Radium Isotope Biogeochemistry in Groundwater

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Abstract

Groundwater discharge has been suggested as an important source of radium to the ocean. To understand the mechanisms controlling the behavior of radium isotopes in groundwater, large-volume groundwater samples were collected from three well fields (Shaw, Morton, and Sheahan) in a semi-confined deep aquifer at Memphis in southwestern Tennessee, USA for analysis of Ra isotopes (^{226}Ra, ^{228}Ra, ^{224}Ra, and ^{223}Ra) in the area. Elevated activities were observed for each of these radioisotopes (^{226}Ra: 0.4-0.8 dpm/L; ^{228}Ra: 0.8-1.6 dpm/L; ^{224}Ra: 1.4-2.4 dpm/L; ^{223}Ra: 0.07-0.1 dpm/L) at the Shaw site where groundwaters are recharged to form the Memphis aquifer, while relatively low activities (^{226}Ra: 0.02-0.07 dpm/L; ^{228}Ra: 0.03-0.1 dpm/L; ^{224}Ra: 0.04-0.13 dpm/L; ^{223}Ra: <0.003 dpm/L) were found at the Morton site where the deep Memphis aquifer is effectively isolated from the unconfined aquifer at shallow depths. At the Sheahan site, the Ra isotope activities in the aquifer all reach maximum values at a depth of ~100 m below the ground surface. The high activities are found to be associated with high dissolved organic carbon concentrations, suggesting that leakage via plumes of contaminated groundwater from the shallow unconfined aquifer into the deep Memphis aquifer may have taken place. As Mn oxides are a strong scavenger of Ra isotopes in low-salinity groundwater, our results imply that the elevated Ra isotope activities in these ground waters may be caused by a reduction/dissolution of Mn oxide coatings on the aquifer solids in association with enhanced microbial activities. This implication points to the potential of using the Ra isotopes as a proxy for assessing deep aquifer microbial activities and their influence on the chemistry of groundwater.