Fate of TiO$_2$ nanoparticles in carbonate and silicate aquifers

RONCHI, B., JORIS, A., JAMIN, P., BROUYÈRE, S., VESCHKENS, M., FRIPIAT, C.

1. Objective

To assess the vulnerability of silicate and carbonate aquifers to the contaminant of emerging concern nano-sized TiO$_2$ (nTiO$_2$), its stability is evaluated in different types of water pumped from carbonate and silicate aquifers and in Milli-Q water. In addition, its behaviour in saturated porous media is evaluated using column test with glass beads, carbonate sands and silicate sands.

3. Stability test

Two replicates suspensions of nTiO$_2$ were prepared in 2 types of natural groundwater (filtered at 0.45μm) and Milli-Q water. Concentrations of TiO$_2$ in the supernatant is analysed over time (ICP-OES; HF/HNO$_3$/H$_2$BO$_3$).

4. Column test

12 cm long-columns are filled with carbonate sands, silicate sands or glass beads. Air was first flushed with CO$_2$, then with water.
1. First a conservative tracer is injected at a flow rate of 4ml/min.
2. Then, a suspension of 150mg/l of nTiO$_2$ in Milli-Q water at pH 3.1 is injected at the same rate.
3. The outflow is analysed by ICP-OES after a triacid digestion (HF/HNO$_3$/H$_2$BO$_3$) procedure.

5. Conclusion

- nTiO$_2$ sedimentation is 2-3 orders of magnitude faster in neutral natural groundwater than in acid Milli-Q water.
- The transport of theses nTiO$_2$ is limited in sandy media by filtration, as nTiO$_2$ aggregates have large diameters.
- The mix of natural minerals in silicate and carbonate sands attenuates naturally nTiO$_2$ transport.
- Questions for future research: study accumulation of nanoparticles in top soils and the evolution of its pollution front.

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