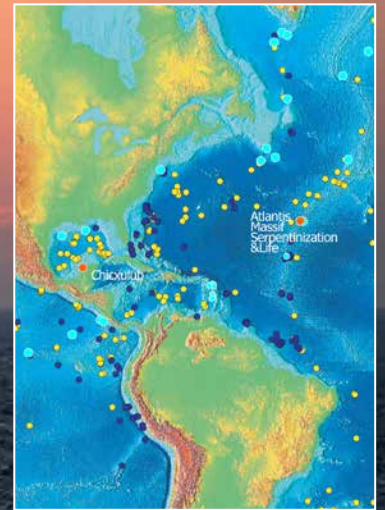
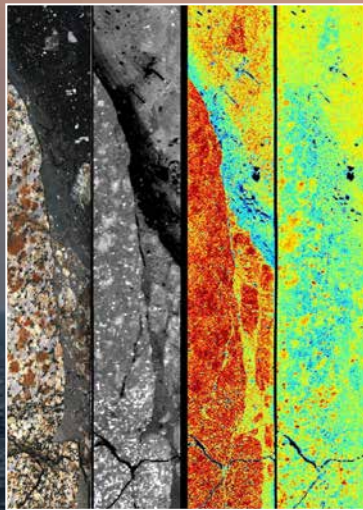




EUROPEAN CONSORTIUM FOR
OCEAN RESEARCH DRILLING

ANNUAL REPORT 2016



From October 2003 to December 2016, European and Canadian scientists participated in the Integrated Ocean Drilling Program (IODP) as part of the European Consortium for Ocean Research Drilling (ECORD). ECORD coordinated the European contribution to the programme through the mission-specific platform (MSP) concept, which allowed the ocean research community to work in technically challenging conditions where the US drillship *JOIDES Resolution* and the Japanese drilling vessel *Chikyu* are unable to operate. The development of the MSP concept has therefore added a new dimension to ocean drilling.

The ECORD Science Operator (ESO) consortium has successfully managed five MSP expeditions for IODP to the Arctic (2004), Tahiti (2005), New Jersey (2009), the Great Barrier Reef (2010), and the Baltic Sea (2013). ECORD's scientific and operational accomplishments have been prolific and of high quality,

and are recognised by our global partners as a crucial contribution to the largest marine geosciences programme in the world.

The International Ocean Discovery Program (IODP), which started on 1 October 2013, builds on this legacy and addresses global challenges facing current and future generations with new research approaches, expanded scientific communities and continued development of its unique collaborative model.

In 2016, IODP involves scientists from 24 countries including the USA, Japan, China, South Korea, India, Australia, New Zealand, Brazil and 16 ECORD countries, including Canada and Israel.

ECORD funds and implements MSP operations for IODP as an independent platform provider, with the aim to carry out on average one expedition per year for the duration of the 2013-2023 programme. In future, MSPs might

include specifically outfitted polar vessels, jack-up rigs, geotechnical vessels, seabed-drilling systems, long-piston coring, anchored barges and others, as determined by scientific priorities and operational efficiency. From 2015 to 2016, ESO has successfully managed two expeditions to the Atlantis Massif and the Chicxulub Impact Crater. ECORD is now preparing for its next MSP expeditions to the Gulf of Corinth, Arctic and Antarctic areas.

ECORD also continues to make financial contributions to the US National Science Foundation (NSF) and to the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) for support and access to the *JOIDES Resolution* and the *Chikyu* respectively. Members of ECORD can therefore take part in all IODP expeditions that address research topics such as climate and ocean change, biodiversity, sub-seafloor life, origin of life, natural hazards on human time scales, as well as the internal structure and dynamics of our planet.

Front cover: from left to right, IODP proposals in the Southern Ocean; CT-scan of Expedition 364 Chicxulub K-Pg Impact Crater (C. Mellet, ECORD/IODP); Kate Littler shows the K-Pg core replica at a summer festival in Falmouth (UK); map of IODP, ODP and DSDP boreholes. Background: sunrise over the Gulf of Mexico seen from L/B Myrtle (photo E. Le Ber, ECORD/IODP).

Back cover: Waiting for the cores aboard the L/B Myrtle during Expedition 364 Chicxulub K-Pg Impact Crater (photo A. Rae, ECORD/IODP).

ECORD Annual Report 2016

1 January 2016 - 31 December 2016

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ECORD entities

As defined in the ECORD Memorandum of Understanding, ECORD comprises **six entities** and **two task forces** (right).

The **ECORD Council** is the funding entity for ECORD and provides oversight for all ECORD activities.

Chair: Magnus Friberg (Sweden; 1 January to 31 December 2016)



Magnus Friberg has a background in applied geophysics. Magnus represents the Swedish Research Council in international collaborations across climate, environment and energy research, and manages support to Swedish and international

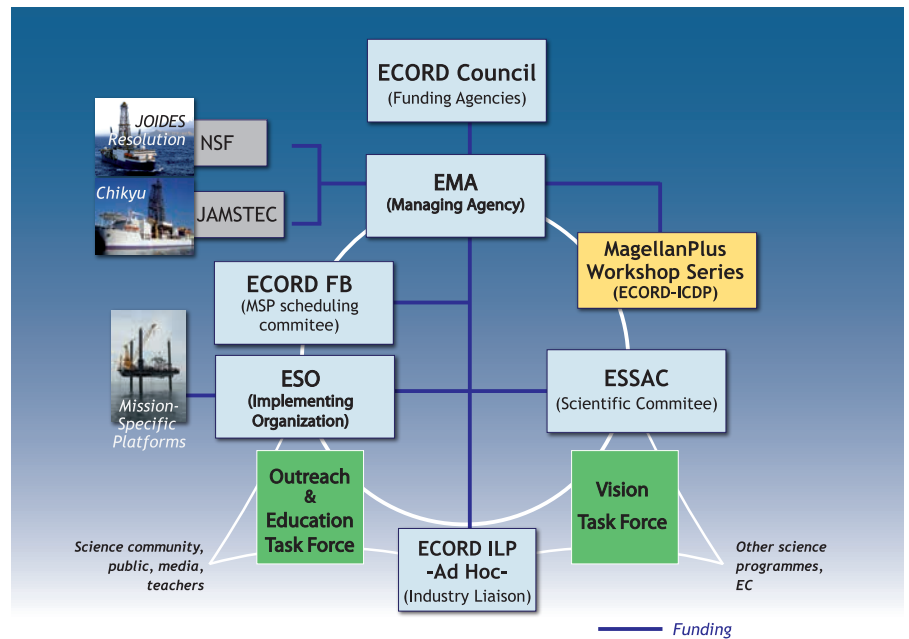
infrastructures in the same areas. Magnus acts as scientific advisor to the Swedish government in bi-lateral and multi-lateral agreements, and is also appointed on several international boards including International Continental Scientific Drilling Program, Horizon 2020, the European Science Forum for Research Infrastructures, the Integrated Carbon Observing System, the Scientific Committee on Antarctic Research and the International Arctic Science Committee.

Outgoing Vice-Chair: Michel Diament (France; 1 January to 30 June 2016)

Incoming Vice-Chair: Michael Webb (UK; 1 July to 31 December 2016)

Council Core Group: Michel Diament (France; 1 January to 30 June 2016), Magnus Friberg (Sweden), Eric Humler (France; 1 July to 31 December 2016), Anders Kjaer (Denmark; 1 January to 31 October 2016), Guido Lüniger (Germany), Marco Sacchi (Italy; 1 November to 31 December 2016) and Michael Webb (UK) <http://www.ecord.org/about-ecord/management-structure/council/>

The **ECORD Executive Bureau (E-EB)** acts as the executive entity of the ECORD Council. The E-EB is composed of the



Council Chair and Vice-chair, the Council Core Group, the EMA Director and the Chairs of ESO, ESSAC and the ECORD-ILP.

The **ECORD Managing Agency (EMA)** is the management body of ECORD and represents ECORD in all IODP entities. EMA is the fund holder for the consortium in IODP and provides oversight of the ECORD Science Operator (ESO) and the ECORD Science Support and Advisory Committee (ESSAC). **Director:** Gilbert Camoin (CEREGE, France)



Gilbert Camoin is a Senior Scientist at the Centre National de la Recherche Scientifique (CNRS) at the Centre Européen de Recherche et d'Enseignement des Géosciences de l'Environnement (CEREGE) in Aix-en-Provence, France.

His major research activities are focused on the records of sea-level, environmental and climatic changes by coral reefs and other carbonate systems. Gilbert was appointed as Director of EMA in January 2012 and served previously as Chair of the ODP/IODP

Environment Science Steering Evaluation Panel (2001-2005), Chair of the ECORD Science Support and Advisory Committee (ESSAC) (2007-2009), Member of the IODP Science Planning Committee (2007-2010), and Member of the IODP Science Plan Writing Committee (2010-2011).

Assistant Director: Nadine Hallmann (CEREGE, France)

Outreach Coordinator: Patricia Maruéjol (University of Lorraine, France)

Administrator: Martine Tiercelin (CEREGE, France; until September 2016), Patricia Rieu (CEREGE, France; from September 2016)

<http://www.ecord.org/about-ecord/management-structure/ema/>

The **ECORD Science Operator (ESO)** is the implementing organisation of ECORD and is tasked with planning and delivering mission-specific platform (MSP) expeditions for the International Ocean Discovery Program (IODP). ESO is a consortium of three European scientific institutions: the British Geological Survey (BGS); the MARUM - Center for Marine Environmental Sciences, University of Bremen, Germany; and the European Petrophysics Consortium (EPC). Each partner contributes specific expertise

to ESO, allowing the consortium to build tailored expeditions to suit the requirements of proposals selected for implementation by the ECORD Facility Board. The BGS coordinates proposal scoping, expedition planning and project management, contracting of drilling services and vessels, operational oversight, and project permitting. MARUM manages the curation services and scientific facilities required by MSPs, provides data management services, and coordinates the implementation of the Onshore Science Party (OSP), hosted at the IODP Bremen Core Repository and laboratories of the University of Bremen. EPC comprises three universities from across Europe: the University of Leicester (UK, lead partner), CNRS Montpellier (France) and RWTH Aachen (Germany). The consortium provides operational, technical and high-level scientific support for MSP expeditions. EPC also has links into a larger international logging community that includes personnel at Lamont-Doherty Earth Observatory (USA) and the University of Tokyo (Japan).

Chair: Robert Gatliff (BGS, UK)



Robert Gatliff is the Director for Energy and Marine Geoscience at the British Geological Survey in Edinburgh, UK, and Chair of the ECORD Science Operator. His expertise is based on basin analysis and seismic interpretation of

the UK and he has led geophysics and drilling expeditions on the NE Atlantic Margin.

Science Manager: David McInroy (BGS, UK)

Operations Manager: Dave Smith (BGS, UK)

Expedition Project Managers: Carol Cotterill (BGS, UK; until September 2016), Sophie Green (BGS, UK), Claire Mellett (BGS, UK)

EPC Managers: Sarah Davies (EPC, UK), Sally Morgan (EPC, UK)

Logging Staff Scientists: Johanna Lofi (EPC, France), Annick Fehr (EPC, Germany), Erwan Le Ber (EPC, UK)

Curation and Laboratory Manager: Ursula Röhl (MARUM, Germany)

Assistant ESO Curation: Holger Kuhlmann (MARUM, Germany; until July 2016), Patrizia Geprägs (MARUM, Germany; from August 2016)

BCR Superintendent: Walter Hale (MARUM, Germany; until July 2016), Holger Kuhlmann (MARUM, Germany; from August 2016)

Data Manager: Hans-Joachim Wallrabe-Adams (MARUM, Germany), Vera Bender (MARUM, Germany), Mary Mowat (BGS, UK)

Outreach Manager: Alan Stevenson (BGS, UK; until October 2016), Carol Cotterill (BGS, UK; from November 2016)

Media Relations: Albert Gerdes (MARUM, Germany; until February 2016), Ulrike Prange (MARUM, Germany; from March 2016)

<http://www.ecord.org/about-ecord/management-structure/eso/>

The **ECORD Science Support and Advisory Committee (ESSAC)** is the ECORD science committee and is responsible for the scientific planning and coordination of ECORD's contribution to IODP.

Chair: Jan Behrmann (GEOMAR, Germany)



Jan Behrmann is a Professor of Marine Geodynamics at GEOMAR Helmholtz Centre of Ocean Research in Kiel, Germany, and President of the German Geological Society - Geological Union. Jan has sailed

on five ODP and IODP Expeditions, leading ODP Leg 141 (Chile Triple Junction) and IODP Expedition 308 (Gulf

of Mexico Hydrogeology) as Co-Chief Scientist. He also served on the JOIDES Tectonics Panel, the IODP Science Planning Committee, the IODP Operations Task Force, and in the Science Advisory Group of the International Continental Scientific Drilling Program (ICDP).

Vice-Chair: Gretchen Früh-Green (ETH Zurich, Switzerland)

Science Coordinator: Hanno Kinkel (GEOMAR, Germany)

<http://www.ecord.org/about-ecord/management-structure/essac/>

The **ECORD Facility Board (EFB)** is the planning forum for MSP expeditions and is responsible for scheduling drilling proposals and for advising on the long-term planning of ECORD's activities and functions. The EFB is composed of the ECORD Executive Bureau and a Science Board.

Chair: Gilles Lericolais (Ifremer, France)



Gilles Lericolais is a marine geologist/geophysicist, based at Ifremer since 1984. He was appointed as Director of the European and International Affairs of Ifremer in 2011. He has been Chief Scientist on many scientific cruises and has led or

coordinated various European science projects. He is the Vice-Chair of the European Marine Board, a member of EurOcean and one of the French representatives on the National board for the IOC of the UNESCO. Gilles was the Chair of the IODP Site Survey Panel from 2008 to 2013.

Vice-Chair: Dominique Weis* (University of British Columbia, Canada)

Members of the Science Board: Gerald Dickens* (Rice University, USA), Stephen Gallagher (University of Melbourne, Australia), Karsten Gohl* (AWI, Germany), Fumio Inagaki (JAMSTEC, Japan)

<http://www.ecord.org/about-ecord/management-structure/efb/>

The **ECORD Industry Liaison Panel (ECORD-ILP)** is the link between

academia and industry, fostering and promoting scientific and technological collaboration.

Chair: Andrea Moscariello (University of Geneva, Switzerland)



Andrea Moscariello is a Professor at the Department of Earth Sciences, University of Geneva, in charge of the reservoir geology and sedimentary basins group and developing several research programmes in

geo-energy topics (geothermal, hydrocarbon, geological storage of CO₂). From 1997 to 2008 Andrea worked as a geoscientist for Shell International all over the world. From 2008-2011 he was an independent consultant in hydrocarbon exploration and production, Assistant Professor at the Technical University of Delft (The Netherlands) and Visiting Lecturer at the University of Cambridge (UK). Andrea is a member of the Executive Committee of AAPG for Europe, a member of the Research Committee of the EAGE and an expert on energy matters for the United Nations ESCWA.

<http://www.ecord.org/about-ecord/management-structure/ecord-ilp/>

The **ECORD Outreach & Education Task Force (E-OETF)** coordinates ECORD's communication tasks, such as outreach/public information and educational activities related to IODP in ECORD countries. The E-OETF is composed of the EMA Outreach Coordinator (Chair), ESO Outreach and Media Relations

Managers, ESSAC Chair and Science Coordinator and EMA Director and Assistant Director.

The **ECORD Vision Task Force (E-VTF)** is the ECORD strategic entity in charge of developing a long-term scientific and funding strategy, and monitoring ECORD's progress towards achieving the objectives of the IODP Science Plan. The E-VTF is composed of the ESSAC Chair, the EMA Director and Assistant Director, the ESO Chair and Outreach Manager and the ECORD- ILP Chair.

Contact ECORD: <http://www.ecord.org/contact-ecord/>

The table *page 5* summarises ECORD and IODP meetings that have been held during 2016, as well as four major science conferences (EGU in Vienna, AESC in Adelaide, IGC in Cape Town and AGU in San Francisco) where IODP-related scientific sessions and exhibition booths have been organised.

The **ECORD Council** meets twice a year with a spring meeting (Berlin, Germany) involving the Council and the members of the ECORD Executive Bureau, and a joint fall meeting with ESSAC (Bremen, Germany,) involving representatives of all the ECORD entities as well as representatives from our IODP partners (funding agencies, operators and science committees) and collaborating science programmes.

ESSAC meets twice a year with a spring meeting (Faro, Portugal) and a fall meeting involving ESSAC Delegates and EMA and ESO representatives, (Bremen, Germany) organised jointly with the ECORD Council.

The **ECORD Facility Board (EFB)** meets once a year (Brussels, Belgium) and involves its constituent members (Science Board and ECORD Executive Bureau), as well as representatives from our IODP partners (funding agencies, operators and science committees).

The **ECORD Education & Outreach Task Force (E-OETF)** meets twice a year, in January and in October (Bremen, Germany, and Edinburgh, UK, respectively) and involves its ECORD members and an ICDP representative; outreach colleagues from the US Science Support Program and CDEX/JAMSTEC (Japan) were invited to attend the October meeting.

ECORD sends representatives to IODP meetings: the *JOIDES Resolution* Facility Board (JRFB) and the *Chikyu* IODP Board (CIB) meetings, the Science Evaluation Panel (SEP), the Environmental Protection and Safety Panel (EPSP) and the IODP Forum meetings.

Calendar of events: <http://www.ecord.org/events-calendar/>

Drilling equipment of Expedition 364 Chicxulub K-Pg Impact Crater (photo G. Tulloch, ECORD/IODP).

ECORD / IODP meetings and conferences in 2016

Jan	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	SEP Meeting La Jolla, USA	ECORD OETF #9 Bremen, Germany					
Feb	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29									
Mar	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31				CIB #4 Kobe, Japan			
Apr	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30				EGU Vienna, Austria				
May	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31				JR Facility Board Arlington, USA	ESSAC Meeting #6 Faro, Portugal		
Jun	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	ECORD Council Spring #2 Berlin, Germany	ECORD Facility Board #4 Brussels, Belgium	SEP Meeting Bremen, Germany	AESC Adelaide, Australia				
Jul	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31				EPSP Meeting College Station, USA			
Aug	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31					35 th IGC Cape Town, South Africa		
Sep	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30				35 th IGC Cape Town, South Africa	IODP Forum #3 Búzios, Brazil			
Oct	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31				ECORD OETF #10 Edinburgh, UK	#357 Review	ESSAC Meeting #7 Bremen, Germany	ECORD Council-ESSAC #4
Nov	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30							IODP France Days Paris, France	
Dec	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31							AGU San Francisco, USA

Vertical layers of the Burgau Formation show many life tracks from the Lower Cretaceous (Praia dos Arrifes, Algarve, Portugal) - Field excursion of the ESSAC meeting, Faro, May 2016 (photo P. Maruéjol).



1. 2016 highlights

ECORD combines research, education and innovation and offers a unique portfolio of science and educational activities, world-class capabilities, state-of-the-art technology and remarkable knowledge-based resources to the European Earth and Environmental science community. 2016 has seen the successful completion of two MSP expeditions from the 2015-2018 MSP operational plan, defined by the ECORD Facility Board: the Onshore Science Party (OSP) of Expedition 357 Atlantis Massif Serpentinization and Life - the first IODP project to use seabed-drill technology, and Expedition 364 Chicxulub K-Pg Impact Crater. Both expeditions will stay as milestones in scientific ocean research drilling for their unique achievements. While starting to plan the procedures related to its renewal beyond 2018, ECORD has begun initiatives in 2016 with the European Commission to increase ECORD's visibility and role in the International Ocean Discovery Program (IODP), and to better serve the scientific community. The intellectual contribution of the ECORD scientists has been, like every year, remarkable, and new initiatives regarding education and outreach activities have been introduced to train the next generation of scientists from ECORD member countries, and better promote ECORD and IODP to wide audiences.

ECORD membership

Following negotiations during the last months of 2015, ECORD has welcomed back one of its historical members, Spain (*below and right*), who has not participated in IODP since 2011.

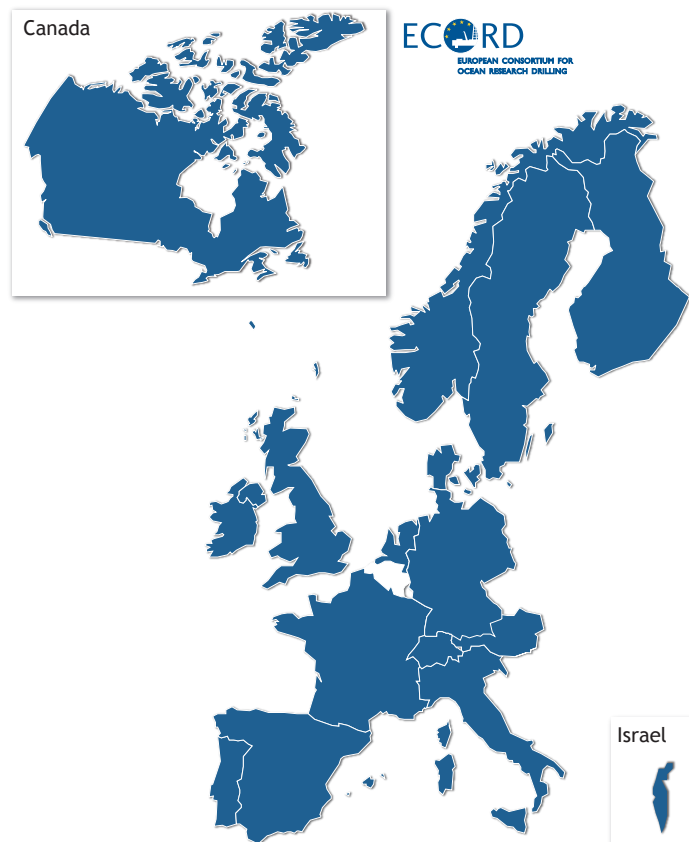
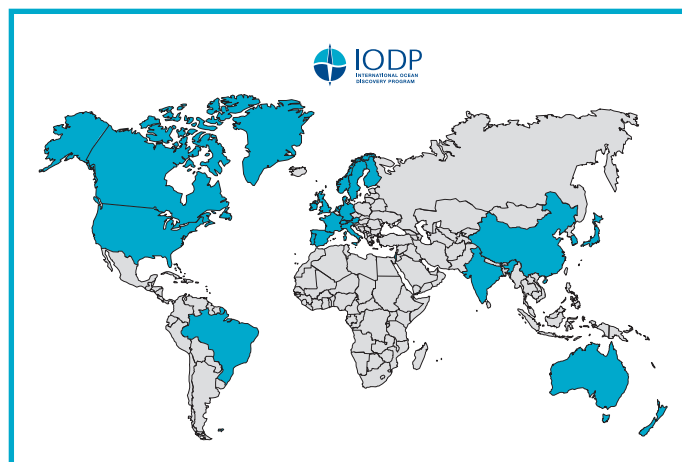
We regrettably learnt about the withdrawal from our Consortium of three members, Poland, Belgium and Israel, which were each represented by only one institute. This emphasises the need for member countries who plan to join ECORD, either to be funded at the national level or to try to

create a national consortium to perpetuate their funding and secure their ECORD membership on a reasonable time scale.

Over the last months, ECORD has been active in trying to attract new members through promising exchanges with Turkey in late 2016, and Russia, through its participation in the "Science of the Future" Conference organised in Kazan, by the Russian Science Ministry. In addition to discussions with the A.P. Karpinsky Russian Geological Research Institute from St Petersburg (VSEGEI), Russia is considering the provision of an in-kind contribution to ECORD for the IODP Expedition 377 Arctic Ocean Paleoceanography, which is scheduled from 2018.

ECORD post-2018 renewal processes

Like most of their IODP partners, the ECORD member countries will have to commit to the second phase (2019-2023) of the International Ocean Discovery Program before the end of 2018. At its two 2016 meetings, the ECORD Council has



Above, ECORD member countries, as of December 2016; left, IODP member countries, as of December 2016 (maps credit: <http://histgeo.ac-aix-marseille.fr>).

approved the procedures for an external evaluation of ECORD's achievements and performance to produce a basic document that will be submitted to all ECORD funding agencies. The ECORD evaluation will be conducted from January to June 2017 by an ECORD External Evaluation Committee (EEC), ending with a general meeting from 6 to 8 June 2017, in Bremen, Germany, and the production of a report soon after. The EEC members have been appointed by the ECORD Council at its fall meeting, which was held in Bremen, Germany, on 23-27 October 2016. The committee includes Helmut Weissert (Chair, Switzerland), Maria Ask (Sweden), Adrian Immenhauser (Germany), Eystein Jansen (Norway), Ralf Littke (Germany), Patrick Pinet (France), Katherine Richardson (Denmark) and Johan Robertson (Switzerland).

