Nitrogen isotope evidence of variable nutrient sources for life over Earth history

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Interpretations of nitrogen cycling on the early Earth are based on our understanding of the modern nitrogen cycle, and on information recorded in the $\delta^{15}N$ values of ancient sediments. The nitrogen cycle is driven largely by biological processes, which produce measurable changes in the ratios of N isotopes ($[\delta^{15}N = (^{15}N/^{14}N)_{sample}/(^{15}N/^{14}N)_{air} - 1] \times 1000$, in ‰) in the associated compounds. These nitrogen compounds can be preserved in the rock record, as organic N or as ammonium incorporated into clays. We have assembled a compilation of $\delta^{15}N$ data (from extracted organic N and bulk rock N) from well-preserved sediments spanning Earth's first major rise in global atmospheric oxygen (the Great Oxidation Event, GOE). Our results suggest a change in dominant nitrogen sources for marine primary productivity, from a large pool of deep-water bioavailable ammonium formed in association with the pre-GOE expansion of oxygenic photosynthesis, through ventilation of the surface oceans and widespread nitrate availability during the GOE (1). The individual records, however, indicate spatial segregation of N cycling pathways, suggesting that depositional facies are critical in assessing the distribution of marine nutrient sources even early in Earth history.

1. Zerkle et al. (2017) *Nature*;