The Geology of Glacier Gulch
A Porphyry Molybdenum - Tungsten Deposit

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INTRODUCTION

The Glacier Gulch porphyry molybdenum-tungsten deposit is located at depth on the east flank of Hudson Bay Mountain approximately 10 kilometres northwest of Smithers, British Columbia. Hudson Bay Mountain lies on the eastern margin of the Hazelton Mountains. Mineralization on surface is partly overlain by the retreating Kathlyn glacier, melt water from which forms twin waterfalls that plunge 60 metres to the Bulkley River Valley below.

To date, the property has been extensively tested by 164 diamond drill holes that include 23,500 metres of drilling from surface and 34,900 metres of drilling from underground, access for whicb is provided by the 1,066 metre (elevation) adit and two cross-cuts, the 15000E and 16100E, containing three kilometres of workings.

REGIONAL GEOLOGY

The Glacier Gulch deposit is situated within the Hazelton Belt, a sub-division of the Intermontane Tectonic Belt (Figure 1). The Hazelton Belt includes Lower and Middle Jurassic basaltic to rhyolitic volcanics and sediments of the Hazelton Group, which are cut by granitic intrusions. A few scattered outcrops suggest that Triassic and Late

Paleozoic rocks underlie the Jurassic. The belt is bisected by the Skeena Arch which separates Jurassic marine sedimentary basins, the Bowser to the north and the Nechako to the south (Figure 1). The Glacier Gulch deposit lies on the boundary between the Skeena Arch and the Bowser Basin. Hazelton Group rocks are locally unconformably overlain by younger rocks, including in the Smithers area the mainly marine sedimentary Lower Cretaceous Skeena Group (Figure 2).

Early Jurassic and Late Cretaceous to Tertiary plutons are scattered throughout the Hazelton Belt and include a calc-alkaline group called the Bulkley intrusions which range in composition from granodiorite to quartz monzonite. Some of these are associated with porphyry deposits that include Yorke-Hardy (Mo), Ox Lake (Cu, Mo), Huckleberry (Cu, Mo) and Bergette (Cu, Mo)(Figure 1).

The dominant structural style in the Hazelton Belt is broad open folding and block faulting of Cretaceous and Tertiary age having a dominant northwest trend. Rare thrust faults and related folds include one exposed on Hudson Bay Mountain.

LOCAL GEOLOGY

Rock Types

At surface, Hudson Bay Mountain consists of the Early Cretaceous Skeena Group and the underlying Early to Middle Jurassic Hazelton Group which are both crosscut by a subradial Late Cretaceous to Tertiary quartz-felspar porphyry dyke swarm (Figure 2). At depth, a series of intrusive rocks (Figure 3) have been located and are listed in order of intrusion: 1) the granodiorite sheet, 2) lamprophyre sills and dykes, 3) a Late Cretaceous to Tertiary (?) rhyolite plug and 4) the Late Cretaceous to Tertiary Hudson Bay Mountain stock and associated quartz-felspar porphyry dykes which include those exposed on surface.

The Skeena Group has a minimum thickness of 300 metres and consists of well-bedded interlayered conglomerate, greywacke, sandstone, siltstone and shale and includes lenticular Albain coal horizons. The Hazelton Group has a minimum thickness of 2000 metres and comprises a sequence of poorly layered intermediate flows and pyroclastics with felsic hypabyssal intrusions and minor sedimentary rocks including limestone, mudstone and chert. Both groups have been affected by low grade regional metamorphism and on surface a biotite-hornblende hornfels aureole can be traced over a 4 by 7 kilometre area (Figure 2).

The granodiorite sheet has been defined by drilling over a strike length of almost 1,200 metres along dip for 1,400 metres and through a maximum vertical extent of 550 metres (Figure 3). The sheet is divided texturally, from upper to lower, into aplitic granodiorite, porphyritic granodiorite and granodiorite. It contains stoped blocks of Hazelton volcanic rocks that form zones traceable for hundreds of metres (Figure 3). The aplitic granodiorite, which forms the upper northeast edge of the sheet, is light coloured with saccharoidal texture containing local areas of granophyric texture. An average modal composition for the aplitic granodiortie is 36 percent quartz, 17 percent K-felspar, 47 percent plagioclase (An 10-18) and no mafic minerals. The porphyritic granodiorite forms the northeastern upper and central portion of the sheet. It is pale green or grey and characterized by 20 percent ragged plagioclase phenocrysts and five percent quartz "eyes" in an aphanitic groundmass. An average composition for the porphyritic granodiorite is 35 percent quartz, 13 percent K-felspar, 50 percent plagioclase (An 28-33) and two percent mafic minerals. The granodiorite is the most common textural type and occupies the lower part of the sheet. It is mottled green or grey with granitic texture consisting of 30 percent quartz, 10 percent K-felspar, 55 percent plagioclase (An 32-34) and five percent mafic minerals.

