SCIENTIFIC OCEAN DRILLING

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Digital Newsletter

the Drilling Dispatch

October 2024

SCIENTIFIC OCEAN DRILLING

In This Issue

IODP Science...
Recent publications featuring Scientific Ocean Drilling

We can't emphasize it enough: The expedition is just the beginning when it comes to scientific ocean drilling research. In this article we've compiled some recent publications that highlight the breadth of research stemming from ocean drilling expeditions, cores, and data, along with the media coverage these investigations have received.

Don't see your paper? Don't worry! This is a live document and can be updated at any point. Send your publication to mpincus@ldeo.columbia.edu to have it added to the list.

IODP Expedition 399: Building Blocks of Life, Atlantis Massif

A long section of serpentinized depleted mantle peridotite in *Science*

Featured in:

- Eos
- Nautilus Magazine
- New York Times

IODP Expedition 398: Hellenic Arc Volcanic Field

Giant offshore pumice deposit records a shallow submarine explosive eruption of ancestral Santorini in *Communications Earth & Environment - Nature*

Featured in:

- The Conversation

IODP Expedition 390/393: South Atlantic Transect

Estimating $CaCO_3$ content based on natural gamma ray (NGR) in deep-ocean sediment cores in *Stratigraphy*

IODP Expedition 386: Japan Trench Paleoseismology

Japan Trench event stratigraphy: First results from IODP giant piston coring in a deep-sea trench to advance subduction zone paleoseismology in *Marine Geology*

IODP Expedition 385: Guaymas Basin Tectonics and Biosphere

Deep subseafloor sediments in Guaymas Basin harbor cosmopolitan microbiota and traces of hydrothermal populations in *Communications Earth & Environment - Nature*

IODP Expedition 383: Dynamics of Pacific Antarctic Circumpolar Current

Five million years of Antarctic Circumpolar Current strength variability in *Nature*

Featured in:

- Sci Tech Daily

IODP Expedition 382: Iceberg Alley and Subantarctic Ice and Ocean Dynamics

A 3.3-Million-Year Record of Antarctic Iceberg Rafted Debris and Ice Sheet Evolution Quantified by Machine Learning in *Paleoceanography and Paleoclimatology*

IODP Expedition 374: Ross Sea West Antarctic Ice Sheet History

Miocene Climatic Optimum and Middle Miocene Climate Transition: a foraminiferal record from the central Ross Sea, Antarctica in *Journal of Micropaleontology*

IODP Expedition 363: Western Pacific Warm Pool

Re-organization of Pacific overturning circulation across the Miocene Climate Optimum in *Nature Communications*

Unravelling changes in the productivity regime during the Late Miocene-Early Pliocene Biogenic Bloom: Insights from the western equatorial Pacific (IODP Site U1488) in *Marine Micropaleontology*

Controls on Sr/Ca, S/Ca, and Mg/Ca in Benthic Foraminifera: Implications for the Carbonate Chemistry of the Pacific Ocean Over the Last 350 ky in *Geochemistry, Geophysics, Geosystems*

IODP Expedition 362: Sumatra Seismogenic Zone

Remagnetization of Pre-Fan Sediments Offshore Sumatra: Alteration Associated With Seismogenic Diagenetic Strengthening in *JGR Solid Earth*

IODP Expedition 349: South China Sea Tectonics

Vanadium isotope records of the transformation from carbonated melt to alkali basalt in *Chemical Geology*

ODP Leg 172: Northwest Atlantic Sediment Drifts

On the relationship between paleomagnetic secular variation and excursions – Records from MIS 11 and 12 – ODP Leg 172, western North Atlantic Ocean in *Physics of the Earth and Planetary Interiors*

ODP Leg 165: Caribbean Ocean History

High-precision U-Pb geochronology for the Miocene Climate Optimum and a novel approach for calibrating age models in deep-sea sediment cores in *Geology*

Featured in:

- Ars Technica

Miscellaneous

Twenty years of MSPs: Technologies and Perspectives in *Marine Geology*

How to...
Find free educational resources on the JR website

written by Maya Pincus (USSSP)

Attention educators! Are you looking for a way to engage your students in authentic ocean-drilling science? Then you've come to the right place!

