Exploring Chemical Fingerprinting of Crude Oil Spills in Environmental Systems

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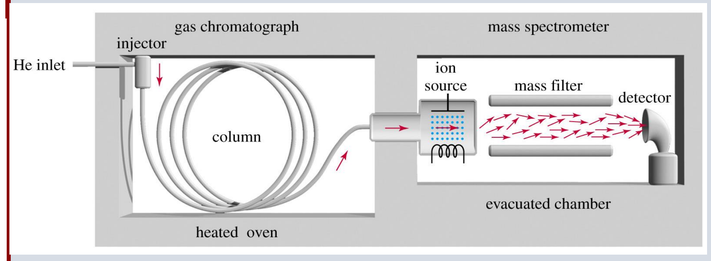
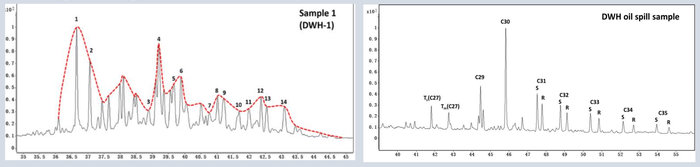
LARGEST CRUDE OIL SPILLS IN HISTORY

The Keystone Pipeline Oil spill (Right) was an extremely recent spill in December 2022, spilling almost 600,000 gallons of oil. The Deepwater Horizon Oil Spill (left) occurred in 2010, and was the largest oil spill in history with over 210 million gallons spilled. This would cause sandy and oil mixtures to eventually form along the Gulf of Mexico, which we refer to as "Tar-balls".

GC/MS



GC/MS is short for gas chromatography and mass spectrometry. We use GC/MS for chemical fingerprinting to identify all the different biomarkers within something, such as oil. In GC/MS procedures, A column is used to first separate all of the compounds, within the gas chromatography portion. Next, the mass spectrometer separates these components into ionized fragments. This allows for the hopanes, steranes and alkanes are identified using different single ion monitoring (SIM) modes. For example, The hopanes are monitored at 191 m/z, the steranes at 217 m/z, and the Alkanes at 85 m/z. Diagnostic ratios were also calculated using integration of the peaks.



The Known Sterane (217 m/z) and Hopane (m/z 191) chromatogram of DWH oil samples. (Han Y, Clement TP, Arekhi M)

OBJECTIVES

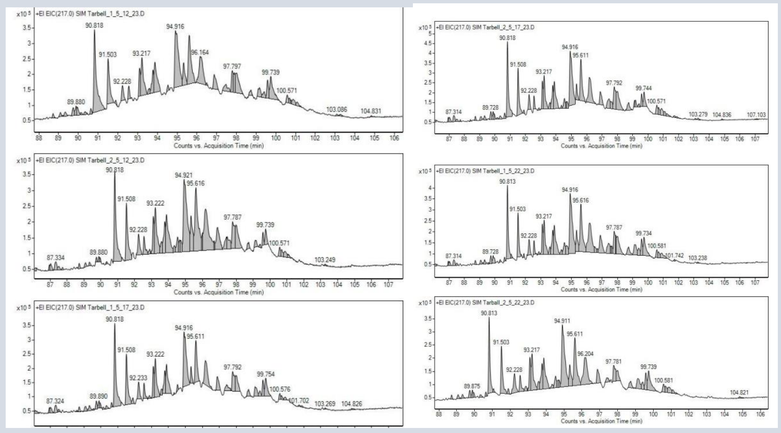
The objectives of these experiments were to complete:

- Reproduction of Chemical Fingerprinting Data regarding the origin of Deepwater Horizon tar-balls by comparing to known crude oil
- Become more familiar with GC/MS procedures and how they can be used to source oils.

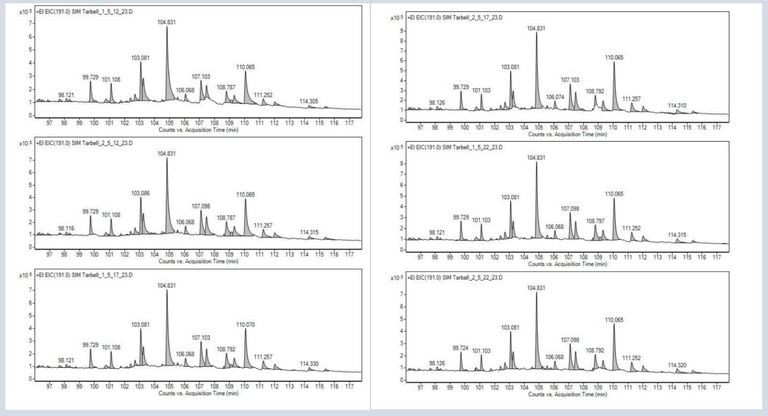
SAMPLING

The tar balls, after homogenization, were extracted using Hexane and collected using a prepared column. After concentration and use of standards, each sample was analyzed using an Agilent Gas Chromatograph along with an Agilent Mass Spectrometer.

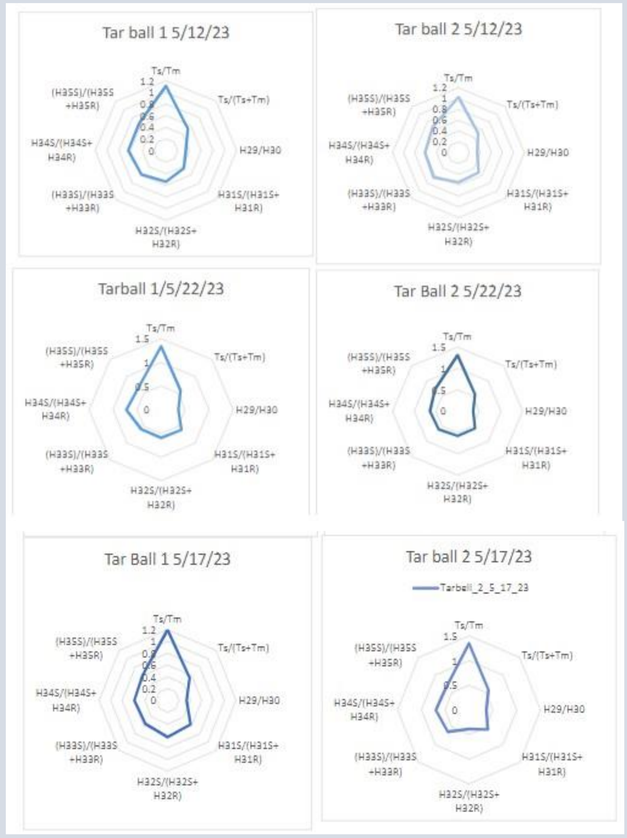
STERANE RESULTS



HOPANE RESULTS



DIAGNOSTIC RATIO RESULTS



DISCUSSION

- How can one be sure these are residue from the DWH?
- Why is the retention time much higher in the result than in the known chromatogram?
- Why is the ion retention much higher in the results than in the example chromatogram?

CONCLUSION

- Sterane and hopane fingerprints as well as the diagnostic ratios conclude the samples are from the Deep Water Horizon Oil Spill.
- The Procedure was followed correctly as the data is extremely similar to the known DWH sample.

LITERATURE CITED

- Han Y, Clement TP. Development of a field testing protocol for identifying Deepwater Horizon oil spill residues trapped near Gulf of Mexico beaches. PloS one. 2018 Jan 12;13(1):e0190508.
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- Arekhi M, Terry LG , John GF, Clement TP Characterization of Tarballs Found along Alabama's Beaches 10 Years after the Deepwater Horizon Oil Spill.