THE GEOLOGY AND MINERALOGY OF THE YREKA COPPER PROPERTY, QUATSINO SOUND, BRITISH COLUMBIA

by

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A THESIS SUBMITTED IN PARTIAL FULFILMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF APPLIED SCIENCE
in the Department
of
GEOLOGY AND GEOGRAPHY

We accept this thesis as conforming to
the standard required from candidates for
the degree of MASTER OF APPLIED SCIENCE

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GEOLOGY AND GEOGRAPHY

THE UNIVERSITY OF BRITISH COLUMBIA

April, 1955

ABSTRACT

The Yreka copper property is situated on the west side of Neroutsos Inlet about nine miles northwest of Port Alice in the northern part of Vancouver Island, British Columbia. The property is underlain by rocks of the Vancouver Group, including greenstones, limestones, breccias and tuffs striking approximately northwest and dipping southwest into the mountainside at about 35 degrees. They are intruded by dykes and sills of quartz-feldspar porphyry, quartz diorite and basalt.

The mineral deposits are located in large bodies of skarn which have been formed in the tuffaceous rocks of the middle part of the sequence. The skarn zones consist roughly of three subparallel units which appear to conform approximately with the bedding. The largest of these skarn zones is about 1500 feet long and more than 100 feet wide, and contains sulphide bodies of economic interest. Other sulphide showings have been found on the property but do not appear to be of economic significance. The skarn zones are of pyrometasomatic origin of the type not related to an igneous contact.

Development work in the early part of the century included stripping and trenching, driving a number of adits in various places in the skarn zones, and mining of a small tonnage of ore. Recent work, consisting of mapping,

sampling and diamond drilling, has shown the property to be a prospect of considerable merit.

ACKNOWLEDGMENTS

The writer is indebted to Mr. B.O. Brynelsen for permission to make use of data obtained by the writer while in the employ of Noranda Exploration Company Limited, during the summer of 1954. Mr. Brynelsen has also kindly made available thin-sections, rock samples, diamond drill logs and reports pertaining to the Yreka property.

The writer also wishes to thank Dean H.C. Gunning and Professor K.C. McTaggart of the Department of Geology, The University of British Columbia, under whose supervision the thesis was written, for valuable help with the petrographic work and for numerous helpful criticisms and suggestions.

Mr. J.A. Donnan made most of the thin-sections.

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THE GEOLOGY AND MINERALOGY OF THE YREKA COPPER PROPERTY, QUATSINO SOUND, BRITISH COLUMBIA

CHAPTER I

INTRODUCTION

History

The mineral claims comprising the Yreka copper property are situated on the west side of Neroutsos Inlet, which is the southeast arm of Quatsino Sound, in the northern part of Vancouver Island, British Columbia. Sixteen of these claims are Crown-granted, and a number of others are held by location.

The mineral deposits were discovered at the end of the last century, the first claims being staked in 1898 and 1899. The discovery was quickly followed by a considerable amount of development work, and by 1903 the property was equipped with an aerial tram, a ten-drill air compressor powered by Pelton wheel, ore bunkers, and a wharf. In that year 2500 tons of copper ore, of unknown grade, were shipped

from the property. In May of 1903 the Northwestern Smelting and Refining Company assumed control of the property from the Yreka Copper Company, but all work ceased in 1904.

Stimulated, no doubt, by the substantial increase in the price of copper which took place towards the end of the First World War, operations were resumed in 1917 under the direction of N.S. Clarke and associates of Seattle. A new wharf, ore bunkers and aerial tramway were erected in the spring of 1917 and a shipment of 900 tons of 3% copper ore was made, but the property was again abandoned later in the year.

No further work was done on the property until 1952, when it was taken over by Noranda Exploration Company Limited. In that year some sampling and general prospecting were carried out. In 1953 Noranda Exploration Company Limited did a considerable amount of detailed mapping and X-Ray diamond-drilling. Further mapping and diamond-drilling were carried out in the summer of 1954, and more work is planned for the 1955 season.

Location and Accessibility

The Yreka property extends up the mountainside from tidewater on the west side of Neroutsos Inlet to an elevation of about 2500 feet, and is about nine miles from Port Alice, which is situated at the head of the Inlet (see Fig.1). The area can be reached in a few hours from Vancouver. Canadian Pacific Airlines has a daily flight from Vancouver to Port Hardy, at the northeast end of Vancouver Island. A

good road connects Port Hardy with Coal Harbour on Holberg Inlet, the northwest arm of Quatsino Sound. From Coal Harbour, Frank Hole water taxi provides daily transportation to Port Alice and points on Quatsino Sound and Neroutsos Inlet. A weekly freight service to the area from Vancouver is provided by the Frank Waterhouse steamer "Chilkoot".

Physical Features

The topography of the Neroutsos Inlet area is generally rugged. On the west side the mountains arise steeply a short distance back from shoreline to elevations exceeding 3000 feet. The highest mountains are located to the south of Canyon Creek, where jagged peaks rise to approximately 4000 feet. Slopes of 45 degrees or more are common at elevations around 2000 feet and higher.

The west side of the arm is drained by a number of streams, the largest being the Teeta River which is about four miles long and flows into the Inlet one and one-half miles northwest of Port Alice. Canyon Creek, one of the larger streams, flows into the Inlet just south of the mineral deposits on the Yreka property.

The area between Neroutsos Inlet and the west coast is one of the few remaining parts of Vancouver Island of which topographic maps have not yet been published. The accompanying map of the Yreka property is based on a contour map prepared from aerial photographs for Noranda Exploration Company Limited on a scale of 300 feet = 1 inch.

The Quatsino area has evidently been heavily glaciated. Strongly truncated spurs can be seen at a number of places between Coal Harbour and Port Alice, especially on the west side of Neroutsos Inlet near Quatsino. Canyon Creek has cut down rapidly in recent geological time in the lower part of its course, resulting in the formation of box canyons with walls up to 100 feet high. The rapid downcutting is obviously a direct result of over-deepening and excavation of Neroutsos Inlet by ice.

Climate and Vegetation

As might be expected from its location, the property has quite a mild climate with a heavy rainfall. Over the past thirty years an average annual precipitation of 110 inches has been recorded at Port Alice. According to Gunning (1929), most of the precipitation takes place between October and May, and summers are usually warm and dry. The summer of 1953 was, nevertheless, a very wet one.

Snowfall above the 1000 foot level is somewhat heavy, with snow persisting on some of the higher peaks into late summer.

The Quatsino area generally is well wooded, mainly by hemlock with smaller amounts of spruce. At elevations above 2000 feet cedar, both red and yellow, is increasingly abundant. Douglas fir is almost completely absent from Neroutsos Inlet area but is found in the Rupert Inlet area to the north. A heavy growth of dense underbrush and numerous windfalls at the lower levels combine with the rugged topography and general lack of outcrops to make geological mapping slow and difficult.

CHAPTER II

GENERAL GEOLOGY OF THE AREA

Previous Geological Work

The first geological work in the northwestern part of Vancouver Island was done by G.M. Dawson (1886). In the summer of 1885 he examined the coastal areas of the northern part of the Island from the Alert Bay area to Quatsino Sound. He briefly described the geology and physical features of the Quatsino area, including the southeast arm (Neroutsos Inlet), Rupert Inlet, and part of Holberg Inlet.

Nothing further was done until 1918, when V. Dolmage (1918) investigated the shores of Quatsino Sound and the adjacent coast and examined a number of mineral properties on the west coast of Vancouver Island, including the Yreka showings.

In 1929 H.C. Gunning (1929) made a reconnaissance of the Quatsino-Nimpkish area and visited some of the mining properties.

Until recently no further geological mapping was done in the area. J.A. Jeletzky of the Geological Survey of Canada has been carrying out stratigraphic studies for the past three years on the west coast of Vancouver Island, and in 1953 was working between Kyuquot Sound and Quatsino Sound. The results of this work have not yet been published.

Regional Geology

For a concise description of the geology and physical features of the Quatsino Sound area the reader is referred to the report by Dolmage (1918, pp. 31-33B). Briefly it may be stated that the Quatsino area is underlain by rocks of the Vancouver Group, consisting of an extensive assemblage of volcanic, pyroclastic and sedimentary rocks, intruded by dykes, sills, and stocks of various compositions. In a few localities the rocks of the Vancouver Group, which are of Triassic and possibly Jurassic age, are overlain by Cretaceous sediments, notably at Coal Harbour and on the north shore of Rupert Arm.

The regional strike is northwesterly with generally moderate dips to the southwest. With regard to the structure, the situation is still somewhat obscure. Little or no further detailed information has been forthcoming since Gunning's work in 1929, and his remarks may well be quoted here. He says (1929, p.104A):

> .... There is not as yet sufficient detailed information to reveal the structure across the strike, but it is presumed that the rocks of the Vancouver Group are compressed into a series of parallel overturned folds with the prevailing dip to the southwest. If this is not so we would be forced to conclude that there is a continuous succession of volcanic and sedimentary beds from the east to the west side of the island, and the resultant thickness of the group would be so enormous that one is forced to discredit the possibility. Also there is evidence in several places of repetition of beds due to tight folding and overturning....

The detailed work recently carried out by Jeletzky may clarify the situation to some extent with respect to the age and structure of the rocks in the northwest part of Vancouver Island.

The Quatsino formation (Gunning, 1931, p.23) borders the east side of Neroutsos Inlet from Quatsino to a point about midway between Jeune Landing and Port Alice, and extends eastward in part as far as Alice Lake. It makes up part of Drake (Limestone) Island and probably forms the floor of a considerable part of the Inlet.

On the west side of the Inlet the rocks consist of an assemblage of volcanic, pyroclastic and sedimentary types, striking approximately parallel to the Inlet in a northwesterly direction. Gunning, in his report on the Nimpkish Lake Quadrangle (1931, p.23A), proposes the name Bonanza Group for the group of rocks over-lying the Quatsino

formation, and the name Karmutsen volcanics for the predominantly volcanic group below the Quatsino formation. It is questionable whether the rocks on the west side of Neroutsos Inlet overlie the Quatsino formation. If the major structural feature of the area is that of a syncline overturned to the northeast, as postulated by Gunning for the Nimpkish Lake - Bonanza Lake area, the rocks on the west side of Neroutsos Inlet underlie the Quatsino formation, and belong to the Karmutsen volcanics. Until more field evidence is forthcoming, therefore, the writer proposes to call the assemblage of sedimentary, volcanic and pyroclastic rocks as exposed on the Yreka property the Yreka formation.

CHAPTER III

GEOLOGY OF THE YREKA PROPERTY

General Statement

On the Yreka property the rocks consist of a series of greenstones, limestones, tuffaceous limestones, breccias and tuffs, striking approximately northwest and dipping southwesterly into the hillside at about 35 degrees. The greenstones and bedded rocks are intruded by dykes and sills of quartz-feldspar porphyry and feldspar porphyry, quartz-diorite and basalt. The geology of the locality is summarised in the table on the following page:

Table of Formations

Late Jurassic or Triassic (?		Coast Range Intrusives	Dykes and sills of feldspar and quartz-feldspar porphyry, quartz-diorite and basalt
		Intrusive Contact	
Lower Jurassic(?) and Triassic	Vancouver Group	Yreka Formation	<u>Upper Greenstone</u>: Porphyritic and amygdaloidal flows with some inter-bedded breccias
			Disconformity (?)
			<u>Upper Bedded Member</u>: (a) Thin bedded tuffs and limy tuffs with some lenses of limestone. (b) Thin-bedded impure limestones and tuffaceous limestones
			<u>Intermediate Green-stone</u> Massive, probably a flow or flows.
			<u>Lower Bedded Member</u> Impure limestones and pyroclastics
			<u>Lower Greenstone</u> Includes fragmental beds
		Quatsino Formation	White to grey crystalline limestone

Greenstones and Bedded Rocks

Lower Greenstone

The Lower Greenstone member is well exposed on the mine road (See accompanying map) between elevations of 200 and 600 feet. It appears to consist mainly of dark green, massive rock, with a well marked fragmental zone in the middle part. In places it is quite soft and calcareous, being traversed by stringers of and containing small irregular blebs of white calcite. The fragmental zone is well seen on the road in the vicinity of the double switch-back about elevation 400 feet. Here the rock is a greenstone breccia with subangular fragments up to two inches across in a fine-grained groundmass. The fragments are almost the same colour as the groundmass, predominantly dark grey to dark green, and are difficult to distinguish on a freshly-broken surface. However, in this vicinity there are a number of ice-smoothed surfaces on which the fragmental nature of the rock is well seen. A small outcrop on the brink of the lower canyon on Canyon Creek about elevation 300 feet also shows well the fragmental texture (Spec. 12-1).

