

ICDP Status and Future

CURRENT STATUS as of January 2020

ICDP Project Schedule 2019/2020

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- Drilling the Eger Rift
- Geological Research through Integrated Neoproterozoic Drilling: The Ediacaran-Cambrian Transition (GRIND-ETC)

Upcoming ICDP Projects

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- Jurassic Earth System and Timescale (JET)
- Trans-Amazon Drilling Project (TransAmazon)
- A Strainmeter Array Along the Alto Tiberina Fault System, Central Italy (STAR)

ICDP Workshops

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Proposal Submissions 2019

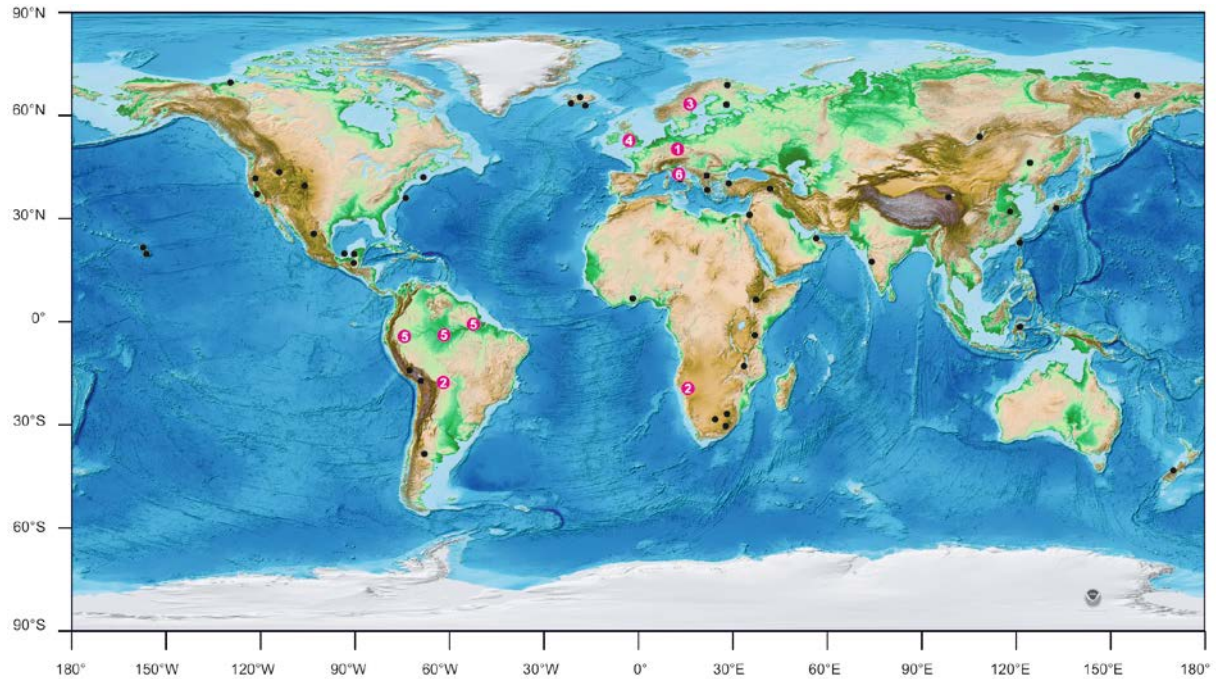
New ICDP Structure

Introducing mDIS

Personal changes in the Operational Support Group

ICDP Profile

ICDP Project Schedule 2019/2020



Currently operating ICDP projects

1	Eger Rift	August 2018-May 2020	Czech Republic
2	GRIND	June 2019-June 2020	Namibia, Brazil, China

ICDP Projects scheduled for 2020

3	COSC-2	April-September 2020	Sweden
4	JET	March –June 2020	Wales (UK)
5	TransAmazon	June-December 2020	Brazil
6	STAR	Summer 2020	Italy



