Bioremediation of Weathered Crude Oil in Complex Soils: A Southern Minnesota Field Study

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Background/Objectives. A winter-time crude oil leak onto a rail line saturated an adjacent complex mixture of railroad ballast and sandy heterogeneous soil in southern Minnesota, providing an opportunity to examine the effectiveness of several bioremediation products (with and without inorganic fertilizer application) on various components of the Bakken crude oil in the field. The spill occurred in frozen soil conditions, with significant subsurface transport over the first five weeks. The crude oil had undergone some degree of weathering through the spring thaw, with the data collection spanning from May – August.

Approach/Activities. The 99-day field study employed GC-MS to evaluate and quantify the presence/degree of weathering of crude oil within each sample plot and analyze the final contamination composition after biodegradation. Biodegradation of BTEX, TPH-GRO, TPHDRO, and TPH-MOR compounds was tracked in the shallow soil subsurface (2-4" bgs), with respect to an untreated control. Data was collected on natural attenuation, fertilized (high and low dosages), and unfertilized rates for each selected Oppenheimer Biotechnology remediation product. Oppenheimer Biotechnology products utilize highly concentrated, naturally occurring communities of selective hydrocarbon degrading archaea within a mineral matrix.

Results/Lessons Learned. Total hydrocarbon reductions observed in the highly heterogeneous matrix were 95.6% of BTEX compounds and 61.5% in the heavier TPH-DRO and TPH-MOR compounds, as compared to natural attenuation reductions of 72.6% (BTEX) and only 7% (DRO, MOR). Soil temperatures and % moisture ranged between 63 °F – 114 °F and 8.1% - 14.7%, respectively. Greater hydrocarbon losses were not observed in the higher fertilizer dose plots compared to low dose plots, but fertilizer application in general resulted in a 17.7% average reduction in BTEX-GRO compounds and a 31.5% average reduction in DRO, MOR compounds, demonstrating a successful use of bioremediation under complex field conditions.