

Lithium isotope evidence for a plumeworld ocean in the aftermath of a Cryogenian Snowball Earth

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The termination of the Cryogenian Marinoan snowball Earth at ~635 Ma was followed by the global deposition of the basal Ediacaran cap dolostone [1]. It has been hypothesized that the cap dolostone was deposited from a plume of glacial meltwaters that overlaid saline marine waters and persisted for 10,000–100,000 years [2]. Here we test this hypothesis using lithium isotope data, taking advantage of the expected difference in $\delta^7\text{Li}$ between meltwaters and seawaters. Our data from the basal Ediacaran cap dolostone of the Doushantuo Formation in South China show a prominent gradient from platform facies (average of $\delta^7\text{Li}$: +14.3‰, n=3) to slope facies (average of $\delta^7\text{Li}$ down to 0.3‰, n=4), drastically different from the homogenous $\delta^7\text{Li}$ of the modern ocean. We assessed the possibility of clay mineral contamination and found that the $\delta^7\text{Li}$ gradient is unlikely an artifact of differential clay mineral contamination. Instead, our data are best explained using a two-endmember mixing model: a fresh water endmember with a $\delta^7\text{Li}$ value of modern river (23‰), and a seawater endmember with a $\delta^7\text{Li}$ value of ~12–13‰. The seawater endmember is distinct from modern seawaters, because of synglacial distillation over ~7–10 million years with very little riverine Li influx and a Li outflux with a reduced isotopic fractionation due to strong reverse weathering during the Marinoan snowball Earth. Therefore, the $\delta^7\text{Li}$ data from the Doushantuo cap dolostone are consistent with the plumeworld hypothesis that a persistent lens of glacial meltwaters sat above seawaters that aged during millions of years of global glaciation that approached a hard Snowball Earth.

1. Hoffman, P.F. and Z.-X. Li, *A palaeogeographic context for Neoproterozoic glaciation*. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 2009. **277**(3): p. 158–172.
2. Shields, G.A., *Neoproterozoic cap carbonates: a critical appraisal of existing models and the plumeworld hypothesis*. *Terra Nova*, 2005. **17**(4): p. 299–310.