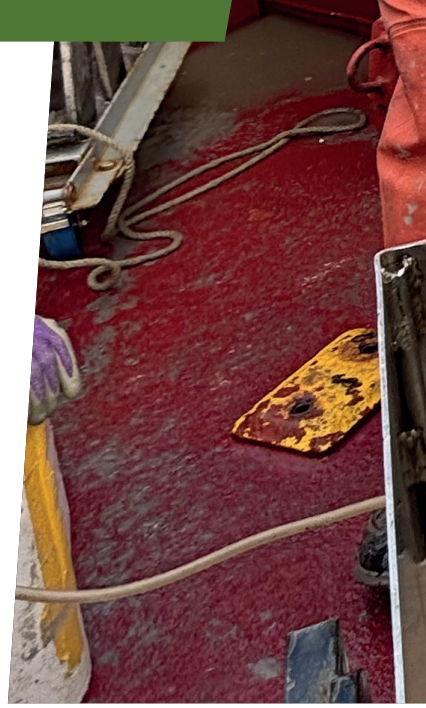
# How is carbon stored in seafloor sediments?

In the summer of 2024, **Dr Émilie Saulnier-Talbot**, a biogeographer from **Université Laval**, and **Dr Hilary Corlett**, a geologist from **Memorial University**, took part in an ocean research expedition around the fjords of northern Canada. By analysing the sediment archives they collected, Émilie and Hilary hope to understand how carbon is transferred from the land to the sea and how it is stored in seafloor sediments.



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**Field of research**
Biogeography

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**Field of research**
Carbonate sedimentology

**Research project**
Modelling the movement of carbon from the land to the sea

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## Earth scientist

**Carbon cycle** — the movement of carbon between the oceans, atmosphere, land and organisms

**Continental shelf** — the shallow seafloor surrounding the edge of a continent

**Corer** — a type of sampling equipment that is lowered off a research ship to collect sediment from the seafloor

**Fjord** — a long, narrow, steep-sided inlet, shaped by the passage of glaciers

**Sediment** — small pieces of material that accumulate on the seafloor, including sand, silt, clay, shells and dead microorganisms

**Sediment core** — a tube (if collected by a gravity corer) or cube (if collected by a box corer) of sediment that has been extracted from the seafloor

**Sediment structures** — textures preserved in layers of sediment

**Terrestrial carbon** — carbon stored on or sourced from the land

Carbon is constantly moving around the planet through a variety of processes, including the photosynthesis of plants, respiration of animals and burning of fossil fuels. The movement of carbon between land, oceans, atmosphere and organisms is one of our planet's most fundamental systems, yet scientists still know relatively little about the ocean's role in it.

"There are many variables to account for when modelling something as complex as the carbon cycle on this scale," says Dr Émilie Saulnier-Talbot, a biogeographer from Université Laval. "There are also many unknowns when accounting for these variables." Carbon entering the ocean (e.g., from soil washed off the land) may be released into the atmosphere or locked up in long-term storage, depending on the processes that take


*Scientists on the CCGS Amundsen take a push core of sediment from a box core recently brought up from the ocean floor*

place. "It's thought that only a small portion of terrestrial carbon will be stored in seafloor sediments, but our current estimates are uncertain," says Dr Hilary Corlett, a geologist from Memorial University.

## Investigating the movement of carbon from the land to the sea

Émilie and Hilary are leading the multidisciplinary 'Land to Sea' component of the wider Canadian Transforming Climate Action project, one of the most intensive investigations ever undertaken into the ocean's role in climate change. By combining their skills, Émilie and Hilary hope to model how much carbon is being transferred from the land to the sea, discover how sediment in the ocean stores or releases this carbon, and investigate which variables are most important for predicting how climate change will affect the carbon cycle in the future.

As a geologist who specialises in carbonate sedimentology, Hilary's aim is to evaluate how carbon is transferred into the sediments that build up along coasts and continental shelves. "This can be determined by looking at different textures, minerals and chemistry of the sediment," she explains. "I also hope to evaluate the processes at work in the sediment layers that may affect their potential for long term storage of carbon."

