

# The Longest, Deepest Diver

The world's most successful research submarine, *Alvin*, has completed over 5,000 dives in its 60-year career.

Its first mission, in 1966, was to search for—and find—a hydrogen bomb that had fallen into the deep ocean.

Two years later, cables snapped while *Alvin* was being lifted aboard its tender ship, and it sunk to the bottom of the Atlantic ... where the sub itself had to be retrieved.

It has been rebuilt several times since—each time making it more robust for deeper diving.

In the '70s and '80s, *Alvin* was the first to explore hydrothermal vents. Scientists expected them to be devoid of life, but were shocked to discover communities of shrimp, mollusks and giant tube worms, supported by symbiotic bacteria.

In 1986, *Alvin* visited the *Titanic*. In 2014, it searched for seafloor damage beneath the *Deepwater Horizon* accident. In fact, half of all deep-sea research missions have been aboard *Alvin*.

Every few years, the sub is completely disassembled so its parts can be inspected for cracks and wear. Several subs were built along with *Alvin*, and several more since, but *Alvin* has outlasted them all.

It's now the Navy's only sub that can transport researchers deeper than 20,000 feet. It will spend its 60th birthday doing what it does best, exploring the bottom of the Gulf of Alaska. I'm sure the scientists aboard will make time to celebrate this timeless little sub.



*Alvin* being lifted onto the deck of WHOI RV *Atlantis* by the A-frame during the 2004 Gulf of Alaska Seamount Expedition.

Credit: NOAA, public domain, via Wikimedia Commons

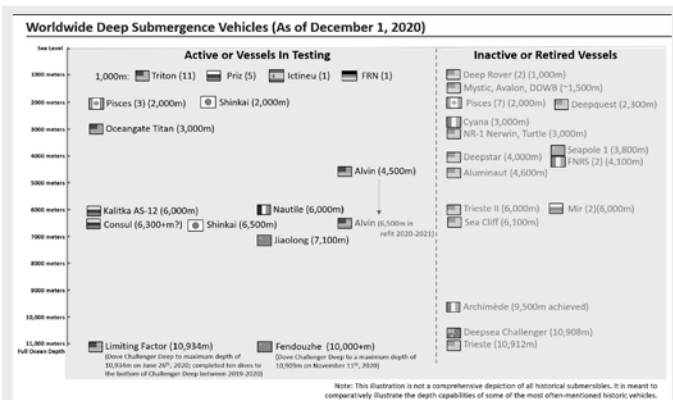


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# Background: The Longest, Deepest Diver

**Synopsis:** The world-famous DSV *Alvin* was commissioned 60 years ago, on June 5, 1964. Today, it is the United States Navy's only deep-submergence vehicle that can safely carry researchers to the seafloor, as deep as 21,300 ft (6,500 m). Upgrades were completed in 1973, 2014 and 2022 to keep it at the forefront of ocean exploration. The list of *Alvin* discoveries gets longer every year, from chemosynthetic hydrothermal "smokers" that changed our understanding of the origins of life to exploration of the sunken *RMS Titanic*. Scientists continue to keep the little sub busy with a variety of cutting-edge deep-sea projects.

- The DSV *Alvin* is operated by the Woods Hole Oceanographic Institute (WHOI).
  - Its missions are supported by National Science Foundation (NSF), National Oceanic and Atmospheric Administration (NOAA) and Office of Naval Research (ONR) funding.
  - The sub holds 3 people and has carried more than 3,000 different passengers in more than 5,100 dives.
  - Around half of the manned research dives ever carried out in Earth's oceans have been on the *Alvin*.
  - There are only seven other manned submarines with similar capabilities that are currently active. Two of these have completed dives to the Challenger Deep. (ED-204 The Deepest Dive).
- In addition to science, *Alvin* has contributed to the engineering development of deep-submergence vehicles.
- In 1950, scientists did not have a way to observe the deep seafloor. Submarines either couldn't go very deep, or they lacked windows.
  - At a conference in 1956, oceanographers agreed with WHOI scientist Allyn Vine that a manned submersible would be preferable to remote viewing systems because people can sense and investigate, while instruments can only sense and record.
- The first deep-submergence vehicle was the windowed *Trieste* bathyscaphe (DSV-1), built in 1952 by Auguste Piccard and purchased by the U.S. ONR in 1957.
  - It was unwieldy, but it informed the design of the more compact and maneuverable *Alvin*-class submarines.
  - It was replaced by the *Trieste II* in 1963, which served until the mid-1980s.
- In the late 1950s General Mills inventor Harold "Bud" Froehlich had designed a small submersible vehicle called "Seapup" that became the model for *Alvin*-class submarines.
  - This class of subs were named "Alvin" after the WHOI scientist Allyn Vine. The name stuck because of the popular cartoon chipmunk of the same name.
  - After two years of construction, *Alvin* (DSV-2) was commissioned in June of 1964 at the WHOI dock and spent its first year doing test dives.
  - *Alvin* earned its sub certification when it was piloted to its depth rating of 6,000 ft (1,800 m) on July 20, 1965, by its first pilot, ex-Navy submariner William Rainnie.



