5.5 SCIENTIFIC-TECHNICAL COLLABORATION WITH OSG

The principal task of the OSG during the operational phase of ICDP drilling projects is to support the scientists involved in the project in the acquisition and management of on-site data. This is done by providing equipment and instructions on its use (e.g., core scanning and logging, gas analysis), performing measurements (downhole logging & monitoring, fluid sampling), and training and support in data management (Drilling Information System, DIS). The on-site data lay the foundation for further scientific investigations by the project scientists. The tasks of the OSG generally do not include performing measurements for OSG staffs´ own scientific purposes.

It is a prerequisite for the funding of drilling projects by ICDP that projects should cover the broadest possible spectrum of relevant scientific issues. However, not all projects funded by the ICDP are able to fully exploit the scientific potential of their drills on their own. Besides staffing issues, reasons for this can be 1) lacking knowledge on new or unknown investigation methods or 2) on the scientific potential of new interpretation of already existing data for the drilling project. The latter (2) may apply, for example, to the scientific interpretation of geophysical borehole measurements (downhole logging).

In lacustrine sediment drilling, the geophysical logging data are often only used to establish depth correlations between drill core and drill holes, but is not further interpreted scientifically. However, beside its value for depth correlation, data from downhole logging also provide significant scientific insights for paleoclimate reconstruction, e.g., on glacial/interglacial cyclicity. The further (1) is relevant to the ICDP online gas analysis of drilling mud OLGA, a relatively new method which, in several ICDP drilling projects, provided important information on fluid compositions and fluid pathways in the subsurface, ideally in combination with downhole fluids and gases taken by the ICDP downhole fluid sampler.

In order to exploit the scientific potential in the field of fluid and gas geochemistry as well as borehole geophysics as comprehensively as possible, the OSG offers cooperation in these subject areas within the framework of a scientific collaboration. The impetus for scientific cooperation between the OSG and the project beyond common operational support should be initiated by the projects. The cooperation between the project scientists and OSG covers the entire course of the experiment, starting with planning and logistics, joint execution of the experiment, evaluation of the data and joint publication. The participating project scientists are thus given a comprehensive insight into the implementation of the experiment. The know-how thus gained is intended to support future own research in the corresponding research field.

Workflow OLGA

If science teams are interested in a scientific collaboration in the field of borehole fluid and gas geochemistry, they are kindly invited to contact the OSG as soon as a concrete time frame for the drilling has been determined. This helps to ensure that the necessary instruments can be made available for the envisaged period. The instruments will then be reserved for the project at the requested time.

For ICDP’s OnLine Gas Analysis of drilling mud OLGA, the project has to provide the staffing to oversee, run, and maintain the experiment on site, ideally a PhD student or postdoc with an interest in geochemistry and a minimum of technical understanding. Once the OLGA instruments are set up and operational, daily standard maintenance does not take more than 2 hours per day. The scientific equipment is provided for the projects for the duration of the experiment on the basis of a loan agreement. No user fee is charged, the only costs for the project are transport and a small fee for consumables. However, the project is liable for damages caused by negligence and loss. Taking out an insurance can be useful here.

In order to ensure that the OLGA experiment is carried out successfully by project scientists, they are trained in the use of the instruments by the OSG. The training can either take place at the GFZ in Potsdam, Germany, ideally a few weeks before drilling begins and e.g., in combination with other training measures (DIS, MSCL, Optical Core Scanner), or on site immediately before drilling begins. Experience has shown that the time at the drill site shortly before drilling begins is relatively stressful, which can make effective training difficult. Therefore, training at the GFZ is, in principle, the better option. The costs for such a training are shared between the project (travel costs) and ICDP (accommodation, food, local transport).

The OLGA experiment is set up on site by the responsible scientist and the OSG a few days before spud in. It takes about 3-4 days to set up, including all calibrations. During drilling operations, the measurements are performed by the responsible scientist on site. Online access or regular transfer of the raw data to the OSG helps to ensure that the experiment is conducted correctly. If necessary, the OSG provides support during the execution of the experiment via e-mail, videoconference or telephone. Only if repairs are required that cannot be carried out by the on-site scientist, an OSG representative will travel to the site in person.

