FY20 Annual Report

International Ocean Discovery Program

JOIDES Resolution Science Operator

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National Science Foundation

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Brad Clement

Director
International Ocean Discovery Program
Texas A&M University

Brad Clement was appointed Director of the International Ocean Discovery Program at Texas A&M University in August 2009. Clement previously chaired the U.S. Science Advisory Committee and has a long history of involvement with the Program, having sailed on four expeditions, worked as an Ocean Drilling Program Staff Scientist, and served on the JOIDES Ocean History Panel. Clement earned his B.S. in Geology from the University of Georgia (1979) and his M.A. (1981) and Ph.D. (1985) in Geology from Columbia University. He previously served as Associate Program Director for the Ocean Drilling Program in the National Science Foundation's Ocean Sciences Division from 2001 to 2003, as a Professor in the Department of Earth and Environmental Science at Florida International University from 1988 to 2009, and as Adjunct Associate Professor of Geophysics at Texas A&M University from 1984 to 1988. Clement was Associate Editor of the *Journal of Geophysical Research* and has served on several American Geophysical Union committees.

Mitch Malone

Assistant Director and Manager of Science Support
International Ocean Discovery Program
Texas A&M University

Mitch Malone was appointed Assistant Director of the International Ocean Discovery Program at Texas A&M University and Manager of Science Operations in 2011. 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), and Acting Director (2008). 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.

Historical perspective

From October 2019 through September 2020, the international marine research collaboration called the International Ocean Discovery Program (IODP) monitored subseafloor environments and explored Earth's history and dynamics as recorded in seafloor sediments and rocks. 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 Center for Deep Earth Exploration (CDEX), 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 *JOIDES Resolution* Facility (JRF) Science Evaluation Panel (SEP) and the JRF 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 Coordination for Improvement of Higher Education, Brazil (CAPES); 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 26 participating nations whose scientists are selected to staff IODP research expeditions conducted throughout the world's oceans.

The *JOIDES Resolution* prepares to depart Amsterdam with a new coat of paint. Photo credit: DHSS Agencies.

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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. 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) and as outlined in approved Annual Program Plans.

The scope of activities associated with initial planning and preparation of IODP expeditions is similar to early Integrated Ocean Drilling Program activities in terms of deliverables, challenges, and risks. In addition, JRSO carries out postexpedition activities related to IODP expeditions and ongoing operational tasks (e.g., completing reports and technical documentation), completing legacy work (e.g., producing scientific publications), conducting long-lead planning work in preparation for expeditions scheduled for future fiscal years, and providing all necessary clearances and environmental assessments for IODP expeditions conducted by JRSO.

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

FY20 overview

During fiscal year 2020, JRSO successfully completed two expeditions that will advance the global understanding of Earth systems and processes. Postexpedition research on the collected cores from these expeditions will improve our understanding of subsurface microbial communities and how life responds to major global change, such as rapid global warming or cooling. In addition, JRSO was able to implement a rescheduled Expedition 384 (Engineering Testing) after the onset of the 2019 Novel Coronavirus (2019-nCoV) and COVID-19 pandemic.

IODP JRSO FY20 expedition summary

Expedition	Operations time (days)	Distance traveled (nmi)	Sites (number)	Holes (number)	Meters cored	Cores recovered (number)	Core recovery (%)	Holes logged (number)
385: Guaymas Basin Tectonics and Biosphere	43.5	2,679	7	26	4,751.8	755	88	3
378: South Pacific Paleogene Climate	11.0	5,344	1	5	1,215.4	145	77	0
384: Engineering Testing	21.8	2,328	2	11	384.2	59	80	1
Totals	**76.3**	**10,351**	**10**	**42**	**6,351.4**	**959**	**85**	**4**

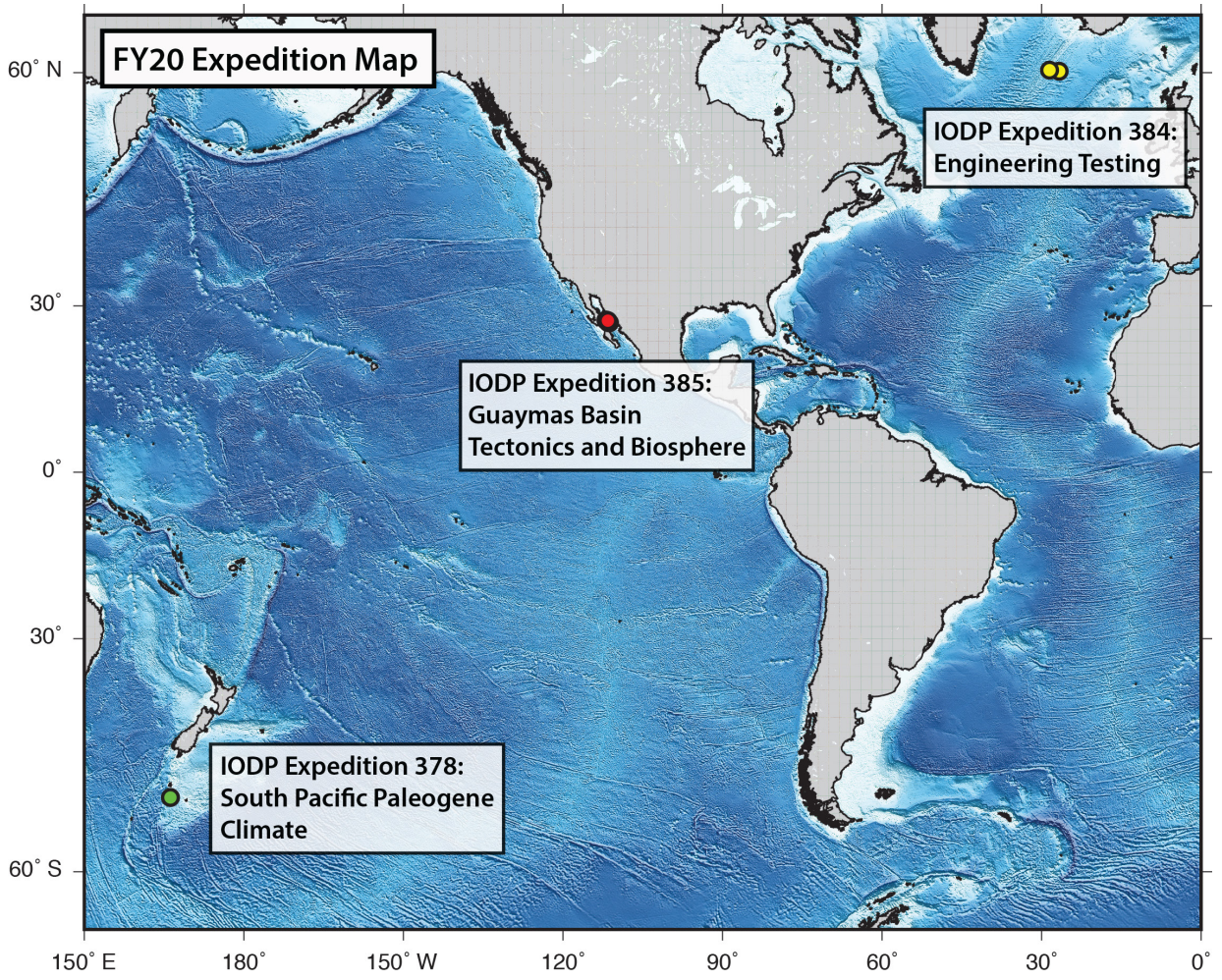
Note: Operations time = time on site (does not include transits, waiting on weather, or breakdown time).

