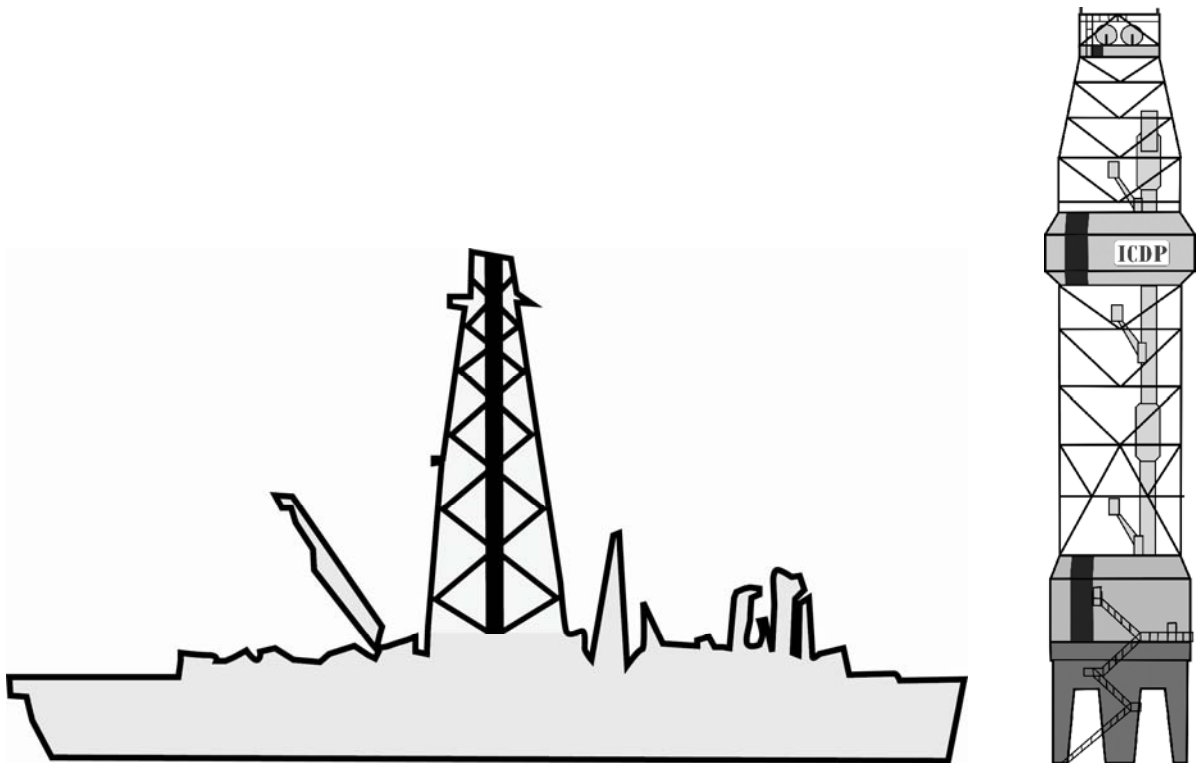


Framework of a German Scientific Earth Probing Consortium (GESEP)



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German Scientific Earth Probing Consortium (GESEP)

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Abstract

Modern geosciences increasingly require data and samples from the deep earth. Another focus is the installation of in-situ observatories as well as laboratories in the upper earth's crust. German geoscientists from universities and other research institutes are therefore participating in a wide range of drilling programs and cover many areas of expertise in scientific earth probing. They participate in developing new drilling technologies and in the experimental exploitation of the geological properties of drillholes. A task force of the "Senate Commission on Collaborative Research in Geoscience" (Senatskommission für Geowissenschaftliche Gemeinschaftsforschung) now proposes to focus the national research efforts in this field. Long-term international leadership will be secured through pooling the existing potential and expertise, but preserving the dispersed, local activities related to scientific earth probing housed in many institutions of higher education or research throughout Germany. Many groups of specialists with their sophisticated instrumentation could optimize their efforts through a small but efficient support unit.

This can be achieved through the foundation of the „**German Scientific Earth Probing Consortium (GESEP)**“, which will be supported through the membership of all interested institutions in- and outside of universities. By paying a modest membership fee, the GESEP will promote the general interests of the German earth probing community through an office located at Potsdam, which would have the following tasks:

- Generate a national and international information platform
- contribute to the technical coordination of major drilling programs (ICDP, IODP, EPICA, others)
- coordination and structuring of the planning phase of drilling projects
- coordination of site surveys
- professional assistance for the preparation of drilling proposals
- support the development of new instrumentation and technologies
- develop and coordinate systematic teaching programs in deep-earth probing
- initiate partnerships with the industry
- develop a program of outreach and training.

The GESEP will operate with only few employees and benefit from the cooperation of staff members of the collaborating member institutions.

Zusammenfassung

Die modernen Geowissenschaften verarbeiten zunehmend Daten und Proben aus dem tiefen Untergrund. Sie installieren verstärkt Observatorien und Laboratorien in der oberen Erdkruste. Zahlreiche deutsche Wissenschaftler aus universitären und außeruniversitären Institutionen sind in einem breiten Spektrum von Bohrprogrammen tätig und decken eine breite Expertise im Bereich des wissenschaftlichen Bohrens ab. Sie nehmen an der Entwicklung neuartiger Bohrtechnologien sowie an der experimentellen Nutzung der Bohrlöcher teil. Eine Task Force der Senatskommission für Geowissenschaftliche Gemeinschaftsforschung der Deutschen Forschungsge-

meinschaft (Geokommission) schlägt daher vor, die nationalen Bestrebungen in diesem Forschungsbereich zu fokussieren und dadurch die internationale Führungsrolle der deutschen Geowissenschaften langfristig zu sichern. Durch Bündelung des vorhandenen Potentials und der Expertise bei gleichzeitiger Wahrung der verteilten Kompetenzen, welche an Hochschulen und Forschungseinrichtungen vorhanden sind, kann dieses Ziel erreicht werden. Zahlreiche Arbeitsgruppen können von einer kleinen, aber leistungsfähigen Organisation profitieren. Dies kann durch ein Konsortium erreicht werden (German Scientific Earth Probing Consortium, GESEP), welches durch Mitgliedschaften der beteiligten Organisationen finanziert werden könnte. Gegen geringe Beiträge solle das GESEP die gemeinsamen Interessen der deutschen Geowissenschaften vertreten.

Aufgaben des Konsortiums:

- Aufbau einer nationalen Informationsplattform
- Unterstützung der internationalen Bohrprogramme (ICDP, IODP, EPICA, u.a.)
- Außendarstellung der deutschen Bohraktivitäten, der Bohr- und Forschungsprogramme
- Strukturierung und Koordination der Planungsphasen diverser Bohrvorhaben
- Koordination und Durchführung von Voruntersuchungen
- Fachliche Begleitung und Beratung der Antragsteller
- Unterstützung bei der Einführung technischer Neuentwicklungen und Innovationen
- Ausarbeitung systematischer Fortbildungsprogramme im Bereich Bohren
- Ausbau der Industriekooperationen.

Das GESEP Konsortium wird ein geringes Personalvolumen haben und auf die Tatkraft von Mitarbeitern der beteiligten Institutionen aufbauen.

1. Preamble

Modern geosciences increasingly require data, samples and space for in-situ laboratories from and in the upper layers of the earth's crust. German geoscientists therefore became internationally involved at an early stage in the DSDP, ODP and IODP; building on the success of KTB, some of the founders of ICDP came from German research institutions. Numerous concurrent national initiatives led to the development of substantial pools of expertise in scientific earth probing, both in the technology of drilling and logging as well as in using wells as subsurface laboratories. These technologies will be indispensable in future geoscientific research; they are subject to rapid development, and costly when being developed and used.

It is clear that substantial pools of technical and analytical expertise for deep-earth probing exist in the exploration industry for non-living earth resources in their broadest sense, as well as in the commercial design and construction of subterranean buildings (tunnels, etc.). Although a close cooperation with industry opens many possibilities for joint efforts, it is also clear that many of the commercial efforts use equipment or methods which go far beyond the means, qualifications and possibilities of the geoscientific research groups at universities and at most publicly funded non-university based institutions. This proposal therefore mainly addresses the needs of basic geoscientific research, even though - wherever possible - a close cooperation with industry should be proactively pursued.

If the German geoscientific research community wants to maintain a focused national research effort in deep-earth probing and simultaneously secure international leadership, it seems important to pool the existing potential and expertise, while at the same time preserving the disperse local groups of specialists with their sophisticated instrumentation.

Ways to achieve these goals have been discussed several times in the "Senate Commission on Collaborative Research in Geoscience" of the German Research Foundation (DFG) and its subsidiary "Working Group for Scientific Drilling", resulting in this investigation about the possibilities and the potential to establish a dedicated "German Scientific Earth Probing Consortium (GESEP)".

2. Motivation

The DFG supports the participation of individual scientists and groups in IODP and ICDP through special dedicated funding schemes ("Priority Programme"). The formal memberships in ICDP and IODP, which are supported directly or indirectly through the DFG and the Federal Ministry of Education and Research (BMBF), provide the indispensable base for this participation. At several of the jointly organized annual European or national workshops, it became clear that the future perspectives of these efforts could be improved by "amphibian" approaches, linking phenomena of continental and oceanic lithosphere together. This approach could be greatly enhanced through pooling some, if not all of the technical expertise in one location.

It is now clear that modern geosciences frequently need to probe the subsurface layers of the earth's crust on a wide scale of subsurface depths, both on land and in the sea. Capacities and qualifications in probing subsurface layers have therefore been developed at many locations and under a variety of organizational and financial schemes. For the individual researcher, it is not always easy to collect information about access requirements and conditions of existing facilities, and it therefore seems desirable to generate one central point for information and regulations. Deep-earth probing is also methodologically under rapid development; to transfer the knowledge and legacy of these capabilities, we need increased efforts to attract a new generation of geoscientists and to provide them with the proper training, which could be organized through a systematic training program. Furthermore, exploration into the mysteries of the earth's interior attracts great public interest; and, considering the public funding of these activities, it seems mandatory to organize professional public outreach programs. These requirements clearly go far beyond the capabilities of any of the smaller groups and seriously suggest the foundation of a particular organization where expertise and qualifications are gathered and from where the individual players can utilize common resources.

Besides participation in both large international programs of deep-earth probing (ICDP, IODP), which is open to any qualified applicant, expertise in drilling technologies and scientific exploitation of shallow and deep drillholes exists in many German geoscientific research groups, which are usually closely linked to international partners. They are described in detail further below.

3. Mission

This working group has recognized that scientific earth probing is an indispensable and essential element of modern geosciences and deals with the following challenges:

- compile the scientific and technical requirements of modern earth probing
- support deep-drilling activities in both planning and subsequent stages
- encourage existing and future potentials of earth probing in Germany
- explore the possibilities to found a modern “Scientific Earth Probing Consortium” with the aim to further develop relevant activities in Germany, whilst maintaining the diversity of locally available scientific and technical capabilities.

4. Major Scientific Themes

The scientific perspectives of earth probing have been described in many scientific reports such as IODP, ICDP, EPICA, etc.. We have thus selected only a few examples which were tailored to German expertise:

History of the Global Environment

The modern climate and the real-time changes of the global environment can only be understood through a thorough knowledge of their past dynamics. Owing to the successful recovery of long and undisturbed sample sequences from ocean and lake

sediments (sediment cores) as well as from the existing remnants of the glacial ice sheets (ice cores), paleoclimate and paleoceanography studies have achieved progress far beyond their expectations. However, many locations within the world oceans, as well as lakes and the oldest ice of the Antarctic ice sheet, will require the continuation of existing drilling programs for many years to come. Furthermore, development of new technology may also require the extension of drilling programs.

Modern and Ancient Geodynamics

While modern geophysics has generated data for all layers of the solid earth, sampling has been restricted to the upper 12 km on the continents and the upper 2 km in the oceans. We urgently need deeper cores to verify the geophysical data through geological samples, and we need new drillholes in geological high-risk localities, which have remained unsampled hitherto. Large concentrations of human population are clustering around some of the geodynamically most active regions of the world. Sampling and monitoring of deeper layers of geologically active localities, such as volcanoes (eruptions) and earthquake-prone fault zones, will help us to reduce fatalities in the case of natural disasters.

