The *Exxon Valdez*, BP MC 252, and other oil spills: What we learned about petroleum biodegradation and bioremediation

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The oil spills from the *Exxon Valdez* oil spill in Prince William Sound, Alaska, the Gulf of Mexico (GOM) oil spill from the Deepwater Horizon MC 252 well accident and several other major spills highlight the role of microorganisms in oil weathering and the mitigation of environmental impact. Bioremediation employing fertilizer addition was used to accelerate rates of *Exxon Valdez* oil biodegradation. Rates of oil degradation were a function of the ratio of nitrogen/biodegradable oil and time. Bioremediation increased the rate of polycyclic-aromatic-hydrocarbon degradation by a factor of 2, and of aliphatic hydrocarbons by a factor of 5. Most of the oil has been eliminated from Alaskan shorelines, but some small patches of sequestered subsurface oil residue still remain 20 years after the spill where there is limited water flow. There is ongoing debate as to whether to leave the buried oil residues in place or whether to attempt to supply oxygen and nutrients in an effort to stimulate biodegradation today. The BP MC252 spill was in deep water. Physical and chemical dispersion of the MC252 oil released into the Gulf of Mexico between April 20 and July 15, 2010 resulted in a cloud of fine droplets at approximately 1100-1200 meters that generally moved in a southwesterly direction while larger droplets moved to the surface and formed slicks. During the release (April-July), concentrations of TPAH attenuated rapidly with distance from the release point (the wellhead). Reductions in concentrations as the oil moved away from the wellhead were accompanied by a decreasing ratio of C17/pristane and C18/phytane and degradation of PAHs based on ratios to the conserved hopane. The half lives for hydrocarbons in the deep sea cloud of oil was estimated to be only a few days, while oil in the surface was biodegraded more slowly.

Organic matter mineralization and trace element post-depositional redistribution in Western Siberia thermokarst lakes

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This study was based on high-resolution sampling of sediments and their porewaters from three thermokarst lakes representing different stages of ecosystem maturity development located within the Nadym-Pur interfluve of the Western Siberia plain. Up to present time, the lake sediments of this region remain unexplored regarding their biogeochemical behavior. The aim was to document the early diagenesic processes to assess their impact on the organic carbon previously sequestrated in the underlying permafrost, and the post-depositional redistribution of trace elements (TE) and their impact on the water column.

Mineralization of organic matter (OM) in the sediments proceeded under anoxic conditions in all the three lakes. In the course of the ecosystem maturity development, a shift in OM mineralization pathways was evidenced with Fe- and Mn-oxyhydroxides (FMO) representing the main terminal electron acceptors in the early diagenetic reactions for the most mature stage. This shift was promoted by the diagenetic consumption of nitrate and sulfate and their gradual depletion in the water column due to progressively decreasing peat lixiviation occurring at the lake's borders. Early diagenesis was responsible for TE post-depositional redistribution. TE were mobilized from host phases (OM and FMO) and partly sequestered in the sediment in the form of authigenic Fe-sulfides. Arsenic and Sb cycling was also closely linked to that of OM and FMO. Shallow diagenetic enrichment of particulate Sb was observed in the less mature stages. As a result of authigenic sulfide precipitation, the sediments of the early stage of lake maturation were a sink for water column Cu, Zn, Cd, Pb and Sb. In contrast, all sediments were a source of dissolved Co, Ni and As to the water column. However, the concentrations of these TE remained low in the bottom waters, indicating that sorption processes on Fe-bounding particles and/or large-size colloids could mitigate the impact of post-depositional redistribution of toxic elements on the water column.