The ECORD evaluation will cover all aspects of ECORD activities: science, technology, management, education and outreach. It will mostly rely on science results measured against the Science Plan and the success of ECORD's financial model for platform operations during the first phase of IODP (2013-2018), in addition to the operational plans defined for mission-specific platform (MSP), *JOIDES Resolution* and *Chikyu* expeditions during the second phase of IODP (2019-2023). The ECORD Managing Agency (EMA) and the ECORD Science Operator (ESO) will be evaluated as part of this process and the ECORD Council will take the decision at its spring 2017 meeting whether to re-tender the roles of both EMA and ESO at the end of 2018 and mid/late 2019 respectively, based on the findings of the review.

The ECORD mid-term renewal process will also encompass revisiting the two Memoranda of Understanding (MoU), which summarise the agreement between ECORD and its partners, Japan (JAMSTEC and MEXT) and the USA (NSF) and their Associate Members, including significant co-funding along with berth exchanges to provide access to these platforms for ECORD scientists, and access to MSP expeditions for scientists from our partners. Preliminary discussions between ECORD and its partners have started in late 2016 and will continue throughout 2017 with the MoU's being revisited in early 2018.

ECORD budget

ECORD is currently funded exclusively by its 15 member countries. In FY16, the total ECORD budget provided by the then 16 member countries amounted to 17.633M USD, showing a slight decrease of 35K USD compared to the FY15 budget. Since 2014, the decrease in the ECORD budget of 1.34M USD has been mainly due to strong fluctuations in the exchange rates between the US Dollar and the European currencies used by five ECORD members (France, UK, Denmark,

Spain and Ireland) when paying their contribution (*See 9. FY16 and FY17 budgets, page 61*).

The ECORD annual budget is seen as a minimum budget as there are opportunities for members to provide external co-funding and/or in-kind contributions for MSP expeditions (*i.e.* direct operational facilities and services that ESO would normally pay for) to allow them to increase their contributions to ECORD on a temporary expedition-by-expedition basis. This opportunity is also open to other IODP member and non-member countries. External co-funding and/or in-kind contributions are rewarded by extra science party positions on the MSP expedition for which the contribution has been rendered. ECORD intends to generalise/encourage in-kind and external co-funding to implement future MSP expeditions.

At the end of December 2016 the ECORD budget showed a positive balance of approximately 10M USD and this sum has been carried over to the ECORD FY17 budget.

ECORD and the European Commission

The "**Distributed European Drilling Infrastructure (DEDI)**" proposal with Achim Kopf (MARUM, Bremen) as Principal Investigator has been selected by the European Commission as 1 of the 33 proposals that will be considered for funding in the framework of the EC H2020-INFRAIA after a final submission due in March 2017. This proposal was initially built on two pre-proposals that were submitted in October 2012, "Distributed European Infrastructure for Subseafloor Sampling and Monitoring (DEISM)" by Gilbert Camoin (EMA, CEREGE) on behalf of ECORD, and "Distributed European Drilling Infrastructure (DEDI)" by Achim Kopf (MARUM Bremen) on behalf of the Deep-Sea and Sub-Seafloor Frontiers Initiative (DS3F). The primary objective of the DEDI proposal is to further enhance the scientific investigation of the solid Earth beneath the surface by providing support for transnational access to cutting-edge technologies and proven scientific services to the European earth science community. DEDI is also designed to foster and improve European collaboration between DEDI partners, research groups and industry in the development and sharing of new, innovative technologies for specialist sub-surface sampling, measurements, downhole logging and long-term monitoring. It includes 25 partners (from 16 countries) spanning all fields of Earth and Environmental Sciences with an interest in drilling and sampling soils, sediments and rocks onshore and offshore, geothermal areas, and ore deposits on land and in the deep sea. Five partners are directly involved in ECORD through ESO and EMA (BGS - coordinator, MARUM, University of Leicester, CNRS Montpellier and CEREGE). DEDI aims at developing close links with the International

Continental Scientific Drilling Program (ICDP), as well as EC-funded infrastructures in the field of Earth and environmental sciences that are on the ESFRI list, most importantly with the European Plate Observing System (EPOS) and the European Multidisciplinary Seafloor Observation (EMSO) distributed research infrastructures.

With the approval of the ECORD Council, EMA is at the forefront in exploring ways for ECORD to be recognised by the EC as a **major European infrastructure of international interest**, thus, enforcing the concept of Global Research Infrastructures (GRI). After some initial fact-finding meetings concerning the ESFRI Roadmap 2018 (Malaga, January 2017; Paris, February 2017), EMA has taken the lead in preparing a proposal to be submitted in August 2017 for the incorporation of ECORD to the ESFRI Roadmap 2018.

Mission-specific platform expeditions

In 2016, two of the four MSP expeditions scheduled for the 2015-2018 MSP operational plan defined by the ECORD Facility Board (EFB) have been completed: the Onshore Science Party (OSP) of Expedition 357 Atlantis Massif Serpentinization and Life - the first IODP project to utilise seabed-drill technology - and Expedition 364 Chicxulub K-Pg Impact Crater ([table page 10](#)). Both expeditions have been successfully implemented and will represent milestones in scientific ocean research drilling ([See 2. Operating and participating in MSP expeditions, page 17](#)).

The unique cores analysed at the **OSP of Expedition 357** brought significant advances in our knowledge regarding oceanic core complexes, and especially the role of serpentinization in driving hydrothermal systems, in sustaining microbial communities, and sequestration of carbon in ultramafic rocks. **16 ECORD scientists, including one Co-chief Scientist** and Lead Proponent were part of the Science Party; three UK berths were related to its in-kind contribution (NERC research vessel *RRS James Cook*). The operational review of this expedition was held on 24 October 2016 in Bremen, Germany, and the committee emphasised "a remarkable success despite exceptionally difficult circumstances".

Expedition 364 was the seventh MSP expedition completed, and was the first to drill the only intact crater peak ring. Operations included invaluable achievements with the best core recovery, the deepest penetration (1335 m) and some of the best core quality ever achieved by an MSP expedition. Major scientific breakthroughs regarding the mechanisms of impact dynamics, the end-Cretaceous mass extinction, and the effects of impacts on the deep biosphere are expected, with the first results published in *Science* on 17 November 2016. **14 ECORD scientists, including one Co-chief Scientist**



Liftboat Myrtle in port in Mexico at the start of Expedition 364 Chicxulub K-Pg Impact Crater (photo G. Tulloch, ECORD/IODP).

and Lead Proponent, have participated in this expedition. The operational review of this expedition is scheduled for 20 June 2017, in Lisbon, Portugal.

Two polar expeditions that were part of the initial 2015-2018 MSP operational plan, **Expedition 373 Antarctic Cenozoic Paleoclimate** and **Expedition 377 Arctic Paleoceanography (ACEX-2)** have been scoped by ESO ([See 3. Anticipating future MSP expeditions, page 23](#)). At its June 2016 meeting, the EFB confirmed the Science Evaluation Panel (SEP) recommendation to drill the two proposed sites on the southern Lomonosov Ridge as presented in the initial proposal on which the ACEX-2 Expedition is based on. This expedition is scheduled for Arctic summer 2018 and will require full in-kind contributions towards ice management and ice-breaking capability, which will most likely be provided by Germany (*R/V Polarstern* from the Alfred Wegener Institute) and Russia. Expedition 373 Antarctic Cenozoic Paleoclimate, which was initially scheduled for late 2017 - early 2018, has been provisionally postponed to 2020 to further test the RockDrill2 (RD2) seabed drill in order to reliably achieve 50 m penetration, which is mandatory to achieve the scientific objectives of this expedition. As a consequence, in October 2016, the EFB endorsed the potential scheduling of **Expedition 381 Corinth Active Rift Development** in late 2017. This expedition was defined by the EFB in June 2016 as a high-priority project to be drilled during the current IODP. The final decision regarding the scheduling of Expedition 381 will be taken in early 2017 based on the final operational cost estimates and the available budget.

At its 2017 meeting, the EFB will further shape the MSP long-term scheduling strategy, taking into account the large spread of expedition costs, which largely depend on the type of drilling platform required, and the budget limits for average annual expedition costs. Provisional reservations for 2020 and 2022 have been made for seabed drilling systems MeBo70/200

and RD2 to accommodate any proposal demands. The operations of these systems, as well as long-piston coring, can be conducted in the low-cost category provided that the research vessels are contributed in-kind.

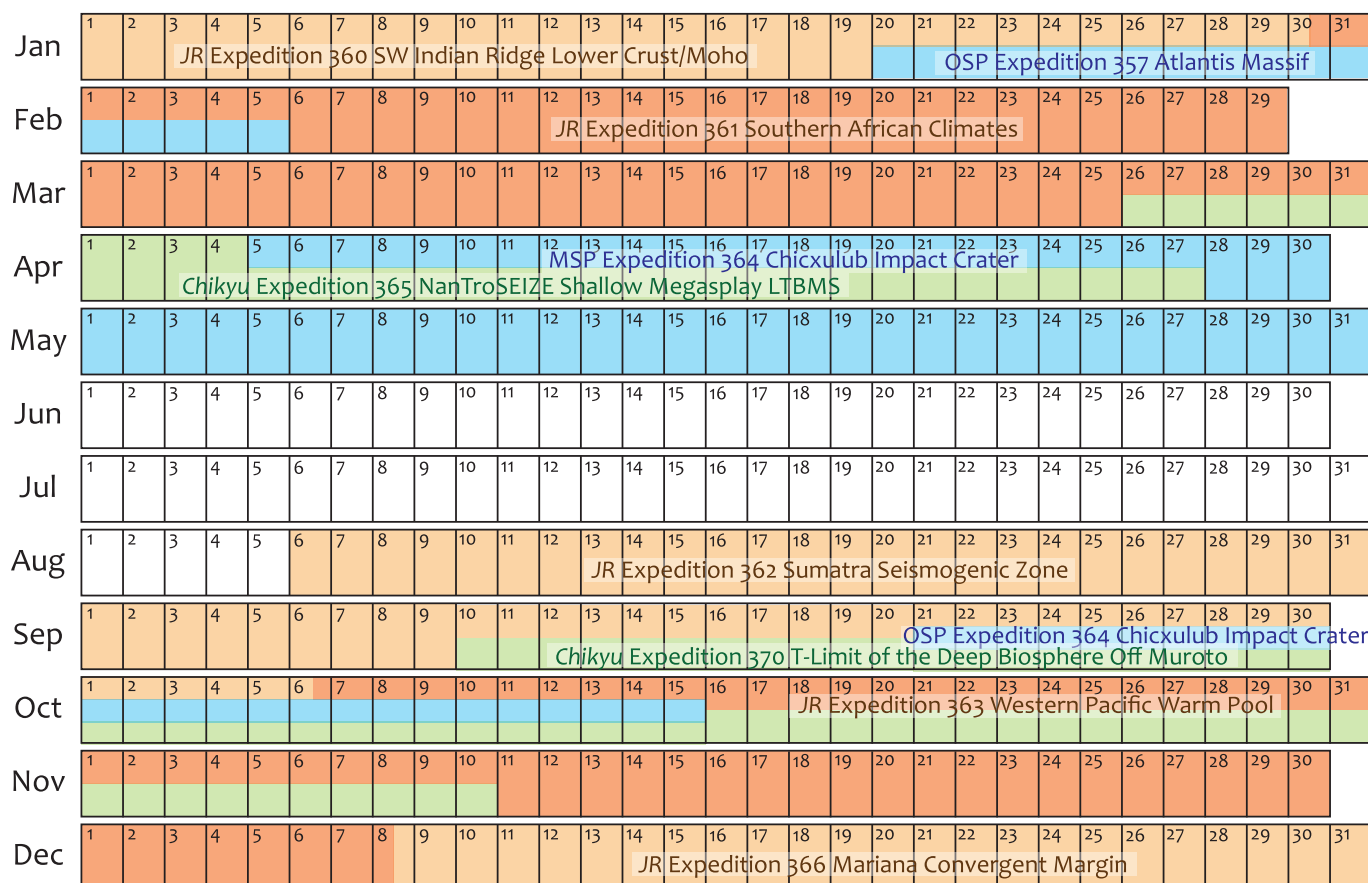
The **13 active mission-specific platform proposals** that were residing at the EFB and the SEP at the end of 2016 may form the basis of the operational plan that will be defined for the second phase of the current programme. The objectives of the MSP proposals are quite diverse in terms of science topics (climate and sea-level change, geohazards, hydrogeology, deep biosphere), drilling systems (drill ships, jack-up rigs, seafloor drills, long piston coring) and geographical areas (Atlantic, Pacific, Arctic and Southern oceans, Mediterranean and Japan seas), thus demonstrating the great opportunities provided by the MSP concept to IODP. These proposals include an Amphibious Drilling Proposal (ADP) whose scientific objectives can only be accomplished by combining land and shallow-water drilling, and a Multi-phase Drilling Proposal (MDP) dealing with long piston-coring technology.

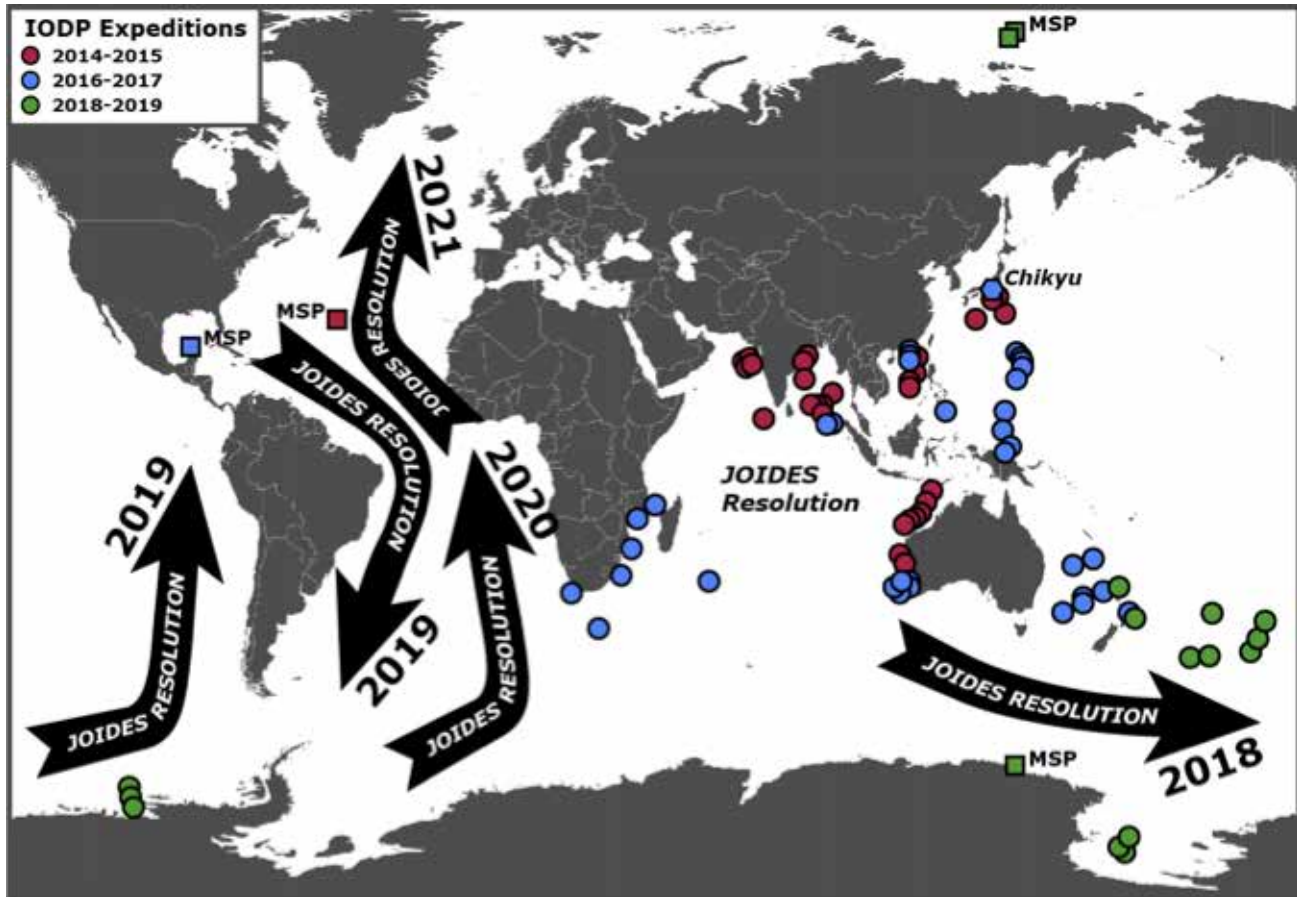
Partnership: JOIDES Resolution and Chikyu IODP expeditions

40 ECORD scientists, including 3 Co-chief Scientists and 59% of berths being allocated to early-career scientists, were invited to participate in the five successful expeditions (addressing all IODP science themes) that were fully/partially implemented in 2016 by the JOIDES Resolution (*table below and see 4. Participating in the JR and Chikyu expeditions, page 29*):

- the second part of the Expedition 360 SW Indian Ridge Lower Crust & Moho, which started in December 2015 and which was dedicated to the structure of the lower crust and the origin of the Moho;
- Expedition 361 Southern African Climates and Agulhas Current Density to reconstruct the history of the greater Agulhas Current system over the past five million years;
- after the remediation of Hole U1473 (Expedition #362T), Expedition 362 Sumatra Seismogenic Zone investigated the seismogenesis, tsunamigenesis and forearc development of the North Sumatran-Sunda plate boundary;
- Expedition 363 Western Pacific Warm Pool, which aimed at understanding the interaction between climate and the Western

IODP expeditions in 2016





Pacific Warm Pool from the middle Miocene to Holocene;

- Expedition 366 Mariana Convergent Margin, which started on 8 December 2016 aims at investigating geochemical, tectonic, and biological processes at intermediate depths of an active subduction zone.

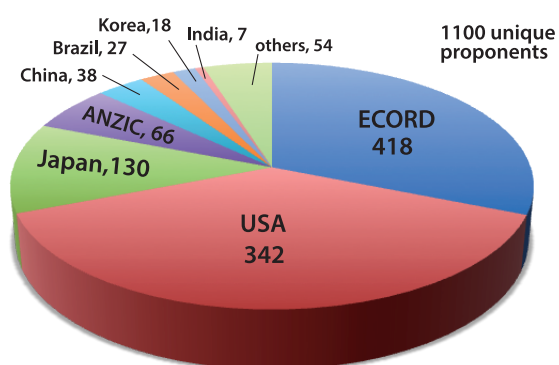
Before March 2019, the *JOIDES Resolution* is expected to implement a total of **10 expeditions** in the Pacific Ocean (expeditions 369 Australia Cretaceous Climate and Tectonics, 371 Tasman Frontier Subduction Initiation and Paleogene Climate, 372 Creeping Gas Hydrate Slides and Hikurangi Logging While Drilling (LWD), 375 Hikurangi Subduction Margin Observatory, 376 Brothers Arc Flux and 378 South Pacific Paleogene Climate), the South China Sea (Complementary Project Proposals -CPPs #67 and 368 South China Sea Rifted Margin) and the Southern Ocean (expeditions 374 Ross Sea West Antarctic Ice Sheet History and 379 Amundsen Sea West Antarctic Ice Sheet History). The most probable scenario considered by the *JOIDES Resolution* Facility Board involves a ship track in the Atlantic Ocean, the Mediterranean, Caribbean, and the Gulf of Mexico during most of the second phase (2020-2023) of IODP (*above*). The proposal pressure concerning these regions is expected to increase significantly in the coming years and the ECORD science community will certainly play a pivotal role.

The *Chikyu* resumed its IODP activities in March 2016 with the implementation of the engineering **Expedition 365 NanTroSEIZE Shallow Megasplay Long-Term Borehole Monitoring System (LTBMS)** during which temporarily installed monitoring instruments (a “GeniusPlug”) were recovered and a permanent long-term borehole monitoring system (LTBMS) deployed as part of the Nankai Trough Seismogenic Zone Experiment (NanTroSEIZE). A second expedition, **Expedition 370 Temperature Limit of the Deep Biosphere off Muroto** was implemented in September-November 2016, investigating sub-seafloor microbial life to better understand the vertical extent of the habitable zone on Earth and the factors that limit life’s maximum depths. **9 ECORD scientists, including 2 Co-chief Scientists** sailed on these two *Chikyu* expeditions. At its last meeting, the ECORD Council decided to re-commence funding the *Chikyu* programme in 2017 after two years, (2015 and 2016), during which the ECORD membership was suspended. The long-term *Chikyu* operational plan still includes many uncertainties related to a general decrease in funding. In 2017, an IODP window has been identified in October - December and the *Chikyu* should implement a relatively short riserless operation - Expedition 380, which is anticipated will not cover entire proposed operational window.

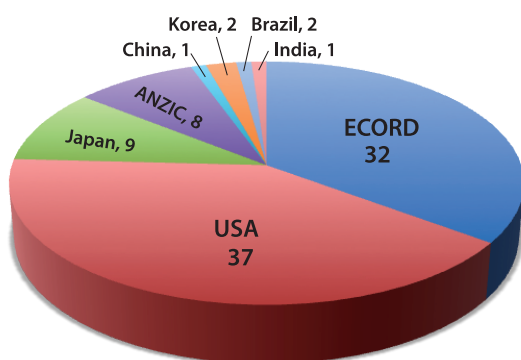
Anticipating future IODP expeditions

A slight increase in proposal submission were noted in 2016 with **19 new proposals**. This follows the “historical low” recorded in 2015 where only eleven new proposals, the lowest number since 2011, were received for the Integrated Ocean Drilling Program. However, we are still well below the 36 new proposals that were submitted in 2014.

ECORD is at the forefront regarding the number of unique proponents (418 out of 1100 - 38%, including 32 lead proponents) (*below*), thus underpinning the great ECORD contribution to IODP science.



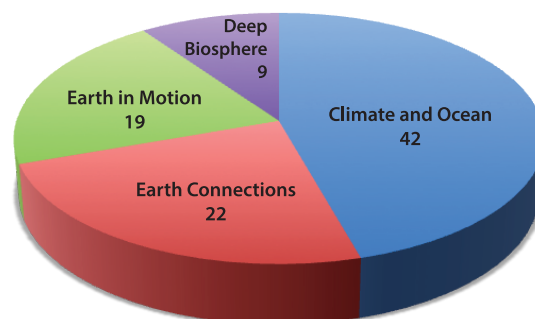
Distribution of IODP active proposals (n = 92) by proponent's member affiliation.



Distribution of IODP active proposals (n = 92) by Lead Proponent's member affiliation.

The distribution of active IODP proposals across the Science Plan themes demonstrates a strong scientific demand in all objectives of the Science Plan (*above right*). 45.6% of the proposals are in the Climate and Oceans Theme, whilst the other proposals are in the Earth Connections (23.9%), Earth and Motion (20.7%), and Biosphere (9.8%) themes.

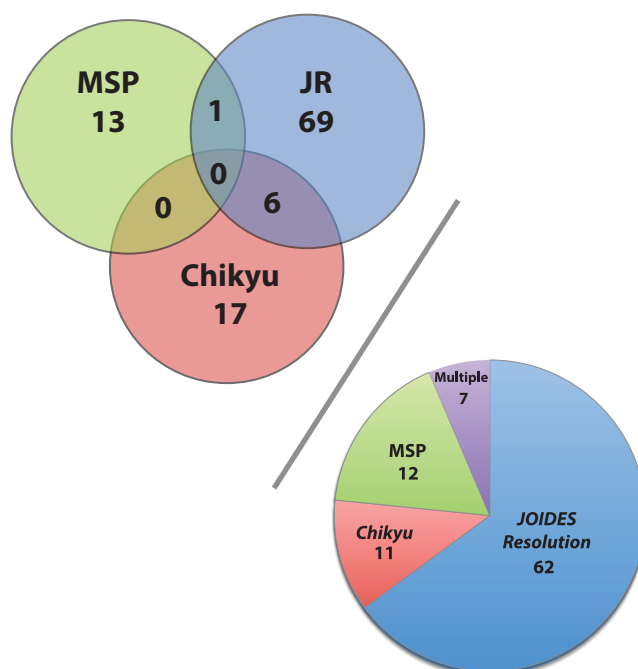
Among the **92 active proposals** that are in the archives of the Science Support Office (as of November 2016) and besides the 12 purely MSP proposals (13%), there are 62 JOIDES Resolution



Distribution of active proposals (n = 92) by IODP Science Plan themes.

proposals (67.4%), 11 Chikyu proposals (12%) and seven multiple proposals (7.6%) involving various platforms (6 for the JOIDES Resolution and the Chikyu combined, and 1 for an MSP and JOIDES Resolution combination) (*below*).

