Stratigraphy and Precious-Metal Occurrences of the Big Missouri Claim Group, Stewart, B.C.

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Abstract

The Big Missouri claims are 25km northeast of Stewart, B.C., via the Granduc Road. They are being evaluated for potential open-pit extraction of precious metals. The claims cover two major rock groups which are separated by an angular unconformity. The lower rocks are northwest trending Lower Jurassic Hazelton Group flows and volcanogenic sedimentary rocks, and the upper strata are tightly folded immature sediments of the Middle to Upper Jurassic Bowser Group. The Hazelton Group volcanic rocks are over 3000m thick, and have at their base a series of grey-green pumice rich ash flow and air fall deposits topped by maroon pyroclastic and epiclastic rocks. These units are overlain by 1500m of porphyritic green andesite lava and pyroclastic flow rocks. There are 1 to 2m thick gold-silver and lead-zinc bearing chert layers within the green andesites, and these layers are enveloped by zones of sericite, quartz and pyrite rich rocks. One group of these chert layers has been traced 6000m along strike. Delete HM

The volcanic rocks represent a cycle of subaqueous volcanism in which ash flow and air fall deposition is followed by quieter effusions of andesite. The metalliferous chert layers were precipitated as chemical sediment originating from fumarolic centres active at periods during the andesite volcanism.

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Introduction

The Big Missouri claims are 25 km northeast of Stewart, B.C., and consist of 23 crown-granted claims, 64 reverted crown-granted claims, and 11 recently staked claims (Fig. 1). Access is by the Granduc Road to the Silbak Premier mill site, and then by a smaller road to the abandoned Big Missouri town site where Tournigan Exploration Ltd. has established an exploration camp (Fig. 2).

The majority of the claims were consolidated in 1973 by Tournigan Exploration Ltd. In 1978, Western Mines of Vancouver optioned the properties and have continued exploration to date with soil sampling, detailed surface and underground mapping plus diamond drilling. The objective is to assess the potential for a precious metal open-pit operation.

The Big Missouri Mine is the only past producer on the claim group. It was operated from 1938 to 1942 by the Consolidated Mining and Smelting Company (Cominco), producing 847,615 tons of ore containing 58,384 ounces of gold, 52,677 ounces of silver, 2712 pounds of lead and 3920 pounds of zinc (Grove, 1971). The Silbak Premier mine site, 5 km south of the Big Missouri claims, produced 4.7 million tons of ore yielding 1.8 million ounces of gold and 41 million ounces of silver (Barr, 1980). The Granduc Mine, 25 km north of the Big Missouri claims, was a major copper producer until 1975.

General Geology

The claims include 2 major groups of northwest trending rocks separated by an angular unconformity (Fig. 3). The stratigraphically lower group is gently southwest dipping flows and volcanogenic sedimentary rocks believed to be of the Lower Jurassic Hazelton Group (Grove 1971, Smitheringale 1977, and Read 1979). These rocks occupy the southwest half of the

