British Columbia Geological Survey
Geological Fieldwork 1986

GEOLOGY AND MINERALIZATION OF THE BRIDGE RIVER MINING CAMP (92J/15, 92O/2, 92J/10)

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INTRODUCTION

The Bridge River mining camp, centred 185 kilometres north of Vancouver, covers an elliptical area of mountainous terrain bounded roughly by Tyaughton Creek on the north and Cadwallader Creek on the south (Figure 2-2-1). The camp has 73 mineral localities including the Bralorne-Pioneer mining complex which attained the status of the foremost gold producer in British Columbia and sixth largest in Canada.

Regional mapping and property evaluations in the camp, covering parts of the Bralorne, Noaxe and Birkenhead NTS sheets, were initiated by the Ministry in response to intense mineral exploration activity stimulated by rising gold prices.

The area is underlain by 15 mappable units comprising bedded volcanic and sedimentary assemblages and a variety of intrusive igneous rocks ranging from Paleozoic to Tertiary age. These units are faulted and locally invaded by quartz veins which form the loci of gold mineralization (Figure 2-2-2).

ACKNOWLEDGMENTS

Mapping and property examinations were carried out with the able assistance of Mary MacLean.

Much appreciation is owing the mining and mining exploration personnel of the Gold Bridge-Bralorne area, especially Drs. B. Cooke of Levon Resources Ltd. and J. Dawson of Kerr, Dawson & Associates Ltd. and to C. Leitch of The University of British Columbia, for informative discussions.

Officers of the Geological Survey of Canada, Drs. K. Dawson, G. Woodsworth and Margaret Rusmore, provided valuable scientific support in this investigation.

BEDDED ROCKS

The principal stratigraphic assemblages of the area are the Fergusson, Cadwallader and Taylor Creek Groups. The name Big Sheep Mountain volcanics is applied informally to a small area of Tertiary lavas and pyroclastic rocks in the northeast part of the camp (Figure 2-2-3).

The Fergusson Group is the oldest known unit in the area (pre-Permian age?). Where best developed on Mount Fergusson, the group consists of steeply dipping chert beds, some marble, schist, gneiss and hornfels (Figure 2-2-4). Chert is the most common rock type, attaining a thickness of 1000 metres or more. The beds are typically thin ribbons of recrystallized light and dark grey quartz, with a few jasper zones and more rarely, green quartz.

Locally the beds are intricately folded and crisscrossed by thin quartz veinlets. In some places cataclasis has reduced bedding laminations to sheared quartz lenses and intensely milled breccias resembling quartz pebble conglomerate.

Impurities in the chert are mostly white mica interlayers and graphitic schist. In the contact aureoles of the major granitoid intrusions the formation is transformed into highly deformed garnet-biotite-quartz gneiss.

The base of the Fergusson Group is nowhere visible. The only marker horizon is a thin marble band, 1 to 10 metres thick, observed infrequently across the map area.

Locally the group is invaded by numerous greenstone dykes and sills. In zones of intense shearing these feeders are reduced to chlorite schist; in the thermal aureoles of the large granitic stocks fine-grained amphibolite is formed from these basic intrusions.

The Cadwallader Group is Upper Triassic age and composed of three formations, namely the Pioneer Formation, Noel Formation and Hurley Formation. The group is best exposed in the northwest and southeast parts of the map area.

The Pioneer Formation is apparently the oldest unit in the Cadwallader Group and consists of greenstones — chlorite and epidote-bearing basic volcanics. These rocks appear to be connected to the greenstone feeders which intrude the underlying Fergusson Group. The common manifestations of the unit are pillow lavas, aquagene breccias and massive effusives.

Massive lava flows, except for their greater abundance of amygdules, are not readily distinguished from feeder dykes and sills. The only sedimentary rocks assigned to the formation are a few small lenses of limestone and thin tephra beds. Maximum thickness of the formation is estimated to be at least 300 metres.

The Noel Formation is typically a discontinuous thinly bedded black argillite and siltstone unit with a few thin zones of dark grey limestone. In the type area on Noel Creek, the formation rests directly on Fergusson chert but nearby it overlies Pioneer greenstones. In the thermal aureoles of the major igneous intrusions, pyrite and andalusite are common secondary minerals developed in the argillaceous facies. Where best developed, the Noel Formation does not appear to exceed 800 metres in thickness and in some sections of the Cadwallader Group the unit is evidently missing.

The Hurley Formation is best exposed in the vicinity of Eldorado Creek in the northwest part of the map area. The predominant composition of these rocks is green, brown and black argillite and cherty argillite. These southwesterly dipping beds (Figure 2-2-4) are locally intercalated with gritty siltstones and sandstones and some calcarenites. At least two limestone marker horizons have been noted midway through the section. Coarse volcanic breccias of dacitic and basaltic composition occur in the upper part of the formation. Boulder and pebble conglomerate has been observed at the base of the formation, resting conformably on thin volcaniclastic beds and pillow lavas of the Pioneer Formation. Conglomerate with limestone clasts is also found above and lateral to the limestone members. Chert from the Fergusson Group is a common clast in the coarse Hurley sedimentary rocks, as are fragments of rhyolite quartz porphyry from an uncertain source. Pebbles of basic volcanic rock, schist and diorite are less common. The thickness of the Hurley Formation is estimated to be in the order of 1200 metres.

The Taylor Creek Group, as examined in the type area in the Taylor Creek basin, consists mostly of coarse clastic sedimentary rocks having an aggregate thickness of about 3000 metres. At the base and middle is a sequence of polymictic pebble and boulder conglomerate beds, each 10 to 15 metres thick, separated by siltstone seams, 1 to 2 metres thick. Above this are sandstones with

British Columbia Ministry of Energy, Mines and Petroleum Resources, Geological Fieldwork, 1986, Paper 1987-1.

