STRATIGRAPHY AND PRECIOUS–METAL OCCURRENCES OF THE BIG MISSOURI CLAIM GROUP STEWART AREA (104B/1)

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INTRODUCTION

The Big Missouri claims are 25 kilometres northeast of Stewart and consist of 23 Crown-granted claims, 64 reverted Crown-granted claims, and 11 recently staked claims (Fig. 76). Access is by the Granduc road to the Silbak Premier millsite and then by a smaller road to the abandoned Big Missouri townsite where Tournigan Mining Explorations Ltd. has established an exploration camp (Fig. 77).

The majority of the claims were consolidated in 1973 by Tournigan Mining Explorations Ltd. In 1978, Western Mines Limited of Vancouver optioned the properties and have continued exploration to date with soil sampling, detailed surface and underground mapping, and 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 Buena Vista Mining Company Limited, subsidiary of The Consolidated Mining and Smelting Company of Canada, Limited (Cominco Ltd.), producing 847,615 tons of ore containing 58,384 ounces of gold, 52,677 ounces of silver, 2,712 pounds of lead, and 3,920 pounds of zinc (Grove, 1971). The Silbak Premier minesite, 5 kilometres 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 kilometres north of the Big Missouri claims, was a major copper producer until 1975.

GENERAL GEOLOGY

The claims are underlain by two major groups of northwest-trending rocks separated by an angular unconformity (Fig. 78). The stratigraphically lower group is gently southwest-dipping flow rocks and volcanogenic sedimentary rocks believed to be of the Lower Jurassic Hazelton Group (Grove, 1971; Smitheringale, 1977; Read, 1979). These rocks occupy the southwest half of the claims. The upper stratigraphic group consists of tightly folded, immature sedimentary rocks of the Middle to Upper Jurassic Bowser Group and occupies the northeast half of the claims.

The main mass of the Coast Plutonic Complex crops out 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 Early 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. 78).

Figure 76. Location map.

