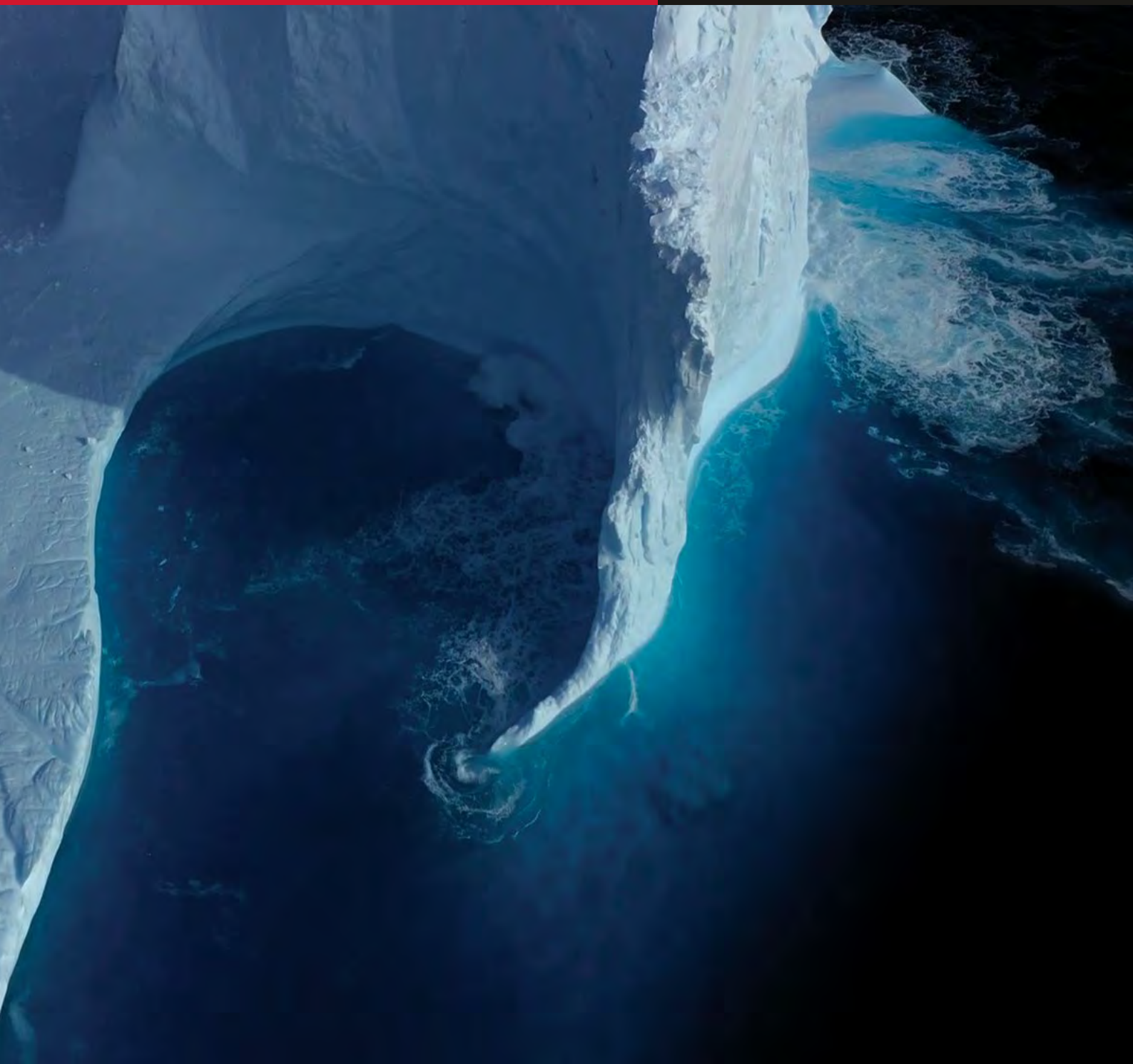
ECORD

EUROPEAN CONSORTIUM FOR
OCEAN RESEARCH DRILLING

ANNUAL REPORT 2019



From 2003 to 2013, the European Consortium for Ocean Research drilling (ECORD) was part of the Integrated Ocean Drilling Program (IODP-1 2003-2013), which became the International Ocean Discovery Program in October 2013.

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-1 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-2), 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.

ECORD funds and implements MSP operations for IODP as an independent platform provider, with the aim to carry out high-profile expeditions and to maintain the implementation of one expedition per year if funding allows for the duration of the 2013-2023 programme. 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 2019, ESO has successfully managed three expeditions to the Atlantis Massif, the Chicxulub Impact Crater and the Rift of Corinth.

ECORD makes 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: Bird's-eye view of an iceberg during IODP Expedition 379 (photo taken by a drone, credit: ECORD/IODP).

Published by the ECORD Managing Agency (EMA) - March 2020.
Layout and design: Malgo Bednarz (EMA Outreach Officer).
www.ecord.org

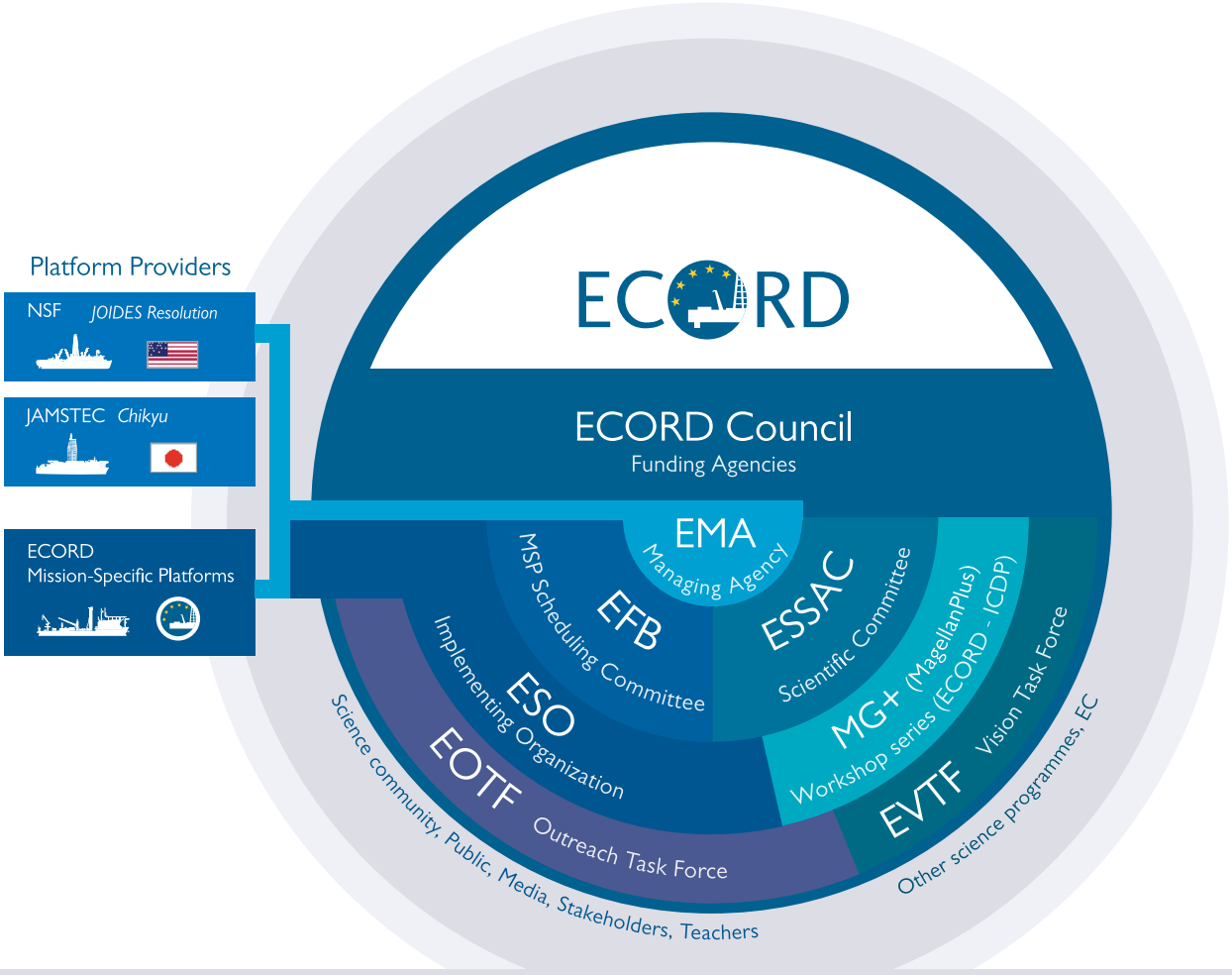
ECORD
EUROPEAN CONSORTIUM FOR OCEAN RESEARCH DRILLING

ECORD Annual Report 2019

1 January 2019 - 31 December 2019

Table of Contents

ECORD entities



2019 ECORD Member Countries

Austria	1	Österreichische Akademie der Wissenschaften (ÖAW)
Canada	2	Canadian Consortium for Ocean Drilling (CCOD)
Denmark	3	Danish Agency for Science and Higher Education (DAFSHE)
Finland	4	Suomen Akatemia
France	5	Centre National de la Recherche Scientifique (CNRS)
Germany	6	Deutsche Forschungsgemeinschaft (DFG)
Ireland	7	The Geological Survey of Ireland (GSI)
Italy	8	Consiglio Nazionale delle Ricerche (CNR)
Netherlands	9	Nederlandse Organisatie voor Wetenschappelijk Onderzoek (NWO)
Norway	10	Forskningsrådet
Portugal	11	Fundação para a Ciência e a Tecnologia (FCT)
Spain	12	Ministerio de Economía y Competitividad (MINECO)
Sweden	13	Vetenskapsrådet (VR)
Switzerland	14	Fonds National Suisse de la Recherche Scientifique (FNS)
United Kingdom	15	United Kingdom Research and Innovation (UKRI)

EUROPEAN CONSORTIUM FOR OCEAN RESEARCH DRILLING

As defined in the ECORD Memorandum of Understanding, ECORD includes **five entities** (ECORD Council, ECORD Managing Agency – EMA, ECORD Facility Board – EFB, ECORD Science Operator – ESO, ECORD Science Support and Advisory Committee - ESSAC) , **two task forces** (ECORD Vision Task Force - EVTF and ECORD Outreach Task Force - EOTF) and **a workshop programme** (MagellanPlus Workshop Series Programme – MG+) (diagram on previous page).

www.ecord.org *ema@cerege.fr* @ECORD_IODP ECORD_IODP ECORD IODP

ECORD Council

www.ecord.org/about-ecord/management-structure/council/

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

Chair	**Eric Humler** then **Stéphane Guillot** (France; 1 January to 31 December 2019)
Outgoing Vice-Chair	**Guido Lüniger** (Germany; 1 January to 30 June 2019)
Incoming Vice-Chair	**Bernard Westerop** (The Netherlands; 1 July to 31 December 2019)

Council Core Group	**Eric Humler** then **Stéphane Guillot** (France) **Guido Lüniger** (Germany) **Bernard Westerop** (The Netherlands) **Marco Sacchi** (Italy) **Michael Webb** (UK)

Eric Humler

ECORD Council Chair 2019

Eric Humler is geologist-geochemist. He did his PhD in petrology and geochemistry of oceanic and continental basalts at the University of Strasbourg. In 2004, Eric became professor at the University of Nantes and directed the Laboratory of Planetology and Geodynamics. In 2013, he was nominated as Research Director at the École des Mines de Nantes, a French high-level engineering school, where he coordinated the research of five laboratories in informatics, robotics, environmental engineering, nuclear physics, and human and social sciences. Since 2015, he is Deputy Scientific Director at the INSU-CNRS (Institut National des Sciences de l'Univers-Centre National de la Recherche Scientifique) where he is in charge of the research field Solid Earth. Furthermore, he is member of a CNRS mission for transversal and interdisciplinary projects (Mission pour les Initiatives Transverses et Interdisciplinaires du CNRS). Eric was appointed as ECORD Council Chair in January 2019.

Stéphane Guillot

ECORD Council Chair 2019

Stéphane Guillot is a senior research scientist at the CNRS (Centre National de la Recherche Scientifique) and works since 2005 at Grenoble-Alpes University in Saint-Martin-d'Hères, France. Since 2007, he works at the Institute of Earth Sciences (ISTerre), which is a joint research unit of the CNRS, Grenoble-Alpes University, the University of Savoie Mont Blanc, the IRD (Institut de recherche pour le développement) and IFSTTAR (Institut français des sciences et technologies des transports, de l'aménagement et des réseaux). Stéphane is former director of ISTerre (2015-2019) and he is now Deputy Director of the Institut National des Sciences de l'Univers (INSU-CNRS). He is geologist and specialist in convergence zones, and his study regions include the Alpes, Variscides, Himalaya, Tibet, Tian Shan, Pamir, Antarctica, Australia, West Africa, Oman, North Andes and the Caribbean. He has authored about 140 peer-reviewed papers and supervised 25 PhD students. Stéphane was appointed as ECORD Council Chair in October 2019.

EMA (ECORD Managing Agency)

www.ecord.org/about-ecord/management-structure/ema/

Director	**Gilbert Camoin** (CEREGE, France)
Assistant Director	**Nadine Hallmann** (CEREGE, France)
Outreach Officer	**Malgo Bednarz** (CEREGE, France)
Administrator	**Patricia Rieu** (CEREGE, France)

ECORD Managing Agency

EMA is the management entity of ECORD. EMA is in charge of: the management of the ECORD budget and the contracts with ECORD partners, the representation of ECORD in all IODP entities and the link between these entities and the ECORD members.

Gilbert Camoin
EMA Director

Gilbert Camoin, PhD, DSc, is a senior research scientist at the CNRS (Centre National de la Recherche Scientifique) and works currently at the CEREGE (Centre Européen de Recherche et d'Enseignement de Géosciences de l'Environnement) in Aix-en-Provence, France. His major research activities are mainly focused on the records of sea-level, environmental and climatic changes by coral reefs and other carbonate systems. He has authored 150 peer-reviewed papers and supervised 11 PhD students and eight post-docs.
Gilbert sailed on ODP Leg 144 and several other cruises, was then lead PI of Proposal 519 and Co-chief Scientist on IODP Expedition 310. He served as Chair of the ODP/IODP-1 Environment Science Steering Evaluation Panel (2001-2005), Chair of the ECORD Science Support and Advisory Committee - ESSAC - (2007-2009), Member of the IODP-1 Science Planning Committee (2007-2010), and Member of the IODP-2 Science Plan Writing Committee (2010-2011). He was appointed as Director of the ECORD Managing Agency in January 2012.

ESSAC (ECORD Science Support and Advisory Committee)

www.ecord.org/about-ecord/management-structure/essac/

Chair	**Antony Morris** (Plymouth University, UK)
Vice-Chair	**Jan Behrmann** (GEOMAR, Germany)
Science Coordinator	**Hanno Kinkel** (Plymouth University, UK)

ECORD ESSAC

ESSAC is the ECORD science committee and is responsible for the scientific planning and coordination of ECORD's contribution to IODP. ESSAC aims at maximising the scientific and technological contribution of ECORD to IODP, as well as promoting appropriate representation of the ECORD scientific community in the IODP Science Advisory Structure.

Antony Morris
ESSAC Chair

Antony Morris is professor of Geophysics and Geodynamics at the School of Geography, Earth and Environmental Sciences at the University of Plymouth. He uses geophysical magnetic methods to investigate fundamental crustal processes. The main focus of his research has been the magnetic analysis of samples of oceanic lithosphere recovered from the world's oceans by the International Ocean Discovery Program and innovative investigations of major ophiolites (slices of oceanic lithosphere that have been emplaced tectonically on to land). He has sailed five times on the *JOIDES Resolution* (IODP Expeditions 304/305, 335, 345, 351, 360) and once on the *RRS James Cook* (part of the UK research fleet, cruise JC21 for IODP Proposal #551). He was appointed as ESSAC Chair in January 2018.

ESO (ECORD Science Operator)

www.ecord.org/about-ecord/management-structure/eso/

David McInroy
ESO Science Manager

David McInroy is Team Leader for Ocean Geoscience at the British Geological Survey in Edinburgh, UK, and is tasked with progressing deep-sea geoscientific research within the BGS Marine Geoscience Directorate. David is a geologist and geophysicist with a research background in the evolution and hydrocarbon prospectivity of the UK's Atlantic Margin, and has participated in geophysical data acquisition cruises on the UK's continental shelf. From 2003-2010, David was Expedition Project Manager for IODP Expeditions 302, 310 and 313, and since 2010 has held the role of ESO Science Manager.

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. 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, hosted at the IODP Bremen Core Repository (**BCR**) and laboratories of the University of Bremen. EPC comprises two European universities: University of Leicester (UK, lead partner) and University of Montpellier (France). 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).

Science Manager	**David McInroy** (BGS, UK)
Operations Manager	**Dave Smith** (BGS, UK)
Expedition Project Managers	**Gareth Carter** (BGS, UK) **Jeremy Everest** (BGS, UK) **Sophie Green** (BGS, UK, until April 2019)
EPC Manager	**Sarah Davies** (University of Leicester, UK)
EPC Administrator & Project Manager	**Simon Draper** (University of Leicester, UK)
Petrophysics Staff Scientists	**Johanna Lofi** (University of Montpellier, France) **Erwan Le Ber** (University of Leicester, UK) **Katharina Hochmuth** (University of Leicester, UK, since February 2019)
Curation and Laboratory Manager	**Ursula Röhl** (MARUM, Germany)
Assistant Laboratory Manager	**Patrizia Geprägs** (MARUM, Germany)
BCR Superintendent	**Holger Kuhlmann** (MARUM, Germany)
Data Managers	**Vera Bender** (MARUM, Germany) **Mary Mowat** (BGS, UK)
Outreach Manager	**Carol Cotterill** (BGS, UK)
Media Relations	**Ulrike Prange** (MARUM, Germany)

EFB (ECORD Facility Board)

www.ecord.org/about-ecord/management-structure/efb/

Chair	**Gabriele (Gabi) Uenzelmann-Neben** (AWI, Germany)
Vice-Chair	**Gilles Lericolais** (Ifremer, France)
Members of the Science Board	**Gretchen Früh-Green** (ETH Zurich, Switzerland) **Ellen Thomas** (Yale University, USA) **Yasuhiro Yamada** (JAMSTEC, Japan) **FengPing Wang** (Shanghai JiaoTong University, China)

Gabriele Uenzelmann-Neben
ECORD Facility Board Chair

Gabriele Uenzelmann-Neben is senior scientist at the Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI) in Bremerhaven, Germany. As a Geophysicist her research interests include continental margins, geophysics of the polar regions, sediment transport processes, glaciomarine sedimentation, reconstruction of sedimentary environments, climate and oceanic circulation using the high-resolution seismic imaging of sedimentary structures, large igneous provinces LIPs (formation and impact on climate and circualtion) and seismic reflection data. Gabi participated in more than 20 cruises as team leader and eight as chief scientist, and has published more than 80 peer-reviewed papers. She was member of the IODP Site Evaluation Panel (2010-2015) and she was ECORD Distinguished Lecturer from 2014 to 2016. Gabi was appointed as EFB Chair in January 2019.

ECORD Facility Board

EFB is the key 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, through operational and management oversight of MSP expeditions. EFB is composed of the ECORD Vision Task Force (EVTF) and a Science Board.

EVTF (ECORD Vision Task Force)

EVTF is the ECORD strategic entity in charge of developing a long-term scientific and funding strategy, and monitoring the ECORD progress toward the completion of the IODP Science Plan.
The EVTF is composed of the ECORD Council Core Group (see Section B2.4), the Director and the Assistant Director of EMA, the Chair of ESSAC, the Chair and the Science Manager of ESO and the Chair of the EFB.

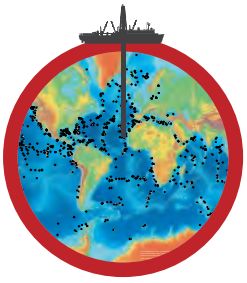
EOTF (ECORD Outreach Task Force)

ECORD Outreach Task Force

The **EOTF** coordinates ECORD communication tasks, such as outreach/public information and educational activities related to IODP in ECORD countries.
EOTF is composed of the EMA Outreach Officer (Chair) and Assistant Director, the ESO Outreach and Media Relations Managers and the ESSAC Science Coordinator. The EMA Director and the ESSAC Chair act as observers.

MG+ (MagellanPlus Workshop Series)

www.ecord.org/science/magellanplus/



ECORD EUROPEAN CONSORTIUM FOR OCEAN RESEARCH DRILLING

icdp

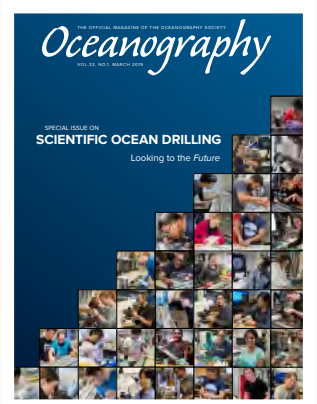
MG+ is designed to support ECORD scientists in developing new and innovative science proposals to meet the IODP Science Plan challenges.

This programme is co-funded by ECORD and the International Continental Scientific Drilling Program (ICDP).

IODP in press and media

SCIENTIFIC OCEAN DRILLING: Looking to the Future

Special Issue of ***Oceanography*** Volume 32 | Number 1 | March 2019



This special issue of *Oceanography* celebrates the more than 50 years of exploring and investigating the subseafloor of the world's ocean that was initiated in 1968. Since then, scientific ocean drilling has transformed into an international programme uniting more than 26 countries under a common scientific banner.

Through the last 50 years, the programme has evolved from DSDP (Deep Sea Drilling Project, 1968–1983), through Ocean Drilling Program (ODP, 1985–2003), the Integrated Ocean Drilling Program (IODP, 2003–2013) and finally into the current International Ocean Discovery Program (IODP, 2013–2023). To date, the four programmes have recovered more than 490 km of core and engaged more than 5,000 scientists from around the world.

Scientific results from the analysis of the cores and geophysical data provided by scientific ocean drilling gave rise to more than 11,000 peer-reviewed publications, including more than 500 in the leading Nature and Science journals.

Open access volume. Download the full issue: *https://tos.org/oceanography/issue/volume-32-issue-01*

THE FIRST DAY OF THE CENOZOIC

New publication on Expedition 364

The Proceedings of the National Academy of Sciences Volume 116 | Issue 39 | Sept 2019

Sean P. S. Gulick et al., The first day of the Cenozoic, The Proceedings of the National Academy of Sciences (PNAS) - September 2019 116 (39) 19342-19351; *https://doi.org/10.1073/pnas.1909479116*

See also:
'What Happened the Day a Giant, Dinosaur-Killing Asteroid Hit the Earth' at Smithsonian.com (*link*)
'Last day of the dinosaurs' reign captured in stunning detail' in National Geographic (*link*)

ECORD and IODP meetings and conferences

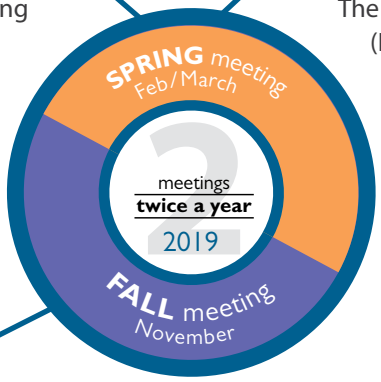
The table on the next page summarizes the ECORD and IODP meetings that have been held in 2019, as well as the two major conferences (EGU in Vienna and AGU in San Francisco) where IODP-related scientific sessions and booths have been organized.

ECORD Council meetings

The **ECORD Council** meets twice a year: a spring meeting involving the Council and the members of the EVTF, and a fall meeting jointly with ESSAC involving representatives of all ECORD entities as well as representatives from IODP partners (funding agencies, operators and science committees) and collaborating science programmes.

EOTF meetings

The **ECORD Outreach Task Force** (EOTF) meets twice a year, in February/March and in fall. Outreach liaisons from the US Science Support Program, JAMSTEC (Japan) and ICDP usually attend the EOTF fall meeting.



ESSAC meetings

ESSAC meets twice a year: a spring meeting involving ESSAC Delegates and EMA and ESO representatives, and a fall meeting jointly with the ECORD Council.

EFB meeting

The **ECORD Facility Board** (EFB) meets once a year. Liaisons from ECORD entities and representatives from IODP partners (funding agencies, operators and science committees) attend the EFB meetings.

ECORD representatives at IODP meetings

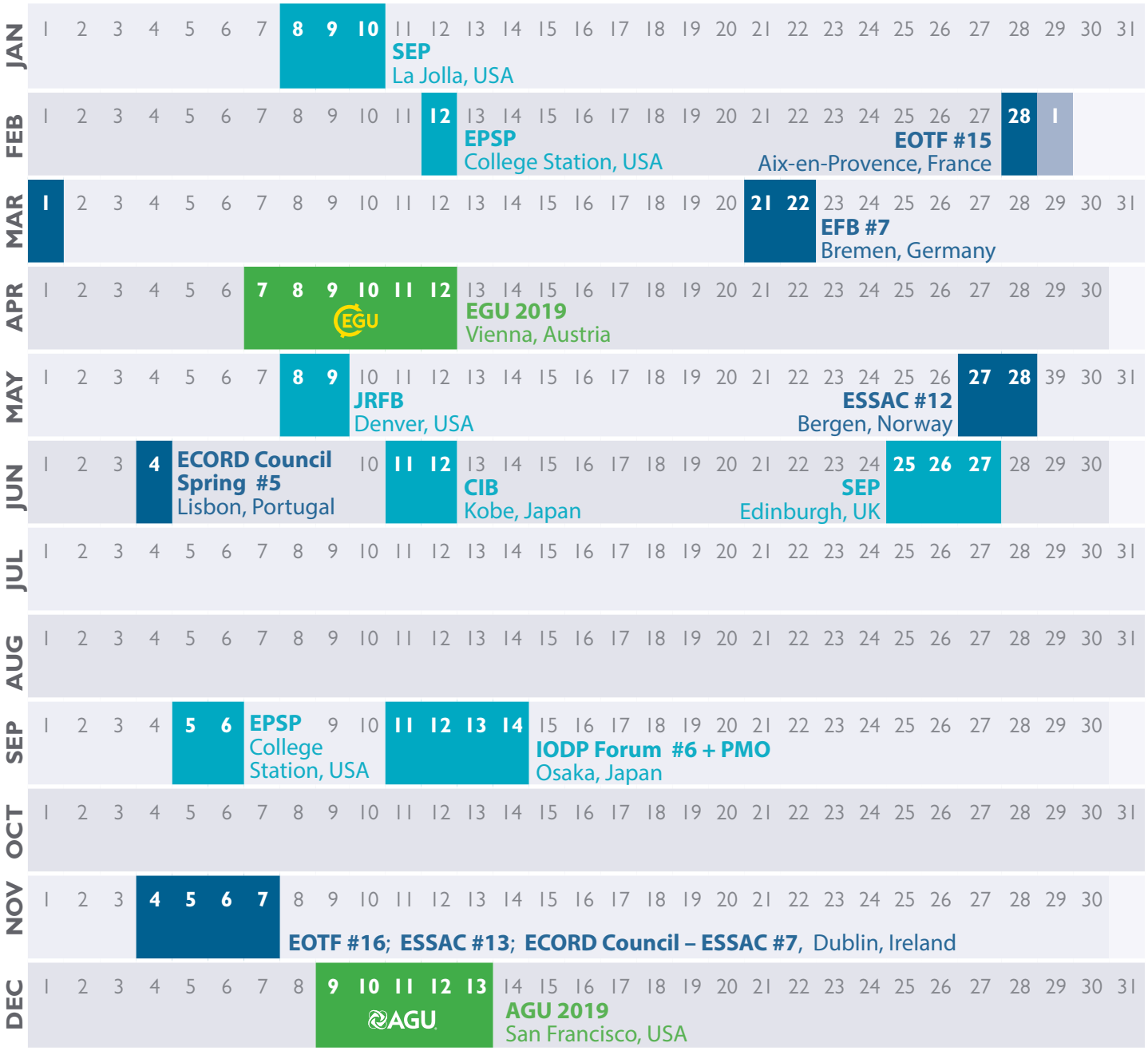
ECORD representatives act as members and/or liaisons to meetings of IODP entities:

- the *JOIDES Resolution* Facility Board (JRFB),
- the *Chikyu* IODP Board (CIB),
- the Science Evaluation Panel (SEP),
- the Environmental Protection and Safety Panel (EPSP),
- the IODP Forum.

See 10. ECORD representatives on IODP panels, page 106.

www.ecord.org/contact-ecord/ *ema@cerege.fr*

ECORD / IODP meetings and conferences 2019 calendar



ECORD meetings IODP meetings International conferences

Figure summarizing the ECORD and IODP meetings that have been held in 2019, as well as the two major conferences (EGU in Vienna and AGU in San Francisco) where IODP-related scientific sessions and booths have been organised.

Acronyms:
AGU - American Geophysical Union, CIB - *Chikyu* IODP Board, EFB - ECORD Facility Board, EGU - European Geosciences Union, EOTF - ECORD Outreach Task Force, EPSP - Environmental Protection and Safety Panel, JRFB - *JOIDES Resolution* Facility Board, SEP - Science Evaluation Panel.

http://www.ecord.org/events-calendar/

1. FY2019 highlights

The vibration isolated television (VIT) camera is lowered through the moonpool during IODP Expedition 379 (photo M. Iwai, IODP).

1. FY2019 highlights

Since its creation in 2003, ECORD has developed a unique European distributed research infrastructure that connects research facilities at multiple sites across Europe and Canada that are engaged in multidisciplinary aspects of subsurface scientific research and have a longstanding culture of cooperation on science, technology and education.

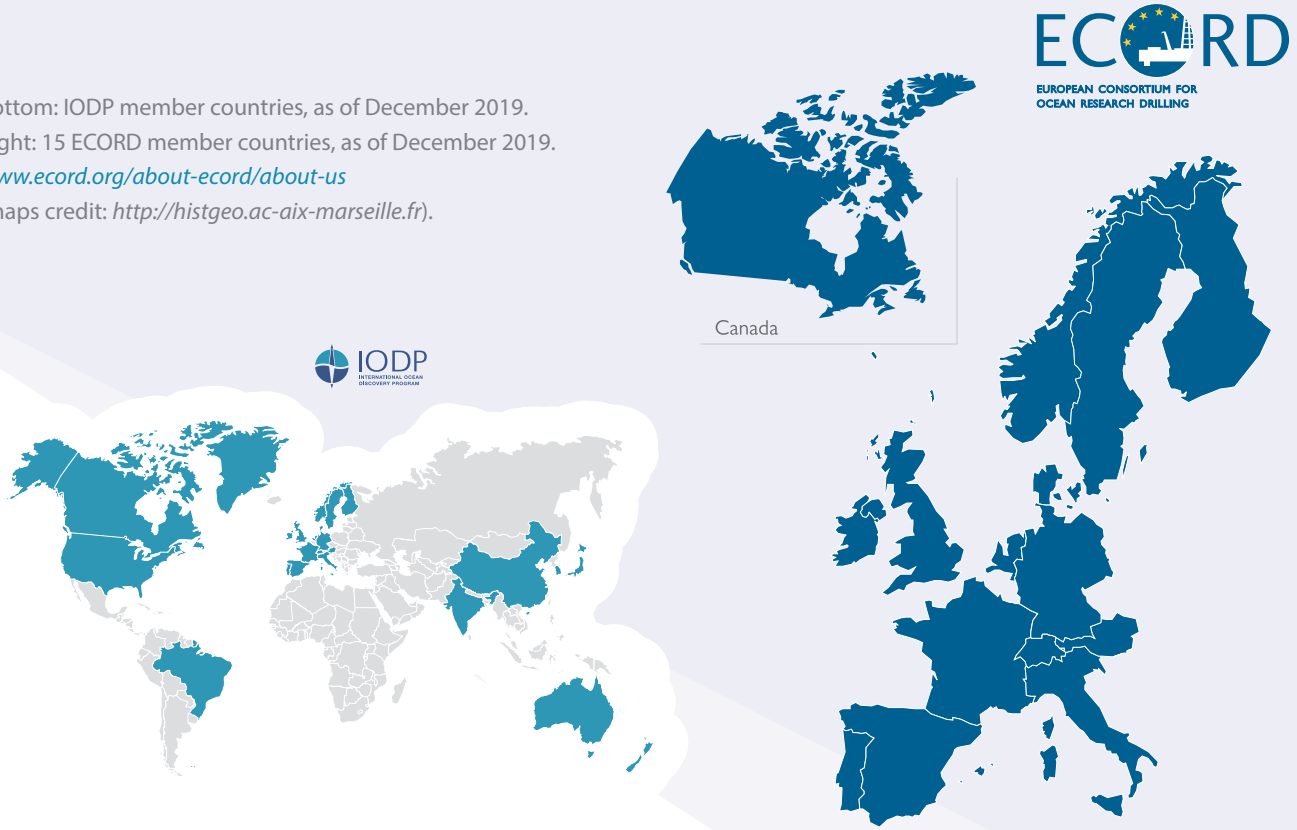
ECORD combines research, education and innovation and offers a unique portfolio of science and educational activities, world-class capabilities, state-of-the-art technology and remarkable knowledge-based resources to the European and Canadian Earth and environmental science community. This portfolio has been significantly enriched since the start of the International Ocean Discovery Program in order to better serve the European and Canadian science communities.

ECORD has now formally entered the second phase (2019-2023) of IODP. The 2019-2023 ECORD Memorandum of Understanding (MoU) has been signed by the 15 current ECORD members. In parallel, ECORD has developed concrete operational plans for the next mission-specific platform (MSP) expeditions and started to plan efforts designed to shape the future of scientific ocean drilling beyond 2023. This transition also included the finalization of an updated version of the ECORD MoU and the revision of the MoU between ECORD and the US National Science Foundation (NSF). The MoU linking ECORD and the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) involves the two partners for the whole duration of the current programme.

In 2019, ECORD has made significant efforts to attract new members. An 'ECORD-IODP Day' has been organized on 3 October 2019 in Athens, Greece, and formal exchanges of information have been established with Croatian scientists who expressed interest in joining the consortium. In parallel, three former ECORD members – Belgium, Israel and Poland - were contacted by the ECORD Managing Agency (EMA) to explore the opportunity for them to join ECORD again.

This Annual Report demonstrates that the ECORD science community is very healthy, especially through its leading role in the submission of drilling proposals, its massive and sustained participation to IODP expeditions and in the publication and promotion of cutting-edge results related to the successive ocean drilling programmes, as well as in its involvement in the building of a future scientific ocean drilling programme.

Bottom: IODP member countries, as of December 2019.
Right: 15 ECORD member countries, as of December 2019.
www.ecord.org/about-ecord/about-us
(maps credit: *http://histgeo.ac-aix-marseille.fr*).



ECORD budget

ECORD is currently funded exclusively by its 15 members. In FY19, the total ECORD budget amounted to $16.887M, showing a decrease of about $300K compared to the FY18 budget (see section 9. on page 94).

Since 2014, the ECORD budget decrease is of $2M (excluding inflation), mainly due to strong fluctuations in exchange rates between the US Dollar and the national currency contributions of five ECORD countries (France, UK, Denmark, Spain and Ireland). Over the last ten years, the ECORD budget has decreased by about $5M (excluding inflation).

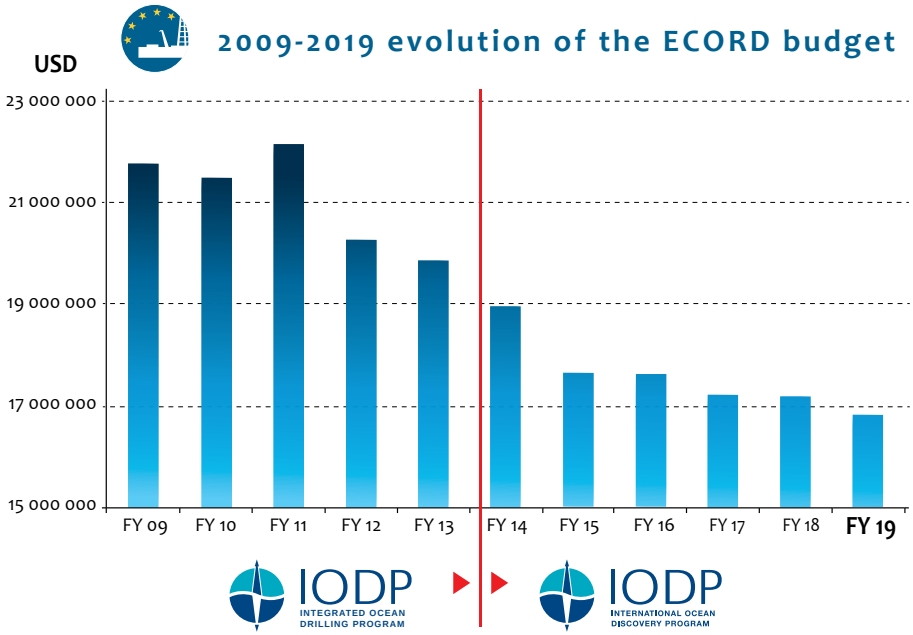


Chart illustrating 2009-2019 evolution of the ECORD budget

The ECORD running costs were very stable in 2019, amounting to approximately 5% of the members' contributions. With an expected stable budget during the second phase of the programme, more than 95% of which being dedicated to the funding of IODP expeditions, ECORD has been able to build concrete plans for 2019-2023 (see sections 2. and 3., pages 32 and 38 respectively).

