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IMMOBILIZING SEDIMENT NUTRIENTS, HYDROPHOBIC ORGANIC CONTAMINANTS, AND METALS USING A DUAL-SORBENT THIN-LAYER CAP.

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Following increasing anthropogenic pressures on coastal ecosystems areas of polluted sediments are expanding and pose a toxicity risk to marine biota, and ultimately to humans. The traditional way of remediating polluted sediments, i.e., dredging, is obsolete due to severe ecosystem impact and high costs. Hence, there is an urgent need for more environmentally friendly, cost-efficient sediment remediation techniques. Here, we present a new sediment remediation method in situ by amending the surface sediment with a thin-layer (1-2 cm) dual-sorbent cap comprised of activated carbon (AC) and an activated calcium-silicate material (Polonite). AC is an effective sorbent of hydrophobic organic contaminants (HOC) and well-studied in the context of thin-layer capping. Polonite is a filter material for waste-water, recently proposed for use on sediment to sorb phosphate and metals.

In a series of mesocosm and laboratory batch experiments we have investigated the AC+Polonite cap and its performance in reducing sediment-to-water fluxes of phosphate, HOC, and metals from heavily contaminated Baltic Sea sites. Importantly, our studies have also focused on contaminant bioavailability and side effects from the treatment, e.g., on sediment biogeochemical processes and response of benthic organisms. Since the AC used in sediment remediation predominantly has been of fossil origin (anthracite), we have tested new activated biochars (waste timber) as a more environmentally friendly alternative to fossil AC.

Our results show that the dual-sorbent thin-layer cap reduces sediment release of phosphate, HOCs, and metals (Figure 1), and also reduces HOC and metal bioavailability, measured as a solubilized fraction in artificial polychaete (sediment feeding worm) gut fluid. Side effects have also been detected, such as increased methanogenesis in eutrophic and low-oxygenated sediment (Figure 1), and increased gut fluid bioavailability of nickel.

Overall, these studies demonstrate the potential of sediment amendment with innovative and environmentally friendly reactive sorbents to stem pollution from sedimentary sources, but also highlight the importance of investigating possible ecological side effects on, for instance, sedimentary microbial processes.

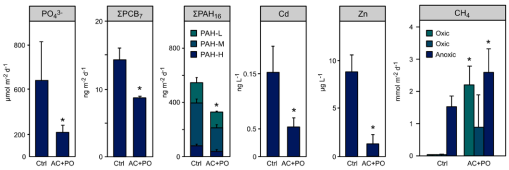

Figure 1. Sediment from a contaminated Baltic Sea-bay was sampled using sediment cores and treated with the dual-sorbent thin-layer cap (AC+PO). Ctrl = untreated control. The cores were incubated to measure sediment-to-water release of phosphate (PO_4^{3-}), seven polychlorinated biphenyls (ΣPCB_7), 16 polycyclic aromatic hydrocarbons (ΣPAH_{16}), cadmium (Cd), zinc (Zn), and methane (CH_4). Methane release was measured under three incubations with varying oxygenation of the water column, from oxic to anoxic.