lesser amounts of epidote, hedenbergite-diopside, and actinolite with minor calcite, magnetite, and pyrite. The outer altered zone varies markedly with the nature of the original rock but commonly has patches of calc-silicate minerals and sulphides in the host rock. The igneous rocks normally are intensely chloritized and the limestone coarsely recrystallized. In general the skarn envelope is three or four times the volume of the orebody. The altered zone passes gradationally outward to fresh rock and is several times larger than the skarn zone.

Conclusions

Conclusive evidence of metamsomatic replacement of basalt, limestone, and plutonic rocks by skarn and ore includes the following:

(1) Kernels of less altered rocks in skarn and ore.

(2) Textures of skarn and ore that are mimetic of the host.

(3) Projection of the contacts of basalt, limestone, and pluton from areas of unaltered and altered zones into the skarn and ore zones.

(4) Differing character of skarn and ore where replacing different hosts. In general skarns replacing limestone are garnet-rich, those replacing volcanic rocks epidote-rich, and ore replacing limestone commonly is sulphide-rich.

The orebodies are arranged around the pluton with conduits, breccia zones or faults, apparently leading in toward it. Those of the west at least form an upwardly branching system that generally follows the contact zone and in its lower part seems spatially related to a pipe-like breccia. Where the conduit system, pipes or flat faults, reach the limestone the main ore and skarn bodies blossom out.

Day 3

ISLAND COPPER: By K. E. Northcote.

LOCATION: Lat. 50° 36′ — Long. 127° 28.5′ — At the northwestern end of Rupert Inlet, 13 km south of Port Hardy on northern Vancouver Island.

OWNERSHIP: Utah Construction & Mining Co.

The Island Copper porphyry deposit was discovered in 1965 as a result of routine prospecting followed by a geochemical survey, the latter having delineated the central portion of the orebody. Subsequent geological and geophysical surveys followed by drilling defined a mineable orebody which is scheduled for initial production in late 1971, and to reach full capacity early in 1972. The company has reported reserves of approximately 280 million tons of 0.52 per cent copper and 0.029 per cent molybdenite.

Regional Setting

The deposit occurs in and adjacent to a small porphyry intrusion found in the upper part of a very thick Mesozoic volcanic and sedimentary succession, the Vancouver Group.

The lower part of this succession, the Triassic Karmutsen Formation, consists of 3,300 to 6,700 metres of oceanic basaltic pillow lavas, breccias, massive flows and interbedded tuffs (see Muller, 1970a, p. 44). These volcanic rocks are overlain by 100 to 820 metres of Upper Triassic limestone (Quatsino Formation) and 165 to 490 metres of Upper Triassic to Lower Jurassic calcareous, argillaceous, and arenaceous sediments (Parsons Bay Formation) (Muller, 1970a, pp. 44 and 47; 1970 b, pp. 11-18; personal communication). During the Early Jurassic there was renewed, partly explosive, volcanic activity from numerous volcanic centres forming an island arc. This activity resulted in deposition of at least 2,600 metres of largely pyroclastic deposits and interbedded lava flows of andesitic and basaltic composition (Bonanza Subgroup) (*see* Muller, 1970a, p. 47). Some intervolcanic basins received deposits of limestone and waterlain arenaceous to argillaceous volcanic debris. The Upper Bonanza basalt and andesite flows are accompanied by some that are rhyodacite which are believed to be co-magmatic with the more felsic of the mid-Jurassic intrusive stocks.

A belt of these mid- (to late?-) Jurassic stocks ranging in composition from diorite to granite extends from the east end of Rupert Inlet, just east of the Island Copper deposit, 65 km northwesterly to the north end of the island. Most of the significant known mineral deposits in the area are associated with this belt of intrusive rocks.

Lower Cretaceous conglomerates, sandstones, siltstones, and shales were unconformably deposited in basins upon intrusive and Vancouver Group rocks.

The structural environment is one of regional block faulting. Major northwesterly trending fault zones break the volcanic and sedimentary succession into a series of moder-

ately southwesterly dipping structural plates which result in both repetition and loss of section. A second fault system trending northeasterly breaks the structural plates into segments.

