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Nickel isotope evidence for dynamic redox evolution in the early Cryogenian interglacial oceans

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The Cryogenian period (~720–635 Myr) was characterized by two Snowball glaciations (Sturtian and Marinoan) separated by a short-lived interglacial interval, coinciding with the proliferation of complex marine eukaryotes [1]. Increased oxygen and nutrient availability has been invoked to explain this biological diversification [2], but debates over the redox evolution of the Cryogenian interglacial oceans – and thus the link between biological diversification and ocean oxygenation – remain far from closed [3-4].

Here, we present nickel (Ni) isotope data (δ^{60}Ni), a promising tracer of ocean biogeochemistry, recorded in OC-rich sediments from the Gaodi and Chengxingpo drill cores deposited in the ocean-facing Nanhua Basin, South China, stratigraphically equivalent to member I of the Datangpo Formation (~662–654 Myr), to track redox evolution in the early Cryogenian interglacial oceans. Both cores show similar trends, though the Gaodi exhibits some distinctive features that are likely caused by greater basin restriction. Multiple geochemical proxies indicate that the Nanhua Basin was a partially restricted basin, most closely resembling the modern Cariaco Basin. Our results suggest that the deep waters of the Nanhua Basin were ferruginous in the immediate aftermath of the Sturtian glaciation. Sedimentary δ^{60}Ni values of ~+0.4‰ most likely reflect a Mn-shuttle signal, which suggests that the surface ocean had developed a deepening chemocline during this period. With intensified chemical weathering, including increased sulfate input, the deep ocean evolved towards strongly euxinic conditions, accompanied by a ~0.5-0.7‰ drop in sedimentary δ^{60}Ni. This decrease is consistent with isotope fractionation between free Ni^{2+} and sulfide species [5]. Although evidence suggests that the deep ocean became moderately oxygenated in the later portion of the early interglacial period, oxygenation remained insufficient to drive systematic changes in seawater δ^{60}Ni, as indicated by the relatively constant sedimentary δ^{60}Ni record.

[1] Brocks et al., 2017. *Nature*.

[2] Bowyer et al., 2023. *Science Advances.*

[3] Lau et al., 2017. *Earth and Planetary Science Letters.*

[4] Pan et al., 2021. *Precambrian Research*.

[5] Vance et al., 2016. *Philosophical Transactions of the Royal Society A.*