Spring 2020

Ocean Discovery

In This Issue

Cover photo: *JOIDES Resolution* in dry dock in Amsterdam
Credit: Heather Barnes, JRSO

Opposite: *JOIDES Resolution* in dry dock in Amsterdam
Neil Craig, Siem Personnel

The International Ocean Discovery Program (IODP) is an international research collaboration among roughly two dozen countries to advance scientific understanding of the Earth through drilling, coring, and monitoring the subseafloor. The U.S. Science Support Program (USSSP) supports the involvement of the U.S. scientific community in IODP and is funded by the U.S. National Science Foundation (NSF). IODP utilizes multiple drilling platforms to carry out its missions: the riserless *JOIDES Resolution*, managed by Texas A&M University; the riser-equipped *Chikyu*, operated by the Institute for Marine-Earth Exploration and Engineering (MarE^3), a subdivision of the Japan Agency for Marine-Earth Science and Technology (JAMSTEC); and various mission-specific platforms operated by the British Geological Survey on behalf of the European Consortium for Ocean Research Drilling (ECORD). For more information, visit: www.iodp.org.

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For more information about USSSP, visit: usoceandiscovery.org/what-is-usssp

Letter from the USAC Chair

Dear U.S. IODP community members,

As we continue to deal with the challenges related to COVID-19, it is sometimes easy to get lost in our own affairs and not engage on the same level as we normally do; however, please be assured that the IODP panel structure, ship operators, and Program Member Offices are fully functional and committed to supporting the program through this period. The advisory panels are communicating remotely and planning for virtual meetings. As you may imagine, this planning can be very challenging given the international membership, but they are coming up with creative strategies to make it work.

The U.S. Science Support Program (USSSP) staff, while working remotely, are maintaining all their core responsibilities, including administration of subawards. U.S. Advisory Committee for Scientific Ocean Drilling (USAC) subcommittees have been active in staffing upcoming expeditions, reviewing workshop and pre-drilling activity proposals, and selecting onboard outreach candidates. Planning for an outreach and education workshop is ongoing, but the timing and format of this activity are still being discussed. The full USAC panel will be holding a virtual meeting in July to accomplish all activities normally undertaken at its summer meeting, including nominations for JRFB, SEP and USAC membership, and selection of presenters for the 2021-2022 Ocean Discovery Lecture Series.

As I write this, derrick repairs on the *JOIDES Resolution* were recently completed in Panama, and the ship is now in dry dock in Amsterdam, where it is undergoing replacement of its thruster seals as well as other maintenance. Unfortunately, the *JOIDES Resolution* Science Operator was forced to defer implementation of Expedition 395 (Reykjanes Mantle Convection and Climate) because of international travel restrictions on the part of the European Union as well as the home countries of various crew members, but there are plans for the *JR* to perform some engineering testing in the North Atlantic in early summer. Meanwhile, the ECORD Science Operator has unfortunately just been forced to postpone MSP Expedition 377 because the combined costs for the required facilities and services were beyond its available budget. We hope this expedition will find its way back onto the schedule at some point soon.

Planning for the future of scientific ocean drilling also continues. The online review of the first draft of the 2050 Science Framework received a very positive response, signaling a clear go-ahead to the Science Framework writing team. I want to thank the 120 reviewers who submitted almost 2,000 comments. It is encouraging that about 30% of the respondents received their PhDs within the last 10 years, signaling the strength and commitment of early career scientists in support of scientific ocean drilling. The second version of the document will be posted for final community review in June and will be open for a comment period of two weeks.

I am aware that we are all experiencing personal and professional challenges related to COVID-19 to different degrees, but I hope we can continue to work together so that IODP will successfully resume its remarkable record of achievement once the crisis has passed.

Most important, please stay healthy and safe.

Sincerely,
Marta Torres

Chair, U.S. Advisory Committee for Scientific Ocean Drilling

IODP Expeditions 390 and 393: South Atlantic Transect

Rosalind Coggon, Jason Sylvan, Gail Christeson, and Damon Teagle

In 1968, Deep Sea Drilling Project (DSDP) Leg 3 spot cored a transect across the South Atlantic Ocean to demonstrate that basal sediment age, and therefore basement age, increases with distance from mid-ocean ridges (Scientific Party, 1970). These data provided definitive proof for the theory of seafloor spreading, which remains one of the major scientific achievements of the enduring international collaboration now known as the International Ocean Discovery Program (IODP). DSDP Leg 3 showed us that transects of drill holes over larger distances can provide fundamental advances to our knowledge of how the Earth functions.

However, sampling both the sediment and the underlying basaltic basement in a specific ocean region has rarely been undertaken, and the few transects completed cover relatively short intervals of Earth history (e.g., Juan de Fuca Ridge, 0–3.5 Ma [Shipboard Scientific Party, 1997; Expedition 301 Scientists, 2005; Expedition 327 Scientists, 2011] and Costa Rica Rift, 0–7 Ma [Anderson, Honnorez, Becker, et al., 1985]).

In celebration of the recent fiftieth anniversary of the achievements of DSDP Leg 3, IODP will execute a two expedition project, the South Atlantic Transect (SAT – Expeditions 390, October–December 2020, and 393, April–June 2021), that will return to the Leg 3 transect area to recover complete sedimentary sections and core the uppermost ~250 m of ocean crust at sites produced between ~7 and 61 Ma at the same segment of the western flank of the slow/intermediate-spreading Mid-Atlantic Ridge (MAR, Figure 1). The SAT is an interdisciplinary project that will quantify the timing, duration, and extent of ridge flank hydrothermal fluid-rock exchange, investigate sediment- and basement-hosted microbial community variation with substrate composition and age, and investigate the responses of Atlantic Ocean circulation patterns and Earth's climate system to rapid climate change, including elevated atmospheric CO_2 during the Cenozoic.

