

Tellurium and related element fractionation in porphyry-epithermal systems, Limnos Island, Greece

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A more sustainable world with CO₂ neutral energy production will require substantial amounts of trace metal(oids). To evaluate the resource potential and to improve the recovery rates of these rare commodities, a better understanding of their magmatic-hydrothermal mineralization processes is required. Limnos island in the northeastern Aegean Sea, Greece, hosts several porphyry-epithermal mineralizations (Fakos, Sardes, Kaspakas), some of which are known for their Te and related element enrichment (e.g., Cu, Au, Ag). However, the fractionation processes of these elements between the porphyry and epithermal environment are still poorly constrained [1].

Subalkaline to alkaline igneous rocks and siliciclastic sediments host the mineralization on Limnos that comprise an early porphyry and a late high- to intermediate-sulfidation epithermal stage [2]. The porphyry mineralization mostly consist of pyrite, magnetite and minor chalcopyrite, whereas the epithermal stage comprises pyrite, sphalerite, galena, chalcopyrite and minor sulfosalts (e.g. enargite, bournonite), tellurides and gold. The mineralization is mostly vein-related with disseminated pyrite occurrences in the porphyry altered host rocks. Pyrite is ubiquitous in all alteration-types and is part of the porphyry and epithermal stage, providing insights into the mineralization processes under all considered fluid conditions [3].

Epithermal pyrite is enriched in most trace metal(loid)s (e.g., As, Ag, Sb, Au, Pb, Tl) compared to porphyry pyrite (Se). This either suggests that the trace metal(loid) deposition from the high temperature (450° - 750°C) fluids was limited or that these elements were preferentially incorporated in phases other than pyrite in the porphyry environment. Hence, the elevated concentrations in epithermal pyrite are likely caused by a more efficient mineralization process at lower temperatures (190° - 310°C). However, Te shows no systematic variation between porphyry and epithermal pyrite, which we refer to its competitive incorporation between pyrite, galena and free-tellurides in the epithermal stage. We present a hydrothermal model based on the mineralogical and chemical data, defining key fractionation factors (e.g. temperature, salinity, pH, redox) for Te and related elements in porphyry-epithermal mineralization.

[1] Keith et al. (2018), *Ore Geology Reviews* 96, 269-282. [2] Voudouris et al. (2019), *Ore Geology Reviews* 107, 654-691. [3] Fornadel et al. (2012), *Mineralogy and Petrology* 105, 85-111.