FY12 Annual Report

Integrated Ocean Drilling Program
U.S. Implementing Organization

Handling downhole tool string

Integrated Ocean Drilling Program

A historical perspective

The Integrated Ocean Drilling Program (IODP) is an international marine research program that monitors subseafloor environments and explores Earth's history and structure as recorded in seafloor sediments and rocks. IODP builds upon the earlier successes of the Deep Sea Drilling Project (DSDP) and the Ocean Drilling Program (ODP), which revolutionized our view of Earth's history and global processes through ocean basin exploration. IODP represents the latest generation of these highly successful scientific ocean drilling initiatives, with principal research themes outlined in the Initial Science Plan: "Earth, Oceans and Life: Scientific Investigations of the Earth System Using Multiple Drilling Platforms and New Technologies."

IODP greatly expands on the previous programs through the use of multiple drilling platforms—a riserless drilling vessel, a riser drilling vessel, and mission-specific platforms—operated by three implementing organizations (IOs) to achieve its scientific goals. The riserless drilling vessel *JOIDES Resolution,* operated by the U.S. Implementing Organization (USIO), allows IODP to drill more deeply than is possible with the other platforms while continuing 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 IODP to drill for months to a year or more 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 IODP 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.

IODP Management International, Inc. (IODP-MI), a nonprofit corporation with an international membership of academic institutions, serves as the central management organization for IODP and is responsible for Program-wide science planning and oversight, as well as provision of continuous performance evaluation and assessment of all elements of IODP. Science planning is provided by the Science Advisory Structure (SAS), which involves many scientists and engineers on numerous standing committees and panels. Each of the IOs provides liaisons with appropriate expertise to interact with SAS panels and other IODP-MI working groups and task forces.

The USIO comprises the Consortium for Ocean Leadership, Inc. (Ocean Leadership), and its partners, Lamont-Doherty Earth Observatory (LDEO) of Columbia University and Texas A&M University (TAMU). Ocean Leadership is the prime contractor, with ultimate responsibility for all contractual obligations entered into by the USIO. LDEO and TAMU serve as subcontractors that contribute distinct but complementary capabilities that collectively support the full range of activities necessary for implementing scientific drilling programs on the *JOIDES Resolution.* Administrative services in support of TAMU activities are provided by the Texas A&M Research Foundation (TAMRF). In this document, references to TAMU include TAMRF.

Stairway on the main deck at sunset

FY12 Annual Report

Integrated Ocean Drilling Program

United States Implementing Organization

Consortium for Ocean Leadership, Inc.

Lamont-Doherty Earth Observatory of Columbia University

Texas A&M University

National Science Foundation
Contract OCE-0352500

IODP Management International, Inc.
Contract IODP-MI-05-03

1 October 2011–30 September 2012

Lowering an ROV platform through the moonpool

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Cover photo: The* JOIDES Resolution *in Barbados

Back cover photo: Downhole tools laid out for deployment

David Divins

Director of Ocean Drilling Programs
Consortium for Ocean Leadership, Inc.

David Divins joined the Consortium for Ocean Leadership (formerly Joint Oceanographic Institutions) in January 2006 as the Associate Director, Ocean Drilling Programs, and became Director, Ocean Drilling Programs, in August 2006. Divins came to Ocean Leadership from the National Oceanic and Atmospheric Agency's National Geophysical Data Center (NGDC) in Boulder, Colorado, where he was a member of the Marine Geology and Geophysics Division from 2000 to 2005. Before joining NGDC, Divins was a Research Scientist at the University of Colorado Cooperative Institute for Research in Environmental Science from 1991 to 2000. Divins received his B.A. from Boston University (1981) and his Ph.D. in Oceanography from Texas A&M University (TAMU) (1991). While at TAMU he was involved in many Ocean Drilling Program (ODP) activities, including sailing on an ODP expedition and working in the data management group.

David Goldberg

Director, Borehole Research Group
Lamont-Doherty Earth Observatory of Columbia University

Dave Goldberg joined the Lamont-Doherty Earth Observatory (LDEO) of Columbia University as a Research Scientist in 1987 and has served as Director of the LDEO Borehole Research Group since 1992. Goldberg earned his S.B. in Geophysics (1981) and S.M. in Marine Geophysics (1981) from Massachusetts Institute of Technology and his Ph.D. in Geophysics (1985) and M.B.A. (1989) from Columbia University. He has sailed on nine Deep Sea Drilling Project and ODP expeditions and is involved in many synergistic activities, including the Department of Energy's Methane Hydrate Advisory Committee; LDEO and Columbia University's Earth Microbiology Initiative; the LDEO Laboratory for Ocean Drilling, Observation, and Sampling; and the Integrated Ocean Drilling Program's (IODP's) International Scientific Logging Consortium.

Brad Clement

Director, Integrated Ocean Drilling Program
Texas A&M University

Brad Clement was appointed Director of IODP at TAMU in August 2009. Clement chaired the U.S. Science Advisory Committee (USAC) and has a long history of involvement with IODP, having sailed on four expeditions, worked as an ODP 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 and as Adjunct Associate Professor of Geophysics at TAMU from 1984 to 1988. Clement was Associate Editor of the *Journal of Geophysical Research* and has served on several American Geophysical Union committees.

Executive Summary

JOIDES Resolution *during the Expedtion 342 port call*

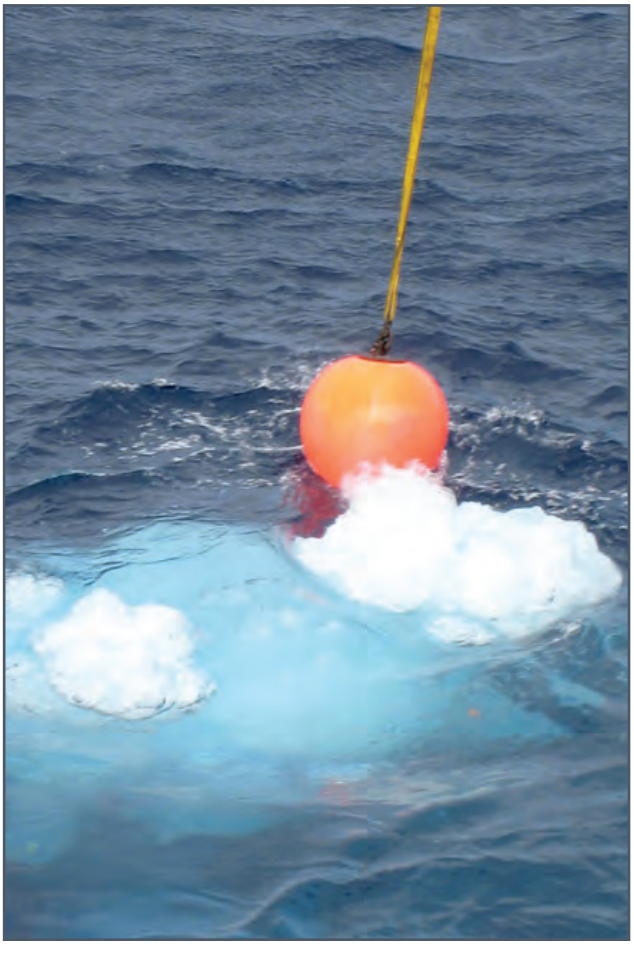
The Integrated Ocean Drilling Program (IODP) U.S. Implementing Organization (USIO) successfully completed five cutting-edge expeditions this year that will advance global understanding of Earth systems. Over the course of these expeditions, the USIO installed new subseafloor observatories in the Mid-Atlantic Ridge; collected the first sediment samples ever recovered from the deep subseafloor in the Gulf of Cádiz, documenting a 1.5 million year record of climate change; studied geophysical properties of gabbroic rock in situ for the first time in scientific ocean drilling; and conducted third-party tool sea trials that collected the first in situ pressure measurement ever made on the Atlantic margin.

Expedition 336, which spanned two fiscal years, drilled into the North Pond region of the Atlantic Ocean to examine the microbiology of a sediment pond and the underlying young, cold, and hydrologically active flank of the Mid-Atlantic Ridge. Two fully functional CORK observatories were installed in new holes, and an instrument and sampling string were replaced in an existing hole to allow scientists to analyze the microbial communities in deep sediments (obtained

Life boats on the JOIDES Resolution

from cores taken during Expedition 336) and basement crustal fluids (obtained over time with the CORKs). Data collected during Expedition 336 will also provide an excellent point of comparison for seafloor observatory studies taking place at the Juan de Fuca Ridge.

The Gulf of Cádiz—the world's premier contourite laboratory—was targeted as a key location for the Expedition 339 investigation of Mediterranean Outflow Water (MOW) flow through the Strait of Gibraltar gateway, its influence on global circulation and climate, and the effects of tectonic activity on the evolution of the Strait of Gibraltar gateway and margin sedimentation. More than 4.5 km of contourite cores were retrieved that provide insight into the distinctive character of contourites and validate the existing paradigm for this type of sedimentation. Expedition 339 scientists also collected evidence for a "tectonic pulse" at the junction between the African and European tectonic plates and unearthed a record of climate change covering at least four major ice ages over the past 1.5 million years. The core collected during Expedition 339 provides a new marine archive to compare against numerous land-based records and ice core records from Greenland and Antarctic ice sheets.



A bubble of expanding air around the buoy during a VSP experiment

The *JOIDES Resolution* stopped briefly at the Mid-Atlantic Ridge for Expedition 340T, a stand-alone operation to conduct borehole logging in IODP Hole U1309D. The goal of this mini-expedition was to determine whether reflectivity patterns seen in prior seismic imaging from this gabbroic rock could be interpreted in terms of hydration pathways within young oceanic crust. Results from Expedition 340T documented the geologic explanation for at least some of the impedance contrast and confirmed that the borehole velocity of altered olivine-rich troctolite intervals at Site U1309 is sufficiently distinct from surrounding rock to produce a multichannel seismic reflection. Measurements collected during Expedition 340T confirm that seismic survey data may be used in the future to infer the pattern of seawater circulation within the deeper crust, making it easier to map

The JOIDES Resolution *in Williamstad, Curaçao, at dusk*

subseafloor geophysical structures and advance our understanding of how rifting and magmatism work together to form a new plate.

Expedition 340 traveled to the Lesser Antilles arc, a row of Caribbean islands where an old tectonic plate sinks back into the convecting mantle beneath, to study the constructive and destructive processes related to island arc volcanism. Because volcanic activity in island arcs is associated with potentially large geohazards (e.g., explosive eruptions and tsunamis), it is important to understand the evolution of these volcanoes and the histories of their related landslides. Expedition 340 aimed to combine the current subaerial geological record with information from related submarine deposits to provide a more complete picture of volcanic activity in this geological setting. Examination of data acquired during Expedition 340 may result in a better understanding of the mechanisms involved in the transport and deposition of volcanic debris avalanche deposits, which may in turn lead to assessment of the

More from the numbers

FY12 expedition operations

Operations time (days)	*244.6*
Time on site (days)	*190.4*
Time coring/drilling (days)	*156.1*
Time logging (days)	*15.1*
Distance traveled (nmi)	*11,107.9*
Sites	*32*
Holes	*83*
Cores	*1,852*
Total penetration (m)	*18,587.5*
Interval drilled (m)	*2,411.0*
Interval cored (m)	*16,176.5*
Core recovered (m)	*13,602.8*

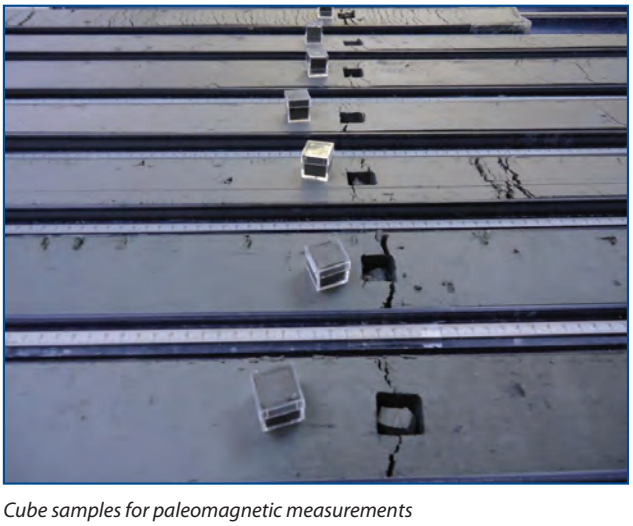
NSF IODP Program Director J. Allan explaining aspects of coring to a group of Portuguese officials

potential for volcanic hazards associated with these avalanches.

Sea trials of the Motion Decoupled Hydraulic Delivery System (MDHDS) with the temperature-dual-pressure probe (T2P) were conducted at Site U1402 on the New Jersey margin before beginning Expedition 342. These efforts successfully acquired in situ data with complete decoupling from the drill string, thereby negating the effect of ship heave on the quality of the data. This deployment was the culmination of the testing and development phase of a delivery system designed to remotely deploy and recover penetrometers, allowing the rapid measurement of in situ pressure in sediment and opening an exciting range of future science for the drilling program.

