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CANTY PROPERTY, HEDLEY AREA.

Introduction.

Two samples taken from BQ drill core were studied with the scanning electron microscope to determine the mineralogy and gold occurrences. The samples came from: C-831, DDH 81-1, 29.55 to 29.60m; and C-832, DDH 81-7 17.30 to 17.34m. The samples were found to be mineralogically and texturally identcal and will be discussed together.

Sample Description.

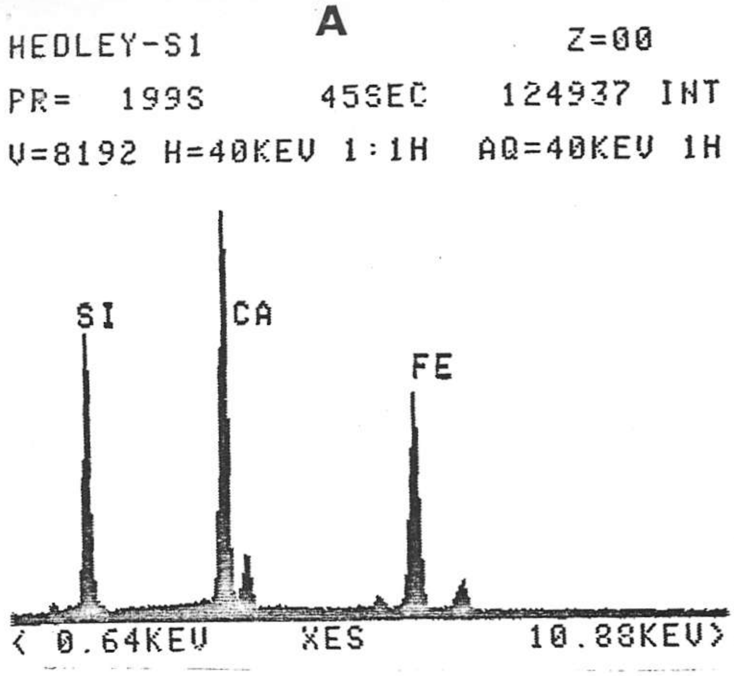
Specimens consist of coarse grained, intergrown arsenopyrite (FeAsS) and loellingite (FeAs), with minor gangue. The iron-arsenic minerals vary from euhedral and massive to irregular shapes with enough incorporated gangue (quartz) to be termed sieve texture. Gangue mineralogy consists of quartz, with minor orthoclase and epidote, andradite garnet ($Ca_3Fe_2Si_3O_{12}$) (green), and idocrase (or vesuvianite, which is yellow). Scapolite was not detected but could be present in small amounts. If scapolite was present it would likely be the calcic and calcite bearing variety as any Na, Cl or S , carried by the other varieties, would be easily recognised and diagnostic.

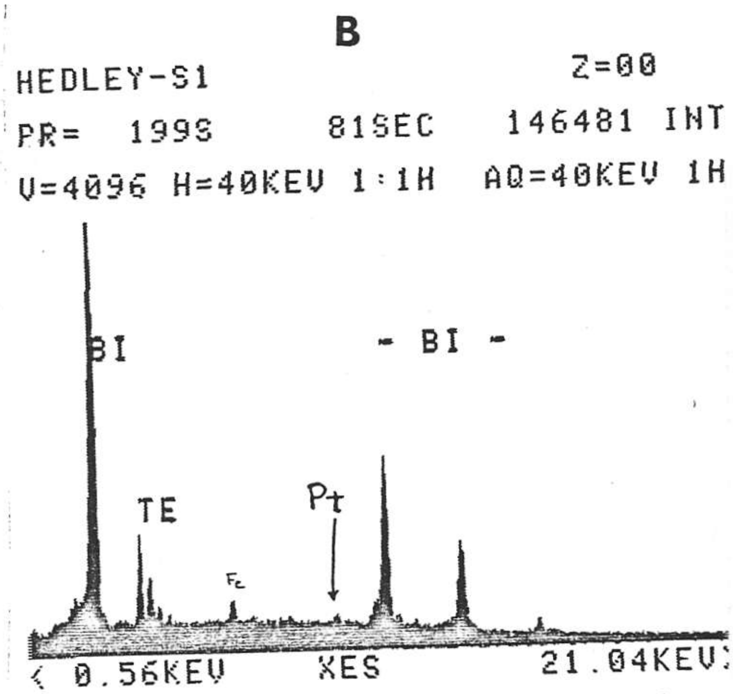
Gold occurred as variably sized (3-30μ), rounded grains within quartz gangue. No gold was observed within the arsenopyrite or loellingite, although a spatial and possibly genetic association exists between the sulphides and gold bearing quartz. A few small grains of galena and sphalerite also occurred within the gangue. Various bismuth minerals were observed as fine disseminations within both the sulphide grains and the gangue. Bismuth phases include: bismuthite (Bi_2S_3), joesite (Bi_3TeS_2), werhlite (or hedleyite, $Bi_{3+x}Te_{2+x}$), and native bismuth. Many of these phases, particularly the tellurium bearing varieties, contained trace amounts of platinum.

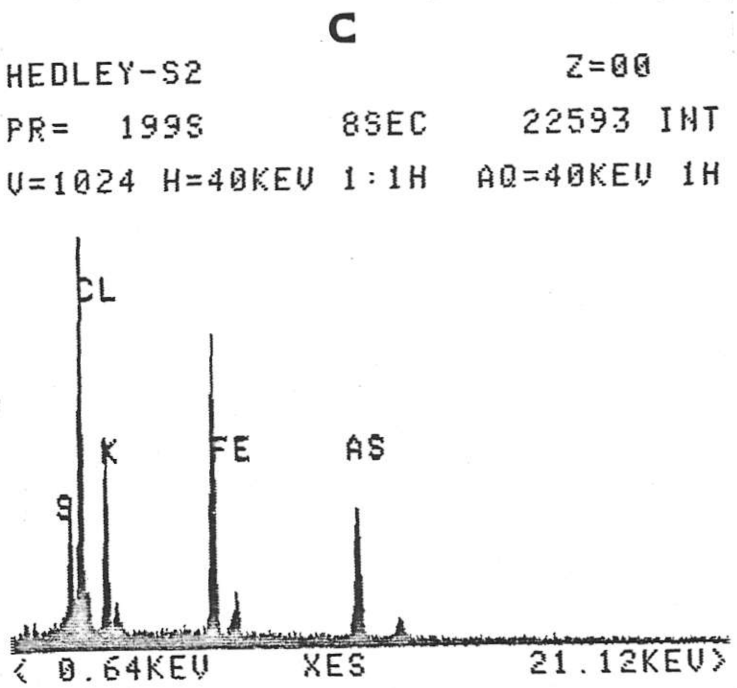
Disscussion.

