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# MINERALOGICAL INVESTIGATION OF A CARBONACEOUS GOLD ORE FROM THE MCINTYRE MINE, WHITNEY AND TISDALE TOWNSHIPS, PORCUPINE DISTRICT, ONTARIO

by

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MINERAL SCIENCES DIVISION

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## SUMMARY

A sample of a carbonaceous gold ore, consisting of head sample and hand specimens, was received from D. Raicevic of the Mineral Processing Division on May 1, 1974. The ore, originally submitted to the Mines Branch by McIntyre Porcupine Mines Limited, is from the McIntyre Mine, Whitney and Tisdale Townships, Porcupine District, Ontario. The ore was reported to contain 0.45 ounces of gold per ton and 2.95 wt % carbon. Shortly after receipt of the ore, control of the property passed to Pamour Porcupine Mines Limited, Schumacher Division, Schumacher, Ontario.

The sample consists chiefly of siliceous gangue minerals containing numerous disseminated grains of pyrite with minor to trace amounts of sphalerite, chalcopyrite, rutile, hematite, goethite, ilmenite, magnetite, pyrrhotite, and covellite. The principal gangue mineral is quartz with minor mica, chlorite, a black graphitic phase, calcite and trace amounts of dolomite and feldspar.

The gold is present as an electrum with a fairly constant gold to silver ratio of 3:1 in wt %. The electrum occurs mainly as inclusions in pyrite with some present as inclusions in sphalerite, gangue and chalcopyrite, and at the interface between the sulphide grains. The electrum is fine-grained with approximately 85% of the particles between 1 to 20 microns in size**.

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

The reported total carbon content is due in part to the presence of a black graphitic-like phase. It occurs as thin, deformed layers or bands interlayered with mica and cutting the granular quartz. X-ray powder diffraction analysis shows that the constituent is amorphous. In addition, the calcite and dolomite in the ore will also contribute to the reported total carbon content.

CONTENTS



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## SAMPLES

The samples, as received, consisted of a number of small hand specimens, 1 to 2 inches in diameter, and a few hundred grams of minus 1/2 inch head sample. In hand specimens, the rock has a black lustrous appearance indicative of shearing or low-grade metamorphism. The ore was reported to contain 0.45 ounces of gold per ton and 2.95 wt % carbon.

## METHOD OF INVESTIGATION

A number of polished sections and one thin section were prepared from the hand specimens. The head sample was screened into plus 35, 35 to 48-, 48 to 65-, 65 to 100-, 100 to 150-, 150 to 200- and minus 200-mesh fractions. One polished section was prepared from a representative portion of each fraction, except for the plus 35 and minus 200 mesh with the remainder separated into float and sink products using a heavy liquid of 3.30. Polished sections were prepared from the sink products, and, together with the previously prepared sections, were examined under the ore microscope to determine the ore minerals, their grain sizes and associations. The gangue minerals were identified by microscopical examination of the thin section, together with X-ray diffractometer analysis of one of the float products. In addition, some of the other minerals were identified by X-ray powder diffraction methods. Electron microprobe analyses were made of a few of the largest electrum grains for the gold and silver contents, and of the pyrite to determine the presence of arsenic.

## RESULTS OF INVESTIGATION

### General mineralogy of the ore

Based on the examination of the head sample (deemed more representative of the ore than the hand specimens) the principal ore mineral* is pyrite. Rutile, sphalerite, and chalcopyrite occur in much smaller amounts. Also present are trace amounts of electrum, pyrrhotite, goethite, ilmenite, hematite, magnetite and covellite. These latter four minerals were not observed in the polished sections of the hand specimens.

The host rock for the ore minerals is composed principally of quartz. Comparatively small amounts of mica and chlorite, together with even less calcite, dolomite, black graphitic material and feldspar were also identified.

### Occurrence of the gold

The gold occurs as electrum (Au,Ag). Electron microprobe analyses of a number of the larger grains showed that it contains from 70.3 to 77.0 wt % Au, and from 22.6 to 30.4 wt % Ag. Approximately 85% of the observed grains occur as inclusions in pyrite (Fig. 1). The remainder are present either as inclusions in sphalerite (Fig. 2) in gangue (Fig. 3) or at the interface between the sulphides (Fig. 4). One inclusion of electrum was observed in chalcopyrite. The electrum ranges from 1 to 60 microns in size, of which 85% are from 1 to 20 microns. An estimation of grain size distribution shows that 30% of the electrum is smaller than 20 microns.

