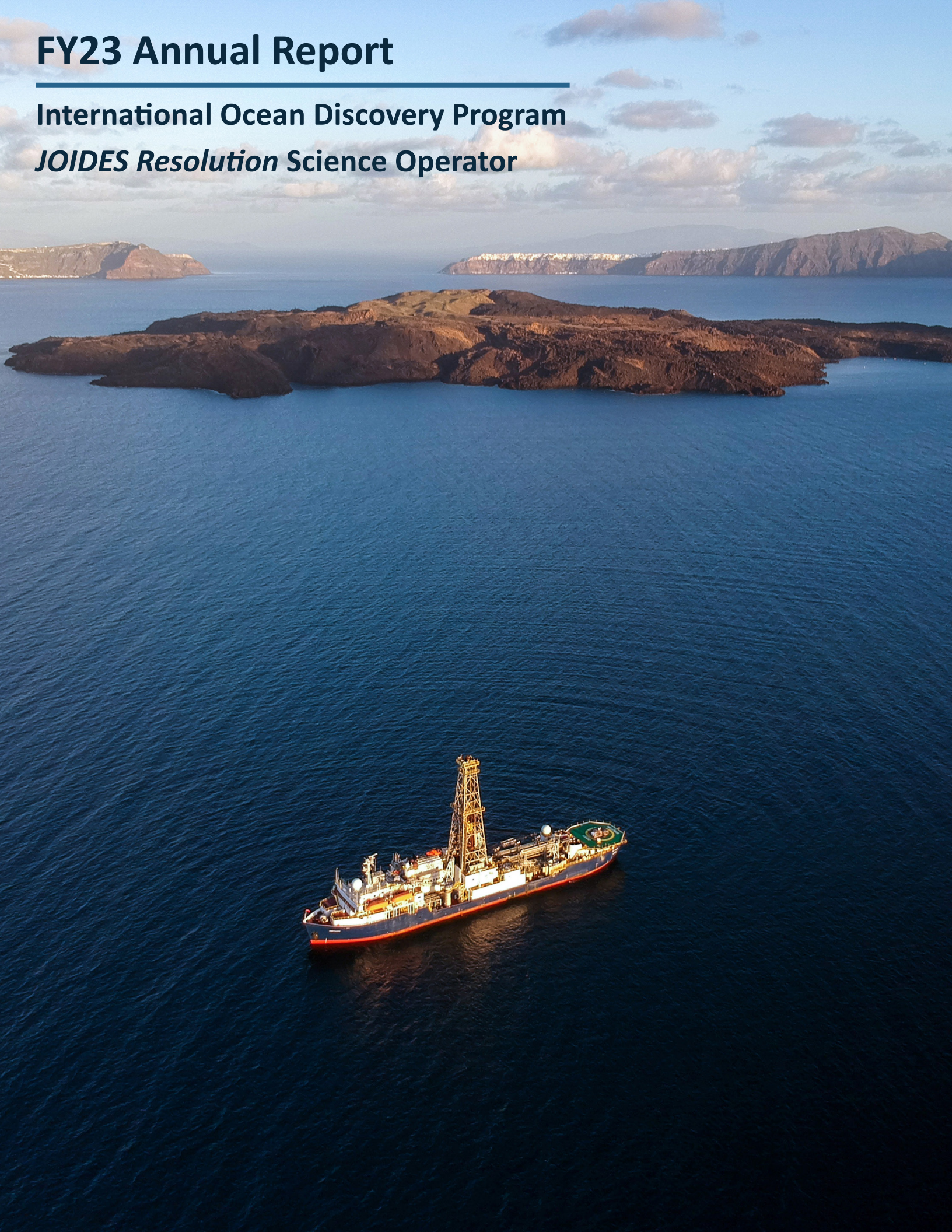
FY23 Annual Report

International Ocean Discovery Program

JOIDES Resolution Science Operator



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International Ocean Discovery Program

JOIDES Resolution Science Operator

National Science Foundation

Cooperative Agreement OCE-1326927

1 October 2022–30 September 2023

JOIDES Resolution Science Operator

IODP INTERNATIONAL OCEAN DISCOVERY PROGRAM

NSF

Publisher's notes

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Cover photograph shows an aerial view of the *JOIDES Resolution* in Santorini's caldera. Photo credit: Thomas Ronge and IODP JRSO.

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Mitch Malone

Director
International Ocean Discovery Program
***JOIDES Resolution* Science Operator**
Texas A&M University

Mitch Malone was appointed Director of the International Ocean Discovery Program at Texas A&M University in 2021. Malone began working for the Ocean Drilling Program as a Staff Scientist in 1995, and after transitioning into the Integrated Ocean Drilling Program as a Staff Scientist in 2003, he held the positions of Supervisor of Science Support (2004–2006), Manager of Science Operations (2006–2011), Acting Director (2008), and Assistant Director and Manager of Science Operations (2011–2021). During Malone's tenure, he has sailed on 10 Ocean Drilling Program and Integrated Ocean Drilling Program expeditions. Malone earned his B.A. in Geography from the University of Texas at Austin (1986) and his M.S. (1989) and Ph.D. (1995) in Geology from Duke University. He is on the Graduate Faculty at Texas A&M University in the Department of Geology and Geophysics and the Department of Oceanography. Malone was an Associate Editor of the *Journal of Sedimentary Research* from 1999 to 2004.

Gary Acton

Assistant Director and Manager of Technical & Analytical Services
International Ocean Discovery Program
***JOIDES Resolution* Science Operator**
Texas A&M University

Gary Acton was appointed Assistant Director of the International Ocean Discovery Program at Texas A&M University in 2021 and Manager of Technical and Analytical Services in 2017. Acton worked for the Ocean Drilling Program as a Staff Scientist (1995–2003), University of California-Davis as a Research Scientist (2003–2013), and Sam Houston State University as an Associate Professor at (2013–2017). He has sailed on 14 scientific coring expeditions. Acton earned his B.S. in Geology from Indiana University (1984), M.S. in Geophysics from University of Arizona (1986), and Ph.D. in Geosciences from Northwestern University (1990). He has served on the ODP Site Survey Panel, the US Advisory Committee for Scientific Ocean Drilling, and the IODP Science Evaluation Panel, and was selected as an IODP US Science Support Program Distinguished Lecturer (2014–2015). Acton served as Secretary of the Geomagnetism-Paleomagnetism Section of the American Geophysical Union from 2008 to 2010 and was elected a Geological Society of America Fellow in 2016.

Historical perspective

From October 2022 through September 2023, the international marine research collaboration called the International Ocean Discovery Program (IODP) continued to explore Earth's history and dynamics as recorded in seafloor sediments and rocks and to monitor subseafloor environments. IODP built on the earlier successes of the Deep Sea Drilling Project (DSDP), Ocean Drilling Program (ODP), and Integrated Ocean Drilling Program, which revolutionized our view of Earth's history and global processes through ocean basin exploration.

The Integrated Ocean Drilling Program and IODP expanded on the predecessor programs through the use of multiple drilling platforms operated by three implementing organizations (IOs) to achieve the Program's goals. The riserless research vessel *JOIDES Resolution*, a research facility managed for IODP by Texas A&M University (TAMU) as the *JOIDES Resolution* Science Operator (JRSO), continues to expand the global sampling coverage and disciplinary breadth that were characteristic of DSDP and ODP. The riser drilling vessel *Chikyu*, operated by Japan's Institute for Marine-Earth Exploration and Engineering (MarE3), allows extended drilling for several months at a single location. Mission-specific platforms operated by the European Consortium for Ocean Research Drilling (ECORD) Science Operator (ESO) allow drilling in environments unsuitable for either the *JOIDES Resolution* or the *Chikyu*, such as locations near the shoreline in shallow-water areas and in climatically sensitive or ice-covered regions. Consistency from one expedition to the next is ensured through provision of an Expedition Project Manager/Staff Scientist from the IO responsible for operating the expedition's platform.

Each IODP platform provider utilizes a Facility Board to make decisions on the effective use of its drilling facility in fulfilling the objectives of the IODP Science Plan, "Illuminating Earth's Past, Present, and Future," and each of the IOs provides liaisons with appropriate expertise to interact with the Facility Boards and other Program working groups and task forces. The *JOIDES Resolution* Facility Board (JRFB) is informed by advisory panels—the Science Evaluation Panel (SEP) and the Environmental Protection and Safety Panel (EPSP)—to evaluate the science, sites, environmental protection, and safety of hypothesis-driven science expedition proposals aligned with principal research themes outlined in the IODP science plan.

