SPRING 2016

OCEAN DISCOVERY

The U.S. Scientific Ocean Drilling Community Newsletter

In This Issue

The International Ocean Discovery Program (IODP) is an international research collaboration among 26 countries to advance scientific understanding of the Earth through drilling, coring, and monitoring the subseafloor. The U.S. Science Support Program (USSSP) supports the involvement of the U.S. scientific community in IODP and is funded by the U.S. National Science Foundation (NSF). IODP utilizes multiple drilling platforms to carry out its missions: the riserless *JOIDES Resolution*, managed by Texas A&M University; the riser-equipped *Chikyu*, operated by the Center for Deep Earth Research (CDEX), a subdivision of the Japan Agency for Marine-Earth Science and Technology (JAMSTEC); and various mission-specific platforms operated by the British Geological Survey on behalf of the European Consortium for Ocean Research Drilling (ECORD). For more information, visit: www.iodp.org.

To contact the editor of *Ocean Discovery*, email: *jspencer@LDEO.columbia.edu*; or call 845-365-8785

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

U.S. SCIENCE SUPPORT PROGRAM

IODP INTERNATIONAL OCEAN DISCOVERY PROGRAM

NSF

CALENDAR

May

17-18 *JOIDES Resolution* Facility Board
Arlington, VA USA

29-June 6 2016 School of Rock
Aboard *JOIDES Resolution*, Cape Town, South Africa

June

15-16 ECORD Facility Board
Brussels, Belgium

21-23 JRF Science Evaluation Panel
Bremen, Germany

26-July 1 ECORD Summer School 2016: Petrophysics
Leicester, United Kingdom

July

3-6 *Chikyu* Onboard School 2016
Shimizu, Shizuoka, Japan

11-13 JRF Environmental Protection and Safety Panel
College Station, TX USA

September

5-16 ECORD Summer School 2016: Submarine Geohazards
Bremen, Germany

21-23 IODP Forum
Búzios, Brazil

November

14-17 USSSP Short Course: Shipboard Sedimentology
College Station, TX USA

Letter from the NSF

It's been a while since we've updated you on the "state of ocean drilling." In short, IODP and the main U.S. contribution to the IODP, the *JOIDES Resolution*, are doing quite well.

Over the past year we have put the "third leg" of the stool in place for the U.S. portion of the program. Along with Cooperative Agreements with Texas A&M University for operation of the *JOIDES Resolution* and with Scripps Institution of Oceanography for oversight of the IODP Science Support Office, NSF now has a new Cooperative Agreement in place with Lamont-Doherty Earth Observatory to manage the U.S. Science Support Program. NSF is very pleased with implementation of these Cooperative Agreements by all three institutions. We are in good hands!

The second bit of good news is that the *JOIDES Resolution* will soon be moving to ten months of operations (five expeditions) per year! The economic efficiencies gained in this new version of IODP, along with low fuel prices, have allowed NSF to instruct the *JOIDES Resolution* Facility Board, the entity that oversees the *JOIDES Resolution*, to begin planning for these additional operations no later than 2018.

In this new IODP, the review of *JOIDES Resolution* facility operations is being conducted yearly through a formal NSF panel, rather than via expedition-by-expedition reviews through a Central Management Office. The first yearly review (Fiscal Year 2015) of the *JOIDES Resolution* Science Operator (JRSO) at Texas A&M University was just completed and NSF was pleased to receive the determination that **"The *JOIDES Resolution* Science Operator Site Visit Panel concludes that the facility is being managed exceptionally well by the JRSO, and that it is also being overseen effectively by the *JOIDES Resolution* Facility Board (JRFB) and the National Science Foundation (NSF) to meet the IODP Science Plan."** This primary finding—that the facility is being run with "exemplary fiscal management"—reflects the dedication, hard work, and competence of the JRSO. The panel provided a number of constructive recommendations to NSF regarding JRSO operations, and these fall into two main areas: those concerning the *JOIDES Resolution* facility and the JRSO, and those concerning the enveloping structure of the International Ocean Discovery Program and how it interacts with the facility. While the panel report itself is confidential, NSF has provided a formal response to the panel and this response will be made public in the very near future.

Keep those great drilling proposals coming in!

Jamie Allan and Tom Janecek

Your NSF Team

Submarine Paleoseismology: Using Giant Piston Coring within IODP to Fill the Gap in Long-term Records of Great Earthquakes

July 16-18, 2015, Zürich (Switzerland)

Cecilia McHugh, Michael Strasser, Antonio Cattaneo, Ken Ikehara

In the past fifteen years, the world has witnessed the catastrophic effects that large earthquakes and tsunamis have had on adjacent heavily populated coasts. A critical problem for dealing with earthquake hazards is that our understanding of seismicity and earthquake recurrence intervals is limited by short instrumental records, particularly for large earthquakes. The evolving field of submarine paleoseismology has been providing a longer-term understanding of earthquakes based on the historical record that in some locations can be as old as 2000 years BP. The techniques applied to obtain this record rely on the fact that the marine environment has the potential to preserve long and continuous sedimentation records that can be used for identifying interfingered earthquake-triggered deposits. Regional correlations have been obtained by developing an event chronology from sediment cores and high-resolution geophysics. Imaging techniques permit the capture of faults, fault basins and structures along trench axes, flat terraces and the deepest parts of basins in unprecedented detail, revealing optimal locations where records of earthquake-triggered sedimentation may be extracted. Although challenging, the development of a chronology for large distance correlations can be achieved by applying radioisotope dating and modeling. Progress has also been achieved in obtaining ages from subduction boundaries below the calcite compensation depth by using short-lived radioisotopes (including those emitted by the Fukushima nuclear reactors), tephra chronology and paleomagnetic secular variability. Rapid response expeditions and analysis of the timing and pattern of submarine cable breaks have permitted direct correlations between earthquakes and mass-wasting and turbidity currents. For example, the 2011 Tohoku earthquake-triggered deformation has been associated with large-scale mass-wasting and turbidity currents, and seismic shaking has been linked to surficial mass-flows that can be tracked for hundreds of kilometers along the trench axis.

