# The Bethlehem Copper Property

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THE Bethlehem Copper Property, comprising 156 mineral claims, is located about 30 miles southeast of the town of Ashcroft in the Highland Valley and on the rolling terrain of the Interior Plateau. Elevations range from 3900 feet on the valley floor to 6000 feet north and south of the valley.

On the property, the main mineralization occurs between 4800 and 5000 feet. During Pleistocene time, the entire area was under ice and now most of the surface is covered with glacial debris. Within the property boundaries only a small part of the area exposes bedrock with overburden averaging about 20 feet between outcrops. In the main valley one hole drilled to a depth of 850 feet has not reached bedrock.

Copper mineralization has been known to exist in the Highland Valley since the early 1900's. The first shipment from what is now the Bethlehem property came from the old Snowstorm mine. The shipment, made between 1915-16, amounted to about 136 tons grading better than 27% copper and 7.5% silver. However, it was not until 1955 when the Bethlehem Copper Corporation Ltd. carried out a major trenching and sampling program that the potential of the area was realized. That year the property was optioned to the American Smelting and Refining Company. From 1955 to 1958, this company carried out an extensive exploration program including 48,456 feet of diamond drilling, 12,959 feet of rotary drilling and 1,830 feet of churn drilling. It was during this period that the Jersey and East Jersey ore bodies were discovered. In May, 1958, ASARCO relinquished their option and Bethlehem Copper Corporation Ltd. undertook an underground program to check the results of the surface diamond drilling. This phase was completed in 1959 and during that time 9,823 feet of drifting and crosscutting, 22,766 feet of percussion drilling and 941 feet of underground drilling were done. In 1960, Sumitomo Metal Mining Co. Ltd. of Japan undertook to further test the East Jersey ore body. Testing consisted of 12,788 feet of surface diamond drilling, 218 feet of raising and 2,080 feet of underground percussion drilling.

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To date, two commercial ore bodies, the Jersey and East Jersey, have been outlined. A third, the Iona, remains to be further tested. Underground mapping shows strong mineralization and structures on the 4600-ft. level in both Jersey and East Jersey zones. In addition, mineralization is known to extend below the bottom of the presently designed pits which in the Jersey is 450 feet below the surface and in the East Jersey 360 feet. There is no reason, then, to believe that the life of the property on these two pits alone will not greatly exceed the expected life of 14 years. Numerous other mineralized occurrences are known within the property boundaries but unfortunately, they are extensively surrounded by drift cover and little or no work has been done on them. Statistically, there are probably other major zones of disseminated copper mineralization which remain concealed and unexplored. These possibilities will be tested in the future.

Geophysical methods employed by ASARCO were extremely helpful in marking structural trends and delineating potential zones of mineralization. The magnotometer very closely outlined the Iona zone while induced polarization delineated the Jersey and East Jersey zones.

Proposed operating schedule is to mine the East Jersey at a rate of 3000 to 3500 tons per day with production scheduled for the fall of 1962. Not later than 1965, production will be increased to 5000 tons per day with the bulk of the ore coming from the Jersey.

The Bethlehem property occurs in the Guichon batholith of lower Jurrassic age. The batholith is about 40 miles long in a north-south direction and about 16 miles wide. The rock is a massive, coarse textured quartz diorite which is locally called the

A paper to be presented at the Prospecting and Exploration Conference, 50th Anniversary, British Columbia and Yukon Chamber of Mines, February 16, 1962.

Guichon or older quartz diorite. At the Bethlehem it has been intruded by granite, a younger quartz diorite, porphyries and breccia. This assemblage of rocks (excluding the granite) has been termed by White, Thompson and McTaggart as the "Younger Complex" and important economically in that they are the major host rocks for the mineralization.

