Speciation analysis of $^{129}$I, $^{137}$Cs, $^{232}$Th, $^{238}$U, $^{239}$Pu and $^{240}$Pu in environmental soil and sediment

The environmental mobility and bioavailability of radionuclides are related to their physicochemical forms, namely species. We here present a speciation analysis of important radionuclides including $^{129}$I (also $^{127}$I), $^{137}$Cs, $^{232}$Th, $^{238}$U and plutonium isotopes ($^{239}$Pu and $^{240}$Pu) in soil (IAEA-375) and sediment (NIST-4354) standard reference materials and two fresh sediment samples from Øvre Heimdalsvatnet Lake, Norway. A modified sequential extraction protocol was used for the speciation analysis of these samples to obtain fractionation information of target radionuclides. Analytical results reveal that the partitioning behaviour, and thus the potential mobility and bioavailability, are exclusively featured for the individual radionuclide. Iodine is relatively mobile and readily binds to organic matter, while plutonium is mainly bound to both organic matter and nitric acid leachable fractions. Thorium is predominated in nitric acid leachable fraction and caesium is primarily observed in nitric acid and aqua regia leachable fractions and residue. Our analytical results reveal that around 50% of uranium might still remain in the residue which could not be extracted with aggressive acid, namely, aqua regia.

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