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Did atmospheric carbon dioxide decline due to the evolution of trees in the Late Paleozoic as suggested by Carbon Cycle Models?

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The hypothesized decline in atmospheric carbon dioxide (pCO_2) during the Late Paleozoic Era (~420–300 million years ago) remains unresolved, despite predictions from seminal geologic models like GEOCARB [1]. These models attribute the pCO_2 drawdown to biological innovations, particularly the evolution of deep-rooted trees that enhanced silicate weathering. However, empirical evidence for this decline remains contentious. While some paleosol carbonate proxies [2] support a stepwise decrease in pCO_2, others do not [3]. Moreover, recent modeling studies [4] challenge this hypothesis, citing carbon budget mass balance constraints.

To resolve this debate, we propose an alternative approach. We aim to reconstruct terrestrial silicate weathering through this period by analyzing a high-quality proxy of chemical weathering, i.e. Lithium isotopes (δ^7Li) preserved in brachiopods, at a high stratigraphic resolution. If a decline in pCO_2 occurred during the Late Paleozoic due to enhanced soil formation (as suggested by the GEOCARB model), it should correspond to a significant increase in terrestrial chemical weathering observable in the rock record. Ultimately, this reconstruction will allow us to determine whether the hypothesized pCO_2 model(s) such as GEOCARB, that base pCO_2 drawdown during this period on enhanced chemical weathering, need reevaluation (no change or depletion in δ^7Li over this record) or if plant root evolution did result in enhanced rates of silicate weathering, resulting in lower pCO_2 during the Late Paleozoic (enriched δ^7Li over this record).

This research is crucial in understanding the geological carbon cycle during the Late Paleozoic, as it is thought to represent a state-shift in pCO_2, from a world of elevated pCO_2 to the relatively low pCO_2 realm we inhabit today. This work sheds light on the hypothesized role of large organisms (trees with deep roots) in shaping the Earth's physical structure (atmospheric composition), during its past.

References:

[1] Berner (1992), *Geochimica et Cosmochimica Acta 56*, 3225-3231.

[2] Mora, Driese, and Colarusso (1996), *Science 271*, 1105–1107.

[3] Witkowski, Weijers, Blais, Schouten, and Sinninghe (2018), *Science Advances 4*, 4556-4556.

[4] D'Antonio, Ibarra and Boyce (2020), *Geology 48*, 29–33.