Deep Biosphere

The discovery of a more than 1 km thick subsurface layer hosting microbial biotas represents one of the most fascinating results of deep-drilling in the oceans. Most of these organisms are unknown, but may also represent a new resource for natural resources. They are adapted to live under extreme conditions (pressure, temperature, chemical environment), and at present we have only scratched the surface of these habitats. Water is also found in deeper (>10 km) layers of the continental crust, and the presence of a much deeper biosphere has yet to be examined. This would require sterile deep-drilling technologies. Several saline lakes resemble the exotic chemical conditions of Precambrian oceans (e.g. Lake Van, Turkey). Probing the deep biosphere of such environments is one of the deep-drilling challenges.

Deep Earth Observatories

The development of continental and marine drilling techniques has not only helped us to look for new resources, samples, and data, but also to install numerous subsurface instruments to monitor the behavior of the earth's interior. Mid-ocean ridges, continental margins and the continental interiors will increasingly be fitted with instruments to help fulfill our needs for real-time data regarding ongoing subsurface processes and controlling-mechanisms. Over the past few decades, deep-earth observatories have been developed and installed in numerous drillholes to monitor geodynamics and fluid / gas flow in real time. Modern tunnels cross the "roots" of mountain chains (e.g. the Alps) and give us access to observe and monitor the dynamics of young mountain chains, with the aims both to understand the processes of mountain building as well as to provide safety for people using new traffic routes.

Energy and Resources

Energy demands of mankind are on the increase, while the conventional earth energy resources are dwindling. Commercially viable geothermal energy has yet to be developed at many locations and requires large drilling efforts over the coming decades. In Germany, the necessary technology is still in its infancy even though the geological conditions seem to be favorable in several locations. This requires substantial exploratory drilling and hydraulic stimulation.

Probing the Unknown

There are many unknown drilling targets both on earth and on extraterrestrial bodies. The large subglacial lakes and their microbial floras under the Antarctic ice sheet have yet to be probed. It would require the development of sterile drilling technologies, which can potentially also be deployed from space probes (e.g. sampling the ice cover of the Europa-moon). The geology and hydrology under the large continent-based ice sheets is completely unknown and has to be explored through novel probes. The continental crust under the remnants of the glacial ice sheets on Greenland and Antarctica represent the largest almost completely unknown geological provinces on earth, which wait to be sampled because the ice drilling technology does not yet permit it.

5. Data Banks and Technologies in Germany

5.1. Data Banks

In order to ensure sustainable and long-term availability of all data with related meta-information resulting from scientific drilling, an information system will be an integral part of the service of the German Scientific Earth Probing (GESEP) Consortium. A data management and implementation plan will define the flow from PI (principal investigator) to the archive, ending in a publication of the data as intrinsic part of scientific achievements and public outreach. A data policy is set up in agreement with the scientific community and funding organizations in order to advise responsibilities for quality and handling, availability and distribution. A data curator will provide the link between science and data library and will be responsible for a well established data flow and synchronization of data, as well as archiving and proof-reading of the data.

In Germany, an operational information system is available for data resulting from scientific drilling. It is based on technology which has been developed over more than a decade by major earth-system research institutions. This system, PANGAEA (www.pangaea.de), is aimed at archiving, distributing and publishing geo-referenced data related to basic research on the earth system and is in use by recent international drilling projects (Cape Roberts Project, ANDRILL, EPICA, IODP). The system is operated according to the principles of Open (and free) Access as a public library, providing long-term reliable access and a proper bibliographic citation of data entities. Citations include a persistent identifier (DOI) and are mirrored to library catalogues. A common geological time scale as an integral part of the data model enables the system to also act as a scientific tool for geologists, e.g. to combine indi-

vidual records from different sites. Scientific data are archived in a consistent format together with meta-information in a relational database and can be retrieved through a search engine, various access clients, and web services. Data are provided in several standard formats following OAI (<http://www.openarchives.org>) recommendations and ISO/OGC standards and can thus be accessed through any geoscientific portal, e.g. GeoPortal.Bund (<http://geoportal.bkg.bund.de>). Technical operation of the system is guaranteed through the long-term commitments by research centers of the Helmholtz Association and by the German Research Foundation.

5.2. Site Surveys

Earth probing requires a careful choice of drilling locations satisfying the scientific goals to be achieved. To identify suitable site locations, an extensive pre-site survey is needed. A pre-site survey provides detailed information on the structure of the subsurface, including stratification of the sequences, faults, and depths of interfaces well beyond the drill target. This is important to avoid problems during drilling which may cause hazards (e.g. fluid/gas outbursts). The following data need to be collected by such surveys: multichannel seismic reflection (MCS) data with cross lines across the proposed sites, seismic velocities from MCS or seismic refraction data, and bathymetric data.

Several German institutions have built-up expertise with respect to the generation of site survey data. AWI, BGR and the Universities of Bremen and Hamburg have collected detailed MCS and bathymetric data and put forward seismic velocity information on a number of previously drilled ODP Legs (e.g. Legs 175 and 177), IODP Expeditions (Exp. 302, ACEX) and proposed IODP (e.g. Argentine Basin, Fram Strait, Agulhas Leakage) and ICDP (e.g. Lake El'gygytgyn) campaigns. These data have been collected with 3 km long streamer systems, various airgun clusters, ocean bottom seismometers, and sonobuoy as well as the Parasound echosounding system and the multibeam systems Hydrosweep and Simrad. Different German (FS Meteor, FS Sonne, FS Polarstern) and international research vessels as well as smaller boats and rafts were used for data acquisition. The German institutions involved in such site surveys share their expertise in both processing and interpretation of the data and have prepared the data needed for the drilling community. To ensure this high standard of site surveys, platforms for the data acquisition have to be made available. An exchange of the data via a suitable data bank will be needed.

5.3. Earth Probing

5.3.1 Continental Drilling

A broad national and international scientific drilling and coring expertise has been established in Germany from a variety of land-based and lake-drilling expeditions. Usually, these continental scientific drilling projects use rotary drilling techniques, often in combination with wireline diamond coring, either with specially developed wireline coring equipment in 159 mm diameter or with slimline core drilling ranging from 60 to 123 mm. Standard directional drilling and reaming in oilfield diameters can sometimes include spot coring with conventional oilfield-coring techniques, while wireline coring is used where continuous coring with high core recovery is the prime scientific drilling objective.

Scientific tasks and budgetary limitations in research projects often require the application of existing and relatively inexpensive drilling technologies such as rotary drilling. However, they also require the integration of newly developed specific techniques, e.g. in the field of coring or long-term downhole instrumentation. A well known example of such integration of newly developed tools with pre-existing ones is the Continental Deep Drilling Project of Germany (KTB), where standard-rotary and hole-opening drilling was extended with a completely new vertical drilling technique at unprecedented temperatures and pressures as well as with new spot coring techniques. Other examples are the combination of rotary drilling with slimline wireline coring in the ICDP projects at the Chicxulub crater in Mexico, the Hawaii Drilling Project, and the Long Valley drilling in California, or the rotary drilling combined with high-end logging-while-drilling techniques during directional drilling at the San Andreas Fault Zone Drilling Project in California (SAFOD). Furthermore, a special wireline coring string for 159 mm holes and providing 94 mm diameter cores was employed in the ICDP projects Dabie-Sulu in China and the Gulf of Corinth drilling.

Innova Rig

The „InnovaRig“ of the GFZ Potsdam is a newly designed scientific drill rig with a depth capacity of up to 5 km. Using the experience and expertise acquired over the past 20 years through the KTB and ICDP projects, a new rig has been designed to address the specific requirements for scientific drilling. The goal of this rig concept is to cover the whole spectrum of technical requirements of land-based scientific drilling projects whilst still providing a cost-effective service.

The InnovaRig is capable of performing:

- Air-lift-drilling in large diameter sections (>12 ¼“)
- standard rotary drilling including hole opening and directional drilling
- 159 mm wireline coring with a new wireline string for continuous coring of large diameter cores (OD 94 mm)
- wireline coring, diameters ranging between 60 mm and 123 mm (mining standard).

The „InnovaRig“ drilling system is designed to allow for special „scientific“ add-ons such as continuous on-line gas analyses in the drilling mud, time-effective geophysical downhole logging, and continuous technical-scientific data acquisition, storage, and distribution as well as completion of permanent downhole observatories. These systems will be combined with other existing field laboratory equipment for core analyses and microbiological investigation such as BugLab, amongst others.

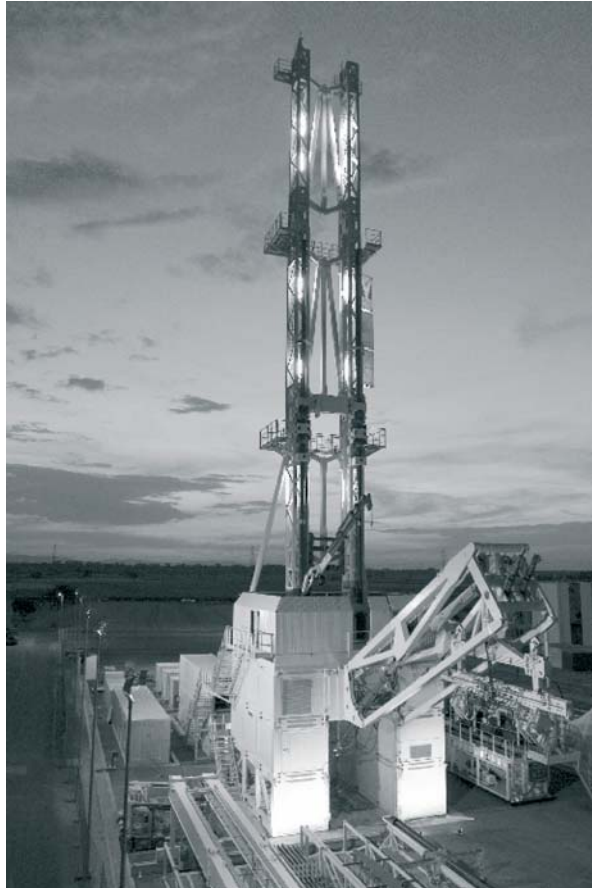


Fig. 1: The Innova Rig prototype (figure: Herrenknecht Vertical GmbH).

5.3.2 Lake Drilling

Following the first drilling operation on Lake Biwa (Japan) in 1982/83, scientific drilling of sediment records in modern lakes has become a cornerstone of paleoclimate research during the past 20 – 25 years, providing key records for a better understanding of the earth’s climate dynamics and their triggers in the geological past. Lakes act as local sedimentary basins on the continent. Therefore, they usually contain undisturbed, continuous sedimentary records of rather high resolution. The lake sediment composition reflects the conditions both in the water column and in the catchment of the lake. Hence, multidisciplinary geoscientific investigations on long lake-sediment records can provide unique paleoenvironmental and paleoclimatic information that ideally complement paleodata from other archives such as marine sediment cores, ice cores, or loess/paleosol sequences.

Initially, lake-drilling projects were exclusively performed using the commercial drilling technique from local or regional companies (e.g. Lake Biwa, Lake Baikal, Lake Malawi). This was associated with high costs and the loss of experience at the end of each individual operation. Consequently, a drilling system especially designed for modern lakes, the GLAD 800 (Global Lake Drilling 800 m), was developed with financial support of the International Continental Scientific Drilling Program (ICDP) and the American National Science Foundation (NSF). The floating barge of this system consists of standard-size shipping containers clamped together while drilling and used for the shipping of all equipment during land transport. The small-size mining-type drill rig used on the barge allows for coring with different slimhole systems such as hydraulic piston coring for soft sediments, extended core bits, and wireline diamond bit drilling.