The main rock mass of the Younger Complex is the Bethlehem quartz diorite with its porphyritic and sub-porphyritic phases. The rock is light coloured with minor mafics (10%) which are unevenly distributed. Poikilitic hornblende with enclosed crystals of plagioclase is well developed. Biotite occurs as prominent plates and quartz generally has a spotty habit. Altered plagioclase is frequently zoned and this seems to be common with other members of the complex. In contrast, the Guichon or older quartz diorite is darker in colour due to increased amounts of both biotite and hornblende which are about equal in amounts. The mafics are evenly distributed and altered feldspars generally unzoned. Quartz has a wedge-shaped habit and at times a slight bluish tint. In the fresh unaltered rock, pink feldspar is prominent.

Two types of porphyry dikes are known. The first type, a dacite porphyry, is light green and often with well developed sieve hornblende. In places, the coarser variety merges with porphyritic Bethlehem quartz diorite. Some of the porphyries show little or no quartz phenocrysts whereas others show conspicuous rounded or kidney shaped quartz phenocrysts. The second type of porphyry is a quartz diorite porphyry (locally called "Crowded" quartz porphyry) that is light grey with a high proportion of phenocrysts to groundmass. Characteristic features of this rock are well developed rounded crystals of quartz that exceed ¼ inch in diameter and the replacement of hornblende by beth tabular and radiation aggregates of epidote. This latter feature appears to be restricted to this rock type.

Dr. J. M. Carr of the B.C. Department of Mines has done considerable detailed mapping through 1957-1959 and has subdivided the dacite porphyry into two categories based on the presence or absence of quartz phenocrysts. Those with little or no phenocrysts are called the P-1 and P-2 porphyry and those with abundant kidney or round shaped quartz phenocrysts the P-3 type which is considered by Dr. Carr to be responsible for the breccia.

The three main known bodies of breccia are in the Iona, Jersey and East Jersey areas. This rock type is important economically in that it serves as a host rock for the mineralization. The rock is hard and dense with only few cavities between the fragments. The exact shape of breccia is unknown but they appear to be tabular, irregular, lens-shaped bands that trend in a northeasterly direction. Intensity of the breccia varies from extreme to weak, being more strongly developed in the Iona and East Jersey than in the Jersey. In places, the contact with the enclosing rock is sharp and clear while in others strong breccia simply fades into undisturbed rock. Areas between the bands generally show weak brecciation or merely disturbed ground with a weak mottling effect. Recognized fragments in the breccia include Bethlehem quartz diorite, dacite porphyry and the Guichon quartz diorite. To date no fragments of the quartz diorite (Crowded) porphyry has been recognized. The larges fragments are older quartz diorite, some of which measure 2 feet across the widest dimension. Fragments of the Younger Complex are smaller in size (less than 6 inches) and generally appear to be more angular. Although there does not appear to be any definite alignment of the Younger Complex fragments, their tabular nature suggests they were well jointed prior to brecciation. The matrix of breccia consists mainly of quartz, feldspar and small rock fragments. Dr. Carr has suggested that the matrix is mostly porphyry which exploded during its final stage of crystallization.

For the most part, rock classification is not too difficult but lack of sharp contacts, convergence of one rock type with another and alteration, leaves doubt at times as to which class certain rocks belong.

The Bethlehem deposit is of the disseminated type and has certain features in common with the porphyry coppers found in the southwest United States. Common to both are, Laramide intrusive, breccia, pervasive alteration, disseminated mineralization and the general shattered condition of the rocks. Of the porphyry coppers, Bethlehem more closely resembles Ajo in that they both have a low pyrite content.

Alteration at Bethlehem is classified as weak, moderate or strong dechloritization, argillization or sericitization. There is no sharp demarcation between the zones and one zone overlaps well into the next. The weakest and most widespread is chloritization. In this zone biotite is converted to chlorite and hornblende to chlorite and epidote. At this stage, the rock is comparatively fresh. With increasing alteration, the feldspars are affected becoming dull in appearance with a noticeable clayey odour. As the intensity of the alteration increases rock textures are gradually obliterated. The rock is soft, greenish in colour and composed of quartz, chlorite and sericite.

