COQUIHALLA GOLD BELT PROJECT
(92H/11, 14)

By G. E. Ray

INTRODUCTION

A third and final field season's mapping along the northern portion of the Coquihalla serpentine belt was completed using a two-man field crew. The work included the following:

(1) Regional geological mapping (scale 1:15 000) comprising an 85-square-kilometre, elongate strip stretching from the vicinity of Boston Bar southward to the Spider Peak area (Figs. 18, 19, and 20). Mapping was concentrated in areas adjacent to both the Hozameen fault system and the Coquihalla serpentine belt.

(2) Surface examination and sampling of the gold-bearing 'Monument' quartz vein (Mineral Inventory 92H/NW-54; Fig. 19).

(3) Collecting grab samples from any sulphide-rich or gossanous zones encountered during the mapping. These were assayed for base and precious metals.

(4) Collecting limestone samples from the Hozameen Group for microfossil age dating.

REGIONAL GEOLOGY

The regional geology adjacent to the Hozameen fault system from Coquihalla River to Boston Bar is shown on Figures 18, 19, and 20. South of Carolin mine (Fig. 18) the Coquihalla serpentine belt forms an elongate, steeply dipping unit that exceeds 2 kilometres in outcrop width; the eastern and western margins of the belt are defined by two major fractures, the East and West Hozameen faults (Ray, 1983) that suffered recurrent vertical and transcurrent movement. The serpentine belt separates the Hozameen Group to the southwest from the Jurassic Ladner Group to the northeast (Fig. 18). The Hozameen Group comprises an ophiolitic sequence of cherts, pelites, and basaltic greenstones, while the Ladner Group consists largely of a succession of turbiditic wackes, siltstones, and slaty argillites. Northward from Carolin mine the belt gradually thins until in the vicinity of Siwash Creek (Fig. 19) the Hozameen and Ladner Groups are either in direct fault contact, or separated by narrow lenses of fault-bounded serpentinite that are generally less than 100 metres in width. North of Gilt Creek (Fig. 19) serpentinites associated with the Hozameen fault disappear entirely; from this vicinity northward to the confluence of the Fraser and Anderson Rivers (Fig. 20), the Hozameen and Ladner Groups are in direct fault contact. However, near Petch Creek (Fig. 20), where serpentinites are exposed on the Trans-Canada Highway, southward to an area approximately 2 kilometres northeast of Chapmans Bar, there is a prominent, continuous belt of serpentinite up to 500 metres in width. This belt marks the western, highly tectonized margin of the Hozameen Group and separates this oceanic, mostly suprascustal assemblage from granitic rocks lying immediately to the west. Thus the Coquihalla serpentine belt, which was regarded formerly as a single, discontinuous elongate unit (Cairnes, 1929; Monger, 1970; Ray, 1983), is separable into dissimilar northern and southern belts. These two belts have contrasting structural and stratigraphic relationships; limited data suggest they also possess marked petrographic and geochemical differences. Consequently, the northern and southern serpentine belts are probably unrelated; their regional on-strike position is coincidentally caused by a set of younger,
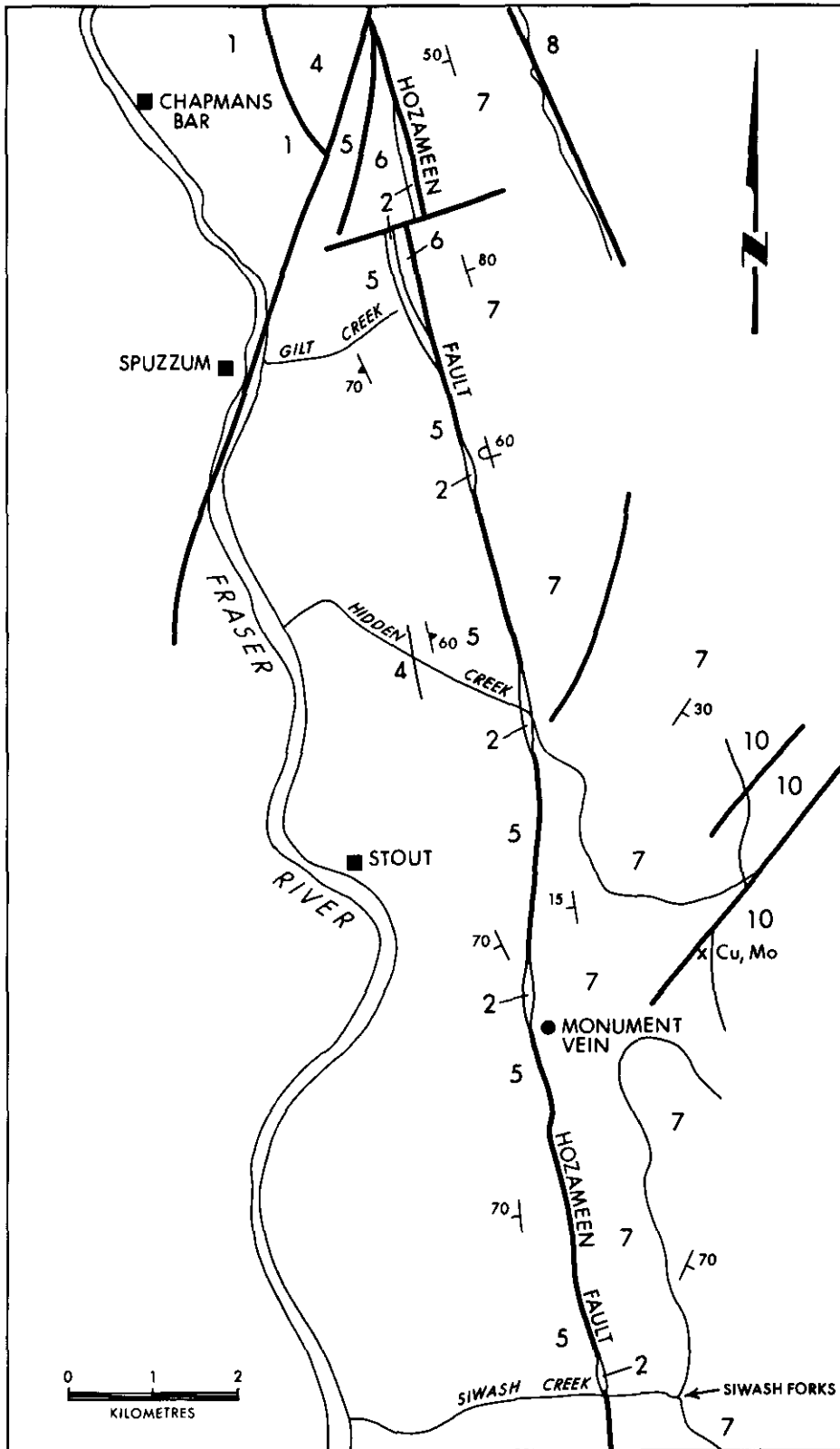
Figure 19. Geology between Siwash Creek and Gilt Creek.