IODP facilities are funded by three platform providers (the US National Science Foundation [NSF], Japan's Ministry of Education, Culture, Sports, Science and Technology [MEXT], and ECORD) with financial contributions from the People's Republic of China Ministry of Science and Technology (MOST); the Australian and New Zealand IODP Consortium (ANZIC) funded by the Australian Research Council (ARC) and GNS Science (New Zealand); and the Ministry of Earth Sciences (MoES), India. Together, these agencies represent 20 participating nations whose scientists are selected to staff IODP research expeditions conducted throughout the world's oceans.

A night-time aerial view of the *JOIDES Resolution* reflecting on the Aegean Sea.

Contents

1. Executive summary

Texas A&M University (TAMU) acts as manager and science operator of the research vessel *JOIDES Resolution* as a research facility for the International Ocean Discovery Program (IODP). Administrative services in support of *JOIDES Resolution* Science Operator (JRSO) activities are provided by the Texas A&M Research Foundation (TAMRF) through the TAMU Sponsored Research Services (SRS).

JRSO scope of work

As the science operator of the *JOIDES Resolution* research facility, JRSO provides wireline coring and logging services along with technical, science, operations, engineering, and information technology (IT) support; curates core materials; develops data applications and manages digital databases; and publishes preexpedition and postexpedition reports and results. In addition, JRSO produces and publishes technical documentation and program plans, completes legacy work (e.g., producing scientific publications), conducts long-lead planning work in preparation for expeditions scheduled for future fiscal years, and provides all necessary clearances and environmental assessments for IODP expeditions conducted by JRSO. All of these Program activities are conducted in accordance with direction provided by the Program's advisory panels and the *JOIDES Resolution* Facility Board (JRFB), as outlined in approved Annual Program Plans.

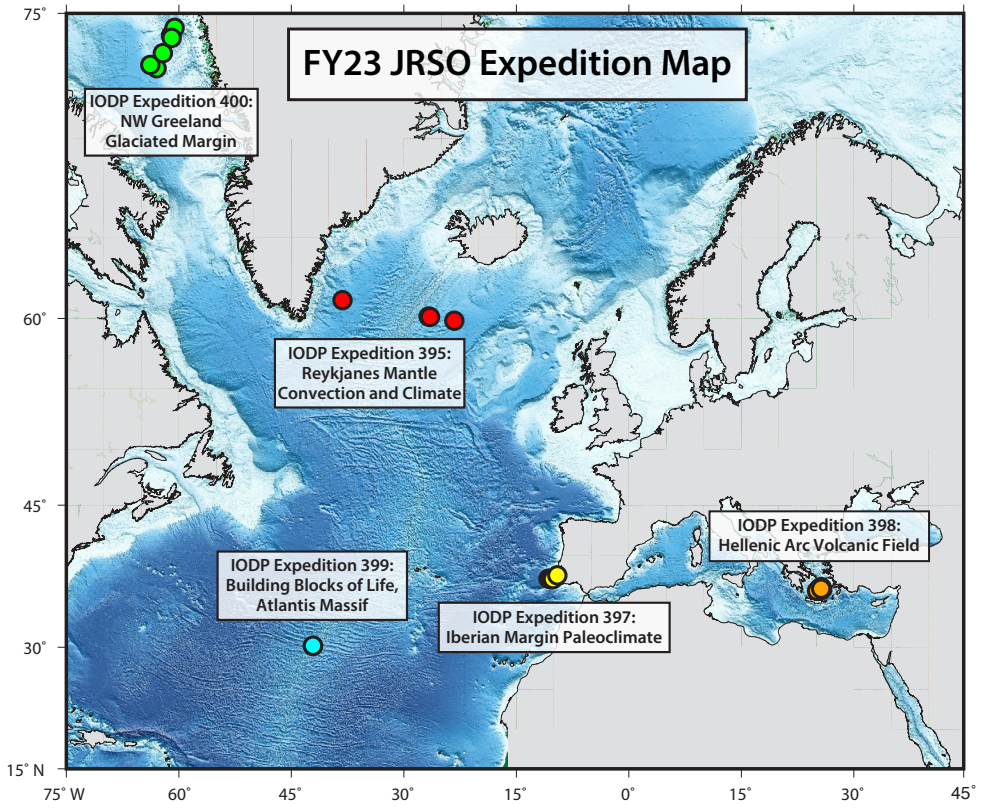
On behalf of JRSO and as outlined in this Annual Report, TAMRF contracted with ODL AS for the services of *JOIDES Resolution* and with Schlumberger Technology Corporation (Schlumberger) for the provision of downhole logging equipment and engineering support.

IODP JRSO FY23 expedition summary

Expedition	Operational days on site (days)	Distance traveled (nmi)	Sites (number)	Holes (number)	Meters cored	Meters recovered	Cores recovered (number)	Core recovery (%)	Holes logged (number)
Expedition 397: Iberian Margin Paleoclimate	51	950	4	16	5,929	6,177	495	104	3
Expedition 398: Hellenic Arc Volcanic Field	49	1,579	12	28	7,082	4,482	844	58	1
Expedition 399: Building Blocks of Life, Atlantis Massif	46	1,874	2	4	1,437	949	286	68	1
Expedition 395: Reykjanes Mantle Convection and Climate	47	2,543	4	11	5,536	3,824	532	87	2
Expedition 400: NW Greenland Glaciated Margin	42	3,663	8	15	3,987	2,299	472	58	4
Totals	**235**	**10,609**	**30**	**74**	**23,971**	**17,731**	**2,629**	**75**	**11**

Note: Operations time = time on site (does not include transits, waiting on weather, or breakdown time).

FY23 expedition sites.



FY23 overview

During fiscal year 2023, JRSO successfully completed four expeditions and most of a fifth expedition. Postexpedition research on the collected cores from the completed expeditions will improve our understanding of the relationships between volcanic activity and crustal rift pulses, millennial and orbital climate changes and their underlying causes and evolving contextuality, past and ongoing water-rock interactions, the extent and diversity of life in the subseafloor in an actively serpentinizing system, and millennial climate variability through the entire Quaternary and Pliocene.

Travel restrictions related to the novel Coronavirus Disease 2019 (COVID-19) pandemic impacted all JRSO staff, scientists, and crew. JRSO and ODL AS followed the COVID Mitigation Protocols Established for Safe JR Operations (COPE) (**https://iodp.tamu.edu/scienceops/JR_COVID-Mitigation-Protocols.pdf**) during the pandemic, and revised operations plans were developed as needed. The COPE document, which has been revised as needed since the start of the pandemic in 2020, underwent further revision this year that primarily resulted in relaxing the protocols as the pandemic transitioned to a mostly endemic phase.

This IODP JRSO FY23 Annual Report details these accomplishments and other activities undertaken in support of National Science Foundation (NSF) Cooperative Agreement OCE-1326927 during the period from 1 October 2022 through 30 September 2023.

2. Expedition operations

Expedition 397: Iberian Margin Paleoclimate

During Expedition 397 (11 October–11 December 2022), 6,176.7 m of core (104% recovery) was recovered at four sites (U1585–U1588) from the Promontorio dos Principes de Avis (PPA), a plateau located on the Portuguese continental slope that is elevated above the Tagus Abyssal Plain and isolated from the influence of turbidites. The drill sites are arranged along a bathymetric transect to intersect each of the major subsurface water masses of the eastern North Atlantic. Multiple holes were drilled at each site to ensure complete spliced composite sections, which will be further refined postcruise by a campaign of X-ray fluorescence (XRF) core scanning.

At Site U1586 (4,691 meters below sea level [mbsl]), the deepest and farthest from shore, a 350-m sequence, recovered from four holes, extends as far back as the Middle Miocene (14 Ma), which is nearly twice as old as initially predicted from seismic stratigraphy. Sedimentation rates are lower (averaging 5 cm/ky in the Quaternary) at Site U1586 than other Expedition 397 sites, and a few slumped intervals were encountered in the stratigraphic sequence. Despite these limitations, Site U1586 anchors the deep end-member of the bathymetric transect and provides an important reference section to study deep-water circulation, ventilation, and carbon storage in the deep eastern North Atlantic.