The member is probably made up essentially of flows and breccias of originally andesitic to basaltic composition, now largely altered and containing considerable amounts of chlorite, to which the overall term "greenstone" may be

appropriately applied.

No bedding or flow structure was noted in the lower greenstone. It has a thickness of about 2000 feet.

Lower Bedded Member

The lower greenstone grades rather abruptly upward into the lower bedded member. This is a light to dark grey or greyish-green rock, generally fine-grained. The bedding is not easily distinguishable, and was well seen in only a few outcrops. There is little variation in colour and texture between the individual beds, but in a few outcrops the rock has been somewhat protected from weathering by vegetation or overhanging rock masses. Here, breakdown of the rock has been slow, and differential weathering has taken place, with the result that the bedding has become easily discernible. Where the rock is unprotected, disintegration is rapid, and the bedding is usually difficult to detect, but sometimes may be recognized by means of the slight colour differences between the individual beds, which average about three inches in thickness.

These rocks are undoubtedly predominantly waterlain, and include beds of fine to coarse tuffaceous material. Many beds are quite calcareous - six out of eight rock specimens effervesce with dilute HCl.

Study of a thin-section made from a specimen taken

from about the middle of the member shows the rock here to be a highly altered crystal tuff, consisting largely of clastic crystals and grains of plagioclase feldspar in a dusty, fine-grained matrix. Epidote and actinolite are secondary. This specimen is non-calcareous.

At one place about 600 feet north of Canyon Creek and at an elevation of 660 feet an excellent outcrop of dark-grey limestone was found. At first sight the rock appeared to be a limy breccia, having a very rough surface. Closer examination, however, shows that what were at first believed to be fragments are most probably casts of brachiopods and possibly other organic remains. The shells of the brachiopods appear to have been completely replaced. On exposed surfaces differential weathering has taken place, so that casts of the brachiopods have weathered out, producing a very rough surface having the appearance of a breccia. This bed is probably near the base of the Lower Bedded member.

The member has a thickness of about 500 feet.

Intermediate Greenstone

In the course of mapping, a comparatively narrow band of greenstone was found between the Upper and Lower Bedded members. On the south side of Canyon Creek this layer is about 350 feet thick, but it appears to thin out north along strike. It was not found on a traverse up Edison Creek,

and may have pinched out to the south. Wherever seen it consisted of massive greenstone with no flow structures, and closely resembles the massive parts of the Lower Greenstone.

Upper Bedded Member

The contact between the Intermediate Greenstone and the Upper Bedded Member seems fairly sharp and can be located within 100 feet or so in several places. Nowhere, however, was the actual contact seen.

In the Upper Bedded Member, at least in its lower part, bedding is much more well defined than in the Lower Bedded Member. In outcrops in the vicinity of Canyon Creek the individual laminae are on the whole much thinner than in the Lower Bedded Member. They vary considerably in resistance to erosion, so that in many places the marked differential weathering that has taken place shows well the bedded nature of the rocks.

The lower beds are highly calcareous, consisting essentially of thin beds, averaging about one-half inch in thickness, of dark grey limestone interbedded with very thin laminae of limy argillite or tuffaceous material averaging one-eighth to one-quarter inch in thickness. The microscope shows the limestone to consist essentially of a mass of interlocking grains of calcite, ranging in size from 0.01 m.m.

and smaller up to about 0.25 m.m., with small amounts of feldspar and very fine-grained dark material. Most of the feldspar grains are angular but some are well rounded as though water-worn. They average 0.1 to 0.2 m.m. in width and some show polysynthetic twinning. The dusty, amorphous material tends to be concentrated into thin, sinuous bands and streaks which are parallel to the bedding planes. The composition of the thin lamellae appears to be very similar to that of the limestone, but with larger amounts of the black amorphous material. Elongated grains and laths of feldspar show a marked preferred orientation parallel to the bedding planes.

There seems to be little doubt that the lower part of the Upper Bedded Member consists of thin bedded limestones with varying amounts of tuffaceous material. To the north of Edison Creek the lower part of the member appears to consist largely of dark grey fine-grained limestone, with well developed beds a little thicker than they are to the south.

In a stratigraphically upward direction the lime content appears to decrease rather rapidly, and the rocks become harder and finer-grained. The overall colour changes imperceptibly from dark grey to dark grey-green. Some good exposures along Canyon Creek show that the rocks change rapidly in character from essentially limy varieties to

thin-bedded, cherty-looking types alternating with soft, limy beds, with some interbedded breccias, probably pyroclastic. A well developed fragmental stratum a few feet thick is exposed in the creek bed near the old Pelton wheel at an elevation of about 1000 feet. Here the fragments, which are dark green and very fine grained, are angular and average one-half to three-quarters of an inch across, with some as much as six inches in width.

As one follows the creek upward from about the 1000 foot level the limestone beds are seen to decrease in frequency of occurrence, so that in the vicinity of the old dam (elevation 1450 feet) the rocks are on the whole very fine grained, very hard, light grey types, thin bedded and probably tuffaceous.

The upper part of the Upper Bedded Member consists essentially of very thin-bedded, mostly very fine-grained hard tuffs, with some interbedded lenses of white crystalline limestone. The limestone lenses seem to be most numerous in and near the main skarn zone. Usually the bedding in the tuffs is difficult to detect on the surface, but it is well shown on a few outcrops in and near the main skarn zone around elevation 2100 feet. It is very well seen in most drill cores.

In contrast to the rocks of the lower members, the tuffaceous rocks of the Upper Bedded Member are in many

places rusty weathering. This is probably due to the small amounts of pyrrhotite that these rocks contain.

A number of thin-sections of specimens from various places in the upper part of the Upper Bedded Member were examined. The microscope shows that these thin-bedded rocks are fine to medium-grained basic crystal-lithic tuffs. Somewhat broken crystals of plagioclase feldspar and clinopyroxene together with rock fragments occur in a fine grained groundmass of minute clastic crystals and volcanic dust.

The clinopyroxene is present mostly in the form of euhedral to subhedral crystals, comprising from 0% to about 40% of the rock, and averaging 0.25 m.m. across. In most sections $Z \wedge C \cong 40$, and where obtainable $2V = 40$ or slightly more, indicating the pyroxene to be most probably augite.

Plagioclase feldspar is present in most thin-sections in the form of subhedral crystals averaging 0.25 m.m. across and usually making up 5-10% of the rock. Many of these crystals are twinned polysynthetically. A few rough determinations indicate the composition to be in the neighbourhood of An_{50}.

The rock fragments make up about 20-30% of the rock and are mostly of basic lava. They consist of a mesh of feldspar laths in a very fine grained groundmass. In some fragments the laths show a distinct preferred orient-

ation, and some fragments contain pyroxene crystals and microphenocrysts of plagioclase. A few fragments of limestone, more or less altered, were found, particularly in thin-section C4. Here euhedral crystals of clinopyroxene, probably diopside, form an interlocking mesh in calcite fragments. The pyroxene is probably secondary (metamorphic).

It seems significant that almost all the tuffs examined in thin-section, particularly those from around the skarn zone, were found to be calcareous to some degree. Evidence will be presented later which strongly suggests that the main skarn zones have been formed for the most part in these calcareous tuff beds.

The Upper Bedded member has a thickness of approximately 2000 feet.

Upper Greenstones

Stratigraphically overlying the Upper Bedded Member is a series of porphyritic and amygdaloidal flows with some interbedded breccias and tuffs. These have been termed collectively the Upper Greenstones. They are well exposed on the cliffs between the south and west forks of Canyon Creek around elevations of 1700-1800 feet, and between the north and west branches at elevations of about 2700 feet. They consist of a series of dark green to dark grey-green flows, with some interbedded dark green breccias and tuffs in

the lower part, and coarse dark red breccias and tuffs in the upper parts. Some of the flows are porphyritic, others are both porphyritic and amygdaloidal, and still others are fine-grained and massive. It is possible that different parts of a single flow may exhibit all of these textures.

In most outcrops the Upper Greenstones do not show bedding or flow structures, so that their attitudes could not be determined with certainty. The only attitude obtained indicated the Upper Greenstones to have the same strike and dip as the Upper Bedded Member.

The contact between the Upper Greenstones and the Upper Bedded Member does not appear to be conformable with the bedding of the latter. To the west of the main mineralized zone the contact appears to be dipping southwesterly at a low angle, and southeast of the main forks the angle of dip of the contact seems considerably less than 35 degrees. More will be said in this respect under "Structure".

At the head of Tuscarora and Edison Creeks the Upper Greenstones appear to extend to the northwest as a sort of lobe or tongue. The rocks in this locality are considerably different in appearance and texture to the typical porphyritic and amygdaloidal greenstones as exposed farther to the south. In the field they are seen to be hard, dark grey, fine-grained rocks, traversed by innumerable joints

and tending to break into small, angular blocks. They are quite rusty-weathering. No bedding or flow structures could be found in these rocks. The contact with the Upper Bedded member in the vicinity of Tuscarora and Edison Creeks occurs at about elevation 2450 feet, the hard, tough rocks of the Upper Greenstones forming high cliffs at this elevation near Tuscarora Creek.

In thin-section these fine-grained greenstones are found to consist of an interlocking mesh of plagioclase crystals with the interstices filled with varying amounts of pyroxene, amphibole, biotite, magnetite, and chlorite.

The plagioclase crystals average about 0.5 m.m. long by 0.25 m.m. wide, and are well twinned. They are mostly unzoned, and are of composition $An_{50}Ab_{50}$. A few crystals show slight gradational zoning from a core of about An_{53} to a shell of An_{47}.

Small amounts of clinopyroxene were found in thin-section 21-2, whereas thin-section 9-4 shows no pyroxene but an approximately equal (ca. 10%) amount of amphibole, probably hornblende. The pyroxene probably includes both pigeonite and augite since a few grains were found to have 2V=20-30 degrees, while in others 2V>40 degrees.

Microscopic examination of the Upper Greenstone

from the vicinity of the south and west branches of Canyon Creek shows these rocks to be mostly strongly porphyritic basalts. The phenocrysts of plagioclase average about three or four m.m. across and are unzoned. They vary in composition from about An_{55} to An_{68} in different specimens. These phenocrysts are embedded in a fine-grained groundmass composed largely of plagioclase laths averaging 0.25 m.m. in length, with minor amounts of augite, pigeonite, chlorite and magnetite. There appears to be at least two varieties of chlorite. The groundmass feldspar is strongly twinned and appears to be of approximately the same composition as the phenocrysts. Many flows or parts of flows are amygdaloidal, the amygdules averaging two or three m.m. across and consisting principally of actinolite, chlorite, carbonate and epidote. In specimen 7-I the amygdules contain small spherulites about 0.4 m.m. in diameter probably consisting of zoisite. The amygdaloidal nature of these rocks shows up well on many weathered surfaces, whereas in some fresh hand-specimens such as 7-I it cannot be detected.

One hand-specimen of the interbedded reddish breccia from the east side of the south fork of Canyon Creek about elevation 2000 feet shows it to be a hard, tough, dark reddish-brown fine-grained rock containing darker coloured angular fragments up to one-half inch across. A large number of boulders of a very similar breccia, many of a coarser

texture, were noted in the bed of south fork of Canyon Creek at about elevation 2000 feet, indicating that these rocks are in place a little farther up the creek.

Intrusive Rocks

General Statement

No large bodies of intrusive rocks have been found on the property. Dolmage (1918) claimed to have found "a small batholith or stock of quartz-diorite", but this may have been one of the larger quartz-feldspar intrusives outcropping along the hanging wall of the main skarn zone.

The intrusive bodies so far found on the Yreka property may be divided into the following groups:

(a) Quartz-plagioclase porphyry and plagioclase porphyry dykes and sills.

(b) Quartz-diorite dykes.

(c) Hypersthene-basalt dykes.

(d) Basalt dykes.

Quartz-plagioclase Porphyry and Plagioclase Porphyry Intrusives

The quartz-plagioclase porphyry and plagioclase porphyry intrusive rocks were seen to cut all the bedded rocks except the Lower and Upper Greenstones. They are grey to light grey and tend to weather to a distinctive whitish colour.

They seem to be most numerous in and around the main skarn zone, and range in thickness from about one foot up to 70 feet or more.

A large number of these intrusive bodies, usually a few feet in thickness, have been noted in the main skarn area in the course of surface mapping and diamond drilling. Here they are very irregular in shape and attitude as shown by their outcrops. Many appear to be sill-like, and conform to the existing bedding in the tuffs, or if in skarn, to the pre-existing bedding. Others, however, definitely cut across the strata.

