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Geochemical and Quartz Mineralogical Vectors to Epithermal Ore in Lithocaps in the TV Tower District, Biga Peninsula, Turkey, and Kassiteres-Sapes District, Greece

Thomas Bissig,[1,*] Thomas Monecke,[2] Elizabeth Ann Holley,[3] Graham Leroux,[1] Panagiotis Voudouris,[4] and Aleksandar Miškovic[5]

[1]Mineral Deposit Research Unit, Department of Earth, Ocean and Atmospheric Sciences, University of British Columbia, Vancouver, BC, Canada
[2]Department of Geology and Geological Engineering, Colorado School of Mines, Golden, CO, USA
[3]Department of Mining Engineering, Colorado School of Mines, Golden, CO, USA
[4]Department of Mineralogy and Petrology, National and Kapodistrian University of Athens, Athens, Greece
[5]Geotarget Solutions Inc., Burnaby, BC, Canada

*Corresponding author: e-mail, tbissig@eos.ubc.ca

High-sulfidation epithermal deposits are hosted in lithocaps: extensive areas of quartz-rich alteration in the shallow parts of magmatic-hydrothermal systems. Normally, two distinct stages of hydrothermal activity can be identified. Early acidic fluids cause residual quartz alteration where most components are leached except SiO_2 and some resistate minerals, such as rutile or zircon. A second hydrothermal stage precipitates euhedral quartz in open spaces or fractures, commonly closely associated with sulfide minerals and precious metal mineralization. Samples from lithocaps in the Kassiteres-Sapes porphyry-epithermal district (Greece) and Küçükdağ in the TV Tower area (Turkey) have been investigated through optical and cathodoluminescence microscopy as well as whole-rock geochemical analysis. Quartz associated with mineralization (> 0.5 g/t Au and/or 30 g/t Ag) is euhedral, oscillatory zoned, and largely devoid of mineral inclusions, except at Küçükdağ, where quartz rich in sulfide inclusions is overgrowing clear oscillatory-zoned quartz. Ore-related quartz presents diagnostic yellow to orange cathodoluminescence colors that can be readily distinguished from residual quartz, which has no CL response or a weak pink to blue luminescence. Ore-stage quartz with similar characteristics has been documented from other epithermal districts outside the western Tethyan region (e.g., Veladero, Argentina; Summitville, Colorado; Quimsacocha, Ecuador; Lagunas Norte, Peru). This diagnostic type of quartz can potentially be used as an epithermal indicator mineral in stream sediments.

Intense acid leaching typically removes most elements except some HFSE (Ti, Nb, Zr, and Hf) and Si, and acid-leached rocks typically have lost considerable mass (up to 60%). The degree of element removal can be used as a guide toward most intensely leached rock, which commonly hosts mineralization due to the permeability generated. Based on data from Küçükdağ, elements such as K, Na, Ca, or Mg are removed from a wide area around the deposit, whereas Al, LREE, and HREE removal occurs in a progressively smaller halo around the deposit. Some elements, including Ce or K, may form a zone of enrichment outboard of the depleted zone. The mineralizing stage overprinting the acid leaching may have reintroduced some REE, including HREE near the core and some LREE outboard. Other elements added during the second stage of hydrothermal activity include Sn and Ba. However, anomalous concentrations of pathfinder elements like Au, Ag, Cu, and As occur somewhat erratically and provide a smaller footprint than the depletion halo

of many of the other elements. Most apparently barren siliceous outcrops south of Küçükdağ are characterized by addition of Si but removal of most other components. Based on geological reconstruction, these probably formed peripheral to a magmatic-hydrothermal system, but clearly below the water table and, thus, below the shallow epithermal environment.