oblique faults that pass from Spuzzum north-northeastward to the Anderson River (Figs. 19 and 20). South of Spuzzum this younger but major fault, which probably belongs to the Fraser fault system, continues along the Skeemis Creek valley; north of Gilt Creek it causes at least 5 to 6 kilometres of right lateral displacement on the older Hozameen fault.

A broad stratigraphic succession is recognized in the Ladner Group (Ray, 1982, 1983) comprising a hetero-geneous lower unit of lithic wackes and conglomerates passing upward into finer grained, more regularly bedded siltstones and slates. The lower clastic unit is economically important because it hosts many of the gold occurrences in the Coquihalla gold belt, including the Idaho zone orebody of Carolin Mines Ltd. The lower unit is best developed in the vicinity of this mine, where it exceeds 200 metres in thickness and unconformably overlies an older pillowed volcanic greenstone sequence of possible Early Triassic age (Ray, 1983). Further north and south, however, the fault cuts progressively to higher stratigraphic levels in the Ladner Group. Consequently, north of Spider Peak the Hozameen fault cuts mostly slates and siltstones in the higher part of the Ladner Group succession, and the lower coarsely clastic unit is generally absent. The basement greenstones underlying the Ladner Group generally lie south of Spider Peak (Fig. 18). North of Gilt Creek (Fig. 19), however, there is another 2-kilometre-long unit of presumed basement greenstone exposed which is bounded by faults and serpentinites; it could represent a tectonic slice of basement greenstone offset from similar rocks in the Spider Peak area by transcurrent movement along the Hozameen fault. If this interpretation is correct, it indicates that at least 18 kilometres of right lateral transcurrent displacement took place along this portion of the Hozameen fault system.

Approximately 5 kilometres east of Stout (Fig. 19) the folded, often gently dipping siltstones of the Ladner and Dewdney Creek Groups are intruded by a large body of massive granodiorite; it covers at least 3 square kilometres but its full dimensions are unknown. This granodiorite probably represents a northern, previously unmapped extension of the Needle Peak pluton; the Needle Peak pluton has been dated by K/Ar methods at 39 Ma (Wanless, et al., 1967). The contact of the granodiorite intrusion is marked by a meta-morphic aureole up to several hundred metres wide in the Ladner Group, together with swarms of both porphyritic and even-grained felsic sills and dykes. At least three types of felsic dykes comprise the swarms; these are:

(1)   feldspar porphyries with coarse euhedral feldspar crystals up to 3 centimetres across,
(2)   quartz porphyries with rounded quartz crystals up to 4 millimetres in diameter, and
(3)   even-grained, siliceous dacitic sills and dykes containing small amounts of biotite and pyrite.

Most sills and dykes are less than 30 metres wide but the feldspar porphyries are extremely widespread within the Ladner Group throughout the district; in places this suite is associated with weak gold mineral-ization as, for example, at the Spuz occurrences (Mineral Inventory 92H/NW-55). These felsic sills predate the main movement on the Hozameen fault, since they are confined to the Ladner Group and absent from both the serpentine belt and the Hozameen Group. Since geological mapping indicates that these sills are related to the Needle Creek pluton, it suggests that the major movements along the Hozameen fault took place less than 39 Ma ago.