At Site U1587 (3,479 mbsl), the second deepest site along the depth transect, coring in three holes resulted in recovery of a 567 m sequence of Late Miocene to Holocene sediments that accumulated at rates between 6.5 and 11 cm/ky. The high sedimentation rates and long continuous record at this site will permit climate reconstruction at high temporal resolution (e.g., millennial) for the past 7.8 My. The complete Messinian Stage (7.246–5.333 Ma) recovered provides a valuable opportunity to study the Messinian Salinity Crisis in an open marine setting adjacent to the Mediterranean.

Site U1385 (Shackleton site) was a reoccupation of a position previously drilled during Integrated Ocean Drilling Program Expedition 339 (Mediterranean Outflow). Site U1385 has yielded a remarkable record of millennial-scale climate change for the past 1.45 My (recent to Marine Isotope Stage [MIS] 47). During Expedition 397, the site was deepened from 156 to 400 meters below seafloor (mbsf) in four new holes, extending the record to near the base of the Pliocene (4.5 Ma). Sedimentation rates remained high,

From left: Rinsing the Gran alkalinity autotitrator cell. The sky flickers with morning reds over the helideck. Cutting core into 1.5 m sections on the catwalk.

averaging between 9 and 11 cm/ky throughout the sequence. The newly recovered cores at Site U1385 will permit the study of millennial climate variability through the entire Quaternary and Pliocene, prior to the intensification of Northern Hemisphere glaciation.

Site U1588 is the shallowest (1,339 mbsl), closest to shore, and youngest site drilled during Expedition 397 and is also the one with the highest sedimentation rate (20 cm/ky). Four holes were drilled at this site, three to 350 mbsf and one to 412.5 mbsf. The base of the 412.5 m sequence is 2.2 Ma, providing an expanded Pleistocene sequence of sediment deposited under the influence of the lower core of the Mediterranean Outflow Water (MOW). Together with other Expedition 339 sites, Site U1588 will be important for determining how the depth and intensity of the MOW has varied on orbital and millennial timescales. In addition, it also provides a marine reference section for studying Quaternary climate variability at very high temporal resolution (millennial to submillennial).

Sediment at all sites shows very strong cyclicity in bulk sediment properties (color, magnetic susceptibility, and natural gamma radiation). Particularly notable are the precession cycles of the Pliocene that can be correlated peak-for-peak among sites. These cyclic variations will be used to derive an orbitally tuned timescale for Expedition 397 sites and correlate them into classic Mediterranean cyclostratigraphy.

The cores recovered during Expedition 397 will form the basis of collaborative postcruise research to produce benchmark paleoclimate records for the late Miocene through Quaternary using the widest range of proxy measurements. It will take many years to complete these analyses, but the records will lead to major advances in our understanding of millennial and orbital climate changes and their underlying causes and evolving contextuality.

Expedition 398: Hellenic Arc Volcanic Field

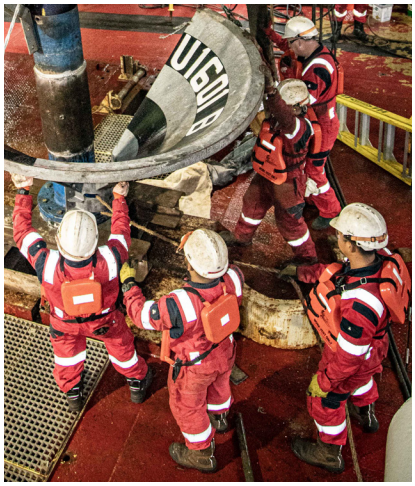
The objectives of Expedition 398 (11 December 2022–10 February 2023) were to study the volcanic record of the central Hellenic island arc; document the links and feedbacks between volcanism/magmatism, crustal tectonics, and sea level; investigate the processes and products of shallow submarine eruptions of silicic magma; and groundtruth the seismic stratigraphy of Santorini caldera. Reconstructing the subsidence history of the southern Aegean Sea and searching for deep life inside and outside of Santorini caldera were additional objectives.

From left: Core sections on the sampling table. Comparing a 3-D model of the seafloor to seismic data collected precruise.

The expedition drilled 10 primary and alternate sites that were originally proposed in addition to 2 extra sites that were requested and approved during the expedition. Outside of Santorini caldera, drilling penetrated the thick basin fills of the crustal rift system hosting the Christiana-Santorini-Kolumbo volcanic field, identifying numerous pumice and ash layers, some known from on land and others hitherto unknown, pushing back the onset of volcanism in the area into the Early Pleistocene or even Pliocene. Significant events of mass wasting into the basins, accompanied by very high sedimentation rates, were also documented. These basin sites served to groundtruth the seismic stratigraphy of the basins and to open the way to unraveling relationships between volcanic activity and crustal rift pulses. Two sites of condensed sequences on the basin margins served to sample many volcanic layers within the detailed age-depth constraints provided mainly by biostratigraphy because diagenetic effects complicated the magnetic reversal record significantly. Drilling at three basin sites northeast of Santorini penetrated the Alpine basement, whereas in the Christiana Basin to the southwest, drilling penetrated a thick sequence of evaporites from the Messinian Salinity Crisis. Drilling inside Santorini caldera penetrated to ~120 mbsf, less than planned because of hole instability issues but deep enough to groundtruth the seismic stratigraphy and to sample the different layers. One intracaldera hole yielded a detailed tephra record of the history of the Kameni Islands, as well as possible evidence for deep bacterial colonies within the caldera. Despite variable recovery in the unstable pumice and ash deposits, the expedition was a significant success that may address almost all of its science objectives once the laboratory work has been completed.

Expedition 399: Building Blocks of Life, Atlantis Massif

Expedition 399 (12 April–12 June 2023) collected new cores from the Atlantis Massif (30°N; Mid-Atlantic Ridge), an oceanic core complex that hosts the Lost City hydrothermal field (LCHF). Studies of the Atlantis Massif and the LCHF have transformed our understanding of tectonic, magmatic, hydrothermal, and microbial processes at slow-spreading ridges. The Atlantis Massif was the site of four previous expeditions (Integrated Ocean Drilling Program Expeditions 304 and 305: Oceanic Core Complex Formation, Atlantis Massif 1 and 2, Integrated Ocean Drilling Program Expedition 340T: Atlantis Massif Oceanic Core Complex, and IODP Expedition 357: Atlantis Massif Serpentinization and Life) and numerous dredging and submersible expeditions. The deepest IODP hole in young (<2 My) oceanic lithosphere, Hole U1309D, was drilled ~5 km north of the LCHF and reached 1,415 mbsf through a series of primitive gabbroic rocks. A series of 17 shallow (<16.4 mbsf) holes were also drilled at 9 sites across the south wall of


From left: Determining core splitting angle based on structures. Building a reentry cone around a short casing string. Shrunken Styrofoam cups after a trip to the seafloor.

the massif during Expedition 357, recovering heterogeneous rock types including hydrothermally altered peridotites as well as gabbroic and basaltic rocks. The hydrologic regime differs between the two locations, with a low-permeability conductive regime in Hole U1309D and a high (and possibly deep-reaching)–permeability regime along the southern wall.

Expedition 399 targeted Hole U1309D and the southern wall area to collect new data on ancient processes during deformation and alteration of detachment fault rocks. The recovered rocks and fluids are providing new insights into past and ongoing water-rock interactions, processes of mantle partial melting and gabbro emplacement, deformation over a range of temperatures, abiotic organic synthesis reactions, and the extent and diversity of life in the subseafloor in an actively serpentinizing system. Fluids were sampled and temperature was measured in Hole U1309D before it was deepened to 1,498 mbsf. The thermal structure was very similar to that measured during Expedition 340T, and lithologies were comparable to those found previously in Hole U1309D. A significant zone of cataclasis and alteration was found at 1,451–1,474 mbsf. Hole U1601C was drilled on the southern ridge close to Expedition 357 Hole M0069A, where both deformed and undeformed serpentinites had previously been recovered. Rapid drilling rates achieved a total depth of 1,267.8 mbsf through predominantly ultramafic (68%) and gabbroic (32%) rocks, far surpassing the previous drilling record in a peridotite-dominated system of 201 m. Recovery was excellent overall (71%) but particularly high in peridotite-dominated sections, where recovery regularly exceeded 90%. The recovery of sizable sections of largely intact material will provide robust constraints on the architecture and composition of the oceanic mantle lithosphere. The deepest portions of the newly drilled borehole may be beyond the known limits of life, providing the means to assess the role of biological activity across the transition from a biotic to an abiotic regime.