Travel restrictions related to the pandemic in early 2020 impacted all JRSO staff, scientists, and crew. JRSO rescheduled FY20 Expeditions 384 (Engineering Testing) and 395 (Reykjanes Mantle Convection and Climate) and FY21 Expeditions 390/393 (South Atlantic Transect 1 and 2), 391 (Walvis Ridge Hotspot), and 392 (Agulhas Plateau Cretaceous Climate). JRSO and ODL AS worked together to develop protocols for safe operations during the pandemic.

The Co-Chief Scientist review and the National Science Foundation (NSF) review panel again culminated in positive feedback that congratulated JRSO for its excellent management of an aging facility that provides a world-class infrastructure for ocean research and continues to successfully address the diverse science questions of the IODP Science Plan.

This IODP JRSO FY20 Annual Report details these accomplishments and other activities undertaken in support of NSF Cooperative Agreement OCE-1326927 during the period from 1 October 2019 to 30 September 2020.

FY20 expedition sites.



2. Expedition operations

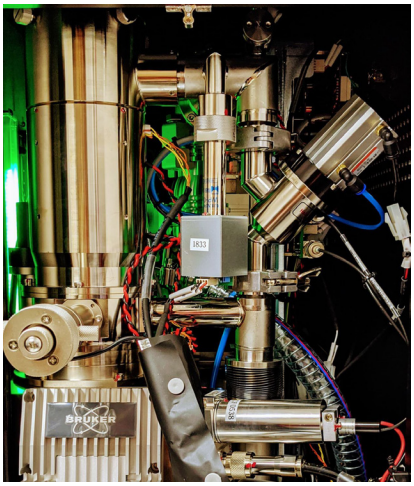
Expedition 385: Guaymas Basin Tectonics and Biosphere

During Expedition 385 (15 September–15 November 2019) organic-rich sediments with sill intrusions were cored on the flanking regions and in the northern axial graben in Guaymas Basin, a young marginal rift basin in the Gulf of California. Guaymas Basin is characterized by widely distributed, intense heat flow and widespread off-axis magmatism expressed by a dense network of sill intrusions across the flanking regions, which is in contrast to classical mid-ocean-ridge spreading centers. The numerous off-axis sills provide multiple transient heat sources that mobilize buried sedimentary carbon, in part as methane and other hydrocarbons, and drive hydrothermal circulation. The resulting thermal and geochemical gradients shape abundance, composition, and activity of the deep subsurface biosphere of the basin.

Drill sites extend over the flanking regions of Guaymas Basin, covering a distance of ~81 km from the northwest to the southeast. In the northwest, at adjacent Sites U1545 and U1546, the oldest and thickest sediment successions were recovered. Sites U1547 and U1548, located in the central part of the northern Guaymas Basin segment, were cored to investigate a 600 m wide circular mound (bathymetric high) and its periphery. The dome-like structure is outlined by a ring of active vent sites called Ringvent. It is underlain by a remarkably thick sill at shallow depth. Hydrothermal gradients steepen at the Ringvent periphery, which in turn shifts the zones of authigenic carbonate precipitation and of highest microbial cell abundance toward shallower depths. The Ringvent sill was cored several times and yielded remarkably diverse igneous rock textures, sediment/sill interfaces, and hydrothermal alteration, reflected by various secondary minerals in veins and vesicles. Thus, the Ringvent sill became the target of an integrated sampling and interdisciplinary research effort that included geological, geochemical, and microbiological specialties. The thermal, lithologic, geochemical, and microbiological contrasts between the two deep northwestern sites and the Ringvent sites form the scientific centerpiece of the expedition.

The scientific outcomes of Expedition 385 will (1) revise long-held assumptions about the role of sill emplacement in subsurface carbon mobilization versus carbon retention, (2) comprehensively examine the subsurface biosphere of Guaymas Basin and its responses and adaptations to hydrothermal conditions, (3) redefine hydrothermal controls of authigenic mineral formation in sediments, and (4) yield new insights into many geochemical and geophysical aspects of both architecture and sill-sediment





From left: Working at the KOACH clean bench. Collecting microbiology rock samples in the glove box. New scanning electron microscope with electron dispersive spectrometer for deployment on the *JOIDES Resolution*.

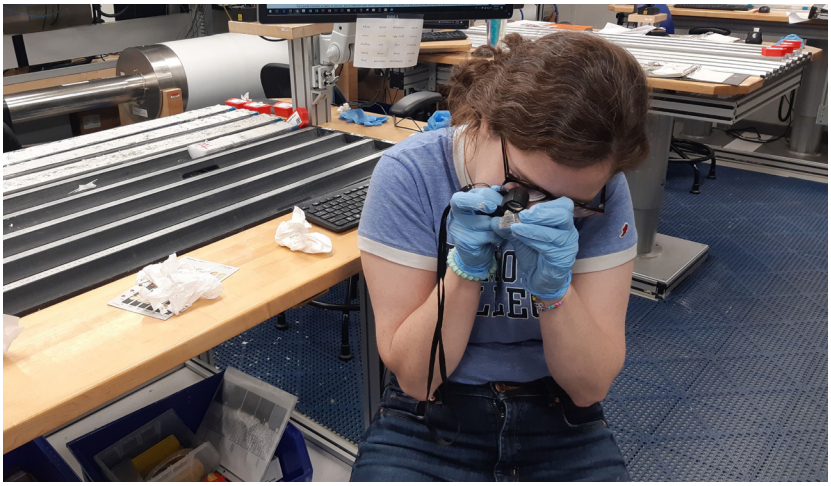
interaction in a nascent spreading center. The generally high quality and high degree of completeness of the shipboard data sets present opportunities for interdisciplinary and multidisciplinary collaborations during shore-based studies. Expedition 385 will in many respects build on the foundations laid by Deep Sea Drilling Project (DSDP) Leg 64 for understanding Guaymas Basin.