On average, there is a discernible conductive heat flow anomaly, interpreted to result from hydrothermal circulation, out to 65 Ma crust (e.g., Stein and Stein, 1994). However, circulation can occur in crust of all ages, with crustal age being only one of a suite of interlinked parameters influencing crustal hydrology that includes spreading rate, basement roughness, volcanic stratigraphy, and flow morphology, as well as sediment type, thickness, and completeness of basement blanketing. These parameters influence the duration, depth, and the intensity of off-axis hydrothermal fluid flow and thermal, chemical, and biological exchange.

The SAT will allow for the testing of how age along a single flow line influences basement petrology, geochemistry, and physical properties, which is critically important to our understanding of elemental fluxes in the ocean over long periods of time. Because the sites selected all originated at the same segment on the southern MAR, and the region targeted does not have unusual bathymetry or seafloor features, the results from SAT will be broadly applicable to a majority of the seafloor. Five sites will be drilled into crust of ages 7, 15, 31, 49, and 61 Ma with normal sediment thickness for their age. An additional site will be drilled into 61 Ma crust to allow for high resolution paleoceanographic sampling and to investigate the difference in crustal evolution between sites with significantly different sediment overburden (180 m and 639 m).

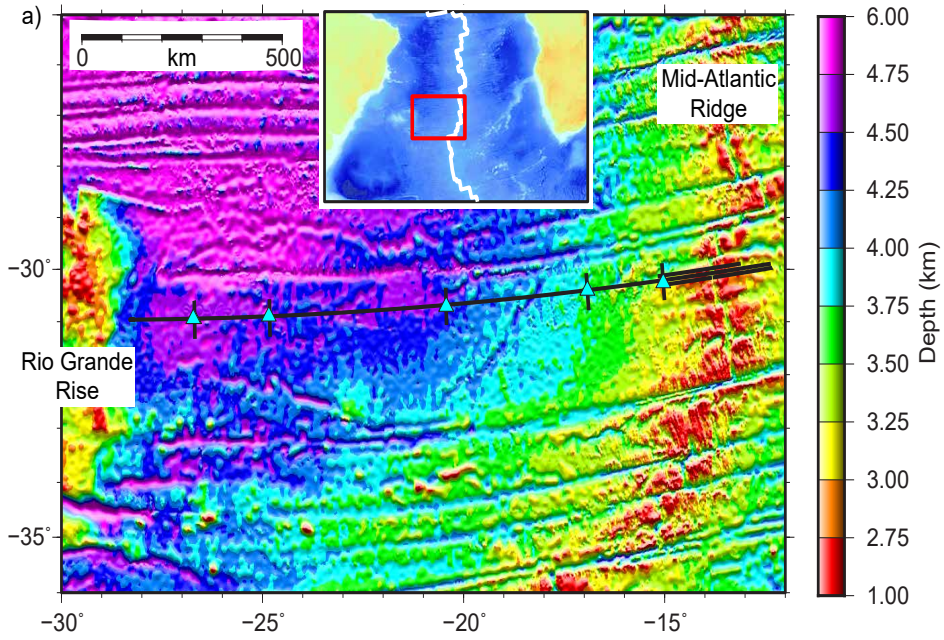

Figure 1. Topography of South Atlantic study region, with inset showing regional setting. Black lines indicate locations of site survey data, and proposed drill sites are displayed with cyan triangles.

