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Use of Two-Dimensional Gas Chromatography (GCXGC) to Supplement the Evaluation of Natural Attenuation at Petroleum Release Sites

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Background/Objectives. Petroleum releases are complex mixtures that contain hundreds to thousands of individual petroleum hydrocarbon compounds (PHCs). In the subsurface, as soon as physical (e.g., volatilization, dispersion) and biochemical natural attenuation processes take hold (e.g., biodegradation); the organic mixture begins to change. Metabolites from biodegradation of PHCs (i.e., polar oxygenated compounds such as organic acids, esters, aldehydes, ketones and phenols) start to form in groundwater, soil and even in Light Non Aqueous Phase liquid (LNAPL). Over the years there has been a great deal of interest in analyzing the organic metabolite mixture to identify the intermediates and products of biodegradation. Two-dimensional gas chromatography (GCxGC) allows for structural class identification of chemical compounds which is particularly useful for identifying the polar metabolites that are products of PHC biodegradation in the organic mixture.

Approach/Activities. In our study we applied analytical methods traditionally used for advanced chemical fingerprinting such as high resolution GC flame ionization detection (FID) and GC mass spectrometry (MS) to confirm natural attenuation and track it along space and time. We applied GCxGC as a supplemental analytical tool to document changes in the chemical structural class of PHC and metabolite mixtures. GCxGC data in groundwater, soil and LNAPL phases were compared to traditional analytical methods to confirm natural attenuation.

Results/Lessons Learned. We will present compiled data and conclusions from biodegrading petroleum release sites where natural attenuation has been documented. We will discuss changes in the structural classes of chemical compounds using GCxGC analysis and compare the results to GC FID and GC MS in groundwater, soil and LNAPL phases in the source area as well as downgradient from source areas. We will also discuss the implications of this in depth understanding of monitored natural attenuation, including the chemistry transformations in the metabolite plume, for risk management decisions.