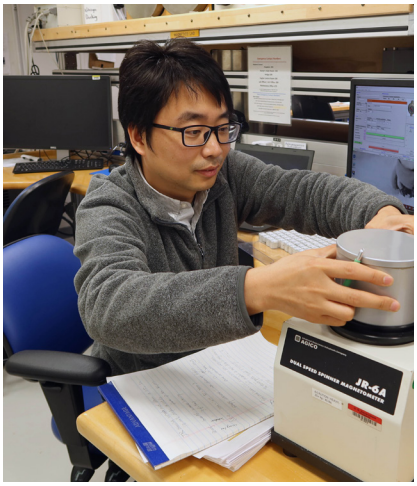
Expedition 378: South Pacific Paleogene Climate

Expedition 378 (3 January–6 February 2020) was designed to recover the first comprehensive set of Paleogene sedimentary sections from a transect of sites strategically positioned in the South Pacific to reconstruct key changes in oceanic and atmospheric circulation. These sites would have provided an unparalleled opportunity to add crucial new data and geographic coverage to existing reconstructions of Paleogene climate. The postponement of Expedition 378 and subsequent port changes resulted in reduction of the number of primary sites, and it was determined that the *JOIDES Resolution* derrick would not support deployment of drill strings longer than 2 km. For these reasons, only 1 of the originally approved 7 primary sites was drilled.

During Expedition 378, the first continuously cored, multiple-hole Paleogene sedimentary section from the southern Campbell Plateau was recovered at Site U1553. This high–southern latitude site builds on the legacy of DSDP Site 277, a single partially spot cored hole, providing a unique opportunity to refine and augment existing reconstructions of the past ~66 My of climate history. In addition, a new siliciclastic unit that had never been cored before was discovered during the expedition.

Previous drilling in the low-latitude Pacific Ocean during Ocean Drilling Program (ODP) Legs 138 and 199 and Integrated Ocean Drilling Program Expeditions 320 and 321 provided new insights into climate and carbon system dynamics, productivity changes across the zone of divergence, time-dependent calcium carbonate dissolution, bio- and magnetostratigraphy, the location of the Intertropical Convergence Zone, and evolutionary patterns for times of climatic change and upheaval. Expedition 378 uniquely complements this work with a high-latitude perspective that is unobtainable in the Northern Hemisphere of the Pacific Ocean.





From left: Inspecting a sample with a hand lens. Preparing to run a sample in the spinner magnetometer.

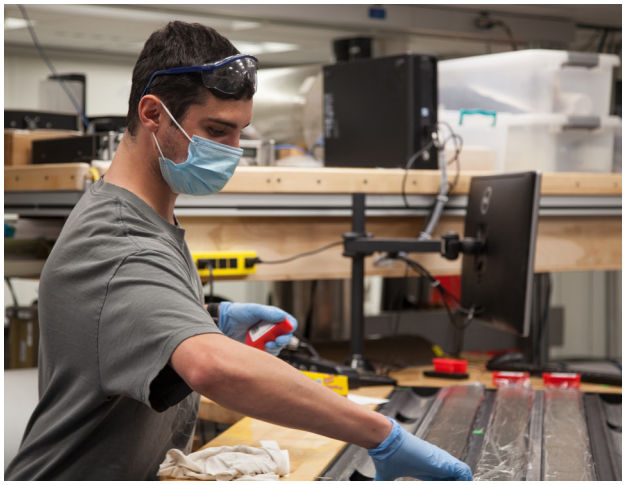
Expedition 384: Engineering Testing

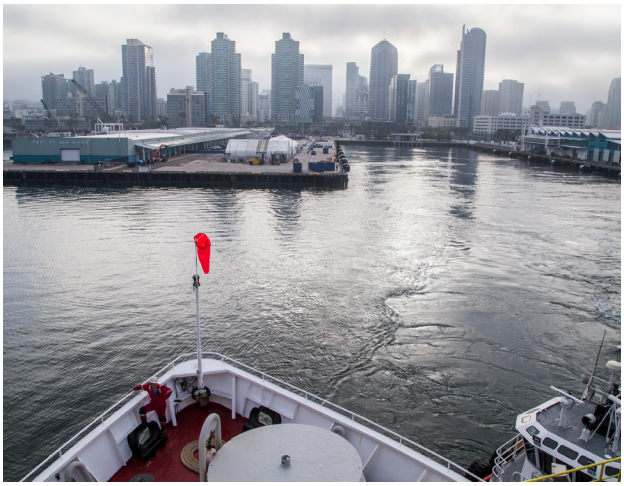
The objective of Expedition 384 (20 July–5 September 2020) was to carry out engineering tests with the goal of improving the chances of success in deep (>1 km) drilling and coring in igneous ocean crust. A wide range of tools and technologies for potential testing were laid out by the Deep Crustal Drilling Engineering Working Group in 2017, based on reports from recent crustal drilling expeditions. The JRFB further prioritized the testing opportunities in 2018. The top priority of all recommendations was evaluation of drilling and coring bits because rate of penetration and bit wear and tear are the prevalent issue in deep crustal drilling attempts and bit failures often require an excessive amount of fishing and hole-cleaning time.

The test location for Expedition 384 was based on various factors, including the *JOIDES Resolution*'s location at the time, our inability to obtain territorial clearance in a short period of time, and a suitable combination of sediment and igneous rock for drilling and coring operations. Expedition 395, which was postponed due to the COVID-19 pandemic, included proposed sites that were suitable for testing during Expedition 384 and offered the opportunity to carry out some serendipitous sampling, logging, and casing work for science.

We triple cored the uppermost 70 m of sediment at Site U1554 to compare core orientation data with the excellent paleomagnetic signature measured in the cores. Comparison of core orientation measurements taken on the ship and on shore revealed that past orientation problems resulted from a 180° misalignment in the assembly of one of the tools, which occurred randomly over many years. The assembly part was fixed and the problem has hopefully been eliminated for future expeditions.