The Hozameen Group between Gilt Creek and Spider Peak (Figs. 18 and 19) comprise a highly deformed assemblage of cherts, argillites, and altered greenstones in which no stratigraphic succession is recognized. The assemblage is cut by several suites of intrusive rocks of felsic to intermediate composition that includes some distinctive quartz porphyries. These intrusive rocks do not occur in the adjacent serpentinites or Ladner Group, which indicates that they predate the main transcurrent movements along the Hozameen fault. Between Boston Bar and Gilt Creek (Figs. 19 and 20) a much wider section of the Hozameen Group has been mapped. The oblique right lateral faulting north of Gilt Creek has moved this northern segment of Hozameen Group rocks, together with its westerly bounding serpentinite belt and adjacent granitic rocks, some 5 to 6 kilometres to the north-northeast. The Hozameen Group assemblage in this northern segment, like that south of Gilt Creek, has been intensely deformed and the overall structure is still poorly
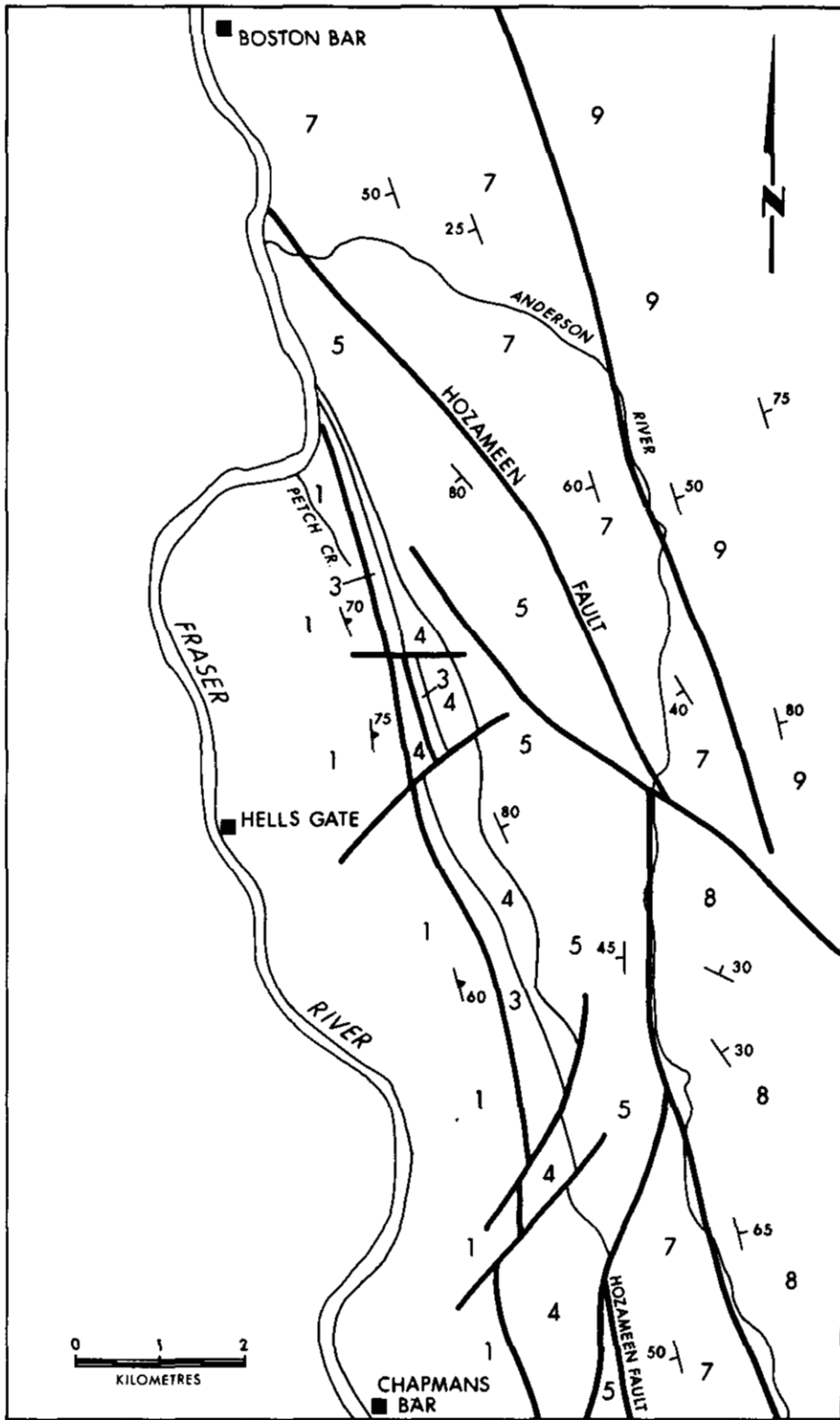
Figure 20. Geology of the Anderson River—Chapmans Bar area.

understood. Nevertheless, a broad stratigraphic succession is recognized in the northern segment, consisting of serpentinites at the base, overlain by a thick unit of greenstones, gabbros, and diorites, which passes stratigraphically upward into a thick sequence of cherts with minor greenstones and argillites. A mixed sequence of cherts, greenstones, altered volcanogenic sedimentary rocks, and small, grey limestone lenses may represent the highest portion of the Hozameen Group stratigraphy exposed in this area, although structural interpretation makes this uncertain. This succession provides supportive evidence that the Hozameen Group represents an ophiolite suite.

