faults or intrusive contacts.

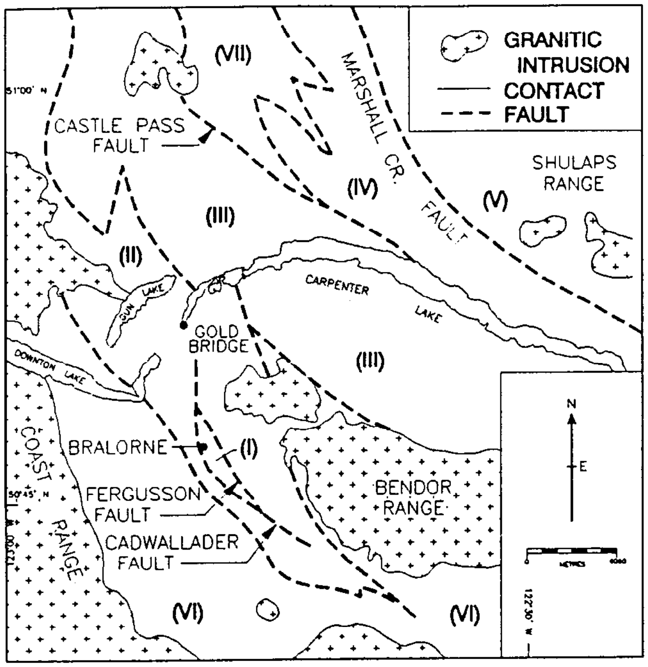


Figure 5.56. Mineral potential tracts for the Bridge River area.

In the Bridge River area seven tracts (labeled I, II, ...VII) are identified and ranked according to mineral potential. Mineral potential is gauged according to past production, reserves, and number of mineral occurrences (Figure 5.56).

Tract (I) has 'very high' potential. It is a relatively small lense-shaped area (5.5 kilometres long and 0.8 kilometres wide) formed by the bend in the Cadwallader fault zone at Bralorne. This lense contains all of the productive orebodies in the Bralorne-Pioneer area and the most important mesothermal gold quartz veins in the Bridge River mining camp. The area is underlain principally by the Bralorne intrusion and Pioneer volcanic rocks.

Tract (II) is assigned 'high' potential. This is the wedge-shaped area between the main phase of the Bendor pluton and the Mount Penrose lobe of the Coast Plutonic Complex west of Gun Lake. The tract contains most of the mineral deposits in the Bridge River camp including the mesothermal gold quartz veins at the Wayside mine and the numerous satellitic deposits in the Bralorne-Pioneer belt. The northeast and southwest boundaries of the tract are splays of the Cadwallader fault system. The tract is underlain by the Bralorne intrusions, the main units of the Cadwallader Group, part of the Bridge River Complex, the President ultramafic rocks and granitic rocks subjacent to the Coast Plutonic Complex that are believed to be the source of the mineralizing solutions.

Tract (III) is assigned 'high to intermediate' potential. This is a northwest trending belt, northeast of tract (II), extending through the Carpenter Lake and the Taylor Creek areas. It is characterized by numerous polymetallic mesothermal and epithermal (stibnite-bearing) vein systems such occur at the Minto and Congress mines and in the Eldorado area. The tract is underlain by the Cadwallader Group, Bridge River Complex, bands of serpentinite and listwanite on fault zones and a few outlying granitic stocks of the Coast Plutonic Complex. the Northeast boundary is a splay of the Castle Pass fault (Schiarizza, 1993).

Tract (IV) is assigned 'intermediate' potential. This is a northwest trending belt southwest of the Marshall Creek fault and north of Carpenter Lake. The Tract is geologically similar to tract (III) except that the area has fewer mineral occurrences and no significant mineral production.

Tract (V) is assigned 'intermediate to low' potential. this is the northeast extremity of the Bridge River mining camp, located northeast of the Marshall Creek fault. The tract is underlain by the Shulaps Ultramafic Complex, units of the Bridge River Complex, Cadwallader Group and a few small granitic 'outriders' of the Coast Plutonic Complex. Other than the gold quartz veins associated with the granitic intrusions at the Elizabeth-Yalakom mine, the principal resources are some small podiform chromite deposits and a minor amount of jade.

Tract (VI) is also assigned 'intermediate to low' potential. This is the southwest part of the Bridge River mining camp underlain mainly by the Coast Plutonic Complex and adjacent metamorphosed facies of the Cadwallader Group and Bridge River Complex. The few mineral occurrences in this area are skarn copper deposits such (Chalco at Piebiter Creek) and quartz veins related to the granitic rocks in the contact aureol (Gray Rock mine). Other potential mineral resources include andalusite in Noel black argillite near the contact of the granitic plutons in the Hurley River valley.

Tract (VII) has the lowest mineral potential in the region. It interfingers with Tracts (III) and (IV) in the northwest part of the Bridge River area. Tract (VII) is underlain mainly by unmineralized or weakly mineralized Cretaceous clastic rocks of the Tyaughton Trough. The Silverquick mercury mine near the Eldorado stock is the only significant deposit.

CHAPTER 6 CONCLUSIONS

"Scientists have an uncanny ability to find what they are looking for."

—Anonymous

The Intermontane tectonic belt of the western Canadian Cordillera (Intermontane Superterrane) contains several smaller allochthonous oceanic and island-arc terranes that evolved separately in middle and late Paleozoic and early Mesozoic time and were subsequently accreted to the North American craton. These include the Stikine and Cache Creek terranes on the west and the Quesnel Terrane on the east (Figure 6.1).

