

Complex redox evolution of Proterozoic Earth's surface environments recorded in the greater McArthur Basin.

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The oxygenation of the Earth's surface and its effects on the evolution of life on our planet remains an intriguing debate. This is particularly true for the Mid-Proterozoic, where atmospheric oxygen seems to invariantly remain at a persistently low level [1]. Such questions are challenging to address because unaltered and well-dated sedimentary units of this age are uncommon. The greater McArthur Basin in Australia offers a key archive of Proterozoic sedimentary units to help provide critical insights into the long-term shifts in palaeoredox conditions. The basin is relatively unmetamorphosed and constrains half a billion years of Earth's history, from ca. 1820–1320 Ma.

The study employs multiple redox-sensitive geochemical proxies, including Ce/Ce* [1] and Zn/Fe ratios [2]. Results show that the redox conditions of the greater McArthur Basin were not stagnant, as it experienced periods of oxic, anoxic, and euxinic environments conditions in various depositional settings. Thermodynamic modelling suggests that the basin recorded multiple intervals when pO₂ exceeded 4% PAL, which are thought to be sufficient for basal metazoans and animal respiration [3,4]. These periods span back to the deposition of the Redbank Package, where the oldest known biomarkers were discovered [5].

[1] Liu, Xiao-Ming, et al. "A persistently low level of atmospheric oxygen in Earth's middle age." *Nature Communications* 12.1 (2021): 351.

[2] Liu, Xiao-Ming, et al. "Tracing Earth's O₂ evolution using Zn/Fe ratios in marine carbonates." *Geochemical Perspectives Letters* (2015).

[3] Bellefroid, Eric J., et al. "Constraints on Paleoproterozoic atmospheric oxygen levels." *Proceedings of the National Academy of Sciences* 115.32 (2018): 8104-8109.

[4] Zhang, Shuichang, et al. "Sufficient oxygen for animal respiration 1,400 million years ago." *Proceedings of the National Academy of Sciences* 113.7 (2016): 1731-1736.

[5] Bellefroid, Eric J., et al. "Constraints on Paleoproterozoic atmospheric oxygen levels." *Proceedings of the National Academy of Sciences* 115.32 (2018): 8104-8109.