Petroleum and Photo-degraded Petroleum Chemical Profiling

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Additional figures, acknowledgements, and references can be found here

Introduction

Alaska has been a hot spot for oil and gas drilling since the 1950s with additional contracts slated for the Beaufort Sea and Cook Inlet.[1] Additionally, as large expanses of the Arctic become ice-free an increase in offshore oil drilling is projected to increase.[2] As petroleum development and shipment increases so does the risk for another major oil spill which can have a devastating effect on the marine environment. Chemical dispersants, herders and *in-situ* burning are often used in an attempt to mitigate these effects. Sunlight has a major impact on crude oil weathering and environmental toxicology by enhancing the toxicity of crude oil 2-100 fold and the toxicity of anthracene, fluoranthene, and pyrene 12-50,000 fold.[3] Since sunlight can last for 24 hours per day during Arctic summers there is likely a significant increase in photo-enhanced toxicity from oil spills occurring in the Arctic regions. Photo-enhanced toxicity of oil and dispersed oil has been identified in numerous studies over the last 20 years to various marine species.[4-9]

Many individuals of the public assume that if you cannot see the oil it is no longer an issue, however that is not the case. Currently, there is little information on the lasting effects of the chemicals and processes to clean up oil spills create for aquatic life and environments.

This study proves that despite not seeing the oil on the surface, the toxic chemicals that have entered the water cause numerous issues and problems for marine life and environments that can also affect humans.

Headline

Figure 1: (right) Exposure chamber. (far right) Bay mussels after exposure.

Experimental Treatments: Bay mussels (*Mytilus trossulus*) in seawater in subarctic conditions were exposed to oil, Corexit 9500, oil dispersed with Corexit 9500, and oil subjected to in-situ burn with three different photoperiods (hours of daylight exposure each day) of 0, 12 and 24 h for five different time periods of 0, 1, 4, and 7 days.

Seawater Analysis: The seawater was extracted, filtered, and analyzed for dissolved organic carbon (DOC) concentration, optical properties, and at the molecular level by ultrahigh resolution mass spectrometry.

Dissolved Organic Carbon (DOC)

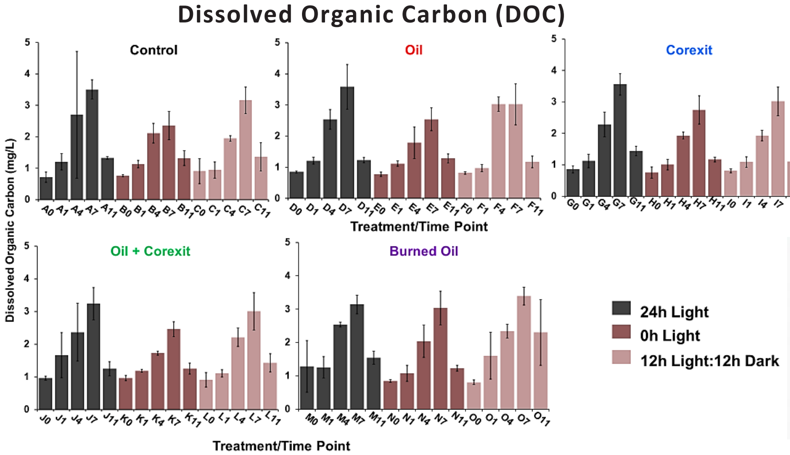

Figure 2: DOC analysis showed a general increase in the concentration of carbon in all treatment types as a function of sunlight exposure.

ID	Treatment
A	Seawater Control 24h Light
B	Seawater Control 24h Dark
C	Seawater Control 12h Light: 12h Dark
D	10 ppm ANS Crude Oil 24h Light
E	10 ppm ANS Crude Oil 24h Dark
F	10 ppm ANS Crude Oil 12h Light: 12h Dark
G	0.5 ppm Corexit 24h Light
H	0.5 ppm Corexit 24h Dark
I	0.5 ppm Corexit 12h Light: 12h Dark
J	10 ppm ANS Crude Oil and 0.5 ppm Corexit 24h Light
K	10 ppm ANS Crude Oil and 0.5 ppm Corexit 24h Dark
L	10 ppm ANS Crude Oil and 0.5 ppm Corexit 12h Light: 12h Dark
M	10 ppm Burned ANS Crude Oil 24h Light
N	10 ppm Burned ANS Crude Oil 24h Dark
O	10 ppm Burned ANS Crude Oil 12h Light: 12h Dark

Excitation Emission Matrix Spectroscopy (EEMS)

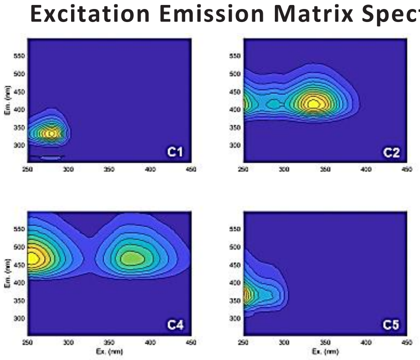

Figure 3: Illustrates the five components which are representative of the different sample treatments in this study, all have mussel dissolved organic matter. **C1)** Oil **C2)** Corexit **C3)** Oil + Corexit **C4)** Sea water **C5)** Burned oil

Fourier Transform Ion Cyclotron Mass Spectrometry (FT-ICR MS)

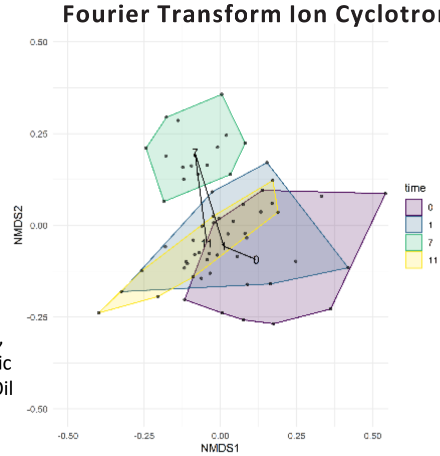

Figure 4: Illustrates the correlations between the treatments, D, E, F (oil), which shows the variability of the samples with the relationship to time. The larger the polygon group, the more similar the samples. **11 day** is the least similar since the old water was replaced with new water leaving various traces of different time points.

Conclusions

- The DOC concentration increased with light exposure for all treatments.
- Optical spectroscopy revealed diverse composition among all treatments with dispersants showing the most change.
- FT-ICR MS revealed a decrease in aromatic character and an increase in oxygen with light treatment. Showing that light and time are the main driving factors of decomposition.

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