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Geology of the Halilağa Porphyry Cu-Au Deposit and Emergence of an Eocene Porphyry Belt in NW Turkey

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The Biga Peninsula of northwest Turkey is an emerging copper-gold province characterized by numerous epithermal and porphyry-type deposits and prospects. Mineralization is associated with Cenozoic calc-alkaline magmatism, ranging between 52 and 18 Ma in age, and related to postcollisional tectonism. The Halilağa Cu-Au deposit, in the central Biga Peninsula, is one of several porphyry systems and is associated with mineralization types. Previous geochronology results indicate a late Oligocene age for porphyry mineralization at Halilağa, suggesting genetic connections with the Evçiler pluton, located 2 km to the southeast. Here, we address the temporal connections of the porphyry mineralization with larger intrusive bodies in the area, and we provide new insights into the age of mineralization and related igneous rocks at Halilağa. The Halilağa host rocks comprise a 500-m-thick, westerly dipping volcanosedimentary sequence consisting of interbedded andesite lavas, volcanic siltstone, volcanic sandstone, and polymictic conglomerate. Contact metamorphism, in the form of biotite hornfels, is well developed adjacent to the intrusion. The Halilağa Cu-Au system comprises two dominant intrusive phases: a mineralized quartz monzonite porphyry with crowded phenocrysts of plagioclase and rounded quartz, and a poorly mineralized, phenocryst-poor, quartz monzonite to granodiorite porphyry. Andesitic dikes, containing pyrite after mafic phenocrysts and surrounded by epidote-chlorite alteration halos, cut and postdate the porphyry intrusions. Porphyry Cu-Au mineralization is locally associated with biotite-magnetite ± K-feldspar alteration and intense quartz veining. This early alteration assemblage has been variably overprinted by pervasive sericite ± quartz alteration, in particular at shallow levels. At depth, selective pervasive sericite-chlorite alteration has overprinted the early biotite-magnetite ± K-feldspar assemblage. Epidote-chlorite-calcite alteration occurs at the edges of the system. Sulfide mineralogy is dominated by chalcopyrite, pyrite, and minor pyrrhotite as inclusions in pyrite. In addition, supergene digenite and covellite occur at shallow levels. New U-Pb zircon geochronology results from the Halilağa district have yielded two clusters of ages for the magmatic sequences: a middle Eocene (40–37 Ma) age for intrusions and host rocks at Halilağa, previously interpreted to be Oligocene based on Ar-Ar geochronology, and an Oligocene (ca. 28 Ma) age for volcanic rocks located northern of Halilağa. Middle Eocene and Oligocene (Chattian) are the two ages of mineralization of epithermal and porphyry mineralization in the Biga Peninsula (e.g., Kuşcayir, Kartaldağ, Ağı Dağı, Tepeoba). At Halilağa, porphyry mineralization is spatially associated with Eocene intrusions, and the temporal link is now confirmed by an Re-Os analysis of molybdenite, yielding a mineralization age of 39.56 ± 0.21 Ma. This is the first reported Eocene mineralization age for porphyry mineralization in the Biga Peninsula.

The new geochronology data preclude a genetic link with the Evçiler pluton and suggest a connection between the Halilağa porphyry deposit and the Eocene Kuşcayir intrusion (K-Ar in

hornblende 38–39 Ma) located 13 km to the west-northwest, indicating a potential northwest mineralization trend in the central Biga Peninsula. To the southeast in Central Anatolia, Eocene porphyry mineralization is associated with early Eocene (Ypresian to Lutetian) magmatism, older than the mineralization at the Biga Peninsula, and distributed in the Karapinar/Bursa District and in the Çöpler/Kabataş magmatic complex.