Borehole fluids from both holes were collected using both the Kuster Flow-Through Sampler and the new Multi-Temperature Fluid Sampler. Wireline logging in Hole U1601C provided information on downhole density and resistivity, imaged structural features, and documented fracture orientations. A reentry system was installed in Hole U1601C, and both it and Hole U1309D are open for future deep drilling, fluid sampling, and potential borehole observatories.

From left: A spectacular sunset framed by clouds. Pouring liquid nitrogen into the cryogenic container in the Paleomagnetism Laboratory.

Expedition 395: Reykjanes Mantle Convection and Climate

The intersection between the Mid-Atlantic Ridge and Iceland hotspot provides a natural laboratory where the composition and dynamics of Earth's upper mantle can be observed. Plume-ridge interaction drives variations in the melting regime, which result in a range of crustal types, including a series of V-shaped ridges (VSRs) and V-shaped troughs (VSTs) located south of Iceland. Mantle upwelling beneath Iceland dynamically supports regional bathymetry and may lead to changes in the height of oceanic gateways, which in turn control the flow of deep water on geologic timescales. Expedition 395 (12 June–12 August 2023) and IODP Expedition 395C recovered basaltic samples from crust that is blanketed by thick sediments, which also contain climatic and oceanic records from modern to earliest Oligocene/late Eocene times. Major, trace, and isotope geochemistry of basalts from this expedition provide insight into spatial and temporal variations in mantle melting processes. These samples will enable testing of the hypothesis that the Iceland plume thermally pulses on two timescales (5–10 and ~30 Ma), leading to fundamental changes in crustal architecture. This idea will be tested against alternative hypotheses involving propagating rifts and buoyant mantle upwelling.

Millennial-scale paleoclimate records are contained in the rapidly accumulated sediments of three contourite drifts cored during Expedition 395: the Gardar, Björn, and Eirik drifts. The accumulation rate of these sediments is a proxy for current strength, which is moderated by dynamic support of oceanic gateways such as the Greenland-Scotland Ridge. These sediments also provide constraints for climatic events including Miocene and Pliocene warmth, the intensification of Northern Hemisphere glaciation, and abrupt Late Pleistocene climate change.

The integrated approach of Expedition 395 allows the relationships between deep Earth processes, ocean circulation, and climate to be explored. These objectives were addressed by recovering 3,826 m of sediment and basement cores from four sites during Expedition 395 and an additional two sites that were completed during Expeditions 384 and 395C (U1555 and U1563). Two sites (U1554 and U1562) are located in the Björn drift above a VSR/VST pair, and another site targeted the Holocene–Eocene sequence of sediments at the Eirik drift, located on the eastern Greenland margin (U1602). The fourth site of Expedition 395 (U1564) is located on 32.4 My old oceanic crust that is devoid of V-shaped features and was chosen because it intersects the Holocene to Oligocene–Miocene sedimentary sequence of the Gardar drift. Downhole logging was completed at two sites. Considered together, the sediments, basalts,

From left: Paleontology sample showing an array of microfossils. Driving the core splitting saw.

and vast array of measurements collected during Expedition 395 will provide a major advance in our understanding of mantle dynamics and the linked nature of Earth's interior, oceans, and climate.

Expedition 400: NW Greenland Glaciated Margin

The NW Greenland Glaciated Margin Expedition (12 August–13 October 2023) will address current knowledge gaps in the evolution and variability of the Greenland Ice Sheet (GrIS) and its role in Earth's climate system. Understanding the long-term history of the GrIS is key to understanding Northern Hemisphere glaciation, elucidating mechanisms underlying amplification of glacial cycles since the Late Pliocene, and predicting how the GrIS will respond to modern climate warming. At the end of FY23, Expedition 400 was drilling along a transect across the northwest Greenland margin, extending from the shelf to Baffin Bay where thick Cenozoic sedimentary successions primarily reflect the evolution of the northern GrIS (NGrIS). The mission strategy is to retrieve a composite stratigraphic succession representing the Late Cenozoic era from Oligocene/Early Miocene to Holocene. The proposed drill sites specifically target high accumulation rate deposits associated with contourite drifts and potential interglacial deposits within a trough-mouth-fan system including proximal shelf deposits, all densely covered by excellent quality 2-D and 3-D seismic data.

By the end of the expedition, approximately 2,300 m of sediments were recovered across six sites. Lithologies recovered include mud, sand, and diamicton spanning the Oligocene/Early Miocene to Holocene. Downhole logging was successful at four sites.

3. Management and administration

JRSO's organizational structure directly reflects the responsibilities specified by NSF for technical and scientific management, administration, and operation of *JOIDES Resolution*, including planning, coordinating, overseeing, reviewing, and reporting activities. The TAMU portion of the organization consists of four departments: Science Operations (SciOps), Technical & Analytical Services (TAS), TAMU Technology Services (IT), and Publication Services (Pubs). Managers of these departments report to the JRSO Director, who is responsible for JRSO's overall management and performance. The Human Resources (HR) and Curation groups are part of the Director's Office. Note that IT and HR both are part of consolidated services at TAMU. Hence they have a dotted line report to the Director.

From left: Collecting a sterile sample for ancient DNA analysis. Large iceberg near Greenland illuminated by the morning sun. Sieving and washing a micropaleontology sample.

On-site administrative staff members dedicated to JRSO support are overseen by a General Manager who reports to the Executive Director of TAMU SRS. This separate reporting chain ensures that the administrative unit retains the independence to ensure regulatory compliance while working directly with JRSO staff to efficiently implement the Program. The Director's Office and the Administrative Services group combined serve as the Management and Administration group.

Reporting and liaison activities

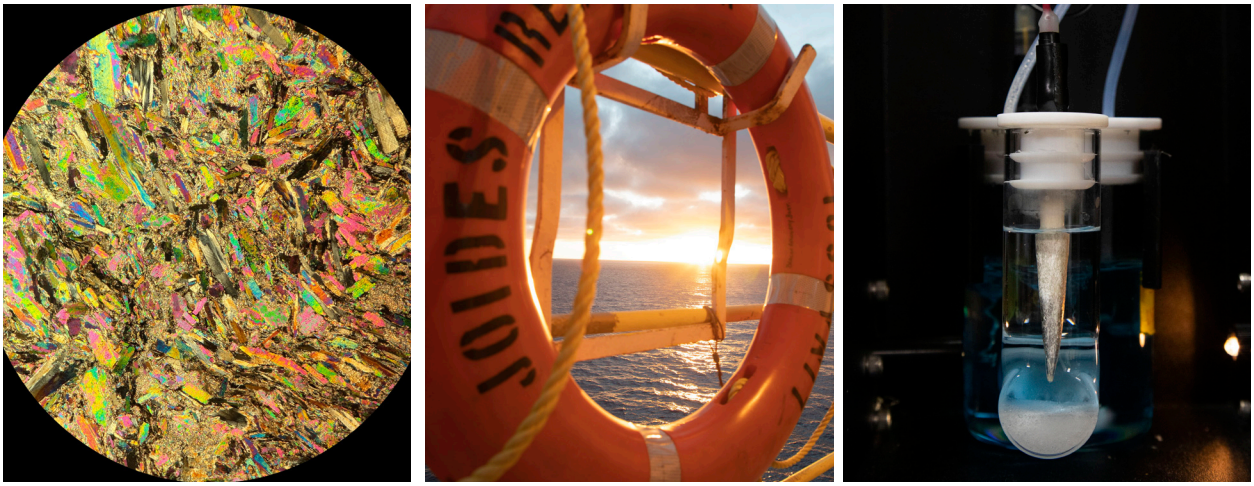
JRSO reports to and liaises with funding agencies and IODP-related agencies (e.g., JRFB, JRFB advisory panels, Program Member Offices (PMOs), and other national organizations and facility boards) and participates in facility board, advisory panel, and IODP Forum meetings. Minutes from the facility board meetings are available online (**http://iodp.org/facility-boards**).

The JRFB includes liaisons from the European Consortium for Ocean Research Drilling (ECORD) and the Institute for Marine-Earth Exploration and Engineering (MarE3), and the *Chikyu* and ECORD Facility Boards each include a JRSO liaison.

