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Fractionation of U, Th, Ra and Pb from boreal forest soils by sequential extractions

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To study the mobility of the natural radionuclides in forest soil a five step sequential extraction procedure was carried out to soil samples taken from various depths down to three meters at the Olkiluoto Island, Finland, where the final disposal repository of spent nuclear fuel is planned to be constructed in the bedrock. The studied extraction fractions were exchangeable, acid-soluble, reducible, oxidizable and tightly bound. It was found that the extractability of most of the studied radionuclides was dependent on the sample grain size and depth. All the elements were found to be concentrated in the smallest grain size samples (<0.063mm). The extraction behaviour of thorium, however, did not vary with sample depth and only about 10 % of thorium extracted until the final extraction step. Stable lead and Pb-210, as well as barium and radium concentrations were found to correlate strongly in the extractions. Radium and barium were leached more readily than the other elements, approximately 17 % of total radium was found in the first extraction fraction representing exchangeable ions. Uranium was found to be more mobile in the top-soil horizons compared to the horizons further down. In the top-soil samples an average of 51% of extractable uranium was already leached in the second extraction step representing the elements soluble in weak acids, whereas only 13% of the uranium in the sub-soil samples was extracted in this step. This might be due to the changes in the soil redox-conditions while going further down in the soil profile. Also the extraction behaviour of lead and iron might suggest more reducing conditions in deeper soil horizons because the extractable percentage of lead and iron in oxidizable-fraction increased with sample depth.

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