Combining low-temperature thermochronology with 3-D probabilistic kinematic modeling including uncertainties in the Eastern Alps

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To understand the exhumation history of the Alps and its foreland, it is important to accurately reconstruct its time-temperature evolution. This is often done employing thermokinematic models. However, one problem of many current approaches is that they rely on prescribed geometric structures at depth without considering their uncertainty.

Therefore, the aim of this work is to compare low-temperature thermochronological data with a 3-D probabilistic kinematic model. To this end, we combine 3-D kinematic forward modeling with a systematic random sampling approach to automatically generate an ensemble of kinematic models in the range of assigned uncertainties. These can later be used to obtain a 3-D probabilistic exhumation map, from which exhumation values for the sample positions of thermochronological data can be interpolated, and compared to estimates made solely from thermochronology. In a next step, the uncertainties assigned to the kinematic model can be updated with the thermochronological data, to obtain an even more robust model.

We apply this approach to the Bavarian Subalpine Molasse, which is particularly suited as a test case, as it connects the Alpine orogen with its foreland, and should shed light on the strain distributions during the latest stages of Alpine mountain building.

Preliminary results using previously published data show that the estimated exhumation from the modeling can serve as a constraint to thermochronological interpretations, leading to an uncertainty reduction. In a next step, we will use our own (U-Th)/He measurements to obtain an integrated picture of foreland evolution and associated uncertainties over space and time.