International Continental Scientific Drilling Program ICDP

Annual Report 2012

Summary

Scientific drilling is an indispensable tool of modern Earth Science research, because it provides the only means of obtaining direct information on processes operating at depth. Drilling allows for determination of *in-situ* properties of solid materials and fluids and permits testing of hypotheses and models derived from surface observations. Drill holes may be used as a natural laboratory for experiments and as observatories for long-term monitoring of ongoing active processes. Earth drilling, therefore, plays a critical role in scientific research directed towards improved understanding of the workings of our planet and has a key role in solving urgent societal problems.

Multinational efforts in continental scientific drilling have been coordinated since 1996 within the ICDP. The concept for this program was developed in response to geosciences community's need for scientific drilling as an essential tool to enable a better understanding of fundamental Earth processes and structure. The program is based on comingled funding and international cost sharing, joint efforts of international science teams, as well as technology and knowledge sharing. The program concentrates on topics of high international priority, and drilling projects are conducted at locations of global geological significance. The organization is simple and flexible comprising an independent science review board, as well as an executive and an oversight committee. Administration assistance and substantial operational support are provided voluntarily by the German Research Centre for Geosciences – GFZ. Funding is provided by a growing number of member countries, usually through national funding agencies.

ICDP fosters proposals through international workshops that assist researchers in the development of a drilling proposal. To date, 58 of these workshops have been funded and have resulted in a total of 28 ICDP supported, successfully executed, drilling projects. Thematically the activities have centered on paleoclimate investigations, earthquake and volcano research, impact events, geodynamics, and potential energy resources (see below for current and future themes). Many scientific results from these drilling and Earth observation projects have been published in high-ranking scientific journals. Training of on-site scientists, engineering, on-site science and data management technologies are also important components of ICDP. The journal Scientific Drilling, jointly issued with the Integrated Ocean Drilling Program, IODP serves to communicate developments form current projects as well as workshop reports and announcements for future scientific-drilling related activities.

Global Partners

ICDP currently has 24 members including 23 countries (Germany, USA, Japan, China, Canada, Austria, Norway, Poland, Czech Republic, Iceland, Finland, South Africa, Italy, South Korea, Spain, Sweden, Switzerland, New Zealand, France, Israel, India, the Netherlands, and the United Kingdom) and UNESCO as member organizations. South Korea and the United Kingdom joined ICDP in 2012. Expressions of interest in membership and/or negotiations are currently underway with Brazil, Russia, Turkey, Portugal,

Denmark, Belgium, among others. The German Research Centre for Geosciences - GFZ is the Executive Agency of the ICDP and acts on behalf of the ICDP members.

Support Level

Drilling projects are an integral component of major geoscience research programs, including comprehensive pre-site investigations, accompanying laboratory studies, drilling (directly supported by ICDP), and measurements and tests in the drill hole. Drilling programs are costly and only realizable to a limited extent by any one entity acting alone. International cost sharing, optimal utilization of all available resources, incorporation of international leading experts, and application of the existing knowledge combined with selection of optimal drilling locations ("World Geological Sites"), are all essential elements of the international continental scientific drilling program ICDP.

ICDP is financed through the annual contributions of its members. The membership fees vary and are based on a number of criteria that include economic factors, the scientific manpower and size of the respective country. The full or Category A members USA, Germany, and Japan provide $700,000 and have the right to chair panels while China, Canada, France and India contribute $200,000. The smaller European countries contribute according to their ESF share between amounts of $20,000 and $70,000 annually (Switzerland: $70.000).

The ICDP funds are used, for the most part, for co-funding of the approved ICDP projects and for the execution of ICDP workshops and training courses. In addition, funds cover expenditures for the maintenance of the ICDP Equipment Pool and the ICDP Drilling Information System (DIS). The annual membership income to support ICDP activities is approximately $3.5M.

