Project no. ERAC-CT-2003- 510218

ECORD-Net

Final Report

February 2009

ECORD European Consortium for Ocean Research Drilling

SIXTH FRAMEWORK PROGRAMME

IODP INTEGRATED OCEAN DRILLING PROGRAM

ECORD-Net coordination
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Front cover images

(top) Transit from the icebreaker Oden to the drillship Vidar Viking during the Arctic Coring Expedition, (middle) detail of the core barrel with drill bit - IODP Tahiti Sea-Level Expedition (all photos ©ECORD/IODP), (bottom) ECORD Summer School took core samples from the muddy tidal flats of the Wadden Sea (photo C. Petrea).

World map: © http://histgeo.ac-aix-marseille.fr

Acknowledgements

The support of the European Commission greatly helped in building the European Research Area in ocean drilling. We are particularly grateful to John Ludden who was one of the key players in setting up the European Consortium for Ocean Research Drilling. He initiated and coordinated the ECORD-Net project before moving on to other responsibilities. Our thanks also go to Svetlana Zolotikova who worked tirelessly as the executive secretary during the first two years of the project. Special acknowledgements are expressed to Alan Stevenson for his help with the production of this document.

ECORD
European Consortium for
Ocean Research Drilling

Project no. ERAC-CT-2003-510218

ECORD-Net

European Consortium for Ocean Research Drilling Network

Instrument: Coordination Action

Thematic Priority

Final Report

Period covered: from 01/12/2003 to 31/8/2008 Date of preparation: 10/02/2009

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Contents

Executive summary

The ECORD-Net project (no. ERAC-CT-2003-510218) was funded under the European Commission's 6th Framework Programme with the main objectives of developing the structure and mechanisms for coordinating and funding ocean drilling research in Europe, and joining the international Integrated Ocean Drilling Program (IODP) as a single European member. IODP is a 10-year project (2003-2013) in which scientific ocean drilling is being undertaken to understand the Global Earth System. Being a member of IODP offers access to address a variety of drilling platforms to obtain records of past climate change, study bio-diversity in sub seafloor systems, establish seafloor laboratories for the study of natural hazards in submarine systems and discover new energy resources. The ECORD-Net project initially included seven workpackages and nine partners, and was funded for 48 months (December 2003 to November 2007) at the level of €2,238,087. Subsequently, the project was expanded to include an additional workpackage and two partners for which, an extra €400,000 was allocated to the budget. The duration was extended to 57 months (August 2008). ECORD-Net was coordinated by INSU-CNRS (France).

At the end of ECORD-Net, the objectives of the project have been fully met. The European Consortium for Ocean Research Drilling (ECORD) is up and running and has proved its effectiveness in building the European research area in ocean drilling. It can be considered as a very successful example of integration at the European level to increase the visibility and strength of Europe in an international programme. The influence of ECORD and its intellectual contribution are well acknowledged within IODP by the Lead Agencies from the USA and Japan.

17 countries (Austria, Belgium, Canada, Denmark, Finland, France, Germany, Iceland, Ireland, Italy, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom) have joined ECORD by signing a Memorandum of Understanding (MoU) and ECORD has joined IODP as a single European member. By negotiating with one voice, ECORD was able to obtain a good deal and the preferential status of 'contributing member' within IODP. Through the ECORD Managing Agency (EMA), ECORD is now able to pool annually about €16.5 million to participate in a €160 million international program. This has allowed ECORD to establish itself as one of the three IODP platform operators, together with the USA and Japan.

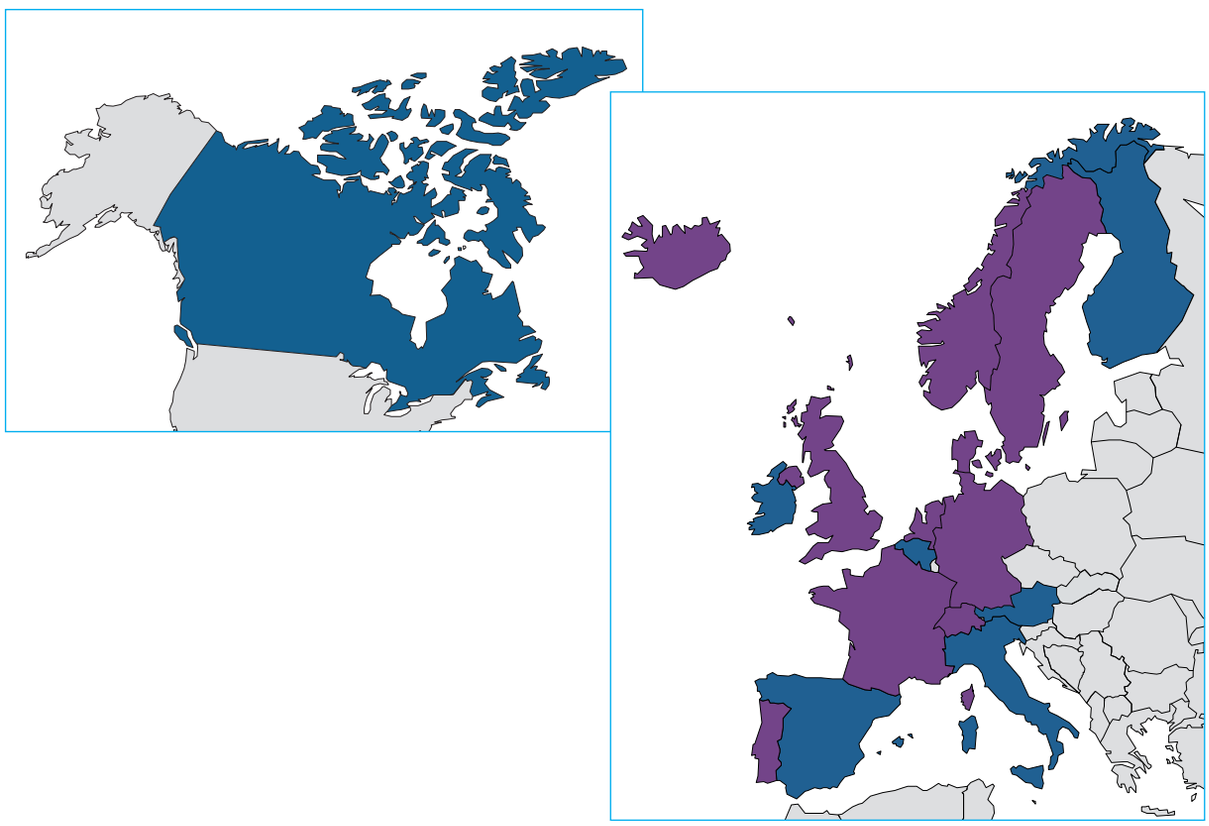
The ECORD Science Support and Advisory Committee (ESSAC) has been very active in leading and organising scientific ocean drilling in Europe. 40% of the drilling proposals to IODP have been submitted by ECORD scientists; they represent about one third of the IODP expedition participants (128 so far) and a significant number have been appointed as of co-chief scientists. ESSAC has developed support activities that aim to train young scientists, reach out to new communities, and convey the exciting achievements of IODP to schools.

The ECORD Science Operator (ESO) has set up a model to implement mission-specific platform expeditions (MSPs) in areas inaccessible to the other IODP platforms (the drillships *JOIDES Resolution* and *Chikyu*), opening new fields of research in shallow waters and ice-covered areas. Two very successful MSP expeditions have already been implemented.

- The Arctic Coring Expedition (ACEX) retrieved the first drill cores to be taken from beneath the Arctic seabed providing a unique archive of the climatic evolution at the polar region of the Arctic during the last 56 million years.
- The Tahiti Sea-Level Expedition obtained the best ever core recovery from drowned fossil corals off Tahiti allowing scientists to reconstruct sea-level variations and environmental changes during the last deglaciation.

