SCIENTIFIC OCEAN DRILLING

CREDIT: Natacha Fabregas & IODP

Digital Newsletter

the Drilling Dispatch

HIGHLIGHTS 2024

SCIENTIFIC OCEAN DRILLING

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In the repository...
Expedition 401: Mediterranean-Atlantic Gateway Exchange

Rachel Flecker and Emmanuelle Ducassou,
Expedition 401 Co-Chief Scientists;
Trevor Williams, Expedition 401 Project Manager

written by Rachel Flecker, Erin Anthony, and Kellan Moss

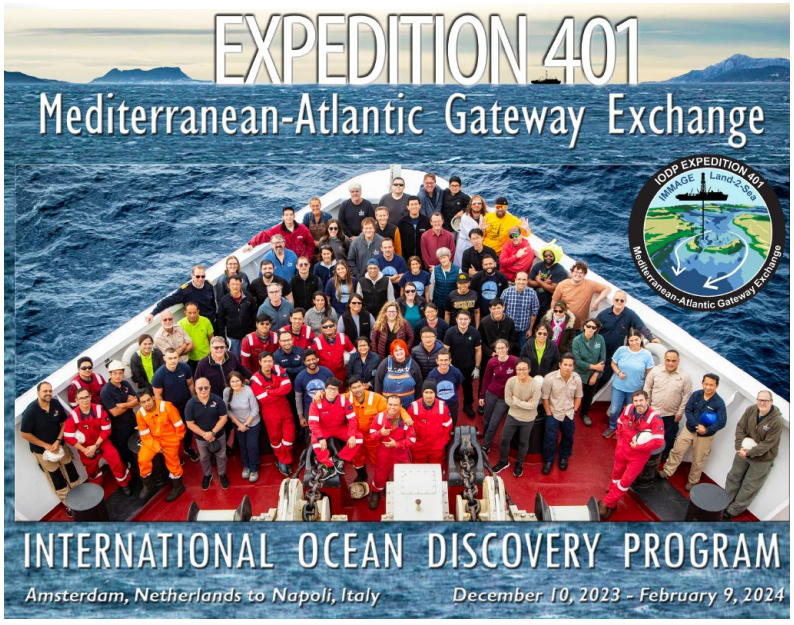
After two months at sea aboard the *JOIDES Resolution* (JR), Expedition 401 came to an end in February. The expedition was focused on studying the connection between the Atlantic Ocean and Mediterranean Sea 8-4 million years ago. Scientists know changes to this gateway profoundly changed the Mediterranean. The question was, did those changes also impact the Atlantic and what happened in the gateway itself?

Today the Gibraltar Strait is the only Mediterranean-Atlantic gateway, but in the past, there were at least two other connections: one to the south in Morocco and one to the north in Spain. These closed and as they did so, the saltiness of the Mediterranean increased dramatically, leading to the accumulation of ~1.5 km of salt on the Mediterranean sea floor, also known as a salt giant.

Expedition 401's aim was to collect sediment cores to test two main hypotheses:

1. that this change in Mediterranean salinity changes the density of the water flowing out into the Atlantic, impacting the circulation of the global ocean, and
2. that the formation of a salt giant changes the chemistry of the global ocean in ways that impact the carbon cycle.

Both these mechanisms have the potential to drive global climate change.



Expedition 401 participants pose for a group photo (Credit: Erick Bravo & IODP JRSO).

The sediment cores the expedition needed were buried up to 1.5 km below the seafloor. It is unusual to be drilling for sediment archives of climate this deep because climate records need to be continuous, and deep drilling rarely results in recovering more than half of the sedimentary layers. However, the expedition was able to take advantage of new drilling technology and the expertise in scientific coring accumulated and honed over more than half a century by both the JR technical team and the drillers. As a result, Expedition 401 recovered unprecedentedly continuous core even from depths of more than 1 km down. The last core recovered from the Mediterranean site was at 1070m and had 96% recovery. In total the expedition collected more than 2.6 km of core at four different sites in the North Atlantic Ocean and the Mediterranean Sea.

What these complete records in the Atlantic show is a clear response to changes in the Mediterranean-Atlantic gateway at the same time that the salt giant formed, making it very likely that there was a physical change in ocean circulation (Hypothesis 1). Detailed analytical work on recovered samples will be required to test Hypothesis 2. The expedition will be holding its sampling party later this year in Bremen, Germany to select the samples needed for this additional analysis.

The big ship-board surprise came from drilling just inside the Mediterranean to the east of Gibraltar. This area, the Alborán Sea, was thought to be the main Mediterranean-Atlantic gateway both immediately before and after the salt giant formed. The cores recovered at this site contained beautiful sediments, exquisitely laminated in a variety of colors. This incredibly fine lamination requires very quiet, low energy conditions. This is not what the science team was expecting to see, because many of the models suggest that during salt giant formation, the Mediterranean Sea level dropped by hundreds of meters, causing major erosion of the margins including in the Alborán Basin. The co-chiefs were also anticipating a sedimentary signal caused by the catastrophic refilling of the Mediterranean, but found no compelling evidence of that either.

All of this means that there are still lots of outstanding questions around the evolution of the Atlantic-Mediterranean corridor 8-4 million years ago. Luckily, Expedition 401 is part of a bigger Land-2-Sea drilling project, IMMAGE, that will drill the fossil gateways now preserved on land. So even though ship-based drilling on the project has come to an end, the team is already starting to plan the next drilling expedition to Spain and Morocco.

