Subject offered for a contract starting October 2019

SUBJECT TITTLE: Tracking the long term carbon cycling in subduction zones

Advisor: **MENEZ, Bénédicte, (Pr), menez@ipgp.fr**
Second Advisor/ Supervisor:
DEBRET, Baptiste (CR), debret@ipgp.fr
Host lab/ Team :
IPGP- Geomicrobiology – UMR7154

Financing: Doctoral contract with or without teaching assignment

For more information go to http://ed560.ipgp.fr, section: Offres de these (PhD offer), You must apply on the Doctoral School website

Presentation of the subject:

The long-term carbon cycle on Earth is intimately related to the appearance and evolution of life over geological times and the rise of O_2 in the atmosphere during the Great Oxidation Event. On modern Earth, the extraction of carbon from the mantle to the external envelopes mainly occurs at mid-oceanic ridges and subduction zones through partial melting and magmatic degassing processes. It was widely considered that between 20 to 80 % of the carbon is then recycled into the deep mantle by subduction. However, recent mass balance calculations predict that most of the carbon budget (up to 100%) of the subducting oceanic lithosphere is transferred from the slab to the mantle wedge by fluids. These discrepancies emphasize the difficulty in determining the extent to which carbon (present in sediments but also in mafic and ultramafic rocks in the form of inorganic and organic compounds) is mobilized during subduction, and if so, whether this is as reduced carbon compounds (e.g., CH_4, organic acids) or CO_X, which may in turn influence the redox state and volatile contents of arc lavas and the deep carbon cycling.

The main objective of this PhD project is to test these two diverging models (deep mantle recycling or transfer to the mantle wedge) by determining the mobility, redox budgets and fluxes of carbon between the slab and mantle wedge in subduction zones. To address this, the PhD student will study oceanic lithosphere relicts (ophiolites) from the Western Alps and the Himalaya (Ladakh area) that experienced a wide range of metamorphic conditions, from non-subducted ophiolites to meta-ophiolites that have been metamorphosed and dehydrated during subduction. He/she will unravel the mechanisms of carbon release and retention by employing a combination of µ-Raman spectroscopy, XANES (X-ray Absorption Near Edge Spectroscopy) and FTIR (Fourier Transform InfraRed spectroscopy) measurements and novel (Fe and Zn) and conventional (C) stable isotope tracers. The objectives will be to: (**1**) characterize the distribution of reduced and oxidized carbon in the oceanic lithosphere and establish its carbon budget; (**2**) unravel the

main mechanism of decarbonation at high pressure, test the empirical models of carbon solubility in slab derived fluids and establish the carbon budget of eclogitic slabs.

Access to Himalayan samples will involve collaboration with Pierre Bouilhol, CRPG, University of Lorraine, France (pierre.bouilhol@univ-lorraine.fr).

Timeline

Year 1: Field work in the Western Alps. Petrographic study of previously collected samples from the Western Alps and the Himalaya. Training in the measurement of novel stable isotopes.
Year 2: Selection and characterisation of Alpine samples; continued petrography and isotope analysis of all samples; Further field sampling. Prepare research for presentation/publication; attend International Conferences.
Year 3: Completion of isotope work and interpretation and modelling of data, writing up. Presentation at national/international conferences.

Training & Skills

-Fieldwork in the French, Italian and Swiss Alps.
-Interpretation of petrographic and spectroscopy data to identify the mechanism of carbon dissolution/precipitation during prograde metamorphism in subduction zones.
-Training in the measurement of novel stable isotopes using high precision MC-ICP-MS techniques at the IPGP, as well as geochemical sample characterisation.
-Presentation of research at both national and international geochemistry conferences.

Applicants should have a master degree in Earth Sciences and a background either in field geology, petrology and/or isotope geochemistry.

Prospective applicants should contact the advisor/co-advisor by email for further details.