In situ geomicrobiological experiment at MoMAR site: chemical and structural imaging of microbial/mineral interactions

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During the summers of 2006 (GRAVILUCK cruise) and 2007 (MoMARDREAM leg2 cruise), we have conducted in situ incubation experiments on the Lucky Strike area, using synthetic and natural basaltic glasses and peridotites, for an extended period of time (15 days to 1 year). This was performed within the framework of the international MoMAR project. The scientific objectives of these experiments are to provide clues to the following questions: [1] Which microbial species at and beneath the seafloor are involved in the processes of minerals weathering? [2] How do they interact with rocks and by which metabolic pathways do they mediate dissolution and/or precipitation reactions? [3] What is the quantitative role of microbial communities in the weathering of the rocks and as a consequence, on geochemical fluxes and modifications of petrophysical properties of the oceanic crust, from the nanometer scale to the scale of the hydrothermal site? [4] Finally, what kind of structural and/or chemical biosignatures do microorganisms leave in the geological record?

For this purpose, we propose to identify the prokaryotes involved in the weathering of the synthetic and natural mineral samples deposited in the Lucky Strike area and to determine the chemical reactions they catalyse by using a microbial diversity approach (DGGE, cloning-sequencing, FISH…) and methods associating molecular biology and chemical imaging. In the meantime, we will characterise and quantify the mineralogical and chemical alterations, at different scales, by monitoring the redox state and more generally the speciation of elements like Fe and Mg (Mössbauer, XANES, EXAFS, STXM, ICP-MS…). Finally, we will image the microorganisms in the mineral environment to correlate their presence with traces of weathering (MEB, MET, Catholuminescence, STXM, FISH, XRF, LSCM-in fluorescence and Raman…). The magnetic and physical properties of the samples (magnetisation, susceptibility, magnetic mineralogy and porosity) will be examined in order to characterise the role of the microorganisms on the “macro properties” of the oceanic crust. In order to better characterize the biosignatures linked with weathering processes, cultural experiments with indigenous strain will be carried out in parallel in laboratory and flow through experiments in basaltic rocks and peridotites.

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