

International Continental Scientific Drilling Program

ICDP

Annual Report 2014

ICDP Project Schedule 2014/2015

ICDP Projects accomplished in 2014

- Collisional Orogeny in the Scandinavian Caledonides (COSC)
- Hominin Sites and Paleolakes Drilling Project (HSPDP)
- Deep Fault Drilling Project (DFDP)

Running ICDP Projects

- Geophysical Observatory at the North Anatolian Fault (GONAF)
- Drilling the Cretaceous Basin in Songliao, China (CCSD-SK)

Upcoming ICDP Projects

- Continental Scientific Drilling Into Coral Reefs (COREF)
- Lake Towuti Drilling Project (TOWUTI)
- Lake Junín Drilling Project (JUNIN)
- International Drilling to Recover Aquifer Sands (IDRAs)

Workshops & Proposal Submissions 2014

ICDP Outreach and Training Activities

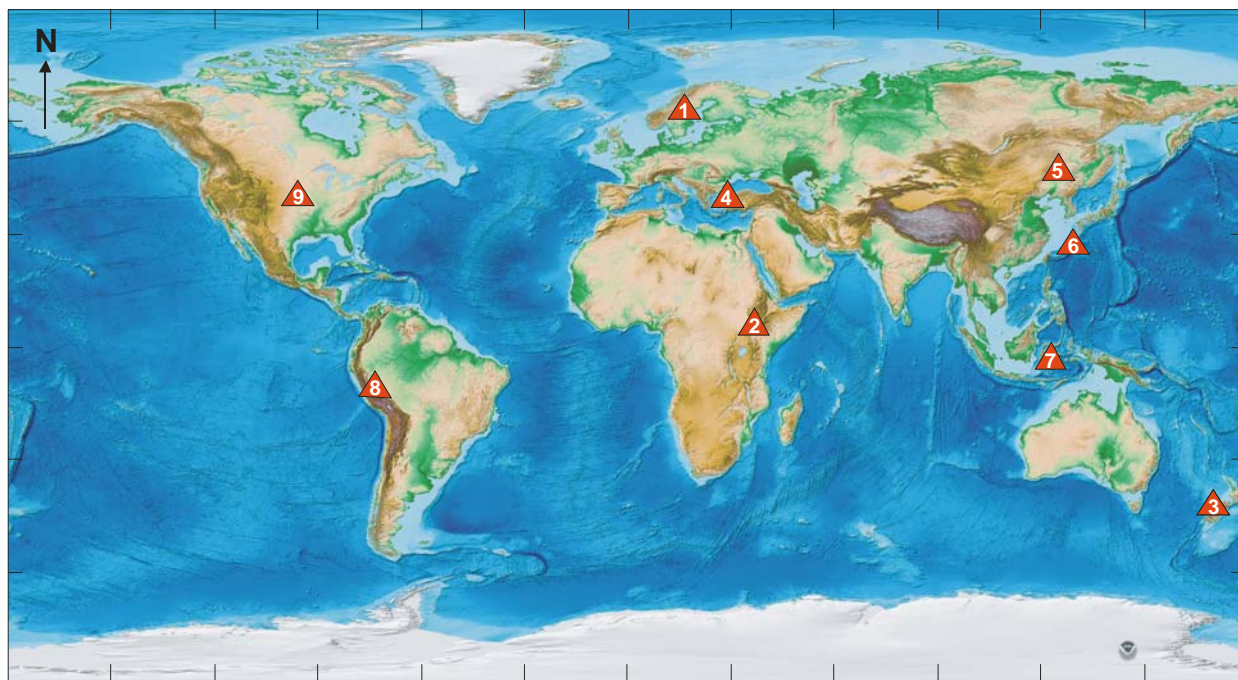
- ICDP Training Course "Drilling in Active Fault Zones" in New Zealand
- ICDP at Conferences (EGU, AGU, ISC) and other Outreach Activities