The system is operated by DOSECC (Drilling, Observation and Sampling of the Earth's Continental Crust), a non-profit consortium of US-American Universities. The GLAD 800 was successfully employed during the past few years on Mono Lake and Great Salt Lake (Utah, USA), and on Lakes Titicaca (Bolivia and Peru), Bosumtwi (Ghana), Qinghai (China), and Peten-Itza (Guatemala). It is also planned for use on the upcoming drilling projects on Lake Van (Turkey) and Lake Potrok Aike (Argentina), which may start as early as 2008. For the drilling operation on Lake El'gygytgyn in the Siberian Arctic (Russia), which is currently scheduled for the winter season 2007/08, in contrast, a new rig will be constructed within a joint venture of DOSECC and the Russian drilling company NEDRA that has successfully drilled Lake Baikal. This rig will be as light and as small as possible to allow transportation by helicopter, operation from the lake ice cover, and sheltering against the harsh climate conditions of the Arctic.

5.3.3. Geothermal Drilling

Geothermal drilling involves different aspects, such as exploratory drilling (1), production drilling (2), and reservoir stimulation (3):

(1) Geothermal exploratory drilling currently uses conventional, mostly rotary, drilling technology of the oil industry. Therefore, geothermal exploration is as expensive as oil and gas exploration, while possible profits are considerably smaller. Accordingly, there are very few dedicated geothermal exploration boreholes. This increases the exploration risks considerably, since the selection of drilling locations is inevitably based on data from boreholes by chance. Thus, exploration of geothermal reservoirs would profit from new, low-cost exploration technology, e.g. by drilling micro-boreholes of no more than 2.5 cm diameter, allowing an innovative, quasi "arthroscopic" geological exploration.

(2) Depending on the type of geothermal energy exploitation, i.e. direct thermal use or conversion of geothermal heat into electric energy, drilling techniques of geothermal production boreholes may differ in some aspects from drilling for hydrocarbons.

In many ways, drilling for direct use of low-enthalpy hot water from deep aquifers is similar to that used for oil industry drilling. The same applies to boreholes that are used as deep borehole heat exchangers, the only difference being the concentric tubing arrangement which is generally used. In contrast, boreholes for the installation of shallow borehole heat exchangers at depths of about 30 m - 150 m are drilled with standard equipment used for drilling water wells. New innovative approaches for drilling such boreholes involve, for instance, supersonic or high-pressure water cutting technology with or without use of abrasive media.

(3) With regard to the stimulation of reservoirs, there are differences between boreholes drilled for the production of oil and hot water. In oil production, so-called hydro fracs are used to increase the inflow of oil from a reservoir rock into the borehole. In contrast, fracs in geothermal wells placed in sediments of low permeability have to be much larger and more conductive than those in oil or gas reservoirs. Methods of creating this kind of fractures are currently being developed in several countries. In Germany, two research projects, Groß Schönebeck and GeneSys, are ongoing. In particular, knowledge of the local and regional stress fields is required for a successful stimulation and to achieve substantial flow rate increase.

In regions which lack natural steam reservoirs, such as the majority of Europe, conversion of geothermal heat into electric energy requires engineering of underground geothermal systems in the basement rock with artificially enhanced fracture-permeability. When cold water is fed into this system, it collects heat at temperatures in excess of 120 °C from the surrounding rock. The hot pressurized water is produced by a second borehole and flushes steam at lower pressure through the turbine. With respect to such "Hot-Dry-Rock" technology or "Enhanced Geothermal System", research over the past two decades shows that hydro fracs, used for many years successfully to stimulate hydrocarbon reservoirs, are less suitable than self-propping "shear stress fracs". These are induced by increasing the pressure in an interval where the borehole intersects a sealed or closed fracture or fault zone which is subject to a shear stress. When, during stimulation, the borehole pressure exceeds a critical value on the fracture, it will shear and dilate. Due to relative movement of the two faces of the fracture, it cannot completely close after pressure release, leaving the fracture with some residual, artificially induced permeability. This technology has been pioneered in geothermal research wells, such as Soultz-sous-Forêts in France, and is currently applied in ongoing commercial projects. However, this technique is still far from being routine, in particular because a successful application requires considerable site-specific investigations, mainly with respect to the fracture or fault inventory and the local stress field.

5.3.4. Deep Ocean Drilling

Research drilling and coring operations in the deep sea have a long history, since the first attempts to penetrate the deep-sea floor from barges were launched in the middle to late sixties. Sufficient scientific interest had grown to make deep-sea drilling a necessity to test fundamental hypotheses on seafloor spreading and the stratigraphy of sedimentary sequences in the abyss as well as along continental margins.

The efforts of ocean drilling quickly resulted in the establishment of DSDP (Deep Sea Drilling Project), run by a number of US oceanographic institutions which employed the dynamically positioned drill ship GLOMAR CHALLENGER. DSDP developed into ODP (Ocean Drilling Program) which was formed in 1984 and employed a more modern drill ship, the JOIDES Resolution, offering enhanced technical capabilities. This ship provided a base for industry-type drilling efforts and a floating laboratory for the analysis of the sampled sea floor stratigraphies.

Integrated Ocean Drilling Program (IODP)

The Integrated Ocean Drilling Program (IODP) is an international marine research drilling program dedicated to advance scientific understanding of the earth by monitoring and sampling sub-seafloor environments. Germany, as a member of the European Consortium for Ocean Research Drilling (ECORD), is investing 3.5 million Euros for the German membership in IODP. In addition, the DFG supports the ODP/IODP priority program with 2.5 million Euros. As a consequence of many years of participation in DSDP/ODP/IODP, a large community of about 500 German scientists is involved and interested in deep-earth probing. This is also reflected in the high number of Germans acting as lead- or co-proponents in 47 drill proposals from a total of 122 within IODP.

The main aims of IODP are to explore the deep biosphere, the pattern of global environmental changes, as well as the cycles and processes of the solid earth. Towards this goal three IODP drilling platforms are operated by three different Implementing Organizations (IOs). Each of the platforms serves different drilling requirements:

- Riserless platform operations are conducted by the JOI Alliance. The JOI Alliance operates JOIDES Resolution (JR), a dynamically positioned drill ship with riserless drilling capabilities. With its uniquely outfitted laboratories for shipboard processing and analysis of cores and borehole data, JR has been the workhorse of the predecessor program ODP for more than 18 years.
- Riser platform operations are conducted by Japan's Center for Deep Earth Exploration (CDEX), overseen by the Japanese Agency for Marine-Earth Science and Technology (JAMSTEC), in cooperation with the Center for Advanced Marine Core Research at Kochi University, which contributes to core processing and core storage. CDEX operates the D/V CHIKYU, the first scientific drilling vessel worldwide with a riser drilling system. Riser drilling employs a secondary pipe guiding the drill string for reentering into the drillhole and helping to maintain controlled hole conditions. There are multiple technical and safety benefits of riser drilling,

especially when drilling beyond 2 km depth, where overpressured formations are expected, such as in the Nankai Trough accretionary prism.

- Mission-specific platform (MSP) operations are conducted by ESO (ECORD Science Operator: British Geological Survey (BGS), University Bremen, European Petrophysics Consortium) on behalf of IODP-MI. The University of Bremen is commissioned by the BGS to undertake curation and care of core repository facilities as well as data management tasks provided by WDC-MARE/PANGAEA (IODP-MSP data portal). GFZ Potsdam additionally supports ESO by contributing the Drilling Information System (DIS) for offshore data acquisition. The European Petrophysics Consortium is contracted by BGS to carry out all logging and petrophysical activities. This consortium comprises of the University of Leicester (coordinator), U.K, the Université de Montpellier, France, and RWTH Aachen, Germany.

ESO conducts drilling expeditions with specially contracted drill ships in areas where other platforms are unable to work. Two highly successful expeditions have been completed so far, the Arctic Coring Expedition in the year 2004 and the Tahiti Drilling Project in 2005.

The AURORA BOREALIS-Project

As part of an international effort to explore the central Arctic Ocean, German researchers have paid particular emphasis to the development of the AURORA BOREALIS-project (of the ESF-European Polar Board and ECORD), which aims to construct a novel research ice breaker with an all-season drilling capability. It could become one of the mission specific platforms of IODP, and will hopefully give ECORD a lead-agency role in IODP.

Polar research and in particular the properties of northern and southern high latitude oceans are currently a subject of intense scientific debate and investigations, because they are at present, and have been during the geologic past, subject to rapid and dramatic change. Polar regions react more rapidly and intensively to global changes than other regions of the earth. Shrinking of Arctic sea-ice could lead to the opening of sea passages to the north of North America and Eurasia, and calving of giant table icebergs from the ice shelves of Antarctica are examples of these recent dynamics.

In spite of the critical role of the Arctic Ocean in climate evolution, it is the only sub-basin of the world's oceans that has not been sampled by the drill ships of the Deep Sea Drilling Project (DSDP), the Ocean Drilling Program (ODP) or the Integrated Ocean Drilling Program (IODP). The CHIKYU and JOIDES drill ships cannot enter ice-covered oceans. The long-term environmental history and tectonic structure of the Arctic Ocean is therefore poorly known. This lack of data represents one of the largest gaps of information in modern earth science. Hence, the new research ice-breaker AURORA BOREALIS (Fig. 2) should be equipped with drilling facilities to fulfill the needs of the IODP for an "Alternate" or „Mission Specific" Platform to drill in deep, permanently ice-covered ocean basins. This will make AURORA BOREALIS a

novel research icebreaker with no national or international competitor. The drilling equipment will only be used during the summer months and should be detachable, potentially to be used and adopted to ICDP-projects. The icebreaker must also be powerful enough to remain stationary against the drifting sea-ice cover and will have to be equipped with dynamic positioning.

An efficient use of the new research icebreaker requires the formation of a consortium of European countries to ensure a high quality of science and efficient employment of the research vessel during all seasons of the year. Extensive and well-developed Arctic research programs exist in several European countries, e.g. Russia, Germany, and particularly in Scandinavia. In each individual country, there are various organizations or working groups with rather diverse structures and influence in their home countries. The construction of AURORA BOREALIS as a joint European research icebreaker would result in a considerable commitment of the participating nations to coordinate and expand their polar research programs in order to operate this ship continuously in a cost-effective manner, as well as considerably strengthen European Arctic research.

Ideas for a new research icebreaker for the Arctic have been developed by several groups. The sketch below demonstrates the initial design of The AURORA BOREALIS.

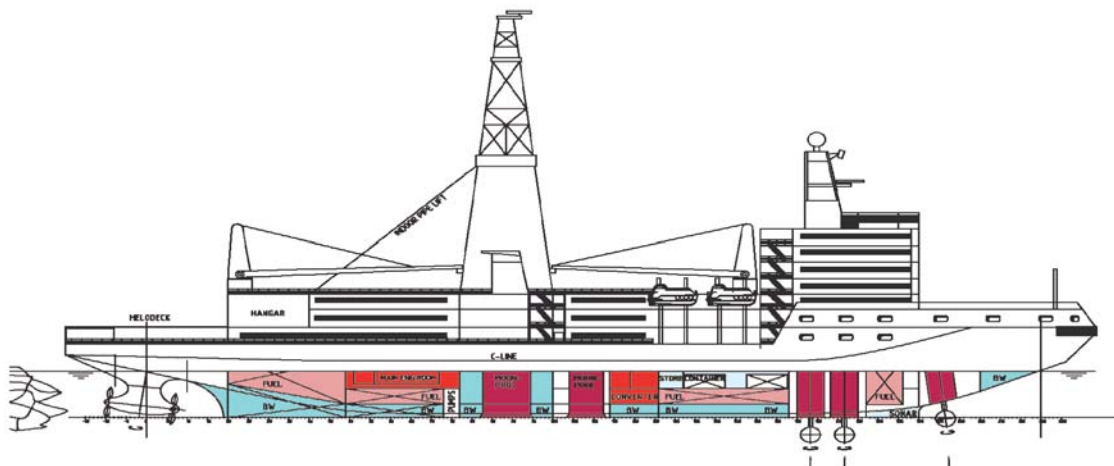


Fig. 2: Schematic drawing of the Aurora Borealis (designed by HSVH (Hafen-Schiffahrts-Verband Hamburg) - shipping joint at the port of Hamburg).

ANDRILL

Antarctic Geological Drilling (ANDRILL) is a multinational collaboration comprising of more than 200 scientists, students, and educators from five nations (Germany, Italy, New Zealand, the United Kingdom and the United States) to recover stratigraphic records from the Antarctic margin using Cape Roberts Project (CRP) technology. The chief objective is to reconstruct a history of paleoenvironmental changes that will guide our understanding of how fast, how large, and how frequent glacial and interglacial changes in the Antarctica region occurred. Prediction of future scenarios of global warming requires guidance and constraints from past history that will reveal frequency and magnitude of potential climatic fluctuations.

