Goo and Gas

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Bubbling up from the ocean’s floor, both crude oil and methane are continuously leaking out of the earth.

The globs of tar that wash up on the coastline below UC Santa Barbara may be a nuisance to beach walkers, swimmers, and surfers, but to researchers, they’re a reminder of an invaluable natural laboratory—one in which significant quantities of oil and gas bubble up continuously from the seafloor.

“There are marine seeps all over the world,” says Ira Leifer, a researcher with UCSB’s Marine Science Institute and Department of Chemical Engineering, “but these are probably among the largest seeps that are easily accessible to any researchers. For us it’s just a 40-minute boat ride.”

The seeps from the Coal Oil Point Seep Field in the Santa Barbara Channel represent both a natural oil spill that can help scientists understand how oil disperses and how marine life deals with it, and a source of methane—a potent greenhouse gas. By studying these seeps, scientists are learning about their contribution to the global methane budget, and they’re testing ways of detecting methane emissions.

Although the seeps off the coast of Goleta have been oozing away for millennia, there’s surprisingly little known about this phenomenon of hydrocarbons leaking out of
the earth,? says Bruce Luyendyk, a professor of marine geophysics. ?More hydrocarbons have leaked out of the earth than are in the earth. It?s happening all over the planet. It?s not a trivial phenomenon.?

Although it?s difficult to know how much oil oozes into the ocean off UCSB, researchers have estimated that the seeps here produce the equivalent of at least 100 barrels of oil a day?using that figure, the infamous Exxon Valdez tanker spilled seven years worth of Santa Barbara seeps in a single catastrophic night.

Over time, the amount of oil the seeps off Coil Oil Point produce is ?much greater than the headline-capturing spills from oil tankers,? Leifer says, ?but they?re not very well understood. Not many people have access to seeps like we do.?

?On a global basis, we simply don?t know how many there are, where they are, and how big they are,? Luyendyk says.

?The more we look, the more we find,? adds David Valentine, an associate professor of earth science, who spent much of the summer bobbing around on a boat off the coast of Santa Barbara. He was part of a team of researchers who used an autonomous underwater vehicle to investigate a prolific seep in the Santa Barbara Channel, to poke around huge underwater volcanoes discovered a couple of years ago, and to locate other seeps off the coast of Los Angeles.

UCSB researchers are now working with NASA scientists to develop remote sensing technologies that could detect methane emissions, like those from the Santa Barbara seeps, from planes or satellites.

They?re using infrared imaging to detect the gas, and comparing that data to methane measurements collected by a plane equipped with sensors, and from a boat. The researchers also compared the methane hotspots with sonar maps of the seeps.

?We know where the methane should be,? Leifer says, ?and we look, and lo and behold, there it is.?

NASA is interested in methane because it?s a potent greenhouse gas?20 times as problematic as carbon dioxide, which is commonly regarded as public enemy number one in the crusade against climate change.

Because methane doesn?t hang around in the atmosphere for anywhere near as long
as carbon dioxide, efforts to control methane emissions would pay off much sooner than measures to scale back carbon dioxide emissions. There are also fewer sources of methane than of carbon dioxide, making the possibility of limiting methane emissions less daunting than dealing with carbon dioxide.

Little is known, however, about the sources of atmospheric methane, which include livestock herds, landfills, rice paddies, and other anthropogenic sources, and natural emissions such as marine seeps. The seeps have been pretty much overlooked, Luyendyk says, although scientists estimate they may make up 10 percent of the planet’s methane budget.

**On a bad tar day Coal Oil Point is almost a solid sheet of tar.**

Researchers studying the seeps in the Santa Barbara Channel are investigating how much of the methane that bubbles out of the seafloor ends up in the atmosphere.

The ocean provides a biological filter for preventing large amounts of methane escaping the subsurface and making it into the atmosphere, says Valentine. Microbes gobble up some of the gas, and although we don’t know who these organisms are, he says, we can measure their activity.

**An all-too-familiar outcome of walking barefoot on the beaches below UCSB.**

One way researchers are doing that is by releasing methane labeled with a mildly radioactive substance into the water column so they can figure out the rate at which it’s consumed by microorganisms.

Scientists here are also studying what happens to the oil that oozes out of the underwater seeps in the Santa Barbara Channel.

It’s a useful approximation of what happens after oil is accidentally spilled into the ocean, Luyendyk says. You actually can’t do the experiment, but here we have a natural source of crude oil. It’s leaking into the ocean and we can start asking questions about that.