Lamprophyre sills and dykes are common and crosscut the Hazelton Group and the granodiorite sheet. They vary in thickness from one centimetre up to 12 metres and where exposed in underground workings dip gently east and are mineralized. They are composed of 40 percent plagioclase and 60 percent hornblende altered in part to chlorite and range in texture from equigranular to ophitic.

The rhyolite plug has been intersected by 12 drill holes. It intrudes the granodiorite sheet and Hazelton Group rocks and astride its upper contact are quartz stockworks and a high silica zone (Figure 3). The plug is oval in plan, 300 by 450 metres, with steep walls and a relatively flat top near 900 metres elevation. It has well defined chill and crenulated quartz band zones and it characteristically a porphyry with 20 percent quartz and felspar phenocrysts set in an aphanitic to fine grained groundmass. It consists of 25 percent quartz, 37 percent K-felspar, 37 percent plagioclase (An 2-5) and one percent biotite.

The Hudson Bay Mountain Stock truncates the rhyolite plug and intrudes the Hazelton Group. K-Ar age dates on the stock range from 67 to 73 my. Although the stock has been intersected by only four drill holes, it is interpreted to be a large pluton, to have produced both the hornfels aureole and the concentric, radial and domal fractures and to be the parent magma of the quartz-felspar porphyry dyke swarm. The Hudson Bay Mountain Stock is composite varying from a pink and grey porphyritic quartz monzonite to an equigranular granodiorite. Phenocrysts include quartz, strongly zoned plagioclase with albitic rims, perthitic K-felspar, biotite and hornblende. An average composition is 33 percent quartz, 22 percent K-felspar, 39 percent plagioclase (An 12-32) and six percent mafic minerals.

Structure

Hudson Bay Mountain is intersected by three major faults (Figure 2). These include the following: 1) the northwest trending, steeply east dripping normal Glacier Gulch Fault which crops out beneath the 1,066 metre adit portal and locally forms the contact between Skeena and Hazelton rocks, 2) the north trending, gently east dipping Hudson Bay Mountain thrust fault on the west slope of the mountain where a Lower Jurassic sequence is thrust over Middle Jurassic rocks and 3) an east trending, steeply south dipping shear zone that crosscuts the south cirque.

Within the area of drilling major fault dislocations do not occur. Surface and underground mapping indicate fractures, joints and veins have three dominant trends - concentric, radial and domal - and are attributed to doming by Tertiary intrusion and uplift.

Rocks of the Hazelton and Skeena Groups on Hudson Bay Mountain have been moderately tilted and domed. Hazelton Group rocks strike east and dip north with progressively steeper dips northwards. Skeena Group rocks have a concentric strike and dip away from the mountain. Folding is locally associated with the major faults.

Alteration

Alteration at Yorke-Hardy includes thermal metamorphism which has resulted in the development of an extensive hornfels aureole together with veins and clots of andradite garnet and epidote affecting the Skeena and Hazelton Groups and the granodiorite sheet. The hornfels aureole extends from the contact with the Hudson Bay Mountain Stock (Figue 3) upward to surface where it is recognized over a 4 by 7 kilometre area (Figure 2). Within the aplitic granodiorite, garnet clot development is locally impressive and is called appaloosa texture. Hydrothermal alteration is fracture and vein contrelled and overprints metamorphic assemblages. It includes the following:

a) Bleaching, particularly of Hazelton Group rocks, has leached up to 90 percent of the iron, magnesium and manganese content above and peripheral to the main area of molybdenite mineralization.

b) A chlorite-magnetite-amphibole-biotite assemblage developed in stockwork fractures and in clots is notable within the Hazelton Group rocks and the granodiorite sheet and also appears to be above and peripheral to the main area of molybdenite mineralization.

c) Phyllic alteration associated with molybdenite veins is best developed within the granodiortie sheet and is observed in and above the 16100E and 15000E crosscuts.

d) Potassic alteration associated with molybdenite veins is observed in the granodiorite sheet in and above the 15000E crosscut.

e) Formation of both crosscutting quartz stockworks and a high silica zone occurs within and above the rhyolite plug (Figure 3).

