



HARRISON LAKE PROJECT
(92H/5, 12; 92G/9, 16)

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INTRODUCTION

Six days were spent in the Harrison Lake area during the summer of 1984. This fieldwork included geochemical sampling of various rock suites in the vicinity of Doctors Point and geological mapping a stratigraphic section in the Fire Mountain area. The latter work also involved examining and sampling the Money Spinner (Mineral Inventory 92G/NE-2) and the Blue Lead (Mineral Inventory 92G/NE-4) gold-bearing veins which form part of the Fire Lake gold camp. This report concerns ongoing research into the geology, geochronology, and gold mineralization of the Harrison Lake fracture system; previous recent work on the regional mineralization is outlined by Ray, *et al.* (1984).

RN MINE (GEO) (Mineral Inventory 92H/SW-92)

The defunct RN gold mine, situated approximately 4 kilometres northeast of Harrison Hot Springs, lies within a biotite-hornblende diorite close to its intrusive margin with Chilliwack Group metapelites. The gold is hosted in thin, massive quartz veins that carry disseminations and clots of pyrrhotite, pyrite, and sericite with traces of chalcopyrite and molybdenite (Ray, *et al.*, 1984). Some veins also contain traces of scheelite and bismuth telluride (D. MacQuarrie, personal communication, 1984). The sericite in these veins gives a K/Ar age of 24.5 ± 1 Ma (J. Harakal, personal communication, 1984; Table 1); this is the apparent age of the gold mineralization. Biotite and hornblende concentrated from samples of the diorite pluton host are currently being dated by K/Ar methods.

TABLE 1
K/Ar AGE DATE, RN MINE, HARRISON LAKE*

Field No.	Location	Rock Type	Material Analysed	Age (Ma)
RR 55	Adit entrance of defunct RN mine, 4.5 kilometres northeast of Harrison Hot Springs (49°20'10"N, 122°45'01"W)	Quartz vein with sericite, pyrrhotite, and pyrite	Sericite (-40+80)	24.5±1.0

*Collected by G. E. Ray (1983)

DOCTORS POINT

The simplified geology of the Doctors Point area, situated approximately 45 kilometres northwest of Harrison Hot Springs, is shown on Figure 34. A suite of moderately dipping volcanic, volcanoclastic, and sedimentary rocks are intruded by five bodies of diorite to quartz diorite composition that range from less than 50 metres to over 2 kilometres in diameter. These are surrounded by a 100 to 300-metre-wide hornfels

