Geophysical Research Abstracts
Vol. 21, EGU2019-14448, 2019
EGU General Assembly 2019

Magmatic residence times and T-t history from REE Y- Cr - P zonation in garnet xenocrysts in mid-crustal granite

Arnaud Devoir, Elias Bloch, and Othmar Müntener
University Of Lausanne, ISTE, Petrology, Lausanne, Switzerland

Accessory phases in magmatic rocks such as zircon and titanite have widely been used to infer residence times in magma reservoirs through high-spatial resolution in-situ Th-U-Pb dating and microgeochemical evolution. Due to their resilience to breakdown and the slow diffusivity of the Th-U-Pb system in these minerals, the chemical and thermal histories of magmatic systems can be elucidated by this methodology.

Here we study the microchemistry of garnet, an ubiquitous mineral in amphibolite to granulite facies metamorphic rocks as well as in mafic to felsic magmas in the Ivrea zone[1]. Garnet is an essential mineral to decipher the P-T-t history of relatively low temperature metamorphic rocks since it preserves major element chemical zoning profiles. In a high-temperature environment diffusion in major elements is fast enough that prograde zoning patterns are mostly re-equilibrated; however, REE+Y+Cr have about 1-2 orders of magnitude slower diffusivities[2,3], and apparently even slower P diffusivity, and therefore these species can be used to study the timescales of magmatic processes that are not recorded by major elements.

With improving high resolution FEG-EPMA and LA-ICP-MS analytical methods and workflow (detection limits, spatial resolution, spectral resolution), we investigated REE+Y and P+Cr zoning in garnet from an I-type granite of hybrid origin[4] in the Ivrea zone. Millimeter to meter-sized enclaves of metapelitic origin (bt + qtz + plg + kfsp + grt ± mnz ± zrc ± ilm ± crd) occur in the granite and can be more or less disrupted in the granite matrix (qtz + plg + bt + kfsp ± ilm ± ap ± crd). The high-P core of garnet is interpreted to be of metamorphic xenocrystic origin, and oscillatory low-P rims to be related to magmatic overgrowth. REE+Y zoning inversely correlate with P reflecting a first HT regional metamorphism followed by the incorporation of metapelitic enclaves including garnet in granite during a second HT event caused by the emplacement of the mafic complex and related granites. Major elements are completely homogenized and show only scattered Mg-Fe zoning when in contact with surrounding biotite. We show that using different chemical systems in garnet can allow to access to: (1) the crystallization history of garnet (P as a proxy), (2) the residence time in a magmatic reservoir (REE+Y+Cr) and (3) the maximum temperature of the system and cooling rate[5] of the magmatic body (Fe-Mg) consistent with independent estimates from the Ivrea lower crust.

[1] Schmid & Wood, 1976: CMP 54, 255-279.

[2] Bloch et al., 2015: Contrib. Mineral. Petrol. 169: 12.

[3] Carlson et al., 2012: Am. Min. 97, 1598 - 1618.

[4] Voshage et al., 1990: Nature 347, 731-736.

[5] Ganguly et al., 2000: EPSL 183, 471 - 486.