Figure 1. Location Map

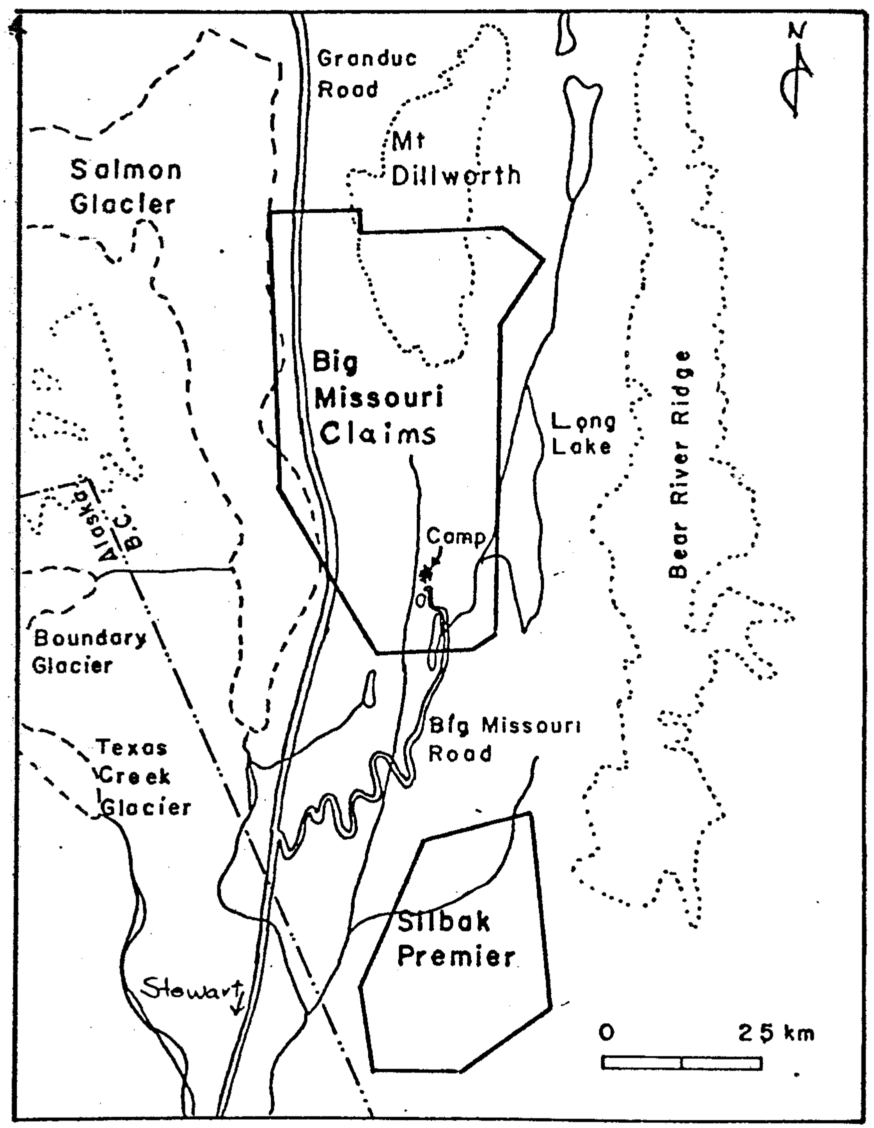


Figure 2. Area of the Big Missouri claims
(modified from Smitheringale & Assoc.,1977).

