Biodegradation of emulsified MC252 oil in coastal salt marshes

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Abstract

On 05/22/10, emulsified form of MC 252oil was collected from Belle Pass near Port Fourchon in Lafourche Parish, LA and used for biodegradation studies. The objectives of this study were to determine the hydrocarbon composition of the emulsified oil, extent of biodegradation of emulsified oil and the change in microbial population. Soil cores were obtained from the salt marshes in Lafourche Parish, LA using aluminum core device and transferred to glass cores (15 cm dia × 100 cm long) and incubated inside a greenhouse. Approximately, 100 g of the emulsified oil was added to cores consistent with oil loadings observed in the field. Replicate cores were used to evaluate three treatment conditions; (i) natural attenuation with existing nutrient concentrations, (ii) nitrogen amendment and (iii) nitrogen + sulfate amendment. The cores were maintained with approximately 1" layer of synthetic seawater above sediment. For each treatment, cores were sacrificed for oil analysis every 30 days for the first three months (short-term fate) and after approximately a year (long-term fate). The cores were cut from the top and polycyclic aromatic hydrocarbons were analyzed from the soil sections 0-2 cm, 2-4 cm and 8-10 cm. Composition of the emulsified oil was characterized as the ratio of the compound analyzed to hopanes. Short-term incubations demonstrated limited biodegradation of key PAHs. Only phenanthrene biodegraded to any statistically significant extent in treatments over the first 3 months. Over the long-term (~1 year), biodegradation of phenanthrenes and dibenzothiophenes was observed and biodegradation extent was greater in fertilized treatments. Spontaneous breaking of emulsions was observed in several cores and this may precede biodegradation. Microbial community structure indicated diverse but different microbial populations in the three treatments.

Introduction

- Port Fourchon, LA was impacted by the Deepwater Horizon oil spill and MC 252 crude oil in the form of emulsion reached shoreline on May 2010
- Emulsified oil was observed in beach area and on the salt marsh following the beach
- Emulsified oil collected from Belle Pass, Port Fourchon, LA on 05/22/10 and soil cores from wetlands were used to understand the fate of emulsified oil

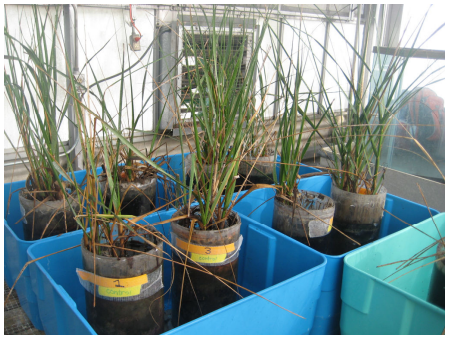
Objectives

- Determine the hydrocarbon composition of the emulsified oil,
- Evaluate the rate and extent of biodegradation of emulsified oil under natural attenuation, nitrogen and sulfate amended conditions and
- Characterize the change in microbial population as a function of biodegradation of the emulsion.

Methods

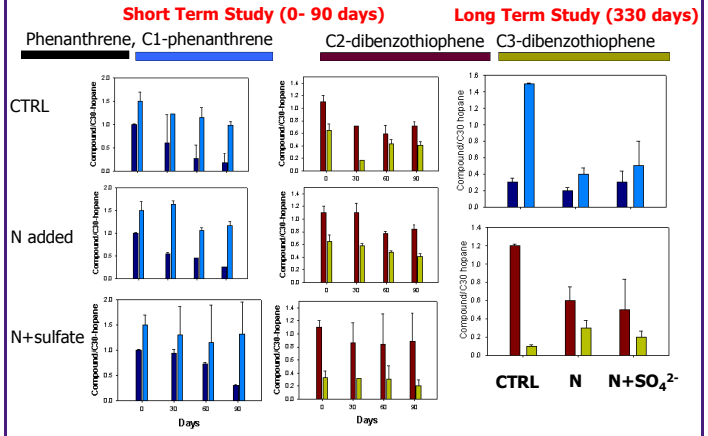
- Soil Cores (6" dia × 36" long) were obtained from the salt marshes in Lafourche Parish, LA
- Approximately 100 g of emulsified oil was added to the cores
- Conditions evaluated (i) natural attenuation, (ii) nitrogen amendment and (iii) nitrogen + sulfate amendment
- Cores were maintained with approximately 1" layer of synthetic seawater
- Core were sacrificed at 30-50 days intervals over 365 days incubation for chemical analysis
- Polycyclic aromatic hydrocarbons (PAHs) were analyzed using gas chromatograph fitted to mass selective detector
- PAHs and alkanes were extracted from soil into hexane/acetone mixture using Accelerated Solvent Extractor

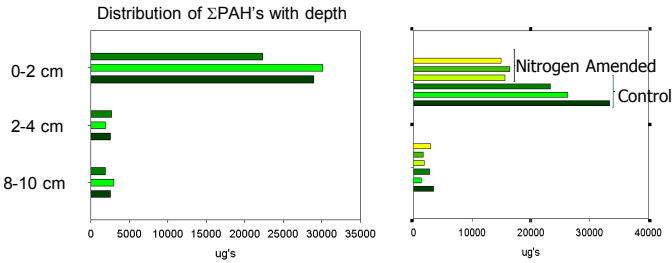
Experimental Set up



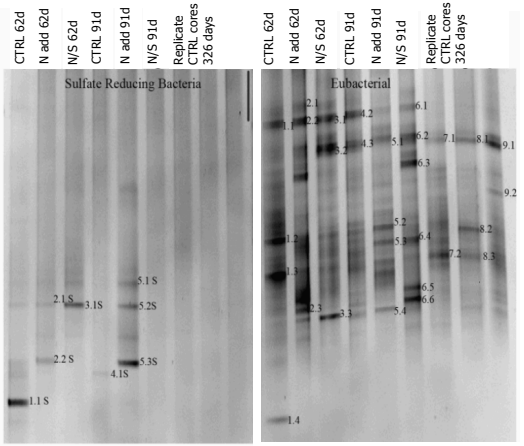
Emulsion Chemical Characterization

Naphthalene	(<0.1)	Phenanthrene	3.1	Chrysene	2.5
C1-NAP	0.51	C1-PHEN	15.2	C1-CHRYS	1.3
C2-NAP	<0.1	C2-PHEN	<0.1	C2-CHRYS	1.2
C3-NAP	<0.1	C3-PHEN	<0.1	C3-CHRYS	1.0
C4-NAP	<0.1	C4-PHEN	0.53	∑PAHs = 50-70 mg/kg soil in 0-2 cm	





Microbial Characterization



Conclusions

- Biodegradation was tracked by comparing PAHs to the poorly biodegradable biomarker C30-hopane (Prince et al., 1994)
- The dominant PAHs observed were phenanthrenes and dibenzothiophenes.
- Chrysene, and C1-chrysene and other lower molecular weight PAHs were observed in minor quantities
- Decline in phenanthrenes/C30-hopane, and dibenzothiophenes/C30-hopane demonstrated that biodegradation was occurring in Cores
- Majority of initial decrease was observed in lower molecular weight PAHs, which is consistent with preferential biodegradation of lower weights PAHs and persistence of heavies PAHs (Hazen et al., 2010)
- Majority of the added PAH remained in the top 2 cm of the cores but quantifiable amounts were observed up to 10 cm depth from the surface
- Nitrogen and Nitroge+sulfate amended treatments demonstrated higher biodegradation compared to natural attenuation treatment
- Microbial characterization indicated the presence of PAH degrading populations, i.e., *Mycobacterium sp.*, adapted to these conditions

References

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