Mineralization

The property is characterized by mineralogical zoning recognized both on and below surface. A molybdenite and scheelite vein zone crops out over three kilometres horizontally and has been located in drilling to a depth of 2,135 metres below surface. This is interior to a quartz vein zone which in turn is enveloped by a pyrite and base metal vein zone that extends out to over a eight kilometre radius (Figure 2).

The lower portion of the granodiorite sheet is host for a high grade molybdenite zone defined to date above the 15000E crosscut. Thus, the granodiorite may be an important lithologic control on mineralization. Molybdenite occurs in three modes, as follows:

1) as early fine-grained hairline stockwork veins,

2) as cross-cutting fine-grained banded quartz-molybenite veins commonly up to a metre in thickness which occur throughout the deposit and form shallowly arching sets above the 15000E cross-cut and,

3) as cross-cutting coarse-grained quartz-molybdenite veins that contain spectacular molybdenite crystals up to five cms in diameter and provide extremely high assays.

Vein types 1) and 3) are associated with potassic alteration and vein type 2) is associated with phyllic alteration. Banded fine-grained quartz-molybdenite veins and coarse-grained quartz-molybdenite veins equally contribute to the high grade zone above the 15000E crosscut while stockwork veins provide relatively uniform background values up to 0.1 percent MoS_2.

Scheelite occurs in quartz ± magnetite ± K-felspar veins formed prior to coarse-grained quartz-molybdenite veins. Late stage vein minerals include pyrite, chalcopyrite, sphalerite and carbonate. The source of mineralizing fluids is presumed to be the Hudson Bay Mountain Stock due to its proximity to mineralization.

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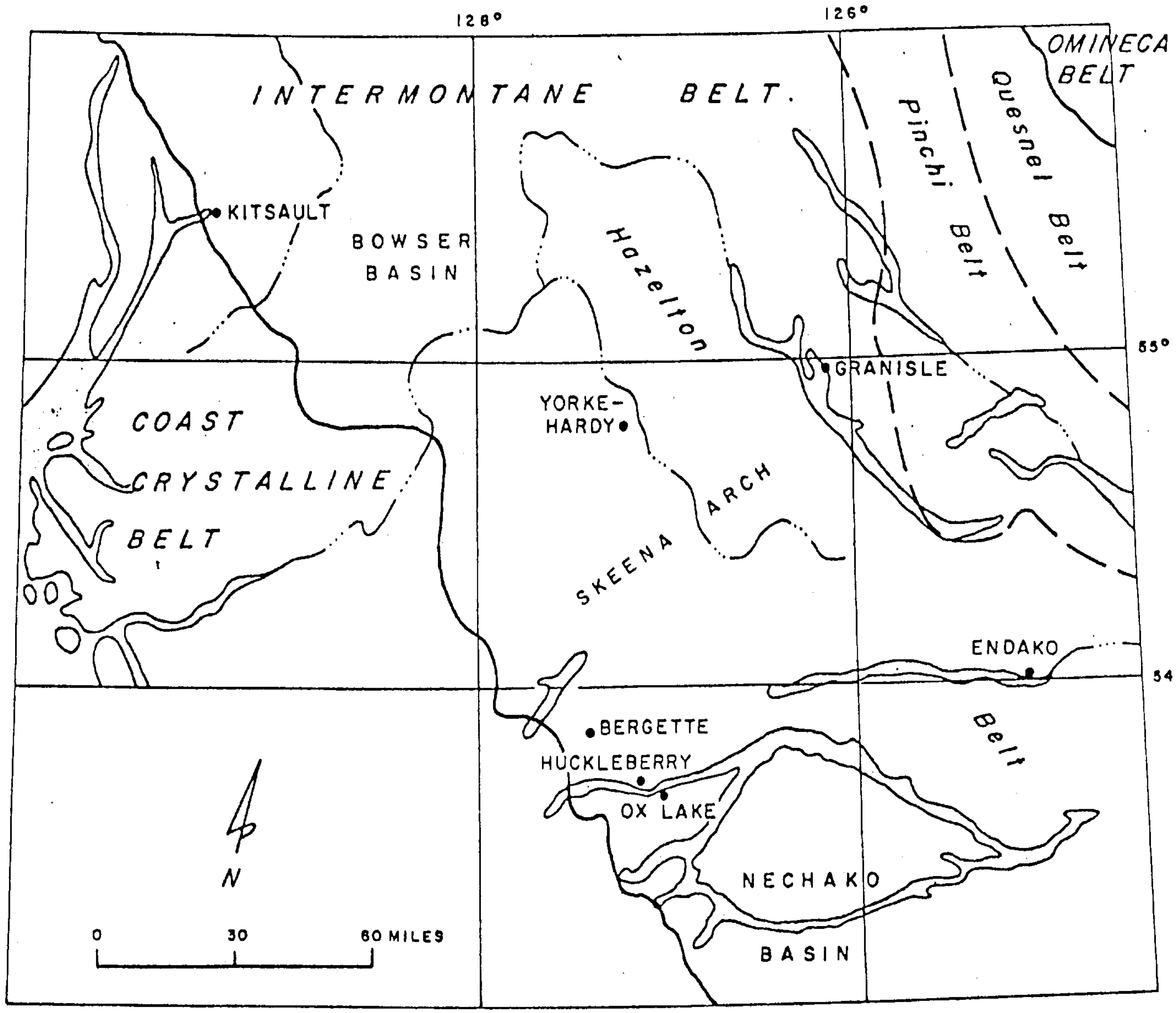

