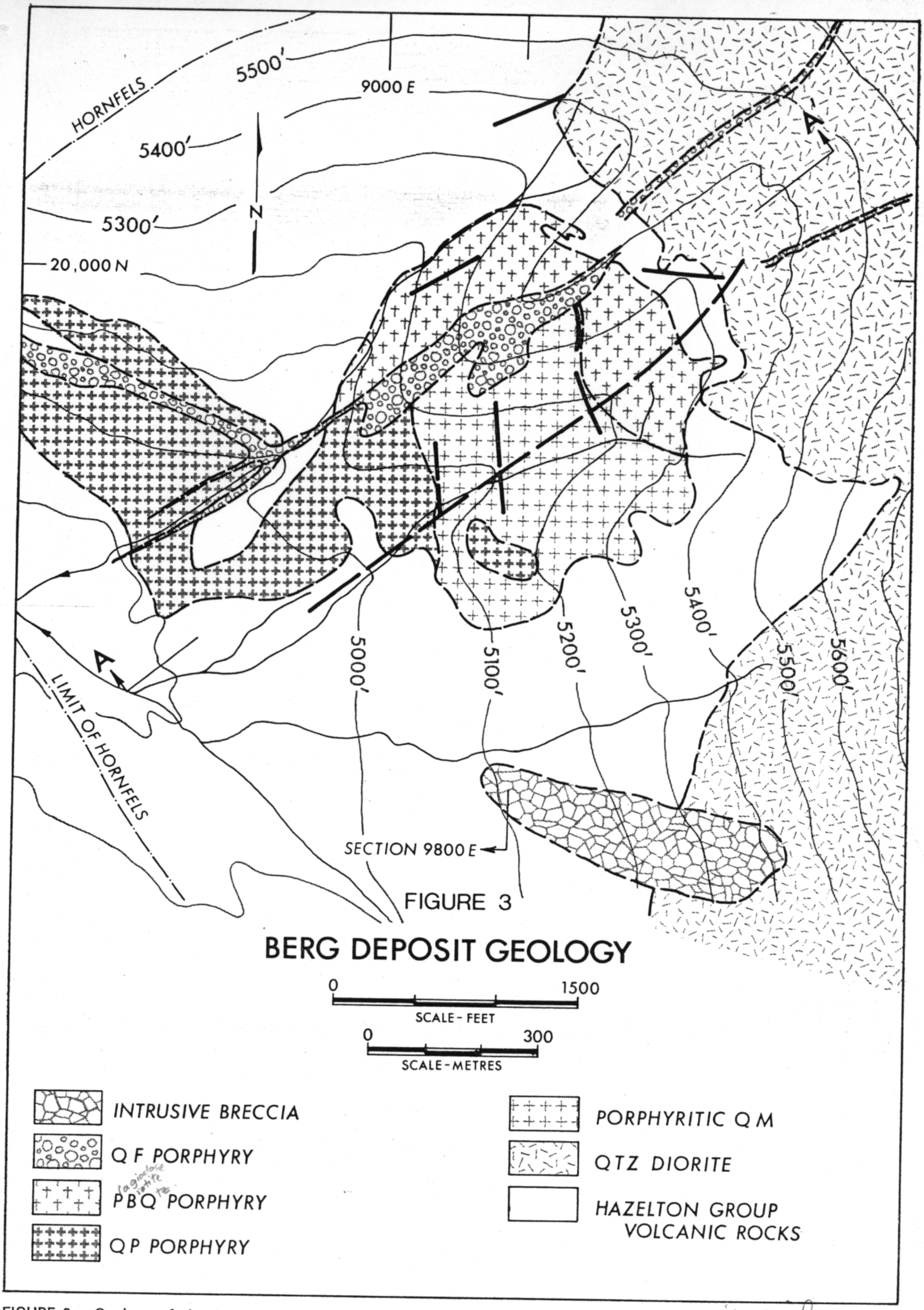

FIGURE 3

BERG DEPOSIT GEOLOGY

FIGURE 3 — Geology of the Berg Deposit.

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## Mineralization

### PRIMARY MINERALIZATION

A quartz-sulphide stockwork centered on the porphyritic quartz monzonite and plagioclase-biotite-quartz porphyry phases of the Berg stock has been outlined by diamond drill holes. The stockwork is imposed on all phases except the quartz-feldspar porphyry and basalt dykes. The intensity of stockwork development varies in such a way that the area most densely veined forms an annular ring around the composite stock. Within this zone, the following vein sequence, from oldest to youngest, has been observed.

