Distribution of soil-to-plant transfer factors for the natural uranium isotopes in the vegetation in zones affected by uranium mines

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High levels of radionuclides are usually found in the surface soil and vegetation of areas affected by uranium mining and milling. .It is also important to understand the behavior of natural uranium in the environment (e.g., mobility, transfers, translocation), because such information can be used to develop, to test models and to obtain the associated parameter values appropriate for radiological assessments [1]. Accurate measurements of the total radionuclide concentration in contaminated soils are required to assess their potential risk. Migration and accumulation of contaminants (including radionuclides) in the soil-plant system is complex, involving processes such as leaching, capillary rise, runoff, sorption, root uptake and re-suspension into the atmosphere. Assessment models commonly utilize a soil-plant concentration ratio, referred to as a transfer factor (TF), to estimate the transport of radionuclides through the food chain [2]. This ratio describes the amount of radionuclide expected to enter in a plant from the soil. Factors such as soil characteristics, climatic conditions, type of plants, part of the plant concerned, physico-chemical form of the radionuclides and the interfering elements can all influence the TF values [3]. In the present study, centered on the around disused uranium mine located in the Baita region in the West of Romania, two compartments are being considered: soil and vegetation. The aim is to investigate the association of the natural uranium (^{234}U, ^{235}U and ^{238}U) with each compartment and the possible transfer between them. The vegetation samples at each point were collected from the surface the tailing near a uranium mine at which the soil sample had to be removed. In all cases, only the aerial fraction was sampled. The samples were carefully washed in the laboratory in order to remove all the adhered soil particles. Ten sampling campaigns (soil and vegetation) were performed during an one-year period. Each sample was dried at 105^0C, ground, and homogenized. Approximately 100g of samples were hemetically closed in plastic beakers and stored for about 40 days to reach radiaoctive equilibrium with the radon daughter. The plant and soil samples were analyzed by gamma-spectrometry using CANBERRA HPGe detector with carbon epoxy window, with a resolution of 1,8 keV at ^{60}Co 1332,5 keV line and approximately 50% relative efficiency, peak (59,5keV) efficiency 6,62%. Efficiencies of the detector at each photon energy are calculated using the specific software Canberra Genie 2000, ISOCS. For both type of samples the total aquisition time was 200000seconds. The radioactivity concentration of each radionuclide was calculated using the following equation [4]:

$$C_i = A/(E \times T \times P \times W)$$

where Ci is the specific activity of each radionuclide in the plant (Bq kg^{-1}), A is the counts of each radionuclide, E is the detector efficiency of the specific g-ray, P is the absolute transition probability of the specific g-ray, T is the time (s) and W is the mass of the sample (kg). Transfer factors (TFs), which are the ratios of specific activities in plant parts and soil (in Bq kg^{-1} dry weight plant part divided by Bq kg^{-1} dry weight soil) can be used as an index for the accumulation of trace elements by plants or the transfer of elements from soil to plants. The corresponding TFs of different plant parts, relating the specific activity of a given radionuclide (^{234}U, ^{235}U and ^{238}U) for every plant at each point were collected from the surface the tailing near a uranium mine. Fig 1. gives the TF values for ^{235}U and ^{238}U at each sampling point.

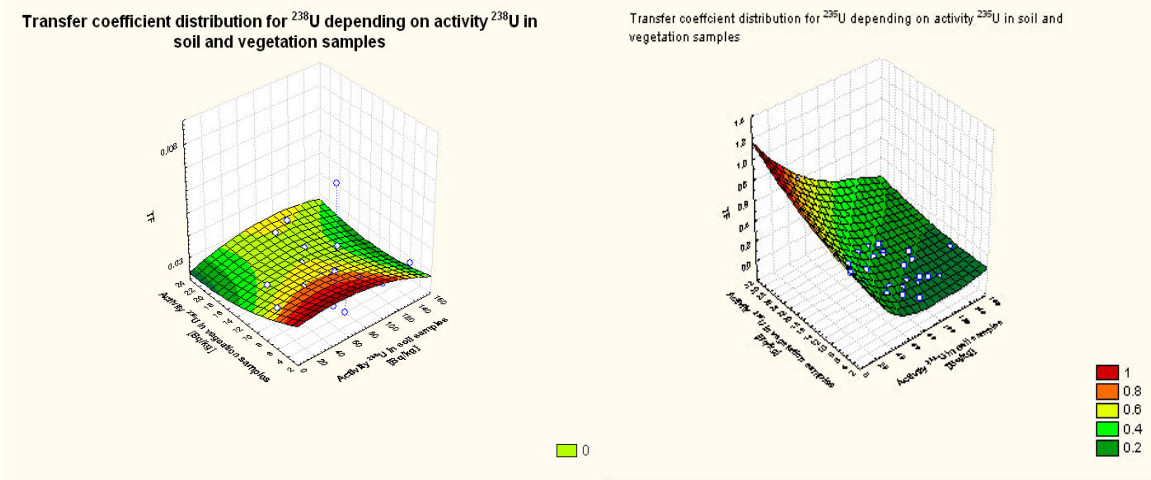

Fig. 1. Transfer coefficient distribution for ^{238}U and ^{235}U depending on activity ^{238}U and ^{235}U in soil and vegetation samples

In general, the comparative uptake of ^{238}U and ^{235}U by different plants is affected by numerous physical, chemical and biological conditions of the soil. The combined effects of these conditions, as well as the individual chemical properties of the nuclides, tend to affect its uptake by plants. Retention of radionuclides onto the soil particles will affect their availability for plant uptake. Martinez-Aguirre et al. [5] reported that ^{235}U exhibited a much lower mobility than ^{238}U, which is consistent with our observations that ^{235}U has smaller TF values. The magnitude and range of TFs of ^{238}U and ^{235}U found in this study appeared to be generally similar to values obtained in other studies. Finally, were compared to results obtained by gamma spectrometric measurements with those obtained by ICPMS at ITU Karlsruhe.

References

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