The northern serpentine belt represents the deepest recognized portion of the Hozameen Group succession and also generally marks the westernmost boundary of the group (Fig. 20). The belt is fault bounded and mostly dips between 40 to 70 degrees east. The serpentinites in the northern segment differ from those associated with the Hozameen fault further south; they commonly include slices of altered ultramafic material in which primary igneous textures are still recognizable. Locally the stratigraphically and structurally overlying greenstone unit also contains thin, discontinuous serpentinite slices. The sharp, easterly dipping tectonic contact between the serpentinites and the granitic rocks to the west is marked by faulting and shearing. In some places the granites immediately adjacent to the serpentinites show signs of mylonitization. The granitic rocks are texturally varied, ranging from massive, apparently undeformed pink to white granodiorite, to well-foliated rocks which includes both leucogranites and highly mafic material. Minor amounts of grey, moderately foliated granitic gneiss are also seen; the latter could represent thin, tectonic slices of Custer gneiss. The granitic rocks approximately 2 kilometres east-southeast of Hells Gate (Fig. 20) include a thin, elongate xenolith of grey marble more than 250 metres in length. The highly deformed marble contains sharply angular, matrix-supported clasts of pink leucogranite up to 20 centimetres in diameter; these clasts probably have a tectonic origin.

The intense faulting and the sporadic development of foliated and mylonitized granites indicate that the western margin of the Hozameen Group represents a major, previously unrecognized fault. This fracture apparently cuts granitic rocks in the Hells Gate-Yale area; these granites have been dated by K/Ar methods at approximately 40 Ma (Wanless, et al., 1967) which sets an older time limit for this fault movement.

ECONOMIC GEOLOGY

The area between Spider Peak and Gilt Creek (Figs. 18 and 19) has been actively prospected over the last 90 years and a number of gold occurrences have been located; these include the Roddick, Emigrant, Marvel, Majestic, Gold Coin, Gold Cord, Spuz, and Monument, as well as the Ward deposit which was briefly worked in 1905. Apart from the Spuz and Monument occurrences, no detailed geological descriptions are available; both the nature of the mineralization and precise locations are uncertain. The remains of an old stamp mill and several collapsed adits at Siwash Forks (Fig. 18) are believed to be the old Ward mine workings (Mineral Inventory 92H/NW-15); reportedly 4 kilograms of gold were produced in 1905 (Mineral Inventory File). The geology in this vicinity comprises Ladner Group slaty argillites with minor amounts of well-bedded siltstones; they are intruded by a large number of porphyritic and massive felsic sills. One short exploratory adit on the north side of Siwash Forks follows the edge of a sill; it seems likely that the gold in this vicinity was won from quartz veins cutting the felsic intrusions.

Another series of adits was reported on the Emigrant property (Minister of Mines, B.C., Ann. Rept., 1917) on the south fork of Siwash Creek; these were not seen during the present work. The Majestic (Mineral Inventory 92H/NW-33) is situated in the upper part of Hidden Creek (Fig. 19) where a collapsed adit is reported. This area is underlain by Ladner Group slaty argillites and siltstones that are intruded by numerous felsic sills. The weak gold mineralization on this property is also probably found in quartz veins cutting these felsic intrusions.

The Monument gold occurrence (Mineral Inventory 92H/NW-54), situated 3 kilometres southeast of Stout (Fig. 19), is hosted in a steeply dipping 1 to 2.5-metre-wide quartz vein that has a strike length of approximately 350 metres (Cochrane and Littlejohn, 1978; Cardinal, 1982). The Monument vein is subparallel to, and 200 metres east of, the Hozameen fault; it is hosted in deformed slaty argillites of the Ladner Group. The white quartz vein contains minor amounts of fine pyrite with rare arsenopyrite and chalcopyrite; five grab samples collected by Cochrane and Littlejohn (1978) averaged 2.8 grams gold per tonne (0.084 ounce per ton) with one richer sample assaying 10.1 grams gold per tonne (0.297 ounce per ton). Cochrane and Littlejohn (1978) report that visible gold in the Monument vein occurs either as small rounded particles between 0.5 to 2 millimetres in diameter embedded within vuggy quartz or as small thin flakes coating shear surfaces at the quartz vein-argillite contact.

The Spuz occurrences (Mineral Inventory 92H/NW-55) comprise numerous minor gold showings that are associated with felsic sills and dykes which intrude the Ladner Group north and northwest of Siwash Forks. The very fine, erratic gold is hosted in narrow quartz and quartz-calcite veins that fill brittle fractures and boudin structures in the sills. These veins also carry sparse pyrite and rare arsenopyrite (Cochrane and Littlejohn, 1978; Cardinal, 1982), while the former authors also report the presence of rare scheelite mineralization.

