Long term fate and behaviour of oil in an Arctic shoreline

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Introduction

Accidental oil spills from vessels, pipelines or offshore oil installations reaching shorelines, may result in comprehensive, time consuming and expensive clean-up operations. Bioremediation is an alternative response option for oil in sediments, especially in remote and sensitive areas, such as the Arctic.

In 1997 an experimental oil spill was conducted on a beach close to Svea, Svalbard to evaluate the effectiveness of in situ shoreline cleaning treatments to accelerate natural recovery (Sergy et al 1998). One site was left as a reference to study the long-term fate and behaviour of a shoreline oil spill. Samplings for chemical analyses have been performed at different intervals until 2011, and the results of chemical fingerprinting analyses were reported in Noreng (2012, Master thesis) and presented on AMOP in 2012 (Faksness et al., 2012a). A new sampling of sediment was recently performed (autumn 2023), from the non-treated oiled field, and from a nearby reference site of the shoreline. In this work, a combination of chemical and microbial analyses of these new sediment samples have been used to study nature's ability to self-purge oil in coastal sediment by bacterial degradation. Revisiting the site after more than 25 years provides a unique insight in the long-term natural degradation of an oil spill.

Objectives and Anticipated benefits

The objective of the current work is to characterize the long-term natural (bio)degradation of oil, and the microbial community composition in a non-treated experimental oil spill in an Arctic shoreline and to achieve more data related to long-term effects of an oil spill on shoreline, and the potential environmental impact if the contaminated site is left to nature.

A better understanding of the natural attenuation can further provide a future basis for choosing bioremediation methodology as a measure in an oil spill situation where the oil has stranded and potentially save the environment for major interventions by avoiding the use of mechanical cleaning methods. Response strategies involving natural attenuation and non-invasive methods are particularly relevant for remote areas in the Arctic, however, more knowledge on biodegradation in the Arctic environment is needed to evaluate the applicability of such response strategies.

Methods

Quantitative results are provided by chemical analyses of the sediments and any remaining oil, to indicate the depletion of oil in the sediment over time. Chemical fingerprinting has been performed using GC/FID and GC/MS. The analysis provides detailed monitoring of biodegradation processes on oil compound level and can also be used to indicate to which extend the oil has been degraded and the depletion of oil. Results from the analyses will be compared to historical data from the same site (1997-2011) (Faksness et al 2012b)

Qualitive results are provided through DNA-sequencing (16S rRNA gene amplicons), allowing characterization of the microbial community. Differences in the community composition in samples from exposed and non-exposed areas provides valuable information on biodegradation performance and further analyses may also indicate when the microbial community structure has returned to a natural/non-exposure state, and the biodegradation has terminated.

References

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