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The Discovery and Mining of the Olympic Dam Deposit: Impacts on the Optimization of Exploration and Mining/Processing of Complex Ores

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Drilling of RD1 in July 1975 marked the discovery of the Olympic Dam breccia-hosted Fe-oxide Cu-U-Au-Ag deposit. The discovery was the culmination of approximately two decades of exploration for copper deposits across Australia by the former Western Mining Corporation. It is one of the renowned exploration success stories of the twentieth century, highlighted by the use of a mineralogy-based, holistic source-transport-trap system approach for generating conceptual exploration models and exploring "undercover" through flat lying, unaltered sedimentary rocks varying in thickness from at least 250 m in remote areas of South Australia. The Olympic Dam (OD) discovery ultimately ignited the recognition of a new class of deposits, iron oxide Cu-Au (IOCG). The global significance of OD is the amount of recoverable contained metals; it is the world’s single largest accumulation of U and one of the largest Cu and Au deposits.

The deposit (~6x3 x 0.8 km deep, locally extending to >2.3 km depth) is hosted within the Olympic Dam Breccia Complex which is derived from weak to intense brecciation and texturally destructive iron metasomatism of the ~1594 Ma Roxby Downs Granite and lesser abundant lithologies (i.e., bedded clastic facies, felsic to mafic to alkaline ultramafic lavas and dykes). OD represents preservation of a post-mineral disrupted, shallow system, hence its somewhat unique character amongst IOCGs. Copper ± Fe sulfide, uranium, and gold and silver mineralization dominantly occurs as <200-micron-sized grains typically disseminated throughout the breccia matrix. Vein-style mineralization is rare. There is an unequivocal spatial relationship of Cu-U-Au-Ag with Fe at the macro- to nano-scale. The deposit also contains geochemically anomalous concentrations of a wide range of elements, including, but not limited to, REEs and other critical metals. Over 100 minerals are present, each with its own unique response (positive, benign, or deleterious) to each part of the metal recovery process. However, less than 25 sulfide, uranium, gangue, and As-, Se-, Te-, Bi-, Sb-bearing minerals account for >99.5% of the deposit mass and are critical to processing.

Metal production at OD commenced in 1988. Mining occurs via sublevel open stoping where ore is hoisted to the surface and processed onsite through a fully integrated metallurgical processing facility to produce Cu-cathode, gold and silver bullion, and uranium oxide concentrate. The presence of uranium and its associated short half-life radionuclides requires Cu-Au-Ag final products to contain extremely low concentrations of U and radionuclides prior to shipping offsite. A high level of complexity in processing OD ores is thus introduced because Cu-Au-Ag and U require multiple processing streams (i.e., milling, sulfide flotation, tailings leach, solvent extraction, solid-liquid separation, concentrate leach, flash and electric furnaces, sulfuric acid plant, ER and EW Cu refineries, and precious metals refinery) for economic recovery. This necessitates game-changing geometallurgical characterization. More than 30 elements (and density and mineralogy) of ore and waste across the deposit, along with fifty geometallurgical predictors of processing performance, are populated into each of the 20M blocks in the resource model, hence serving as the fundamental input into immediate and future planning of the OD asset.