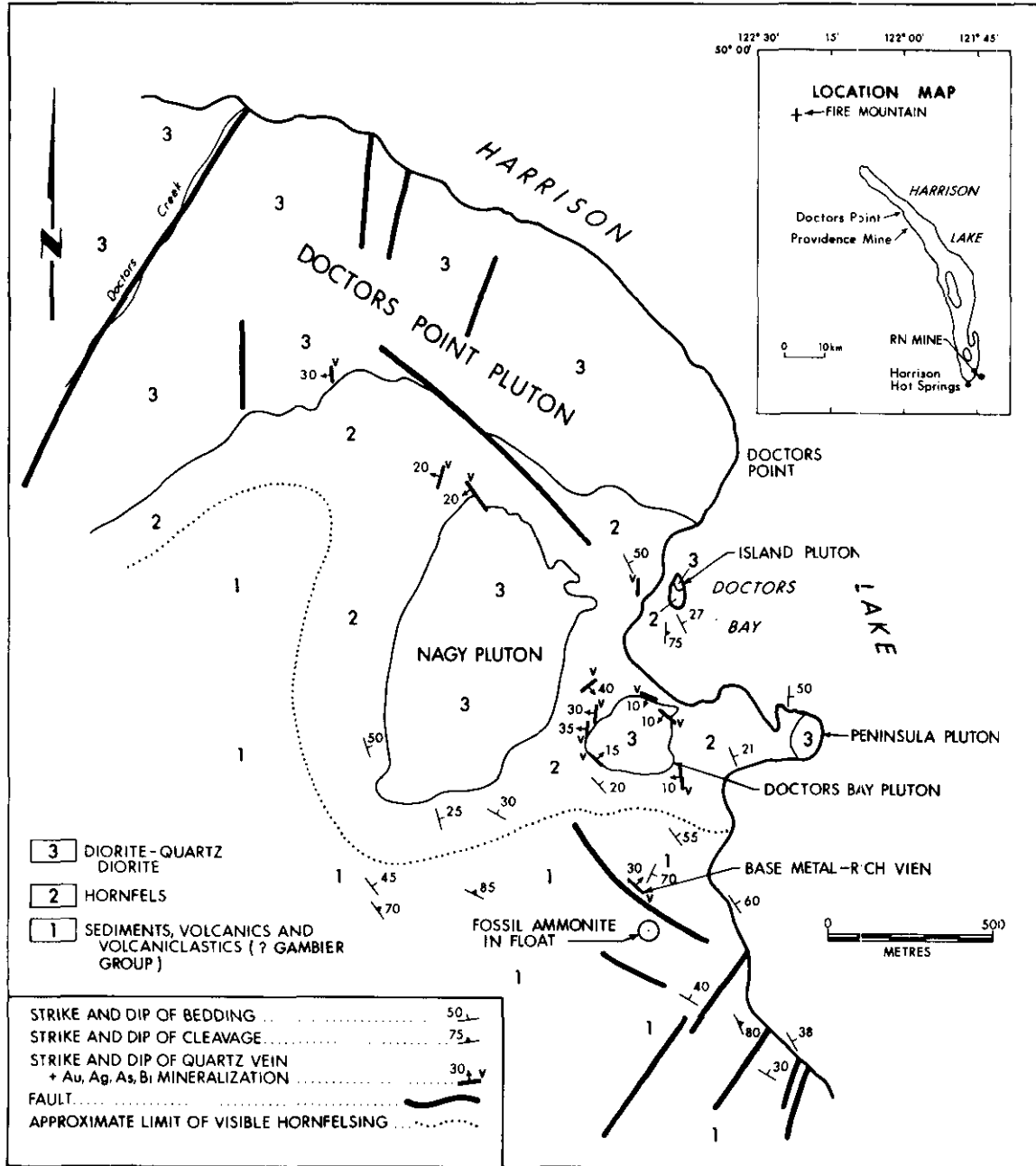


Figure 34. Geology of the Doctors Point area, Harrison Lake.

aureole marked by pervasive recrystallization, the growth of fine-grained biotite, and the local development of cordierite, andalusite, and pyrite-pyrrhotite. The gold-silver mineralization is hosted in narrow, gently dipping, vuggy quartz-sulphide veins that show an overall spatial association to the pluton margins (Fig. 34) and which have followed pre-existing low angle fractures; these probably represent cone sheet-type fractures formed during the diorite intrusion. Veins are found in 12 separate localities (Fig. 34), 11 of which are underlain by either diorite or hornfelsic rocks. These veins generally contain moderate to high gold values and are enriched in arsenopyrite and pyrite with traces of galena and sphalerite. However, the southernmost mineralized fracture (Fig. 34) lies outside the hornfelsic aureole that surrounds the plutons. Furthermore, it is not associated with quartz veining and contains little gold, but is enriched in silver, lead, zinc, and arsenic. This zone contains pyrite, arsenopyrite, tetrahedrite, and galena, together with alteration minerals that include scorodite, anglesite ($PbSO_4$), schultenite ($PbHAsO_4$), jarosite, and malachite (J. Kwong, personal communication, 1984). Thus, a temperature-related mineral and element zoning probably exists in the area, with gold being found closer to the pluton margins and base metals predominating outside the hornfelsic envelope.

The age of the volcano-sedimentary sequence is uncertain. Monger (1970) included these rocks within the Upper Jurassic Mysterious Creek Formation, while Ray, et al. (1984) suggested that the sequence belongs to the Middle Jurassic Harrison Lake Group (Crickmay, 1925). However, Mr. Neil Froc of Rhyolite Resources Inc. discovered an ammonite fossil in the area (Fig. 34), which was identified by Dr. H. Tipper (personal communication, 1984) as *Cleoniceras perezianum* of Middle Albian age. Thus the sequence at Doctors Point is probably Early Cretaceous in age, and possibly represents a lateral equivalent to the Gambier Group. The fossil was found in float at the base of an old roadside outcrop of grey, cherty tuff below British Columbia Hydro tower No. 36-1. Identical lithologies make it probable that the fossil-bearing float was derived from the adjacent outcrop, although a systematic search in the immediate vicinity failed to locate further fossils.

Biotite and hornblende samples extracted from the Doctors Bay pluton (Fig. 34) are currently undergoing K/Ar analysis for age dating. However, a preliminary estimate of circa 25 Ma from the biotite (J. Harakal, personal communication, 1984) suggests the diorite bodies were contemporaneous with gold-bearing veins at the RN mine, approximately 45 kilometres to the southeast. Thus, a synchronous event characterized by regional plutonism and gold mineralization probably took place along the Harrison Lake fracture system in Late Oligocene-Early Miocene time.

