

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

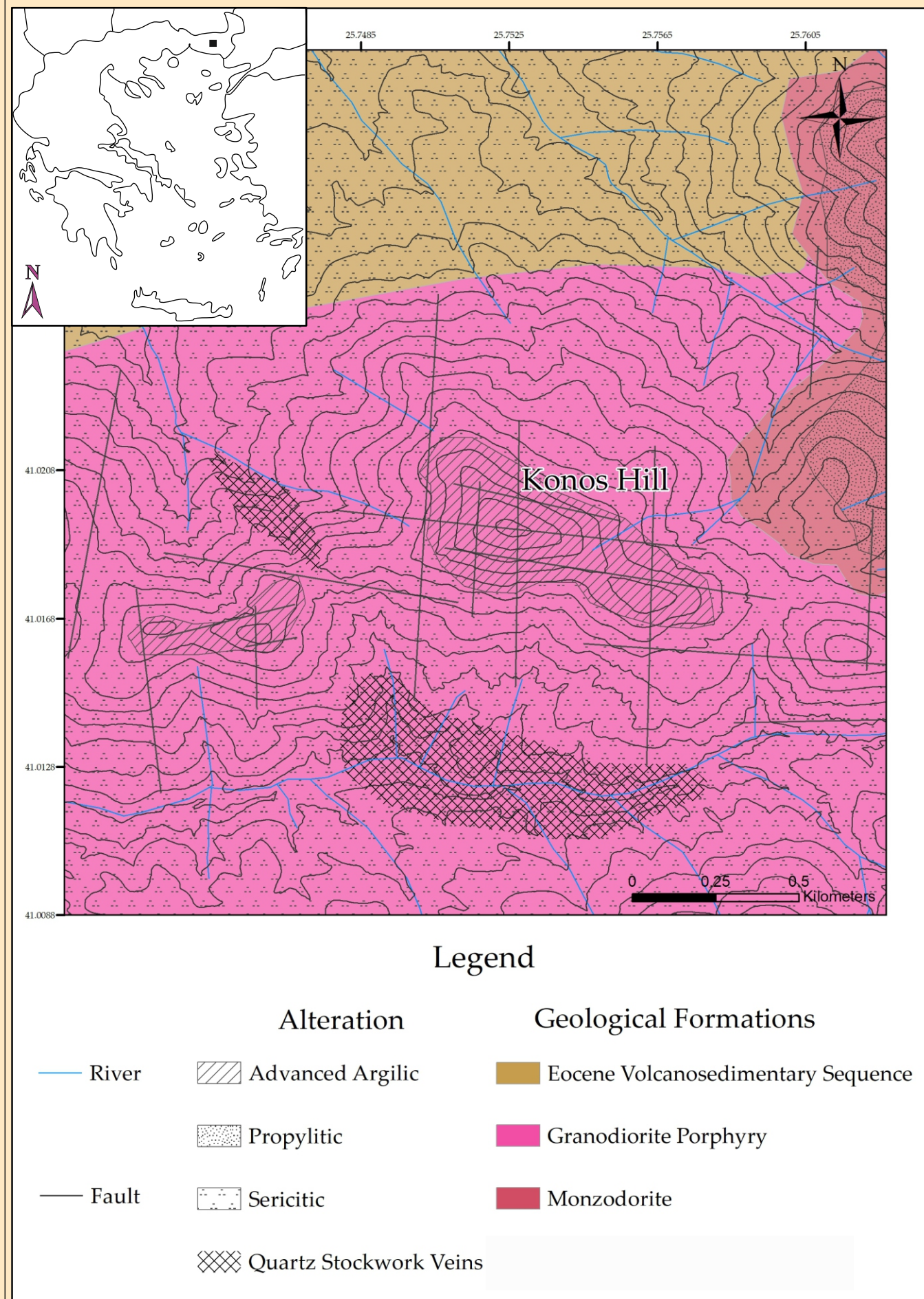


Figure 1. Geological and alteration map of Konos Hill area. Black square in the map of Greece (top-left corner), marks the location of the study area.

Zunyite $[Al_{13}Si_5O_{20}(OH,F)_{18}Cl]$ 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 argillic alteration assemblages, which commonly develop in shallow levels, above porphyry Cu-Au deposits.

