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Metallogeny of the Bridge River Mining Camp (092J10, 15 & 092O02)

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By: B.N. Church (P.Eng.) and L.D. Jones (P.Geo.), 1999

Abstract

The Bridge River mining camp, known principally for gold-quartz mineralization, is remarkably similar to the Mother Lode camp of California in terms of ore mineralogy, wallrock alteration, and geological setting. In both camps, ore veins occupy major fault zones in belts of elongated serpentinite bodies flanked by granitic plutons. The 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. It is underlain by Paleozoic, Mesozoic, and Tertiary volcanic and sedimentary beds and igneous intrusions. The Bralorne intrusions and Pioneer volcanic rocks are the most consistently mineralized rocks in the area. The intrusions form small gabbro and diorite stocks aligned along the Cadwallader fault zone and in the Shulaps complex. Zircon from a coarse-grained phase of the Bralorne diorite yielded a U-Pb date of 293± 13 Ma indicating that the intrusions are among the oldest in the area. These rocks have 45-55% SiO_2 (averaging 50.8%), similar to the Pioneer volcanic rocks, but have relatively high Mg and low Ti and iron oxides. The Bralorne and the Pioneer rocks are clearly discriminated on Ti versus felsic index (Qz+Or+Ab) plots. The Bralorne intrusions are further characterized by Ti/V values close to the 10 line and resemble ocean island arc magmas. The Pioneer volcanic rocks are predominantly tholeiitic and MORB-like basalts, possibly derived from a mantle diapir by progressive melting in the garnet and then in the spinel stability fields. Unlike basalts related to subduction zones, REE patterns of the tholeiites lack negative Nb and Ta anomalies.

The geology of the camp records repeated deformation. The oldest rocks are strongly fragmented and intricately folded; greenschist-grade metamorphism is common. Numerous slices and wedges of Cadwallader Group and Bridge River Group rocks outcrop throughout the area. Interleaving of Cadwallader and Bridge River units was during plate collision by imbricate thrusting and stacking of oceanic and ocean margin rocks with lenses of underlying gabbroic and ultramafic rocks. Faults and folds disrupt all these units. The youngest units are generally weakly metamorphosed and block faulted. The present configuration of the major units mainly reflects Cretaceous and Tertiary tectonics. The predominant structural style is manifested by panels of diverse rocks (including ramped blocks of older rocks) bounded by major northwest- and north-trending faults of the Cadwallader and Yalakom systems. An intricate system of fractures is thought to have controlled movement of ore-solutions. The source of the mineralizing solutions was originally considered to be the Bralorne intrusions, and differentiation of Bralorne gabbroic and dioritic magmas was thought to have produced the soda granite (plagiogranite) and the ore fluids. However, it is now known that the Bralorne intrusions are Paleozoic and therefore much older than the ore veins, and that the mineralizing solutions are probably of mixed connate and juvenile origin. The age of mineralization

at Bralorne is close to the age of the Gwyneth Lake stock, dated at 85.9 Ma west of Bralorne, which is consistent with the age of wall rock alteration hosting the gold quartz veins (85.1 Ma) and zircon ages from the Bendor pluton (69.5 to 98.4 Ma). It is speculated that the stresses caused by the intrusion of these granitic plutons resulted in shearing, development of fissure veins, and reactivation of the Cadwallader fault zone. Emplacement of the Coast Plutonic complex may have provided the structural controls and the thermal engine to drive the mineralizing solutions.

Introduction

The Bridge River mining camp, 180 kilometres north of Vancouver, extends across an area of 1500km^2 in the Bridge River drainage basin between the Coast Range Mountains west of the towns of Bralorne and Gold Bridge, and the Shulaps and Chilcotin Ranges north of Carpenter Lake (Figure 1 and Figure 2a, 2b). Elevations diminish from a maximum of 2880 metres at the summit of Mount Truax to the local base level of 650 metres on Carpenter Lake (Figure 3). The camp has 60 mineral localities, including the Bralorne-Pioneer mining complex, which is the foremost gold producer in British Columbia and sixth largest in Canada. The area is underlain by 14 mappable units consisting of bedded volcanic and sedimentary assemblages and a variety of intrusive igneous rocks. These units are faulted and invaded by veins that form the loci of gold, silver, tungsten, antimony, molybdenum, and mercury mineralization.

Gold in the Bridge River valley was first located by placer miners on Gun Creek in 1859, and along the lower section of Tyaughton Creek at about 1866. It was not until 1882 that placer gravels were discovered at the mouth of the Hurley River near the present town of Gold Bridge, and in 1886 on Cadwallader Creek. Total recovery from the Haylmore placer (MINFILE 092JNE026) at the mouth of the Hurley River is estimated to be more than 1000 ounces (31,000 grams) of coarse gold. It is reported that the most common nuggets were in the 28 to 142-gram range, the largest weighing 368 grams.

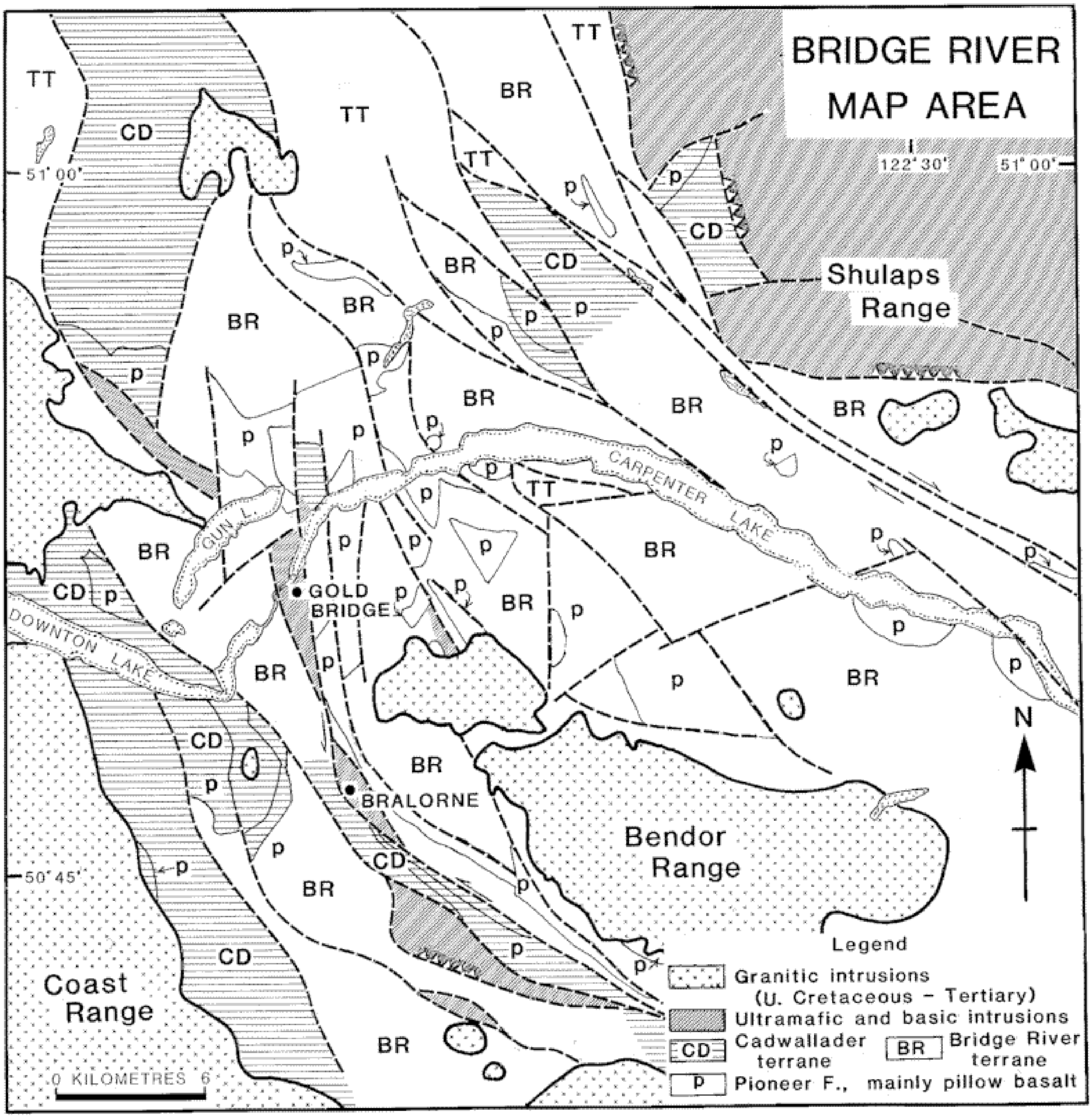
Most lode gold sources were located from 1896 to 1915, although discoveries and desultory development continued until construction of the Mission Dam in 1959 and rerouting of the main road to the north shore of the B.C. Hydro reservoir that now forms Carpenter Lake. The Pioneer mine began production in 1908, followed by the Bralorne mine in 1932, although minor production occurred from 1900. These operations were amalgamated in 1959 and soon attained primary status in gold production in British Columbia. Operations closed in 1971, with intermittent clean up until 1983. The combined total output of ore attained 7,295,900 tonnes. This yielded 17.7 grams per tonne gold and 4.1 grams per tonne silver. North and northeast of Gold Bridge on the main road north of Carpenter Lake, other past producers include the Wayside (at 3.2 km), Congress (at 6.0 km), and Minto (7.7 km). Most mining was in the period 1933 to 1940. The Wayside mine produced 39,109 tonnes yielding 4.2 grams per tonne gold and 0.67 gram per tonne silver; the Minto mine had an output of 80,650 tonnes of ore that yielded 6.8 grams per tonne gold and 19.5 grams per tonne silver; and the Congress mine produced 943 tonnes yielding 2.7 grams per tonne gold and 1.4 grams per tonne silver (Harrop and Sinclair, 1985).

This report outlines the geology of the region, gives synoptic descriptions of the main mineral deposits, and provides production and resource tables.

General geology

The rocks of the Bridge River mining camp comprise a variety of Paleozoic, Mesozoic and Tertiary sedimentary and volcanic rocks and igneous intrusions (Table 1). The oldest rocks are highly deformed and fragmented, and greenschist metamorphism is common throughout the area. Younger cover beds are locally folded and tilted by block faulting and exhibit significant metamorphism only near contacts with major intrusions.

Figure 1: Generalized geological map of the Bridge River mining camp.



The bedded rocks range in age from mid-upper Paleozoic to mid-Tertiary (Figure 4). The oldest rocks were assigned to the Fergusson group (Church, 1996). This unit is a Paleozoic ocean floor assemblage that forms part of a metamorphic terrane referred to as the Bridge River complex. The Triassic Cadwallader group is thought to be an arc assemblage accreted to the Bridge River complex. The Jurassic and Cretaceous Relay Mountain and Talyor Creek groups were deposited in a seaway known as the Tyaughton trough that was superimposed on the Bridge River-Cadwallader basement.

Outlying Tertiary beds (Eocene) are preserved as down faulted blocks mainly along the Marshall Lake fault. The youngest Tertiary rocks form small remnants of Miocene basalt (Chilcotin group) uplifted in the Coast Range.

Figure 2a, 2b: Panoramic view of Bridge River area showing geology.

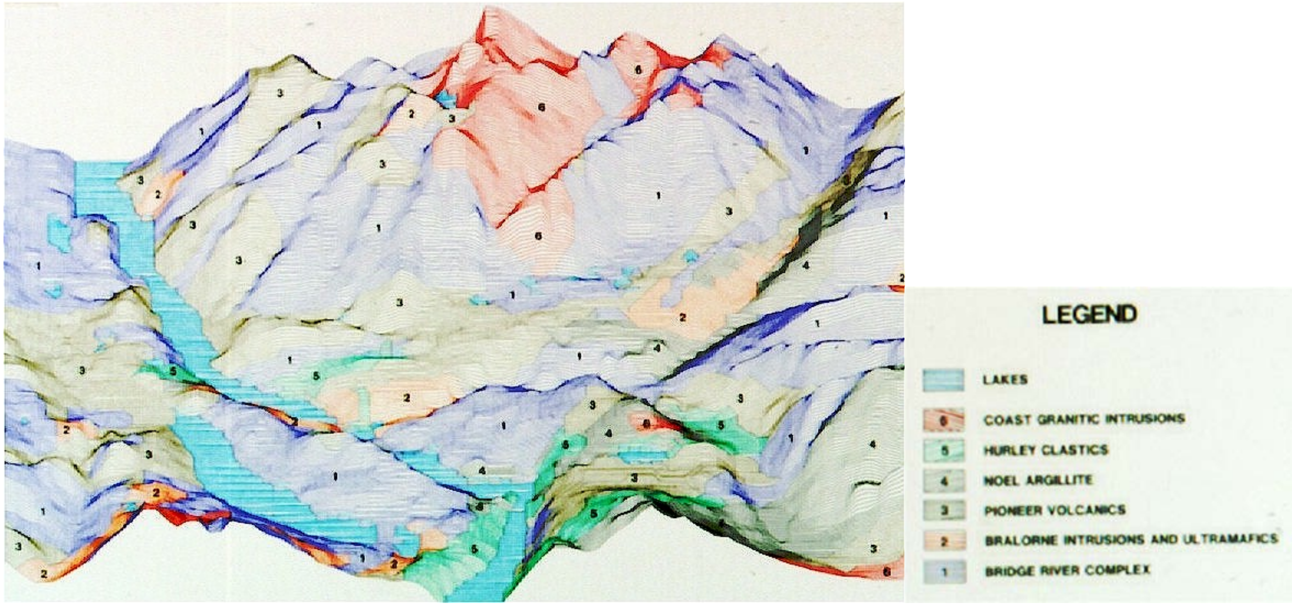
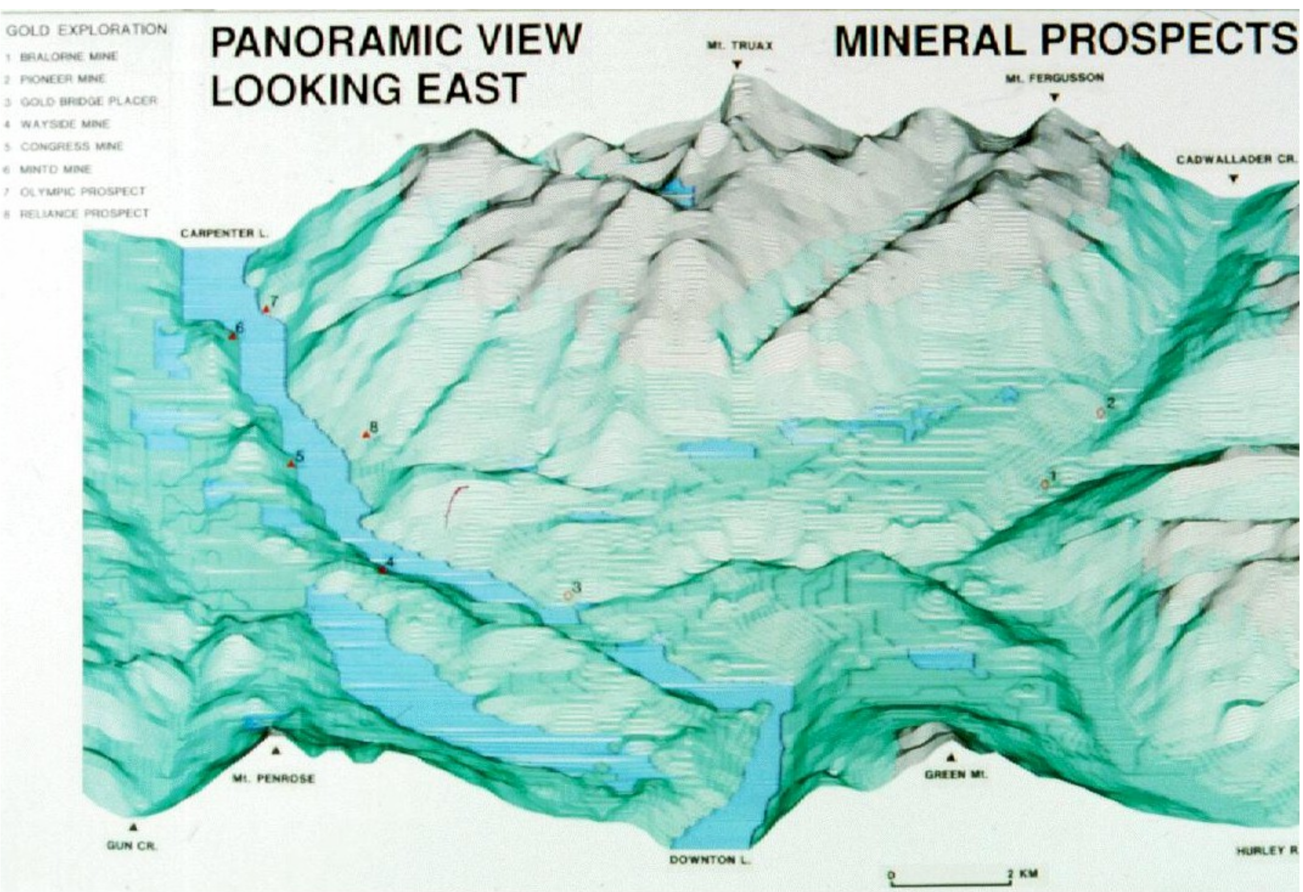


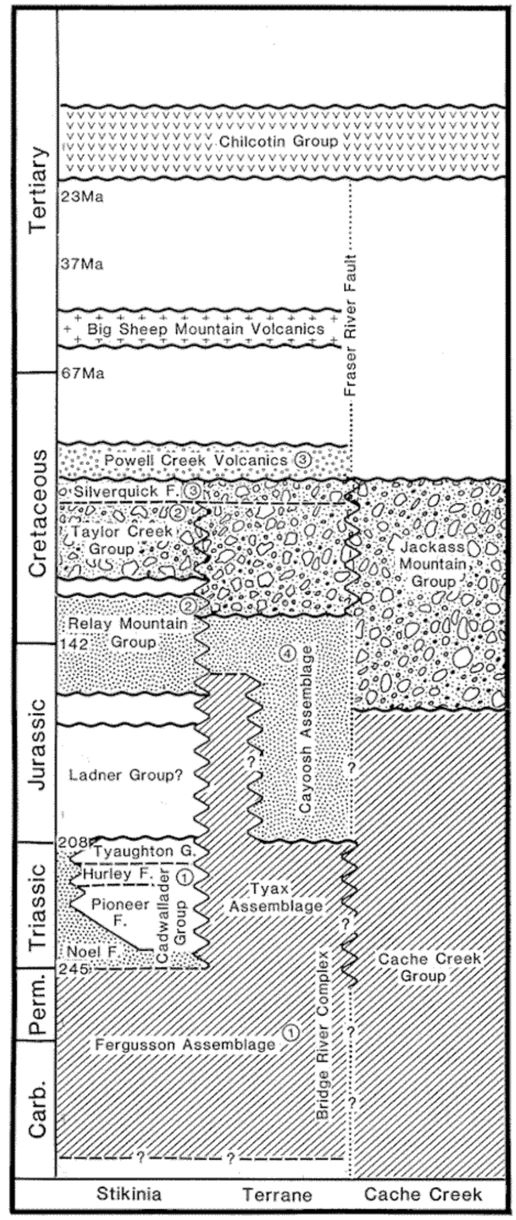
Figure 3: Panoramic view of Bridge River area showing location of mineral prospects.



The igneous intrusions cover about the same age span as the bedded rocks. The oldest is the Permo-Carboniferous Bralorne gabbro/diorite. These rocks occur on many of the major faults and are accompanied by ultramafic rocks and small granitic stocks. The principal ultramafic bodies are the Shulaps and President intrusions. These appear to be part of a disrupted ophiolite complex, possibly the same age as the Bralorne intrusions.

The Coast Plutonic complex comprises an assortment of mainly upper Cretaceous to lower Tertiary granite to diorite plutons and smaller satellite stocks scattered along the axis of the Coast Range and peripheral areas.

Figure 4: Hypothetical columnar section of Stikine terrane, Tyaughton trough and younger units, Gold Bridge area.



Bedded Rocks

The names Fergusson, Cadwallader, Relay Mountain and Taylor Creek and Chilcotin are retained in this report for the principal stratigraphic divisions although knowledge of some of the constituent units is incomplete. For example, the lithology of the Fergusson assemblage (Paleozoic) 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.

Bridge River Complex

The name '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). Much of 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 (1987) discovered relatively young Triassic and Jurassic fossils along Carpenter Lake, in areas mapped by McCann as Permian (Bridge River series).

The 'Bridge River terrane' is a relatively new tectonostratigraphic term (Monger and Berg, 1984). It is roughly equivalent to the Cache Creek and Hozameen terrane packages 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 by 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) is equivalent to Cache Creek rocks that typically contain Tethyan fauna and no major Permian-Triassic unconformity (Danner, 1992). The Upper Permian/Lower Triassic boundary has not been found and Tethyan fauna are not identified in the Bralorne area.

