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Jeff Mitchell

Under the Sea

Voyaging across a vast swath of the Pacific Ocean to learn more about how the Earth's tectonic plates work, scientist Zach Eilon was assisted along the way by friendly deep-sea denizen SpongeBob SquarePants.

No, the beloved animated character wasn't *really* there, but SpongeBob was the nickname Eilon, a UC Santa Barbara assistant professor of earth sciences, gave the sophisticated instrument that played a key role in his research.

Otherwise known as ocean bottom seismometers, or OBS's, these instruments are sensitive enough to detect earthquakes on the other side of the world.

While the seismometers themselves sit on the seafloor, they are attached to a bright yellow flotation package — hence, the SpongeBob comparison — and are about a meter in width. The packages are affixed to a plastic base containing complex electronics.

Eilon and collaborators carefully placed 30 of them on the ocean floor about 2,000 miles southeast of Hawaii during their recent Pacific ORCA (Pacific OBS Research into Convecting Asthenosphere) expedition aboard the U.S. Navy research vessel Kilo Moana.

The trip and the experiment were part of an ongoing and high-profile international effort, on which UCSB is one of three lead institutions in the U.S., to seismically instrument the Pacific Ocean.

Oceanic plates make up 70 percent of the Earth's surface and offer important windows into the Earth's mantle, Eilon said, yet they are largely unexplored due to the obvious challenge of putting sensitive electronics three miles beneath the sea surface. The earth science community has identified several unanswered questions regarding the thermal structure of oceanic plates, the significance of volcanism in the middle of oceanic plates and how the convecting mantle beneath the plates controls their movements.

Undulations in the gravity field and unexplained shallowing of the ocean floors hint that small-scale convection may be occurring beneath the oceanic plates, but this remains unconfirmed, according to Eilon. The new experiment could help prove it.

"Our little instruments will sit on the ocean floor for approximately 15 months, recording earthquakes around the world," he said. "When we return to retrieve them next year they'll hold seismic data in their memory banks that could change the way in which we understand the oceanic plates. That understanding is pretty significant, considering that these plates make up about 70 percent of our planet's surface."

When they are recovered in July 2019, the OBS units are expected to provide data that allows Eilon and his collaborators to make 3-D images of the oceanic tectonic plates – a bit like taking a CAT-scan of the Earth. Of particular interest is the mysterious asthenosphere, the zone of Earth's mantle lying beneath the lithosphere (the tectonic plate) and believed to be much hotter and more fluid than rocks closer to the surface. The asthenosphere extends from about 60 miles to about 250 miles below Earth's surface.

Once ready for deployment, the weighted instrument packages are designed to carefully sink upright to the seafloor. When the science party returns to the site, the ship will send an acoustic signal down to the individual science packages, commanding them to release the weight holding them down, allowing the buoyant yellow "SpongeBob" portion of the device to slowly float them to the surface, he explained.

Once on the surface, the ship's crew will home in on the package (which has a light, flag, and radio so the scientists can locate it) and lift it from the sea. From there the science team will commence the process of downloading the seismic data which are detailed records of the ocean floor vibrations. Turning these wiggles into 3D images is the result of highly complex computer processing and mathematics.

Eilon said that in addition to giving researchers a better idea of how the Earth's tectonic plates work, the data is expected to provide important information about geologic hazards.

"By improving our understanding of interactions between plates, the data we collect should improve our ability to forecast earthquakes and volcanic eruptions," he said, "which I hope will help authorities save lives when these events occur."

Eilon, along with co-principal investigator Jim Gaherty of Columbia University, led the expedition's diverse 14-member science team (drawn from 11 institutions across three continents). The $4-million research project is supported by the National Science Foundation.

About UC Santa Barbara

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