The philosophy of ICDP support for projects is based on the "comingled funding" principle. This means that the ICDP is usually one of several funding partners in a joint drilling project. The financial contribution by ICDP to directly support an ICDP drilling project varies between about 5% to about 70% (in rare cases) of the total operational costs. The remainder of the funding for the drilling project is provided by national funding agencies or other sources of support for scientific drilling. Since the inception of the ICDP in 1996, 28 major drilling projects have been supported.
The program is based on a reliable budget with regular financial contributions by the member institutions, strict expense policies including moderate project funding with no long-term financial commitments and very low program administration costs. This allows for attracting new Earth science communities through opportunities to get workshop and project proposals funded. ICDP´s organization, financing through comingled funding, and the bottom-up project policy relying on unsolicited proposals driving the program at large is serving as a model for other programs.

ICDP Organizational Structure and Management

The Assembly of Governors (AOG) provides financial and scientific oversight of the ICDP. It determines the program policies, decides on EC-recommended full proposals and allocates the amount of comingled ICDP funding for each individual drilling project. In addition, the AOG decides on the annual program plan and the associated budget, and it discusses the long-range plans of the ICDP as prepared and proposed by the EC.

The Executive Committee (EC) is responsible for the operation and management of the program. It decides on workshop and technical proposals, reviews the operational, technical, managerial and financial feasibility of full proposals, recommends funding of full proposals to the AOG, assembles the scientifically prioritized projects into an annual program plan with an associated annual budget and prepares the long-range program plan that constitutes the ICDP program. The EC is made up of one appointee from each ICDP member nominated by the respective funding partners of the program. EC members typically are science managers with expertise in drilling and/or coordination of major research projects. The chair of the EC (executive chair) represents the ICDP internationally and has the executive responsibility for carrying out the program. The executive chair plays a key role as the international spokesperson and ambassador for the ICDP. Tireless efforts to attract membership of an increasing number of countries have resulted in a strong growth of the scientific community for drilling.

The Science Advisory Group (SAG) is an independent body of internationally renowned experts in the research fields covered by the program. It has the task of carrying out thorough scientific evaluations of all pre-proposals, full proposals and workshop proposals submitted to the ICDP and to assign priority based on their expected scientific impact and their outreach and educational potential. The SAG recommendations are the primary input to the EC as it develops projects for both annual and long-range programs. The SAG has developed the following set of evaluation criteria:

- Quality of Science
- Need for Drilling
- Qualifications of Proponent
- Societal Relevance
- Budget
- Responsiveness to previous recommendations
- Technical Feasibility
- Adequacy of Site Characterization
- Cost Effectiveness
- Project Organization

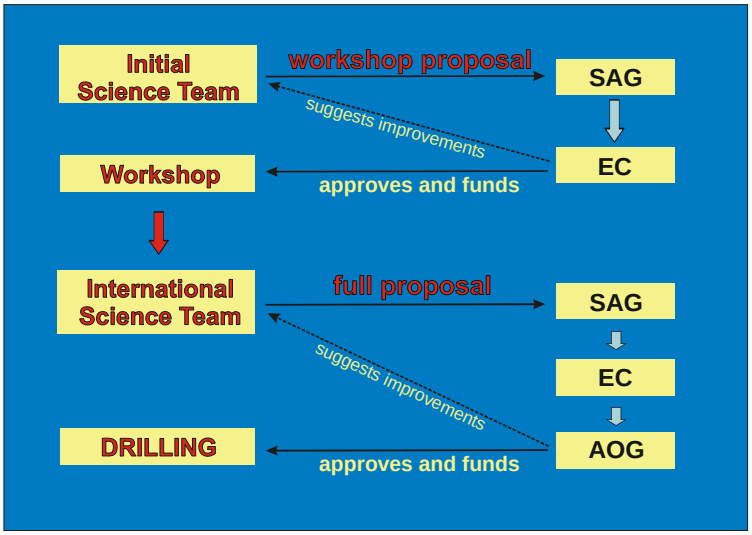
The Operational Support Group (OSG) plays a major role in supporting the management of the program and in providing expertise and stability to planning and operation of the overall program. The German Research Centre for Geosciences (GFZ) handles the administration of the program, including financial accounting and contractual support. Currently the GFZ finances from its own budget a group of six scientists, engineers and technicians who compose the core of the ICDP Operational Support Group and who are based at the GFZ. The OSG serves to support the following functions:

- Provide technical and scientific liaison to SAG and EC
- Develop Joint Research Ventures for each project authorized by EC
- Management and support of Secretariats for AOG and EC
- Assistance in contracting and permitting
- Support for scientific and engineering drill-site operations
- Support for field facility for core and sample description and management
- Provide all data collected during each project through a readily accessible data management system for ICDP projects, the Drilling Information System (DIS)

- Prepare - through this Drilling Information System - Initial Reports that describe drilling, engineering and sample and core description and procedures for each project
- Provide training courses in scientific drilling prior to and during drilling projects
- Organize outreach activities on major international geoconferences (AGU, EGU, IGC)
- Edit the IODP-ICDP journal 'Scientific Drilling'
- Develop, purchase, and maintain an ICDP Equipment Pool comprising scientific-technical instruments and tools for on-site use in ICDP projects
- Provide management support for individual ICDP projects
- Provide and operate ICDP equipment

Management of ICDP activities at the GFZ takes place in the Platform "Scientific Drilling" by the following personnel:

- Prof. Dr. Brian Horsfield
- Dr. Ulrich Harms (Executive Secretary and Head of the ICDP Operational Support Group).

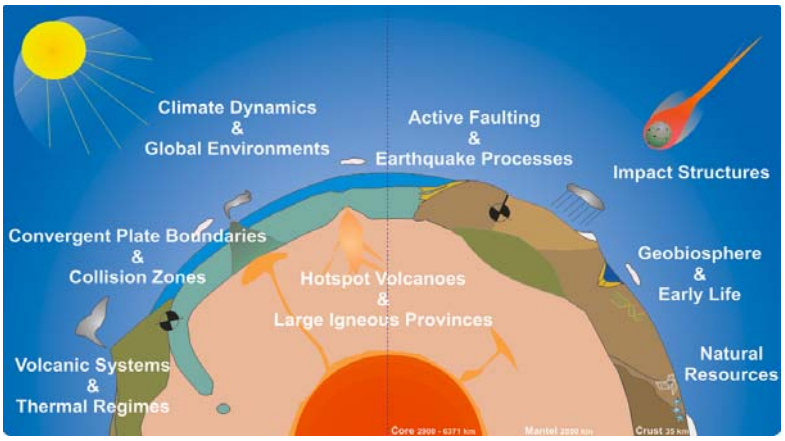


ICDP proposal handling workflow

ICDP Strategy-present and future

The 2nd Potsdam Conference on Continental Drilling from March 30 to April 1, 2005, identified and elaborated the current main themes and key questions for future drilling activities on land including:

- Climate Dynamics and Global Environments
- Active Faulting and Earthquake Processes
- Volcanic Systems and Thermal Regimes
- Impact Structures and Impact Processes
- Geobiosphere and Early Life
- Convergent Plate Boundaries and Collision Zones
- Mantle Plumes and Large Igneous Provinces
- Natural Resources and Industry Coupled Scientific Drilling.



Scientific themes of the ICDP

A new ICDP Science Plan is currently planned in order to emphasize the societal impact of continental scientific drilling through a more targeted understanding of geoprocesses tackled by ICDP funded projects. Nevertheless, societal relevance is already one key criterion for ICDP project selection.

Understanding of Geoprocesses

Societal Challenges	Active Faulting & Earthquake Processes	Heat and Mass Transport	Global Cycles	The Hidden Biosphere
Water Quality, Availability and Sustainibility		■		■
Climate and Ecosystem Evolution			■	■
Energy and Mineral Resources		■		
Natural Hazards	■	■		

The new ICDP Science Plan towards a targeted understanding of geoprocesses

An ICDP Science Conference will be held from November 11-14, 2013 in Potsdam to implement the new Science Plan, to strengthen and expand our ties with ICDP member countries, to present ICDP achievements and current activities and pave the way for outreach measures for media and policy makers. The conference is entitled “Imaging the Past to Imagine the Future”.

ICDP Workshops

ICDP workshops are funded upon pre- and workshop proposals to support a group of international scientists with an outstanding scientific theme of socio-economic relevance that requires drilling. The workshops serve to form a broad and competent Science Team and to develop full drilling proposals to ICDP and other co-funding agencies or industry. Over the past years, ICDP supported the conduction of workshops with a broad topical spectrum addressing either future drilling projects or thematic issues.

