TRACKING OIL FROM DEEPWATER HORIZON OIL SPILL IN BARATARIA BAY SEDIMENTS

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Abstract

The Deepwater Horizon (DWH) was the largest offshore oil spill in history. To track the oil residues from this spill, marsh and sediment cores and marsh grab samples were collected from ten different locations in Barataria Bay (BB). On selected samples, total aliphatic and polycyclic aromatic hydrocarbons (PAHs) concentrations were determined by GC-MS analysis. Surface total petroleum hydrocarbons (TPH) range from 93 to 3,000 ug/g throughout the area with the exception of samples collected nearest the source (Area "A": average = 410,000 ug/g).

Similarly, concentrations of aromatic hydrocarbons (PAHs) in the surface samples range from 39 to 490 ng/g in contrast with the average concentration encountered for samples in area "A" (21,000 ng/g). Most cores collected in the area showed a nearly homogeneous distribution with depth while concentrations in area "A" decreased from 30,000 ng/g at the surface to 430 ng/g at a depth of 9 cm.

Comparison of hydrocarbons in the sediment samples to Macondo oil is complicated due to confounding factors (e.g., already present hydrocarbons and weathering processes). Our preliminary data indicates that oil in sediments have similar signature to DWH, and the impact of the DWH in BB is limited to area A.

Introduction

In April 2010, approximately 4.9 million barrels (205.8 million gallons) of light, sweet Louisiana crude (SLC) oil, including 205,000 mT of methane (CH_4), were accidently released into the Gulf of Mexico during the Deepwater Horizon Macondo Mc252 Oil Spill (Lehr et al., 2010). The initial impact on the environment was significant; It affected marsh and marine ecosystems of Louisiana, and many beaches in Mississippi and Alabama.

One and a half years after this incident, a set of oiled marsh samples (2 grab samples) coupled with nearby subtidal and intertidal cores (12 cores) were collected from Barataria Bay (BB), Louisiana to determine the probable source of petroleum residues present, and to characterize the chemical composition of the oil. On selected samples, n-alkanes, PAHs and biomarker analysis were done using GC-MS. Additionally, to examine the decadal-scale history of sedimentation in these marshes, a sediment core was analyzed for the radioisotope ^{137}Cs, and to identify the stable carbon isotopic compositions ($^{13}C/^{12}C$ ratios) of samples from A and B sampling locations.

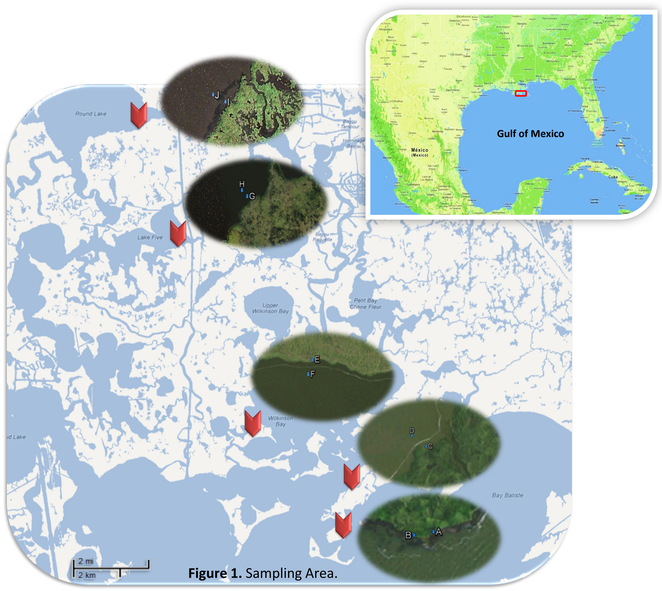
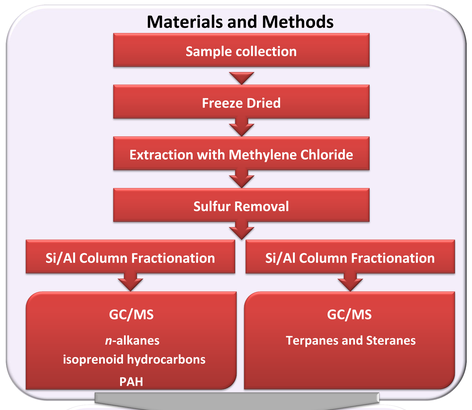


Figure 1. Sampling Area.

