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Enrichment and characterization of sulfate reducing, naphthalene degrading microorganisms

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Polycyclic aromatic hydrocarbons (PAH) are pollutants of great concern due to their potential toxicity, mutagenicity and carcinogenicity. PAH are widely distributed in the environment by accidental discharges during the transport, use and disposal of petroleum products, and during forest and grass fires. Caused by their hydrophobic nature, PAH basically accumulate in sediments from where they are slowly released into the groundwater. Although generally limited by the low water solubility of PAH, microbial degradation is one of the major mechanisms leading to the complete clean-up of PAH-contaminated sites. Whereas organisms and biochemical pathways responsible for the aerobic breakdown of PAH are well known, anaerobic PAH biodegradation is less understood; only a few anaerobic PAH degrading cultures have been described.

We studied the anaerobic PAH degradation in a microcosm approach to enrich anaerobic PAH degraders. Anoxic groundwater and sediment samples were used as inoculum. Groundwater samples were purchased from the erstwhile gas works facility and a former wood impregnation site. In contrast, sources of sediment samples were a former coal refining area and an old fuel depot. Samples were incubated in anoxic mineral salt medium with naphthalene as sole carbon source and sulfate as terminal electron acceptor. Grown cultures were characterized by feeding with 13C-labeled naphthalene, 16S rRNA gene sequencing using an Illumina® approach, and functional proteome analyses.

Finally, six enrichment cultures able to degrade naphthalene under anoxic conditions were established. First results point to a dominance of identified sequences affiliated to the freshwater sulfate-reducing strain N47, which is a known anaerobic naphthalene degrader, in four out of the six enrichments. In those enrichments, peptides related to the pathway of anoxic naphthalene degradation in N47 were abundant. Overall the data underlines the importance of Desulfobacteria for natural attenuation of environmental contaminants. Understanding of diversity and physiology of anaerobic PAH degradation will contribute to remediation efforts of low-oxygen environments such as aquifers or river sediments.