At Site U1555, three types of drill bits were tested in six holes (U1555A–U1555F): a tungsten carbide insert (TCI) tricone bit, a polycrystalline diamond compact (PDC) bit, and a more novel PDC/TCI hybrid bit. In addition, a TCI bit was paired with an underreamer with expanding cutting blocks instead of extending arms. The TCI bits were the best performers, the PDC/TCI hybrid bit did not stand up to the harsh formation, and the PDC bit did not get sufficient run time due to a mud motor failure. The cutting block underreamer was deemed unsuitable for major hole opening in basalt but could be useful for knocking out ledges. The PDC coring bit cut good quality basalt cores but did so at an unacceptably low rate.





From left: Implementing COVID-19 mask protocol while working at the core description table. A tug assisting with departure from San Diego.

In Hole U1555G, the seventh and final hole, we used a rotary core barrel (RCB) PDC coring bit to recover the entire 130 m basalt section specified in the Expedition 395 *Scientific Prospectus* and provided the project team with shipboard data and samples. The basalt section was successfully wireline logged before the logging winch motor failed, which precluded further operations for safety reasons.

3. Management and Administration

JRSO's organizational structure directly reflects the responsibilities specified by NSF for technical and scientific management, administration, and operation of the *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); and Publication Services (Pubs). Managers of these departments report to the JRSO Director, who is responsible for the Program'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 [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 January Science Evaluation Panel (SEP) meeting held in Galveston, Texas, and participated virtually in the SEP meeting in June, the JRFB meeting in August, and the IODP Forum in September. The ECORD Facility Board meeting was postponed until October, and the *Chikyu* IODP Board meeting was postponed indefinitely.

The JRSO Director attended the ECORD Council meeting held 5–7 November in Dublin, Ireland, and senior JRSO staff attended the United States Science Support Program (USSSP) leadership meeting held 11 December in conjunction with the IODP town hall meeting at the American Geophysical Union (AGU) Fall Meeting in San Francisco, California.

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

- Expedition 382 (Iceberg Alley and Sub-Antarctic Ice and Ocean Dynamics) editorial meeting, 14–18 October
- Expedition 383 (Dynamics of Pacific Antarctic Circumpolar Current) editorial meeting/sampling party, 6–17 January

The Expedition 382 postcruise sampling party was held 18–26 November in Bremen, Germany.

Scheduled postcruise editorial meetings and sampling parties for Expeditions 385 and 378 were postponed because of COVID-19 travel restrictions. The Expedition 385 editorial meeting was conducted

online using Google Drive collaboration tools, and plans were made to conduct the Expedition 378 editorial meeting in the same manner in early FY21. Expedition 385 sampling was done by JRSO staff after easing of the local shelter-in-place order. JRSO staff completed the X-ray fluorescence (XRF) measurements of Expedition 378 cores and rescheduled the sampling party for January 2021, which will mainly consist of on-site JRSO staff and possibly, if US travel restrictions and the University restrictions allow, some US scientists. Scientists who are unable to attend will provide a sample list, and samples will be mailed to them in early February.

Project portfolio management

M&A managed large cross-departmental tasks and projects through teams using a formal project portfolio management (PPM) approach to identify, categorize, review, evaluate, select, and prioritize proposed projects. Projects closed, continued, or planned during FY20 are listed below.

JRSO staff completed the Data Publishing and JR Communications Update projects this year and continued work on the following projects:

- GEODESC
- SampleMaster Replacement
- X-Ray Linescan Core Imager
- Core Orientation Gyro System
- QC Data Viewer
- New Rig Instrumentation System
- Digital Asset Management System

Facility assessment

JRSO hosted a facility review on 24 and 25 February during which the FY19 expedition Co-Chief Scientists, in person or through video conferencing, assessed JRSO's performance in implementing FY19 Expeditions 379 (Amundsen Sea West Antarctic Ice Sheet History), 382 (Iceberg Alley and Sub-Antarctic Ice and Ocean Dynamics), 383 (Dynamics of the Pacific Antarctic Circumpolar Current [DYNAPACC]), 385T (Panama Basin Crustal Architecture and Deep Biosphere), and the inaugural JR100 (Expedition 379T).

From left: *JOIDES Resolution* preparing to enter the Panama Canal. Photo by Zenon Mateo. Freshly painted *JOIDES Resolution* in drydock.

Their findings were compiled in a report that was presented at the JRSO Site Visit Panel held 26–28 February to assess JRSO's performance as a facility in meeting the needs of IODP in fulfilling its Science Plan. The Panel concluded that "the facility is being managed extremely well by JRSO, with continued positive evolution of management practices, facility enhancements, and efforts related to making data and publications more widely available to the scientific community" and "JRSO interacts extremely well with the JRFB and related panels to implement the IODP Science Plan."

The Panel was impressed by JRSO's effective implementation of the JR100 program, which represented an additional major effort on top of IODP expedition implementation, and JRSO's ability to adapt to the challenging and repeatedly changing circumstances of FY19 expedition planning due to repercussions from the August 2018 Subic Bay dry dock incidents.

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 the *JOIDES Resolution*. JRSO and ODL AS executed a restatement of the TAMRF/ODL contract that simplified the document by removing irrelevant material and condensing amendments into cohesive text.

JRSO continued to interact with Schlumberger to ensure that wireline logging operations aboard the *JOIDES Resolution* continue in an efficient and compliant manner and to streamline travel and shipping activities. JRSO recompeted the wireline logging subcontract by issuing a call for proposals. Schlumberger was the sole respondent, and a fully executed contract is in place.

5. Science Operations

The Science Operations (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

JRSO hosted the following preexpedition meetings in College Station:

- Expedition 391: 21 and 22 October
- Expedition 390/393: 4–6 November
- Expedition 392: 4 and 5 December

Because of COVID-19 travel restrictions, the preexpedition meeting for Expedition 395 was held virtually.

