GEOLOGY OF THE GOOD HOPE – FRENCH MINE AREA, SOUTH-CENTRAL BRITISH COLUMBIA* (92H/8)

By G.L. Dawson, C.I. Godwin
The University of British Columbia;
G.E. Ray;
J. Hammack and D. Bordin
Corona Corporation

KEYWORDS: Economic geology, Hedley, gold skarn, French mine, Good Hope mine, ore controls, mineralogy.

INTRODUCTION

The Good Hope and French mines, in the Hedley mining camp, are gold skarn deposits hosted by French Mine formation limestones of the Upper Triassic Nicola Group. They are located approximately 5 kilometres east of the town of Hedley in south-central British Columbia, about 5 kilometres south of the Nickel Plate open-pit mine. Access to the property is by gravel road off the Nickel Plate mine road. The property is owned by Golden North Resource Corporation and is being explored by Corona Corporation.

This report incorporates regional mapping by Ray and Dawson (1987, 1988), and detailed mapping by Hammack (1988) and Dawson in this study. This work forms the basis of an M.Sc. thesis by Dawson at The University of British Columbia.

REGIONAL GEOLOGY

The Hedley gold camp lies within Quesnellia in the Intermontane Belt of the Canadian Cordillera. The first regional mapping of the area by Bostock (1930, 1940a, b) has recently been updated by Ray and Dawson (1987, 1988).

Plate 2-6-1. Possible sediment-sill complex in the Hedley area consisting of Hedley diorite sills intruding Late Triassic Hedley formation limestone and siltstone. Photo, half a kilometre east of Hedley township, was taken looking north from Highway 3.

The Table of Formations (Table 2-6-1) outlines the evolution of nomenclature in the camp.

A sill swarm exposed on the cliffs east of the township of Hedley (Plate 2-6-1) is one of the most visually striking features of the area. Sills of hornblende-porphyritic diorite are part of the Hedley intrusive suite believed to be Late Triassic or Early Jurassic (199 Ma based on U-Pb dates of zircons from the Banbury stock, 3.5 kilometres west of Hedley). In this location the sills, which vary from 1 to 25 metres in thickness, make up almost 50 per cent of the stratigraphic column where they intrude laminated limestone and siltstone of the Hedley formation. They occur both adjacent to the Toronto quartz diorite to gabbro stock and as far away as 2 kilometres from it. Auriferous skarn mineralization is spatially and genetically associated with the stock and the adjacent diorite sills (Billingsley and Hume, 1941; Dolmage and Brown, 1945; Ray *et al.*, 1986, 1987, 1988). A similar sill swarm is developed within the French Mine formation at the French mine and a single sill is associated with mineralization at the Good Hope mine.

LOCAL GEOLOGY

The Good Hope–French mine area is underlain by sedimentary and volcanic rocks of the Late Triassic Nicola Group and the Middle to Late Paleozoic and Triassic Apex Mountain complex (Figure 2-6-1). The Apex Mountain complex, a deformed ophiolite package, consists of greenstone, chert, argillite, siltstone and minor limestone (Milford, 1984).

Structure within the Good Hope–French mine area is relatively simple with units generally striking to the north-northeast and dipping gently west (Figure 2-6-1). Major faults include the Cahill Creek fracture zone and the Good Hope fault that were important in controlling intrusion of the Cahill Creek pluton. Major folds have not been identified, however, Hammack (1988) mapped numerous small north-west and northeast-trending small-scale flexures.

The Nicola Group has been informally subdivided into three stratigraphically distinct formations within the Good Hope–French mine area (Ray *et al.*, 1987, 1988): a lower volcanic package called the Peachland Creek formation, a middle carbonate package called the French Mine formation, and an upper volcanic package called the Whistle Creek formation. The contact between the Nicola Group and the

* This project is a contribution to the Canada/British Columbia Mineral Development Agreement.

TABLE 2-6-1. TABLE OF FORMATIONS, HEDLEY AREA, SOUTH-CENTRAL BRITISH COLUMBIA.