The number of **active MSP proposals (12 + 1)** (*table page 27*) could be considered as satisfying at first glance. However, it must be noted that three of the six MSP proposals that currently reside at the EFB form the basis of expeditions scheduled in the 2017 - 2020 time window. Moreover, among the seven MSP proposals that are with the SEP, three pre-proposals have not had any response/action from their proponents for several years. A higher MSP proposal submission rate would be desirable to get a significant pool of proposals from which to formulate a long-term MSP operational plan. An MSP proposal offer must account for the large spread of expedition costs, which largely depend on the



Distribution of IODP proposals by platforms (n = 92). Multiple proposals include one MSP + JR and six Chikyu + JR (Data provided by the IODP Science Support Office as of November 2016).

Member country or consortia	First authors of serials	Serial contributions by country	Serial contributions by author	Total contributions
Australia-New Zealand Consortium	279	254	310	589
Australia	164	169	194	358
New Zealand	115	85	116	231
Brazil	20	15	15	35
China	311	108	129	440
ECORD	3,755	2,851	3,650	7,405
Austria	8	17	17	25
Belgium	41	42	46	87
Canada	311	216	265	576
Denmark	44	64	68	112
Finland	8	5	5	13
France	570	456	635	1,205
Germany	882	577	763	1,645
Ireland	5	11	13	18
Israel	21	6	6	27
Italy	247	205	264	511
Netherlands	193	133	145	338
Norway	126	104	117	243
Poland	15	4	4	19
Portugal	8	21	33	31
Spain	119	126	151	270
Sweden	96	70	70	166
Switzerland	125	99	107	232
United Kingdom	936	695	951	1,887
India	159	30	31	190
Japan	580	485	1,168	1,748
Korea	35	42	47	82
United States	3,648	1,545	3,207	6,855
Total papers	8,787			17,344

Serial publication authorship by first author, contributing country, contributing authors and total contributions (1969-2016).

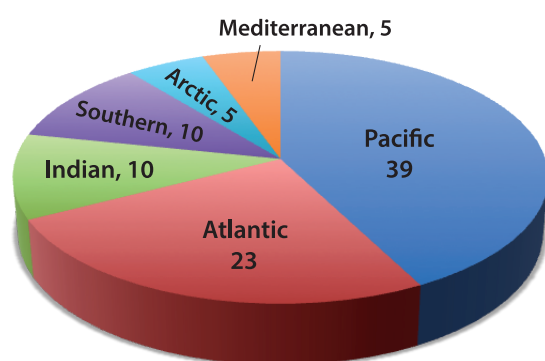
Member country or consortia			Theses and dissertations		
	Serials	Misc	B.S.	M.S.	Ph.D.
Australia New Zealand	279	376	3	5	3
Brazil	20	24	-	-	-
China	311	82	-	-	-
ECORD	3,755	4,092	14	17	100
India	159	38	-	3	3
Japan	580	610	-	-	-
Korea	35	34	-	-	-
United States	3,648	5,777	20	214	302
Total	8,787	11,033	11	11	408

First-authored non-programme publications by type and funding consortium (1969-2016).

type of drilling platform required for the scientific objectives, and take into account budget limits on average annual expedition costs.

In addition to the 6 MSP proposals that reside at the ECORD Facility Board (*table page 27*), there are 38 proposals at the appropriate facility boards ready to be selected for drilling (29 for the *JOIDES Resolution* Facility Board and 9 at the *Chikyu* Facility Board).

By geographic distribution, 39 proposals aim to drill in the Pacific, followed by 23 proposals in the Atlantic, 10 in the Indian Ocean, 10 in the Southern Ocean, 5 in the Arctic, and 5 in the Mediterranean (*below*).



Distribution of active proposals (n = 92) by target ocean.

The great scientific contribution of the ECORD science community to the ocean drilling programmes is also reflected by the publication of scientific results covering records related to the Deep Sea Drilling Project (DSDP), the Ocean Drilling Program (ODP), the Integrated Ocean Drilling Program (IODP), and the International Ocean Discovery Program (IODP) from 1969 through to June 2016. The 2016 Scientific Ocean Drilling Bibliographic Database Report, which was produced by International Ocean Discovery Program Publication Services in September 2016, demonstrates the leading role played by the ECORD science community in the successive ocean drilling programmes (*tables page 13 and see 5. Selected 2016 IODP publications from ECORD scientists, page 35*).

Engaging the community

ECORD has designed a portfolio of science and educational activities for scientists, students, early-career scientists and from members from industry, policymaking and education, which have proved very attractive with high demand from across both academia and industry (*See 7. Engaging the community, page 49*).

The wealth of ECORD-led active IODP proposals partly relies on the ECORD-ICDP MagellanPlus Workshop Series Programme - <http://www.ecord.org/science/magellanplus/>, which provides substantial support to ECORD scientists working to develop innovative drilling proposals concerning diverse scientific topics for any of the three IODP platforms.

3 MagellanPlus workshops have been funded or co-funded in 2016 :

- Brazilian Equatorial Margin II (30 March - 1 April, Ubatuba, Brazil),
- Antarctica's Cenozoic Ice and Climate History (9-11 May, College Station, TX, USA),
- Bend-Fault Serpentinization (18-20 June, London, UK).

The promotion of IODP scientific achievements to a large audience within universities and institutes has been actively conducted by five "ECORD Distinguished Lecturers", C. France-Lanord (France), J. Kallmeyer (Germany), A. Morris (UK), P. Vannucchi (UK) and G. Uenzelmann-Neben (Germany), who gave **39 lectures in 12 countries** across Europe, Canada, Israel and Turkey in 2015 and 2016.

A major goal of ECORD is to train the next generation of scientists from ECORD member countries. **More than 150 students and early-career scientists** benefitted from the ECORD Schools and Grants in 2016, and 15 of them received a scholarship to attend one of these schools.

3 ECORD Summer Schools were sponsored by ECORD in 2016 - <http://www.ecord.org/education/summer-schools/>: The 13th Urbino Summer School in Paleoclimatology (13-29 July 2016, in Urbino, Italy), the 10th ECORD Bremen Summer School (5-16 September 2016, in Bremen, Germany) focusing on "Submarine Geohazards: Mapping, Monitoring, and Modelling", and the first Summer School on Petrophysics (26 June to 1 July 2016, in Leicester, UK) focusing on the application of downhole logging and core physical properties data to scientific questions related the IODP Science Plan themes. The Petrophysics Summer School was a new and innovative ECORD educational activity, including a combination of lectures, discussion groups, and practical exercises on the different elements and data types used in petrophysical analysis.

The **ECORD Training Course** - <http://www.ecord.org/education/summer-schools/>, which is tailored to provide a "Virtual Drillship Experience" for scientists from academia and industry at the IODP Bremen Core Repository at MARUM, Bremen, has been held for the second time from 7 to 11 March

2016. The high number of applications (61) demonstrates the growing success of this initiative.

7 ECORD Research Grants - <http://www.ecord.org/education/research-grant/> - were awarded to PhD students and early-career scientists to conduct research on core materials and/or data related to successive scientific ocean drilling programmes (DSDP/ODP/IODP).

Following the major efforts that ECORD has deployed towards teachers in 2015, **4 ECORD teachers** have taken part in educational activities onboard all IODP platforms: two ECORD teachers have sailed onboard the *JOIDES Resolution* (Expeditions 362 Sumatra Seismogenic Zone and 366 Mariana Convergent Margin) as Education Officers, one ECORD teacher participated in the Onshore Science Party of the MSP Expedition 364 Chicxulub K-Pg Impact Crater, and one ECORD teacher attended the first *Chikyu* Onboard School in Yokohama, Japan.

Communicating

One of the major and constant goals for ECORD is to disseminate information about the IODP scientific results and technological advances and to promote ECORD and IODP activities and accomplishments to large audiences, including scientists, classrooms and the general public (*See 8. Communicating, page 57*). ECORD constantly update and create

communication and educational material that are distributed across the ECORD member countries.

To increase ECORD's visibility and to better convey information to the science community and wider audiences, the ECORD Outreach & Education Task Force and a French web design company (COSIWEB - www.cosiweb.fr), successfully launched the **new ECORD website** on 19 September 2016. The new website now incorporates the former ECORD, ESSAC and ESO websites under a single portal, and includes links to all other IODP websites.

In 2016, ECORD actively promoted the IODP and ICDP programmes at major international (EGU, AGU, IGC) and national science conferences with the organisation of **joint ECORD/IODP-ICDP booths under a "Scientific Drilling" banner**.

The two most recent MSP expeditions, Expedition 357 Atlantis Massif Serpentinization and Life and, especially, Expedition 364 Chicxulub K-Pg Impact Crater generated a significant international media interest (TV, radios, journals, newspapers and a documentary by Barcroft productions).

Related websites:

<http://www.ecord.org>

<http://www.iodp.org>

Field excursion, ESSAC meeting in Faro, Portugal, in May 2016.



7th MSP
expedition
completed

1335 m
deepest MSP
penetration

100%
core recovery
and best core
quality in MSP
expedition

1st MSP
in intact peak-
ring crater

20 m
shallowest
water IODP
expedition

Drilling operations onboard *L/B Myrtle* during Expedition 364 Chicxulub K-Pg Impact Crater
(photo C. Lowery, ECORD/IODP).

2. Operating and participating in mission-specific platform expeditions

In 2016, the ECORD Science Operator (ESO) completed the Onshore Science Party (OSP) for Expedition 357 Atlantis Massif Serpentinization and Life, and both the offshore phase and OSP for Expedition 364 Chicxulub K-Pg Impact Crater ([page 34](#)).

Expedition 357 was the first IODP project to utilise seabed-drill technology, representing an exciting milestone in scientific ocean research drilling. The unique cores analysed at the Expedition 357 OSP included highly complex material from the detachment faults in this oceanic core complex. The cores were also found to contain: a record of early magmatism in the shallow mantle; multi-phased and continuous serpentinisation and metasomatism; dolerite-melt injection; and recent basaltic volcanism.

Expedition 364 was also a significant success, with the best core recovery and some of the best core quality ever achieved by a mission-specific platform (MSP) expedition. Expedition planning included several months of interaction with a challenging permitting system, and implementation took place under huge media attention. For the first time, a high-impact paper in *Science* was prepared by an MSP Science Party and submitted prior to the OSP, with publication on 17 November 2016.

In parallel to the preparation and implementation of Expeditions 357 and 364, planning activities for future MSP expeditions continued throughout the year. Expedition 373 Antarctic Cenozoic Paleoclimate, previously scheduled for December 2017 - February 2018, was postponed by ESO for at least two years. This was to allow time to achieve a higher level of technological readiness with the BGS Rockdrill2 (RD2) to ensure the best chance of success for this high latitude expedition. Investigations for an alternative 2017 expedition consequently took place towards the end of the year, with Expedition 381 Corinth Active Rift Development being the main focus for scoping. ESO has continued to scope and plan for Expedition 377 Central Arctic Paleooceanography, provisionally scheduled for August-September 2018.

IODP Expedition 357 Atlantis Massif Serpentinization and Life

Co-chief Scientists: *Gretchen Früh-Green (ECORD, Switzerland) and Beth Orcutt (USA)*

Expedition Project Managers:
Sophie Green and Carol Cotterill

Petrophysics Staff Scientist: *Sally Morgan*



- **Scientific objectives**

Major goals of the Atlantis Massif Serpentinization and Life Expedition (based on IODP Proposal 758-Full2) were to better understand the role of serpentinization in driving hydrothermal systems, in sustaining microbiological communities, and in the sequestration of carbon in ultramafic rock.

- **Operations**

The offshore phase of Expedition 357 took place from 26 October to 11 December 2015 and is documented in the 2015 Annual Report.

During the OSP, the cores were described in detail and IODP measurements were made, in line with IODP Standard Measurements and Data Management policies. The ESO-Bremen and European Petrophysics Consortium (EPC)-teams were instrumental in preparing the laboratories for IODP measurements and organising the logistics for, and conveying the workflow during, the OSP. A pre-OSP measurement programme was undertaken by the MARUM and EPC teams from 5 to 11 January, when 360° through-liner core images and natural gamma ray data were acquired.

The main focus of ESO outreach strategy for Expedition 357 was the dissemination of expedition activities online (science

Science Party of Expedition 357 (photo Voelker Diekamp, MARUM).



reports) and communication of the OSP activities as they occurred in real time on social media. In addition, a media day was held at the BCR on 1 February 2016, with numerous items broadcast on both TV and radio, and news articles published online.

With the OSP complete and post-expedition research by the Science Party underway, the expedition is expected to meet many of the scientific objectives outlined in Proposal 758-Full2. Specifically, expedition investigations have shown low and variable cell densities in select samples, and the Science Party anticipate achieving many of the deep biosphere-related objectives of the expedition in the coming years. Additionally, post-expedition petrological, structural, and geochemical studies are anticipated to achieve a significant number of expedition goals. Expedition 357 was a unique expedition for many reasons, not least owing to the many and varied technological developments involved. One of these, the borehole plug system, is going to be key in facilitating time-series borehole fluid sampling, with an NSF-funded cruise returning to Atlantis Massif in 2018-19.

• Post-cruise activities

Further details of the offshore and OSP operations, the ESO staff who participated, and initial scientific findings are reported in the IODP Expedition 357 Preliminary Report, which was published in May 2016. The Expedition 357 Editorial Meeting took place in College Station at the offices of the *JOIDES Resolution* Science Operator (JRSO) from 7 to 10 June. Editorial activities for the Expedition Report continued throughout 2016 in preparation for publication on 5 February 2017. The second post-cruise meeting for this MSP is scheduled for September 2017 in Liguria, Italy. It is anticipated for peer-reviewed papers from this expedition to start emerging in journals from October 2018.

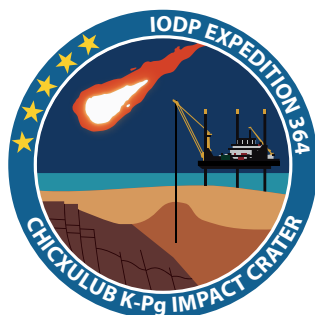
Expedition webpage: <http://www.ecord.org/expedition357/>

IODP Expedition 364 Chicxulub K-Pg Impact Crater

Co-chief Scientists: Joanna Morgan (ECORD, UK) and Sean Gulick (USA)

Expedition-Project Manager: Claire Mellett

Petrophysics Staff Scientist: Johanna Lofi



Expedition web page:

<http://www.ecord.org/expedition364/>



Liftboat Myrtle during Expedition 364 Chicxulub K-Pg Impact Crater (photo L. Pérez-Cruz, ECORD/IODP).

• Scientific objectives

The major aim of this expedition was to drill the impact crater to study impact dynamics mechanism, the peak-ring lithology and formation, the impact effect on the deep biosphere, the extent of the hydrothermal system, the energy and mass extraction of the impact, and the biotic recovery.

• Operations

Expedition 364 successfully cored a single borehole to 1334 mbsf, located approximately 35 km NW of Progreso, Yucatan, Mexico, positioned above the now buried and well-preserved Chicxulub impact crater. The expedition cored into the crater to investigate the nature, lithology and physical state of the Chicxulub peak ring, how rocks are weakened during large impacts so that they collapse into flat, wide craters, and what caused the environmental changes that led to mass extinctions worldwide. The scientific background, rationale and objectives of Expedition 364 are described in the expedition's Proposal 548-Full3 and Addendum 548-Add4, as well as the Scientific Prospectus and Preliminary Report (due February 2017 at the time of writing. However, this may be subject to further embargo to allow further publication in high-impact journals).

The expedition mobilised in Port Fourchon, USA, between 10 and 15 March 2016, with the ESO laboratory containers coordinated to arrive together after being prepared and packed at the different ESO partner institutions. Additionally, logging tools and equipment from the University of Montpellier, the University of Alberta and the University of Texas at Austin were prepared and shipped to Port Fourchon for the mobilisation. On 15 March, the drilling platform sailed to Progreso, Mexico, for customs clearance.

The expedition set sail from Progreso on 5 April, and began a second phase of mobilisation on site later that day. The offshore phase was conducted over a period of 56 days, completing on 30 May. The platform utilised was the *Liftboat Myrtle* (page 18), operated by Montco Offshore Inc., Houston, with drilling services contracted to Drilling, Observation and Sampling of the Earth's Continental Crust (DOSECC, Salt Lake City) and logging services coordinated by EPC.

After casing was deployed on 7 April, open holing was carried out to 503 mbsf. The Science Party joined the vessel on 14 April, and coring operations commenced on 17 April.

Between 5 April and 30 May (56 days), a total of 48.1 days were spent operational on station (86%), 6.5 days on technical downtime (11.5%), 0.3 days in transit (0.5%), and 1.1 days in port for mobilisation or demobilisation activities (2%). The statistics do not include transit time to and from Port Fourchon, USA, or the additional mobilisation and demobilisation periods at that location.

Coring rates were variable, sometimes exceeding 50 m per day. However, some technical challenges with the casing and top drive meant the overall coring rate was 26 m per day. A total of 839.51 m of extremely high quality cores from a range of pre- and post-impact lithologies were recovered to a total depth of 1334.7 mbsf. Starting at 505.7 mbsf, approximately 112 m of hemipelagic and pelagic Paleogene post-impact sediments were recovered, including the Paleocene-Eocene Thermal Maximum (PETM). The Cretaceous-Paleogene (K-Pg) boundary was recovered at approximately 618 mbsf, intact and within a high-quality core, beneath which the top of the peak ring was encountered.

Approximately 717 m of peak ring rocks were recovered, comprising around 130 m of breccia with impact melt fragments (*below*) overlying clast-poor impact melt rock,

followed by around 587 m of felsic basement rocks. An unprecedented core recovery of approximately 100% was achieved in all lithologies.

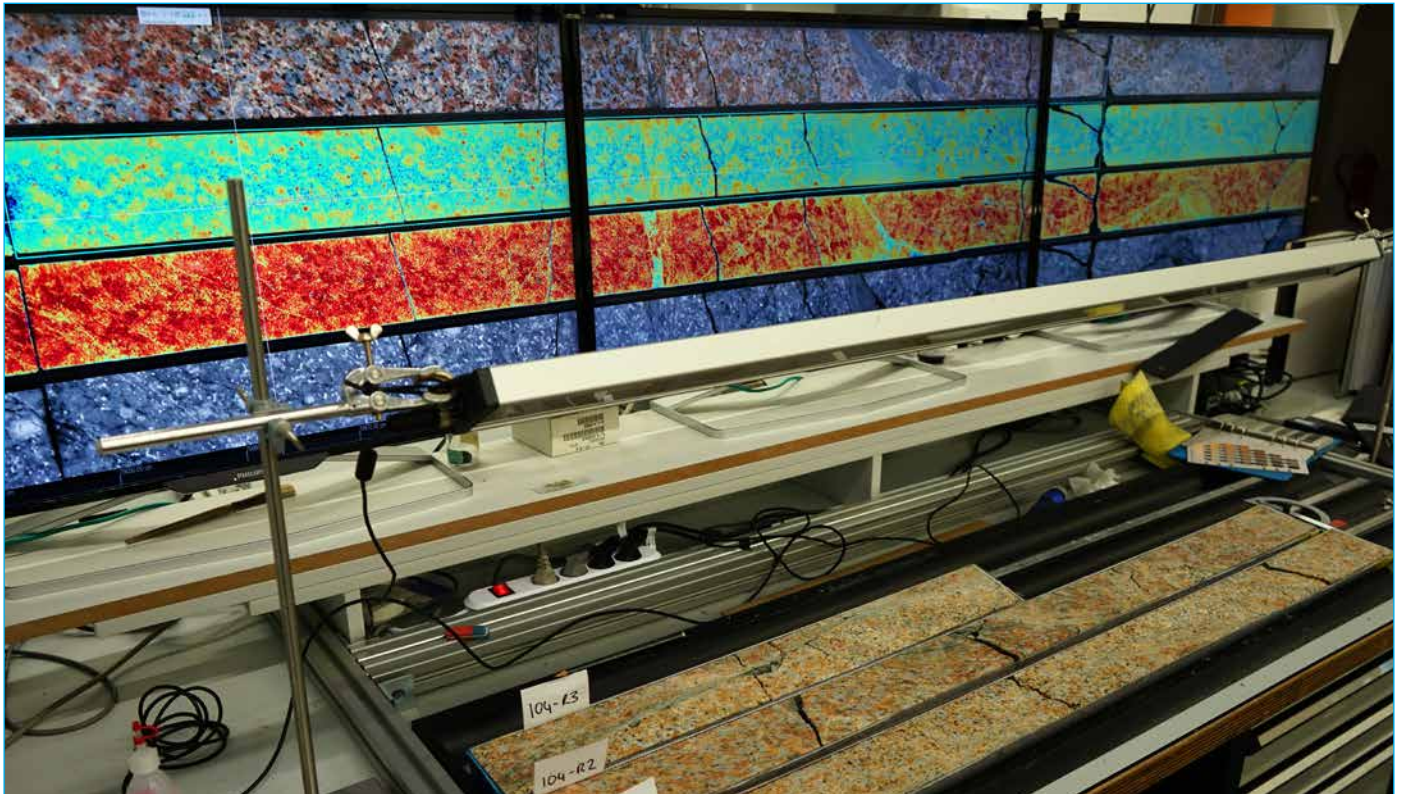
Super-slimline downhole logging services were contracted from the University of Montpellier for wireline logging and the University of Alberta and the University of Texas at Austin for the vertical seismic profiling (VSP) experiment. More than 5.8 km of wireline downhole logs were acquired in open hole. The downhole-logging data is of very high quality, and is an excellent dataset to complement the exceptional core recovery. Downhole logs acquired include: resistivity, magnetic susceptibility, spectral gamma ray, sonic, and acoustic and optical borehole images, in addition to the vertical seismic profiling. A particular highlight is the clear imaging of structures that will facilitate core reorientation.

As is normal for MSP expeditions, science activities on the platform were limited to those essential for core curation, measurement of ephemeral properties, and securing samples for pore-water chemistry and microbiology. Offshore measurements included acquiring physical properties data from all cores on the multi-sensor core logger (MSCL), initial structural, petrophysical, sedimentological and micropaleontological characterisation of core-catcher samples, and taking samples for gas analyses, pore-water, and microbiology analysis (*below*). For the first time during an MSP, natural gamma radiation measurements on cores were taken during the offshore phase. This represented a significant time- and associated cost-saving for the pre-OSP period, when the dataset has traditionally been acquired.

ESO staff attended the demobilisation of the *L/B Myrtle* at Port Fourchon to supervise the shipment of temperature-controlled (deep-frozen) microbiology samples to scientists' laboratories and shipment of the multi-sensor core-logger's radioactive source to the UK.



Expedition 364 Chicxulub K-Pg Impact Crater: left, laboratory onboard *L/B Myrtle* (photo E. Le Ber ECORD/IODP); right, various core materials collected during Expedition 364 (photo C. Mellett, ECORD/IODP).



Core imagery and real cores during the Onshore Science Party of Expedition 364 Chicxulub K-Pg Impact Crater (photo E. Le Ber, ECORD/IODP).

Pre-OSP X-ray CT scanning, secured by the Co-chief Scientists, was facilitated by ESO and allowed the systematic acquisition of high-resolution X-ray CT images (by Weatherford International Ltd.) and image processing/derived products (by Enthought) (above). On import to the USA, the refrigerated container with the expedition cores was immediately transported to Houston for scanning. Extra expedition funds were granted by ECORD to allow the 2-week scanning programme to take place. After successful scanning, in which a ~5 TB expedition dataset was acquired, the cores were shipped to the Bremen Core Repository (BCR) in Germany in time for the OSP, which began on 21 September.

ESO maintained good relations with Mexican collaborators, local authorities and government agencies to allow the project to proceed in Mexican territorial waters (a non-IODP country). Although permitting was not a simple process, project permits were secured in time for the project to start on schedule and to allow the cores to leave Mexico. Separate permits were required for both the drilling (secured by ESO-BGS) and the use of a radioactive source in relation to acquisition of physical properties data (secured by ESO-EPC). The assistance of Mexican participants Jaime Urrutia Fucugauchi, Mario Rebolledo-Vieyra and Ligia Perez-Cruz was highly appreciated by ESO and the Science Party.

The OSP was conducted between 21 September and 15 October, at the BCR and the MARUM, with further

analytical laboratories being accessed at the Department of Geosciences, University of Bremen. In the months leading up to the OSP (before, during and after the offshore phase) preparations for the OSP were undertaken by ESO, including: science planning; tailoring the expedition-specific core flow; preparing the offshore thin section billet samples; maintenance of existing, and purchase of new, equipment and consumables; selecting and hiring student helpers; and defining and booking accommodation.