Local Geology

Island Copper deposit lies near the east end of a belt of granitic intrusive stocks which extends from the east end of Rupert Inlet 65 km northwesterly to the north coast of Vancouver Island. The orebody is a porphyry copper deposit in which most of the mineralization occurs within brecciated, metasomatically altered rocks of the Bonanza pyroclastic sequence. Copper and molybdenum mineralization occurs as disseminations and in quartz and fracture stockworks. The mineral deposit and altered zone envelop a locally intensely brecciated, altered, elongate digitated quartz (feldspar) porphyry dyke and siliceous differentiates (see Fig. 8). The quartz (feldspar) porphyry dips fairly steeply northward and cuts the moderately southerly dipping Bonanza rocks at a high angle.

Stratigraphy

The Island Copper deposit occurs within the lower part of the pyroclastic Lower Jurassic Bonanza volcanic sequence. Where bedding attitudes are visible, northwesterly strikes and gentle to moderate southwesterly dips prevail. Drill holes on the north side of the deposit show thin-bedded, siliceous tuffs. The siliceous tuff is interbedded with and overlain by more massive tuff, lapilli tuff, and tuff breccia of andesitic and basaltic composition. Few lava flows are recognized in this part of the section. Andesitic and basaltic rocks not of a pyroclastic nature observed in core may be sills and dykes rather than flows. Shades of green-grey, green, and mottled multi-colours of purplish red, purplish grey with green, and green-grey are prevalent in the pyroclastic rocks. Outside the zone of alteration the rocks are weakly chloritic, have widely disseminated pyrite grains, and contain fracture fillings of zeolites (laumonite), carbonate, and lesser amounts of quartz and epidote.

The elongate quartz (feldspar) porphyry dyke trends northwesterly across the property and appears to have originated from one or more larger porphyry bodies at shallow depth (*see* Fig. 9). Large, rounded, resorbed quartz phenocrysts, characteristic of this porphyry, and large clots of fine-grained sericite and/or pyrophyllite are set in a very

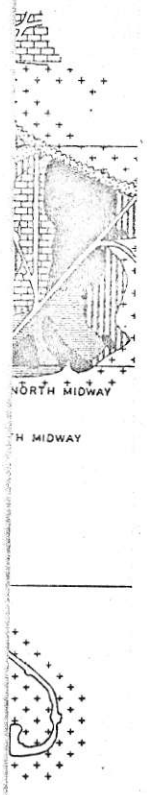


Figure 8

GEOLOGICAL MAP OF ISLAND COPPER DEPOSIT

BASE MAP PROVIDED BY ISLAND COPPER

0 400 800 1200 FEET
0 100 200 300 400 METERS

TOPOGRAPHIC LINEAMENTS
25 BEDDING
GRADATIONAL CONTACTS

EAST MAIN LAKE
EAST MAIN LAKE
N
BRECCIATION ZONE
BRECCIATION ZONE
BRECCIATION ZONE

LOWER CRETACEOUS SEDIMENTARY CONGLOMERATES AND SANDSTONES
QUARTZ(FELDSPAR) PORPHYRY DYKE COMPLEX (GENERALIZED)
BONANZA SUBGROUP: TUFF, LAPILLI TUFF, TUFF BRECCIA, MINOR CARBONATE, EPIDOTE, CHLORITE, PYRITE, LAUMONTITE
ENVELOPE OF ALTERATION IN BONANZA: CARBONATE, EPIDOTE, CHLORITE, PYRITE, LAUMONTITE, SERICITE, SILICA VEINS AND PERVASIVE QUARTZ; PYROPHYLLITE, MAGNETITE
PYROPHYLLITE, DUMORTIERITE ALTERATION IN QUARTZ FELDSPAR PORPHYRY AND BONANZA (?)

