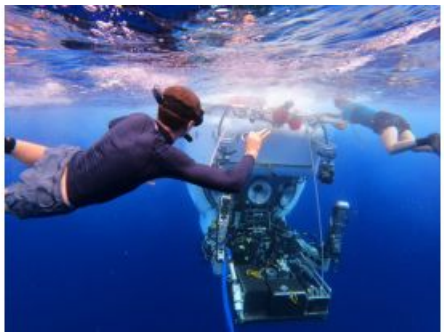
Human-occupied Vehicle Alvin Successfully Completes Science Verification



The human-occupied submersible *Alvin* is ready to return to scientific research at its newly certified maximum depth of 6,500 metres. That's the conclusion of a team of scientists who have spent the past three weeks taking the iconic sub through its paces at locations at the Puerto Rico Trench and Mid-Cayman Rise, testing its scientific and engineering systems to ensure that they are capable of supporting the demands of deep-sea sample and data collection.

"We set a high bar for *Alvin* and it easily met or exceeded our expectations," said Woods Hole Oceanographic Institution (WHOI) associate scientist Anna Michel, chief scientist of the National Deep Submergence Facility that operates *Alvin:* "*Alvin* is ready for science."

Michel and University of Rhode Island geophysicist Adam Soule led *Alvin's* science verification expedition, which left San Juan, Puerto Rico, on 26 July and completed five scientific dives in the Puerto Rico Trench. Those dives focused on the sub's ability to support multidisciplinary research, including geological sampling and observation among the towering cliffs formed by the collision between the North American and Caribbean tectonic plates and biological sampling at abyssal and hadal depths. Scientists were able to make direct observations and collect samples of exposed oceanic crust, deep channels carved into the Puerto Rican platform and seafloor organisms, some of which were the deepest known examples of their species.

Hydrothermal Vent and Seep Sites

After a short stop in San Juan to exchange scientific crew, *Alvin*'s support ship, the research vessel *Atlantis*, proceeded to a region south of the Cayman Islands known as the Cayman Rise, where the two plates are separating at a rate of about 15 millimetres per year. There, scientists conducted another nine dives, focusing on chemical and biological sampling around hydrothermal vent and seep sites, including at the Beebe Vent Field – the hottest and deepest known hydrothermal vents on Earth.

Swimmers Matt Skorina (foreground) and Kaitlyn Beardshear prepare Alvin for recovery after a dive. Skilled divers attach lines that allow for the 18-ton vehicle to be winched back up to the research vehicle Atlantis after a day of exploration. (Courtesy: Woods Hole Oceanographic Institution)

"These were complicated dives in complex locations that posed a test not just of the sub, but of the people who operate it and who make the science possible as well," said Soule. "Their skill and recent upgrades to the sub meant we were able to make fundamental new discoveries while also confirming its operation."

Exploring Deep Seafloor Sites

The upgrades were funded by the National Science Foundation (NSF), installed during an overhaul period that began in March 2020 and built on additional improvements completed in 2014. The most recent round of upgrades included new titanium ballast spheres, an upgraded hydraulic system, new thrusters and motor controllers, updated command-and-control and navigation systems and a new 4K imaging system. Because *Alvin* is owned by the U.S. Navy, it then completed a three-week sea trial in collaboration with the Naval Sea Systems Command (NAVSEA), which oversees the safety of all ships and submarines in the fleet, which culminated in official certification to operate at depths to 6,500 metres.

In total, *Alvin* completed 14 dives during the NSF-funded science verification expedition for a total of 102 hours submerged, 53 of which were spent exploring the seafloor, a significant achievement given the extended time required to reach sites that are as much as 2,000 metres deeper than the sub's previous maximum depth. In addition, the dives allowed 11 scientists to make their first dives in *Alvin*, something Michel said was an intentional part of the expedition.

"*Alvin* is built and maintained to enable new discoveries and provide new insight into the way our planet works," said Michel. "Every generation of scientists presents new questions and *Alvin* has responded in ways that have rewritten textbooks. There's a new generation waiting to use the sub and to them we say, '*Alvin* is ready, where do you want to go?'"

The human-occupied vehicle (HOV) Alvin at the surface after a dive, during its recent science verification expedition at locations on the Puerto Rico Trench and Mid-Cayman Rise in the Atlantic.

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