Linking Pulsed Porphyry Cu-Mo Formation to Distinct Magmatic Episodes During 30 m.y. of Pluton Emplacement in Southern Armenia, Lesser Caucasus

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The Lesser Caucasus is a key area to understand the metallogenic and geodynamic link between the western and eastern domains of the Tethys belt. The southern part of the Lesser Caucasus records long lasting geological and metallogenic evolution from the Jurassic to the Cenozoic. The Meghri-Ordubad composite pluton is located on the territories of southern Armenia, Nakhitchevan, and northernmost Iran. The composite pluton illustrates a stationary Eocene to Miocene magmatic system that is temporarily and spatially associated with porphyry Cu-Mo deposits over an area of 1400 km^2. Based on laser ablation ICP-MS zircon U-Pb dating of 30 samples, three successive magmatic episodes have been distinguished: (1) a mid-Eocene gabbro-diorite-quartz diorite magmatic suite dated between 45.9 and 43.0 Ma, associated with coeval NNE-trending basaltic-andesitic dikes, (2) an upper Eocene-lower Oligocene gabbro-monzogabbro-monzodiorite-syenodiorite-quartz monzonite magmatic suite dated between 37.7 and 31.8 Ma, contemporaneous with NNE-trending trachyandesitic and syenitic dikes emplacement, and (3) an upper Oligocene-lower Miocene trachybasaltic mafic dike swarm yielding ages between 26.7 and 24.3 Ma, followed by felsic granodioritic to granitic intrusions between 22.7 and 22.2 Ma, which are coeval with E-W–trending granodioritic dikes dated between 22.3 and 21.2 Ma. Based on Re-Os molybdenite dating, two distinct ore-forming episodes are recognized during the Eocene with the formation of porphyry Cu-Mo deposits (Agarak at 44.2 Ma; Hanqasar at 43.14 Ma; Aygedzor at 42.6 Ma), and the late Oligocene with the formation of porphyry Mo-Cu deposits (the giant Kadjaran between 27.2 and 26.4 Ma; Paragachay at 26.7 Ma).

Within this geochronological framework, we illustrate important geochemical changes from the calc-alkaline mid-Eocene magmatic suite to an alkaline-shoshonitic signature in the upper Eocene-lower Oligocene suite and a transition from alkaline dikes to calc-alkaline granodiorites in the upper Oligocene-lower Miocene suite. These major element characteristics together with systematic variations in LREE/HREE and/or MREE/HREE ratios suggest an evolution from subduction-related calc-alkaline magmatism to syn-collisional alkaline magmas followed by post-collisional magmatism over time. The Hf isotope composition of U-Pb dated zircons and whole-rock Nd-Sr isotope compositions become systematically more juvenile from the Eocene to Miocene magmatic episodes. These trends either reflect a decrease in crustal contamination through time or a change in the crustal contaminant to cannibalization of young juvenile intrusions. We favor cannibalization of previous intrusive pulses, a process that is also consistent with the concept of metal enrichment by remelting and recycling.

Another potentially important feature with respect to ore genesis is the transition from calc-alkaline subduction-related magmatism to alkaline magmatism. While all magmatic episodes culminate in the formation of porphyry Cu-Mo deposits, the alkaline episode is associated with the giant Kadjaran porphyry-epithermal deposit.