Seawater Sr-Nd-Os isotope variations recorded by foraminifera over the last 150 kyrs

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Geographical variations of radiogenic isotopes in seawater, through time, have the potential to provide information on changes in erosional input and ocean circulation patterns, and their relation to tectonic and climatic events. For those elements which have a long residence time, such as Sr, the oceans are isotopically uniform on a global scale, and the geographical source of any chemical or isotopic variations can not be easily identified. By comparison, the residence times of Nd and Os are sufficiently short that both systems have the capability to respond, in phase, to short term fluctuations in input (Richter and Turekian, 1993). Foraminifera potentially offer a high-resolution radiogenic isotope record, amenable to precise biostratigraphic or isotopic dating, that can be directly related to the stable isotope, trace metal, and palaeoenvironmental information from the same material. This study presents Sr-Os-Nd isotopic variations recorded by foraminifera for the past 150 ka from ODP site 758 in the North East Indian ocean. This locality is of particular interest because it potentially preserves not only a record of the composition of seawater accompanying climate change, but also the local effects of continental erosion from the Himalaya-Tibet region.

Results

The sediment at site 758 is primarily pelagic carbonate, and all samples have been dated using oxygen isotope chronstratigraphy. Studies of trace elements in foraminifera have shown it is necessary to remove both organic material and metallic coatings (Boyle and Keigwin, 1985/86). *P. obliquiloculata, G. menardii* and mixed planktic species were separated and cleaned following established techniques (Boyle and Keigwin, 1985/86) prior to isotopic analysis. For all samples the Sr isotopic composition of cleaned *obliquiloculata* and *menardii* yield indistinguishable results that cannot be resolved from the value for modern seawater, consistent with previous data from this locality (Henderson *et al.*, 1994). Nd concentrations are constant for individual species, but differ between species, and range from 0.7 to 1.6 ppm. Os concentrations are also constant being around 3 ppt. Holocene *obliquiloculata* and *menardii* give ε_{Nd} values of -10.12 ± 0.16 and -10.28 ± 0.16, respectively (where ε_{Nd} is the measured $^{143}Nd/^{144}Nd$ ratio relative to the chondrite reservoir). In contrast, the same two species in samples from the last glacial maximum give values of -7.39 ± 0.16 and -7.02 ± 0.16, respectively, indicating a shift in $\varepsilon_{Nd} = 3.0 \pm 0.3$. The $^{187}Os/^{186}Os$ ratio of *obliquiloculata* in Holocene samples is 8.55 ± 0.14, indistinguishable from modern seawater (Sharma *et al.*, 1997). In contrast, samples from the last glacial maximum give a $^{187}Os/^{186}Os$ ratio of 7.91 ± 0.11, indicating a shift of 0.64 ± 0.25.

Discussion

If cleaned foraminifera faithfully preserve the chemical composition of seawater then the data presented here suggest that there are significant variations in both Os and Nd isotopes on glacial-interglacial timescales, that cannot be resolved in the Sr isotope record (Henderson *et al.*, 1994). The shift in Os isotopes is comparable to that seen in metalliferous sediments at the East Pacific Rise (Oxburgh, 1997) and sediments from the Santa Barbara basin (Williams and Turekian, 1997). For both Os and Nd the sense of change is consistent with

reduced continental input, characterised by less radiogenic Nd and more radiogenic Os, during glacial intervals. Finally, the Os isotopic composition for all samples, both glacial and interglacial, is no higher than that of modern seawater (Sharma *et al.*, 1997) which suggests that riverine input from the Himalaya-Tibet region has not been a major source of radiogenic Os over the last 150 ka.

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