Submarine paleoseismic studies—for example, in the Cascadia subduction margin offshore North America; the Calabrian arc subduction system and Algiers margin in the Mediterranean; the Chile Trench; the Sumatra Trench offshore Indonesia; the Hikurangi Trench offshore New Zealand; and most recently the Ja-

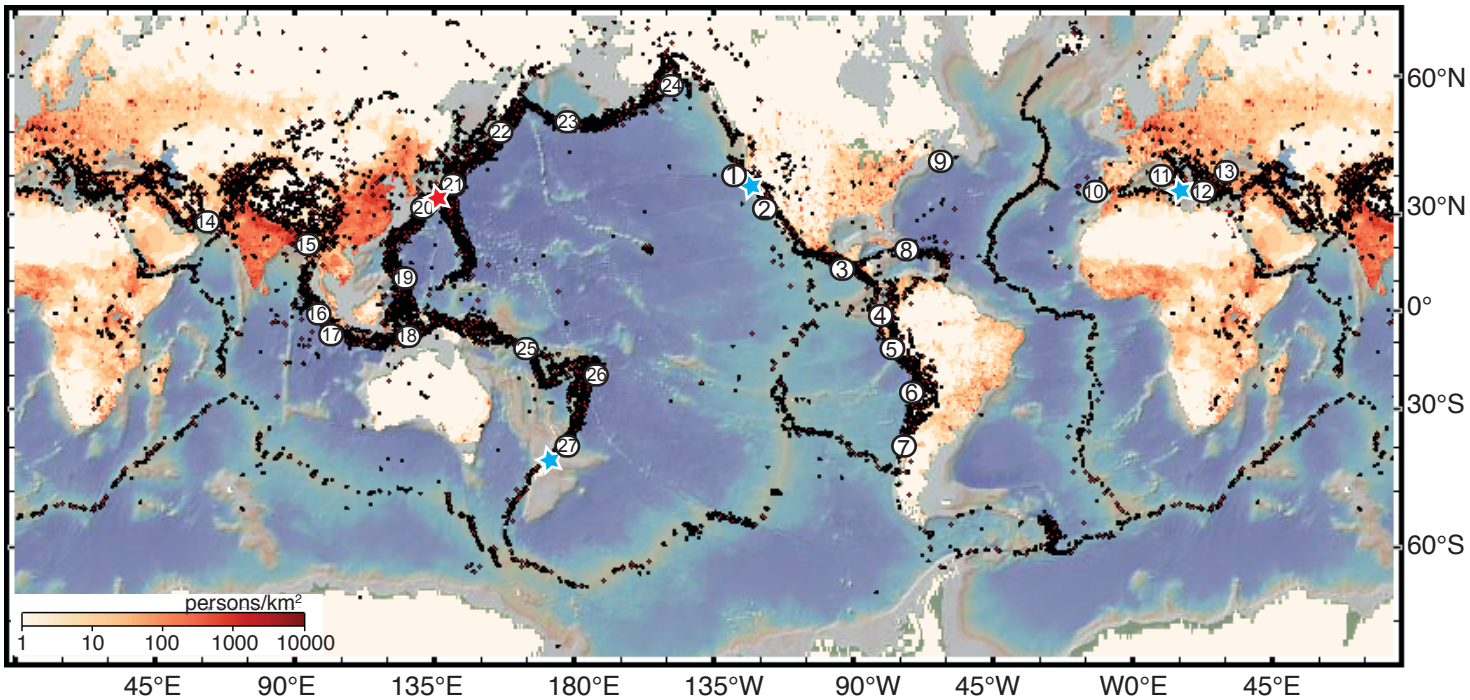


Figure 1. Global distribution of earthquakes with magnitude >5.0 (1973-2013) and human population density for the Year 2000. These data highlight the critical need to better understand the paleoearthquake record, given high population density along plate boundaries. Red star = location, Japan Trench 866-Pre; Blue stars = areas identified for development of future proposals. Numbers indicate where paleoseismic studies recovered archives of earthquakes. Full caption, explanatory notes and references.

