The Glacier Gulch (Hudson Bay Mountain or Yorke-Hardy) porphyry molybdenum-tungsten deposit, west-central British Columbia

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ABSTRACT

Porphyry molybdenum-tungsten mineralization on the east flank of Hudson Bay Mountain crops out over 5 km² and is intersected to depths of 2 km. Features such as a hornblende-biotite aureole, mineralogical zoning and dike, vein and fracture geometries within lithologies of the Middle to Lower Jurassic Hazelton Group and Cretaceous Skeena Group reflect an intrusive complex, the Upper Cretaceous to Early Tertiary Hudson Bay Mountain stock which has been intersected by drill holes. The stock is believed to be the mineralizing agent. A southeast-dipping granodiorite sill has been outlined by drilling within the Hazelton Group. Molybdenite and scheelite veins cut all rock types; however, the granodiorite sill hosts a higher density of fine-grained, banded, quartz-molybdenite and pegmatitic quartz-molybdenite veins reflecting a competency contrast between the intrusive sill and other country rock. Due to the relative abundance of these veins, grade is higher within areas of the sill. Above the 15000E cross-cut 20.6 million tonnes grading 0.401% MoS_2 and 0.041% WO_3 have been defined. During exploration of the deposit sampling procedures had to be adjusted because of the nugget effect attributed to drill intersections of banded and pegmatitic veins.

Introduction

Molybdenite was discovered in outcrop at the foot of Kathlyn Glacier on Hudson Bay Mountain and first reported by the Geological Survey of Canada in 1944. The deposit has several names: Hudson Bay Mountain or Glacier Gulch, both after its location, and Yorke-Hardy after the original staker.

The deposit is on the east flank of Hudson Bay Mountain, 9 km northwest of Smithers, west-central British Columbia, within NTS area 93L/14 (54° 49′ North, 127° 18′ West, Fig. 1). Hudson Bay Mountain, on the southern edge of the Bulkley Valley, is a dominant topographical feature reaching 2590 m elevation. Mineralization is partly overlain by the Kathyln Glacier which is visible from Highway 16. Access to the 3100 m of underground development is from a portal at 1066 m elevation on the east slope of Hudson Bay Mountain.

History

In 1957, William Yorke-Hardy and associates staked the surface exposure at the foot of Kathyln Glacier. American Metal Co. optioned the property between 1957 and 1959 and explored it by trenching and drilling. In 1961, American Metal Climax Inc. optioned the property again and transferred it to Climax Molybdenum Corp. of B.C. Ltd. The company completed purchase in 1971 and still maintains mineral rights to the property. In 1966, an adit was collared on the east slope of Hudson Bay Mountain and underground workings including two cross-cuts, the 15000E and 16600E, were excavated to gain access for underground drilling (Fig. 1). A total of 164 holes were drilled including 41 from surface for 23 500 m and 123 from underground for 34 907 m. On completion of the most recent drilling in 1980, a reserve of 20.6 million tonnes grading 0.401% MoS_2 and 0.041% WO_3 at a 0.2% MoS_2 cutoff was defined as a higher grade area within the larger geologic resource of 91.6 million tonnes grading 0.297% MoS_2 (Kirkham et al., 1982).

Regional Geology

The deposit is in Jurassic and Cretaceous rocks of Stikinia terrane. Intrusions associated with the mineralization are Upper Cretaceous to Early Tertiary calc-alkaline porphyritic quartz monzonite plutons of the Bulkley type.

Geology of Deposit

Mineralized and altered lithologies include: Early Cretaceous Skeena Group greywacke, sandstone and mudstone with coal seams; Lower to Middle Jurassic Hazelton Group mafic to felsic flows, tuff, breccia and lesser mudstone, conglomerate and limestone; a Middle to Late Jurassic granodiorite sill; metabasaltic sills and dikes and Late Cretaceous to Early Tertiary intrusions that include a rhyolite plug, quartz-feldspar porphyry dikes and the Hudson Bay Mountain stock.

