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Preliminary observations of the magmatic mineralogy of Pliocene volcanics from Alchar, Macedonia: significance for the mineralization process

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The formation of porphyry and epithermal ore deposits requires a number of agents including chlorine as main ligand for transporting metals in hydrothermal systems (e.g., HEINRICH 2005). Here, we investigate the compositions of magmatic and hydrothermal minerals of the volcanic-hosted hydrothermal ore system of Alchar, Macedonia as no mineral chemistry of was reported from the Alchar volcanic complex. Alchar is a calcalkaline intrusive and extrusive complex also extending to northern Greece (YANEV et al. 2008), which hosts an epithermal Au-As-Sb-Tl deposit (KOCHNEVA et al. 2006). The volcanic products including the cooling history of a subvolcanic latite body of Alshar (Alshar latite in the further text) were recently dated by $^{40}Ar/^{39}Ar$ mineral dating and the ages range from 5.1 Ma (age of intrusion) to 3.3 Ma (age of cooling through ca. 200°C; NEUBAUER et al. 2009). The biotite ages of 5.0± 0.1 and 5.1±0.1 Ma from blocks of the Vitacovo tuff forming likely the initial Pliocene volcanism in the Alchar region indicating that Alchar latite and the Vitacovo tuff formed at the same time by the same process. A hydrothermal K-feldspar of Alshar precisely dates the main event of subsequent hydrothermal alteration at 4.31±0.02 Ma.
Our investigations of amphibole and biotite of subvolcanic latite from Alchar and of the Vitacovo tuff show a significant compositional variation of magmatic minerals. Phenocrystic amphiboles of the Vitacovo tuff exhibit a significant zoning. The cores are commonly magnesio-hornblende, rims magnesio-hastingsite. Clinopyroxene phenocrysts are also commonly zoned and their compositions vary within the diopside field. The chlorine contents of amphiboles and phlogopite are between 0.02 and 0.1 wt%. Some amphiboles, clinopyroxenes and plagioclases reveal an oscillatory zoning and the variation of plagioclase is between $Ab_{42.5}An_{55.4}Or_{2.2}$ and $Ab_{63.6}An_{30.8}Or_{5.6}$. Oscillatory zoning of amphibole, plagioclase and clinopyroxene response either to P-T fluctuations during crystallization (GARCIA-CASCO et al. 2002) or can be related to mixing events in magma chambers. Magmatic processes such as crystallization recharge in magma chambers, decompression during ascent and convection can explain these patterns (GINIBRE et al. 2007).
The phenocrystic amphibole is uncommon in the Alshar latite. Diopside is again slightly zoned. Plagioclase is less zoned than in the about coeval Vitacovo tuff and compositions range between $Ab_{57.1}An_{37.4}Or_{5.6}$ and $Ab_{48.6}An_{48.7}Or_{2.7}$. The chlorine content in rare amphibole and abundant phlogopite ranges between 0.08 and 0.18 and is similar to that of same minerals of the Vitacovo tuff.
Our new mineral data suggest that chlorine as a major agent for ore formation originates from the magmatic system and was likely released from the magma. Fluid inclusions of the epithermal ore system indicate a low-salinity hydrothermal fluid for mineralization (KOCHNEVA et al. 2005). The above mentioned dated K-feldspar is relatively rich in the albite component (27.6 to 29.0 mol percent), low in the An component and shows BaO contents of 0.76 and 2.30 wt%. The high albite content seems uncommon for hydrothermal alkali feldspars.

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Artiodactyl trackways in Pleistocene eolianites on Antiparos (Central Cyclades, Greece)

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Yellowish calcarenite sandstones have been mapped along the NW coast of Antiparos island (Aegean). These sandstones form dm to 5 m thick layers which cover greenschist to amphibolite grade metamorphic rocks of the Attic-Cycladic Crystalline of the Central Hellenides. The sandstones can be traced from below sea-level up to an elevation of approximately 80 m. Generally, the sandstone layers and the internal lamination are parallel to the slopes of the underlying crystalline without forming any morphological terraces; cross-bedding with dip-angles >35° has only rarely been recorded. The sandstones are dominated by marine bioclasts including mainly corallinaceaen red algae, benthic foraminifers and fragments of gastropods and bivalves with siliciclastic components of less than 20 %. The sandstones are