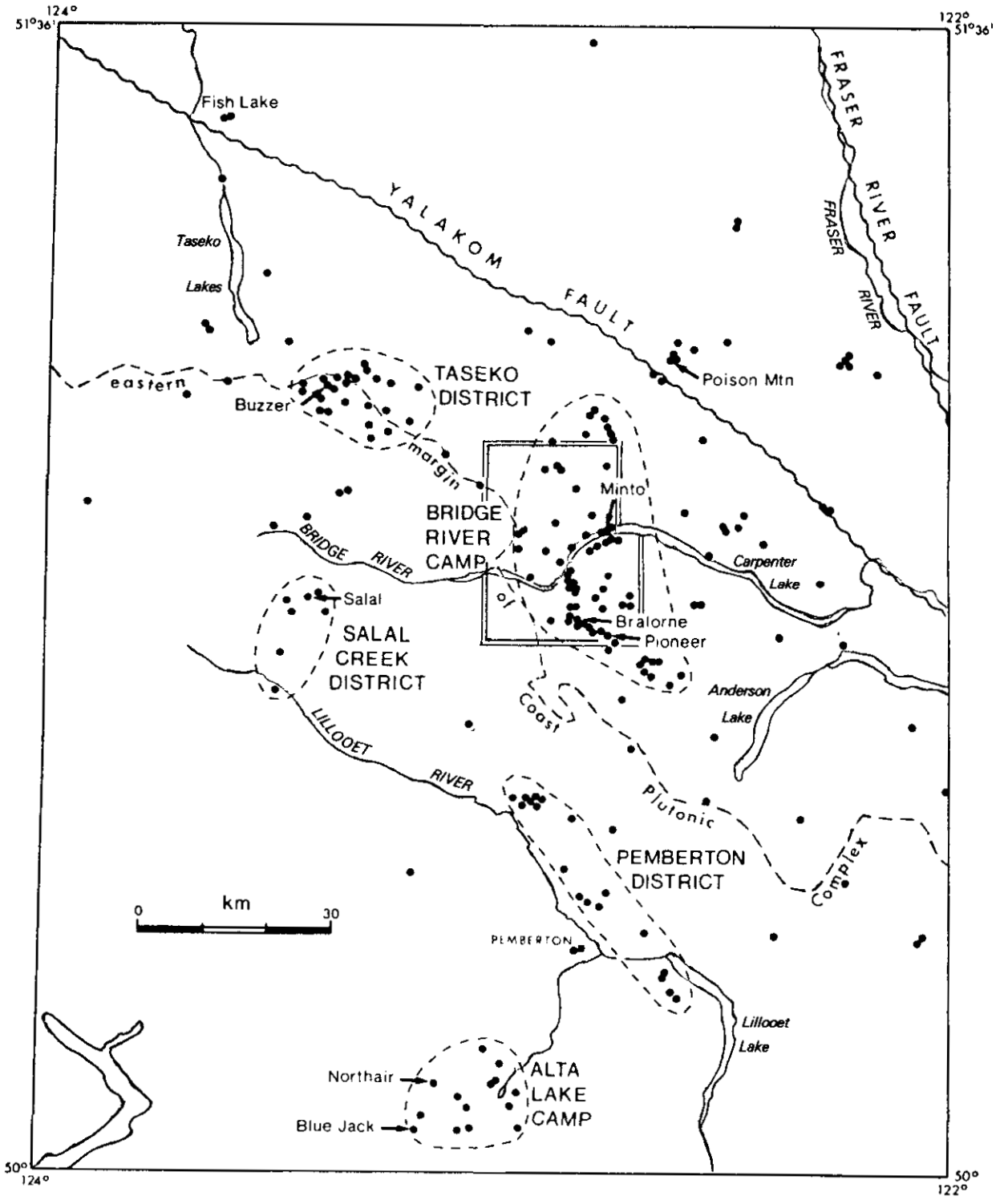

Figure 2-2-1. Location of 1:20 000-scale 1986 mapping (double frame) in Bridge River mining camp; mineral deposits shown as dots (after Woodsworth, Pearson and Sinclair, 1977).