Two more expeditions will be implemented in 2009.

A particularly important achievement of ECORD-Net has been the development of the Deep-Sea Frontier initiative, which aims to improve the future integration of ocean drilling with other approaches that will lead to a better understanding of the processes occurring at the deep seafloor. This initiative will hopefully be integrated in the strategy for marine and maritime sciences that should develop in Europe, as recommended in the 'Aberdeen Declaration' approved by ECORD in 2007.
Within the European funding agencies, the ECORD partners have already started thinking about the future of ocean drilling post 2013. The ECORD Council has tasked a 'vision group' to investigate the best approach to secure ocean drilling in Europe and its integration with other activities on the deep sea, for the sustainable use of the oceans within a concerted European Marine and Maritime Policy.



The 17 ECORD country members (in blue) include the ECORD-Net partners (in purple), which are Denmark, France, Germany, the Netherlands, Norway, Portugal, Sweden, Switzerland and the United Kingdom.

Introduction

Scientific ocean drilling is the only direct approach to investigating the archives recorded in deposits beneath the seafloor. The cores allow groundtruthing of indirect measurements such as seismic profiles but can also be used for measuring *in-situ* properties, and for long-term monitoring. Access to ocean drilling technology is therefore essential to the scientific community to understand the Global Earth System. Scientific ocean drilling started in the late sixties with the US Deep Sea Drilling Project (DSDP) *(page 9),* which became an international program in 1975. DSDP was followed by the Ocean Drilling Program (ODP) in 1985. In 2003, the Integrated Ocean Drilling Program (IODP) took up the reins for a duration of 10 years (2003-2013). In DSDP and ODP, Europe was represented by three countries (France, Germany and UK) and a consortium of smaller countries (known as 'ECOD') run by the European Science Foundation (ESF). To become a significant partner of the IODP, the European countries involved in scientific ocean drilling decided to form a consortium, ECORD (European Consortium for Ocean Research Drilling), and join as a single member.

These coordination efforts were initially supported by the Joint European Ocean Drilling Initiative (JEODI), a Thematic Network that had as its principal objective the implementation of the technical strategy for European involvement in scientific ocean drilling after the termination of the Ocean Drilling Program in October 2003. JEODI brought together 15 nations from September 2001 to December 2003 and established the basis of the current structure of ECORD *(page 10)*.

At the start of IODP, the European Commission decided to support the set up of ECORD with an ERA-NET project. The ECORD-Net project (no. ERAC-CT-2003-510218), coordinated by INSU-CNRS, initially included seven workpackages and nine partners, and was funded for 48 months (December 2003 to November 2007) at the level of €2,238,087. An additional workpackage and two partners were subsequently added and further funding of €400,000 was allocated to give a total budget of €2,638,087. The duration of the project was extended to 57 months (August 2008).

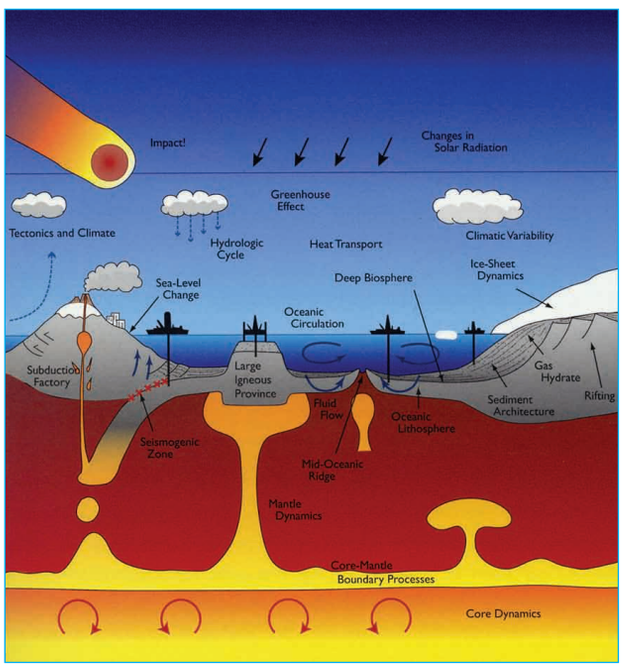
The following workpackages (WP) have been implemented and have contributed to setting up the European Research Area in ocean drilling, and the development of ties with other initiatives investigating the deep-sea floor *(see rear cover for organisational names in full)*

- **Workpackage 1 (WP1)**: A system of mutual exchange of information. Leader: FCT (Portugal)
- **Workpackage 2 (WP2)**: Opening ECORD to other countries. Leader: VR (Sweden)
- **Workpackage 3 (WP3)**: Exchanges of strategic actions. Leader: DFG (Germany)
- **Workpackage 4 (WP4)**: Management of pooled national funding. Leader: INSU-CNRS (France)
- **Workpackage 5 (WP5)**: Implementation of complex scientific programmes. Leader: NERC (UK)
- **Workpackage 6 (WP6)**: Mutualisation of European science programmes in IODP. Leader: NWO (the Netherlands)
- **Workpackage 7 (WP7)**: Consortium management. Leader: INSU-CNRS (France)
- **Workpackage 8 (WP8)**: Establishment of a European Programme on Deep-Sea Floor Science. Leader: DFG (Germany)

Today, ECORD has 17 members - 16 European + Canada *(left)* and has become an essential partner in IODP.

1 - ECORD and IODP

IODP is an international 10-year program (2003-2013) led by the USA and Japan. ECORD is a contributing member; China and Korea are associate members, and ANZIC (Australia New Zealand IODP Consortium) and India are in the final stages of negotiations to become members of the program.



Earth system components, processes and phenomena from space to atmosphere, ice, ocean, crust, mantle and core (figure reprinted from Earth, Oceans and Life, IODP Initial Science Plan 2003-2013, IWGSO, May 2001, courtesy of A.Taira, University of Tokyo)

Compared to its predecessors which operated a single drilling vessel, IODP has more ambitious goals. The IODP Initial Science Plan (ISP) has been elaborated by the scientific community through international workshops. The scientific objectives are to understand the Global Earth System *(left)* and its societal impacts by studying records of past climate changes, biodiversity in sub-seafloor systems, establishing seafloor laboratories for the study of natural hazards in submarine systems and discovering new energy resources. The results of this program help to resolve the problems our society is facing today. To achieve these goals, IODP operates three types of drilling platforms *(below)*: a riserless vessel, the *JOIDES Resolution* funded and operated by the US; a state-of-the-art vessel equipped with a riser, the *Chikyu*, built and operated by Japan; mission-specific platforms (MSPs) operated by ECORD. The total cost of the program to operate the three platforms and deliver the science (core curation, minimum measurements, databases, core repositories) has increased from about €40 million in 2004 to €160 million currently.