JRSO representatives participated in the Science Evaluation Panel (SEP) meetings in January and June, the annual JRFB meeting in May, the IODP Forum/PMO meeting in October, the IODP Forum meeting in April, the US Advisory Committee meeting in July, and the *Chikyu* IODP Board meeting in June.

Project portfolio management

M&A managed large cross-departmental tasks and projects through teams using a formal project portfolio management approach to identify, categorize, review, evaluate, select, and prioritize proposed projects. During FY23, JRSO staff completed the X-Ray Linescan Core Imager, Sample and Data Request Replacement, and GEODESC (core description software) projects and worked on the New Rig Instrumentation System and Hyperspectral Line Scan Logger projects. The Gulf Coast Repository (GCR) Core Storage Expansion project was canceled and was replaced by a new project to accommodate demobilized instrumentation from the ship. The Google Migration project remained on hold, and the Core Orientation project was discontinued.



From left: Thin section microscopic image under cross-polarized light showing birefringence. Sunrise viewed through a life preserver. Coulometer reaction electrochemistry cell.

4. Subcontractor activities

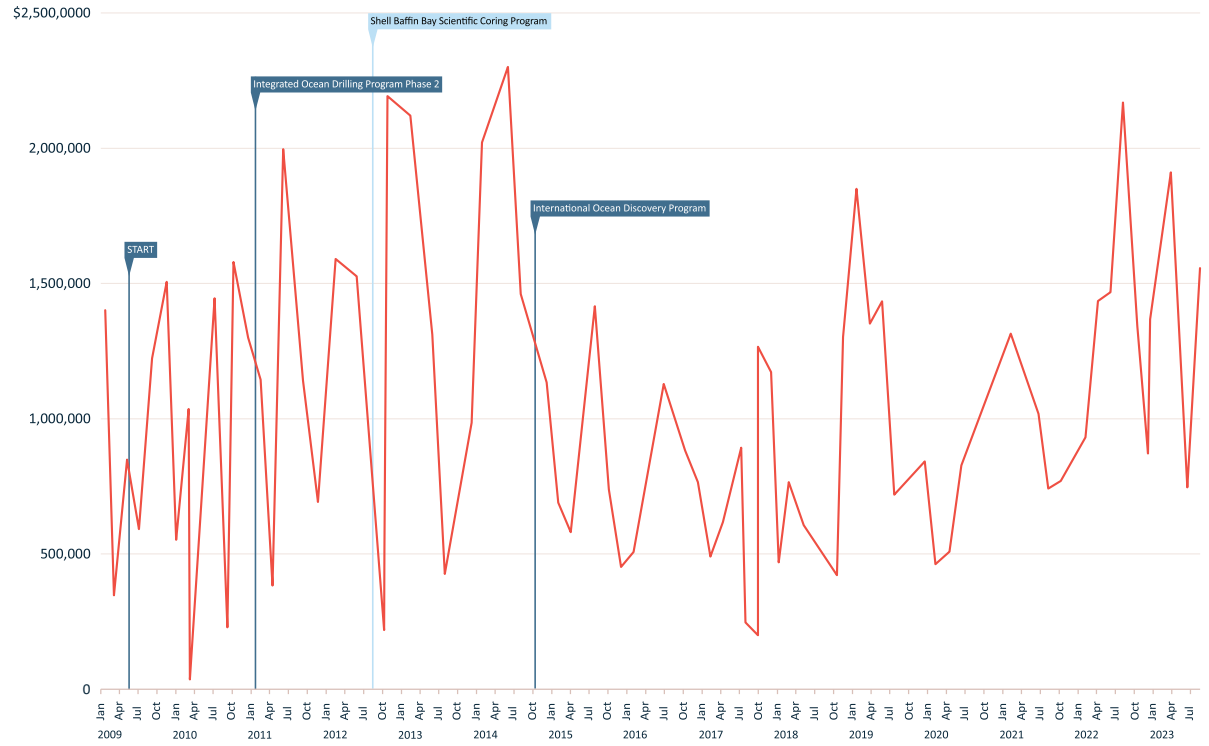
The Administrative Services department managed subcontracts with ODL AS for ship services and Schlumberger for wireline logging services. Administrative Services staff reviewed subcontractor invoices prior to payment and ensured financial compliance with cost allowability and other contractual requirements.

JRSO continued to interact with ODL AS to ensure efficient and compliant operations of *JOIDES Resolution*. JRSO management met with ODL AS frequently to discuss evolving travel/shipping restrictions as the pandemic progressed. JRSO continued to interact with Schlumberger to ensure that wireline logging operations aboard *JOIDES Resolution* continue in an efficient and compliant manner. JRSO and Schlumberger worked successfully to streamline travel, shipping, and maintenance activities. Replacement severing charges were shipped to the vessel in July, and a new high-temperature cable was installed as the primary wireline for use during Expedition 399, which sailed with an additional logging engineer so that flasked triple combo tools could be deployed if needed.

5. Science operations

The SciOps department provides scientific and operational planning and implementation for *JOIDES Resolution* drilling expeditions by leading the scoping, planning, and implementation of science expeditions; interacting with and providing technical oversight to the drilling and logging subcontractors; conducting long-range operational planning for out-year JRSO expeditions; and utilizing IODP resources to oversee engineering development projects.

Actual ship fuel costs FY09–FY23.



Expedition planning

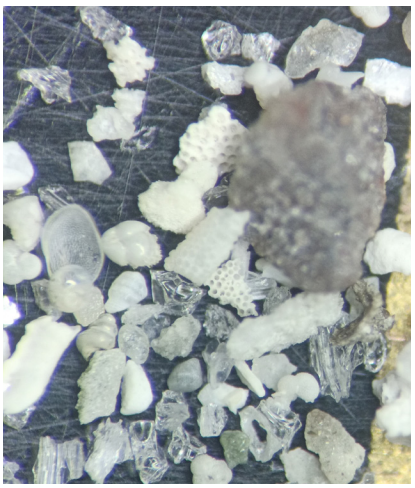
JRSO hosted preexpedition meetings in College Station, Texas, for Expeditions 401 (Mediterranean Atlantic Gateway Exchange) on 3–4 January and 403 (Eastern Fram Strait Paleo-Archive) on 13–14 March. Virtual meetings were also held between the Expedition Project Managers (EPMs), Co-Chief Scientists, curators, and technical staff to review laboratory measurements, operations plans, and sampling plans for Expeditions 399, 395, 400, 401, 402 (Tyrrhenian Continent Ocean Transition), and 403. Medical exams and precruise safety training were completed preceding all FY23 expeditions.

JRSO continued to adjust COPE based on risk and how COVID has evolved. Following the COPE protocols, the Expedition 397 science party and crew boarded the vessel on 13 October after a 4-day hotel quarantine. November, December, and January COPE revisions continued to relax the protocols in the lowest risk expeditions, and quarantine was not required after Expedition 398.

Expedition 399 engineering activities included the design and manufacturing of crossover parts for the Elevated Temperature Borehole Sensor (ETBS) downhole temperature tool. The science party boarded the vessel on 13 April. The occurrence of asbestos minerals in basement rocks during Expedition 399 resulted in a modified shipboard core flow for safety reasons. Most core description, shipboard sampling, and analyses and all personal sampling was deferred to shore.

The Expedition 395 end port was changed to Reykjavik, Iceland, because of the problematic multi-month process required to obtain Canadian visas for some crew members and staff. This resulted in a gain in operational time. The addendum to the *Scientific Prospectus* was completed and published in April. The laboratories were professionally cleaned before Expedition 395 to ensure any potential chrysotile fibers (an asbestiform mineral) from the Expedition 399 cores were removed. No fibers were identified in precleaning air and surface samples or postcleaning air samples. Replacement severing tools from Schlumberger were shipped to the vessel, and the science party boarded the vessel on 13 June.

The Expedition 400 start and end ports were changed to Reykjavik, Iceland, and the expedition was extended by 1 day to mitigate the loss of operational time. The science party boarded the vessel on 13 August. Starlink was installed on the vessel to improve satellite communications in the Baffin Bay operational area. The new Starlink service will also improve communications for Expedition 403 operations.



From left: Microfossils and other materials observed through a microscope can provide estimated ages of cores. Tugboat departing after the *JOIDES Resolution* leaves port.