New Panel Leadership

October, 2015 brought significant change to the leadership of various IODP panels and committees. Here are the new chairs:

Jamie Austin
University of Texas at Austin

Chair, IODP Forum

Beth Christensen
Adelphi University

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

Anthony Koppers
Oregon State University

Chair, *JOIDES Resolution* Facility Board

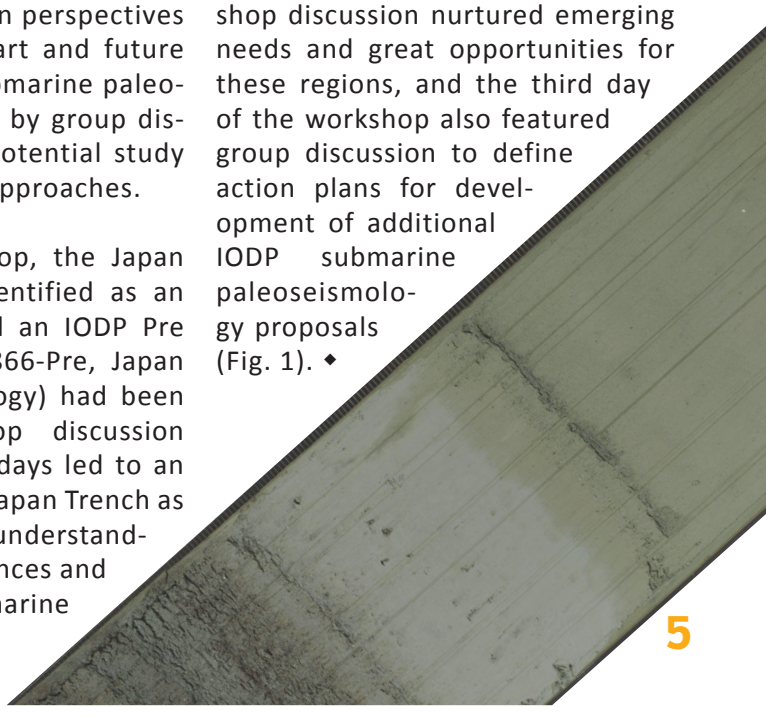
Ken Miller
Rutgers University

Chair, Science Evaluation Panel

pan Trench—have been successful in obtaining a record of paleoearthquakes within the Holocene. A common finding among all these studies is that in tectonically active margins during high-stands of sea-level most sedimentation events can be correlated to the instrumental and, when available, historical record of earthquakes. The techniques applied so far demonstrate that submarine paleoseismology is effective and that a growing scientific community is ready to take the next step in obtaining longer-term earthquake records. This in turn will provide information about the development of structures to better characterize fault segmentation, contributing to a better understanding of plate boundary evolution. The International Ocean Discovery Program recognized the value of further investigating the need for obtaining longer, older than Holocene, sediment records through IODP long piston coring and supported a workshop that took place in Zürich, Switzerland on July 16-18, 2015.

During the workshop, a strategy was defined for how and where major advances in submarine paleoseismology could best be made using giant piston coring efforts within IODP. Fifty-nine participants (including 24 students/early-career scientists) from 14 countries, and representing a broad spectrum of expertise ranging from marine geology to seismology, attended the workshop. The first day was devoted to overview presentations of major scientific themes and questions. This laid the groundwork for a group discussion that broadly addressed objectives, needs, opportunities and challenges for submarine paleoseismology within IODP. The second day featured several presentations and posters by participants highlighting their own perspectives on the state-of-the-art and future opportunities for submarine paleoseismology, followed by group discussion to identify potential study areas and scientific approaches.

Prior to the workshop, the Japan Trench had been identified as an ideal study area and an IODP Pre Proposal (Proposal 866-Pre, Japan Trench Paleoseismology) had been submitted. Workshop discussion during the first two days led to an endorsement of the Japan Trench as a primary target for understanding causes, consequences and recurrences of submarine earthquakes and tsunamis. The third day was dedicated to developing IODP Proposal 866-Full based on input from the previous workshop days. The constructive discussions and clearly defined action plan constitute a critical step toward the development of a competitive full proposal, to be submitted in 2016. Furthermore, the workshop also identified significant potential for the application of submarine paleoseismology within IODP to advance our understanding of long-term earthquake histories in the Mediterranean Sea, and the Hikurangi and Cascadian Margins. Workshop discussion nurtured emerging needs and great opportunities for these regions, and the third day of the workshop also featured group discussion to define action plans for development of additional IODP submarine paleoseismology proposals (Fig. 1). ◆



Expedition 356 Tracks the Indonesian Throughflow and Australian Climate History

Craig Fulthorpe, Stephen Gallagher, Kara Bogus, Beth Christensen, Jeroen Groeneveld & Expedition 356 Scientists

The Indonesian Throughflow (ITF) is a critical part of the global thermohaline conveyor. It transports heat from the equatorial Pacific (the Indo-Pacific Warm Pool) to the Indian Ocean and exerts a major influence on global climate (Figure 1). Expedition 356 was designed to investigate ITF history by drilling along the passive margin of Western Australia downstream of the region of tectonic deformation in the Indonesian Archipelago that has periodically restricted and redirected the ITF. The *JOIDES Resolution* departed Fremantle on August 3rd, 2015, and drilled a latitudinal transect, across 10° latitude, of seven shelf and upper slope sites (Sites U1458-U1464) from the Perth Basin, through the Northern Carnarvon Basin, to the Roebuck Basin, before arriving in Darwin on September 30th (Figure 2). The drilling locations lie directly in the pathway of the ITF and of the southward-flowing Leeuwin Current, itself partially driven by the ITF. Expedition cores therefore provide direct biogeographic and sedimentological evidence of changes in the ITF in addition to containing terrigenous sediment transported from Australia. The goals of Expedition 356 are to: 1) determine the timing and variability of the ITF and Leeuwin Current and their impact on extratropical carbonate and reef deposition; 2) obtain a ~5 My orbital-scale climatic and paleoceanographic record comparable to deep-ocean oxygen isotopic records to chart the variability of the Australian monsoon and the onset of aridity in northwestern Australia; and 3) constrain spatiotemporal patterns of subsidence along the margin that can be used to place funda-

