Constraining the geodynamic evolution of the Alps with sedimentary provenance and detrital thermochronometer data, II. Detrital thermochronology

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This project was designed to disentangle sedimentary signals controlled by changes in the lithosphere, the upper crust, and climate change in the European Alps. The hypothesis was that if lithospheric reorganisation in the Alps (such as slab break-off or tearing) occurred, it would lead to spatio-temporal changes in buoyancy, influencing the location of rock uplift and erosion. Specifically, we wanted to test this hypothesis using a multi-proxy provenance approach (sedimentary provenance tools, detrital thermochronology) at key stratigraphic time slices (28, 25, 20, 17, 15, and 12 Ma) from the northern and southern foreland basins. Foreland basin deposits represent a rich archive of erosional processes controlled by tectonics, climate, and lithology. This presentation concerns part II of the study, the detrital thermochronology, which we use as "tracer thermochronology".

Applications of tracer thermochronology exploit a known or assumed surface thermochronometric age map (based on either interpolated observed or modelled bedrock ages) to determine the provenance of detrital grains within fluvial or glacial catchments. The goal is to interpret the erosion pattern and processes within the sampled catchment. Before reconstructing and interpreting past erosion patterns and exhumation from detrital zircon fission-track (ZFT) age distributions and modelled bedrock ZFT ages back in time, we produce a frame of reference for today's situation. We do this by investigating signals from 26 modern river samples (21 previous [1,2] and nine new samples) and the present-day erosion pattern and mineral fertility in the Alps. We discuss observed and predicted (based on possible erosion scenarios) ZFT age distributions and potential pitfalls of the method (such as poor bedrock control in some areas of the Alps and challenges in combining previous and new data). Modern river results are consistent for adjacent, similar-size catchments and with expected erosion patterns. Most samples show a higher proportion of younger ZFT ages than would be predicted for uniform erosion and zircon fertility scenarios. Furthermore, we show preliminary results from stratigraphic sections from north and south of the Alps.

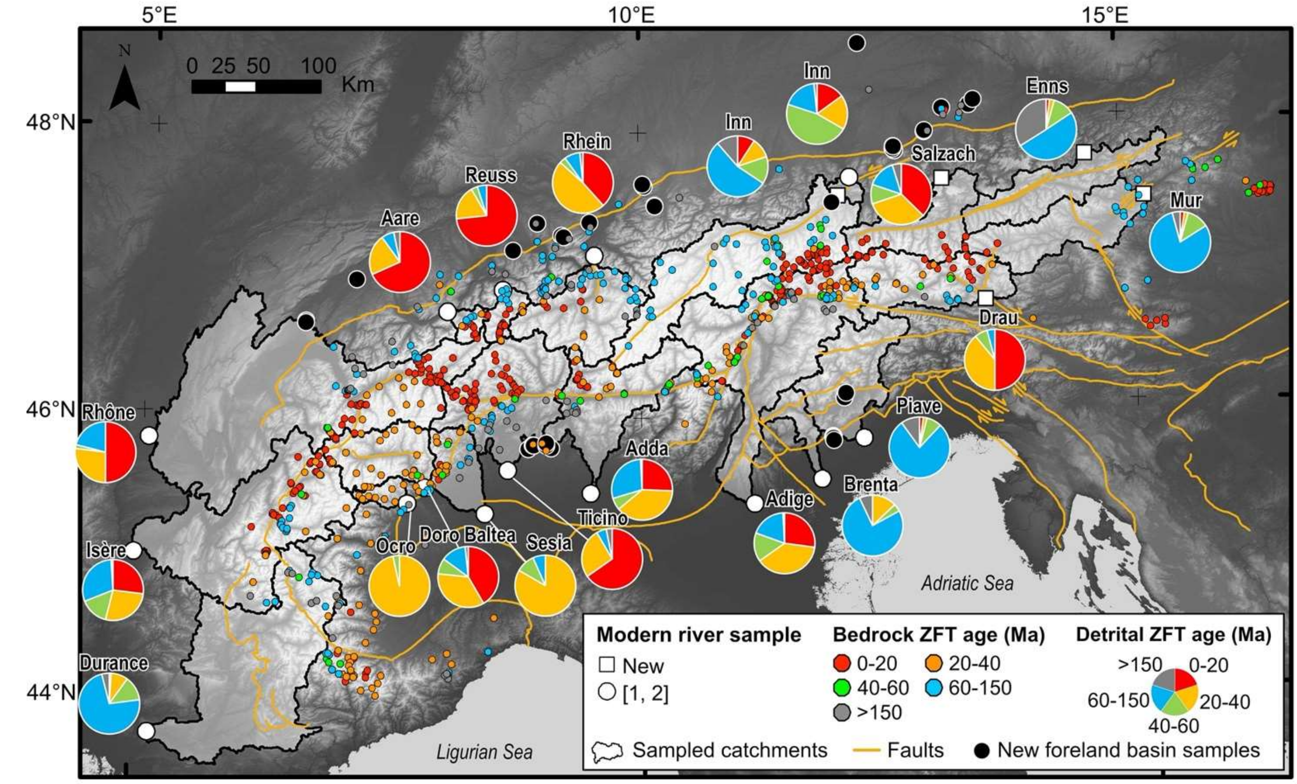

Figure 1: Overview of available bedrock ZFT ages (small circles) and previous and new modern river detrital ZFT data (pie charts, binned single-grain ages for visualisation; four additional samples are still being analysed) from the European Alps. Locations of new foreland basin samples are marked (black circles). Faults from [3].

[1] Bernet et al. (2004), Downstream changes of alpine zircon fission-track ages in the Rhône and Rhine rivers, https://doi.org/10.1306/041003740082

[2] Bernet et al. (2004), Fundamentals of detrital zircon fission-track analysis for provenance and exhumation studies with examples from the European Alps, https://doi.org/10.1130/0-8137-2378-7.25

[3] Schmid et al. (2004), Tectonic Map and overall architecture of the Alpine orogen, https://doi.org/10.1007/s00015-004-1113-x