If a tanker spills oil, you want to know where it’s going to go, what impact it’s going to have on the environment, and if it’s going to threaten endangered species, Leifer
says. ?We have here a permanent natural oil spill, and we can use it to test spill models.? 

Once the oil that bubbles out of the seeps reaches the sea surface and sits in slicks, volatile compounds evaporate, and eventually ?the oil gets thicker and thicker until it starts to form tar balls and it washes up on the beach, where it sticks to people?s feet,? Leifer says. ?Then it washes away with the next tide.? 

UCSB students given the task of scooping tar from the sand around Coal Oil Point found that only about 10 percent of the oil that oozes out of the seeps ends up on beaches in the immediate vicinity, Luyendyk says. ?Much of it goes somewhere else.? 

The amount of oil that washes up on local beaches varies seasonally, with up to ten times more tar turning up during the summer months than during the wintertime.

?On a bad tar day,? Leifer says, ?Coal Oil Point is almost a solid sheet of tar.? 

During surveys, this specially built buoy is slowly towed through seep plumes. The collected gas is funneled into a chamber where differential pressure is measured and later converted to sea surface gas flux.

Much of that difference can be attributed to variations in wind direction and swell height, Luyendyk says. In the winter, offshore winds and higher swells keep the tar suspending...
in the water, and there also may be seasonal variations in the amount of oil produced by the seeps.

It’s tricky to figure out how much oil they put out, Luyendyk says, but researchers have tried to do it by scooping oil from the sea surface using a skimmer designed to clean up oil spills. They came up with a rough figure of 100 barrels a day, but Luyendyk says it’s likely to be more.

It’s easier to estimate how much gas bubbles out of the seeps using sonar because the bubbles are very good acoustic targets; they reflect very well, Luyendyk says. By calibrating that data with sonar of bubbles released from scuba tanks positioned on the seafloor, researchers figured that about 3.5 million cubic feet of gas gurgles out of the seeps in the Santa Barbara Channel every day—a quantity that’s remained fairly constant over the last decade or so, Luyendyk says.

Before that, though, Luyendyk and other researchers noted a steady and significant decrease in the amount of seepage from the Coal Oil Point field, and in papers published in 1999, they attributed that decline to the effect of offshore oil production in the area reducing the pressure in the reservoir of hydrocarbons in the seafloor. However in the decade since, our thinking has changed, Luyendyk says, and some of the facts have changed.

There was certainly a long-term decrease in emissions from the seep field until 1997, Leifer says, but there’s been an increase since then.

There’s probably a cyclical process, he adds; seismic activity can affect how oil moves through the seabed, and pressure from hydrocarbons building up below the seafloor can periodically force bursts of oil and gas into the ocean that is responsible for most of the variation in seep volume over the years, far eclipsing the influence of oil drilling.

Humans are adding something into it, Leifer says, but not at this point driving it. Natural processes seem to be the most important.

Because the seeps here have been oozing and bubbling away for at least half a million years, they also offer an opportunity to study how marine life has adapted to the oily, gassy environment.

Even though it’s natural and it’s not pollution, it contains toxins that affect multiple species, Leifer says.

Some have developed defenses against their hydrocarbon-heavy environment. The eggs of sea urchins in the Santa Barbara Channel are less susceptible to damage from oil and tar than those found elsewhere, Leifer says, thanks to a cellular pump that gets rid of the toxins.

Survival strategies like those developed by sea urchins could have implications for medical research, Leifer says—notably into how the body deals with the poisonous onslaught of chemotherapy by trying to pump toxins out of its cells.

These are unique biological adaptations to a unique environment, he says.
As Leifer sees it, Santa Barbara is “blessed” to have the seeps and the research opportunities they offer close by, even if it sometimes means dodging globs of oil on the beaches and tolerating the smell of hydrocarbons out on the water.

“They’re a great natural laboratory,” he says.

Links:

- [Ira Leifer](http://www.coastalresearchcenter.ucsb.edu/cmi/Leifer.html)
- [Bruce Luyendyk](http://www.geol.ucsb.edu/faculty/luyendyk/)
- [David Valentine](http://www.geol.ucsb.edu/faculty/valentine/)
- [Information on marine hydrocarbon seeps](http://www.bubbleology.com)
- [UCSB seeps group](http://seeps.geol.ucsb.edu/)

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