Reconstructing atmospheric oxygen concentrations during the Neoproterozoic and Paleozoic

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Earth's atmosphere has undergone at least three stepwise oxygenation events during its 4.5 billion year history. While geochemical proxies and biogeochemical modelling can account for the timing and broad dynamics of the Great Oxidation Event [1] and the Paleozoic Oxygenation Event [2,3], the concentration of atmospheric oxygen throughout the Neoproterozoic, and the links to biosphere evolution, remain hotly debated [e.g. 4].

Here we extend the Phanerozoic biogeochemical model: GEOCARBSULFOR [3], to compute quantitative atmospheric oxygen levels through the Neoproterozoic. The model is a revision of Berner's GEOCARBSULF [5] and uses an isotope mass balance approach to reconstruct the operation of Earth's global carbon, sulphur and oxygen cycles with respect to known geological and biological information.

Using the carbon isotope record, alongside proxies for tectonic CO_2 input, continental growth, and paleogeography, we quantify the various mechanisms by which oxygen can be produced and consumed in an attempt to construct the first continuous history of atmospheric oxygen for the last ~800 million years. Finally, we explore links between our reconstruction for atmospheric oxygen, the oxygenation of the oceans, and the emergence of animals.

[1] Lyons *et al.* (2014) *Nature* **506**, 307-315. [2] Lenton *et al.* (2016) *PNAS* **113**, 9704-9709. [3] Krause *et al.* (2018) *Nat. Comms*. **9**, 1-10. [4] Och and Shields-Zhou (2012) *Earth-Sci. Rev*. **110**, 26-57 [5] Berner (2006) *Geochim. Cosmochim. Acta* **70**, 5653-5664.