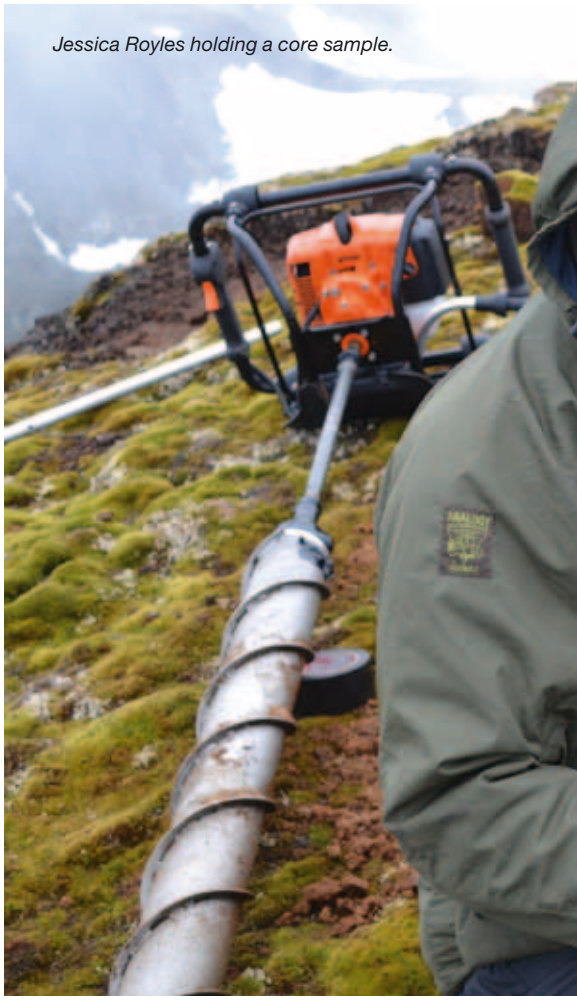
Unlocking the secrets of Antarctic moss banks


Jessica Royles holding a core sample.

You might expect research on Antarctica's past climate to involve drilling and analysing ice cores. But the warmer, more vegetated parts of the Antarctic Peninsula offer very different kinds of evidence. Matt Amesbury and Jessica Royles explain more, through the eyes of their recent field season down south.

As we approach Green Island, the primary target for our recently completed field season, the waters turn uncharted. Not many people come this way. The first recorded landing was in 1903 and since then the island has remained relatively untouched.

HMS *Protector*, the Royal Navy ship that is supporting our work in the Antarctic Peninsula, nudges cautiously forward. The *James Caird IV*, the ship's smaller survey vessel, is out ahead, plotting a safe course through the multitude of icebergs that cluster around the island, scraping and clattering against each other with ominous low rumbles. Eventually, the ship can go no further and we are dispatched, via the rope ladder that drops some five metres from the main deck to the choppy sea, into another small boat to attempt a landing.

This landing has been a long time coming. Last year when we had completed most of the fieldwork for our project, supported through NERC's Antarctic Funding Initiative, Green Island was surrounded by impenetrable frozen pack ice and could not be accessed. It is the last piece in the puzzle; the final hole to be plugged in a north–south transect of moss bank samples that stretches over almost ten degrees of latitude, or more than 1000km.

The Antarctic Peninsula is one of the most rapidly-warming parts of the planet, with temperature rises of 3°C recorded in some locations since the 1950s. But this warming record lacks a longer-term perspective over centuries to millennia. That is what we aim to provide.

The official landing spot on the more exposed north coast, highlighted in the island's management plan – Green Island is an Antarctic Specially Protected Area due to the unusual richness and fragility of its vegetation – is inaccessible, awash with floating ice fragments and blocked by an unworkable cross-current.

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As an icy wind bites through our many layers, we search for an alternative. The Captain comes over the radio to say that if we can't land now, then unfortunately the ship's schedule won't permit another attempt. It is now or never and the success of our five-week trip, focused entirely on this one place, this one moment, hangs precariously in the balance.

Fortunately, due to the skill and persistence of the boat crew and our indispensable British Antarctic Survey field assistant Ashly Fusiarski, we make it. Here, the hard work begins; first we must move 500kg of kit away from the rocky shore to safety and establish our campsite. Then we can explore the moss banks.

Gathering moss

Over much of Antarctica, very little grows. There are a multitude of mosses and lichens, but just two species of higher plants. On the Antarctic Peninsula, summer brings just enough warmth and water to enable the mosses we are studying to grow by a couple of millimetres or so, before they are frozen again during the long, cold, dark winter months. The following summer the snow melts and the moss grows another few millimetres. When this sequence continues long enough, moss banks begin to form.

In some places this very slow accumulation has continued for thousands of years. The deepest moss banks in the region, almost three metres deep and 5000 years old, are found on Elephant Island, perhaps best known for its part in

Our campsite on Green Island.

A moss bank on Green Island.

Shackleton's Endurance expedition of 1916. On Green Island, as we discover after an extensive survey, the moss banks are about a metre in depth, suggesting an age of roughly 1500 years.

Antarctic moss banks are ideal archives for research into past climate. The plant material in them is well preserved through freezing in permafrost, so it can be dated easily using radiocarbon dating, and is dominated by just one or two species; at Green Island the banks turn out to be almost entirely made up of the moss *Polytrichum strictum*. Despite slow growth rates, low levels of decomposition mean we can develop records with about one sample per decade – pretty high resolution for this type of study.

So why is it so important to put recent climate change on the Antarctic Peninsula into a longer-term context? Broadly speaking, Antarctica is an important part of the Earth system, both influencing and responding to global ocean and atmospheric circulation. The Antarctic ice sheet also plays a major role in sea-level change, so understanding changes in the continent's climate and biosphere is critical for predicting future global change.

The recent rapid warming on the Antarctic Peninsula has been associated with falling sea-ice extent, ice-shelf collapse, glacier retreat and changes to ecosystems on land and sea. Much still remains to be understood about the causes and context of these changes, which are not well captured in current global climate models. Discovering more about the patterns of past natural climate variability in the region covered by our sites will help answer these questions.

We stay four days on Green Island, often working in such wet and windy conditions that we're happy just to return to the tent to dry out and warm up each evening. In the end we collect two priceless cores as well as a range of surface moss and water samples and climate data. Since the moss banks are frozen solid from 30cm down, we have to use a modified permafrost corer to extract our precious cargo.

Analysis of the surface samples will provide vital understanding of the modern processes taking place in the moss banks, which gives us the context we need to interpret our proxy climate data from the core samples. Added to the cores collected last year, our work in the field is now complete. All that remains is the decidedly less glamorous lab work.

MORE INFORMATION

Matt Amesbury and Jessica Royles are postdoctoral researchers at the Universities of Exeter and Cambridge/British Antarctic Survey respectively. The project's other members are Dan Charman of the University of Exeter, Dominic Hodgson and Pete Convey of BAS and Howard Griffiths of the University of Cambridge.

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