It is generally acknowledged in the literature that gold occurs as micron sized inclusions associated with pyrrhotite within arsenopyrite aggregates in "Hedley type" mineralization. A recent undergraduate thesis at UBC, on similar type mineralization in the Apex area noted grains of gold along arsenopyrite-loellingite grain boundaries. It is difficult to determine, on the basis of two sections, whether the gold occurrence of this study constitutes a different type of mineralization. It does, however, suggest that arsenopyrite is not necessarily an indicater of gold values.

The platinum content of the bismuth minerals is small but should be verified by assay. If any platinum is detected then routine geochemical analyses of bismuth or tellurium, with follow up platinum assays on the anomalous samples, should be considered. A possible relationship between bismuth and gold is indicated by the presence of gold grains within areas of clustered bismuth minerals. Because bismuth and gold appear the same on SEM back scattered electron images, and an EDS analysis is required to identify each grain, the strength of the association is not known. For the same reason some very fine (1μ) gold grains may occur within arsenopyrite in ares of disseminated bismuth minerals (see photo).





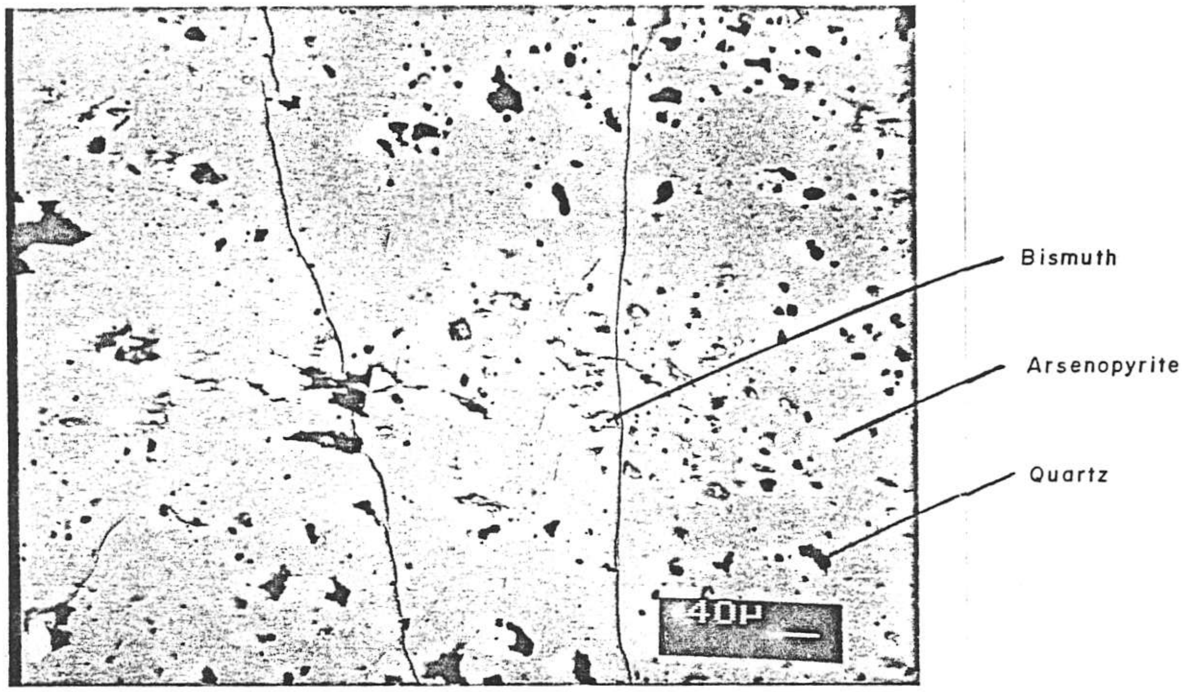


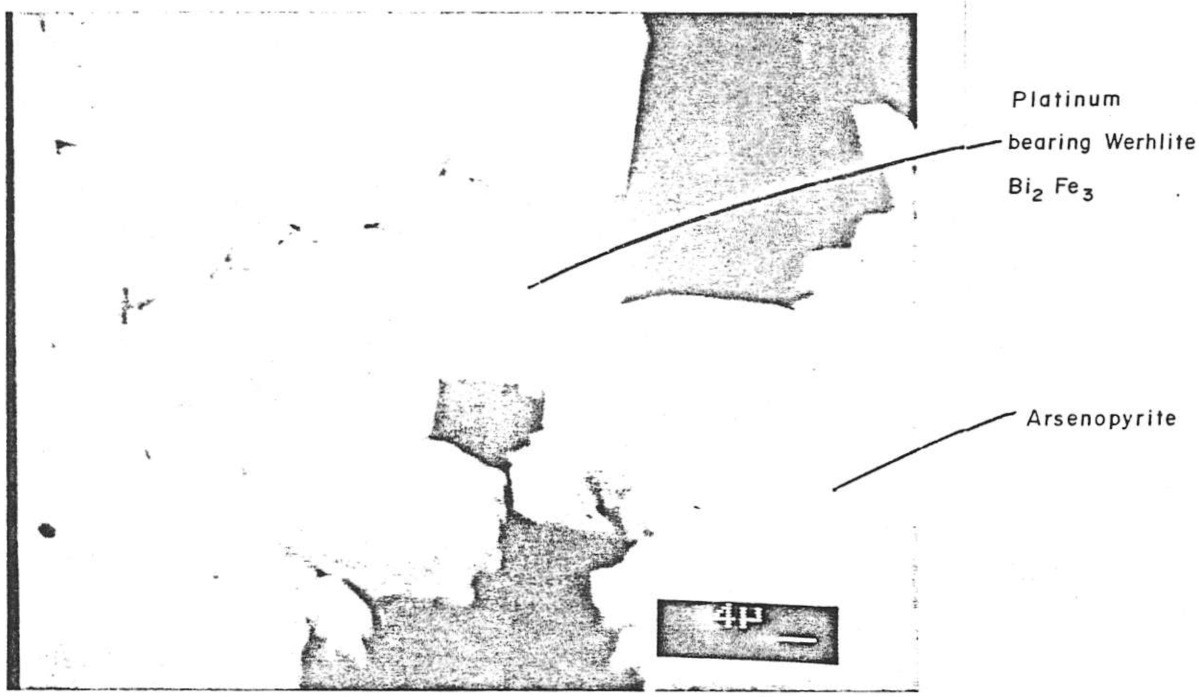
SEM/EDS analyses of phases within samples from the Canty property:

