

# ASU expedition finds an aquatic world teeming with life

## Scientists explore the deep sea to learn about microbial life and ocean health

By Sandy Keaton Leander, ASU News  
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Imagine descending nearly a mile and a half into a watery abyss, watching the sunlight disappear as the world around you turns completely black. Then suddenly, you find yourself surrounded by a shower of brilliant, bioluminescent fireworks.

This is just the beginning of an ocean expedition into the realm of deep-sea hydrothermal vents<sup>1</sup> — alien ecosystems teeming with life we have yet to fully understand. Here, a place where the sunlight never reaches, crabs, rays and fish thrive even under the extreme hydrostatic pressure.

A team of intrepid researchers from Arizona State University embarked on a recent journey to these hidden depths to learn more about nitrogen cycling and the microbial life thriving in these extreme conditions. These microscopic organisms play a vital role in the ocean's delicate chemistry.

"I think the deep sea is one of the final frontiers of exploration on Earth," said [Carolynn Harris](#), a postdoctoral researcher in ASU's [School of Earth and Space Exploration](#). "We know more about the surface of the moon than we know about the bottom of the ocean on our own planet."

[Sheryl Murdock](#), a postdoctoral research scholar with ASU's [School of Ocean Futures](#), part of the Julie Ann Wrigley Global Futures Laboratory, led the expedition along with Elizabeth Trembath-Reichert, an associate professor with the School of Earth and Space Exploration. Six ASU students and staff participated, working on everything from taking samples and planning the next day's dive, to testing equipment and leading the team's experiments and school outreach.

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### Why this research matters

Research is the invisible hand that powers America's progress. It unlocks discoveries and creates opportunity. It develops new technologies and new ways of doing things.

Learn more about ASU discoveries that are contributing to changing the world and making America the world's leading economic power at [researchmatters.asu.edu](https://researchmatters.asu.edu).

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Murdock and her research team are working to understand exactly what the smallest inhabitants of the ocean are contributing to ocean chemistry. While microbes are tiny, they have a tremendous impact, and Murdock says they're not something that gets thought about often when it comes to protecting and managing the ocean.

"Nobody's going to buy the 'save the microbes' bumper sticker," Murdock said. "We need the public to know that the way the chemistry of the ocean stays in balance has loads to do with microbes and how they cycle nitrogen and other chemical elements. And by understanding what microbes contribute, we can learn how that plays into the wider ocean chemistry and, importantly, ocean health."

One way the researchers learn more is by taking samples of microbes that thrive under deep-sea pressure — gathered from water and sediment samples. But this team is trying something that has never been done before.

"We are working to understand the microbes living in tubeworm communities by sampling the fluids and then bringing the water back onto the ship, running incubations, and looking at how those microbes use different sources of nitrogen," Murdock said. "What's novel about this is bringing them to the surface but keeping them under seafloor pressure and running experiments at that high pressure."

This process is difficult at best. The team must travel far out to sea on a ship called the [R/V Atlantis](#) — a U.S. Navy-owned research vessel operated by the Woods Hole Oceanographic Institution. This ship is designed specifically to launch [Alvin](#), a specialized "human occupied vehicle," or HOV, used by researchers to explore the deep sea.

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## What's it like inside Alvin?

(Video: [https://youtu.be/\\_BvXo2LA0kk](https://youtu.be/_BvXo2LA0kk))

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Once the team reached its final destination in the Pacific northwest — a spreading center between tectonic plates called the Juan de Fuca Ridge — the team performed multiple dives in the submersible, as weather conditions allowed.

Their innovative approach to collecting water, sediment and microbial samples — bringing them to the surface under the same pressure — is expected to bring new insights to our understanding of ocean chemistry, what roles microbes play on the seafloor, and how they contribute to ecosystem health and function.

## Ship to shore: Bringing deep-sea exploration to the classroom

Beyond the scientific breakthroughs, the expedition sparked a wave of inspiration among hundreds of students back on land. The cruise carried a dedicated outreach team — responsible for a ship-to-shore "virtual field trip" program that brought live video, interviews and demonstrations into classrooms thousands of miles away.

Will Carter, an outreach coordinator with the ASU [Bermuda Institute of Ocean Sciences](#), or BIOS, helped build the pipeline.

“We had a full Zoom setup,” Carter said, describing a dizzying array of gear: a handheld gimbal and iPhone for roaming footage, a 360 conference camera to show a room, and microphones that had to survive both wind and poor bandwidth. “You can imagine with all of these different tech elements, especially being on a ship where there's limited Wi-Fi, it took a long time to really set up and master.”

