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Tectonic-magmatic cycles, C-S-redox coupling and the Lomagundi-Jatuli carbon isotope excursion

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Zircon abundance, isotopic and REE-based proxies and the seawater strontium isotope curve confirm the existence of long supercontinent cycles, marked by orogeny, peneplanation and rift volcanism, during much of Earth history. Since the Great Oxidation Episode (GOE), which culminated at about 2.3 Ga, such tectonic cycles have also been characterised by systematic changes to weathering regimes and nutrient flux that are also expressed in the carbon isotope record with supercontinent tenure marked by exceptionally high $\delta^{13}C$ values. Conversely, tectonic collisions are marked by relatively low $\delta^{13}C$ values, and during the Proterozoic by negative $\delta^{13}C$ anomalies. Pioneers in Earth system science considered that coupling between carbon and sulfur redox reactions governs Earth's long-term exogenic oxygen budget and might sometimes be expressed as C and S isotopic anomalies, whereby a mole of sulfate leaving the marine realm into the sedimentary rock record would be accompanied by an increase of about two moles of organic carbon being buried. Here we explore this coupling in relation to the Lomagundi-Jatuli positive carbon isotope anomaly that occurred during a time of elevated volcanic activity in the aftermath of the GOE between about 2.2 and 2.0 Ga. We consider using biogeochemical box models that this event was caused by the build-up of the first substantial sulfate reservoir on Earth due to nutrient-limitation of pyrite burial caused by low erosion rates. A subsequent rise of eutrophic conditions and widespread euxinia coincided with a return to lower carbon isotope values and sulfide mineralisation during the Orosirian Period. We consider that a similar chain of events accompanied the tenure and rupture of the later supercontinents Rodinia and Pangaea, although with markedly different consequences due to increases in the exogenic sulfate reservoir over time.