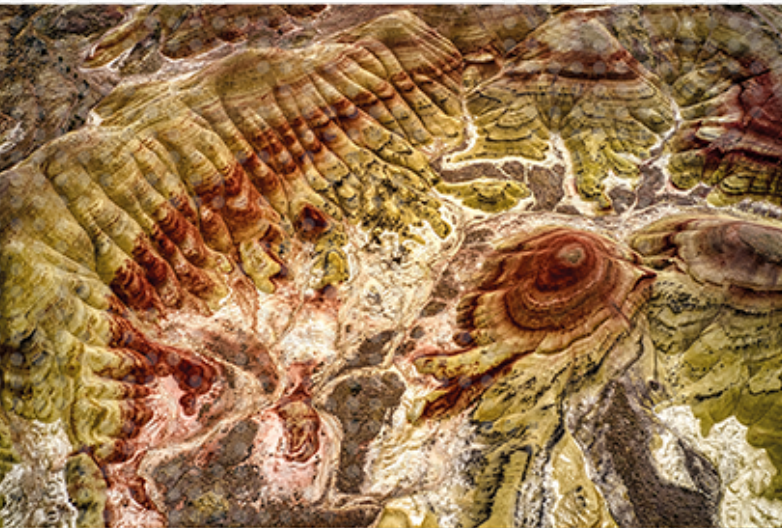


ICDP Status and Future

Status as of December 31st, 2024



ICDP Project with drilling operations in 2024

- Drilling the Ivrea-Verbano ZonE (DIVE)
- Trans Amazon Drilling Project (Trans Amazon)
- Sensitivity of the West Arctic Ice Sheet to 2 Degrees Celsius of Warming (SWAIS2C), to be continued in 2025/26
- Lake Nam Co Drilling project (NamCore)
- Bushveld Drilling Project (BVDP), to be continued in 2025

ICDP Project with drilling operations scheduled for 2025

- Gabon and Oxygenation of Earth - Drilling Early Earth Project (GOE-DEEP)
- Weihe Basin Drilling Project (WBDP), Phase I
- Paleogene Earth Perturbations, U.S. Atlantic Coastal Plain (PEP-US)
- Deep Dust Drilling Project (DeepDUST)