Fergusson Assemblage

'Fergusson assemblage' is an adaptation of the term 'Fergusson group' that was introduced by Cairnes (1943) for deformed strata thought to be Paleozoic. These rocks are mainly silicified ribbon cherts with intercalated argillite, greenstones, and thin recrystallized limestone bands. The limestone bands, 1 to 10 metres thick, are the only known stratigraphic markers in the succession. The assemblage attains a thickness of more than 1000 metres where best developed on Mount Fergusson, although the base is nowhere visible. These beds consist mostly of thin ribbons of light and medium grey metachert, one to four centimetres thick, interlayered with thin seams of dark grey graphitic pelite. The ribbons are cut by numerous small quartz veinlets normal to bedding. In thin section, the rock is a mosaic of recrystallized quartz grains (0.1 to 1.0 mm) with local subcircular pellet structures or shell remnants, and concentrations of micaeous minerals and opaques. X-ray diffraction analyses of cherty argillite from localities across the map area show a mixture of mostly quartz, albite, chlorite, and muscovite accompanied by accessory amphibole and opaque minerals such as magnetite, pyrite and pyrrhotite in some samples. Biotite, potassium feldspar, and carbonate minerals were found in a few samples.

The beds are locally intricately folded and, in some places, bedding is disrupted to form isolated or overlapping cherty lenses in schist. In some instances, these fragmented rocks resemble pebbly conglomerates. Near contacts with major granitic intrusions, the cherty rocks and pelites recrystallized to garnetiferous biotite-quartz gneiss and the volcanic rocks and feeder intrusions baked to amphibolitic hornfels.

The Fergusson rocks are lithologically similar to the Cache Creek and Hozameen assemblages (Cairnes, 1937). The unit is considered Paleozoic based on crosscutting by the Bralorne intrusions (Permian) and several conodont and radiolarian determinations (Church, 1996; Schiarizza et al., 1997).

Tyax Assemblage

The term Tyax assemblage is proposed for Triassic and Jurassic ocean floor volcanic and sedimentary rocks 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 a limestone member outcropping at the mouth of Tyaughton Creek on the north shore of Carpenter Lake. The limestone is part of a five kilometre-long alignment of limestone lenses traced northwesterly to Liza Creek. Conodonts from this locality indicate a late Middle to early Upper Triassic age. The Tyax assemblage extends along Carpenter Lake from the Minto mine to the Marshall Creek fault. Nine fossil sites, reported by Cordey (1986), underlain by chert contain a rich collection of radiolarians ranging from middle Triassic to early Jurassic. To the west and north of this belt, the Tyax and older rocks appear to be imbricated in a series of thrust faults that also involve Cadwallader group, the Fergusson beds, and Bralorne plutonic rocks.

Cadwallder Group

The name Cadwallader group used by Roddick and Hutchison (1973) is an adaptation of the

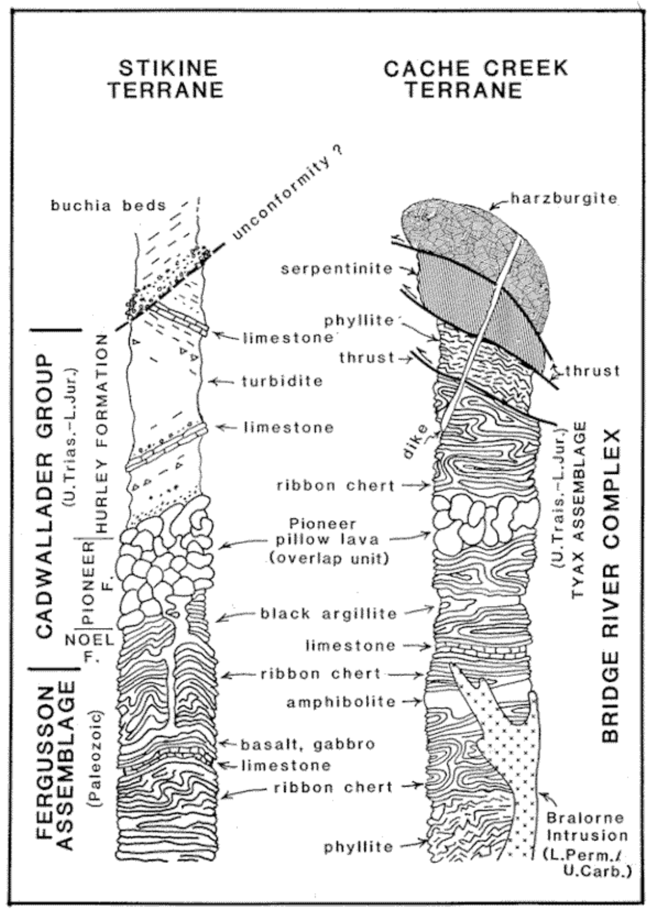
Cadwallader 'series' (Upper Triassic) of McCann (1922). The group comprises the Pioneer, Noel and Hurley formations. This is a sequence of volcanic and sedimentary rocks, several hundred metres to a few thousand metres thick, on the east flank of the Coast Plutonic complex. These rocks are exposed along 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 Mt. Waddington area, 150 kilometres to the northwest (Tipper, 1969). Together these outliers form what is considered 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 5). Sampling limestones for conodonts has generally confirmed the Upper Triassic age previous assigned to the Cadwallader group. These data coincide with the age of units of the Bridge River complex determined by Cameron and Monger (1971) and Cordey (1986).

The Cadwallader rocks comprise (in part) island arc deposition (Rusmore, 1987) and the Bridge River rocks appear to represent a more distal ocean basin environment; common elements in these adjacent packages being the Pioneer and Noel formations (Cairnes, 1937, p.17).

Figure 5: Lithology of adjacent sections of Stikine and Cache Creek terranes.



Pioneer Volcanic Rocks

The Pioneer volcanic rocks are in the lower part of the Cadwallader group and consist primarily of basaltic volcanic rocks and feeder intrusions. The unit is well developed at the California and Pioneer mines on the Hurley River and Cadwallader Creek. The only sedimentary 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 report the name Pioneer formation is used to include significant thicknesses of upper Triassic and older basalt. The upper contact of the Pioneer formation is gradational with the upper Triassic Hurley formation. The relationships are less clear at the base of the formation. In places, pillow lavas seem to rest on Noel argillite, but elsewhere similar rocks are intercalated with Fergusson or Tyax chert beds.

The Pioneer unit contains abundant pillow lavas, volcanic breccias, and massive flows. 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 lavas sequences are especially well displayed in the Eldorado basin and on the Congress, Reliance, and Olympic properties towards 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 one metre in diameter. The pillows are commonly somewhat flattened and elongated subparallel in the plane of bedding. Downward pointing cusps at the base of the pillows point away from bedding tops, although single observations of these structures are not always reliable for top determination. The spaces between the pillows may contain hyaloclastite breccia, chlorite from pillow selvages, and carbonate minerals. Joints, cracks, and amygdales are commonly filled with calcite.

Table 1: Table of Formations in the Bridge River Mining Camp.

Age	Units / Lithology / Structural History	
	- block faulting -	
Neogene	Chilcotin Group	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 -	
Upper Cretaceous	Coast Plutonic Complex (60-110 Ma)	biotite hornblende granodiorite plutons, minor diorite and granite.
	- Tyaughton trough -	
Middle Cretaceous	Taylor Creek Group	cyclic polymictic conglomerate beds with minor sandstone and shales.
Lower Cretaceous/ Upper Jurassic	Relay Mountain Group	*Buchia* beds of varying lithologies, mostly grey shales with minor conglomerate, ~650 m.
	- terrane docking (imbrication) -	
Lower Jurassic/ Upper Triassic	Stikine Terrane/Cadwallader Group Hurley sandstones, mudstones, limestones ~700m; Pioneer spilitic basalts ~300 m	Cache Creek Terrane/ Bridge River Complex/ Ophiolitic rocks ultramafics, ribbon chert, schists, minor limestones, greenstones with chlorite, prehnite, epidote and epidote Fergusson Group + 1000 m.
Permo-Carboniferous	Bralome intrusions (260-293 Ma) px-hb diorite, gabbro and anorthositic gabbro; soda granite	

Volcanic breccia occurs throughout the sequence as thick accumulations, as thin layers between lava flows and as intercalations in sedimentary sequences. In the Eldorado basin, the Pioneer pillow lava and volcanic fragmental deposits grade into the overlying Hurley sedimentary rocks. In the areas west of Gwyneth Lake and northeast of Bralorne, hyaloclastite breccias are locally well developed. 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.

Massive lava flows are also found throughout the area. Except for differences in grain size and abundance of amygdales, lava flows are not always readily distinguished from sills and feeder dikes. In drill core and underground workings, individual lava flows range from less than one metre to a few tens of metres thick. The thick flows, dikes, and sills appear to be the least affected by deformation, and primary structures are generally well preserved. The Pioneer rocks have undergone greenschist and sub-greenschist grade regional metamorphism. This has changed the mineralogy of the rocks, 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 millimetres long with interstitial chlorite and abundant magnetite dust. In some flows, amphibole is also present and may contain pyroxene cores. Amygdales are filled with quartz, calcite, and epidote. Calcic feldspar has been largely transformed to albite and chlorite generally replaces the primary ferromagnesian minerals. Individual magnetite grains may have survived the effects of regional metamorphism. However, much of the iron is contained in very fine-grained opaque dust associated with the decomposition of the original mineral and vitreous components. X-ray diffraction analyses of basaltic rocks from across the map area show that common minerals are albite, quartz, chlorite, calcite, and magnetite (from most to least abundant); pyroxene, amphibole, epidote, biotite and pyrite are significant constituents in some of the rocks.

A relic of low temperature-high pressure mineralogy (blueschist) is exposed on North Cinnabar ridge. This rock is a highly sheared basalt and contains abundant glaucophane and lawsonite. Metamorphic recrystallization caused by emplacement of the Coast Range batholith may account for the relative infrequent occurrence of this mineralogy and also the prehnite-pumpellyite facies such as found along the lower course of the Bridge River east of the Bridge River mining camp (Potter, 1983).

The ternary system MnO-TiO_2-P_2O_5 purportedly discriminates between several major petrotectonic environments. In this system, the Pioneer basalts show relatively constant TiO_2 but some dispersion between ocean island basalt (OIB) and mid ocean ridge basalt (MORB) fields (Dostal and Church, 1992). A few analyses can be classified as island arc tholeiites (IAT) but none fall into the island arc calc-alkaline field (CAB).

Noel Formation

The Noel formation is a sequence of mostly thinly bedded, fine-grained sedimentary rocks 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 McGillvary pass. A second belt begins on the north shore of Downton Lake and trends southeasterly to Mt. Noel along the east flank of the Coast Plutonic complex (Cairnes, 1937 and 1943). In the type locality, near the confluence of Cadwallader Creek and Noel Creek, the unit is more than 350 metres thick and consists of grey siltstone and finely laminated black argillite accompanied by 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 matrix. Metamorphism, manifested by the development of biotite, garnet, and andalusite, is evident near the contact with the Coast Plutonic complex in the Mount Sloan - Green Mountain area. 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 upper and lower contact relations of the unit are uncertain. Stevenson (1958) reported a transition from mainly cherty Fergusson assemblage 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, and chert pebbles in conglomeratic facies of the Noel formation on the ridge south of the Standard mine were probably derived from the adjacent Fergusson terrane. However, on the Slim Creek logging road northeast of the Wayside mine, black argillites resembling typical Noel formation overlie Pioneer volcanic rocks and are overlain in turn by Hurley sandstones and conglomerates. These varying relationships suggests that the age of the Noel range from Paleozoic to Mesozoic. No diagnostic fossils have been found in the Noel.

Hurley Formation

The Hurley formation is best developed 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. Other major areas of exposure are along Cadwallader Creek, on Downton Lake, and in the Lisa Lake area. Similar rocks have been reported in the Pemberton and Tenquille Lake area 30 to 80 kilometres south of the Bridge River mining camp (Riddell, 1991) and in the Hanceville area to the north (Rusmore and Woodsworth, 1991).

The total thickness of the Hurley formation, where best developed in the Eldorado basin, is estimated to be at least 700 metres. The unit consists mainly of relatively soft, green, brown and black argillites and harder siliceous argillites. These are intercalated with gritty siltstones, sandstones, conglomerates, and fossiliferous limestone lenses. Large thicknesses of alternating sandstone, siltstone, and mudstone bands commonly display graded bedding and load and flame structures typical of turbidites. The unit contains little chert is notably more limey than the Noel formation. Volcanic breccia and tuff occur throughout and are particularly abundant in the lower part of the sequence where the unit appears to be locally gradational with the Pioneer formation. Pillow lavas, up to several metres thick, intercalated with volcanic breccias and sedimentary rocks, are exposed locally on the ridges in the north and south parts of the Eldorado basin.

In thin section, the 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 basaltic or andesitic microporphyritic rocks and glassy fragments replaced by chlorite and iron oxide dust. The quartz form discreet angular fragments of clear slightly undular quartz and quartz porphyry fragments, generally less than 10%, composite quartz grains, and fine-grained recrystallized chert and schist. The feldspar appears as solitary, angular twinned and untwinned plagioclase grains, and as 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 rocks, and cherty rocks of mixed local and distal sources. Conglomerates containg almost entirely limestone boulders and pebbles are less common but are widely distributed and are especially well developed lateral to massive limestone lenses in the Eldorado basin. Light coloured clasts of felsic rock with feldspar and/or quartz phenocrysts is a common accessory and predominates 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 area of Eldorado Creek.

Cairnes (1943) considered that the Hurley formation is Triassic, which is confirmed by conodont fossils that give upper Triassic (late Carnian-early Norian) ages.

The Relay Mountain Group

The Relay Mountain group, originally described by Jeletzky and Tipper (1968), is mostly a uniform sequence of late Jurassic to early Cretaceous Buchia-bearing shales, siltstones, and greywackes. These rocks are up to 650 metres thick and occur along the southeasterly trending axis of the Tyaughton Trough.

The main exposures in the camp are west of Spruce Lake south of the type section, and near Truax Creek. At Spruce Lake, the outcrops are steeply dipping Buchia- and ammonite-bearing beds overlain by massive sandstones. In the Truax area, Buchia beds are associated with conglomerate in a downfaulted block (Church and MacLean, 1987).

At the Truax locality, the unit consists of several hundreds of metres of grey shales and siltstones underlain by polymictic conglomerate containing granitic clasts of unknown provenance. If derived from early uplift of the Coast Mountains to the west, the southwest margin of the Tyaughton basin would have formed earlier than mid-Cretaceous, the time proposed by Kleinspehn (1984).

The 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 considered to be partly the marine equivalent of the Cretaceous Jackass Mountain group (Albian) east of the Yalakom fault. The Taylor Creek group is a sequence, with few erosional unconformities, that forms a broad sedimentary wedge containing debris derived from Bridge River chert, greenstone and blueschist to the southwest. The headwall fault of the basin, exposed on North Cinnabar ridge, marks the southern limit of the unit. These rocks extend easterly and northeasterly from Eldorado Mountain to Tyaughton Creek. The beds are mainly westerly dipping pebble and boulder conglomerates with minor intercalations of siltstone and shale. Well-preserved marine fossils are rare but wood fragments are found throughout. Paleocurrent indicators such as crossbedding are rare. Turbidite-like sandstone-conglomerate units show both normal and inverse grading.

In the type area, between Tyaughton Creek and Taylor basin, the group is about 3000 metres thick and consists mostly of clast-supported conglomerate. The base and middle of the unit comprises beds of polymictic pebble and boulder conglomerate 10 to 15 metres thick, separated by siltstone seams one to two metres thick. Above this are sandstones with silty and conglomeratic interlayers, 600 metres thick, and a dark grey shale marker zone.

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 fraction appears to have been derived from unroofed ultramafic rocks, possibly the nearby Shulaps complex. Yellow limonitic clasts, conspicuous in some of the upper pebble conglomerate units, may have had a volcanic or basic intrusive source. The source of white mica and chloritized biotite seen in thin sections of some interlayered sandstone beds is thought to be felsic plutonic rocks, although clasts of these rocks are not seen.

The Silverquick conglomerate is a coarsely bedded phase, more than 1000 metres thick, split off from the Taylor Creek group by Garver et al. (1989). These rocks are poorly constrained in age and appear to rest directly on the Bridge River complex in some places and on the Taylor Creek group elsewhere. The clasts are mostly Bridge River chert.

The Big Sheep Mountain Volcanics

The term ‘Big Sheep Mountain volcanic rocks’ 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 downfaulted northerly trending panel on Big Sheep Mountain, 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 flows, pyroclastic rocks, and sedimentary rocks. Felsic feeder dikes and sills cut Taylor Creek conglomerates and Shulaps ultramafic rocks at the base of the unit. A similar thickness of rhyolite and dacite tuff breccia form a series of light coloured hoodoo bluffs along the Marshall Creek fault. According to McCann (1922) these volcanic rocks are the extrusive equivalent of the adjacent Rexmount porphyry (Eocene). The beds dip 40 to 45° northeast against the fault and are underlain by conglomerates and sandstones and shales with thin lignite seams.

Chilcotin Group

Small remnants of plateau basalts occur at high elevations on the north and south spurs of Noel Mountain. These are horizontally layered basalts 100 to 150 metres thick (dated 18.7 Ma) similar to the tiered and locally columnar flows that form the summit of Cardtable Mountain and on Castle Peak in the Noaxe area to the north. These basalts are distal outliers of the Chilcotin Group (Mathews, 1990). Equivalent units near the Fraser River and Interior Plateau regions to the east occur at considerably lower elevations.

The basalts are medium to dark grey and commonly fine grained and brittle, displaying conchoidal fractures. Porphyritic varieties include distinctive flows crowded with feldspar, and some with sparse scattered olivine phenocrysts. In thin section, the rocks mostly consist of randomly arranged plagioclase laths, 1 to 10 millimetres long, mixed with olivine euhedra that are commonly replaced by iddingsite, in a groundmass enriched in pyroxene grains and magnetite dust. Chemical analyses indicate a range of 52 to 53% silica, normative feldspar from 65 to 73% and pyroxene in the range 20 to 27%.

Igneous Intrusions

The main igneous intrusions are the Bralorne intrusions (Paleozoic), the Shulaps and President ultramafic rocks and a variety of granitic intrusions including the Coast Plutonic complex (Mesozoic). In addition, small felsic to basic Mesozoic and Tertiary stocks, sills, and dikes are scattered across the map area.

The Bralorne Intrusions

The 'Bralorne intrusives' were mapped by Cairnes (1937) as relatively small Jurassic(?) stocks occurring mostly along the Cadwallader break in the Bralorne- Pioneer belt. The range of rock types stocks includes gabbro, augite diorite, hornblende diorite, amphibolite, soda granite, and aplite. Although the relationships of these rocks are not fully understood, crosscutting relationships indicate that the granite and aplite are younger than the gabbro and diorite.

In this report 'Bralorne intrusions' refers to the diorite and gabbro bodies at Bralorne and outlying areas, including Lajoie Lake, Sumner Creek, Steep Creek, and in the Shulaps Range. These are the pyroxene and hornblende diorites of Bateman (1914), McCann (1922), and Cockfield and Walker (1932) that are the prime host rocks for mineralization in the region. The elongatation and linear arrangement of these bodies suggests emplacement along major fracture systems. The age of these rocks is now known to be Permo-carboniferous from radiometric analyses. 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 (Church, 1996). This is close to 287 ± 20Ma, the K/Ar result obtained by Armstrong (1981, unpublished U.B.C. analysis) 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. Fractures are coated with glossy dark green chlorite superficially resembling serpentine. In contrast, gabbroic feeders to younger basaltic volcanic rocks in the area are generally fresh, homogeneous, and distinguished by a light rust weathering. X-ray diffraction analyses of the rocks from various parts of the map area show that the most common minerals are plagioclase, amphibole, augite, and chlorite (from most to least abundant); prehnite, clinozoisite, pumpellyite are also important constituents in some samples (more than 10%).

In thin section, samples consist of subhedral to euhedral clusters of calcic plagioclase (55 to 80%) and lesser amounts of ferromagnesian minerals, mostly green hornblende and/or diopsidic augite, olivine (altered), and magnetite. In the severely altered rocks, plagioclase is commonly replaced by a fine mixture of sodic feldspar, white mica, clay, and carbonate minerals. The ferromagnesian minerals are replaced by chlorite, talc, iron oxide dust, and carbonates minerals.

Locally these rocks grade into medium- and coarse-grained 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 are locally the result of strain-induced grain size reduction of igneous textures, such as seen near the Cadwallader fault at the Pioneer mine (Stanley, 1960).