The intrusive bodies contain phenocrysts of plagioclase, hornblende, and more rarely quartz in an aphanitic groundmass.

The plagioclase phenocrysts are euhedral to subhedral and average 1 m.m. across. They are mostly fresh and unaltered and usually show multiple polysynthetic twinning. Carlsbad twinning is not very common. Most crystals are weakly to moderately zoned. Zoning is normal and mostly smoothly gradational, ranging from An_{27} (shell)$\rightarrow An_{41}$ (core) to An_{41} (shell)$\rightarrow An_{51}$ (core). Some crystals have undergone moderate amounts of saussuritisation, with the formation of albite, epidote and chlorite. A few large phenocrysts show extensive alteration to these minerals.

Hornblende is present in most of these intrusive bodies in the form of subhedral phenocrysts up to two or three m.m. long, and making up about 5% of the rock. It is weakly pleochroic, from colourless to pale greenish-yellow, and appears to have been bleached. The birefringence is normal, namely ca. 0.023. Most of the crystals are bordered by a thin rim of a colourless mineral with a higher relief than the hornblende. In some crystals this high-relief mineral extends into the hornblende as thin bands or slivers parallel to the cleavage planes. One crystal is composed of about half hornblende and half the high-relief mineral. The latter has a low birefringence, ca. 0.013, and a large extinction angle, $Z_{\wedge}C=45$ degrees, whereas the hornblende has $Z_{\wedge}C=24$ degrees. The marked difference in extinction angles is well shown in the above crystal.

A mineral with a very similar appearance to the colourless, high-relief mineral above mentioned is present in the form of corroded grains up to 0.5 m.m. long. This mineral has all the properties of clinopyroxene except that the birefringence is abnormally low, ca. 0.013. It is believed to be pyroxene that has been subjected to some late alteration process that has caused a reduction in the birefringence. This mineral and the colourless, high-relief mineral rimming and penetrating hornblende are believed to be one and the same.

This belief is supported by the following observations. Wherever seen the pyroxene grains are surrounded by reaction rims or zones of very fine-grained, granular material, the identity of which is doubtful, but may be zoisite. Likewise, most of the hornblende crystals show a thin reaction rim of this type of material, and it is thought that the alteration product was actually derived from the pyroxene rimming the hornblende.

An outline of the processes which gave rise to these somewhat unusual textures might be as follows:

In a magma consolidating at considerable depth hornblende was in process of crystallization. Part of the magma was then transferred to an environment of reduced pressure, which resulted in the escape of a large proportion of the volatiles. In this way the formation of hornblende, a mineral containing hydroxyl, was inhibited, and pyroxene, an anhydrous mineral, began to form. Not only did pyroxene crystallize separately, but it mantled hornblende crystals, and hornblende was partly converted to pyroxene.

Finally the pyroxene became unstable, possibly due to a further change in the environment, and it began to be attacked by the magmatic liquid, thus giving rise to the present texture of corroded pyroxene grains and hornblende crystals mantled by corroded rims of pyroxene. The bleaching of the hornblende and the alteration of the pyroxene resulting

in the lowered birefringence may have taken place at this time or slightly later.

The quartz content of the intrusives ranges from 0% up to ca. 15%. It is present both as phenocrysts and as small subhedral to anhedral grains in the fine-grained groundmass. The phenocrysts, which are all corroded to a greater or less extent, average about 0.5 m.m. across, and are irregularly hexagonal or almost square in cross-section. Some show only slight corrosion, whereas others have been almost completely assimilated. A single, almost perfectly elliptical corroded grain of quartz was found in one thin-section, and the hand specimen shows at least two small, elliptical, smoothly rounded quartz grains that are evidently corroded phenocrysts. Where quartz phenocrysts are abundant, the groundmass is finely granular and contains appreciable amounts of quartz in the form of very small crystals with square cross-sections and smaller anhedral grains, whereas the intrusive bodies containing no quartz as phenocrysts have a fine-grained, more fibrous groundmass which appears to consist largely of very small lathe of feldspar.

The presence of the corroded quartz crystals draws attention to the quartz-porphyry problem in petrology. According to Bowen's theory of the crystallization of magmas, quartz should be one of the last minerals to crystallize. It is evident that in the intrusive bodies being discussed quartz crystallized early, and then later became unstable in its environment, resulting in partial reassimilation.

The crystallization of the quartz may have followed a similar trend to that of the hornblende. It would seem that a considerable amount of magmatic differentiation first took place, giving rise to a melt with a high silica and high volatile content. Then crystallization of quartz and hornblende began, later followed by environmental changes as previously postulated, resulting in reaction of quartz and hornblende with the melt, and giving rise to the textures as previously described.

All thin-sections showed very small amounts of sphene and apatite as accessory minerals. Sphene occurs as anhedral grains averaging 0.1 m.m. across, which are mostly considerably altered to a whitish, opaque mineral which is probably leucoxene. Very small amounts of apatite are present as euhedral crystals averaging 0.1 - 0.05 m.m. long.

The relation of the quartz-feldspar and feldspar intrusives to the skarn zone and mineral deposits will be discussed under Economic Geology.

Quartz-diorite dykes

About 1000 feet west of the main skarn zone and at an elevation of 2100 feet, a light-coloured, medium to fine-grained dyke cuts greyish-green tuffaceous beds. It is about two and one-half feet thick, is steeply dipping and was traced along strike for about twenty or thirty feet.

A similar rock was found near the head of Tuscarora Creek at an elevation of 2760 feet. The outcrop measured only about ten square feet in area and it was impossible to determine whether the intrusive was a sill or dyke or to obtain its attitude. It is evidently not a large intrusive body as outcrops of the Upper Greenstones were found partially surrounding it at no great distance.

Microscopic examination shows the two igneous bodies to be very similar in texture and composition, the chief difference being that the dyke found at the lower elevation contains practically no biotite whereas the other intrusive has appreciable amounts.

Both rocks are made up largely of plagioclase and quartz, with smaller amounts of orthoclase, hornblende, biotite (little or none in spec. 21-I), and magnetite.

The plagioclase is present as euhedral to subhedral crystals ranging from ca. 0.25 m.m. to two m.m. across and averaging ca. 0.5 m.m. It is very well twinned and strongly zoned. Zoning is normal, the cores ranging in composition from An_{32} to An_{63} and averaging ca. An_{40}. The outer shells range from An_{23} to An_{38} and average ca. An_{27}.

The orthoclase is present as untwinned anhedral grains interstitial to the plagioclase and quartz. It also appears to have partly replaced plagioclase. In thin-section

21-1 the following examples of what appears to be replacement of plagioclase by orthoclase were noted:

(a) Core replacement. A small central area ca. 0.25 m.m. across in a large plagioclase phenocryst has been converted to orthoclase. The replacement is well shown by the pinkish caste, low relief and different extinction angle of the orthoclase.

(b) Peripheral replacement. A number of plagioclase crystals were seen to be partly replaced in their outer parts by orthoclase.

The orthoclase has a distinctly pale pinkish colour, a relief considerably lower than balsam, and in many places shows thin exsolution lamellae, probably of albite, along cleavage planes (microperthite). An average of five determinations of $X \wedge 001$ cleavage planes gave 12 degrees. This value checks for slightly sodic orthoclase. The orthoclase comprises about 5% of the rock in spec. 21-1 and slightly less in spec. 21-4.

Quartz is present in both igneous bodies to the extent of about 20% as anhedral grains averaging 0.33 m.m. across, and appears to have partially replaced plagioclase.

Mafic minerals consist of hornblende and biotite. The hornblende is present as greenish, slightly pleochroic ragged grains up to two m.m. long, and spec. 21-4 contains small amounts of rich brown biotite in euhedral to subhedral

crystals up to four m.m. across. Accessory minerals include sphene, apatite and magnetite.

These quartz-diorite dykes appear to be distinct from the quartz-feldspar porphyry intrusives for at least the following reasons:

(a) The average composition of the plagioclase is more sodic and is more strongly zoned in the quartz-diorite dykes than in the quartz-feldspar porphyry intrusives.

(b) In the quartz-diorite dykes, quartz is present as anhedral grains and shows evidence of being at least partially secondary, whereas in the quartz-feldspar porphyry intrusives it occurs as euhedral crystals, and is an original or primary constituent of the rock.

(c) The colour and texture of the two groups of intrusives are considerably different.

Hypersthene-basalt Intrusives

A dark grey, fine-grained porphyritic rock outcrops near the head of the north branch of Canyon Creek (spec. 11-8). In the field the rock is massive and has a somewhat different appearance to that of the fine-grained varieties of the Upper Greenstones. It is evidently more resistant to weathering than the surrounding rocks and forms a small cliff about fifteen feet high, but the total area of outcrop is small.

In thin-section the rock is seen to be porphyritic, consisting essentially of subhedral crystals of basic plagioclase together with subhedral crystals of hypersthene and augite in a very fine-grained groundmass of what appears to be essentially a mixture of quartz and feldspar.

The plagioclase crystals range in size from about 0.1 m.m. up to 2 m.m. across and are strongly zoned and twinned. The composition ranges from An_{70} for the cores to An_{53} in the outer shells. Most crystals are quite fresh and unaltered, but a few of the larger phenocrysts have suffered some core alteration which may be albitisation.

Pyroxene forms about 15% of the rock, of which about 10% is hypersthene and 5% augite. The remaining mafic minerals include small amounts of biotite, hornblende and magnetite.

The rock contains about 5% of quartz in the form of small anhedral grains irregularly distributed.

It is questionable whether this single outcrop is part of a flow or part of an intrusive body. No other thin-section examined contains hypersthene and the rock does not at all resemble the porphyritic volcanics or finer-grained varieties of the Upper Greenstones. It is therefore provisionally classed as an intrusive until further information from the field may be available.

Basalt Dykes

At approximately the 2000 foot level the north branch of Canyon Creek is bounded on the northeast side by a hard, tough rock that forms almost perpendicular bluffs about 100 feet high. This rock is very rusty-weathering, and the bluffs are heavily iron-stained.

Microscopic examination of a specimen of this rock shows it to have the composition of a porphyritic basalt, and in composition and texture it closely resembles some of the basic flows of the Upper Greenstone horizon. It is thought, however, that it is more likely to be an intrusive for the following reasons:

(a) The feldspar phenocrysts are strongly zoned. In all known flows on the property the feldspar phenocrysts show little or no zoning, whereas the ones in the intrusives previously described are strongly zoned.

(b) The rock contains a few strongly corroded quartz grains averaging ca. 0.5 m.m. across, and of the same order of size as the feldspar phenocrysts. These quartz grains are surrounded by well-marked reaction rims or zones of fine-grained muscovite or chlorite. Corroded quartz crystals are characteristic of the quartz-feldspar porphyry dykes and are not found in rocks that are known to be flows.

(c) The rock contains small amounts of hornblende.

This mineral is not found in the known flows, but is common in known intrusives.

(d) Topographic expression: The rock is considerably more resistant to erosion than the tuffs which bound it to the east and the greenstones bounding it on the west. This has resulted in the formation of high bluffs as already mentioned.

Although the quartz-basalt itself is well exposed on the bluffs, outcrops in the immediate vicinity are poor, and the location of the contacts with the adjoining rocks is somewhat obscure. A traverse down the creek in this locality demonstrated that the creek bed is composed of tuffs of the Upper Bedded member. Thus the quartz-basalt appears to be confined to the northeast side of the creek.

McKechnie claims to have found dykes and sills of basalt and diabase on the property in addition to the quartz-feldspar porphyries. Unfortunately, it was not until after leaving the field that the writer became aware that McKechnie had published a report on the Yreka property. The result was that one or two occurrences of diabase and basalt reported by McKechnie were not seen by the writer.

Structure

The series of sedimentary, pyroclastic and metamorphic rocks on the Yreka property strike approximately

north-west and dip south-west into the hillside at angles of about 35 degrees. Strikes and dips, where bedding can be seen, vary little throughout the area mapped. According to Menzies (1953), however, at the face of the north drift, No.1 tunnel, the strata are flat-lying, while the normal north-westerly strike and southwesterly dip of 35 degrees are found above on the surface. He states also that on the Ready Cash and Superior mineral claims there is a steepening of the Intermediate skarn horizon from the normal 35 degrees on the surface to about 50 degrees 100 feet down the dip.

