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Evidence of mantle heterogeneity underneath slow-spreading ridges? Case-study at 45°N mid-Atlantic ridge

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Axial volcanic ridges (AVR) are a ubiquitous feature along mid-oceanic ridges. Although numerous studies have been performed on their structure and volcanic activity, many questions still remain unanswered, e.g. do AVR basalts have a common parental magma, and are the basalts derived from different magma chambers erupting at different times?
During cruise JC24 in 2008, nearly 300 basaltic samples were collected with the ROV ISIS in order to answer some of these questions.
A large dataset has now been compiled and some preliminary results will be presented. Rare earth element (REE) data coupled with trace element data of 30 samples revealed three different groups of samples. Group I is charaterized by low La/Yb, and incompatible element concentrations between normal and enriched mid-oceanic ridge basalt (N- and E-MORB). Group III has highly elevated La/Yb ratios, and a pattern of incompatibles that is more enriched in light REE than E-MORB. Group II lies in between but shows clear gaps to both other groups.
As REEs are not available for all samples yet, the incompatible and alteration-resistant elements Nb-Zr-Y were used to extend the grouping to a further 230 samples analysed by XRF. The results are coherent with the REE groupings. In addition, groups II and III could be subsequently split into subgroups.
The most enriched samples occur on (1) flat-topped volcanoes, situated off-AVR, (2) in the median valley near these volcanoes, (3) in the median valley walls on the western side as well as in the western axial floor, and (4) at the northern tip of the main AVR structure. Group II occurs on the axial floor north and west of the AVR, in the western median valley wall, and at the northern and southern tips of the AVR. Group I samples are located on the main AVR structure, and in the eastern axial floor.
It is quite obvious that even on a small scale, considerable geochemical heterogeneity can be found. Within only 3 km the trace element concentration changes from highly enriched in light REE to normal MORB. The question arises how these different melts ascend through the mantle and crust without being homogenized.
So far, the origin of the highly enriched basalts is not known. Isotope work is planned to facilitate a comparison to samples coming from hotspot locations. However, hotspot influence in this region is unlikely, as isotope and trace element work on the Azores [1] and Iceland [2] hotspots have shown. Mello & Cann [3] suggested a former triple junction near 45°N between 59 and 26 my ago. Maybe the source of the material lies there.
It is the aim of this study to reveal connections between volcanic structures, as well as to define the various melt sources.
Wider implications of this study are insights into the magma storage and plumbing underneath the AVR, and a detailed geochemical map of a (typical) mid-Atlantic ridge segment.

[1] Goslin, Triatnord Shipboard Party (1999), Geology 27 (11), 991-994.
[2] Taylor, Thirlwall, Murton, Hilton & Gee (1997), Earth and Planetary Science Letters 148, E1-E8.
[3] Mello & Cann (1999), Journal of Geophysical Research 104 (B12), 29335-29349.