The Expedition 342 drilling area was positioned to capture sedimentary records of ocean chemistry and circulation changes beneath the Deep Western Boundary Current in the northwest Atlantic Ocean Newfoundland ridges. The expedition was designed to recover Paleogene sedimentary sequences with unusually high deposition rates across a wide range of water depths to study the rate and magnitude of past ecosystem changes and to further our understanding of climate change, ocean currents, and glaciations. Intermittent calcareous sediments were discovered in the Cretaceous, Paleocene, and early to middle Eocene at 4.5 km paleodepth, suggesting a deep Atlantic carbonate compensation depth (CCD) during these times. Sequences were recovered with sedimentation rates high enough to enable studies of the dynamics of past abrupt climate change, including transitions into both "greenhouse" and "icehouse" climate states, the full magnitudes of hyperthermal events, and rates of change in the CCD. The expedition also unexpectedly recovered a number of Cretaceous "critical boundaries" that were drilled opportunistically when they were encountered near or above target depth for a given site.

The USIO continued to produce and publish scientific publications—the primary method of disseminating IODP research to the scientific community and the public—for all three IODP implementing organizations (IOs). During FY12, IODP Expedition Reports DVDs for seven expeditions were distributed to more than 800 program member offices, universities, libraries, and geological organizations worldwide, and online IODP scientific publications were accessed more than 229,000 times. The annual Ocean Drilling Citation Database Report, a tool for documenting the impact of IODP science through publications, was expanded this year to include the number of times scientific publications have cited primary IODP expedition research since 2003 (a total of 5,000 citations). Efforts to improve distribution



Cube samples for paleomagnetic measurements

of IODP scientific publications and documentation of how postexpedition research impacts the scientific community through publications led to two new IODP Publications website projects. Users can now download or burn a replica of the Expedition Reports portion of any *IODP Proceedings* volume, and a "cited-by linking" project was started that will enable readers to determine which journals or books have cited IODP publications.

The *JOIDES Resolution* continued to serve as a platform for education, with Onboard Education Officers promoting USIO expeditions and IODP science through the joidesresolution.org website and other social media tools. Live ship-to-shore video broadcasts and expedition video updates reached tens of thousands of viewers worldwide and throughout the United States. The joidesresolution.org website received more than 100,000 visits this year, and activity on other *JOIDES Resolution* and IODP Science News social networking sites also increased dramatically. The largest group to ever visit the *JOIDES Resolution*—nearly 800 local and regional high school and college-level students, scientists, and political dignitaries—toured the ship during the January 2012 port call in Lisbon, Portugal. Throughout the year, the USIO-published IODP community newsletter—*Core Discoveries*—provided readers with timely updates and information on IODP activities.

Alliances with national museums and science partners resulted in grant-funded development of educational materials and websites and partly supported the traveling "Getting to the Core: the *JOIDES Resolution*" museum exhibit and two School of Rock workshops. One of these workshops was designed to kick-start development of Ship-to-Shore Science grant pilot projects that will use the *JOIDES Resolution* as a platform for informal science education; one was designed to collect participant feedback for a full-scale implementation proposal to bring ocean drilling science to minority-serving institutions. In addition, two USIO-managed diversity outreach initiatives provided educational and career-building experiences to minority students.

Compressed core liner

This IODP-USIO Fiscal Year 2012 Annual Report details these accomplishments and other activities undertaken in support of National Science Foundation (NSF) Contract OCE-0352500 and IODP Management International, Inc. (IODP-MI), Contract IODP-MI-05-03 during the period from 1 October 2011 to 30 September 2012.

More online

IODP-USIO website: iodp-usio.org

IODP Science Plan: iodp.org/isp

IODP-USIO FY12 Annual Program Plan: iodp.tamu.edu/publications/PP.html

IODP-USIO FY12 Quarterly Reports: iodp.tamu.edu/publications/AR.html

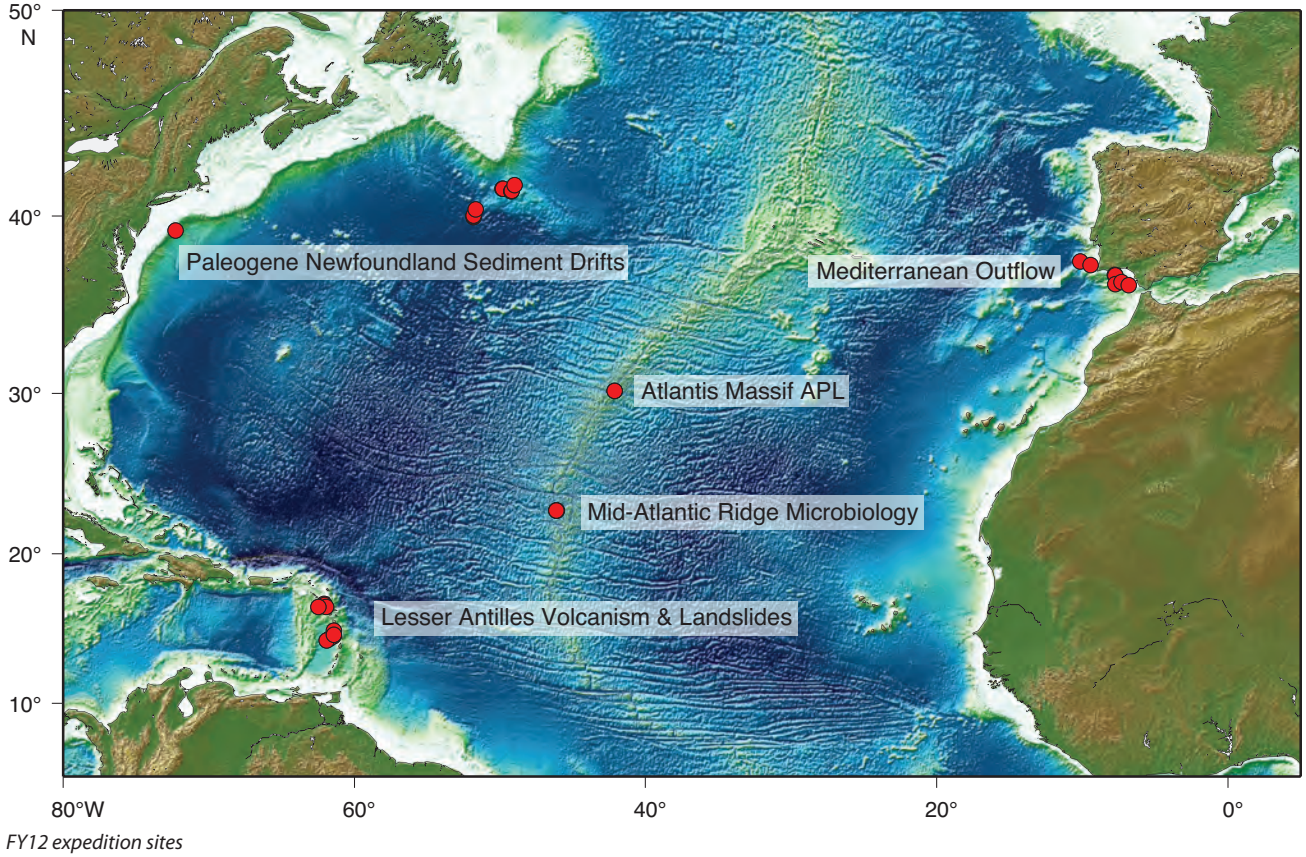
The* JOIDES Resolution *derrick at sunrise

IODP-USIO Expeditions

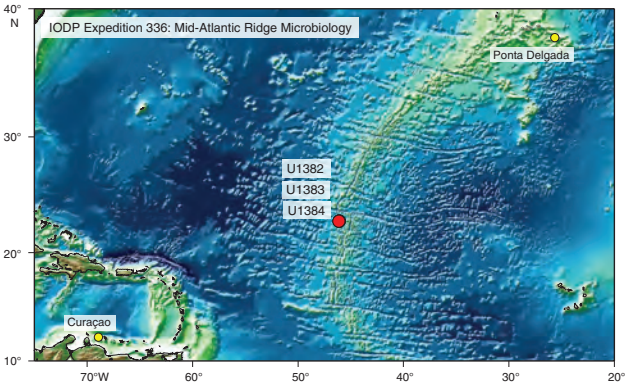
Expedition 336: Mid-Atlantic Ridge Microbiology

Expedition 336 (16 September–16 November 2011) successfully initiated subseafloor observatory science at a young mid-ocean-ridge flank setting. The four sites drilled during this expedition are located in the North Pond region of the Atlantic Ocean. This area is known from previous ocean drilling and site survey investigations as a site of particularly vigorous circulation of seawater in permeable 8 Ma basaltic basement underlying a <300 m thick sedimentary pile. Understanding how this seawater circulation affects microbial and geochemical processes in the uppermost basement was the primary science objective of Expedition 336 in service of a fundamental objective of the IODP Initial Science Plan (ISP)—study of the subseafloor biosphere.

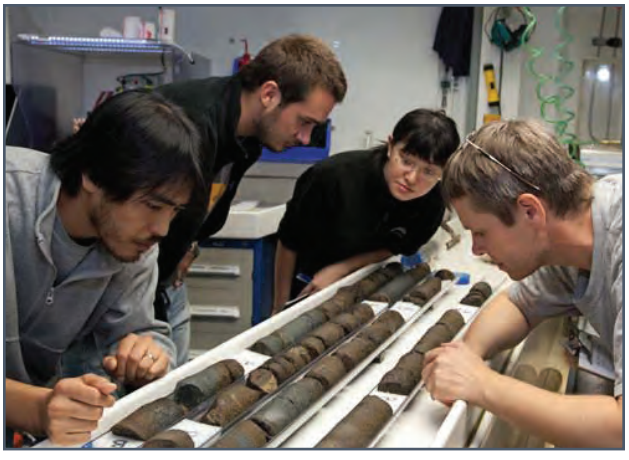
Major strides in ridge-flank studies have been made with subseafloor borehole observatories (CORKs) because they facilitate combined hydrological, geochemical, and microbiological studies along with controlled experimentation in the subseafloor. During Expedition 336, two fully functional observatories were installed in two newly drilled holes (U1382A and U1383C) and an instrument and sampling string were placed in an existing hole (395A). The CORK observatory in Hole U1382A has a packer seal in the bottom of the casing and monitors/samples a single zone in uppermost oceanic crust extending from 90



FY12 expedition sites



Expedition 336 site map



Examining core in the splitting room

to 210 meters below seafloor (mbsf). Hole U1383C was equipped with a three-level CORK observatory that spans a zone of thin basalt flows with intercalated limestone (~70–146 mbsf), a zone of glassy, thin basaltic flows and hyaloclastites (146–200 mbsf), and a lowermost zone (~200–331.5 mbsf) of more massive pillow flows with occasional hyaloclastites in the upper part.

Expedition 336 aimed to address two major scientific questions: (1) Where do deep-seated microbial communities come from? (2) What is the nature of the microbial communities harbored in young ridge flanks, and what is their role in the ocean crust weathering? North Pond is the ideal location to test opposing hypotheses concerning the first question, which have important mechanistic implications concerning dispersal mechanisms in the deep biosphere and evolutionary consequences for microbial life on Earth. With the samples recovered, scientists will analyze the microbial communities in both deep sediments (obtained from cores taken during the expedition) and basement crustal fluids (obtained with the CORKs postexpedition). The low heat flow ridge flank at North Pond represents an ideal model system for studying biologically mediated oxidative basement alteration in an attempt to answer the second question. The work completed during Expedition 336 will also provide an excellent point of comparison for the studies taking place at the Juan de Fuca Ridge.

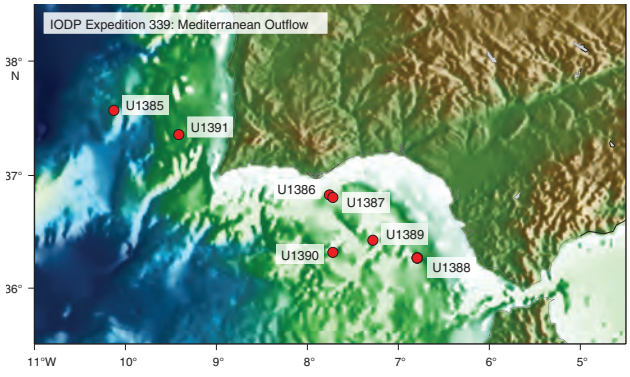
Expedition 339: Mediterranean Outflow

During Expedition 339, five sites were drilled in the Gulf of Cádiz and two sites were drilled off the West Iberian margin from November 2011 to January 2012. The Gulf of Cádiz was targeted for drilling as a key location for the investigation of MOW flow through the Strait of Gibraltar gateway and its influence on global circulation and climate. The gulf is also a prime area for understanding the effects of tectonic activity on the evolution of the Strait of Gibraltar gateway and margin sedimentation.

Drilling in the Gulf of Cádiz and off the West Iberian margin offers a unique opportunity to tackle key scientific goals enumerated in the IODP ISP related to (1) oceanic gateways and their global influence, (2) paleocirculation and climate, (3) rapid climate

More from the IODP scientists

"It feels much like pioneering the exploration of outer space in our own 'Apollo' mission. We don't understand most of this planet. We know more about the surfaces of other planets in the solar system than we do about the ocean floor. The North Pond is perfect because it is perfectly average and has seen scientists of all stripes recording various data about it for the past 40 years. We're building on a great history of research. We're trying to find the bottom of the biosphere." —K. Edwards, Expedition 336 Co-Chief Scientist



Expedition 339 site map

Expedition 339 scientists excited about core recovery

change, (4) sea level and related controls on sediment architecture, and (5) neotectonic activity and controls on continental margin sedimentation.