From a review of all the data available it appears to the writer that the structure is essentially homoclinal rather than that of a series of tightly folded beds forming an isoclinal structure. There does not appear to be any repetition of beds in a southwesterly direction up the mountain-side. Any deviation from normal dips of about 35 degrees might be explained as being due to minor warping, dragfolding, or possibly drag in the vicinity of faults.

Field work did not reveal any primary structures in the bedded rocks that might indicate whether or not they are overturned. It is possible, however, that a more thorough examination than the writer was able to make might be successful in this respect. The lower part of the Upper Bedded member would seem to be the most favourable stratum for the development of primary sedimentary structures.

No major displacement of the bedded rocks has been detected. However, faulting of some importance has taken place in the vicinity of the main skarn zones. A strong fault zone is exposed in No. 1 adit striking north 45 degrees east and dipping 70 degrees southwest. It is probable that this fault extends in a northeasterly direction at least as far as Canyon Creek, for at a point just below the falls, a small gulch with almost vertical walls joins the main canyon on the north bank at an angle of about 45 degrees. This gulch is situated approximately at the point where the fault, if projected, would intersect the creek. There is no evidence of the extension of the fault on the south side of the creek.

A small shear zone was found in the bed of the north branch of Canyon Creek at about 2000 feet elevation. It is about two feet wide and strikes approximately 130 degrees; the angle of dip could not be determined. It is exposed in the creek bed for about ten feet, being obscured by rubble both up and downstream. Chlorite and garnet are developed in the shear zone, with small amounts of sphalerite, chalcopyrite and pyrite.

Menzies believes that the upper parts of Edison and Tuscarora Creeks follow fault zones.

It is probable that there are a number of other faults on the property, particularly in the vicinity of the

main skarn zone.

As previously mentioned while describing the Upper Greenstones, the dip of the contact between this member and the Upper Bedded Member does not appear to be conformable with the dip of the latter. The position of the contact as shown on the accompanying map is believed to be fairly accurate. To the west of the main skarn zones it is apparently dipping to the southwest at a considerably lower angle than 35 degrees, and between the west and south branches of Canyon Creek it appears to be dipping east at a low angle. The writer was able to obtain only one attitude in the Upper Greenstones. At a point about elevation 2100 feet and about 400 feet from the south branch of Canyon Creek, an outcrop of bedded fragmental rocks was found striking 155 degrees and dipping 34 degrees southwest - the same attitude as the Upper Bedded Member.

The dark grey, fine-grained rock, presumably volcanic, outcropping on the high ground between the head of the north branch of Canyon Creek and the head of Tuscarora and Edison Creeks was not found on the south side of Canyon Creek. Here the strongly porphyritic greenstones appear to be in direct contact with the Upper Bedded Member.

The field evidence suggests, therefore, that some erosion of the Upper Bedded Member took place before deposition of the dark grey, fine-grained flow. In other

words, a disconformity may exist between the fine-grained flow and the Upper Bedded Member. A further period of erosion may have partly removed this flow before deposition of the porphyritic flows and pyroclastics. This might account for the absence of the fine-grained flow rock on the south side of Canyon Creek.

Metamorphism

Greenstones and Bedded Rocks

Gunning (1929) found that the volcanic and pyroclastic rocks of the Vancouver Group in the Quatsino-Nimpkish area on the whole have been considerably altered. He says:

> .... Typically the rocks (flows) are light to dark green or almost black. Flow structures are almost entirely lacking, but many beds of amygdaloid are developed, particularly in the basalts. The amygdules are filled with calcite, quartz, chlorite, epidote, and occasionally feldspar, and where quartz and epidote are developed the amygdules generally stand out prominently on weathered surfaces. Epidote, in specks and irregular areas up to several feet in diameter, is quite typically but by no means always developed. The common alteration, which is frequently quite extreme, is the development of chlorite with lesser amounts of sericite, calcite and epidote...

This description applies almost perfectly to the volcanic rocks on the Yreka property, particularly the Upper Greenstones. Microscopic examination of specimens of these

latter rocks shows that they are considerably altered, with development of chlorite, actinolite, carbonate and epidote. Chloritisation is the main alteration. In several specimens the fine-grained groundmass has been more or less altered to chlorite, and the plagioclase phenocrysts are veined by and contain many small blebs of chlorite. In the amygdaloidal rocks the amygdules contain actinolite, carbonate, zoisite, muscovite and biotite or phlogopite. Lithic-crystal tuff beds in the Upper Greenstones have been highly altered, so that what were formerly probably large clastic crystals of pyroxene are now merely "ghosts" consisting of very fine-grained biotite or phlogopite with a little fine-grained quartz. The groundmass now consists of a fine-grained aggregate of actinolite, biotite or phlogopite and quartz with some larger ragged grains of actinolite.

As previously stated, the Lower Greenstones are highly altered intermediate to basic flows and pyroclastics, now consisting essentially of chlorite, carbonate and epidote.

The sedimentary and pyroclastic rocks of the Upper and Lower Bedded members do not seem to have undergone as much alteration as the greenstones, except in and near the mineralized zones.

A number of rock specimens were collected from the

lower part of the Upper Bedded member along the trail between elevations of 1000 and 1100 feet (Y1, Y8, Y9, Y10, Y11 A & B). In hand-specimen these rocks are seen to be light grey, massive, very fine-grained types. The microscope shows them to be limestones and tuffaceous limestones, metamorphosed to a greater or less extent.

Specimen Y9 consists largely of amphibole, probably tremolite (ca. 80%), in the form of radiating fine-grained fibrous aggregates arranged in clumps and veinlets. Scapolite is present to the extent of about 5% as subhedral crystals averaging 0.25 m.m. long. The mineral was identified by the following properties:

Colour:	Colourless
Cleavage:	One good parallel to length of crystals, basal sections show two cleavages at right angles.
Birefringence:	0.022
Extinction:	Parallel to length and cleavage trace.
Orientation:	Length fast.
Interference figure:	Uniaxial negative.

The rest of the rock consists of epidote, diopside, albite (?), and an unknown, very fine-grained colourless mineral.

Specimen Y8 is a highly altered crystal tuff containing scapolite, carbonate, pyroxene (diopside and

hedenbergite), plagioclase and quartz.

Specimens Y10 and Y11A are very similar in part to Y9 and in part to Y8. They are evidently fine-grained tuffaceous sediments strongly metamorphosed.

Specimen Y1 is a homogeneous fine-grained limestone containing a few tuff particles, and is little altered.

Microscopic examination of some of the lithic-crystal tuffs from the hanging wall of the main mineralized zone showed them to be fairly fresh. Most contained moderate amounts of carbonate. Since some of the tuffs contain fragments of recrystallised limestone there is no doubt that at least part of the carbonate is an original constituent of these rocks.

Intrusives

The quartz-feldspar and feldspar intrusives are on the whole quite fresh. In a few thin-sections small amounts of carbonatisation and epidotisation were noted. Thin-section Y23 shows small amounts of a yellow chlorite. In the course of diamond drilling in the main skarn zone, however, it was found that quartz-feldspar and feldspar porphyry intrusives in skarn were considerably altered within about a foot or so of the walls. The hard, light grey, fresh unaltered rock is changed to a strongly mottled greenish rock, probably containing considerable amounts of

chlorite and epidote. The change is gradational. A number of these intrusives cut in diamond drill holes were found to be mineralized with pyrrhotite and chalcopyrite near the walls, particularly where the intrusives were in mineralized skarn.

The alteration of the quartz-diorite dykes has been previously mentioned. It consists chiefly of silicification.

Skarn Zones

In a number of places the sedimentary and pyroclastic rocks have been more or less strongly metamorphosed, resulting in the formation of skarn zones consisting essentially of garnetite. These skarn zones are mineralized with chalcopyrite, pyrrhotite, magnetite, sphalerite and pyrite, and constitute the bodies of economic interest on the property. Most are small and do not appear to be of economic significance. The main zone on which most of the work has been concentrated is located on the northwest side of Canyon Creek in the central part of the Upper Bedded Member. It is roughly 1500 feet long and 100 feet wide. It strikes in a northwesterly direction and appears to be roughly comformable with the bedding. The original rock has been more or less converted to a medium to coarse-grained garnet skarn. The skarn ranges from a dark reddish-brown to a light green garnetite, with small amounts of

calcite, biotite, chlorite, actinolite, epidote and pyroxene. It is irregularly mineralized with pyrrhotite, chalcopyrite, pyrite and magnetite, in order of abundance. The writer agrees with McKechnie that the skarn was formed from tuffaceous beds. Evidence for this belief will be presented in the chapter on Economic Geology.

Smaller skarn zones, mineralogically and texturally practically identical with the main zone, are located stratigraphically below it towards Canyon Creek, and to the northwest of it near the head of Edison Creek.

General

To sum up, it would appear that the rocks of the Yreka property have been subjected to very low grade regional metamorphism, with quite incomplete reconstitution of the rocks, followed by moderate to strong more-localised pyrometasomatism which has resulted in the formation of the skarn zones and mineral deposits. The question immediately arises as to what has caused the formation of the skarn zones. No large bodies of intrusive rock were found on the property. The quartz-feldspar and feldspar porphyry intrusives are very numerous in and near the main skarn zone. Here they appear to form what almost might be termed an intrusive stockwork. However, the individual bodies are on the average only a few feet thick, and

it would appear unlikely that they could have transformed such large volumes of rock into skarn. The only other alternative would seem to be that the necessary heat for the transformation has been supplied from a deep-seated intrusive body, from which the dykes and sills are probably offshoots.

CHAPTER IV

ECONOMIC GEOLOGY

Mineral Deposits

Main Skarn Deposits

Skarn zones on the Yreka property have been briefly mentioned in the chapter on Geology of the Yreka Property. The important mineral deposits are located in the main skarn zones, which extend from just northwest of Canyon Creek in the lower part of the Upper Bedded Member along the hillside almost to the upper part of Tuscarora Creek at approximately the 2000 foot level. These zones comprise three more or less distinct units: The Upper or Main zone, the Intermediate zone, and the Lower zone.

The width of the Main zone ranges from a few tens of feet to 100 feet or more. Within it, all gradations from unaltered tuff to true skarn are found. Mineralization is somewhat erratic, but almost all the skarn contains some sulphides, particularly pyrrhotite.

The earliest work on the property was concentrated at the lower or southeast end of the Main skarn zone. Here, at approximately elevation 1300 feet, four

adits, Nos. 1 - 4, were driven, comprising a total length of 1500 feet. About 2500 tons of copper ore were mined and shipped from the Clyde stope, an underground opening about 90 feet by 40 feet reached by means of a short adit at approximately the 1250 foot level. No. 2 adit was driven from the Clyde cut about 150 feet in a southwesterly direction in barren or poorly mineralized skarn. An internal shaft or winze was sunk from the floor of the Clyde cut to a shallow depth, but evidently the ore body could not be traced downward, and the workings were abandoned. The shaft is now filled with water.

To the northwest, the Clyde skarn body grades rapidly into little-altered country-rock. This extends to about the 1500 foot level where skarn again begins to appear. From this level a strong skarn zone extends in a northwesterly direction to within about 300 feet of the upper part of Tuscarora Creek. The width as exposed on the surface ranges from about 70 feet to more than 100 feet. From the attitude of the zone as exposed on the surface, and from data from underground openings and drill holes, it appears that it is roughly conformable with the bedding, i.e. strike northwest and dip southwest into the hillside. The true thickness is probably very variable, but more than 100 feet of practically continuous skarn were cut in vertical diamond drill holes located

near the northwest end of the zone, and one hole cut more than 200 feet.

The whole zone is shot through with a ramifying system of quartz-feldspar porphyry and feldspar porphyry dykes and sills, ranging from one foot or less to about ten feet in thickness.

A considerable amount of stripping and trenching was done by former operators with the result that the greater part of the Main Zone is well exposed, and fairly detailed mapping and sampling can be carried out.

Chalcopyrite in the skarn is erratic, tending to occur in bunches and streaks. In many places good grade material grades into barren skarn over a few feet. Nevertheless, two more or less continuous ore-shoots have been opened on the surface. The first of these, exposed in what is termed the Intermediate cut, is about 350 feet long and averages ten to fifteen feet in width. It is located about 500 feet up the hillside from the Clyde body at approximately the 1800 foot level. The second shoot is exposed in the Upper cut and is located near the northwest end of the skarn zone. It is about 450 feet long and about 14 feet in width on the surface, but increases rapidly in width down dip to more than 50 feet, as shown by diamond drilling.

