Engineered nanoparticle transport and interactions in partially saturated porous media

ISHAI DROR[1]*, YINON YECHESKEL[1], BRIAN BERKOWITZ[1]

[1] Department of Earth and Planetary Sciences, Weizmann Institute of Science, 7610001, Rehovot, Israel (*correspondence: ishai.dror@weizmann.ac.il)

The growing applications of engineered nanoparticles (ENPs), included in numerous products and industrial processes, are expected to spread in the near future on a global level. Along with the properties that make ENPs so appealing, the concern that they may act as a new class of persistent and toxic contaminants also arises. The post-use release of ENPs to the environment is inevitable and soil appears to be one of the largest sinks of these potential contaminants. To date, despite the significant attention that ENP behavior in the environment has received, only a few studies have considered the fate and transport of ENPs in partially saturated systems. In this presentation, we report on the transport and fate of commonly used ENPs – in partially saturated soil and sand. It is also noted that suspended ENPs may act as vehicles that mobilize other emerging contaminants in the subsurface. The results show that ENP interactions with the solid matrix and solution components affect their speciation, environmental fate and transport. Negatively-charged ENPs (AgNPs and AuNPs) are shown to be mobile in sand and soil (which is also negatively charged) under various conditions, including water saturation levels and inlet concentration. Various aging scenarios were considered and the interaction of AgNPs with sulfides, chlorides, and calcium ions, all of which are known to interact and change AgNP properties, are shown to affect AgNP fate; however, in some cases, the changed particles remain suspended in solution and mobile. Positively-charged ENPs show very low mobility, but when humic acid is present in the inlet solution, interactions leading to enhanced mobility are observed. The presence of humic acid also changes ENP size and surface charge, transforming them to negatively-charged larger aggregates that can be transported through the sand. Finally, remobilization of particles that were retained in the porous media is also demonstrated for positively-charged ENPs, indicating possible release of entrapped ENPs upon changes in solution chemistry.