The Bralorne intrusions show a range of chemical compositions, with an average of 50.8% SiO_2, similar to the Pioneer volcanic rocks (Church, 1996). AFM values (averaging 15-30-55) indicate comparatively high magnesium and low iron content. The low iron is also reflected in the low magnetic susceptibility of these rocks. Relatively high LOI values (1.84 to 11.48%) reflect significant amphibole and hydrous alteration and low-grade metamorphic minerals. The intrusions display a strong anorthositic to mafic cumulate trend and the chromium and magnesium/iron ratio of clinopyroxene suggests an ocean gabbro magmatic affinity. The Bralorne gabbros and the Pioneer basalts are readily discriminated on a Ti versus felsic index (Qz+Or+Ab) plot; the major variable in the index being sodic feldspar (Ab), a feature not shown by the Pioneer volcanic rocks.

The Ultrabasic Rocks

There is an unusual abundance of ultrabasic rocks in the Bridge River mining camp. These rocks consist of small serpentine and talc-carbonate lenses and larger bodies of dunite, pyroxenite, and peridotite in steeply dipping fault zones and imbricated thrust sheets. The largest bodies are in the Shulaps ultramafic complex (180 km^2) underlying the Shulaps Range in the northeast part of the camp and the President intrusion (10 km^2) on Sunshine Mountain south of the Pioneer mine.

Cairnes (1937), Leech (1953), and Stevenson (1958) described the ultramafic rocks as intrusions. However, contact relations are generally obscured by shearing and most bodies are disrupted by major faults. Emplacement of the ultramafic bodies as wholly liquid igneous magmas is precluded by most authors because of the very high temperatures that would be required and the lack of evidence such as broad contact metamorphic halos. However, the main bodies show rhythmical layering of peridotite and dunite suggesting crystal accumulation on the bottom of a magma chamber. Wright (1974) ascribed this to tectonic forces "resulting from plastic deformation and recrystallization accompanied by metamorphic differentiation producing alternate olivine and orthopyroxene-rich layers". This, however, is not a completely satisfactory explanation for the chromite bands reported by Leech (1953), consequently a melt or crystal mush origin is suspected. Emplacement of melts, at least in part, is also suggested by apophyses and dike-like forms observed in some phases of the ultrabasic rocks (Stevenson, 1958).

The ultramafic bodies have been variously classified as 'alpine type' by Leech (1953) and 'ophiolitic' by Nagel (1979), Wright et al. (1982), and Calon et al. (1990). Amstutz (1980) argued that the ultramafic rocks go together with the Bridge River ribbon cherts and spilites comprise the principal components of ophiolitic complexes. This assumes that the Bridge River host rocks are the same age as the ultramafic rocks.

The timing of emplacement of the ultramafic bodies either by intrusion or faulting is gauged by the presence of chromite in the sedimentary record, assuming that the ultramafic rocks are the only readily available source of chromite. The occurrence of chromite in late Lower Jurassic beds was noted by Leech (1953), in Upper Jurassic beds by Roddick and Hutchison (1973) and middle Cretaceous beds (this study). This suggests that ultramafic rocks were exposed at the surface as early as the Jurassic and erosion continued episodically since that time. Leitch (1989) indicated that the original ultramafic rocks may be pre-Permian.

From widely scattered areas in the camp, the main mineral components of the ultramafic rocks are forsterite (1.3 to 85.0%), enstatite (5.9 to 51.9%), and wollastonite (0.9 to 31.0%). These minerals form a rock types including dunite (predominantly olivine), harzburgite (mixed olivine and orthopyroxene), and websterite (mixed olivine and clinopyroxene). Silica (SiO_2) is lowest in dunite (38.27%) and highest in pyroxene rich rocks (52.88%).

Harzburgite, the most common rock of the major ultramafic bodies (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 or arranged in layers in a fine-grained recessively weathered matrix. In thin section the ratio of pyroxene to olivine is generally less than one to four. Pyroxene (mostly enstatite) forms clusters or individual subhedral crystals, 0.4 to 3 millimetres across, surrounded by olivine. Diopsidic augite is a minor constituent (less than 10%), occurring interstitially and as exsolution lamellae in enstatite. In most samples enstatite and diopsidic augite are less serpentinized than olivine. Chromite is present mostly as dark brown translucent grains with black fringes forming small inclusions in olivine and pyroxene.

Dunite is interlayered with harzburgite and forms irregular massive bodies with smooth, tan-weathered surfaces and dark fresh surfaces. In thin section, the rock uniformly fine to medium grained. Commonly the olivine is cut by numerous fractures filled by veinlets of serpentine. Chromite is the principal accessory mineral and forms embayed dark-fringed individual grains and clusters surrounded by serpophite and chlorite(?).

The largest concentration of chromite is on the steep hill side (elevation 1675 metres) between Marshall Lake and Brett Creek on the southwest flank of the Shulaps Range (MINFILE 092JNE099). This chromite-rich zone is several metres long and consists of a few narrow pods of chromitite in sheared serpentine. According to Leech (1953) purified chromite from this location yielded 57.43% Cr_2O_3, 7.44% Al_2O_3, 5.08% Fe_2O_3 and 12.09% FeO. Analyses of a nearby sample yielded 41% Cr_20_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 tectonite that includes a mixture of serpentine and exotic blocks of chert, greenstone volcanic rocks and gabbro with some garnetiferous (roddingite) alteration (Nagel, 1979). On the east side of the Shulaps body, and at many other localities in the camp, serpentinite coincides with steeply dipping faults (Stevenson, 1958).

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

In thin section, sheared serpentine is cut 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 replaces olivine and original silicates. The veinlets are carbonate (some fibrous serpentine) with centre lines marked by small opaque granules of iron oxide. Patches of antigorite replacing orthopyroxene are typically charged with tiny aligned and subparallel rods of iron oxide replicating the shiller 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 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, 1961). The jade is a dark green nephritic variety composed mainly of a semi-translucent microscopic intergrowth of tremolite with chlorite, magnetite, and\or chromite impurites. Several tonnes of jade were quarried and sold in 1969 from the Noel Creek prospect.

Talc occurs as an alteration phase within the serpentine (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 (Cadwallader Creek, MINFILE 092JNE113) and along the margin of the President ultramafic body (Crazy Creek, MINFILE 092JNE137). Generally, talc concentrations are associated with the iron and magnesium carbonate minerals that are a byproduct of serpentinization. In the Pioneer Extension mine, a shaft penetrates 30 metres of talc-bearing rocks rocks containing exotic blocks of chert and argillite and intruded by albite dikes. Analyses of the talc concentrate from this location indicates ~12 per cent impurity, mainly alumina and iron oxide (MacLean, 1988). On the south contact of the President intrusion, talc-carbonate-chlorite schist is developed between the serpentinite and the surrounding country rocks. Within this zone talc increases locally across a few metres or a few tens of metres.

The association of listwanites (talc-carbonate rocks) and serpentine in belts of ultramafic rocks is a feature of the Bridge River camp, similar to the Mother Lode area of California. By reaction, serpentine + carbon dioxide yields talc + magnesite + water. The listwanites are light orange-buff coloured with patches of bright green fuchsite/mariposite development in the outer zone of ultrabasic metasomatism. The main zones of listwanite development are in the Eldorado and Taylor Creek basins, Steep Creek, Tyaughton Creek, and Liza Lake areas. These bodies are locally cut by reticulate veinlets of chalcedonic quartz. In the Tyaughton Creek area at the Tungsten King and Tungsten Queen prospects (MINFILE 092O 020; 092O 018) scheelite is reportedly associated with quartz veins in listwanite, although only 33 tonnes of this ore were developed. In the Liza Lake area, magnesite prospects in listwanites are along the margins of the Marshall Lake fault zone. The largest prospect, 250 by 60 metres (Liza Lake A, MINFILE 092JNE102), is 1 kilometre east of Liza Lake; another, 16 by 15 metres (Liza Lake B, MINFILE 092JNE127), is northwest of the lake. The composition of these deposits reportedly ranges from 28.14 to 43.42 per cent MgO (Grant, 1987). Analyses of listwanites from the Tyaughton Lake, Steep Creek, and Taylor basin areas report a similar range of MgO from samples containing 70 to 95 per cent magnesite.

Granitic Intrusions

Granitic intrusions underlie about 15% of the map area and range from late Paleozoic to mid-Tertiary. Plutonism occurred episodically within this period coinciding with major tectonic events and mineralization.

Granitic plutonism began in the early Permian. At this time the soda granite bodies of the Bralorne-Pioneer belt were intruded. Granitic magmatism in the Triassic, mainly preserved as quartz-feldspar porphyry clasts in the Hurley conglomerate, appears to be related to island arc evolution. Granitic clasts in Buchia beds of the Relay Mouton group (Church and MacLean, 1987), are the first evidence in this area of the unroofing of the Coast Plutonic complex and development of the western rim of the Tyaughton trough (late Jurassic-early Cretaceous). The full emplacement of the Coast Plutonic complex occurred in the late Cretaceous and appears to coincide with the major period of mineralization in the area (Leitch, 1990; Woodsworth et al., 1977). Final granitic plutonism, manifested here by the Rexmount porphyry (Eocene) appears to mark the beginning of extension tectonics and major volcanism in interior British Columbia (Armstrong, 1988).

The division of granitic rocks, using petrological and geochemical parameters, reflects genetic and tectonic conditions and changes in the orogenic cycle. The classification assumes that 'calc-alkaline' rocks are typical of Cordilleran post-orogenic uplift igneous regimes (I-type granites), that 'alkaline' rocks typically represent within-plate late orogenic domains (A-type), that 'aluminous' granitic rocks record anatexis of sedimentary rocks during continental collisions (S-type) and that plagiogranites are mantle derived (M-type).

The Soda Granite

Small masses of 'soda granite' associated with the Bralorne gabbro/diorite bodies are on the Bralorne, Pioneer, and Pioneer Extension properties, and in the workings of the Arizona and the Wayside mines. Cairnes (1937) considered that the soda granite was the result of differentiation of the Bralorne diorite. Zircon dating of the diorite and granite at Bralorne by Leitch et al. (1991) gave an age of 270 ± 5 Ma for both rocks that tends to confirm a comagmatic relationship.

The soda granite at Bralorne-Pioneer is the largest body, measuring 2400 metres long and 300 metres wide. This is a northwest-southeast elongated lens-like intrusion bounded by gabbro\diorite on the southwest and greenstone 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 host rocks. In contrast, the northeast contact 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 (Stevenson, 1958).

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

On the Wayside property, several small granitic lenses, up to 200 metres long, occur in gabbroic rocks. Two of these bodies are centred 200 metres north of the Paxton adit and another two at 850 metres to the north. Also, a small granitic body is 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.

The granite is light coloured, fine to medium grained and distinguished by quartz contents that range up to about 50%; using mineralogy, it would be considered quartz diorite or tonalite according to the Streickeison classification. In thin section, the rocks are composed of interlocking quartz and sodic feldspar grains, two to five 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, and clay and carbonate minerals. Potassium feldspar is not generally 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 show SiO_2 values ranging up to 75% and K_20 to 1% (Church, 1996). Most of the samples plot in the (M) mantle fractionate field near (I) but are distinguished from post-orogenic (I) granites that typically have a calc-alkaline signature. Two of six analyzed samples plot beyond the (M) field. However, most could be included in the oceanic plagiogranite group.

The Coast Plutonic Complex

The Coast Plutonic complex comprises the contiguous granitic terrane that marks the southwest extremity of the Bridge River mining camp. The complex also includes the outlying (somewhat younger) Bendor and Eldorado plutons and many smaller related plugs and dikes scattered throughout the region. According to Armstrong (1988) magmatism was mainly between 110 and 95 Ma, during convergence of the Pacific and North American 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 . The most common rock type is biotite hornblende granodiorite. 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 gives 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 host rocks extends laterally to one kilometre or more from the contact of the batholith. Pyritiferous skarns, amphibolitic hornfels, and biotite, garnet, and andalusite schists inhabit the contact zones. The magnetic susceptibility of the intrusive rocks is generally low because of low ferromagnesian content. Magnetic anomalies in adjacent country rocks may reflect zones of skarns and hornfels.

In thin section the rocks are equigranular and, more commonly, porphyritic. Typical samples contain rectangular zoned plates up to 6mm long in an interlocking matrix of smaller plagioclase crystals (40 to 55%), quartz (7 to 20%), amphibole (5 to 15%), and 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, solitary crystals with numerous inclusions, concentrations of small crystals associated with magnetite and biotite.

Comparing analyses of the Bendor stock and the main body of the Coast Plutonic complex, SiO_2 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 + 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 satellite stocks, and indicates 'calcic' classification for the complete suite. The satellite Eldorado stock is similar in composition to the Bendor sample and the Gywneth intrusion is similar to facies of the Coast Batholith.

Xenoliths form a small part of the granitic intrusions. These are generally rounded or elliptical, dark grey cognate or accidental bodies commonly ranging from a few centimetres to less than a metre in diameter. Compared to the host rocks, xenoliths are more variable in composition and almost always enriched in ferromagnesian minerals, especially magnetite, amphibole, and biotite. The chemical composition of three xenoliths from the Bendor intrusion show relatively high major oxide values for K_2O, FeO + Fe_2O_3, MnO, MgO and CaO. Among the minor elements, Cr and Ni are anomalously high.

The youngest age of the intrusions is 63.4± 2.2 Ma (K/Ar biotite) from a sample of granite from the south side of the Bendor intrusion in the Hawthorne Creek area. This is similar 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, and 63.7 Ma on biotite from the Eldorado granitic stock (by K. Dawson of the Geological Survey of Canada, personal communication 1987). Also, a K/Ar date of 62.5 Ma (uncorrected) 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).

U-Pb zircon dating of the Bendor intrusion (west lobe) by gives an older Cretaceous age of 73.5 Ma with a wider range of error that could include a significantly older age (Church, 1996). 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.

The oldest samples that could be ascribed to the Coast Plutonic complex are granitic boulders dated 119 ± 4 Ma by K/Ar from conglomerate beds exposed on the Gray Rock road near Truax Creek. This is the first evidence of uplift and unroofing of the Coast intrusions (Church, 1996). Other dates thought to represent main Coast plutonic events are a 95 Ma zircon date obtained on granitic rocks from the summit of Mt. Penrose and a 85.9± 3 Ma K/Ar date on biotite from the Gwyneth Lake granitic stock west of the Bralorne mine. This latter date is similar to 85.5 ± 3 Ma by K/Ar on alteration associated with the Bralorne vein system.

The Rexmount Porphyry

The Rexmount porphyry, 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) to the southeast (Schiarizza et al, 1990) and the intrusive equivalent of felsic volcanic rocks exposed to the south. The rock is conspicuously light coloured and consists of tabular plagiocase phenocrysts (20%) intermixed with rounded quartz grains (5 %), and a few chloritized biotite flakes in a fine-grained quartzofeldspathic matrix. Chemical analysis of the rock shows high SiO_2 composition (71%) and low CaO 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 and massive and less deformed than the adjacent host rocks. The Cretaceous-Tertiary dikes and sills are generally fresh and undeformed, although alteration (mostly carbonate) may be pronounced in some mineralized zones. The main extrusive rocks are light brown feldspar porphyries and fine-grained equivalents, grey and brown hornblende andesite porphyries 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 date of 67.7 Ma, within the age range of the Bendor pluton. The composition range of dikes and small intrusions from across the map area is generally similar to the composition of various phases of the Coast Plutonic complex.

The Blue Creek porphyries described by Leech (1953) are the best known of these intrusions. 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 mm long) in a finer grained groundmass of quartz, plagioclase, hornblende, and biotite. Accessory minerals are magnetite, apatite, sphene, and pyrite. The pyrite is most common in altered samples accompanied by sericite, clay, and carbonate minerals, replacing feldspar, and actinolite, chlorite, and magnetite pseudomorphic after hornblende. Whole rock K/Ar analysis of this rock gave a date of 58.4 ± 2 Ma, which is judged to be the age of alteration. A somewhat older date of 70.5 ± 6.5 Ma, based on 40Ar/39Ar analysis of hornblende from the same porphyry (Archibald, et al., 1989) is within the age range of the Coast Plutonic complex.

Structural Geology

The geology of the Bridge River mining camp records repeated cycles of deformation. The total effect of this is manifested by the oldest units of the Bridge River complex that are commonly steeply dipping and intricately folded. The younger Cadwallder beds, recording only part of this history, are less deformed, although numerous slices and wedges of these rocks are found throughout the map area. Structural mixing of rocks from diverse terranes likely occurred during plate collision by steep reverse faulting, imbricate thrusting, and stacking of oceanic and ocean margin rocks with lenses of underlying gabbroic and ultramafic rocks.

A relatively young structural style is predominant in the region and consists of panels of diverse rocks (including ramped blocks of older rocks) bounded by fractures subparallel to the Cadwallader and Yalakom fault systems. The associated major northwest- and north-trending faults mark the boundaries of the principal structural domains that have sustained through the emplacement of the Upper Cretaceous-Tertiary granitic plutons.

Fracture Domains

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

The principal vein attitudes from the camp are listed in Table 2. 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-west to northeasterly and dip northerly, such as the important 27 vein at the Pioneer mine. Other significant veins trend northeast and dip northwesterly (Congress); and north-south dipping easterly (Minto).

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. The structural setting and history of the area has been reviewed by Price et al. (1985), Potter (1986), Schiarizza et al. (1997) and Rusmore and Woodsworth (1991). The Intermontane belt is underlain by 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 Stikine and Cache Creek on the west and Quesnel and Slide Mountain on the east. Although knowledge of the temporal and spatial conditions of accretion is incomplete, it is known that the eastern terranes onlap the continental rocks and that this onlapping or docking was mostly achieved by middle Mesozoic (Price et al., 1985).

In the map area, the Bridge River complex comprises multiple slabs of oceanic and transitional crust (Cache Creek equivalent) partly delaminated from the mantle and lithospheric base and stacked against the continental margin together with units of the Cadwallader group (Stikine terrane). Potter (1986) and Rusmore et al. (1988) considered that the Middle Jurassic was the most probable time of docking of these western terranes (Figure 6). However, Schiarizza et al. (1989) argued that few structures can be unequivocally assigned to this age or earlier deformation. Nevertheless, it is agreed that by mid-early Cretaceous no major sutures remained 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, and the occurrence of detrital chromite in earliest middle Jurassic beds (Leech, 1953) that gives the first indication of uplift and unroofing of ultramafic crustal units.

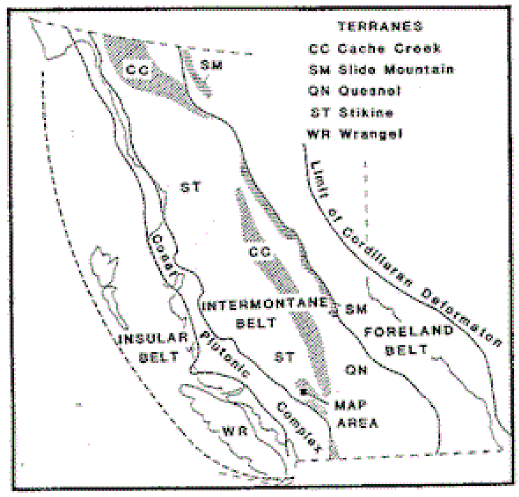
The absence of any apparent consistency in the direction of fold axes in the ribbon chert across the area has been noted by Potter (1983) and Church (1996). This may be explained by polyphase deformation superimposed on syndepositional folding related to gravity sliding.

Table 2: Principle vein attitudes in the Bridge River Mining Camp (092JNE & 092O).