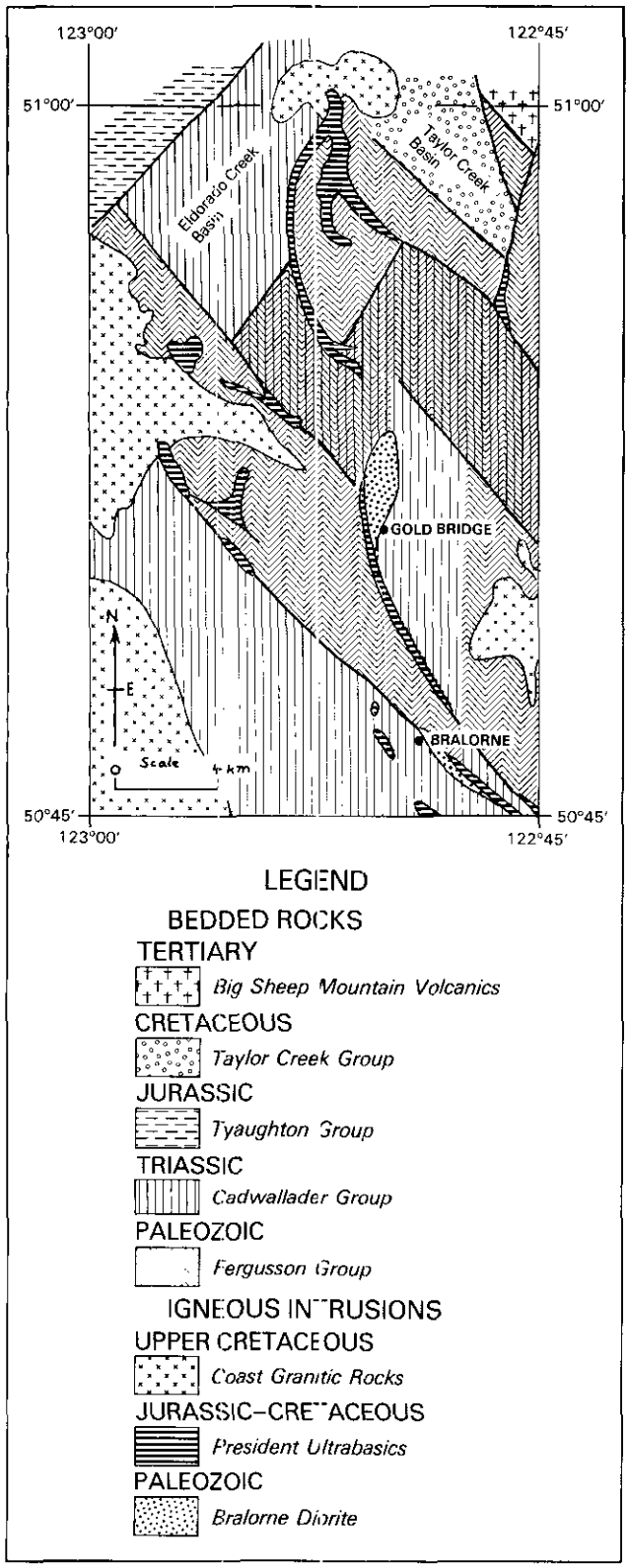

Figure 2-2-2. Generalized geology of the Gold Bridge area (92J/15W).

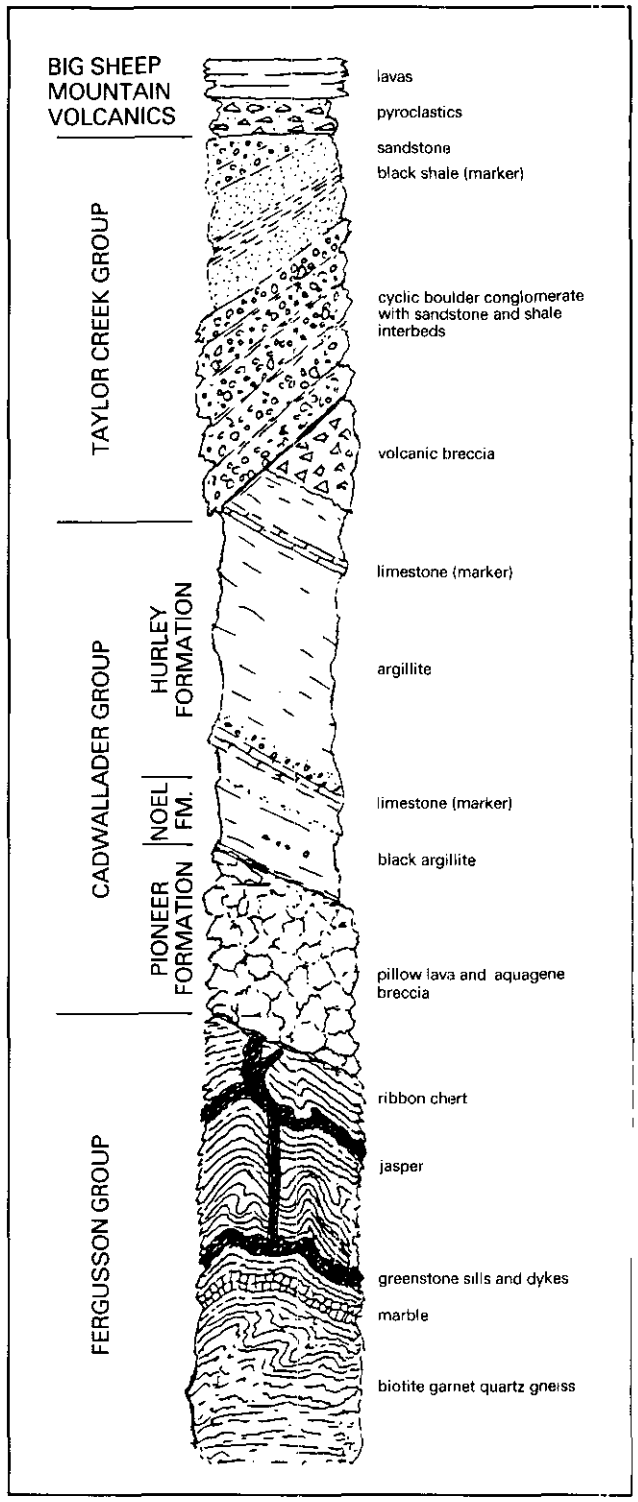

Figure 2-2-3. Stratigraphy in the Gold Bridge mining camp.