The granodiorite sill intrudes Hazelton Group volcanic rocks, exhibiting concordant and discordant contacts. The sill, defined by drilling over a 1200 m strike length, dips at 20° southeast steepening to 70° at the 16000E cross-cut and ranges in thickness from 75 m to 550 m (Fig. 2). Emplacement of the sill may be along an east-dipping premineral thrust fault (Kirkham, 1966).

The sill can be subdivided on texture and mineralogy (Fig. 2). The higher grade reserve is hosted by the portion characterized by granitic texture which most commonly forms the basal and southern segments of the sill. The granitic portion is the most mafic part of the sill and the primary mafic mineral content is estimated at 5% to 10%. The porphyritic central and upper part of the sill has an aphanitic groundmass with euhedral to ragged plagioclase phenocrysts to 5 mm, euhedral quartz phenocrysts to 2.5 mm and clots of chlorite, pyrite and magnetite replacing primary mafic minerals. Porphyritic granodiorite locally has intrusive contacts with other parts of the sill. The aplitic section forms the uppermost and northeast edge of the sill. It is light coloured and has spectacular granophyric intergrowths of quartz and feldspar.

Within the sill there are numerous dark green to black, equidimensional, stoped Hazelton Group volcanic blocks up to 3 m across forming zones up to 30 m thick (Fig. 2). Partial digestion of the blocks suggests interaction with the granodiorite melt. Breccia zones containing subrounded sill fragments in a mafic matrix are locally common.

Numerous basaltic dikes, sills and erratically shaped bodies crosscut Hazelton Group lithologies and the sill.

A rhyolite plug intrudes Hazelton Group rocks and the granodiorite sill and is truncated by the Hudson Bay stock (Atkinson, 1983a