Workshop Title	Date and Venue	Participation	Countries
Scientific Drilling of the Lake Chalco, Basin of Mexico	March 4 to 9, 2012 Mexico City, Mexico	40	6
Drilling of Lake Towuti, Indonesia: International collaboration on the climatic, environmental, and geological evolution of a tropical Pacific lake.	March 26-29, 2012 Bandung, Indonesia	69	9
Iceland Deep Drilling Project IDDP-2 : Workshop to Plan a 5 km deep borehole (IDDP-2) into the Root Zone of an Analog to a Black Smoker on Land at Reykjanes, Iceland	September 3-5, 2012 Svartsengi, Iceland	94	12
Scientific Drilling of Lake Challa: Research on the climatic and ecological history of Equatorial East Africa	September 10-14, 2012 Nairobi and Taveta, Kenya	unknown	unknown
Scientific Drilling of the Samail ophiolite, Sultanate of Oman: Past and present processes in crust and mantle from an oceanic spreading center	September 13-17, 2012 New York, USA	78	11
Forthcoming Workshops			
Japan Beyond-Brittle Project (JBBP): Scientific drilling to demonstrate the feasibility of engineered geothermal systems in ductile zones	March 12–16, 2013 Sendai, Japan,	-	-
Mochras revisited: a new global standard for Early Jurassic Earth history	March 20 –21, 2013 Oxford, UK	-	-
Drilling Overdeepened Alpine Valleys	April 3-5, 2013 Como, Italy	-	-

Summary of ICDP workshops conducted 2012 and planned for 2013

ICDP Projects accomplished in 2012

The Snake River Plain Scientific Drilling (Project Hotspot)

The fundamental scientific objective of this project is to understand the interaction of deep mantle plumes and continental lithosphere and their evolution in time and space. Plume-related volcanism has distinct chemical and isotopic characteristics that are well constrained by studies of ocean island basalts. Continental lithosphere has distinct isotopic signatures, which vary with age and location that can be used to distinguish different lithospheric and crustal domains, and can be compared to oceanic reservoirs to determine the extent of source interactions. The Snake River Plain represents a world-class example of active mantle plume volcanism in an intra-continental setting. Because it is young and tectonically undisturbed, the complete record of volcanic activity can be sampled only by drilling. The Snake River Plain furthermore represents an area with high heat flow and thermal anomalies which root deep into

the mantle, making evaluation of the geothermal potential another important target of the Hotspot project. Snake River Plane drilling has successfully drilled three deep holes at Kimama, Kimberley and Mountain Home Air Force Base. The drilling has produced over five kilometer of core. All drill holes have been geophysically logged with a full suite of logging tools. Vertical seismic profiles (zero-offset and walk-away VSP) have been conducted to identify and characterize seismic sources and determine in situ seismic velocities. Funding for this project is provided by ICDP, the US Department of Energy (DOE), the United States Air Force, and participating institutes from the US, Canada, Germany, UK and France.

Peering into the cradle of live: the Barberton drilling project

The Barberton Greenstone Belt in South Africa is one of the best-preserved successions of mid-Archean supracrustal rocks in the world, and, as such, it is a remarkable natural laboratory where conditions and processes at the surface of the Archean Earth can be studied in detail. Despite generally good outcrop, nowhere in the Barberton belt are complete field sections preserved, and crucial features such as the contacts of lava flows and continuous successions of critical sedimentary rock sequences are not exposed. The drilling was conducted using a standard rig and conventional technology under the supervision of experienced geologists from South African universities and mineral exploration companies. Diamond drilling obtains continuous sections and relatively unaltered samples through the volcano-sedimentary successions. Core drilling started in July 2011 and was completed in May 2012. Five wells have been drilled (BARB 1: 420.0 m, BARB 2: 431.4 m, BARB 3: 899.6 m, BARB 4: 538.6 m, BARB 5: 763.2 m) and 3052 m of drill core was retrieved from the five drill holes with a core recovery better than 98%. Comprehensive summaries of the lithologies and structures sampled in each hole have been published. The distribution of samples and post-drilling research will be coordinated by a steering committee comprising representatives from all major participating countries. A workshop is scheduled for February 2013 to discuss the outcome of the project and as first sampling party. The project is supported by scientists from 13 countries in five continents and by the mineral exploration industry.