The Gulf of Cádiz is the world's premier contourite laboratory and thus presents an ideal testing ground for the contourite paradigm. Existing models for contourite deposition were found to be sound following recovery of >4.5 km of contourite cores that include the first sediment samples ever recovered from the deep subseafloor in this region. These cores provide extensive marine sediment resulting from a deep, powerful Mediterranean Outflow through the Gibraltar gateway that began more than 4.5 million years ago. Further study of these models will undoubtedly allow us to resolve outstanding issues of depositional processes, drift budgets, and recognition of fossil contourites in the ancient record onshore.

Expedition 339 scientists found evidence for a "tectonic pulse" at the junction between the African and European tectonic plates. This pulse caused repeated rising and falling of structures in and around the Strait of Gibraltar, a gateway that affects the circulation of major ocean currents, and led to strong earthquakes and tsunamis that dumped large flows of debris and sand into the deep sea. The expedition also verified the presence of a larger than expected quantity and extensive distribution of clean and well-sorted contourite sands. These sands represent a completely new and important exploration target for potential oil and gas reservoirs. Preliminary work has shown a remarkable record of orbital-scale variation in bulk sediment properties of contourites at several of the drift sites and good correlation between all sites. Climate control on contourite sedimentation is clearly significant at this scale; further work will determine the nature of controls at the millennial scale.

One of the sites drilled during the expedition on the west Portuguese margin unearthed a record of climate

More from the IODP scientists

"The recovery of nearly four kilometers of contourite sediments deposited from deep underwater currents presents a superb opportunity to understand water flow from the Mediterranean Sea to the Atlantic Ocean. Knowledge of this water flow is important for understanding Earth's climate history in the last five million years." —J. Allan, IODP Program Director at the U.S. National Science Foundation

"We set out to understand how the Strait of Gibraltar acted first as a barrier and then a gateway over the past six million years. We now have that understanding and a record of a deep, powerful Mediterranean outflow through the Gibraltar gateway."—J. Hernandez-Molina, Expedition 339 Co-Chief Scientist

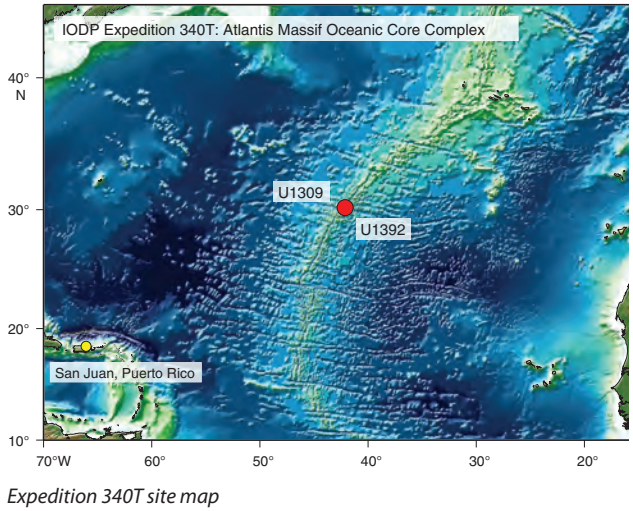
Prepping the G-gun cluster for the vertical seismic profile experiment

change over the past 1.5 million years, covering at least four major ice ages and providing a new marine archive to compare against ice core records from Greenland and Antarctic ice sheets, and with numerous land-based records. Shipboard analyses have already revealed the first evidence of climate cycles. Yet, it will take many months and even years of postexpedition research in shore-based laboratories to properly decode the signals of climate change in the past, to document periods of very rapid change comparable to rapid global warming today, and hence help understand what we might expect in Earth's future.

Expedition 340T: Atlantis Massif Oceanic Core Complex

During Expedition 340T (15 February–2 March 2012), borehole logging was completed in IODP Hole U1309D on the domal core of Atlantis Massif just west of the spreading axis of the Mid-Atlantic Ridge. This expedition aimed to test the hypothesis that highly altered intervals and/or fluid-bearing fault zones at depth might be responsible for density/seismic contrasts sufficient to reflect seismic energy. Such contrasts were found in the dominantly gabbroic section cored during IODP Expedition 304/305. If this hypothesis proves true, it will allow interpretation of the reflectivity patterns in terms of hydration pathways within young ocean crust. Atlantis Massif provided a good location for this study because it includes rock types that are typically only found much deeper in ocean crust. Geophysical properties of these gabbroic rocks were studied in situ for the first time during Expedition 340T, providing measurements that will allow scientists to infer how gabbroic rocks will appear on future seismic surveys, making it easier to map subseafloor geophysical structures.

Prior seismic imaging showed considerable reflectivity within the footwall of this oceanic core complex, and new results document the geologic explanation for at least some of the impedance contrast. Data from



Expedition 340T site map

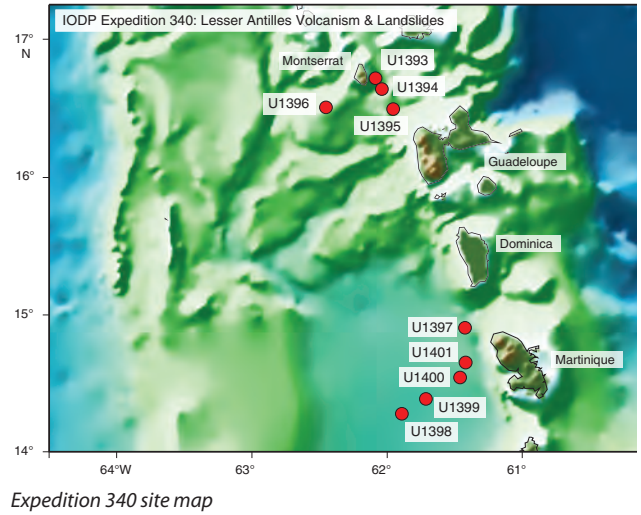
Carrying the last core of Expedition 340

Expedition 340T confirm that borehole velocity of altered olivine-rich troctolite intervals at Site U1309 is sufficiently distinct from surrounding rock to produce a multichannel seismic reflection. Small dips in temperature found in borehole fluid adjacent to known faults suggest that percolation of seawater along the fault zone is still active, not a past process that produced the alteration documented in Expedition 305 cores. Expedition 340T obtained the first seismic coverage of the 800–1400 mbsf portion of Hole U1309D. Vertical seismic profile station coverage at zero offset now extends the full length of the hole, including the uppermost 150 mbsf, where detachment processes are expected to have left their strongest imprint. Opportunistic sampling of a seafloor feature, now designated IODP Site U1392 and located a few meters from Hole U1309D, recovered fragments of possible cap rock that may provide information on processes within the exposed detachment.

Two observations made during Expedition 340T inform young ocean lithosphere studies in general. Each required minimum possible disturbance approaching and reentering the hole. Visual observation of whether the well was "producing" (flow out of the hole) addresses fluid flow within the crust and chemical exchange with seawater in maturing lithosphere. Measurement of borehole fluid temperature assesses conditions that may be encountered by future ultradeep drilling/logging of an intrusive oceanic section and tests for possible fluid flow (temperature deviations) within fault zones of Atlantis Massif's footwall.

Expedition 340: Lesser Antilles Volcanism and Landslides

The primary aim of Expedition 340 (2 March–17 April 2012) was to further understanding of the constructive and destructive processes related to island arc

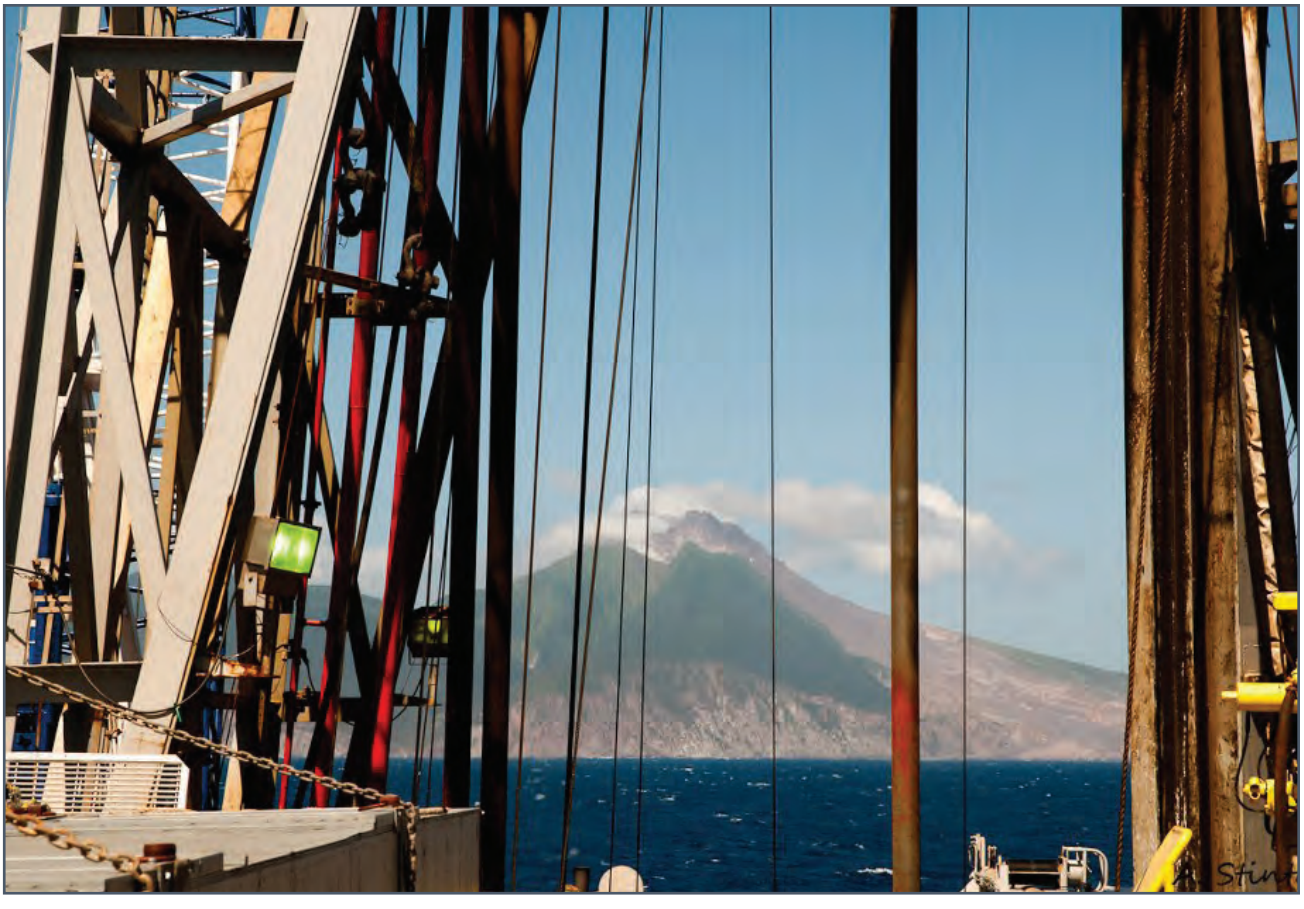


Expedition 340 site map

More from the scientists

"This [Expedition 340T] work significantly adds to our ability to infer ocean crust structure and composition, including predicting how ocean crust has 'aged' in an area, thereby giving us new tools for understanding ocean crust creation from Earth's mantle."—J. Allan, IODP Program Director at the U.S. National Science Foundation

"Vast ocean basins cover most of the Earth, yet their crust is formed in a narrow zone. We're studying that source zone [during Expedition 340T] to understand how rifting and magmatism work together to form a new plate."—D. Blackman, Expedition 340T Co-Chief Scientist



View of Montserrat Island from the JOIDES Resolution *rig floor during Expedition 340*

volcanism. Processes occurring along these arcs are among the most fundamental on Earth. Styles of magmatism and eruptive activity are diverse in this geological setting not only between different arcs, but also between the different islands that make up an arc. Because of the association of volcanic activity in island arcs with potentially large geohazards (explosive eruptions and tsunamis), it is imperative to further investigate and thus better understand the evolution of these volcanoes and the histories of their related landslides.

Knowledge of island arc volcanism is largely limited to the subaerial geological record. Combining this record with information from related submarine deposits will provide a more complete picture of volcanic activity in this geological setting. The Lesser Antilles arc is well suited to achieving this combined record, offering a diverse range of magmatic and eruptive styles across a relatively small geographic area. In addition, the frequency of flank collapse events that result in the deposition of debris avalanches is high, with the style of flank collapse varying along the arc.

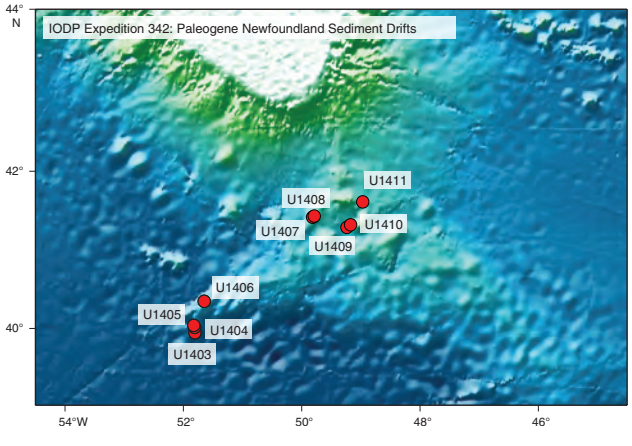
The scientific objectives for Expedition 340 were (1) to understand the timing and emplacement processes of potentially tsunamigenic large debris avalanche emplacements, (2) to document the long-term eruptive history of the arc to assess volcano evolution (cycles of construction and destruction) and major volcanic hazards, (3) to characterize the magmatic cycles and long-term magmatic evolution of the arc, (4) to document dispersal of sediment into the deep ocean, and (5) determine the processes and element fluxes

associated with submarine alteration of volcanic material. These objectives are related to the overarching ISP objective of "Recycling of Oceanic Lithosphere into the Deeper Mantle and Formation of Continental Crust."