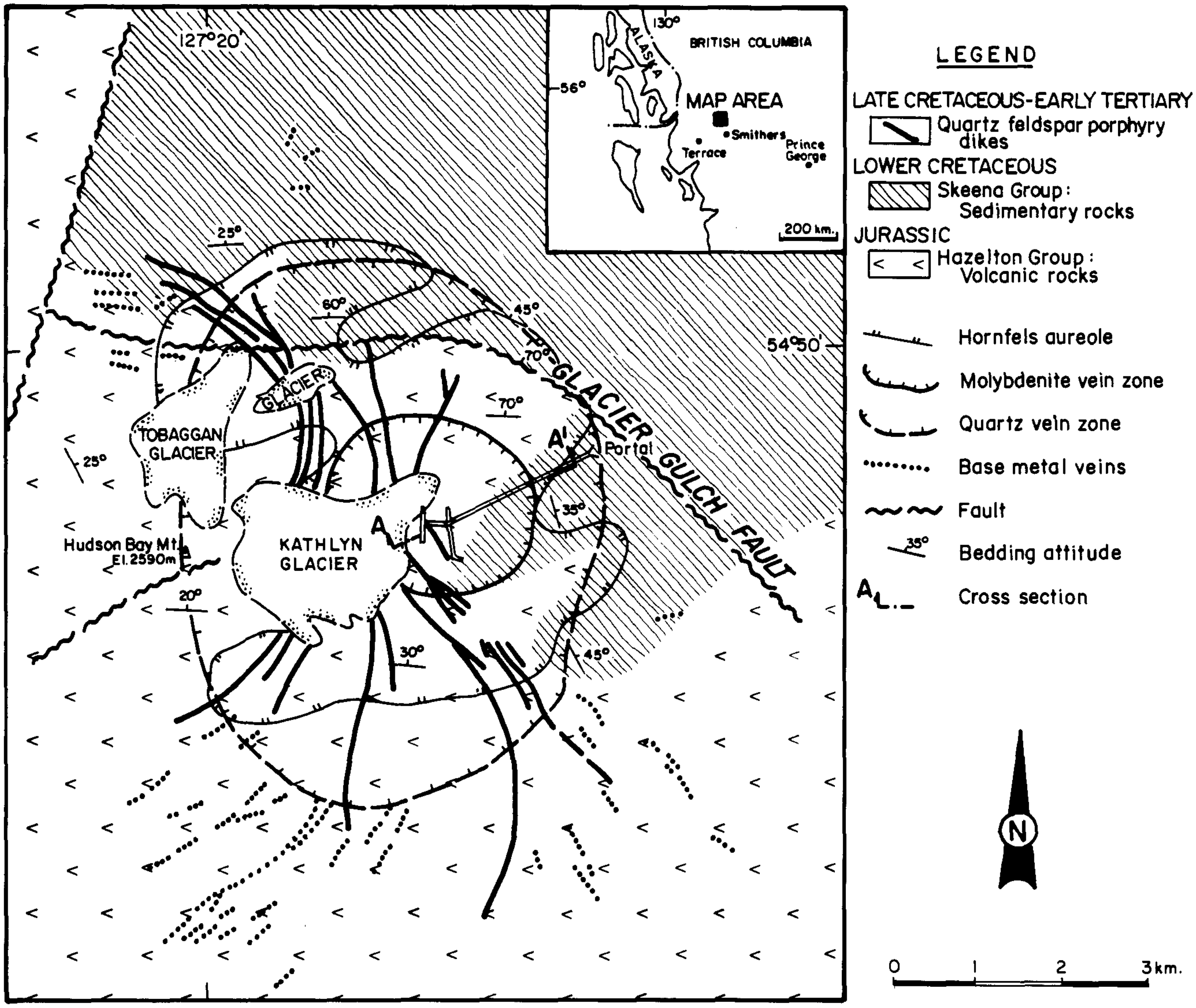

FIGURE 1. Location and geological map of Hudson Bay Mountain to show rock types, mineralogical zonation and the Yorke-Hardy deposit.

and 1983b; Fig. 2). The plug is oval in plan, measures 450 m by 300 m, is steep-sided and has a relatively flat top with its apex at the 880 m level (Fig. 2). It is a calc-alkaline quartz-feldspar porphyry with a chilled margin extending 30 m into the plug. A quartz crenulate zone consisting of alternating 1 mm to 5 mm layers of quartz and rhyolite extends up to 60 m into the plug (Fig. 2). Quartz layers have undulatory extinction and consist of euhedral, unidirectional terminations into the stock indicating the quartz grew into the magma and the bands were plastically deformed at magmatic temperatures during crystallization. This texture has been described as unidirectional solidification texture (Shannon et al., 1982), comb quartz layers (Kirkham and Sinclair, 1988), or brain rock. Intrusion of the plug produced breccias and was accompanied by at least two stages of rhyolite dike emplacement.

A sub-radial quartz-feldspar porphyry dike swarm dated at 60 ± 5 Ma (Kirkham, 1966) has been mapped on surface and underground, and has been intersected by drilling. These dikes are temporally and compositionally related to the Hudson Bay stock whose east flank has been intersected by four drill holes at depths ranging from 400 m to 1000 m. Uplift features related to emplacement of the Hudson Bay stock include concentric, radial and domal fracture and vein patterns. Intersections of the stock show it is composite ranging from quartz monzonite to granodiorite. Age dates on biotite are 67 ± 5 Ma (Kirkham, 1966) and 73.3 ± 3.4 Ma (Carter, 1974).

Mineralization

The Glacier Gulch molybdenite-scheelite porphyry deposit occurs near the centre of a 155 km^2 mineral district (Kirkham, 1966) that comprises encompassing zones of quartz veins, pyrite veins and zoned base-precious metal, sulphide-sulphosalt veins. The latter comprise 60 radially trending veins (Fig. 1). The Hudson Bay stock is thought to be the source of the mineralizing fluids with mineralogical zoning centred around what appears to be the interpreted apex of the intrusion.