**Stage 1** — A. Quartz-pyrite-chalcopyrite-molybdenite-chlorite veins with envelopes of quartz-sericite (common) or of chlorite (less common) or of K-feldspar (rare).
QPpy w/ envelopes
B. Quartz-pyrite-chalcopyrite-molybdenite-chlorite veins without envelopes.
QPpy w/o envelopes

(The above associations may be modified by various combinations of the vein minerals and may include magnetite, purple anhydrite, traces of bornite, epidote, carbonate and clay minerals.)

**Stage 2** — A. Quartz-molybdenite (or molybdenite alone) veins without envelopes.
QM
B. Quartz-pyrite veins.
QP

**Stage 3** — Quartz-calcite-pyrite-sphalerite-chalcopyrite-tetrahedrite-gypsum-epidote±galena.
QC

**Stage 4** — Gypsum-filled fractures.
Gyps.

Cross-cutting relationships of Stage 1 veins allow at least 5 vein stages to be recognized. However, the similar mineralogy of the various stages and the complex, often contradictory, relationships observed suggest that veins of Stage 1A and B have filled a previously crackled zone rather than generated a sequential-stage stockwork system. Stage 1 quartz-pyrite veins are the most common type, although quartz-pyrite veins younger than Stage 1 veins might be present. Stage 2 veins cross-cut all earlier veins. Stage 3 is weakly developed outside the composite stock and Stage 4 is widespread throughout the mineralized zone.

A fragment of hornfels cut by a quartz-molybdenite vein and incorporated within porphyritic quartz monzonite has been noted. This suggests that an early molybdenum mineralization stage is associated with porphyritic quartz monzonite, but the significance of this type of mineralization with respect to the main mineralization sequence cannot be appraised at present.

Disseminated chalcopyrite and molybdenite are rare over-all. Locally, the three main intrusive phases and quartz diorite are mineralized with disseminated chalcopyrite and very rare disseminated molybdenite, but truly disseminated ore minerals are greatly subordinate to those in fractures, veins and quartz stockworks.

Sulphide minerals are distributed in annular zones, which are vertical cylinders coaxial with and partly overlapping the porphyritic quartz monzonite and plagioclase-biotite-quartz porphyry phases of the Berg stock. The quartz-plagioclase porphyry is transected by the mineralized zone. The three main primary sulphides (pyrite, chalcopyrite and molybdenite) are best visualized to be present in three separate, overlapping, concentric cylindrical shells (Figs. 6, 7 and 8). The zone of molybdenite mineralization (Fig. 8) is the smallest of the three, extending outward from

by and large w/in Hazelton Group volcanics

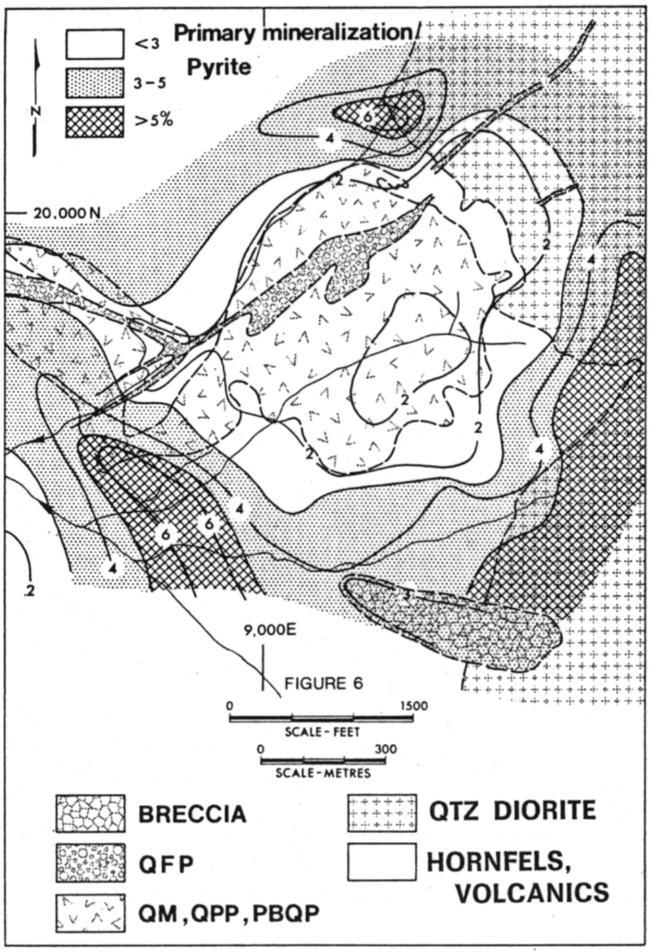

FIGURE 6 — Distribution of pyrite.

