

ICDP Status and Future

Status as of January 2024



ICDP Project Schedule 2023/2024

ICDP Project with drilling operations in 2023

- Trans Amazon Drilling Project (Trans Amazon), to be continued in 2024
- Drilling the Ivrea-Verbano Zone (DIVE), to be continued in 2024
- Sensitivity of the West Arctic Ice Sheet to 2 Degrees Celsius of Warming (SWAIS2C), to be continued in 2024

ICDP Projects with scheduled drilling operations for 2024

- Bushveld Drilling Project (BVDP)
- Nam Co Drilling project (Nam-Core)

ICDP Conference

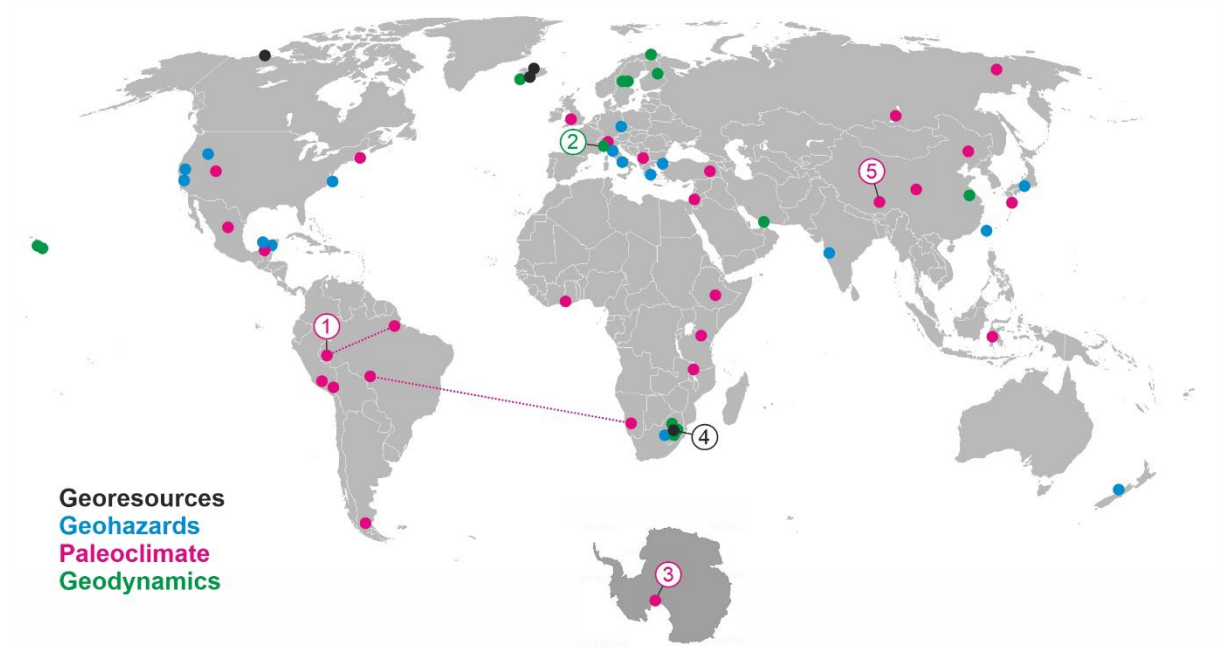
ICDP Workshops

Proposal Submissions 2023

Journal SCIENTIFIC DRILLING

ICDP Profile

ICDP Project Schedule 2023/2024



ICDP Projects with drilling operations in 2023

1 Trans Amazon	June 2023 – June 2024	Brazil
2 DIVE	October 2023 – March 2024	Northern Italy
3 SWAIS2C	October - December 2023	Antarctica

