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The Transport and Impact of Metal Nanoparticles in Soil

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The fate, transport and mobility of nanoparticles in soil are strongly dependent on environmental conditions. In this study we present the effect of soil properties on the transport of silver nanoparticles (AgNPs) in a set of laboratory column experiments, using different combinations of size fractions of a Mediterranean sandy clay soil. AgNPs are shown to have high mobility in soil with outlet relative concentrations ranging from 30% to 70%, depending on experimental conditions. The AgNP mobility through the column decreases when the fraction of smaller soil aggregates is larger. An early breakthrough pattern was found for the AgNP but not observed for AgNPs in pure quartz columns nor for bromide tracer in soil columns, suggesting that early breakthrough is related to the nature of AgNP transport in natural soils. Micro-CT and image analysis used to investigate structural features of the soil, suggest that soil aggregate size strongly affects AgNP transport in natural soil. These findings point to the importance of AgNP–soil chemical interactions as a retention mechanism, and demonstrate the need to employ natural soils rather than glass beads or quartz in representative experimental investigations. It is further noted that little is known about the possible effects of nanoparticles on soil chemical, physical and biological properties. Here we show that although copper oxide nanoparticles (nCuO) had little impact on the macroscopic properties of the soil, they did cause changes to humic substance structure and affected the soil bacterial community composition. In particular, the nCuO was found to have a strong effect on bacterial hydrolytic activity, oxidative potential, community composition and size in Bet-Dagan soil. These results indicate that CuO NPs are potentially harmful to soil environments. Furthermore, the results suggest that the clay fraction and organic matter in different soils interact with the nCuO and reduce its toxicity.