FIGURE 1. GENERALIZED TECTONIC MAP OF WEST-CENTRAL BRITISH COLUMBIA

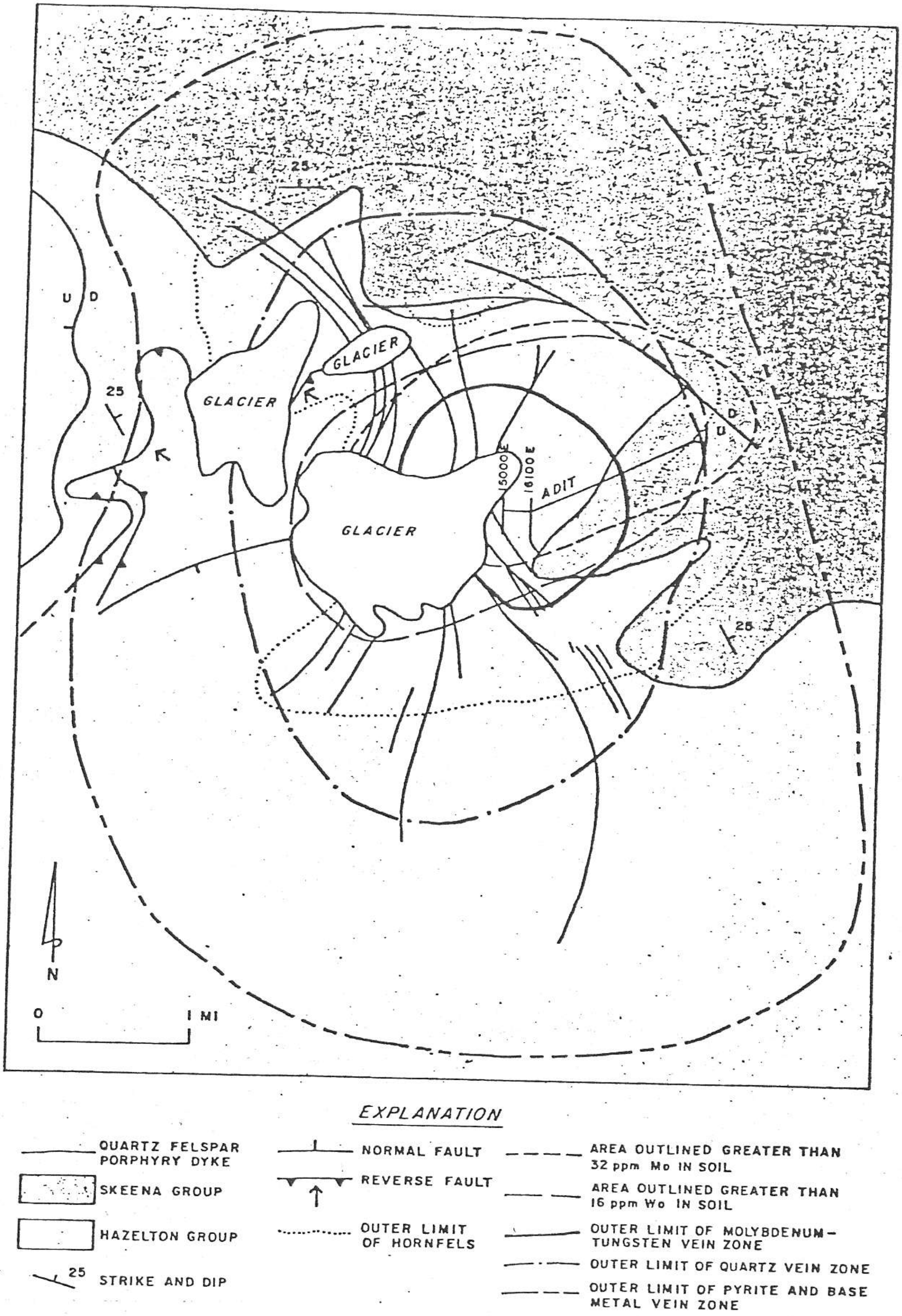

FIGURE 2. YORKE-HARDY GENERALISED SURFACE GEOLOGY.

