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Mantle flow and deforming continents, insights from the Tethys realm

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Continent deformation is partly a consequence of plate motion along plate boundaries. Whether underlying asthenospheric flow can also deform continents through basal shear or push on topographic irregularities of the base of the lithosphere is an open question. Eurasia has been extending at different scales since 50 Ma, from the Mediterranean back-arc domains to extension of Asia between the India-Asia collision zone and the Pacific subduction zones. While compression at plate margins, in subduction or collision zones can propagate far within continents, the mechanism explaining extension distributed over thousands of kilometres is unclear. We use trajectories of continental plates and continental fragments since 50 Ma in different kinematic frames and compare them with various proxies of asthenospheric flow such as seismic anisotropy at various depths. These trajectories partly fit sub-lithospheric seismic anisotropy with two main circulations, one carrying Africa and Eurasia away from the large low velocity anomaly (LLSVP) underlying South and West Africa and one carrying the Pacific plate away from the LLSVP underlying the southern Pacific. Under eastern Eurasia the flow converges with the Pacific flow and distributed extension affects eastern Asia all the way to Western Pacific back-arc basins. We speculate that the flow carrying India northward and Eurasia eastward has invaded the Pacific domain and caused this widely distributed extension that interferes with the strike-slip faults issued from the Himalaya-Tibet collision zone. This model is in line with earlier propositions based on geochemical proxies. We discuss this model and compare it to other widely distributed extensional deformation episodes such as the Early Cretaceous extension of Africa and lastly propose a scheme of large-scale continental deformation in relation to underlying mantle convection at different scales.