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 an ad-hoc / expedition by expedition basis, in exchange of extra science party positions. IKC correspond to direct operational facilities and services that the ECORD Science Operator (ESO) would normally pay for.

The contributions to the ECORD budget are unevenly distributed between its members, ranging from $5.6M to $80K (see section 9. on page 95). The three major ECORD contributors - Germany ($5.6M), France ($3.92M) and the UK ($3.47M) - provide 76% of the total ECORD budget. The contributions of other ECORD members range from $80K to $1.1M.

The ECORD budget shows a positive balance of $18,829,700 at the end of 2019 and this sum will be carried forward to the ECORD FY20 budget.

The ECORD budget shows a positive balance of $ 18,829,700 at the end of 2019 and this sum will be carried forward to the ECORD FY20 budget.

Early morning view from the platform, Expedition 313 (photo A. Fehr, ECORD/IODP).

Mission-specific platform (MSP) expeditions are ECORD's landmark since 2004.

ECORD is one of the three IODP Platform Providers since 2013.

No MSP expedition has been implemented in 2019 due to the postponement of Expedition 398: Hawaiian Drowned Reefs in early 2019 after the preferred bidder pulled out of negotiations for business reasons at a late planning stage (see page 43).

Expedition 386: Japan Trench Paleoseismology

The scheduling of Expedition 386: Japan Trench Paleoseismology (Co-chief Scientists: M. Strasser, ECORD-Austria and Ken Ikehara, Japan) has been approved by the ECORD Council at its 2018 Fall meeting. It will be the fourth full expedition implemented by ECORD for IODP since 2013, after Expedition 357: Atlantis Massif Serpentinization and Life (2015), Expedition 364: Chicxulub Impact Crater (2016) and Expedition 381: Corinth Active Rift Development.

The offshore phase of Expedition 386 will be implemented in Spring 2020 (21 April - 9 June 2020) with the JAMSTEC-operated research vessel *Kaimei*. The Onshore Science Party will be organized on board *Chikyu* docked in Shimizu, as an alternative to the Bremen Core Repository, on 14 October - 13 November 2020.

This expedition aims at reconstructing the Late Pleistocene-Holocene history of giant earthquakes, which are major geological events with catastrophic societal consequences. Expedition 386 is being jointly implemented by ESO and the Institute for Marine-Earth Exploration and Engineering (MarE3) within the Japan Agency for Marine-Earth Science and Technology (JAMSTEC), thus ushering cross collaboration and operational knowledge exchange between IODP operators for the implementation of IODP expeditions. Expedition planning has been mostly carried out in 2019 through regular exchanges between JAMSTEC, ESO and EMA. The R/V *Kaimei* and the D/V *Chikyu*, as well as staff and many elements will be partly provided as an IKC from JAMSTEC.

More on page 34

Expedition 377: Central Arctic Paleoceanography (ArcOP)

In March 2019, the ECORD Facility Board (EFB) proposed Expedition 377: Central Arctic Paleoceanography (ArcOP; Co-chief Scientists: R. Stein, ECORD-Germany and K. St. John, USA) for scheduling. At its last meeting that was held in Dublin, Ireland, on 5-6 November 2019, the ECORD Council has approved the **scheduling of ArcOP in late summer 2021** in light of scientific priorities and budgetary situation.

IKCs from the Swedish Polar Research Institute (SPRS) and the Federal Institute for Geosciences and Natural Resources (BGR) in Hannover were secured, following actions from ESO and EMA. This expedition, which is considered as a first-priority expedition for ECORD, aims at reconstructing the long-term Cenozoic climate history of the central Arctic Ocean at high resolution, with a special focus on the Neogene and the Pleistocene.

More on page 40

At its next meeting, which will be held in Aix-en-Provence, France, on 24-25 March 2020, the EFB will consider possible ways **to implement additional MSP expeditions before the end of the current programme**, based on the scoping by ESO.

ECORD partnership: *JOIDES Resolution* and *Chikyu* 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.

JOIDES Resolution expeditions

ECORD, as a contributing member of the *JOIDES Resolution* Consortium, was entitled to eight scientists on every expedition until 30 September 2019 and to seven scientists since 1 October 2019, based on the new ECORD-NSF MoU that was signed in 2019.

Thirty-seven ECORD scientists, including three Co-chief Scientists - all of them from Germany - and 40% of early-career scientists, were invited to participate in four expeditions that were implemented in 2019 by the *JOIDES Resolution* (see table below and section 4., page 48):

1. **Expedition 379: Amundsen Sea West Antarctic Ice Sheet History** (18 January - 20 March 2019) whose primary objective concerned the reconstruction of the Paleogene to Holocene glacial history of West Antarctic Ice Sheet;

2. **Expedition 382: Iceberg Alley and Subantarctic Ice and Ocean Dynamics** (20 March - 20 May 2019) aimed at documenting the first spatially and temporally integrated record of iceberg flux from the Antarctic Ice Sheet into warmer waters;

3. **Expedition 383: Dynamics of Pacific Antarctic Circumpolar Current** (20 May - 20 July 2019) to reconstruct, along a latitudinal transect, the evolution of the Antarctic Ice Sheet through major Late Neogene transitions since the Mid Miocene;

4. **Expedition 385: Guaymas Basin Tectonics and Biosphere** (16 September - 16 November 2019) to unravel chemical and microbial processes, their interactions, and their ultimate consequences for carbon cycling in the Guaymas Basin.

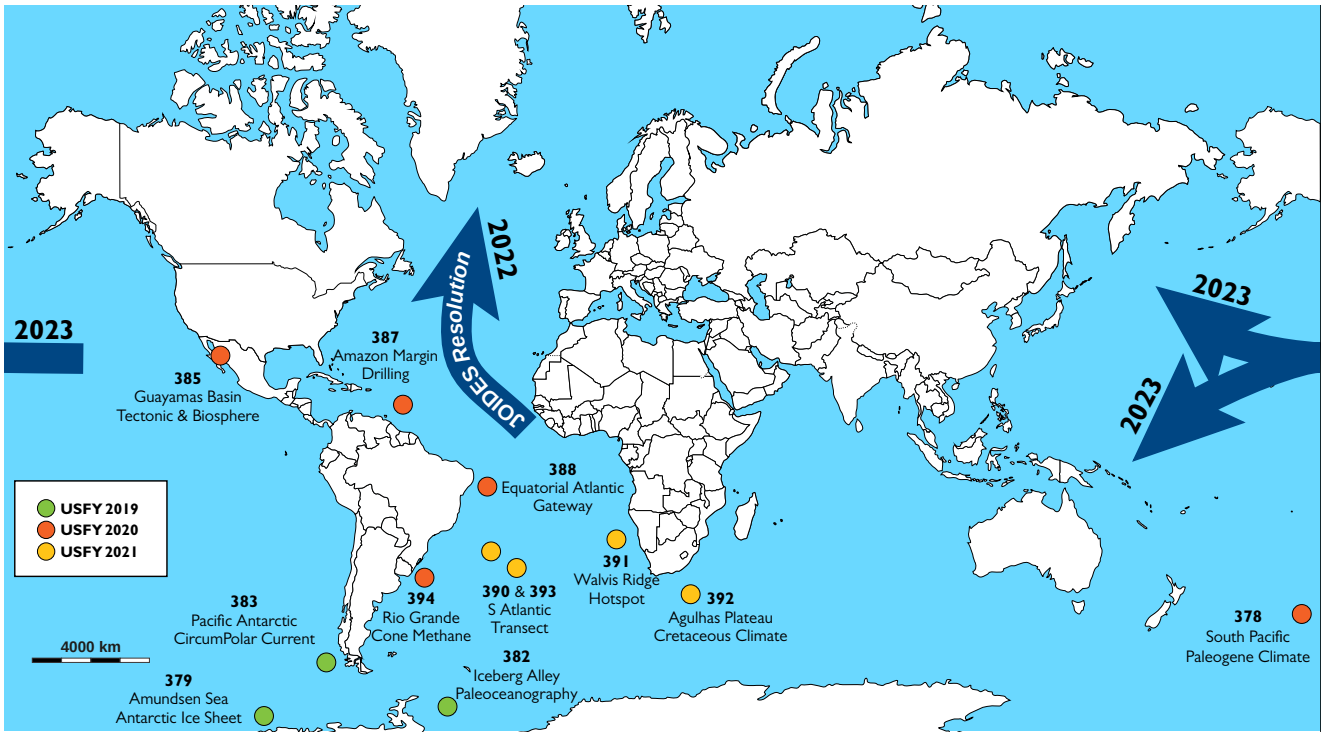
In addition, an engineering cruise (Expedition 385T: Panama Basin Crustal Architecture and Restoring Hole 896A) has been implemented from 18 August to 16 September 2019.

The JR Facility Board (JRFB) has scheduled five JR expeditions in the Pacific and Southern Ocean before the end of 2019 (see table below).

2019 expeditions in the Pacific and Southern Ocean

Expedition name	#	Dates	Ports
Amundsen Sea West Antarctic Ice Sheet History	379	18 Jan -20 Mar 2019	Punta Arenas / Punta Arenas
Iceberg Alley and Subantarctic Ice and Ocean Dynamics	382	20 Mar - 20 May 019	Punta Arenas / Punta Arenas
Dynamics of Pacific Antarctic Circumpolar Current	383	20 May - 20 July 2019	Punta Arenas / Punta Arenas
Panama Basin Crustal Architecture (504B) and Restoring Hole 896A	385T	18 Aug - 16 Sept 2019	Antofagasta / San Diego
Guaymas Basin Tectonics and Biosphere	385	16 Sept - 16 Nov 2019	San Diego / San Diego

2019-2021 *JOIDES Resolution* IODP expeditions and planned *JOIDES Resolution* ship track



JOIDES Resolution in the Admunsen Sea duringIODP Expedition 379 (photo P. Christie, IODP)

The JR Facility Board (JRFB) has scheduled one JR expedition in the Pacific Ocean - Expedition 378: South Pacific Paleogene (initially scheduled in late 2018), and four expeditions in the Atlantic Ocean in 2020 (see table below).

While writing these words, the JR is currently implementing Expedition 378 but, unfortunately, due to problems with its derrick, this expedition has been shortened and only one of the nine primary/alternates sites will be drilled. The JR will need to be repaired sometimes in 2020.

The JR will implement four expeditions in the South Atlantic Ocean in 2021 (see table below), before starting to operate in the general area of the Equatorial and North Atlantic, Gulf of Mexico, Mediterranean, Caribbean, and the Arctic in FY22 (see map on the previous page).

Four out of the 12 scheduled expeditions in FY20 and FY21 are based on **proposals led by ECORD scientists.**

2020-2021 *JOIDES Resolution* expeditions

Expedition name	#	Dates	Ports
South Pacific Paleogene Climate	378	3 Jan - 4 Mar 2020	Fiji / Papeete
(*JOIDES Resolution* Engineering Testing)	384	4 Mar - 26 Apr 2020	Papeete / Barbados
Amazon Margin	387	26 Apr - 26 June 2020	Barbados / Recife
Equatorial Atlantic Gateway	388	26 June - 26 Aug 2020	Recife / Recife
South Atlantic Transect, Expedition #1	390	5 Oct - 5 Dec 2020	Rio de Janeiro / Cape Town
Walvis Ridge Hotspot	391	5 Dec 2020 - 4 Feb 2021	Cape Town / Cape Town
Agulhas Plateau Cretaceous Climate	392	4 Feb - 6 Apr 2021	Cape Town / Cape Town
South Atlantic Transect, Expedition #2	393	6 Apr - 6 June 2021	Cape Town / Rio de Janeiro
Rio Grande Cone Methane and Carbon Cycling	394	2 Oct - 2 Dec 2021	TBD

The JR is still expected to complete its global circumnavigation in the Indo-Pacific region near the end of the programme in FY23 (see map on the previous page). At its future meetings, the JRFB will consider expeditions for scheduling to the end of FY24, subject to the availability of the JR. The JRFB has encouraged the IODP science community to continue to generate proposal pressure along the anticipated long-term ship track for FY22-FY24.

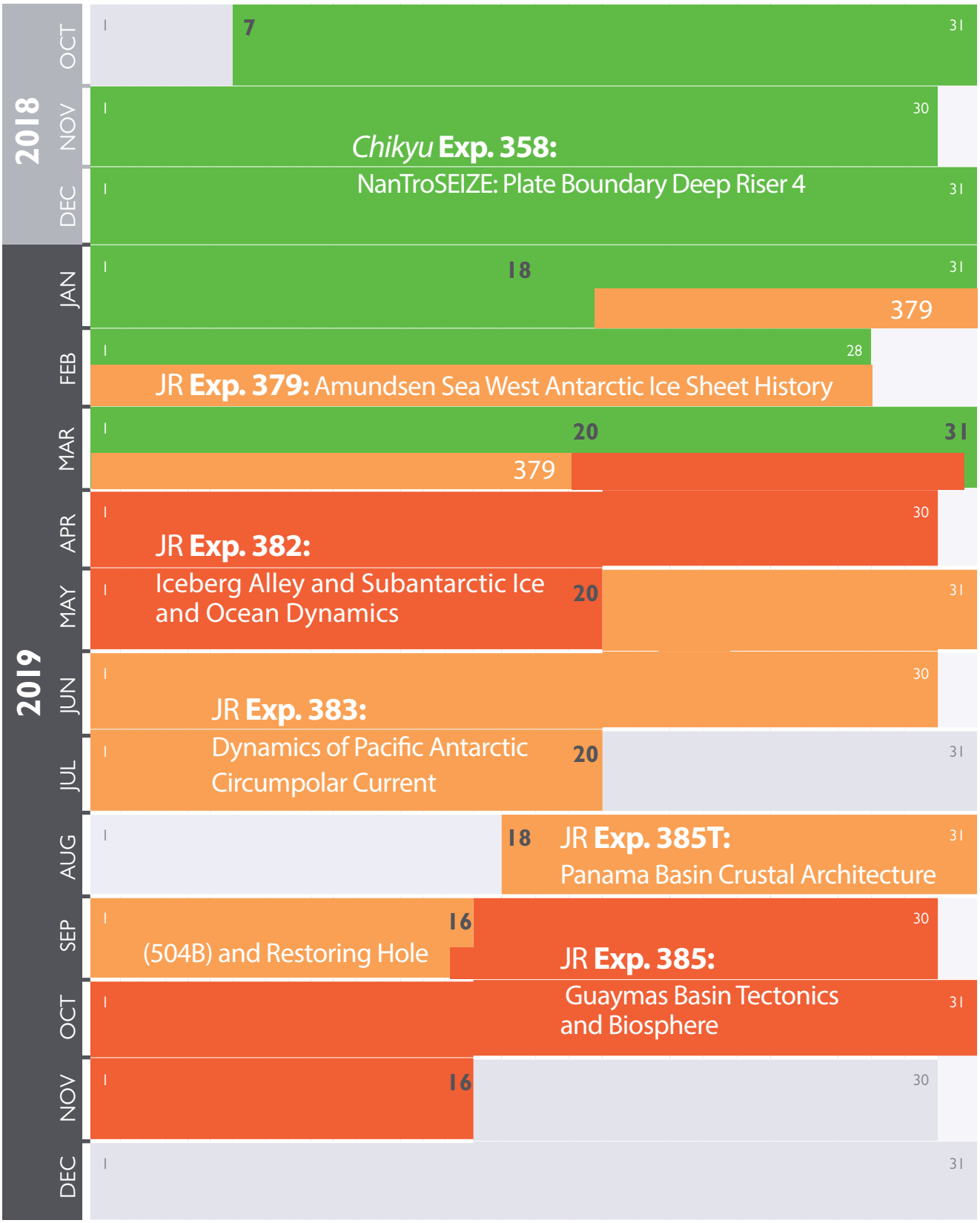
Chikyu expeditions

Chikyu spent over 160 days at sea to complete the IODP Expedition 358: NanTroSEIZE - Plate Boundary Deep Riser 4, which started in October 2018, in pursuit of the first deep plate boundary logs and core sampling. The main expedition goal was to deepen riser hole C0002F/N/P from 3000 mbsf to the primary megathrust fault target at ~5200 mbsf, using logging-while-drilling (LWD), downhole measurements, and drill cuttings analysis extensively, in addition to limited coring intervals. Ultimately, the primary science target was not reached. However, there were certain accomplishments, such as the extension of the ultimate record for scientific drilling to 3262.5 mbsf, the use of industry drilling tools new to scientific drilling and of a realtime logging software system (InterACT) that displayed logging data onshore for viewing by the CDEX management and the expedition science leaders. The expedition has also pioneered a new science-operator working team, the Real-Time Geomechanics (RTG) evaluating the geomechanics findings and advising the drilling team in realtime. There remains some exciting science to be done with the samples and data that were collected. Finally, this expedition has increased experience with drilling in one of the world's most unforgiving environments; a living accretionary prism.

The science team was comprised of 36 scientists, 11 from ECORD, six senior level, and 16 early career/students. The nine Science Leaders included five Japanese, three U.S. and one ECORD.

At its 2019 meeting, the *Chikyu* IODP Board (CIB) decided that no new Chikyu riser projects will be scheduled for the current phase of IODP and recommended that proponents for completely new riser projects do not submit new proposals until the publication of the New Science Framework concerning a potential post-2023 programme. The CIB also suggested that JAMSTEC organizes an international workshop, including the NanTroSEIZE scientists as well as other seismogenic zone proponent groups, for future seismogenic zone deep riser drilling projects using D/V *Chikyu*.

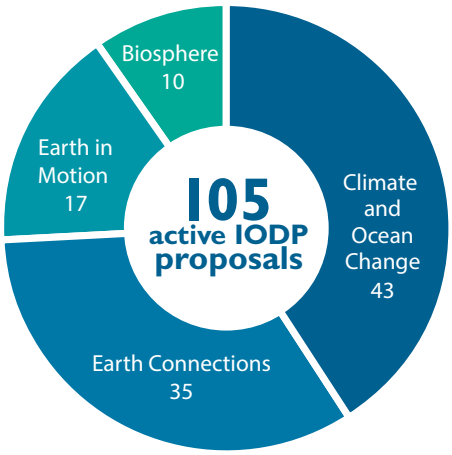
IODP expeditions 2019 calendar



Anticipating next IODP expeditions

New IODP Proposals

Thirty-two new IODP proposals have been submitted in 2019, i.e. the double than in 2018 (32 vs 16). This is the highest number of new proposals since 2014 – at the start of the current programme - when 36 new proposals were submitted. This demonstrates a strong scientific demand and a sustained involvement of the scientific community in IODP science. This has to be interpreted as a strong signal sent by the scientific community while the IODP partners started to consider and prepare the future of international scientific ocean drilling beyond 2023.

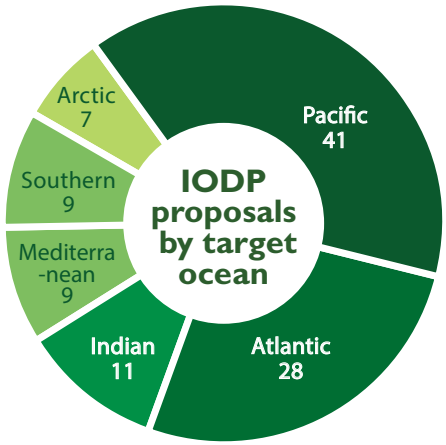


Distribution of active proposals (n = 105) by IODP Science Plan themes. Data provided by the IODP Science Support Office (as of 14 October 2019)

Active IODP Proposals

There are currently 105 active IODP proposals in the archives of the Science Support Office (as of 14 October 2019). Their distribution across the Science Plan themes demonstrates a good to very good proposal pressure in all objectives of the Science Plan (top diagram, right side) and rather constant ratios between the two leading themes - Climate and Ocean Change (43%) and Earth Connections (35%) - and the Earth in Motion (17%), and Biosphere (10%) themes.

Regarding the geographical distribution of active proposals (bottom diagram, right side), the number of drilling proposals in the Atlantic and the Mediterranean has significantly increased compared to 2018 (28 vs 23 and 9 vs 7 respectively), encouraged by the JR track planned in FY22 and FY23.



Distribution of active proposals by target ocean. Data provided by the IODP Science Support Office (as of 14 October, 2019)

The increasing proposal pressure has benefitted only to the JR with 15 more JR proposals in the system in 2019 (76 in 2019 vs 61 in 2018, i.e. 72.3% vs 68.5% of all proposals), while the number of proposals concerning the other platforms remained fairly constant in 2019 compared to 2018: 13 vs 12 *Chikyu* proposals (12.4% vs 13.5% of all proposals), and ten MSP proposals (9.5% vs 11.2% of all proposals); six active proposals concern the use of multiple platforms (top left diagram on page 21).

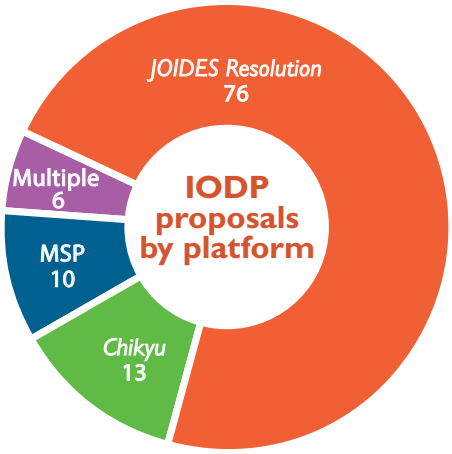
The active MSP proposals that are residing at the EFB and the Science Evaluation Panel (SEP) form the basis of the MSP operational plan that will be developed during the second phase of the current programme (see section 3., page 38). Their scientific objectives are quite diverse in terms of science 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 Sea, Japan Sea), thus illustrating the contribution of the MSP concept to the IODP science. However, the fact that several IODP partners (Japan, China, Brazil, India and Korea) do not have any active MSP proposal in the system demonstrates the necessity to make additional efforts in communication regarding the opportunities offered by the MSP concept.

'Land-to-Sea Proposals'

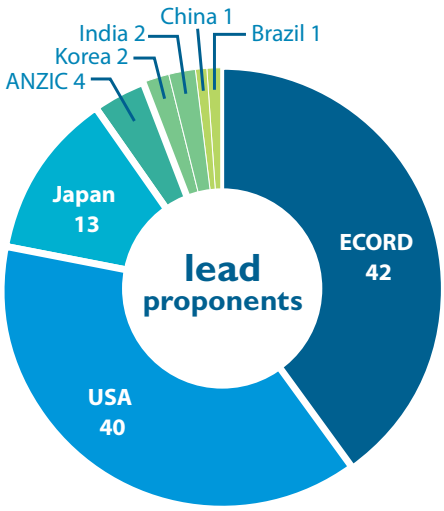
One MSP proposal concerns an **Amphibious Drilling Proposal** (796-ADP NADIR: Nice Amphibious Drilling), i.e. a proposal whose scientific objectives can only be accomplished by combining land and shallow-water drilling. This exemplifies the necessary closer collaboration

ECORD EUROPEAN CONSORTIUM FOR OCEAN RESEARCH DRILLING

icdp



Distribution of IODP proposals by platforms (n = 105). Multiple proposals consist of combined *Chikyu* and JR drilling. Data provided by the IODP Science Support Office (as of 14 October 2019)

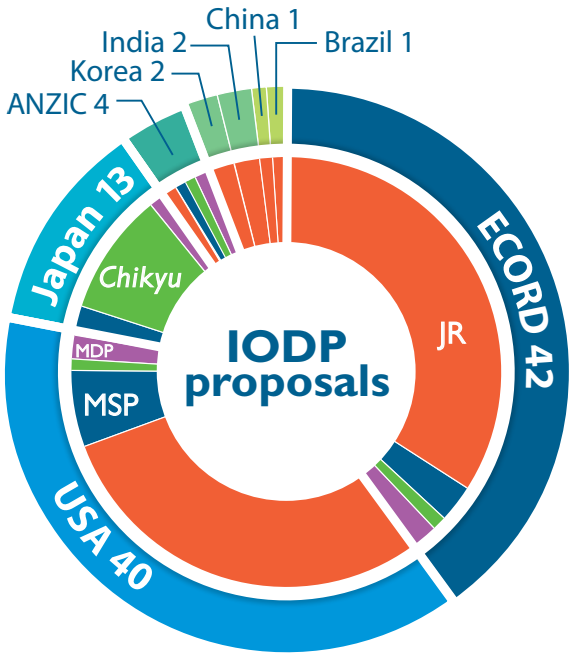


Distribution of active proposals (n = 105) by **lead proponents' member affiliation**. Data provided by the IODP Science Support Office (as of 14 October 2019)

between ICDP and IODP, especially through ECORD given that most ADPs will likely involve MSP operations. This concept has been brought by ECORD to the first IODP Forum in 2014 and has evolved since then through the activity of different working groups involving both IODP and ICDP representatives. More recently, a subgroup of the IODP Forum attendees has reworked the previous guidelines to streamline and simplify the Amphibious Drilling Proposal (now called **'Land-to-Sea Proposal'**) review process. Recently, several workshops have been focused on the development of land-to-sea transects (see next page) and drilling proposals are expected to be submitted to form potentially a significant pool of MSP proposals in the near future.

The need for higher MSP proposal pressure

A higher MSP proposal pressure including different science themes and involving various potential drilling/coring systems in diverse environments will be necessary to provide additional scientific, operational and funding opportunities in the near future and to ensure a future to the MSP concept in a new programme that could be developed beyond 2023.



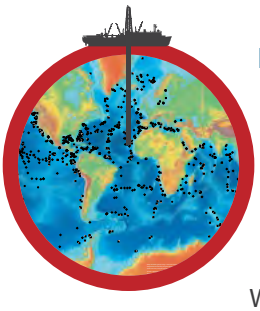
Distribution of IODP proposals by IODP members (n = 105). Data provided by the IODP Science Support Office (as of 14 October 2019)

To further increase operational flexibility of MSP expeditions and to offer more opportunities to the science community, ECORD has initiated the definition of new options to the proponents through the definition of various implementation plans, including a Basic Plan that will correspond to the minimum requirements for expedition success, and variable operational times that are shorter than the standard two-month expedition.

This might serve as a model for the implementation of drilling expeditions in a future programme.

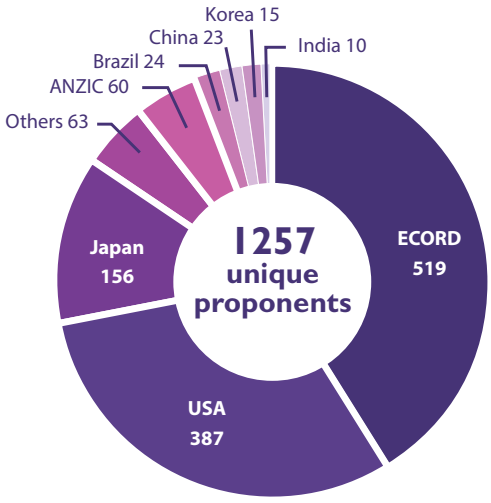
ECORD proponents

Since the start of the current programme, ECORD is providing a huge contribution to IODP science, including the submission of drilling proposals concerning all IODP capabilities. ECORD has a leading role in proposal submission in the current programme with percentages of unique proponents constantly above 37% since 2014. Currently, 519 ECORD scientists out of 1257 are proponents of active IODP proposals (i.e. 41.2%), including 42 lead proponents (see diagram on the right and the diagrams on previous page).



ECORD-ICDP MagellanPlus Workshop Series Programme

The remarkable involvement of ECORD scientists in IODP active proposals partly relies on the success of the ECORD-ICDP MagellanPlus Workshop Series Programme (*www.ecord.org/science/magellanplus/*; see 7. Engaging the community, page 85), which provides a substantial support to ECORD scientists to develop innovative drilling proposals concerning diverse scientific topics addressed by the three IODP platforms and/or the ICDP infrastructure. Since 2014, 25 MagellanPlus workshops have been organized (as of December 2019), involving a bit less than 1,000 scientists (about 20% of early-career scientists), and 16 drilling proposals were submitted (see figure below).



Distribution of active proposals (n = 105) by **proponents' member affiliation** (Data provided by the IODP Science Support Office as of 14 October 2019)

Three MagellanPlus workshops have been held in 2019.

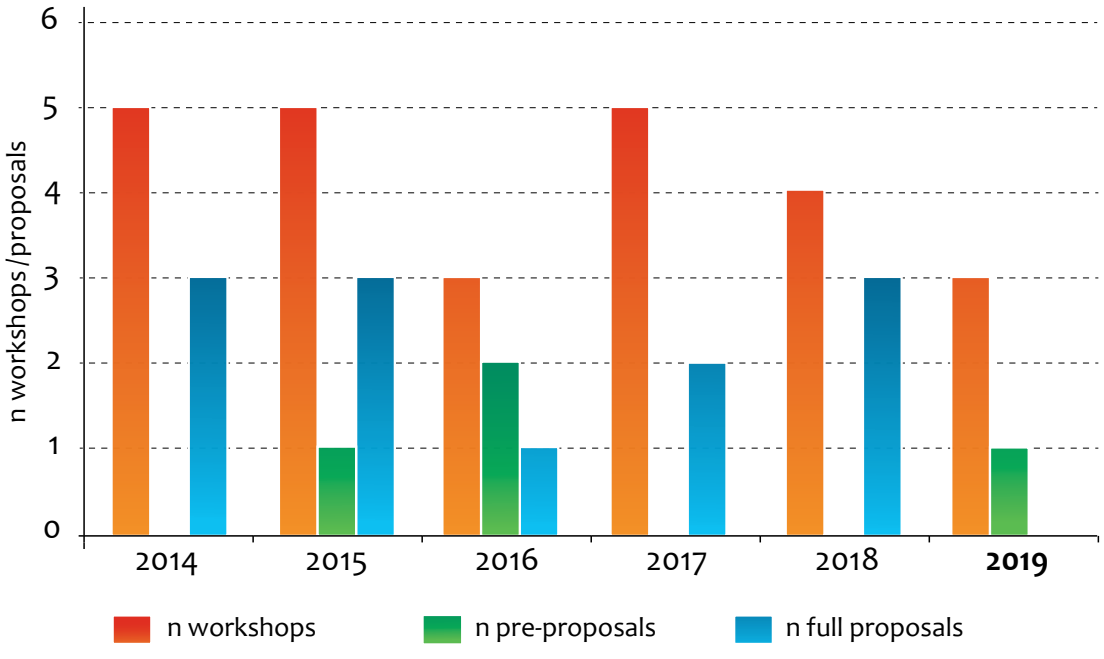
Two concerned land-to-sea transects:

- 'New Caledonia Peridotite Amphibious Drilling Project', 22-24 January 2019, Montpellier, France;
- Haiti-DRILL Workshop, 20-22 May 2019, Plouzané, France.

The third workshop concerned JR drilling offshore Portugal:

- 'The Role of Lithospheric Inheritance on Subduction Initiation – RELICT, 12-13 September 2019, Lisbon, Portugal), i.e. well-aligned with the 2022-2023 JR track.

MagellanPlus workshops and related proposals since 2014



Promoting IODP science

The Scientific Ocean Drilling Bibliographic Database and Publication Impact Report (*http://iodp.tamu.edu/publications/AGI_studies/2019_Pub_Impact.pdf*), which is published annually, monitors the valorization of Programme science through publications related to successive ocean drilling programmes from 1969 through June 2019. With a total of 5,298 out of 11,450 papers published in 30 highly ranked peer-reviewed journals, based on the Clarivate Analytics journal impact factor (table below), this document demonstrates the impact of the ocean drilling science and the attractivity exerted by the scientific ocean drilling programmes on the science community. It must be reminded here that scientists were encouraged to publish post-cruise research results in English language peer-reviewed journals rather than the Program Proceedings volumes since 1996 only.

Journal	Journal Impact Factor (2018)	Number of Program-related papers published		
		1969–2013	2014–2019	Total
Nature	43.07	307	9	316
Science	41.037	186	17	203
Nature Geoscience	14.48	43	26	69
Proceedings of the National Academy of Sciences of the U.S.A.	9.58	39	19	58
Earth-Science Reviews	9.53	19	17	36
Geology	5.006	411	64	475
Quaternary Science Reviews	4.641	120	32	152
Earth and Planetary Science Letters	4.637	586	127	713
Geophysical Research Letters	4.578	166	36	202
Geochimica et Cosmochimica Acta	4.258	212	65	277
Global and Planetary Change	4.1	36	43	79
Geological Society of America Bulletin	3.97	101	12	113
Chemical Geology	3.618	123	36	159
Journal of Geophysical Research	3.585	345	0	345
Marine and Petroleum Geology	3.538	60	24	84
Climate of the Past	3.47	44	67	111
Journal of Petrology	3.38	40	6	46
Marine Geology	3.349	40	1	41
Sedimentary Geology	3.244	51	7	58
Sedimentology	3.244	39	10	49
Contributions to Mineralogy and Petrology	3.23	53	10	63
Organic Geochemistry	3.12	60	16	76
Paleoceanography	3.087	485	114	599
Geochemistry, Geophysics, Geosystems	2.946	287	105	392
Deep-Sea Research (Parts I and II)	2.848/2.430	22	23	45
Geosphere	2.847	19	21	40
Geophysical Journal International	2.777	59	13	72
Tectonophysics	2.764	51	24	75
AAPG Bulletin	2.677	38	4	42
Marine Micropaleontology	2.663	272	36	308

Table illustrating highly ranked peer-reviewed serials publishing Program-related expedition research results (1969–2019).

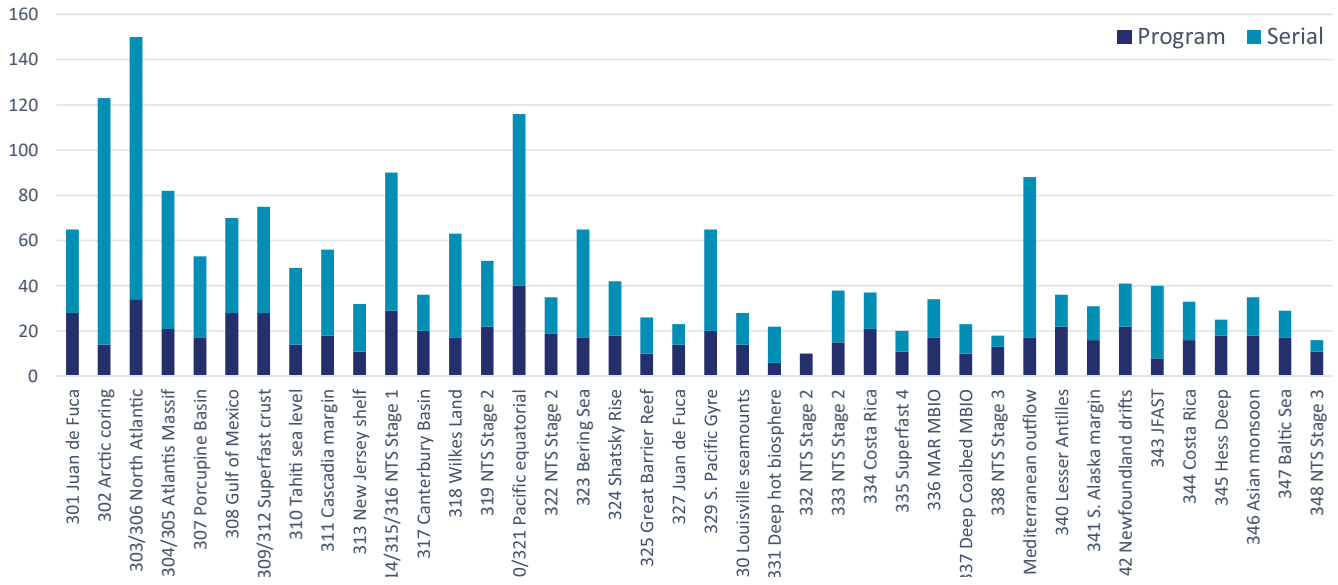
As every year, the 2019 Scientific Ocean Drilling Bibliographic Database and Publication Impact Report reflects the outstanding intellectual contribution of the ECORD scientists to IODP science. With 11,310 out of 26,588 serial contributions (42.5% of total publications) related to the successive ocean drilling programmes, the ECORD science community demonstrates its leading role in the international geoscience landscape (see table below).