The Intermediate skarn zone appears to be a narrow, fairly well-defined zone about 1500 feet long and a few feet thick subparalleling the main zone and located stratigraphically and topographically below it. It is sparsely and irregularly mineralized with pyrrhotite and chalcopyrite, although some good grade material occurs in places in narrow bands along the foot-wall. The Intermediate skarn zone has not been prospected in as much detail as the Main zone, partly because it outcrops mostly on very steep ground, and some parts are difficult of access.

A third sulphide-skarn zone lies below the Intermediate zone. It extends from just below the portal of No. 1 adit for 300 or 400 feet in a northwesterly direction subparalleling the larger zones above. The trail crosses it at approximately 1100 feet elevation. An adit is reported to have been driven in this zone below No. 1 adit, and some good-grade copper ore shipped. The portal, however, was covered by dump-rock from No. 1 adit, and is now inaccessible. Where exposed on surface this Lower skarn zone appears to be largely barren of sulphides, but a small pocket of good-grade ore outcrops near its northwest end on the steep hillside above the trail.

Other Showings

A number of other smaller showings have been found

on the property, including the Pride of the Isle and Blue Grouse showings.

The latter lies on a steep bluff on the south side of Canyon Creek about elevation 1400 feet. Menzies (1953) describes the showing as follows:

> ....Thirty feet of tunnelling and some stripping were done by the former operators although no records of this work are now available. Last fall an area 120 feet in length by 40 feet in width was stripped and several shallow trenches blasted across the exposed showing .... The main Blue Grouse showing lies in a northwesterly pointing wedge of strata which strikes southwesterly and dips 60 degrees southeasterly. The western boundary of the showing is a northwest fault that dips 80 degrees southwest and the eastern boundary is a more westerly-striking fault or shear zone dipping 70 degrees in the opposite direction. Sulphide mineralization is not uniform but varies from light to massive pyrrhotite with low copper-zinc values. The showing apparently lies along the upper contact of a limy horizon which is capped by a very hard, flinty light grey tuff ....

The Pride of the Isle showing is located on the south side of Canyon Creek at an elevation of about 660 feet. Here a small open cut in the hillside about 20 feet long shows moderate chalcopyrite-pyrrhotite-sphalerite mineralization in fine to medium-grained calcite-garnet skarn.

About 600 feet south of the Pride of the Isle cut and at an elevation of approximately 1000 feet on a steep hillside were found large angular pieces up to two feet across of low-grade pyrrhotite-sphalerite float.

Overburden is heavy and underbrush is thick in this area, and the writer was unable to locate the source of the float, but judging by the size of some of the pieces they have not come far.

At an elevation of about 2700 feet at the head of the north branch of Canyon Creek, a number of boulders a foot or so in diameter and well mineralized with pyrrhotite and chalcopyrite were found. Overburden in this locality is heavy, and trenching failed to locate the source of the float.

A number of small open cuts near the right bank of Edison Creek near the 1000 foot level show low-grade pyrrhotite-sphalerite mineralization in thin-bedded dark grey-green rocks. Diamond drilling of these showings in 1953 failed to indicate anything of economic interest.

Mineralogy and Petrology of the Skarn

The skarn rock consists essentially of garnet, usually to the extent of 80-90%, with minor amounts of calcite, biotite, chlorite, actinolite, epidote, quartz, hedenbergite, sulphides and magnetite.

The garnet is massive to coarsely crystalline; crystals are euhedral to subhedral and range up to about one-half inch in diameter. The colour ranges from deep reddish-brown to light olive-green, with the brown garnet

greatly predominating. Most garnet crystals are strongly zoned. This is well shown in thin-section, where the outer part of many crystals is seen to consist of concentric, alternating dark and light anisotropic bands.

The results of specific gravity and refractive index determinations carried out on brown and green garnet are as follows:

(a) Specific Gravity

Brown		Green	
* 3.61		* 3.47	
3.69		3.76	
3.78	Average	3.77	Average
3.62		3.84	
3.91	3.79	3.72	3.76
* 4.03		3.72	
3.86		3.77	
3.86			

* discarded

(b) Refractive Index

Both the red and the green garnet were found to have refractive indices greater than 1.82, which was the value of the highest index oil available.

Referring to the diagram on p.482 (Winchell, 1951), the above experimentally-determined values indicate both the red and green garnet to be in the grossularite-andradite region. Winchell (1951, p.483) makes the following point:

> ....Natural garnets only rarely approach any single formula, but are crystal solutions of two or more end members. Ford found that one-sixth of all analysed garnets could be represented by only two formulas (no others greater than 5%); another sixth required four or more formulas (each at least 5%); and the remaining two-thirds required three formulas....

The microscope shows that many of the garnets consist of a strongly-zoned, partly anisotropic core surrounded by a thick isotropic outer zone or rind. Under plane light the core is practically colourless, while the outer part has a pale greenish-yellow colour. In many crystals the dividing line between the two parts is well marked by an abrupt colour change.

Garnet has been partially replaced by calcite, sulphides, chlorite and biotite (see Plates III A,B,C,D; IV B) Corroded garnet crystals and grains, embedded in a groundmass of medium to coarsely crystalline calcite, are abundant (see Plates III A,B).

Bowan (1940) has shown that at certain temperatures and pressures a mixture of quartz and calcite becomes unstable, and a reaction between the two takes place resulting in the formation of wollastonite and carbon dioxide, viz:

Wollastonite

$$SiO_2 + CaCO_3 \rightleftharpoons CaSiO_3 + CO_2$$

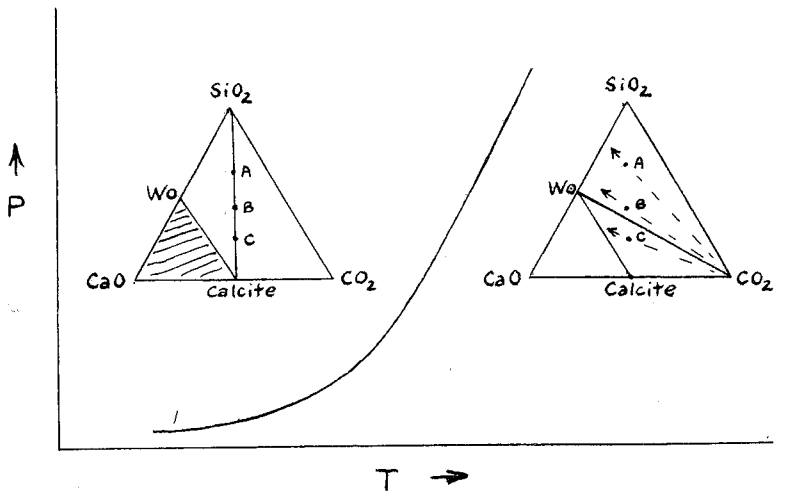

Fig. 2 Pressure-temperature diagram and paired composition diagrams of above reaction equation

(i) Mixture A → Wollastonite + Quartz
(ii) Mixture B → Wollastonite + little Quartz
(iii) Mixture C → Wollastonite + Calcite

Any given condition of temperature (T) and pressure (P) can be expressed by a point on the above graph. If the point lies on the curved line, a state of equilibrium will exist, and the four phases will co-exist. If the point lies to the left of the line, a mixture of quartz and calcite or a siliceous limestone will be stable, and no reaction will take place. If, however, the point lies to the right of the line, the silica and calcite will react to form wollastonite, and carbon dioxide will be

given off.

It is probable that a similar reaction takes place when garnet is formed from calcareous rocks during metamorphism, viz:

$$CaCO_3 + Fe \text{ (introduced)} + SiO_2 \rightleftharpoons \overbrace{Ca_3Fe_2(SiO_4)_3}^{\text{andradite}} + CO_2$$

As the pyrometasomatic processes begin to wane the temperature will fall, and the temperature-pressure point will move to the left. As soon as it crosses the reaction line, the above chemical reaction will tend to reverse and go to the left. Usually all or most of the carbon dioxide will have escaped, and no change will take place as the rock cools. If, however, carbon dioxide is present in sufficient amounts and under sufficient pressure, it is conceivable that the reaction would start to reverse, the carbon dioxide attacking the garnet and forming calcite and silica. This situation might occur in a particular zone into which large quantities of carbon dioxide were migrating from below, either from a cooling magma or from metamorphism of calcareous rocks.

Conversion of silicates to carbonates by reaction with carbon dioxide has been briefly discussed by Turner and Verhoogen. They say (1951, p.494):

> ....Whereas silica readily displaces carbon dioxide from carbonates at moderate and high temperatures, many silicates are converted with equal ease to carbonates by hydrothermal reaction with solutions containing carbon dioxide or soluble carbonates, at low temperatures. Autometasomatic replacement of such minerals as feldspars, augite and olivine by carbonates is a common deuteric process illustrated by igneous rocks of widely different composition, and in extreme cases may give rise to rocks composed largely of carborate such as the Fen area of Norway, for which a true magmatic origin has even been suggested....

The evidence suggests, therefore, that calcite was formed from garnet by reaction with carbon dioxide or with carbon-bearing fluids during the later stages of metasomatism, probably when temperatures were falling:

$$\overset{\text{andradite}}{Ca_3Fe_2(SiO_4)_3} + CO_2 \longrightarrow CaCO_3 + Fe + SiO_2$$

$$\overset{\text{grossularite}}{Ca_3Al_2(SiO_4)_3} + CO_2 \longrightarrow CaCO_3 + Al + SiO_2$$

Iron, silica and alumina, released from grossularite or andradite by reaction with carbon dioxide, were probably carried away by circulating solutions or fluids, since there is no evidence of the formation of quartz, or of any minerals containing iron or aluminum, as a result of replacement of garnet by calcite.

Most thin-sections of skarn showed small amounts of hedenbergite ($CaFeSi_2O_6$). The mineral was well seen in thin-section M.S.1 where it is present in the form of narrow, blade-like crystals and aggregates up to ca. 1 m.m.

long. In other thin-sections hedenbergite is present as small, subhedral crystals averaging ca. 0.2 m.m. long, closely associated with garnet. The mineral was identified by the following characteristics:

Birefringence:	0.018
$Z \wedge C$:	48°
Relief:	1.70 - 1.75
Cleavage:	Two at ~ 90°, basal sections

Some excellent examples of replacement of hedenbergite by sulphides were noted in thin-sections Y19 and MS 2 (see Plates IV A).

Several thin-sections show moderate amounts of a strongly pleochroic, green mineral closely resembling chlorite. The birefringence, however, is much too high for chlorite. The optical properties are as follows:

Colour:	Greenish. See pleochroism	
Pleochroism: (X<Y & Z)	X pale straw yellow	Y and Z grass green
Form:	Subhedral subequidimensional crystals averaging 0.05 - 0.1 m.m. across. Lamellar or micaceous habit.	
Cleavage:	Good in one direction.	
Relief:	Fair, n>balsam.	
Birefringence:	0.035.	

Extinction: Parallel to cleavage traces.

Orientation: Slow ray parallel to cleavage traces.

Interference figure: Uniaxial negative.

These properties indicate the mineral to be green biotite (Winchell, 1951, p.376). It is present to the extent of ca. 10% in thin-section Y1 and ca. 5% in thin-section MS 3. It was seen to have partially replaced garnet in a number of thin-sections. Core replacement seems to be particularly common. Plates III D show replacement of garnet by green biotite.

Closely associated with the biotite are small amounts of a very fine-grained, dark olive-green mineral. It is fairly strongly pleochroic and appears to have a birefringence of about 0.015, but is so fine-grained (grains ca. 0.005 m.m. across) that the optical properties could not be determined with any degree of accuracy. The mineral may be a variety of chlorite.

Small amounts of a greenish, fibrous mineral, associated with biotite and chlorite, were noted. It appears to be developing in calcite, and is present in the form of aggregates of long, thin, bladelike or needlelike crystals, strongly pleochroic from colourless to sea-green, and with a small extinction angle. Although no basal sections were seen to confirm the determination,

this mineral is in all probability actinolite.

Quartz is present in the skarn in very small amounts in the form of euhedral to subhedral crystals about 0.5 m.m. long, and appears to be associated with the sulphides. Sulphides were seen to have corroded and eaten into quartz crystals in a number of places.

Epidote appears to be a very minor constituent of the skarn. A few irregular crystals averaging 0.5 m.m. long were noted in thin-section MS 4 replacing garnet and calcite.

Sulphides found on the Yreka property in order of abundance are pyrrhotite, chalcopyrite, pyrite, dark brown resinous sphalerite, cubanite and galena. Magnetite occurs in some abundance at the southern end of the Intermediate cut in coarse-grained skarn. McKechnie (1953) reports small amounts of specularite and notes that sphalerite and galena occur sparsely on Edison Creek in skarn beds from four to six inches thick.