A - andradite garnet ($Ca_3Fe_2Si_3O_{12}$), note; peak heights are proportional to element abundance and atomic weight.

B - werhlite or hedleyite with minor platinum

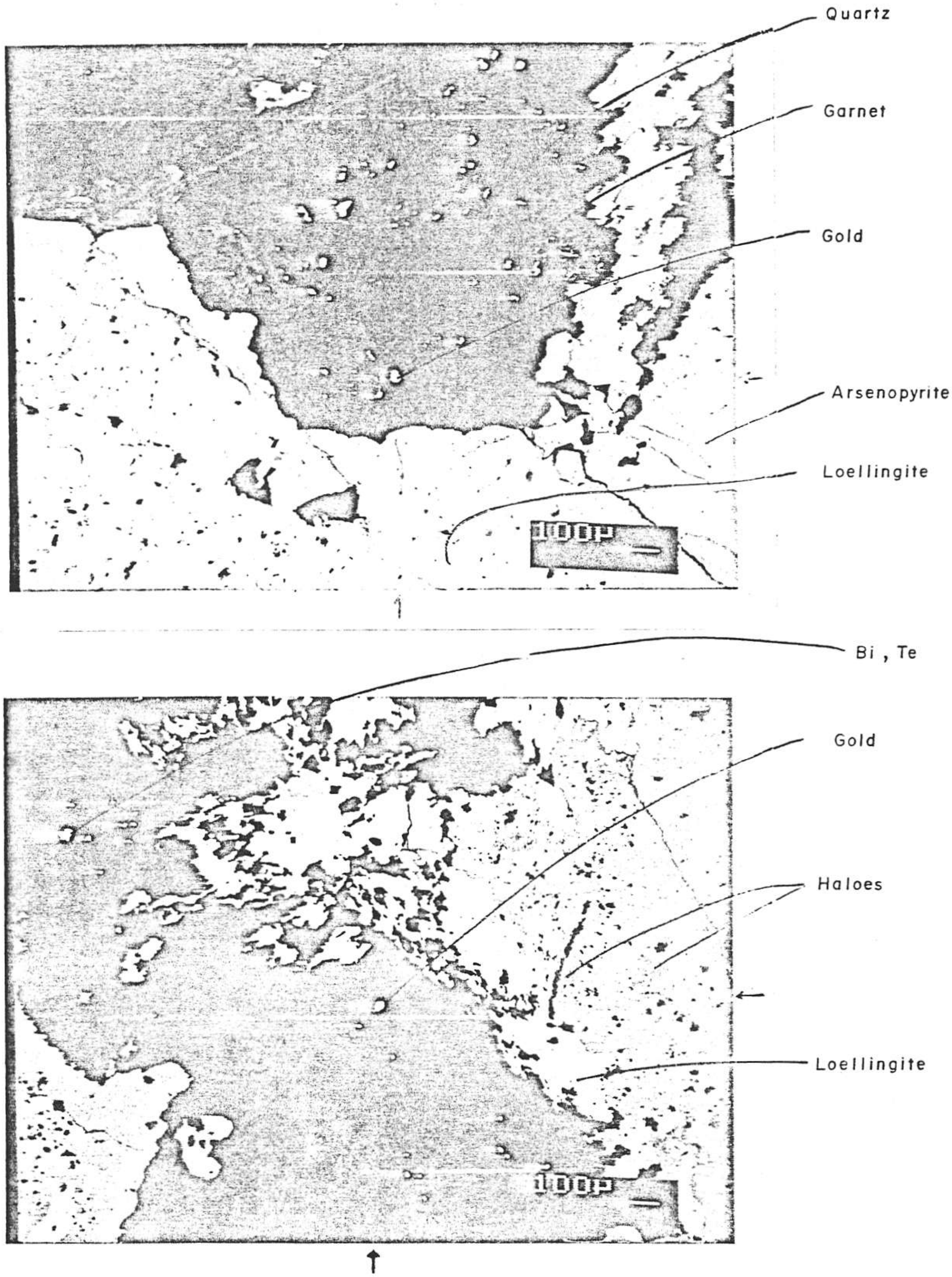
C - sylvite or other inclusion in arsenopyrite. It is possible, but unlikely, that this analysis represents contamination from finger prints.





Top: Back scattered electron image of disseminated bismuth minerals in arsenopyrite. Some of the finer grains might be gold. Note the abundant included gangue.

Bottom: BSE image (close-up) of platinum bearing werhlite within arseno-pyrite.



Gold grains (bright white, where arrows on photo edge meet) within gangue (quartz) near arsenopyrite (dark grey) or loellingite (light grey). Other bright spots are mostly bismuth minerals with some finer gold grains. The dark circular areas or haloes within the asenopyrite in the lower photo are inclusions (fluid ??) containing K and Cl.

HEDLEY GOLD MINING DISTRICT

Geology 558 — April 1981

Guidebook — Brad Cooke

Introduction

Hedley is located in the Similkameen River valley on Highway #3 some 40 km east-south-east of Princeton in southwestern British Columbia. The old Nickel Plate, Hedley Mascot and Canty Gold mines lie on Nickel Plate Mountain, northeast of Hedley, and the former French mine occurs southeast of Hedley along the Similkameen River.(Figure 1).