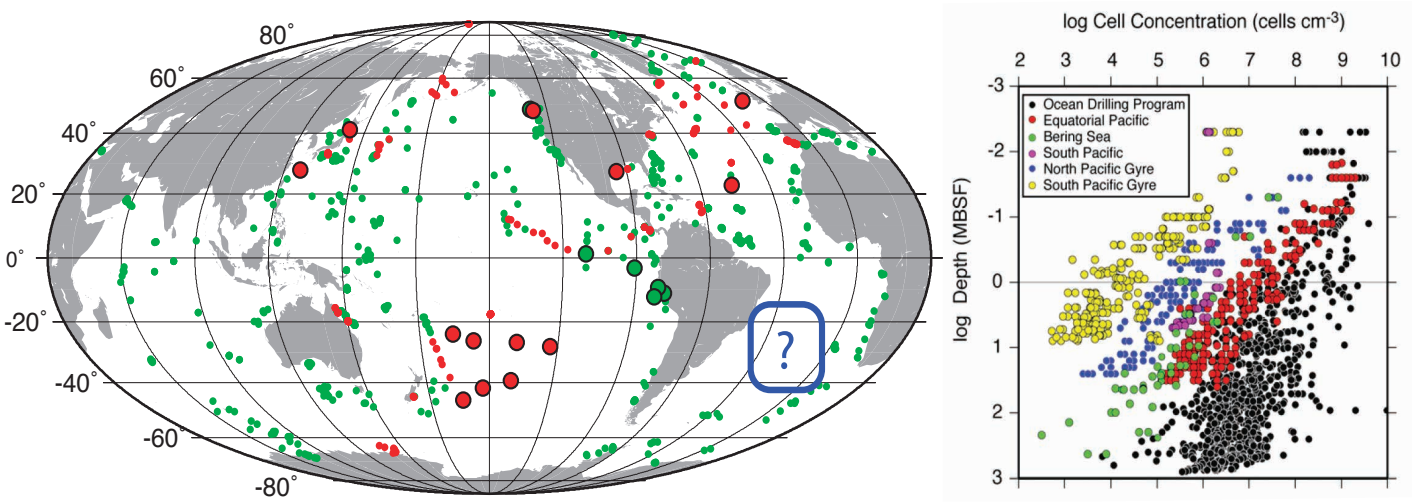

Figure 2. Left: global distribution of ODP (green circles) and IODP (red circles) drill sites. Sites where microbiological samples were taken are indicated by larger circles. Right: microbial cell abundance versus depth (meters below seafloor) at sampled sites, which reveal over five orders of magnitude of variation in biomass-depth trends, depending on the geographic origin of samples (after Kallmeyer et al., 2012; Orcutt et al., 2014). The South Atlantic represents a crucial gap in knowledge, and the sampling proposed here will be used to ground-truth models predicted from the current biomass database. Note that the symbol colors in left and right panels are not related, because these diagrams are derived from different sources.

The SAT traverses the previously unexplored sediment- and basalt-hosted deep biosphere beneath the South Atlantic Gyre from which samples are essential to refine global biomass estimates and investigate microbial ecosystems' responses to variable conditions in a low-energy gyre and aging ocean crust (Figure 2). The transect approach will allow us to investigate how aging of the ocean crust influences the composition of the crustal biosphere and the role of subseafloor microbes in biogeochemical cycles. The SAT will provide access to rich paleoceanographic records of carbonate chemistry and deep-water mass properties (e.g., temperature and composition) across the western South Atlantic. Complete sedimentary sections will allow us to study processes such as South Atlantic deepwater circulation, the Cenozoic history of the South Atlantic subtropical gyre, and intervals of climate change such as the Paleocene/Eocene thermal maximum (PETM) and the Oligocene/Miocene boundary.

IODP Expeditions 390 and 393 will address fundamental questions about the evolution of the earth, subseafloor microbiology, and paleoceanography. It is unusual and challenging for an IODP project to address so many interdisciplinary questions and to drill and core all sites through the sediments and several hundred meters into basement. We are excited to embark on the SAT and hope that it will become a prime example of how multiple disciplines can make important advances by working together on IODP expeditions.

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School children's shrunken cups from Expedition 382

2019: Onboard Outreach Program Year in Review

It was a busy and diverse year in the Onboard Outreach Program, as the U.S. Science Support Program (USSSP) recruited, selected, and supported U.S.-based Onboard Outreach Officers for *JOIDES Resolution* Expeditions 379, 382, 383, 385T, and 385, while also training the non-U.S. outreach/education officers who participated on those expeditions.

Expedition 379

Expedition 379 (Amundsen Sea West Antarctic Ice Sheet History) sailed with two Onboard Outreach Officers: Karen Romano Young (U.S.), a children's author and illustrator, informal educator, and the creator of a weekly science comic, #AntarcticLog; and Vivien Cumming (U.K.), a geologist as well as a photographer, writer, and filmmaker who tells expedition science stories in the media. Cumming had sailed previously on IODP Expedition 369. The team documented the expedition using film, photo, writing, and interviews. Media coverage included interviews with Co-Chief Scientist Karsten Gohl for German science TV Nano on 3sat, which aired in February 2019, as well as French TV. Photos, interviews, and information were provided for two German news articles and two French news articles. Three U.S. news articles arose out of the published press releases. BBC Earth Instagram published a series of photos from the expedition with an explanation of the expedition objectives; the post reached an audience of over 2.1 million viewers and was "liked" by over 40,000 people. The BBC World Service radio interviewed Co-Chief Scientist Julia Wellner.

Expedition 382

Expedition 382 (Iceberg Alley and Subantarctic Ice and Ocean Dynamics) sailed with two U.S. Outreach Officers: Marlo Garnsworthy, an author, illustrator, editor, and science communicator from the U.S./Australia; and Lee Stevens, a videographer, animator, photographer, and science communicator who works at the American Museum of Natural History. Professional development for the science team was a significant focus of this E&O team, which provided science communication and social media workshops for the scientists and technicians onboard. Garnsworthy worked with scientists as writers/bloggers through developmental editing and consultation. This cruise generated significant media attention, with 13 external newspaper and magazine articles, two TV appearances, and radio interviews. Videographer Stevens filmed and edited hours of footage for CBS's *This Morning*, interviewing Co-Chief Scientist Maureen Raymo (LDEO) for a piece featured on Earth Day, and provided footage to be used by German filmmakers MobyDok for a documentary about sea level rise featuring Co-Chief Scientist Mike Weber. Garnsworthy wrote and illustrated *Iceberg of Antarctica*, a children's book available as a free educational download from joidesresolution.org, and is writing a book for middle grades. She wrote articles for EGU Cryosphere, *Oceanbites*, and *Envirobites* and has delivered multiple post-cruise presentations and talks.

Expedition 383

Expedition 383: Dynamics of Pacific Antarctic Circumpolar Current sailed with Dr. Sian Proctor as the sole Outreach Officer. Proctor is a community college educator from Phoenix, Arizona, analog astronaut, geoscientist, and science communicator with a passion for Earth and space exploration. With a 360-degree camera in hand, Proctor's main objective was to work with Arizona State University's Center for Education through Exploration to create an inter-