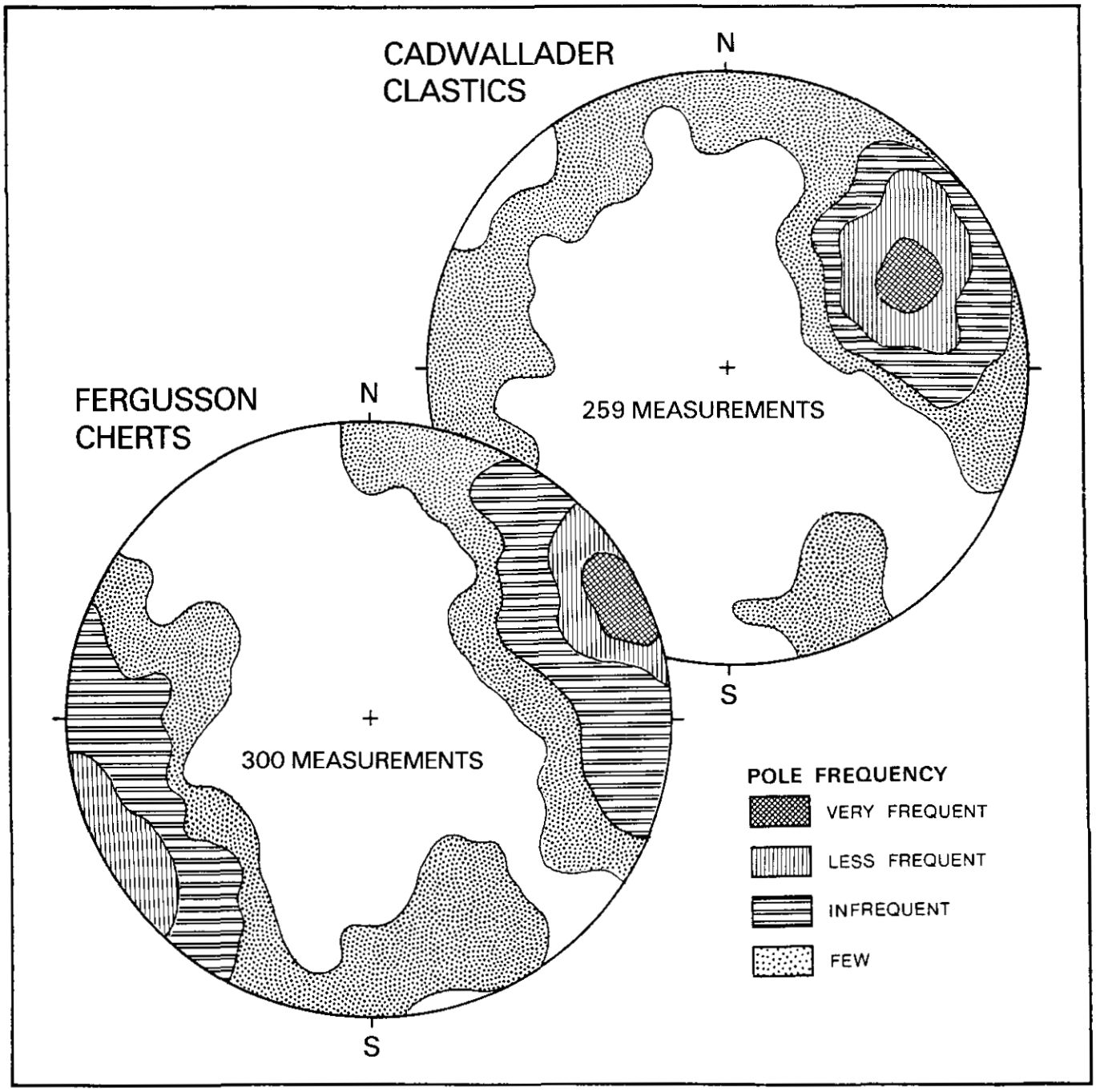

Figure 2-2-4. Equal area plots of bedding attitudes of Fergusson and Cadwallader Group rocks in the Gold Bridge area.

silty and conglomeratic interlayers, 600 metres thick, and a dark grey argillite marker zone, about 50 metres thick. Chert predominates among the clasts in the conglomerate, although porphyry, quartz, shale, limonite, conglomerate and limestone rock types are also present. The source of these fragments is believed to be the Fergusson Group and Hurley Formation.

