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Bioavailability and remineralization of sediment-derived dissolved organic carbon from the Baltic Sea depositional area

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Sediment pore waters in the depositional areas of the Baltic Sea are enriched with the dissolved organic carbon (DOC), which results in a diffusive flux of DOC to the water column. It was found that up to 30% of OM deposited in the sediments returns to the water column and may alter processes occurring there e.g. increase the oxygen demand in the bottom waters. Still little is known about the bioavailability of sediment-derived DOC and its remineralization dynamics. Thus, the aim of this study was to assess the bioavailability, degradation rate constant and half-life time of sediment-derived DOC.

Bottom water and pore water, collected during r/v Oceania cruise in March 2018 in the Gdańsk Deep, have been mixed in a volume ratio of 4:1. To ensure oxic conditions in the experiment, the mixture was bubbled with the ambient air to reach 100% O_2 saturation. Incubation of such prepared samples was conducted in 23±0.1°C for 126 days. At the beginning (t=0) and after 1, 2, 6, 18, 35, 73 and 126 days of the incubation the individual samples were analyzed for total dissolved organic carbon DOC. In parallel, untreated bottom water was incubated as a control, while the obtained results have been used to decouple the remineralization dynamics in the mixture.

The DOC decay had an exponential character. The highest dynamics of DOC remineralization was at the beginning of the experiment and it gradually decreased over time. During the incubation period pore water DOC concentration decreased from 1408 to 850 µmol l^{-1}, which corresponds to almost 40% loss. In the control samples (bottom water) DOC concentration decreased from 304 to 260 µmol l^{-1} i.e. by ~14%.

In the experiment three different DOC fractions have been identified: labile DOC (DOC_L), semi-labile DOC (DOC_{SL}) and refractory DOC (DOC_R). To quantify the DOC remineralization rate constants (k) and half-life times ($t_{1/2}$) the first order kinetics was used. The total bioavailable fraction of pore water DOC (DOC_L+DOC_{SL}) amounted to 54%, while k and $t_{1/2}$ were 0.0958 d^{-1} and 7.24 d for DOC_L and 0.0082 d^{-1} and 84.53 d for DOC_{SL}, respectively.

This study shows that about half of sediment-derived DOC is bioavailable, which gives a new insight on the Baltic Sea carbon cycle and O_2 consumption in deeper water layers.