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Subduction dynamics beneath Anatolia: tectonic, metamorphic and thermal consequences on the Aegean/Anatolian transition zone

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Slab rollback and tearing are common features in subduction zones and have a strong impact on the tectonic and metamorphic evolution of the overriding plate. Slab tearing below the Aegean Sea for instance had first order tectonic and magmatic consequences because it induced toroidal asthenospheric mantle flow that controls the typology and distribution of melts at the surface but also lateral gradients of extension in the upper plate. However, coupling mechanisms between the complex 3D mantle flow at depth and deformation in the upper plate above slab tear have received little attention so far. In addition, there is no consensus about the time-space evolution and the thermal consequences of such tearing. This study is focused on the description of the distribution and kinematics of deformation in the eastern part of the Aegean Sea, within the gradient of extension between the Cyclades and the Menderes Massif, where the Dodecanese and Eastern Aegean Islands archipelagos have been little studied. We complete the description of the extensional strain field above the slab tear and discuss the geodynamic implications of the observed kinematics and P-T evolution. We firstly clarify the correlations and differences between the Aegean Sea and the Menderes Massif in terms of lithological and tectonic units and in terms of metamorphic evolution. Secondly, we further show that in the transition zone between Aegea and the Menderes, extension related to slab retreat and tearing keeps a constant NNE-SSW direction accommodating the difference in finite rates of extension, and no localized large strike-slip fault and blocks rotation. We thus suggest that a SSW-striking simple ductile flow in the now-exhumed lower crust probably reflects the asthenospheric mantle flow above the tear. Through 3D numerical models involving slab rollback and tearing, we highlight that subduction-related asthenospheric return flow controls the overriding crustal deformation, favouring shear heating and thus heat production at the base of the crust. Results show that heat flow values are around 100 mW.m-2 and reach locally up to 130 mW.m-2 above the slab tear at 12.4 Myr at the base of the crust. We found that 46 % of heat flow is due to mantle shear heating, and the remaining part being due to the advection of hot material. These thermo-mechanical instabilities primarily trigger and control the distribution of crustal-scale thermal domes, analogous to crustal and lithospheric boudinage in the back-arc domain. These instabilities may thus explain (1) the HT parageneses in MCCs and (2) the development of the ductile lower crustal flow observed in the transitional zone between the Aegean Sea and the Menderes Massif.