Age	Camsell, C. (1910)	Bostock, H.S. (1930)	Bostock, H.S. (1940)	Ray and Dawson (1988 and in press)
Tertiary	aplite, rhyolite & andesite dikes, granodiorite		basalt flows, pyroclastics	Unit 13: basaltic flows
			conglomerate sandstone	Unit 12: conglomerate, sandstone
		Unconformity	Unconformity	Unconformity
Early Cretaceous				**Spences Bridge Group** Unit 11: andesite – rhyolite pyroclastics, minor sedimentary rocks
			Intrusive contact	Intrusive contact
				Unit 10: Verde Creek stock; granite to microgranite
			Intrusive contact	Intrusive contact
Middle Jurassic				Unit 9: Ashnola Hill formation andesite – dacite pyroclastic rocks
			Intrusive contact	Intrusive contact
				Unit 8: Cahill Creek pluton (168 Ma); granodiorite – quartz monzodiorite
				Unit 7: quartz-feldspar rhyolite porphyry dike (171 Ma)
Early Jurassic		granite	granite	Unit 6: Bromley batholith (198 Ma)
		granodiorite	granodiorite	granodiorite
Late Triassic(?) – Early Jurassic		diorite, gabbro	diorite, gabbro	Unit 5: Hedley intrusive suite; (199 Ma); phyric and aphyric quartz diorite – gabbro
		Intrusive contact	Intrusive contact	Intrusive contact
Late Triassic		**Nicola Group** Unnamed section; volcanic & sedimentary rocks	**Nicola Group** Wolfe Creek formation; andesite – basalt tuff, minor sedimentary rocks	**Nicola Group** Unit 4: Whistle Creek formation; andesite ash & lapilli tuff, minor siltstone
				Unit 3d: Copperfield breccia, limestone breccia
		Aberdeen formation; quartzite limestone, argillite	Henry formation; argillite tuff, impure limestone	Unit 3c: Stemwinder Mountain formation (western facies); argillite, limestone
		Red Mountain formation; tuffs & breccias	Hedley formation; limestone, quartzites, argillite conglomerate, breccia, tuff	Unit 3b: Hedley formation (central facies); siltstone, limestone
		Nickel Plate formation; limestone & quartzite	Sunnyside formation; limestone	
		Redtops formation; limestone, quartzite, argillite, tuff, breccia, limestone	Redtop formation; limestone quartzite, argillite, tuff, breccia	
				Unit 3a: French Mine formation (eastern facies); limestone, limestone conglomerate
				Unit 2: Peachland Creek formation; basalt tuffs and flows, argillite, chert pebble conglomerate, limestone olistostrome
	Contact occupied by the Cahill Creek pluton	Contact occupied by the Cahill Creek pluton	Contact occupied by the Cahill Creek pluton	Contact occupied by the Cahill Creek pluton
Middle to Late Paleozoic and Triassic	**Cache Creek Group** Aberdeen formation; limestone, quartzite, argillite, tuff, volcanic breccia		Independence formation; chert, argillite, basalt – andesite flows, breccia	Unit 1: Apex Mountain complex; argillite, greenstone, limestone, chert
	Red Mountain formation; tuff, volcanic breccia, quartzite, argillite		Bradshaw formation; argillite, tuff, quartzite, breccia, andesite, limestone	
	Nickel Plate formation; limestone, quartzite, argillite, tuff			
	Redtop formation; limestone, quartzite, argillite, tuff, breccia			

