Variations in anthropogenic release and distribution of titanium dioxide nanoparticles in a river near an industrial site

Danielle Slomberg[1], Nelly Guéniche[2], Bernard Angeletti[1], Mélanie Auffan[1,3], Olivier Aguerre-Charriol[4] and Jérôme Rose[1,3]

[1] CEREGE, Aix-Marseille Université, CNRS, IRD, Collège de France, INRA, Aix-en-Provence, France
[2] Université de Rennes, Rennes, France
[3] Labex Serenade, Aix-en-Provence, France
[4] INERIS, Verneuil en Halatte, France

Several industries manufacture and process large quantities of engineered nanomaterials to fabricate their products, thus increasing the potential for their environmental release during waste management and disposal. Herein, we quantified the release and distribution of titanium dioxide (TiO_2) particles emitted from an industrial waste stream that flows into a nearby river, analyzing both surface waters and sediments. Heavy and trace metal concentrations were also measured as indicators of anthropogenic pollution.

Two sampling campaigns were carried out on the river in October 2017 (fall) and March 2018 (spring), with surface waters and sediments sampled from 9 selected sites both upstream and downstream of an industrial canal and 2 wastewater treatment plants (WWTPs). Waters were collected and filtered on-site (0.2 and 0.02 µm) to distinguish between particulate, colloidal, and dissolved TiO_2. Sediments from each site were recovered from the top layer, sieved, and dried. All samples were then homogenized as necessary, submitted to total acid digestion, and analyzed for Ti and heavy and trace metals with ICP-MS.

As shown in Figure 1, a large TiO_2 input from the industrial canal and 2 WWTPs was observed for raw surface waters sampled in the fall. Anthropogenic TiO_2 inputs were not as evident in waters sampled in spring, possibly due to waste disposal management or dilution from snowmelt.

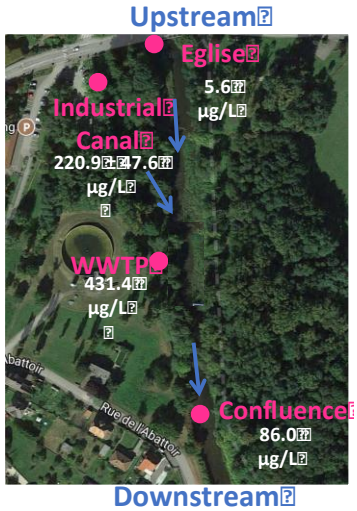

Figure 1: TiO_2 concentrations (µg/L) measured in raw river surface waters in October 2017.

TiO_2 concentrations measured in the dissolved fraction were negligible, thus confirming that the majority of emitted TiO_2 is in particulate form. For the sediment samples, significant increases in TiO_2 were measured in both fall and spring at the industrial canal and WWTP sites. Ratios between concentrations of Ti and other naturally occurring elements (e.g., Al, V, and Fe) were also calculated as an added support for anthropogenic TiO_2 emission. Thus, there is an important release of particulate TiO_2 from both the industrial canal and WWTPs into the river, with the majority of particles sedimenting rapidly near the emission source. Current work is underway to assess what fraction of these emitted particles lies in the colloidal size range.

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