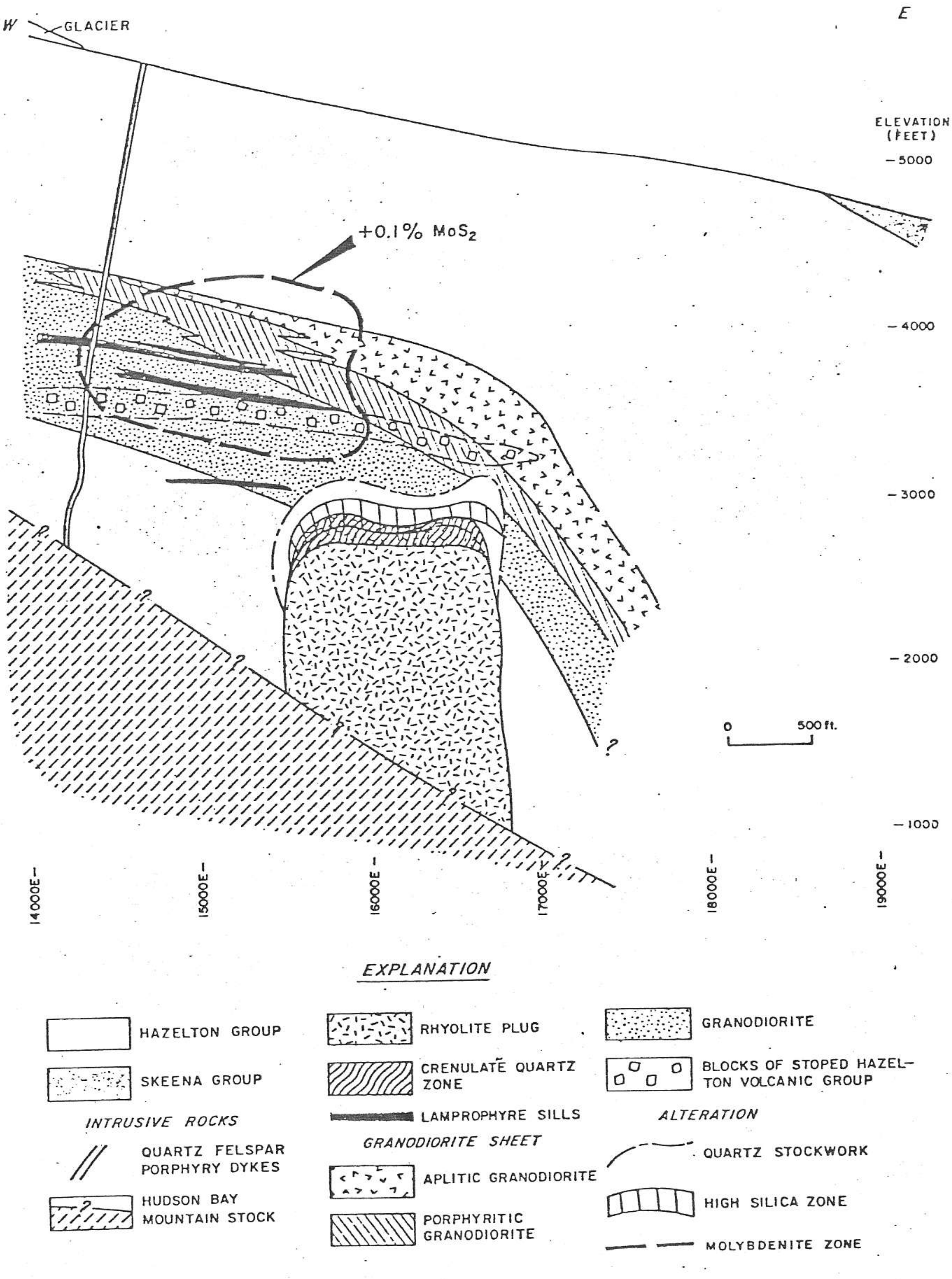

FIGURE 3. YORKE-HARDY GENERALIZED GEOLOGICAL CROSS SECTION (SOUTH OF ADIT)