
Helena Haraštová • Diarmuid Ó Cathain
SUBMARINE
ALL ABOARD!
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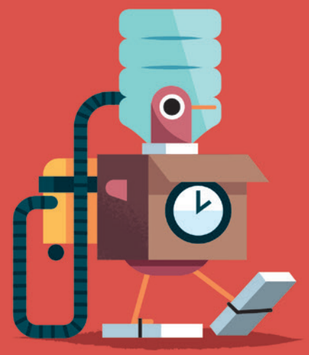
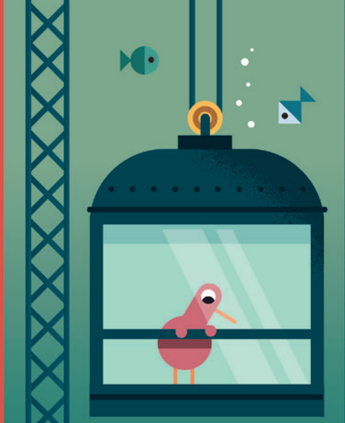
Whenever he had a few free night-time moments, kiwi bird Karl would claw his way up the hill, where he studied the silvery surface of the ocean from on high. He wondered who lived there, and what it was like on the bottom.

If only I could dive into the mysterious deep!

Karl dived headlong, but he ran out of breath and his feathers carried him back to the surface.



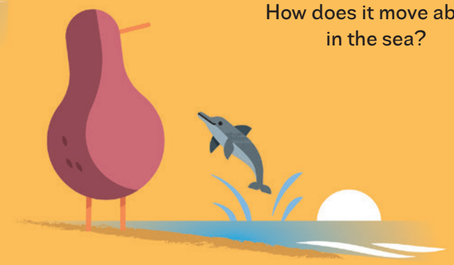
He tried to put together a diving suit of his own design. But it was too heavy!



How about building a see-through undersea elevator? But Karl had no idea how this could be done.

He had run out of inspiration.

How does it move about in the sea?



But then, right in front of him, a dolphin jumped from the water.

Of course! I must join explorers on board a

RESEARCH SUBMARINE!

Before we go on board

Since time immemorial, many humans have longed for discovering the undersea world. Although deep-diving submersibles have made great progress in this regard, still **we know barely one tenth of the ocean bed.**

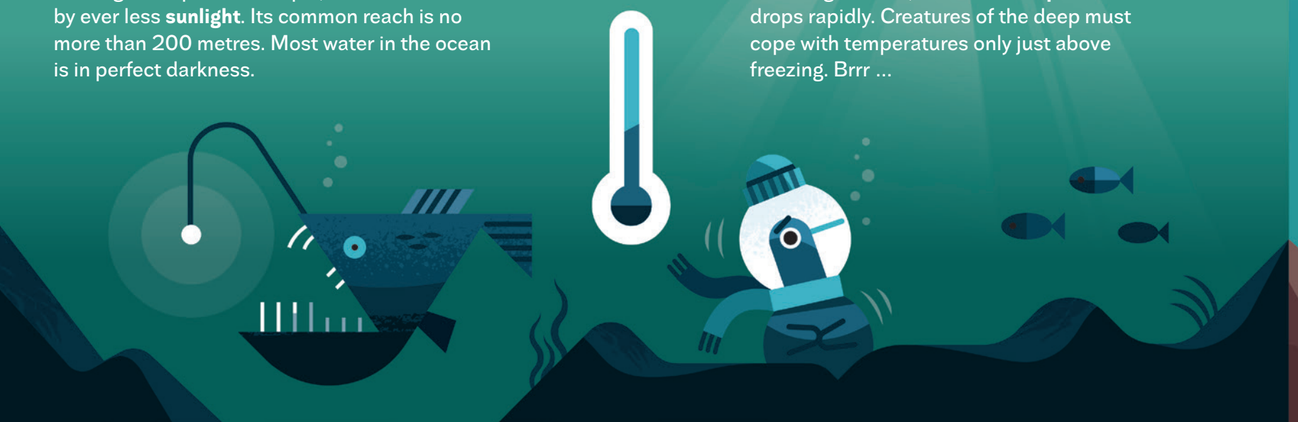
Oceans cover **3/4 of our planet's surface**. So why is it known as Earth and not Sea?

