Cliffs, clams and coral reefs: looking below the sea's surface

by **David Derbyshire**

Biologists have decoded the human genome, geographers have mapped every mountain range and astronomers have named every object visible in the night sky.

Yet when it comes to understanding the ocean floor, marine geoscientists are still largely in the dark.

It's become something of a cliché that we know more about the surface of Mars than we do about the bottom of the sea. Yet the oceans contain some of the most breath-taking scenery and richest habitats on the planet – gigantic canyons sliced into the sea bed, mountains that tower miles over muddy plains, and pitch-black trenches that plunge far below the surface.

The ocean covers more than two thirds of the world, but we have a detailed map of less than 20% of its floor. Slowly, marine geoscientists are filling in the gaps. Their discoveries are changing our understanding of the undersea world and revealing the impact of human activity on ecosystems out of sight.

Delving into the deep-blue sea

Understanding the terrain of the ocean's floor is vital. It plays a key role in the patterns of deep-sea currents that influence our climate, in the management of fisheries, and the vulnerability of coastal communities to tsunamis.

Dr Veerle Huvenne, of NERC's National Oceanography Centre (NOC), has pioneered new techniques for mapping vertical marine rock faces in the deep sea as part of the CodeMAP project. She said: "You might not think of the deep sea floor including vertical cliffs. They are impossible to study directly from a ship. Shipboard sonar images look down, so they can't 'see' the cliff face. We have the same issue with sending down equipment from ships on long cables."

Roving robots

To test a new approach to mapping these cliffs, her team boarded the RRS *James Cook* in 2015 to spend five weeks in the Whittard Canyon, a refuge for cold water corals 300km off the Cornish coast. Canyons like Whittard are some of the most complex deep sea environments in the world. They transport sediment between the land and deep sea, and can create some of the richest biodiversity hotspots in the oceans.

There are around 10,000 large marine canyons globally. Until recently, traditional exploration equipment could not reach them. But in the last decade, autonomous underwater vehicles (AUVs) have started to shed light on these mysterious environments.

The Whittard Canyon is nearly the size of the Grand Canyon and reaches from 200 metres to more than 4km water depth. Some of its cliffs are home to cold water corals, and are described by Dr Huvenne as 'hanging gardens'. Unlike tropical corals which need sunlight, those coral species can survive in darkness and get their food from the passing water.

Dr Huvenne's team mapped the towering sides of the canyon using two robotic vehicles. First, a specially adapted AUV fitted with a sideways-facing echo-sounder scanned the cliffs. The Autosub6000 is kitted out with collision-avoidance technology and can operate at depths of 6km, where pressures are 600 times greater than at the surface.

The team also lowered ISIS – the UK's deepest diving remotely operated vehicle – into the canyon to create high-precision maps.

Deep-sea snail living in the cold-water coral reef at 800 metres depth.
NOC

ISIS – the UK's deepest diving remotely operated vehicle.

The technology to explore further than ever

NERC unmanned marine vehicles go further and deeper than any commercial or military capability. Over 15 years of investment has created the largest, most diverse fleet of robotic research vehicles in Europe with a collective value estimated at £20 million. The vehicles developed by the National Oceanography Centre are deployed in challenging and inaccessible areas such as the Southern Ocean, helping scientists to understand changes in the Antarctic region and lead global efforts to tackle climate change. Marine robotic vehicles underpinned by NERC technology are now being manufactured, sold and exported by two UK companies, Autonaut and L3 ASV, attracting inward investment and international clients.

Corals, clams and deep-sea creatures

By combining the new mapping techniques with statistical simulations, the team have identified biodiversity hotspots vulnerable to climate change, fishing, litter and oil exploration.

"Some creatures like to live on the top of hills, others on steep flanks, others on muddy sea beds," Dr Huvenne said.

"With these mapping techniques we can see where the habitat is more varied. That tells us where there will be more diversity."

The team found that life in the Whittard Canyon is more varied than previously thought – they captured pictures of blue sharks and swordfish, cold water corals, clams, deep-sea oysters and much more. There was as much variation between different canyon branches as there was between the canyon and the surrounding sea floor.

