REPORT

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QUATERNARY SAMPLES COLLECTED DURING THE IKU SHALLOW DRILLING CRUISE IN THE BARENTS SEA 1987

REPORT NO.: 21.3441.00/02/89

AUTHORS:

J. Sættem, H.M. Weiss and D.A. Westgaard

IKU
SINTEF GROUP

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SUMMARY:

During July to September 1987 18 shallow boreholes were drilled in Quaternary and pre Quaternary sediments in the Barents Sea as part of three different IKU projects. More than 60 Quaternary samples were collected from 16 of these holes.

Most of the Quaternary samples are collected by hammer - or push - sampling but a number of samples of stony soil are also collected by rotary diamond coring.

The present report gives the result of cores obtained in the boreholes drilled as part of project 21.3427.00 - SHALLOW DRILLING BARENTS SEA 1987.

KEY WORDS:

Barents Sea	Shallow drilling
Quaternary	Glacigenic sediments
Soil conditions	Project 21.3427.00

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PREFACE

The present report gives the results of analyses carried out on Quaternary samples collected as part of the project during 21.3427 Shallow Drilling Barents Sea 1987, a combined shallow drilling cruise in the southern Barents Sea in 1987.

The participants of the project are:

Norsk Agip A/S
BP Norway Limited U.A.
Elf Aquitaine Norge A/S
Esso Norge a.s
Fina Exploration Norway
Norsk Hydro a.s
Mobil Exploration Norway Inc.
Norwegian Petroleum Directorate
A/S Norske Shell
Statoil
Total Marine Norsk A/S

as "early participants" in the project and:

Amoco Norway Co.
Conoco Norway Inc.
Deminex (Norge) A/S
Saga Petroleum a.s

as "late participants".

The field work was coordinated by Tom Bugge and Joar Sættem and the laboratory work by Joar Sættem. The report is based on contributions from the following IKU personnel:

Field work: T. Berg, T. Bugge, G. Elvebakk, E. Haugane, G. Haugen, L. Husvik, A. Mørk, H. Rendall, L. Rise, J. Sættem, D.A. Westgaard.

Sample description: D.A. Westgaard and J. Sættem.

Laboratory analyses: H. Rendall, H.M. Weiss and D.A. Westgaard.

Foraminifer picking: R. Wilhelmsen.

Drawing: R. Angell-Petersen, B. Fossum, J. Johansen.

Typing: K.D. Brønner, M. Kjærvik.

Printing: G. Herje

A study of magnetic properties is carried out by R. Løvlie and K.L. Ellingsen at the University of Bergen, geotechnical laboratory investigations are carried out by the SINTEF Division of Geotechnical Engineering.

H.P. Sejrup at the University of Bergen has been responsible for the amino acid measurements and G. Possnert at the Swedberg Laboratory in Uppsala has done the ^{14}C datings.

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1. INTRODUCTION

During a shallow drilling cruise in the Barents Sea in 1987 (Appendix 1) samples were obtained from the Quaternary sediments covering the pre Quaternary rocks in the area. The purpose of this sampling was to document the conditions of the drilled Quaternary formation and to provide some regional data on general geotechnical conditions and glacial geology of the area.

The sampling was carried out by a hammersampler, a hydraulic pushsampler or by rotary diamond coring. The latter method was used when the soil conditions hampered penetration by standard soil boring bits and the piggyback equipment was used to advance to bedrock. Brief descriptions of the methods are given in Appendix 1.

The present report provides documentation of the Quaternary samples and results of various analyses done on this material. The report focuses on data documentation and discussion and interpretation of the results is limited to a few brief comments outlining typical conditions and to some comments related to crossplots of index parameters.

2. SUMMARY OF MAIN FINDINGS, AND BRIEF COMMENTS ON THE RESULTS

2.1 Physical properties

The sites are located in areas with Quaternary thickness varying from 20 m to 75 m. The sea bed has typically a rough relief caused by relict iceberg ploughmarks, and in the Nordkapp Basin area numerous small pockmarks occur on the sea bed. A smooth, soft sediment sea bed is found in the trough close to the coast of Finnmark.

A general sediment description for most of the material would be: "silty, sandy, clay, with scattered fragments of fine gravel". Towards the rockhead the content of gravel tends to increase, and close to the Norwegian coast the samples reflect the provenance from a shield area by a reduced clay content and increase in size and amount of crystalline rock fragments. Nearly all the samples are homogeneous and nonstratified, but a slight fissility is found in a number of the samples. This fissility is often enhanced and deformed by strain related to the sampling.

A number of routine soil mechanical analyses and various other tests have been carried out on these samples. Details of the results are given in Chapter 5.

In Figure 2.1 all measured undrained shear strength (with few exceptions from falling cone tests) from all sites are plotted along a common depth axis. Two straight lines in the plot represent $0.2 - 0.3 \times p_o'$. They are based on an average bulk density of 2.03 g/cm^3. Undrained shear strength is as a rule of thumb generally expected to plot in the vicinity of these lines, and the figure indicates that many of the soil samples represent a sediment that has been overconsolidated - probably by the direct effect from an ice sheet or by previous sediment load which has been eroded away.

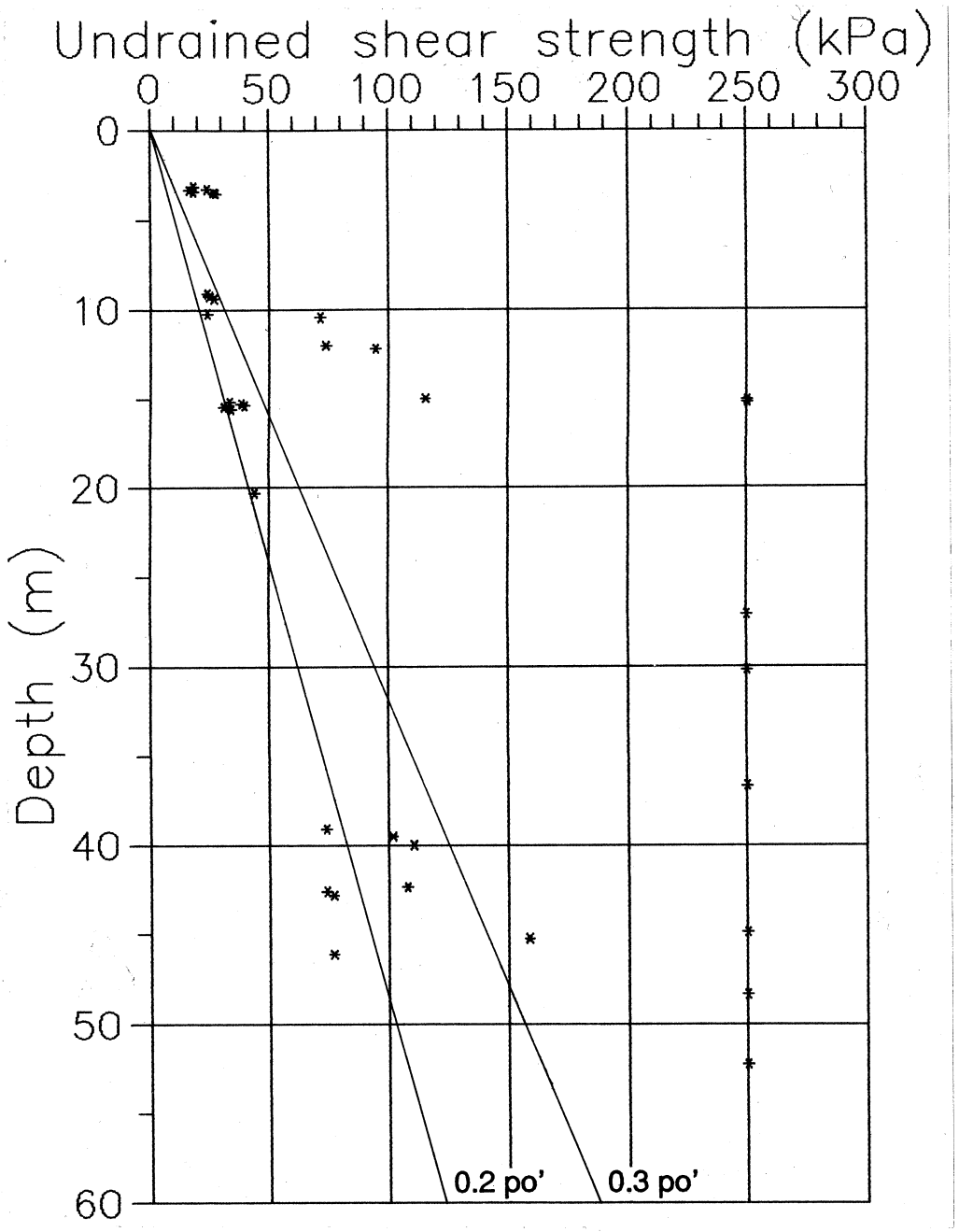


Figure 2.1: ***Undrained shear strength from all sites plotted along a common depth axis. Straight lines represent 0.2 and 0.3 x p_o'. All datapoints along s_u = 250 kPa are minimum values.***

In Figure 2.2 undrained shear strength is plotted versus remoulded shear strength. This plot illustrate the low sensitivity of the clays which compare well with what is found for till and glaciomarine clays elsewhere on the Norwegian continental shelf (e.g. Rokoengen et al 1980; Fig.18). Nearly all samples plot within the "glacial clay" - area in the summarizing diagram of Terzaghi and Peck (1967) and close to the T-line of Boulton and Paul (1976) in the plasticity chart (Figure 2.3). This T-line is, however, not regarded as unique for tills (Sladen and Wrigley 1983).

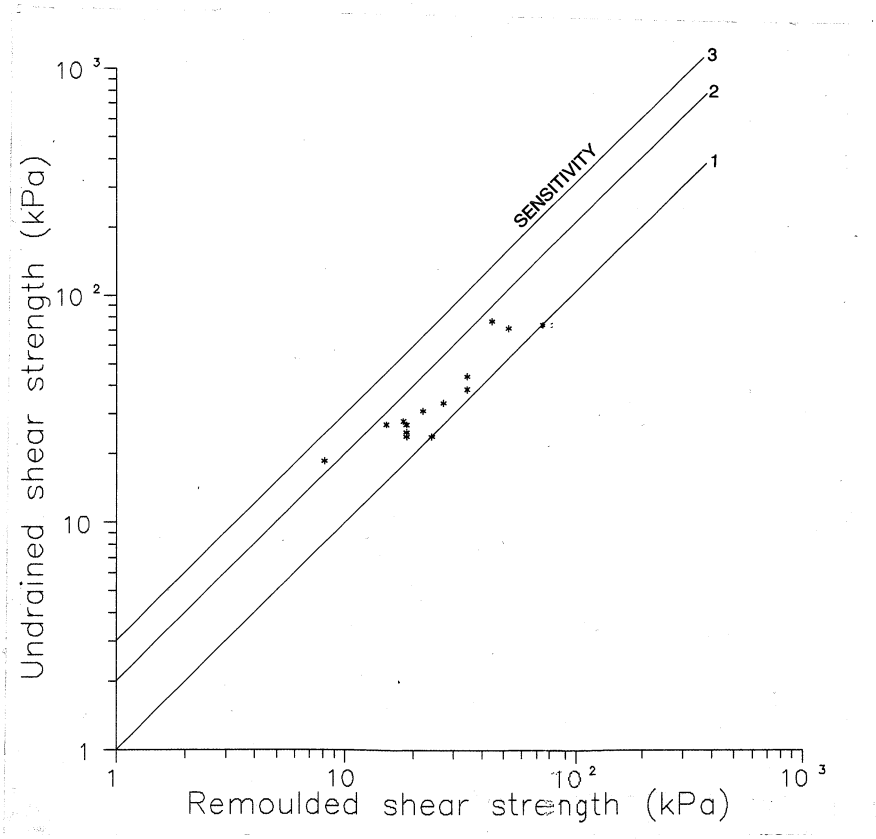


Figure 2.2: ***Undrained versus remoulded shear strength. Straight lines represent sensitivity values (s_u/s_r) of 1, 2 and 3.***

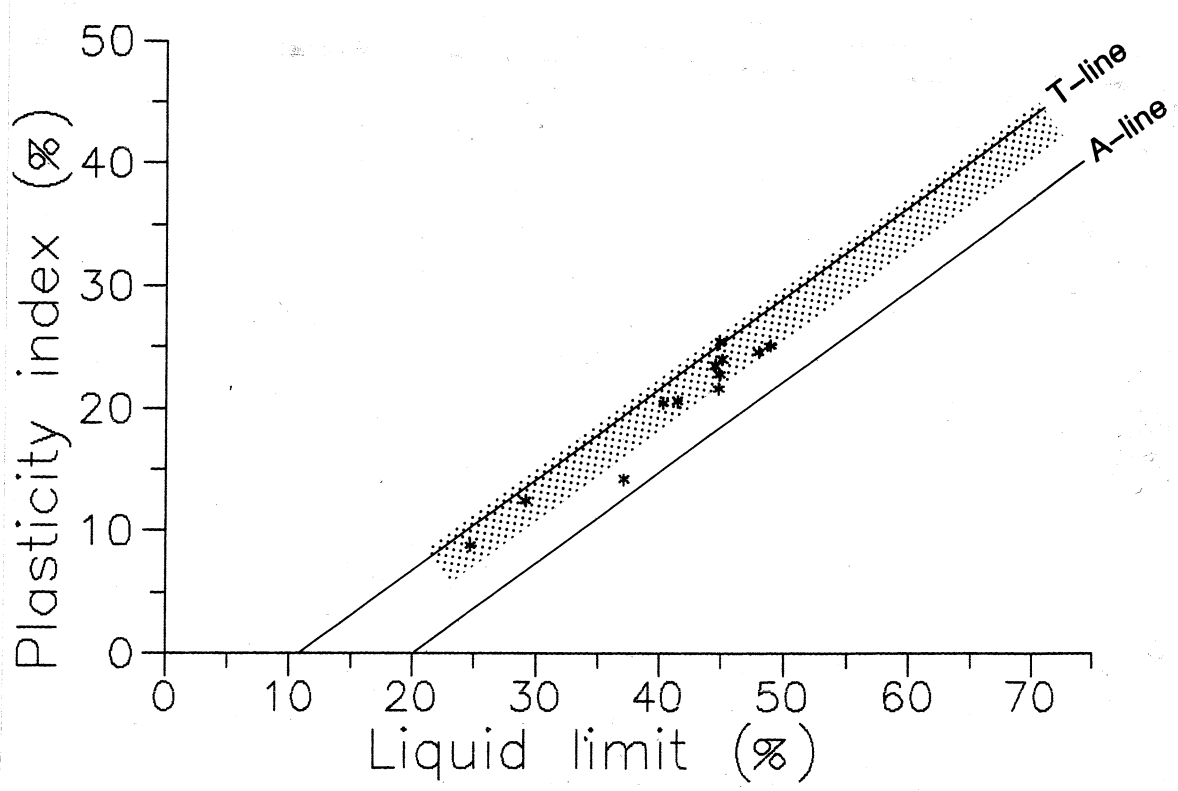


Figure 2.3: ***Plasticity chart. The A-line is the boundary between sediments of inorganic (above) and organic (below) nature (Casagrande 1948). The T-line is the "till line" of Boulton and Paul (1976). Note that the dotted regression line corresponds closely to the T-line.***

2.2 Age

No age indications have been successfully obtained from the 21.3427 - project sites.

3. DRILL SITE KEY DATA

3.1 Location of sites

Bentech A/S in Tromsø was operator of the navigation chains in the Barents Sea, and they provided equipment and personnel for positioning of the drilling vessel.

Hyperfix was used as the main system, with Navstar GPS as a backup system during the about 8 hours a day this system provided navigation coverage. The Hyperfix was calibrated using a Syledis navigation chain. This chain has a range of about 100 km, and calibration was done every time the vessel approached the coastal area.

The general survey activity in the area was moderate this year, and the Hyperfix chain was therefore available in range-range mode all the time. We also had access to the same station combination as during the seismic survey. The best possible navigation accuracy was therefore achieved during the whole survey.

The final positions are listed in Table 3.1. - the sites is also shown in Figure 3.1.

Table 3.1: Final positions for the sites drilled as part of project 21.3427.00.

LOCATION	Latitude 72° 40′ 51.10" N Longitude 30° 22′ 29.51" E	
7230/05-U-02	Northing 8 068 253.5 m Easting 612 090.4 m	UTM 27°
LOCATION	Latitude 72° 41′ 10.05" N Longitude 30° 22′ 26.70" E	
7230/05-U-03	Northing 8 068 838.5 m Easting 612 031.5 m	UTM 27°
LOCATION	Latitude 72° 41′ 39.74" N Longitude 30° 22′ 26.63" E	
7230/05-U-04	Northing 8 069 757.0 m Easting 611 979.1 m	UTM 27°
LOCATION	Latitude 72° 42′ 06.00" N Longitude 30° 22′ 31.64" E	
7230/05-U-05	Northing 8 070 571.8 m Easting 611 979.5 m	UTM 27°
LOCATION	Latitude 72° 42′ 21.21" N Longitude 30° 22′ 28.86" E	
7230/05-U-06	Northing 8 071 041.5 m Easting 611 927.4 m	UTM 27°

Table 3.1.B: ***Continued.***

LOCATION	Latitude 71° 09′ 35.45" N Longitude 29° 16′ 42.77" E
7129/10-U-01	Northing 7 896 983.0 m Easting 582 110.9 m UTM 27°
LOCATION	Latitude 71° 07′ 13.47" N Longitude 29° 13′ 23.12" E
7129/10-U-02	Northing 7 892 512.6 m Easting 580 274.6 m UTM 27°
LOCATION	Latitude 70° 49′ 36.18" N Longitude 30° 44′ 31.07" E
7030/03-U-01	Northing 7 862 512.1 m Easting 637 093.3 m UTM 27°

3.2 Data recovery

Table 3.2 summarizes key data for the boreholes. The recovery of Quaternary samples for each site and shallow drilling project is given in detail in Table 3.3.

The samples are collected by use for hammersamples, wip push-samples or piggyback rotary coring. The methods are further described in Appendix 1.

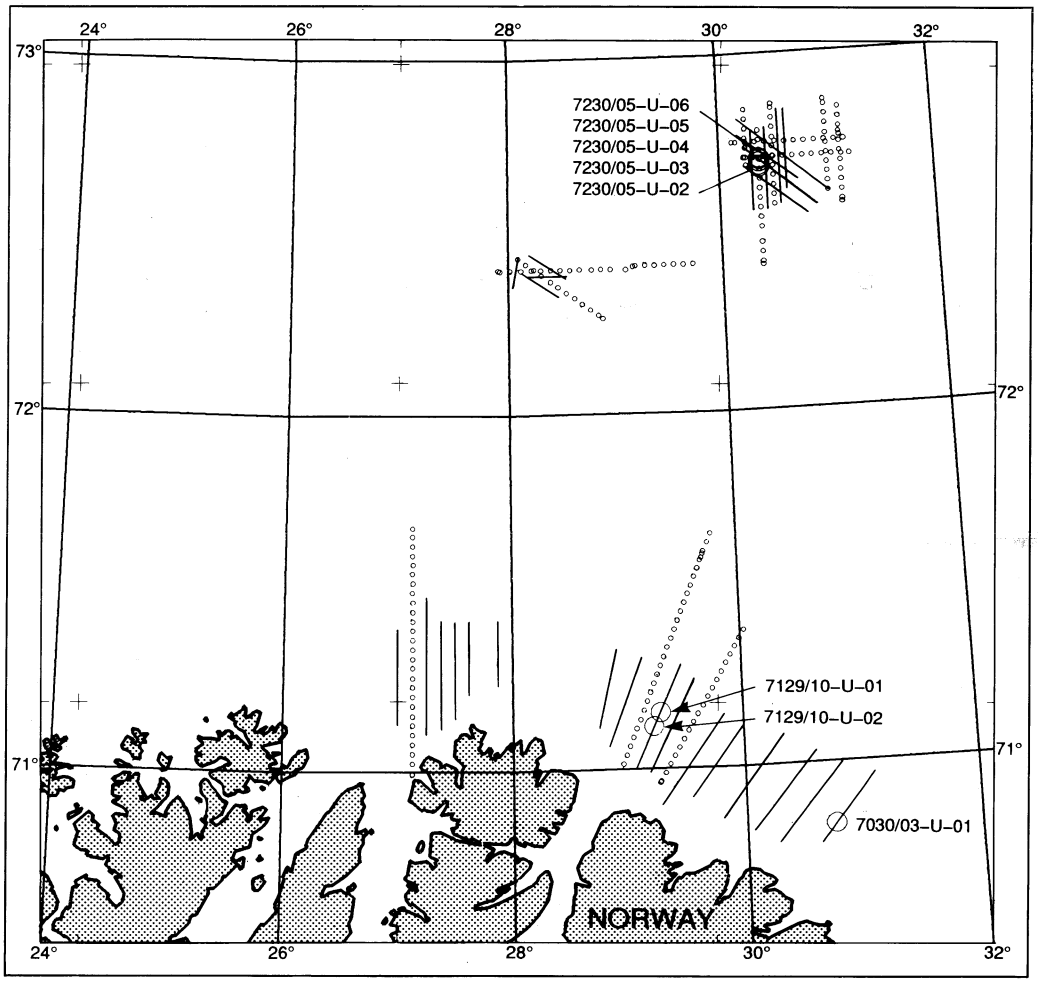


Figure 3.1: Location of the 21.3427.00 - project sites.