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

Konos 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 chalcopyrite-pyrite-molybdenite-rheniite.

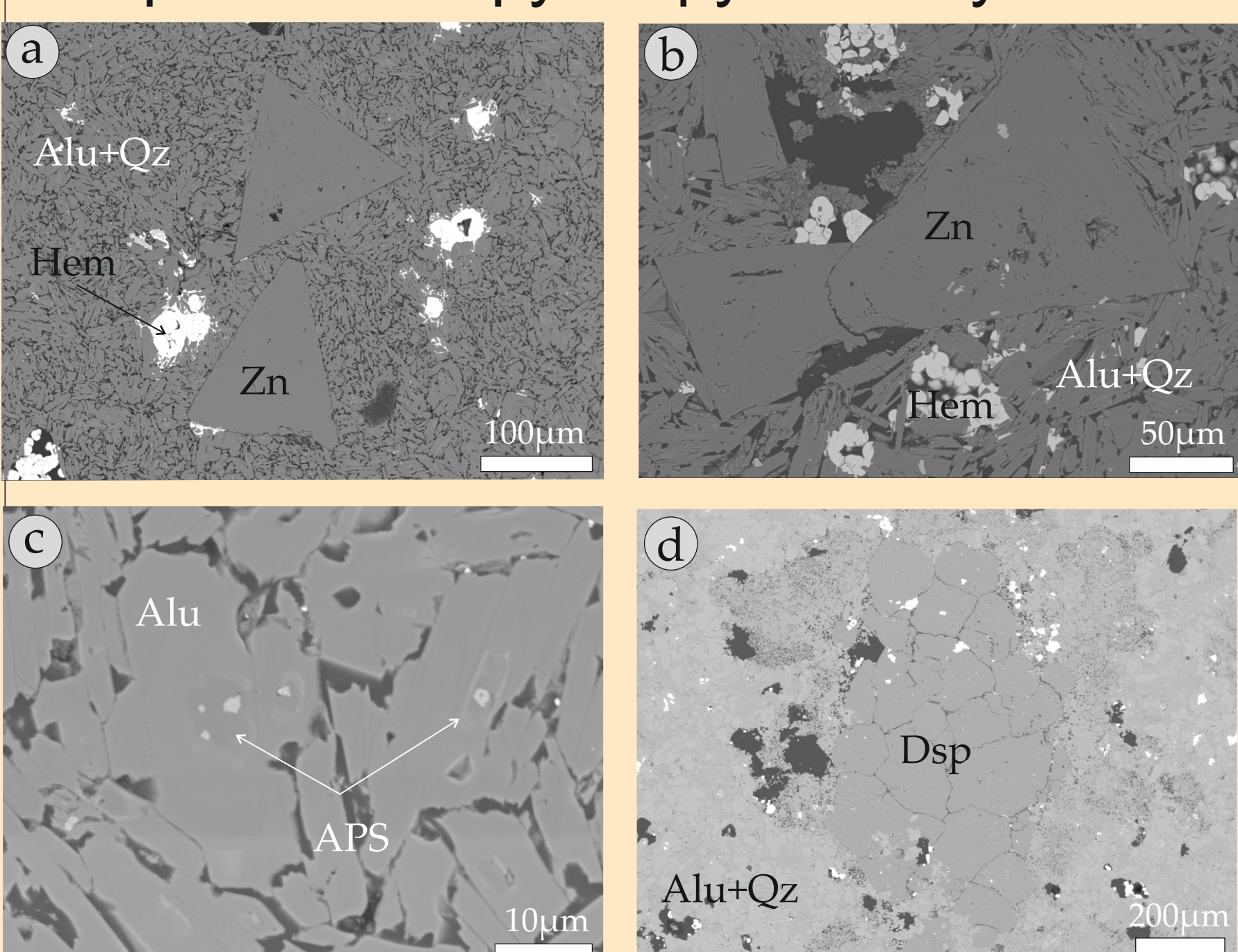


Figure 4. Back-scattered electron microphotographs: (a,b) Euhedral zunyite (Zn) crystals in association with quartz, tabular alunite (Alu+Qz) and hematite (Hem); (c) APS minerals in the core of alunite crystals; (d) Diaspore (Dsp) crystals set in an alunite and quartz (Alu+Qz) dominated matrix.