Contrary to preliminary conclusions of Ray, et al. (1984), the mineralization at Doctors Point is now believed to be genetically and temporally related to the diorite plutons and probably represents a late

hydrothermal phase of this magmatic event. The Nagy and Doctors Bay plutons (Fig. 34), and the siliceous hornfels immediately adjacent to their margins, locally contain abundant pyrite and pyrrhotite, although these sulphide-rich pockets are not enriched in gold or silver. The gold-silver mineralization postdates both the intrusion of the plutons and a late suite of mafic dykes. The postulated sequence is: (1) emplacement of the diorite plutons with some barren sulphide mineralization, accompanied by low angle cone sheet fracturing in the hornfels aureole (Fig. 35); (2) intrusion of the mafic dykes; (3) minor thrust faulting along the fractures; (4) gold-silver-arsenic mineralization along some of the cone sheet fractures; and (5) late subvertical faulting. Veins generally dip toward the pluton cores and are associated mostly with the Doctors Bay pluton, although a few veins lie within or adjacent to the Doctors Point and Nagy plutons (Fig. 34). This suggests that the five diorite bodies in the area are related and probably represent apophyses of a single major body.

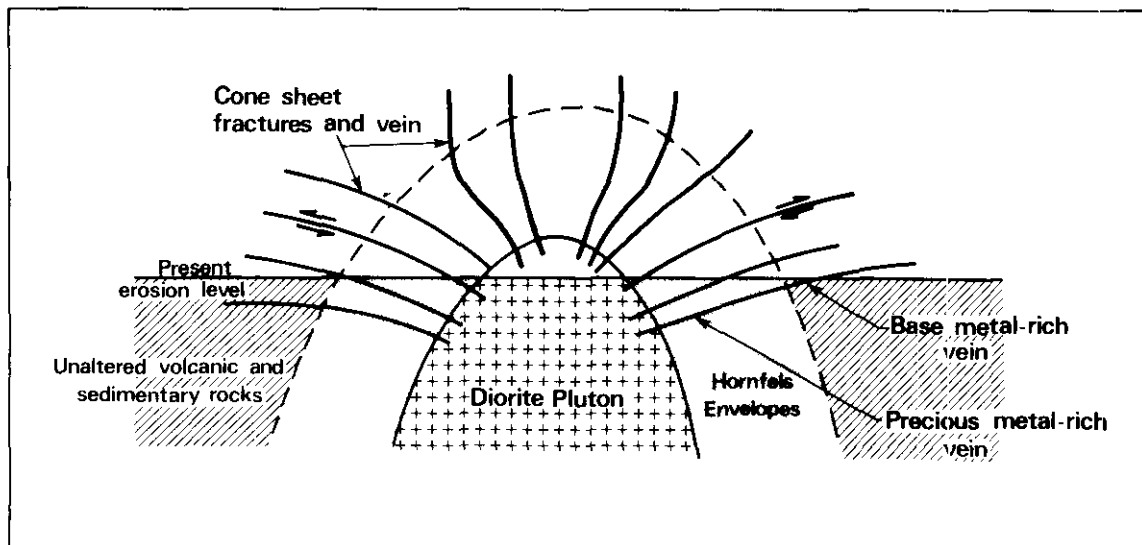


Figure 35. Model depicting development of cone sheet fracturing and associated veins to explain Doctors Point mineralization (adapted after Anderson and Jeffreys, 1936).

FIRE MOUNTAIN-FIRE LAKE AREA

INTRODUCTION

This area, situated approximately 25 kilometres northwest of the north end of Harrison Lake (Fig. 34), is underlain by the Upper Jurassic to Lower Cretaceous Fire Lake Group (Roddick, 1965), a 4 500-metre-thick

sequence of largely sedimentary rocks with lesser amounts of volcanic greenstone. The Fire Lake camp (Ditson, 1978) includes six mineralized veins, five of which are clustered in the vicinity of Fire Mountain (Fig. 38; Table 2). All are quartz veins hosted in greenstones and they carry chalcopyrite and sporadic native gold. Two of the veins, the Money Spinner and the Blue Lead (Mineral Inventory 92G/NE-2 and 92G/NE-4), were visited and sampled during this study. The sixth vein, the Dandy (Mineral Inventory 92G/NE-10), which lies 10 kilometres northwest of Fire Mountain, is a lead-zinc-bearing quartz carbonate vein hosted in brecciated sedimentary rocks (Ditson, 1978).

TABLE 2
AREAS WITH MINERALIZED VEINS ASSOCIATED WITH THE HARRISON LAKE FRACTURE SYSTEM

Name	MI No.	Host Type	Gangue	Reported Mineralization
Money Spinner	92G/NE-2	Greenstone	Quartz	Cu-Au
Barkoola	92G/NE-3	Greenstone	Quartz	Cu-Au
Blue Lead	92G/NE-4	Greenstone	Quartz	Cu-Au
King No. 1 (Star)	92G/NE-5	Greenstone	Quartz	Cu-Au
Richfield	92G/NE-6	Greenstone	Quartz	Au
Dandy (Mayflower)	92G/NE-10	Brecciated sedimentary rocks	Quartz-carbonate	Pb-Zn-Ag-Au
Doctors Point (Nagy)	92H/NW-71	Diorite and hornfelsed volcanic and sedimentary rocks	Quartz	Au-Ag-As-Bi
Providence Mine	92H/NW-30	Greenstone	Quartz-carbonate	Pb-Zn-Ag-Au
RN Mine (Geo)	92H/SW-92	Diorite	Quartz	Cu-Au