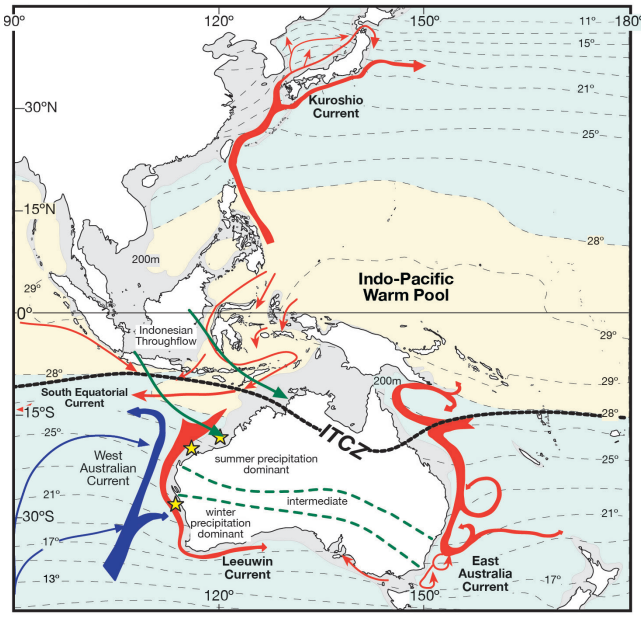


Figure 1. Oceanography and climate of the western Pacific. Currents (red = warm, blue = cold), and direction (green arrows) and geographic extent of the summer monsoon (dashed green lines) are shown (see Expedition 356 Prospectus). Average January position of the Intertropical Convergence Zone (ITCZ) is shown. Yellow stars mark positions of three groups of Expedition 356 drill sites: southern group (U1458, U1459 and U1460), central group (U1461 and U1462) and northern group (U1463 and U1464). See Figure 2 for individual site locations.

Expedition 356 Science Party

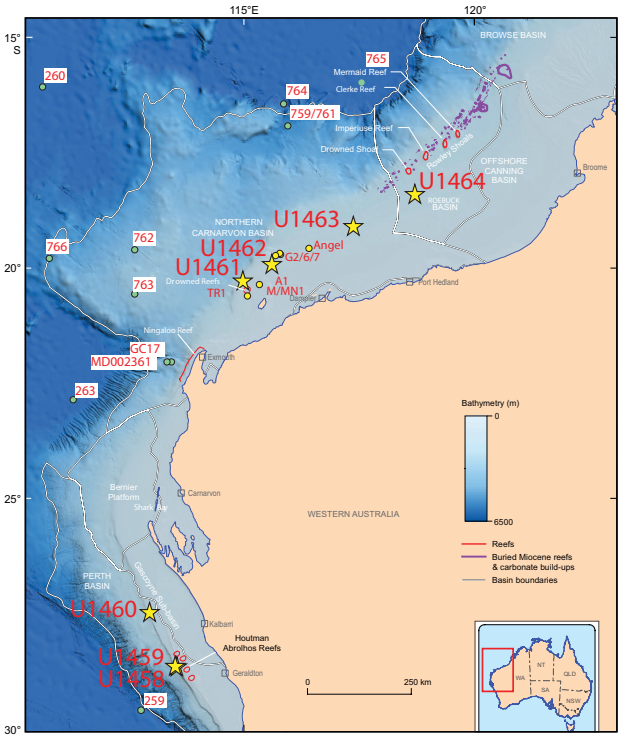


Figure 2. Locations of IODP Sites U1458-U1464.

mental constraints on the interaction between Australian plate motion and mantle convection and to groundtruth geodynamic models.

