Effectiveness of riverbank filtration for silver nanoparticle retention

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Riverbank filtration systems are important natural systems that ensure the cleaning of surface water for producing drinking water. The effectiveness of riverbank filtration in removing pollutants such as silver nanoparticles (Ag NP) is therefore of high importance. In our study, we investigated the potential risk of Ag NP transport through these systems. Specifically, we studied the influence of natural organic coating of NP on the transport as well as the role of biofilms in riverbank sediments on the retention of Ag NP under natural conditions. With ecotoxicological tests we analyzed the effect of riverbank filtration on the toxicity of the NP suspensions.

Uncoated and natural organic matter- (NOM) coated Ag NP (1 mg l^{-1}) were applied to water-saturated quartz sand columns (length 1.5 m, diameter 1 m), simulating a riverbank filtration scenario. Aqueous samples were taken over a period of 1 month in different depths of the column (i.e 0.15, 0.3, 0.6, and 0.9 m). Sediment samples were taken at the end of the experiments and Ag concentrations were measured in water and sediment samples by ICP-MS. Ecotoxicity on *Daphnia magna* was tested for water samples collected in 0, 15, 30, and 90 cm depth of the column. The influence of biofilms on NP transport will be investigated in laboratory column experiments (length 15 cm, diamter 4.7 cm).

High Ag contents in the sediment indicated a low mobility of Ag NP and an accumulation of NP in the upper 7 cm of the column. While uncoated Ag NP were not measured in any water samples, low amounts of NOM-coated NP broke through in 15 and 30 cm depth. The ecotoxicity of the NP suspension entering the column was very high, but no adverse effects were observed after riverbank filtration. Laboratory column experiments are expected to confirm the important role of biofilms for the retention of NP in natural sediment systems.

We conclude that the natural filtration mechanisms of riverbank filtration systems are effective for the retention of Ag NP, even though a coating with NOM can enhance NP mobility. The transport through sediment systems reduces the toxicity of Ag NP suspensions rapidly, most likely by attachment of NP to biofilms and sediment surfaces.