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Unveiling the Long-Lived Fertility Signature of Cu-Au Porphyry Systems: Insights from Apatite and Zircon at Tampakan, Philippines

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The present study focuses on the use of accessory minerals such as zircon and apatite to investigate ore-forming processes relevant to porphyry systems. These are an essential source of a variety of base and precious metals such as Cu, Au, and Mo. Despite the importance of these mineral systems and the large number of studies available in the scientific literature, the metallogenic events that lead to their development remain elusive[1,2]. The spatiotemporal information of the ore-forming pulses and magmatic events that induce fertility remains enigmatic and difficult to fingerprint. Zircon and apatite from the world-class Tampakan porphyry and high-sulfidation system (2,940 million tons grading 0.52% Cu, 0.19 g/t Au, 64 ppm Mo) were characterized using a combined analytical approach that included whole-rock geochemistry, radiogenic isotopic systems (Hf in Zr/ Nd in Ap), and O isotopes, as well as trace element signatures in zircon. The data validate previously identified fertility indicators[3,4] and highlight the presence of elevated Cl and S concentrations in apatite associated with Cu porphyry mineralization. In addition, the combined Hf, O, and Nd isotope analyses in zircon and apatite indicate that the melt source associated with the Tampakan porphyry and high-sulfidation system remain essentially unchanged for a large period of time, showing a fertile signature before and after the ore-forming event, for a time window of approximately 7 m.y. Furthermore, the mantle source is juvenile and does not show any evidence of contamination with an older crustal component. Overall, our study indicates that the combination of zircon and apatite in situ geochemical characterization provides valuable information to refine targets to explore porphyry systems on a regional and district scale.

References

[1]Richards JP (2003) Tectono-magmatic precursors for porphyry Cu-(Mo-Au) deposit formation. Economic Geology 98(8):1515-1533

[2]Cooke D, Wilkinson J (2014) 13.14 Geochemistry of Porphyry Deposits. Treatise on Geochemistry, Second Editionth edn Elsevier, Oxford:357-381

[3]Lu YJ, Loucks RR, Fiorentini ML, McCuaig TC, Evans NJ, Yang ZM, Hou ZQ, Kirkland CL, Parra-Avila LA, Kobussen A (2016) Zircon compositions as a pathfinder for porphyry Cu ± Mo ± Au deposits, . Society of Economic Geologists Special Publication No. 19:329-347

[4]Mao M, Rukhlov AS, Rowins SM, Spence J, Coogan LA (2016) Apatite trace element compositions: a robust new tool for mineral exploration. Economic Geology 111(5):1187-1222