Dangerous pressure

It is so difficult to explore the ocean deep because of **hydrostatic pressure**. This force presses down on all objects in water. The deeper the water, the greater the pressure! It is as though you were carrying the whole weight of the water on your back.

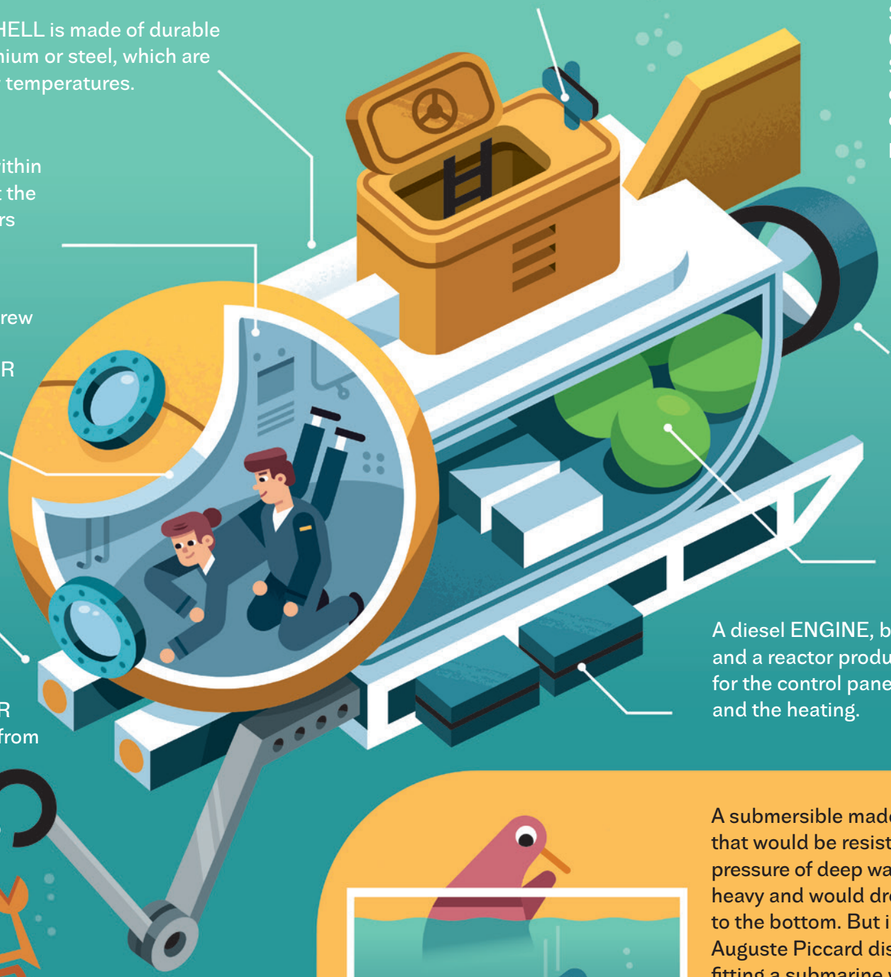
As we get deeper and deeper, we are reached by ever less **sunlight**. Its common reach is no more than 200 metres. Most water in the ocean is in perfect darkness.

As the light fades, the **water temperature** drops rapidly. Creatures of the deep must cope with temperatures only just above freezing. Brrr ...



How to build a submarine

As a research submarine must be equipped to deal with whatever dangers may await below the surface, it is very difficult and expensive to make.



A submersible made of a material that would be resistant to the pressure of deep water, would be too heavy and would drop immediately to the bottom. But in the 1930s, Auguste Piccard discovered that by fitting a submarine with a tank filled with gasoline, the vessel could be made to float in very deep water.