The felsic sills associated with the granodiorite body 5 kilometres east of Stout (Fig. 19) are occasionally related to weak pyritization in the adjacent country rocks. However, more intense, pervasive sulphide alteration is seen in the thermally altered siltstones within 1 kilometre of the granodiorite margin, where dyke swarms of felsic intrusive rocks are common. The metasedimentary rocks contain disseminated pyrite with some weak silicification and iron carbonate alteration. This pyritization appears to be associated with the siliceous dacitic sills and not related to the more abundant feldspar porphyry intrusions. Grab samples of sulphide-rich material were assayed for base and precious metals without significant results. However, at one locality (620100E — 5498500N) less than 100 metres from the granodiorite margin (Fig. 19), the thermally altered, sulphide-rich siltstones are cut by 5 to 8-centimetre-wide vuggy quartz veins which are folded and sheared. These veins contain pyrite, chalcopyrite, and some coarse flakes of molybdenum, but no gold. This previously unreported copper-molybdenum occurrence suggests that the Needle Peak pluton and its thermal aureole could represent a viable exploration target for base metals and possibly gold.

DISCUSSION

REGIONAL CONTROLS OF MINERALIZATION IN THE COQUIHALLA GOLD BELT

The Coquihalla gold belt comprises the currently operating Carolin mine and four past producers (Emancipation, Aurum, Pipestem, and Ward), as well as 19 minor gold occurrences (*see* Table 3, Ray, 1983). These deposits and occurrences are extremely variable in their form, geochemistry, mineralogy, and host rock lithology; this makes it difficult to recognize common relationships and controls. For example, the producers are hosted in several different rock lithologies: Carolin and Pipestem in sedimentary wackes, Emancipation in volcanic greenstones, Aurum in talcose shears, and the Ward* in felsic sills. Their form varies widely from discrete quartz veins as seen at Emancipation mine, to more diffuse, possibly replacement-type orebodies as found at Carolin mine. The gold-bearing quartz veins at Emancipation mine and the Monument and Murphy occurrences are sulphide poor, whereas the mineralization at Carolin mine and the McMaster zone are rich in pyrite, pyrrhotite, and arsenopyrite.

The sparse available data suggest the gold mineralization along the belt exhibits some geochemical as well as mineralogical differences. No mercury enrichment is reliably reported from any occurrence or deposit but both the Carolin deposit (Ray, 1983) and the Monument vein (Cochrane and Littlejohn, 1978) are

*No geological description of the Ward mine exists. The assumption that the mineralization was hosted in felsic sills is based on the geology in the Ward mine area.

associated with anomalous tungsten values. The identical mineralogy and geochemistry of the Carolin deposit and the McMaster zone suggest that the two are related and synchronous; they are distinctive in that the gold-sulphide mineralization is associated with abundant albite. No such sodium enrichment is reported elsewhere in the belt. The Aurum mineralization is unique because it is the only example where gold occurs within the East Hozameen fault; it is closely associated with the talcose, highly sheared serpentinite margin. It also appears to include a variety of sulphides, including millerite (Cairnes, 1929).

Despite these variations some generalizations are possible. In all cases the introduction of gold was accompanied by variable amounts of silica and at least four forms of orebody or occurrences are recognized; these are:

(1) Thin, highly irregular and generally discontinuous quartz veins; these host the majority of the minor gold occurrences including the Murphy and Spuz occurrences.

(2) More continuous, wider, and discrete quartz veins as seen at the Emancipation mine and the Monument occurrence.

(3) Irregular orebodies hosted in highly fractured, coarse clastic sedimentary rocks which are associated with silicification, network quartz veining, albitization, and abundant sulphides as present at the Carolin mine deposit and the McMaster zone. Recent underground mapping by Carolin mine geologists (Shearer and Niels, 1983) shows that the Idaho zone mineralization is concentrated in an antiformal hinge zone.

(4) Gold within talcose shears along the East Hozameen fault immediately adjacent to serpentinites and Ladner Group metasedimentary rocks. The Aurum mineralization is the only discovered example of this type.

When the deposits and occurrences in the belt are examined, some relationships between their host rock types, and their distance from both the East Hozameen fault and the greenstone-Ladner Group contact are discernible. Figure 21a shows the five gold producers together with 13 occurrences for which reliable data is available; it plots their host rock type and relative distance from the East Hozameen fault and serpentinite contact. This shows the gold is found only east of the East Hozameen fault and none is reported from within the serpentine belt. Moreover, the majority of occurrences are hosted in metasedimentary rocks, mostly belonging to the Ladner Group. While gold can be found up to 1 kilometre east of the serpentine belt, most occurrences and deposits are concentrated within 600 metres of the East Hozameen fault. Figure 21b clearly demonstrates moreover, that most gold production in the belt was derived from deposits less than 200 metres from the serpentinite margin and East Hozameen fault.

Figure 22a reveals the close spatial relationship that exists between the greenstone-Ladner Group contact and various deposits and occurrences for which reliable location data exist. This relationship is further demonstrated on Figure 22b which shows that over 95 per cent of the gold production from the belt has taken place within 150 metres of this lithological contact.