Data acquired during this expedition will be utilized to further investigate magmatic evolution and eruptive activity along the Lesser Antilles arc. In addition, a better understanding of the mechanisms involved in both the transport and deposition of volcanic debris avalanche deposits may be reached, and the potential for volcanic hazards associated with these avalanches may be assessed.

Expedition 342: Paleogene Newfoundland Sediment Drifts

Expedition 342 (1 June–30 July 2012) was designed to recover Paleogene sedimentary sequences with unusually high deposition rates across a wide range of water depths to answer a series of pressing questions about the rate and magnitude of past ecosystem changes. The drilling area was positioned to capture sedimentary records of ocean chemistry and circulation changes beneath the Deep Western Boundary Current in the northwest Atlantic Ocean to further our understanding of climate change, ocean currents, and glaciations. The major objectives of Expedition 342 addressed the extreme climates and transient climate ISP objectives. In addition, two operational days were dedicated to a sea trial of the MDHDS developmental tool (see "Third-party tool support" in "Operational and Technical Support").



Expedition 342 site map

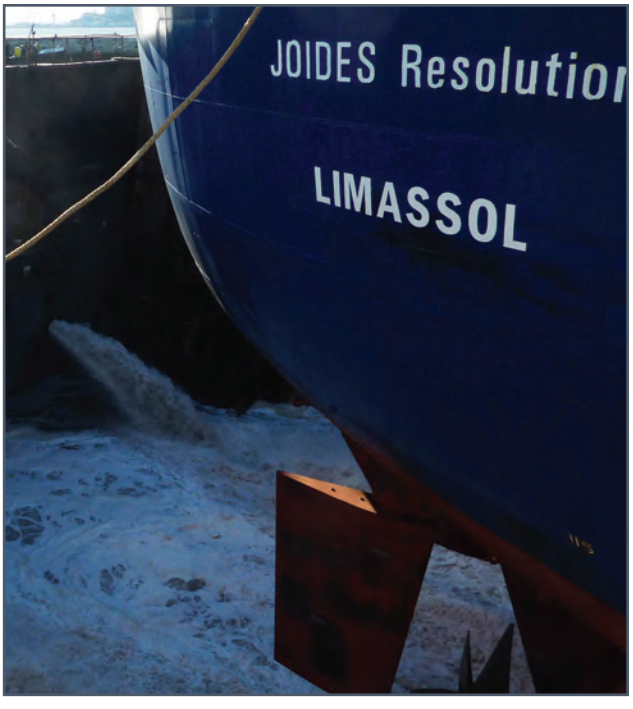
Examining the Cretaceous/Paleogene (K/P) boundary

More from the IODP scientists

"This is a site that will go down truly in history, I think. Because we have, by far and away, the most detailed record of this sort of transition into a fully glaciated world—that exists anywhere on the globe—right here. . . . In our hold are cores of the North Atlantic reef, a great ocean suffocation, a meteor plowing in to the Yucatan, fantastic 'died yesterday' fossils of all kinds (never seen before out in the deep blue sea), extreme global change events when the world became a hothouse, and a grand-daddy of all glaciations when Antarctica became the ice continent . . . a tour of the sweet spots of the ancient world over the past 120 million years." —D. Norris, Expedition 342 Co-Chief Scientist

Floating the JOIDES Resolution *off the drydock blocks*

The expedition was primarily targeted at reconstructing the Paleogene CCD in the North Atlantic for reference to recently obtained high-fidelity records of the CCD in the equatorial Pacific. The combination of sites yields a record of the history of CCD change over a 2 km depth range from the ocean abyss to middle range water depths. Notable findings include the discovery of intermittent calcareous sediments in the Cretaceous, Paleocene, and early to middle Eocene at 4.5 km paleodepth, suggesting a deep Atlantic



The JOIDES Resolution *rudder*

CCD during these times. A second major objective of Expedition 342 was to recover clay-rich sequences with well-preserved microfossils and high rates of accumulation in comparison to the modest rates of accumulation typically encountered at pelagic sites. As anticipated, Expedition 342 recovered sequences with sedimentation rates high enough to enable studies of the dynamics of past abrupt climate change, including transitions into both "greenhouse" and "icehouse" climate states, the full magnitudes of hyperthermal events, and rates of change in the CCD. An unexpected finding was the recovery of a number of Cretaceous "critical boundaries," including the Cretaceous/Paleogene (K/Pg) boundary, the Campanian–Coniacian interval, the Cenomanian/Turonian boundary and oceanic anoxic Event (OAE) 2, and the Albian/Cenomanian boundary OAE 1d. These intervals were drilled opportunistically when they were encountered near or above the target depth for a given site.

IODP-USIO FY12 expedition coring and logging summary

Expedition	Meters cored	Cores recovered (number)	Core recovery (%)	Meters logged	Sites logged (%)
336: Mid-Atlantic Ridge Microbiology	645.5	80	56.0	1,514.0	75.0
339: Mediterranean Outflow	6,301.6	681	86.4	3,542.4	71.4
340T: Atlantis Massif Oceanic Core Complex	0.0	0	0.0	1,415.5	50.0
340: Lesser Antilles Volcanism and Landslides	3,487.5	434	68.4	878.2	44.4
342: Paleogene Newfoundland Sediment Drifts	5,741.9	657	94.3	0.0	0.0
Totals	**16,176.5**	**1,852**	**84.1**	**7350.1**	**40.6**

More online

IODP Expedition information: iodp.tamu.edu/scienceops/expeditions.htm

Proceedings of the Integrated Ocean Drilling Program: *iodp.org/scientific-publications*

Preparing the VIT subsea camera deployment system

Operational and Technical Support

The USIO provided operational and technical support for four complete expeditions during FY12 and the ending of a fifth expedition that straddled two fiscal years. Significant improvements were made to shipboard facilities, laboratory infrastructure, and database systems during a dry-dock period and a maintenance period in Curaçao, which also provided an opportunity for planning sessions concerning work for others, laboratory remobilization, and a School of Rock program (see "Education" in "Broader Impacts"). New capabilities were introduced this year through analytical system and engineering tool development and acquisitions, as well as information technology (IT) software development projects. The USIO also continued to coordinate with and provide support for the Center for Deep Earth Exploration (CDEX) and the European Consortium for Ocean Research Drilling (ECORD) Science Operator (ESO).

Expedition planning

Pre-expedition planning meetings were held in College Station, Texas, for FY13 Expeditions 344 (Costa Rica Seismogenesis Project [CRISP] 2), 345 (Hess Deep Plutonic Crust), and 346 (Asian Monsoon). Corrosion issues in the sea chest of the *JOIDES Resolution* required a brief dry dock for repairs, which shifted the expedition schedule and delayed Expedition 340T (Atlantis Massif Oceanic Core Complex) 4 weeks. No operational days were lost.

The USIO coordinated science staffing to fulfill specialized needs and made shipboard berths available to accommodate education and outreach efforts (see "Education" in "Broader Impacts"). Science staffing was completed this year for FY12 Expeditions 339 (Mediterranean Outflow), 340T, 340 (Lesser Antilles Volcanism and Landslides), and 342 (Newfoundland Sediment Drifts), including MDHDS participant staffing, and FY13 Expeditions 344, 345, and 341 (Southern Alaska Margin Tectonics, Climate, and Sedimentation). Staffing of FY13 expeditions was re-opened during the last quarter to allow participation of scientists from the newest IODP member country, Brazil.

Clearance applications were submitted to the U.S. State Department for operations in the Exclusive Economic

FY12 USIO expedition science staffing breakdown

	Expedition					
Member country/consortium	**336**	**339**	**340T***	**340**	**342**	**Total**
United States Science Support Program (USSSP)	8	8	2	8	9	35
Japan Drilling Earth Science Consortium (J-DESC)	4	6	0	8	7	25
European Consortium for Ocean Research Drilling (ECORD)	7	10	0	8	9	34
Korean IODP (K-IODP)	1	1	0	0	1	3
IODP-China	1	1	0	1	2	5
Australia-New Zealand IODP Consortium (ANZIC)	0	1	0	1	2	4
India	0	1	0	1	1	3
Total Science Party participants	**21**	**28**	**2**	**27**	**31**	**109**

*Because this was only a 3-day operation to execute an Ancillary Project Letter (APL) during a transit, participants are not counted against the staffing quota.

Shipboard science meeting

Zone (EEZ) waters of Spain and Portugal during Expedition 339; the Montserrat, Guadeloupe, Dominica, and Martinique EEZs during Expedition 340; and the Costa Rica EEZ during Expedition 344; and to include new locations for Expedition 340 sites that were shifted because of proximity to submarine cables. Requests were submitted to the Environmental Protection and Safety Panel (EPSP) and Texas A&M University (TAMU) Safety Panel to extend the drilling depth of Expedition 339 proposed Site GC-09A to 870 mbsf, and the Bureau of Ocean Energy Management was notified of the dates and objectives of Expedition 341 and the MDHDS test during Expedition 342, both of which would take place in U.S. waters. Environmental evaluations for vertical seismic profile (VSP) work during Expeditions 340T, 340, and 344 and the use of acoustic sources as part of the Expedition 344 check shot surveys were submitted to NSF, and development of the environmental evaluation report for Expedition 341 was initiated. Seismic data collected during FY11 Expedition 334 (CRISP 1) also resulted in the development of a request to the EPSP for one new primary site and several additional alternate sites for Expedition 344.

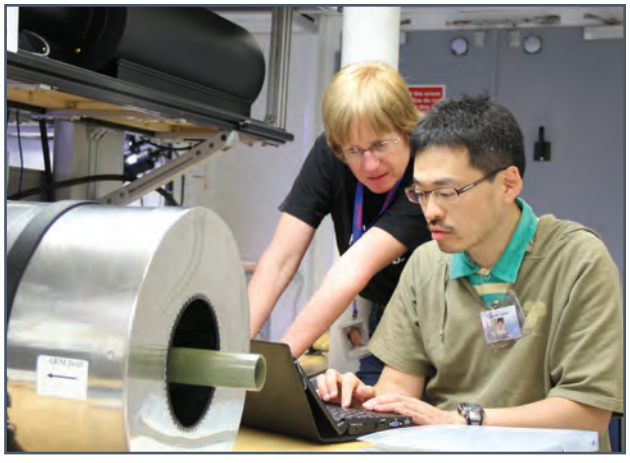
Substantial overlap/collaboration with the Expedition 334 Science Party was observed during evaluation of Expedition 344 sample requests, as expected, and some Expedition 334 cores were identified for shipment to the port call along with all of the Expedition 334 data. Operational and laboratory supplies, including third-party analytical equipment, were acquired and shipped to the re-supply port call in St. Johns, Newfoundland (Canada), for Expedition 344. Design modifications were completed this year for hammer-drill–type funnels and free-fall funnels to increase the options for establishing reentry capabilities for Expedition 345, and planning began for core description support for select Ocean Drilling Program (ODP) Leg 147 cores and thin sections that will be on board during the expedition. Finally, the decision to use Valdez, Alaska, as the end port for Expedition 341 and beginning port for Expedition 346 resulted in reduced overall transit time, potentially adding 3 days of operations to Expedition 341 and ~4 days of operations to Expedition 346.

Shipboard and laboratory improvements

Laboratory working groups

The Geochemistry, Geology, Geophysics, and Curation and Core Handling laboratory working groups (LWGs) comprise technical and science staff members 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 began attending bimonthly TAMU Issues Management Team meetings to allow management to better prioritize the LWG efforts, and the *IODP Laboratory Working Groups Newsletter* was established to communicate LWG activities to the general TAMU staff. The four LWGs advised new

Checking instrumentation in the core laboratory



Checking paleomagnetic data

Laying out core in the splitting room

equipment acquisitions and replacements during FY12, including

- Two MS2C-90 mm Bartington magnetic susceptibility loops to be deployed on the Whole-Round Multisensor Logger (WRMSL) and Special Task Multisensor Logger (STMSL) to help prevent jams caused by liner patches and twisted liners.
- A new Gaussmeter and Hall Probe to assist in improving superconducting rock magnetometer (SRM) measurements.
- A GigaPanEPIC robotic camera mount to facilitate panoramic image capture for virtual laboratory tours as well as public relations activities.
- A high-definition (HD) video camera for use on the *JOIDES Resolution*.
- A set of diffuse color standards from Labsphere to improve color reflectance data quality.
- Smaller ovens for the moisture and density (MAD) determination that vent to the rear and can be mounted below the benchtop, freeing up needed counter space.
- Two additional Zeiss Stereo Discovery V8 microscopes, with polarizing lighted bases for thin section examination and SPOT Idea MP3 cameras for the acquisition of digital images.
- New SPOT cameras that are compatible with Windows 7 and perform much more quickly than the older cameras.
- A Hitachi benchtop scanning electron microscope (SEM) to replace an older, lower-magnification microscope. The new SEM system can be expanded in the future to include energy dispersive spectroscopy (EDS) capability for elemental analysis of specimens.
- Additional wider aperture (10 mm) integrating spheres for the color spectrophotometer, which were purchased after tests on the one existing wide-aperture sphere showed improved data quality.
- A pair of Mettler-Toledo XP56DR balances for weighing very small (submilligram) masses on board the ship, as part of a project to replace the capability of aging Cahn electrobalances for which an equivalent system no longer exists on the market.
- Additional TeKa Berlin half-space needle probes to provide spares for shipboard thermal conductivity measurements.