The piggyback cores are obtained in sites where difficult soil conditions inhibited further penetration with the API-string. Piggyback coring was in such cases carried out in order to be able to penetrate further. The piggyback coring method has therefore proven to be a useful method also for penetrating and coring difficult soils.

Table 3.2: Key data for the shallow drilling sites.

Site	Seismic Line	SP	Water depth (m)	Quaternary thickness (m)	Quaternary samples		Temp. points	TD below seabed (m)
					No of samp.	Acc.samp. length		
7030/03-U-01	IKU-10-87	164.1	308	26.3	3	0.69		173.8
7128/09-U-01	IKU-01-87	217	405.5	~55	8	4.89		23.2
7128/09-U-01A	IKU-01-87		405.5	~55				36.3
7129/10-U-01	IKU-3-87	358.5	382.0	55.4	7	1.70		93.3
7129/10-U-02	IKU-3-87	466.0	336.0	30.3	2	0.60		119.9
7230/05-U-02	IKU-302230-87	760.0	286.0	28.7	3	1.01		126.0
7230/05-U-03	IKU-302230-87	721.2	288	27.0	3	0.60		115.5
7230/05-U-04	IKU-302230-87	660.9	282.7	23.6	1	0.15		78.8
7230/05-U-05	IKU-302230-87	604	286.0	23.3	3	1.52	5	17.5
7230/05-U-05A	IKU-	606.4	286.0	23.3	2	0.30		49.7
7230/05-U-06	IKU-302230-87	575.1	285.5	24.6	2	0.75		96.3
					34	12.21		

Table 3.3: Quaternary sample recovery.

Location	Depth	Equipment
7230/05-U-02	10.00-10.51	Hammer
	20.00-20.04	Hammer
	25.00-25.46	Hammer
7230/05-U-03	3.00- 3.60	Hammer
7230/05-U-04	23.60-23.75	Hammer
7230/05-U-05	9.00- 9.60	Hammer
	11.93-12.43	WIP
	14.90-15.32	WIP
7230/05-U-05A	17.00-17.14	Hammer
	23.50-23.66	Hammer
7030/03-U-01	3.00- 3.56	Hammer
	12.00-12.07	Hammer
	22.60-22.66	Hammer
7128/09-U-01	15.10-15.75	Hammer
	36.30-36.69	Piggyb.
	38.24-39.00	Piggyb.
	39.44-40.05	Piggyb.
	42.24-43.01	Piggyb.
	44.74-45.80	Piggyb.
	48.15-48.50	Piggyb.
	52.15-52.45	Piggyb.
7129/10-U-01	15.00-15.30	Hammer
	20.00-20.59	Hammer
	30.00-30.07	Hammer
	39.00-39.45	Hammer
	46.00-46.18	Hammer
	53.77-53.83	Hammer
	55.14-55.39	Piggyb.
7129/10-U-02	15.00-15.26	Hammer
	27.00-27.34	Hammer
7230/05-U-06	22.80-23.30	Hammer
	23.75-24.00	Hammer

4. LABORATORY ANALYSES

4.1 On board procedures

As soon as each sample the total amount of the sample was retrieved during drilling, it was extruded from the sampling tube and measured. The sample was then cut in shorter lengths and when possible sound velocity was measured both vertically and horizontally (V_{vert} and V_{hor} respectively in Table 5.1) using a portable ultrasonic (100 kHz) non destructive tester, make Pundit. The samples collected at the heat flow sites were also subjected to measurement of thermal conductivity.

The samples were then packed and stored. A number of samples chosen for oedometer or triaxial testing were waxed in order to prevent water loss and disturbance. A few samples were also canned and stored in a -80°C freezer for later gas analyses.

4.2 On shore work

4.2.1 Physical properties

In the IKU laboratory the samples have been visually described, photographed and radiographed. Then a suite of standard soil mechanical tests have been performed.

The following routine soil mechanical analyses were carried out in the IKU laboratories.

- water content (w, % of dry sample weight)
- unit weight of soil (γ, kN/m^3)
- undrained shear strength (s_u, kN/m^2)
- remoulded shear strength (s_r, kN/m^2)
- sensitivity (s_u/s_r)

In addition to this some further routine analyses in addition to a number of oedometer and triaxial tests were done at the SINTEF, Division of Geotechnical Engineering. These tests include:

- unit weight of soil (γ, kN/m^3)
- water content (w, % of dry sample weight)
- liquid limit (w_L, %)
- plastic limit (w_P, %)
- plasticity index ($I_p=W_l-W_p$)
- undrained shear strength (s_u)
- grain size distribution

4.2.2 Organic geochemistry (by Hermann Weiss)

Experimental procedures

Headspace gas:

The can was thawed over night and shaken vigorously. Then a septum was attached to the can and a sample of the headspace gas was taken for analysis of C_1, C_2, C_3, i-C_4 and C_{5+} hydrocarbons.

This analysis was performed on a Carlo Erba Fractovap 2350 gas chromatograph equipped with a 2 m x 1/8" stainless steel column filled with Porapak Q on Chromosorb using nitrogen as carrier gas. An oven temperature of 150°C was used. After elution of n-butane, the column was back-flushed and C_{5+} compounds were recorded as one peak. A standard gas sample containing methane, ethane, propane, n-butane, n-pentane and n-hexane (100 ppm each) was used for quantification.

The can was then opened and headspace volume, water volume, and sample weight were measured.

Total Organic Carbon:

Bulk samples were crushed in a mortar. Aliqouts of the samples were then weighed into Leco crucibles, then treated three times with hot 10% HCl in order to remove carbonate, and finally washed four times with distilled water in order to remove any traces of HCl. The crucibles were then placed on a hot plate (60°C) and dried for 24 hours. The total organic carbon (TOC) content of the dried samples was determined using a Leco CS 244 carbon/sulphur analyser.

The instrument was calibrated using a sediment standard with 2.72% carbon. Calibration and blank runs were carried out every 15th measurement.

The total carbon (TC) content was determined on untreated crushed sediment.

4.2.3 Dating and amino acid measurements

No successful aminoacid measurement was achieved on any of the 21.3427 - project cores.

4.2.4 Magnetic properties

Magnetic properties were measured at the University of Bergen on 83 samples from 13 locations of the 1987 - cruise. The purpose of this was to measure magnetic fabric and paleomagnetic properties for genetic interpretation or chronostratigraphy. The conclusion so far is that the stress and deformation induced by the sampling seems to disturb the magnetic properties and that the results therefore are difficult to use. These problems will, however, be studied thoroughly as the magnetic property studies has a potential both in chronostratigraphy and in genetic classification.

5. DATA PRESENTATION

5.1 General comments to data presentation

Chapter 5 gives the results of laboratory analyses of the Quaternary samples. The data presentation is organized as follows:

In Chapter 5.2 all test results are given in tables for each type of analysis and with reference to appendices where necessary.

In Chapter 5.3 the information is grouped in drill sites. Each subchapter commences with a brief site description. A seismic section across the site is then shown and seismic reflections are shown. Deep towed boomer and sidescan sonar data are included where they exist). This is followed by a soil boring summary sheet. On this sheet physical properties and age information are plotted. Reflections detected on the seismic profiles are also drawn.

5.2 Test result tables

5.2.1 Soil mechanical data and sound velocities

Table 5.1 shows results from routine soil mechanical analyses and on board measurement of sound velocity of the samples.

Table 5.1: Routine soil mechanical data and sound velocity measured on Quaternary samples (Abbreviations are explained in Chapters 4.1 and 4.2.1)).

SITE: 7230/05-U-05

DEPTH (m)	w (%)	γ (kN/m³)	w_L (%)	w_p (%)	I_p (%)	s_u (kN/m²)	s_r (kN/m²)	S_t	Vhor (m/s)	Vvert (m/s)
9.07	33.6	19.3								
9.12						24.0	18.6	1.29		
9.24	32.8	19.5								
9.26						25.0	18.6	1.34		
9.38	32.4	19.7				27.0	18.6	1.45		
9.50	34.7	18.4	44.8	23.2	21.6	21.1				
12.00	25.7	16.4								
12.07						74.0				
12.18						95.0				
15.01	21.1	22.0				115.8				
15.05									1872	
15.09	18.2	20.8	44.5	21.0	23.5	245.0				
15.10						>250.0				
15.25						>250.0			1888	1787

SITE: 7230/05-U-05A

DEPTH (m)	w (%)	γ (kN/m³)	w_L (%)	w_p (%)	I_p (%)	s_u (kN/m²)	s_r (kN/m²)		Vhor (m/s)	Vvert (m/s)
17.06	12.8	22.5								

SITE: 7030/03-U-01

DEPTH (m)	w (%)	γ (kN/m³)	w_L (%)	w_p (%)	I_p (%)	s_u (kN/m²)	s_r (kN/m²)	S_t	Vhor (m/s)	Vvert (m/s)
3.24	16.1	22.4				24.0				1724
3.45	18.8	20.9	24.7	15.9	8.8	27.0				
3.48						28.0	18.0	1.56		

Table 5.1: Continued.

SITE: 7128/09-U-01

DEPTH (m)	w (%)	γ (kN/m³)	w_L (%)	w_p (%)	I_p (%)	s_u (kN/m²)	s_r (kN/m²)	S_t	Vhor (m/s)	Vvert (m/s)
14.08			48.9	23.8	25.1					
15.18									2150	
15.23									1900	
15.30	21.6	17.5								
15.35						38.7	34.3	1.1		
15.48						31.0	22.0	1.4		
15.50									2073	
15.62	17.5	20.7	29.1	16.6	12.5	34.3				
30.20			41.5	20.9	20.6					
36.67	19.2					>250.0				
39.52	16.4	12.8				102.1				
40.00	13.9					110.9				
42.34						108.0				
42.60	23.9	20.5								
42.63			44.9	19.5	25.4					
42.65						74.1				
42.80	24.4	20.6								
42.91						77.0	44.1	1.8		
44.80	12.9	21.8								
44.85						>250.0				
45.19	15.7									
45.25						159.0				
48.22						>250.0				
48.29	14.2									
52.20	11.4					>250.0				

SITE: 7129/10-U-01

DEPTH (m)	w (%)	γ (kN/m³)	w_L (%)	w_p (%)	I_p (%)	s_u (kN/m²)	s_r (kN/m²)	S_t	Vhor (m/s)	Vvert (m/s)
15.20	27.4	20.3								
15.23			40.3	19.9	20.4					
15.28						33.8	27.0	1.3		
15.36									1727	1656
15.40	27.5	20.5								
15.45						39.7				
20.06									1699	
20.17									1728	1718
20.20	25.1	20.7								
20.35						44.1	34.3	1.3	1815	1756
20.46	23.8	19.8	37.1	22.9	14.2	40.7				
39.10	21.3	20.6								
39.18						74.1	74.1	1.0		
46.08	15.3									
46.12						77.0				
55.14	19.4									

Table 5.1: Continued.

SITE: 7129/10-U-02

DEPTH (m)	w (%)	γ (kN/m³)	w_L (%)	w_p (%)	I_p (%)	s_u (kN/m²)	s_r (kN/m²)		Vhor (m/s)	Vvert (m/s)
15.05	18.3	22.2								
15.10									1949	1881
15.12			48.0	23.4	24.6					
15.15						>250.0				
27.11						>250.0			1924	1544

SITE: 7230/05-U-02

DEPTH (m)	w (%)	γ (kN/m³)	w_L (%)	w_p (%)	I_p (%)	s_u (kN/m²)	s_r (kN/m²)	S_t	Vhor (m/s)	Vvert (m/s)
10.10	29.4	20.0								
10.22						24.0	24.0	1.0		
10.32	31.9	19.1	45.1	21.1	24.0	24.0				
10.45	29.5	20.2								
10.47						71.6	52.5	1.4		

SITE: 7230/05-U-03

DEPTH (m)	w (%)	γ (kN/m³)	w_L (%)	w_p (%)	I_p (%)	s_u (kN/m²)	s_r (kN/m²)	S_t	Vhor (m/s)	Vvert (m/s)
3.10	62.4	16.3								
3.18						18.6	8.1	2.3		
3.30	36.0	18.5	44.9	22.1	22.8	18.6				
3.40									1746	1729
3.45	33.4	19.3								
3.52						27.0	15.2	1.8		

SITE: 7230/05-U-04

DEPTH (m)	w (%)	γ (kN/m³)	w_L (%)	w_p (%)	I_p (%)	s_u (kN/m²)	s_r (kN/m²)		Vhor (m/s)	Vvert (m/s)
23.65	17.7									

Additional routine analyses and advanced soil mechanical tests are carried out by the SINTEF Division of Geotechnical Engineering. A summary of the results is given in Table 6.2. Symbols and abbreviations used are as follows:

a	=	Coulombian attraction (kN/m^2)
c_v, c_h	=	vertical, horizontal coefficient of consolidation (m^2/year)
m	=	deformation modulus number
p_o'	=	effective overburden pressure (kN/m^2)
p_c'	=	preconsolidation pressure (kN/m^2)
s_u	=	undrained shear strength (kN/m^2)
$\tan\rho$	=	mobilized friction
w	=	water content (%)
w_L	=	liquid limit (%)
w_p	=	plastic limit (%)
ε_f	=	failure strain (%)
γ	=	unit weight of soil (kN/m^3)

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Table 5.2: Extract of results from analyses performed at the SINTEF Division of Geotechnical Engineering.

Boring No.	Sample depth m	w %	Index Properties					Soil Description		Oedometer Tests				Triaxial Tests				Remarks/Sample Quality
			w_L %	w_p %	γ kN/m³	$s_{u\ cone}$ kN/m²	Clay <2μ %		~ p_o' kN/m²	~p_c' kN/m²	m -	c m²/year	Hor./ Vert.	s_u kN/m²	a kN/m²	tanφ -	ϵ_f %	
7030/03-U-01	3.37-3.53	18.8	24.7	15.9	20.9	27.0	19.5	Sandy Silt/Clay.	37.1	p_o'	28.3	2.1	V	-	-	-	-	Slightly disturbed.
7128/09-U-01	15.55-15.70	17.5	29.1	16.6	20.7	34.3	27.0	Sandy Silt/Clay. Some sand grains.	166.7	-	-	-	-	70	20	0.55	8	Good.
7129/10-U-01	20.40-20.55	23.8	37.1	22.9	19.8	40.7	30.2	Silty Clay. Some sand/gravel grains.	200.7	p_o'	17.9	1.0	V	73	0	0.54	7	Good. Some large sand grains.
7230/05-U-02	10.25-10.40	31.9	45.1	21.4	19.1	24.0	37.6	Clay. Sand and gravel grains.	94.0 -	p_o' 60	18.0 20.6	0.4 0.4	V H	-	-	-	-	Good.
7230/05-U-03	3.24-3.39	36.0	44.9	22.1	18.5	18.6	41.1	Clay. Some sand and gravel grains.	28.2	50	16.4	0.4	V	-	-	-	-	Good.
7230/05-U-05	9.45-9.60	34.7	44.8	23.2	18.4	21.1	40.4	Clay. Some sand grains.	80.0 -	p_o' 150	20.0 16.0	0.4 0.5	V H	-	-	-	-	Good.
	15.02-15.17	18.2	44.5	21.0	20.8	245.0	41.4	Clay. Sand grains and sandstone.	163.8	800	20.3	3.0	V	164	50	0.56	6	Good.

IKU SINTEF-GRUPPEN

Grain size distribution analysis has been carried by use of the falling drop method.

The percentage of equivalent particle sizes above 0.06 mm, 0.02 mm, 0.006 mm and 0.002 mm have been recorded. The results are given in Figure 5.1 and in the soil boring summary sheets.

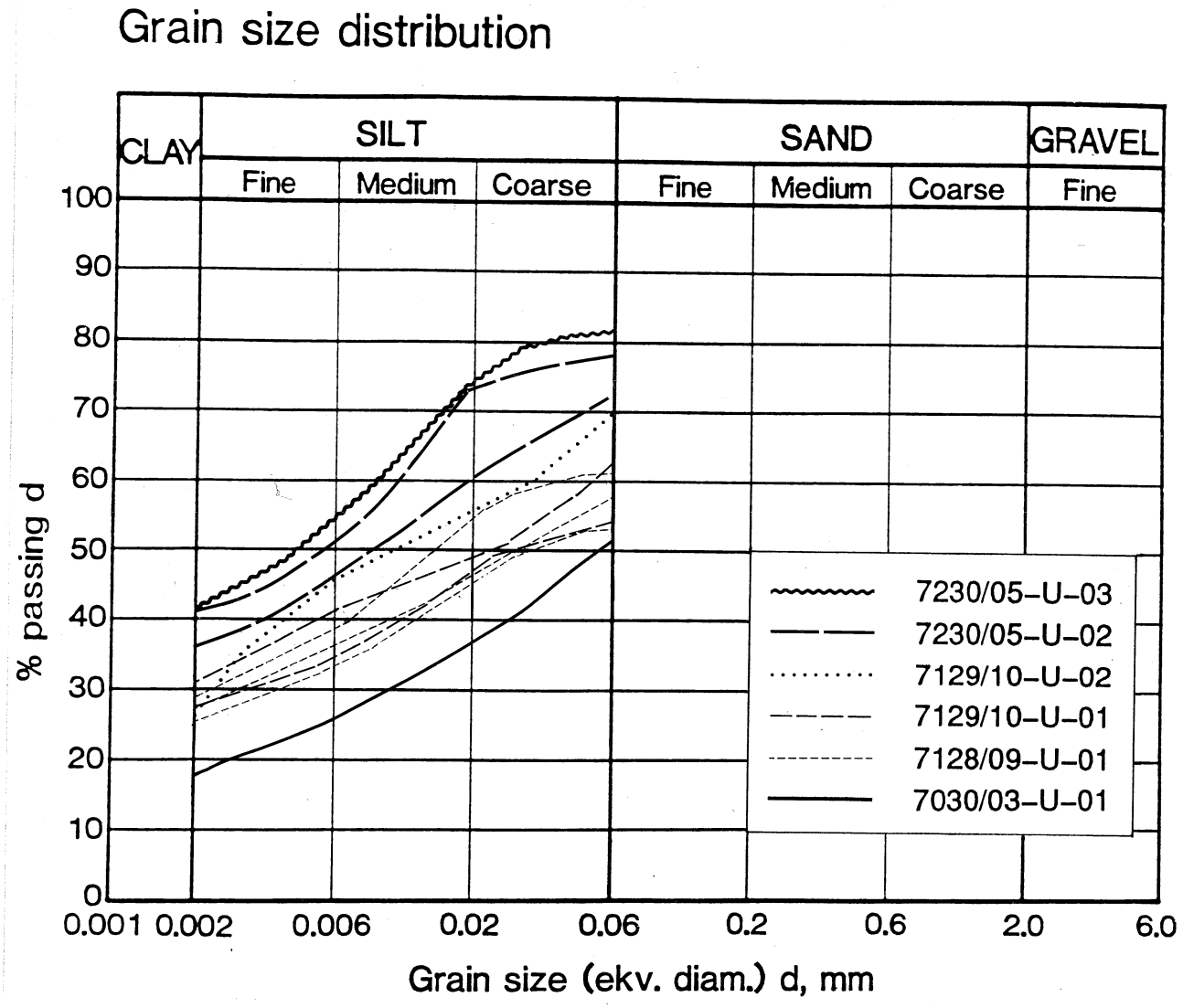


Figure 5.1: *Grain size distribution curves. The grain size distribution as a function of depth is shown in the soil boring summary sheets.*

5.2.2 Micropaleontology and Amino acid measurements

The micropaleontological analysis have been limited to a brief scanning of samples and identification and picking of foraminifera for amino acid measurement (Elphidium Excavatum).