The data evaluation includes, first of all, the creation of gas depth profiles to identify fluid inflow zones in almost real-time. Possible further supporting measurements on gas samples (e.g., noble gas isotopes) can be arranged at the GFZ and can be conducted either by the OSG or project scientists. These measurements do not involve any additional costs, but if they are carried out by project scientists, the costs for their stay at the GFZ (travel, accommodation, meals) must be borne by the project.

The use of the OLGA system implies scientific collaborations between the OSG and a science team member (STM) of the drilling project and should result in a joint publication (Podugu et al., 2019, Wiersberg et al., 2020).

Fig. 6.5: Possible knowledge transfer workflow in ICDP projects

OSG downhole logging support

The OSG offers support for downhole logging in ICDP projects. The support encompasses evaluation and support of planning and management of downhole logging programs within ICDP proposals, the actual performance downhole logging, and the scientific interpretation of the acquired data. OSG's level of assistance in preparing downhole logging programs primarily depends on the requests of the ICDP project PI's. It can be comprised of:

- helping to develop or optimizing a downhole logging plan that accommodates the scientific targets and the given project conditions

- review of offers and quotations of potential logging service providers (time and availability of equipment & expertise)
- support with the equipment acquisition
- cost assessment.

If desired, the OSG can carry out downhole logging measurements with its own logging equipment suitable for most ICDP logging conditions. The close in-house cooperation with other OSG experts (drilling, core handling and data management) assures smooth and optimized operations. If desired the OSG may also assist in the management and oversight of logging activities of external providers.

OSG logging can complement any other logging services or carry out all the downhole logging of a project. Costs are minimized and are comprised only of a very low tool utilization fee, travel/transport costs of personnel and equipment and insurance of the equipment. No depth or measurement charges and personnel costs are imposed as these are covered by overall ICDP funds. The low costs enable downhole logging even for ICDP projects with a low budget.

OSG participation in downhole logging operations is not mandatory. OSG consulting is free of charge for ICDP projects. OSG cannot and will not compete with commercial logging service providers. OSG preferably recommends the use of commercial services if these provide more parameters, higher resolution, more powerful, advanced methods, and if the project budget allows.
Following the actual downhole logging campaign, a logging job report is compiled comprising the operational details: logging tools used, logging depth intervals, depth reference, number of runs, problems encountered, statistics, and first findings, if possible. Logging data itself are usually not handed out on-site but only later after depth correlation and environmental corrections have been applied at the office.

OSG log interpretation support

Some ICDP projects use the acquired downhole logging data only for core depth correction and for filling gaps in sections with core loss. In these cases, the downhole logging data are not further evaluated so that the high-quality logging data are achieved with great effort but the full potential of the data is not fully utilized.

The under-utilization of the downhole logging data is usually because individual ICDP project teams are missing a logging specialist to analyse, interpret and undertake research using the available logging data. The downhole logging team of the OSG provides geoscientific analysis and interpretation of downhole logging data. In case an ICDP project has no resources to analyse and interpret the logging data, the OSG logging team can perform the analysis and interpret the borehole measurement data, thereby adding value to the ICDP project. Some of these analyses have to be combined with additional data (i.e., core/cuttings data, seismic data) from other research teams. In such cases the OSG logging team becomes member of the project's science team and gets access to the complete dataset of the ICDP project.

The OSG logging analyst will work on the logging data as part of a research project that will result in publications, where logging is integral to achieving an expedition’s objectives. The interpretation of downhole logging data and the results will be submitted to the PIs for approval and then be published according to the Science Team plan.

In case the ICDP project team already includes an individual or a group with an interest in a specific logging dataset but not in the other available collection, the OSG logging specialist can be involved in analysing the other pool of borehole logging data according to the PIs and the aim of the ICDP project. Together with the team, the entire pool of logging data can be integrated adding value to the scientific output of the project. An additional aspect of the involvement of a logging analyst concerns the data quality control of downhole logging measurements. During the logging campaign technical problems with tools or the well may occur but remain unrecognized during the acquisition phase. Afterwards, the logging analyst can perform quality control of the data set (e.g., the orientation of the tool, value of the data reasonable) and identify any artefacts in the logs.

