The provision of

offshore geological sampling services

in connection with the

Petroleum Infrastructure Programme Group 4

Report from cruise
CE0619
with R/V CELTIC EXPLORER
on the Porcupine Bank

by

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1. Introduction

PIPCo RSG Ltd, the company that represents the members of the Irish Shelf Petroleum Studies Group (ISPSG), awarded a contract to the Centre for Marine Environmental Sciences (MARUM) to deploy the seafloor drilling rig MeBo from the Irish Marine Institute's research vessel, "Celtic Explorer". The aim of the drilling programme was to acquire hard rock samples from the principal rock types of the Porcupine Bank (Fig. 1), in a number of pre-selected locations with a maximum sampling depth of 50 m.

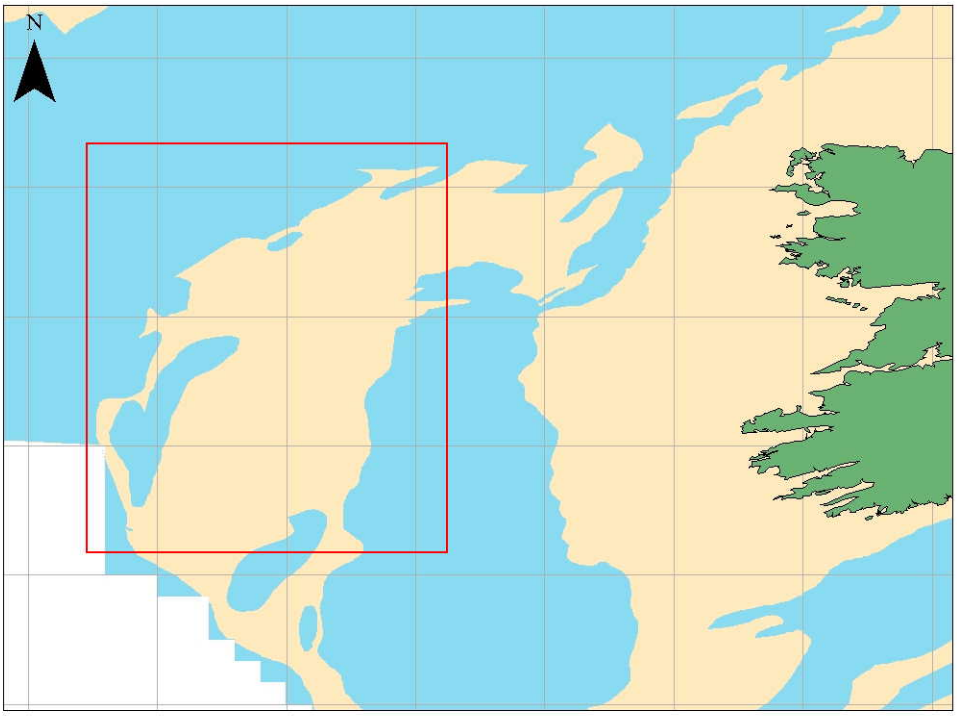

Fig. 1: Research area of interest

ISPSG wished to deploy MeBo from the Celtic Explorer in cooperation with MARUM and the Marine Institute who wished to obtain further drilling experience with the sea floor drill rig MeBo, to demonstrate the ability of Marine Institute to deploy MeBo on an Irish Research vessel and to consolidate a partnership between the Marine Institute and the University of Bremen for the provision of sea floor drilling services for research.
The work was estimated to require 10-11 days of acquisition and an estimated 3-4 days mobilisation / demobilisation. The RV Celtic Explorer mobilised on the 13th July and set sail on the evening of the 15thth July.

2. Narrative of the cruise

On 12 July 2006 the launch and recovery system (MeBo-LARS) was installed by the decks crew of the R/V CELTIC EXPLORER on the working deck. The drill tool container was unloaded at the pier and the drill tools were loaded on a pipe rack on the working deck. A 300-tonnes crane arrived at the morning of 13 July at the pier. The winch, the drill rig, the workshop container and the control container were loaded on deck and first installation work was conducted. Installation of the MeBo system as well as construction of a supporting structure for the control container continued at 14 and 15 July. Next to usual connection work of power and communication lines and placing into operation of the MeBo system a newly developed emergency release system had to be installed and tested during the mobilisation. A harbour test for the launch and recovery of the MeBo and a check of the high voltage system was conducted before we set sail for the first station on the evening of 15 July 2006.

We reached the first station at the northern rim of the Porcupine Bank (Fig. 2) in the afternoon of the 16th July. Following test on the system and modification of the emergency release on the 17th July a first test deployment, which reached a drill depth of 2.54 m was conducted on the afternoon of 17 July 2006 (GeoB10901-1// **25/7-sb(MeBo)1**). After successful modification of the emergency release and reorganisation of the communication lines we were able to deploy the drill rig 4 times at three different stations between 18 July and 21 July until bad weather stopped drilling during deployment GeoB10903-2 // **25/27-sb(MeBo)3** at 8.6 m depth below sea floor. The drill rig performed well in the difficult geology (up to 6.8 m cover of sand and gravels above hard rocks) and cored granite at site GeoB10902-**1 / 25/7-sb(MeBo)3** and gneisses and breccias with metamorphic boulders at site **GeoB10903-2 / 25/27-sb(MeBo)2**.

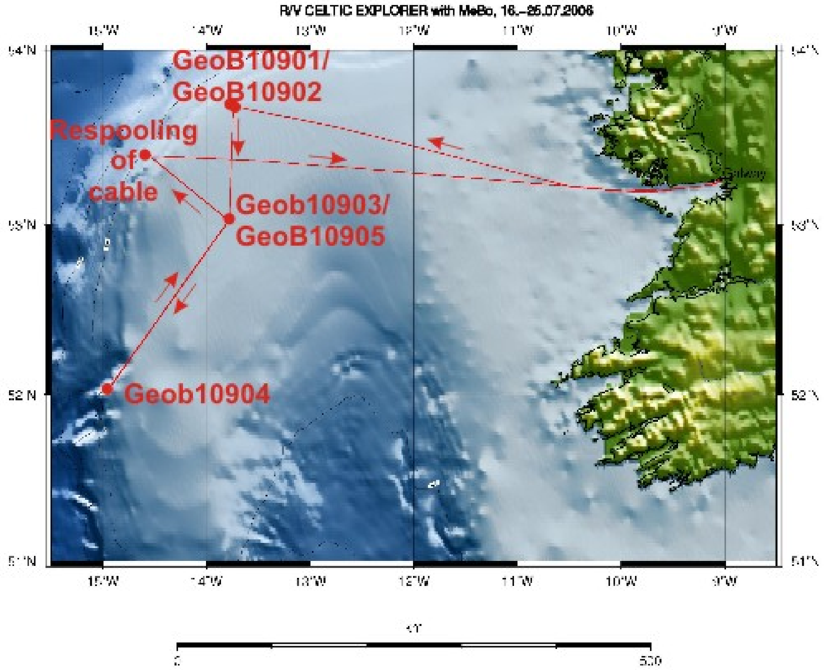

Fig. 2: Cruise track for research cruise CE0619, 15.7. – 25.7.2006

After the bad weather period, the fourth deployment took place during the night of the 22/23 July in water depths approximately 700 m. Deteorating weather during the deployment made landing the drill on the sea bed difficult and resulted in damage to the drill, the loading arm slipped out of its bearing and the drill had to be recovered. During repair works on the MeBo we were forced to return to the previous site as the damage to the drill prevented any further deployment at site **GeoB10904-1 / 74/26-sb(MeBo)1**. After returning to **GeoB10905-1 / 25/27-sb(MeBo)3 we** drilled down to 2.6 m below sea floor until a hydraulic pump of the drill rig failed at the late evening of 23 July. The hydraulic failure was inspected the following day and it was discovered that the damage could not be repaired on board. The Celtic Explorer Then sailed to a nearby location with water depth of 1000 m. Here we were able to respool the cable in order to alleviate the high tensions on the cable, that occured during recovery of the drill at the 700 m station at high dynamic loads due to the weather, this work was completed on the evening of 24 July. We returned to the harbour on the evening of the 25^{th} July. Demobilisation of the equipment followed, which took two days.
In summary MeBo drilled approximately 19.3 m at three different sites. Maximum penetration was 8.6 m and the maximum deployment time was just under 16 hours. We had three days downtime due to technical problems and one day due to bad weather conditions. The drill was able to core granite and metamorphic rocks as well as to penetrate (and partly sample) gravel and sand layers of up to 6.8 m thickness. The experience that was collected during this cruise will be used in order to increase the time efficiency of the system.

3. Sampling procedure and operation overview

3.1. MeBo System overview

The underwater drill rig MeBo (“**Me**eresboden-**Bo**hrgerät”, German for “sea-floor drill rig”) is an electro-hydraulic system that was developed at the Marum Center for Marine Environmental Sciences (Marum) in 2004/2005. This portable and remotely operated drill can be deployed from research vessels of opportunity. It is launched on the sea floor and is capable of retrieving 50-m long cores from sediments and hard rocks.

The central parts of the drill are the drill head and the feeding system (Fig.3). The drill head is a rotary unit that provides the required torque and rotation speed for rotary drilling and for making or breaking the threads of the drill string. The feeding system consists on the mast along which the drill head mounted on a guide carriage moves up and down. Cores are taken from the sea floor by simple pushing a push core barrel (push coring suitable for soft sediments) or by rotating and pushing a rock barrel (rotary drilling for hard rocks). A flush water pump provides sea water for flushing the drill string for cooling of the drill bit and for removing the drill cuttings.

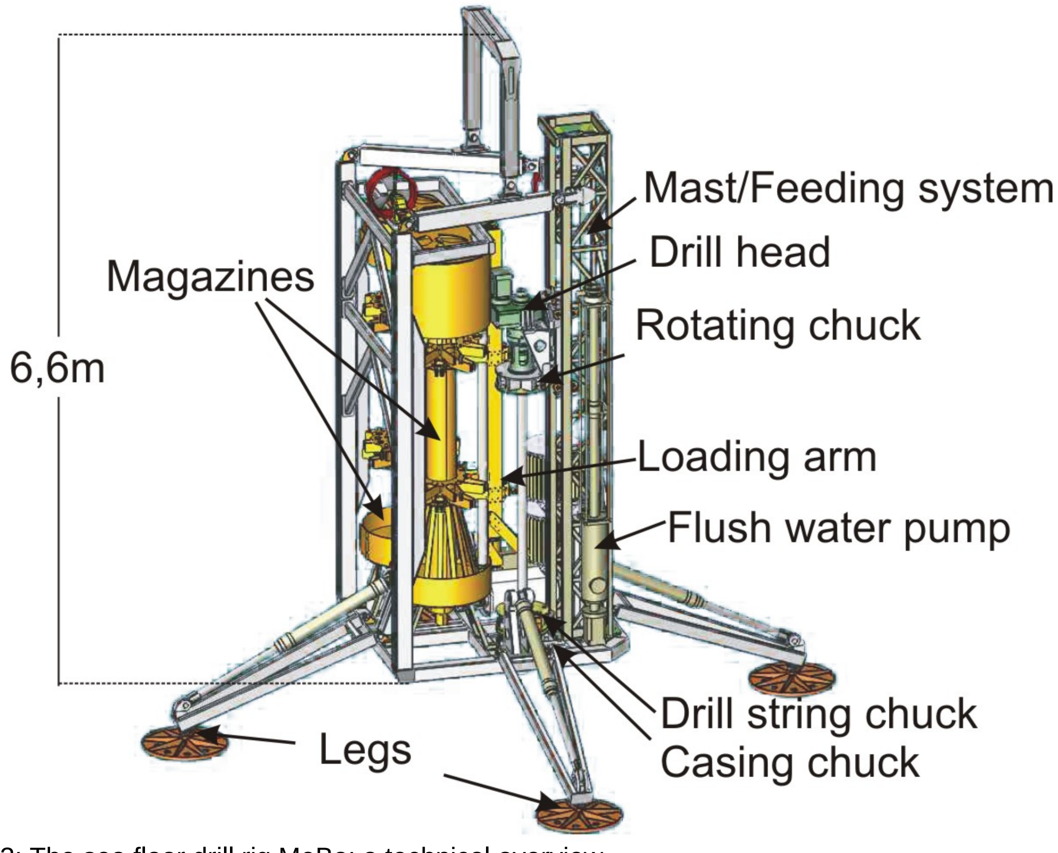

Fig. 3: The sea floor drill rig MeBo: a technical overview

The core length for each push and rock barrel is 3 m. When the barrel has finished sampling it is recovered out of the drilled hole (holding it with the rotating chuck below the drill head) and stored by the loading arm in a magazine. The next barrel is lowered into the drill hole, a 3 m rod is added and the next 3 m can be sampled. For making the thread connection the drill string is held by the drill string chuck while the rod is rotated slowly down. In order to get a water tight connection the drill head is

screwed on the drill string before drilling. 17 barrels and 16 rods are required to sample the sea floor down to 50 m. The drilled hole can be stabilised by another set of 15 casing tubes. The casing tube string is flushed or drilled down to the depth where the last sampling ended, before it is held by the casing chuck and the drill string is build up for sampling the next 3 m.
MeBo is connected to the research vessel by a steel armoured umbilical with a diameter of 32 mm and a breaking load of 55 t that weighs about 3 kg per meter in water. This umbilical is used to launch and recover the drill. A winch is used both for storage of 2500 m of this umbilical and to provide the required force to carry the weight of the drill and of the umbilical. Floats are attached to the umbilical above MeBo in order to force the umbilical into an S-shaped catenary while MeBo sits on the sea floor such that ship movements due to waves or currents do not affect the drill. Movable legs allow for increased stability of MeBo on the sea floor and for adjustment to an upright position even in rough and uneven environments.
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 the deck of the vessel. All operations of the drill are surveyed by video cameras and a variety of sensors.

