Mineralization and Paragenesis of the South Vulcan IOCG Prospect, South Australia

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The Vulcan iron oxide copper-gold (IOCG) prospect is located in the eastern Gawler craton, 30 km northeast of Olympic Dam, South Australia. Mineralization is basement-hosted hematite-sericite-chlorite-carbonate breccias of a nature similar to other Gawler craton IOCG systems. Geophysical data show two main anomalous high-density areas, with this research examining Vulcan South. Highest-grade mineralization occurs in hematite breccias, with the best intercept to date at Vulcan South being 163 m at 0.23% Cu and 0.08 g/t Au. Basement is covered with 800 to 900 m of Adelaidean and younger sedimentary cover, a depth which has led to relatively poor understanding of basement in the region.

This study set out to identify the breccia protolith and develop a breccia and mineralization paragenesis. Key tools used to achieve this included detailed core logging, petrology, U-Pb geochronology (zircon LA-ICP-MS, monazite LA-ICP-MS, and monazite microprobe chemical analysis), and SEM mineral identification.

Geochronology shows the South Vulcan breccia complex is housed in brecciated equivalent to paragneiss found in historic WMC drill hole SHD1. Clasts also include fragments of mylonite between the Cooyerdoo Granite and the Sleaford Complex in age, along with undeformed sediment fragments with a maximum depositional age of 1625 ± 10 Ma.

Breccias were classified as one of 10 facies based on cement type, and then clast and matrix type, size and morphology, internal organization, and profile geometry were used to further group 15 subfacies. Breccias are interpreted to have formed through a combination of tectonic, hydraulic, and hydrothermal breccia processes which included at least four hydrothermal iron oxide brecciation cycles. Iron oxide evolved from magnetite dominant to hematite dominant, before a late partial overprint to ochreous hematite. Pyrite was introduced early in this evolution and has been recycled through subsequent hematite brecciation events. Undeformed sediment clasts imply hematite breccias either breached the paleosurface or sampled shallow subsurface portions of a sedimentary basin.

Textural and spatial relationships in the South Vulcan hematite breccias indicate copper mineralization occurred as a result of chalcopyrite replacement of anhydrite and possibly as direct void infill (although these observations may not apply in the higher-grade North Vulcan). Remnant anhydrite occurs inside quartz-rimmed voids, providing temporal relationships of initial quartz rimming of voids, followed by anhydrite infill, after which copper was introduced. Only very minor chalcopyrite is attributed to pyrite replacement. Textural and crosscutting relationships further show copper was introduced after all cycles of brecciation had ceased and also postdates shallow emplacement of intermediate dikes. Geochronology implies that the complete process of (1) hematite breccia formation post-H1 subfacies, (2) dike emplacement, and (3) quartz, anhydrite, and copper-bearing fluid infiltration occurred between 1625 and 1586 Ma.