ICDP Workshops

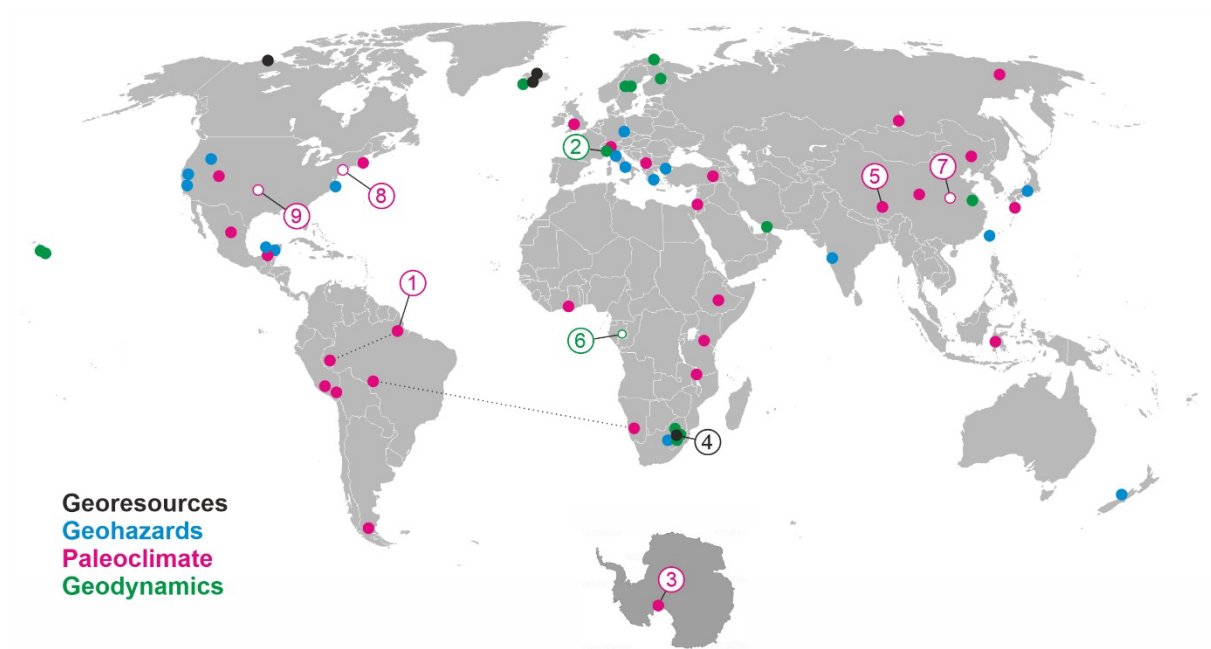
Proposal Submissions 2024

ICDP Lacustrine Sediment Drilling Strategy

Journal SCIENTIFIC DRILLING

ICDP Profile

ICDP Project Schedule 2024/2025



ICDP Projects with drilling operations in 2024

1 Trans Amazon	June 2023 – August 2024	Brazil
2 DIVE	October 2023 – March 2024	Northern Italy
3 SWAIS2C	October 2023 – January 2026	Antarctica
4 Bushveld	May 2024 – July 2025	South Africa
5 NamCore	June – August 2024	P.R. China

ICDP Projects with drilling operations scheduled for 2025

6 GOE-DEEP	June – July 2025	Gabon
7 Weihe Basin	March – November 2025	P.R. China
8 PEP-US	Summer 2025	U.S.A.
9 DeepDUST	Summer 2025	U.S.A.

ICDP Projects with drilling operations in 2024



Trans Amazon Drilling Project TADP

The overarching goals of TADP are to document the evolution of biodiversity of the Amazon ecosystem across most of its entire reach throughout its entire history, and to determine how the geologic processes, such as the uplift of the Andes and the formation of the Amazon River system and basin, has shaped the generation, distribution, and preservation of neotropical biodiversity. Another important objective of TADP is to shed light on the origin of the Amazonian “Pentecaua” diabase sills, a large intrusive complex, and the impacts of this intrusion on the atmospheric gas composition and mass extinction at the Triassic/Jurassic boundary. The two boreholes target the entire Cenozoic sequence into the underlying diabase sequence in 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. One set of cores from the Central Amazonian basin near Manaus provided by the mineral exploration industry was already described and sampled in summer 2022.

The drilling of the first borehole started in June 2023 in the Acre state, the westernmost region of the country. By November 2023, the drilling had reached a depth of 923 meters with overall excellent core quality and core recovery. The second drilling was conducted in the Marajó region between May and September 2024, reaching a final depth of 924 meters.



TADP Project Manager Isaac Salém Bezerra interviewed by a regional TV station.



Drilling the Ivrea Verbano Zone DIVE

The Ivrea Verbano Zone in the Southern Alps (Italy) probably represents the most complete pre-Permian lower crust – upper mantle transition in the world. DIVE aims at accessing and studying the Ivrea Verbano Zone by two ~1000 m deep boreholes in a first (pilot) phase. Scientific drilling includes petrological sampling sections of the lower continental crust and its transition to the upper mantle, geophysical characterization of the crust-mantle transition zone, to study the rheology of continental roots through the distribution of brittle and ductile deformation, and to shed light on the role of the lower crust as a dynamic environment for fluid flow, fluid-rock reactions, volatile cycles, and extreme niches for hosting microbial activities.