LEFT: Expedition 401 curatorial specialist Carel Lewis marks a core liner to indicate where sections will be cut). RIGHT: The SIEM Offshore drilling crew poses as a group on the rig floor. (Credit: Erick Bravo & IODP JRSO)

In the repository...
Expedition 402: Tyrrhenian Continent-Ocean Transition

Nevio Zitellini and Alberto Malinverno
Expedition 402 Co-Chief Scientists
Emily Estes, Expedition Project Manager

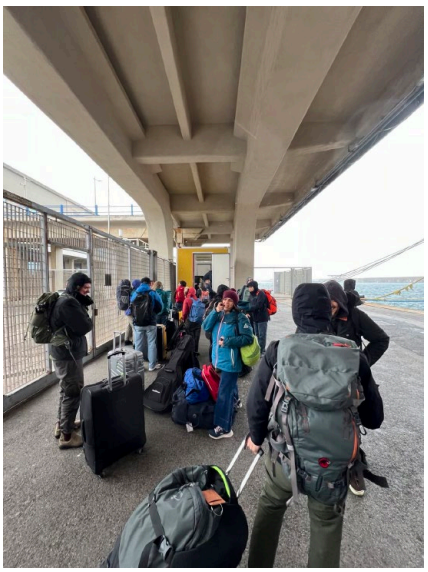
written by Tessa Peixoto and Larkin Bohn, Expedition 402 Onboard Outreach Officers

It was windy and a bit drizzly when the Expedition 402 science party stepped off a bus at the cruise port to start boarding the *JOIDES Resolution*. For veterans and rookies alike, it was an awesome sight to see the ship after months of Zoom meetings, and emails preparing us for the two-month-long expedition. We finally were seeing each other in person and on the ship!

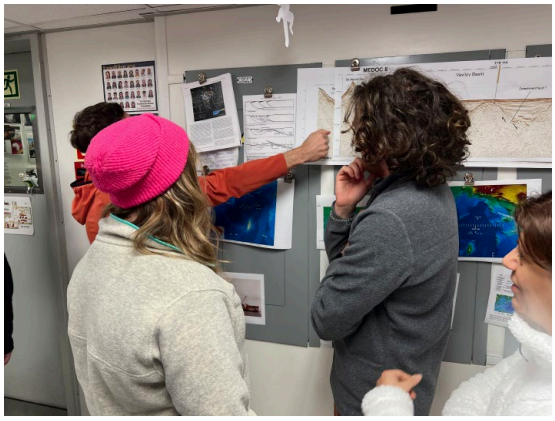
The 402 scientists unpacked and immediately went into onboarding meetings where we learned how to access our ship-board emails, connected to the ship's wifi, and were trained in laboratory instrumentation and safety. You could feel the energy coming off everyone as our excitement and anticipation to get started grew.

Expedition 402 set out to build a better understanding surrounding the exposed mantle that was recovered during ODP Leg 107, and interpret what happened as the crust was stretched and the mantle below it was exposed to the seafloor during the opening of the Tyrrhenian Sea. There were three main locations that we wanted to drill: the Campania terrace, the Cornaglia terrace, and the Vavilov Basin. Before we could get any mantle rocks or sediment cores, we had to build the drill string by connecting sections of drill pipe, which, depending on the site, could be as short as 2700m or as long as 3800m (the water depth at these locations). The incredibly talented SIEM Offshore crew seamlessly assembled and disassembled the drill string every time we moved onto another drilling site.

Our first drilling site provided a rough start, where the large amount of material from regional volcanic eruptions in sediment made operations more challenging and required some modifications to our original plan. One change was that we needed to install reentry



TOP: The *JOIDES Resolution* docked in the port of Naples (Credit: Tessa Peixoto & IODP). BOTTOM: Expedition 402 scientists waiting to board the ship (Credit: Tessa Peixoto & IODP).



TOP: Scientists analyze seismic data for one of the drill sites (Credit: Tessa Peixoto & IODP). MIDDLE: Excitement fills the lab stack every time a new core is laid out on the catwalk (Credit: Tessa Peixoto & IODP). BOTTOM: Crew members prepare to release the Vibration Isolated Television frame down the drill string (Credit: Tessa Peixoto & IODP).

cones and casing. These special devices, typically 2.3m tall and 4m in diameter and painted with a bull's eye, sit on the seafloor and help the crew re-enter the same hole multiple times. They also help stabilize the borehole so that it does not collapse in on itself over time like boreholes normally do. How does the crew find this cone with a drill string over two kilometers long? Outstanding question! With the help of a Vibration Isolated Television frame that holds an underwater camera that wraps around the drill string and is capable of transmitting the footage in real time from the deep all the way up to the skilled operators on the vessel. The SIEM crew may be the ones in charge of the action, but the entire ship can enjoy the show from monitors located on every deck! That's right, while the drillers and captain are working together to carefully line up the end of the drill string with the cone, thanks to the dynamic positioning system, the entire ship is on the edge of their seats watching! The dynamic positioning system includes an impressive set of twelve propellers, all working together to hold the ship in place despite the winds and ocean currents that can move the vessel away from the target site.