ICDP Future

- ICDP Science Plan 2014-2019
- Amphibious Drilling Proposals – a new way of cooperation between IODP and ICDP

ICDP Profile

ICDP Project Schedule 2014/2015



Accomplished in 2014

1	COSC	Apr. Sep. 2014	Jämtland, Sweden
2	HSPDP	Jun. 2013 -Dec. 2014	Kenya, Ethiopia
3	DFDP	Aug. 2014 -Dec. 2014	Whataroa, New Zealand

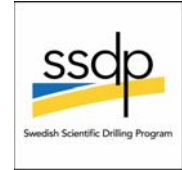
Currently running

4	GONAF	since Sep. 2012	Istanbul, Turkey
5	Songliao Basin	Apr.2014 Dec. 2016	Songliao Basin, China

Upcoming in 2015

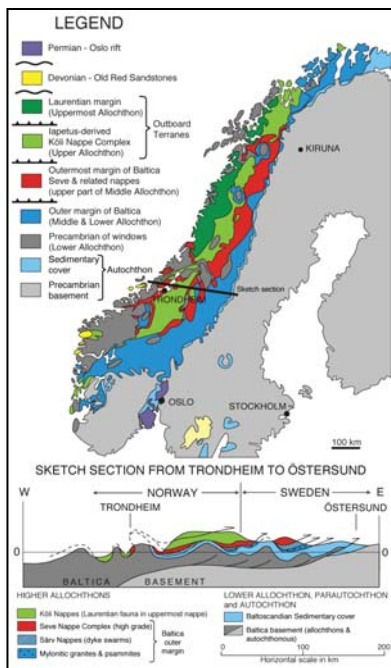
6	COREF	Apr. May 2015	Ryukyu Islands, Japan
7	Lake Towuti	May 2015	South Sulawesi, Indonesia
8	Lake Junin	Jul.-Aug.2015	Lake Junin, Peru
9	IDRAS	Sept. 2014	Missouri, US

ICDP Projects accomplished in 2014



Collisional Orogeny in the Scandinavian Caledonides (COSC)

The COSC project focuses on the transport and emplacement of subduction-related high-grade continent-ocean transition zone (COT) complexes onto the Baltoscandian platform and their influence on the underlying allochthons and basement. The main scientific objectives of the COSC scientific drilling project are to establish a coherent model of mid Palaeozoic (Scandian) mountain building in the regional context of the North Atlantic Caledonides by testing different hypothesis of nappe emplacement, to compare and contrast the plate collisional processes in on-going and older orogens, and to apply these new insights to the interpretation of modern analogues, in particular the Himalaya- Tibet mountain belt, to better understand how the collision of continents and resulting orogeny control the environment on Earth and the evolution of the biosphere. This includes studies on Geology and Thermochemistry, Geophysics, Geothermics, Hydrogeology, and Microbiology. Evaluation of the applicability of the new wireline diamond core drilling systems for the needs and requirements of scientific drilling projects was another target of the project.



Geological map and drilling activities at COSC

The completely wireline cored 2496 m deep COSC-1 drill hole, drilled between April and August 2014 near Åre, penetrates through the tectonic stack from the high-grade Lower Seve Nappe and well into the Baltican basement and achieved 100 % core recovery. On-site investigations include drill core analysis and description, drilling mud gas monitoring, fluid sampling, downhole logging, and seismic studies (VSP). A sampling party is scheduled for February 2015 in the core repository of the German Federal Institute for Geosciences and Natural Resources (BGR) at Berlin Spandau, Germany.



