Factors Controlling Pu-239 and Cs-137 Mobility in Contaminated Isolated Pond Sediments, Savannah River Site, South Carolina

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There remains a lack of knowledge regarding ecosystem transfer, transport processes, and mechanisms, which influence the *long-term* mobility of ^{239}Pu and ^{137}Cs in natural environments, particularly with respect to how anthropogenic radionuclides interact with natural biogeochemical cycles. Furthermore, monitoring the distribution and migration of trace anthropogenic radioisotopes as ecosystem tracers has the potential to provide insight into the underlying mechanisms of geochemical cycles. This study investigated the distribution of the anthropogenic radionuclides ^{239}Pu and ^{137}Cs, along with total organic carbon, iron and trace element concentrations, and the microbial community in contaminated sediments of Pond B at the Savannah River Site (SRS) in South Carolina.
Pond B received SRS R-reactor cooling water from 1957–1964, resulting in trace amounts of ^{239}Pu and ^{137}Cs being introduced into the pond. Since then, the pond has been relatively isolated except for a sampling campaign in the 1980s evaluating radionuclide distributions in the water and sediment. In this work, sediments were collected throughout the Pond B site to determine the spatial variability of Pu and Cs, as well as sediment cores to determine the concentrations of 239Pu, 137Cs, and major and minor elements in the solid phase. Additionally, an electrochemical method using an in-situ core probe was used on wet cores before extraction to determine the concentration and speciation of dissolved redox-active species.
More than 50 years after deposition, ^{239}Pu and ^{137}Cs concentrations in Pond B sediments are primarily located in the upper 5 cm of sediment in an area where deposition of particulate-bound contaminants was most prevalent and located between 5 and 10 cm in areas of high sedimentation. An analysis of the geochemical data coupled with a factor analysis demonstrated different sediment facies across the pond which result in a range of geochemical processes controlling the accumulation of Pu and Cs in the sediment. The highest concentrations of ^{239}Pu and ^{137}Cs appear to be controlled by particulate input from the influent canal. Elevated ^{239}Pu concentrations in the sediments were observed in areas with high organic matter content and high sedimentation rates indicating strong association of Pu with organic matter. Notably, the sediment microbial community at the pond outlet is likely involved in organic matter degradation processes and may impact Pu-associated organic matter.