In the Bridge River area of southwestern British Columbia, the Cadwallader Group and Bridge River Complex are believed to represent parts of the two westerly terranes; the latter, a typically oceanic assemblage; the former, a turbiditic ocean-margin assemblage. That parts of the Cadwallader and Bridge River suites were deposited penecontemporaneously, perhaps in adjacent terranes, is suggested by similar fossils and similarities in the volcanic rocks.

The geology of the Bridge River area records repeated cycles of deformation. The oldest rocks are strongly fragmented and intricately folded; spilitic greenschist metamorphism is common. Slices and wedges of Cadwallader and Bridge River rocks are found throughout the area, testifying to a complicated tectonic history. It is believed that the interleaving of Cadwallader and Bridge River suites occurred at the time of plate collision by imbricate thrusting and stacking of various sedimentary lithologies, volcanic rocks and lenses of underlying gabbroic and ultramafic rocks as manifested in the Shulaps area.

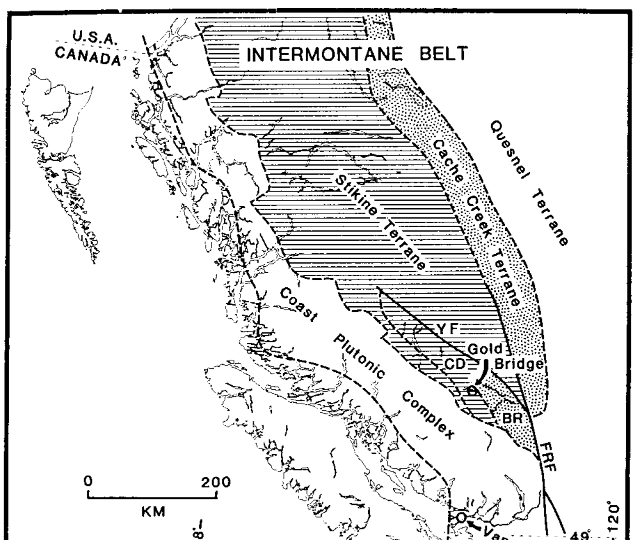


Figure 6.1. Terrane map of southwestern British Columbia.

Although knowledge of the temporal and spacial conditions of docking is incomplete, it has been inferred that the eastern terranes onlapped the continental rocks by Early Jurassic time while Middle Jurassic has been proposed as the time of accretion of the western terranes.

The present configuration of major units in the Bridge River area mainly reflects Cretaceous and Tertiary tectonism. Although current studies allow tentative restoration of the terranes (inter-arc, oceanic areas) the details of reconstruction remain controversial.

The map area is underlain primarily by rocks of the Cadwallader Group and Bridge River Complex. The Cadwallader Group is exposed mostly along the flank of the Coast Plutonic Complex and appears to connect with the Stikine Terrane to the north. The Bridge River Complex is mostly east of Stikinia and is juxtaposed against the Cache Creek Terrane to the east. The Bridge River is the faulted southern part of the Cache Creek Terrane, according to recent concepts, and separation occurred during the Cretaceous and Tertiary by major episodes of transcurrent movement along the Yalakom and Fraser River fault system. However, it may be that these terranes are only partly equivalent. The Cache Creek rocks typically contain Tethyan fauna and there is no major Permian-Triassic unconformity recognized in the succession. In the Bridge River area it is noted that the Upper Permian - Lower Triassic boundary appears to be gradational and Tethyan faunas have not been found. Docking sutures within the Bridge River Complex are not delineated and it seems likely that some so-called 'Bridge River' sections are part of the Stikine Terrane.

The Pioneer volcanic rocks and Bralorne intrusions are the principal mineralized rocks and are the focus of mapping, geochemical and petrological investigation in the present study.

The Pioneer volcanics are voluminous and widespread and are common to the Cadwallader and Bridge River sequences. Information on the genesis of these rocks and their original tectonic setting sheds light on the emplacement of basaltic magmas providing tectonic constraints on accretionary models (Figure 6.2). The lavas include MORB-like tholeiites which show changes in the abundances of incompatible elements, probably due to progressive melting of a rising mantle diapir (enriched in garnet at depth and spinel at higher levels) in a back-arc setting.

The Bralorne gabbro-diorite intrusions outcrop primarily along the Cadwallader break and in the Shulaps Range.

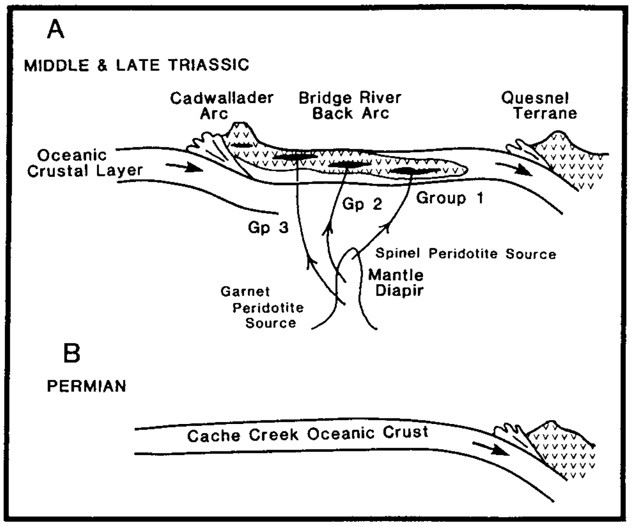


Figure 6.2. Model of basin development and eruption of Pioneer basalts.