Occurrence	MINFILE Number	Latitude	Longitude	Elevation (m)	Vein Attitudes		
ALMA	092JNE003	50.7833	122.8328	990	180°/75°E		
ARIZONA	092JNE024	50.8417	122.8389	760	135°/50°NE	155°/30°NE	
B R JEWEL	092JNE135	50.7736	122.8458	1235	060°/55°SE		
BENBOE	092JNE098	50.8069	122.5444	1380	025°/50°NW		
BIG	092O 047	51.0300	122.6600	2438	180°/90°		
BLACKBIRD	092JNE002	50.7708	122.7931	1250	115°/65°NE	090°/65°N	
BRISTOL	092JNE071	50.8147	122.5347	1133	020°/80°SE		
BUTTE-IXL	092JNE011	50.7069	122.6583	1475	125°/80°SW		
CALIFORNIA	092JNE020	50.8194	122.8236	1040	133°/55°NE		
COMMODORE	092JNE124	50.8750	122.8319	732	160°/50°NE		
CONGRESS	092JNE029	50.8939	122.7814	749	030°/50°NW	010°/85°W	
CORONATION	092JNE007	50.7667	122.7861	1245	110°/65°NE		
COSMOPOLITAN	092JNE164	50.7911	122.8086	1280	135°/85°NE		
DAN TUCKER	092JNE166	50.7236	122.6847	1675	110°/80°SW		
DAUNTLESS	092JNE073	50.9081	122.7475	755	052°/75°NW		
ELIZABETH	092O 012	51.0314	122.5494	2333	030°/65°NW	010°/75°W	
EMPIRE	092JNE002	50.7708	122.7931	1250	110°/45°NE	105°/80°NE	065°/60°NW
FORTY THIEVES	092JNE023	50.8319	122.8361	780	130°/45°NE		
GOLDEN GATE	092JNE025	50.8458	122.8361	778	155°/50°NE		
GOLDEN LEDGE	092JNE165	50.8083	122.8300	1050	165°/55°SW	180°/65°W	
GRAY ROCK	092JNE066	50.8042	122.6986	2130	070°/50°SE		
GRULL	092JNE017	50.7972	122.8306	930	025°/80°NW		
HOLLAND	092JNE008	50.7611	122.7606	1520	070°/60°NW	150°/80°SW	095°/70°N
HOWARD	092JNE132	50.8903	122.7964	663	165°/50°SW		
JEWEL	092JNE108	50.9056	122.9472	6000	070°/65°SE		
KELVIN	092JNE129	50.8903	122.7514	686	160°/70°SW		
KING	092JNE001	50.7778	122.8208	960	085°/55°N	110°/45°NE	022°/60°NW
LECKIE	092JNE092	50.8908	122.7417	670	145°/60°SW	125°/90°	
LITTLE GEM	092JNE068	50.8964	122.9533	1900	095°/75°S		
LOST GOLD	092JNE058	50.7875	122.8647	1260	090°/55°N	065°/50°SE	090°/90°
LUCKY JEM	092JNE032	50.9903	122.8958	2010	160°/60°E	180°/15°E	160°/80°SW
LUCKY STRIKE	092JNE045	50.9833	122.8617	1950	170°/85°SW		
MARY MAC	092JNE067	50.8583	122.6875	1372	100°/45°NE	130°/80°NE	
MINTO	092JNE075	50.8986	122.7500	670	180°/75°E		
NO. 1	092JNE130	50.8917	122.7222	990	120°/45°NE		
NORTHERN LIGHT	092JNE105	50.9942	122.8725	2241	045°/80°NW		
PEERLESS	092JNE076	50.9256	122.7889	1040	045°/65°NW		
PILOT	092JNE027	50.8750	122.8889	914	160°/80°SW	015°/40°SE	
PIONEER	092JNE004	50.7611	122.7792	1215	115°/75°NE	075°/52°NW	
PIONEER EXTENSION	092JNE009	50.7542	122.7533	1270	100°/45°NE		
RANGER	092JNE090	50.8353	122.7453	2438	120°/20°SW	150°/80°SW	
RED HAWK	092JNE012	50.7194	122.6764	1660	130°/65°SW	135°/40°NE	
RELIANCE	092JNE033	50.8828	122.7725	1000	060°/80°NW		
ROBSON	092O 026	51.0231	122.8875	1737	038°/35°NW	070°/90°	
ROYAL	092JNE014	50.7000	122.6458	1460	120°/80°SW	045°/30°SE	
SENATOR	092JNE136	50.8783	122.7878	840	036°/54°NW		
SHORT O'BACON	092JNE016	50.7778	122.8403	1130	160°/90°		
SILVERQUICK	092O 017	51.0406	122.8167	1669	020°/50°NW	020°/20°NW	145°/20°SW
SILVERSIDES	092JNE042	50.7903	122.5431	1530	010°/65°W		
SUMMIT	092JNE035	50.8731	122.5261	1420	080°/40°NW	110°/30°NE	130°/75°SW
TRUAX GOLD	092JNE060	50.8228	122.7667	2286	110°/10°N		
VERITAS	092JNE031	50.8417	122.9139	930	110°/80°NE		
WAYSIDE	092JNE030	50.8769	122.8278	670	160°/55°NE	130°/50°NE	090°/68°N
WHY NOT	092JNE021	50.8236	122.8264	1070	010°/35°E	125°/45°/NE	

Post-docking structures are better understood. The Tyaughton trough developed from late Jurassic through middle Cretaceous near the present physiographic boundary between the Coast Mountains and Intermontane belt. The trough extended southeast beyond the Canada - USA border and was limited by intermittently uplifted lands to the northeast and southwest. It began as a westward-facing marine sedimentary wedge and developed to a narrow epicontinental seaway into which the Relay Mountain group (Oxfordian-Neocomian) was deposited (Jeletzky and Tipper, 1968). That the trough broadly overlapped the older accreted terranes is proved 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, 1987).

Figure 6: Major tectonic belts and terranes in the Canadian Cordillera, simplified from Monger and Berg (1984).



Uplift and erosion of Cordillera-like lands along the west margin of the Tyaughton trough led to unroofing of metamorphic and granitic rocks (Coast Plutonic complex) during the Neocomian. Continued uplift until mid-Cretaceous resulted in the dispersion of clasts from the Coast Mountains to form conglomerate beds (Taylor Creek group).

The culminating intrusions of the Coast Plutonic complex occurred in middle Cretaceous from 110 to 90 Ma (Armstrong, 1988). After this period magmatism moved easterly and continued intermittently until about 45Ma (Leitch et al. 1989).

Late Cretaceous and Tertiary structures are superimposed on older features. The tectonics included major uplift, thrusting, and transcurrent faulting interspersed with the magmatic events (Schiarizza et al., 1989). A system of northwest- to north-trending faults predominates the regional structural grain.

Major dextral strike-slip movement on the Yalakom and Marshall Creek fault systems is at least partly during the Tertiary age and after southwesterly vergent thrust emplacement of the Shulaps (and President) ultramafic complex. The Yalakom fault cuts the Tyaughton trough on the northwest and is in turn cut by the Fraser strike-slip fault (late Eocene-Oligocene) on the east. More than 100 kilometres of lateral displacement is estimated on each of these faults.

Block faulting and further magmatism followed initial strike-slip movements resulting in emplacement of the Mission Ridge pluton at 47.5Ma into the existing fracture and 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 differences in elevation of plateau lavas (Chilcotin group) in the Coast Range relative to similar lavas in the Interior Plateau region (Mathews, 1990).

Lithoprobe Results

Results of the 1988 Lithoprobe survey includes seismic transect line 17 that traverses the Bridge River camp from Truax Creek along the south shore of Carpenter Lake, through Gold Bridge and along the Hurley Road. Because the survey was designed to receive deep-level data, shallow structures (at depths of less than about four 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.

In the area, the survey defined 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. The east-dipping reflectors are similar to the imbricated thrust sheets, reverse faults, and foliated shear zones recognized in the Shulaps Range and in the Cadwallder area by Wright (1974) and Potter (1983). The west-dipping reflectors may include faults, such as the west-dipping segments of the Cadwallader fault system. Also, because most of the Bridge River and Cadwallader bedding attitudes dip westerly many of these reflectors may simply represent bedding.

The Cadwallader Break

The 'Cadwallader break' (Bacon, 1978) is a fault zone that hosts the principal mines of the Bridge River camp (Cairnes, 1937). The several splays of this fault zone are detailed by a set of linear magnetic anomalies along Cadwallader Creek (Figure 7). At the Bralorne mine, the strike of the fault changes abruptly from north to southeast; dips are steep westerly and southwest. The break is essentially straight and uninterrupted for 11 kilometres proceeding north between Bralorne and the Wayside mines and 15 kilometres east southeast from the Bralorne and Pioneer mines to McGillvary pass. To the north of Wayside, the system is deflected along the valley of Gun Creek; on the south it extends beyond McGillvary Pass to Anderson Lake. In overall plan view, the system weaves between major lobes of the Coast Plutonic complex. The slivers of country rock comprising this fault system include Paleozoic and Mesozoic diorite, greenstone, chert, and siliciclastic sedimentary rocks. The break is cut by Cretaceous and Tertiary dikes, the Bralorne diorite (Permo-Carboniferous), and a narrow belt of ultramafic rocks (Figure 7 and Figure 1).

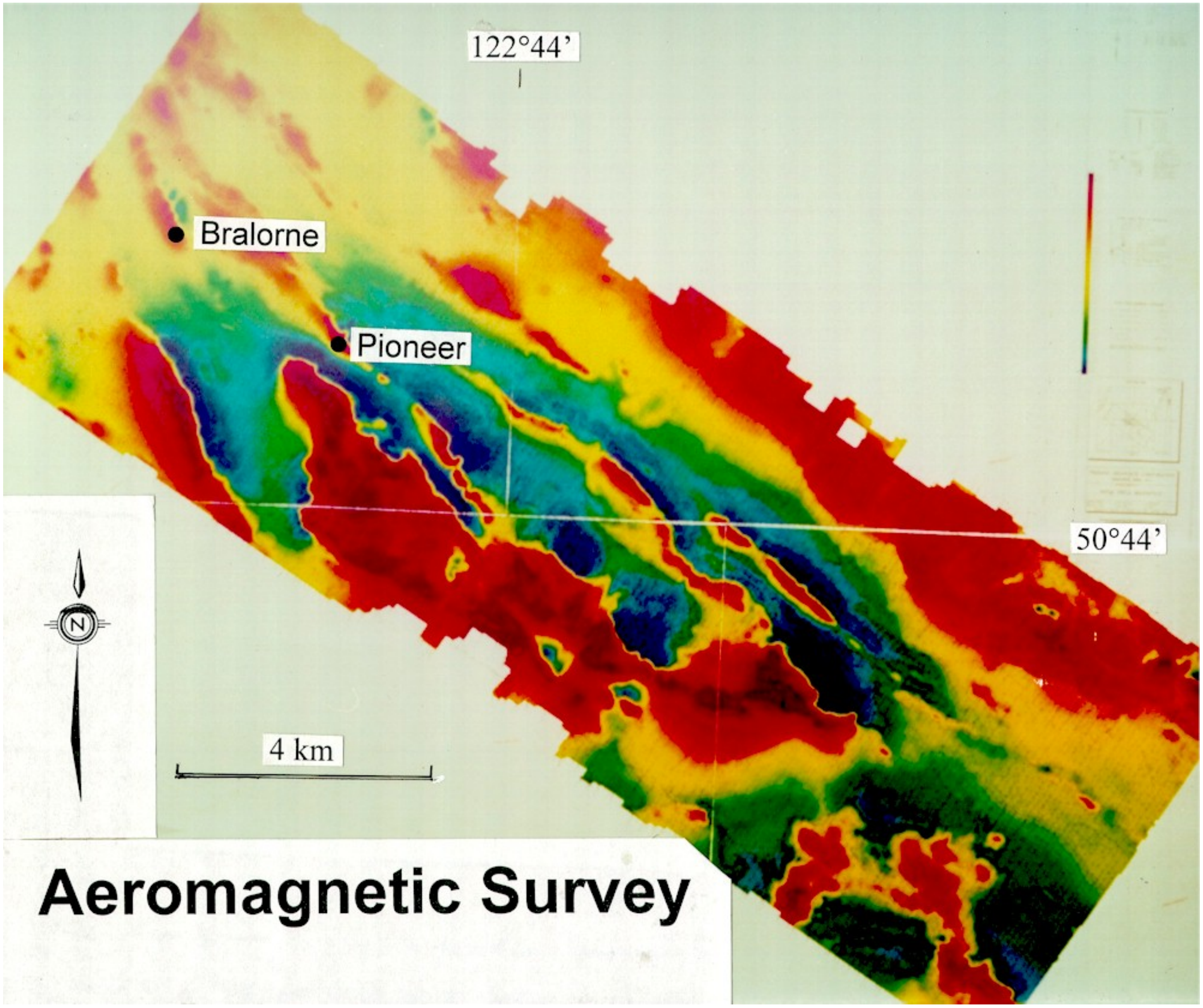
According to Campbell (1975), "The net displacement along the Cadwallader zone is difficult to determine because the zone trends parallel to the surrounding formations; however, Permian formations on the east side of the fault have been thrust over younger formations on the west. In addition, there are 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 serpentine 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 wedge-shaped area subtending the bend in the fault at Bralorne, contains all the productive orebodies in the Bralorne-Pioneer area. It appears that the deflection in the trend of the fault at Bralorne induced stresses producing a second failure known as the Fergusson fault. The Fergusson fault leaves the main Cadwallader break just southeast of Pioneer mine and rejoins it northwest of the Bralorne mine enclosing a lense of rock 5.5 kilometres long and 0.8 kilometre wide. Within this domain the ore-bearing veins occupy fractures and shears that cut the lens obliquely. The veins mostly strike easterly and southeasterly and dip to the north and northeast. Rotation on crosscutting faults may also explain changes in vein attitude, as exemplified by the Empire fault and some of the faults in the King workings of the Bralorne mine (Hedley, 1935; Poole, 1955). Movement on the Cadwallader fault was interrupted by intrusion of the Coast Plutonic complex at ~95 Ma. The strike-slip regime is linked to the 86-91 Ma period of gold mineralization at Bralorne (Leitch, 1989). At the south end, further movement on the break (Journeay, 1990) was sealed by intrusion of the Scuzzy pluton (Santonian-Campanian).

Metallogeny

The Bridge River camp is similar to the Mother Lode camp of California. As noted by Campbell (1975), "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."

Figure 7: Total field magnetic response for the Bralorne-Pioneer area, Cadwallader Creek section. Airborne survey with terrain clearance at 60 metres, flight lines ~100 metres apart. Contours range from dark blue (55696) through yellow (56327) to red purple (58195) nanotestals; GPS positioning. Triband Resources Corp. and Geoterrex-Dighem, a division of CGG Canada Ltd.



Cairnes (1937) and Joralemon (1935) considered the source of the mineralizing solutions in the Bridge River camp to be magmatic and that differentiation also produced the soda granite and albite 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 (Leitch, 1989).

The age of gold quartz mineralization in the Bralorne area is constrained by dikes dated at 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 satellite stock just west of Bralorne dated at 85.9 Ma. This is consistent with zircon ages of 69.5 to 98.4 Ma for the nearby Bendor pluton, and alteration of the Bralorne intrusion that hosts the gold quartz veins dated at 85.1 Ma (Church, 1996).

An extensive fracture system in the camp related to reactivation of the Cadwallader fault zone, a pre-existing major break 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. Emplacement of the Coast Plutonic complex may have provided the thermal engine and structural setting that controlled the mineralizing 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 main types of mineral deposits distinguished within the zonal pattern are manifested by the Bralorne-Pioneer- Wayside deposits, which have relatively high gold to silver ratios, and the Minto-Congress deposits, which have lower gold to silver ratios, higher antimony, 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 (i.e. the Bralorne mine). Farther away, the veins are mixed mesothermal and epithermal types with abundant pyrite, stibnite, sphalerite, and galena (i.e. the Minto mine). Cinnabar prospects are found along the northeast fringes of the camp (e.g., the Silverquick mine).

The Woodsworth, el al. (1977) model 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, 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) showed 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).

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Appendix – Mineral Deposits

The Bridge River mining camp comprises five former mines, including two large gold producers, Bralorne and Pioneer, three small producers, Wayside, Minto and Congress (Table 3 and Figure 3), 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 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.

Specific details of the history, geology, geochemistry, and geophysics of the various properties are recorded in the numerous assessment reports covering the area.

Table 3: Mineral Production in the Bridge River Mining Camp (092JNE & 092O).

MINFILE Number	Name	Mined (tonnes)	Gold	Silver	Copper	Lead	Zinc	Other	First Year	Last Year
			(grams)		(kilograms)					
092JNE001	Bralorne	4981419	87643244	21969603		157	157		1900	1980
092JNE002	Ida May (L.457)	145	2581	311					1918	1919
092JNE004	Pioneer (L.456)	2314459	41525831	7611999		59	139		1908	1983
092JNE007	Coronation (L.539)	11155	219339	31227					1899	1927
092JNE022	Gloria Kitty (L.3171)	4343	467	311					1938	1938
092JNE029	Congress	943	2582	1306	38				1937	1937
092JNE030	Wayside	39109	166122	26064					1915	1937
092JNE045	Lucky Strike (L.6828)	4	217	2116		336	31		1981	1981
092JNE066	Gray Rock	7						Antimony: 3765	1951	1951
092JNE075	Minto Mine (L.5601)	80650	546106	1573314	9673	56435			1934	1940
092JNE108	Jewel	51	3732	404	199				1938	1940
092JNE122	Mead Lake	23						Limestone: 22680	1932	1932
092O 012	Elizabeth	8	156	156	0	24	8		1958	1958
092O 017	Silverquick Mine	1						Mercury: 3247	1965	1965
092O 018	Tungsten Queen	55						Tungsten: 7896	1953	1953
092O 023	Manitou	141						Mercury: 543	1939	1939
092O 026	Robson	34	2208	18071	193	2640			1939	1940
Totals		**7432547**	**130115229**	**31234882**	**10103**	**59651**	**335**	**Tungsten: 338363 Mercury: 3790 Antimony: 3765 Limestone: 22680**	**1899**	**1983**

The following property summaries are arranged beginning with the most important mines. The location, access, history, geological setting, mineralization 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 from field visits. References are consolidated in the previous section of this report.

At the end of the report is a complete list of mineral occurrences in the Bridge River Mining Camp (Table 4) and a list of occurrences with mineral inventory (Table 5).

Bralorne (MINFILE 092JNE001, 002, 007)

The largest concentration of mineral prospects in the Bridge River camp is 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, which follows the lower course of the Hurley River, and parallels faults on Steep Creek and along the valley of Truax Creek (Figure 8a, 8b, 8c).

The Bralorne mine is on Cadwallader Creek, latitude 50° 46' 35", longitude 122° 49' 12", at 975 metres (3200 feet) elevation, eight kilometres south of Gold Bridge (Figure 8a). Access is by Highway 40, 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.

History and Development

The Bralorne property is centred on a gold-quartz vein system. The **Bralorne** mine, comprising the **King**, **Empire** (or Ida May) and **Crown** workings, operated continuously from 1932 to 1971. Production during this period and from older operations totals 4.9 million tonnes of ore yielding 87.6 million grams of gold and 21.9 million grams of silver, for an average recovery of 16.1 grams per tonne gold and 4.03 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 the railway. 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 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 purchased the Lorne mine from William Sloan and Dan Hurley. Before this, the Lorne, King and Woodchuck veins had been successfully worked by Mike Gaynor, Nat Coghlan, William Young, John Williams, and E.J. Taylor.

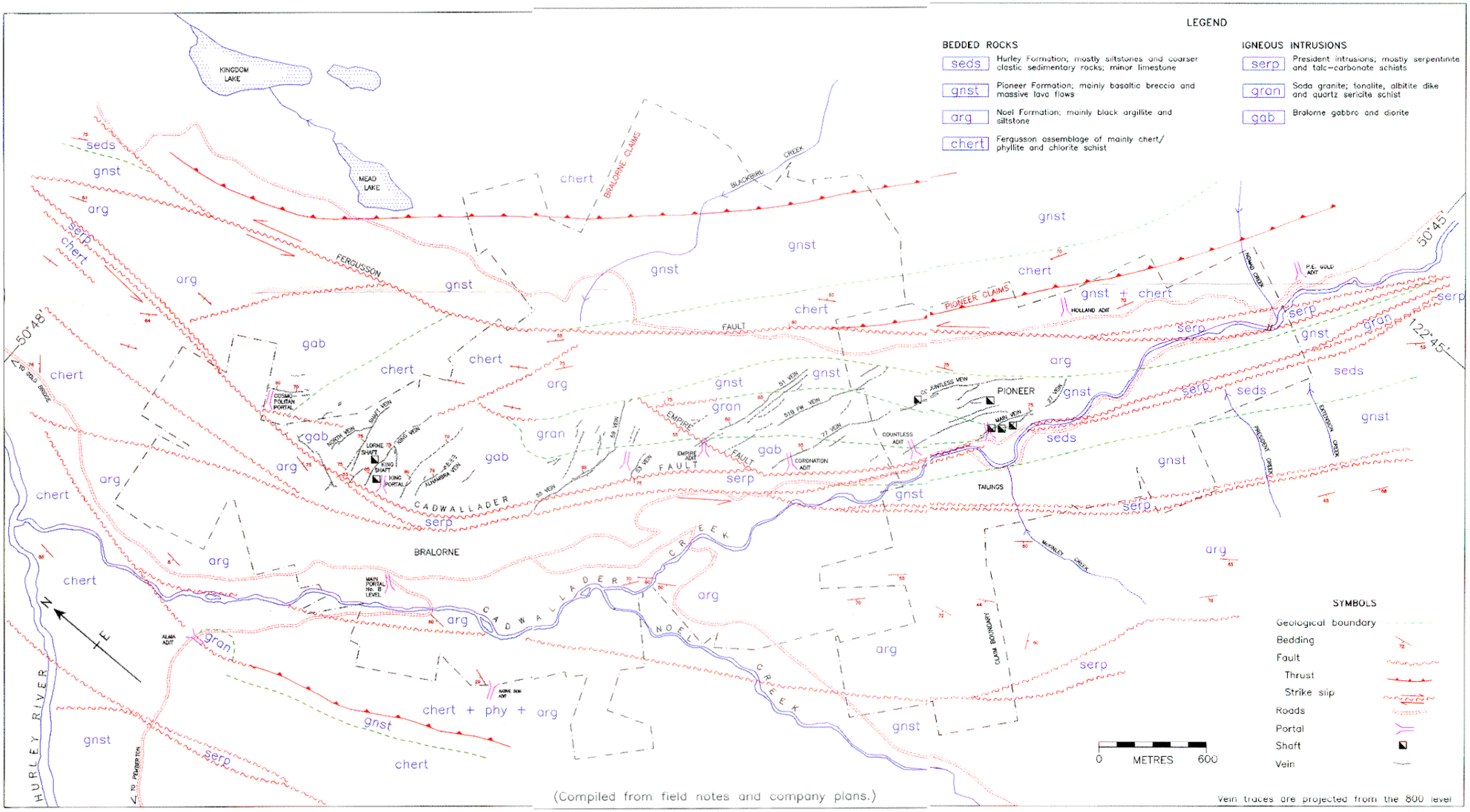
In 1910, Lorne Amalgamated Mines Company gained control of the King mine and the adjacent key ground that included the Lorne, Golden King, Woodchuck, Wood Duck, Telephone, and Marquis Crown-granted claims. After shallow surface workings were completed, the No.3 adit-crosscut was driven 335 metres to intersect the King vein. Work on the property was facilitated in 1915 when the Pacific Great Eastern Railway reached Lillooet on the Fraser River. Supplies from the coast were then routed 90 kilometres westward by road following the Bridge River. By 1920, 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 so remote an 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 tunnel 800 feet (245 metres) below the surface showings, and by 1929, the principal veins in the King mine were delineated. However, in 1930 underground development was suspended because of financial difficulties.