Examination of the sink products prepared from the various screened fractions of the head sample shows that crushing has caused many of the coarser pyrite grains to fracture and liberate the electrum (Figs. 5, 6 and 7) for recovery by cyanidation, whereas others require further grinding (Fig. 1).

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

Carbon-bearing minerals

The total carbon content of the ore was reported as being 2.95 wt %. A black graphitic-like material was identified, that occurs as clusters or deformed stringers of thin flakes distributed throughout the gangue minerals (Fig. 8). It is usually interlayered with mica. X-ray diffraction analysis shows that this mineral is amorphous. The ore also contains small amounts of the two carbonates, calcite and dolomite. Therefore, some of the total carbon must be due to these two minerals. It is suggested that an attempt be made to determine the percentage of carbon present in the ore as $CO_2$.

Other ore minerals

The dominant ore mineral is pyrite, which occurs entirely as disseminations in the siliceous rock, ranging from a few microns to more than 3 millimetres in size. The pyrite contains inclusions composed principally of rutile and gangue with minor chalcopyrite, pyrrhotite, sphalerite and electrum. These inclusions range from 1 to 400 microns in size. A few pyrite grains have been partially altered to goethite. Electron microprobe analysis shows that the pyrite contains up to 1.4 wt % arsenic. Its average arsenic content is approximately 0.6 wt %.

Rutile, sphalerite and chalcopyrite grains, ranging from about 5 to 400 microns in size, also occur as disseminations in the gangue. Some of the sphalerite contains minute blebs of chalcopyrite (Fig. 2). Pyrrhotite was observed only as inclusions in the pyrite.

Magnetite, covellite, and combined grains of hematite-ilmenite were seen only in the head sample, therefore, their associations are not known.

## CONCLUSIONS

Results of the study show that the gold occurs as electrum, principally associated with pyrite and as inclusions in sphalerite and gangue. The grains range from 1 to 60 microns in size, however, the grain size distribution shows that approximately 30% are smaller than 20 microns. Many of the smaller grains have been liberated to cyanidation through fractures caused by crushing (Figs. 5 and 6), whereas, others (Fig. 1), require finer grinding.

The presence of carbon as an amorphous graphitic-like material has been established. It is not, however, associated to any extent with the pyrite and it is largely dispersed throughout the gangue minerals.

## ACKNOWLEDGEMENTS

The author wishes to express his appreciation to Y. Bourgoin for the heavy liquid separations and the preparation of the polished sections, to R.G. Pinard for the photomicrographs, and to E.J. Murray, of the Crystal Structure Group, for the identification of some of the gangue minerals by X-ray diffraction methods.

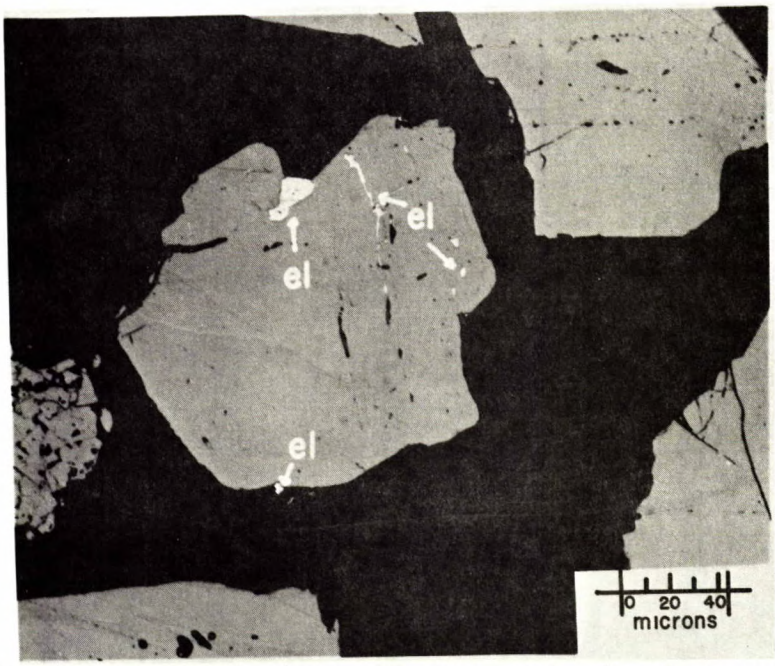


Fig. 1. Photomicrograph (in oil immersion) of a polished section of the sink product from the 65 to 100-mesh fraction of the head sample. The field shows a number of small inclusions of electrum (el) in pyrite (greyish white), two of which are accessible to cyanidation, whereas the others are completely locked.