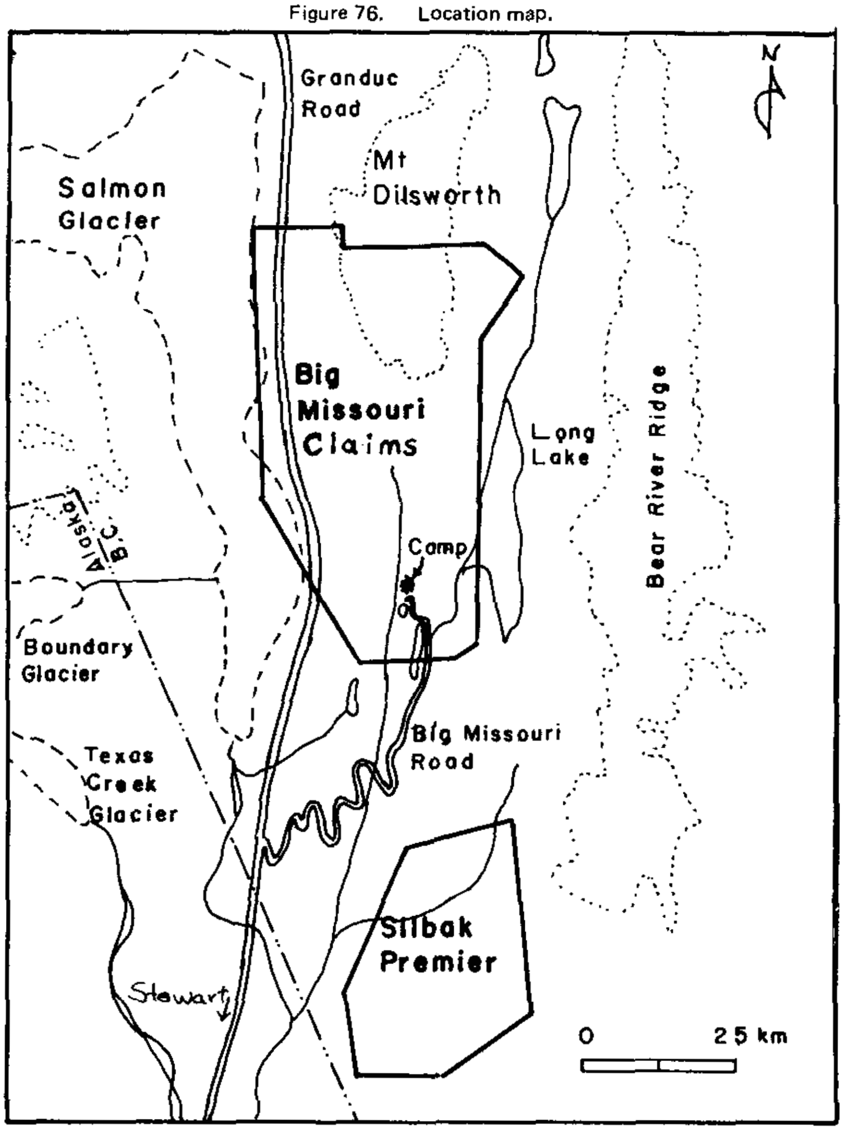

Figure 77. Area of the Big Missouri claims (modified from Smitheringale, W. G. & Associates, 1977).

Two sets of dykes crosscut 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 also strike northwest but cut the larger granite and granodiorite dykes.

HAZELTON GROUP

Flow rocks and volcaniclastic sedimentary rocks of the Hazelton Group are approximately 3 000 metres thick. The oldest rocks are near the east margin of the claims where they are in contact with the overlying Bowser Group sedimentary rocks. The youngest rocks are at the west margin of the claims along the Salmon Glacier. Rocks dip shallowly to the southwest and sedimentary and volcanic structures indicate that the section is right-side-up. The section consists of more than 1 000 metres of compositionally varied volcaniclastic rocks in its lower part, overlain by 1 500 metres of compositionally more uniform pyroclastic and effusive flow rocks. Within this upper part are precious and base metal-bearing siliceous horizons (Fig. 79).

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 porphyritic 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 50-metre layer of heterolithic agglomeratic tuff overlaps the basal black tuff at the southeast edge of the claim group. This agglomerate has a light green matrix and contains subrounded to angular fragments, up to 6 centimetres 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 relatively massive.

UNIT 1c: GREEN–GREY TUFF

Next in the sequence is a dark green to grey fragmental rock which has a thickness of 150 metres at the southeast corner of the claims and wedges out in approximately 500 metres. This unit is agglomeratic tuff and lapilli tuff in which several flow rocks are present; contacts are difficult to define. Angular to subangular fragments, up to 10 centimetres 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 300 metres 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, thinly laminated sedimentary fragments, and rare agglomeratic layers. The matrix contains what appear to be devitrified glass shards. In its upper part the unit consists of sandstone and conglomeratic equivalents of the tuffs; the epiclastic rocks

