Ecole Doctorale des Sciences Fondamentales

Title of the thesis: Cerium isotopic composition of the upper mantle

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Summary :

Mid-ocean ridge basalts (MORB) have homogeneous isotopic compositions (Sr, Nd, Pb) compared to those of oceanic island basalts (OIB). This is generally interpreted as reflecting, on the one hand, the homogenization by mechanical mixing of the upper mantle source of MORB, and on the other hand, the great variety of materials (oceanic crust, sediments, sub-continental lithosphere, ...) recycled within the deep source of OIB.

The $^{138}Ce/^{142}Ce$ isotope ratios measured in MORB (^{138}La decays into ^{138}Ce by beta emission; half-life 292.5 Gyr) show "large" variations of the order of those recorded in OIB (1 εCe unit in MORB against 1.5 units in OIB, to be compared for example with the 3 and 12 εNd units observed for these same samples). The origin of these variations is not identified. Do they traduce the heterogeneity of the MORB source mantle and/or the syn/post magmatic processes modifying the source message in the composition of MORB?

The first part of the thesis will focus on the measurement of the Ce isotopic composition of MORB samples. Two segments of ridge, one located close to and the other at a distance from an oceanic archipelago associated with the presence of a hot spot, will be considered in order to test the "plume-ridge" interaction (measurements of the Ce isotopic composition of OIB will also be considered). At the same time, particular interest will also be given to the identification and quantification of the effect of the segmentation of the ridges (samples close to a transform fault). Finally, a large geographical database comparing samples from the northern and southern hemispheres will allow to discuss the DUPAL anomaly with respect to the La/Ce systematics.

In a second step, the measurement of Ce isotopes will be adapted to very-low-Ce samples in order to document representative peridotites of the upper mantle, and thus the source of the MORB. Whole-rock samples and also separate minerals (inclusion of chromites in olivine or pyroxene crystals) will be considered in order to avoid disturbances related to metasomatism. This second part will allow to quantify the part of the isotopic variability of MORB related to their source.

This project is based on the measurement of a large quantity of terrestrial samples. Candidates must have a strong interest in geochemistry and a first experience in clean lab work and/or mass spectrometry is essential.

Methods: clean room chemistry, mass spectrometry (ICPMS, TIMS, MC-ICPMS), isotope dilution techniques.