Examining Natural Attenuation and Acute Toxicity of Petroleum-Derived Dissolved Organic Matter with Optical Spectroscopy

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Results and Discussion

Groundwater samples containing petroleum-derived dissolved organic matter (DOM_{HC}) originating from the north oil body within the National Crude Oil Spill Fate and Natural Attenuation Research Site near Bemidji, MN, USA were analyzed by optical spectroscopic techniques (i.e., absorbance and fluorescence) to assess relationships that can be used to examine natural attenuation and toxicity of DOM_{HC} in contaminated groundwater. A strong correlation between the concentration of dissolved organic carbon (DOC) and absorbance at 254 nm (a_{254}) along a transect of the DOM_{HC} plume indicates that a_{254} can be used to quantitatively assess natural attenuation of DOM_{HC}. Fluorescence components, identified by parallel factor (PARAFAC) analysis, show that the composition of the DOM_{HC} beneath and adjacent to the oil body is dominated by of aliphatic, low O / C compounds ("protein-like" fluorescence) and that the composition gradually evolves to aromatic, high O / C compounds ("humic- / fulvic-like" fluorescence) as a function of distance downgradient from the oil body. Finally, a direct, positive correlation between optical properties and Microtox acute toxicity assays demonstrates the utility of these combined techniques in assessing the spatial and temporal natural attenuation and toxicity of the DOM_{HC} in petroleum-impacted groundwater systems.

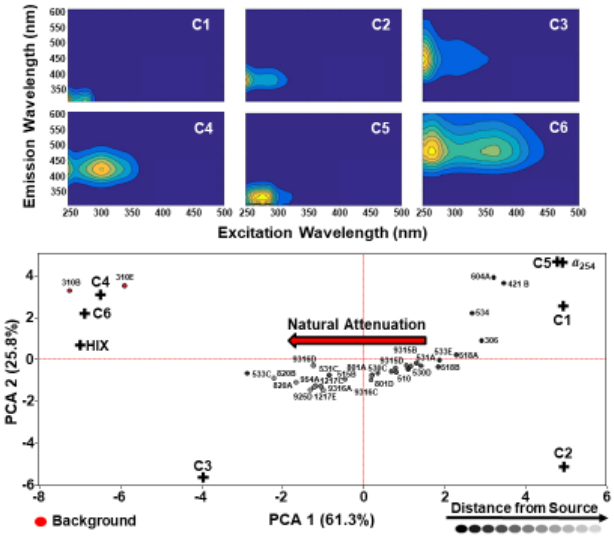

Fig. 1. The six components obtained from the validated PARAFAC model (top). Principal component analysis (PCA) of the values obtained by optical measurements of the DOMHC at the Bemidji Site (bottom) show the changes in chemical composition along a transect of the plume.

Acknowledgements

NVDOC data generated during this study are available at https://doi.org/10.5066/F7CN733T.94 This work was supported by the 2017 Enbridge Ecofootprint Grant awarded by the Minnesota Association of Resource Conservation and Development (Project #1703033), U.S. Geological Survey Toxic Substances Hydrology Program, and the National High Magnetic Field Laboratory (NSF DMR-1157490). DCP and RGMS were partially supported by NSF OCE-1333157 and OCE-1464396. The authors thank Jared Trost, Ean Warren, Andrew Berg, Jeanne Jaeschke, and the rest of the Bemidji research team for their assistance. The authors also thank the three anonymous reviewers and Jeffery Steevens from the U.S. Geological Survey Fish and Invertebrate Toxicology Branch for their contributions.

References

Podgorski, D.C., *et al*., Environmental Science & Technology **52**(11), 6157-6166 (2018).