Petrography and Provenance of Bedded Sedimentary Units Within the Olympic Dam Deposit

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The tectonic-hydrothermal breccia complex that hosts the supergiant Olympic Dam Cu-U-Au-Ag deposit occurs within a Mesoproterozoic Hiltaba Suite granite pluton. The majority of the hematite-rich breccia complex comprises clasts of relatively unaltered to intensely hematite altered granite, with subordinate volumes of volcanic clasts, mafic dikes, and bedded sedimentary units. Mainly located near the top of the breccia complex, these sedimentary rocks occur as clasts and large blocks (up to 1.3 km in extent). The sedimentary units played a major role in defining the diatreme model of Olympic Dam. However, information regarding their petrography, mineralization, and age is scarce.

Approximately 100 samples from the two largest sedimentary blocks in the deposit were used to describe three distinct facies: (1) red mudstone and sandstone, (2) green mudstone and sandstone, and (3) polymictic conglomerate. The red mudstone and sandstone is typified by interbedded hematite-rich mudstone and granitoid-derived quartz sandstone. Both red and green mudstone and sandstone facies are found to contain minor copper sulfide mineralization as well as detrital zircon and tourmaline. In the red mudstone and sandstone these heavy minerals occur in crossbeds with hematite. The green mudstone and sandstone is dominated by chlorite-altered, mafic volcanic clasts with textures ranging from glassy to porphyritic. Felsic, feldspar-phyric volcanic, and granite clasts are abundant, whereas volcanic quartz is relatively uncommon. Chromite occurs in a subset of mafic clasts and as detrital grains. The conglomerate is a polymictic assemblage of felsic volcanic and subordinate mafic volcanic, granite and hematite clasts.

Zircon U-Pb geochronology and analysis of volcanic quartz melt inclusions were employed in order to further constrain the provenance of the sedimentary units. Zircons from the red and green sandstone and mudstone facies yield a uniform U-Pb age of ≈1590 Ma, which correlates with the coeval Hiltaba Suite granites and Gawler Range Volcanics. The Hiltaba Suite is interpreted as a probable source of the granitoid components of the red mudstone and sandstone. It is possible the hematite in the red mudstone and sandstone was derived from the hematite-rich breccia complex. The preponderance of felsic and mafic volcanic clasts suggest the green mudstone and sandstone was primarily derived from the Gawler Range Volcanics. Varied detrital chromite compositions further indicates a broad provenance. The compositions of the volcanic quartz melt inclusions indicate a potential rhyolitic contribution to the green mudstone and sandstone.