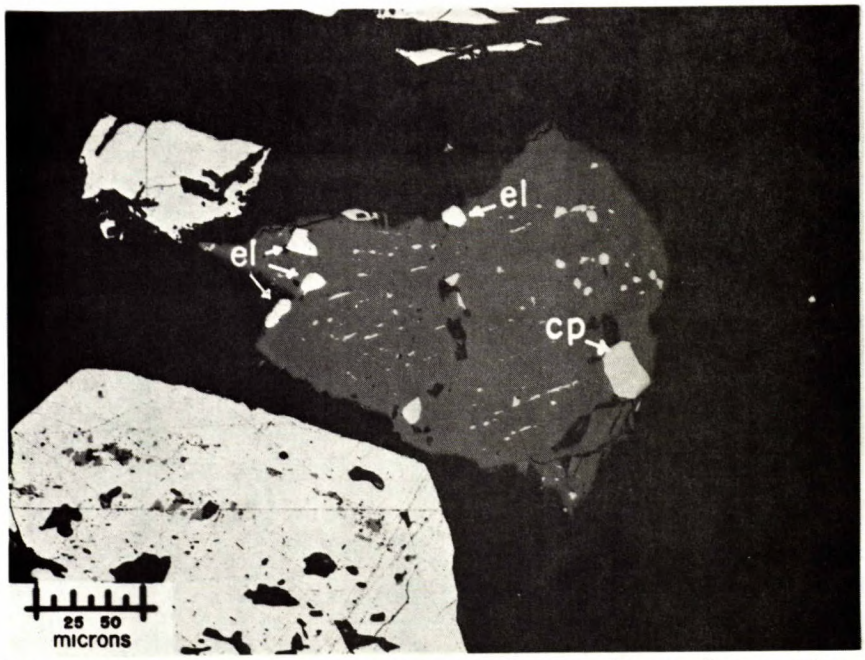


Fig. 2. Photomicrograph of the sink product from the 35 to 48-mesh fraction of the head sample. The field shows four small grains of electrum (el) in a grain of sphalerite (dark grey). The sphalerite also contains numerous small blebs of chalcopyrite (cp). The large white grains are pyrite.

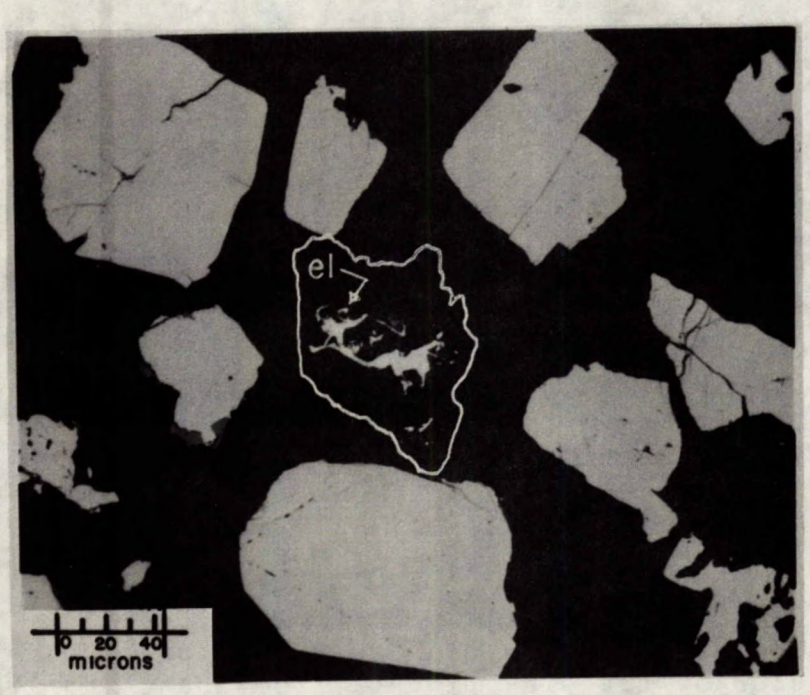


Fig. 3. Photomicrograph of a polished section of the sink product of the 150 to 200-mesh fraction of the head sample. The field shows a grain of electrum (el) in gangue outlined with a white line. The other greyish white grains are pyrite.