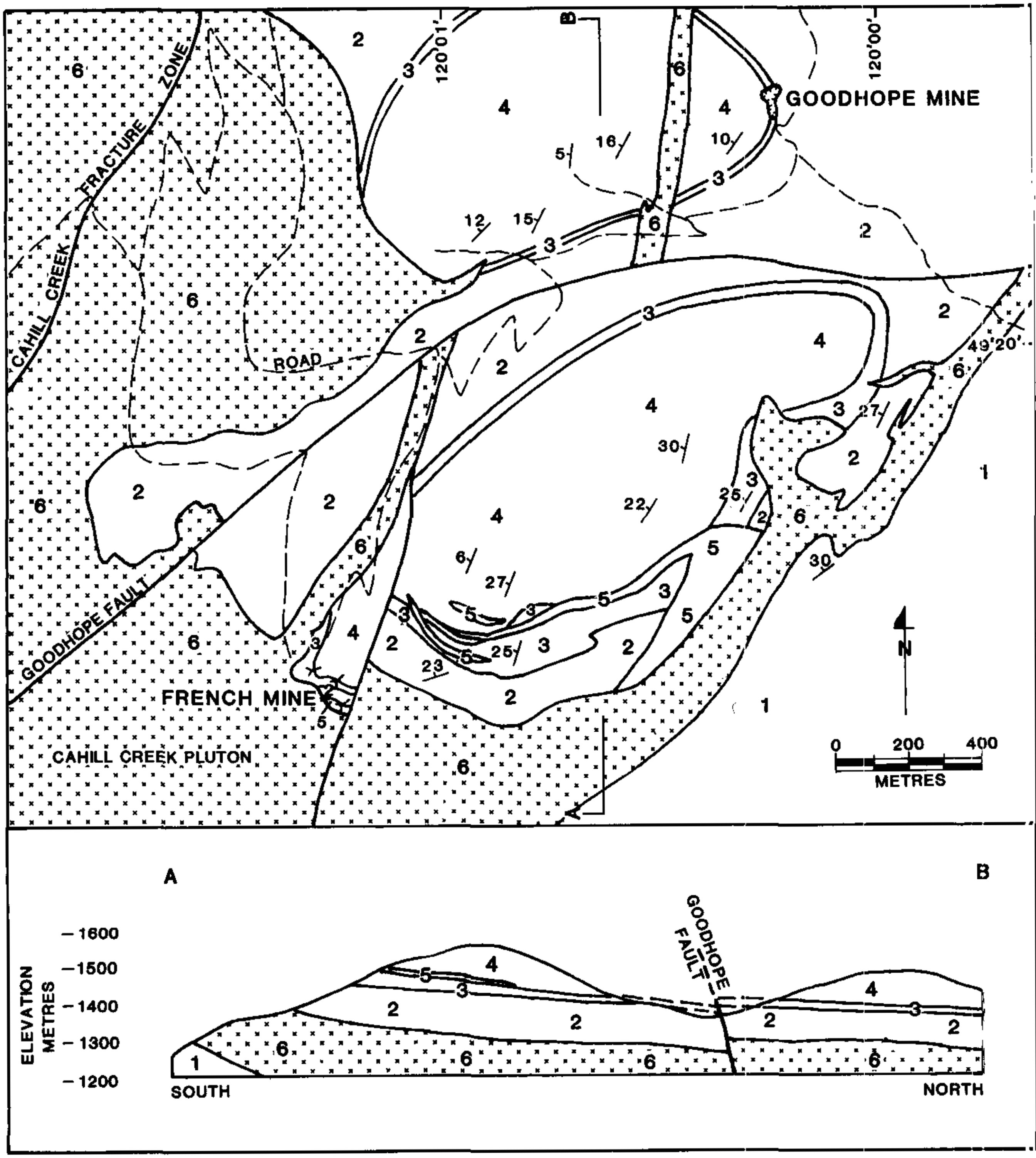

Figure 2-6-1. Geology of the Good Hope to French mine area, south-central British Columbia. Units on the figure, from oldest to youngest, are: 1 = Apex Mountain complex, 2 = Peachland Creek formation, 3 = French Mine formation, 4 = Whistle Creek formation, 5 = Hedley intrusive suite, 6 = Cahill Creek pluton, 7 = Quartz-feldspar rhyolite dike.

Apex Mountain complex is occupied by the Cahill Creek pluton. Consequently it is unknown whether the original contact was an unconformity or a suture.

The Peachland Creek formation comprises the oldest Nicola Group rocks identified in the study area. It is correlated with, and named after, a volcaniclastic sequence in the Pennask Mountain area approximately 30 kilometres west of Peachland (Dawson and Ray, 1988).

Massive to poorly bedded, andesitic to basaltic tuffs and volcanic flows with minor argillite and limestone comprise most of the sequence. The tuffs often contain sparse chert and recrystallized quartz grains. Rare, thin chert-pebble conglomerate beds may represent turbidite deposits derived from the Paleozoic Apex Mountain complex farther east. Algal-rich marble blocks, up to 5 metres in diameter and occurring throughout the sequence, are interpreted as olistostromes that were derived from carbonate reefs to the east. Bedding underlying the olistostrome is locally disrupted. Spherical argillaceous carbonate mud balls or oncolites, up to 2 centimetres in diameter, are found locally, indicating a shallow depositional environment. The base of the Peachland Creek formation is not exposed in the map area but the unit is at least 400 metres thick.

The French Mine formation stratigraphically overlies the Peachland Creek formation and consists of massive to poorly bedded limestone interlayered with limestone pebble to boulder conglomerate and minor limestone breccia. It has a maximum thickness of 100 metres and tapers westward towards the Cahill Creek fracture zone (Figure 2-6-1).