Placer gold was first discovered in Similkameen River and Hedley Creek in 1859 but it was not until 1898 that two prospectors found gold on Nickel Plate Mountain. Production of gold ore from the Nickel Plate Mine commenced in 1904 and continued, with only one break (1931 to 1934) , until 1955. Hedley became known for a 3.1 hectare fraction in the original claim group that was staked by another prospector and later sold to other mining interests. The now famous Mascot Fraction was mined by Hedley Mascot Gold Mines between 1936 and 1949. The Hedley district produced a total of 50 million grams of gold from 3.7 million tonnes of ore at an average grade of 13.6 grams per tonne (Table 1).

Exploration and development of the old workings and adjacent areas on Nickel Plate Mountain is presently being carried out by two junior mining companies, Good Hope Resources Ltd., and Mascot Gold Mines Ltd., both registered in Vancouver, B.C. Although commonly considered to be a lode gold mining camp, the Hedley ore bodies are here classified as gold (silver, copper) skarn deposits of contact metasomatic origin.

Geology

The Hedley region lies in the Intermontaine belt of the Canadian Cordillera and consists of Permian oceanic sediments (Bradshaw, Independence, Shoemaker, and Old Tom Formations) and Triassic eugeoclinal volcanics and sediments (Nicola Group) , intruded by Jurassic mafic plutons (Hedley Intrusions) and felsic plutons (Similkameen Intrusions). These rocks are overlain by eugeoclinal volcanics and sediments (Kingsvale Group) and intruded by felsic plutons (Otter Intrusions) of Cretaceous age, finally overlain by Tertiary (Princeton Group) continental volcanics and sediments (Figure 1). Near Hedley, the Nicola Group is conspicuous for its lack of volcanic rocks and abundance of sedimentary rocks riddled by sills of the Hedley Intrusions (Table 2).

The stratigraphy forms a northeast plunging asymmetrical anticline with the Nickel Plate, Hedley Mascot and Canty Gold mines on the western limb and the French mine on the eastern limb. On Nickel Plate Mountain, southeasterly overturned drag folds are associated with three northwest dipping thrust faults, and the strata are crosscut by later small northwest plunging folds. A quartz diorite to diorite stock intrudes the strata and grades upwards into quartz gabbro to gabbro and outwards into diorite and gabbro porphyry dikes and sills towards the northeast. Nickel Plate Mountain is underlain by a granodiorite stock and minor felsic and mafic dikes crosscut the mines area. (Figure 2).

Gold ore occurs in calcsilicate skarn within interbedded limestones, argillites and quartzites of the lower Hedley Formation near gabbro and diorite porphyry sills and dikes of the Hedley Intrusions. Skarn on Nickel Plate Mountain forms a shallow bowl tilted to the west, the lower and outer limit of which is called the "marble line". (Figure 2). Three types of skarn occur depending on the original composition of the replaced strata:

1) limestone replaced by coarse grained, massive garnet, pyroxene and epidote skarn

2) quartzite replaced by fine grained, banded cherty skarn which may be interbanded with massive skarn

3) gabbro and diorite porphyry sills and dikes replaced by pyroxene and amphibole skarn

Near the marble line, scapolite is locally abundant.

Ore occurs in three main zones as tabular, pipelike or irregular bodies stacked on echelon with a shallow northwesterly plunge. Gold forms micron sized blebs in arsenopyrite associated with pyrrhotite, chalcopyrite and other minor sulphides occurring in skarn as disseminations, veins and massive replacements. The major ore controls include:

1) localization in coarse grained, massive skarn, preferring pyroxene skarn > garnet skarn > epidote skarn

2) proximity to the marble line (within 80m)

3) intersections of dikes and sills

4) undulations in dikes and sills

5) northwest trending fold axes

Small supergene ore zones with visible gold in gossan (preserved in shallow troughs on Nickel Plate Mountain) formed the richest ore mined at Hedley.

Model

The traditional model for ore genesis at Hedley involves metasomatism and mineralization of the Nicola Group by Hedley Intrusion related hydrothermal solutions. The intrusions acted as solution guides and ore formed by the damming effect of dikes, sills and folds in the strata.

However, the ore forming hydrothermal fluids could easily be related to the Similkameen Intrusions, for the following reasons:

1) the Hedley Intrusions are mafic in composition and would not be expected to evolve much magmatic fluid

2) the Hedley Intrusions were emplaced prior to the development of skarn and ore and so are unlikely sources for the ore fluids

3) although the Similkameen Intrusions lie hundreds of metres below the mine levels, late felsic dikes occur at surface

4) similar skarn and ore occurs at the French mine near the Similkameen Intrusions but 5 km from the nearest Hedley Intrusions.

It is possible that the Hedley Intrusions served as a heat source to the establishment of meteoric water convection cells which leached metals from the sediments and intrusions in the skarn process, and deposited them in the ore zones. However, such a model requires strong local control on the dissolution, transport and deposition of ore metals.

Escape of magmatic fluids upwards and outwards from the Similkameen Intrusions along permeable zones in the overlying stratigraphic pile (e.g. fault, intrusive and bedding contacts) would produce skarn between limestone and argillite, quartzite, diorite or gabbro (i.e. country rock facies control on metasomatism). Late stage metal bearing fluids would form ore by replacement of skarn in suitable structural traps (i.e. physical control on mineralization). Metals held in solution by sodium and potassium chloride complexes would form ore associated with scapolite and orthoclase near the marble line (i.e. chemical control on mineralization). Late surficial weathering produced supergene ore enrichment, some of which was preserved from glacial erosion.

