FY22 Annual Report

International Ocean Discovery Program

JOIDES Resolution Science Operator

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National Science Foundation

Cooperative Agreement OCE-1326927

1 October 2021–30 September 2022

JOIDES Resolution Science Operator

IODP INTERNATIONAL OCEAN DISCOVERY PROGRAM

NSF

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Cover photograph shows dawn illuminating the derrick of the *JOIDES Resolution*. Photo credit: Debadrita Jana 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 (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 2021 through September 2022, the international marine research collaboration called the International Ocean Discovery Program (IODP) continued to explore Earth's history and dynamics as recorded in subseafloor 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 characteristics 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 Interim Asian Consortium, represented by the Korea Institute of Geoscience and Mineral Resources (KIGAM); 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 21 participating nations whose scientists are selected to staff IODP research expeditions conducted throughout the world's oceans.

Full moon during transit to the first drill site.

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 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.

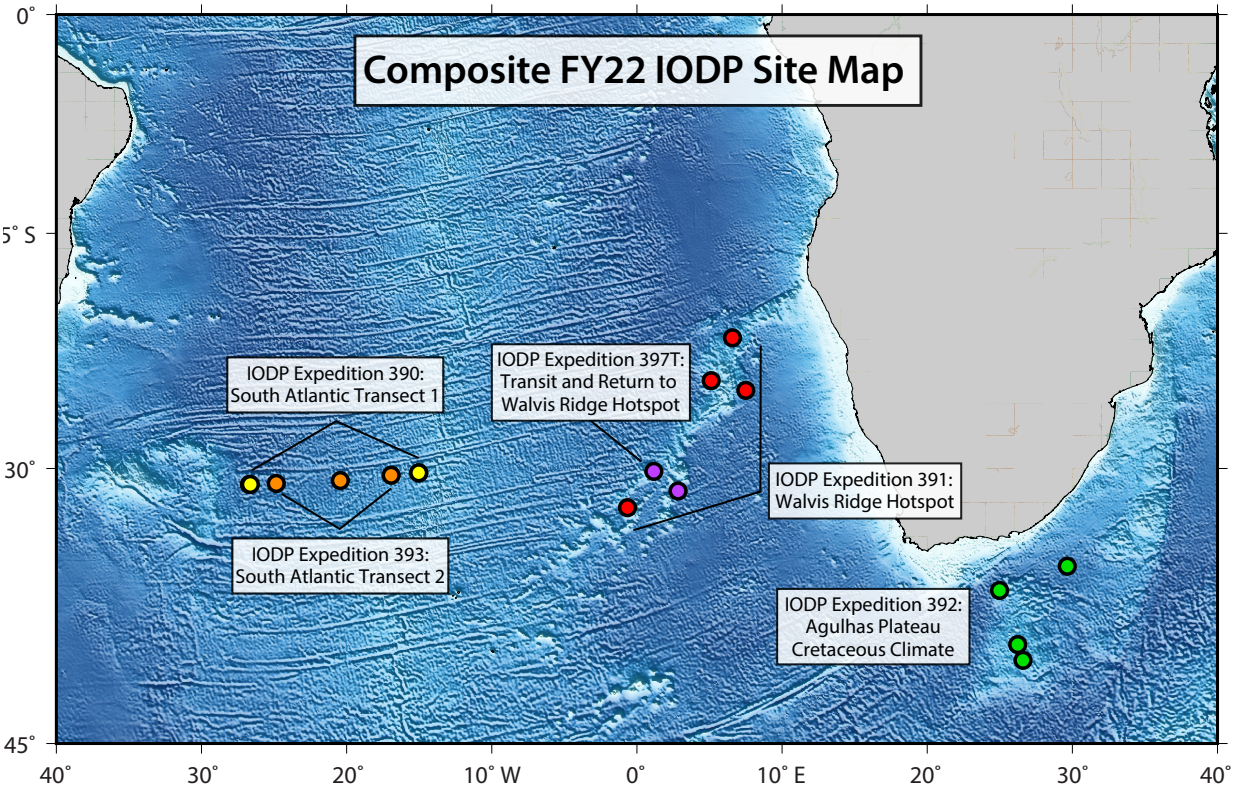
On behalf of JRSO and as outlined in this Annual Report, TAMRF contracted with ODL AS for the services of *JOIDES Resolution* and with Schlumberger Technology Corporation (Schlumberger) for the provision of downhole logging equipment and engineering support.

IODP JRSO FY22 expedition summary

Expedition	Operations time (days)	Distance traveled (nmi)	Sites (number)	Holes (number)	Meters cored	Meters recovered	Cores recovered (number)	Core recovery (%)	Holes logged (number)
Expedition 391: Walvis Ridge Hotspot	27	4,812	4	5	1,496	954	190	64	—
Expedition 392: Agulhas Plateau Cretaceous Climate	48	2,714	4	10	2,599	1,980	315	76	3
Expedition 390: South Atlantic Transect 1	30	4,624	4	7	905	700	124	77	2
Expedition 393: South Atlantic Transect 2	38	4,446	4	12	1,152	775	187	67	2
Expedition 397T: Transit and Return to Walvis Ridge Hotspot	8	5,442	2	2	431	241	46	56	—
Totals	**151**	**22,038**	**18**	**36**	**6,583**	**4,650**	**862**	**85**	**7**

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

FY22 expedition sites.



FY22 overview

During fiscal year 2022, JRSO successfully completed four expeditions and drilled two sites during a transit that a previous expedition had not been able to accommodate due to the novel Coronavirus Disease 2019 (COVID-19) complications. Postexpedition research on the collected cores from the completed expeditions will improve our understanding of the evolution and alteration of ocean crust and overlying sediment and the microbial response in these systems, the temporal and geochemical evolution of hotspots, and the paleoceanographic effects of tectonic gateway openings during a time of sustained greenhouse conditions.

Travel restrictions related to the 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) developed in 2020 for operations during the pandemic, and revised operations plans were developed as needed. The COPE document was revised this year, with improvements focusing on increasing testing frequency on board to reduce the transmission of COVID-19 during the early days of expeditions.

This IODP JRSO FY22 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 2021 through 30 September 2022.

