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Late Cretaceous to Miocene cooling patterns in the Eastern Alps reflecting tectonic interactions of the Alps-Adria-Carpathian system

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New structural and thermochronological (Rb-Sr biotite and zircon and apatite fission track) data constrain the deformation and exhumation history of the eastern most Alps and highlight distinct differences compared to the western Eastern Alps, including the Tauern Window. The new data has been collected along and in the surroundings of the Mur-Mürz fault (MMF), an area that hitherto had a scarce availability of low and medium temperature thermochronological data but is a key area to understand and quantify the influence of processes, such as Pannonian back-arc extension, on the Eastern Alps evolution. The obtained cooling ages document rapid (ca. 15°C/Ma) and diachronous exhumation during the Late Cretaceous to Paleocene with an eastward youngening of cooling ages across a greenschist facies normal shear zone. We interpret this cooling pattern as a post-metamorphic exhumation occurring during Campanian-Maastrichtian synorogenic extension that is characterized by an east directed migration. We suggest that oblique subduction of the Alpine Tethys or slab roll-back driven processes during final closure of the Neotethys could both be mechanisms that drive this eastward migration. Subsequently, the eastern most Alps reflect Eocene to Oligocene slow cooling (ca. 2°C/Ma) suggesting that the region was unaffected by significant crustal thickening or erosion which strongly contrasts with the units exposed in the Tauern Window and surrounding Austroalpine units. The slow cooling continued far into the Miocene and is contemporaneous with early Miocene kinematics that reflect a pre-extrusion NW-SE contraction followed by syn-extrusion NE-SW to NNE-SSW contraction recorded by middle Miocene strike-slip faulting. Field kinematics and cooling ages located on opposite sides of the MMF suggest that lateral extrusion in the eastern most Alps is not associated with significant vertical motions but is rather restricted to lateral motions along dispersed strike-slip faults. This mode of deformation is attested by the complex distribution of cooling ages and fragmentation of the Styrian Block, thereby suggesting that the Pannonian basin back-arc extension might be of greater influence in this area with respect to the effects of ongoing northward motion of Adria. The strong link to Pannonian basin tectonics is further evidenced by a successive late Miocene to Pliocene inversion recorded along the MMF associated with renewed fast exhumation (ca. 14°C/Ma) of Austroalpine units, occurring contemporaneous with Pannonian basin inversion. The young, post 10 Ma, exhumation is not uniform and concentrates at the MMF-Vienna basin transition in response to underthrusting of the Bohemian Massif, where it enhances a regional uplift of the Eastern Alps during ongoing Alps-Adria convergence.