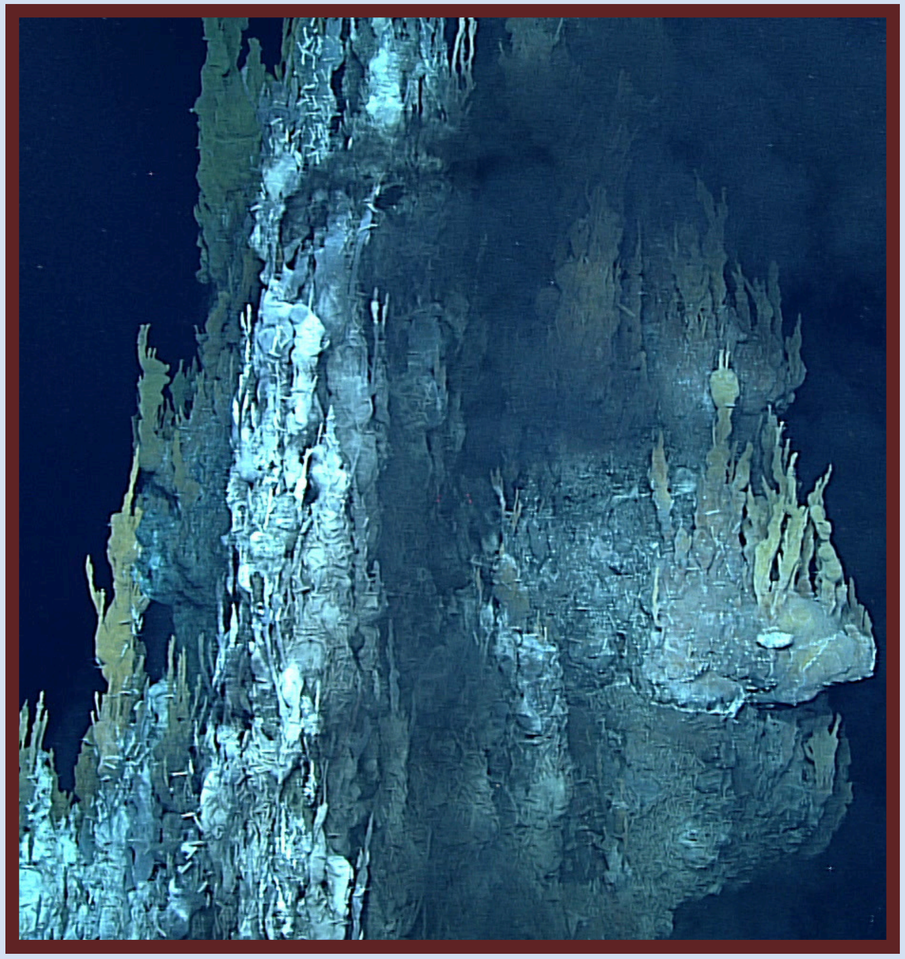
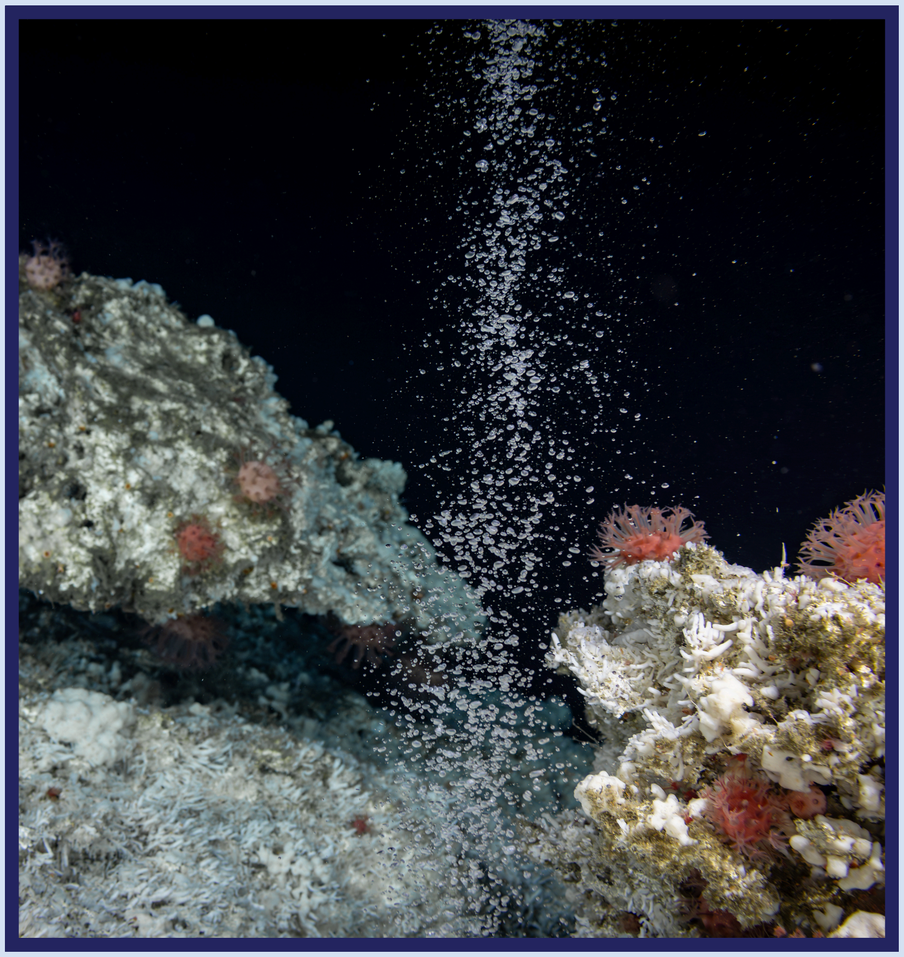
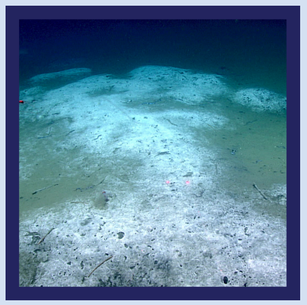
Life Beyond Light