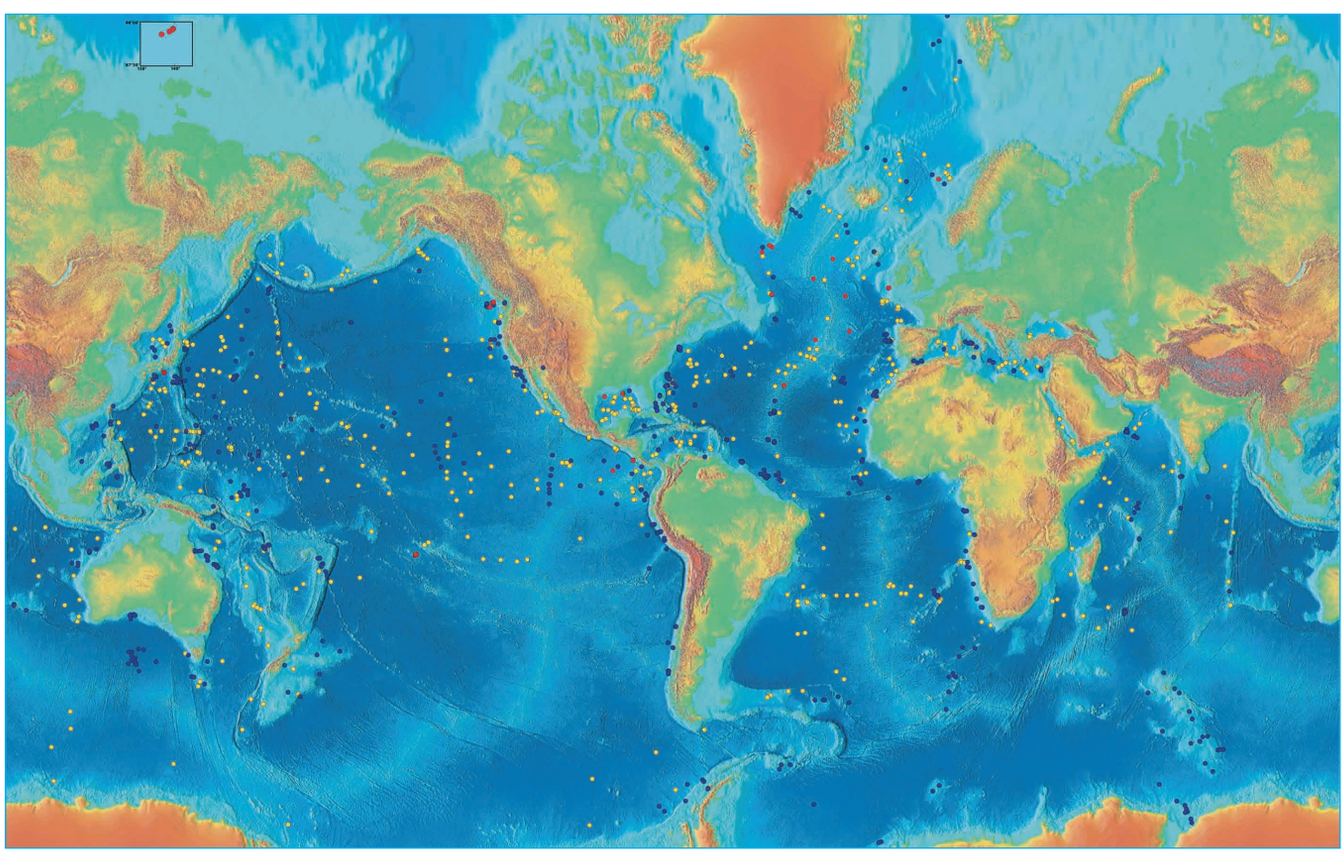
The JOIDES Resolution, the drilling vessel used during both the ODP and IODP, has proved its efficiency as a riserless vessel. It has already retrieved 333 km of cores from the seabed, and the deepest hole reaches 2,111 m beneath the seafloor. The vessel has allowed major breakthroughs in deciphering past climates, understanding Earth dynamics and documenting the deep biosphere. The JOIDES Resolution has recently undergone a major refit. Completely modernised, it will resume operations in March 2009.

The Chikyu is a new riser drillship built by Japan, fitted with the most up-to-date technology. This 213 m-long vessel is capable of drilling in unstable area to 6-7 km below the seabed. The Chikyu started operation within IODP in 2007 in the Nankai Trough, off the east cost of Japan. By drilling into a major seismogenic zone and instrumenting boreholes to monitor long term variations of key parameters, the aim of this ambitious project is to understand what triggers devastating earthquakes and tsunamis.

Mission-specific platforms (MSPs) are operated in areas inaccessible to the two other drillships, i.e. shallow waters and ice-covered areas. The most appropriate platforms (which may be a ship, drilling rig, etc.) are contracted on a case by case basis, depending on the environment of the science target. So far, ECORD has implemented two MSP expeditions. The first drilled the seabed of the Artic Ocean beneath the ice pack; the second drilled the drowned fossil coral reef of Tahiti.

ECORD plays a strategic role in the program. By pooling national to IODP contributions at the European level, ECORD was able to become an operator, in parallel with the USA and Japan. This required an infrastructure that allowed European countries to interact with IODP as a single entity and to contract vessels to implement drilling expeditions.

This coordination effort was supported by the ERA-Net ECORD, which started in December 2003 for a duration of 4 years. The funding agencies from nine European countries initially participated in ECORD-Net with two new agencies joining in 2005, to expand the membership to eleven members representing ten countries. An additional workpackage was added to better integrate drilling with other initiatives on the deep seafloor. The duration of the project was subsequently extended by nine months and ECORD-Net ended on August 31, 2008. ECORD-Net was instrumental in helping the funding agencies to set up ECORD organisational structure, to organise the European scientific community, and to establish the ECORD Science Operator as operator of the mission-specific platforms.



Drilling sites sampled during the first phase (2003-2008) of the Integrated Ocean Drilling Program (IODP) (red dots) and its two legacy programmes, the Deep Sea Drilling Project (DSDP) and the Ocean Drilling Program (ODP).
This map was designed by ODP/National Science Foundation, from a computer-generated image of colour-shed relief created by National Oceanic and Atmospheric Administration - National Geophysical Data Centre (NOAA-NGDC).
Scale: 1:40,000,000 at Equator - Coverage: 80° North - 80° South Latitude, 270° West - 120° East Longitude.

2 - How does ECORD function?

The executive authority of ECORD is the ECORD Council, in which each ECORD member country is represented. The Council Chair, which changes every six months, is assisted by two Vice Chairs, and an

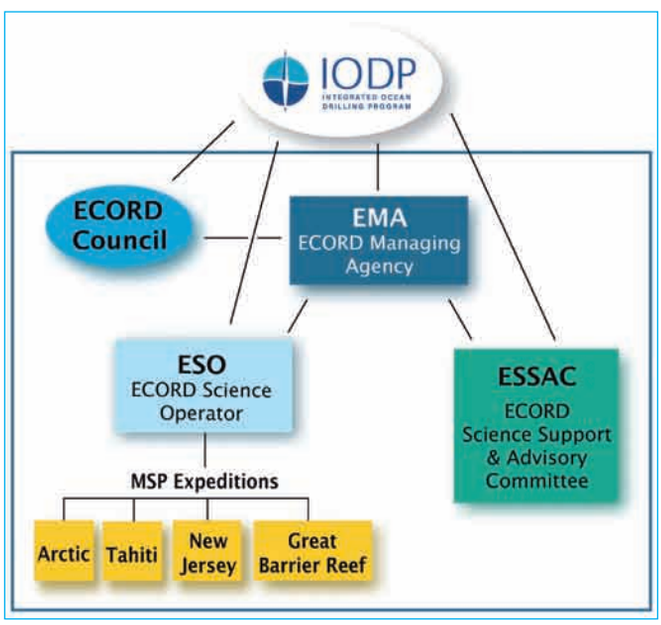
12 member countries signed the ECORD MoU.

Executive Committee. The first task of the ECORD Council was to elaborate the ECORD Memorandum of Understanding (MoU) that specifies the structure of the consortium and the tasks and responsibilities of all ECORD bodies. The MoU was finalised in December 2003 and signed initially by twelve countries *(above)*. Since then, the membership of ECORD has increased to 17 countries. The ECORD member countries commit to financial participation, which allows ECORD budget to pay their contribution to IODP.

