REPORT

REPORT TITLE:

SHALLOW DRILLING SURVEY OFF MØRE-TRØNDELAG 1988
FIELD REPORT.

REPORT NO.: 21.3434.00/01/88

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SUMMARY:

Off Møre/Trøndelag a shallow drilling survey was carried out in a 23 day period from 20 May to 12 June 1988. A total of 8 holes were drilled at 7 different locations near the coast. Four locations were west of Bud (near Molde), two locations off the island Smøla and one location north of Frøya. A/S Farmand Survey with the Norwegian drillship M/S Bucentaur was the main contractor. A total of 300 m Quaternary overburden was drilled using an open centre 6-cone roller-bit. The piggyback coring method was applied in the bedrock, using a diamond bit producing a 54 mm thick core. A total of 628 m bedrock was penetrated, and 541 m core was recovered.
A total of 176.5 m of the bedrock was penetrated in the deepest hole, which was terminated 190.1 m below the seabed. Petrophysical logging was performed at all locations.

On board work on the cores includes subsampling for screening analyses, sound velocity and spectral gamma-ray measurements, slabbing of cores and sedimentological description.

KEY WORDS:

Mid-Norway	Field report
Bedrock	
Shallow drilling	

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1. BACKGROUND FOR THE SHALLOW DRILLING PROGRAMME

The Project "Shallow drilling off Møre-Trøndelag 1987/1988" was initiated through a nearshore bedrock mapping project between 62°-65°N funded by NPD and Statoil (Haugane & Rise, 1987). The report presented 1:250 000 scale maps showing the subcropping bedrock units below the Quaternary, and isopach maps of the Quaternary overburden. The database for the interpretation was conventional seismic lines made available from NPD and Statoil, and regional shallow seismic data collected by IKU. Based on this mapping potential areas for shallow drilling were proposed.

The results of the nearshore mapping and a shallow drilling project proposal were presented for invited oil companies at a meeting in June 1987. Originally seven companies committed to the proposed shallow drilling project. The first phase of the project was to collect additional shallow seismic data in order to improve the interpretation of the subcropping units and propose sites for a shallow drilling programme.

The shallow seismic survey was conducted in August 1987, and a total of 763 km airgun and 201 km of high resolution shallow seismic (water gun) was run. The airgun data was recorded to 2.5 sec, and three different areas were surveyed. Further information is given in the field report (Mogensen and Rokoengen, 1987).

The interpretation of the shallow seismic data and an evaluation of potential shallow coring sites were reported by Haugane et al, 1987. This report and the shallow seismic lines have been evaluated by the participating companies, and at a workshop in April 1988 the participants and IKU had a detailed discussion of shallow drilling targets and sites.

At a steering committee meeting in April 1988 the drilling programme was established by voting of drillsite priorities.

The shallow drilling survey was carried out in the period 20 May to 12 June 1988. Re-evaluation of drilling priorities was done during the survey, based on dating results of samples sent ashore.

The borehole numbers were given by NPD before the survey, based on the planned sites.

2. NAVIGATION AND POSITIONING

A/S Geoteam was subcontracted by IKU to take care of the navigation and positioning services on board the survey vessel M/S Bucentaur. The work is reported in Geoteam report no. 31648.8, June 1988. A total of 8 drilling stations were positioned. As one of the locations was respudded, only 7 locations are shown on the map. The map in Figure 2.1 also shows the shallow seismic data collected by IKU in 1987.

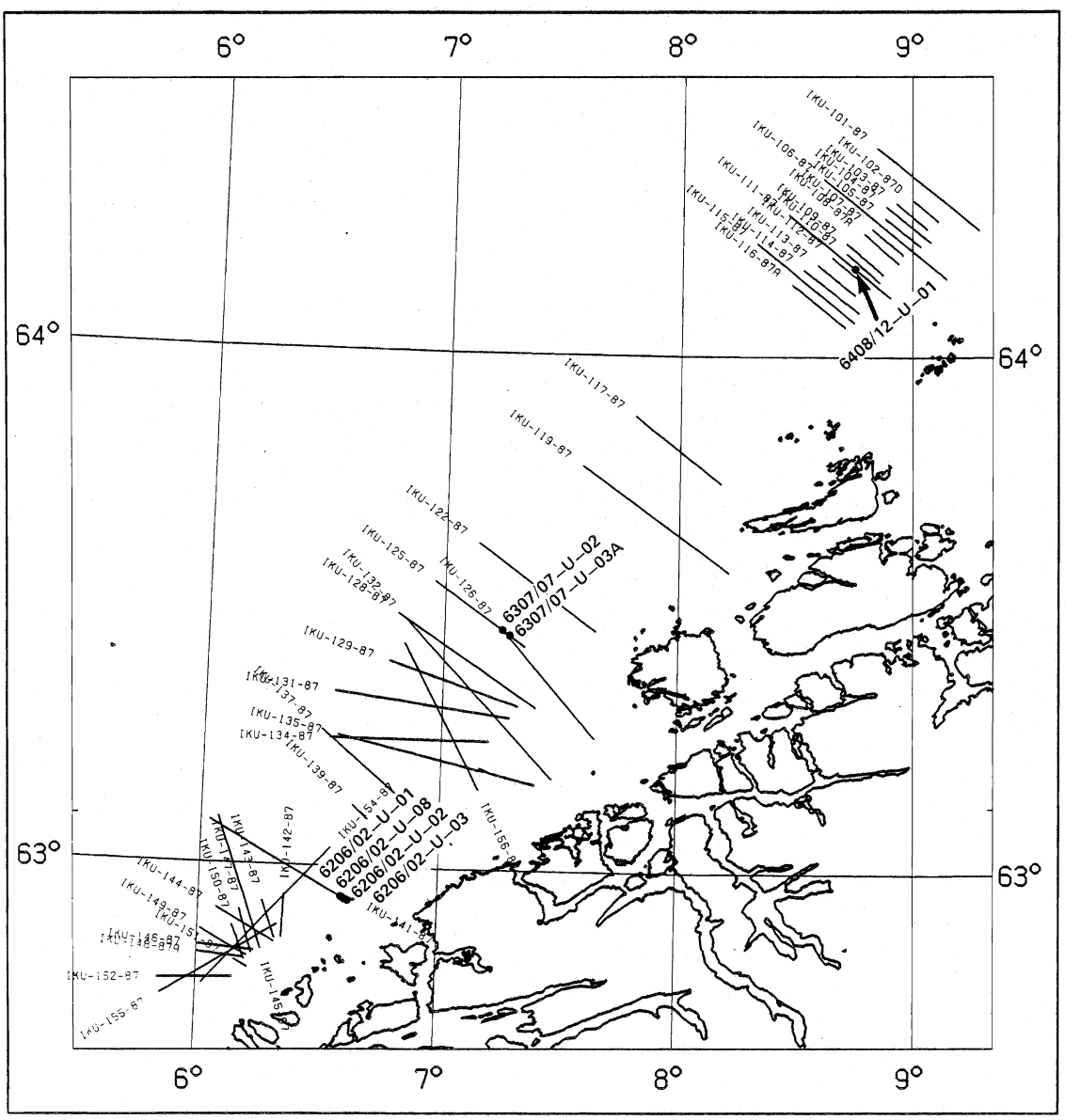


Figure 2.1 Shallow drilling Møre-Trøndelag 1988. Locations of boreholes.

