Assessments of the effects by mass-dependent fractionation for ^{142}Nd compositions in Archean rocks

R. FUKAI[1,2,3*], H. ASANUMA[2], T. KOMIYA[2], T. YOKOYAMA[3], T. HIRATA[2]

[1] Japan Aerospace Exploration Agency, [2] The University of Tokyo, [3] Tokyo Institute of Technology
(*correspondence: fukai.ryohta@jaxa.jp)

The ^{146}Sm–^{142}Nd radioisotope system ($T_{1/2}$ = 103 Myr) provides important constraints on the early differentiation of silicate Earth. Archean rocks with ages between 4.0–3.5 Ga show both positive and negative μ^{142}Nd values compared to modern terrestrial rocks [e.g., 1]. Although the variation is interpreted to reflect early Sm-Nd fractionation before the extinction of ^{146}Sm, there are some possibilities that can shift the μ^{142}Nd values including mass-independent fractionation (MIF) during chemical separation and an inappropriate correction of mass-dependent fractionation (MDF) with the exponential law (kinetic processes) for samples that experienced natural MDF with equilibrium processes [2].

To further investigate this issue, we measured Nd isotope ratios in two adamellites and six basalts from the North Pole Dome (NPD) area in Pilbara craton, Australia. In contrast to the previous study [3], some of the rock samples displayed negative μ^{142}Nd values when normalized to the standard (JNdi-1) with instrumental MDF correction using the exponential law. Additionally, these samples showed non-zero μ^{148}Nd and μ^{150}Nd values. The Nd isotopic patterns negate the cases for MIF during chemical separation and nucleosynthetic isotopic anomalies. Rather, the observed μ^{148}Nd and μ^{150}Nd anomalies are apparent ones that likely resulted from the MDF correction by the exponential law for samples that experienced natural MDF with equilibrium processes. The magnitude of natural Nd isotopic fractionation in the NPD basalts was not linearly correlated with the Th/Yb ratio and Zr contents, indicating that the fractionation process has no association with the fractional crystallization process. After the correction, μ^{142}Nd values for NPD rocks are indistinguishable to the standard.

References: [1] Rizo et al. (2012) *Nature*. [2] Saji et al. (2016) *JAAS*. [3] Archer et al. (2019) *EPSL*.