Heteroaggregation of PS microplastic with ferrihydrite leads to rapid removal of microplastic particles from the water column

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Abstract

Pollution with plastic materials has emerged as one of the most relevant current and future environmental problems. In the last few years, research focused predominantly on the occurrence and distribution of microplastics (MP) in the environment. Only recently, a more fundamental understanding of MP behaviour in the environment has started to attract attention. Transport and removal processes of MP in the water column are strongly controlled by interaction with environmental particles, such as ferric (oxy)hydroxides. However, our understanding of the mechanisms controlling aggregation and subsequent sedimentation of MP during interactions with multivalent oxides is still limited. Here, we analysed the heteroaggregation of 1 μm polystyrene (PS) particles and ferrihydrite, a common naturally occurring ferric (oxy)hydroxide. Furthermore, we performed sedimentation experiments in which PS and PS + ferrihydrite were analysed in settling columns after 1 day and 1 week of settling time. The presence of ferrihydrite increased sedimentation rates of PS at all pH values studied (pH 3-11). At pH 6 we found that almost all PS particles were removed from the water column after only one day of exposure time. For the same samples, SEM/EDS imaging and particle size measurements confirmed strong heteroaggregation between PS and ferrihydrite. At acidic pH values, zeta potential measurements indicated that the negatively charged PS surface was coated with positively charged ferrihydrite particles leading to charge reversal. Our results demonstrate for the first time that ferric (oxy)hydroxides drive heteroaggregation and subsequent removal of MP from the water column, especially at typical pH values found in natural lake environments. Given their abundance in aquatic systems, ferric (oxy)hydroxides need to be regarded as key scavengers of MP.

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