A new mining era began in 1931 when Lorne sold 60% interest to Austin Taylor and Associates who then organized Bralorne Mines Limited and took control of the property. A 100-ton mill was installed employing blanket concentration and floatation, thus commencing a 40-year period of continuous production (Photo 1). 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.

Figure 8a, b, c: Geology of the Bralorne-Pioneer area.



By 1962 there were three operating internal shafts (Crown, Queen and Empire); the original Coronation shaft was now defunct (Mamen, 1962). The Crown shaft connects the No.8 (the 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 simply to pick up 70-75% of the free gold in jigs and blanket tables, and float the remainder with the sulphides. Total recovery was 96% and gold content of the float concentrate was about 280 grams per tonne. Cyanidation was introduced at this time to replace flotation and save the cost of shipping and treatment of the sulphide concentrates at the Tacoma smelter ($50 per ton).

Photo 1: Bralorne Mill, 1937.

Bralorne Mines Limited gained control of the adjacent Pioneer mine in 1959. The 30 veins on the amalgamated property were developed by 80 kilometres of tunnelling on 44 levels, the deepest of which traced the 77 vein to a depth of 1900 metres. Approximately half of the underground drifting on this property intersected 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). 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 economic conditions. 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. Then in 1986 a 60% interest in the property was optioned by Mascot Gold Mines Limited. Exploration programs sponsored 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 thousand tonnes grading 8.9 grams per tonne gold (with a cut off at 4.8 grams per tonne). However, much of this is inaccessible because of old workings (Kilburn, 1992). From 1988 through 1991 the property was controlled by Corona Corporation Limited who undertook a program of mine rehabilitation, surface and underground drilling, sampling, and mapping. Corona determined 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 purchased the property from E & B Explorations, International Corona, Cathedral Gold and Geomex Development for three million common shares. This combined Avino's discoveries on the Cosmopolitan claims to the north with the Bralorne-Pioneer mine potential. Current plans announced by the company are to reopen 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 reserve ('proven and probable') above the 1000 level of 292 thousand tonnes grading 12 grams per tonne gold. Reserves between the 1000 and 2600 level (accessible by dewatering the mine) are estimated at 673 thousand tonnes grading 8.2 grams per tonne (Avino's report, October, 1992).

Geological Setting

The Bralorne property is underlain by Fergusson and Cadwallader metasedimentary rocks and greenstones that are cut by a major steeply dipping, southeasterly striking fault system known as the "Cadwallader break". This break is cutd by a variety of dikes, a narrow belt of steeply dipping ultramafic rocks (named the 'President Intrusions' by Cairnes, 1937) and felsic to basic stocks, the largest of which is an elongated 0.7 by 3.3 kilometre body known as the Bralorne 'diorite' (Permo-Carboniferous). It was succeeded by younger intrusions that include a large body of soda granite flanking the diorite on the northeast side, albitite dikes (Late Cretaceous), and minor post-vein lamprophyres (Tertiary).

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. These ultramafic rocks were named the 'President Intrusions' by Cairnes (1949) because of the steeply dipping, dike-like aspect of these rocks; emplacement was probably a crystal mush injection rather than an ultramafic magma (Gabrielse, 1963). The ultramafic rocks are partially serpentinized and altered to talc but at the Bralorne and Pioneer mines there is no listwanitic development.

The fault consists of numerous gouge-filled fractures dipping vertically and steeply to the southwest and west. Splays and offshoots from the fault interlace the Bralorne-Pioneer workings northeast of Cadwallader Creek (Figure 8a).

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

Rocks enclosed by the Fergusson-Cadwallader fault lens 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 supplemented by northeast-trending tensional fractures. It is evident from the many ages of sheared and brecciated quartz that the system of fracture sets was adjusted and reopened repeatedly.

Mineralization

The limits of vein fissuring at Bralorne-Pioneer, as delineated by the mining operations, define a southeasterly elongated rectangular area 4600 metres long and 550 metres wide. The main producing veins occupy tension fractures and shears that strike generally easterly, and dip steeply north, cutting diagonally across the Bralorne intrusion, which 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 age of the Gwyneth Lake stock and vein alteration of the Bralorne intrusion (Church, 1990), that is slightly younger than the albitite dikes (86-91 Ma) at Bralorne (Leitch, 1989; Church, 1996, Table 2.2, Nos.15 and 16).

Only half 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 are known as the '51' (Empire, Ida May) and '77' (Coronation) veins, the faulted extensions of these, the '55' (Blackbird) and '53' and the crossover veins '59', '73', '75' and '79'. The bulk of production came from the '51', '55' and '77' 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 carbonate minerals, 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 repeated hydrothermal events, such as described by Sibson et al. (1988). Calcite and ankerite occur as light coloured alteration envelopes on vein walls, especially in areas of fair to good ore development. Sericite is 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 (1953) reports the occurrence of shoots of a few hundred tons of scheelite ore that were mined in the 1940s near the east end of the 51vein, 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 plums 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. Small inclusions of native gold are adjacent to or within sphalerite. Joubin (in Bacon, 1978) noted that sphalerite was commonly accompanied by a rise in gold content, and that 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 (1953) indicated that most of the movement is along the northeast contact of the serpentine belt, left-lateral motion is suggested by rotation of veins. At the adjacent Pioneer mine, Cleveland (1938) noted that "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 along the Cadwallader and Fergusson faults. 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 open 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 competent rock. It is very brittle and has not sustained single, wide continuous fissures but rather has failed by tight, braided fractures along which movement in many places has been taken up 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 in veins near the serpentinite belt. Cleveland (1938) suggested 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 individual 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."

Cambell (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 in the vein system (Joubin, 1948). However, beneath a roughly horizontal non-commercial zone in the intermediate levels of the mine, grades 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.

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 (Joralemon, 1934; Cleveland, 1938).

The Empire fault is a major post-ore fault system that divides the Crown and Empire sections of the mine into east and west blocks. On average the fault shrikes 160° and dips 54° west. Matching the veins across this fault has been an ongoing endeavour. Detailed analysis by Poole (1955) showed that it is an oblique-reverse fault in which the west block has moved diagonally up dip 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 shows a rotation of the principal vein fissures from 118/45NE east of the fault to an average attitude of 105° /66° NE west of the fault. This suggests a rotation between the footwall and hanging wall blocks of about 10°.

It is concluded that 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 an overall length of 1480 metres in the east 'footwall' block of the Empire fault, striking, on average about 110°, with a short deflection to 075°; dips range from 45° northerly to vertical. The vein cuts 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 in a metre-wide envelope of sheared wallrock. Free gold is associated with arsenopyrite and pyrite intergrowths and, locally, fine-grained tetrahedrite. The vein is developed from surface to the 2000 level; a vertical distance of 854 metres. Stevenson (1958) reported 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 was followed a few hundred metres on the 400 and 800 levels. It is subparallel to the main 51 vein, but locally has a more gentle dip, (25°- 45° north), and converges at depth. The vein consists of both massive and banded quartz from 0.3 to one metre wide. patches of sulphides and local high grades are the most important features. In the past several years, this vein was 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 hanging wall 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 is 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 down dip and along strike. The widest ore shoot is where the vein is splayed, and several shallow 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 the serpentinite, where it begins as a weak fracture zone, then is deflected sharply southeast along the contact of the greenstone and soda granite where it gradually disappears on the Pioneer ground (Figure 8b). Below the 1000 level, the vein follows an albitite dike six metres wide and 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 was stoped west of the granite contact across widths ranging from 3 to 7 metres for a continuous vertical interval of about 1400 metres, and along strike lengths range 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 local stibnite, galena, and molybdenite. The gold is closely associated with arsenopyrite. The orebody consisted of upper and a lower enriched zones and an intervening lean section. At the bottom of the mine on the 4500 level, the vein averaged 38 grams per tonne gold across a width of two metres and a strike length of 162 metres (Grove, 1974), somewhat higher grades than encountered on 3900 and 4100 levels. The potential ore reserves below the workings are estimated to be more than 80 thousand tonnes at the same grade as on the 4500 level (Grove, 1974; Bacon, 1978).

The 53 vein, the faulted extension of the 77 vein, 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). Fracturing of the Bralorne intrusion and adjacent sedimentary and volcanic rocks occurred in grid pattern oriented north and east, with 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, closely following emplacement of the dikes. This quartz was refractured and refilled with gold-bearing quartz and arsenopyrite, accessory sphalerite, and galena, and a little tetrahedrite. Significant faulting occurred after vein emplacement. Most of the motion in the King mine was along the north-trending fractures following earlier veins and aplite dikes and new fractures. This resulted in movement of westerly blocks northward and upward.

According to Joralemon (1934) "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."

However, it is now known (Leitch, 1989), that the albitite dikes are the same age as the Coast Plutonic complex and unrelated to the much older Bralorne diorite. Nevertheless, radiometric dating further constrains the age of mineralization (85 to 91 Ma) indicating that Joralemon was correct in observing a close relationship between the albitite dikes and the quartz veins (Church, 1996).

Pioneer (MINFILE 092JNE004)

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 volcanic rocks 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.

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

The writer visited the property in early July 1986, and many times subsequently, finding the veins mostly inaccessible because of the defunct 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 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 was worked from five shafts and 29 levels to a depth of more than 1000 metres.

Photo 2: The Arrastre at Pioneer, 1910.

The Pioneer claim was staked in 1897 by Harry Attwood. High 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 constructed a small mill powered by a water wheel in Cadwallader Creek (Photo 2). This primitive machinery produced 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 constructed. 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.

Photo 3: Pioneer Gold Mine, 1937.

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 that 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. Major development was achieved in 1933 and the largest gold production of any mine in the province was attained in this year (Photo 3). 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. It is significant to note 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 of 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 focussed on the 27 vein where a rich ore shoot, up to 240 metres in strike length, was traced on Nos.20, 21 and 25 levels. In 1952 a major diamond-drilling program was completed. The No.5 decline shaft was then sunk to the No.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 No.20 level and another crosscut, 600 metres long, was extended easterly towards the Pacific Eastern workings (Figure 8c). 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 Nos.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 Pioneer has been jointly owned by International Corona Corporation and Imperial Metals Corporation. In late 1991 Avino Mines and Resources Limited acquired 100% of the Corona interest. Up until 1989 Corona had focussed 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 in Pioneer greenstones 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 host rock 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 amygdaloidal and intercalated repeatedly with flow-breccia phases flows are 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 some phases may be cogenetic. Stevenson (1958) indicated that some of the greenstone was 'dioritized' and Stanley (1956) 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 are 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) noted that there is no obvious deflection of the veins where they cross the contact, indicating that the intrusive event and shearing predated the emplacement of the quartz veins.

Mineralization

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 sources of ore at the Pioneer mine was the 'Main' vein (until 1944) and the '27' vein (until the end of production in 1962). The vein-fissures commonly split forming hangingwall and footwall branches that were 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. Four main ore shoots were worked to 1074 metres down dip and 1140 metres along strike (Stanley, 1960). The west ore shoot was the original ore body 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 No.9 level. The second ore shoot is joined with the west shoot above No.5 level and mined down to No.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 No.12 to No.29 level in the area west of No.2 and No.3 shafts. This was a narrow discontinuous body with a maximum strike length of 150 metres.

Four veins (named alphabetically) occurring in the hanging wall of the Main Vein were intersected on the No.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 is 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. Perhaps because of generally low grades there appears to have been 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, was traced from No.17 through to No.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, suggesting structural interdependence of these veins. The only stope on 'J' vein is along the central part of the trough between No.26 and No.27 levels.

The 27 vein occupies a tension fracture branching off the hangingwall of the Main vein. It is a blind, not seen at surface and does not extend much above the No.12 level (most of the ore occurring below No.18 level). It strikes northeast and dips moderately northwest, averaging 30 to 150 centimetres in width but locally ranging to 6 metres wide. The '27' vein was followed along strike for 570 metres and is distinctive from the Main vein in that the quartz is massive "bull" quartz rather than ribboned. At one point on the No.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 No.25 level having a drift length of 172 metres, and 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 MINFILE 092JNE007). The vein is persistent but approaches ore grade (10.3 grams per tonne gold) for only a few intervals of about 30 metres in the adit workings (Stanley, 1960). The 28 vein is small and occurs on No.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, high-grade pockets of 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 was considered 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 west end drifting on the No.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) form disseminations in massive quartz or in the ribbon partings. Massive arsenopyrite is commonly 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 locally found in the wallrocks.

In the fracture pattern of the Pioneer mine the Main vein and '27' vein are the most persistent in attitude of any of the veins. The Main vein formed at an acute angle to the (southeast striking) Cadwallader shear zone and that the Main vein itself became a shear zone. It is interesting to note that '27' vein, which is clearly identified as a tensional fissure, strikes northeast in the general direction of the Bendor intrusion - the probable source of the mineralizing solutions.

Wayside (MINFILE 092JNE030, 121, 124, 150)

The Wayside mine is on the north side of Carpenter Lake at latitude 50° 52' 30", longitude 122° 49' 40", 3.2 kilometres north of Gold Bridge (Figure 9a). Access to the property is by bush roads that connect directly to Highway 40 and the Gun Lake road. The property and mine site were visited repeatedly by the writer between 1986 and 1988. The geology of the property was examined together with a magnetometer survey and logging of 20 drill cores provided by Chevron Minerals Limited.

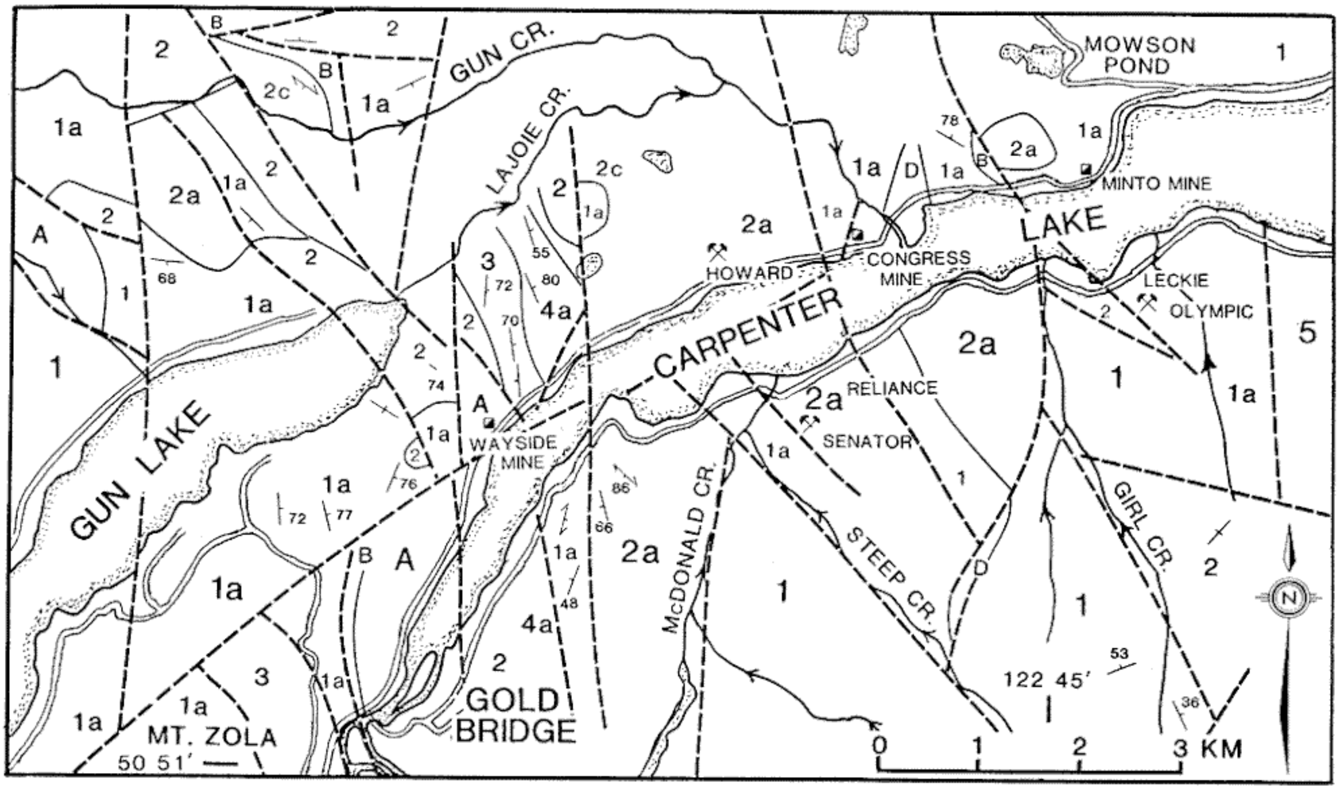
History and Development

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 pyrite-enriched 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 were installed, including a hydroelectric plant; the Wayside vein system had been exposed on five levels in 300 metres of tunnelling for a vertical interval of 150 metres. Production in 1915 and from 1934 to 1937, totalled 39,109 tonnes, 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 and, with the addition of hoisting equipment, 900 tonnes of ore were produced for metallurgical testing. A fire at the mine in 1953

Figure 9a, b: Geology of Gun and Carpenter lakes area.



LEGEND

BEDDED ROCKS

UPPER JURASSIC

5 RELAY MOUNTAIN GROUP: *buchia-bearing grey shales, siltstones, tuffaceous and polymictic conglomerate*

TRIASSIC

4 CADWALLADER GROUP: *HURLEY FORMATION: soft brown and green argillites, siliceous and calcareous argillites with sandstone and conglomerate (4a), limestone (4b) and volcaniclastics (4c)*

3 *NOEL FORMATION: mainly black argillite and siltstone with some calcareous zones*

2 *PIONEER FORMATION: basaltic pillow lava (2a), aquagene breccia and lenses of limestone breccia (2b), tuffs and amygdaloidal lava (2c)*

PALEOZOIC AND EARLY MESOZOIC

1 FERGUSSON GROUP: *mostly ribbon chert (1a), ranging to biotite quartz gneiss (1b), some marble bands (1c) and fine-grained amphibolite (1d)*

IGNEOUS INTRUSIONS

TERTIARY

D **FELSIC DYKES:** *felsic phase of the (Eocene) Mission Ridge pluton and equivalent stocks, sills and dykes*

CRETACEOUS

C COAST INTRUSIONS: *biotite and hornblende diorite, granodiorite and granite (including the various phases of the Eldorado (Ca) and Bendor (Cb) stocks)*

MESOZOIC

B *ULTRABASIC ROCKS: peridotite, serpentine and listwanite (Ba)*

PALEOZOIC

A *BRALORNE INTRUSIONS: mostly heterogeneous amphibolite, diorite and gabbro with felsic veinlets*

SYMBOLS

Geological Boundary
Bedding — horizontal, inclined
Foliation, schistosity
Fault — approximate, assumed
Roads
Properties — Mines
Prospects

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, sampling, and diamond drilling (2344 metres in 1980). 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 (1829 metres in 1984; 2438 metres in 1985). Early in 1987, Amazon Petroleum Inc. and Carpenter Lake Resources Limited optioned the property to Chevron Canada Resources Limited. This began renewed exploration on the property based on similarities in geological setting, morphology, and 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 metres) were completed in Chevron's 1987-88 program to locate faulted segments of the Wayside veins and similar mineralization. Work in 1992 by Wayside Gold Mines Ltd. and Brigadier Resources Limited, in a 50/50 partnership relationship, included dewatering of the lower levels of the Wayside mine and resampling the main vein and Notman vein systems. They drilled 31 underground holes in 1993. Wayside Gold Mines Ltd. became International Wayside Gold Mines Ltd. in 1994.