A Sercel Syledis MR3 System, using shore stations in the North Sea Navigation A/S Mid-Norway Syledis Chain and Geoteam's Møre Syledis Chain (northern part), was used as primary navigation system. The Syledis was

interfaced to an HP 9000 Series 310 computer with graphic display of position information, logging on disc and hard copy printout of data.

The vessel's HPR (Hydroacoustic Positioning Reference System) and gyro were also interfaced to the HP computer. Three Syledis ranges were used in the calculation of the positions.

Final positions were computed by taking an average of Syledis and HPR readings. The data sets applied are selected from periods with stable Syledis and HPR data and with a good Syledis station geometry. The choice of Syledis stations is to some extent also affected by the choice of stations applied in IKU's seismic survey programme in 1987.

GPS (Global Positioning Satelite System) was intended to be used as a back-up navigation system without applying any differential corrections. The system, however, proved to be too unstable, and it was decided not to use GPS in the last survey period.

The overall performance of the Syledis navigation was of good quality during the survey. Syledis was used as primary navigation system and three-way positions were calculated from ranges from stations Ulla, Gullberget, Kjerringa, Hestskjær and Alnæs (Geoteam's Møre Chain) in different combinations. The stations Slettringen, Halten and Kopparen (NSNs Mid-Norway Chain) were also used but at a lesser extent. The Syledis signal strength was mainly high with AGC values up to 50%.

The mean standard deviations of the Syledis fixes were between 3-5 metres.

An HPR transponder was mounted on the SEACALF (Jack) approx. 1 m from the centre, but this offset value was ignored for the final positions of the sampling stations. The HPR functioned well during the survey and no corrections were used.

The final site positions reported by A/S Geoteam are shown below in Table 2.1. All positions refer to ED1950, UTM Zone 32 (CM 9°E). The Syledis station combination used are also listed below.

Table 2.1 Final co-ordinates for boreholes

Location	UTM Co-ordinates	Geographical Co-ordinates	Syledis Stations
6206/02-U-02	N 6 981 038 m E 378 724 m	62° 56' 14.68" N 06° 36' 38.00" E	U - G - Kj
6408/12-U-01	N 7 116 198 m E 487 758 m	64° 10' 13.29" N 08° 44' 53.49" E	Ko - Ha - S
6307/07-U-03	N 7 037 651 m E 414 088 m	63° 27' 19.20" N 07° 16' 36.97" E	G - R - He
6307/07-U-03A	N 7 037 645 m E 414 098 m	63° 27' 19.02" N 07° 16' 37.70" E	G - R - He
6206/02-U-01	N 6 981 473 m E 378 037 m	62° 56' 27.90" N 06° 35' 48.17" E	G - R - He
6206/02-U-08	N 6 981 260 m E 378 375 m	62° 56' 21.43" N 06° 36' 12.69" E	G - U - He
6206/02-U-03	N 6 980 651 m E 379 417 m	62° 56' 03.01" N 06° 37' 28.12" E	G - U - He
6307/07-U-02	N 7 038 781 m E 412 557 m	63° 27' 54.35" N 07° 14' 44.26" E	G - R - He

Abbreviations:

U = Ulla
R = Rossvoldberget
He = Hestskjær
G = Gullberget
Kj = Kjerringa
Ha = Halten
S = Slettringen
Ko = Kopparen

3. DESCRIPTION OF THE DRILLING OPERATION

3.1 General

Main contractor for the drilling operations was A/S Farmand Survey in Oslo, who is the owner and the operator of the drill ship M/S "Bucentaur" (Figure 3.1). M/S Bucentaur has a dynamic positioning system, and positioning on the drillsites is very efficient. A bedrock coring machine, the DB 1500S from Diamant Boart, Belgium/Norway was used, and Dia-Team, Norway provided diamond drilling staff.



Figure 3.1 The drill ship M/S "Bucentaur".

3.2 Technical data

Drill ship M/S "Bucentaur"

Length over all	78.07 m
Breadth moulded	16.00 m
Draft fully loaded	5.55 m
Displacement	4.470 tonnes
Gross register tonnage, international	2.768 tonnes

Main engine:	Four Wärtsilä diesels, type Vasa 8R22HE, each driving a van Kaick generator of 1200 kW at 1200 RPM, 600V/60 periods AC.
Propulsion units:	Two azimuthing thrusters with CP propeller in nozzle, make Liaaen.
Bow thrusters:	Two tunnel thrusters with CP propeller, make KaMeWa.
Dynamic positioning system:	One GEC simplex system with GEC-Elliot 2050 computer, video display and joystick. Positioning reference by deep water tautwire system and by Simrad HPR T209 hydro-acoustic system.
Hard-tie winch:	One Ingersoll Rand, max pull 10,000 lbs, with auto. Failsafe brake.
Elevator:	Wirth, type special pipe pick-up chuck, suitable for 51/2" F.H. joints.
Slips:	Wirth power slips type B12, with inserts for 5" pipe.
Heavy lift winch:	One winch make Pusnes, capacity on single drum 2 lengths each 1200 m wire 36 mm dia. Braking force 90 tonn.
Mud system:	Complete dry mud system with mud mixing equipment mud storage, and mud pumps (three X: WIRTH TPK 51/2" x 51/2", 84 HP hydraulic motor, capacity 1600 l/min at 20 bar).

Main drill string

Drill pipe:	2000 m of API-5" Grade E, range II, 19.5lbs/ft with 51/2" tool joints, 4" I.D.
Drill collars:	Sixteen, each 5 m long, 7" O.D. and 4" I.D. with 51/2" tool joints.

Diamond core drill system Drilling machine: DBH 1500S electro/hydraulic drill.

Spindle opening:	127 mm
Rotating speed:	max 900 rpm.
Drill string:	Wireline HR Heavy duty rods O.D. 88.9 mm, I.D. 70 mm, length 10 ft, weight 38 kg. Back-up NR Heavy duty wire line drill rods, O.D. 69.9 mm, I.D. 60.3 mm.
Core barrels:	Triple tube, 10 ft with split tube.
Core diameter:	HR triple tube 54.2 mm, NR triple tube 38.1 mm. HR double tube 57.3 mm
Drilling capacities:	HR - 1000 m, NR 1500 m.
Sea bed template:	Fugro SEACLAM with hydraulic pipe clamping system, inclinometers and underwater TV camera.

3.3 Brief description of standard drilling operation

With reference to the sketch in Figure 3.3, a summary description of the drilling operation is given.

(a) M/S "Bucentaur" moves onto position and sets the dynamic positioning system (D.P.) in operation.

(b) Seabed re-entry template is lowered to the seabed, and constant tension is applied to the template cables via the template heave compensation system.

(c) The 5" drill pipe with open centre bit is lowered on a guided template cable rider to the seabed.

(d) The Quaternary overburden is penetrated until the drillbit is drilled into rockhead. Hammer samples of main Quaternary units are recovered during drilling.

(e) The powerswivel heave compensator is then set to give the chosen main bit weight (often slightly in excess of the maximum weight that may be required by the diamond core bit used for the coring), and the 5" drill string is clamped to the seabed template.

(f) The coring pipe and wireline core barrel is then run into the hole.

(g) Core drilling commences, with length of each run being determined by the length of the inner tube (3.05 m), or by the drilling conditions. Coring continues for 1-2 days. Typical production rates are 2.0 - 3.0 m/h.