The *JOIDES Resolution* website hosts a vast library of free resources. Whether you teach students in kindergarten or college, there is guaranteed to be a lesson perfect for your class. Given that we've been creating lessons and activities since the early 2000s, there is a lot to search through if you're looking for something specific. Use this guide to find exactly what you're looking for.

- **Step 1**: Navigate to the *JOIDES Resolution* website (https://joidesresolution.org).
- **Step 2:** Click "For Educators" on the right side of the page (or to skip a step, go straight to https://joidesresolution.org/for-educators).
- **Step 3:** Look around. You can request a replica of one of our most famous cores for your classroom,
- download one of many free posters or children's books, play an online video game, or...
- **Step 4:** Find a lesson plan to engage your students in real ocean-drilling data. Click the "Classroom activities" tab.
- **Step 5:** Use the drop-down menu to filter your search. You can sort lessons by type of resource, intended age group, and topic, or just browse the entire library from newest to oldest. There is also a search option at the bottom of the page if you have a specific keyword in mind.
- **Step 6:** If you'd like to browse the resources organized by the Strategic Objectives of the 2050 Science Framework, you can preview a new version of the website, developed during the 2021 virtual School of Rock workshop.
- **Step 7:** Finally, for those of you who love spreadsheets, you can access and manipulate a complete database of educational materials here.

We are partnering with the American Geosciences Institute (AGI) to revise and update our resources! Over the next two years we will modernize the lessons on our website to ensure consistent formatting, updated links, connections to real IODP data, and alignment to the Next Generation Science Standards. All materials in their present state will be available in an archive, so you won't lose the resources you know and love, but stay tuned for the revitalized versions coming soon!

FEATURED VIDEO

Japan Trench Fast Drilling Project

In 2012, JAMSTEC-operated D/V *Chikyu* sailed to the Japan Trench to understand the very large fault slip that occurred near the axis of the Japan Trench during the 2011 Tohoku earthquake. Expedition 343: Japan Trench Fast Drilling Project (JFAST) was the precursor to the current Expedition 405, which began on September 6, 2024.

For your calendar

- **Targeting Pacific Highs for Past Records of Climate Change workshop**
  (application deadline: 25 July 2024; Texas, USA; learn more)
- **Autonomous Investigation during Drilling workshop**
  (registration deadline: 15 October 2024; Massachusetts, USA; learn more)
- **Request for proposals: Novel Projects in support of Scientific Ocean Drilling**
  (deadline: 1 November 2024; learn more)
- **Request for proposals: Workshops in support of Scientific Ocean Drilling**
  (deadline: 1 December 2024; learn more)
- **American Geophysical Union Annual Meeting**
  (9-13 December 2024; Washington, D.C., USA; learn more)
- **Provide input on Future Ocean Drilling in the U.S. (FOCUS)**
  (open deadline; learn more)

SCI COMM RESOURCE OF THE MONTH

This Open Educational Resource (OER) focuses on scientific ocean drilling and its contributions to our knowledge of ocean science and overall Earth systems. The project team, all former *JOIDES Resolution* Onboard Outreach Officers, authored this book to increase scientific and oceanic literacies.

Scientific Ocean Drilling: Exploration and Discovery through Time

Spotlight on...
Yan Zhang

written by Maya Pincus (USSSP)