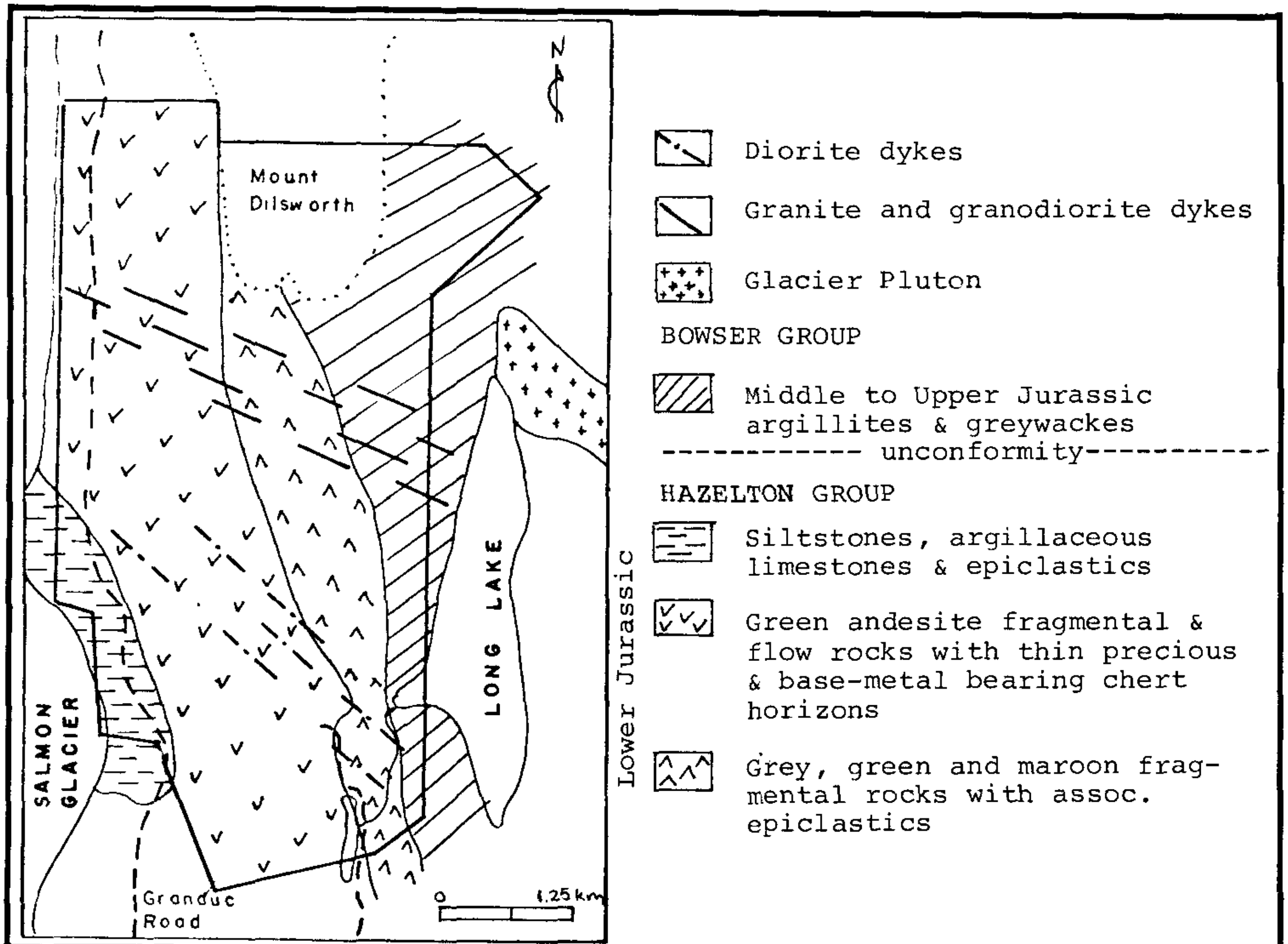

Figure 78. Sketch map of the general geology, Big Missouri claim group.

have layering and graded bedding. The northernmost exposure of this rock type is coarse pyroclastic material with an over-all decrease in grain size toward the south. This is the only rock observed to date which contains quartz lapilli.

DR: DILSWORTH RHYOLITE

A small rhyolite dome intrudes the section on the south flank of Mount Dilsworth where units 1a and 1d are in contact. The dome is 200 metres long in a northwest direction and 50 metres wide. It intrudes units 1a and 1b, and is surrounded by coarse brecciated material from both units. The dome is composed of rhyolite fragments consisting of sericite, quartz, and feldspar and angular coarse-grained grey carbonate fragments up to 50 centimetres in length. Disseminated pyrite comprises up to 20 per cent of the rock. The Bowser-Hazelton contact lies directly east of the rhyolite dome, and the Mount Dilsworth snowfield 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 comprise a thick wedge in the southeast corner of the claims, disappear in the middle, and reappear in the northern third of the claim where they are more than 300 metres thick. In the south the rocks are massive to well-layered maroon-coloured tuff and lapilli tuff with intercalated green volcaniclastic layers; the green layers become dominant near the middle of the claims. The most massive of the maroon rocks contain green lapilli that are flattened parallel to the layering. Near the south edge of the claim group lenses of reworked maroon 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 1 metre in diameter. This rock is gradational to maroon lapilli tuff and tuff.

