Geophysical Research Abstracts
Vol. 19, EGU2017-6659, 2017
EGU General Assembly 2017

Two ultra high temperature (UHT) metamorphic events in the Gruf complex (Central Alps) ? Constraints by in situ dating of zircon and monazite

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The Gruf complex in the Lepontine Alps is one of the two occurrences of Phanerozoic UHT metamophism in the world. This area is thus of major interest to understand the geodynamic signification of such extreme metamorphic conditions. However, the age of the UHT metamorphism is currently a matter of debate. Based on zircon U/Pb dating, Galli et al. (2013, Swiss J. Geosc. p33 and ref herein) have proposed a Permian age. Minerals of the charnockitic paragenesis are included within the zircon cores. Rims of these zircon grains yield 34-29 Ma ages interpreted as dating the Alpine amphibolite facies migmatisation. A different interpretation is proposed by Liati and Gebauer (2003, Schweiz. Miner. Petrog., p159) who consider that the zircon Alpine rims grew during the UHT metamorphic event. Based on monazite dating, Schmitz et al. (2009, Eur. J. Mineral., p927) follow this interpretation, whereas Galli et al. (2013) suggest that the Alpine age is the result of monazite resetting processes during Alpine migmatisation.

In order to try to solve this controversy, we have realized LA-ICPMS in situ dating on zircon and monazite from a restitic granulite within charnockite showing the typical well preserved UHT mineral assemblage (Spr-Al-rich Opx- Sil-Crd-Grt-Bt ± mesoperthite - Qtz-Spl). Only complex symplectitic Crd-Spl-Spr-Opx assemblages correspond to the beginning of the retrograde evolution. Both zircons and monazites are included in the large crystals from the UHT assemblage as well as in the late symplectites. In such restitic rocks, a significant fluid interaction is unlikely, precluding a fluid mediated resetting of the monazite. U/Pb ages in zircon and Th/U/Pb ages in monazite measured in the same sample confirm the ages previously measured. Zircon cores yield Permian ages (from around 250 to 304 Ma), sometimes surrounded by a narrow rim at 33.2 ± 1.2 Ma. Intermediate ages may reflect mixing between core and very thin rim. Monazites are present in the core of large Spr, Opx, Crd crystals or form clusters of small grains in the late symplectites. All the grains are strongly zoned in Th, U and Y, but all yield a 31.8 ± 0.3 Ma age interpreted as the time of complete (re-)crystallisation of the monazite in equilibrium with the UHT paragenesis.

In agreement with Galli et al. (2013), these results show that the Permian age preserved in the zircon cores is related to the charnockitisation. But the monazite age also demonstrates that the Spr-Opx-Sil UHT paragenesis in the restites in the charnockites equilibrated at 32 Ma, in agreement with Liati and Gebauer (2003) and Schmitz et al. (2009). We propose that this typical UHT paragenesis cristallised from refractory lithologies such as restites or schlieren in the charnockites. The refractory character was acquired during the previous metamorphic event, although it is difficult to precise what were the mineral assemblages in these rocks during the Permian (U?)HT metamorphism.