One thing you can depend on is that fieldwork is full of surprises. Seismic surveys are incredibly useful to give us an estimate of how deep basement rock lies under the sediment, but it is only when you start to drill that the real depth is determined. Sometimes we found the basement to be more than 100m deeper than predicted. Due to the difference of basement depths and core recovery, Expedition 402 had its work cut out for the sedimentologists, while the petrologists waited patiently for their time to shine. The day we retrieved our first core of mantle rocks there were applause and literal cheers of joy on the core deck.

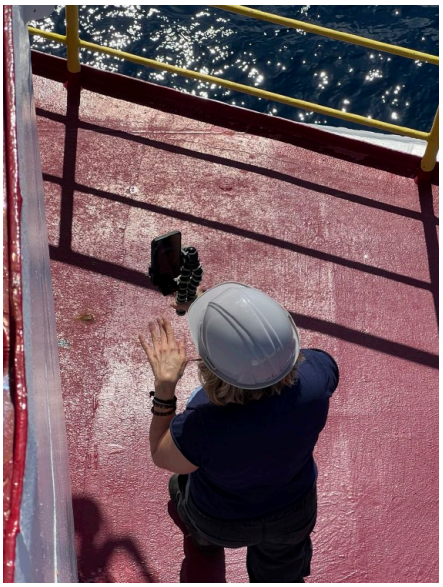
As the expedition carried on, cheers of joy turned to curiosity and hard work from the petrologists. Throughout the expedition, we successfully cored at all three locations, were even able to return to one of the sites to get more core. This gave us an opportunity to obtain more basement samples. There is not much downtime on the ship, especially when each site was within a few hours of each other. The longest break we ever had between cores was the twelve hours it took to build the drill string, or the 2-8 hours it took to move

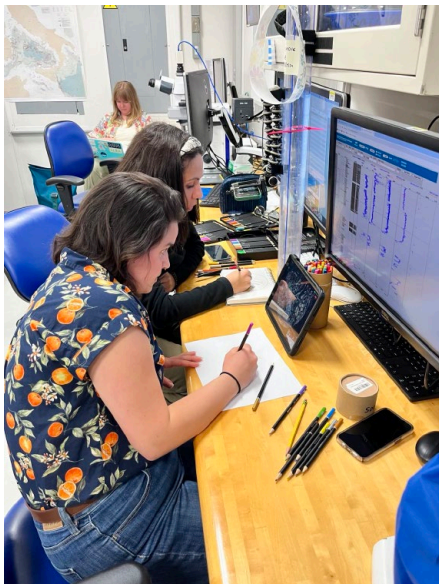
between our sites. During that transit time, one of the physical properties scientists studied data generated by the sonar system, an instrument the ship utilizes while navigating to map out the seafloor. Scientists are always looking for an additional piece of data to solve the puzzle. By comparing the new data and samples collected during Expedition 402 with the seismic data collected a few years earlier, scientists can better understand similarities and differences among the drill sites and answer the main question, what happened when the Tyrrhenian sea opened.

Outreach Tessa Peixoto and Larkin Bohn sailed as Expedition 402 Onboard Outreach Officers. By the end of the expedition Larkin and Tessa had hosted 104 ship-to-shore broadcasts, providing up to four tours per day for international audiences, some featuring scientists speaking other languages. Forty-eight of the 104 tours were delivered in Italian, to the point that Tessa now falls asleep to the phrase *Ci senti?* which means "Do you hear us?" in Italian. The reason we were able to give tours so frequently during Expedition 402 is due to the enthusiasm of the science party. This dedicated group loved to share their experiences with the audience, and the Outreach Officers were thrilled to facilitate such conversations. Word of mouth is a powerful factor in the number of broadcasts delivered. In one case, a broadcast scheduled by an Italian teacher ended up having over 200 students join, because other teachers in the school wanted to participate as well!

This expedition, broadcasts were not just for virtual audiences abroad, but were held for some of the ship crew! These were a very different kind of tour, since the *JOIDES Resolution* staff know the ship better than the science party. The "tour" was more of a Q&A style chat where Entier staff shared real life experiences with earthquakes as we discussed plate tectonics, and SIEM staff connected the dots when it came to why one hole can be harder to drill than another after seeing the samples up close!

One of Larkin's goals was to showcase the scientists' passion and turn the notion that science is stuffy or





LEFT: Larkin teamed up with Italian observer Alessio Sanfilippo to give ship-to-shore tours to students in Italy (Credit: Tiffany Liao & IODP JRSO). MIDDLE: Larkin also hosted several popular LIVES on Instagram (Credit: Tessa Peixoto & IODP). RIGHT: Tessa and metamorphic petrologist Eirini Poulaki led sketching workshops to teach viewers about the interpretation of thin sections (Credit: Tessa Peixoto & IODP).

LEFT: Scientists hosted some crewmembers in the core lab to make connections between drilling and the samples recovered (Credit: Tessa Peixoto & IODP). RIGHT: The new year's ball was dropped for the last time (Credit: Tessa Peixoto & IODP).

sterile upside down, proving it is anything but. One way she did that was to conduct six LIVES on Instagram to present an immediate look into daily life and provide a "behind the scenes" feel to the public. She also made a moving, longform video for YouTube, featuring interviews with scientists as they reflected on their careers and the importance of the *JOIDES Resolution*.

