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Selective recording of a tectonic forcing in different grain-size fractions in the Oligocene/Miocene Eastern Alpine Molasse Basin

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Sedimentary archives are the main source of information for climatic and tectonic changes in Earth's history. We investigate how the tectonically triggered early (28±1 Ma) exhumation of the Tauern Window in the Eastern European Alps is recorded in the Oligocene/Miocene Northern Alpine Foreland Basin (NAFB) in Upper Austria. We combined Nd isotopic compositions on clay-sized bulk sediment and of sand-sized single-grain apatites with additional trace-element geochemistry, fission track (AFT) and U-Pb dating to investigate the timing of when this tectonic signal reaches the sediment archive within these different grain-size fractions.

This well-investigated basin offers an excellent opportunity to investigate environmental signal propagation. From ~27 to 19 Ma, a deep-marine basin-axial, gravity-flow dominated channel controlled the West to East directed sediment transport in the Upper Austrian NAFB. The sediments were sourced in the Eastern and Central Alps. At 19 Ma, channel sedimentation ceased and clinoforms prograded from the southern margin northward into the basin. This change in sediment-routing direction cut off the Central Alpine sediment source.

Drill cuttings of one well on the northern basin slope and drill cores from 12 wells were sampled for clay and the single-grain analysis. Clay eNd values remain stable around -9.7 (±0.5) from 27 to 19 Ma but increase afterwards to -8.7 (±0.2) at 18.3 Ma. In contrast, apatite single-grain results significantly change at 23.3±0.3 Ma from a domination of apatites from low-grade (<upper amphibolite-facies) metamorphic sources, Permo-Mesozoic and late Variscan U-Pb ages and AFT ages >40 Ma to a domination of high-grade metamorphic apatites with late Variscan U-Pb ages and an increasing number of AFT ages <30 Ma. The high-grade metamorphic apatites have slightly more positive eNd values (-2.2 ± 3.9) than the low-grade metamorphic apatites (-4.4 ± 4.2).

The changes in the single-grain data sets have been previously interpreted to mirror the exposure of a new Upper Austroalpine nappe as a consequence of the ongoing early Tauern Window exhumation. The total signal lag time between the beginning of the exhumation and the arrival of the signal within the apatite assemblage in the sedimentary archive is therefore 3.4 to 6 Myrs. The clay eNd values do not record this change in provenance at 23.3±0.3 Ma as they stayed stable until 19 Ma when they increased slightly. This might point towards a delayed recording of the

provenance change revealed at 23.3±0.3 Ma by the apatites. The difference in signal recording is caused by the characteristics of the applied methods. Whereas single-grain distributions of orogen-wide sediment-routing systems can be dominated by geographically small areas with high erosion rates and high mineral fertility, bulk-rock methods integrate over the entire drainage area, a process that diminishes extreme values. The disconnection of the Central Alpine sediment source at 19 Ma, increased the relative proportion of the more positive eNd values of the Upper Austroalpine Nappe in the drainage area, leading to an increase in clay eNd values in our data set. Our results show that different information from the hinterland is recorded in the different grain-size fractions and methods.