The combination of: Logistic considerations; the extent of existing knowledge of the region; a proven chronological framework; availability of suitable strata for paleoenvironmental and geological study, and the majority of initial interest, dictated that the McMurdo Sound region be the first area for further Antarctic drilling under the ANDRILL banner. Future target areas around the West Antarctic margin include the Eastern Ross Sea, Weddell Sea, and Palmer Basin in West Antarctica, Terra Nova Bay, Beaver Lake, Prydz Bay, and Wilkes Land in East Antarctica. Due to the wide range of proposed drilling targets, individual drilling objectives are grouped into logistically-constrained portfolios. The first is the McMurdo Sound Portfolio (MSP).

Specific scientific objectives of the MSP include:

- Obtain high-resolution sediment cores that record major glacial events and transitional periods over the past 40 million years
- determine orbital and sub-orbital glacio-climatic fluctuations that vary on 100, 40, and 20 kyr cycles
- obtain a refined record of the onset and development of the East Antarctic Ice Sheet (EAIS) 40 million years ago
- better identify how the Antarctic region responded to past events of global warmth
- derive a detailed history of Antarctic Holocene environmental change
- test global linkages between climate change in the Northern and Southern hemispheres.

Operations and logistics for ANDRILL are managed by Antarctica New Zealand. The scientific research is administered and coordinated through the ANDRILL Science Management Office, located at the University of Nebraska-Lincoln.

5.3.5. Shallow Marine Drilling

Standard research vessels permit to sample the sea floor by simple methods like gravity coring or dredging. The length of the retrieved cores from soft sediments is often shorter than desired, and hard rock samples can with these methods only be collected from the surface of the sea floor. While this limitation can be overcome by drill ships, the availability and costs impose a severe limitation to this approach. Drill rigs that are deployed from standard research vessels can bridge this gap in sediment and hard rock coring techniques. Such drill rigs like the German MeBo („Meeresboden-Bohrgerät”, German for ‘sea floor drill rig’) and the British Rockdrill 2 are deployed on the seabed and remotely controlled from the vessel. High quality samples can be obtained by this approach, since ship movements due to currents or waves do not have an impact on the drill string and the bit pressure.

MeBo

The sea floor drill rig MeBo (Fig. 3) was developed during 2004/2005 at the University of Bremen. The development of the drill was funded by the German Ministry of Education and Research and by the Bremen State Government. The drill is an electro-hydraulic system that is remotely controlled from the ship. A steel armored umbilical is used to lower the 10 ton device to the seabed, where four legs extend ensuring

stability of the rig. Copper wires and fibre optic cables within the umbilical are used for energy supply from the vessel and for communication between the MeBo and the control unit on deck of the vessel. The system utilizes commercial rotary core barrels, as well as push-coring barrels, and can set casing as needed for special lithologies. The MeBo stores drilling rods, casing tubes, and has push-coring and rotary barrels on two rotating magazines that can be loaded with a mixture of tools specifically required for a drill job. The MeBo has the capability to drill up to 50 m into the sea floor to recover cores from soft sediments and hard rocks with 74 – 84 mm diameter and to stabilize the drilled hole to a depth of 40 m by casing. The complete MeBo-system, including drill, winch, launch and recovery system, control unit as well as a workshop and spare drill tools, are shipped within six containers. It has already been deployed from several large research vessels.

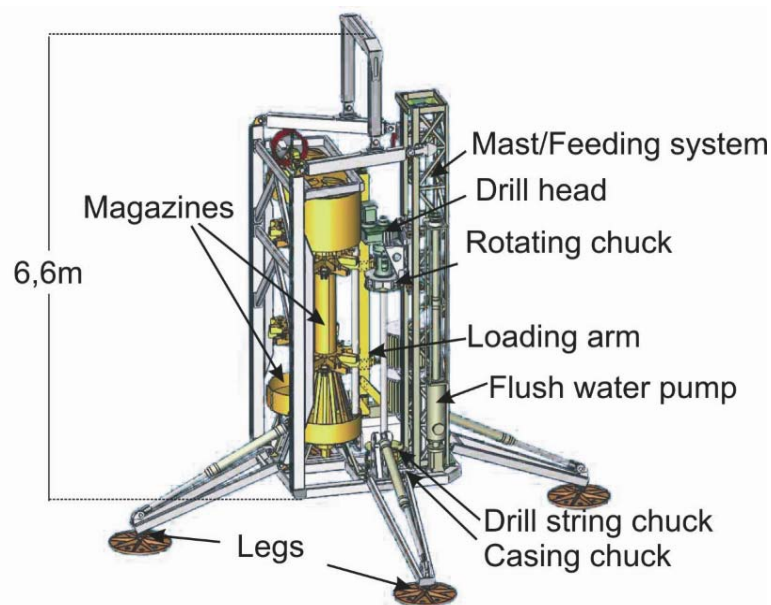


Fig. 3: The sea floor drill rig MeBo (Meeresboden Bohrgerät).

Rockdrill 2

The seabed drilling device Rockdrill 2 is a tripod frame with 2 carousels. It hosts 10 core barrels and rods, each 1.8 m long, and total core length will be 15 m. The nominal core diameter is 51 mm, the borehole diameter is 66 mm. The total weight of the system in air is about 5 tons. The system comes with a 3500 m long umbilical, but is designed for water depths up to 3100 m. The legs of the tripod are retractable, yet reach 4.5 to 5 m when fully extended and are maneuverable to ensure a level drill platform. All system components are transported in containers and installed on the vessel on back tie-down points. Drilling operations are remotely operated and fully controlled by a number of sensors, but also by online color cameras, partly mounted on pan/tilt units. Two thrusters enable small-scale maneuvers above the seafloor. Casing of the first meter will stabilize the drillholes.

The construction of Rockdrill 2 was finalized in 2005 at the Marine Operations and Engineering Group of the British Geological Survey in Edinburgh (UK). It is currently being built and tested at the BGS base in Edinburgh. A sea trial was already carried

out. Following technical consultation from BGS and financial contribution of the IFM-GEOMAR Kiel, a new deepwater umbilical cable and winch package to accompany the Rockdrill 2 is being prepared.

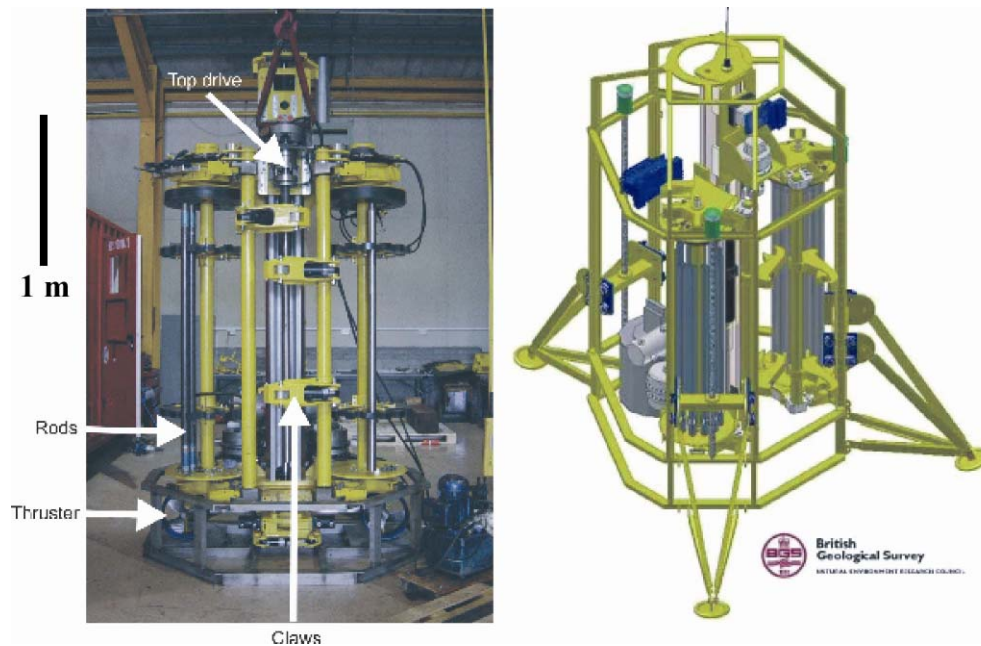


Fig. 4: The seabed drilling device Rockdrill 2. Left: Photograph of the main frame of Rockdrill 2 with core rods, thrusters, claws and top drive. The hydraulics is located on the backside of the drill. Right: Schematic drawing of Rockdrill 2 with legs fully extended (© BGS Edinburgh).

5.3.6. Ice Drilling and Subglacial Recovery

Drilling in ice requires a technology which is different from the one used either in IODP or in ICDP, and there is no industrial use for such a technology. This leaves all technological development in the hands of a few research institutions, which collaborate on international level, thus the development of deep ice-core drilling is an ongoing process. Fast-access drilling technology for subglacial recovery is being debated and will gain more attention in the near future with upcoming new scientific goals, such as deciphering sub ice geology or sub ice water masses. In this context, one must envisage the modification of existing deep-drilling technologies to the special environment and logistic requirements of the polar ice sheets.

Germany has experience in ice-drilling spanning the past three decades. Whilst shallow firn coring was additionally undertaken by university groups, ice-core drilling deeper than approximately 20 m depth and hot-water drilling required the infrastructure of the Alfred-Wegener-Institute of Polar- and Marine Research (AWI) as the principal German Polar Research Institute.

While AWI's glaciological group participated only scientifically in the early deep-drilling projects, the newly founded ice-core drilling group at AWI gained drilling experience by active participation in drilling operations and design of equipment during the North Greenland Ice Core Project (NGRIP). After NGRIP, AWI took the lead of

the Dronning Maud Land (DML) deep ice-core drilling during the past five years in the frame of the EPICA. Traditionally, deep ice-core drilling in Europe is done in close co-operation between European laboratories, so that design work can be shared and common equipment can be maintained. AWI's main contribution to ice coring in the past was related to the design and outlay of surface-drilling and core-handling equipment as well as downhole drilling, logging units and mechanical drill bit design. The ice-core group at AWI is internationally recognized by participation in many committees.

AWI has designed its own hot-water drilling equipment and drilled through the Filchner Ronne Ice Shelf, the Ross Ice Shelf as well as the Ekströmsisen for deployment of oceanographic probes, sub-shelf-ice sediment gravity coring and acoustic observation of marine mammals. Earlier instrumentation developments at AWI also comprised a melt probe, but were unfortunately discontinued, when the responsible group leader retired. However, the engineers that were involved are still at AWI, so the experience is preserved and the development could be re-established if required.

At the bottom of the NGRIP as well as the DML drilling, sub-glacial water soared up into the hole and refroze therein. Both sites were the first and only accesses to sub-glacial water in Greenland and Antarctica respectively, and since the water froze quickly and no gas effusion occurred, microbial and mineralogical material from the ice phase is to be expected. There is great interest from various disciplines to re-drill the frozen sub-glacial water. Furthermore, there is demand for sub-glacial bed material, the recovery of which is a technical challenge. The ice-drilling group at AWI will continue to improve drilling and sampling techniques for the sub-glacial environment. It will be prepared to take the lead for major deep-drilling activities in Antarctica and Greenland, as e.g. formulated in IPICS, together with longstanding strategic partners such as the glaciological group at the University of Copenhagen.

5.3.7. Subglacial Lakes

How to sample sub-glacial lakes free of contamination is an ongoing discussion in the scientific community. Groups worldwide investigate sampling instrumentation. A promising assessment is to drill an access hole with a hot water drill and to continue with a melt probe thereafter. The AWI with its experience in hot-water drilling and in melting-probes is ready to participate in developing the equipment for penetration into sub-glacial lakes. The glaciological group at AWI is internationally recognized by representation in the Sub-glacial Lake Committee of the National Academy of Sciences Washington. The EPICA deep-drilling site with sub-glacial water close to the German summer base Kohnen is an ideal facility to test sub-glacial contamination-free sampling and drilling equipment.

