Goldschmidt 2000
September 3rd–8th, 2000
Oxford, UK.

Journal of Conference Abstracts
Volume 5(2), 394

The Bio-availability of Polycyclic Aromatic Hydrocarbons in Soils

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Polycyclic aromatic hydrocarbons (PAHs) are common contaminants in the soils and sediments of coal gas manufacturing (CGM) plants. Microbial degradation is often a primary route for the transformation and removal of such contaminants, however, the rate and extent of a PAH biodegradation in soils may be limited by the toxicity of contaminants present, unfavorable microbial growth conditions and the un-availability of the pollutants to micro-organisms. Sorption of contaminants and their slow sequestration in soil particles is an important constraining factor to *in situ* biodegradation, particularly in the case of highly insoluble hydrophobic contaminants such as PAHs. The very high sorption coefficients of the large PAHs, such as benzo(a)pyrene, result in very low, often undetectable concentrations in the soil solution and hence very limited amounts available for bacterial degradation. In addition, a process of aging or sequestration takes place over a prolonged period and it would appear to vary with soil composition. During this time there is a progressive decline in bio-availability as shown by bioassays with bacteria. Attempts to quantify the bio-available fraction have met with varying success. In the present study the efficacy of biological methods for measuring the bio-availability of PAHs, including luminescent biosensors and ^{14}C-mineralisation, have been examined.

Studies were performed using luminescent biosensors in which the bacterium *Pseudomonas fluorescens* HK44 contains a *lux*-gene cassette fused to the promoter 5' to the operon encoding the naphthalene degradation pathway. Naphthalene induced bioluminescence was demonstrated with a peak in output 3 hours after induction. However, induction of luminescence did not occur with other PAHs. The kinetics of naphthalene degradation and substrate specificity of *Pseudomonas fluorescens* HK44 were investigated further by means of ^{14}C-PAH mineralisation assays. A Michaelis-Menten naphthalene K_S value of 80 μm was derived. The bio-availability of PAHs was analysed in terms of the competitive effect of other PAHs on ^{14}C-naphthalene mineralisation. The results will be discussed in the context of the bio-remediation of contaminated soils.