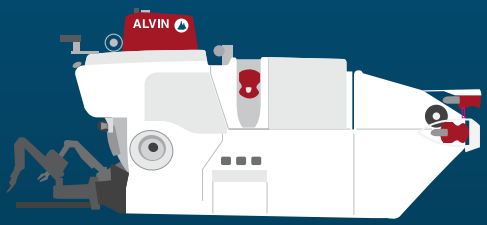
EXPLORING THE OCEAN WITH ALVIN

I know I do not look like a typical boat or submarine, and that's because I am special. My full name is **Deep-Ocean Submersible Human Occupied Vehicle, ALVIN**, which is just a fancy way of saying that I can explore the depths of the ocean.

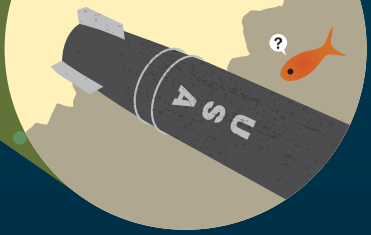
Navy Engineers built me in 1964. I can do all sorts of cool things: I can go all the way down to the ocean floor, take pictures of the creatures I meet, and use my two robotic arms to perform experiments for scientists.

National Science Foundation
WHERE DISCOVERIES BEGIN

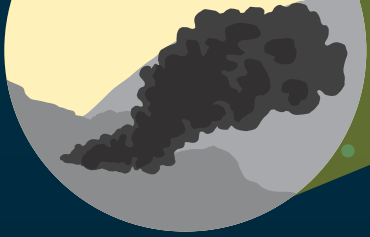
I've made over 4,400 dives over the years!



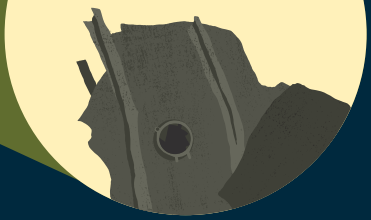
I found a lost **hydrogen bomb**



discovered **smoky black water**



and even **studied the ruins of the Titanic!**



Scientists from all over the world have searched the sea with me, and now it is your turn! Come with me down into the depths of the ocean—**it's time to explore!**

FUN OCEAN FACTS

The ocean holds 97% of Earth's water and covers 70% of the Earth's surface, which is why the ocean is so important for us to study.

It is home to unique life forms, deep ocean trenches, and even explosive underwater volcanoes. But, believe it or not, we've only explored a tiny part of our world's ocean—just 5%! We still have a long way to go before we can solve all of the mysteries of the deep. That is why I dive into the ocean depths to learn more about the exciting world beneath the waves.

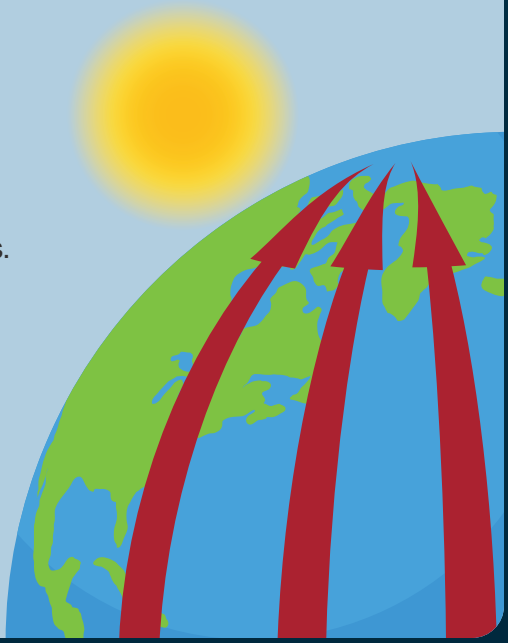
Scientists divide the ocean into zones based on how much sunlight can get through. The deeper you get, the darker the ocean. But just how deep is the ocean and what can we find there?

It's time to find out—hold on tight for the dive into our first zone, the **epipelagic zone**!

DID YOU KNOW?

