Geophysical Research Abstracts
Vol. 16, EGU2014-2356, 2014
EGU General Assembly 2014

Subduction / exhumation dynamics: Petrochronology in the Glacier-Rafray slice (Western Alps, Italy)

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Petrochronology is the combination of in situ age-dating, geothermobarometry and structural geology and aims to unravel Pressure-Temperature-deformation-time (P-T-ε-t) paths. To link P-T conditions to deformation stages is daily business for metamorphic petrologists, but recent micro-mapping techniques (XMapTools program) provide an additional tool to achieve this goal. Absolute age is often difficult to assess in metamorphic rocks, as it is challenging to link specific P-T conditions to most of the mineral chronometers.

Allanite is a common accessory phase in high-P metamorphic rocks and is a potential target to determine Th(-U)/Pb ages. Allanite from a leucocratic gneiss of the Glacier-Rafray slice in the western Alps consists of several chemically different zones: one major zone can be linked to a first high-P phengite generation. To determine the age of this high-P growth zone we used La-ICP-MS in situ techniques, which allowed us to date an appropriate growth rim per grain. Even so particular care was required when evaluating the isotope signals laser ablation leads to the excavation of a volume, which potentially can be chemically and/or age-zoned. We have developed a new method to track changes in the plasma during the ablation. This method aims to identify discrete age zones. La-ICP-MS spectra have been modeled so as to reproduce the shape of the spectra measured. These results indicate that high-P allanite first grew in equilibrium with phengite at 84 ± 4 Ma, whereas a second growth event occurred at $\sim$40 Ma. A final epidotic rim grew at greenschist facies conditions, but this stage could not be dated.

These findings have implications for our interpretation of several units in the Western Alps: In the Sesia Zone (former Adriatic margin), the earliest high-P metamorphism occurred at 85 Ma (Regis et al., 2014), precisely as the first high-P peak we discovered in the Glacier-Rafray slice. Austroalpine klippen such as this are commonly seen as extensional allochthons; one would expect these to have entered the subduction zone together with the Piemonte oceanic units. Yet all high-P ages reported for the Piemonte oceanic units are around 40 Ma. We propose that the Glacier-Rafray slice experienced subduction together with Sesia units and may have been juxtaposed on the Piemont-Ligurian-Ocean units during Eocene exhumation. Strain associated with this juxtaposition may have triggered growth of the second allanite. Joint exhumation of the oceanic units and the Glacier-Rafray klippe followed at retrograde T.