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 y*et al*l 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 ^{187}Os/^{188}Os 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 travese in the Bengal alluvial plain. As these waters are highly reducing, a specific method was developed (heating with Cr^{VI} 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 ^{187}Os/^{188}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 ^{188}Os groundwater flux of ~ 9 M/yr. This estimate represents more than three times the Os flux from the Ganges and a radiogenic contribution similar to that of the Amazon [2]. If realistic, this estimate would significantly reduce the estimate of the Os residence time in the ocean, and may suggest that Himalayan derived Os has had an important effect on the ^{187}Os/^{188}Os ratio of seawater. On the other hand, prelimimary results on groundwaters from the fresh/salt water transition area show that a substantial quantity of Os could be trapped here. This may indicate non-conservative behaviour which would significantly reduce our estimate of the groundwater Os flux that reaches the ocean.

References

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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-^{87}Sr/^{86}Sr 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 ^{87}Sr/^{86}Sr characteristics. In ^{176}Hf/^{177}Hf vs. Lu/Hf, ^{143}Nd/^{144}Nd vs. Sm/Nd, and ^{87}Sr/^{86}Sr 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; ^{87}Sr/^{86}Sr: 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 ^{87}Sr/^{86}Sr ratios (0.70244 to 0.70237). In contrast, the data from segments A1 and A4 define distinctive linear arrays. This involves a depleted end-member with high εNd (up to +13), high εHf (up to +22), and low ^{87}Sr/^{86}Sr ratios (0.70244 to 0.70237) and an enriched end-member with low εNd and εHf and high ^{87}Sr/^{86}Sr 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; ^{87}Sr/^{86}Sr ratio: 0.70284). Samples from the submarine stage of Ascension Island are displaced towards higher εHf (+13.1 to +13.5), indicating that the volmetrically 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.