Credit: Yan Zhang

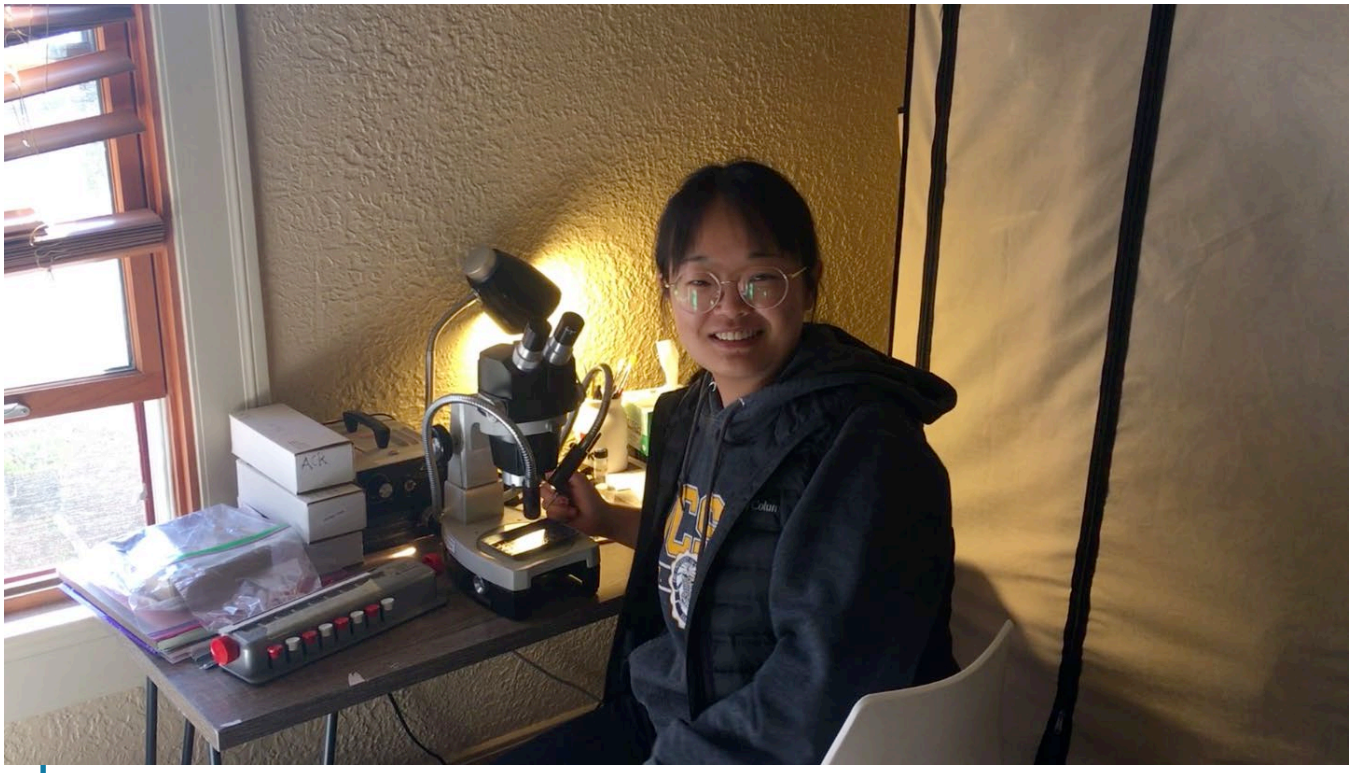
As a young student, 2023-2024 Schlanger Fellow Yan Zhang was advised by her mother “Do what you want, no matter whether it’s easy or not to find a job in the future. Just try to find what’s your interest.” Yan took the advice to heart. Both academically and how she chooses to live her life, it is clear that Yan is boldly following her passions, shaping a life that balances boundary-pushing research with plenty of adventure.

It took some years before Yan settled into the course of study she now pursues. In her youth, she hoped for a career that would keep her busy with field trips, away from the office. This was fueled by the animal videos and nature documentaries she watched on repeat. Thinking about the vastness and beauty of the world around her, “that was my first wish or initial motivation to choose the ocean and earth science major.”

Yan made the decision official in her final year of high school, choosing to pursue her passion by enrolling in the School of Ocean and Earth Science at Tongji University. Although she faced some disagreements regarding her choice of major, with her mother’s support, Yan moved to Shanghai, over 1500 km away from her home in Chongqing. This trip also foreshadowed the next several years of even farther journeys Yan would make.

Even having already determined her major, it still took Yan all four years of undergraduate studies to figure out what actually motivated her. Undaunted, she tried what felt like every option in the department, from physical to biological oceanography. In this process, she jumped on every opportunity she could to expand her horizons, both academically and geographically. Early on, she worked with Dr. Jiangtao Li to investigate the composition of biological communities within deep sea hydrothermal vent systems. During the summer after her junior year, she participated in a summer intern program in Canada to be involved in a physical oceanography project at Queen’s University, working with Dr. Ryan Mulligan. Although Yan was unable to delve deeply into wave dynamics through the research project, she had a wonderful experience in Canada, living abroad on her own for the first time.

