

The Gandy and Abolhassani Epithermal Prospects in the Alborz Magmatic Arc, Semnan Province, Northern Iran

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Abstract

The Gandy and Abolhassani epithermal precious and base metal deposits occur in the Torud-Chah Shirin mountain range in the Alborz magmatic belt of northern Iran. The mountain range is considered to be part of the Paleogene Alborz volcanic arc. The exposed rocks in the study area consist of a volcanoclastic sequence of thin-bedded siltstones and sandstones, lapilli tuffs, volcanic breccias, and intermediate lava flows at Gandy, and mostly andesitic flows at Abolhassani. The flows are middle to upper middle Eocene age and they show a typical arc geochemical signature, with low concentrations of Nb, Ta, Zr, Hf, and Ti.

Variable hydrothermal alteration occurs in scattered outcrops, covering about 4 km² at Gandy and 1 km² at Abolhassani. The Gandy and Abolhassani areas are about 3 km apart, and each contains a small abandoned Pb-Zn mine. Mineralization at Gandy occurs in quartz sulfide veins and breccias and is accompanied by alteration halos of quartz, illite, and calcite up to 2 m wide. The mineralization is divided into three main stages: brecciation (I), fracture filling (II), and crustiform banding (III). Stage I is economically important in terms of precious metal content. Stage II consists of four substages and contains the majority of base metal ore with quartz, calcite, and barite. Native gold is commonly found within partially oxidized pyrite and secondary iron (hydr)oxides such as goethite in stage I and coexists with galena and chalcocopyrite in stage II. The final stage is dominated by quartz and calcite. Mineralization in the Abolhassani veins occurred in three main stages. The first two stages, which are economically important, contain similar mineral assemblages, including quartz, calcite, barite, galena, sphalerite, pyrite, and chalcocopyrite, whereas the final stage is dominated by quartz and calcite. No gold grains were found in the Abolhassani samples. The average (max) assays from 14 channel samples of Gandy veins are 14.5 (68.3) g/t Au, 30.6 (161) g/t Ag, 3.1 (13) wt percent Pb, 0.84 (3.8) wt percent Zn, and 1.0 (6.3) wt percent Cu. For comparison, the values from 19 channel samples of Abolhassani veins are 0.85 (6.0) g/t Au, 29.5 (115) g/t Ag, 6.4 (16.5) wt percent Pb, 1.2 (5.2) wt percent Zn, and 0.83 (7.7) wt percent Cu.

Fluid inclusion and sulfur isotope compositions were analyzed for the sulfide-sulfate assemblages of stage II at Gandy and stages I and II at Abolhassani. In both cases fluid inclusion assemblages were examined mostly in subhedral crystals of sphalerite. The average homogenization temperatures (T_h) and salinities of fluid inclusion assemblages from Gandy range from 234° to 285°C, with a peak at about 250°C and 4.2 to 5.4 wt percent NaCl equiv. These T_h values are in good agreement with isotopic temperatures from two sphalerite and galena pairs (236° and 245°C). The temperature and salinity values in fluid inclusion assemblages from the Abolhassani deposit range from 234° to 340°C and 6.7 to 18.7 wt percent NaCl equiv. Sulfide pairs of sphalerite-galena do not give reasonable isotopic equilibrium temperatures at Abolhassani. Comparison of T_h versus ice melting ($T_{m(ice)}$) values for the two deposits indicates the presence of a moderate-salinity fluid (5–6 wt % NaCl equiv) of similar temperature (~250°C) in each deposit but with a higher temperature and salinity component also present at Abolhassani. The base metal-rich mineralization at Abolhassani may thus have been caused by the periodic injection of this higher salinity fluid. The Abolhassani deposit has a higher average Ag/Au ratio (~35) and Pb + Zn concentration (up to 7.6 wt %) than Gandy (Ag/Au ~ 2 and 3.9 wt %), consistent with this interpretation.

The minimum depth of formation was at least 430 m below the paleowater table for Gandy and possibly as much as 600 m at Abolhassani. The lower grades of gold and the presence of higher salinity fluids at Abolhassani suggest that the occurrence of higher grade precious metal zones is unlikely at greater depth. By contrast, Gandy may have potential at depth for extensions of the high-grade gold veins. Exploration in the region should focus on areas with geologic evidence for relatively little posthydrothermal erosion, <200 to 300 m, thus increasing the preservation potential of epithermal veins with high gold grades, similar to those at Gandy. Results from Gandy and Abolhassani may aid exploration and assessment of the numerous, untested epithermal and related prospects along this 1,800-km-long volcanic belt in northern Iran.

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