GEOLOGY OF THE FIRE MOUNTAIN-FIRE LAKE AREA

Details of a single geological traverse over the area are on Figure 36, and a geological section across the 2 500-metre-thick, northeasterly dipping succession is shown on Figure 37. Bedding-cleavage intersections and minor fold structures indicate that the section occupies the northern limb of a major, southeast-trending antiform (Fig. 37). Vague graded bedding in some wacke horizons suggests the sequence is upright, and apart from local areas of tight folding north of Fire Mountain (Fig. 37), there is no evidence of major structural repetition in the succession.

Three broad divisions are recognized in the succession: a lower 700-metre-thick volcanic greenstone unit with possible subvolcanic intrusive rocks, an intermediate 1 000-metre-thick sequence of mainly wacke, conglomerate, and volcanoclastic rocks, and an upper 800-metre-thick unit of argillite and minor amounts of wacke. The upper unit consists largely of poorly bedded, well-cleaved, black to grey slaty argillites that are generally pyritiferous. These are locally interbedded with siltstones, while on the northern slopes of Fire

Mountain there are thin, tightly folded horizons of lithic wacke containing 8 to 15-centimetre-thick beds of marl and impure limestone. These calcareous beds are tightly folded, disrupted, and boudined.

The middle unit includes abundant green-coloured wacke, lithic wacke, and water-lain tuff that locally shows graded bedding. Other rock types include conglomerates with angular to subrounded felsic and intermediate volcanic clasts up to 8 centimetres in diameter, together with green to grey, volcanogenic siltstone that display rare ripple markings and grading. The middle unit also includes minor amounts of volcanic breccia, rare thin mafic flows, and some aquagene breccias.

