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Textures of the Hellyer Volcanic-Hosted Massive Sulfide Deposit, Tasmania—the Aging of a Sulfide Sediment on the Sea Floor

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Abstract

The relatively undeformed, polymetallic, massive sulfide ore of the Hellyer deposit retains many textures developed during the early crystallization history. Common textures in the least modified ore away from the main feeder zone include pyrite framboids, concentric- and radial-textured spheres, dendritic and fibrous forms, breccias, mineral banding, veins, and reniform and crustification textures. Many are typical of early crystallization within a medium at high degrees of supersaturation, some result from open-space filling, and others indicate disturbances of the sulfide mass possibly due to tectonic activity and volume adjustment; the banding could be due to current winnowing. Most of these textures are found in modern midocean ridge and Kuroko massive sulfide deposits, but at Hellyer the framboids are much more common. Hexagonal outlines in ore sphalerite indicate derivation of much of the sphalerite by inversion of wurtzite. The high content of chalcopyrite in the wurtzite-derived sphalerite appears in most cases to have developed by exsolution rather than replacement or coprecipitation (although there is local evidence of both processes having operated), possibly resulting from early asymmetrical crystal growth. Comparison of Hellyer ore and typical Kuroko ores reveals other differences than framboid abundance (e.g., metal contents and ratios, mineralogy, and sulfur isotope compositions), the most significant of which are the relatively high salinities of the Hellyer ore fluids. These, together with evidence of a coeval basin, imply sulfide deposition in a brine pool, as previously proposed. The development of a quenched sulfide mud at the bottom of a basin filled with spent ore fluid, with little or no involvement of seawater, explains the different mineral content (e.g., lack of Fe oxides, scarcity of barite in the massive sulfide, and the pyrite-arsenopyrite assemblage), the high metal content, lack of chimney structures, and differences in sulfur isotope compositions. The sulfide mud, dominated by Fe-S phases, would be an ideal growth medium for framboidal pyrite.

The weight of experimental evidence concerning the development of framboidal pyrite points to involvement of metastable precursor Fe-S phases, such as mackinawite and greigite, in a weakly oxidized environment. Oxygen may have been added to the reduced, acid brine pool as a result of inward diffusion of oxygen from overlying seawater, which is shown to have been oxic by the presence of sessile benthic dendroids in the shales overlying the ore deposit. However, the level of oxidation was insufficient to form marcasite.