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Low-temperature thermochronology and vitrinite reflectance data reveal long-wavelength exhumation of the Molasse basin

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The processes driving the late-stage evolution of the Alps and in particular the influence of mantle-driven processes remain uncertain. Since the Molasse basin shows uplift and exhumation since the Miocene, it can help to constrain exhumation processes, which may at least partly be associated with mantle processes. However, until now, thermochronological data to constrain exhumation is mostly available from the western part of the basin (e.g. Mock et al. 2020; Hagke et al. 2015; Hagke et al. 2012). Here, >900 m of stratigraphic succession has been removed. The driver of this exhumation is still debated: Tectonic shortening, increased erosion due to river capture or climate-change and the resulting isostatic rebound, or mantle related processes. Additional data covering larger parts of the basin that have not been affected by tectonic shortening of the external Jura Mountains could help to better understand the processes causing this exhumation.
To better quantify the wavelength and timing of exhumation, a new apatite (U-Th)/He data set from surface outcrops of the German Molasse was generated in this study and complemented with a compilation of already existing vitrinite reflectance data spanning the entire basin. The new apatite (U-Th)/He ages in the unfolded part of the basin (Foreland Molasse) are mostly older than their respective stratigraphic age. This means, they were not buried below the Apatite partial retention zone (=PRZ =40-75°C) and therefore show that exhumation is smaller than ~1.5 km. In the folded and thrusted part of the basin (Subalpine Molasse), apatite (U-Th)/He ages are partially reset showing that they witnessed exhumation below the PRZ with a strong peak at approximately 20 Ma. This timing coincides with the proposed formation of a slab window in the Eastern Alps. Vitrinite reflectance data reveal a trend of exhumation increasing gradually from east to west across the entire basin. Therefore, exhumation in the west cannot be solely related to Jura thrusting. Although the Subalpine Molasse shows evidence of localized exhumation driven by thrusting, on the large scale, a longwave exhumation pattern with a spatial scale of over 700 km and exhumation exceeding 1000 m is suggested by earlier work (Frings et al. 2022; Cederbom et al. 2011; Mazurek et al. 2006). With the new data set, the magnitude, timing and spatial distribution are constrained in more detail. The derived exhumation pattern of the Molasse basin (high in the West and low in the East) coincides with the extent of the down-going European slab beneath the Alps, as mapped in recent tomographic images (Handy et al. 2021; Paffrath et al. 2021; Kästle et al. 2020). These maps interpret that the European slab is still-attached to the European lithosphere in the Western and Central Alps, semi-attached in the eastern Central Alps and detached in the Eastern Alps. However, a causal relationship is not evident since we would assume higher exhumation in areas where a lithospheric slab is detached. Hence, in this poster the new data set is presented and an outlook with open questions and future work is given.

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