Thus, the main regional controls to mineralization in the Coquihalla gold belt are:

(1) The presence of competent rocks suitable for open space fracturing. Consequently the area between the Emancipation mine and Spider Peak, where the lower coarse clastic rocks of the Ladner Group are best developed, contains most of the sediment-hosted gold occurrences, as well as the Carolin mine deposit (Fig. 18).

(2) Close proximity to the volcanic greenstone-Ladner Group contact. In many places the unconformable contact, due to competency differences, is marked by shearing, brittle fracturing, and quartz veining.
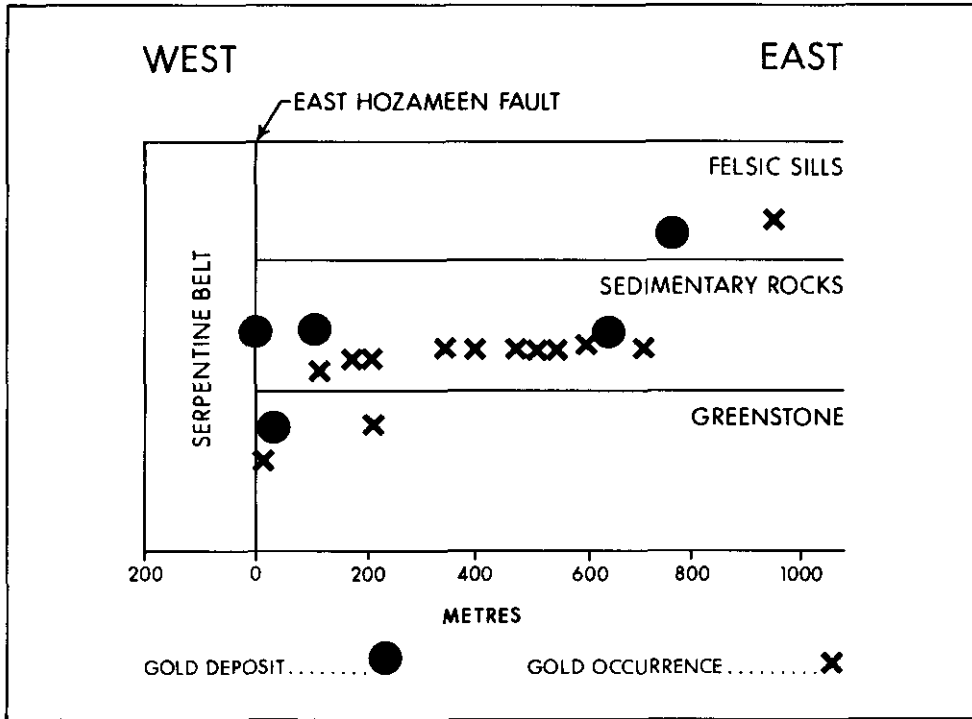
WEST   EAST

EAST HOZAMEEN FAULT

FELSIC SILLS

SEDIMENTARY ROCKS

SERPENTINE BELT

GREENSTONE

200   0   200   400   600   800   1000
METRES

GOLD DEPOSIT........●   GOLD OCCURRENCE.........✖

Figure 21a.   Coquihalla Gold Belt — relationship between host rock lithologies and distance
of mineralization from the East Hozameen fault.

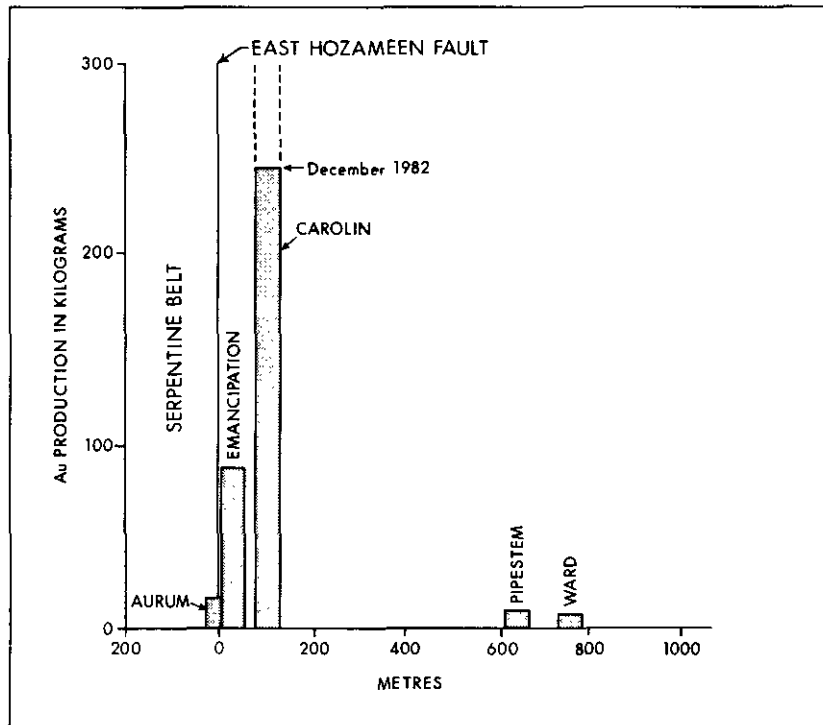EAST HOZAMEEN FAULT

300

December 1982

CAROLIN

Au PRODUCTION IN KILOGRAMS

200

SERPENTINE BELT

EMANCIPATION

100

PIPESTEM

WARD

AURUM

0

200   0   200   400   600   800   1000
METRES

Figure 21b.   Relationship between gold production from the Belt and distance from
the Hozameen fault.

