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Control of lateral strength variations on deformation of the Adriatic plate: insights from lithospheric-scale analogue models

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In convergent settings, indenters are strong lithospheric blocks that deform relatively weaker lithosphere. Within the frame of the Cenozoic Alpine orogeny, the Adriatic continental (upper) plate, represents such an indenter. Recent 3D gravity and thermal modelling studies (Spooner et al., 2019), supported by strength calculations (Willingshofer and Cloetingh, 2003), suggest that the Adriatic crust is more mafic, denser and thus stronger when compared to the European crust. Also, thermal modelling studies show that the geothermal gradient within Adria is relatively low, consistent with "cold" and thus strong lithospheric conditions. Yet overall stronger, lateral strength variations linked to Permian intrusives and extrusives and a pre-existing platform-basin geometry related to Jurassic extension, seem to have existed within the Adriatic crust at the onset of Alpine shortening.

We present new lithospheric-scale analogue experiments to address the effect of laterally varying crustal strength conditions on the deformation of the eastern Southern Alps (ESA) lithosphere, which is key for establishing causal relations between crustal and lithospheric deformation and surface uplift patterns associated with Miocene S(E)-vergent basin inversion.

Different to previous lithospheric-scale analogue modelling studies on Alpine-style continent-continent collision settings which focused on shortening of weak orogenic wedges at plate boundaries, our study centres on internal deformation of the indenter. Our models incorporate intra-crustal heterogeneities that are aligned with the direction of convergence and mimic above named heterogeneities. Furthermore, we assume a relative "weak" lower crust, a pre-condition for the formation of a lower crustal wedge.

The modelling results show that variations in lithospheric strength control the localisation of strain and the wavelength of deformation. Additionally, lateral variability of ductile lower crustal thickness predicts stronger uplift in areas of thicker lower crust. A similar relationship has been documented for the northwestern ESA, where Miocene thickening of the lower crust is expected to correlate with higher uplift in the Tauern window (Jozi Najafabadi et al., 2022).

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Session: *Pangeo workshop: Earth's Spheres (Crust, Mantle & Core)*
Keywords: *lithospheric-scale analogue modelling, crustal inheritance, indenter-internal deformation, eastern Southern Alps*