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Mine	Ore (Tonnes)	Gold (grams)	Silver (grams)	Copper (kilograms)
Nickel Plate	2,983,900	41,705,393	4,160,118	981,030
Hedley Mascot	619,019	6,936,964	1,706,995	870,817
French	65,070	1,335,996	45,348	0
Canty Gold	26	995	31	0
Total	3,667,989	49,979,348	5,912,492	1,851,847
Grade		13.63 g/T 0.47 oz/ton	1.61 g/T 0.06 oz/ton	0.50 kg/T 1.23 lb/ton

Table 1 Production Data (compiled from B.C.M.E.M.P.R. Minfile)

Era	Period	Unit	Lithology
Cenozoic	Tertiary	Princeton Group	basalt, andesite, shale sandstone, conglomerate
		unconformable contact	
Mesozoic	Cretaceous	Otter Intrusions	granite, quartz monzonite, granodiorite
		intrusive contact	
		Kingsvale Group	basalt, andesite, breccia agglomerate, greywacke
		unconformable contact	
	Jurassic	Similkameen Intrusions (164 Ma)	granodiorite, quartz monzonite, granite
		intrusive contact	
		Hedley Intrusions (189 Ma)	diorite, quartz diorite gabbro, quartz gabbro
		intrusive contact	
	Triassic	Nicola Group	andesite, porphyry, tuff argillite, limestone
		Hedley district:	
		Henry Formation	argillite, tuff, limestone
		Hedley Formation	limestone, quartzite, argillite, chert, tuff, breccia
		Sunnyside Formation	limestone
		Redtop Formation	quartzite, argillite, limestone
		unconformable contact	
Paleozoic	Permian	Bradshaw Formation Independence Formation Shoemaker Formation Old Tom Formation	chert, argillite, limestone

Table 2 Formations and Lithologies (modified from Rice 1960)

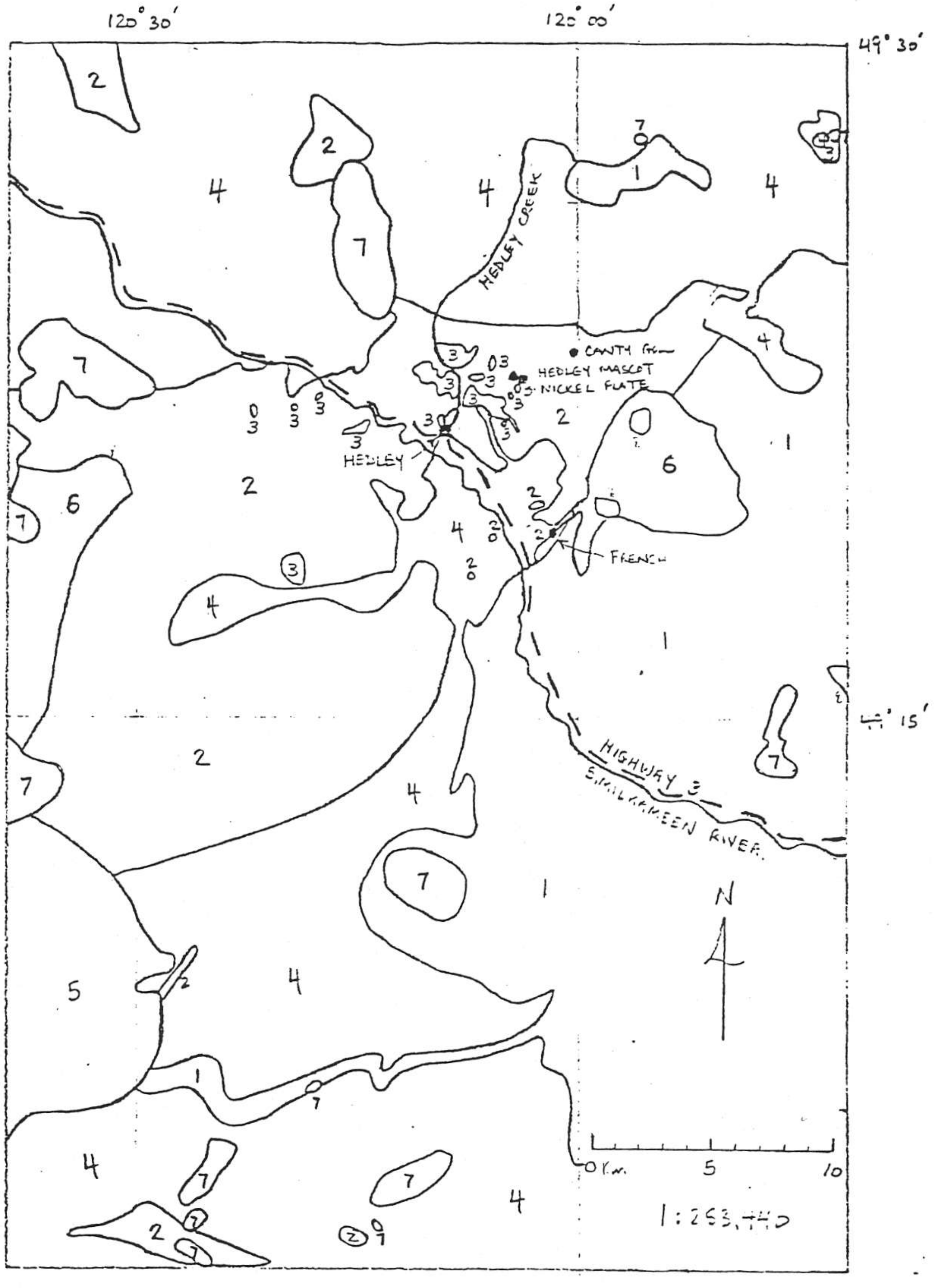


Figure 1 Regional Geology (modified from Rice 1960)
(1=Permian Bradshaw Fm etc., 2=Triassic Nicola Gp, 3=Jurassic Hedley Int, 4=Jurassic Similkameen Int, 5=Cretaceous Kingsvale Gp, 6=Cretaceous Otter Int, 7=Tertiary Princeton Gp)