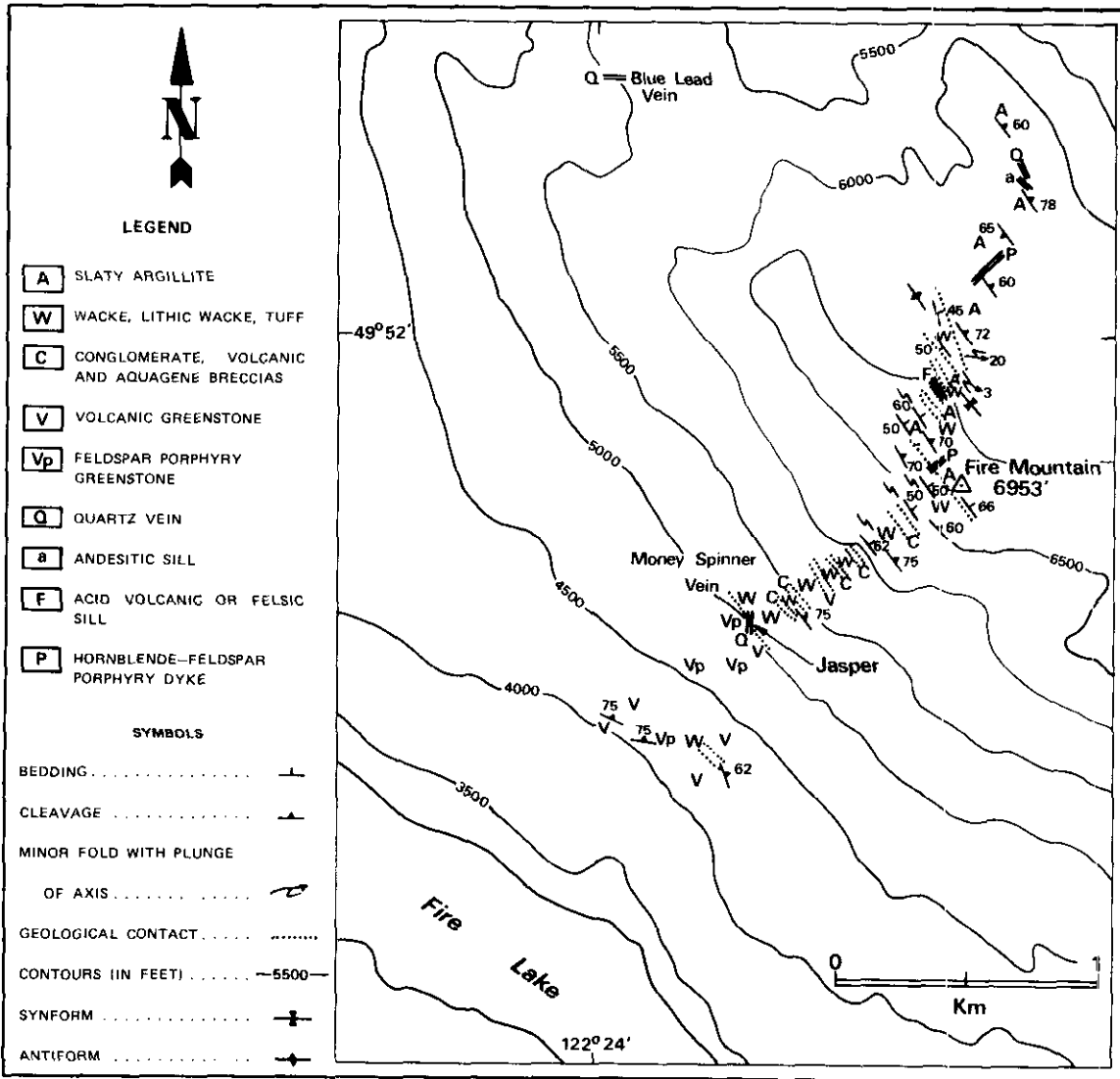


Figure 36. Geology between Fire Lake and Fire Mountain.

The lower unit (Fig. 37) comprises massive, fine-grained, equigranular volcanic greenstone, and porphyritic greenstone characterized by rounded feldspar phenocrysts up to 1 centimetre in diameter. It is uncertain whether the porphyritic greenstone is an extrusive or a subvolcanic intrusive rock. Locally the lower unit includes minor amounts of volcanic wacke and bedded tuff, together with volcanic breccia containing clasts up to 2 centimetres in diameter. Highly disrupted layers, lenses, and pods of red jasper up to 0.3 metre thick occur in the vicinity of the Money Spinner adit, close to the contact between the lower and middle units. The massive to finely banded jasper is associated with aquagene and volcanic breccias and bedded tuffs, and contains disseminated magnetite and specular hematite with traces of chalcopyrite and malachite. No attempt was made to trace the jasper-bearing horizon along strike, but malachite-stained, jasper-bearing float was noted at several locations in scree material for approximately 200 metres northwest of the Money Spinner adit. Jasper at the volcanic-sediment interface could indicate submarine exhalative activity, which suggests that the Fire Lake Group is a viable exploration target for massive sulphide mineralization.

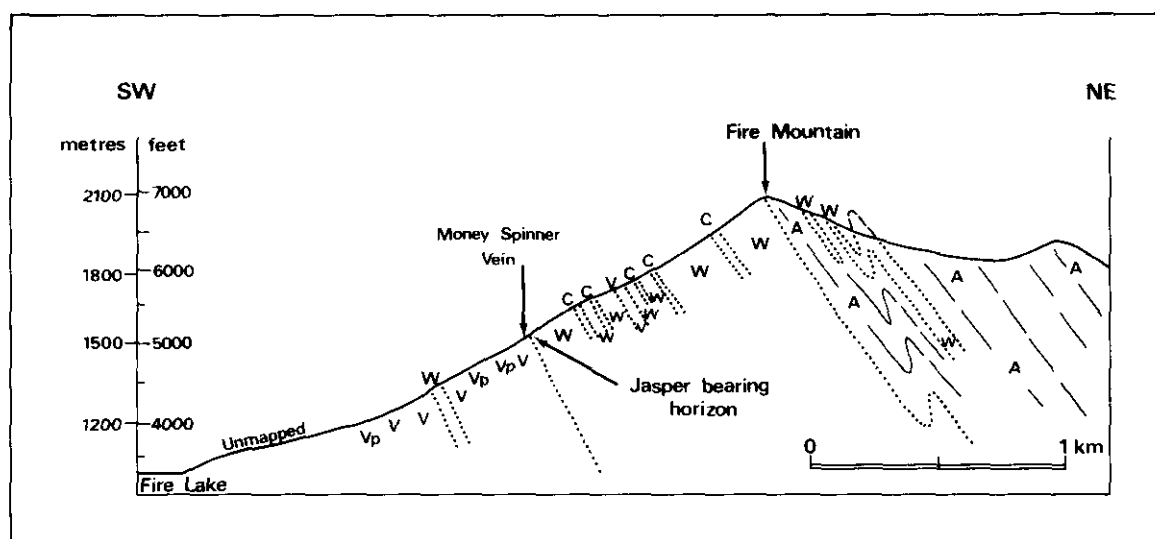


Figure 37. Southwest-northeast geological section through Fire Mountain (for symbols see Fig. 36).