Below the surface

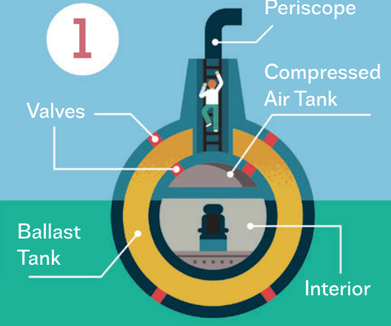
How are submarines able to descend to the deep and then come up again?

For moving up and down in water, we can use two opposing forces: **buoyancy**, which keeps whatever is lighter than water on the surface, and **gravity**, which pulls to the bottom everything heavier than water.

How to dive

The hull contains ballast tanks: empty compartments that can be filled with water or compressed air. When a submarine sits on the surface, its ballast tanks are full of air.

1



2

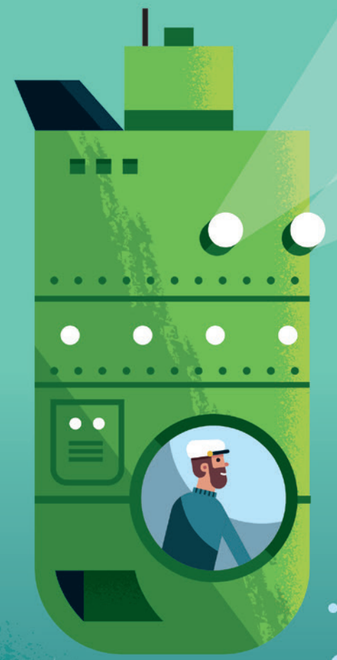
As the submarine submerges, the ballast tanks gradually fill with water, so increasing the submarine's density in a controlled manner as it sinks towards the bottom.

3

If the density of the submarine is the same as that of the surrounding water, the submarine keeps its position.

4

As compressed air enters the ballast tanks, the density of the submarine decreases and the vessel rises towards the surface.

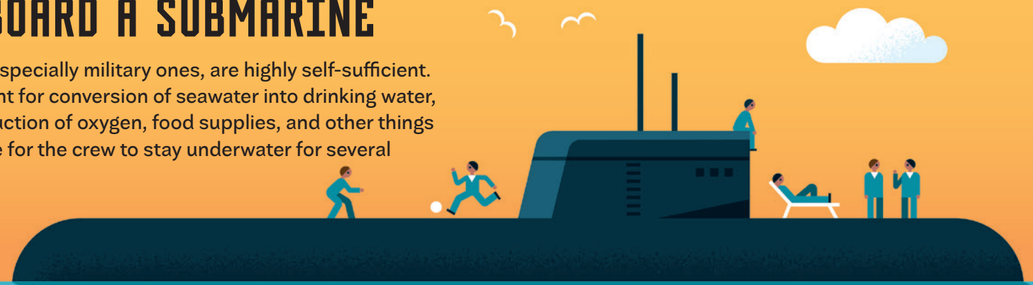


Some deep-diving submarines have heavy steel weights attached. When the moment comes to make the dive, the crew release these weights, which sink to the bottom, where they will remain buried.

Research submarines tend to be so small that the crew can't even stretch their legs out comfortably in the cabin. A **control ship or platform** sits on the surface, supplying the submarine with oxygen and propulsion and maintaining communication with its crew.

LIFE ON BOARD A SUBMARINE

Large submarines, especially military ones, are highly self-sufficient. They carry equipment for conversion of seawater into drinking water, generators for production of oxygen, food supplies, and other things that make it possible for the crew to stay underwater for several weeks at a time.



