

MAY MEETING OF THE MINERALOGICAL
SOCIETY OF AMERICA

The "mid-year" meeting of the Mineralogical Society of America was held May 6-7 on the campus of the Sault Ste. Marie Branch of Michigan Technological University in conjunction with the Institute of Lake Superior Geology and the Society of Economic Geologists.

Saturday, May 7

SESSION IIIB

MINERALOGICAL SOCIETY OF AMERICA

Brady Hall

Co-chairmen: L. G. BERRY (Queen's University) and
J. A. MANDARINO (Royal Ontario Museum)

- 9:00 A.M. Michipicoten scheelite deposit near Michipicoten harbour, Ontario. Louis Moyd
9:25 A barite-quartz phase in the Firesand River Carbonatite, Wawa, Ontario
..... E. Wm. Heinrich and Richard W. Vian
9:45 Clay minerals in glacial deposits, Houghton, Baraga and Ontonagon Counties,
Michigan A. P. Ruotsala, G. J. Koons, and S. C. Nordeng
10:05 The Mn-bearing minerals of Champion mine, Champion, Michigan
..... Larry L. Babcock
10:25 Unique intergrowth of calcite and pyrite Paul W. Zimmer
- Pause*
- 11:10 Short-range chemical variations in a managanoan axinite from the Mesabi
Range, Minnesota Bevan M. French
11:30 Textural relations of hematite and magnetite in some Precambrian metamor-
phosed oxide iron formations Tsu-Ming Han

THE MANGANESE-BEARING MINERALS OF CHAMPION MINE,
CHAMPION, MICHIGAN

LARRY L. BABCOCK, *Michigan Technological University, Houghton, Michigan*

Champion Mine is a "hard" iron ore producer on the southern limb of the Marquette synclinorium. The mine vicinity underwent staurolite-grade regional metamorphism during the post-Animikie, pre-Keweenaw interval.

Manganese-bearing quartz shear veins, generally conformable with the schistosity of the host Negaunee iron formation, are found at depths greater than 2,000 feet below the No. 7 shaft collar. These veins cut non-schistose host rock containing major percentages of spessartine and spessartine-andradite, with the former garnet zoned on the latter. Associated minerals include tabular hematite, magnetite, anhydrite, talc, manganese carbonates, diopside, actinolite, and manganose cummingtonite-tirodite. Tourmaline, molybdenite, pyrite and chlorite are associated with some manganese carbonates. Randomly oriented actinolite, hematite, and talc folia, and other criteria indicate that the manganese minerals are late-stage metamorphic. The presence of zoned garnets suggests that the processes of contact metasomatism acted to remobilize primary manganese in an iron-rich environment. Spessartine-andradite (spandite) has been reported from the contact metasomatic manganese ores of India, *i.e.*, "kodurites".

Other manganese minerals under study include jacobsite, rhodonite, rhodochrosite,

manganosiderite, manganankerite, kutnahorite, and several associated unknowns. Jacob-site, $MnFe_2O_4$, has previously been unreported from the Western hemisphere.

Champion represents the first known occurrence of an amphibolite-grade manganese-bearing iron formation in the Western hemisphere, with mineralogical similarities to deposits in Norway, Sweden, India and Japan. Some of the above minerals have been reported from Franklin, New Jersey.

SHORT-RANGE CHEMICAL VARIATIONS IN A MANGANOAN AXINITE FROM THE MESABI RANGE, MINNESOTA

BEVAN M. FRENCH, *Laboratory for Theoretical Studies, National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Maryland*

A new occurrence of the calcium borosilicate axinite has been identified in a pegmatitic vein cutting metamorphosed Biwabik iron formation on the eastern Mesabi Range, Minnesota. The mineral occurs as yellow-brown, poorly-crystalline patches associated with large crystals of quartz and potassium feldspar. Two different size fractions of the crushed axinite, separated by identical heavy-liquid and magnetic methods, give different chemical compositions. Fraction 1 (-100+150 mesh) gives: SiO_2 41.66, TiO_2 0.01, B_2O_3 5.96, Al_2O_3 18.00, Fe_2O_3 0.10, FeO 3.27, MnO 11.66, MgO 0.25, CaO 18.00, H_2O (-110°) 0.04, H_2O (+110°) 1.26, Na_2O 0.15, K_2O 0.02. Fraction 3 (-150+200 mesh) gives, by contrast: Al_2O_3 14.23, Fe_2O_3 1.95, FeO 5.25, MnO 10.60. Similar significant differences exist in unit-cell parameters of the two fractions obtained by computer treatment of x-ray powder diffraction data. An unexpected discrepancy in the calculated unit-cell contents of Fraction 3 can be removed by substituting about 25 per cent of the Mn as Mn^{3+} with aluminum, although the existence of both Mn^{2+} and Mn^{3+} in the same silicate has yet to be demonstrated. Refractive indices of the two fractions appear identical within the determinative uncertainty (± 0.003): $\alpha = 1.678$, $\beta = 1.687$, $\gamma = 1.692$ (Fraction 1).

