International Research:
CENTRAL INDIAN RIDGE

Sampling and surveying ridge-hotspot interaction on the Central Indian Ridge, 19°S: Cruise KNOX11RR

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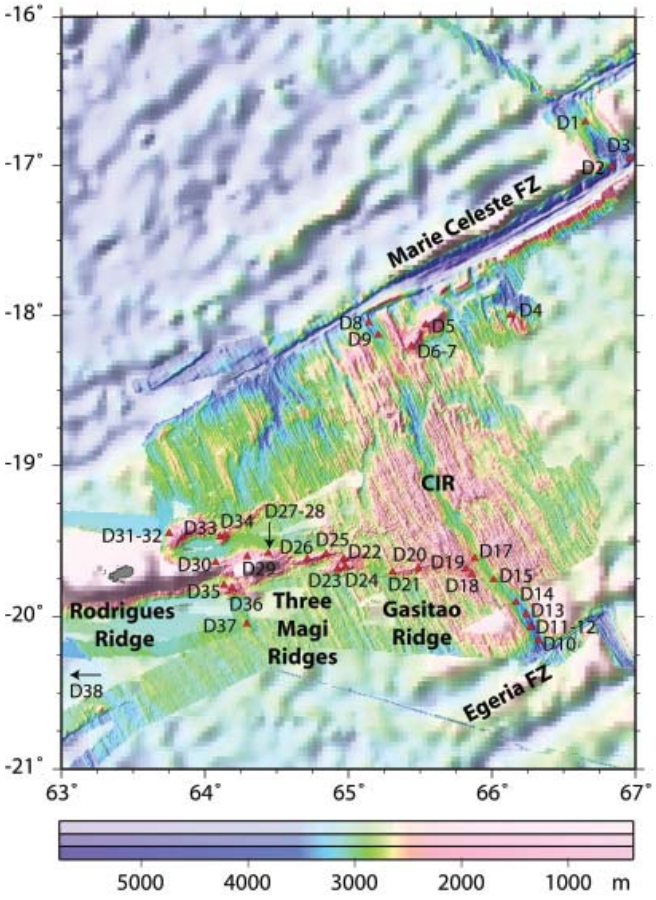
The KNOX11RR cruise of Nov. 2007 was a 19-day, multi-national joint geochemical sampling and geophysical surveying cruise to the Central Indian Ridge (CIR), between 16°70'S and 20°16'S, and the adjacent Gasitao Ridge, Three Magi Ridges, and Rodrigues Ridge (Fig. 1; Dyment et al., 1999). This region presents an opportunity to study the oblique interaction between a spreading ridge (CIR) and a hotspot (presently located at Réunion Island, ~1100 km to the west of the ridge).

Our principal goal was to test the hypotheses of Murton et al. (2005) and Nauret et al. (2006) regarding the direction of asthenospheric mantle flow between Réunion and the CIR. In the first case, Murton et al. (2005) found that young (zero age) basalts from the CIR exhibit an enrichment in incompatible elements that increases northward towards the Marie Celeste FZ (Fracture Zone). In addition, CIR basalts appear to lie on a mixing line between N-MORB and a source component that closely resembles present-day Réunion hotspot lavas. This suggests that enriched mantle is being supplied from Réunion in the form of an eastward-flowing tongue of material that migrates towards the CIR against the motion of the lithosphere. In contrast, Nauret et al. (2006) noted that only off-axis magmatism, located to the west of the ridge axis, appears to contain a Réunion component. They suggested that Réunion-like source material is diverted further south towards the Egeria FZ.



Thus, our strategy was to sample the Marie Celeste FZ and select sections of the CIR as well as the adjacent (off-axis) ridges to supplement samples collected on previous French and UK cruises. Noble gas (He, Ne, Ar) and volatile (CO_2, H_2O, Cl, F, and S) analyses of fresh basaltic glass rims combined with major and trace element and radioisotope data (Sr, Nd, Pb, Hf, Os) will provide the means to discriminate between the two hypotheses outlined above.

