Utilizing Select U/Th Series Radionuclides as Tracers of Hyporheic Exchange within Florida's Coastal Rivers

Brian Blake-Collins[1], Peter Swarzenski[2], Kevin Kroeger[2], and Chris Reich[2]
[1]ETI, St. Petersburg, Florida
[2]U.S. Geological Survey Florida Integrated Science Center, St. Petersburg, Florida

Florida's coastal rivers are unusual in that they most often have small watersheds, wherein the bi-directional exchange of groundwater with surface water is often ubiquitous and hard to quantify. This active exchange of groundwater and surface water (hyporheic flow) across the sediment/water interface within the lower reach of a coastal river or stream may be important in terms of the delivery of water and associated constituents to coastal receiving waters. Hydrogeologists and resource managers alike can thus benefit from the development and application of new tools and methods that enable the accurate separation of groundwater from surface-water budgets in such streams and rivers.

We have recently utilized ^{222}Rn and the Ra quartet (^{223,224,226,228}Ra) to identify and also quantify rates of submarine groundwater discharge within coastal bottom waters of select Florida estuaries. Radon-222 has a short half-life (3.8 d), is inert as a gas, and is produced by radioactive decay of its immediate parent (^{226}Ra, $t_{1/2}$ = 1600 y) at a predictable rate within bottom sediments. The activity of excess radon in a coastal water column has been shown to be proportional to the rate of submarine groundwater discharge. By measuring near-continuous ^{222}Rn activities, one can thus obtain information on the geographical distribution of submarine groundwater discharge. Results from such ^{222}Rn surveys in Tampa Bay, Loxahatchee River estuary, and the Suwannee River delta are compared. Concurrent radium isotope systematics can provide regional-scale submarine groundwater-discharge estimates.

Results suggest that ^{222}Rn is particularly well suited as a groundwater tracer in Florida's coastal waters and rivers that are often rich in phosphatic (i.e., U/Th series isotopes) deposits. For example, groundwater ^{222}Rn activities can range above 5000 dpm L^{-1} below the Alafia River, Tampa Bay. In comparison, background ^{222}Rn activities in coastal waters are generally < 5 dpm L^{-1}. Observed elevated Rn upstream in all river systems suggests that this isotope could be very useful as a tracer of groundwater in such river systems. The application of Ra isotope systematics yields submarine groundwater discharge rates that are in the range of other coastal settings, and when multiplied by representative groundwater nutrient concentrations, provide at least a first-order submarine groundwater-discharge-derived nutrient flux to coastal receiving waters.