Several samples were investigated. The foraminifera content is, however, extremely low, and sufficient material was found only in a few samples. The foraminifera were typically intact (although fractured do occur) and the surface structure is intact.

The results is given in Table 5.3. A possible uncertainty in the results is introduced by the fact that the foraminifera were glued on glass plates during transportation to the laboratory in Bergen. According to Sejrup (pers.comm.) all the glue has apparently successfully been removed before the analysis. If any of the glue has influenced on the results, it may only result in a too low D-allo/L-iso ratio, as the glue contains no alloisolucine.

Table 5.3: Amino acid measurement results.

Site	Depth (m)	Weight dry bulk samples	No. of Elph.exc.	Amino acid analysis D-allo/L-iso-ratio	Laboratory references no.
7129/10-U-01	39.0-39.20	229	89	lost during prep.	BAL 1428
7230/05-U-05	9.10-9.27	327	103	0.035	BAL 1430

5.2.3 Organic geochemistry

The total carbon (TC) and total organic carbon (TOC) content of the Quaternary sediments were determined on 19 samples. The results are given in table 5.4. The TC contents range from 0.33 to 1.67 wt% and the TOC contents vary between 0.22 and 1.17 wt% of the dry sediment. Both parameters usually show a fair correlation with each other and increase slightly with depth. The inorganic carbon (TC-TOC) is thought to be present in the form of carbonates. Assuming that all calcium carbonate is the only carbonate present in these sediments, the difference between the TC and TOC was expressed in wt% $CaCO_3$. These values range from 0 to 10.3% and vary independently from the TC and TOC contents.

Table 5.4: Analysis of total carbon (TC), total organic carbon (TOC) and content of $CaCO_3$.

Site	IKU ref. no.	Depth (m)	TC (wt% of dry sediment)	TOC	$CaCO_3$
7128/09-U-01	C-7202	15.36	0.74	0.31	3.59
	C-7183	15.70-15.75	0.66	0.34	2.67
	C-7184	31.50-31.55	0.83	0.22	5.09
	C-7199	36.65	0.81	0.49	2.67
	C-7200	42.73	0.77	0.45	2.67
	C-7185	48.33	1.29	0.19	9.17
	C-7201	52.15	1.45	0.22	10.26
7129/10-U-01	C-7186	15.47-15.50	0.86	0.46	3.34
	C-7187	20.55-20.59	0.93	0.45	4.00
	C-7188	39.20-39.25	1.08	0.52	4.67
7129/10-U-02	C-7203	15.10	0.91	0.62	2.42
	C-7189	15.21-15.25	1.15	0.72	3.59
	C-7204	15.26	0.85	0.49	3.00
	C-7190	27.28-27.34	1.33	0.81	4.34
7230/05-U-03	C-7205	3.16	1.30	1.05	2.09
	C-7191	3.55- 3.60	1.44	1.09	2.92
7230/05-U-05	C-7026&	11.93-11.96			
	C-7027*)	12.41-12.43	1.67	1.17	4.17
7230/05-U-06	C-7192	23.95-24.00	0.33	0.37	0.00**)

---

*) Two samples in same can. Sediment was homogenized during shaking prior to headspace analysis.

**) Repeated analyses also gave slightly higher values for TOC than for TC.

5.3 Description of individual sites

5.3.1 Site 7230/05-U-02

Seismic interpretation

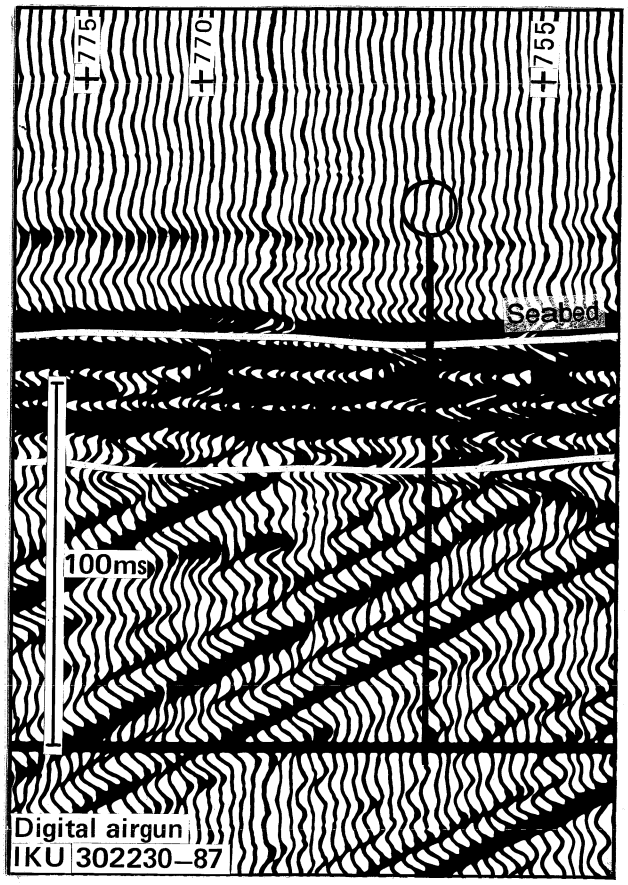
The top bedrock reflection is found at about 32 ms but is somewhat poorly defined on the seismic record. During drilling it was penetrated at 28.7 m. This implies a sound velocity in the Quaternary sediments of 1794 m/s. The digital seismic do not have resolution to show intra Quaternary reflections. On the deep towed boomer record, however, the following subdivision can be done. A band of irregular reflections occur in a zone 5 - 7 ms below seabed. The pattern could represent an iceberg ploughed paleo seabed which later is modified by infilling and possibly deformation of the ploughmark morphology. Pockmarks are abundant on the seabed, and some of the irregular reflection pattern may also be related to shallow gas. The top of this band is named reflection 1A, and the base is named reflection 1B. A smooth, high amplitude undulating reflection at 14 ms (reflection 2) is probably related to erosion. A clear, but less distinct reflection (3) occur at 20 ms. The sediments below this reflection show a pattern of internal incoherent reflections whereas the sediments above are acoustically structureless. The reason for this difference is not clear.

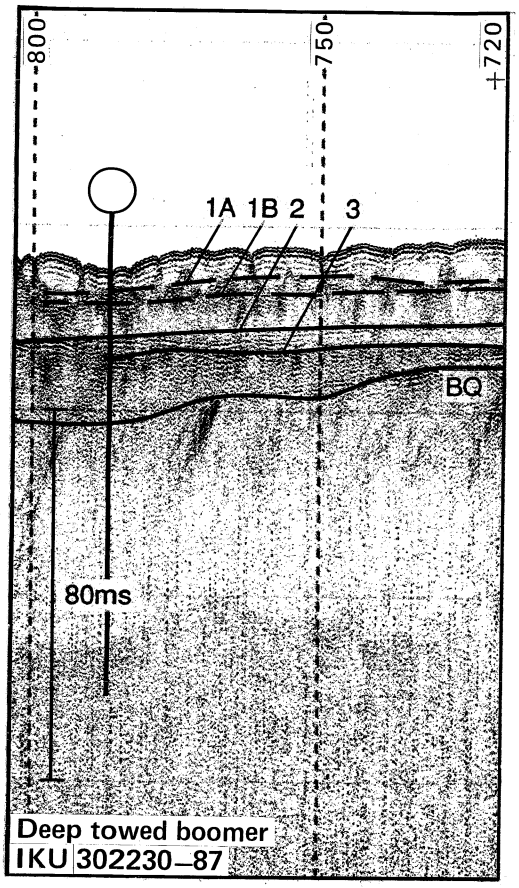
Lithology and mechanical properties

One sample is obtained above the reflection 2 - level. It comprised a silty, sandy clay with some gravel (f-m). The smallest rock fragment are dominated by subangular - subrounded claystone/siltstone. Some larger fragments of angular crystalline rocks occur. The water content is well above the plasticity limit and an undrained shearstrength of 24 kPa is recorded (sensitivity is 1.0). An oedometertest indicate a normally consolidated sample. The recorded value of 71.6 kPa is probably affected by drying of the sample.

Two samples were collected below reflection 3- level. At 20 m a very silty, sandy(f) clay with some gravel was found. Whereas the sample at 25m comprise a clayey, silty gravel (f-m). The gravel dominate the sample and consists of angular claystone fragments. The lower part of the sample is considered as intensely fractured and chrushed rock and should perhaps be termed a glaciotectonite. This sediment explains why the top bedrock reflection is porly defined at this site.

LOC. 7230/05-U-02





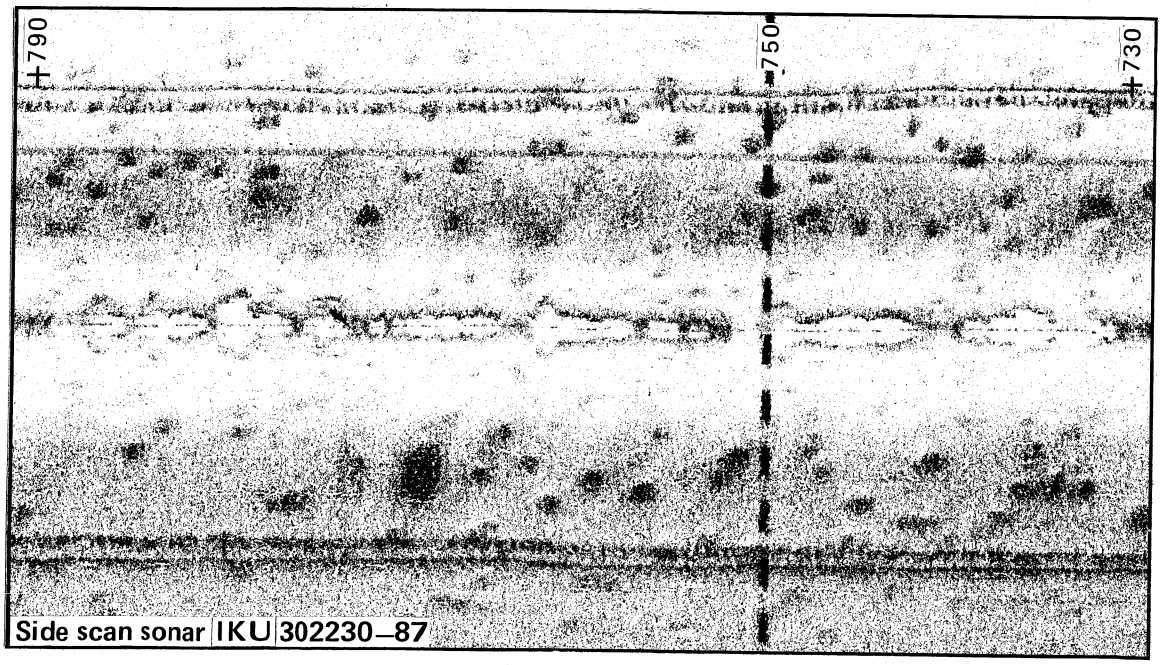
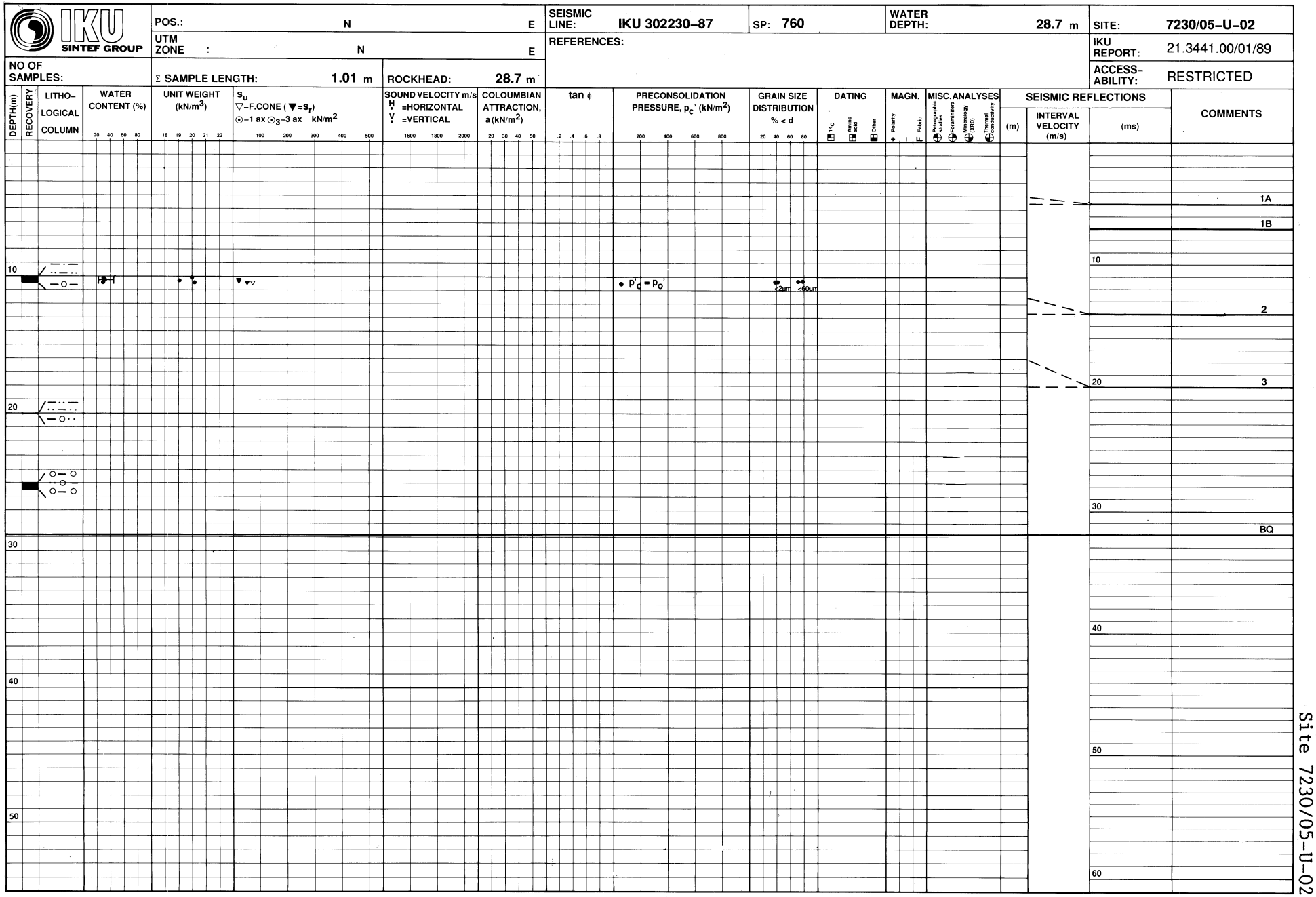


Figure 5.2: ***Seismic section across site 7230/05-U-02. The figure is continued on the following pages by a soil boring summary sheet, a description sheet and drawings of radiographs for each sample.***

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Site 7230/05-U-02

IKU SINTEF-GRUPPEN

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IKU SINTEF-GRUPPEN	Project		Location
	21.3441.00: Quaternary samples Barents Sea 1987		7230/05 - U - 02
Equipment	**Water depth**	**Latitude**	**Longitude**	**Depth below seabed**
Hammer sampler	286.0 m	72°40´51.10"N	30°22´29.51"E	10.00 - 10.51 m

Analytical results	Subsample	m	Lith.	Core description		s_u	s_r
		10.00		CLAY, silty, sandy, some gravel (f-m)	5Y - 4/1 Dark grey		
	Magn.						
w = 29.4% γ = 20.0kN/m³		.10		Angular crystalline fragment (2 cm) Angular pyrite fragment (1 cm)			
				2 Angular pyritic fragment, 0.5 cm			
		.20				24.0	24.0
w = 31.9% γ = 19.1kN/m³		.30					
w_L = 45.1% w_P = 21.4%	Oe K_f						
		.40					
w = 29.5% γ = 20.2kN/m³						(71.6)	(52.5)
		.50		Rounded claystone fragment, 0.5 cm			
		10.51					

Comments:

Symbols:

K_f	= grain size distribution	T	= triaxial test
k_γ	= thermal conductivity	TOC	= total organic carbon
XRD	= mineralogy	TC	= total carbon
w	= water content (% water of dry sample)	s_u	= undrained shear strength from falling cone test (kN/m²)
w_L-w_P	= liquid and plasticity limits		
γ	= unit weight of soil (kN/m³)	s_r	= remoulded shear strength
V_{sH}	= horizontal sound velocity (m/s)	Magn.	= magnetic fabric
V_{sv}	= vertical sound velocity (m/s)	OG	= organic geochemistry
Oe	= oedometertest	MPal	= micropaleontology

IKU SINTEF-GRUPPEN	Project		Location
	21.3441.00: Quaternary samples Barents Sea 1987		7230/05 - U - 02
Equipment	**Water depth**	**Latitude**	**Longitude**	**Depth below seabed**
Hammer sampler	286.0 m	72°40´51.10"N	30°22´29.51"E	20.00 - 20.04 m

Analytical results	Subsample	m	Lith.	Core description		s_u	s_r
		20.00		CLAY, very silty, sandy (f), some gravel (f)	5Y - 4/1		
		20.04		Laminated with fine sand in thin layers	Dark grey		

Comments:

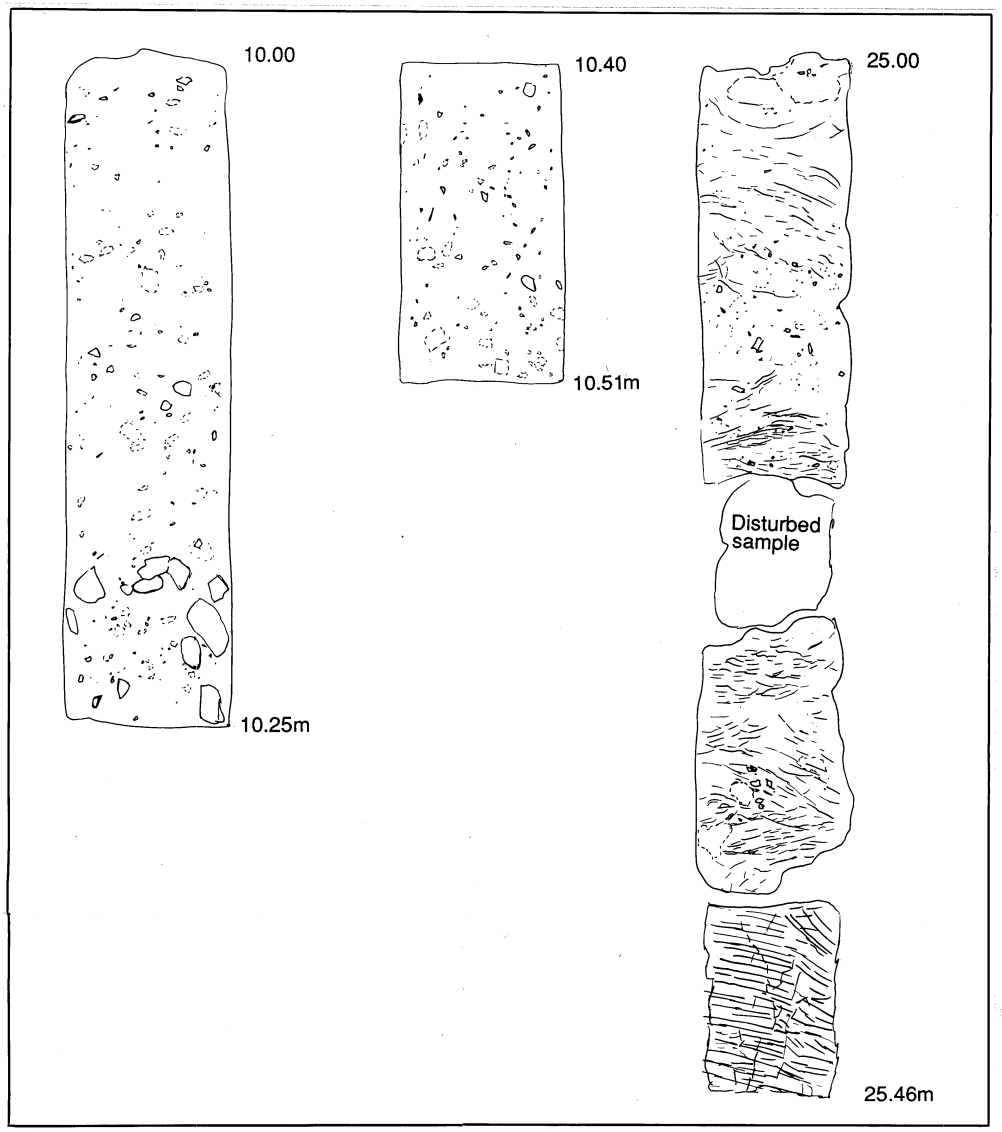
Symbols:

K_f	= grain size distribution	T	= triaxial test
k_γ	= thermal conductivity	TOC	= total organic carbon
XRD	= mineralogy	TC	= total carbon
w	= water content (% water of dry sample)	s_u	= undrained shear strength from falling cone test (kN/m²)
w_L-w_P	= liquid and plasticity limits		
γ	= unit weight of soil (kN/m³)	s_r	= remoulded shear strength
V_{sH}	= horizontal sound velocity (m/s)	Magn.	= magnetic fabric
V_{sv}	= vertical sound velocity (m/s)	OG	= organic geochemistry
Oe	= oedometertest	MPal	= micropaleontology

Site 7230/05-U-02

IKU SINTEF-GRUPPEN

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IKU SINTEF-GRUPPEN	Project			Location
	21.3441.00: Quaternary samples Barents Sea 1987			7230/05 - U - 02
Equipment	**Water depth**	**Latitude**	**Longitude**	**Depth below seabed**
Hammer sampler	286.0 m	72°40'51.10"N	30°22'29.51"E	25.00 - 25.46 m

Analytical results	Subsample	m	Lith.	Core description	s_u	s_r
		25.00		GRAVEL (f-m), clayey, silty 5Y - 2.5/1 Black		
				Transition to crushed black shale		
		.10		Claystone fragments		
		.20				
		.30				
		.40				
		25.46				

Comments:

Symbols:

K_f	=	grain size distribution	T	=	triaxial test
k_T	=	thermal conductivity	TOC	=	total organic carbon
XRD	=	mineralogy	TC	=	total carbon
w	=	water content (% water of dry sample)	s_u	=	undrained shear strength from falling cone test (kN/m²)
w_L-w_P	=	liquid and plasticity limits			
γ	=	unit weight of soil (kN/m³)	s_r	=	remoulded shear strength
V_{SH}	=	horizontal sound velocity (m/s)	Magn.	=	magnetic fabric
V_{SV}	=	vertical sound velocity (m/s)	OG	=	organic geochemistry
Oe	=	oedometertest	MPal	=	micropaleontology

Site 7230/05-U-02

IKU SINTEF-GRUPPEN

5.3.2 Site 7230/05-U-03

Seismic interpretation

The seismic stratigraphy is similar to site 7230/05-U-02, although the depths to the various reflections are slightly different. At this site an average sound velocity for the Quaternary sediments of 1742 m/s is found by comparing seismic and borehole data.

Lithology and mechanical properties

The one sample from 3.0 - 3.6 m collected at this site comprise a laminated very silty, sandy clay with scattered fine gravel fragments. The water content is above the plasticity. Undrained shear strength is measured as 18 - 27 kPa and the sensitivity is 1.8 - 2.3. Oedometer test indicate a slight overconsolidation of the sediment.

LOC. 7230/05-U-03

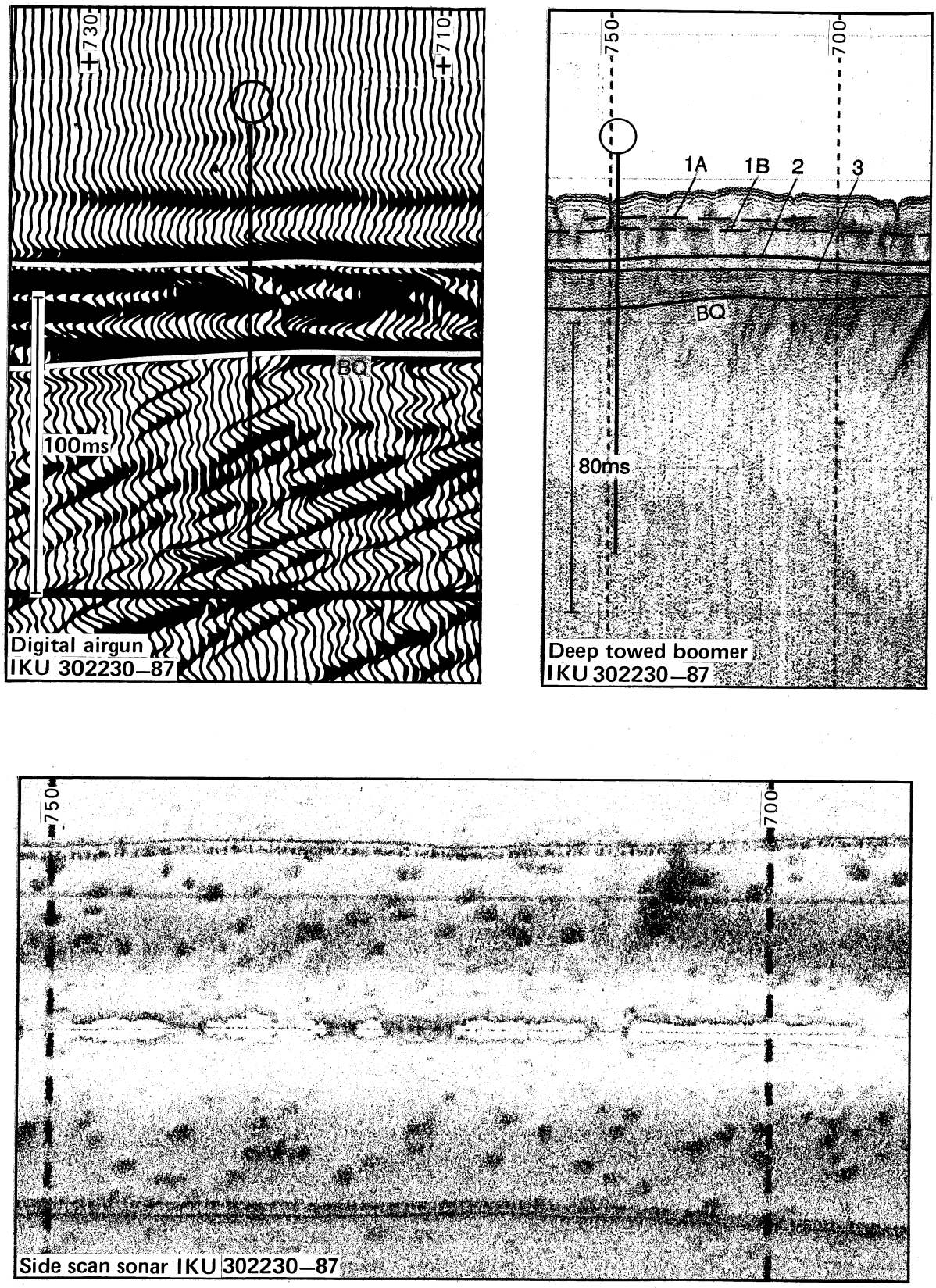


Figure 5.3 *Seismic section across site 7230/05-U-03. The figure is continued on the following pages by a soil boring summary sheet, a description sheet and drawings of radiographs for each sample.*

IKU SINTEF GROUP

POS.: N E	SEISMIC LINE: IKU 302230-87	SP: 721.2	WATER DEPTH: 288 m
UTM ZONE : N E	REFERENCES:		
NO OF SAMPLES:	Σ SAMPLE LENGTH: 0.6 m	ROCKHEAD: 27.0 m	

SITE: 7230/05-U-03
IKU REPORT: 21.3441.00/01/89
ACCESS-ABILITY: RESTRICTED

DEPTH(m) | RECOVERY | LITHO-LOGICAL COLUMN | WATER CONTENT (%) 20 40 60 80 | UNIT WEIGHT (kN/m³) 18 19 20 21 22 | s_u ▽-F.CONE (▼=s_r) ⊙-1 ax ⊙3-3 ax kN/m² 100 200 300 400 500 | SOUND VELOCITY m/s H ○=HORIZONTAL V =VERTICAL 1600 1800 2000 | COLOUMBIAN ATTRACTION, a (kN/m²) 20 30 40 50 | tan φ .2 .4 .6 .8 | PRECONSOLIDATION PRESSURE, p_c' (kN/m²) 200 400 600 800 | GRAIN SIZE DISTRIBUTION % < d 20 40 60 80 | DATING ¹⁴C, Amino acid, Other | MAGN. Polarity +, I, Fabric F | MISC. ANALYSES Petrographic studies, Foraminifera, Mineralogy (XRD), Thermal conductivity | SEISMIC REFLECTIONS (m) | INTERVAL VELOCITY (m/s) | (ms) | COMMENTS

16.3 <2µm <60µm

1A
1B
10
2
20
3
30
BQ
40
50
60

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Site 7230/05-U-03

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Site 7230/05-U-03

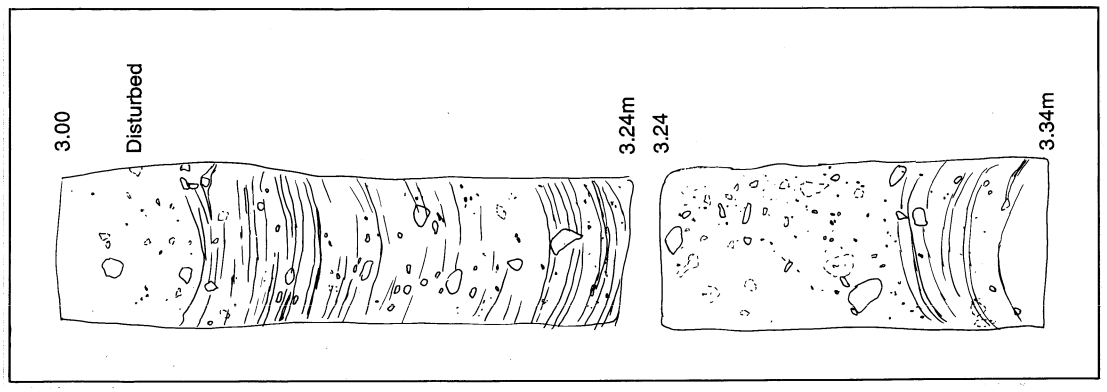
IKU SINTEF-GRUPPEN	Project: 21.3441.00: Quaternary samples Barents Sea 1987			Location: 7230/05 - U - 03
Equipment: Hammer sampler	Water depth: 288.0 m	Latitude: 72°41'10.05"N	Longitude: 30°22'26.70"E	Depth below seabed: 3.00 - 3.60 m

Analytical results	Subsample	m	Lith.	Core description		s_u	s_r
		3.00		CLAY, very silty, sandy, scattered gravel (f) fragments	5Y - 4/1 Dark grey		
	Magn.			Laminated			
		.10		Subrounded calystone and sandstone fragments			
w = 62.4% γ = 16.3kN/m³						18.6	8.1
	TOC/TC						
		.20					
w = 36.0% γ = 18.5kN/m³	K_r	.30				18.6	
w_L = 44.9% w_p = 22.1%	Oe						
		.40					
V_{BH}=1746m/s V_{BV}=1729m/s							
w = 33.4% γ =19.3kN/m³	Magn.	.50				27.0	15.2
	TOC/TC	3.60					

Comments:

Symbols:

K_r	= grain size distribution	T	= triaxial test
λ_r	= thermal conductivity	TOC	= total organic carbon
XRD	= mineralogy	TC	= total carbon
w	= water content (% water of dry sample)	s_u	= undrained shear strength from falling cone test (kN/m²)
w_L-w_p	= liquid and plasticity limits	s_r	= remoulded shear strength
γ	= unit weight of soil (kN/m³)	Magn.	= magnetic fabric
V_{BH}	= horizontal sound velocity (m/s)	OG	= organic geochemistry
V_{BV}	= vertical sound velocity (m/s)	MPal	= micropaleontology
Oe	= oedometertest		



5.3.3 Site 7230/05-U-04

Seismic interpretation

The seismic stratigraphy is similar to site 7230/05-U-02, although the depths to the various reflections are slightly different. At this site an average sound velocity for the Quaternary sediments of 1748 m/s is found by comparing seismic and borehole data.

Lithology and mechanical properties

The only sample is obtained at 23.6 m and comprise a sandy (fine-medium) gravel. The gravel consists of angular claystone fragments, and the sample is similar to the lowermost sample in 7230/05-U-03 and is probably of a similar origin. Fractures dipping 70-80° were noted within the uppermost approx 9 m of the bedrock during coring at this site. This possibly corresponds to the maximum depth of glaciotectonic deformation at this site.

LOC. 7230/05-U-04

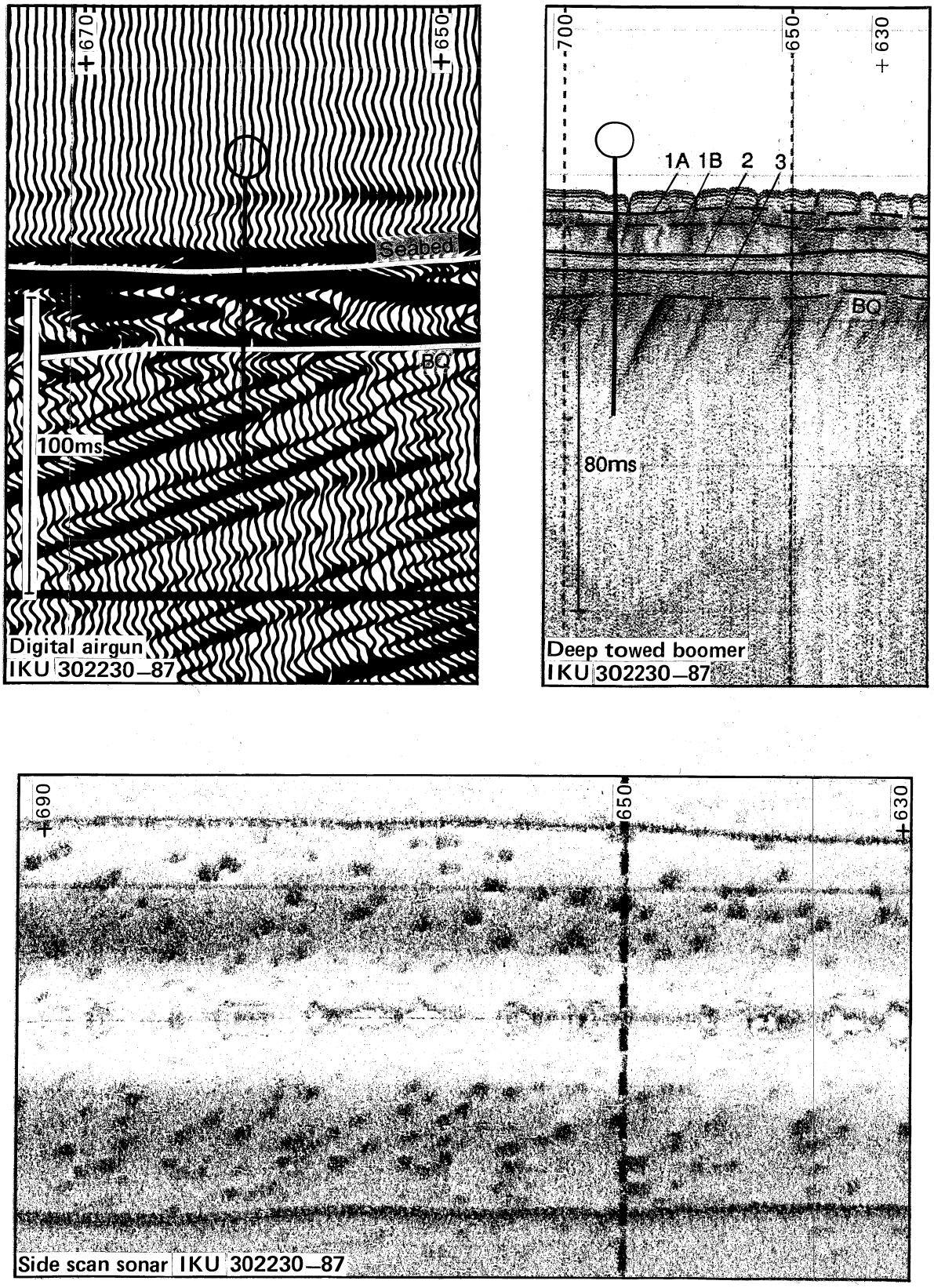


Figure 5.4 *Seismic section across site 7230/05-U-04. The figure is continued on the following pages by a soil boring summary sheet, a description sheet and drawings of radiographs for each sample.*

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IKU SINTEF GROUP

POS.: N E

UTM ZONE : N E

NO OF SAMPLES:

Σ SAMPLE LENGTH: 0.15 m

ROCKHEAD: 23.6 m

SEISMIC LINE: IKU 302230-87

SP: 660.9

WATER DEPTH: 282.7 m

REFERENCES:

SITE: 7230/05-U-04

IKU REPORT: 21.3441.00/01/89

ACCESS-ABILITY: RESTRICTED

DEPTH(m)	RECOVERY	LITHO-LOGICAL COLUMN	WATER CONTENT (%) 20 40 60 80	UNIT WEIGHT (kN/m³) 18 19 20 21 22	s_u ▽-F.CONE (▼=s_r) ⊙-1 ax ⊙-3 ax kN/m² 100 200 300 400 500	SOUND VELOCITY m/s H =HORIZONTAL V =VERTICAL 1600 1800 2000	COLOUMBIAN ATTRACTION, a (kN/m²) 20 30 40 50	tan φ .2 .4 .6 .8	PRECONSOLIDATION PRESSURE, p_c' (kN/m²) 200 400 600 800	GRAIN SIZE DISTRIBUTION % < d 20 40 60 80	DATING ¹⁴C Amino acid Other	MAGN. Polarity + I F Fabric	MISC. ANALYSES Petrographic studies Foraminifera Mineralogy (XRD) Thermal Conductivity	SEISMIC REFLECTIONS (m)	INTERVAL VELOCITY (m/s)	(ms)	COMMENTS
																	1A
																	1B
10																10	
																	2
20																20	3
																	BQ
30																30	
40																40	
50																50	
																60	

IKU SINTEF-GRUPPEN

Site 7230/05-U-04

IKU SINTEF-GRUPPEN

Site 7230/05-U-04

IKU SINTEF-GRUPPEN	Project 21.3441.00: Quaternary samples Barents Sea 1987			Location 7230/05 - U - 04
Equipment Hammer sampler	Water depth 282.7 m	Latitude 72°41'39.74"N	Longitude 30°22'26.63"E	Depth below seabed 23.60 - 23.75 m

Analytical results	Subsample	m	Lith.	Core description	s_u	s_r
w = 17.7%		23.60 .70 23.75		GRAVEL, sandy 5Y - 4/1 Dark grey Hard		

Comments:
The sample represents glaciotectonized sandstone

Symbols:

K_i	=	grain size distribution	T	=	triaxial test
k_c	=	thermal conductivity	TOC	=	total organic carbon
XRD	=	mineralogy	TC	=	total carbon
w	=	water content (% water of dry sample)	s_u	=	undrained shear strength from falling cone test (kN/m²)
w_L-w_P	=	liquid and plasticity limits			
γ	=	unit weight of soil (kN/m³)	s_r	=	remoulded shear strength
V_{sH}	=	horizontal sound velocity (m/s)	Magn.	=	magnetic fabric
V_{sv}	=	vertical sound velocity (m/s)	OG	=	organic geochemistry
Oe	=	oedometertest	MPal	=	micropaleontology

5.3.4 Site 7230/05-U-05 and -05A

(Data from the two attempts at this site are merged.)