At the same time Tessa's goal was to combine science and art as a way to make science more approachable and accessible to the public. Tessa conducted two Science & Art broadcasts in which she and the metamorphic petrologist, Eirini Poulaki, guided viewers through drawing a thin section while discussing why those key features are important for scientific interpretation.

With all the joy and excitement of Expedition 402 came the understanding that it would be the penultimate expedition aboard the *JOIDES Resolution* within the International Ocean Discovery Program. Despite uncertainty surrounding the next phase of U.S.-based scientific ocean drilling, every single person involved in the expedition gave their all to ensure that the quality of work never wavered. As normal operations continued on, teams behind the scenes identified what on the ship could be removed before the last expedition, such as the New Year's ball and the radioisotope van (affectionately known as the Rad Van).

But there is still one more expedition to look forward to! Be sure to follow the *JOIDES Resolution* on social media (X, Instagram, and Facebook) to stay involved and support the scientific community as we strive to continue ocean science research!

The Expedition 402 group photo (Credit: Tiffany Liao & IODP JRSO).

In the repository...
Expedition 403: Eastern Fram Strait Paleo-Archive

Kristen St. John and Renata Giulia Lucchi,
Expedition 403 Co-Chief Scientists;
Thomas Ronge, Expedition 403 Project Manager

written by Tim Lyons, Expedition 403 Onboard Outreach Officer

The Long Road Home

What was once an endless expanse of sea is replaced by a Dutch industrial landscape that slowly trods by as the *JOIDES Resolution* (JR) makes its way back into the port of Amsterdam. Greeted by two tugboats at the mouth of Lock IJmuiden, the expedition would end the same way it began. With the North Sea to its back the large gates of the lock closed, allowing the water table to lower and match that of the 30km of canal ahead. It was a symbolic transition that meant after two months of working under the Arctic sun, Expedition 403 was coming to an end.

A crowd gathers on the picnic tables below the bridge, overlooked by the same looming windmills that hung overhead at the start of the Expedition. With every kilometer passed, the crowd grows larger until enthusiastic shouts from the dock can be heard. In a blink, the offloading process flew by, from the first mooring lines being cast to the shuffling luggage onto buses.

What made this return to port so different was there wasn't another science party waiting on that dock; instead waited a group of technicians ready to begin the process of decommissioning the vessel. All of the specialized lab equipment that has been refined expedition after expedition would have to be painstakingly removed and brought into storage. With this in mind, every step of Expedition 403, from the arrival of the last core on deck to the serving of the last lava cake, was infused with significance.

For a program that has devoted so much time and so many resources toward looking into the past, the vision of both the expedition and extended groups of people that made it possible remained dutifully upon the future. As a high-recovery cruise, over 5 kilometers of sediment cores were successfully retrieved, and upon reading this, they will have already arrived safely to their final resting place at the University of Bremen's core repository. The samples will serve as a source of analysis to better understand the complex inner workings of the Arctic for decades to come.

Science Objectives

Led by Renata Giulia Lucchi (National Institute of Oceanography and Applied Geophysics-OGS) and Kristen St. John (James Madison University), Expedition 403 was focused on achieving three primary objectives:

- to reconstruct the West Spitsbergen Current variability transporting warm North Atlantic Water to the Arctic Ocean,
- to understand the influence of oceanic water patterns on climate changes particularly during key climate transitions (late Miocene–Pliocene transition, late Pliocene–Pleistocene transition, MPT, mid-Brunhes transition, and suborbital Heinrich-like events),
- and, to measure the impact this exchange has on the Arctic glaciations, ice shelf development and stability, and sea ice distribution.

High-resolution, continuous, and undisturbed sedimentary sequences are the only method available for attaining the information required for meeting the stated objectives. After two months at sea, samples at the selected drill sites along the Vestnesa Ridge, the Svyatogor Ridge, the Bellsund Drift, and the Isfjorden Drift were successfully retrieved. This data will be valuable for ground-truthing climate models of projected future CO_2, temperature, and ice sheet stability.

With every new batch of core to arrive on the sample table from below the seafloor, members of the science party would swarm around to see what distinguishing features could help solve the puzzle of the when and what they were looking at. The silty clay/clayey silt, sandy mud intervals, various amounts of evidence of bioturbation, and the occasional mixture of dropstones all provided useful hints. Excitement continually came from being the first humans to see the sediments since they originally came to rest on the seafloor. Co-chief Renata Giulia Lucchi described the experience as feeling like visiting another planet for the first time. Our planet's climate has changed so much throughout its history that if we were to go back in time far enough, what we would find would be a place that is completely unrecognizable. Perhaps the projection of visiting another planet is appropriate.

This glimpse into the Eastern Fram Strait's history will help fill in knowledge gaps and provide higher-resolution views of the region's past. Through a better understanding of the formation and history of the West Spitsbergen Current, researchers can gain a deeper understanding of the role it plays in bringing heat, moisture, and salt into the Arctic Region. Equally as important is the modality of decay of a former ice sheet that covered Svalbard and the Barents Sea roughly 21,000 years ago. The ice sheet is considered

the best available analog to the modern, marine-based West Antarctic Ice Sheet (WAIS), which poses a significant threat to sea level rise, if warming global temperatures lead to significant melting.

Considered a "sentinel of climate change," the area around Svalbard is very sensitive to climatic variability. The samples retrieved on Expedition 403 will provide a clearer view of that "sentinel" and, in doing so, help guard us against changes to come, whether that be a warming Arctic or rising seas.