ICDP Projects scheduled for 2024

4 Bushveld	February – December 2024	South Africa
5 NamCore	June – August 2024	Germany

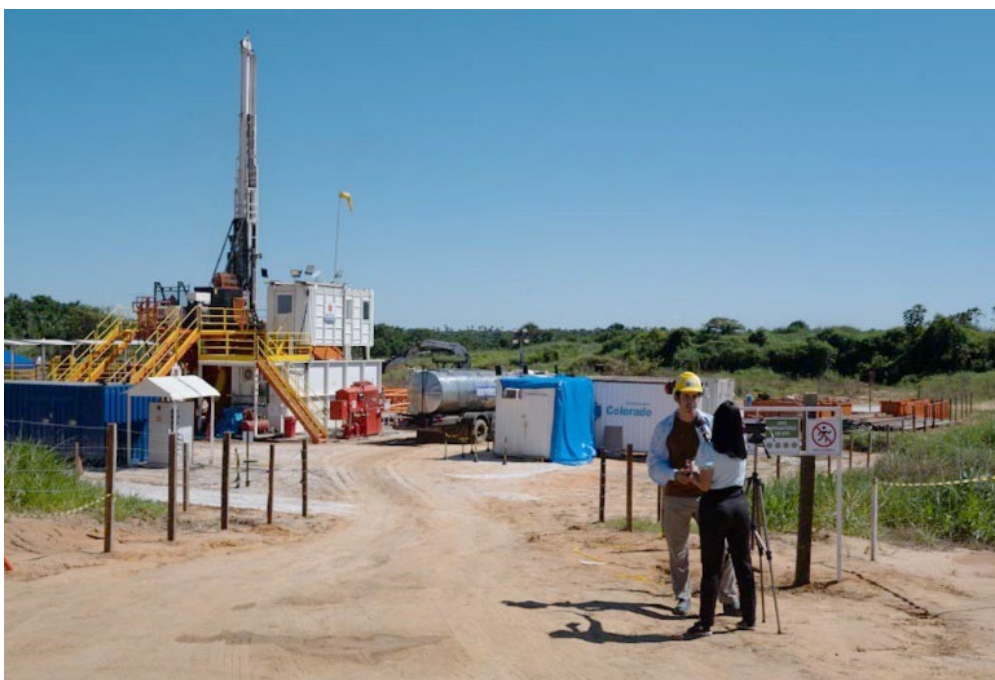
ICDP Projects with drilling operations in 2023



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, 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.

The project started with drilling the first of two boreholes in June 2023 in the Arce region in the extreme west of Brazil. It is planned to drill the entire Cenozoic sequence into the underlying diabase sequence at this and one other site, 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. In November 2023, the drilling reached a depth of 923 meters with overall excellent core quality and core recovery. For technical reason, it was decided in December 2023 to finish drilling and complete the borehole at this depth and demobilize the drilling equipment. Drilling at the second TADP drill site in northern Brazil (Pará) is scheduled for 2024.



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 initial scientific goals and 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 into pre-Permian mafic lower continental crust to investigate peridotite/pyroxenite-gabbro metasedimentary interfaces in late October 2023 and reached 315 m depth by the end of the year. Drilling was planned to resume in January 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, 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 are 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 were running according to plan and hot water drilling started on December 18. Hot water drilling through ~580 m of ice at Kamb Ice Stream went exceptionally well. Underneath this ice is 55 m of sea lying between the ice and the seafloor, composed of ancient layers of mud and rock. A total of eight gravity cores and three hammer cores, containing a total 7.6 m of sediment, could be retrieved from the seafloor. On December 23rd, operations were halt due to technical challenges after ~80 m of drill string, including the heavy steel bottom hole assembly and many lengths of sea riser made of glass reinforced epoxy, have been deployed. Drilling will resume in the Arctic Summer 2024/25. At the second site, Crary Ice Rise, the shelf ice sits directly on the seafloor and is more than 500 meters thick. Here it is planned to drill through both ice and the Antarctic continent itself to recover sediment cores. Drilling at these different sites allows to compare how the ice shelf behaves in different temperatures.



The SWAIS2C team at the KIS (Kamb Ice Stream) camp.