APPROXIMATE OUTLINE OF OREBODY AT SURFACE
ULTIMATE PIT OUTLINE

RUPERT INLET

BY K.E. NORTHCOTE, 1970

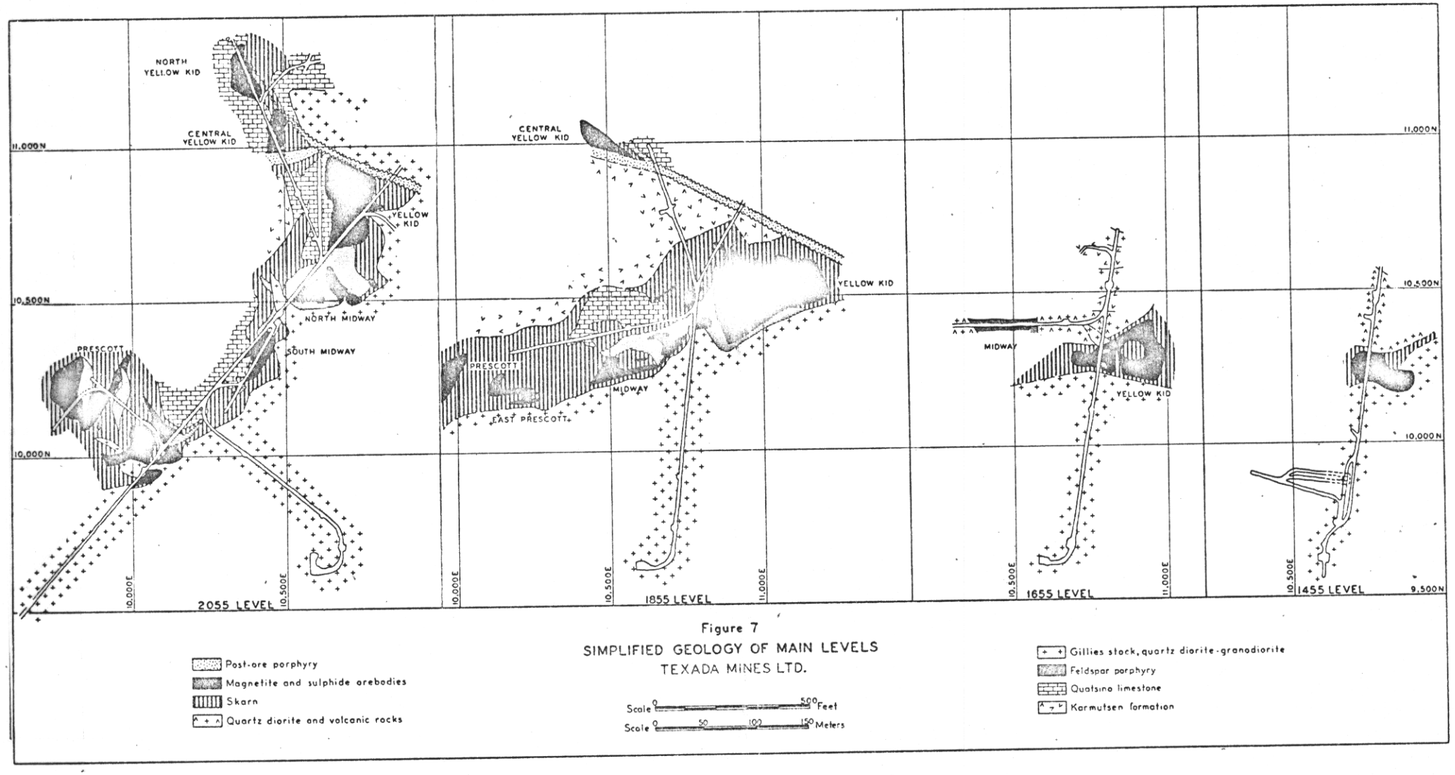


Figure 7

SIMPLIFIED GEOLOGY OF MAIN LEVELS
TEXADA MINES LTD.

inches
0 1
0 1 2
centimetres

This reference scale bar has been added to the original image. It will scale at the same rate as the image, therefore it can be used as a reference for the original size.

