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Electrum (Au-Ag±Cu) in association with Ag-Au and Ag tellurides and Bi-Te-Se phases in the intermediate conglomerate, Perama Hill epithermal Au deposit, Thrace, NE Greece

Stavros Triantafyllidis

National Technical University of Athens, School of Mining and Metallurgical Engineering, Iroon Polytechneiou 9, 157 80 Zografou, Athens, Greece, striantafyllidis@metal.ntua.gr

Geologic setting

The Perama Hill epithermal Au deposit is located approximately 30 km west-northwest of the city of Alexandroupolis (Thrace, NE Greece), at the eastern margin of the N-S trending Petrota Graben. According to Lescuyer et al. (2003) and Juras et al. (2010), the deposit is mushroom shaped, and two major sectors may be recognized, the upper, oxide sector (Perama sandstone) with free Au (Triantafyllidis & Skarpelis, 2015) which is the target of exploitation (Juras et al., 2010), and the lower, refractory ore in the underlain andesites, whereas a volcanoclastic conglomerate unit with ranging thickness lies between the upper oxidized and the lower refractory ore. According to Juras et al. (2010), the calculated reserves (proven and probable) in the oxidized ore (Perama sandstone) are 9.4 Mt with average Au and Ag grades 3.20 gr/t and 3.75 gr/t respectively.

Sampling – Analytical methods

Drill core samples from the intermediate volcanoclastic conglomerate of the Perama Hill epithermal Au deposit were selected and used for the mineralogical investigation of ore and hydrothermal alteration phases. Scanning Electron Microscopy was carried out at the Laboratory of Mineralogy, Petrology and Economic Geology, Section of Geological Sciences, School of Mining and Metallurgical Engineering, National Technical University of Athens. It involved the use of a JEOL JSM 6380LV scanning electron microscope combined with energy dispersive X-ray spectrometry (OXFORD ISIS Link electron microprobe) and equipped with a Jeol Analytical back-scattered electron detector. Operating conditions for the SEM were 20 kV accelerating voltage, 20mm working distance and 1.0 nA beam current. Counting time for each analysis was 50 sec, with 15 sec dead time.