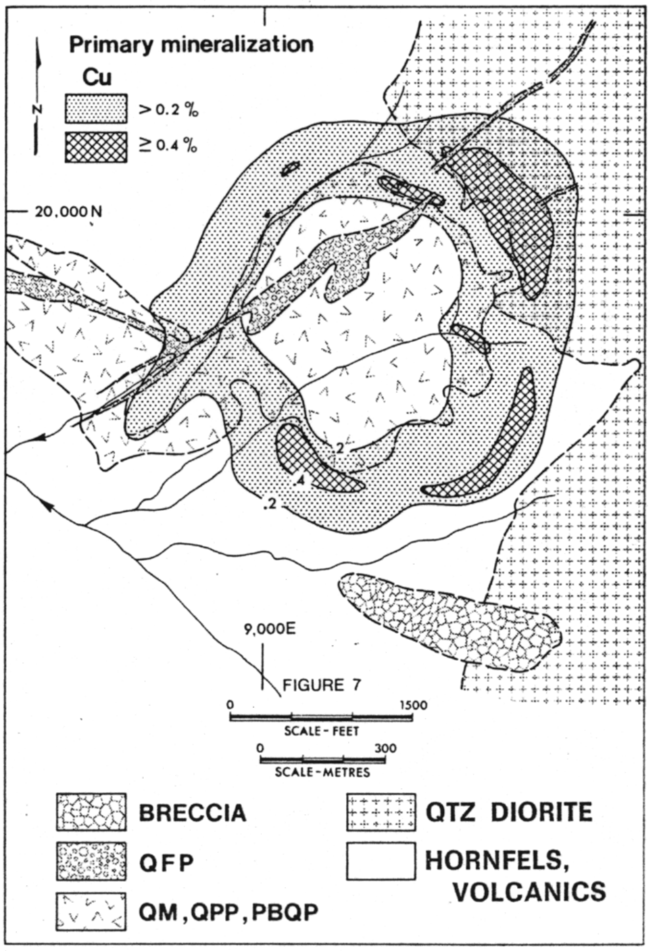

FIGURE 7 — Primary copper mineralization.

the hornfels-intrusive stock contact for 100 to 135 meters. The chalcopyrite zone (Fig. 7) also overlaps the contact and extends outward for over 260 meters from it, but the best copper grades are within 130 to 170 meters of the contact. The pyrite zone (Fig. 6) overlaps all other shells, forming a pyrite halo around the entire zone of mineralization, and extends about 700 meters to the south of the central stock. The width of the pyrite halo is considerably less in quartz diorite to the northeast.

Outward from the pyrite halo, several quartz-carbonate-pyrite-sphalerite-galena-tennantite veins occur on the ridge to the north and northeast of the Berg stock. In general, sphalerite-bearing veins within the stock are rare, but a few veinlets up to 3 millimeters in width and containing quartz-pyrite-sphalerite-carbonate have been noted.

## SUPERGENE MINERALIZATION

At the Berg deposit, a large limonite-stained zone over the mineralized zone is particularly striking, because the area is mostly above the tree line. Beneath the limonite-stained area, chalcocite (digenite?) and covellite are the most important secondary copper minerals. Chalcocite occurs as thin coatings on pyrite and chalcopyrite in rocks between the leached zone at surface and the gypsum-bearing rocks at depth. Figure 4 illustrates the relative position of the leached and enriched zones, and the gypsum surface in two sections across the Berg stock. The blanket of supergene enrichment (Fig. 9) has increased the copper grade of the primary mineralization by a factor in the order of 1.25. There are two areas, in the northeastern and southeastern portions of the mineralized zone, where supergene enrichment persists to depths of 135 meters or more. These areas are characterized by extensive rock fracturing, which has resulted in excessively deep weathering and solution of gypsum, permitting supergene development.