Petrographic and electron microprobe studies suggest that the more iron-rich axinite (Fraction 3) has originated by fracture-controlled alteration of the original axinite during a period of more widespread secondary alteration indicated by (1) widespread sericitization of feldspar, and (2) almost complete chloritization of garnet. Relative higher pO_2 values during this latter stage are indicated by the increased Fe^{3+}/Fe^{2+} in Fraction 3 and are consistent with the suggested partial conversion of Mn^{2+} to Mn^{3+} .

TEXTURAL RELATIONS OF HEMATITE AND MAGNETITE IN SOME PRECAMBRIAN METAMORPHOSED OXIDE IRON-FORMATIONS

TSU-MING HAN, *Cleveland-Cliffs Iron Co., Ishpeming, Michigan*

Hematite-magnetite is a common ore mineral assemblage in the Precambrian oxide iron-formations. The textural relationship of the two minerals changes with the grade of metamorphism.

In the low-grade metamorphosed iron formations (ore minerals co-existing with fine-grained dusty quartz and/or sheet iron silicates), one may find hematite with magnetite rims; hematite crystal outlines reappearing in partially oxidized magnetite; magnetite veinlets in fine-grained hematite; fractures in hematite bands cross-cut by magnetite; and magnetite crystals embedded in jaspilites. These textural relations suggest that magnetite is stable whereas hematite tends to be reduced to magnetite during the metamorphism.

The iron formations of medium-grade metamorphism (ore minerals co-existing with medium-grained fairly clean quartz and/or double-chain iron silicates), specularite embedded in fine-grained magnetite; specularite containing magnetite remnants; magnetite

cross-cut by specularite; and specularite bands with relicts of magnetite clusters are commonly observed. Such features suggest that during the metamorphism specularite is a stable phase whereas magnetite tends to be oxidized to specularite.

Hematite and magnetite in iron formations of high-metamorphic order are more or less simultaneously developed, and commonly associated with coarse-grained clear quartz and/or double- and single-chain iron-rich silicates. However, the cross-cutting of specularite by magnetite in some ores may suggest the earlier development of specularite.

In conclusion, reduction and oxidation do occur in iron formations during metamorphism, although in general ore mineral assemblages are governed by those of the pre-metamorphic sediments. Such processes are believed to be responsible for the development, at least in part, of the magnetite-bearing jaspilite, oölitic magnetite, and specularite-magnetite ore types. The degree of such types of metamorphism tends to improve the concentrating characteristics of ores and has a direct effect on the process chosen for iron ore beneficiation.

A BARITE-QUARTZ PHASE IN THE FIRESAND RIVER CARBONATITE, WAWA, ONTARIO

E. WM. HEINRICH AND RICHARD W. VIAN, *The University of Michigan,
Ann Arbor, Michigan*

The Firesand River alkalic complex, 4.5 miles east of Wawa, Ontario, is unusual in that it consists predominantly of carbonatite with a highly subordinate outer ring of mafic to ultramafic alkalic silicate rock. The carbonatite core is composite, with an inner core of rauhaugite encircled by sövite and silicate sövite. The ferruginous rauhaugite body, which appears to be pipe-like and vertical (in contrast to the sövite ring, which represents the accretion of a series of inward-dipping cone-sheet slices), is itself a composite of several texturally and mineralogically distinctive rocks. Among these are 1) a porphyritic phase in which calcite phenocrysts are set in a finer-grained matrix of iron-bearing carbonate; and 2) a barite-quartz-carbonate rock. This rock contains barite euhedra, quartz grain fragments deeply corroded by carbonate, and euhedral smoky quartz crystals, some as long as three inches. Most of the quartz grains appear to have been metamorphosed, showing undulatory extinction, mosaic structure, and a strong parallel alignment of "bubble train" inclusions. Against the carbonate they are locally armored by "reaction rims" of very fine-grained ferruginous apatite.