Two sites located 8 km apart in the villages of Megolo and Ornavasso within the Ossola Valley were selected to achieve the initial scientific goals and to provide baseline data for deeper drilling in a second phase. Drill site DT-1b, located in the municipality of Ornavasso in Val d'Ossola, was drilled between October and December 2022 and reached its key targets already at 578.5 m depth. Scientific investigations at the site included surface seismic surveys, downhole geophysical logging, gas monitoring, and sampling for deep biosphere studies. Drill site DT-1a (Megolo) started drilling in late October 2023 into pre-Permian mafic lower continental crust to investigate peridotite/pyroxenite-gabbro metasedimentary interfaces and reached its final depth of 909 m by April 2024.



Scientists in front of the final DIVE DT-1b drill core

Sensitivity of the West Arctic Ice Sheet to 2 Degrees Celsius of Warming SWAIS2C

In the last interglacial period, ~125,000 years ago, global temperatures were 1°C warmer than pre-industrial times, similar to what we see today. SWAIS2C aims to determine 1) whether the West Antarctic Ice Sheet has advanced and retreated during the Holocene, a period of relatively stable climate that has characterized the last 10,000 years prior to the industrial revolution and the onset of the Anthropocene, 2) how marine-based ice sheets respond to a world that is 1.5°–2°C and >2°C warmer than pre-industrial times, and 3) the local, regional, and global impacts and consequences of the response of the Antarctic Ice Sheet to this warming. For these purposes, geological ice and sediment records will be taken from the center of West Antarctica by scientific drilling at two different sites on the Ross Ice Shelf.

Mobilization, shipments procedures and site preparation for the drilling season 2024/25 were running according to plan. The sea riser (steel pipe that connects the ice shelf surface to the sea floor and helps support the drill string) was successfully deployed through the 588 m ice shelf and the ocean cavity, reaching the sea floor at a total distance of 632 m. In preparation for HPC (Hydraulic Piston Coring), the drill string was then lowered down the riser. However, after more than halfway through the process of lowering the drill string down the riser, operations were halted due to a serious technical challenge. The issue could not be resolved in the field, and drilling operations at KIS3 have been stopped for the season on December 27. The SWAIS2C team now looks ahead to the next season at Crary Ice Rise, armed with new insights regarding the technological approach.



The SWAIS2C team at the KIS (Kamb Ice Stream) camp in Antarctic Summer 2024/25. Photo: Anthony Powell

Bushveld Drilling Project BVDP



With about 1 million km³ of igneous rocks, the Bushveld Complex in South Africa constitutes by itself a Large Igneous Province that poses first-order questions about how such vast volumes of magma can be generated from the mantle. However, apart from its size, the Bushveld has several other features that make it remarkable. The Bushveld Complex is bimodal in composition, with subequal proportions of mafic and felsic igneous rocks, providing an opportunity to study relationships between mantle and crustal sources of magmatism in detail. The complex also holds an enormous wealth of mineral resources including ores of strategic importance.

Most of the 8 km-thick layered sequence of the Bushveld Complex is below the surface. Mining operations or fortuitous outcrop reveals only parts of the sequence in detail and without vertical continuity. However, understanding how the Bushveld magmas accumulated and crystallized into layers and how ores formed within them, requires studying a continuous vertical sequence including the roof and floor zones. Furthermore, some of the most interesting science topics require techniques or conditions such as oriented core, or fluid and biological sampling, which will be provided by dedicated new scientific drilling boreholes.

The first phase of the Bushveld Complex Drilling Project, BVDP, was launched at the University of the Free State in Bloemfontein in April 2021 with logging and description of a pre-existing 6-km-long drill core section, provided by the company Impala Platinum Ltd as in-kind contribution. This core section covers the upper two-thirds of the 9 km-thick Bushveld layered intrusion. Active drilling began in April 2024, with 1.3 km of an approximately 3 km borehole – that targets the lower section and the base of the intrusion – being completed by the end of 2024.



Drillers lay down the core barrel while the science team waits for the core.

