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Upper plate deformation, magmatism and mineralization illuminating crustal and mantle dynamics in the eastern Mediterranean region: kinematic reconstructions and numerical models

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Geodynamics of the eastern Mediterranean region is largely governed by the Africa-Eurasia convergence and involves a succession of subduction, collision, obduction, slab retreat and tearing events since the late Cretaceous. The resulting complex 3D dynamics of the subduction zone is still largely discussed and a large number of geological data have to be considered to better constrain this evolution.
We propose new detailed kinematic reconstructions of the eastern Mediterranean region (integrating notably stratigraphic, metamorphic, structural and paleomagnetic data) also showing the distribution of magmatic products and mineralization in space and time. Moreover, we test the parameters controlling this tectonic and magmatic evolution with 3D thermo-mechanical numerical models of subduction with realistic lithospheric and mantle rheologies.
A continuous southward retreating subduction zone has been active in the region since the late Cretaceous with the subduction and accretion of several oceanic and continental domains. Separated by a barren compressional period in the Paleocene-Eocene, two back-arc extensional events are highlighted. (1) In the late Cretaceous, a slow extension was active and a wide calc-alkaline magmatic province associated with porphyry Cu deposits emplaced along the Balkans and the Pontides. During this period, the trench was long and linear, similarly to the present-day Andean margin. (2) Since the Oligocene, a sensibly faster extension occurred in the Aegean-west Anatolian region where K-rich magmatism and Au-rich ore deposits emplaced. Back-arc extension and related mantle flow have induced the rising of the isotherms within the upper plate, allowing the partial melting of the lithospheric mantle or the base of the crust, where Au was previously stored. Emplacement at shallow level of this mineralization was then largely controlled by large-scale structures such as detachments that drained the magmatic-hydrothermal fluids.
In addition, besides the general southward migration of this magmatic-hydrothermal activity since the late Cretaceous, a secondary westward migration is observed during the Miocene from the Menderes massif to the Cyclades. This feature is a possible consequence of a slab tearing event and related asthenospheric flow, as suggested notably by tomographic models below western Anatolia. Using 3D high-resolution thermo-mechanical numerical models, we test the effects of slab retreat and tearing on asthenospheric flow and its consequences on crustal deformation and magmatic activity. Results suggest that this asthenospheric flow partly controls both the crustal deformation in hot regions (such as in the back-arc domain) and the lateral migration of partially molten materials stored at the base of the stretched crust.