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GEOLOGY OF THE DOLLY VARDEN CAMP ALICE ARM AREA (103P/11, 12)

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INTRODUCTION

The Dolly Varden property straddles the Kitsault River 27 kilometres upstream from Alice Arm in the Portland Canal area, approximately 185 kilometres north of Prince Rupert. Geological mapping, initiated by Lytton Minerals Ltd., Toronto, in the area developed the base map and cross-section of Figures 50-1 and 50-2. Previous workers considered all mineralization to be in epithermal veins (Hanson, 1921; Black, 1951; Campbell, 1959). Mapping, however, shows that the main mineral occurrences can be reconstructed to form one continuous ore horizon that conforms to stratigraphy. This type of mineralization is called, here, 'Dolly Varden type' (DVT); it is stratiform, volcanogenic massive sulphide.

Fieldwork during June and July 1985 by a two-man crew included 1:5000-scale regional geological mapping and 1:2000-scale mapping of the Torbrit, Moose-Lamb, Dolly Varden, Northstar, and Wolf deposit areas. This mapping forms the basis of a M.Sc. thesis study for the senior author.

PROPERTY GEOLOGY

LITHOLOGY

The Dolly Varden property is underlain by sedimentary and volcanic rocks of the Lower Jurassic Hazelton Group. These rocks have been intruded by basaltic, andesitic, and lamprophyric dykes of probable Tertiary age (not shown on Figs. 50-1 and 50-2). Black (1951) subdivided rocks of the Hazelton Group in the area into two sedimentary formations and two volcanic formations. Mapping this past summer, however, showed that the Dolly Varden property is underlain by only one major volcanic and one major sedimentary formation; these could be subdivided into units based on lithologic characteristics and on consistent stratigraphic relationships.

Sedimentary rocks exposed in the southeast and northeast parts of the map-area, and in the Kitsault River valley to the northwest, appear to be the oldest rocks on the property. These sedimentary rocks consist of thinly bedded shale and argillite (Figs. 50-1 and 50-2; unit 1a) overlain by massive fossiliferous greywacke and sandstone (unit 1b), which in places is capped by a locally well-bedded, maroon-coloured siltstone (unit 1c).

Volcanic rocks, primarily pyroclastics, conformably overlie the sedimentary formation. These volcanic rocks, the most abundant rock type in the map-area, host the most significant silver-lead-zinc prospects. The volcanic formation has also been subdivided. Unit 2b is a light green, dacitic ash tuff that rests conformably upon the rocks of the sedimentary formation; it grades upward into a thick sequence of darker green andesitic tuff (unit 3). Lenses or individual flows of andesite are observed locally in unit 3. Unit 3 grades into an overlying maroon-coloured rock (unit 4) which consists of locally well-bedded, lapilli and crystal-lithic tuff. Unit 4 is relatively siliceous, possibly indicating a more dacitic composition. Unit 5a overlies the maroon-coloured unit and consists of pale green tuff of either an andesitic or dacitic composition; it has very distinct, angular, shard-like fragments. Unit 5a is also siliceous and possibly albitic; it is invariably interbedded with DVT mineralization (unit 5b). Unit 5a is well defined in the hangingwall of the Dolly Varden and Northstar deposits, as seen in drill core and underground workings. Unit 6 overlies either unit 5a or unit 5b; it is another maroon lapilli tuff and tuff breccia of either andesitic or dacitic composition. Unit 7, a green andesitic tuff, overlies unit 6. This green tuff unit appears to be the youngest unit within the volcanic formation identified within the map-area.

Hazelton Group rocks in the northwest and east-central parts of Figure 50-1 are intruded by either stocks or sills (unit 2) of the 'Copper Belt' intrusives. When fresh, unit 2 intrusions are porphyritic with plagioclase and minor hornblende phenocrysts, and either a dioritic or andesitic appearance. West of the Kitsault River and north of Evindsen Creek, Copper Belt intrusives are closely associated with a zone of silicification annd pyritization (unit 2a), which characteristically is strongly altered feldspar porphyry. The Copper Belt porphyries are probably cogenetic, based on preliminary galena-lead isotope data, with the Hazelton Group volcanic rocks, in particular the dacitic ash tuff (unit 2b). Other intrusive rocks in the map-area include numerous fine-grained basalt, andesite and lamprophyre dykes, which intrude all rocks of the Hazelton Group and the Copper Belt intrusives. These dykes are probably Tertiary in age.