5. References

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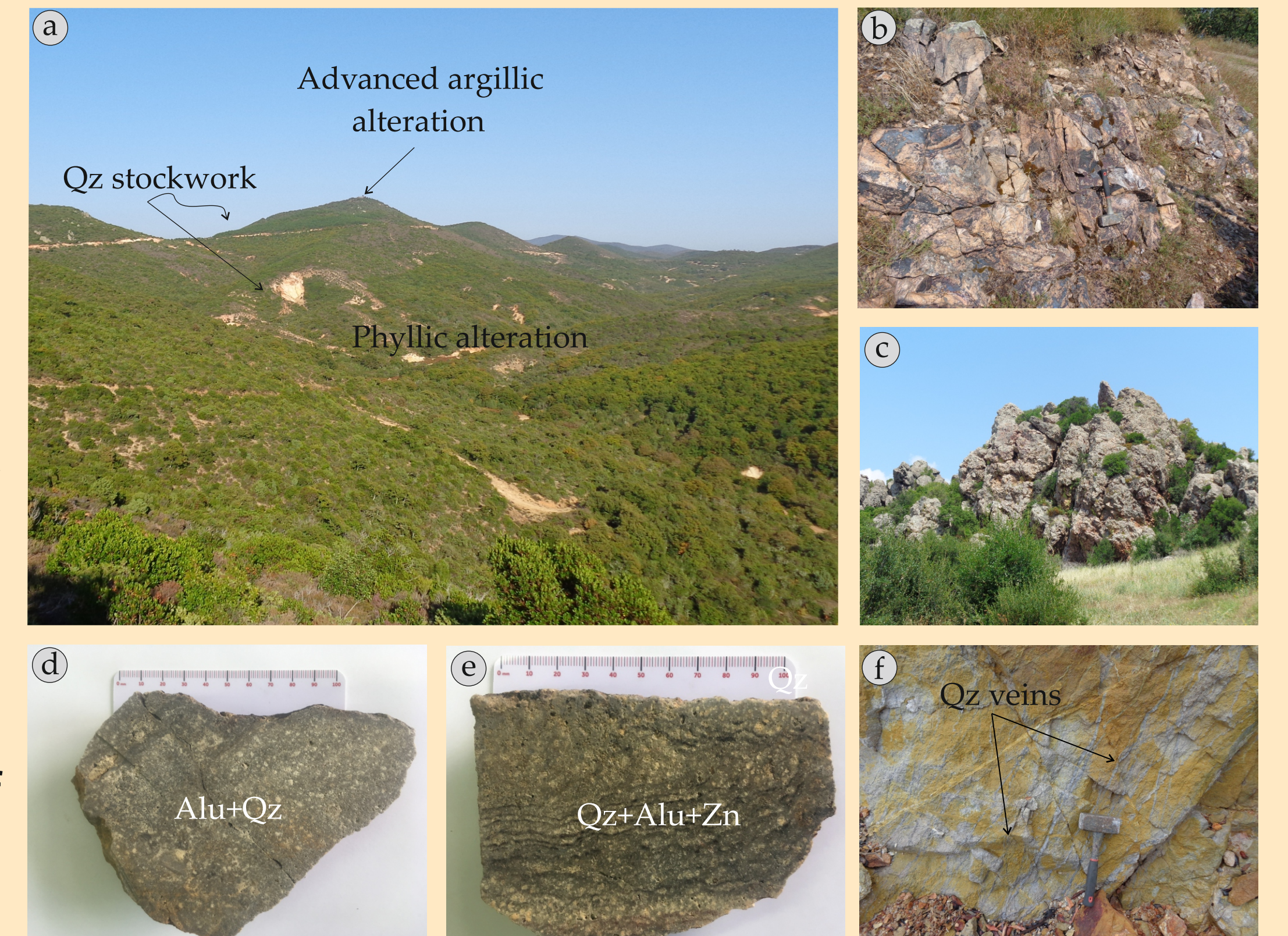


Figure 2. Field and hand-specimens photographs: (a) Panoramic view of Konos Hill; (b) Quartz-alunite-zunyite bearing rocks on top of Konos Hill; (c) Quartz-alunite-diaspore bearing in the NW slopes of Konos Hill; (d,e) Hand-specimens of quartz-alunite and quartz-alunite-zunyite assemblages; (f) Quartz porphyry stockwork veins in sericitic-altered granodiorite (Saporema Creek).

