Geophysical Research Abstracts
Vol. 21, EGU2019-14030, 2019
EGU General Assembly 2019

Subduction dynamics beneath the Eastern Mediterranean: tectonic, metamorphic and thermal consequences from Cretaceous to Present

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Slab dynamics (i.e. rollback and tearing) below the Eastern Mediterranean area is well imaged by numerous mantle tomography studies elucidating deep mantle structures. It induces asthenospheric mantle flow that had first order tectonic and metamorphic consequences in the overriding plate. However, there is no consensus about the time-space evolution, the deformation and the thermal consequences of such dynamics. We combine these information (i.e. mantle tomography) to high-resolution laser 40Ar-39Ar dating of micas, U-Pb dating of monazite, RSCM Tmax data and regional-scale kinematic-structural data in the Menderes Massif and in the Eastern Aegean islands, which have been little studied. This study then shed light on a common regional tectono-metamorphic evolution from Cretaceous to Present. In particular, we demonstrate the existence of different nappes which recorded different high-pressure and low-temperature conditions in the studied area: (i) the Upper Cycladic Blueschist Nappe (excluding the Vourliotes Nappe in Samos) characterized by eclogite paragenese and (ii) the Lower Cycladic Blueschist Nappe (e.g. Amorgos, a part of the Dodecanese and Fourni islands) and the colder units of the upper Menderes Complex (i.e. the Kurudere-Nebiler units) witnessing blueschist metamorphism. A part of these units was partly obliterated by the Eocene Barrovian-type metamorphism overprint associated with collision and crustal stacking events in western Turkey. This event was mainly exhumed along the top-S syn-orogenic extensional Selimiye shear zone during the Eocene (47 to 33 Ma, 40Ar/39Ar on micas). Then, a second high-temperature low-pressure metamorphic event (with local anatexis) associated with post-orogenic extension induced by slab dynamics (i.e. tearing and slab retreat) occurred during the Oligo-Miocene. Our geochronological investigations reveal the formation of a large thermal pulse contemporaneous with the exhumation of the Menderes metamorphic core complex (MCC) and other MCCs in Cyclades. This latter is also exploited for geothermal production today, particularly in the Menderes Massif. In details, we suggest that crustal-scale low-angle normal faults convey hot fluids to the surface and represent the first-order control on geothermal systems. In addition, our study of the Eastern Aegean islands, allows us to complete the description of the extensional strain field in the overriding plate around the Miocene slab tear and retreat. Extensional tectonics keeps a constant NNE-SSW direction, without localized crustal-scale strike-slip faults and block rotations above the tear. Such dynamics are also consistent with numerical modelling, suggesting that, when slab tearing occurs, Moho temperatures can temporarily increase by up to 250°C due to shear heating controlled by the fast-flow of the uppermost mantle. At the scale of MCCs, the bulk fluid flow pattern is controlled by topography-driven flow while buoyancy-driven flow dominates within the permeable detachments, focusing reservoir location of high-energy geothermal systems at shallow depth beneath detachments.