STRUCTURE

Reliable bedding plane measurements were obtained both from compositional layering within the sedimentary units and alignment of tuff and lapilli fragments in the tuffaceous units. This, along with other structural data, shows a series of anticlines and synclines with gentle, northwest plunges. Thus, sedimentary rocks exposed east of the Torbrit mine area lie in the core of an anticline, which, when projected to the northwest, crops out in the Kitsault River valley. Mineralized zones of the Dolly Varden, Northstar, Torbrit, and Moose-Lamb prospects (Figs. 50-1 and 50-2) are conformable to the enclosing host rocks and occur on the steeply north-dipping, western limb of a syncline which is adjacent to, and west of, this anticline.

Numerous nearly vertical block faults striking in two directions, occur in the map-area. Timing of the faulting events is defined by relative displacements of units — especially the stratiform horizons — and earlier faults by younger faults. The earliest set of faults trends northwest and downdrops blocks to the west. Examples of this set include the Dolly Varden and Moose-Lamb faults (Figs. 50-1 and 50-2). The later set of faults trends north-northeast, with displacement either up or down. These faults include the Campbell, Mitchell, and Hanson faults (Figs. 50-1 and 50-2).

MINERALIZATION

Mineral occurrences on the Dolly Varden property have been described by most workers as quartz-barite-jasper-sulphide-native silver veins in Hazelton Group rocks (Hanson, 1921; Black, 1951; Campbell, 1959) or chalcopyrite-gold-silver veins associated with the Copper Belt zone of silicification and pyritization (Hanson,

British Columbia Ministry of Energy, Mines and Petroleum Resources, Geological Fieldwork, 1985, Paper 1986-1.