UNIT 1f: INTERMIXED TUFF

The maroon tuff is topped by a mixed sequence of maroon and green volcaniclastic rocks which have angular blocks up to 40 centimetres in diameter of maroon and green porphyritic andesite in a green or maroon tuffaceous matrix. Several outcrops have angular rhyolite fragments up to 6 centimetres in diameter and 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 1 500 metres of the stratigraphic column consists of green andesitic pyroclastic rocks and effusive flows. Most of the layers have feldspar phenocrysts or fragments and many have amphibole crystals or crystal fragments. Biotite is the only primary mafic mineral identified in the lower part of the volcanic sequence. Unit 2 is thickest near the middle part of the claims and always exceeds 1 000 metres in thickness along its strike length. Tuff, lapilli tuff, and agglomerate occur throughout the sequence but the lower 50 to 100 metres is mainly coarse breccias, some of which are heterolithic. Generally, however, matrix and clasts of the coarser rocks are similar in composition. Lava flows within the sequence are massive rocks containing euhedral phenocrysts of feldspar and amphibole. Individual flows are difficult to recognize on the hand-specimen scale because of the uniform green colour of matrix and clasts.

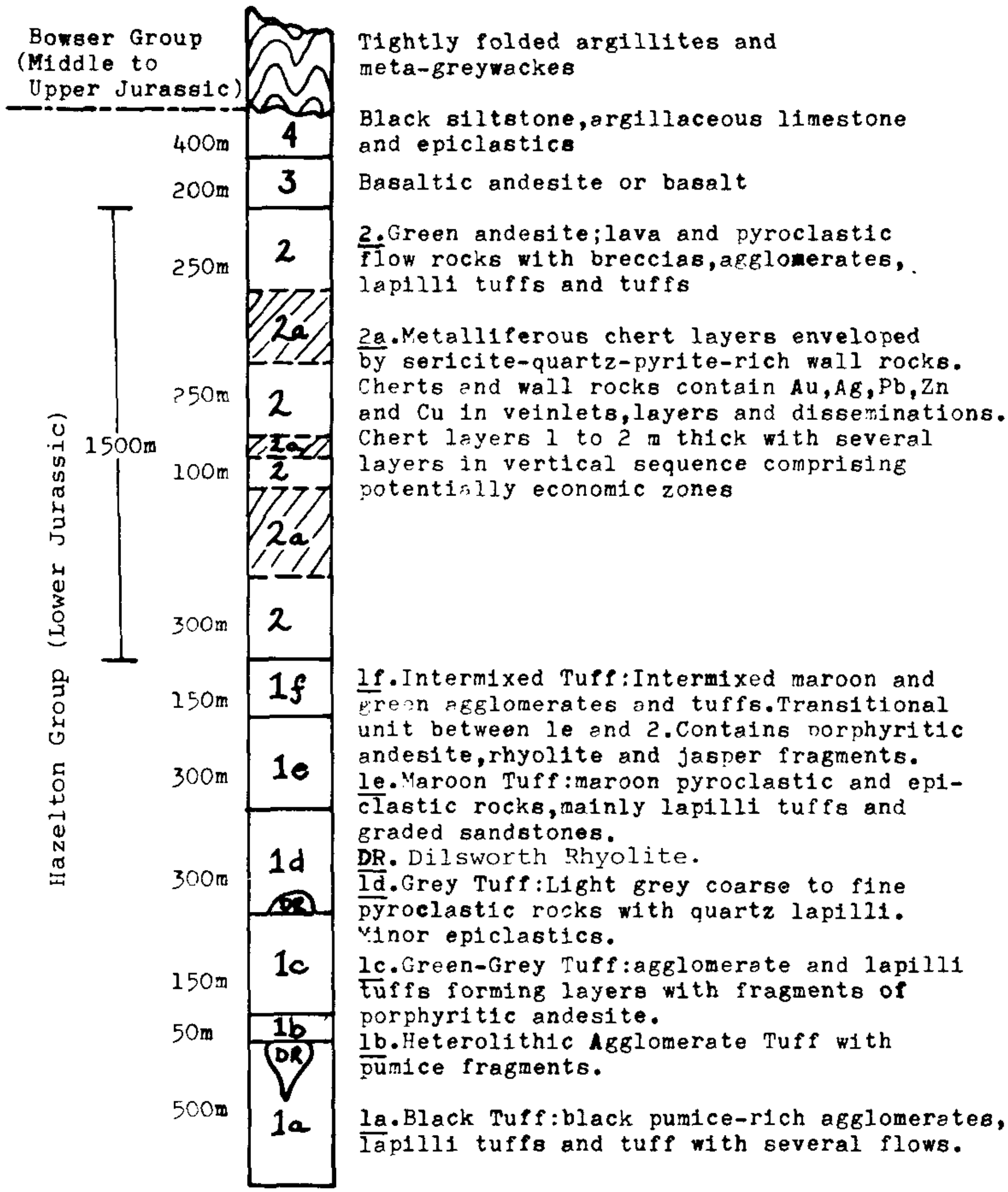

Figure 79. Summary of rock succession, Big Missouri claims.

UNIT 2a: METALLIFEROUS CHERT HORIZONS

The only major variations in composition within the green andesite unit are thin stratiform siliceous layers located at various stratigraphic levels within the andesites and sericite-quartz-pyrite-rich rocks that envelop these 'chert' horizons. These quartz-rich layers and the accompanying sericite-quartz-pyrite-rich rocks are significant because some carry precious metals and base metal sulphides.

UNIT 3: BASALTIC ANDESITE OR BASALT

The green andesite unit is topped by darker green, brown-weathering basaltic andesite or basalt. Most are lapilli tuff and tuff but some may be effusive flows. Carbonate veining is abundant in this unit.