Geological Setting

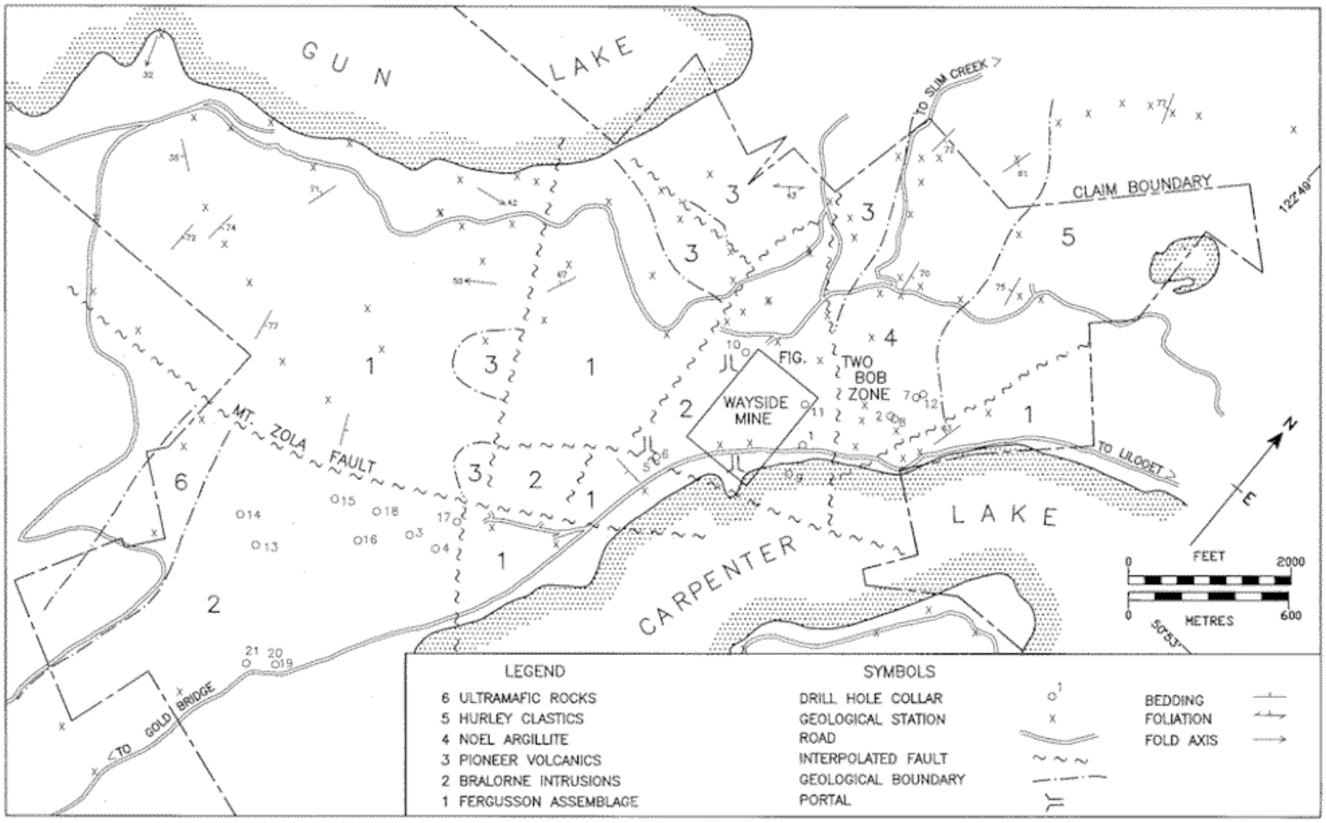
The Wayside property is near the northern extremity of the 'Cadwallader break'; a geological setting similar to the Bralorne and Pioneer mines 15 kilometres to the south (Figure 9a). In detail, the property is underlain by faulted segments of the Bralorne intrusion and volcanic and sedimentary rocks of the Cadwallader group and Bridge River complex (Figure 10a). The 'Bralorne diorite', described by Cairnes (1937), is 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; Church, 1996, Table 2.8, U-Pb zircon date of 293±13Ma). Country rocks along the west contact of the Bralorne intrusion are highly deformed Fergusson cherts and phyllites. This intrusive contact is injected by a dike-like narrow band of ultramafic rocks. The three principal formations of the Cadwallader group, the Pioneer volcanics, Noel argillites, and Hurley conglomerates and sandstones are faulted against the Bralorne intrusion on the northeast side.

Mineral Deposits

The main exploration targets are veins in the Bralorne intrusion: the Wayside mine, and the Commodore and '3T' veins. The 'New Discovery zone' and 'Two Bob zone' are adjacent the Bralorne intrusion in host rocks of the Bridge River complex and Cadwallader group, respectively.

The **Wayside** mine (MINFILE 092JNE030), centred on the Wayside Crown-granted claim, consists of seven adits and three subsurface levels, developed in a northerly trending shear zone in the Bralorne intrusion. Gold-quartz mineralization is in the main shear zone and branching fissures, known as the footwall veins Nos.1 and 2, and the hangingwall or 'Notman' vein (Figure 10b). 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 five 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. The 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 across 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.

Figure 10a: Geology (a) and Legend (b) of the Wayside property.

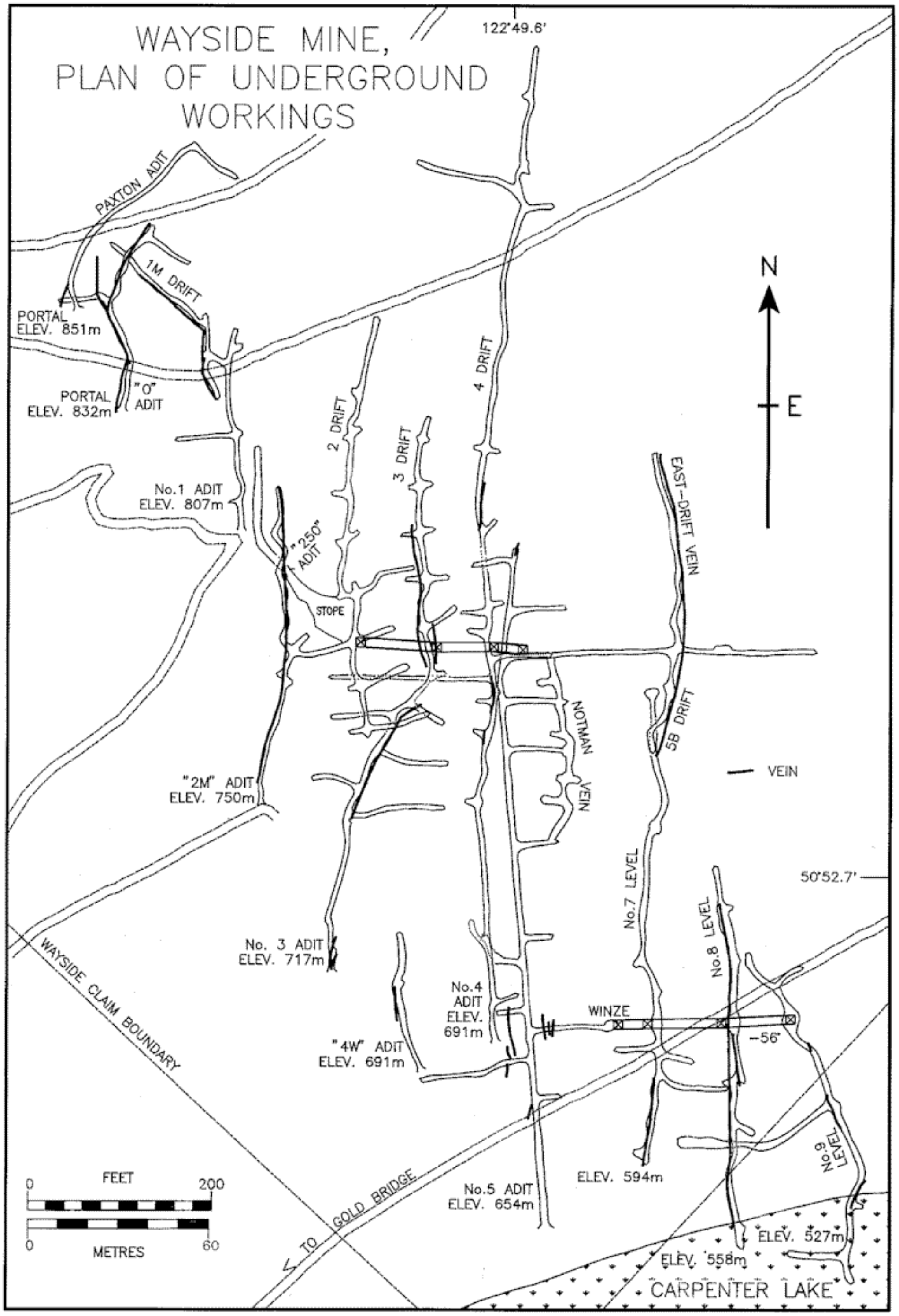


Much of the main shear contains little or no mineralization, and the higher-grade material is found in branch fissures off the main shear and at shear junctions. The ore minerals include pyrite, arsenopyrite, chalcopyrite, telluride (probably sylvanite), galena, tetrahedrite, sphalerite, stibnite, and native gold. Alteration minerals are siderite, mariposite, talc, sericite, and chlorite. The main shear was reported by Amazon Petroleum Inc. to have less than 1.7 grams per tonne as an average gold assay, but relatively recent drilling 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.

An objective of recent exploration by Chevron Minerals Limited was to locate the faulted segments of the Wayside vein system. In the Wayside area, a northwesterly trending fault, known locally as the Mount Zola fault, appears to have dislocated part of the Bralorne intrusion and the Wayside veins.

The **Commodore** (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. Diamond drilling by Amazon Petroleum and Carpenter Lake Resources in 1984 showed that the vein dips 45° to 54° northeast, consists of quartz and albite accompanied by minor arsenopyrite and pyrite, and is hosted by carbonate-altered soda granite. Sampling by Lammle (1974) yielded grades 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.

Figure 10b: Wayside Mine, plan of underground workings.



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. 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' (MINFILE 092JNE150) 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 host rocks 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 Highway 40 immediately to the south (Figure 10a).

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

The Congress mine is centred near the north shore of Carpenter Lake, latitude 50° 52' 00", longitude 122° 43' 35", west of the mouth of Gun Creek, six kilometres northeast of Gold Bridge on Highway 40 (Figure 10a). Geological mapping was completed by the writer during several visits to the property in 1986 and the Ace adit was examined and sampled. The Howard adits and Lou decline surveyed in July 1988.

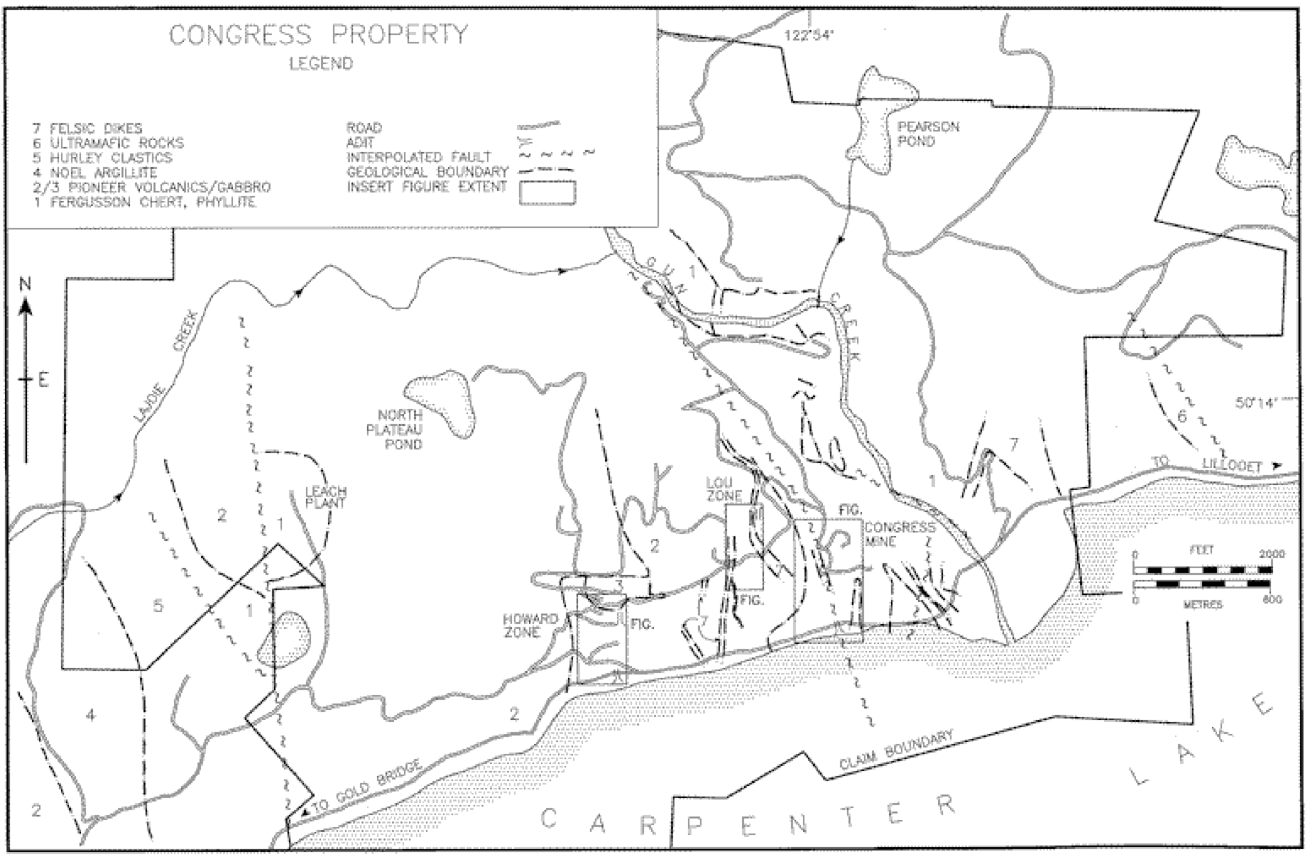
History

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 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 Congress 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 Mines Limited did underground work on the Howard vein and continued drifting at the Congress mine while also carrying out surface and underground drilling. 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, during the next five years, completed 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 continuation of the exploration program. The principal exploration has been 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 with the collaboration of 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.

Figure 11a: Geology of the Congress property.

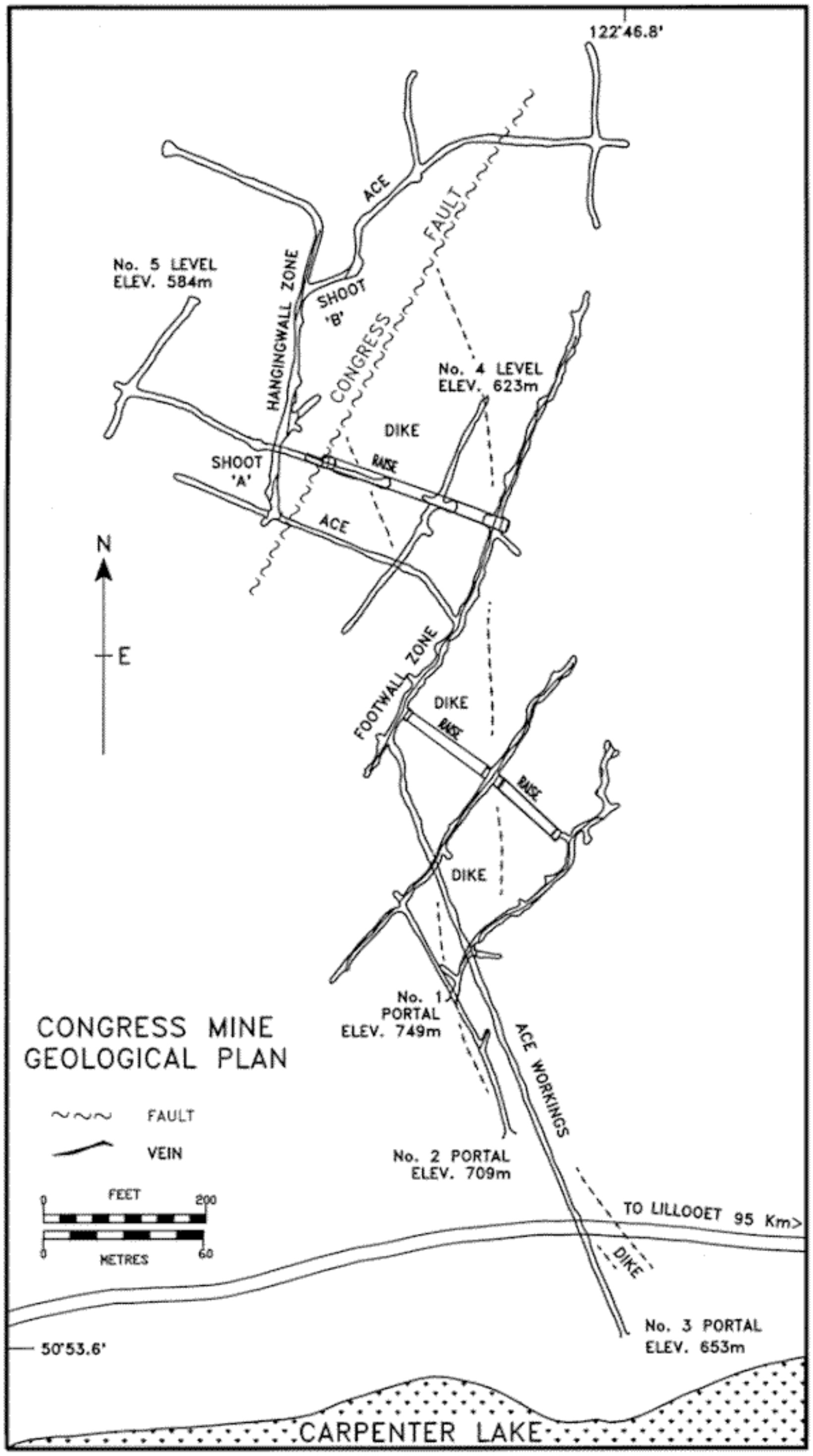


Description

The Congress property is underlain by a panel of Pioneer pillow lavas and associated basalt 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 11a). Tertiary feldspar porphyry dikes are conspicuous in the mine workings as well as areas of fractures and faults. 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 (mainly three adit levels) through a vertical distance of 200 metres (Figure 11b). 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 cut 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 have been reported in a few places (Stevenson, 1949b). Adjacent to veins and shears, the wallrocks are altered to as much as 5 metres with ankeritic carbonates, sericite, chlorite, minor kaolinite, and patches of dense, finely crystalline quartz.

Figure 11b: Congress Mine, plan of underground workings.



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 trace to 34 grams per tonne silver across 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 the abundance of 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 locally occurs at the contact of feldspar porphyry dikes and sheared greenstone.

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

The Extension vein, immediately north of the Congress workings, is considered 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), about 900 metres west of the Congress mine, was explored by more than 1220 metres of drifts and crosscuts on two adit levels (Figure 11a). 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 is cut by Tertiary dikes that are commonly altered and locally mineralized. The veins are discontinuous quartz-carbonate lenses containing stibnite, pyrite, arsenopyrite and rarely, free gold, in a light coloured alteration envelope, 2 to 7 metres wide, composed mostly of ankerite, sericite and kaolinite. Sebert (1987) reported some galena and rhodochrosite in early fracture-filling quartz. Assays of the mineralization range from 47.6 grams per tonne gold across 3 metres to 2 grams per tonne gold across a metre, with estimated ore reserves ranging from 10,000 to 270,000 tonnes grading 11 grams per tonne gold (Cooke, 1986; Seraphim, 1983).

The **Lou** zone (MINFILE 092JNE131) is a fracture system 12 metres wide striking north to northwest, following a Tertiary porphyry dike that intrudes the contact between the Pioneer pillow basalts to the west and Fergusson metacherts and schists to the east (Figure 11a). The geological setting is similar to the Congress mine, 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.

Maheux (1989) identified 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 minor sphalerite, tetrahedrite, and cinnabar coating fractures and grain boundaries. Secondary minerals include covellite on tetrahedrite and kermesite on stibnite.

Based on extrapolations from trenching and drilling, the zone was estimated to contain 34,000 tonnes of ore grading 2.7 grams per tonne gold. However, work on the Lou decline was abandoned in July 1988 after 370 metres of tunnelling because mining results were less than original estimates.

The **Paul zone - Slide zone** (MINFILE 092JNE133) consists of numerous west-trending veins following shears in greenstones and schists of the Bridge River complex in an area crosscut by 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 Paul zone, follows a sheared contact between greenstones and metasedimentary rocks 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 of ore grading 9.6 grams per tonne gold (Cooke, 1986). Drill hole intersections on the Slide zone gave an average grade 11.3 grams per tonne gold across 2 metres (Cooke et al., 1986).