The main zones of mineralization occur within the areas of moderate to strong alteration with the stronger mineralization associated with the more intense alteration.

Mineralization, consisting principally of chalcopyrite and bornite with minor pyrite and occasional molybdenite, occurs as true disseminations, irregular discontinuous fracture fillings, films of joint planes and as coarse blobs and blebs. In the Jersey and East Jersey chalcopyrite and bornite occur in about equal amounts while chalcopyrite is much the dominant mineral in the Iona. Sulphides show a marked preference for dark minerals such as chlorite, biotite and hornblende.

Unlike most of the porphyry copper deposits of the southwest, there is no secondary enriched zone. The low pyrite content precludes the formation of strong solvents te attack the copper sulphides and release the copper in the soluble sulphate form. Consequently, any secondary copper formed is quickly deposited as carbonates and silicates. This is probably the explanation for the weak but widespread green and blue staining seen on many of the joint surfaces.

In the East Jersey, the ore zone is long and narrow and approximately 900-1000 feet in a north-south direction and from 70-250 feet in width. The zone has been tested by 21,882 feet of surface diamond drilling, 1,662 feet of underground development and 8,670 feet of long hole percussion drilling. The average grade is between 1.12 and 1.20% Cu. Mapping on the 4600′ level shows the bulk of the mineralization to occur as irregular northeasterly trending bodies. This trend is well shown when the mineralization is subdivided into various grade ranges. (See Figure B). Down-dip projections from surface drilling suggest a steep westerly dip. Individual lenses vary in length up to 660 feet and in width up to 150 feet with areas between the lenses being barren or weakly mineralized. On the 4600′ level, which is 360 feet below the surface, both the structures and the mineralization are strong and there is no reason to suppose that commereial mineralization does not extend for at least the same distance below the level.

The Jersey ore body lying about 1000 feet west of the East Jersey is a separate and distinct zone. It has been tested by 21,882 feet of surface diamond drilling, 3,700 feet of underground drifting, and 16,176 feet of long hole percussion drilling. The average grade varies between 0.78 and 0.84% Cu. depending on the cut-off grade. Mineralization is much the same as in the East Jersey and the same northeasterly trends are still much in evidence. On Fig. A., the shape of the zone is roughly circular being about 900 feet in an east-west direction and 800 feet in a north-south direction. This circular shape owes its existence to the irregular arc shaped contact between the Guichon quartz diorite and the Younger Complex. Although pyrite occurs in only minor amounts, it is more abundant on the east side of the zone. From Fig. B it will be seen that the centre of the induced polarization anomaly lies near the eastern margin of the zone and not directly over the ore body. The probable explanation is that the amount of total sulphide is greater on the east side than elsewhere. Although the copper sulphides occur both as disseminations and fracture fillings, the former appear to be the dominant mode of occurrence. Metal values are much more uniformly distributed than in the East Jersey although locally there are some high grade zones. Actually, the Jersey body is a zone of stronger copper mineralization encompassed by a much larger and weaker zone. Towards the margins, the values gradually decrease and the walls are therefore assays walls. Increase in copper prices could easily extend the present pit walls and add substantially to the ore tonnage. In contrast, the contacts between waste and ore are sharp in the East Jersey and the copper values more erratically distributed. Alteration is pervasive and the rock is generally greenish in color due to abundant chlorite. In the highly altered sections the rock appears to be mainly quartz, chlorite and sericite. As in the other mineralized zones there is a strong affinity of the copper sulphides for the mafics minerals, biotite, hornblende and chlorite. Locally breccia is strong but the whole zone appears to have a weakly shattered or mottled effect and there does not appear to be any appreciable difference in copper values between the brecciated and unbrecciated rock. Again, this is in contrast to the extreme brecciated areas seen in the East Jersey and with which the better mineralization appears to be associated. That faulting has influenced deposition is shown by the Jersey Fault. This is a strong northerly trending gouge filled structure with a steep westerly dip. Strong mineralization occurs on both sides of the faults for a distance of 200 feet.