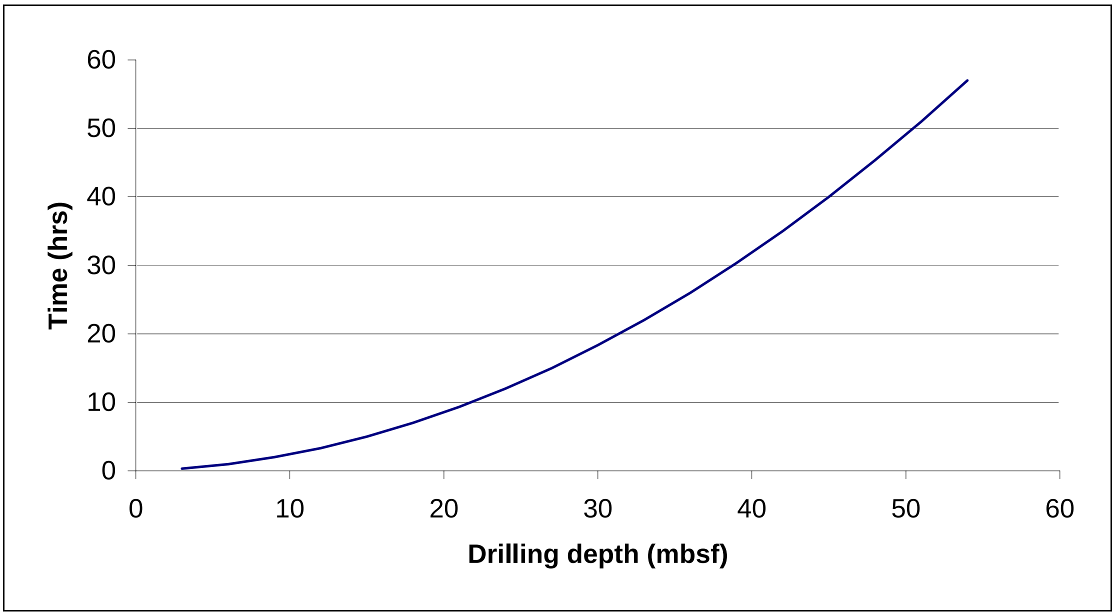

Fig. 4: Cumulative time required for drill pipe handling assuming that each rod to be added or removed takes about 10 minutes.

The cumulative time required for drill pipe handling increases nearly exponentially with drilling depth, for each 3 m section the entire drill string has to be built up for coring and built down again for recovering the core (Fig. 4). Lithology also has a major impact on the rate of drilling. While soft sediments can be sampled by push coring with a rate of penetration of more than 300 cm/minute, this rate of penetration decreases for hard rock sampling by rotary drilling down to 1 – 3 cm/minute. The more information the drill rig operater has about the expected geology, the better he can select the required drill bit (Fig. 5). Five different kinds of drill bits are used on the MeBo. Table 1 indicates the suitable drill bits for various lithological groups and also an approximate rate of penetration.

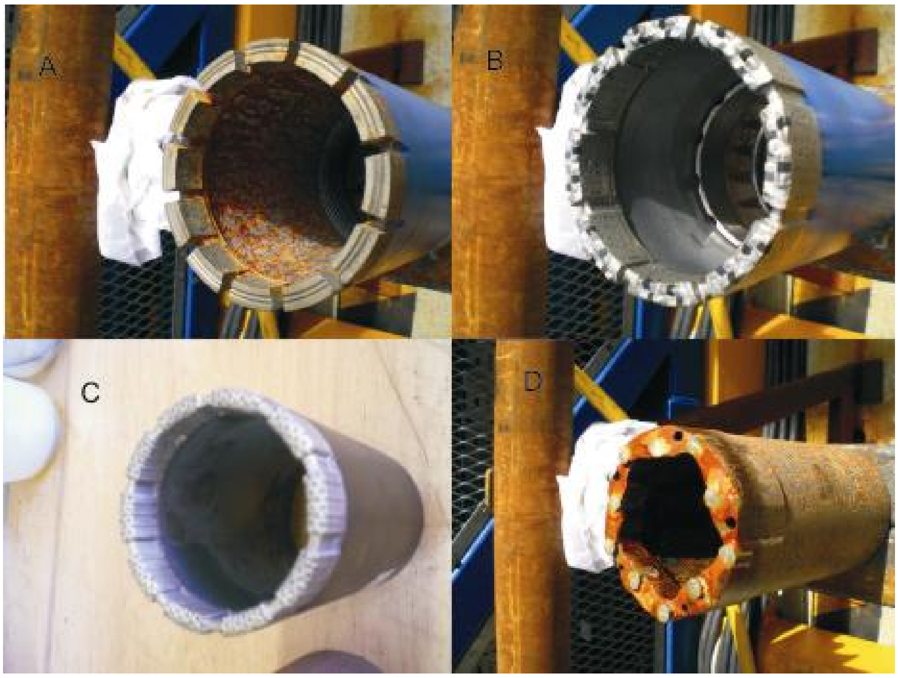

Fig. 5: Different kind of rotary drill bits; A: diamond impregnated bit; B: Synset bit; C: Surface set bit; D: Hard metal bit

Tab. 1: Specification of favorable rock type and rate of penetration (ROP) for different kind of drill bits.

Drill bit	Lithology	ROP (cm/min)
Push	Soft sediments	300
Hard Metal	Consolidated sediments	10
Synset	Limestone, schist, claystone	3
Surface set	Sandstone, hard limestone	3
Diamond impregnated	Basalt, granite, hard sandstone	3

After completion of the drilling work at each site the drill is recovered by being winched back onto the deck of the vessel and the drilled cores are unloaded for further analyses. The cores recovered are photographed, depth intervals marked on each core liner and recovery percentages recorded. A quick geological description is carried out before the core is placed in plastic liners with depth and way up markings.

3.2. Time schedule

The mobilisation of the system on the R/V Celtic Explorer commenced on the 13th of July in Galway harbour. It took one day to mount the Launch and Recovery System (MeBo-LARS) on deck, and two days for installing the MeBo-System on deck and to test the deployment procedure in the harbour. The R/V Celtic Explorer left the harbour in the evening of 15th of July. The cruise was scheduled for the 15th until the 26th of July including 2 days of steaming to and from the working area, as well as 9 operation days at the Porcupine Bank area. Demobilisation of the system was planned for the 27th of July. Because of a non-repairable damage of one of the MeBo hydraulic pumps at the end of the cruise and one day of bad weather, we only had 7 days for operation. Within these 7 days the MeBo was deployed 7 times and operated in total

58 hours (Fig. 6). Next to the usual maintenance work (loading/unloading drill tools, predive check) about 2 days were used for trouble shooting and repair especially at the start and end of the cruise. The extra day due to early termination was used as extra demobilisation time since the crane hired could not be rescheduled.

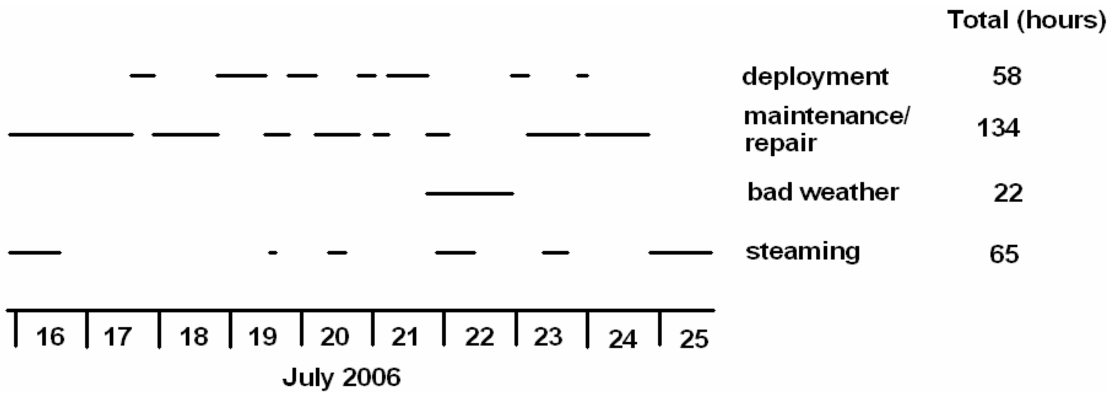

Fig. 6: Overview on use of time for MeBo deployments during cruise CE0619. Total hours for maintenance and repair contain 45 hrs for steaming and estimated 21 hrs for (un)loading magazines and predive checks (6 hrs per deployment, estimated 3 hrs per deployment after steaming). An extra 20 hrs were used for umbilical care at the end of the last station. Loss of time due to repair work adds accordingly to about 48 hours plus 1 day for early termination.

3.3. Technical performance and reliabilty of the MeBo

The MeBo system was developed within a time period of one year. After the system integration in the summer of 2005, it was tested on two cruises in August and December 2005. Experience from these test cruises, was used to collect information about the reliability of the different components of the system and to improve it. After some initial problems during this cruise (CE0619) the drill rig performed well for more than three days until bad weather stopped the drilling. After this bad weather period damages during launching the drill on the sea bed at high waves and the failure of one hydraulic pump prevented a succesful continuation of the drilling. Technical problems during this cruise include:

- The emergency release (this allows opening of the chucks and of the connection between drill head and drill string in case of loss of communication or energy while drilling), did not work at the beginning of the cruise due to an error during the installation of a control valve. Installation and testing of the emergency release in the workshop in Bremen in preparation of this project was not possible due tohealth problems of the engineer responsible.
- The communication between control cabin and drill rig had some faults that were not observed during the tests in the workshop. After a reorganisation we were able to reduce the effects of these faults. The cause of the faults will be investigated further after this cruise.
- The dynamic factor on the umbilical load was critical at wave hights greater than 2 m. The tension control modus of the MeBo winch could not be used under these conditions since hard stops during switching this modus on and off caused high snap loads.
- Landing of the drill rig in bad weather caused damage of one foot plate and on the supporting structure of the loading arm.

- One of the hydraulic pumps failed near to the end of the cruise and could not be replaced.

3.4. Drilling overview

The MeBo system was deployed 7 times and operated for a total of 58 hours. About 19% of the operation time was used for core drilling or pushing (Tab.2). Nearly 50 % of the deployment time had to be used for pipe handling and trouble shooting. Breaking the threads between drill head and barrel head was the main cause for delays in drill string handling:

- The high torque that affected the drill string during drilling of gravel and crystalline rocks made it difficult to break the thread between drill head and barrel head. This problem was caused by the ill-fitting rim of the thread connection at the drill head. Up until this cruise the MeBo drilled only soft rocks, this problem wasn't encountered before. This problem was solved onboard by modification of the thread connection.
- When trying to unscrew the thread between barrel head and drill head it was often the case, that the thread between outer barrel and barrel head was opened. This is not a problem for land drill rigs, since assistance of the rig operator during pipe handling allows a different configuration of chucks. This is the reason why standard core barrels are not secured at the barrel head for unintended opening of the thread between outer barrel and barrel head. After realising the problem we tried to glue this thread by lock tite or by wealding. However, neither method was entirely succesful.

Tab. 2: Overview on time (hrs:min) of different tasks during MeBo-deployments on cruise CE0619. Leveling of MeBo is estimated to take 30 minutes per station, the time required for pipe handling and trouble shooting is calculated as difference of launch, recovery, levling and drilling time from total deployment time.