The ECORD Council established three management groups *(right)*: the ECORD Managing Agency (EMA), the ECORD Science Support and Advisory Committee (ESSAC) and the ECORD Science Operator (ESO). These functions were filled through an open call within the member countries.

EMA *(pages 11-13)*, run by the INSU-CNRS in France, manages memoranda between ECORD members, negotiates directly with the USA's National Science Foundation (NSF) and the Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT), pools funding from members, and subcontracts to ESO, the operational arm of ECORD. EMA is also in charge of ECORD outreach and public relations.

ESSAC *(pages 14 to 16)* is the scientific committee of ECORD. The host organisation for the ESSAC office changes every two years. ESSAC makes decisions on science strategy, nominates ECORD scientists to participate in IODP expeditions, panels and committees, and planning through workshops and by holding regular workshops is responsible for defining and planning the content of joint European research programmes.



The four component parts of the European Consortium for Ocean Research Drilling.

ESO *(pages 17-18)*, the operational arm of ECORD, is managed by the British Geological Survey (part of the UK's Natural Environment Research Council). ESO operates under subcontracts to EMA and undertakes drilling operations and technological developments for mission-specific platform (MSP) expeditions. ESO subcontracts to university and industrial partners for coring, sample archiving and laboratories (Bremen University) and petrophysics/logging (European Petrophysics Consortium).

3 – The management of ECORD

During the initial phase, ECORD-Net (WP4) supported the setting up of EMA. EMA is run by INSU-CNRS, and the office is located at the Institut de Physique du Globe de Paris (IPGP), France. The EMA director is assisted by an executive secretary and a scientific officer.

EMA interacts with the managers of the IODP Lead Agencies (USA and Japan) and the other IODP members. On behalf of the ECORD Council, EMA, together with the ECORD Chair and Vice Chairs, negotiated a Memorandum with the Lead Agencies to join the program. The Memorandum was signed in Bremen during March 2004 *(below)*, and ECORD became a 'contributing member' of IODP. The Memorandum specifies the rights and

M. Leinen (NSF, USA), S. Joussaume (INSU-CNRS, ECORD) and Mr Tanaka (MEXT, Japan) signed the IODP Memorandum in Bremen.

obligations of ECORD. ECORD has committed in principle to contribute 4 participation units (P.U.) to IODP. A part of this budget is allocated to ESO to operate mission-specific platforms as one of the three IODP platforms. The rest of the budget is paid to IODP to cover science operation costs at the international level. By joining as a single partner, Europe was able to negotiate a much better deal in terms of participation in IODP cruises than each member country would have been able to achieve separately. The intellectual contribution of Europe to the program was clearly recognised.

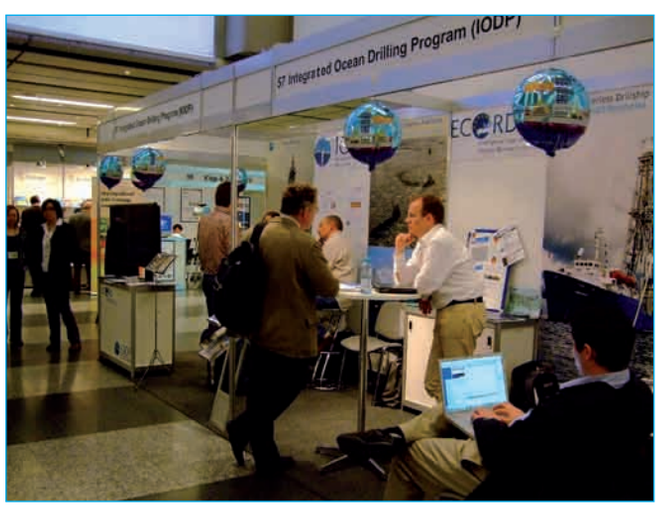
- Pooling the ECORD funds

Each member country pays an annual contribution to ECORD. The level of contribution is variable, depending on the annual Gross National Product (GNP) of the country and the size of its science community. The contributions are negotiated with ECORD Council and specified in the MoU signed between each country and EMA; they currently vary from €20,000 to €4,500,000. The mechanism for pooling the funds from the ECORD member countries is now well established. According to the ECORD MoU, each ECORD member country signs a commitment every year with the EMA for its annual contribution. The funds are pooled at INSU-CNRS. They are used by the EMA to cover:

- the annual contribution to IODP, according to the IODP Memorandum,
- the cost of operating mission-specific platforms within IODP: a contract between EMA and ESO is signed every year to cover the expenses,
- the running costs of the EMA and ESSAC offices.

The ECORD budget has increased over the years, from €10.5 million in 2004 to about €16.5 million in 2009, due to the addition of new members and the higher financial commitment of member countries.

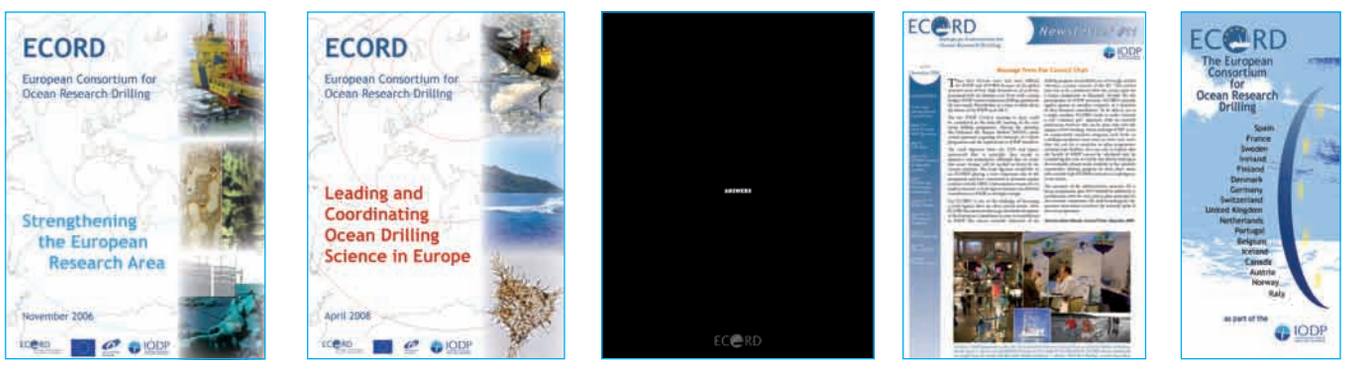
- Promoting ECORD



Visitors of the ECORD-IODP booth at EGU 2008 in Vienna received a wide range of information and caught the most recent news of the program (photo K. Umetsu © JAMSTEC/IODP).

With the support of ECORD-Net, one of the EMA's first actions was to set up the ECORD web site - **www.ecord.org** *(page 13)*, linked with the IODP web site - **www.iodp.org**. It now has links with the more recently developed ESSAC and ESO web sites. The ECORD web site provides all the information concerning ECORD activities: news, meetings, reports, expeditions, etc. It also provides access to the ECORD Information database, which

maintains a record of ECORD participation in IODP through panel and committee members, participants in IODP expeditions, etc.
The ECORD Newsletter is published twice a year and distributed in Europe through the national offices.
A number of brochures have been published in coordination with ESSAC and ESO *(below)*, and with the support of ECORD-Net, to advertise ECORD and in 2008, had a more ambitious scope and gathered representatives from nine countries (Cyprus, Estonia, Greece, Israel, Lithuania, Poland, Russia, Slovenia and Ukraine) as well as young scientists from ECORD member countries. Recommendations on how to improve communication between ECORD and potential new members came out of this very successful meeting and will be implemented. Although these meetings have



From left to right, ECORD-Net brochure-2006, ESSAC brochure-2008, Answers-2008, ECORD Newsletter #11-November 2008, ECORD leaflet-2008.

to promote its accomplishments. They are regularly distributed at major conferences, and can also be downloaded from the ECORD web site.
ECORD and IODP are also presented in exhibition booths at major scientific conferences in Europe and worldwide. The booths at the European Geophysical Union (EGU) annual meetings *(page 11)* and at the 33rd IGC in Oslo have provided unique opportunities to reach out to new communities.