Required but unplanned derrick maintenance forced a reduced operations schedule for Expedition 378 and postponement of Expedition 384. The *JOIDES Resolution* transited to Balboa, Panama (arriving 25 February), where ODL AS began extensive repairs on the derrick to make it ready to conduct deep-water expeditions in the Atlantic Ocean. In late February, JRSO was notified that leaks with some of the

JOIDES Resolution thruster seals required the ship to go into a dry dock to change the seals before it could resume science operations. The dry dock could not take place until after the derrick repairs were successfully completed at the end of April, which led to postponement of Expedition 387, which had been scheduled for 26 April–26 June 2020. In February, the Brazilian government informed the State Department that Expeditions 387 and 388 could not be implemented because of a Brazilian decree on marine scientific research that banned drilling. Despite efforts to determine if an exception for scientific ocean drilling could be granted, Expedition 388 was postponed. In response, the JRFB rescheduled Expedition 384 to follow completion of dry dock and scheduled Expedition 395 (Reykjanes Ridge Mantle Convection and Climate) in the previous Expedition 388 window (26 June–26 August 2020).

Dry dock delays and COVID-19 travel restrictions forced another postponement of Expedition 384, and the expedition was rescheduled for 20 July–5 September. The *Scientific Prospectus* for Expedition 384 was published with two sites selected for drill bit testing, one from the Expedition 395 proposal (REYK-13A) and Site U1309 from FY05 Expedition 304/305 (Oceanic Core Complex Formation, Atlantis Massif), and a secondary objective of systematically testing the advanced piston corer (APC) core orientation tools at proposed Expedition 395 Site REYK-6A.

JRSO and ODL AS worked together to develop the "COVID Mitigation Protocols Established for Safe JR Operations (COPE)" document, which defines protocols for operating the *JOIDES Resolution* as safely as possible during a time when COVID-19 is present globally and has the potential to cause illness, long-term health complications, and even death. COPE requires a reduced science and technical shipboard complement, allowing minimal staff on board to (1) provide safety measurements, (2) drive operational decisions, and (3) capture ephemeral properties. Expedition 384 shipboard staff tested and provided insights on implementing COPE and developed the COPE Summary Guidelines, a short practical guide to using COPE.

COVID-19 travel restrictions also caused Expedition 395 and, subsequently, Expeditions 390 (South Atlantic Transect 1) and 391 (Walvis Ridge Hotspot) to be postponed.

The JRFB met (virtually) in August to address the *JOIDES Resolution* schedule in light of issues being faced by the pandemic. Expeditions 390–393 in the South Atlantic were rescheduled as a block in FY22, starting in December of 2021. Expedition 395 was rescheduled for late June 2021 to be followed by

From left: Filming at drydock. Photography by ScienceMedia.nl (Dick Peterse) - 2020 © IODP-NL, NWO & ECORD. Examining whole-round core with a hand lens.

Expedition 396 (Mid-Norwegian Continental Margin Magmatism) as the first expeditions with science parties to be implemented since the onset of the pandemic.

In the interim, JRSO will attempt to accomplish a range of operational objectives that will benefit scheduled expeditions or proposals. In the October–December 2020 window, JRSO will attempt to install five of the six reentry systems planned for Expeditions 390 and 393. This plan saves ~14 days of operations time from Expeditions 390 and 393, which better ensures that target penetration depths can be achieved at all sites and increases the probability that several sites can be established as legacy holes.

In addition, JRSO was tasked with remediating Hole U1309D (removing the caliper lost from the Versatile Seismic Imager [VSI] during Expedition 340T, Atlantis Massif Oceanic Core Complex), which is proposed to be deepened in IODP Proposal 937. This will require obtaining borehole fluid samples and a temperature profile before the hole is disturbed during fishing operations. JRSO assigned an Expedition Project Manager (EPM) and an operations superintendent and contacted the lead proponent of Proposal 937 to begin discussions about operations and sampling. JRSO also proposed installing a reentry system, which was included in Proposal 937. The remainder of Expedition 395E (April–June 2021) will be used to conduct engineering testing, including testing the drill bit that was to be tested during Expedition 384 near Site U1309D and completing the testing of the PDC drill bit, which was cut short because of a mud motor failure. Principal Investigators are completing land tests for the probe delivery tool (PDT), which is a replacement for the motion decoupled hydraulic delivery system (MDHDS). The MDHDS may also be tested, if ready.

Expedition staffing

Expedition 384 took place with limited JRSO staff. The Expedition 395 EPM and Co-Chief Scientists created a draft shipboard staffing list that will implement COPE and asked science party members to confirm their participation by 1 November. Scientists who were planning to participate in Expeditions 390/393, 391, and 392 will be asked to confirm their participation at a later date.

Logistics support

Operational ship supplies were acquired and shipped preceding all FY20 expedition port calls.

IODP JRSO FY20 expedition science staffing breakdown.

Member country/consortium	Expedition		
	385	378	Total
United States Science Support Program (USSSP)	11**	11*	22
Japan Drilling Earth Science Consortium (J-DESC)	3	2	5
European Consortium for Ocean Research Drilling (ECORD) Science Support and Advisory Committee (ESSAC)	9	7*	16
Korea Integrated Ocean Drilling Program (K-IODP)	1	1	2
IODP-China	3	2	5
Australia/New Zealand IODP Consortium (ANZIC)	0	1	1
India Ministry of Earth Science (MoES)	1	2	3
Coordination for Improvement of Higher Education (IODP-Brazil)	0	1	1
Total Science Party Participants	**28**	**27**	**55**

Notes: * = includes one Co-Chief Scientist. ** = includes two Co-Chief Scientists. Numbers do not include observers that become part of the Science Party. No scientists participated in Expedition 384.

Clearance/Environmental permitting/Risk management

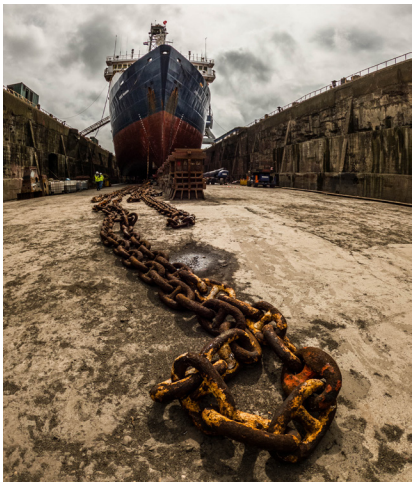
The Environmental Protection and Safety Panel (EPSP) and the TAMU Safety Panel met on 18 and 19 February to review and make recommendations on scheduled expeditions, proposals at the JRFB, and preview selected proposals at SEP. The EPSP approved several new sites for Expedition 391 and depth extensions for two Expedition 392 sites and a ribbon at another site.

In accordance with the New Zealand Exclusive Economic Zone (EEZ) Act, JRSO submitted to the New Zealand Environmental Protection Authority (EPA) the Expedition 378 Report of Pre-Activity Notification of Relevant Iwi (EPA Form 2) on 16 December and the Notice of Commencement and Notice of Completion Forms on 15 and 25 January, respectively.