Sphalerite is present in only very small amounts in the main skarn zones, but is prominent in the smaller showings, particularly the Pride of the Isle cut and the Blue Grouse showing.

In material from the main zones, the microscope showed sphalerite to be present as minute, irregular in-

clusions in chalcopyrite. Sphalerite, chalcopyrite and pyrrhotite were noted in a polished section of material from the Pride of the Isle cut. The three minerals, except as noted below, show mutual boundary textures and appear to be contemporaneous. Much of the sphalerite contains minute inclusions of chalcopyrite, probably exsolved from the sphalerite.

Cubanite was found in a polished section of mineralized skarn from the northern end of the Main skarn zone. It is present as small, irregular parallel laths in some of the chalcopyrite grains.

Cubanite has been reported from a number of places in North America, as well as in several foreign deposits. It is probably more abundant than is generally realised, as it can usually be detected only by microscopic examination of polished surfaces.

In the United States, cubanite has been reported in the contact-metamorphic deposits at Fierro, New Mexico (Schwartz, 1923), the Ducktown copper deposits, Tennessee (Schwartz, 1927), and the Mizpah copper property, Idaho, a high-temperature replacement deposit of the Ducktown Type (Anderson, 1941).

In Ontario, cubanite is found in the nickel-copper ores of the Sudbury district (Lindgren, 1933, p.807;

Burns 1948; Witherspoon, 1952; Yates, 1948, p.604), and in copper deposits at Parry Sound (Schwartz, 1924).

Gunning (1932 p.45) found cubanite in material from a copper prospect in the Zeballos area, Vancouver Island, British Columbia.

Schwartz (1927) proved experimentally that a solid solution could be formed from the natural intergrowth of chalcopyrite and cubanite at 450 degrees C. and that by slow cooling the two mineral phases could be reprecipitated.

Edwards (1947, p.85) states that

> .... Cubanite ($Cu_2Fe_4S_6$) commonly occurs as parallel laths or bands in the (111) directions of chalcopyrite ($CuFeS_2$). Such intergrowths are found only in high-temperature deposits, and if heated above 450 degrees C., the cubanite enters into solid solution in the chalcopyrite....

It is evident that cubanite is a not-uncommon mineral of pyrometasomatic and high-temperature replacement deposits. Mineral deposits in which it is found were formed at temperatures in excess of 450 degrees C.

Paragenesis

The earliest minerals to form from the original bedded rocks were garnet and hedenbergite. These minerals probably formed simultaneously in the early stages of the

metasomatic episode. In thin-section, garnet is seen to be replaced by sulphides, biotite, chlorite, quartz and calcite. Both hedenbergite and calcite are replaced by sulphides, biotite, chlorite, quartz and epidote.

To summarise, the sequence of mineralization in the main skarn zones was probably as follows. Metasomatism caused formation of skarn rock, consisting essentially of garnet and hedenbergite, and possibly some calcite, from calcareous bedded rocks, As temperatures began to fall, but while they were still quite high, of the order of 500 degrees C., hydrothermal fluids, permeating the skarn, deposited biotite, calcite and chlorite, shortly followed by magnetite, sulphides, quartz, actinolite and epidote. Pyrite, pyrrhotite, and chalcopyrite appear to be contemporaneous, and are found in intimate association, particularly chalcopyrite and pyrrhotite. Cubanite exsolved from the chalcopyrite when temperatures fell below 450 degrees C.

The hydrothermal fluids contained large quantities or iron and sulphur, and smaller amounts of copper and zinc. The presence of traces of scapolite in some of the metamorphosed rocks as already mentioned suggests that small amounts of chlorine also were added.

The whole sequence of mineralization was probably continuous and took place in a comparatively short time.

Origin of the skarn and Controls of Ore Deposition

The structure of the rocks on the Yreka property presented favourable conditions for the formation of pyrometasomatic deposits. Bedded calcareous rocks dip into the mountainside at moderately steep angles. Emanations from a deep-seated intrusive body to the southwest underlying the mountain would tend to migrate upward along bedding planes or faults. It has already been pointed out that the main skarn zones roughly follow the strike and dip of the enclosing rocks. All the evidence indicates, therefore, that the mineralized skarn zones are of the pyrometasomatic type not related to an igneous contact (Lindgren, 1933, p.735).

Certain beds in the Upper Bedded Member appear to have been particularly favourable for the formation of the deposits. The skarn has been formed in calcareous tuffs containing some thin, interbedded limestone lenses. A number of limestone remnants can be seen in various places in the main skarn zone. One of the largest of these is about 100 feet long by about ten feet thick. It consists of a medium-grained white to light grey recrystallized limestone. Similar limestone is also present along the footwall of the Main skarn zone for several hundred feet in the form of beds and lenses several feet thick, assoc-

iated with very thin bands of garnetite and thin, sill-like intrusives.

McKechnie (1953) believes the skarn to have formed in limy tuffs. He says:

> ....The epidote - garnet alteration seems to have been confined to a particular type of bed which, for the following reasons, the writer believes to have been a limy tuff rather than a limestone:
>
> (1) Where recrystallized limestone and skarn are in contact, the contacts uniformly are sharp and regular, showing no sign of gradation from one rock type to the other.
>
> (2) Thin bedding is visible in some of the skarn, and elsewhere is seen only in the tuffaceous beds.
>
> (3) Some less-altered remnants in the skarn beds resemble tuff rather than limestone.
>
> (4) Bedding planes where visible in contiguous limestone and skarn, do not pass directly from one type to the other - they are conformable but not continuous....

The writer agrees with McKechnie that most of the skarn has formed from calcareous tuffs. All of the above four pieces of evidence have been verified by the writer. In many places in the main skarn zone tuffaceous rocks can be seen in various stages of transformation to garnetite or skarn rock. Evidence from diamond drilling is also strongly in favour of this thesis. A number of holes were drilled vertically downward into the Main skarn zone from the hillside above, and aimed to intersect it

about 300 feet down the dip. Study of drill cores shows that as the main skarn zone is approached from the hanging wall, usually the first sign of alteration is the development of very fine-grained garnetite along bedding planes in the tuffs. Gradually the amount of garnet increases and it becomes coarser grained, and mafic minerals such as chlorite begin to appear, until finally the rock is completely converted to skarn. Drilling also shows that the skarn contains numerous partly altered beds of tuff and a very few thin bands of crystalline limestone. The limestone gives evidence of being markedly lenticular, and shows no sign of mineralization with sulphides even though the skarn above and below it is so mineralized. Alteration in limestone lenses is chiefly epidotisation, with appreciable sericitisation in some bands.

Drilling indicates that the main skarn zone dips into the hillside at roughly the same angle as the bedded rocks, namely about 35 degrees. Very thin bedding in the tuffs is well seen in drill cores, especially when they are wetted. The angle of dip of the bedding does not change appreciably through a vertical range of several hundred feet and a horizontal distance along strike of more than 500 feet.

Most drill holes intersected several porphyritic intrusives a few feet thick. These appear to be dykes, probably steeply dipping. The following evidence suggests

that they were intruded before formation of the skarn, and are therefore pre-ore, although it is by no means conclusive.

(1) Most intrusives show distinct alteration at the contact with the skarn for one or two feet inward from the walls. This alteration appears to be primarily epidotisation and chloritisation. Contacts are not sharp, and usually skarn appears to grade into intrusive over a core length of several inches.

(2) Most intrusives cutting skarn well mineralized with sulphides are themselves mineralized with sulphides near the walls. The following extracts from drill logs will serve as examples:

D.D.H. 54-2

Feet	
173-186	Good grade copper ore in skarn.
186-203	A light-grey mottled rock, with dark grey phenocrysts about 1/16 - 1/8 inch across. Finely speckled with chalcopyrite in places, some thin fractures healed with chalcopyrite and pyrrhotite. Probably intrusive.

D.D.H. 54-8

Feet	
223-227	Good copper ore in altered tuffs.
227-243	Intrusive. As 243 wall of intrusive is approached, get increasing chalcopyrite mineralization, both disseminated and along fractures. Estimate 240-243 grades 1½% Cu.
243-245	Good ore in skarn, some massive sulphides.

From surface observations and study of drill cores it seems that the porphyritic intrusives have exerted little general control on deposition of sulphides, or formation of skarn. However, there is some evidence that suggests that they may have had some localizing effect in places on deposition of sulphides. In D.D.H. 54-8 (see Figure 3), two closely adjacent intrusive bodies were intersected at about 200 feet depth, separated by four feet of high-grade ore, and with about seven feet of good grade ore on the underside of the lower body. The intrusives, being more resistant to alteration and replacement than the tuffs, have evidently had a damming effect on the ore - forming fluids, resulting in a concentration of sulphides on their undersides or footwalls. A similar concentration of sulphides adjacent to an intrusive body was noted in D.D.H. 54-2.

On the other hand, in D.D.H. 54-1, a wide section of good-grade ore not closely associated with intrusive bodies was intersected.

At the present stage of investigation of the deposits, few definite controls of ore deposition have been recognised. Mineralization on the Blue Grouse showing appears to be related to faulting, as may be the mineralization at the lower or southeast end of the Main skarn zone (Clyde area). The Main and Intermediate skarn zones them-

selves appear to have formed under stratigraphic control, and do not appear to be related to faulting. However, it must be admitted that at present not much is known of faulting on the property. The heavy cover of overburden, coupled with the fact that no good horizon marker in the tuffaceous beds of the Upper Bedded member has yet been found, renders difficult detection from surface of faults of small displacement. The sulphide mineralization in the skarn zones may yet be found to be related to secondary faulting after formation of the skarn. A number of fissures and narrow oxidised zones were encountered in diamond drilling especially near the surface, but these may be merely fractures related to the present steep topography. They do not appear to have any relation to skarn formation or sulphide mineralization.

At present, all that can be said is that ore shoots occur in the main skarn bodies or in altered tuffs closely adjacent to skarn. Where the skarn is poorly developed, mineralization is likewise usually poor. Oreshoots so far discovered are somewhat small, but it is considered that structural conditions are sufficiently favourable to warrant the initiation of underground development work.

Recommendations for Future Work

The writer believes that further development work should be planned along the following lines:

(1) Extend No. 6 adit along its present direction through the skarn zone and into the hanging wall. Drift north and south along the mineralized zone and prepare stopes.

(2) After stoping is under way, or possibly before, collar a new adit about 150 feet vertically below No. 6 on the hillside between No. 6 and No. 7 adits. The position of the portal of the new adit would be determined chiefly by topographic considerations, as the hillside is very steep in this locality.

(3) Crosscut in a west-south-west direction so as to pass directly under the collar of D.D.H. 54-1. This point should be reached at a distance of about 550 feet from the portal. Continue the crosscut well into the hanging wall of the zone. Drift northwest - southeast along the oreshoot and prepare stopes.

(4) Explore for further ore-bodies at depth by diamond drilling from line-drives put out from the end of the crosscut in the hanging-wall.

Search for further oreshoots can probably be best effected by diamond drilling from underground openings as

outlined above. The topography and the attitude of the ore-zone are such that further drilling from surface to intersect the skarn zone at depth will entail deep holes up to 700 or 800 feet. Furthermore, the hillside steepens considerably above the 2100 foot level. This fact alone would make drilling slow and difficult.

Conclusions

Exploration during the past two years has demonstrated that the Yreka property is a prospect of considerable merit. The chief problem is to determine whether or not the skarn zones are strong structural features and extend to considerable depths without appreciable diminution of their present lengths and thicknesses. Also to be determined is the pitch or rake of the skarn zones, assuming that they dip approximately parallel to the bedding. Diamond drilling carried out during the past summer suggests either that the Main skarn zone is pitching to the north or it is diminishing in length with depth.

It seems clear that the property can best be further tested by underground development work in the central part of the Main skarn zone. Since control of ore deposition is as yet imperfectly understood, the best method of search for ore would seem to be systematic diamond drilling of the Main skarn zone from underground stations.

This should quickly yield valuable structural information as well as indicating whether commercial orebodies exist at depth. If further development along these lines yields disappointing results, then there would seem to be little incentive to do further work on the other showings, including the Clyde area.

The property is well located with regard to transportation and processing of the ore. A small wharf could be built at the foot of the hill below the main showings at no great cost. This would enable either ore or concentrates to be loaded directly into ocean-going vessels. The cost of transportation per ton of material to the smelter at Tacoma should thus be low, if large enough tonnages are shipped. An aerial tramway would seem to be the solution to the problem of transportation of ore from the mine to tidewater. If reasonably large tonnages of ore can be developed, construction of a concentrator would of course be justified. However, in the early stages it might be more advantageous to ship raw ore. This would probably entail some sorting to obtain a high enough grade for shipping.