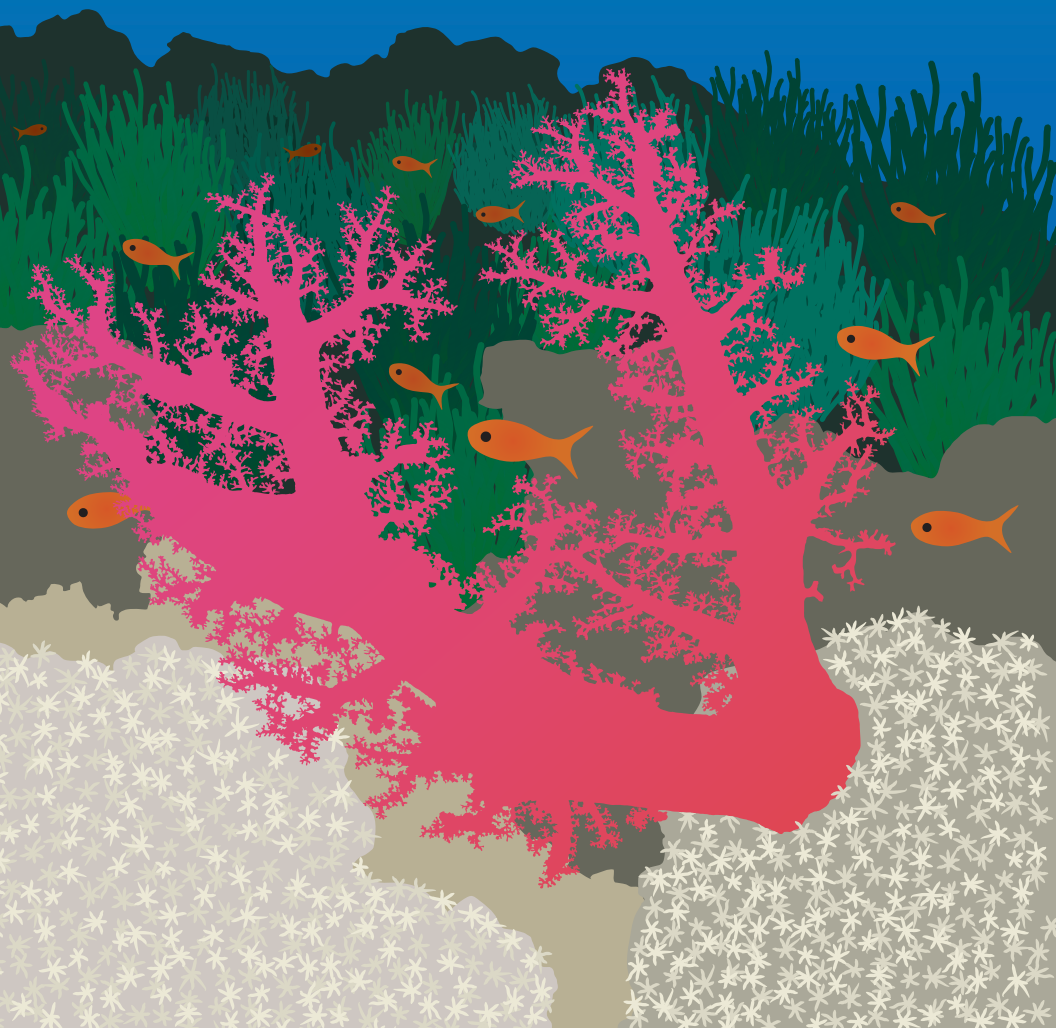
The ocean is important for our Earth's climate. Water absorbs heat from the Sun in the tropics and moves it to the North and South Poles.

The ocean was created 3.8 billion years ago, shortly after the Earth formed 4.6 billion years ago. It has played an important role in shaping the surface of the Earth since its formation.



THE EPIPELAGIC/ SUNLIGHT ZONE

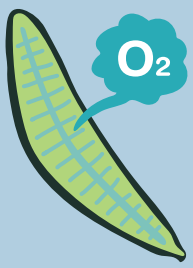
What do you think of when you picture the ocean? It probably looks a lot like the **epipelagic zone**, which stretches from the ocean surface to 660 feet deep. Scientists also nickname this zone the **sunlight zone** because light from the sun keeps the water bright and warm. That is good, because you will able to see all of the different creatures that live in this zone: fish, turtles, jellyfish, dolphins, and even sharks. If you were to go scuba diving near the ocean floor at this depth, you would also see colorful coral reefs.



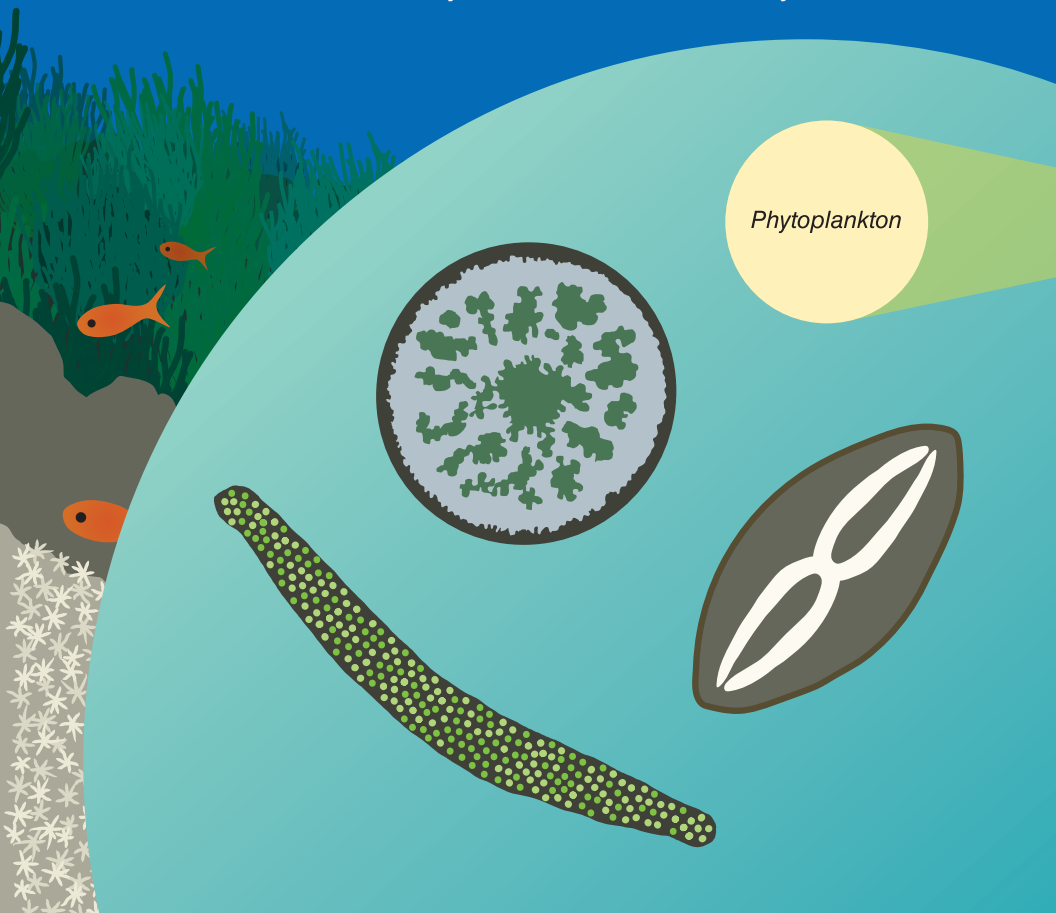
DID YOU KNOW?

