Spatially constrained nitrogen cycling on a Neoarchaean ocean margin

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We present nitrogen isotope ($\delta^{15}N$) data from shallow-water sediments of the ~2.5Ga Campbellrand-Malmani carbonate platform, which reveal temporal and spatial heterogeneity in Late Neoarchaean N-cycling. Drillcore BH-1 Sacha records the development of this marginal marine setting from ramp to lagoonal environments. The lowermost part of the core contains sediments from a silici-clastic/carbonate ramp that was likely relatively open to oceanic influence. Here $\delta^{15}N$ values are strongly negative, indicating non-quantitative assimilation of upwelling ammonium (NH_4^+) by marine organisms from a large, stable NH_4^+ pool (e.g. *1*). In the upper part of the core $\delta^{15}N$ values are ca. 0‰ indicating the complete utilization of a smaller DIN-pool. Complete utilization reflects limited diazotrophy as progradation towards sub- to peri-tidal and/or lagoonal conditions isolated the depositional setting from upwelling of nutrients. Despite the suggestion of transient oxygen-oases prior to the Great Oxidation Event (*2*) and the presence of straomatolites in these shallow settings, these $\delta^{15}N$ values provide no evidence for the presence of abundant nitrate (NO_3^-). We conclude that the N-cycle in these shallow waters was dominantly anaerobic, and/or that any (NO_3^-) that was generated was rapidly and quantitatively consumed during anaerobic respiration. We suggest that the partial uptake of ^{15}N-depleted NH_4^+ might have created an isotopically heavy residual DIN pool providing an alternative explanation for small positive $\delta^{15}N$ values in more distal but temporally-equivalent sediments.

1. Hoch et al. (1992) *Lim. & Ocean*. :*2*. Godfrey and Falkowski (2009) *Nat. Geosci*.