A graphic representation of all major manned deep-diving submersibles along with their maximum rated depth achieved and whether or not they were in active service in late 2020.

Credit: Vlvescovo, CC BY-SA 4.0, via Wikimedia Commons

## References: The Longest, Deepest Diver

- History of *Alvin* | Woods Hole Oceanographic Institution (WHOI)
- Three Decades Ago, a Reporter Took a Plunge into Wonder—and Danger | New York Times
- The Evolution of *Alvin* | National Geographic
- Trailblazer in the Ocean | WHOI Oceanus
- Human-Occupied Submersible *Alvin* Makes Historic Dive | TechXplore

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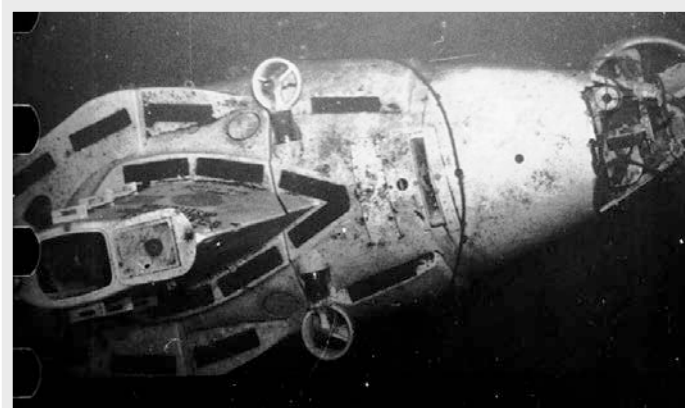
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- *Alvin* has three retired siblings: DSV-3 *Turtle* was identical to *Alvin*, operating from 1968 to 1998, DSV-4 *Sea Cliff* operated from 1968 to 1998 and again briefly after 2002 and DSV-5 *Nemo* operated from 1970 to 1998.
- *Alvin*'s first big adventure came in 1966, when it joined the search for a hydrogen bomb that fell into the Mediterranean Sea off the coast of Spain.
  - On January 17, 1966, during midair refueling of a B-52G bomber by a KC-135 tanker, the two U.S. Air Force planes collided, killing seven airmen and dropping four hydrogen bombs near the Mediterranean coast.
  - The nonnuclear detonation of two of the bombs resulted in plutonium contamination of about 0.77 mi<sup>2</sup> (2 km<sup>2</sup>) of land near a fishing village and a third was located intact, but the fourth ended up in the Mediterranean Sea.
  - On March 15, under the command of Admiral William "Wild Bill" Guest, 18 U.S. Navy ships with 2,200 crew gathered to search for the remaining bomb. The ships included the *USS Notable*, which supported both the DSV *Alvin* and the larger Reynolds Metals Company *Aluminaut* submersibles.
  - On April 2, *Alvin* found the bomb at a depth of 2,890 ft (869 m). It was recovered by the unmanned torpedo-recovery vehicle *CURV-I* on April 7, 1966, and loaded onto the *USS Petrel*.
- *Alvin*'s worst accident happened in 1968, and it was a good thing that an *Aluminaut* was around.
  - After cables on its tender ship *Lulu* snapped, *Alvin* dropped 5,200 ft (1,585 m) to the Atlantic seafloor south of Nantucket Island on October 16, 1968.



More than two months after it fell into the ocean following the January 1966 midair collision between a nuclear-armed B-52G bomber and a KC-135 refueling tanker over Palomares, Spain, this B28FI hydrogen bomb was located by the DSV *Alvin* and recovered by a remotely operated vehicle from 2,850 feet (869 meters) of water then lifted aboard the *USS Petrel* (note the missing tail fins and badly dented "false nose"). The B28 series of bombs had a maximum yield of 1.45 megatons, approximately 90 times more powerful than the nuclear weapon that destroyed 90% of Hiroshima, Japan. This photograph was among the first ever published of a U.S. hydrogen bomb.

Credit: U.S. Navy, courtesy of the Natural Resources Defense Council, public domain, via Wikimedia Commons



In 1968, while *Alvin* was being brought aboard its support ship, *Lulu*, a cable broke. With the hatch open, the submersible quickly filled with approximately 8,000 pounds (3,630 kilograms) of water and sank to a depth of 5,200 feet (1,585 meters) 88 miles (142 kilometers) off the coast of Nantucket, Massachusetts. This photo of *Alvin* was taken from DSV *Aluminaut* during the 1969 rescue mission.