Did you know that tiny **phytoplankton** help us breathe? Their photosynthesis produces nearly half of all of the oxygen in our atmosphere!

The ocean tastes salty because of the elements that get absorbed in the water.

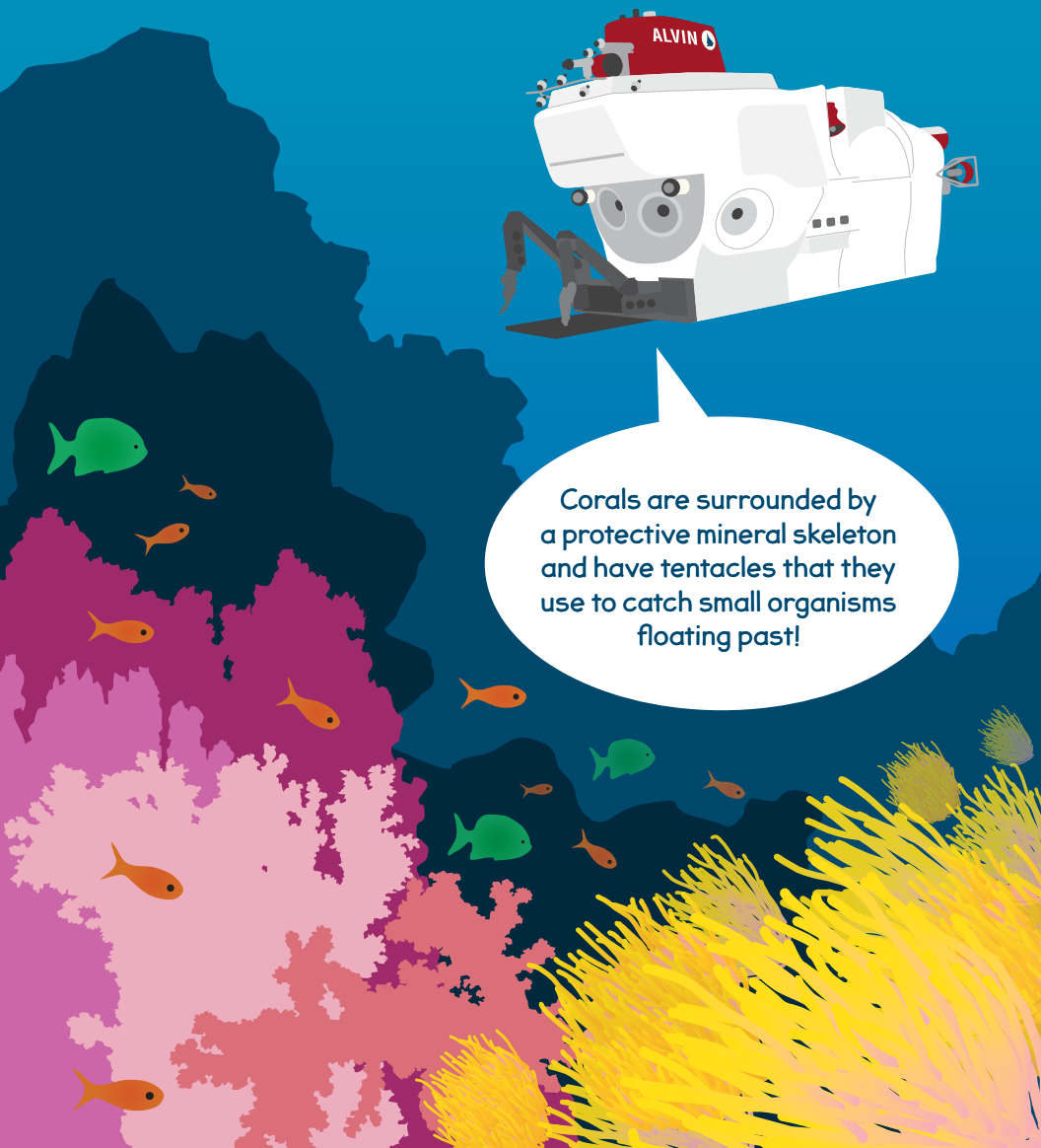


Why are there so many animals here? The sunlight allows underwater plants and algae to use **photosynthesis**, which is how plants convert carbon dioxide into energy and food for other creatures to eat. Microorganisms like phytoplankton also use photosynthesis. Plants, algae, and microorganisms that perform photosynthesis are important food sources that allow many of the creatures around you to survive.



A CLOSER LOOK AT CORAL REEFS

Coral reefs are important ecosystems that directly support 25% of all ocean species. Coral reefs are also beneficial for humans. They protect our shorelines, sustain food sources, and even hold medical cures for diseases.