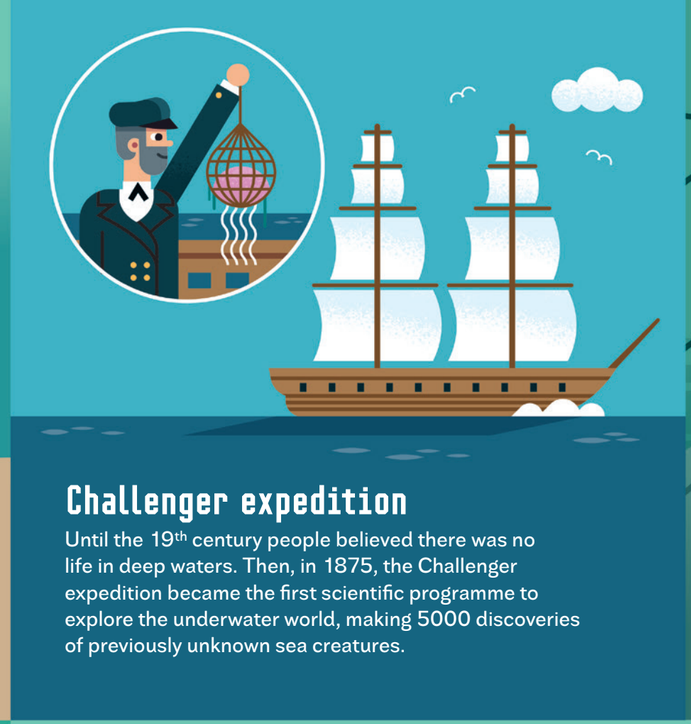
A History of Submarines in Brief

What about divers?

Although humans can dive to depths of several dozen metres, they cannot manage in water without an air supply. The first, heavy diving suits appeared in the Middle Ages. Later, soldiers and labourers who worked on the construction of bridges and dams wore diving suits.

Aristotle's bell

In the 4th century BCE, the Greek philosopher Aristotle described a diving bell, a simple apparatus within which air is trapped for the duration of the dive.



Challenger expedition

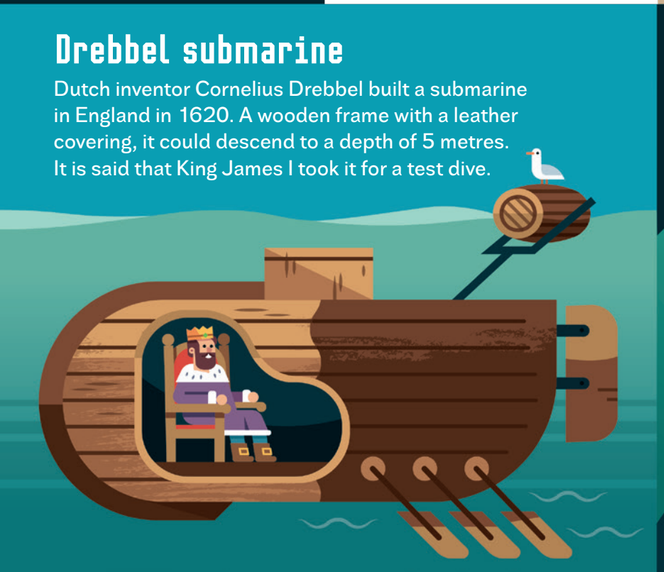
Until the 19th century people believed there was no life in deep waters. Then, in 1875, the Challenger expedition became the first scientific programme to explore the underwater world, making 5000 discoveries of previously unknown sea creatures.

Bathysphere

In the 1930s, Otis Barton gave the world the steel **bathysphere**, the first deep-sea submersible. As it was lowered into the water on a cable from a support ship, it could move up and down only vertically. Even so, it became the first vessel in the world to descend to a depth of 1 kilometre.

Drebbel submarine

Dutch inventor Cornelius Drebbel built a submarine in England in 1620. A wooden frame with a leather covering, it could descend to a depth of 5 metres. It is said that King James I took it for a test dive.

