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## Geology of the Sari Gunay Epithermal Gold Deposit, Northwest Iran\*

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### Abstract

The Sari Gunay epithermal gold deposit is located within a mildly alkaline latitic to trachytic volcanic complex in central-northwest Iran. Intrusive and volcanic rocks that host the deposit have been dated at between 11.7 and 11.0 Ma (with one younger sample at 8.0 Ma; <sup>40</sup>Ar/<sup>39</sup>Ar dating of igneous biotite and hornblende), whereas sericitic alteration associated with an early stage of hydrothermal activity occurred between ~10.8 and ~10.3 Ma (the best age estimate is 10.7 Ma obtained by <sup>40</sup>Ar/<sup>39</sup>Ar dating of sericite). The main hydrothermal system was structurally localized by a diatreme breccia complex centered on the Sari Gunay hill. Earliest hydrothermal activity, only encountered at depth (>300 m below surface), produced weak potassic alteration and quartz-sulfide-magnetite veining with low grades of Cu and Au mineralization, reminiscent of shallow-level (≤1.5-km depth) porphyry gold systems. Paragenetically later quartz-tourmaline breccias and veins followed the south-southwest–north-northeast trend of the diatreme breccias and produced strong sericitic alteration and silicification in igneous clasts and wall rocks. Fluid inclusions indicate temperatures of 246° to 360°C and salinities of 34.4 to 46.1 wt percent NaCl equiv in hypersaline inclusions coexisting with low-density, CO<sub>2</sub>-bearing vapor-phase inclusions. These fluids do not appear to have deposited gold, but the breccias provided further structural permeability for flow of later mineralizing epithermal fluids.

Invisible gold occurs in solid solution in fine-grained arsenical pyrite and minor arsenopyrite, deposited in the early stages of quartz-adularia-pyrite-stibnite veins. Late-stage minerals in these veins include realgar, orpiment, cinnabar, and extremely rare wire gold. Liquid-rich fluid inclusions in these veins have an average homogenization temperature (≈trapping temperature) of 199 ± 24°C, salinities of 3.6 ± 1.1 wt percent NaCl equiv, and coexist with low-density CO<sub>2</sub>-bearing vapor-phase inclusions, suggesting low-pressure conditions. Phase separation may have been a contributory cause of gold deposition, but precipitation of sulfides in response to rapid cooling of the system may have been the main control on deposition of pyrite-hosted gold.

The Sari Gunay gold deposit and its host volcanic system form part of the Takab belt of structurally controlled, middle Miocene, mildly alkaline volcano-plutonic complexes. The sediment-hosted Zarshuran gold deposit, located ~190 km to the north-northwest along the belt, is also related to middle Miocene magmatism. The Takab belt is marginally younger than, and displaced to the southwest of, the extensive Eocene-Miocene Urumieh-Dokhtar calc-alkaline volcanic arc, which hosts several large porphyry Cu deposits (e.g., Sar Cheshmeh, Meiduk). Rocks of the Takab belt are also distinctly more alkaline than the Urumieh-Dokhtar rocks. Viewed in the context of plate tectonic models for Neogene closure of a Neo-Tethys ocean between the Afro-Arabian and Eurasian plates, these differences may reflect a normal subduction zone origin for the Urumieh-Dokhtar arc and contained porphyry Cu deposits but a collisional origin for the slightly younger Takab belt volcanic rocks and epithermal gold deposits. The Sari Gunay deposit may thus be classified as a collision-related alkalic-type epithermal system, although it is less alkaline than classic deposits of this group such as Porgera, Emperor, or Cripple Creek (the latter apparently being related to postcollisional or back-arc extensional rather than syncollisional processes).

\*A digital supplement with fluid inclusion data is available at <[http://segweb.org/EG/papers/Abs 101-8\\_files/RichardsAppendix.pdf](http://segweb.org/EG/papers/Abs 101-8_files/RichardsAppendix.pdf)>.

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