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The Response of Os Isotope in a Ferromanganese Crust from the West Pacific to Paleaoceanographic Events

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ABSTRACT

This paper researches the ferromanganese crust MHD79 from bottom to top 20 Os isotope data from the Central Pacific. The results showed that: in the Ferromanganese crust MHD79, each $^{187}Os/^{188}Os$ value low point corresponds to the Os content high point, and corresponds to a large-scale volcanic (magmatic) activity or meteorite impact event. In the early three stages of the ferromanganese crust MHD79, Os content gradually increased with the decreasing of $^{187}Os/^{188}Os$, which demonstrates that Os content correlated with $^{187}Os/^{188}Os$ negatively during this period; in the stages IV and V, the Os contents still correlated negatively with the $^{187}Os/^{188}Os$, but the 187Os/188Os value increased gradually; in the stage VI, the Os contents increased and correlated positively with the $^{187}Os/^{188}Os$. The evolution of Os contents and $^{187}Os/^{188}Os$ in the ferromanganese crust MHD79 suggested that, mantle and extraterrestrial material were the main contributors to the Os in the ocean relative to terrestrial material from late Cretaceous to Paleocene; Thereafter, the terrestrial material input increased gradually; after Oligocene, the terrestrial material input increased rapidly and became the main contributor for the Os in the ocean.

KEY WORDS: ferromanganese crust; Os isotope; the West Pacific; paleaoceanographic events

INTRODUCTION

The ferromanganese oxides in marine sediments have recorded the seawater Os isotope composition when they were deposited. Therefore, sediments containing ferromanganese oxides, e.g. carbonates, metaliferous siliceous ooze, ocean clay, ferromanganese crust and ferromanganese nodules, may all be used in the research of seawater Os isotope composition evolution (Burton et al., 1999; Martin et al., 2001; Alves et al., 2002; McDaniel et al., 2004; Williams and Turekian, 2004; Dalai et al., 2005; Klemm et al., 2005; Fu et al., 2005; Paquay et al., 2008; Meng et al., 2008). Sharma et al. (1997) determined that the lower limit of Os residence time in the ocean can be 4.4×10^4a. The Os in seawater has four dominant sources: (1) the continental crust from which Os is supplied to the ocean by riverine processes, $^{187}Os/^{188}Os$ ratio of this source is high ($^{187}Os/^{188}Os = 1.2\text{-}1.8$); (2) eolian dust ($^{187}Os/^{188}Os \sim 1.08$); (3) the mantle from which Os is released via hydrothermal activity or low temperature alteration, the $^{187}Os/^{188}Os$ ratio of which is mainly unradiogenic Os ($^{187}Os/^{188}Os \sim 0.12\text{-}0.13$); (4) cosmic dust and meteorites ($^{187}Os/^{188}Os \sim 0.12\text{-}0.13$) (Klemm, 2006). The Os isotope composition in seawater are constrained mainly by the weathering rates of the continent substance, the glacial-interglacial variations of the sedentary product source areas, the rates of water-rock reaction in seabed and the variation of the cosmic dust input flux (Ravizza et al., 1999). The osmium isotope system in seawater could provide the relative variation record of Os input flux from these source areas along with the time because the osmium isotope in seawater can reflect the balanced inputs of osmium from various source areas. The exchange rate of Os is very low after its deposition into ferromanganese crust. The Os diffusion coefficient can be calculated by the formula of Henderson and Burton (Henderson and Burton, 1999) as low as being 3×10^{-8} cm^2/a. Therefore, the influence of the diffusion to the Os isotope can be neglected after the Ferromanganese crust has deposited. Because the ferromanganese crusts formed during a rather long period, and the oldest layers in some crusts formed about 70 Ma (Klemm et al., 2005; Ling et al., 1997; 2005), the Os isotope in ferromanganese crusts can reveal the long-term changes of paleaoenvironment and the evolution of crust-mantle interaction.

In order to obtain more accurate age frame and further to reveal the influence of marine environmental variation to the crust growth, a ferromanganese crust sample with enough thickness and clear layered structure is required for the analysis of Os isotope. We select a Ferromanganese crust sample with multi-layered structure, which was collected from the Central Pacific MH seamount during the DY105-15 cruise and numbered MHD79.This crust is 9.7 cm thick, and platy, and can be divided into 6 layers from bottom to surface: Layer I is a dense layer, showing layered and columnar microscopic structures; layer II is a sub-dense layer, with palmate and stromatolithic microscopic structures; layer III is the lower loose layer, intercalated with plenty of grey-white and yellow-white lumps and stringer veins, and dominated by the taxitic microscopic structure; layer IV is the upper loose layer, having yellow-white stringer veins, and the microscopic structures are palmate, dendritic and taxitic; layer V is a sub-dense layer, and dominated by columnar and palmate microscopic structures; layer VI is a dense layer, dominated by columnar and layered microscopic