The limestone pebbles and cobbles in the conglomerates make up 95 per cent of the clasts; they are 5 to 50 centimetres in diameter, subangular to subrounded, and both clast and matrix supported. Rare clasts of tuff, argillite and aphyric mafite(?) occur within this unit. The limestone breccia clasts are angular, generally less than 5 centimetres in diameter, and are clast supported. The matrix of the limestone conglomerate and breccia is altered to massive garnet or garnet-diopside reaction skarn, which reflects the variable composition of the matrix and its high porosity. The limestone is invariably recrystallized to marble. This unit probably represents a shallow-water shelf environment of fore-reef or lagoonal facies. It hosts the gold skarn mineralization at the Good Hope and French mines.

Whistle Creek formation stratigraphically overlies the French Mine formation and consists primarily of laminated to massive tuffaceous siltstone and andesite tuff. The lower part of this unit is markedly epiclastic and often exhibits graded beds, flame textures and load casts. These features indicate that the unit is right-way-up and that paleocurrent directions are predominantly from the east. The section grades upwards into more thickly bedded to massive ash, lapilli and tuff breccia that is arc-related and includes both alkalic and subalkalic rocks of andesitic to basaltic composition (Ray and Dawson, in preparation). Biotite + pyroxene + potassium feldspar hornfels is common in the lower sedimentary section of the unit, probably because it is close to Cahill Creek intrusive rocks; higher permeability of the bedded units and the chemical gradients between individual laminations or beds often enhance alteration. The maximum thickness of this unit in the district is 1200 metres (Ray and Dawson, in preparation), but near the Good Hope and French mines it is about 200 metres thick.

Hedley intrusive rocks in the study area form both phyric and aphyric sills, dikes and stocks throughout the Nicola Group rocks, but are absent from the Apex Mountain complex. A U-Pb isotopic age of 199 Ma (Ray and Dawson, in preparation) from the Banbury stock indicates that they are Early Jurassic in age, however contact relationships within the study area suggest they may be as old as Late Triassic.

The phyric Hedley intrusive rocks are commonly calc-alkaline and dioritic in composition (Ray *et al.*, 1988). In hand sample they consist of medium-grained inequigranular feldspar-hornblende diorite and coarse-grained hornblende-porphyritic diorite. In thin section, the hornblende phenocrysts and matrix commonly contain very fine grained felted biotite and oscillatory zoned plagioclase.

Aphyric Hedley intrusive rocks are massive, dark brown to black, biotitic, aphanitic and sulphide rich. They generally occur as small sill and dike-like bodies or as margins to the larger phyric Hedley intrusions. They are interpreted (by the first two authors) as a quenched phase of the Hedley intrusive suite. Peperite-like textures (Plate 2-6-2; *cf.* Busby-Spera and White, 1987; Kokelaar, 1982) developed along some contacts suggest intrusion into wet sediment. The authors do not concur with this interpretation of the origin for these aphyric, biotite-rich rocks. Further detailed work is planned to investigate their origin and to differentiate them from non-bedded mafic tuffs and argillites in the area.

The Cahill Creek pluton consists of medium-grained biotite-hornblende granodiorite to monzodiorite of calc-alkaline composition (Ray *et al.*, 1988). It is the next youngest intrusive suite in the Good Hope–French mine area, and forms a large body with minor apophyses controlled in part by the Cahill Creek fracture zone. Uranium-lead isotopic dates from zircons give a mid-Jurassic age of 168 Ma (Ray and Dawson, in preparation). Minor late aplitic dikes occur both in the pluton and adjacent to it.

Quartz-feldspar rhyolite, the youngest intrusive rock identified in the study area, forms a dike less than 3 metres wide

Plate 2-6-2. Possible globular peperite developed along the contact of aphyric mafite(?) Hedley sill and massive limestone of the French mine formation.

that cuts mineralization at the French mine. A similar intrusive unit, 11 kilometres southwest of Hedley, returned a U-Pb isotopic zircon age of Middle Jurassic (171 Ma, Ray and Dawson, in preparation). This dike suite may be a feeder system to previously unrecognized mid-Jurassic volcaniclastic rocks on Ashnola Hill 10 kilometres southwest of the project area, and on Lookout Mountain 7 kilometres to the north. These rocks were originally mapped as Nicola Group by Bostock (1940a) and as Early Cretaceous Spences Bridge Group by Ray and Dawson (*1987, 1988*).