Structural elements such as intrusives, breccia, pervasive alteration as well as mineral distribution shows a similar north to northeasterly trend suggesting that all were controlled or influenced by the same deep-seated zone of weakness.

The main zones of mineralization lie close to the Guichon-Younger Complex contact. While this contact is somewhat generalized and shown as a rather smooth line, it actually is very irregular and complex. At these localities the rocks prior to the development of the breccia were shattered and jointed. This is evidenced by the tabular nature of some of the fragments. Subsequent mineralization took place in these fractured and brecciated areas. Not all the breccia is mineralized and in most cases mineralization extends beyond the boundaries of those that are.

As to the formation of the breccia there is some disagreement. Dr. Carr has suggested that it resulted from the explosion of the dacite porphyry (P-3) under special conditions. He bases his opinion on the fact that the breccia matrix resembles the quartz porphyry (P-3) and that breccia is developed along them or at their terminations. Since no quartz diorite porphyry (Crowded porphyry) fragments have been recognized he believes that the breccia was formed before the intrusion of the Crowded porphyry. Drs. White, Thompson and McTaggart, on the other hand, have suggested that the matrix is composed of comminuted rock material and that gases escaping through the breccia have redistributed the fine matrix material. Both, however, agree that the breccia is an intrusive breccia and not a fault breccia.

It seems plausible that the final explosion along pre-existing faults resulting in somewhat tabular shaped breccia masses trending in a direction of the guiding faults. The final result being areas of intense breccia adjacent to the faults with less disturbed ground away from the faults. Depending on the closeness of the faults will depend the size of the brecciated area. This is suggested as a possible explanation to account for those brecciated masses alternating with areas of undisturbed or weakly disturbed rocks.

Both Deer Valley and Witches Brook appear to be fault controlled. Due to absence of suitable markers, the amount of displacement along known or inferred breaks is not known although the trend of electromagnetic conductors suggest that some of the faults are left handed.

For prospecting in the Highland Valley area, the following guides will be found helpful in the search for mineralization: north to northeasterly trending faults, breccia, porphyries (particularly the P-3 type) and alteration of rock types. Careful attention should be paid to the Guichon-Younger quartz diorite contact.

The writer wishes to thank H. H. Huestis, President of Bethlehem Copper Corporation Ltd. (N.P.L.) and D. W. Pringle, Mine Manager, for permission to publish this paper.

Special thanks are due J. H. Courtright of the American Smelting and Refining Co. and O. Evans, formerly of that Company. To Drs. Carr, White, Thompson and McTaggart and Messrs. K. Matsuda and G. Hirata of the Sumitomo Metal Mining Co. the writer also acknowledges his thanks. Many of the writer's opinions have been conditioned by lively discussion with the above geologists.