Vertical zoning is illustrated on Figure 10, which shows: (1) copper depletion and partial oxidation of molybdenite in a strongly oxidized zone near surface **(leached zone)**; (2) downward migration of cupriferous ground water and enrichment by replacement of pre-existing sulphides by chalcocite and covellite **(enriched zone)**; and (3) a clearly defined gypsum surface, below which fractures remain tightly cemented by gypsum and where there has been minimal ground-water circulation **(primary zone)**.

Barakso and Bradshaw (1971) reported that spring and drill-hole discharge waters from the leached zone ranged from Eh 0.4 to 0.9 and from pH 3.1 to 5.9. During summer dry periods, pH was measured as 2.8. Under these oxidizing acidic conditions, all sulphides except molybdenite are leached. Iron from pyrite and chalcopyrite breakdown is precipitated as orange or orange-brown, powdery, amorphous limonite, and locally as jarosite, which stains the rocks and coats all fractures. Transported limonite forms ferricrete blankets up to 1 meter thick where springs emerge at surface. Copper from chalcopyrite is removed in aqueous solution during weathering, but molybdenum is immobile under acidic conditions (Garrels, 1954; Sato, 1960; Titley, 1963; Hansuld, 1966). Molybdenite is locally oxidized. Where this occurs, molybdenum is not leached, but remains as ferrimolybdite or molyb-

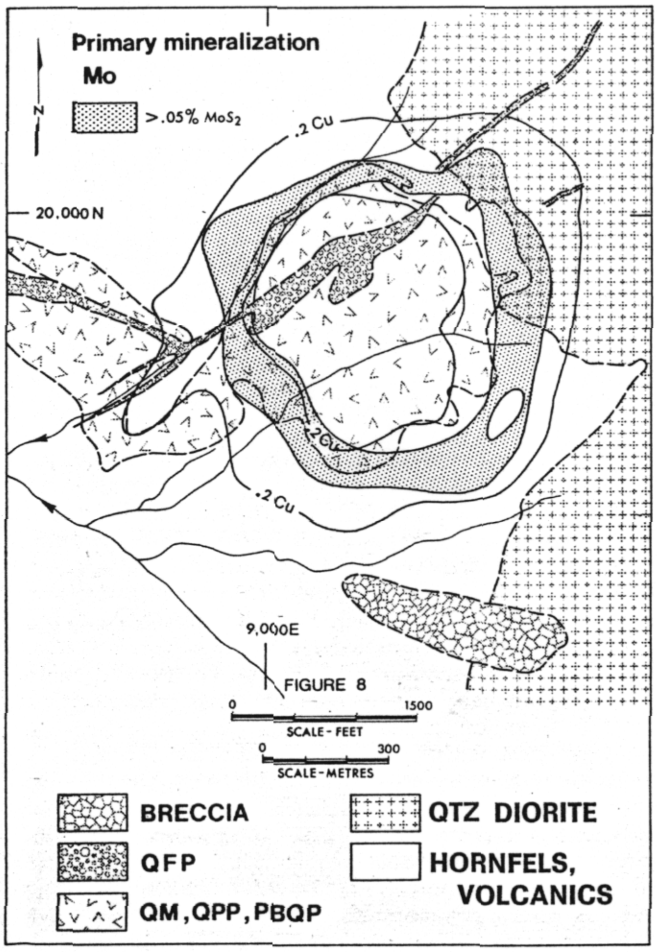

FIGURE 8 — Primary molybdenum mineralization.