The Hominin Sites and Paleolakes Drilling Project (HSPDP)

HSPDP (Hominin Sites and Paleolakes Drilling Project) obtained sediment cores from several of the most important fossil hominid and early Paleolithic artifact sites in the world, located in Kenya and Ethiopia for understanding hominid phylogeny and covering key time intervals for addressing questions about the role of environmental forcing in shaping human evolution. Continuous drill cores of lacustrine strata preserved organic matter, fossils and other archives and provide a spatially resolved record at the landscape scale to improve our understanding of environmental history in the places and times where various species of hominids existed. The five drill sites (Tugen Hills, West Turkana, Lake Magadi (Kenya), Chew Bahir, Northern Awash (Ethiopia) are all currently on-land and consist of thick lacustrine sedimentary sequences with high deposition rates. The five sites were successfully drilled in 2013 and 2014 and delivered long, highly continuous and informative paleoenvironmental records at relatively low costs (in comparison with open water, deep lake sites).



The Chew Bahir on-site team



WT (Western Turkana): 175 m (2013)

TH (Tugen Hills): 228 m (2013)

NA (Northern Awash): 245 m (2014)

LM (Lake Magadi): 198 m (2014)

CB (Chew Bahir): 279 m (2014)

Downhole logging was carried out at Tugen Hills and West Turkana by the logging team of the ICDP Operational Support Group.

Locations and achieved depths of the five HSPDP Drill Sites



The Deep Fault Drilling Project (DFDP)

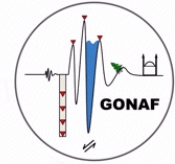
The Alpine Fault in western South Island of New Zealand ruptures every 200-400 years in a magnitude ~7.9 earthquake, and is thought to have last ruptured in 1717 AD. Compared to other well known faults such as e.g. the San Andreas Fault in America or the North Anatolian Fault in Turkey, the Alpine Fault is unique in the fact that rapid uplift and mountain building has exhumed fault rocks from depth, and uplift continues to restrict earthquake activity to depths that are shallower than normal. The Deep Fault Drilling Project is motivated by a long-standing scientific question: what are the physical conditions in the mid-crust under which large, active continental faults evolve and generate earthquakes? Two shallow and one deeper vertical borehole have been drilled in the lower Whataroa Valley (New Zealand) to address these questions through drilling, sampling, and monitoring the Alpine Fault at depth, to take advantage of excellent surface exposures and the relatively shallow depths of geological transitions, and hence to better understand fundamental processes of rock deformation, seismogenesis, and earthquake deformation. DFDP-1 was completed in February 2011 with the successful construction of two boreholes intersecting the Alpine Fault at Gaunt Creek, South Westland. DFDP-2B aimed to intersect the fault at a target depth of 1500 m and reach a total depth of 1600 m. The objectives of DFDP-2B were to characterize fault zone lithologies and structures from drill cores and wireline logs, to determine in-situ temperatures, fluid pressures, and stresses via wireline logging and low-volume minifrac tests, to measure bulk rock permeability using hydraulic tests and to install a resilient permanent observatory around the fault at 1500 m depth.



DFDP drill site in front of the New Zealand Alps

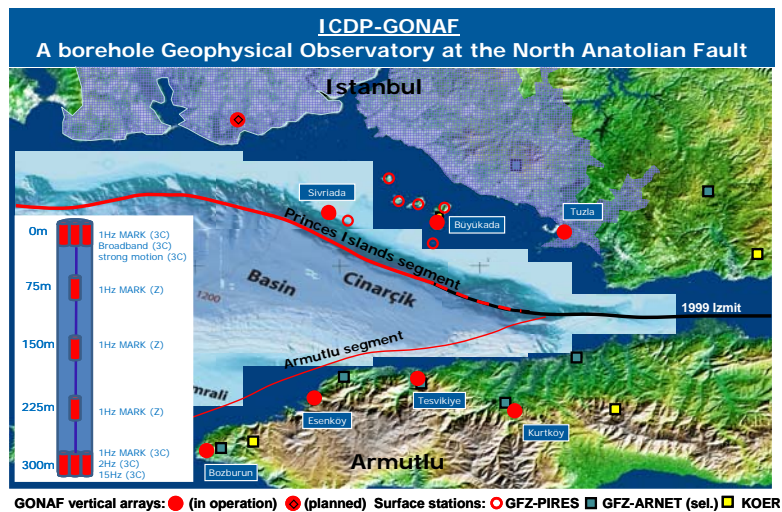
DFDP-2 drilling started in September 2014 but after several technical challenges during the drilling the premature end of DFDP-2B was decided on December 16 at a borehole depth of at 892 m. Important data and samples have been obtained but sampling and downhole instrumentation within and below the fault is postponed to a later project stage. A seismometer and fiberoptic cables are now installed in the borehole for continuous monitoring.