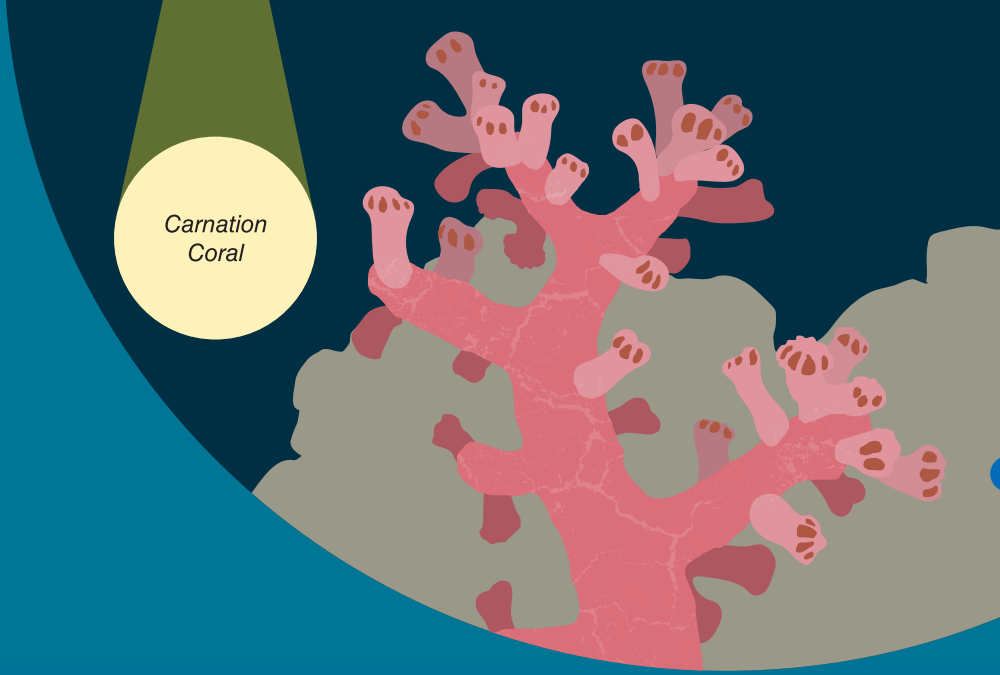


DID YOU KNOW?

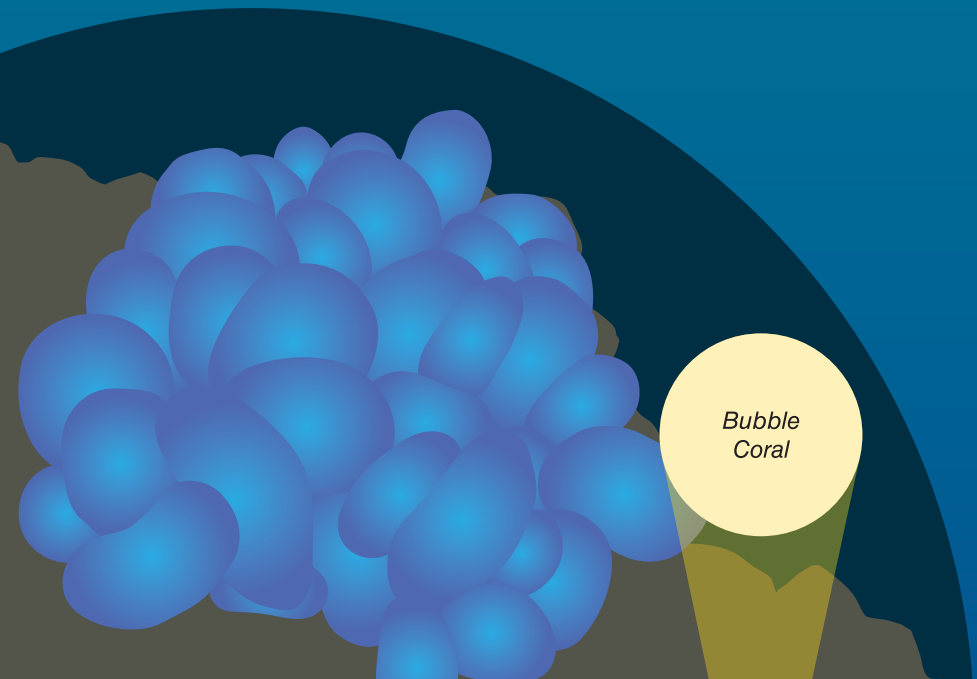
The Great Barrier Reef in Australia is the largest living thing on Earth. It is so big that it can be seen from outer space!

We can figure out the age of corals by the rings in their skeletons, which grow outward like tree rings. Some coral communities have been around for more than 4,000 years!

The reefs and other organisms provide food and protections that allow both the organism and the coral to survive. For example, certain types of algae provide food for the coral, and in return, the coral gives nutrients to the algae. The reefs also provide shelter for fish, crabs and shrimp, who hide from predators.

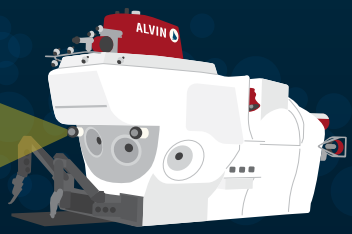


We study coral reefs because they protect coastlines, and provide shelter for many marine organisms. Coral reefs are vulnerable to changes in water chemistry, climate, and pollution. Scientists collect samples of corals on dives to understand how we can best protect them and the ecosystems that they support.