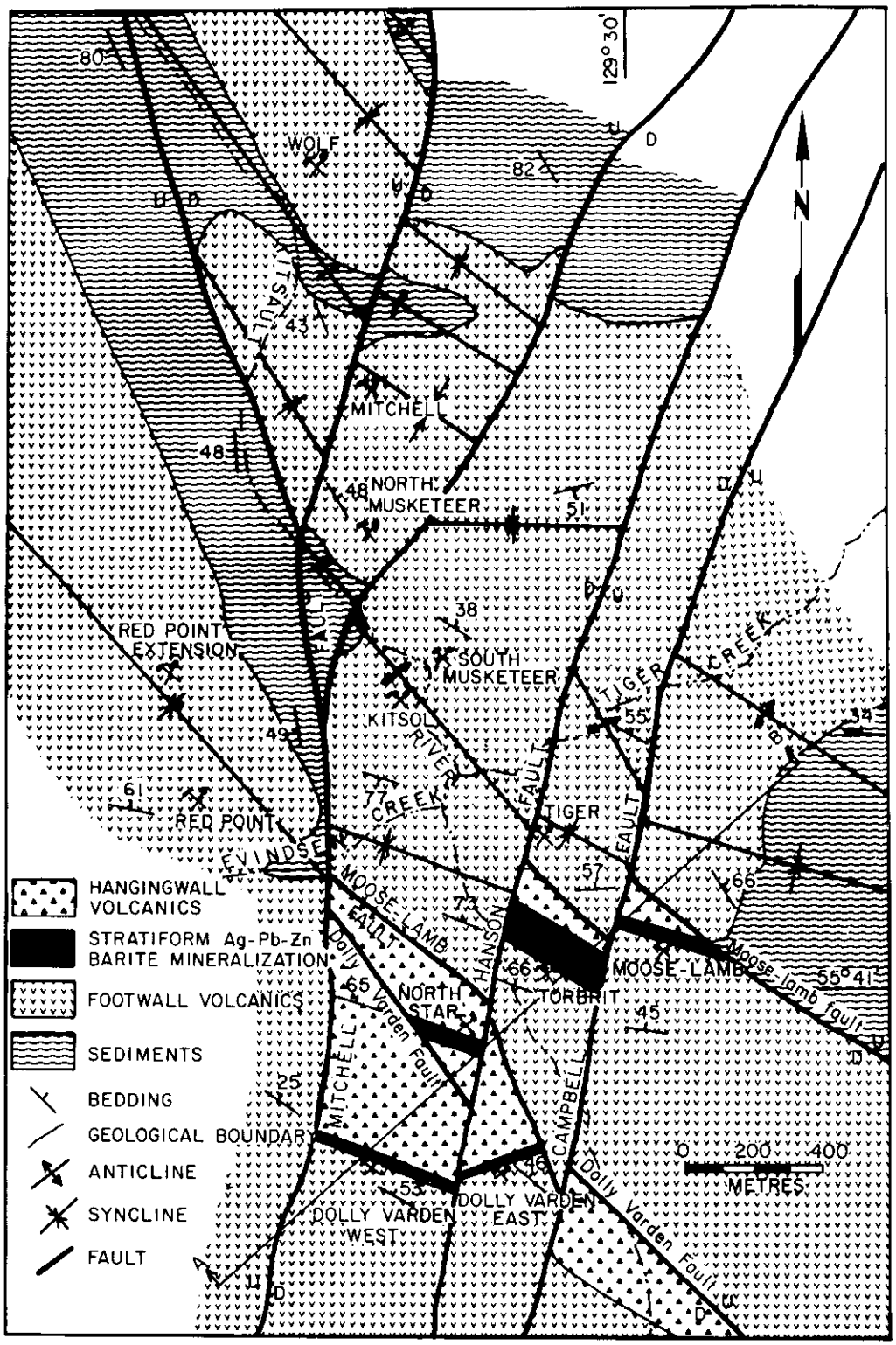

Figure 50-1. Geology of the Dolly Varden property, Alice Arm area, northwestern British Columbia. Cross-section A-B is on Figure 50-2. All units are within the Jurassic Hazelton Group (Tertiary dykes are not shown). Sediments: unit 1a = black argillite and shale; unit 1b = greywacke; unit 1c = maroon siltstone. Footwall volcanics: unit 2 = feldspar porphyry; unit 2a = silicified and pyritized zone; unit 2b = dacite ash tuff; unit 3 = green andesite tuff and flows; unit 4 = maroon andesite lapilli and crystal-lithic tuff. DVT horizons: unit 5a = siliceous tuff and pale green shard tuff; unit 5b = stratiform silver-lead-zinc-barite mineralization. Hangingwall volcanics: unit 6 = maroon andesite lapilli tuff and tuff breccia; unit 7 = green andesite tuff.

1921; Black, 1951; Carter, 1970) In this study, the two types of mineralization are recognized but the quartz-barite-jasper-sulphide-native silver veins are interpreted to be stratiform volcanogenic silver-lead-zinc-barite deposits (DVT).

DVT mineral occurrences typically contain significant silver and base-metal values; barite is strontium rich (up to 1 per cent) (Campbell, 1959). Examples on Figure 50-1 include the Dolly Varden, Northstar, Torbrit, and Moose-Lamb deposits as well as two small, isolated occurrences north of Tiger Creek on the east side of the Kitsault River. Mineralization of this type is commonly layered and conformable with enclosing wallrocks. Another characteristic feature is property-scale mineral zoning from the Dolly Varden (quartz-sulphide), through the Northstar (carbonate-barite-sulphide), to the Torbrit and Moose-Lamb (barite-oxide-sulphide). Vertical mineral zonation with a pyrite-rich footwall and a sphalerite-galena-rich hangingwall has also been recognized in drill core from the Northstar deposit (W. Pearson, personal communication, 1984).

On the Dolly Varden property silver-lead-zinc mineralization also occurs as structurally controlled replacement deposits and veins. Examples of this type include the Wolf deposit and North and South Musketeer, Kitsol, Tiger, and Mitchell prospects (Fig. 50-1). Generally, this type of mineralization is not restricted to any specific rock unit, but volcanic rocks, especially the dacitic ash tuffs of unit 2b, are favoured. These occurrences are usually discontinuous and develop along a northeast direction, subparallel to the youngest set of faults in the area. The zones are predominantly quartz and pyrite with minor calcite, barite, and other sulphides. Wallrock alteration and limonite staining are common. Metal values are generally erratic as indicated by drilling at the Wolf deposit (W. Pearson, personal communication, 1984).

Showings within the Copper Belt are mainly vein deposits. Examples include the Red Point and the Red Point Extension showings (Fig. 50-1) which are characterized by chalcopyrite, with locally significant gold and silver values, within an extensive zone of silicification and pyritization related to feldspar porphyry. These veins are generally small, discontinuous, and randomly oriented; gold, silver, and copper values are erratic.

CONCLUSIONS

The oldest rocks on the property were formed during the Lower Jurassic Hazelton period by submarine deposition of sedimentary strata; this was followed by intrusion of the Copper Belt porphyritic rocks, then submarine eruption of predominantly tuffaceous rocks. Submarine volcanism was accompanied by deposition of stratiform volcanogenic Dolly Varden-type (DVT) mineralization. The area was then regionally folded into upright folds with axes plunging gently northwest. The area was subsequently cut by steeply dipping, northwest-trending faults which downdropped rocks to the west and displaced the stratiform DVT horizon. Numerous north-northeast-trending, steeply dipping faults cut these earlier structures. Epithermal silver-lead-zinc occurrences, such as the Wolf deposit, and later dykes of probable Tertiary age, are subparallel to these later north-northeast faults. Gold-silver-copper vein mineralization occurring in a zone of silicification and pyritization in the western part of the property, is believed to be related to intrusion of the Copper Belt porphyritic rocks.

