A critical study of age constraints on metamorphism in convergence zones: from burial to exhumation

3-year PhD position at the University of Rennes (France)

Advisors: Pavel Pitra, Marc Poujol, Philippe Yamato

Dating metamorphic events is a major challenge for the understanding of orogenic processes. It brings temporal constraints on the pressure-temperature evolution (P-T path) of rocks during their burial (e.g. in subduction zones) and subsequent exhumation. Coupling metamorphic and geochronological data is therefore crucial for the understanding of the dynamics of convergence zones and, consequently, for proposing any geodynamic reconstructions. The robustness of this link is therefore a first-order issue. As an example, sub-contemporaneous ages obtained for both the high- and low-pressure metamorphic stages in a same geological domain can lead to either (i) propose extremely fast exhumation rates, the physical and/or tectonic mechanisms of which remain unknown, or (ii) question the classic interpretation of the pressure recorded by metamorphic rocks in terms of burial depth, or (iii) reconsider the overall interpretation of the acquired radiometric data in metamorphic rocks.

High-pressure rocks (e.g. eclogites) that have undergone significant decompression (e.g. in the low-pressure granulite facies) are the most interesting targets for addressing these issues. Classically, P-T paths are linked to ages through the analysis of trace elements in the dated minerals, which are supposed to reflect the moment of crystallization of the mineral along the P-T path. However, our preliminary results from several variscan eclogites show the limitations of this approach, as it does not necessarily yield reliable results. This has a strong impact on the geodynamic interpretation of the studied region.

This study will be focused on two specific eclogite-facies rock targets, the Norwegian Caledonides and the Rhodope belt, where the 'issue' of sub-contemporaneous ages attributed to the high- and low-pressure stages of their respective metamorphic evolution is known. The advantage of these two orogens is also that they cover a large time span to explore (~400 Ma for the Caledonian belt and ~50 Ma for the Rhodope). The goal of this PhD project is to combine state-of-the-art petrological, geochemical and geochronological analyses on these eclogite-facies rocks, using a large spectrum of methods:

- a detailed petrological analysis, including meticulous petrography and phase equilibria modelling (Theriak-Domino, THERMOCALC)
- combination of several dating techniques (U-Th-Pb on zircon, monazite, rutile, titanite, apatite,…, Sm-Nd and Lu-Hf on garnet)
- trace elements (REE) partitioning between the dated minerals and the main metamorphic rock-forming phases
- using Raman spectroscopy to identify inclusions in the dated minerals and to constrain their entrapment pressure (shift of spectral peaks)
- trace-element thermobarometry (Ti-in-zircon, Zr-in-rutile, Ti-in-quartz)

Requirements: The candidate must hold a Master diploma (MSc or equivalent) in geology and have solid basic knowledge in metamorphic petrology, geochronology and tectonics. Previous experience with one or several of the methods used is a plus. Good communication skills are expected.

Some more details can be found at https://theses.u-bretagneloire.fr/egaal/theses-2018. The application must also be done through this web page, but interested candidates are invited to first contact the advisors (Pavel Pitra <pavel.pitra@univ-rennes1.fr>, Marc Poujol <marc.poujol@univ-rennes1.fr>, Philippe Yamato <philippe.yamato@univ-rennes1.fr>) and send a full CV, a statement of interest, mark reports, details about previous internships etc., and the names and emails of two references, before mid-May. The deadline for online application is May 31, 2018.