THE MESOPELAGIC/ TWILIGHT ZONE

It's getting dark– **time to turn on our searchlights!**

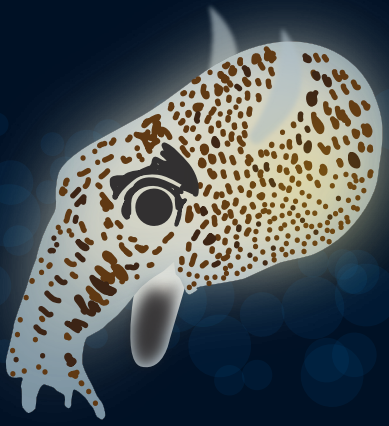


But it is not nighttime. Here in the **mesopelagic zone**, the water is 660 to 3,300 feet deep, and most of the sunlight has been absorbed above. That is why this zone is commonly called the **twilight zone**. Less light also means that the water around us is getting much colder.

In the twilight zone, there's not enough light for photosynthesis, so the fish have to wait for food to fall from the sunlight zone or swim upwards to find things to eat. Some fish have adapted to produce their own light. This is called **bioluminescence**. Researchers think animals use bioluminescence for signaling, camouflage, and luring prey.

The twilight zone is also home to volcanoes like the Daikoku seamount in Japan.

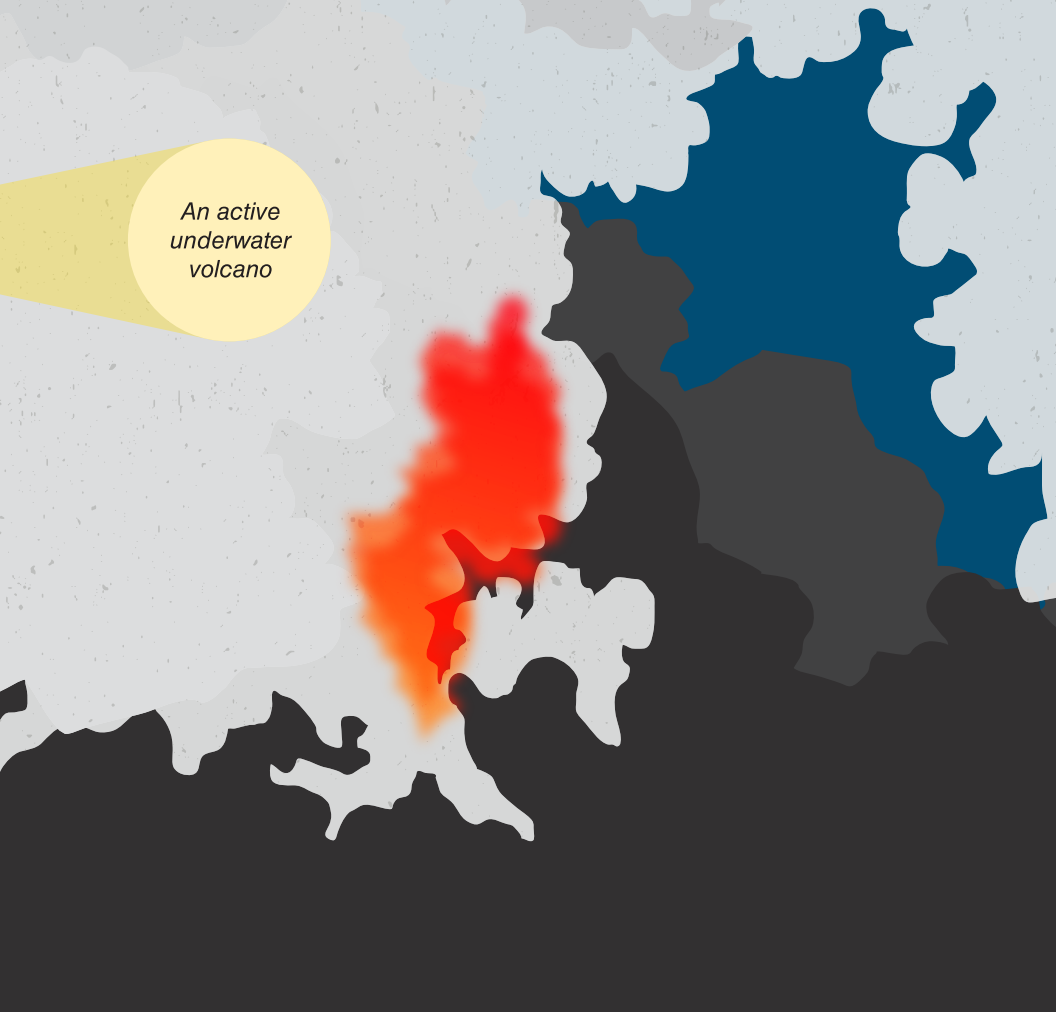
Bioluminescent Squid



UNDERWATER VOLCANOES

It turns out that we cannot actually see most of the volcanoes on Earth from dry land. The greatest number of volcanoes are underwater, on the ocean floor.

If a volcano erupts, it is called an **active volcano**. Active volcanoes are more likely found along the borders of **tectonic plates**, slabs of the Earth's crust that can crash into, move apart, or slide against each other. The rigid **lithosphere plates** rest on top of the hotter, softer layer of the Earth, called the **mantle**. This is where **magma** is found.



