Os isotope record of seawater over the past 500 ky: Implication for variations in intensity of silicate weathering

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It is well known that silicate weathering controls long-term global climate through consumption of atmospheric CO2. Recently, it has been also pointed out that the atmospheric CO2 consumption by silicate weathering was linked to even shorter-term variations such as glacial-interglacial cycles, although still controversial (some researchers have proposed that weathering intensity decreased during the glacial periods (Munhoven and Francois, 1996), while others have proposed vice versa (Ludwig et al., 1999)). The Os isotopic composition of seawater is very useful to monitor the intensity of silicate weathering because of the following reasons; (1) dominant influxes into oceans (radiogenic continental crustal detritus and unradiogenic mantle-like materials derived from oceanic crust and meteorites) have striking differences in 187Os/188Os ratios (˜1.4 vs. ˜0.13), (2) the residence time of Os in the ocean is enough short (˜104 yr) to capture short-term (104-105 yrs) fluctuations of these influxes. During the Cenozoic, because the influxes from mantle and cosmic dust were likely constant, the marine Os isotopic composition is considered to have been determined by the intensity of silicate weathering. In our study, we reconstruct the marine Os isotopic composition over the past 500 ky from the metalliferous carbonates of the ODP Site 834 in the Lau Basin.

Fe2O3∗and MnO contents of the study sediments show positive correlations with P2O5, V, Co, Ni, Cu, Zn, Y, REEs, and Os. PAAS-normalized REE patterns exhibit large negative Ce anomalies. These geochemical signatures indicate a significant contribution of hydrothermal Fe-Mn precipitates scavenging these elements from ambient seawater. Seawater-derived Os in our samples is estimated to be greater than 98%. The marine 187Os/188Os ratios are from 0.824 to 0.991. There is no distinct difference in 187Os/188Os ratios between glacial and interglacial periods. The 187Os/188Os ratios of the LGM (Last Glacial Maximum) and MIS 6 (Marine Isotope Stage) periods obtained from the present study agree with those of the previous studies (Oxburgh, 1998; Williams and Turekian, 2004). However, as to the periods between them (from 34 ka to 101 ka), the ratios (0.914-0.943) are significantly lower than those reported by Oxburgh (˜1.02). Based on box model calculations, we estimate that the riverine Os flux at LGM was ˜40 % of the present riverine Os flux. This decrease in riverine Os flux may have been caused by the decrease in riverine water flux due to cold and arid climate at LGM.