The Expedition 401 science party prepared new safety packages for additional Environmental Protection and Safety Panel (EPSP) meetings that were held on 31 March and 29 September to evaluate a drill-down request, a new site request, and the risk of potential gas at some sites. Although no changes were made to the drill sites following the September meeting, the JRSO will follow a stricter gas safety protocol by measuring the gas content of the sediment as each core is collected before cutting the next core over a ~200 m interval at one of the primary sites. The Expedition 401 *Scientific Prospectus* was published in April, and a precruise workshop was held at Bristol University (England) in July for expedition scientists and IMMAGE (Land-2-Sea project) investigators.

JRSO began developing a deployment plan and sampling plan for the Kuster tool string to be deployed during Expedition 402. In preparation for the expedition, procedures on handling serpentinized rocks that may contain asbestiform minerals will be refined based on measurements that occur during handling of Expedition 399 cores at TAMU. The *Scientific Prospectus* was published in June.

The end port for Expedition 403 was changed in mid-March to Amsterdam, The Netherlands, following NSF's decision to demobilize the ship in FY24. The operations plan was adjusted accordingly, and the *Scientific Prospectus* was published in May. An Onboard Outreach Officer training program was held on 27–29 June at the GCR.

As a result of NSF's decision to end JR operations at the end of IODP and demobilize the vessel in FY24, Expedition 404 (Arctic-Atlantic Gateway Paleoclimate) was removed from the schedule as recommended by the JRFB. *JOIDES Resolution* is expected to be demobilized in Amsterdam, The Netherlands.

Expedition staffing

Science staffing was completed this year for FY23 Expedition 400 and FY24 Expeditions 401, 402, and 403. Two scientists withdrew from FY23 Expedition 395 (Reykjanes Mantle Convection and Climate), which was staffed during FY22. A Special Call was issued and three US graduate students were invited and accepted the invitation to sail. A sedimentologist for Expedition 395 was unable to sail, but the position was not restaffed because of time constraints.

Logistics support

Operational ship supplies were acquired and shipped preceding all FY23 expedition port calls.

IODP JRSO FY23 expedition science staffing breakdown

	Expedition					
Member country/consortium	**397**	**398**	**399**	**395**	**400**	**Total**
United States Science Support Program (USSSP)	11	12	13*	12*	14*	**62**
Japan Drilling Earth Science Consortium (J-DESC)	2	3	2	2	2	**11**
European Consortium for Ocean Research Drilling (ECORD) Science Support and Advisory Committee (ESSAC)	9**	9**	6*	10*	7*	**41**
IODP-China	2	2	2	1	2	**9**
Australia/New Zealand IODP Consortium (ANZIC)	1	1	1	1	1	**5**
India Ministry of Earth Science (MoES)	1	1	1	1	1	**5**
Total Science Party Participants	**26**	**28**	**25**	**27**	**27**	**133**

Notes: * = includes one Co-Chief Scientist. ** = includes two Co-Chief Scientists. Observers: 397 (1), 398 (3), 400 (1).

Clearance/Environmental permitting/Risk management

As part of the Expedition 391 (Walvis Ridge Hotspot) Marine Science Research (MSR) Clearance Application, the *Preliminary Report* for Expedition 397T (Transit and Return to Walvis Ridge Hotspot) was submitted to the US State Department in December 2022.

The Portuguese Navy requested a timetable of when *JOIDES Resolution* would occupy Expedition 397 primary Sites 14A and 04C (and alternate Sites 16B and 17A) because these are near submarine routes. In addition to providing the timetable, the expedition also reported their location to the Portuguese Navy every day. JRSO received the Portuguese authorization on 11 October.

In the latter part of Expedition 398, the Co-Chief Scientists requested the addition of three new sites. The EPSP and the TAMU Safety Panel conducted an electronic review and approved two of the sites. Shortly after, the Greek Ministry of Foreign Affairs granted permission following several communications with one of the Greek observers on board, the Manager of Science Operations, and the US Embassy in Athens. The entire process took less than 10 days.

The Expedition 399 Environmental Evaluation (EE) was approved by NSF in the first quarter.

In addition to one site in Greenland's Exclusive Economic Zone (a sovereign state of Denmark), some Expedition 395 sites were within Iceland's new Extended Continental Shelf submission. Therefore, the clearance application included both Denmark and Iceland as coastal states. The MSR application was prepared and submitted to the US State Department on 11 November. Authorization was received from Iceland and Denmark (Greenland) to conduct research in the Iceland Extended Continental Shelf and the Greenland Exclusive Economic Zone (EEZ) on 1 February and 21 March, respectively. A genetic resources application required for microbiological work in Greenland was completed and submitted in mid-June, and the application was approved by Greenland on 28 June. This requirement had not been included in the permit issued by Denmark.

The Expedition 400 MSR application was prepared and submitted to the US State Department on 21 December. Denmark (Greenland) gave authorization to conduct research in the EEZ on 9 June. The EE required for the Versatile Seismic Imager (VSI) measurements was completed and was approved by NSF on 30 May. A genetic resources application required for microbiological work in Greenland was completed and submitted in mid-June. The application was approved by Greenland on 28 June. This requirement had not been included in the permit issued by Denmark.

The Expedition 401 science party submitted several requests to EPSP to deepen some sites, drill down at some sites, and add new sites. EPSP and the TAMU Safety Panel conducted an electronic review and approved most of these requests. The expedition will take place within the Portuguese and Spanish EEZ, so the MSR with the revised sites was submitted on 4 May to Portugal, Spain, and Morocco, and the State Department submitted the Diplomatic Notes to Morocco and Portugal. Because Spain requested the vessel's flag state to submit the MSR application, the Cyprus Embassy submitted the application on behalf of the US Department of State. An environmental assessment for vertical seismic profile (VSP) operations was initiated. Clearance permits are pending from Portugal and Spain.

Expedition 402 will take place within the Italian EEZ. The MSR application was completed and submitted to the US State Department on 22 May, and the State Department submitted the Diplomatic Note to Italy. The clearance permit is pending from Italy.

The Expedition 403 Co-Chief Scientists requested to reposition one primary site in May, and the request was approved by EPSP and the TAMU Safety Panel This expedition will take place within the Norwegian

EEZ. Shipboard personnel will include two ice observers in addition to a potential observer from Norway. JRSO submitted the completed MSR application to the US State Department on 15 September. An EE will be required due to acoustic activity associated with check shot surveys and will be completed in FY24.

Postexpedition activities

JRSO hosted the following postexpedition meetings in College Station, Texas:

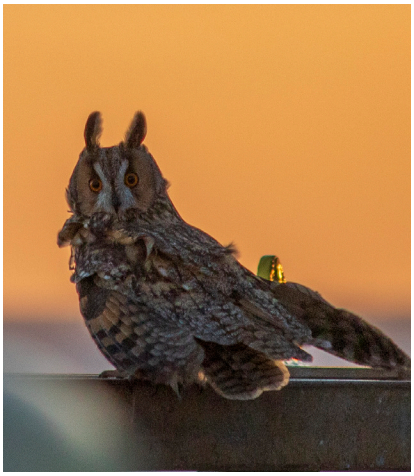
- Expeditions 390 and 393 editorial meeting and hard rock sampling party, 7–18 November
- Expedition 397 editorial meeting, 27–31 March
- Expedition 398 editorial meeting, 22–26 May

A postcruise sediment sampling party for Expeditions 390 and 393 was held 16–21 January at the Bremen Core Repository (BCR) at the University of Bremen (Germany). Shore-based sampling parties were also held at the BCR for Expeditions 397 (5–18 June) and 398 (24–30 July).

During the summer, GCR staff began preparations for Expedition 399 shore-based description and sampling. A doublewide trailer was rented and installed next to the IODP building to accommodate these activities based on recommendations from TAMU Environmental Health and Safety.

Education/Outreach support

Onboard Outreach Officers sailed during Expeditions 397, 398, 399, 395, and 400, and support was provided for social media postings, videoconferences, and other activities. Expedition 398 had an extensive outreach program that included a preexpedition "In Search of Earth's Secrets" exhibit in Santorini, Greece. In addition, while in the Santorini caldera, the ship hosted several film crews and journalists, two prominent Geology professors from Greece and the United Kingdom, the Mayor and Deputy Mayor of Santorini, and the Santorini Coast Guard Commander. At least two documentaries are being produced by Greek and German film crews. Two US Science Support Program (USSSP)–funded outreach activities were hosted on *JOIDES Resolution* during the transit and tie up. The JR Academy group joined the ship for the transit between Heraklion, Greece, and Tarragona, Spain (12–22 February), and a School of Rock group joined the ship at the Tarragona tie-up (24 February–2 March).



