Oil Fingerprinting & Degradation
in the Gulf of Mexico

A Deep-C Consortium Fact Sheet

Studying the fate of oil in the environment

Images courtesy of the Reddy Lab at Woods Hole Oceanographic Institution

What is oil?

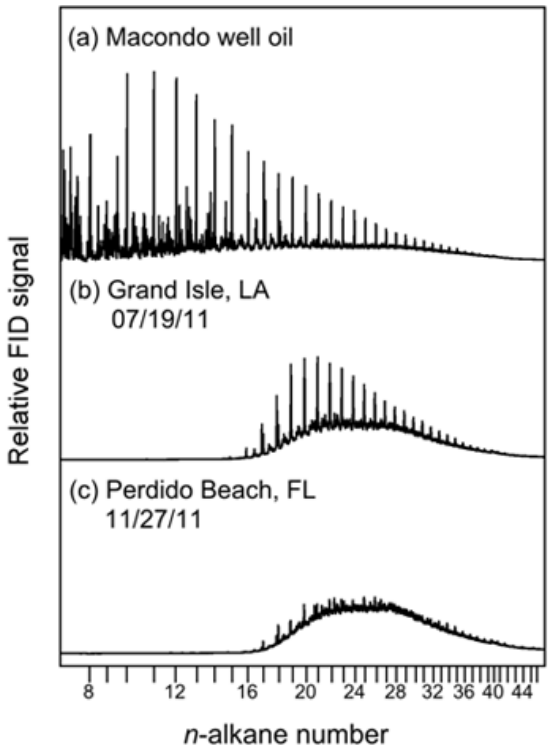
Oil comes from plant debris and prehistoric organisms heated and compressed ("cooked and squeezed") over millions of years – a process that changed their chemical composition, eventually transforming them into oil. **Most crude oils are different.** Oil varies in consistency, composition, and quality. Some oils are very thin and runny, like maple syrup. Others are as thick and viscous as honey. Oil from around the world has different properties. Yet, even oils made in the same general area will have unique characteristics and can be definitively matched. So, just like a crime scene investigator can look at fingerprints to identify a suspect… scientists can look at the distinct "fingerprints" or "genetic markers" of different oils and determine their origin, much like a forensic investigator analyzes DNA.

What is oil weathering?

One of the ways the fate of oil released into the environment can be determined is to study an effect called "weathering" — that is, how oil changes over time due to natural processes, like sunlight or microbial degradation. Oil is made up of many different compounds and weathering affects the properties of spilled oil in different ways.

Chromatography

Chromatography is a precise laboratory technique that allows scientists to evaluate oil by separating the molecules contained in a sample. Once a molecule is separated from the oil mixture, it can be isolated and quantified. The different peaks on the chromatogram correspond to different components in the sample and allows for tracking the fate or extent of weathering of many compounds.



These are gas chromatographic traces from the Deepwater Horizon as well as samples from Louisiana and Florida. The samples found clearly show that nature has changed the composition relative to the original oil but also that weathering is different in the Grand Isle sample vs. Perdido Beach, even though they were both collected at nearly the same time.

Where does released oil go?

A lot of the compounds that are associated with the toxicity of oil evaporate quickly and when oil evaporates it goes up into the atmosphere, gets diluted and breaks down from exposure to sunlight. However, other compounds in oil can persist in the environment and have long-lasting effects on the ecosystems they reach.

What oil samples can tell us

Understanding what happens to oil discharged in the oceans helps scientists anticipate what crude oil will do when it is spilled and where it will go. Tracking oil from a spill over a long period of time helps researchers account for how much of the released oil broke down and where remaining material still resides. Lastly, if we study the long-term fate of oil, we identify areas where it has the greatest likelihood to persist, which in turn, can be used in the next spill when setting priorities on what to "protect" or what to clean-up first.

Collecting a sand patty in Grand Isle, Louisiana in 2011. Photo credit: Chris Reddy, WHOI.

Deep-C's research on the Deepwater Horizon oil spill

Even though it occurred more than four years ago, researchers still find trace amounts of oil from the Deepwater Horizon oil spill along the Gulf Coast beaches and in the ocean sediment. Scientists from the Reddy Lab routinely revisit sites along the coast to collect samples they suspect contain oil from the 2010 spill. Every one of those samples is a clue to how oil behaves after it is released into the environment. Using chromatography, they connect biomarkers in the oil-soaked sand patties they find. Analysis of these samples allows them to track oil from the spill and reveal how that oil has changed after prolonged exposure to the natural environment.

"These biomarkers are not as resilient as once thought, and they may provide a future window into determining how much, and how quickly, these oil components may linger in the environment when exposed to air, sunlight, and the elements." — Dr. Chris Reddy

Deep-C Scientist Profile: Dr. Christopher Reddy

Dr. Chris Reddy, senior scientist in the Department of Marine Chemistry and Geochemistry at Woods Hole Oceanographic Institution, studies the fate and transport of the spilled oil following the Deepwater Horizon disaster. Specifically, Dr. Reddy tries to determine what compounds found in the oil last the longest in the environment and why. He describes his work as trying to find the toughest kid on the block. Reddy was born, raised, and educated (kindergarten through college) in Rhode Island, the "Ocean State." He earned his bachelor's degree in chemistry at Rhode Island College, where he was a Scholar All-American wrestler. He had intended to continue his studies by investigating chemical reactions initiated with lasers. But Reddy found his heart was just not in that and instead he earned his PhD in chemical oceanography, studying his first oil spill in 1996 (the North Cape). Reddy now juggles work on numerous oil spills ranging from the 1989 Exxon Valdez to a recent spill in Galveston Bay, Texas (2014).

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This research made possible by a grant from BP/The Gulf of Mexico Research Initiative. For more information, visit deep-c.org