American Mineralogist, Volume 103, pages 1200–1207, 2018

Sulfide partial melting and chalcopyrite disease: An experimental study

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Abstract

Speckling of sphalerite with micrometer-sized blebs of chalcopyrite is usually referred to as "chalcopyrite disease." Fe-rich sphalerites are particularly prone to chalcopyrite disease. Considering the low degree of solid solution between sphalerite and chalcopyrite, exsolution is discarded as a process to explain the development of chalcopyrite disease. Diffusion-controlled replacement of Fe by Cu, and sphalerite-chalcopyrite co-precipitation are invoked as the most probable mechanisms. Although metamorphism is expected to dispel inhomogeneities through recrystallization, chalcopyrite disease interestingly appears unaffected and to be quite common in metamorphosed sulfide ores. We have conducted experiments on different bulk compositions in the system ZnS-PbS-FeS-Cu_2S-As_2S_3 at 600 °C and annealed the run products containing melt at 350 °C to evaluate the role of sulfide partial melting, if any, in the development of chalcopyrite disease. The results indicate that chalcopyrite blebs developed only in those sphalerites that contained Fe and in which S atoms were in excess over Fe + Zn atoms. Also it was observed that the occurrence of Fe-bearing sphalerite and the sulfide partial melt (that invariably was S-deficient and Cu-enriched) in direct contact with each other was necessary for the chalcopyrite blebs to form. We propose nonstoichiometry-driven diffusion of Cu as the mechanism and sulfide partial melting as the principal causative factor behind the development of chalcopyrite disease in sphalerite. Chalcopyrite disease thus may be used as an easily identifiable potential indicator of sulfide partial melting in metamorphosed base metal sulfide deposits.

Keywords: Chalcopyrite disease, chalcopyrite blebs, sulfide partial melting, nonstoichiometry, sphalerite; Planetary Processes as Revealed by Sulfides and Chalcophile Elements