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CANADA

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# MINERALOGICAL EXAMINATION OF PORPHYRY COPPER ORE FROM THE BELL COPPER DEPOSIT, BABINE LAKE, BRITISH COLUMBIA

by

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MINERAL SCIENCES DIVISION



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## SUMMARY

Samples of porphyry copper ore, consisting of head samples and hand specimens were received on January 15, 1974, from Peter Ogryzlo, Geologist, Noranda Mines Limited, Bell Copper Division, P.O. Box 2000, Granisle, B.C. Mr. Ogryzlo requested that the samples be examined to determine the occurrence of the gold, reported to range from 0.015 to 0.020 ounces per ton. At the present time, approximately one half of the gold is being recovered.

The occurrence of the gold in these samples could not be established. However, assays of various products prepared from the head sample (Table 1), indicated that the gold is probably associated with the sulphides.

Therefore, a request was made for a sample of copper concentrate, reported to contain higher gold values (0.44 ounces per ton). This sample was received on March 25, 1974, from M. Paul Spira, Head, Extractive Metallurgy Division, Noranda Research Centre, 240 Hymus Boulevard, Pointe Claire 730, Quebec.

Six grains of native gold were identified in two of the products prepared from the copper concentrate. Three of these grains were liberated, two were enclosed in chalcopyrite, and the sixth was in contact with pyrite. Electron microprobe analyses show that the gold contains from 3.7 to 4.2 wt % silver. The above occurrences, together with assays of various products of the copper concentrate (Table 2) indicate that the gold occurs as the native metal, as liberated grains and as inclusions in chalcopyrite, and associated with pyrite.

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## SAMPLES

The samples from the Bell Copper deposit consisted of four large hand specimens, 4 to 6 in. in dia., and about 650 grams of minus 35 mesh head sample. Three of the hand specimens, labelled "#9507, #9508 and #9509" were composed essentially of siliceous gangue with minor sulphide mineralization, whereas the fourth, labelled "#9506" was composed largely of massive pyrite. The head sample was labelled "#9510", and was reported to contain 0.015 to 0.020 oz of gold per ton.

The copper concentrate obtained from Mr. Spira was reported to contain 27 wt % copper, and 0.44 and 0.80 oz per ton of gold and silver, respectively. The copper concentrate was essentially all minus 200 mesh, and weighed about 600 grams. Mr. Spira reported (verbally) that the copper concentrate was obtained from the Bell Copper production of 1972.

## METHOD OF INVESTIGATION

### Head sample and hand specimens

Polished sections were prepared from pieces of each hand specimen. A portion of the head sample was sent for gold and silver assay and the balance retained for screen analysis. The five finest fractions of the screen analysis were separated into float and sink products using a heavy liquid (S.G. 2.96), to concentrate the heavier ore minerals. Polished sections were prepared from portions of the sink products. Sufficient sample was retained in three of the sink products (65 to 100-, 100 to 150- and 150 to 200-mesh size) for further concentration. This was done by elutriation using a heavy liquid (S.G. 3.39). First and second sink products* were obtained from each mesh size and used to prepare polished sections. Polished sections prepared from the hand specimens and from various products of the head sample were

*"Sink products" obtained by elutriation can be equated to the 'tip' obtained from the superpanning of powdered samples.

examined under the ore microscope. Electron microprobe studies were made on many of the polished sections to determine if trace amounts of gold occurs in the pyrite, and, as a supplementary aid to detecting gold-bearing minerals. In addition, when sufficient sample was available, portions of the float and sink products obtained from separations made on the screened fractions of the head sample were assayed for gold (Table 1). Some of the massive pyrite from hand specimen #9506 was also assayed for gold.

Copper concentrate

The copper concentrate was essentially minus 200 mesh in size. It was screened into plus and minus 400 mesh fractions, and representative portions of each assayed for gold (Table 2). The coarser mesh size (plus 400) was selected for detailed study. This fraction was first placed in a heavy liquid (S.G. 2.96) to remove the siliceous gangue minerals. It was then separated into two magnetic (0.6 and 1.2 amperes) and one non-magnetic subfractions (1.2 amperes) by means of a Franz Isodynamic Separator. Representative portions of each subfraction were removed for both gold assays and polished sections. The three subfractions were then elutriated using a heavy liquid (S.G. 3.30). The first and second sink products obtained by elutriation were used to prepare polished sections. None of these sink products were large enough for gold assays. Polished sections prepared from the various fractions and products of the copper concentrate were examined under the ore microscope and by the electron microprobe.

## RESULTS OF INVESTIGATION

Head sample and hand specimens

Although a detailed mineralogical examination of the ore was not specifically requested, a few brief comments are required on the minerals present and their association.

The ore consists essentially of a siliceous matrix which contains coarse- to fine-grained disseminations of sulphides and some iron oxides. Based on the examination of the head sample (deemed more representative of the ore than the hand specimens) the principal ore mineral* is pyrite. Chalcopyrite and hematite occur in much smaller amounts. Also present are very small to trace amounts of bornite, covellite, digenite, tennantite, marcasite, goethite, galena, tetrahedrite, magnetite, rutile, sphalerite, pyrrhotite and molybdenite. The gangue minerals consist chiefly of quartz, with somewhat less mica and siderite.