Meanwhile, Émilie, a biogeographer who specialises in aquatic ecology, is examining the dead microorganisms (which, through photosynthesis, play a key role in the carbon cycle) found in seafloor sediment to track changes in ocean ecosystems through time and how these relate to environmental changes and variations in the carbon cycle. "I hope to see how different coastal environments vary, and how rapidly they are changing in response to the climate breakdown," she explains.

## Life onboard a research ship

In August 2024, Émilie and Hilary spent nine days on the research ship *CCGS Amundsen* with a team of scientists from the Geological Survey of Canada. During the expedition, they visited three fjords on Baffin Island to collect sediment and water samples for their research as part of the Land to Sea project. As senior scientists on the ship, Émilie and Hilary were in charge of selecting sampling sites and ensuring sampling was done correctly.

To collect sediment samples, the team lowered corers from the boat down through the water to the seafloor. A box corer collected the sediment (essentially mud!) sitting on the seafloor, while a gravity corer penetrated up to seven metres below the seafloor to collect deeper (and therefore older) sediment. Once the sediment cores were brought on deck, the team tried to move them as little as possible. "This was because we want to limit the disturbance to the layers of sediment in the cores so that we can scan them back in the lab," says Hilary. At each coring site, the team also collected water samples from different depths to get a better picture of the water column.

Life onboard a research ship is very organised. "On the days we were coring, we were often up at 4am and on deck with the coring equipment," says Émilie. "We had to be ready for coring whenever we reached a sampling site, and we visited up to four sites a day." Because the expedition took place north of the Artic Circle during summer, it was almost always daylight, meaning scientific work could easily continue around the clock.

## Analysing the sediment

When the *CCGS Amundsen* returned to shore, the sediment cores were sent to Université Laval where they are currently being scanned to create 3D pictures of the sediment structures. "Sediments are deposited on the seafloor through various mechanisms, and these processes are recorded in the structures preserved in the sediment," explains Hilary. With the 3D images of the cores, she and her team will uncover how the sediments were deposited.

Once they have been scanned, Émilie and her team will use microscopes to observe the remains of microorganisms in the sediment. By comparing microorganism communities in sediment collected from different locations and depths, they will uncover how microorganism communities have changed through time and how they are influenced by different environments.

From these analyses, Émilie and Hilary will be able to build a clearer picture of how terrestrial carbon is transferred to the ocean to be stored in sediments or released. "We are confident that the results from this multidisciplinary programme will contribute to a better understanding of how the continents and oceans are linked and how the climate of our planet is partly regulated by the complex processes that take place along the continental shelf," says Émilie.


# About *Earth science*

Earth science encompasses all aspects of our planet, from the atmosphere and oceans to the history of life. Within this broad field, Émilie specialises in biogeography and Hilary specialises in carbonate sedimentology.

"Biogeography is concerned with where and when organisms live(d) and why," explains Émilie. Research questions range from how and why vegetation changes as you travel up a mountain, to how warming waters will affect lobster migration. "In the current context of the biodiversity crisis, biogeography can help to guide our conservation actions," she continues.

Carbonate sedimentology is the study of carbonate rocks, primarily made from the skeletons of ancient marine life. "I use the sediment record to understand more about the chemistry of the world's oceans through time," says Hilary. "This can tell me why a community of organisms may have existed and thrived in one location during Earth's history or have been decimated through various shifts in Earth's climate."

## The joys of a career in Earth science

"I most enjoy the chance to contribute to our understanding of the world's oceans," says Hilary. "When I start a new research project, I am typically trying to investigate a question or puzzle that would help in our understanding of Earth's processes through time and how we can use this to understand future changes on Earth."

"I love the diversity of life on our planet and my work allows me to explore many different environments," says Émilie. "I have worked around the world, from the Arctic to the tropics, to collect material that I analyse to understand a particular environment or species. There is never a dull moment because there are so many questions to answer!"

## Pathway from school to *Earth science*

In high school, studying geography, biology, chemistry and geology will prepare you for further studies in Earth science.

At university, a degree in Earth science, geology, geography, biology or environmental science would be a good route to a career in Earth science. If you are interested in biogeography, you could also consider studying biochemistry, microbiology or bioinformatics, and if you are interested in carbonate sedimentology, then you could study palaeontology, geophysics or geochemistry.

