

Alunite Occurrences in the Sapes Porphyry-Epithermal Deposit, Ne Greece, and Their Genetic Relation to High-Sulfidation Epithermal Cu-Au-Ag-Te Deposition

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The Sapes area is a telescoped porphyry-epithermal system, hosted within Oligocene postcollisional calc-alkaline to high-K calc-alkaline granodiorite, microdiorite, and quartz-feldspar porphyries and their volcanic equivalents. Sapes is characterized by widespread development of silicic-advanced argillic alteration lithocaps and associated high-sulfidation epithermal Au-Ag-Cu-Bi-Te mineralization that overprint and also occur alongside two porphyry Cu-Mo-Re ± Au mineralized centers exposed at Koryfes and Konos Hills.

The lithocaps are vertically zoned, from quartz-pyrophyllite-diaspore-corundum-topaz-APS minerals-natroalunite at depth to quartz-alunite-kaolinite-dickite and vuggy quartz at shallower levels, where the causative fluid was cooler and more acidic. Advanced argillic alteration mostly occurs at St Demetrios and Viper deposits, and at St Barbara, Galaxy, Sapana, and Kamenio prospects in the western part of the district. Microscope studies and EMPA and SEM data for the Sapes alunite supergroup minerals indicate a complete solid solution between natroalunite-alunite, as well as woodhouseite present as pseudocubic crystals in diaspore and in the cores of natroalunite.

Three types of alunite are recognized in the area: Type I (pre-ore?), tabular natroalunite (up to 6.3 wt % Na₂O) and natroalunite-alunite solid solution of magmatic-hydrothermal origin, are associated with pyrite replacing magmatic phenocrysts. Type II, magmatic-steam alunite forms plumose aggregates in banded alunite ± barite ± chalcedony veins. Type III alunite occurs as rhombohedral and pseudocubic crystals filling vugs and cementing silicified breccias, or in veinlets crosscutting stage II alunite. Types II and III alunite (with up to 9.7 wt % K₂O) were contemporaneous to high-sulfidation mineralization. The chemical zoning of the alunite supergroup minerals at Sapes (e.g., APS mineral cores and natroalunite-alunite rims) could have resulted due to rapid changes in solution chemistry during a decrease in pH and temperature from about 300° to 250°C. Relatively lower temperatures (between 250° and 200°C) are considered to have prevailed during the formation of alunite (stages II to III) plus kaolinite/dickite without APS minerals. At Sapes area, stage II and III alunite is similar to that observed elsewhere (e.g., Tambo, Chile), where high-sulfidation gold ore is hosted in barite and alunite + quartz of magmatic-hydrothermal origin and also associated with alunite of magmatic-steam origin.

Alteration and mineralization in the area probably reflect multiple periods of injection of vapor-rich magmatic fluids into the Sapes stratovolcano. The results of the study will help better understand the evolution of the magmatic-hydrothermal processes in an eroded volcanic center and at the transition between a porphyry and high-sulfidation epithermal system.