Outreach

Like the core samples safely stored in Bremen the outreach efforts of this Expedition were primarily focused on capturing history with the future in mind. Although typical outreach objectives were achieved in the form of a YouTube web series, multiple magazine articles, blogposts, and social media posts, a vast majority of the focus was put onto shooting a feature length documentary on the subject of paleoclimate research and its methods.

Every working member of the Expedition went above and beyond to assist in reaching this goal. These efforts included allowing time for in-depth interviews, a continuous exchange to keep the representation of the science accurate, and, above all, unprecedented access to the vessel while in action. One example of this was an exciting perspective directly above the moon pool taken while a free fall funnel was dropped into place. This was achieved through the mounting of a cinema camera to an extended crane above the funnel as it was released into the pool. The resulting drop had the splash land squarely in the center of the frame, paying homage to the compositional style of science fiction films taking place in space.

Unique angles can be exciting, but the goal was to capture the amount of coordinated work that goes into a single expedition. The Arctic Ocean provided a surreal backdrop to tell this larger story, and with the help of everyone onboard, over 40 terabytes of footage successfully made it home. Like with the core samples now safely in Bremen, the hope is that this story will provide inspiration for future scientists for decades to come.

Image credits:

(1) Tim Lyons & IODP
(2) Tim Lyons & IODP
(3) Thomas Ronge, IODP JRSO
(4) Chris Lyons & IODP

In the repository...

JR Academy Expedition 402T: From Fire to Flood

written by Clarene Davis, JR Academy 2024 participant

In the heart of Earth's embrace,
Where time is carved in stone,
JR Academy's young minds roam,
With geology's secrets to own.
Indigenous scientists,
Guardians of ancient lore,
Unravel Earth's mysteries,
As they've done before.
With hands that touch the soil,
Feeling stories untold,
They listen to the whispers of legends manifold.
From mountains high to rivers deep,
They trace the land's design,
Honoring indigenous wisdom,
A heritage divine.
Each rock a tale,
Each fossil a song,
Passed down through generations,
Where ancestors belong.
Their knowledge intertwined with Earth's rhythmic flow,
Guiding young geologists as they learn and grow.
In JR Academy's halls, diversity blooms,
Celebrating indigenous brilliance,
Dispelling old glooms.
For science knows no borders,
no cultural divide,
It's a tapestry of voices,
In which we all confide.
So let's cherish the geologists,
Both young and old,
Who walk in harmony with nature,
Their stories yet untold.
For in JR Academy's realm,
Geology's dance is grand,
Where indigenous knowledge and science hand in hand.

Creative COREner...
The journey of Patrick the Safety Penguin

written by Dr. Laura Guertin

Patrick the Safety Penguin secured for sailing (Credit: Laura Guertin & IODP, Expedition 390).

Affectionately referred to as Patrick the Safety Penguin, this (un)official mascot of the scientific research vessel *JOIDES Resolution* has been spotted at the base of the gangway while the ship is docked in ports around the globe. While the ship is underway, Patrick is safely tucked away and secured on the level above the Bridge Deck. Many selfies have been taken with Patrick, and just the mention of this penguin dressed in his nautical uniform brings a smile to the faces of those that have met him. But where did Patrick come from, and how did he get the opportunity to have a permanent berth* on the JR? *(*a berth with fresh air and an amazing view, no less!)*

This story begins in 2013, when *JOIDES Resolution* was transiting from Balboa, Panama, to Victoria, British Columbia (IODP Expedition 341T Transit). The JR departed Panama on February 12 and arrived in Canada on March 4. The ship remained in port until May 19, when it spent nine days at sea for Expedition 341S (SCIMPI & 858G CORK).

Victoria is the home to The Maritime Museum of British Columbia. Opening in 1955, the museum has a mission to "engage communities in witnessing and preserving maritime heritages." Since 2004, the museum has held an Annual Massive Marine Garage Sale as a fundraiser to support museum programming, exhibits, maintenance, and a variety of other projects. In 2013, the Garage Sale was held in the Pier A warehouse building at Ogden Point (the cruise ship terminal) on April 20, from 9AM to 1PM. Admission to the event was $5, and the prior year's Garage Sale had brought in $12,000 for the museum.

So what could one find at this event in 2013, the 10th annual museum fundraiser?

To learn more and find out how Patrick became a JR fixture, read the rest of the story on Dr. G's blog!

Google placemark at Pier A warehouse building at Ogden Point, Victoria, BC (Credit: Google Earth).

