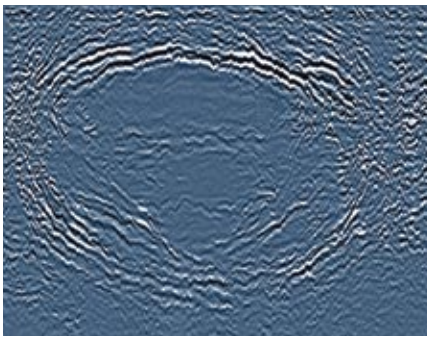
OCEANOGRAPHY

Listening to a Mix

Seismic "noise" in oil-prospecting data could decipher ocean mixing BY LUCAS LAURSEN

Three decades ago researchers discovered what are essentially enormous saltwater lakes in the Atlantic Ocean. These "lakes," called meddies, are gently spinning lenses of water up to 100 kilometers across and one kilometer thick. They float a few hundred meters below the surface of the ocean. Such large, warm bodies, which turned out to come from the Mediterranean Sea, should have an impact on heat exchange in the ocean—and on the planet's climate. But efforts to study meddies—conventionally by dropping probes that directly measure the ocean's temperature, salinity and velocity—have proved too costly, infrequent and spread out to reveal how the meddies dissipate their heat.



BERTA BIESCAS AND VALENTÍ SALLARÈS *Marine Technology Unit, Spanish National Research Council*

NICE RING TO IT: Spanning about 80 kilometers, a ring of warm, salty water in the Atlantic, called a meddy, was recently imaged with seismic survey data taken 15 years ago.

Now researchers have demonstrated that a tool adapted from the oil industry can take rapid, high-resolution snapshots of the meddies. The technique, first used to find oil deposits under the seafloor, exploits sound reflections. Prospectors on ships fire air guns just below the sea surface; the acoustic waves then propagate down through the seafloor and bounce back to a towed array of microphones. The timing of sound waves' return reveals the density of the material through which they passed.

Boundaries between bodies of water also have a very faint sonic signature, which the oil industry used to treat as noise. But in 2003 a team led by W. Steven Holbrook of the University of Wyoming adopted the technique and created unexpectedly

clear acoustic images of density boundaries in the ocean. Changes in the density of seawater are interpreted as changes in its temperature and salinity. Because these properties tend to be unique to each ocean current, the researchers could visualize interactions between ocean fronts, much like climatologists map the boundaries of weather fronts.

Since then, researchers have analyzed old oil industry surveys and cobbled together experiments that could be piggybacked on oceanographic and oil industry cruises. Using data from a 1993 seismic survey off Spain's southwestern coast, a team led by Valentí Sallarès of the Marine Technology Unit of the Spanish National Research Council in Barcelona reports in the June 14 *Geophysical Research Letters* that it has imaged three meddies in unprecedented detail.

Sallarès's seismic images reveal "salt fingers" and other mixing features as small as 10 meters across. "At first blush, it's just exciting for people to be able to see these things," says Raymond Schmitt, an oceanographer at the Woods Hole Oceanographic Institution. But Schmitt says he and his colleagues are still grappling with how to interpret seismic images of meddies and other ocean-mixing hotspots such as underwater waves and the boundaries between ocean currents.

Seismic profiling is still not widely used in the oceanography community, in part because nobody has published a reliable quantitative conversion between seismic and traditional oceanographic measurements. Seismology detects reflections from places where the speed of sound changes. Oceanographic probes directly measure water conditions. Sallarès hopes to unify the two types of data: "The first step was the images, but if we're not capable of quantifying mixing processes we won't have anything."

Sallarès says that preliminary results from a recent dedicated seismic oceanography cruise suggest that temperature and salinity values may be harder to distinguish than originally thought. Holbrook, who led his own seismic oceanography survey off the coast of Costa

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Rica in April, wrote from his research vessel that seismic oceanography needs to "produce exciting and useful quantitative results" so that oceanographers can view it as "a critical enhancement of their toolbox, rather than a curiosity."

"I'm also hoping that we don't exhaust the patience of the physical oceanography community while we develop the necessary techniques," Holbrook adds. Researchers from both sides of the Atlantic will be gathering in November near Gerona, Spain, to share results from recent expeditions and to hash out the field's next steps.

In the meantime, nobody knows exactly what meddies contribute to the Atlantic's mixing, but Sallarès says that seismic profiling "is a clear first look and is more precise than what the oceanographic data can give us."

Lucas Laursen (www.lucaslaursen.com) is based in Cambridge, England.

A Warm, Salty Sea

The Mediterranean Sea's relative isolation and sunny climate make it vulnerable to rapid evaporation. As a result, it is much saltier than the Atlantic Ocean. Mediterranean waters enter the Atlantic in the form of meddies, gently spinning pools up to 100 kilometers across and one kilometer thick. Meddies carry their salt and heat into the open ocean, so their edges appear as particularly strong boundaries in seismic images.

MEDICINE

First in Class

Rocky debut for a nicotine mimic tempers hope for widespread use BY CHRISTINE SOARES

As the pharmaceutical giant Pfizer was reminded in May, arriving first has its rewards, but they come with the risks of venturing into uncharted territory. This past spring the Federal Aviation Administration banned pilots and air traffic controllers from taking the company's popular smoking-cessation aid, varenicline, which is sold in the U.S. as Chantix. Amid 6.5 million prescriptions written worldwide since 2006, the drug had spawned highly publicized reports of acute psychiatric episodes that included seizures, psychosis and suicidal depression. In May the nonprofit Institute for Safe Medication Practices documented 988 such "adverse events," prompting the aviation ban.

The Food and Drug Administration has now added strong warning language to varenicline's medication guide, and Pfizer is reviewing evidence that might help explain the rare but severe incidents. Although the bad publicity may dampen sales of the drug, observers say that some adverse events are not unexpected when a new drug hits the market, especially one that is the first of its kind. Varenicline is not just a novel smoking-cessation tool; it is the first of an entire class of medications specifically designed to target a powerful family of receptors on the surface of brain cells. Known as neuronal nicotinic acetylcholine receptors, they can mediate pain, mood, memory, attention and other cognitive functions.

Abbott Laboratories, Targacept and AstraZeneca have nicotinic receptor drugs in clinical trials for memory impairment, adult attention-deficit hyperactivity disorder and pain. The National Institute on Drug Abuse is testing varenicline itself as a treatment for cocaine and alcohol dependence. Preclinical studies