From Arctic to Alps, icy exploration expands understanding of global warming

April 27 2023, by Vedrana Simičević

Credit: AI-generated image (disclaimer)

Microalgae in sediments signal what happened in the environment thousands of years ago, illuminating the range of future climate-change impacts.

In the freezing Arctic waters of Greenland's Melville Bay, palaeoclimatologist Sara Harðardóttir and her colleagues faced a moment of suspense aboard their vessel.

The scientists deployed a heavy-duty gravity corer—a device designed to "catch" sediments from the sea bottom. After lowering the corer 1 000 metres below the surface, they suddenly saw a large iceberg drifting toward the wire connecting the device with the vessel.

Reconstructing the past

For several minutes, it looked as if the team of experts would have to cut the wire and sacrifice their key research tool. But the iceberg ended up floating by without incident.

'Working in the Arctic is always a challenge—it is remote, the weather is unforeseeable and ships must be specially equipped for the icy waters,' said Harðardóttir, an Icelander who coordinates the EU-funded ICEPRINT project.

Under the 40-month initiative, which is due to end next week, she and her team sampled marine sediments in the hope of isolating traces of DNA from microalgae, tiny organisms that will help paint a picture of what was happening with Arctic sea ice thousands of years ago.

Reconstructing climate conditions from the ancient past—the goal of the field known as paleoclimatology—is helping scientists understand how global warming will affect the Earth.

That's because knowledge of past variability offers insights into the range of future impacts from climate change, just as greater understanding of the past in countless fields ranging from geology to diplomacy helps inform the present and anticipate developments in those areas of expertise.

Many current climate models designed to forecast what will happen in the environment are based on records only since the satellite era.

'By incorporating paleorecords into model simulations, we can better interpret current trends in the context of centuries or even millennia of climate variability,' said Harðardóttir. 'Today's climate is a result of the response of the atmosphere, oceans and ice to changing solar radiation and higher carbon-dioxide levels over hundreds and thousands of years.'

Sea clues

The only way to reconstruct the ancient climate is to search for evidence preserved in the environment. Included among these natural time capsules are fossils of microalgae, which inhabit seas, rivers and lakes.

Invisible to the human eye, hundreds of thousands of microalgae species are inextricably linked to life on Earth. Besides producing half of the global supply of oxygen, they are a promising source of food and biofuels.

Harðardóttir and her colleagues from the Geological Survey of Denmark and Greenland and Laval University in Canada made a crucial finding: they established a link between DNA traces of microalgae in sediments and the number of days that sea ice was present in the area.

More specifically, the team verified that targeting DNA from a microalgae species of the group called dinoflagellates was a way to measure the extent thousands of years ago of sea ice—one of the biggest victims of climate change today.

By mid-century, the Arctic could lose all its sea ice during the warmest months, according to the United Nations Intergovernmental Panel on Climate Change. Knowing how long sea ice seasons lasted through different periods in Earth's geological past can shed light on current and future changes.

The ICEPRINT team collected sediment samples from sea ice, icy surface water and seabed along the North Greenland coast and in Nares Strait and Baffin Bay, parts of the sea connecting Greenland and Canadian territory.

Because the age of the sediment could be determined, the research proved that this DNA "clue" can show how long ice seasons lasted as far back as around 12 000 years.

'Sea ice microalgae leave DNA traces in the ocean seafloor and can provide us with direct evidence of past sea ice variability,' said Harðardóttir. 'This is a great tool.'

Alpine secrets

Several thousand kilometres south of the Arctic, in an environment similarly vulnerable to global warming, another type of microalgae is helping scientists reconstruct ancient climate conditions.

Through the EU-funded Hydro-ALPS project running for 24 months through June 2024, a team from the French National Centre for Scientific Research, or CNRS, is using remains from diatoms to uncover past hydrological changes in Alpine lakes.

Diatoms are microscopic organisms that inhabit almost every aquatic environment on Earth.

The Alps, a mountain range spanning seven European countries, are an important water source for rivers like the Danube, Rhine, Po and Rhone. But it's unclear what the future holds for these "water towers of Europe" as they are increasingly hit by droughts, floods and landslides.

Led by diatomist and geochemist Rosine Cartier, the Hydro-ALPS team is retrieving sediments from two lakes in the Mercantour massif in the French Alps to find micro-traces of diatoms that have accumulated since the retreat of the glaciers.

By carrying valuable information from the past, diatoms can help improve knowledge about the future of local water resources.

'Many studies have shown that air temperatures are increasing faster than the global average in the Alps of the Mediterranean region,' said Cartier. 'We are expecting this environment will be prone to really fast changes, which is why we are focusing on these lakes.'

The aim is to improve understanding of how this elevated environment evolved through time.

Donkey deliveries

This is where diatoms preserved in sediments might come in handy.

These unicellular organisms build a cell wall made of silica using oxygen and silicon from the water. Scientists were able to use these diatom's silica shells as a sort of archive in which changes in the water chemistry are recorded through time.

'In this way, we can get the idea of changes happening in the water balance and temperature,' said Cartier.

Radiocarbon dating of the sediments can track these changes back 12 000 or 13 000 years.

Both lakes are located 2 200 metres above sea level, complicating preparations for the scientific fieldwork. At one point, the researchers used donkeys to help carry material to the sites.

People exploited these particular mountain areas over many centuries for different activities including mineral extraction, pastoralism and deforestation, so scientists hope that lake diatoms could also reveal how humans influenced water quality and soil erosion.

'Our results could not only help to improve climate projections at the local scale and at the different altitudes, they could also help stakeholders to adapt water-resource strategies for the future,' said Cartier.

More information:

- ICEPRINT
- Hydro-ALPS
- EU-funded research and innovation on climate change science

Research in this article was funded via the EU's Marie Skłodowska-Curie Actions (MSCA). The article was originally published in Horizon, the EU Research and Innovation Magazine.

Provided by Horizon: The EU Research & Innovation Magazine

Citation: From Arctic to Alps, icy exploration expands understanding of global warming (2023, April 27) retrieved 26 April 2024 from https://phys.org/news/2023-04-arctic-alps-icy-exploration-global.html