Creative COREner...
1000 Years

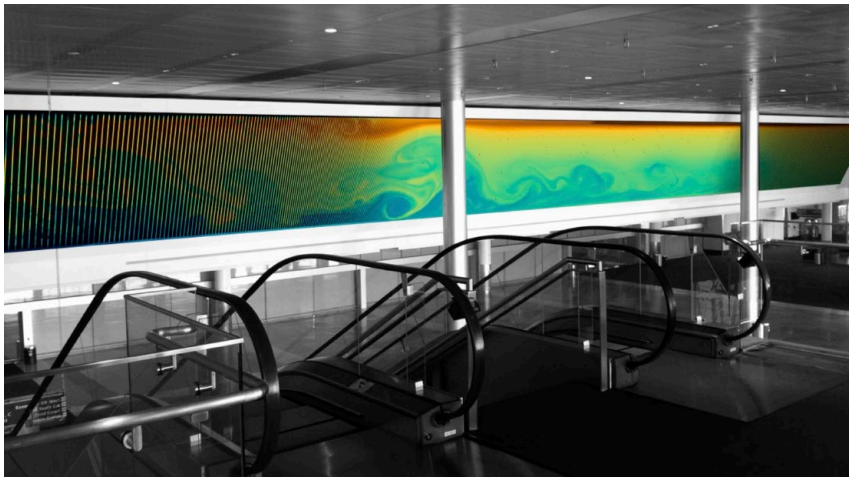
written by W. Benjamin Bray

Our sense of the ocean is often in spatial units of measure, as we think of its vast surface and profound depth. Distances in the ocean seem greater than on land because it's so much more difficult to explore. Yet time is a more pertinent measure, as it often incurs cost, and its value to us increases as we get older. So, let's consider the ocean volume in terms of both, as a flowing system thousands of miles long, and a record of our influence a thousand years deep.

The "deep" domain of the ocean, according to many ocean scientists, is below 200m. This is the depth to which photosynthesis can be sustained - the deepest direct influence of natural illumination from the surface (the Sun). In the context of global climate, the deep ocean is the most dominant reservoir of heat on Earth, a density-driven, multi-layered network of flows connecting the polar regions. The deep ocean is essentially unfathomable, a vast common for doubt, where our relationship oscillates between rigorous debate and detached ambiguity. Like the Arctic and the Antarctic, it affects innumerable downstream climatic changes, but is far more difficult and expensive for scientists to explore and sense directly. And so, it remains a hiding place—a dark, massive, subconscious presence that lies outside the domain of what society generally perceives as under its control or as its responsibility.

Relative to human activity, however, the ocean isn't deep at all. If there were an "Anthropic Zone" in the ocean defined by the depth to which humans affect ocean chemistry and habitat, it would extend all of the way to the bottom. And because so much of the ocean is dark, we don't see the profound depths of humanity's influence. The ocean is deep relative to our knowledge of it, but also shallow relative to our influence.

The Meridional Overturning Circulation is the primary system of ocean currents spanning the entire globe, driven by temperature and salinity-dependent instabilities, and large-scale wind patterns. Cold, salty water is more dense than warm, fresh water, and when you have this vertical instability in the water column, you have overturning. This overturning flow is the strongest connection between the surface ocean and the deep ocean. A complete overturning of the Earth's oceans occurs in approximately 1000 years, the same time period over which human activity affects the Earth in the Anthropocene.



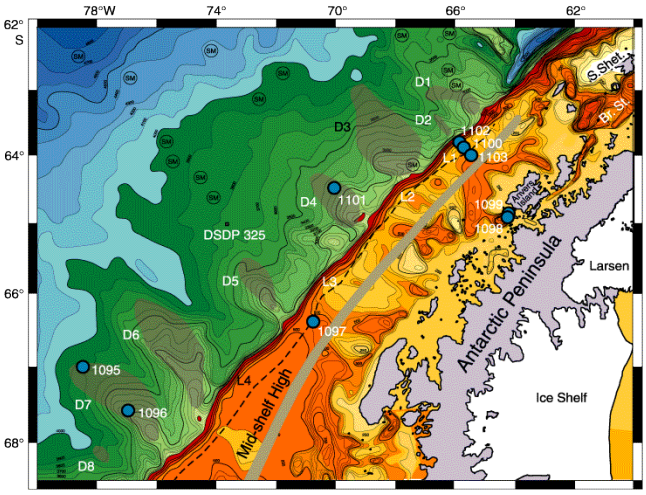
This massive display in the Boston Convention and Exhibition Center combines the flow and accumulation concepts presented in the the 1000 Years project, rendered as a 60-sec simulation (Credit: W. Benjamin Bray and Mark J. Stock).

From top: The flowing Meridional Overturning Current as three tubes, in sequential stages of flow; the 1000-year sediment core (Credit: W. Benjamin Bray).

The accompanying photos present 1000 years of overturning in borosilicate tubes 1.52m long. One tube, shown in sequential stages of flow, depicts the Meridional Overturning Circulation, with cold, downwelling seawater flowing underneath warm water full of detritus that's settling to the bottom. Melting chunks of frozen seawater dyed blue trace the downwelling, while warm espresso traces the buoyant, flowing surface current. The flowing currents mix together over 48 hours into a continuous shade of dark blue-green.

The other tube presents a sediment core: a layered collection of detritus extracted from a single location in the ocean floor. Oceanic detritus that's heavy enough and isn't recycled through ocean biochemistry eventually settles to the bottom, creating layers of sediment reflecting changes in the biogeochemical dynamics of the water column over many years. Sedimentation rates vary considerably throughout the ocean, and in the Southern Ocean just west of Palmer Land, Antarctica, the sedimentation rate is approximately 1.52mm/per year, or 1.52m per millennia, the same length as the glass tube. This sediment core was photographed by the artist at the International Ocean Drilling Program repository in College Station, TX.

These depictions of the ocean in units of time and space are easier to grasp than units of influence, because the latter is more difficult to study and understand, due to its dependence on the former. But our influence on the ocean continues to reveal itself as we collect more data beyond its darkest horizons.