UNIT 4: SILTSTONES, ARGILLACEOUS LIMESTONES, AND WACKES

The Hazelton Group volcanic sequence underlying the claims is overlain by a series of black siltstones, calcareous siltstones, and green-grey, sand-rich epiclastic beds. The unit was followed westward to the Granduc road. Grove (1971) mapped these sedimentary rocks further westward to the Salmon Glacier. Grove placed these sedimentary rocks in the Bowser Group but it is more likely that they are part of the Hazelton succession.

PRECIOUS AND BASE METAL OCCURRENCES

Two types of metal concentration occur on the Big Missouri claims. These are (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 crosscutting veins of vuggy quartz with local concentrations of base metals and silver. The large veins can 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 metres thick and are mainly dark grey to white microcrystalline quartz. Angular fragments of andesite partly altered to sericite and quartz are found near the footwall contacts. Fragments of cryptocrystalline quartz, some finely laminated, occur both in the chert layers and in the immediate hangingwall rocks. Fine-grained amorphous black carbon may comprise 15 per cent 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 chert horizons are capped by a distinct, carbon-rich layer. Pyrite is abundant as disseminations, layers, and veinlets. There are at least two generations of pyrite and the younger occurs as 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 but chalcopyrite is an accessory in several showings. Silver minerals, electrum, native silver, and gold form disseminations and veinlets in pockets within certain horizons. Silver minerals such as polybasite and pyrargyrite occur along with the electrum, native silver, and gold. Sulphides occur as disseminations, veinlets, and lenses in the chert horizons, as well as in veins and veinlets in the adjacent wallrocks. Pyrite concentrations are generally proportional to base metal sulphide concentrations.