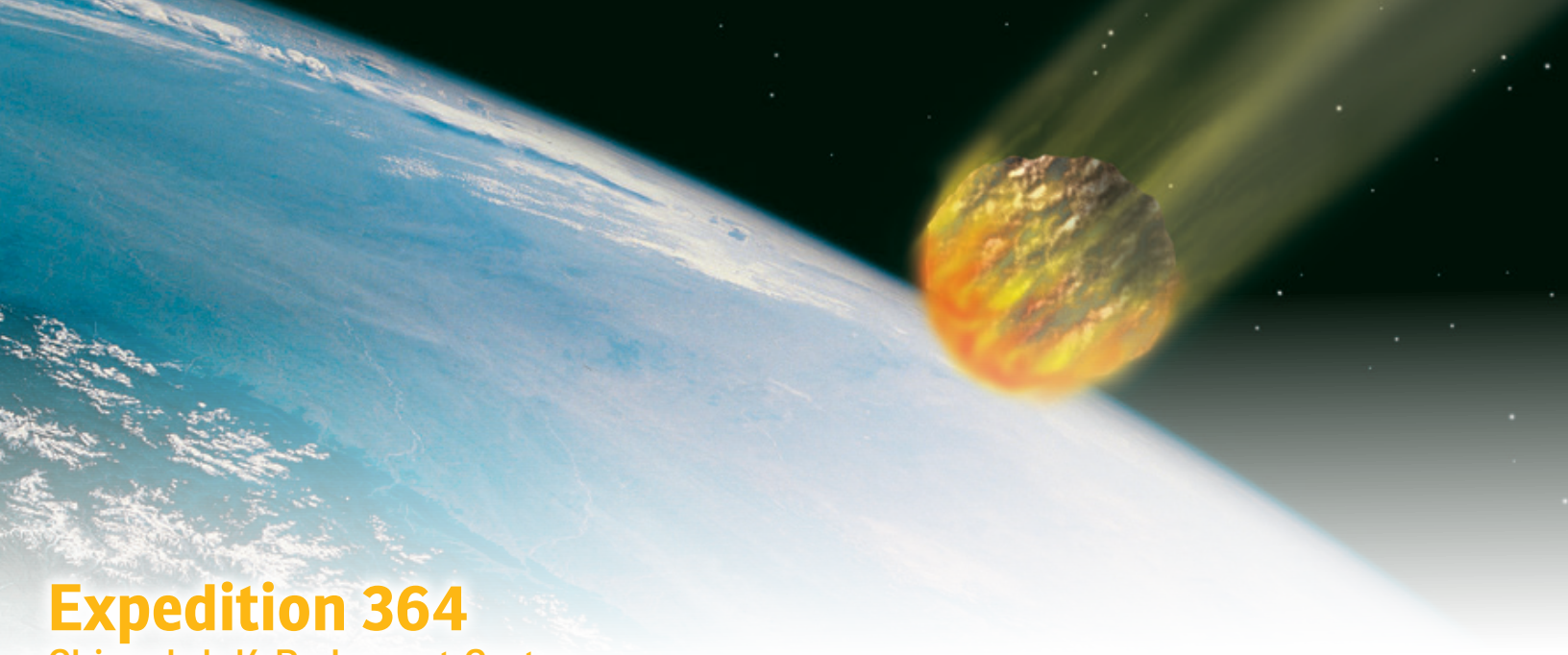
The expedition met or exceeded expectations in addressing each of the proposed objectives, despite the curtailing of some planned borehole seismic measurements as a result of the annual humpback whale migration. Biostratigraphic, sedimentological and geochemical analyses, coupled with an array of downhole measurements, provide comprehensive Neogene shelf and slope stratigraphic records. The relative abundance of biogeographically significant Indo-Pacific benthic foraminifera will document intermittent ITF connectivity. In addition, most sites are located near active or buried reefs and will constrain the timing of reef initiation and demise in response to both ITF connectivity and Leeuwin Current intensity. Pleistocene ooids, also indicators of shallow-water tropical conditions, were recovered at Sites U1461 and U1462 and provide additional information on paleobathymetry and also on the conditions necessary for ooid formation.

Before Expedition 356, there were no orbital-scale climate records extending beyond 500 Ka along the entire Western Australian margin. This record can now be greatly extended. Sites U1459-U1460 provide a record of up to 5 My of the southern winter-dominated rainfall regime of Australia, whereas Sites U1461-U1464 yield a complementary record of the summer rainfall-dominated Australian monsoon. At Site U1464, there is potential to extend a high-resolution climate record to the middle Miocene, using wireline logging data to augment coring results. The sediments recovered are predominantly carbonates, but a siliciclastic component is also present at varying concentrations that reflect periods of increased fluvial and/or aeolian transport. Wireline logs of potassium and uranium content are being investigated as potential proxies for fluvial and aeolian inputs, respectively. Such proxies, together with sedimentological evidence of arid conditions, are proving particularly valuable for tracking transitions between arid and humid climates since the Middle Miocene Climate Optimum, culminating in the onset of the modern Australian monsoon. These climatic transitions are linked to the development of the Antarctic ice sheet as well as changes in Indian Ocean circulation and restriction of the ITF. Recognition of the importance of these results has already led to submission of two high-impact papers to Nature Geoscience.

> ***Before Expedition 356, there were no orbital-scale climate records extending beyond 500 Ka along the entire Western Australian margin.***

Ongoing research will evaluate biogeographic and sea-surface temperature (using multi-proxy inorganic and organic geochemistry) evidence of ITF connectivity and produce high-resolution stable isotopic and sediment compositional records. Integration of core and seismic data will allow documentation of the onset of post-Miocene reef and carbonate platform development, previously poorly constrained in this region. Finally, drilling results will also allow quantification of the unusually high subsidence rates observed at several sites and constrain its cause. Anomalous subsidence in the region is the result of dynamic topography associated with the northward movement of Australia over a mantle anomaly, although uncertainty remains over whether the anomaly is fixed and long-lasting or transient.

The unparalleled documentation of the geology and geophysics along this continental margin extends our knowledge of Australian and regional climate and paleoceanography back in time well beyond the limits of existing studies. Expedition 356 data will yield new understanding of Australia's role in the global climate system and drive research by the expedition scientific party and other scientists for many years to come.◆