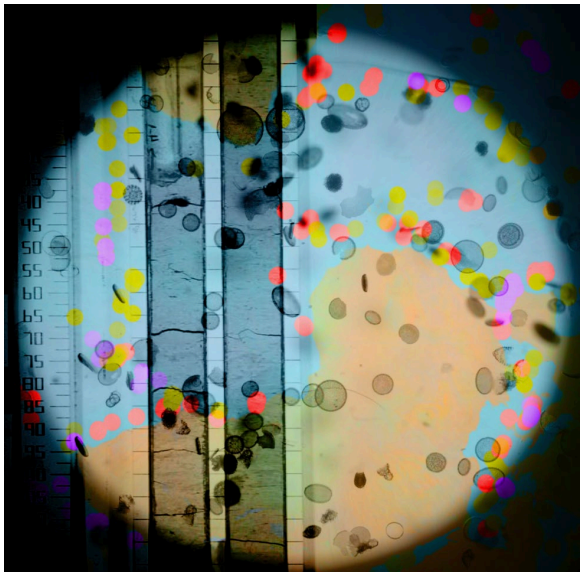
The 1000-year core was collected from Hole U1098A during Ocean Drilling Program Leg 178. This map shows sites drilled during that expedition on the Antarctic Peninsula Pacific margin, with bathymetry from Rebesco et al. (1998) and showing sediment Lobes L1-L4 on the outer continental shelf, Drifts D1-D8 on the upper continental rise, the mid-shelf high (MSH), and DSDP Site 325. Br. St. = Bransfield Strait, S. Shet = South Shetland Islands. (Credit: ODP)

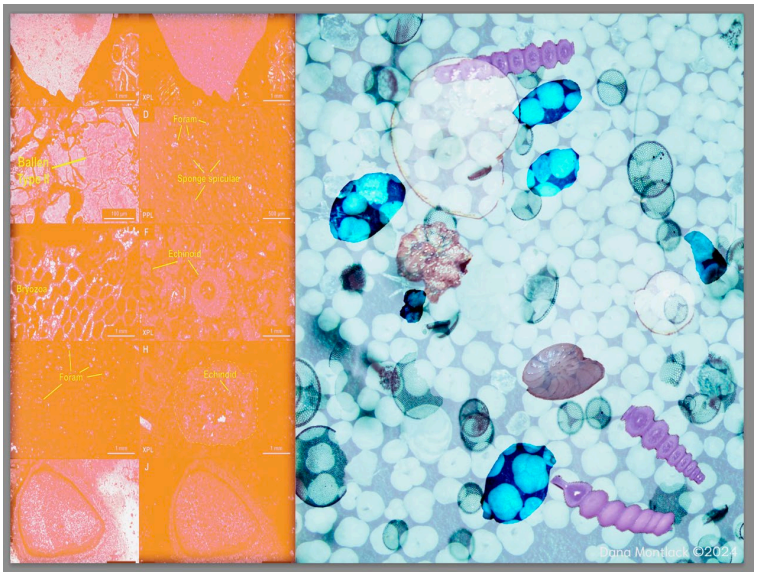
To learn more about this piece and others, visit the artist's website.

Creative COREner...

Scientific ocean drilling montages by Dana Montlack

Dana Montlack is an Interdisciplinary Biospheric Artist, researcher and educator utilizing her decades-long exploration of natural elements to bridge the worlds of art and science through a unique style of layered imagery centering on the environment. Her groundbreaking work has been exhibited in museums and galleries worldwide, as well as featured in both private and public spaces, including Burning Man Festival, Whitney Marine Biology Research Center; Atlantis The Palm, Dubai; Scripps Memorial Hospital and the Museum of Contemporary Art in San Diego. The works featured in this article were developed as the result of Dana's participation in the May 2024 School of Rock workshop. Each image is a photo montage, consisting of approximately 8-15 images incorporated into the final piece. They will eventually be printed and mounted on Aluminum, with a possible projection series. All images © Dana Montlack 2024.





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

written by Isabel Dove (University of Rhode Island)

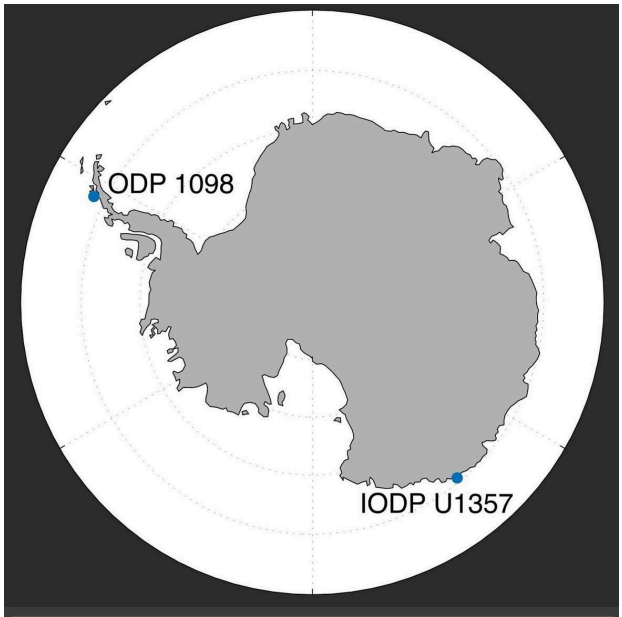
Fellow graduate students all know that hobbies are essential to coping with the rigor and stress of graduate school. My favorite hobby is knitting because I find the process meditative and the end product of a hand-made garment rewarding. Even though I started knitting as a way to relax, I sometimes 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.!