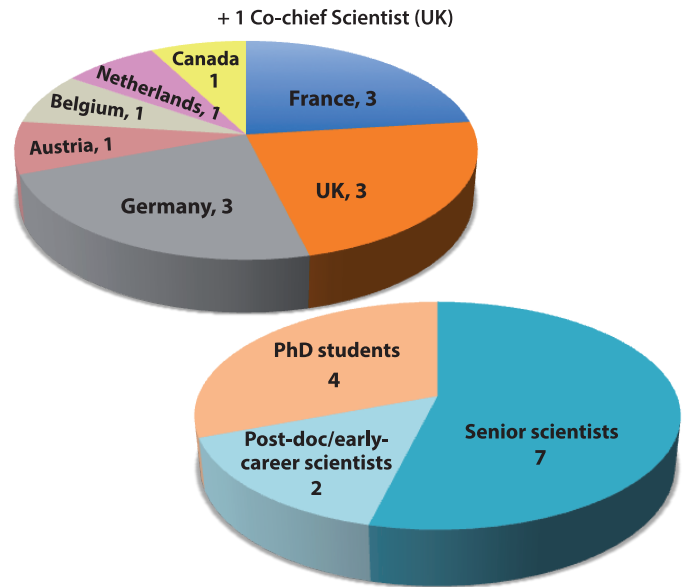
As for previous OSPs, the ESO-Bremen team was instrumental in preparing the laboratories for IODP measurements, as well as coordinating and facilitating the workflow during the OSP. Additionally, the ESO-EPC team prepared the physical properties facilities, which included developing an appropriate methodology to efficiently perform thermal conductivity measurements on split hard-rock cores.

During the OSP, the cores were described in detail and high-quality measurements were collected, in line with IODP Standard Measurements and Data Management policies. The OSP was successfully completed after 30 days of core processing, sampling, and report writing, and all IODP Standard Measurements undertaken were included in the Expedition Report. For the first time two educators were part of an MSP, participating in the OSP to share the excitement and science of the expedition with the rest of the world (See 8. *Communicating, page 57*)

The offshore and OSP phases of the expedition were supported by the Data Management team, who planned and implemented the hardware and software requirements for the expedition. A new version of ExpeditionDIS (Expedition Drilling Information System) was created, with new features to handle core cuttings, mud samples, the import of X-ray CT-scanning images and their export for visualisation on the CoreWall system (page 20)

Expedition 364 was a huge technical and scientific success, a view supported by ESO staff, the Science Party, and individuals across the ocean drilling community. The expedition was completed safely, with consideration for the environment, on schedule and within budget.

For the first time in an MSP expedition, a high impact paper in *Science* was prepared by the Science Party and submitted prior to the OSP (published 17 November). The initial results from the expedition presented in the paper show that the Chicxulub peak ring is formed from shocked, fractured, felsic basement rocks that have been uplifted and emplaced above downthrown Mesozoic sedimentary rocks. This supports a model for peak-ring formation that involves the



dynamic uplift and outward collapse of mid-crustal rocks. Data acquired by Expedition 364 will be used to (1) refine numerical models of the formation of the Chicxulub crater and environmental effects of this impact and (2) improve simulations of impact craters on other planetary bodies so that they can be used as a diagnostic tool for revealing near-surface rheology and composition.

The Science Party are confident that the data acquired during Expedition 364 will accomplish the goals of the expedition and go a significant way toward answering the many questions posed about the impact crater, the end-Cretaceous mass extinction, and the effects of impacts on the deep biosphere.

• **Participation**

A total of 13 ECORD scientists were invited to participate in Expedition 364, plus one UK Co-chief Scientist, representing a total of seven ECORD countries (above and table left). Again, students/early-career scientists represent almost half of the scientists, establishing a good proportion between senior and less experienced scientists (above).

Related website:

<http://www.ecord.org/about-ecord/management-structure/eso/>

ECORD participants (Expedition 364)

Co-chief Scientists		
Joanna Morgan	Imperial College London	UK
Scientists		
Elise Chenot	University of Bourgogne	France
Philippe Claeys	Free University Brussels	Belgium
Charles Cockell	University of Edinburgh	UK
Ludovic Ferrière	Natural History Museum, Vienna	Austria
Catalina Gebhardt	AWI Bremerhaven	Germany
Rubén Ocampo-Torres	University of Strasbourg	France
Annemarie Pickersgil	University of Glasgow	UK
Michael Poelchau	University of Freiburg	Germany
Auriol Rae	Imperial College London	UK
Jan Smit	Free University Amsterdam	Netherlands
William Zylberman	CEREGE-CNRS, Aix en Provence	France
Teacher at sea		
Barbara Matyssek	Kippenberg Gymnasium, Bremen	Germany

Science Party of Expedition 364 (photo Voelker Diekamp, MARUM).



4-year MSP
operational plan

2 poles
being explored
before 2020

13 active MSP
proposals in
IODP

ECORD

EUROPEAN CONSORTIUM FOR
OCEAN RESEARCH DRILLING

MSP proposals
with diverse science
themes and drilling
technologies

3. Anticipating future mission-specific platform expeditions

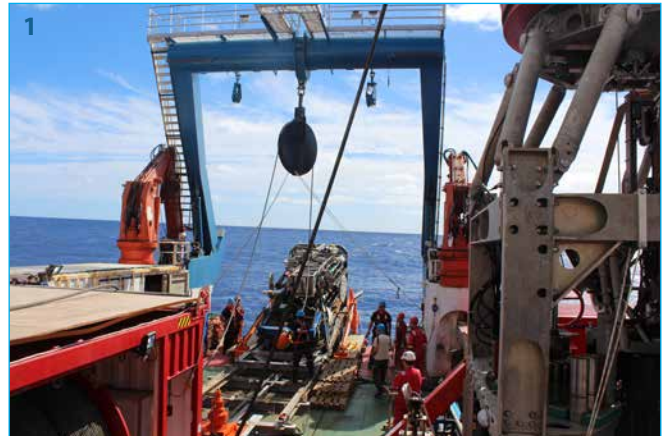
Operational review of completed expeditions

On 24 October 2016, the ECORD Facility Board (EFB) oversaw the operational review of Expedition 357 Atlantis Massif Seafloor Processes: Serpentinization and Life (page 17) in Bremen, Germany. The Operational Review Committee was composed of two external reviewers, Bo Barker Jørgensen (Aarhus University, Denmark) and Christopher Macleod (University of Cardiff, UK), and three EFB members, Karsten Gohl, Stephen Gallagher and Gilles Lericolais (Chair). The committee recognised the extraordinary complexity of this expedition compared to previous expeditions and congratulated all parties (scientists, operators, engineers, technicians) for such a remarkable success despite exceptionally difficult circumstances. Expedition 357 was the sixth MSP expedition organised by ECORD and the first IODP expedition to use the advanced technology of seabed rock drills: the MeBo, MARUM, University of Bremen, and the RockDrill2 (RD2), British Geological Survey (right). While seafloor drilling using these systems has been successfully carried out in recent years from different research vessels, the drilling operations carried out on the Atlantis Massif were new and particularly challenging.

The next operational review scheduled for 20 June 2017 in Lisbon, Portugal, will assess Expedition 364 Chicxulub K-Pg Impact Crater (page 18).

Scheduled expeditions

A five-year mission-specific platform (MSP) operational plan (2014-2018) was defined by the EFB at its previous meetings in 2013-2015. At its last meeting, which was held on 15-16 June 2016 in Brussels, Belgium, the EFB specifically discussed Expedition 377 Arctic Paleooceanography (ACEX-2) and confirmed the Science Evaluation Panel (SEP) recommendation to drill the two proposed sites on the southern Lomonosov Ridge as presented in the initial proposal. This expedition is scheduled for Arctic summer 2018



Seafloor drills onboard the RRS James Cook during Expedition 357: 1, deployment of the MeBo over the stern of the ship (photo Y. Morono, ECORD/IODP), and 2, recovery of the RD2 over the side of the ship (photo D. Smith, ECORD/IODP).

and will require full in-kind contributions (IKC) for icebreaker support (table below).

Expedition 373 Antarctic Cenozoic Paleoclimate, which was initially scheduled for late 2017-early 2018, has been provisionally postponed to 2019 or 2020. As a consequence,

Long-term scheduling strategy (2017-2023) for MSP expeditions

2017	2018	2019	2020	2021	2022	2023
Exp 381 Corinth jack-up platform or drillship MC-HC	Exp 377 Arctic drillship HC	N.N. (LC)	Exp 373 Antarctic RD2 LC-MC	N.N. (LC)	N.N. seabed drill (LC)	N.N. MC -HC

LC = low-cost (<8M USD), MC = mid-cost (8-15M USD), HC = high-cost (>15M USD) - RD2: Rockdrill2 is a seafloor-drilling system.

in October 2016, the EFB endorsed the potential scheduling of Expedition 381 Corinth Active Rift Development in October-November 2017. In June 2016, this expedition was defined by the EFB as a high-priority proposal to be drilled during the current IODP phase.

At the next meeting to be held on 8-9 March 2017 in Hannover, Germany, the EFB will further shape the MSP long-term scheduling strategy (*i.e.* until the end of the current IODP phase in 2023), accounting for the large spread of expedition costs, which largely depend on the required type of drilling platform, and for budget limits on average annual expedition costs. Provisional reservations for 2020 and 2022 have been made for seabed drilling systems MeBo70/200 and RD2 to accommodate any proposal demands. The operations of these systems as well as long-piston coring can be conducted in the low-cost category provided that the research vessels are contributed in-kind.

- **Expedition 381 Corinth Active Rift Development**

Co-chief Scientists: Lisa McNeill (ECORD, UK) and 2nd Co-chief Scientist TBC

Expedition Project Manager: Sophie Green and Jez Everest

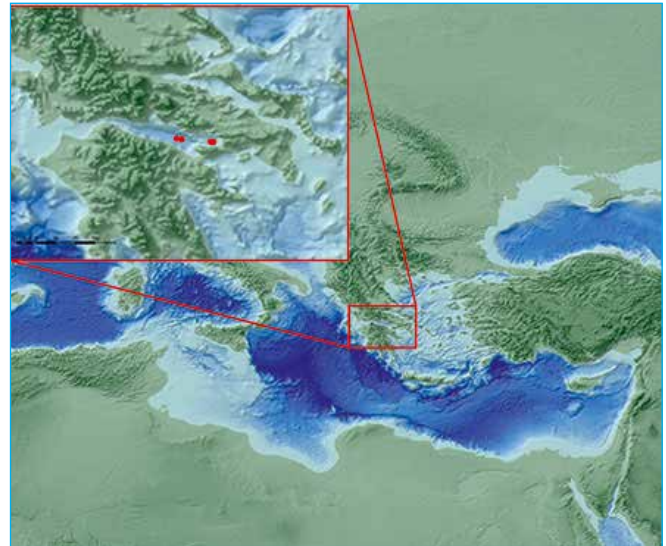
Petrophysics Staff Scientist: Erwan Le Ber

- **Scientific objectives**

The major goal of this expedition is to resolve the syn-rift chronology and paleoenvironment and integrate this with an existing seismic database and onshore stratigraphy to address numerous objectives. The distribution of tectonic strain in time and space and the timescales of fault evolution in a young rift at high resolution will be established. Furthermore, the evolution of a rift-controlled, closed drainage system and the relative impact of tectonics and climate on sediment flux will be determined.

- **Operations**

At the end of 2016, ESO started the procurement exercise for a geotechnical vessel and coring rig for Expedition 381. The water depths and ground penetrations are such that a vessel and rig combination similar to previous MSP expeditions (*e.g.* Expedition 347 Baltic Sea Paleoenvironment) is likely. Responses to the Notice of Interest for drilling services are due at the end of February 2017. As for previous MSP expeditions, ESO will provide the appropriate drilling oversight, science support and container laboratories, and will either contract or provide downhole-logging services depending on the final coring set up



Expedition 381 Corinth Active Rift Development: location of the drillsites.

selected. The offshore operation is provisionally scheduled for up to 60 days in October-November 2017, with the final schedule and ports negotiated with the drilling contractor.

Expedition web page:

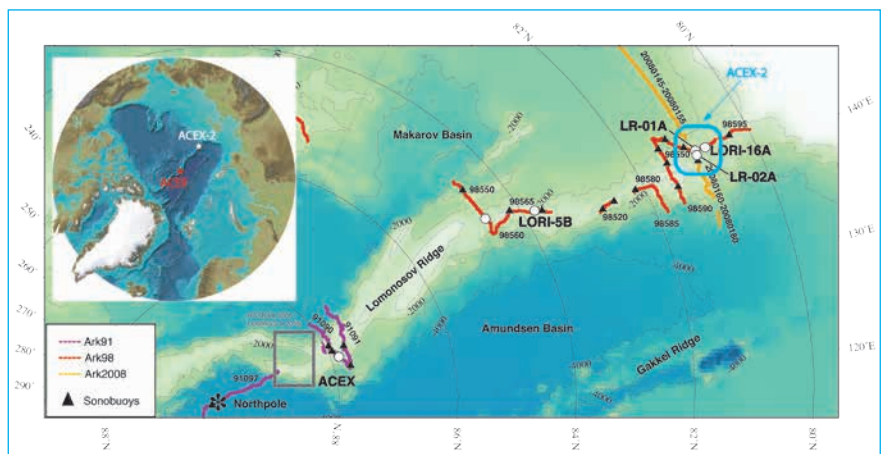
<http://www.ecord.org/expedition381/>

- **Expedition 377 Central Arctic Paleooceanography**

Co-chief Scientists: Rüdiger Stein (Germany) and Kristen St. John (USA)

- **Scientific objectives**

The overall goal of this proposal is the recovery of a complete stratigraphic sedimentary record on the southern Lomonosov Ridge to reconstruct the continuous long-term Cenozoic climate history of the central Arctic Ocean at high resolution, with a special focus on the Neogene and the Pleistocene. Key objectives are related to the reconstruction



Map indicating seismic profiles (bold numbers AWI lines) and location of IODP Expedition 302 (ACEX) drillsite and proposed (ACEX-2) drillsites on the Lomonosov Ridge (primary site LR-01A and alternate sites LR-02A, LORI-5B, and LORI-16A). Grey box shows HOTRAX study area (for references see IODP Proposal 708).

of the history of circum-Arctic ice-sheets, sea-ice cover, Siberian river discharge, as well as deepwater circulation and ventilation and their significance within the global climate system.

• Operations

Work continued in 2016 on the scoping for Expedition 377 Central Arctic Paleooceanography, provisionally scheduled for August-September 2018. The proposal aims to build on the success of the first MSP, Expedition 302 Arctic Coring. The proponents submitted a new addendum to the EFB in April, and updated the IODP Site Survey Database with new data collected since the original proposal submission. The revised sites allow for reaching critical stratigraphic targets with less total penetration, putting it within reach of existing geotechnical coring rig capability. The new sites have been approved by the SEP and ESO will work with the proponents to identify the final site strategy, which will remain flexible to deal with ice conditions at the time of drilling.

Throughout the year, ESO continued to scope potential drilling methodologies and ice-management scenarios for this expedition. The realisation of this expedition depends on securing IKC towards ice management and ice-breaking capability. Co-chief Scientist Rüdiger Stein facilitated the IKC of the *R/V Polarstern* by the Alfred Wegener Institute, Germany, and ESO are continuing to explore further opportunities for ice management IKCs with other IODP and non-IODP countries.

Expedition web page:

<http://www.ecord.org/expedition377/>

• Expedition 373 Antarctic Cenozoic Paleoclimate

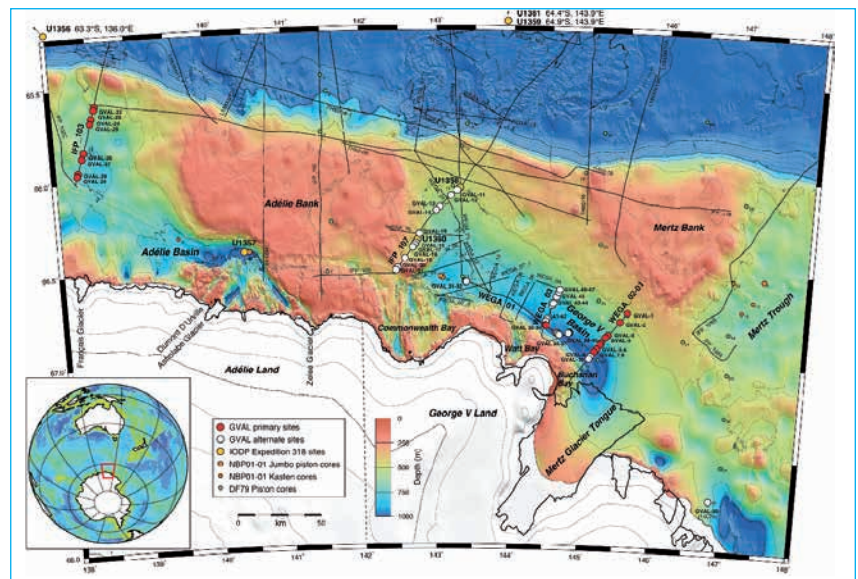
Co-chief Scientists: Trevor Williams (USA) and Carlota Escutia (ECORD, Spain)

• Scientific objectives

This proposal aims to drill the shallowly-buried strata along the George V and Adélie Land shelf of East Antarctica (*above right*) to obtain a record of Antarctica's climate and ice history from the Eocene (greenhouse) to the Neogene (icehouse).

• Operations

Throughout 2016, planning discussions for Expedition 373 continued with the Division of Polar Programs and Antarctic



Proposal 813 Antarctic Cenozoic Paleoclimate (Williams et al.): Transects of primary and alternate sites along existing seismic lines with a total of 18 primary and 29 alternate sites up to 80 m penetration (353-1407 m WD).

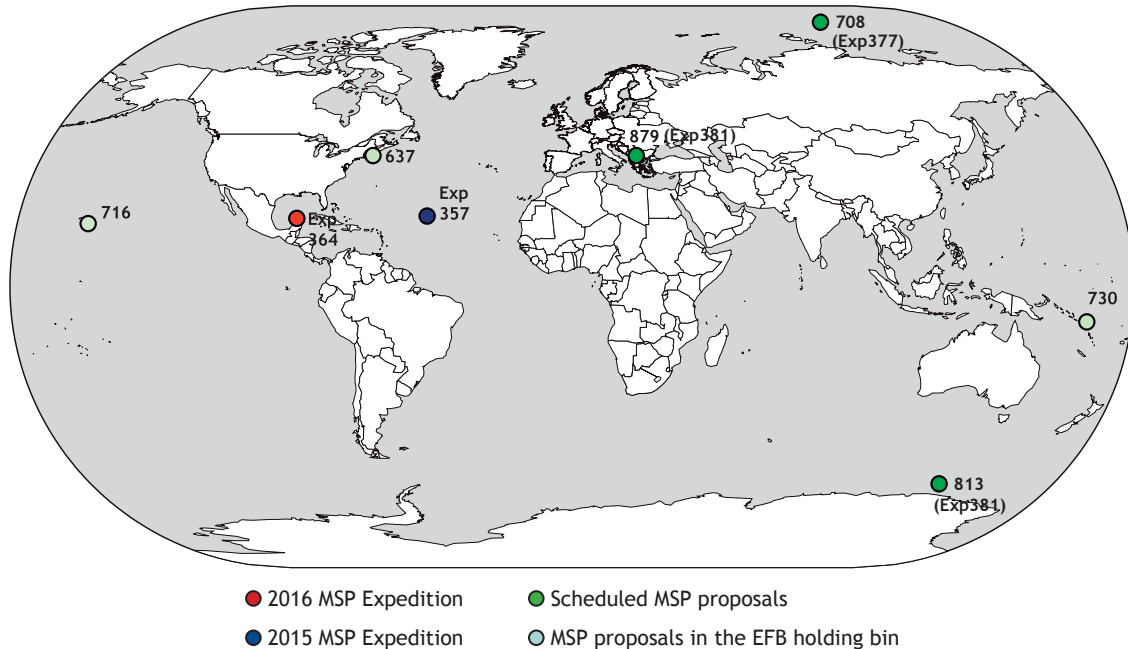
Support Contract (ASC) at the National Science Foundation (NSF) regarding the utilisation of the BGS RD2 on the research icebreaker *N. B. Palmer*, with a view to implementing the expedition from December 2017 to February 2018. A call for scientists was open between 1 July and 31 August, during which time a webinar was hosted by ESO to inform potential applicants about the project.

Since Expedition 357 in October 2015, the performance of seabed-drill technologies has been monitored closely by ESO operational staff. From July to August, the BGS RD2 was deployed on a research cruise for the EU-funded Blue Mining Project in the mid-Atlantic, to characterise massive sulphide deposits. Similar to its performance on Expedition 357, the RD2 experienced various technical issues during the Blue Mining project. Owing to it being essential to reach the target depth of 50 m to achieve the scientific objectives of Expedition 373, it was recommended by ESO to the ECORD Council and the EFB that the expedition is postponed until 2019 or 2020. This postponement has been provisionally agreed by ASC, and the seabed drill to be used for the expedition will be determined nearer the time, following further (non-IODP) projects being undertaken by both the BGS RD2 and MARUM MeBo teams. Following on from this decision, ESO moved to initiate scoping of an alternative expedition to start in late 2017.

Expedition web page:

<http://www.ecord.org/expedition373/>

2015-2016 MSP expeditions and proposals at the EFB



MSP proposals at the ECORD Facility Board and at the Science Evaluation Panel

There are currently 13 active mission-specific platform proposals (as of November 2016), out of the 92 active drilling proposals. The objectives of the MSP proposals are quite diverse in terms of science topics, drilling systems and geographical areas.

Six MSP proposals currently reside at the EFB (*table page 27*), including three proposals that form the basis of expeditions scheduled in the 2017-2020 time window:

- 708 Arctic Ocean Paleooceanography (Expedition 377),
- 813 Antarctic Ocean Paleoclimate (Expedition 373);
- 879 Corinth Active Rift Development (Expedition 381).

At its last meeting, the EFB has deactivated Proposal 581 Coralgal Banks due to a lack of communication from the proponents who did not respond to the most recent communications from the EFB. With this latest decision, the EFB has so far scheduled a total of five MSP expeditions until 2020. There are currently three proposals in the EFB holding bin (*table page 27*):

- 637 New England Shelf Hydrogeology;
- 716 Hawaiian Drowned Reefs;
- 730 Sabine Bank Sea-Level.

The two last proposals focusing on sea-level objectives were positively evaluated and discussions have started to consider the scheduling of one or both proposals before the end of the current IODP. Following the EFB recommendations, a workshop entitled "New England Freshwater Resources", including the drilling plans related to Proposal 637, is scheduled for 22-23 May 2017 in Woods Hole, USA.

Seven MSP proposals are with the SEP (*table page 27*) and include an Amphibious Drilling Proposal (796 ADP Nice Amphibious Drilling Ligurian Landslide; Lead Proponent: A. Kopf) whose scientific objectives can only be accomplished by combining land and shallow-water drilling. A Multi-phase Drilling Proposal (863 MDP ISOLAT S-Ocean Paleoclimate; Lead Proponent: L. Peterson) could be the first IODP expedition using long piston-coring technology.

Related websites:

<http://www.ecord.org/about-ecord/management-structure/efb/>

<http://www.iodp.org/active-proposals>

<http://www.iodp.org/facility-boards#SEP>

Mission-specific platform proposals

Proposal #	Short title	Lead Proponent	Country Lead Proponent	Ocean/Sea	Drill Platform
at EFB					
716-Full2	Hawaiian Drowned Reefs	Webster	Australia	Pacific	geotech. rig/MeBo200
637-Full2	New England Shelf Hydrogeology	Person	USA	Atlantic	liftboat/jack-up rig
730-Full2	Sabine Bank Sea Level	Taylor	USA	Pacific	MeBo200
708-Full	Central Arctic Paleoceanography	Stein	ECORD (Germany)	Arctic	drillship
813-Full	East Antarctic Paleoclimate	Williams	USA	Southern Ocean	RD2
879-Full	Corinth Active Rift Development	McNeill	ECORD (UK)	Mediterranean	drillship
at SEP					
796-ADP**	NADIR: Nice Amphibious Drilling	Kopf	ECORD (Germany)	Mediterranean	geotechnical rig, MeBo
866-Pre	Japan Trench Paleoseismology	Strasser	ECORD (Austria)	Pacific	long-piston coring
863-MDP***	ISOLAT Southern Ocean Paleoclimate	Peterson	USA	Southern Ocean	long-piston coring
812-Pre	Ross Sea Glacial History	Wilson	USA	Southern Ocean	seafloor drill
806-Pre	Beaufort Gas Hydrates	Paull	USA	Arctic	geotech. rig
797-Pre	Alaska Beaufort Margin	Ruppel	USA	Arctic	drill rig (or JR?)
907-Pre	Sunda Shelf Sea Level	Statteger	ECORD (Germany)	Pacific	drill rig (?)