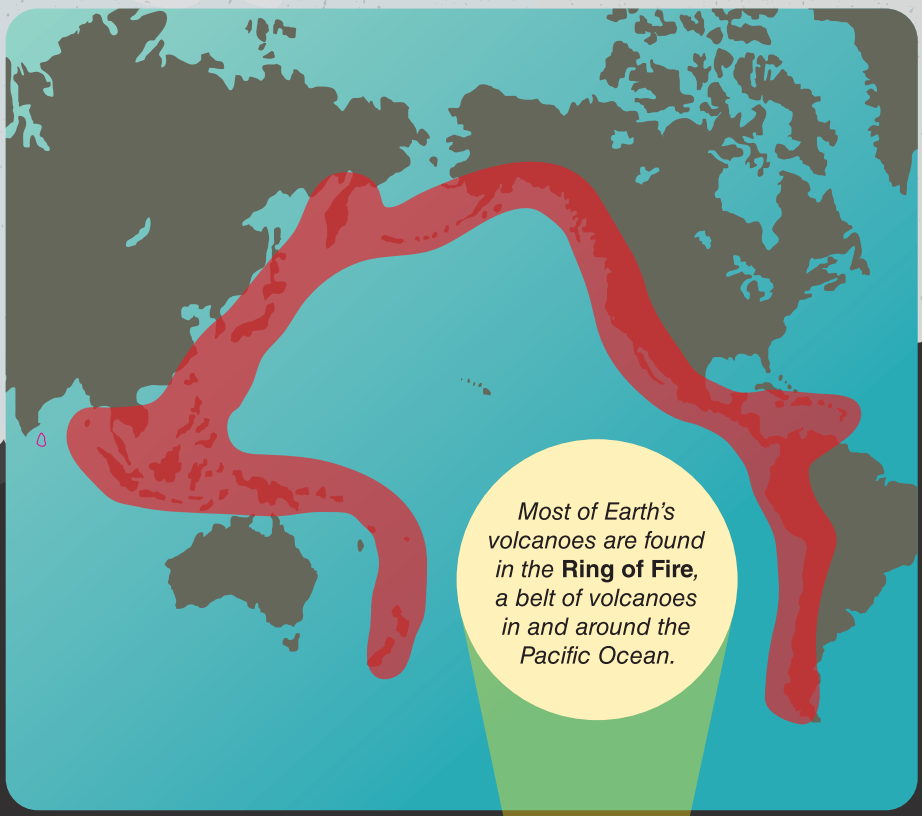
An active underwater volcano

DID YOU KNOW?

The Hawaiian Islands are actually volcanoes in the ocean that rise above the surface.

The magma underneath the ocean floor also has important functions, like renewing the Earth's surface. When magma rises from underneath the cracks in Earth's crust, it can create new layers of ocean floor.

Scientists use advanced technologies to help predict when eruptions will occur, even if the eruptions occur in deep water. It is important to monitor deep-sea eruptions, since they can cause earthquakes and other natural disasters.



Most of Earth's volcanoes are found in the **Ring of Fire**, *a belt of volcanoes in and around the Pacific Ocean.*

THE BATHYPELAGIC ZONE/ MIDNIGHT ZONE

The pitch-black **Bathypelagic Zone** is also called the **midnight zone**, where no sunlight can pass through the water. Many of my explorations happen in this zone, which stretches from 3,300 feet to 13,100 feet. The conditions here are extreme: water temperature is only 39 degrees Fahrenheit (7 degrees above freezing) and the water pressure is 400 times greater than the pressure we feel on land!

In the complete darkness, the only light you will see comes from bioluminescent organisms like the anglerfish, which has an enormous mouth and a bright light dangling from its head to lure prey.

DID YOU KNOW?

The colors of light disappear at different ocean depths. Blue light penetrates furthest, and red light disappears the quickest. Objects that are red on land, including some animals, actually appear black at great depths!

You might be wondering—how can organisms even survive at this depth without photosynthesis? On the seafloor, underwater springs called **hydrothermal vents** release boiling hot chemicals like hydrogen sulfide. Bacteria use hydrogen sulfide to make energy similar to how plants use photosynthesis. This process is called **chemosynthesis** and allows deep-sea communities of worms, crabs, mussels and shrimp to survive.

The tubeworm colony pictured below is an example of an organism that relies on chemosynthesis. Bacteria living in the tubeworms use chemosynthesis to produce energy for both organisms.

HYDROTHERMAL VENTS

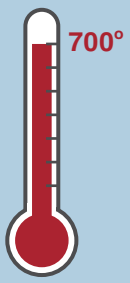
Like underwater volcanoes, hydrothermal vents are closely related to fissures in the Earth's crust. At plate boundaries, areas where two tectonic plates move towards or away from each other, seawater can seep through the cracks in the crust. The water is heated by the magma and emerges once again, forming a hydrothermal vent.

Vents, also called **smokers**, can produce different colors of smoke depending on the minerals in the fissure. **Black smokers** spew iron sulfide, while **white smokers** spray barium, calcium, and silicon. We nickname the mineral deposits that form **chimneys**, because they look like the chimneys on roofs when they emit smoke. Some chimneys can grow many stories high!