(h) The coring pipe and subsequently the 5" drill pipe are pulled and stored on the deck. The seabed template is hoisted into the moonpool, D.P. is disengaged and the vessel proceeds to the next location.

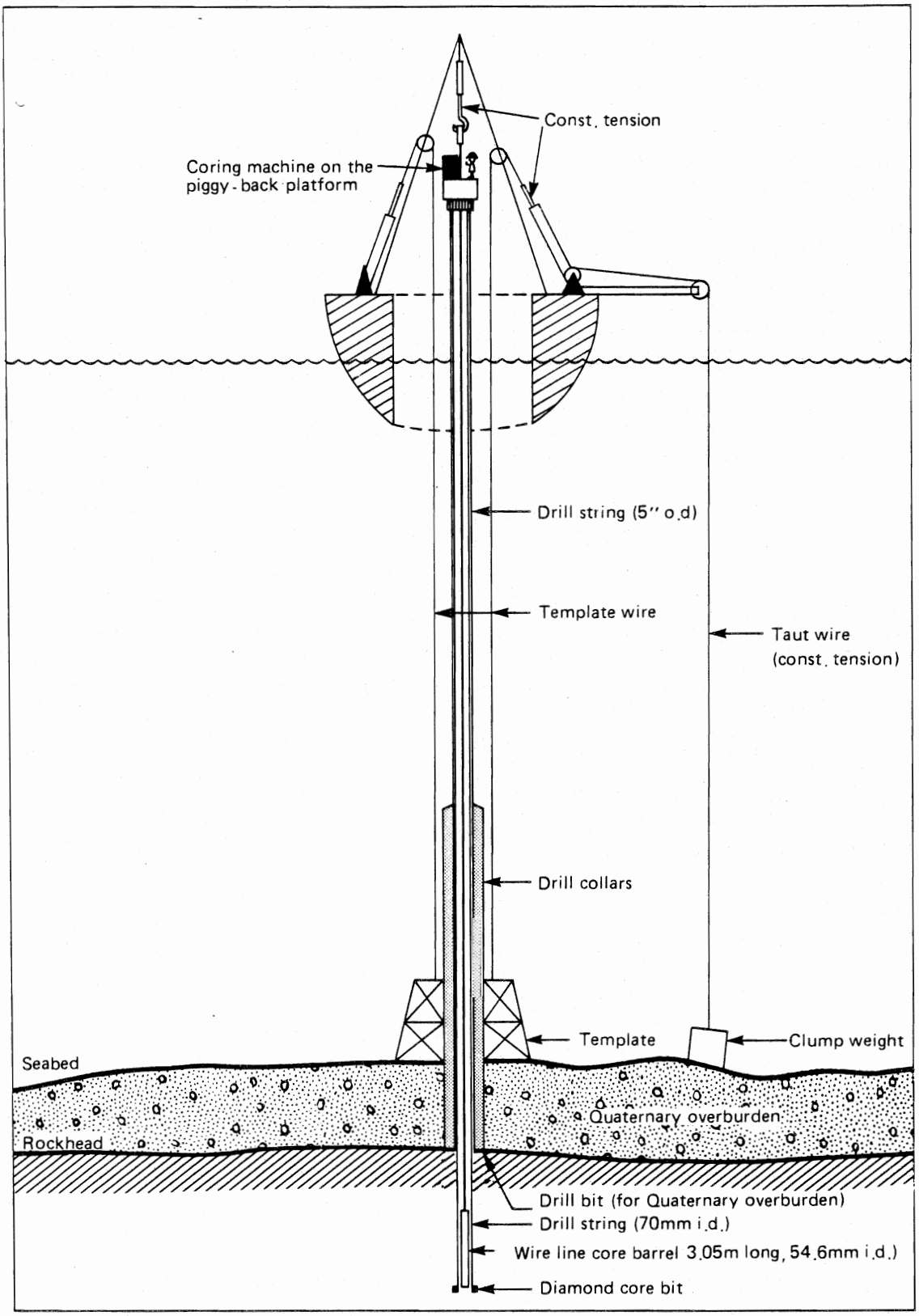


Figure 3.3 Sketch showing the drilling operation for M/S "Bucentaur".

3.4 Deviations from the standard operation

At a few locations drilling was performed with slight deviations from the standard operation. On three locations we drilled some metres into the bedrock with the open centre bit (API-bit). This was done in order to obtain good sealing of the API-bit before starting the coring operation. It is impossible to start piggyback coring in unconsolidated sand, and at one location we had to drill 15 m into the bedrock, and take samples using the hammer sampling method.

At two locations we also used an wireline operated insert bit which latched into the diamond bit. This fullface drilling (non-coring) was done in order to speed up the operation where coring problems were encountered, or penetrate previous cored sections.

4. FIELD OPERATION

The field operation was carried out during 23 days from 20 May to 12 June 1988. The operation was within an excellent weather period, and a minimum of technical problems were encountered. Figure 4 gives a summary of the field operation.

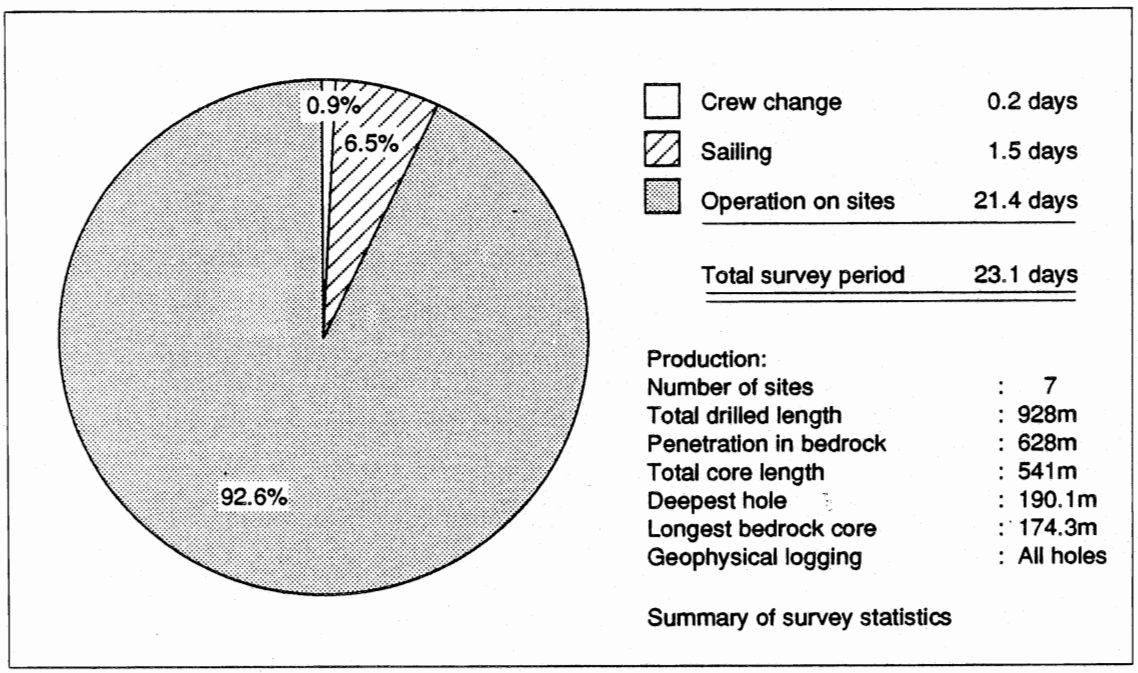


Figure 4 Summary of the field operation

4.1 Key data of the boreholes

Eight holes were drilled, and various key data for the boreholes are shown in Table 4.1.1. The table also show where API-drilling have been applied in the upper part of the bedrock. The sketch in Figure 4.1 shows a semi-geographical placement of the boreholes, and illustrates the total drilled lengths, the Quaternary overburden penetrated and the drilling method applied in the bedrock. Note that where API-drilling and fullface diamond bit drilling were applied (see chapter 3.4), the core recovery of the total penetrated bedrock is less than the piggyback coring recovery. Borehole 6307/07-U-03 had to be respudded due to operational problems, and is not presented in Figure 4.1.