5.3.8. Sterile Drilling, Deep Biosphere

Over the last decade, it has become evident that the deep biosphere is one of the most important and promising research frontiers in both the terrestrial and marine realm. The discovery of ubiquitous microbial life in deep subsurface successions has fundamentally changed our perception of how deep and under which conditions life can exist on earth.

Technical challenges go hand in hand with research objectives and drilling operations as far as the Deep Biosphere is concerned. The fundamental issue of Deep Biosphere drilling is to obtain samples free of contamination by surface microorganisms and non-indigenous material. This has ultimately led to the development of sophisticated controls and monitoring methods in Geomicrobiology.

Over the last few years, several techniques have been used to drill cores for microbiological investigations. In marine environment, the ODP has provided a significant number of samples, and several studies have investigated the usefulness of the techniques applied. For terrestrial drilling operations, mud rotary drilling is most common for depths greater than ca. 40 m.

Contamination control (various methods have been described in the literature) is the technologically appropriate strategy. In order to obtain undisturbed samples, coring and cores have to be uncoupled from the mechanical actions of the drill bit and the drill string. Wire-line operated coring tools are used to achieve this. They are launched through the drill string, latched into the bottom hole assembly, core ahead of the hole through the drill bit, and are finally retrieved through the drill string, which remains in the hole and continues drilling ahead. Specialized tools have been developed for collecting and sub-sampling cores under in-situ conditions.

Two wireline pressure coring tools were designed and built as part of the European-funded HYACE project and refined during the subsequent HYACINTH project. Both tools permit cores to be recovered and retained up to a maximum pressure of 250 bar using specially designed flap valves. The coring equipment has been designed to allow the core to be transferred, without loss of pressure, into laboratory chambers for study and analysis. Because both tools use 'dry' cutting mechanisms in a non-rotating drill string, they probably take relatively uncontaminated samples when compared with other tools that flush at the bit with drilling mud or water.

A mobile Geomicrobiology and Geochemistry Laboratory (BUGLab) is presently under construction at the GFZ Potsdam. It will enhance biological studies and provide a state-of-the-art laboratory environment at drill sites for a wide range of applications, covering:

- Microbiological and biogeochemical sampling of diverse subsurface environments
- on-site analyses of biologically significant transient properties
- on-site analyses of chemical and physical properties that will be used to guide microbiological and biogeochemical sampling strategies

BUGLab will be part of the standard procedures of most ICDP drilling operations and will be available for other drilling projects. It will be housed in a standard shipping

container for easy transport by truck, ship or rail. Due to its highly modular outfit, it can be specifically equipped for the different tasks arising from the highly variable nature of the different drilling projects. The facility will be equipped with standard geochemical and microbiological equipment but can also accommodate other items for specialized analysis. The facility will be maintained and managed by a dedicated staff scientist at GFZ Potsdam, who will also be responsible for the development of standard protocols and their implementation, as well as for maintaining a liaison with IODP to ensure compatibility of results between Land and Sea based samples.

5.4. Logging

Logging describes the process of measuring physical, chemical, and structural properties of penetrated geological formations using tools that are either lowered into the borehole on a wireline cable (wireline logging) or placed just behind the drill bit as part of the drill pipe itself (logging-while-drilling). The tools employ various measurement techniques to acquire downhole logs of properties such as natural gamma ray activity, sonic velocity, density, and electrical resistivity. Standard logging tools provide data sets with sampling rates of typically 15 cm. Higher sampling rates are collected by image tools (electrical and acoustical scanning), which provide high-resolution images of the borehole wall down to a sub-cm-scale.

Downhole logs are continuous with depth, and measure in situ properties. In uncored sections and depth intervals with limited core recovery, they are the only depth-related record on formation properties and thus form the basic information to borehole stratigraphy and lithology. In cored sections, the in-situ nature of the downhole measurements is an advantage, since physical properties of rock samples can strongly change due to pressure decreases from drilling depth to surface conditions.

Logging data can be interpreted in terms of the formation's stratigraphy, lithology, mineralogy and the nature of pore fluids. Furthermore, petrophysical data, e.g. porosity or permeability of the formation, can be gathered. Logs also provide the major link between borehole and seismic sections. Velocity logs and checkshots improve depth to travel-time conversion, and synthetic seismograms may be compared directly to the seismic section. For these reasons, measurements are an integral part of science operations performed in the IODP and ICDP research programs.

In Germany, three research groups operate in the field of downhole logging: GFZ Potsdam, RWTH Aachen, and GGA Hannover. Activities of other research groups are extremely specialized (e.g. Tech.Univ. Freiberg – acoustic borehole tomography). The equipment of GFZ, RWTH, and GGA is listed in the appendix. It is important to notice that in all three institutes only wireline logging is performed. Experience in logging-while-drilling could only be gained by participating in ODP/IODP projects (e.g. Leg 190 and 196 in the Nankai Trough). To interpret the logging data, knowledge about the physical properties of cores is paramount.

GFZ operates a spectrum of downhole-logging tools for a wide variety of borehole conditions: slimhole and big size tools, special tools for hydraulic investigations, winches, and test boreholes. GFZ has gained downhole measurement experience

and expertise in more than 12 years attending national and international projects. Since 1999, the GFZ-Operational Support Group (OSG) practiced downhole logging in 27 campaigns within 15 drilling projects, taking place in 11 countries, from shallow-lake drillings to the ultra deep KTB holes.

GFZ participates in all stages of downhole logging activities in various ICDP and non-ICDP drilling projects with differing targets and demands. This includes pre-project consultations, development of logging plans, cost and time analyses, management and execution of downhole logging operations, and scientific evaluations of the gathered data. GFZ has special experience in analysis and interpretation of downhole geothermic investigations. The OSG provides for the measurements that are performed with ICDP and GFZ logging tools a basic data processing, encompassing e.g. depth corrections, sonic velocity picking as well as structure picking on images. Special analyses of the data sets, however, are usually performed by the projects downhole geophysicist. Due to the extremely variable project goals, rock types, and environments, there is no general unified processing and interpretation procedure for downhole-logging data in ICDP-OSG.

The RWTH Aachen logging group operates a slimhole-logging equipment suitable for holes drilled down to 1500 m. Logging activities are complemented by laboratory facilities, which comprise of several petrophysical core-scanner and petrophysical devices for measurements on core plugs and mud samples. The RWTH Aachen group has 15 years work experience in log interpretation and the study of petrophysical properties from scientific drillholes. Research emphasis is on the characterization of rocks for geological, geothermal, and hydrogeological studies, and on the physical and thermal structure of the oceanic crust with its time-integrated heat and mass fluxes. Another topic is the development of log interpretation methods for magmatic and metamorphic rocks. A log response database and log interpretation charts exist for various igneous and metamorphic rock types of oceanic and continental crust.

Since 1998, the RWTH Aachen group is an active partner within the ODP/IODP research programs. The RWTH holds a sub-contract with the Columbia University (Lamont-Doherty Borehole Research Group) and belongs to the "European Petrophysics Consortium", which is one of the three components of the ESO. Members of the RWTH Aachen logging group, particularly trained for this purpose, regularly participate as Logging and Petrophysics Staff Scientists on ODP/IODP cruises.

The major research activities of GGA Hannover are logging and interpretation of logging data in numerous German drillholes in sediments or crystalline and magmatic environments. Beyond this, the know-how was improved in several international projects like ODP Leg 190 and 196 (Nankai Trough), Lake Bosumtwi impact crater (ICDP), Cape Roberts Project (Antarctica), and Promess-1 (Mediterranean Sea). Logging and interpretation of numerous geothermal drillhole data (e.g. Soultz, France), Urach (Germany)) complete the research activities of GGA, which has gained experience in interpretation of logging data in more than 10 years. Especially the statistical analysis of logging data, based on spectral analysis and classification

algorithms like cluster analysis, neuronal networks and support vector machines, could be improved during the last years.

5.5. Deep Observatories

A growing number of research drilling projects utilize the completed wells for various scientific objectives for a long-term downhole monitoring period, which include predominantly geophysical, geo-mechanical, environmental and geochemical investigations as well as data acquisition from the subsurface geosystem. Pacesetters of this trend in the framework of ICDP are the fault zone drilling projects followed by the volcano drilling activities. Impact crater drilling projects are expected to discover similarly in the future the value of downhole monitoring, which is presently done in drill sites for CO₂ storage and geo-thermal energy with respect to the geologic and hydrologic characterization of the subsurface.

Likewise, IODP continues to emphasize the importance of permanent downhole monitoring for their current and future marine research drilling projects. Their retrofit kits for marine wells to be turned into long-term observatories, known as CORKS (Circulation Obviation Retrofit Kits), is a very efficient engineering solution and proved very successful in many IODP wells over the last years. The University of Bremen is strongly involved in the development and application of CORKS, not only as a member of the 'CORK task force' of IODP, but especially with the last successful IODP CORK deployment, instrument exchange, data readout and interpretation offshore Costa Rica (ODP Leg 205), and also for future projects like North Pond/CRISP or NanTroSEIZE.

Consequently, we will see a future growing need for an intense coordination of engineering knowledge and best practices between ICDP and IODP.

SAFOD, San Andreas Fault Zone Observatory at Depth, USA

The "Stage-3 Permanent Downhole Monitoring Array" is a project managed by OSG in Potsdam. The objectives are twofold

(1) the location of <M2 events over a 12 month period, followed by a
(2) permanent installation of a 5-level seismometer / tiltmeter array in the fall of 2007. The instrument design for all "stage-3" instrumentations are driven by the requirement to record both the near field low magnitude as well as the distant and deep major earthquake events in real-time and with the highest signal fidelity possible. High-temperature and oilfield proven tiltmeter measurements in every level will complement the micro-seismic data acquisition. The high level array specifications and layout for the stage-3 observatory are:

- up to 125°C and 500 bar
- 0-60° borehole inclination
- 3 years MTBF system performance
- 5 stations, 75 m spacing
- 1 inflatable casing packer
- FO and electrical data transmission

- Pipe conveyed, high-side aligned
- Hydraulic lines to surface

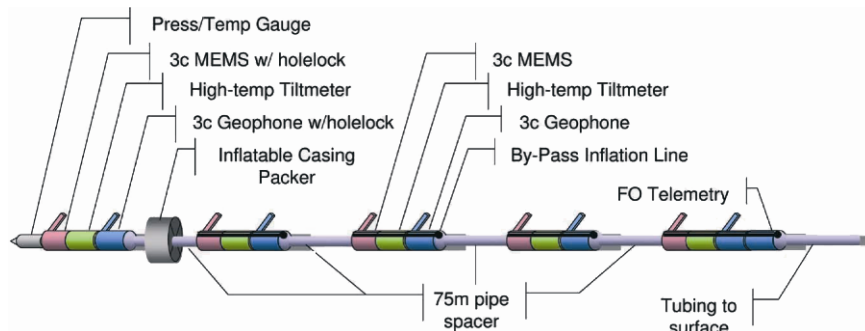


Fig. 5: Borehole observatory instrumentation.

5.6. Mobile Field Laboratories

Scientific drilling projects require continuous scientific on-site attendance in order to ensure appropriate initial sample description, curation and scientific measurements which cannot be performed in a later laboratory phase. In addition, such drilling projects need scientific oversight through dedicated scientists (PIs/ co-chiefs) to ensure that drilling operations are in accordance with scientific needs. Hence, the field laboratory is also a science-control-center. Typically, the main tasks of the field lab scientists comprise:

- Sampling and sample handling, description, archiving, curation
- initial analysis and interpretation (e.g., lithological description, microscopy, petrophysical analyses)
- information management, digital data distribution, reporting, outreach
- administration

Laboratory and core-curation facilities are normally set up in mobile containers that are equipped for the specific purpose. The University of Bremen provides mobile laboratory containers, e.g. a curation container that, depending on the available space, includes facilities for porewater sampling and initial analyses.

Another mobile field lab equipment presently based in Germany is the Drilling Information System developed at GFZ Potsdam and used at several ICDP projects. The equipment usually encompasses optical core scanners for core documentation and annotation (e.g. slabbed mode and 360° unrolled cores), a petrophysical core logger (GEOTEK), on-line gas geochemical analyses equipment, etc.