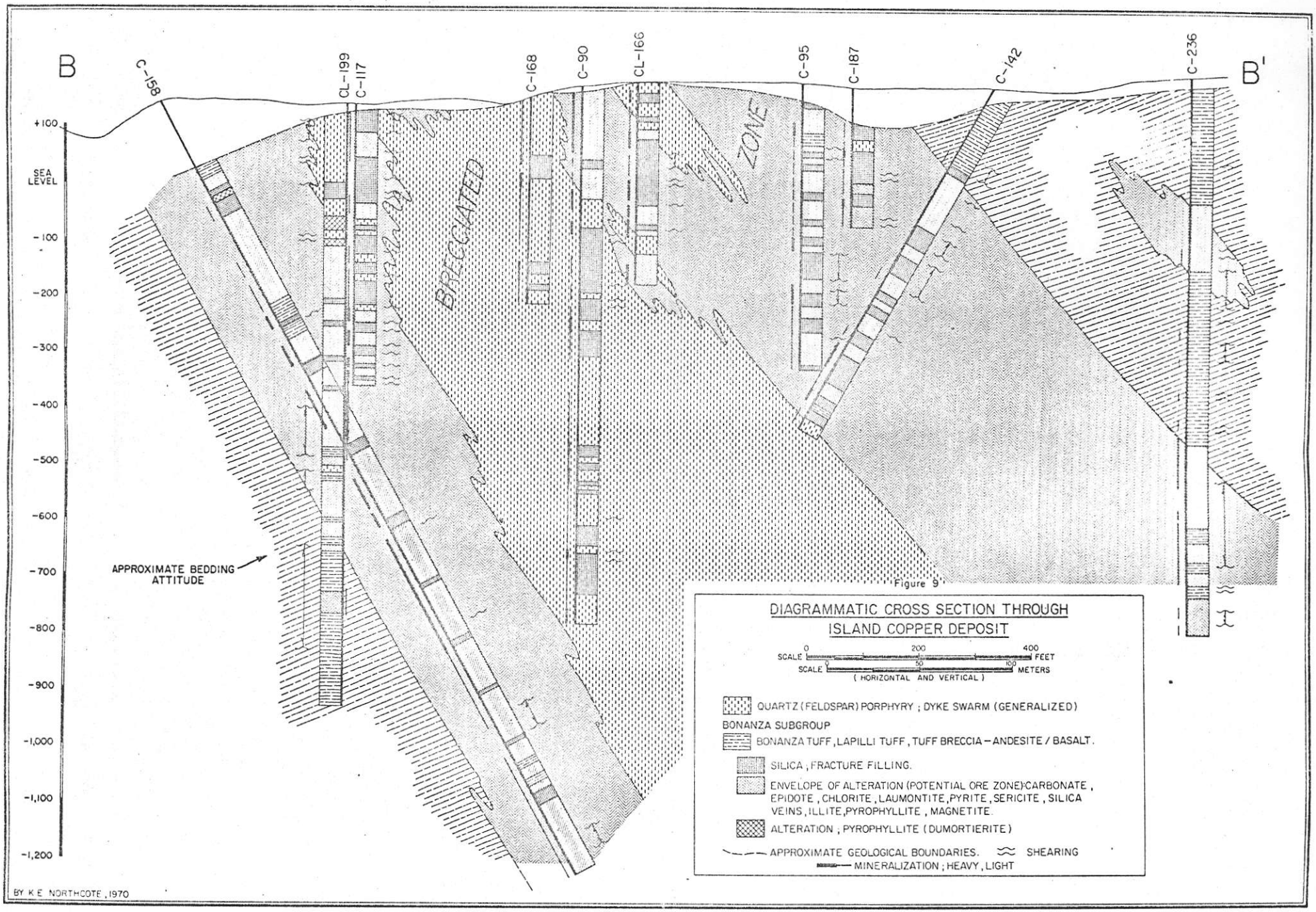

B
B'
C-158
CL-199
C-117
C-168
C-90
CL-166
C-95
C-187
C-142
C-236
BRECCIATED
ZONE
+100
SEA LEVEL
-100
-200
-300
-400
-500
-600
-700
-800
-900
-1,000
-1,100
-1,200
APPROXIMATE BEDDING ATTITUDE
DIAGRAMMATIC CROSS SECTION THROUGH ISLAND COPPER DEPOSIT
SCALE 0 200 400 FEET
SCALE 0 50 100 METERS
(HORIZONTAL AND VERTICAL)
QUARTZ (FELDSPAR) PORPHYRY ; DYKE SWARM (GENERALIZED)
BONANZA SUBGROUP
BONANZA TUFF, LAPILLI TUFF, TUFF BRECCIA – ANDESITE / BASALT.
SILICA, FRACTURE FILLING.
ENVELOPE OF ALTERATION (POTENTIAL ORE ZONE): CARBONATE, EPIDOTE, CHLORITE, LAUMONTITE, PYRITE, SERICITE, SILICA VEINS, ILLITE, PYROPHYLLITE, MAGNETITE.
ALTERATION, PYROPHYLLITE (DUMORTIERITE)
APPROXIMATE GEOLOGICAL BOUNDARIES.
SHEARING
MINERALIZATION ; HEAVY, LIGHT
BY K.E. NORTHCOTE, 1970

Figure 9

fine-grained, siliceous matrix. The fine-grained siliceous matrix also contains flecks of sericite or pyrophyllite and carbonate. Where the porphyry has been brecciated, veined by quartz, and silicified, it is commonly mineralized by pyrite and chalcopyrite. A brecciated zone of intense hydrothermal alteration characterized by abundant dumortierite and pyrophyllite occurs along the quartz (feldspar) porphyry trend at the northwest side of the deposit. This intensely altered zone is in part quartz (feldspar) porphyry.

Structure

Bedding, where visible in Bonanza rocks, strikes northwesterly and has low to moderate southwesterly dips. The quartz (feldspar) porphyry was apparently emplaced along a steep to moderate northerly dipping shear zone which cuts the bedding at a high angle (*see* Fig. 9). Late shear zones, evident in core and in present exposures, trend north 70° west or north 50° east (*see* Young and Rugg, 1971) and contain gouge and argillic (illite) alteration.

An extremely complicated and incompletely solved history of fracturing and brecciation is evident in core and rock exposures overlying and flanking the quartz (feldspar) porphyry complex. Fragments of quartz (feldspar) porphyry, bedded and massive tuff, tuff breccia, etc., form a breccia with a siliceous, sericitic matrix that is cut by at least two generations of quartz veins. This breccia appears to have been locally rebrecciated, healed by dumortierite, brecciated, healed by pyrophyllite, and