FB-4D: Foreland basin evolution records the effects of plate reorganization, surface evolution and crustal deformation on mountain building

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The influence of plate reorganization and associated slab dynamics on mountain building and exhumation is increasingly recognized in many regions around the globe (e.g. Handy et al., 2010; von Hagke et al., 2016). However, these deep signals may be masked by tectonic or climatic forcing (e.g. Braun et al., 2014; Champagnac et al., 2009), and it is difficult to isolate and quantify the exhumation signal from slab dynamics. Whereas the thermochronological signal of the stacking of thrust sheets in the orogen can overwhelm subtle signals related to mantle processes, the foreland basin records large-wavelength subsidence or uplift. Preliminary results of a recent compilation by the applicants of thermochronological and vitrinite reflectance data and a burial history model of the western Molasse basin shows that timing of erosion and uplift cannot be constrained. The data show there are no spatial trends in exhumation within the Swiss Molasse Basin (Figure 1). Sediments in the entire basin must have experienced high exhumation rates, even in distal, undeformed parts. The most likely explanation of this long-wavelength exhumation signal are deep lithospheric processes. We do however not know if this signal persists along strike, i.e. also in the central Molasse Basin, and if so, how much timing and spatial extent differs from the signal in the west. However, the data suggest it is possible to use data from the Molasse basin to constrain the contribution of mantle dynamics to surface evolution.

Tectonic forces and mantle processes vary strongly along strike in the Alps, and so does their expression in the burial and exhumation history of the adjacent foreland basin. Following its initial stage as a classical foreland basin, the Molasse basin has undergone substantial exhumation (~2-3 km) during the Neogene, which can only partly be explained by known tectonic processes. The entire basin has been exhumed to a degree that is sufficient for low-temperature thermochronometers to map the timing and rate of exhumation at high resolution. Within this project, we will test the following hypotheses:

1. **Mantle signals have distinct expressions in the exhumation of the whole Molasse basin, and not only on its western side.**
2. **Mantle-related exhumation of the Molasse Basin is different in the central and the western part of the basin**
3. **Much of the exhumation of the Molasse basin in the western part is related to slab roll back or break off, whereas in the Eastern Alps it is the result of polarity reversal and lateral extrusion**

To do so, we build on our work in the western part of the basin to quantify the exhumation history of the central Molasse Basin using low-temperature thermochronology along three transects. We will quantify the timing and rate of exhumation using a new probabilistic thermal model specifically designed for studies of sedimentary basins in combination with tectonic reconstructions (Fig. 2). With this combination, we will quantify the contribution of tectonic, climatic and mantle drivers to exhumation of the Molasse basin.