Station	Launch	Recovery	Leveling	Drilling	Pipe handling/ trouble shooting	Total
GeoB10901-1	00:30	00:59	00:30	00:10	05:08	**07:17**
GeoB10901-2	02:24	01:00	00:30	04:45	07:16	**15:55**
GeoB10902-1	02:18	00:36	00:30	03:47	01:56	**09:07**
GeoB10903-1	01:10	00:46	00:30	00:01	03:00	**05:27**
GeoB10903-2	01:00	00:40	00:30	02:13	08:42	**13:05**
GeoB10904-1	01:13	02:27	00:30	00:00	00:13	**04:23**
GeoB10905-1	00:41	00:36	00:30	00:06	01:11	**03:04**
Sum (hrs)	**09:16**	**07:04**	**03:30**	**11:02**	**27:26**	**58:18**
(% of total)	**15.9**	**12.1**	**6.0**	**18.9**	**47.1**	**100.0**

In total 19.57 m have been drilled (Tab. 3). Most of the drilling took place in sand and gravel- the most difficult strata for core drilling. While we got ~100 % recovery in the hard rocks drilled (granite, metamorphic rocks and breccias) most of the gravels and sands were not held in the barrel by the core catchers used.

Tab. 3: Overview on drilling depth and sample recovery (in cm) with MeBo during cruise CE0619

Site	Sand and gravel		Hard rock		Total	
	drilling depth	sample	drilling depth	sample	drilling depth	sample
GeoB10901-1	254	55	0	0	254	55
GeoB10901-2	397	116	0	0	397	116
GeoB10902-1	33	35	96	85	129	120
GeoB10903-1	53	0	0	0	53	0
GeoB10903-2	689	102	169	174	858	276
GeoB10904-1	0	0	0	0	0	0
GeoB10905-1	266	0	0	0	266	0
Total	**1692**	**308**	**265**	**259**	**1957**	**567**
Recovery (%)	**18**		**98**		**29**	

3.5. Outlook

This cruise was the first time that the MeBo system drilled hard rocks. The results of this cruise have shown that it is well suited for this task. Even gravel layers of more than 6.5 m thickness were successfully penetrated in order to sample the underlying crystalline and sedimentary hard rocks. The experience of this cruise has to be used in order to improve the effectivity of the system.

- Core barrels: The core barrels worked well in hard rocks. For the gravels different kind of core catchers should be tested in order to increase the recovery rate in that kind of strata. The threads between the barrel head and outer core barrel have to be secured in order to prevent unintentional opening during recovery of the barrels
- Reliability: With increasing experience of the system, those components that are susceptible for failures will be identified. Working on these components will result in a general improvement of the system reliability
- Spare parts: The stock of spare parts has to be increased (e.g. hydraulic pumps).
- Weather risk: The pitch angle of smaller vessels like R/V Celtic Explorer is higher than on bigger vessels, which increases the risk of down time due to high dynamic loads on the A-frame and the umbilical in case of bad weather. An investigation into the reduction of the dynamic load by improving the tension control modus on the MeBo-winch will be undertaken.
- Pre-site Survey: A good knowledge on the expected strata is crucial for an effective planning of the drilling operations (loading of magazines, choice of drill bits and core catchers). High resolution shallow seismic data would be helpful.
- Decision making: The project manager should participate on the cruise if final decisions lie with them. Seeing/experiencing the physical and technical

circumstances and the drilling results is crucial for decisions on working plans and can’t be replaced effectively by reports.

4. Site Description

4.1. Pre-cruise site selection

Site selection was based on all available data sources in the region. Multibeam and Sub-bottom Profiler data from the Geological Survey of Ireland (GSI) was examined for all highs that had hard rock characteristics and all seismic profiles over the area was examined in the Petroleum Affairs Division (PAD) for apparent basement outcrops, a number of the GSI and PAD selected sites were then further examined by the University College Dublin (UCD) and further site suggestions and rejections were contributed to the list by UCD.

A total of seven sites were included in the final selection (Tab. 4, Fig. 7), all sites chosen were based on seismic profiles and had favourable characteristics on Multibeam and Sub-bottom Profiler. These sites were given a ranking of one to seven, which was the desired order the sites were to be drilled in, if time allowed for all sites to be drilled

Tab. 4: Overview on proposed sites for shallow drillings with the sea floor drill rig MeBo

Location	PAD Name	Seismic Location	Shot-point	WGS84 Lat (decimal minutes)	WGS84 Long (decimal minutes)	Rank	Water Depth
B II	25/7-sb(mebo)1	WI-26	268	53°40.918'	13°44.819	1	-277
A I	25/19-sb(mebo)1	Hunt 73-08	1560	53°22.035'	-13°23.155'	2	-177
L	25/27-sb(mebo)1	Hunt 73-04	1160	53°1.612'	-13°47.024'	3	-189
D II	75/26-sb(mebo)1	WI-7	397	52°22.696'	-14°27.454'	4	-354
X	74/26-sb(mebo)1	Isrock96_90	940	52°1.899'	-14°56.926'	5	-720
F I	84/05-sb(mebo)1	WI_22	762	51°56.87'	-15°2.779'	6	-765
G	25/12-sb(mebo)1	Isrock96_44	2580	53°32.51'	-13°39.874'	7	-229

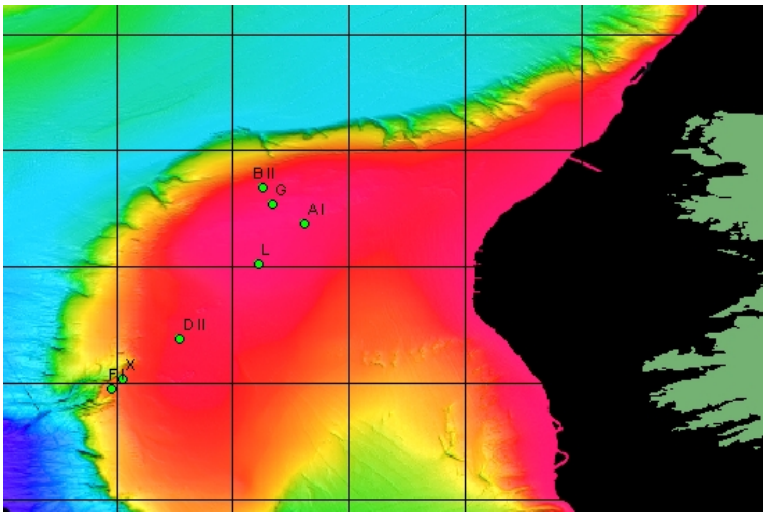

Fig. 7: Map with locations of all 7 final selection sites on the Porcupine Bank

4.2. Site re-evaluation during cruise

After the first days of the cruise it was apparent that a maximum of 4 sites would be drilled successfully, However, if progress was swift the selected sites would be re-evaluated daily.

The loss of time while maintenance/modification work was underway on the MeBo in the beginning of the cruise, the thick overburden at some of the sites and the pipe handling time for the depths required to reach basement were re-evaluated as the time lines became more pressing.

It was agreed that a wide spread of drill locations, with a selection of sites with thin overburden would be the most advantageous approach to getting an overview of the Porcupine Bank. Three sites were selected as the main priority sites to drill during the cruise (Tab.5, Fig. 8).

Tab. 4: Overview on finally selected sites for shallow drillings with the sea floor drill rig MeBo

Location	PAD Name	Seismic Location	Shot-point	WGS84 Lat (decimal minutes)	WGS84 Long (decimal minutes)	New Rank	Water Depth
B II	25/7-sb(mebo)1 GeoB10901-1	WI-26	268	53°40.918'	13°44.819	1	-277
L	25/27-sb(mebo)1 GeoB10903-1	Hunt 73-04	1160	53°1.612'	-13°47.024'	2	-189
X	74/26-sb(mebo)1 GeoB 10904-1	Isrock96_ 90	940	52°1.899'	-14°56.926'	3	-720

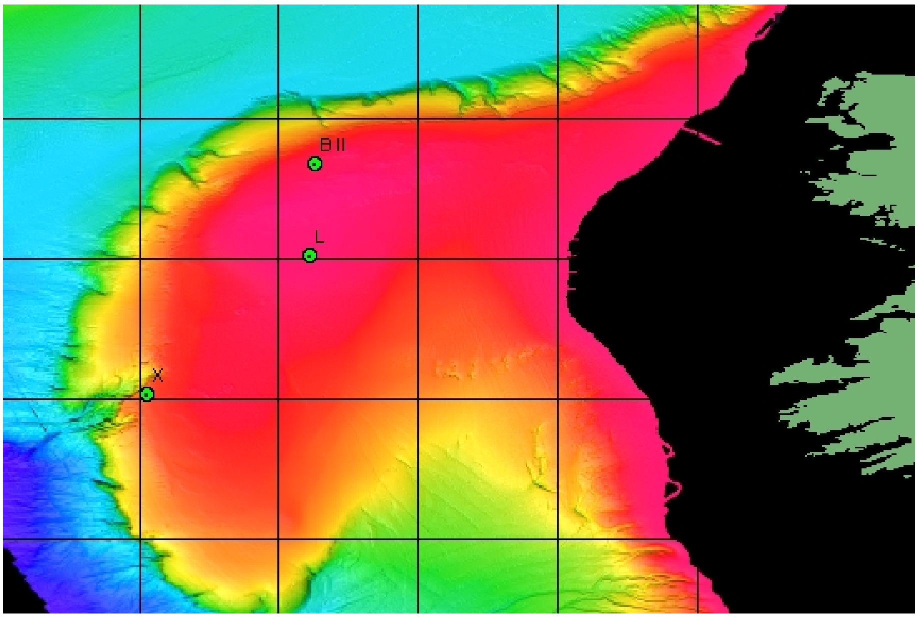

Fig. 8: Map with locations of finally selected sites for shallow drillings at the Porcupine Bank

4.3. Drilling results

4.3.1 GeoB10901-1 / 25/7-sb(MeBo)1

Location 53°40.92N, 13°44.82W

The first deployment of the MeBo was intended to be a test drilling in order to test the MeBo system and the drill strategy. Video pictures of the sea bed showed a sandy surface. We decided to start with a push core barrel (GeoB10901-1) that stopped at 108 cm below sea floor (bsf) at a maximum push pressure of 4 tonnes. Expecting hard rock of unknown type below the surface sediments we continued with a rotary barrel with surface set drill bit. After reaching the maximum penetration depth for the first barrel of 254 cm we stopped drilling in order to inspect the drilled samples after recovery of the drill rig. We recovered a push core sample of 55 cm length consisting of medium/coarse sand with shells and rock fragments and some gravel in the core catcher (Fig. 9). The rock barrel was empty and showed erosion on the drill bit and the outer barrel probably from gravel. Some granitic angular gravel was found in the bottom part of the barrel magazine in the drill rig (Fig. 10).

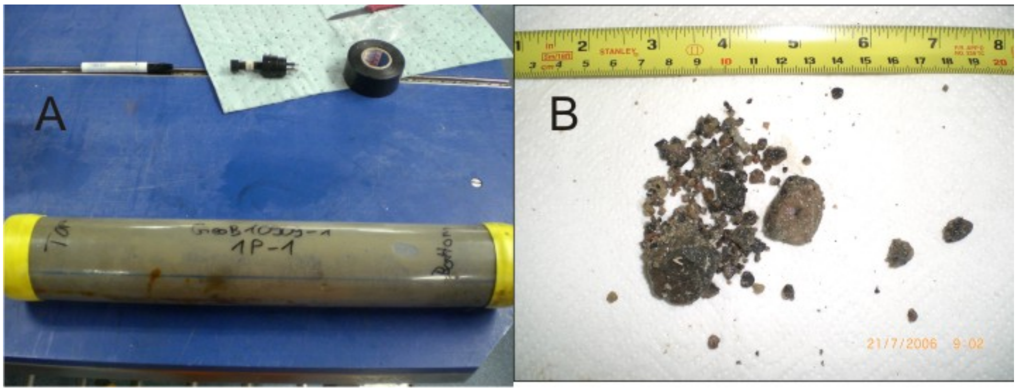

Fig. 9: Photographs of A GeoB10901-1-1P-1 in liner and Granitic gravel from the core catcher of this barrel

Fig. 10: Granitic gravel and mud samples found in the barrel magazine after recovery of the drill rig from deployment GeoB10901-1