From left: Core-top inside core liner on the rig floor. Elevator buttons on the *JOIDES Resolution*. An owl visits the *JOIDES Resolution*.

EPMs also facilitated outreach activities for Expeditions 395, 397, 399, and 400 and contributed to IODP outreach efforts by participating in Onboard Outreach Officer training and supporting the USSSP Early Career Workshop that took place at the GCR in June. In addition, planning began for a School of Rock to be held during the Expedition 400T transit from Reykjavik, Iceland, to Amsterdam, The Netherlands, in October.

6. Technical and analytical services

The TAS department facilitates core flow and oversees laboratories. TAS stocks the shipboard laboratories; operates scientific measurement equipment and provides support to shipboard scientists; provides a supervisory and reporting structure for seagoing JRSO personnel; educates customers regarding laboratory and general shipboard safety; maintains, repairs, and develops scientific equipment at sea; provides support for downhole tools and measurements; works to ensure quality assurance/quality control of measurements made in the shipboard laboratories; and supports shore-based laboratories.

Analytical systems

The new SPECIM FX10 hyperspectral camera was returned from the vendor after repair. Different lenses and filters were purchased to try to resolve the spectral distortion at low wavelengths, but the HyperScan project team determined that the current hyperspectral camera has unacceptable noise in the 400–430 nm spectral band. Another camera from a different vendor was evaluated and selected, and research and development will resume when the new camera arrives.

Expedition 397 scientists and technicians conducted image-resolution tests on the new NanoImages scanning electron microscope–energy dispersive spectrophotometer (SEM-EDS) and found distortion to images being taken at higher than very low magnification (>2000×). Additional vibration-isolation measures were only partially effective, and the system continued to be more sensitive to the ship's motion and vibration than the older Hitachi TM-3000 SEM. Therefore, the Hitachi will remain on board to provide SEM capability while the Nanoimages system is used primarily for EDS.

The standalone X-Ray Linescan Imager (XSCAN) was installed on *JOIDES Resolution* and used during Expeditions 399, 395, and 400. The XSCAN replaces the prototype X-Ray Imager that had been in use

From left: Cutting a core into sections on the catwalk. A view of the *JOIDES Resolution*'s mast and derrick from the deck.

since 2019. Like the prototype, the XSCAN provides the fundamental 2-D X-ray images for scientists to observe structures or objects such as dropstones, lamination, shells, burrows, faults, and fractures that might aid in the interpretation of geologic processes, depositional settings, environmental conditions, alteration, and tectonics. Unlike the prototype, the XSCAN is capable of producing line-scanned X-ray images of each core section that can be viewed in the LIVE application or used for stratigraphic correlation or other analyses similar to the images produced by the Section Half Imaging Logger (SHIL). Additionally, the XSCAN source and detector can rotate around the core, providing different angular views of structures within the core sections.

Data archiving

During FY23, data from IODP Expeditions 350, 352, 354, 361, 362, 366, 368X, 369, 376, 382, 385, 392, and 396 were published in Zenodo (**https://iodp.tamu.edu/database/zenodo.html**), which is a general-purpose open-access repository operated by the European Organization for Nuclear Research (CERN). Archiving these data is part of an effort to create a long-term repository of referenceable information for all IODP expeditions, including information beyond that which is currently available online in the IODP Laboratory Information Management System (LIMS) database. The data are uploaded within the IODP community on Zenodo (**https://zenodo.org/communities/iodp**), which can also be used by the general science community to archive data collected postexpedition. Each dataset uploaded is assigned a unique DOI, allowing the data source to be tracked and cited accurately. Links to the uploaded data are provided within the associated IODP *Proceedings* volume. For example, data from Expedition 350 that have been published on Zenodo have links at **http://publications.iodp.org/proceedings/350/datasets.html**.

Laboratory working groups

The Geochemistry and Microbiology, Geology, Geophysics, and Curation and Core Handling laboratory working groups (LWGs) include technical and science staff members and external participants who review cruise evaluations, expedition technical reports, and issues management communications to develop advice on corrective actions and potential developments on *JOIDES Resolution* and on shore. The LWGs provided advice on equipment acquisition and upgrades, improvements to methodologies and measurements, improvements to laboratories, additional procedural documentation, and ongoing quality assurance work during FY23.

Shipboard laboratory support

More than 14,000 core sections were processed through the shipboard laboratories during the FY23 expeditions, and more than 55,000 samples were taken. Shipboard technical staff and expedition scientists made well over 5 million shipboard measurements on FY23 samples and placed more than 21,000 images (sections, close-ups, and microimages) in the database archive.

7. TAMU technology services

TAMU Technology Services oversees JRSO data collection/storage, management, and archiving; maintains IT infrastructure on ship and shore; develops and maintains instrument-specific software for data acquisition; and manages the Program's extensive databases.

Expedition data services and program-wide data query services

During expeditions, laboratory work aboard *JOIDES Resolution* produces a vast amount of data that are stored in LIMS. LIMS data collected during JRSO Expeditions 397, 398, 399, and 395 were successfully transferred to shore, merged with the cumulative LIMS database, and made available online to participating scientists. More than 57,444 downloads were made from the LIMS database during FY23, and more than 94,000 downloads were made from the Janus database.

Network systems operation, maintenance, and security

JRSO conducted routine system maintenance in accordance with the TAMU IT security policy and completed its annual TAMU IT risk assessment.

8. Core curation

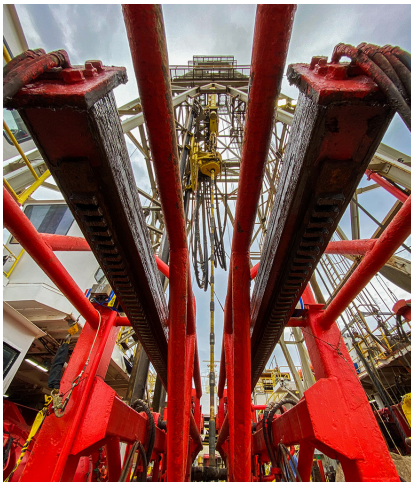
Core Curation provides services in support of IODP core sampling and curation of the core collection archived at the GCR and also supports the XRF core scanning facility at the GCR to provide scanning as Program measurements.

Sampling at the Gulf Core Repository

In FY23, the GCR processed a total of 18,779 samples. In addition, the GCR conducted sample parties for Expeditions 390 and 393 (South Atlantic Transect 1 and 2), 395C (Reykjanes Mantle Convection and Climate: Crustal Objectives), and 392 (Agulhas Plateau Cretaceous Climate), during which an additional combined total of 22,209 samples were taken. JRSO also provided curatorial support to the Bremen Core Repository (BCR) for the Expedition 397 postexpedition sampling party, during which more than 52,000 samples were collected.

Use of core collection and education and outreach activities

The GCR core collection was used for Program outreach through materials provided for display at meetings and museums, tours of the repository, and educational programs. JRSO staff gave tours of the GCR to 284 visitors, including congressional staffers, TAMU officials including the university president and



From left: A flock of seagulls catching a ride on the *JOIDES Resolution*. Upward view of the derrick, top drive, and drill string seen through the pipe stabber.

chancellor, several TAMU classes, visiting scientists, Outreach Officer training participants, a USSSP-funded Early Career workshop group, middle school students as part of the TAMU Summer Science Safari Camp, and local children related to subcontractors that fabricate materials used on the *JOIDES Resolution*. The GCR also hosted a film crew working on a documentary on the Cretaceous/Paleogene (K/Pg) extinction event and the Chicxulub impact crater.

Onshore XRF scanning

More than 3,400 core sections were XRF scanned this year, and 14 cores were processed through the shore-based Section Half Imaging Logger (SHIL).

9. Publication services

The IODP Pubs department provides publications support services for JRSO expeditions and editing, production, and graphics services for all required reports and scientific publications as defined in the JRSO cooperative agreement with NSF.