ALTERATION AND MINERALIZATION

The Good Hope mine (MINFILE 92H 060) has produced 178 kilograms of gold, 120 kilograms of silver and 602 kilograms of copper from 11 410 tonnes of ore mined during the period 1946 to 1948 and in 1982. Production was from gold-enriched skarn developed along the contact between the French Mine formation and a Hedley diorite sill (Figure 2-6-2). In general the bedding in the area is gently dipping, but a broad synclinal structure is exposed within the trench area.

The diorite sill is approximately 2 metres thick and is composed of feldspar and hornblende crystals, less than 3 millimetres in diameter, set in a fine-grained matrix. The hornblende crystals and matrix contain fine-grained felted biotite with minor diopside occurring along fractures. Skarn

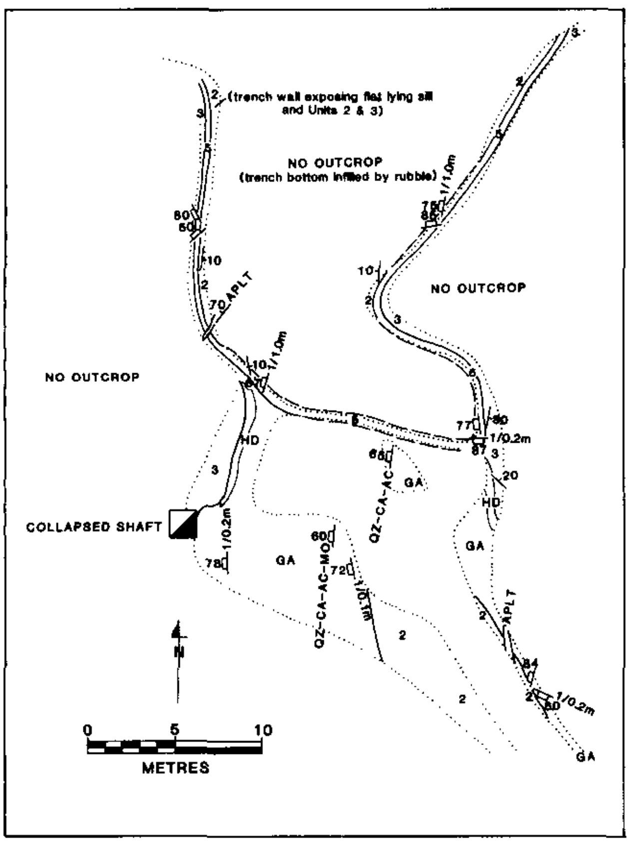

Figure 2-6-2. Sketch map of the Good Hope trench (*see* Figure 2-6-1 for legend), additional abbreviations are: APLT = aplite, GA = garnet, HD = hedenbergite, QZ = quartz, CA = calcite, AC = actinolite, MO = molybdenite, SC = scapolite).

is best developed in the hangingwall of the sill. A distinct mineralogical zonation is recognized from the sill contact upwards into the overlying marble: this consists of a massive garnetite zone adjacent to the sill and up to 2 metres thick followed by a discontinuous zone, less than 0.3 metre thick of large tabular hedenbergite crystals. The garnet crystals are reddish brown to black, subhedral to euhedral, less than 1 centimetre in diameter, anisotropic and exhibit sector twinning. Microprobe analysis of selected garnet grains show they are Ad_{10} to Ad_{30} mole per cent and enriched in manganese (11%) compared to other skarns in the Hedley area (Ettlinger and Ray, 1989). Tabular euhedral hedenbergite crystals, up to 10 centimetres long, are oriented perpendicular to the marble contact. Microprobe analysis show they range from Hd_{90} to Hd_{100} and are also enriched in manganese (10%).

Minor retrograde skarn consisting of calcite, epidote and sulphides occurs interstitial to the hedenbergite crystals. Sulphides consist of finely disseminated and massive pyrrhotite, arsenopyrite, pyrite, marcasite and chalcopyrite with minor native bismuth and hedleyite. Grab samples from the hedenbergite-sulphide skarn assayed up to 94 ppm gold (Ettlinger and Ray, 1989). Local zones of jasperoid are developed along the upper contact of the sill with the marble.

A second period of mineralization crosscuts the auriferous skarn mineralization and consists of north-striking quartz + actinolite + epidote + calcite ± molybdenite ± scheelite veins bordering the aplitic dikes of the Cahill Creek pluton.