2. Expedition operations

Expedition 391: Walvis Ridge Hotspot

Hotspot tracks provide important records of plate motions, as well as mantle geodynamics, magma flux, and mantle source compositions. The Tristan-Gough-Walvis Ridge (TGW) hotspot track, which extends from the active volcanic islands of Tristan da Cunha and Gough through a province of guyots and then along Walvis Ridge to the Etendeka flood basalt province, forms one of the most prominent and complex global hotspot tracks. The TGW hotspot track displays a tight linear age progression in which ages increase from the islands to the flood basalts (covering ~135 My). The plan for Expedition 391 was to drill at six sites, three along Walvis Ridge and three in the seamount (guyot) province, to gather igneous rocks to better understand the formation of track edifices, the temporal and geochemical evolution of the hotspot, and the variation in paleolatitudes at which the volcanic edifices formed.

After a delay of 18 days to address an outbreak of the COVID-19 virus, Expedition 391 drilled at four of the proposed sites: three sites on Valdivia Bank, an ocean plateau that comprises the northeastern part of the ridge, and one site on the lower flank of a guyot in the Center track. One hole was drilled at Site U1575, located on a low portion of the northeastern Walvis Ridge north of Valdivia Bank. At this location, 209.9 m of sediment and 122.4 m of igneous basement were cored. Two holes were drilled at Site U1576 on the west flank of Valdivia Bank, recovering a remarkable ~380 m thick sedimentary section consisting mostly of chalk covering a nearly complete sequence from Paleocene to Late Cretaceous (Campanian). These sediments display short and long cyclic color changes that imply astronomically forced and longer term paleoenvironmental changes. Coring at Site U1577, on the extreme eastern flank of Valdivia Bank, penetrated a 154 m thick sedimentary section, the bottom ~108 m of which is Maastrichtian–Campanian (possibly Santonian) chalk with vitric tephra layers. Site U1578, located on a Center track guyot, provided a long and varied igneous section, coring through 184.3 m of pelagic carbonate sediments mainly consisting of Eocene and Paleocene chalk followed by 302.1 m of igneous basement.

Although the igneous penetration was only two-thirds of the planned amount, drilling during Expedition 391 obtained samples that will lead to a deeper understanding of the evolution of the Tristan-Gough hotspot and its track. Relatively fresh basalts with good recovery provide ample samples for

From left: View of Cape Town disappearing in the distance. Assembling a free-fall funnel.

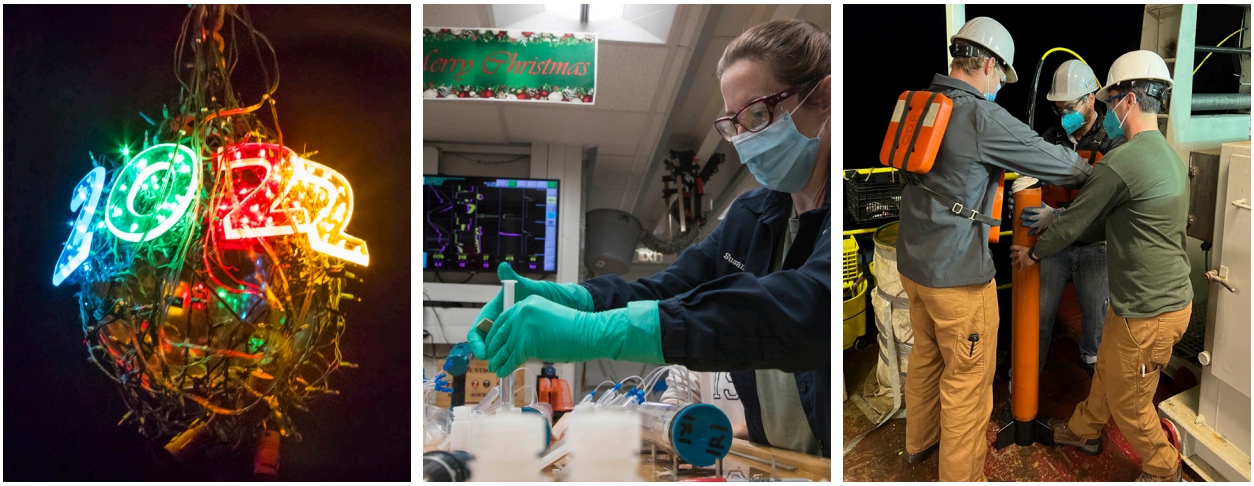
geochemical, geochronologic, and paleomagnetic studies, and the recovered Late Cretaceous and early Cenozoic chalk successions provide samples for paleoenvironmental studies.

Expedition 392: Agulhas Plateau Cretaceous Climate

During Expedition 392, three sites were drilled on the Agulhas Plateau and one site was drilled in the Transkei Basin in the Southwest Indian Ocean. This region was positioned at paleolatitudes of ~53°–61°S during the Late Cretaceous (100–66 Ma) and within the new and evolving gateway between the South Atlantic, Southern Ocean, and southern Indian Ocean basins. Recovery of basement rocks and sedimentary sequences from the Agulhas Plateau sites and a thick sedimentary sequence in the Transkei Basin provides a wealth of new data to (1) determine the nature and origin of the Agulhas Plateau; (2) significantly advance the understanding of how Cretaceous temperatures, ocean circulation, and sedimentation patterns evolved as CO_2 levels rose and fell and the breakup of Gondwana progressed; (3) document long-term paleoceanographic variability through the Late Cretaceous and Paleogene; and (4) investigate geochemical interactions between igneous rocks, sediments, and pore waters through the life cycle of a large igneous province (LIP). Importantly, postcruise analysis of Expedition 392 drill cores will allow testing of competing hypotheses concerning Agulhas Plateau LIP formation and the role of deep ocean circulation changes through southern gateways in controlling Late Cretaceous–early Paleogene climate evolution.

