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Tracking Magmatic-Hydrothermal Cycles from Subduction-Related to Post-Subduction Settings over 30 m.y. in the Meghri-Ordubad Pluton, Southern Armenia, Lesser Caucasus

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The Tethyan orogenic belt is of great economic and scientific importance, as it is recognized to host major porphyry copper deposits in subduction-related, collision-related, and postcollisional settings. This represents an ideal opportunity to investigate a number of questions concerning the primary controls on porphyry copper deposit genesis, as most established models require active subduction to generate large volumes of hydrous, oxidized, S-rich, Cu-rich magmas derived from a subcontinental lithospheric mantle metasomatized by slab fluids. The Meghri-Ordubad pluton is exposed over 800 km^2 in southern Armenia and represents the largest ore-bearing pluton in the Lesser Caucasus. It is described as a composite pluton emplaced during a subduction-related to a postsubduction evolution. Here we present a new comprehensive zircon U-Pb geochronology survey depicting 30 m.y. of incremental growth in the Meghri-Ordubad pluton. Three main magmatic events are recognized, including (1) middle Eocene calc-alkaline subduction-related magmatism lasting 5.8 ± 0.8 m.y., followed by (2) postsubduction upper Eocene-lower Oligocene shoshonitic magmatism over 9.7 ± 0.9 m.y, and (3) upper Oligocene-lower Miocene adakitic magmatism consisting of shoshonitic dike swarms and high-K calc-alkaline porphyritic granodioritic magmas emplaced over 5.4 ± 0.4 m.y. Published molybdenite Re-Os ages allow us to precisely link the formation of variable-sized porphyry copper deposits to the end of the first two intrusive suites, and the third magmatic episode is spatially associated with Cu-rich epithermal veins. In the Meghri-Ordubad pluton, the size of porphyry copper deposits correlates with the duration of the associated intrusive suite. Several small-tonnage (10–40 Mt at 0.2–0.5% Cu, 0.03–0.04% Mo) and the giant Kadjaran (2,200 Mt at 0.3% Cu, 0.05% Mo) deposits are, respectively, linked to the middle Eocene and upper Eocene-lower Oligocene intrusive events. Although a subduction-related setting is required to fertilize the lithospheric mantle, long-lived mantle-derived magmatism and a favorable structural setting represent two critical factors to form porphyry copper deposits independent of the geodynamic settings. In the Meghri-Ordubad pluton, we propose that the tempo of porphyry copper deposit formation reflects the ability to sustain prolonged thermal rejuvenation and episodic transfer and accumulation of enough hydrous, oxidized, S-rich, metal-rich, mantle-derived magmas to upper crustal, crystal-rich reservoirs. Ultimately, cooling of the lower crust will favor complete crystallization of the upper crustal, melt-rich reservoirs and release ore-forming fluids.