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Fluid evolution in the Cu-Mo ± Re ± Au porphyry system of Maronia, NE Greece: Insights from the chemistry of pyrite, molybdenite and quartz

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The western Tethyan metallogenic belt is host to epithermal-porphyry deposits enriched in precious and energy-critical elements such as Au, Ag, Re, Te, Se, Cu and Mo [1, 2]. For the European Union these deposits may have a strategic importance regarding import independence of these commodities, and thus ancient mining sites should be reevaluated for their metal(loid) endowment. The monzodioritic to granitic intrusion of Maronia in NE Greece is such an example, which hosts an anomalously Re-rich Cu-Mo ± Re ± Au porphyry system [2, 3]. The mineralization is dominated by pyrite, molybdenite, native Au, rheniite (ReS_2), and arsenopyrite in quartz-bearing hydrothermal veins associated with potassic, sericitic, and sodic-calcic alteration, and shows an epithermal overprint. To decipher the hydrothermal processes leading to the enrichment of Mo, Re, and Au at Maronia, we used detailed imaging techniques such as BSE-SEM and CL-SEM and analyzed pyrite, arsenopyrite, molybdenite, and quartz from different hydrothermal veins and miarolitic cavities by EPMA and LA-ICP-MS. We combined this trace element approach with in-situ $\delta^{34}S$ measurements of pyrite by LA-ICP-MS.

The various vein types associated with the different alteration zones provide a framework for the time-space relations at Maronia. Hydrothermal quartz CL intensity and textures correlate with the temporal changes and suggest decreasing formation temperatures with time. Pyrite shows an increase in As, Au, and Ag and decrease in Se and Ni from early to later vein generations consistent with the porphyry-epithermal transition. High $\delta^{34}S$ values in pyrite from low sulfidation epithermal veins ($\delta^{34}S$ = 4.6 ‰) indicate an influence of meteoric waters in the epithermal overprint. Rhenium is hosted by molybdenite (Re âŒ€ = 0.84 wt.%) and rheniite in early quartz-molybdenite veins. Our multi-mineral trace element and $\delta^{34}S$ approach at Maronia allows us to constrain the physicochemical fluid parameters of the porphyry-epithermal transition favorable for the enrichment of elements like Au, Ag, Re, Te, and Se. This will help us to develop a hydrothermal model controlling this metal endowment in space and time.

[1]Baker, T. (2019), *Economic Geology* **114**

[2]Melfos, V. et al. (2002), *Mineralium Deposita* **37**

[3]Voudouris, P. et al. (2019, *Ore Geology Reviews* **107**