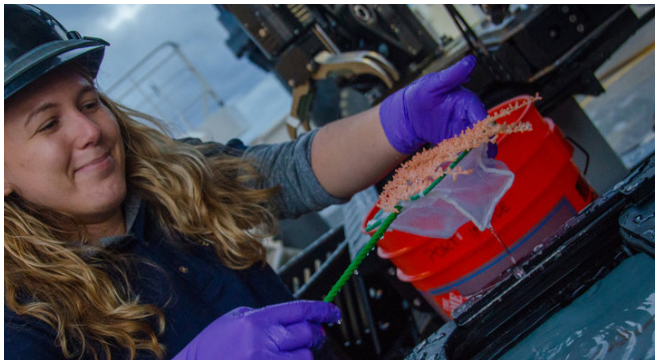
Deep-Sea Sampling

The deep sea is one of the largest, most remote, and unexplored environments on Earth. Deep-sea ecosystems are challenging to study given their extreme pressures, cold temperatures, and intense darkness. Studying small, carefully collected biological, geological, and water samples from deep-sea environments provides a record of these unexplored areas, helps scientists create well-informed hypotheses about the larger ecosystem, and creates a baseline for future comparisons.



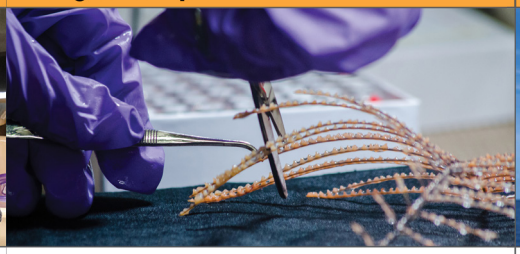
Gathering a coral sample. *Image courtesy of NOAA Ocean Exploration.*

What types of deep-sea samples are collected?

Ocean exploration begins with mapping a region, followed by targeted exploration using submersibles such as remotely operated vehicles (ROVs) or autonomous underwater vehicles (AUVs). Often, the first view of an area is captured by high-definition cameras mounted on these vehicles. This imagery provides a record that can be used to describe the geological, physical, and biological processes observed in an area. This video is watched live by scientists, recorded, and archived, allowing others to visually assess a deep-sea habitat without physically traveling to that location.

As cameras are viewing an area, they can guide targeted collection of physical samples like those described below. Deep-sea samples offer a physical record of an area and supplement the visual observations.

A video engineer adjusts the zoom, focus, and lighting on ROV *Deep Discoverer's* main high-definition camera to obtain the best shot of a tiny jellyfish. *Image courtesy of NOAA Ocean Exploration.*

Geological samples	Biological samples	Water samples
		
Geological samples include rocks and rubble picked up from the seafloor, as well as sediment samples. These are often collected to establish the geological history of an area, characterize rock types, understand sedimentation rates, and further explore seismic activity. *Image courtesy of NOAA Ocean Exploration.*	**Biological samples** include clippings or pieces of organisms living in a specific place, gathering enough material for taxonomic, genetic, and/or ecological studies. Whole specimen samples can also be taken, if necessary, and sometimes, a live specimen (e.g. a crab or shrimp), can be collected. *Image courtesy of NOAA Ocean Exploration.*	Environmental data is also collected via water samples and other onboard sensors. **Water samples** can be collected at certain depths or at specific locations. These samples are further analyzed for factors including dissolved oxygen, salinity, nutrients, carbon, pH, pollutants, and more. Water samples are also taken to collect and study environmental DNA. *Image courtesy of NOAA Ocean Exploration.*

What protocols surround deep-sea sampling?

In order to explore ocean habitats and collect samples, exploration teams must go through strict permitting processes and consultation with local community and resource managers. Expedition planning and goals weigh the amount of new knowledge to be gained from samples versus any potential impacts. The type and number of samples taken are limited to those that can be

safely and efficiently collected and that provide the most scientific value. The best observations are made without disturbing the environment, and sampling occurs only when absolutely necessary.

