

Minerals and mineral-organic complexes as key factors in nanoplastic transport and retention in the riverine and terrestrial environments

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A comprehensive study of nanoplastics (NPs) interactions with organic and inorganic colloids (minerals) is of great significance for understanding NPs fate and transport, ultimately aiding in the mitigation of environmental and human health risks [1-3]. In the realistic environment, minerals are often associated with organic matter and form organo-mineral complexes (OMCs), exhibiting different reactivity than their pure mineral phase. Current work focuses on understanding NPs interaction with abundantly occurring ferrihydrite (Fh), its subsequent weathered mineral goethite (Goe) and their respective organic complexes (i.e., Fh-OM and Goe-OM) under varying environmental parameters. Results showed that the pure minerals (Fh and Goe) phase showed maximum interaction compared to their respective mineral-organic complexes. Zeta potential and sedimentation kinetic studies suggested higher heteroaggregation and coagulation in the goethite-NPs bimodal system. FTIR analysis of reaction mixture precipitate revealed the vital role of surface functionality in NPs-mineral/OMCs interaction.

In a natural environment, surfaces of granular media are frequently coated with Fe/Al oxy-hydroxides. Column transport experiments were performed to mimic the subsurface media and delineate the role of Fe/Al oxy-hydroxides coated sand on the E-MNPs transport behavior with varying environmental parameters using breakthrough curves (BTCs). Column transport experiments revealed that minerals/OMCs coated sand showed higher NPs retention than bare quartz sand under different pore water chemistry. Ferrihydrite and goethite coated sand columns have shown maximum NPs retention. Our study provides insight into environmentally relevant mineral phases and OMCs impact on the fate and transport of NPs in aqueous and terrestrial environments.

1. Aniket, C., et al., (2022), Science of The Total Environment, 818,151831.

2. Aniket, C., et al., (2024), Science of The Total Environment, 912, 169132.

3. Aniket, C., et al., (2025), Marine Pollution Bulletin, 212, 117560.