Asphalt Volcanoes Discovered Off Coast

UCSB Scientists Identify Large Structures Created 40,000 Years Ago by Natural Petroleum Leakage

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UCSB scientists have recently discovered underwater volcanoes rising from the sea floor about 10 miles off of the coast of Santa Barbara. These volcanoes, dating 40,000 years back to the Ice Age, sit at the bottom of the Santa Barbara Channel at depths of 700 feet. They have remained unnoticed by humans due to their extreme depth, which proves too deep for scuba diving.

According to UCSB earth science professor and scientist David Valentine, the volcanoes — which have laid dormant for the last 1,000 years — prove to be a “massive feature” on the ocean floor and are “larger than a football field long and as tall as a six story building.”

UCSB scientists worked with colleagues from Woods Hole Oceanographic Institute (WHOI), UC Davis, University of Sydney, and University of Rhode Island to identify these volcanoes. Ed Keller, professor of earth science at UCSB, also conducted research on bathymetry studies (the examination of underwater depth of ocean floors) from the 1990s which revealed unusual activity in this part of the Santa Barbara Channel.

Valentine and colleagues took the research submarine Alvin to the site in 2007 to investigate these unusual sea floor features. Valentine offered a course in marine geochemistry, and as a culmination of the course, he took an entire class out on each of the three cruises to inspect the volcanoes. One student, Chris Farwell, is a co-author on the paper concerning these volcanoes.

Valentine and colleagues used Alvin’s robotic arm to break off pieces of the volcano, and used these samples for testing in UCSB and Woods Hole Oceanographic Institution (WHOI) labs. Valentine and colleagues made two more expeditions on Alvin in 2009, and also used the underwater vehicle Sentry to take thousands of pictures of the sea floor.

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

According to Valentine, Sentry allowed the researchers to see the details of the volcanoes. “You can see all of the textures of a flowing liquid that solidified in place,” he said. “That's one of the reasons we’re calling them volcanoes, because they have so many features that are indicative of a lava flow.”

With the aid of carbon dating, microscopic fossils, mass spectrometer, and comprehensive, two-dimensional gas chromatography, researchers determined that these volcanoes were formed when petroleum flowing from the floor of the channel solidified over 30,000-40,000 years ago. The volcanoes are composed primarily of asphalt, which proves to be a byproduct of petroleum cracking processes.

According to Valentine, the volcanoes “are certainly made of asphalt. What we don't know is just how far down that asphalt extends. The cracks, crevices and steep walls suggest the asphalt is more than a thin coating. It could well be that the asphalt extends into the subsurface like the roots of a tree, but we won't know unless we drill into its core.”

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

According to Chris Reddy, director of the Coastal Ocean Institute at WHOI and co-author of this study, these petroleum produced volcanoes are more common that you'd expect.

"Half the oil that enters the coastal environment is from natural oil seeps like the ones off the coast of California."

During the Ice Age, these volcanoes also produced a large amount of methane, as seen by the depressions surrounding the two largest volcanoes, which are about a kilometer apart. These depressions, according to Valentine, are a result of the greenhouse gas methane bubbling from the subsurface. Currently, the volcanoes still produce small amounts of methane bubbling from their surfaces, which Valentine describes as harmless "residual gas" due to its minimal amount.

Valentine used two high-profile studies examining events from the Ice Age to determine the environmental impact of methane on the area. The research concluded that there was a period in the Ice Age during which the water in this area became anoxic, or lacking a sufficient amount of oxygen. Valentine and colleagues now hypothesize that the past immense amount of methane bubbling from these volcanoes correlates with the anoxic water during the Ice Age.

As far as the volcanoes benefiting the current environment, Valentine contended that "The volcanoes serve as hard bottom seafloor, which promotes a diversity of benthic life.