Materials and Methods



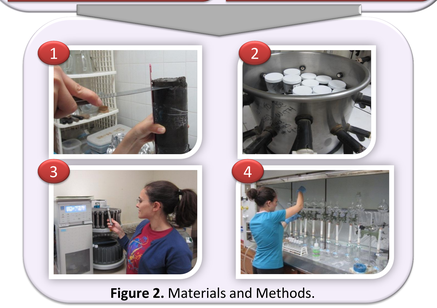


Figure 2. Materials and Methods.

Results and Discussion

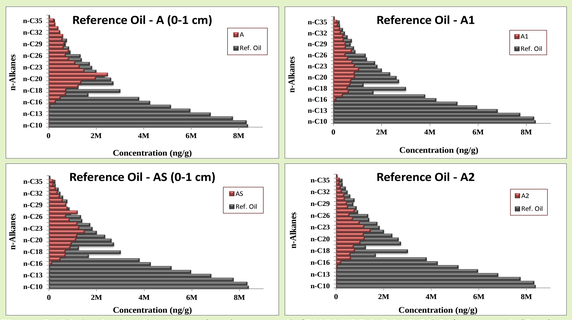


Figure 3. Aliphatic distributions of reference oil (DWH NRDA QA10 Oil 01) versus A (0 -1) cm AS (0-1 cm), A1 and A2. The loss of low molecular weight *n*-alkanes in BB samples is apparent relative to the reference oil.

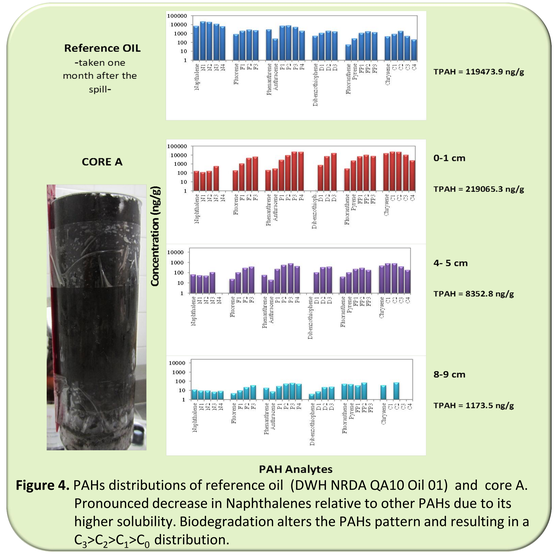


Figure 4. PAHs distributions of reference oil (DWH NRDA QA10 Oil 01) and core A. Pronounced decrease in Naphthalenes relative to other PAHs due to its higher solubility. Biodegradation alters the PAHs pattern and resulting in a $C_3>C_2>C_1>C_0$ distribution.

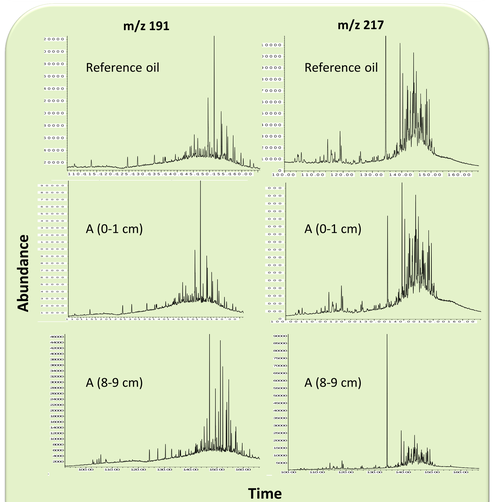


Figure 5. Terpanes (m/z 191) and Steranes (m/z 217) signatures of reference oil (DWH NRDA QA10 Oil 01) and core A.

