Deglaciation of the Cryogenian glaciations: Intense silicate weathering and large element fluxes in the oceans

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The Cryogenian marks an important period in Earth's history, with large-scale climatic change characterized by global glaciations and the emergence of metazoan organisms. The cap carbonates from South Australia and China deposited at the end of the Marinoan and Sturtian glaciations are potentially critical archives for understanding environmental change throughout the Neoproterozoic. The deglaciation during the aftermath of such large glacial events unquestionably impacted the chemistry of ocean, which could have contributed to the evolution of metazoan organisms.

Here we use lithium isotopes (δ^7Li) as a proxy for silicate weathering as they fractionate during clay-water interaction. The δ^7Li values in cap carbonates are used to understand the environmental changes and riverine fluxes into the ocean during the aftermath of both global glaciations. The duration of deglaciation is not well constrained, but we propose that a phase of intense silicate weathering during deglaciation may have caused a large flux of continentally derived elements to the ocean via rivers. A box model approach for the oceanic Li cycle is used to investigate the riverine flux of Li to the ocean. Our model suggests that this flux of Li, and by inference nutrients, may have been significantly larger than the modern-day, resulting in the possible oversaturation of the ocean with nutrients potentially leading to the evolution of complex life. After such oversaturation, our model suggests a rapid recovery of the ocean and continents from glaciation back to pre-glacial environmental conditions.