In the driller's shack

- Two new UIC CM5015 coulometers to replace the aging CM5011 models used on the ship.

- Components for a narrow-footprint Section Half Imaging Logger (SHIL) to replace the shipboard SHIL, with the aim of freeing up additional floor space in the core description area.

- Helium pycnometer cells to provide an additional 6-cell system on board the ship to enable greater sample throughput and allow the ability to perform more moisture and density tests on sediment cruises.

- Two new Agilent 7890 gas chromatographs (GCs) to replace the gas chromatograph (GC3) and natural gas analyzer (NGA) systems in the chemistry laboratory. The new GCs will provide fully separated C1 to C3 hydrocarbons and are capable of analyzing fixed gases and hydrocarbons out to C7, all within a faster time window than the existing instruments.

Shipboard systems and laboratories

While the *JOIDES Resolution* was in dry dock to repair corrosion in the sea chest, the USIO made repairs and modifications to laboratory and other shipboard science-use spaces. A new split-level drop ceiling with LED lighting was installed in the microbiology cold room to provide better lighting and help control noise from the fan coil unit, ceiling light fixtures in the conference room were reconfigured, a new fan coil was installed in the core refrigeration space, and damaged floors in the laboratories were repaired.

During the maintenance period in Curaçao, the USIO enhanced shipboard laboratory facilities with new refrigeration units in the core storage reefer, cold-weather enclosure panels for the catwalk, and several IT infrastructure and software upgrades. Shipboard safety was addressed with laboratory safety audits and a radiation safety course for all hands, both provided by representatives of Texas A&M University's Environmental Health and Safety department. The maintenance period was also used to work on the MDHDS tool prior to installation during Expedition 342 and to service SERCO microscopes and train USIO technical staff. Additional technical staff sailed on the transit to Bermuda as part of the remobilization effort, testing instruments and software to ensure readiness for Expedition 342.

The passive heave compensator

Shore-based Geosciences Laboratory
The TAMU Ocean Drilling and Sustainable Earth Science (ODASES) Geosciences Laboratory housed at IODP-TAMU hosted scientists for X-ray fluorescence (XRF) scanning projects throughout the fiscal year, including one commercial client who scanned shale cores in collaboration with a scientist from the University of Hawaii. The XRF scanner was kept in use for nearly 50% of the available days, and visiting scientists used the shore-based SHIL for imaging cores prepared for XRF analysis and the WRMSL for magnetic susceptibility measurements. Work continued on a time-available basis to add density by gamma ray attenuation and *P*-wave velocity capabilities.

Engineering and tool development and support

Vibration-isolated television
Vendors were selected and purchase orders issued for components of a new vibration-isolated television (VIT) camera system to replace the almost 30-year-old existing VIT system. Installation of the new VIT system is scheduled for the Victoria, British Columbia (Canada), tie-up period in FY13. A project was also initiated to convert VIT camera system surveys and reentries to a common format and archive them digitally and to convert older VHS tapes to digital format on a time-available basis.

Large-diameter pipe handling infrastructure
Work progressed during FY12 on the design and fabrication of infrastructure for safely and efficiently handling large-diameter (6-5/8 inch) pipe on board the *JOIDES Resolution*. Representatives from the USIO and subcontractors met on board the *JOIDES Resolution* during the Curaçao maintenance period in early May and reviewed detailed engineering drawings of an insert version of the 350- and 500-ton elevators, including new weight and size specifications to account for the center of gravity and provide the ability to swing and latch. Based on this review, a new handler will be designed to remediate excessive wear that occurs on the elevator bearings-guide rollers when using the existing 430-ton IODP elevator. The final design phase began of the elevators for 5, 5-1/2, and 6-5/8 inch drill pipe that will accommodate USIO recommended tool joint lengths, thus allowing additional recuts that could potentially extend the drill pipe's length of service. As this project neared completion, the USIO began exploring potential targets for at-sea testing of the new equipment.

Magnetic susceptibility sonde rebuild
The USIO completed construction of two new magnetic susceptibility sonde (MSS)-B tools this year. The MSS deep-reading sensor was successfully deployed during Expeditions 340T and 340, and the entire MSS tool suite was pressure tested, bench tested, calibrated, and shipped to the *JOIDES Resolution* for deployment in future IODP expeditions.

Multifunctional Telemetry Module
The USIO's Multifunction Telemetry Module (MFTM), which transmits third-party tool downhole data back to the surface in real time, was successfully deployed this year during Expedition 342 as part of the MDHDS initiative (see "Third-party tool support"), allowing real-time monitoring of formation temperatures and pressures while the MDHDS penetrometer was decoupled from the motion of the drill string. The MFTM is also scheduled for use in May 2013 during Expedition

Teamwork on the rig floor

341S as part of the Simple Cabled Instrument for Measuring In Situ Parameters (SCIMPI) deployment.

Multisensor magnetometer module

The USIO continued development of the multisensor magnetometer module (MMM), a third-party borehole magnetometer tool that will provide borehole and tool orientation data, continuous downhole records of formation magnetization surrounding the borehole, and measurements of the borehole field on three axes, allowing calculation of the full formation magnetization vector: inclination, declination, and total field intensity. The MMM will be capable of working in both strongly magnetized hard rock formations and in sediments with weaker magnetizations, providing downhole magnetic information that will complement core sample magnetic measurements and significantly enhance IODP's ability to magnetostratigraphically date sediment sequences. During FY12, a new pressure housing design resolved problems encountered during pressure testing with seals between the composite material and nonmagnetic field joints. All nonmagnetic housings were successfully pressure tested to 10,000 psi, the MMM was assembled, and all sensors are operational. Complete systems integration testing is anticipated in late 2013.

Third-party tool support

A sea trial of the MDHDS with the T2P was conducted at Site U1402 on the New Jersey margin before the main leg of Expedition 342. This deployment was the culmination of the testing and development phase of a delivery system designed to remotely deploy and recover penetrometers. The benefit of this system over its predecessor is the complete decoupling of the penetrometer from the drill string, negating the effect of ship heave on the quality of data. The second of two deployments of this system fulfilled the mission goals by successfully acquiring in situ data with complete decoupling from the ship. This is the first in situ pressure measurement made on the Atlantic margin in scientific ocean drilling and confirms previous indirect pressure estimates. We now have a dependable method to deploy pore pressure penetrometers successfully, which will allow the rapid measurement of in situ pressure in

sediment. This new capability opens an exciting range of future science for the drilling program.

USIO Technical Panel

The USIO established a new technical panel this year that comprises external members from industry and academia who will review engineering and operations issues within the USIO. After creating a Terms of Reference document and membership list, the USIO issued invitations to five external members from industry and approximately ten internal members and guests to attend two USIO Technical Panel meetings per year. The first meeting was held at USIO-TAMU in March 2012, proceedings were circulated within the USIO, and an agenda was drafted for a second meeting to be held at USIO-Lamont-Doherty Earth Observatory (LDEO) in October 2012.

Data management

The USIO manages data in support of IODP activities, including expedition and postexpedition data; provides long-term archival access to data; and supports USIO IT services. Upgrades for IT infrastructure and science system services were implemented this year, along with completion of a high-priority development project.

Databases

Laboratory Information Management System

During expeditions, laboratory work on board the *JOIDES Resolution* produces a vast amount of data that are stored in the Laboratory Information Management System (LIMS). LIMS data collected during USIO Expeditions 336, 339, 340, and 342 were successfully transferred to shore, merged with the cumulative LIMS database, and made available online to participating scientists.

Log database

Standard and image data for USIO Expeditions 336, 339, 340T, and 340 and CDEX Expeditions 319 and 322 were processed and placed online. ESO Expedition 325 data were received and formatted, and CDEX Expedition 332 data were reviewed and are pending detailed documentation of the processing performed by the Japanese logging group. Starting with Expedition 336, a new data set, sonic waveform images, was added to the online database. In addition, software modifications were necessary to accommodate new data sets from CDEX Expeditions 319 and 322.

Inspecting the core catcher

Development projects

LIMS Reports and LIMS Overview

The LIMS Reports application provides scientists with a simple, intuitive web interface with reports designed to extract LIMS data via the web and quickly generate reports for scientific analysis. Each report displays the primary data relevant for that system and provides a description, definitions, and examples to guide scientists unfamiliar with the data. The USIO added three new stratigraphic correlation reports to LIMS Reports this year: create composite depths, splice tie points, and splice intervals. Additionally, the USIO completed the LIMS Overview (drill-down) project, which leverages work accomplished during the LIMS Reports projects to provide a tabular summary of 33 analytical reports by site. Example reports summaries include magnetic susceptibility, *P*-wave velocity, hole summary, and gas elements. Clicking on any one of these reports launches the LIMS Reports application, which provides additional search capability and far greater detail.

Cutting core

DESC Reports

The DESC Reports project was completed this year to provide online access to all descriptive data, including macroscopic and microscopic core descriptions, paleontological investigations, stratigraphic unit definitions, and so on, that were collected on board the *JOIDES Resolution* since IODP Expedition 320. This project includes data collected using the DESClogik data capture application, as well as other spreadsheet or form-based data captured outside of DESClogik and data generated based on DESClogik data exports. Data are accessed from links on the LIMS Reports interface, where the USIO already provides access to numerous reports of instrumental data.

System updates and backup

The USIO replaced nine first-generation Mac Pro workstations at LDEO, deployed new wireless access points throughout the Borehole Building, purchased a Cummins 85 KW whole-building generator for the Borehole Building, and began the transition from old RAID (redundant array of independent disks) storage units on Solaris servers to iSCSI volumes hosted on NAS (network-attached storage) units.

JOIDES Resolution Logging Office computers were also replaced during the Curaçao tie-up period and the Xserve RAID storage unit was replaced with a new Netgear ReadyNAS device. Images of all systems were made for installation on the shore-based testbed, which was established this year to allow configuration and testing of new equipment in a simulated ship environment. The USIO also completed a redesign of the *JOIDES Resolution*'s video distribution system and scheduled system reconfiguration to take place during the Expedition 341T transit.

Curatorial support

The USIO provides services in support of IODP core sampling and curation of the core collection archived at the Gulf Coast Repository (GCR). During FY12, the new Sample/Data Request System was tested in the Regional Test and Integration Facility environment and slated for deployment on the production server in early October 2012. The GCR hosted the Expedition 340 sampling party, and USIO personnel traveled to the Bremen Core Repository to assist with the Expedition 339 sampling party. In addition, the GCR core collection was used for Program outreach through tours of the repository, materials provided for display at meetings and museums, and classrooms and educational programs hosted at the GCR.

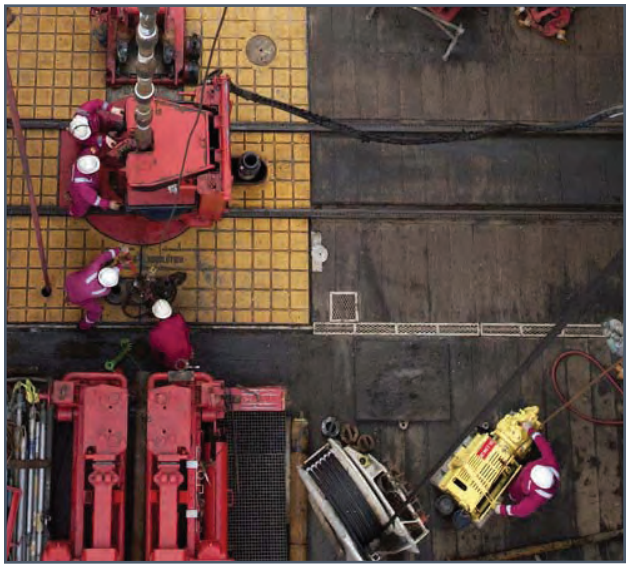
More from the numbers

Repository and sample statistics

	Visitors hosted	Samples taken
Gulf Coast Repository	*726*	*27,394*
JOIDES Resolution	*0*	*26,441*

Database statistics

	Visitor sessions	Query hits
LIMS database	*3,543*	*22,158*
Janus web database	*13,523*	*69,113*
Log web database	*5,243*	*34,098*



View of the JOIDES Resolution *rig floor from the derrick*

Several core legacy documentation projects continued throughout the year, including scanning of DSDP and ODP paper sample request files and thin section archive samples for accessibility via the database. The USIO also conducted digital imaging of all working half sections that were pulled for sampling during the year, posting high-resolution images on the web to show the extent of working half sampling to date.

Program integration and support for others

The USIO continued to collaborate with and support CDEX and ESO during FY12, providing Log Database services, storage, and search capabilities for nonmoratorium data to ESO and working with CDEX to set up a similar service. A USIO Publications Assistant sailed during CDEX Expedition 343, and the USIO provided input regarding the impact of ESO expedition science on the scientific community through articles in science publications for a presentation at the 34th International Geological Congress in Brisbane, Australia. Close collaboration with IODP outreach colleagues in Europe and Japan also allowed the coordination of complementary content for the American Geophysical Union (AGU) Fall 2011 Meeting.