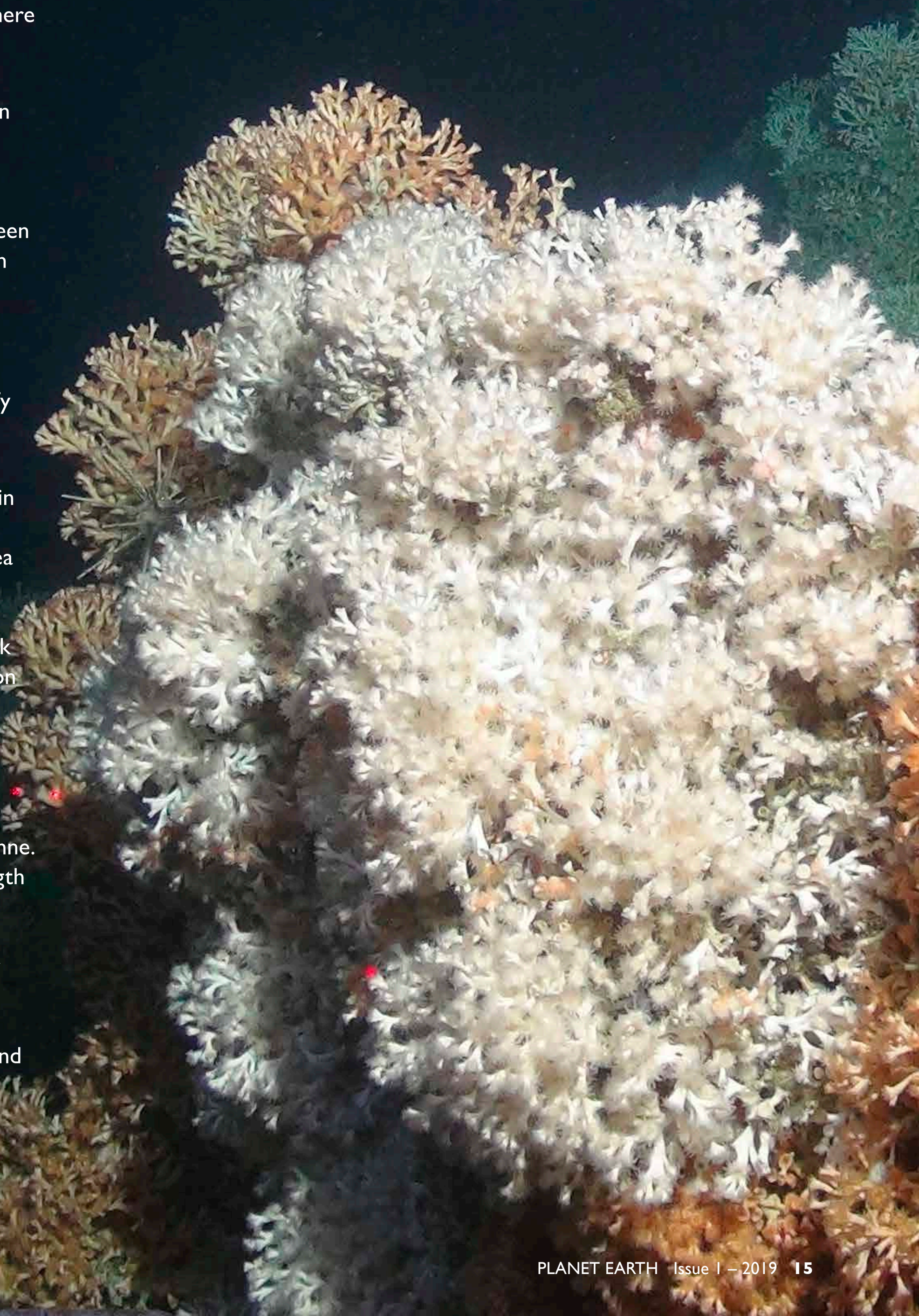
More to discover

The team is using these techniques to predict other biodiversity hotspots. Where they identify vulnerable areas, those can be designated as protected.

Next, the team is moving its focus to the Darwin Mounds, an extensive area of sandy mounds north of Scotland that house corals, sponges, sea stars and more. Discovered in 1998, they were protected in 2003 to avoid deep-water nets breaking up the fragile corals. The team will look at how corals are responding to the conservation measures, and how they hopefully will have recovered from the damage in the late 1990's.

Why does it matter?

"What lives with the corals could be a fantastic component for new technology", says Dr Huvenne. "People are looking at how sponges build strength to build lighter airplanes. People are looking at anemones with chemical defences which might be useful in medicines. It's the same reason why we need to protect the rainforest – there's an enormous amount of undiscovered life in our oceans. It would be sad if this were destroyed and we didn't even know it was there."



Cold-water coral reef in English waters at 800 metres depth. NOC