These rocks are similar in silica content to the Pioneer volcanics but contain relatively high magnesia and low titania and iron oxides. Also, it is now known that the Bralorne intrusions are Permo-Carboniferous and not early Mesozoic age, as once thought. Based on their minor element signature these rocks appear to be typical subduction-related oceanic-arc gabbros with depleted upper mantle origin similar in some ways to the gabbros of ophiolitic association occurring in the Troodoos Complex of Cyprus and at Thetford, Quebec. The Bralorne intrusions do not include sheeted dikes such as found in the Troodoos Complex but they do contain small, irregular bodies of plagiogranite typical of Thetford. However, the soda granites associated with Bralorne intrusions are compositionally distinct from typical ophiolitic plagiogranites and are not related to the gabbros by fractional crystallization.

Mineral occurrences in the Bridge River camp are principally gold-quartz veins. It was once believed that the most important veins were deposited from fluids derived from the soda granite which was itself derived by fractionation of the Bralorne gabbro-diorite. However, radiometric dating at the Bralorne mine shows that the major vein systems are Late Cretaceous (much younger than the soda granite) and within the age range of the Coast Plutonic Complex. Thus the Pioneer greenstones and Bralorne intrusions are simply good (suitably brittle and well located) hostrocks and not genetically related to the major vein mineralization.

Coast intrusions (plutons, stocks and dikes), characterized by granite, granodiorite, monzodiorite and diorite 'calcic' magmas are associated with mineralization in the several geographic areas (fracture domains) comprising the Bridge River camp. These are dikes, the Gwyneth Lake stock and the Bendor pluton in the Bralorne area; dikes and the Bendor pluton in the Pioneer area; dikes and the Mount Penrose lobe of the Coast Plutonic Complex in the Wayside-Pilot area; and dikes and outlying small stocks of the Coast Plutonic Complex in the Lucky Strike and Robson areas; the Bristol-Benboe area, and the Elizabeth-Yalakom prospect in the heart of the Shulaps Range. An intricate system of fractures is thought to have controlled the movement of ore-bearing solutions, the major fractures being the main channelways connected to the intrusions. Metal zoning is manifest by arsenic enrichment in mesothermal veins near the plutonic rocks that is overlapped locally by antimony and superseded distally by mesothermal and epithermal antimony and mercury mineralization.

At the Bralorne mine and elsewhere in the Bridge River camp, emplacement of the Coast Plutonic Complex provided not only the thermal engine driving the circulation of the mineralizing solutions but also the structural setting for the development of the veins. Stresses caused by the intrusion of the granitic plutons resulted in shearing and the development of vein fissures - the country rocks were displaced laterally to accomodate these intrusions. It is believed that an important part of this movement is manifest in reactivation of the Cadwallader fault zone, a pre-existing major break.

The principal mineral potential is within a wedge-shaped tract bounded by splays of the Cadwallader fault system between the main phase of the Bendor pluton and the Mount Penrose lobe of the Coast Plutonic Complex. The tract contains most of the mineral deposits of the Bridge River mining camp including the mesothermal gold quartz veins of the Bralorne-Pioneer mines at Bralorne and the Wayside mine near Gold Bridge. It is proposed that the tract is underlain at depth by granitic rocks that may be the ultimate source of mineralizing solutions.

Weaker mineralized tracts to the northeast, characterized by polymetallic mesothermal and epithermal deposits, may be the result of northeasterly migration of the axis of the Coast Plutonic Complex, reflecting an end phase of generally deeper and more feeble episodes of magmatic activity.

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APPENDIX

This appendix provides a summary of selected geological traverses in the Bridge River camp beyond the principal mining properties that are described in Chapter 5 of this report. These data assist in documenting the key geology and cross-sections show on Figure 1A. The total array of sample stations overlayed on the geography of the map-area is shown on Figure 1B in the pocket.

Stations BRC 1-10: Southeast shore of Downton reservoir. Stations 1-2 include laminar chert beds typical of Bridge River Complex whereas stations 7-10 are mainly argillite and siltstone similar to Noel F. of Cadwallader Gp. Stations 3-5 consist of less deformed siltstone, calcarenite, limestone and pebble conglomerate.

Stations BRC 11-27: North shore of Downton Lake. Stations 11-12 are steeply dipping Hurley siltstone and sandstone beds with tops to the west. Station 15 is black serpentinite. Stations 13-25 consist of folded and sheared dark grey Bridge River ribbon chert - fold axis striking 188°, plunging 50° south. Stations BRC 26-27 are at B.C. Hydro's quarry that is developed in Bralorne gabbro and ultramafites (Lab Nos. 32572 and 32573).

Stations BRC 30-40: Area northwest of Gywneth Lake accessed from West Hurley forestry road. Stations 30-31 are outcrops of Pioneer lava and aquagene breccia (Lab No. 32574). Stations 39-40 consists of black argillite and siltsones and fossiliferous Hurley conglomerate (GSC Cat. No. -C-158871). The remainder of the stations are sheared argillite and Bridge River ribbon chert beds.

Stations BRC 41-54: To south boundary of map-area along West Hurley forestry road. Station 41 is Hurley calcarenite with dark shaly seams. Station 46 is Pioneer volcanic breccia. The remaining stations are mainly black argillite and siltstone beds of Noel F. with local development of andalusite and pyritized near the contact with the Coast Plutonic Complex.

Stations BRC 55-60: Area southwest of the Hurley River. Stations 55-58 mainly Noel argillite, locally with small andalusite laths, dipping southwest. Station 59-60 is Pioneer volcanic breccia overlying folded Bridge River ribbon chert - fold axis striking 186°, plunging 24° south.

Stations BRC 62-74: Gun Lake road. Mostly grey, steep northeast and north dipping Bridge River chert with dark chloritic and/or graphitic folia between chert ribbons.

