Internal deformation and tectonic evolution of the Dolomites Indenter, eastern Southern Alps: A combined field and analogue modelling study

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In the evolution of the Alps, the Adriatic plate is traditionally considered as rigid indenter and research on collision and extrusion tectonics mainly focused on the areas north of it. However, the structure of the northernmost part of the Adriatic microplate in the eastern Southern Alps of Italy and Slovenia, referred to as Dolomites Indenter (DI), demonstrates significant internal deformation of a continental indenter that contains the structural memory of Jurassic extension leading to the formation of the Alpine Tethys. Here we argue that these pre-existing NNE-SSW trending normal faults are of paramount importance for understanding and explaining Paleogene to Neogene crustal deformation of the DI. In particular, we demonstrate through physical analogue modelling that lateral changes of thrust fault orientations are controlled by the inherited fault bound basin and platform configuration (e.g., in the Cadore area, where the Trento platform merges into the Belluno basin).

In our brittle and brittle-ductile analogue experiments, shortening is orthogonal or oblique to platform and basin configuration, which is represented by either (i) pre-scribed strength contrasts between platforms/basins or (ii) graben structures modelled by an initial extensional phase. This approach allows us to test various deformational wavelengths as well as timing and localisation of uplift of the DI's upper to middle crust. Modelling results indicate that the localisation of deformation is controlled by lateral strength contrasts, as transitions from platforms to basins represent. Analyses of surface displacement vectors show that these areas are associated with changes in shortening directions, resulting in, curved faults. All models emphasise that the overall style of deformation is less dependent on the material of the basal décollement, but is ruled by the inherited platform and basin configuration, independent of orthogonal or oblique inversion.

To compare analogue modelling results with deformation in the DI, structural fieldwork accompanied by thermochronological sampling was carried out. Examined cross-cutting criteria covering the entire DI comprise evidence for four distinguishable deformation phases during Paleogene (Dinaric) shortening and subsequent Neogene (Alpine) continental indentation: Top SW, Top (S)SE, Top S and Top E(SE). However, shortening directions along several of the studied faults, e.g. the overall SSE-vergent Belluno thrust (Valsugana fault system), change locally from top SSW to top SSE along strike.

Based on our modelling results, we infer that the variability of shortening directions along these thrust faults may depend on inherited structures and do not necessarily reflect different deformation phases. As such the number of deformation phases in the Southern Alps may have been overestimated so far.