

UC SANTA BARBARA

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Underwater Asphalt Volcanoes Discovered by Scientists

About 10 miles off the Santa Barbara coast, at the bottom of the Santa Barbara Channel, a series of impressive landmarks rise from the sea floor. They've been there for about 40,000 years, but they've remained hidden in the murky depths of the Pacific Ocean -- until now.

UC Santa Barbara scientists, working with colleagues from Woods Hole Oceanographic Institution (WHOI), UC Davis, University of Sydney, and University of Rhode Island, say that they have identified a series of asphalt volcanoes on the floor of the Santa Barbara Channel. The largest of these undersea Ice Age domes is at a depth of 700 feet (220 meters) -- much too deep for scuba diving -- which explains why the volcanoes have never been spotted by humans.

"It's larger than a football field long and as tall as a six-story building," said David Valentine, professor of earth science at UCSB and the lead author of a National Science Foundation-funded study published online this week in the journal *Nature Geoscience*. "It's a massive feature, completely made out of asphalt."

Chris Reddy, director of the Coastal Ocean Institute at WHOI and a co-author of the study, has studied oil spills his whole career. "These volcanoes are an astonishing display of nature," Reddy said. "And they underscore one little-known fact: Half of the oil that enters the coastal environment is from natural oil seeps like the ones off the coast of California."

Valentine, Reddy, and their colleagues first viewed the volcanoes during a 2007 dive on the research submarine Alvin, though Valentine credits Ed Keller, professor of earth science at UCSB, with guiding them to the site. "Ed had looked at some bathymetry (sea floor topography) studies conducted in the 1990's and noted some very unusual features," Valentine said.

Based on Keller's research, Valentine and other scientists took Alvin into the area in 2007 and located the mystery features. Using the sub's robotic arm, the researchers broke off samples and brought them to labs at UCSB and WHOI for testing. In 2009, Valentine and colleagues made two more dives to the area in Alvin and also did a detailed survey of the area using an autonomous underwater vehicle, Sentry, which takes photos as it glides about nine feet above the ocean floor.

"When you fly Sentry over the sea floor, you can see all of the cracking of the asphalt and flow features," Valentine said. "You can see all of the textures of a flowing liquid that solidified in place. That's one of the reasons we're calling them volcanoes, because they have so many features that are indicative of a lava flow."

But tests showed that these aren't your typical lava volcanoes found in Hawaii and elsewhere around the Pacific Rim. Using a mass spectrometer, carbon dating, microscopic fossils, and comprehensive, two-dimensional gas chromatography, the scientists determined that these are asphalt and were formed when petroleum was flowing from the floor of the channel about 30,000-40,000 years ago.

The researchers also determined that the volcanoes were at one time a prolific source of methane, a greenhouse gas. The two largest volcanoes are about a kilometer apart and have pits or depressions surrounding them. These pits, according to Valentine, are signs of "methane gas bubbling from the subsurface." That's not surprising, Valentine said, considering how much petroleum was flowing. "They were spewing out a lot of petroleum, but also lots of natural gas," he said, "which you tend to get when you have petroleum seepage in this area."

The discovery that vast amounts of methane once emanated from the volcanoes caused the scientists to wonder if there might have been an environmental impact on the area during the Ice Age. Valentine found two high-profile studies, one in the journal *Science* and the other in the *Proceedings of the National Academy of Sciences*, which examined events from that time, including a period in which water in the channel became anoxic. "It became a dead zone," Valentine said. "We're

hypothesizing that these features may have been a major contributor to those events."

While the volcanoes have been dormant for thousands of years, the 2009 Alvin dive revealed a few spots where gas was still bubbling. "We think it's residual gas," said Valentine, who added that the amount of gas is so small that it is harmless because it never reaches the surface.

Other co-authors of this study are Christopher Farwell, Sarah C. Bagby, Brian A. Clark, and Morgan Soloway, all from UCSB; Robert K. Nelson, Dana Yoerger, and Richard Camilli, from WHOI; Tessa M. Hill, UC Davis; Oscar Pizarro, University of Sydney; and Christopher N. Roman, University of Rhode Island.

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† Top photo: From left, UCSB's Christopher Farwell, Sarah Bagby, and David Valentine with asphalt recovered from underwater volcanoes during a dive on the research submarine Alvin.

Credit: George Foulsham Office of Public Affairs

†† Middle photo: High-resolution bathymetry of one of the extinct asphalt volcanoes, collected using the autonomous underwater vehicle Sentry.

Credit: Dana Yoerger

††† Bottom photo: A schematic diagram shows the formation of an asphalt volcano and the associated release of oil and methane to the surrounding environment.

Credit: Jack Cook

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