Stations BRC 75-84: Gywneth Lake to Hurley River. Noel argillite and siltstone and fossiliferous Hurley siltstone, sandstone and conglomerate - beds dipping southwest, tops up. Station 78 Gywneth Lake granodiorite stock (Lab No. 32575).

Stations BRC 86-96: East Hurley road. Stations 86-94 Noel black argillite (with andalusite) dipping southwest. Stations 95-96 Pioneer volcanics.

Stations BRC 98-108: Main road from Pioneer to California mine. Station 98 massive ultramafic rocks on banks of Cadwallader Creek at bridge (Lab No. 32578). Stations 99-101 Noel black argillite and siltsone, beds vertical, horizontal and dipping northeast. Stations 102-107 Bridge River chert and argillite dipping northeast. Station 108 massive greenstone.

Stations BRC 109-130: Bralorne-Pioneer area. Stations 125-127 Pioneer lava and aquagene breccia. Stations 128-129 Noel black argillite and siltstone; stations 110-118 sheared argillite. Stations 123, 125 Bridge River chert and schist, fold axis strikes 150°, plunges 65° southeast. Stations 109, 120-122, 130 Bralorne intrusions.

Stations BRC 131-139: Slim Creek road in Congress area. Stations 131-132 Pioneer pillow lava (Lab No. 32585). Stations 133, 138-139 Noel argillite and siltone. Stations 134-137 vertical and southwest dipping Hurley siltstone, sandstone and conglomerate.

Stations BRC 140-153: Highway cuts in Congress area, mostly Pioneer pillow lava intruded locally by feldspar porphyry dikes (Lab No. 32579). Station 153 Bridge River chert with argillaceous seams, fold axis strikes 174°, plunging 40° south.

Stations BRC 154-177: Taylor Creek - North Cinnabar Ridge area. Stations 541-163 southwest-dipping (35-60°) Talyor Creek Group consisting mostly of polymictic pebble and boulder conglomerate (enriched in Bridge River chert and metamorphic clasts, some well indurated Hurley sandstone and rare limestone clasts and accessory clasts of Pioneer volcanics, Bralorne diorite and Shulaps? ultramafic rocks); Station 160 grey mudstone (marine) marker horizon 150 m. thick. Stations 164-168 mixture of basic and ultramafic rocks (including some listwanite), blueschist and chert in fault zone. Station 169 Pioneer lava. Stations 170-176 laminar bedded grey chert, jasper, thin limestone of Bridge River Complex dipping south and southwest with fold axes striking 340°, plunging 52° northwest and 202°, plunging 30° southwest.

Stations BRC 178-198: Minto area. Stations 178, 184-186 mainly Bridge River chert including some brecciated light cloured units. Stations 179-183 Pioneer pillow lava (Lab No. 32581) cut by felsic dikes. Station 198, large north-trending dike adjacent main vein system at Minto mine (Lab No. 32584).

Stations BRC 222-246: Slim Creek road south of Gun Creek. Mostly Bridge River chert (with argillaceuos seams) dipping steeply southwest; fold axis striking 143°, plunging 51° southeast. Stations 222, 235, greenstones.

Stations BRC 268-288: Area north of Gun Creek is mostly underlain by Bridge River chert with seams of argillite striking variously and cut by ultramafic rocks at stations 271, 278 and 281. Stations 273-275 Pioneer volcanics. Station 279 Hurley sandstone, shale and conglomerate (dipping southwest) with clasts of limestone, amygdaloidal lava and limestone.

Stations BRC 289-302: Area northwest of Congress prospect. Cadwallader section dipping east and northeast (tops up) comprising Pioneer volcanics stations 289-290, 293-294, 302; Noel black argillite and siltstone stations 300-301; Hurley siltstone, sandstone and conglomerate stations 296-299. Stations 291-292 Bridge River chert and argillite.

Stations BRC 312-315: Knoll south of Gun Creek with Pioneer pillow lava stations 313-314 overlying southwesterly dipping Bridge River chert-argillite stations 312, 315.

Stations BRC 316-334: Shore of Downton Lake. Stations 317, 319-320 Coast Plutonic Complex. Station 316, 318 biotite-garnet hornfels. Stations 321-322, 328, 332-334 pyritzed Noel argillite and siltstone dipping variously but mainly steeply southwest. Stations 323-326 southwest-dipping Hurley clastic beds characterized locally by limestone-pebble conglomerate. Stas 330-331 massive greenstone. Station 329 Bridge River laminar bedded chert with fold axis striking 190°, plunging 5° south.

Stations BRC 341-350: Kingdom Lake area. The area is underlain by a belt of Bridge River chert-argillite trending through Kingdom Lake, stations 346-348, and Pioneer volcanics to the west stations 341-345, 350.

Stations BRC 351-368: Mt. Zola area. Exposures are mainly Bridge River chert intercalated with graphitic schist cut by a variety of dikes. Thinly bedded Noel argillite and siltstone occurs just east of the crest of the hill station 351.

Stations BRC 367-386: Area north of Gun Creek is underlain mostly by deformed Bridge River ribbon chert with rare interbedded limestone; at station 385, fold axes strike 006°, plunging 23° north and 069°, plunging 80° northeast. Stations 371, 378-382 Pioneer pillowed and massive lava.

Stations BRC 387-393: Pearson Creek area. Stations 387, 391-392 Bridge River chert and schist. Stations 390, 393 Pioneer volcanics. Stations 388-389 Hurley? brown sandstone.

Stations BRC 394-403: Downton Lake shore. Stations 394-395, 403 southwesterly dipping Hurley limestone and clastic beds. Stas 397-399, 401 Pioneer volcaniclastics. Stations 396, 398, 400 Bridge River chert-argillite, fold axis strikes 140°, plunging 38° southwest. Sta 402 serpentinite.