Chalcopyrite is the principal copper-bearing mineral. The abundance of the other copper-bearing minerals (bornite, digenite, covellite, tennantite and tetrahedrite) in proportion to the chalcopyrite, is minimal. Microprobe analyses of a few grains of tetrahedrite showed that it contains approximately 11 wt % silver.

No native gold or other gold-bearing minerals were identified during the examination of either the hand specimens or the head sample. However, some indication as to the occurrence of the gold can be construed from the results of the gold assay of the massive pyrite in hand specimen #9506, and from the gold assays of selected float and sink products prepared from the head sample (Table 1). Unfortunately, only a few of these products were of sufficient size to submit for assay, and in a few instances similar products had to be combined.

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*The term "ore mineral" as used in this report, does not necessarily have an economic connotation.

TABLE 1

Results of gold assays of massive pyrite and of selected float and sink products prepared from the head sample*

| Sample or product | Gold oz/ton |
|---|---|
| Original head sample | 0.015 |
| Massive pyrite hand specimen #9506 | 0.145 |
| (100 to 150-)+(150 to 200-mesh) float 2.96 | trace |
| " " " " " " sink 2.96 | 0.130 |
| (200 to 325-mesh) float 2.96 | trace |
| (200 to 325-)+(-325 mesh) sink 2.96 | trace |
| (-325 mesh) float 2.96 | 0.019 |

*Analytical Chemistry Subdivision, Internal Reports MS-AC 74-34 and 74-184.

The assay results listed in Table 1 show that the only concentration of gold occurs in the combined sink products of the 100 to 150- and 150 to 200-mesh fractions. The gold values have increased by a factor of ten over those for the original head sample. Microscopic examination of polished sections prepared from this sink product showed that it consists essentially of pyrite, together with minor amounts of chalcopyrite and hematite, no evidence of native gold or other gold-bearing minerals was observed. Electron microprobe studies were made on the pyrite to determine if trace amounts of gold might be present, but none was detected. Examination of the sink products from the other sized fractions was also negative.

Higher than average gold values were also found in the massive pyrite from hand specimen #9506. The same procedure as above was followed, and again proved negative. However, both of these results tend to indicate that the gold is associated in some manner with the sulphides.

One anomalous result is also indicated in Table 1. This is the gold value obtained from assaying the float product of the minus 325-mesh fraction of the head sample. It can only be

assumed that this value, which is equivalent to that of the original head sample, is due to the entrapment of either sulphides with inclusions of native gold, or of minute particles of free gold, during the heavy liquid separation. This could readily happen, because the separation of such fine-grained particles, by means of heavy liquids, often results in impure fractions.

The polished sections of the first and second sink products obtained by elutriation (S.G. 3.30) were also examined under the ore microscope. As in other products, no gold was detected. The sink products resulting from elutriation were all less than 0.2 grams in weight.

Copper concentrate

The copper concentrate consists essentially of chalcopyrite. Other copper sulphides include bornite, covellite, digenite, tennantite and tetrahedrite. The principal contaminant is pyrite; traces of marcasite, rutile and siderite were also identified. The presence of pyrite in the concentrate is the result of being partly to completely locked with grains of chalcopyrite. However, some liberated pyrite is present, probably as a result of entrapment during beneficiation.

The results of gold assays of the two screened fractions of the copper concentrate and the three magnetic subfractions of the plus 400-mesh size are shown in Table 2.

As shown in Table 2 the higher gold values are found in the finer of the two mesh fractions. However, the coarser fraction (plus 400) was selected for further study as it is more amenable to magnetic separation and elutriation.

The result of the magnetic separations was a concentration of the copper sulphides in the two magnetic subfractions and of pyrite in the non-magnetic subfraction, with a corresponding increase in gold content. Again neither native gold nor gold-bearing minerals was identified in the polished sections.

TABLE 2

Results of gold assays of the screened fractions and of the magnetic subfractions of the plus 400-mesh size*

| Fraction or subfraction | Gold (oz/ton) |
|---|---|
| Screened fraction (-400 mesh) | 0.454 |
| Screened fraction (+400 mesh) | 0.236 |
| Magnetic at 0.6 amp (+400 mesh) | 0.193 |
| Magnetic at 1.2 amp (+400 mesh) | 0.206 |
| Non-magnetic at 1.2 amp (+400 mesh) | 0.380 |

*Analytical Chemistry Subdivision, Internal Report MS-AC 74-184.

The occurrence of native gold was established in the sink products obtained by elutriation of the subfractions. Two grains were identified in the sink product of the magnetic subfraction (1.2 amperes). Both occurred as inclusions in chalcopyrite (Fig. 1), and measured 15 and 30 microns in size*. Four grains of native gold occurred in the sink product of the non-magnetic subfraction (1.2 amperes). Three were completely liberated, whereas, the fourth adhered to two small particles of pyrite (Fig. 2). The grains of native gold ranged from 10 to 55 microns in size. Electron microprobe analysis of two of the largest grains showed that they contained from 3.7 to 4.2 wt % silver.