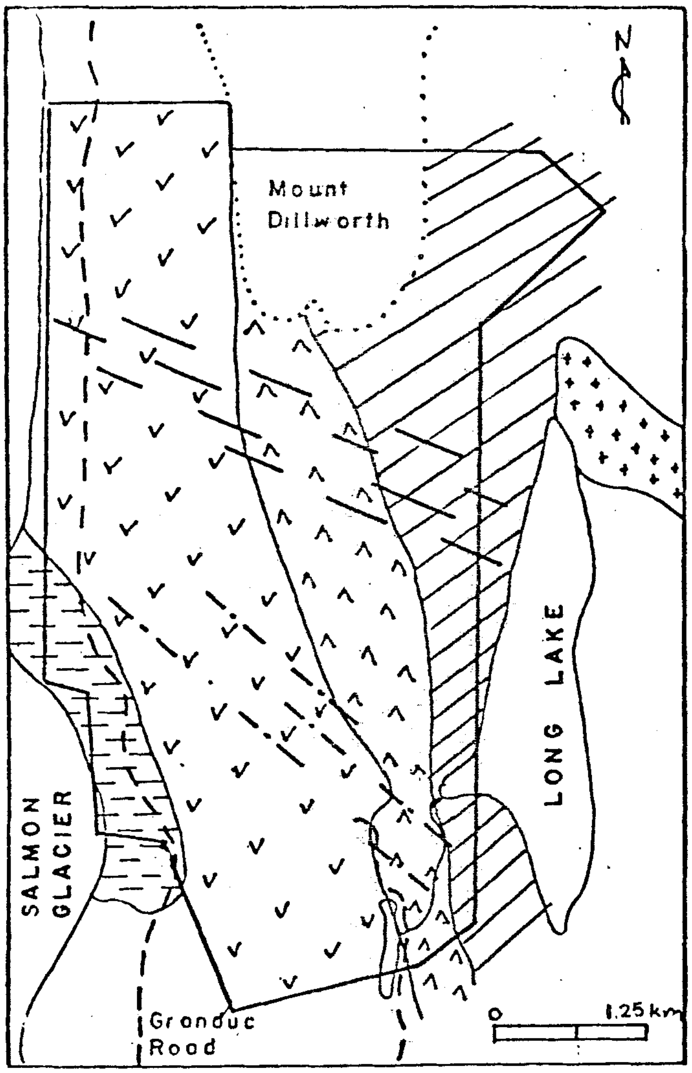


Figure 3

SKETCH MAP OF THE GENERAL GEOLOGY,

BIG MISSOURI CLAIM GROUP

Diorite dykes

Granite and granodiorite dykes

Glacier Pluton

BOWSER GROUP

Middle to Upper Jurassic argillites & greywackes

------------ unconformity ------------

HAZELTON GROUP

Lower Jurassic

Siltstones, argillaceous limestones & epiclastics

Green andesite fragmental & flow rocks with thin precious & base-metal bearing chert horizons

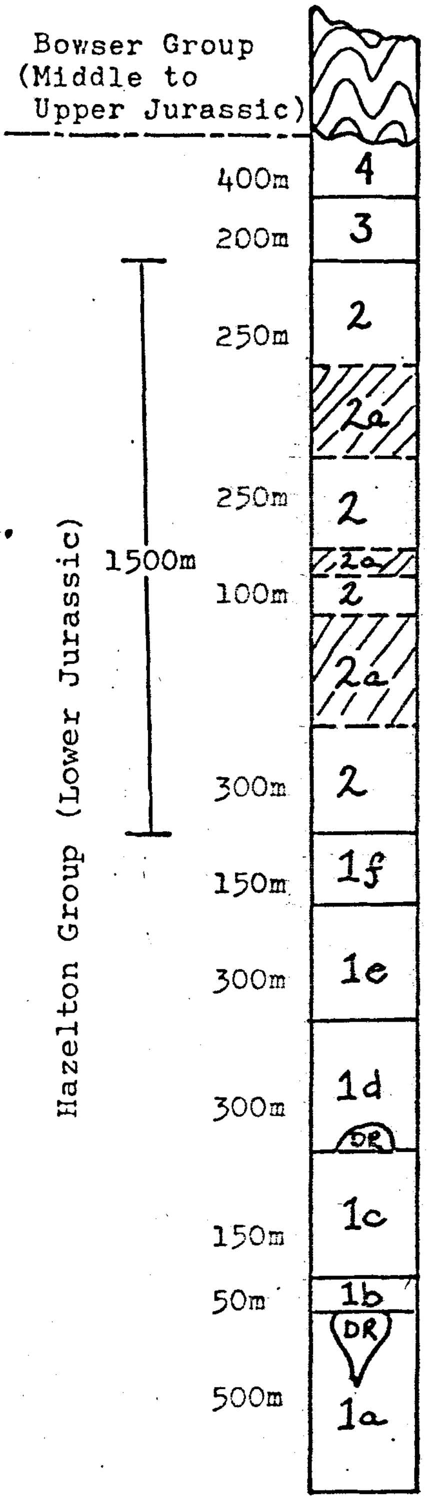
Grey, green and maroon fragmental rocks with assoc. epiclastics claims. The upper stratigraphic group is tightly folded, immature sedimentary rocks of the Middle to Upper Jurassic Bowser Group which occupy the northeast half of the claims.

The main mass of the Coast Plutonic Complex outcrops west of the claims across the Salmon Glacier, and includes three major plutons: the Texas Creek, Boundary, and Hyder plutons (Grove, 1971). They range in age from Lower Jurassic to Cretaceous, and in composition from granodiorite to quartz monzonite. A small intrusion known as the Glacier Pluton outcrops directly east of the claims at the north end of Long Lake (Fig. 3).

Two sets of dykes cross-cut the claims. In the north there are large quartz feldspar porphyritic granite and granodiorite dykes which strike northwest. In the south there are several generations of diorite dykes which strike northwest and cut the larger granite and granodiorite dykes.

Hazelton Group

Flows and volcanoclastic sedimentary rocks of the Hazelton Group are approximately 3000 m thick. The oldest rocks are near the east margin of the claims and are in contact with the overlying Bowser Group sedimentary rocks. The younger rocks are at the west margin of the claims along the Salmon Glacier. Rocks dip shallowly to the southwest with sedimentary and volcanic structures indicating that the section is right side up. The section is characterized by over 1000m of compositionally varied volcanoclastic rocks in its lower part, overlain by 1500m of compositionally more uniform pyroclastic and effusive flows. Within this upper part are precious and base metal bearing siliceous horizons (Fig. 4).



