Anaerobic benzene oxidation via phenol in Geobacter metallireducens - DTU Orbit (27/07/2019)

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Anaerobic activation of benzene is expected to represent a novel biochemistry of environmental significance. Therefore, benzene metabolism was investigated in Geobacter metallireducens, the only genetically tractable organism known to anaerobically degrade benzene. Trace amounts (<0.5 μM) of phenol accumulated in cultures of Geobacter metallireducens anaerobically oxidizing benzene to carbon dioxide with the reduction of Fe(III). Phenol was not detected in cell-free controls or in Fe(II)- and benzene-containing cultures of Geobacter sulfurreducens, a Geobacter species that cannot metabolize benzene. The phenol produced in G. metallireducens cultures was labeled with O-18 during growth in (H2O)-O-18, as expected for anaerobic conversion of benzene to phenol. Analysis of whole-genome gene expression patterns indicated that genes for phenol metabolism were upregulated during growth on benzene but that genes for benzoate or toluene metabolism were not, further suggesting that phenol was an intermediate in benzene metabolism. Deletion of the genes for PpsA or PpcB, subunits of two enzymes specifically required for the metabolism of phenol, removed the capacity for benzene metabolism. These results demonstrate that benzene hydroxylation to phenol is an alternative to carboxylation for anaerobic benzene activation and suggest that this may be an important metabolic route for benzene removal in petroleum-contaminated groundwaters, in which Geobacter species are considered to play an important role in anaerobic benzene degradation.

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