Carter, who has a background in biology and media studies, edited dive footage each night and crafted short, punchy videos for the next day's calls. Their goal was modest at first — reach a few hundred students — but the appetite for real-time science grew fast.

For students at Osborne Middle School in Phoenix, the experience wasn't a distant slideshow. Science teacher Jim Hess watched his seventh and eighth graders press toward the screen, leaning in to see hydrothermal chimneys and hear Alvin crew explain life in a tin can at the bottom of the world.

“They decorated Styrofoam cups before the team left to go to the boat,” Hess said. The cups were taken down on the outside of the submersible; at 2,300 meters (more than six Empire State Buildings) deep, the air is crushed out of the foam. “Your regular six-inch Styrofoam cup shrinks down to about the size of your thumb,” he told students. The cups were returned as tiny souvenirs — a reminder that sometimes science is a tactile thrill as much as it is data.

Middle schoolers asked the questions adults skip.

“How do you use the bathroom?” one asked. And the answer — “you try to go before, and if not, then you go on this little red bedpan” — produced exactly the reaction the outreach team wanted: awe and laughter, followed by curiosity.

“Those middle school questions,” Carter said, “are perfect.”

From the beginning, the ship-to-shore goal was simple but ambitious: bring real impact and working science directly to students in real time, as discovery is unfolding live.

“We knew to get this over the goal line, it couldn't just be creating a curriculum module,” said [Kaitlin Noyes](#), director of education and community engagement at ASU BIOS. “It needed to be something bigger.”

That “something bigger” became a series of live broadcasts from the research vessel and the submersible using special communications tools, connecting students from third grade through college — and even professional educators — to science, as it was happening at sea.

Over the course of the two-week expedition, they hosted 29 live shows and reached 857 participants.

“A lot of these kids have never had interaction with anything outside of their immediate area,” Hess said. “They hear about ASU, but they don't really know what that means. This shows them the world is bigger — and that they can be part of it.”

(Video: {<https://youtu.be/xNUGxfuPEr0>})

## From under the sea to under the microscope

Back on deck, the science had its own setbacks: rough weather grounded dives, forcing the team to compress their goals into fewer opportunities. Harris described how team dynamics became essential in cramped, chilly, sometimes seasick conditions.

“Anytime you take a group of people and put them in a confined, isolated situation, the group dynamics are so important,” she said. “We had a quarter fewer dives than we had hoped, but we still accomplished all of our major science objectives.”

Now the team’s samples — including water, sediments and microbes — will be analyzed. The next phase will take time and precision: sequencing DNA from microbes, measuring nitrogen species and piecing together how these unseen organisms move nutrients through a world without sunlight.

As the team measures the samples over the next several months, the researchers share a message: The deep sea is not a desolate wasteland but a vibrant ecosystem facing unprecedented threats due to climate impacts, overfishing and bottom-trawling, pollution and potential deep-sea mining.

“Industrialization of the deep sea is really knocking at the door,” Murdock said. “Our research is but one important step to reaching a better understanding of how our ocean works, and by doing that, we hope to contribute to strategies that ensure future ocean health.”

*This story originally appeared on [ASU News](#).*

<sup>1</sup> Hydrothermal vents are similar to geysers at Yellowstone National Park; water percolates down into the crestral rocks on the bottom of the sea floor, is heated by a magma source and then seeps up into the cold seawater.

## Main image



ASU postdoctoral researcher Sheryl Murdock advises ASU PhD student Alexi Avery before a dive in "Alvin," a specialized "human occupied vehicle," or HOV, used by researchers to explore the deep sea. The dive is part of an ocean expedition to study deep-sea hydrothermal vents. Photo courtesy of Kaitlin Noyes

## Gallery





The ASU BIOS outreach team brought live virtual field trips to more than 850 students, ranging from third graders through graduate students. Students interacted with the research team aboard the Alvin submersible by using a hydrophone, and aboard the Atlantis research vessel. The interactive field trips changed daily depending on research activity during the expedition.



Jim Hess teaches science at Osborne Middle School in Phoenix. Hess worked with the ASU BIOS outreach team to bring live virtual field trips to his classrooms. Their goal is to spark middle school students' interest in ocean science.