Expeditions 390 and 393: South Atlantic Transect 1 and 2

The South Atlantic Transect (SAT) is a multidisciplinary scientific ocean drilling experiment to investigate the evolution of the oceanic crust and overlying sediments across the western flank of the Mid-Atlantic Ridge (MAR). This project comprises four IODP expeditions: fully staffed Expeditions 390 and 393 (April–August 2022) built on engineering preparations by Expeditions 390C and 395E, which took place without science parties during the height of the COVID-19 pandemic. Through operations along a crustal flow line at ~31°S, the SAT expeditions recovered complete sedimentary sections and the upper ~40 to 340 m of the underlying ocean crust formed at a slow to intermediate spreading rate at the MAR over the past ~61 My. The sediments along this transect were originally spot cored more than 50 years ago during Deep Sea Drilling Project (DSDP) Leg 3 (December 1968–January 1969) to help verify the theories of seafloor spreading and plate tectonics.



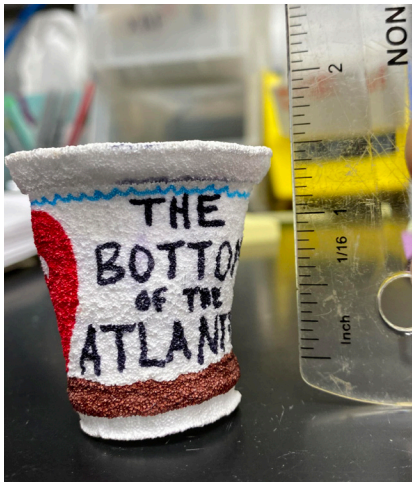
From left: *JOIDES Resolution* welcomes 2022. Transferring a sample into a container. Preparing to deploy the towed magnetometer to collect seafloor magnetic data.

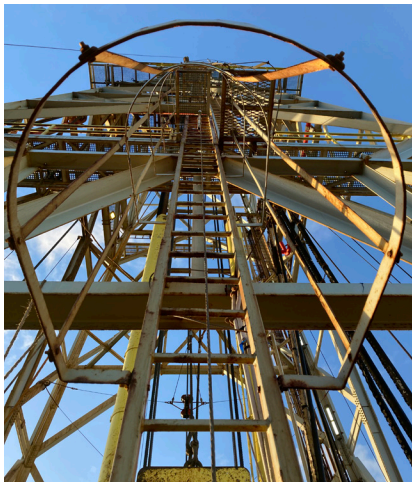
In FY21, engineering Expeditions 390C and 395E cored a single hole through the sediment cover and into the uppermost rocks of the ocean crust with the advanced piston corer (APC)/extended core barrel (XCB) systems at five of the six primary proposed SAT sites. These expeditions then installed reentry systems with casing either into basement or within 10 m of basement at each of those five sites. Expedition 390 conducted operations at three of the SAT sites, recovering 700 m of core (77% recovery) over 30.3 days of onsite operations. Sediment coring, basement coring, and wireline logging was conducted at two sites on 61 Ma crust (Sites U1556 and U1557), and sediment coring was completed at the 7 Ma Site U1559. At Site U1557, on 61 Ma crust, the drill bit was deposited on the seafloor to leave the hole available for future deepening and to establish a legacy borehole for basement hydrothermal and microbiological experiments. Expedition 390 scientists additionally described and analyzed data from 792 m of core collected during Expeditions 390C and 395E. Expedition 393 operated at four sites, drilling in 12 holes to complete this initial phase of the SAT. Complete sedimentary sections were collected at Sites U1558, U1583, and U1560 on 49, 31, and 15 Ma crust, respectively, and together with 257.7 m of sediments cored during earlier operations, more than 600 m sediments were characterized. The uppermost ocean crust was drilled at Sites U1558, U1560, and U1583 with good penetration (~130 to ~204 meters sub-basement), but only ~43 m of basement penetration was achieved in this initial attempt at the youngest ~7 Ma Site U1559. Geophysical wireline logs were achieved only at Sites U1583 and U1560. Expeditions 390 and 393 established three legacy sites (U1557, U1560, and U1559) available for future deepening and downhole basement hydrothermal and microbiological experiments.

The six sites drilled during Expeditions 390 and 393 fill critical gaps in our sampling of intact in situ ocean crust with regard to crustal age (7, 15, 31, 49, and 61 Ma), spreading rate, and sediment thickness. The recovered cores will allow us to improve the quantification of past hydrothermal contributions to global biogeochemical cycles and help develop a predictive understanding of the impacts of variable hydrothermal processes and exchanges. Sediment- and basalt-hosted biosphere samples will be essential to refine global biomass estimates and examine microbial ecosystem responses to variable conditions in a low-energy gyre and aging ocean crust.

Expedition 397T: Transit and Return to Walvis Ridge Hotspot

Following a 1-month maintenance period in Cape Town, South Africa, the transit to Lisbon, Portugal, offered the opportunity to conduct operations at two Walvis Ridge sites that were not drilled as a





From left: Examining green sediment for volcaniclastics. A shrunken Styrofoam cup that traveled more than 5 km through the water column, twice, as it was carried in a mesh bag attached to the VIT frame. Looking up the derrick.

result of time lost during Expedition 391. See above for a detailed description of the scientific objectives. Expedition 397T (10 September–11 October 2022) included a week of coring time at Sites U1584 and U1585, located on the Gough and Tristan tracks, respectively. Together with Site U1578, drilled on the Center track during Expedition 391, they form a transect across the northern Walvis Ridge Guyot Province. The goal was to core seamount basalts and associated volcanic material for geochemical and isotopic, geochronologic, paleomagnetic, and volcanologic studies. Scientifically, one emphasis is to better understand the split in geochemical and isotopic signatures that occurs at the morphologic split. New geochronological ages will refine the established age progression. Finally, the paleomagnetic study seeks to establish paleolatitudes for Walvis Ridge sites and compare them to those from Pacific hotspot chains to test true polar wander and the fixity of hotspots in the global hotspot reference frame.

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); Development, Information Technology, & Databases (DITD) (now Technology Services); 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 and Curation groups are part of the Director's Office.

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, and other national organizations and facility boards) and participates

From left: Working on the big picture. Rotary core barrel drill bit after several hours of drilling young basalt.

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.