Seismic interpretation

The seismic stratigraphy is similar to site 7230/05-U-02, although the depths to the various reflections are slightly different. At this site an average sound velocity for the Quaternary sediments of 1726 m/s is found by comparing seismic and borehole data.

Lithology and mechanical properties

All samples except one from this site are described as silty clays containing some sand and fine gravel. The subangular-subrounded rock fragments are dominated by claystone, but some few sandstone are seen. As illustrated by the redrawn radiographs the samples are homogeneous an nonstratified. The sample at 17 m is described as a silty sand and has a faint layering.

The reflection 2-level corresponds to a clear soil mechanical boundary. Above the water content is above the plasticity limit and undrained shear vary between approx. 25 kPa and 95 kPa. The large variation in shear strength may be related to local sediment disturbance by the suggested iceberg ploughing which could soften a zone of affected sediments (Lien 1986; Lien and Christophersen 1986). The low sensitivity of the sediments at approx. 9 m (also recorded at other sites in the vicinity) could also be related to such remoulding.

Below reflection 2 the sediments are clearly overconsolidated. The water content is below the plasticity limit and undrained shear strength is more than 100 kPa to more than 250 kPa.

Age

Amino acid measurements on foraminifera (Elphidium excavatum) from approx. 9 m gave a D-allo/ L-iso ratio of 0.035 which probably reflects a Middle to Late Weichselian age.

LOC. 7230/05-U-05-05A

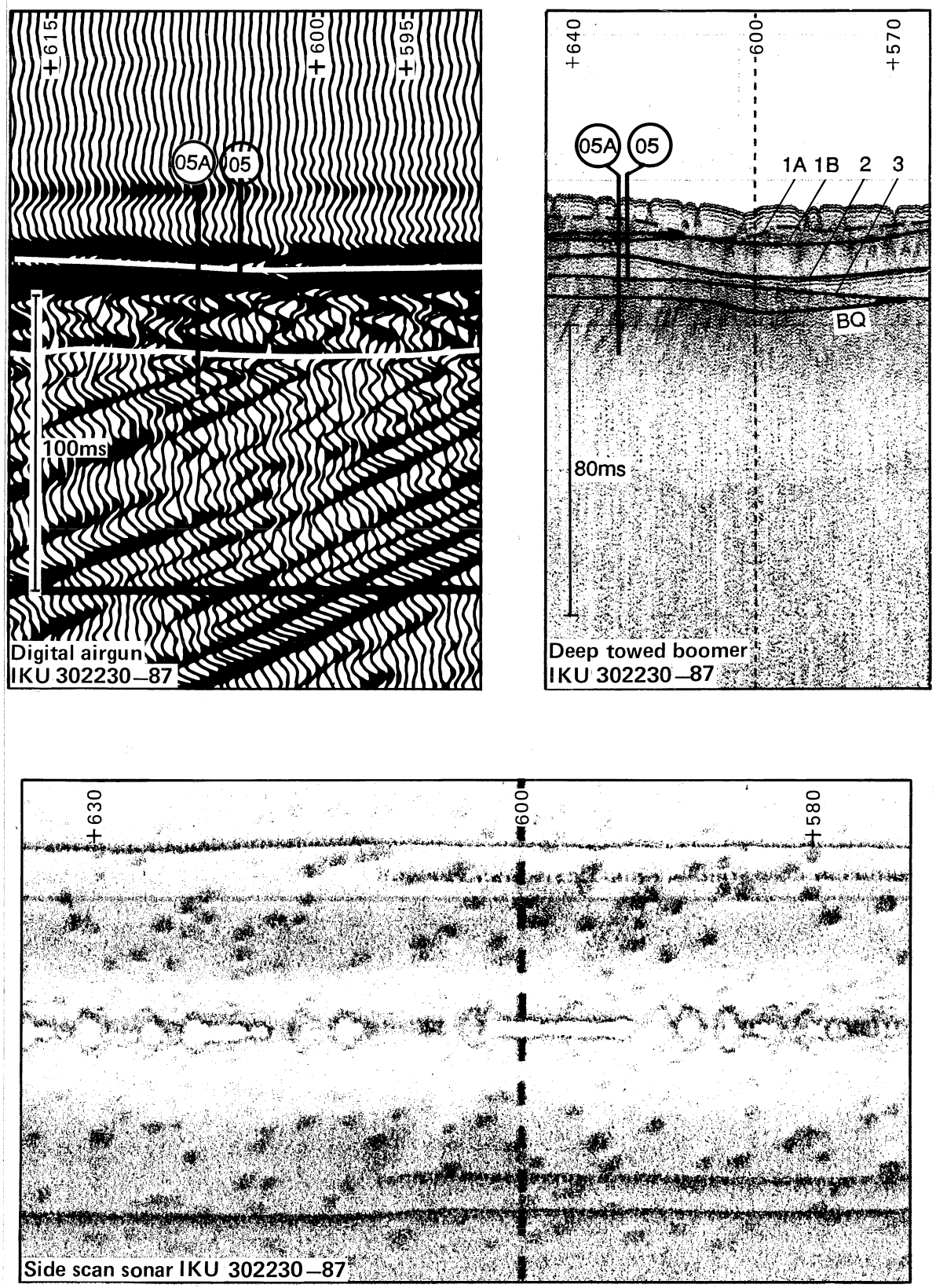


Figure 5.3: *Seismic section across site 7230/05-U-05 and -05A. The figure is continued on the following pages by a soil boring summary sheet, a description sheet and drawings of radiographs for each sample.*

mk_rep806:[21344100]rapport/aa4/45/js/ame/jbl/3-MAY-90

IKU SINTEF GROUP

POS.: N E

UTM ZONE : N E

NO OF SAMPLES:

Σ SAMPLE LENGTH: 1.82 m

ROCKHEAD: 23.3 m

SEISMIC LINE: IKU 302230–87

SP: 604

WATER DEPTH: 286.0 m

REFERENCES:

SITE: 7230/05–U–05

IKU REPORT: 21.3441.00/01/89

ACCESS–ABILITY: RESTRICTED

DEPTH(m)	RECOVERY	LITHO–LOGICAL COLUMN	WATER CONTENT (%) 20 40 60 80	UNIT WEIGHT (kN/m³) 18 19 20 21 22	s_u ▽–F.CONE (▼=s_r) ⊙–1 ax ⊙$_3$–3 ax kN/m² 100 200 300 400 500	SOUND VELOCITY m/s H$_o$ =HORIZONTAL V =VERTICAL 1600 1800 2000	COLOUMBIAN ATTRACTION, a(kN/m²) 20 30 40 50	tan φ .2 .4 .6 .8	PRECONSOLIDATION PRESSURE, p_c' (kN/m²) 200 400 600 800	GRAIN SIZE DISTRIBUTION % < d 20 40 60 80	DATING ^{14}C Amino acid Other	MAGN. Polarity + – F Fabric	MISC. ANALYSES Petrographic studies Foraminifera Mineralogy (XRD) Thermal Conductivity	SEISMIC REFLECTIONS (m)	INTERVAL VELOCITY (m/s)	(ms)	COMMENTS
																	1A
10					16.4				~p_o'		D–allo/L–iso = 0.035					10	1B
									~p_o'	<2µm <60µm							2
20																20	3
																	BQ
30																30	
40																40	
50																50	
																60	

IKU SINTEF-GRUPPEN

Site 7230/05–U–05

mk_rep506:[21344100]rapport/aa4/46/js/amne/jbl/3-MAY-90

IKU SINTEF-GRUPPEN	Project			Location
	21.3441.00: Quaternary samples Barents Sea 1987			7230/05 - U - 05
Equipment	**Water depth**	**Latitude**	**Longitude**	**Depth below seabed**
Hammer sampler	286.0 m	72°42´07.14"N	30°22´32.09"E	9.00 - 9.60 m

Analytical results	Subsample	m	Lith.	Core description	s_u	s_r
		9.00		CLAY, silty, some sand and gravel (f) 5Y - 4/1 Dark grey Subrounded-subangular claystone fragments		
w = 33.6% γ = 19.3kN/m³		.10			24.0	18.6
	MPal.	.20				
w = 32.8% γ = 19.5kN/m³	Magn. XRD				25.0	18.6
		.30				
w = 32.4% γ = 19.7kN/m³		.40			27.0	18.6
w = 34.7% γ = 18.4kN/m³	k_t	.50			21.1	
w_L = 44.8% w_p = 23.2%	Oe					
		9.60				

Comments:
MPal, amino acid (BAL 1430):
D-allo/L-iso=0.035
(Elph. exc.)

Symbols:

K_t	= grain size distribution	T	= triaxial test
k_T	= thermal conductivity	TOC	= total organic carbon
XRD	= mineralogy	TC	= total carbon
w	= water content (% water of dry sample)	s_u	= undrained shear strength from falling cone test (kN/m²)
w_L-w_P	= liquid and plasticity limits		
γ	= unit weight of soil (kN/m³)	s_r	= remoulded shear strength
V_{pH}	= horizontal sound velocity (m/s)	Magn.	= magnetic fabric
V_{pV}	= vertical sound velocity (m/s)	OG	= organic geochemistry
Oe	= oedometertest	MPal	= micropaleontology

IKU SINTEF-GRUPPEN	Project			Location
	21.3441.00: Quaternary samples Barents Sea 1987			7230/05 - U - 05
Equipment	**Water depth**	**Latitude**	**Longitude**	**Depth below seabed**
WIP sampler	286.0 m	72°42´07.14"N	30°22´32.09"E	11.93 - 12.43 m

Analytical results	Subsample	m	Lith.	Core description	s_u	s_r
		11.93		CLAY, silty, some sand and gravel (f) 5Y - 4/1 Dark grey		
	OG			Subangular-subrounded silt -and claystone fragments		
	TOC/TC			Subangular fragment claystone, 5 cm		
	Magn.					
w = 25.7% γ = 16.4kN/m³	XRD	12.03				
					74.0	
		.13		Limestone fragment, 3 cm		
	k_T				95.0	
		.23		Rounded gravel fragment,1 cm (Pyrite)		
	k_T Magn.	.33				
	TOC/TC OG					
		12.43				

Comments:

Symbols:

K_t	= grain size distribution	T	= triaxial test
k_T	= thermal conductivity	TOC	= total organic carbon
XRD	= mineralogy	TC	= total carbon
w	= water content (% water of dry sample)	s_u	= undrained shear strength from falling cone test (kN/m²)
w_L-w_P	= liquid and plasticity limits		
γ	= unit weight of soil (kN/m³)	s_r	= remoulded shear strength
V_{pH}	= horizontal sound velocity (m/s)	Magn.	= magnetic fabric
V_{pV}	= vertical sound velocity (m/s)	OG	= organic geochemistry
Oe	= oedometertest	MPal	= micropaleontology

Site 7230/05-U-05

IKU SINTEF-GRUPPEN

mk_rep$06:[21344100]rapport/aa4/47/js/ame/jbl/3-MAY-90

IKU SINTEF-GRUPPEN	Project		Location
	21.3441.00: Quaternary samples Barents Sea 1937		7230/05 - U - 05
Equipment	**Water depth**	**Latitude**	**Longitude**	**Depth below seabed**
WIP sampler	286.0 m	72°42'07.14"N	30°22'32.09"E	14.90 - 15.32 m

Analytical results	Subsample	m	Lith.	Core description	s_u	s_r
		14.90		CLAY, silty, some sand and gravel (f) 5Y - 3/1		
				Subangular silt -and claystone fragments Very dark grey		
	Magn.			2 sandstone fragments, 4 cm and 2 cm, subangular		
				Chert ?, 4 cm		
				Red, angular pebble (chert?)		115.8
w = 21.1% γ = 22.0kN/m³		15.00		Sandstone fragment, subangular		
V_{SH} = 1872 m/s	K_f				245.0	
w = 18.2% γ = 20.8kN/m³	Oe/T				250.0	
w_L = 44.5% w_P = 21.0%		.10				
	Magn.	.20				
V_{SH}=1888m/s V_{SV}=1787m/s	k_T				250.0	
		.30				
		15.32				

Comments:

Symbols:

K_f	= grain size distribution	T	= triaxial test
k_T	= thermal conductivity	TOC	= total organic carbon
XRD	= mineralogy	TC	= total carbon
w	= water content (% water of dry sample)	s_u	= undrained shear strength from falling cone test (kN/m²)
w_L-w_P	= liquid and plasticity limits		
γ	= unit weight of soil (kN/m³)	s_r	= remoulded shear strength
V_{SH}	= horizontal sound velocity (m/s)	Magn.	= magnetic fabric
V_{SV}	= vertical sound velocity (m/s)	OG	= organic geochemistry
Oe	= oedometertest	MPal	= micropaleontology

IKU SINTEF-GRUPPEN	Project		Location
	21.3441.00: Quaternary samples Barents Sea 1987		7230/05 - U- 05A
Equipment	**Water depth**	**Latitude**	**Longitude**	**Depth below seabed**
Hammer sampler	286.0 m	72°42'06.00"N	30°22'31.64"E	17.00 - 17.14 m

Analytical results	Subsample	m	Lith.	Core description	s_u	s_r
		17.00		SAND (f), some silt.		
				Ocasional gravel (f) fragments 5Y - 4/1		
	K_f			Limestone fragment, 1 cm, subrounded Dark grey		
	Magn.					
w = 12.8% γ = 22.5kN/m³		.10				
	k_T			Thin layer of sand (f)		
	XRD	17.14				

Comments:

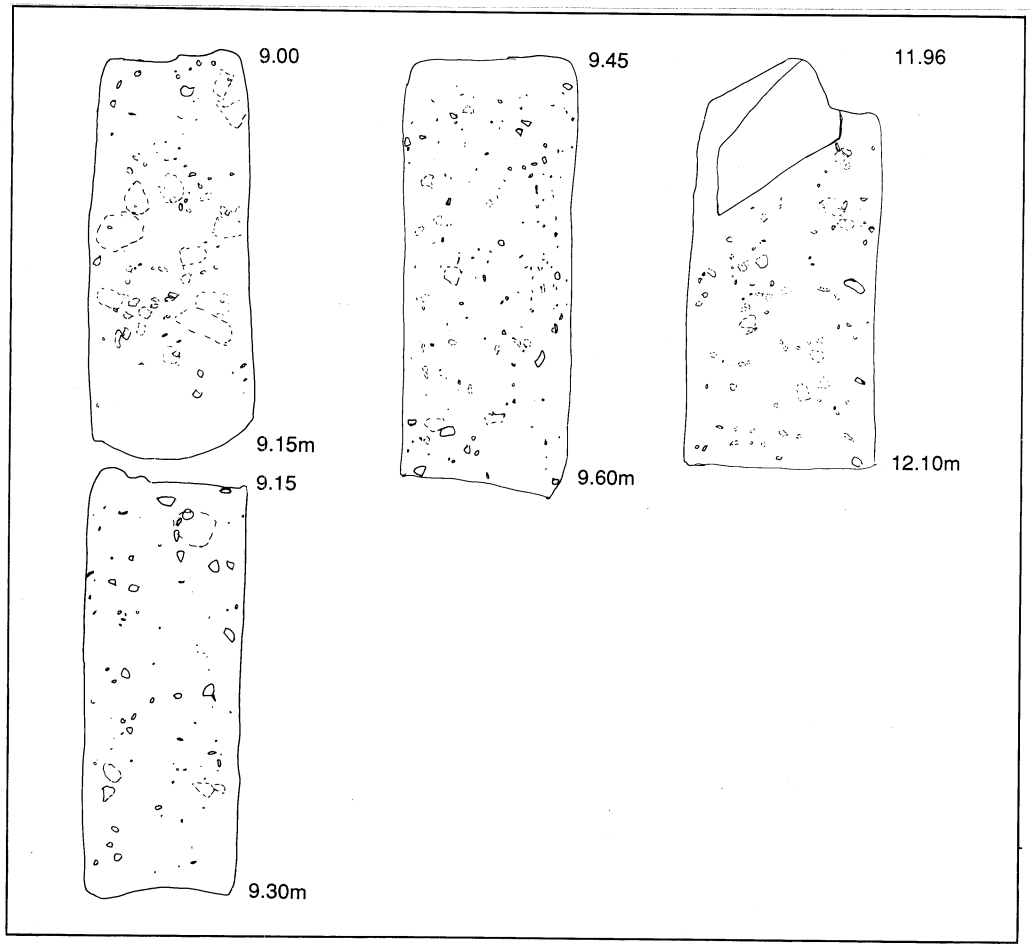
Symbols:

K_f	= grain size distribution	T	= triaxial test
k_T	= thermal conductivity	TOC	= total organic carbon
XRD	= mineralogy	TC	= total carbon
w	= water content (% water of dry sample)	s_u	= undrained shear strength from falling cone test (kN/m²)
w_L-w_P	= liquid and plasticity limits		
γ	= unit weight of soil (kN/m³)	s_r	= remoulded shear strength
V_{SH}	= horizontal sound velocity (m/s)	Magn.	= magnetic fabric
V_{SV}	= vertical sound velocity (m/s)	OG	= organic geochemistry
Oe	= oedometertest	MPal	= micropaleontology

Site 7230/05-U-05

IKU SINTEF-GRUPPEN

mk_rep$06:[21344100]rapport/aa4/48/js/ame/jbl/3-MAY-90



IKU SINTEF-GRUPPEN	Project			Location
	21.3441.00: Quaternary samples Barents Sea 1987			7230/05 - U - 05A
Equipment	**Water depth**	**Latitude**	**Longitude**	**Depth below seabed**
Hammer sampler	286.0 m	72°42'06.00"N	30°22'31.64"E	23.50 - 23.66 m

Analytical results	Subsample	m	Lith.	Core description	s_u	s_r
		23.50		CLAY, silty 5Y - 4/1 Dark grey Very stiff - hard		
		.60				
		23.66				

Comments:

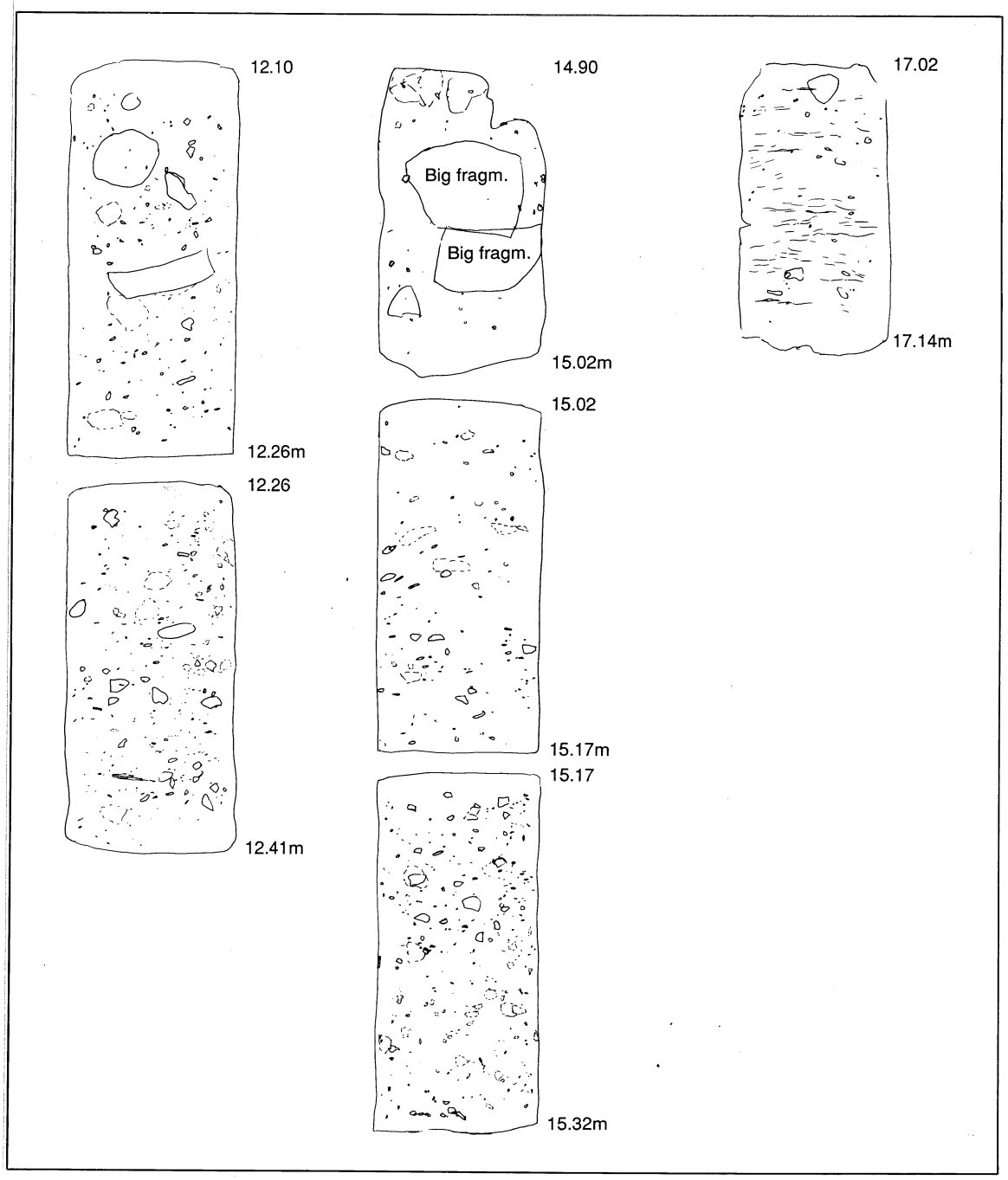
Symbols:

K_j	=	grain size distribution	T	=	triaxial test
k_r	=	thermal conductivity	TOC	=	total organic carbon
XRD	=	mineralogy	TC	=	total carbon
w	=	water content (% water of dry sample)	s_u	=	undrained shear strength from falling cone test (kN/m²)
w_L-w_P	=	liquid and plasticity limits			
γ	=	unit weight of soil (kN/m³)	s_r	=	remoulded shear strength
V_{sH}	=	horizontal sound velocity (m/s)	Magn.	=	magnetic fabric
V_{sv}	=	vertical sound velocity (m/s)	OG	=	organic geochemistry
Oe	=	oedometertest	MPal	=	micropaleontology

Site 7230/05-U-05

IKU SINTEF-GRUPPEN

Site 7230/05-U-05



5.3.5 Site 7230/05-U-06

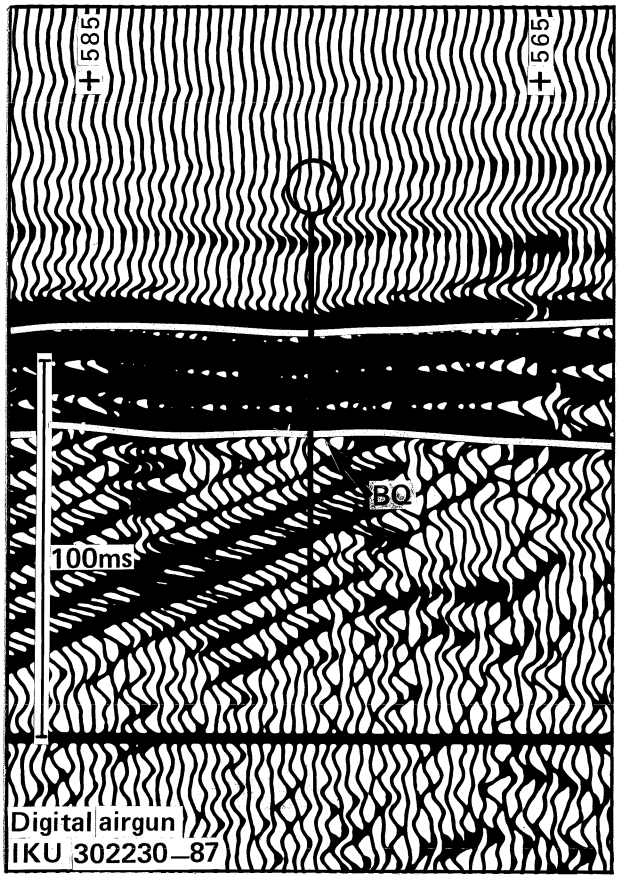
Seismic interpretation

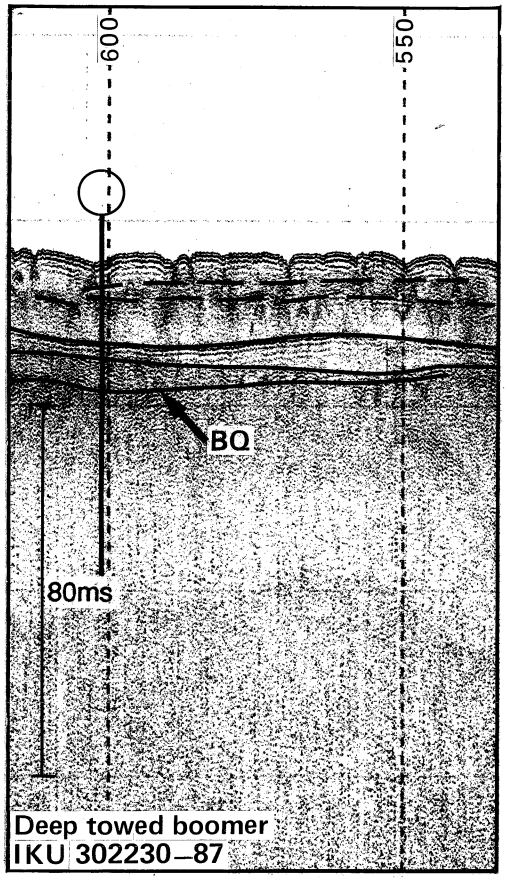
The seismic stratigraphy is similar to site 7230/05-U-02, although the depths to the various reflections are slightly different. At this site an average sound velocity for the Quaternary sediments of 1697 m/s is found by comparing seismic and borehole data.

Lithology and mechanical properties

Two samples were collected at this site. Both are from the interval below reflection 3, and a silty, sandy clay and a silty, clayey sand(vf-f) were obtained. Subangular sandstone fragment is recorded. No mechanical properties were measured during laboratory description, but the sample were described on board as very stiff-hard.

LOC. 7230/05-U-06





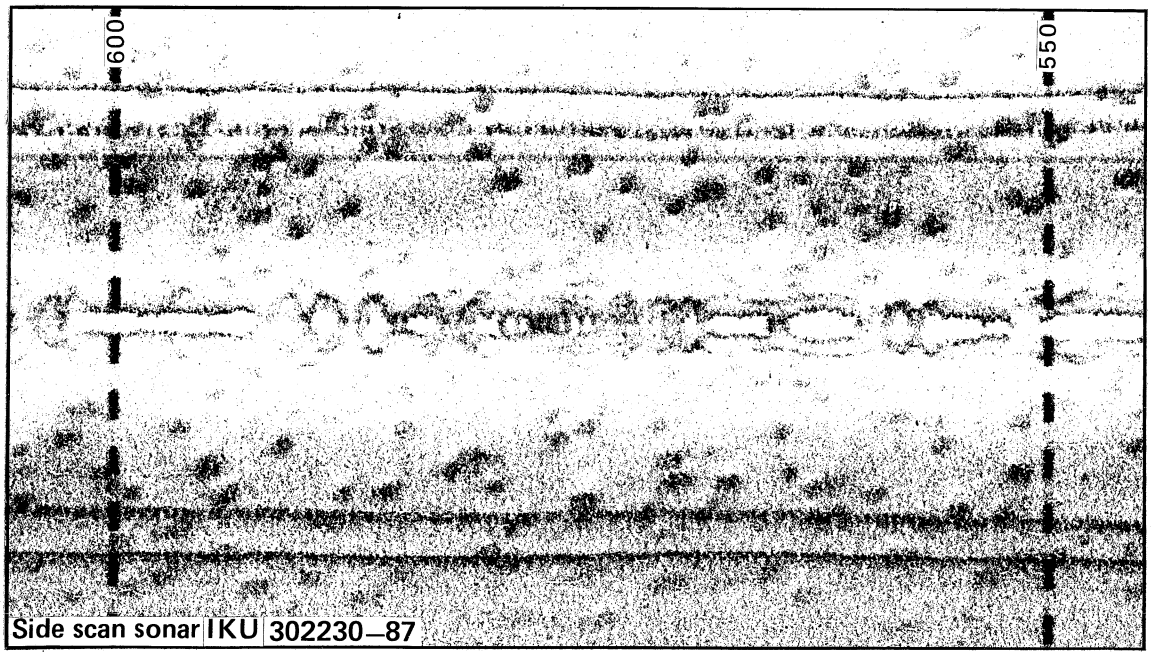


Figure 5.6 *Seismic section across site 7230/05-U-06. The figure is continued on the following pages by a soil boring summary sheet, a description sheet and drawings of radiographs for each sample.*

rep$24:[21344100]rapp2/AAO/jbl/53/21-DEC-89

IKU SINTEF GROUP

POS.: N E	SEISMIC LINE: IKU 302230–87	SP: 575.1	WATER DEPTH: 285.5 m
UTM ZONE : N E	REFERENCES:		
NO OF SAMPLES:	Σ SAMPLE LENGTH: 0.75 m	ROCKHEAD: 24.6 m	

SITE: 7230/05–U–06
IKU REPORT: 21.3441.00/01/89
ACCESS–ABILITY: RESTRICTED

DEPTH(m) | RECOVERY | LITHO–LOGICAL COLUMN | WATER CONTENT (%) 20 40 60 80 | UNIT WEIGHT (kN/m³) 18 19 20 21 22 | s_u ▽–F.CONE (▼=s_r) ⊙–1 ax ⊙3–3 ax kN/m² 100 200 300 400 500 | SOUND VELOCITY m/s H: =HORIZONTAL V: =VERTICAL 1600 1800 2000 | COLOUMBIAN ATTRACTION, a(kN/m²) 20 30 40 50 | tan ϕ .2 .4 .6 .8 | PRECONSOLIDATION PRESSURE, p_c' (kN/m²) 200 400 600 800 | GRAIN SIZE DISTRIBUTION % < d 20 40 60 80 | DATING ¹⁴C, Amino acid, Other | MAGN. Polarity + I, Fabric F | MISC. ANALYSES Petrographic studies, Foraminifera, Mineralogy (XRD), Thermal conductivity | SEISMIC REFLECTIONS (m) | INTERVAL VELOCITY (m/s) | (ms) | COMMENTS

(ms)	COMMENTS
	1A
	1B
10	
	2
20	
	3
	BQ
30	
40	
50	
60	

IKU SINTEF-GRUPPEN
Site 7230/05–U–06

rep$24:[21344100]rapp2/AA0/jbl/54/21-DEC-89

IKU SINTEF-GRUPPEN	Project			Location
	21.3441.00: Quaternary samples Barents Sea 1987			7230/05 - U - 06
Equipment	**Water depth**	**Latitude**	**Longitude**	**Depth below seabed**
Hammer sampler	285.5 m	72°42'21.21"N	30°22'28.86"E	22.80 - 23.30 m

Analytical results	Subsample	m	Lith.	Core description		s_u	s_t
		22.80		SAND (vf-f), silty, clayey	5Y - 4/1 Dark grey		
		.90		Subangular sandstone fragment, 1.5 cm			
		23.00					
		.10					
		.20					
		23.30					

Comments:

Symbols:

K_i	= grain size distribution		T	= triaxial test	
k_r	= thermal conductivity		TOC	= total organic carbon	
XRD	= mineralogy		TC	= total carbon	
w	= water content (% water of dry sample)		s_u	= undrained shear strength from falling cone test (kN/m²)	
w_L-w_P	= liquid and plasticity limits				
γ	= unit weight of soil (kN/m³)		s_r	= remoulded shear strength	
V_{sH}	= horizontal sound velocity (m/s)		Magn.	= magnetic fabric	
V_{sV}	= vertical sound velocity (m/s)		OG	= organic geochemistry	
Oe	= oedometertest		MPal	= micropaleontology	

IKU SINTEF-GRUPPEN	Project			Location
	21.3441.00: Quaternary samples Barents Sea 1987			7230/05 - U - 06
Equipment	**Water depth**	**Latitude**	**Longitude**	**Depth below seabed**
Hammer sampler	285.5 m	72°42'21.21"N	30°22'28.86"E	23.75 - 24.00 m

Analytical results	Subsample	m	Lith.	Core description		s_u	s_t
		23.75		CLAY, silty, sandy (vf)	5Y - 4/1 Dark grey		
		.85					
		.95					

Comments:

Symbols:

K_i	= grain size distribution		T	= triaxial test	
k_r	= thermal conductivity		TOC	= total organic carbon	
XRD	= mineralogy		TC	= total carbon	
w	= water content (% water of dry sample)		s_u	= undrained shear strength from falling cone test (kN/m²)	
w_L-w_P	= liquid and plasticity limits				
γ	= unit weight of soil (kN/m³)		s_r	= remoulded shear strength	
V_{sH}	= horizontal sound velocity (m/s)		Magn.	= magnetic fabric	
V_{sV}	= vertical sound velocity (m/s)		OG	= organic geochemistry	
Oe	= oedometertest		MPal	= micropaleontology	

Site 7230/05-U-06

IKU SINTEF-GRUPPEN

5.3.6 Site 7030/03-U-01

Seismic interpretation

Only analog sleeve airgun data exist across this site. On this data the sediments appear as acoustically nonstratified, but with some possible faint internal local reflections. A reflection at 8 ms is probably regional.

Lithology and mechanical properties

One sediment sample is obtained. It is located above the mentioned reflection and comprise a very sandy, silty clay with angular crystalline rocks and some subangular sandstone- and claystone fragments. The undrained shear strength is about 27 kPa, and the sediment is possibly slightly overconsolidated although oedometer tests do not reveal any effective preconsolidation pressure. The watercontent is above the plasticity limit.

LOC. 7030/03-U-01

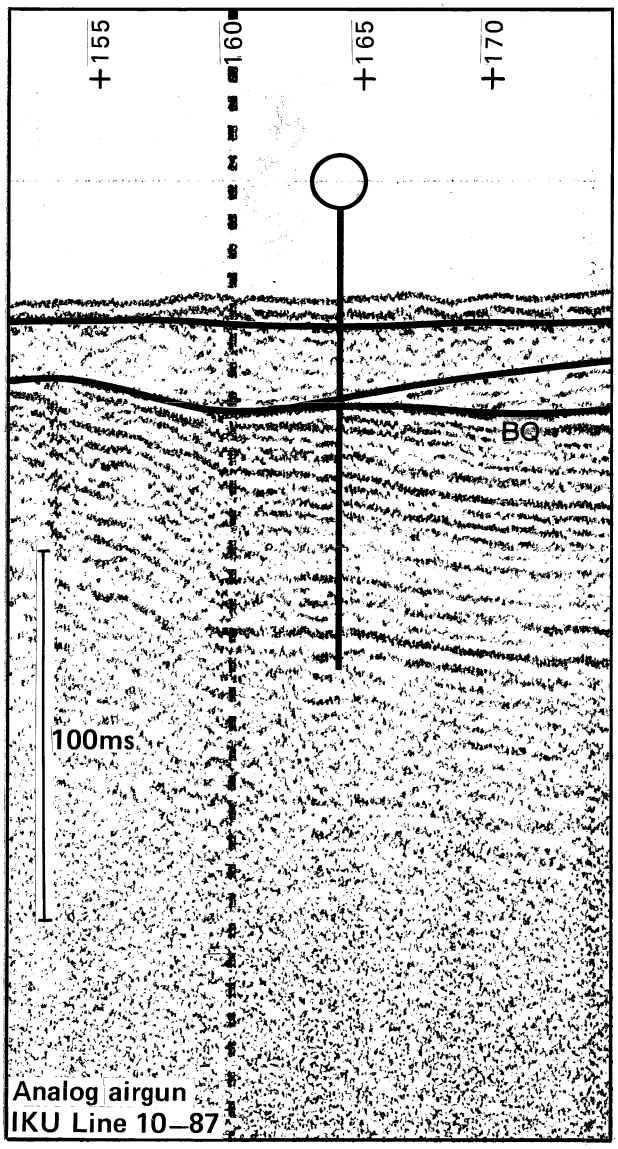


Figure 6.7 *Seismic section across site 7030/03-U-01. The figure is continued on the following pages by a soil boring summary sheet, a description sheet and drawings of radiographs for each sample.*

rep$24:[21344100]rapp2/AA0/jbl/57/21-DEC-89

IKU SINTEF GROUP

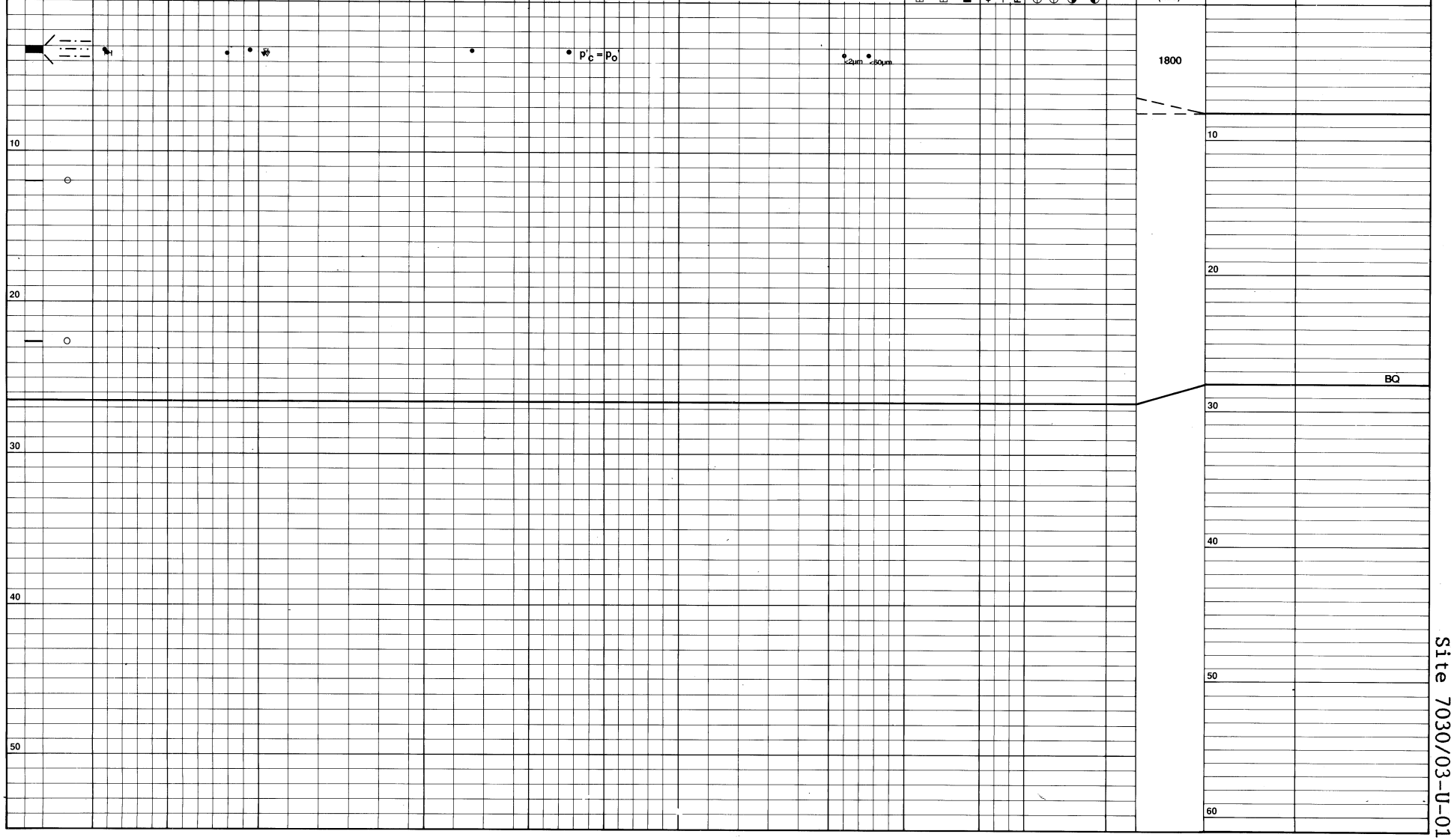
POS.: N E	SEISMIC LINE: IKU 10–87	SP: 164.1	WATER DEPTH: 308 m
UTM ZONE : N E	REFERENCES:		
NO OF SAMPLES:	Σ SAMPLE LENGTH: 0.69 m	ROCKHEAD: 26.3 m	