*The word "size", as used in this report, refers to the greatest dimension of the mineral grain being described.

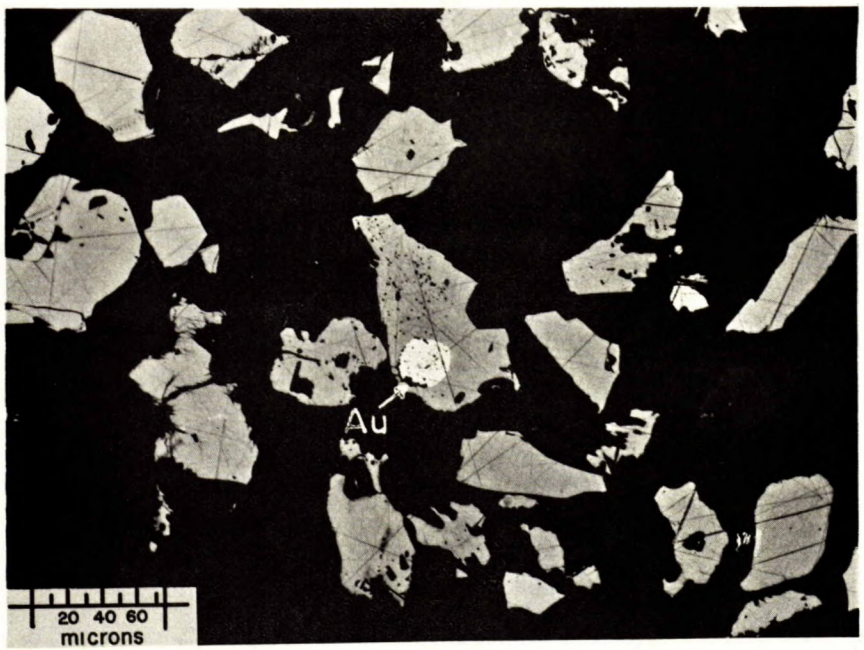


Fig. 1. Photomicrograph (in oil immersion) of the sink product from the magnetic subfraction (1.2 amperes) showing a number of grains of chalcopyrite (greyish white) one of which contains an inclusion of native gold (Au).

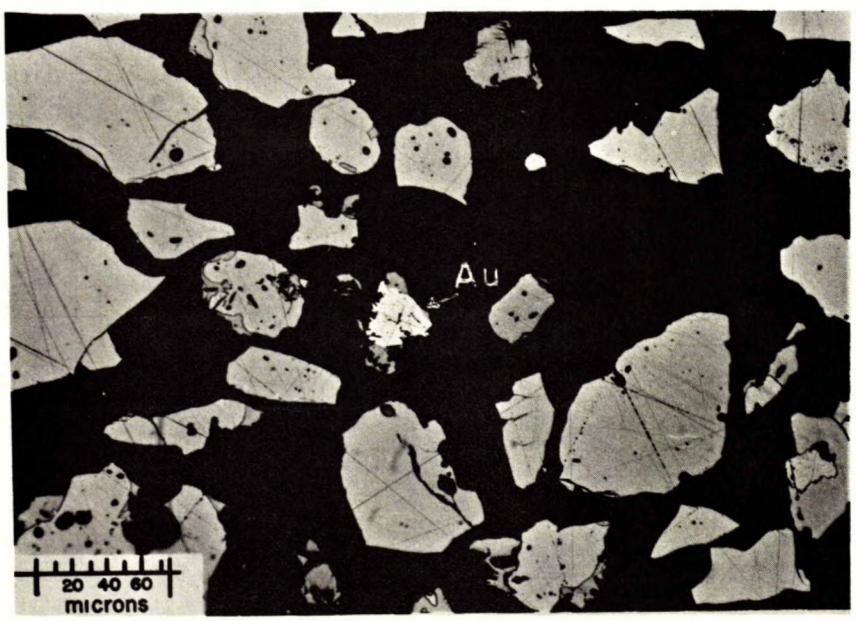


Fig. 2. Photomicrograph (in oil immersion) of the sink product from the non-magnetic subfraction (1.2 amperes) showing a number of grains of pyrite (light grey). At the centre of the field is a grain of native gold (Au) with two adhering particles of pyrite.

## CONCLUSIONS

Results of the study show that gold occurs as the native metal. It contains minor amounts of silver and is associated with chalcopyrite and pyrite. The largest grain identified was 55 microns in diameter.

## ACKNOWLEDGEMENTS

The author wishes to express his appreciation to E. J. Murray of the Crystal Structure Group for identifying some of the gangue minerals, to R.G. Pinard for the photomicrographs, and in particular to Y. Bourgoin for the numerous magnetic separations and heavy liquid separations, as well as preparation of the polished sections.

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