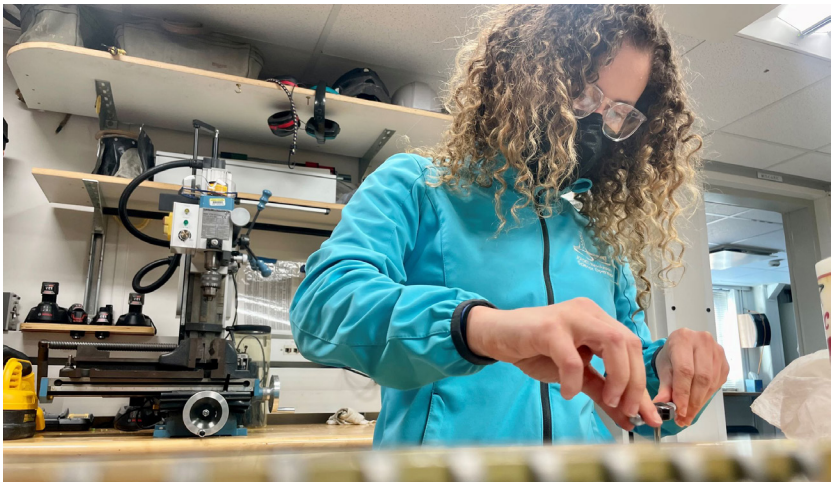
JRSO representatives participated in the Science Evaluation Panel (SEP) meetings in January and June, the Environmental Protection and Safety Panel (EPSP) meeting in February, the annual JRFB meeting in May, the Program Member Office (PMO) meeting in September, and IODP Forum meetings in October, April, and September. The JRSO Director attended the US Advisory Committee meeting in July and the *Chikyu* IODP Board meeting in August, and the JRSO Assistant Director attended the ECORD Facility Board meeting in September.

Project portfolio management

Management and Administration 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. Projects closed, continued, or planned during FY22 are listed below.

JRSO staff completed the Digital Asset Management Migration and Quality Control (QC) Data Viewer projects and worked on the following projects:

- GEODESC
- X-Ray Linescan Core Imager
- Core Orientation
- New Rig Instrumentation System (iRIS)
- Sample and Data Request Replacement (SaDR)
- GCR Core Storage Expansion
- Google Migration



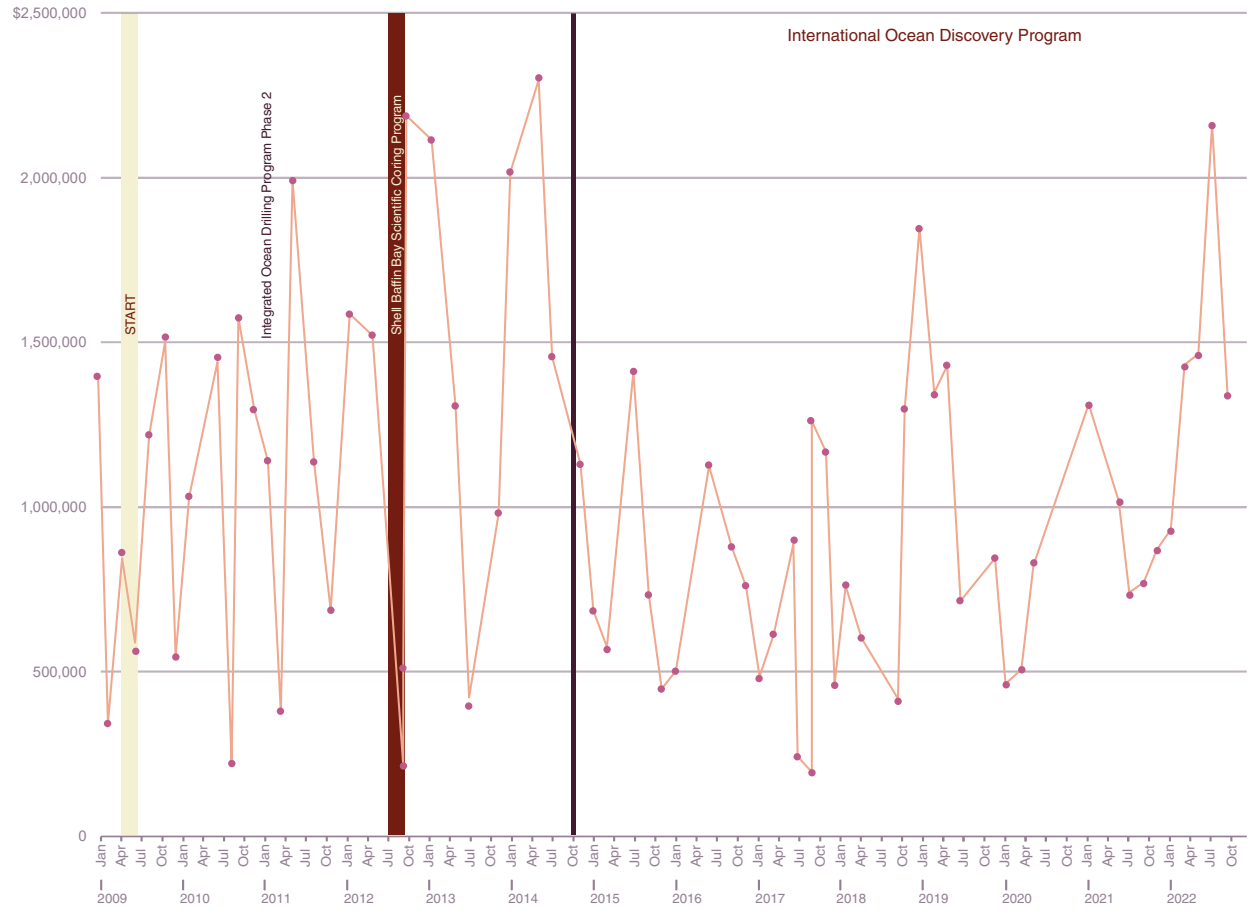
From left: Preparing for installation of the new Scanning Electron Microscope (SEM). Working in an anaerobic chamber to maintain anoxic conditions for experiments of viral and microbial activity in sediment.

4. Subcontractors

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 and to streamline travel, shipping, and maintenance activities. Maintenance was conducted in November at the tie up in Cape Town, South Africa, and a new high-temperature wireline cable was ordered. During the tie-up period following Expedition 393, Schlumberger and Siem Offshore personnel replaced the logging wireline winch and active heave compensation (AHC) unit and its power supply and created a plan to test the AHC during future operations. The new high-temperature wireline cable was received in late September. A significant budgetary impact for FY22 was the doubling of global fuel (marine gasoil) price that occurred between December 2021 and June 2022.

