DEEP SEA SECRETS

The oceans regulate temperature, drive the weather and ultimately link all of Earth's systems through flows of mass and energy. Buried beneath the ocean floor are records of millions of years of Earth's climatic, biological, chemical and geological history. Scientific ocean drilling allows scientists to explore how our planet works.

Caution: If you're someone with megalohydrothalassophobia – the fear of large things in water – the following list of oceanic creatures, all real, will likely make your blood run cold.

Firstly, at over five metres long and found at a depth of 160 metres, is the Megamouth Shark – it only eats plankton but still... it has a massive mouth. Plunging ten times deeper we find the 11-metre long Giant Oarfish. At 2000 metres we encounter the Fangtooth fish, which has the largest teeth proportionate to body in the ocean. Deeper still are the 14-metre long Colossal Squid, the Pink See-Through Fantasia and the Black Swallower fish, which is capable of consuming prey ten times its mass. Descending to 4500 metres we find the habitat of the Vampire Squid, the Deep-Sea Dragonfish and finally, at a staggering 8,178 metres, the deepest-living known fish, discovered in 2014: the Mariana Snailfish.

The world is fascinated with extra-terrestrials, which remain non-existent – at the very least unproven – yet there is a huge list of underwater aliens that we know precious little about. The number of ›

Right: Marine-riser equipped Japanese deep sea drilling vessel 'Chikyu'

known species populating Earth is approximately 1.4 million. However, expert estimates on the number of species yet to be discovered in the 'deep sea' (a depth of 1800 metres or more) vary between 10 and 30 million. The deep sea is the real unexplored frontier – our planet's largest living realm with a baffllingly vast complex of thriving ecosystems.

Dr Cindy Lee Van Dover, the deep sea biologist famous for being among the first people to pilot the ALVIN deep-diving submersible (and to date the only woman), has spent a long career studying the seabed and the creatures that populate the deep sea. Since Van Dover's first piloted dive in 1990, she has descended into the ocean 235 times and has discovered new species of tubeworms, mussels and shrimp.

In her 1997 book *Deep-Ocean Journeys*, Van Dover dispels the 19th century notion that the seabed is a vast lifeless and uniform wasteland and reveals the wonders of the ocean floor. Speaking to the *New York Times* about her career, Van Dover said: "While all my friends liked cats, dogs, four-legged creatures, I was intrigued by horseshoe crabs. They had 10 eyes and ate with their knees. I loved that."

Although Van Dover originally wanted to be an astronaut, in her youth she came across a book at her grandparents' house and became fascinated by large sea squirts, giant pill bugs and countless other sea dwellers. Her goal shifted from space to the ocean and Van Dover continues to shine a light on the murky depths that cover 70% of the planet's surface.

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DR CINDY LEE VAN DOVER,
Deep sea biologist

"Man has observed less than 1% of the seafloor," she said, adding: "The challenge lies before us. During the twentieth century, the deep sea became accessible. In this twenty-first century, the deep sea will become known."

It's a curious fact that we know more about the moon, stars and planets than we do about the depth of the oceans. On July 20, 1969, the Apollo 11 spaceflight landed the first two humans on the moon. The conspiracy theorists dismissed, a further 10 people have walked on the moon, yet only three people have been to the very bottom of the ocean.

US Navy Lieutenant Don Walsh and Swiss oceanographer Jacques Piccard successfully reached the 'Challenger Deep' – at 10,916 metres, the deepest known point of the Mariana Trench – in the bathyscaphe Trieste on January 23, 1960. Canadian film director and *National Geographic* explorer James Cameron succeeded this achievement on March 26, 2012, when he made a record-breaking solo dive in the Deepsea Challenger, which was able to explore the sea bottom for several hours.

