# Scientists Map Origin of Large Hydrocarbon Plume


A plume of hydrocarbons at least 22 miles long and more than 3,000 feet below the surface of the Gulf of Mexico, a residue of the BP Deepwater Horizon oil spill, has been detected by scientists funded by the National Science Foundation (NSF) and affiliated with the Woods Hole Oceanographic Institution (WHOI). The 1.2 mile wide, 650 foot high plume of trapped hydrocarbons was detected during a ten-day subsurface sampling effort from 19th to 28th June 2010 near the wellhead. The results provide a snapshot of where the oil has gone as surface slicks shrink and disappear.

Christopher Reddy, a WHOI marine geochemist and one of the authors of a paper on the results that appears in this week's issue of the journal Science, concludes that these results create a clearer picture of where the oil is in the Gulf.

The study, which was enabled by three rapid response grants from NSF's chemical oceanography program, with additional funding from the U.S. Coast Guard and NOAA through the Natural Resource Damage Assessment Program, confirms once again that a continuous plume was found "at petroleum hydrocarbon levels that are noteworthy and detectable," Reddy said.

The researchers measured petroleum hydrocarbons in the plume and, using them as an investigative tool, determined that the source of the plume could not have been natural oil seeps but had to have come from the Deepwater Horizon blowout at the Macondo well.

They reported that deep-sea microbes were degrading the plume relatively slowly, and that it was possible that the plume had and could persist for some time if the rate of microbial degradation or the dilution of the plume does not accelerate.

These findings confirm what NOAA and its federal partners have reported about the presence and concentration of subsurface oil, and provide an additional piece of the puzzle as aggressive monitoring of the fate of the oil in the Gulf is continued, says Steve Murawski, NOAA's chief scientist.

NSF has so far issued a total of 90 RAPID grant awards to investigators; the grants to date are worth USD10.2 million for study of the spill. NSF has invested an additional USD3 million in ship-related operating costs.

The scientists accomplished the feat using two technologies: the autonomous underwater vehicle (AUV) Sentry and a type of underwater mass spectrometer known as TETHYS (Tethered Yearlong Spectrometer).

The researchers began tracking it about three miles from the well head and out to about 22 miles (35 kilometers) until the approach of Hurricane Alex forced them away from the study area.

The levels and distributions of the petroleum hydrocarbons show that the plume is not caused by natural [oil] seeps in the Gulf of Mexico.

Whether the plume's existence poses a significant threat to the Gulf is not yet clear, the researchers say. It is not know how toxic it is and it is unknown how or why it formed. Knowing the size, shape, depth, and heading of this plume will be vital for answering many questions.

The key to the discovery and mapping of the plume was the use of the mass spectrometer TETHYS integrated into the Sentry AUV. The mass spectrometer was developed in close industrial partnership with Monitor Instruments Co. in Cheswick, Pa., through a grant from the National Ocean Partnership Program.

The TETHYS, which is small enough to fit within a shoebox, is capable of identifying minute quantities of petroleum and other chemical compounds in seawater instantly.

Sentry, funded by NSF and developed and operated by WHOI, is capable of exploring the ocean down to 14,764 feet (4,500 meters) depth. Equipped with its advanced analytical systems, it was able to criss-cross plume boundaries continuously 19 times to help determine the trapped plume's size, shape, and composition.

This knowledge of the plume structure guided the team in collecting physical samples for further laboratory analyses using a traditional oceanographic tool, a cable-lowered water sampling system that measures conductivity, temperature, and depth (CTD).

This CTD, however, was instrumented with a TETHYS. In each case, the mass spectrometer was used to positively identify areas containing petroleum hydrocarbons.

The researchers detected a class of petroleum hydrocarbons at concentrations of more than 50 micrograms per litre. The water samples collected at these depths had no odor of oil and were clear. The scientists benefited not only from new technology but older methods as well.

Contrary to previous predictions by other scientists, they found no "dead zones," regions of significant oxygen depletion within the plume where almost no fish or other marine animals could survive.

They attributed the discrepancy to a potential problem with more modern measuring devices that can give artificially low oxygen readings when coated by oil.

The team on *Endeavor* used an established chemical test developed in the 1880s to check the concentration of dissolved oxygen in water samples, called a Winkler titration. Of the dozens of samples analysed for oxygen only a few from the plume layer were below expected levels, and even these samples were only slightly depleted.

Gas chromatographic analyses of plume samples confirm the existence of benzene, toluene, ethybenzene, and total xylenes, together called BTEX, at concentrations in excess of 50 micrograms per litre.

It may be a few months of laboratory analysis and validation before they know the entire inventory of chemicals in the plume.

Other WHOI members of study team included Assistant Scientist James C. Kinsey and Research Associates Cameron P. McIntyre and Sean P. Sylva. The research team also included Michael V. Jakuba of the University of Sydney, Australia, and a graduate of the MIT/WHOI joint program in Oceanographic Engineering, and James V. Maloney of Monitor Instruments Co.

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