Actual ship fuel costs FY09–FY22. **View chart data.**



5. Science Operations

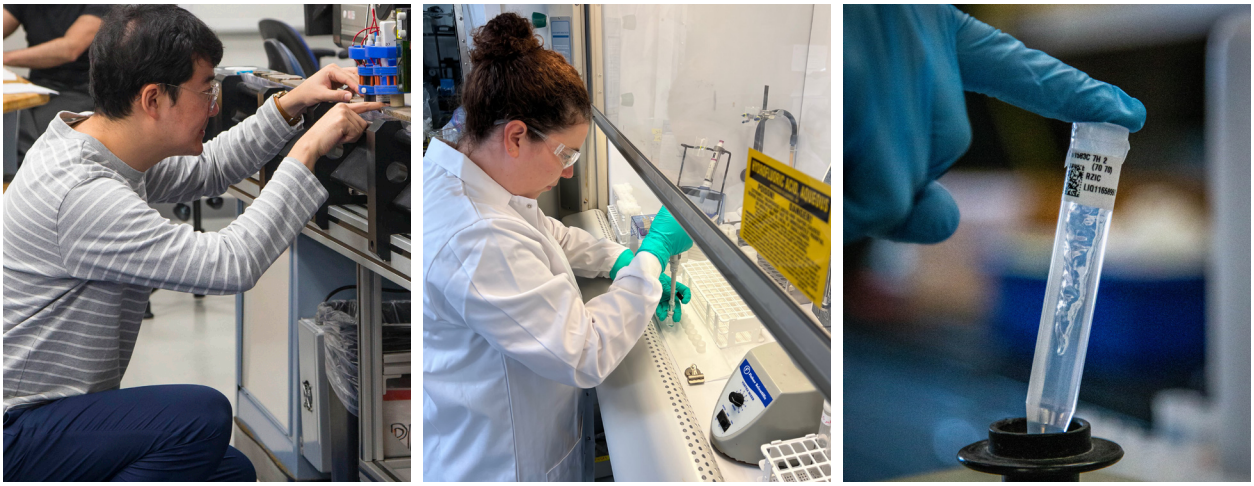
The SciOps department provides scientific and operational planning and implementation for *JOIDES Resolution* drilling expeditions by leading the scoping, planning, and implementation of science expeditions; interacting with and providing technical oversight to the drilling and logging subcontractors;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

Expedition planning, implementation, and scientific leadership

Because of COVID-19 travel restrictions, preexpedition kick-off meetings for Expeditions 397 (Iberian Margin Paleoclimate), 398 (Hellenic Arc Volcanic Field), and 399 (Building Blocks of Life, Atlantis Massif) were held virtually. JRSO hosted the Expedition 400 (NW Greenland Glaciated Margin) preexpedition meeting in College Station, Texas, on 2–4 May.

Virtual meetings were also held between the Expedition Project Managers (EPMs), Co-Chief Scientists, curators, and technical staff to review laboratory measurements and sampling plans for Expeditions 390–393 and 397. An Expedition 397 informational webinar hosted by the US Science Support Program (USSSP) was held on 19 October and was attended by a record number of 94 scientists. Additionally, a USSSP informational webinar for Expedition 400 was held on 11 May.

The first expedition of the year was affected by COVID-19. Expedition 391 COVID-19 mitigation measures included following Center for Disease Control recommendations for a 7-day quarantine and testing period (assuming close contact during travel to port) prior to boarding *JOIDES Resolution*, followed by a 2-week shipboard mitigation period (e.g., masking, social distancing as much as possible, and restricted galley access schedules). Despite these efforts, an initial positive case was reported while the ship was in transit to the first site, and several more individuals became infected soon after. Upon arrival at the site, the decision was made to suspend operations and return to Cape Town, South Africa, so that the infected individuals and close contacts could isolate on shore and more effectively stop transmission. All infected individuals had been vaccinated and consequently had mild symptoms or were asymptomatic. After the appropriate isolation period had passed, the ship was able to depart Cape Town on 29 December. The operations plan was scaled back to four sites instead of the original six primary sites.



From left: Working on the Section Half Multisensor Logger (SHML). Pipetting samples for shipboard analysis. Mixing a water sample by vortex for ion chromatograph (IC) analysis in the chemistry lab.

On 18 January, the COPE protocol was revised to focus on further reducing the transmission of COVID-19 during port call activities and aboard *JOIDES Resolution*. The Expedition 392 science party and crew arrived in Cape Town, South Africa, on 31 January and, following the updated COPE protocols, boarded the vessel on 7 February after a 7-day hotel quarantine.

The Expedition 390 port call was changed from Montevideo, Uruguay, to Cape Town, South Africa, after concerns about not being able to implement the COPE protocol. Because of the slightly longer transit times, a revised operations plan was completed that also took into account the progress made during Expeditions 390C and 395E. The addendum to the Expedition 390/393 *Scientific Prospectus* was published in May. The science party and crew for Expedition 390 arrived in Cape Town, South Africa, on 2 April and boarded the vessel on 9 April after a 7-day hotel quarantine. The vessel departed Cape Town on 12 April and completed operations at three sites. On 23 May, during operations in Hole U1559D, the bearings failed on the forward drawworks brake. The vessel departed ~8.5 days early for Cape Town so that a replacement brake could be installed before the start of Expedition 393. A spare drawworks brake was air freighted from Houston, Texas, and repairs were made at the end of Expedition 390. The Expedition 393 science party and crew boarded the vessel on 9 June after a 7-day hotel quarantine. Because of the drawworks brake failure, the operations plan for Expedition 393 was changed, and the three originally planned sites plus Site U1559 were revisited in June.

The JRFB approved the request to core two more Walvis Ridge sites during Expedition 397T. The Expedition 397T *Scientific Prospectus* was published in July, and the science party was instructed to submit additional sample requests. The seven scientists who sailed were chosen from the Expedition 391 science party. The science party and crew boarded the vessel on 10 September after a 4-day hotel quarantine.

The Expedition 397 *Scientific Prospectus* was published on 14 February, the Expedition 398 *Scientific Prospectus* on 17 March, and the Expedition 399 *Scientific Prospectus* on 22 June.

