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Organic additive release from benthic plastic debris through the sediment towards the water column

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The hypothesis of the sediment as a sink for plastic debris in the marine environment is increasingly considered by the scientific community.[1-2] The sediment is otherwise recognized as a reactor for the degradation of organic matter via biogeochemical reactions occurring along with early diagenesis. These processes could thus favor the degradation kinetics of plastics and release of toxic additives that constitute on average 6% of the mass of plastics produced worldwide.[3] The questions driving the present work are: is the sediment a biogeochemical compartment where plastic aging is enhanced? Is the sediment a non-point source of plastic additives including phthalates, OPEs, bisphenols and their transformation products to the water column? These questions were addressed for the first time using an experimental pilot under laboratory-controlled conditions (temperature, light, oxygen, redox conditions) involving homogenized defaunated marine sediment enriched with reference polyethylene and reference additives. The objectives were to i) characterize the role of the main sedimentary biogeochemical processes on the degradation kinetics of plastic particles, ii) quantify the release of additives from plastic particles to the sediment, and iii) quantify the fluxes of additives from the sediment porewaters to the water column. Here, we present the preliminary results obtained after one year of exposure including the identification of additives contained in the reference plastics material by liquid chromatography coupled with time-of-flight mass spectrometry (LC-QTOF) and their subsequent analysis in the different compartments of the experimental microcosm (supernatant water, solid sediment and pore water in oxic, sub-oxic and anoxic layers). We assume otherwise to observe i) a slight aging of the plastic particles in terms of oxidation, density increase, fragmentation and loss of flexibility, ii) a release of additives at the sediment oxic layer, iii) a preferential degradation of organic additives at the sediment oxic layer, and iv) a flux of organic additives and their degradation products at the sediment/water interface.

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