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WEST   EAST

┌UNCONFORMITY

GREENSTONE   LADNER AND DEWDNEY
                         CREEK GROUPS

EMANCIPATION ● ● ● CAROLIN ● PIPESTEM
                  AURUM

400   200   0   200   400   600
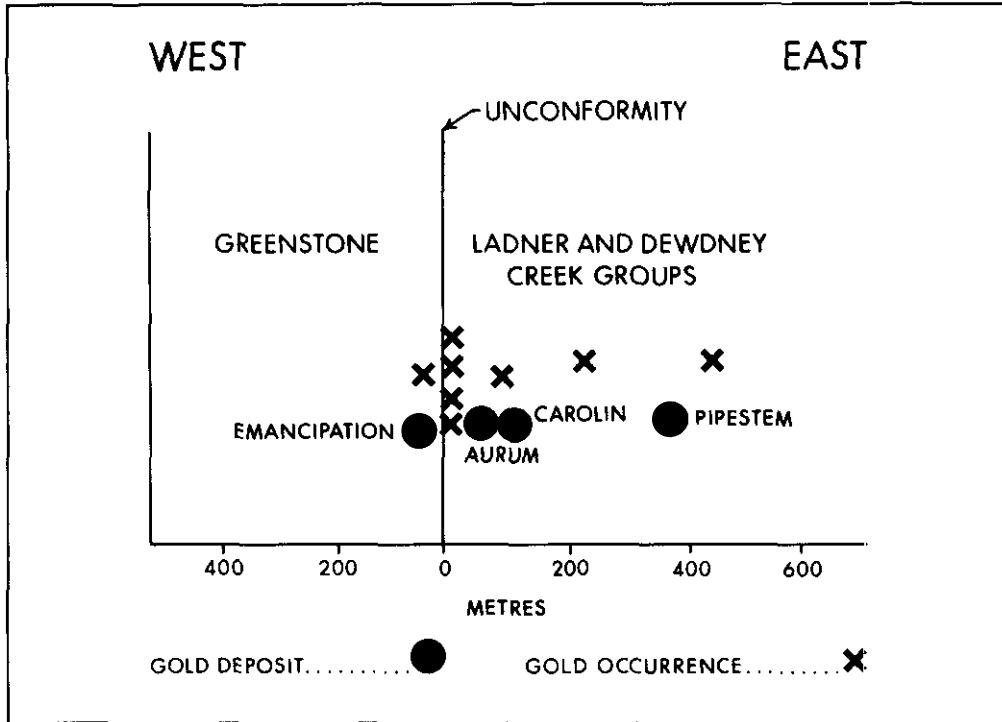   METRES

GOLD DEPOSIT.........●   GOLD OCCURRENCE.........✖

Figure 22a. Coquihalla Gold Belt — relationship between gold mineralization and the
Ladner Group—greenstone contact.

300 ┐   ┌UNCONFORMITY

                                        December 1982

200   LADNER AND DEWDNEY
                                        CREEK GROUPS
GREENSTONE

                                        CAROLIN

Au PRODUCTION IN KILOGRAMS

100

0
400   200   0   200   400   600
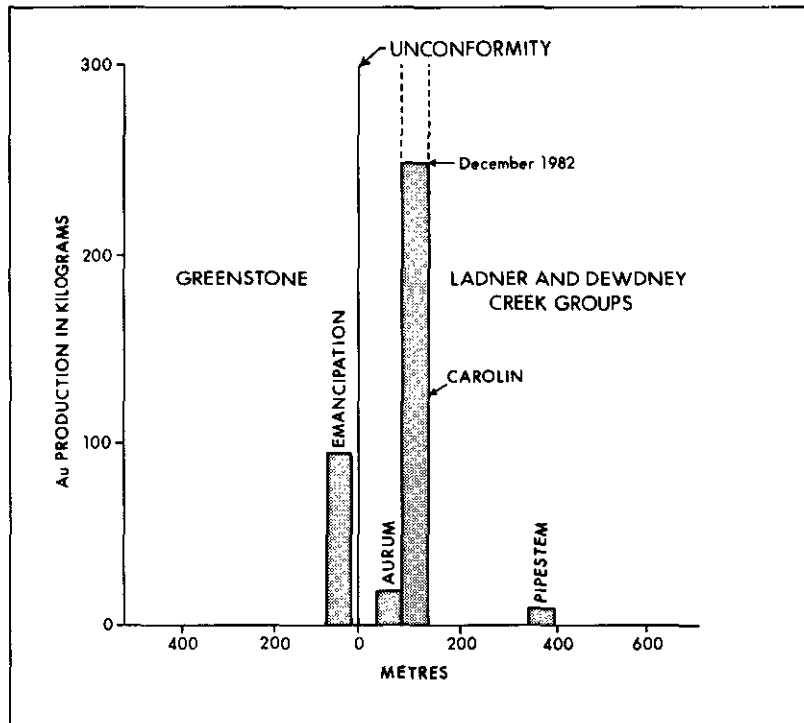   METRES

Figure 22b. Relationship between gold production and the Ladner Group—
greenstone contact.

