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Partial Transformation Products as Indicators of Microbial Hydrocarbon Degradation in Soils

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Monitored natural decay (intrinsic bioremediation), a cost-effective method for remediating contaminated property, is widely applied to fuel contaminated sites. If an intrinsic bioremediation approach could be supported for the clean up of polynuclear aromatic hydrocarbon (PAH) contaminated properties, millions of dollars in clean-up costs could potential be saved, especially in transfers of industrial properties that will continue to be used for industrial purposes. Proving intrinsic biodegradation of polynuclear aromatic hydrocarbons (PAHs) is problematic. Slow PAH biodegradation rates in contaminated soils mean that oxygen mass transfer rates into the soil exceeds bacterial oxygen demand. Likewise carbon dioxide production during degradation is sufficiently slow that carbon dioxide will not accumulate in the soil gas to levels exceeding background, uncontaminated soils. Therefore, oxygen depletion and carbon dioxide accumulation, typical indicators of intrinsic remediation activity at fuel contaminated sites, are of little use in demonstrating intrinsic PAH remediation. Additionally, direct measurement of PAH loss over time is of limited use in the absence of extensive historical records, especially at sites that are still emitting PAHs as part of their operations. PAH loss rates may be in the order of 10% per year, whereas combined sampling and analytical error can be greater than 50%. It is our hypothesis that PAH degradation products, such as aromatic carboxylic acids and dihydrodiols, will be present in soils where biodegradation is occurring and absent in soils that are biologically inactive. We have developed methods for the extraction of PAH biodegradation products from soils and the analysis of these metabolites by both gas chromatography and high performance liquid chromatography. We have tested our hypothesis against soils undergoing both active and passive bioremediation. Our results indicate that PAH degradation products are detectable in many soils and that the presence of metabolites is correlated with PAH degradation.

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