Pollutants in ocean-floor sediment

New measurement methods to protect the marine environment

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What kinds of contaminants are enriched in sediment – and are these then absorbed by the organisms that live there? What role do microplastics play? To answer these questions, Professor Gesine Witt's team is using pollutant samplers made from silicone-coated glass fibre to investigate the sea floor. And not just as research for research's sake but because the protection of our environment is a top priority.

The Stockholm Convention on Persistent Organic Pollutants (POPs) mentions several chemicals that are extremely harmful and presents the twelve most dangerous substances of all as a list known as the "dirty dozen". These pollutants are extremely long-lived (persistent), which enables their concentrations to increase along the food chain (bioaccumulation), and have a highly toxic, carcinogenic and genetically harmful effect on organisms. Their persistence also means that they can spread worldwide from their point of origin ("grasshopper effect"). Familiar examples include the polychlorinated biphenyls (PCBs) produced until a few decades ago or the pesticide dichlorodiphenyltrichloroethane (DDT), a chemical still used in Africa to control the Anopheles mosquito, which is a carrier of malaria.

Many organic substances that have long since been banned in Germany continue to enjoy widespread use around the world. This makes the ban only marginally effective: damage control and damage prevention must make a far greater impact if they are to contribute effectively to the preservation of the environment.

Innovative pollutant samplers

The work of our research unit at the Department of Environmental Engineering is focused on one aspect of environmental pollution, namely the investigation of pollutants in the sediment on the sea floor. Our team has developed a new kind of pollutant sampler consisting of microscopic, silicone-coated glass fibres of a kind typically used in data communications. Silicone is especially suitable for this task since this polymer can absorb pollutants from the sediment pore water in a way similar to that found in lugworms or shellfish. In our samplers, the persistent organic pollutants diffuse into the silicone coating, where they are then absorbed.
The absorption of the analytes dissolved in water is a diffusion process in which the silicone only takes up pollutants also capable of passing through the cell membranes of living organisms. In this way, POPs are absorbed from the sediment only if they are also biologically available to the sea creatures that live there.
In our studies to date, the collector has proved to be a low-cost and zero-energy solution that is rugged enough

for everyday use while also offering greater precision than the results returned by conventional analysis.

How is the solution used in practice? What are the benefits? After these samplers have spent three months in the sediment absorbing pollutants, they are tested in the lab. The sampler silicone-coated fibres require no additional sample preparation: they are simply placed directly in the gas chromatograph's liner for analysis. Alongside the automation of fibre injection, this procedure also guarantees loss-free chemical analysis with a high level of reproducibility for pollutant testing. The thermal desorption process involves the analytes being desorbed directly into the GC column, i.e. without a transfer line. Mass spectrometry is then used for pollutant identification and quantification. An analysis of the sampler replicas ensures the reproducibility of the measurement. Since the entire process is fully automated, even the analysis of a large number of samples is nonetheless a low-cost, rapid procedure. This facilitates the comprehensive investigation of sediments from entire ocean regions.

To test the effects of the toxic POPs collected by the silicone, the contaminated samplers are introduced in parallel into biological test systems. Since silicone is itself chemically inert and non-toxic in biological tests, a toxic reaction from bacteria, algae or fish eggs – such as reduced growth rates or deformities – means that a threat to the marine environment from the sediment is also highly probable.

By using the results obtained from experiments conducted by our research team, input sources can be estimated very quickly for the sediment, as can the level and risk of contamination. Thanks to our basic research in this area, we have taken a decisive step towards the goal of protecting the environment and thus satisfying the requirements of the 2008 European Marine Strategy Framework Directive (MSFD).

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Bibliography
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The article is also available online from the q&more-Portal
- **www.bit.ly/qmore-1502-11**

Taking samples from the Saaler Bodden in Althagen harbour.
Photo: © S. Teichmann

Gesine Witt studied technical and analytical chemistry at the University of Greifswald before completing her doctoral studies and her habilitation at the University of Rostock. Her work as a research assistant at the Leibniz Institute for Baltic Sea Research Warnemünde (IOW) was decisive in shaping the course of her research career. After receiving the Heisenberg fellowship from the German Research Foundation (DFG), she spent a year in research at the University of Queensland's National Research Centre for Environmental Toxicology in Brisbane, Australia. Her last seven years have been spent in research and teaching at the Hamburg University of Applied Sciences (HAW) in the field of environmental chemistry, where she heads the Applied Environmental Analysis and Ecotoxicology unit that surveys damage to aquatic and ocean floor environments. She is a member of the German Chemical Society (GDCh) and the Society of Environmental Toxicology and Chemistry (SETAC). Due to her expertise, SETAC and others have nominated Gesine Witt as a candidate (Board 318, Water Research) for the DFG Review Board elections to be held in October 2015. She applies her keen interest in research directly to her day-to-day work with students, not only ensuring her student researchers are kept abreast of recent findings and involved in her environmental analysis work but regularly encouraging them to maintain a critical yet holistic approach to their work and to gain experience at other universities and research institutions.