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Abstract

Submarine groundwater discharge (SGD) and dissolved trace metal cycling in the subterranean estuary and coastal ocean

By

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During the past quarter century, submarine groundwater discharge (SGD) has gained increasing recognition as a major contributor to chemical budgets in the coastal ocean. Advection of groundwater through permeable sediments is now accepted to be large and generally ubiquitous in the coastal marine environment. Rapid organic matter remineralization couples with high fluid exchange rates in these sediments to make them very active zones of geochemical cycling. However, little is known about the distribution and speciation of trace metals in the subsurface mixing zone of fresh and saline groundwaters, and how geochemical cycling in permeable sediment porewater affects trace metal fluxes via SGD. The purpose of this dissertation is to examine these two issues. In two Long Island, NY, estuaries – Jamaica Bay and Great South Bay – mass balance calculations for the suite of Ra isotopes indicated an SGD flux for each embayment of 1 to 10 billions of liters per day. A seasonal trend in Ra-derived SGD estimates was reflected in dissolved Mo levels in the water column, as increased recirculation of seawater through permeable sediments apparently resulted in Mo removal. Conversely, positive correlation between ^{223}Ra and dissolved Fe, Co, Zn, and Ni in bottom waters indicated that SGD was a source of these metals to the Jamaica Bay water column. In Great South Bay, the spatial distribution of Ra matched previous reports of regions enriched with dissolved trace metals. Shallow, high-resolution depth profiles were collected in Great South Bay permeable sediments to examine dissolved metal cycling and speciation in the subterranean estuary. Geochemical cycling of trace metals in shallow porewater resulted in order-of-magnitude enrichments over surface waters. A major portion of the total dissolved pool for many metals comprised kinetically-labile species. Although metal-oxide cycling at the sediment-water interface probably prevents release of most metals from the sediments, evidence for preferential conduits of vertical flow may allow substantial dissolved metal transport by SGD. Thus, SGD can represent a significant source or sink for different trace metals in coastal waters, and geochemical cycling in surficial porewater and the subterranean estuary is vastly important in determining the trace metal composition of submarine groundwater.

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