brecciated again. Some of the fracturing and brecciation is undoubtedly the result of shearing and movement in fault zones. However proximity to quartz (feldspar) porphyries, large variety of rock fragments in the breccia (including quartz (feldspar) porphyry), and the locally low fragment to matrix ratio suggest explosive brecciation during the following emplacement and crystallization of quartz (feldspar) porphyry. Some siliceous differentiates of the porphyry permeated the brecciated rocks and altered and mineralized them. Other siliceous veins are unmineralized.

Alteration

There is an apparent zoning of the types of alteration inward towards the core of the alteration envelope, but the pattern is obscured by more intense or different kinds of alteration in localized zones, presumably following shear zones. However, the outer margins of the altered zone generally show an increase in amount of pervasive carbonate,

sericite, and pyrite. Clots of epidote are conspicuous on some weathered surfaces. Carbonate and zeolite veins become more numerous and some quartz veins occur. Progressing inwards the number of quartz veins increase, and chloritization and sericitization, occurring in clots, is more intense. Silicification becomes more pervasive near the quartz (feldspar) porphyry swarm. In additon Young and Rugg (1971) report hydrothermal orthoclase. Dumortierite and pyrophyllite occur in a zone of intense alteration on the northwest side of the ore zone as presently outlined. Argillic alteration (illite) seems most abundant in fractures and shear zones where it is probably the result of weathering processes.

Mineralization

Copper mineralization occurs as very fine-grained disseminated chalcopyrite in siliceous veinlets, and in brecciated, altered Bonanza rocks and quartz (feldspar) porphyry. Chalcopyrite is commonly associated with fine-grained magnetite. In addition, Young and Rugg report bornite (see Young and Rugg, 1971). Molybdenite occurs in siliceous zones as coatings in fractures. Hematite is common and pyrrhotite less common in the altered zone.

Suggested ore controls are:

(1) Early vertical to steep north dipping fracture or shear zone across bedding of Bonanza.

(2) Explosive brecciation accompanying emplacement and crystallization of quartz (feldspar) porphyry.

