Where Are Mines Hiding on the Seafloor?

New research reveals how waves, currents, and swirling sands can bury mines

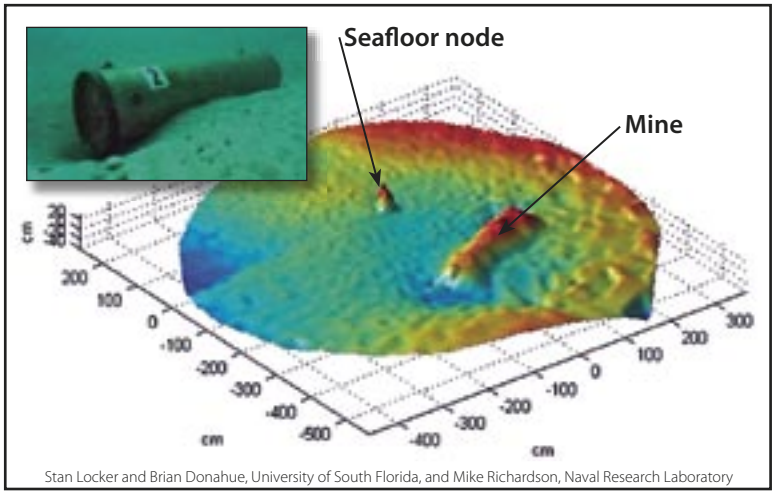
Eternally and incessantly, waves and currents stir up sand from the seafloor near the coast. Sediments get suspended in the ocean, carried onshore and off, and deposited elsewhere. In the process, objects on the seafloor—natural and unnatural—can get buried and uncovered.

It is a seemingly esoteric process, but the Navy has a vested interest because its enemies use mines to defend coastlines. Those mines often become buried by sand, making them all the more dangerous. Buried mines are difficult to detect, yet they still can be triggered by ships passing overhead. To assess the threats from mines and ways to avoid them—from mine hunting and sweeping to avoiding areas entirely—the Navy would like to predict what may be buried under the harbors and beaches where it wants to maneuver.

That requires an understanding of how mines get buried in different environments. In the past, divers tried to observe the processes firsthand. But diving once or twice a day, they could rarely observe a burial in progress. They merely observed the before-and-after conditions. And divers cannot work in storms and strong tidal currents—precisely the forces that cause most burials.

Observing the entire process

For more than a decade, WHOI scientist Peter Traykovski has doggedly explored the complex factors that move sand to continually reshape the seabed and our shorelines. That work has drawn attention from the Navy. Traykovski, with the assistance of WHOI scientist Jim Irish, has developed instrument systems that measure waves and currents and that capture images of sands shifting on the seafloor and suspended in the ocean.



Stan Locker and Brian Donahue, University of South Florida, and Mike Richardson, Naval Research Laboratory

MINE EYES HAVE SEEN—WHOI scientist Peter Traykovski helped reveal how mines are buried by sand on the seafloor, using a rotary sidescan sonar that continuously monitored the process. This sonar image shows a partially buried mine and the seafloor node that supplies power to the sonar.

From 2001 to 2004, Traykovski and colleagues at WHOI and the Naval Research Laboratory conducted a series of experiments, funded by the Office of Naval Research, to make continuous, long-term observations that no human divers could ever make. Using the WHOI Martha's Vineyard Coastal Observatory, they plugged instruments—including acoustic Doppler velocimeters, pressure sensors, and rotary sidescan sonars—into seafloor nodes, powered via cables from the observatory's shore-based facility. (See "The New Wave of Coastal Ocean Observing," page 16.)

In the fall, they deployed mines on the coastal seafloor, armed not with explosives but with instruments that recorded how the mines pitched, rolled, or sank. Divers who returned in April found a smooth seafloor desert and no hint of the buried mines. But Traykovski's rotary sidescan sonar—sampling every half-hour for nearly eight months and producing thousands of images—provided an unprecedented view of the processes that buried the mines.

Different sands, different effects

It turned out that mines behaved differently depending on the type of sand they sat on. In fine sand, mines jutting upward created turbulence that accelerated the flow around them. A similar process occurs when waves rush past your foot on the beach. The sand disappears around your foot, your foot sinks, and then sand washes back to fill in the hole and bury your foot. Likewise, fine sand quickly covers mines, and once buried, they stay buried.

In coarse sand, however, waves and currents create big sand ripples on the seafloor. The currents rotate the mines to align with the ripples. At that point, the mines become integrated into the rippled seascape, and currents bury them no deeper than the height of the surrounding ripples.

Armed with such information, the Navy can better predict and detect the presence of buried mines in different locales and circumstances. Beyond this crucial military relevance, Traykovski's research also offers coastal managers greater understanding of the forces and phenomena that shape our beaches, harbors, and coastal zones.

—Lonny Lippsett