ICDP Projects scheduled for 2024



Bushveld Drilling Project (BVDP)

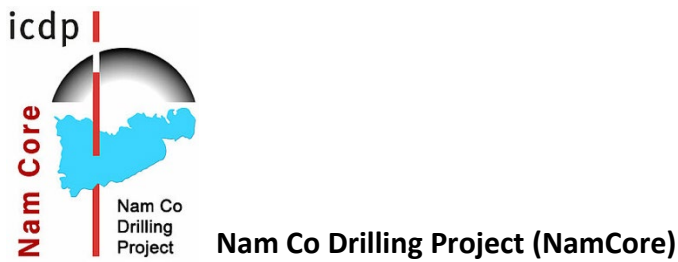
With about 1 million km³ of igneous rocks, the Bushveld Complex in South Africa by itself constitutes a Large Igneous Province that poses first-order questions about how such vast volumes of magma can be generated from the mantle. However, apart from its size, the Bushveld has several other features 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 drillcore 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. BVDP plans drilling approximately 3 km through the lower section of the intrusion and through the base of the intrusion in March 2024.



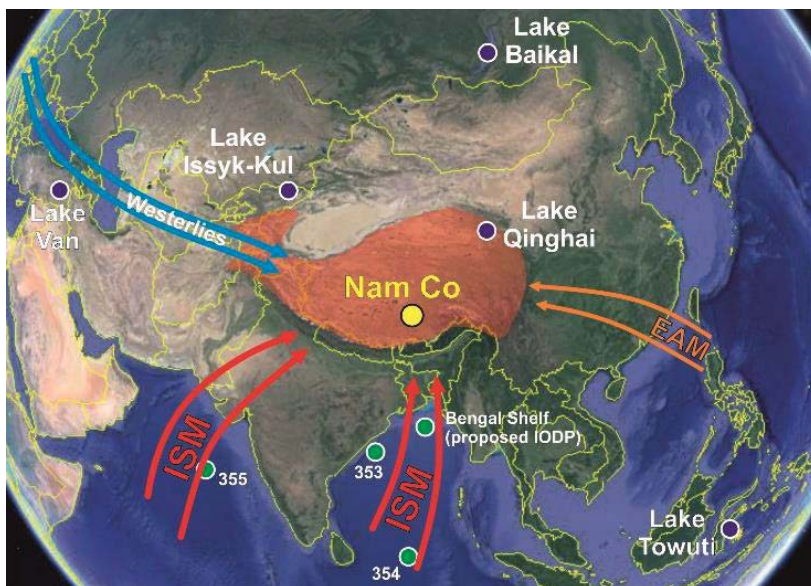
Marking and logging drill cores from the Bushveld Complex Main Zone. Photo: J. Magson, University of the Free State, South Africa.



Nam Co, one of the largest and deepest lakes on the Tibetan Plateau, is located in the modern monsoon regime and, due to its location, 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 are capable to 1) fill a paleoclimate data gap between two ICDP/IODP transects that will allow comparisons of climate evolution/behaviour on a continental scale, 2) to study sediment budget changes under varying climatic and tectonic settings and contribute to a better understanding of the Quaternary geomagnetic field, and 3) to 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.

Drilling at Nam Co is foreseen for summer 2024.



Strategic location of Nam Co on the Tibetan Plateau (orange), with respect to further potential and drilled ICDP/IODP sites. ISM: Indian Summer Monsoon, EAM: East Asian Monsoon. Map: Google Earth.