The ore is relatively coarse-grained, with simple mineralogy, and concentration should present no difficulties. A fine grind would probably not be required.

The Yreka deposits resemble closely the large, low-

grade copper deposits at Phoenix, in the Boundary District of British Columbia, mined during the early part of the century by the Granby Company (Brock, 1902; LeRoy, 1912). The two deposits occur in very similar rocks, namely altered limestones, tuffs and other calcareous sediments. No igneous intrusive bodies of any appreciable size are found near the skarn zones, and the mineralogy of the two deposits is practically identical. Approximately 13,000,000 tons of low-grade copper ore were yielded by the Phoenix deposits until they were exhausted towards the end of the First World War. It is not suggested that the Yreka property is likely to develop into another Phoenix, but it is well to bear in mind that deposits of this type, upon which many geologists and engineers are apt to look with a somewhat jaundiced eye, have in the past supported substantial and profitable mining operations.

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PLATE I

A. Lithic-crystal tuff, Upper Bedded Member, showing limestone fragment. x12. Plane light.

B. Enlarged view of same limestone fragment, showing development of euhedral diopside crystals. x30. Crossed nicols.

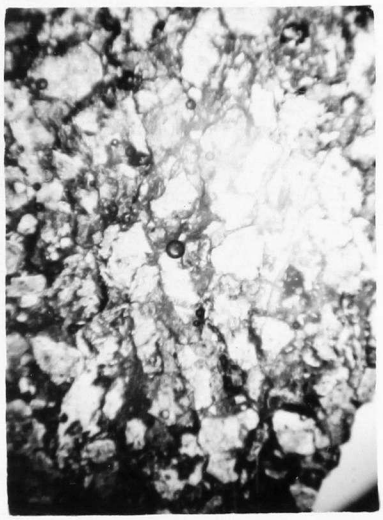
C. Medium-grained crystal tuff, Upper Bedded Member. x12. Plane light. f = plagioclase.

D. Quartz-feldspar porphyry dyke showing corroded quartz phenocrysts. x12. Crossed nicols. f = plagioclase, h = hornblende, q = quartz. Tiny white dots are quartz crystals.

PLATE I

A

B



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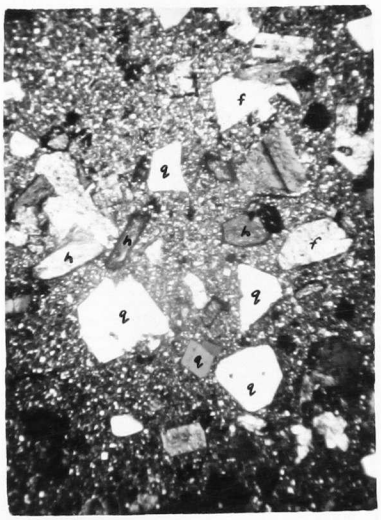

D

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PLATE II

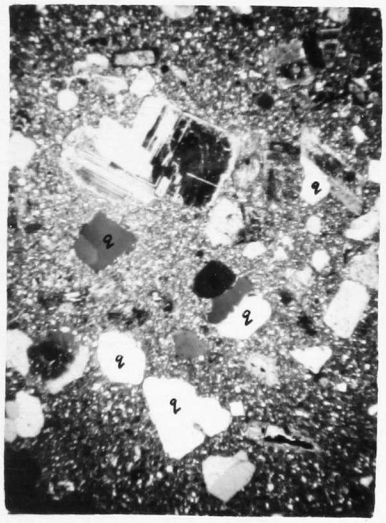
A. Quartz-feldspar porphyry dyke showing twinned plagioclase crystal and corroded quartz phenocrysts. q = quartz. x12. Crossed nicols.

B. Basaltic dyke showing corroded quartz phenocryst with reaction rim of chlorite and muscovite. x12. Crossed nicols. q = quartz, f = feldspar.

C. Basaltic dyke showing double-cored zoned plagioclase crystal. x12. Crossed nicols.

D. Skarn. Quartz replacing garnet. x30. Plane light. q = quartz.

PLATE II



A

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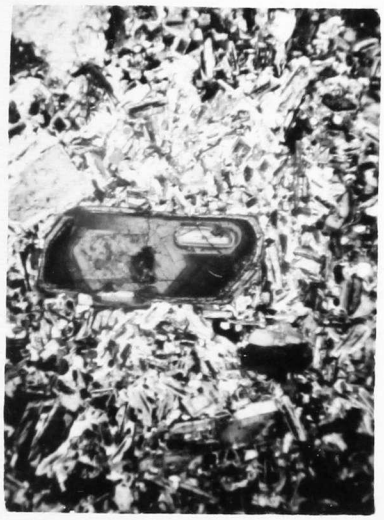

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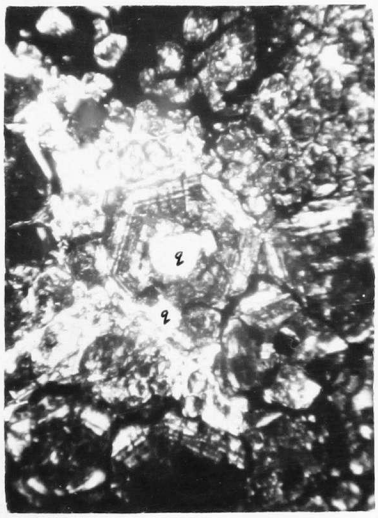

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PLATE III

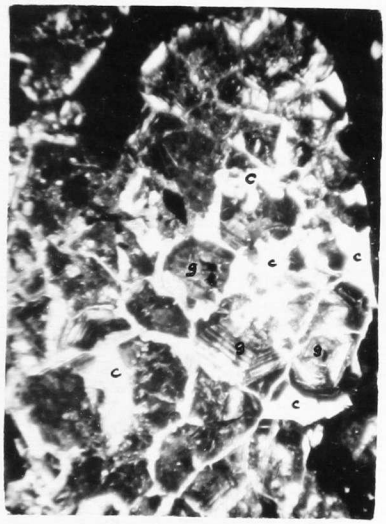
A. Skarn. Calcite replacing garnet. x30. Plane light. c = calcite, g = garnet.

B. Skarn. Calcite replacing garnet. x12. Crossed nicols. e = epidote, g = garnet, c = calcite.

C. Skarn. Chlorite replacing garnet. x30. Plane light. g = garnet, q = quartz, c = chlorite.

D. Skarn. Green biotite replacing garnet. x30. Plane light. b = biotite, g = garnet.

PLATE III



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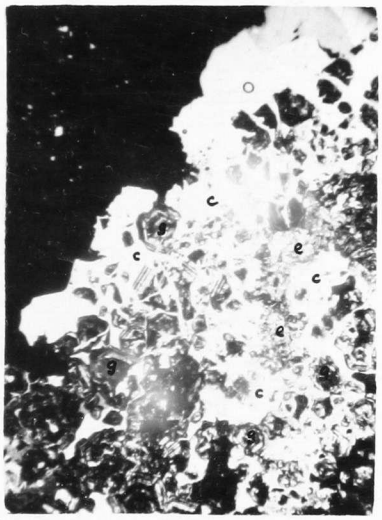

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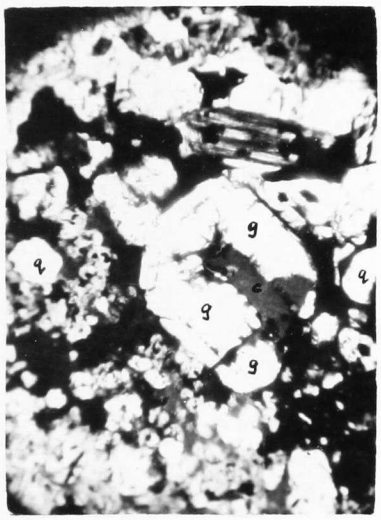

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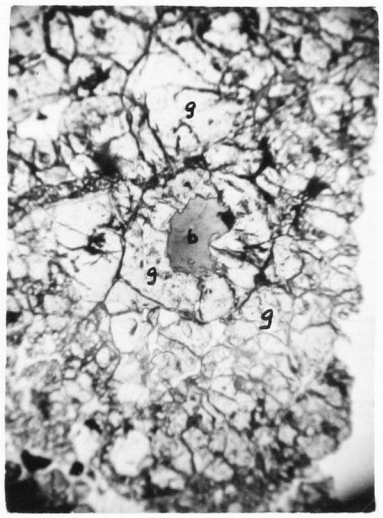


D

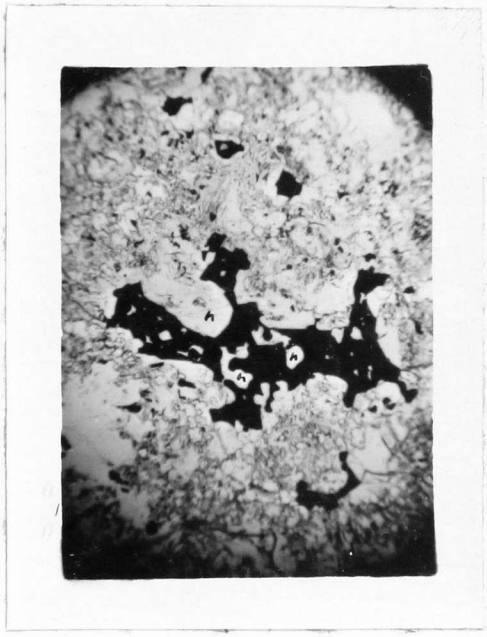
80

PLATE IV

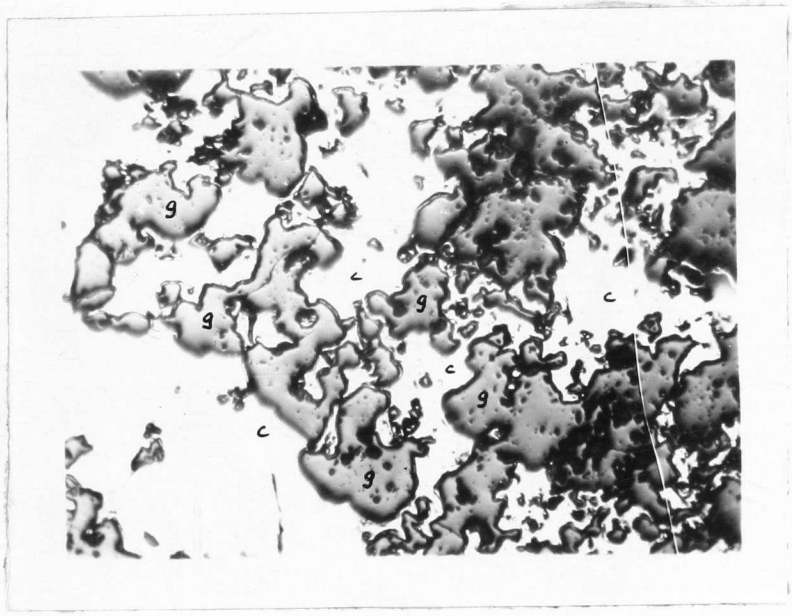
A. Skarn. Sulphides replacing hedenbergite. x30. Plane light. h = hedenbergite.