It was during an exchange program in her senior year that Yan finally fell into something she loved. She spent five months at the Massachusetts Institute of Technology, working with a paleoclimate and geochronology group led by Dr. David McGee, to conduct the research that would lead to her senior thesis. Engaged in the content of graduate-level classes and immersed in lab work, “that was the start of my trip to paleoclimate and paleoceanography.” With the help of a graduate mentor Christopher Kinsley, Yan reconstructed dust flux at ODP Site 1208 in the North Pacific during the late Pleistocene, learning analytical



Yan is so dedicated to her research that she has a microscope and microbalance at home for picking foraminifera (Credit: Yan Zhang).

tools and methods such as column chemistry and inductively coupled plasma mass spectrometry. “At that point,” Yan remembers, “I realized I liked the lab work and I loved the history of Earth climate. I wanted to learn more.” It was then that she decided to continue in the field of paleoclimate research.

After a gap year spent back home with family, Yan made another big move. She returned to the U.S., this time on the west coast to study under Dr. Christina Ravelo at the University of California, Santa Cruz. Yan describes her doctorate work in two parts. More generally, she is interested in the monsoon dynamics, hydroclimate, and productivity changes in the Pacific warm pool during the Pleistocene. This region is important because it distributes heat and moisture from low latitudes to the global system, with ripple effects that contribute to monsoons and the El Niño-Southern Oscillation (ENSO). Yan is motivated to learn more about these processes because they are “very significant for the people’s lives and also global climate change.”

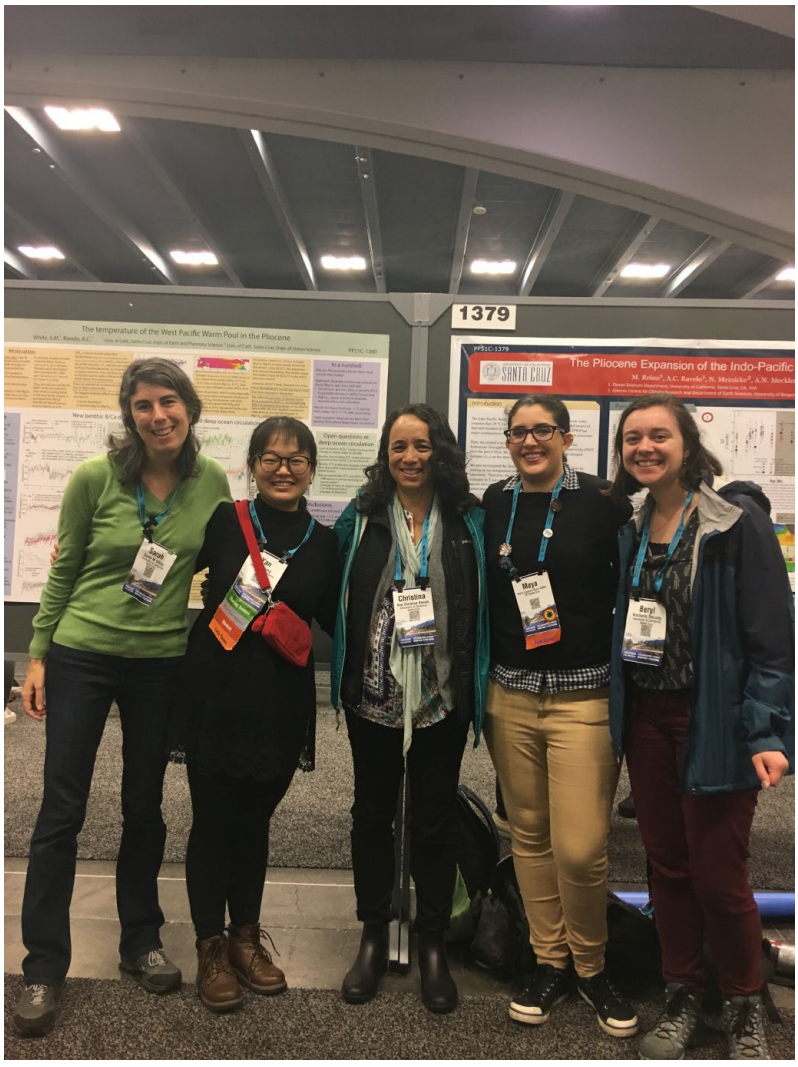
With Schlanger Fellowship funding, Yan is augmenting her research by analyzing the element nitrogen. As a limiting nutrient in the ocean system, the amount of nitrogen within the ocean system can influence biological productivity, carbon sequestration, and climate change. However, there is a “big gap” in what is currently known about marine nitrogen dynamics and cycling over geologic time. Yan describes this field of study as “super complicated” because “nitrogen cycling is involved in all biological activities.”