The porphyry deposit is 2.5 km across and extends to depths of 2 km. It is dominated by moderately to steeply dipping stockwork veins that range from hairline to 5 mm in width. Stockwork veins, even within one vein assemblage, exhibit a complex history of cross-cutting relationships and offsets. Early stockwork assemblages include andradite garnet, epidote, chlorite, magnetite and quartz followed by molybdenite which occurs as both fine-grained fracture coatings and in veins with quartz and K-feldspar gangue. These assemblages are cross-cut by banded veins of fine-grained quartz + molybdenite ± pyrite ± scheelite and rarer banded quartz + magnetite as much as 1 m wide. These veins occupy both steeply dipping radial fractures and moderately to shallowly dipping concentric fractures. Banded veins are cross-cut by magnetite + scheelite and quartz + K-feldspar + scheelite veins. The latter assemblage represents the principal tungsten mineralizing event.

Astride the contact of the rhyolite plug with Hazelton Group volcanic rocks and the granodiorite sill, quartz stockwork veins coalesce to form a high silica zone that mimics the shape of the top of the plug (Fig. 2). The high silica zone averages 40 m thick and contains trace fluorite, topaz, magnetite and biotite.

Hydrothermal alteration is fracture controlled. Vein alteration haloes rarely exceed a metre in width. Where veins are numerous, overlapping haloes form zones of pervasive alteration but deposit scale zonation has not been established. Within Hazelton Group rocks, hydrothermal alteration includes Na metasomatism, silicification and destruction of mafic minerals resulting in bleaching of the lithologies. Within the granodiorite sill alteration includes the development of pink potassic alteration which envelops magnetite, quartz, stockwork molybdenite, and pegmatitic quartz-molybdenite veins. Grey or greenish-grey phyllic alteration envelops magnetite, quartz and banded quartz-molybdenite veins. Three pulses of hydrothermal fluids are interpreted from the cross-cutting relationships of the alteration envelopes.

Economics

The distribution of molybdenite is unpredictable due to its erratic occurrence in pegmatitic and banded veins. The nugget effects of these high-grade veins caused non-reproducibility of assays from split core and problems in ore zoning using standard techniques. During 1979 to 1980, HQ core was drilled and entire lengths of core were crushed and split to obtain samples for assay that were representative and reproducible. Geological cross-sections were then constructed using computerized drill hole data from drill fans on sections at 30 m spacing above the 15000E cross-cut. Ore zones based on 0.1%, 0.2% and 0.3% MoS_2 cutoffs were interpreted on 23 cross-sections and MoS_2 grade was calculated using the assays and a tonnage factor. The ore zones were digitized and kriging techniques were used to establish MoS_2 grade within the ore zones on 30 m benches. From this a 20.6 million tonne reserve was defined grading 0.401% MoS_2 and 0.041% WO_3 at a 0.2% MoS_2 cutoff. Other areas containing similar swarms of veins are recognized on the property; however, they have not been tested by close-spaced drilling to define reserves.

Discussion and Conclusions

Glacier Gulch is a fracture-controlled Mo-W deposit spatially, temporally and genetically associated with Late Cretaceous to Early Tertiary Bulkley porphyritic quartz monzonitic intrusion. The quartz-molybdenite stockwork, one of the intrusion-centred vein assemblages, contains most of the molybdenum. Stockwork formation is attributed to recurrent fracturing during intrusive movement and hydrofracturing by hydrothermal fluids emitted from magma that formed the rhyolite plug and the Hudson Bay composite stock. Host rocks were domed and fractured and steeply dipping radial dikes, veins, fractures and joints indicate vertical orientation of the maximum principal stress during emplacement of the Hudson Bay Mountain stock. High-grade zones correspond to banded quartz-molybdenite in steeply dipping radial vein sets and moderately to gently dipping concentric vein sets. These banded veins are more abundant in the granodiorite sill in which a lack of structure and a contrasting competency with the Hazelton Group volcanic rocks allowed dilational fractures to develop better. High-grade zones also correspond to clots and rosettes of molybdenite in pegmatitic veins. These are believed to have formed under nearly static conditions as open-space fillings of tensional fractures which opened during one event. This large deposit has not been fully explored.

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