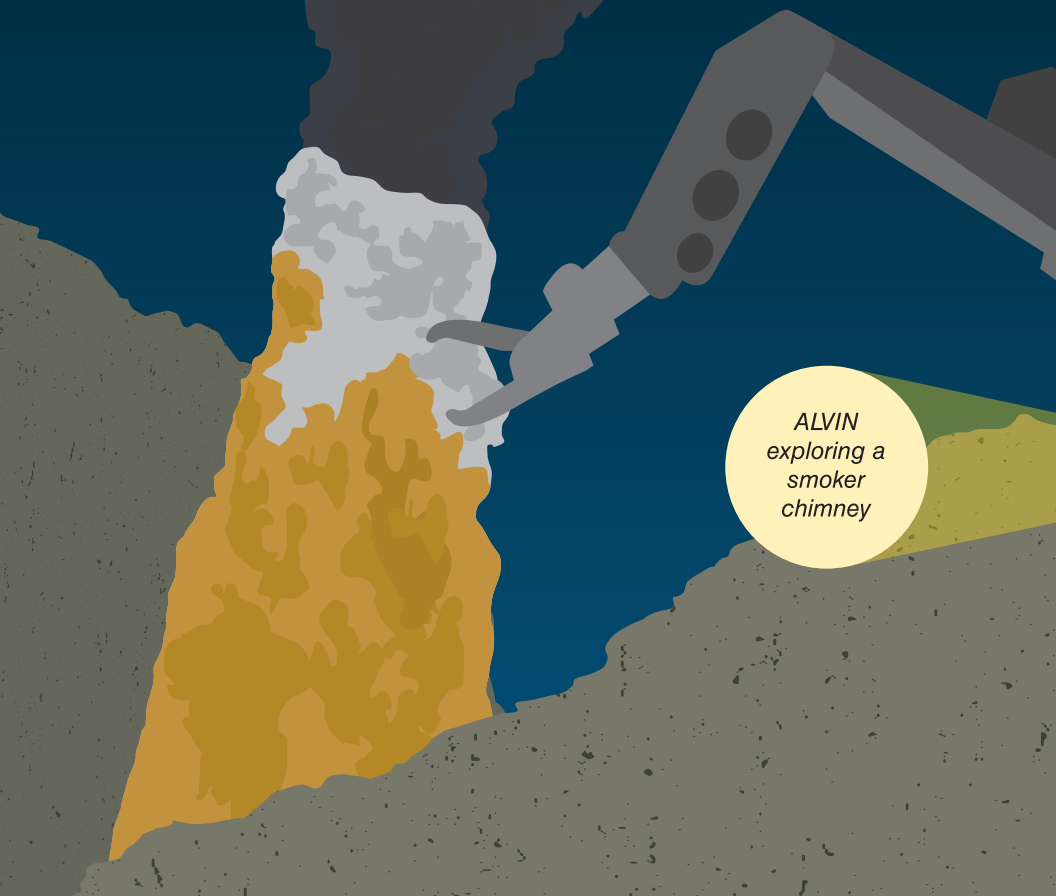
DID YOU KNOW?

Scientists first observed hydrothermal vents in 1977 near the Galapagos Islands.

The temperature of the seawater in hydrothermal vents can be more than 700 degrees Fahrenheit! Boiling water on the stove is around 212 degrees.

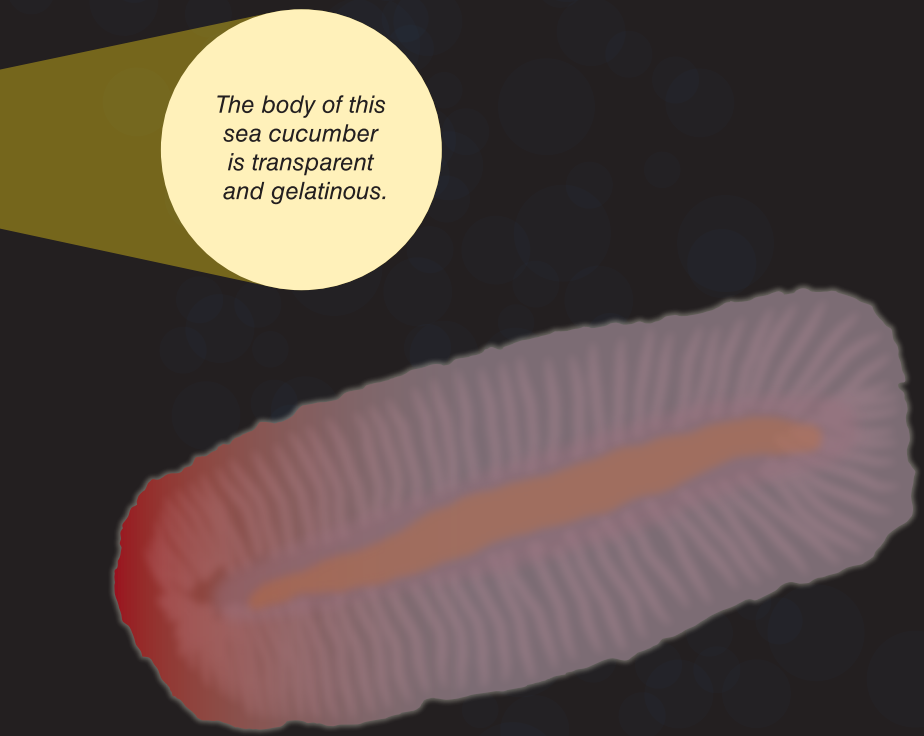


The chemicals and acids from hydrothermal vents would be harmful to most animals, except for those that have adapted to survive around vents. Without vents, we would not have these interesting creatures and chemosynthetic communities.



WHAT LIES BELOW?

We know very little about the deepest parts of the ocean. I can only dive up to about 14,800 feet, so what we do know about the deep **abyssopelagic zone** (13,100–19,700 feet) and **hadalpelagic zone** 19,700–36,070 feet) is from a few expeditions by other deep-sea submersibles. Only a few creatures with special adaptations and microbes that rely on chemosynthesis can survive these enormous pressures, near-freezing temperatures, and complete darkness.



