GEOLOGY OF THE HUDSON BAY MOUNTAIN MOLYBDENUM DEPOSIT

BY R. V. KIRKHAM

INTRODUCTION

The deposit, located 5 miles northwest of Smithers on the eastern side of Hudson Bay Mountain, was staked in 1956 by W. Yorke-Hardy and associates of Smithers and is presently being explored by Climax Molybdenum (B.C.) Ltd. This large but low grade deposit promises to be a major molybdenum producer in the future.

The writer has spent three summers studying the regional geology and mineral deposits of Hudson Bay Mountain. The work is not yet complete so this paper should be considered a progress report.

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REGIONAL GEOLOGY

The Hudson Bay Mountain area includes several ridges and peaks that form an isolated range about 200 square miles in extent. It is situated near the northern limit of the Interior Plateau and lies about 25 miles east of the main chain of the Coast Mountains. The 50 to 60 known mineral deposits of the area occur in the eastern half of the range.

The area is underlain mainly by volcanic and sedimentary strata of the Hazelton Group and sedimentary strata of the Bowser Group. Most of these rocks are probably Jurassic; however, the age of many of the volcanic sequences has not been established accurately. A few small bodies of granodiorite and quartz monzonite are exposed in the northern and western parts of the district and numerous porphyry dykes and some small plugs and stocks occur near the molybdenum deposit in Glacier Gulch. Greenstone, diabase, and diorite dykes and felsitic intrusions are abundant in most volcanic sequences.

Structural geology of the area is complex. Most of the major structural features are the result of doming and faulting with minor associated folding. Some rather indefinite thrust faults appear to be of major tectonic importance. However, the lack of internal features in some volcanic units, absence of good marker horizons, scarcity of fossils in the volcanic units, and presence of numerous alteration zones make a clear understanding of the regional structures difficult.

The main ore minerals of the district are pyrite, pyrrhotite, arsenopyrite, chalcopyrite, sphalerite, galena, magnetite, molybdenite, scheelite-powellite, tetrahedrite, and ruby silver minerals. Most of the known mineral deposits are relatively small, complex sulphide-sulphosalt veins rich in zinc and lead. These deposits are open-space filling and replacement bodies within sheeted and brecciated fracture zones and are crudely arranged in a zonal pattern about the centrally located stockwork molybdenite deposit. An inner Mo, Cu, W zone is surrounded successively by a barren quartz zone, a Zn, Au, Cu, As zone and a Pb, Ag, Zn, Cu, As zone. These deposits appear to be genetically related but the zonal pattern is complicated by the fact that there were several stages of mineralization. For example, it has been established that there were at least two main periods of molybdenum mineralization.

GEOLOGY OF THE MOLYBDENUM DEPOSIT

On surface the molybdenum mineralization occurs over an area of about 1 mile by 1 1/2 miles and in places it is known to extend to depths greater than 3,000 feet. Most of this area is underlain by a bedded, pyroclastic sequence of highly altered and metamorphosed Hazelton volcanic rocks of intermediate composition. Aphanitic felsitic volcanic intrusions have cut this pyroclastic sequence. A small part of the mineralized area is underlain by Upper Jurassic clastic sediments of the Bowser Group that unconformably overlie the volcanic strata.

A concealed discordant and differentiated granodiorite sheet up to 1,700 feet thick is present at depth within most of the mineralized area. Parts of this sheet have aplitic, porphyritic, and granophyric textures; while other parts have a fine grained granitic texture. Most of the sheet is highly altered and the original mafic minerals have been destroyed. Numerous basic dykes and irregular bodies have intruded both the granodiorite sheet and the volcanic rocks but do not cut the Bowser sediments; hence it is believed that the granodiorite is pre-Upper Jurassic.

Three porphyry bodies and numerous small quartz-feldspar porphyry and aplite dykes, tentatively dated as Tertiary, occur in the Glacier Gulch area. Two concealed bodies are thought to be small stocks and a partly exposed body, a small plug. The dykes, which have a modified radial pattern, both cut and are cut by molybdenite-bearing quartz veinlets, hence have been designated intra-mineral dykes.

One of the concealed bodies is a porphyritic granodiorite that probably has a suboutcrop under the glacier. Biotite from this body has been dated as 67 $\pm$ 5 m.y. (Paleocene) by the Geological Survey of Canada. At present there is nothing to suggest that this body is related to the mineralization. A K/Ar date obtained from hornblende in a molybdenite-bearing quartz vein is 40 $\pm$ 8 m.y. (Eocene).

The second concealed body is a quartz latite-quartz monzonite porphyry that underlies the ridge south of the toe of the glacier. The top of the stock occurs about 3,000-3,500 feet below the crest of the ridge. The upper contact of this stock Is marked by a chilled zone containing unusual fine "wormy" quartz veinlets, and an intensely silicified zone that extends into the overlying volcanic rocks and the granodiorite sheet, and a number of intra-mineral quartz porphyry dykes. It is believed that this intrusion is the source of the first stage of molybdenum mineralization.

The third body is a granodiorite porphyry partly exposed in a crevasse near the toe of the glacier. The shape and dimensions of this body are unknown but it is thought to be a small plug. Apparently it post-dates the surface molybdenite mineralization but is cut by numerous veinlets containing chalcopyrite.

