

## **Hydrothermal circulation during exhumation constrained by fluid inclusion analyses, zircon fission-track and monazite Th-Pb dating (Belledonne massif, external Alps)**

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In the Lauziere granite (external crystalline massif of Belledonne, Alps), a multidisciplinary approach was used to constrain the timing of hydrothermal activity and its influence on the geothermal gradient of the neighbouring rocks. The samples were collected within a metric cleft (a fissure partly filled with hydrothermally grown minerals) and within the granite host-rock, taken at different distances from the cleft. The cleft is mainly filled by quartz, albite, adularia, chlorite. It also contains numerous species of accessory minerals such as anatase, rutile, ilmenite, hematite, apatite, monazite or xenotime that can reach several millimeters in size. Cleft monazite age was determined by in-situ isotopic Th-Pb dating on different compositional domains of four grains. Within a single grain, monazite ages, obtained in domains with distinct compositions, overlap. This indicates that hydrothermal monazite grain precipitates over a relatively short geological time period around a mean age of  $12.4 \pm 0.1$  Ma (MSWD = 1.7; N= 86). In order to constrain the conditions of monazite precipitation, fluid inclusions analyses have been attempted in quartz and monazite. Microthermometric data for fluid inclusions indicate that monazite precipitated in the earliest stage of the vein formation from a hydrothermal fluid with a temperature probably  $>400^{\circ}\text{C}$  (based on the isochor calculation at minimum pressure of 1.0 kbar). In the host-rock, exhumation age and the impact of fluid circulation were investigated from zircon fission track (ZFT) dating in the host-rock. At the cleft contact, resetting of the ZFT ages indicates that hydrothermal fluid locally reheated the granite host-rock, which was already exhumed and cooled down at temperature  $\ll \sim 240\text{-}280^{\circ}\text{C}$ . This study thus confirms the crucial role of fluid circulations on ZFT resetting and the possible impact they can have on exhumation reconstruction.