It is concluded that this unusual rock was formed by the carbonatization of a quartzite xenolith cut by small quartz veins into which were introduced (in order): 1) barite, 2) apatite and 3) carbonate.

MICHIPICOTEN SCHEELITE DEPOSIT NEAR MICHIPICOTEN HARBOUR, ONTARIO

LOUIS MOYD, *National Museum of Canada, Ottawa, Canada*

A scheelite deposit on the shore of Lake Superior about 12 miles west of Michipicoten Harbour was explored. The host rock is a nearly vertical, northwest-trending septum of biotite and hornblende schist about 200 feet thick enclosed in a large body of granodiorite. Scheelite is irregularly distributed through quartz pods which form vein-like elongate swarms along the central portion of the tabular mass of schist. The mineralized zone can be seen under the lake and has been traced inland for about a mile.

The quartz pods are lenticular and vary greatly in size. Each swarm consists of pods, side by side or *en echelon* in both horizontal and vertical aspects, with long axes paralleling

the foliation of the enclosing schist. Individual swarms may reach 30 feet in width, but are irregular and patchy, with some portions along the strike of the zone nearly free of the pods.

Individual pods are separated by septa of contorted schist from a fraction to several inches in width. Locally, adjoining portions of two or more pods have coalesced, with the intervening schist completely replaced or now represented only by strings and patches of coarsely crystallized mica and feldspar.

The scheelite is in the form of cream to buff anhedral grains and clusters from $\frac{1}{8}$ inch to about 12 inches in diameter. Most of the scheelite occurs near the margins of the pod, or if well within them, along the zones of coarsely crystallized mica and feldspar which represent earlier schist septa.

CLAY MINERALS IN GLACIAL DEPOSITS, HOUGHTON BARAGA, AND ONTONOGAN COUNTIES, MICHIGAN

A. P. RUOTSALA, G. J. KOONS AND S. C. NORDENG, *Michigan Technological University Houghton, Michigan*

The clay-sized fractions from surficial glacial tills, outwash, and lacustrine deposits from thirteen Baraga, Houghton, and Ontonogon County localities have been examined by x -ray diffraction. Results show that the clay fraction of most recent deposits consist of illite (clay-mica) and chlorite approximately in equal amounts. Clay fractions from older glacial deposits contain either montmorillonite or degraded illite in addition to illite-chlorite. Basal reflections typically consist of single broad 12.6 Å peaks or double 11.2–12.6 Å peaks which expand to 14 or 17 Å upon treatment with ethylene glycol. Those which expand to 14 Å collapse to 10 Å upon treatment with KBr.

The differences in clay mineralogy with depth may represent a weathering sequence in the local area and suggests the possibility of correlation of glacial deposits on the basis of clay mineralogy.

A UNIQUE INTERGROWTH OF CALCITE AND PYRITE

P. W. ZIMMER, *The Hanna Mining Company, Iron River, Michigan*

A rather unique intergrowth of calcite and pyrite is here described. These crystals were found in the Groveland Iron Mine of The Hanna Mining Company near Iron Mountain, Michigan. The regional geological setting of where the crystals were found is summarized from *U.S.G.S. Professional Paper 310*.

The pyrite and the calcite show evidence of simultaneous crystallization. The pyrite grew on the vertical symmetry planes of the calcite. The calcite has a simple habit with only the prism and the negative rhombohedron. The negative rhombohedron was indicated by the relationship to the cleavage. The cleavage of calcite is parallel to the positive rhombohedron. The pyrite also has a simple habit with only the cube or cube and octahedron observed.

The orientation of the two crystals is such that the dodecahedron of the pyrite, although not developed, is parallel to the negative rhombohedron of the calcite. While the pyrite grew on the vertical symmetry planes of the calcite, the symmetry planes of the pyrite are not necessarily parallel to the symmetry plane of the calcite. The $d(110)$ spacing of the pyrite is 3.82 Å and the $d(0112)$ spacing of the calcite is 3.86 Å or a difference of .04 Å. This is an example of epitaxy and explains the trifoliated pattern of the pyrite.

Such parallel intergrowths may be used as characteristic of simultaneous crystallization. Further work in epitaxy with ore minerals may throw more light to the study of paragenesis.