Calcium isotope constraints on the terminal Ediacaran rise of calcified animals

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The rise of calcified animals during the terminal Ediacaran Period is one of the most exciting moments in the history of life on Earth. The cause(s) of this evolutionary event remains a mystery. Recent studies suggest that the rise of macrobiota biomineralization was environmentally triggered by changes in marine calcium chemistry in the terminal Ediacaran ocean [1, 2]. However, direct geochemical evidence for changes in global marine Ca cycle is lacking.

The Ca isotopic composition ($\delta^{44/42}$Ca) of seawater provides a potential pathway for the reconstruction of the global Ca cycle over this critical time. Here, we provide the first high-resolution $\delta^{44/42}$Ca record from marine carbonates from the terminal Ediacaran Dengying Formation (551–541 Ma) in South China. Our data reveal a large negative shift in $\delta^{44/42}$Ca (~0.45‰) in the lower Dengying, reaching a minima in the middle Dengying. This negative shift was followed by a positive shift of ~0.3‰ in the middle-upper Dengying Formation. If this negative shift in $\delta^{44/42}$Ca represents primary seawater signal, then it is highly likely that there was a significant increase in seawater Ca concentration in the terminal Ediacaran ocean, thus providing the first direct geochemical evidence that links the global marine Ca cycle and the rise of calcified animals. However, the $\delta^{44/42}$Ca signal of carbonate rocks is influenced not only by the $\delta^{44/42}$Ca of seawater but also by diagenetic processes and fractionation associated with carbonate precipitation [3]. Modeling of the Ca isotope cycle can help to evaluate the extent to which our observed $\delta^{44/42}$Ca shifts reflect secular variations in global marine Ca cycle in the terminal Ediacaran ocean.

[1] Wood et al. (2017) Proc. R. Soc. B 284, 20170059. [2] Wood et al. (2017) Geology 45(1), 27–30. [3] Lau et al. (2017) Chem. Geol. 471, 13–37.