Planning for the future

The USIO continued to support the International Working Group Plus (IWG+) in their efforts to map out a multinational program architecture that promotes delivery of exciting and relevant science to the broad science community and the public through scientific ocean drilling. USIO representatives attended IWG+ meetings held in January 2012 in Goa, India, and in June 2012 in Arlington, Virginia, and participated in discussions regarding the Science Advisory Structure (SAS) structure and transition plan, program management for the next scientific ocean drilling program, the new IODP framework, and the transition from IWG+ to the Program Governing Board.

USIO representatives also attended the workshop titled *Building U.S. Strategies for 2013–2023 Scientific Ocean Drilling,* held 30 April–2 May 2012 in Denver, Colorado, where participants prioritized the scientific challenges outlined in the *2013–2023 Science Plan for the International Ocean Discovery Program,* identified new approaches for more efficient planning of scientific ocean drilling expeditions, and proposed an innovative model for implementing the science plan.

More online

IODP expedition schedule: iodp.org/expeditions
Core database: iodp.tamu.edu/database
Log database: iodp.ldeo.columbia.edu/DATA/index.html
LIMS Reports: web.iodp.tamu.edu/UWQ
Sample requests: iodp.tamu.edu/curation/samples.html
IODP-USIO FY12 Quarterly Reports: iodp.tamu.edu/publications/AR.html
Illuminating Earth's Past, Present and Future: The Science Plan for the International Ocean Discovery Program 2013–2023: iodp.org/Science-Plan-for-2013-2023

IODP-USIO Expedition 336 **Proceedings** *volume art*

Broader Impacts

The USIO's ongoing publications, education, and outreach efforts continue to expand the visibility of IODP as a societally relevant, cutting-edge international Earth science research program. Diverse initiatives were coordinated this year to share IODP contributions to the global understanding of Earth's ocean basins with a broad audience, educating the public about Earth's structure, microbiology, and history as understood through scientific ocean drilling.

Publication Services

IODP scientific publications are the primary method of disseminating IODP research to the scientific community and the public. The USIO is responsible for production of Program-wide scientific publications, reports, and technical documentation, and for warehousing and distributing Deep Sea Drilling Project (DSDP), ODP, and IODP publications.

Publishing IODP science

The USIO produces and publishes *Scientific Prospectuses, Preliminary Reports,* Expedition Reports, and data report and synthesis contributions to the *Proceedings of the Integrated Ocean Drilling Program* volumes for all three IODP implementing organizations. During FY12, the USIO produced seven *Scientific Prospectuses* and

The USIO Publications Specialist office at sunset

A high school class visits the JOIDES Resolution *in Ponta Delgada, Azores (Portugal)*

four *Preliminary Reports*, coordinated postexpedition publications, and published eighteen postexpedition data reports and expedition reports from nine expeditions in the *Proceedings of the Integrated Ocean Drilling Program*.

To facilitate production of the *Proceedings of the Integrated Ocean Drilling Program,* the USIO sails Publications Specialists to coordinate shipboard reports and hosts postexpedition meetings during which Publications staff coordinate science reviews of all Expedition Reports content and assist meeting participants with editing of shipboard reports and core descriptions prior to publication. In FY12, Publications Specialists sailed during all USIO expeditions, a Publications Assistant sailed during CDEX Expedition 343, and the USIO-TAMU office in College Station, Texas, hosted postexpedition meetings for four USIO expeditions.

IODP publications accessibility and impact

The USIO is responsible for distributing Program scientific publications and documenting how postexpedition Program-related research is disseminated into the scientific community through publications. IODP Expedition Reports DVD distribution includes more than 800 program member offices, universities, libraries, and geological organizations worldwide, and the USIO provides additional print or electronic copies of legacy publications upon request. During FY12, the USIO added the availability to download ISO disc images from the IODP Publications website, through which users can download or burn a replica of the Expedition Reports portion of any *IODP Proceedings* volume. This capability will enable the USIO to discontinue distributing DVDs in future years.

All DSDP, ODP, and IODP scientific publications are easily accessible online through the IODP Publications website,

Videographer documenting core on deck

the Ocean Drilling Citation Database subset of the American Geological Institute GeoRef database, and CrossRef, an official digital object identifier registration agency for scholarly and professional publications. The number of times Program publications were accessed through these resources gives an indication of the level of interest in IODP scientific publications. There were nearly 230,000 visits to the IODP Publications website during FY12. Program publications accessed through CrossRef nearly doubled this year to more than 58,000 DOI resolutions for IODP publications and more than 72,500 DOI resolutions for DSDP and ODP publications. More than 11,000 queries were run on the Ocean Drilling Citation Database, and additional records for more than 6,000 citations were viewed.

The 2012 Ocean Drilling Citation Database Report shows that more than 475 articles based on Program science have been published in the top two high-impact science journals—*Science* and *Nature*—and more than 130 of those articles were published since the inception of IODP in 2003. More than 15 dissertations based on IODP expedition science have been published to date, and more than 5,000 scientific publications have cited primary IODP expedition research since 2003. Efforts to more effectively document the impact of IODP science through publications also led to a new "cited-by linking"

More from the numbers

Websites	**Site visits**	**Page views**
U.S. Implementing Organization	*334,947*	*1,852,400*
ODP Legacy	*1,128,754*	*5,195,492*
DSDP Legacy	*195,338*	*727,435*
IODP Publications	*229,904*	*1,196,482*
Deep Earth Academy	*43,667*	*62,541*
JOIDES Resolution	*71,445*	*236,592*
Total Program-related websites	**2,004,055**	**9,270,942**

Students touring the JOIDES Resolution *core laboratory in Ponta Delgada, Azores (Portugal)*

project that, once implemented, will enable readers to use a link from IODP publications table of contents pages to learn which journals or books have cited IODP publications.

Education

The USIO implemented programs using the *JOIDES Resolution* as a platform for education and produced new expedition-specific and thematic video and learning materials throughout the year. Professional development opportunities allowed teachers to experience IODP science in workshops and on board the *JOIDES Resolution,* while IODP scientists participated in shipboard and onshore educational programming and planning. USIO representatives also worked to develop and strengthen ongoing relationships with national and international museums and science partners and pursued outreach initiatives that exposed minority undergraduate and graduate students to careers in scientific ocean drilling.

IODP science online presence and social networking

Information about IODP science is easily accessible online through expedition science reports posted daily on the USIO website, and the educational website "*JOIDES Resolution*: Exploring beneath the Ocean Floor" promotes USIO expeditions and IODP science and serves as the hub for Program social networking on Facebook, Twitter, and YouTube sites. The home page and internal navigation site maps for joidesresolution.org were overhauled during FY12, and the site received more than 100,000 visits, nearly doubling the number of site visits received during the previous year. Activity on *JOIDES Resolution* social networking sites also increased dramatically throughout FY12, culminating in more than 3,000 "likes" on the Facebook page and an increase in the number of Twitter followers to nearly 1,000. A *JOIDES Resolution* Tumblr page was initiated during the last quarter to further expand visibility of the Program through social media.

Promoting IODP science from the *JOIDES Resolution*

Onboard Education Officers reached out to global audiences during each of the IODP-USIO expeditions this year through *JOIDES Resolution* website content, blogs and facilitated blog entries from expedition participants, video broadcasts, and entries posted to *JOIDES Resolution* social networking sites.

More from the educators

"The immersive aspect of the JOIDES Resolution experience is so valuable in promoting understanding of the deep-sea drilling process and earth sciences in general. Being involved on the ship 24/7 provides the opportunity to take the time to meet with and work with people in different disciplines and jobs that teachers would not have access to otherwise. Keep it up! This program is such a unique and valuable way to communicate the content and processes of deep earth science to audiences on shore." —J. Magnusson, Expedition 336 Onboard Education Officer

USIO judge and Ocean Science award winners at the Intel International Science and Engineering Fair

Live video broadcasting from the *JOIDES Resolution* continued to expand this year with nearly 125 ship-to-shore video broadcasts to museums, teacher workshops, special events, conferences, summer camps, elementary schools, high schools, and colleges. Broadcasts presenting tableaus of life at sea, the careers of scientists and technicians on board, and science conducted on board the *JOIDES Resolution* reached thousands of viewers worldwide and in every state in the United States.

IODP documentaries and expedition video updates

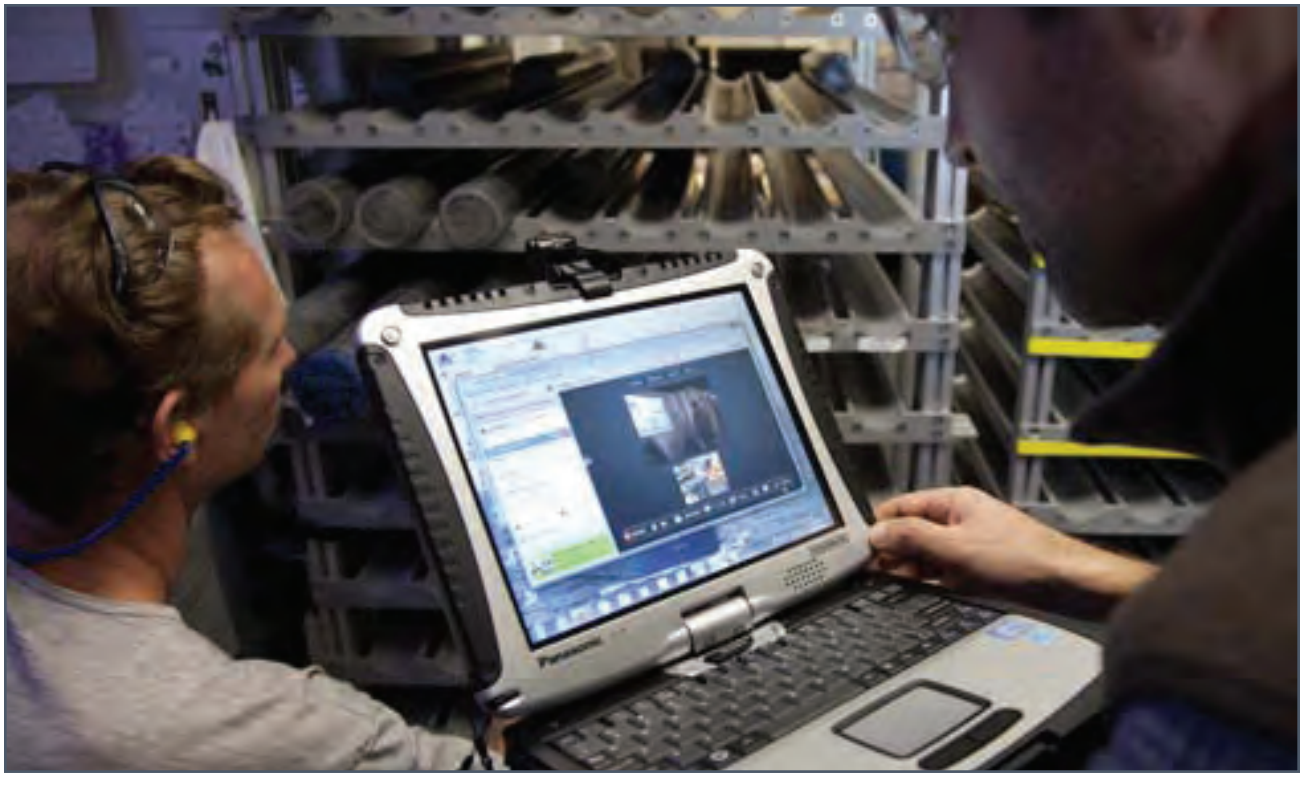
Four new USIO videos were produced this year with subjects including the School of Rock, scientific observatories, studying microbiology, and what it's like to be a scientist. A videographer sailed during Expedition 342 and produced six expedition video updates, a video series called "Eocene Invasion" for younger children, and a series called "Titanic Tales" that focused on connections to the 100th anniversary of the sinking of the *Titanic*. The videos produced during Expedition 342 had almost 9,000 views on the Ocean Leadership YouTube channel by the end of FY12.

Strategic partnerships for education

The USIO continued to foster partnerships and alliances with national and international museums and science partners with synergistic goals and objectives. USIO staff also submitted proposals for outside funding that would complement USIO science and education activities, including two awarded grants that partly supported the 2012 Schools of Rock.