Brazil requested clarification on the drilling process for Expeditions 387 and 388, and JRSO submitted the requested information along with additional clearance documentation, supplemental material, and the cooperation agreements between TAMU and the Co-Chief Scientists' institution. JRSO was notified in February that Brazil would not allow an exception to a drilling ban in an internal decree governing marine scientific research, despite previously granting an exception for *JOIDES Resolution* operations during ODP Leg 155 in 1994. The Expedition 387 and 388 Co-Chief Scientists, proponents, and IODP-Brazil continued to try to develop an alternate pathway to allow Expeditions 387 and 388 to be implemented as scheduled until 6 March, when it became clear that an exception would not be granted. Expeditions 387 and 388 are back at the JRFB to be rescheduled when Brazil will allow the *JOIDES Resolution* to conduct research in their jurisdictional waters.

JRSO submitted the marine scientific research (MSR) application for Expedition 391 to the US State Department on 13 May, and the US State Department submitted the application and diplomatic note to the Namibian government on 1 June. The Namibian National Commission on Research, Science, and Technology approved the project, which is Step 1 in the overall Namibian clearance process, and requested a nominal registration payment, which was successfully wire transferred on 1 July. Because the expedition was rescheduled, the clearance application will need to be resubmitted with the new dates.

The Expedition 392 MSR application was submitted to the US State Department; however, because the expedition was rescheduled, the clearance application may need to be resubmitted with the new dates. Additionally, the Environmental Evaluation (EE) required for Expedition 392 acoustic activity associated



From left: Anchor chain with *JOIDES Resolution* bow in drydock. Photography by ScienceMedia.nl (Dick Peterse) - 2020 © IODP-NL, NWO & ECORD. Collecting a sample from the Kuster fluid sampler tool.

with check shot surveys was approved by NSF. Because the expedition is scheduled in the same austral summer window, the EE remains valid.

NSF approved the EE required for Expedition 395 acoustic activity associated with check shot surveys. Because the rescheduled expedition will take place in the same summer weather window in 2021 the EE remains valid.

Outreach support

JRSO staff assisted with planning for Expedition 385 port call public relations and outreach activities, which included a symposium at Scripps, and facilitated and conducted tours of the *JOIDES Resolution* for 160 people in San Diego, California, including media, NSF, TAMU dignitaries, and local universities at the September port call. During the second San Diego port call in November, a USSSP School of Rock spent one day on the ship and two small tours for local colleges were conducted. JRSO staff also facilitated onboard outreach activities during Expedition 378.

JRSO scientists mentored 15 college students this year through Staff Scientist science engagement activities, which culminated in presentations of students' work at the TAMU Geology & Geophysics research symposium, the TAMU student research week, and the Geological Society of America South-Central Joint Section Meeting in March. JRSO Staff Scientists also co-supervised two Ph.D. students, served on the committees of seven Ph.D. students and three M.S. students at TAMU and TAMU Galveston, taught GEOS 210 (Climate Change), and taught the inaugural First Year Experience course in the TAMU College of Geosciences.

JRSO Staff Scientists contributed to IODP outreach efforts by participating in the TAMU College of Geosciences Aggieland Saturday Open House and the Children's Museum of the Brazos Valley Ocean Camp, assisting with the continued implementation of the NSF-funded *JOIDES Resolution* Pop-Up/Drill Down Exhibit, hosting core activities for Austin Community College students as part of another NSF-funded grant, teaching in a high school AP Environmental Science class, and participating in a "Letters to a Pre-Scientist" pen pal program. In addition, one Staff Scientist sailed as a Science, Technology, Engineering and Math Student Experiences Aboard Ships (STEMSEAS) instructor on the research vessel *Neil Armstrong* and was a webinar speaker at the "Demystifying the IODP Proposal Process for Early Career Scientists" workshop.

From left: Working with the spinner magnetometer. Carrying new core on the catwalk.

