ABSTRACTS OF PAPERS PRESENTED AT THE ELEVENTH ANNUAL MEETING

A NEW OCCURRENCE OF SAPPHIRINE IN SALVADOR, BAHIA, BRAZIL

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Sapphirine $(Mg, Fe)_2Al_4SiO_{10}$ was found within a single spherical mass of phlogopite-spinel bronzitite in Precambrian hypersthene granulites. The granulites are interlayered with quartzofeldspathic granulites, garnet-sillimanite granulites, hornblende granulites, and spinel diopsidites. Locally, the granulites are intersected by aplitic dikes genetically related to the quartzofeldspathic granulites.

Sapphirine is part of a bronzite-spinel-phlogopite-cordierite-plagioclase-garnet-perthite assemblage. It occurs both as symplectitic intergrowths in bronzite and as a replacement product of phlogopite, bronzite, and spinel. In outcrop, the sapphirine-cordierite-plagioclase-perthite assemblage is more abundant in the outer and intermediate portion of the bronzitite mass. In thin sections, this assemblage commonly occurs along cleavage and parting planes of the coarse bronzite crystals as well as along grain boundaries within the mass.

The sapphirine-bearing body is believed to be of sedimentary origin because of the concretion-like geometry, unusual bulk composition, and the presence of abundant detrital zircons.

The coarse-grained bronzitite mass differed in competence from the fine-grained hypersthene granulites. Metamorphism and deformation caused shattering of the outer edges of the bronzitite body facilitating the ingress of solutions rich in K, Na, and Si which replaced the bronzite, spinel, and phlogopite by cordierite, minor plagioclase and perthite, and sapphirine.

COMPOSITION, STRUCTURE AND TEMPERATURE OF STABILITY OF NATURAL AND SYNTHETIC PYRRHOTITES

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The composition and structure of the phases identified in natural pyrrhotite from 82 North American and European deposits are as follows (atomic % metals): hexagonal FeS – 50.0, hexagonal $Fe_{1-x}S$ – 48.1 to 47.5, monoclinic $Fe_{1-x}S$ – 46.5. All phases possess a supercell. Seventy-five per cent of the pyrrhotites examined are two-phase mixtures of hexagonal $Fe_{1-x}S$ and monoclinic $Fe_{1-x}S$; 13 per cent are single-phase, hexagonal $Fe_{1-x}S$; 7 per cent are monoclinic $Fe_{1-x}S$; and 5 per cent are two-phase mixtures of FeS and hexagonal $Fe_{1-x}S$. Two-phase mixtures of FeS and hexagonal $Fe_{1-x}S$ occur as lamellar intergrowths and are readily detected on unetched polished surfaces. Intergrowths of hexagonal $Fe_{1-x}S$ and monoclinic $Fe_{1-x}S$ can be detected on etched polished surfaces. X-ray diffraction methods cannot detect less than 10 weight per cent of the minor phase in a mixture, whereas less than 1 weight per cent of the minor phase can be detected on polished surfaces. The pyrrhotites examined are interpreted to be low temperature phases.

Preliminary low temperature heating experiments on both natural and synthetic pyrrhotites, sealed in evacuated silica-glass tubes, indicate that two-phase mixtures of FeS and hexagonal $Fe_{1-x}S$ are stable up to approximately 110 °C. A one-phase hexagonal $Fe_{1-x}S$ unmixes FeS in less than 90 days at 100 °C. The composition of hexagonal $Fe_{1-x}S$

coexisting with FeS varies in composition from 47.8 atomic % metals at 20 °C to 48.5 atomic % metals at 100 °C. Monoclinic $Fe_{1-x}S$ is stable up to approximately 310 °C. Hexagonal $Fe_{1-x}S$ inverts to monoclinic $Fe_{1-x}S$ in less than 60 days at 305 °C.

CRYSTALLOGRAPHY OF HATCHITE

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One crystal of hatchite, from the British Museum collections, corresponding to figure 1 in the original description by Solly and Smith (1912), is triclinic, with lattice dimensions $a = 7.71$, $b = 7.92$, $c = 9.13$ Å, $\alpha = 116°31$, $\beta = 85°55'$, $\gamma = 112°57'$, $a:b:c = 0.973:1:1.153$ in reasonable agreement with the morphological data. The least oblique cell in the normal setting, with $a = 7.92$, $b = 9.03$, $c = 7.71$ Å, $\alpha = 105°40'$, $\beta = 112°57'$, $\gamma = 64°48'$ is related to the morphological setting by the matrix (old to new) 010/011/100.

SUBSOLIDUS STUDIES IN THE ZnS–FeS–FeS_2 SYSTEM

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The sluggish nature, measured in periods up to twelve months, of solid state reactions in the Zn-Fe-S system has hampered the low temperature phase studies of earlier workers. New techniques were devised involving special starting material preparation and fluxing which made it possible to grow (Zn, Fe)S crystals in equilibrium with pyrrhotite and pyrite in less than a week at 400 °C. The sphalerite solvus in the ZnS-FeS-FeS_2 system was investigated from 714 °C to a new low temperature of 303 °C. The results of this study differ from those of Kullerud (1953), but are in excellent agreement with the Barton & Toulmin (1963) data over their range of experimentation, (743 °C – 580 °C).

After reaching a FeS composition maximum at 580 °C, the sphalerite solvus drops vertically at a constant composition of approximately 21 mole per cent FeS to the hexagonal-monoclinic pyrrhotite inversion temperature. It does not bend towards 0 mole per cent FeS at 0 °C as postulated by Barton & Toulmin. At 303 °C hexagonal pyrrhotite, pyrite and sphalerite constitute the equilibrium assemblage on the sphalerite solvus. Monoclinic pyrrhotite was present in runs at 210 °C.

Preliminary studies indicate that (Zn, Fe)S crystals, synthesized in equilibrium with monoclinic pyrrhotite and pyrite, have a higher FeS content than do sphalerites in equilibrium with hexagonal pyrrhotite and pyrite, synthesized immediately above the pyrrhotite inversion temperature.

INDIUM IN CO-EXISTING MINERALS FROM THE MOUNT PLEASANT TIN DEPOSIT

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At Mount Pleasant 2.1, 1.18, 0.19, 0.11 and 0.04 weight per cent indium was determined by electron microprobe analyses in the co-existing sulphides isostannite, sphalerite, chalcopyrite, chalcocite and hexastannite respectively. The associated cassiterite contains a maximum of 0.03 weight per cent indium. Although high indium values are characteristic of certain sulphide minerals from the cassiterite-sulphide-silicate type of tin deposit, at Mount Pleasant the indium contents are larger than previously recorded for this type of mineralization.

Isostannite and chalcopyrite have derivative structures of sphalerite which, like the latter, are based on metal atoms in tetrahedral co-ordination with sulphur. The similarity of the metal-sulphur bonds (2.32–2.43 angstroms) and the indium-sulphur bond (2.53 angstroms) might be an important control on indium substitution.