Table 4.1.1 Keydata for the boreholes.

WELL	QUATERNARY THICKNESS (M)	API BEDROCK (M)	DIAMOND BIT DRILLING (M)	PENETRATION IN BEDROCK (M)	CORE LENGTH (M)	CORE RECOVERY OF TOTAL/OF CORING (%)		TOTAL DRILLED LENGTH (M)
6206/02-U-03	94,50	-	79,70	79,70	78,32	98,3	98,3	174,2
6206/02-U-02	68,00	5(?)	60,25	65,25(?)	50,75	77,8	84,2	133,25
6206/02-U-08	56,25	-	50,45	50,45	25,55	50,7	67,1	106,7
6206/02-U-01	54,50	-	127,30	127,30	118,92	93,4	93,4	181,8
6307/07-U-03A	3,0	3,5	73,60	77,1	63,25	82,0	98,6	80,1
6307/07-U-03	3,0	4,1	14,05	18,15	13,03	71,8	92,7	21,15
6307/07-U-02	13,55	-	177,60	176,55	174,26	98,1	98,1	190,1
6408/12-U-01	8,0	15	18,25	33,25	16,88	58,4	92,5	41,25
				628	541			928

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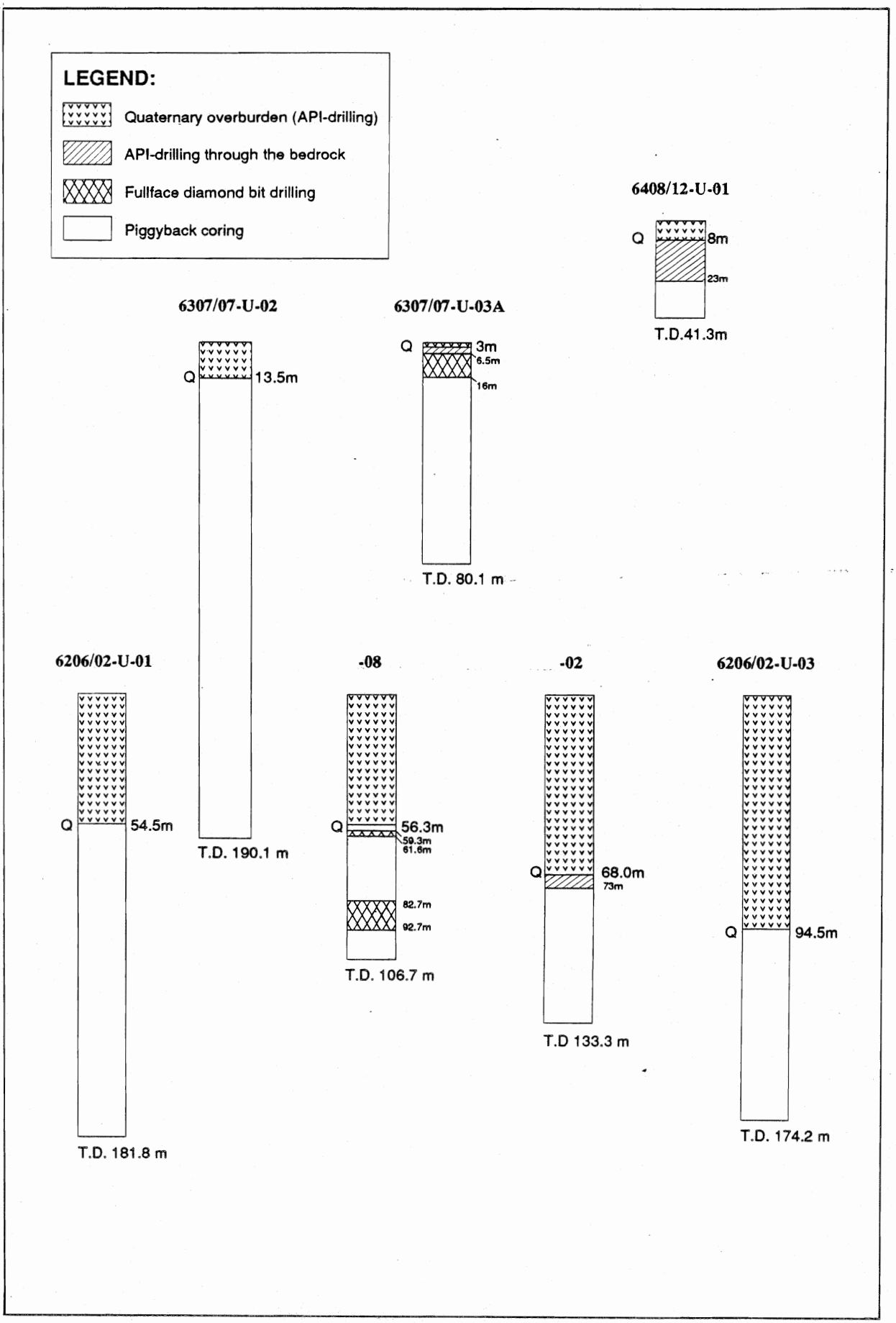


Figure 4.1 Sketch illustrating the drilling methods applied and drilled length.

4.2 Drilling and coring - operational comments

A total of approx. 300 m Quaternary sediments were penetrated, with an average penetration rate varying from 6 to 10 m pr. hour. No drilling problems were encountered. A special designed 6-cone rollerbit was used at all holes, and the drilling performance was better than previously experienced during shallow drilling operations. During the API-drilling of the overburden, hammer-samples were taken of the various Quaternary units.

As shown i Figure 4.1, the API-rollerbit was also drilled into the upper part of the bedrock at some locations in order to obtain good sealing and to avoid piggyback coring in loose sands.

This year a monitoring device was installed in the diamond drilling machine to measure the various coring parametres: Penetration rate, rotation speed, momentum, bit load, mud pressure and amount of drilling fluid applied. The data was recorded on tape, and displayed after completion of the well. At a few location display problems were experienced, and some of the data were lost during recording.

Figure 4.2 illustrates penetration rates obtained during the piggyback operation in the bedrock. Most of the drilling problems experienced were related to poorly consolidated sediments. This caused several delays due to occasional collapsing of the formations and plugging of the corebarrel with a mixture of compacted sand/mud. Coarse and loose sediments are probably also responsible for the fact that during this survey we experienced several tripping rounds (drillstring up and down) due to worn out or destroyed diamond bits.

However, the overall performance of the piggyback coring/drilling was highly satisfactory with a total bedrock penetration of 628 m, and recovery of 541 m cores. Operational comments given below should be related to the penetration/time plot shown in Figure 4.2.