Table 1. Molecular characteristics of reference oil (DWH NRDA QA10 Oil 01) and BB samples.

	Reference Oil	A (0-1 cm)	AS (0-1 cm)	A1	A2	F (0-1 cm)
TPH (ng/g)	1396336	77399.4	618185.7	424383.5	532187.3	93.8
TPAHs(ng/g)	119473.9	219065.3	138504.8	193396.6	263869.8	119.5
C_{17}/pristane	1.658	0.689	0.689	0.765	1.03	6.79
C_{18}/phytane	2.189	0.591	0.767	1.06	0.810	4.03
Pristane/phytane	1.335	0.582	0.771	0.907	0.808	0.31
CPI (Carbon Preference Index)	0.971	1.051	1.01	1.00	1.05	2.92

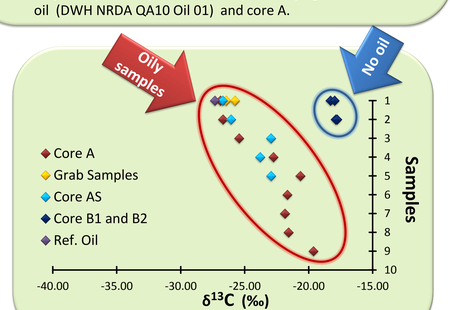


Figure 6. $\delta^{13}C$ isotopic composition of oily and non-oily samples.

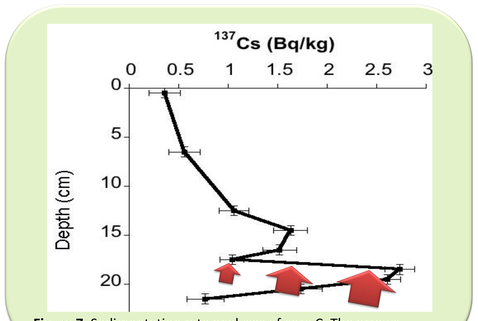


Figure 7. Sedimentation rate analyses of core C. The arrows represent the ^{137}Cs that caught at a depth of 19 cm.

Conclusions

- The impact of the Deepwater Horizon (DWH) oil spill in Barataria Bay is higher in area A, closer to the spill source.
- One and a half years after the DWH, low-molecular weight n-alkanes were lost, and target PAHs and their alkylated homologues were moderately degraded, but high molecular weight PAHs and the biomarker compounds remain.
- Biomarker composition of DWH and area A samples compare well which means that the likely source of the oil in the samples is DWH. The signature of DWH can be tracked to a depth of 9 cm, which suggests that a penetration of 9 cm in the sediment column.
- Although weathering can have a significant impact on the composition of the oil, the ratio C_{17}/pristane, C_{18}/phytane, pristane/phytane and CPI can remain the same.
- Stable carbon isotope analysis show a significant shift between oily (avg. $\delta^{13}C$ = -23.87) and non-oily (avg. $\delta^{13}C$ = -17.99) samples.
- The calculated sediment accumulation rate, 0.39 cm/yr, is lower than the long-term rate of relative sea level rise at Grand Isle (~0.94 cm/yr). This suggests that these marshes are in a long-term elevation disequilibrium that is likely to result in marsh loss, regardless of the impacts of the Deepwater Horizon oil spill- though that spill may accelerate wetland loss processes.

References

- Lehr, W., Bristol, S., and Possolo, A., 2010, Oil Budget Calculator Deepwater Horizon Technical Documentation.
- Graham, W., R. Condon, et al. (2010). "Oil carbon entered the coastal planktonic food web during the Deepwater Horizon oil spill " ENVIRONMENTAL RESEARCH LETTERS.

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