Ongoing projects

The Campi Flegrei Deep Drilling Project (CFDDP)

Campi Flegrei drilling began in July 2012 with drilling of a deep pilot hole to infer mechanical properties and temperatures of the Campi Flegrei caldera host rocks and to characterize different fluid regimes at depth in order to plan the deep drilling and deviation in detail. The pilot hole is also aimed to study the volcanic stratigraphy of the eastern caldera border and to host innovative borehole sensors for volcano monitoring and risk mitigation. Pilot hole drilling was executed in two phases (22.07-29.07. and 22.11-

02.12.2012) and reached a final depth of 506m. The pilot hole was logged (Schlumberger) and cased. Lithological description based on analysis of cuttings and few drill cores. ICDP online drilling mud gas monitoring (OLGA) was conducted as well. The post-drilling use of the borehole for long-term geochemical monitoring and fiber-optical measurements is currently in preparation.

Geophysical Observatory at the North Anatolian Fault (GONAF)

The GONAF plate boundary observatory (Geophysical Observatory at the North Anatolian Fault) was set up to determine and monitor the seismic hazard of the region and the processes occurring in the fault zone beneath the Marmara Sea off Istanbul with cutting edge earthquake monitoring technology. Drilling the first of eight ~300m deep holes started on September 7, 2012. Specially designed seismic sensors in eight boreholes on the outskirts of Istanbul and around the eastern Marmara Sea will monitor the seismic activity of the region with high precision. In each of the respective 300 meter deep holes several borehole seismometers will be permanently installed at various depths. These detect even barely perceptible earthquakes with very small magnitudes at a high resolution and can thus provide information about the earthquake rupture processes associated with these. Upon successful completion and handover of the fully equipped pilot bore hole on the peninsula Tuzla just off Istanbul a first test phase will commence before the remaining seven wells will be drilled.

Spud-in for the first of eight boreholes of the Geophysical Observatory at the North Anatolian Fault

Upcoming projects

Projects planned for 2013 comprise drilling 1) of Lake Ohrid in Macedonia, 2) for Hominide sites in Kenya, 3) into the Chinese Songliao Basin and 4) in the Scandinavian Caledonides.

1) Lake Ohrid, situated at the border between Albania and Macedonia, is considered to be the oldest continuously existing lake in Europe with an age of likely three to five million years and is worldwide unique for it's more than 210 described endemic species. Lake drilling will shed new lights into the evolution of this aquatic ecosystem. Some shallow holes have been drilled in summer 2011. Deep drilling was scheduled for spring 2012 but was delayed due to a fire onboard the cargo vessel MSC Flaminia that seriously damaged parts of the drilling equipment. Drilling is now planned to start in early April 2013 if all replacement are shipped to Macedonia in time.

2) HSPDP (Hominid Sites and Paleolakes Drilling Project) aims to obtain sediment cores from several of the most important fossil hominin and early Paleolithic artifact sites in the world, located in Kenya and Ethiopia for understanding hominin phylogeny, covering key time intervals for addressing questions about the role of environmental forcing in shaping human evolution. The four proposed sites are all currently on-land, but consist of thick lacustrine sedimentary sequences with high deposition rates. Therefore, the sites combine the attributes of relatively low cost targets (in comparison with open water, deep lake sites) and the potential for long, highly continuous and informative paleoenvironmental records obtainable from lake beds. Drilling in Kenya is scheduled for June-August 2013 and the operations in Ethi0pia for late 2013 and early 2014.

3) The principle target of drilling in the Chinese Songliao Basin is the recovery of a nearly complete Cretaceous terrestrial sedimentary record from a 5 km deep corehole in order to determine the basin-filling history and understand the response of terrestrial environment to geological events related to the carbon cycle and greenhouse climate change. Start of drilling was postponed for political reason and is now anticipated for spring 2013.