The French mine (MINFILE 92H 059) produced 161[illegible] kilograms of gold and 124 kilograms of silver from 79 00[illegible] tonnes of ore during the periods 1950 to 1955, 1957 to 1961 and in 1983. Mineralization is confined to a broad anticlinal structure within a down-faulted block of the French Mine formation (Figure 2-6-1). Within the area of the mine workings, the French Mine formation consists dominantly of massive limestone with some limestone conglomerate and breccia layers present in the western end of the workings. The anticlinal structure strikes west to northwest and has been worked along two main stopes over a horizontal distance of 225 metres (Figure 2-6-3). Mineralization is terminated against the high-angle French fault on the west and the west dipping Cariboo thrust fault on the east. Other northeast and northwest-striking high-angle faults have been identified underground, however displacements are generally less than 3 metres. The stopes are about 3 metres wide and are believed to be separated by biotite-rich aphyric mafite sills of Hedley diorite (the authors do not concur – the separating unit may be hornfelsed tuffs and argillites).

A distinct skarn mineralogical zonation is developed outwards from aphyric mafite sills and dikes. Zones consist of successive envelopes of: scapolite + potassium feldspar + quartz, followed by garnet + diopside, followed by massive marble. The scapolite + potassium feldspar + quartz envelope is up to 50 centimeters thick. The garnet + diopside envelopes are up to 1 metre thick and are composed of massive, fine-grained reddish brown isotropic garnet with minor diopside. Microprobe analysis of garnets within the ore zone shows that they are enriched in iron and range in composition from Ad_{80} to Ad_{100} mole per cent; garnets from the outer margin of the skarn envelope range from Ad_{13} to

