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Using a Suite of Radium Isotopes and CH_4 to Study Submarine Groundwater Discharge at a Site in Indian River Bay, DE

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At any land-sea boundary, the exchange of continentally derived water with seawater occurs either at sites of well-defined surface water runoff, or through the upward migration of interstitial water (meteoric or recycled water) across the sediment/water interface. This latter process has recently been defined as submarine ground water discharge (SGD), and occurs in what has been termed a 'subterranean estuary'. According to Church (1996), estimates of the cumulative flux of SGD may be as much as 10% of surface water runoff. The importance of SGD, however, does not usually lie in the total flux of water exchanged across the sediment-water interface. Rather, the importance of SGD lies in the geochemical signature of its water and solutes. As ground water moves through porous strata, both redox and adsorption-desorption reactions may entirely alter the speciation and availability of water-borne constituents. These diagenetic transformations, in concert with favorable hydraulic gradients, can result in the substantial delivery of reactive nutrients and metals to coastal waters. One tool that has recently shown promise as a useful tracer of SGD are the four naturally occurring isotopes of radium. Here we present some preliminary findings from a radium/methane survey at one site within Indian River Bay, Delaware.

There is an overwhelming spatial correlation between the water column activities of all four radium isotopes as well as concentrations of methane. Such trends are likely tied to the underlying hydrogeologic structure, where detailed stratigraphic and hydrologic investigations have identified the most probable zone of SGD. A first-order mass balance model was developed to estimate the integrated flux of water within the sampling grid using multiple Ra isotopes. Within the constraints and assumptions of the model that utilize ^{223}Ra/ex^{228}Ra ratios to correct for mixing effects, the age of the water mass within the grid is estimated to be on the order of ~ 16 days. Using this ~ two week water mass age, one can calculate the total amount of excess ^{226}Ra within the system as a function of time. If one divides this excess ^{226}Ra activity (dpm d^{-1}) by an average ground water ^{226}Ra activity (dpm m^{-3}), one can estimate a SGD flux of about 18,000 m^3 d^{-1}.