

EGU2020-14509

<https://doi.org/10.5194/egusphere-egu2020-14509>

EGU General Assembly 2020

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Heteroaggregation of micro-polystyrene in the presence of amorphous iron hydroxide (ferrihydrite)

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Plastic pollution in the marine and terrestrial environments is ubiquitous and a widespread problem. While the occurrence of plastics and microplastics, as well as their effects on marine and freshwater organisms, have already been investigated in numerous studies, so far only little attention has been paid to the fate, transport, and transformation processes of microplastics in the environment. In this work, the aggregation behavior of polystyrene (PS) microplastics in the presence of ferrihydrite, a natural inorganic colloid, was studied using zeta potential and hydrodynamic diameter measurements, as well as scanning electron microscope (SEM) techniques, considering the influence of pH and ionic strength. An increase of pH led to a more negative surface charge of PS. Furthermore, increasing concentrations of NaCl and CaCl₂ showed that mono- and divalent cations influence the zeta potential in a different way. Divalent ions compress the electric double layer more efficiently compared to monovalent ions, which resulted in a decrease of repulsive forces. Studies on the heteroaggregation between PS and ferrihydrite showed that the highest aggregation took place at neutral pH values. Aggregate sizes in samples with neutral pH increased significantly compared to more acidic and alkaline pH values. Furthermore, the results indicated that at neutral pH values, ferrihydrite completely covers the PS surface. SEM images and hydrodynamic diameter measurements revealed that the heteroaggregation between PS and ferrihydrite increased with ionic strength. Our results demonstrate that the fate of microplastic particles in aquatic systems can be strongly influenced by natural colloidal water constituents, such as iron hydroxides.