# Understanding the Hirnantian: evidence from lithium isotopes and carbon cycle models

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The end-Ordovician Hirnantian interval (~445Ma) represents one of the largest mass extinctions in Earth history, and coincides with low temperatures, a major glaciation, and a significant drop in sealevel. Analogies have therefore been drawn with Plio-Pleistocene glaciations. Cooling was likely driven by either suppressed atmospheric $CO_2$ input, or by enhanced $CO_2$ drawdown via weathering. Recovery may then also have been caused by a temperature-driven decline in $CO_2$ removal by silicate weathering. As such, this time interval may represent a natural laboratory for studying the operation and timing of the Earth's weathering thermostat.

Lithium isotopes are a relatively novel tracer of continental weathering, but one which circumvents the lithology- or biology-based ambiguities that other tracers suffer. During weathering, Li isotopes are fractionated by the silicate weathering congruency.

We have determined Li isotope ratios through multiple marine carbonate sections from Anticosti Island in Canada and through a shale section at Dob's Linn in the UK. The sections show an increase in $\delta^7$Li, reaching its peak slightly earlier than the peak in the C isotope excursion caused by the glaciation, suggestive of a reduction in silicate weathering driven by a cooling climate.

We have further developed a dynamic coupled carbon cycle model, to determine changes in the carbon cycle that could have caused the glaciation and observed Li isotope changes. This suggests that declining $CO_2$ degassing initiated cooling, which led to decreased weathering, and eventually allowed $CO_2$ levels to recover, terminating the glaciation.