To resolve these limitations in the existing data, Yan is researching the nitrogen cycle at million-year timescales since the Miocene, by using isotopes and model simulations. Specifically, she generated geological $\delta^{15}N$ isotope records and is using biogeochemical box models to simulate global marine nitrogen cycling, including the $\delta^{15}N$ isotopes, nitrogen flux of different processes, as well as inputs and

outputs in the whole nitrogen budget over time. Her first experiment analyzed the mid-late Miocene, when the Central American Gateway was progressively shallowing. As this seaway became increasingly restricted, Yan was curious how that would affect the evolution of oxygen minimum zones (referring to nitrogen isotope changes) in the eastern tropical Pacific.

Soon into her PhD, Yan faced the challenge of reconciling the complicated bulk $\delta^{15}N$ data she produced from globally distributed ocean sediment samples. To add clarity, through mentoring by Dr. Mathis Hain, Yan learned how to code so that she could run biogeochemical box models to simulate nitrogen cycling for different ocean basins. “We know that marine nitrogen cycling is super complicated,” she explained, “so you cannot offer an accurate interpretation just based on the isotope records. You have to use models to disentangle the information.” This is just one example of the initiative Yan has shown to ensure her work is as thorough as possible. “I suffered a lot to write the code,” she lamented, “because we started from scratch. We had to do everything step-by-step.”

An additional, if ambitious, component of Yan’s research is an attempt to develop a new method for analyzing foraminifera-bound $\delta^{15}N$. The standard practice for most labs is to use the denitrifier method to obtain these data. Yan has been experimenting with a nano elemental analyzer (NanoEA) to measure very small amounts of nitrogen, a technique that will hopefully allow more researchers to analyze foraminifera-bound $\delta^{15}N$ more quickly and at a lower cost.



From the enthusiasm with which she talks about this work, you’d never know how many challenges Yan has encountered while trying to conduct her research. Even though she has not quite succeeded with the nano elemental analyzer method, “we were very close quite a number of times.” She shared stories of instrument issues and technician turnover, a common side of research that often goes unmentioned, on top of a certain global pandemic that paralyzed her lab. She is still trying to calibrate the system, but has to rely on others whenever one component or another inevitably breaks down. She has made some progress, developing a technique that is “kind of in the middle between NanoEA and the denitrifier method,” but at this point it is likely that the project will be completed by others after Yan graduates. Instead, Yan

In a photo titled “I love my lab,” Yan poses with her PhD advisor, Dr. Christina Ravelo (left) and other members of her lab group at a conference (Credit: Yan Zhang).

LEFT: The lab at UC Santa Cruz where Yan conducts her research (Credit: Yan Zhang). RIGHT: As hard as she works in the lab, Yan puts equal effort into finding fun things to do on the weekends. Here, she poses while on a hike in the western U.S. (Credit: Yan Zhang).

conducted her foraminifera-bound $\delta^{15}N$ analysis at Dr. Abby Ren's lab at National Taiwan University, which provided her with a valuable experience and journey.

It may sound like a cliché, but Yan's story should serve as inspiration to other students and early career researchers who are discouraged by the process. Her perseverance, optimism, and gratitude to those who support her consistently shine through to dissipate the frustration. One of the first things she said when describing her dissertation was, "The thing that gives me the most motivation and support is my advisor. She is always super supportive and tries to help me figure things out to deal with issues. That makes it so that I can survive, so that I can hang out here still." She is quick to credit her advisors and mentors whenever she talks about her own success. And she is quick to find the positive side of any situation: "It's been a lot of work to get those data, but I'm very happy."