* CPP: Complementary Project Proposal, ** ADP: Amphibious Drilling Proposal, *** MDP: Multi-phase Drilling Project, RD2: RockDrill2, JR: JOIDES Resolution,



The drillpipe seen from the drill rig onboard *L/B Myrtle* during Expedition 364 (photo A. Rae, ECORD/IODP)



2 *Chikyu*
expeditions

59% early-
career scientists

49 ECORD
scientists

5 ECORD
Co-chief
Scientists

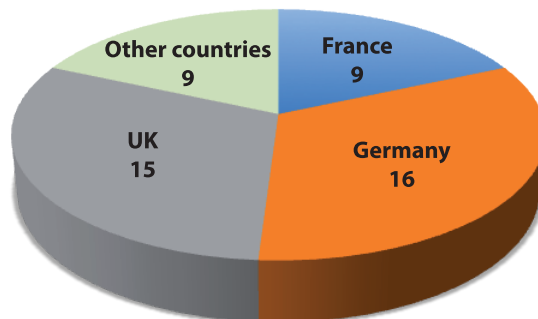
4 *JOIDES*
Resolution
expeditions

All IODP science
themes addressed

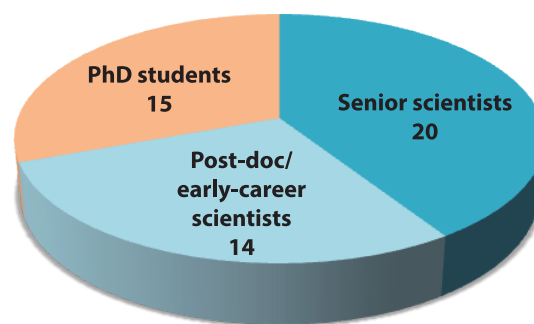
4. Participating in 2016 *JOIDES Resolution* and *Chikyū* expeditions

IODP expeditions - <http://www.iodp.org/expeditions> - provide ECORD scientists with an excellent opportunity to participate in international multidisciplinary ocean drilling projects and to have priority access to unique samples and data. ECORD, as a contributing member of IODP, is entitled to **an average of 8 scientists on every expedition**. Scientists are chosen following an open call for applications and a competitive selection process. After a nomination proposal by ESSAC, discussions are held with the implementing organisations, the appointed Co-chief Scientists and the IODP member countries/consortia. Participation of ECORD scientists is proportional to financial contributions of the member countries ("quotas"). Selection of the Science Party is, therefore, based on both scientific merit and a time-average country quota. However, country quotas do not apply when a specific expertise is requested through a special call, or if the expedition occurs in territorial waters of an ECORD member country. In both cases, ECORD scientists sail as the result of special calls or as observers.

In FY16, **4 expeditions** were implemented on the *JOIDES Resolution* and **2 expeditions** on the *Chikyū*. A total of **49 ECORD scientists from 10 ECORD member countries** (left and below) were invited to participate and sailed, including **5 Co-chief Scientists**, three from Germany and two from the UK.

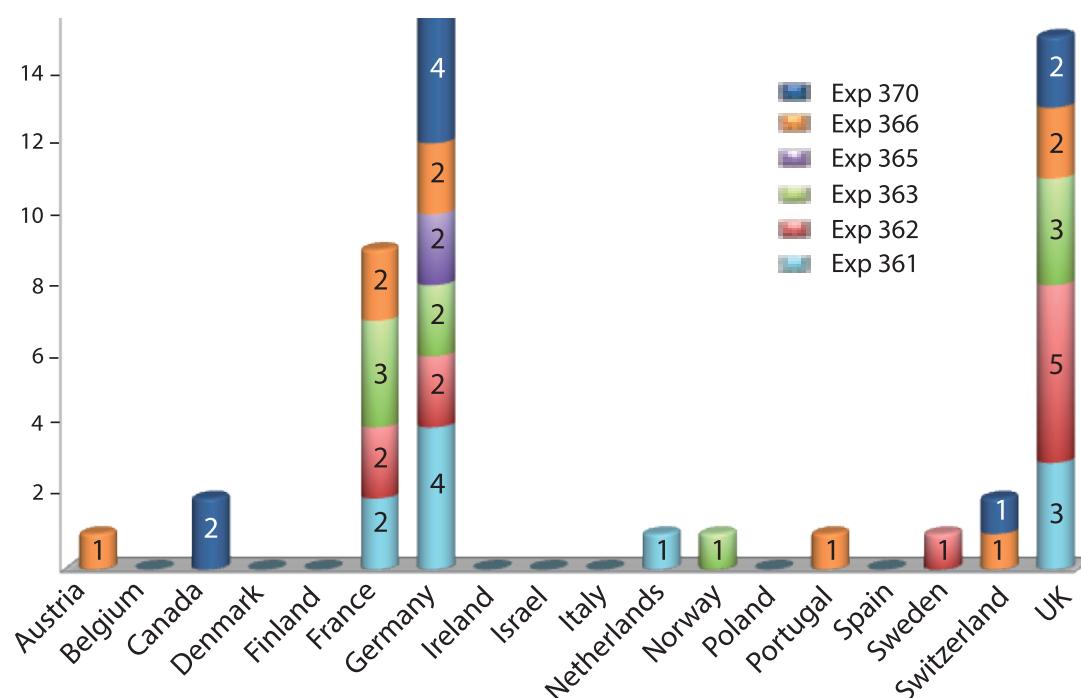


Distribution of ECORD participants based on country affiliations (Expeditions 361 to 370, n = 49).



Distribution of ECORD participants based on academic career stage (Senior scientists include five Co-chief Scientists).

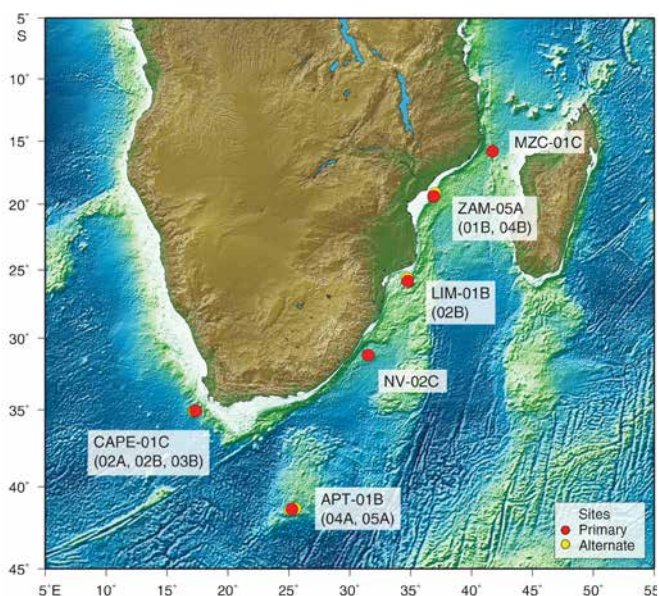
Distribution of participants based on country affiliations (Expeditions 361 to 370), including five Co-chief Scientists and two Special Calls.



Two of the 49 scientists participated as the result of special calls. Fifteen PhD and Master students and 14 Post-docs or early-career scientists had the opportunity to participate in *JR* and *Chikyu* expeditions, making up 59% of the ECORD participants in 2016 (page 29). More than three quarters of the ECORD scientists came from the large contributing countries, France, Germany and the UK, and nine berths were allocated to scientists coming from other ECORD countries.

- **JOIDES Resolution Expedition 361 Southern African Climate and Agulhas Current Density (29 January-31 March 2016)**

Expedition 361 was based on original proposals 702-Full2 and 845-APL, and drilled **six sites (U 1474 to 1479)** on the southeast African margin and in the Indian-Atlantic ocean gateway in the southwest Indian Ocean (below). A total of 5175 m of core was recovered, with an average recovery of 102%, during 29.7 days of on-site operations.



The main objectives of the expedition were (1) to establish the sensitivity of the Agulhas Current to climatic changes during the Pliocene-Pleistocene, (2) to determine the dynamics of the Indian-Atlantic gateway circulation during this time, (3) to examine the connection of the Agulhas leakage and the Atlantic Meridional Overturning Circulation (AMOC), and (4) to address the influence of the Agulhas Current on African terrestrial climates and coincidences with human evolution. Additionally, the expedition set out to fulfill the needs of the Ancillary Project Letter (APL), consisting of high-resolution interstitial water samples to constrain the temperature and salinity profiles of the ocean during the Last Glacial Maximum. The recovered sequences allowed generation of complete spliced stratigraphic sections that span from 7 Ma to present



Expedition 361: Jeroen van der Lubbe, Paleomagnetist, works with the spinner magnetometer (photo Jens Gruetzner & IODP).

time. This sediment will provide decadal- to millennial-scale climatic records that will allow answering the paleo-oceanographic and paleoclimatic questions set out in the drilling proposal.

ECORD participants (Expedition 361)

Co-chief Scientist		
Ian Hall	Cardiff University	UK
Scientists		
Stephen Barker	Cardiff University	UK
Thibaut Caley	EPOC, Bordeaux	France
Julien Crespin	EPOC, Bordeaux	France
Jens Gruetzner	AWI, Bremerhaven	Germany
Janna Just	University of Cologne	Germany
Andreas Koutsodendris	University of Heildeberg	Germany
Margit Simon	Cardiff University	UK
Deborah Tangunan*	University of Bremen	Germany
Jeroen van der Lubbe	Free University Amsterdam	Netherlands

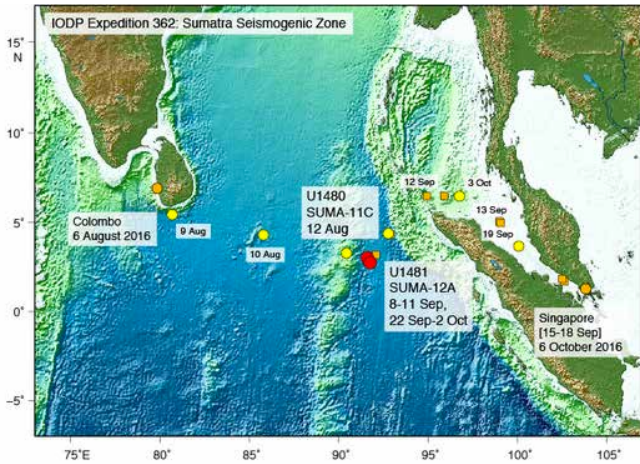
* Participation resulting from a special call

http://iodp.tamu.edu/scienceops/expeditions/southern_african_climates.html

- **JOIDES Resolution Expedition 362 Sumatra Seismogenic Zone (6 August-6 October 2016)**

During Expedition 362, **two sites (U1480 and U1481)** were drilled (page 31, top left), to recover a complete section of the oceanic plate sedimentary section and uppermost basalts and to investigate local variations of the lower part of the Nicobar fan and underlying pelagic sediments and basement.

The 2004 Moment magnitude 9.2 earthquake and tsunami that struck North Sumatra and the Andaman-Nicobar Islands devastated coastal communities around the Indian Ocean. The goal of Expedition 362, based on IODP Proposal 837-Full, was to establish (1) initial and evolving properties of the North Sumatran incoming sediments seaward of the



Sunda plate boundary overthrust and (2) their potential effect on seismogenesis, tsunamigenesis and forearc development. Site U1480 will allow scientists to determine how the properties of the input section may lead to shallow seismogenic slip and to unusual forearc/prism development. Site U1480 also offers the opportunity to obtain a complete section of the Nicobar Fan sequence at 3°N where the onset of fan deposition was expected to be ~30-40 Ma based on interpolation between previously drilled sites (e.g. Expedition 354 Bengal Fan).

ECORD participants (Expedition 362)

Co-chief Scientist		
Lisa McNeill	NOC, Southampton	UK
Scientists		
Jan Backman	Stockholm University	Sweden
Sylvain Bourlange	University of Lorraine	France
Tim Henstock	University of Southampton	UK
André Hüpers	MARUM, Bremen	Germany
Steffen Kutterholf	GEOMAR, Kiel	Germany
Freya Mitchison*	Cardiff University	UK
Kevin Pickering	University College, London	UK
Hugo Poudroux	University of Rennes	France
Paola Vannucchi	Royal Holloway London	UK
Education Officer		
Agnès Pointu	Lycée de Broglie, Marty-le-Roi	France

http://iodp.tamu.edu/scienceops/expeditions/sumatra_seismogenesis.html

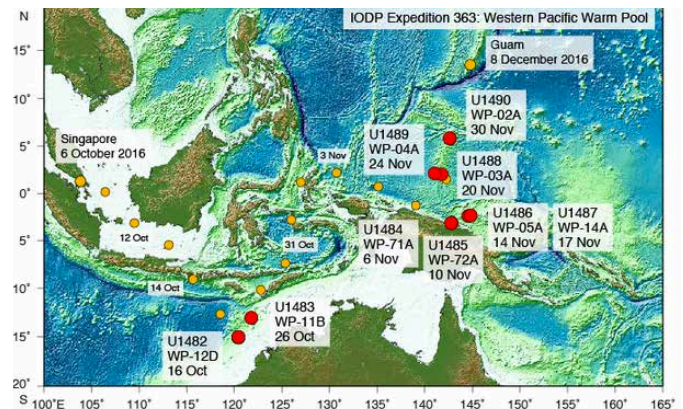
• JOIDES Resolution Expedition 363 Western Pacific Warm Pool (6 October-8 December 2016)

Expedition 363 aimed to understand the interaction between climate and the Western Pacific Warm Pool (WPWP) from the middle Miocene to Holocene. **Eight sites (Sites U1482 - U1490)** were drilled in the western equatorial Pacific and eastern Indian Ocean (above right) to investigate (1) the role and response of the WPWP to millennial climate variability



Expedition 362: ECORD participants (photo Tim Fulton IODP, JRSO).

during the late Quaternary, (2) changes in the WPWP and relation to monsoon activity on orbital timescales during the Pliocene-Pleistocene, (3) changes in the Indonesian throughflow during the Pliocene-Pleistocene, and (4) the long-term evolution of WPWP sea-surface temperature (SST) and intermediate water temperatures (IWT) and water chemistry since the middle Miocene. Sediments obtained



Expedition 363: an artistic view of a core (photo Tom Dunkley Jones & IODP JRSO).

from all drilled sites will elucidate the relationships between millennial-scale variability in the tropical Pacific and in the northern Atlantic, controls on tropical Pacific SST patterns on various time scales, the response of the hydrologic cycle and the mechanisms controlling these variations. Furthermore evidence will be documented regarding the evolution of the WPWP from the mid-Miocene Climate Optimum to the present and the relationships between changes in the equatorial Pacific mean climate state and dynamical processes.

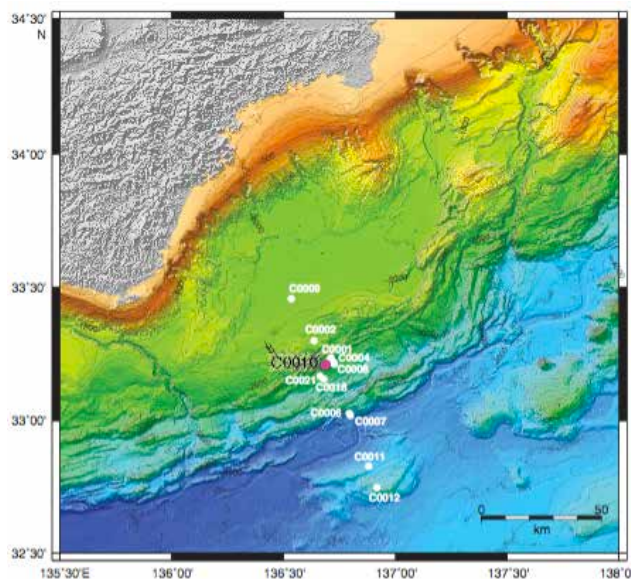
ECORD participants (Expedition 363)

Co-chief Scientist		
Ann Holburn	Kiel University	Germany
Scientists		
Germain Bayon	Ifremer, Brest	France
Luc Beaufort	CEREGE-CNRS, Aix en Provence	France
Anna Drury	MARUM, Bremen	Germany
Tom Dunkley-Jones	University of Birmingham	UK
Niklas Meinicke	University of Bergen	Norway
Paul Pearson	Cardiff University	UK
Christopher Poole	Newcastle University	UK
Anais Schmitt	University of Nantes	France

http://iodp.tamu.edu/scienceops/expeditions/pacific_warm_pool.html

• **Chikyu Expedition 365 NanTroSEIZE Shallow Megasplay LTBMS (26 March-27 April 2016)**

IODP Expedition 365 forms part of the Nankai Trough Seismogenic Zone Experiment (NanTroSEIZE). The expedition recovered temporarily installed monitoring instruments (a “GeniusPlug”) from the previously drilled and cased **Site C0010 (below)**, and deployed a permanent Long-Term Borehole Monitoring System (LTBMS) in the same hole after deepening it to about 651 mbsf. The expedition completed



Expedition 365: Preparing to lower the LTBMS onboard the Chikyu (© JAMSTEC/IODP).

preparations begun during IODP Expeditions 319 and 322. Before recovery, the temporary instrument had collected pressure and temperature data in the borehole for a period of five years. The newly installed LTBMS is equipped with a thermometer array, strainmeter, broadband seismometer, tiltmeter, geophones, accelerometers and pressure ports. Fixed with cement in a stable layer downhole it can observe and detect even slight changes in the splay fault and surrounding rocks. The LTBMS will be connected to the Dense Oceanfloor Network System for Earthquakes and Tsunamis (DONET) to collect real-time observatory data in the future.

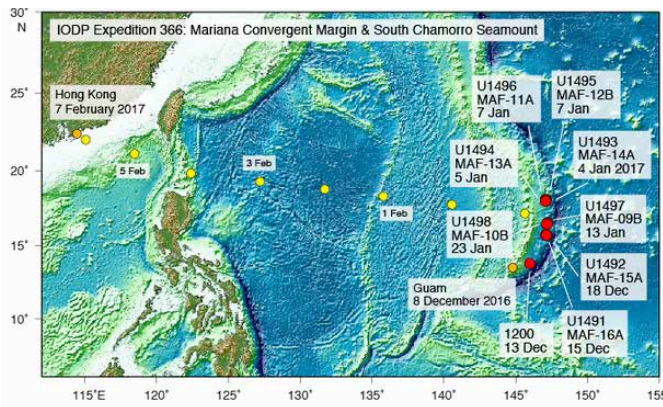
ECORD participants (Expedition 365)

Co-chief Scientist		
Achim Kopf	MARUM, Bremen	Germany
Scientists		
Alexander Rösner	MARUM, Bremen	Germany

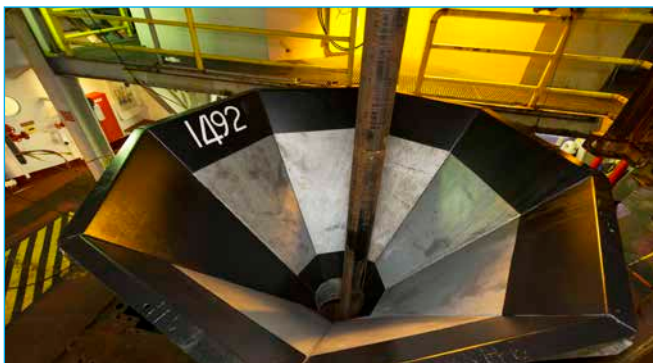
<http://www.jamstec.go.jp/chikyu/e/nantroseize/index.html>

• **JOIDES Resolution Expedition 366 Mariana Convergent Margin & South Chamorro Seamount 8 December 2016 - 7 February 2017)**

Based on IODP proposals 505-Full5 and 693-APL, Expedition 366 investigated geochemical, tectonic, and biological processes at intermediate depths of an active subduction zone. This expedition cored the summits and flanks of serpentinite mud volcanoes on the forearc of the Mariana system, a non-accretionary convergent plate margin in the western Pacific at **8 sites (U1491-1498)**. In addition, a re-entry cone and casing system were installed at three of these sites (**U1492, -1496 and -1497**) to provide the infrastructure for post-cruise installation of long-term monitoring. The existing borehole observatory a Circulation Obviation Retrofit Kit (CORK) at ODP Site 1200 was partly removed. Sediments, rocks, and fluids recovered during this expedition will be used **(1)** to understand mass transport and geochemical



cycling in subduction zones of non-accretionary forearcs at convergent margins, (2) to ascertain spatial and temporal variability of slab-related fluids in the forearc environment to trace dehydration, carbonate dissolution, and water/rock reactions in the subduction zone, (3) to understand physical properties of the subduction zone as controls over dehydration reactions and seismicity, (4) to study spatial and temporal variability in metamorphic and tectonic processes and the history of these processes in non-accretionary forearc regions and (5) to investigate controls over biological activity associated with these mud volcano processes.



Expedition 366: A reentry cone in position for deployment (photo Tim Fulton, IODP, JRSO).

ECORD participants (Expedition 366)

Scientists		
Elmar Albers	University of Bremen	Germany
Baptiste Debret	University of Cambridge	UK
Philip Eickenbusch	ETH Zurich	Switzerland
Walter Kurz	University of Graz	Austria
Victor-Hugo Magalhaes	IPMA, Lisbon	Portugal
Walter Menapace	University of Bremen	Germany
Catriona Menzes	NOC Southampton	UK
Olivier Sissmann	IFPEN, Rueil Malmaison	France
Bastien Walter	University of Lorraine	France
Education Officer		
Martin Böttcher	Rabanus-Mauris Schule, Fulda	Germany

http://iodp.tamu.edu/scienceops/expeditions/mariana_convergent_margin.html

Chikyū Expedition 370 T-Limit of the Deep Biosphere off Muroto (10 September - 23 November 2016)

Expedition 370 aimed to explore the limits of life in the deep seafloor biosphere at a location where temperature increases with depth at an intermediate rate and exceeds the known temperature maximum of microbial life (~120°C) at the sediment/basement interface ~1,210 mbsf. Expedition 370 drilled **1 site (C0023)** in the vicinity of ODP Sites 808 and 1174 at the protothrust zone in the Nankai Trough off Cape Muroto at a water depth of 4776 m (below).



The primary objectives were to study the relationship between the deep seafloor biosphere and temperature by (1) studying factors that control biomass, activity, and diversity of microbial communities in a sub-seafloor environment where temperatures increase from ~2°C at the seafloor to ~120°C at the sediment/basement interface and thus likely encompassing the biotic–abiotic transition zone, and (2) determining geochemical, geophysical, and hydrogeological characteristics in sediment and the underlying basaltic basement and if the fluids may support seafloor microbial communities in the Nankai



Expedition 370: Sedimentologists Man-Yin Tsang and Stephen Bowden, describe the lithology of a split core onboard the Chikyū (© JAMSTEC/IODP).