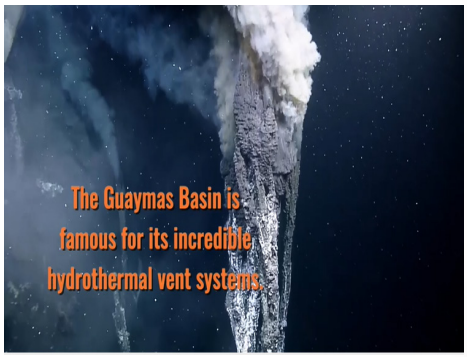
active and immersive Virtual Field Trip of the *JR* (https://aelp.smartsparrow.com/learn/open/fzmylbw2). This consists of 18 video interviews with the crew and expedition scientists. She highlighted the *JR* crew and science party members by creating 42 career profiles on the joidesresolution.org/EXP383 page. Her final cruise blog post was a comparison of what it's like to live in a Mars simulation for four months versus living on the *JOIDES Resolution* for two months. Scientist Anieke Brombacher also created the Finding Fossils: Biostratigraphy Activity, available for download. The expedition website also has a link to the Columbia University Earth Institute State of the Planet blog series, where Co-Chief Gisela Winckler and scientists Julia Gottschalk and Jenny Middleton posted articles about Expedition 383 (https://blogs.ei.columbia.edu/features/ocean-of-extremes/).

Expedition 385T

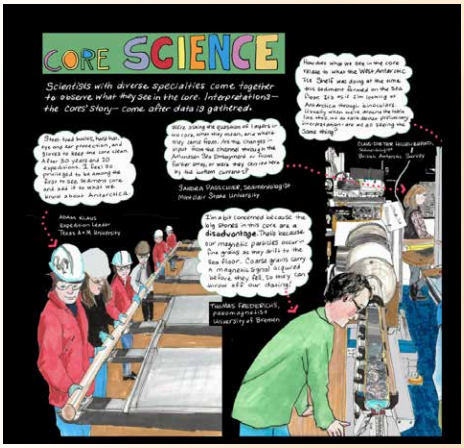
Expedition 385T included a team of 3 Onboard Outreach Officers, including Nicole Kurtz from the USSSP Office; Randi Brennon, a formal educator from Hawaii; and Kristen Weiss, a science communicator from California. All three had sailed previously and brought their experience to the special tasks of this 1-month expedition. Taking advantage of the limited science party and expedition objectives, the outreach team utilized their time onboard to review past practices and achievements of the Onboard Outreach Program and develop new strategies. In addition to this program assessment, the outreach team also supported students attending the *JR* Academy, a novel undergraduate credit program aboard the *JR*, assisting them with science communication coursework/projects. The Onboard Outreach Officers also conducted special individual projects, helped with ship-to-shore broadcasts, and contributed to social media and other content on joidesresolution.org.

Expedition 385

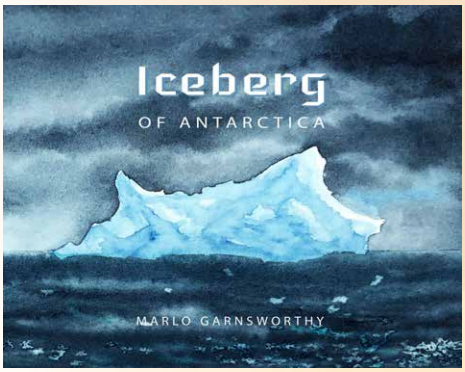
Expedition 385 (Guaymas Basin Tectonics and Biosphere) sailed with Onboard Outreach Officer Rodrigo Pérez Ortega, a bilingual science communicator and journalist. The outreach goals for this expedition included a strong focus on communities in Mexico. To accomplish this, Pérez Ortega produced a number of social media posts and a podcast episode in Spanish. He also completed thee short videos on shipboard science for social media platforms. Additional outreach efforts included an "AGU Takeover" campaign in which the *JOIDES Resolution* team posted content to the AGU account three to four times a week. Pérez Ortega and the expedition management team also partnered with the Tumble podcast. (Tumble is a podcast for children with episodes focused on scientists in the field to "understand the big picture on how science actually works.") Two members of the science party were featured in the episode.



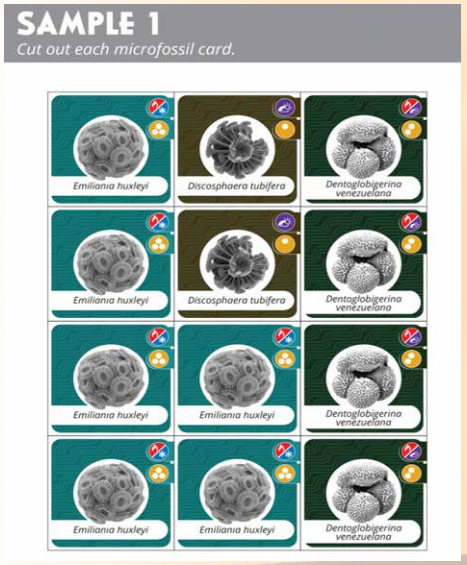
*Shot from **The Hydrothermal Vents of Guaymas Basin** video, edited by Rodrigo Pérez Ortega*



*From **Antarctic Log** comic, created by Karen Romano Young, available for download at https://joidesresolution.org/activities/antarctic-log-comic/.*



***Iceberg of Antarctica** children's book by Marlo Garnsworthy, available for download at https://joidesresolution.org/activities/iceberg-of-antarctica-book/.*



*From **Finding Fossils: Biostratigraphy Activity** by Anieke Brombacher, available for download at https://joidesresolution.org/activities/finding-fossils/.*

Expedition 378 Recovers Long-term Sedimentary Sequence from the Southern Campbell Plateau

Debbie Thomas, Ursula Röhl, Laurel Childress, and the Expedition 378 Science Party

As the world's largest ocean, the Pacific Ocean is intricately linked to major changes in the global climate system. IODP Expedition 378 was designed to reconstruct key changes in oceanic and atmospheric circulation by recovering the first comprehensive set of Paleogene sedimentary sections from a transect of sites in the South Pacific. The principal drilling targets include sediments deposited during the very warm late Paleocene and early Eocene, including the Paleocene/Eocene boundary and Eocene–Oligocene transition, to investigate how the Eocene Earth maintained high global temperatures and high heat transport to the polar regions despite receiving near-modern levels of solar energy input. Investigation of the recovered sediments will provide critical constraints on subpolar Pacific Ocean climate, oceanographic structure, and biogeochemical cycling through much of the Cenozoic, and possibly the latest Cretaceous. However, testing and evaluation of the *JOIDES Resolution* derrick in the weeks preceding the expedition determined that it would not support deployment of drill strings in excess of 2 km. Thus, during Expedition 378, we drilled one site out of the originally approved seven primary sites.