Fig. 4. Photomicrograph of a polished section of the sink product of the 65 to 100-mesh fraction of the head sample. The field shows a grain of electrum (el) occurring at the interface between pyrite (greyish white) and chalcopyrite (cp). A small inclusion of sphalerite (sp) occurs in the pyrite.

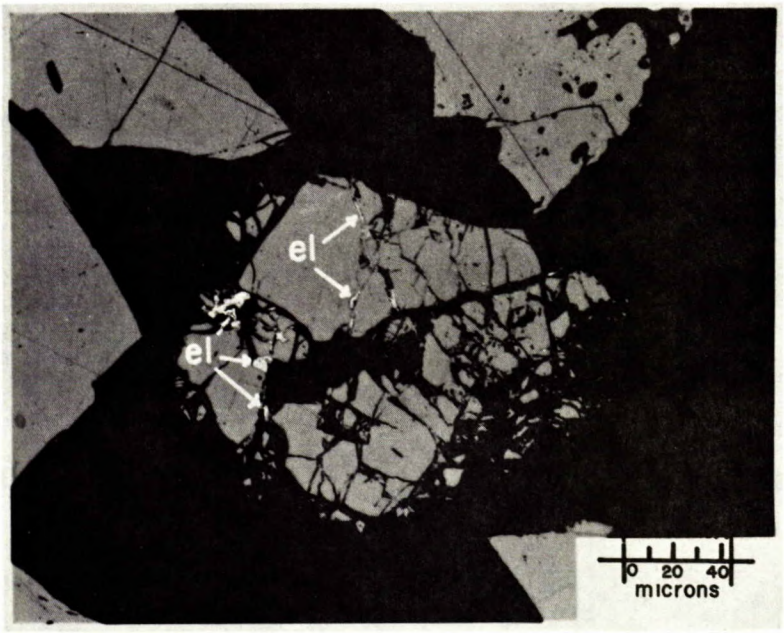


Fig. 5. Photomicrograph (in oil immersion) of a polished section of the sink product from the 65 to 100-mesh fraction of the head sample. The field shows a grain of fractured pyrite (greyish white) containing a number of very small inclusions of electrum (el).

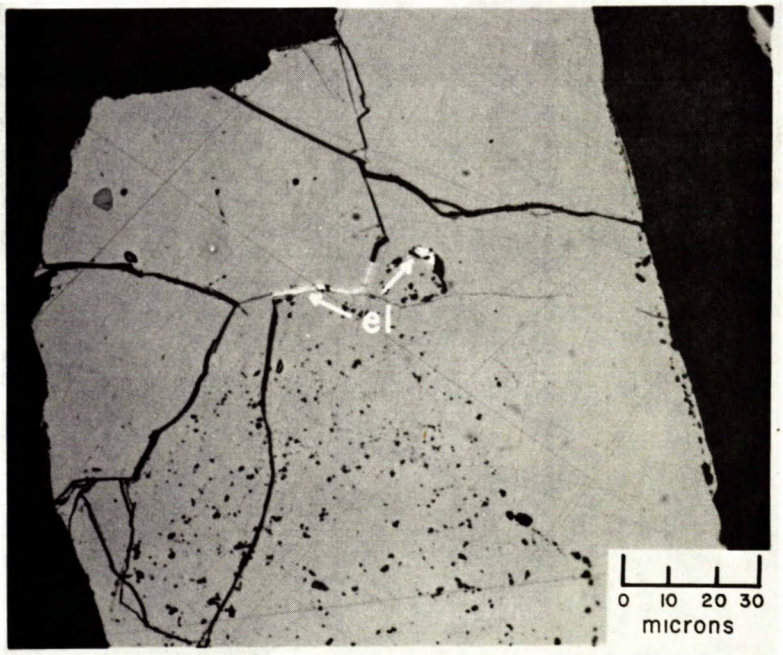


Fig. 6. Photomicrograph (in oil immersion) of a polished section of the sink product from the 65 to 100-mesh fraction of the head sample. The field shows minute inclusions of electrum (el) along fractures in part of a grain of pyrite (greyish white).