Lake Projects are an outstanding example where downhole measurements can complement core losses or poor recovery. Often the ICDP Lake project team does not have a specialist or a specific interest in using downhole geophysical measurements. Together with the OSG, the OSG can design a scientific plan on how to utilize the logging data. Recent approaches that use the downhole logging data focus on:

1. Reconstruction of the history of lake records covering the glacial-interglacial cycles data without the high-resolution data derived from core analysis. The response of depositional environments to the climatic variations is periodic in time and these climatic variations are embedded on sediments and recognized as variation in their physical properties (e.g., grain size, mineral type, mineral abundance especially for clay, organic matter), which are also detected by downhole logging measurements.
2. Identification of glacial/interglacial cyclicity merging the downhole logging data (e.g., GR, SGR, MSUS) and mineralogical analysis. Linking the abundance and the lack of e.g., clay minerals in core samples with the downhole logging data, a relationship between geological history of the lake and climate change processes can be recognized reflecting glacial/interglacial climate cyclicity.
3. Facies characterization from downhole logging data by cluster analysis. Downhole logging data of lacustrine sediment records can be analyzed in terms of sediment evolutions and lithological changes.
4. Core-log seismic integration allows relating physical properties of reflectors found in the core records to seismic profile in order that the spatial and temporal extent of these reflectors can be traced well beyond the borehole. In the course of this process, geophysical logging data acts as an intermediary in achieving this goal. CLSI allows integrating core measurements, logging data and seismic data, which differs in spatial resolution and rock properties.
5. Combination and integration mud gas data (OLGA), core and logging data, as successfully done at the ICDP COSC-1 project.

5.6 THE ICDP EQUIPMENT POOL

Most of the research in continental scientific drilling projects is performed after drilling operations in labs. However, there are investigations that, for several reasons, need to be executed during drilling. This includes:

- on-site investigations to provide rapid information for aiding decisions, e.g., core/borehole correlation studies for depth matching or the identification of target depths related to formation testing, sidewall coring, or side tracking
- studies (downhole logging, fluid sampling) requiring access to open hole
- studies on ephemeral properties and on microbiota
- studies providing a fundamental database for all subsequent research activities (e.g., lithological log)

Given the limitations in manpower, time and space at most drill sites and the rough on-site conditions (e.g., fluctuating power supply), the set of scientific on-site investigations should be limited to the absolute minimum. Generally, sampling should be performed after completing the drilling operations, e.g., during sample parties in core repositories. Some studies, however, require sample material to be obtained immediately after fresh core arrives at the surface, e.g., microbial sampling for deep biosphere studies, or any sampling of material that would otherwise suffer decay, degradation or contamination at the surface. Furthermore, sampling of fluids and gases from downhole fluid sampling, drilling mud gas and core voids require immediate action at the drill site. The sampled material must be stored immediately after sampling under special conditions regarding temperature and pressure (e.g., vacuum) to avoid degradation or contamination. On-site sampling must be requested from and approved by the Principal Investigators prior to spud-in.

On-site science in lake drilling

During lake drilling projects, where mostly soft sediments are retrieved, the drill cores remain in their respective plastic core liner until they reach the designated core repository, which naturally limits the applicable on-site research to non-destructive methods which penetrate through the core liner (e.g., Magnetic Susceptibility measurements on un-split cores conducted on with multisensor-type scanner). Core opening, washing, sawing, lithological description (except of core catcher material), optical and X-ray based investigations and sampling will therefore be conducted after drilling.

For most lacustrine and lake sediment drilling, the completeness of a core record from a drill site is crucial, which can be provided on site by core-borehole correlation. For this purpose, magnetic susceptibility and gamma density measurements on drill core and downhole logging are the most common tools. Gamma density measurements require logging with radioactive sources that is logistically challenging and therefore not provided by the OSG. Magnetic susceptibility, obtained from drill core by core logging (using a Multi Sensor Core Logger-MSCL), in combination with downhole logging therefore builds the base for site-to-site core-borehole correlation, and is thus strongly recommended for lacustrine drilling projects.

On-site science on land

In contrast to lake sediment drilling, where several holes are drilled at one site for the completeness of a sediment record, land drilling projects with a multi-hole approach follow different objectives. The purpose of two or more holes (Monitoring Hole/Pilot Hole/Main Hole) at one site is here i) to get background information on the lithology for later Main Hole drilling, ii) for seismic or hydraulic cross-hole investigations, and iii) for long-term monitoring. While some ICDP drillings have retrieved an almost complete core record by wireline coring (e.g., Songliao Basin, Oman, COSC, Donghai, HOTSPOT, Barberton), other projects (e.g., SAFOD, Mallik, IDDP) recovered only spot cores from target horizons. Depending on the drilling techniques used in scientific drilling projects (slimhole or oilfield-drilling), rock sample types (cuttings or core), and project objectives, different on-site investigations are recommended for aiding rapid decisions, including the lithological description of core or cuttings, drilling data (lag depth, ROP, WOB, time in/out, drilling mud volume etc.), MWD/LWD (if available), core scanning, core and downhole logging, and on-line gas monitoring (if available).