Member country or consortia	First authors of serials	Serial contributions by country	Serial contributions by author	Total contributions
Australia/New Zealand Consortium	325	498	622	947
Australia	186	334	397	583
New Zealand	139	164	225	364
Brazil	26	36	38	64
China	447	356	475	922
ECORD	**4,235**	**5,525**	**7,075**	**11,310**
Austria	15	43	44	59
Canada	329	421	502	831
Denmark	56	110	123	179
Finland	8	10	11	19
France	628	804	1,128	1,756
Germany	1,043	1,233	1,600	2,643
Ireland	5	24	26	31
Italy	288	364	478	766
Netherlands	233	276	300	533
Norway	141	192	223	364
Portugal	16	45	55	71
Spain	156	250	309	465
Sweden	105	143	149	254
Switzerland	142	217	234	376
United Kingdom	1,070	1,393	1,893	2,963
India	176	101	120	296
Japan	724	868	1,923	2,647
Republic of Korea	56	91	104	160
United States	4,025	3,384	6,217	10,242
Total papers:	**10,014**			**26,588**

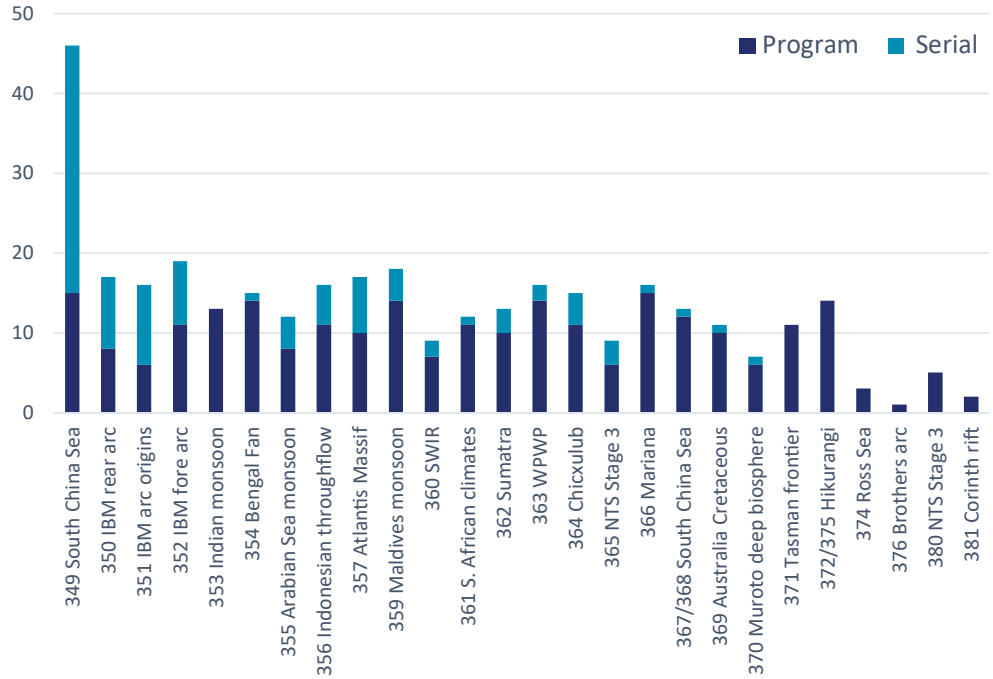
Table illustrating Serial publication authorship by first author, contributing country, contributing authors, and total contributions (1969–2019)

The MSP expeditions, which are implemented only since 2004 and represent less than 10% of all IODP expeditions, have generated a significant proportion of the peer-reviewed scientific publications arising from the programmes (see figures below). Furthermore, the list of the most-cited IODP expedition–related papers as of July 2019 illustrates the high-impact and high-quality science achieved by MSP expeditions (see table on the next page).

However, the figures and the table on next page do not yet include the high scientific return expected from the most recent MSP expeditions, especially Expeditions 364 and 381, which will further enhance the scientific impact of MSP expeditions.



Number of Program and serial publication records for Integrated Ocean Drilling Program Expeditions 301–348 (2003–2019).
MSP expeditions are Expeditions 302, 310, 313, 325 and 347.
MSP expeditions 310 and 325 should be combined as they are based on the same proposal (#519).



Number of Program and serial publication records for International Ocean Discovery Program Expeditions 349–357, 359–372, 374–376, 380, and 381 (2003–2019).
MSP expeditions are Expeditions 357, 364 and 381.

Article	Citations (N)	Altmetric score
Sluijs, A., Schouten, S., Pagani, M., Woltering, M., Brinkhuis, H., Sinninghe Damsté, J.S., Dickens, G.R., et al., 2006. Subtropical Arctic Ocean temperatures during the Palaeocene/ Eocene Thermal Maximum. Nature, 441(7093):610–613. *https://doi.org/10.1038/nature04668*	611	91
Moran, K., Backman, J., Brinkhuis, H., Clemens, S.C., Cronin, T., Dickens, G.R., Eynaud, F., et al., 2006. The Cenozoic palaeoenvironment of the Arctic Ocean. Nature, 441(7093):601–605. *https://doi.org/10.1038/nature04800 533*	533	28
Kallmeyer, J., Pockalny, R., Adhikari, R.R., Smith, D.C., and D'Hondt, S., 2012. Global distribution of microbial abundance and biomass in subseafloor sediment. Proceedings of the National Academy of Sciences of the United States of America, 109(40):16213–16216. *https://doi.org/10.1073/pnas.1203849109*	528	130
Lipp, J.S., Morono, Y., Inagaki, F., and Hinrichs, K.-U., 2008. Significant contribution of Archaea to extant biomass in marine subsurface sediments. Nature, 454(7207):991–994. *https://doi.org/10.1038/nature07174*	526	4
Grimes, C.B., John, B.E., Kelemen, P.B., Mazdab, F.K., Wooden, J.L., Cheadle, M.J., Hanghøj, K., and Schwartz, J.J., 2007. Trace element chemistry of zircons from oceanic crust: a method for distinguishing detrital zircon provenance. Geology, 35(7):643–646. *https://doi.org/10.1130/G23603A.1*	384	Not available
Pagani, M., Pedentchouk, N., Huber, M., Sluijs, A., Schouten, S., Brinkhuis, H., Sinninghe Damsté, J.S., Dickens, G.R., and Expedition 302 Scientists, 2006. Arctic hydrology during global warming at the Palaeocene/Eocene Thermal Maximum. Nature, 443(7103):671–675. *https://doi.org/10.1038/nature05043*	371	15
Deschamps, P., Durand, N., Bard, E., Hamelin, B., Camoin, G., Thomas, A.L., Henderson, G.M., Okuno, J., and Yokoyama, Y., 2012. Ice-sheet collapse and sea-level rise at the Bølling warming 14,600 years ago. Nature, 483(7391):559–564. *https://doi.org/10.1038/nature10902*	363	Not available
Moore, G.F., Bangs, N.L., Taira, A., Kuramoto, S., Pangborn, E., and Tobin, H.J., 2007. Three-dimensional splay fault geometry and implications for tsunami generation. Science, 318(5853):1128–1131. *https://doi.org/10.1126/science.1147195*	340	11
Frost, B.R., and Beard, J.S., 2007. On silica activity and serpentinization. Journal of Petrology, 48(7):1351–1368. *https://doi.org/10.1093/petrology/egm021*	302	Not available
Brinkhuis, H., Schouten, S., Collinson, M.E., Sluijs, A., Sinninghe Damsté, J.S., Dickens, G.R., Huber, M., et al., 2006. Episodic fresh surface waters in the Eocene Arctic Ocean. Nature, 441:606–609. *https://doi.org/10.1038/nature04692*	298	54

Top cited Program-related serials as of July 2019 with corresponding Altmetric scores. Most of them are in the top journals by impact factor. MSP expeditions are Expeditions 302 and 310.

Managing knowledge-based resources

IODP and ECORD implement a sustainable sample and data curation management plan of data conservation and provision to the science community.

Hundreds of kilometres of core, other types of samples (fluids, biota) and data have been acquired and stored in three core repositories (Gulf Coast Repository, College Station, USA; Kochi Core Center, Kochi, Japan; Bremen Core Repository – BCR, Bremen, Germany) where they are made accessible to the international community for post-moratorium studies.

BCR, which celebrated its 25th anniversary in 2019, currently contains more than 158 km of cores acquired during 90 expeditions. All cores collected during expeditions that will be implemented by the JR in the Atlantic Ocean from 2020 through 2022 or 2023, will be stored at BCR before the end of the current programme. In 2019, a total of 51,693 samples were taken at BCR for 270 requests, including 163 requests submitted by ECORD scientists.

In parallel, ECORD has developed and maintained several databases in order to make available to the science community all the necessary information to the development of drilling proposals and to allow the scientists to get access to the data collected during the drilling expeditions and keep track of ECORD activities in IODP (see section 6. Archiving IODP cores: the Bremen Core Repository, page 70).

Engaging the community

Promoting IODP science in ECORD and non-ECORD countries and training the next generation of scientists from ECORD members are major goals for ECORD.

The outstanding portfolio of science and educational activities that ECORD has gradually developed over the last years has been very effective in 2019 with high demand from scientists, students and early-career scientists (see section 7. Engaging the community, page 76).

The promotion of IODP scientific achievements to a large audience within universities and institutes has been actively conducted in 2019 by four 'ECORD Distinguished Lecturers' representing a broad spectrum of IODP science (*http://www.ecord.org/education/dlp/*), who gave twenty presentations in nine different ECORD and non-ECORD countries: Rebecca Bell (UK), Marguerite Godard (France), Verena Heuer (Germany) and Luc Beaufort (France).

In 2019, ECORD educational activities have included three Summer Schools and a Training Course and have involved more than 140 students and early-career scientists. Fifteen ECORD scholarships were provided to support outstanding students to attend the ECORD Summer Schools and the ECORD Training Course.

Three ECORD Summer schools were sponsored by ECORD in 2019 (*http://www.ecord.org/education/summer-schools/*): the 16th Urbino Summer School in Paleoclimatology (10-26 July 2019; Urbino, Italy), the 13th ECORD Bremen Summer School (16-27 September 2019; Bremen, Germany) focused on Subduction Zone Processes: Magma, Volcanoes, Ore Deposits, Geohazards and the fourth 'ECORD Petrophysics Summer School' (29 June - 5 July 2019; Leicester, UK).

The fifth ECORD Training Course (*http://www.ecord.org/education/summer-schools/*) has been held at the IODP Bremen Core Repository at MARUM, Bremen, on 25-29 March 2019. This one-week course, with a focus on the IODP core-flow procedures, is tailored to prepare the participants for sailing on an offshore drillship expedition through a unique 'virtual drill ship' approach including core description, analyses and sampling.

Seven ECORD Research Grants (*http://www.ecord.org/education/research-grant/*) were awarded to PhD students and early-career scientists to conduct research on core material and data related to past DSDP / ODP / IODP expeditions and collaborate with other research groups outside their home institutions.

Communicating

Promoting activities and accomplishments of IODP to various audiences, including scientists, classrooms and the general public, is a major goal of ECORD.

News promoting ECORD and MSP expeditions frequently appear on national and international Internet portals, TV stations and newspapers.

ECORD constantly update and create communication and educational material (core replicas, leaflets, videos, brochures, etc.) that are distributed across the ECORD members for exhibitions and exhibition booths, as well as through the MagellanPlus workshops and ECORD Training Course and Summer Schools (see section 8. Communicating, page 86).

In 2019, the ECORD Outreach Task Force (EOTF) has started to develop exhibition material for temporary exhibitions in museums and aquariums, thus ushering a new communication environment for ECORD.

In 2019, the ECORD outreach staff has promoted the IODP and ICDP programmes under the umbrella of 'Scientific Drilling' at major international (EGU, AGU) and national science conferences with the organization of joint ECORD-ICDP booths and a Townhall meeting at the EGU in Vienna, which hosted more than 16,000 scientists from 113 countries.

In parallel, the EOTF has prepared the communication plan and promotional material concerning the upcoming MSP Expedition 386: Japan Trench Paleoseismology.

While entering the second phase of the current programme, most IODP member countries and consortia have started in 2019 to plan efforts designed **to shape the future of scientific ocean drilling beyond 2023**, through several workshops at the national or consortia levels (ECORD, USA, Japan, ANZIC, China), which highlighted a remarkable consensus on the priorities for a future drilling programme.

The challenges to build a successor to the current programme are enormous since such a programme may have to fit to a totally different operational, financial and programmatic model from that of its predecessors. This endeavor will require the full mobilization and involvement of all stakeholders to assess the technologies needed to meet the scientific needs of the community.

The IODP Forum has played a pivotal role in coordinating initiatives taken at the national or consortia levels, especially through its endorsement of the process to develop a new Science Framework to express community's long-range vision for taking scientific ocean drilling into the mid-21st century. The 'Framework for Scientific Ocean Drilling through 2050' is expected to be finalized in 2020 by a team of writers and reviewers that has been assembled in late 2019. This effort has a unique opportunity to initiate the momentum that is needed to maintain scientific ocean drilling research in the next decade.

Even if the concept and design of the current IODP structure has been recognized highly successful and appropriate to take forward into the next phase of scientific ocean drilling post-2023, this structure will necessarily require adjustments in implementation to facilitate future developments, such as the inclusion of additional platform providers (e.g. China). Furthermore, the envisioned mix of drilling platform capabilities needed to reach its full potential will have to be assessed and clearly delineated.

PROCEED
EXPANDING FRONTIERS OF SCIENTIFIC OCEAN DRILLING

The ECORD 'PROCEED' ('Expanding Frontiers of Scientific Ocean Drilling') workshop that has been held at the Austrian Academy of Sciences, Vienna, Austria, on 6-7 April 2019, has provided an outstanding contribution to these planning efforts (see page 30). Emerging and new scientific topics have been identified and the need for land-to-sea transects through a closer link to the International Continental Drilling Program (ICDP, *www.icdp-online.org*) has been emphasized. Regarding the future roles of ECORD in IODP, the ECORD support to all facilities as well as its role as platform provider have been reaffirmed. In addition, a better use of the versatility of MSPs will have to be pursued. A higher MSP proposal pressure including different science themes and involving various potential drilling/coring systems in diverse environments will be necessary to provide additional scientific, operational and funding opportunities in the programme to be developed beyond 2023.

ECORD has already reaffirmed its commitments to the 'philosophy' of the successive scientific ocean drilling programmes: a single international Science Plan/ Framework, the international staffing of expeditions and advisory panels, standard policies and guidelines, programme-wide publication policy, public access to IODP cores and data, and programme-wide core curation.

The strategy that ECORD will define for the future of scientific ocean drilling beyond 2023 will be also based on the legacy of its achievements, success and innovations, which have systematically pushed the boundaries of IODP by providing access to new drilling environments, introducing new technologies in IODP and by opening up IODP to new scientific topics and communities.

Based on the well-established operation of the ECORD infrastructure, its successful implementation, its competitiveness in the international research landscape and maximum return from the investment, ECORD intends to play a prominent role in a future scientific ocean drilling programme.

Gilbert Camoin
ECORD Managing Agency Director

ECORD
EUROPEAN CONSORTIUM FOR OCEAN RESEARCH DRILLING

IODP
INTERNATIONAL OCEAN DISCOVERY PROGRAM

Related websites

http://www.ecord.org
http://www.iodp.org

Sunset on board L/B *Myrtle* during IODP Expedition 364 (photo E. Le Ber, ECORD/IODP).

2019 PROCEED Workshop – Outcomes Summary

6-7 April 2019, Austrian Academy of Sciences, Vienna, Austria

PROCEED
EXPANDING FRONTIERS OF SCIENTIFIC OCEAN DRILLING

ECORD convened the PROCEED (ExPanding FROntiers of SCiEntific OcEan Drilling) workshop at the Austrian Academy of Sciences, Vienna (Austria), **to respond to the significant challenges of building a successor programme to IODP.**

The organising committee nominated a group of 16 ECORD scientists to join a PROCEED Scientific Committee, to develop the workshop agenda and convene the meeting. This group was selected to span the membership of ECORD and breadth of IODP science, with a particular focus on encouraging the next generation of IODP scientists to take the lead in this effort.

The workshop was attended by 137 participants (36% female scientists) from 21 countries (14 ECORD member countries, five IODP partners and two non-IODP member countries), including 42% senior, 34% mid-career, and 26% early-career scientists (statistics below). Ideas from the broader community were also gathered through a pre-meeting online survey.

The workshop programme comprised a combination of invited keynote presentations, panel sessions, and breakout and plenary discussions with 'real-time' audience feedback collected via Pigeonhole, an online platform.

The overarching goal of the workshop was to define the new goals for a future international scientific ocean drilling programme beyond 2023.

Special emphasis:

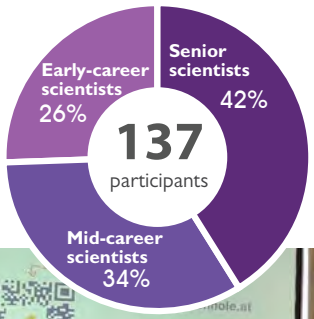
1. New science frontiers
2. Technological developments in a multiple drilling platform approach

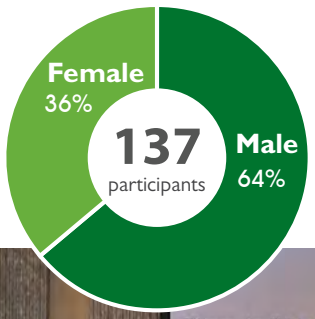
PROCEED discussions lead to the consensus that the content of the current Science Plan is still relevant, but a new architecture is required to better reflect the interdisciplinary nature of our science and to excite funding agencies.

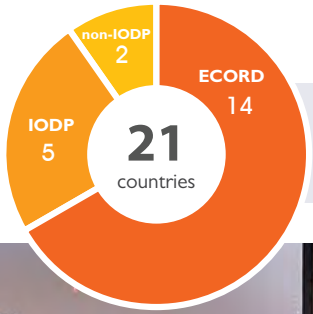
The meeting identified many exciting new/emerging topics, some of which can only be addressed with land-to-sea transects. A closer link with ICDP (and other entities) should thus be explored.

PROCEED testified that the ECORD science community is very healthy, and must continue to be an IODP partner, participating in all aspects of IODP globally, using and supporting all IODP facilities, while continuing to be a platform provider.

Furthermore, the ECORD community should explore and advertise the versatility of mission-specific platforms (MSPs) and continue to explore ways to leverage more funding in order to meet the challenges of the new programme. The full workshop report is available on ECORD website (link below).







PROCEED full report

www.ecord.org/science/proceed

Group photo of PROCEED participants (photo H. Kinkel ECORD/IODP) and statistics (top).

The new 'Science Framework'

PROCEED as part of international planning

PROCEED was one of six international planning workshops organised between September 2018 and August 2019, by IODP-India, J-DESC, ECORD, ANZIC, USSSP and IODP-China. In all, more than 650 scientific ocean drilling scientists participated.

Science Framework Working Group (SFWG)

The results from the above-mentioned workshops were presented and discussed on 23-24 July during the first meeting of the Science Framework Working Group (SFWG) at Columbia University, New York, USA. This group comprised 19 scientist delegates representing all IODP member countries and consortia, including IODP-Brazil and IODP-Korea, nominated by their respective PMOs. ECORD was represented by: Rosalind Coggon (UK), Antony Morris (UK), and Matt O'Regan (Sweden).

The SFWG were tasked with providing a consensus proposal for a new science framework in support of future Scientific Ocean Drilling Beyond 2023, based on the outcomes of the six planning workshops. The relevant proposal outlined a strategy to develop a new science framework with a long-term, greater than 25-year outlook, ending in 2050. The proposed framework centers around eight core Strategic Objectives and five Flagship Initiatives.

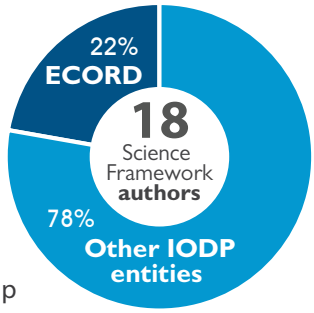
The new 'Science Framework' - a living document

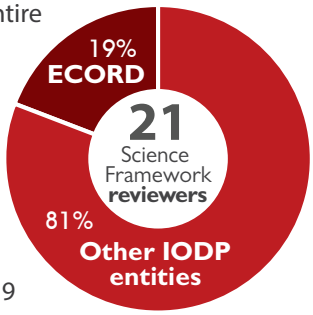
The Strategic Objectives are foundational research areas that are open-ended to encourage innovation and new discoveries through the mid-21st century. This distant time horizon of the science framework allows for the implementation of **Flagship Initiatives**, which comprise coordinated, sustained scientific ocean drilling endeavors that cross-cut multiple Strategic Objectives and require interdisciplinary efforts over several decades to address specific societal challenges.

All framework documents will be produced as online-only high-end PDF files and will be made available on IODP.org for free access and downloading. The science framework will be a living document, which, under the auspices of the IODP Forum, may be updated based on five-year programmatic reviews.

From 6 to 26 August 2019, a draft of this proposal was posted on IODP.org for commenting by the IODP community, and based on constructive community input, a revised proposal was presented to, debated and endorsed by the IODP Forum during its September 2019 meeting in Osaka, Japan. The Forum also endorsed the SFWG's nominations of Anthony Koppers (US) and Rosalind Coggon (ECORD-UK) as co-lead editors of the 2050 Science Framework. The PMOs were asked to nominate experienced IODP scientists who were actively involved in their respective planning workshop to join the writing and review teams that would develop the 2050 Science Framework.

Based on those nominations a team of 18 authors (including four ECORD scientists) and 21 (including four ECORD scientists) reviewers was assembled, with the former group predominantly composed of early- to mid-career scientists. Since October 2019, this team has worked in small groups to write and develop individual chapters of the framework. In December 2019, the whole group met at a pre-AGU writers meeting to review the second draft of the entire document.





The strategy for and progress towards developing the framework were presented to the international community at the IODP Townhall meeting on 11 December 2019 (San Francisco, USA). Since then, the writing team have been preparing the third draft of the framework (Version 1), which will be published online for the first round of community review in late February 2020.

Following community feedback on Version 1, a professional science writer and illustrator will help us develop the final format and content of the document (Version 2), which will also be reviewed by the international community, prior to preparation of **the final 2050 Science Framework ready for publication online in summer 2020.**

Rosalind Coggon
PROCEED Co-chair and Co-lead editor of the 2050 Science Framework

2. Operating and participating in mission-specific platform expeditions

L/B *Myrtle* during IODP Expedition 364 (photo G. Tulloch, ECORD/IODP).

2. Operating and participating in mission-specific platform expeditions

There was no MSP Expedition in 2019, due the cancellation of Expedition 398 Hawaiian Drowned Reefs in early 2019.

Throughout 2019, the **ECORD Science Operator (ESO)** continued detailed planning for Expedition 386: Japan Trench Paleoseismology, which will be jointly implemented in 2020 with the Institute for Marine-Earth Exploration and Engineering (MarE3) within the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) (page 34).

ESO support for past MSP expeditions also continued throughout the year, including XRF core scanning of Expedition 381 cores (below).

Completed MSP expedition support

IODP Expedition 381

COMPLETED (2017)

Corinth Active Rift Development

Expedition website *www.ecord.org/expedition381*

28 February 2019, the moratorium ended
for Expedition 381: Corinth Active Rift Development.

All shipboard data made public via the PANGAEA® Data Publisher: *http://iodp.pangaea.de*

Publication of the IODP Proceedings: *http://publications.iodp.org/proceedings/381/381title.html*

Prior to the date of the end of moratiorium, ESO-Bremen staff undertook sampling for the expedition's shore-based requests.

Expedition 381: Research and peer-reviewed papers

The Science Party and their collaborators continued their post-expedition research throughout 2019, and the majority of peer-reviewed papers are expected to be submitted before October 2020. Several papers are in preparation or in press, with the first high-impact paper submitted to **Nature Scientific Reports** in February, entitled "High-resolution record reveals climate-driven environmental and sedimentary changes in an active rift". New peer-reviewed publications associated with Expedition 381 will be listed in the expedition-related bibliography. Throughout 2019, ESO-Bremen staff supported Expedition 381 Scientists to conduct extensive XRF core scanning of 115 archive half sections, which was gathered as expedition data.

Expedition 381: 2nd post-expedition meeting preparations

Preparations continued for the Expedition 381 2nd post-expedition meeting, which will be held in Stemnitsa, Greece, 27-30 April 2020. At this meeting, the Science Party members will present the first results from their individual post-expedition research projects, and will coordinate their publication strategies. A field trip has been organised on 1 May for the participants to visit onshore outcrops around the Gulf of Corinth.

IODP Expedition 364

COMPLETED (2016)

Chicxulub K-Pg Impact Crater

Expedition website *www.ecord.org/expedition364*

In June 2019, the majority of **peer-reviewed papers** based on post-expedition research as part of Expedition 364: Chicxulub K-Pg Impact Crater were published.

In addition to the reports and **supplementary materials** of the Proceedings volume, 15 peer-review papers and 88 conference abstracts have been produced by the Science Party members and their collaborators.
http://publications.iodp.org/proceedings/364/364title.html

IODP Expedition 386

21 April - 9 June 2020

Japan Trench Paleoseismology

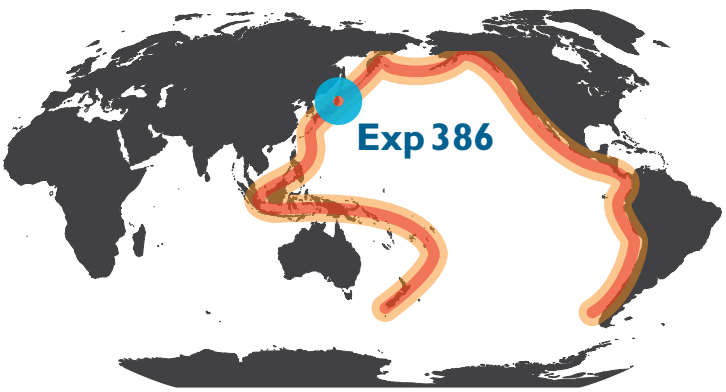
Co-chief Scientists	**Michael Strasser** (University of Innsbruck, Austria) **Ken Ikehara** (Geological Survey of Japan, AIST)
Expedition Project Manager	**Carol Cotterill** (ESO, BGS, UK)
Petrophysics Staff Scientist	**Katharina Hochmuth** (EPC, University of Leicester, UK)
Vessels	***Kaimei*** - Offshore phase ***Chikyu*** - Onshore phase
Expedition website	*www.ecord.org/expedition386*

Exp. 386 Scientific background

Japan is located on the **Pacific Ring of Fire** (illustration below), an approximately 40,000 km long arc-shaped belt around the Pacific Ocean.

More than 90% of stress accumulated by global plate tectonics is released along active margins through subduction earthquakes, and **the majority of Earth's earthquakes occur within the Pacific Ring of Fire,** including two of the largest known magnitude: the giant 2004-Mw9.2-Sumatra and 2011-Mw9.0-Tohokuoki earthquakes.

These high-impact earthquakes and associated tsunamis were major geological events with catastrophic societal consequences. Giant Mw9 class earthquakes have a long reoccurrence time, and instrumental and historic records are inadequate to reduce uncertainties in seismic hazard assessment and predictions across time scales relevant to subduction zone processes.



Exp. 386 Scientific objectives

Expedition 386
aims to fill the gap in long-term
records of giant earthquakes

Expedition 386 aims to use multiple shallow **giant piston coring (GPC)** at 18 primary sites to 40 meters below sea floor (mbsf), in water depths generally between 7 and 8 km. Upper Pleistocene to Holocene sediments will be recovered to test and develop submarine palaeoseismology in the Japan Trench.

Submarine paleoseismology is a promising approach to investigate deposits from deep-sea (hadal) environments. Earthquakes leave traces in isolated, poorly-connected hadal trench basins. For example, observed sediment remobilisation event-deposits can be linked to the giant Tohoku-oki earthquake. Expedition 386 aims to fill the gap in long-term records of giant earthquakes, by testing and developing submarine paleoseismology in axis-parallel trench-fill basins of the Japan Trench. This is an ideal location to reconstruct a long history of giant earthquakes as event-deposits here have high preservation potential, as conventional coring reveals good agreement between the sedimentary record and historical documents covering the last ~1,500 years. Targets for paleoseismological investigations over longer time scales are accessible through giant piston coring, potentially unravelling an earthquake history that is 10 to 100 times longer than is currently available, advancing our understanding of recurrence patterns of giant earthquakes and earthquake-induced geohazards globally.

ESO and MarE3 cooperation

ECORD Science Operator

JAMSTEC 国立研究開発法人 海洋研究開発機構 Japan Agency for Marine-Earth Science and Technology

ESO and MarE3 continued joint expedition planning throughout 2019 (timeline below), using a combination of fortnightly video calls and face-to-face visits, and covered all aspects of expedition planning including deck plans, workflows, equipment, services, staff, Information Technology (IT) and health and safety.

Mission-specific platform for Exp. 386: *RV **Kaimei***

The mission-specific platform for this expedition will be the **JAMSTEC-operated research vessel *Kaimei***, which is equipped with its own 40 m giant piston corer.

Offshore phase on *Kaimei*
21 April - 9 June 2020

The offshore phase is anticipated to run from 21 April - 9 June 2020, on board *Kaimei* from/to Yokosuka.

Onshore phase on *Chikyu*
14 October - 13 November 2020

Onshore Science Party from 14 October - 13 November 2020, on board *Chikyu* docked in Shimizu. *Chikyu* is being provided as the location for the Onshore Science Party, as an alternative to the Bremen Core Repository, with many elements provided as an in-kind contribution from JAMSTEC (e.g. technicians/consumables).

November, December

In the final weeks of 2019, ESO signed the Science Party members up to the expedition, and gathered their research plans and sample requests (incoming sample requests and scientist details were transferred into the Drilling Information System - DIS).

Deck plans, workflows and the provision of equipment, services and staff was agreed between ESO and MarE3, with modifications made to standard operating procedures to ensure data remain consistent between all MSP operations. Final testing of some equipment took place, in preparation for packing into the containers that are ready

9 September

A meeting of operator/Co-chief in Osaka, prior to the IODP Forum. In addition to operational and science planning, the meeting focused on the review of the shortlisted Science Party nominations.

20 June

An expedition information webinar was held to provide information to potential Science Party applicants while the Call for Scientists was open (application closing date was 5 July).

20-22 May

An ESO delegation met with MarE3 at JAMSTEC, Yokosuka, Japan, and began detailed planning for Expedition 386. ESO visited both the *Kaimei* (offshore phase) and *Chikyu* (Onshore Science Party location).

2019

Joint planning and practice activities will continue in the first quarter of 2020, when ESO and MarE3 staff will join another GPC trial cruise on board the *Kaimei* in February 2020.

2020

October

The Science Party was selected, provisional invites were issued on 3 October, and formal invites were issued on 15 October. As part of the Osaka visit, an ESO-EPC staff member visited the *Kaimei* MSCL container to check the equipment and inventory with MarE3 colleagues. A list of required spares has subsequently been distributed and agreed upon.

The Expedition's Scientific Prospectus was published in cooperation with the JRSO Publication Services: *http://publications.iodp.org/scientific_prospectus/386/*

24 June

ESO, EMA and MarE3 met in Edinburgh, UK, to discuss the operational details that would directly influence the anticipated ECORD-JAMSTEC Memorandum of Understandings that will underpin this joint expedition.

23–31 May

An ESO staff member took part in GPC trials onboard the *Kaimei* and began the work of interfacing the GPC routines with the IODP-MSP workflow and developing an MSP layout on the *Kaimei*.

Key facts in ESO and MarE3 **joint Expedition 386 planning** throughout 2019

ESO facility, service and general activities

Upgrading containerised laboratories

ESO partners continued the process of upgrading their containerised laboratories throughout 2019. Standards and regulations for containerised spaces offshore USA are provided by the American Bureau of Shipping (ABS), and are enforced by the US Coast Guard (USCG). New, more stringent regulations have come into effect, primarily in response to the Deepwater Horizon disaster in 2010. The new, more stringent regulations cover many aspects from container structure strength and container wall thickness (ability to withstand the 100 year wave), and addressing fire-related risks (combustible materials, emergency escape routes, self-sealing doors, fire-proof utility routing etc.).

ESO started the process of upgrading the containerised laboratories in 2018 (scoping, specification), as new and upgraded containers would be required for **Expedition 389: Hawaiian Drowned Reefs**. In 2019, an assessment of containerised labs was initiated by all partners, and a workflow to meet the new ABS regulations was started that includes both retrofitting existing containers, and tendering for the development and purchase of completely new containers.

Even with the postponement of Expedition 389, the upgrades are prudent to allow implementation of any future expedition in US waters. Each ESO partner individually coordinated the specification and procurement of the containers for which they are responsible, due to the fact that our existing containers are not identical, have varying specifications and have very different outfitting requirements. Partners individually liaised with their suppliers to discuss specific requirements such as container structure, integrated equipment, interiors and connections.

The ESO-Bremen team took delivery of their new Curation and Geochemistry containers at the beginning of August, and work continued to equip and test the lab containers with basic infrastructure (power, wifi, cabling, -80°C freezer, fridge, heating and air condition systems).

The ESO-EPC team placed an order with Geotek Ltd for a replacement MSCL container, which is expected to be delivered in early 2020.

The BGS team shipped their four containers (Science, ESO Office, Database and Drilling) to a supplier for upgrade and refitting at the end of August.

General equipment maintenance

General equipment maintenance and performance testing continued as normal throughout the year, including for the MSCL equipment, logging winch, and containerised laboratory equipment. Maintenance and testing activities were timed to allow equipment to be accessed during periods of training (e.g. ECORD training course laboratory practicals).
In addition to maintenance activities, ESO staff researched and prepared tenders for new equipment that will improve our laboratory provision (e.g. a new rock drill and saw).

QA/QC procedures

For MSP proposals under investigation for potential implementation, ESO-Bremen staff continued to scope QA/QC procedures for analytical equipment and instrumentation, including the new microbiology setup. This involves incorporating QA/QC documentation into offshore laboratory routines, and continuously improving the online tutorials for both the Offshore Phase and the Onshore Science Party (OSP) available on the web. Part of the work was to migrate all information on numerous webpages to the new MARUM webpages.

Staff training

Staff training continued throughout 2019, to develop staff skills and to meet regulatory requirements. ESO staff took part in offshore personal survival techniques, offshore safety training, radiation protection courses, first responders training, MSCL training, dangerous and radioactive materials transport training, and personal development training.

Preparation of the BGS 55 m Rockdrill (RD2) remotely operated sampling system for operation below sea floor during IODP Expedition 357 (Photo D. Smith, ECORD/IODP).

3. Anticipating future mission-specific platform expeditions

Onboard RV *Greatship Maya* during IODP Expedition 325 (photo C. Cotteril, ECORD/IODPI)

3. Anticipating future mission-specific platform expeditions

Related websites:
www.ecord.org/about-ecord/management-structure/efb
www.iodp.org/active-proposals
www.iodp.org/facility-boards#SEP

Expedition 386

21 April - 9 June 2020

Japan Trench Paleoseismology

The scheduling of Expedition 386: Japan Trench Paleoseismology (Co-chief Scientists: M. Strasser, ECORD-Austria and Ken Ikehara, Japan) has been approved by the ECORD Council at its 2018 Fall meeting. This expedition will be jointly implemented in 2020 by the ECORD Science Operator (ESO) and the Institute for Marine-Earth Exploration and Engineering (MarE3) within the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) (page 34).

Expedition 377

Scheduled for 2021

Arctic Ocean Paleoceanography (ArcOP)

At its 2019 meeting that was held on 21-22 March 2019 in Bremen, Germany, the ECORD Facility Board (EFB) reaffirmed that Expedition 377: Arctic Ocean Paleoceanography (ArcOP) is a first-priority expedition for ECORD. EFB extensively discussed possible ways to implement this expedition despite rising costs significantly beyond the expedition budget initially approved by the ECORD Council and lower than anticipated in-kind contributions (IKC). At its last meeting that was held in Dublin, Ireland on 5-6 November 2019, the ECORD Council has approved the scheduling in late summer 2021 of Expedition 377 proposed by the EFB, in light of scientific priorities and budgetary situation, including secured IKCs. (page 40).

In parallel, EFB investigated ways to implement **additional MSP expeditions** until the end of the current programme and ESO continued to scope and plan future MSP expeditions:

Proposal 637: New England Hydrogeology (page 44),
Expedition 389: Hawaiian Drowned Reefs (page 43), and
Expedition 373: Antarctic Cenozoic Paleoclimate (page 42).

IODP Expedition 377

Scheduled for 2021

Arctic Ocean Paleoceanography (ArcOP)

Co-chief Scientists: **Rüdiger Stein** (Alfred Wegener Institute, Germany); **Kristen St. John** (James Madison University, USA)

Expedition website: *www.ecord.org/expedition377*

Exp. 377 Scientific objectives

The general aim of the ArcOP Expedition is to recover 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. Key objectives are related to the reconstruction 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.

Exp. 377 Expedition planning

In **November 2018**, the ECORD Council agreed to **increase the budget allocation for Expedition 377**, and scheduled it for late summer 2021.

The **SPRS** programmed the *IB/RV Oden* for IODP in Sep-Oct 2021, and was able to provide an **in-kind contribution** in the form of SPRS staff on board, and in support of, the *Oden*.

Issuing the **'Prior Information Notice'** (PIN)

In the final weeks of 2018, ESO-BGS prepared a 'Prior Information Notice' (PIN) for an imminent call to tender for ice and fleet management services. The PIN, which was issued in early 2019, is a method for providing the market place with early notification of intent to award a contract, which can lead to early supplier discussions to help inform the development of the project specification.

Contracting requirements

Conversations at an operational level took place between ESO, the **Swedish Polar Research Secretariat (SPRS)** and an ice management company on the contracting requirements for an icebreaker fleet and ice management for this expedition. The agreed approach was to subcontract this aspect of the operation in its entirety.

This strategy would result in two main commercial contracts:

- ice and fleet management, and
- drilling and coring, in addition to services provided by ESO.

Icebreaker vessels

A capable 'secondary' icebreaker is the *IB/RV Oden* (Sweden). A video conference was held between ESO and the Director-General of SPRS on 4 March, to discuss a possible **in-kind contribution from the SPRS**. The *IB/RV Oden* will be an integral part of the ice management, and will be declared in the specification for the contract notice for ice management.

Platform and logging contractors

ESO continued to scope platform and logging contractor options with potential providers. The drilling platform will be the subject of a formal contract notice exercise. There are reduced numbers of icebreaker vessels with moonpool capability for conversion to drill ships currently available due to recent sales, including Expedition 302's *RV Vidar Viking* to Canada for other icebreaker and rescue applications. However, initial scoping by ESO identified feasible options which can accommodate a suitable rig, as well as the Science Party and laboratories.

