The impact of the Bohemian Spur on the cooling and exhumation pattern of the Eastern Alpine wedge

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Fold and thrust belt dynamics and architecture may largely be impacted by the geometry of the overridden basement. The Bohemian Spur, the subcrop extension of the Bohemian massif, guided thrust propagation leading to the arcuate shape of the orogen and a narrowing of the Molasse Basin at the transition to the between the W-E trending Eastern Alps and the SW-NE trending Western Carpathians. Thermochronological studies in the Eastern Alps were mainly focused on the core of the collisional orogen, where deformation has been most prominent. Further to the east, some FT work is concentrated along fault zones but thermochronometers with lower closure temperatures have hardly been applied to higher elements of the nappe pile. Due to the scarcity of the dataset and preferential application of fission track dating uppermost crustal cooling below ca. 80 °C remains undetected.

In this study we present new apatite (U-Th)/He and apatite fission track data from clastic units of the Rhenodanubian Flysch zone and the Northern Calcareous Alps. We find reset ages, that monitor a so far un(der)appreciated phase of prominent Late Oligocene to Miocene cooling. Thermal modeling of age data from the flysch samples reveals rapid Early Miocene cooling at rates of up to 40 °C/Ma between ca. 20 and 15 Ma. We propose a buttressing effect of the underlying tectonically structured eastern rim of the Bohemian Spur to be the driving mechanism for this phase of intensified exhumation. Our tectonic model (Fig. 1a) invokes contractional reactivation of pre-existing normal faults inherited from Penninic continental rifting. This positive inversion led to the shortening of the Jurassic half-graben infill and its extrusion as a major fold.

Thermochronological data and thermal modeling of data from samples in the Lunz nappe of the Northern Calcareous Alps nappe pile indicate less punctuated cooling and exhumation. Modeling defines an increase of cooling rates at the latest at ca. 27 to 25 Ma, i.e., earlier than in the Flysch samples. Cooling occurred at a much lower rate of 3 to 6 °C/Ma and was synchronous with northward movement of the deformation front. In our tectonic model (Fig. 1b), we propose a staircase pattern that influences wedge dynamics: The topographically segmented downgoing plate leads to less localized and more distributed deformation invoking a broader area of uplift than the spatially focused uplift of the Flysch samples. Wedge propagation is initially inhibited or retarded by the relief of the basement. The ongoing northward movement of the propagating wedge is compensated through deep duplexing of the autochthonous foreland sequence.

When calling upon deep-seated processes to explain the exhumation pattern the buttressing effect needs to be taken into account. Early Miocene drainage pattern reorganization in the Molasse Basin is proposed to be a consequence of uplift induced by the subcrop promontory.

Fig. 1a: Tectonic model for Flysch sites

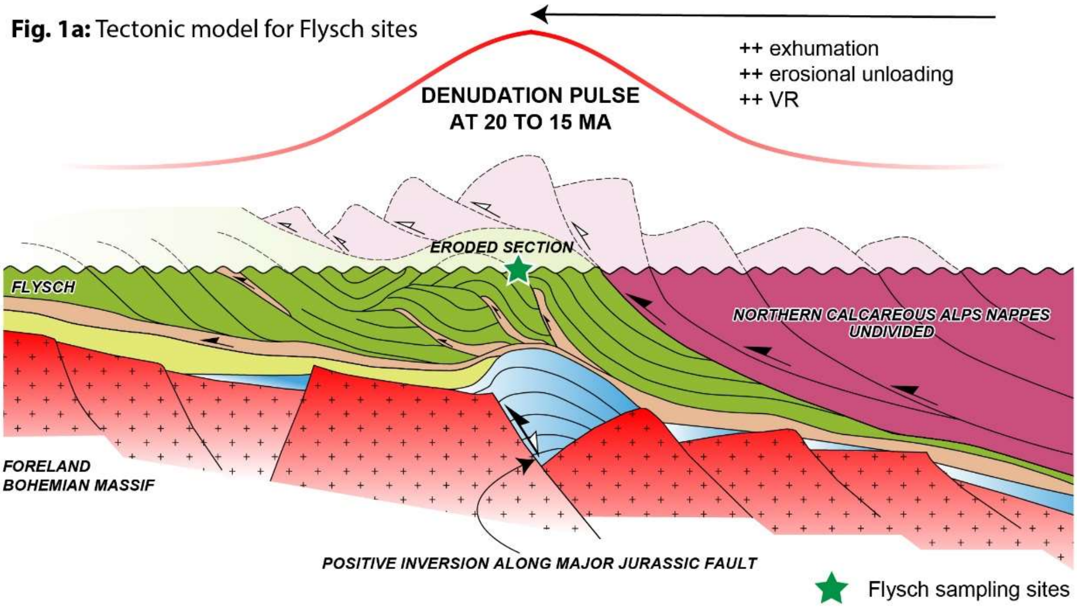

Fig. 1b: Tectonic model for Northern Calcareous Alps sites

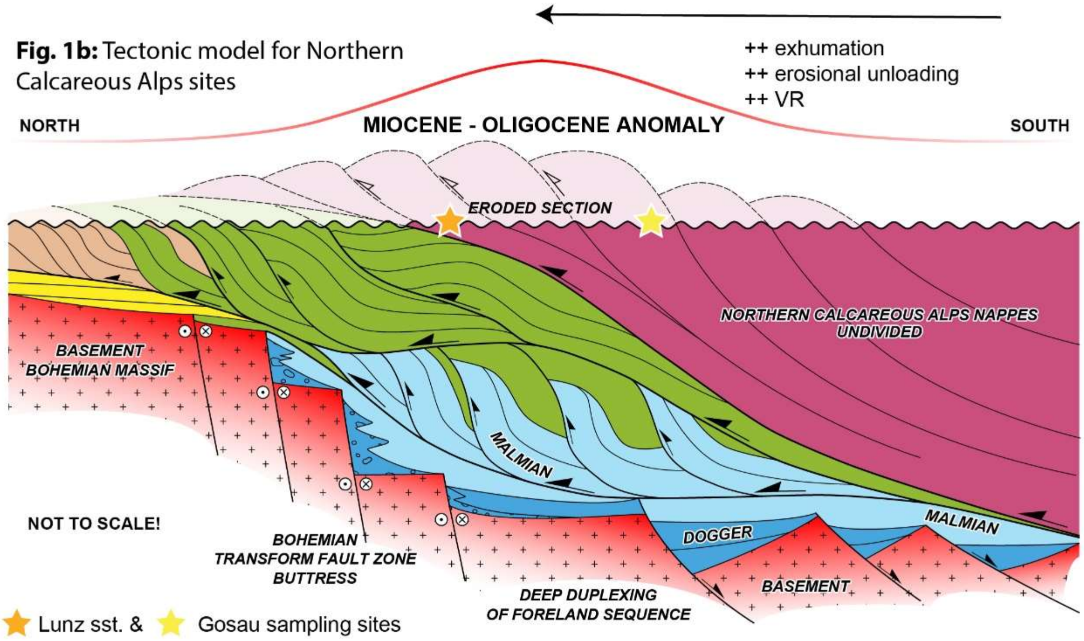

Figure 1: Cartoons depicting the tectonic evolution of **a)** Flysch samples and **b)** samples from the Northern Calcareous Alps above major basement steps of the Bohemian Spur.