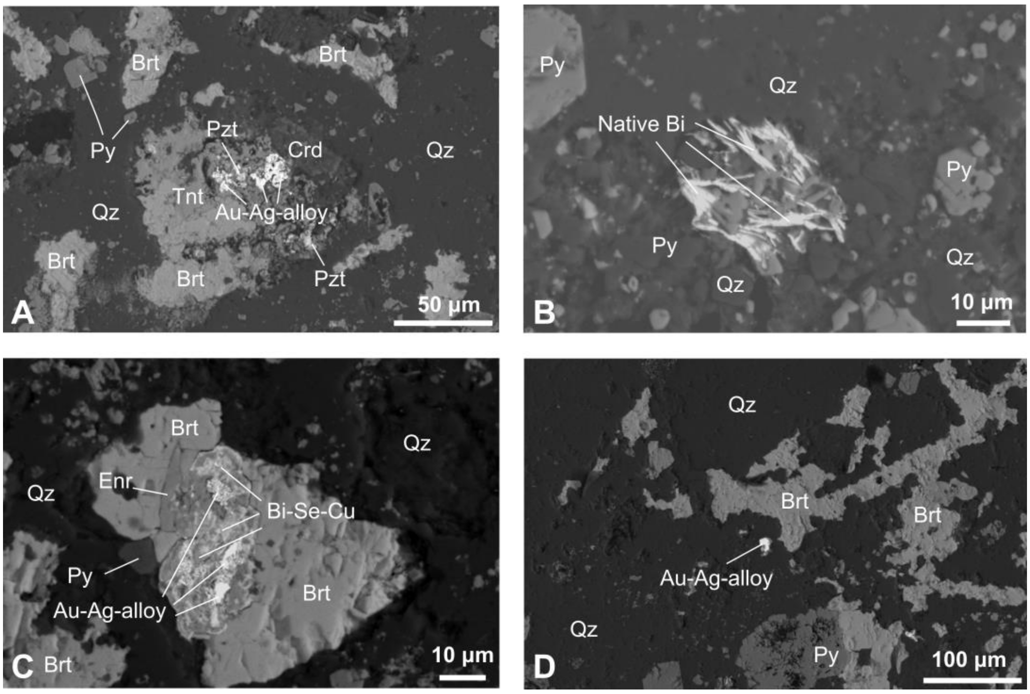

Figure 1. A. Electrum (Au-Ag±Cu alloy) in association with petzite (Pzt), anhedral tennantite (Tnt) and disseminated euhedral pyrite (Py) in silicified sectors of the intermediate conglomerate. Barite (Brt) and crandallite (Crd) are also identified. B. Needle shaped native Bi in association with euhedral to subhedral pyrite (Py). C. Electrum (Au-Ag±Cu alloy) in association with barite (Brt), enargite (Enr) and un-identified Bi-Se-Cu phases in silicified rock. D. Electrum (Au-Ag±Cu alloy) in association with abundant euhedral coarse-grained barite (Brt) and pyrite (Py) aggregates in silicified intermediate conglomerate. Abbreviations for barite, pyrite, tennantite, enargite and quartz after Whitney and Evans (2010).

Results and discussion

Previous studies on the mineralogy of the lower refractory ore from Voudouris et al. (2011) and Skarpelis et al., (2006) revealed the presence of Bi-Te-Se±(Au,Ag) mineralization in the southern and central part of the Perama Hill epithermal system hosted in the lower andesitic breccia. Mineralogical investigation of drill core samples from the intermediate volcanoclastic conglomerate indicates the presence of Au-Ag-Bi-Te-Se mineralization in several parts of the Perama Hill epithermal system, and in particular the southern and central part, where the main hypogene feeder zones are located. Relative to studies performed on the lower refractory ore, the intermediate volcanoclastic conglomerate is characterized by higher concentrations of precious metals, as evident by the presence of electrum (Au-Ag±Cu alloy, Figure 1A,1C,1D) and precious metal tellurides, including petzite and hessite (Figure 1A, Figure 2). This observation supports the statement of Juras et al. (2010) that the Au content in the Perama epithermal system is not uniformly distributed, and the highest Au grades are identified in drill core samples from the upper and the lower part of the epithermal system scheduled for exploitation.

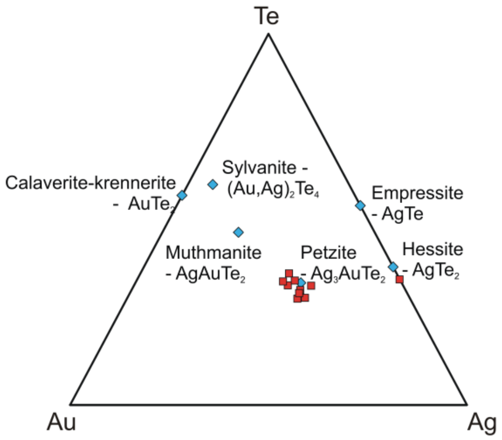

Figure 2. Ternary Au-Ag-Te diagram of typical Au, Ag and Au-Ag tellurides (blue rhombs), and Au-Ag and Ag tellurides (red squares) from the intermediate volcanoclastic conglomerate of the Perama Hill epithermal Au deposit.

The relatively increased precious and critical metal load of the intermediate volcanoclastic conglomerate may be attributed to sudden changes in hydraulic conductivity between the lower and cohesive andesitic breccia (refractory ore) and the upper, unconsolidated and highly porous felsic sandstone. According to Lescuyer et al. (2003), the Perama mineralization is considered contemporaneous to the host rocks, hence the ascending, rich in precious and critical metals hydrothermal fluids may have unloaded a significant part of their precious and critical metal load in such locations where the hydraulic conductivity changes rapidly, resulting in a late stage Au-Ag-Bi-Te-Se mineralization, including electrum, precious metal tellurides, Bi-Te-Se phases as well as native Bi (Figure 1B). This hypothesis is also supported by the high content of barite in all samples examined where disseminations and swarms of coarse-grained euhedral barite are identified (Fig. 1C, 1D).

The absence of any evidence of supergene alteration further supports the hypothesis of hypogene origin of precious metals and in particular Au-Ag alloys. No alteration of primary sulfides is observed (Figure 1), whereas the presence of APS-type phases in the intermediate conglomerate is not related to supergene phenomena but to hypogene hydrothermal alteration procedures that led to the formation of such phases probably after dissolution of primary phosphates in the host rock, as suggested by Voudouris et al. (2011). The presence of APS-type phases combined with the presence of enargite and unaltered pyrite in the intermediate conglomerate may be related to circulation of oxidative hydrothermal fluids and the development of an advanced argillic gangue assemblage (Dill, 2001).

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