Legacy documentation

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

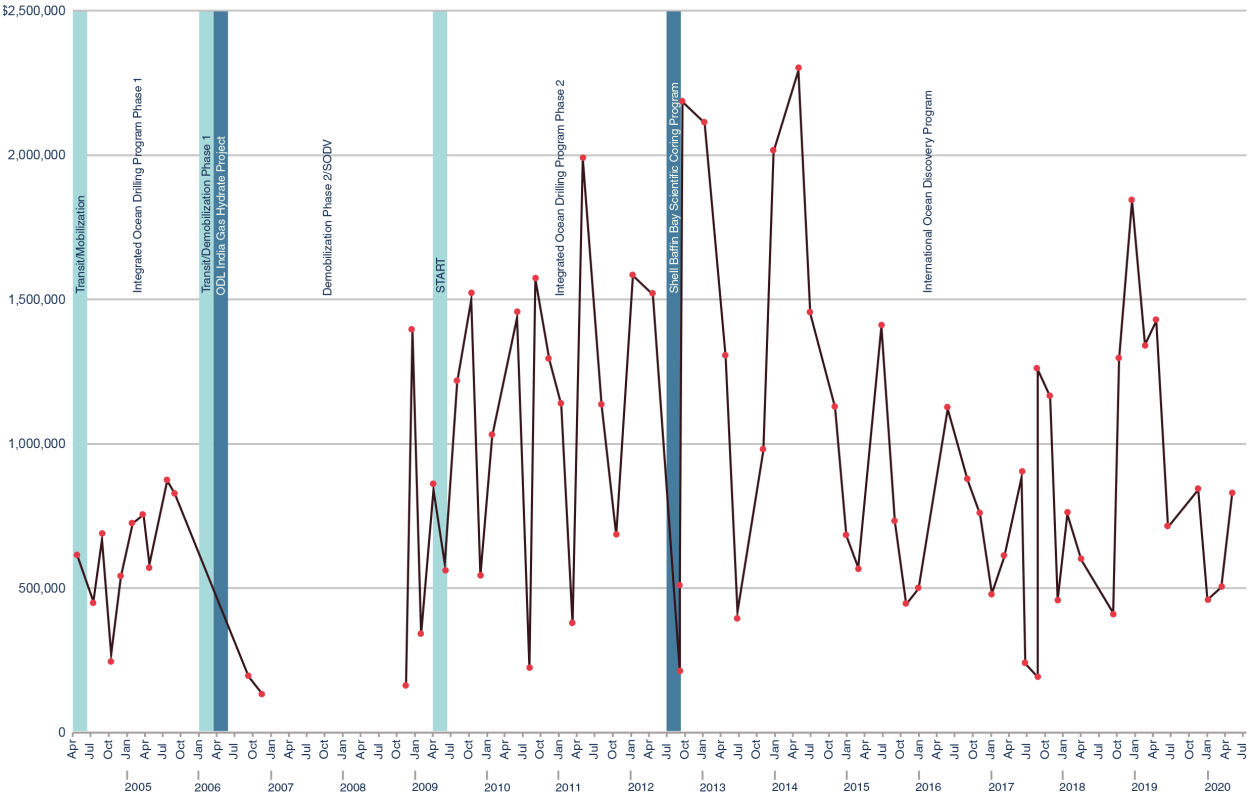
6. Technical and Analytical Services

The Technical & Analytical Services (TAS) department develops, maintains, and operates a diverse array of scientific equipment for analyzing cores and core samples; staffs the shipboard laboratories with skilled technicians; provides support for shipboard scientists; stocks the shipboard laboratories; educates scientists and staff about laboratory and general shipboard safety; provides support for downhole tools and measurements; works to ensure quality assurance/quality control (QA/QC) of measurements made in the shipboard laboratories; facilitates shipboard core curation, handling, and shipping; and supports shore-based laboratories.

Analytical systems

JRSO designed a standalone linescan X-ray system for imaging whole-round and split-core sections. The X-ray Linescan Core Imager (XSCAN) will produce a continuous linescan of core section analogous to the linescan color images (i.e., core photos) acquired by the Section Half Imaging Logger (SHIL). It will replace the X-ray Imager on a multisensor core logger (XMSL), which acquires 12 cm long images along a core section. Those images could not be stitched into a continuous core section image because of the geometry of the X-rays generated by the X-ray source. More significantly, when the XMSL is in use, one of the two Whole-Round Multisensor Loggers (WRMSLs) cannot be used to collect magnetic susceptibility

Actual ship fuel costs FY04–FY20. **View chart data**.



or density data, which impedes timely stratigraphic correlation. Currently, science parties must cease X-ray imaging if they want to use both whole-round loggers. The XSCAN is a standalone system, so it will alleviate this issue and enable JRSO to meet one of the milestones of ODP and IODP—coring complete, continuous stratigraphic sections through the use of real-time stratigraphic correlation, a process that requires the simultaneous operation of two WRMSLs.

New equipment acquired for the shipboard laboratories included

- A NanoImages SNE-4500M scanning electron microscope (SEM) equipped with a Brüker XFLASH 630 Mini energy dispersive spectrophotometer (EDS) to replace the older Hitachi TM-3000 SEM, which will be transferred to College Station, Texas, where it will be available for use by visiting scientists;
- A Bartington MS3 magnetic susceptibility (MS) meters to be integrated into the WRMSLs (MS2C loops), the Section Half Multisensor Logger (SHMSL; MS2K loop), and in the paleomagnetism laboratory to run the MS2B dual-frequency discrete-sample sensor and a small-diameter MS2C loop sensor;
- A Bartington MS2B dual-frequency sensor for rapid determinations of susceptibility on discrete samples as a supplement to the Agico KLY-4 KappaBridge;
- An Agico MFK2-FA dual-frequency Kappabridge MS meter to replace the aging Agico KLY-4 Kappabridge MS system, which runs via a DOS emulator and is no longer supported by the vendor;
- A new carbon-hydrogen-nitrogen-sulfur (CHNS) analyzer (Thermo FlashSmart Elemental Analyzer) to replace the aging Flash EA1112 CHNS analyzer, which had developed a fracture in one of its combustion furnaces;
- A Brüker AXS Tracer-5g portable X-ray fluorescence spectrometer (pXRF) to replace the Olympus DELTA Premium pXRF, which uses a software architecture that is no longer supported by Microsoft; and
- A Perkin Elmer TriCarb 4910 liquid scintillation counter (LSC) and computer to replace the aging Wallac LSC in the Radiation Van.

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 the *JOIDES Resolution* and on shore. The LWG technical and science leads attend Issues Management Team meetings to help management better prioritize the LWG efforts. 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 FY20.

Shipboard laboratory support

More than 4,900 core sections were processed through the shipboard laboratories during the three FY20 expeditions, and more than 28,000 samples were taken. Shipboard technical staff and expedition scientists made well over 1.6 million shipboard measurements on FY20 samples and placed more than 8,900 images (sections, close-ups, and microimages) in the database archive.

During the ship tie-up period, transit, and dry dock, TAS modified the layout of the tables in the Core Description area to improve the use of the space and to provide additional desktop space and storage

shelves for scientists; installed new flooring in the Core Splitting Room; modified the overhead lighting in the upper tween storage area to increase the space available for storage; installed two new large refrigerators, one in the chemistry laboratory and one in the chemical storage area; replaced the –86°C freezer on the Foc's'le deck; designed and installed a new light source for the SHIL; and designed and installed a new *P*-wave velocity caliper (PWC) frame and updated the PWC software.

7. Development, IT, and Databases

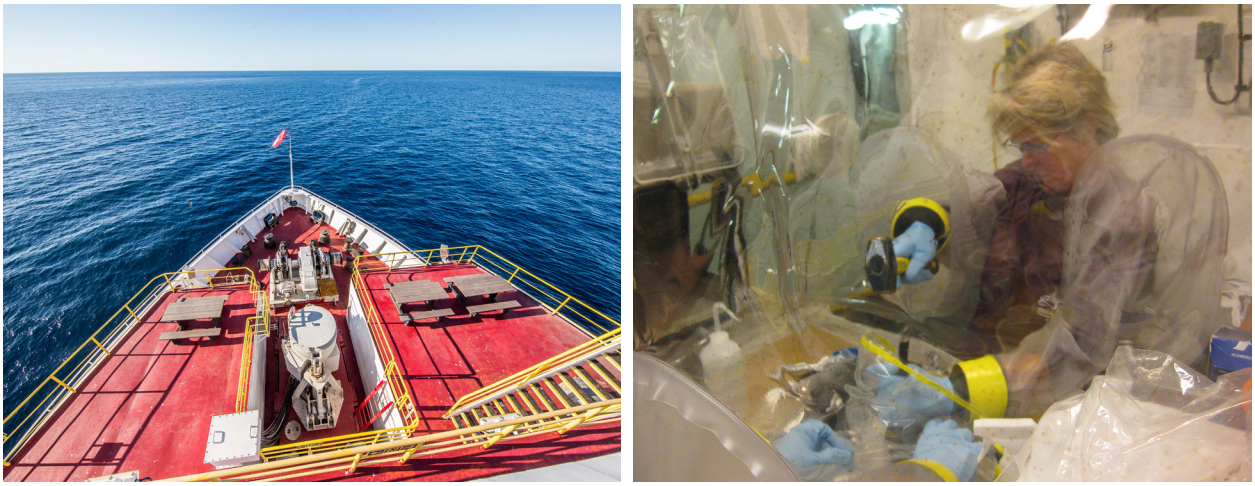
The Development, IT, & Databases (DITD) department oversees JRSO data collection/storage, management, and archiving; maintains IT infrastructure on ship and shore; develops and maintains instrument-specific software for data acquisition; manages the Programs' extensive database services; and administers JRSO's IT security program.