SITE: 7030/03–U–01
IKU REPORT: 21.3441.00/01/89
ACCESS–ABILITY: RESTRICTED

DEPTH(m) | RECOVERY | LITHO–LOGICAL COLUMN | WATER CONTENT (%) 20 40 60 80 | UNIT WEIGHT (kN/m³) 18 19 20 21 22 | s_u ▽–F.CONE (▼=s_r) ⊙–1 ax ⊙$_3$–3 ax kN/m² 100 200 300 400 500 | SOUND VELOCITY m/s H =HORIZONTAL V =VERTICAL 1600 1800 2000 | COLOUMBIAN ATTRACTION, a (kN/m²) 20 30 40 50 | tan ϕ .2 .4 .6 .8 | PRECONSOLIDATION PRESSURE, p_c' (kN/m²) 200 400 600 800 | GRAIN SIZE DISTRIBUTION % < d 20 40 60 80 | DATING ^{14}C Amino acid Other | MAGN. + Polarity – F Fabric | MISC. ANALYSES Petrographic studies Foraminifera Mineralogy (XRD) Thermal conductivity

SEISMIC REFLECTIONS: (m) | INTERVAL VELOCITY (m/s) | (ms)

COMMENTS



IKU SINTEF-GRUPPEN
Site 7030/03–U–01

IKU SINTEF-GRUPPEN	Project		Location
	21.3441.00: Quaternary samples Barents Sea 1987		7030/03 - U - 01
Equipment	**Water depth**	**Latitude** / **Longitude**	**Depth below seabed**
Hammer sampler	308.0 m	70°49´36.18"N / 30°44´31.07"E	3.00 - 3.56 m

Analytical results	Subsample	m	Lith.	Core description	s_u	s_r
	Magn.	3.00		CLAY, very sandy (f-m), silty, 5Y - 4/1 Dark grey		
		.10		Crystalline angular pebble, 1 cm		
				Subangular claystone fragment, 4 cm		
				Coral ?		
w = 16.1% γ = 22.4 kN/m³		.20				
				Subangular sandstone fragment, 2 cm		
		.30				
w =18.8% γ = 20.9 kN/m³	Oe	.40			27.0	
w_L = 24.7% w_P = 15.9%	K_T				28.0	18.0
		.50				
		3.56				

Comments:

Symbols:

K_T	= grain size distribution	T	= triaxial test
k_T	= thermal conductivity	TOC	= total organic carbon
XRD	= mineralogy	TC	= total carbon
w	= water content (% water of dry sample)	s_u	= undrained shear strength from falling cone test (kN/m²)
w_L-w_P	= liquid and plasticity limits		
γ	= unit weight of soil (kN/m³)	s_r	= remoulded shear strength
V_{SH}	= horizontal sound velocity (m/s)	Magn.	= magnetic fabric
V_{SV}	= vertical sound velocity (m/s)	OG	= organic geochemistry
Oe	= oedometertest	MPal	= micropaleontology

IKU SINTEF-GRUPPEN	Project		Location
	21.3441.00: Quaternary samples Barents Sea 1987		7030/03-U-01
Equipment	**Water depth**	**Latitude** / **Longitude**	**Depth below seabed**
Hammer sampler	308.0 m	70°49´36.18"N / 30°44´31.07"E	12.00 - 12.07 m

Analytical results	Subsample	m	Lith.	Core description	s_u	s_r
		12.00	X	Subangular crystalline pebble, 6 cm		
		12.07				

Comments:

Symbols:

K_T	= grain size distribution	T	= triaxial test
k_T	= thermal conductivity	TOC	= total organic carbon
XRD	= mineralogy	TC	= total carbon
w	= water content (% water of dry sample)	s_u	= undrained shear strength from falling cone test (kN/m²)
w_L-w_P	= liquid and plasticity limits		
γ	= unit weight of soil (kN/m³)	s_r	= remoulded shear strength
V_{SH}	= horizontal sound velocity (m/s)	Magn.	= magnetic fabric
V_{SV}	= vertical sound velocity (m/s)	OG	= organic geochemistry
Oe	= oedometertest	MPal	= micropaleontology

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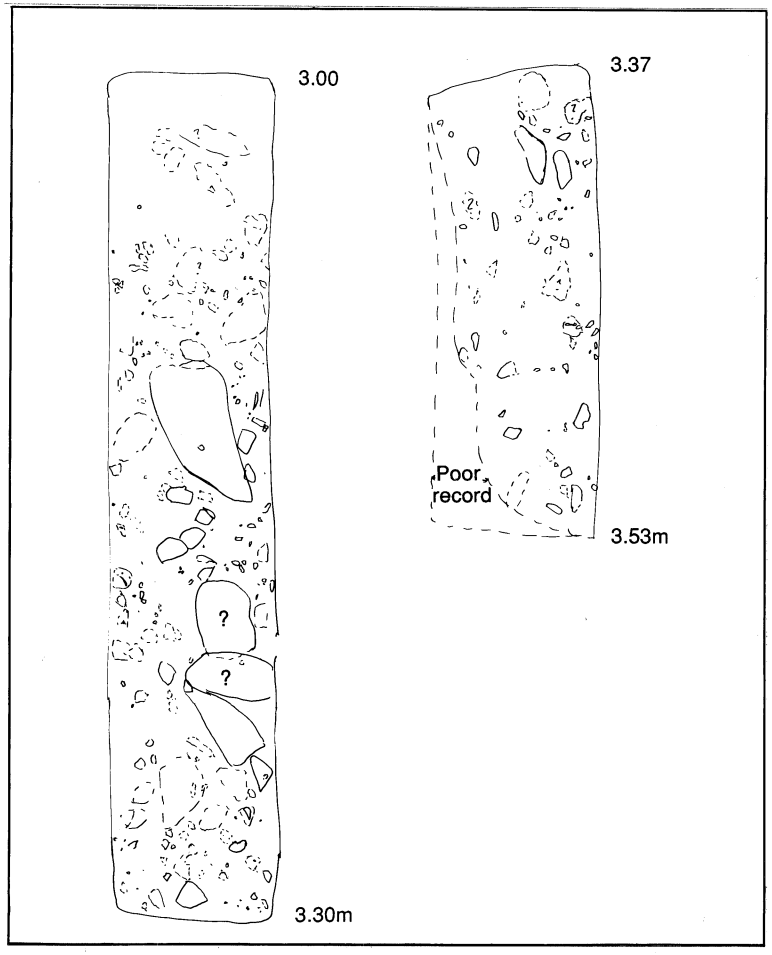
IKU SINTEF-GRUPPEN	Project			Location
	21.3441.00: Quaternary samples Barents Sea 1987			7030/03 - U - 01
Equipment	Water depth	Latitude	Longitude	Depth below seabed
Hammer sampler	308.0 m	70°49'36.18"N	30°44'31.07"E	22.60 - 22.66 m

Analytical results	Subsample	m	Lith.	Core description	s_u	s_r
		22.60		Angular amphibolitic gneiss pebbles (fragmented during drilling)		
		22.66				

Comments:

Symbols:

K_f	=	grain size distribution	T	=	triaxial test
k_r	=	thermal conductivity	TOC	=	total organic carbon
XRD	=	mineralogy	TC	=	total carbon
w	=	water content (% water of dry sample)	s_u	=	undrained shear strength from falling cone test (kN/m^2)
w_L-w_P	=	liquid and plasticity limits			
γ	=	unit weight of soil (kN/m^3)	s_r	=	remoulded shear strength
V_{SH}	=	horizontal sound velocity (m/s)	Magn.	=	magnetic fabric
V_{SV}	=	vertical sound velocity (m/s)	OG	=	organic geochemistry
Oe	=	oedometertest	MPal	=	micropaleontology



IKU SINTEF-GRUPPEN

5.3.7 Site 7128/09-U-01

Seismic interpretation

At this locality an upper, 20 ms thick seismic unit of acoustically stratified sediments occur. The layering of the lower 10 ms of this unit mimics the irregular topography of its base. The upper 10 ms has less strong reflections and tends to smoothen the relief. The topmost 3 ms may probably be separated as a separate unit, possibly consisting of soft Holocene-late-glacial clay. This sequence is only found in major depressions in the Barents Sea and resembles the Emerald Silt Facies Described from off Canada by King and Fader (1986).

Top bedrock is found at approx 60 ms, corresponding to a sound velocity of 1833 m/s. Between 20 and 60 ms the sediments are acoustically nonstratified. buty a marked reflection is found at 48 ms.

Lithology and mechanical properties

One sample comprising a sandy, clayey silt with some gravel(f) was obtained from the acoustically laminated unit. Crystalline angular rock fragments dominate, but subangular sandstone and claystone also occur. The sample appear to be normally consolidated and has a watercontent above the plasticity limit and an undrained shear strength (falling cone) of 30-40 kPa. The s_u-value of 70 kPa from a triaxial test is probably not representative. Several samples are obtained from the interval below 20 ms while attempting to penetrate the overburden by piggyback coring. These are all diamictons with a high content of sand and gravel. Crystalline rocks dominate. The recorded stiffness of these sediments is uncertain because of the high content of coarse fragments, but most of the samples would probably be regarded as firm to stiff. It is noted difficult drilling conditions was experienced in these sediments, and this is probably related to the combination of matrix stiffness and grave/boulder content.

Age

Amino acid measurements on foraminifera (Elphidium excavatum) from approx. 15 m gave a D-allo/L-iso ratio of 0.042 which could reflect a late Weichselian age. A small shell fragment at 36.6 m may hopefully give an age indication of the lower part of the borehole.

LOC. 7128/09-U-01-01A

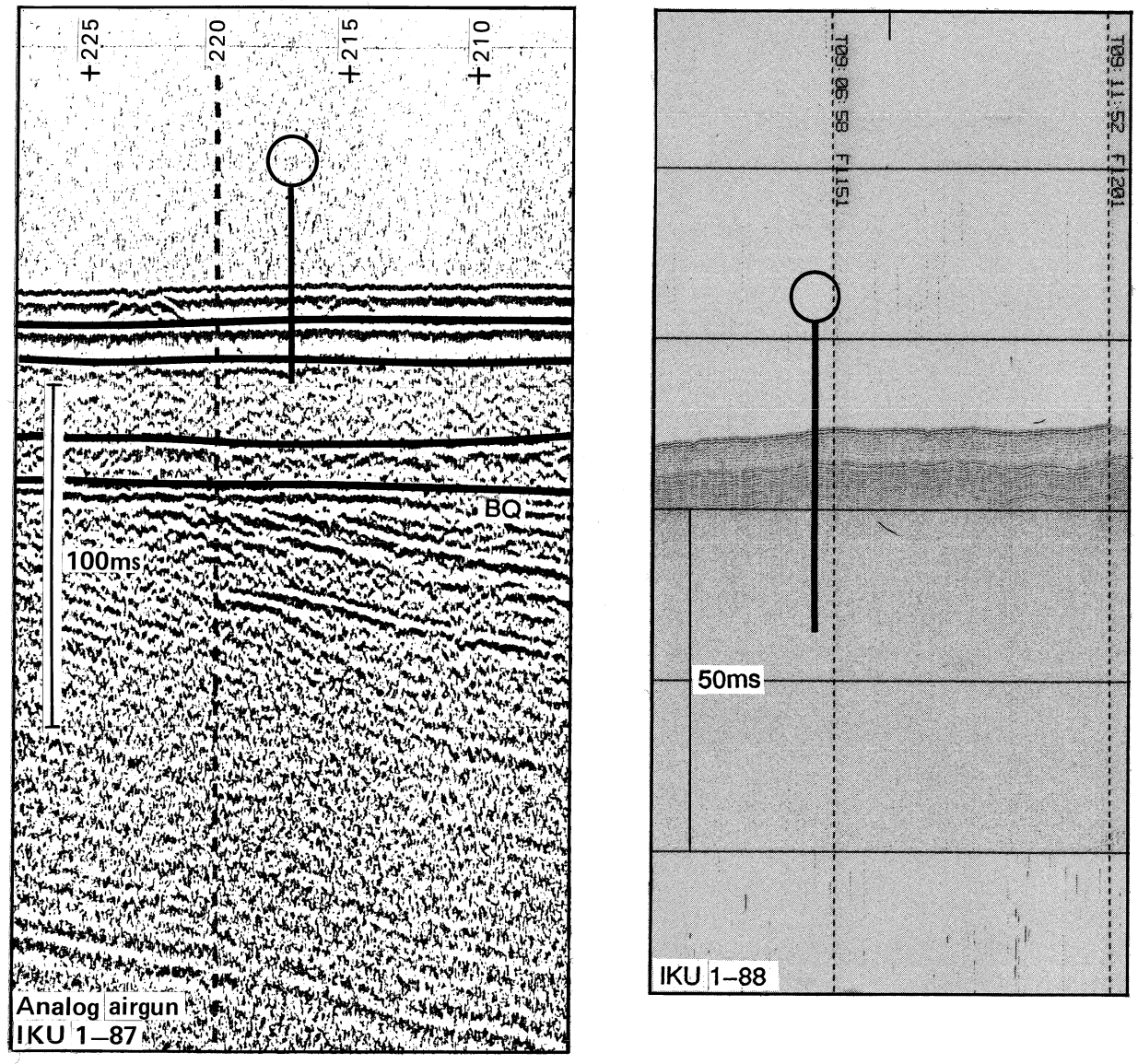


Figure 5.8 *Seismic section across site 7128/09-U-01. The figure is continued on the following pages by a soil boring summary sheet, a description sheet and drawings of radiographs for each sample.*

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IKU SINTEF GROUP

POS.: N E

UTM ZONE : N E

NO OF SAMPLES:

Σ SAMPLE LENGTH: 0.69 m

ROCKHEAD: ~ 55 m

SEISMIC LINE: IKU 01–87

SP: 217

REFERENCES:

WATER DEPTH: 405.5 m

SITE: 7128/09–U–01

IKU REPORT: 21.3441.00/01/89

ACCESS–ABILITY: RESTRICTED

DEPTH(m) | RECOVERY | LITHO–LOGICAL COLUMN | WATER CONTENT (%) 20 40 60 80 | UNIT WEIGHT (kN/m³) 18 19 20 21 22 | s_u ▽–F.CONE (▼=s_r) ⊙–1 ax ⊙$_3$–3 ax kN/m² 100 200 300 400 500 | SOUND VELOCITY m/s H ○ =HORIZONTAL V ⋮ =VERTICAL 1600 1800 2000 | COLOUMBIAN ATTRACTION, a (kN/m²) 20 30 40 50 | tan ϕ .2 .4 .6 .8 | PRECONSOLIDATION PRESSURE, p_c' (kN/m²) 200 400 600 800 | GRAIN SIZE DISTRIBUTION % < d ′ 20 40 60 80 | DATING ^{14}C Amino acid Other | MAGN. Polarity + I – Fabric F | MISC. ANALYSES Petrographic studies Foraminifera Mineralogy (XRD) Thermal conductivity | SEISMIC REFLECTIONS (m) INTERVAL VELOCITY (m/s) (ms) | COMMENTS

10

20

30

40

50

2150

<2µm <60µm

D–allo/L–iso = 0.042

128

Uncertain values due to lithology

60

IKU SINTEF-GRUPPEN

Site 7128/09–U–01

IKU SINTEF-GRUPPEN	Project			Location
	21.3441.00: Quaternary samples Barents Sea 1987			7128/09 - U -01
Equipment	**Water depth**	**Latitude**	**Longitude**	**Depth below seabed**
Hammer sampler	417.0 m	71°15´23.41"N	28°51´11.98"E	15.10 - 15.75 m

Analytical results	Subsample	m	Lith.	Core description	s_u	s_r
		15.10		SILT, sandy, some gravel (f) 5Y - 4/1 Dark grey Angular crystalline pebble		
V_{SH} = 2150 m/s	Magn.	.20				
V_{SH} = 1900 m/s	XRD					
w = 21.6% γ = 17.5kN/m³		.30				
	TOC/TC MPal.			Subangular claystone fragment, 0.5 cm Angular crystalline with fragments, 1-2 cm	38.7	34.3
		.40		Subrounded sandstone fragment? laminated, 1.2 cm		
V_{SH} = 2073 m/s		.50		Subrounded meta sandstone (?) fragment, 2.5 cm	31.0	22.0
w = 17.5% γ = 20.7kN/m³	K_t	.60			34.3	
w_L = 29.1% w_P = 16.6%	T					
		.70				
	TOC/TC	15.75				

Comments:
MPal, amino acid (BAL 1427):
D-allo/L-iso = 0.042
(Elph. -exc.)

Symbols:

K_t	= grain size distribution	T	= triaxial test
k_t	= thermal conductivity	TOC	= total organic carbon
XRD	= mineralogy	TC	= total carbon
w	= water content (% water of dry sample)	s_u	= undrained shear strength from falling cone test (kN/m²)
w_L-w_P	= liquid and plasticity limits		
γ	= unit weight of soil (kN/m³)	s_r	= remoulded shear strength
V_{SH}	= horizontal sound velocity (m/s)	Magn.	= magnetic fabric
V_{SV}	= vertical sound velocity (m/s)	OG	= organic geochemistry
Oe	= oedometertest	MPal	= micropaleontology

IKU SINTEF-GRUPPEN	Project			Location
	21.3441.00: Quaternary samples Barents Sea 1987			7128/09 - U - 01
Equipment	**Water depth**	**Latitude**	**Longitude**	**Depth below seabed**
Piggyback coring	417.0 m	71°15´23.41"N	28°51´11.98"E	36.30 - 36.69 m

Analytical results	Subsample	m	Lith.	Core description	s_u	s_r
		36.30		GRANITE		
		.40				
		.50		GNEISS		
	TS					
		.60		CLAY, silty, gravelly (f-m), sandy 5Y - 3/1 Angular claystone fragments Very dark grey		
	TOC/TC				>250	
w = 19.2%		36.69		Very small shell fragments (Dateable?)		

