Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.28764

Tracking Cu Isotopes from Ore to Anode: A Case Study from The Olympic Dam IOCG Deposit

MRS. AMUWELA APPUHAMILAGE SUMITHA VIDUSHI GUNATILAKE[1], LUCY MCGEE[1], ALLAN PRING[1], NIGEL COOK[1] AND KATHY EHRIG[2]

[1]University of Adelaide
[2]BHP Olympic Dam

Cu isotope ratios have been widely applied to fingerprint metal sources, track fluid pathways, and trace mineralization processes, providing valuable insights into ore formation and hydrothermal fluid evolution. While previous copper isotope studies have mostly focused on porphyry, sedimentary, and volcanogenic massive sulfide (VMS) deposits, iron-oxide copper gold (IOCG) ore systems remain relatively understudied. This is in part likely due to their mineralogical heterogeneity and the potential for large data scatter. However, the behaviour of Cu isotopes, not only across distinct mineralization zones but also throughout the processing-smelting-refining cycle remains poorly understood. Bridging these gaps is essential for both optimisation of geological models and metal recovery strategies.

In this study, we address Cu isotopes in the world-class Olympic Dam IOCG deposit, South Australia, often considered to be the archetypal IOCG deposit. The study investigates Cu isotope ratios in the main copper sulfide minerals (bornite, chalcopyrite, chalcocite) and native copper. Additionally, the study aims to provide a holistic understanding of Cu isotope behaviour throughout the entire processing chain, from ore, through flotation, smelting, and refining all the way to fabrication of high-purity copper anode.

Preliminary data on copper sulfide minerals, native copper and the anode reveal distinctly different Cu isotopic signatures, reflecting fractionation effects during ore formation and in the processing plant. Samples of a copper anode had unfractionated δ^{65}Cu. Native copper has the highest δ^{65}Cu (1.08 ± 0.02‰), followed by chalcopyrite (0.43 ± 0.02‰), bornite (0.07 ± 0.01‰), and chalcocite (-0.51 ± 0.07‰) in that order. This pattern corresponds with the concentric zoning observed in the Olympic Dam deposit, where chalcopyrite-pyrite is found at the deepest levels, chalcopyrite-bornite at intermediate levels, and bornite-chalcocite at the shallowest levels. To further support these findings, an experimental study will be conducted to examine how Cu isotope exchange occurs between copper sulfide minerals and Cl-bearing hydrothermal fluids under varying temperature and time conditions. Through a detailed Cu isotope analysis that combines data from Cu-bearing minerals and hydrothermal fluid experiments, this research aims to improve the understanding of Cu isotope systematics in IOCG deposits and their behaviour in mineralization and metallurgical processes.