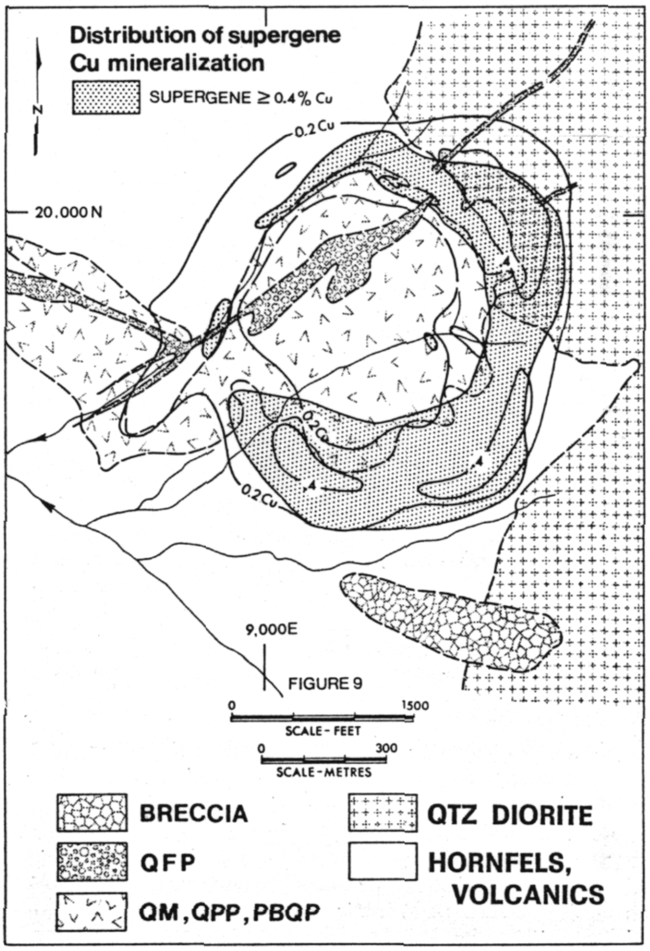

FIGURE 9 — Supergene copper mineralization.

## METAMORPHISM

Hornfels is poorly developed or absent near the diorite; in contrast, the granodiorite has a well-developed hornfels aureole surrounding it that includes a zone of copper and molybdenum mineralization. Rocks unaffected by either of the two intrusions have a well-developed metamorphic assemblage of albite, chlorite, calcite and epidote.

## VEINING AND ALTERATION

Nine vein types have been developed within four recognized stages of vein development (Table 1). The stages are based on relative ages of veins determined from cross-cutting relationships.

Potassic, albitic, propylitic, sericitic and argillic alteration occur in the deposit. Each can be related to a specific vein type. The paragenesis of some of the alteration minerals is given in Figure 3.

Intensity of veining is high along the western contact and adjacent hornfels and low along the eastern contact of the intrusion and adjacent hornfels. Biotite and potash feldspar occur as envelopes on fractures, with fracture filling, where present, less than 0.1 mm wide. Later propylitic veins are 0.5 to 5 mm wide and quartz-molybdenite and quartz veins are 2 to 10

