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# Reconstructing ancient palaeoenvironments from the Mid-Proterozoic packages of the greater McArthur Basin, Northern Australia

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The step-wise increase in our planet's atmospheric oxygen is intrinsically linked to the emergence of complex life. However, these relationships are poorly understood in the Mid-Proterozic. As such, we look to constrain past biological productivity and water conditions in a major continental seaway by investigating the 1.75–1.60 Ga sedimentary packages of the McArthur Basin in northern Australia. Inorganic and organic geochemical datasets were collected from four different units. Furthermore, $\delta^{18}O$, $\delta^{13}C_{carb}$ and $^{87}Sr/^{86}Sr$ isotopes were applied as proxies to highlight post-depositional alteration, the dissolved inorganic carbon pool and input between riverine/continental and marine/hydrothermal sources into the sedimentary system. Importantly, our study provides the first stable $\delta^{88/86}Sr$ results from Proterozoic carbonates that will aid in the palaeoenvironment reconstructions of these packages.

Alteration indicators suggest that the rocks analysed in this study have not experienced significant post-depositional secondary perturbations and are likely to record primary palaeoseawater chemistry. Bioproductivity proxies from these units display strong relationships with several redox-sensitive elements. In turn, these signatures closely mirror the regional transgressive-regressive cycles. These cycles can control the sedimentation rate and input, impacting the accumulation and abundance of trace elements. However, isotopic results here indicate that sedimentation rate was not the only driver in how geochemical signatures vary. Heavier $\delta^{13}C_{carb}$ values coincide with more juvenile $^{87}Sr/^{86}Sr$ signatures and increasing $\delta^{88/86}Sr$ results. These patterns also coincide with negative Ce anomalies and occur at relatively higher base level. Consequently, we suggest that increased productivity demonstrated by $\delta^{13}C_{carb}$ were driven by a more mafic input indicated by the radiogenic and stable Sr isotopes. These nutrient-rich fluxes are likely derived from mantle-like, mafic hydrothermal provenance associated with deeper environments or influx of oxygenated marine waters flooding the previously restricted domain. In contrast, restricted environments with relatively lower sea-levels would likely be dominated by more felsic, continental, nutrient-poor sources; starving biological life; and limiting oxygen production. This shows the importance of incorporating sedimentological analysis with geochemical interpretations, especially during the hetereogenously oxygenated Proterozoic world. Periods of local transgression in intracontinental systems could be crucial oases needed for early biological life to survive during this eon.