The area was affected by one episode of regional folding which produced major and minor folds with southeast-striking, steep northeast-dipping axial surfaces and gentle to moderate, southeasterly plunging axes. This deformation was accompanied by development of a slaty cleavage in the argillites and some wackes, and the local development of a fracture cleavage in the greenstones. The argillites were deformed subsequently by late kink folds whose axial surfaces strike east-northeast and along which there has been local faulting and the subsequent injection of narrow quartz veins. As well as the Money Spinner and Blue Lead veins, other quartz veins noted in the area include a 0.3-metre-wide,

southeasterly striking, muscovite and pyrite-bearing vein approximately 1.5 kilometres north of Fire Mountain (Fig. 36) and numerous irregular, gash-filling veins within wackes and lithic wackes south of Fire Mountain. These are steep to gently inclined and up to 0.4 metre wide; they contain milky quartz and minor amounts of feldspar but no sulphides.

Small-scale intrusions in the area include late, 0.5 to 3-metre-wide, northeasterly trending dykes of felsic, amphibole-bearing feldspar porphyry that intrude the argillites. Some dykes follow the disrupted axial planar surfaces of the kink folds, but postdate the thin quartz veins. It is uncertain whether an outcrop of pale, fine-grained feldspar porphyry within the argillites 0.3 kilometre north of Fire Mountain is an acid volcanic flow or an intrusive rock. Approximately 0.75 kilometre further north, a single, deeply weathered 4-metre-wide andesitic sill intrudes the slaty argillites (Fig. 36).

GEOLOGY OF THE MONEY SPINNER AND BLUE LEAD VEINS

The Money Spinner vein, situated approximately 1 kilometre southwest of Fire Mountain (Fig. 36), was discovered and worked in the 1890's and some subsequent work was done in the 1930's. Approximately 180 metres of underground workings were driven on the property, and reportedly the vein was exposed for over 300 metres on surface (Roddick, 1965). Both the vein and the host rocks are well exposed at the entrance to the collapsed main adit, which lies immediately above the old waste dump. The remains of a shorter tunnel are discernible approximately 40 metres lower down the hillside.

The 1 to 1.3-metre-wide vein strikes north-south and dips 65 degrees west. It has a ribboned appearance, comprising layers of white quartz between 0.5 to 2.5 centimetres wide separated by thin partings of black, sheared chlorite. Many quartz crystals are elongated parallel to the layering and exhibit a pronounced mineral lineation that plunges 35 degrees toward a 205-degree direction. The vein contains variable amounts of chalcopyrite with traces of bornite and sericite and some rare quartz-lined vuggy cavities. In parts the vein is malachite stained but no visible gold was detected.

Most of the vein material on the waste dump comprises ribboned, chalcopyrite-bearing quartz, similar to that in the vein outcrop. However, the dump also contains material not seen on surface; this consists of very coarse-grained, randomly orientated quartz intergrown with crystalline masses of pale brown calcite. Trace amounts of fine sericite and dravite (tourmaline) were identified (J. Kwong, personal communication, 1984), but no sulphides or gold were seen.

The westerly dipping Money Spinner vein has sharp margins and lies within a north-south-striking fault. The hangingwall consists of feldspar

