

Effect of colloids on the retention and release of engineered nanoparticles in soil

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Nanoparticles (NP) like AgNP and carbon nanotubes (CNT) belong to the emerging contaminants. Column experiments were conducted to investigate the transport, retention, and release behavior of AgNP and CNT in a natural soil [1-3]. We found experimental evidence that colloids affect the retention and release of these NP.

Transmission electron microscopy, energy-dispersive X-ray spectroscopy, and correlations between released soil colloids and AgNP indicated that some of the released AgNP were associated with the released clay fraction [1]. Also in our recent study of flow interruption, the strongly increased Al and Fe concentration in the effluent suggested that soil colloids facilitated the release of AgNP (cotransport) [2]

Water-dispersible colloids (WDC) are indicators for mobile soil colloids. Therefore, knowledge of the interaction and association between NP and WDC is important for better understanding the fate of NP in soil. Analysis of CNT concentrations in different soil size fractions revealed that >24% of the retained CNT mass was associated with WDC, even though this fraction was only a minor portion of the total soil mass (2.4%). More CNT were retained on the WDC fraction in the presence of Ca²⁺ than K⁺. These findings also indicated that some of the released CNT by ionic strength reduction and cation exchange were associated with the released soil colloids, and suggest the potential for facilitated transport of CNT by WDC [3].

[1] Liang Y., Bradford S.A., Simunek J., Heggen M., Vereecken H., Klumpp E. (2013) *Environ. Sci. Technol.*, 47(21), 12229–12234

[2] Makselon J., Zhou D., Engelhardt I., Jacques D., Klumpp E. (2017) *Environ. Sci. & Technol.* 51(4), 2096-2104

[3] Zhang M., Bradford S.A., Simunek J., Vereecken H., Klumpp E. (2017) *Water Research* 109, 358-366