Expedition budget and in-kind contributions

ESO presented its latest scoping of Expedition 377 to EFB at its meeting on 21-22 March 2019. At the meeting, ESO highlighted the potential for Expedition 377 costs to rise significantly beyond the expedition budget approved by ECORD Council, due to lower than anticipated in-kind contribution values and rising operational costs.

Efforts to address the affordability of Expedition 377 continued throughout the spring and summer. In-kind contribution opportunities continued to be explored

by EMA, ESO and the Co-chief Scientists. ESO, EMA and a contact from Stockholm University met by video conference on 28 June to discuss Swedish science community interest in Expedition 377, and to discuss a **novel participation model** for this expedition to encourage increases in the value of the in-kind contributions offered. ESO also separately explored the inclusion of a possible academic-industry co-funded ice research project in the expedition, to reduce the cost of the ice management.

Re-examination of the coring strategy

In parallel to these in-kind contribution/co-funding efforts, the Co-chief Scientists and their co-proponents re-examined the coring strategy in light of new site survey data, and suggested that they could de-scope the proposal to one hole. ESO reviewed the revised proposal sent by the lead proponent on 23 July, and concluded that, from a purely operational viewpoint, the de-scoped proposal presented a significant cost-saving opportunity.

Updating costs

On 28 October, ESO produced an update paper for ECORD which provided an update on costs and the in-kind contribution status for Expedition 377. The paper also included a fresh analysis of the financial risks associated with Expedition 377 (impacts of fuel price rises, longer-than-anticipated icebreaker transits and drilling date rate increases). These latest costings were presented to the ECORD Council on 6 November 2019 in Dublin.

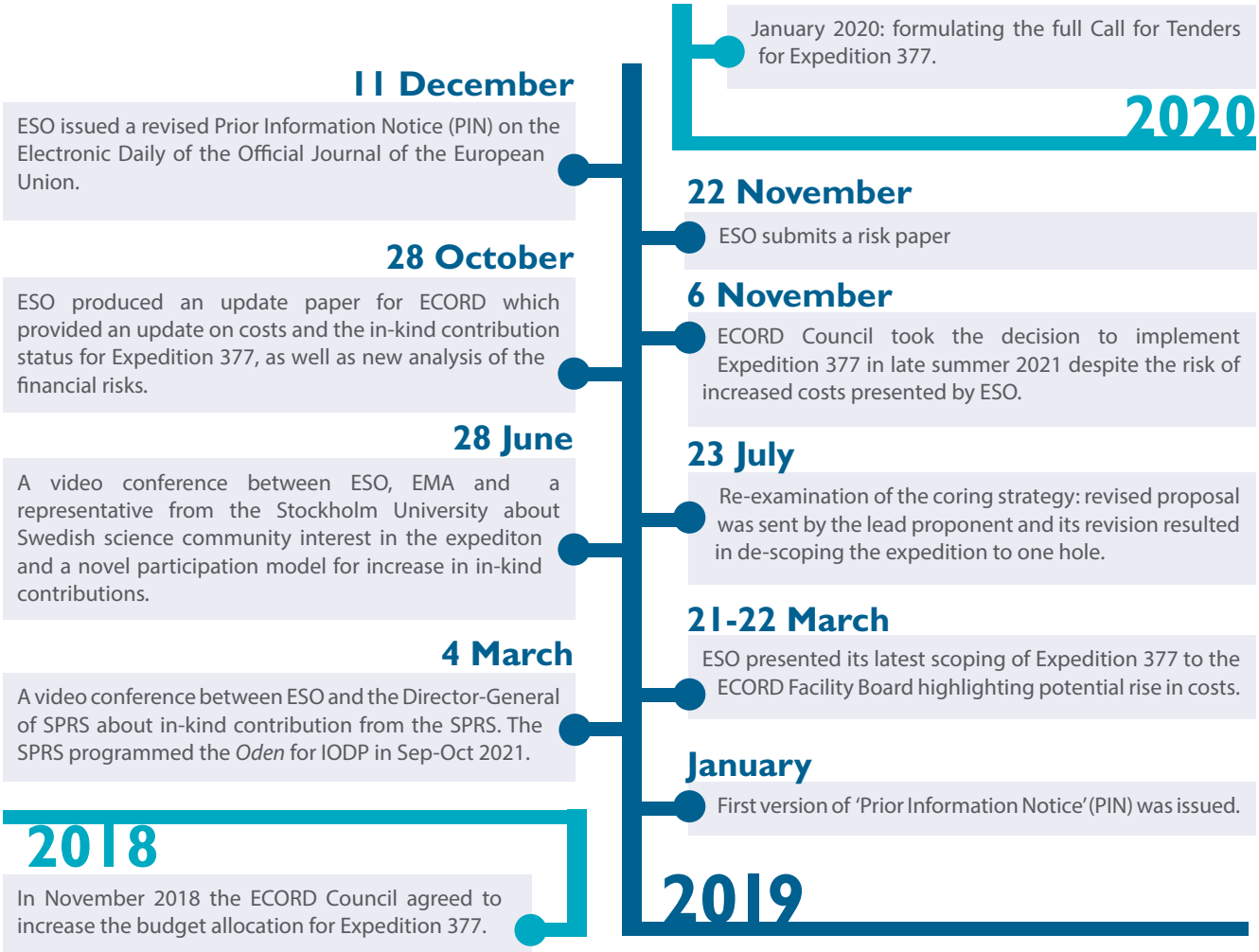
Decision to implement Expedition 377

At the November **ECORD Council-ESSAC** meeting, the ECORD Council took the **decision to implement Expedition 377** in late summer 2021 despite the risk of increased costs.

In response to a request from the ECORD Council, ESO produced a risk paper (submitted 22 November 2019) that provided a description and analysis of the planning and technical risks we anticipate during the expedition.

Issuing revised **'Prior Information Notice'**

On 11 December 2019, ESO issued a revised Prior Information Notice (PIN) on the Electronic Daily of the Official Journal of the European Union. Since its publication, we have been fielding enquiries from interested suppliers, which will help formulate the full **Call for Tenders for Expedition 377, anticipated January 2020.**



Key facts in **Expedition 377 planning** throughout 2019

EXPEDITIONS TO BE RESCHEDULED

IODP Expedition 373

To be rescheduled

Antarctic Cenozoic Paleoclimate

Co-chief Scientists	**Trevor Williams** (Texas A&M University, USA) **Carlota Escutia** (University of Granada, Spain)
Expedition website	*www.ecord.org/expedition373*

Exp. 373 Scientific objectives

The aim of this expedition, based on Proposal 813, is to drill the shallowly-buried strata along the George V and Adélie Land shelf of East Antarctica (page 28) to obtain a record of Antarctica's climate and ice history from the Eocene (greenhouse) to the Neogene (icehouse).

Exp. 373 Operations

Expedition 373: Antarctic Cenozoic Paleoclimate was postponed until further notice, after a 2018 tender exercise demonstrated no vessel availability for the 2019/20 or 2020/21 Antarctic summer seasons.

Limited scoping was undertaken for Expedition 373 in 2019. ESO continued to support ECORD in exploring possible options to access the new Australian research vessel RSV *Nuyina*, ideally as an in-kind contribution, though co-funded and fully-funded options appear to be possible. ESO continued to liaise with the Science Coordination Manager of the Australian Antarctic Division regarding potential opportunities to utilise the RSV *Nuyina*, as a mission-specific platform. ESO is planning to visit the RSV *Nuyina* in 2020 before it is delivered to Australia, either in the dockyard in Romania, or at a European port before, during or after sea trials in the Arctic.

The scheduling of **IODP Expedition 373** by the ECORD Facility Board remains possible in the current phase of IODP.

RV *Vidar Viking* transitting through ice during IODP Expedition 302 (photo ECORD/IODP).

IODP Expedition 389

To be rescheduled

Hawaiian Drowned Reefs

Co-chief Scientists **Jody Webster** (University of Sydney, Australia)
Christina Ravelo (University of California, USA)

Expedition website *www.ecord.org/expedition389*

Exp. 389 Scientific objectives

The overall goal of the drilling campaign is to sample a unique succession of drowned coral reefs around Hawaii now at -134 to -1155 m below sea level. As a direct result of Hawaii's rapid but nearly constant subsidence, a thick (100-200 m) expanded sequence of shallow coral reef dominated facies is preserved within the reefs. These reefs span important periods in Earth climate history, either not available or highly condensed on stable (Great Barrier Reef, Tahiti) and uplifted margins (Papua New Guinea, Barbados) due to a lack of accommodation space and/or unfavourable shelf morphology. Specifically, these data show that the reefs grew into, during and out of the majority of the last five to six glacial cycles. Scientific drilling through these reefs will generate a new record of sea-level and associated climate variability during several controversial and poorly understood periods over the last 500 kyr.

Exp. 389 Operations

Expedition 389: Hawaiian Drowned Reefs was scheduled by EFB for September-October 2019, as the alternative expedition to Expedition 373: Antarctic Cenozoic Paleoclimate (a 2018 tender exercise demonstrated no vessel availability).

In August 2018, ESO issued a call to tender for platform and drilling services for Expedition 389. The tender called for both a vessel and a suitable drilling system, and specifically encouraged submission of seafloor drilling equipment. The bids were evaluated in October 2018 and ESO engaged discussions with potential drilling contractors at the end of 2018.

At the beginning of December 2018, the preferred bidder formally withdrew their bid citing business reasons. Since a contract had not been signed, the bidder was able to leave negotiations without penalty.

At the beginning of December 2018, the preferred bidder formally withdrew their bid citing business reasons. Since a contract had not been signed, the bidder was able to leave negotiations without penalty.

An alternative, more costly and not wholly compliant bidder was immediately engaged in early 2019. Discussions with the alternative bidder led to the conclusion that, at this time, Expedition 389 would carry significant technical risk as well as additional cost. These risks were presented to the ECORD Council and EFB in February, to inform a 'go/no-go' decision.

After the EFB March meeting, the ECORD Council postponed the expedition until further notice.

During the first three months of 2019, work by all ESO partners in the planning of Expedition 389 was well underway. Staff focused on delivering a range of expedition-related tasks including permitting, equipment purchases, scoping and assessing new equipment based on discussions with the Co-chief Scientists (provision of CT scanning pre-OSP, and split-core hyperspectral scanning). Permitting paperwork was readied for submission, and ultimately put on hold in light of the postponement of the Expedition. The work invested in permitting will be applicable in the event of rescheduling.

Whilst liaising with potential drilling contractors for Expedition 389 in 2018, ESO learned of new regulations for portable accommodation modules on US-registered vessels and on vessels entering US waters for various offshore applications. This led to a program of container renewal and upgrade, which was started in 2018 and continued throughout 2019 (see 'ESO facility, service and general activities', page 36).

IODP Expedition 389 is postponed until further notice, and no further planning work was undertaken in 2019. The scheduling of this expedition by the ECORD Facility Board remains possible in the current phase of IODP.

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

The number of active MSP proposals in the IODP system is fairly constant and includes ten proposals concerning various science topics and geographical areas that reside both at EFB and SEP.

A higher MSP proposal pressure including different science themes and involving various potential drilling/coring systems in diverse environments would be desirable to provide additional scientific, operational and funding opportunities in the near future.

MSP proposals currently at the EFB

Six MSP proposals currently reside at EFB (table below), including the two expeditions that were postponed (i.e., Expeditions 373 and 389) :

- Proposal 708: Central Arctic Paleoceanography (Expedition 377)
- Proposal 866: Japan Trench Paleoseismology (Expedition 386)

There are currently four proposals in the EFB waiting room:

- Proposal 637: New England Shelf Hydrogeology (Expedition 389)
- Proposal 716: Hawaiian Drowned Reefs
- Proposal 730: Sabine Bank Sea Level
- Proposal 813: Antarctic Cenozoic Paleoclimate (Expedition 373)

Proposals at EFB

Proposal	Short title	PI	Ocean	Drilling system
637 Full2	New England Shelf Hydrogeology	Dugan (USA)	Atlantic	Liftboat / jack-up rig
708 Full	Central Arctic Paleoceanography	Stein (ECORD)	Arctic	Drillship
716 Full2	Hawaiian Drowned Reefs	Webster (ANZIC)	Pacific	Geotech. rig / MeBo200
730 Full2	Sabine Bank Sea Level	Taylor (USA)	Pacific	MeBo200
813 Full	Antarctic Cenozoic Paleoclimate	Williams (USA)	Southern Ocean	RD2
866 Full2	Japan Trench Paleoseismology	Strasser (ECORD)	Pacific	Long-piston coring

IODP Proposal 637

Active proposal in the EFB waiting room

New England Shelf Hydrogeology

Proposal (PDF) *https://docs.iodp.org/Proposal_Cover_Sheets/637-Full2_Person_cover.pdf*

ESO continued to scope IODP Proposal 637: New England Shelf Hydrogeology, which continues to offer an exciting expedition option for EFB to consider in the current phase of IODP.

On 29 April 2019, ESO-BGS staff held a video call with the lead proponent, to discuss project risks, science priorities, operations (how to integrate pump tests with coring and logging), the hazard survey for fixed platform positioning, and EPSP approval of amended sites. This call was followed up on 5 August and 7 November with further video calls, during which ESO and the proponents updated each other on scoping progress, and to discuss in more detail how to carry out pump tests in the context of a coring and logging operation.

ESO looked into offshore renewable activity by Vineyard Wind in the area of the drill sites, to investigate any opportunities or conflicts with those developments. Fortunately there was no direct spatial overlap between the windfarm developments and the drilling locations, however the timing of development activity (from April 2019 until March 2020) will not overlap with expedition operations, so there is unlikely to be an opportunity to take advantage of geotechnical vessels temporarily located nearby.

MSP proposals at SEP

Four MSP proposals are at SEP (table below), two of those requiring long-piston coring technology:

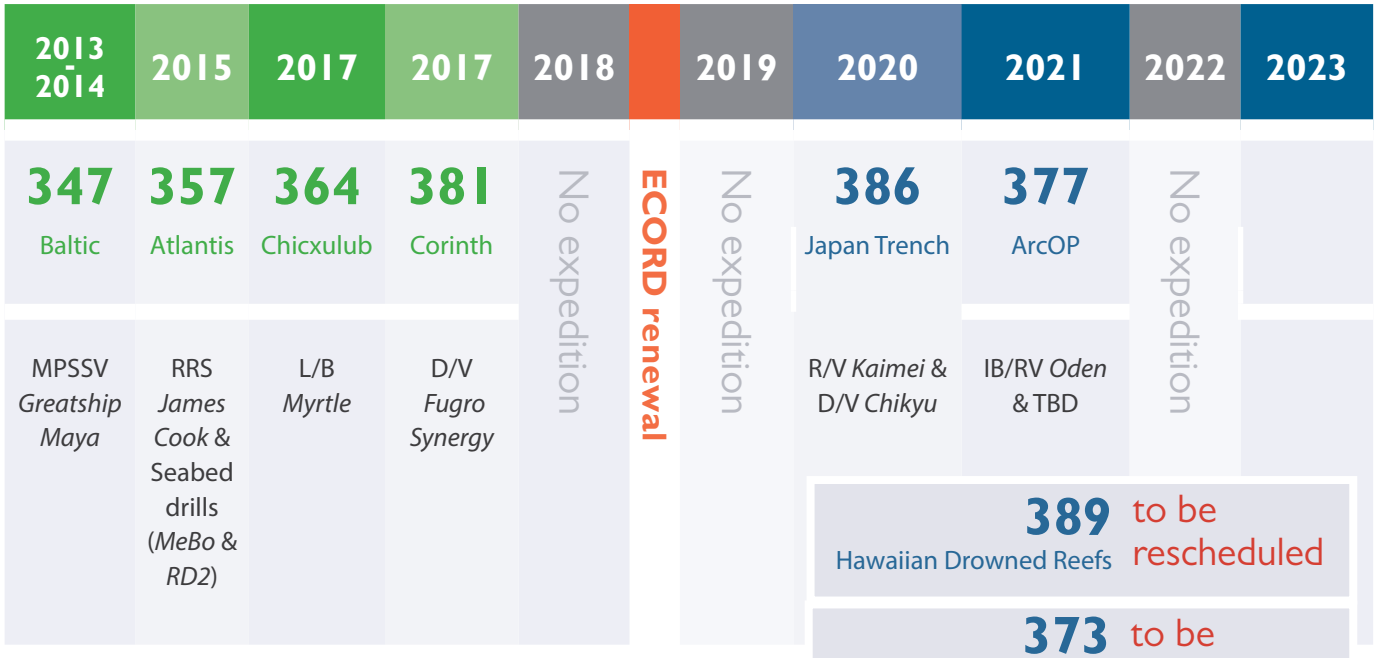
- Proposal 796 ADP: NADIR Nice Amphibious Drilling Ligurian Landslide (Lead Proponent: A. Kopf)
- Multi-phase Drilling Proposal MDP 863: ISOLAT S-Ocean Paleoclimate (Lead Proponent: L. Peterson)
- Proposal 915-Pre: North Atlantic Fjord Sediment Archives (Lead Proponent: J. Giraudeau)
- Proposal 931-Pre: East Antarctic Ice Sheet Evolution (Lead Proponent: A. Shevenell)

Three of those proposals did not record any progress for several years (# 796, 863, and 931) and could be deactivated by the *JOIDES Resolution* Facility Board if no action is taken soon.

MSP proposals at SEP

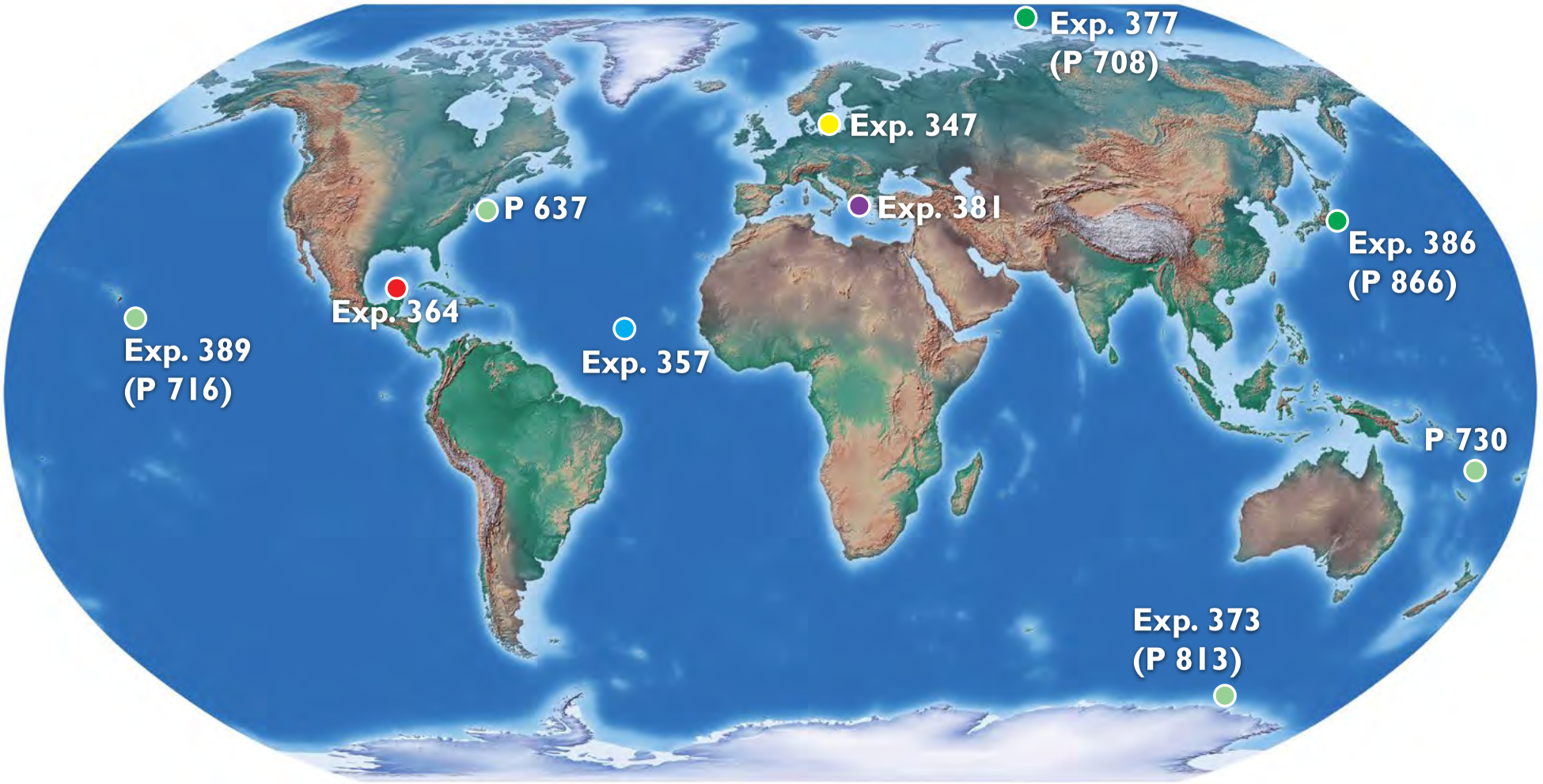
Proposal	Short title	Lead proponent	Ocean	
796 ADP	NADIR: Nice Amphibious Drilling	Kopf (ECORD)	Mediterranean	Geotech. rig / MeBo
863 MDP	ISOLAT Southern Ocean Paleoclimate	Peterson (USA)	Southern Ocean	Long-piston coring
915 Pre	N Atlantic Fjord Sediment Archives	Giraudeau (ECORD)	Atlantic	Long-piston coring
931 Pre	East Antarctic Ice Sheet Evolution	Shevenell (USA)	Southern Ocean	TBD

Scheduling of MSP expeditions for the four coming years (2020-2023)



347 - Expedition 347: Baltic Sea Paleoenvironment
357 - Expedition 357: Atlantis Massif Serpentinization and Life
364 - Expedition 364: Chicxulub K-Pg Impact Crater
381 - Expedition 381: Corinth Active Rift Development
386 - Expedition 386 Japan Trench Paleoseismology
377 - Expedition 377: Arctic Ocean Paleoceanography (ArcOP)
389 - Expedition 389: Hawaiian Drowned Reefs
373 - Expedition 373: Antarctic Cenozoic Paleoclimate

Mission-specific platform expeditions and proposals at the EFB



Patrizia Geprägs (ESO) cutting a freshly retrived core during IODP Expedition 381 (photo E. Le Ber, ECORD/IODP).

4. Participating in 2019 *JOIDES Resolution* and *Chikyu* expeditions

Night shift scientists and technicians on the *JOIDES Resolution* helipad at sunrise during IODP Expedition 383 (photo C. A. Zarikian, IODP)

4. Participating in 2019 *JOIDES Resolution* and *Chikyu* expeditions

IODP expeditions

www.iodp.org/expeditions

IODP 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.

Participation of ECORD scientists

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 following a quota system. Selection of Science Party members is, therefore, based on both scientific merit and a time-averaged 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, scientists from ECORD member countries can also sail following special calls or sail as observers.

JOIDES Resolution Science Operator

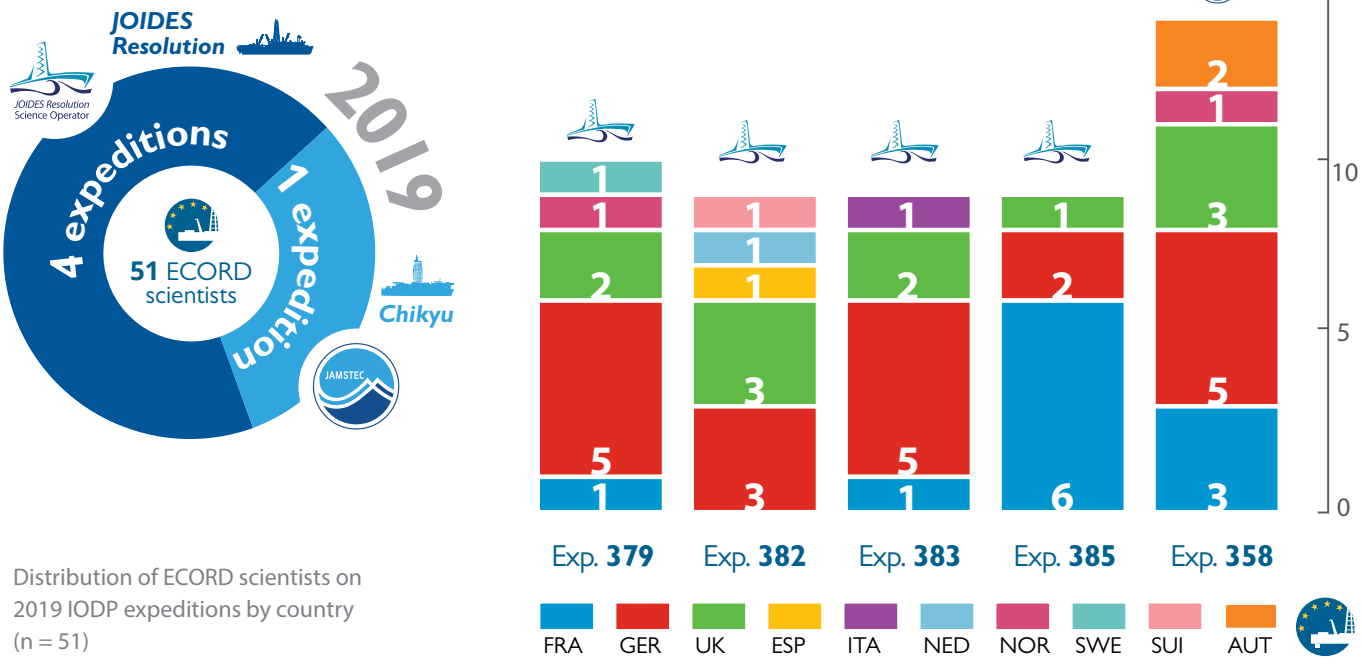
7 ECORD scientists
on each JR expedition

ECORD, as a contributing member of the ***JOIDES Resolution*** (JR) Consortium, was entitled to eight scientists on every expedition until 30 September 2019 and to seven scientists since 1 October 2019.

JAMSTEC

≥ 3 ECORD scientists
on each *Chikyu* expedition

ECORD, as a ***Chikyu*** member, is entitled to a minimum of three scientists on every *Chikyu* expedition.



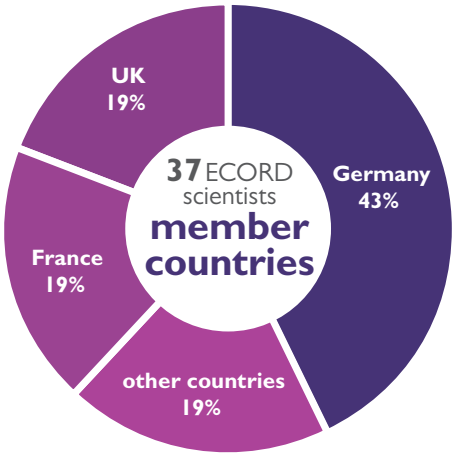
Distribution of ECORD scientists on 2019 IODP expeditions by country (n = 51)

ECORD participation in 2019 ***JOIDES Resolution*** expeditions

In 2019, **four expeditions** were implemented on the *JOIDES Resolution* (JR).

A total of 37 ECORD scientists from nine ECORD member countries were invited to participate and sail, including **three Co-chief Scientists** (all from Germany).

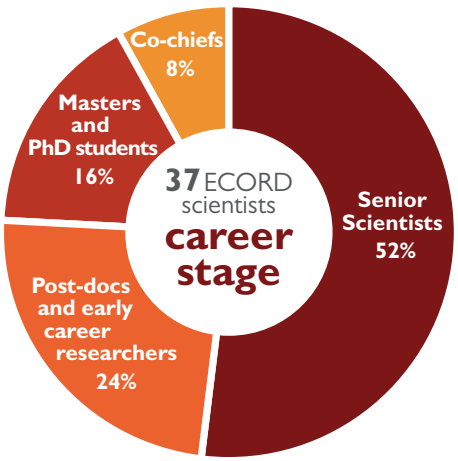
Exp. 379 | Exp. 382 | Exp. 383 | Exp. 385



ECORD participants on 2019 JR expeditions by country (n = 37)

Two of the 37 ECORD scientists participated following **special calls.**

More than two thirds of the ECORD scientists came from the three major ECORD contributors, Germany, France and the UK, and seven berths were allocated to scientists coming from other ECORD member countries (top circle diagram on the left).



ECORD participants on 2019 JR expeditions by career stage (n = 37).

Six PhD students and nine post-doctoral or early-career scientists had the opportunity to participate, making up 40% of the ECORD participants (bottom circle diagram on the left).

View at *JOIDES Resolution* during sunset at the dock in San Diego during IODP Expedition 385 (photo T. Höfig, IODP).

IODP Expedition 379

JOIDES Resolution Science Operator

18 January - 20 March

Amundsen Sea West Antarctic Ice Sheet History

Co-chief Scientist	Karsten Gohl (AWI, Bermerhaven, Germany)
Participating Scientists	Thorsten Bauersachs (Kiel University, Germany) Steve Bohaty (University of Southampton, UK) Margot Courtillat (University of Perpignan, France) Mariana Esteves (Arctic University of Norway, Norway) Thomas Frederichs (University of Bremen, Germany) Claus-Dieter Hillenbrand (British Antarctic Survey, UK) Johann Klages (AWI, Bermerhaven, Germany) Benedict Reinardy (Stockholm University, Sweden) Johan Renaudie (Museum für Naturkunde, Germany)
Outreach Officer	Vivien Cumming (UK)

Expedition website: *https://joidesresolution.org/expedition/379/*

The Amundsen Sea sector of Antarctica has long been considered the most vulnerable part of the West Antarctic Ice Sheet (WAIS) because of the great water depth at the grounding line and the absence of substantial ice shelves. Glaciers in this configuration are thought to be susceptible to rapid or runaway retreat. Ice flowing into the Amundsen Sea Embayment is undergoing the most rapid changes of any sector of the Antarctic Ice Sheet outside the Antarctic Peninsula, including changes caused by substantial grounding-line retreat over recent decades, as observed from satellite data. Recent models suggest that a threshold leading to the collapse of WAIS in this sector may have been already crossed and that much of the ice sheet could be lost even under relatively moderate greenhouse gas emission scenarios.

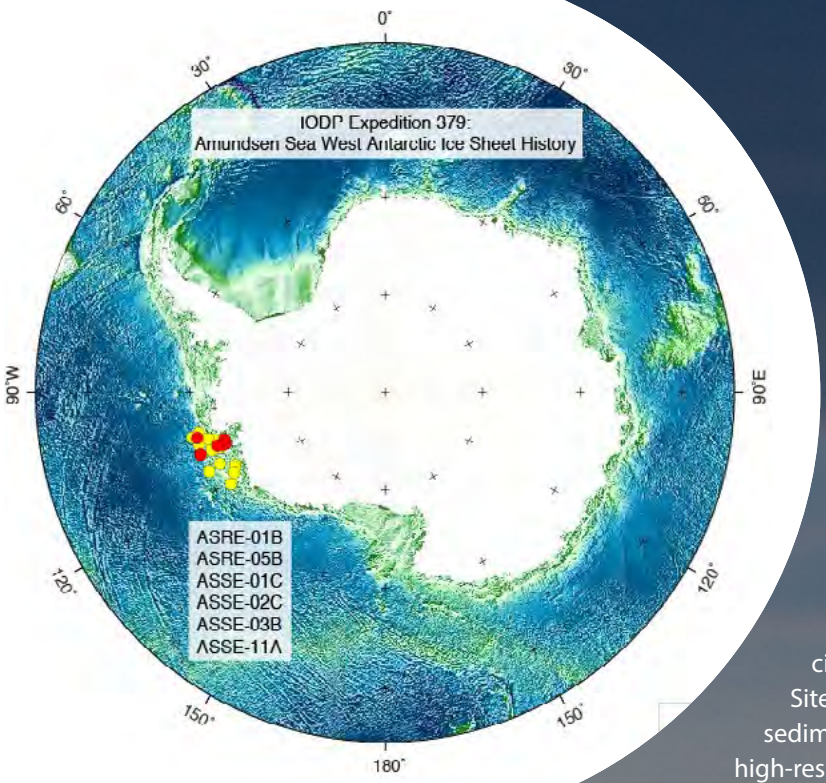
Drill cores from the Amundsen Sea provide tests of several key questions about controls on ice sheet stability. The cores offer a direct record of glacial history offshore from a drainage basin that receives ice exclusively from the WAIS, which allows clear comparisons between the WAIS history and low-latitude climate records. Today, warm Circumpolar Deep Water (CDW) is impinging onto the Amundsen Sea shelf and causing melting of the underside of the WAIS in most places. Reconstructions of past CDW intrusions can assess the ties between warm water upwelling and large-scale changes in past grounding-line positions. Carrying out these reconstructions offshore from the drainage basin that currently has the most substantial negative mass balance of ice anywhere in Antarctica is thus of prime interest to future predictions.

Exp. 379 Principal goals

The scientific objectives for this expedition were built on hypotheses about WAIS dynamics and related paleoenvironmental and paleoclimatic conditions. The main objectives are:

- to test the hypothesis that WAIS collapses occurred during the Neogene and Quaternary and, if so, when and under which environmental conditions;
- to obtain ice-proximal records of ice sheet dynamics in the Amundsen Sea that correlate with global records of ice-volume changes and proxy records for atmospheric and ocean temperatures;
- to study the stability of a marine-based WAIS margin and how warm deep-water incursions control its position on the shelf;
- to find evidence for earliest major grounded WAIS advances onto the middle and outer shelf;
- to test the hypothesis that the first major WAIS growth was related to the uplift of the Marie Byrd Land dome.

Further reading: *http://publications.iodp.org/preliminary_report/379/index.html*



IODP Expedition 379 completed two very successful drill sites on the continental rise of the Amundsen Sea. Site U1532 is located on a large sediment drift, now called Resolution Drift, and penetrated to 794 m with 90% recovery. Almost-continuous cores were collected from the Pleistocene through the Pliocene and into the late Miocene. At Site U1533, we drilled 383 m (70% recovery) into the more condensed sequence at the lower flank of the same sediment drift. The cores of both sites contain unique records that will enable study of the cyclicity of ice sheet advance and retreat processes as well as bottom-water circulation and water mass changes. In particular, Site U1532 revealed a sequence of Pliocene sediments with an excellent paleomagnetic record for high-resolution climate change studies of the previously sparsely sampled Pacific sector of the West Antarctic margin.

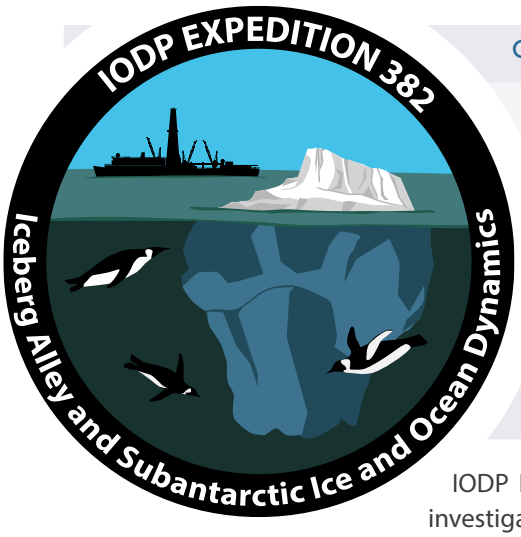
View on an iceberg from the *JOIDES Resolution* during IODP Expedition 379 (photo T. Fulton, IODP).

IODP Expedition 382

JOIDES Resolution Science Operator

20 March - 20 May

Iceberg Alley and Subantarctic Ice and Ocean Dynamics



Co-chief Scientist: Michael Weber (University Bonn, Germany)

Participating Scientists:
Ian Bailey (University of Exeter, UK)
Marga Garcia (University of Granada, Spain)
Marcus Gutjahr (GEOMAR, Kiel, Germany)
Ivan Hernández-Almeida (ETH Zurich, Switzerland)
Frida Snilsveit Hoem (Utrecht University, The Netherlands)
Victoria Peck (British Antarctic Survey, UK)
Lara F. Perez (British Antarctic Survey UK)
Thomas Ronge (AWI Bremerhaven, Germany)

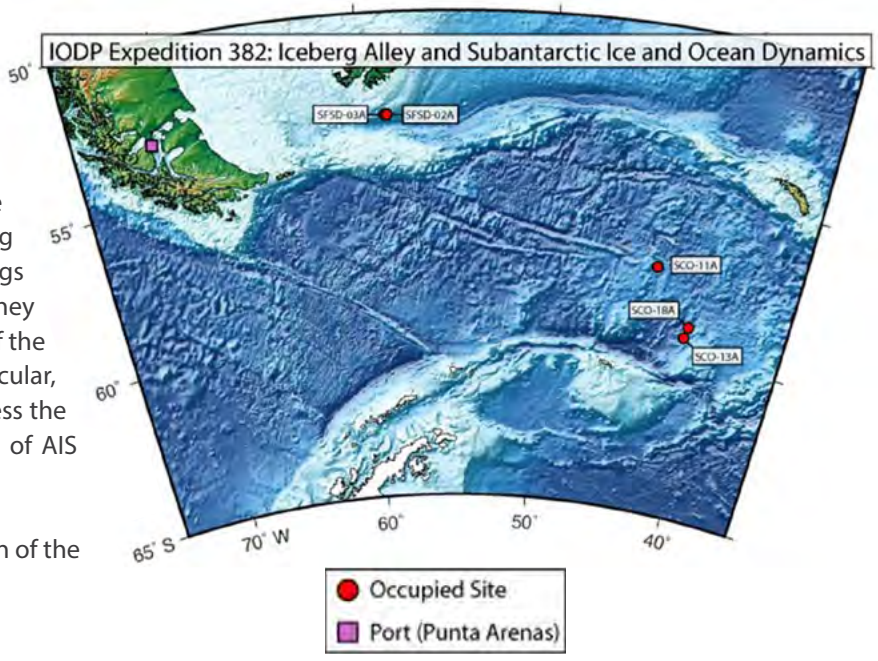
Expedition website: *https://joidesresolution.org/expedition/382/*

IODP Expedition 382: Iceberg Alley and Subantarctic Ice and Ocean Dynamics, investigated the long-term climate history of Antarctica, seeking to understand how polar ice sheets responded to changes in insolation and atmospheric CO_2 in the past and how ice sheet evolution influenced global sea level and vice versa. Five sites (U1534–U1538) were drilled east of the Drake Passage: two sites at 53.2°S at the northern edge of the Scotia Sea and three sites at 57.4°–59.4°S in the southern Scotia Sea. We recovered continuously deposited late Neogene sediment to reconstruct the past history and variability in Antarctic Ice Sheet (AIS) mass loss and associated changes in oceanic and atmospheric circulation.