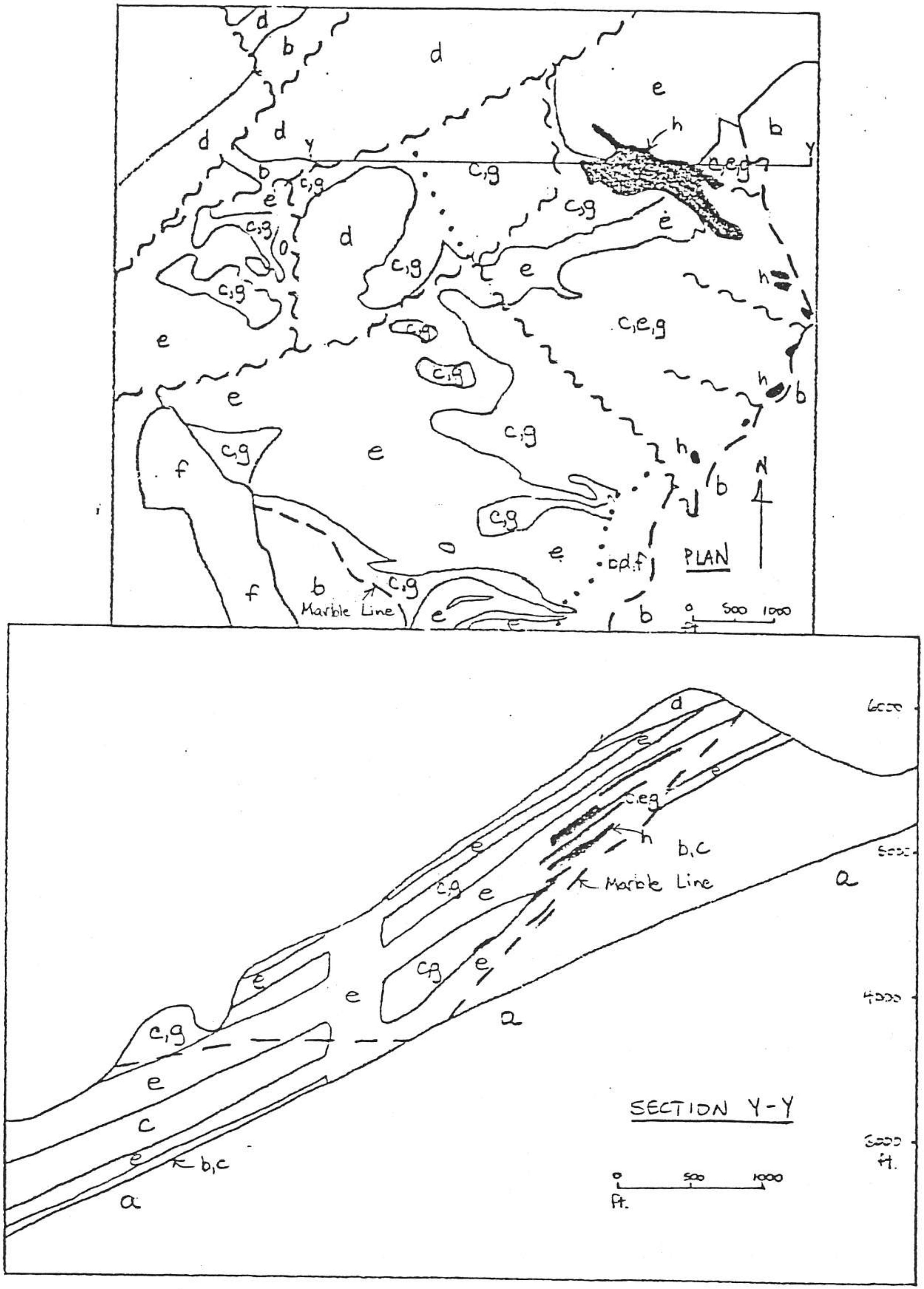


Figure 2 Detailed Geology Plan and Section (modified from Dolmage et.al. 1945 and Billingsley et.al. 1941)
(a=Redtop Fm, b=Sunnyside Fm, c=Hedley Fm, d=Henry Fm, e=Hedley Int, f=Similkameen Int, g=skarn, h=ore)

