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# Improving the use of the fallout radionuclide 7Be as a sediment tracer by incorporating the hydraulic conductivity in the conversion model

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There is growing interest in the application of the natural fallout radionuclide 7Be as a soil erosion and sediment tracer. Development of robust datasets is, however, hampered by unquantified spatial variability in its distribution within the surface soil. Models that convert 7Be inventory measurements to soil erosion estimates are all based on the observed depth distribution of 7Be, described by the relaxation mass depth (h0) parameter. Previous work, however, has not considered potential spatial variation in h0 linked to variability in soil physical properties, which could have major implications for the reliability of soil erosion estimates. This work addresses the close relation between infiltration rate and the 7Be depth distribution.

During a laboratory rainfall simulation experiment, water spiked with stable 9Be was used to study the variability in 9Be depth distribution for eight compacted and eight non-compacted natural undisturbed soil cores, whereby 9Be was used as a substitute for 7Be. X-ray Computed Tomography (CT) scans were used to characterize the porosity of both groups, showing significant lower, strongly horizontally oriented, total porosity of the compacted soil cores. The average saturated hydraulic conductivity (ksat) of the different groups was 0.89 m day-1 and 17 m day-1 for the compacted and the non-compacted samples respectively. This physical compaction resulted in a clear distinction in 9Be depth distribution between both groups. With an average h0 of 4.66 ± 1.1 kg m-2, 9Be penetrated deeper in the non-compacted soil cores, while the compacted cores showed an average h0 of 2.42 ± 0.26 kg m-2. The reported h0 values at the former site were also characterized by a larger coefficient of variation (24%) than those at the latter site (11%), similar to the variations in soil structure observed by the CT-scans. Furthermore, the correlation between the hydraulic conductivity and the 9Be depth distribution is under investigation by artificially compacting 24 soil cores, the ksat of these samples after compaction ranged from 0.005 m day-1 to 14 m day-1. These soil cores are subjected to the same rainfall simulation as both groups of the natural, undisturbed soil samples. The correlation between hydraulic conductivity and the beryllium depth distribution is essential to incorporate and assess a correction factor in the conversion model to reduce uncertainty related to variations in physical soil properties.

The results of the rainfall simulations indicate the importance of selecting appropriate reference sites to encompass local variability in soil physical properties. Hydraulic conductivity assessment is showing potential as a useful approach to properly assess suitable reference sites and assign the number of samples needed to assess the reference inventory in a statistically sound manner. Furthermore a correction factor should be included in the widely used conversion model, which would incorporate the spatial variation in hydraulic conductivity across a hill slope.