Minto Mine (L. 5601) (MINFILE 092JNE075, 073, 077)

The Minto mine is on the north shore of Carpenter Lake, centred at latitude 50° 53', longitude 122° 45', east of Gun Creek (Figure 10a). Access is directly from Highway 40, seven kilometres northeast of Gold Bridge. Mapping of this property by the writer began 1986 and was completed in July 1988 assisted by drill core logs 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 including Omega and Omega 1- 4, Alpha fraction, Jack fraction and Golden Girl; reverted Crown-granted claims, including 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 about 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 the 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 this 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.

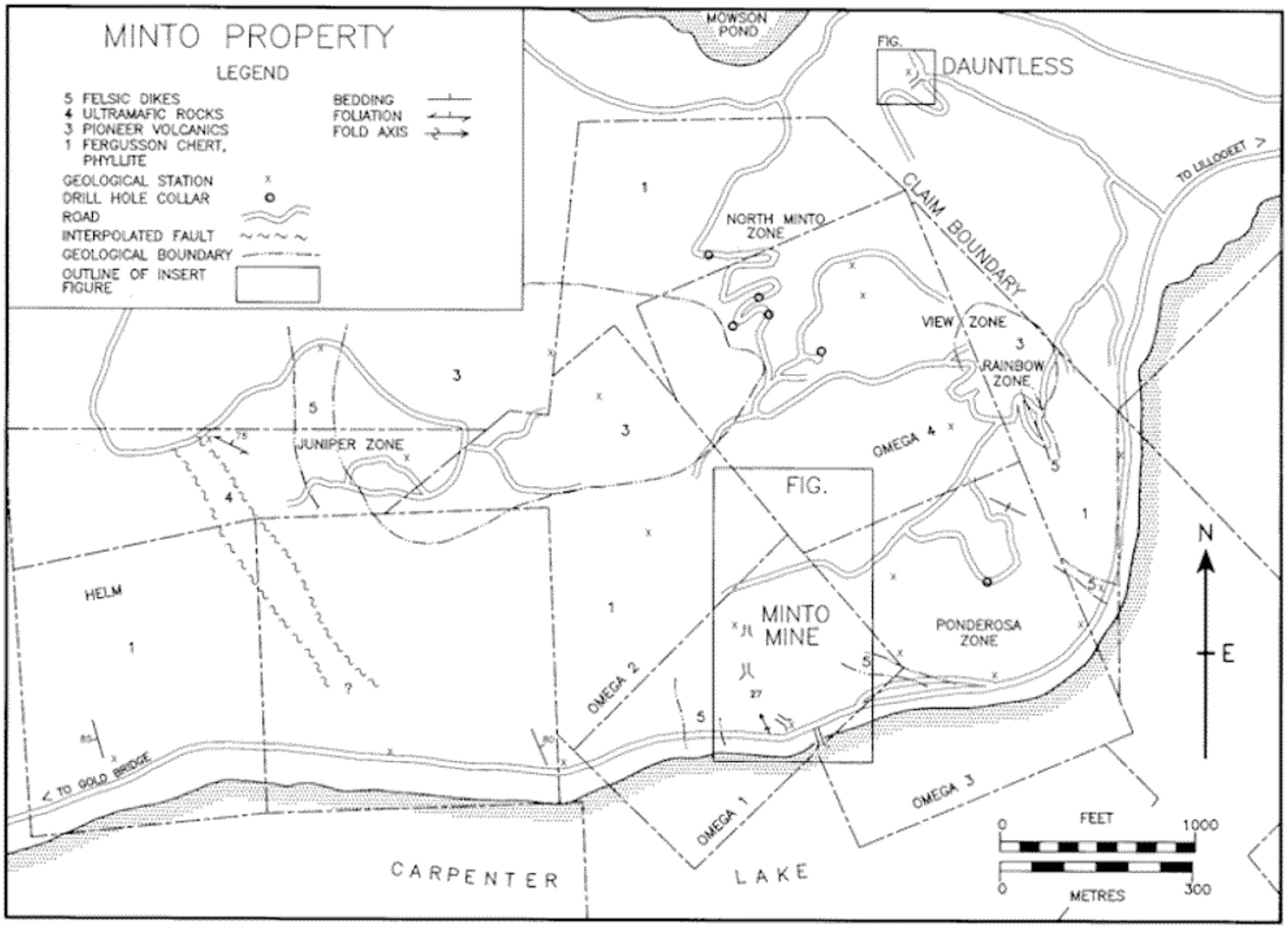
Pioneer Gold Mines Limited obtained an option from 1941 to 1942; in 1959 the claims were acquired by Ace Mining Company Limited. Little additional work was done and the property, now under the name of Minto Trading and Development Company, became part of the estate of Marguerite W. Wiles. In 1975 Empire 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 that 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 80.6 thousand tonnes of ore was mined yielding a total 0.5 million grams of gold, 1.6 million grams of silver, 9.7 million grams of copper, and 56.4 million grams of lead (MINFILE 092JNE075).

Geological Setting

The property is underlain mainly by Fergusson chert and phyllite, serpentinite, greenstone, and felsic dikes (Figure 12a). Ribbon chert, the most common rock, is locally markedly deformed 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.

Figure 12a: Geology of the Minto property.

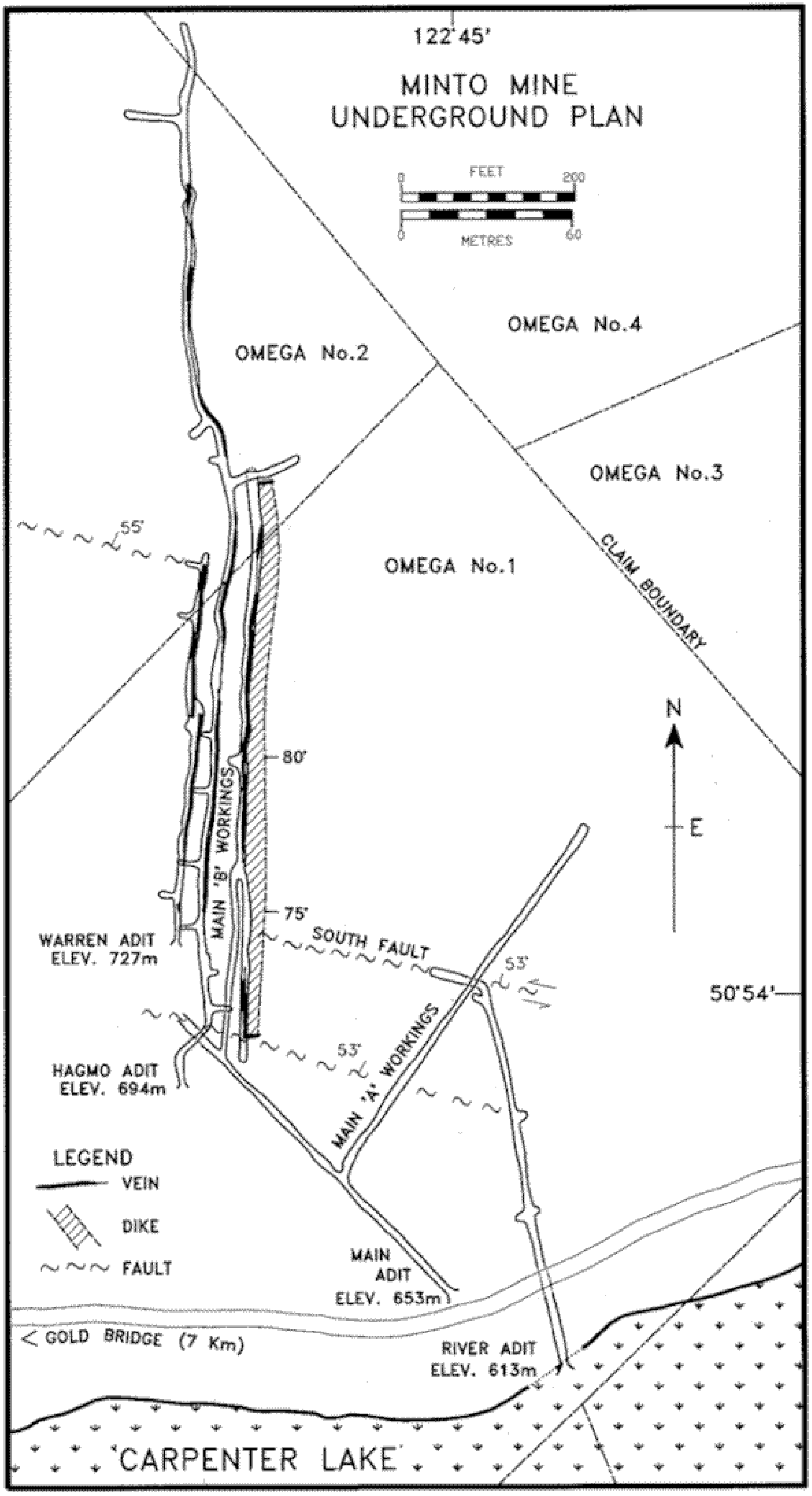


The fracture pattern in the Minto area is similar to the Congress property. The principal fractures dip steeply and trend northerly subparallel to the attitude of the chert. Cross fractures striking 050° to 080° and dipping 45° to 80° northwest, and several northeasterly dipping faults, were mapped in the mine workings.

Mineral Deposits

The Minto vein was 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 12b). 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, and smaller amounts of galena, chalcopyrite, tetrahedrite, stibnite, jamesonite, marcasite, pyrrhotite, bismuthinite, and native gold (Frieson, 1988). The main ore shoots occur in the cherts, which are relatively unaltered except for shearing. However, the greenstones to the west are leached and carbonatized, 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).

Figure 12b: Minto Mine, plan of underground workings.



Recent exploration consists mainly of bulldozer trenches north of the old Minto mine workings. Many of these trenches were dug near the powerline road, which passes westerly from the highway across the property; more trenches and diamond-drill holes are on the central high ground (Sampson, 1988a). Five new mineralized zones were located during this program, the Ponderosa, 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 ore body, and may be the extension of this structure. Assay results from chip samples across a one metre width of the zone range up to 10 grams per tonne. Work on the adjoining Minto Extension claims by Avino Mines and Resources Limited gave good results. According to company reports trench sampling across widths of 1 to more than 28 metres yields 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 ore-body, 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; and the Winter zone, where an old (1934) adit explored galena-sphalerite-stibnite-arsenopyrite-pyrite veins in a narrow shear 200 metres long. The best recent assay was 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 zone of sheared listwanite and serpentinite, and feldspar porphyry and fine-grained felsic dikes. The principal workings are centred about 450 metres west of the Minto mine. These are open cuts, two short adits and a northeasterly trending crosscut adit (315 metres long) developed 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 fracture zones 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) reported that "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; also, some gold was reported. Subsequent work included geological and geochemical surveys by Empire Metals Corporation (Ikona, 1975) and Avino Mines and Resources, Ltd. (Sampson, 1988a). These investigations focussed on a gold geochemical anomaly in soils on the Juniper shear zone north of the old workings.

Table 4: Mineral Occurrences in the Bridge River Mining Camp (092JNE & 092O).

MINFILE Number	Names	Status	Commodities	NTS Maps	Longitude	Latitude	Deposit Types
092JNE001	BRALORNE, BRALORNE MINE, LORNE (L.588), KING, WOOD CHUCK (L.579), CROWN, WEDGE, QUEEN, MADDIE, PETER, BIG SOLLY, TELEPHONE, TAYLOR, 52, ZONE B	Past Producer Production Report Inventory Report	Gold Silver Lead Zinc Copper Tungsten	092J15W	122 49 15 W	50 46 40 N	Au-quartz veins.
092JNE002	IDA MAY (L.457), EMPIRE, 51 VEIN (BRALORNE), BRADIAN, BLACKBIRD (L.1176), 55 VEIN (BRALORNE)	Past Producer Production Report	Gold Silver Lead	092J15W	122 47 35 W	50 46 15 N	Au-quartz veins.
092JNE003	ALMA (L.2375), NEW ERA, SILVER BASIN, GRULL - WIHKSNE	Prospect	Gold	092J15W	122 49 58 W	50 47 00 N	Au-quartz veins.
092JNE004	PIONEER (L.456), PIONEER MINE, COUNTLESS, LOCO	Past Producer Production Report Inventory Report	Gold Silver Lead Zinc Copper Antimony Tungsten	092J15W	122 46 45 W	50 45 40 N	Au-quartz veins.
092JNE005	MIX (L.6157,6159)	Showing	Gold	092J10E 092J15E	122 43 50 W	50 44 50 N	
092JNE006	NATIVE SON (L.5896), BRIDGE RIVER OGDEN	Showing	Gold Silver	092J15W	122 49 15 W	50 46 15 N	Au-quartz veins.
092JNE007	CORONATION (L.539), 77 VEIN (BRALORNE), COUNTLESS (L.1177), BEN D'OR, 53 VEIN (BRALORNE), LITTLE JOE MINE	Past Producer Production Report Inventory Report	Gold Silver Zinc Tungsten Lead Molybdenum Copper	092J15W	122 47 10 W	50 46 00 N	Au-quartz veins.
092JNE008	HOLLAND (L.7258,7079), NOMAD, RIEL	Prospect	Gold	092J15W	122 45 38 W	50 45 40 N	Au-quartz veins.
092JNE009	PIONEER EXTENSION (L.5560), PACIFIC EASTERN	Developed Prospect	Gold Silver Copper Lead Zinc Talc	092J15W	122 45 12 W	50 45 15 N	Au-quartz veins. Ultramafic- hosted talc-magnesite.
092JNE010	PAYMASTER, PAYMASTER NO. 2 (L.6872), TRUCK, LAZY BOY, IONE, IRIS, PAY	Prospect	Gold	092J10E	122 44 30 W	50 44 15 N	Au-quartz veins.
092JNE011	BUTTE-IXL, BUTTE, IXL	Showing	Copper Lead Gold Zinc	092J10E	122 39 30 W	50 42 25 N	Au-quartz veins.
092JNE012	RED HAWK, DAN TUCKER (L.5806,5802), GOLDSTREAM, JANA, BUTTE	Showing	Gold Talc	092J10E	122 40 35 W	50 43 10 N	Au-quartz veins. Ultramafic- hosted talc-magnesite.
092JNE013	BRAMOOSE, PERIDOT	Showing	Copper Gold Limestone	092J10E	122 39 45 W	50 43 25 N	Cu skarn. Limestone.

092JNE014	ROYAL (L.5650), JANA	Prospect	Tungsten Molybdenum Copper Zinc Gold Silver	092J10E	122 38 45 W	50 42 00 N	Porphyry Mo (Climax-type).
092JNE015	STANDARD (L.1940), UNICORN, BULLDOG, LION, STANDARD CREEK	Showing	Gold Silver Molybdenum Arsenic	092J10E	122 36 08 W	50 41 30 N	Au-quartz veins.
092JNE016	SHORT O'BACON (L.7509)	Prospect	Gold Silver	092J15W	122 50 25 W	50 46 40 N	Au-quartz veins.
092JNE017	GRULL (L.2378), GRULL - WIHKSNE, SILVER KING, SILVER BASIN	Showing	Gold	092J15W	122 49 50 W	50 47 50 N	Au-quartz veins.
092JNE018	SUCCESS (L.3093)	Showing	Gold	092J15W	122 49 15 W	50 47 50 N	Au-quartz veins.
092JNE019	WATERLOO, SUMMIT	Prospect	Gold Silver Antimony Zinc Copper	092J15W	122 45 25 W	50 47 35 N	Au-quartz veins.
092JNE020	CALIFORNIA (L.3173), JEWESS, BRX	Developed Prospect	Gold Silver Copper Zinc Tungsten	092J15W	122 49 25 W	50 49 10 N	Au-quartz veins.
092JNE021	WHY NOT (L.649), BRIDGE RIVER CONSOLIDATED, ELEPHANT (L.444)	Developed Prospect	Gold	092J15W	122 49 35 W	50 49 25 N	Au-quartz veins.
092JNE022	GLORIA KITTY (L.3171), BRX, NATIONAL, ARIZONA	Developed Prospect Production Report	Gold Silver	092J15W	122 49 30 W	50 49 50 N	Au-quartz veins.
092JNE023	FORTY THIEVES (L.443), BRIDGE RIVER CONSOLIDATED, URAL (L.442), ELEPHANT (L.444)	Developed Prospect	Gold Silver Copper	092J15W	122 50 10 W	50 49 55 N	Au-quartz veins.
092JNE024	ARIZONA (L.3176), BRX	Developed Prospect	Gold Silver Tungsten Lead Zinc Copper Molybdenum	092J15W	122 50 20 W	50 50 30 N	Au-quartz veins.
092JNE025	GOLDEN GATE, BRX	Prospect	Gold	092J15W	122 50 10 W	50 50 45 N	Au-quartz veins.
092JNE026	HAYLMORE PLACER, HURLEY RIVER	Past Producer	Gold	092J15W	122 50 25 W	50 50 50 N	Surficial placers.
092JNE027	PILOT, YPRES	Developed Prospect	Gold	092J15W	122 53 20 W	50 52 30 N	Au-quartz veins.
092JNE028	SHULAP COPPER	Showing	Copper	092J15E	122 35 35 W	50 57 10 N	
092JNE029	CONGRESS, CONGRESS MINE	Past Producer Production Report Inventory Report	Gold Silver Copper Antimony Mercury Zinc	092J15W	122 46 53 W	50 53 38 N	Stibnite veins and disseminations. Au-quartz veins.
092JNE030	WAYSIDE, WAYSIDE MINE, NOTMAN, HANGING WALL	Past Producer Production Report Inventory Report	Gold Silver Copper Lead Zinc Antimony	092J15W	122 49 40 W	50 52 37 N	Au-quartz veins.
092JNE031	VERITAS (L.2355-2357)	Prospect	Gold Lead Copper	092J15W	122 54 50 W	50 50 30 N	Au-quartz veins.
092JNE032	LUCKY JEM, BOB	Prospect	Gold Silver	092J15W	122 53 45 W	50 59 25 N	Polymetallic veins Ag-Pb-Zn±Au.
092JNE033	RELIANCE, NEMO 7 (L.7657), FERGUSSON, TURNER, RIVER, DIPLOMAT, SENATOR, IMPERIAL, MERIT, CROWN, EAGLE	Developed Prospect Inventory Report	Gold Antimony Silver	092J15W	122 46 21 W	50 52 58 N	Stibnite veins and disseminations. Au-quartz veins.

092JNE035	SUMMIT, FRINGE BENEFIT, SHADOW OF DOUBT, GLAMOROUS GOLD, PAYMUCK, PS, TOMKEN, KEN, SNOBALL, HOG, CAT, QUINTO, Q, LMT, UMT	Prospect	Gold Silver Zinc Lead Copper Antimony	092J15E	122 31 34 W	50 52 23 N	Polymetallic veins Ag-Pb-Zn±Au.
092JNE036	EMPIRE, CHOPPER, PEAK, JUNE, MAC, TOM, PAT	Prospect	Silver Gold Copper Zinc Lead	092J10E	122 36 12 W	50 42 30 N	Au-quartz veins.
092JNE037	WIDE WEST	Showing	Gold Copper	092J15W	122 51 09 W	50 59 24 N	Au skarn.
092JNE038	BEN, AXE	Showing	Gold Molybdenum	092J09W 092J10E	122 29 40 W	50 41 30 N	
092JNE039	PRIMROSE, CONGRESS EXTENSION	Showing	Copper	092J15E	122 34 50 W	50 55 48 N	Au-quartz veins.
092JNE041	LILLOMER, CHARLOTTE, ANN, MARION, CONARDON MERCURY	Prospect	Mercury	092J15W	122 49 32 W	50 57 56 N	Silica-Hg carbonate.
092JNE042	SILVERSIDE	Showing	Gold Silver Copper Zinc Lead	092J15E	122 32 35 W	50 47 25 N	Polymetallic veins Ag-Pb-Zn±Au.
092JNE043	CHALCO 5 (L.7700), LOWER PIEBITER, PIEBITER CREEK, LIME CREEK	Developed Prospect Inventory Report	Tungsten Copper Gold Silver Molybdenum	092J10E	122 38 35 W	50 43 20 N	W skarn.
092JNE044	CHALCO 12 (L.7702)	Showing	Tungsten Copper	092J10E	122 38 17 W	50 43 28 N	Cu skarn.
092JNE045	LUCKY STRIKE (L.6828), URAL, VICTORIA, WHITE AND BELL, WHITE, BELL	Prospect Production Report	Gold Silver Zinc Lead Copper	092J15W	122 51 42 W	50 59 00 N	Polymetallic veins Ag-Pb-Zn±Au.
092JNE046	TYAUGHTON	Showing	Mercury	092J15E	122 41 35 W	50 56 25 N	
092JNE058	STIBNITE, LOST GOLD, ORO	Prospect	Antimony Gold Silver Copper	092J15W	122 51 53 W	50 47 15 N	Stibnite veins and disseminations. Au-quartz veins.
092JNE059	TRUAX, SPRUCE	Showing	Gold Antimony Silver	092J15E	122 42 00 W	50 48 37 N	Stibnite veins and disseminations.
092JNE060	TRUAX II, ROCK, ROY	Showing	Gold Silver Antimony Zinc Copper Lead Molybdenum	092J15W	122 46 00 W	50 49 22 N	Porphyry Mo (Climax-type).
092JNE064	4-TON (L.2085), MARSHALL CREEK	Showing	Jade/Nephrite Gemstones	092J15E	122 30 46 W	50 54 10 N	Jade.
092JNE065	GREENBAY (L.2084), BRETT CREEK, BLUE	Past Producer	Jade/Nephrite Gemstones	092J15E	122 31 10 W	50 54 12 N	Jade.