Exp. 382 Principal goals

The sites from the southern Scotia Sea (Sites U1536–U1538) will be used to study the Neogene flux of icebergs through "Iceberg Alley," the main pathway along which icebergs calved from the margin of the AIS travel as they move equatorward into the warmer waters of the Antarctic Circumpolar Current (ACC). In particular, sediments from this area will allow us to assess the magnitude of iceberg flux during key times of AIS evolution, including the following:

- the middle Miocene glacial intensification of the East Antarctic Ice Sheet,
- the mid-Pliocene warm period,
- the late Pliocene glacial expansion of the West Antarctic Ice Sheet,
- the mid-Pleistocene transition (MPT), and
- the "warm interglacials" and glacial terminations of the last 800 ky.



We will use the geochemical provenance of iceberg-rafted detritus and other glacially eroded material to determine regional sources of AIS mass loss. We will also address interhemispheric phasing of ice sheet growth and decay, study the distribution and history of land-based versus marine-based ice sheets around the continent over time, and explore the links between AIS variability and global sea level.

Further reading: *http://publications.iodp.org/preliminary_report/382/index.html*

By comparing north–south variations across the Scotia Sea between the Pirie Basin (Site U1538) and the Dove Basin (Sites U1536 and U1537), IODP Expedition 382 will also deliver critical information on how climate changes in the Southern Ocean affect ocean circulation through the Drake Passage, meridional overturning in the region, water mass production, ocean–atmosphere CO_2 transfer by wind-induced upwelling, sea ice variability, bottom water outflow from the Weddell Sea, Antarctic weathering inputs, and changes in oceanic and atmospheric fronts in the vicinity of the ACC.

Comparing changes in dust proxy records between the Scotia Sea and Antarctic ice cores will also provide a detailed reconstruction of changes in the Southern Hemisphere westerlies on millennial and orbital timescales for the last 800 ky. Extending the ocean dust record beyond the last 800 ky will help to evaluate dust-climate couplings since the Pliocene, the potential role of dust in iron fertilization and atmospheric CO_2 drawdown during glacials, and whether dust input to Antarctica played a role in the MPT.

The principal scientific objective of Subantarctic Front Sites U1534 and U1535 at the northern limit of the Scotia Sea is to reconstruct and understand how ocean circulation and intermediate water formation responds to changes in climate with a special focus on the connectivity between the Atlantic and Pacific basins, the "cold water route." The Subantarctic Front contourite drift, deposited between 400 and 2000 m water depth on the northern flank of an east–west trending trough off the Chilean continental shelf, is ideally situated to monitor millennial- to orbital-scale variability in the export of Antarctic Intermediate Water beneath the Subantarctic Front. During IODP Expedition 382, we recovered continuously deposited sediments from this drift spanning the late Pleistocene (from ~0.78 Ma to recent) and from the late Pliocene (~3.1–2.6 Ma).

These sites are expected to yield a wide array of paleoceanographic records that can be used to interpret past changes in the density structure of the Atlantic sector of the Southern Ocean, track migrations of the Subantarctic Front, and give insights into the role and evolution of the cold water route over significant climate episodes, including the following:

- the most recent warm interglacials of the late Pleistocene and
- the intensification of Northern Hemisphere glaciation.

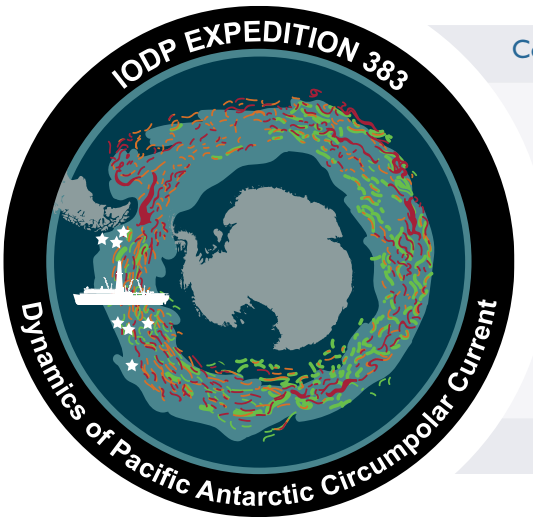
View from the *JOIDES Resolution* during IODP Expedition 382 (photo G. Messe, IODP).

IODP Expedition 383

JOIDES Resolution Science Operator

20 May - 20 July

Dynamics of Pacific Antarctic Circumpolar Current (DYNAPACC)



Co-chief Scientist: Frank Lamy (AWI, Bremerhaven, Germany)

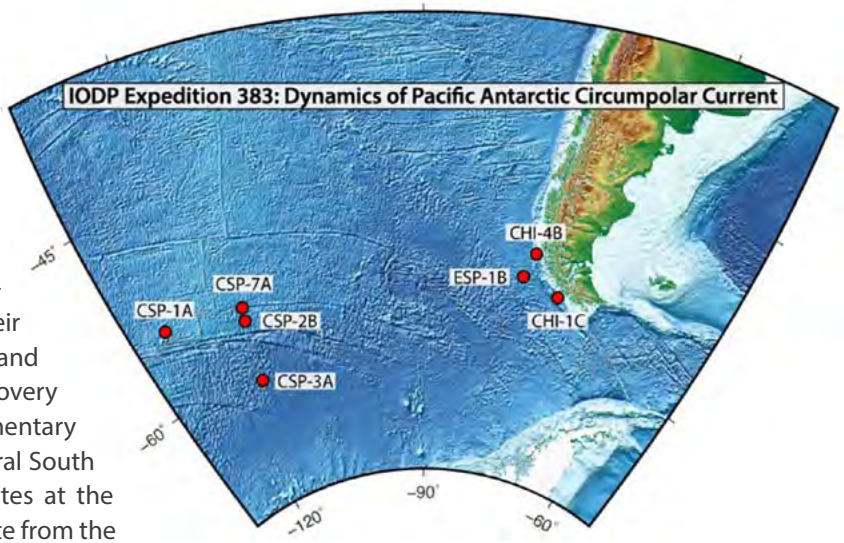
Participating Scientists:
Helge Arz (Institute for Baltic Sea Research Warnemünde, Germany)
Oliver Esper (AWI, Bremerhaven, Germany)
Elisa Malinverno (University of Milano-Bicocca, Italy)
Elisabeth Michel (LSCE, Gif-sur-Yvette, France)
Anieke Brombacher (NOC, Southampton, UK)
Lester Lembke-Jene (AWI, Bremerhaven, Germany)
Mariem Saavreda-Pellitero (University of Birmingham, UK)
Simone Moretti (MPI Mainz, Germany)

Expedition website: *https://joidesresolution.org/expedition/383/*

The Antarctic Circumpolar Current (ACC) is the world's strongest zonal current system that connects all three major ocean basins of the global ocean and therefore integrates and responds to global climate variability. Its flow is largely driven by strong westerly winds and constricted to its narrowest extent in the Drake Passage. Transport of fresh and cold surface and intermediate water masses through the Drake Passage (cold-water route) strongly affects the Atlantic Meridional Overturning Circulation together with the inflow of Indian Ocean water masses (warm-water route). Both oceanographic corridors are critical for the South Atlantic contribution to Meridional Overturning Circulation changes. In contrast to the Atlantic and Indian sectors of the ACC, and with the exception of drill cores from the Antarctic continental margin and off New Zealand, the Pacific sector of the ACC lacks information on its Cenozoic paleoceanography from deep-sea drilling records.

Exp. 383 Principal goals

To advance our knowledge and understanding of Miocene to Holocene atmosphere-ocean-cryosphere dynamics in the Pacific and their implications for regional and global climate and atmospheric CO_2, International Ocean Discovery Program (IODP) Expedition 383 recovered sedimentary sequences at (1) three sites located in the central South Pacific (U1539, U1540, and U1541), (2) two sites at the Chile margin (U1542 and U1544), and (3) one site from the pelagic eastern South Pacific (U1543) close to the entrance to the Drake Passage. Because of persistently stormy conditions and the resulting bad weather avoidance, we were not successful in recovering the originally planned Proposed Site CSP-3A in the central South Pacific in the Polar Frontal Zone.



The drilled sediments at Sites U1541 and U1543 reach back to the late Miocene, and those at Site U1540 reach back to the early Pliocene. High sedimentary rate Pleistocene sedimentary sequences were drilled both in the central South Pacific (Site U1539) and along the Chile margin.

Further reading: *http://publications.iodp.org/preliminary_report/383/index.html*

Taken together, the sites represent a depth transect from ~1100 m at the Chile margin site (U1542) to ~4070 m in the central South Pacific (Site U1539) and allow investigation of changes in the vertical structure of the ACC, a key issue for understanding the role of the Southern Ocean in the global carbon cycle. The sites are located at latitudes and water depths where sediments will allow the application of a wide range of siliciclastic-, carbonate-, and opal-based proxies to address our objectives of reconstructing with unprecedented stratigraphic detail surface to deep-ocean variations and their relation to atmosphere and cryosphere changes through stadial to interstadial, glacial to interglacial, and warmer than present time intervals.

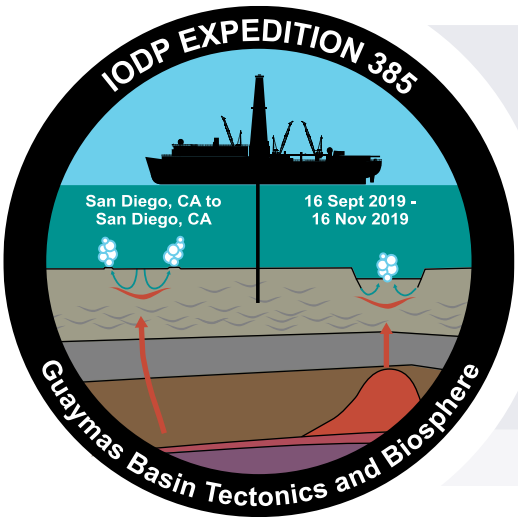
View from the *JOIDES Resolution* during IODP Expedition 382 (photo G. Messe, IODP).

IODP Expedition 385

JOIDES Resolution Science Operator

16 September - 16 November

Guaymas Basin Tectonics and Biosphere



Participating Scientists

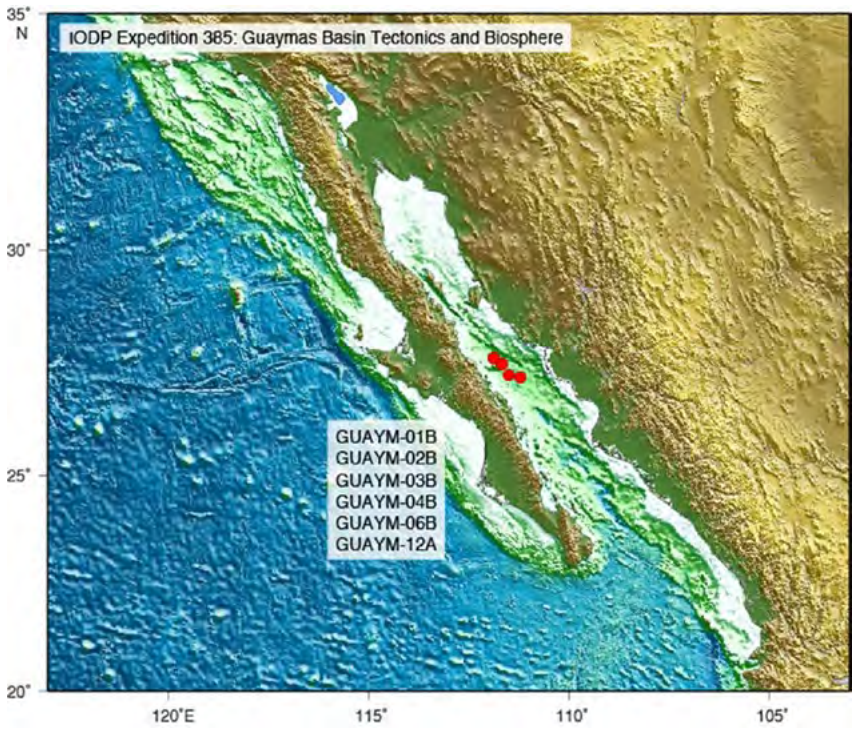
Martine Buartier (Université Bourgogne Franche-Comté, France)
Swanne Gontharet (Université du Littoral Côte d'Opale, France)
Verena Heuer (University of Bremen, Germany)
Laurent Toffin (IFREMER, Brest, France)
Armelle Riboulleau (Université de Lille, France)
Christophe Galerne (GEOMAR, Kiel, Germany)
Lucie Pastor (IFREMER, Brest, France)
Louise Kornneef (University of Plymouth, UK)
Florian Schubert (GFZ Potsdam, Germany)

Expedition website: *https://joidesresolution.org/expedition/385/*

The Guaymas Basin in the Gulf of California is a young marginal rift basin characterized by active seafloor spreading and rapid deposition of organic-rich sediments from highly productive overlying waters. The high sedimentation rates in combination with an active spreading system produce distinct oceanic crust where the shallowest magmatic emplacement occurs as igneous intrusion into overlying sediments. The intrusion of magma into organic-rich sediments creates a dynamic environment where tightly linked physical, chemical, and biological processes regulate the cycling of sedimentary carbon and other elements, not only in a narrow hydrothermal zone at the spreading center but also in widely distributed off-axis venting. Heat from magmatic sills thermally alters organic-rich sediments, releasing CO_2, CH_4, petroleum, and other alteration products. This heat also drives advective flow, which distributes these alteration products in the subsurface and may also release them to the water column. Within the sediment column, the thermal and chemical gradients created by this process represent environments rich in chemical energy that support microbial communities at and below the seafloor. These communities may play a critical role in chemical transformations that influence the stability and transport of carbon in crustal biospheres.

Collectively, these processes have profound implications for the exchange of heat and mass between the lithosphere and overlying water column and may determine the long-term fate of carbon accumulation in organic-rich sediments.

The fate of carbon deposited in Guaymas Basin, throughout the Gulf of California, and more broadly within similar marginal seas throughout the world, depends on the relative efficiencies of interacting physical, chemical, and microbial processes, some working to sequester carbon and others working to release carbon back to the ocean and the atmosphere.



Further reading: *http://iodp.tamu.edu/scienceops/expeditions/guaymas_basin_tectonics_biosphere.html*

Exp. 385 Principal goals

Drill core samples from IODP Expedition 385 to Guaymas Basin will enable us to study the above processes, their interactions, and their ultimate effects on carbon cycling. Samples obtained from scientific drilling are crucial to these goals, which include:

- quantifying the sedimentary and elemental inputs to the system through time and their variation with oceanographic and climatic conditions;

- sampling igneous sills and the surrounding sediments to determine the products and efficiency of alteration and key hydrologic factors such as sediment type, faulting, and permeability evolution; and

- studying subsurface microbial communities hosted by alteration products to determine their efficiency at capturing carbon-bearing alteration products and to further our understanding of the conditions that limit life in the deep biosphere.

Verena Heuer (Organic Geochemist, University of Bremen, Germany) sampling the core catcher of the 500th core of IODP Expedition 385 (photo T. Fulton, IODP)

IODP Expedition 358

7 October 2018 - 31 March 2019

NanTroSEIZE: Plate Boundary Deep Riser 4

Exploring Japan's Earthquake Zone

Co-chief Scientist	Matt Ikari (MARUM, Bremen, Germany)
Participating Scientists	Marianne Conin (University of Lorraine, France) Mai-Linh Doan (University of Grenoble-Alpes, France) Anja Schleicher (GFZ, Potsdam, Germany) Daniel Faulkner (University of Liverpool, UK) Achim Kopf (MARUM, Bremen, Germany) Michael Strasser (University of Innsbruck, Austria) John Bedford (University of Liverpool, UK) Wi-Lei Hong (Geological Survey, Tromsø, Norway) Jade Ditilleul (University of Lorraine, France) Pauline Cornard (University College London, UK) Dominik Jäger (University of Innsbruck, Austria) Junli Zhang (MARUM, Bremen, Germany) Katja Stanislowski (MARUM, Bremen, Germany)
Further reading:	*http://www.jamstec.go.jp//e/nantroseize/expedition_358.html*

IODP Expedition 358: NanTroSEIZE Plate Boundary Deep Riser 4 which started on 7 October 2018 (see ECORD Annual Report 2018) ended on 31 March 2019.

Exp. 358 Principal goals

The central scientific objectives of the NanTroSEIZE project were to:

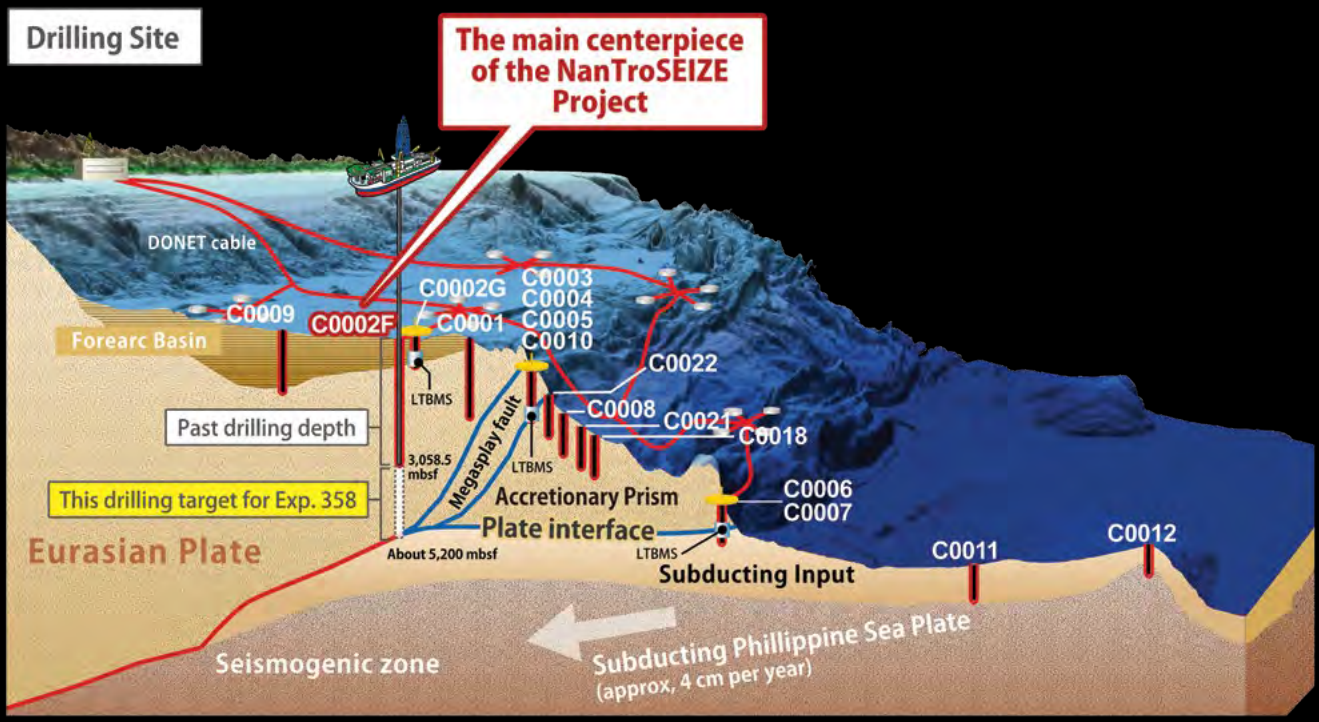
- determine the composition, stratigraphy, and deformational history of the Miocene accretionary prism;
- reconstruct its thermal, diagenetic, and metamorphic history;
- determine horizontal stress orientations and magnitudes;
- investigate the mechanical and hydrological properties of the upper plate of the seismogenic plate boundary.

IODP Site C0002 is the deep centerpiece of the NanTroSEIZE Project, intended to access the plate interface fault system at a location where it is believed to be capable of seismogenic locking and slip, and to have slipped coseismically in the 1944 Tonankai earthquake. This drilling target also is in close proximity to the location where a cluster of very low frequency (VLF) seismic events and the first tectonic tremor recorded in any accretionary prism setting has been found, all suggesting fault processes related to the up-dip limit of megathrust seismogenic mechanics are active here.

The main operational goal of IODP Expedition 358 was to deepen riser hole C0002F/N/P from 3000 mbsf to the primary megathrust fault target at ~5200 mbsf, using logging-while-drilling (LWD), downhole measurements, and drill cuttings analysis extensively, in addition to limited coring intervals. Unfortunately, the deepest penetration was of 3262 mbsf, i.e. shallower than targeted, but still the deepest hole ever drilled in a scientific ocean drilling programme.

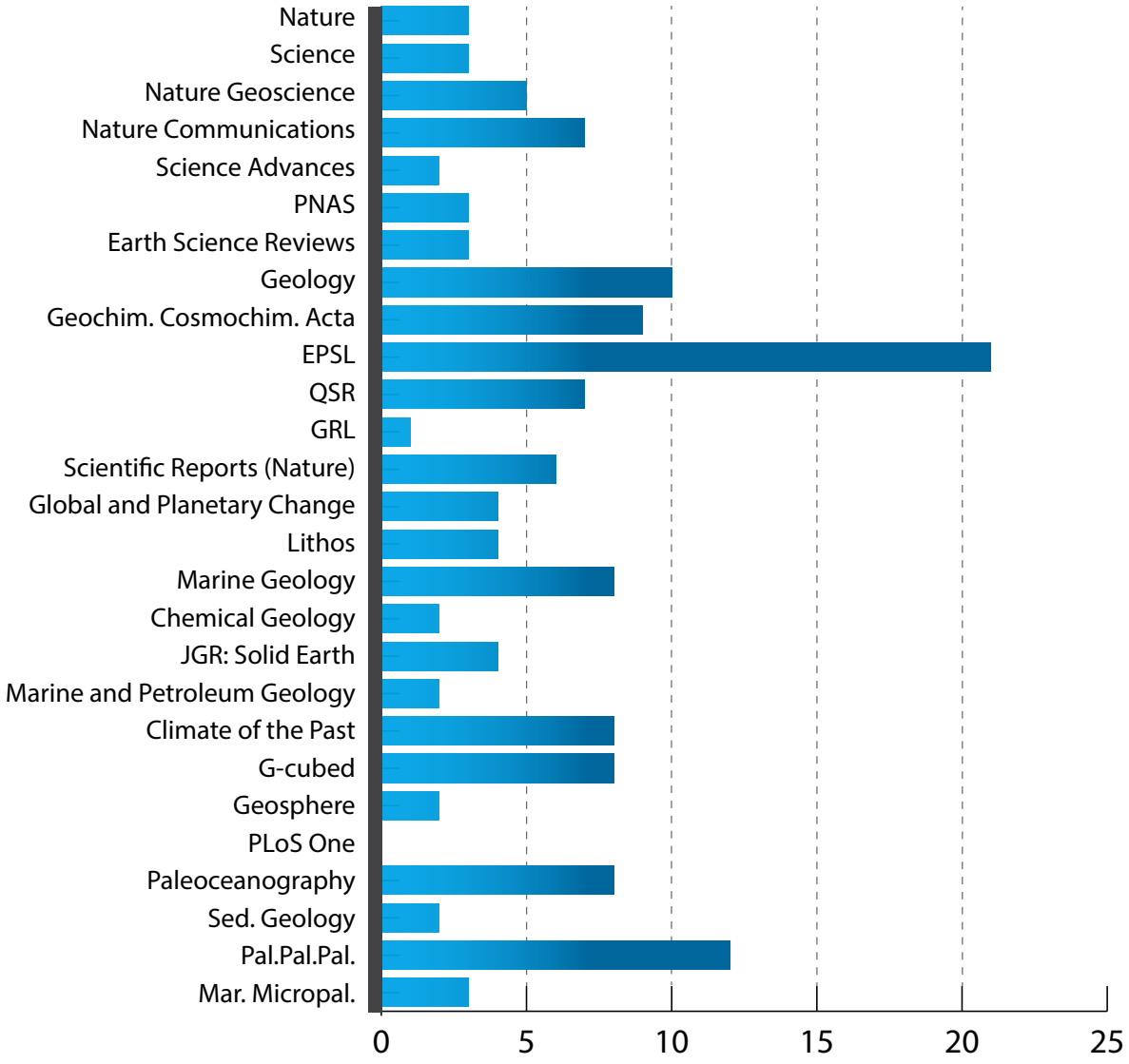
This expedition had nine Science Leaders (five Japanese, three U.S. and one ECORD), three Expedition Project Managers and 39 Science Party members, of those 32% from ECORD countries, 26% from the USA and 40% from Japan. There are two ongoing reviews, one about the management of this project and the second one is a technical review.

ECORD participants on 2018/2019 *Chikyu* expedition by country (left, n = 14) and by career stage (right, n = 14).



Credits: IODP/JAMSTEC

5. Selected 2019 IODP publications from ECORD scientists



Publications involving authors from ECORD member countries in journals ranked after their Impact Factor (n = 138; not showing 49 publications in other journals).

5. Selected 2019 IODP publications from ECORD scientists

187 publications

1. Agrinier, P. et al. Strong impact of ion filtration on the isotopic composition of chlorine in young clay-rich oceanic sediment pore fluids. Geochimica et Cosmochimica Acta 245, 525–541 (2019).

2. Aiello, I. W. et al. Climate, sea level and tectonic controls on sediment discharge from the Sepik River, Papua New Guinea during the Mid- to Late Pleistocene. Marine Geology 415, 105954 (2019).

3. Akizawa, N., Früh-Green, G. L., Tamura, A., Tamura, C. & Morishita, T. Compositional heterogeneity and melt transport in mantle beneath Mid-Atlantic Ridge constrained by peridotite, dunite, and wehrlite from Atlantis Massif. Lithos 105364 (2019).

4. Albers, E., Schroeder, T. & Bach, W. Melt Impregnation of Mantle Peridotite Facilitates High-Temperature Hydration and Mechanical Weakening: Implications for Oceanic Detachment Faults. Geochem. Geophys. Geosyst. 20, 84–108 (2019).

5. Alonso-Garcia, M. et al. Sea-surface temperature, productivity and hydrological changes in the Northern Indian Ocean (Maldives) during the interval ~575-175 ka (MIS 14 to 7). Palaeogeography, Palaeoclimatology, Palaeoecology 536, 109376 (2019).

6. Alvarez, S. A. et al. Diversity decoupled from ecosystem function and resilience during mass extinction recovery. Nature 574, 242–245 (2019).

7. Anderson, R. F. et al. Deep-Sea Oxygen Depletion and Ocean Carbon Sequestration During the Last Ice Age. Global Biogeochemical Cycles 33, 301–317 (2019).

8. Ando, A., Kuroda, J., Werner, R., Hoernle, K. & Huber, B. T. Post-Eocene intensification of deep-water circulation in the central South Pacific: Micropalaeontological clues from dredged sites along the eastern Manihiki Plateau margin. Terra Nova 31, 28–38 (2019).

9. Andò, S. et al. Integrating heavy-mineral, geochemical and biomarker analyses of Plio-Pleistocene sandy and silty turbidites: a novel approach for provenance studies (Indus Fan, IODP Expedition 355). Geol. Mag. 267, 1–10 (2019).

10. Ardenghi, N. et al. Temperature and moisture variability in the eastern Mediterranean region during Marine Isotope Stages 11–10 based on biomarker analysis of the Tenaghi Philippon peat deposit. Quaternary Science Reviews 225, 105977 (2019).

11. Armbrecht, L. H. et al. Ancient DNA from marine sediments: Precautions and considerations for seafloor coring, sample handling and data generation. Earth-Science Reviews 196, 102887 (2019).

12. Auderset, A. et al. Gulf Stream intensification after the early Pliocene shoaling of the Central American Seaway. Earth and Planetary Science Letters 520, 268–278 (2019).

13. Badger, M., Chalk, T. B., Foster, G. L., the, P. B. C. O.2019. Insensitivity of alkenone carbon isotopes to atmospheric CO2 at low to moderate CO2 levels. Clim. Past *doi:10.5194/cp-15-539-2019*

14. Bale, N. J., Hennekam, R., Hopmans, E. C.2019. Biomarker evidence for nitrogen-fixing cyanobacterial blooms in a brackish surface layer in the Nile River plume during sapropel deposition. Geology 47, 1088–1092 (2019).

15. Bankole, S. A., Buckman, J., Stow, D. & Lever, H. Automated Image Analysis of Mud and Mudrock Microstructure and Characteristics of Hemipelagic Sediments: IODP Expedition 339. J. Earth Sci. 30, 407–421 (2019).

16. Bankole, S. A., Buckman, J., Stow, D. & Lever, H. Grain-size analysis of mudrocks: A new semi-automated method from SEM images. Journal of Petroleum Science and Engineering 174, 244–256 (2019).

17. Bao, R., Jia, G. & Zhang, C. Spatiotemporal variation of organic geochemical properties since the mid-Miocene in the deep South China Sea (IODP Expedition 349). Journal of Asian Earth Sciences 183, 103961 (2019).

18. Bao, R., Jia, G. & Zhang, C. Spatiotemporal variation of organic geochemical properties since the mid-Miocene in the deep South China Sea (IODP Expedition 349). Journal of Asian Earth Sciences 183, 103961 (2019).

19. de Bar, M. W., Rampen, S. W., Hopmans, E. C., Sinninghe Damste, J. S. & Schouten, S. Constraining the applicability of organic paleotemperature proxies for the last 90 Myrs. Organic Geochemistry 128, 122–136 (2019).

20. Barry, P. H. et al. Forearc carbon sink reduces long-term volatile recycling into the mantle. Nature 568, 487–492 (2019).

21. Beltran, C., Rousselle, G., de Rafélis Journal of, M.2019. Evolution of the Zonal Gradients Across the Equatorial Pacific During the Miocene–Pleistocene. Geology 89, 242–252 (2019).

22. Bendif, E. M. et al. Repeated species radiations in the recent evolution of the key marine phytoplankton lineage Gephyrocapsa. Nature Communications 10, 237–9 (2019).

23. Bergen, J. A., Truax, S., III, de Kaenel Geological, E.2019. BP Gulf of Mexico Neogene Astronomically-tuned Time Scale (BP GNATTS). GSA Bulletin 131, 1871–1888 (2019).

24. Bergmann, F., Schwenk, T., Spiess, V. & France-Lanord, C. Middle to Late Pleistocene Architecture and Stratigraphy of the Lower Bengal Fan—Integrating Multichannel Seismic Data and IODP Expedition 354 Results. Geochem. Geophys. Geosyst. 21, 397 (2020).

25. Berndt, C. et al. Tectonic Controls on Gas Hydrate Distribution Off SW Taiwan. J. Geophys. Res. Solid Earth 124, 1164–1184 (2019).

26. Bialik, O. M., Frank, M., Betzler, C., Zammit, R. & Waldmann, N. D. Two-step closure of the Miocene Indian Ocean Gateway to the Mediterranean. Scientific Reports 9, 1–10 (2019).

27. Blake-Mizen, K. et al. Southern Greenland glaciation and Western Boundary Undercurrent evolution recorded on Eirik Drift during the late Pliocene intensification of Northern Hemisphere glaciation. Quaternary Science Reviews 209, 40–51 (2019).

28. Blaser, P., Pöppelmeier, F., Schulz, H., acta, M. G. E. C.2019. The resilience and sensitivity of Northeast Atlantic deep water εNd to overprinting by detrital fluxes over the past 30,000 years. Geochimica et Cosmochimica Acta 245, 79–97 (2019).

29. Bono, R. K., Tarduno, J. A. & Bunge, H.-P. Hotspot motion caused the Hawaiian-Emperor Bend and LLSVPs are not fixed. Nature Communications 10, 1–9 (2019).

30. Boswell, S. M., Toucanne, S., Pitel-Roudaut, M.2019. Enhanced surface melting of the Fennoscandian Ice Sheet during periods of North Atlantic cooling. Geology

31. Boulton, C. et al. Temperature-dependent frictional properties of heterogeneous Hikurangi Subduction Zone input sediments, ODP Site 1124. Tectonophysics 757, 123–139 (2019).

32. Bradbury, H. J. & Turchyn, A. V. Reevaluating the carbon sink due to sedimentary carbonate formation in modern marine sediments. Earth and Planetary Science Letters 519, 40–49 (2019).

33. Braga, J. C. et al. Microbialites in Last Glacial Maximum and deglacial reefs of the Great Barrier Reef (IODP Expedition 325, NE Australia). Palaeogeography, Palaeoclimatology, Palaeoecology 514, 1–17 (2019).

34. Bridgestock, L., Hsieh, Y.-T., Porcelli, D. & Henderson, G. M. Increased export production during recovery from the Paleocene–Eocene thermal maximum constrained by sedimentary Ba isotopes. Earth and Planetary Science Letters 510, 53–63 (2019).

35. Buchs, D. M. & Oemering, S. A. P. Long-term non-erosive nature of the south Costa Rican margin supported by arc-derived sediments accreted in the Osa Mélange. Earth and Planetary Science Letters 115968 (2019).

36. Busson, J. et al. High-resolution stratigraphic forward modeling of a Quaternary carbonate margin: Controls and dynamic of the progradation. Sedimentary Geology 379, 77–96 (2019).

37. Català, A., Cacho, I., Frigola, J., Pena, L. D. & Lirer, F. Holocene hydrography evolution in the Alboran Sea: a multi-record and multi-proxy comparison. Clim. Past 15, 927–942 (2019).

38. Chalk, T. B., Foster, G. L. & Wilson, P. A. Dynamic storage of glacial CO2 in the Atlantic Ocean revealed by boron [CO32−] and pH records. Earth and Planetary Science Letters 510, 1–11 (2019).

39. Chao, L. et al. Depositional architecture and structural evolution of a region immediately inboard of the locus of continental breakup (Liwan Sub-basin, South China Sea). GSA Bulletin 131, 1059 (2019).

40. Chen, C. et al. Calcium isotopic compositions of oceanic crust at various spreading rates. Geochimica et Cosmochimica Acta (2019).

41. Clotten, C. et al. On the causes of Arctic sea ice in the warm Early Pliocene. Scientific Reports 9, 1–8 (2019).

42. Coletti, G. et al. Environmental evolution and geological significance of the Miocene carbonates of the Eratosthenes Seamount (ODP Leg 160). Palaeogeography, Palaeoclimatology, Palaeoecology 530, 217–235 (2019).

43. Cosgrove, G. I. E., Hodgson, D. M., Mountney, N. P. & McCaffrey, W. D. High-resolution correlations of strata within a sand-rich clinothem using grain fabric data, offshore New Jersey, USA. Geosphere 15, 1291–1322 (2019).

44. Cramwinckel, M. J. et al. Harmful algae and export production collapse in the equatorial Atlantic during the zenith of Middle Eocene Climatic Optimum warmth. Geology 47, 247–250 (2019).

45. Dailey, S. K. et al. Large-scale mass wasting on the Miocene continental margin of western India. GSA Bulletin 132, 85 (2019).

46. Davies, A., Hunter, S. J., Gréselle, B., Haywood, A. M. & Robson, C. Evidence for seasonality in early Eocene high latitude sea-surface temperatures. Earth and Planetary Science Letters 519, 274–283 (2019).

47. Debret, B. et al. Shallow forearc mantle dynamics and geochemistry: New insights from IODP Expedition 366. Lithos 326-327, 230–245 (2019).

48. Deplazes, G. et al. Fingerprint of tropical climate variability and sea level in sediments of the Cariaco Basin during the last glacial period. Sedimentology 66, 1967–1988 (2019).

49. Dick, H. J. B. et al. Dynamic Accretion Beneath a Slow-Spreading Ridge Segment: IODP Hole 1473A and the Atlantis Bank Oceanic Core Complex. J. Geophys. Res. Solid Earth 88, 319 (2019).

50. Diester-Haass, L. & Faul, K. Paleoproductivity Reconstructions for the Paleogene Southern Ocean: A Direct Comparison of Geochemical and Micropaleontological Proxies. Paleoceanography and Paleoclimatology 34, 79–97 (2019).

51. Ding, W. et al. Lateral evolution of the rift-to-drift transition in the South China Sea: Evidence from multi-channel seismic data and IODP Expeditions 367&368 drilling results. Earth and Planetary Science Letters 115932 (2019).

52. Dirksen, J. P., Hennekam, R., Geerken, E. & Reichart, G.-J. A Novel Approach Using Time-Depth Distortions to Assess Multicentennial Variability in Deep-Sea Oxygen Deficiency in the Eastern Mediterranean Sea During Sapropel S5. Paleoceanography and Paleoclimatology 34, 774–786 (2019).

