Intensification of Antarctic chemical silicate weathering during the EOT revealed by Mg and Li isotopes

*Adam David Sproson[1,2], Toshihiro Yoshimura[2], Takahiro Aze[1], Yusuke Yokoyama[1,2], Naohiko Ohkouchi[2], Tsuyoshi Ishikawa[3], Shigeyuki Wakaki[3]

1. Atmosphere and Ocean Research Institute, The University of Tokyo, 2. Department of Biogeochemistry, Japan Agency for Marine-Earth Science and Technology, 3. Kochi Institute for Core Sample Research, Japan Agency for Marine-Earth Science and Technology

Future warming beyond 2°C could lead to the crossing of a threshold beyond which positive feedbacks within the Earth System, such as permafrost thawing, increased bacterial respiration and forest dieback, would create a “Hothouse Earth” [1]. Understanding the interplay of feedback mechanisms is therefore of utmost importance to predicting future climate change. On million-year timescales, the hydrolysis of silicate minerals and subsequent precipitation of carbonate minerals in the ocean acts as a negative feedback within the carbon-cycle [2]. On shorter, more relevant, timescales, the production of fine-grained material and associated subglacial chemical weathering during expansion and contraction of glaciers may influence atm. CO_2 and temperature [3].

The Eocene-Oligocene Transition (EOT; ca. 34 Ma) marks the sudden appearance of ice sheets on Antarctica which caused a surge in erosion recorded by Nd isotopes, Pb isotopes and clay mineralogy [4, 5]. However, the response of chemical silicate weathering is not well understood. Here, we present Mg and Li isotope data for the authigenic and detrital phases of marine sediments from ODP Site 738 on the Kerguelen Plateau. Magnesium and Li isotopes fractionate significantly during chemical weathering [6, 7] and the δ^{26}Mg and δ^{7}Li records of the authigenic and silicate phases from Site 738 reveal a dramatic intensification of silicate weathering across the EOT, displaying similar variation to previous Pb and Nd isotope records [4, 5]. This intensification is well correlated to oxygen isotopes suggesting continental ice sheet expansion over Antarctica led to increased silicate weathering, atm. CO_2 drawdown and further cooling. Such feedbacks may help reverse future warming as ice sheets begin to retreat.

[1] Steffen et al. (2018) *PNAS* **115**, 8252-8259. [2] Berner (2006) *GCA* **70**, 5653-5664. [3] Kump & Alley (1994) 46-60. [4] Basak & Martin (2013) *Nature Geoscience* **6**, 121-124. [5] Scher et al. (2011) *Geology* **39**, 383-386. [6] Wimpenny et al. (2011) *EPSL* **304**, 260-269. [7] Huh et al. (1998) *GCA* **62**, 2039-2051.

Keywords: Magnesium, Lithium, Eocene-Oligocene Transition, Silicate Weathering, Antarctica