- Enlarging the research area

From the start, ECORD had the ambition to expand the 12-member consortium; this was the main objective of ECORD-Net WP2. As a result, five more countries (including Canada) joined ECORD between 2004 and 2005. ECORD is still aiming to attract new members, in particular from EU country members in eastern Europe and the Newly Associated States (NAS) and Newly Independant States (NIS). With the support of ECORD-Net, meetings have been organised to explain the program to representatives of potentially interested countries both at the science and the management levels. A first meeting organised in Stockholm in 2004 gathered representatives from the Baltic countries. A second meeting *(bottom right)*, organised in Edinburgh not yet resulted in new members, several countries are investigating national funding opportunities.

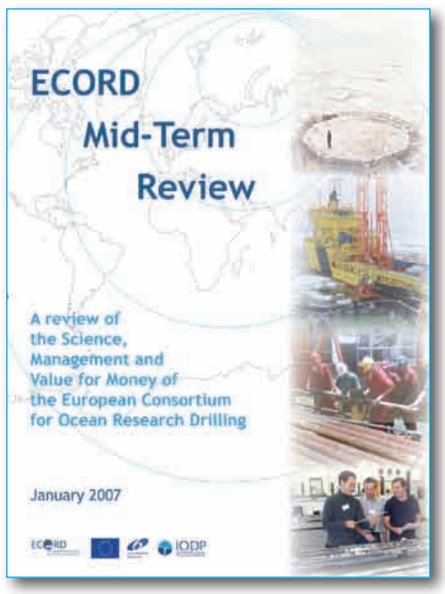
To further promote the program, the ECORD Council has decided to open ESSAC support activities to scientists from non-ECORD European countries, and has encouraged ESSAC to consider applications to IODP expeditions from this group of scientists. Moreover, during the Arctic Coring Expedition, Russia was sub-contracted by ESO for its icebreaker facilities, and a

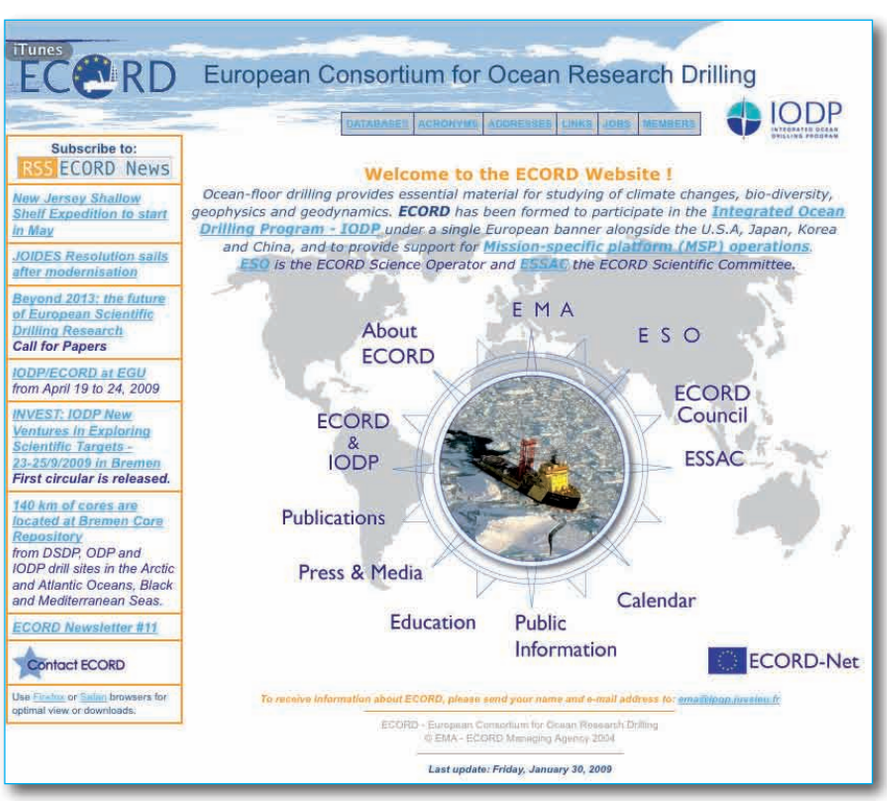
Edinburgh Workshop 'Drilling for the Future: Research Opportunities with ECORD', May 2008.

Russian scientist was invited on the cruise.
Awareness of ECORD has definitively grown in Europe and hopefully new members will join in the future.

- Evaluating the efficiency of ECORD

Three years after its formation, ECORD commissionned an independent committee to evaluate its performance and efficiency. The initiative was supported by ECORD-Net and in 2006, a panel of six prominent European scientists was appointed. The panel produced the "ECORD Mid-Term Review" *(right)*, published in January 2007. Minor problems were identified within the ECORD organisation and the ECORD Council took action to address these. However, as a whole, the report emphasised the excellent performance of the consortium, as illustrated in its last sentence:
"ECORD and its associated scientists are producing high-quality, international research in ocean science. It clearly represents excellent value for money and although we can see potential issues with the somewhat cumbersome management structure we find it to be an outstanding example of good international cooperation. We would wish to see funding continue for it and would very much welcome further approaches to the EU 7th Framework Programme for additional support for what is clearly an essential component in understanding the critical processes of climate evolution, the deep biosphere and geodynamics."





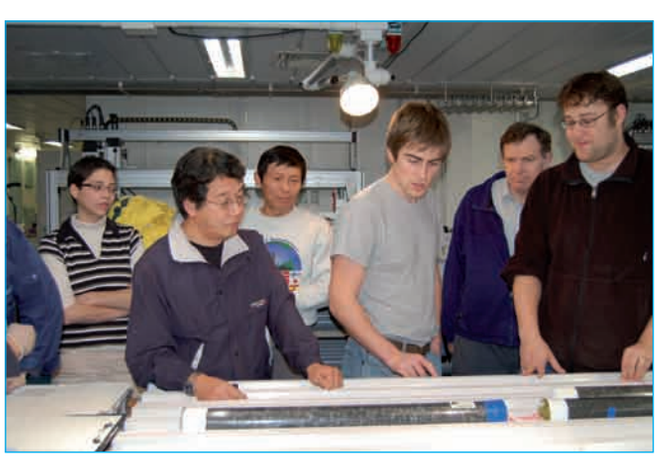
Front page of the ECORD web site - http://www.ecord.org

4 - Leading and coordinating scientific ocean drilling in Europe

ECORD, through its scientific committee ESSAC, has played a major role in organising the European scientific ocean drilling community. ESSAC provides scientific advice to ECORD and coordinates all ECORD scientific activities in IODP. ESSAC consists of a national delegate and an alternate from each member country with equal voting rights (one country - one vote). The ESSAC office resides with the Chair of the committee who is supported by a scientific coordinator. The office re-locates every two years. The current office is located in Aix en Provence (CEREGE), France. Previously, ESSAC was located in Cardiff, UK (2005-2007) and in Amsterdam, the Netherlands (2003-2005). Initially supported by ECORD-Net (WP6), the ESSAC office and activities are now essentially funded from the ECORD budget.