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(3) Close proximity (less than 200 metres) to the East Hozameen fault and serpentinite margin. However, this fault does not represent a single fracture that suffered recurrent movements, but instead comprises several generations of oblique, intersecting faults as seen in the Emancipation mine vicinity (Fig. 18). This probably accounts for the variation in intensity of shearing and alteration along the fault system. In some parts the serpentinite contact is sharp and unaltered, whilst close to the Emancipation and Aurum deposits the fault is occupied by a wide unit of highly sheared talc. The gold mineralization may only show a spatial relationship to one particular generation of fracturing in the East Hozameen fault system, which would explain why certain areas adjacent to the fault, despite having favourable brittle host rocks, do not contain any gold occurrences.

SUMMARY

(1) The Coquihalla serpentine belt, which was previously regarded as a single, related unit, is separable into distinctive northern and southern belts which have entirely different tectonic relationships and are probably unrelated to each other.

(2) The northern serpentine belt generally occupies the western, highly tectonized margin of the Hozameen Group; it separates these rocks from variable granitic rocks further west.

(3) The southern belt is associated with the Hozameen fault system and generally marks the eastern boundary of the Hozameen Group, separating these supracrustal rocks from the Ladner Group further east.

(4) Numerous gold occurrences and deposits are located adjacent to the southern serpentine belt, but the northern belt is not associated with any gold mineralization. This suggests that the two belts could have fundamental geochemical differences.

(5) The Hozameen Group contains a broad stratigraphy consisting of basal serpentinites (northern serpentinite belt) overlain by greenstones and gabbros, which pass upward into a predominantly chert assemblage. This stratigraphy suggests that the Hozameen Group represents an ophiolite sequence.

(6) An upward-fining stratigraphic succession is recognized in the Lower to Middle Jurassic Ladner Group. These metasedimentary rocks unconformably overlie a greenstone unit of possible Early Triassic age. The lowermost coarse clastic unit in the Ladner Group is economically important as it hosts the Carolin mine deposit (Idaho zone) and many other gold occurrences.

(7) The Pipestem mine mineralization is hosted in fossiliferous wackes which were formerly regarded as belonging to the middle portion of the Ladner Group stratigraphic sequence (Ray, 1983). However, *Buchia* fossils in these wackes are identified as Late Jurassic in age (H. Tipper; J. A. Jeletzky, personal communication) indicating that the host rocks belong to the Dewdney Creek Group, which elsewhere disconformably overlies the Ladner Group (Coates, 1974). Thus some rocks previously assigned to the Ladner Group, including those in the vicinity of Ladner Creek, probably include Dewdney Creek Group metasedimentary rocks. The general absence of megafossils and the similar sedimentary lithologies makes it difficult to distinguish these two groups in the field.

(8) Although gold mineralization throughout the Coquihalla gold belt was generally accompanied by the introduction of silica, usually as quartz veins, the mineralogies, form of occurrence, and host rock lithologies are highly variable.

(9) Most minor gold occurrences are associated with thin, irregular, discontinuous quartz veins; at the Emancipation mine and the Monument occurrence, however, the veins are wider (0.5 to 2.5 metres) and more continuous (up to 350 metres).

(10) Most gold mineralization throughout the belt is sulphide poor. However, the mineralization at Carolin mine and the McMaster zone contains up to 15 per cent sulphides, mainly pyrrhotite, pyrite, and arsenopyrite; it is also associated with abundant albite.

(11) A number of regional controls to mineralization in the Coquihalla gold belt are recognized; these include (a) the presence of brittle host rocks suitable for open space facturing, (b) proximity to the East Hozameen fault and the eastern margin of the southern serpentine belt, and (c) proximity to the Ladner Group-greenstone unconformity which is often the locus of brittle shearing. Over 95 per cent of the total gold production from the belt has come from deposits less than 200 metres from the East Hozameen fault and the basal Ladner Group unconformity.

(12) Porphyritic felsic sills intruding the Ladner Group throughout the district are probably related to the Needle Peak pluton, which has been dated at 39 Ma. The age of the mineralization at Carolin mine and elsewhere is unknown; however, sporadic gold hosted in the felsic sills indicates that some gold in the belt is less than 39 Ma in age.

(13) These felsic sills are only found in the Ladner Group which suggests that the major movements along the Hozameen fault system postdate 39 Ma. Geological interpretation indicates that at least 18 kilometres of right lateral transcurrent movement occurred along the Hozameen fault.

(14) The discovery of pyrite-chalcopyrite-molybdenum mineralization in the faulted, thermal metamorphic aureole of what is believed to be the Needle Peak pluton, suggests that this granodiorite body could form a viable exploration target for base and precious metals.

(15) The Hozameen Group, which appears to represent an oceanic ophiolite suite, could form a good regional exploration target for massive sulphide deposits containing gold and/or cobalt.

ACKNOWLEDGMENTS

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