Dating the youngest deformation in the Alps with ESR thermochronometry

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Low-temperature thermochronology is a useful tool to reconstruct tectonic deformation and landscape evolution within the first 2 km of the crust. It is a suitable tool to investigate deformation associated with cooling and exhumation of the lower crust in orogenic settings. Low temperature thermochronology is applied here to understand the Neogenic post-collisional extensional event that occurred in the Alps, because a gap in previous age dating exists between a thousand and a million years.

Quartz is the most common mineral in the crust; occurring in magmatic as well as sedimentary and metamorphic rocks. The potential of quartz electron-spin resonance (ESR) as a radiation dosimeter has been well documented, and many studies applied the method to date sediments and heated rocks (e.g. tephra). In this study, we apply quartz ESR dating as an ultralow-temperature thermochronometer, characterized by a closure temperature of 30°-90°, and dating range of 10^3-10^7 years.

We show the results of ESR thermochronometry on quartz applied to rocks from crustal-scale faults in the Central (Simplon Fault) and Eastern Alps (Brenner and Salzachtal Faults). Here, the lower crust has been tectonically exhumed, associated with exhumation of the Lepontine Dome and Tauern Window, respectively. Thermochronological data are available from this area, such as fission tracks or U-Th/He data on zircon and apatite. Results of the ESR measurements of 15 samples crossing the Brenner and Salzachtal faults (northern and western border of the Tauern Window) show that the ESR ages of quartz get younger (<1Ma) inside the western part of the Tauern Window, in accordance with fission track and (U-Th)/He ages. In general, younger ages (between 200 and 500 ka) are also obtain closer to the fault zone, localized near (e.g. Simplon Fault) or at the bottom of the valley (e.g. Brenner Fault), compared with the protolithic rocks (600-900 ka). We interpret the trend of the ESR ages as an exhumation of the isotherms due to both recent uplift of the footwall of the fault and for erosion of the valley, where the later overprints the former. These results promise to establish ESR as an ultra-low thermochronometer using quartz for the Quaternary landscape reconstruction of the Alpine chain.