Stations BRC 404-413: Gun Lake shore with mainly exposures of variably folded Bridge River chert, fold axes strike 157°, plunging 32° southeast and 200°, plunging 68° northwest. Station 407 massive intrusive? greenstone.

Stations BRC 419-430: Carpenter Lake shore mostly Pioneer pillow lava and breccia. Stations 420, 423 Bridge River chert and chert breccia. Station 419 Hurley sandstone and argillite. Station 424 serpentinite - listwanite.

Stations BRC 434-440: Hurley River area. Stations 435-436 Noel black argillite-siltstone. Stations 437-438 Hurley conglomerate. Station 439 Pioneer aquagene breccia. Station 434 wide zone of ultramafic rock on banks of Hurley River at water fall.

Stations BRC 442-460: MacDonald Ridge towards south end consists mainly of light coloured Bridge River ribbon chert and some limestone intruded by numerous greenstone sills and dikes stations 447-449. North end of ridge is mostly Pioneer lava (amygdaloidal), breccia and pillows stations 450-460.

Stations BRC 463-468: Old Hurley road. Stations 463-464, 467 laminar bedded Bridge River chert, fold axis strike 043°, plunging 25° northeast, overlain unconformably by Pioneer lava station 51. Station 468 Hurley sandstone and conglomerate.

Stations BRC 469-500: B&F Creek area. Stations 469, 489, 498-500 Pioneer pillow lava and breccia. Stations 471-473, 477-479, fossiliferous Hurley conglomerate and sandstone including volcanicastics transitional to Pioneer F. Stations 476, 486, 488, 490, 496-497 ultramafic rocks and listwanite associated with major faulting. Stations 482-483, 485, 491-495 Bridge River chert and associated schistose rocks, fold axis strike 048°, plunging 28° northeast.

Stations BRC 501-513: Eldorado Ridge with outcrops of mainly Hurley siltstone, fossiliferous limestone (GSC Cat. No. C-15884), conglomerate, volcaniclastics dipping steeply south - step faulting. Stations 506-510 volcanic breccia, felsic to intermediate composition. Station 511, felsic dike (Lab No. 32571).

Stations BRC 517-552: Eldorado Mountain: stations 518-521 Eldorado granodiorite. Stations 517, 522-526 east and southeast-dipping Hurley siltstone and argillite with some contact metamorphism. Station 527 metamorphosed Taylor Creek polymictic conglomerate including chert and diorite clasts. Stations 529-531, 538-539 ultrabasic rocks (Lab No. 38927 and 32592) including some listwanite. Stations 534-537, 544-545, 548-552 variably dipping Bridge River chert-argillite, minor limestone, fold axis striking 276°, plunging 47° west.

Stations BRC 553-574: Eldorado Mountain - Taylor Creek ridge is underlain by the Eldorado granite pluton in the west part, stations 553, 561-562, 564 (Lab No. 32593), that truncates ultramafic rocks, stations 553, 555, 557-558, 560 (some disseminated sulphides - including pentlandite), and highly deformed Bridge River gneiss at station 559. The east part of the ridge exposes the westerly dipping Taylor Creek Group composed of thick beds of polymictic conglomerate cyclic with thin sandstone-siltstone layers in the lower part and a mixture of pebble conglomerate and sandstone in the upper part with a marker band of dark grey (marine) argillite stations 565-574.

Stations BRC 575-599: Mount Fergusson consists of three main rock units on the south side - these are Bendor granodiorite, stations 580, 583, 588, 591; Bridge River biotite-quartz gneiss and schist (contorted), stations 575-579, 584, 587-588, 589-590, 592-593, 595-599; amphibolite stations 581-582, 585-586, 589, 594.

Stations BRC 600-609: Talyor Creek to North Cinnabar Creek area that is underlain principally by southwest-dipping Taylor Creek conglomerate with abundant Bridge River chert clasts (tops up). Stations 605-606 felsic Tertiary? (altered) pyroclastic rock underlain by Taylor Creek Group. Station 608 Bridge River ribbon chert (Paleozoic age) on North Cinnabar Creek near bridge. Station 609, listwanitic ultramafic rocks.