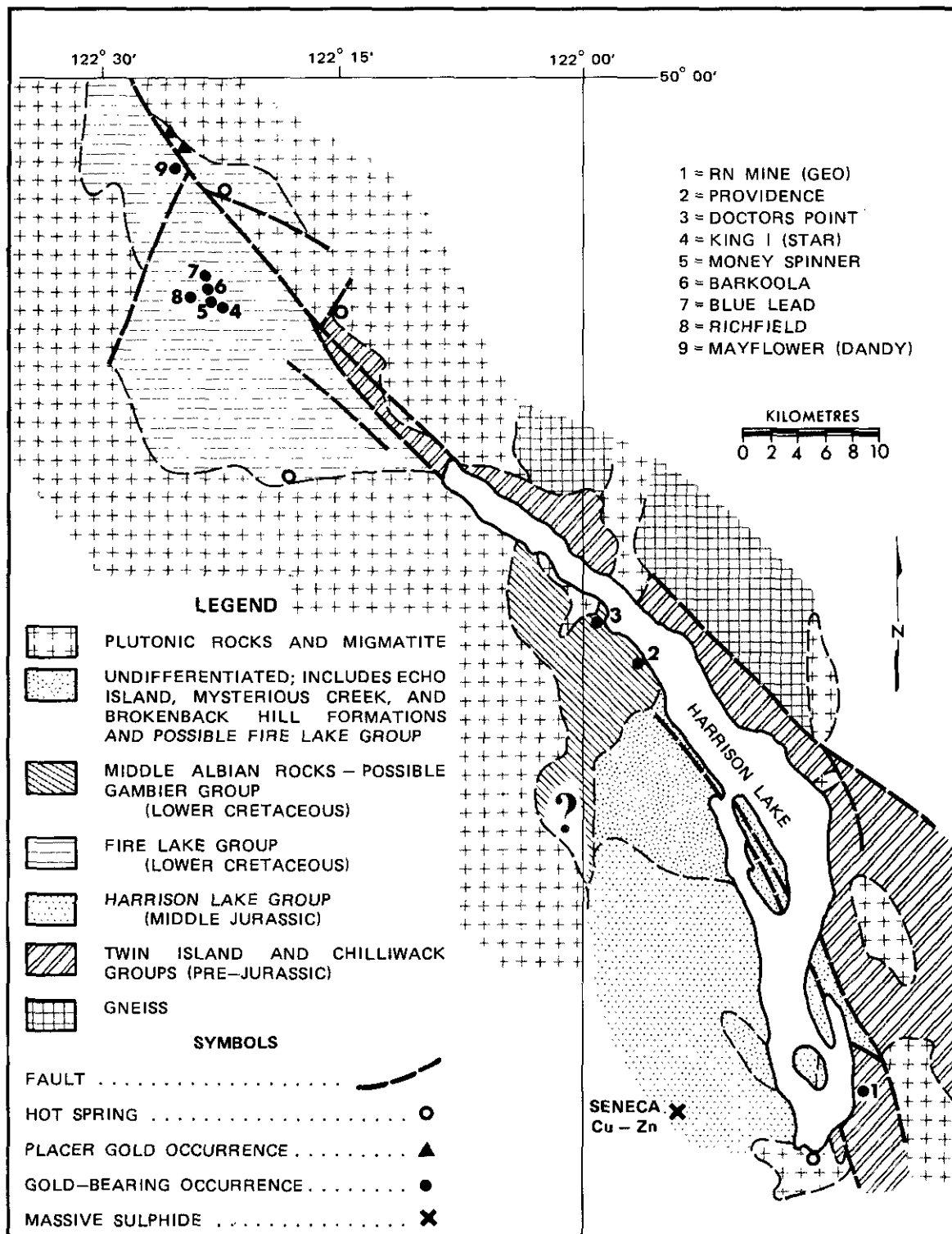


Figure 38. Regional setting of the Harrison Lake fault system.

porphyry greenstone, while the footwall comprises highly altered, green-coloured tuff, wacke, and aquagene breccia that locally carries thin, disrupted jasper horizons. The preferred orientation of quartz crystals in the vein and the interpreted displacement of the stratigraphy suggest that the hangingwall moved upward and southward relative to the footwall.

The Blue Lead vein, which lies about 2 kilometres northwest of Fire Mountain (Fig. 36), was visited by one author (S. Coombes) during this present survey. The vein varies from 20 to 60 centimetres in thickness, strikes east-west, and dips approximately 50 degrees north. The vein material resembles the white ribbon-textured quartz outcropping at the Money Spinner adit and contains thin, dark chloritic laminae orientated parallel to the sharp vein margins. The malachite-stained quartz contains occasional small vugs, as well as minor amounts of chalcopryrite and traces of sericite, hematite, dravite (tourmaline), and visible native gold. A subparallel, 10 to 30-centimetre-thick quartz vein occurs 5 metres north of the main vein, but this apparently carries no sulphides. A 10-metre-long decline has been driven down the main vein, and the host rocks comprise green-coloured, faintly layered rocks that are interpreted to be an interbedded sequence of volcanogenic sedimentary rocks and greenstones.

CONCLUSIONS

All known mineralization associated with the Harrison Lake fracture system (Fig. 38; Table 2) appears to be vein type (Ray, *et al.*, 1984) that, on the basis of vein mineralogy and host rock lithology, can be broadly separated into three types:

- (1) Gold-bearing quartz veins which have variable precious metal and sulphide mineralization but are genetically and temporally related to a 25-Ma episode of regional diorite plutonism. These veins are seen at Doctors Point and at the RN mine (Fig. 38).
- (2) Quartz veins in the vicinity of Fire Mountain (Fig. 38) which are hosted in greenstones and carry sporadic free gold and chalcopryrite. The Money Spinner and Blue Lead are examples of this type.
- (3) Quartz carbonate veins carrying galena, sphalerite, silver, and gold; these occur at the Providence mine (Mineral Inventory 92H/NW-30) and probably comprise the Dandy vein.

The mineralized veins at Doctors Point are related to dioritic plutons which preliminary K/Ar dating suggests are 25 Ma in age. This date coincides with a K/Ar of 24.5 Ma from gold-bearing veins associated with similar dioritic rocks at the defunct RN mine at the southern end of Harrison Lake (Fig. 38). Thus, the gold mineralization at both localities may form part of a synchronous, regional, magmatic-related Tertiary event along the Harrison Lake fracture system. This episode

is also coeval with some ages obtained from both the Mount Barr and Chilliwack batholiths (Richards and White, 1970), which lie along a projected southeasterly extension of the Harrison Lake fracture system.

The veins at Doctors Point exhibit a close spatial relationship to the margins of the plutons and were controlled by pre-existing, gently inclined cone sheet-type fractures that developed during forcible intrusion of the diorite (Fig. 35). Some temperature-related precious and base metal zoning is apparent within the vein system, and recognition of the cone sheet fracture control may help locate other mineralized veins in the district.

