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A novel application of Mg and Li isotopes reveals a link between erosion, chemical weathering, and atmospheric CO_2 during the expansion of Antarctica's ice sheets (ca. 34 Ma)

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Future warming beyond 2˚C could lead to the crossing of a threshold beyond which, positive feedbacks within the Earth System could 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 timescales, the production of fine-grained material and associated chemical weathering during expansion and contraction of glaciers may influence global atmospheric CO_2 and temperature [3].

The Eocene-Oligocene Transition (EOT; ~34 Ma) marks the appearance of continental-scale Antarctic ice sheets, associated with a large surge in physical weathering as recorded by Nd isotopes, Pb isotopes, and clay mineralogy [4, 5]. However, the response of chemical silicate weathering to this dramatic erosion event is not well understood. Here, we present magnesium isotope ($\delta^{26}Mg$), lithium isotope ($\delta^{7}Li$), rare-earth element (REE), and major element measurements for the authigenic (Fe-Mn-oxides) and detrital (silicate) phases of marine sediments from ODP Site 738 off the coast of East Antarctica (Kerguelen Plateau).

The $\delta^{26}Mg$ and $\delta^{7}Li$ records of the authigenic and detrital phases from Site 738 display a large fractionation during the EOT, like previous Pb and Nd isotope records. This fractionation could be due to many processes: (1) increase in weathering intensity; (2) lower clay formation; (3) carbonate weathering; (4) grain size variation. Since last year's meeting [6], we have conducted further Mg and Li isotope measurement of the decarbonated authigenic and detrital fine (<63μm) fraction to distinguish between these processes. Overall, our new data sets may suggest continental ice sheet expansion over Antarctica led to increased silicate weathering, atmospheric 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] Vance et al. (2009) *Nature* **458**, 493-496. [4] Basak & Martin (2013) *Nat. Geosci.* **6**, 121-124. [5] Scher et al. (2011) *Geology* **39**, 383-386. [6] Sproson et al. (2021) Goldschmidt Virtual, 4-9 July.