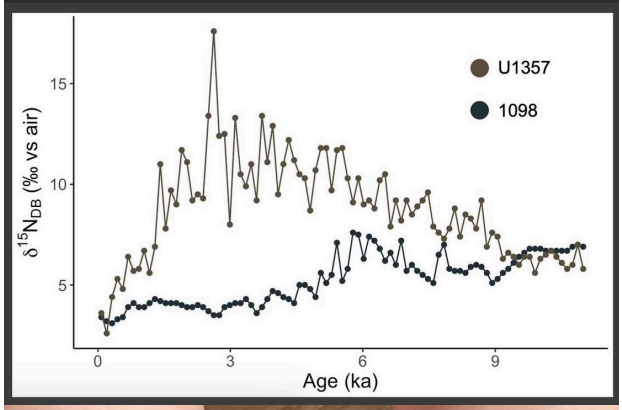
My inspiration for paleoceanography-themed knits stems from two science communication initiatives: Warming Stripes and the Tempestry Project. Warming Stripes, a concept by climate scientist Ed Hawkins, uses color to represent temperature changes over time. The Tempestry Project similarly uses color to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

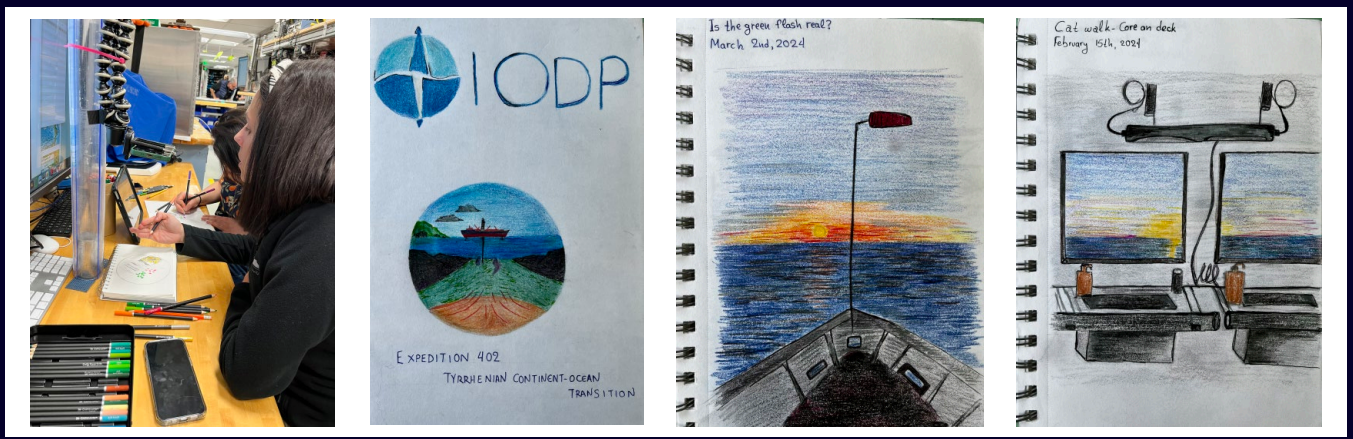
Next, I assigned a color to each row based on the $\delta^{15}N_{DB}$ value for each point. In a nod to the ocean, I chose a color scheme of blues and greys. I assigned the lightest color to the lowest $\delta^{15}N_{DB}$ values, indicating less nutrient utilization, and the darkest color to the highest $\delta^{15}N_{DB}$ 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.

Creative COREner

Illustrations of Expedition 401

Kellan Moss, who acted as an Onboard Outreach Officer during IODP Expedition 401, is a freelance visual artist and science illustrator. This project for Expedition 401 showcases the various science done aboard the *JOIDES Resolution* and the journey the scientists go through during their two month cruise.



Expedition 402 Sketch Diary

Eirini Poulaki sailed aboard the *JOIDES Resolution* as a metamorphic petrologist for Expedition 402: Tyrrhenian Continent-Ocean Transition. Here you can read about the ways in which she finds that the creative process makes her a better scientist, and explore the colored pencil sketches she drew while at sea.

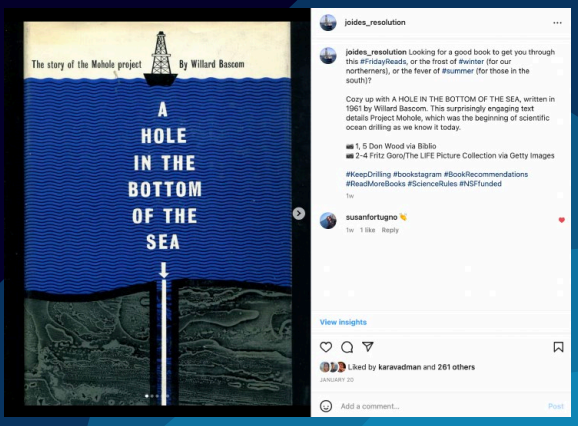
Call for contributions

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 decorated 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 have 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 the 20th of the month to be featured in the next issue.

Find us on the web!



You don't need to wait for next month's newsletter to keep up-to-date with our adventures in science! We update our blog and social media regularly. Get involved, and stay in touch!

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