Nitrogen cycling and trace gas dynamics in coastal aquifers

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Coastal groundwater contains relatively high concentrations of nutrients and organic matter and its discharge makes significant contributions of these dissolved constituents to coastal ecosystems [1]. Ongoing work at Cabretta Island, a barrier island in Georgia, is designed to determine which processes control biogeochemical processes and submarine groundwater discharge (SGD), and the impact of storm events on these processes. Groundwater geochemistry monitoring data from Cabretta Island indicate an active zone of nitrification near the beach-dune interface. This zone is characterized by elevated concentrations of dissolved nitrous oxide and nitrate and very low concentrations of dissolved ammonium. Coupled nitrification and denitrification could be an important mechanism for nitrogen removal from the system, and either of these biogeochemical processes could be responsible for nitrous oxide production. To better document the sources and sinks of nitrous oxide within the aquifer we: 1) estimated the groundwater-derived flux of dissolved nitrous oxide from the system using radium mass balance and loading relationships and 2) measured direct atmospheric nitrous oxide flux over a tidal cycle using flux chambers and an infrared gas analysis system. We quantified rates of nitrification and denitrification in the nitrous oxide production zone using push-pull tests to elucidate the nature of nitrogen cycling within the aquifer and the mechanism for nitrous oxide production.

[1] Krest *et al*. (2000) *Global Biogeochemical Cycles* **14**, 167–176.

Present-day serpentinization and microbial activity in peridotites hosting high-pH spring waters, Gruppo di Voltri (Italy)

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The alteration of mantle rocks during serpentinization is a fundamental process that has significant geochemical and biological importance in marine systems and present-day weathering of mantle rocks on land. Studies on serpentinites from marine peridotite-hosted hydrothermal systems have shown that opaque mineral assemblages and sulfur and carbon isotopic signatures preserved in the rock reflect fluid fluxes, redox conditions and microbial activity that prevailed during serpentinization and carbonate precipitation.

In this study we investigate peridotite-hosted Ca-OH springs which are characterized by a pH of 11-12, high Ca concentrations, varying sulfur contents and negligible bicarbonate or carbonate concentrations. Dissolved methane concentrations are between 10 and 723 μmol/l, whereas H_2 concentrations are relatively low. Here we present the sulfur and carbon geochemistry of the serpentinites that comprise the basement of these highly alkaline springs. Growth of microbial filaments below the outflow channels of the spring waters, high sulfur contents in the rock samples and the sulfur and carbon isotopic composition of the serpentinites point to microbial activity in these systems.

In many aspects these springs are similar to the peridotite-hosted hydrothermal system at Lost City along the Mid-Atlantic Ridge, where high pH fluids with elevated methane and H_2 concentrations eminate from carbonate chimneys and support distinct microbial communities in the subsurface and in the carbonate towers. To understand hydrogen-based biospheres in marine and terrestrial settings it is therefore essential to link inorganic reactions during serpentinization, cycling of carbon and sulfur, and microbial activity in these high pH systems and to compare active and ancient marine, and terrestrial peridotite-hosted hydrothermal systems.