ECORD participants (Expedition 370)

Co-chief Scientist		
Verena Heuer	MARUM, Bremen	Germany
Scientists		
Stephen Bowden	University of Aberdeen	UK
Margret Cramm	University of Calgary	Canada
Suzann Henkel	AWI, Bremerhaven	Germany
Lorenzo Lagostina	ETH Zurich	Switzerland
Haley Manners	University of Southampton	UK
Florence Schubotz	MARUM, Bremen	Germany
Man-Yin Tsang	University of Toronto	Canada
Bernhard Viehweger	MARUM, Bremen	Germany

accretionary complex. To address these objectives and questions, Expedition 370 penetrated 1180 m and recovered 112 cores across the sediment/basalt interface. More than 13,000 samples were collected, and selected samples

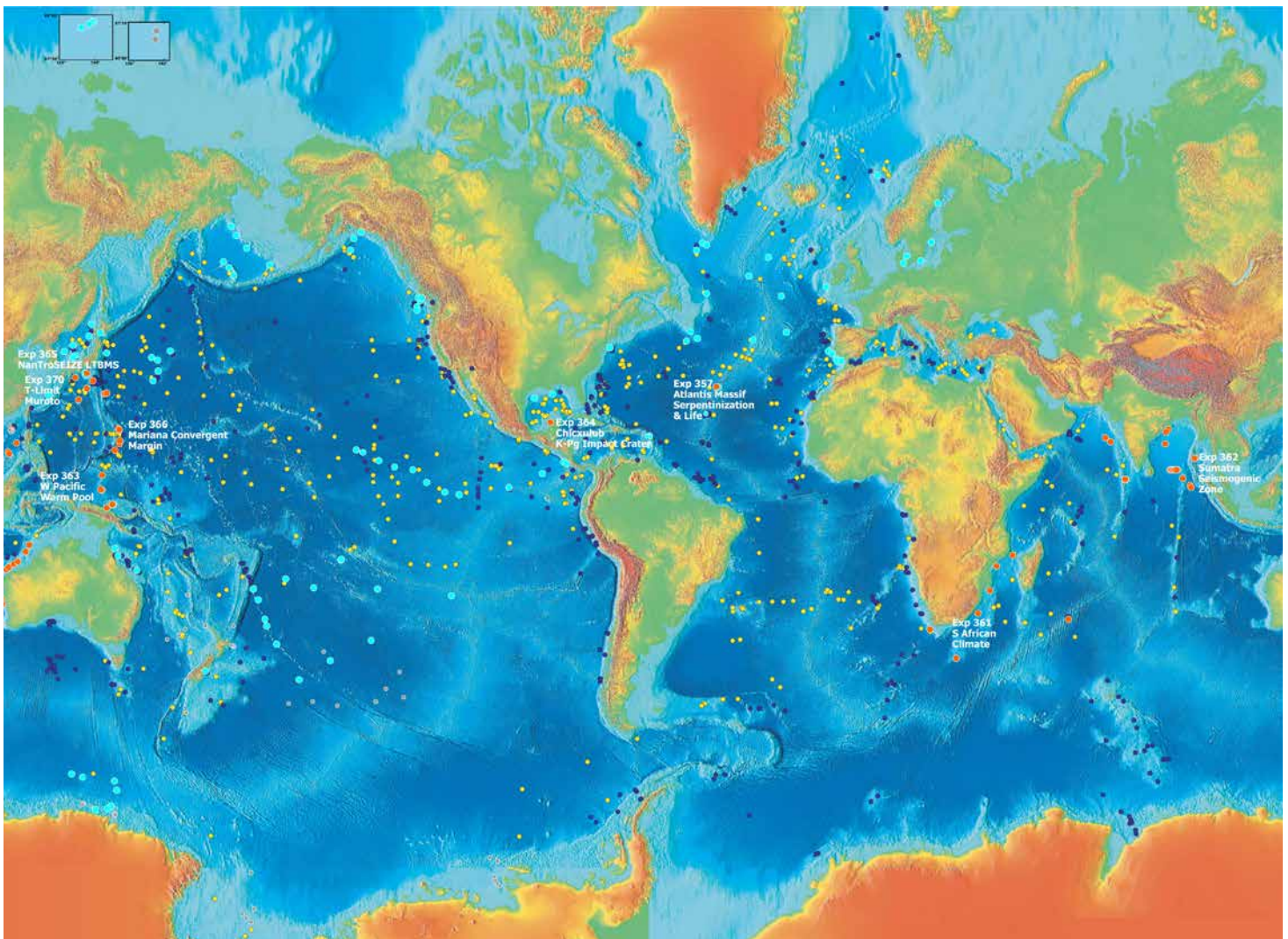
were transferred to the Kochi Core Center by helicopter for simultaneous microbiological sampling and analysis in laboratories with a super-clean environment. The concurrent scientific operation between the two teams (offshore and onshore), for the first time in *Chikyu* IODP operational history, enabled the analysis of fresh samples with state-of-the-art facilities onshore. Following the coring operations, a temperature observatory with 13 thermistor sensors was installed in the borehole to 863 mbsf.

<http://www.jamstec.go.jp/chikyu/e/exp370/>

Related websites:

- <http://iodp.tamu.edu/scienceops/expeditions.html>
- <http://www.jamstec.go.jp/chikyu/e/chikyuexp//>

JOIDES Resolution, Chikyu and MSP expeditions in FY16



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Air gun test during Expedition 364 Chicxulub K-Pg Impact Crater (photo A. Rae, ECORD/IODP).



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View of the Gulf of Mexico from
L/B Myrtle during Expedition 364
Chicxulub K-Pg Impact Crater
(photo J. Lofi, ECORD/IODP).

The derrick of the *JOIDES Resolution* seen from the drill rig during Expedition 362 Sumatra Seismogenic Zone (photo Tim Fulton, IODP-JR50).



154.5 km
of cores from 89
expeditions

Upgraded
CoreWall system

Improved
CurationDIS

41,382
samples taken
in 2016

6. Archiving IODP cores: the Bremen Core Repository

The Bremen Core Repository (BCR) at the MARUM, University of Bremen, Germany, is one of three IODP core repositories. The others are the Gulf Coast Repository (GCR) located at Texas A&M University in College Station (USA) and the Kochi Core Center (KCC) in Kochi (Japan) (*below*). In accordance with IODP convention and practice, the BCR hosts all of the cores recovered from the Atlantic and Arctic oceans, as well as the Mediterranean, Baltic and Black seas since the beginning of scientific ocean drilling. The BCR is also responsible for organising and hosting the Onshore Science Parties (OSP) of mission-specific platform expeditions (MSPs), and providing mobile laboratories offshore.

Samples and requests at BCR

The BCR presently contains almost **154.54 km** of deep-sea cores from **89 expeditions**. A total of **41,382 samples** were taken at the BCR during FY16 for **290 requests** (of which 180 were submitted by ECORD-country scientists).

A series of improvements in CurationDIS have been implemented and a new version (6.0) is now installed at the BCR. This includes a number of important additions to the system, *e.g.*, update of filter mechanisms and page navigation, new datagrid technology, assignment of International Geo Sample Numbers (IGSN), subsample input, Quick Response (QR) -code labels, more user-friendly online sample data queries and export of results, adjusted label design, expanded core photo views, and exporting core section and image information to CoreWall. As a result, the repository and online versions of DIS are faster, more powerful, flexible and efficient.

Work on the sample and request database also involved preparations for the transfer of Expedition 357 Atlantis Massif

Bremen Core Repository and sample statistics		
	Expeditions	Length of cores (km)
	89	154,543
	All sample requests	All sample taken
	6,570	> 1.62 M
	Individual scientists	
	3,436	
Bremen Core Repository FY 2016		
	Sample requests (from ECORD countries)	
	290 (180)	41,382

Serpentinization and Life data from the ExpeditionDIS into CurationDIS at the end of the moratorium period (February 2017).

All BCR samples (over 1.62 M sample, incl. samples taken earlier at the Gulf Coast Repository for legacy cores that are now at BCR; more than 6570 sample requests; over 3436 individual scientists) are entered into the BCR DIS Internet Interface. This database is accessible to the general public for post-moratorium samples (web interface for curatorial data - <http://dis.iodp.pangaea.de/BCRDIS/>). It was redesigned to be more flexible and user-friendly, making it easier for scientists to retrieve their own sample lists and for repository staff to obtain historical data for reporting sampling and request statistics. The data export function has been modernised to retrieve data directly into an Excel file if desired, and an online tutorial has been added.



MSP expeditions at BCR

CoreWall-Corelyzer, initially used during MSP OSPs, has been continuously undergoing improvements. The CoreWall system was significantly upgraded through installation of a new graphics card and additional RAM to increase performance. New 27-inch 4K monitors have been installed to display the core images at a higher resolution and allow visualisation of additional data (such as CT images) (*below*) simultaneously on the screens. We are continuing to explore new ways to integrate Corelyzer into our daily normal operations, including education and outreach. Visitors are always amazed by the sharp, high-resolution pictures of cores, even at extremely close range, and the ability to view the sediments from a complete hole from top to bottom. Use of the new 'IODP Sample and Data Request' (SaDR) system by the general science community has continued to function well. It is now being used for all requests for samples from all DSDP and ODP Legs as well as all IODP expeditions.



CoreWall-Corelyzer during the Onshore Science Party of Expedition 364 Chicxulub K-Pg Impact Crater (photo E. Chenot, ECORD/IODP).

The Scientific Earth Drilling Information Service - SEDIS (<http://sedis.iodp.org/>) continued in the new IODP and will continue to be maintained. It has recently been updated with recent publications and metadata for the current expeditions.

ESO has continued to implement Quality Assurance/Quality Control (QA/QC) procedures within MSP operations. This involves various work packages encompassing overall policies and procedures for upcoming and recently completed expeditions (*e.g.*, for geochemistry data in the database of past MSP expeditions). This primarily involves examining QA/QC procedures for analytical equipment and instrumentation under the areas of scoping, writing



Live transmission from the BCR reefer to the "unterirdisch" GeoShow show at Bonn University during the Science Night (photo DFG).

(insertion of QA/QC documentation into offshore lab work routines), and constantly improving the online tutorials for both the offshore phase and the OSP:

http://www.marum.de/en/Offshore_core_curation_and_measurements

http://www.marum.de/en/Onshore_Science_Party_OSP.html.

Maintenance and upgrade of laboratory containers and equipment, including analytical instruments utilised during OSPs, are ongoing activities at the BCR.

Visitors at BCR

The location of the BCR on the University of Bremen campus has proven to be very convenient for many visitors, including walk-in scientific visitors, the general public, school classes (including live-video conferences to GeoShow "unterirdisch" in Bonn (*above*) and Heidelberg), visiting student groups from other universities located in Germany and Europe and official delegations visiting the University of Bremen.

In 2016, amongst others, the BCR was visited by a Chinese delegation from the Qingdao National Laboratory for Marine Science and Technology (QNLN), two Ministers of the German Federal Parliament, (Frau Bettina Hornhues (Bremen) and Frau Sybille Benning (Münster)), the ECORD Outreach & Education Task Force, Ludwig Scheidegger of the Werner Siemens Foundation (Switzerland), the IODP Science Evaluation Panel (SEP), scientific members of the Petrology section of the German Mineralogy Society, members of the Bremen State Radioactivity Measurements Laboratory, and a Brazilian choir of more than 40 persons visiting the University of Bremen. Equally important for informing and educating

the general public of our goals and scientific and technical achievements are the frequent visits by representatives of television, radio and print media.

This year the BCR provided core material for numerous course studies run by various instructors. These were usually visits to the BCR by classes, but in special cases, cores were transported to schools within Germany. These courses included core description and visual illustration of geoscientific concepts. The BCR is an ideal place to train students, with the opportunity to work on real cores and have access to laboratory facilities. The BCR plays a key role in the ECORD Summer Schools. The 10th ECORD Summer School and the 2nd ECORD Training Course were run in 2016 (*See 7. Engaging the community, pages 51-52*), which combine practical exercises using IODP-style “shipboard” methodologies, as well as lectures and interactive discussions on the main themes of IODP. Through these efforts, numerous young emerging



Participants of the ECORD Bremen Summer School 2016 (photo Volker Diekamp, MARUM).

scientists have been exposed to and inspired by materials from IODP.

Related website:

http://www.marum.de/en/Partner_to_the_ECORD_Science_Operator.html



MARUM personnel split cores during the Onshore Science Party of Expedition 364 Chicxulub K-Pg Impact Crater (photo U. Prange, ECORD/IODP).

3 MagellanPlus
workshops on 3
IODP themes

7 research grants
distributed to
young scientists

150 students
& early-career
scientists trained
in 2016

39 IODP-related
lectures given in
12 countries

1st ECORD
Summer School on
Petrophysics

7. Engaging the community

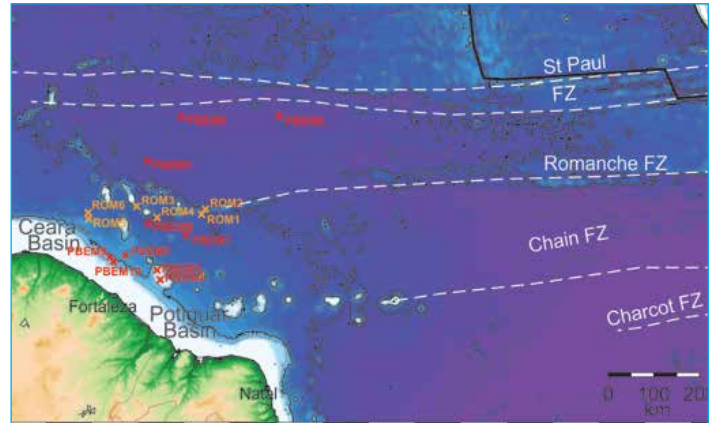
Development of future drilling proposals: the MagellanPlus Workshop Series Programme

The ECORD-ICDP MagellanPlus Workshop Series Programme is designed to support European, Canadian and Israeli scientists to develop new and innovative science proposals for IODP and ICDP. In 2016, one call for organising workshops in 2016-early 2017 was issued. 5 proposals - 1 ICDP, 2 amphibious and 2 IODP - were received and 3 workshops took place in 2016.

- The Brazilian Equatorial Margin - BEM II, 30 March - 1 April 2016, Ubatuba, Brazil

Convener: Paola Vannucchi (UK)

Following a previous meeting, BEM I, organised in Maresias in 2014, the BEM II workshop offered a unique opportunity for scientists to focus on the Brazilian Equatorial Margin, which has maintained a stable intertropical latitude since its formation in the Early Cretaceous and contributed to the reconfiguration of the world's ocean circulation. Furthermore BEM is shaped by the interaction of the continental margin with transform faults/fracture zones so it remains a rare seismically active intraplate environment. Among the different themes discussed at the first BEM I meeting, two themes were developed to the stage where they were submitted as two pre-proposals in October 2014: 875-Pre, the Cenozoic Paleoceanography of BEM (P-BEM), and 882-Pre, the Tectonics of BEM (T-BEM). P-BEM focuses on unraveling the Cenozoic paleoclimate and paleoceanographic record in the inter-tropical latitudes, while T-BEM aims at understanding the role of transform faults/fracture zones in the evolution of continental margins. The goal of this BEM II workshop was to coordinate the two proposals for drilling in the Brazilian Equatorial Margin (*above right*). The MagellanPlus BEM II workshop was also an outstanding opportunity to build upon the Brazilian community's knowledge of the equatorial margin and to review the large amount of industry-related datasets on the submarine margin. CAPES (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior) and FAPESP (Fundação de Amparo à Pesquisa do Estado de São Paulo) research foundations also sponsored the workshop, which hosted **45 attendees from 9 countries**. The outcome was a wide open discussion and sharing of data and new results that resulted in a clear focus for building on this knowledge to explore and develop a drilling strategy to recover the critical record of the BEM.

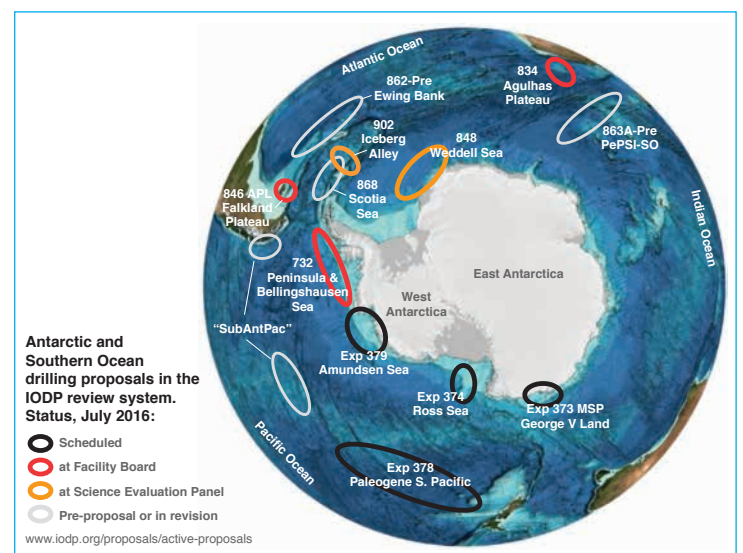


Location of drillsites identified during the BEM II MagellanPlus workshop.

- Antarctica's Cenozoic Ice and Climate History, 9-11 May 2016, College Station, USA,

Conveners: Laura De Santis (Italy), Trevor Williams (USA), Rob McKay (New Zealand), Karsten Gohl (Germany), Jim Channell (USA) and Rob Larter (UK).

The US Science Support Program (USSSP) and MagellanPlus-funded Antarctica's Cenozoic Ice and Climate History workshop is part of a coordinated plan developed since 2009 by the Past Antarctic Ice Sheet Dynamics (PAIS) research programme through the Scientific Committee on Antarctic Research (SCAR - www.scar.org) and the International Council for Science (ICSU) committee, to stimulate Antarctic Margin drilling proposals. The workshop discussed the status of the Antarctic and Southern Ocean proposals currently in the IODP review system (*below*) and highlighted the requirement of geographically diverse drilling transects, as recent observation



and modeling studies reveal a heterogeneous response of the Antarctic ice sheet to oceanic and atmospheric forcing. Three drilling proposals (751 in the Ross Sea; 839 in the Amundsen Sea; and 732 in the Bellingshausen Sea and Antarctic Peninsula), approved by the Scientific Evaluation Panel (SEP) and under consideration for scheduling by the *JOIDES Resolution* Facility Board (JRFB) at the time of the workshop, form a coherent West Antarctic Margin Portfolio of drillsites, that will illuminate the spatial and temporal variations of past Antarctic ice-sheet dynamics and guide model skill for future predictions, by (1) reconstructing the orbital-scale Cenozoic dynamics of the West Antarctic Ice Sheet (WAIS), (2) identifying drivers and their thresholds, especially of ocean forcing, for past WAIS retreat, and (3) assessing relationships between the Antarctic cryosphere, ocean circulation, and global climate. This is particularly timely because the 2015 United Nations Climate Change Conference in Paris requested that the Intergovernmental Panel on Climate Change (IPCC) write a special report by 2020 to assess the climate impacts of climate stabilisation at +2°C and +1.5°C and the response of Antarctic ice sheets will comprise an important component of this report. The IODP expeditions will provide near-field ice sheet data to complement and constrain the far-field sea level and paleoceanographic data obtained by expeditions in the Southern Ocean.

- **Bend-Fault Serpentinization, 18-20 June 2016, London, UK.**

Convener: Jason Morgan (United Kingdom)

The aim of the meeting was to move forward on organising, coordinating, and writing a full-proposal(s) on bend-fault serpentinization (BFS). BFS favours chemosynthesis, hence bend-faults could host a major unseen component of the deep biosphere. This workshop is needed to develop a *Chikyu*-based IODP proposal(s) to study BFS in the regions targeted by the BFS and H-ODIN IODP pre-proposals. The workshop was supported by JAMSTEC, UK-IODP and ECORD. A final report is still in preparation.

Related website: <http://www.ecord.org/science/magellanplus/>

Training and sponsoring young scientists

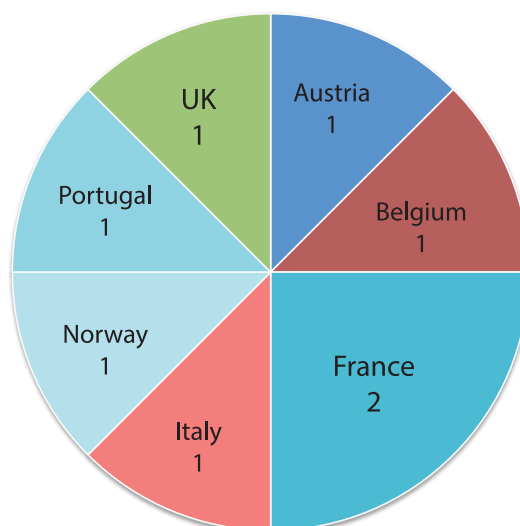
A major goal of ECORD is to train the next generation of scientists from member countries and promote IODP-motivated science. ECORD Summer Schools, initiated in 2007, are well established and are attended annually by many Masters and PhD students as well as Post-doc researchers from ECORD member countries and beyond. Three ECORD Summer Schools and one ECORD Course were sponsored by ECORD in 2016. ECORD Scholarships provide support to outstanding

students to attend the ECORD-sponsored summer schools. In 2016, 15 scholarships were supported over 44 applications.

- **ECORD Petrophysics Summer School, Leicester, UK, 26 June - July 2016**

The first ECORD Petrophysics Summer School was organised by the European Petrophysics Consortium (EPC). The school focused on the application of downhole logging and core physical properties data to scientific questions, with case studies from each of the IODP Science Plan themes. It consisted of lectures, discussion groups, and practical exercises on the different elements and data types used in petrophysical analysis. A total of 18 lectures and tutors from five different countries provided the programme of the summer school with a broad mix from academia, IODP operators, and industry. In addition, basic training in industry-standard software packages, including Schlumberger's Techlog, formed a core part of the summer school. Sessions at the summer school fell into one of three categories, (1) explaining and describing the principles behind petrophysical measurements, (2) demonstrating the methods by which petrophysical measurements are acquired and (3) revealing the ways in which petrophysical data can be used in the pursuit of scientific objectives through integration and interpretation.

An off-site excursion centred on downhole-logging activities, including the development, testing, calibration and deployment of downhole-logging tools was included. Practical exercises including demonstrations of physical properties data acquisition, by way of multi-sensor core loggers. Integration of these core physical properties data and use of them to calibrate the *in-situ* measurements formed a key component of the summer school.



Distribution of ECORD Scholarship applications to the Petrophysics Summer School 2016 (n = 8).

29 students from 10 different countries (nine ECORD and the USA) participated in the summer school (*photo page 52*). 8 applications for an ECORD scholarship were received from 7 ECORD member countries (*page 50*). **3 scholarships from 3 ECORD member countries** (Belgium, Italy and Norway) were distributed (*table below*). In addition the USSSP provided ten travel awards to US-based scientists to support their attendance at the Petrophysics Summer School.

Scholarship awardees - Petrophysics Summer School

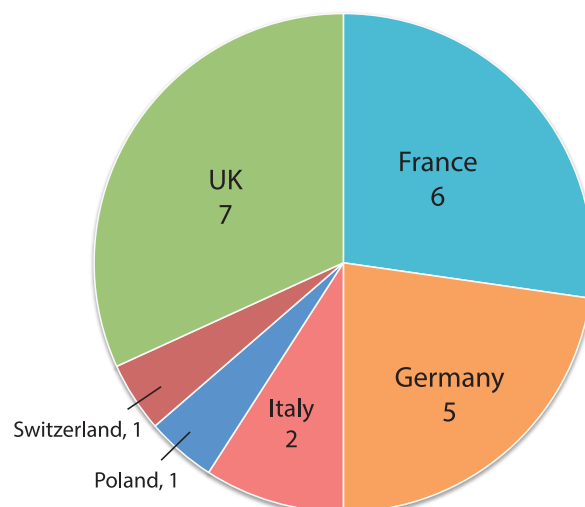
Claire Aupart	University of Oslo	Norway
Luca Bianchin	University of Trieste	Italy
Matthias Sinnesael	Free University, Brussels	Belgium

Related website: <http://www2.le.ac.uk/epc>

• 13th Urbino Summer School in Paleoclimatology on Past Global Change Reconstruction and Modelling Techniques, Urbino, Italy, 13 - 29 July 2016

The Urbino Summer School in Paleoclimatology (USSP) is organised annually by an international consortium of scientists and is hosted by the Faculty of Sciences and Technology at the University of Urbino, Italy. The school is open to students from ECORD member countries, the USA and other countries, and is designed to provide training in many different areas of paleoclimatology, including biogeochemical cycling and paleoceanography, continental systems, and aspects of deep-time climate modeling. The course provided an integrated student-centred programme comprised of (1) integrated topical lectures by 33 internationally recognised scientists, (2) student-centred data-based exercises, investigations, and presentations on field data and modeling results, (3) parallel sessions providing groups of participants with more focused selected topics within paleoclimatology, (4) a regional field excursion to classic Cretaceous and Cenozoic sections (*above right*) and (5) intensive discussions of specific palaeoclimate topics in small student working groups facilitated by dedicated instructors.

The summer school brought together **66 students from 10 ECORD member countries** (Canada, Finland, France, Germany, Israel, Italy, Netherlands, Sweden, Switzerland and the UK) and five non-ECORD member countries (Australia, New Zealand, Poland, Singapore and the USA). **22 applications from 6 ECORD member countries** were received and **6 scholarships for 3 ECORD member countries** were distributed: four for UK, one for Germany and one for France (*above right*).



Distribution of ECORD Scholarship applications to the Urbino Summer School 2016 (n = 22).