Running ICDP Projects



Geophysical Observatory at the North Anatolian Fault (GONAF)

The objectives of GONAF are to monitor the North Anatolian Fault Zone transition from the 1999 Izmit rupture to the Princes Islands offshore Istanbul, where a M 7 earthquake can reasonably be expected to occur, and to determine ground-motion amplification and near-surface properties at the GONAF sites. GONAF involves the installation of a high-resolution borehole seismic observatory to monitor the seismic activity of the Istanbul region in eight 300 meter deep holes. Five geophone arrays are fully operational while two more are being completed in spring 2015.



Drilling the Cretaceous Basin in Songliao, China (DPCSB, CCSD-SK)



DPCSB proposes to conduct scientific drilling in the Cretaceous Songliao Basin, Northeast China. The DPCSB project (SK-II) proposes to obtain about 4500 m cores of Huoshiling to Quantou Formation, to be combined with the existing SK-I(n) and SK-I(s) to form the first nearly complete Cretaceous terrestrial sedimentary record in the world. This will provide excellent high resolution climate records of the terrestrial environment for the whole Cretaceous. Spud in of SK-II was on April 13, 2014 using the new Chinese rig “Crust-1” with 10 km depth capacity. On-site facilities include an engineering center and the on-site core repository.



Upcoming ICDP Projects

COREF - Continental Scientific Drilling Into Coral Reefs

The COREF Project is designed to perform continental scientific drilling into Quaternary reef-complex deposits in different settings in the Ryukyu Islands to verify the nature and magnitude of the coral-reef front migration in order to clarify the climatic/oceanographic factors controlling the reef formation. Determination of the variation of the coral reef ecosystem respond to climatic changes on millennial to glacial-interglacial timescales and quaternary carbonate accumulation rates in coral reefs are other important objectives.

Lake Towuti Drilling Project (TOWUTI)

The Towuti Drilling Program will provide valuable new information to understand the climate, biological, and geomicrobiological evolution of a tropical pacific lake. Lake Towuti's location in central Indonesia provides an important opportunity to reconstruct long-term terrestrial paleoclimate change in a crucially important yet understudied region- the Western Pacific warm pool, heart of the El Niño-Southern Oscillation. Lake Towuti has high rates of floral and faunal endemism and is surrounded by one of the most diverse tropical forests on Earth making it a hotspot of Southeast Asian biodiversity. The ultramafic (ophiolitic) rocks and lateritic soils surrounding Lake Towuti provide ferruginous metal substrates that feed a diverse, exotic microbial community in the lake and its sediments, potentially analogous to the microbial ecosystems that operated in the Archean Oceans and on Mars.

The Lake Junín Drilling Project (JUNIN)

Lake Junín is a scientifically mature site that will yield critical scientific insights that only drilling coupled with analysis by a select international team of scientists can unlock. Lake Junín, located at 4000 m asl in the inner-tropics of the Southern Hemisphere, is a prime target for drilling because it contains a thick (>125 m) sediment package deposited at a high rate (0.2 to 1.0 mm yr⁻¹). Lake Junín is one of the few lakes in the tropical Andes that predates the maximum extent of glaciation and is in a geomorphic position to record the waxing and waning of glaciers in nearby cordillera.