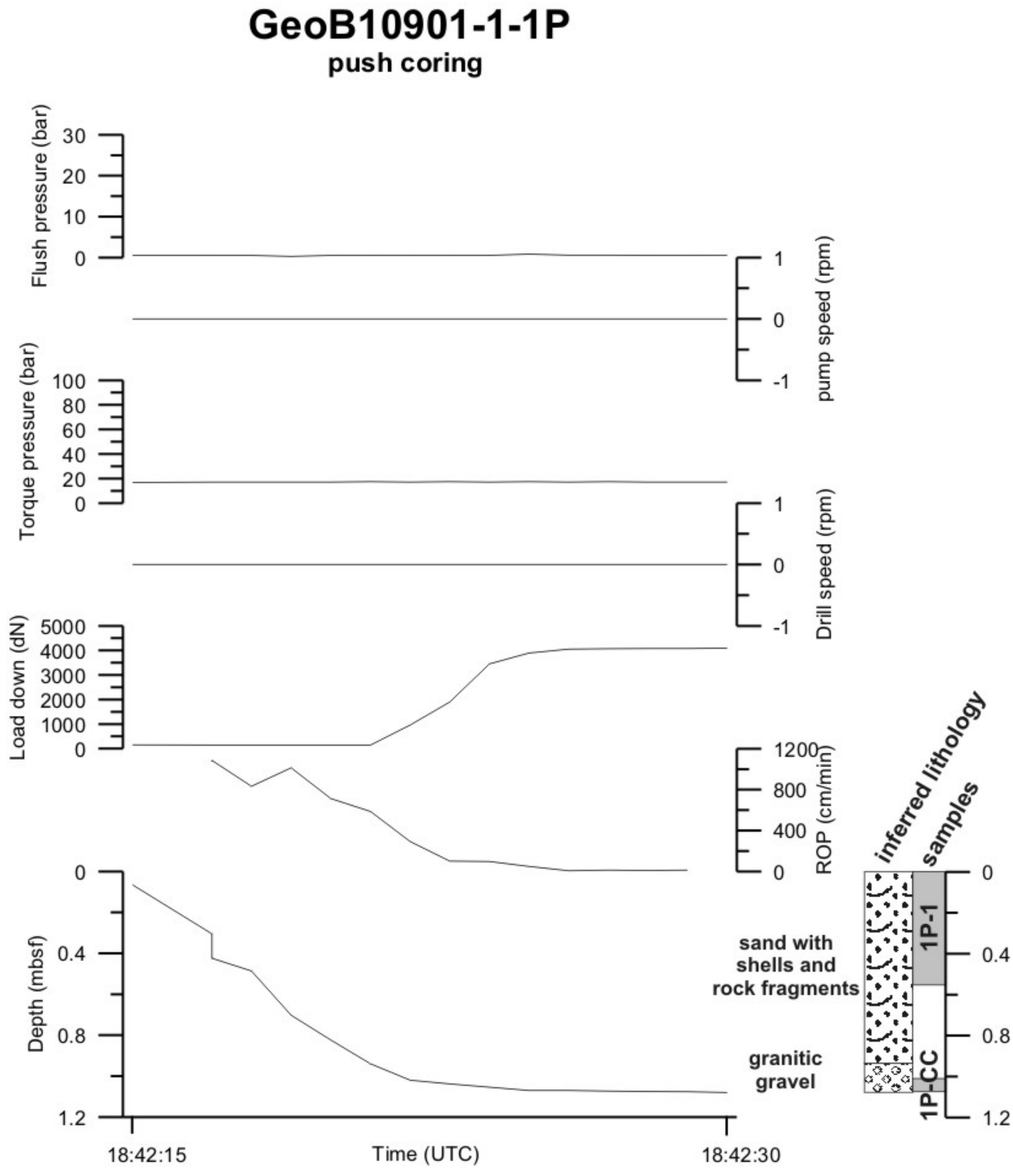

Fig. 11: Drill log data of GeoB10901-1-1P

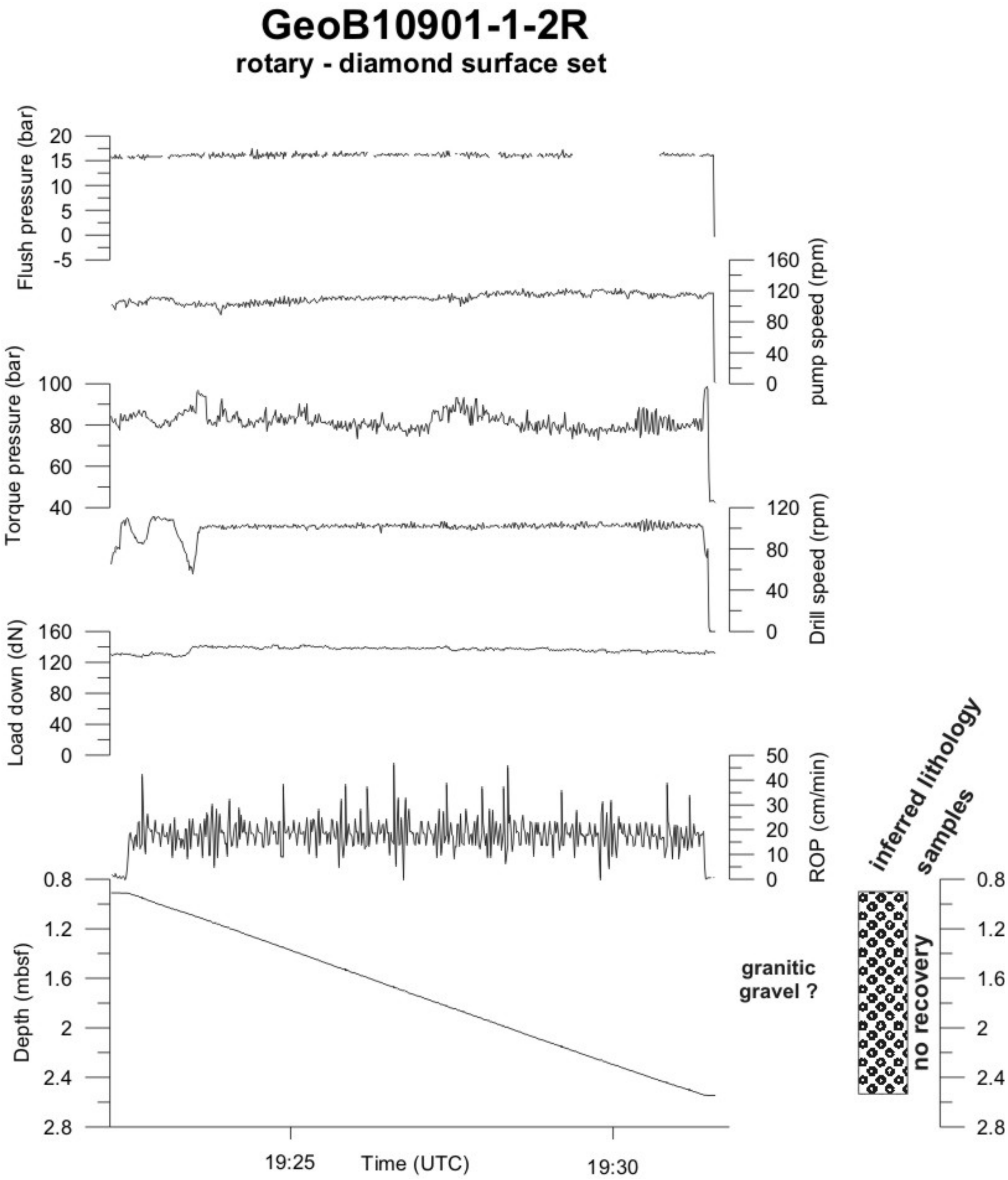

Fig. 12: Drill log data of GeoB10901-1-2R (ROP: rate of penetration; Torque pressure: hydraulic pressure measured at the drill head is proportional to the torque)

4.3.2 GeoB10901-2 / 25/7-sb(MeBo)2

Location 53°40.92N, 13°44.82W

Using 4 barrels we reached a depth of about 4 mbsf. With the experience gained during the first deployment, at this site we started with rotary drilling with hard metal bit in order to penetrate the upper gravel layer of unknown thickness. After a decrease of the rate of penetration at about 1.9 mbsf we decided to change the barrel. Assuming that the gravel layer was penetrated and expecting marine sands below the gravel layer we continued with push coring. However, with a maximum penetration depth of 1.3 mbsf we didn't reach the base of the collapsed drill hole and recovered only coarse marine and granitic sands that were collapsed from the upper 75 cm into the drilled hole. Using then two rotary barrels with hard metal bit a depth of nearly 4 mbsf was reached when a noticeable decrease in rate of penetration was observed. Deployment of a fifth barrel with surface set bit that stuck in the collapsed drill hole was stopped.
A highly variable torque during drilling indicated the presence of gravel in the upper 4 m. This gravel pressed on the outer barrel and on the rod during drilling. Reentry into the partly collapsed hole with new core barrels was very difficult. However, from each barrel we recovered at least a small sample (13 to 58 cm per barrel) that supported our interpretation of the dominance of gravel in the upper 4 m at this site. The angular pieces varied between 1 and 8 cm diameter (Fig. 13). The gravel was almost entirely composed on granite and and only slightly rounded. We conclude that this granite gravel originates rather from weathering of granitic basement at this location than from transport processes.

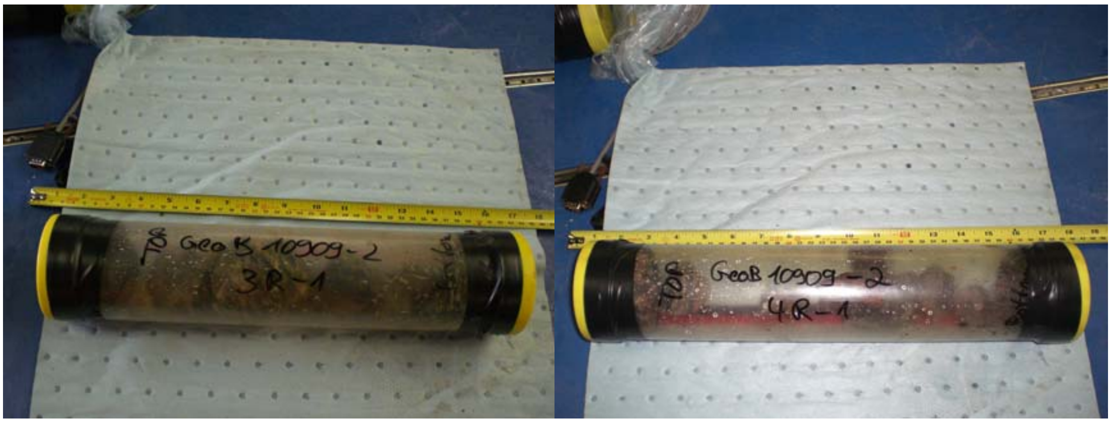

Fig. 13: Granite angular pieces from core barrels GeoB10901-2-3R-1 and GeoB10901-2-4R-1 in plastic liners