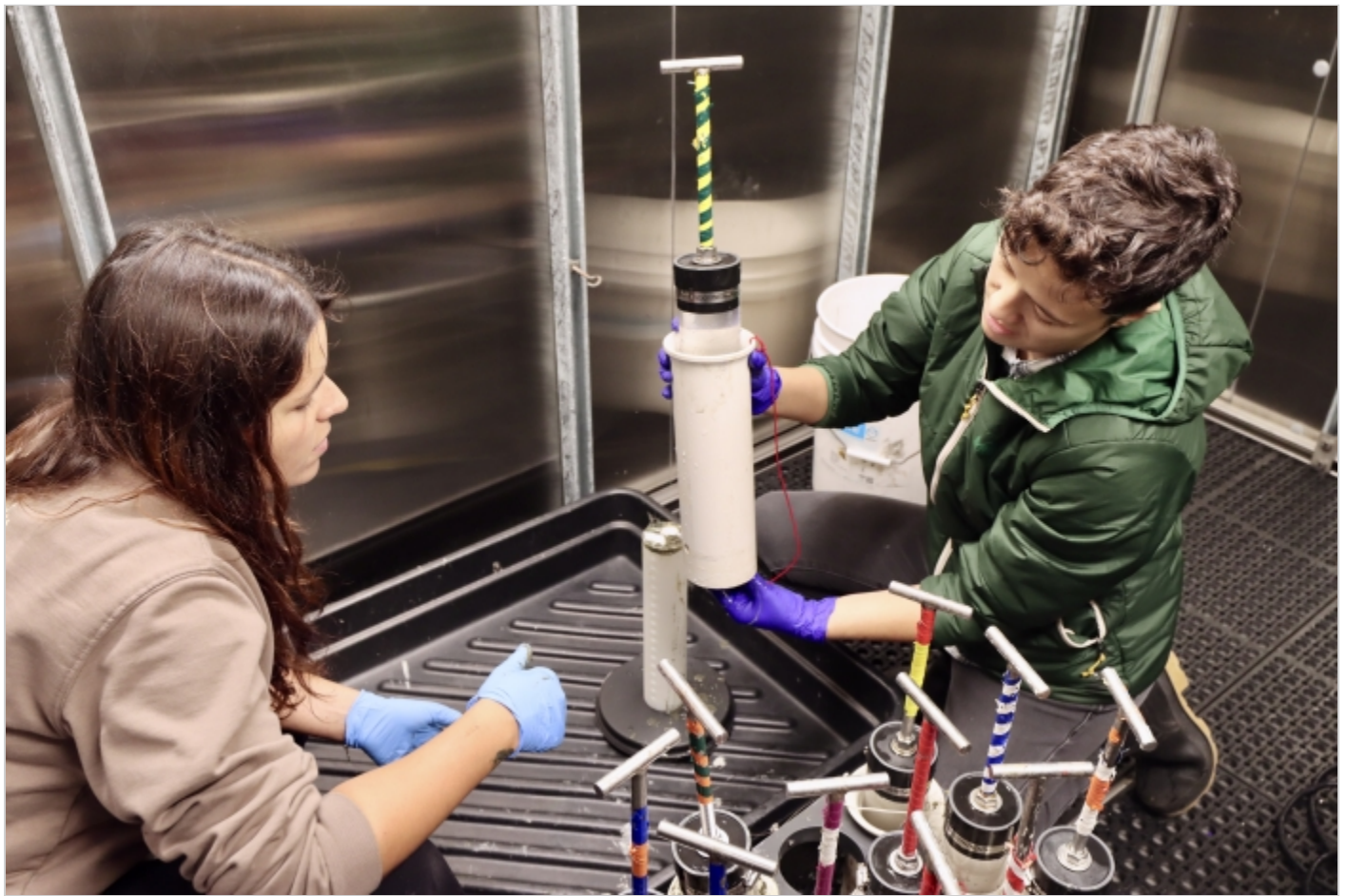
Kaitlin Noyes and Will Carter, both with ASU BIOS, prepare to film a ship-to-shore live interaction on the side deck of R/V Atlantis. The ASU BIOS outreach team played these film clips during live virtual field trips with hundreds of students across the country.