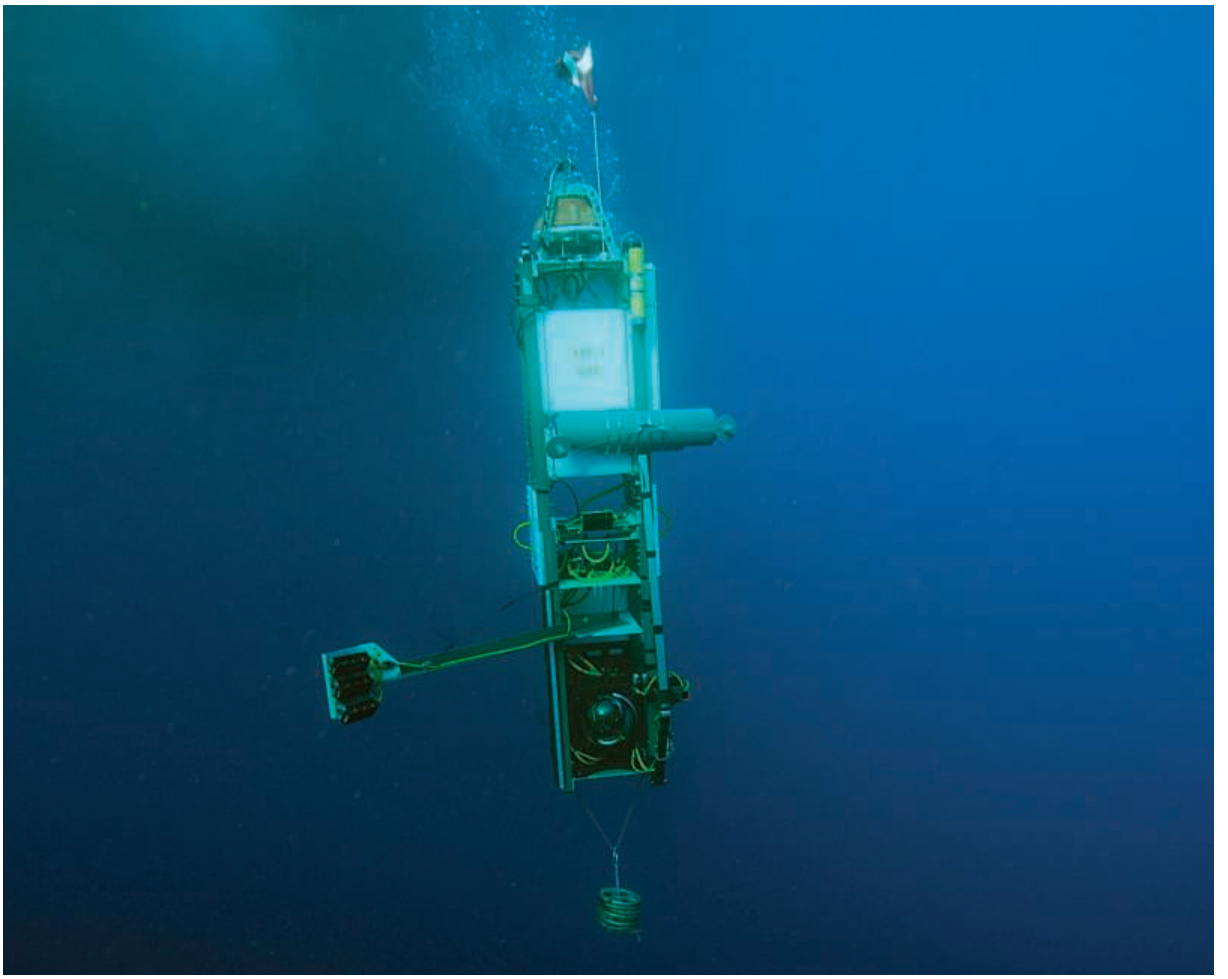
Commenting on the imbalance between our knowledge of space and the oceans, Dr Paul Snelgrove, a marine biologist and author of *Discoveries of the Census of Marine Life: Making Ocean Life Count* – which took a global network of researchers in more than 80 nations ten years to create – said: "We know more about the surface of the moon and about Mars than we do about the deep sea floor, despite the fact that we have yet to extract a gram of food, a breath of oxygen or a drop of water from those bodies."

