Translocation of synthetic inorganic nanoparticles in a water-saturated sediment column

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Breakthrough of synthetic, inorganic nanoparticles (NP) in porous media observed in laboratory experiments [1] raises the assumption of NP posing a risk to drinking water treatment methods [2] such as riverbank filtration. Hence, the aim of this experiment was (i) to gain first hints on the fate of NP under near-natural conditions and (ii) to understand the processes of NP interactions taking place in the water phase and the sediment.

Four types of NP (TiO_2, Ag(0), CeO_2, Sb_2O_5) were suspended in the supernatant of a water-saturated sediment column (1 m length) implemented into a slow sand filtration pond. The column was filled with coarse-grained medium sand and was fed with surface water (pH 7, 8, I = 19 mM, turbidity = 3 FNU) from the surrounding pond. The column was sampled in various depths (20 cm, 40 cm, 60 cm, 80 cm) and at the outflow. The NP were fractionated by filtration (0.45 μm and 0.1 μm) and the respective analytes (Ti, Ag, Ce, Sb) were determined using ICP-MS.

In the water phase, NP concentrations were reduced by a factor of 1000 due to particle aggregation, which was predominantly caused by an increase in ionic strength in relation to the original NP suspension. This resulted in a shift of the particle size distribution towards larger sizes and NP were found to form hetero-aggregates with suspended particulate matter. Our observations demonstrate that hydrochemical conditions substantially affect size distribution and aggregation of the investigated NP.

In the sediment, Sb_2O_5, the NP with the most negative zeta potential, was the only NP showing breakthrough (up to a depth of 40 cm). This result confirms that the zeta potential is a key factor in NP suspension stability. The various conditions led to a change in particle size distribution during sediment passage, too. The processes which play a key role in NP translocation remain to be elucidated.

[1] Torkzaban, Kim, Mulvihill, Wan & Tokunaga (2010) *Journal of Contaminant Hydrology* **118**, 208–217. [2] Boxall, Tiede & Chaudhry (2007) *Nanomedicine* **2**, 919–927.

The role of mineral surface chemistry in the prebiotic selection of pentose sugars

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Pentose sugars are major biochemical building blocks. Prebiotic syntheses have been proposed leading to complex mixtures including 4-, 5-, and 6-carbon sugars [1, 2]. However, the pentose sugar D-ribose has the greatest biological importance because it is the sugar found within modern nucleic acids. We are investigating whether this is due to some exceptional characteristic of ribose associated with its interaction with mineral surfaces.

Recent study of the adsorption of nucleosides and nucleotides on rutile [3] indicates that adjacent OH-groups on the ribose part of these molecules play a critical role in the attachment to mineral surfaces. The four pentose sugars ribose, xylose, lyxose and arabinose differ only in the arrangement of the OH-groups and their stereochemistry in solution. This suggests that the different structures of these sugars might lead to selective adsorption on mineral surfaces.

The present study is focused on interactions of D-ribose and D-xylose on rutile (α-TiO_2, pH_{PPZC} = 5.4, BET = 18.1 m^2/g) in 10 and 100 mM NaCl solutions over a wide range of pH conditions (3-10). The rutile powder is the same as previously used for amino acid adsorption studies [4]. Batch adsorption experiments of the two sugars individually and in mixtures indicate that adsorption of both sugars increases with increasing pH of the solution. The pH dependancy of adsorption is more pronounced for ribose leading to a difference of ~20% adsorbed at pH > 8.5. Our preliminary results indicate a significant difference in the adsorption behavior of the two sugars.

[1] Springsteen & Joyce (2004) *J. Am. Chem. Soc.* **126**, 9578–9583. [2] Shapiro (1988) *Origin Life Evol. Biosphere* **18**, 71–85. [3] Cleaves *et al.* (2010) *Astrobiology* **10**, 311–323. [4] Jonsson *et al.* (2009) *Langmuir* **25**, 12127–12135.