53. Duncan, B. et al. Lipid biomarker distributions in Oligocene and Miocene sediments from the Ross Sea region, Antarctica: Implications for use of biomarker proxies in glacially-influenced settings. Palaeogeography, Palaeoclimatology, Palaeoecology 516, 71–89 (2019).

54. Dupont, L. M., Caley, T. & Castañeda, I. S. Effects of atmospheric CO_2 variability of the past 800 kyr on the biomes of southeast Africa. Clim. Past 15, 1083–1097 (2019).

55. Eberli, G. P. & Betzler, C. Characteristics of modern carbonate contourite drifts. Sedimentology 66, 1163 (2019).

56. Elling, F. J. et al. Archaeal lipid biomarker constraints on the Paleocene-Eocene carbon isotope excursion. Nature Communications 10, 242–10 (2019).

57. Fagereng et al. Mixed deformation styles observed on a shallow subduction thrust, Hikurangi margin, New Zealand. Geology 47, 872–876 (2019).

58. Farmer, J. R. et al. Deep Atlantic Ocean carbon storage and the rise of 100,000-year glacial cycles. Nature Geosci 12, 355–360 (2019).

59. Freymuth, H., Andersen, M. B. & Elliott, T. Uranium isotope fractionation during slab dehydration beneath the Izu arc. Earth and Planetary Science Letters 522, 244–254 (2019).

60. Galeotti, S. et al. Stratigraphy of early to middle Eocene hyperthermals from Possagno (Southern Alps, Italy) and comparison with global carbon isotope records. Palaeogeography, Palaeoclimatology, Palaeoecology 527, 39–52 (2019).

61. Gillis, K. M. & Coogan, L. A. A Review of the Geological Constraints on the Conductive Boundary Layer at the Base of the Hydrothermal System at Mid-Ocean Ridges. Geochem. Geophys. Geosyst. 20, 67–83 (2019).

62. Glombitza, C., Egger, M., Røy, H. & Jorgensen, B. B. Controls on volatile fatty acid concentrations in marine sediments (Baltic Sea). Geochimica et Cosmochimica Acta 258, 226–241 (2019).

63. Greene, S. E. et al. Early Cenozoic Decoupling of Climate and Carbonate Compensation Depth Trends. Paleoceanography and Paleoclimatology 34, 930–945 (2019).

64. Greenop, R. et al. Orbital Forcing, Ice Volume, and CO2 Across the Oligocene-Miocene Transition. Paleoceanography and Paleoclimatology 34, 316–328 (2019).

65. Gruetzner, J. et al. A New Seismic Stratigraphy in the Indian-Atlantic Ocean Gateway Resembles Major Paleo-Oceanographic Changes of the Last 7 Ma. Geochem. Geophys. Geosyst. 20, 339–358 (2019).

66. Gulick, S. P. S. et al. The first day of the Cenozoic. PNAS 116, 19342–19351 (2019).

67. Hahn, A., Bowen, M. G., Clift, P. D., Kulhanek, D. K. & Lyle, M. W. Testing the analytical performance of handheld XRF using marine sediments of IODP Expedition 355. Geol. Mag. 355, 1–5 (2019).

68. Hallenberger, M. et al. Increased fluvial runoff terminated inorganic aragonite precipitation on the Northwest Shelf of Australia during the early Holocene. Scientific Reports 9, 1–9 (2019).

69. Hartman, J. D., Sangiorgi, F., Bijl, P. K. & Versteegh, G. J. M. Nucicla umbiliphora gen. et sp. nov.: a Quaternary peridinioid dinoflagellate cyst from the Antarctic margin. Palynology 43, 94–103 (2019).

70. Hasenfratz, A. P. et al. The residence time of Southern Ocean surface waters and the 100,000-year ice age cycle. Science 363, 1080–1084 (2019).

71. He, J., Garzanti, E., Cao, L. & Wang, H. The zircon story of the Pearl River (China) from Cretaceous to present. Earth-Science Reviews 103078 (2019).

72. Head, M. J. Formal subdivision of the Quaternary System/Period: Present status and future directions. Quaternary International 500, 32–51 (2019).

73. Head, M. J. & Mantilla-Duran, F. Atlanticodinium striaticonulum n. gen., n. sp., a widespread extant dinoflagellate cyst from the late Cenozoic, and its comparison with Atlanticodinium janduchenei (Head et al., 1989) n. comb. Marine Micropaleontology 101774 (2019).

74. Henehan, M. J. et al. Rapid ocean acidification and protracted Earth system recovery followed the end-Cretaceous Chicxulub impact. PNAS 116, 22500–22504 (2019).

75. Hochmuth, K., Gohl, K., Uenzelmann-Neben, G. & Werner, R. Multiphase magmatic and tectonic evolution of a large igneous province - Evidence from the crustal structure of the Manihiki Plateau, western Pacific. Tectonophysics 750, 434–457 (2019).

76. Ridge: The temporal and spatial diversity of South Atlantic intraplate volcanism and its possible origin. Geochimica et Cosmochimica Acta 245, 16–34 (2019).

77. Humblet, M. et al. Late glacial to deglacial variation of coralgal assemblages in the Great Barrier Reef, Australia. Global and Planetary Change 174, 70–91 (2019).

78. Hüpers, A. et al. Spatiotemporal Characterization of Smectite-to-Illite Diagenesis in the Nankai Trough Accretionary Prism Revealed by Samples From 3 km Below Seafloor. Geochem. Geophys. Geosyst. 20, 933–951 (2019).

79. Hutchinson, D. K. et al. Arctic closure as a trigger for Atlantic overturning at the Eocene-Oligocene Transition. Nature Communications 10, 1–9 (2019).

80. Imachi, H. et al. Cultivable microbial community in 2-km-deep, 20-million-year-old subseafloor coalbeds through ~1000 days anaerobic bioreactor cultivation. Scientific Reports 9, 16213–16 (2019).

81. Incarbona, A., Di Stefano, E., Maiorano, P., Marino, M. & Pelosi, N. The response of calcareous nannoplankton to sea surface variability at Ceara Rise during the early Pleistocene glacial-interglacial cycles. Italian Journal of Geosciences 138, 3–16 (2019).

82. Isola, I. et al. The 4.2 ka event in the central Mediterranean: New data from a Corchia speleothem (Apuan Alps, central Italy). Clim. Past 15, 135–151 (2019).

83. Jaeger, D., Stalder, R., Masago, H. & Strasser, M. OH defects in quartz as a provenance tool: Application to fluvial and deep marine sediments from SW Japan. Sedimentary Geology 388, 66–80 (2019).

84. Jehle, S., Bornemann, A., Lägel, A. F., Deprez, A. & Speijer, R. P. Paleoceanographic changes across the Latest Danian Event in the South Atlantic Ocean and planktic foraminiferal response. Palaeogeography, Palaeoclimatology, Palaeoecology 525, 1–13 (2019).

85. Jiang, F., Xiong, Z., Frank, M., Yin, X. & Li, A. The evolution and control of detrital sediment provenance in the middle and northern Okinawa Trough since the last deglaciation: Evidence from Sr and Nd isotopes. Palaeogeography, Palaeoclimatology, Palaeoecology 522, 1–11 (2019).

86. Jones, M. T. et al. Mercury anomalies across the Palaeocene–Eocene Thermal Maximum. Clim. Past 15, 217–236 (2019).

87. Kast, E. R. et al. Nitrogen isotope evidence for expanded ocean suboxia in the early Cenozoic. Science 364, 386–389 (2019).

88. Kim, J. et al. Naturally occurring, microbially induced smectite-to-illite reaction. Geology 47, 535–539 (2019).

89. Kioka, A., Tsuji, T., Otsuka, H. & Ashi, J. Methane Concentration in Mud Conduits of Submarine Mud Volcanoes: A Coupled Geochemical and Geophysical Approach. Geochem. Geophys. Geosyst. 20, 792–813 (2019).

90. Kirillova, V., Osborne, A. H., Störling, T. & Frank, M. Miocene restriction of the Pacific-North Atlantic throughflow strengthened Atlantic overturning circulation. Nature Communications 10, 1–7 (2019).

91. Knutz, P. C. et al. Eleven phases of Greenland Ice Sheet shelf-edge advance over the past 2.7 million years. Nature Geosci 12, 361–368 (2019).

92. Kocken, I. J., Cramwinckel, M. J., Zeebe, R. E., Middelburg, J. J. & Sluijs, A. The 405 kyr and 2.4 Myr eccentricity components in Cenozoic carbon isotope records. Clim. Past 15, 91–104 (2019).

93. Kotov, S. & Pälike, H. Enhanced Principal Tensor Analysis as a tool for 3-way geological data reconstructions. Computers & Geosciences 123, 161–171 (2019).

94. Koutsodendris, A., Kousis, I., Peyron, O., Wagner, B. & Pross, J. The Marine Isotope Stage 12 pollen record from Lake Ohrid (SE Europe): Investigating short-term climate change under extreme glacial conditions. Quaternary Science Reviews 221, 105873 (2019).

95. Kutterolf, S., Schindlbeck, J. C., Jegen, M., Freundt, A. & Straub, S. M. Milankovitch frequencies in tephra records at volcanic arcs: The relation of kyr-scale cyclic variations in volcanism to global climate changes. Quaternary Science Reviews 204, 1–16 (2019).

96. Lagabrielle, Y. et al. Mantle exhumation at magma-poor passive continental margins; Part I, 3D architecture and metasomatic evolution of a fossil exhumed mantle domain (Urdach Lherzolite, north-western Pyrenees, France). BSGF - Earth Sci. Bull. 190, (2019).

97. Lambart, S. et al. Highly heterogeneous depleted mantle recorded in the lower oceanic crust. Nat. Geoscience 12, 482–486 (2019).

98. Lanci, L. et al. Dataset of characteristic remanent magnetization and magnetic properties of early Pliocene sediments from IODP Site U1467 (Maldives platform). Data in Brief 27, 104666 (2019).

99. Lanci, L. et al. Magnetic properties of early Pliocene sediments from IODP Site U1467 (Maldives platform) reveal changes in the monsoon system. Palaeogeography, Palaeoclimatology, Palaeoecology 533, 109283 (2019).

100. Lee, H. et al. Sustained wood burial in the Bengal Fan over the last 19 My. PNAS 116, 22518–22525 (2019).

101. León, R., Palomino, D., Vázquez, J.-T., Medialdea, T. & Somoza, L. A new scenario for the mass transport deposits west Canary volcanic province. Earth and Planetary Science Letters 509, 27–37 (2019).

102. Leutert, T. J. et al. Sensitivity of clumped isotope temperatures in fossil benthic and planktic foraminifera to diagenetic alteration. Geochimica et Cosmochimica Acta 257, 354–372 (2019).

103. Levy, R. H. et al. Antarctic ice-sheet sensitivity to obliquity forcing enhanced through ocean connections. Nat. Geoscience 12, 132–137 (2019).

104. Li, H.-Y. et al. Radiogenic isotopes document the start of subduction in the Western Pacific. Earth and Planetary Science Letters 518, 197–210 (2019).

105. Li, K., Li, L., Pearson, D. G. & Stachel, T. Diamond isotope compositions indicate altered igneous oceanic crust dominates deep carbon recycling. Earth and Planetary Science Letters 516, 190–201 (2019).

106. Lindhorst, S., Betzler, C., Wunsch, M., Lüdmann, T. & Kuhn, G. Carbonate drifts as marine archives of aeolian dust (Santaren Channel, Bahamas). Sedimentology 66, 1386 (2019).

107. Lindhorst, S., Betzler, C. & Kroon, D. Wind variability over the northern Indian Ocean during the past 4 million years – Insights from coarse aeolian dust (IODP exp. 359, site U1467, Maldives). Palaeogeography, Palaeoclimatology, Palaeoecology 536, 109371 (2019).

108. Liu, J., Nowaczyk, N., Frank, U. & Arz, H. Geomagnetic paleosecular variation record spanning from 40 to 20 ka – implications for the Mono Lake excursion from Black Sea sediments. Earth and Planetary Science Letters 509, 114–124 (2019).

109. López-Quirós, A. et al. Glaucony authigenesis, maturity and alteration in the Weddell Sea: An indicator of paleoenvironmental conditions before the onset of Antarctic glaciation. Scientific Reports 9, 376–12 (2019).

110. Lougheed, B. C. & Obrochta, S. P. A Rapid, Deterministic Age-Depth Modeling Routine for Geological Sequences With Inherent Depth Uncertainty. Paleoceanography and Paleoclimatology 34, 122–133 (2019).

111. Lübbers, J. et al. The Middle to Late Miocene 'Carbonate Crash' in the Equatorial Indian Ocean. Paleoceanography and Paleoclimatology 34, 813–832 (2019).

112. Lucero, A. C., Spinelli, G. A. & He, J. The Thermal Effects of Plate-Bending-Related Thickening of the Oceanic Crustal Aquifer in the Nankai Trough and Japan Trench Subduction Zones. J. Geophys. Res. Solid Earth 124, 1205–1221 (2019).

113. Lyle, M., Joy Drury, A., Tian, J., Wilkens, R. & Westerhold, T. Late miocene to holocene high-resolution eastern equatorial pacific carbonate records: Stratigraphy linked by dissolution and paleoproductivity. Clim. Past 15, 1715–1739 (2019).

114. Martínez-Sánchez, M. et al. Reconstruction of surface water dynamics in the North Atlantic during the Mid-Pleistocene (~540–400 ka), as inferred from coccolithophores and planktonic foraminifera. Marine Micropaleontology 152, 101730 (2019).

115. McCarthy, A. et al. Isotopic Characteristics of Neogene-Quaternary Tephra From IODP Site U1438: A Record of Explosive Volcanic Activity in the Kyushu-Ryukyu Arc. Geochem. Geophys. Geosyst. 63, 1489 (2019).

116. McNeill, L. C. et al. High-resolution record reveals climate-driven environmental and sedimentary changes in an active rift. Scientific Reports 9, 448–11 (2019).

117. Merle, R. E., Jourdan, F., Chiaradia, M., Olierook, H. K. H. & Manatschal, G. Origin of widespread Cretaceous alkaline magmatism in the Central Atlantic; a single melting anomaly? Lithos 342, 480 (2019).

118. Mestdagh, T., Lobo, F. J., Llave, E., Hernandez-Molina, F. J. & Van Rooij, D. Review of the late Quaternary stratigraphy of the northern Gulf of Cadiz continental margin: New insights into controlling factors and global implications. Earth-Science Reviews 198, 102944 (2019).

119. Miguez-Salas, O., Dorador, J. & Rodríguez Tovar, F. J. Introducing Fiji and ICY image processing techniques in ichnological research as a tool for sedimentary basin analysis. Marine Geology 413, 1–9 (2019).

120. Ming, S. et al. Reassessing two contrasting late Miocene-Holocene stratigraphic frameworks for the Pearl River mouth basin, northern South China Sea. Marine and Petroleum Geology 102, 899 (2019).

121. Mortimer, N. et al. Late Cretaceous oceanic plate reorganization and the breakup of Zealandia and Gondwana. Gondwana Research 65, 31–42 (2019).

122. Mueller, C. O. & Jokat, W. The initial Gondwana break-up: A synthesis based on new potential field data of the Africa-Antarctica Corridor. Tectonophysics 750, 301–328 (2019).

123. Mulder, T. et al. Into the deep: A coarse-grained carbonate turbidite valley and canyon in ultra-deep carbonate setting. Marine Geology 407, 316–333 (2019).

124. Nilsson-Kerr, K. et al. Role of Asian summer monsoon subsystems in the inter-hemispheric progression of deglaciation. Nature Geosci 214, 59 (2019).

125. Nirrengarten, M. et al. The thermal imprint of continental breakup during the formation of the South China Sea. Earth and Planetary Science Letters 115972 (2019).

126. Nozaka, T., Akitou, T., Abe, N. & Tribuzio, R. Biotite in olivine gabbros from Atlantis Bank: Evidence for amphibolite-facies metasomatic alteration of the lower oceanic crust. Lithos 348-349, 105176 (2019).

127. Nugraha, H. D., Jackson, C. A. L., Johnson, H. D., Hodgson, D. M. & Reeve, M. T. Tectonic and oceanographic process interactions archived in Late Cretaceous to Present deep-marine stratigraphy on the Exmouth Plateau, offshore NW Australia. Affiliation (analytic): ConocoPhillips Company, Global New Ventures Exploration, Houston, TX 31, 405–430 (2019).

128. Ohneiser, C. et al. Magneto-biostratigraphic age models for Pleistocene sedimentary records from the Ross Sea. Global and Planetary Change 176, 36–49 (2019).

129. Osinski, G. R. et al. Explosive interaction of impact melt and seawater following the Chicxulub impact event. Geology (2019).

130. Patterson, M. A. et al. Bioerosion traces in the Great Barrier Reef over the past 10 to 30 kyr. Palaeogeography, Palaeoclimatology, Palaeoecology 109503 (2019).

131. Pattier, F. et al. Neogene-Quaternary architecture and sedimentary processes on an isolated carbonate-fed deep-water basin (Fairway Basin, Southwest Pacific). Marine Geology 413, 27–47 (2019).

132. Paulat, M., Lüdmann, T., Betzler, C. & Eberli, G. P. Neogene palaeoceanographic changes recorded in a carbonate contourite drift (Santaren Channel, Bahamas). Sedimentology 66, 1361 (2019).

133. Qiang, Z. et al. Mechanism for enhanced eolian dust flux recorded in North Pacific Ocean sediments since 4.0 Ma; aridity or humidity at dust source areas in the Asian interior? Geology 48, 77 (2019).

134. Quéméneur, M. et al. Hydrostatic Pressure Helps to Cultivate an Original Anaerobic Bacterium From the Atlantis Massif Subseafloor (IODP Expedition 357): Petrocella atlantisensis gen. nov. sp. nov. Front. Microbiol. 10, 333 (2019).

135. Rae, A. S. P. et al. Stress-Strain Evolution During Peak-Ring Formation: A Case Study of the Chicxulub Impact Structure. J. Geophys. Res. Planets 124, 396–417 (2019).

136. Rashid, H. et al. Dynamics of sediments on a glacially influenced, sediment starved, current-swept continental margin: The SE Grand Banks Slope off Newfoundland. Marine Geology 408, 67–86 (2019).

137. Rasmussen, C. et al. U-Pb memory behavior in Chicxulub's peak ring — Applying U-Pb depth profiling to shocked zircon. Chemical Geology 525, 356–367 (2019).

138. Reagan, M. K. et al. Forearc ages reveal extensive short-lived and rapid seafloor spreading following subduction initiation. Earth and Planetary Science Letters 506, 520–529 (2019).

139. Remmelzwaal, S. R. C. et al. Investigating Ocean Deoxygenation During the PETM Through the Cr Isotopic Signature of Foraminifera. Paleoceanography and Paleoclimatology 34, 917–929 (2019).

140. Reolid, J., Betzler, C. & Lüdmann, T. The record of Oligocene - Middle Miocene paleoenvironmental changes in a carbonate platform (IODP Exp. 359, Maldives, Indian Ocean). Marine Geology 412, 199–216 (2019).

141. Reolid, J., Betzler, C. & Lüdmann, T. Facies and sedimentology of a carbonate delta drift (Miocene, Maldives). Sedimentology 66, 1243 (2019).

142. Reolid, J. & Betzler, C. The ichnology of carbonate drifts. Sedimentology 66, 1427 (2019).

143. Reuber, K., Mann, P. & Pindell, J. Hotspot origin for asymmetrical conjugate volcanic margins of the austral South Atlantic Ocean as imaged on deeply penetrating seismic reflection lines. (2019).

144. Robinson, R. S. et al. A Cool, Nutrient-Enriched Eastern Equatorial Pacific During the Mid-Pleistocene Transition. Geophysical Research Letters 46, 2187–2195 (2019).

145. Robinson, S. A. et al. Southern Hemisphere sea-surface temperatures during the Cenomanian-Turonian: Implications for the termination of Oceanic Anoxic Event 2. Geology 47, 131–134 (2019).

146. Rodríguez Tovar, F. J., Dorador, J. & Hodell, D. A. V. Trace fossils evidence of a complex history of nutrient availability and oxygen conditions during Heinrich Event 1. Global and Planetary Change 174, 26–34 (2019).

147. Rohling, E. J. et al. Asynchronous Antarctic and Greenland ice-volume contributions to the last interglacial sea-level highstand. Nature Communications 10, 38 (2019).

148. Saavedra-Pellitero, M., Baumann, K.-H., Gallagher, S. J., Sagawa, T. & Tada, R. Paleoceanographic evolution of the Japan Sea over the last 460 kyr – A coccolithophore perspective. Marine Micropaleontology 152, 101720 (2019).

149. Sahy, D. et al. Accuracy and precision of the late Eocene-early Oligocene geomagnetic polarity time scale. GSA Bulletin 132, 373 (2019).

150. Sánchez Goñi, M. F. et al. Pronounced northward shift of the westerlies during MIS 17 leading to the strong 100-kyr ice age cycles. Earth and Planetary Science Letters 511, 117–129 (2019).

151. Scher, H. D. et al. Onset of Antarctic Circumpolar Current 30 million years ago as Tasmanian Gateway aligned with westerlies. Nature 523, 580–583 (2015).

152. Schirrmacher, J. et al. Multi-decadal atmospheric and marine climate variability in southern Iberia during the mid-to late-Holocene. Clim. Past 15, 617–634 (2019).

153. Scholz,F.etal.Shelf-to-basinironshuttleintheGuaymasBasin, Gulf of California. Geochimica et Cosmochimica Acta 261, 76–92 (2019).

154. Scholz, F. et al. Oxygen minimum zone-type biogeochemical cycling in the Cenomanian-Turonian Proto-North Atlantic across Oceanic Anoxic Event 2. Earth and Planetary Science Letters 517, 50–60 (2019).

155. Shalev, N., Bontognali, T. R. R., Wheat, C. G. & Vance, D. New isotope constraints on the Mg oceanic budget point to cryptic modern dolomite formation. Nature Communications 10, 438–10 (2019).

156. Shervais, J. W. et al. Magmatic Response to Subduction Initiation: Part 1. Fore-arc Basalts of the Izu-Bonin Arc From IODP Expedition 352. Geochem. Geophys. Geosyst. 20, 314–338 (2019).

157. Simon, M. H. et al. Development of a protocol to obtain the composition of terrigenous detritus in marine sediments -a pilot study from International Ocean Discovery Program Expedition 361. Chemical Geology 119449 (2019).

158. Simon, Q., Suganuma, Y., Okada, M. & Haneda, Y. High-resolution 10Be and paleomagnetic recording of the last polarity reversal in the Chiba composite section: Age and dynamics of the Matuyama–Brunhes transition. Earth and Planetary Science Letters 519, 92–100 (2019).

159. Skonieczny, C. et al. Monsoon-driven Saharan dust variability over the past 240,000 years. Sci. Adv. 5, eaav1887–646 (2019).

160. Staudigel, P. T. & Swart, P. K. A diagenetic origin for isotopic variability of sediments deposited on the margin of Great Bahama Bank, insights from clumped isotopes. Geochimica et Cosmochimica Acta 258, 97–119 (2019).

161. Stoll, H. M. et al. Upregulation of phytoplankton carbon concentrating mechanisms during low CO 2 glacial periods and implications for the phytoplankton pCO 2 proxy. Quaternary Science Reviews 208, 1–20 (2019).

162. Stott, L. D., Harazin, K. M. & Quintana Krupinski, N. B. Hydrothermal carbon release to the ocean and atmosphere from the eastern Equatorial Pacific during the last glacial termination. 14, (2019).

163. Su, M. et al. Reassessing two contrasting Late Miocene-Holocene stratigraphic frameworks for the Pearl River Mouth Basin, northern South China Sea. Marine and Petroleum Geology 102, 899–913 (2019).

164. Svensen, H. H. et al. Thinking about LIPs; a brief history of ideas in large igneous province research. Tectonophysics 760, 229 (2019).

165. Swart, P. K. et al. Cyclic anoxia and organic rich carbonate sediments within a drowned carbonate platform linked to Antarctic ice volume changes: Late Oligocene-early Miocene Maldives. Earth and Planetary Science Letters 521, 1–13 (2019).

166. Swart, P. K., Mackenzie, G. J., Eberli, G. P., Lüdmann, T. & Betzler, C. Do drifts deposited adjacent to carbonate platforms record the signal of global carbon isotopic values? Sedimentology 66, 1410 (2019).

167. Tamblyn, R. et al. Blueschist from the Mariana forearc records long-lived residence of material in the subduction channel. Earth and Planetary Science Letters 519, 171–181 (2019).

168. Teixeira, M. et al. Interaction of alongslope and downslope processes in the Alentejo Margin (SW Iberia) – Implications on slope stability. Marine Geology 410, 88–108 (2019).

169. Timms, N. E. et al. New shock microstructures in titanite (CaTiSiO5) from the peak ring of the Chicxulub impact structure, Mexico. Contrib Mineral Petrol 174, 38 (2019).

170. Vannucchi, P. Scaly fabric and slip within fault zones. Geosphere 15, 342–356 (2019).

171. Vickers, M. L., Bajnai, D., Price, G. D., Linckens, J. & Fiebig, J. Southern high-latitude warmth during the Jurassic-Cretaceous: New evidence from clumped isotope thermometry. Geology 47, 724–728 (2019).

172. Waelbroeck, C. et al. Consistently dated Atlantic sediment cores over the last 40 thousand years. Sci Data 6, 1–12 (2019).

173. Weiss, G. M. et al. Paleosensitivity of Hydrogen Isotope Ratios of Long-Chain Alkenones to Salinity Changes at the Chile Margin. Paleoceanography and Paleoclimatology 34, 978–989 (2019).

174. Willard, D. A. et al. Arctic vegetation, temperature, and hydrology during Early Eocene transient global warming events. Global and Planetary Change 178, 139–152 (2019).

175. Wörmer, L. et al. Microbial dormancy in the marine subsurface: Global endospore abundance and response to burial. Sci. Adv. 5, eaav1024 (2019).

176. Worne, S., Kender, S., Swann, G. E. A., Leng, M. J. & Ravelo, A. C. Coupled climate and subarctic Pacific nutrient upwelling over the last 850,000 years. Earth and Planetary Science Letters 522, 87–97 (2019).

177. Worne, S., Kender, S., Swann, G. E. A., Leng, M. J. & Ravelo, A. C. Coupled climate and subarctic Pacific nutrient upwelling over the last 850,000 years. Earth and Planetary Science Letters 522, 87–97 (2019).

178. Wu, F. et al. The impact of eustatic sea-level fluctuations, temperature variations and nutrient-level changes since the Pliocene on tropical carbonate platform (Xisha Islands, South China Sea). Palaeogeography, Palaeoclimatology, Palaeoecology 514, 373–385 (2019).

179. Yu, J. et al. More efficient North Atlantic carbon pump during the Last Glacial Maximum. Nature Communications 10, 2170 (2019).

180. Yu, Z. et al. Sea level-controlled sediment transport to the eastern Arabian Sea over the past 600 kyr: Clay minerals and SrNd isotopic evidence from IODP site U1457. Quaternary Science Reviews 205, 22–34 (2019).

181. Zarkogiannis, S. D. et al. Influence of surface ocean density on planktonic foraminifera calcification. Scientific Reports 9, 1–10 (2019).

182. Zeebe, R. E. & Lourens, L. J. Solar System chaos and the Paleocene–Eocene boundary age constrained by geology and astronomy. Science 365, 926–929 (2019).

183. Zeeden, C., Meyers, S. R., Hilgen, F. J., Lourens, L. J. & Laskar, J. Time scale evaluation and the quantification of obliquity forcing. Quaternary Science Reviews 209, 100–113 (2019).

184. Zhang, Y. G. et al. Refining the alkenone-pCO2 method I: Lessons from the Quaternary glacial cycles. Geochimica et Cosmochimica Acta 260, 177–191 (2019).

185. Zhao, D. et al. Quaternary sedimentary record in the northern Okinawa Trough indicates the tectonic control on depositional environment change. Palaeogeography, Palaeoclimatology, Palaeoecology 516, 126–138 (2019).

186. Zhao, R., Hannisdal, B., Mogollón, J. M. & Jørgensen, S. L. Nitrifier abundance and diversity peak at deep redox transition zones. Scientific Reports 9, 1–12 (2019).

187. Zindorf, M. et al. Deep Sulfate-Methane-Transition and sediment diagenesis in the Gulf of Alaska (IODP Site U1417). Marine Geology 417, 105986 (2019).

Lester Lembke-Jene (Physical Properties Specialist, Alfred Wegener Institute, Germany) up top on the weather deck on the *JOIDES Resolution* during IODP Expedition 383 (photo X. Zhao, IODP).

6. Archiving IODP cores: the IODP Bremen Core Repository

Tour to the BCR reefer during the ECORD Summer School 2019 "Subduction Zone Processes: Magma, Volcanoes, Ore Deposits, Geohazards" (photo U. Röhl, MARUM).

IODP Bremen Core Repository (BCR)

www.marum.de/en/Research/IODP-Bremen-Core-Repository.html

The Bremen Core Repository (BCR) at the MARUM, University of Bremen, Germany, is one of the three IODP core repositories. The other two are the Gulf Cost Repository (GCR) located at Texas A&M University in College Station, USA, and the Kochi Core Center (KCC) in Kochi, Japan.

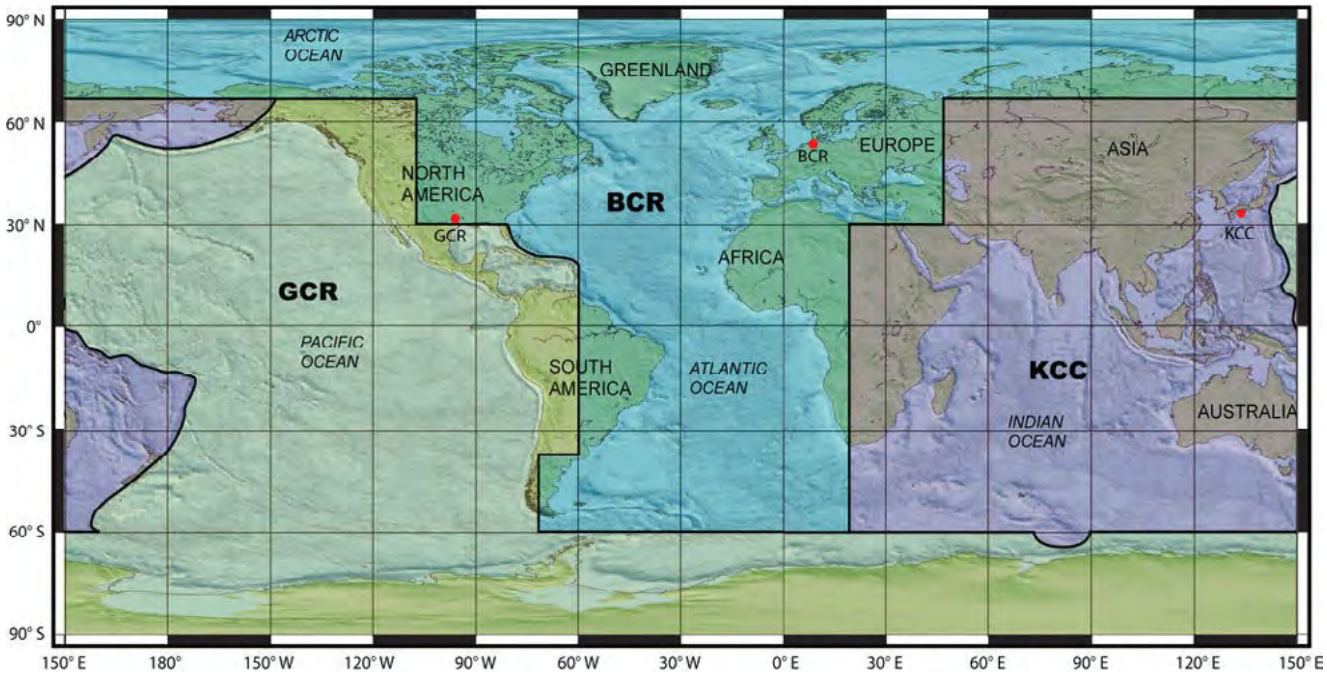
In accord with IODP convention and practice, the BCR hosts all the cores recovered since the beginning of scientific ocean drilling from the Atlantic and Arctic Oceans as well as the Mediterranean, Baltic and Black Seas. The BCR is also responsible for organizing and hosting the Onshore Science Parties of mission-specific platform expeditions (MSPs) and providing mobile laboratories and scientific expertise for those expeditions.

BCR provides core material for numerous course studies run by various instructors, and is usually visited by classes (including skype conferences to geo show "unterirdisch" in Cologne at the occasion of the German IODP/ICDP Meeting). The related courses include core description and visual illustration of geoscientific concepts. BCR is also an ideal place to train students, with the opportunity to work on real cores and have access to laboratory facilities.

Universität Bremen ECORD IODP

25th anniversary of the Bremen Core Repository

In 2019, the BCR celebrated its 25th anniversary. On this occasion, a scientific symposium was held in the House of Science, Bremen. BCR was founded in 1994 and moved to the MARUM building on the University of Bremen campus in 2005. During the DSDP/ODP Core Redistribution project (2006-2008) the collection grew from 75 km to 140 km of cores, currently the collection holds more than 158 km of cores acquired during 90 expeditions.



Geographic Assignment of Core Samples to Repositories.
Adapted from Firth, JV, Gupta, LP and Röhl, U (2009) New focus on the Tales of the Earth - Legacy Cores Redistribution Project Completed. Scientific Drilling, 7. 31-33. doi:10.2204/iodp.sd.7.03.2009. [Map Mar 15, 2016].
Retrieved from *http://www.marum.de/en/Cores_at_BCR.html*

Samples and data management at BCR

BCR statistics

A total of 51,693 samples were taken at the BCR for 270 requests (of which 163 were submitted by ECORD scientists) during FY19.

All BCR samples (over 1.75 million samples out of more than 7347 sample requests, including samples taken earlier at the ECR for legacy cores that are now at BCR) are entered into a database, the BCR Drilling Information System (DIS) Internet Interface, that is accessible to the general public for post-moratorium samples (web interface for curatorial data *http://dis.iodp.pangaea.de/BCRDIS/*).

Repository and sample statistics

	Expeditions	Amount of core (km)
	90	158
	Sample Requests (from ECORD countries)	**Samples taken**
Bremen Core Repository FY19	270 (163)	51,693
Bremen Core Repository (since opening in 1994)	5012	1,073,661
From all cores stored at BCR	7347	1,750,000

Database: the BCR DIS Internet Interface

The CurationDIS (6.3) is currently in operation at the BCR and working smoothly. This year an upgrade of the databases CurationDIS and ExpeditionDIS was carried out. Also, due to an overall MARUM server reorganization the ExpeditionDIS and CurationDIS servers needed to migrate. This is already or will be completed in due course. We closely follow the developments of the next generation of database, the "mobile Drilling Information System" (mDIS, initiated by ICDP) by participating at the presentation of the current mDIS beta version in October and hosted a subsequent workshop to identify necessary functionalities towards a generic mDIS curation version in December.

The import of IODP-MSP Expedition 325 post-moratorium sample data from KCC to the CurationDIS was finalized. The sample data are publicly available via the IODP-BCR core & sample inventory web interface (*http://dis.iodp.pangaea.de/BCRDIS/*).

Data management activities in 2019 mainly focussed on the end of the Expedition 381 moratorium, and the setting up of IT systems for the upcoming Expedition 386. Migration of IODP-MSP Expedition 381 data from the ExpeditionDIS to the CurationDIS was completed. Further, International Geo Sample Numbers (IGSNs - International Geo Sample Numbers) of all Expedition 381 cores, sections and samples have been registered and published. The publication of the Expedition 381 data was initiated with the PANGAEA® Data Publisher and the IODP MSP data portal within PANGAEA® updated.

In preparation for Expedition 386, ESO database staff continued to contribute IT advice to the development of new offshore Curation and Geochemistry Lab containers, with special regard to LAN and power cabling aspects. After delivery, staff installed network switches and WiFi access points, and carried out in-depth functionality testing of network components (junction boxes, plugs and cablings). In parallel, the MARUM ESO cloud system was set up to allow online collaboration and file sharing with the Co-chief Scientists and Science Party. IT topology maps were produced for the offshore and OSP phases of Expedition 386 in collaboration with MarE3 IT staff, and the preparation of the ExpeditionDIS-386 was initiated. All ESO partners updated, prepared and renewed IT equipment before packing into containers for shipping.

SEDIS: The Scientific Earth Drilling Information Service

The Scientific Earth Drilling Information Service – SEDIS (*http://sedis.iodp.org/*) is continued in the new IODP and being maintained.

Expeditions at BCR

IODP Expedition 381: Corinth Active Rift Development

The moratorium for IODP Expedition 381: Corinth Active Rift Development ended on 1 March 2019. Nevertheless, several moratorium sample requests have been processed and extensive XRF core scanning of numerous archive half sections for shipboard measurements has been completed by Expedition 381 science party members. Measurements for individual post-cruise projects (i.e. in relation to ECORD grant for Natascha Fabregas, University of Bergen, Norway) are ongoing.

IODP Expedition 382: Iceberg Alley and Subantarctic Ice and Ocean Dynamics

Expedition 382 Sampling Party was conducted between 18-26 November 2019 and involved 22 participants, including mostly science party members, BCR staff, student helpers and an expedition outreach officer. All sample requests were completed by the end of the sampling party and a total of 26,179 samples taken.