- Selecting IODP expedition participants

As a contributing member of IODP, ECORD is entitled to eight berths on every IODP expedition *(below)* - the same number as USA and Japan. According to the ECORD MoU, the number of participants from each ECORD member country is proportional to their financial contribution on a long-term basis. ESSAC invites European and Canadian scientists to participate in IODP expeditions via an open call for applications. ESSAC then evaluates and ranks the applications and assists the drilling platform operators in composing the final expedition science party. Since June

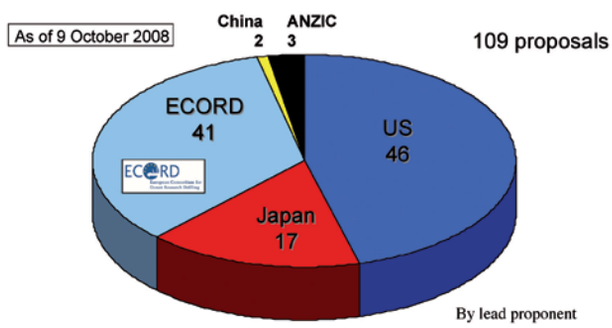


Scientists participating in the NantroSEIZE Expedition 316 'NanTroSEIZE Shallow Megasplay and Frontal Thrusts' on board the Chikyu, December 2007 - February 2008 (© JAMSTEC/IODP).

2004, 12 co-chief scientists and 116 ECORD scientists have participated in 15 IODP expeditions.

- Playing a strategic role in IODP

Drilling proposals from the scientific community are the essence of the program. The intellectual contribution of ECORD scientists is of primary importance in IODP: they lead 40% of the proposals currently being evaluated or scheduled for drilling. ESSAC influences the decision-making at all stages of the science planning process in IODP by appointing scientific experts from the ECORD



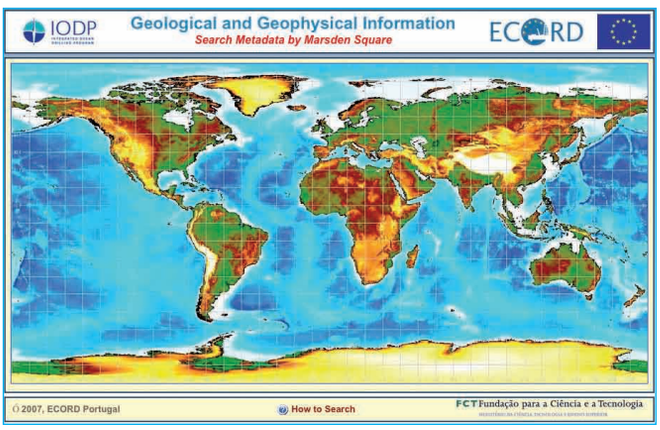
Distribution of the active proposals by IODP members.

community to the committees of the IODP Science Advisory Structure (SAS). Many of the ESSAC delegates are themselves current or recent SAS panel members.

- Preparing the ground for submitting drilling proposals

To help stimulate IODP proposal submission by European scientists, ECORD initiated the Magellan Workshop Series in 2006. This 'bottom-up' 5-year programme is funded by 12 ECORD member organisations and run by the European Science Foundation (ESF) in coordination with ESSAC. Workshops are selected twice per year, after an open call for proposals. ESSAC delegates provide strategic guidance through their representation in the Magellan Steering Committee. In addition, the Magellan programme funds individual scientists to participate in international workshops. The scientific topics of the workshops cover the full spectrum of marine research such as paleoclimatic and impact topics, volcanism and geo-hazards, natural resources or deep-biosphere subjects. Each workshop brings together scientists from various research fields to discuss and to refine future or actual IODP European scientific proposals and to create new collaboration. Eleven workshops have been funded so far, and more will follow. ESSAC also

regularly organises the EuroForum where the scientific community with interests in ocean drilling gathers to present scientific results and to discuss future strategies.



Front page of the Geological and Geophysical Information metadatabase.

Before IODP drilling can take place, extensive geological and geophysical surveying must be carried out. Such surveys are expensive, and beyond the means of some of the smaller member countries of ECORD.

To achieve the maximum benefit from Europe's investment in IODP, and to maintain its international scientific leadership, ECORD and the ESF initiated a joint 3-year EUROCORE programme called EuroMARC (European Collaboration for Implementation of Marine Research on Cores), which would allow European nations to pool their national funds for pre- and post-cruise science, in particular to support site surveys. EuroMARC aims at enhancing the benefit from already established funding groups and research communities such as ECORD and the International Marine Past Global Change Study (IMAGES). Nine ECORD member organisations support this trans-national programme.

As part of ECORD-Net WP1, ECORD has also developed the "Geological and Geophysical Information" web portal *(left)*, which links with related existing databases in Europe. This portal helps scientists locate existing site survey data in Europe.

- Training the next generation of scientists

To reach out to students and young scientists as well as the science community at large, ECORD has initiated a number of activities to promote the accomplishments of the program and to encourage involvement of new communities. ESSAC coordinates these activities, issues the corresponding calls and selects the applicants, and advises on educational concepts. These activities are open to non-ECORD European countries, to raise awareness of ocean drilling.

ECORD Summer Schools *(below)*: to train the next generation of scientists who will participate in marine science and ocean drilling, ECORD initiated a summer school programme in 2007. Following an open call, ESSAC selects the applying institutions based on pedagogic and scientific merits. Four summer schools have already been held in 2007 and 2008, covering two themes of the IODP science plan : "Environmental Change, Processes

ECORD Summer Schools 2008: (right) Past Climate Reconstruction and Modelling Techniques - Urbino Summer School in Paleoclimatology (photos USSP) - 15 July - 3 August, Italy, (left) ECORD Summer School on Deep Subsea-floor Biosphere, 1-12 September, Bremen, Germany (photos Marum/GLOMAR).

and Effects" and "The Deep Biosphere and Sub-Seafloor Ocean". In 2009, the third theme, "Solid Earth Cycles and Geodynamics will be also covered.

ECORD Scholarship: ECORD funds 12 scholarships annually to allow outstanding young scientists to attend a summer school. ESSAC selects the best candidates after a call open to both ECORD members and non-ECORD European countries.

ECORD Distinguished Lecturer Programme: this programme is designed to bring the exciting scientific discoveries of IODP to the geosciences community in Europe and Canada. ESSAC selects three Distinguished Lecturers per year, one in each of the main thematic areas of IODP. Applications to host a Distinguished Lecturer are accepted from any college, university, or non-profit organisation in ECORD members and non-ECORD European countries. In 2007-2008, the first round of the programme took the three lecturers to 13 ECORD countries (Austria, France, Canada, Finland, Germany, Iceland, Italy, The Netherlands, Portugal, Spain, Sweden, Switzerland and the UK) and 2 non ECORD countries (Croatia, Czech Republic).

- Conveying the achievements of ocean drilling to a wider audience

ESSAC augments the visibility of IODP by publicising the exciting scientific discoveries and their relevance to society to a wide audience. Target groups include teachers, students and the general public. As well as representing Europe and Canada as a single entity, ECORD also strongly encourages educational activities in the individual member countries. Educational activities at a national level have included participation of a Swedish teacher in the Arctic Coring Expedition; visits to school classes in France; a roadshow to German universities; an expedition logbook by a Swiss writer and a travelling photo exhibition at universities in Spain.

The first **ECORD Teachers' Workshop** dedicated to high-school teachers *(top right)* was organised in 2007, in association with the GIFT (Geophysical Information for Teachers) symposium at EGU in Vienna, Austria. 70 teachers from 22 countries registered for the workshop which presented current ocean-drilling scientific results and future science plans concerning sea-level

change, slope stability, earthquakes, volcanoes and life in extreme environments in addition to presenting the IODP drilling fleet. This first workshop was funded by ECORD-Net (WP2) as a test case. ESSAC is now seeking new funding sources to support this activity, which has been highly appreciated by all the participants.

