Re-Os isotope and highly siderophile element constraints on the origin of ancient depleted domains in the modern convecting mantle

AKIRA ISHIKAWA[1,2]*, RYOKO SENDA[2], KENICHIRO TANI[3], KATSUHIKO SUZUKI[2] AND TERUAKI ISHII[4]

[1] The University of Tokyo, Tokyo 153-8902, Japan (*correspondence : akr@ea.c.u-tokyo.ac.jp)
[2] Japan Agency for Marine-Earth Science and Technology, Yokosuka 237-0061
[3] National Museum of Nature and Science, Tsukuba 305-0005
[4] Fukada Geological Institute, Tokyo 113-0021

Recent accumulation of Os isotope data obtained either from abyssal peridotites or from ocean island peridotite xenoliths has clearly demonstrated that the modern convecting mantle is substantially heterogeneous. Unlike other radiogenic isotope systematics in oceanic basalts, largely controlled by incorporation of recycled crustal materials, the observed range of Os isotope compositions in oceanic peridotites likely reflect varying degrees of ancient melt extraction from peridotitic mantle. However, the nature and timing of this melt extraction still remain elusive.

We examined the $^{187}Os/^{188}Os$ ratios and highly siderophile element (HSE: Os, Ir, Ru, Pt, Pd, Re) concentrations in peridotite-serpentinite recovered from the Pacific area (Hess Deep in the East Pacific Rise, Taitao ophiolite in Chile, Izu-Ogasawara and Tonga forearc, peridotite xenoliths from Hawaii and Malaita) because the number of data available is yet scarce when compared with data from other oceans (Atlantic, Arctic and Indian Ocean). Our primary purpose is to test whether mantle regions underlying four major oceans are distinct in terms of Os isotope variations, reflecting the pattern of mantle convection or mixing efficiency. The results demonstrate that samples from each area display very similar Os-isotope variations with a pronounced peak in $^{187}Os/^{188}Os$ =0.125-0.128. The relatively larger datasets obtained from Hess Deep, Taitao, Hawaii and Malaita clearly exhibit the presence of secondary peak in $^{187}Os/^{188}Os$ =0.114-0.120 (Re-depletion ages 1-2 Ga). These characteristics are almost identical to the global population mainly comprised of data from other oceans. The most unradiogenic $^{187}Os/^{188}Os$ samples in the global population tend to be restricted in harzburgites (Al_2O_3 <2 wt%) with low-Pd/Ir ratios (<1.0), suggesting that a common melt extraction process created highly depleted residues in Proterozoic. These residual harzburigtes were transported into deep mantle, and are now homogeneously distributed over large scales as ancient depleted domains in the modern convecting mantle.