Participants of the IODP Expedition 382 sampling party at the BCR sampling lab (photo M. Garnsworthy, IODP)

Cores from ODP Legs 117, 122 and 189 from the Kochi Core Center (Photo U. Röhl, MARUM)

Cores visiting from the Kochi Core Center (KCC)

A larger shipping of KCC 575 core sections (ODP Legs 117, 122, and 189 for three different sample requests) arrived at BCR for XRF core scanning in the MARUM lab. XRF scanning was completed by visiting scientists over the course of a couple of months and the cores were packed in shipping boxes on six pallets in one 20″container to be shipped back to the KCC.

Visitors at BCR

The location of the BCR on the University of Bremen campus has proven to be very convenient for many visitors, including summer school and conference participants, young scientists and students, university visitors, TV teams, radio stations, journalists, photographers, artists, official delegations, VIPs, IODP meeting participants, industry visitors, schoolchildren, teachers, the general public, future expedition participants, museum representatives, individual scientists, and sampling party participants. Each visit presents an opportunity for ESO-Bremen staff to promote the work and opportunities of IODP to diverse audiences.

In 2019, amongst others, the BCR was visited by

Delegations from:

- the German-Israeli-Association;
- the Arctic University Tromsø, Norway;
- the German Science Foundation (DFG) Review Board for Geology and Paleontology;
- the University Qingdao, China;
- the Natural History Museum, Münster.

Participants of:

- the MARID VI (Marine and River Dune Dynamics) Conference held at MARUM;
- the 'Hydrographic Day 2019' held at MARUM.

Individuals:

- Kim Senger (The University Centre in Svalbard);
- Konstantinos Vaziourakis and students (Patras University, Greece);
- H. von Neuhoff (Curator at the Maritime Museum, Hamburg);
- Prof. V. C. Vahrenkamp and A. Petrovic (King Abdullah University of Science and Technology - KAUST, Saudi Arabia);
- Dr. Claudia Schilling (Senator for Science, Ports and Justice of the Free Hanseatic City of Bremen);
- Tim Cordssen (Counsellor).

Media representatives:

- Maaike Anne Stevens (Dutch visual artist based at Amsterdam);
- film teams from several regional TV stations;
- Dirk Asendorpf (science journalist);
- a film team from the German TV station ZDF with "Terra X" moderator Dirk Steffens.

Preparing the filming for Terra X in the BCR lab at MARUM (photo U. Prange, MARUM).

Students during the ECORD Training Course 2019 (photo V. Diekamp, MARUM)

7. Engaging the community

Students during 2019 Petrophysics Summer School 2019 at the University of Leicester, Leicester, UK (photo E. Le Ber, ECORD/IODP).

7.1 Training young scientists

A major goal of ECORD is to train the next generation of scientists from member countries and promote IODP-motivated science.

The **ECORD Summer Schools**, initiated in 2007, are well-established and are attended annually by many Masters-level and PhD students as well as post-doctoral research fellows from ECORD member countries and beyond. Three ECORD Summer Schools and one ECORD Training Course were sponsored by ECORD in 2019.

144 students

ECORD 5th Training Course

MARUM, University of Bremen, Germany, 25-29 March 2019

www.marum.de/en/education-career/ECORD-training/ECORD-Training-Courses.html

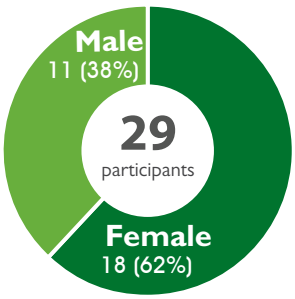
29 students

MARUM (Center for Marine Environmental Sciences, University of Bremen) is an important hub for the next generation of IODP scientists. The Bremen Core Repository (BCR) located at MARUM, is one of three IODP core repositories worldwide.

The course is tailored to prepare participants for sailing on an IODP expedition, and to give them an appreciation of the high standards required for all kinds of coring projects. Here, scientists can access cores for description, analyses and sampling, as well as receive training in IODP science and procedures at an early stage of their career.

The 5th ECORD Training Course built upon the successes of previous years and was attended by 29 participants from ten different countries, including non-ECORD and non-IODP member countries.

The five-day course started with an introductory session on the structure and objectives of ECORD and IODP, and a general tour of MARUM and BCR, before focusing on the IODP core-flow procedures and practical classes in typical expedition laboratory procedures in smaller groups. These IODP-style laboratory exercises formed the foundation of the course, following the pattern of the unique "virtual drill ship" approach developed for ECORD Summer Schools held in Bremen.



More info in ECORD Newsletter #33: *www.ecord.org/?ddownload=12194*
Detailed programme: *www.marum.de/en/education-career/ECORD-training/ECORD-Training-Course-2019.html*

ECORD 4th Petrophysics Summer School

University of Leicester, Leicester, UK , 30 June - 5 July 2019

https://www2.le.ac.uk/departments/geology/research/gbrg/projects/iodp/petrophysics-summer-school-2019

The Petrophysics Summer School in Leicester (UK), organized by the European Petrophysics Consortium (EPC), is an integral part of our training activities and was held for the fourth time in 2019. The School explores the relevance and unique insights of these data for a range of fields, including palaeoclimatology, sedimentology, hydrogeology, and broader geological and ecological processes.

27 students

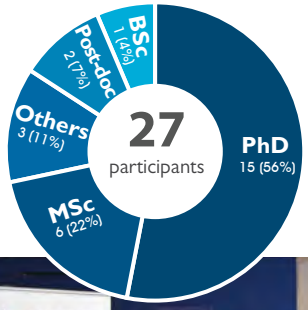
The course aimed to build on the success and participant feedback from the previous three years. Retaining historically popular course elements, the 2019 Petrophysics Summer School maintained variety in the delivery of teaching through lectures and computer and paper-based practical exercises. Course participants were introduced to fundamentals in the Petrophysics 101 course, before being able to see a variety of logging tools at Weatherford and get hands-on experience with recovered cores at the British Geological Survey (BGS) Core Store during the mid-week fieldtrip. After being given the opportunity to see how and why logging data are acquired, participants were able to practice the skills acquired during the course by analysing real IODP expedition data during two days of training in using Schlumberger's Techlog software package. Additional time was also set aside for participants to bring along their own logging data and put their new Techlog skills to the test alongside tutors and helpers.

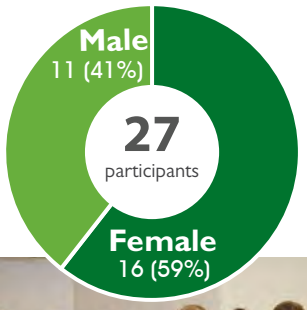
Scattered throughout the week were many more additional sessions, including talks and practical sessions on offshore operations, estimating in-place hydrocarbon volumes, acoustic processing, borehole-seismic integration, and an opportunity to play with physical properties equipment including a Geotek core-logger.
Part of the Summer School also included a mini conference with posters and short "elevator pitches".

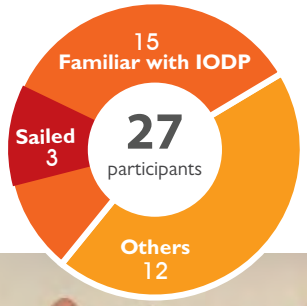
Alongside intense days of teaching, the Petrophysics Summer School also included a variety of evening social events throughout the week – with a talk on the local geology during a reception at the New Walk Museum.

As in previous years, the course accommodated a varied demographic representing 11 nationalities across the **27 participants**. With general statistics comparable to previous years, one new aspect to the 2019 participant cohort was the number of graduate and Masters-level attendees, at 26%. The remainder of the participant pool resembled past Summer Schools with the majority of attendees joining mid-PhD, but also with several post-doctoral researchers and a few from other global research bodies and those holding private sector positions.

The teaching pool for the Summer School consisted of **13 instructors** from both academia (EPC, Imperial College London, Lamont-Doherty Earth Observatory, JAMSTEC-MarE3, and the University of Leicester) and industry BP-UK and Schlumberger Information Systems) - providing varied and global coverage alongside extensive experience.







11 Nationalities

4 Institution Countries

Petrophysics Summer School 2019 at the University of Leicester (photo credit: Colin Brooks Photography).

ECORD 16th Urbino Summer School in Paleoclimatology

Urbino, Italy, 10-26 July 2019

http://www.urbinossp.it

32 teachers **63 students**

To promote integration of field data and modelling results for the next generation of palaeoclimatologists, the USSP Consortium and teacher pool organized the 16th ECORD Urbino Summer School in Paleoclimatology (USSP) in Urbino, Italy.

The USSP 2019 provided an integrated student-centred programme consisting of:

- topical lectures by internationally recognized scientists;
- student-centred data-rich exercises, investigations, and presentations using field data;
- parallel sessions providing groups of participants with a more focused coverage of selected topics within palaeoclimatology;
- a regional field excursion to classic Cretaceous and Cenozoic sections;
- student poster presentations;
- evening lectures/discussions on professional development.

As usual, the first week focused on IODP elements and comparison of oceanic sequences with counterparts in the local geological succession through student-centred investigations. In addition, the programme included a one-day workshop (20 July 2019) where many instructors gave informal presentations on their latest, often unpublished, field and modelling results, providing students with an excellent opportunity to experience the cutting edge of scientific progress. Student course evaluations were extremely positive.

As in past years, the Faculty of Economics of the University of Urbino hosted the programme, providing a large hall for lectures, and smaller rooms for student working groups and parallel sessions.

The Urbino Summer School in Paleoclimatology 2019 brought together 32 world experts in palaeontology, palaeoceanography, palaeoclimatology, and geochemistry, including many past and future ODP/IODP participants, to lecture and mentor 63 typically first-year graduate students from about 20 nations.

Participants of the ECORD Urbino Summer School 2019 (photo L. Lourens, ECORD/IODP)

ECORD 13th Bremen Summer School

on "Subduction Zone Processes: Magma, Volcanoes, Ore Deposits, Geohazards"

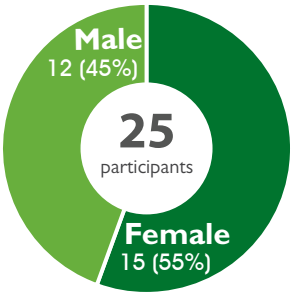
MARUM, University of Bremen, Germany, 16-20 September 2019

https://www.marum.de/en/education-career/ECORD-training/ECORD-Summer-Schools/2019.html

marum
Center for Marine Environmental Sciences
University of Bremen

Twenty-five young scientists from 13 different countries took part in the 13th ECORD Summer School held at MARUM and BCR. They came together to learn about the numerous processes relating sub-seafloor fluid transport and gas hydrate dynamics. A tour of the BCR reefer and laboratories and the MARUM workshop was crucial at the start of the Summer School. The school then moved onto a combination of lectures and practical and laboratory exercises on state-of-the-art IODP-style shipboard methodologies given by ESO-Bremen and ESO-EPC staff.

Lecture topics ranged from volcanic hazards, arc magmatic and hydrothermal systems to rock geochemistry and element cycling, evolution from oceanic crust to continental crust, as well as fluid flow and seafloor fluxes to hazards in convergent margins and deep life.



Via this "**virtual drillship experience**", the participants gained insights into how IODP samples and measurements are actually acquired. Many aspects of a typical core workflow during an IODP expedition were addressed in practicals, including e.g. the identification of compositions and structures in core sections, thin sections or smear slides, the measurement of physical properties, core and downhole logging and the acquisition of temperature and heat flow data.

Participants gained familiarity with IODP in general, its organizational structure and world of acronyms, application processes, importance and procedures of outreach, proposal writing, core curation, downhole logging, current planning and future trends that all might pave the way for their future involvement in IODP expeditions. Moreover, the participants had the opportunity to present results related to their own research projects in order to exchange their most recent findings and ideas regarding sub-seafloor fluid transport and gas hydrate dynamics.

Coffee, tea, and lunch breaks as well as socializing "after shift" in the evenings or during organized weekend tours provided numerous opportunities for discussions and networking with new colleagues and potential future collaborators.

Participants of the ECORD Bremen Summer School 2019 (photo: V. Diekamp, MARUM/University of Bremen).

7.2 Sponsoring research for young scientists

ECORD Scholarships

15 SCHOLARSHIPS awarded

ECORD Scholarships provide support to outstanding students **to attend the ECORD-sponsored summer schools**. A total of 55 applications were received in 2019.

1. **The ECORD 4th Petrophysics Summer School** (Leicester, UK) received 14 applications for ECORD scholarships from four ECORD member countries. Four scholarships were awarded to students from three ECORD member countries. In addition, ten travel grants were awarded by USSSP to US-based scientists for their attendance at the ECORD Petrophysics Summer School.

2. **The ECORD 16th Urbino Summer School in Paleoclimatology** received a total of 35 applications for ECORD scholarships from 11 ECORD member countries. Nine students from five ECORD member countries were funded.

3. Six applications for ECORD scholarships were received from four ECORD countries for the **ECORD 13th Bremen Summer School** on "Sub-seafloor Fluid Transport and Gas Hydrate Dynamics". Two students from two ECORD member countries were funded.

ECORD Research Grants

7 GRANTS awarded

ECORD supports outstanding early-career scientists through the sponsorship of merit-based **awards for research** using core materials and data from previous DSDP/ODP/IODP expeditions.

The aim is to foster participation of early-career scientists in ocean drilling research and encourage them to develop their own projects and collaborate with other research groups outside their home institutions.

Sixteen applications by PhD students and post-doctoral researchers from nine ECORD member countries were submitted in 2019. Seven grants were awarded to five scientists from Denmark, Ireland, Norway, Spain and the UK and to two scientists from Italy.

Engaging the science community

7.3 ECORD Distinguished Lecturer Programme

The ECORD Distinguished Lecturer Programme (DLP) is designed to bring scientific discoveries of IODP to the geosciences community in ECORD and non-ECORD countries, through **lectures covering each of the four main themes of the IODP Science Plan 2013-2023**.

In 2019, four Distinguished Lecturers were selected, representing a broad spectrum of IODP science:

1. **Luc Beaufort** (CEREGE, Aix-en-Provence, France):
"Evolution and adaptation of calcareous nannoplankton to Plio-Pleistocene oceanographic environments - A way to increase the biostratigraphic resolution"

2. **Verena Heuer** (MARUM, Bremen, Germany):
"The role of deep subseafloor life and its limits in the context of the global carbon cycle"

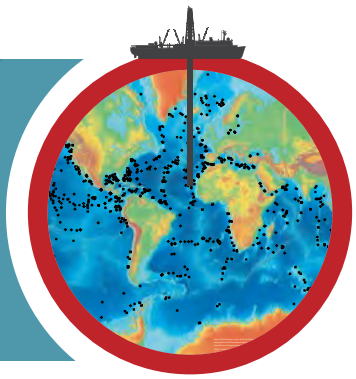
3. **Rebecca Bell** (Imperial College London, UK):
"Unlocking the secrets of slow slip using next-generation seismic experiments and IODP drilling at the north Hikurangi margin, New Zealand"

4. **Marguerite Godard** (Geosciences Montpellier, France):
"Drilling the oceanic mantle lithosphere : A window on melt extraction and mantle metasomatism at ridges"

So far, twenty presentations have been given in nine different ECORD and non-ECORD countries.

7.4 MagellanPlus Workshop Series Programme

The ECORD/ICDP MagellanPlus Workshop Series Programme is designed to support European and Canadian scientists **to develop new and innovative science proposals** that follow the major themes of the IODP and ICDP Science Plans.



The MagellanPlus Workshop Series Programme funds workshops and/or travel grants that are expected to lead to or foster high-quality and innovative scientific drilling proposals for submission to IODP and ICDP.

Two calls for workshops were issued in 2019 for the organization of workshops in 2019 or in early 2020.

At the 15 January deadline, two proposals were received (one Amphibious Drilling Proposal and one IODP -related proposal); both proposals were funded.

A second call for proposals was issued with the 15 May as deadline. For this call, four IODP-related proposals have been received; of those, two proposals have been funded.

Three MagellanPlus workshops have been organized in **2019**

MagellanPlus: **New Caledonia Peridotite Amphibious Drilling Project**
Montpellier, France, 22-24 January 2019

Convenors	Julien Collot (France), Marguerite Godard (France), Rupert Sutherland (New Zealand), Juerg Matter (UK)
More info	*https://newcaledoniadp.wordpress.com*

The workshop aimed at developing an amphibious IODP/ICDP proposal for drilling the onshore peridotites of New Caledonia and their offshore extension.

It engaged senior and young scientist specialists in marine geology, tectonics, (bio-)geochemistry, and borehole (hydro-)geophysics with colleagues from georesource industries to facilitate synergies.

The workshop focused on:

- the mechanisms driving the peridotite obduction and carbonate platform formation, and
- the present-day serpentinization and weathering processes and their impacts on mineral resources, renewable energies and life.

MagellanPlus: **The Haiti-DRILL Amphibious Drilling Project**

Plouzané, France, 20-22 May 2019

Convenors	Chastity Aiken (France), Walter Roest (France), Frauke Klingelhoefer (France), Nadine Ellouz-Zimmermann (France)
More info	*https://wwz.ifremer.fr/gm/Activites/Colloques/Haiti-DRILL-Magellan-Plus-Workshop-May-20-22-2019*

The Haiti-Drill Amphibious Drilling Project workshop was the second workshop held for developing a drilling project targeting the dual transform fault system along the northern boundary of the Caribbean plate in the Haiti region.

The two transform fault zones – the Enriquillo-Plaintain Garden Fault zone (EPGFZ) and Oriente-Septentrional Fault zone (OFSZ) - are both highly segmented, have multiple splay faults, and in some places have no observable fault trace. A compressional wedge exists between the eastern portions of these fault zones, which has the potential for producing vertical displacements. The occurrence of the 12 January 2010 magnitude 7.2 near Port-au-Prince Haiti earthquake, near the eastern terminus of the EPGFZ, led to one of the highest earthquake death tolls ever-recorded (>200,000). And recently, in October 2018, a magnitude 5.9 earthquake occurred within the La Tortue Channel just west of Port de Paix in the northern Haiti peninsula, along the OSFZ. Thus, this dual fault system presents a risk to Haitians in terms of seismic and tsunami hazard.

The first workshop was held in 2015 and pre-proposals were submitted to IODP. Pre-proposal reviews recommended making a stronger scientific link between the objectives and the drilling sites of the onshore and offshore targets, as well as identify scientific questions of both global and local significance.
During the 2019 workshop, results obtained since the 2015 workshop were discussed and two scientific questions were posed as potential overarching goals for the project:

- What are the relative ages and slip rates of the faults and are they examples of young transform fault zones?
- How do the rheological properties of the fault zones compare to other transform fault zones in the world?

Overall, workshop participants were in agreement that more research and surveys need to be done to gain a deeper understanding of the dual transform fault system before developing a full amphibious drilling proposal. In particular, high-resolution wide-angle seismic reflection, geological mapping, and additional coring need to be conducted to enhance our understanding of the architecture and palaeo-record of the region prior to deeper drilling.

Due to certain difficulties (e.g. surveys needed, ship time scheduling), future small projects - either onshore or offshore - conducted in support of drilling will be worked separately on their own timescales for the moment. As a first step, Haiti-TWiST, a deep crustal oceanographic survey, has been submitted for funding in 2019.

MagellanPlus: **RELICT Workshop**

The RolE of LIthospheriC InheriTance on Subduction Initiation on a Passive Margin

Lisbon, Portugal, 12-13 September 2019

Convenors	Pedro Terrinha (Portugal), Marta Neres (Portugal), Vitor Magalhães (Portugal)
More info	*http://relict-magellanplus.ipma.pt*

The aim of RELICT was to discuss the rationale to submit an IODP multiple drilling proposal to retrieve cores across the continental Moho in the SW Iberia rifted Margin, the Ocean-Continent Transition (OTC) and the Africa-Eurasia transform-subduction plate boundary in the Atlantic.

The workshop was a timely fit with the *JOIDES Resolution's* timeline (drilling in 2023-2024 in the North Atlantic), and offered the possibility to tackle fundamental questions such as the nature of the lithospheric mantle in hyper-extended continental margins and OCT, and subduction initiation at transform faults.

The main outcome of the discussions was that the central addressed topic: subduction initiation in a passive margin, that is the core topic of a proposal that was submitted to IODP at the 1 October 2019 deadline (977-Pre).

Two MagellanPlus workshops to be organized in **2020**

In 2019, it was decided to fund two more MagellanPlus workshops, which will be organized in 2020.

MagellanPlus: **EFRAM-ARC Workshop - Eastern Fram Strait Paleo Archive**
Trieste, Italy, 21-24 January 2020

Convenors	Renata G. Lucchi (Italy), Michele Rebesco (Italy), Riccardo Geletti (Italy), Jan Sverre Laberg (Norway), Jens Gruetzner (Germany)
More info	*www.inogs.it/en/content/september-15-applications-efram-arc-workshop*

The workshop aims at bringing together scientists with different background in Arctic studies, to bridge knowledge gaps in the present understanding of the Arctic Quaternary palaeoclimatic and palaeoceanographic record, and to explore common scientific goals and specific drilling targets within the EFRAM-ARC APL-954 initiative in synergy with the other active Arctic IODP proposals.

Participants of EFRAM-ARC Workshop. Photo: ECORD/IODP.

MagellanPlus: **COSNICA Workshop - The life cycle of a microplate at a convergent margin**
Graz, Austria, 19-20 June 2020

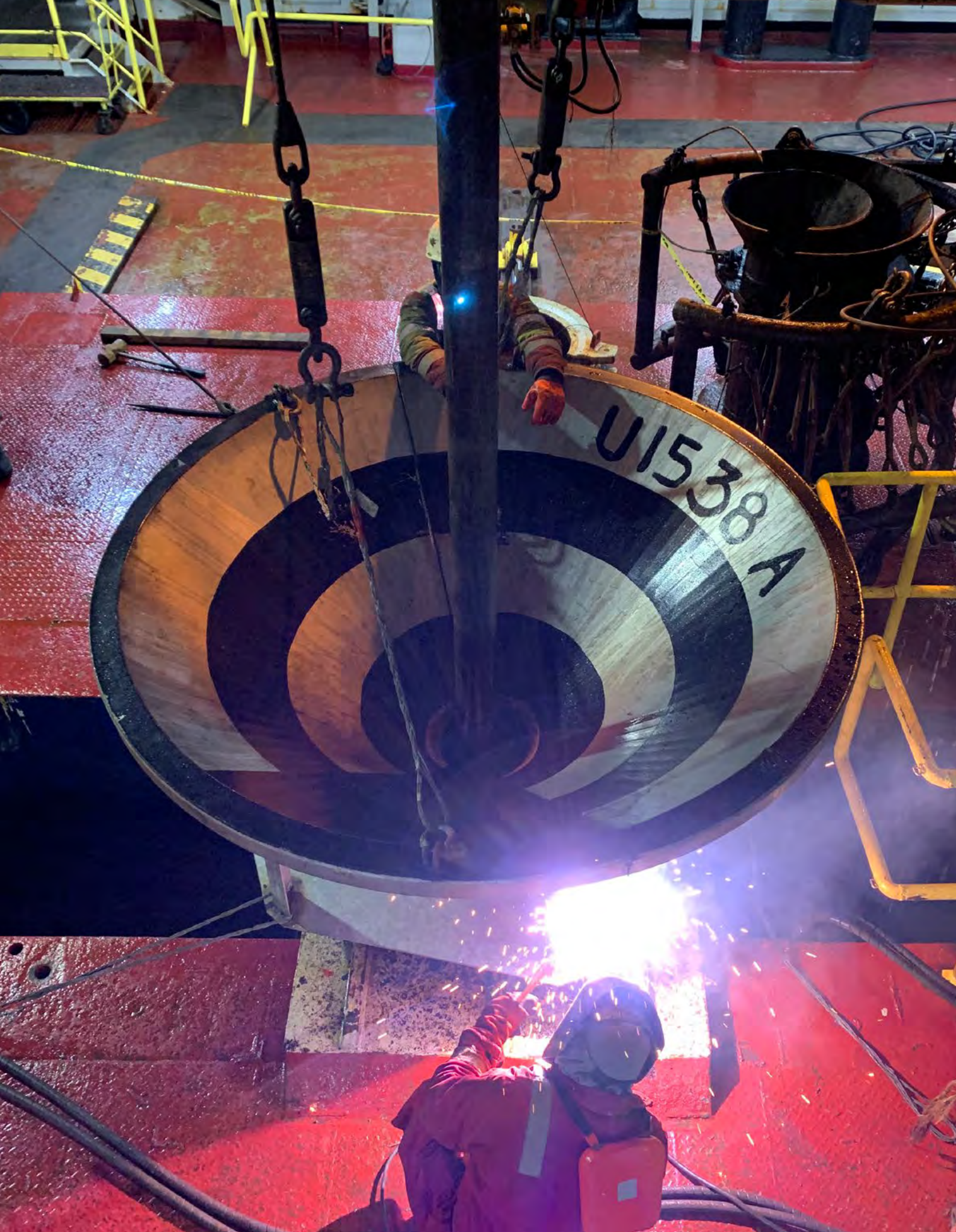
Convenors	Walter Kurz (Austria), Steffen Kutterolf (Germany), Jennifer Brandstätter (Austria), Paola Vannucchi (UK)
More info	*http://cosnica.uni-graz.at*

The overarching workshop objective is to integrate several drilling projects offshore Nicaragua and Costa Rica under a general umbrella theme, and to develop and brainstorm two IODP-Pre-proposals targeting the Cocos Plate and the Nicaraguan fore arc region. The first objective is the result of unsolved questions arising from two CRISP expeditions (IODP Expeditions 334 and 344) and the second objective has a potential amphibian component associated to the ICDP workshop proposal that will be held in March 2020 in Nicaragua to drill the terrestrial part of the Nicaragua depression.
These two drilling targets will additionally complement a third proposed project at the Nicaraguan section of the incoming Cocos Plate where bend faults will be targeted and where a successful Magellan Plus workshop was held in 2016 in London, UK.

More info

A more complete overview of all MagellanPlus workshops, reports and summaries can be found at:

www.ecord.org/science/magellanplus



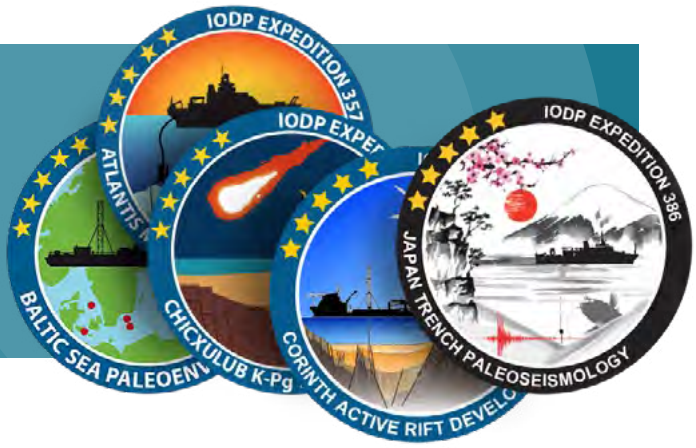
IODP Expedition 382 offshore crew members weld a free-fall funnel together before sending it down along the pipe to the seafloor (photo L. Stevens, IODP).

8. Communicating

Lunch & Learn talk for early-career scientists at the joint 'Scientific Drilling' booth of ECORD-IODP and ICDP during the EGU 2019, Vienna, Austria (photo M. Bednarz, ECORD/ICDP).

8. Communicating

Promoting IODP activities and accomplishments to large, often non-scientific, audiences is a major and ongoing goal of the ECORD Outreach Task Force (EOTF).



Within ECORD, responsibilities for outreach activities are distributed between EMA (coordination, publications and web), ESO (MSP expeditions and media) and ESSAC (education), and are coordinated by the ECORD Outreach Task Force (EOTF).

More info

www.ecord.org/outreach

www.ecord.org/resources

ECORD Outreach Task Force meetings

EOTF meetings are attended by ECORD and ICDP outreach teams to enhance cooperation between ECORD and ICDP. The EOTF met twice during 2019:

EOTF spring meeting #15

28 February – 1 March 2019, Aix-en-Provence, France

EOTF fall meeting #16

7 November 2019, Dublin, Ireland

The fall meeting was held in Dublin and hosted by the Geological Survey Ireland (GSI) right after the ECORD Council-ESSAC meeting. Outreach colleagues from the US Science Support Program (USSSP) and MarE3 (Institute for Marine-Earth Exploration and Engineering/JAMSTEC, Japan) attended the fall meeting to enhance cooperation between ECORD and IODP partners.

Follow ECORD

info@ecord.org

www.ecord.org

@ECORD_IODP

ECORD IODP

ECORD_IODP

ECORD_IODP

8.1 Communicating with scientists

Promoting IODP/ECORD at conferences, exhibitions and workshops

EOTF promotes IODP and ICDP under the umbrella of **"Scientific Drilling"** at the EGU (European Geosciences Union, Europe) and AGU (American Geophysical Union, USA), which are meetings attended by thousands of scientists from all over the world every year.

EGU 2019 Vienna, Austria, 7–12 April 2019

www.egu2019.eu *>16 000 scientists from 113 countries*

European Geosciences Union (EGU) Conference in Vienna is the main annual event for ECORD. At EGU 2019, ECORD and the ICDP jointly sponsored a booth and organised a Townhall meeting.

ICDP logging scanner demonstrations, videos and lunch talks attracted many visitors to the booth.

Similarly as in 2018, the **ECORD/IODP Outreach session** was organised at the EGU General Assembly meeting:

- Achievements and perspectives in scientific ocean and continental drilling *https://meetingorganizer.copernicus.org/EGU2019/session/31032*
- Outreach in Geosciences: what does it mean to you *https://meetingorganizer.copernicus.org/EGU2019/session/31743*

AGU 2019 San Francisco, USA, 9-13 December 2019

https://events.jspargo.com/agu19/public/enter.aspx *>25000 scientists from > 100 countries*

In coordination with our US and Japanese IODP partners and the ICDP outreach staff, a joint IODP-ICDP booth was organised at the AGU Fall Meeting 2019.

IODP China collaborated with the IODP partners and anticipated its participation to a joint booth at the AGU 2020.

Other international meetings

In 2019, ECORD supported promotion of IODP at many other international scientific meetings in Europe and worldwide (see table on page 90). The events were (co-) organised by EOTF, IODP national offices, Distinguished Lecturers or international scientists.

ECORD at MagellanPlus workshops, ECORD Summer Schools and Training Course

ECORD information was also widely distributed through the ECORD-ICDP MagellanPlus Workshop Series Programme (page 82) and ECORD Training Course and Summer Schools (page 77).

8.2 Communicating with the general public

IODP expeditions

IODP Expedition 386: Japan Trench Paleoseismology

www.ecord.org/expedition386

In preparation of IODP Expedition 386: Japan Trench Paleoseismology, promotional materials, a logo, leaflet, banner and expedition web page were designed.

IODP Expedition 379: Amundsen Sea W Antarctic Ice Sheet History

https://joidesresolution.org/expedition/379

In 2019, ECORD funded an Outreach Officer, Vivien Cumming (UK), to sail on IODP Expedition 379: Amundsen Sea W Antarctic Ice Sheet History (page 52) to create outreach materials and live broadcast form the ship.

Materials and activities of the Outreach Officer include fivelive broadcasts (to USA, France, Germany), 26 blogs on the JR website, video for German and French TV, news articles (UK, USA, France, Germany), photos and post on BBC Earth Instagram, and posts on social media. The direct audience size of over two million is estimated due to BBC Earth social media sharing and publicity on BBC Global News that has a weekly audience size of 394 million people globally.

Audiences reached through broadcasts:

- 680 people were reached through live broadcasts, and
- 400,000 through the *JOIDES Resolution* website and social media.

Outreach events

In 2019, EOTF continued to support member countries through the organisation of exhibition booths and/or exhibitions at multiple outreach events (see table on page 90):

ECORD resources

The EOTF has created new resources, brochures, video and tools to broaden outreach activities to the general public.

The **ECORD Newsletter** is published twice a year to coincide with the EGU and AGU conferences. The ECORD Newsletter provides the main published source of general ECORD information and includes reports on recent outreach and education activities.

Leaflets explaining the programme objectives and the latest information resulting from eighth completed MSP expeditions are included in an ECORD folder, which is continuously updated.

ECORD at 2019 scientific events

1	PROCEED Workshop, Austrian Academy of Sciences *https://www.ecord.org/science/proceed/*	6-7 April	Vienna, Austria
2	EGU 2019 - European Geosciences Union *https://www.egu2019.eu/*	7-12 April	Vienna, Austria
3	Girls in Geoscience at Plymouth University *https://www.plymouth.ac.uk/research/earth-sciences/girls-into-geoscience*	26 June - 2 July	Plymouth, UK
4	Ciência 2019 - National Science and Technology Summit *http://www.encontrociencia.pt/home/en.asp*	8-10 July	Lisbon, Portugal
5	SIMPSGI- SoGeI - annual geoscience conference in Italy *http://parma2019.socminpet.it/*	16-19 September	Parma, Italy
6	Lecture: ECORD distinguished lecturer Rebecca Bell, University of Lisbon *https://ciencias.ulisboa.pt/pt/evento/25-09-2019/unlocking-the-secrets-of-slow-slip-using-next-generation-seismic-experiments-and*	25 September	Lisbon, Portugal
7	IODP-ECORD Day in Greece at University of Athens *https://www.ecord.org/ecord-iodp-day/*	3 October	Athens, Greece
8	4th SwissDrilling Day at University of Bern	4 October	Bern, Switzerland
9	Arctic Ocean Drilling workshop, Stockholm University	16 October	Stockholm, Sweden
10	French Geological Society Scientific Drilling Days at the Museum of Natural History in Paris *http://www.iodp-france.org/pro/journees-sgf-sur-les-forages-iodp-icdp/*	16-17 October	Paris, France
11	'Female scientists by profession' at Universita' Ca' Foscari Venezia *https://www.unive.it/pag/31372/?tx_news_pi1%5Bnews%5D=8007&cHash=2c8fd3499bf7892a10471a38a2659b72*	30 October	Venice, Italy
12	SwissDrilling: 2 days conference by Swiss Geoscience Community	22-23 November	Fribourg, Switzerland
13	AGU 2019 - American Geophysical Union *https://events.jspargo.com/agu19/public/enter.aspx*	9-13 December	San Francisco, USA

ECORD at 2019 public events

14	'Mysteries of the Deep': temporary exhibit at The Lapworth Museum of Geology, University of Birmingham *https://www.mysteriesofthedeep.org/*	11 March - 17 June	Birmingham, UK
15	Festival del Mare – ECORD/IODP exhibition booth *http://festivaldelmare.unige.it/*	16-18 May	Genoa, Italy
16	Great Exhibition Festival 2019 - ECORD/IODP exhibition booth *https://www.greatexhibitionroadfestival.co.uk/event/nature-zone/*	29-30 June	London, UK

Exhibitions of ECORD core replicas in 2019

Core replica		Event /University/Museum		
K/Pg	17	University of Plymouth	Dec 2018 - April 2019	Plymouth, UK
	18	Festival de Mare, IODP-Italy	16-18 May	Genoa, Italy
	19	Urbino Summer School 2019, University of Urbino	10-26 July	Urbino, Italy
	20	'Female scientists by profession', Universita' Ca' Foscari Venezia	30 October	Venice, Italy
PETM	21	University of Plymouth	Dec 2018 - April 2019	Plymouth, UK
	22	Great Exhibition Festival 2019, Imperial College	3-30 June	London, UK
	23	Urbino Summer School 2019, University of Urbino	10-26 July	Urbino, Italy
	24	University College London	15 Nov - 5 Dec	London, UK
Oceanic Crust	25	'Mysteries of the Deep', temporary exhibit, the Lapworth Museum of Geology, University of Birmingham	1 March - 18 June	Birmingham, UK
	26	Girls in Geoscience, University of Plymouth	26 June - 2 July	Plymouth, UK
Tahiti	27	EPC, University of Leicester	8-10 March	Leicester, UK
	28	'Female scientists by profession', Universita' Ca' Foscari Venezia	30 October	Venice, Italy
ACEX	29	'Mysteries of the deep', temporary exhibit, the Lapworth Museum of Geology, University of Birmingham	1 March - 18 June	Birmingham, UK

Core replicas

www.ecord.org/resources/core-replicas

Replicas of drilling cores from ODP/IODP legs and expeditions are valuable tools to introduce ODP/IODP science and to raise awareness about ocean drilling to the public.

In 2019, core replicas were provided to support open days in science centres, scientific exhibitions and festivals, university courses in the United Kingdom and Italy (bottom table on the previous page).

How to loan a core replica?

To order a loan, contact **Malgo Bednarz** at *bednarz@cerege.fr* with inquiry about the availability of any particular core replica.

ECORD shares the core replicas free of charge, on a temporary basis to sscientists, educators and exhibitors under the conditions described in the loan document.

8.3 Media activities

News that promote IODP expeditions are frequently appearing in the national and international Internet portals, TV stations and newspapers.

EOTF supports authors and press representatives providing information and high-resolution photographs from MSP expeditions on request.

