Settling of superparamagnetic silica encapsulated DNA microparticles in river water

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Abstract

Particle tracers are sometimes used to track sources and sinks of riverine particulate and contaminant transport. A potentially new particle tracer is ~200 nm sized superparamagnetic silica encapsulated DNA (SiDNAFe). The main objective of this research was to understand and quantify the settling and aggregation behaviour of SiDNAFe in river waters. Our results indicated, that in quiescent conditions, more than 60% of SiDNAFe settled within 30 hours, starting with a rapid settling phase followed by an exponential-like slow settling phase in the three river waters we used (Meuse, Merkske, and Strijbeek) plus MilliQ water. From this, we inferred that the rapid SiDNAFe settling was mainly due to homo-aggregation and not due to hetero-aggregation (e.g., with particulate matter present in river water). Incorporating a first-order mass loss term which mimics the exponential phase of the settling in quiescent conditions seems to be an adequate step forward when modelling the transport of SiDNAFe in river injection experiments. Furthermore, we validated the applicability of magnetic separation and up-concentration of SiDNAFe in real river waters, which is an important advantage for carrying out field-scale SiDNAFe tracing experiments.

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