The only site occupied during Expedition 378 was Site U1553 at the location of classic DSDP Site 277. Site U1553, situated at 1221.2 m water depth, recovered the first continuously cored, multiple-hole Paleogene sedimentary section on the southern Campbell Plateau (Figure 1). The recovered sediments include multiple holes of an expanded Oligocene through Paleocene section, including most of the critical boundaries and events within the Paleogene (e.g., the Eocene-Oligocene Transition, the Mid-Eocene Climatic Optimum, the Eocene hyperthermals, and the Paleocene-Eocene Thermal Maximum). The succession provides a unique opportunity to refine and augment existing reconstructions of Paleogene climate history and will enable reconstruction of intermediate water compositions in addition to exploiting the critical contribution to the latitudinal gradient.

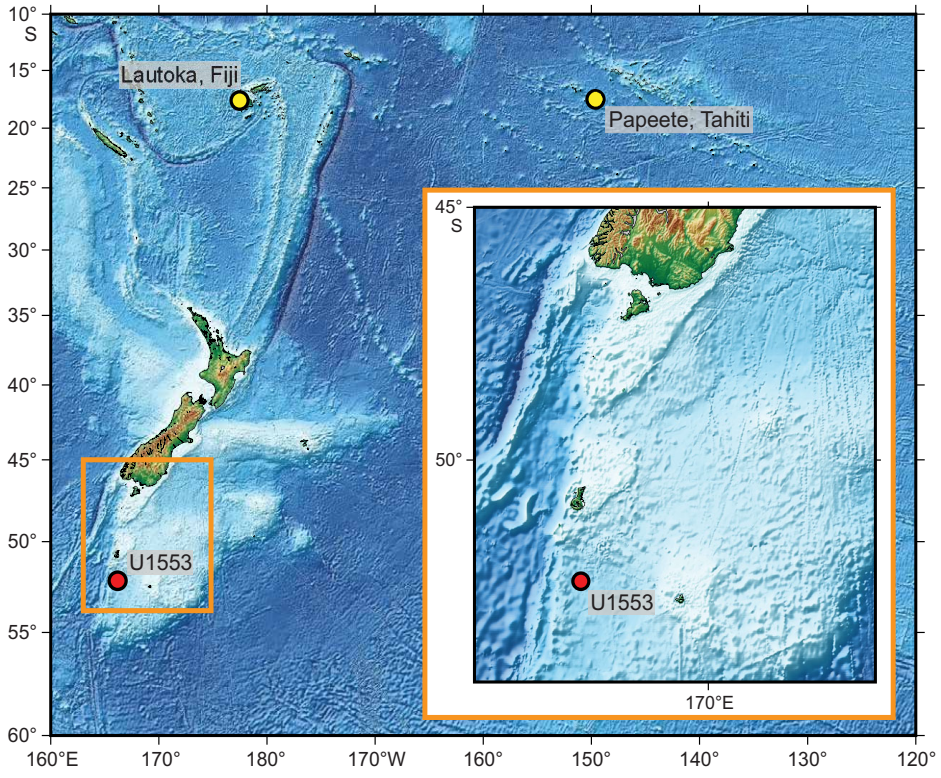


Figure 1. Map indicating the location of Expedition 378 ports and Site U1553. Figure from Thomas, D.J., Röhl, U., Childress, L.B., and the Expedition 378 Scientists, 2020.

Five holes were cored at Site U1553 according to the plan to triple core the upper portion of the sedimentary sequence using the APC/XCB drill string and then rotary core two deep holes to a maximum of 670 mbsf. Expedition 378 operations at Site U1553 reached a maximum depth of 584.3 mbsf and recovered a 581.16 m long sedimentary succession of deep-sea pelagic sediment of Pleistocene and Oligocene to early-Paleocene age from the Campbell Plateau. The recovered sections comprise five lithostratigraphic units (Figure 2). About ~4m of Plio-Pleistocene foraminifera-rich nannofossil ooze