### REFERENCES

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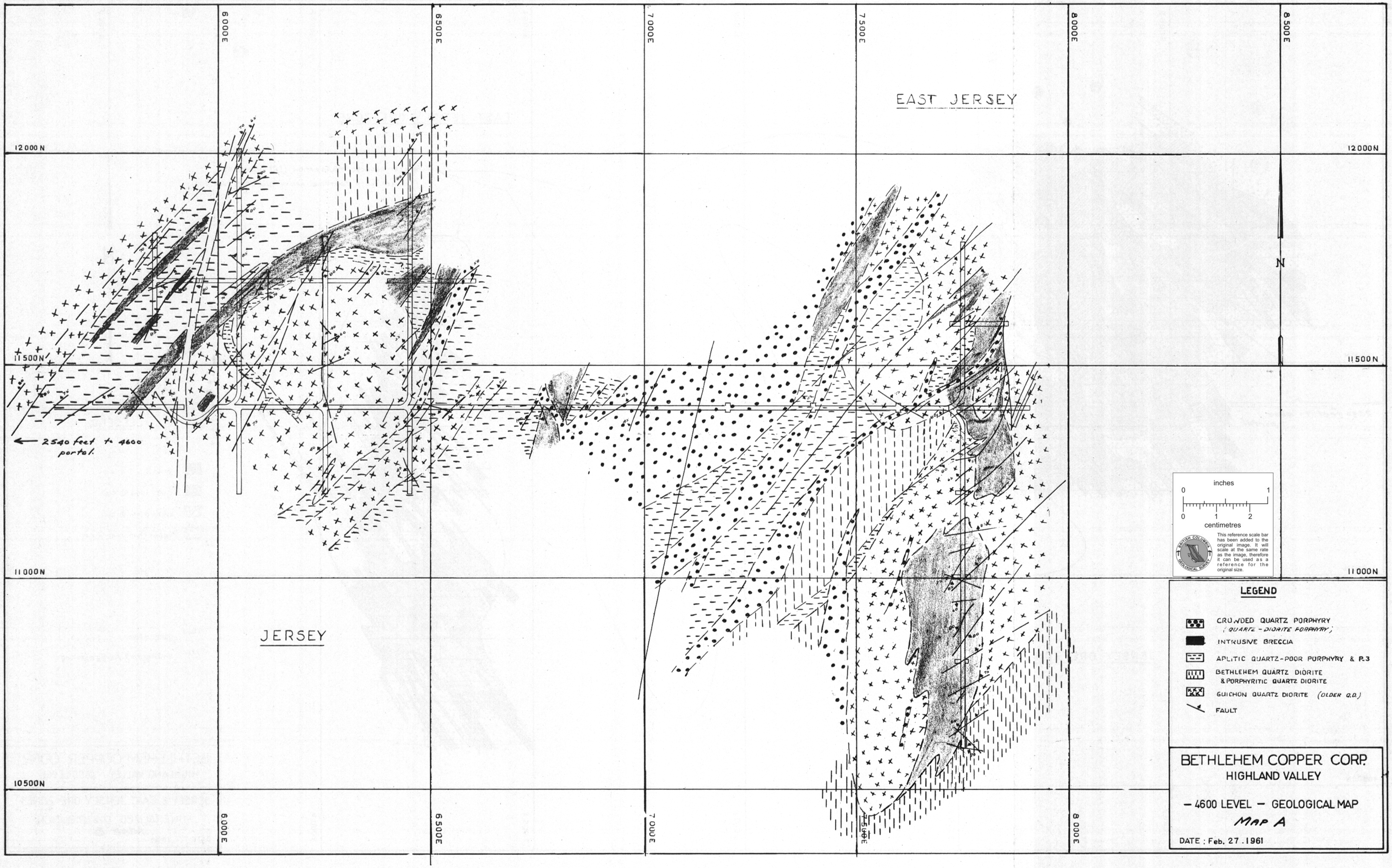
2. **White, W. H., Thompson, R. M., McTaggart, K. C.:** The Geology & Mineral Deposits of the Highland Valley, B.C. C.I.M. Trans. LX 1957.
3. **Carr, J. M.:** Porphyries, Breccias and Copper Mineralization in the Highland Valley, B.C. Canadian Mining Journal, Vol. 81, 1960.