Nam Co Drilling Project NamCore

Nam Co, one of the largest and deepest lakes on the Tibetan Plateau, is located in the modern monsoon regime and, therefore, ideally suited for recording the temporal development of large-scale atmospheric circulation systems. Seismic data clearly show an infill of >700 m of well-layered, undisturbed sediments in the central part of the lake, spanning several glacial/interglacial cycles. Short piston-core sediment accumulation rates for the past 24 ka and seismostratigraphic investigations suggest a lake formation of >1 Ma.

Continuous, high-resolution Nam Co paleoenvironmental records help to 1) fill a paleoclimate data gap between two ICDP/IODP transects that will allow comparisons of climate evolution/behavior on a continental scale, 2) study sediment budget changes under varying climatic and tectonic settings and contribute to a better understanding of the Quaternary geomagnetic field, and 3) better understand the high degree of endemism of high altitude aquatic microorganisms that were dependent on persistent water bodies, which makes Nam Co also a first-class site to study the links between climate and biological evolution within isolated Tibetan Plateau ecosystems. Three months of drilling (May-August) at an altitude of 4.7 km resulted in several boreholes, the deepest one being 510 meters below the lake floor, and an overall core recovery of 84%.



Drilling at Lake Nam Co on the Tibetan Plateau, at an altitude of 4,718 meters above sea level.

ICDP Project with drilling operations scheduled for 2025

Gabon and Oxygenation of Earth - Drilling Early Earth Project (GOE-DEEP)

The GOE-DEEP project aims to expand our understanding of Paleoproterozoic Earth history by drilling a well-preserved archive of Paleoproterozoic sediments in the Franceville Basin in Gabon. This multinational, multidisciplinary initiative will provide a new drill core archive for sedimentology, paleontology, geochronology, and geochemistry studies, helping to resolve uncertainties about ancient geochemical proxy signals and reconstruct environmental conditions. The project focuses on understanding the development of Earth's hydrosphere-atmosphere-biosphere system, the evolution of life, and environmental changes during early Paleoproterozoic time. Key questions include the controls on Proterozoic biogeochemical cycles, the timing of atmospheric and oceanic redox changes, the relevance of meteorite events, and the potential for early eukaryotic life in the region. The project will involve close collaboration with universities in Gabon and other partners and will provide critical data to address these fundamental scientific questions.

Weihe Basin Drilling Project - Mio-Pleistocene Asian hydroclimate variability and dynamics

The Weihe Basin, located in central China, offers a unique opportunity to sample thick, continuous sedimentary layers for studying Cenozoic climate change. These layers provide a terrestrial record of Asian hydroclimate changes, rendering the Weihe basin an ideal location for high-resolution environmental studies. A two-phase international drilling program was proposed to extract these sediments. In Phase I, scheduled for 2025, drilling will focus on the upper 3000 meters, spanning the Late Miocene to Holocene, and Phase II will aim to retrieve the full 7500 meters. Initial pilot cores confirm the presence of fine-grained sediments ideal for studying long-term climate variability and its impact on mountain erosion and basin filling. The project will also explore how the deep biosphere has responded to past environmental changes. This research will create a detailed stratigraphy, chronology, and paleoclimate record, and lay the groundwork for the more extensive/deeper Phase II drilling.

Paleogene Earth Perturbations, U.S. Atlantic Coastal Plain (PEP-US)

PEP-US aims to drill expanded deep-sea sections in the U.S. Coastal Plain to better understand the Paleocene-Eocene Thermal Maximum (PETM) and other Paleogene hyperthermal events, which serve as analogs for modern anthropogenic climate change. The research will focus on thick sections (>10 m) of the PETM and related events in regions where prior drilling has left gaps or insufficient data, such as in New Jersey, Maryland, and Virginia. By analyzing the Marlboro Clay, which has high sedimentation rates, the project aims to assess the speed of carbon release and its relationship with temperature rise and sedimentation changes during the PETM. PEP-US will also study the potential connection between extraterrestrial impacts and

climate change during this period and the biological consequences of PETM. PEP-US will employ state-of-the-art analytical methods and will involve public outreach, training for early-career researchers, and collaboration with government agencies, universities, and museums.