Tightly folded argillites and meta-greywackes

Black siltstone, argillaceous limestone and epiclastics

Basaltic andesite or basalt

2. Green andesite; lava and pyroclastic flow rocks with breccias, agglomerates, lapilli tuffs and tuffs

2a. Metalliferous chert layers enveloped by sericite-quartz-pyrite-rich wall rocks. Cherts and wall rocks contain Au, Ag, Pb, Zn and Cu in veinlets, layers and disseminations. Chert layers 1 to 2 m thick with several layers in vertical sequence comprising potentially economic zones

1f. Intermixed Tuff: Intermixed maroon and green agglomerates and tuffs. Transitional unit between 1e and 2. Contains porphyritic andesite, rhyolite and jasper fragments.

1e. Maroon Tuff: maroon pyroclastic and epiclastic rocks, mainly lapilli tuffs and graded sandstones.

DR. Dillworth Rhyolite.

1d. Grey Tuff: Light grey coarse to fine pyroclastic rocks with quartz lapilli. Minor epiclastics.

1c. Green-Grey Tuff: agglomerate and lapilli tuffs forming layers with fragments of porphyritic andesite.

1b. Heterolithic Agglomerate Tuff with pumice fragments.

1a. Black Tuff: black pumice-rich agglomerates, lapilli tuffs and tuff with several flows.

Figure 4. Summary of rock succession, Big Missouri Claims

Unit 1a: Black Tuff

The base of the section exposed on the claims is black to dark grey pyroclastic rock. There is cyclic grading from tuffaceous agglomerate and lapilli tuff to tuff. Pumice fragments in the tuffaceous agglomerate and lapilli tuff are flat to oblate and inversely graded at several locations. Lithic fragments are angular and include porphyritc andesite and rare banded rhyolite . Matrix varies from an abundant quartz-rich mass to a dark felted mass of possibly devitrified glass. These rocks are massive to slightly foliated, and abundantly fractured.

Unit 1b: Heterolithic Agglomeratic Tuff

A 50m layer of heterolithic agglomeratic tuff overlaps the basal rocks at the southeast edge of the claim group. This agglomerate has a light green matrix and contains subrounded to angular fragments, up to 6 cm in diameter, of pumice, dark to light grey tuff and porphyritic andesite. The larger fragments are found near the centre of the horizon. This rock is quite massive.

Unit 1c: Green-Grey Tuff

Next in the sequence is a dark green to grey fragmental rock which has a thickness of 150m at the southeast corner of the claims and wedges out in approximately 500m. This unit is agglomeratic tuff and lapilli tuff in which several flows are present, but contacts are difficult to define. Angular to sub-angular fragments, up to 10 cm in diameter, of feldspar porphyritic andesite are abundant in a matrix of feldspar lapilli and fragments of biotite and small angular clasts of principally carbonate and chlorite. Small fragments of finely laminated sedimentary rock are also present in the matrix. The rock is massive to slightly foliated and well-jointed.

Unit 1d: Grey Tuff

A light grey tuff is next in the succession and is thin and sporadic in the south part of the claims, gradually thickening to 300m in the central third, and absent from the north part of the claim group. This rock is aphanitic to medium-grained with feldspar, quartz and biotite lapilli, and thinly laminated sedimentary fragments, and rare agglomeratic layers. The matrix contains what appear to be devitrified glass shards. Its upper part has sandstone and conglomeratic equivalents of these rocks with layering and graded bedding. The northern most exposure of this rock type is coarse pyroclastic material with an overall decrease in grain size toward the south. This is the only rock observed to date which contains quartz lapilli.

DR: Dillworth Rhyolite

A small rhyolite dome intrudes the section on the south flank of Mt. Dillworth where Units 1a and 1d are in contact. The dome is 200m long in a northwest direction and 50m wide. The dome intrudes Units 1a and 1d, and is surrounded by coarse brecciated material from both units. The dome is composed of sericite, quartz and feldspar with angular coarse-grained grey carbonate fragments up to 50 cm in length. Disseminated pyrite comprises up to 20% of the rock. The Bowser-Hazelton contact lies directly east of the rhyolite dome, and the Mt. Dillworth snow field is directly north and northwest. No stratigraphic equivalents of this rock have been found.

