Sediment-hosted Cu mineralization and dolomitization by deep basinal fluids in the Timna-Faynan ore deposits, S Israel and Jordan

A. ELIYAHU[1*], Y. KATZIR[1], P. MUCHEZ[2]

[1]Ben Gurion University of the Negev, Be'er Sheva, Israel (*correspondence: amit_eliyahu@yahoo.com)
[2]Earth and Environmental Sciences, KU Leuven, Belgium

Sediment-hosted stratabound copper (SSC) mineralization in southern Israel and Jordan occurs in two geological units: (1) Cambrian carbonate-siliciclastic beds of the Timna/Burj Formation (Cu silicates, carbonates and rare sulfides), and (2) Lower Cretaceous sandstones (mostly Cu sulfides and carbonates). The SSC deposits occur at the southern margins of a Precambrian to recent sedimentary basin along the northern edge of the Arabian-Nubian Shield. The total amount of known minable Cu in the Cambrian ore is ~2 million tonnes. The current metallogenic ore model involves (i) syn-sedimentary precipitation of Cu sulfides, seizing copper leached from exposed Neoproterozoic basement; (ii) early-diagenetic dolomitization and oxidation of Cu sulfides to oxides, carbonates and silicates; (iii) transport of Cu by oxidizing hydrothermal fluids from the Cambrian beds up-section and its entrapment as Cu sulfides in reducing horizons. Nonetheless, our field and petrographic observations show that ore-grade Cu mineralization is associated with zones of evaporite dissolution breccia and that in drill cores, intersecting these ore-zones over 200m below the surface, sulfides are absent. Fluid inclusion microthermometry indicates that regional dolomitization and structurally controlled mineralization of hard calcite-dolomite lenses within the Timna Fm. occurred at 90°-130°C by saline fluids (up to 23% NaCl eq) of H_2O-NaCl-$CaCl_2$-$MgCl_2$ composition. In contrast, Cu sulfides hosted in calcite and barite veins within the Cretaceous sandstones were precipitated at 150°C from a low salinity NaCl-H_2O solution, likely of meteoric origin. We thus suggest that oxidizing basin fluids leached metals from underlying Ediacaran-Cambrian red-beds and Neoproterozoic basement, were driven up-section along faults and the basement topography towards the Cambrian sediments where they mixed with sulfur-rich interstitial water to precipitate Cu-sulfides. Hot and highly saline basin fluids caused stratabound dolomitization and formed carbonate lenses. Progressively the trapped fluids dissolved evaporites and carbonates leading to the formation of stratabound dissolution breccia zones and mineralization of primary Cu silicates and carbonates.