ICDP Workshops

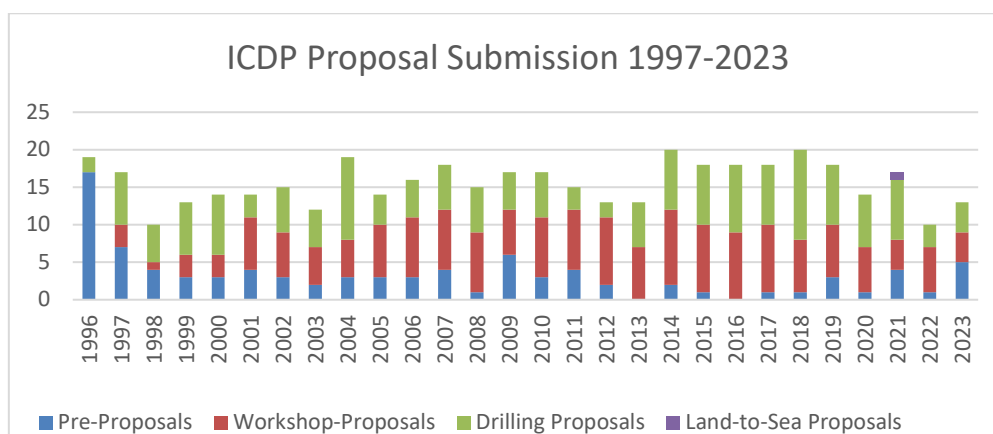
ICDP funds workshops to support groups of international scientists with an outstanding scientific theme of socio-economic relevance that requires continental drilling. The workshops serve to form a broad and competent Science Team and to develop full drilling proposals to ICDP and other co-funding agencies or industry. 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.

The following Table summarizes recently held or upcoming ICDP-funded workshops.

Workshops 2023	Date and Venue	Participants	Countries
Connections Among Life, geo-Dynamics and Eruptions in a Rifting Arc caldera (CALDERA)	24-27 January 2023, Tauranga, New Zealand	65	15
Drilling an alkaline-carbonatite complex to understand how fluid-rock interaction influences rare earth element mineralisation, groundwater and deep life (REEDRILL)	22-26 May 2023, Zomba, Malawi	49	10
The Fucino sedimentary succession recording five Million years the Earth system history (MEME)	24 -27 October 2023 in Gioia dei Marsi (Italy)	32	10
Fiordland Assessment of Climate, Environment and Tectonics (FACET)	August 27-September 2, Aotearoa, New Zealand	33	10
Afar Dallol Drilling (ADD-ON)	28-31 August, Addis Ababa, Ethiopia	70	13
Follow the CO2 - Drilling into an actively degassing intraplate volcano underlain by a silicic-carbonatitic intrusion (EIFEL)	4 - 6 December, Bad Honnef, Germany	77	10
Workshops 2024	Date and Venue		
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	--	--

ICDP proposal submission 2023

Four Full Proposals, four Workshop Proposals and five Pre-Proposals were submitted to ICDP by the annual deadline January 15, 2023. The corona pandemic and the resulting limited opportunities to conduct workshops and conceptualize new project ideas and joint studies, such as on-site surveys still having an impact and were the reason for the still comparatively low number of full proposals.



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. After 18 years, SCIENTIFIC DRILLING has finally been listed with an impact factor (1.2) in Clarivate Analytics' Web of Science in June 2023, which resulted in a significant increase in the number of articles submitted in the second half of 2023.

SCIENTIFIC DRILLING Vol. 32 includes nine papers and was published October on behalf of ICDP by Copernicus Publications, jointly issued with the International Ocean Discovery Program IODP.



SCIENTIFIC DRILLING volume 32 was published in October 2023

ICDP 25⁺² years International Continental Drilling Program

The IV. International Conference of Continental Scientific Drilling "ICDP in the Second Quarter of its First Century" was convened at the German Research Center for Geosciences GFZ in Potsdam, Germany, July 21-23, 2023. The conference highlighted achievements of the past years and discussed the scientific outlook and the organization of our program, which included

- 1) actions to implement the objectives defined in the ICDP Science Plan 2020-2030,
- 2) strengthening and expanding ties among member countries and partner organizations,
- 3) initiating new measures for a better integration and involvement of early-career researchers in ICDP.

139 invited attendees from 23 countries took part representing the entire range of Earth science disciplines and career stages, including PIs of completed, ongoing and future ICDP drilling projects, members of ICDP panels, representatives from partner organizations and funding agencies, as well as 30 international early-career researchers.

The conference program was divided into nine sessions with a mixture of contributions on the four core research themes of the ICDP (Geodynamics, Geohazards, Georesources, Environmental Change) with outlines of achievements and short presentations on new plans and projects, as well as five 'cross-topics' on the future organizational direction of the ICDP, funding of major drilling projects, organization of operational support, major new research initiatives related to ICDP, and outreach activities with a focus on early-career researchers.