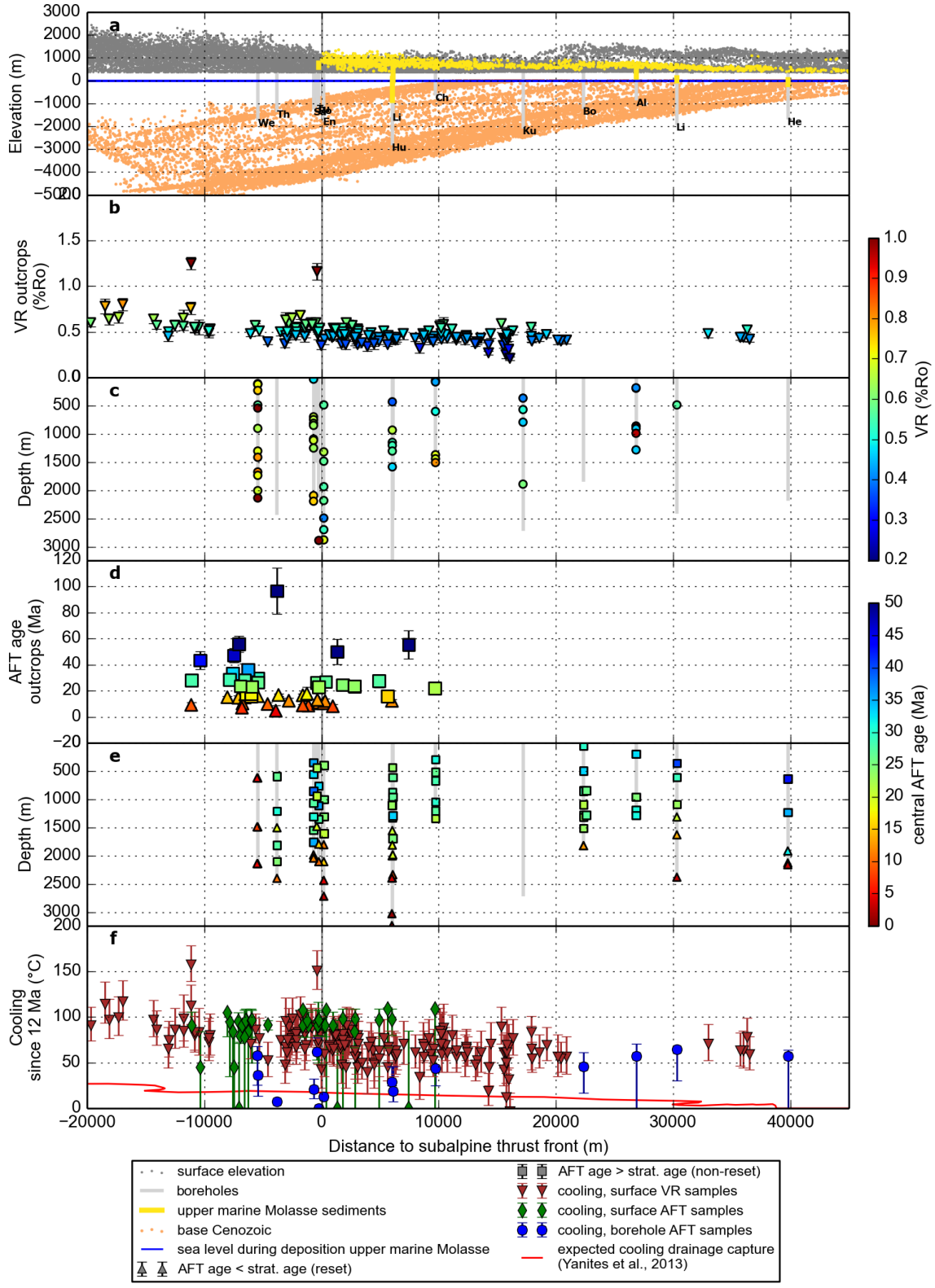

***Figure 1**: A new compilation of apatite fission track and vitrinite reflectance data in the Swiss part of the Molasse Basin versus distance to the Alpine thrust front. The data and interpreted cooling rates show no or only a weak correlation with distance to the thrust front, elevation and relief. This suggests a large wavelength exhumation signal that is most likely the result of deep lithospheric processes (von Hagke et al., 2012; von Hagke et al., 2015).*

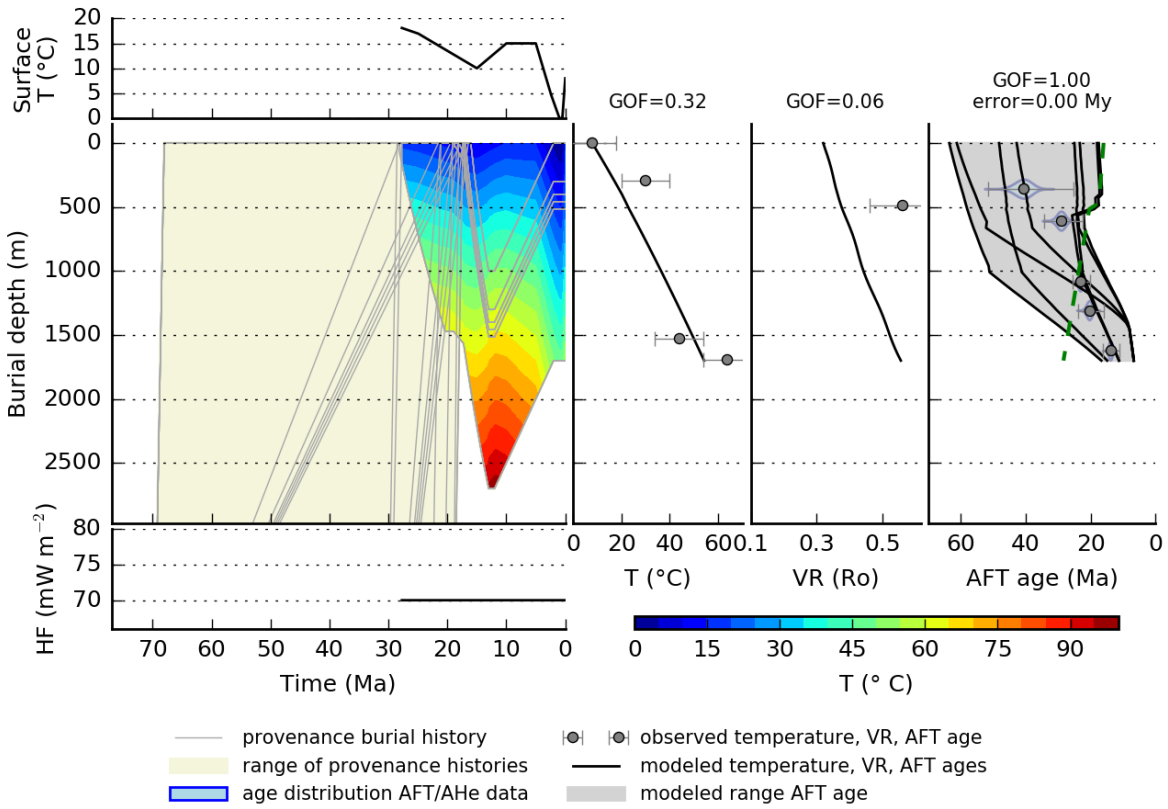

Figure 2: *Example of model run of thermal history model PyBasin (Luijendijk et al., 2011) for borehole Lindau located in the undeformed plateau Molasse. The left panel shows the burial and temperature history of the borehole's sediments, the right hand panels show the modeled and observed present-day temperature, vitrinite reflectance and apatite fission track data.*

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