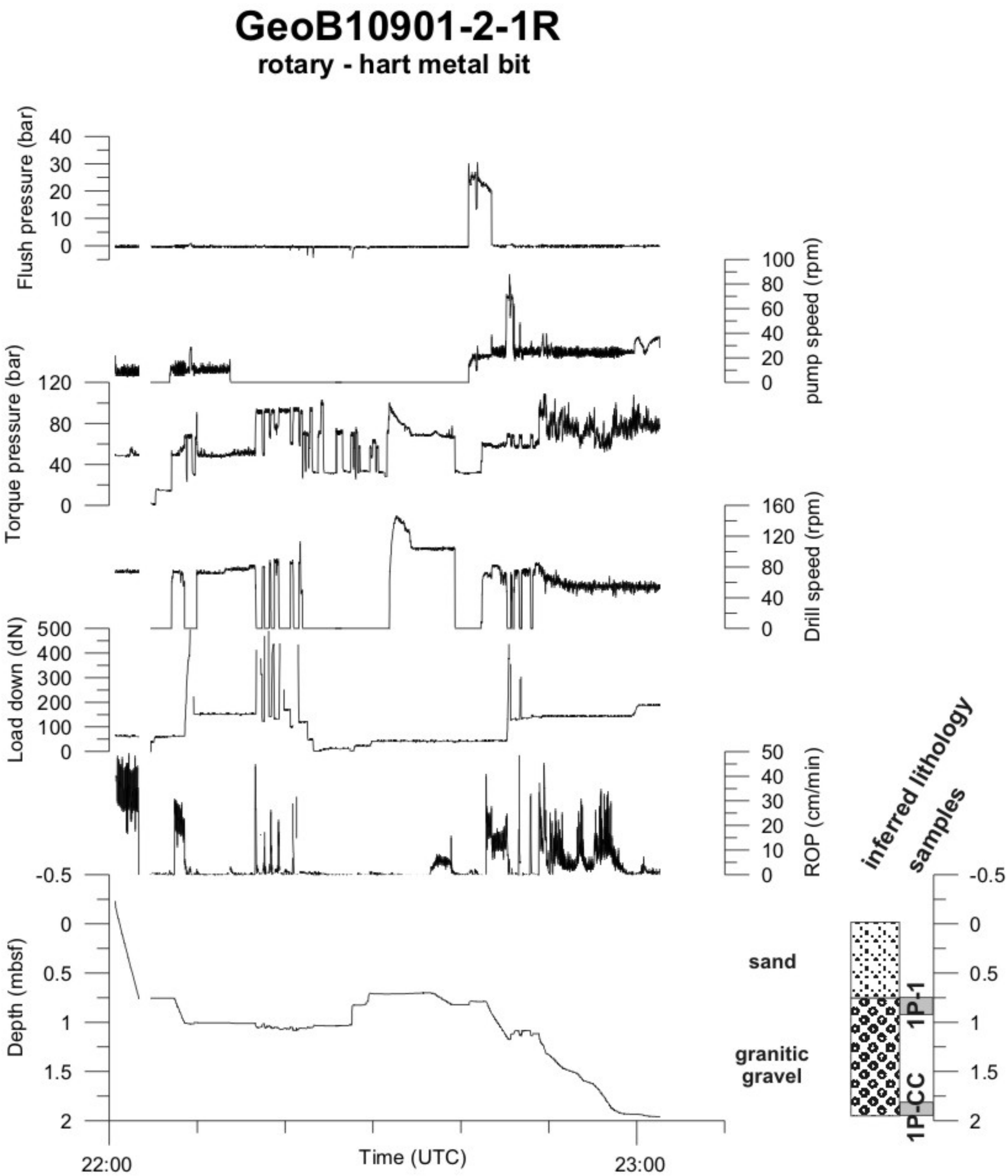

Fig. 14: Drill log data of GeoB10901-2-1R

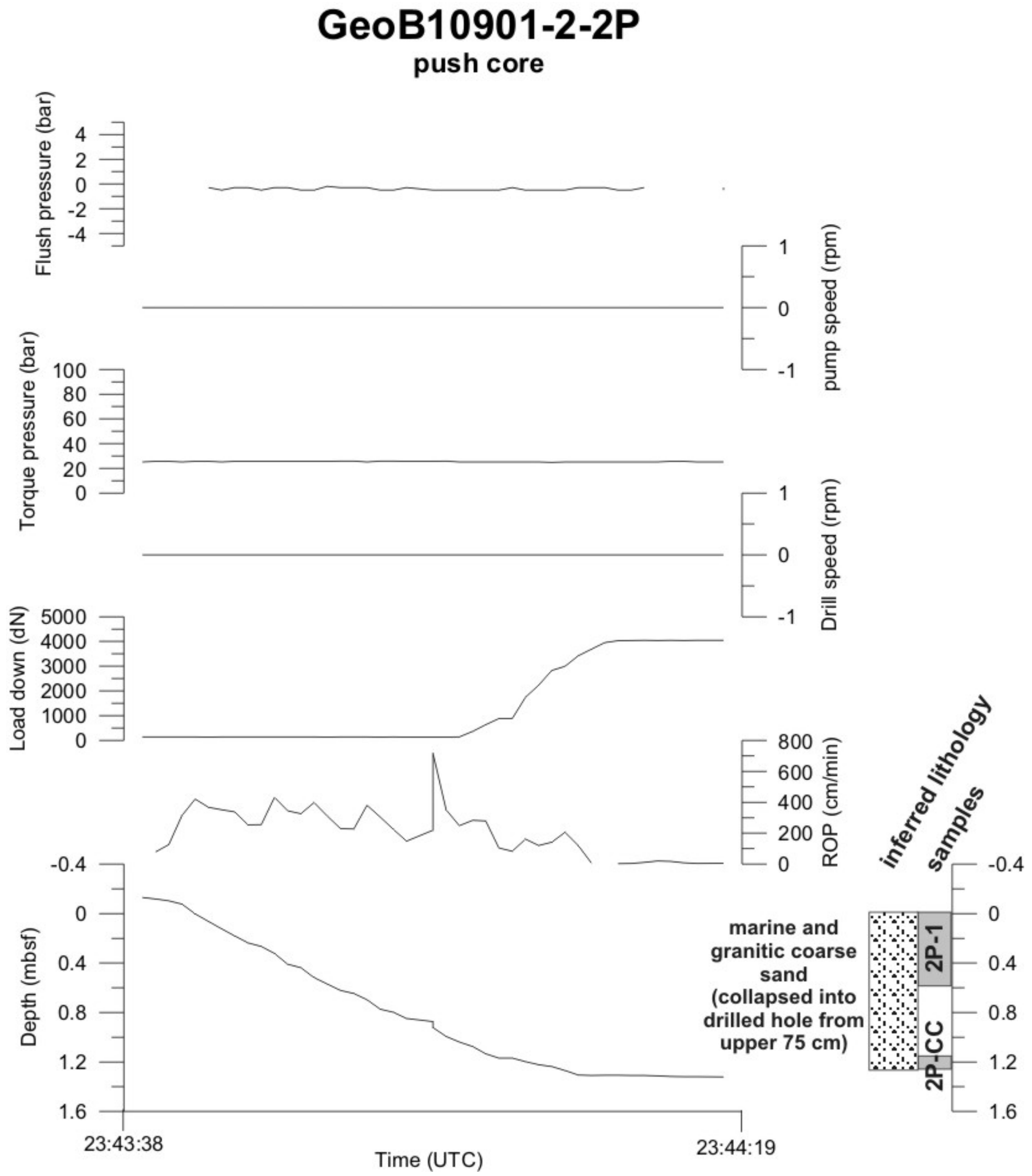

Fig. 15: Drill log data of GeoB10901-2-2P

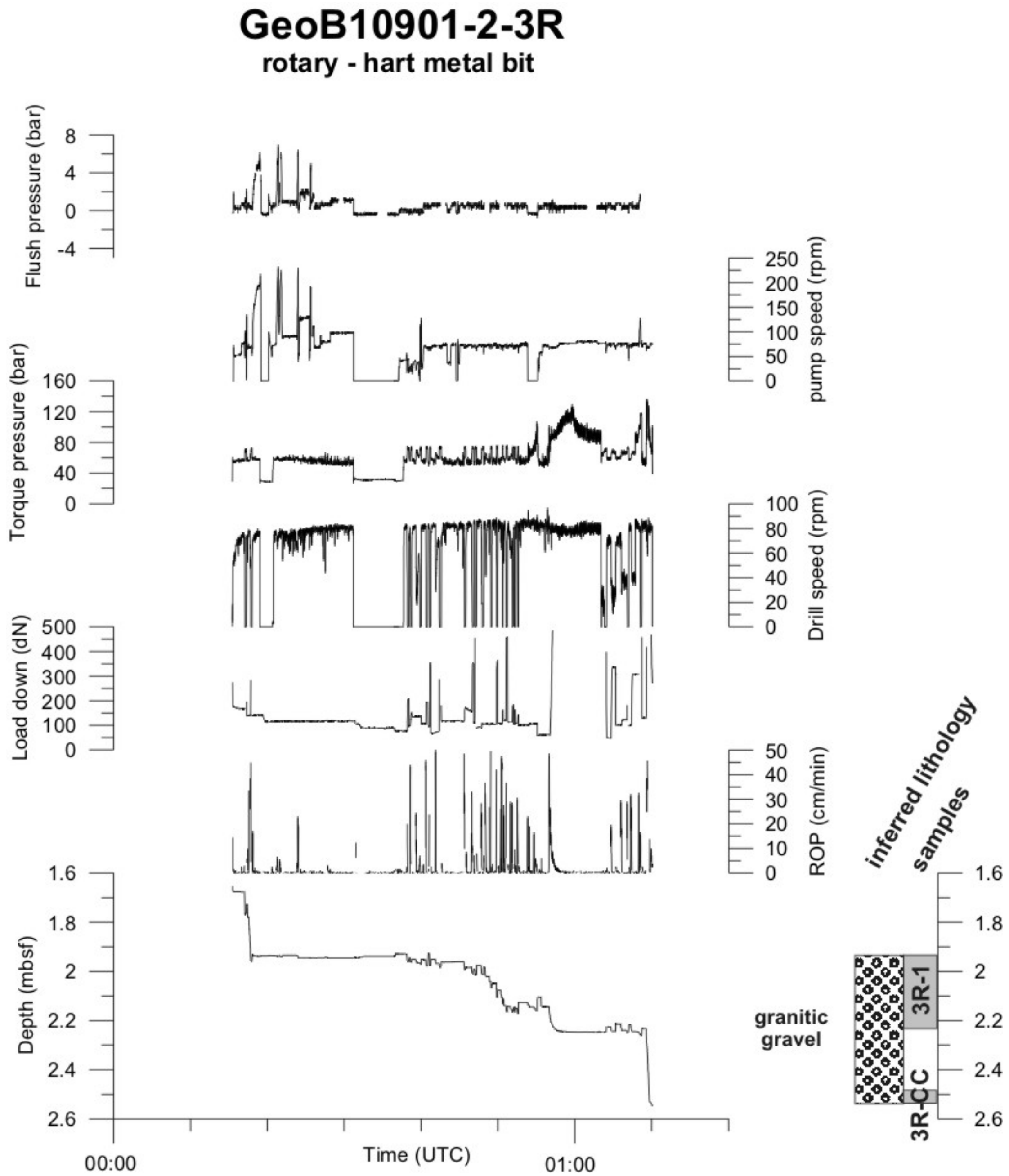

Fig. 16: Drill log data of GeoB10901-2-3R

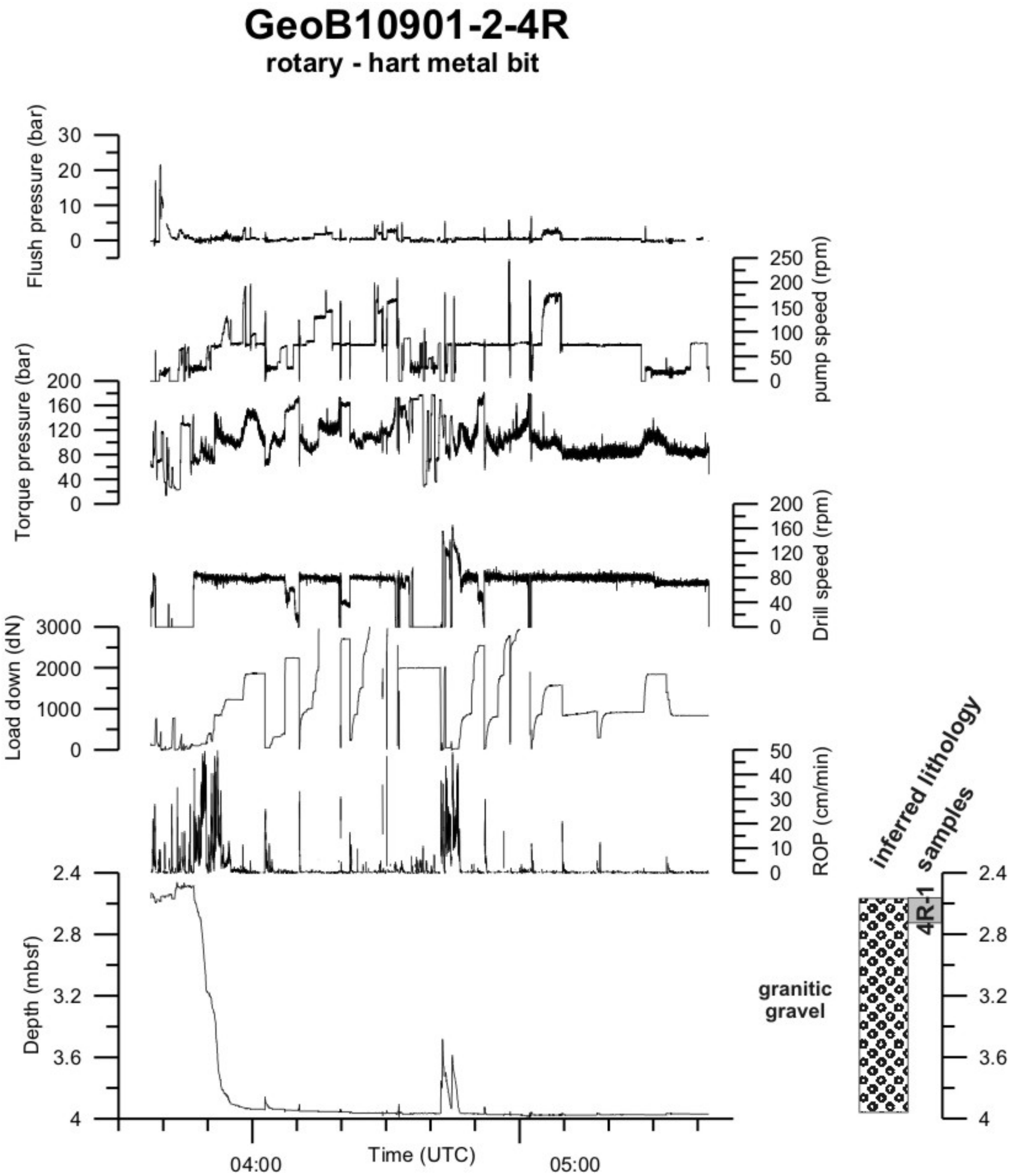

Fig. 17: Drill log data of GeoB10901-2-4R

4.3.3 GeoB10902-1 / 25/7-sb(MeBo)3

Location 53°40.69N, 13°43.72W

This site is located near to the previous site on top of the same morphological structure. We assumed that the thicknes of the gravel layer would decrease towards the top. We started with a rotary barrel with hard metal bit and changed after 30 cm penetration to surface set bit for hard rock. We stopped at about 1.3 mbsf due to reduced rate of penetration (worn out drill bit). We had to abort the plan to change to diamond impregnated bit due to problems opening the thread between barrel head and drill head.

