Construction of the oceanic crust: links between magmatism and tectonism at slow-spreading ridges

Directrice de thèse : Mathilde CANNAT
Co-directeurs : Julie CARLUT (ENS), Javier Escartin et Anne Deschamps (UBO)
Equipe d'accueil : Géosciences marine IPGP

Mid-ocean ridges are by far the most active and extensive volcanic system on Earth. They extend over more than 60000 km, and erupt nearly 3 times more lava yearly than sub-aerial volcanoes. Mid-ocean ridges also undergo large tectonically-accommodated extension. This is particularly the case at slow spreading ridges, which represent about 30000 km of axis, and where the ratio of tectonically-accommodated plate divergence over plate divergence accommodated by magma emplacement can locally be 50% or more. Faults play a critical role to allow seawater to interact with magmas at depths, thus allowing for major heat and chemical exchanges between the solid Earth and the Oceans. Faults also interact in complex ways with magmatism because both mechanisms are controlled by, and modify the state of stress in the axial lithosphere. Tectonic-volcanic interactions are one of the major issues presently being addressed by ridge scientists internationally.

This PhD project will contribute to this research effort by bringing new constraints on tectonic-volcanic interactions at the slow-spreading Mid Atlantic Ridge. The study area is located at about 37°N (lat) in the Lucky Strike segment of the ridge. This segment has been extensivelly surveyed as part of the MoMAR program for setting up a seafloor observatory dedicated to long-term monitoring of active ridge processes.

The student will join the multidisciplinary team working on the MoMAR project at IPGP and in other laboratories in France, Portugal, the UK, and the USA. He-she will work on a large set of high-resolution site survey data including high resolution bathymetry and seafloor reflectivity, seafloor photographs, and near-bottom magnetic data. Most of these data have been collected during two recent cruises (Bathyluck 2008 and 2009) using the Remotely Operated Vehicle (ROV) VICTOR and the Autonomous Underwater Vehicle (AUV) AsterX.

Using these data, the student will be able to bring new constraints on the geometry of volcanic units, the relative importance of diking, and the relative timing and distribution of eruptions in the Lucky Strike ridge segment. Absolute age constraints may be derived from near-bottom magnetics. These data will also allow to quantify fault-related deformation, and to establish a chronology of faulting and lava emplacement at key locations in the segment. Based on these constraints, the Candidate will develop quantitative models of upper crust construction at a slow-spreading ridge. These models will include predictions of physical parameters such as the distribution of porosity and the density in the upper crust (based on the predicted proportion of lava flows vs. dikes). The student will evaluate these predictions based on seismic velocity models of the Lucky Strike area which have been developed at IPGP based on the results of the 2005 SisMoMAR cruise.