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Kinetic quantification of vertical solid matter transfers in soils by a multi-tracers approach

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We will present a novel multi-tracers method - combining different isotopic systems (137 Cs, 210 Pb (xs), meteoric 10 Be, 206/207 Pb, δ13 C, 14 C) with numerical modeling based on a non-linear diffusion-convection equation with depth dependent parameters - to quantify vertical transfer of solid matter in Luvisols, namely clay translocation and bioturbation. Our results show that as much as 91 $\pm$ 9 % and 80 $\pm$ 9 % of 137Cs and 10Be, respectively, are associated with the clay size fraction (0-2 μm) and provide therefore relevant tracers to investigate vertical transfer of solid matter in soils with pH > 5 and low organic carbon contents. Lead partitioning between different solid phases is more complex. Considering two spatial distributions of isotopes (macropores or soil matrix) depending on the contribution of a fraction inherited from the loess parent material to the soil concentration, we built up a multi-tracers modeling approach that simulates the experimental data with the common set of transfer parameters and allows us to quantify the relative contributions of vertical solid matter transfers to present-day 0-2 μm vertical distributions. Clay translocation is responsible for 9 to 66 % of clay accumulation in the Bt-horizon. The diffusion coefficients quantifying the rate of soil mixing by bioturbation yields values that are significantly higher than those estimated in previous ecological studies. Modeling the kinetics of solid matter transfer at various spatial and temporal scales should become a reference method in modern pedogenic and critical zone studies.