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

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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 O_2 (> 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 ($\delta^{98/95}$Mo) 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 $\delta^{98/95}$Mo 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 $\delta^{98/95}$Mo 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 $\delta^{98/95}$Mo (+0.03 +/- 0.18‰) estimated from Archean and early Paleoproterozoic glacial diamictites (Greaney et al., 2020 *EPSL*). The observed little $\delta^{98/95}$Mo 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 $\delta^{98/95}$Mo data imply oscillations of atmospheric oxygen across 10^{-5} PAL before the GOE. Alternatively, a high atmospheric O_2 level (>10^{-5} PAL) is required to cause large $\delta^{98/95}$Mo variations in fluvial deposits.