Scholarship awardees - 13th Urbino Summer School

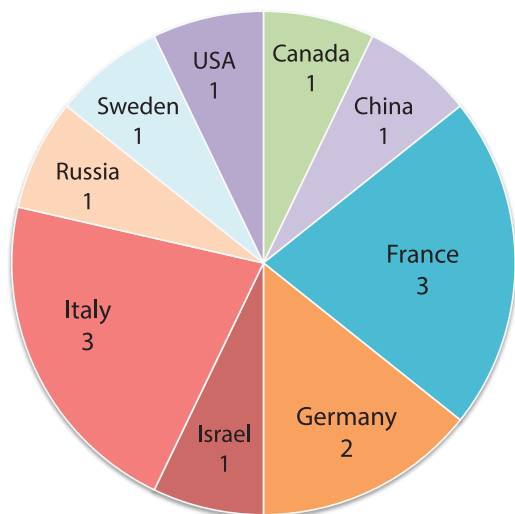
Myriam Agnel	University of Lyon	France
Kim Alix Jakob	University of Heidelberg	Germany
Katrina Kerr	Open University	UK
Sarah Lucas	Oxford University	UK
Sophie Nuber	Cardiff University	UK
Ritwika Sengupta	Oxford University	UK

Related website: <http://www.urbinossip.it/>

• 10th ECORD Bremen Summer School on "Submarine Geohazards: Mapping, Monitoring, and Modelling", Bremen Germany, 5 - 16 September 2016

As in past years, the ECORD Bremen Summer School was held at the Bremen Core Repository (BCR), taking advantage of the "Virtual Ship" facilities at the repository and the laboratory facilities at MARUM, University of Bremen. The two-week course combined lectures and interactive discussions on the (1) geohazards: introduction into the dynamics of earthquakes, submarine landslides, their trigger, failure and transport mechanisms, as well as their geohazard potential, e.g. tsunamigenesis from earthquakes and landslides, (2) mapping of submarine geohazards: geophysical methods and core-analysing techniques, (3) monitoring of submarine geohazards: observatories, long-term monitoring, and (4) modelling of submarine geohazards: different modelling techniques - from analogue lab experiment to numerical simulation. These topics were further covered by practical exercises, with the latter mainly using the facilities of the BCR. The weekend between the first and the second week gave the participants the opportunity to join a field trip. During the summer school the participants had the chance to give

a short presentation introducing their own research work. This summer school brought together 27 instructors as well as **25 PhD students and Post-doc researchers** (photo page 47) from **7 ECORD member countries** (Germany, Norway, France, UK, Israel, Italy, and Canada), as well as China, Czech Republic, Malta, New Zealand, Romania, Russia, and Slovenia. **14 applications** from six ECORD member and 3 non-ECORD countries were received (below). **6 scholarships** for **4 ECORD member countries** (France, Germany, Israel and Italy) were distributed (table below).



Distribution of ECORD and non-ECORD Scholarship applications to the Bremen Summer School 2016 (n = 14).

Scholarship awardees - 10th Bremen Summer School 2016

Morgane Brunet	IPG Paris	France
Olivero Candoni	OGS Trieste	Italy
Judith Elger	GEOMAR	Germany
Ovie Emmanuel Eruteya	University of Haifa	Israel
Elisabetta Olivo	OGS Trieste	Italy
Eliana Valenzano	University of Bari	Italy

ECORD Petrophysics Summer School 2016 (Colin G Brookes Photography).



Related website: http://www.marum.de/en/ECORD_Summer_School_2016.html

• **ECORD Training Course "The Virtual Drillship Experience", Bremen, Germany, 7 - 11 March 2016**

For the second time the ECORD Training Course took advantage of the setting of the BCR at MARUM, University of Bremen in 2016 and provided a "Virtual Drillship Experience" for scientists from academia and industry. This one-week course was focused on basic training in IODP core-flow procedures and preparing participants to sail on an offshore drillship expedition. IODP-style lab exercises (page 55) form the basis of the ECORD Training Course and follow the pattern of the unique "Virtual Ship Experience" developed for the Bremen ECORD Summer Schools.

MARUM received **61 applications from 20 countries**, which attests to the established success of this new course. A total of **30 participants** from ECORD (Germany, Belgium, France, Denmark, UK, Ireland and Sweden) and non- ECORD (US and Croatia) countries attended the course.

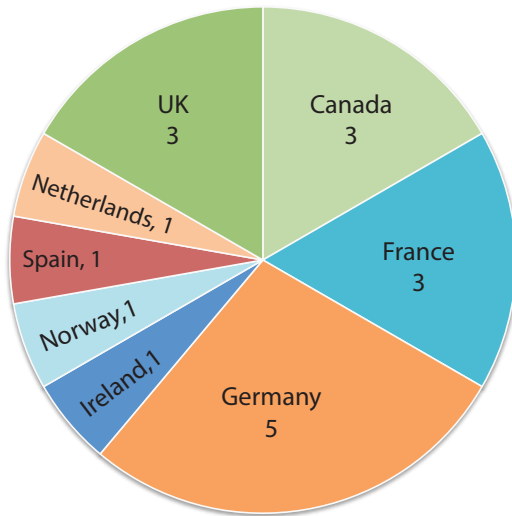
Related website: http://www.marum.de/en/ECORD_Training_Course_2016.html

• **ECORD Research Grants 2016**

ECORD supports outstanding early-career scientists by sponsoring merit-based awards for research that is directed toward scientific objectives of past or upcoming DSDP/ODP/IODP expeditions (core material and data). The aim of this endeavour is to foster participation of young scientists in ocean drilling research and encourage them to develop their own projects and to collaborate with other research groups outside of their home institutions.

18 applications from 8 ECORD member countries were submitted in 2016 from PhD students and Post-doc

researchers (*below*); **7 grants** were awarded: two for UK, two for Germany, one for Canada, one for the Netherlands and one for Norway (*table below*).



Distribution of applications to the ECORD Research Grants 2016 (n = 18).

ECORD Research Grants 2016

Sonja Felder	Newcastle University	UK
Kim Alix Jakob	University of Heidelberg	Germany
Stefanie Kaboth	Utrecht University	Netherlands
David King	University College London	UK
Caroline Seyler	McGill University	Canada
Bernhard Viehweger	MARUM, Bremen	Germany
Rui Zhao	University of Bergen	Norway

Related website: <http://www.ecord.org/education/research-grant/>

Engaging teachers

As part of the "Teachers at Sea" programme, initiated by Ocean Leadership and sponsored by the USA, teachers from ECORD countries have the opportunity to participate onboard the *JOIDES Resolution* as Education Officers on IODP expeditions - <http://joidesresolution.org/node/453>. The primary objectives of this education programme are to **(1)** provide educators with the opportunity to sail onboard a sea-going marine research vessel, working along-side scientists and using state-of-the-art scientific approaches to address problems of global interest and obtain first-hand knowledge of the results of the expeditions, **(2)** translate scientific results into useful teaching resources, such as classroom curriculum materials and **(3)** disseminate education resources into classroom settings and motivate other teachers to use IODP science and materials in their curriculum.



Physical Properties Specialist Nisha Nair, left, and Education Officer, Agnès Pointu, right, examine the cores at the sampling table during Expedition 362 Sumatra Seismogenic Zone (photo Tim Fulton, IODP-JRSO).

Following a call for applications in January, ESSAC selected four teachers from 8 applicants from ECORD member countries to sail on *JOIDES Resolution* expeditions in 2016/17. In 2016 **Agnès Pointu** (France) (*above*) participated in Expedition 362 Sumatra Seismogenic Zone and **Martin Böttcher** (Germany) was selected for Expedition 366 Mariana Convergent Margin. They both sailed with financial support from their national IODP office.

Education Officers **Marion Burgio** (France) (*below*) and **Lucas Kavanagh** (Canada), presented outcomes from Expedition 360 SW Indian Ridge Lower Crust and Moho. Lucas produced a podcast "A hole in the bottom of the ship" and a number of short videos. Marion who conducted 50 videoconferences (*below*) with schools and university classes, took part in an Education and Outreach session at AGU 2016.

A Special Call was released for Teachers at Sea to participate in the OSP of MSP Expedition 364 Chixculub K-Pg Impact Crater held at the BCR in Bremen in September 2016. Due to the short notice ECORD received only one application from



Education Officers Alejandra Martinez, left, and Marion Burgio, right, prepare the camera for a live broadcast (photo Bill Crawford, IODP-JRSO).

Germany. **Barbara Mattysek** (Germany) joined the OSP together with Kevin Kurtz (US), who was supported jointly by ECORD and USSSP (See 8. *Communicating* - page 58).

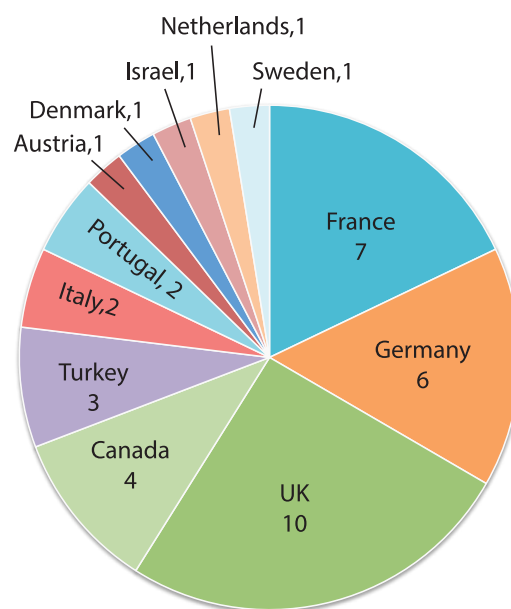
In addition ECORD supported **Helder Pereira** (Portugal) to participate in the first *Chikyu* Onboard School in July 2016 (below). During the course, the participants had a unique opportunity to learn about the *Chikyu*'s scientific research highlights, involving laboratory work relating to the actual procedures used onboard for analysing cores. The school included a ship tour (riser-drilling system), lectures and practical exercises.

Related website: <http://www.ecord.org/education/teachers-at-sea/>

Promoting IODP science through the ECORD Distinguished Lecturer Programme

The ECORD Distinguished Lecturer Programme (DLP) is designed to bring the scientific achievements of ocean drilling to a broad audience within universities/institutes in ECORD member countries. ESSAC selects "Distinguished Lecturers" who then tour ECORD member countries, and on occasion non-ECORD countries, to present the exciting discoveries from one of the four main scientific themes addressed by the IODP Science Plan - <http://www.iodp.org/science-plan-for-2013-2023>. Any university or institution in an ECORD member country may apply to host a lecturer.

The current DLP continues to be a great success, with five lectures that cover the major IODP themes:



Distribution of the ECORD Distinguished Lecturer in 2015 and 2016 (n = 39).

- **Christian France-Lanord** (Centre de Recherches Pétrographiques et Géochimiques, CNRS, Nancy, France) - Himalaya: from mountains to drilling in the Bengal fan;
- **Jens Kallmeyer** (GFZ German Research Centre for Geosciences, Helmholtz Centre, Potsdam, Germany) - What controls abundance and activity of microbial life in subsurface sediments? New insights from scientific drilling;
- **Antony Morris** (School of Geography, Earth and Environmental Sciences, Plymouth University, UK) - What can magnetism tell us about oceanic tectonics? New insights from scientific drilling;
- **Gabriele Uenzelmann-Neben** (Alfred Wegener Institut Helmholtz Zentrum für Polar- und Meeresforschung, Bremerhaven, Germany) - Reconstructing palaeo-circulation: Reading sediment drifts with the aid of IODP information;
- **Paola Vannucchi**, (Earth Sciences Department, Royal Holloway, University of London, UK) - Understanding megathrust earthquakes through ocean drilling.

39 DLP lectures were scheduled in 2015 and 2016 with the DLP lecturers visiting **11 ECORD countries** and **Turkey**.

A DLP for hosting ECORD lecturers in 2017 was announced at the end of 2016.

Related website:

<http://www.ecord.org/education/dlp/>



Participants of the first *Chikyu* Onboard School (© JAMSTEC).

MagellanPlus Workshops and ECORD Summer Schools/Training Course in 2016

Jan	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31			
Feb	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29					
Mar	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31			
							ECORD Training Course																											
Apr	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30				
May	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31			
							MagellanPlus workshop Antarctic																											
Jun	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30				
							MagellanPlus workshop Bend-Fault Serpentinization																											
Jul	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31			
Aug	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31			
Sep	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30				
							Bremen Summer School																											
Oct	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31			
Nov	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30				
Dec	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31			

MSCL practising at the ECORD Training Course 2016 (photo Volker Diekamp, MARUM).





ARTISAN CREPE

2 teachers
on MSP
Expedition 364

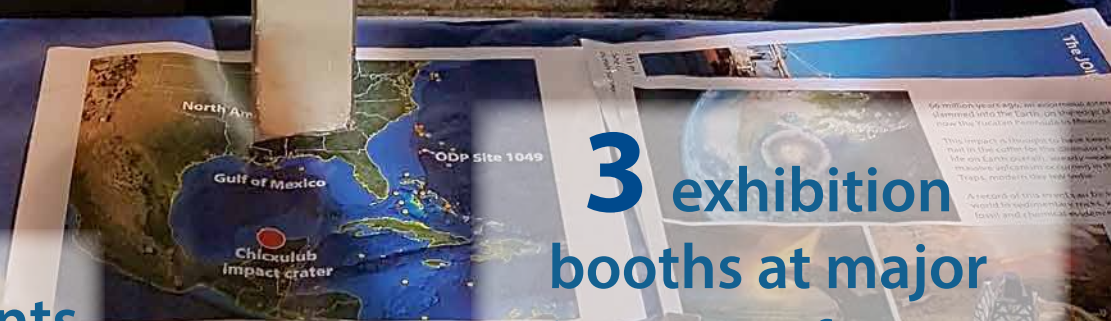
New ECORD
website launched
in September 2016

16 events
showing ODP/
IODP replicas

4 media events
related to MSP
expeditions

3 exhibition
booths at major
science conferences

Kate Littler (ESSAC Alternate,
University of Exeter, UK) shows the
K-Pg core replica at "Science in the
Square" in Falmouth, UK



8. Communicating

Promoting the activities and accomplishments of the IODP via the ECORD website, information database, publications, reports, exhibition booths, press releases and educational actions to large, often non-scientific, audiences is a major and ongoing goal. Within ECORD, responsibilities for outreach and education activities are distributed between EMA (coordination, publications and web), ESO (MSP expeditions and media) and ESSAC (education), and coordinated by the ECORD Outreach & Education Task Force (E-OETF).

Communicating with scientists

In 2016, ECORD outreach staff continued to promote both the IODP and the International Continental Scientific Drilling Program (ICDP) under the umbrella of "Scientific Drilling" at science conferences. In coordination with our colleagues in the USA and Japan, and with the ICDP outreach staff, two joint IODP-ICDP booths were organised at the **35th International Geological Congress (IGC)** in Cape Town (South Africa) and the **AGU Fall Meeting 2016** in San Francisco (USA) (*below*). However, the main event for ECORD was the **European Geosciences Union (EGU) Conference** in Vienna (Austria) in April, at which ECORD and the ICDP jointly sponsored a booth and supported a Townhall meeting. ICDP core-scanner demonstrations and videos attracted many visitors to the booth and programme information and subscriptions were accessed via online tools (*pages 58-59*). The success of these joint events will lead to similar collaborations in 2017 at the EGU as well as at the AGU.

During the summer, Diane Hanano, the IODP-Canada Science Coordinator, was invited to represent ECORD in the JAMSTEC/CDEX exhibition booth organised at the Goldschmidt

ECORD, IODP and ICDP outreach personnel at AGU 2016 (photo T. Wiersberg).



Conference in Yokohama (Japan) (*page 58*). ECORD also supported member countries Italy, Spain and France with organising successful exhibition booths at science conferences as well as at national science days. ECORD information was also widely distributed through the ECORD-ICDP MagellanPlus Workshop Series.

The **ECORD Newsletter** (*above*) is published twice yearly to coincide with the EGU and AGU conferences (spring and fall of each year). The newsletter represents the main published source of general ECORD information, and includes reports on recent outreach activities. Leaflets explaining the programme objectives and the latest information resulting from five MSP expeditions are included in an ECORD folder, which is continuously updated. In preparation for the start of Expedition 364 Chicxulub K-Pg Impact Crater, promotional materials, a logo, leaflet, banner and expedition web page were designed to create the individual identity of the expedition. Promotional materials were updated throughout the later half of 2016 by the outreach team in response to media requests and publication of the first scientific results from Expedition 364.

Media activities

A media day focusing on the very first results of **Expedition 357 Atlantis Massif Serpentinization and Life** took place in MARUM, University of Bremen, on 1 February 2016 during the Onshore Science Party (OSP). A media release was issued on the same day and resulted in various news items.

Media interest in the **Expedition 364 Chicxulub K-Pg Impact Crater** was very high, from both large and small outlets worldwide, especially in Canada, USA, UK, Japan, the Netherlands, Austria and Spain. Local media interest in Mexico was also very high, and a dedicated supply vessel run was made to ferry **24 Mexican journalists** to the platform. Numerous items have appeared on radio, in print and online, including features by Science, Nature and the BBC. Media activities were conducted by the ESO outreach staff and coordinated with outreach representatives from the ICDP who co-funded the expedition. ECORD issued a Communications Plan to all of the Science Party members prior to the expedition. Throughout the expedition, ESO facilitated access to operations and personnel for Barcroft Productions Ltd., a production company, to gather material for a documentary. The TV documentary is being financially supported by the BBC and PBS Nova, both of whom are expected to broadcast at least a one-hour documentary in April 2017.

A media conference was organised at the start of the expedition at El Gran Museo del Mundo Maya, in Mérida (Mexico) on 13 April 2016, in collaboration with Mexican representatives. The event was conducted in both Spanish and English and attended by **40 media representatives**, mainly from Mexican radio, TV and print media. During the offshore phase of the expedition, a media day was organised on 23 April, when media representatives and VIPs were able to visit the platform *L/B Myrtle* (page 59). The event received global interest and was reported in the USA, Canada, Australia and Mexico as well as several countries in Europe and Asia.

During the Onshore Science Party, a third media event was held on 11 October 2016, featuring short presentations from the Co-chief Scientists followed by interviews and tours of the laboratory facilities and IODP core repository at MARUM, University of Bremen (Germany). The event was attended by the BBC and by several German radio and TV representatives. A press release was issued to communicate the first results of the expedition to the public.

<http://www.ecord.org/outreach/press-releases/>

Communicating with classrooms and the general public

ECORD teachers who take part in IODP expeditions and educational activities are vital to bringing IODP science into the classrooms. In 2016, **5 ECORD teachers** were involved in activities onboard all IODP platforms; the mission-specific platform *Liftboat Kayd*, the *JOIDES Resolution* and the *Chikyu* (See 7. *Engaging the community*, page 53).



The ECORD-ICDP booth at EGU 2017 (photo Thomas Wiersberg, ICDP).



Diane Hanano (IODP-Canada) and CDEX/JAMSTEC personnel at the Goldschmidt 2016 in Yokohama (© JAMSTEC).

Expedition 364 was the first MSP expedition since the Arctic Coring Expedition in 2004 to involve two Education Officers, Kevin Kurtz (USA) and Barbara Matyssek (Germany) (below), during both the offshore and onshore phases. Barbara conducted interviews with researchers related to questions from school students, whilst Kevin did a series of live videos events, organising tours and interviews with scientists to 33



Education Officers Barbara Matyssek and Kevin Kurtz during the Onshore Science Party of Expedition 364 Chicxulub K-Pg Impact Crater (photo U. Prange, ECORD/IODP).

school groups, which reached over 1400 people.

<http://www.ecord.org/education/teachers-at-sea/>

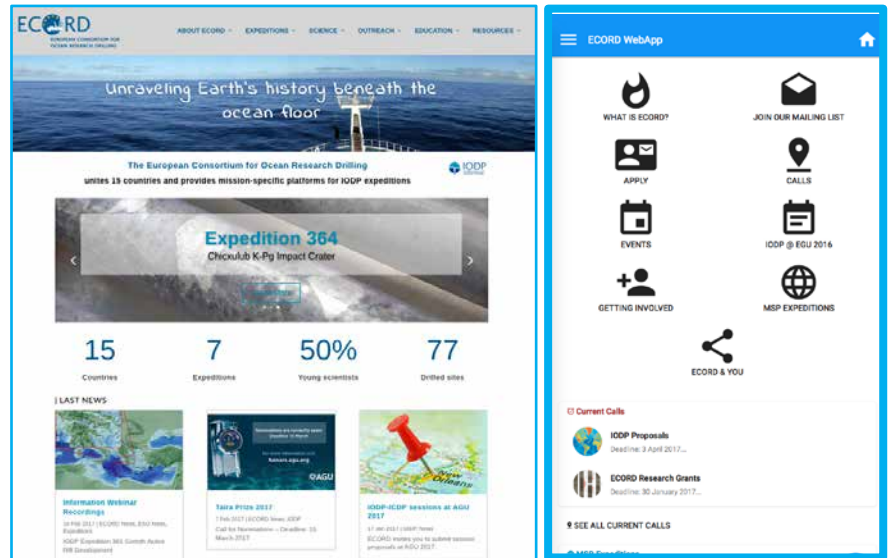
Replicas of cores from ODP/IODP legs and expeditions are valuable tools to highlight ODP/IODP science to a wide range of scientific and non-scientific audiences. In 2016, core replicas were used to support teaching in middle and high schools (Pau and Valbonne, France) and universities (University College London, UK and University of Lorraine, France). Educational materials were also

provided to support a large number of public events organised in several European countries including: a museum exhibition on climate change in Lunéville (France) organised by Michel Champenois, public events and science exhibition in Exeter and Falmouth (UK) organised by Kate Littler ([page 56](#)), European Researchers' Night in Kiel (Germany) organised by Hanno Kinkel, Fête de la Science in Nancy (France) organised by Marianne Conin, science festival in Barcelona (Spain), organised by Maria José Jurado, and an open day at Our Dynamic Earth in Edinburgh (UK) organised by Carol Cotterill, Alan Stevenson and Sophie Green from ESO.

<http://www.ecord.org/resources/core-replicas/>

ECORD online

Conveying information to the science community and the wider public is mandatory during major ECORD/IODP events. ECORD continues to share information via ECORD Headlines -



Front pages of the renewed ECORD website, left, and ECORD web app.

<http://www.ecord.org/outreach/headlines/>, and news posts and photos on its official social media outlets on Twitter - @ECORD_Outreach and @ESO_Outreach and Facebook - [essac.ecord](#) and [ESO-outreach](#). During Expedition 364 the ESO Facebook page reached 20,000 visitors on 7 May 2016. An expedition blog was maintained throughout both the offshore and onshore phases of Expedition 364 and received 5,982 views in April and 10,911 in May, principally from the USA, the UK, Mexico, Germany and France. <https://esoexpedition364chicxulubimpactcrater.wordpress.com/>

An important task completed by the E-OETF was the entire renewal of the **ECORD website** - <http://www.ecord.org/>. After nine months of work in collaboration with a French web company, COSIWEB, the new ECORD website was launched on 19 September 2016. The new website provides information as a single portal for all ECORD entities and has a mobile-friendly responsive layout ([above left](#)). The use of mobile platforms, such as the new ECORD web app ([above right](#)) will help make information more widely available and also enable outreach staff to capture details of interested parties more easily when attending conferences. Since the launch of the new website and the webapp, 210 new subscribers have joined the ECORD mailing.

Related websites:

<http://www.ecord.org/outreach/>
<http://www.ecord.org/resources/>



Media day onboard L/B Myrtle during Expedition 364 Chicxulub K-Pg Impact Crater Expedition (photo D. Smith, ECORD/IODP).

 @ECORD_Outreach

 ESSAC ECORD

 ECORDES channel



+10M USD
at the end of 2016

85% of the
ECORD budget
for operational
costs

>7M USD
annually to
implement MSP
expeditions

The drillstring below L/B *Myrtle* during the Chicxulub K-Pg Impact Crater Expedition (photo D. Smith, ECORD/IODP).

9. FY16 and FY17 budgets

ECORD

- FY2016 ECORD budget**

ECORD is currently funded exclusively by 15 member countries.

In FY16, the total ECORD budget provided by 16 members amounted to 17.625M USD (*below*), showing a decrease of 35K USD compared to the FY15 budget. Since 2014, the ECORD budget has decreased by 1.34M USD, mainly due to strong fluctuations in exchange rates between the US Dollar and the national currency contributions impacting the contributions of five ECORD countries (France, UK, Denmark, Spain and Ireland) .

The ECORD budget is seen as a minimum budget due to the opportunity for members to make direct cash and/or in-kind contributions (IKC) that allow them to increase their contributions to ECORD on a *ad-hoc* expedition by expedition basis.

The contributions to the ECORD budget are unevenly distributed between the member countries, ranging from 5.6M USD to 30K USD (*below*). Based on their contributions, each

Austria	99,979
Canada	29,954
Denmark*	150,151
Finland	79,954
France*	4,394,436
Germany	5,600,000
Ireland*	111,050
Israel	29,978
Italy	399,923
Netherlands	500,000
Norway	1,099,979
Portugal	90,773
Spain*	168,000
Sweden	527,949
Switzerland	599,964
United Kingdom*	3,751,598
TOTAL	17,625,678

* countries paying their contribution in their own currency

ECORD member country contributions for FY16 (USD).