Mining drilling mostly delivers continuous core that can be opened, described and measured at the drill site (core scanning and logging). The lithological description of core, core scanning, and downhole logging build the data base for making decisions on site and furthermore provide an important dataset for later sampling parties.

Table 5.1: Different drilling methods and sizes for the various drilling scenarios as part of planning and conducting drill experiments on land and on lakes

Drilling Technique	Lake Sediment Drilling	Continuous Coring/ Mining drilling	Rotary Drilling/ Oilfield drilling
Borehole Diameter	PQ, - HQ - NQ (123 – 95 – 76 mm)	PQ, HQ, NQ (123 – 95 – 76 mm)	26-22-17 ½ -12 ¼ - 8 ½ - 6 ¼ inch
Average numbers of holes per site	>1	1-2	1-3
Coring technique	continuous wireline coring	continuous wireline coring	Roundtrip, spotcore
Most common sample type	core	core	Cuttings, spot core, sidewall core
On-site core handling	Core remains in liner. Marking, packing, labeling.	Opening, cleaning, sawing, description, marking, packing, labeling	If applicable: opening, cleaning, sawing, description, marking, packing, labeling
On-site core investigations	Core Logging (MSCL)	Core Logging (MSCL), Core scanning	Core scanning
On-site lithological description	-	Based on core	Based on cuttings
Use of drilling data	Limited, data not continuously recorded	Limited, data not always continuously recorded	Continuously recorded (RoP, WoB, Lag Depth….)
Other methods	Downhole Logging	Downhole Logging	Downhole Logging, MWD/LWD, OLGA, Downhole Fluid Sampling
Further borehole use	-	VSP/MSP, long-term monitoring	VSP/MSP, Testing, long-term monitoring

Most projects applying oilfield-drilling technique have to deal with cuttings: small rock chips of variable size dragged out of the borehole by circulating drilling mud. Drill core is only available from few target horizons, if ever. The lithological description on-site is therefore based cuttings analysis. In contrast to mining drilling, continuous technical drilling data are often available in oilfield drilling which are important for e.g., cutting analysis (lag depth) and for making on-site decisions. As for the other drilling techniques, downhole logging is performed during drill stops, but oilfield drilling also allows integration of logging tools to the Bottom Hole Assembly (BHA) (MWD, LWD) which can deliver data in almost real-time. Cutting analysis can prove in almost real-time if side-tracking is successful.

Available tools

Instruments and tools acquired through ICDP grants are integrated and maintained in the ICDP Equipment Pool by the Operational Support Group (OSG). Project scientists can operate a number of these scientific instrument sets at drill sites. The tools will be provided to ICDP projects on request. Requests are to be made as early as possible (first-come, first-serve policy). The OSG usually introduces on-site scientists of individual projects to the use of these devices. The instruments listed below have been used at several drill sites in support of the core handling procedures and the initial core description.

Multi-Sensor Core Logger

The Multi Sensor Core Logger (MSCL, Geotek) measures a suite of geophysical parameters rapidly, accurately and automatically on sediment or rock cores. The rugged nature of the equipment makes it suitable even for use in a laboratory container on-site (Fig. 8.1). Core sections up to 10 cm diameter and up to 1.55 m long can be logged at spatial intervals as low as a few millimetres. ICDP's Multi Sensor Core Logger is configured to measure:

- P-wave velocity (250-500 kHz piezo-electric ceramic transducers, spring-loaded against the sample. Accurate to about 0.2%, depending on core condition
- Gamma density (bulk density): ^{137}Cs gamma source in a lead shield with optional 2.5 mm or 5 mm collimators. Density resolution of better than 1% depending upon count time
- Magnetic susceptibility: Bartington loop sensor of 100 or 120 mm diameter, or point sensor (on split cores) giving 5% calibration accuracy over two ranges: 1×10^{-6} and 10×10^{-6} cgs.
- Natural gamma radiation: three 3″ × 3″ NaI(Tl) detectors housed in 6″ diameter lead shields generate 1024 channel spectra to be used for calculating elemental yields for K, U and Th.