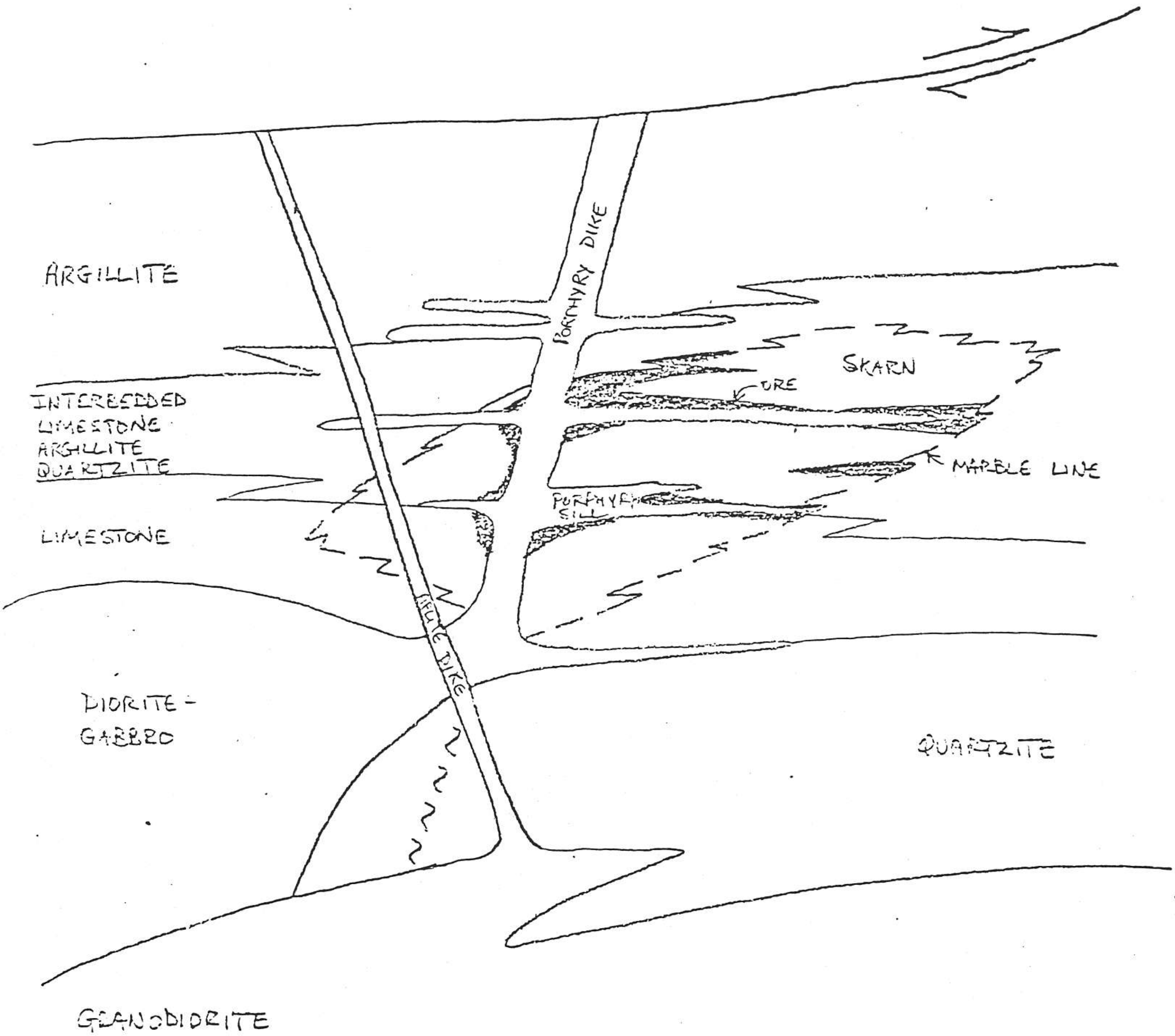


Figure 3 Schematic Ore Model

Mineralogy at Nickel Plate Mine*

By Harry V. Warren *and* John M. Cummings

THROUGH the kindness of Mr. W. C. Douglass, General Manager of the Kelowna Exploration Company, which is operating the old Nickel Plate Mine at Hedley, the University of British Columbia have not only been furnished with a suite of samples but have also been allowed to make public some of the results of the mineralogical investigation of these samples which may be of interest both to the various companies operating at Hedley and to others who have knowledge of similar deposits elsewhere.

The illustrations are at magnifications hitherto unobtainable in Western Canada and are the result of the new "superpolisher" and allied equipment which is now installed in the laboratories of the Geology Department of the University of British Columbia.

Location

The Nickel Plate mine is in Nickel Plate mountain, which is near the town of Hedley. It is in the Osoyoos mining division and lies about 27 miles north of the international boundary and 1½ miles west of the 120th meridian.

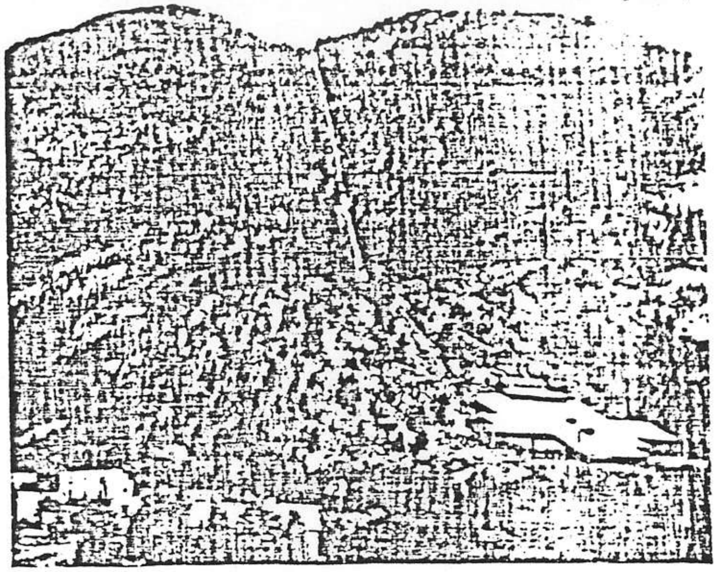
Hedley, on a spur of the Great Northern Railway, is situated between Keremeos, 17 miles to the southeast, and Princeton, which is on the Kettle Valley line of the Canadian Pacific Railway and lies 25 miles to the northeast. The southern Trans-Canada highway affords excellent road connections between Hedley and Princeton and Hedley and the Okanagan Valley.

Previous Work and History

Previous information on the property is confined largely to Provincial Minister of Mines[1] and Dominion Geological Survey reports, the most important being those by C. Camsell[2] and H. S. Bostock.[3]

Although staked a few years previously consistent work was not started on what was to be the Nickel Plate Mine until January, 1899. Production, commenced in 1904, continued with varying fortunes until 1930, when the owners, the Hedley Gold Mining Co. Ltd., closed the mine. In 1932 the Hedley Company's holdings were optioned to J. W. Mercer of New York and in July, 1933, the Kelowna Exploration Company Limited was formed to take over the property and, after considerable development work had been carried on under the guidance of one of the greatest American geologists, Paul Billingsley, sufficient ore was proved up to justify reconditioning the old mill, which is today working steadily. The rehabilitation of Hedley is an accomplished fact.

The business of recovering the gold from the Hedley mines has always been difficult and a mineralogical and mineragraphical study of these ores was attempted in an effort to assist these mines in their attack on this problem.



The 200-ton combination flotation and cyanidation mill at the Nickel Plate, Hedley, British Columbia. The complex Hedley ore presents one of the most difficult metallurgical problems in the Province.

General Geology

The commercial ore deposits so far discovered lie in the upper portion of Nickel Plate mountain, where a series of westward dipping Triassic sedimentary rocks have been intruded by large bodies of igneous rock of later Mesozoic or possibly Tertiary age.

Bostock[4] writes: "The Nickel Plate ore deposit belongs to that class generally described as the contact metamorphic type. The ore consists of gold-bearing arsenopyrite in a gangue of metamorphic silicates and occurs in a group of sedimentary rocks amongst which a nearly equal volume of igneous rock has been intruded in the form of sheets."

Some sedimentary beds have apparently been more susceptible to replacement by the ore-bearing solutions than others, but recent work appears to show that ore deposition has been controlled more particularly by structural features such as minor folding.

For further details the reader is referred to the reports of Bostock[5] or Camsell.[6]

The Mineralogy of the Hedley Ore

On the basis of the few samples submitted it is obviously impossible to consider any results as being final. Nevertheless sufficient material has been studied to open up new lines of thought and it is with the intention of bringing fresh ideas on the subject of the Hedley ore that this paper is presented.