4) The COSC project (Collisional Orogeny in the Scandinavian Caledonides) focuses on the mid Paleozoic Caledonide Orogen in Scandinavia in order to better understand orogenic processes, both in the past and in today's active mountain belts. The Caledonides in Scandinavia provide unique opportunities for understanding Himalayan-type orogeny and the Himalayan Orogen itself, thanks to the deep level of erosion (mid to lower crustal) and the paucity of superimposed post-Paleozoic deformation. This project targets both the Caledonian nappes ("hot" allochthon) and the underlying basement, with two c. 2.5 km drillholes, located near Åre and Järpen in western Jämtland. Drilling will start in the second half of 2013.

Education and Outreach Activities

The 2012 ICDP Training Course carried out at Minneapolis in close cooperation with the National Lacustrine Core Facility (LacCore) from the University of Minnesota focused on soft and lacustrine sediment drilling. 30 participants from 19 countries attended the Training Course. Ten international experts held lectures on lake drilling engineering, downhole logging basics, application of downhole logging data, pre-site surveys, drill core sampling, handling, storage and analysis, data management, application strategies, project planning and management and report from currently completed and planned ICDP lake drilling projects (Lake Van, Lake Ohrid). A visit of the LacCore facilities delivered valuable insights into state-of- the-art lacustrine core handling and storage.

ICDP outreach measures were conducted at the 2012 EGU meeting in Vienna, the 34th IGC in Brisbane and the 2012 AGU meeting in San Francisco, including Town Hall meetings, booths, workshops and scientific sessions.

Joint Town Hall meetings at the EGU (ICDP-IODP) and AGU (ICDP-DOSECC) were very well received events with generally more than 200 attendees who met to hear about the news of the respective scientific drilling programs and initiatives. Joint IODP-ICDP exhibition booths at the 2012 EGU and the 34th IGC were active focal points for the scientific drilling community and also for scientists from related fields of research from ICDP member and non member countries. At the 34th IGC, ICDP carried out a workshop ("Primer") to introduce into the ICDP program structure and how to apply/cooperate. Twelve oral and twenty-four poster presentations from the IODP-ICDP EuroFORUM 2012 summarized and reviewed major scientific achievements in ocean and continental drilling with special emphasis on the European contributions to IODP and ICDP. Furthermore, perspectives and visions for drilling projects using a multi-platform approach were tackled.

Developments

Retrieving drill cores, drilling cuttings, and formation fluids and gases are one main goal in scientific drilling. These materials should be available for scientific investigations even long time after sample retrieving, which is only feasible if samples are safely stored and well recorded So far, not all ICDP project partners have access to facilities for proper storage of sample material, i.e. national core repositories. For an accurate core curation of continental drill cores e.g.; from ICDP projects, the German Scientific Earth Probing Consortium GESEP has established a modern core repository consisting of two facilities. In September 2012, one facility opened in Berlin-Spandau at a branch office of the Federal Institute for Geosciences and Natural Resources (BGR) with capacities for up to 41 km of core, mainly for crystalline rock samples without cooling. The second facility is integrated into the Bremen Core Repository at MARUM which is designed for soft sediment core curation and storage at +4°C. Originally constructed for the Integrated Ocean Drilling Program and similar programs for curation of up to 270 km, it is now also open for lacustrine cores of the ICDP. Both facilities provide state-of-the-art equipment for core opening, description, sampling parties and analyzes.

The new core repository at Berlin-Spandau was opened in September 2012

ICDP International Science Conference 2013 "Imaging the Past to Imagine the Future"

An important outcome of the ICDP evaluation in May 2011 was to start developing a new ICDP Science Plan. The AOG has therefore planned for the International Symposium on Continental Scientific Drilling in 2013 as mentioned before. The new ICDP Science Plan will emphasize the societal impact of continental scientific drilling through a targeted understanding of geoprocesses tackled by ICDP funded projects. The ICDP Science Conference held from November 11-14, 2013 will implement the new Science Plan, to strengthen and expand ties with ICDP member countries, to present ICDP achievements and current activities and pave the way for outreach measures for media and policy makers.

Dr. Thomas Wiersberg and Dr. Ulrich Harms
ICDP Office
GFZ, Potsdam, Germany