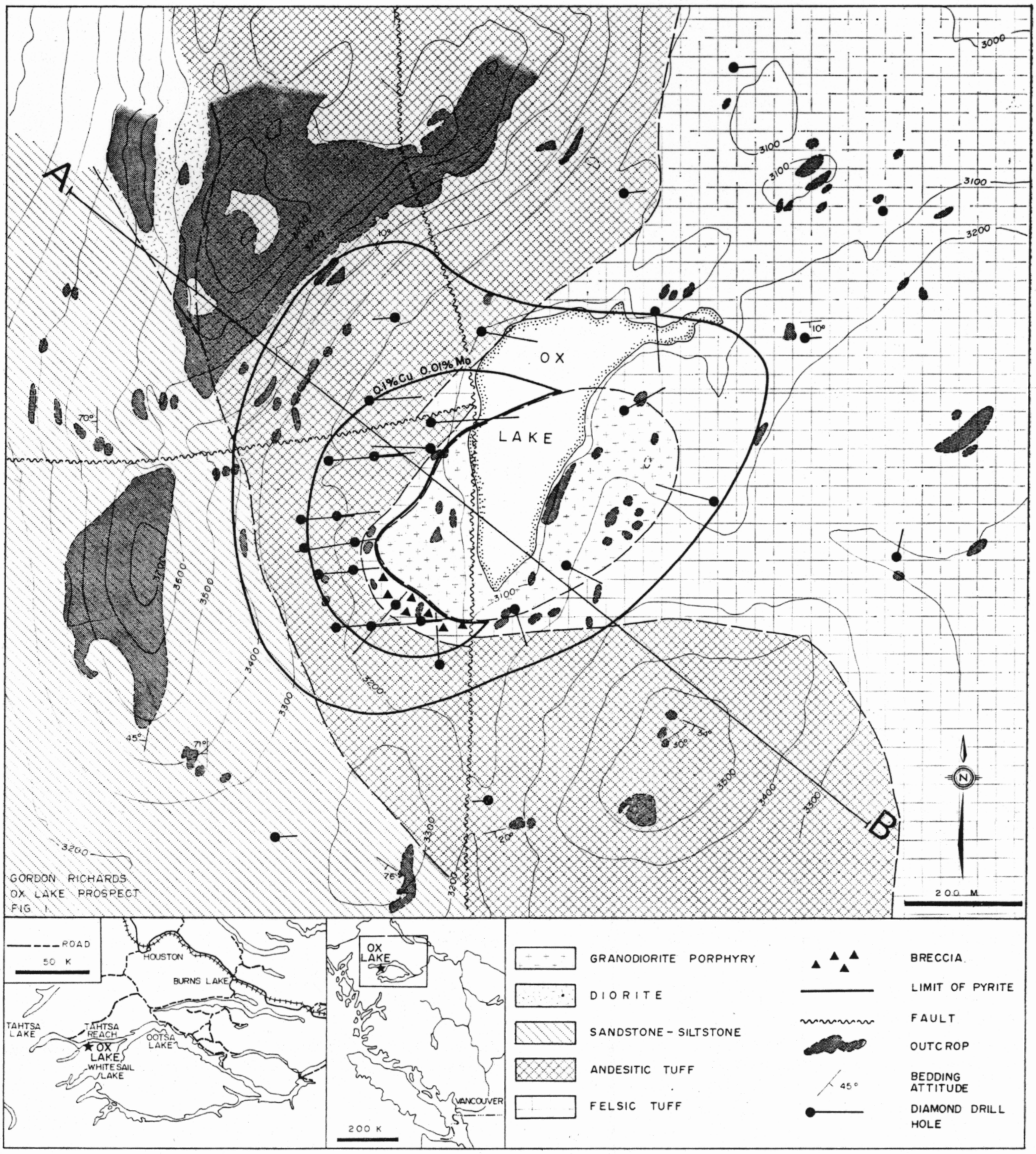

FIGURE 1 — General geology of the Ox Lake deposit.

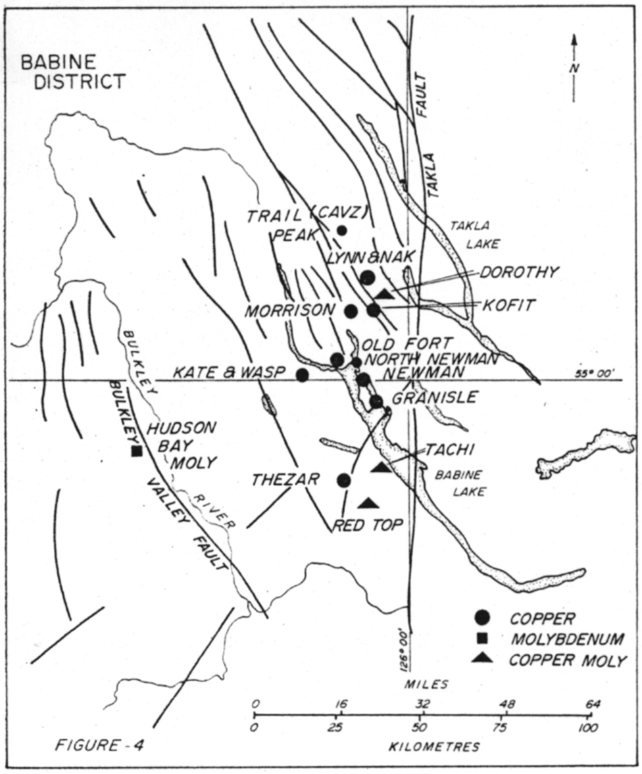

FIGURE 4 — **Babine District** — adapted from Carter, N.C. (1974). The porphyry deposits coincide with a strong set of northwest-trending lineaments west of the Takla Fault.

flows, aligned northeasterly between and near the B.C. Moly and Bell Moly deposits, also may be related to a northeasterly striking fault that is not exposed. The Ajax deposit has higher fracture density and better grade of mineralization near the northeasterly and northerly trending fracture zones. The setting of the Ajax deposit is also of interest in that the warping of the sedimentary beds around the core of small irregular plugs indicates that the emplacement of these plugs was forceful.

The Alice Arm district also provides a good example to illustrate that the type of mineralization may be related to the type of host rock. The Kinskuch porphyry copper deposit is emplaced in andesitic volcanic rocks, whereas the molybdenum porphyry deposits are emplaced on meta-siltstones and meta-greywackes (Carter, 1974).