Credit: Office of Naval Research, public domain, via Wikimedia Commons

## References: The Longest, Deepest Diver

- History of *Alvin I* Woods Hole Oceanographic Institution (WHOI)
- Three Decades Ago, a Reporter Took a Plunge into Wonder—and Danger | New York Times
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- *Alvin* was rebuilt, increasing its depth capability to 14,800 ft (4,500 m), thus enabling dives to the Mid-Atlantic Ridge in 1973 (ED-015 The Longest Mountain Range).
  - The biggest shock to scientists in the submersible was the ruggedness of the seafloor, especially as they neared the rift. They had imagined it would be much smoother (ED-286 First Map of the Ocean Floor).
- In 1977, *Alvin* crossed to the Pacific Ocean through the Panama Canal to begin one of its most famous missions: To transport scientists to the Galápagos Rift to study the interaction of seawater with spreading center volcanism.
  - This *Alvin* mission enabled discoveries that forever revolutionized the way we think about origins and extremes of life, both on Earth and beyond.
  - Scientists suspected that heat from Earth's mantle was escaping into seawater at spreading center rift zones and hoped to prove that seawater was being heated as it was percolating through volcanics and leaching chemicals into the ocean at hydrothermal vents.
- They expected the ocean would be mostly barren of life at these depths, because there was no sunlight for photosynthesis.
- They found the vents and confirmed they were spewing out mineral laden hot water but were not prepared for what they found near the vents—huge, thriving communities of clams, mussels and giant tube worms.
- In 1979, further *Alvin* research dives confirmed that microbes, operating chemosynthetically, form the base of the food chain around the vents and that most of the larger deep-sea animals had no mouths or digestive systems, relying on internal symbiotic bacteria to provide an energy source (food) in return for safe haven inside the animals.
- In that same year, *Alvin* dove on the East Pacific Rise at 21°N, this time finding the “black smokers” that belched acidic black plumes of mineral-rich water at more than 678°F (359°C).
- In 1985, *Alvin* also found hydrothermal vents on the Mid-Atlantic Ridge swarming with shrimp that lived with symbiotic bacteria, and in 2000, it found 60-ft-tall (20 m) white tower formations along the ridge that were named “the Lost City.”



Tube worm habitat at 9.5°N on the East Pacific Rise in 2010.

Credit: Sabine Gollner et al., CC BY 2.5, via Wikimedia Commons



East Pacific Rise at 21°N latitude, showing the base of a “black smoker” chimney in the Pacific Ocean.

Credit: W.R. Normark, Dudley Foster, public domain, via Wikimedia Commons

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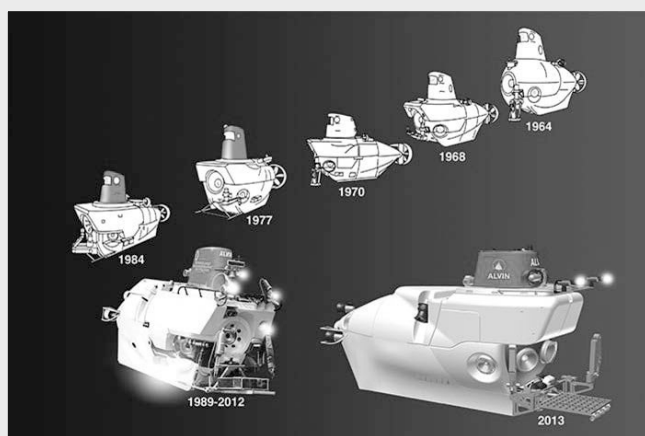
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- Over time, *Alvin* scientists also discovered and explored cold seeps of hydrogen sulfides and methane around the Florida Escarpment, in the Gulf of Mexico, in the Gulf of California, and in the Guaymas Basin of Mexico.
- In another famous voyage, *Alvin* visited the 1912 wreck of the *RMS Titanic* in 12,500 ft (3,800 m) of water in 1986, piloted by Dr. Robert Ballard.
  - The *Titanic* sank on her maiden voyage on April 15, 1912, after striking an iceberg. More than 1,500 people died.
  - *Alvin* had been fitted with electric thrusters and brought a remotely operated sidekick, the *Jason Junior*, along for the adventure. It also had a new support ship, the *RV Atlantis II*.
- *Alvin* is booked for science expeditions years in advance.
  - In March and April of 2014, *Alvin* revisited deep coral communities from previous studies to look for damage near the site of the *Deepwater Horizon* oil spill.
  - In 2022, *Alvin* was upgraded with a refit to enable dives to 21,325 ft (6,500 m).
  - On *Alvin*'s 60th birthday, the sub will be busy researching microbial communities of the deep-ocean methanosphere in the Gulf of Alaska with Dr. Lisa Levin of the University of California San Diego's Scripps Institution of Oceanography. Maybe they will have time to celebrate!



View of the bow of the *RMS Titanic*, photographed in June 2004 by the ROV *Hercules* during a later expedition returning to the shipwreck of the *Titanic*. The *Alvin* and the prototype *Jason Junior* remotely operated vehicle first visited the wreck in 1986.

Credit: NOAA/Institute for Exploration/University of Rhode Island (NOAA/IFE/URI), public domain, via Wikimedia Commons



In 60 years of operation, the deep-submergence vehicle *Alvin* has evolved and changed its look several times. In fact, the sub has been completely disassembled every three to five years so engineers can inspect every last bolt, filter, pump, valve, circuit, tube, wire, light and battery—all of which have been replaced at least once in the sub's lifetime.

Credit: E. Paul Oberlander, Woods Hole Oceanographic Institution

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