Fig. 5.9: Multisensor core logger in field lab

Data can be obtained from whole core sections and core sections contained in plastic liners. More details on instrument functionality, calibration and so on can be found under: http://www.geotek.co.uk/products/mscl-s. Additional information on typical parameters measured for drilling projects:
www-odp.tamu.edu/publications/tnotes/tn26/TOC.HTM.

Prerequisites for core logging

MSCL measurements are essential for depth matching of drill core from lake and soft sediment drilling. If the ICDP owned scanner is used, space must be provided in a laboratory trailer, container or similar makeshift lab space. The size of the MSCL is

$4.7 \times 1.4 \times 0.9\ m^3$ ($l \times h \times w$) plus some additional space ($0.6 \times 0.6\ m^2$) is required for the electronics bench. Trailer space can be utilized alongside other instruments (e.g., Core Scanner) if no liquids (e.g., water) are used in the trailer. Power supply (220 V) must be buffered or electrically disconnected and independent from rig power (e.g., external generator or public power supply). The power input of the MSCL is ~2000 VA.

Scientists should state in their full proposal to ICDP that they are interested in utilizing the ICDP MSCL. Requests to use the devices are to be made to OSG as early as a drilling timeline is fixated. In case of overlapping requests, ICDP's OSG will try to organize one device from other sources for the group, which placed the request at a later time. The equipment will be provided on the base of a lending agreement. Shipping costs, custom fees, etc., are to be covered by the project.

Scientists in charge of operating the MSCL have to be designated by the project. ICDP will not provide the manpower to operate and maintain the experiment during drilling but technical support if necessary. Training of on-site operator(s) can be conducted by OSG in Potsdam some weeks prior to drilling operations start. Costs for training are to be shared between the project and ICDP. The on-site instrument operator with OSG support will assemble the experiment immediately before spud in.

Optical Core Scanner

ICDP provides one DMT Core Scan3 line scanning device. The instrument allows optical high-resolution scanning of whole or slabbed hard rock drill cores and soft rock half cores in diameters from 4 to 22 cm and maximum length of 1 m. The device can also be used to scan cuttings and other sample specimens in close-up views. Additionally, the DMT Core Scan3 is capable to acquire core box overview scans. Image sizes are up to 25 MByte with a resolution of 5 - 10 pixel/mm = 127 - 254 dpi.

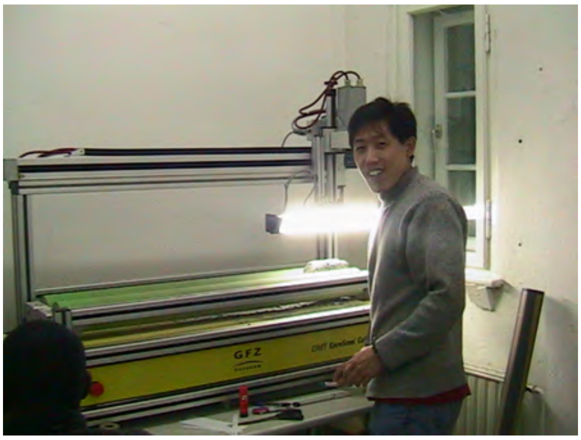

Fig. 5.10: Optical core scanner in operation

Prerequisites for scanning

Optical scans of whole round cores are essential for initial and long-term digital documentation (and distribution) with the ICDP Drilling Information System. Ideally this happens in the field, right after core retrieval. Thereafter, cores are cut and sampled, annotations of characteristics and sampling made, and/or digital geological profile construction, core-log integration or well correlation, re-orientation, tectonic, petrographic and image analyses are performed.

Interested scientists should apply to use one of the ICDP scanners in their full proposal to ICDP. Requests to use one of the devices are to be made to OSG as early as a drilling timeline is fixed (first-come first-serve policy), but ICDP cannot guarantee that a scanner will be available. The equipment will be provided free of costs on the base of a lending agreement but shipping and related fees are to be covered by the project. If not part of an ICDP grant a maintenance fee may be necessary.

