**Report InterRidge fellowship 2012**

**Title*: “The role of the melt supply variability in the development of a detachment fault system”***

**Fellow: Dr. Alessio Sanfilippo; Università degli Studi di Pavia (now at Kanazawa University)**

**Sponsor: Dr. H.J.B. Dick; Woods Hole Oceanographic Institution**

The InterRidge Fellowship 2012 allowed me to take part into the Cruise KN210-05 (May-June 2013) at the 16.5ºN area of the Mid Atlantic Ridge and to spend additional time at Woods Hole Oceanographic Instituion (USA) (November 2013 and January 2014) to study the rock samples. The area investigated during this cruise is characterized by a complex detachment faulting system, where neo-volcanic zone are associated with zone of active detachment, and can thus be considered an ideal place where the link between detachment faulting a magmatism can be explored.

During the cruise, I was mainly devoted to the collection, curation, description, and interpretation of the rock samples. In the months after the cruise (September and October 2013), all the recovered gabbroic samples were studied under the optical microscope and ~20 samples were selected for the chemical analyses. Up to date, I determined the major element mineral composition of these samples through Electron Microprobe analyses (Università di Milano); the trace element mineral compositions of the major mineral phases are in phase of characterization by Laser Ablation Mass Spectrometry. This preliminary geochemical study, integrated with the high-resolution mapping and geophysical survey obtained during the cruise, resulted in two main discoveries:

1. the gabbroic rocks exposed at the ocean core complexes in our mapping area show a “bimodal” compositional distribution (i.e. large proportion of rocks crystallized either from chemically primitive and evolved magmas and lack of chemically intermediate cumulates), which is hardly reconcilable with that expected for crystallization of a mid-ocean ridge basalt magma. During my visit at WHOI (Novermber 2013 - January 2014), under the advisement of Dr. H.J.B. Dick, we found a scenario that might explain why this anomalous compositional distribution characterizes our study area. Using the theoretical free-energy minimization modelling program *Melts* we showed that a similar bimodal compositional distribution of the lower crust can be produced if mantle melts are intruded into the mantle, rather than into a thick pre-existing layer of gabbro. Given that the input of this model is the proportion and composition of the erupted basalts in the area, we created a powerful tool for assessing the architecture of the lower crust at ocean ridges, where it cannot be accessed directly. These results have been presented at the Goldschmidt Conference 2014 and are discussed in a manuscript in preparation.
2. the highly deformed primitive gabbroic rocks (troctolite ultra-mylonites) are mineralogically and chemically distinct from the host rocks (porphyroclastic to mylonitic troctolites) and contain large amount of hydrous silicate phases such as amphibole. The preliminary geochemical characterization of these rocks indicates that the high-temperature deformation occurred during the late magmatic stages, in concomitance with the ingress of considerable amount of water into the magmatic system. Together with Dr. H.J.B. Dick and Dr. H. Marschall (WHOI), we discussed on the origin of these rocks convening that detailed analyses including trace element compositions and Li and B isotopes of amphiboles are necessary to define if and at what extent seawater is involved at the onset of the detachment faulting.

Given the multidisciplinary characters and the high impact of these preliminary results, it is not difficult to imagine how the InterRidge Fellowship 2013 is enhancing my career. The data I obtained during the cruise and during the working period at WHOI already provided shocking results that will be likely published on major international journals. Importantly, some of these preliminary results will be used as fundamental starting point for detailed studies in collaboration with scientists from WHOI. This is enabling long-standing relationships and has the potential to create an important net of collaborations between WHOI and my past (Università di Pavia) and present (Kanazawa University) institutions.

Nonetheless, thanks to this fellowship I co-authored a manuscript and several conference papers based on the results obtained during the cruise.

I hope this reports fully express my gratitude to InterRidge for such a unique opportunity.

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*Preliminary results:*

* Smith D, Schouten H, Dick HJB, Cann J, Salters V, Marschall H, **Sanfilippo A** et al. Development and evolution of detachment faulting along 50 km of the Mid-Atlantic Ridge near 16.5N. Geochemistry Geophysics Geosystems, under review.
* **Sanfilippo A**., Dick H.J.B. (2014). A quantitative model to explain the bimodal distribution of gabbros from the 16.50ºN core complex: an attempt to explain the compositional heterogeneity of the lower oceanic crust. Goldschmidt 2014, Sacramento USA.
* Dick H.J.B., Salters V., **Sanfilippo A.,** Shouten H., Smith D. (2014) Focused Melt Flow and Abyssal Magmatism at Lower Magma Supply Rates. Goldschmidt 2014, Sacramento USA.
* **Sanfilippo A.,** Palmiotto C., Dick H.B.J., Smith D., Schouten H., et al. (2013). Linkage between detachment faulting and magmatism in the central Mid Atlantic Ridge (16.5° N region, Atlantic Ocean): preliminary data of the cruise KNR 210-5 (part II). Congresso Nazionale Società Geologica Italiana, Pisa (Italy)
* Palmiotto C., **Sanfilippo A.,** Smith D., Schouten H., Dick H.B.J., et al., (2013). Linkage between detachment faulting and magmatism in the central Mid Atlantic Ridge (16.5° N region, Atlantic Ocean): preliminary data of the cruise KNR 210-5 (part I). Congresso Nazionale Società Geologica Italiana, Pisa (Italy).