Feedback mechanism of solid earth system on glacial-interglacial climate cycles: Constraints from osmium isotopic mass-balance in the ocean

*Yusuke Kuwahara[1], Kazutaka Yasukawa[2,1,3], Koichiro Fujinaga[3,2], Tatsuo Nozaki[4,2,5,3], Junichiro Ohta[2,3,6], Honami Sato[3,4], Jun-Ichi Kimura[6], Kentaro Nakamura[1], Yasuhiro Kato[2,1,3,4]

1. Department of Systems Innovation, School of Engineering, The University of Tokyo, 2. Frontier Research Center for Energy and Resources, School of Engineering, The University of Tokyo, 3. Ocean Resources Research Center for Next Generation, Chiba Institute of Technology, 4. Submarine Resources Research Center, Japan Agency for Marine-Earth Science and Technology, 5. Department of Planetology, Graduate School of Science, Kobe University, 6. Volcanos and Earth's Interior Research Center, Research Institute for Marine Geodynamics, Japan Agency for Marine-Earth Science and Technology

Solid earth has affected and responded to changes in the global carbon cycle and climate. Volcanic degassing of carbon dioxide (CO_2) and silicate chemical weathering consuming atmospheric CO_2 are believed to have regulated the carbon budget of Earth's surface system on a geologic timescale (>10^6 yr). However, characteristics of the solid earth response against shorter (<10^5 yr) fluctuations such as the Quaternary glacial-interglacial cycles, are still controversial. In order to constrain the response of the solid earth to glacial-interglacial climate changes, we employed the marine Os isotopic ratios ($^{187}Os/^{188}Os$) as a proxy of solid earth response. The marine Os isotopic ratio reflects the relative intensity of two dominant influxes to the ocean: radiogenic continental 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 can constitute a sensitive tracer for mantle and continental inputs into the marine environment on a glacial-interglacial timescale. Here we show a high-resolution record of the marine osmium isotopic composition ($^{187}Os/^{188}Os$) as a proxy of solid earth's response during the past 300,000 years. We demonstrate that the seawater $^{187}Os/^{188}Os$ has varied associating with glacial-interglacial cycles. Based on a marine Os isotopic mass-balance simulation, the observed $^{187}Os/^{188}Os$ fluctuation cannot solely be explained by the change of global chemical weathering rate synchronized with glacial-interglacial climate changes. Instead, the fluctuation can be reproduced by a combination of two short-term processes: (1) inputs of radiogenic Os derived from the intense weathering of glacial-till during deglaciation, and (2) inputs of unradiogenic Os derived from enhanced seafloor hydrothermalism during glacials. Our results constitute the first evidence that the solid earth system involving chemical weathering of glacial-till and seafloor magmatism systematically and repetitively responded to the glacial-interglacial cycles on <10^5 yr timescales.

Keywords: Glacial-Interglacial cycles, Seawater Osmium isotopic ratio, Carbon cycle