Currently operating ICDP projects

Drilling the Eger Rift

The Bohemian Massif (500-250 Ma), the easternmost part of the Variscan orogenic belt, is one of the largest stable outcrops of pre-Permian rocks in Central and Western Europe. This region has persistent geodynamic activity that is clearly linked to the upper mantle, and offers a globally unique location for studying intra-continental earthquake swarm (ES) activity in combination with deep crust and mantle degassing as well as their interaction with the deep biosphere. The main questions regarding seismicity, microbial life and origin, and heat flow are all linked by the common questions of fluid flow, pathways, and composition. The ICDP project 'Drilling the Eger Rift' aims to develop a comprehensive laboratory at depth for the study of ES, crustal fluid flow, mantle-derived CO₂ and He degassing, and processes of the deep biosphere. In order to reach a new level of high-frequency, near source, and multi-parameter observation of ES and related phenomena, such a laboratory will comprise of a high-frequency 3D seismic array with a set of four shallow boreholes, combined with modern continuous real-time fluid monitoring at depth (the shallow boreholes) and the study of deep biosphere. From the microbiological viewpoint active fault zones could be seen as hot spots of microbial life in the deep subsurface compared to other continental deep biosphere ecosystems due to an intensified substrate support by the CO₂-dominated fluid flow. Therefore, active fault zones provide unique conditions for studying microbial life at depths and in-situ. The regular occurrence of persistent ES with known radiation effects offers the unique possibility to design and tune a borehole-based monitoring network for optimized analysis of the high frequency content of weak swarm-like seismicity, which appears clearly related to fluid-flow in the crust between 5 and 10 km depth. A 108.50 m deep pilot hole was drilled in spring 2016 to study the impact of CO₂-rich mantle-derived fluids on the geo-bio interaction. In October 2018, the HQ-size borehole Studenec was drilled to 400 m depth using wireline coring technique. The extracted drill core consists mainly of phyllites. Drilling resumed in May-July 2019 with coring a 402 m deep borehole at Landwüst, Germany, and the Hartoušov mofette field (F3) in August-September 2019. The latter was drilled with the Atlas Copco CT20C rig from Lund University in Sweden ("Riksriggen").



Core description at Landwüst (left) and F3 drilling at Hartoušov (right).

Geological Research through Integrated Neoproterozoic Drilling: The Ediacaran-Cambrian Transition (GRIND-ECT)

The Neoproterozoic Era (1000 - 541 Ma) is one of the most dramatic in Earth history: metazoans evolved, the supercontinent Rodinia formed and broke apart, the global carbon cycle underwent high-amplitude fluctuations, oxygen concentrations rose and climate experienced at least two episodes of worldwide glaciation. However, the discontinuous and fragmented nature of outcrop-based studies has hindered developing quantitative models of Earth system functioning during that Era. The multi-phase GRIND project will rectify this scientific shortcoming by obtaining cores, each from 150 to 550 m, through the archetype successions that record the environmental and biogeochemical context during which life on Earth exploded. The specific targets of the first GRIND phase are the Ediacaran-Cambrian transition strata (560-530 Ma) of west Brazil, south China and south Namibia. The objective is to create a core network of correlative ECT strata that will enable constructing a highly resolved, temporally constrained geobiological, stratigraphic and geochemical database, as well as to provide a legacy archive for future research. The goal is to understand the drivers of the Neoproterozoic Earth system revolution: it began with simple eukaryotes that populated Earth during the preceding billion years of the Mesoproterozoic, underwent multiple Snowball Earth events, and emerged with the oxygenated, diverse ecosystems of the Cambrian. The three-nation drilling program will be undertaken sequentially.

Drilling in Namibia was started in a first phase between September and November 2019 at Tierkloof in the southern Namibian desert and retrieved 1862 m drill core from 7 sites. It will continue in spring 2020 while drilling in Brazil is planned for summer 2020, with successive drilling in China. All cores will be split and either being archived in repositories within each of the target nations or used for research purposes by GRIND-ECT scientists and for education and training for national capacity building and outreach activities. The working half of all cores will be permanent stored in the Federal Institute for Geosciences and Natural Resources in Berlin-Spandau, Germany.



GRIND drilling and core description in Namibia in fall 2019.

