Denitrification pathways and rates in the sandy sediments of the Georgia continental shelf

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The significance and mechanisms of denitrification in sandy sediments, which comprise 70% of the global shelf area, are not well known. These sediments typically contain low organic matter and dissolved inorganic nitrogen (N) contents and high pore water oxygen concentrations, characteristics that are generally thought unfavorable for supporting heterotrophic denitrification. The possibility of alternative pathways to N_2, which may not be limited by organic matter content, oxygen, or observed dissolved inorganic N levels, have not been examined in these widespread environments. These alternative pathways include coupled nitrification-denitrification, anammox (anaerobic ammonium oxidation), and OLAND (oxygen-limited autotrophic nitrification-denitrification). Core incubations and isotope pairing techniques were employed to determine pathways and rates of denitrification in the coarse-grained, sandy sediments of the Georgia continental shelf. In these sediments, heterotrophic denitrification was the dominant process for fixed N removal. The alternative pathways (coupled nitrification-denitrification, anammox, and OLAND) were not evident over the 24 and 48-hour timescale of the incubation experiments. Heterotrophic denitrification processes produce 22.8 – 34.1 μmole N m^{-2} d^{-1} of N_2 in these coarse-grained sediments. These denitrification rates are approximately two orders of magnitude lower than rates determined in fine-grained shelf sediments. These lower rates may help reconcile unbalanced marine N budgets which calculate global N losses exceeding N inputs.

A tale of two margins: A comparison of redox and productivity paleo-proxies in sediments off Oman and Peru

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Reconstruction of past changes in environmental redox conditions is valuable for elucidating the interactions and sensitivities between climate change and redox-sensitive biogeochemical cycles. Where suboxic conditions occur in the water column, they are maintained by a combination of poorly ventilated intermediate waters as well as high organic matter (OM) fluxes. However, the sensitivity of suboxia to variations in either is not well known.

We have observed in Oman margin sediments from the Arabian Sea strong variations in denitrification and by inference suboxia in response to climate change at a variety of scales. Across one D-O event examined in detail (Higginson et al., 2004), increased water column denitrification (rising $\delta^{15}N$) was syncronous with increased suboxia (increased V/Al, Mo/Al and reduced Mn/Al). Productivity intensified at the same time as detected by productivity sensitive metals as well as organic-based proxies suggesting local to regional OM flux as the forcing for variations in suboxic intensity.

On the Peru margin, these relationships at first appear to generally hold. During the latest Holocene, centennial-scale events of sharply increased suboxia as detected by V/Al and Mo/Al correspond to increased productivity as marked by increased Ni/Al and Zn/Al as well total alkenones/Al. During the last deglacial, however, a sharp rise in denitrification marked by high $\delta^{15}N$ is not synchronous with changes in either sediment redox-sensitive metal concentrations or productivity proxies. In this critical interval, remote change in intermediate water ventilation appears to be the prinicpal forcing.

Reference

Higginson, M. J., D. W. Murray, M. A. Altabet, R. W. Murray, and T. D. Herbert. 2004. *Geochimica et Cosmochimica Acta* **68**, 3807-3826.