Arctic challenge

Drilling through moving sea ice into the Arctic ocean floor might unlock the mystery of climate change, and help save Europe from mass flooding or another ice age, writes Andy Kingdon.

Last century, as human activities caused changes in the atmosphere, the climate started warming at an alarming rate. All the climate models in the world cannot tell us for sure how these changes will affect the climate in the next decades. One reason for this is that models are all based on guesswork about what happened in the Arctic in the past. To find out the truth, we need to drill cores from the Arctic Ocean floor, something that no one has ever succeeded in doing before.

The new Integrated Ocean Drilling Programme (IODP) is going to the Arctic to try drilling into the seabed below thick sea ice. And the British Geological Survey is part of this mission.

IODP, one of the world's largest scientific programmes, grew out of the Ocean Drilling Programme, which has explored beneath the ocean floors since 1985. This new project is different in several ways. Previously ocean drilling could not safely drill deep boreholes in water less than 200m deep, nor in polar oceans covered in ice sheets.

Also, in the previous programme the USA did all the drilling. This time the USA and Japan are providing ships that can drill in deep parts of the oceans, but Europe is contributing directly to the scientific operation. As part of a group of 13 European countries, the European Consortium for Ocean Research Drilling (ECORD), we'll be drilling in previously inaccessible parts of the oceans.

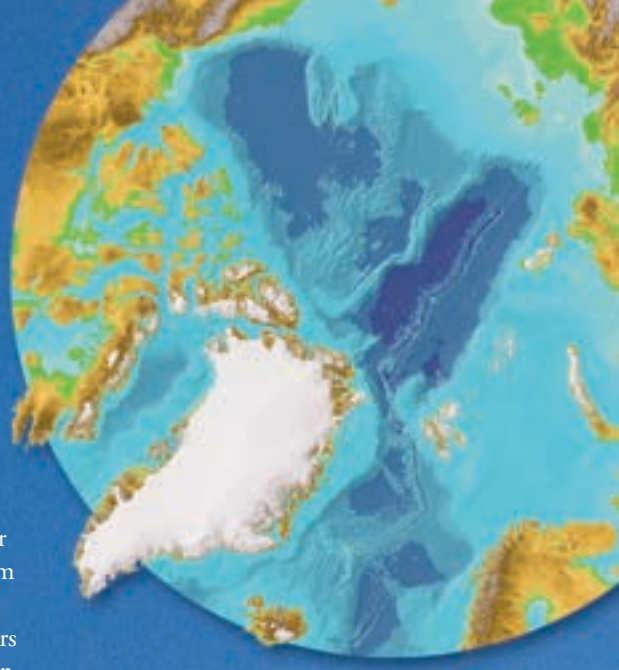
Marine earth science institutes from several of these countries, including the British Geological Survey, are taking the lead under the banner of the ECORD Science Operator.

We each bring different experience. The University of Bremen hosts one of the largest ocean core stores and has managed their curation, storage and distribution. The European Petrophysical Consortium (universities in Leicester, Montpellier, Aachen and Amsterdam) performed the same task for the programme's geophysical bore-hole data. BGS is involved because for 40 years we've cored the seabed with mining and civil engineering drilling equipment on small research and supply vessels, rather with than a dedicated drilling vessel. So we really know how to drill from non-standard drilling vessels. And our first drilling platform is about as non-standards as it gets: an Arctic ice-breaker.

After years of dreaming and planning, we are close to contracting ice-breakers for the first serious attempts to drill the ocean floor within 200 miles of the North Pole. We plan to collect sediment cores from the top of the Lomonosov ridge, a piece of uplifted crust crossing the Arctic Ocean from Siberia to Greenland under the North Pole. It has been subsiding gently for millennia. These sediments should

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contain continuous climate records in pristine condition dating back 50 million years. These start in the Eocene Greenhouse climate when the Earth was at its warmest, before gradually cooling, and entering the ice age to the present day.

There are just two problems. The ridge is 800m below sea level at its shallowest point (less than 200 miles from the North Pole) and the Arctic Ocean is covered year round in several metres of ice travelling at several kilometres per day. This ice would crush a conventional drilling rig. So we are chartering an ice-breaker, customised to carry a rig, that can drill to nearly 2km below sea level. We are also preparing support ice-breakers to get the drilling vessel there and keep the sea ice away from the delicate drill string while we collect the cores.

Next summer we hope to spend 45 days recovering this climate history. That includes ten days to get there and ten days to get back, using the support ice-breakers to clear a channel through the ice for the drilling rig. But the really difficult part, which no one has ever done before, is holding a drilling vessel still in a moving ice sheet long enough to drill through the sediments. Ice-breakers break ice by moving through it; staying stationary was never part of the plan. We need two ice-breakers to make sure only small fragments of ice pass close to the drilling platform's ice strengthened hull. The day-time temperatures are always below zero and we'll be hundreds of miles across the ice from land and further from any back up. It's difficult to imagine a more hostile place on Earth to do anything, never mind such a complex operation.

To complicate things further, ice sheets vary in thickness, speed and direction. Pressure ridges, too thick for any ice-breaker to smash through, form where sheets are squeezed together. So we'll use satellite photos and helicopters to keep an eye on what's coming. Then we can warn the drill crew to pull the drill-string out of the borehole, before the pressure ridge ice can push the drill ship off station, and snap the drill-string like a twig.

So why is this worth the time and money? Because it will help solve one of the Earth's most complex and important mysteries: climate change. For nearly 50 million years the Earth's climate gently cooled. Then, around 2.5 million years ago, it suddenly went haywire, swinging every few thousand years from ice ages, with ice covering much of Britain, to periods when the UK climate was considerably hotter than today. And no one really knows why.

> *'The Arctic is covered in several metres of ice travelling at several kilometres per day.'*

We know it has something to do with changes in deep ocean currents flowing from the polar regions, but we're not quite sure how. Interpreting the data we have now, say for cores drilled in the North Atlantic drilling project, is like studying the moon's geology from a telescope on Earth: you can't see the full picture. Only when astronauts brought back rock samples did we really understand what the moon was like. This is our Apollo mission. The Lomonosov Ridge core should allow us to look at evidence from the Arctic itself, and see what happened in the 50 million years that led up to the climate going mad.

With cores through the period when ice caps began to collect, we might finally understand what made ice sheets form, made them disappear or might even make them start spreading again. Europeans are faced with the terrifying prospect of rising sea levels drowning huge areas of land or ice sheets advancing from a newly deep frozen north. If we can find out how such things happen then, just possibly, we can find ways and the political will to change the situation before it is too late.

Drilling on the Lomonosov ridge is a huge technical challenge and an extraordinary adventure, but it may help us change our future. It is difficult to imagine a more important task and the BGS drilling team's skills are one of the keys to making this happen.

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