Control of inherited structures and mechanical heterogeneities on the internal deformation of the Dolomites Indenter, eastern Southern Alps: a multi-scale analogue modelling study

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DOI: http://dx.doi.org/10.17169/refubium-41085

During the Cenozoic evolution of the Alps, the Adriatic plate is traditionally considered as a rigid indenter. The structure of the northernmost part of the Adriatic plate in the eastern Southern Alps of Italy and Slovenia, referred to as Dolomites Indenter (DI), however, demonstrates significant internal deformation. Mostly Miocene shortening is accommodated within a WSW-ENE striking, S-vergent fold-and-thrust belt overprinting a pre-existing platform-basin geometry related to Jurassic extension. In this contribution we present two new sets of physical analogue experiments, addressing the effect of lateral crustal heterogeneities on the internal deformation of the DI on crustal- and lithospheric scale.

The upper crust of the western Trento platform (western DI) is compositionally heterogeneous linked to Permian intrusives and extrusives (i.e., Athesian Volcanic Complex). Together with inherited basement structures this lateral heterogeneity, which strengthened the platform locally, is key for understanding upper crustal deformation and surface uplift patterns associated with Miocene basin inversion. We present brittle crustal-scale analogue experiments with inversion of pre-scribed platform-basin geometries, which indicate that variations in thickness, shape, and basement structure of especially the western platform (WP) have impact on timing and uplift of the DI's upper crust. The mentioned variations in crustal composition, lead, compared to the reference model with simple platform-basin geometry, to (i) overall fewer thrust sheets, (ii) footwall cut-offs of the frontal thrust further in the hinterland, and to (iii) longer and flatter flats of the frontal thrust. Regarding the topographic evolution, a variation in, e.g., basement structure shows strain localization at the margin of the basal plate and stronger uplift within the southern part of the WP compared to limited uplift of the northern WP, which is consistent with documented little vertical movement north of the Valsugana fault system since the Jurassic.

On the scale of the lithosphere, new analogue experiments with pre-scribed platform and basin geometries in the upper crust show similar lateral variations in thrust fault orientation across transfer zones as crustal-scale analogue models (Sieberer et al., 2023). Additionally, lateral variability of ductile lower crustal thickness predicts stronger uplift in areas of thicker lower crust. Documented thickening of the lower crust in some parts of the Southern Alps close to areas of higher uplift, tentatively interpreted being Miocene in age (Jozi Najafabadi et al., 2022), might support this finding.

Ultimately our crustal and lithosphere-scale modelling predictions will be validated by high resolution low-temperature thermochronological data which cover the entire Dolomites Indenter.

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