Unit 1e: Maroon Tuff

A series of predominantly maroon-coloured rocks are next in the stratigraphic column. These rocks are a thick wedge in the southeast corner of the claims, disappear in the middle and reappear in the north third of the claims where they are more than 300m thick. In the south the rocks are massive to well layered maroon-coloured tuff and lapilli tuff with intercalated green volcaniclastic layers which become dominant near the middle of the claims. The most massive of the maroon rocks contain green lapilli that are flat parallel to the layering. Near the south edge of the claim group maroon lenses of reworked volcanic material are abundant. Graded bedding is common, with fine to coarse-grained angular sand-sized particles predominating. Where the maroon rocks are absent from the central part of the claims, the underlying Unit 1d is generally topped by epiclastic beds. The north half of the maroon rock sequence has very coarse agglomerate beds near its base, with boulders of porphyritic andesite up to 1m in diameter. This rock is gradational to maroon lapilli tuff and tuff.

Unit 1f: Intermixed Tuff

The maroon tuff is topped by an intermixed horizon of maroon and green volcanoclastic rocks which have angular blocks up to 40 cm in diameter of maroon and green porphyritic andesite in a green or maroon tuffaceous matrix.

Several outcrops have angular rhyolite fragments up to 6 cm in diameter. Contorted and broken layers of jasper are present in one horizon. Green andesite fragments and matrix dominate the top of the unit.

Unit 2: Green Andesite

The next 1500m of the stratigraphic column is green andesitic pyroclastic rocks and effusive flows. The majority of the layers have feldspar phenocrsts or fragments and many have amphibole crystals or crystal fragments. This is a change from the lower part of the volcanic sequence where the only primary mafic mineral identified is biotite. The succession is thickest near the middle part of the claims and is not less than 1000m thick along its strike length. Tuff, lapilli tuff and agglomerate are throughout the sequence although the lower 50 to 100m is mainly coarse breccias, some of which are heterolithic. More commonly matrix and clasts of the coarser rocks are similar in composition. The presence of massive rocks containing euhedral phenocrysts of feldspar and amphibole indicate lava flows within the sequence. Individual flows are difficult to recognize on the hand specimen scale because of the uniform green colour of matrix and clasts.

Unit 2a: Metalliferous Chert Horizons

The only major variations in composition within the green andesite sequence are: a) thin stratiform siliceous layers located at various stratigraphic levels within the andesites, and b) sericite-quartz-pyrite rich rocks enveloping these chert horizons. It is within these quartz-rich layers and the accompanying sericite-quartz-pyrite rich rocks that precious and base-metal sulphide minerals have been discovered.

Unit 3: Basaltic Andesite or Basalt

The green andesite unit is topped by darker green, brown weathering basaltic andesites or basalts. The rocks are lapilli tuff and tuff plus possible effusive flows. Carbonate veining is abundant in this unit.

Unit 4: Siltstones, Argillaceous Limestones and Wackes

The Hazelton Group volcanic sequence in the claims is topped by a series of black siltstones, calcareous siltstones, and green-grey sand-rich epiclastic beds. The unit was mapped west to the Granduc Road. Grove (1971), extends these sedimentary rocks west to the Salmon Glacier, but has placed them in the Bowser Group.

Precious and Base-Metal Occurrences

There are 2 types of metal concentration on the Big Missouri claims: a) concentrations of precious and base-metal sulphide minerals in stratabound cherty horizons and associated sericite-quartz-pyrite rich zones within Unit 2, and b) large cross-cutting veins of vuggy quartz with local concentrations of base-metal and silver. The large veins may be traced for several hundred meters but erratic metal concentrations make them lower priority targets than the stratabound occurrences.

The metal bearing chert horizons are 1 to 2 m thick of dark grey to white microcrystalline quartz. Angular fragments of andesite altered to sericite and quartz are found near the footwall contacts. Fragments of cryptocrystalline quartz, some finely laminated, are found in the chert layers and in the immediate hangingwall rocks. Fine-grained amorphous black carbon may comprise 15% of the layers, although the amount varies from one horizon to another. The carbon is found in veinlets and vugs associated with anhedral to subhedral pyrite. In some instances a chert horizon is topped by a distinct carbon-rich layer. Pyrite is abundant as disseminations, layers and veinlets. There are at least two generations of pyrite, the youngest is disseminations in the chert horizons and wallrock andesite. A few showings have lenses of grey coarse-grained carbonate associated with the sulphide-bearing horizons.

