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Modern-like shallow marine redox conditions recorded by ~2.46 Ga banded iron formations

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The Great Oxidation Event (GOE) at 2.45–2.22 Ga marks the permanent rise of the atmosphere oxygen (O_2), driven by enhanced O_2 production in surface oceans. Although the oxidation of the atmosphere is relatively well constrained, the time, tempo, and worldwide synchronicity of marine redox evolution remain poorly resolved. In this study, we present new nitrogen isotope ($d^{15}N$) data of 2.46 Ga billion-year-old banded iron formations (BIFs) from the Kuruman and Griquatown formations in the Griqualand West Basin, Transvaal Supergroup, South Africa. Our results reveal extensive oxygenation of shallow marine conditions immediately prior to the GOE. Moreover, stratigraphic comparison with coeval BIF successions from the Hamersley Basin demonstrates a comparable trajectory and pace of marine oxidation across these basins, despite the Griqualand West Basin recording comparatively more oxygenated conditions. Together, these findings suggest that Neoarchean-Paleoproterozoic ocean oxygenation may not be a localized phenomenon, but instead reflected a broader, potentially global reorganization of marine redox structure. Our findings indicate that, during the GOE, ocean redox structure may at times have been comparable to that of the modern ocean, underscoring the need for higher resolution, globally integrated reconstructions of early Earth's oxygenation history.