CHEMOSYNTHETIC COMMUNITIES OF THE DEEP OCEAN: HYDROTHERMAL VENTS AND COLD SEEPS

For the majority of life on Earth, the food chain is based on photosynthesis, with plants and plankton converting sunlight into energy. In the deep ocean, however, there is no sunlight, so life had to find another way: **chemosynthesis**. Chemosynthesis occurs when bacteria and other organisms use chemical energy from sulfides, methane, and other inorganic compounds to produce food. These bacteria form the basis of the food chain for life at places on the seafloor where photosynthesis is not possible, such as **hydrothermal vents and cold seeps**.







Hydrothermal vents are volatile, short-lived openings in the seafloor created through volcanism. Magma-heated, high-temperature water rich in acidic fluids, and gases like hydrocarbons, hydrogen sulfide, and minerals emerges from these vents, often forming large chimneys. Here, organisms grow quickly.

Cold seeps are relatively stable, long-lived places on the seafloor where fluid rich in methane, oil, or hydrogen sulfide and similar in temperature to surrounding water slowly seeps up from cracks in the seafloor, often as methane or hydrogen sulfide. Here, organisms grow slowly and can be extremely long-lived.

Visit **oceanexplorer.noaa.gov** to learn more about hydrothermal vents and cold seeps.

NOAA OCEAN EXPLORATION

HYDROTHERMAL VENTS

Hydrothermal vents are found at tectonically active areas like mid-ocean ridges and the Pacific Ring of Fire. Vent images from poster front:

Top: At hydrothermal vents, microbes such as bacteria and archaea use the chemical-rich soup spewing from the vents as a source of energy through a process called chemosynthesis. At vent sites, bacteria often form mats, like these iron-oxide encrusted microbial mats at West Mata volcano. Image location: Lau Basin within the Pacific Ring of Fire at a depth of approximately 1,280 meters (4,199 feet). *Image courtesy of NOAA/National Science Foundation/Woods Hole Oceanographic Institution.*

Middle: Microbes at hydrothermal vents form the basis of food webs that support diverse vent ecosystems. Animals at vent sites, such as shrimp, mussels, and crabs, are adapted to live in total darkness and to withstand extreme ranges of water temperatures, pressures, and high concentrations of what would normally be toxic chemicals. In this image, a caridean shrimp crawls over a hydrothermal vent chimney within the Moytirra Vent Field. Image location: Mid-Atlantic Ridge at a depth of approximately 2,950 meters (1.8 miles)

Bottom: Tubeworms thriving at hydrothermal vents can grow to be over 2 meters (6.5 feet) in length! They get their nutrition from symbiotic, chemosynthetic bacteria that live in their guts and transform sulfur into energy. The *Riftia* tubeworms in this image were found colonizing diffuse vent habitats between broken pieces of lava. Image location: Northwest of the Galapagos Islands, along the Galapagos Rift, at a depth of approximately 2,560 meters (1.6 miles).

Center: This incredibly active, 30-meter (100-foot) tall hydrothermal vent was observed gushing high-temperature fluid full of metal particulates. This vent was home to many different animals, including shrimp, squat lobsters, crabs, limpets, mussels, and snails. Image location: Marianas Trench Marine National Monument at a depth of approximately 3,290 meters (10,800 feet).

COLD SEEPS

Cold seeps are found at tectonically active areas like the Cascadia Margin in the Eastern Pacific, and along passive (inactive) continental margins, like along the U.S. Atlantic coast and the Gulf of America. Seep images from poster front:

Top: At cold seeps, the first organisms to colonize a new site are microbes, including bacteria and archaea. These bacteria, which often form thick mats along the seafloor like those in this image, produce energy from chemicals such as methane and hydrogen sulfide that emerge from the seeps via a process known as chemosynthesis. The energy produced by these bacteria forms the base of the food web in cold seep ecosystems. Image location: Off the Outer Banks of North Carolina at a depth of approximately 460 meters (1,510 feet).

Middle: Dense beds of mussels or clams often form at seep sites and are nourished by symbiotic, chemosynthetic bacteria in their tissues that produce energy from methane. These bacteria are related to, but are not the same species as those that form bacterial mats. The bed of *Bathymodiolus* mussels in this image formed the basis of a chemosynthetic community that also included tubeworms, sea cucumbers, shrimp, anemones, and brittle stars. Image location: Gulf of America at a depth of approximately 2,160 meters (1.3 miles).

Bottom: Tubeworms are a common species at cold seeps. Much like seep mussels and clams, tubeworms get their food from billions of symbiotic bacteria that live inside of them; however instead of methane, the bacteria use hydrogen sulfide as an energy source. Dense “fields” of *Lamellibranchia* sp. tubeworms, pictured here, extended over an area that was at least 200 meters (656 feet) wide, but may have been even larger based on the bubble trail discovered during expedition mapping operations. Image location: Alaska waters at a depth of approximately 2,020 meters (1.25 miles).

Center (large): Methane bubbles escape a cold seep in front of a diversity of sponges, corals, anemones, and more. Image location: Chatham Seep offshore southeastern Alaska at a depth of approximately 700 meters (2,300 feet).

Learn more about chemosynthesis, the process by which food is made by bacteria or other living things using chemicals as the energy source, typically in the absence of sunlight: https://oceanexplorer.noaa.gov/edu/materials/chemosynthesis-fact-sheet.pdf.