There was no recovery from the first barrel (GeoB10902-1-1R) from the upper 30 cm. The core catcher was not able to hold the mixture of sand and gravel that formed the sea bed cover according to camera observation of the sea floor. The second barrel had nearly 100 % recovery. It contained about 35 cm granitic gravel that covered about 85 cm fractured pegmatitic granite (fig. 18). The amount of fractures increased toward the top, which is typical for physical weathering. The granite contains plagioclase crystals with up to 4 cm diameter indicating it is part of a larger granite structure, which cooled slowly during emplacement.

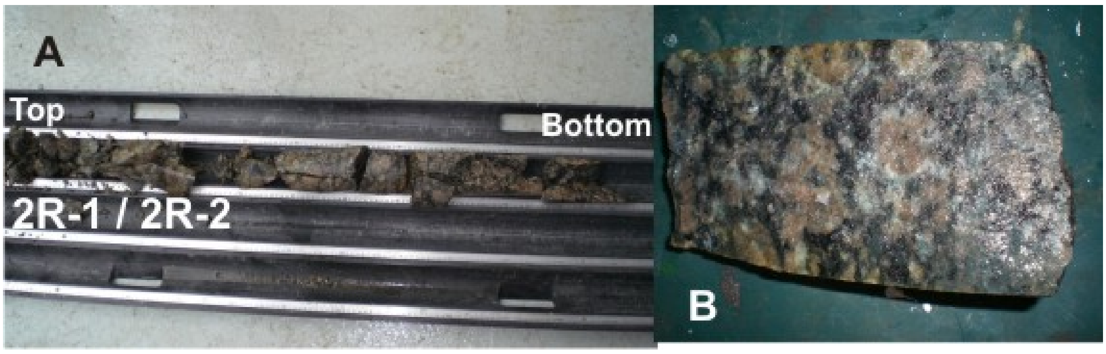

Fig. 18: About 120 cm long granite core (A) recovered at site GeoB10902. Plagioclase cristals with up to 4 cm diameter are found in this granite (B)

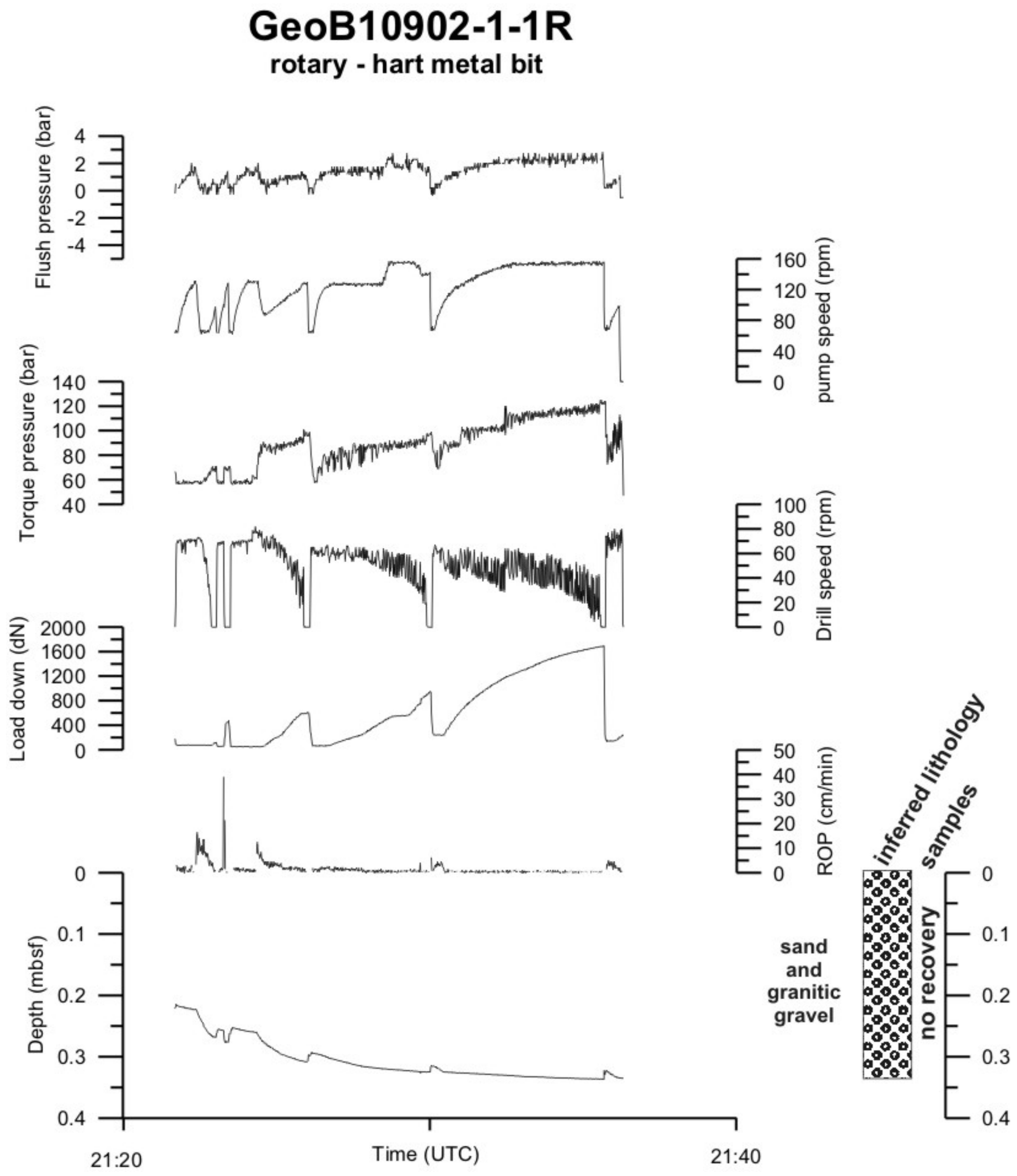

Fig. 19: Drill log data of GeoB10902-1-1R

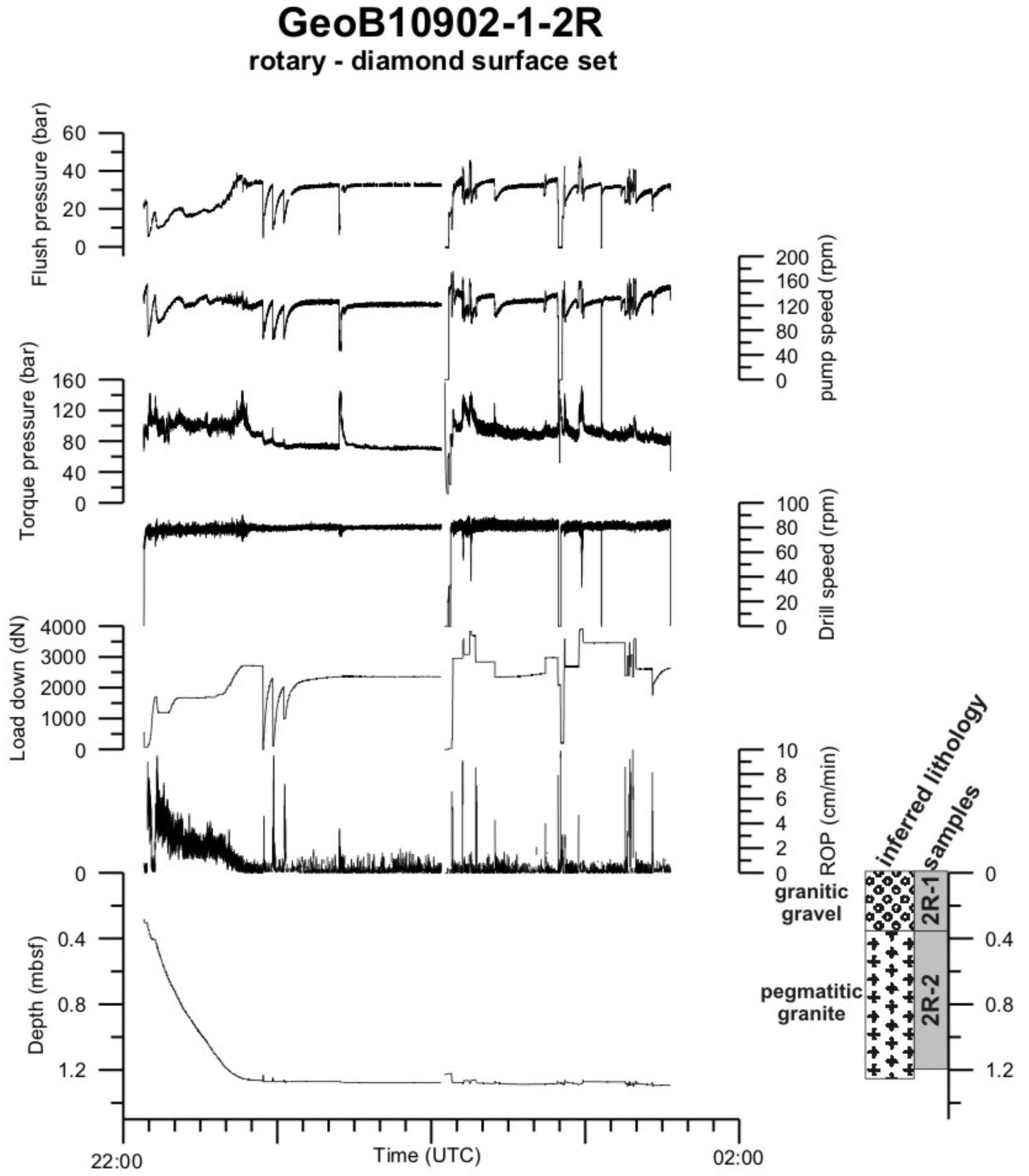

Fig. 20: Drill log data of GeoB10902-1-2R

4.3.4 GeoB10903-1 / 25/27-sb(MeBo)1

Location 53°01.56N, 13°47.00W

Due to a sandy surface we started with a push core barrel at this site. After a maximum depth of about 0.5 mbsf penetration rate decreased to zero at a load of 4 tonnes. Again we had to abort the plan to change to a rotary barrel due to problems during opening the thread between barrel head and drill head. Accidently the thread between barrel head and barrel was opened and could not be rescrewed. Inspection of the open barrel after recovery of the drill revealed total loss of sample.

