Osmium concentration and composition in the Indian Ocean water

S. Levasseur
J.-L. Birck
C. J. Allègre

Laboratoire de Géochimie et Cosmochimie, Institut de Physique du Globe, 4, Place Jussieu, 75252 Paris Cedex 05, France

Variations in the isotopic composition of osmium in seawater, recorded by marine sediments, are a proxy of the relative variations of continent, mantle and meteorites contributions and potentially provide a record of continental weathering. Analyses have been made on several kind of sediment samples but until recently (Sharma *et al.*, 1997; Koide *et al.*, 1996) no direct measurement of the present day composition of seawater osmium was carried out because of analytical difficulties. This study presents two depth profiles of the concentration and isotopic composition of osmium in the Indian ocean. Osmium concentration in seawater is a key parameter to determine the residence time of osmium in ocean. This parameter is in turn quite important to understand the significance of the osmium proxy in the ocean as recorded in marine sediments: the residence time determines the response of the ocean to sudden variations in the input of osmium and consequently the shortest period and smallest amplitude of change resolvable by our present analytical precision of osmium measurements.

Sampling and analysis

Our seawater samples come from the Indian ocean and were collected during the EDUL cruise of the N/O Marion Dufresne at two different sites along the south-west indian ridge (CTD4 (27°52′S, 63°51 × W) and CTD12 (34°11′S, 55°37′W)). The extraction and purification of osmium have been made using the technique developed in our laboratory (Birck *et al.*,
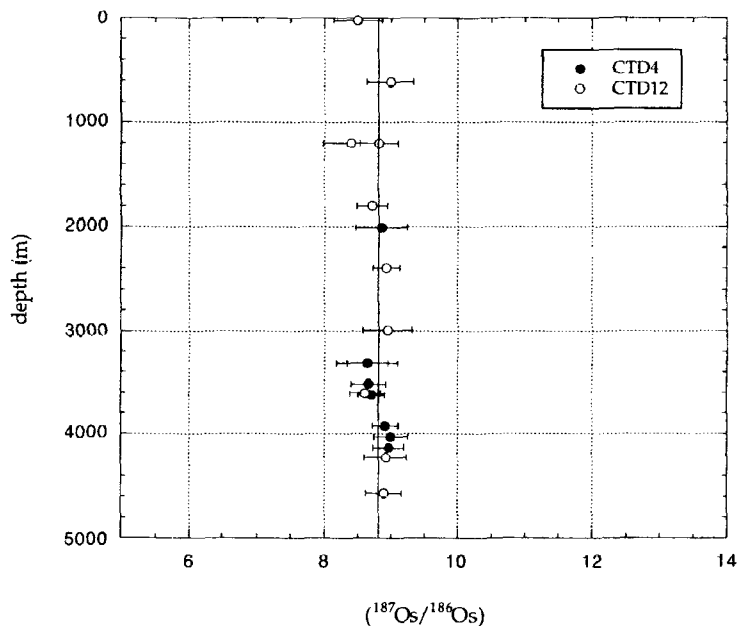

FIG. 1. Depth profile of $^{187}Os/^{186}Os$. The vertical line represents the average along the profile: 8.81 ± 0.07.
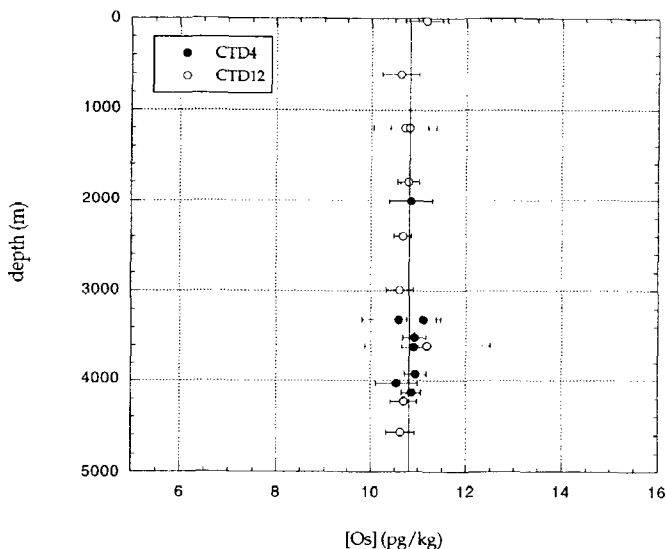
FIG. 2. Depth profile of [Os]. The vertical line represents the average along the profile: 10.79 $\pm$ 0.07 (unnormalized to constant salinity).

1997) and adapted to water samples. This technique allows direct measurement of osmium concentration and composition without coprecipitation from 50 cc of seawater with a blank contribution of 5%. Our measurements were made on unfiltered samples in order to compare our results with the earlier results obtained on larger samples from the Atlantic and the Pacific ocean by Sharma et al. (1997).

Results and discussion

Isotopic composition and concentration measurements do not vary within analytical precision along the profiles and from one site to another (distance of several hundred km). Our results of isotopic composition (Fig. 1) are in agreement with those of Sharma et al. (1997) with a mean $^{187}Os/^{186}Os$ ratio over the two profiles equal to 8.81 $\pm$ 0.07 (2σ error).

Although the individual uncertainties of the [Os] are too large (2–7%) to test a correlation with salinity the variation of which is only 3.5% over the two profiles, the constant osmium concentrations (Fig. 2) seems to indicate a conservative behaviour. The mean concentration over all the samples is equal to 10.87 $\pm$ 0.07 pg/kg (normalized to 35‰) or 10.79 $\pm$ 0.07 pg/kg unnormalized (2σ error). This result is 3 times larger than the previously measured [Os] in the Atlantic and the Pacific ocean. As it is very unlikely that such a variation in [Os] occurs in the whole ocean, (obviously the $^{187}Os/^{186}Os$ is at least roughly

homogeneous in the ocean which indicates a reasonably well mixed osmium) the discrepancy must be attributed to the differences in the extraction procedures of osmium from seawater before analysis.

These results indicate that the behaviour of Os should be conservative and confirm that it is quite well mixed in the ocean. An homogenous worldwide isotopic composition of osmium confirms the use of osmium as a proxy to determine the global relative imputs from a mantle type component derived either from oceanic crust or cosmic dust and from continental crust through weathering. Using our results of osmium concentration in the Indian ocean and preliminary measurements on water samples from large rivers (Amazon, Changjiang, Mekong, St Lawrence, MacKenzie, Niger, (mean [Os] = 8.2 pg/ kg)), a τ_{Os} equal to 4.2 $\times$ 10^4 years is obtained provided the soluble osmium flux is not modified in estuaries. This result is quite sensitive to the Amazone concentration and requires further investigation.

References

Birck, J.L., Barman, R., Capmas, F. (1997) Geostand. Newslett., 20, 19–27.

Koide, M., Goldberg, E.D. and Walker, R. (1996) Deep Sea Research II, 43, 53–55.

Sharma, M. Papanastassiou, D.A. and Wasserburg, G.J. (1997) Geochim. Cosmochim. Acta, 61, 3287–99.