ÉCOLE DOCTORALE
SCIENCES DE LA TERRE ET DE L'ENVIRONNEMENT
ET PHYSIQUE DE L'UNIVERS, PARIS

Subjet offered for a contract starting 2015

SUBJECT TITLE: Strain localization in oceanic detachment faults: the extreme case of a magma-starved slow spreading ridge.

Advisor : **CANNAT Mathilde, DR-CNRS, cannat@ipgp.fr**

Host lab/team: **IPGP- Equipe de Géosciences Marines – UMR7154**

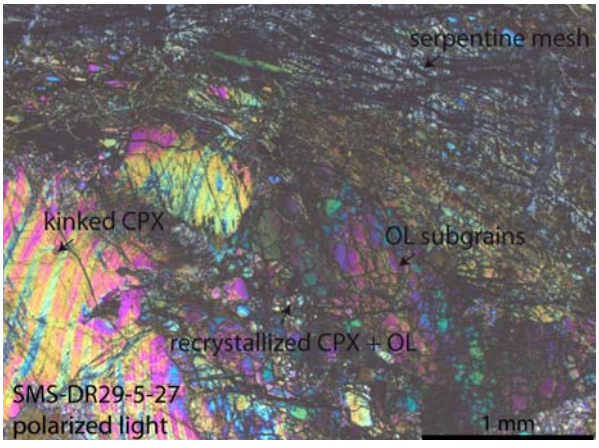
Financing : **Doctoral contrat with or without assignment**

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

The Southwest Indian Ridge in its eastern part has particularly low magmatic inputs and is therefore a natural laboratory to study oceanic accretion in an extreme configuration for which the divergence of the plates is almost completely accommodated by large offset normal faults, also called detachment faults. These faults exhume mantle-derived peridotites. This Southwest Indian Ridge laboratory is also a plausible analog for processes at the continent-ocean transition of divergent margins.

This PhD project concerns the deformation recorded by mantle rocks during their exhumation, and in particular the modes of strain localization in these rocks prior to serpentinization. Serpentinization (hydrothermal alteration of peridotites), and more generally the metamorphic reactions involving hydrated minerals have been shown to control strain localization in the upper levels of the mid ocean ridge detachment faults, where hydrothermal fluids circulate. Very little is known by contrast of the mechanisms that operate in the lower levels of the lithosphere of slow spreading ridges: how do detachments root in the ductile part of the lithospheric mantle? Or in other words, what are the characteristics of the plate boundary in these deeper levels? Is it diffuse? or localized? How is displacement partitionned between seismic deformation and slow slip? What is the role of magmatic circulations? These questions are critical to understand the tectonic evolution of slow spreading ridges.

Photomicrograph of a shear band combining brittle (kinks, microfractures) and plastic deformation mechanisms (slip dislocations and recrystallization) in a partially serpentinized peridotite exhumed to the axis of the South West Indian Ridge(near 64°E, Sismosmooth cruise).



The thesis work will characterize the deformation textures, analyze strain localization mechanisms, as well as mineralogical assemblages associated with these mechanisms on samples selected from a corpus of over 250 samples dredged during the SismoSmooth cruise (2010) at over 30 sites on both flanks of the ridge. The microstructural study of deformation (optical microscopy, study of minearl preferred orientations by EBSD and SEM imaging) will be coupled with the petrological and geochemical study (microprobe and LA-ICPMS) of the affected minerals. Samples from other, more magmatic, ridges, and samples from possible ophiolitic analogues may be included in the study. These data will allow to estimate the temperature and stress during deformation, and to detect the passage of fluids in the shear bands. The thesis will also include a digital modeling component for which the student will be advised by Luc Lavier (University of

Texas at Austin). The objective will be to incorporate these new constraints in thermomechanical models of the lithosphere slow ridges. Several stays in Austin will be planned for this modelling component.

The candidates must have a strong interest and possibly a good background in rock mechanics, tectonics, and the petrology of mantle rocks and oceanic crust. An oceanographic cruise involving ROV (Remotely Operated Vehicle) exploration of the South West Indian ridge study area is funded, but the timing of this cruise is not defined yet. This cruise (ROV-Smooth project) will allow for in situ geological observations, fine scale mapping and additional sampling of the deformation structures associated with the detachment faults. If as we hope the cruise is scheduled during the thesis, the student will be involved in processing of these new data. In all cases, the student will become part of the group of researchers who are currently working on the dataset collected during the Sismosmooth dredging cruise at IPGP, the IPG Strasbourg, the University of Modena (Italy), and at ENS Lyon.