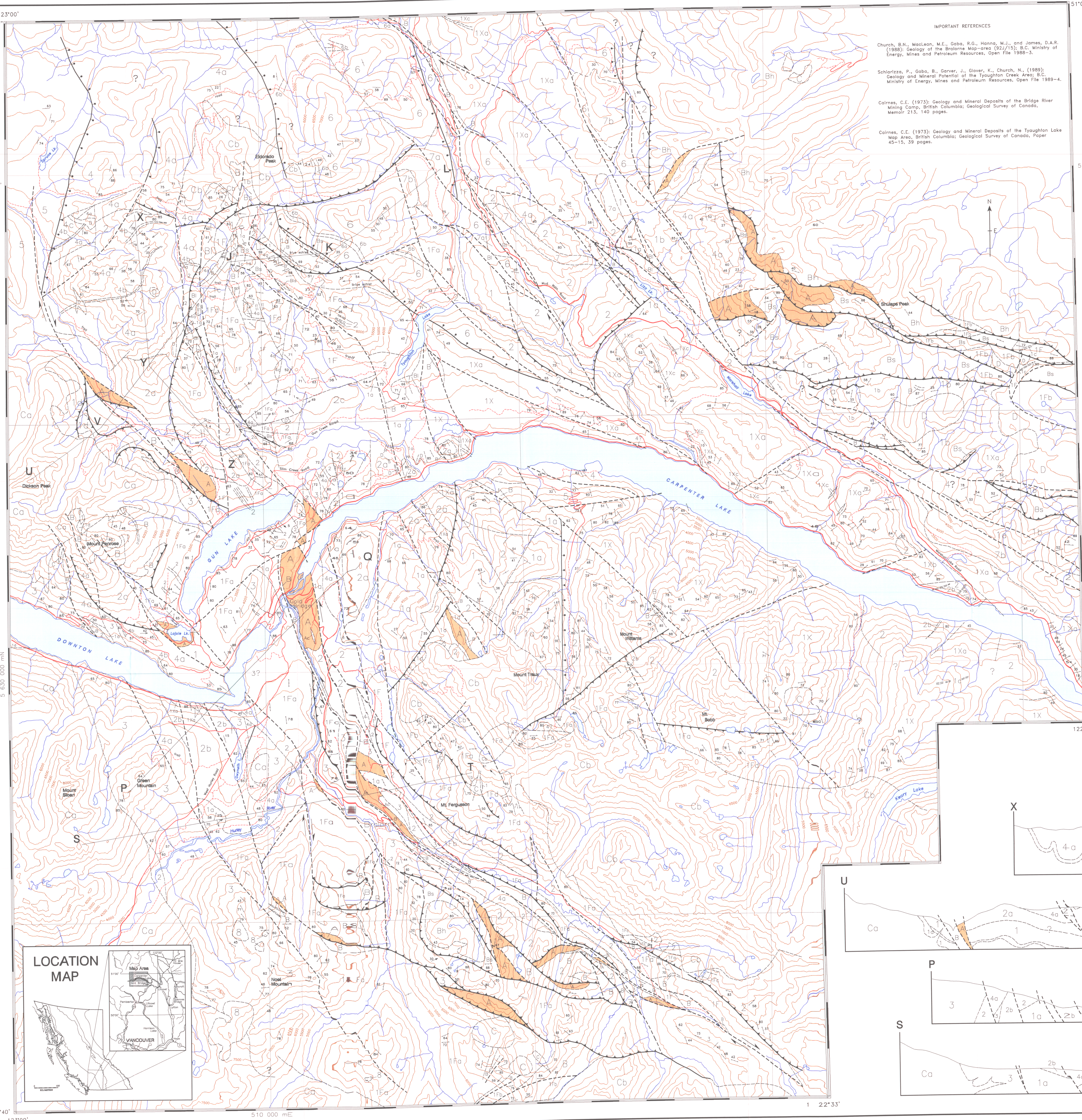
Stations BRC 625-654: Eldorado basin with numerous exposures of Hurley F. consisting mostly of northwesterly dipping (tops up to northwest) siliceous and calcareous argillites and siltstones interbedded with fossiliferous limestone, limestone conglomerate, polymictic conglomerate and less common volcaniclastic beds and pillow lavas. Stations 627, 629 fold axes strike 304°, plunging 38° west and 320° plunging 24° northwest. Stations 634, 648 fold axes strike 029°, plunging 32° northeast and 045°, plunging 34°.

Stations BRC 658-671: Wayside area showing Noel argillite, stations 658, 659 661, 671, in fault contact with Bralorne intrusion, stations 662-664, and highly deformed Bridge River chert, stations 666-670. At Station 662 soda granite (Lab No. 32567) intrudes Bralorne gabbro as seen in highway cut.

Stations BRC 672-688: Tyaughton Lake to Taylor Creek. Stations 672-674, westerly dipping polymictic Taylor Creek conglomerate with interbedded sandstone seams. Stations 678, 683-684, 689, Bridge River chert - black, grey and green facies. Stations 687-688, Tertiary lava and breccia (Lab No. 32568).

Stations BRC 690-725: Pearson Creek basin is underlain mainly but Bridge River chert-argillite with a few narrow limestone bands, stations 693, 697, 720, cut by zones of serpentinite and listwanite on major faults, stations 701, 704-706, 708, 717, 723-724.

Stations BRC 725-729: Downton Lake - Mount Penrose area. Stations 725-730, rusted Noel black argillite-siltstone. Station 730 massive greenstone dike.



IMPORTANT REFERENCES

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BRITISH COLUMBIA
Ministry of Employment and Investment
Energy and Minerals Division
Geological Survey Branch

Figure 1A

Geological Survey Branch
PAPER 1995-3

GEOLOGY OF THE BRIDGE RIVER MINING CAMP

NTS 92J/10, 15, 16; 92O/2

By B. N. Church

0 KILOMETRES 6

LEGEND

BEDDED ROCKS

MIOCENE

8 — Plateau basalt (Chilcotin group); rather flat lying lavas and breccias transitional in composition between quartz tholeiites and alkali olivine basalt

EOCENE?

7 — Intermediate to basic lava and breccia (7a), felsic volcanic breccia, dikes and sills (7b)

CRETACEOUS

6 — Interbedded polymictic conglomerate containing mostly chert and greenstone clasts (6a) intercalated with shale (6b) and mica bearing sandstone (including Taylor Creek group)

LOWER CRETACEOUS / UPPER JURASSIC

5 — Mainly grey shales, siltstone, minor conglomerate, and Buchia beds (mainly Relay Mountain group)

UPPER TRIASSIC

4 — Interbedded siltstones, calcarenite, and minor conglomerate (4a), limestone (4b), and volcaniclastics (4c)-(Hurley formation)

MIDDLE MESOZOIC TO UPPER PALEOZOIC

3 — Mainly black argillite with minor calcareous beds (Noel formation)

2 — Spilitic (MORB-type basalt) pillow lava (2a), aquagene breccia with lenses of limestone (2b), tuff and amygdaloidal lava-including Pioneer formation

1 — Mostly ribbon chert and phyllite (1a), schist and gneiss (1b), limestone and marble (1c), and hornfels (1d)-including Tyax (1X) and Fergusson (1F) assemblages

IGNEOUS INTRUSIONS

TERTIARY

D — Quartz-feldspar porphyry stocks, sills and dikes, including the Rexmount porphyry

LATE CRETACEOUS / EARLY TERTIARY

C — Mostly biotite-hornblende granodiorite, diorite and granite including various phases of the Coast (Ca) and Bendor (Cb) intrusions

JURASSIC ?

