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Why nanoplastics do not enhance the transport of contaminants in the critical zone

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The impact of nanoplastics on the co-transport of emerging contaminants is a subject of ongoing debate. Agricultural soils face potential contamination from micro- and nanoplastics through diverse agricultural practices. Various authors argue that the substantial surface area of small particles and their high sorption potential may considerably augment the mobility of numerous contaminants within the critical zone. Concerns have been expressed regarding the role of micro- and nanoplastics as carriers for organic contaminants into deeper soil layers, posing a potential threat to groundwater resources, particularly in agricultural soils where sewage sludge and plant protection products are frequently applied.

In this study, we investigated the correlation between transport and desorption timescales by employing two diffusion models for micro- and nanoplastics ranging from 100 nm to 1 mm. To assess the transport of contaminants bound to these plastics, we examined the diffusion and partitioning coefficients of prominent agrochemicals and additives, along with commonly used polymers like polyethylene and tire material. Our modeling analysis reveals that the desorption rate of most organic contaminants is too rapid for micro- and nanoplastics to serve as effective transport facilitators in soil. Notably, the transport of contaminants facilitated by microplastics was observed to be significant only for highly hydrophobic contaminants under preferential fast-flow conditions.

While micro- and nanoplastics could potentially introduce harmful contaminants into agricultural soils, our study suggests they do not significantly enhance contaminant mobility. Importantly, we found that nanoplastics, in particular, do not promote contaminant relocation under conditions relevant to almost all contaminants of concern.