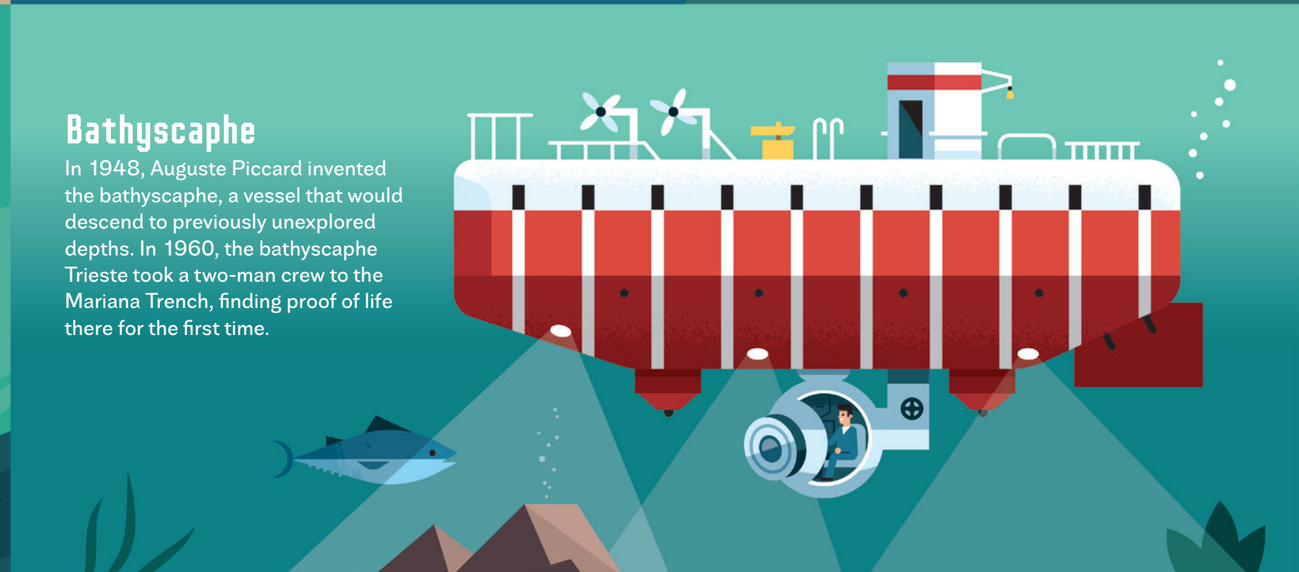


Nautilus

Nautilus was designed by Robert Fulton in 1800. Originally, its three-man crew used candles to see by; later, Nautilus was equipped with a window.

Bathyscaphe

In 1948, Auguste Piccard invented the bathyscaphe, a vessel that would descend to previously unexplored depths. In 1960, the bathyscaphe Trieste took a two-man crew to the Mariana Trench, finding proof of life there for the first time.



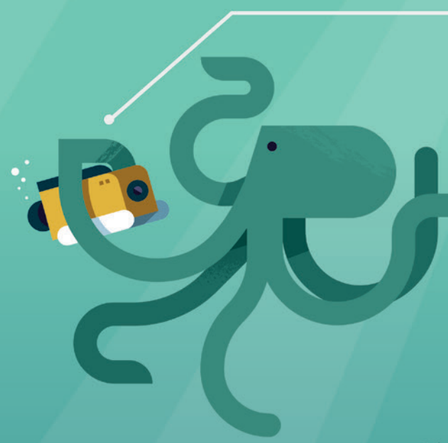
Human creations in the deep

Slowly but surely, humans are penetrating to the deepest parts of the world's oceans. They build incredibly sophisticated machines that perform their work flawlessly in extreme conditions.
So, what are these machines?

Which deep-submergence vehicles have broadened our knowledge of the oceans?

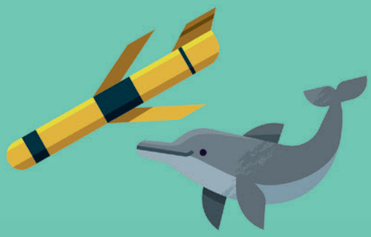
Tourist submarine

For the enthusiastic amateur, this mini-submarine with a partially glazed bottom is just the thing. It will take you about 400 metres below the surface.