Zinc, lead, copper, silver and gold are concentrated in the chert layers and their immediate wallrocks. Sphalerite and galena are the most abundant base-metal sulphides with chalcopyrite an accessory in several showings. Silver minerals such as polybasite and pyrargyrite occur along with electrum, native silver and gold. Sulphide minerals occur as disseminations, veinlets and lenses within the chert horizons, as well as in veins and veinlets within the immediate wallrocks. Silver minerals, electrum, native silver and gold form disseminations and veinlets in pockets within certain horizons. Pyrite concentrations generally increase proporionally with base-metal sulphide minerals.

There are lenses up to 1m thick of massive banded pyrite, sphalerite, galena and chalcopyrite. The lenses are at the base of the chert horizons (Fig. 5). Abundant pyrite may be present along a section of a chert horizon, but precious metal content is negligible unless galena and sphalerite are also present. Consequently, an indication whether an horizon may contain gold and silver is the bluish-grey tinge to the quartz caused by the presence of disseminated sphalerite and galena.

Precious and base-metal bearing chert horizons are found at three major stratigraphic levels within Unit 2 (Fig. 4). Each level is composed of two or more chert layers in vertical

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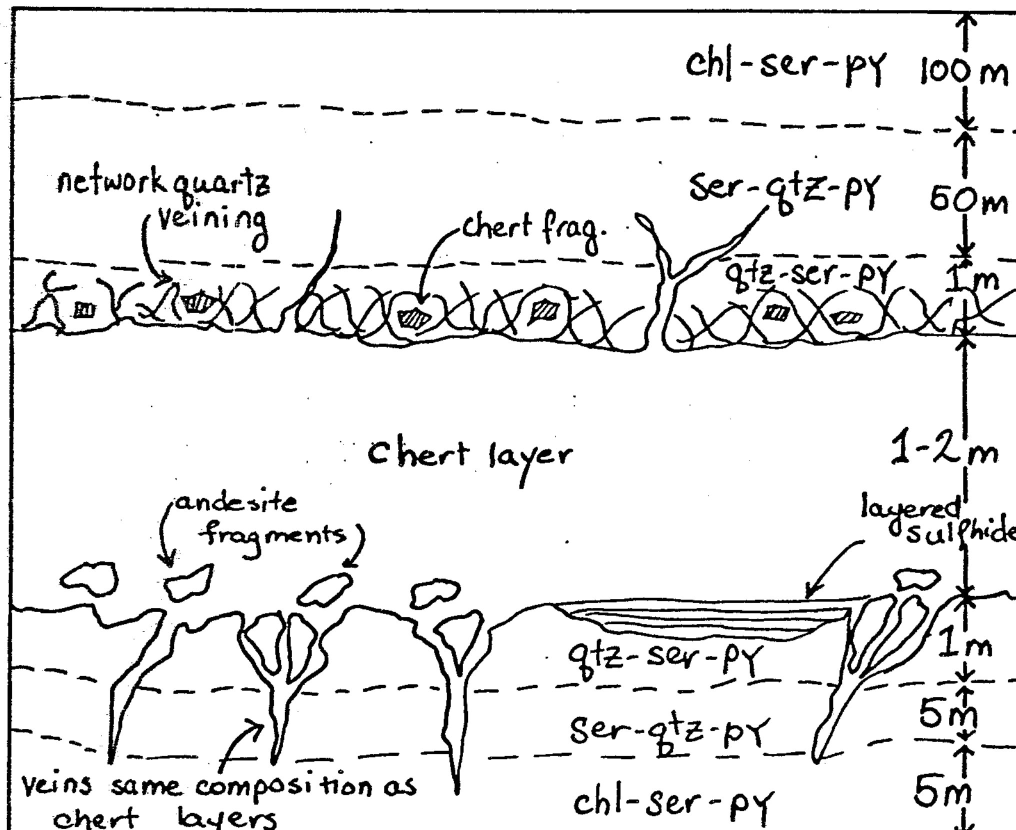

Figure 5: Sketch showing relationship between chert layers and immediate wall rocks (not to scale)

stratigraphic succession, each chert layer enveloped by sericite-quartz-pyrite rich rocks. The zones are up to 50m thick, with chert horizons 10 to 15m apart. Potentially economic zones in the upper part of Unit 2 are the most extensive, having been correlated over 6000m of strike length, with individual zones up to 500m long. Down-dip extension of these zones is being tested by diamond drilling. The combination of relief and bedding attitude has placed the three major metal-bearing zones enechelon east to west. This arrangement makes it possible to develop each zone separately in a series of open pits.

