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Interaction of emerging contaminants (nanoplastics) with minerals of varying weathering sequence in aquatic and subsurface environments.

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Accumulation of emerging contaminants i.e., nanoplastics (NPs) in freshwater and soil has increased drastically and become a global concern. However, the majority of research has been focused on the marine environment. Rock and minerals undergo continuous weathering in both aquatic and subsurface environments releasing colloidal mineral particles. Their transformation of mineral particles over time defines mineral weathering sequence and may further impact the fate of NPs. Mimicking the natural phenomenon, for the first time, we investigated NPs interaction with a typical weathered sequence of silicate and iron oxide minerals (IOMs) under varying environmental conditions. The impact of environmental parameters like varying ionic strength, pH, humic acid, and natural aqueous matrix, i.e., river water, on the mineral-NPs interaction was studied in detail. Adsorption isotherm results revealed that gibbsite and primary iron oxide minerals exhibit maximum sorption of NPs due to their smaller size, higher positive surface charge, and surface hydroxyl functionality. Whereas, continuous adsorption-desorption and limited sorption capacity of feldspar and kaolinite can be attributed to their negative surface charge, larger size, crystalline nature, and physical sorption. The achievement of a point of zero charge in gibbsite-NPs and magnetite-NPs bimodal system suggests the coagulation and sedimentation of NPs in the presence of gibbsite and magnetite. Further, column experiments were performed to understand the impact of iron oxide mineral-coated sand on the transport of NPs in subsurface conditions to elucidate the subsurface migration of NPs. Results revealed higher NPs retention in IOMs coated sand compared to bare quartz sand. Also, maximum NPs retention (>80%) in magnetite-coated quartz sand column, suggested a limited risk of NPs mobility in the subsurface conditions. Overall, this study improved our understanding of the role of weathering mineral sequence on the transport of NPs in surface and subsurface environments, highlighting the NPs fate in rivers and groundwater.