The Big Sheep Mountain volcanics is an informal name applied to a small area of Tertiary andesitic lava and tuff breccia occurring in the extreme northeast corner of the map area. Little is known about the structure and petrography of these rocks. The cream and brown-coloured assemblage appears to be downfaulted in a small northerly trending graben. Petrological and age correlation with Tertiary dykes elsewhere in the map area is a possibility.

IGNEOUS INTRUSIONS

The main igneous intrusions are the Bralorne diorite (Paleozoic), the President ultrabasic rocks and the Coast plutonic rocks (Mesozoic). In addition there is a variety of small felsic to basic Mesozoic and Tertiary dykes and sills scattered across the map area.

The Bralorne diorite is exposed at intervals from the Pacific Eastern property near the southeast extremity of the map area, through the Bralorne-Pioneer mineral belt, to the town of Gold Bridge on the Carpenter Lake Highway. The alignment and elongated shape of these bodies suggest emplacement of the diorite in a major fault zone. The diorite is a mottled greenish-grey rock with a variable texture usually characterized by a reticulate pattern of light-

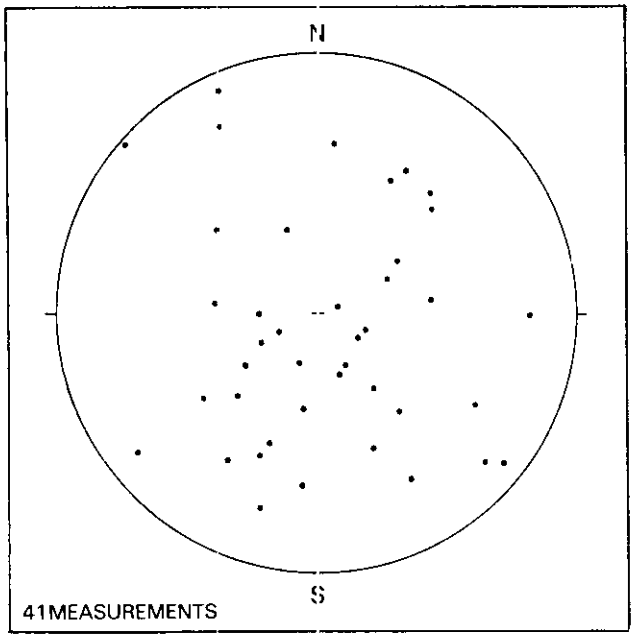

Figure 2-2-5. Stereographic plot of fold axes for Fergusson chert beds in the Gold Bridge area.

coloured veinlets of felsic minerals; epidote, prehnite and calcite. In thin section a typical sample is found to consist of about equal amounts of amphibole and plagioclase. According to the mineralogical scheme of rock classification, the name diorite has been applied because of the sodic composition of the plagioclase, although the chemical composition of these rocks ranges to gabbro. Potassium-argon analyses, performed at The University of British Columbia on a sample of the diorite from Gold Bridge, yielded an Upper Carboniferous age.

The President ultrabasic rocks are lenticular bodies that follow the belt of the Bralorne diorite. Other major elongated zones of ultrabasic rocks occur along major faults on Mount Penrose and in the area between the Eldorado Creek and Taylor Creek basins. Although much of the rock has been converted to serpentine, numerous textural phases are seen in outcrop. These range from bright green schistose phases and dull black massive varieties to porphyritic serpentine with phenocrysts of bastite. In the Eldorado and Taylor Creek basins, the serpentine zones are commonly accompanied by bright rust-coloured carbonate bands known as "listwanites". The origin of these ultrabasic rocks is thought to be solid emplacement of pyroxenite and dunites in fault zones followed by extensive metasomatism. The age of the ultrabasic intrusions is known to be younger than the Upper Triassic Hurley sedimentary rocks that they cut, and older than the overlying Middle Cretaceous (Albian) Taylor Creek beds.

The Coast plutonic rocks comprise an assortment of granitic plutons exposed mainly in the southwest and west part of the map area in the vicinity of Mount Sloan, Mount Dickson and the westerly ridges of Mount Penrose. Other related, but isolated stocks, occur on Mount Eldorado on the north boundary of the map area and in the Bendor Range on the southeast boundary. These rocks are mostly hornblende granodiorite with accessory biotite and sphene found in some samples. Quartz diorite and biotite granite are local phases within the larger granodiorite intrusions. Apophyses of "soda granite" occur associated with the quartz veins in the Bralorne-Gold Bridge belt. The age range for these intrusions is Upper Cretaceous (~80 million years) to Lower Tertiary (58.9 million years), the Bendor stock being the youngest.