Fossil evidence indicates that the volcanic and sedimentary sequence hosting the diorite bodies at Doctors Point are Middle Albian in age, and thus may be lateral equivalents to the Gambier Group (Armstrong, 1953; Roddick, 1965), which elsewhere hosts the Britannia and Northair deposits (Barr, 1980; Payne, *et al.*, 1980). This, and the presence of andesitic and acid volcanic and pyroclastic rocks at Doctors Point, suggests that the area warrants exploration for Kuroko-type, massive sulphide mineralization. Likewise, the recognition of a jasper-bearing exhalite horizon on Fire Mountain also indicates that parts of the Fire Lake Group may have massive sulphide potential.

ACKNOWLEDGMENTS

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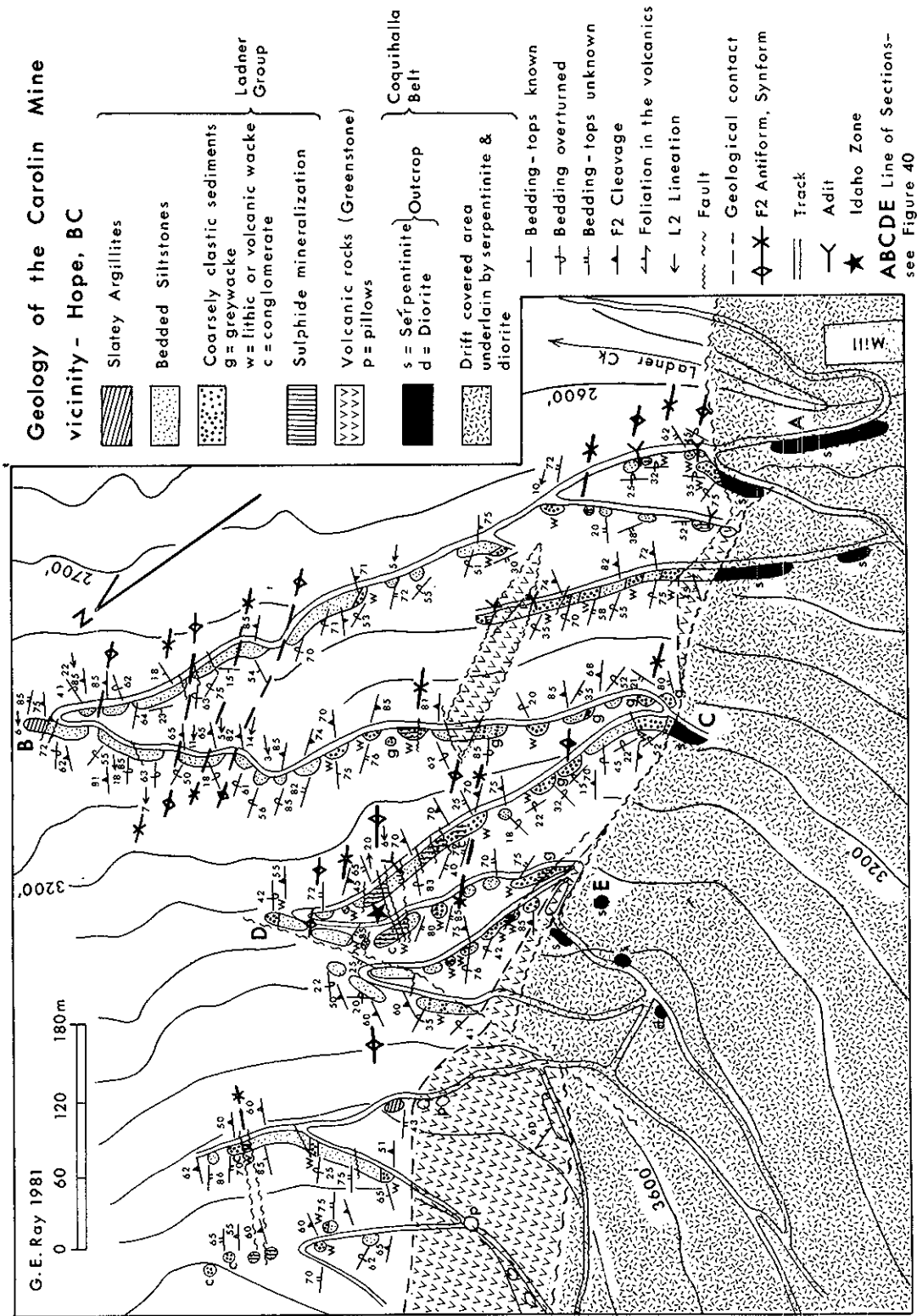


Figure 39. Geology of the Carolin mine vicinity, Hope, British Columbia.