Sulfide partial melting and chalcopyrite disease in sphalerite

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Chalcopyrite disease in sphalerite is characterized by the presence of variable amounts of variably sized blebs of chalcopyrite in sphalerite. Diffusion controlled replacement of Fe-rich sphalerite is accepted to be the mechanism behind the production of such inclusions [1,2]. However, sphalerite-chalcopyrite co-precipitation also has been proposed as a viable mechanism [3]. Chalcopyrite disease developed in sphalerite in an experimentally produced assemblage of sphalerite + galena + melt in the system ZnS-PbS-FeS-Cu_2S-As_2S_3 at 600 °C when annealed at 350 °C. Diffusion of Cu into sphalerite occurred from the quenched melt, which contained 21.89 atom % Cu, 14.59 atom % Pb, 11.77 atom % As, 3.69 atom % Fe, 0.48 atom % Zn and 47.58 atom % S. Chalcopyrite disease seems to develop in the Fe-rich part as a whole within zoned sphalerites rather than the compositionally steep interfaces where lattice strains may be focussed and favor diffusion [1]. We observe higher S/(Zn+Fe) in spahalerites in our experiments and similar non-stoichiometry has been also reported in natural sulfide samples that has undergone partial melting during prograde metamorphism [4]. We propose that this non-stoichiometry in S is the main driving force for the diffusion of Cu and the formation of chalcopyrite disease in sphalerite. It may be favored by sulfide partial melting as low-T sulfide partial melts are invariably enriched in Cu and are S-deficient in nature [4,5].

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