ICDP Operations scheduled for 2020

Collisional Orogeny in the Scandinavian Caledonides (COSC-2): Drilling the main Caledonian décollement and into the basement of the Fennoscandian Shield

The Collisional Orogeny in the Scandinavian Caledonides (COSC) scientific drilling project is investigating mountain building processes at mid to lower crustal levels in a deeply eroded Paleozoic collisional orogen of Himalayan dimensions by means of two boreholes. The COSC-1 borehole was drilled 2014 and provided detailed insights into continent-continent collision, including the hydrogeological-hydrochemical state and geothermal gradient of the mountain belt as well as the deep biosphere in metamorphic rocks and the crystalline basement [Lorenz et al., 2015]. The 2496 m deep borehole was drilled close to the town of Åre, Central Sweden. COSC-2 drilling is scheduled for April-September 2020 and will define the character and age of deformation of greenschist facies thrust-sheets, the main Caledonian décollement and the Precambrian basement that underlie the nappes drilled in COSC-1. The upper part of the borehole will sample a Cambro-Silurian succession, including both distal shelf sedimentary formations typical of the Baltoscandian platform and also foreland basin turbidites of both mid Ordovician and Early Silurian age, separated by significant environmental changes at the Ordovician-Silurian boundary. After drilling through the main décollement, COSC-2 will penetrate 1-1.5 km into the basement of the Fennoscandian Shield, where prominent seismic reflections indicate the presence of significant crustal shortening of Caledonian or Sveconorwegian age. Study of this internal basement deformation is particularly important for understanding the passage from thin-skinned tectonics in the foreland of the orogen to thick-skinned tectonics in the hinterland, where the underriding Baltica plate experienced deformation and (U)HP metamorphism. ICDP drilling will result in a fully cored borehole that will be further characterized by downhole logging, as well as complemented by VSP and electromagnetic surveys in separate projects. COSC-2 research will span several geoscientific disciplines – geology, geophysics, geochronology, hydrogeology, geothermics and microbiology.

Jurassic Earth system and Timescale (JET)

The major goal of this ICDP project is to produce a new global standard for the Early Jurassic Epoch, a time of extreme environmental change. Through the Early Jurassic there are well-documented examples of rapid transitions from cold, or even glacial climates, through to super-greenhouse events, the latter characterized worldwide by hugely enhanced organic carbon burial, multiple large-magnitude isotopic anomalies, global sea-level changes and mass extinctions. These events not only reflect changes in the global climate system but are also thought to have had significant influence on the evolution of Jurassic marine and terrestrial biota. The initial plan of re-drilling a 45-year-old borehole at the Mochras Farm on the coast of Cardigan Bay had to be revised due to permitting issues. A new site (Prees) that fulfills and even exceeds the initial science objectives will be drilled in the Cheshire Basin (Shropshire, England). Situated close to a former oil and gas exploration well, the new site allows recovering approximately 850 m of primarily latest Triassic to Early Jurassic strata, including the Jurassic-Triassic boundary. This new approach will integrate astrochronology,

chemostratigraphy, biostratigraphy, and magnetostratigraphy and, combined with data being generated from the old Mochras core, will become the international standard for these 25 million years of Earth history. Drilling the Cheshire Basin is expected to take place between March and June 2020.

Trans-Amazon Drilling Project

The Trans-Amazon Drilling Project will address fundamental questions about the geologic and biotic evolution of the Amazon, focusing on (1) how Cenozoic climate and geologic history, including uplift of the Andes and development of the Amazon fluvial system, influenced the origins of the Amazon rainforest and its incomparable biodiversity; and (2) the origin of the Amazonian “Pentecaua” diabase sills, one of Earth’s largest intrusive complexes, and the impacts of this intrusion on the atmospheric gas composition and mass extinction at the Triassic/Jurassic boundary. It is planned to drill the entire Cenozoic sequence (and for two sites also the underlying diabase sequence) in five continental sites in four different ancient sedimentary basins that are aligned along the modern Amazon River and that transect the entire near-equatorial Amazon region of Brazil, from the Andean foreland to the Atlantic Ocean. This transect, coupled with proposed IODP sites on the Amazon continental margin, will encircling nearly 10% of Earth’s equatorial circumference. Spud in of the first well is currently planned for in July 2020.



