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Oil-spill Bacteria Gobbled Gases First

Levels of ethane and propane consumed by Gulf microbes spark questions about the oil's fate.

By Amanda Mascarelli

Bacteria dining on the oily feast in the Gulf of Mexico enjoyed a first course made mainly of gases in the months after the Deepwater Horizon oil spill, according to a study published in Science[1] today. This may have primed the microorganisms to digest some of the more complex hydrocarbons in oil, but raises questions about how much oil degradation has actually occurred.

A team of researchers studied four hydrocarbon plumes located at varying depths and in different directions, between 1 and 12.5 kilometres from the spill site. By analysing biodegradation both in the water and in lab experiments, they found that consumption of the gases most palatable to bacteria, such as ethane and propane, accounts for up to 70% of the observed oxygen decrease in the deepwater plumes.

Though the oxygen dips have not been extreme enough to cause oxygen-starved conditions in the deep water, researchers say the impacts on marine life are still an open question.

Gases collected from the seafloor - here flared at the surface - formed a first course for oil-eating microbes in the Gulf. David L. Valentine, UC Santa Barbara

Most oil spills occur in surface waters, where gases escape quickly into the atmosphere. But in the deep waters of the Gulf, "natural gases are in many ways driving the show", says lead author David Valentine, a geomicrobiologist at the University of California, Santa Barbara.

In addition to the estimated 750 million litres of oil that gushed from the wellhead, Valentine estimates that 30% more hydrocarbons jetted out in the form of gases. Whereas a significant fraction of oil made it to the surface, gases are more soluble in water, so "almost all of the gas stayed deep", says Valentine.

Richard Camilli, an oceanographer at the Woods Hole Oceanographic Institution in Massachusetts, say that the study "provides clear evidence that microbial hydrocarbon degradation was mostly limited to natural gas".

The fact that gases such as ethane and propane break down quicker than other hydrocarbons is well established. But the surprise, says Camilli, was the "disproportionate role of these compounds".

The findings cast more questions on the fate of the oil in the notorious plumes, which have been tricky to track and characterize. "Although the natural gas rapidly biodegraded near the well site, much of the oil that entered these subsurface plumes may still remain," says Camilli, first author of a study published last month that mapped the largest known plume[2].

Valentine and his colleagues' study is based on data collected between 11 and 21 June. The researchers measured the concentrations of hydrocarbon gases and oxygen in the water, and using radioactive and stable isotope tracers both shipboard and in the lab, they quantified the rates of biological consumption of each gas to determine how the plumes were ageing.

"It's a very elegant piece of work done very quickly," says Ronald Oremland, a microbiologist specializing in geochemistry at the US Geological Survey in Menlo Park, California.

Slim pickings

The research helps to explain why oxygen losses are more pronounced in certain locations, and why some researchers have observed significant oxygen depressions within the plumes but others have not.

The researchers found that the bacteria first consumed gases that are easy to break down, such as ethane and propane. When these gases were plentiful, bacteria multiplied rapidly, lowering oxygen in the surrounding water. But once those gases had been consumed, probably within weeks, these bacteria and others specialized to feed on methane would have subsisted on a leaner diet of compounds that degrade less easily, such as methane and longer-chain oil components. As metabolism decreased and the plumes were replenished with fresh oxygen from surrounding water, oxygen concentrations went back up, says Valentine.

"We found that as ethane begins to become scarce, then methane metabolism picks up," says Valentine. Methane degrades slowly in the water column, because only certain microorganisms with specialized machinery such as the enzyme methane monooxygenase can break it down. But over time, says Valentine, methane is likely to be the dominant food source.

The wild card is the oil. Valentine is at present on a research cruise in the Gulf and has been taking samples some 160–240 kilometres from the wellhead. His team is still picking up clear signals of the oil and oxygen anomalies. "We really don't know how much of the oil is being degraded," says Valentine.

Valentine says that it is unclear whether the oxygen levels being detected are likely to pose harm to marine life, because so little is known about organisms at these depths. "These are organisms that are so accustomed to a constant environment that even slight changes may have an impact on them," he says.

"We just don't know enough," he adds. "You can take an organism into the lab and do a respiration study, but it's hard to take the lab to a kilometre deep in the ocean and do respiration studies and controlled experiments."