***Museum outreach—"Getting to the Core: the* JOIDES Resolution"**

This year a traveling exhibit called "Getting to the Core: the *JOIDES Resolution*" toured the Texas Maritime Museum in Rockport, Texas; The North Museum in



Web broadcast from the core laboratory

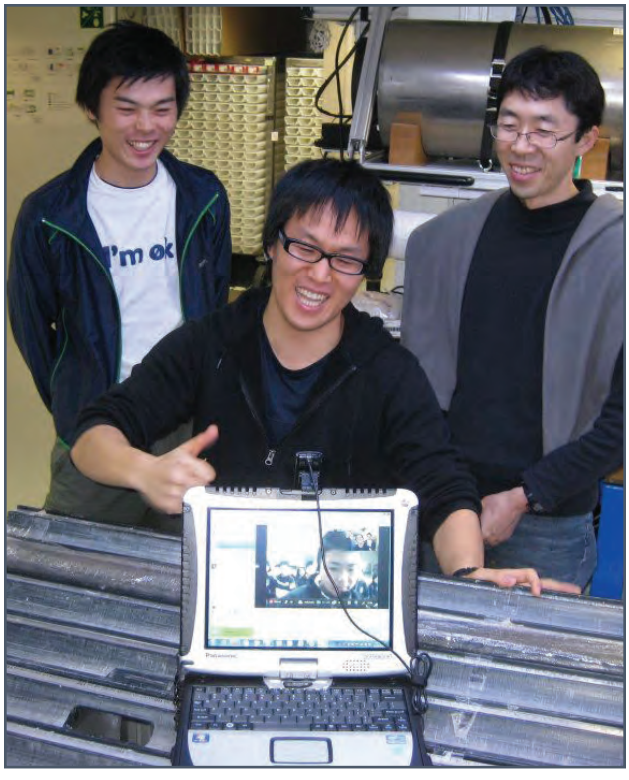
Lancaster, Pennsylvania; and the Brazos Valley Museum of Natural History in Bryan, Texas. The exhibit featured large-scale banner graphics, real sediment cores, drilling artifacts, video, a 3D model of the *JOIDES Resolution,* activities for children, and a montage of more than 50 spectacular photos and images. Exhibit-related activities included a "guide-by-cell" phone tour with recorded messages about parts of the exhibit that could be accessed from anywhere in the world, live ship-to-shore events, and a children's (ages 4–12) spring-break science camp called "Adventures in Oceanography: Exploring the Deep Blue Sea" that focused on marine/oceanographic geology and IODP science.

Center for Dark Energy Biosphere Investigations partnership

The USIO partnership with the Center for Dark Energy Biosphere Investigations (C-DEBI) continued this year, resulting in Adopt-a-Microbe v.4.0—an updated version of the project that allowed students and educators to follow a mission in real time and virtually "adopt" a microbe from the bottom of the ocean—and complementary materials that will repurpose the online program into a stand-alone unit for educators. Other projects included a website called "Classroom Connections" targeted toward students with special needs and a *How Science Works* poster and related materials that were developed through USIO collaboration with C-DEBI, the University of California at Berkeley, and the Coalition for the Public Understanding of Science. Funds from C-DEBI also helped to support the "Getting to the Core: the *JOIDES Resolution*" museum exhibit and travel for several participants to make presentations at the AGU 2012 Fall Meeting and the AGU 2012 Ocean Sciences Meeting.

School of Rock: Ship-to-Shore Science

The NSF Informal Science Pathways grant called "Ship-to-Shore Science—the *JOIDES Resolution* as a Platform for Education" was kicked off mid-year in Washington, DC, where 55 educators, scientists, media specialists, and program managers came together to brainstorm



Videoconference with Misumi Elementary School (Japan)

Image from a "LIVE Aboard the JR*" Skype session*

topics related to using the *JOIDES Resolution* as a platform for informal science education. Participants generated hundreds of ideas that culminated in 14 project proposals reviewed by USIO staff and a review panel. Key personnel from the four selected pilot projects and other key partner organizations participated in the first 2012 School of Rock, which began on board the *JOIDES Resolution* at the end of the tie-up period in Curaçao and continued during the transit to Bermuda (23 May–2 June). This experience was a crucial component to kick-start development of the funded Ship-to-Shore Science pilot projects.

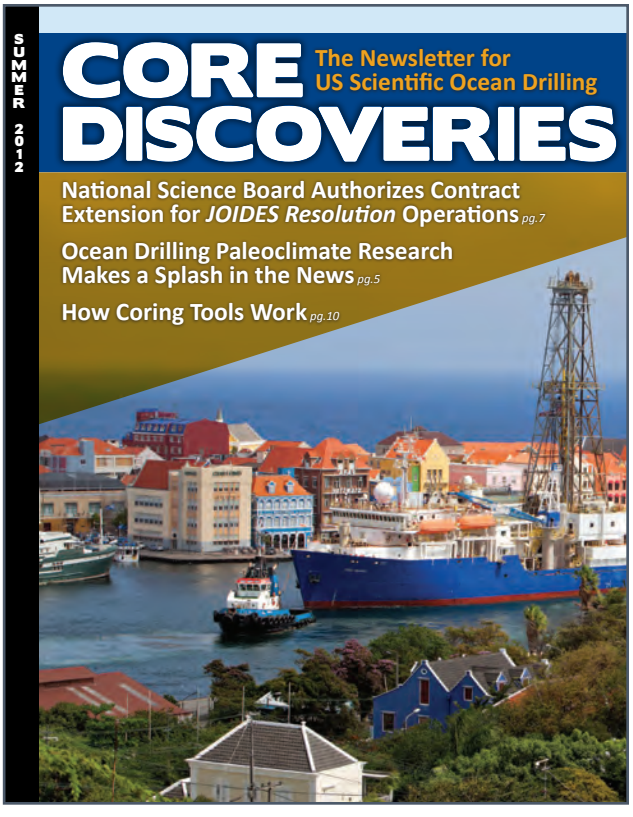
School of Rock: Enhancing Diversity in the Geosciences

The second 2012 School of Rock, held 3–7 June at the GCR in College Station, Texas, was partly funded through an NSF Opportunities for Enhancing Diversity in the Geosciences program grant for faculty members of minority-serving institutions. The USIO collaborated with the American Meteorological Society, James

More from the educators

"The experience as Education Officer on the JOIDES Resolution changed me . . . I am more sensitive to communicating science to others and understand the communication gap between scientists and the public . . . I am more eager to experiment with ideas that haven't been tried before and realize real science takes longer and is often more complicated than is presented in school. I believe my experience has impacted my students through my attitude and because I have been able to help them expand their horizons for career opportunities and helped them see science differently." —J. Kane, Expedition 327 Onboard Education Officer

Episode 6 of educational outreach comic series Tales of the Resolution!



The IODP-USIO newsletter, Core Discoveries

Madison University, and Los Angeles Valley College to guide School of Rock participants through laboratory exercises and collected feedback for a full-scale implementation proposal. At the end of the fiscal year, the project team was preparing to submit its findings in response to the NSF solicitation of community input regarding broadening participation programs in the geosciences.

Diversity initiatives

USIO staff organized the first-ever IODP booth at a minority-focused conference during the 2011 SACNAS National Conference and managed two diversity initiatives as part of its strong commitment to engaging ethnic and racial minority university and college students.

IODP-USIO Diversity Internship

The IODP-USIO Diversity Internship exposes minority students to careers in scientific ocean drilling by providing them with a 10–12 week educational and career-building experience at one of the institutions that comprise the USIO. The internship highlights opportunities within IODP and science program management that may encourage students/interns to pursue advanced studies in Earth system sciences (or complementary fields) and/or careers in scientific ocean drilling. The second IODP-USIO Diversity Intern worked with the U.S. IODP Communications group at Ocean Leadership in Washington, DC, this year to help develop and implement initiatives that effectively communicate science news and information related to IODP expeditions, publications, and other activities.

The USIO also cosponsored the participation of two diversity interns in the 10-week LDEO Summer Internship program. The students worked with mentors from LDEO on research projects that used scientific ocean drilling data and/or cores. One student helped characterize and date the spherule-bearing layer in five *Eltanin* cores collected from the Ross Sea, Antarctica, and Deep Sea Drilling Project Leg 28 sites. The other

Portuguese officials examining core replica pencils during a tour of the JOIDES Resolution

student used the K/Ar system on ODP sediment cores collected from the Prydz Bay sector in Antarctica (ODP Leg 188) to find the provenance of glacially eroded material in the cores, and assess the relative importance of physical versus chemical weathering. Research results from their projects are available online.

Minorities in Scientific Ocean Drilling Fellowship

The Minorities in Scientific Ocean Drilling Fellowship provides a mechanism for minority graduate students enrolled full-time in a geoscience or engineering program to complete research in topics related to scientific ocean drilling or develop technology that will help advance science or engineering in a scientific ocean drilling research setting. The fellowship also highlights opportunities within IODP that may encourage the selected Fellow to pursue a career in scientific ocean drilling and/or participate in IODP. The Spring/Summer 2012 Minorities in Scientific Ocean Drilling Fellow used data from DSDP Leg 90 and ODP Leg 181 to work on a fellowship research project titled "Investigating a Potential Mechanism for Sustained Pliocene Warmth Using Micropaleontology and Alkenone Paleothermometry" to answer critical questions in Pliocene climate research.

Outreach

USIO Outreach activities build an easily accessible foundation of knowledge about IODP, raise the visibility of the connection between the emerging scientific knowledge and its positive contribution to society worldwide, and encourage interest in the Program. During FY12, the USIO publicized expeditions, developed products designed to highlight the Program's success, and took advantage of forums such as the AGU 2012 Fall Meeting, the Geological Society of America's 2012 GSA Annual Meeting and Exposition, and the European Geosciences Union General Assembly 2012 to engage the science, education, and political communities in IODP research.

Broadcasting rig floor activity

Port call outreach

JOIDES Resolution port calls during FY12 provided an excellent opportunity to conduct public outreach related to ongoing operations. Nearly 300 local students, teachers, scientists, reporters, and local dignitaries (including the Regional Secretary for Science and Technology) toured the *JOIDES Resolution* during the 17–21 November 2011 port call in Ponta Delgada, Azores (Portugal). The USIO collaborated with ECORD to coordinate outreach activities during the January 2012 port call in Lisbon, Portugal. Activities included a press briefing for nearly 30 regional journalists and ship tours for approximately 800 local and regional high school and college-level students, scientists, and political dignitaries (including a former President of Portugal, the Portuguese Secretary of State for Science, and several members of Portuguese Parliament).

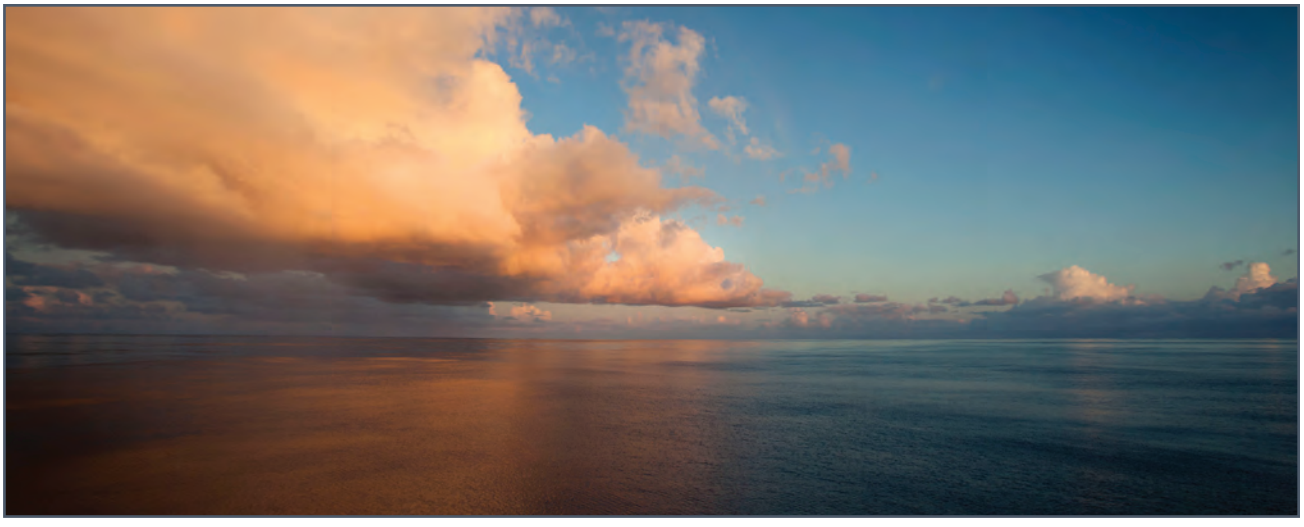
Outreach support and product development

Expedition scientists received training from USIO communications staff to help them prepare for press interviews and public lectures and to instruct them on opportunities and risks of social media and press embargo policies of high-profile science journals. The USIO also collaborated with others conducting IODP outreach worldwide and developed media advisories, press releases, and outreach products designed to publicize long-term and recent achievements.

Four issues of the full-color IODP community newsletter—*Core Discoveries*—were published during FY12, providing readers with timely updates and information on USIO activities. An "IODP Science News" Twitter account, @SeafloorSci, was also launched in FY12 to augment the efforts of the education-focused *JOIDES Resolution* Twitter account. The outreach-focused Twitter account, which was designed to share news highlights targeted primarily to the geoscience media and blogging community, had approximately 250 followers by the end of FY12.

