Os isotope record of the Quaternary seawater derived from pelagic sediment in the Lau Basin, western South Pacific Ocean, and its implications for global climate changes

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Silicate weathering on land has been considered to play an important role in controlling global climate change through the consumption of atmospheric CO_2 on long timescales (>10^6 yr). This process has been working as a negative feedback mechanism, which has prevented the Earth system from runaway warming or cooling. However, whether this system works on even shorter-term global climate changes on the timescale of 10^4–10^5 yr such as Quaternary glacial-interglacial cycles is still controversial. In order to constrain the response time of the solid earth to global climate change, we employed the marine Os isotopic ratios ($^{187}Os/^{188}Os$) as a proxy of continental weathering. The marine Os isotopic ratio reflects the relative intensity of two dominant influxes to the ocean; radiogenic continental-derived materials ($^{187}Os/^{188}Os$ = 1.0–1.4) and unradiogenic mantle-like materials (i.e. hydrothermal fluids and cosmic dust) ($^{187}Os/^{188}Os$ = ~0.12). Owing to the contrasting $^{187}Os/^{188}Os$ values between these two influxes, and short residence time of Os in the ocean (~10^4 yr), the variability in $^{187}Os/^{188}Os$ of seawater constitutes a sensitive tracer for mantle and continental input into the marine environment. By assuming that the fluxes of mantle-derived materials into the ocean were constant during the Quaternary, we can obtain the fluctuation in the intensity of continental silicate weathering on glacial-interglacial timescales from the marine Os isotope record. Here, we report the marine Os isotopic variations during the glacial-interglacial cycles derived from the pelagic sediment in the Lau Basin, western South Pacific Ocean. In the present work, we targeted metalliferous carbonate as the most suitable media preserving marine Os isotope records at the timing of deposition. This sediment is enriched in hydrothermal Fe-oxyhydroxides that absorb Os in seawater efficiently and deposits rapidly without significant contamination of detrital materials from continents. As the result, we observed a clear fluctuation of the marine $^{187}Os/^{188}Os$ value along with the glacial–interglacial cycles. Based on the marine $^{187}Os/^{188}Os$ record, we also present the fluctuation of riverine Os flux calculated by simple 1-box mass-balance modeling, and its implications for the Quaternary climate change.

Keywords: Glacial–interglacial cycle, Global warming, Osmium isotopic ratio, Carbon cycle, Hydrothermal sediment

