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Mantle convection, tectonics and the evolution of the Tethyan subduction zone

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Mantle convection drives plate tectonics and the size, number and thermotectonic age of plates codetermines the convection pattern. However, the degree of coupling of surface deformation and mantle flow is unclear. Most numerical models of lithospheric deformation are designed such that strain is a consequence of kinematic boundary conditions, and rarely account for basal stresses due to mantle flow. On the other hand, convection models often treat the lithosphere as a single-layer stagnant lid with vertically undeformable surface. There is thus a gap between convection models and lithospheric-scale geodynamic models. The transmission of stresses from the flowing mantle to the crust is a complex process. The presence of a ductile lower crust inhibits the upward transmission of stresses but a highly extended crust in a hot environment such as a backarc domain, with no lithospheric mantle and a ductile lower crust in direct contact with asthenosphere, will be more prone to follow the mantle flow than a thick and stratified lithosphere. We review geological observations and present reconstructions of the Aegean and Middle East and discuss the possible role played by basal drag in governing lithospheric deformation. In Mediterranean backarc regions, lithosphere-mantle coupling is effective on geological time scale as shown by the consistency of SKS fast orientations in the mantle with stretching directions in the crust. The long-term geological history of the Tethyan convergent zone suggests that asthenospheric flow has been an important player. The case of Himalaya and Tibet strongly supports a major contribution of a northward asthenospheric push, with no persistent slab that could drive India after collision, large thrust planes being then decoupling zones between deep convection and surface tectonics. The African plate repeatedly fragmented during its northward migration with the separation of Apulia and Arabia. Indeed, extension has been active on the northern side of Africa from the Jurassic until the collision in the Oligocene, and even afterward when Arabia formed by opening of the Red Sea and the Gulf of Aden. This also suggests a dominant role of an underlying flow at large scale, dragging and mechanically eroding plates and breaking them into fragments, then passively carried. Only during a short period of the Late Cretaceous did the situation change drastically with the obduction event giving the large ophiolitic nappes observed from Oman to Turkey. This obduction event has never been really explained. It has been shown to be coeval with faster plate velocities and more active formation of oceanic crust globally, which in turn suggests a link with deep mantle convection. We discuss this succession of events and propose to relate them with the basal drag induced by convective mantle flow below the African continental lithosphere. We discuss the effects of convection on crustal deformation at different scales from deep convection related to plumes and subduction zones to more local mantle flow due to slab retreat and tearing.