Remotely operated underwater vehicle (ROV)

Remote-controlled robotic vehicles are used in deep, dangerous places. They can enter narrow openings in rock. As well as filming undersea life, they perform repair work on oil rigs and attach ropes to sunken wrecks. Their super-precise robotic hands are perfect for sample collection.

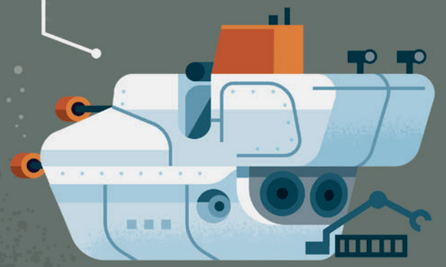


Ocean glider

This small unpiloted machine measures the temperature and salinity of the water, charts sea currents, records sound, and even helps to forecast hurricanes.

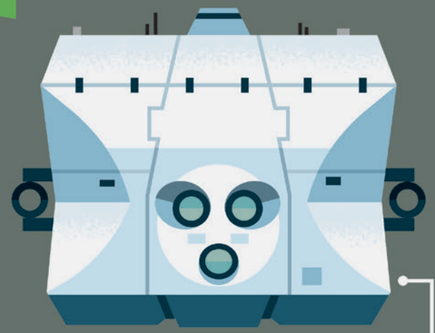
1 Alvin

One of the oldest functional submarines of all. Since entering operation in 1964, it has made over 4600 dives. In 1966, Alvin helped recover a hydrogen bomb from the bottom of the Mediterranean Sea.



2 Deepsea Challenger

In 2012, this cigar-shaped mini-submarine (it is only 7 metres long) transported James Cameron, the famous director, to the Mariana Trench.

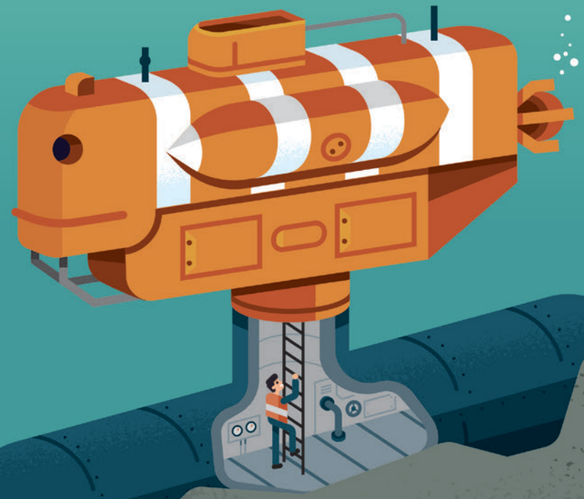


3 limiting Factor

This mini-submarine for 2 people has gradually conquered the five deepest known undersea trenches. It was the first human creation to manage repeated deep dives.

Deep-submergence vehicle

Forget the bathyscaphes of old: this is a state-of-the-art underwater champion! Deep-submergence vehicles can dive several kilometres under the surface. They have excellent orientation capability, allowing it to control its own movement and so conduct independent research.



Deep-submergence rescue vessel

When a submarine breaks down in the deep, humans cannot simply swim away. But help may be at hand from a deep-submergence rescue vehicle.

Zones of the ocean

Sunlight zone

The water here is lit by the sun's rays and rich in oxygen, which is made by aquatic plants. Life abounds in many various forms: almost half of all sea creatures live here.

200 Meters

Seal

Mola Mola

Megamouth shark

Shark

Swordfish

Whale

Starfish

Twilight zone

As the sunlight gets weaker, twilight gives way to darkness. Creatures that live here have excellent sight. Some are **bioluminescent** – they can emit light.

1000 Meters

Eel

Helmet jellyfish

Octopus

Ray

Some creatures without a light-producing mechanism of their own host bacteria that have this ability.