## Gallery

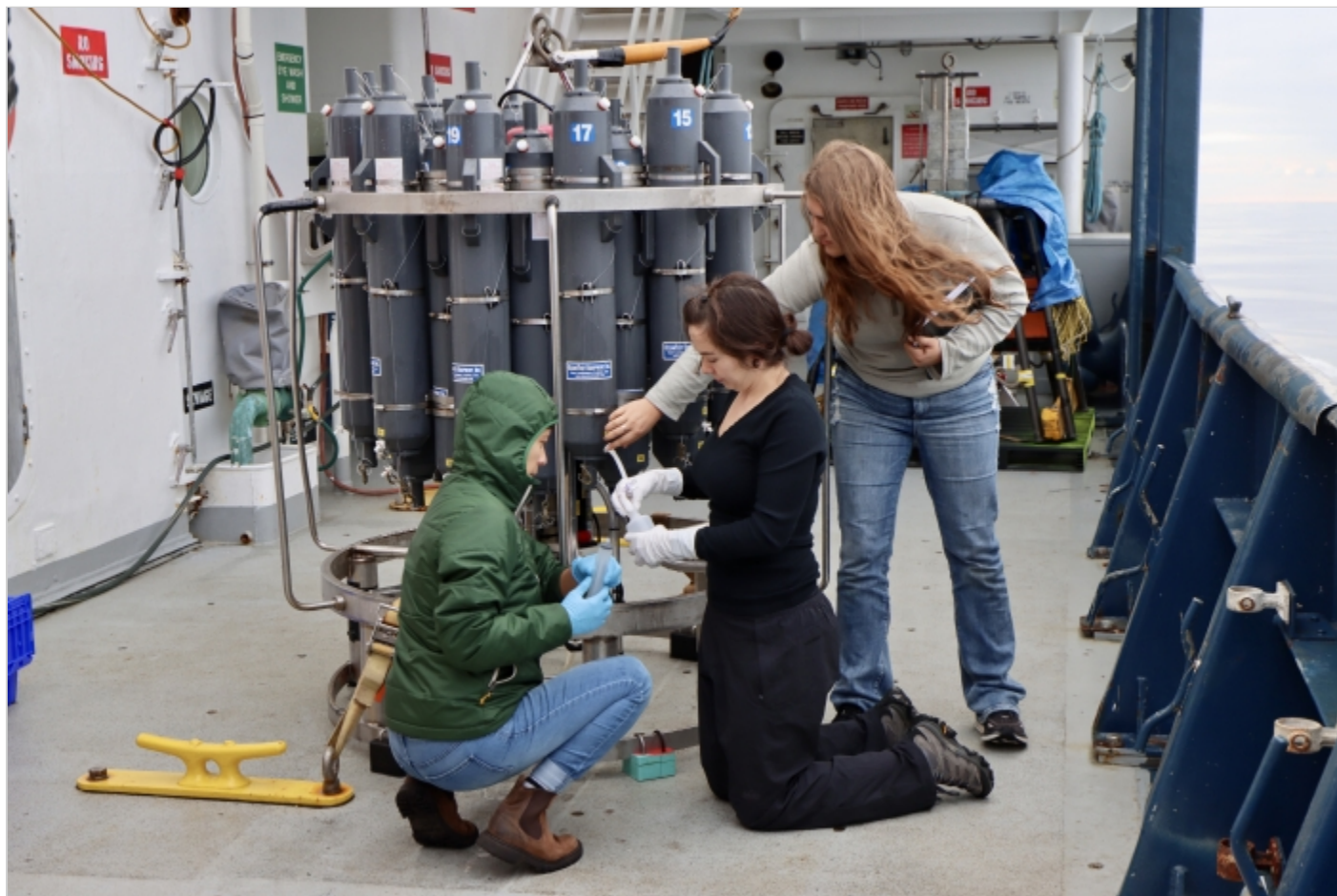




Isobaric gas-tight samplers are carefully retrieved from Alvin's basket for processing and analysis.



The research team subsamples a sediment core collected by the DSV Alvin for geochemical and microbiological analysis.



The ASU-led research team samples what's known as a "CTD rosette" that has profiled temperature, salinity and depth while collecting seawater for microbial incubation experiments. These microbes will be studied to better understand ocean biogeochemical processes.





Arizona State University undergraduate researcher India Rohl preserves endemic hydrothermal vent tubeworms for controlled microbial incubation and subsequent laboratory analysis.





ASU postdoctoral researcher Sheryl Murdock (left) and PhD student Alexi Avery sample hydrothermal vent fluid for the study.

## Gallery



The research vessel Atlantis is owned by the U.S. Navy and operated by Woods Hole Oceanographic Institution for the oceanographic community. This sophisticated research vessel is specifically outfitted for launching and servicing the Alvin human occupied submersible. An ASU-led research team completed a recent deep-sea expedition aboard the vessel.



