High resolution Hf isotope stratigraphy of ferromanganese crusts

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Early studies of ferromanganese nodules had lead to the conclusion that Hf isotopes might provide a good tracer for changes in hydrothermal activity in the oceans. However, ferromanganese nodules have been shown to be a poor indicator for sea water Hf because of their potentially complex growth history (Godfrey *et al.*, 1997). Hydrogenous ferromanganese crusts may preserve a better record of the sea water chemistry, since they grow by scavenging metal oxide directly from sea water (Burton *et al.*, 1997; Christensen *et al.*, 1997; Godfrey *et al.*, 1997). There exists a considerable variation in the isotopic composition of Hf extracted from the outermost layers of Fe-Mn crusts from within the same as well as different ocean basins, indicating a short residence time for Hf in the oceans relative to the global ocean mixing timescale (Godfrey *et al.*, 1997). Here we present the first high resolution and high precision Hf isotopic profiles for two Fe-Mn crusts dredged from central Pacific seamounts, CD29-2 and D11-1, in order to better understand the chemical evolution of Hf in central Pacific deep water and its implications to palaeoceanographic changes.

Both crusts display a considerable growth history that extends throughout much of the Cenozoic (Hein *et al.*, 1990; Ling *et al.*, 1997). A slab of each of the crusts was sampled with an average temporal resolution of $\leqslant$ 0.4 myr. The chemical separation and MC-ICPMS Hf isotopic measurements are similar to those of Godfrey *et al.* (1997), and the analytical precision ($2\sigma_M$) is typically 40 ppm or better.

In general, the outermost surface of CD29-2 exhibits Hf isotopic compositions similar to those reported by Godfrey *et al.* (1997) at ~+7 ε_{Hf}, deviations in 10^4 from the present day chondritic $^{176}Hf/^{177}Hf = 0.282772 \pm 29$ (Blichert-Toft and Albarède, 1997). However, Hf isotopic compositions exhibit significant and clearly resolvable variations of more than 3 ε_{Hf} units through time. The most unradiogenic Hf signal sampled by this crust occurs around 15 and 28 Ma (~ +5.5 ε_{Hf}), and shows a gradual increase in either direction with the most radiogenic Hf at ~22 Ma (~+8.5 ε_{Hf}). Preliminary data from D11-1 seem to correlate well with that of CD29-2, despite the separation of the two crusts by > 3000 km.

The overall Hf record of CD29-2 appears to be independent from the Pb and Nd records from the same crust (Christensen *et al.*, 1997; Ling *et al.*, 1997). Despite the poor resolution of the Nd record (Ling *et al.*, 1997), the lack of a parallel variation in Hf and Nd and a much more radiogenic Hf for a given Nd seem to strengthen the argument that Hf and Nd are decoupled during continental weathering, or that Hf isotope data may have preserved a record of hydrothermal activity through time. Alternatively, the decoupling between Hf and Nd may reflect differences in their residence times. Although Pb and Hf records display no general agreement, the most radiogenic Hf seems to coincide with the least radiogenic $^{206}Pb/^{204}Pb$ at ~22 Ma (Christensen *et al.*, 1997). The lack of a radiogenic Nd signal at the same time argues against a volcanic component being responsible for such a shift. Based on the available Hf isotope data, circum-Pacific volcanic arcs are also unlikely to be the dominant sources for such a shift. No apparent correlation is observed between the Hf isotope data and independent evidence of enhanced hydrothermal activity on the E.P.R. It is most likely that the variations are dominated by the vigour and pattern of ocean circulation within the Pacific. Further work should demonstrate to what extent Hf was introduced from other ocean basins during the Cenozoic, and to what extent the different behaviour of Hf, Nd and Pb is due to differences in residence time.

References

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