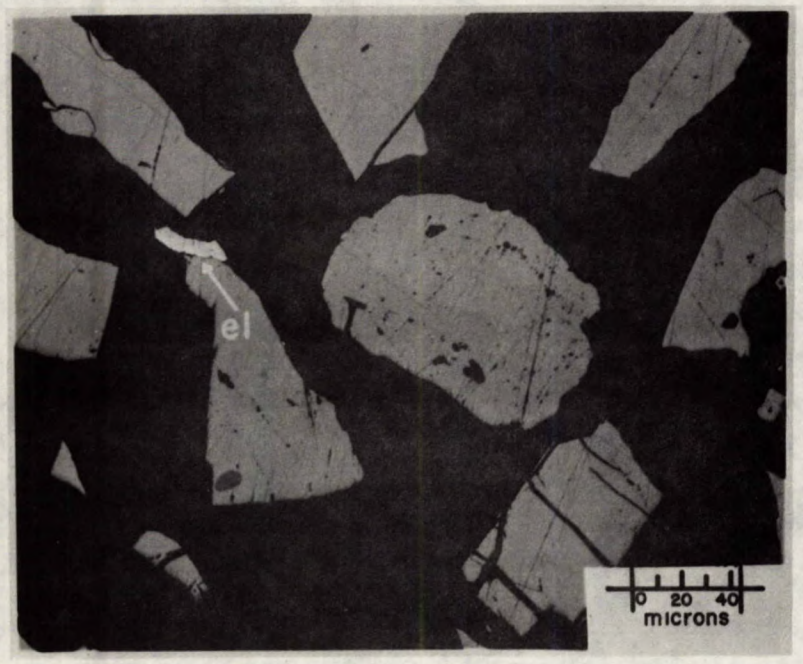


Fig. 7. Photomicrograph (in oil immersion) of a polished section of the sink product from the 150 to 200-mesh fraction of the head sample. The field shows a particle of electrum (el) adhering to a grain of pyrite (greyish white).

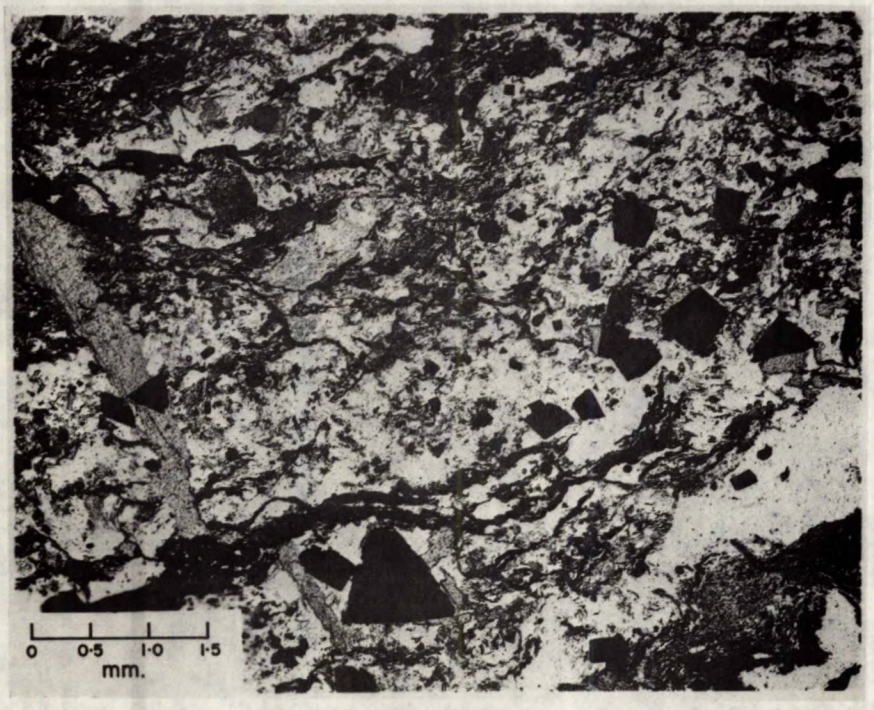


Fig. 8. Photomicrograph of a thin section prepared from a hand specimen. The field shows a matrix composed largely of quartz (white) cut by veinlets of combined graphite and mica (black). A vein of carbonate (light grey) can be seen in the lower left-hand corner of the field. The black euhedral grains are pyrite. The small light-grey areas bordering the pyrite are chlorite.