(3) Mineralization by differentiates of quartz (feldspar) porphyry.

Port Hardy to Smithers

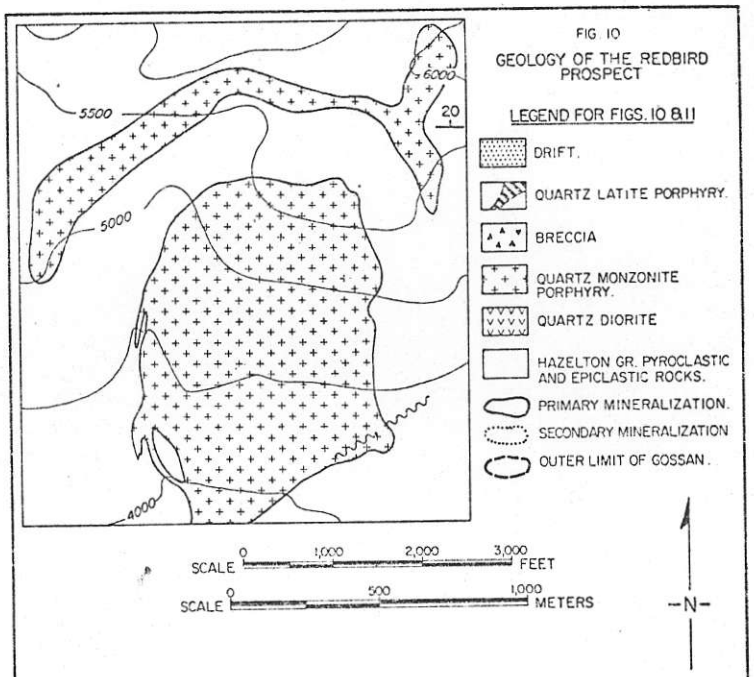
En route by air from Port Hardy to Smithers we hope to view several porphyry deposits of simple or elaborate type in which the topography and colour anomalies reflect the cylindrical form of the small mineralized plutons.

RED BIRD PROSPECT: By A. Sutherland Brown.

LOCATION: Lat. 53° 18′ — Long. 127° 00′ — 3 km east of the Coast Crystalline Belt and 165 km south of Smithers.

OWNERSHIP: Ashfork Mines Ltd. (a subsidiary of Phelps Dodge Corporation of Canada, Limited).

The Red Bird prospect is a simple porphyry molybdenum deposit centred on a cylindrical pluton about 1,000 metres



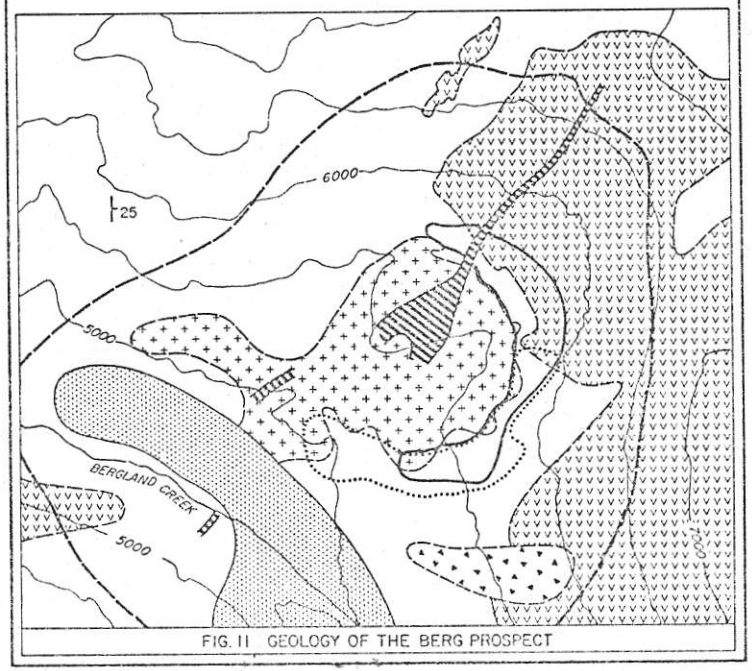


FIG. 11 GEOLOGY OF THE BERG PROSPECT

Figs. 10 and 11.

in diameter with a semicircular ring-dyke about the northern circumference (*see* Fig. 10). The pluton consists largely of a single phase, a leucocratic quartz monzonite that has an apparent age of 50 ± 2 million years. This pluton intrudes the Middle Jurassic Hazelton Group consisting locally of dark-coloured pyroclastic rocks, that are only gently folded.