## BABINE DISTRICT

Lineaments in the Babine district trend predominantly northwesterly and are grouped to the west of the major northerly striking Takla fault (Fig. 4). Individual fault zones are difficult to trace, because thick till covers much of the area, but trenching and drilling on many deposits, and mining on the Granisle and Bell (Newman), have exposed some of the faults. Numerous small, mineralized intrusions are situated adjacent to major strands of the northwesterly trending fault system.

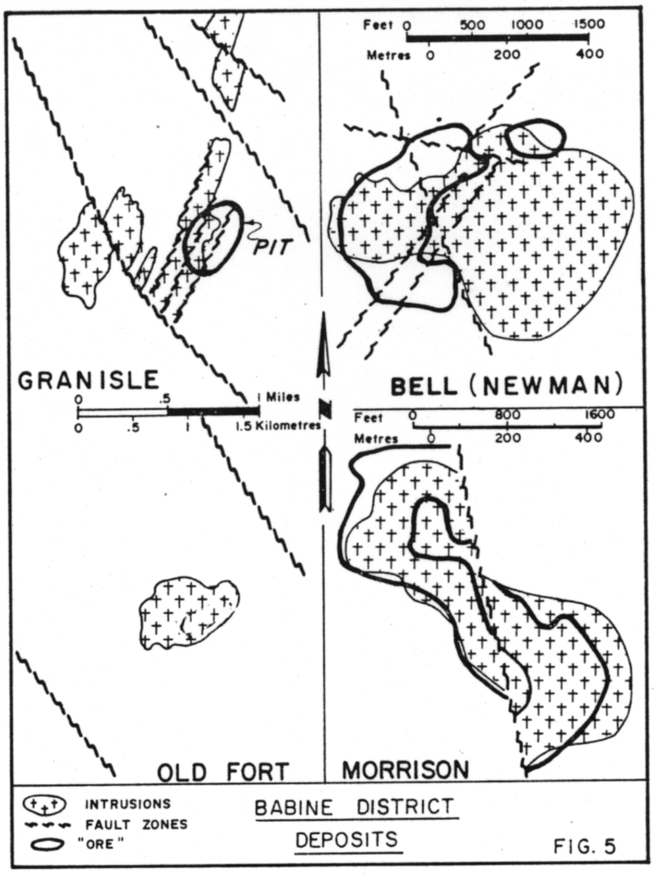

FIGURE 5 — **Babine District Deposits** — adapted from Carter, N.C. (1974) and company plans. The better grade of mineralization at Granisle and Bell may be present because of intense fracturing and brecciation provided by fault intersections and breccia pipes.

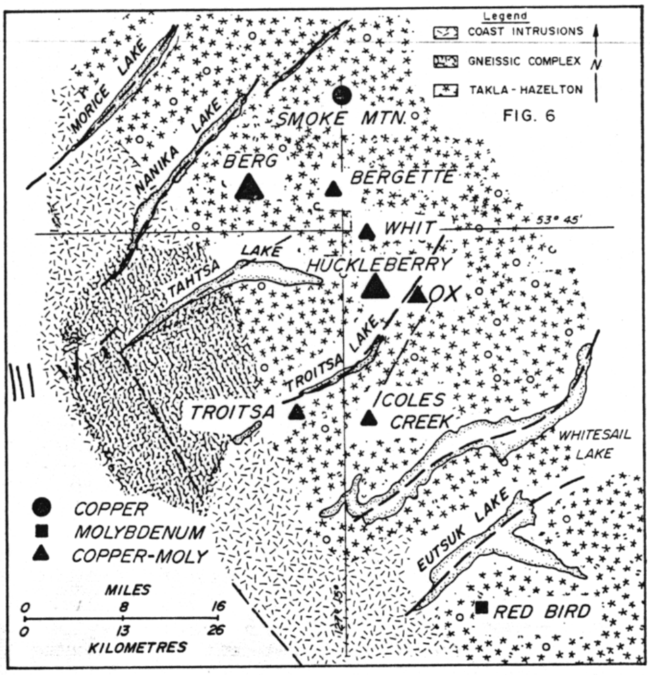

FIGURE 6 — **Tahtsa District** porphyry deposits are emplaced in a structural setting similar to that in the southern part of the Alice Arm district.