Scientific publications

IODP publications for FY23 included JRSO quarterly and annual reports, six *Scientific Prospectuses* for JRSO, ECORD Science Operator (ESO), and MarE3 expeditions, five *Preliminary Reports* for JRSO and ESO expeditions, and two *Proceedings of the International Ocean Discovery Program* volumes for JRSO Expeditions 392 and 396. IODP Pubs also coordinated postexpedition publications and published Expedition Research Results content for 10 USIO and JRSO expeditions, including 11 data reports.

Shipboard publications support and postexpedition editorial meetings

Publications Specialists sailed during JRSO expeditions to coordinate shipboard reports. During postexpedition editorial meetings, Publications staff coordinate science reviews of all expedition reports content and assist meeting participants with editing prior to publication. In FY23, JRSO staff in College Station, Texas, hosted postexpedition editorial meetings for four JRSO expeditions and one ESO expedition.

Web services

IODP Pubs hosts web services for expeditions, publications, and legacy programs. In addition to internal JRSO web page updates and additions, new content is regularly added to IODP expedition web pages at **http://iodp.tamu.edu/scienceops/expeditions.html**. All Deep Sea Drilling Project (DSDP), Ocean Drilling Program (ODP), Integrated Ocean Drilling Program, and IODP Program scientific publications are accessible online at the IODP Publications and legacy websites. Volumes are available as disk images or zip files so users can download the expedition reports portion of any IODP *Proceedings* volume. There were 363,047 visits to the IODP Publications website during FY23.

Discovery and accessibility

Metadata for IODP publications are deposited with CrossRef, an official digital object identifier (DOI) registration agency for scholarly and professional publications. Program publications accessed through CrossRef numbered 299,354 DOI resolutions for Integrated Ocean Drilling Program and IODP publications and 536,572 DOI resolutions for DSDP and ODP publications.

IODP Pubs also participates in CrossRef's cited-by linking; open reference initiative; text and data mining; ORCID, license, and funding registration; and CrossMark metadata validation services. IODP Pubs deposited 25 chapters from Integrated Ocean Drilling Program and IODP *Proceedings* volumes into ScienceOpen, a professional networking research platform for scholars and publishers. The IODP collection can be viewed at **https://www.scienceopen.com/collection/IODP_Publications**. In addition, IODP Pubs deposited more than 1,000 records from expedition-related research published in outside literature into the Scientific Ocean Drilling Expedition Research Results collection, which can be viewed at **https://www.scienceopen.com/collection/8b0582f6-47bf-4988-b90a-8533135e6fcc**.

IODP Pubs contributed publications metadata for the same Integrated Ocean Drilling Program and IODP *Proceedings* chapters to TAMU's Symplectic Elements database, which feeds data to Altmetric.com, a platform that enables monitoring of online activity surrounding academic research.

IODP Program publications are also deposited to NSF's Public Access Repository (PAR) and indexed on Google Scholar, and IODP Pubs is a member of the Committee on Publications Ethics.

Citation management

AGI database

The Scientific Ocean Drilling Bibliographic Database is a subset of the American Geosciences Institute's (AGI) GeoRef database and includes more than 40,800 entries related to IODP and the preceding scientific ocean drilling programs, representing more than 50 years of scientific ocean drilling research. In FY23, more than 4,300 queries were run on the Scientific Ocean Drilling Bibliographic Database, and additional records for more than 2,300 citations were viewed. IODP Pubs works closely with AGI to curate the bibliographic database by identifying and submitting expedition-related research publication citations.

ManTrack database

IODP Pubs tracks Integrated Ocean Drilling Program and IODP expedition-related peer-reviewed publications from journals, serial monographs, books, and theses/dissertations in an in-house database (ManTrack). ManTrack contains more than 4,000 records relating to Expeditions 301–396. This

Sun rays illuminating a silhouette of Greek islands.

database is used to generate current impact statistics for inclusion in the annual Scientific Ocean Drilling Bibliographic Database and Publications Impact Report.

IODP bibliography

Pubs maintains an EndNote library comprising more than 23,500 records including all DSDP, ODP, Integrated Ocean Drilling Program, and IODP publication citations; citations from all IODP publication reference lists; and expedition-related journal articles, theses, book chapters, and conference abstracts. The complete IODP Bibliographic EndNote library is available in Research Information Systems (RIS)–format on the IODP publications website, and customized excerpt RIS lists are available upon request.

Legacy and archiving activities

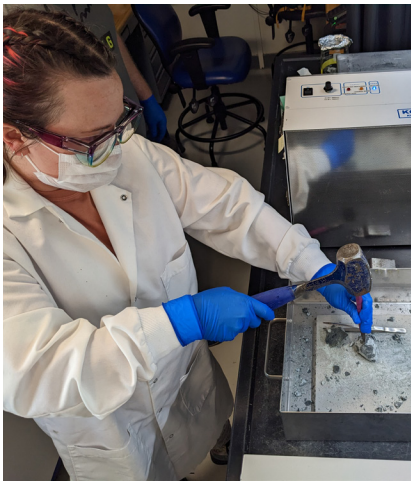
The main IODP publications website (**http://publications.iodp.org/index.html**), which includes the full content from all Integrated Ocean Drilling Program and IODP volumes, and other publications pages are archived at the Internet Archive, a long-term archive specializing in full website backups. Currently, our collection houses 2 TB of data and more than 8.5 million files.

Progress reporting

JRSO operations and management reports were submitted to NSF for the following quarters:

- Fourth quarter of FY22 (July–September 2022) on 27 October
- First quarter of FY23 (October–December 2022) on 27 January
- Second quarter of FY23 (January–March 2023) on 5 May
- Third quarter of FY23 (April–June 2023) on 29 July

All reports are available at **http://iodp.tamu.edu/publications/reports.html**.



From left: Breaking up hard rock to expose fresh surfaces for microbiological analysis. A double rainbow over the ocean after a downpour.

URL list

IODP JRSO website: **http://iodp.tamu.edu**

IODP Program Member Offices: **http://www.iodp.org/about-iodp/program-member-offices**

JOIDES Resolution Facility Board and Panels: **http://www.iodp.org/facility-boards**

IODP Science Support Office: **http://www.iodp.org/program-organization/science-support-office**

IODP JRSO FY22 Annual Program Plan: **http://iodp.tamu.edu/publications/PP/IODP_JRSO_FY22_APP.pdf**

IODP JRSO FY22 Quarterly Reports: **http://iodp.tamu.edu/publications/reports.html**

COVID Mitigation Protocols Established for Safe JR Operations (COPE): **https://iodp.tamu.edu/scienceops/JR_COVID-Mitigation-Protocols.pdf**

Illuminating Earth's Past, Present and Future: The Science Plan for the International Ocean Discovery Program 2013–2023: **http://iodp.org/about-iodp/iodp-science-plan-2013-2023**

IODP expedition schedule: **http://iodp.tamu.edu/scienceops/index.html**

IODP expedition information: **http://iodp.tamu.edu/scienceops/expeditions.html**

LIMS Reports: **https://web.iodp.tamu.edu/LORE**

IODP expedition data: **https://zenodo.org/communities/iodp**

Gulf Coast Repository: **http://iodp.tamu.edu/curation/gcr/index.html**

Core database: **http://iodp.tamu.edu/tasapps**

Sample requests: **http://iodp.tamu.edu/curation/samples.html**

IODP scientific publications and expedition-related citation lists: **http://publications.iodp.org**

Scientific Ocean Drilling Bibliographic Database: **http://iodp.americangeosciences.org/vufind**

2022 Scientific Ocean Drilling Bibliographic Database and Publication Impact Report: **http://iodp.tamu.edu/publications/AGI_studies/2022_Pub_Impact.pdf**

IODP Publications ScienceOpen page: **https://www.scienceopen.com/collection/IODP_Publications**

IODP expedition-related outside literature ScienceOpen page: **https://www.scienceopen.com/collection/8b0582f6-47bf-4988-b90a-8533135e6fcc**

IODP Publications Internet Archive collection: **https://archive-it.org/collections/9148**

DSDP digital collection: **https://babel.hathitrust.org/cgi/mb?a=listis&c=1930557976**

HathiTrust ODP digital collection: **https://babel.hathitrust.org/cgi/mb?a=listis&c=1868324439**

DSDP volumes: **http://www.deepseadrilling.org/**

ODP volumes: **http://www-odp.tamu.edu/publications/**

"Legacy" site: **http://odplegacy.org**