Benthocodon jellyfish

Blobfish

Monkfish

Bristlemouth fish

Football fish

Cuttlefish

Midnight zone

Only the most resilient creatures survive the eternal dark and cold and the extreme pressure. Many of these look weird and scary to us – look at those sharp teeth, blind eyes, snake-like bodies...

4000 Meters

Viviparous brotula

Yuck! What ugly monsters! Maybe their sight is so bad to keep them from scaring each other.

Anglerfish

Viper fish

Frilled shark

Giant squid

Sea cucumber

Bottomless zone

Total darkness, freezing temperatures and extreme hydrostatic pressure! The only creatures we encounter here look like weird-and-wonderful aliens or prehistoric organisms. Exceptions to this are found around hydrothermal or sulphur springs.

6000 Meters

Halosaur

Deepsea octopus

Clams

Flatfish

Oceanic trenches

The deepest places on Earth are hidden in deep-sea trenches. We know very little about these narrow places. Humans have visited them only a few times.

Mariana snailfish

Brotulid fish

Bristle worm

Dumbo squid

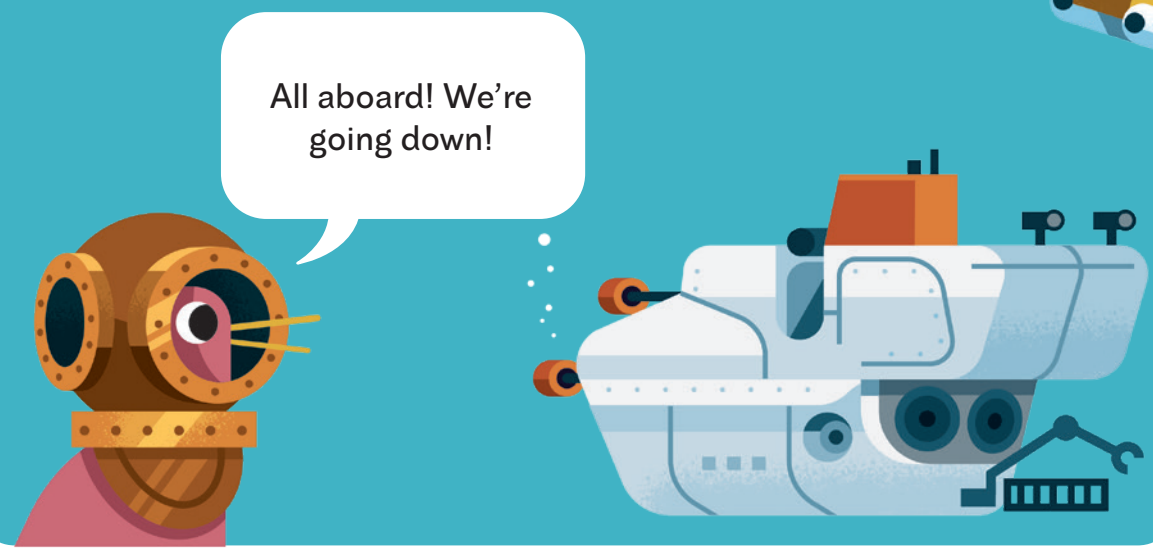
Deep-water sea anemone


Congratulations!
You are now a true undersea researcher. Climb aboard!
We're going down!

Are you interested in the ocean and its mysterious inhabitants? Would you like to go underwater to see the fish, octopuses, jellyfish and sharks for yourself? Do you dream of travel to the dark depths of the seabed?

Karl the kiwi would answer yes to all these questions. He is forever looking at the calm surface of the ocean, imagining that one day he will explore the underwater world up close and in detail.

If you join Karl on a research submarine, you, too, will discover the glories and secrets of the ocean, and much else besides! Plus, you will learn which machines people use for their watery travels, how a submarine works, why deep oceans remain unexplored, and all about the superpowers of inhabitants of the deep.



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