Biogeochemical controls on radioactive Strontium-90 transport at the sediment – water interface of two distinct wetlands

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Strontium-90 (^{90}Sr) is a radioactive and toxic isotope of strontium (Sr) with a half-life of 29 years, that is only produced by nuclear fuel irradiation. As a calcium analogue, ^{90}Sr is very mobile and widely distributed in groundwater located near nuclear reactors and waste management areas. At these sites, groundwater-fed wetlands have the potential to act as sinks for ^{90}Sr pollution. To better characterize the physical and chemical processes governing the fate of Sr at the sediment – water interface, laboratory and field studies were conducted. Laboratory adsorption and desorption isotherm experiments and Nuclear Magnetic Resonance analysis on various wetland substrates demonstrated the key role of specific organic matter groups, e.g., proteins, in the strong retention of Sr. Decaying wetland vegetation was shown to remobilize Sr in the form of Sr-attached small colloids. A follow-up field study in two wetlands with contrasting vegetation and hydrologic regimes was carried out. Using passive porewater samplers called peepers, and undisturbed sediment core analysis, the results confirmed the dominant role of organic compounds on Sr transport. Via TOF-SIMS analysis and sequential extractions, the results showed that iron and manganese oxides contributed to Sr retention but to a much lower extent than organic components. The wetland incorporating vegetation and undergoing fluctuating water levels showed the highest efficiency in delaying Sr transport from the groundwater. The results of these studies were used to inform on how to best design and manage wetlands receiving ^{90}Sr pollution.