Geophysical Research Abstracts
Vol. 21, EGU2019-7808, 2019
EGU General Assembly 2019
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Structural Thermochronology along the NFP-20E, TRANSALP and EASI Profiles: Understanding the Role of Slab Break-Off on the Neogene Structural and Exhumation History of the Alps

Paul R. Eizenhöfer (1), Christoph Glotzbach (1), Lukas Büttner (1), Jonas Kley (2), and Todd A. Ehlers (1)

(1) Department of Geosciences, Eberhard-Karls-Universität Tübingen, Tübingen, Germany, (2) Geoscience Center, Georg-August-Universität Göttingen, Göttingen, Germany

Despite being one of the most-studied orogens on Earth, recent deep-seismic data found profound heterogeneities in the deep mantle along-strike the Alpine orogen: in the Eastern Alps the subducting slab is steeply inclined, whereas in the Western Alps it is shallower and consistent with southward directed subduction after slab break-off possibly during Plio- to Pleistocene times. A goal of this study is to explore the long-term effects on the upper crustal structural and exhumation history by contrasting the western NFP-20E, central TRANSALP and eastern EASI seismic profiles utilising thermochronological and structural analyses. We achieve this in three steps: (1) by obtaining new low-temperature thermochronology data along the three profiles (apatite and zircon [U-Th/He]), (2) by modelling structural kinematics based on newly created balanced cross-sections for each profile, and (3) using these kinematics as input for an integrated thermo-kinematic forward model to predict cooling ages that can be compared to those measured at the surface. This approach will enable us to constrain rock uplift potentially associated with slab break-off in the Western Alps, and whether this mechanism is able to explain the overall higher topography in surface elevation compared to the Eastern Alps.

Here we present new thermochronological ages along the NFP-20E and TRANSALP profiles together with preliminary thermo-kinematic forward models. These data are in accordance with recent exhumation focussed in the central part of the sections. The cooling ages show a slight north-to-south increase from $\sim$5 Ma to $\sim$10-15 Ma in apatite fission track ages and from $\sim$10-15 Ma to $\sim$20-25 Ma in zircon (U-Th/He) ages within the Tauern Window, and a sharp increase in cooling ages north of the Periadriatic Line. Apatite (U-Th/He) ages remain within $\sim$5-10 Ma. North and South of the Tauern Window cooling ages tend to successively increase. We propose that the cooling age distribution measured at the surface is consistent with an in-sequence activation of mid-crustal ramps coeval with fault activity in the immediate hanging wall of the Periadriatic Line since the Oligocene.

The unique setting, comparing the structural and exhumational history along sections above contrasting deep-seismic profiles, enables us to better understand, and possibly link, mantle processes and their influence on the crust and the surface during Palaeogene to Neogene Alpine orogenesis, while providing new insights into the formation of collisional mountain belts in general.