Most major continental drilling projects are carried out over a time span of only a few months. Therefore, the field laboratory does not need to be installed in permanent buildings, but is usually installed in mobile shipping containers. If connected to drill-site services such as power, water, sewage, and communication, these containers serve as fully equipped field labs. An extended concept with three 20 ft containers for laboratory space and a tent roofing a free working area has been developed for the

ICDP by the OSG. According to project needs, this system can be extended with additional equipment.

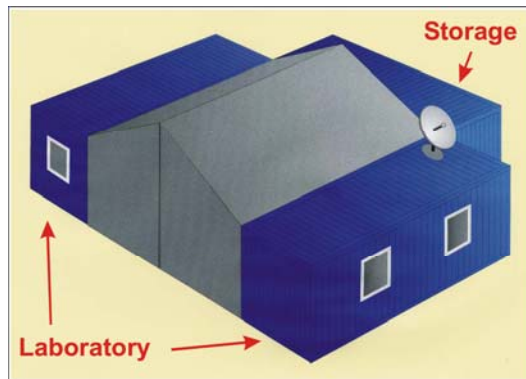


Fig. 6: Schematic view of a mobile field lab.



Fig. 7: Sketch and standard equipment for hard rock projects.

Bremen Core Curation Van - outfit for TAHITI, 20' container (5.6m x 2.2 m inside)

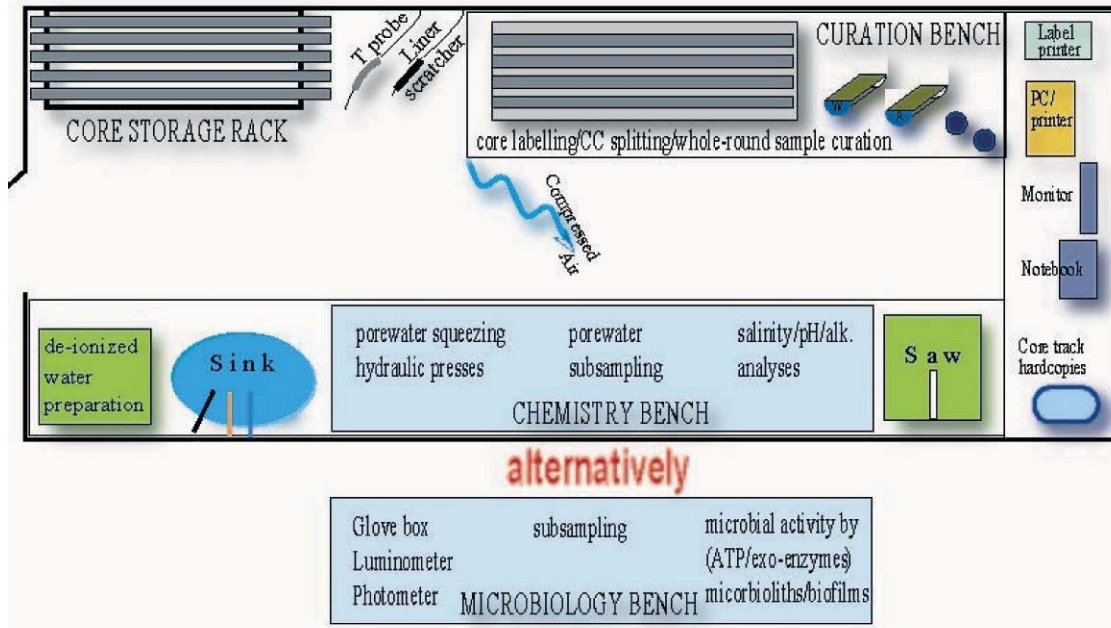


Fig. 8: Combined core curation /pore water acquisition container as outfitted for the IODP Expedition 310 (Tahiti Sea level Expedition). Please note that the microbiology module was located in a separate container.

5.7. Core Repositories and Initial Analysis

International science and research institutes are brought together through the Integrated Ocean Drilling Program (IODP), the purpose of which is to promote investigation of the earth's structure beneath the sea floor. Deep-drilling beneath the ocean floor is carried out worldwide by the crews of three different scientific drilling platforms. The cores retrieved offer a unique view into the origin, development, and present-day structure of the ocean floor.

The IODP Bremen Core Repository (BCR) is an important contact point for scientists from all over the world (about 2000 scientists have visited it so far) and therefore significantly contributes to the exchange and transfer of marine science knowledge in Bremen, leading to cooperation and scientific interaction with the leading geosciences institutions around the world. The Center of Marine Environmental Sciences (MARUM) established at Bremen University was opened in early 2005. The present collection of 85 km of deep-sea sediment and hard-rock cores from 36 expeditions will be expanded by cores drilled in the Atlantic Ocean by the summer of 2007, then the BCR will comprise of 135 kilometers of deep-sea cores and will be the largest IODP core repository worldwide. In the new building on campus the BCR has an 1100 m² refrigerated storage area and racks with a height of 5.5 m, most of them are movable. An additional refrigerated storage hall is planned to be completed within the next two years

The infrastructure of the Geosciences Department at Bremen University features a unique set of state-of-the-art, high-capacity facilities for both the initial handling and for highly sophisticated analyses of marine sediments. Access to the laboratory facilities will also be provided for the IODP Mission Specific Projects operated by the ESO, of which Bremen University is one of the key partners. Lab facilities at BCR include several core scanners (Multi Sensor Core Loggers, digital linescan camera; two X-ray fluorescence Core Scanners) for measuring physical properties and geochemical element intensities. The Bremen University group also provides access to various labs (geochemistry, mineralogy, geotechnics, stable isotopes).

Scientists may request samples from any ODP or DSDP leg by filling out the ODP online sample request form (for samples from any of the four world wide repositories). Samples from the new IODP from expeditions with the non-riser vessel can be requested online as well. For samples from mission specific platforms (MSP-Projects of the European Consortium for Ocean Research Drilling) an online sample request form will soon be available. Samples can be taken by repository staff, or the scientists themselves.

Collections of marine piston or gravity cores are stored at Bremen University (GeoB cores), Kiel (IfM-Geomar, University Kiel), AWI, and BGR. Ice cores are stored at the Alfred Wegener Institute for Polar and Marine Research (AWI) in Bremerhaven.

6. Education, Training

Education and training could become one of the central activities of the planned GESEP. Upcoming scientific drilling projects would greatly benefit, if scientist and PI involved were previously informed about available drilling and measurement techniques, especially about their potentials and limitations in the prospected geological environment. A main objective is to make scientists basically familiar with the disciplines involved in scientific drilling, which covers terminological aspects, specific measurement techniques and their requirements on sample conditions and data quality. In addition, an active GESEP might serve as “knowledge-center”, in which all information about the different techniques and methods used in scientific drilling, new successful developments as well as pitfalls, is collected and kept. This would not only help PIs and scientists in the planning stage, but also improve the scientific communication during and after the drilling phase.

A modular approach using existing university lectures and training courses of all cooperating universities and scientific institutes would make the start of a GESEP-Educational-Program very smooth and easy.

A GESEP-Educational-Program should be arranged as a 3 level program (from a more practical to increasing theoretical levels):

- Project specific Training Courses for PIs, members and co-workers of forthcoming drilling projects (which exist already)

- periodical Summer Schools for graduate students and post-docs (at the KTB drill site)
- university lectures for students of all geosciences (as completion of the curriculum of the particular faculties).

Below, a selection of some training courses and educational programs already existing in Germany is given.

6.1 Education programs

The Faculty of Geosciences at the University of Bremen offers access to a unique set of highly sophisticated, state-of-the-art equipment with high capacities necessary for multi-proxy-based paleoenvironmental studies. These facilities combined with high quality scientific expertise provide the opportunity for a broad spectrum of marine research activities, especially for young European scientists, ranging from the initial handling of sediment cores through the measurement and statistical analysis of paleoenvironmental data to the interpretation of results. Special programs offered to the community are the Universum Science Center in Bremen with 500,000 visitors per year, and the UNI School Lab (www.unischullabor.de), which has already benefited 13,000 school students. The DFG-Research Center “Ocean Margins” (RCOM) has its own PR department (www.rcom.marum.de), including journalists, and is also involved in outreach work related to expeditions of the ESO.

At the RWTH Aachen University, educational programs are available for students, comprising lectures for borehole geophysics, practical exercises in logging, and the integration of graduate studies in research projects. Special courses in log interpretation have been provided within ICDP and ODP/IODP on national and international level. The RWTH Aachen University also provides courses taught in English in petrophysics, log interpretation, geothermics and Nuclear Magnetic Resonance (NMR) as part of a new international master program in Applied Geophysics (www.idealeague.org/geophysics) between the IDEA-League universities Technical University Delft (TUD), Eidgenössische Technische Hochschule Zürich (ETH) and Aachen University (RWTH).

The planned GESEP, created as an information center, could provide access to education and training and help to recruit young scientists into the drilling community. Based on available education programs, specific drilling-related virtual lectures, open workshops and short courses could be established concentrating expertise and knowledge from German Universities.

6.2 Training Courses

For several years, ICDP has provided a specific training program for all aspects of scientific drilling. The training program is developed and organized by the OSG and targeted for scientists and PIs of upcoming drilling projects.

The basic idea of the training is to teach fundamentals about drilling-related techniques and methods, beginning with the project management of a drilling project (including fiscal and legal questions) through the fundamentals of drilling and logging technique, responsibilities and safety regulations at the drill site, ending with the analysis and interpretation of samples and data. Descriptive lectures, hands-on exercises, practical applications in the field, and a workshop-type environment guarantee a high training success. The course participants are introduced to the different terminologies of scientists and drilling engineers. This improves the communication basis for all parties involved. Communication problems may cause very cost-intensive deficient decisions at the drill site and sometimes a failure of the whole project.

The current basis of the ICDP training is a set of ten courses covering almost all drilling-related topics of a complete drilling project life time:

- Planning and managing of a scientific drilling project
- on-site geology
- petrophysical investigation of cores and cuttings
- basic borehole logging and interpretation
- log interpretation in the non-hydrocarbon environment
- fundamentals of drilling technology
- the principles of drilling fluid technology
- borehole stability
- hydraulic testing / fluid sampling
- information and data management

Lessons are taught by a team of instructors from several institutions, such as RWTH Aachen, Würzburg University, Drilling School Celle, DOSECC USA, LBEG Hannover, GFZ-Potsdam and others. All instructors are experts in their fields and have an extensive practical and industrial experience. Most of them were involved in the scientific drilling project KTB as well as in different ICDP or IODP projects worldwide. Additional specialists from the industry or scientific institutes will be engaged for specific topics or individual courses if necessary.

The training program can be arranged at the GFZ-Potsdam or as in-house courses at any place in the world. The ICDP/OSG is interested in integrating a current drilling project in the program, and to hold the courses near a drill site in close cooperation and with participation of the particular principal investigators, responsible scientists and engineers. Since 1997, more than 20 training sessions have been carried out in locations such as Hawaii, Beijing, Mexico City, Donghai, Shimabara, Bosumtwi, Potsdam, Celle, Windisch-Eschenbach.

7. Outreach

Outreach is generally recognized as an important and elementary accompanying component of scientific work. Hence, providing communication to the general public, to the media, to political and economic instances and decision makers as well as to the own science community must be considered important not only in Germany. Dur-

ing recent years, the German geoscientific community has made great progress to communicate new discoveries to the wider public and to specific target groups respectively. Growing opportunities to communicate geoscientific findings via the media was induced in these efforts. New popular scientific TV formats were introduced, and many newspapers extended their science sections.

Currently, public outreach activities in Germany in the field of scientific drilling are dispersedly promoted as part of outreach efforts of institutes and universities. Among them are the major geoscience institutes such as AWI, GFZ, BGR, RCOM, IFM-GEOMAR and occasionally other institutes. Usually, the start and the successful ending of drilling projects, ship cruises, or the publication of important new findings related to a drilling campaign are used by the public relation officers of the institute for a press release, or universities release media information, e.g. on the occasion of having a PI or Co-Chief Scientist in a mission. In addition, established relations to the media and press allow the launch of articles in newspapers and magazines, while contacts to journalists or production firms allow the preparation of broadcast features and TV science movies. The latter is often only achieved through a commitment in co-funding of these activities. In summary, there is outreach, but no coordination or unified consistency.

