Correlation between attachment efficiency (α) and soil properties studying Au and Ag_2S nanoparticles

K. K. NORRFORS[1*] AND G. CORNELIS[1]

[1]Department of Soil and Environment, SLU Swedish University of Agricultural Sciences, PO Box 7014, SE-75007 Uppsala, Sweden (*correspondence: karin.norrfors@slu.se)

The attachment efficiency (α) has been suggested as the most appropriate fate descriptor for describing attachment and transport of engineered nanoparticles (ENPs) in soils. The α value is specific for the type of soil and ENPs present in the system, but a quantitative descriptions of this relationship is lacking, mostly because of large differences in the used column protocols and because homogeneous sands, rather than natrual soils are usually studied. In case of release of ENPs in terrestrial environments, estimates of the overall attachment of ENPs in different soil types are, however, necessary in the context of risk assessment.

In this work, attachment of nominally 20 nm and 80 nm citrate coated Au ENPs and 27 nm PVP coated Ag_2S ENPs was studied in five soils sampled in UK with varying properties. Saturated column tests were used to estimate the α values where artificial rainwater was used as an eluent. α was calculated using five different approaches: (i) from the total recovery of Au or Ag in the breakthrough curves [1], or from the attachment rate constant (k_{att}) modelled using Hydrus 1D assuming one irreversible site fitted to data from (ii) the breakthrough curve /or (iii) the depth profile [2], or including straining in the models for estimating α from k_{att} fitted to data from (iv) the breakthrough curve or (v) the depth profile.

The α values appear highly dependent on the pH and the zeta potential of the specific soil, as also described by Babakhani et al [3]. The α values increases with decreasing zeta potential in the soils. This indicates that the attachment is mainly controlled by electrostatic interactions between the ENPs and the soils. In addition, the α values for 80 nm AuNPs are higher than the α values for 20 nm AuNPs. No correlation was found between α and other soil properties.

[1] Harvey, R. W. and Garabedian, S. P., Environmental Science & Technology 1991, 25, (1), 178-185.

[2] Praetorius, A. et al., Environmental Science: Nano 2014, 1, (4), 317-323.

[3] Babakhani et al., Water Resour. Res., 2017, 53, 4564-4585.