The Amazon region is target of upcoming ICDP drilling activities. Photo: P. Baker

A Strainmeter Array Along the Alto Tiberina Fault System, Central Italy (STAR)

STAR aims at deploying a STRainmeter ARray in shallow boreholes to monitor slow (aseismic) deformation to address questions about the relationship between creep, slow slip, dynamic earthquake rupture and tectonic faulting at the low-angle normal Alto Tiberina fault (ATF) in the Northern Apennines. Understanding the physics controlling both -seismic and aseismic-slip on a single fault patch, has implications for seismic hazard and risk assessment globally. STAR will consist of six 80-160 m deep vertical boreholes covering the portion of the ATF that exhibits repeated earthquakes at shallow depth (~4 km), instrumented with

strainmeters, downhole seismometers and pressure transducers. Each site will be also equipped with surface GPS and a meteorological instrument allowing correlation between seismicity, degassing (CO₂, Rn) measurements and subsurface strain. STAR will provide the international community an opportunity to study creep at local scale and over periods of minutes to months poorly constrained by other geophysical instruments. STAR drilling is planned to be conducted in summer 2020.

ICDP Workshops

ICDP funds workshops to support groups 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. ICDP also supports post-drilling workshops after completion of the operative work and basic core and sample description for e.g. discussing of initial results and organizing individual sampling. Over the past years, ICDP supported the conduction of workshops with a broad topical spectrum addressing various future drilling projects.

Workshops 2019	Date and Venue	Participants	Countries
Probing the Late Paleozoic Icehouse-Greenhouse Transition (DeepDust)	March 7-10, 2019 Norman, Oklahoma, USA	67	16
Early Mesozoic, Low- to High-Latitude Coring Transect for Environmental, Climatic, Biotic, and Solar System Evolution Normal (CPCP-2)	May 11-14, 2019 St. George, Utah, USA	40	9
Scientific Drilling of Lake Tanganyika	June 17-20, 2019 Dar es Salaam, Tanzania	>70	12
Forthcoming Workshops			
Deep Geothermal Test Borehole, Cornell Campus	January 8-10, 2020, Ithaca, New York, USA	-	-
Paleoclimate, Paleoenvironment, and Paleoecology of Neogene Central America: Bridging Continents and Oceans (NICA-BRIDGE)	March 2-5, 2020 Montelimar, Nicaragua	-	-
Lake Izabal Basin Research Endeavor (LIBRE)	August 2-5, 2020 Antigua, Guatemala	-	-



Participants of the CPCP-2 workshop in St. Georg, Utah.

ICDP Outreach and Training Activities

Journal SCIENTIFIC DRILLING

Two issues (Vol. 25 and Vol. 26) of the IODP-ICDP program journal SCIENTIFIC DRILLING were published 2019 by Copernicus Publications. Publications include four Science Reports, two Progress Reports, one Report on Technical Developments, and five Workshop Reports.



ICDP Training Course

The annual ICDP Training Course focused on Downhole Measurements and was held June 24-28, 2019 in Kuopio and Outokumpu, Finland. Topics were different technical and scientific aspects of downhole measurements and their analysis in scientific drilling, including borehole logging under various conditions and scientific demands, seismic borehole measurements, downhole hydraulic tests, fluid logging & sampling, and fiber optical methods for recording temperature and deformation. 20 candidates from running or upcoming scientific drilling projects were selected based on qualification and need out of 84 applicants, representing 15 ICDP member countries. Lectures in Kuopio and hands-on exercises at the Outokumpu drill site helped to improve knowledge and skills of the attendees.



The ICDP training course on downhole measurements included hands-on exercises at the Outokumpu drill site.

ICDP at conferences

ICDP was presented at the 2019 EGU General Assembly in Vienna with a joint IODP-ICDP booth, Town Hall meeting, and a scientific session. At the 2019 AGU Fall Meeting in San Francisco, a joint Town Hall meeting with CSDCO (Continental Scientific Drilling Coordination Office, Minneapolis, USA) was held and a joint IODP-ICDP booth attracted the attention of AGU participants.

