Groundwater Nutrient Geochemical Transformations in Organic-Rich Coastal Sediment

ALEXANDER F. LAMORE*, ALEXANDRA CHURCH, CHRISTOPHER JOHN BARNES II AND NATASHA DIMOVA

Box 870338, Tuscaloosa, AL 35487
[*correspondence: aflamore@crimson.ua.edu]
[aichurch@crimson.ua.edu] [cbarnes@anchorqea.com]
[ntdimova@ua.edu]

Previous studies of groundwater nutrient dynamics in coastal Baldwin County, AL indicate that groundwater is contaminated with NO_3^-. However, recently a mass-balance of nutrient fluxes indicated that there are positive fluxes of reduced nitrogen species, NH_4^+ and dissolved organic nitrogen (DON), while NO_3^- fluxes were negative. It was also found that there is an organic-rich coastal sediment layer through which groundwater percolates, suggesting that geochemical transformations within this organic-rich layer could be responsible for the observed nitrogen fluxes. The goal of this study is to examine the geochemical transformations occurring in these organic-rich shallow coastal sediments, as well as to identify the quantity and quality of carbon exported by groundwater discharging to Mobile Bay, AL. In a laboratory-based study, sediment cores containing the identified organic-rich layer collected from the eastern shore of Mobile Bay, where waters are impacted by hypoxia, were incubated with 25ppm and 50ppm NO_3^- solutions, natural groundwater, and ultra-pure carbon-free water (UPCFW) to evaluate how the sediment reacts to different nutrient compositions. Analyses of the coastal sediment were conducted to evaluate in-situ sediment conditions and examine the history of the site, to gain insight on the transformations occurring. Nutrient results do not show excess of NH_4^+ in pore water incubations with increased NO_3^- loading, but higher NH_4^+ was detected from UPCFW incubations. DON fluxes are most significant with the highest nitrate loading, and lowest in UPCFW incubations. NO_3^- levels in pore water after incubation are lower than the amounts added to the system, while NO_2^- is consistantly higher in the experiments with added NO_3^-. Total carbon is generally higher in incubations without added NO_3; however, calculated remineralization of organic matter is slightly higher where NO_3^- is added. Higher NH_4^+ in the absence of NO_3^- loading, as well as significant DON from incubations with added NO_3^- suggest that the sediment acts as a source of reduced nitrogen species. Furthermore, NO_2^- is high, while NH_4^+ and total nitrogen are not, suggesting loss of nitrogen from the system as gaseous nitrogen species; therefore, denitrification seems to be the most common pathway for NO_3^- reduction.