Perhaps most importantly, Yan treats her own well-being as a priority. On the weekends, it is common for Yan to join her friends on road trips around California and the surrounding states. She loves to hike; by so frequently exploring this new terrain, she is fully taking advantage of her time so far from home. She also uses her free time to experiment with cooking, eager to try new foods that are different from what she would normally eat in China.

When asked to reflect on the motivation behind her many transnational journeys, Yan laughed and responded "People are brave when they're young." But if anything is clear from her story, Yan is still just as brave. Wrapping up the final stages of her dissertation, she is looking forward to the next chapter, in which she hopes to continue her exploration of paleoclimate and the United States through a postdoc position. But she is keeping her eyes open to any opportunity that may come her way, especially in the evolving landscape of international scientific ocean drilling.

Creative COREner...
Knit your Ph.D.!

written by Isabel Dove (University of Rhode Island)

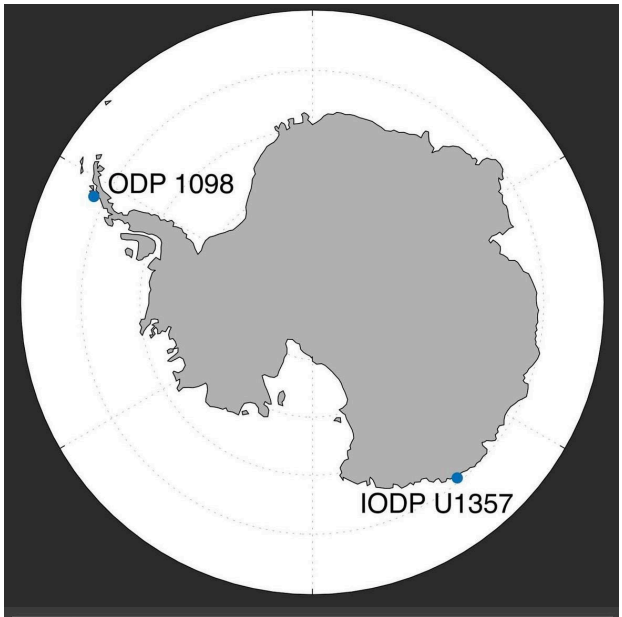
Fellow graduate students all know that hobbies are essential to coping with the rigor and stress of graduate school. My favorite hobby is knitting because I find the process meditative and the end product of a hand-made garment rewarding. Even though I started knitting as a way to relax, I sometimes combine my downtime with my work by knitting patterns based on paleoceanographic datasets. I have previously knit a blanket of the benthic oxygen isotope stack and now, having recently defended, I am knitting my Ph.D.!

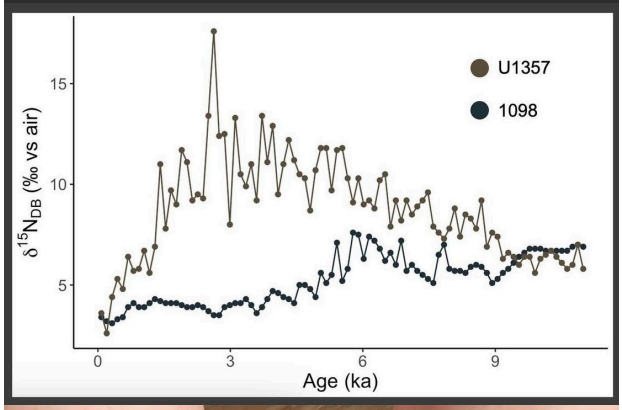
My inspiration for paleoceanography-themed knits stems from two science communication initiatives: Warming Stripes and the Tempestry Project. Warming Stripes, a concept by climate scientist Ed Hawkins, uses color to represent temperature changes over time. The Tempestry Project similarly uses color to represent environmental conditions over time, but through fiber art.

Upon learning about the Tempestry Project in 2020, I briefly considered knitting their flagship project: a tapestry of daily temperature throughout a year, with each row representing a day and the color of each row determined by average temperature. Then, while pondering which year to knit, I realized that I could make the project more practical and more personal. Instead of a tapestry, I would knit a blanket. Instead of an annual temperature record, this paleoceanographer would knit a 5.3 million-year record of temperature and global ice volume!