International Drilling to Recover Aquifer Sands (IDRAS)

IDRAS seeks to identify the limited set of parameters that need to be considered in order to make meaningful predictions about the vulnerability of a low-As aquifer. Elevated groundwater arsenic (As) concentrations impact the health of over 100 million villagers across Pakistan, Nepal, India, Bangladesh, Myanmar, Cambodia, Vietnam, and China who rely on tubewells as their main source of drinking water. As first step, a new tool to recover uncompromised core samples (freeze-shoe sampler) will be tested in a drilling in Missouri scheduled for September 2015.

Workshops & Proposal Submissions 2014

ICDP Workshops

ICDP funds workshops 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
Accelerating Neoproterozoic Research through Scientific Drilling (MagellanPlus)	March 17-19, 2014 Nottingham, UK	49	14
Scientific Deep Drilling in Koyna	May 16-18, 2014 Koyna, India	38	8
Advancing Sub-Surface Biosphere and Paleoclimate Research Workshop (MagellanPlus)	August 21-23 Seoul, South Korea	28	9
Drilling the Bushveld Complex	September 7-9, 2014 Johannesburg, South Africa	52	8
Coring the Paleogene Hemipelagic Sediments of Tanzania	September 10-12, 2014 Dar-es-Salaam, Tanzania	26	8
Krafla Magma Drilling	September 15-19, 2014 Krafla, NE Iceland	45	10
A New Drill Core at Surtsey Volcano	September 30 - October 4, 2014 Heimaey Island, Iceland	24	10
Forthcoming Workshops	Date and Venue		
Trans-Amazon Drilling Project Workshop	March 18-20, 2015 Manaus, Brazil	-	-
Coring North Sea Cenozoic Workshop	March 18-21, 2015 Utrecht, Netherlands	-	-
Multi-Well Deep Underground Laboratory in the Songliao Basin	June 27 -30, 2015 Beijing, PR China	-	-

ICDP Proposal Submission

ICDP funding is proposal-driven. Scientists from ICDP member countries or countries considering membership have the right to submit unsolicited proposals to the ICDP. Proposals may be assembled by individuals or groups of scientists from single or groups of countries. ICDP accepts proposals of all kinds up to **January 15** each year.

Proposal Type	Number of received proposals	Funded/encouraged	Funded + Addendum	Rejected/not encouraged
Full Proposal	7	3	2	2
Workshop Proposal	8	8	-	2
Pre-Proposal	2	1	-	1

ICDP Outreach and Training Activities

ICDP Training Course "Drilling in Active Fault Zones"

The annual ICDP Training Course took place at the Franz Josef Glacier resort in New Zealand from October 5 to 10 nearby the parallel running ICDP Alpine Fault drilling (DFDP). The training course touched upon relevant aspects of scientific drilling in active fault zones, including lecturers on drilling engineering, samples and sampling strategies, pre-site studies, downhole logging, permanent downhole monitoring, data management, and project planning and management. Practical exercises and a one-day visit of the drill site helped deepen the acquired expertise.



Group photo of the ICDP Training Course and on-site training

33 Scientists from 13 countries involved in running or upcoming scientific drilling campaigns attend the training course, including New Zealand, USA, UK, Canada, Finland, India, China, Italy, Korea, the Netherlands, Swiss, Spain, and Germany.

ICDP at Conferences (EGU, AGU, ISC) and other outreach activities

ICDP was present at the 2014 EGU meeting in Vienna, the International Sedimentology Congress (ISC) in Geneva and the 2014 AGU meeting in San Francisco with a joint ECORD-ICDP booths and executed Town Hall meetings (AGU, EGU) and scientific sessions (EGU, ISC).



