Efflux of Metals from Contaminated Marine Sediments due to Bacterial Remineralisation of Phytodetritus

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Introduction: Large phytoplankton blooms occur each year on the Belgian Continental Zone (BCZ). These blooms are mainly composed of diatoms and *Phaeocystis globosa* and it was estimated that 24% of the phytoplancton production is deposited onto the sediments of the BCZ [1]. Many areas of the BCZ are composed of muddy sediments and are highly contaminated by metals and metalloids (As, Cd, Pb, Ni, etc.) [2, 3]. Previous studies have suggested that sedimentation of fresh particulate organic matter (POM) derived from phytoplankton blooms might cause metal effluxes on the BCZ [3]. However the type of metals released and the importance of such effluxes has not been measured. The aim of the present research is to investigate these trace metal effluxes during phytodetritus remineralisation on the BCZ using metal contaminated muddy sediments in a microcosm approach.

Methods: Sediments were collected on the BCZ by a Reineck corer (diameter 30 cm) at station 130 (51°16.25 N - 02°54.30 E; depth: ± 11 m) in March 2010. Station 130 is one of the most contaminated subtidal station of the BCZ [2, 3]. Undisturbed cores were immediately transferred into 18 cylindrical plexiglass microcosms of the same diameter (30 cm) together with 4 cm of overlaying seawater. Two independant 20 liters cultures of unicellular algae were prepared : *Phaeocystis globosa* (a Prymnesiophyte) and *Skeletonema costatum* (an early spring diatom). Cultures were mixed and deposited onto the sediments in the microcosms. Seawater was deposited on the controls. The proportion of the two algae in the algal suspension was 50:50 (w/w), the final chlorophyll a content was 750 ± 35 μg L^{-1} (mean ± SD). Microcosms were then incubated in the dark at 15°C and sampled after 2h, 2 days (Day-2) and 7 days (Day-7). Geochemical parameters were followed : Eh and pH profiles, oxygen levels at the interface, salinity of the overlying seawater, chlorophyll a in sediments, dissolved organic carbon (DOC) in porewaters, metals in seawater, and metals in porewaters as determined by the DET and DGT approaches. Microbial parameters included bacterial and nanoflagellates biomass (DAPI counts) and three bacterial activity measurements : tritiated thymidine incorporation (3HT), fluorescein diacetate analysis (FDA), and community level physiological profiling (CLPP). All analyses were performed on the 0-5 mm layer of the sediments.

Results: Profiles of pH were altered (slight but significant acidification). DET and DGT approaches revealed that porewater metal profiles were deeply modified by the bacterial mineralization of the phytodetritus accumulated at the surface of the sediments when compared to controls (Fig. 1). Co, Mn and As were released into the overlying water.

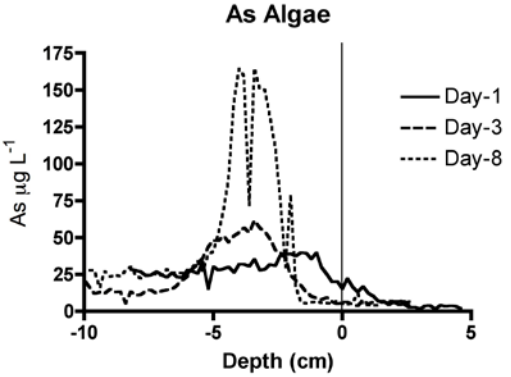

Fig.1. DET profile for arsenic in a microcosm exposed to the phytodetritus.

DAPI counts were significantly increased at Day-7 ($2.9.10^9$ cells to $3.8.10^9$ cells g^{-1} dw). FDA activity was significantly increased at Day-7 (2 times). CLPP was significantly modified at all sampling points and bacterial production was significantly increased at Day-2. All this demonstrates bacterial activity.

Discussion: This study shows that deposition of phytodetritus on metal contaminated muddy sediments may lead to the subsequent release of toxic metals into the overlying water. This is a problem as phytoplankton blooms are frequent on the BCZ.

References: [1] Lancelot et al. (2005) *Mar Ecol Prog Ser* **289**:63-78; [2] Gillan & Pernet (2007) *Biofouling* **23**:1-13; [3] Gao et al. (2009) *Mar Chem* **117**:88-96.