Much of the ocean floor lies in the abyssopelagic zone, where the seafloor is mostly muddy and flat. This is called the **abyssal plain**, where worms, shrimp, sea stars, sea cucumbers, and other organisms live. These areas cover about 50% of the Earth's surface.

DID YOU KNOW?

Some trench-dwelling creatures are able to navigate vertical distances of over half a mile from the bottom of the trench every day.

The deepest living fish known is the **abyssobrotula galatheae**, an eel-like bony fish, found in the Puerto Rico Trench.

Even deeper areas are found in **trenches**: deep, narrow parts of the ocean floor. The deepest point of the ocean is called the **Challenger Deep** in the Mariana Trench (6.83 miles).

We still have much of the ocean to explore. Who knows what secrets the depths still have in store for science?

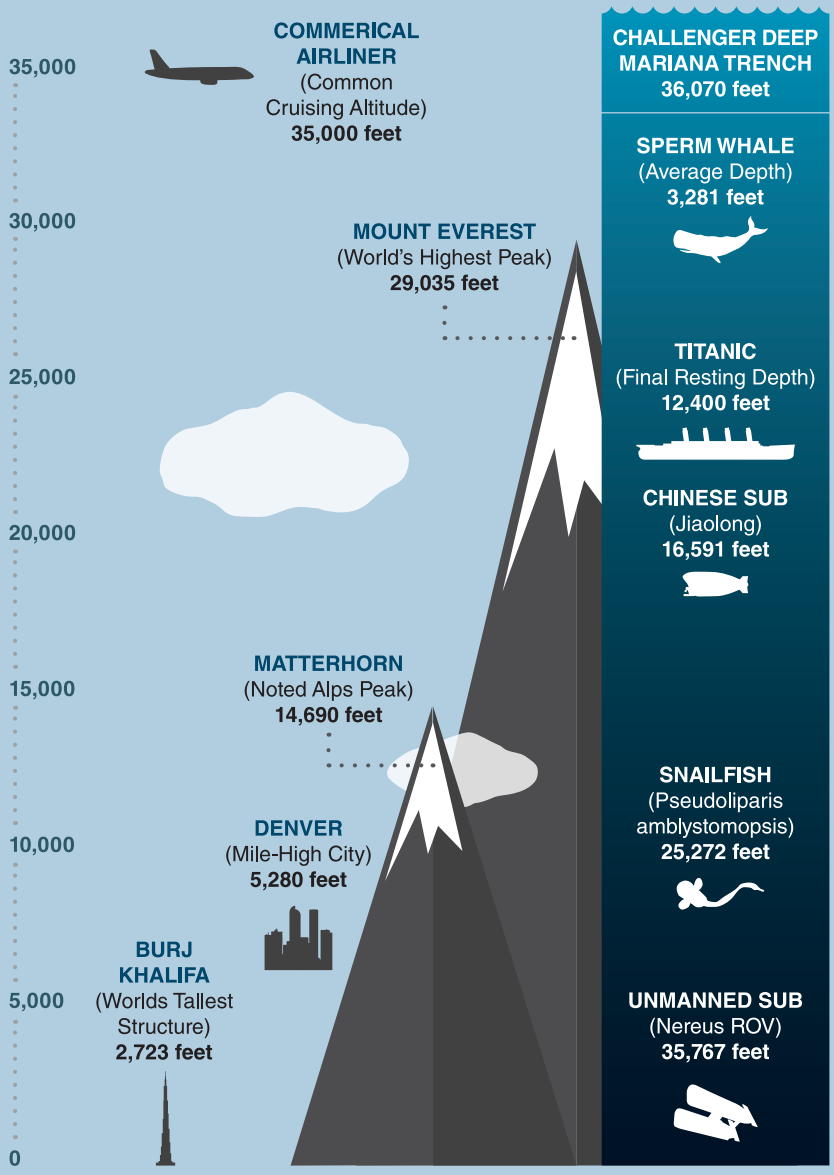
THE TRENCHES

The movement of tectonic plates is responsible for how trenches and hydrothermal vents form. When two plates of different densities meet, the more dense plate bends downward, sliding and then melting beneath the less dense plate. This process is called **subduction**, which leads to the formation of trenches.

What is it like in an ocean trench? We still have lots to find out. Until the 1950s, we were not sure whether life even existed in ocean trenches. In fact, only three people have ventured to the Challenger Deep! We do know that the temperature is just above freezing, and the pressure is extremely strong at 1,000 times that of the surface pressure. Some organisms related to sea stars and jellies can survive without being crushed by the enormous pressure.

HOW DEEP IS THE MARIANA TRENCH?

The Mariana Trench is even deeper than Mount Everest is tall! Mount Everest is 29,026 feet above sea level and the Mariana Trench is 35,462 feet below sea level.



Based on an infographic from National Geographic

WHY KEEP STUDYING THE OCEAN?

The ocean is fascinating to explore and observe, but is also important for all life on Earth. The ocean causes changes in weather, influences the planet's climate, and helps support living organisms both in the water and on land. It also provides natural resources, promotes transportation and business, and makes our planet beautiful. It is our responsibility to learn about our ocean, so we can understand how best to protect it and its many functions that are crucial for our planet's survival.

Scientists discovered more than 100 new marine species in the Philippines, such as this sea slug.

Special thanks to Claire Bratzel, Andrew Ligeralde and Marianne Cartagena!