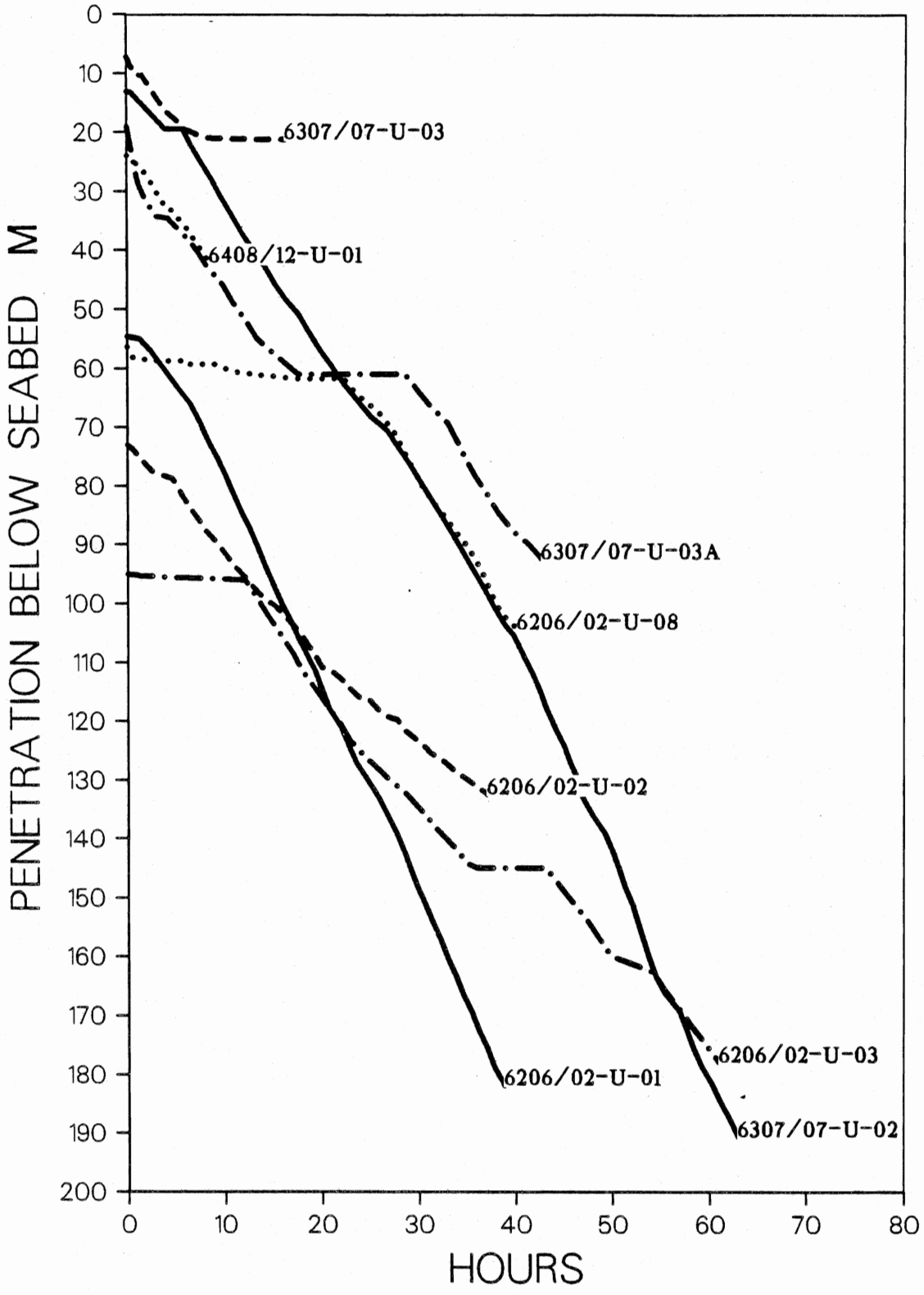


Figure 4.2 Plot showing penetration rate in bedrock vs. time.

6206/02-U-02

Drilling through the approx. 68 m thick overburden became easier than expected. 7.5 hours were used, and approx. half of the time was drilling in the 12 m thick stiff basal till in order to obtain good sealing conditions. The API-bit was drilled approx. 5 m into the bedrock or Quaternary/bedrock transition zone.

The coarse conglomerate containing frequent cracks and loose stones did not cause any drilling problems. Careful coring was, however, necessary to avoid bit plugging, particularly in the lowermost 20 m of the hole. The hole was terminated voluntarily at 133.3 m below the seabed.

6408/12-U-01

No problems were encountered when drilling through the 8 m thick Quaternary overburden. As the upper part of the bedrock comprised nearly unconsolidated sand, API-drilling had to be applied to 23 m below the seabed. Short hammer samples of the sand were taken at 1.5 m intervals, giving only 17% recovery in the uppermost 15 m of the bedrock.

The piggyback coring was carried out without problems, and the borehole was terminated voluntarily at 41.3 m below the seabed.

6307/07-U-03

The Quaternary overburden was only 3 m, and in order to obtain good sealing conditions the API-bit was drilled to 7 m below seabed.

Piggyback coring was carried out without problems to approx. 21 m below the seabed. Then the HR-drillstring was pulled in order to change a broken bit. New problems were encountered when coring started again, and we had to trip the drillstring another time. Broken fragments of the first bit had destroyed the new one. To avoid further problems we decided to respud the hole.

6307/07-U-03A

At this location API-bit was drilled 3.5 m into the bedrock. As the uppermost sedimentary unit was cored at location 6307/07-U-03, we applied fullface drilling (non-coring) to 16 m below the seabed using a wireline operated insert bit in the diamond bit.

During piggyback coring we experienced some minor delays due to fishing of a lost core-catcher and downfall of sand causing bit plugging. At approx. 60 m below the seabed, the inner tube (core sampling device) did not latch into the corebarrel because it was filled with sand. This resulted in tripping of the HR-drillstring in order to clean the corebarrel which was entirely filled with compact mixture of sand/mud. After flushing the hole with heavy mud the drillstring was re-entered, and non-coring was applied to drill through the collapsed lower part of the hole. Heavy mud was pumped in order to stabilize the hole.

Piggyback coring continued without problems, and the hole was terminated voluntarily at 80.1 m below the seabed.

6206/02-U-01

Drilling through the 56.5 m thick Quaternary overburden was carried out without problems. The piggyback coring operation was very efficient, with an average bedrock penetration 3.6 m/hr. No problems were encountered before the inner-tube got stuck in the corebarrel at 181.8 m below the seabed, and we decided to terminate.

When attempting to pull the API-drillstring it was stuck. After 7 hours we managed to rotate and pull the string. In this period the hydraulic system was used to the capacity limits, and this caused several repairs. The hydraulic motor in the main powerswivel had to be changed during heavy swell.

6206/02-U-08

In order to avoid problems retrieving the main drillstring, we flushed the hole using more heavy mud when drilling through the Quaternary. No drilling problems were encountered.

During the first day at this location, operational problems were encountered. When starting piggyback coring, the diamond bit (reaming shells) was destroyed when drilling through the API-bit. After tripping of the drillstring, downfall of sand from the formation caused bit plugging, and we had to apply the non-coring bit. During this operation we lost equipment, and had delays due to fishing.

After restarting the piggyback coring, several problems were encountered due to the poor condition of the formation. The HR-bit and reaming shells

were destroyed due to coring through collapsed material with stones rolling in front of bit. We also experienced problems with plugging of the drillstring due to collapsing of the lower part of the hole. In order to continue we had to apply the non-coring bit for 10 m (from 82.7 - 92.7 m below the seabed).

