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The complex thermotectonic history of the eastern Southern Alps

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Neogene to ongoing N(W)-directed continental indentation of the Adriatic microplate into Europe controls the evolution of the European eastern Southern Alps (ESA). Despite the Adriatic plate acting as a rigid indenter, it has undergone internal deformation, with predominantly Miocene shortening being accommodated within a WSW-ENE striking, S-vergent fold-and-thrust belt. This deformation overprints a compositionally heterogeneous upper crust affected by several magmatic and tectonic events. We present new (Apatite (U-Th)/He (AHe) and Fission Track (AFT) data along a N-S profile in the western ESA to better understand the thermotectonic evolution of this complex area.

Time-temperature path modelling confirms the Valsugana phase as the most significant period of tectonic exhumation within the western ESA. AFT data in the research area tend to cluster within consistent distinguishable tectonic blocks, however, they are quite scattered especially in the central part of the ESA, warranting further investigation. The geodynamic history of the ESA is characterised by multiple heat pulses, which must be considered when interpreting the AFT data especially as the temperature of this pulses likely did not significantly exceed the partial annealing zone of AFT. Potential heating events are the (1) Permian magmatism, (2) Ladinian magmatism, (3) Jurassic crustal extension, (4) sedimentary superimposition (maximum thickness in Cretaceous), Middle Eocene to Lower Oligocene (5) Periadriatic intrusions and (6) Veneto Volcanic Province magmatic event.

Modelled cooling paths indicate that nearly all samples experienced heating just above the AFT partial annealing zone during the Middle Triassic, preceding the Jurassic extension and Cretaceous maximum burial indicated by the stratigraphic record. Detailed analysis of AFT data reveals that only a small, single-digit percentage of analysed grains give a single grain age older than Middle Triassic. Accounting for the σ1 error, all single grain ages can be interpreted as post-Middle Triassic. This suggests that the Ladinian magmatic event caused a geothermal anomaly affecting the entire research area, not just the well-known magmatic centres (e.g. Predazzo area). During and after the subsequent relaxation of the geothermal gradient the aforementioned events (3) – (6) overprinted the geothermal field locally. Based on the modelled cooling paths, it can be assumed that most of the samples remained in the temperature range of the AFT partial annealing zone or at slightly cooler temperatures during this period. Finally, during Miocene, the entire area was affected by fast tectonic exhumation on thrusts related to the Valsugana phase. This sequence of regional and local, magmatic and tectonic events results in very complex cooling histories that can vary significantly even for closely situated samples, explaining the scattered AFT ages.