Effect of activated carbon, biochar and compost on the desorption and the biodegradation of low concentrations of phenanthrene sorbed to different soils

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Most regulations and regulatory accepted assessment procedures on soil and sediment contamination are still based on total concentrations. When removal of the contaminant is an option, there are however doubts on the risks posed by the contaminants this often leads to a "wait and see" attitude. Site investigations are often repeated, but no actions are taken to reduce the risks of the contaminants. From a risk-based point of view, contaminations are only a risk if they are or may become (bio)available. This widens the range of management options of contaminated sites and can facilitate more tailor-made solutions for individual sites. In a risk based approach stimulation of biodegradation and/or immobilization and isolation of the contaminant may play a role. In particular bioavailability can be the underlying basis for the description of risks and site management. In some cases it can be used to break the infinite circle of new site investigations. Bioavailability should be more than a concept and including bioavailability in site management asks for methods to measure the bioavailable fraction. Such methods should have an understandable physical base (ISO 17402) and are fortunately available. Using the Tenax method the available and therefore degradable fraction can be measured. Using the different available fractions it is possible to predict the rate of degradation of PAHs and mineral oil and depending on this rate a management plan can be developed.

Effects of activated carbon amendments on microbial communities in PAH contaminated urban soil


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The effect of activated carbon (AC) amendments on microbial communities involved in the biodegradation of the organic pollutants. In this work, urban soils impacted by 2.3±1.5 mg per kg polycyclic aromatic hydrocarbons were sampled from a remediation field trial, and the long-term effect of 2.0% powder (PAC) or granular (GAC) activated carbon amendments on the microbial community structure and functioning was studied, using by molecular techniques. Denaturing gradient gel electrophoresis (DGGE) analysis showed a statistically significant shift in the predominant microbial community in the soils over time, whereas the effect of PAC or GAC amendments was not statistically significant in an ANOSIM comparison. After three years, the total microbial cell count and soil respiration rates were highest for the GAC amended soils, but cell numbers and respiration rates agreed within a factor three. The sequencing of the predominant DGGE bands, which had similar relative intensity in all soils, revealed the presence of taxa with closest affinities to known PAC degraders (ie. Rhodococcus jostii RHA-1), or taxa known to harbour PAC degraders (ie. Rhodococcus erythropolis). The potential of the microbial community to degrade PAC was evaluated by quantifying specific dioxygenase genes, using real-time polymerase chain reaction (PCR) assays. Similar PAC degradation rates were measured in both the PAC- and GAC-amended soils. Polyphenylene (PP) and GAC amended soils. Polyphenylene (PP) were measured in soils. These studies showed a reduction of the PAC availability with biodegradation compared to PAC amended soils, with 75% difference between sterile and live soil slurries, whereas the lowest PAC availability was found in PAC amended, live soil. The combination of the chemical and microbial studies suggested that microorganisms with the ability to degrade PACs persist long-term in soils, regardless of the presence of activated carbon amendments which reduce the PAC availability, presumably because they utilized other soil organic matter as their main carbon source.

Bioavailability of hydrophobic organic contaminants of concern such as polychlorinated biphenyls (PCBs) in sediments is strongly influenced by the nature of contaminant sorption and, consequential redistribution of the bioavailable fraction. However, recent studies indicate that AC amendments may influence adverse ecological effects on aquatic organisms, e.g. sediment avoidance, inhibition in growth and alteration in settlement behaviour. The direct biological effect of AC on organisms may have an influence for both laboratory-scale biodegradation and toxicity testing and field-scale ecological impact assessment. The aim of this study was to test the responses of carbon-amended sediments containing low concentrations of phenanthrene to different soils (Outfield, RS, Olsen) to abiotic desorption and/or stimulation of vegetation to evaporate water thereby preventing leaching have been used for isolation.

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Polycyclic aromatic hydrocarbons (PAHs) are an important class of soil and groundwater pollutants. Often, a large portion of the PAHs are degraded by soil microorganisms within just a few days. On the one hand this limits bioavailability and uptake by organisms leading to reduced toxicity, but on the other hand this might also decrease biodegradation. The aim of this study was to characterize the soil amendments activated charcoal (AC), biochar (charcoal) and compost for their ability to reduce the desorption and biodegradation of phenanthrene as a model PAH in three different sandy loam soils (Outfield, RS, Olsen). The extent of abiotic desorption of [9-14C]phenanthrene from suspensions made up of soil (either Outfield, RS, or Olsen) plus amendment (either AC, charcoal, or compost) was investigated over a period of 24 days by adding an infinite silicon sink. The extent of desorption was then compared to the extent of mineralization (r = 15 d) of phenanthrene sorbed to the soil plus amendment suspensions by Sphingomonas sp (DSM 12247). The total amount of phenanthrene desorbed was 6% to 10% for AC, 38% to 44% for charcoal, 87% to 106% for compost, and 95% to 106% for control without any soil amendments after 24 d. This was more than percentage of initial %C found in the CO2-trap at experiment completion, i.e., amount mineralized. These ranged between 3.0 to 5.4% for AC, 10.4 to 14.8% for charcoal, 14.9 to 21.8% for compost, and 25.5 to 31.2% for control. The amounts of phenanthrene mineralized were slightly lower than the maximum amounts that were abiotically desorbed and indicate that sorption to the soil amendments had a stronger inhibitory effect on mineralization than abiotic desorption. Nevertheless, desorption into an infinite silicon sink might be useful as a tool to estimate the maximal extent of mineralization (and biodegradation) in soils polluted with PAHs.

The influence of field aging of activated carbon in sediment on PCB sorption in field trials

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Bioavailability of hydrophobic organic contaminants of concern such as polychlorinated biphenyls (PCBs) in sediments is strongly influenced by the nature of contaminant sorption and, consequential redistribution of the bioavailable fraction. The effect of sorption capacity of activated carbon (AC) to control PCB toxicity by monitoring over several years at pilot-scale application sites at Hunters Point, CA and Grasse River, NY USA has demonstrated that AC amendment reduces contaminant bioavailability by controlling both chemical accessibility and activity. One important question is the long-term sustainability of this remediation strategy under field conditions. To further evaluate the sorption effectiveness of AC after prolonged exposure in the field, sorption of freshly spiked and native PCBs to 1) AC aged for 2-2.5 years under field conditions and 2) fresh AC amendments to untreated sediments were compared for sediments collected from both pilot sites. Pure water concentrations and sorption coefficients (K_d) were determined using passive sampler in batch tests. In a separate study, a mass transfer model simulation of the effectiveness of AC amendment...