

Geochemical Characterisation of the Orion Massive Sulfide Deposit and Surrounding Prospects, Wunaamin Miliwundi Orogen, Western Australia

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Massive sulfides have been recently intercepted undercover at the Orion prospect in the Paleoproterozoic Wunaamin Miliwundi Orogen, Western Australia. The deposit style has so far been unclear with limited exploration drilling.

The mineralogy of the Orion prospect consists primarily of pyrite–pyrrhotite–chalcopyrite–sphalerite ± galena ± sulfosalts hosted by the Paleoproterozoic Ruins Dolerite and Marboo Formation metasediments. $\delta^{34}\text{S}$ data from sulfides at Orion measured in situ by SHRIMP-SI had a range of 2.4 – 8.3 ‰, consistent with a Volcanogenic Massive Sulfide (VMS) origin. Sulfur is modelled to have been derived from mixing leached volcanic sulfur and reduced seawater sulfate. $\delta^{18}\text{O}_{\text{H}_2\text{O}}$ values of 1.0 – 4.5 ‰ were calculated based on fluid temperatures of 250–350 °C, comparable to VMS deposits.

Assemblages of Se-enriched galena, Bi-Sb alloys and various Bi-Ag-Pb sulfosalts are present throughout the ore. These are low melting point chalcophile elements (LMCEs) which lower the melting point of sulfides. Based on their chemical and textural evidence, the sulfide assemblages are interpreted to be the result of sulfide partial melting during greenschist facies metamorphism. Precursor sulfosalts likely acted as nucleation sites for melting which facilitated diffusion of trace LMCEs from the surrounding sulfide into the melt. Immiscible melt fractionation resulted in assemblages of early sulfides followed by sulfosalts and alloys.

Orion is interpreted to be a metamorphosed VMS deposit that has undergone partial sulfide melting. Remobilisation may have occurred on a larger scale, potentially invalidating the standard VMS exploration model at this deposit. Cassiterites in the ore were dated to a ^{208}Pb -corrected $^{206}\text{Pb}/^{238}\text{U}$ age of 457 ± 12 Ma using SHRIMP-RG. This age likely represents a resetting of the cassiterite U-Pb system during a Phanerozoic alteration event postdating the youngest recognised c. 590-500 Ma Wunaamin Miliwundi Orogeny, potentially extending the duration of this orogeny.