At the base of the chert horizons there are massive sulphide lenses up to 1 metre thick of banded pyrite, sphalerite, galena, and chalcopyrite. Although abundant pyrite may be present in a chert horizon, precious metal content will be negligible unless galena and sphalerite are present. Consequently, an indication whether a horizon may also contain gold and silver is the bluish grey tinge to the quartz caused by the presence of disseminated sphalerite and galena.

IMMEDIATE WALLROCKS

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

Sericitization, silicification, pyritization, and minor chloritization of the andesite wallrock have taken place. Ghost textures, such as outlines of feldspar and amphibole phenocrysts, suggest that the rock was originally similar in composition to the unit 2 andesites. Alteration in the andesites gradually intensifies toward chert contacts. 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.

The frequency of veining increases with proximity to the chert horizons. Small, clear quartz veinlets with associated sericite-quartz-pyrite alteration appear and increase in size and abundance within several metres of a chert horizon. Then large, blue-grey quartz veins up to 30 centimetres in diameter and carrying visible sphalerite and galena become abundant. These large veins resemble the chert layers in texture and composition. Closely-spaced networks of small, clear to white quartz veins are common in the hangingwall rocks. Blue-grey quartz-carbonate and large milky quartz veins crosscut both alteration zones and chert horizons.

Alteration is more extensive in the hangingwall than the footwall rocks. At several showings chlorite-sericite alteration zone is only 1 to 2 metres wide in the footwall rocks of the metal-bearing chert layer, but the hangingwall sericite-quartz-pyrite zone extends for more than 50 metres into the andesites.

STRUCTURE

Two structural directions dominate within the claim group. A well-developed foliation strikes northwest and dips southwest at a steeper angle than the bedding. A second, weaker, northeast-striking foliation warps the dominant foliation and bedding into a large Z-fold. Poles of measurements of the second foliation plane scatter suggesting that a third phase may be present.

Faulting is extensive on the claim group; it 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 correlation of individual chert horizons over large distances difficult. However, careful logging of characteristic sequences of green andesite layers in unit 2 in drill core has allowed accurate determination of displacement across several important faults. The claims are in close proximity of the Coast Plutonic Complex which most likely caused the majority of the large-scale structures.

CONCLUSIONS

The sequence of events that led to the deposition of the rocks and concentrations of metals is as follows:

(1) A period of highly explosive volcanism that deposited 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 indicates an erosional hiatus between the two volcanic events.

(2) During the second volcanic event fumarolic activity caused deposition of thin layers of metal and quartz-rich chemical sedimentary rocks. 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 eruption of additional andesite flows. The newly erupted flows were relatively permeable, allowing fluid discharge from fumarolic centres to continue. This continued fumarolic activity produced the hanging-wall alteration present above many of the metalliferous horizons.

(3) Accumulation of intercalated siltstones and reworked volcanic material mark cessation of active volcanism. Epiclastic and jasper beds in the maroon tuff, chert horizons in the green andesite sequence of unit 2, and siltstones of unit 4 that cover 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 precious metals and the base metal sulphides. Recognition that these mineral deposits are syngenetic and an understanding of their relationship to the volcanic cycle will facilitate future exploration for volcanic-hosted precious metal deposits in northwest British Columbia.

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REFERENCES

Barr, D. A. (1980): Gold in the Canadian Cordillera, *C.I.M.*, Bull., Vol. 73, No. 818, pp. 59-76.

Grove, E. W. (1971): Geology and Mineral Deposits of the Stewart Area, B.C., *B.C. Ministry of Energy, Mines & Pet. Res.*, Bull. 58.

Read, P. B. (1979): Preliminary Geological Mapping of the Big Missouri Property near Stewart, Northern British Columbia, private report, *Tournigan Mining Explorations Ltd.*, 17 pp.

Smitheringale, W. G. and Associates (1977): An Exploration Proposal for the Big Missouri Property, Skeena Mining Division, British Columbia, private report, *Tournigan Mining Explorations Ltd.*, 34 pp.