The structural history of the mineralized area remains uncertain. However, the writer believes that the granodiorite sheet was intruded along a thrust plate. Subsequently the volcanic rocks above the granodiorite sheet were partially eroded and the continental-marine strata of the Bowser Group were deposited on these volcanic strata. Then, probably sometime in the lower Tertiary, a number of small porphyry intrusions were emplaced in the Glacier Gulch area. There appears to have been some faulting and the attitudes of the Bowser sediments show that there was a broad gentle doming associated with the intrusive activity. It is difficult to evaluate the importance of the doming on the structural evolution of the area as the volcanic units must have had an initial dip prior to the doming, and the doming at no locality was sufficiently intense to make the volcanic rocks on the top of the dome horizontal.

ROCK ALTERATION AND BLEACHING

Hydrothermal alteration and bleaching are common both inside and outside the area of molybdenum mineralization. Although no specific type of alteration can be directly related to molybdenum deposition as a whole, there is quartz, sericite, carbonate, and minor potash-feldspar alteration that seems vaguely related to areas of more intense mineralization. Quartz, sericite (and muscovite), carbonate, potash feldspar, biotite, chlorite, hornblende, epidote, garnet, magnetite (?), and pyrite (?) are widespread alteration minerals. In the vicinity of the molybdenum deposit, most of the hydrothermal alteration is superimposed on an area of thermal metamorphism.

Bleaching, a removal of mafic constituents (pigment material) without significant alteration of the remaining minerals, is extensive in the area. Many veinlets in the deposits have bleached halos (borders), some have alteration halos and others lack halos.

DETAILS OF VEINING

Molybdenite, the main ore mineral, occurs almost entirely in a stockwork of quartz veinlets with negligible dissemination in the wall rocks. Most of the veinlets are less than 1/2 inch wide averaging from 1/32 to 1/4 inch. The largest veins are 2 feet wide but these are very rare. The mineralogy, texture, structure, and chronology of the veins are very complex. Minerals found in the veins are quartz, hornblende, biotite, chlorite, potash feldspar, muscovite, gypsum, sphene, stilbite, magnetite, pyrite, molybdenite, pyrrhotite, chalcopyrite, scheelite-powellite, bismuthinite, tennantite, and arsenopyrite. Sphalerite and galena have been found in the deposit but they occur in quartz-carbonate veins that cut the quartz stockwork.

It has been reasonably well established that there have been at least two main periods of molybdenum mineralization. The veins belonging to these periods have been designated Type I and Type II (Table I). The first stage of molybdenum mineralization was preceded by the emplacement of a stockwork of barren quartz veinlets. These veinlets are concentrated in the contact region of the quartz latite-quartz monzonite stock where they have coalesced to form a rock that ranges from 80 to 99 per cent silica. Type I molybdenite veinlets seem to radiate outward from this area. The "wormy" quartz veinlets in the contact zone of the stock pre-date the barten quartz veinlets. The Type II veinlets form regular sets that dip moderately and gently to the southwest. They are concentrated in a zone 500 to 1,000 feet above the stock. Their source is unknown. The granodiorite sheet was a particularly favourable host for mineralization. Some of the best grade mineralization occurs in it where Type I and Type II veinlets intersect. However, lower zones composed primarily of Type I veinlets contain good grade material.

Molybdenite-bearing veinlets, some of which are very similar to Type I, cut Type II veinlets but at this time it is difficult to evaluate their importance. Also, it has been found from studies of veins on surface that contradictory age relationships between vein sets exist and that many veinlets are difficult to classify as either Type I or II.

The area of quartz veining is far more extensive than that of molybdenite mineralization. Possibly this could be used as a prospecting tool. The quartz veins on

Hudson Bay Mountain related to molybdenum deposit occur over an area of about 10-15 square miles. The attitude of the veins becomes more regular away from the central area. Most of the veins strike approximately north-south and dip moderately to steeply west.

ORE GENESIS

The importance of the presence of intra-mineral dykes cannot be over stressed. Existence of such dykes signifies that there was magmatic activity concomitant with mineralization. However, intrusive activity was very complex in the Glacier Gulch area and it is rather early to evaluate the relative importance of each pluton in the formation of the deposit. The writer believes that hydrothermal solutions, derived from one or more of the stocks of the area, followed permeable joints to the positions of ore deposition. These joints were probably formed during cooling following thermal metamorphism or possibly from relaxation of the magmatic forces that caused the doming. The fact that the granodiorite was the most favourable host could have been for chemical or structural reasons or purely fortuitous. In summary the evidence indicates that the molybdenum mineralization of Hudson Bay Mountain was a product of hydrothermal activity associated with the emplacement of porphyritic Tertiary intrusions.

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TABLE I.--FEATURES OF TYPE I AND TYPE II MOLYBDENUM MINERALIZATION

	Mineralogy	Texture and Structure
TYPE I (EARLY)	quartz, molybdenite, magnetite, pyrite, sericite, calcite, chlorite, biotite, hornblende, scheelite-powellite, pyrrhotite, chalcopyrite, sphene	- all minerals fine grained, sugary - many have well developed banded (ribbon) structure - many sets mainly steeply dipping
TYPE II (LATE)	quartz, molybdenite, pyrite, pyrrhotite, chalcopyrite, potash feldspar, muscovite, calcite, gypsum, chlorite, biotite, hornblende, scheelite-powellite	- all minerals coarse grained - drusy cavities are common - mainly in sets that dip gently to moderately westerly