The Deep Dust Drilling Project: Earth-System Responses to the Penultimate Icehouse Collapse and Greenhouse Intensification

DeepDUST seek to constrain paleoclimatic conditions, climate forcings, and biospheric responses through Permian time in a key region of the paleoequatorial zone ranging from sub-millennial to Milankovitch and beyond by acquiring cores in a continental lowland preserving stratigraphically complete records dominated by loess and lacustrine strata, and an adjacent upland. Drilling locations in the U.S. (Anadarko Basin and adjacent Wichita Uplift, Oklahoma) will capture high-resolution continental Permian facies that span the entire Permian, and yoked paleo-uplands preserving hinterland environments. The target sections include evaporite strata housing inclusions that trap Permian surface- and groundwater, enabling exploration of diurnal surface temperatures, atmospheric compositions and— potentially— remnants of the fossil microbial biosphere. In addition, DeepDUST plans exploration of the modern deep microbial biosphere in a region known to harbor complex microbial ecosystems from basinal fluid seeps.

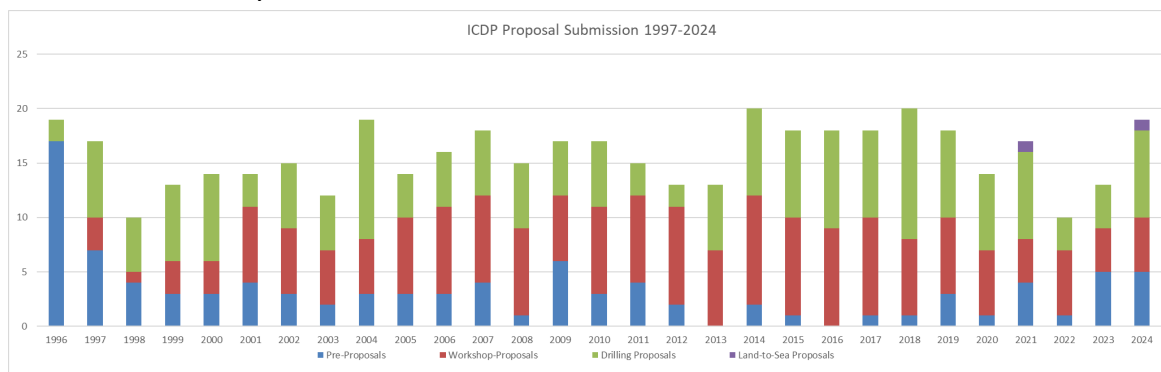
ICDP Workshops

ICDP funds workshops to support groups of international scientists with an outstanding scientific theme of socio-economic relevance at a world-class site that requires continental 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. The following Table summarizes recently held or upcoming ICDP-funded workshops.

Workshops 2024	Date and Venue	Participants	Countries
An urban energy laboratory for monitoring and better understanding of subsurface processes related to low-enthalpy geothermal heat production (UrbEnLab)	June 18-20 in Delft, the Netherlands	76	12
Workshops 2025	Date and Venue		
Middle Jurassic Earth system and Timescale (M-JET)	2–6 June 2025, Figueira da Foz, Portugal		
Probing the Lithosphere Under Samoa (PLUS) to explore hotspot-trench interactions, continental recycling, the deep biosphere, and geothermal resources	12-16 August 2025, Samoa		
Lake Kinneret Drilling: reconstructing Pliocene-Quaternary hydroclimate and seismic history of the Levant	12-15 July 2025, Potsdam, Germany		
ICDP Early Career Researcher workshop “The Next Generation”	25-27 April, Vienna, Austria		

ICDP proposal submission 2024

By the annual deadline of January 15, ICDP received eight Full Proposals, five Workshop Proposals, and six Pre-Proposals, including one Land-to-Sea proposal. The high number of Full Proposals underlines that the lingering effects of the COVID-19 pandemic, including limited opportunities to hold workshops and develop new project ideas and collaborative studies, such as on-site surveys, have been overcome.