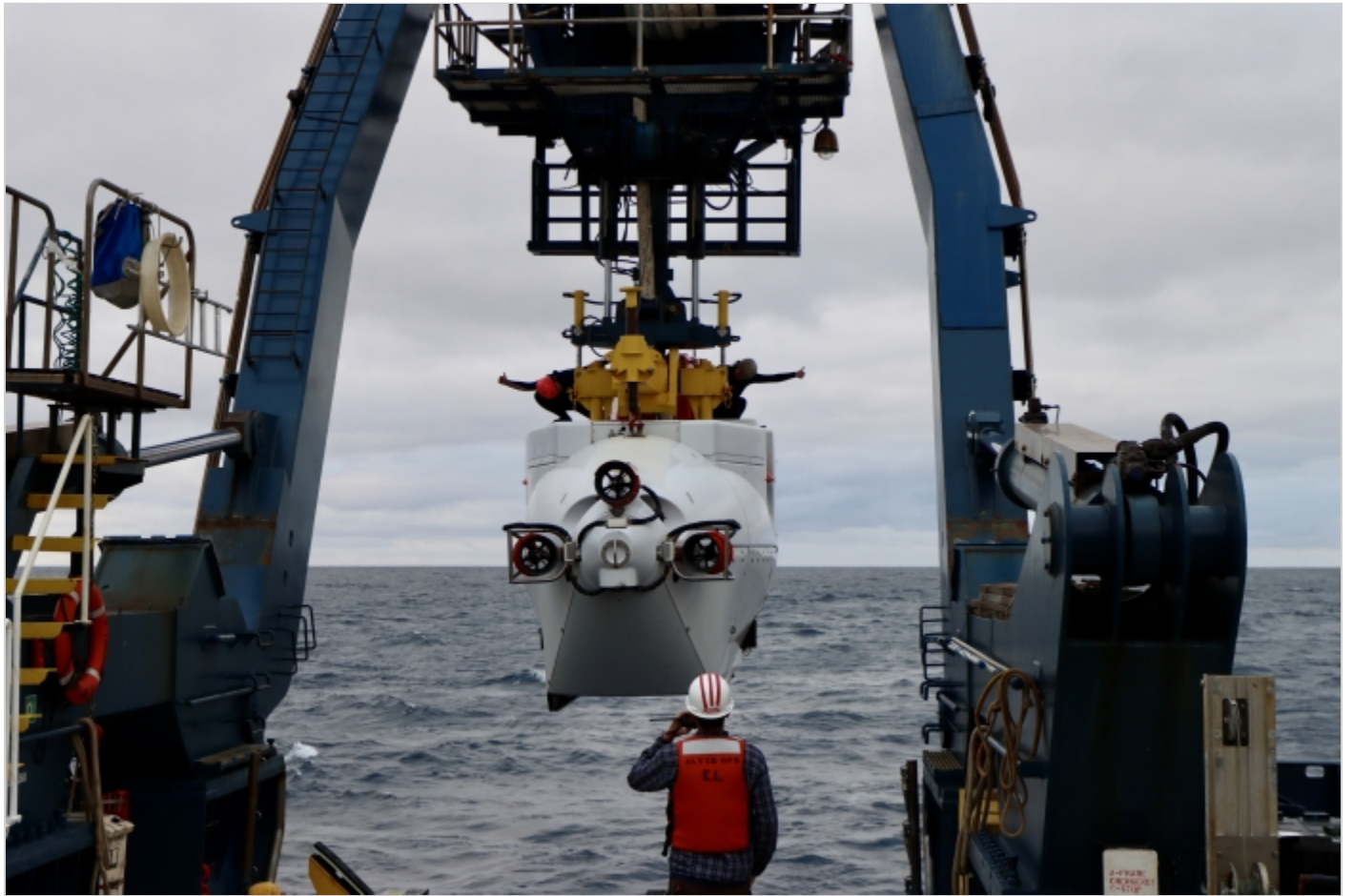
ASU undergraduate researcher India Rohl operates a winch and hoists research equipment back onto the deck of the Atlantis.