During expedition planning, community input is sought from state, local, and tribal governments, local communities, not-for-profit organizations, academia, and private industry to identify sampling needs or concerns. When exploring, and possibly sampling in culturally significant areas, regional, local and indigenous community input is essential to respect local heritage and the spiritual significance of a region.

Image courtesy of NOAA Ocean Exploration.

How are deep-sea samples collected?

The methods and tools used for collecting deep-sea samples depend on the material or measurement to be taken and the environment being explored. Since the biological, geological, and chemical structure of deep-sea habitats varies, many different tools are used for ocean sampling.

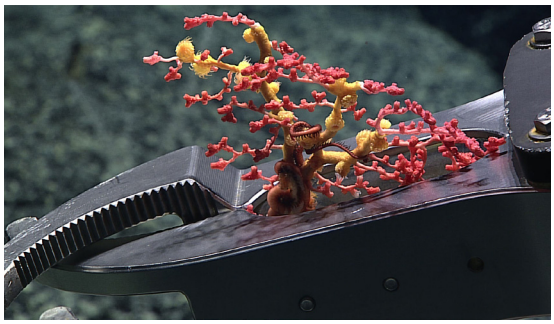


Image courtesy of NOAA Ocean Exploration.

ROVs are most commonly used to collect deep-sea samples. The most basic ROV sampling method is called a "**grab**", using a vehicle's manipulator arm. The arm ends in a hinged jaw that opens and closes to pick up a sample. The force of the manipulator arm's gripper can be adjusted to handle delicate specimens, like corals/sponges, and heavier loads, like large rocks.

An ROV manipulator arm can be equipped with a variety of precision tools including sharp **coral cutters** to trim off samples, soft "fingers", suction samplers, scoops, and nets. Temperature probes, mass spectrometers, gas collectors, and other instruments, can also be deployed by the manipulator arm to detect and measure characteristics of the water column or an area of interest, like a hydrothermal vent or a cold seep.

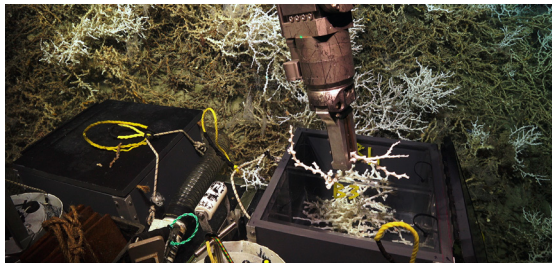


Image courtesy of Ivan Hurzeler and DEEP SEARCH 2019 - BOEM, USGS, NOAA, ROV Jason, ©Woods Hole Oceanographic Institution.

Storage and transport boxes: The ROV is equipped with "bioboxes", containers with watertight lids to safely transport biological samples, and rock boxes to carry geological samples.

Push Cores: Used for seafloor sediment sampling, a push core is a clear tube with a handle for the manipulator jaw to hold. Once the manipulator has grabbed the tube, it is pushed down into the sediment and then carefully pulled back out, filled with sediment. The core is then pushed into a secure holder on the ROV for safe transport. Other tools like "scoops" and "slurps" can also be used to collect sediment.

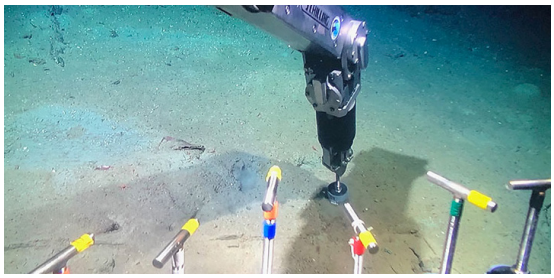


Image courtesy of Microbial Stowaways.

Niskin bottles: These large plastic bottles are often attached to the ROV to collect water samples. Each bottle has a wire trigger for the manipulator arm to pull in order to close its lid and take samples at particular times and depths.

A variety of additional equipment and sensors are commonly added to expand an ROVs capabilities. All of the resulting data can be precisely matched to the locations where specimens were collected.

Image courtesy of Art Howard/GFOE.

LEARN MORE: Tools of Ocean Exploration
The Life Cycle of a Deep-Sea Sample

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