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Osmium isotope stratigraphy of a Ferromanganese crust from the Romanche Fracture Zone and implications for the radiogenic isotope evolution of the Atlantic Ocean

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The interpretation of changes in seawater isotope compositions recorded in hydrogenetic ferromanganese (Fe-Mn) crusts over time hinges on a reliable chronology. The ^{10}Be dating method is only reliable for the past 10 Myr. For older parts of the crusts the Co-constant flux method has been used. Both approaches, however, will fail to account for any growth hiatus or erosion in the sections older than 10 Ma. Attempts to use Sr isotope stratigraphy have failed due to post-depositional exchange with seawater.

In contrast, in the case of osmium (Os) isotopes, calculations of the rate of post-depositional exchange with seawater suggest that long-term records in Fe-Mn crusts are reliable. Comparison of the ^{187}Os/^{188}Os isotope records of crusts to the established seawater record for the last 80 Myr should thus allow the identification of changes in growth rate, cessation of growth and/or intervals of crust erosion. Bolz et al. (2004) demonstrated that this method is reliable for a hydrogenetic crust from the Central Pacific Ocean (CD29-2). To verify this method we analysed a crust from the Romanche Fracture Zone in the central Atlantic Ocean (ROM46). The crust has a thickness of 8.5cm and was previously dated in the younger part applying ^{10}Be/^{9}Be and yielded decreasing growth rates between 7.5 mm/Ma and 1.35 mm/Myr. Combination with results of the Co-constant flux method in the older part of the crust yielded a total total

age of 33Ma at the base of the crust (Frank et al., 2003).

Samples for Os isotope analyses were taken every 2mm for the first 13mm of the crust and every 8mm below. For each sample the $^{187}Os/^{188}Os$ ratio and the ^{187}Os concentration ([^{187}Os]) were determined by ID-NTIMS. The [Re] was measured by MC-ICPMS, allowing correction for decay of ^{187} Re. The corrected $^{187}Os/^{188}Os$ ratios were compared to the established seawater record. The results of the Os isotope stratigraphy and the Be isotope-based chronology in the upper part of the crust agree very well. For the lower part of the crust the osmium isotope record was matched to the osmium seawater curve by increasing the growth rate from 7.2mm/Myr to 9mm/Myr starting below a depth of 13mm towards the base of the crust. The crust thus has an age of about 15Ma at the base, and not as previously thought, 33Ma. This requires reinterpretation of the radiogenic isotope data published by Frank et al. (2003).

Hydrogenetic crust ROM46 from the Atlantic Ocean, as well as two other hydrogenous crusts from the Central Pacific, show a previously not identified, but pronounced $^{187}Os/^{188}Os$ minimum between 13 and 11 Ma. This signal may have been caused by a process such as an increase in flood basalt, island arc or ophiolite weathering or a decrease in continental weathering, which was significant enough to change the global osmium isotope composition of seawater.

Bolz et al (2004); Osmium Isotope Stratigraphy of Marine Ferromanganese Crusts Eos Trans. AGU, 85 (47), Fall Meet.Suppl., Abstract PP33A-0912

Frank et al (2003); Evolution fo deepwater mixing and weathering inputs in the central Atlantic Ocean over the past 33Myr; Paleoceanography, Vol.18; 1091