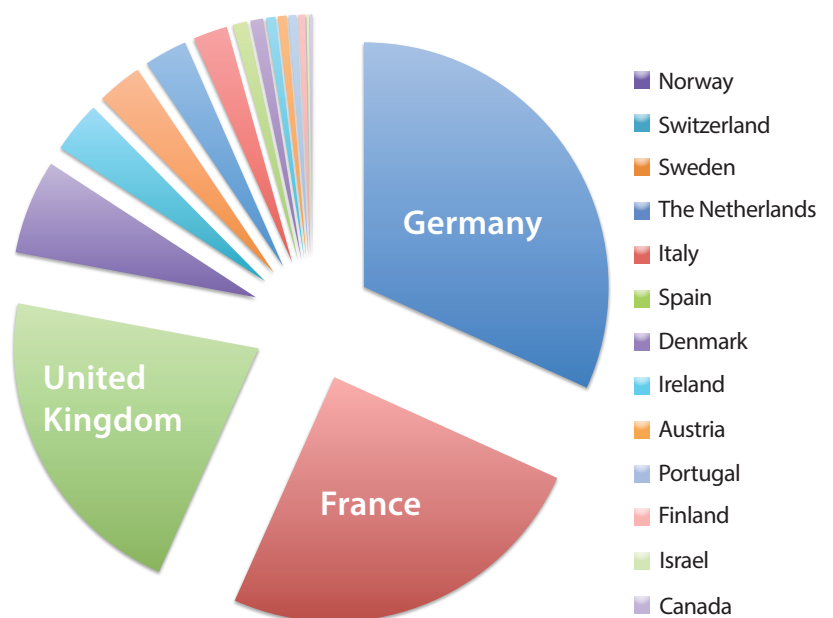
The amount in USD is based on the exchange rate (when applicable) at the time of the payment by the relevant partner.

ECORD member country receives a participation quota for all IODP expeditions (*page 29*). However, the participation of ECORD member countries to the ECORD educational programme (*page 49*) is standard and not based on levels of financial contributions.

The three major ECORD contributors, Germany (5.6M USD), France (4.394M USD) and UK (3.751M USD), provide 78% of the total ECORD budget. The contributions of other member countries range from 30K USD to 1.1M USD. In January 2016, ECORD welcomed back Spain, who withdrew from the Integrated Ocean Drilling Program in 2011. Spain became the 16th ECORD member country with a planned annual contribution of 162K USD. Canada decreased its contribution in 2016 and is seeking new funding sources to ensure its ongoing participation in ECORD. Belgium and Poland did not contribute in 2016 and decided to withdraw from ECORD.

The table *page 62* summarises the ECORD budget for FY16. The expenses are given for comparison.

The ECORD running costs are very stable, amounting to approximately 15% of the member country contributions, leaving 85% of the ECORD budget for direct operational costs, including the implementation of MSP expeditions (Expedition 364 Chicxulub K-Pg Impact Crater in 2016) and a contribution of 7M USD to the National Science Foundation (NSF) to support the *JOIDES Resolution* operations.



Distribution of ECORD member contributions.

ECORD FY16 budget (in USD)			
	FY16 Income	FY16 Expenses	FY15 Expenses
FY15 balance	12,331,661		
FY16 contributions	17,625,678		
ECORD-NSF MoU		7,000,000	7,000,000
ECORD-JAMSTEC MoU		0*	0*
ESO		11,904,608	6,040,000
EMA		258,940	296,440
MagellanPlus		78,400	89,000
ECORD Outreach		61,000	58,500
ECORD website		32,750	-
ESSAC		287,130	313,720
Support for SEP Co-Chair		0	85,920
Support for ECORD-ILP Chair		0	12,510
BCR		332,174	264,120
TOTAL	29,957,339	19,955,074	14,160,210
FY16 balance	10,002,265		

Exchange rate: 1€ = 1.12USD

* membership suspended in FY15 and FY16

The ECORD Council decided in March 2015 that it would suspend its membership contribution of the *Chikyu* programme for 2015 and 2016, in light of the delay in the implementation of *Chikyu* expeditions in the International Ocean Discovery Program. However, in October 2016, the ECORD Council decided to resume its annual funding of 1M USD from 2017 towards *Chikyu* operations from 2017 onwards, due to implementation of two *Chikyu* expeditions in 2016.

The ECORD budget shows a positive balance of 10,002,265 USD at the end of 2016 (*table above*) and this sum will be carried forward to the ECORD FY17 budget.

• FY17 ECORD budget

The expected total contributions for FY17 from the 15 ECORD members countries is about 17.216M USD (*table top right*). Italy will increase its annual contribution from 400K to 500K USD; Canada will keep a minimum contribution in 2017 whilst identifying new funding sources; Israel decided to withdraw its membership from ECORD at the end of 2016.

The table *above right* summarises the expected ECORD budget for FY17. The ESO expenses are shown as "pending" whilst a decision is taken regarding the implementation of an MSP expedition in 2017.

Austria	100,000
Canada	30,000
Denmark*	145,000
Finland	80,000
France	4,428,000
Germany	5,600,000
Ireland*	108,000
Italy	500,000
Netherlands	500,000
Norway	1,100,000
Portugal	90,000
Spain*	162,000
Sweden	528,000
Switzerland	600,000
United Kingdom*	3,245,000
TOTAL	17,216,000

* countries paying their contribution in their own currency

ECORD member country contributions for FY17 (in USD).

The amount in USD will be based on exchange rate (when applicable) at the time of the payment by the relevant partner. (1 € = 1.08 USD in this table)

ECORD FY17 budget (in USD)		
	FY17 Income	FY17 Expenses
FY16 balance	10,002,265	
FY 17 contributions	17,216,000	
ECORD-NSF MoU		7,000,000
ECORD-JAMSTEC MoU		1,000,000
ESO		<i>pending</i>
EMA		274,400
MagellanPlus		78,400
ECORD Outreach		63,300
ESSAC		276,783
BCR		313,642
TOTAL	27,218,265	9,006,525
Expected FY17 balance	18,211,740	

Exchange rate: 1€ = 1.08USD

The amounts in USD are subject to exchange rate fluctuations.

Budgets of ECORD Entities

• ECORD Managing Agency (EMA)

The table *page 63* summarises the EMA budget for FY16+ and FY17+ as approved by the ECORD Council in October 2016. Most of the expenses remain stable with the exception of a

slight increase in salaries (+ 7.4%), an increase in the compensation for the EMA Director (+ 8.7%) and a new budget of USD 10,080 to cover the organisation of the ECORD Evaluation Committee and the Expedition 364 Operational Review Committee (ORC). Overall, the EMA FY17 budget anticipates an increase of 4.6% compared to FY16.

EMA budget for FY16 and FY17					
	FY16 €	FY16 USD*	FY17€	FY17 USD*	Variance ** %
Salaries					
Outreach Coordinator	47,000	52,640	47,000	52,640	0
Assistant Director	47,000	52,640	54,000	60,480	14.9
Total	94,000	105,280	101,000	113,120	7.4
Compensation for the Director	46,000	51,520	50,000	56,000	8.7
Travel EMA @ CEREGE	50,000	56,000	50,000	56,000	0
Travel EC (8) and ORC (2)	0	0	9,000	10,080	100
ECORD Meetings	5,000	5,600	5,000	5,600	0
Consumables	5,000	5,600	2,500	2,800	-50
SEP June meetings	7,500	8,400	7,500	8,400	0
MagellanPlus	70,000	78,400	70,000	78,400	0
"Scientific Drilling" journal	3,700	4,140	0	0	-100
Overheads	20,000	22,400	20,000	22,400	0
TOTAL	301,200	337,340	315,000	352,800	+4.6

* 1€ = 1.12 USD (22 September 2015); ** based on the budget in €

- **ECORD Science Support and Advisory Committee (ESSAC)**

The table below summarises the ESSAC budget for FY16+ and FY17+ as approved by the ECORD Council in October 2016.

ESSAC budget for FY16 and FY17			
	FY16 (€)	FY17 (€)	Variance (%)
Salaries			
Science Coordinator (TVÖD E14, 03-12, 2016)	66,686	68,686	3
Science Coordinator ETHZ (01-02,2016)	20,000	0	-100
Compensation for the Chair	50,000	50,000	0
Total salaries/compensation	136,686	118,686	-13.2
Office costs	6,000	6,000	0
Travel			
Chair	15,000	15,000	0
Science Coordinator	6,000	6,000	0
Meetings			
ESSAC May meeting	2,500	2,500	0
ESSAC October meeting	2,500	2,500	0
Travel support for invited speakers to ESSAC meetings	3,000	3,000	0
Travel support for ESSAC Liaison to SEP meetings	0	3,000	100
Conference travel support	3,000	4,000	33.3
Education & Outreach			
Support for ECORD Distinguished Lecturer Programme	10,000	12,000	20
Support for ECORD Summer Schools	30,000	30,000	0
ECORD Training Course	6,500	6,500	0
ECORD Summer School Scholarships	15,000	15,000	0
ECORD Research Grants	16,000	18,000	12.5
Teachers at sea (travel support)	7,500	7,500	0
Total costs excluding salaries	124,000	131,000	5.65
TOTAL	260,686	249,686	-4.2

+Fiscal year covers the period from 1 January - 31 December of the relevant year

- **ECORD Science Operator (ESO)**

The table *below* summarises the expenditure breakdown of ESO for FY16 in US dollars. The table *page 65* summarises the ESO budget for FY 2017.

ESO FY16 expenditure breakdown (in USD)									
	FY16 Annual Program Plan Budget*				FY16 Expenditure				Variance*
	BGS	MARUM	EPC	TOTAL	BGS	MARUM	EPC	TOTAL	
Management and administration	378,219	156,949	264,288	799,456	503,622	140,012	261,788	905,422	-105,966
Personnel	303,219	111,949	188,288	603,456	274,246	99,869	188,288	562,402	41,054
Travel	60,000	30,000	48,000	138,000	10,899	26,762	48,000	85,661	52,339
Supplies	5,000	5,000	9,000	19,000	0	4,460	9,000	13,460	5,540
Shipping	0	0	0	0	646	0	0	646	-646
Communication	0	0	0	0	14,923	0	0	14,923	-14,923
Contractual Services	0	0	0	0	25,771	0	0	25,771	-25,771
Equipment	5,000	5,000	9,000	19,000	327	4,460	7,500	12,287	6,713
Other	5,000	5,000	10,000	20,000	176,811	4,460	9,000	190,271	-170,271
Technical, Engineering and Science Support	8,106,936	1,453,674	1,171,617	10,732,227	8,152,647	1,296,800	1,174,117	10,623,564	108,663
Personnel	638,695	497,412	468,023	1,604,130	565,950	443,734	468,023	1,477,707	126,423
Travel	54,000	54,000	46,000	154,000	111,129	48,172	46,000	205,301	-51,301
Supplies	0	723,102	0	723,102	3,059	645,068	0	648,127	74,975
Shipping	25,000	164,160	16,500	205,660	55,811	146,444	16,500	218,755	-13,095
Communication	0	0	0	0	17,711	0	0	17,711	-17,711
Contractual services	0	0	25,000	25,000	0	0	25,000	25,000	0
Equipment	5,000	0	2,000	7,000	46,632	0	4,500	51,132	-44,132
Other	7,384,241	15,000	614,094	8,013,335	7,352,356	13,381	614,094	7,979,831	33,504
Core Curation	0	70,724	0	70,724	0	63,092	0	63,092	7,632
Personnel	0	57,724	0	57,724	0	51,495	0	51,495	6,229
Travel	0	6,000	0	6,000	0	5,352	0	5,352	648
Supplies	0	2,000	0	2,000	0	1,784	0	1,784	216
Shipping	0	5,000	0	5,000	0	4,460	0	4,460	540
Data Management	121,677	147,025	26,560	295,262	68,315	131,159	26,560	226,034	69,228
Personnel	12,677	125,525	26,560	164,762	25,597	111,979	26,560	164,136	626
Travel	8,000	8,000	0	16,000	0	7,137	0	7,137	8,863
Supplies	6,000	0	0	6,000	0	0	0	0	6,000
Contractual Services	75,000	0	0	75,000	38,211	0	0	38,211	38,789
Equipment	20,000	13,500	0	33,500	4,507	12,043	0	16,550	16,950
Publications	150,000	0	0	150,000	180,087	0	0	180,087	-30,087
Contractual Services	150,000	0	0	150,000	180,087	0	0	180,087	-30,087
Outreach	48,125	24,929	13,280	86,334	100,286	22,239	13,280	135,805	-49,471
Personnel	32,125	16,929	13,280	62,334	75,844	15,102	13,280	104,226	-41,892
Travel	8,000	8,000	0	16,000	19,215	7,137	0	26,352	-10,352
Supplies	8,000	0	0	8,000	2,824	0	0	2,824	5,176
Equipment	0	0	0	0	2,404	0	0	2,404	-2,404
GRAND TOTAL	8,804,957	1,853,301	1,475,745	12,134,003	9,004,957	1,653,301	1,475,745	12,134,003	0

*1 Final budget = Original budget (10,600,000 USD) + ICDP Contribution (784,003 USD) + CT-scan extension (150,000 USD) + 2016 extension (600,000 USD)

- **Bremen Core Repository (BCR)**

The table *below* summarises the BCR budget for FY16⁺ and FY17⁺ as approved by the ECORD Council in October 2016.

BCR budget for FY16 and FY17					
	FY16*		FY17**		Variance ***
	€	USD	€	USD	%
Salaries					
Personnel (1.6 FTE)	160,154	184,177	162,777	181,750	-1.3
Student workers	10,000	11,500	6,500	7,280	-35
Travel	2,500	2,875	2,500	2,875	0
Supplies	6,000	6,900	3,500	3,920	-41.7
Shipping	12,500	14,375	11,250	12,600	-10
Curation DIS updates	4,165	4,790	3,000	3,360	-28
SEDIS web portal maintenance & service 24/7 (incl. 0.08 FTE)	11,000	12,650	11,000	12,320	0
Indirect costs	82,528	94,907	80,011	89,612	-3
TOTAL	288,847	332,174	280,038	313,642	-3

* 1€ = 1.15 USD; ** 1€ = 1.12 USD; *** based on the budget in €.

- **ECORD Outreach & Education Task Force (E-OETF)**

The table *below* summarises the E-OETF budget for FY16⁺ and FY17⁺ as approved by the ECORD Council in October 2016. There is a slight increase in the total 2017 budget compared to 2016, mostly due to an increase in the cost of exhibition booths at EGU and AGU, the revision of ECORD web tools (information database and web app) and "other costs". This represents more support for both outreach activities and resources. Sponsorship of early-career scientists/students during the Goldschmidt 2017 in Paris is being discussed.

ECORD outreach budget for FY16 and FY17					
	FY16		FY17		Variance**
	€	USD	€	USD	%
Exhibit booths at conferences	16,200	18,144	18,000	20,160	11.1
Publications	12,050	13,496	13,000	14,818	7.9
Overheads	5,000	5,600	3,020	3,427	-39.6
Other costs	6,000	6,720	7,600	8,670	26.7
Shipping	3,300	3,696	4,000	4,480	21.2
Travel	10,500	11,760	10,900	12,298	3.8
TOTAL	53,050	59,416	56,520	63,302	+6.5

* 1€ = 1.12 USD (22 September 2015); ** based on the budget in €

⁺Fiscal year covers the period from 1 January - 31 December of the relevant year



J-FAST core replica
(photo J. Gutierrez Pastor).

10. ECORD participation in IODP panels

The **International Ocean Discovery Program (IODP)** is composed of; three platform providers (NSF-USA for *JOIDES Resolution*, MEXT/JAMSTEC - Japan for *Chikyu* and ECORD for MSPs), three facility boards, two IODP advisory panels, a Science Support Office and the IODP Forum. ECORD participation in the IODP entities in 2016 was:

The **JOIDES Resolution Facility Board - JRFB** is the planning forum for expeditions using the *JOIDES Resolution*. **ECORD Members of the JRFB:** Gilbert Camoin (France), Wolfgang Bach (Germany) and Paul Wilson (UK). <http://www.iodp.org/facility-boards#JRFB>

The **Chikyu IODP Board - CIB** is the planning forum for expeditions using the *Chikyu*. **ECORD Members of the CIB:** Gilbert

Camoin (France) and Heinrich Villinger (Germany). <http://www.iodp.org/facility-boards#CIB>

IODP advisory panel: Science Evaluation Panel (SEP) evaluates the scientific objectives and relevance of proposed expeditions using all IODP platforms.

SEP ECORD Members: Rebecca Bell (UK), Steve Bohaty (UK), Calvin Campbell (Canada), Louis Géli (France), Marguerite Godard (France), Marc-André Gutscher (France), Samuel Jaccard (Switzerland), Jens Kallmeyer (Germany), Sebastian Krastel (Germany), Andrew McCaig (UK), Werner Piller (Austria), Michael Riedel (Germany), Heinrich Villinger (Germany). <http://www.iodp.org/facility-boards#SEP>

IODP advisory panel: Environmental Protection and Safety Panel (EPSP) evaluates the environmental protection and safety of proposed expeditions using all IODP platforms.

EPSP ECORD Members: Martin Hovland (Norway), Philippe Lapointe (France), David Long* (UK), Dieter Strack (Germany). <http://www.iodp.org/facility-boards#EPSP>

The **IODP Forum** is the overarching arm of the programme, providing advice to IODP Facility Boards on platform provider activity and giving a forum for the exchange of ideas.

ECORD attendees at the 2016 IODP Forum: Jan Behrmann (Germany), Magnus Friberg (Sweden), Robert Gatliff (UK), Christian Huebscher (Germany), Antony Morris (UK). <http://www.iodp.org/iodp-forum>

* rotating off in 2016



IODP drillships in operation in FY16: from left to right, the *JOIDES Resolution* (photo William Crawford, IODP/TAMU), *Liftboat Myrtle* during Expedition 364 *Chicxulub K-Pg Impact Crater* (photo D. Smith, ECORD/IODP) and the *Chikyu* (© JAMSTEC/IODP).

Contributors



Jan Behrmann
ESSAC Vice-Chair



Gilbert Camoin
EMA Director



Carol Cotterill
ESO Outreach
Manager



Sarah Davies
EPC Manager



Robert Gatliff
ESO Chair



Nadine Hallmann
EMA Assistant Director



Hanno Kinkel
ESSAC Science
Coordinator



Gilles Lericolais
EFB Chair



Lucas Lourens
MagellanPlus Chair



Patricia Maruéjol
EMA Outreach
Coordinator



David McInroy
ESO Science Manager



Sally Morgan
EPC Manager



Ulrike Prange
ESO Media Relations



Ursula Röhl
ESO Curation and Lab
Manager



David Smith
ESO Operations
Manager



Alan Stevenson
ESO Outreach
Manager

List of acronyms

AAPG: American Association of Petroleum Geologists	EMSO: European Multidisciplinary Seafloor Observation	LWD: Logging While Drilling
ACEX: Arctic Coring Expedition	EPC: European Petrophysics Consortium	MARUM: Center for Marine Environmental Sciences, University of Bremen
ADP: Amphibious Drilling Proposal	EPOS: European Plate Observing System	mbsf: metres below sea floor
AESC: Australian Earth Sciences Convention	EPSP: Environmental Protection and Safety Panel	MDP: Multi-phase Drilling Project
AGU: American Geophysical Union	ESA: European Space Agency	MeBo: Meeresboden-Bohrgerät
AMOC: Atlantic Meridional Overturning Circulation	ESCWA: Economic and Social Commission for Western Asia	MEXT: Ministry of Education, Culture, Sports, Science and Technology
ANZIC: Australia-New Zealand IODP Consortium	ESO: ECORD Science Operator	MEXT: Ministry of Education, Culture, Sports, Science and Technology
APL: Ancillary Project Letter	ESSAC: ECORD Science Support and Advisory Committee	MoU: Memorandum of Understanding
ASC: Antarctic Support Contract	ETH: Eidgenössische Technische Hochschule	MSCL: Multi-Sensor Core Logger
AWI: Alfred-Wegener-Institute	FAPESP: Fundação de Amparo à Pesquisa do Estado de São Paulo	MSP: Mission-specific platform
BCR: Bremen Core Repository	FTE: Full-time equivalent	NanTroSEIZE: Nankai Trough Seismogenic Zone Experiment
BEM: Brazilian Equatorial Margin	FY: Fiscal Year	NERC: Natural Environment Research Council
BFS: Bend-fault serpentization	GCR: Gulf Coast Repository	NOC: National Oceanography Centre
BGS: British Geological Survey	GEOMAR: Helmholtz Centre for Ocean Research Kiel	NSF: National Science Foundation
CAPES: Coordenação de Aperfeiçoamento de Pessoal de Nível Superior	GFZ: Deutsches GeoForschungsZentrum	OGS: Istituto Nazionale di Oceanografia e Geofisica Sperimentale
CDEX: Center for Deep Earth Exploration	GRI: Global Research Infrastructures	ODP: Ocean Drilling Program
CEREGE: Centre Européen de Recherche et d'Enseignement des Géosciences de l'Environnement	H2020: Horizon 2020	ORC: Operational Review Committee
CIB: <i>Chikyu</i> IODP Board	ICDP: International Continental Scientific Drilling Program	OSP: Onshore Science Party
CNRS: Centre National de la Recherche Scientifique	ICSU: International Council for Science	PAIS: Past Antarctic Ice Sheet Dynamics
CORK: Circulation Obviation Retrofit Kit	lfremer: French Research Institute for Exploitation of the Sea	PETM: Paleocene-Eocene Thermal Maximum
CPP: Complementary Project Proposal	IGC: International Geological Congress	QA/QC: Quality assurance/quality control
CT: Computed Tomography	IGSN: International Geo Sample Number	QNLN: Qingdao National Laboratory for Marine Science and Technology
DEDI: Distributed European Drilling Infrastructure	IKC: In-kind contribution	RD2: Rockdrill2
DEISM: Distributed European Infrastructure for Subseafloor Sampling and Monitoring	INSU: National Institute of Sciences of the Universe	RWTH: Rheinisch-Westfälische Technische Hochschule
DIS: Drilling Information System	IOC: Intergovernmental Oceanographic Commission	SaDR: Sample and Data Request
DLP: Distinguished Lecturer Programme	IODP: Integrated Ocean Drilling Program (2003-2013) & International Ocean Discovery Program (2013-2023)	SCAR: Scientific Committee on Antarctic Research
DONET: Dense Oceanfloor Network System for Earthquakes and Tsunamis	IPCC: Intergovernmental Panel on Climate Change	SEDIS: Scientific Earth Drilling Information Service
DOSECC: Drilling, Observation and Sampling of the Earth's Continental Crust	IPG: Institut de Physique du Globe	SEP: Science Evaluation Panel
DSDP: Deep Sea Drilling Project	IPMA: Instituto Português do Mar e da Atmosfera	SOR: School of Rock
DS3F: Deep-Sea and Sub-Seafloor Frontiers Initiative	ISOLAT: Integrated Southern Ocean Latitudinal Transects	USSP: Urbino Summer School in Paleoclimatology
E-EB: ECORD Executive Bureau	IWT: Intermediate Water Temperature	TAMU: Texas A & M University
E-ILP: ECORD Industry Liaison Panel	JAMSTEC: Japan Agency for Marine-Earth Science and Technology	VSP: Vertical Seismic Profile
E-OETF: ECORD Outreach & Education Task Force	JOIDES: Joint Oceanographic Institutions for Deep Earth Sampling	SST: Sea-Surface Temperature
E-VTF: ECORD Vision Task Force	JR: <i>JOIDES Resolution</i>	TVÖD: Tarifvertrag für den Öffentlichen Dienst
EAGE: European Association of Geologists & Engineers	JR-FB: <i>JOIDES Resolution</i> Facility Board	UNESCO: United Nations Educational, Scientific and Cultural Organization
EC: European Commission	JRSO: <i>JOIDES Resolution</i> Science Operator	USSP: Urbino Summer School in Paleoclimatology
ECORD: European Consortium for Ocean Research Drilling	KCC: Kochi Core Center	USSSP: U.S. Science Support Program
EEC: ECORD Evaluation Committee	K-Pg: Cretaceous–Paleogene	VSEGEI: A.P. Karpinsky Russian Geological Research Institute
EFB: ECORD Facility Board	LTBMS: Long-Term Borehole Monitoring System	VSP: Vertical Seismic Profiling
EGU: European Geosciences Union		WAIS: West Antarctic Ice Sheet
EMA: ECORD Managing Agency		WD: Water depth
		WPWP: Western Pacific Warm Pool



FY16 ECORD Members

Austria: Österreichische Akademie der Wissenschaften (ÖAW)

Denmark: Forsknings- og Innovationsstyrelsen

Canada: Université du Québec à Montréal - Centre GEOTOP-UQAM-McGill

Finland: Suomen Akatemia

France: Institut National des Sciences de l'Univers - Centre National de la Recherche Scientifique (INSU-CNRS)

Germany: Deutsche Forschungsgemeinschaft (DFG)

Ireland: The Geological Survey of Ireland (GSI)

Israel: Mediterranean Sea Research Center of Israel (MERC I)

Italy: Consiglio Nazionale delle Ricerche (CNR)

Netherlands: Nederlandse Organisatie voor Wetenschappelijk Onderzoek (NWO)

Norway: Forskningsrådet

Portugal: Fundação para a Ciência e a Tecnologia (FCT)

Sweden: Vetenskapsrådet (VR)

Switzerland: Fonds National Suisse (FNS)

United Kingdom: Natural Environment Research Council (NERC)

<http://www.ecord.org>