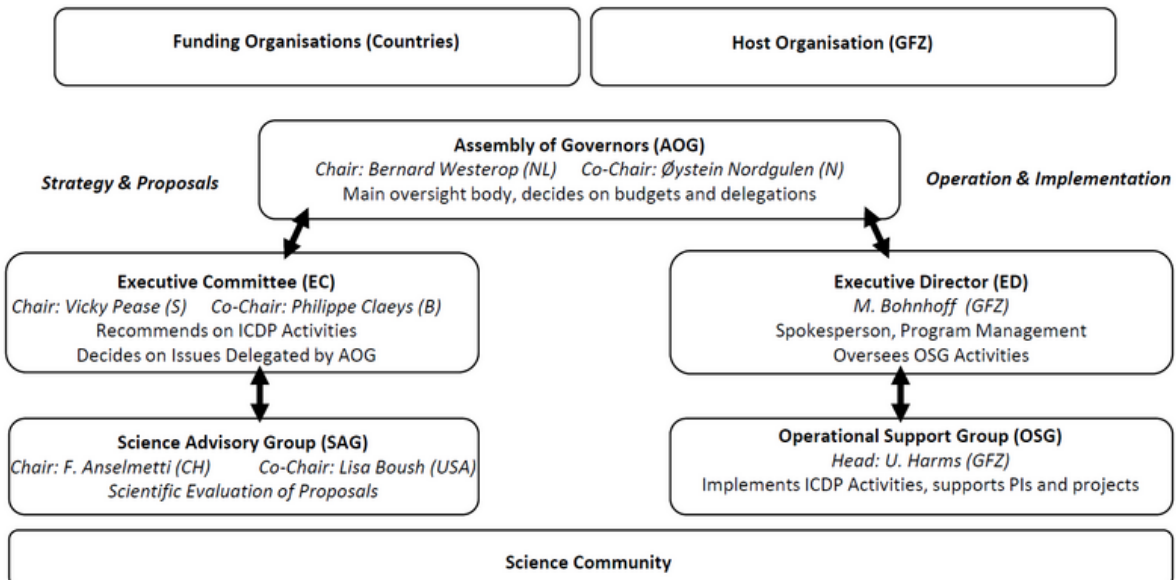
ICDP proposal submission 2019



Eight Full Proposals and ten Workshop and Pre-Proposals were submitted by January 15, 2019. After the submission record in 2018, the number of submitted proposals remained high.

New ICDP structure

In more than 20 years of operations ICDP has maintained the original simple structure with three panels, SAG, EC, AOG, and operational support through the OSG hosted at the GFZ in Potsdam, Germany. After several rounds of panel discussions on adapting the programs structure to growth and changing needs, ICDP's AOG decided upon EC recommendation in May 2019 to separate the scientific evaluation and science policy from program operations and project support. This led to the establishment of an ICDP Executive Director who is overseeing the implementation and all operations. In addition each of the three main panels is now led by a chair and a co-chair with regular rotation to ensure continuity, distribution of duties and broad involvement of several country representatives. The new organigram and the current representatives as established since summer 2019 are shown below.





Introducing mDIS

The Drilling Information System (DIS) is the ICDP data portal for field, lab and sampling data to facilitate data management of drilling projects. A completely new version of the DIS called the mobile DIS (mDIS) was developed in 2018 and 2019. For the first time mDIS is now platform independent and can be utilized from smartphone to desktop devices alike. It is based on open-source components, web-based, and platform-independent. A beta version of mDIS designed for fieldwork was presented to the community at the EGU 2019 General Assembly. First mDIS deployments in the field have been conducted during GRIND and Eger Rift drilling to capture critical datasets of the recovered rock samples, on-site sample requests, and drilling engineering data, together with a unique International Geo Sample Number (IGSN) to ensure a high-quality reference data set available for all science team members of a drilling project. The mDIS version for core repositories will be introduced in 2020.

New personnel in the ICDP Operational Support Group

From mid-February 2019 on, ICDP reinforced its outreach activities with the help of Ursula Heidbach, who has a background in Communication Design and Scientific Outreach. Ursula, who has longtime experience in visualizing scientific projects in the field of Arctic research for the Alfred-Wegener-Institute and climate research at the Potsdam Institute for Climate Studies, will be shaping the ICDP profile with a focus on social media content including the new Science Plan and social media ICDP's media content for the coming two years.

For more than two decades, data management in ICDP has been relying on Ronald Conze, who retired from the OSG by the end of 2019. Furthermore, ICDP project data scientist Tanja Hörner left the Operational Support Group in mid-October 2019. Both are replaced by Cindy Kunkel and Katja Heeschen as new members of the Operational Support Group in charge of data management. Cindy has a background in sedimentology, geothermal data utilization and experience in a scientific deep drilling campaign where she was in charge of the data management using the Drilling Information System. Katja is geochemist with long experience in gas hydrate research and a background in marine drilling.