In contrast, the scientific community outreach is on a well coordinated basis through the Joint Annual National Colloquia of the ICDP and IODP programs supported by the DFG and the joint publication of the journal Scientific Drilling. Both are having an important impact on the community. Nevertheless, there is an urgent need to recruit young scientists into the “drilling community”, and to provide access for education and training within the community. Thus, outreach into the broader science community also needs to be increasingly addressed.

Although several public relation activities are quite successful (e.g. regarding the mission specific platform operations carried out by the ECORD) and serve to sharpen the profile of geoscience in Germany, there was so far neither an attempt to coordinate existing outreach actions nor to create a permanent contact point covering all drilling-related issues for media and public. However, based on the great expertise and activities in drilling-related geosciences, there is an obvious added value of pooling interests and capabilities in the future such as:

a) An outreach component, which is rather inexpensive and easily achievable through a joint effort with minimum funding, will be a website as a general entry point and basic knowledge resource, providing an overview of existing expertise and referring to specific sites at the various institutions. The discussed structure of the paper on the Scientific Drilling Consortium could serve as an outline of an initial website and as a resource of further information with materials addressing specific groups, such as the service industry. This webpage will have to be continuously maintained by a professional.

b) A next step in assuring persistent up-to-date information and reference to specific issues should be the employment of a professional in charge of outreach as individual contact for the general public, the media, as well as the scientific community, and

for initiating specific outreach activities in cooperation or on behalf of projects or institutes.

To assure an effective and successful outreach program for the German Scientific Drilling Consortium, we propose to install a Task Force Group. This group should consist of outreach professionals who have experience in both public relations and education. Its major task could be to supervise outreach activities of ongoing programs and projects and at the same time initiate own activities in a coordinated way. The group could serve as a staff team to the managing board of the center. It could meet twice a year.

A communication strategy is being outlined below, which could serve as a first basis for the internal discussion of the Task Force Group. The strategic options and goals of the Task Force Group on Outreach include:

- Assessment of current situation

What has been achieved in respect to outreach on scientific drilling projects in the past? Were key messages available to be communicated to specified target groups? Which specific communication channels were used? Questions like these should be incorporated into a situation analysis (not necessarily a written document) which could then be the starting point to develop a consistent communication plan.

- Definition of objectives

As a guideline for its activities, the Outreach Task Force Group should define about three ultimate goals to make clear whereupon communication in respect of scientific drilling projects aims at.

- Definition of the target audience

During recent years, target group concepts have been established in science communication. Those concepts are helpful in order to communicate messages successfully. As the basis of its work, the Task Force Group should define target groups like “journalists”, “young scientists” etc., including subcategories like “TV-journalists”, “radio journalists” etc. and “young scientists from Eastern European countries” for target-orientated communication.

- Messages to convey

Depending on the above mentioned general objectives, the Task Force Group should develop a number of central messages to be conveyed to a specific target audience. These could be used for a unified wording in press releases, statements to the media, talks, web etc. and would strengthen a coherent communication.

- Tools

Developing communication tools must take two directions: The tools should address the drilling community and thereby improve internal communications. Also, they must address the outside world (see above: target groups). The challenge of the Task Force Group is to brainstorm and to develop strategies like written internal briefings. As a basis, the contact and address database of the individual members of the Scientific Drilling consortium could be combined and

used, e.g. the German IODP coordination maintains a database of more than 500 people who are active or interested in marine scientific drilling.

- Drilling Online

As discussed above, one of the most important communication tools is an attractive website.

- Work plan

Depending on the brainstorming, especially in relation to two last bulleted items above the Task Force Group should develop a timeline to effectively organize the communication process and to make clear what steps should be taken and in which order.

8. Present Distribution of Drilling Expertise and Facilities in Germany



Fig. 9: Distribution of expertise in Germany ○ and members of the task force ●.

Germany has always played an important role in international scientific drilling projects. Many universities and extra-university research institutes in Germany are involved in the DFG priority programs ICDP and IODP/ODP. Major activities and experience available at institutions at Aachen, Bremen/Bremerhaven, Hannover and Potsdam are outlined below. They reflect only part of the know-how and facilities within the German geoscientific community.

AACHEN

For more than 15 years, log interpretation and the study of petrophysical properties have been major research topics at the Applied Geophysics group, RWTH Aachen University. Research emphasis is placed on the characterization of rocks for geological, geothermal and hydro-geological studies, and on the physical and thermal structure of the oceanic crust with its associated time-integrated heat- and mass fluxes. These require the study of physical properties in the laboratory and the analysis and interpretation of borehole geophysical data measured in situ. Since 1999, the Applied Geophysics group at RWTH Aachen, as a subcontractor of Columbia University, has been providing logging staff scientists for ODP/IODP expeditions on a regular basis.

Lab facilities of the Applied Geophysics group, RWTH Aachen University, comprise several core scanners (thermal conductivity, spectral gamma, gamma density, sonic velocity and susceptibility) supplemented by petro-physical devices for measuring hydraulic, thermal and electrical properties on core plugs or mud samples. The Aachen working group is equipped with an Antares slimhole logging equipment suitable for holes drilled down to 1500 m. A suite of petrophysical tools (spectral gamma, acoustic, electric, gamma density) is available as well as a high resolution temperature, pressure and salinity tool. Several professional software packages exist for well log interpretation and analysis of laboratory data.

In the field of log interpretation, one major research topic of the Aachen geophysics group is the development of log interpretation methods for magmatic and metamorphic rocks. A log response database and log interpretation charts exist for various igneous and metamorphic rock types deriving from oceanic and continental crust. Studies also focus on image log interpretation techniques. The target is to develop algorithms for automatic rock classification, and identification, as well as quantification of rock and morphological features of oceanic rocks.

In the field of petrophysics, thermal and hydraulic properties of porous and fractured rocks have been addressed in various studies. Among other achievements, a fractal rock model approach was developed, accounting for the relationship between porosity and permeability, which has been confirmed for different sedimentary and crystalline rocks. More recent studies focus on NMR technologies applied to petrophysical problems. A new mobile NMR core scanner and methods for predicting porosity, permeability, and pore size distribution from NMR signals are currently being tested and adapted to rock types common in IODP. In several research projects, petrophysical data serve as input for numerical modeling, targeted, for instance, on quantifying groundwater flow by thermal methods, deriving thermal properties from logging data, and studying the influence of both paleoclimate and groundwater flow on the borehole scale. The need for improved inversion methods resulted in the development of a new algorithm for inversion, which allows describing the physical properties of rocks in a more general way.

RWTH Aachen University is part of the ECORD Petrophysics Consortium (EPC) within ESO and contributes scientific and technical support for logging and petrophysical measurements on MSPs and scientific parties on shore.

BREMEN / BREMERHAVEN

As a partner to the ESO Consortium for IODP, Bremen University undertakes the curation, databasing and archiving of collected cores. As there may not be any detailed core inspection facilities available offshore on MSP operations, Bremen provides the necessary facilities and personnel to open the cores and carry out the minimum required measurements. Bremen University contributes scientific, technical and logistical support and access to analytical facilities in the new IODP core repository, the Geosciences Department, the Center for Marine Environmental Sciences (MARUM), and the Research Center Ocean Margins (RCOM). Mobile Offshore Laboratories (e.g., for core curation, pore-water chemistry) were also provided for the first time during the two MSP projects, the Arctic Coring Expedition (ACEX, Aug/Sept 2004) and Tahiti Sea Level (Oct/Nov 2005).

Having operated the Bremen Core Repository (BCR) for the Ocean Drilling Program (ODP) for ten years, Bremen University is well experienced in the required functions and guiding policies, which were carried over into the new IODP. Close collaboration with the core repositories of the other Implementation Organizations within IODP in Texas (Gulf Coast Core Repository, GCR) and Japan (Kochi Core Center, KCC) assures international program-wide consistency and transparency for scientists working with this valuable resource material.

The experience residing at the University of Bremen in respect to deep observatories lies within the field of long-term marine observatories in ODP/IODP drillholes, so called CORKs. Within past projects, CORKs were installed, exchanged with the help of submersibles, the data was readout and interpreted. Future activity, as well in CORK design, will be within the North Pond/CRISP and NanTroSEIZE projects.

The Alfred-Wegener-Institute of Polar and Marine Research, the Faculty of Geosciences Bremen together with the BCR runs data management for projects in scientific drilling (Cape Roberts Project; ODP; IODP Mission Specific Platforms; Lake El'gygytgyn, GRIP/GISP, EPICA, IMAGES (long piston coring), ANDRILL). Equipment and experience are the following:

- Operational information system fulfilling all requirements needed for the archiving and distribution of data resulting from scientific drilling (PANGAEA – Publishing Network for Geosc. & Environmental Data)
- library and publication system for data
- open source portal software
- core group of 5 persons with 12 years of experience in information handling and project data management.

Training can be provided upon request.

HANNOVER

The Leibniz Institute for Applied Geosciences (GGA), Hannover hosts major research activities in the following areas:

- Logging and interpretation of logging data in numerous German drillholes in sediments (e.g. the maars in Messel, Baruth, Enspel, Bayerhof, Eckfeld) or drillholes in crystalline and magmatic environment (Rittsteig, Vogelsberg)
- Interpretation of logging-while-drilling measurements of ODP Leg 190 and 196 (Nankai Trough) concerning clay mineralogy; compaction in the accretionary prisms of Nankai and Barbados
- Determination of characteristics differentiating impact and maar structures using downhole measurements in impact rocks and lake sediments of the Lake Bosumtwi impact crater
- Logging in the Cape Roberts Project (Antarctica) and interpretation of downhole data regarding statistical analysis, sedimentological interpretation and analysis
- Logging in the Promess-1 Project and interpretation of downhole logging data regarding sediment deposition and climatic cycles in the Mediterranean Sea
- Logging and interpretation of numerous “geothermal” drillhole data (e.g. Soultz, Urach).

The following equipment is available at the GGA: slimhole logging tools (spectral gamma ray, neutron, geochemical logging tool, density, sonic, vertical seismic profile, borehole viewer, susceptibility, induction, induced polarisation, dipmeter, dual-laterolog, focused electric log, electric survey, Flowmeter, caliper, sampler, temperature and salinity) and a 1,300 m winch with a 4-conductor cable; a winch with a 6000 m 4-conductor cable with an analogous temperature probe (up to 260°C) and a digital tool measuring temperature, pressure, flow velocity, and gamma ray up to 170°C. Several devices exist in the GGA-labs to determine: magnetic properties of cores and core plugs (Grubenhagen); thermal properties of cores and core plugs (thermal conductivity) and the density of the cores. Also a NMR device for core plugs is available. For more than 10 years now, experience in interpretation of logging data is being gained at GGA. Especially, the statistical analysis of logging data based on spectral analysis and classification algorithms like cluster analysis, neuronal networks, support vector machines has been focused on in recent years.

POTSDAM

The GeoForschungsZentrum Potsdam (GFZ) operates a spectrum of downhole logging tools and surface equipment for a wide variety of borehole situations (see below for details): slimhole tools, standard sized tools, special tools for hydraulic investigations, winches, and test boreholes. The GFZ holds downhole measurement experience and expertise of more than 12 years in national and international projects, e.g. since 1999 the GFZ-OSG practiced downhole logging, from shallow lake drillings to the ultra deep KTB holes. GFZ participates in all stages of downhole logging planning (planning, management and operation) in various ICDP and non-ICDP drilling projects with differing targets and demands. This includes pre-project consultation, de-

velopment of a logging plan, cost and time breakdown, management and execution of downhole logging operations, and scientific evaluation of the gathered data. GFZ has special experience in analysis and interpretation of downhole geothermics investigations.

The GFZ works with two suites of tools: big size and slimhole tools. GFZ owns several winches. The most important ones are: (a) an off shore Schlumberger logging unit with a 4,500 m 7-conductor cable, (b) a Harvester unit with a 7,000 m 7-conductor cable mounted in truck and (c) a winch for operating the slimhole tools only with a 2,000 m 4-conductor cable.