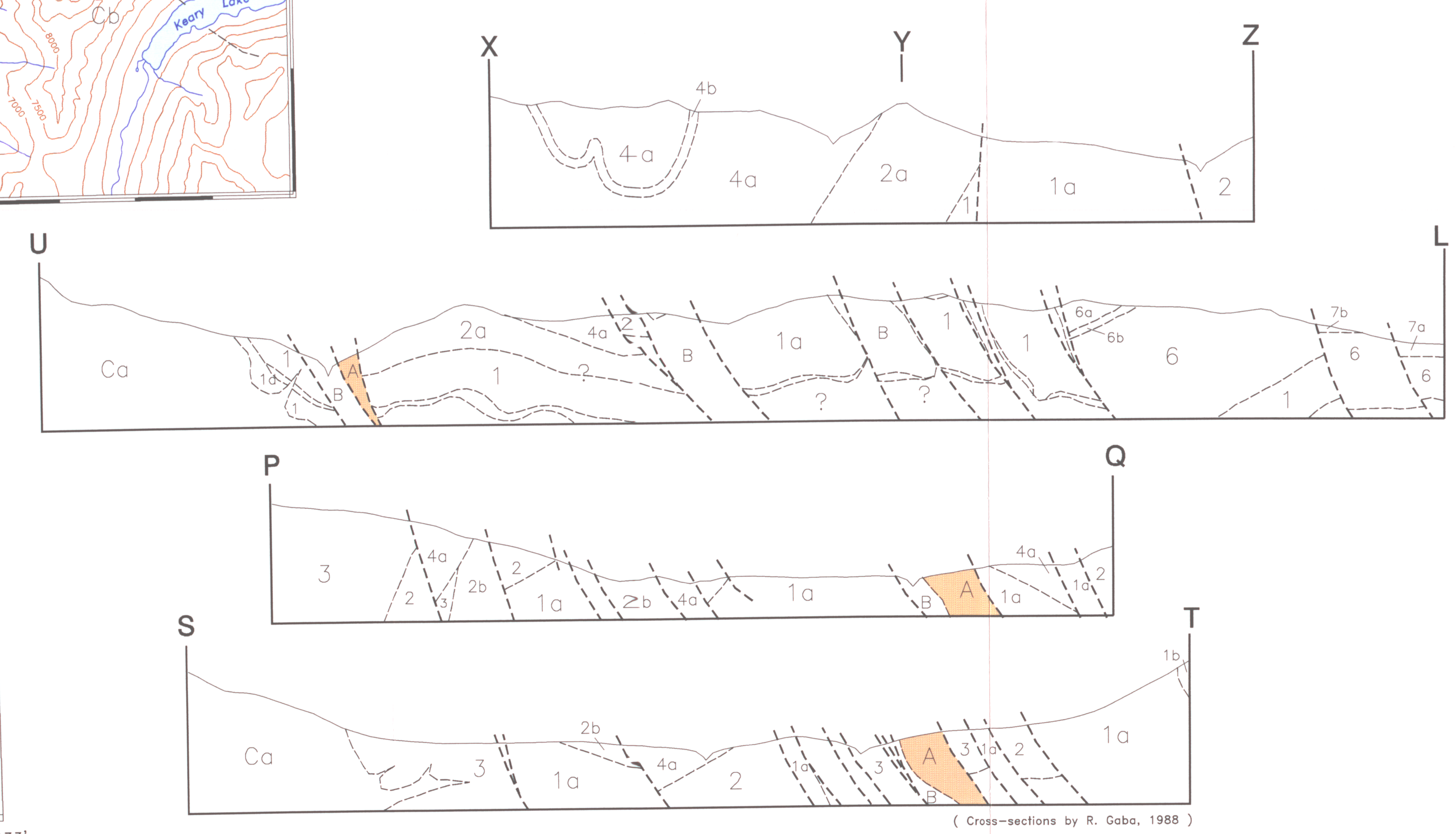
B — Ultrabasic rocks including harzburgite (Bh), serpentinite (Bs) and listwanite (Bl) -Shulaps and President intrusions

PERMIAN / CARBONIFEROUS

A — Gabbro, anorthositic gabbro and amphibolite including other Bralorne intrusions such as soda granite (Ac)

SYMBOLS

Geological boundary
Bedding - horizontal, inclined
Foliation, schistosity
Fold Axis (plunge)
Faults: normal
assumed
thrust
strike slip
Roads
Topographic contours



(Cross-sections by R. Gaba, 1988)


