

EXPOSURE IN GULF ESTABLISHED

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Characterization of subsurface polycyclic aromatic hydrocarbons at the Deepwater Horizon site

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[1] Here we report the initial observations of distributions of polycyclic aromatic hydrocarbons (PAH) in subsurface waters near the Deepwater Horizon oil well site (also referred to as the Macondo, Mississippi Canyon Block 252 or MC252) well. Profiles of *in situ* fluorescence and beam attenuation coefficients during 9–16 May 2010 were characterized by distinct peaks at depths greater than 1000 m, with higher intensities closer to the wellhead and decreasing intensities with increasing distance from the wellhead. This characteristic fluorescence (FC/F₀) analysis of water samples coinciding with the deep fluorescence and beam attenuation anomalies confirmed the presence of polycyclic aromatic hydrocarbons (PAH) at concentrations reaching 150 μg L⁻¹ (ppb). Subsurface exposure to PAH at levels considered to be toxic to marine organisms could have occurred in discrete depth layers between 1000 and 1400 m in the region southeast of the wellhead site and southward to at least 1000 km from the wellhead.

2. Methods
[2] The area of operations (Figure 1a) was in the vicinity of the Deepwater Horizon wellhead location. A series of 31 stations were occupied (see auxiliary material Table S1) but we focus here on two transects extending as far as 27 km from the wellhead (Figure 1b). Vertical profiles of water column properties were acquired using a Seibert Electronics, Inc. SBE 1111 conductivity-temperature-depth (CTD) profiling package equipped with dual temperature and conductivity sensors, dual oxygen sensors, a WET Labs, Inc. C-Site instrument for the measurement of beam attenuation, and a WET Labs volume dissolved organic matter (CDOM) fluorometer. Many accumulations of surface oil were recorded with the profiling package as well as contaminants the sampling gear or diverge instruments.

[3] The profiling package was equipped with two 6-L Ocean 7 Oceanic Niskon bottles which could be triggered to sample at specified depths. Water samples for analysis of polycyclic aromatic hydrocarbons (PAH) were collected in 62-L amber glass bottles with Teflon caps. The sample bottles were thoroughly rinsed and filled with sample and sealed with 0–10 mL of acrylonitrile butadiene methyl methacrylate (ABTM) cap. Analysis was subsequently conducted according to methods previously described (Joye et al., 1996).

3. Results and Discussion

[4] The profiles of fluorescence and beam attenuation coefficients (Figure 1b) show distinct peaks at depths greater than 1000 m, with higher intensities closer to the wellhead and decreasing intensities with increasing distance from the wellhead.

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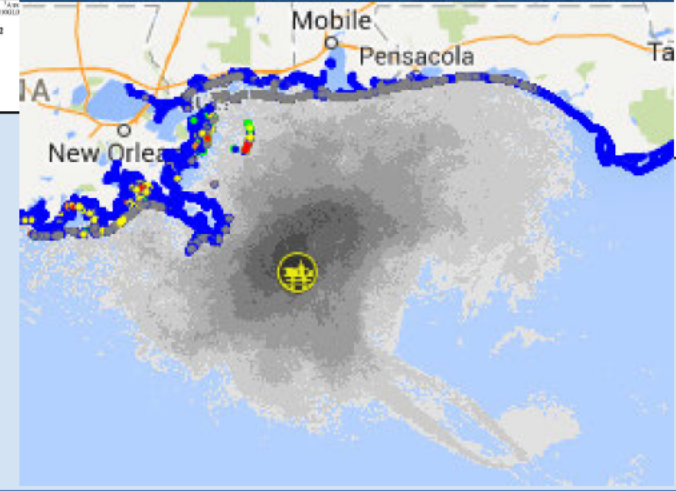


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ERMA DEEPWATER GULF RESPONSE



Scienceexpress Report

Tracking Hydrocarbon Plume Transport and Biodegradation at Deepwater Horizon

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The Deepwater Horizon blowout is the largest offshore oil spill in history. We present results from a subsurface hydrocarbon survey using an autonomous underwater vehicle and ship-mounted sampler. Our findings indicate the presence of a continuous plume over 25 km in length, at approximately 1000 m depth that persisted for months within the subsurface food web. Samples collected from within the plume reveal continuous petroleum hydrocarbon concentrations in excess of 50 μg L⁻¹. These data indicate that non-aqueous liquid in this plume was at least 5000 kg day⁻¹, which is more than double the total source rate of all natural seeps of the meso-economeric petroleum hydrocarbons in the western Gulf of Mexico. Dissolved oxygen concentrations suggest that mixed at respiratory rates within the plume were not appreciably more than 1.0 g O₂ day⁻¹.

The Deepwater Horizon blowout at the MC 252 Macondo well was an offshore blow without precedent (30 million barrels of oil into the Gulf of Mexico (GOM)). In weeks and months after, at 1500 m below the sea surface, exposure a relatively unorganized category of oil spill. The mechanisms of plume formation are complex due to intense factors including the interplay of gas and oil in real plume flow, preferential solubility of methyl compounds, and potential gas hydrate formation (2). Consequently, deep water oil spills are difficult to model and plume dynamics remain challenging to predict (2–4). Many deepwater models include the Gulf of Mexico as a trapped succession (4–6).

We recently observed a subsurface layer of oil between 1070 and 1200 m depth during a United States Coast Guard authorized flow measurement effort at the well site in the Macondo well (June 2010) (Fig. 1b). This layer's characteristics include plume structure from the Deepwater Horizon blowout, as postulated in a subsurface sampling effort including three deep water surveys from 19 to 20 June 2010 along the National Deep Submergence Facility's autonomous underwater vehicle (AUV) Seaview (Fig. S7) and a collaborative scientific collection effort (Fig. S7), each equipped

with a 777075 m to the seafloor (800 m water depth) (7). An AUV was chosen for these operations based on its reduced class detection ability in characterizing deep ocean hydrocarbon seeps (7) and its 40–60 m (7). Sampling, followed an iterative approach of tests, testing, and retested data analysis to identify select parameters to describe and any associated risks associated. The three AUV surveys, all conducted between 13 and 17 June 2010 at depths of 1000 m, repeated for 60 hours to cover a linear distance of 275 km. During these deployments, Seaview's main spectrometer recorded over 1500 discrete sample measurements, simultaneously making five independent channel parameters in real time. Another 2300 sample measurements were recorded by mass spectrometry during results pending. These mass spectrometry have provided baseline and for the first time, measuring 1000 m depth off the coast of California and the Gulf of Mexico (7, 7), tracking subsurface oil leaks from blowout processes damaged by hurricanes in the Gulf of Mexico (7), and for tracking deep ocean hydrocarbon seeps in real time (7).

Mass spectrometry and fluorescence data, recorded during vertical profiling with the AUV's sampling system, approximately 1 km from the leak source, confirmed the presence of a large plume of approximately 1000 to 1200 m depth, as well as more diffuse plume extending between 50 and 600 m depth (Fig. 1). An open water oil slick in a plume is a discrete spatial region with hydrocarbon signals at signal intensities (i.e., colored dissolved organic matter or aromatic hydrocarbon fluorescence) more than two standard deviations above the mean ocean water background variability.

Mass spectrometry of a representative hydrocarbon distribution is displayed in comparison at a depth of 1000 m (Fig. 2). For example, the peaks associated with n-alkanes hydrocarbons such as hexane and decane (i.e., C₆ and C₁₀), respectively, are present at 1400 m, but nearly absent at 1070 m. This difference in composition may be the result of differential solubility during spreading and/or degradation through the water column, or volatilization. These

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