Oligocene/Miocene sediments from the Austrian Molasse did not reflect a large-scale surface response to slab break-off: results from detrital apatite fission track analysis

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The reconstruction of Earth-surface response to changes in geometry of the subduction zone on million-year time scales and the propagation of these tectonic signals into the sedimentary record is a matter of ongoing debate. A key area for investigating this topic is the Eastern Alps, where teleseismic tomographic images suggest present-day northward subduction of the Adriatic plate. The opposite subduction direction prevails beneath the Central Alps. The Upper Austrian Northern Alpine Foreland Basin (NAFB) offers an excellent opportunity to investigate the potential surface response of the Central and Eastern Alps to the proposed slab polarity switch at ~20 Ma during the Oligocene and Miocene, as this part of the basin formed the transfer zone for Alpine detritus.

During deposition of the deep-marine sediments of the Zupfing Formation (29.6–26.8 Ma), Lower (LPF) and Upper (UPF) Puchkirchen Formation (26.8–19.6 Ma), and the lower Hall Formation (19.6–18.1 Ma), sediment routing in the basin was largely controlled by a submarine channel system along the basin axis. The channel separated the basin into a wide, gently-sloping northern basin margin and a steep, tectonically active southern slope. Channel sedimentation terminated during deposition of the early Hall Formation at 19.0 Ma, concomitant with a sea-level highstand. Subsequently, northward prograding clinoforms filled up the basin.

In this study, we present 706 new detrital apatite fission track (AFT) single grain ages from Oligocene and Miocene sedimentary archives, represented by 22 drill cores and one surface outcrop. Basin stratigraphy was recently updated and, hence, the depositional ages of the strata are well known.

The AFT ages from the Puchkirchen Group show three distinct age populations: Cretaceous, Eocene, and Oligocene. The proportions of these populations change from dominantly Eocene ages (~60%) in the LPF to dominantly Oligocene ages (~50%) in the UPF. AFT ages from the Hall Formation are dominated (~75%) by Eocene ages; Oligocene ages are rare.

The new AFT ages suggest that parts of the Central and Eastern Alps (Lepontine Dome, Tauern Window) experienced an Oligocene exhumation event whereas other parts were relatively unaffected by this event and supplied Eocene and Cretaceous AFT ages (e.g. Silvretta or Ötztal nappe complex). The increase in young, Oligocene ages from the LPF to the UPF is either related to the acceleration of exhumation or a more efficient transport from the source areas to the Austrian NAFB. The dominance of Eocene ages in the Hall Formation and the increase in lag time reflect the uplift and redeposition of material from the Augenstein Formation in the south.

Our data contradicts the idea of a large-scale surface response to a tearing or break-off event underneath the Eastern Alps in late Oligocene/early Miocene times. The presence and partial dominance of Eocene and Cretaceous AFT ages suggest that large parts of the Central and Eastern Alps experienced slow and steady erosion during this time.