Subject offered for a contract starting October 2018

SUBJECT TITTLE: *Fluid-rock interactions in the context of mantle exhumation at slow spreading ridges.*

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Second Advisor/ Supervisor:
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Host lab/ Team :
IPGP- Team Géosciences Marines – 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

Mid-ocean ridges can be viewed as factories that continuously manufacture new oceanic lithosphere that is then recycled into the mantle at subduction zones. This involves hydrothermal exchanges of heat and matter with the Ocean, contributing to the background, long-term exchanges between the solid Earth and its fluid envelopes. At slow spreading ridges (and some distal continental margins), the new seafloor is commonly made of tectonically exhumed mantle, and hydrothermal reactions lead to the hydration of the peridotites (serpentinization), to the release of substantial volumes of hydrogen and methane, to the formation of high pH fluids and to the crystallization of carbonates, and of condensed reduced carbon compounds in the serpentinized basement. This thesis project will contribute to a better understanding of these processes.

The PhD will work primarily on data acquired during the recent ROVsmooth cruise of the research vessel Pourquoi Pas? During this cruise, we used the Remotely Operated Vehicle (ROV) Victor 6000 to map and sample the seafloor at the slow-spreading eastern Southwest Indian Ridge. The study area is a region of this ridge that receives very little magma. In this context the divergence of the plates is accommodated by large offset normal faults that are also called oceanic detachment faults. The resulting seafloor is made of ultramafic rocks that have been uplifted by these faults all the way from the base of the lithospheric mantle. The objectives of the PhD will be to acquire new constraints on the hydrothermal fluid pathways, and on the fluid-rock reaction and exchanges in this end-member, tectonically-dominated mid-ocean ridge context.

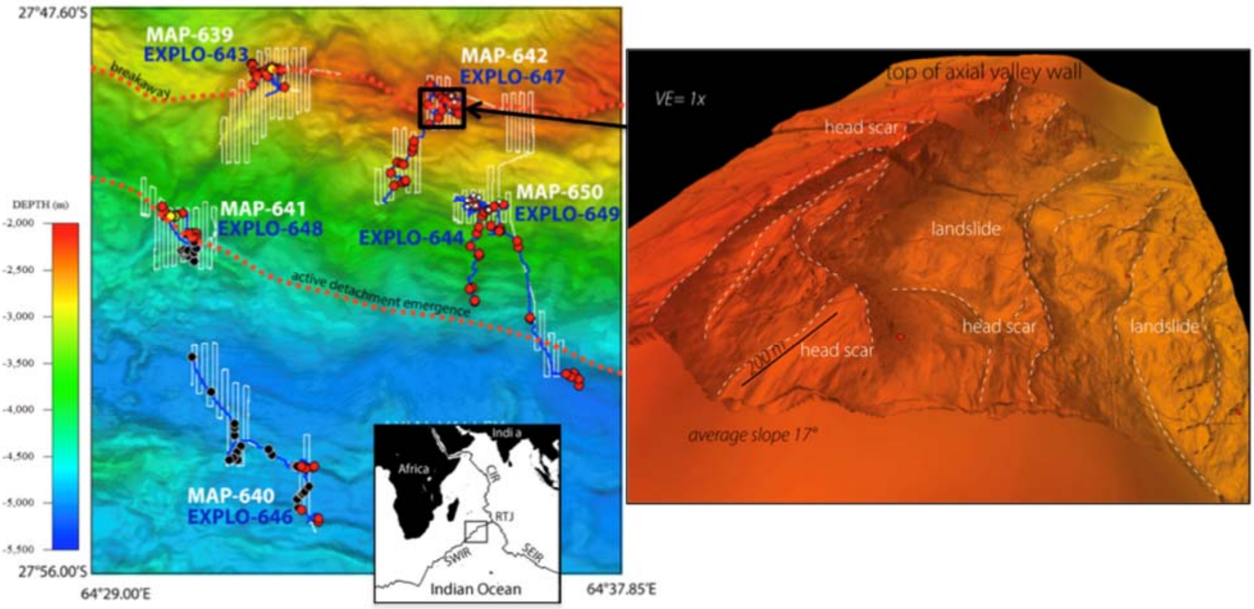
The PhD will work as a member of the ROVsmooth research teamwork. As such he-she will have opportunities to collaborate with researchers of a range of disciplines, from geophysics and numerical modelling, to geochemistry and biogeology. His-her work plan will be organized in two parts:

1- the first part of the work will be to analyze the geological and tectonic setting of the study area from the scale of the outcrops to the scale of the ridge axial valley, and to replace the samples of ultramafic rocks collected during the ROV dives in this geological and tectonic setting. For this, the PhD will use high-resolution bathymetric and magnetic mapping, outcrop-scale geological observations (video of ROV dives), and sample studies. These sample studies will be carried out to define a typology of deformation and fluid-rock interactions in the study area. To do so, the PhD will analyze the samples in thin section, using primarily standard petrographic techniques (optical microscope, MEB, microprobe, RX..) to determine structural and textural relationships (overprint relationships, multiple vein generations…). Other techniques (RAMAN, cathodoluminescence, FTIR) may also be used in an exploratory way at this stage, in order to select the best samples for the second part of the project.

2- the second part of the work will be to further study a selection of the samples in order to more fully unravel the mineralogical, petrological, and geochemical fingerprints of hydrothermal alteration (primarily serpentinization and carbonation) in these samples. The PhD will apply a range of micro-imaging and analytical techniques to fully characterize the mineralogy of inorganic and organic chemical constituents and their textural relationships. Stable isotope analyses (C, H, O and Δ47) and thermodynamic modeling of phase equilibria will also be applied, which can provide important constraints on the fluid/rock history: temperature of equilibration of the minerals, fluid-rock ratios, and composition of the fluid.

Applicants should have a master degree in Earth Sciences and be particularly curious about rocks, plate tectonics, seafloor exploration, the interactions between Solid Earth and Ocean, and global geochemical cycles. Previous background in field geology and petrology would be good. Applicants with a dominantly geophysical or geochemical background are however also welcome if they demonstrate their motivation for the field-based approach developped in the project.

Prospective applicants should not hesitate to contact the advisor/co-advisor by email for further details. One applicant will be selected to present his-her background, and motivation for the project during the doctoral school formal interviews in june 2018 (see information on the Doctoral School website).



Location of the study area at the Southwest Indian Ridge. The map to the left shows the axial valley region, with seafloor as deep as 5200m in the bottom of axial valley and a 2500m-high relief to the north. This relief is created by the axial detachment fault. It exposes variably serpentinized and deformed peridotites (the samples to be studied during the PhD are the red dots on this wall and in the deep axial valley seafloor). Part of the work will be to analyse the geological setting of these samples based on ROV dives videos, and on high resolution topographic maps such as the one used to produce the 3D block shown on the right. The map shows the tracks of the ROV dives, ROVsmooth cruise. White tracks for high-resolution mapping and magnetic surveys. Blue tracks for geological exploration dives.