Expedition data services and program-wide data query services

During expeditions, laboratory work aboard the *JOIDES Resolution* produces a vast amount of data that are stored in the Laboratory Information Management System (LIMS). LIMS data collected during JRSO Expeditions 385 and 378 were successfully transferred to shore, merged with the cumulative LIMS database, and made available online to participating scientists. More than 65,350 downloads were made from the LIMS database during FY20. Additionally, data from Expeditions 361, 362, and 366 were published on Zenodo and assigned digital object identifiers (DOIs). These data are available online at **https://zenodo.org/communities/iodp**.

Operation and maintenance

JRSO and ODL AS replaced the very small aperture terminal (VSAT) system. This initiative added dual-band capability (C and Ku bands) and increased JRSO's available bandwidth to a 3 Mbps synchronous committed information rate (CIR) in support of voice and data applications. Bandwidth capacity is burstable up to 6 Mbps download and 5 Mbps upload. JRSO configured and successfully placed new Oracle Database Appliances (ODAs) into service on ship and shore, providing customers with vastly improved data query performance and availability. The annual JRSO IT risk assessment began in May.



From left: Heading out to sea. Collecting microbiology rock samples in the glove box.

In June, JRSO requested that a TAMU Provost IT security expert conduct a thorough practice IT security audit, which began in early August. This audit rehearsal should be completed by November.

8. Curation

Core Curation provides services in support of IODP core sampling and curation of the core collection archived at the Gulf Core Repository (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 FY20, the GCR processed a total of 22,613 sample requests and hosted a sample party for Expedition 383, during which an additional 30,000 samples were taken. The Expedition 385 sample party was canceled because travel restrictions due to COVID-19 prevented science party participation. JRSO staff collected ~10,600 Expedition 385 samples, plus an additional ~11,000 Expedition 383 samples that were not completed during the January sample 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. This year, the GCR hosted TAMU classes for undergraduate and graduate students, an annual workshop for students from Austin Community College, and a French-based visual artist, Angelika Markul, who is collaborating with Expedition 364 Co-Chief Scientist Sean Gulick (University of Texas at Austin) on a video installation exhibit. JRSO staff gave tours of the GCR to more than 140 visitors, including a TAMU Oceanography class, the International Association of Drilling Contractors student drilling organization, the TAMU OCEANS club, Chevron fellows, and future *JOIDES Resolution* Onboard Outreach Officers.

Onshore XRF scanning

More than 2,600 core sections were XRF scanned this year, and 775 cores were imaged on the shore-based SHIL.

9. Publication Services

The Publication Services (Pubs) department provides publications support services for JRSO drilling expeditions and editing, production, and graphics services for all required reports and scientific publications as defined in the JRSO cooperative agreement with NSF. IODP publications for FY20 included JRSO quarterly and annual reports; *Scientific Prospectuses* for JRSO and ESO expeditions; *Preliminary Reports* for JRSO expeditions and MarE3 expeditions; *Proceedings of the International Ocean Discovery Program* volumes for JRSO expeditions; and Data Reports for JRSO and ESO 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 FY20, JRSO staff in College Station, Texas, hosted postexpedition editorial meetings for three JRSO expeditions and conducted a virtual postexpedition editorial meeting for another.

IODP scientific publishing and publication coordination

IODP Pubs produced and published six *Scientific Prospectuses*, three *Preliminary Reports*, and two Expedition Reports volumes for JRSO, MarE3, and ESO expeditions. During FY20, IODP Pubs also coordinated postexpedition publications and published Expedition Research Results content for 12 expeditions, including 19 data reports. IODP Program publications are indexed on Google Scholar, and IODP Pubs is a member of the Committee on Publications Ethics (COPE).

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, 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 more than 90,000 visits to the IODP Publications website during FY20.

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 37,700 entries related to IODP and the preceding scientific ocean drilling programs, representing more than 50 years of scientific ocean drilling research. In FY20, more than 3,800 queries were run on the Scientific Ocean Drilling Bibliographic Database, and additional records for more than 5,900 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 more

Sunset with the *JOIDES Resolution* at the dock in Lautoka, Fiji.

than 135,000 DOI resolutions for Integrated Ocean Drilling Program and IODP publications and more than 295,900 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 validation services.

IODP Pubs deposited 35 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 400 records from expedition-related research published in outside literature into the Expedition Research Results collection, which can be viewed at **https://www.scienceopen.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 the 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 quarterly crawls incrementally update the archive with new files. In addition, the archive houses legacy publication sites for DSDP and ODP. At the end of FY20, the JRSO archive collection contained 322.4 GB of data and more than 4 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 FY19 (July–September 2019) on 14 November 2019
- First quarter of FY20 (October–December 2019) on 14 February 2020
- Second quarter of FY20 (January–March 2020) on 8 May 2020
- Third quarter of FY20 (April–June 2020) on 31 July 2020

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

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 FY20 Annual Program Plan: **http://iodp.tamu.edu/publications/PP/IODP_JRSO_FY20_APP.pdf**

IODP JRSO FY20 Quarterly Reports: **http://iodp.tamu.edu/publications/reports.html**

COVID Mitigation Protocols Established for Safe JR Operations (COPE): **http://iodp.tamu.edu/scienceops/JR_COVID-Mitigation-Protocols-2020-07-02.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.esdu/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**

2020 Scientific Ocean Drilling Bibliographic Database and Publication Impact Report: **http://iodp.tamu.edu/publications/AGI_studies/2020_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**

HathiTrust 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**