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The influence of biofilms and mineral loading on marine plastic fate

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Plastic pollution is a global concern and potential marker of the Anthropocene, yet controls on the environmental fate of this contaminant remain underexplored. Synthetic polymers emitted to aquatic systems undergo chemical, physical and biological forces that affect their weathering, aggregation, degradation, leaching, transport and burial. In the aquatic environment, plastic surfaces attract both biological and mineralogical loading. The presence of biofilm on marine plastics suggests a significant microbial role in the fate of plastic in this new ecological niche, called the Plastisphere. Microorganisms may influence degradation, transport and burial of plastic in the sediment, but also plastic´s incorporation into biogeochemical cycles. Likewise, mineral crystallization on plastic surfaces (i.e., phosphate, iron – rich) induced by microbial processes or formed abiotically may play an important role in plastic aggregation, transport, degradation and burial of meso- to nanoscale size plastics.

Here, we present our current field and laboratory investigations of biological and mineralogical loading of plastics in various geochemical settings. We combine bioimaging (He-ion microscopy (HIM), Scanning Electron Microscopy-Energy Dispersive X-Ray Spectroscopy (SEM-EDS), microbial community and eco-physiology studies, as well as elemental analysis to test mechanisms of loading on plastics, aggregation, transport, and potential impact on element cycling. Results of an on-going in situ study of polystyrene (PS), polyethylene (PE), marine paint, and wood exposed in Svanemøllen Harbor, Copenhagen and laboratory experiments are described. We explore whether surface characteristics and biogeochemical setting are important drivers for the development of mineral-rich biofilm and the role of these mineral-microbe associations in the fate of plastics.