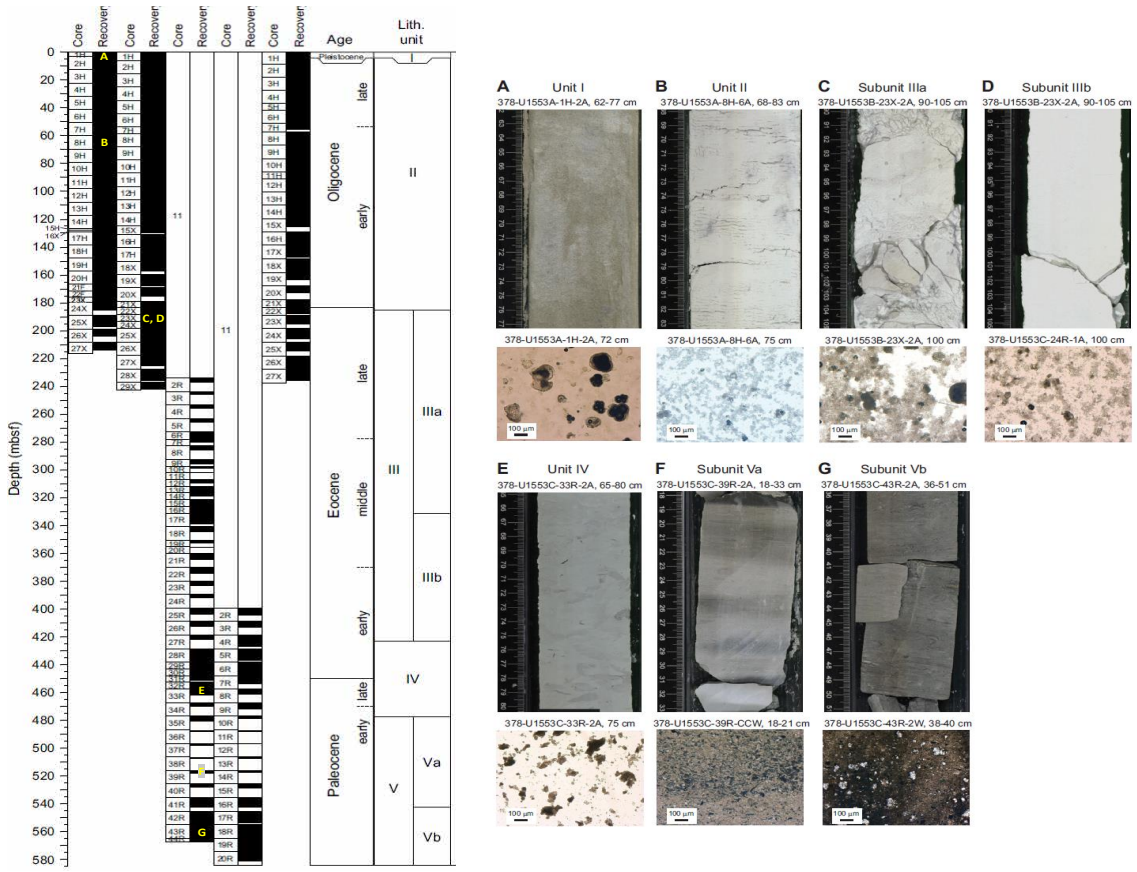


Figure 2. Lithostratigraphic summary of Site U1553 with representative photographs from each of the lithostratigraphic units. Figure modified from Thomas, D.J., Röhl, U., Childress, L.B., and the Expedition 378 Scientists, 2020.

(lithostratigraphic Unit I) overlies an expanded sequence (~200 m thick) of late Oligocene through early Oligocene nannofossil ooze with foraminifers (Unit II). The nannofossil ooze of Unit II gradually transitions into nannofossil chalk of Unit III over 50 m from ~175 to 225 mbsf. Lithification of carbonates continues downcore to result into limestone, categorized as Unit IV. Finally, the bottom ~100 m of the sediment column contains siliciclastic Unit V, characterized by alternating mudstone, sandy mudstone, and very fine to medium grained sandstone.

Apart from a thin veneer of Pleistocene sediments, the succession spans the early late Oligocene to early Paleocene, with an expanded ~250 m-thick Oligocene–late Eocene interval with good preservation of all the investigated microfossil groups (namely calcareous nannofossils, foraminifera, and radiolarians). Diatoms and sponge spicules are also abundant and well-preserved throughout this interval. The Eocene and Paleocene intervals are less expanded with more variable microfossil abundance and preservation, but biostratigraphic and lithological evidence indicates the presence of the Eocene–Oligocene transition (EOT) and Paleocene–Eocene (P/E) boundary. Low calcareous and siliceous microfossil abundance and poor preservation in the basal muddy sandstone unit (Unit V) hamper exact age determination of the basal part of the section. Much of the recovered section was characterized by a very low abundance of magnetic minerals, hence both paleomagnetic age determination and magnetic susceptibility-based correlations were difficult to perform shipboard.

Comparison of the recovery from Holes U1553A through E to the single hole drilled during DSDP Site 277 indicates the potential for substantially more complete records of the Oligocene, much of the Eocene, and much deeper into the Paleocene (Figure 3, next page). Post-cruise analyses employing state-of-the-art proxies will enable us to accomplish most of the revised science objectives, which include:

- Development of a common chronostratigraphic framework for Paleogene Southern Ocean including magnetostratigraphy, biostratigraphy, and cyclostratigraphy
- Reconstruction of surface and deep-water temperatures, as well as vertical temperature gradients through the Paleogene, with emphasis on the long-term sedimentation as well as the major events that punctuate this long-term record (EOT, Middle Eocene Climatic Optimum, Eocene Thermal Maximum events, Paleocene–Eocene Thermal Maximum, K/Pg Boundary)
- Tracking the development and variability of South Pacific intermediate-water composition and its role in overturning circulation during the Paleogene, with emphasis on refining the timing and development of the Antarctic Circumpolar Current
- Refinement of our understanding of the evolution of seawater chemistry

and reconstruction of the evolution of Paleogene wind field

- Evaluation of Paleogene biological productivity and determine nutrient exchange and mixing of surface and subsurface waters
- Investigation of potential Paleogene development of ice rafting from Antarctica
- Refinement of Paleogene Pacific plate motion

Citation

Thomas, D.J., Röhl, U., Childress, L.B., and the Expedition 378 Scientists, 2020. Expedition 378 Preliminary Report: South Pacific Paleogene Climate. International Ocean Discovery Program. http://doi.org/10.14379/iodp.pr.378.2020