Expedition 364

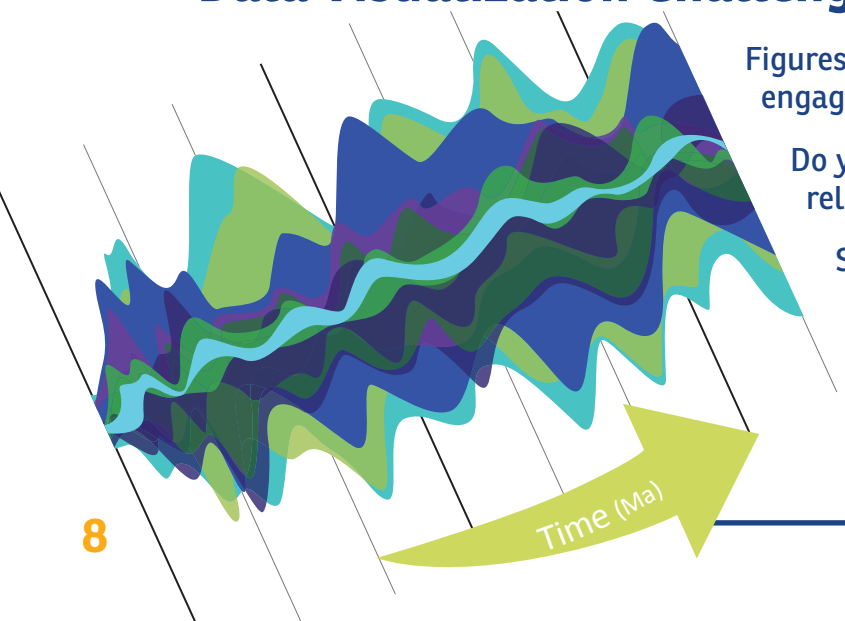
Chicxulub K-Pg Impact Crater

The Chicxulub impact structure in Mexico was formed when a large asteroid hit the Earth around 66 million years ago. The impact is linked to the end-Cretaceous mass extinction, and is widely known for its association with the demise of the dinosaurs. Perhaps less widely appreciated is its distinction as the only known terrestrial crater with an intact, topographic peak ring—a ring of hills that stand above the otherwise flat crater floor. Peak rings are a common feature of large craters on rocky bodies throughout the solar system, but there is no consensus on their formation. Expedition 364, scheduled for April 5 – June 6, 2016, will drill into the peak ring to understand how hypervelocity impacts temporarily change rock behavior in a way that allows peak rings to be formed. The expedition is also investigating the hypothesis that impacts could have generated and sustained habitats for chemosynthetic life on the early Earth. Also of interest is how ocean life recovered after this impact, and what changes occurred across the Paleocene-Eocene Thermal Maximum (PETM).

The team will specifically address questions on these three themes:

- Peak-ring formation: What is the nature of the rocks that form a peak ring? Are they from the upper, mid or lower crust? Why do they have such a low density and seismic velocity? What are the kinematics and dynamics of peak-ring formation? What rock-weakening mechanism controls large crater formation?
- Habitability: Was there intense hydrothermal activity in the rocks that form the peak ring and how long did it last? What microbiological life colonized the peak ring, was it diverse and/or exot-

Data Visualization Challenge



Figures can inform but also inspire through visually engaging graphics.

Do you have a figure that communicates your IODP-related science in a particularly compelling way?

Send it to us and we will feature the most eye-catching entries in the next issue of Ocean Discovery!

To Submit:
usoceandiscovery.org/datavizchallenge

ic, and was it shaped by the post-impact hydrothermal system?

- Recovery of life: After the impact, how long did it take for the ocean to return to normal conditions? Did diversity gradually recover, or did the whole assemblage return simultaneously once the environment stabilized? What is the relationship between the survivors of the K-Pg event and newly evolved taxa, and the mass survival at the PETM 10 million years after?

The expedition will last two months and involve penetrating beneath the seabed from an offshore platform, the Liftboat *Myrtle*. The core will be the first complete sample of the rock layers from near the crater's center.

Twenty nine scientists from the USA, Mexico, Japan, Australia, Canada and six European countries, are participating in the expedition, which is planned and conducted by the European Consortium for Ocean Research Drilling (ECORD) as part of the International Ocean Discovery Program (IODP). The expedition is also supported by the International Continental Scientific Drilling Program (ICDP).

As only a minimum number of measurements will be carried out on the cores while at sea, only twelve members of the science team will participate offshore. The entire team will meet for an onshore phase (the "Onshore Science Party") at the IODP Bremen Core Repository and MARUM laboratories in Germany later in 2016. There the core will be split in two and one half will be immediately analyzed by the team of scientists. The other half will be saved at the Gulf Coast Core Repository at Texas A&M University for future research by the international community. ◆

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2016-17 Ocean Discovery Lecture Series

For over twenty years, the Ocean Discovery Lecture Series (formerly the Distinguished Lecture Series) has brought the exciting results and discoveries of scientific ocean drilling to academic research institutions and informal learning centers. The roster of 2016-17 Ocean Discovery Lecturers will focus on topics such as climate change, tectonics, hydrogeology, microbiology and more. For further information on the 2016-17 lectures, visit http://usoceandiscovery.org/lecturer-series

Cathy Busby
University of California, Davis
Anatomy of a Long-Lived Oceanic Arc: Synthesis of Three IODP Expeditions in the Izu-Bonin-Marianas Arc

Kira Lawrence
Lafayette College
Back to the Future? Insights into Future Climate Change from Warm Climate Intervals of the Past

Andrew Fisher
University of California, Santa Cruz
Subseafloor Experiments and Models Reveal Complex Patterns of Coupled Fluid-Heat-Solute Transport Throughout the Ocean Crust

Jian Lin
Woods Hole Oceanographic Institution
South China Sea: Drilling Back in Time to Determine the Evolution of a Vital Marginal Sea

John Jaeger
University of Florida
Building Mountains in an Icy World: Results from IODP Drilling in the Gulf of Alaska

Jason Sylvan
Texas A&M University
Those Rocks are Alive! Geomicrobiology of the Deep Biosphere in Subseafloor Igneous Basement

Expedition 360
Education and Outreach Team

Berth space availability on Expedition 360: SW Indian Ridge Lower Crust and Moho allowed for a larger than usual education and outreach team. The European Consortium for Ocean Research Drilling (ECORD) sailed Canadian science communicator Lucas Kavanagh and Marion Burgio, a high school teacher from France. Participating from IODP China was senior journalist Jianson Zhang. And USSSP sailed middle school teacher Alejandra Martinez from Eagle Pass, Texas. Together, this education and outreach team reached a large and particularly diverse collection of shore-based audiences.

