Geochemical variations at a ridge-centered hotspot caused by variable melting of a veined mantle

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Geochemical observations at ridge-centered hotspots offer clues into the nature of the melting process as well as the composition of the mantle that feeds volcanism. For example, observations at the Iceland hotspot show that lava composition varies with distance along the Mid-Atlantic Ridge (MAR), changing from relatively incompatible element enriched compositions near the hotspot to relatively depleted compositions far from the hotspot. This observation indicates the presence of mantle compositional heterogeneity below the MAR, where an "enriched" component is expressed strongest in hotspot lavas. Such an expression could occur by two possible end-member scenarios (1) the plume is compositionally distinct from the ambient asthenosphere and the gradients reflect progressive dilution of the plume along the ridge axis or (2) gradients reflect variation in melting of the plume and ambient mantle with no geochemical distinction between them. We explore the second possibility by modelling the 3-D dynamics and melting of a ridge-centered plume and predict the geochemical composition of magma at the surface. Our model couples flow, heat transfer, and melting of a heterogeneous (veined) mantle that is the same in the plume and ambient mantle. We assume that the heterogeneous mantle comprises two lithologies with different solidi, and that the less refractory lithology has an isotope signature of long-term enrichment in incompatible trace-elements. Calculations predict the hot mantle from the plume to spread and generate anomalously thick crust hundreds of kilometers along the ridge axis. An important finding is that variations in shallow mantle dynamics give rise to broad, along-axis variations in lava compositions, with increasing contribution from the enriched lithology towards the center of the plume. This effect is augmented by an increase in viscosity due to melting dehydration and the along-ridge geochemical anomaly scales with the diameter of the plume. Calculations show that melting and upper mantle dynamics contribute to large-long wavelength geochemical variations, which must be considered before using lava compositions to infer regional-scale source variations.

A genetic view of diversity beneath the seafloor

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Subseafloor sediments may hold 1/3rd to 1/10th of the microbial biomass on Earth. As such, we anticipate that they also hold a large, mostly untapped reservior of microbial genetic diversity. In order to examine this genetic diversity, we have analyzed methods to improve recovery of nucleic acid extraction, particularly the extraction of high molecular weight DNA from sediments. With such extracted DNA, we are persuing multiple analyses to determine the extent and nature of the genetic diversity in these sediments.

From sediment collected during Ocean Drilling Program Leg 201, we are in the process of analyzing the microbial diversity within multiple geochemical sediment regimes by fosmid libraries, metagenomics and the massively high throughput method of tagged sequencing [1]. Through these studies, we have seen that the subseafloor environment has a diversity pattern that is distinct from terrestrial or pelagic environments. While some sites reveal a detectable contribution from the water column, most microbial groups are unique to the benthic sediments. Another unique aspect of this environment is the presence of many uncultivated archaeal groups belonging to the Crenarchaeota. These assumed low-temperature Crenarchaeota are phylogenetically and functionally distinct from high-temperature Crenarchaeota; based on evidence from the metagenome, they may be a basal group to both high-temperature Crenarchaeota and Euryarchaeota, as other low-temperature Crenarchaeota [2]. Our ongoing studies of the subseafloor highlight the unexhausted potential for novel genetic diversity in this vast environment.

[1]. Sogin *et al.* (2006) *PNAS* **103**, 12115-12120. [2] Brochier-Armanet *et al.* (2008) *Nat. Rev. Micro* **6**, 245-252.