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Dampened nitrogen cycling can manifest as elevated ^{15}N in the sediments of shallow alkaline-hypersaline lakes

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Alkaline lakes are the most bioproductive aquatic ecosystems on Earth. The factors that ultimately limit productivity in these systems can vary, but nitrogen cycling in particular has been shown to be adversely affected by high salinity, evidently due to the inhibition of nitrifying bacteria (i.e., those that convert NH_x to NO_x) [1]. Recent work suggests that denitrification (conversion of NO_x to N_2) may also be substantially hampered by both elevated pH and salinity [2]. The coastal plain of Coorong National Park in South Australia provides an ideal natural laboratory for examining how fine-scale differences in the geochemistry of alkaline lakes can lead to broad variations in nitrogen cycling, as manifest in sedimentary $\delta^{15}N$. There, several alkaline lakes exist along 130km of coastline. The salinity, pH, and carbonate chemistry of these lakes varies on both seasonal and decadal timescales [3]. We present a wide range of $\delta^{15}N$ values (3.8–18.6‰) measured in the shallow sediments (0-35cm) of five lakes of the Coorong region. Additional data include major element abundances, carbonate $\delta^{13}C$ and $\delta^{18}O$ values, and the results of principal component analyses. Stable nitrogen isotopes and Na wt.% display positive correlation (R^2=0.59) across all lake systems. Principal component analyses further support the notion that the abundance of salinity-associated, monovalent cations impacts nitrogen cycling, particularly in samples with $\delta^{15}N$>11‰. The inhibition of nitrification and/or denitrification may lead to the accumulation of reduced nitrogen species, which, when exposed to the water column, are prone to ammonia volatilization exacerbated by the high alkalinities and the concomitant significant isotope fractionation effect [5]. In this scenario, the nitrogen that remains in the lakewater and is eventually buried in the sediments is isotopically enriched. Analogous enrichments in the rock record may provide important constraints on past chemical conditions and their associated microbial ecologies. Specifically, ancient terrestrial aquatic systems with high $\delta^{15}N$ values attributed to denitrification and thus oxygen deficiency may warrant re-evaluation within this framework. [1]Oren (1999) Microbiol. Mol. Biol. Rev. 63. [2]Pan et al. (2023), Sci Rep 13(1). [3]von Der Borch (1965) GCA 29(7). [4]Wright & Wacey (2005) Sedimentology 52(5). [5]Li et al. (2012) GCA 84.