B. Skarn. Chalcopyrite replacing garnet. x100. Plane light. g = garnet, c = chalcopyrite.

PLATE IV



A



B

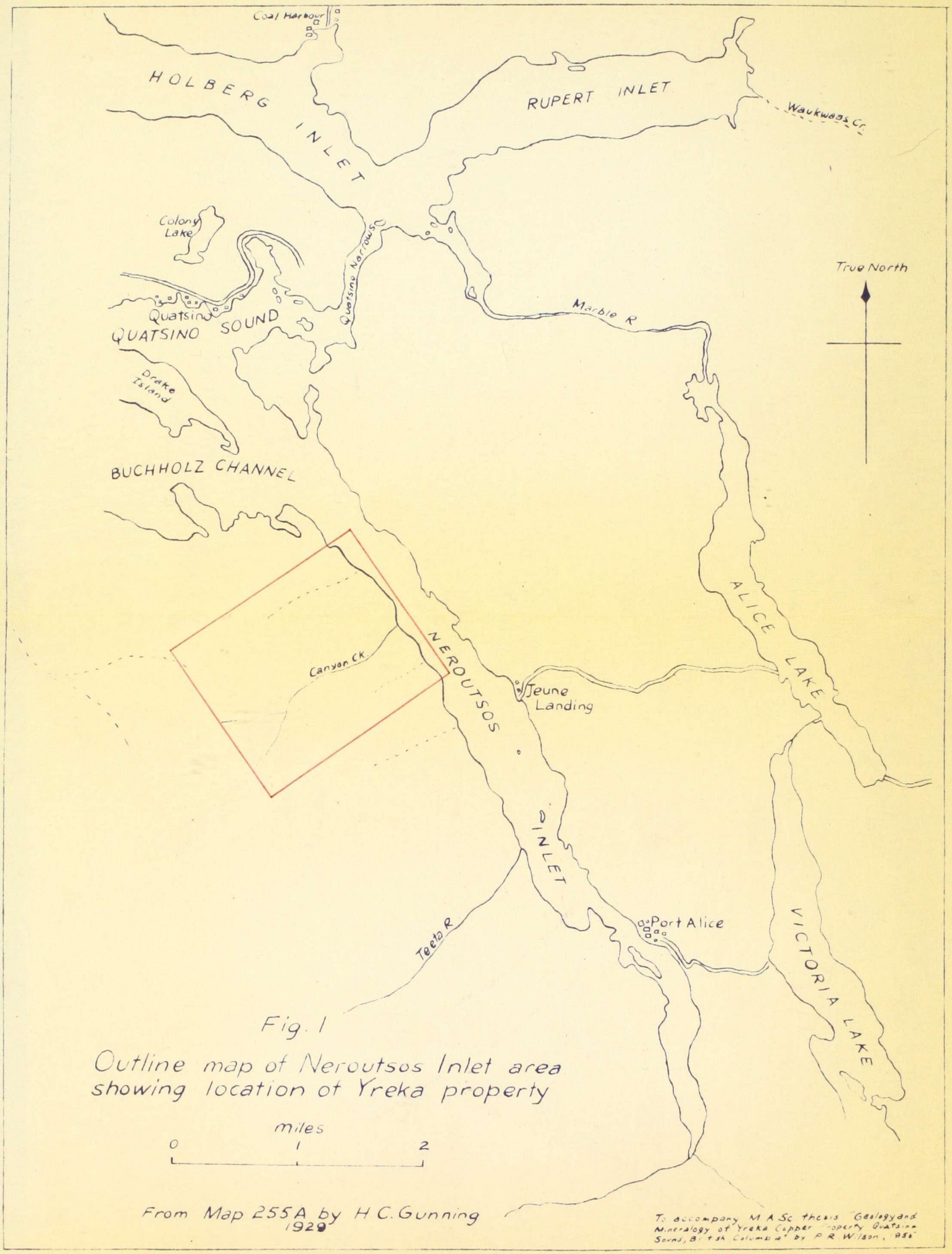


Fig. 1

Outline map of Neroutsos Inlet area showing location of Yreka property

From Map 255A by H.C. Gunning 1928

To accompany M.A.Sc. thesis "Geology and Mineralogy of Yreka Copper Property, Quatsino Sound, British Columbia" by P.R. Wilson, 1956

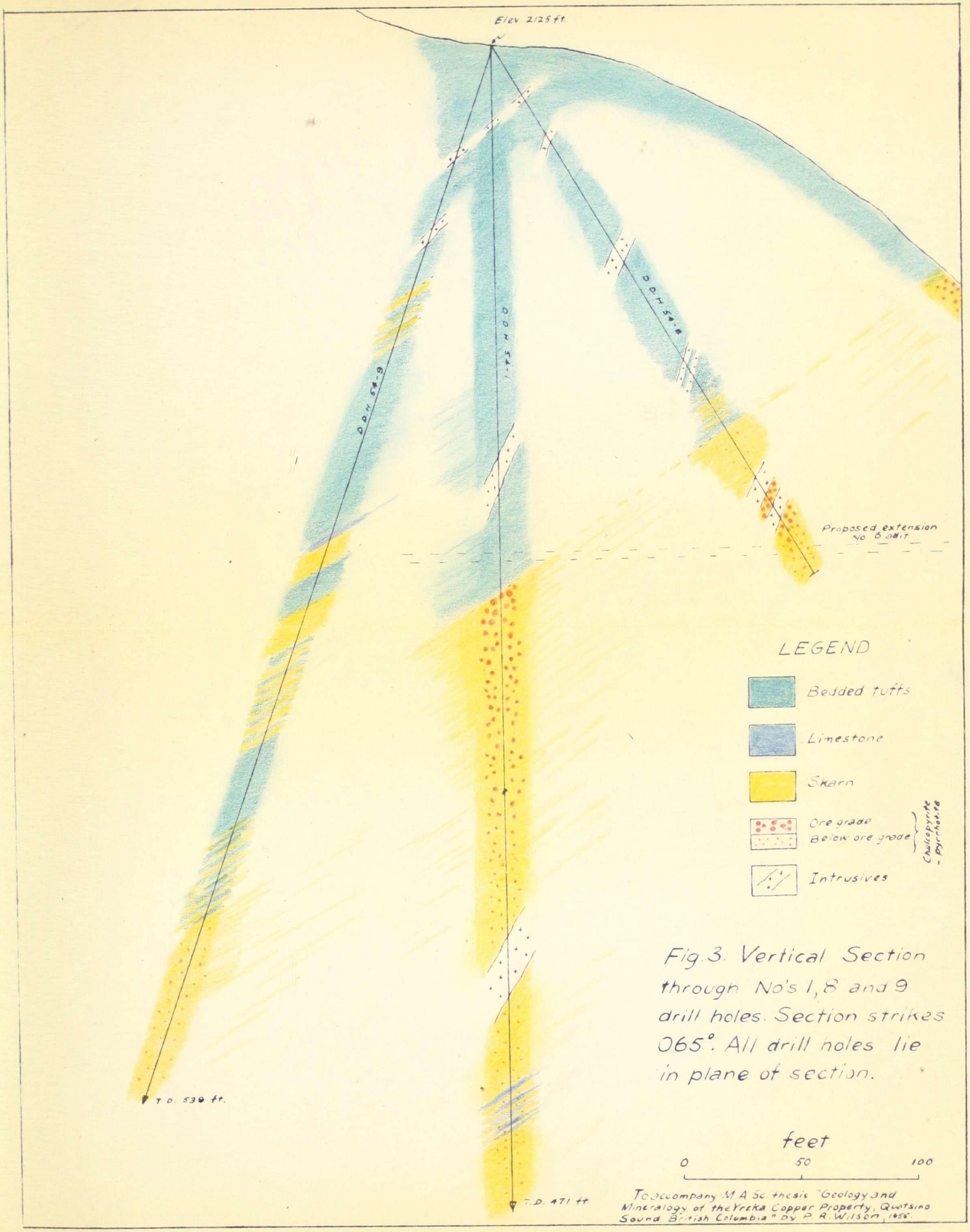
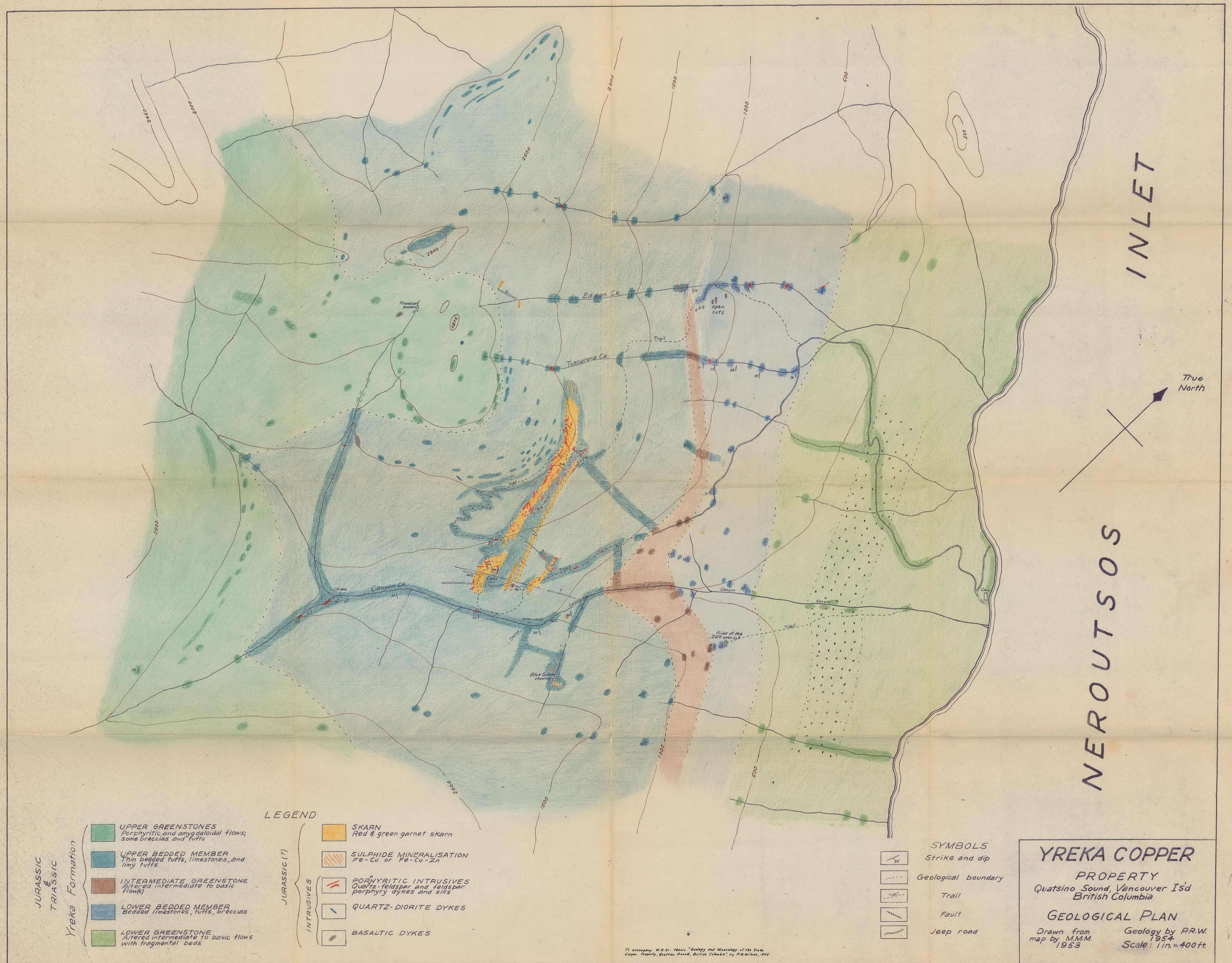


Fig. 3. Vertical Section through No's 1, 8 and 9 drill holes. Section strikes 065°. All drill holes lie in plane of section.

To accompany M.A.Sc. thesis "Geology and Mineralogy of the Yreka Copper Property, Quatsino Sound British Columbia" by P. R. Wilson, 1956.


INLET
NEROUTSOS
True North
Edison Ck.
Tuscarora Ck.
Canyon Ck.
Trail
Open cuts
Mineralized boulders
Old dam
Pattenwood
Blue Grouse showing
Pride of the Isle open cut
Cabin
3450
3000
2500
2000
1500
1000
500
2900
5800
2500
2000
1500
1000
500
LEGEND
JURASSIC & TRIASSIC
Yreka Formation
UPPER GREENSTONES
Porphyritic and amygdaloidal flows; Some breccias and tuffs
UPPER BEDDED MEMBER
Thin bedded tuffs, limestones, and limy tuffs
INTERMEDIATE GREENSTONE
Altered intermediate to basic flow(s)
LOWER BEDDED MEMBER
Bedded limestones, tuffs, breccias
LOWER GREENSTONE
Altered intermediate to basic flows with fragmental beds
JURASSIC (?)
SKARN
Red & green garnet skarn
SULPHIDE MINERALISATION
Fe-Cu or Fe-Cu-Zn
INTRUSIVES
PORPHYRITIC INTRUSIVES
Quartz-feldspar and feldspar porphyry dykes and sills
QUARTZ-DIORITE DYKES
BASALTIC DYKES
SYMBOLS
Strike and dip
Geological boundary
Trail
Fault
Jeep road
To accompany M.A.Sc. thesis "Geology and Mineralogy of the Yreka Copper Property, Quatsino Sound, British Columbia", by P.R.Wilson, 1955.
YREKA COPPER
PROPERTY
Quatsino Sound, Vancouver Is'd
British Columbia
GEOLOGICAL PLAN
Drawn from map by M.M.M. 1953
Geology by P.R.W. 1954
Scale: 1 in. = 400 ft.