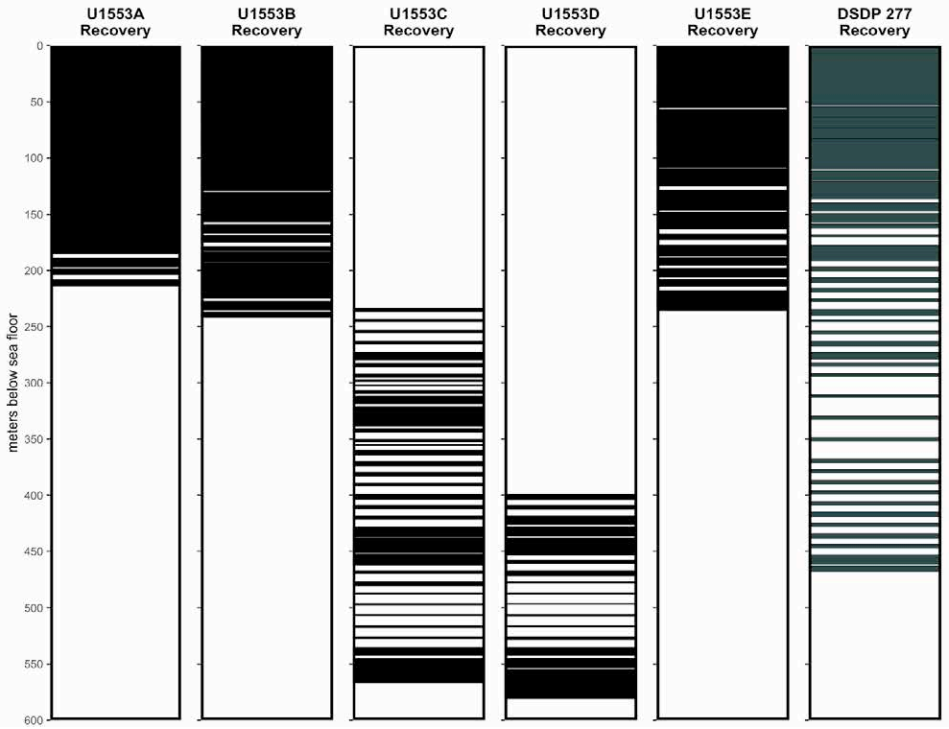


Figure 3. Figure comparing the recovery within Holes U1553A-E and that of DSDP Site 277. Figure modified from Thomas, D.J., Röhl, U., Childress, L.B., and the Expedition 378 Scientists, 2020.

Schlanger Fellows 2020-2021

Meet our 2020-2021 Schlanger Ocean Drilling Fellows! Each of the recipients will receive a $30,000 award to conduct IODP-related research during the 2020-2021 academic year. Additional information on their projects can be found at https://usoceandiscovery.org/fellowships/

Sarah McGrath

Brown University

What drives the Indian summer monsoon? New perspectives from the Bay of Bengal

Nicolette Meyer

Stanford University

Fire and famine: Controls on microbial activity in the deep hydrothermal subsurface of the Guaymas Basin

Nicholas Sullivan

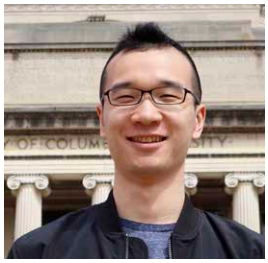
University of Wisconsin-Madison

The integration of astrochronology and constrained optimization (CONOP) to resolve the history of the Southern Ocean during the Neogene

Courtney Wagner

University of Utah

Quantifying magnetofossil assemblages: Implications for paleoecology, diagenesis, and past, present, and future global change



Yuxin Zhou

Lamont-Doherty Earth Observatory

Heinrich event ocean circulation and iceberg melting in the North Atlantic during the last glacial period

Early Career Workshop Mentors Dozens of Young Scientists

On 17 – 20 February, 2020, a USSSP-sponsored workshop on "Demystifying the IODP Proposal Process for Early Career Scientists" was held at the Lamont-Doherty Earth Observatory of Columbia University in Palisades, NY.

The workshop was organized by a team of early career researchers: Jeanine Ash (Rice University), Rocío Cabellero-Gill (George Mason and Brown Universities), Andy Fraass (Academy of Natural Sciences, Drexel University/University of Bristol), Jessica Labonté (Texas A&M University, Galveston), Chris Lowery (University of Texas, Austin), Steve Phillips (University of Texas, Austin), and Sonia Tikoo (Stanford University). This highly-motivated team worked together with a trio of experienced scientists from the IODP community—Steve Clemens (Brown University), Cecilia McHugh (Queens College), and Marta Torres (Oregon State University)—who acted as mentors, guiding and advising the organizers and participants throughout the workshop.

The goals of the workshop were to educate early career scientists about the IODP structure and proposal process and introduce them to various ways to engage in IODP science as their careers evolve. The primary activity was the development of a series of scientific drilling proposal concepts, focused geographically on the Pacific Ocean, which were reviewed by an expert panel at the conclusion of the workshop. Research concepts were generated by the participants themselves, and the top five ideas were determined by the group during the workshop. This approach allowed participants to self-select the most exciting science topics and determine which proposal team to join, but also served to build connections with new potential collaborators and colleagues for the future. Panel reviews identified strengths and weaknesses for each idea and provided advice for developing these concepts into drilling proposals.