Gilles Henry (EPC, Université de Montpellier) presents and explains some logging tools to high-school students and teachers of Lycée Paul Gauguin, Papeete who visited the drillship DP Hunter (photo © ECORD/IODP).

ECORD takes advantage of port-calls to offer guided tours of the drillships to schools. In Tahiti, students from several Papeete elementary and high schools had the opportunity to visit the drillship *DP Hunter* and learn about drilling techniques *(above)*. Many individual initiatives by ECORD scientists have also allowed the excitement of the expeditions to be conveyed by communicating directly from the ship to schools during the drilling operations.

5 – ECORD as an operator of mission-specific platform expeditions

ECORD plays a major part in IODP by providing access to new fields of research in ice-covered areas and shallow waters. The ECORD Science Operator (ESO) has proven its ability to operate mission-specific platforms (MSPs) to the benefit of the science community. The support of ECORD-Net was essential in setting up ESO and documenting best practices in its activities (WP5).

ESO consists of:

• the **British Geological Survey (BGS)** acts as the consortium coordinator responsible for overall management. BGS provides the Science Manager, who acts as the main contact with both EMA and the ECORD Council. BGS also provides the Operations Manager, Data Manager and Outreach Manager for the consortium, as well as the Staff Scientist and Administrative Support for each MSP,

• **Bremen University** provides the ESO Laboratory and Curation Manager, who is responsible for analytical facilities during offshore MSP operations and the Onshore Science Party. The Bremen Core Repository (BCR) *(top right)* is the ESO facility for core curation and management. The University is also involved in data management tasks provided by WDC-MARE/PANGAEA (IODP-MSP data portal), and provides the Public Relations Manager for ESO. GFZ in Potsdam additionally supports ESO by contributing the Drilling Information System (DIS) for offshore data acquisition,

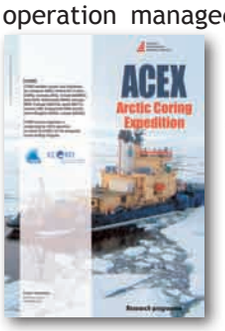
• the **European Petrophysics Consortium (EPC)** carries out all logging and petrophysical activities for ESO. This consortium comprises the universities of Leicester (co-ordinator), UK, Montpellier, France and Aachen, Germany.

Implementing an MSP expedition is always a challenge. Whereas the US and Japanese ships, *JOIDES Resolution* and *Chikyu*, are dedicated drilling vessels fitted out with permanent drilling, laboratory and offshore core repository facilities, MSPs are platforms especially chosen to fulfil particular scientific objectives, in areas such as ice-covered seas or in shallow waters. Under these particular circumstances, ESO has developed an efficient model to implement the expeditions and fulfil its obligations towards the scientific community as an IODP operator. For a given expedition, ESO identifies and contracts the suitable platform. Offshore, only a limited number of mobile containers are provided and equipped

The Bremen Core Repository is the largest of the IODP core repositories. Several kilometres of DSDP, ODP and IODP deep-sea cores are stored in a refrigerated hall.

for core curation and some laboratory facilities. Therefore, only a sub-group of the science party sails on the drilling platform. Comprehensive scientific analyses on the sediment cores are carried out during the Onshore Science Party, which takes place at the Bremen Core Repository several months after the offshore operations have been completed *(page 18)*. The whole science party is involved in these onshore activities. Two very successful MSP expeditions, funded by from the ECORD budget, have been implemented so far.

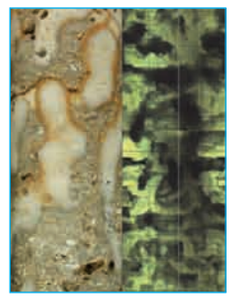
The **Arctic Coring Expedition (ACEX, IODP expedition 302)** was the first IODP mission-specific platform operation managed by ESO (in cooperation with the Swedish Polar Research Secretariat (SPRS) in 2004, at a cost of about €10.5 million. The drillsites were located on a submarine high, the Lomonosov Ridge, at a point only 250 km from the North Pole. ACEX was a huge logistical challenge because the drillship had to hold its position while surrounded by the moving ice sheets of the Arctic Ocean. This required two icebreakers, the *Oden* and *Sovetskiy Soyuz* to clear a channel through the ice to allow a third icebreaker, *Vidar Viking*, specially converted for the task, to undertake the drilling *(page 18)*. The 496 metres of cored sediments provided the first record of the paleoenvironmental history of the Arctic during the last 56 million years and documented the transition from a 'greenhouse' world to an 'icehouse' world. Arctic temperatures reached subtropical levels during the Paleocene Eocene Thermal Maximum (PETM)



55 million years ago. The massive occurrence of the fern *Azolla* indicate a freshwater episode ~ 49 million years ago. The new data also documented that the Arctic ice developed much earlier than previously believed. The first pebbles carried by icebergs appear by 45 million years ago, at approximately the same time as in the Antarctic, and become widespread by 14 million years ago. The ACEX results have already resulted in over 20 publications in high-profile scientific journals.

(left) Icebreaker Vidar Viking was the drilling vessel of the Arctic Coring Expedition, (right) drill rig on the Vidar Viking during coring operations (© ECORD/IODP).

The **Tahiti Sea-Level Expedition (IODP Expedition 310).** In 2005, ESO contracted the *DP Hunter (top right)* at a cost of about €7 million to implement the Tahiti Sea-Level expedition. The expedition aimed at understanding the history and effect of sea-level fluctuations and climate changes for a critical period of global climate change by studying cores from the coral reefs of the tropical island of Tahiti. The timing and course of past global sea-level changes may help to understand present and future sea-level rise due to global greenhouse conditions. Since the climax of the last ice age about 23,000 years ago, global sea-level has risen by about 120 metres, mainly due to melting of large inland ice sheets and thermal expansion of the global ocean water masses attributed to rising temperatures. Because corals have strict ecological requirements and are extremely sensitive to environmental changes, fossil reefs are accurate and sensitive recorders of past sea-level and climatic changes. ESO chose a drilling technique that allowed the best ever core recovery in drowned fossil corals (>90%) in scientific ocean drilling. The logging data collected from the boreholes were outstanding and allowed a better understanding of how



(left) Drillship DP Hunter of the Tahiti Sea-Level Expedition (right) optical borehole viewer used to examine the walls of the newly drilled boreholes to see the internal structures of the coral reefs.

the reef was built *(above)*. The results of this expedition are currently being finalised.

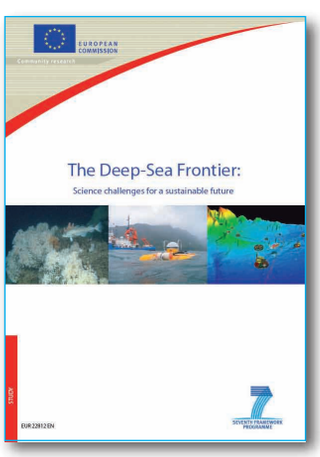
Contracting vessels has proved more challenging than was initially envisioned due to the problems associated with having to hire the same drilling platforms that are required by the oil industry. However, ESO is getting ready to implement two MSP expeditions in 2009. The New Jersey Shallow Shelf Expedition, off the east coast of the USA, receives additional financial support from the International Continental Scientific Drilling Program (ICDP) and aims at reconstructing sea-level changes during the past 42 million years, and deciphering how sedimentation on the shelf responded to these changes. To complement the work started in Tahiti, the Great Barrier Reef Environmental Changes Expedition will establish the course of sea-level rise during the last deglaciation, as well as the associated environmental changes, by drilling submerged fossil corals along the shelf edge of the Great Barrier Reef.