Numerous Mesozoic and Tertiary dykes and sills occur throughout the map area. Dyke swarms of basic to intermediate composition (greenstones), 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 Tertiary dykes and sills are generally fresh and undeformed, although alteration may be pronounced in some mineralized zones (that is, carbonated dykes). The main Tertiary effusives are light brown feldspar porphyries and fine-grained pulaskite equivalents, grey and brown hornblende andesite porphyries and, less commonly, fresh basalt dykes. Some of these rocks form small plugs and volcanic necks.

STRUCTURAL GEOLOGY

The structural history of the Bridge River mining camp records repeated cycles of folding and faulting. The total effect of this is displayed in the rocks of the Fergusson Group, which are the oldest in the area. These rocks are steeply dipping and intricately folded. The lack of any apparent consistency in the direction of fold axes across the region (Figure 2-2-5) is evidently due to localization of structures because of (1) the presence of primary slump folding, (2) deformation at the irregular margins of the granitic plutons and (3) rotation of beds by repeated episodes of faulting. The Hurley beds, recording only part of this history, are more simply deformed; only two periods of folding have been identified.

The major fault lineaments, marking the boundaries of the principal structural domains, commonly coincide with the zones of ultramafic rocks which are readily mapped. These boundaries, which trend north and northwest, have sustained through the emplacement of the Upper Cretaceous-Tertiary granitic plutons. The north-trending boundaries appear to be tension faults separating horst and graben panels in the northern part of the map area; the northwest trend is the principal shear direction in a regional stress scheme.

MINERALIZATION

The Bridge River mining camp remains foremost in total gold production in British Columbia. Only five of the 73 properties in the camp achieved significant production. The statistics are as follows:

TABLE 2-2-1
PRODUCTION FROM THE BRIDGE RIVER CAMP

	Tonnes	Gold (kg)	Silver (kg)	Copper (kg)	Lead (kg)	Zinc (kg)
Congress	943	2.5	1.3	38	—	—
Wayside	36 977	166.0	26.0	—	—	—
Minto	79 073	546.0	1 573.0	9 673	56 435	—
Pioneer	2 240 552	41 475.0	7 611.0	—	59	139
Bralorne	4 954 473	87 759.0	21 969.0	—	157	—