The hole was terminated voluntarily at 106.7 m below the seabed.

6206/02-U-03

A total of 14 hours was used to penetrate the 94.5 m thick Quaternary overburden and of this time the drilling through the 10 m thick and hard basal till with stones and boulders took 9 hours. The drilling rate was slow, but no drilling problems were encountered.

When starting the piggyback operation, coring was impossible. The HR-bit used had been wrongly labelled at the factory, and the coring problems were caused by an oversize core (3 mm too large diameter). After re-building of the inner-tube coring continued without problems.

Due to totally worn out HR-bit, the drillstring had to be tripped for changing of the bit.

The coring was terminated 174.2 m below the seabed because the corebarrel broke.

6307/07-U-02

Drilling at this location was very efficient and the average coring rate through 176.5 m of the bedrock was 3.0 m/hr. The sandstone unit was cored at an average rate of 3.9 m/hr.

The hole was terminated voluntarily at 190.1 m below the seabed.

4.3 Petrophysical logging of the boreholes

Petrophysical logging of the holes was performed by British Plaster Board (BPB) after termination of the drilling. The following logging tools were available:

Sonde 1 Multichannel Sonic (MS1)
Sonde 2 Gamma, dual Density, Caliper (DD3)
Sonde 3 Gamma, dual Neutron (NN1)
Sonde 4 Temperature (TT1)
Sonde 5 Vertical Dipmeter (VO1/DV1)
Sonde 6 Experimental Sidewall Waveform Sonic (SS1)

In general the bedrock was weak and unstable, and in order to ensure gamma or density/neutron data, 3 of the holes was logged before pulling the inner string (HR-string). Normally the HR-drillstring was pulled in order to bring the HR-bit to the API-bit level or a few metres below.

Tables 4.3.1 and 4.3.2 give a summary of the logging operations, with comments on operational problems due to collapsing of holes and other reasons.

Due to poor hole stability, the radioactive sondes were used in only 3 open holes. Vertical dipmetre was run in two holes. Due to too low sonic velocity in the formations, experimental Sidewall Waveform Sonic (SS1) could not be used.

The sketch in Figure 4.3 gives a visual view of where the various sondes have been run.

The reference depth for the logging operations is the API-bit level. The same reference level is used for calculation of the top and base below the seabed for each core run.

The logs were displayed on board at 1:100 scale, and thus proved useful for the on board sedimentological description and evaluation of core-losses.

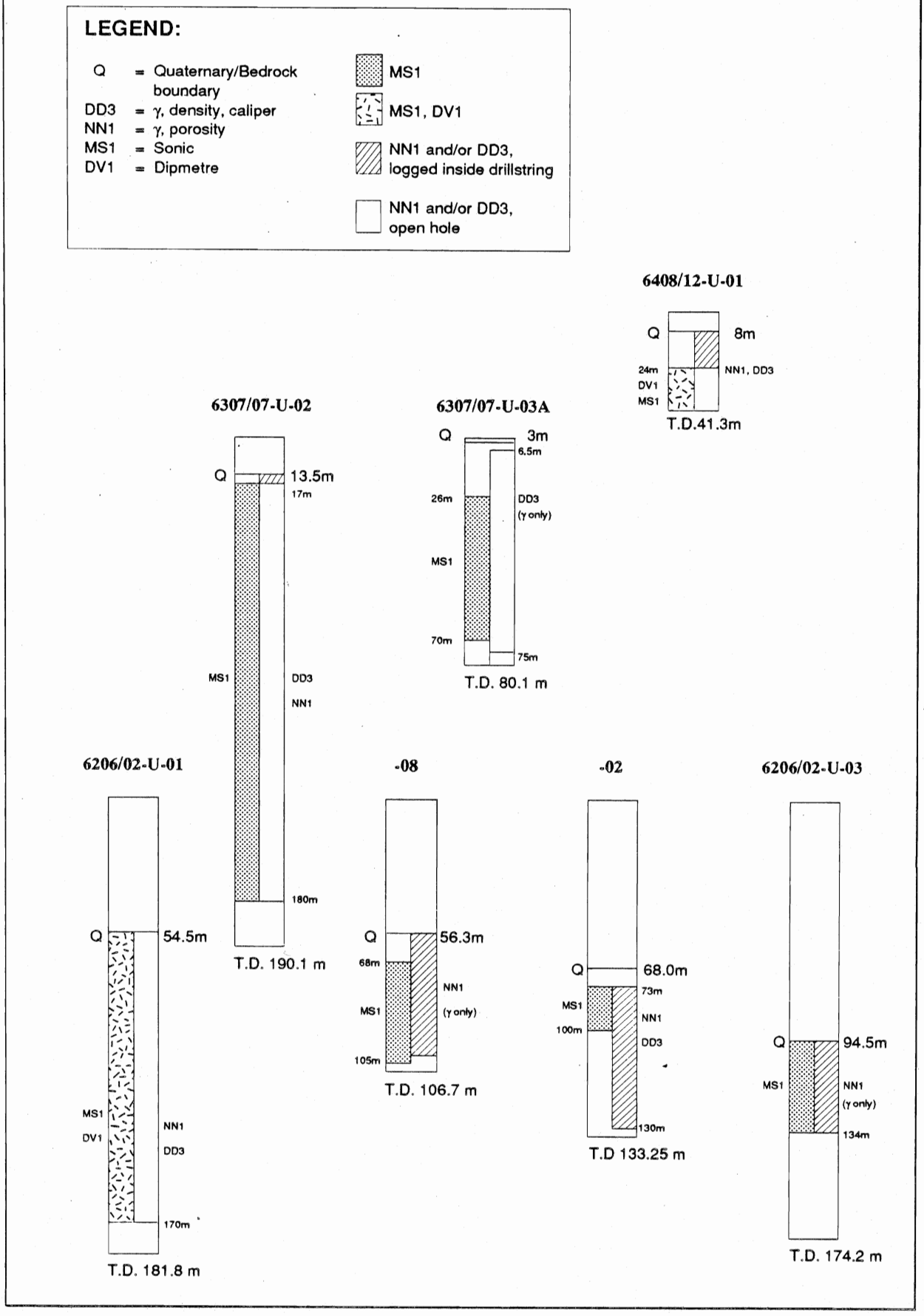


Figure 4.3 Sketch illustrating the logging operation in the bedrock.