ICDP Training Course 2024

An annual ICDP Training Course was held from May 13-17 at the 'Geozentrum an der KTB' in Windischeschenbach, Germany. The course was attended by 25 participants, primarily Early-Career Scientists. It featured a combination of lectures and practical exercises in various aspects of scientific drilling.



Journal SCIENTIFIC DRILLING

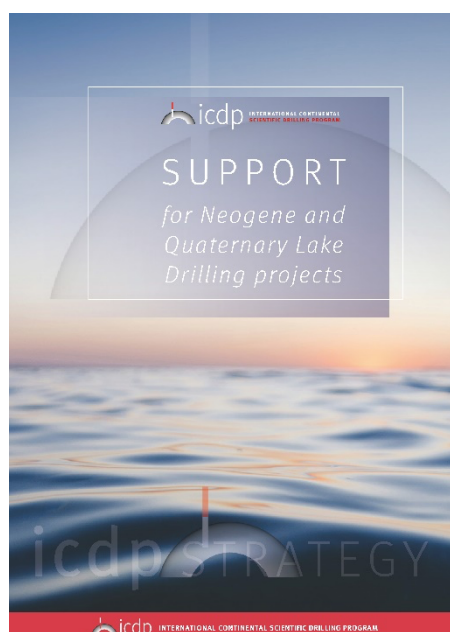
The open access ICDP-IODP program journal SCIENTIFIC DRILLING serves to communicate developments from current projects as well as workshop reports and announcements for future scientific-drilling related activities. SCIENTIFIC DRILLING is currently listed with an impact factor of 1.6 in Clarivate Analytics' Web of Science.

SCIENTIFIC DRILLING is published on behalf of ICDP by Copernicus Publications, in collaboration with the International Ocean Discovery Program (IODP), now: International Ocean Drilling Program (IODP³). Due to a shift in the publication model towards a purely online format, SD volume 33 has been split into two issues. The March 2024 Volume 33, Issue 1, featuring six papers, was the final issue to include a printed version. Issue 2, currently comprising seven papers, is scheduled for publication in January 2025.



SCIENTIFIC DRILLING volume 32 and 33 (issue 1)

ICDP Lake Drilling Strategy



Driven by an increasing number of ICDP proposals targeting lacustrine sediments over the past few years, a task force of key scientists and ICDP representatives developed guidelines to identify and prioritize current knowledge gaps in environmental change from lake drilling and to define funding strategies for future ICDP lake drilling. The guidelines have been published in a document that should help PIs streamline their ICDP proposals on lake drilling research (www.icdp-online.org/downloads/white-paper).

ICDP Program

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 its foundation in 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 contribution, 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 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 ICDP workshops have been funded and have resulted in 61 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.

