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Low-temperature thermochronological constraints on the Miocene exhumation of the Adamello Complex, Southern Alps, Italy

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The Adamello Complex is the largest of the Periadriatic intrusions, situated as a wedge between the Periadriatic Fault System (locally called the Tonale line), the South Giudicarie line and the Val Trompia thrust. More than seven kilometers of overburden has been removed since its emplacement in the late Eocene-early Oligocene and modern overall relief is over 2 km. Major rivers which dissect the complex flow into overdeepened valleys inferred to be areas of maximum incision from the Messinian Salinity Crisis (MSC). This makes it an ideal location to determine the role and magnitude of tectonic events (Giudicarie phase shortening in the late Miocene) and superimposed erosional events driven by climatic or other external environmental conditions (MSC and Neogene glaciation) as drivers of near surface exhumation.

Low-temperature thermochronometers, such as, apatite (U-Th-Sm)/He dating (AHe) and apatite fission-track dating (AFT), constrain near-surface (<5 km) exhumation rates that can be used to characterize climate or tectonic forcing. In this study we present AHe and AFT ages for samples collected in the two largest valleys of the Adamello Complex. The ages determined in this study span the Miocene and display a normal age-elevation relationship, where age increases with elevation. All AFT ages along with high elevation AHe samples (3600-2700 m) record early to mid-Miocene ages, while samples located below 2400 m record nearly identical AHe ages, within error, of 6.5$\pm$1 Ma. This pattern reveals the possible base of an exhumed AHe partial retention zone located at a modern elevation of $\sim$2400m, which suggests that a minimum of 3 km of exhumation has occurred since $\sim$8 Ma, inferring 4 km of exhumation between 29 Ma and 8 Ma, as constrained by pluton emplacement age and depth.

The fast cooling of the low elevation samples as recorded by their AHe ages indicate that at least 1.5km of rock was exhumed rapidly at 8 Ma. The magnitude and timing of this event constrains a period of transpressional activity along the South Giudicarie line, further supported by AHe ages from a sample located between the S. Giudicarie line and Mt. Sabion line. Older AHe ages determined for the Val Trompia thrust area indicate that it was inactive during this event, but may have played a role in earlier exhumation. The final 1.5 km of exhumation since 6 Ma may be due to erosion driven by external climatic conditions. In order to test possible exhumation and landscape development scenarios, our data was modelled using Pecube (Braun, 2003), a 3-D heat conduction model including topographic relief and erosion and the recently developed GLIDE program, which extracts exhumation rates from thermochronological data.