Geophysical Research Abstracts
Vol. 21, EGU2019-7517, 2019
EGU General Assembly 2019

Exhumation and cooling rates of Variscan granites in an anatectic complex of the Central Iberian Zone, Portugal: constraints from LA-ICP-MS Zircon and Apatite U-Pb ages

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Crustal melting and granitic magma generation are paramount as mountain building processes. In the case of the Iberian Variscides, large volumes of felsic magmas were generated and emplaced in the core of this orogeny. The geochronometric study of granites can, thus, be of utmost importance to unveil the orogenic crustal evolution. The Figueira de Castelo Rodrigo-Lumbrales Anatectic Complex (FCR-LAC) is located within the autochthonous terrane of the variscan Central Iberian Zone (CIZ) and it is an example of the association between two-mica S-type granites and migmatites (metatexites and diatexites). This anatectic complex is limited by two important shear zones (Huebra and Juzbado-Penalva do Castelo) putting it in contact with low-grade metamorphic units of Edicaran-Cambrian and Ordovician ages, respectively. New U-Pb zircon and apatite age data allowed us to constrain Variscan crystallization ages, to characterise an inherited zircon population and to determine cooling rates for different facies of these granites. Combined, these data help to characterize emplacement conditions of these widespread S-type granites within the framework of the Variscan Orogeny. The crystallization ages mostly range between 314 and 318 Ma for the syn-tectonic granites, whereas a late-tectonic granite provided an age of 300 Ma. Gathering the U-Pb zircon ages with the U-Pb apatite ages and considering their respective closure temperatures, it was possible, for the first time, to quantitatively constrain the cooling rates of the FCR-LAC granites (13 to 35 ºC/Ma). These values are significantly higher than the expectable from conductive heat transfer, suggesting a rapid exhumation towards shallower and colder crustal levels of these granites, which are genetically- and spatially-related with migmatites. Taking into account that migmatites were tectonically transported to shallower levels, being in contact with greenschist facies rocks, and assuming 42ºC/km as the geothermal gradient (see Pereira et al., 2017), a vertical displacement of ca. 8 km is estimated for granites at exhumation rates ranging from 0.3 to 0.84 mm a-1. These are compatible with the transpressive shearing along the above mentioned shear zones. Additionally, the predominance of inherited zircons suggests melting of Cadomian metasediments (650 – 550 Ma), Upper Cambrian-Lower Ordovician rocks (495 – 470 Ma; Ollo de Sapo Formation) and of some minor older components up to Paleoproterozoic in age.
The application of zircon and apatite as geothermochronometers in syn- and late-tectonic granites of the CIZ for the first time has proven to be useful in constraining their emplacement conditions This is an important tool to understand the evolution of the continental crust, namely cooling and exhumation rates of felsic magmatism during orogenesis, and these results reinforce the importance of late shearing in the exhumation of hot crust produced as a result of the orogen development.

Reference:
Pereira et al. (2017) - Journal of the Geological Society, 174 (6): 1004-1018.
DOI: https://doi.org/10.1144/jgs2016-159

Acknowledgements: Publication supported by FCT- project UID/GEO/50019/2019 - Instituto Dom Luiz