Alteration and mineralization are arranged concentrically to the pluton. Pyroclastic rocks surrounding the pluton are pyritized and weathered in a prominent annular gossan about 3 km in maximum diameter. A smaller exterior annulus is converted to hornfels characterized by very fine new biotite. The core of the pluton has a moderate potassic alteration with about half the original plagioclase phenocrysts converted to potash feldspar. An annulus that overlaps the contact but is principally within the pluton has an intense stockwork of quartz veinlets with accompanying, moderately intense, pervasive silicification.

Molybdenite is widely distributed in trace amounts in the pluton but mineralization approaches ore-grade only in an annulus whose outer margin is roughly coincident with the contact. The maximum grade occurs about 20 metres within the pluton. Beyond the contact molybdenum mineralization falls off sharply but pyrite with minor chalcopyrite continues in the quartz stockwork. Still further out the quartz-filled stockwork grades to dry pyrite-coated fractures.

BERG PROSPECT: By C. S. Ney.

LOCATION: Lat. 53° 48′ — Long. 127° 25.5′ — Twelve km east of the Coast Crystalline Belt and 115 km south of Smithers.

OWNERSHIP: Kennecott Copper Corporation.

The Berg is a somewhat elaborate porphyry with a central cylindrical pluton 800 metres in diameter of quartz monzonite porphyry which is dated at 50 ± 2 million years. The pluton intrudes a homclinally east-dipping sequence of greywacke, tuff, and andesite breccias correlated with the Middle Juraissic Hazelton Group (*see* Fig. 11). Part of the country rock on the east is an irregular quartz diorite stock that preceded the porphyry pluton by a few million years. Dykes and masses of quartz latite porphyry succeeded the central porphyry by a few million years. One such dyke outcrops as a conspicuous spine trending at 040° outside the central stock on the northeast, and less regular masses are

developed within. The porphyry pluton is surrounded by an anular gossan 2 km in diameter.

Alteration and primary mineralization are closely associated in annular zones eccentrically disposed around the central pluton. Potash feldspar, topaz, biotite, and silica are developed in hornfels within 50 to 250 metres of the pluton, and the best primary mineralization is in this zone. Outward the alteration becomes chloritic and barren pyrite predominates as the valuable sulphides decrease. The outer limit of visible gossan, 300 to 600 metres from the stock, marks a decline in pyrite content of about 2 per cent, coincident with little alteration other than epidote. Random fractures spaced at 1 to 3 cm characterize the mineralized zone, and superimposed on this is a reticulate network of low-dipping gypsum veinlets.

Molybdenum and copper are zoned in an irregular annulus centred on the pluton which is weakly mineralized in both metals. Molybdenum attains maximum value immediately adjacent to the stock and falls off slowly outward. Copper increases outward, reaching peak values 100 to 200 metres out, more or less at the chlorite-biotite line.

Although glaciers are still present nearby, the Berg basin escaped severe Wisconsin glacial erosion, so that supergene leaching extends down to more than 100 metres from the surface. This leaching was facilitated by the network of soluble gypsum veinlets. Chalcocite has developed as a weak irreguiar blanket particularly in the low valley slopes southeast of the stock where primary copper grade is enhanced by a factor of one-third.

END

Day 4

GRANISLE: By N. C. Carter.

LOCATION: Lat. 54° 56.5′ — Long. 126° 00′ — The mine is situated on McDonald Island near the north end of Babine Lake, 65 km northeast of Smithers.

OWNERSHIP: Granisle Copper Ltd. (controlled by The Granby Mining Company Limited).

McDonald Island was first prospected in the early 1900's when several workings were developed on veins in what is now the Granisle mine. In 1929 Cominco drilled five holes that indicated 8 million tons grading 0.8 per cent copper with minor gold and silver. The property was then dormant