Underwater atmosphere

Nathalie Goodkin and colleagues dug deep into coral geochemistry and wrestled with waves for a 200-year record of the North Atlantic Oscillation.

What was the objective of the work?
We wanted to reconstruct past variability in the North Atlantic Oscillation (NAO) using a sea surface temperature proxy, the strontium/calcium (Sr/Ca) ratio in corals. There were many detours *en route*, including the discovery that our proxy–sea surface temperature relationship was strongly affected by summertime coral growth. This severely affects annual-mean reconstructions of climate, but, as we found out through extensive modelling, there are fortunately no such complications in winter, when the NAO is most influential.

Why did you choose this location?
Bermuda lies in a very sensitive area called the 'NAO tripole', where there is a particularly strong connection between sea surface temperature and the NAO. Furthermore, Bermuda is situated at the northernmost tip of coral growth in the Atlantic Ocean, and corals were essential to our work because they are one of the few palaeo-proxies able to provide sub-annual resolution, century-long lifespans and precise dating. Finally, the Bermuda Institute of Ocean Sciences (BIOS) has been monitoring the physical characteristics of the ocean off the coast of Bermuda for the past 50 years, providing us with a long record of sea surface temperature for the verification of our proxy temperature signal.

Did you encounter any difficulties?
Processing more than 2,500 samples on two different instruments presented many logistical challenges; at moments I felt we were a team of engineers. I arrived at work between 4 and 5 a.m. every day to ensure that I had both instruments up and running and time to prepare the samples for the following day. I still remember oversleeping one day, and a colleague saying he was really glad that for once my car wasn't the first in the parking lot that morning.

A coral around a metre across is sliced for sampling at a granite mine.

Any low points?
Rogue waves! To check if our assumptions about the surrounding sea water were correct, we had to collect sea water samples every month. When I started in July, water temperatures were close to 30 °C and the air temperature was warm, so a low-cost, low-tech option seemed ideal: each month I swam out to a near-shore reef, dived down and collected some water. By November, however, the water temperature had dropped to 23 °C, the air temperature was cooler, and I had a much harder time finding a companion. On the day of sampling, the weather was stormy, and my only volunteer — my husband — decided he would stay on shore with a cell phone for safety. All went well until I came back to shore, stood up without looking, and was taken down by a very large wave. All I really remember was holding on to my thermometer and keeping it as far from me as possible. When I came up, the thermometer was unscathed but my shoulder wasn't. We spent a cold 30 minutes waiting for the three bottles to wash up on shore; two of them eventually did. From December to March, my husband went in with me every time. Sometimes a love of science becomes a family affair.

What was the highlight of the experiment?
I remember the first time I was able to clearly see the NAO in our Sr/Ca record. More than five years had passed since the coral had been collected by our colleagues at BIOS and Woods Hole Oceanographic Institution. It had been more than three years since I started my dissertation, and statistical results had confirmed the connection between our Sr/Ca record and the NAO. But it wasn't until I filtered the instrumental and proxy records and plotted them together that we finally saw the NAO stretching back over the past 200 years. Thousands of data points, hours in the lab, several necessary projects in between, and we finally had what we believed we could find.

This is the backstory to the work by Nathalie F. Goodkin and colleagues, published on page 844 of this issue.

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