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Rhizosphere interactions in radionuclide speciation, transfer and plant-uptake –Impacts on spent nuclear fuel disposal and mining areas

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Radionuclides may have damaging consequences for ecosystems and may present variable threats for biota, if released from repository or mining areas. In soils, bioavailable radionuclides may affect adversely to microbiological activity and vitality, cause changes in community structure and inhibit the growth of microorganisms. On the other hand, soil microbiota can modify soil chemical environment and thus alter the mobility and uptake rates of radionuclides into plant tissues. These modifications may occur through various mechanisms including biosorption and –accumulation, bioprecipitation, oxidation and reduction reactions as well as through complexation on excreted ligands. Moreover, soil microorganisms may also prompt mobilization of radionuclides through acidic extracellular metabolites thus potentially increasing their uptake and transfer to plants.

Considering the effects of soil microorganisms on the behaviour of radionuclides originating from spent nuclear fuel in acidic bog environments, we have observed that the highly diverse microbial communities inhabiting the deep anoxic soil layers endure in high metal concentrations and may concurrently contribute to the total retention of radionuclides [1]. Microbiota dwelling in this habitat contribute to radionuclide mobility through several distinctive mechanisms including redox reactions (Se(IV))[2], direct biosorption (Ni(II), Ag(I), Cs(I))[1, 3-5] and extracellular enzyme activity (I(-I))[6]. Similarly, in a former uranium mine area (Paukkajanvaara) we also observed several bacterial groups adapted to the elevated radiation levels [7]. We also observed certain bacterial strains (*Pseudomonas* spp.) to take up radium and to concurrently increase sulfate concentrations in the leached solution.

Rhizospheric root-microbe interactions are of key importance to the terrestrial ecosystems. Certain soil bacteria (e.g. *Pseudomonas* sp. T5-6-I) can influence radionuclide plant-uptake (e.g. transfer of 75Se to *Brassica oleracea* and *Arabidopsis thaliana*), and to produce changes in root morphology as well as in protein expression [8]. Although generally Se(IV)–>Se(0) reducing, we have shown *Pseudomonas* sp. T5-6-I to promote Se(IV) transfer to plants by a yet unknown mechanism [8]. However, Se(IV) taken up by the plant appears to end up in organic C-Se-H and C-Se-C bonds irrespective of the presence of bacteria [8]. Regardless of the evident importance of rhizospheric interactions, they are often overlooked due to the difficulty to image the root-microorganism-system. However, the emergence of new imaging techniques, such as state-of-the-art high-resolution synchrotron methods, have enabled more detailed imaging and better understanding of these interactions [9].

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