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Abstract title: The Sonajil Cu-Au porphyry-epithermal deposit, NW Iran: Zircon U-Pb dating and Regional implications for the timing of porphyry Cu mineralization in NW Iran

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Abstract:

The Sonajil porphyry Cu and epithermal Au deposit is located 100 km northeast of Tabriz in northwest Iran, at the junction between the Alborz–Azerbaijan structural zone and the Urumieh–Dokhtar magmatic arc of Cenozoic age. The Lower-Eocene andesitic to basaltic rocks were intruded by the Sonajil microdioritic porphyry stock and the Incheh diorite to quartz-diorite stock. The stocks possess shoshonitic to high-K calc-alkaline affinity and metaluminous nature. They are rich in LILEs and LREEs and depleted in HFSEs and have subduction-related characteristics. The Sonajil porphyry stock brought about hydrothermal alteration haloes and porphyry Cu, as well as epithermal gold mineralization. Stock-work quartz veins/veinlets are found especially within the potassic alteration zone, which contain pyrite, chalcopyrite, bornite and scarce molybdenite, tetrahedrite and enargite, with the Cu grade of 0.1 to 0.5%. The high-sulfidation epithermal

mineralization is located 4.5 km to the SW of the porphyry mineralization zone, 1400 m by 10–50 m, extending up to the depth of 200 m, which includes pyrite, chalcopyrite, sphalerite and native gold (U–Pb dating, the Sonajil porphyry stock is older than the Incheh stock, with a weighted mean $^{206}\text{Pb}/^{238}\text{U}$ age of 43.5 ± 0.8 Ma and a concordia intercept age of 42.6 ± 2.1 Ma, corresponding to Middle Eocene (Lutetian), while the Incheh stock yielded a weighted mean $^{206}\text{Pb}/^{238}\text{U}$ age of 41.5 ± 1.2 Ma and a concordia intercept age of 40.4 ± 2.4 Ma. These intrusive units, along with the Qaradagh granodiorite (about 100 km to NW; 44.04 ± 1.00 Ma) represent the oldest reported intrusive units of Cenozoic age in northwest Iran, confirming that Paleogene plutonic activities commenced here in Middle Eocene, earlier than the widely accepted Oligocene age. These ages are older than all the porphyry Cu-related intrusions and mineralizations in central and east Iran. Considering the fact that the Ahar–Jolfa metallogenic zone in NW Iran shows magmatic, geodynamic and mineralization similarities with the South Armenian Block (SAB) to the north, where the Meghri–Ordubad pluton (MOP) hosts many porphyry and epithermal Cu–Mo–Au mineralizations, comparing the magmatic and mineralization events between these two zones will provide useful information to constrain the evolutionary history of the whole region. This comparison shows that the studied intrusive bodies are coeval with the first phase of incremental magmatism in MOP, especially in the southern part of it and near the border with Iran. Finally, comparing the U and Th contents of the Sonajil porphyry and Incheh stocks with other ore-related intrusive rocks in NW Iran shows that the Sonajil and Incheh stocks have low U (mostly 100–200 and 100–300 ppm, respectively) and Th contents (31–250 ppm) with Th/U ratios between 0.58 and 1.10. These low contents indicate a magmatic source and support the origination of the parental magmas from a dominant mantle source with insignificant contribution of the continental crust.