Petrogenesis of the Ethiopian plateau basalts and their bearing on mantle plume components

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The Ethiopian-Yemen continental flood basalts represent an Oligocene Large Igneous Province where some typical features of deep mantle plume, including high $^3He/^4He$ ratios, have been documented (Afar plume; Courtillot *et al*., 2003). In the Ethiopian plateau large volumes (ca. 300000 Km^3) of tholeiitic magmas, erupted in a short time span (31-28 Ma), appear to be zonally arranged with low-Ti basalts in the NW part of the province, and high-Ti basalts (and picrites) in the eastern sector neighbouring the Afar-Red Sea region (Pik *et al*. 1998)

An integrated petrogenetic model based on major element mass balance calculations, phase equilibria, and thermo-barometric evaluations indicates that primary basaltic magmas were generated by ca. 15-20% melting of mantle lherzolite at ~1250-1300 °C / 13-16 Kb and ~ 1300-1350 C° / 14-19 Kb for low-Ti and high-Ti tholeiites, respectively; high-Ti picrites by ~ 30% melting at ~1400-1450 °C / 20-30 Kb.

The calculated mantle sources invariably require hydrated lherzolite composition with up to 5% and 10% of amphibole for low-Ti and high-Ti magmas respectively, and a parallel increase of 2 – 17 times incompatible element abundances with respect to those observed in the Ethiopian mantle xenoliths. Further Ti-rich metasomatic phases (e.g. rutile, ilmenite, armalcolite) are required in the mantle sources, particularly for the generation of extremely high-Ti magmas (TiO_2 up to 5-6%). Therefore, low-Ti basalts may have been generated in the outer zone of the Afar-plume by partial melting of moderately metasomatized lithospheric mantle sources, in connection with the activation of the hotspot and related crustal bulging. High-Ti basalts/picrites could in turn be generated in the inner part of the Afar buoyancy flux from mantle sources significantly more enriched by plume components. These metasomatizing components may correspond to Na-alkali silicate mafic melts enriched in Ba, Th, Nb, Ti, Zr as well as light REE and show compositional analogies with the Ti-rich alkali silicate metasomatism documented in some mantle xenoliths from Kerguelen Islands (Grégoire *et al*., 2000)

References

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Biogeochemistry of advective intertidal sediments

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Introduction

At tidal flat margins where the sediment surface slopes towards tidal creeks, deep advective pore water flow may be generated driven by the hydraulic gradient between sea water and pore water level at low tide (Billerbeck *et al*. 2006; Howes and Goehringer 1994; Wilson and Gardner 2006). Tidal and seasonal variation of trace metal and nutrient concentrations in deep pore waters of advective intertidal sediments have however remained largely unknown.

Results and Discussion

In-situ pore water sampling down to 5 m sediment depth in an intertidal sand flat in NW Germany revealed trace metal profiles similar to those observed in the upper centimetres of deep sea sediments. The pore water composition is strongly influenced by the location of the sampling site and its specific characteristics, like oxygen penetration depth and H_2S concentration.

At a location close to the main tidal creek tidal variations of trace metals, dissolved organic carbon (DOC), and nutrients were determined. Manganese concentrations e.g. increase by a factor of two from low to high tide in these depths, whereas uranium concentrations are decreasing to values half as high in the same time period. Pore water advection is shown to be most significant at 1 to 3 m depth. In these depth levels DOC and nutrients are enriched, whereas trace metals are enriched or depleted depending on their specific behavior under reducing conditions. Elemental species enriched in deep pore waters presumably represent an important source for the open water column when seeping out of the sediment. Release of manganese-enriched pore water supposedly explains tidal variations observed in the open water column of the study area. Seasonal pore water composition and temperature variations in depth profiles support the hypothesis that advection is significantly influencing the tidal flat system. The study of seasonal concentration patterns further evidences the interaction of trace metals like vanadium with DOC.

References

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