A core scanner at a drill site requires about $2.5 \times 2\ m^2$ space in a dry place such as a laboratory trailer, container or similar. Trailer space can be shared with other instruments (e.g., MSCL). Power supply (220V) must be buffered or electrically independent from rig power (e.g., external generator or public power supply).

OSG cannot provide the manpower to operate and maintain the experiment during drilling, but will support it remotely as necessary. Hence, an operating scientist or program-aid (student; temporary technician hired for the project, or project volunteers) has to run the tool. On-site operator(s) of a scanner can be trained by OSG at the GFZ in Potsdam. Costs for specific instrument training are to be shared between the project and ICDP. The on-site operator with OSG support will assemble the experiment immediately before spud in.

OnLine GAs monitoring OLGA

Continuous mud gas logging during drilling as well as offline mud gas sampling are standard techniques in oil and gas exploration, where they are used to measure hydrocarbons in reservoir rocks while drilling. ICDP's online gas monitoring OLGA extends this technique for scientific drilling in hydrocarbon and non-hydrocarbon formations to sample and study the composition of crustal gases. Hydrocarbons, helium, radon and with limitations carbon dioxide and hydrogen are the most suitable gases for the detection of fluid-bearing horizons, shear zones, open fractures, sections of enhanced permeability or permafrost methane hydrate occurrences. Offsite isotope studies on mud gas samples serve to reveal the origin and evolution of deep-seated crustal fluids.

OLGA has been proven to be a reliable and inexpensive source of information on the composition and spatial distribution of gases at depth in real time. It is suitable to detect fluid-bearing horizons, shear zones, open fractures, sections of enhanced permeability and methane hydrate occurrences in the subsurface of fault zones, volcanoes and geothermal areas, permafrost regions, and other rheological formations. Offsite isotope studies on mud gas samples help reveal the origin, evolution, and migration mechanisms of deep-seated fluids. It also has important applications to aiding decisions if and at what depth rock or fluid samples should be taken or formation testing should be performed. The method had been successfully applied on several continental scientific drilling projects of ICDP (Mallik, SAFOD, Unzen Volcano, Koyna, COSC-1) and IODP (NanTroSEIZE EXP. 319, 338, 348).

Operation Flow

Drilling mud gas that circulates in the borehole comprises air and gaseous components that are mechanically released by the drill bit, including components present in the pore space of the crushed rock and gas entering the borehole through permeable strata, either as free gas or, more likely, dissolved in liquids. Continuous inflow of fluids in the borehole along the entire borehole wall is mostly hampered through the rapid formation of mud-cake that covers the borehole wall and acts as a seal.

Back at the surface, a portion of the circulating mud is admitted to a mud gas separator and gas dissolved in the drilling mud is extracted mechanically under a slight vacuum. The separator is composed of a steel cylinder with an explosion-proof electrical motor on top that drives a stirring impeller mounted inside the cylinder. The gas separator is normally installed in the 'possum belly' above the shaker screens as close as possible to the outlet of the mudflow line to minimize air contamination and degassing of the drill mud immediately before gas extraction (Fig.

8.3). A small membrane pump is used to build up vacuum and to pump the extracted gas into a laboratory trailer, which should be installed not more than a few tens of meters away from the gas separator.

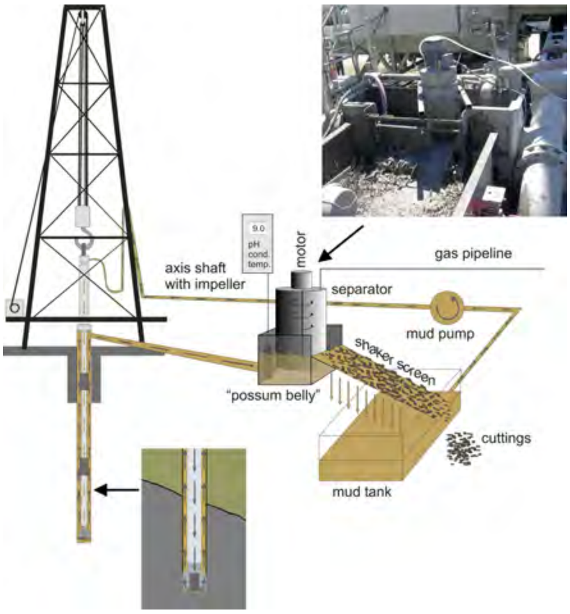

Fig. 5.11: Scheme of drill mud flow and gas extraction by gas separator; inset photo shows gas separation device

