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Monitoring the biodegradation of polycyclic aromatic hydrocarbons in a co-contaminated soil using stable isotope labeling

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Conventional remediation techniques like “dig and dump” are costly and limited in scale. Plant- and microbe-based alternatives, e.g. phytoremediation options, offer a cheap and environmentally friendly approach that can be applied on larger areas. However, the application of phytoremediation techniques to co-contaminated sites may be hindered due to a potential inhibition of biodegradation processes by the presence of heavy metals in soil. Therefore, the objective of this study is to test the hypothesis that the degradation of organic pollutants can be enhanced by immobilising potentially toxic heavy metals.
This study aims to identify the influence of heavy metal immobilisation on the degradation of organic pollutants, and to determine chemical, physical and biological measures further accelerating these processes. The influence of heavy metals on organic pollutant degradation dynamics is assessed using 13C-phospholipid fatty acid analysis (13C-PLFA). Application of 13C-labeled phenanthrene allows the identification of microbial groups responsible for the degradation process. For metal immobilisation and enhanced biodegradation, distinct mineral and organic soil amendments (iron oxides, gravel sludge, biochar) are deployed, partly in combination with fast-growing and pollution-tolerant woody plants (willow, black locust and alder). Results of an incubation batch experiment show a fast degradation of the phenanthrene label within the first two weeks by various microbial groups (gram negative bacteria as indicated by the cy17:0 peak) resulting in a decrease by up to 80% of the total PAH concentration (Σ 16 EPA PAHs) measured in soil. A similar trend was observed in the greenhouse pot experiment, whereby heavy metal accumulation in the woody plants growing on the co-contaminated soil significantly varied with plant species (willow > black locust, alder).