Molybdenum isotopic composition of ca. 2.45-Gyr-old sandstones from the Huronian Supergroup, Canada

KOSUKE T GOTO1, GEN SHIMODA1, YUMIKO HARIGANE1 AND EIICHI TAJIKA2

1Geological Survey of Japan, AIST
2The University of Tokyo

Presenting Author: k.goto@aist.go.jp

A major change in the oxidation state of the atmosphere, called the Great Oxidation Event, occurred sometime between 2.4 and 2.1 Ga (Lyons et al., 2014 Nature 506, 307-315). However, accumulation of free oxygen before this period is often documented. A recent multiple sulfur isotope record suggests trace amount of O2 (> 10^-5 PAL) in the atmosphere before the first Paleoproterozoic glaciation at ~2.43 Ga (Warke et al., 2020 PNAS 117, 13314-13320). In contrast to this finding, molybdenum isotopic compositions (δ98/95Mo) of glacial diamictites suggest a reducing atmosphere during the first Paleoproterozoic glaciation (Greaney et al., 2020 EPSL 534, 116083).

To better understand the oxidation state of the atmosphere-ocean system before the GOE, we investigate the nature of weathering at ~2.45 Ga by analyzing δ98/95Mo of sandstones collected from the Matinenda Formation in the Huronian Supergroup, Canada. The Matinenda Formation formed in shallow braided channels and contains one of the largest placer uranium deposits (Fralick & Miall, 1989 Sediment. Geol. 63 127-153). The analyzed samples are also frequently enriched in U (up to ~80 ppm) due to the presence of U-bearing detrital minerals. The δ98/95Mo values of the samples range from 0.01 to 0.24 permil (avg. +0.10 +/- 0.16 permil) and are comparable to the average Archean upper continental crust δ98/95Mo (+0.03 +/- 0.18‰) estimated from Archean and early Paleoproterozoic glacial diamictites (Greaney et al., 2020 EPSL). The observed little δ98/95Mo variations suggest that there was limited oxidative weathering and authigenic Mo enrichment during the transport and deposition of Matinenda sandstone. Combined with the recent sulfur isotope record, the new δ98/95Mo data imply oscillations of atmospheric oxygen across 10^-5 PAL before the GOE. Alternatively, a high atmospheric O2 level (>10^-5 PAL) is required to cause large δ98/95Mo variations in fluvial deposits.