Assessing the role of eclogite in the North Atlantic mantle source

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The origin of the chemically heterogeneous, high productivity magmatism of the North Atlantic large igneous province (NAIP) remains uncertain. Two opposing models have been advanced. The first attributes the high melt productivity to anomalously high potential temperatures associated with a chemically zoned plume originating from the transition zone or deeper [1]. The second claims that high melt productivity derives from abundant, fertile Iapetus crust (eclogite) in the subcontinental mantle at the time of Pangea breakup [2, 3]. To evaluate these competing hypotheses we have devcloped a forward melting model simulating a heterogeneous source containing eclogite and peridotite. We incorporate experimentally - determined melt productivity functions, melting reactions, solidii and partition coefficients for eclogite and peridotite, and thermodynamic constraints. For a given mantle potential temperature and initial source compositions, the model outputs the trace element and isotopic compositions derived from the pooling of melts from the heterogeneous source. We have applied this model to assess the composition of Paleogene basalts erupted along the East Greenland rifted margin traversing the Caledonian Front and recording peak melt productivity. We find that Paleogene lavas erupted within the zone of Caledonian deformation require modest excess potential temperatures ($\leq$50°C), a minor eclogite component (~1 – 10%) and lava compositions can be modeled reasonably by a two-component plum-pudding type mantle source containing depleted peridotite and light-rare earth element – enriched eclogite. The small proportion of eclogite in the source required to explain magma compositions necessitates a component of active upwelling (similar to previous estimates [4]) to account for observed crustal thicknesses along the rifted margin. Our results do not support sampling of discrete domains within a compositionally zoned plume source [5] during the Paleogene and also contrast with non-plume models invoking the involvement of large amounts of eclogite. To better understand the along-rift variation in these key parameters, we extend the analysis to Paleogene lavas erupted southwest of the Caledonian Front and to the modern spreading ridge.

[1] Fitton *et al.* (1997) *EPSL* **153**, 197-208. [2] Korenaga & Kelemen (2000) *EPSL* **184**, 251-268. [3] Foulger *et al.* (2005) *JVGR* **141**, 33-44. [4] Holbrook *et al.* (2001) *EPSL* **190**, 251-266. [5] Barker *et al.* (2006) *Geology* **34**, 481-484.

Synchrotron X-ray studies of bacteria-mineral-metal ion interactions

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Bacteria, organic matter, and mineral particles in aquatic systems interact with each other and compete for dissolved metal ions, particularly when the bacteria or organic matter are present as surface coatings on the minerals. Such interactions affect the geochemical cycling of the metal ions as well as transformation of the minerals into other forms. The extent of this competition is difficult to assess unless *in situ* measurements are made on systems containing all components of interest. Over the past few years, we have carried out a series of *in situ* synchrotron X-ray studies of the interaction of metal ions with single crystal mineral surfaces coated by microbial biofilms or organic polymers and of the interaction of bacteria capable of Fe(III) reduction with iron oxide nanoparticles. Systems studied include Pb(II)-Zn(II)-*Shewanella oneidensis* MR-1-hematite-water; Pb(II)-Zn(II)-*S. oneidensis*-alumina-water; As(V)-*S. putrefaciens*-lepidocrocite-water; Zn(II)-As(V)-*S. putrefaciens*-maghemite-water; Pb(II)-Ca(II)-Fe(III)-Ni(II)-Cu(II)-Zn(II)-Cl(-1)-PO_4^{-3}-SO_4^{-2}-*Caulobacter crescentus*-alumina-water, Pb(II)-*Burholderia cepacia*-alumina-water, Pb(II)-*B. cepacia*-hematite-water; Se(VI)-*B. cepacia*-alumina-water, Zn(II)-oxalate-hematite-water; Pb(II)-oxalate-alumina-water, and Pb(II)-As(V)-polyacrylic acid-alumina-water. Long-period X-ray standing wave and GI-XAFS spectroscopy were used to determine the partitioning and speciation of ions for the single crystal substrates, and XAFS and STXM were used to study microbe-mineral-metal ion interactions for the powdered substrates. Highlighs of these studies will be presented.