3. Methods

Advanced argillic alteration minerals were identified through XRD analyses, at the Faculty of Geology, University of Athens.

Chemical compositions were determined by EPMA (JEOL 8530F instrument) at the Institute for Mineralogy, University of Munster, Germany.

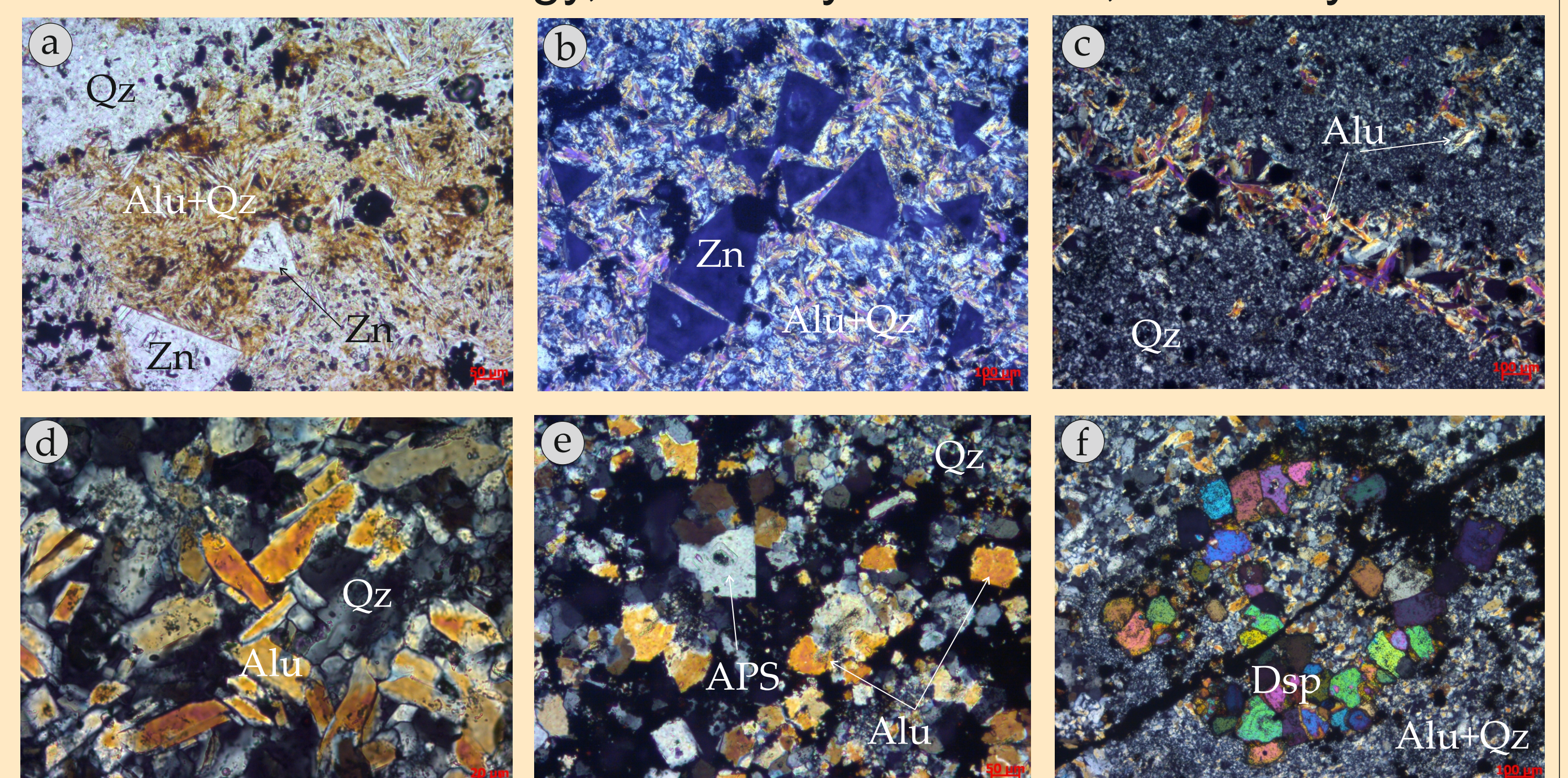


Figure 3. Transmitted light microphotographs of advanced argillic alteration assemblages from the Konos Hill area. (a,b) Euhedral zunyite (Zn) crystals in association with quartz and tabular alunite (Alu+Qz, // and + nicols respectively); (c) Alunite (Alu) vein crosscutting silicified granodiorite (+ nicols); (d) Tabular alunite crystals in association with quartz (Qz, + nicols); (e) APS minerals are found in the core of pseudocubic alunite (+ nicols); (f) Subhedral diaspore (Dsp) crystals set in an alunite and quartz (Alu+Qz) dominated matrix (+ nicols).

