# Geochemical transition zones are hotspots of nitrogen cycling in Arctic marine sediments

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The early diagenesis of organic matter is the major energy source for the marine sedimentary biosphere and thus is a major controlling factor regulating the population size. However, the vertical distributions of functional groups of microorganisms and their coupling to the diagenesis of organic matter remains unclear, not at least for those microbes involved in nitrogen transformation, which metabolism exert a critical control on the nitrogen flux between reservoirs.

Here we employed biogeochemical and microbiological approaches to investigate the vertical distributions of nitrifiers, denitrifiers and anaerobic ammonium oxidizing bacteria in sediment cores retrieved from the Arctic Mid-Ocean Ridge in the Norwagian-Greenland Sea. We observed a clear geochemical zonation in the sediments revealed by high-resolution pore water measurements of oxygen, nitrate, ammonium, manganese and sulfate concentrations. We identified distinct geochemical transition zones, including the oxic-anoxic transition zone (OATZ) and nitrate-manganese transition zone (NMTZ), found at the boundaries between geochemical zones. Reaction-Transport modeling suggested that nitrate was mainly produced in the surface oxygenated sediments through nitrification and consumed primarily in the NMTZ, either linked to organic matter degradation or the re-oxidation of $NH_4^+$ and $Mn^{2+}$. Abundances of ammonia oxidizers, nitrite oxidizers, and denitrifiers estimated via quantitative PCR targeting the corresponding functional genes, generally decreased with depth, but were constantly elevated around the OATZ and NMTZ. Anammox bacteria were mainly detected around the NMTZ where both nitrate/nitrite and ammonium are available. Community profiling by prokaryotic 16S rRNA gene-tag sequencing confirmed the vertical distributions of the functional groups. This study illustrates that nitrogen cycling processes are intensified in the geochemical transition zones, in which the active growth of microbes can also been inferred. Similar scenarios are likely occurring in other stratified environments on Earth.