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

Sarah Louis (PhD student), Christoph von Hagke, Elco Luijendijk, David Hindle, Jonas Kley

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). 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 (see first report of this project). Sediments in the entire basin must have experienced high exhumation rates, even in distal, undeformed parts.

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. We have tested this by analyzing a structural corss section across the Subalpine Molasse in western Switzerland (Mock et al. 2020). The signal is consistent with previous data (von Hagke et al., 2012, 2014, 2015). We confirm that tectonic processes can only partly explain the exhumation signal of the Molasse. We combine thermochronological data with interpretations of geophysical data acquired during this SPP (Kästle et al. 2020). We speculate that the termination of the Subalpine Molasse east of Munich is associated with the extent of the downgoing European Plate.

We have acquired an extensive data set from the Molasse Basin, including low-temperature thermochronological data as well as VR data. Data from the Subalpine Molasse show a (partial) reset of the AHe system, particularly in western Bavaria. A general trend towards lesser exhumation in the east can be observed, as expected from stratigraphic data.
For the basin-wide study, we hence hypothesize that

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 lateral extrusion**

The results of this project contribute to quantifying reorganizations of the lithosphere through time for both the western and eastern Alps (RT 1). Our quantitative estimates on how much exhumation can be attributed to different drivers will constrain the contribution of surface processes on exhumation (RT 2). Our results may be compared with surface evolution models including isostatic rebound (RT 2). Eventually, as we constrain kinematics of the Subalpine Molasse along strike the orogen, we provide new data for studies that track spatial and temporal patterns of faulting through time (RT 4).

Publication List: Long-wavelength late-Miocene thrusting in the north Alpine foreland: implications for late orogenic processes (2020) S. Mock, C. von Hagke, F. Schlunegger, I. Dunkl, M. Herwegh; Solid Earth 11 (5), 1823-1847

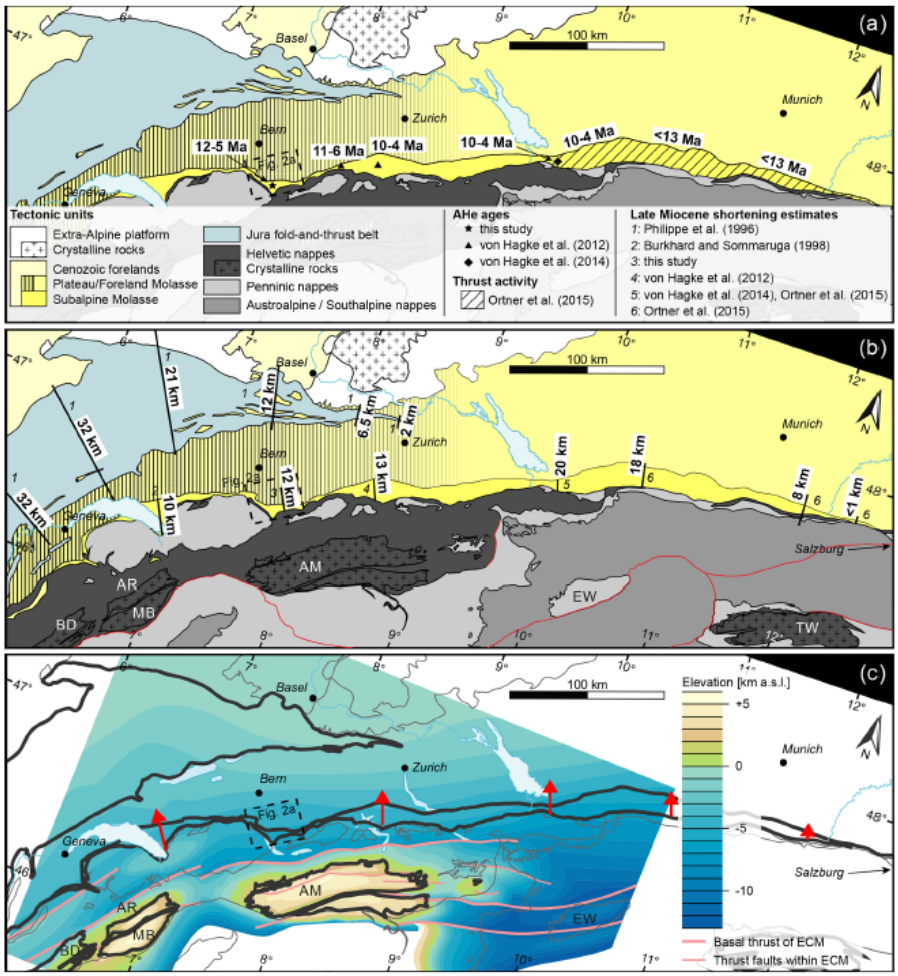

***Figure 1 (from Mock et al. 2020)**: Along-strike variations in late-Miocene deformation of the north Alpine foreland between Lake Geneva and Salzburg. (a) Tectonic map (modified from Schmid et al., 2004) and activity of thrusting in the Subalpine Molasse deduced from AHe ages and geological interpretation. (b) Tectonic map (modified from Schmid et al., 2004) and estimated amount of late-Miocene shortening in the north Alpine foreland (i.e. Subalpine Molasse and Jura FTB). Estimates from the Subalpine Molasse record minimum shortening. (c) Top basement map of the Central Alps (modified from Pfiffner, 2011) showing the highly non-cylindrical hinterland architecture with the high-relief domains of the external crystalline massifs (ECMs). Red arrows indicate the constant late-Miocene deformation signal with a decrease in horizontal shortening recorded in the north Alpine foreland. AM, Aar Massif; AR, Aiguilles Rouges Massif; BD,Belledonne Massif; EW, Engadine Window; MB, Mont Blanc Massif; TW, Tauern Window.*