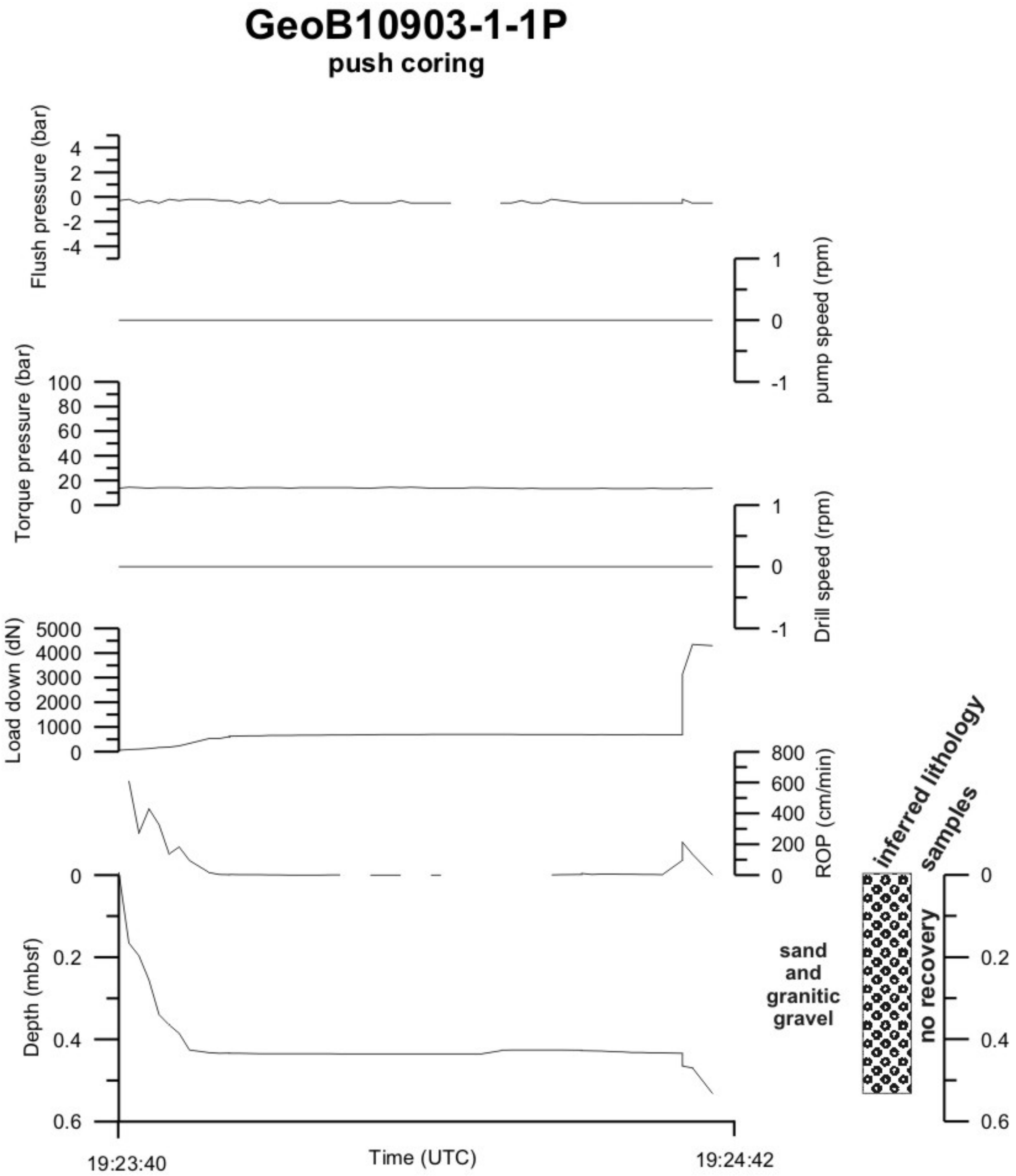

Fig. 21: Drill log data of GeoB10903-1-1P

4.3.4 GeoB10903-2 / 25/27-sb(MeBo)2

Location 53°01.56N, 13°47.00W

During the second deployment of the MeBo at this site we used 4 rotary barrels and drilled down to about 8.6 m until a deteoration of the weather conditions forced us to stop and recover the drill. We drilled with two rotary barrels with hard metal bits down to 5.66 mbsf. The rythmic variability in rate of penetration at a fairly low torque pressure pointed to a predominance of rounded gravel below a surface sediment cover of sand. The third barrel was equipped with a synset drill bit. After a decrease in rate of penetration at about 7.1 mbsf we changed to surface set bit for the fourth barrel.
From the drill log data and the core recovery we conclude on a thickness of sand and gravel coverage of about 6.8 m. While the first two barrels were empty except for some gravel and shells in the core catcher of the second barrel, the third barrel contained about 65 cm of partly rounded metamorphic gravel and sand above a layer of lithified breccia (Fig. 22). The fourth barrel contained lithified conglomerates and breccias with boulders of up to 40 cm thickness in a yellow-brownish sandy carbonate matrix below a gravel layer (resampled from collapsed drill hole). The matrix was partly porous and contained in the lowest section shells and tubes of marine (?) organisms. The rock fragments and boulders are dominated by metamorphous rocks (e.g. Gneiss). Overall we drilled through 1.7 m lithified conglomerates and breccia with about 100 % core recovery at this site. Due to the dominance and size of the metamorphic gravel and boulders we conclude, that these rocks are of local origin and form the basement at this area.

Fig. 22: Examples from the core recovery at site GeoB10903. A: subangular partly rounded metamorphic gravel (GeoB10903-3R-1); B: contact conglomerate to Gneiss boulder (GeoB10903-4R-2); C: 70 cm section of breeccia with large boulder of Gneiss at he bottom (GeoB10903-4R-3); D: detail of the Gneiss (GeoB10903-4R-3)