In 2019 IODP-related news appeared in:

- Earth & Space Science News (Eos.org, publication of the American Geophysical Union). Article related to IODP Expedition 302 'ACEX': *https://eos.org/research-spotlights/reconstructing-150-million-years-of-arctic-ocean-climate*
- Article Article on the University of Utrecht website presenting an interview featuring three scientists from the University of Utrecht who reported about their recent experiences on board the *JOIDES Resolution*. *https://www.uu.nl/en/background/international-co-operation-at-its-best*
- BBC video by ECORD Outreach Officer Vivien Cumming: 'The 'time machines' unlocking Antarctica's past' *https://www.bbc.com/reel/video/p07bvx51/the-time-machines-unlocking-antarctica-s-past*
- Science News for Students: 'Reliving the last day of the dinosaurs' *https://www.sciencenewsforstudents.org/article/reliving-last-day-dinosaurs*

Following the new scientific publication on IODP Expedition 364 ('The first day of the Cenozoic', The Proceedings of the National Academy of Sciences, *https://doi.org/10.1073/pnas.1909479116*), several articles for general public were published in the international media:

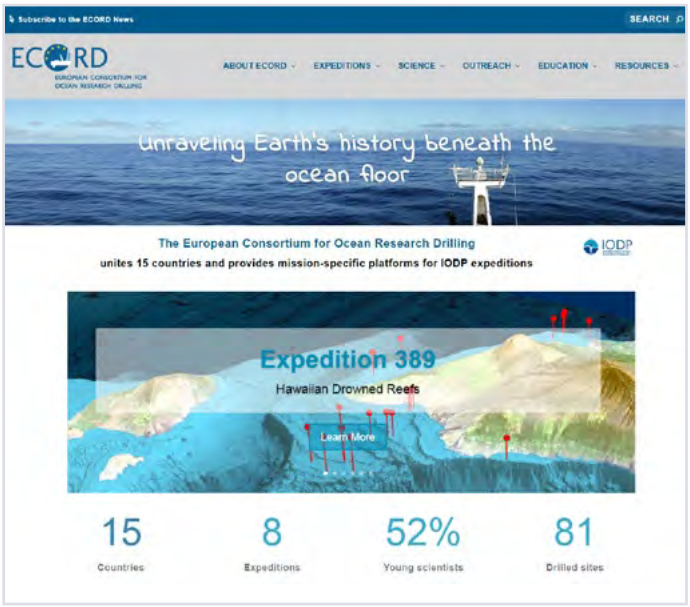
- Euronews.com, article related to IODP Expediton 364: 'Chicxulub K-Pg Impact Crater' *https://es.euronews.com/2019/09/10/retrato-hiperrealista-del-dia-en-que-un-meteorito-provoco-la-extincion-de-los-dinosaurios* (in Spanish)
- Smithsonian.com: 'What Happened the Day a Giant, Dinosaur-Killing Asteroid Hit the Earth' *https://www.smithsonianmag.com/science-nature/dinosaur-killing-asteroid-impact-chicxulub-crater-timeline-destruction-180973075/#ubfCpccku27X0ZjK.03*
- National Geographic: 'Last day of the dinosaurs' reign captured in stunning detail' *https://www.nationalgeographic.com/science/2019/09/last-day-dinosaurs-reign-captured-stunning-detail/?no-cache&fbclid=IwAR2O4SxxeAP2RtZXLB8q-sNvTngT5FM9sl4kDxfb0dvchfa-ucXx8shzc4w*
- The New York Times 'A New Timeline of the Day the Dinosaurs Began to Die Out' *https://www.nytimes.com/2019/09/10/science/chicxulub-asteroid-impact-dinosaurs.html*

8.4 ECORD online

ECORD website

www.ecord.org

In 2019, the ECORD website had an average of 400 visits per day with a total of 129,296 visitors.



ECORD on social media

EOTF continues to be active on social media networks. Social networks posts help guiding users to specific ECORD webpages and encourage return visits to the website. Conveying information to the science community and the wider public is especially useful during major ECORD/IODP events, such as MSP expeditions or international scientific conferences.

400 visits/day

1177 followers

1940 followers

ECORD IODP

ECORD_IODP

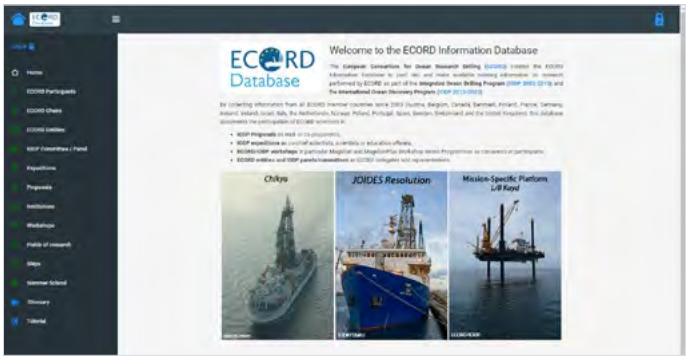
@ECORD_IODP

ECORD_IODP

ECORD Information Database

http://ecordbase.ecord.org

The renewal of the ECORD Information database has been completed. The new database was launched in September 2019.



Display of the JFAST core replica at the ECORD/IODP booth during The Great Exhibition Festival 2019 in London, UK (photo D. Ricardo, P. Bastidas, ECORD/IODP).

9. FY19 and FY20 budgets

Positive balance of **18.8 M** at the end of 2019

About **95%** of the ECORD budget for direct operational costs

Annual budget of about **6M USD** to implement MSP expeditions

Sunset on board drill ship *Greatship Maya* during IODP Expedition 325 (photo C. Cotterill, ECORD/IODP).

9. FY19 and FY20 budgets

FY19 ECORD budget

ECORD is currently funded exclusively by its 15 member countries.

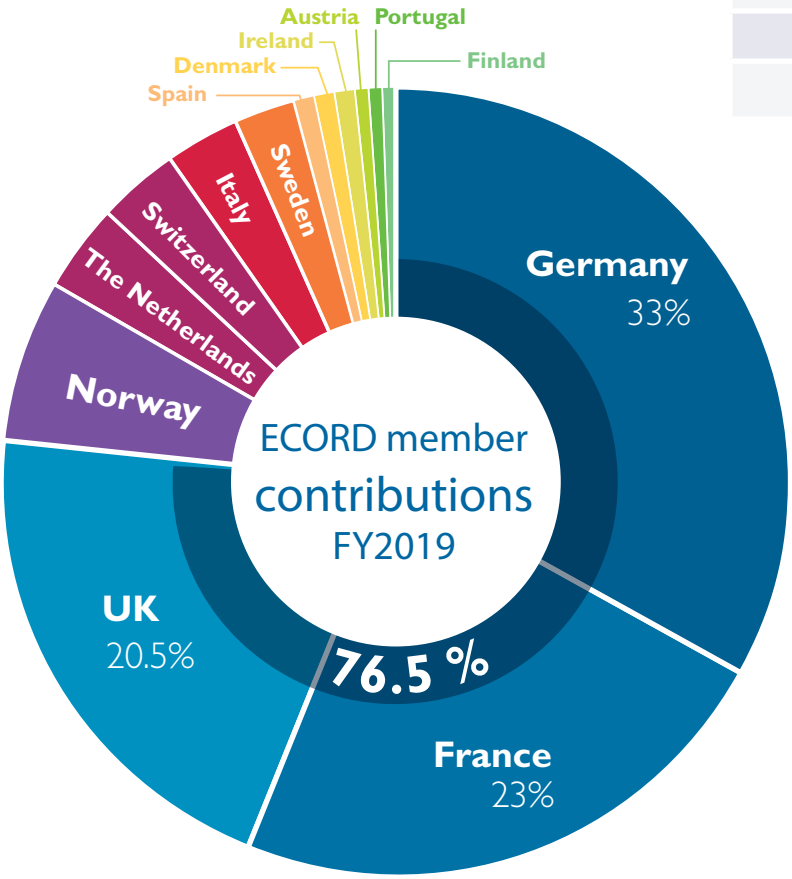
In FY19, the total ECORD budget amounted to $ 16.887M (below), showing a decrease of about $300K compared to the FY18 budget. Since 2014, the ECORD budget decrease is of $2M, mainly due to strong fluctuations in exchange rates between the US Dollar and the national currency contributions of five ECORD 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 an expedition-by-expedition basis.

The contributions to the ECORD budget are unevenly distributed between the member countries, ranging from $5.6M to $80K (below). Based on their contributions, each ECORD member country receives a participation quota for all IODP expeditions. However, the participation of ECORD member countries to the ECORD educational programme (page 76) is not based on financial contributions.

ECORD contributions FY19 (USD)	
Germany	5,600,000
France *	3,920,000
UK *	3,466,000
Norway	1,100,000
Switzerland	600,000
The Netherlands	600,000
Italy	500,000
Sweden	400,000
Spain *	168,000
Denmark *	148,000
Ireland *	115,000
Austria	100,000
Portugal	90,000
Finland	80,000
Canada	0
TOTAL	**16,887,000**

ECORD member country contributions for FY19 (USD). The amount in dollars is based on exchange rates (when applicable) at the time of the payment by the relevant partner.
* countries paying their contribution in their own currency



The three major ECORD contributors, Germany ($5.6M), France ($3.92M) and UK ($3.47M), provide 76.5% of the total ECORD budget.

The contributions of other member countries range from $80K to $1.1M.

Distribution of ECORD member contributions for FY2019.

The table below summarises the ECORD budget for FY19.

The ECORD fixed costs were stable, amounting to approximately 5% of the member country contributions, leaving 95% of the ECORD budget for direct operational costs.

The ECORD budget shows a positive balance of $18,829,700 at the end of 2019 and this sum will be carried forward to the ECORD FY20 budget.

ECORD **FY2019** Budget (in USD)

	FY19 Income (USD)	FY19 Expenses (USD)
FY18 balance	15,918,781	
FY19 contributions	16,887,000	
ECORD-NSF MoU		7,000,000
ECORD-JAMSTEC MoU		3,000,000 *
ESO		2,584,740
EMA		356,700
MagellanPlus		81,326
IODP Chairs support		144,000
IODP publication support **		15,000
ESSAC		315,606
BCR		353,109
Outreach basic		66,400
Outreach stakeholders **		11,200
Outreach expeditions **		30,000
ECORD Information Database **		18,000
TOTAL	32,805,781	13,976,081
FY19 balance	**18,829,700**	

* Payments 2017-2019

** Non-recurrent budget items

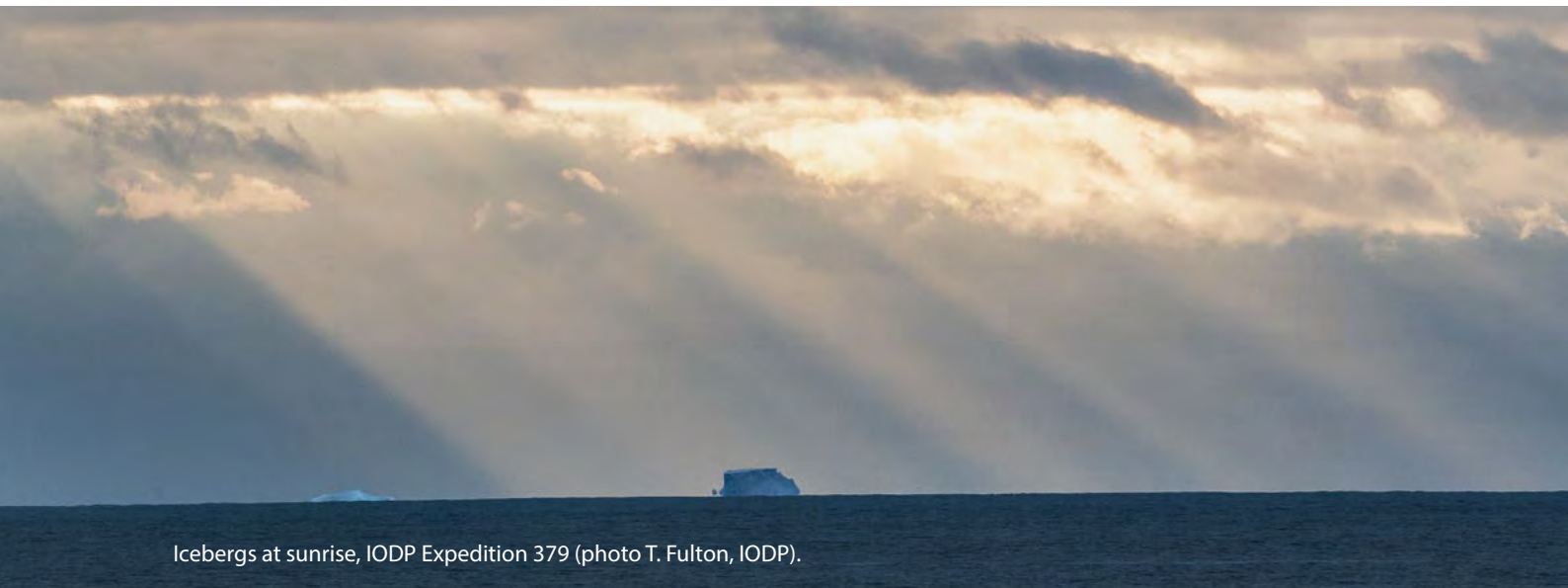
Artistic photograph of drilling equipment, IODP Expedition 325 (photo C. Cotterill, ECORD/IODP).

FY20 ECORD budget

The expected total contributions for FY20 from the 15 ECORD member countries is about $16.866M (see table below).

ECORD contributions FY20 (USD)	
Germany	5,600,000
France *	3,908,000
UK *	3,364,000
Norway	1,100,000
Switzerland	600,000
The Netherlands	600,000
Italy	500,000
Sweden	400,000
Spain *	163,000
Denmark *	146,000
Ireland *	109,000
Canada	106,000
Austria	100,000
Portugal	90,000
Finland	80,000
TOTAL	**16,866,000**

The amount in US dollars will be based on exchange rates (when applicable) at the time of the payment by the relevant partner.
* countries paying their contribution in their own currency.



Icebergs at sunrise, IODP Expedition 379 (photo T. Fulton, IODP).

ECORD **FY2020** Budget (in USD)

	FY20 Income (USD)	FY20 Expenses (USD)
FY19 balance	18,829,700	
FY20 contributions	16,866,000	
ECORD-NSF MoU		7,120,000
ECORD-MarE3 MoU		3,000,000 *
ESO		3,149,515
EMA		305,880
MagellanPlus		86,800
IODP Chairs Support		169,000
ESSAC		319,064
BCR		392,162
Outreach basic		66,400
TOTAL	**35,695,700**	**14,608,821**
Expected FY20 balance	**21,086,879**	

* Including operational costs of IODP Expedition 386.
The amounts in USD are subject to exchange rate fluctuations.

Budget of ECORD Entities

ECORD Managing Agency

The table below summarises the EMA budget for FY19 and FY20, as approved by the ECORD Council in June 2019.

EMA budget for FY19 and FY20					
	FY19		FY20		Variance
	€	USD	€	USD	€
Salaries					
Assistant Director	68,000	78,880	68,000	84,320	0
Outreach Officer	68,000	78,880	68,000	84,320	0
Outreach Coordinator	26,000	30,160	0	0	26,000 (-)
Compensation for the Director	50,000	58,000	50,000	62,000	0
Travels and meetings					
Travel costs EMA CEREGE	50,000	58,000	50,000	62,000	0
Invited speakers to ECORD meetings	3,000	3,480	3,000	3,720	0
Organisation ECORD Meetings	10,000	11,600	10,000	12,400	0
Organisation SEP June Meeting	10,000	11,600	10,000	12,400	0
MagellanPlus	70,000	81,326	70,000	86,900	0
Consumables / Office costs	2,500	2,900	3,000	3,720	500 (+)
Overheads CEREGE	20,000	23,200	25,000	31,000	5000 (+)
TOTAL	**377,500**	**438,026**	**357,000**	**442,780**	**20,500 (-)**
2019 overpayment				-50,000	
GRAND TOTAL	**377,500**	**438,026**	**316,758**	**392,780**	

ECORD Science Support and Advisory Committee (ESSAC)

The table below summarises the ESSAC budget for FY19 and FY20 as approved by the ECORD Council in June 2019.

ESSAC budget for FY19 and FY20					
	FY19		FY20		Variance
	€	USD	€	USD	€
Salaries					
Science Coordinator (Grade 8/43)	68,921	85,462	69,610	86,316	0,689 (+)
Compensation for the Chair	50,000	62,000	50,000	62,000	0
Compensation for the Vice-Chair	5,000	6,200	5,000	6,200	0
Travels and subsistence					
Science Coordinator	7,500	9,300	7,600	9,424	0,100 (+)
Chair	19,000	23,560	20,000	24,800	1,000 (+)
Office Costs	6,100	7,564	6,200	7,688	0,100 (+)
Meetings					
ESSAC Spring meeting	2,600	3,224	2,700	3,348	0,100 (+)
ESSAC Fall meeting	2,600	3,224	2,700	3,348	0,100 (+)
Travel support invited speakers	3,100	3,844	3,150	3,906	0,050 (+)
Travel Support ESSAC Liaison to SEP Meeting	3,100	3,844	3,150	3,906	0,050 (+)
Conference Travel Support	4,100	5,084	4,200	5,208	0,100 (+)
Education and Outreach					
ECORD DLP Support	13,000	16,120	13,500	16,740	0,500 (+)
ECORD Summer Schools	30,000	37,200	30,000	37,200	0
ECORD Training Course	6,500	8,060	6,500	8,060	0
ECORD Scholarships	15,000	18,600	15,000	18,600	0
ECORD Research Grants	18,000	22,320	18,000	22,320	0
TOTAL	**254,521**	**315,606**	**257,310**	**319,064**	**2,789 (+)**

ECORD Science Operator

The table below summarises the expenditure breakdown of ESO for FY19 in US dollars.

ESO budget for FY19									
	2019 Annual Program Plan Budget				2019 Expenditure				2019 variance
	BGS	MARUM	EPC	Total	BGS	MARUM	EPC	Total	
Management and administration	230,884	176,701	386,297	793,882	228,290	176,701	386,297	791,288	2,594
Personnel	156,884	126,701	322,297	605,882	204,067	126,701	322,297	653,065	-47,183
Travel	50,000	26,000	40,000	116,000	19,070	26,000	40,000	85,070	30,930
Supplies	7,000	7,000	7,000	21,000	0	7,000	7,000	14,000	7,000
Communication	0	0	0	0	704	0	0	704	-704
Equipment	7,000	7,000	7,000	21,000	4,351	7,000	7,000	18,351	2,649
Other	10,000	10,000	10,000	30,000	98	10,000	10,000	20,098	9,902
Technical, Engineering and Science Support	498,172	428,065	264,480	1,190,717	646,172	428,065	264,480	1,338,717	-148,000
Personnel	282,672	131,815	193,480	607,967	259,225	131,815	193,480	584,520	23,447
Travel	24,000	24,000	24,000	72,000	22,691	24,000	24,000	70,691	1,309
Supplies	0	0	0	0	0	0	0	0	0
Shipping	0	0	0	0	759	0	0	759	-759
Communication	0	0	0	0	1,584	0	0	1,584	-1,584
Contractual Services	0	0	25,000	25,000	0	0	18,750	18,750	6,250
Equipment	3,000	3,000	2,000	8,000	19,475	3,000	8,250	30,725	-22,725
Other	188,500	269,250	20,000	477,750	342,437	269,250	20,000	631,687	-153,937
Core Curation	0	87,094	0	87,094	34	87,094	0	87,128	-34
Personnel	0	74,094	0	74,094	0	74,094	0	74,094	0
Travel	0	6,000	0	6,000	34	6,000	0	6,034	-34
Supplies	0	2,000	0	2,000	0	2,000	0	2,000	0
Shipping	0	5,000	0	5,000	0	5,000	0	5,000	0
Data Management	138,380	93,416	27,640	259,436	57,059	93,416	27,640	178,115	81,321
Personnel	29,380	75,416	27,640	132,436	27,229	75,416	27,640	130,285	2,151
Travel	8,000	8,000	0	16,000	0	8,000	0	8,000	8,000
Supplies	6,000	0	0	6,000	0	0	0	0	6,000
Communication	0	0	0	0	0	0	0	0	0
Contractual Services	75,000	0	0	75,000	28,544	0	0	28,544	46,456
Equipment	20,000	10,000	0	30,000	1,285	10,000	0	11,285	18,715
Publications	44,064	0	0	44,064	52,171	0	0	52,171	-8,107
Contractual Services	44,064	0	0	44,064	52,171	0	0	52,171	-8,107
Outreach	196,314	30,329	55,280	281,923	51,713	30,329	55,280	137,322	144,601
Personnel	47,787	22,329	55,280	125,396	29,324	22,329	55,280	106,933	18,463
Travel	8,000	8,000	0	16,000	8,707	8,000	0	16,707	-707
Supplies	8,000	0	0	8,000	9,206	0	0	9,206	-1,206
Shipping	0	0	0	0	2,147	0	0	2,147	-2,147
Communication	0	0	0	0	143	0	0	143	-143
Other	132,527	0	0	132,527	2,185	0	0	2,185	130,342
Grand Total	1,107,814	815,605	733,697	2,657,116	1,035,438	815,605	733,697	2,584,740	72,376

Bremen Core Repository (BCR)

The table below summarises the BCR budget for FY19 and FY20 as approved by the ECORD Council in June 2019.

BCR budget for FY19 and FY20					
	FY19		FY20		Variance
	€	USD	€	USD	€
Salaries and Fringes	239,344	277,639	234,990	291,388	4,354 (-)
Student workers	9,892	15,827	14,630	18,141	4,738 (+)
Travels	2,585	2,999	1,750	2,170	835 (-)
Supplies	19,891	23,074	21,210	26,300	1,319 (+)
Shipping	10,772	12,495	29,400	36,456	18,628 (+)
CurationDIS updates	4,309	4,998	4,200	5,208	109 (-)
SEDIS maintenance 24/7 & upgrades	12,208	14,161	10,080	12,499	2,128 (-)
Total	**299,001**	**351,193**	**316,260**	**392,162**	**17,259 (+)**

IODP Expedition 379 Co-chief Scientists Julia Wellner (University of Houston, USA) and Karsten Gohl (Alfred Wegener Institute, Germany) (photo T. Fulton, IODP).

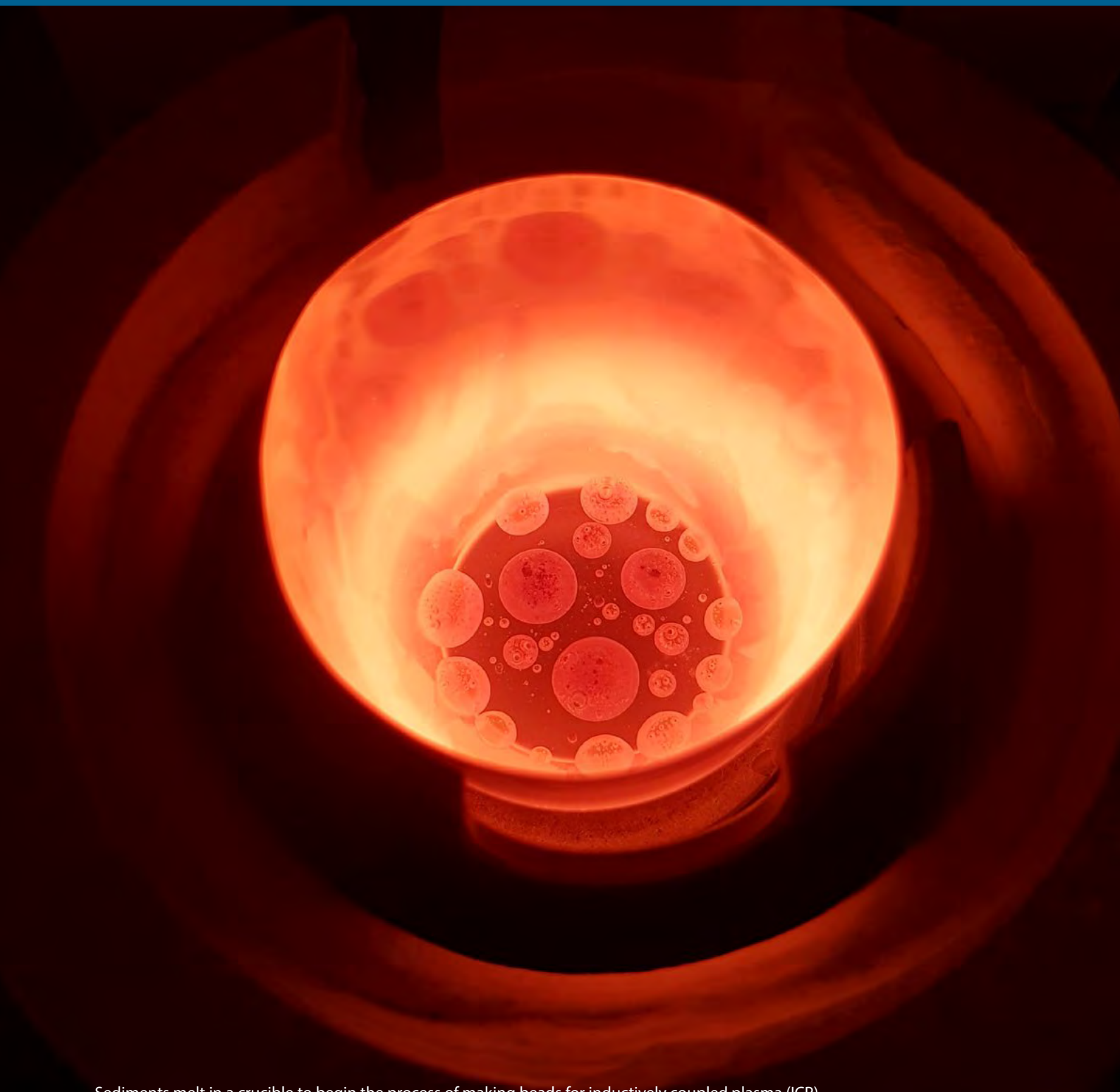
ECORD Outreach Task Force (EOTF)

The table below summarises the EOTF budget for FY19 and FY20 as approved by the ECORD Council in June 2019.

EOTF budget for FY19 and FY20					
	FY19		FY20		Variance
	€	USD	€	USD	USD
Core outreach activities					
ECORD Publications	7,457	8,650			0
Annual Report 2019			3,589	4,450	0
Newsletters (#34 and #35)			3,387	4,200	0
Managing core replicas	5,043	5,850	4,718	5,850	0
EGU and AGU booths	17,543	20,350	16,411	20,350	0
ECORD website	1,465	1,700	1,371	1,700	0
Travels	14,267	16,550	10,484	13,000	3,550 (-)
Shipping	2,543	2,950	2,379	2,950	0
Goodies	6,853	7,950	6,411	7,950	0
Office costs	N/A	N/A	2,863	3,550	3,550 (+)
Pre- and post-cruise flyers (#386)	1,030	1,200	968	1,200	0
Expedition logos and stickers	1,030	1,200	968	1,200	0
TOTAL basic outreach activities	**57,231**	**66,400**	**53,548**	**66,400**	**0**
Donators and Stakeholders					
Image video	5,862	6,800	N/A	N/A	
Image brochure	3,793	4,400	N/A	N/A	
Onboard Outreach Officer	25,862	30,000	N/A	N/A	
ECORD Information Database	15,517	18,000	N/A	N/A	
TOTAL	**108,265**	**125,600**	**53,548**	**66,400**	

Drill bit, IODP Expedition 325 (photo D. Smith, ECORD/IODP).

10. ECORD representatives on IODP panels



Sediments melt in a crucible to begin the process of making beads for inductively coupled plasma (ICP) chemical element analyses, IODP Expedition 382 (photo S. Kachovich, IODP)

10. ECORD representatives on IODP panels

The International Ocean Discovery Program (IODP) is composed of three platform providers (NSF for *JOIDES Resolution*, JAMSTEC/MarE3 for *Chikyu* and ECORD for MSPs), three Facility Boards, two IODP advisory panels, a Science Support Office and the IODP Forum. The ECORD representatives on IODP panels are listed below:

JOIDES Resolution Facility Board - JR**FB**

http://www.iodp.org/facility-boards#JRFB

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)
Steve Bohaty (UK)

Chikyu IODP Board - **CIB**

https://www.jamstec.go.jp/cib/

The *Chikyu* IODP Board - CIB is the planning forum for expeditions using *Chikyu*.

ECORD Members of the CIB
Gilbert Camoin (France)
Benoît Ildefonse (France)

Environmental Protection and Safety Panel - **EPSP**

http://www.iodp.org/facility-boards#EPSP

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)

IODP Forum

http://www.iodp.org/iodp-forum

The IODP Forum represents the overarching umbrella of the programme and provides advice to IODP Facility Boards on platform provider activity.

IODP Forum Chair
Dick Kroon (ECORD)

ECORD attendees at the IODP Forum 2019 in Osaka, Japan
Gilbert Camoin (France)
Nadine Hallmann (France)
Jan Behrmann (Germany)
André Bornemann (Germany)
Carol Cotteril (UK)
Jochen Erbacher (Germany)
Patrick Grunert (Germany)
Hanno Kinkel (UK)
Guido Lüniger (Germany)
David McInroy (UK)
Lisa McNeill (UK)
Antony Morris (UK)
David Smith (UK)
Iris Sonntag (Germany)
Michael Strasser (Austria)
Gabriele Uenzelmann-Neben (Germany)

Science Evaluation Panel - **SEP**

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

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

SEP ECORD Members
Maria Angela Bassetti (France)
Thorsten Bauersachs (Germany)
Rebecca Bell (UK)
Silvia Ceramicola (Italy)
Adélie Delacour (France)
Karsten Gohl (Germany)
Christian Hübscher (Germany)
Lisa McNeill (UK, Co-Chair)
Kevin Pickering (UK)
Julie Prytulak (UK)
Michelle Rebesco (Italy)
Tilmann Schwenk (Germany)
Kazuyo Tachikawa (France)
Paola Vannucchi (UK)

IODP INTERNATIONAL OCEAN DISCOVERY PROGRAM

ECORD EUROPEAN CONSORTIUM FOR OCEAN RESEARCH DRILLING

Contributors

Malgo Bednarz
EMA Outreach Officer

Gilbert Camoin
EMA Director

Carol Cotterill
ESO Outreach Manager

Rosalind Coggon
PROCEED Co-chair

Sarah Davies
EPC Manager

Nadine Hallmann
EMA Assistant Director

Hanno Kinkel
ESSAC Science Coordinator

Gilles Lericolais
EFB Chair

Lucas Lourens
MagellanPlus Chair

David McInroy
ESO Science Manager

Antony Morris
ESSAC Chair

Ulrike Prange
ESO Media Relations

Ursula Röhl
ESO Curation and Lab Manager

David Smith
ESO Operations Manager

Gabi Uenzelmann-Neben
EFB Chair

Sunset on the ship during IODP Expedition 313 (photo C. Cotterill, ECORD/IODP).

Ab List of acronyms

ABS: American Bureau of Shipping

ACC: Antarctic Circumpolar Current

ACEX: Arctic Coring Expedition

ADP: Amphibious Drilling Proposal

AGU: American Geophysical Union

AIS: Antarctic Ice Sheet

AIST: National Institute of Advanced Industrial Science and Technology

ANZIC: Australian and New Zealand IODP Consortium

APL: Ancillary Project Letter

ArcOP: Arctic Ocean Paleoceanography, IODP Expedition 377

AWI: Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Bremerhaven

BCR: Bremen Core Repository

BGR: Bundesanstalt für Geowissenschaften und Rohstoffe - Federal Institute for Geosciences and Natural Resources, Hannover

BGS: British Geological Survey

CCOD: Canadian Consortium for Ocean Drilling

CDW: Circumpolar Deep Water

CEREGE: Centre Européen de Recherche et d'Enseignement des Géosciences de l'Environnement - Centre for Research and Education in Environmental Geosciences, Aix-en-Provence

CIB: *Chikyu* IODP Board

CNR: Consiglio Nazionale delle Ricerche - National Research Council of Italy

CNRS: Centre National de la Recherche Scientifique - National Center for Scientific Research, France

CRISP: Costa Rica Seismogenesis Project

CT: Computed Tomography

DAFSHE: Danish Agency for Science and Higher Education

DFG: Deutsche Forschungsgemeinschaft - German Research Foundation

DIS: Drilling Information System

DLP: Distinguished Lecturer Programme

DSDP: Deep Sea Drilling Project

EC: European Commission

ECORD: European Consortium for Ocean Research Drilling

EFRAM-ARC: Eastern Fram Strait Paleo Archive

EFB: ECORD Facility Board

EGU: European Geosciences Union

EMA: ECORD Managing Agency

EOTF: ECORD Outreach Task Force

EPC: European Petrophysics Consortium

EPGFZ: Enriquillo-Plaintain Garden Fault zone

EPSP: Environmental Protection and Safety Panel

ESO: ECORD Science Operator

ESSAC: ECORD Science Support and Advisory Committee

ETH: Eidgenössische Technische Hochschule - Swiss Federal Institute of Technology, Zurich

EVTF: ECORD Vision Task Force

FCT: Fundação para a Ciência e a Tecnologia - Foundation for Science and Technology, Portugal

FNS: Fonds National Suisse de la Recherche Scientifique - Swiss National Science Foundation, SNSF

FY: Fiscal Year

GCR: Gulf Coast Repository

GEOMAR: Helmholtz Centre for Ocean Research Kiel

GFZ: Deutsches GeoForschungsZentrum - German Research Centre for Geosciences, Potsdam

GPC: Giant Piston Coring

GSI: The Geological Survey of Ireland

IBM: Izu-Bonin-Mariana

ICDP: International Continental Scientific Drilling Program

Ifremer: Institut Français de Recherche pour l'Exploitation de la Mer – French Research Institute for Exloitation of the Sea

IGSN: International Geo Sample Number

IKC: In-Kind Contribution

INSU: Institut National des Sciences de l'Univers - National Institute of Sciences of the Universe, France

IODP: Integrated Ocean Drilling Program (2003-2013) & International Ocean Discovery Program (2013-2023)

ISOLAT: Integrated Southern Ocean Latitudinal Transects

JAMSTEC: Japan Agency for Marine-Earth Science and Technology

J-DESC: Japan Drilling Earth Science Consortium

JOIDES: Joint Oceanographic Institutions for Deep Earth Sampling

JR: *JOIDES Resolution*

JRFB: *JOIDES Resolution* Facility Board

JRSO: *JOIDES Resolution* Science Operator

KAUST: King Abdullah University of Science and Technology

KCC: Kochi Core Center

K-Pg: Cretaceous–Paleogene

LSCE: Laboratoire des Sciences du Climat et de l'Environnement - Laboratory for Sciences of Climate and Environment, Gif-sur-Yvette

LWD: Logging While Drilling

MarE3: Marine-Earth Exploration and Engineering Division

MARUM: Center for Marine Environmental Sciences, University of Bremen

mbsf: metres below sea floor

mDIS: mobile Drilling Information System

MDP: Multi-phase Drilling Project

MeBo: Meeresboden-Bohrgerät - seafloor drill

MG+: MagellanPlus Workshop Series Programme

MINECO: Ministerio de Economía y Competitividad - Ministry of Economy and Competitiveness, Spain

MoU: Memorandum of Understanding

MPI: Max Planck Institute

MPT: Mid-Pleistocene Transition

MSCL: Multi-Sensor Core Logger

MSP: Mission-Specific Platform

NADIR: Nice Amphibious Drilling In-situ Monitoring and Risk Analysis

NanTroSEIZE: Nankai Trough Seismogenic Zone Experiment

NOC: National Oceanography Centre, Southampton

NSF: National Science Foundation

NWO: Nederlandse Organisatie voor Wetenschappelijk Onderzoek - Netherlands Organisation for Scientific Research

ÖAW: Östereichische Akademie der Wissenschaften - Austrian Academy of Sciences

OCT: Ocean-Continent Transition

ODP: Ocean Drilling Program

OFSZ: Oriente-Septentrional Fault zone

OSP: Onshore Science Party

PIN: Prior Information Notice

PMO: Program Member Office

PROCEED: Expanding Frontiers of Scientific Ocean Drilling

QA/QC: Quality Assurance/Quality Control

RD2: Rockdrill2

RELICT: Role of Lithospheric Inheritance on Subduction Initiation

SEDIS: Scientific Earth Drilling Information Service

SFWG: Science Framework Working Group

SEP: Science Evaluation Panel

SPRS: Swedish Polar Research Secretariat

UKRI: United Kingdom Research and Innovation

USCG: US Coast Guard

USSP: Urbino Summer School in Paleoclimatology

USSSP: U.S. Science Support Program

VR: Vetenskapsrådet - Swedish Research Council

WAIS: West Antarctic Ice Sheet

XRF: X-Ray Fluorescence

Helge Arz (Sedimentologist, Leibniz Institute for Baltic Sea Research Warnemünde, Germany) preparing a core for description on board *JOIDES Resolution* during IODP Expedition 383 (photo S. Proctor, IODP).

@ECORD_IODP

ECORD_IODP

ECORD IODP

2019 ECORD Member Countries

Austria	1	Österreichische Akademie der Wissenschaften (ÖAW)
Canada	2	Canadian Consortium for Ocean Drilling (CCOD)
Denmark	3	Danish Agency for Science and Higher Education (DAFSHE)
Finland	4	Suomen Akatemia
France	5	Centre National de la Recherche Scientifique (CNRS)
Germany	6	Deutsche Forschungsgemeinschaft (DFG)
Ireland	7	The Geological Survey of Ireland (GSI)
Italy	8	Consiglio Nazionale delle Ricerche (CNR)
Netherlands	9	Nederlandse Organisatie voor Wetenschappelijk Onderzoek (NWO)
Norway	10	Forskningsrådet
Portugal	11	Fundação para a Ciência e a Tecnologia (FCT)
Spain	12	Ministerio de Economía y Competitividad (MINECO)
Sweden	13	Vetenskapsrådet (VR)
Switzerland	14	Fonds National Suisse de la Recherche Scientifique (FNS)
United Kingdom	15	United Kingdom Research and Innovation (UKRI)

ECORD
EUROPEAN CONSORTIUM FOR OCEAN RESEARCH DRILLING

http://www.ecord.org

info@ecord.org