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Subduction and slab tearing dynamics constrained by thermal anomalies in the Anatolia-Aegean region

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Most previous geodynamic studies treat subduction zones with backward migration (rollback), slab tearing or slab breakoff by numerical or laboratory experiments and by integrating seismicity, tomography data and geochemical studies. Here we investigate these processes in the Aegean-Anatolian domain and particularly the western side of Turkey (western Anatolia) by incorporating thermal regime of the crust, and in particular the geothermal fields as anomalies that could reflect the thermal state of Aegean subduction zone at depth.

This domain is characterized by 1) extensional crustal deformation which progressively localized during the Aegean slab retreat from late Eocene to Present, enabling the development of a hot backarc domain; this extension accelerated between 15 and 8 Ma coeval with a fast rotation of the Hellenides and 2) since the latest Miocene, extension is coupled with the development of the North Anatolian Fault that accommodates the westward escape of the Anatolian block. Both the acceleration of 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, a second one below eastern Turkey and a last one below the Corinth Rift (Faccenna et al., 2006; Jolivet et al., 2013). The distribution of magmatism and mineral resources has been suggested to be largely controlled by these retreat and tearing events (Menant et al., submitted).

The development of a widespread active geothermal province in western Anatolia is unlikely to simply result from the Quaternary magmatism whose volcanism part has a too limited extent. Conversely, the long wavelength east-west variation of surface heat flow density could reflect deep thermal processes in the lower crust and/or deeper, and we thus look for possible connections with larger-scale mantle dynamics. We use the distribution of thermal anomalies at different scales and the 3D shape of the Aegean slab to discuss mantle and crustal dynamics. In order to constrain the development and the propagation of slab tears during subduction beneath western Anatolia, we used spatial and temporal data on magmatic activity, geochemical signatures of this activity (e.g. increase of mantle source component), seismic tomography models and seismicity data. We also discuss the origin of the thermal anomalies propagating all the way to the surface, whether they relate to deep-seated mantle processes only (western Anatolia, Turkey) or to more superficial volcanic processes above a hot mantle like in Central and Eastern Anatolia.