Volcanosedimentary and Chronostratigraphic Architecture of the Host Rock Succession at Prominent Hill, South Australia

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The Prominent Hill deposit occurs at the contact between two different basin phases separated by a disconformity/unconformity. The older succession that hosts the orebody dominantly comprises metasediments that have been affected by multiple phases of alteration including sericite, hematite, chlorite, quartz, and carbonate. It also includes mafic units (lava flows, dikes, or sills) and carbonate units, including one that is immediately south of the hanging-wall fault zone that cuts the pit. The protolith to this succession appears to have been poorly sorted, subwave base, clastic turbiditic, debris flow and hemipelagic sediments with intercalated carbonate reefs that is provisionally interpreted to record a shallow marginal marine environment. This facies association, in combination with limited detrital zircon geochronology, suggests that this succession is a correlate of the Wallaroo Group.

The younger basin phase comprises a southward-facing succession of high-energy, oxidized clastic sediments deposited in a subaerial setting, probably an alluvial and/or fluvial plain. Sedimentation was locally disrupted by extrusive bimodal volcanism, probably accompanied by high-level intrusive activity. At one point a series of basal flows dammed the channel system and formed a lake into which volcaniclastic debris eroded from the basaltic deposits was shed. Both sedimentary and volcanic units are relatively unaltered and have well-preserved original textures. Although the succession dips steeply to vertically, it otherwise resembles parts of the Gawler Range Volcanics as described in the literature, especially the lower bimodal part. Limited detrital and magmatic zircon studies confirm this interpretation.

Although this study did not examine the mineralization, the occurrence of ore in/around the basal unconformity of the Gawler Range Volcanics is broadly similar to that recently proposed for the giant Olympic Dam deposit. In a broad sense, this tectonostratigraphic position is also similar to that which controls the formation of basement-hosted unconformity-related U deposits. In these systems, it is interpreted to be either a site of enhanced mixing of reduced basement- and oxidized basin-derived fluids or a zone where the latter can interact with reductants in the basement. This study has not considered the mineralizing process at Prominent Hill, but it is clear that the former scenario fits with some of the ideas on the genesis of IOCG deposits in general that propose ore formation in response to mixing of high-temperature, reduced (magmatic?) fluids with oxidized basinal brines.