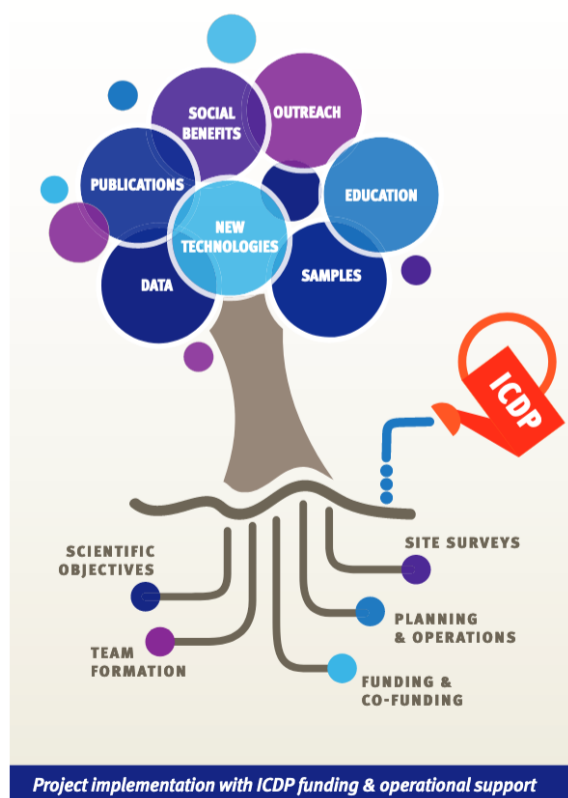
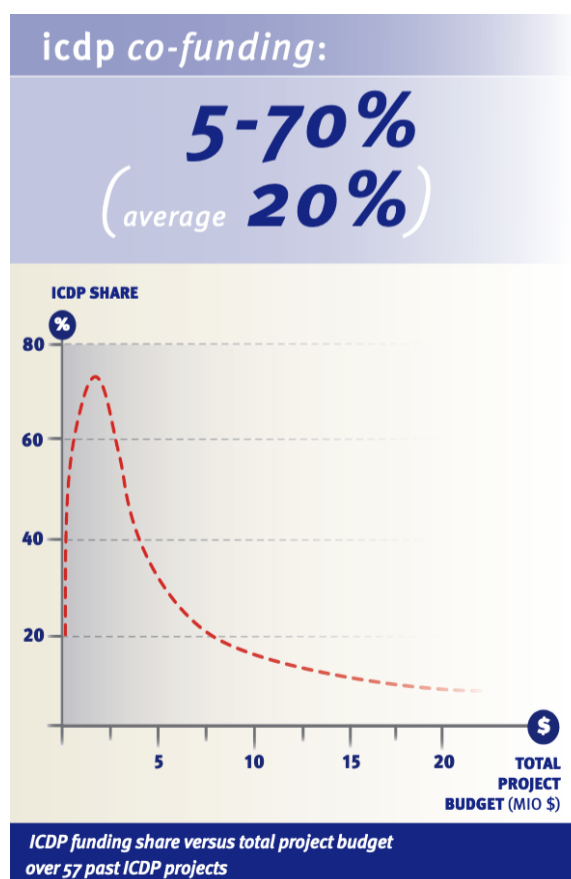
Global Partners

ICDP currently has (as per December 31, 2024) 23 members including 22 countries (Austria, Australia, Belgium, China, Estonia, Finland, France, Germany, Iceland, India, Israel, Italy, Japan, The Netherlands, New Zealand, Norway, South Africa, Spain, Sweden, Switzerland, United Kingdom, USA) plus UNESCO as corporate member organization. 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), 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 world-unique drilling locations (“World Class 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 are negotiated between new members and ICDP and vary, based on a number of criteria that include economic factors, scientific impact, manpower and population of the respective country. Low-income developing countries can become ICDP member under the UNESCO membership umbrella.



The ICDP funds are, for the most part, used 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 which includes 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 – after an in-depth scientific and strategic evaluation – provides partial funding of a project that then typically serves as a door opener for acquiring matching funds. 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.

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 to attract 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 relies on unsolicited proposals and thus drives the program at large, serves 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 are typically science managers with expertise in drilling and/or coordination of major research projects.

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 to 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



Left: ICDP Executive Director Marco Bohnhoff. Right: Members of the ICDP Operational Support Group.

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 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 a group of six scientists, engineers and technicians from its own budget 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

Uli Harms, who served as the Head of the ICDP Operational Support Group for many years, handed over the leadership of the OSG to his successor, Thomas Wiersberg, in May 2024. Uli Harms will remain with ICDP as Liaison Officer.

Management of ICDP activities at the GFZ is conducted by the following personnel:

- Prof. Dr. Marco Bohnhoff (Executive Director)
- Dr. Thomas Wiersberg (Executive Secretary, Head of the ICDP Operational Support Group).

