Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.17186

The impact of Antarctic ice sheet expansion (ca. 34 Ma) on silicate weathering, erosion and the carbon cycle: insights from Li and Mg isotopes

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Understanding the interplay between feedback mechanisms within the Earth system is key to predicting future climate change [1]. On million-year timescales, the hydrolysis of silicate minerals and subsequent precipitation of carbonate minerals in the ocean acts as a negative feedback on global climate [2]. On shorter timescales, the production of fine-grained material and associated chemical weathering during expansion and contraction of glaciers may influence ocean chemistry, atmospheric CO_2, and global temperatures [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 (δ^{26}Mg), lithium isotope (δ^{7}Li), rare-earth element (REE), and major element measurements for the carbonate, Fe-Mn-oxide and detrital (bulk and fine) phases of marine sediments from ODP Site 738 off the coast of East Antarctica (Kerguelen Plateau).

The δ^{26}Mg and δ^{7}Li records of all extracted phases from Site 738 display a large isotopic shift during the EOT, often correlated with previous Pb and Nd isotope excursions, possibly related to the following processes: (1) silicate weathering intensity; (2) clay formation; (3) carbonate weathering; (4) carbonate/dolomite precipitation. Overall, our new data sets suggest continental ice sheet expansion over Antarctica led to more efficient silicate weathering and increased carbonate weathering which would have influenced ocean chemistry, atmospheric CO_2, and global temperatures. Such feedbacks are likely to be active 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.