The following minerals were identified in the sections

Arsenopyrite	Pyrite
Lollingite	Calcite
Cobaltite(?)	Garnet
Unknown Grey Mineral	Epidote
Pyrrhotite	Other silicates
Sphalerite	Gold
Chalcopyrite	

Arsenopyrite (FeAsS).—This is the most important metallic mineral in the ore. It is predominantly massive and anhedral, although it occasionally develops crystal form when in contact with gangue minerals. It occasionally occurs with pyrrhotite, in which case it is found in tiny subhedral or

*Note: This is the fifth of a series of articles on the mineralogy of some of the mines and prospects of British Columbia. For the specimens used in these mineralogical investigations it has been necessary to a large extent to rely on the kindness of the various individuals referred to from time to time. Consequently, although all ordinary precautions have been taken to ensure that the specimens studied are representative of the mines concerned, the authors do not assume any responsibility for the results hereafter discussed. The articles are appearing in haphazard order; the order therefore bears no relation whatsoever to the importance of the property which is being discussed.

rounded grains, often as clusters or small masses. Blebs of pyrrhotite in arsenopyrite grains are common. Arsenopyrite is the most common host mineral for native gold.

Lollingite ($FeAs_2$).—This mineral was only seen in one section of high grade ore which was examined. It occurs rarely as rounded blebs and inclusions in arsenopyrite.

Cobaltite (CoAsS).—Under magnifications of 900 diameters, what are thought to be specks of this mineral were seen in one place enclosing "islands" of pyrrhotite, but usually as tiny inclusions in and completely surrounded by arsenopyrite. A microchemical test betrayed the presence of cobalt and its etch reactions and physical properties are indicative of cobaltite. The presence of a cobalt mineral has been long suspected because of the occurrence, albeit somewhat rare, of erythrite—a hydrous cobalt arsenate—on the weathered outcrop of the Nickel Plate ore.[7]

Unknown Grey Mineral.—This was only noted in one place. The mineral was softer than arsenopyrite, was highly anisotropic, and was darkened by HNO_3. Unfortunately the smallness of the particle precluded the making of any further tests.

Pyrrhotite ($Fe_x S_{x+1}$).—Sometimes pyrrhotite appears to be of roughly the same age as the arsenopyrite, but more often it is definitely younger and with chalcopyrite replaces the gangue minerals, flowing around and occasionally cutting arsenopyrite.

In the rich samples of supposedly pure pyrrhotite arsenopyrite has always been found to be present, but nevertheless a few of the largest fragments of gold were found in pyrrhotite.

Sphalerite (ZnS).—Sphalerite is quantitatively rare but is frequently seen as grains in pyrrhotite and more rarely in chalcopyrite.

Chalcopyrite ($CuFeS_2$).—Chalcopyrite is not abundant except locally. Where present it is usually close to pyrrhotite but smooth contacts exist between the two minerals, each of which is relatively free from inclusions of the other except in the immediate vicinity of the boundary zone.

Chalcopyrite was not seen in the high grade specimens and its presence may possibly be indicative of a relatively low gold content.

Pyrite (FeS_2).—This mineral, which is usually so abundant in B. C. gold mines, is rarely found at the Nickel Plate mine. In the sections examined one small cube of pyrite was seen in pyrrhotite.

Calcite ($CaCO_3$).—Calcite was observed as coarsely crystalline masses and as tiny inclusions in the metallic minerals. It is, however, reported in minute cracks in the sulphides.[8] Possibly two generations of calcite are represented in the ore.

Silicate Gangue Minerals.—As the examination of the ore was confined to the metallic minerals not very much attention was paid to these. They include enhedral garnets, epidote, pyroxene, and possibly axinite. All are older than the ore minerals and have been replaced by them in varying degrees.

Gold. Distribution and Mode of Occurrence

Under high magnifications native gold was seen in all the richer samples and was actually seen in sections carrying as little as .58 oz. of gold to the ton.

There appears to be enough of this native gold in the ore to account for all the gold reported by assays.

There is no evidence to suggest that any gold is chemically related to or in solid solution with the arsenopyrite or pyrrhotite, the two minerals with which the gold is most closely associated.

Numerous tiny inclusions of gold—from 7 microns down to the limit of microscopic resolution—are distributed erratically throughout the arsenopyrite, without any apparent tendency to be controlled as to size or location by the enclosing sulphide.

There is little evidence of control of gold values by either lollingite or cobaltite. It may or may not be of significance that these minerals were observed only in the richest samples examined.

In only a few cases could the gold be seen in arsenopyrite without etching by nitric acid. However, after etching with $1{:}1 HNO_3$ for a few seconds, numerous grains appeared in a previously barren field. A notable feature was that every grain was surrounded by a "crater" or "pit."

Native gold in arsenopyrite with associated pyrrhotite. 200 mesh grid superimposed. Magnification approximately 650 diameters.

Gold in arsenopyrite. Typical occurrence in Hedley Mascot ore (adjoining Nickel Plate). 200 mesh grid superimposed. Magnification approximately 1000 diameters.

Where gold was seen in pyrrhotite it was in much larger grains, the largest, however, being only 91 microns in size. Although the gold occurs directly in pyrrhotite in a few places it is commonly in or surrounded by arsenopyrite even though pyrrhotite is the dominant mineral in the section.

Paragenesis

The following paragenesis is suggested.

(1) Formation of silicates.
(2) Introduction of arsenopyrite.
(3) Introduction of pyrrhotite, chalcopyrite, and sphalerite.
(4) Fracturing and veining of ore by calcite stringers.

The gold appears to have been deposited in and contemporaneously with arsenopyrite.

Summary and Conclusions

The gold values in the Hedley Nickel Plate Mine are contributed by native gold present most abundantly in arsenopyrite and occasionally in pyrrhotite.

The gold particles are very fine. Even in the pyrrhotite, where the coarsest gold is found, over 75 per cent of the grains are smaller than 325 mesh, and in the bulk of the ore they are virtually all less than 7 microns in size.

From these facts it would seem probable that the gold could be recovered by flotation of the arsenopyrite and pyrrhotite by relatively coarse grinding. Unfortunately the recovery of the gold from these concentrates by means of cyanidation will be relatively low.

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2. Geol. Surv., Canada, Memoir 2, 1910.
3. Geol. Survey., Canada, Summ. Rept. 1929, Part A, pp. 198-252
4. Op. cit., p. 227A.
5. and 6. Op. cit.
7. Camsell, op. cit.
8. Bostock [illegible]