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Magma Fertility Evolution Trends: Lessons from the Kerman Porphyry Belt, SE Iran

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The Kerman porphyry belt in SE Iran is located in the center of the Mesozoic-Cenozoic Neotethyan orogenic belt and is the most highly explored and well-studied part of the belt. The Iranian part of the Neotethyan orogenic belt hosts several world-class porphyry Cu deposits, which are mostly associated with postcollisional calc-alkaline magmas, including Sungun (21.01 ± 0.15 Ma; 3.446 Gt @ 0.48 Cu) in the Ahar-Arasbaran porphyry belt, Sar Cheshmeh (13.6 ± 0.1 Ma; 3.125 Gt @ 0.41% Cu), Sar Cheshmeh B Anomaly or Sereidun (1.645 Gt @ 0.38% Cu), Meiduk (12.5 ± 0.1 Ma; 792.53 Mt @ 0.67% Cu, 0.01% Mo, 0.08 g/t Au), and several smaller/less explored deposits such as Takht Gonbad (~26 Ma; ~160 Mt @ 0.34% Cu) in the Kerman porphyry belt.

The temporal and geochemical evolution of arc magmatism has been studied at the different magmatic suites in the Kerman porphyry belt. Thirty-six samples from outcrops or drill cores were collected from the various Eocene to Pleistocene porphyry-related and unmineralized magmatic suites along the belt. Whole-rock and zircon geochemical data, together with zircon uranium-lead laser ablation-inductively coupled plasma-mass spectrometry geochronology, were interpreted to compare and contrast characteristics of porphyry-related (fertile) and barren (infertile) suites and consequential fertility trends during temporal evolution of the orogenic belt. Data analysis revealed decreases in zircon Eun/Eu* (Eun/Eu*= Eun/Smn×Gdn1/2), positive Ce anomalies in zircon, and whole-rock Sr/Y and La/Yb ratios, as well as increases in negative Eu anomalies in zircon with age. These findings suggest that in the Kerman porphyry belt, and generally in all fertile arcs, the younger magmatic suites are more evolved, volatile-rich (hydrous), and oxidized and thus are considered more prospective for economic porphyry mineralization. This relative age relationship, together with an understanding of arc erosion level, can serve as a valuable exploration tool.