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Timing and evolution of Middle Triassic magmatism in the Southern Alps from integrating zircon petrochronology and thermal modelling

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The timing, duration and distribution of volcanic and intrusive products are a characteristic feature of magmatic provinces that potentially allow placing igneous activity into a tectonic framework. Middle Triassic magmatism in the Southern Alps comprises widespread felsic volcaniclastic deposits, basaltic lava flows and irregularly distributed intrusive complexes. The origin, petrogenesis and the tectonic setting of this magmatic event as well as the temporal and genetic relationship between volcanics and intrusive products remain poorly understood.
We present a consistent set of high-precision zircon U-Pb ID-TIMS ages from several localities throughout the Southern Alps in order to unravel the eruption and emplacement history and evolution of this five million years lasting Middle Triassic magmatism. Dated zircons record an early phase of explosive silicic volcanic eruptions most likely fed by several vents that lead to episodic deposition of ash beds throughout the Southern Alpine realm followed by intense intrusive and effusive basaltic to intermediate magmatism that rapidly filled several hundred meter deep basins in the Dolomites. The volcanic record is anchored against two key stratigraphic sections at Seceda (Dolomites; Wotzlaw et al. 2017) and the Anisian-Ladinian GSSP section at Bagolino (Lombardy; Brack et al. 2005). Zircon trace element geochemistry (e.g. Yb/Dy vs. Th/U) clearly distinguishes the silcic volcanics from the intrusions and records a complex evolution of the magmatic centres.
Hafnium isotope analyses of U-Pb dated zircons employing solution MC-ICPMS allow tracing changes in mantle-crust interaction through time. Systematic variations in hafnium isotopic composition with time record progressively stronger crustal assimilation over the first four-million-years reflected by a decrease in εHf(zircon) from +3 to -6. This is followed by a rapid increase towards more positive εHf (+2) within less than one-million-year. This isotopic evolution may point towards a recurrent thermal evolution of the underlying lower crustal magmatic system.
This petrochronologic framework complemented by geochemical data and detailed field observations provides first order constraints on the petrologic evolution of the underlying crustal-scale magmatic system. These constraints are implemented into a numerical thermal model (Karakas et al. 2017) that allows quantifying the magma flux and heat budget necessary to fuel the protracted evolution of the magmatic system in the lower crust prior to intrusion and eruption.

References

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