Using iPads on the ship, the education team interacted with 129 groups of students—a total of 5,753 people in 15 countries—to share the scientific goals and progress of the expedition. This format, as per usual on *JOIDES Resolution* expeditions, allowed for direct communication between students on shore and scientists aboard the ship. A typical session included a brief demonstration of crust-mantle models using samples and diagrams, followed by a lab tour that traced the path of a core onboard the ship. Events concluded with questions and answers with one or more members of the science party.

An experienced podcaster, Mr. Kavanagh published five 20-minute podcast episodes featuring explanations of scientific concepts and interviews, which have reached 1200 listeners across 17 countries. The podcasts can be found at https://soundcloud.com/joides-resolution. In addition, Mr. Kavanagh produced two videos—a time-lapse montage of life aboard the ship during Expedition 360, and a short video featuring the use of technology on the *JOIDES Resolution* to be featured as part of the "Codemakers" program, a Canadian computer science outreach initiative sponsored by Actua and Google.

In addition, the onboard presence of Ms. Zhang generated significant coverage in China. The Xinhua News Agency released more than 30 news reports as well as more than 120 photographs about Expedition 360. Xinhua is the most authoritative official media in China, and this represented the first time it had reported on IODP at such length. ◆

Sun-Earth Day IODP Outreach at the AMNH

Kicking off USSSP's new partnership with the American Museum of Natural History in New York City, IODP was featured prominently during AMNH's Sun-Earth Day events March 18-19, 2016. During a Friday evening lecture for more than 100 New York-area teachers, Dr. Jerry McManus of Lamont-Doherty Earth Observatory spoke on "Sun and Earth: Cycles and Abrupt Shifts in Past Climate." His lecture was both preceded and followed by opportunities for teachers to learn about IODP education resources from USSSP staff and children's author and former Education Officer, Kevin Kurtz.

On Saturday, March 19, the events continued with a special program from current USAC chair Dr. Beth Christensen for the Lang Scholars, a group of New York high school students who participate in regular science programming with the museum. Dr. Christensen spoke to about 65 students about how and why we drill into the ocean floor, what it's like to live and work on the *JOIDES Resolution*, and how to pursue careers in science. She also presented a "lightning talk" about IODP for general museum visitors. Throughout the day, USSSP staff and Mr. Kurtz manned an interactive station in the Hall of Planet Earth, where families could learn more about IODP and its achievements, and the various ways to stay informed about the program's activities. ◆

Letter from Former USAC Chair

"How do I get a chance to sail?" was one of the most common questions that I received during my time as USAC Chair. As it often came from early career scientists, especially students, I took this as a very positive indication that IODP was conducting novel science that could inspire interest from the next generation in our community. Unfortunately, I also often heard that they are told it is very difficult to be selected, which ultimately discourages them from applying. This removes a talented pool of up-and-coming scientists from our community.

For my final letter as the former chair of USAC, I want to try to do my best to dispel this myth.

For IODP Expeditions 301 through 361, the U.S. Science Support Program (USSSP) received 1248 U.S. applications to sail, with 75% of those coming from early career scientists. USSSP's role in the staffing process is to nominate U.S. applicants to the three platform operators. A USAC Staffing Subcommittee reviews and ranks all U.S. applications, with the highest ranking given to those with a participation plan that best complements and helps achieve the expedition objectives. Of the early career applicants, 20-40% were given the highest priority ranking. While this ranking was no guarantee that the operators would choose them to sail, it does indicate that USSSP strongly supported the participation of newcomers to the community. With the potential for up to five *JOIDES Resolution* expeditions per year over the next few years, there will be many opportunities for early career scientists to participate, including an additional shipboard scientist slot as the result of an increase in the size of each U.S. science party beginning this fall.

So how can someone who hasn't sailed craft a competitive application and participation plan? My strongest recommendation is to apply to attend one of the various planning workshops that USSSP sponsors each year. A specific number of workshop participant slots are reserved for early career scientists. While at a workshop, reach out to the conveners and those who have sailed previously to discuss how your scientific interests can be incorporated into a participation plan that maps into the required shipboard responsibilities (e.g., core description, physical property measurements, microbiology, etc.). If you cannot attend these workshops, but still want to apply to sail on future expeditions, contact members of the USAC Staffing Subcommittee to get their opinion on how to best craft a plan that fits within these staffing requirements. My most enduring memory of serving on USAC is the degree of dedication among USSSP and its USAC members to advancing and promoting opportunities for participation of U.S. scientists in such a strong international scientific program.