The Expedition 395 Co-Chief Scientists began working on a revised expedition plan that takes into account operations that have already been completed. To make the best use of operations time, a new site was proposed, evaluated by the EPSP and moved to a new location (REYK-14B), and then approved

From left: Demonstrating the lockable float valve (LFV) that allows the to return to coring following logging. This technology was developed by IODP. Working at the stratigraphic correlation workstation.

by the JRFB at the May meeting. The scientists are finalizing core descriptions from the Expedition 395C shore-based sample party that was held at the Gulf Coast Repository (GCR) in May.

The Expedition 400 *Scientific Prospectus* was published in September.

Expedition staffing

Science staffing was initiated or completed this year for Expeditions 390, 393, 395, 397, 398, 399, and 400. Because of COVID-19 travel/institutional restrictions or infections immediately preexpedition, Expedition 391 sailed without seven staffed scientists, Expedition 392 without four scientists, Expedition 390 without five scientists, and Expedition 393 without four scientists. One of the Expedition 390 scientists was able to sail on Expedition 393. In all cases, scientists who were not able to sail retained their full status as members of the science party.

Logistics support

Operational ship supplies were acquired and shipped preceding all FY22 expedition port calls. Cores and personal samples were shipped to the participants' institutions or the GCR following all expeditions. In addition, Schlumberger equipment and tools were shipped to and from the ship for maintenance and special measurements.

Clearance/Environmental permitting/Risk management

During review of the Expedition 391 clearance application, the Namibia Environmental Commissioner (EC) requested a scoping document of drilling operations and the ship's environmental management plan in place of a full environmental assessment. These documents were submitted on 1 November. A diplomatic note was issued by the US embassy in Namibia on 12 November to support the clearance approval process, and approval of the environment scoping document was received from the EC on 7 December. After several discussions and emails with the Namibian officials at the National Commission of Research, Science, and Technology, JRSO obtained authorization to conduct research in the Namibian Extended Continental Shelf on 16 December. Overall, the Namibian clearance process required JRSO to contact multiple agencies directly and to submit supplementary documentation that is not typically part of the clearance process. A depth extension for one Expedition 391 site was approved at the February EPSP meeting.

IODP JRSO FY21 expedition science staffing breakdown

	Expedition					
Member country/consortium	**391**	**392**	**390**	**393**	**397T**	**Total**
United States Science Support Program (USSSP)	11*	12	12*	14*	4	53
Japan Drilling Earth Science Consortium (J-DESC)	1	2	3	2	0	8
European Consortium for Ocean Research Drilling (ECORD) Science Support and Advisory Committee (ESSAC)	10*	12**	8*	10*	2	42
Korea Integrated Ocean Drilling Program (K-IODP)	1	0	1	1	0	3
IODP-China	2	2	2	2	0	8
Australia/New Zealand IODP Consortium (ANZIC)	0	1	0	0	0	1
India Ministry of Earth Science (MoES)	1	1	1	1	1	5
Total Science Party Participants	**26**	**30**	**27**	**30**	**7**	**120**

* = includes one Co-Chief Scientist. ** = includes two Co-Chief Scientists.

Authorization for Expedition 392 to conduct research in the South Africa Exclusive Economic Zone (EEZ) was obtained on 13 December, and JRSO requested and received approval during the expedition to collect surface water samples in the South African EEZ.

The clearance permit JRSO obtained for Expedition 391 covered the Expedition 397T dates, and Namibia approved the request to revisit the sites in September. The Co-Chief Scientists proposed adding a new site and requested drilling through the sediment to increase the time available for coring hard rock. The EPSP approved the new site and the drill-down request based on the thin sediment cover and Expedition 391 chemistry data. A request for the new site was sent to Namibia, and approval was received on 28 June. Once coring operations started at the first Walvis Ridge site, it became evident that the shallower locations chosen to save time were unlikely to result in the recovery of appropriate basaltic material. A new drill-down request was made for one of the alternate sites, and the EPSP recommended its approval on 26 September.

The Expedition 397 marine scientific research (MSR) application was completed and submitted to the US State Department on 10 March. During review of the Expedition 397 clearance application, JRSO was notified on 23 September that the Portuguese Navy required a timetable of when *JOIDES Resolution* will occupy two of the four Expedition 397 primary sites. This information was forwarded to Portugal on 26 September. Portugal also selected an observer for Expedition 397 who has joined the science party as a sedimentologist.

JRSO submitted the Expedition 398 MSR application to the US State Department on 29 April. An ecological research company provided an Environmental Evaluation (EE) for NSF review and approval. An EE was required due to acoustic activity associated with check shot surveys. Greece approved the clearance application on 2 August, and NSF approved the EE. As requested by the Greek permit, a notice to use a non-Greek-flagged vessel was sent to the Santorini port authority on 7 September and was approved.

An EE was also required for Expedition 399 due to acoustic activity associated with check shot surveys. An ecological research company was contacted and provided the EE for NSF review and approval.

The Expedition 395 Co-Chief Scientists proposed a new site within the Greenland EEZ, which will require a Greenland/Denmark MSR application to be submitted. An Iceland MSR application will also need to be submitted to address a new extended continental shelf claim by Iceland. The already approved EE was amended to include the new site, and NSF was informed.

Education/Outreach support

Onboard Outreach Officers sailed during Expeditions 391, 392, 390, 393, and 397T, and support was provided for social media postings, videoconferences, and other activities. The Expedition 391 Onboard Outreach Officer also provided essential precruise support during the Namibia clearance approval period by organizing events with Namibian museums and educational institutions. A training session was held 24–26 August in College Station, Texas, for the USSSP Onboard Outreach Officers for Expeditions 397T, 397, 398, 399, 395, and 400. JRSO staff also participated in planning for an Expedition 398 exhibit to be displayed in mid-October in Santorini, Greece, and for VIPs and television crews to board the vessel during operations at the two Santorini caldera sites.