Two major sets of faults bound structural blocks that host DVT mineralization, such as the Moose-Lamb, Torbrit, Northstar, Dolly Varden East, and Dolly Varden West deposits. Within these individual blocks, orebodies on the southwest sides of northwest-trending faults have been downdropped. An example of this relationship is shown for the structural block bounded by the Hanson and Campbell faults containing the Dolly Varden East deposit (Fig. 50-1). This orebody has been downdropped by the Dolly Varden fault and is laterally equivalent to the Torbrit deposit. Similar conclusions for the Dolly Varden West deposit indicate that it is the downdropped equivalent of the Northstar deposit. It is also possible that DVT mineralization reported in the southern part of the map-area might represent the extension of the Moose-Lamb deposit.

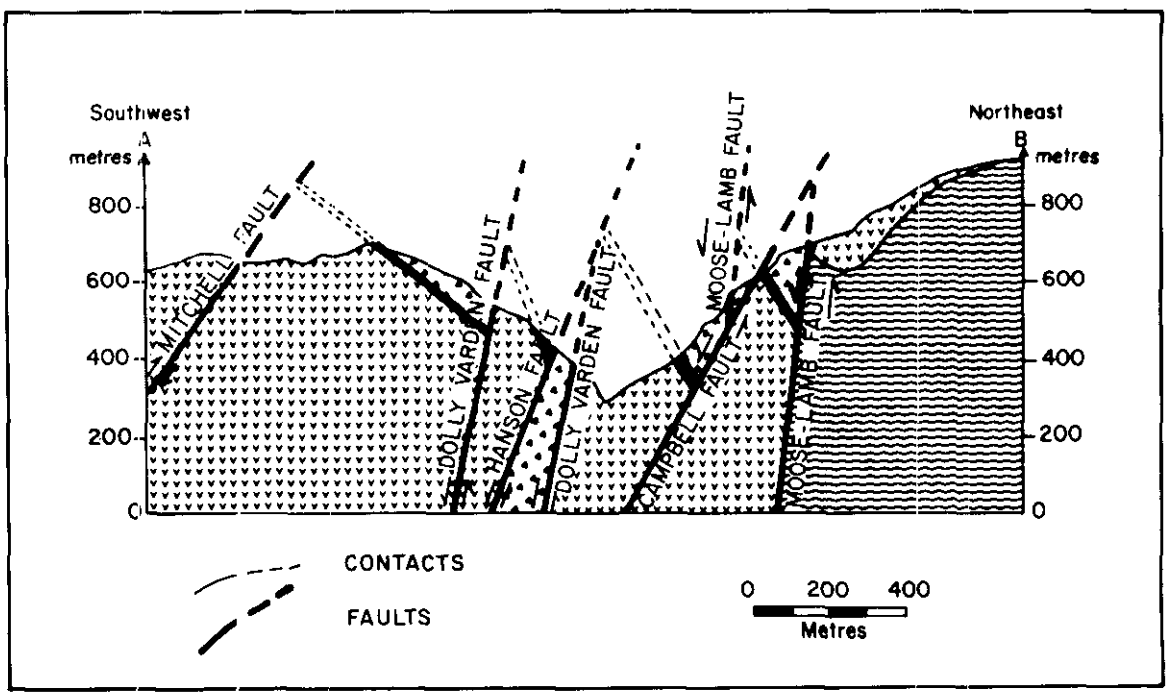

Figure 50-2. Cross-section A-B (for location *see* Fig. 50-1), looking northwest, of the Dolly Varden, Northstar, Torbrit, and Moose-Lamb areas. Units are described in the caption for Figure 50-1.

The genesis of DVT mineralization is of special importance because of its exploration implications. DVT mineralization probably formed as submarine exhalative deposits associated with andesitic and dacitic volcanism. Conformity with stratigraphy is key support for this hypothesis. Another line of evidence for a volcanogenic origin is the typical mineral zonation from quartz-pyrite lodes in the vent or source area of mineralization located in the vicinity of the Dolly Varden East deposit, through the quartz-carbonate-barite-sulphide Northstar lode, to the well-layered, barite-oxide-sulphide mineralization of the Torbrit and Moose-Lamb deposits; the latter represents distal, shallower deposition. Vertical mineral zonation in the Northstar deposit from a pyritic footwall to a galena-sphalerite-rich hangingwall is also typical of volcanogenic deposits. Other key features supporting this model include a consistent stratigraphic position between the maroon hangingwall (unit 6) and the grey-green footwall (unit 5a), conformability of the layered mineralization (unit 5b) to enclosing host rocks, and fragments of stratiform ore within the tuffaceous hangingwall rocks (either unit 5a or unit 6).

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