Geophysical Research Abstracts
Vol. 18, EGU2016-9536, 2016
EGU General Assembly 2016

Geometry and thermal structure of the Menderes Massif Core Complex (Western Turkey), implications for thermal evolution of Hellenic subduction zone

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The eastern Mediterranean region is one of the most promising geothermal areas, with more than 250 geothermal fields discovered in Turkey (Parlaktuna, 2013), in a region of active tectonics and volcanism. Although the potential of these deep geothermal resources has not been systematically investigated yet, the geothermal activity of the western Turkey area is the most recent signature of the high heat flow (120-140 mW/m^2; Aydin, 2005, from Teczan, 1995). Based on Turkish data, 2084 MWt are being utilized for direct applications and most of the energy originates from the Menderes Massif (Baba et al., 2015). This large-scale thermal anomaly at the surface is correlated to a long wavelength east-west increase of surface heat flow that could reflect the thermal state of Aegean subduction zone at depth. In order to better understand and characterize the possible connections between large-scale mantle dynamics and surface processes in space and time, we study the structure and thermal evolution of the Menderes Massif.

Both the acceleration of the Aegean extension in the Middle Miocene and the recent escape of Anatolia have been proposed to result from several slab tearing events, the first one being located below western Turkey and the Eastern Aegean Sea. These events have triggered the formation of metamorphic complexes with contrasted exhumation P-T paths. While the extension in the Aegean domain is well-characterized with high-temperature domes in the center and east, the succession of several metamorphic events in the Menderes Massif and their significance in terms of geodynamics is still debated. Hence, the exhumation history is key to understanding the temporal and spatial distribution of the thermal signature of the Hellenic slab and its tearing/detachment.

The Menderes Massif displays a large variety of metamorphic facies, from the Barrovian type metamorphism in the Eocene (the Main Menderes Metamorphism) to the coeval (?) HP-LT metamorphism on the southernmost part of the massif and the Oligocene migmatites observed in the north. The geometrical relations between these differently metamorphosed units are unclear. Our findings, based on a structural analysis combined with a geothermometry approach (Raman Spectrometry of Carboneous Materiel, RSCM), yield new constraints (temperature data) on the tectono-metamorphic evolution of the Menderes Massif, from the subduction/obduction-related events in the Late Cretaceous all the way to the active geothermal fields. Temperature data indicate an inversion of the metamorphic gradient in the Menderes units with the coldest units below the HT gneissic basement. At the large scale, we discuss the development and the thermal propagation of slab tears during subduction beneath western Anatolia by using seismic tomography models, but also by analyzing the geological record of magmatic activity and its geochemical signature (e.g. increase of mantle source component).