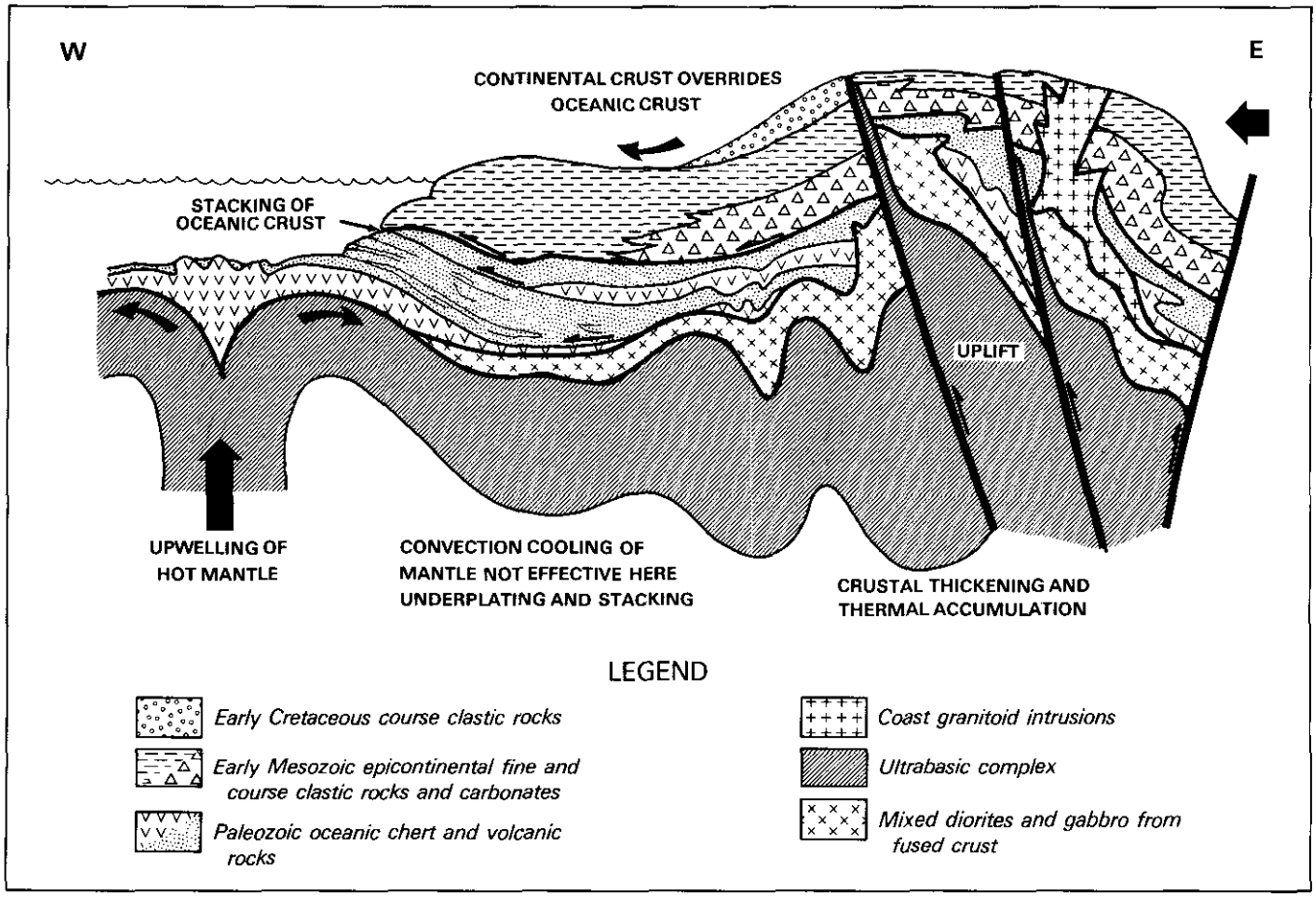

Figure 2-2-6. Tectonic model for Early Cretaceous events in southwestern and interior British Columbia.

It has been proposed that the extensive fissure system in the camp provided the necessary channelways for vein-forming and mineral-bearing solutions. In this model the Coast granitic intrusions served as the heat and water source and possible origin of the metals. This concept is supported by a 35-kilometre-wide zonation of deposits developed lateral to the Coast plutons (Woodsworth *et al.*, 1977). Close to the Coast plutons ores tend to be arsenic rich, passing outwards through an antimony zone to deposits enriched in mercury.

Examples of proximal to distal deposits are the Bralorne, Pioneer and Congress mines, and the Lillomer prospect respectively.

At the Bralorne and Pioneer mines the gold and arsenopyrite-bearing quartz veins fill en echelon tension fractures in the Bralorne diorite and Pioneer greenstones. The source of these veins and the associated carbonate alteration appears to be the apophyses and cupolas of the soda granite.

At the Congress mine mineralization is characterized by an abundance of stibnite, arsenopyrite and some cinnabar associated with ankeritic alteration and quartz lenses in shears. The host rocks include fissured Tertiary porphyry dykes. The deposit is distal to local granitic intrusions.

The Lillomer mercury prospect is located on North Cinnabar ridge remote from the Coast Plutonic Belt. Cinnabar and native mercury occur with calcite in a fissure system near the contact of the Fergusson and Cadwallader Groups.

It has been noted that the veins in the mines of the area were often abnormally rich adjacent to the ultrabasic rocks. Consequently it can be argued that the ultimate source of gold is related to deep fissures along which the ultrabasic rocks were intruded. The rise of ultrabasic mantle material may coincide with underplating and stacking of oceanic and mantle slabs beneath an overriding continental plate (Figure 2-2-6). The subsequent intrusion of granitic plutons could have caused redistribution of metals already introduced on the major faults.

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