More from the educators

"The [onboard educator] experience has given me a whole new appreciation for what goes into research and an awareness of the variety of careers that are available in oceanographic research. For me, the expedition is still continuing as people ask me about my experience and what life is like being out on the ocean for such an extended period of time." —J. Monaco, Expedition 329 Onboard Education Officer



Calm seas at the Mid-Atlantic Ridge

More online

IODP scientific publications: iodp.org/scientific-publications

IODP-USIO FY12 Quarterly Reports: iodp.tamu.edu/publications/AR.html

IODP-USIO FY12 Annual Program Plans: iodp.tamu.edu/publications/PP.html

Ocean Drilling Citation Database: odp.georef.org/dbtw-wpd/qbeodp.htm

2012 Ocean Drilling Citation Report: iodp.tamu.edu/publications/AGI_studies/AGI_study_2012.pdf

Deep Earth Academy website: oceanleadership.org/education/deep-earth-academy

JOIDES Resolution *website: joidesresolution.org*

JOIDES Resolution *facebook page: facebook.com/joidesresolution*

JOIDES Resolution *twitter page: twitter.com/thejr*

JOIDES Resolution *Tumblr page: joidesresolution.tumblr.com*

USIO Newsroom website: iodp-usio.org/Newsroom/default.html

USIO videos: youtube.com/user/OceanLeadership

Core Discoveries: oceanleadership.org/programs-and-partnerships/scientific-ocean-drilling/core-discoveriesnewsletter

Tales of the Resolution: ldeo.columbia.edu/BRG/outreach/media/tales/index.html

Adopt-a-Microbe Project v.4.0: aam.darkenergybiosphere.org

Classroom Connections: darkenergybiosphere.org/classroomconnection

Coalition for the Public Understanding of Science: undsci.berkeley.edu

IODP-USIO Diversity Internship: oceanleadership.org/education/diversity/iodp-usio-diversity-internship

Minorities in Scientific Ocean Drilling Fellowship: oceanleadership.org/education/diversity/minorities-in-scientific-ocean-drilling-fellowship

***Evening on the* JOIDES Resolution**

Contractual and Financial Overview

IODP is funded by several entities acting as international partners. NSF and Japan's Ministry of Education, Culture, Sports, Science and Technology (MEXT) are lead agencies, and ECORD is a contributing member. Associate members include the People's Republic of China Ministry of Science and Technology (MOST); Interim Asian Consortium, represented by the Korea Institute of Geoscience and Mineral Resources (KIGAM); Australian/New Zealand Consortium funded by the Australian Research Council (ARC) and GNS Science (New Zealand); and the Ministry of Earth Sciences (MoES), India. The Coordination for Improvement of Higher Education Personnel, Brazil, joined IODP as a full member late in FY12.

The USIO provides all deliverables through contracts with NSF for platform operating costs (POC) and other program integration costs (OPIC) and with IODP-MI for science operating costs (SOC). The commingled funds that comprise the SOC budget come from IODP-MI's international partners as part of their membership fees used to fund IODP science. POC funding for each implementing organization is the responsibility of the agency supplying the platform capability.

USIO contractual relationships

The USIO was formally established in 2003 when Ocean Leadership, formerly known as Joint Oceanographic Institutions, established subcontracts with LDEO of Columbia University and the College of Geosciences at TAMU through TAMRF. Each of the three USIO institutions (Ocean Leadership, LDEO, and TAMU) provides fiscal and contractual administration, and the organizational structure employed by the USIO accommodates the work breakdown element

Breakwater jetty protecting the harbor in Ponta Delgada, Azores (Portugal)

Tugboats in Ponta Delgada, Azores (Portugal)

accounting structure used by IODP. This structure also aligns the organization to efficiently and economically provide the full array of USIO deliverables.

USIO prime contractor

As the U.S. Systems Integration Contractor, Ocean Leadership is ultimately responsible to NSF and IODP-MI for overall program leadership; technical, operational, and financial management; and delivery of services for the *JOIDES Resolution* and related activities. Ocean Leadership leads long-term planning development for the USIO and represents the USIO and the Program as a whole, when appropriate.

USIO subcontractors

LDEO and TAMU contribute distinct but complementary capabilities that directly support the full range of scientific and technical activities necessary for implementing a riserless scientific drilling program. LDEO is responsible for logging-related shipboard and shore-based science services and technological support and for leading an international logging consortium to participate in scientific ocean drilling operations. LDEO provides downhole logging equipment and engineering support through an ongoing contract with Schlumberger. In FY12, LDEO also contracted with Howard and Associates, Inc., for engineering oversight of the large-diameter pipe–handling infrastructure project and with LGL Limited–Environmental Research Associates for preparation of environmental evaluation

Spinning the JOIDES Resolution *into position for docking (Bermuda)*

reports for check shot survey work to be conducted during four USIO expeditions.

TAMU is responsible for providing services directly related to the scientific and engineering activities necessary to support science cruises (vessel and drilling operations, ship- and shore-based science laboratories), as well as managing expedition-related, shore-based functions (data management, core curation, and publications). Administrative services in support of TAMU activities are provided by TAMRF. On behalf of the USIO, TAMRF contracts with Siem Offshore (previously known as Overseas Drilling Limited) for the services of the *JOIDES Resolution*, the riserless drilling vessel for USIO operations.

USIO FY12 Annual Program Plans to IODP-MI and NSF

FY12 USIO contractual requirements for SOC and POC funds are outlined in the IODP-USIO FY12 Annual Program Plan to IODP-MI; POC and OPIC budgets are combined in the systems integration contract (SIC) costs outlined in the IODP-USIO FY12 Annual Program Plan to NSF. The Annual Program Plans set forth the goals

The bridge of the JOIDES Resolution*, under way at night*

of the USIO, scope of USIO work for IODP deliverables, definitions of projects, and details of required budgets that incorporate funding allocations from NSF or IODP-MI for science operations and from NSF for platform operations and U.S.-sponsored tasks (education and outreach efforts and associated management and administrative support).

The complex nature of IODP operations requires Annual Program Plans that establish priorities and allow procurement of long–lead time equipment and services for activities that span multiple years. The FY12 Annual Program Plans were based on (1) the mission forecast provided on 29 April 2011 for the USIO by NSF, (2) the USIO operations schedule that was approved by the Operations Task Force (OTF) and Science Planning Committee (SPC) in August 2010, and (3) the 18 and 19 June 2011 OTF and 23 June 2011 IODP Council approval for platform operating costs for an additional expedition to be supported through commingled funds from IODP-MI. Budgets outlined in the Annual Program Plans included costs associated with the necessary planning and purchase of long–lead time items and additional items to support expeditions scheduled for FY12 and beyond.

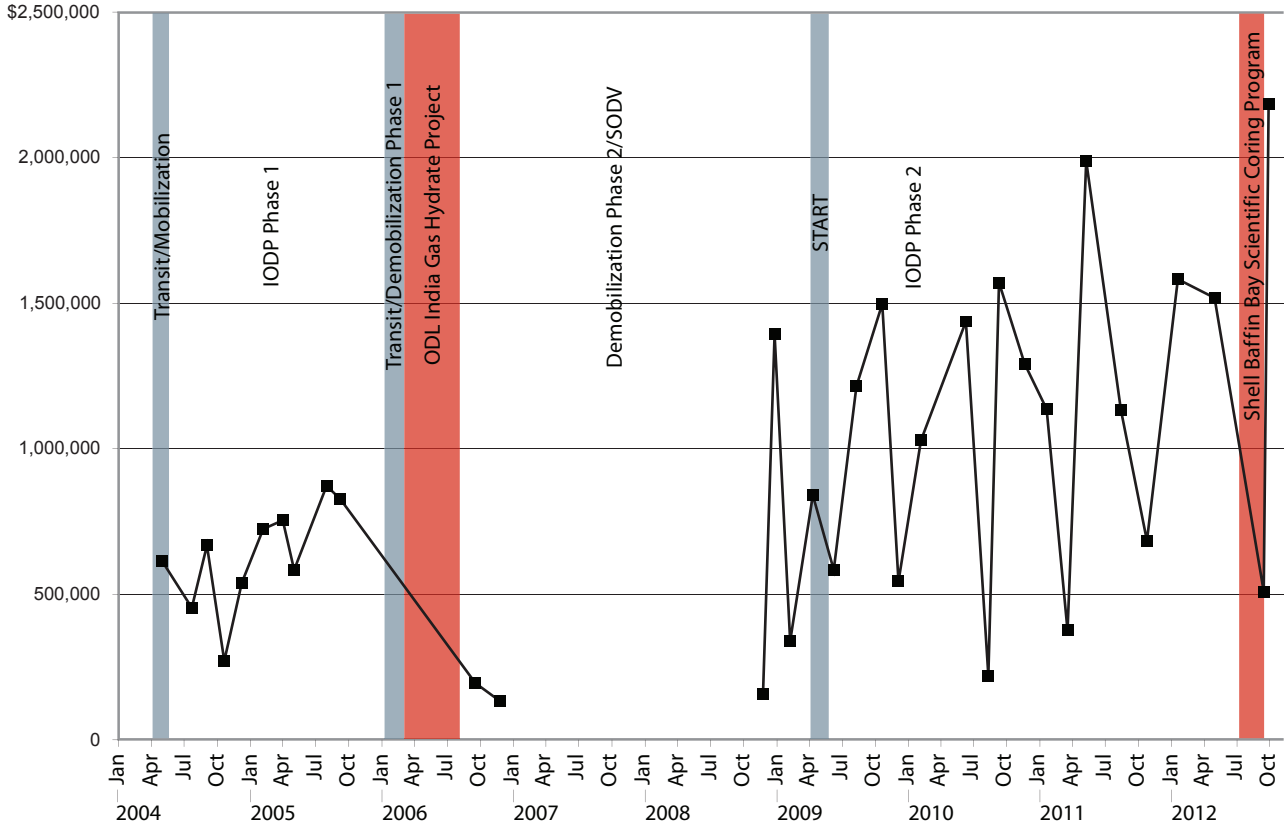
Financial tables

The following financial tables provide a detailed overview of the FY12 IODP-USIO Annual Program Plan budget, including FY11 carryforward of obligated and unobligated funds, budget modifications that took place throughout the fiscal year, expenditures that were made to execute the Annual Program Plan, and end-of-year totals of obligated and unobligated funds pending approval for transfer to FY13.

These tables individually represent the following:

- USIO FY12 end-of-year financial summary, which encompasses SOC and SIC budgets for the USIO with detail provided for each USIO institution (Ocean Leadership, LDEO, and TAMU);
- USIO FY12 end-of-year financial summary for the POC (NSF and IODP-MI) budget;
- USIO FY12 end-of-year financial summary for the SOC (IODP-MI only) budget; and
- USIO FY12 end-of-year financial summary for the SIC (NSF only) budget.

Actual fuel cost FY04–FY12



More online

IODP-USIO website: www.iodp-usio.org

IODP-USIO FY11 Annual Program Plan: iodp.tamu.edu/publications/PP.html

IODP-USIO FY11 Quarterly Reports: iodp.tamu.edu/publications/AR.html

Please contact info@oceanleadership.org for hard copies of the financial pages (43–55).

Acronym List

Acronym	Definition
AGU	American Geophysical Union
ARC	Australian Research Council
CCD	carbonate compensation depth
C-DEBI	Center for Dark Energy Biosphere Investigations
CDEX	Center for Deep Earth Exploration
CORK	circulation obviation retrofit kit
CRISP	Costa Rica Seismogenesis Project
DSDP	Deep Sea Drilling Project
ECORD	European Consortium for Ocean Research Drilling
EEZ	Exclusive Economic Zone
EPSP	Environmental Protection and Safety Panel
ESO	ECORD Science Operator
GCR	Gulf Coast Repository
IO	implementing organization
IODP	Integrated Ocean Drilling Program
IODP-MI	IODP Management International, Inc.
ISP	Initial Science Plan
IT	information technology
IWG+	International Working Group Plus
KIGAM	Korea Institute of Geoscience and Mineral Resources
LDEO	Lamont-Doherty Earth Observatory
LIMS	Laboratory Information Management System
LWG	Laboratory Working Group
mbsf	meters below seafloor
MDHDS	Motion Decoupled Hydraulic Delivery System
MEXT	Ministry of Education, Culture, Sports, Science and Technology (Japan)
MFTM	Multifunction Telemetry Module
MMM	multisensor magnetometer module
MoES	Ministry of Earth Sciences (India)
MOST	Ministry of Science and Technology (People's Republic of China)
MOW	Mediterranean Outflow Water
MSS	magnetic susceptibility sonde
NSF	National Science Foundation
ODASES	Ocean Drilling and Sustainable Earth Science
ODP	Ocean Drilling Program
OPIC	other program integration costs
POC	platform operating costs
SAS	Science Advisory Structure
SHIL	Section Half Imaging Logger
SIC	systems integration contract (costs)
SOC	science operating costs
SPC	Science Planning Committee
TAMU	Texas A&M University
USIO	U.S. Implementing Organization
VIT	vibration-isolated television
XRF	X-ray fluorescence

PUBLISHER'S NOTES

This publication was prepared by the Integrated Ocean Drilling Program U.S. Implementing Organization (IODP-USIO): Consortium for Ocean Leadership (Ocean Leadership), Lamont-Doherty Earth Observatory of Columbia University (LDEO), and Texas A&M University (TAMU), as an account of work performed under the international Integrated Ocean Drilling Program, which is managed by IODP Management International (IODP-MI), Inc. Funding for the program is provided by the following agencies:

- National Science Foundation (NSF), United States
- Ministry of Education, Culture, Sports, Science and Technology (MEXT), Japan
- European Consortium for Ocean Research Drilling (ECORD)
- Ministry of Science and Technology (MOST), People's Republic of China
- Korea Institute of Geoscience and Mineral Resources (KIGAM), South Korea
- Australian Research Council (ARC) and GNS Science (New Zealand), Australian/New Zealand Consortium
- Ministry of Earth Sciences (MoES), India
- Coordination for Improvement of Higher Education Personnel, Brazil

Citation:
Integrated Ocean Drilling Program United States Implementing Organization, 2013. FY12 Annual Report.
http://iodp.tamu.edu/publications/AR/FY12AR.PDF

DISCLAIMER

Early morning sunrise off Martinique

A view of the moon from the **JOIDES Resolution** *main deck*

IODP
Integrated Ocean Drilling Program
United States Implementing Organization

NSF

IODP
INTEGRATED OCEAN
DRILLING PROGRAM

Integrated Ocean Drilling Program, U.S. Implementing Organization

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