Biodegradation of Crude Oil and Corexit EC9500A in Arctic Seawater

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Background/Objectives. The risk of petroleum spills in the Arctic marine environment has been increasing in recent years due to increases in offshore oil and gas exploration as well as marine transport across the Arctic region. These factors, coupled with the likelihood of using the chemical dispersant Corexit 9500 in the event of a spill, necessitate further understanding of the fate and effects of oil and dispersants in the Arctic. This study seeks to assess the total (biotic+abiotic) and abiotic losses of Alaska North Slope crude oil and Corexit 9500 both separately and in the presence of each other within the first 30 days of a spill and to identify microorganisms potentially involved in their biodegradation.

Approach/Activities. Seawater was collected from the Chukchi Sea, supplemented with 16 ppm of Bushnell-Haas media, aliquoted into 800 milliliter mesocosms in glass media bottles, and treated with either 50 ppm of Alaska North Slope crude oil, 5 ppm of Corexit 9500 (1:10 dispersant-oil ratio), or both. Incubations were kept at 4°C and sampled at 0, 5, 10, 20, and 30 days. An additional incubation series of 6-liter mesocosms of seawater was also performed and subsampled daily for 7 days in order to study the rapid degradation of several surfactant components of Corexit. Analyses to date include total petroleum hydrocarbon (TPH), n-alkane, branched alkane, and polycyclic aromatic hydrocarbon (PAH) loss using GC/MS, degradation of dominant surfactant components of Corexit using LC/MS/MS techniques, nutrient concentrations (NO_2^-, NO_3-, NH_4^+, PO_4^{-3} and SiO_4^{-4}) over time using flow injection analysis, and 16S (bacterial and archaeal) and 18S (eukaryotic) rRNA gene sequencing on an Illumina MiSeq platform to characterize shifts in microbial community structure.

Results/Lessons Learned. Significant biodegradation of crude oil and Corexit components was observed in Arctic seawater and there was no evidence that Corexit 9500 suppressed crude oil biodegradation. Rapid degradation of the nonionic surfactant components of Corexit was also observed. However, conclusions regarding the degradation of the anionic surfactant DOSS remains unclear at this time. Gas chromatographic analyses also revealed that the Corexit 9500 component dipropylene glycol n-butyl ether (DGBE) persisted in significant quantities relative to oil constituents at the end of the 30-day incubation. Future analyses will focus on changes to the microbial community, including 16S and 18S rRNA gene sequencing, qPCR to quantify bacterial, archaeal, and eukaryotic microbes, and metatranscriptomics to study the expression of genes associated with hydrocarbon degradation, carbon cycling, and nutrient cycling gene.