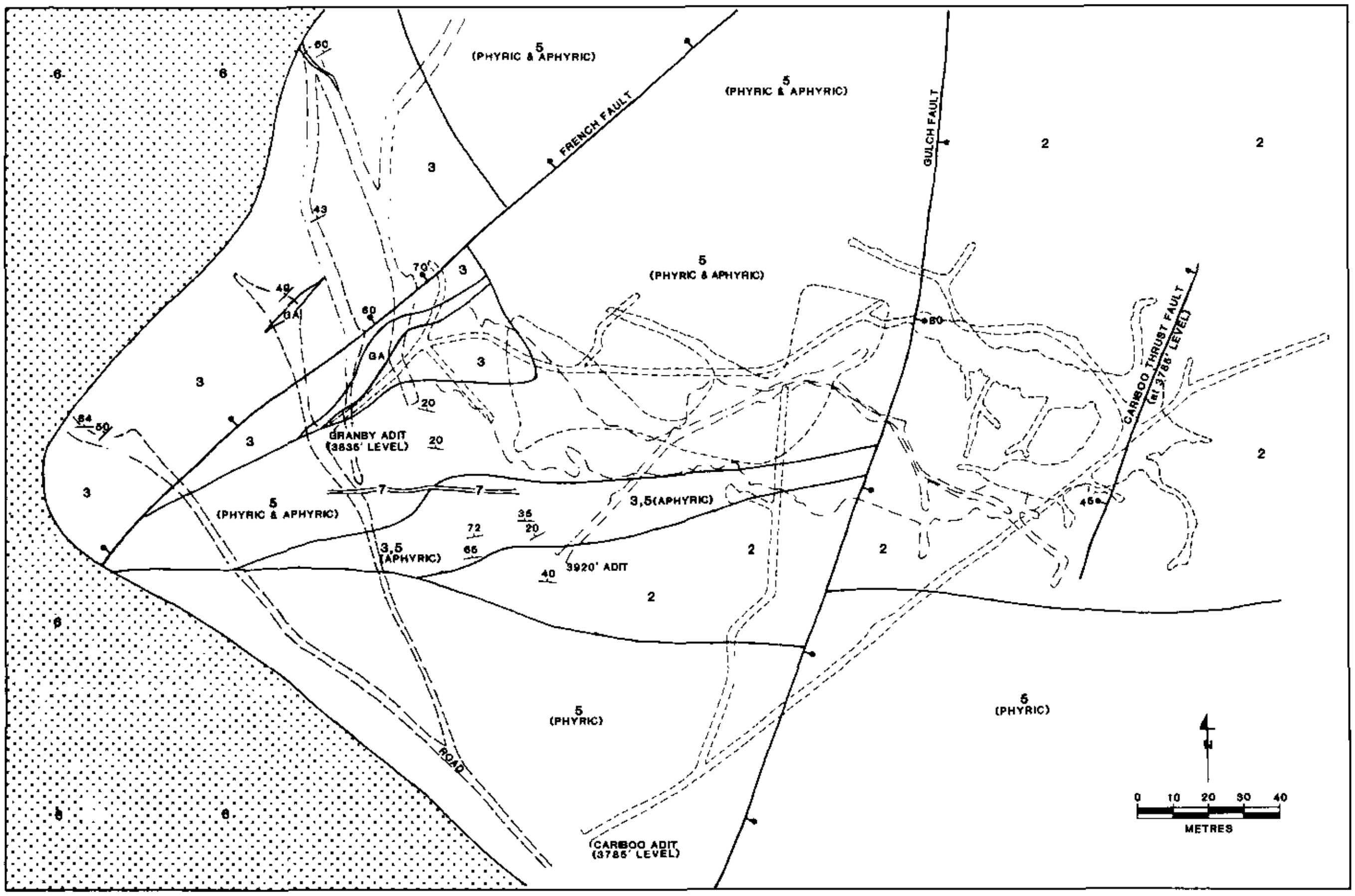

Figure 2-6-3. Sketch map of the French mine area (*see* Figure 2-6-1 for legend and Figure 2-6-2 for abbreviations; Note: short dash = lower stope and haulage level, and long dash and dot = upper stope and haulage level).

Ad_{25}. Pyroxene crystals range from Hd_{63} to Hd_{67} and have a low (less than 1%) manganese content. Associated skarn minerals include minor epidote, wollastonite and sulphides.

Sulphides average less than 5 per cent by volume throughout most of the deposit, except for the western part that was relatively rich in copper and low in gold. The major sulphides identified are pyrrhotite, chalcopyrite, bornite, covellite, pyrite and arsenopyrite. Minor cobaltite, erythrite, tellurides and native gold have been identified. In the lower stopes visible gold is associated with coarse telluride grains. Recent underground chip sampling by Corona Corporation has outlined zones of high grade gold mineralization over a strike length of 65 metres with several samples returning values over 35 grams per tonne gold over widths of 1 metre (Godfrey, 1989). Down-dip extentions of the ore horizons and the diplaced horizons underneath the Cariboo thrust are currently being tested by drilling.

Sporadic coarse scheelite and molybdenite are also reported. A 35-metre chip sample along an underground face averaged 0.68 per cent WO_3 (Ray *et al.*, 1988). The relationship of this mineralization to the major gold-bearing skarns remains uncertain, but it may be related to the underlying Cahill Creek pluton.

SUMMARY

The Good Hope–French mine area is underlain by the Upper Triassic Nicola Group consisting of the lower volcanic Peachland Creek formation, the middle carbonate-dominant French Mine formation and the upper volcaniclastic Whistle Creek formation. Calcsilicate reaction skarn, widely developed throughout the French Mine formation, may have been formed by the Hedley intrusive suite, the younger Cahill Creek granodiorite, or both. However, auriferous skarn mineralization at the Good Hope and French mines is genetically and spatially related to the Hedley intrusive suite. A second period of mineralization consisting of quartz + actinolite + calcite + molybdenite + scheelite veins crosscuts earlier auriferous skarn mineralization and may be associated with the aplitic phase of the Cahill Creek pluton.

At the Good Hope mine, auriferous skarn is best developed along the upper contact of a feldspar-hornblende-phyric Hedley diorite sill. Successive envelopes of garnet, diopside and hedenbergite skarn are developed outwards into the overlying marble of the French Mine formation. Sulphides and associated gold mineralization are concentrated in the coarse-grained hedenbergite envelope; this suggests iron-rich hydrothermal fluids were important in transporting gold. Jasperoid developed along the sill-marble contact and along pre-intrusion faults might be a late feature of the skarning process (*i.e.* fluids were not hot enough to produce calc-silicate mineralogy).

At the French mine, scapolite, garnet-diopside and marble envelopes are developed adjacent to numerous small Hedley aphyric mafite sills and dikes which have intruded limestone of the French Mine formation. Mineralogical zoning suggests hydrothermal fluids were confined to areas between individual sills and dikes resulting in multiple "box-like" zones of skarn alteration. Minor calcite + quartz + chlorite + sulphides, and associated gold mineralization, are found predominantly within the garnet-diopside skarn.

The recognition of possible aphyric mafite intrusions as a quenched mineralized phase of the Hedley intrusive suite, formed by intrusion into wet sediment, has important genetic and economic significance in gold skarn models. Some implications are: contemporaneous sedimentation and intrusive volcanism; shallow depth of intrusion and associated skarn formation; availability of large quantities of seawater that might facilitate chlorine complexing and transportation of metals; and depositional environment within an extentional regime, perhaps related to rifting in a back-arc basin.

