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New insights on lithospheric foundering from thermo-mechanically coupled numerical modelling

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Earth's lithosphere is recycled into the mantle as required by global mass considerations. At least during the latest 1 G.y. the main mechanism of lithospheric foundering into the mantle has been subduction. Yet other mechanisms of mantle removal such as Rayleigh–Taylor-type instability or delamination have significant influence at present as revealed by mantle anomalies, and are considered to be likely candidates for the main recycling mechanisms of lithospheric during the Archean.

Although lithospheric mantle removal has been geophysically imaged, e.g. Carpathians, Colorado Plateau, at many other locations geophysical and geological observations also seem to indicate that mantle lithosphere is anomalously thin or absent. Potential places where lithospheric mantle foundering processes took place are The Urals, the Variscides, underneath the Ibero Armorican Orocline in western Europe, and the Tibetan, Puna and Anatolian Plateaus.

Lithospheric foundering has been blamed for, among others, cratonization processes, rapid surface uplift, generation of voluminous magmatism, changes in crustal stress from compression to extension and a long etc. However, its triggering mechanisms are not well studied, and a variety of possible explanations have been given for lithospheric foundering processes, including convective instability following orogenic thickening or some other perturbation of thermal boundary layers, development of eclogitic roots, erosion of the lithosphere by a flat-subducting slab or partial melting of the asthenosphere, and partial intruding pyroxenites into the base of lithosphere.

To understand the mechanisms, causes and consequences of lithospheric foundering, we explored lithospheric foundering in an assortment of scenarios using the numerical code, ELEFANT, an user-friendly multipurpose geodynamics code. Preliminary results indicate that changes in geometry, thermal state and composition of the lithosphere, associated with mantle flow, can have a first order effect on local instabilities and therefore on foundering.