Scientists sampled cores of the Arctic Coring Expedition at the Onshore Science Party held at Bremen University (© ECORD/IODP).

6 - Integration with other science initiatives

The deep seafloor is a complex bio-geosphere system in the world's ocean environment. This not very well known system, though the largest on our planet, modulates global climate, global ocean circulation, contains present and future marine resources, and supports the largest biosphere on Earth. To fully investigate the deep seafloor, ocean drilling needs to be combined with other approaches. This led ECORD-Net (WP3 then WP8) to develop the 'Deep-Sea Frontier' (DSF) initiative, to establish a major European research and technology effort originating from three large European geoscientific communities related to ocean drilling, ocean margin research, and seafloor observations.

Only a small part of the interacting processes occurring at the deep seafloor are understood. Future studies of the seabed call for an interactive



and integrated network of sophisticated sensors covering the interacting environments of microbial, chemical and geological processes. A variety of individual national programmes have started, and the research community in Europe now requests the infrastructure to build a leading role in deep-sea research and technology. One example is a breakthrough in technology and knowledge regarding biogeochemical and microbial processes related to anaerobic oxidation of methane. Methane is a major greenhouse gas, thus it is very important to understand the role of seabed processes in transporting methane into the ocean and atmosphere. Another example is a breakthrough in technology, which allowed scientists to discover the world of deep-subsurface bacteria in IODP boreholes.

Organised by ECORD-Net, the 'Deep-Sea Frontier Workshop: an integrated approach to study the deep seafloor and its history' (June 1-2, 2006, Naples, Italy) brought together 70 scientists, representatives from the oil industry as well as programme managers and administrators of national and European funding agencies *(left)*. The aim of the workshop was the identification of research needs and new research targets in European marine sciences, as well as better integration of the scientific fields necessary to create joint research programmes in deep-sea floor science for the next decade. Working groups were assigned to develop a science plan leading to integrated research. The capability of European marine geosciences and technology on the deep seafloor is to be significantly improved in areas where IODP starts probing the marine deep biosphere, where academic geoscience is starting 3D seismic reflection imaging, where the overall importance of the marine methane cycle to the broad earth science community is picking up, but still remains a major unknown, and where now the overall importance of geohazards, climate control, ecosystems, and sustainable exploitation of deep-sea resources have now been widely recognised. During this workshop, experts from a wide range of scientific disciplines such as geophysics, seismology, sedimentology, geochemistry, paleontology, paleoclimatology, paleoceanography, marine geology, volcanology, marine biology, microbiology, fisheries, and marine policy jointly discussed the challenges, opportunities and threats to innovative research and technology developments in marine sciences.

Based on the outcome of the workshop, a 'Foresight Paper' on deep-sea research for the next decade was prepared by the DSF Steering committee *(left)*, which includes twelve representatives of the respective European research programmes and the ECORD-Net, and published by the European Commission. This strategic document is the first step towards an integrated approach of the deep-sea environment.

Conclusion

At the end of ECORD-Net, it is clear that the objectives of the project have been fully met. ECORD is up and running, and has proved its efficiency. It can be considered as a very successful example of integration that has increased the visibility and strength of Europe in an international program. The influence of ECORD and its intellectual contribution are well acknowledged within IODP by the Lead Agencies. ECORD opens new avenues of research to the international drilling community by providing access to mission-specific platforms in shallow waters and ice-covered areas. Two very successful MSP expeditions have already been implemented. ECORD scientists are very active in submitting drilling proposals; they represent about one third of the expedition participants and a significant number of ECORD co-chief scientists have been appointed. ESSAC has developed support activities that aim to train young scientists and to reach out to new communities.

ECORD is now able to pool annually about €16.5 million to participate in a €160 million international program. However at this stage, because of the very large difference in the contributions of individual ECORD member countries, the ECORD budget cannot be considered as a common pot. Although delegates in the ECORD Council and ESSAC have equal rights, quotas still apply to cruise participants. Additional direct financial contributions from the European Commission to ECORD would definitively help move towards a true common pot scheme that would benefit the European science community. Unfortunately, this has not yet been possible. However, it is important to point out that even though ECORD-Net has ended, the member countries have committed to the program for 10 years and will continue funding ECORD till 2013, the end of the current phase of IODP.

For the future, a particularly important achievement of ECORD-Net has been the development of the Deep-Sea Frontier initiative. In the 7th Framework Programme, there is an opportunity for a coordination action with the aim of enhancing synergies between deep-sea research and drilling programmes. Hopefully, the scientific community will seize this opportunity and develop a comprehensive strategic plan for the future. This initiative will hopefully be integrated in the strategy for marine and maritime sciences that should develop in Europe, as recommended in the 'Aberdeen Declaration'. This declaration, drafted by a committee representing a number of leading European and regional Marine Science and Technology Consortia, Networks and Institutions (including ECORD), was approved during the EurOCEAN Conference in Aberdeen in 2007.

Within the national funding agencies, ECORD partners have already started thinking about the future of ocean drilling post-2013. The Aurora Borealis project, listed in the European Strategy Forum on Research Infrastructures (ESFRI) list, is certainly an opportunity to consider the investigation of the Arctic Ocean, which will definitively become a priority in the near future. The ECORD Council has tasked a "vision group" to investigate the best approach to secure ocean drilling in Europe and its integration with other activities in the deep sea, for the sustainable use of the oceans within a concerted European Marine and Maritime Policy. Hopefully, whatever comes out of this initiative will receive the support of the European Commission.

ECORD members

Austria	Österreichische Academie der Wissenschaften (ÖAW) & Fonds zur förderung der Wissenschaftlichen Forschung (FWF)
Belgium	Fund for Scientific Research - Flanders (FWO-Vlaanderen)
Denmark	Forsknings- og Innovationsstyrelsen (DASTI)
Canada	GEOTOP, Université de Québec à Montréal, McGill
Finland	Suomen Akatemia
France	Institut National des Sciences de l'Univers - Centre National de la Recherche Scientifique (INSU-CNRS)
Germany	Deutsche Forschungsgemeinschaft (DFG)
Iceland	Rannsóknamiðstöð Íslands (RANNIS)
Ireland	The Geological Survey of Ireland (GSI)
Italy	Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGS), Istituto Nazionale di Geofisica e Vulcanologia, (INGV), Consorzio Nazionale Interuniversitario per le Scienze del Mare (CoNISMA) & Consiglio Nazionale delle Ricerche (CNR)
The Netherlands	Nederlandse Organisatie voor Wetenschappelijk Onderzoek (NWO)
Norway	Forskningsradet
Portugal	Fundação para a Ciência e a Tecnologia (FCT)
Spain	Ministerio de Ciencia e Innovación (MICINN)
Sweden	Vetenskapsrådet (VR)
Switzerland	Fonds National Suisse (FNS)
United Kingdom	Natural Environment Research Council (NERC)

ECORD-Net members

Denmark	Forsknings- og Innovationsstyrelsen (DASTI)
France	Institut National des Sciences de l'Univers - Centre National de la Recherche Scientifique (INSU-CNRS) and Institut français de recherche pour l'exploitation de la mer (Ifremer)
Germany	Deutsche Forschungsgemeinschaft (DFG)
Iceland	Rannsóknamiðstöð Íslands (RANNIS)
The Netherlands	Nederlandse Organisatie voor Wetenschappelijk Onderzoek (NWO)
Norway	Research Council of Norway (Forskningsradet)
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Sweden	Vetenskapsrådet (VR)
Switzerland	Fonds National Suisse (FNS)
United Kingdom	Natural Environment Research Council (NERC)

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