EPMs mentored nine college students this year through staff scientist science engagement activities, which culminated in presentations of students' work at the TAMU Geology & Geophysics research symposium and the TAMU student research week. JRSO Staff Scientists co-supervised one M.S. student, taught GEOS 105 (Environmental Geosciences; 92 students) and GEOS 210 (Climate Change; 95 students)

in the TAMU College of Geosciences, and taught at the Glacial Sediment School, Oregon State University Marine Geological Repository (25 graduate students). In December, the Clearance and Permitting Specialist presented a talk on Geology and IODP to elementary school students at St. Francis Xavier in Willard, Ohio.

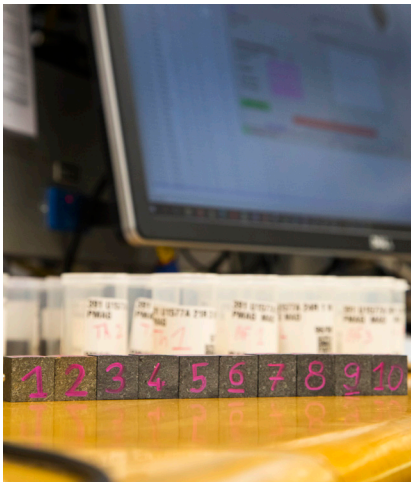
Six JRSO staff worked at the IODP/USSSP booth at the American Geophysical Union (AGU) Fall Meeting, and one EPM presented a virtual talk to the AGU Ocean Sciences meeting. One EPM continued to support the *JOIDES Resolution* Pop-Up/Drill-Down Exhibit as a Co-Principal Investigator on an NSF grant and coordinated the shipment of the MICRO-JR inflatable to New Orleans, Louisiana, for the AGU Fall Meeting. Another EPM continued working on an NSF EarthCube grant to integrate IODP data with the paleobiology database (eIODP), supervised several student workers for this effort, hosted a Coding the Column seminar associated with the grant, and helped coordinate the June EarthCube meeting at Scripps (University of California San Diego). All EPMs are involved with the JRSO Diversity, Equity, and Inclusion Working Group, which aims to improve inclusion and diversity on the *JOIDES Resolution*.

Legacy documentation

Copies of documents and reports produced by JRSO on behalf of IODP, including expedition science and operations reports, were archived electronically.

6. Technical and Analytical Services

The TAS department oversees the shipboard laboratories and facilities core curation, handling, and shipping. 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; archives shipboard data and ensures they are made available in a long-term open-access repository; responds to data requests from the scientific community; and supports shore-based laboratories.



From left: Leading an outreach broadcast. Paleomagnetism cube samples ready to be measured in the laboratory.

Analytical systems

The main upgrades and maintenance activities this year are as follows:

- Two new UIC CM5017 coulometers were installed on the ship. These replace two CM5015 units, which are still functional but are no longer supported by the vendor. The older units will be installed at the GCR for use by visiting scientists and staff.
- A new carbon-hydrogen-nitrogen-sulfur (CHNS) analyzer was installed on the ship. The older unit will be installed at the GCR for use by visiting scientists and staff.
- A new Brüker AXS Tracer-5g handheld portable X-ray fluorescence spectrometer (pXRF) was sent to the vessel prior to Expedition 393 to replace the Olympus DELTA Premium pXRF, which had an X-ray source failure.
- During the tie-up period preceding Expedition 397T, the following tasks were completed:
    - Around 100 laboratory computers were replaced, requiring the testing and recalibration of multiple laboratory instruments.
    - A new NanoImages scanning electron microscope–energy dispersive spectrophotometer (SEM-EDS) was installed on the ship. This replaces the Hitachi TM-3000 SEM and adds EDS capabilities, which had been repeatedly requested by the science community over the past years. The old SEM will be transferred to College Station, Texas, where it will be available for use by visiting scientists and staff.
    - The superconducting rock magnetometer (SRM) was serviced to repair issues related to high noise levels for two of the superconducting quantum interference detectors (SQUIDs).
- Work continued on the X-ray Linescan Core Imager (XSCAN) on shore. This will eventually replace the prototype X-Ray Imager that has been in use since Expedition 379 (Amundsen Sea West Antarctic Ice Sheet History). The prototype was only capable of collecting X-ray photos every 12 cm along a core section rather than a continuous linescan. Additionally, the XSCAN will be able to rotate the source and detector around the core, which will provide different angular views of structures within the sections and provide core diameter estimates that can be used to improve other datasets.
- A SPECIM FX10 camera was installed on a shore-based track system to investigate acquisition of ultrahigh-resolution color reflectance and color spectra data.

Majestic ocean view through the Hawsehole.

Data archive

During FY22, data from Expeditions 351, 352, 372A, and 374 were published in Zenodo, which is a general-purpose open-access data repository operated by 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 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 gets 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 374 that have been published on Zenodo have links at **http://publications.iodp.org/proceedings/374/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 evaluation recommendations, 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 FY22.

Shipboard laboratory support

More than 4,200 core sections were processed through the shipboard laboratories during the FY22 expeditions, and more than 30,000 samples were taken. Shipboard technical staff and expedition scientists made well over 1.5 million shipboard measurements on FY22 samples and placed more than 11,000 images (sections, close-ups, and microimages) in the database archive.

From left: Oriented rock cubes collected for paleomagnetism studies. Hard rock core pieces flagged for sampling.

7. TAMU Technology Services (formerly Development, IT, and Databases)

All DITD department employees transitioned to a unified TAMU Technology Services organization on 1 September. 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 is stored in the Laboratory Information Management System (LIMS). LIMS data collected during JRSO Expeditions 396 (Mid-Norwegian Margin Magmatism and Paleoclimate Implications), 391, 392, 390, and 393 were successfully transferred to shore, merged with the cumulative LIMS database, and made available online to participating scientists. More than 45,400 downloads were made from the LIMS database during FY22.