Most important of all, develop your curiosity about the world around you. "To be a biogeographer, you need endless curiosity about life on Earth," says Émilie. "You need to care deeply about all life, and you should realise how lucky we are to live in such a diverse place."

## Explore careers in *Earth science*

Careers in Earth science range from resource extraction (e.g., mining, oil and gas exploration) to ocean research to environmental protection. Whatever aspect of our planet most interests you, you can find a career to match!

"Now more than ever, as we adapt to shifts in the climate and changes in economic commodities, we need more people to train as Earth scientists to develop a better understanding of Earth's processes and cycles," says Hilary.

Émilie and Hilary recommend getting involved with citizen science projects or community nature groups, contacting scientists to ask if you can help with their fieldwork or lab research, and attending Earth science public talks and open days.

The National Geographic Society (**nationalgeographic.org/society**), Canadian Government (**science.gc.ca**), NASA (**nasa.gov**) and The Geological Society (**geolsoc.org.uk**) provide educational resources, careers information and citizen science opportunities.

## **Meet** *Émilie*

**As a teenager, I was very much into history, geography, music and travel.** I was also obsessed with how dinosaurs disappeared from the Earth.

**I was inspired to become a biogeographer** during my geography undergraduate degree by Professor Reinhard Pienitz. In one of his classes, I wrote an essay about the different theories that could explain the extinction of large mammals at the end of the last Ice Age, and for my dissertation, I looked at how life colonised a newly formed volcanic island south of Iceland. Reinhard introduced me to the theory of island biogeography which I found fascinating, and that really got me hooked on this discipline.

**What I most liked about my time on the *CCGS Amundsen* was getting to know Hilary!** We had never actually met in person before the trip and now we are great friends as well as colleagues. I also learned a lot about ocean science, because I'm used to working on smaller boats and nearer to shore. And the views were amazing. The Arctic is a very special place and anyone who can visit there is very lucky.

**One thing that was pretty special about our cruise was that women were in charge!** The captain, first officer, chief scientist and senior scientists were all women. This is amazing if you think that just 50 years ago, women were not even allowed on research vessels.

**When I'm not working, I love to spend time with my family** and my husky, Ghost, who makes me get up early and take long walks to watch the sun rise. I still love music and enjoy going to concerts.

## **Meet** *Hilary*

**I've always loved the ocean and marine life and been curious about nature.** I went to university to become a marine biologist but became hooked on the geology courses I took. When I took a course in carbonate sedimentology and learned that carbonates are formed from the skeletons of marine life, I realised I could combine my love of marine biology and geology while studying the ocean frozen in time.

**I've been fortunate to travel the world doing research** – I've worked in Egypt, the Cayman Islands, the Canadian Northwest Territories, and now here in Newfoundland.

**My favourite memories onboard the *CCGS Amundsen*** are of looking inside each box of sediment that we pulled up from the ocean floor. Each time, there was something new to see, and it was amazing to discover how much life there is even on a 50 cm by 50 cm surface of the ocean floor. It was also inspiring and humbling to see the beautiful and fragile environment of the North, which is something that few people get to do.

**I have osteoarthritis and arthrogryposis,** a physical disability that can limit my movement and causes me a lot of pain. As I sometimes need crutches, I was nervous about being able to move around the ship and worried that I wouldn't be of help to my team. In the end, the wonderful thing about being on a ship is that there are railings everywhere to hold on to! I was able to get around and I contributed to our efforts through site selection, recording data and preparing cores. I also had the help of my teammate Émilie, who I got to know on board the ship and who I consider to be a wonderful friend as well as a colleague.

**My husband and I have recently moved to Newfoundland,** which is a fantastic place for hiking. I also enjoy kayaking, swimming, downhill skiing and making pottery.

## **Émilie's** *top tips*

1. Be determined, persistent and patient. Things in academia rarely happen overnight – after finishing my PhD, it took 13 years for me to find a position as a professor.
2. Be creative to find ways in which you can continue to do what you love.

## **Hilary's** *top tips*

1. Pursue what you're interested in and don't let others put you off. It takes hard work and determination to find a career and lifestyle that brings you joy, but it's worth it.
2. Talk to your teachers about what you want to do and find a way to do it.