During the KNOX11RR cruise, we recovered material from 28 out of a total of 38 dredges along the Marie Celeste FZ, the CIR axis, the Three Magi Ridges, the Gasitao Ridge, and the

Figure 1: Bathymetric map of CIR and the adjacent Gasitao Ridge, Three Magi Ridges, and Rodrigues Ridge. The three levels of color for the bathymetry data represent a) pale colors, bathymetry "predicted" from satellite altimetry (Smith and Sandwell, 1997); b) intermediate colors, previous multibeam bathymetric data from R/V *Marion Dufresne* (1998; Dyment et al., 1999), *L'Atalante* (2000; Dyment et al., 2000), and *Hakuho-Maru* (2007; Okino et al., 2008); c) bright colors, multibeam bathymetric data collected by R/V *Revelle* on this cruise. Sample locations are shown as solid triangles.

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Rodrigues Ridge. Eleven dredges were successfully deployed along the ridge axis and another three at adjacent seamounts. Basalts from this region are fresh, aphyric and, in many cases, have glass rims, up to ~3 cm thick (Fig. 2). One dredge (D2) recovered coarse-grained gabbros, as well as harzburgitic and lherzolitic material, from an oceanic core complex located at the intersection of the CIR with the Marie Celeste FZ. The off-axis structures, i.e., the Three Magi Ridges, the Gasitao Ridge, and the Rodrigues Ridge, were also dredged and mapped. Thirteen dredges generally yielded older, Mn-encrusted pillow basalt fragments. However, variable amounts of fresh basaltic glass were recovered from several stations. Multibeam bathymetry and magnetics were collected throughout the cruise.

Preliminary results of helium isotope and abundance analyses show that the helium concentrations decrease southward along the CIR (Fig. 3). MORB-like $^3He/^4He$ ratios are found in glasses recovered in the vicinity of the Marie Celeste FZ, while the highest $^3He/^4He$ ratios (~11R_A, where R_A = atmospheric $^3He/^4He$) are found between 18.91° and 19.95°S on the ridge axis. However, even higher ratios were measured in some of the glass samples recovered off axis, from the Three Magi Ridges and the Gasitao Ridge.

Therefore, our initial data appear consistent with asthenospheric flow impinging the ridge axis adjacent to the Gasitao Ridge. Additional noble gas and volatile data will be combined with major/trace element and radioisotope data to provide further details of ridge-hotspot interaction at the CIR.

Acknowledgments

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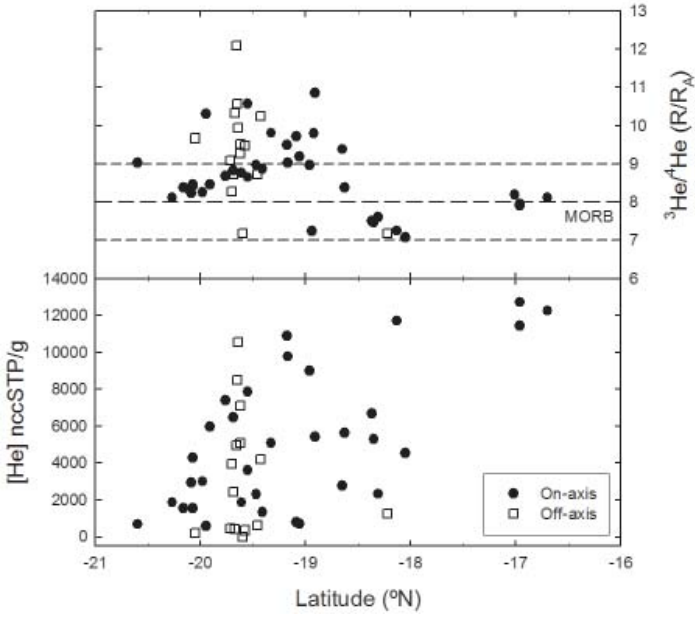

Figure 2: (upper) Pillow basalt fragment with fresh glass rim.

Figure 3: (lower) Helium isotope ratios ($^3He/^4He$) and concentrations of Central Indian Ocean basalt glasses as a function of latitude. Helium isotope ratios are shown as R/R_A, where R = $^3He/^4He$ ratio measured in the sample and R_A = $^3He/^4He$ ratio of air. With the exception of dredges D1 - D3, all on-axis samples were dredged between the Marie Celeste and Egeria Fracture Zones. With the exception of dredges D4 - D7, all off-axis samples were collected to the west of the CIR axis. Samples include those collected during KNOX11RR (Füri et al., unpublished), CD127 (Murton et al., 2005), and GIMNAUT (Nauret et al., 2006) cruises.