Aggregation of $nTiO_2$ and illite colloids: effect of co-presence of phosphate and calcium

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The stability and aggregation of nanoscale and colloidal-sized fine particles, which are commonly found in soil and groundwater, have important implications to water quality and contaminant transport. Extensive studies have been conducted on the aggregation of nanoscale titanium dioxide particles ($nTiO_2$) and illite colloids under simple water chemistry conditions. In natural aquatic systems, however, water chemistry could be complicated and suspended $nTiO_2$ and illite particles could encounter multiple water components simultaneously, yet, the combined effects of some components have not been investigated. In this study, the aggregation of $nTiO_2$ and illite colloids was examined in the presence of phosphate (0.1 mM) and Ca ions (0.5 mM) at different pH and under low ionic strength conditions (1.5 mM). Results obtained from the batch experiments indicated that the hydrodynamic diameter of the $nTiO_2$ was strongly influenced by phosphate and Ca ions, which both modified $nTiO_2$ surface charges. Calcium cations also had a substantial effect on the zeta potential of $nTiO_2$ at pH 9 where the particles were positively charged for any phosphate concentration up to 0.1 mM. Illite aggregation was studied under the same water chemistry conditions. Results showed that illite colloids carried negative charge at pH 5 and 9 and the presence of phosphate and Ca did not have a substantial effect on the zeta potential and hydrodynamic diameter of the particles. This study revealed that the combined effect of Ca and phosphate on the aggregation of the $nTiO_2$ can be different from that of their individual influence. In addition, natural suspended particles, including illite, can be much less sensitive to the water chemistry compared to the engineered metal nanoparticles such as $nTiO_2$. These findings are important for understanding of the fate and transport of $nTiO_2$ and illite in natural aquatic systems where various anions and cations coexist.

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