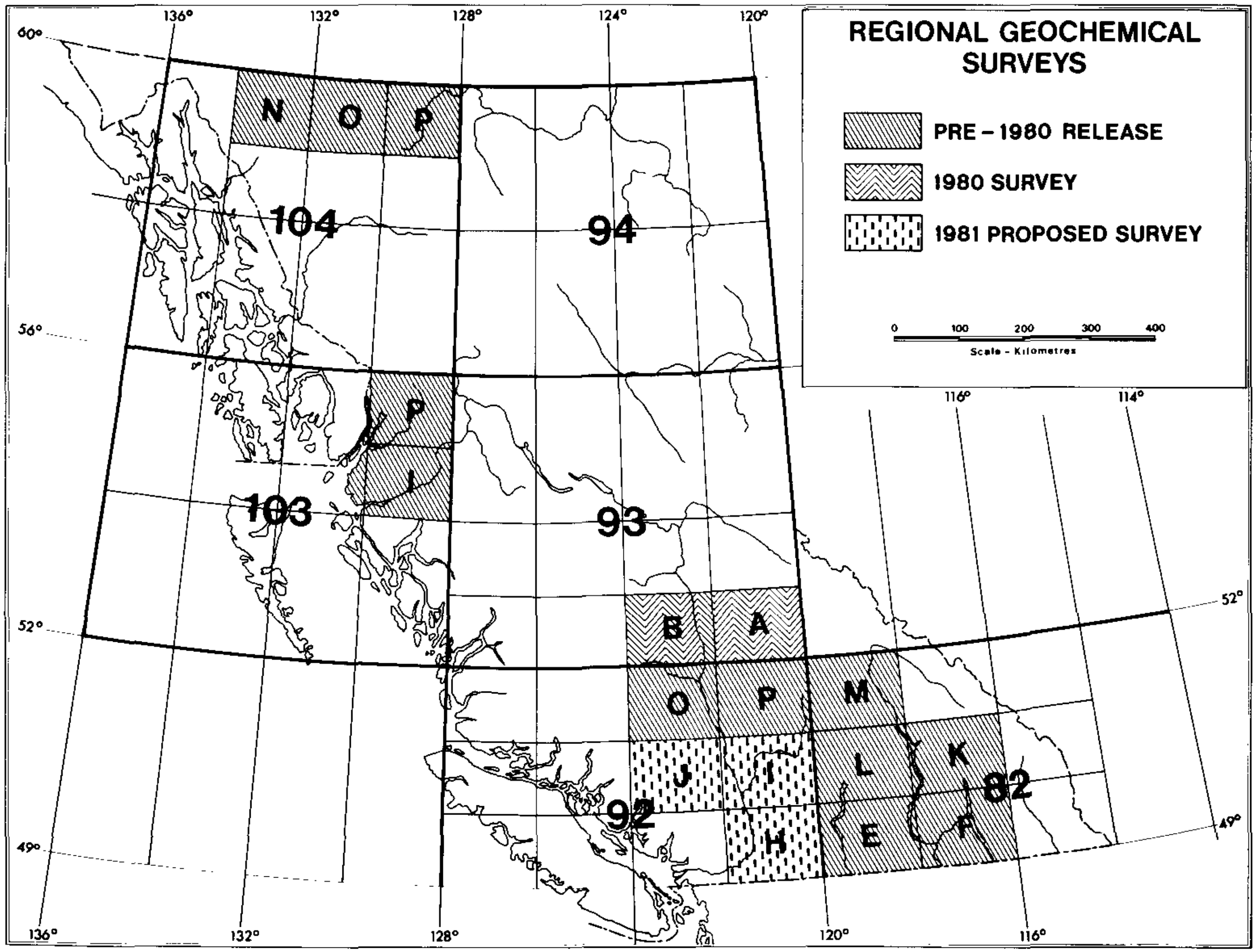

Figure 80. Index map – regional geochemical surveys.