Table 4.3.1 Summary of logging operations

Location	NN1	DD3	MS1	DV1	Comments
6206/02-U-03	134-0m	-	134-94m	-	NN1 (γ ray only) run through HR drillstring. Hole in poor condition.
Water depth 219 m	B+Q (Bedrock & Quaternary)		B only (Bedrock only)		
6206/02-U-02	130-0m	130-0m	100-73m	-	DD3, NN1 Run through HR string. MS1, TT1 not taken below 100m due to hole condition.
Water depth 216 m	B+Q		B only		
6206/02-U-08	105-0m	-	105-68m	-	NN1 (γ ray only) run through HR string. Hole in poor condition.
Water depth 214 m	(γ only) B+Q		B only		
6206/02-U-01	170-0m	170-0m	172-54m	165-57m	
Water depth 202 m	B+Q		B only		
6307/07-U-03A	78-0m	75-0m	70-25m	-	NN1 (γ ray only) run through HR string. Hole in poor condition.
Water depth 245 m	(γ only)	(γ and Caliper)			
	B+Q		B only		
6307/07-U-02	187-0m (γ only)				NN1 (γ ray only) run through HR string. HR then pulled back to 17 m below seabed. DD3 & NN1 openhole HR. Then withdrawn in order to run DV1, but hole blocked off 1 m below API.
Water depth 289 m	180-0m	180-0m	180-17m	-	
	B+Q		B only		
6408/12-U-01	40-0m	40-0m	40-24m	40-24m	
Water depth 292 m	B+Q		B only		

Tools available:
DD3 (γ, density, caliper)
NN1 (γ, porosity)
MS1 (sonic)
DV1 (Dipmeter)
TT1 (Temperature)
SS1 (Exp. sonic)

Table 4.3.2 Logging tools run and operational comments

Hole no.	Tools run	Depths (approx.)	Remarks
6206/02-U-03 Water depth 219 m	γ ray MS1	134-0 m 134-94 m	Hole blocked at 136 m Core barrel lost downhole. Because of the very poor condition of the hole, no other logs were attempted. Bottom hole temperature 15°C.
6206/02-U-02 Water depth 216 m	I. DD3, NN1 II. MS1, TT1	130-0 m 100-73 m	I. Run through HR drill string. II. HR withdrawn Hole condition poor. No radioactive logs in openhole formation. Unsuitable for both dipmeter and Exp. sonic. Bottom-hole temp. 14°C.
6206/02-U-08 Water depth 214 m	I. γ ray II. MS1	104-0 m 105-68 m	Due to poor hole conditions, the hole was logged in two sections. I. HR bit on bottom. II. HR bit pulled back to ≃ 68 m. No other openhole logs were attempted. Bottom hole temperature 15°C.
6206/02-U-01 Water depth 202 m	DD3, NN1 MS1 DV1	170-0 m 172-54 m 165-57 m	Temperature of no interest Formation too slow for SS1 Logged during heavy swell (4 m) making tool changes slow. Hole filling in during logging. Bottom hole temperature 16°C.
6307/07-U-03A Water depth 245 m	I. NN1 (γ ray) II. DD3 (γ, cal) MS1	78-0 m 75-0 m 70-26 m	I. Run through HR drill string II. HR withdrawn Hole condition poor filling in during logging. No radioactive logs in open hole. Dip meter would not pass through 54 mm bit. Formation too slow for SS1. Bottom hole temp. 14°C.
6307/07-U-02 Water depth 289 m	I. γ ray II. MS1, DD3, NN1 III. DV1 *	187-0 m 180-0 m -	I. γ ray run through HR string. II. HR pulled back to 4 m below API string. III. HR withdrawn Bottom hole temperature 18°C. * Hole blocked off 1 m below API.
6408/12-U-01 Water depth 292 m	DD3, NN1 MS1, DV1	40-0 m 40-24 m	Temperature of no interest Formation too slow for SS1. Bottom hole temp. 13°C.

4.4 Survey statistics

In Figure 4.4 a pie diagram illustrating the duration of the various survey activities. Nearly half the total survey time was used for effective coring in the bedrock.

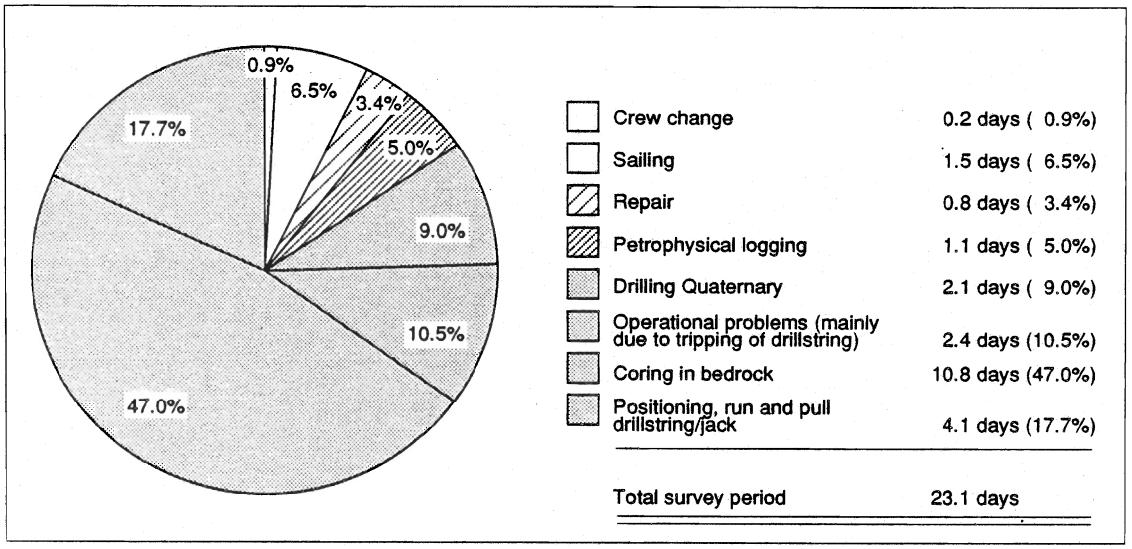


Figure 4.4 Duration of various survey activities.

5. ON BOARD WORK ON CORES

5.1 Laboratory measurements and subsampling

After pushing the core out of the wireline operated inner-tube (normally approx. 3 m), it was carefully washed at a bench on deck and transferred to a specially designed v-frame. In the on board laboratory the following keydata was registrated in a database:

- Date/time
- Location
- Run number (wireline)
- Penetration length
- Length of the core

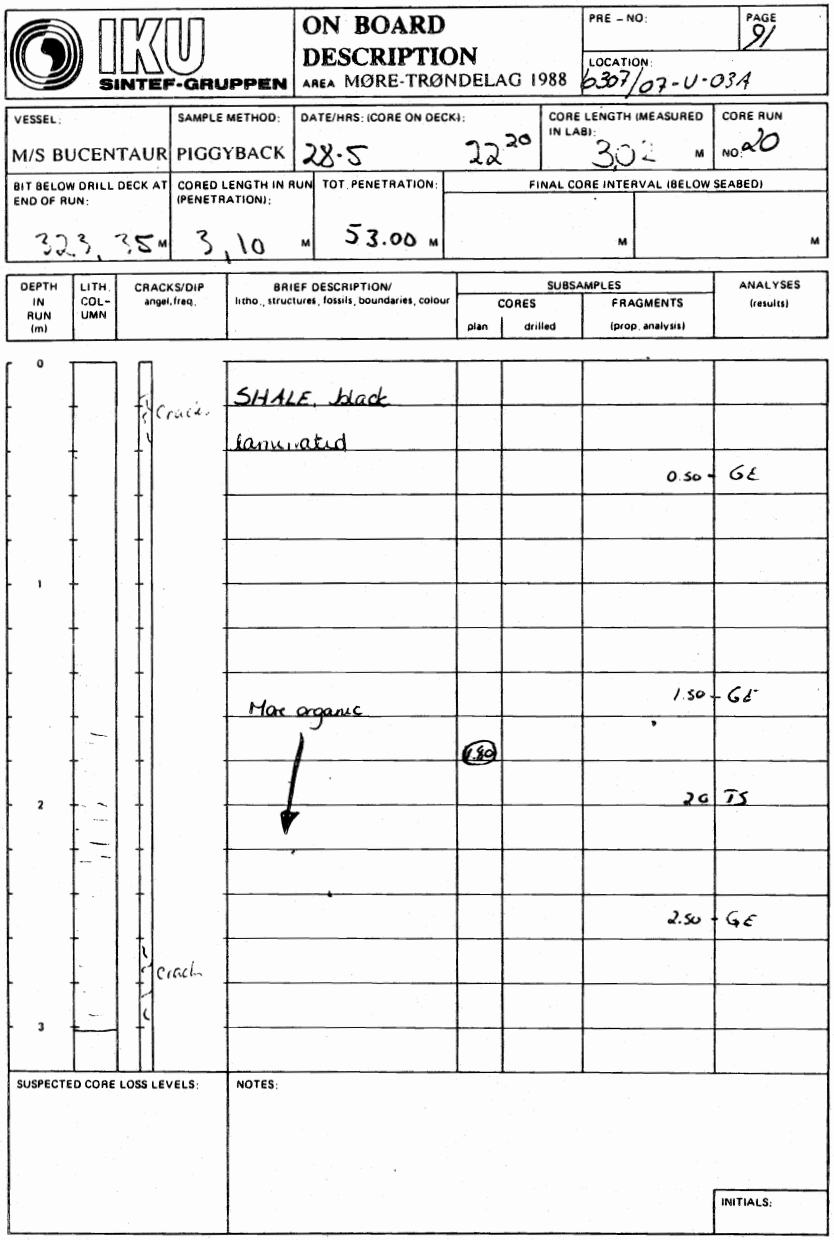
The following measurements were done on board:

Sound velocity was measured on fresh, water-saturated cores using small 200 kHz transducers and a portable ultrasonic non destructive indicating tester (PUNDIT). The transit time was measured across the diameter with the core lying in the v-frame. In good quality cores 3-5 measurements were carried out on each metre. A few vertical measurements were also conducted. In poorly consolidated sandstone, in fractured cores and partly in conglomerates, few measurements have any confidence due to weak or unstable signals.

Routine spectral γ-radiation measurements were also carried out in our on board laboratory. The detector used was a 5"x5" Nal detector connected to a 4084 channel analyser of the Canberra 40 series. A 15-20 cm long piece of the whole core was placed in a lead chamber below the detector, and counts were recorded for 10 minutes. Normally one measurement for each 2-3 m core were carried out.

Subsamples were picked out for various screening analyses. All measurements and subsamples were registered in the data base, and labels were printed for the subsamples. In Figure 5.1 a "run summary sheet" is shown, which was printed immediately after the laboratory work on the core was completed. A hand-written data sheet for basic information are also shown.

In the laboratory it was decided where plugs for various analysis should be drilled.



IKU SINTEF-GRUPPEN

ON BOARD DESCRIPTION

AREA MØRE-TRØNDELAG 1988

PRE – NO:

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LOCATION: 6307/07-U-03A

VESSEL:	SAMPLE METHOD:	DATE/HRS: (CORE ON DECK):	CORE LENGTH (MEASURED IN LAB):	CORE RUN NO.
M/S BUCENTAUR	PIGGYBACK	28.5 22[20]	3,02 M	20

BIT BELOW DRILL DECK AT END OF RUN:	CORED LENGTH IN RUN (PENETRATION):	TOT. PENETRATION:	FINAL CORE INTERVAL (BELOW SEABED)	
323,35 M	3,10 M	53.00 M	M	M

DEPTH IN RUN (m)	LITH. COL-UMN	CRACKS/DIP angel,freq.	BRIEF DESCRIPTION/ litho., structures, fossils, boundaries, colour	SUBSAMPLES CORES plan	CORES drilled	SUBSAMPLES FRAGMENTS (prop. analysis)	ANALYSES (results)
0			SHALE, black				
		Crack	laminated				
						0.50 – GE	
1							
			Mor organic			1.50 – GE	
				150			
2						2.6 TS	
						2.50 – GE	
		Crack					
3							

SUSPECTED CORE LOSS LEVELS:

NOTES:

INITIALS:

RUN SUMMARY SHEET

DATE: 30.05.88
TIME: 12:55

WELL: 6206/02-U01
RUN: 4

LENGTH: 2.91 m

FINAL TOP : 0.00 m
FINAL BOTTOM: 0.00 m

COMMENTS :

SAMPLES

IKUno	Depth	R_depth	Diff.	Purpose
D 319	0.00 m	0.00 m	0.00 m	
D 316	0.00 m	0.09 m	0.00 m	XR
D 317	0.00 m	0.50 m	0.00 m	GE
D 318	0.00 m	0.70 m	0.00 m	XR
D 320	0.00 m	1.20 m	0.00 m	XR
D 321	0.00 m	1.40 m	0.00 m	RM
D 322	0.00 m	1.50 m	0.00 m	GE
D 323	0.00 m	1.68 m	0.00 m	TS
D 324	0.00 m	2.50 m	0.00 m	GE

Number of Samples in run : 9

GAMMA

Depth	R-depth	Counts	K	Th	U	Total
0.00 m	1.37 m	600	1906	510	502	27373
0.00 m	2.80 m	600	1900	553	484	27823

Number of Gamma – samples in run : 2

VELOCITY

Depth	R_depth	Hor.vel.	Vert.vel.
0.00 m	0.25 m	2267	0
0.00 m	0.60 m	2068	0
0.00 m	1.40 m	2167	0
0.00 m	2.10 m	2305	0
0.00 m	2.60 m	2202	0
0.00 m	2.85 m	2125	0

Number of Velocity – samples in run : 6

SDa

IKU SINTEF-GRUPPEN

Figure 5.1 Run summary sheet. On board description sheet.

After completion of the laboratory work, the core was transferred to a corebox which was carefully labelled.

5.2 Slabbing of cores and plug drilling

Where possible, the cores have been sawed in two parts, comprising one third and two thirds of the core respectively. The "one third slab" is the reference core, and no subsampling will be done on that.

Very poorly consolidated cores and weak laminated rocks were frozen before sawing. The "one third slab" was kept frozen in order to preserve the slab for epoxy mounting. As the freezing procedure, sawing of frozen cores and labelling of slabs were time consuming, this work was done on board only so far the available time permitted.

Cores with macrofossils were not cut on board. This will be done after the cores have been examined and the fossils have been subsampled.

Plugs with one inch diameter were drilled on board for extra subsampling (for porosity/permeability, thin sections, etc.). A non-magnetic bit was used for this purpose. Due to the poor quality of the cores, the amount of plugs taken out was less than planned.

Paleomagnetic measurements on plugs were done on board for an internal IKU-project.

5.3 Sedimentological description

After the core-slabbing was completed, the cores were brought to a container laboratory for sedimentological description. The sedimentologist on board logged at a scale of 1:10 or 1:50, depending on the complexity of the cores.

The sedimentologist was also responsible for taking photographs of the core boxes. In addition he followed the current production of cores, and made sedimentological descriptions for the daily reports.

5.4 Evaluation of core losses

Evaluation of the core losses was done immediately after completion of the well. Due to a general poor rock quality, the core recovery was less than expected in some of the boreholes (see Table 4.1.1). For evaluation of the

core losses in the wireline runs the driller's log, examination of the cores and the petrophysical logs were used. If no specific information related to core- losses existed, the loss was placed in the uppermost part of the run.

After calculating the final top and base of each wireline core-run (in metres below the seabed) and the coreless intervals, the database was updated and new labels with final depths were printed for the subsamples. All coreboxes were also marked with final depths.

6. REFERENCES

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