Operation and maintenance

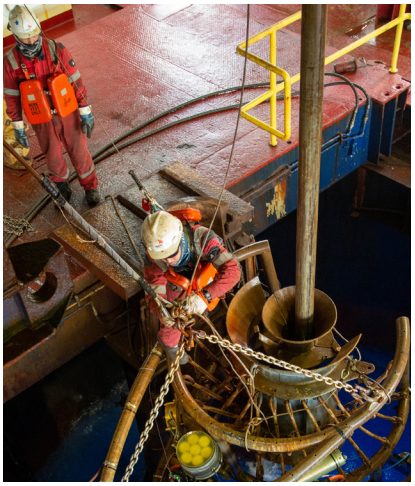
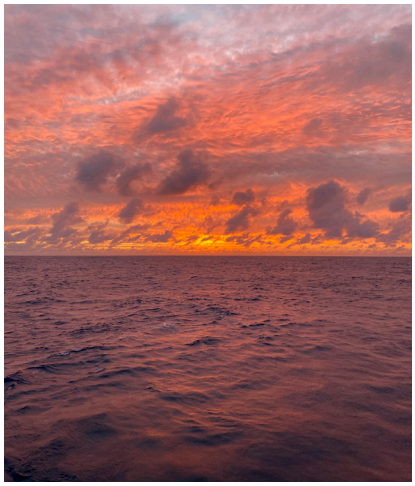
JRSO conducted routine system maintenance in accordance with the TAMU IT security policy, responded to two emergent TAMU campus-wide system security vulnerability remediation requests, and completed its annual TAMU IT risk assessment in September.

8. 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 X-ray fluorescence (XRF) core scanning facility at the GCR to provide scanning as Program measurements.

Sampling at the Gulf Core Repository

In FY22, a total of 18,204 samples were taken from legacy core collections. The GCR conducted a sample party for Expedition 392, during which an additional 15,092 samples were taken; and it hosted a


From left: Maneuvering over the VIT to release it from the pipe after diving to around 4,300 meters deep. Sunrise. Looking for microfossils under a stereo microscope.

core description and sample party during which Expedition 395 science party members described more than 2.5 km of core collected during Expeditions 384 (Engineering Testing) and 395C (Reykjanes Mantle Convection and Climate: Crustal Objectives). JRSO also provided curatorial support to the Bremen Core Repository (BCR) for the Expedition 396 postexpedition sampling party.

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. Visitors to the GCR were limited this year because of COVID-19 restrictions. JRSO staff gave tours of the GCR to 335 visitors, including several TAMU classes, scholars visiting TAMU, representatives from the TAMU Division of Research, the TAMU Oceans Club, middle school students as part of the TAMU Summer Science Safari Camp, and students from a local secondary school who also participated in a hands-on exercise featuring cores recording the K/Pg boundary while also testing the new GEODESC program. Additionally, JRSO staff gave VIP tours to leaders from Los Alamos National Laboratory and visiting congressional staffers. A documentary film crew visited the GCR to shoot footage of Expedition 364 cores and an interview with Co-Chief Scientist Sean Gulick for an upcoming documentary on the K/Pg extinction event and the Chicxulub impact crater.

The GCR also oversaw the transfer of the Amoco micropaleontology collection to other institutions and museums. Palynology slides were transferred to the Center for Excellence in Palynology (CENEX) at Louisiana State University, fusulinid slides to the University of Kansas Natural History Museum, and all slides from Alaskan wells to the Alaska Geologic Materials Center.

Onshore XRF scanning

More than 2,500 core sections were XRF scanned this year, and 263 cores were processed through the shore-based Section Half Imaging Logger (SHIL).

9. Publication Services

The 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

From left: Placing a discrete paleomagnetic sample into the spinner magnetometer. Placing a just-arrived rock core into liners and marking the direction of pieces as they come out of the core liner.

cooperative agreement with NSF. IODP publications for FY22 included JRSO quarterly and annual reports; *Scientific Prospectuses*, *Preliminary Reports*, and *Proceedings of the International Ocean Discovery Program* volumes for JRSO expeditions; and Data Reports for USIO, JRSO, and MarE3 expeditions.

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 FY22, JRSO staff in College Station, Texas, hosted postexpedition editorial meetings for JRSO Expeditions 396, 391, and 392.

IODP scientific publishing and publication coordination

IODP Pubs produced and published six *Scientific Prospectuses*, five *Preliminary Reports*, and one Expedition Reports volume for JRSO expeditions. During FY22, IODP Pubs also coordinated postexpedition publications and published Expedition Research Results content for 14 expeditions, including 17 data reports. IODP Program publications are indexed on Google Scholar, and IODP Pubs is a member of the Committee on Publications Ethics.

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 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 168,950 visits to the IODP Publications website during FY22.

Bibliography and citation management

The Scientific Ocean Drilling Bibliographic Database is a subset of the American Geosciences Institute's (AGI) GeoRef database and includes more than 40,500 entries related to IODP and the preceding scientific ocean drilling programs, representing more than 50 years of scientific ocean drilling research. In FY22, more than 3,900 queries were run on the Scientific Ocean Drilling Bibliographic Database and additional records for more than 1,900 citations were viewed. IODP Pubs works closely with AGI to curate the bibliographic database by identifying and submitting expedition-related research publication citations.

Publications metadata

Metadata for IODP publications are deposited with CrossRef, an official DOI registration agency for scholarly and professional publications. Program publications accessed through CrossRef numbered 223,806 DOI resolutions for Integrated Ocean Drilling Program and IODP publications and 474,967 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 20 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 800 records from expedition-related research published in outside literature into the Expedition Research Results collection, which can be viewed at **https://www.science-open.com/collection/8b0582f6-47bf-4988-b90a-8533135e6fcc**.

IODP Pubs also 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.

Legacy and archiving

IODP Pubs uses Archive-It to save publications to the Internet Archive, a long-term archive specializing in full website backups. The complete IODP publications website is available at the Internet Archive, including full content from all Integrated Ocean Drilling Program and IODP volumes, and regular crawls incrementally update the archive with new files. In addition, the archive houses legacy publication sites for DSDP and ODP. At the end of FY22, the JRSO archive collection contained 1.7 TB of data and more than 8 million documents. The archive can be viewed at **https://archive-it.org/collections/9148**.

Progress reporting

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

- Fourth quarter of FY21 (July–September 2021) on 8 December 2021
- First quarter of FY22 (October–December 2021) on 27 January 2022
- Second quarter of FY22 (January–March 2022) on 27 April 2022
- Third quarter of FY22 (April–June 2022) on 29 July 2022

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

From left: Packing a sample for microbiological analysis. One of the sea lions in Cape Town harbor accompanies the vessel. Displaying a freshly split rock piece.

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**