SUNKEN SHIPPING CONTAINERS FORM ARTIFICIAL REEFS

It seemed like as good a place as any to brood, so whelks covered it with their eggs. Then crabs crawled onto the scene in a slow-motion seafloor pursuit. Octopi floated in from the murky abyss. Together they tore the whelks from the shells, and left behind a mound of empty conches as a warning to others. Sunken shipping containers are not safe for whelks. But they might make a safe refuge for a lot of other sea creatures, according to a new study that examined how the detritus of seaborne commerce affects residents of the deep sea.

Various estimates suggest that thousands of sturdy metal shipping containers spill overboard every year — but no one knows the exact number. They wind up strewn across the world's oceans in both shallow and deep water. In some ways, the containers are not very different from the tanks, old railcars or decommissioned ships that are occasionally used to build artificial reefs. They can initiate local ecosystems, attract new species and influence the local flow of currents. But there is one important difference: Sunken containers are unplanned.

In February 2004, a 12-meter-long container full of rubber tires fell off a ship called the Med Taipei, which was carrying goods from San Francisco to Los Angeles, and landed in the Monterey Bay National Marine Sanctuary in about 1,300 meters of water. A few months later, the red container appeared on the video monitor of a submersible on an unrelated mission for the Monterey Bay Aquarium Research Institute, which alerted the sanctuary about the container.

In March of this year, sanctuary marine biologist Andrew DeVogelaere and his colleagues began exploring how the shipping container that fell into the sanctuary is affecting the environment about 20 kilometers offshore Monterey, Calif.

When DeVogelaere and his team visited the site using a submersible ROV to explore, they found crabs and octopi thriving around the container— and very little corrosion of the metal container itself.

Changes there appear to be slow, DeVogelaere says. "I was surprised by how little the container had changed in seven years since it was dropped."

In this initial survey, the team collected 30-centimeter sediment cores and recorded sediment data to create a baseline to monitor future sediment changes and species succession. DeVogelaere and his colleagues plan to revisit the container every few years to track the changes.

Two king crabs near the shipping container lost in Monterey Bay. The empty shells are from the gastropod *Neptunea amianta*.

A gastropod (*Neptunea amianta*) crawling atop the shipping container.

The actual shipping container lost off the Med Taipei as it now rests in the Monterey Bay National Marine Sanctuary.

Researchers viewing the shipping container on the seafloor about 1,300 meters below the surface.

One important question they'll study is whether and how the container is changing the grain size of sediments that accumulate at the site. Sedimentation could change as local currents adjust to flow around the new impediment on the seafloor. Determining sediment changes is important because, for instance, burrowing creatures may move closer or further from the container in search of their preferred type of sediment.

"We're interested in changes in the local ecology," DeVogelaere says. "Putting something with a hard substratum right

Bottom: Chad King/SIMoN NOAA; top three: NOAA/MBARI

in the middle of soft mud — how does that change things?"

For one thing, says marine biologist Chou Loke Ming of the National University of Singapore who studies shallow-water artificial reefs in the Pacific but was not involved in the current study, "it will affect the living communities inside the seafloor, like mollusks, worms and sea fans."

Grain size also affects how fast the seafloor absorbs potential pollutants. This container is full of rubber tires, according to customs paperwork, but others carry chemicals that could seep out into the surrounding environment. Such material could be poisonous, or it could provide food for opportunistic deep-sea dwellers. "We can't say whether a change is necessarily a good or a bad thing," says marine ecologist Tom Wilding of the Scottish Association for Marine Science in Scotland who was not involved in this study.

One container could make for a good case study, DeVogelaere says, but researchers are more curious about what might emerge from studying multiple containers or even networks of containers. There's no telling what effect the containers might have; it could even be that marine populations might travel between them, enabling long-distance migration among these human-made seafloor "islands" in the otherwise barren deep.

The "stepping stone" idea is certainly possible, Chou says. But Wilding notes that whatever the effect of shipping containers on the seafloor, "it's on a very small scale … it's a drop in the ocean, so to speak."

Lucas Laursen

AGI/Meteor Studios

MANTLE PLUMES DRIVE TECTONIC MOVEMENT?

Scientists may have recognized a new driver of tectonic plate motion. Current thinking holds that plates are either pushed apart from mid-ocean ridges, where new crust is created, or pulled along by the mass of older, denser parts of the plates sinking into the mantle. New research suggests that mantle plumes — which funnel magma from the deep mantle to the surface — may also affect the motion of plates.

Mantle plumes were first described in the early 1970s as a way to explain volcanoes that don't occur along plate margins, such as the Hawaiian Islands. The conventional idea of a plume describes a narrow column of magma rising from deep within the mantle — perhaps from the core-mantle boundary — to a subsurface hot spot where the magma may pool into a mushroom-shaped plume head.

Now, Steven Cande and Dave Stegman, geophysicists at the Scripps Institution of Oceanography, suggest that a mantle plume may have changed the Indian Plate's motion starting about 65 million years ago, causing it to accelerate toward the Eurasian Plate.

At the time, the newly emerged Reunion mantle plume was centered below the Indian Ocean northwest of Madagascar and near the boundaries of the Indian, African and Antarctic plates. This plume was responsible for feeding the massive flood basalt eruptions in southwestern India, known as the Deccan Traps, 65 million years ago. Furthermore, scientists have recognized that the Indian Plate suddenly accelerated its movement toward the Eurasian Plate at about the same time, while the African Plate simultaneously slowed its motion. But these events have never previously been linked.

Cande and Stegman suggest in Nature that the events were indeed linked and that the Reunion plume was the singular cause. Evidence for the acceleration and deceleration of the plates is found on the ocean floor at the mid-ocean ridges that separate the Indian, African and Antarctic plates. A period of very fast spreading lasting about 5 million years followed by slower-but-still-fast spreading until 50 million years ago is apparent from paleomagnetic indicators preserved in the newly formed crust at the ridges.

The finding may give geophysicists modeling the motion of tectonic plates "a lot more to chew on," Cande says. But, he adds, the mechanism by which mantle plumes alter plate motion is still unclear. The plume head may spread out faster than the overlying plates, dragging them with it, or the hot plume head may simply reduce the drag beneath the plates that usually resists the pull of subduction.

The study's ideas have attracted support, including from Don Forsyth, a geophysicist at Brown University and the author of one of the first studies describing the two actions — ridge push and slab pull — of plate motion. He says the new study contains "the most convincing demonstration … that there really was a faster spreading in the Indian Ocean" and calls Cande and Stegman's mantle plume theory "a very good explanation for it."

Sam Lemonick

Mantle plumes have long been thought to cause hot spots like the one that's building the Hawaiian Islands. But new research suggests they also can move continental plates.