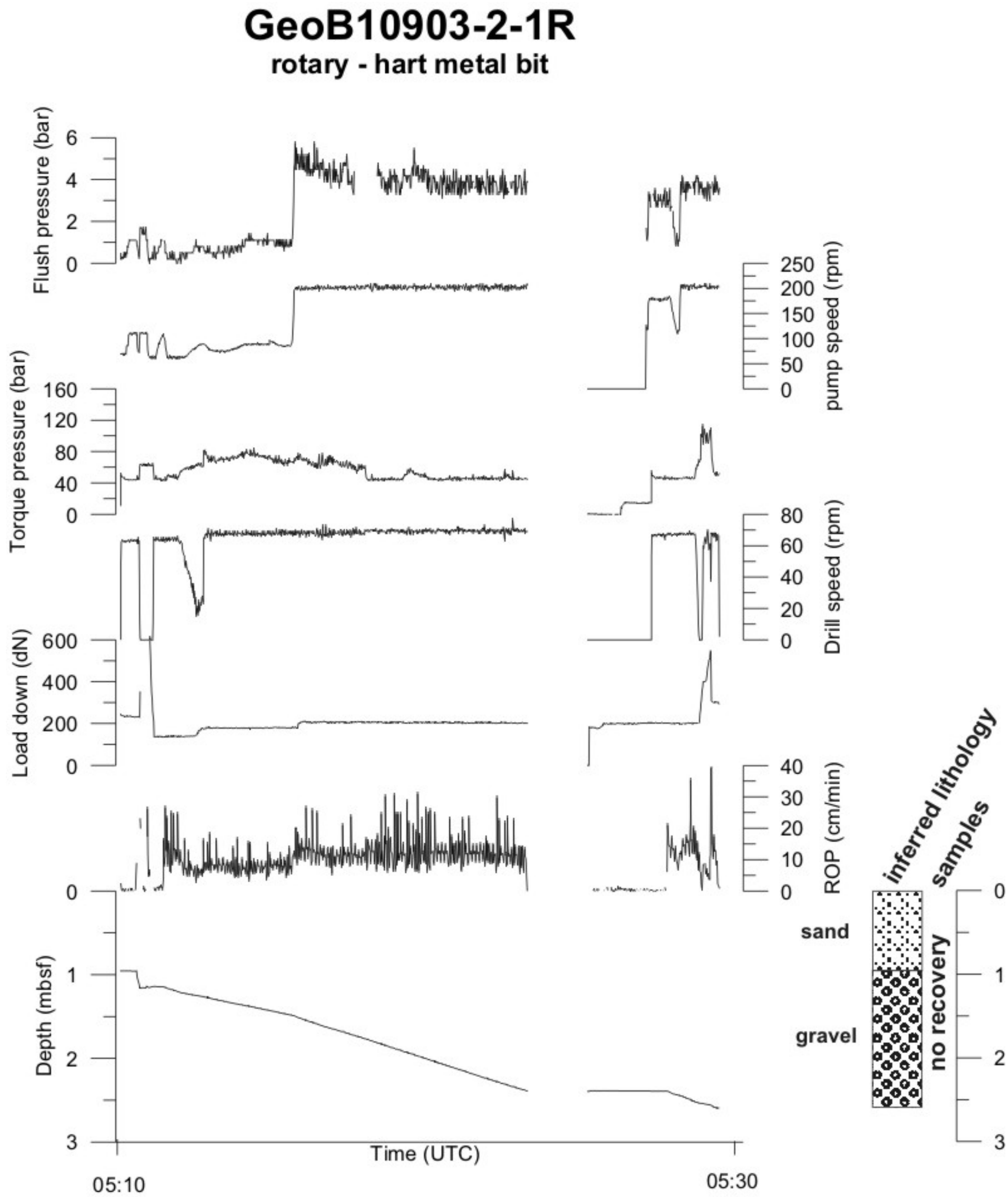

Fig. 23: Drill log data of GeoB10903-2-1R

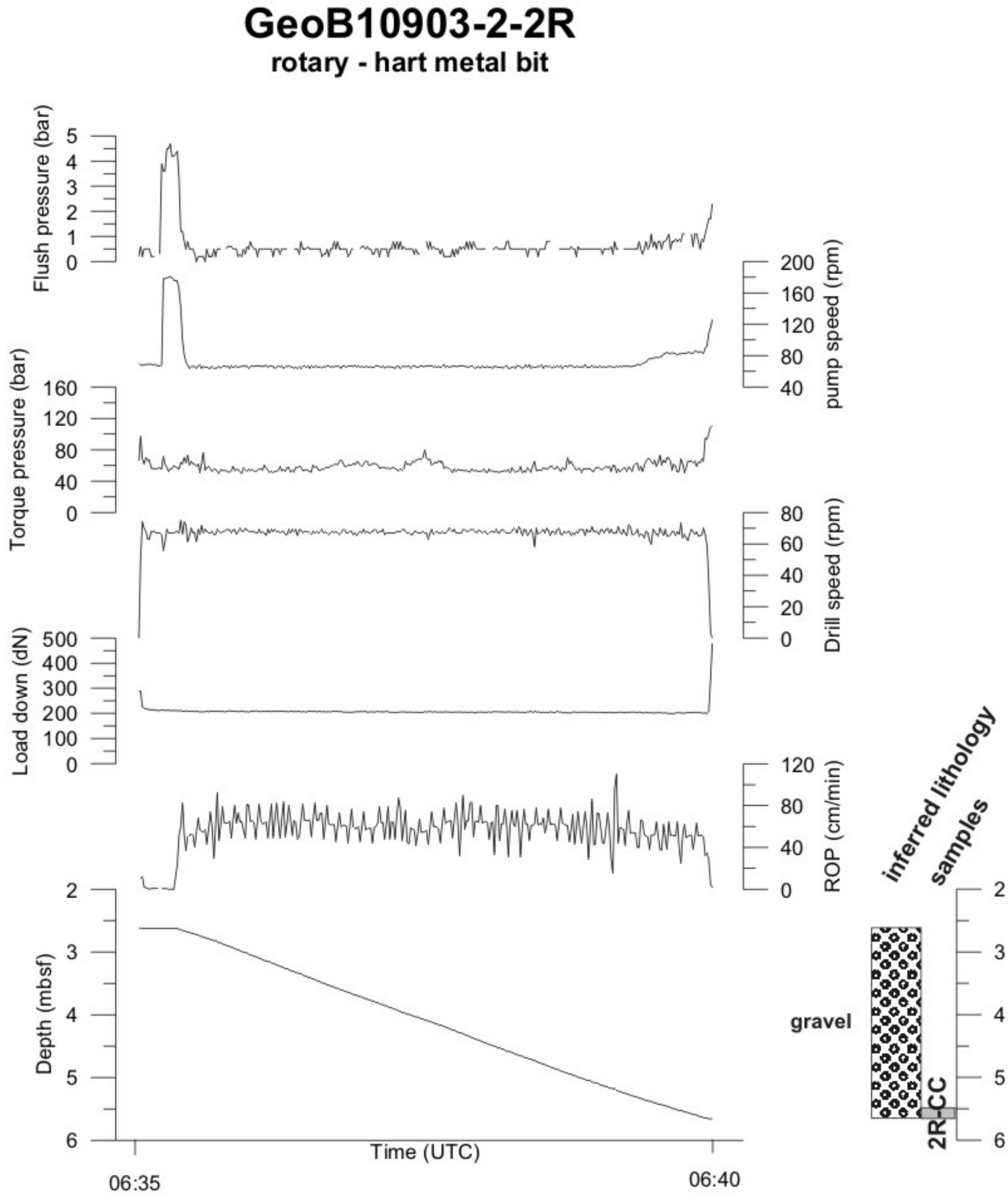

Fig. 24: Drill log data of GeoB10903-2-2R

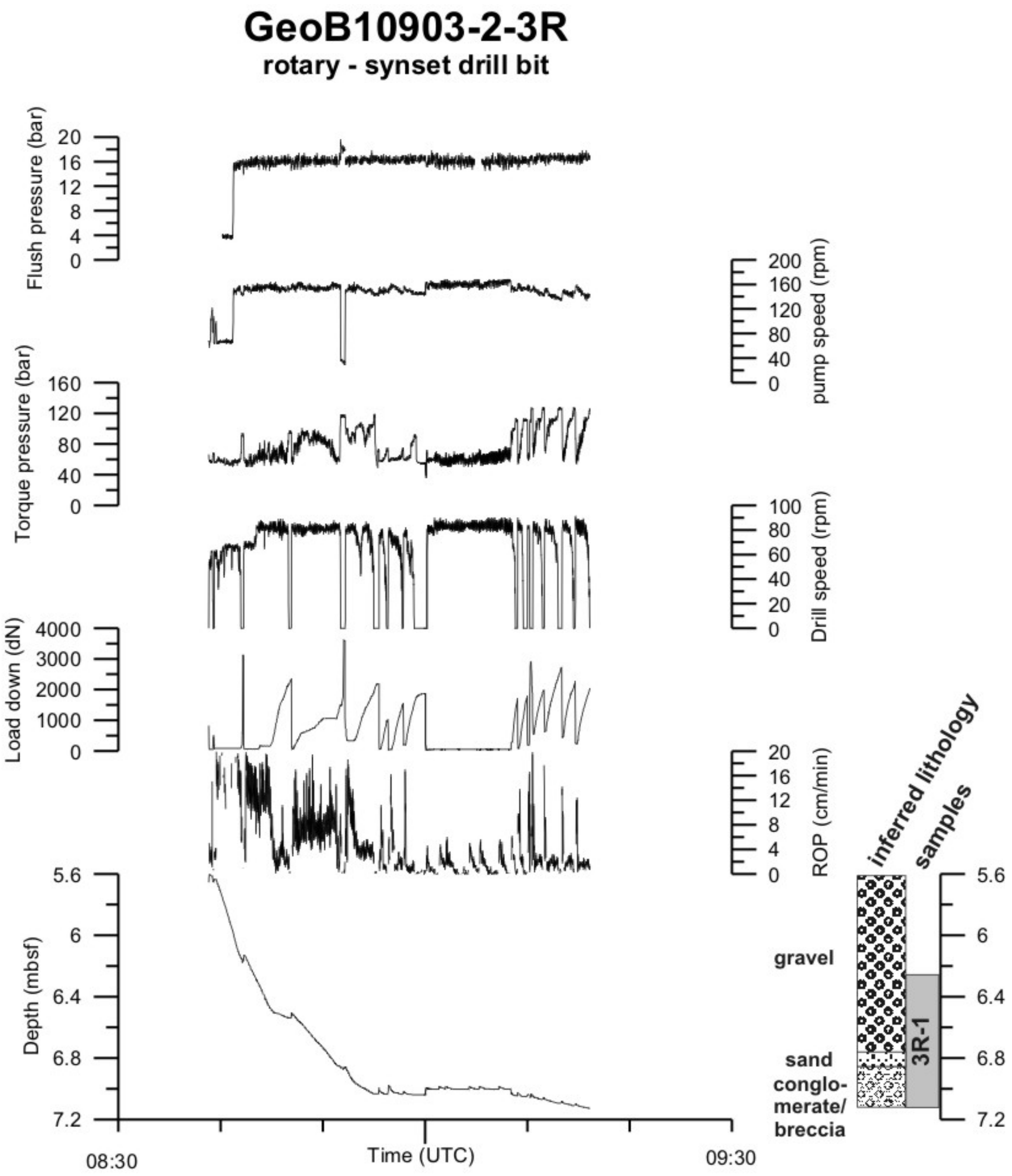

Fig. 25: Drill log data of GeoB10903-2-3R

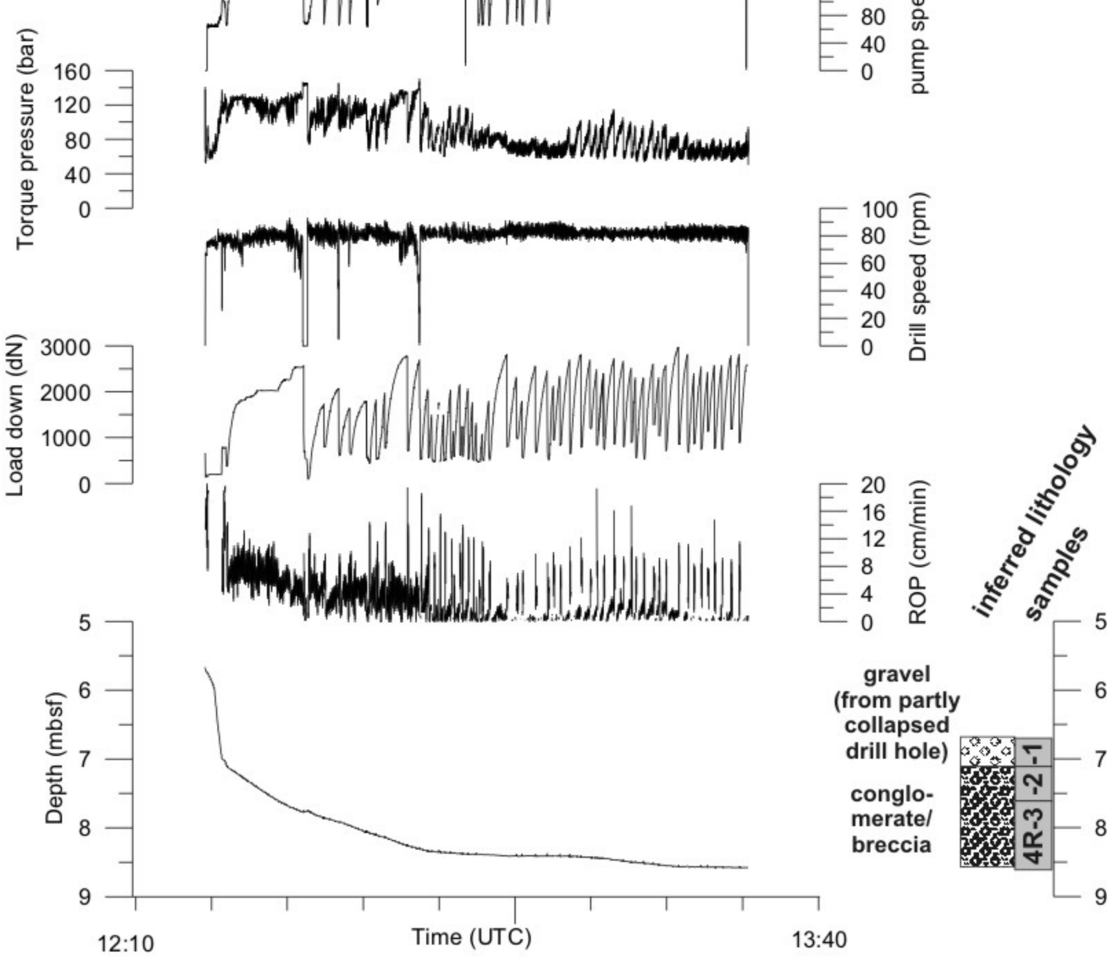

Fig. 26: Drill log data of GeoB10903-2-4R

4.3.6 GeoB10904-1 / 74/26-sb(MeBo)1

Location 52°01.90N, 14°56.93W

Rough weather conditions during the landing phase caused damage on the drill rig. The loading arm had to be repaired and the drill was recovered, no coring action was conducted during this deployment.

4.3.7 GeoB10905-1 / 25/27-sb(MeBo)3

Location 53°01.61N, 13°47.02W

We drilled with a rotary core barrel with hard metal bit down to 2.65 mbsf. A failure of a hydraulic pump forced us to stop the deployment. Besides of two pieces of gravel in the core catcher we got no recovery of the drilled sands and gravels.

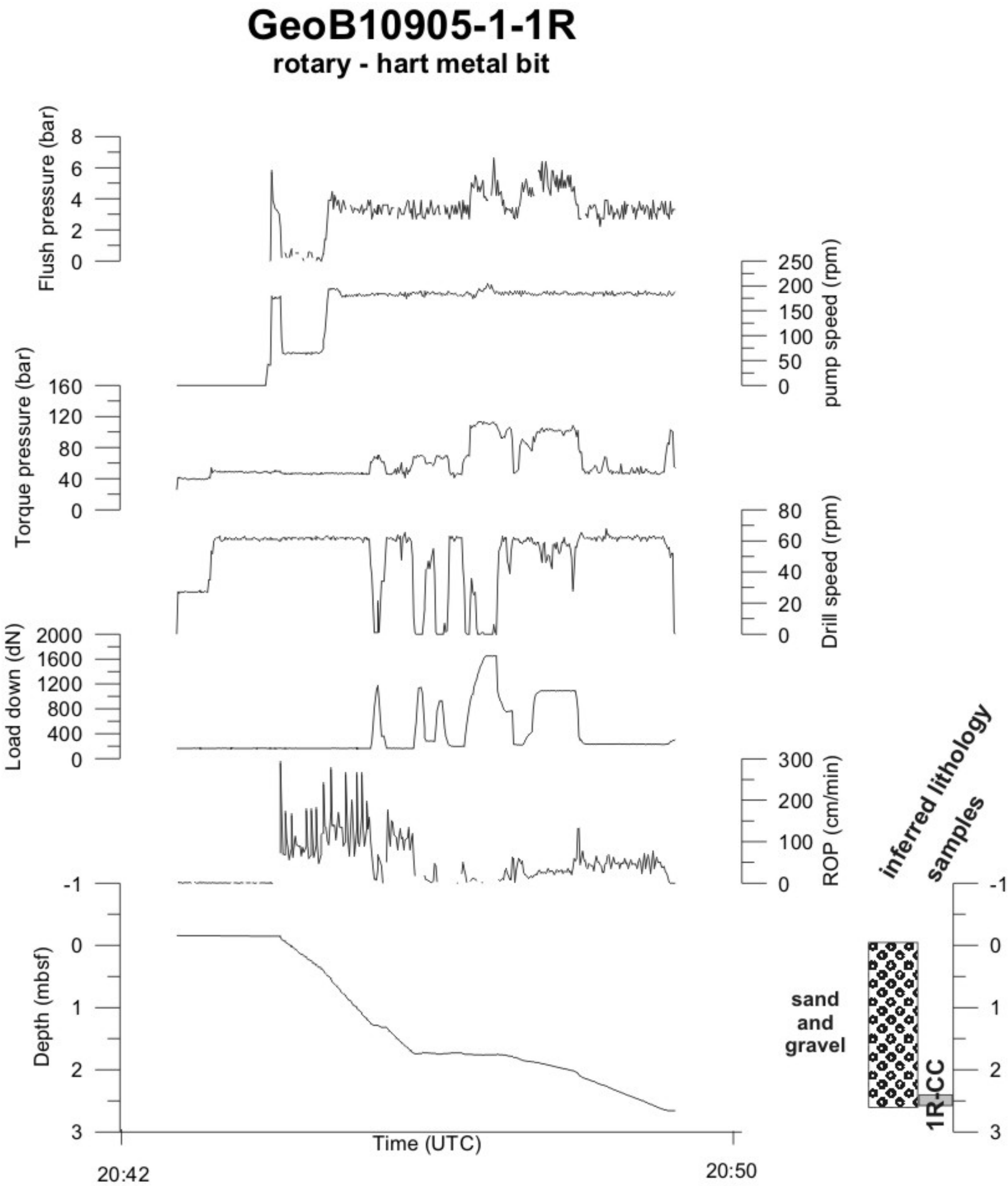

Fig. 27: Drill log data of GeoB10905-1-1R

4.3.8 Overview on core recovery

Tab. 6: Overview on core recovery from MeBo deployments during R/V CELTIC EXPLORER cruise CE0619. (CC: core catcher bag sample; [1] liner length in brackets if different from core length; [2] top is assumed to be start of drilling in case that correlation of lithological units can't be correlated with drill log data)

Stat.-No.	Barrel No	Start of drilling (cm bsf)	End of drilling (cm bsf)	Reco-very (%)	Section No	Section length (cm)[1]	Rock type	Top (cm bsf)[2]	Bottom (cm bsf)[2]
10901-1	1R	0	108	51	1	55	Sand	0	55
					CC		Gravel		55
	2R	91	254	0	---	---	---	---	---
10901-2	1R	0	196	7	1	13(33)	Gravel	75	88
					CC		Gravel		196
	2P	0	132	44	1	58	Sand	Collapsed material	
					CC		Sand		
	3R	166	254	34	1	30	Gravel	196	226
					CC		Gravel		254
	4R	256	397	11	1	15(39)	Gravel	256	271
10902-1	1R	0	33	0	---	---	---	---	---
	2R	0	129	93	1	35(50)	Gravel	0	35
					2	85(100)	Granite	35	120
10903-1	1P	0	66	0	---	---	---	---	---
10903-2	1R	0	259	0	---	---	---	---	---
	2R	262	566	0	CC		Gravel		566
	3R	566	713	59	1	87	Gravel/ Sand/ Breccia	626	713
	4R	713	858	103	1	37	Gravel	Collapsed material	
					2	50(69)	Breccia	708	758
					3	100	Breccia	758	858
10905-1	1R	0	266	0	CC		Gravel		266

5. Station List CE0619

Date	Stat.-No.	WD	Device	Lat			Lon			Remarks
		[m]		[°]	min	N	[°]	min	W	
17.07.2006	10901-1	276	MeBo	53	40.90		013	44.85		Drill depth 254 cm; Core recovery 55 cm
18.07.2006	10901-2	280	MeBo	53	40.92		013	44.82		Drill depth 397 cm; Core recovery 116 cm
19.07.2006	10902-1	254	MeBo	53	45.69		013	43.70		Drill depth 129 cm, Core recovery 120 cm
20.07.2006	10903-1	192	MeBo	53	01.56		013	47.00		Drill depth 53 cm, Core recovery 0 cm
21.07.2006	10903-2	192	MeBo	53	01.56		013	47.00		Drill depth 858 cm, Core recovery 276 cm
22.07.2006	10904-1	708	MeBo	52	01.90		014	56.93		Damage during landing
23.07.2006	10905-1	188	MeBo	53	01.61		013	47.02		Drill depth 266 cm, Core recovery 0 cm