Geophysical Research Abstracts
Vol. 21, EGU2019-15184, 2019
EGU General Assembly 2019

Timescale of deformation and fluid circulation in the external crystalline massifs of the Western Alps: Insights from hydrothermal monazite

Emilie Janots (1), Alexis Grand'Homme (1), Matthias Bernet (1), Damien Guillaume (2), Edwin Gnos (3), Valérie Bosse (4), Marie-Christine Boiron (5), Anne-Magali Seydoux-Guillaume (2), and Magali Rossi (6)

(1) ISTerre, UGA, Grenoble, France (emilie.janots@univ-grenoble-alpes.fr), (2) Univ Lyon, CNRS, UJM-Saint-Etienne, SAINT-ETIENNE, France., (3) Natural History Museum of Geneva, Geneva, Switzerland, (4) Laboratoire Magmas et Volcans, Clermont Ferrand, France, (5) GeoRessources, Université de Lorraine, CNRS, Nancy, France , (6) EDYTEM,Univ. Savoie Mont-Blanc, Chambéry, France

Dating deformation and associated fluid/rock interactions are difficult tasks because they generally occur in open and multistage systems, possibly leading to disturbances of geochronometers. In hydrothermal environments, monazite is a powerful geochronometer because data concordance can be controlled through the three radioactive decay series of the U-Th-Pb isotopic systems. Together with detailed petrological characterisation, in-situ dating can be obtained in different compositional domains, and reveal for the successive growth stages even within one grain. Furthermore, with negligible solid diffusion, the age can be thus interpreted as a crystallisation (or replacement) age rather than an apparent cooling age. In Alpine clefts (open fissures partly filled by hydrothermal crystals), hydrothermal monazite can reach several millimetres, providing a unique opportunity to investigate the time, duration and periodicity of hydrothermal activity in link with deformation. In the external crystalline massif of the Western Alps (Lauzière granite), a multi-method approach reveals unusually hot hydrothermal conditions in a vertical cleft that is oriented perpendicular to sub-vertical, N020-N040 oriented mylonitic microstructures of the host granite. This granite shows partial retrogression at temperatures of <400°C during Alpine tectonometamorphism. The investigated Alpine cleft is mainly filled with quartz, albite, adularia, chlorite, and contains numerous species of accessory minerals including mm-sized monazite. Cleft monazite ages were determined by in-situ isotopic dating on different compositional domains in four grains. Within a single grain, monazite ages, obtained in domains with distinct compositions, overlap in age indicating that hydrothermal monazite grain precipitated over a relatively short geological time. Furthermore, the mean Th-Pb age at 12.4 ± 0.1 Ma (MSWD = 1.7; N= 86) is coherent with the U-Pb age (Tera-Wasserburg diagram). Novel microthermometric data and chemical compositions of fluid inclusions obtained on monazite and on quartz crystals from the same cleft indicate early precipitation of monazite from a hot fluid at T>410°C, followed by a main stage of quartz growth at 300-320°C and 1.5-2.2 kbar. Comparison of monazite crystallization ages with ZFT data in samples taken at 30 and 100 meters distance from the cleft, indicates that the hot fluid infiltration (T>410°C) took place when the host-rock had already cooled to T<280 °C. The advective heating, due to the hot fluid flow in the colder host-rock, is recorded by the ZFT in the cleft hanging wall, with a younger age at 10.3 ± 1.0 Ma compared to the ZFT far from the cleft (14-16 Ma). The results attest of highly dynamic fluid pathways, allowing the circulation of deep mid-crustal fluids, 150-250°C hotter than the host-rock, which affect the thermal regime only at the wall-rock of the Alpine-type cleft. Such advective heating may impact the ZFT data and represent a pitfall for exhumation rate reconstructions in areas affected by hydrothermal fluid flow.