Distinguishing barren calcsilicate reaction skarn from economic auriferous skarn mineralization is difficult. However, the presence of iron-rich prograde mineral assemblages such as andraditic garnet and hedenbergite pyroxene and retrograde minerals such as epidote, calcite, quartz, amphibole, chlorite and sulphides may indicate that the skarn is not isochemical and therefore has auriferous potential.

The amount of alteration and mineralization developed appears to be proportional to the number of sills present. The presence of only one sill at the Good Hope mine may explain its small size as compared to the Nickel Plate and French mines where sill swarms are more extensively developed.

ACKNOWLEDGMENTS

Field support was provided by a grant financed by the Canadian/British Columbia Mineral Development Agreement. Golden North Resource Corporation and Corona Corporation granted permission to work on the property and provided free access to all data and drill core. Field assistance was provided by Ann Pickering and Ian Webster.

REFERENCES

Billingsley, P. and Hume, C.G. (1941): The Ore Deposits of Nickel Plate Mountain, Hedley, British Columbia; *Canadian Institute of Mining and Metallurgy*, Bulletin, Volume XLIV, pages 524-590.

Bostock, H.S. (1930): Geology and Ore Deposits of Nickel Plate Mountain, Hedley, British Columbia; *Geological Survey of Canada*, Summary Report, 1929, Part A.

——— (1940a): Map of the Hedley Area; *Geological Survey of Canada*, Map 568A.

——— (1940b): Map of the Wolfe Creek Area; *Geological Survey of Canada*, Map 569A.

Busby-Spera, C.J. and White, J.D.L. (1987): Variations in Peperite Textures Associated with Differing Host-sediment Properties; *Bulletin of Volcanology*, Volume 49, pages 765-775.

Camsell, C. (1910): The Geology and Ore Deposits of Hedley Mining District, British Columbia; *Geological Survey of Canada*, Memoir 2.

Dawson, G.L. and Ray, G.E. (1988): Geology of the Pennask Mountain Area, 92H/16; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Open File 1988-7.

Dolmage, V. and Brown, C.E. (1945): Contact Metamorphism at Nickel Plate Mountain, Hedley, British Columbia; *Canadian Institute of Mining and Metallurgy*, Bulletin, Volume XLVIII, pages 27-68.

Ettlinger, A.D. and Ray, G.E. (1989): Precious Metal Enriched Skarns in British Columbia: An Overview and Geological Study; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Paper 1989-3.

Godfrey, J. (1989): Release of Sampling Results, French Mine; in Stockwatch, J. Woods, Editor; *Canjex Publishing Ltd.*, Vancouver.

Hammack, J. (1988): Geological Map of the Good Hope – French Area; *Corona Corporation*, unpublished map (1:6000), October, 1988.

Kokelaar, B.P. (1982): Fluidization of Wet Sediments during the Emplacement and Cooling of Various Igneous Bodies; *Journal of the Geological Society*, Volume 139, pages 21-33.

Milford, J.C. (1984): Geology of the Apex Mountain Group, North and East of the Similkameen River, South-central B.C.; unpublished M.Sc. thesis; *The University of British Columbia*.

Ray, G.E. and Dawson, G.L. (1987): Geology and Mineral Occurrences in the Hedley Gold Camp, British Columbia; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Open File 1987-10.

——— (1988): Geology and Mineral Occurrences in the Hedley Gold Camp; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Open File 1988-6.

——— (in preparation): Geology of the Hedley Gold Camp, South-central British Columbia; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Bulletin

Ray, G.E., Dawson, G.L. and Simpson, R. (1987): The Geology and Controls of Skarn Mineralization in the Hedley Gold Camp, Southern British Columbia; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Geological Fieldwork 1986, Paper 1987-1, pages 65-79.

——— (1988): Geology, Geochemistry and Metallogenic Zoning in the Hedley Gold-skarn Camp (92H/8; 82E/5); *B.C. Ministry of Energy, Mines and Petroleum Resources*, Geological Fieldwork 1987, Paper 1988-1, pages 59-80.

Ray, G.E., Simpson R., Wilkinson, W. and Thomas P. (1986): Preliminary Report on the Hedley Mapping Project; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Geological Fieldwork 1985, Paper 1986-1, pages 101-105.

NOTES