092JNE066	GRAY ROCK, BELLORE, EASTER, IBEX, TRUAX GOLD, ROBIN	Past Producer Production Report Inventory Report	Silver Antimony Lead Zinc Gold Copper	092J15E	122 41 55 W	50 48 15 N	Stibnite veins and disseminations.
092JNE067	MARY MAC (MAIN), MARY MAC (NORTH), BEN DOR, MAIN, NORTH	Past Producer Inventory Report	Gold Antimony Molybdenum Silver Copper	092J15E	122 41 15 W	50 51 30 N	Stibnite veins and disseminations. Porphyry Mo (Low F- type).
092JNE068	LITTLE GEM (L.7567), NORTHERN GEM, GEM, GUN CREEK	Developed Prospect Inventory Report	Cobalt Gold Uranium Molybdenum Arsenic	092J15W	122 57 12 W	50 53 47 N	Classical U veins. Five-element veins Ni-Co-As-Ag±(Bi, U). Porphyry Cu ± Mo ± Au.
092JNE070	MOUNT PENROSE, PH	Showing	Asbestos	092J15W	122 57 45 W	50 52 55 N	Ultramafic-hosted asbestos.
092JNE071	BRISTOL, BENBOE	Prospect	Tungsten Gold Silver Zinc Copper Lead	092J15E	122 32 05 W	50 48 53 N	Au-quartz veins.
092JNE072	CONBRA	Showing	Gold	092J10E	122 41 57 W	50 42 25 N	
092JNE073	DAUNTLESS, GOLDBELT, GOLDEN SIDEWALK	Showing	Gold Silver Zinc	092J15E	122 44 51 W	50 54 29 N	
092JNE075	MINTO MINE (L.5601), ALPHA FR, OMEGA, GOLDEN QUEEN, JACK FR, HILLSIDE, HAGMO, GOLDEN GIRL, PRINCE, PONDEROSA, RAINBOW, WINTER	Past Producer Production Report	Gold Silver Copper Lead Zinc	092J15E 092J15W	122 45 00 W	50 53 55 N	Stibnite veins and disseminations.
092JNE076	PEERLESS (L.6770), ZINC, GOLDEN SIDEWALK	Prospect	Gold Silver Zinc Lead	092J15W	122 47 20 W	50 55 32 N	Polymetallic veins Ag-Pb-Zn±Au.
092JNE077	GOLDEN, HELM FR. (L.6328), DREAM, DOMINION, GOLDEN QUEEN (L.6323), GOLDEN KING (L.7077)	Prospect	Gold Silver Antimony	092J15W	122 45 30 W	50 54 00 N	Stibnite veins and disseminations.
092JNE086	OLYMPIC (MANNERS ZONE), MANNERS, ALTA (L.6282)	Prospect	Gold Silver Molybdenum Copper	092J15E	122 43 35 W	50 53 40 N	Cu skarn.
092JNE089	WHYNOT	Showing	Gold Silver	092J15E	122 42 47 W	50 55 46 N	Stibnite veins and disseminations.
092JNE090	RANGER, LUCKY RANGER. BEE, FOXY, BEN D'OR, BIG APPLE, MORE APPLE	Showing	Gold Silver Copper Zinc	092J15E	122 44 43 W	50 50 07 N	Au-quartz veins.
092JNE092	OLYMPIC, MAGEE ZONE, MARGARITA ZONE, LECKIE ZONE	Prospect	Gold Silver Zinc Lead Copper Arsenic	092J15E	122 44 30 W	50 53 27 N	Polymetallic veins Ag-Pb-Zn±Au.
092JNE095	NORTHERN LIGHT 1 (L.6831), GOLDSIDES PROJECT, 24TH OF MAY	Prospect	Gold Silver	092J15W	122 51 40 W	50 59 16 N	
092JNE096	MARY MAC (SOUTH ZONE), SOUTH	Developed Prospect Inventory Report	Gold Antimony Molybdenum Copper	092J15E	122 41 20 W	50 51 50 N	Stibnite veins and disseminations. Porphyry Mo (Low F- type).

092JNE098	BENBOE	Showing	Gold Silver	092J15E	122 32 40 W	50 48 25 N	Au-quartz veins.
092JNE099	SHULAPS RANGE	Showing	Chromium	092J15E	122 32 18 W	50 54 47 N	Podiform chromite.
092JNE100	TAYLOR CREEK CHROMITE	Showing	Chromium Nickel	092J15W 092O02W	122 52 00 W	50 59 59 N	Podiform chromite.
092JNE102	LIZA LAKE A	Showing	Magnesite Chromium	092J15E	122 37 33 W	50 57 33 N	Ultramafic-hosted talc-magnesite.
092JNE103	COMSTOCK, BRADLEY, HOMESTAKE (L.5745), COMSTOCK 2 (L.5744)	Prospect	Gold	092J15W	122 47 40 W	50 47 00 N	Au-quartz veins.
092JNE105	NORTHERN LIGHT 6 (L.6836), GOLDSIDES PROJECT, 24TH OF MAY	Prospect	Gold Copper Silver Zinc Arsenic	092J15W	122 52 21 W	50 59 39 N	Polymetallic veins Ag-Pb-Zn±Au.
092JNE107	OLYMPIC (L.6280) (BILLYO ZONE), OLYMPIC (MOLY ZONE), BILLYO, MOLY	Prospect	Molybdenum Gold Silver Copper	092J15E	122 44 00 W	50 53 45 N	Cu skarn.
092JNE108	JEWEL	Past Producer Production Report	Gold Silver Copper	092J15W	122 56 50 W	50 54 20 N	
092JNE111	JIM CREEK	Showing	Jade/Nephrite Gemstones	092J15E	122 33 15 W	50 56 55 N	Jade.
092JNE113	CADWALLADER CREEK	Showing	Talc Chromium	092J15W	122 46 10 W	50 46 06 N	Ultramafic-hosted talc-magnesite.
092JNE118	NOEL CREEK, ROYAL JADE MINE, CAR	Past Producer Inventory Report	Jade/Nephrite Gold Gemstones	092J10W	122 48 52 W	50 44 45 N	Jade.
092JNE120	PAUL	Showing	Mercury	092J15W	122 45 35 W	50 59 30 N	Silica-Hg carbonate.
092JNE121	WAYSIDE (NEW DISCOVERY), NEW DISCOVERY	Developed Prospect Inventory Report	Gold Copper Zinc Lead	092J15W	122 50 00 W	50 52 15 N	Cyprus massive sulphide Cu (Zn).
092JNE122	MEAD LAKE	Past Producer Production Report	Limestone	092J15W	122 46 52 W	50 47 22 N	Limestone.
092JNE123	MARSHALL RIDGE	Showing	Limestone	092J15E	122 34 56 W	50 53 17 N	Limestone.
092JNE124	WAYSIDE (COMMODORE), COMMODORE FRACTION (L.5503), COMMODORE, 3T, 3 T	Prospect	Gold Silver	092J15W	122 49 55 W	50 52 30 N	Au-quartz veins.
092JNE127	LIZA LAKE B	Showing	Magnesite	092J15E	122 39 13 W	50 57 31 N	Ultramafic-hosted talc-magnesite.
092JNE129	KELVIN, ALMA, ROAD, OLYMPIC	Prospect	Gold Silver Copper Zinc	092J15W	122 45 05 W	50 53 25 N	Polymetallic veins Ag-Pb-Zn±Au.
092JNE130	OLYMPIC (HILLSIDE),	Prospect	Antimony Gold	092J15E	122 43 20 W	50 53 30 N	Stibnite veins and disseminations.
	HILLSIDE 6 (L.6279)						
092JNE131	CONGRESS (LOU), LOU	Developed Prospect Inventory Report	Gold Antimony Silver	092J15W	122 46 12 W	50 53 52 N	Stibnite veins and disseminations.
092JNE132	CONGRESS (HOWARD), HOWARD	Developed Prospect Inventory Report	Gold Antimony Silver Copper	092J15W	122 47 47 W	50 53 25 N	Stibnite veins and disseminations. Au-quartz veins.
092JNE133	CONGRESS (PAUL), PAUL, SLIDE	Developed Prospect Inventory Report	Gold Silver Copper Antimony	092J15W	122 47 30 W	50 54 18 N	Stibnite veins and disseminations.
092JNE134	NORMA	Showing	Gold Silver	092J15W	122 47 30 W	50 51 25 N	
092JNE135	B R JEWEL, BRJ 1, HOBO	Prospect	Gold Silver Copper	092J15W	122 50 45 W	50 46 25 N	Au-quartz veins.

092JNE136	SENATOR (L.7651), SENATOR ROAD, IMPERIAL, BONA ROAD	Prospect	Gold Silver Antimony	092J15W	122 47 16 W	50 52 42 N	Stibnite veins and disseminations.
092JNE137	CRAZY CREEK	Showing	Talc	092J10E	122 43 51 W	50 43 30 N	Ultramafic-hosted talc-magnesite.
092JNE138	LJ	Showing	Gold Silver	092J15E	122 44 19 W	50 51 34 N	Stibnite veins and disseminations.
092JNE139	BILL MINER, BILL MINER'S GOLD, LAD'S GOLD	Showing	Gold Silver	092J15E	122 42 23 W	50 53 16 N	Stibnite veins and disseminations.
092JNE140	LIZA LAKE C	Showing	Magnesite	092J15E	122 39 55 W	50 58 11 N	Ultramafic-hosted talc-magnesite.
092JNE141	PERIDOTITE CREEK	Showing	Chromium	092J15E	122 31 41 W	50 59 21 N	Podiform chromite.
092JNE142	SUNSHINE MOUNTAIN	Showing	Chromium	092J10W	122 46 28 W	50 43 31 N	Podiform chromite.
092JNE143	PIEBITER CREEK	Showing	Limestone Tungsten Copper	092J10E	122 38 54 W	50 43 21 N	Limestone.
092JNE145	UPPER PIEBITER, CHALCO 13	Prospect	Gold Copper	092J10E	122 38 04 W	50 43 12 N	Au-quartz veins.
092JNE149	MUDMAIN	Showing	Magnesite Antimony	092J15E	122 42 54 W	50 58 15 N	Ultramafic-hosted talc-magnesite.
092JNE150	TWO BOB, WAYSIDE, HELIUM	Showing	Gold Arsenic	092J15W	122 49 22 W	50 52 50 N	Au-quartz veins.
092JNE151	CANADA DAY	Showing	Gold Silver	092J15W	122 45 43 W	50 53 27 N	
092JNE152	ENIGMA	Prospect	Gold Antimony	092J15E	122 44 07 W	50 53 42 N	Stibnite veins and disseminations.
092JNE153	FOX, OWL	Showing	Silver Copper Lead Molybdenum	092J10E	122 33 53 W	50 41 43 N	Au-quartz veins.
092JNE155	MINTO EXTENSION 1	Showing	Gold Zinc Lead	092J15E	122 42 30 W	50 55 14 N	Stibnite veins and disseminations.
092JNE164	COSMOPOLITAN, PETER, LOCO, TAYLOR, MILLCHUK	Developed Prospect Inventory Report	Gold Silver Lead Zinc Antimony	092J15W	122 48 31 W	50 47 28 N	Au-quartz veins.
092JNE165	GOLDEN LEDGE, RUTH, JUPITER, LOUISE, JESSE ANNE	Prospect	Gold	092J15W	122 49 48 W	50 48 30 N	
092JNE166	DAN TUCKER	Showing	Gold	092J10E	122 41 05 W	50 43 25 N	
092O 012	ELIZABETH, YALAKOM, YALAKOM NO. 1-4 (L.7408-7411)	Developed Prospect Production Report Inventory Report	Gold Silver Lead Zinc Copper Molybdenum	092O02E	122 32 58 W	51 01 53 N	Au-quartz veins.
092O 013	BLUE CREEK	Showing	Jade/Nephrite Gemstones	092O02E	122 30 42 W	51 02 42 N	Jade.
092O 017	SILVERQUICK MINE, TYAUGHTON CREEK	Past Producer Production Report	Mercury	092O02W	122 49 00 W	51 02 26 N	
092O 018	TUNGSTEN QUEEN, PHILLIPS' TUNGSTEN, PHILLIPS' CINNABAR	Past Producer Production Report	Tungsten Antimony Mercury Gold	092O02W	122 45 12 W	51 02 10 N	Au-quartz veins.
092O 020	TUNGSTEN KING, CINNABAR KING, LORNTZSEN	Past Producer	Tungsten Antimony Mercury	092O02W	122 45 27 W	51 02 44 N	Au-quartz veins.
092O 023	MANITOU, EMPIRE, ROSE GROUP	Past Producer Production Report	Mercury	092O02W	122 46 05 W	51 03 36 N	Silica-Hg carbonate.
092O 026	ROBSON, BONANZA, PEARSON	Past Producer Production Report	Gold Silver Lead Zinc Copper	092O02W	122 53 15 W	51 01 23 N	Polymetallic veins Ag-Pb-Zn±Au.
092O 047	BIG SHEEP MOUNTAIN	Prospect	Gold Silver	092O02E	122 39 36 W	51 01 48 N	Epithermal Au-Ag: low sulphidation.

092O 018	TUNGSTEN QUEEN, PHILLIPS' TUNGSTEN, PHILLIPS' CINNABAR	Past Producer Production Report	Tungsten Antimony Mercury Gold	092O02W	122 45 12 W	51 02 10 N	Au-quartz veins.
092O 020	TUNGSTEN KING, CINNABAR KING, LORNTZSEN	Past Producer	Tungsten Antimony Mercury	092O02W	122 45 27 W	51 02 44 N	Au-quartz veins.
092O 023	MANITOU, EMPIRE, ROSE GROUP	Past Producer Production Report	Mercury	092O02W	122 46 05 W	51 03 36 N	Silica-Hg carbonate.
092O 026	ROBSON, BONANZA, PEARSON	Past Producer Production Report	Gold Silver Lead Zinc Copper	092O02W	122 53 15 W	51 01 23 N	Polymetallic veins Ag-Pb-Zn±Au.
092O 047	BIG SHEEP MOUNTAIN	Prospect	Gold Silver	092O02E	122 39 36 W	51 01 48 N	Epithermal Au-Ag: low sulphidation.
092O 056	EVA, AVE, THULE	Prospect	Gold Antimony Copper Bismuth	092O02W	122 55 30 W	51 02 55 N	Epithermal Au-Ag: low sulphidation.
092O 059	MUGWUMP, RELAY CREEK, BRALORNE MERCURY	Developed Prospect	Mercury Antimony	092O02W	122 48 16 W	51 04 07 N	Au-quartz veins.
092O 096	NOAXE CREEK	Showing	Magnesite	092O02E	122 44 31 W	51 01 06 N	Ultramafic-hosted talc-magnesite.

Table 5: Mineral Resources in the Bridge River Mining Camp (092JNE & 092O).

MINFILE Number/ Name	Ore Zone	Year	Resource Category	Tonnes	Au	Ag	Cu	Pb	Zn	Other	Comment	Reference
					(grams per tonne)		(per cent)					
092JNE001 BRALORNE	UNDERGROUND	1996	Combined	432500	10.63						Proven and probable reserves above the 800 level and readily available for extraction.	Information Circular 1996-1, page 17; 1997-1, page 20.
	UNDERGROUND WORKINGS	1995	Combined	673 kt	8.23						Proven and possible reserves between the 1000 and 2600 levels, accessible by dewatering the shaft.	Information Circular 1996-1, page 17.
	UNDERGROUND WORKINGS	1996	Unclassified	549125	9.26						Estimated resource below the 800 level.	Information Circular 1997-1, page 20.
	VEIN	1995	Combined	570 kt	8.22						Detailed exploration programs, in recent years, have outlined proven, probable and possible reserves for the formerly producing Bralorne 51 vein area.	Information Circular 1996-1, page 17.
092JNE043 CHALCO 5 (L.7700)	LIME CREEK	1980	Combined	72500						W: 1.03	Proven and probable reserves based on 1980 drilling results. Grade given was 1.3% WO3; conversion to W using the factor 1.2611.	Assessment Report 15871.
092JNE029 CONGRESS	CONGRESS	1996	Indicated	146 kt	6.85						Probable reserves.	George Cross News Letter No.56 (March 19), 1996.
092JNE132 CONGRESS (HOWARD)	HOWARD	1986	Combined	267505	11.31						Measured, indicated, inferred reserves; 15% classified as measured, based on underground sampling and surface and underground drilling.	MDAP - Congress Project, Stage I Report, September 1988.
092JNE131 CONGRESS (LOU)	LOU	1986	Indicated	34466	2.74						Average grade of indicated (proven geological) oxide ore reserves at a 1:1 strip ratio; grade is over 20 metres.	George Cross News Letter No.26, 1986.
	LOU	1986	Inferred	89793	2.40						Inferred (probable geological) reserves of open pittable oxide ore.	George Cross News Letter No.26, 1986.
092JNE133 CONGRESS (PAUL)	PAUL	1986	Inferred	83444	9.60						Possible underground reserves over a 1.1 metre width.	George Cross News Letter No.26, 1986.
092JNE007 CORONATION (L.539)	CORONATION	1973	Indicated	80723	38.40						Probable (geological) reserve.	Property File - Campbell, 1973.
092JNE164 COSMOPOLITAN	VEINS	1994	Inferred	362800	17.20						Two veins on the Loco property.	Information Circular 1995-1, page 15.

092JNE066 GRAY ROCK	NO. 1 VEIN	1966	Measured	17780		342.8		2.40		Sb: 4.0	Calculated from drift 18 metres below surface, 9 metres above and below sampled drift. "Proved ore".	Assessment Report 837.
	NO. 1 VEIN	1966	Combined	70488		342.8		2.10		Sb: 3.0	Total of proven, probable and possible reserves.	Assessment Report 837.
092JNE068 LITTLE GEM (L.7567)	LITTLE GEM	1975	Unclassified	18140	22.64					Co: 3.0 U: 0.20		Canadian Mines Handbook 1974-75, page 251.
	LITTLE GEM	1979	Indicated	4740	23.04					Co: 2.974 U: 0.212	U3O8 0.2499 per cent.	Allen 1955.
	LITTLE GEM	1979	Indicated	27705	21.74					Cobalt: 2.045	Calculated from 1219 metres of diamond drilling over 1.5 metres width.	George Cross News Letter No.87, 1979.
092JNE067 MARY MAC (MAIN)	MAIN	1983	Indicated	22300	7.434						Cutoff grade is 3.11 grams per tonne, vertical depth 60 metres, strike length 140 metres, average vein width 2.7 metres.	Assessment Report 11647.
	NORTH	1983	Indicated	10800	5.256						Cutoff grade is 3.11 grams per tonne, vertical depth 40 metres, strike length 40 metres, average vein width 2 metres.	Assessment Report 11647.
092JNE096 MARY MAC (SOUTH ZONE)	SOUTH	1983	Indicated	27300	8.18						Cutoff grade is 3.11 grams per tonne, vertical depth 40 metres, strike length 100 metres, average vein width 2.6 metres.	Assessment Report 11647.
092JNE118 NOEL CREEK	QUARRY	1972	Combined	525						Jade/ Nephrite: 100.0	Possible and probable reserves in rejected 13.5 tonne block-cuttings and boulders.	Geological Survey of Canada Paper 78-19.
092JNE004 PIONEER (L.456)	VEIN	1995	Combined	110 kt	17.10						Probable and possible reserves of the Countless vein.	Information Circular 1996-1, page 17.
092JNE033 RELIANCE	RELIANCE	1988	Combined	410916	5.96						Proven and drill indicated reserves.	George Cross News Letter April 14, 1988.
092JNE030 WAYSIDE	WAYSIDE	1989	Indicated	283950	3.43		2.00		2.50		Drill indicated. This is likely a reserve for New Discovery (092JNE121). Additional 98,000 tonnes reported under the old workings.	Canadian Mines Handbook 1989-90, page 36; 1992-93, page 69.
092JNE121 WAYSIDE (NEW DISCOVERY)	NEW DISCOVERY	1985	Indicated	150000			1.76		3.03		'Potential Reserves' using a true thickness of 4.8 metres. Additional minor precious metals. See Wayside (092JNE030).	Assessment Report 14164, page 31 (Amazon Petroleum Corp.).
092O 012 ELIZABETH	NO. 9	1984	Indicated	3853	41.10						Preliminary results.	George Cross News Letter No.158, 1984.