# Mining Alumni Annual Meeting

The Provincial Institute of Mining Alumni Association, a non-profit organization of former students at the Provincial Institute of Mining, Haileybury, Ontario, will hold its annual meeting May 5th, 1962. Registration will commence at 9:00 a.m. in the Haileybury Hotel. Anyone seeking further information should contact J. O. Wolf, Vice-President, Box 54, Timmins, Ontario.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– 4600 LEVEL – GEOLOGICAL MAP
MAP A
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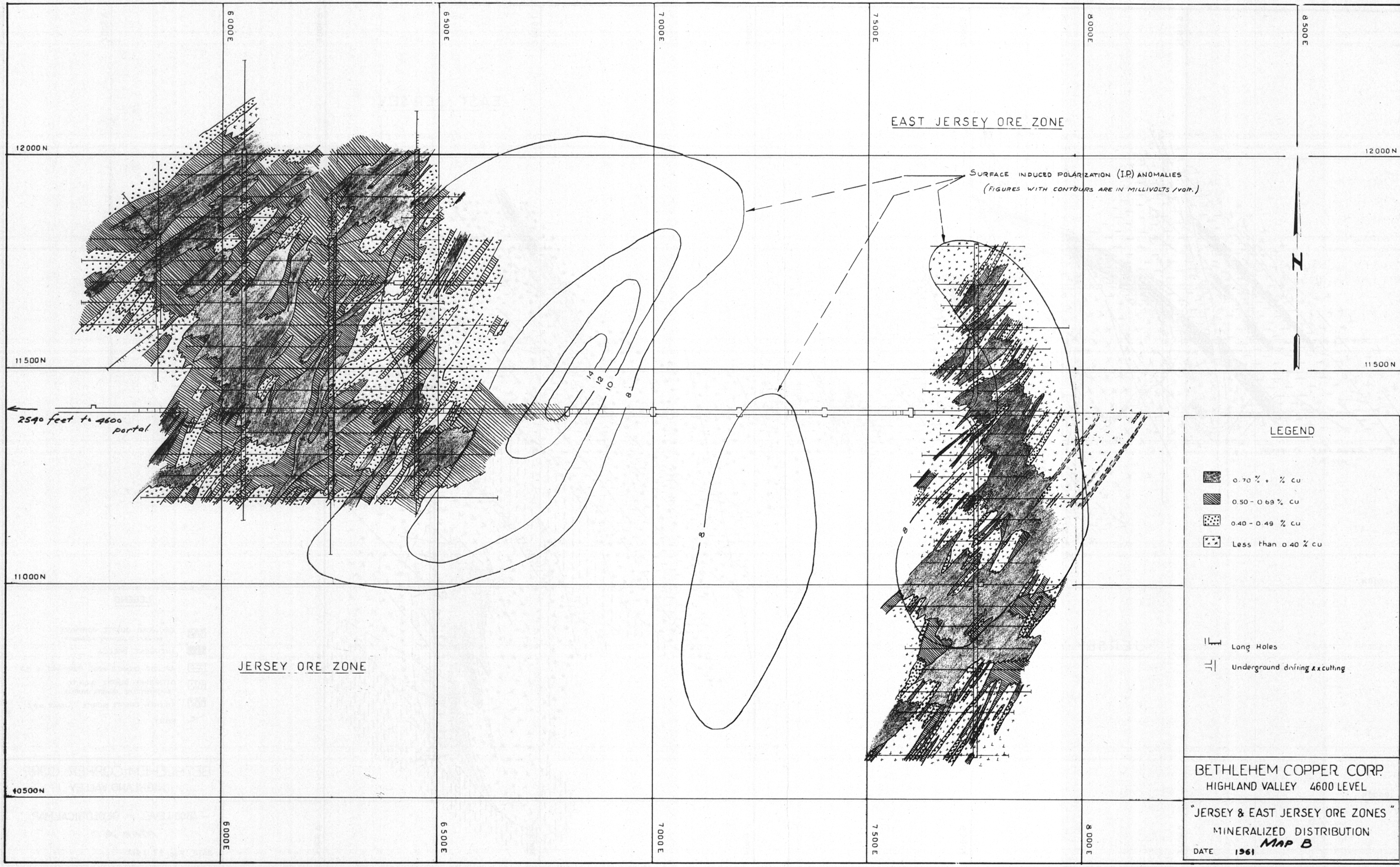


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