ÉCOLE DOCTORALE SCIENCES DE LA TERRE

Subject offered for a contract starting in September 2012

SUBJECT TITTLE: Melt-lithosphere interactions at mid-ocean ridges from the study of abyssal gabbros and of gabbroic veins in abyssal peridotites. A petrostructural and geochemical approach.

Advisor/Supervisor: **CANNAT Mathilde, DR, cannat@ipgp.fr**
Second Advisor/Supervisor: **MOREIRA Manuel, PR, moreira@ipgp.fr**

Host lab/ Team: **IPGP- Geosciences Marines and Geochemistry labs**

Financing: **Doctoral contract with or without assignment**

For more information go to http://ed109.ipgp.fr, section: Offres de these (PhD offer), You must apply on the Doctoral School website

Presentation of the subject: (1 or 2 pages)

Melts produced by mantle melting at mid-ocean ridges fractionate gabbros in proportions of 2 to 3 for each volume of basalt. This fractionation occurs under conditions that are still very much unconstrained in terms of depth, associated cooling rates, stress and strain, access to hydrothermal fluids or to already hydrothermally altered host rocks. Evidence from slow and ultraslow ridges points to melt crystallization in the form of veins and intrusions within the mantle, all the way up from the lithosphere-asthenosphere boundary at depths > 15 km. At fast ridges, the context of melt fractionation is discussed with two possible end-members: shallow fractionation in a melt lense, or deeper fractionation in sills injected in highly viscous melt-mush formations. At both fast and slow ridges, the interactions between melts and already fractionated gabbros, residual mantle rocks, or variably altered rocks in the axial lithosphere are active topics of research, with broad implications for the structure, composition, and hydrothermal alteration of the oceanic crust, a major component of the global geochemical cycle. Constraining the depth, deformation and hydrothermal context of gabbro crystallization is also important to understand the melt plumbing system and the nature of the asthenosphere-lithosphere boundary beneath mid-oceanic ridges.

This thesis will address these issues based primarily on a joint petrostructural and geochemical study of a suite of gabbroic rocks dredged at the ultraslow Southwest Indian Ridge in a region that is a magma-poor end-member of the global ridge system. Normal faults there accommodate most of the plate divergence, and gabbros are intrusive into ultramafic rocks that have been tectonically exhumed from the mantle. Microstructures (magmatic foliation, low stress plastic foliation, brittle fabrics …) will be used to constrain rheology and dynamics of the host rock and of the melt-mush or of the solidified gabbros, and the relative timing of crystallization of igneous and secondary minerals. Mineral chemistry including in-situ ICPMS trace measurements, and isotopic ratios including noble gases will be used as tracers of mantle source heterogeneity, magmatic fractionation and of melt-rock, melt-fluid and fluid-rock interactions.

Geochemical tracers of hydrothermal contamination will be trace elements and isotopic ratios (Sr, Pb, H, O) as well as noble gases.

These results will be interpreted in the frame of existing geophysical data that constrain the regional structure of the axial lithosphere, and of the geochemistry of basalt from the same region.

The thesis will also develop a comparative approach with gabbros from less magma-starved ridges, both slow and fast, based on existing rock collections from the Southwest Indian Ridge, Mid-Atlantic Ridge and from the East Pacific Rise at Hess Deep. Concerning this fast spreading ridge location the plan is for the PhD student to seek a participation, either as a shipboard scientist, or as a shore-based associate, to the upcoming IODP leg 345 drilling leg.