British Columbia
Ministry of Employment and Investment
Energy and Minerals Division
Geological Survey Branch
Figure 1B
Geological Survey Branch
PAPER 1995-3
DISTRIBUTION OF GEOLOGICAL STATIONS IN THE BRIDGE RIVER MINING CAMP
NTS 92J/10,15,16; 92O/2
By B. N. Church
0 KILOMETRES 6
SYMBOLS
Mineral occurrences
Geological station
Fossil location C-117575
Analytical Sample No. 039159
Moss mat sample 39
Main road
Secondary road
LOCATION MAP
Map Area
VANCOUVER
123°00'
51°03'30"
122°24'
51°00'
50°40'
122°33'
510 000 mE
5 630 000 mN
N
E
CARPENTER LAKE
DOWNTON LAKE
GUN LAKE
Tungsten King
Tungsten Queen
Silverquick
Big Sheep
Elizabeth-Yalakom
Robson
Eldorado Peak
Lucky Jem
Northern Light 6
Wide West
Lucky Strike
Lillomer
Shulaps Copper
Jim Creek
Shulaps Peak
Primrose
Peerless
Paul Zone
Dauntless
Golden
Minto Mine
Lou Zone
Congress
Howard
Leckie
Kelvin
Reliance
Senator
Wayside Mine
Dickson Peak
Little Gem
Pilot
Mount Penrose
Summit
Mary Mac
Veritas
Lajoie Lk.
GOLD BRIDGE
Haylmore
Golden Gate
Arizona
Forty Thieves
Gloria Kitty
Whynot
California
Ranger
Truax Gold
Mount Truax
Mount Williams
Gray Rock
Mount Bob
Benbow
Bristol
Silversides
Grull
Success
Cosmopolitan
Green Mountain
Mount Sloan
Alma
BRALORNE
Bralorne Mine
Short O'Bacon
Native Son
Blackbird
Ida May
Lost Gold
Coronation
Countless Holland
Pioneer Mine
Pioneer Extension
Mix
Mount Fergusson
Paymaster
Bramoose
Chalco
Dan Tucker
Red Hawk
Butte I.X.L.
Royal
Standard
Noel Mountain
Keary Lake

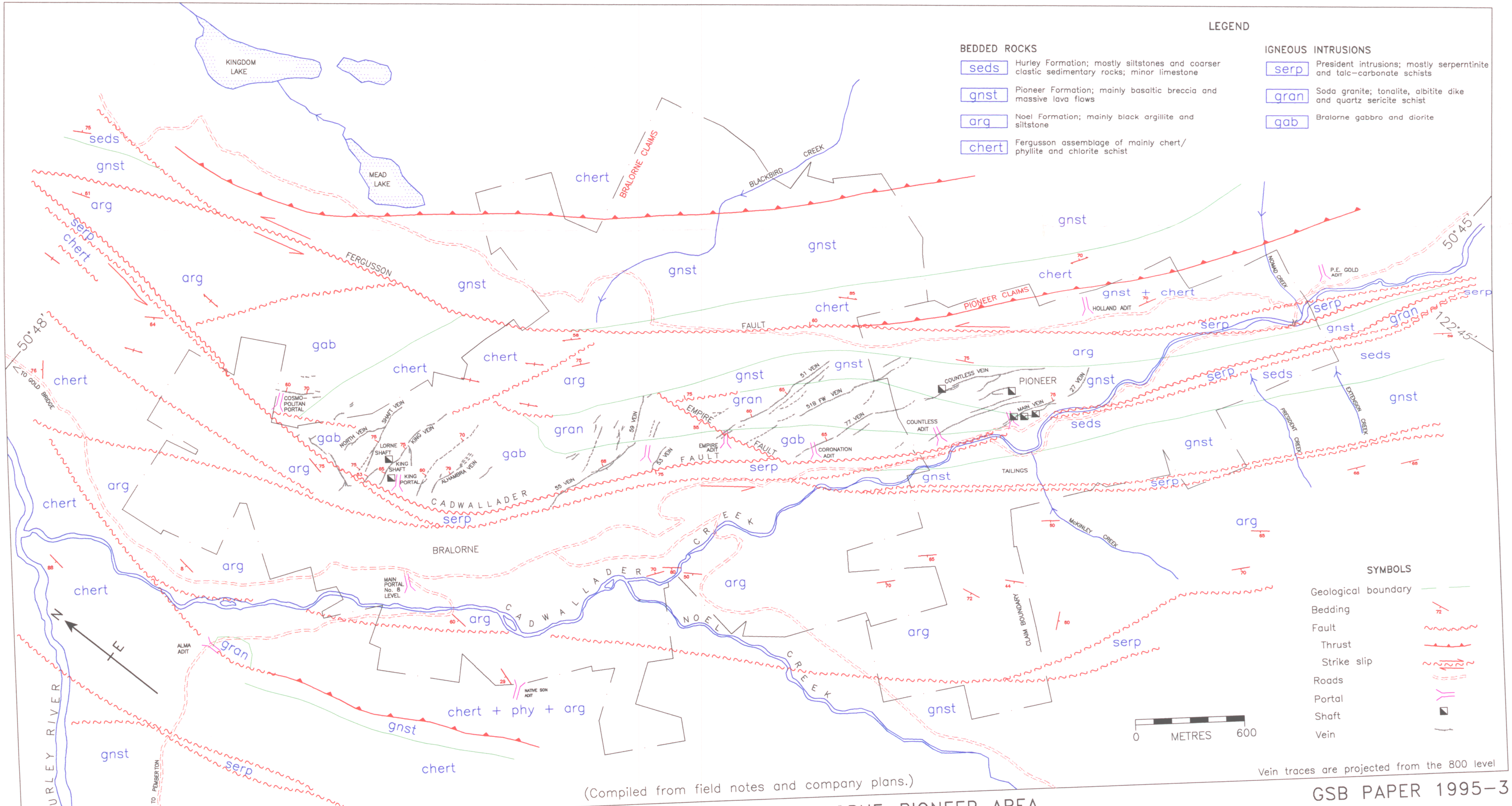


Figure 5.1 GEOLOGY OF THE BRALORNE–PIONEER AREA

GSB PAPER 1995–3