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LETTER

Nanoscale "liquid" inclusions of As-Fe-S in arsenian pyrite

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ABSTRACT

A new mode of arsenic incorporation into arsenian pyrite has been discovered. Electron microprobe analyses and elemental maps of arsenian pyrite from Pueblo Viejo, Dominican Republic, show that its chemical composition varies from $(Fe_{0.998}As_{0.003})_{1.001}S_2$ to $(Fe_{0.963}As_{0.050}Cu_{0.003}Ag_{0.001})_{1.017}S_2$ and that arsenic is inversely correlated with Fe. High-resolution transmission electron microscopy (HRTEM) images show that some arsenic in this pyrite is present as nanoscale inclusions of amorphous As-Fe-S in a matrix of arsenian pyrite. The amorphous inclusions display negative facets with a cubic or rectangular morphology, typical of negative inclusions of pyrite and arsenopyrite or marcarsite, respectively, and they are oriented parallel to the lattice fringes (100) of the arsenian pyrite matrix. Elemental maps collected by high-angle annular dark-field scanning transmission electron microscopy (HAADF-STEM) show that the inclusions have a higher content of arsenic than the surrounding pyrite, and TEM-EDX analyses indicate approximate atomic proportions of 62 at% S, 28 at% Fe, and 10 at% As for the inclusions, which are near the minimum melting temperature in the As-Fe-S ternary. These observations suggest that the inclusions were trapped as liquids during growth of the surrounding arsenian pyrite. Although not a new mineral, this constitutes a third form for arsenian pyrite, which has previously been shown to contain arsenic as either As^{1-} or As^{3+}.

Keywords: Arsenian pyrite, arsenic, inclusion, Pueblo Viejo, HRTEM