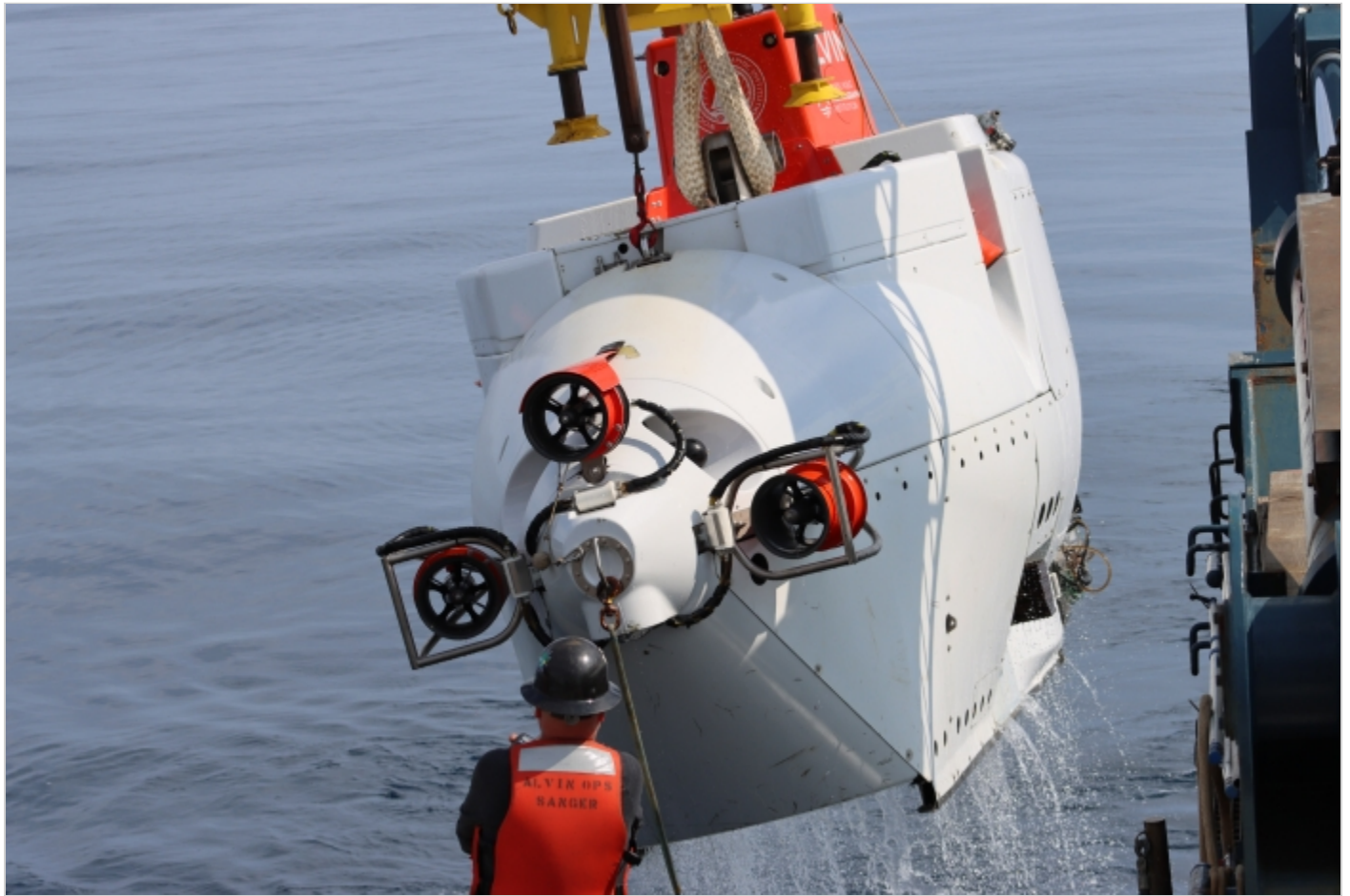


The ASU-led research team prepare research equipment for deployment during nighttime operations at sea.





DSV Alvin submersible enters the ocean as launch swimmers assist with final safety checks before descent to the deep sea in the Endeavour Hydrothermal Vents Marine Protected Area.



The Alvin submersible is recovered on deck following a seven-hour dive, concluding a successful day of hydrothermal vent sampling.



ASU science and engineering researchers. Top row, from left: Alexi Avery, PhD student; Kaitlin Noyes, ASU-BIOS; Leah Gaines-Sewell, research project manager; Kaitlyn Beardshear, WHOI/ASU; Elizabeth Trembath-Reichert, ASU associate professor; and Will Carter, ASU BIOS. Bottom row, from left: Sheryl Murdock, postdoctoral researcher; Carolyn Harris, postdoctoral research scholar; and India Rohl, undergraduate.