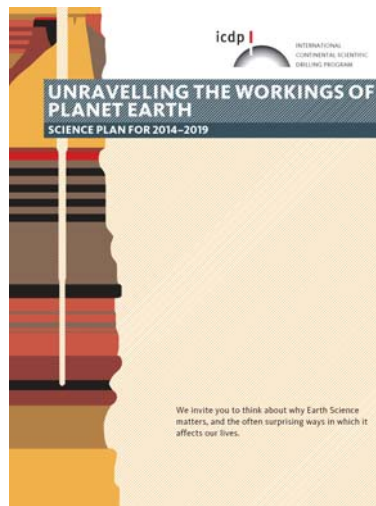
Two issues of the IODP-ICDP program journal SCIENTIFIC DRILLING were published by Copernicus Publications in 2014 (SD 17 in April and SD 18 in December), including Science Reports, Workshop Reports, Progress Reports and reports on Technical Developments.

ICDP Future

ICDP Science Plan 2014-2019

The new ICDP Science Plan for the forthcoming years, summarized in a White Paper, has been published in 2014. It will broaden the goals of continental scientific drilling towards targeted understanding of geoprocesses in relation to society. In future, scientific drilling for faulting and earthquakes processes, for heat and mass transport, for global cycles and environmental change and for the hidden biosphere shall be considered in the context of societal needs and relevance such as water quality and availability, climate and ecosystem evolution, energy and mineral resources and natural hazards. The new ICDP Science Plan strengthen and expand ties between member countries and partner programs (IODP, ANDRILL), invites and integrates early career researchers in upcoming ICDP activities, debates incorporation of industry partners into selected ICDP strategic activities for a science-driven mutual benefit and discusses new outreach measures to media, policy makers and the interested public. The ICDP White Paper can be downloaded from the ICDP webpage:

http://www.icdp-online.org/fileadmin/icdp/outreach/doc/ICDP_SciencePlan2014_19.pdf



Amphibious Drilling Proposals – a new way of cooperation between IODP and ICDP

The International Ocean Discovery Program and the International Continental Scientific Drilling Program support scientific endeavors requiring drilling on the ocean or on land, respectively. Scientific interests in these topics potentially span onshore and offshore drilling objectives, though programmatically crossing the shoreline can be a challenge since IODP is primarily ocean scientific drilling and ICDP is primarily continental scientific drilling. Although previous onshore-offshore coordinated drilling proposals have been successful (New Jersey shallow shelf and Chicxulub impact structure), IODP and ICDP recognized the challenges in proposing scientific drilling to two organizations with different deadlines and procedures.

To simplify the submission of drilling proposals crossing the shoreline, a new tool (Amphibious Drilling Proposal, ADP) has been developed. ADPs are those in which the scientific objectives can only be accomplished by drilling both onshore *and* offshore and will be reviewed by panels from both programs but decided upon based on a joint decision.

ICDP Profile

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 by ICDP since 1996. 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 commingled 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, 83 of these workshops have been funded and have resulted in a total of 35 ICDP supported, successfully executed, drilling projects. Thematically the activities have focused 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 International Ocean Discovery Program IODP, serves to communicate developments from current projects as well as workshop reports and announcements for future scientific-drilling related activities.

Global Partners

ICDP has currently (31.12.2014) 23 members including 22 countries (Germany, USA, Japan, China, Canada, Austria, Norway, Poland, Czech Republic, Iceland, Finland, Italy, South Korea, Sweden, Switzerland, New Zealand, France, Israel, India, the Netherlands, the United Kingdom, and Belgium) and UNESCO as member organization. Expressions of interest in membership and/or negotiations are currently underway with Brazil, Russia, Turkey, Portugal, Denmark, 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 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.

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 “commingled 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 a drilling project varies between about 5% to about 70% (in rare cases) of the total operational costs. Usually national funding agencies or other sources of support for scientific drilling provide the remainder of the funding for the drilling project.

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 commingled 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 commingled 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 by the following personnel:

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

Potsdam, 22. 01.2015

Thomas Wiersberg, ICDP OSG

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