While the moon landings may have grabbed global headlines, the Deep Sea Drilling Project (DSDP) began its pioneering work several years before the Apollo mission. On June 24, 1966, the prime contract between the National Science Foundation (NSF) and The Regents, University of California was signed, marking phase one of the DSDP.

Since that first commitment to scientific ocean drilling over 50 years ago, the DSDP has undergone several name changes and developed from being a solely US funded operation to an international collaboration involving 24 countries, including the European Consortium for Ocean Research Drilling (ECORD).

Major discoveries from oceanic drilling include the confirmation of seafloor spreading – a process in which new oceanic crust is formed through volcanic activity – that played a pivotal role in understanding plate tectonics; direct evidence of an asteroid impact during the era when the dinosaurs went extinct 66 million years ago; and salt deposits that support the


CHIKYU



Above: The Deepsea Challenger carried James Cameron 10,908 metres below the ocean surface

hypothesis that the Mediterranean Sea completely dried out five million years ago.

Another discovery was how young the ocean floor is in comparison to Earth's geologic history. Scientists have concluded that the seabed is likely not much older than 200 million years, meaning it's just a baby in comparison with the 4.5 billion-year age of the Earth.

The first ship built for and used by the DSDP was the Glomar Challenger, which commenced service on August 11, 1968. This pioneering vessel conducted drilling and coring operations in the Atlantic, Pacific and Indian Oceans and also in the Mediterranean and Red Seas. The ocean drilling results addressed fundamental questions about the history and structure of the Earth.

In 1983, the DSDP became the Ocean Drilling Program (ODP) and the Glomar Challenger was retired and replaced in 1985 by the JOIDES Resolution, which was known as 'JR', for the next 20 years until 2003. During that period, the JR conducted 110 expeditions for the ODP at 2000 drill holes located throughout the world's ocean basins in an international cooperative effort to explore and study the composition and structure of the Earth's sub-seafloors.

This remarkable ship, which as well as conducting oceanic drilling also operates as a floating laboratory, was refurbished when the ODP morphed into the Integrated Ocean Drilling Program (IODP) in 2003. The IODP spent the next decade building upon the international partnerships and scientific success of the DSDP and ODP by employing multiple drilling platforms financed by the contributions from 26 participating nations. The JR was joined by a new marine-riser equipped Japanese deep sea drilling vessel called 'Chikyu' to reach new areas of the global sub-surface for 52 expeditions.

In October 2013, the IODP underwent another name change, although the acronym remains the same, as the International Ocean Discovery Program (IODP). The science plan for the IODP – Illuminating Earth's Past, Present and Future – is a guide to multidisciplinary international collaboration on scientific

Above: Canadian film director and *National Geographic* explorer James Cameron made a record-breaking solo dive in the Deepsea Challenger

Right: The JOIDES Resolution conducts scientific oceanic drilling and operates as a floating laboratory

ocean drilling for the period of 2013 - 2023. It was devised on behalf of earth, ocean, atmospheric and life scientists at the request of science funding agencies from 24 nations, representing approximately 75% of the world's economy.

The document describes how the IODP will increase knowledge and support international collaboration and education. Ultimately it aims to advance our understanding of Earth's past to be able to better understand and predict its future and inform decision making about some of the most important environmental issues facing society today.

As a rapidly expanding global population demands more resources and a better understanding of geological hazards and future climate change, knowledge deduced from data and samples from scientific ocean drilling is essential.

The plan states: "The programme will allow the scientific community to address fundamental questions, such as: what are the limits of life on our planet? How do ecosystems respond to rapid environmental change? How do deep Earth processes affect Earth's surface environment? What are the underlying mechanisms of geologic hazards and how can we improve risk assessment and prediction of summary catastrophic events? How do fluids flowing through most of the seafloor impact linked geological and biological systems? Scientific ocean drilling will play a central role in testing, calibrating and improving predictive Earth system models at local to global spatial scales, and on decadal to millennial time scales."

Van Dover, who continues to contribute to our knowledge of oceanic drilling and its results, claims: "There's a huge amount left to discover in the deep sea: new forms of life, new types of habitats. When you're down there, you really see how this environment could have been the cradle of life on Earth."