Knitting the LR04 benthic stack – arguably the most famous paleoceanographic dataset – motivated me to knit my own data. My Ph.D. research focuses on the diatom-bound nitrogen isotope ($\delta^{15}N_{DB}$) paleoproxy. Diatoms are microscopic phytoplankton with ornate opaline shells that are preserved in marine sediment. The nitrogen isotopic composition of the organic matter within fossil diatom shells is used to study nutrient utilization over time and therefore changes in biological pump efficiency. The biological pump is the set of biological, chemical, and physical processes by which CO_2 is drawn out of the atmosphere and sequestered in the deep ocean. Given CO_2's profound influence on our climate, records of past biological pump efficiency are important for understanding the ocean's role in modulating global climate change over time.

While $\delta^{15}N_{DB}$ records have proven to be useful for studying past climate, there are outstanding questions regarding whether certain types of diatoms bias these records in addition to a spatial gap in records near the Antarctic coast. My research quantifies how a special type of diatom, *Chaetoceros* resting spores, influences $\delta^{15}N_{DB}$ records and applies those findings to two new $\delta^{15}N_{DB}$ records from resting spore-rich





coastal Antarctic sediment cores. In terms of knitting, a *Chaetoceros* sweater is in the works, and I am proud to present a pair of socks representing my coastal Antarctic $\delta^{15}N_{DB}$ records!

Both records are Holocene-aged, spanning approximately the last 11,000 years. One is from Site 1098 on the Antarctic Peninsula, collected during ODP Leg 178: Antarctic Glacial History and Sea-Level Change. The other—the topic of my 2022-2023 Schlanger Fellowship—is from Site U1357 offshore East Antarctica, collected during IODP Leg 318: Wilkes Land Glacial History. My U1357 record is higher resolution than my 1098 record, so the first step in creating my sock pattern was to transform the data to a consistent time step. This ensured that a row in one sock corresponds to the same time as the same row in the other sock. After transforming the data, I was left with 91 data points spanning 10,920 years, so each row represents a 120-year time step. Let's take a second to appreciate these amazingly high-resolution cores!

Next, I assigned a color to each row based on the $\delta^{15}N_{DB}$ value for each point. In a nod to the ocean, I chose a color scheme of blues and greys. I assigned the lightest color to the lowest $\delta^{15}N_{DB}$ values, indicating less nutrient utilization, and the darkest color to the highest $\delta^{15}N_{DB}$ values, indicating enhanced nutrient utilization. Just like a sediment core, the oldest samples are on the bottom (by the toe) and the youngest samples are on the top (by the cuff). The result: a cozy pair of striped socks representing changes in nutrient utilization in the coastal waters surrounding Antarctica throughout the Holocene.

This project was fun and satisfying, enabling me to combine my love of wool with my love of marine sediment. Interestingly, the process of creating and executing an original knit pattern is not dissimilar from completing a Ph.D. I began with a "literature review" of published patterns to guide my methodology. For my sweater especially, I had to do LOTS of math. Despite careful preparation, the results were not always consistent with expectations. Achieving the finished product was sometimes tedious and took determination, but was definitely worth it in the end.

Call for contributions

If there's one thing that can be said about the International Ocean Discovery Program (and the Integrated Ocean Drilling Program, and the Ocean Drilling Program, and the Deep Sea Drilling Project), it's that we are a tight-knit community. Just as much as this newsletter is for you, we want it to be from you, too! In future editions we will highlight our readers by featuring the following community contributions:

- **From the Field** - Have you had an experience with scientific ocean drilling that you want to share? Write a piece to tell us your perspective "from the field" for our next edition. Bonus points if you include some pictures!
- **Scientist Spotlight** - Do you know someone who's making waves in the ocean drilling scene, whether it's a grad student or accomplished scientist? Send us a nomination! Briefly tell us why this person deserves a shout-out, and ideally how to get in touch with them. Self-nominations are also accepted.
- **Photo Montage** - We'll take any photos you want to share!
- **Creative COREner** - Scientists are creators too! Send in your paintings, drawings, digital designs, poems, short stories, sculptures, or any other ocean science art you've made.

Send your contributions (and questions and concerns) to **mpincus@ldeo.columbia.edu** no later than **October 20, 2024** to be featured in next month's newsletter.

See you next month!