Among the workshop participants were 20 PhD students, 13 postdoctoral researchers, 5 assistant professors, and 4 research scientists/associates/geologists. During the week, participants also heard presentations on the history and future of the drilling program, the inner workings of the IODP proposal system, and the IODP platforms and capabilities. Scientists from Lamont and other local institutions joined the mentors on a series of panels that focused on developing strong research proposals and navigating the range of challenges faced by early career researchers.

From all accounts, these early career scientists benefited from the experience in many ways and walked away with a new network of colleagues focused on marine geological research and scientific plans for the future.

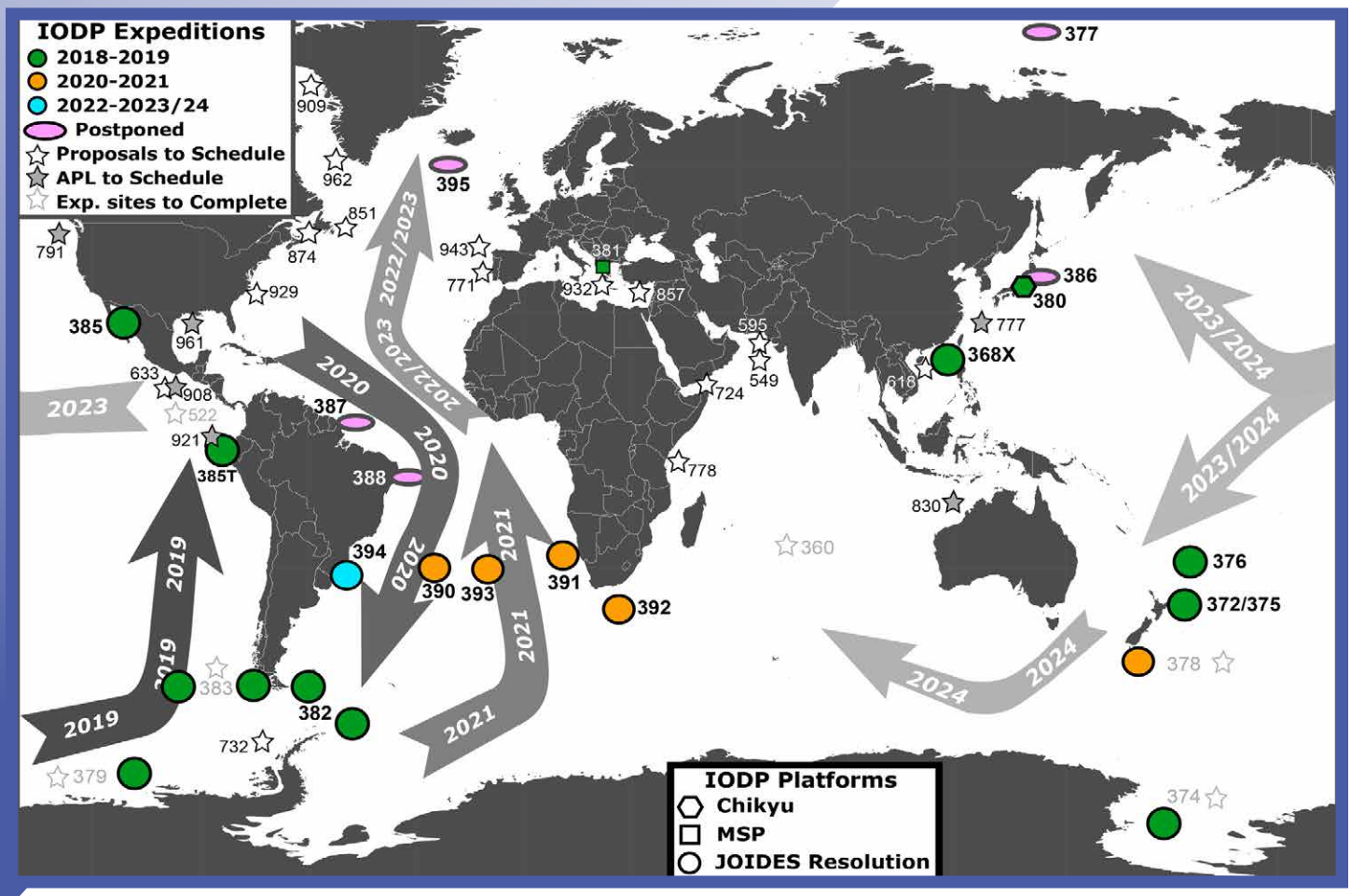
For more information about the workshop, visit https://usoceandiscovery.org/workshop-early-career-2020/. #ECRPAC2020

2020-2022 IODP EXPEDITION SCHEDULE

Platform	#	Expedition	Dates	Ports
	390	South Atlantic Transect 1	10/5/20 – 12/5/20	Rio de Janeiro, Brazil – Cape Town, South Africa
	386	Japan Trench Paleoseismology	postponed into 2021/22	Yokosuka, Japan – Yokosuka, Japan
	391	Walvis Ridge Hotspot	12/5/20 – 2/4/21	Cape Town, South Africa – Cape Town, South Africa
	392	Agulhas Plateau Cretaceous Climate	2/4/21 – 4/6/21	Cape Town, South Africa – Cape Town, South Africa
	393	South Atlantic Transect 2	4/6/21 – 6/6/21	Cape Town, South Africa – Rio de Janeiro, Brazil
	394	Rio Grande Cone Methane and Carbon Cycling	10/2/21 – 12/2/21	TBD – TBD
	377	Arctic Ocean Paleoceanography	TBD	TBD – TBD

JOIDES Resolution
Mission Specific Platform

The *JOIDES Resolution* Ship Track and Proposal Pressure at the JRFB



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