The big size tool suite consists of a mud parameter tool, temperature, dual induction, micro spherical focused log, self potential-redox potential, gamma ray, spectral gamma ray, sonic, and a geophone chain for monitoring use. The slimhole suite comprises a dual laterolog, sonic, spectral gamma ray, susceptibility, dipmeter, borehole televiewer, mud parameter, Flowmeter, temperature, sampler.

The OSP of the ICDP is hosted by the GFZ Potsdam and is manned by 6 permanent scientists and engineers and 3 non-permanent staff members. The Group oversees all ICDP projects funded by the International Program in the last 10 years (Fault Zone Drilling, Volcano Drilling, Lake Sediment Recovery and Paleoclimate including Gas Hydrates, Impact Crater Research) such as Hawaii, San Andreas, Chicxulub, Unzen, Mallik, Corinth, Taiwan, Donghai/Dabie, Bosumtwi, Titicaca, Malawi, Peten Itza, Chesapeake Bay, and so forth including KTB experiments, Geothermal Research Gross Schönebeck and the Sequestration of CO₂. The following equipment is available:

- Wireline coring equipment (5.5 km)
- 5 km drill rig “GFZ InnovaRig”
- logging equipment
- mobile field lab equipment (Core scanners, core logger etc)
- complete data management program set (Drilling Information System, Data Warehouse)

On site training is available in addition to training courses for major ICDP projects in e.g. USA, Mexico, Japan, Africa, and China.

9. Interaction and Cooperation with Industry

Scientific Drilling has become a significant economic factor in Germany. Over the past years, it has become obvious, that the German geoscience community is capable to raise an increasing amount of funds for drilling and drilling-related issues. Mainly drilling-experienced scientists trained in ODP/IODP, KTB and ICDP are now addressing new scientific and societal questions with drilling and setup or operate facilities serving the global drilling community such as the Bremen Core Repository or the Operational Support Group at GFZ Potsdam. The vast majority of the acquired financial resources are spent for service industry contractors and manufacturers in Germany. Still several companies in Germany are directly or indirectly involved in hydrocarbon exploration or the exploration of mineral and geothermal resources. Via

drilling in frontier areas or through the development of tools for drilling and logging, industry often benefits directly from the activities of the German scientific drilling community.

During recent years, operational and manufacturing costs for land drilling included e.g. the CO₂-Sink Project (8 Mio. €), the GeneSys-Project in Hannover (3 Mio. €), the SuperC Project in Aachen (4 Mio. €), the planned Prometheus at Bochum University (8 Mio. €), the Geothermal Projects in Gross Schönebeck (9 Mio. €), and the new InnovaRig at GFZ Potsdam (12 Mio. €). 40 Mio € for land-drilling have been or will be invested for drilling contractors in Germany during the next three years, on average a minimum of 12 Mio € per year mere for drilling contracts. Additionally, significant funds were spent in the form of contracts with service industry companies. They also make up a considerable amount. Scientific instruments such as geophysical down-hole logging tools have been purchased for several 100 k€ by GGA, RWTH Aachen University, and GFZ Potsdam from the same manufacturer. Other costs as for example the experiments at the KTB drill site are in the range of 500 thousand € per year. Additional large funds for infrastructure and instruments, for e.g. the Bremen Core Repository (5 Mio.€), submarine drilling tools MeBo in Bremen (2.5 Mio. €), and Rockdrill at IfM-Geomar (300 k€), as well as the development of several tools for the in-situ measurements in boreholes and the post-coring instrumentation of marine boreholes (50 k€), are further important expenses.

So far, all these expenses for drilling and related science are spent individually without an overarching coordination. There is no single reliable constant partner to the service industry and accordingly no persistent relation, no unified contracting setting standards e.g. in pricing, safety policies etc. This means, each project is starting again from scratch in terms of industry relation. Nevertheless, there is a well established cooperative environment between science and service companies in Germany, which certainly could be enhanced by a coordinated contact between the science community and industry. A German Scientific Earth Probing Consortium indeed would enable numerous synergy effects and would be of great advantage with respect to coordinating and pooling major purchases of equipment, and with respect to negotiating contracts. Such a central access point could play a leading role in establishing constant and persistent relations to industry. A consequent future step is the opening of the GESEP for industry partners, which then will serve as a communication platform between science and industry.

10. Pros and Cons for a German Scientific Earth Probing Consortium (GESEP)

A lively debate about the arguments for (pros) and against (cons) the formation of a GESEP developed within the task force. Ultimately, the favoring arguments prevailed by far.

The Cons came mostly from smaller institutions, which feared the formation of a new centralized entity, drawing on the current insufficient funding and leading to additional coordination activities and to a flood of unnecessary new emails. Some of the small-

size institutions were afraid that they would lose their impetus in competition with larger and more powerful institutions, others were against a centralization of the decentral expertise. However, after an intense debate, the entire task force came to the conclusion that such fears could be overcome.

The Pros have been listed extensively on the previous pages. The material collected by the task force documents in a convincing way that diversified expertise and the capabilities of the many different groups in Germany would gain national and international visibility and scope. The new center could provide a platform for information and advice as well as public outreach and training activities. It could bring the numerous multi-scale decentralized activities in contact with each other without weakening them, and it could foster the planning for and formation of major scientific drilling programs, both on land and in the sea. It would keep German geoscientific research in touch with cutting edge technology and would guarantee a good regional distribution of the efforts and support access to sophisticated instrumentation. It would generate new and good contacts to relevant industry, it would make sure that information and experience is preserved, it would support excellent standards of operations and safety, and ensure an intense evaluation of collected data (access through data banks) as well as samples (through core repositories). Proponents for new drilling projects, who are sometimes not educated in drilling technologies, could find here the needed support in project planning and management from the first idea to the finished project. The center would comprise adequate counterparts for representatives of the drilling industry to ensure that the scientific drilling project will be customized to the technique and not the technique to the project. The center should therefore comprise an Operational Support Group.

11. Concluding Remarks

The preceding documentation of scientific interest, capabilities and growing demand for scientific drilling in German research institutions has made clear that the need for this action is steadily increasing, calling for a better coordination and organization of these activities. Increasingly larger numbers of young geoscientists are confronted with scientific problems which have to be solved through Scientific Earth Probing. They have to be made aware of all of its various aspects at an early stage, far beyond the capabilities of the individual groups.

Several German research institutions are worldwide at the forefront in scientific drilling activities. A better coordination of the diverse activities will improve their international competitiveness and make Germany one of the leading countries in scientific drilling.

The present state of the dispersed activities calls for the formation of a consortium of all qualified working groups in German research institutions as well as the foundation of a new German Scientific (Deep) Earth Probing Consortium (GESEP) while maintaining the geographically dispersed expertise and technical capabilities. Thus, we envisage a two-step approach towards facing the needs for a better organization of German scientific drilling activities: a consortium which will combine scientific and

technical resources. It will pave the way to establish a German Scientific Earth Probing Consortium.

11.1 Scientific Drilling Consortium

The consortium shall have the tasks and the responsibilities listed below:

- Pooling the entire German expertise in scientific earth probing
- representing the members interests and remaining open for industrial partners
- improving local expertise
- mobilizing available technology of its members
- fostering technological exchange between partners
- coordinating regional activities without limiting local developments
- supporting small-size institutions
- intensifying interdisciplinary cooperation
- preparing a master plan for the establishment of the German Scientific Earth Probing Consortium (GESEP)
- The following financial arrangements are envisaged:
 - Modest membership fees by the participating institutes
 - financial support by DFG / BMBF / Foundations

11.2 Tasks, Structure and Staffing of the GESEP

In the following paragraph the basic tasks, initial structure and potential staffing of the GESEP are suggested. The “initial phase” of the GESEP is proposed to start soon (fall 2007), if the planned Consortium on Scientific Earth Probing will be established by that time. Accordingly, the GESEP in its initial phase should be run by or attached to an already existing infrastructure. However, a second, more sophisticated, fully operational phase is envisaged which will require additional funding as well as a fully operational Consortium on Scientific Earth Probing.

Tasks during the initial phase:

- Generating and acting as the national information platform
- fostering the integration of the national continental, lake, marine and ice drilling communities
- establishing linkages and ties to German scientific drilling institutions towards a joint virtual institute
- providing technical and logistical advice and assistance in planning and eventually conducting scientific drilling projects and site surveys
- coordinating and structuring planning processes
- assisting in the preparation of scientific drilling proposals
- gathering and distributing information about funding possibilities
- evaluating commercial bids
- coordinating existing public outreach and developing an GESEP outreach program
- developing partnership with industry

- coordinating, representing, and promoting German scientific drilling interests

During the fully operational phase:

- Developing instrumentation and technologies for drilling engineering and on-site/initial science
- establishing and running a national scientific core repository for continental cores
- coordinating and establishing data archives
- developing training programs for (graduate) students and scientists
- technically coordinating the German components of major drilling programs (IODP, ICDP, ANDRILL, EPICA, etc.).

Structure and Staffing

Initial phase:

In the initial phase of GESEP, a coordination office with 1 or 2 scientists plus 1 assistant under the supervision of the growing Consortium on Scientific Earth Probing is believed to be sufficient. It is suggested, that members of the consortium (departments, research institutions, industry and universities) may delegate personnel to the office for a limited time span (e.g. 6 months).

Fully operational:

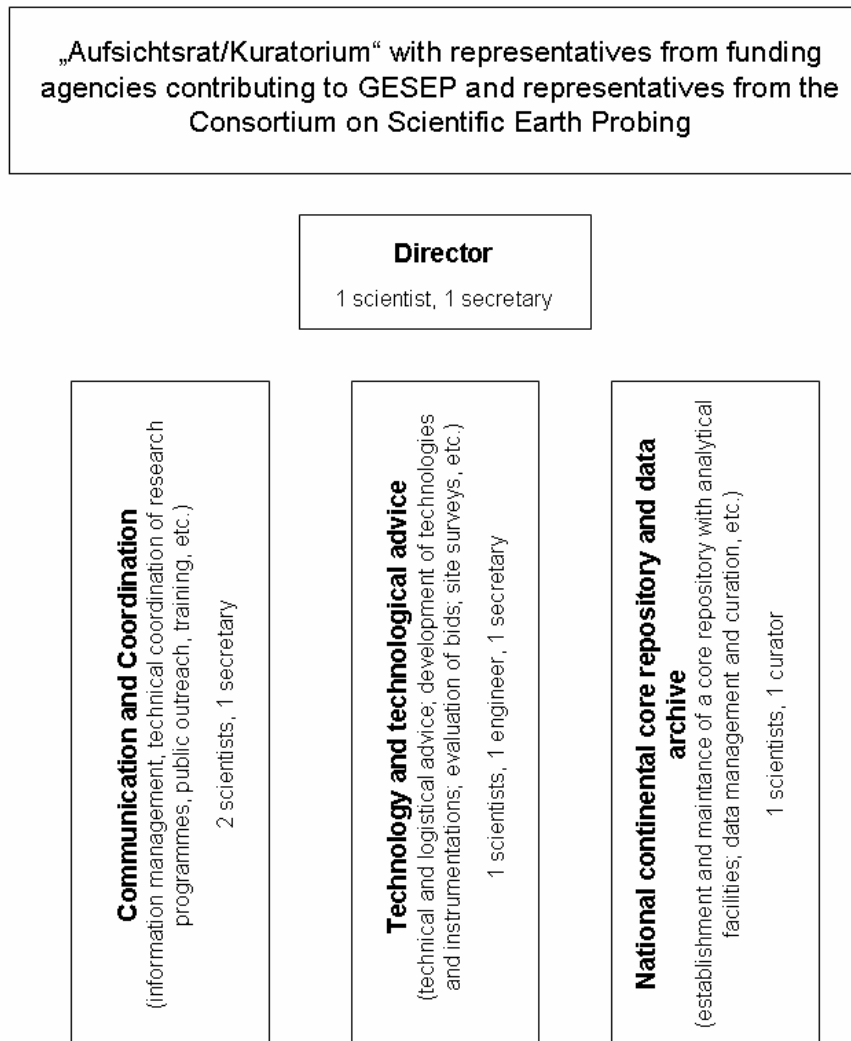


Fig 10: Structure and staffing in the initial phase of GESEP.