Geochemical Signatures from Porphyry Cu Systems in Sonora, Mexico

Oscar Daniel Torres-Alarcon[1], David Hernández-Uribe[1], Martín Valencia-Moreno[2], Cecilia Santillana-Villa[2]
[1]University Of Illinois - Chicago, Chicago, United States, [2]Universidad Nacional Autonoma de Mexico - Estacion Regional del Noroeste, Hermosillo, Mexico

Porphyry Cu deposits (PCDs) stand as the primary global source of copper. While PCDs are relatively well described, less attention has been given to the magmatic conditions required to form this type of ore deposit. In this study, we constrain the geochemical signatures of the most representative PCDs and barren rocks in Sonora, Mexico, including the Buenavista del Cobre PCD (~7140 Mt of Cu) in the Cananea mining district. Barren rocks yield pressures-temperatures of ~0.3-2.7 kbar and ~613-831 °C, consistent with emplacement depths at 1 to 9 km. PCDs formed between ~621 to ~837 °C. Zircon chondrite-normalized rare earth elements (REE) patterns show heavy-REE enrichment in barren rocks and PCDs. However, barren rocks display a stronger negative Eu anomaly, indicating either greater plagioclase fractionation or different redox conditions. U-Pb geochronology yield weighted mean ages of 73–57 Ma in barren rocks and 80–57 Ma in PCDs, consistent with the magmatism in the Cretaceous-Eocene Mexican Magmatic Arc. PCDs exhibit higher oxygen fugacity (fO_2; ~1.2 ΔFMQ), H_2O content (~7.4 wt%), and Eu/EuN* (0.5) than barren rocks (~0.5 ΔFMQ, ~6.3 wt% and ~0.4, respectively). This indicates an evident higher magmatic fertility in PCD-related intrusions compared with barren rocks. The zircon copper fertility index (ZCFI) coefficient varies widely but is higher in PCDs (~3.7) compared to barren rocks (~2.4). Notably, the PCDs's ZCFI yield values below the proposed fertility limit of 0.45. Our results provide the first state-of-the-art quantitative constraints of the geochemical signatures of PCDs and barren rocks from different mining districts in Sonora, Mexico. We find that higher H_2O content, fO_2, and Eu/EuN* are key proxies for magma fertility.