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Porphyry Cu Fertility of Late Mesozoic-Cenozoic Magmatism Along the East Anatolian Magmatic Belt Based on Zircon Trace Element Compositions

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The East Anatolian Magmatic Belt (EAMB) is a product of the closure of the Southern Neotethys ocean and subsequent collision between the Tauride-Anatolide and Arabian blocks during the Mesozoic-Cenozoic. Cretaceous to Eocene subduction-related and Late Oligocene-Miocene collisional to post-collisional igneous rocks of the belt display whole-rock geochemical signatures broadly consistent with derivation from subduction-modified sources. Nevertheless, economic porphyry Cu±Mo±Au systems at EAMB are rare and appear to be restricted to two narrow time intervals: ~48 to 44 Ma (Çöpler and Mavidere) and ~25 to 24 Ma (Cevizlidere).

In order to constrain porphyry magma fertility signatures along the EAMB, we investigated zircon trace element compositions of selected Late Cretaceous-Miocene intrusive suites. Zircons from mineralized Eocene and Oligocene intrusions display weak negative Eu anomalies on chondrite-normalized plots, whereas barren intrusions have prominent negative Eu anomalies. Mineralized intrusions are also distinguished by lower Ti contents (<7 ppm) as well as by lower Dy/Yb (<0.25) and higher Eu/Eu* (>0.3), Ce/Nd (>3), and (Ce/Nd)/Y (>0.003) ratios compared to most other intrusive suites.

Calculated temperatures based on Ti-in-zircon thermometry revealed relatively lower crystallization temperatures of <730°C (avg.= 708°C) for mineralized intrusions compared to barren intrusions (704–817°C; avg.= 758°C). Additionally, an increase in magma fO_2 is evident from the Late Cretaceous (∆FMQ: -0.6 to +0.8) to middle Eocene and Oligocene-Miocene intrusive systems (∆FMQ: +0.4 to +2.0).

Zircon trace element data suggest an evolutionary trend for EAMB magmatism with increasing magma oxidation states and water contents from the Late Cretaceous to the middle Eocene-Oligocene period, a change likely triggered by crustal thickening prior to the onset of Eocene magmatism. Mineralized igneous suites are dominated by early amphibole fractionation and higher degrees of crustal interaction, which are hereby suggested as key factors for magma fertility.