John Jaeger

Schlanger Fellows 2016-2017

Meet our 2016-2017 Schlanger Ocean Drilling Fellows! Each of the recipients will receive a $30,000 award to conduct IODP-related research during the 2016-17 academic year. Additional information on their projects can be found at http://usoceandiscovery.org/schlanger-fellows-2016-2017

Laura Zinke

University of Southern California

Active Microbial Carbon Cycling in the Baltic Sea Basin

Richard Berg

University of Washington

Quantifying Global Rates of Magnesium Uptake into Marine Sediments

Jody Wycech

University of Wisconsin-Madison

Evaluating the Impact of Central American Seaway Closure on Pliocene Walker Circulation

Philip Staudigel

University of Miami

The Application of Clumped Isotopes in Studying the Post-depositional Alteration of Marine Carbonates

Robert Poirier

Rensselaer Polytechnic Institute

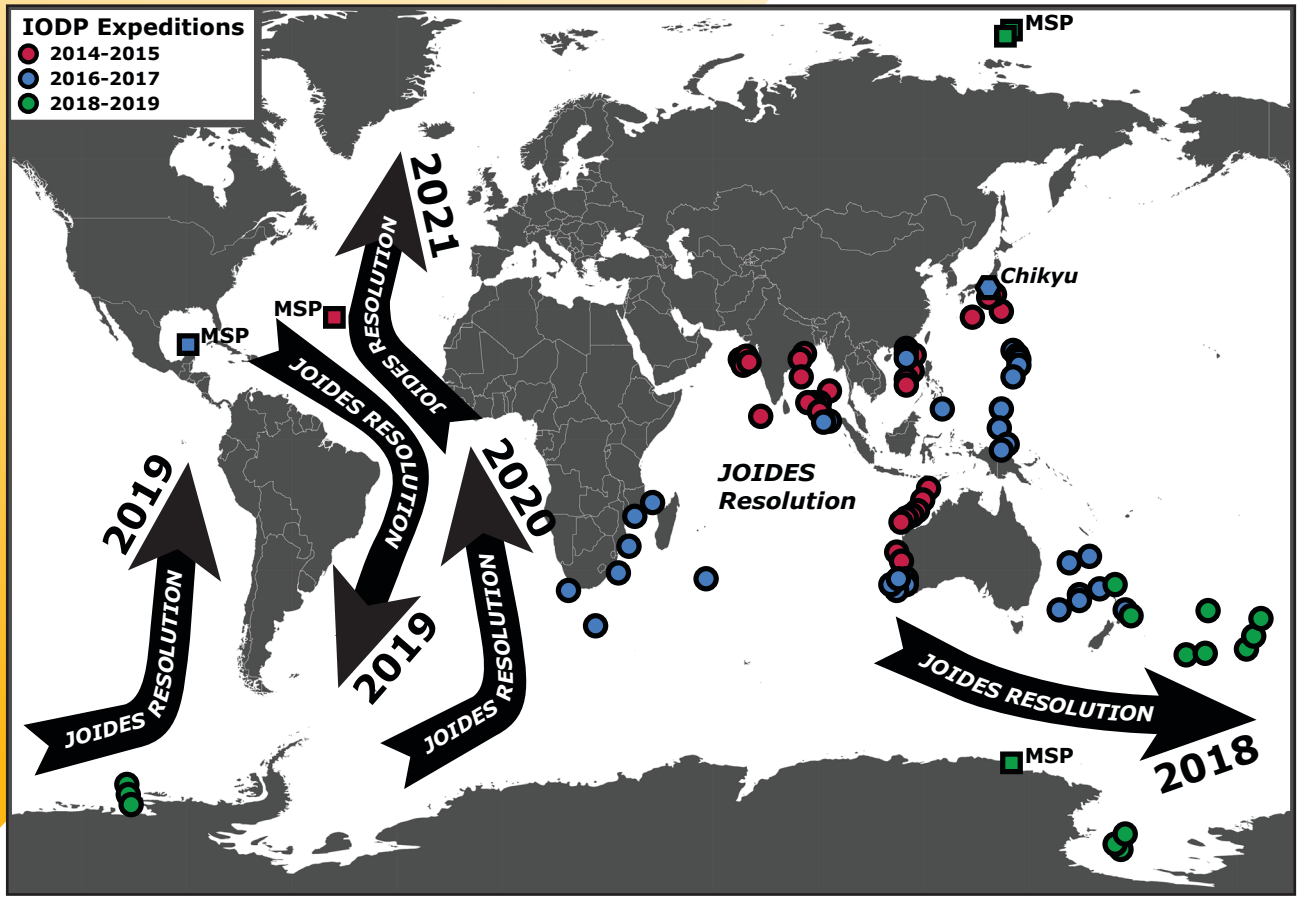
Assessing Millennial-scale Variability in the Densest Limb of Meridional Overturning Circulation during the PRISM Timeslice

2016 - 2017 IODP EXPEDITION SCHEDULE

Platform	#	Expedition	Dates	Ports
	364	Chicxulub K-Pg Impact Crater	04/01/16 - 05/31/16	Progreso, Mexico - Progreso, Mexico
	362	Sumatra Seismogenic Zone	08/06/16 - 10/06/16	Colombo, Sri Lanka - Singapore
	370	Temperature Limit of the Deep Biosphere off Murato	09/10/16 - 11/10/16	Shimizu, Japan - Kochi, Japan
	363	Western Pacific Warm Pool	10/06/16 - 12/08/16	Singapore - Guam
	366	Mariana Convergent Margin	12/08/16 - 02/07/17	Guam - Hong Kong
	367	South China Sea Rifted Margin A	02/07/17 - 04/09/17	Hong Kong - Hong Kong
	368	South China Sea Rifted Margin B	04/09/17 - 06/09/07	Hong Kong - Hong Kong
	369	Australia Cretaceous Climate and Tectonics	09/28/17 - 11/28/17	Fremantle, Australia - TBD

JOIDES Resolution
Chikyu
Mission Specific Platform

The *JOIDES Resolution* Ship Track: Summer 2016 and beyond



(Map modified to reflect consensus statements of the JRFB, May, 2016)