4. Conclusions

- Advanced argillic alteration in Konos Hill was formed by acidic fluids that were channelled 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 Dummett porphyry Cu-Au deposit which formed at this range of temperatures.

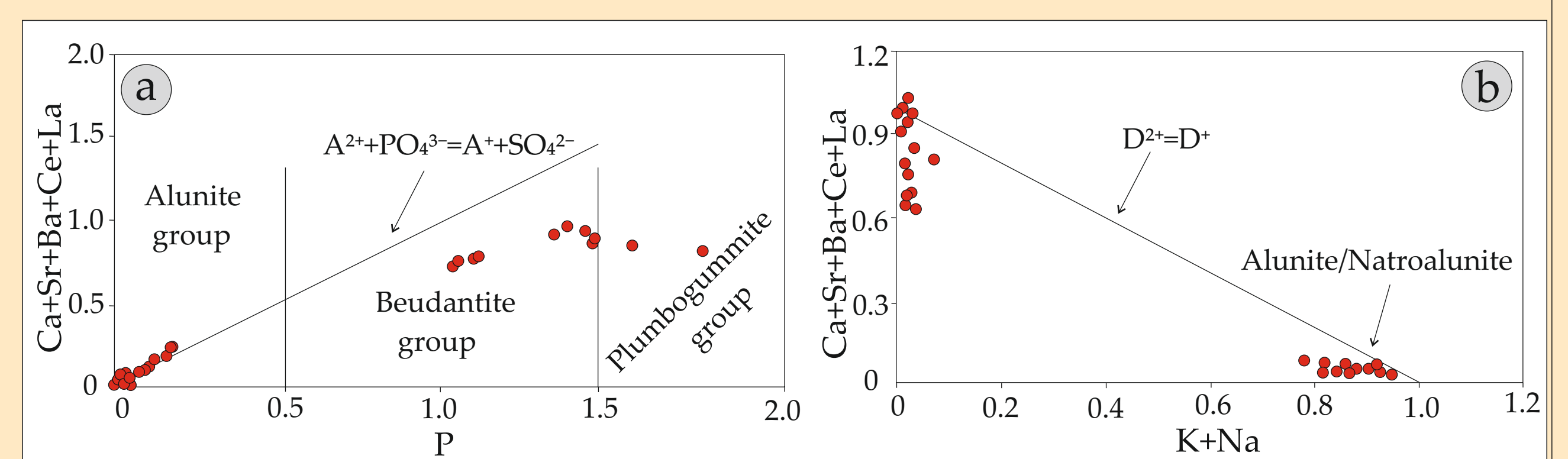


Figure 5. Chemical variation diagrams of analyzed alunite and APS minerals from Konos Hill area: (a) Ca+Sr+Ba+Ce+La vs P plot (marked line represents the occupancy of divalent and trivalent cations in A site, relative to trivalent anions in X site); (b) Ca+Sr+Ba+Ce+La vs K+Na plot (marked line represents occupancy of monovalent relative to divalent cations in D site).