Multimineral chronology of a complex high pressure terrane: insights from the Theodul Gletscher Unit (Western Alps, Switzerland)

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Reconstructing the tectonic history of metamorphosed terranes is a key step towards establishing a comprehensive model for collisional orogens such as the Alps. Single chronometers tend to record one specific component of such history—be it inheritance, reactions or cooling—or record several of these, without a clear indication of what each age datum means. Resolving the complex evolution of such terranes requires chronometric data of different minerals, which on the basis of their chemistry, may be linked to distinct stages. Here we present a multi-mineral geochronology of the Theodul Gletscher Unit (TGU; Western Alps). The tectonic unit is a metamorphic sequence containing a variety of pelitic and mafic rocks that mainly record Alpine low-temperature, high-pressure metamorphism. In addition, however, the rocks are known to host age components related to events and processes in the Permian and Jurassic; these could be attributed to inherited components and pervasive fluid-rock interaction during oceanic alteration and subduction. To investigate this, we subjected pelitic schists and mafic rocks from the TGU to a multi-method analysis, involving thermometry, oxygen isotope analysis in garnet, and zircon U-Pb and garnet Lu-Hf dating.

Zircon crystals in all rock types are Permian in age and have no significant record of Alpine metamorphism; they are interpreted as dating the source of the felsic and mafic sediments. Complex garnet textures in the schists reveal multiple growth stages: whereas the garnet rim reflects the subduction stage, the relict nature of the garnet core allows for speculation of an older, perhaps Permian age (Bucher et al., 2019). A distinct and abrupt rim-ward drop in δ¹⁸O coherent with major-element zoning in garnet from the schists indicates open system fluid-rock interaction. Rutile included in the different garnet zones as well as in the matrix of the schists provided consistent Zr-in-rutile thermometry results of 520–560 °C (calculated at 2.5 GPa). Similarly, Raman spectroscopy of carbonaceous material in the same textural positions indicates 540–580 °C. These results indicate a single Alpine metamorphic cycle. To look back beyond that stage, Lu-Hf data will be presented for garnet with and without seemingly inherited cores, as well as for cores that were physically isolated from the sample material. The results, together, provide new insight into the petrological and tectonic processes that affected rocks in the TGU during and prior to their Alpine history.
REFERENCES: