A novel stable cadmium isotope record of the Great Oxygenation Event

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Studies of the modern marine biogeochemical cycling of the micronutrient cadmium have shown that stable Cd isotope fractionation is mainly driven by biological uptake of light Cd in surface waters [1]. A few geological records have emerged suggesting that Cd isotopes might be able to trace ancient bio-productivity [2, 3, 4]. Past marine productivity remains enigmatic, however, particularly during the Precambrian when oxygen and nutrient levels as well as ecosystems differed considerably. Here we investigate the geological record of the Turee Creek Group in the Hamersley Basin, Australia, which provides a continuous stratigraphic sedimentary section across the Great Oxygenation Event (GOE) and examine the changes in the biogeochemical cycling of Cd during the rise in atmospheric oxygen levels.

Stable Cd isotope data and concentrations were obtained on the Boolgeeda Iron Fm., siliciclastic and carbonate successions of Kungara (including the Meteorite Bore Member) and the Kazput Fm. The low Cd concentrations in BIFs indicate a nutrient-starved depositional environment, with higher content in the Kungarra and Kazputt Fm. associated with elevated major and trace elements diagnostic of enhanced detrital contribution. The $\varepsilon^{112/110}$Cd vary between +1.3 and -2, with negative values typically found in organic and Cd-rich shales and siltstones of the Kungarra and Kazput Fms. This new evidence for lithological control on Cd isotopes reveals three isotopically distinct pools, with a shift upward in the section, from an authigenic Cd isotopic signal preserved in the cherts and analogous to that of modern deep waters, to an increasing detrital imprint, consistent with enhanced oxidative weathering and organic matter burial. Although experimental Cd isotope studies under biogeochemical conditions relevant to the GOE ocean are desirable, our results put a first constraint on its Cd isotope signature which, by comparison to the modern cycling of Cd, suggests an overall long-term stability of Cd sources and sinks.

[1] Abouchami et al. (2011) EPSL 305, 83-91; [2] Abouchami et al. (2011) Goldschmidt abs.; [3] Hohl et al. (2016) GPL 3, doi: 10.7185/geochemlet.1704; [4] John et al. (2017) Palaeogeography, Palaeoclimatology, Palaeoecology, 466, 202–208.