First zunyite-bearing lithocap in Greece: The case of Konos Hill Mo-Re-Cu-Au porphyry system

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1. Introduction and Regional Geology

Zunyite [Al₅Si₂O₆(OH,F)₄Cl] is a rare F- and Cl-bearing, aluminosilicate that was originally described from and named after the Zuni Mine, Colorado, USA. Zunyite has been recognized as a rare mineral in advanced argentiferous alteration assemblages, which commonly develop in shallow levels, above porphyry Cu-Au deposits.

In the Sapes-Kssiteses district, lithologies of the Makri unit (Circum Rhodope Belt) predominate, especially in its southern part. Overlaying extended outcrops of the Eocene volcanosedimentary sequence occupy most of the study area, along with hydrothermally-altered subvolcanic intrusions.

Kunos Hill, its most prominent topographic feature, consists of a hydrothermally-altered granodiorite which intruded into the volcanosedimentary sequence (Figure 1). Further to the E-NE part of the study area, a monzodioritic body has intruded the volcanosedimentary sequence and the granodiorite. Previous studies in this area have shown that granodiorite hosts the Konos Hill porphyry Cu-Mo-Re-Au porphyry prospect.

2. Alteration and Mineralization

Advanced argillic alteration at Konos Hill is related to E-W, NNW-SSE and N-S trending faults and produced a significant overprint of the porphyry-style alteration and mineralization, which is exposed in lower topographic areas (Figure 2a).

Silicified zones grade outwards into advanced argillic assemblages (Figures 2b-e). Adjacent to silicification, alunite+APS minerals+quartz+zunyite+pyrophyllite assemblages predominate, while more distal assemblages are composed of quartz+alunite+APS minerals+diaspore+kaolinite+pyrophyllite.

Advanced argillic alteration assemblages evolve through a transitional zone of quartz+alunite+pyrophyllite+sericite, into a typical sericite-rich assemblage, which is the most widespread type of hydrothermal alteration. Porphyry-style quartz stockwork veins (Figure 2f), hosted in granodiorite, comprise chloropyrite-pyrite-molybdenite-renenite.

3. Mineral Chemistry

- **Zunyite**: SiO₂ and Al₂O₃ range from 22.7 to 25.14 wt.%, and 54.97-55.81 wt.%; F and Cl range from 4.07-5.93 and 2.72-2.97 wt.%. Traces of BaO, TiO₂, Na₂O and CeO₂ were detected.

- **Alunite-Natroalunite**: Most alunites are K-rich, (K₂O up to 9 wt.%). Alunite-Natroalunite is also common and usually forms euhedral, tabular-shaped crystals. NaO content is up to 5.12 wt.%. APS: analyzed compositions yielded woodhouseite and stromant woodhouseite.

- **Diaspore**: stoichiometric compositions with traces of TiO₂, BaO, CeO₂ and NdsO₃.

- **Kaolinite/Pyrophyllite**: were verified through XRD analyses.

4. Conclusions

- Advanced argillic alteration in Konos Hill was formed by acidic fluids that were channeled through fault planes.

- The presence of zunyite in a lithocap that overlies a porphyry deposit, is described here for the first time in Greece and suggests the availability of F and Cl in the hydrothermal fluid.

- A T range of 280-350 °C for zunyite formation is based on the similarity of zunyite-bearing assemblages at Konos Hill with those observed in the Hugo Dummet porphyry Cu-Au deposit which formed over this range of temperatures.