N_2, O_2, Ar, CO_2, CH_4, He, and H_2 are determined by a quadrupole mass spectrometer (QMS) of the type OmniStar™ (Pfeiffer Vacuum, Germany). A complete QMS analysis with detection limits between 1 and 20 ppmv (parts per million by volume) is achieved with this setup after an integration time of less than 20s (Fig. 8.4.). However, a sampling interval of one minute is mostly chosen to reduce the amount of data produced. Hydrocarbons (CH_4, C_2H_6, C_3H_8, i-C_4H_{10}, and n-C_4H_{10}) are analysed at 10-min intervals with an automated standard field gas chromatograph (GC), which is equipped with a flame ionization detector. Detection limits for the hydrocarbons are at about 1 ppmv. Gas samples for further studies e.g., of isotopes are taken automatically when a given threshold level at the QMS is exceeded.

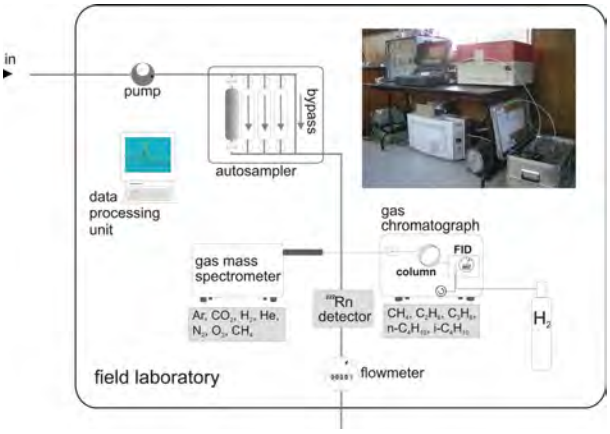

Fig. 5.12: Flow path of gas analyses steps

Prerequisites for gas monitoring

The drilling mud acts as carrier for fluids and gas transport to the surface. Drilling mud circulation is therefore crucial to apply OLGA. The method is, for example, not applicable for lake drilling. OLGA will not replace commercial mud logging for hazard warning purposes.

ICDP will provide all necessary equipment for a successful execution of the experiment. In turn, the project must provide space (2×3 m^2) in a laboratory trailer, container or similar facility. Trailer space can be shared with other groups if no liquids (water) are used in the trailer. The lab trailer should be placed in close vicinity (not more than 50 m) to the shale shakers to keep the travel time of the gas short. Power supply (220 V) for the analytical devices in the lab trailer must be electrically separated from rig power (e.g., external generator or public power supply). The power input of the analytical devices is ~1000 VA.

Gas composition data are recorded versus time. Additional data are needed to convert the raw data set into gas composition at depth. These data (lag depth, ROP) must be provided, for example, from mud logging or the drilling company on a minute base (ideally), but at least every five minutes. The equipment will be provided on the base of a lending agreement. Shipping costs, custom fees, etc., are to be covered by the project.

The OSG will offer the OLGA system upon request if a project scientist can run the instrument on the drill site. ICDP will not provide the manpower to operate and maintain the experiment during drilling, but will provide technical support from outside if necessary. In addition, OSG will train the on-site operator(s) before a drilling project starts. The costs for this training will be partly covered by ICDP. The on-site operator and the OSG gas geochemist will assemble the experiment immediately before spud in. OSG offers OLGA as part of a scientific cooperation for joint data evaluation and interpretation. Additional lab investigations on, for example, noble gas isotopes can be arranged by OSG if prepared beforehand.

References

Podugu, N., Mishra, S., Wiersberg, T., Roy, S. (2019) Chemical and noble gas isotope compositions of formation gases from a 3 km deep scientific borehole in the Koyna Seismogenic Zone, Western India, Geofluids, vol. 2019, 1078942, doi.org/10.1155/2019/1078942.

Wiersberg T., Pierdominici S., Lorenz H., Almqvist B., Klonowska I. (2020): Identification of gas inflow zones in the COSC-1 borehole (Jämtland, central Sweden) by drilling mud gas monitoring, downhole geophysical logging and drill core analysis, Applied Geochemistry, Volume 114, 104513, doi.org/10.1016/-j.apgeochem.2019.10451.

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