BIOGEOCHEMICAL AND HYDROLOGICAL CONTROLS ON NITROUS OXIDE CYCLING IN KARSTIC AQUIFERS

Madison K. Flint[1]*, Adrian Barry-Sosa*[2]*, Tatiana Summerall*[1]*, Jonathan B. Martin*[1]*, Brent C. Christner*[2]

[1]Department of Geological Sciences, University of Florida, Gainesville, FL, USA

[2]Department of Microbiology & Cell Science, University of Florida, Gainesville, FL, USA

Increasing environmental abundance of reactive nitrogen species due to human activities has elevated atmospheric nitrous oxide (N_2O) concentrations, a potent greenhouse gas, which continues to rise ~0.3% annually. Reactive nitrogen may form N_2O through several microbial and abiotic processes, including denitrification, nitrification, and redox driven interactions between iron and nitrogen species. We hypothesize that all of these processes are sources of N_2O in karst aquifers as extensive surface water-groundwater exchange delivers dissolved oxygen, iron, nitrate and dissolved organic carbon (DOC) to the subsurface. We tested this hypothesis at three settings in the Upper Floridan Aquifer (UFA) with distinct DOC concentrations and water residence times ranging from days to years: (1) Ichetucknee springs system with low DOC concentrations and apparent CFC ages of 20 to 40 years, (2) Madison Blue, Peacock, and Little River springs, which periodically (~1 per year) reverse flow during flooding to receive oxygenated and DOC-rich flood waters (residence times of weeks to months), and (3) the Santa Fe River sink-rise system, where DOC-rich surface water continuously flows ~7 km through a subsurface network of flooded conduits (residence times – days to weeks). All of the springs had elevated N_2O concentrations (up to 1,700% supersaturation) with respect to atmospheric equilibrated water (~11 nM). N_2O concentrations within the Ichetucknee springs system ranged from 15-64 nM, with elevated concentrations observed in younger spring waters. Madison, Peacock, and Little River springs exhibit N_2O concentrations that ranged from 60-108 nM. The highest N_2O concentrations (ranging from 8 to 138 nM) were observed at the Santa Fe River Rise during base-flow when surface water flowing into the River Sink mixes with groundwater stored in matrix porosity prior to discharge. These are the first data to indicate that the UFA and other karst hydrologic systems may be important sources of N_2O to the atmosphere.

PRESENTER BIO: Madison Flint is a PhD candidate in the Department of Geological Sciences at the University of Florida. She has a strong background in both organic and inorganic synthetic chemistry and her major research interests include investigating human induced perturbations of global geochemical cycles - particularly with respect to greenhouse gas emissions - from both terrestrial and marine aquatic ecosystems.