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Mechanisms of late Neogene exhumation of the Alps: Insights from AFT and AHe vertical profiles in the Aar massif (Switzerland) and the Lepontine Alps (Italy)

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The volume of Neogene sediment preserved shows a sharp increase overlying the Mio-Pliocene boundary in a variety of settings worldwide (Molnar, 2004) and around the Alps in particular (Kuhlemann, 2000). This observation, linked to the exhumation of the Swiss Molasse basin since ca. 5 Ma led Cederbom et al. (2004) to propose that the bulk of the Alps experienced accelerated exhumation and isostatic uplift since this time. As the deformation record for the same period is (arguably) very limited, climate change has been proposed as the driving mechanism. Consequently, it is predicted that a denudation signal of this age should be present throughout the axial Alpine crystalline massifs. In a previous study (Vernon et al., in press), we used the uniquely dense AFT record over the Western Alps to build isoage surfaces and extract exhumation rates between 13.5 and 2.5 Ma. In addition to supporting the simultaneity of sedimentation and denudation rates increase after $\sim$5 Ma, this study suggests that several patterns of exhumation may have overlapped in different areas of the Western Alps with an increase starting between 6.5 Ma and 2.5 Ma or later. This observation is compatible with the signal displayed by sedimentation or isostatic rebound, assuming that cumulated localised trends are buffered into a broad exhumation signal centered around 5 Ma.

In order to quantify the degree of localization in the exhumation histories overprinting the general trend, we present new AFT and AHe ages sampled on two vertical profiles in the central Aar massif (Switzerland) and the western Lepontine Alps (Italy), crossing the Central Alps along a traverse proximal to the Cederbom et al. study in the basin. Although commonly used to estimate exhumation rates, the slope of age / elevation relationships in vertical profiles is frequently overestimated (Braun, 2002); extreme cases showing an infinite or even negative slope. This bias is due to the topography effect on the shape of closure isotherms and to sampling profiles being almost never perfectly vertical.

To avoid this pitfall, we used the 3-D heat-equation solver Pecube (Braun, 2003) linked to a model of fission-track annealing and helium diffusion to predict AFT and AHe ages for a range of tested exhumation histories in a self-consistent manner. The scenario with the smallest misfit between measured and modelled ages is retained in each study area. According to preliminary results, we describe at least two phases of accelerated exhumation in the Central Alps at 8 and 4 Ma, with the stronger 4 Ma signal recorded in the Lepontine Alps. Contingent upon further flexural modelling, the exhumation recorded in the axial region of the Alps since 5 Ma does not seem to match that predicted by Cederbom et al. (2004) in order to explain the denudation in the Swiss Molasse basin by simple isostatic rebound. Rather, the data hint at additional mechanisms of rock-uplift in the Molasse basin, such as crustal delamination or wedge propagation to the Jura mountains.

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