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Chapter 3

The Geology of the Kişladağ Porphyry Gold Deposit, Turkey*

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Abstract

The Kişladağ porphyry gold deposit (16.8 Moz) is located in western Anatolia, Turkey, and is hosted in a nested complex of monzonite porphyries that intruded coeval volcanic rocks of the Beydağı stratovolcano and the Menderes metamorphic basement. The intrusions and volcanic rocks have a high K calc-alkaline to shoshonitic affinity similar to the regional volcanic rocks of western Anatolia. Three main intrusive phases are recognized with average gold grades highest in the early intrusions, Intrusion 1 (~0.8 g/t Au) and Intrusion 2 (~0.7 g/t Au), followed by the weakly mineralized Intrusion 3 (typically <0.2 g/t Au). The highest gold (~0.84 g/t) is also associated with the higher temperature potassic (biotite-K feldspar ± actinolite) core of the deposit in Intrusion 1. Molybdenum is most closely associated with Au, whereas the Cu concentration on average is unusually low (~200 ppm) but increases with depth (500–1,000 ppm). Surrounding and partly overlapping the potassic zone is a distinct tourmaline-white mica (± pyrite ± albite ± quartz) alteration with tourmaline abundant up to 500 m from the center of the deposit. White mica is more widely distributed with compositions varying from proximal muscovite-paragonite to distal phengite. Stockwork veinlets are common within the potassic and tourmaline-white mica zones and evolve from volumetrically minor quartz-rich, to quartz-pyrite, to quartz-pyrite with tourmaline envelopes, to the most abundant pyrite-tourmaline veins and breccias, and finally pyrite-only veins. A poorly mineralized advanced argillic alteration assemblage (quartz-alunite ± dickite ± pyrophyllite ± pyrite) postdates the tourmaline-white mica alteration and is particularly abundant in the eastern flank of the deposit and as a lithocap. The most widespread alteration is argillic comprising kaolinite ± smectite ± pyrite ± quartz, and overprinting all alteration phases, and is particularly widespread in the surrounding volcanic package.

New geochronological results from the Kişladağ deposit constrain the timing and duration of the main gold mineralization stage to <0.4 m.y. (14.76 ± 0.01–14.36 ± 0.02 Ma). The system evolved in the following sequence: (1) Intrusion 1 (>14.76 ± 0.01 Ma), (2) Intrusion 2 (14.76 ± 0.01 Ma), (3) potassic alteration coeval with mineralization (14.4 ± 0.1 Ma), and (4) Intrusion 3 (14.36 ± 0.02 Ma). The deposition of gold is constrained by the emplacement of the sulfide mineralization dated at 14.49 ± 0.06 Ma by Re-Os on molybdenite.

The Kişladağ deposit is classified as a gold-only porphyry deposit due to its exceptionally low Cu/Au ratio (≈0.03). There are few economically significant global analogues—examples include the Maricunga porphyry deposits (9.8 Moz Au) in Chile and La Colosa (33.2 Moz Au) in Columbia. The low Cu/Au ratio may in part be related to the shallow level of emplacement (<1 km?) but also reflects the postcollisional setting. The deposit formed at least 50 m.y. after closure of the northern Neotethys ocean that was related to Cretaceous collision and compression, and 15 m.y. after the commencement slab roll-back of the southern Neotethys ocean and the onset of upper plate extension in the late Eocene to early Oligocene. The Miocene volcanic rocks that host Kişladağ are in part related to a slab tear that resulted in upwelling of asthenospheric mantle, which melted previously metasomatized subcontinental lithospheric mantle. Postcollision extension, fertile upper mantle, shallow subduction, and slab tear-induced magmatism, and shallow level of emplacement may have been important factors in the gold-rich nature of Kişladağ.

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