ICDP Profile

Scientific drilling is an indispensable tool of modern Earth Science research because it provides the only means of obtaining direct information about on-going processes below the surface of the Earth and at depth. Drilling allows determining *in-situ* properties of solid materials and fluids, and permits testing of hypotheses and models derived from surface and remote sensing observations. Drill holes may be used as a natural laboratory for experiments and observatories for long-term monitoring of ongoing active geological, microbiological

processes. Earth drilling, therefore, plays a critical role in scientific research directed towards improving our 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 the geosciences community's need for scientific drilling as an essential tool to achieve 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, comprises an independent science review board and executive and oversight committees. Administrative assistance and substantial operational support are provided voluntarily by the GFZ German Research Centre for Geosciences in Potsdam. Funding is provided by a growing number of member countries, usually through corresponding national funding agencies.

ICDP fosters proposals through international workshops that assist researchers in the development of a drilling proposal. To date, more than 90 of these workshops have been funded and have resulted in a total of 48 ICDP supported and 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 scientists in engineering, on-site science and data management technologies is also an important component of ICDP's strategy to foster the success of ICDP-related drilling proposals. 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 (as per December 31st, 2019) 22 members including 21 countries (namely: Germany, USA, Japan, China, Austria, Norway, Czech Republic, Iceland, Finland, Israel, Italy, South Africa, Spain, Sweden, Switzerland, New Zealand, France, 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 Australia, Brazil, Russia, Turkey, Portugal, Denmark, among others. The GFZ German Research Centre for Geosciences in Potsdam 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, scientific impact and manpower and population of the respective country. The members USA and Germany provide \$1,000,000, Japan \$350,000, while China, France, United Kingdom and India contribute about \$200,000. The smaller European countries contribute amounts between \$30,000 and \$70,000 annually. The ICDP funds are used, for the most part, for co-funding of approved ICDP projects and for executing 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 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, its financing through comingled funding, and the bottom-up project policy, which is relying on unsolicited proposals and thus 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, associated budget and discusses the long-range plans of the ICDP as they are prepared and proposed by the EC.

The Executive Committee (EC) is responsible for the scientific orientation and objectives 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 and multi-year program plan. The EC is made up of one appointee from each ICDP member country and 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 Executive Director (ED) represents the ICDP internationally and has the executive responsibility for carrying out the program. She or he plays a key role as the international spokesperson and ambassador for the ICDP and oversees the OSG during the planning,

implementation and termination of ICDP-supported scientific drilling projects. Another key duty is to translate the program plan into annual and long-range program and budget plans.

The Science Advisory Group (SAG) is an independent body of internationally renowned experts in the research fields covered by the program. Its task is to carry out thorough scientific evaluations of all pre-proposals, full proposals and workshop proposals as they are submitted to the ICDP. The SAG also assigns priority on each proposal based on expected scientific impact, 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 GFZ German Research Centre for Geosciences in Potsdam 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 are based at the GFZ. The OSG serves to support the following functions:

- Providing technical and scientific liaison to SAG and EC
- Developing Joint Research Ventures for each project authorized by the EC
- Managing and supporting the Secretariats for AOG and EC
- Assisting in contracting and permitting
- Supporting scientific and engineering drill-site operations
- Supporting field facility for core and sample description and management
- Providing all data collected during each project through a readily accessible data management system for ICDP projects, the Drilling Information System (DIS)
- Preparing – through ICDP's DIS - Initial Reports that describe drilling, engineering, sample and core description, and also procedures for each project
- Providing training courses in scientific drilling prior to and during drilling projects

- Organizing outreach activities on major international geoconferences (AGU, EGU, IGC)
- Editing the IODP-ICDP journal 'Scientific Drilling'
- Developing, purchasing and maintaining an ICDP Equipment Pool comprising scientific-technical instruments and tools for on-site use during ICDP projects
- Providing management support for individual ICDP projects
- Providing and operating ICDP equipment

Management of ICDP activities at the GFZ takes place by the following personnel:

- Prof. Dr. Marco Bohnhoff (Executive Director)
- Dr. Ulrich Harms (Executive Secretary and Head of the ICDP Operational Support Group).

Credits: Topographic/Bathymetric world map (Page 2) with courtesy from NOAA. All photos by ICDP, if not mentioned otherwise.