The recommendations of the conference discussions have been compiled and critical suggestions such as improving involvement of early career scientists will be considered and decided on at the 2024 ICDP board meetings.



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 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 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 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 almost 60 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.

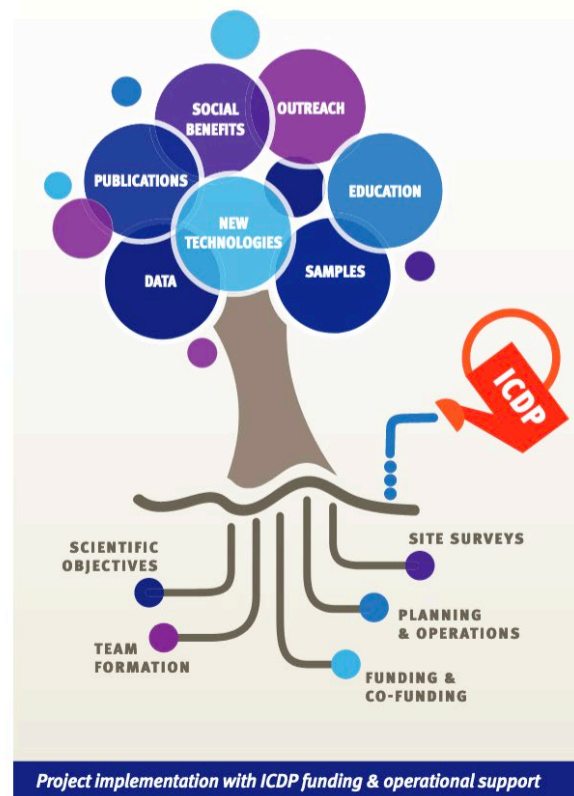
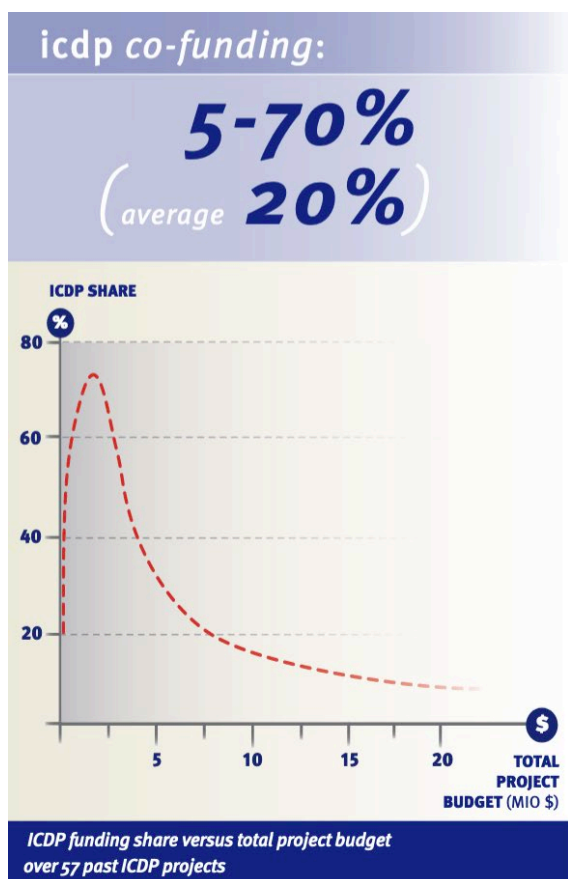
Global Partners

ICDP currently has (as per December 31st, 2023) 23 members including 22 countries (Austria, Belgium, China, Czech Republic, Estonia, Finland, France, Germany, Iceland, India, Israel, Italy, Japan, The Netherlands, New Zealand, Norway, South Africa, Spain, Sweden, Switzerland, United Kingdom, USA), and, in addition, 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), 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 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 commingled 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 commingled 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

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

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