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Immediate Wallrocks

The weathered surface of the sericite-quartz-pyrite rich wallrocks to the chert horizons are buff-coloured with heavy iron oxide staining. The distinct weathering clearly marks stratigraphic intervals containing the precious- metal bearing horizons. In drill core the light grey to white colour of these rocks and increased quartz and quartz-sulphide veining indicate proximity to potential ore-bearing horizons.

Sericitization, silicification, pyritization and minor chloritization of the andesite wallrock has taken place. Ghost textures, such as outlines of feldspar and amphibole phenocrysts, indicate that the rock was originally similar in composition to the Unit 2 andesites. Alteration is gradational towards the contacts between the chert horizons and andesite wallrocks. Chlorite-sericite-pyrite alteration changes to sericite-quartz-pyrite, quartz-sericite-pyrite and finally to almost pure quartz with abundant pyrite in veinlets and disseminations (Fig. 5).

Frequency of veining increases with proximity to the chert horizons. Small clear quartz veinlets appear with sericite-quartz-pyrite alteration and within several meters of a chert horizon the veins increase in size and abundance. Large blue-grey quartz veins up to 30cm in diameter become abundant and have visible sphalerite and galena. These large veins resemble the chert layers in texture and composition. Close-spaced networks of small clear to white quartz veins are common in the hangingwall rocks. Blue-grey quartz-carbonate and large milky quartz veins cross-cut both alteration zones and chert horizons.

Alteration is more extensive in the hangingwall rocks. At showings in the northwest corner of the claim group a 1 to 2 m chlorite-sericite zone is present in the footwall rocks of the metal-bearing chert layer, but a sericite-quartz-pyrite zone extends for more than 50m into the hangingwall andesites.

Structure

Two major structural directions have been recognized within the claim group. A major foliation strikes northwest and dips southwest more steeply than the bedding. A weaker northeast striking foliation warps the major foliation and bedding into a large Z-structure. Scattering of the poles to the planes of the second foliation suggest a third phase may be present.

Faulting is extensive on the claim group, and is dominated by two north trending faults known as the Harris Creek and Union-Silver Creek Faults. These faults cut all other structures on the properties, and may be high angle reverse faults. Thrust faulting may also have occurred on the claims. Numerous smaller faults offset the section making compilation of individual chert horizons difficult over large distances, however, logging characteristic sequences of green andesite layers in Unit 2 from drill core allows accurate determination of displacement across several important faults. The proximity of the Coast Plutonc Complex is most likely responsible for the majority of the large scale structures on the claims.

Conclusions

The sequence of events that caused the deposition of the rocks and metal concentrations is as follows:

1) A period of highly explosive volcanism depositing pumice and glass-rich ash flow and air fall layers was followed by quieter eruptions and extrusion of a thick sequence of andesite lava and pyroclastic flows. The presence of epiclastic rocks in Units 1d and 1e indicate an erosional hiatus between the two volcanic events.

2) During the second part of the volcanism fumarolic activity deposited thin layers of metal and quartz-rich chemical sediments. Sericite-quartz-pyrite alteration took place around fissures in the andesite which acted as conduits for the metal-rich brines. Formation of individual chert layers was terminated by deposition of additional andesite flows. The newly erupted overlying pyroclastic flows were relatively permeable, allowing fluid discharge from fumarolic centers to continue. This continued fumarolic activity produced the hangingwall alteration present above many of the metalliferous horizons.

3) Cessation of active volcanism is marked by the accumulation of intercalated siltstones and reworked volcanic material. The presence of epiclastic and jasper beds in the Maroon Tuff, chert horizons in the green andesite sequence of Unit 2 and the siltstones of Unit 4 topping the entire section

indicate that the environment of deposition was subaqueous during the major part of the volcanic cycle.

Research is continuing in order to fully substantiate the proposed model and investigate the relationship between the precious metals and base-metal sulphide minerals. Recognition of these mineral deposits as syngenetic, and an understanding as to how in the volcanic cycle they form will facilitate future exploration for volcanic-hosted precious metal deposits in northwest B.C.

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