Granisle and Bell are the only deposits currently in production, and they have the best grade reported in the district. It may be more than coincidental that both are situated at intersections of northeast-striking faults with the northwest-striking faults (Fig. 5) and both contain intrusion breccia pipes. The pit at Granisle is almost coincident with a breccia pipe (Kirkham, 1971) and the ore at Bell occurs on the flank of a group of breccia pipes (Carson *et al.*, this volume).

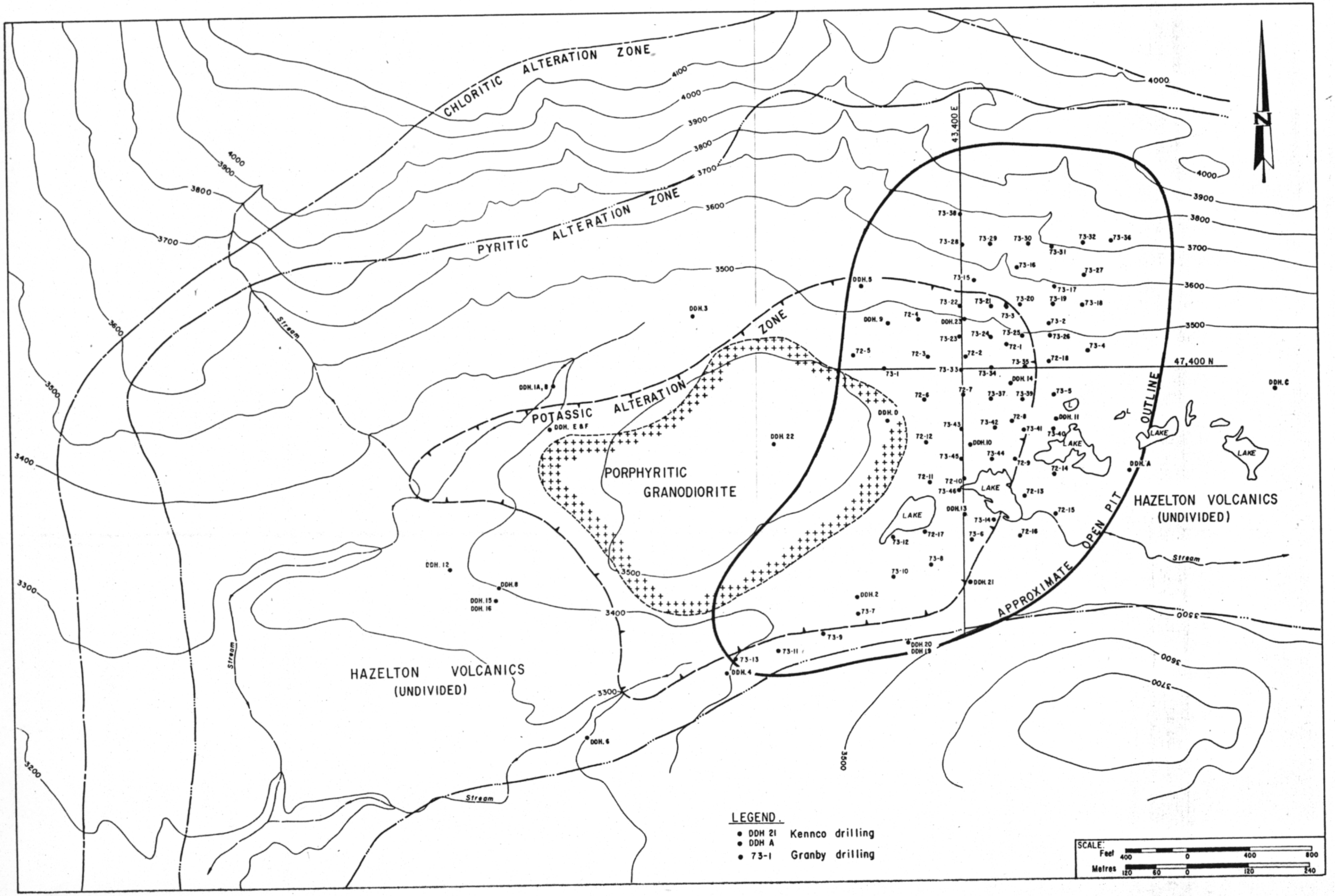

FIGURE 1 — Huckleberry Prospect, geology and drill plan.