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Various-scale controls of complex subduction dynamics on magmatic-hydrothermal processes in eastern Mediterranean

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In subduction environment, magmatic-hydrothermal processes, responsible for the emplacement of magmatic bodies and related mineralization, are strongly controlled by slab dynamics. This 3D dynamics is often complex, resulting notably in spatial evolution through time of mineralization and magmatism types and in fast kinematic changes at the surface. Study at different scales of the distribution of these magmatic and hydrothermal products is useful to better constrain subduction dynamics. This work is focused on the eastern Mediterranean, where the complex dynamics of the Tethyan active margin since the upper Cretaceous is still largely debated.

We propose new kinematic reconstructions of the region also showing the distribution of magmatic products and mineralization in space and time. Three main periods have thus been identified with a general southward migration of magmatic and ore bodies. (1) From late Cretaceous to lower Paleocene, calc-alkaline magmatism and porphyry Cu deposits emplaced notably in the Balkans, along a long linear cordillera. (2) From late Paleocene to Eocene, a barren period occurred while the Pelagonian microcontinent was buried within the subduction zone. (3) Since the Oligocene, Au-rich deposits and related K-rich magmatism emplaced in the Rhodopes, the Aegean and western Anatolian extensional domains in response to fast slab retreat and related mantle flow inducing the partial melting of the lithospheric mantle or the base of the upper crust where Au was previously stored.

The emplacement at shallow level of this mineralization was largely controlled by large-scale structures that drained the magmatic-hydrothermal fluids. In the Cyclades for instance, field studies show that Au-rich but also base metal-rich ore deposits are syn-extensional and spatially related to large-scale detachment systems (e.g. on Tinos, Mykonos, Serifos islands), which are recognized as subduction-related structures.

These results highlight the importance at different scales of subduction dynamics and related mantle flow on the emplacement of mineralization and magmatic bodies. Indeed, besides a general southward migration of the magmatic-hydrothermal activity since the upper Cretaceous from the Balkans to the present-day Aegean volcanic arc, 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 mantle flow, as suggested notably by tomographic models below western Anatolia. To further test the effects of slab retreat and tearing on the flow and temperature field within the mantle, we performed 3D thermo-mechanical numerical modeling. Models suggest that the asthenospheric flow induced by the development of a slab tear controls the migration of magmatic products stored at the base of the crust, influencing the distribution of potentially fertile magmas within the upper crust.