Osmium groundwater flux from the Bengal basin: Implications for the osmium marine budget

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The Os residence time in the oceans is currently poorly constrained, in part because the sources of Os to ocean water have not yet all been explored. One such source, potentially important, may be groundwater flux. Basu et al. [1] suggested that Bengal Basin groundwaters may provide a large flux of radiogenic Sr to the oceans. By analogy, and considering that the Ganges has the most radiogenic 187Os/188Os ratio yet measured in the world’s rivers [2], groundwater of the Ganges alluvial plain may provide a significant flux of radiogenic Os to the oceans.

We present Os isotopic and concentration data for groundwaters collected along a traverse in the Bengal alluvial plain. As these waters are highly reducing, a specific method was developed (heating with CrVI in a high pressure asher, HPA-S at 250°C) to allow complete oxidation of all of the Os, and thus equilibration with the Os isotopic tracer. Oxidation at lower temperatures, in the HPA-S or in teflon vessels [3], led to underestimation of the Os concentration by as much as a factor of two.

Os concentrations are high (30-250 pg/l) and display 187Os/188Os os ratios (2.2-2.6) in agreement with those of Ganges water and sediments. Os contents correlate strongly with those of Sr and several other elements, which allows us to roughly estimate the groundwater Os flux from the Bengal alluvial plain. Assuming conservative behaviour and both the mean Sr concentration and the groundwater flux of [1], we estimate an 188Os groundwater flux of ~9 M/yr. This estimate represents a radiogenic contribution similar to that of the Amazon [2]. If more than three times the Os flux from the Ganges and a 187Os/188Os groundwater flux of ~9 M/yr. This estimate represents an Os flux from the Bengal alluvial plain may provide a significant flux of radiogenic Os to the oceans.

Sub-segment scale mantle heterogeneity beneath the Mid-Atlantic Ridge near Ascension Island from combined Hf-Nd-Sr isotope evidence

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The Mid-Atlantic Ridge (MAR) between 7°30’S and 11°30’S shows prominent bathymetric along-axis variations with a shallow central part (segments A2 and A3) and deeply incised segments to the north and south (segments A1 and A4). These topographic variations are mirrored by a large compositional variations spanning the entire range of Atlantic MORB analyzed so far in εHf-εNd and εHf-87Sr/86Sr space. Ascension Island is located in the immediate vicinity (80 km west of the MAR), indicating voluminous off-axis partial melting in the mantle. We analysed near primitive samples (MgO> 5 wt%) for Hf-Sr-Nd isotope and trace element compositions and our data for the submarine and subaerial portions of Ascension Island and the different segments along the MAR show that there are systematic changes in terms of εHf, εNd, and 87Sr/86Sr characteristics. In 176Hf/177Hf vs. Lu/Hf; 144Nd/144Nd vs. Sm/Nd, and 86Sr/88Sr vs. Rb/Sr spaces, the different segments define linear arrays. These arrays do not have any age significance but are mixing lines.

The central segment (A3) shows enriched mantle characteristics (εHf ~ +12.5; εNd: +7.5 to +8; 87Sr/86Sr: 0.70267 to 0.70277). Segment A2, located immediately to the north, has higher values in εNd (+10.2 to +11.7) and εHf (+13.2 to +14.5) but lower 87Sr/86Sr ratios (0.70244 to 0.70237). In contrast, the data from segments A1 and A4 define distinct linear arrays. This involves a depleted end-member with high εNd (up to +13), high εHf (up to +22), and low 87Sr/86Sr ratios (0.70244 to 0.70237) and an enriched end-member with low εNd and εHf and high 87Sr/86Sr ratios. Since there are no consistent trends with water depth or along axis position of the samples, sub-km scale mantle heterogeneities must be present beneath segments A1 and A4. The samples representing subaerial volcanism of Ascension Island mark the isotopically enriched extension of the linear array defined by MAR segments A1 and A4 (εNd: +6.8, εHf: +9.9; 87Sr/86Sr ratio: 0.70284). Samples from the submarine stage of Ascension Island are displaced towards higher εHf (+13.1 to +13.5), indicating that the volcanically dominant volcanic basement was fed from a distinctive, enriched mantle source. Hence, all of these observations imply that mantle material, representing the enriched end member component for segments A1 and A4, replaced the mantle domain responsible for submarine Ascension Island volcanism prior to the onset of subaerial volcanism (<1 Ma). Altogether, these relationships argue against a mantle plume origin for Ascension Island.

References