Comments:
TS = Thin section

Symbols:

K_t	= grain size distribution	T	= triaxial test
k_t	= thermal conductivity	TOC	= total organic carbon
XRD	= mineralogy	TC	= total carbon
w	= water content (% water of dry sample)	s_u	= undrained shear strength from falling cone test (kN/m²)
w_L-w_P	= liquid and plasticity limits		
γ	= unit weight of soil (kN/m³)	s_r	= remoulded shear strength
V_{SH}	= horizontal sound velocity (m/s)	Magn.	= magnetic fabric
V_{SV}	= vertical sound velocity (m/s)	OG	= organic geochemistry
Oe	= oedometertest	MPal	= micropaleontology

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IKU SINTEF-GRUPPEN	Project		Location
	21.3441.00: Quaternary samples Barents Sea 1987		7128/09 - U - 01
Equipment	**Water depth**	**Latitude**	**Longitude**	**Depth below seabed**
Piggyback coring	417.0 m	71°15´23.41"N	28°51´11.98"E	38.24 - 39.00 m

Analytical results	Subsample	m	Lith.	Core description		s_u	s_r
		38.24		CLAY, gravelly (f-m), silty, sandy	5Y - 4/2 Olive grey		
		.34					
		.44					
		.54					
		.64					
		.74					
		.84		Abundant gravel fragments (Crystalline), angular/Subangular			
		.94					
		39.00					

Comments:

Symbols:

K_i	= grain size distribution	T	= triaxial test
k_r	= thermal conductivity	TOC	= total organic carbon
XRD	= mineralogy	TC	= total carbon
w	= water content (% water of dry sample)	s_u	= undrained shear strength from falling cone test (kN/m²)
w_L-w_P	= liquid and plasticity limits		
γ	= unit weight of soil (kN/m³)	s_r	= remoulded shear strength
V_{SH}	= horizontal sound velocity (m/s)	Magn.	= magnetic fabric
V_{SV}	= vertical sound velocity (m/s)	OG	= organic geochemistry
Oe	= oedometertest	MPal	= micropaleontology

IKU SINTEF-GRUPPEN	Project		Location
	21.3441.00: Quaternary samples Barents Sea 1987		7128/09 - U - 01
Equipment	**Water depth**	**Latitude**	**Longitude**	**Depth below seabed**
Piggyback coring	417.0 m	71°15´23.41"N	28°51´11.98"E	39.44 - 40.05 m

Analytical results	Subsample	m	Lith.	Core description		s_u	s_r
		39.44		CLAY, gravelly (f-m), silty, sandy	5Y - 4/1 Dark grey		
w = 16.4% γ = 21.8kN/m³				Sandstone fragment, 4 cm, rounded		102.1	
		.54		GRAVEL (c-m), silty, sandy			
		.64					
				Fragment of amphibolite (~ 30 cm core piece)			
		.74					
		.84					
		.94		CLAY, silty, sandy, gravelly (f-m)	10YR - 4/2 Dark greyish brown		
w = 13.9%				Chert ? 1 cm			
		40.05		Red, rounded siltstone fragment, 3 cm			110.9

Comments:

Symbols:

K_i	= grain size distribution	T	= triaxial test
k_r	= thermal conductivity	TOC	= total organic carbon
XRD	= mineralogy	TC	= total carbon
w	= water content (% water of dry sample)	s_u	= undrained shear strength from falling cone test (kN/m²)
w_L-w_P	= liquid and plasticity limits		
γ	= unit weight of soil (kN/m³)	s_r	= remoulded shear strength
V_{SH}	= horizontal sound velocity (m/s)	Magn.	= magnetic fabric
V_{SV}	= vertical sound velocity (m/s)	OG	= organic geochemistry
Oe	= oedometertest	MPal	= micropaleontology

Site 7128/09-U-01

IKU SINTEF-GRUPPEN

IKU SINTEF-GRUPPEN	Project			Location
	21.3441.00: Quaternary samples Barents Sea 1987			7128/09 - U - 01
Equipment	**Water depth**	**Latitude**	**Longitude**	**Depth below seabed**
Piggyback coring	417.0 m	71°15´23.41"N	28°51´11.98"E	42.24 - 43.01 m

Analytical results	Subsample	m	Lith.	Core description	s_u	s_r
		42.24		CLAY, sandy, silty, some gravel (f) 5Y - 4/1 Subangular silt -and claystone fragments Dark grey		
		.34			108.0	
				Subangular crystalline fragment, 3.0 cm		
		44				
		.54				
	K_t XRD					
w = 23.9% γ = 20.5kN/m³		.64				
w_L = 44.9% w_P = 19.5%					74.1	
	TOC/TC	.74		Subrounded sandstone fragment, 2.5 cm		
w = 24.4% γ = 20.6kN/m³		.84				
					77.0	44.1
		.94		Sandstone fragment (7 cm core piece)		
		43.01				

Comments:

Symbols:

K_t	= grain size distribution	T	= triaxial test
k_r	= thermal conductivity	TOC	= total organic carbon
XRD	= mineralogy	TC	= total carbon
w	= water content (% water of dry sample)	s_u	= undrained shear strength from falling cone test (kN/m²)
w_L-w_P	= liquid and plasticity limits		
γ	= unit weight of soil (kN/m³)	s_r	= remoulded shear strength
V_{SH}	= horizontal sound velocity (m/s)	Magn.	= magnetic fabric
V_{SV}	= vertical sound velocity (m/s)	OG	= organic geochemistry
Oe	= oedometertest	MPal	= micropaleontology

IKU SINTEF-GRUPPEN	Project			Location
	21.3441.00: Quaternary samples Barents Sea 1987			7128/09 - U - 01
Equipment	**Water depth**	**Latitude**	**Longitude**	**Depth below seabed**
Piggyback coring	417.0 m	71°15´23.41"N	28°51´11.98"E	44.74 - 45.74 m

Analytical results	Subsample	m	Lith.	Core description	s_u	s_r
		44.74		SAND (f), gravelly (f-m), silty, some clay 10YR - 4/2 Dark greyish brown		
w = 12.9% γ = 21.8kN/m³		.84			>250	
		.94		Abundant gravel (gneiss, granite, quartzite), 3 - 8 cm, subangular		
		45.04		Limestone fragment, 4 cm		
		.14		SAND, gravelly (f-m), silty, some clay 10YR - 4/2 Dark greyish brown		
w = 15.7%		.24			159.0	
		.34		Crystalline subangular pebble, 4 cm		
				GRAVEL (c-f), silty, sandy, some clay		
		.44				
		.54				
		.64				
		.74		Crystalline subangular pebble		

continue next page

Comments:

Symbols:

K_t	= grain size distribution	T	= triaxial test
k_r	= thermal conductivity	TOC	= total organic carbon
XRD	= mineralogy	TC	= total carbon
w	= water content (% water of dry sample)	s_u	= undrained shear strength from falling cone test (kN/m²)
w_L-w_P	= liquid and plasticity limits		
γ	= unit weight of soil (kN/m³)	s_r	= remoulded shear strength
V_{SH}	= horizontal sound velocity (m/s)	Magn.	= magnetic fabric
V_{SV}	= vertical sound velocity (m/s)	OG	= organic geochemistry
Oe	= oedometertest	MPal	= micropaleontology

IKU SINTEF-GRUPPEN

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IKU SINTEF-GRUPPEN	Project			Location
	21.3441.00: Quaternary samples Barents Sea 1987			7128/09 - U - 01
Equipment	Water depth	Latitude	Longitude	Depth below seabed
Piggyback coring	417.0 m	71°15´23.41"N	28°51´11.98"E	45.74 - 45.80 m

Analytical results	Subsample	m	Lith.	Core description	cont.	s_u	s_r
		45.74		GRAVEL (c-f), silty, sandy, some clay			
		45.80					

Comments:

Symbols:

K_l	= grain size distribution	T	= triaxial test
k_T	= thermal conductivity	TOC	= total organic carbon
XRD	= mineralogy	TC	= total carbon
w	= water content (% water of dry sample)	s_u	= undrained shear strength from falling cone test (kN/m²)
w_L-w_P	= liquid and plasticity limits		
γ	= unit weight of soil (kN/m³)	s_r	= remoulded shear strength
V_{SH}	= horizontal sound velocity (m/s)	Magn.	= magnetic fabric
V_{SV}	= vertical sound velocity (m/s)	OG	= organic geochemistry
Oe	= oedometertest	MPal	= micropaleontology

IKU SINTEF-GRUPPEN	Project			Location
	21.3441.00: Quaternary samples Barents Sea 1987			7128/09 - U - 01
Equipment	Water depth	Latitude	Longitude	Depth below seabed
Piggyback coring	417.0 m	71°15´23.41"N	28°51´11.98"E	48.15 - 48.50

Analytical results	Subsample	m	Lith.	Core description	s_u	s_r
		48.15		CLAY, gravelly (f-m), sandy, silty 10YR - 4/2 Dark brownish grey		
	TOC/TC				>250	
	K_l	.25				
w = 14.2%		.35		Subrounded sandstone fragments, 3 and 4 cm		
		.45				
		48.50		Subrounded sandstone fragment, 4 cm		

Comments:

Symbols:

K_l	= grain size distribution	T	= triaxial test
k_T	= thermal conductivity	TOC	= total organic carbon
XRD	= mineralogy	TC	= total carbon
w	= water content (% water of dry sample)	s_u	= undrained shear strength from falling cone test (kN/m²)
w_L-w_P	= liquid and plasticity limits		
γ	= unit weight of soil (kN/m³)	s_r	= remoulded shear strength
V_{SH}	= horizontal sound velocity (m/s)	Magn.	= magnetic fabric
V_{SV}	= vertical sound velocity (m/s)	OG	= organic geochemistry
Oe	= oedometertest	MPal	= micropaleontology

Site 7128/09-U-01

IKU SINTEF-GRUPPEN

IKU SINTEF-GRUPPEN

Site 7128/09-U-01

IKU SINTEF-GRUPPEN	Project			Location
	21.3441.00: Quaternary samples Barents Sea 1987			7128/09 - U - 01
Equipment	Water depth	Latitude	Longitude	Depth below seabed
Piggyback coring	417.0 m	71°15'23.41"N	28°51'11.98"E	52.15 - 52.45 m

Analytical results	Subsample	m	Lith.	Core description	s_u	s_r
	TOC/TC	52.15		CLAY, sandy, silty, gravelly (f-m) 10YR - 4/2 Dark brownish grey		
	XRD				>250	
w = 11.4%		.25		GNEISS boulder		
		.35		GRAVEL (c-m) with clay matrix		
		52.45		Subangular crystalline pebble, 5 cm		

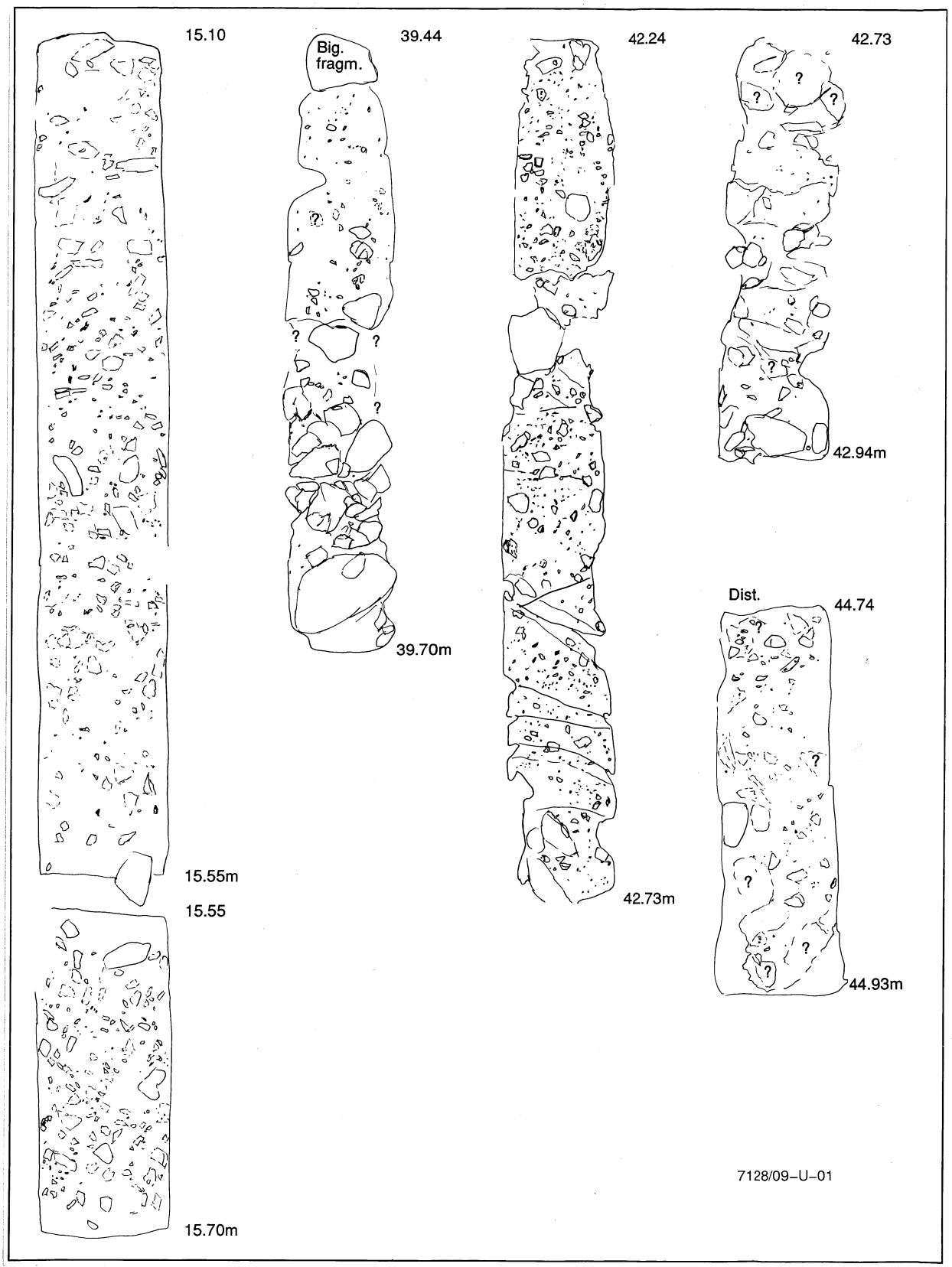
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Symbols:

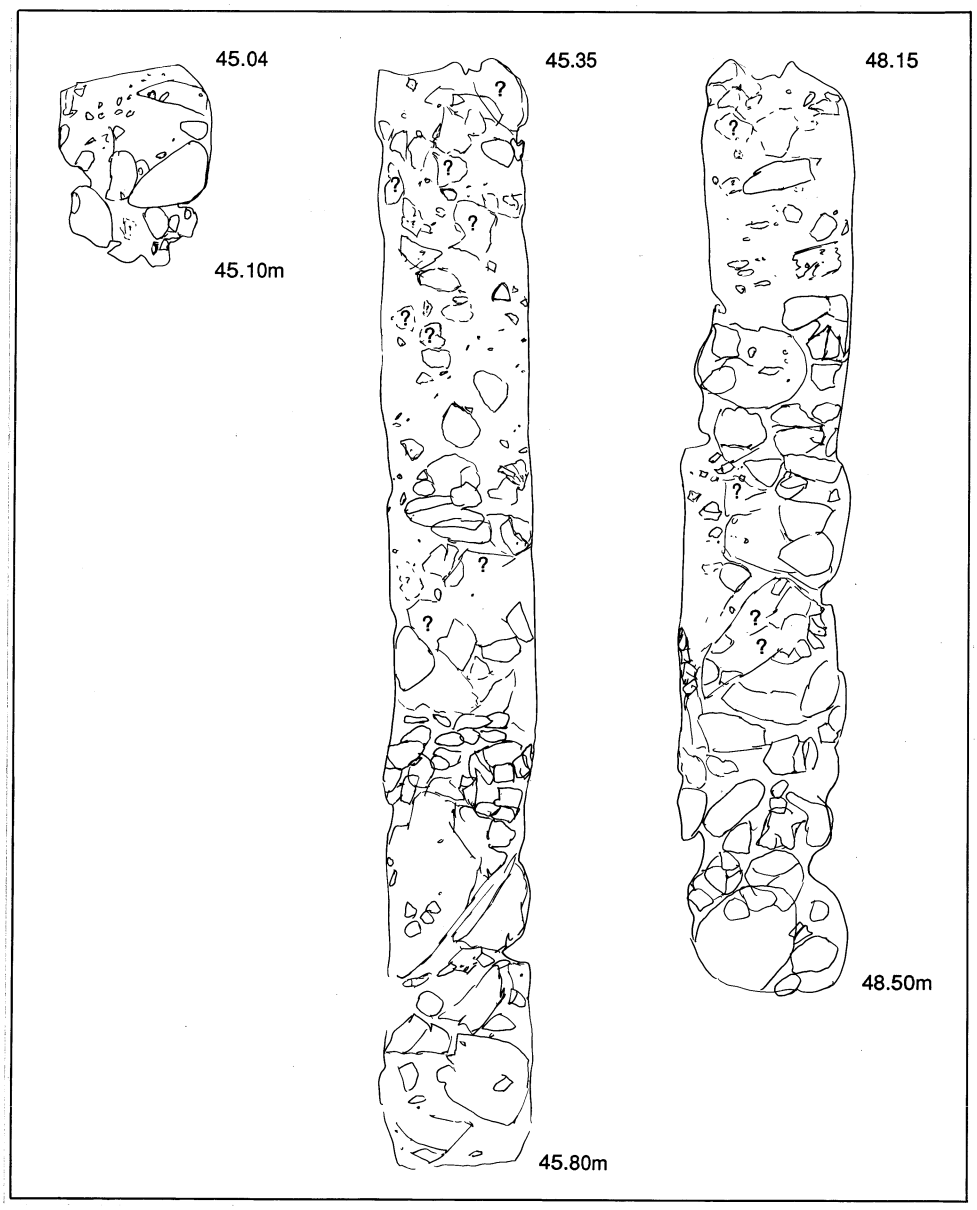
K_l	= grain size distribution	T	= triaxial test
k_r	= thermal conductivity	TOC	= total organic carbon
XRD	= mineralogy	TC	= total carbon
w	= water content (% water of dry sample)	s_u	= undrained shear strength from falling cone test (kN/m²)
w_L-w_P	= liquid and plasticity limits		
γ	= unit weight of soil (kN/m³)	s_r	= remoulded shear strength
V_{sH}	= horizontal sound velocity (m/s)	Magn.	= magnetic fabric
V_{sv}	= vertical sound velocity (m/s)	OG	= organic geochemistry
Oe	= oedometertest	MPal	= micropaleontology

IKU SINTEF-GRUPPEN

Site 7128/09-U-01



Site 7128/09-U-01



5.3.8 Site 7129/10-U-01

Seismic interpretation

The top bedrock reflection is found at 61 ms and the borehole penetrated top bedrock at 55.4 m. This corresponds to an average sound velocity of 1816 m/s. Three categories of seismic signature occur at this site. Above a reflection at 6 ms the sediments are acoustically stratified on the boomer record. In the upper 2.5 ms the strata tend to smoothen the preexisting relief whereasin the lower part the layering drape the substratum. Between 6 ms and 30 ms the sediments are acoustically transparent. The reflection at 30 m is rather irregular and frequent hyperbolas from this reflection and similar reflections at 42 and 48 ms may be the cause for the apparent chaotic seismic signature below 30 ms.

Lithology and mechanical properties

No samples are obtained from the stratified interval. Two samples from the transparent interval comprise a silty, sandy clay with some gravel(f). The biggest fragments are mostly crystalline rocks. Claystone/ siltstone is also present. The water content is above the plasticity limit, and undrained shearstrength is measured as to between 30 and 45 kPa by the falling cone method. One value from a triaxial test is 73 kPa. Both the samples from this interval are normally consolidated. The upper 15 m are, however, not tested. The sample from 39 m is similar to the samples above although the shear strength has increased to 77 kPa. The other samples from the interval below 30 ms are more silty or sandy and have a higher gravel content. This, and the judged high proportion of angular to subangular crystalline fragments show that much of the material originate from the onshore area.

Age

No dates are available at present. Dating will, however, be attempted on a small shell fragment found at about 20 m.

LOC. 7129/10-U-01

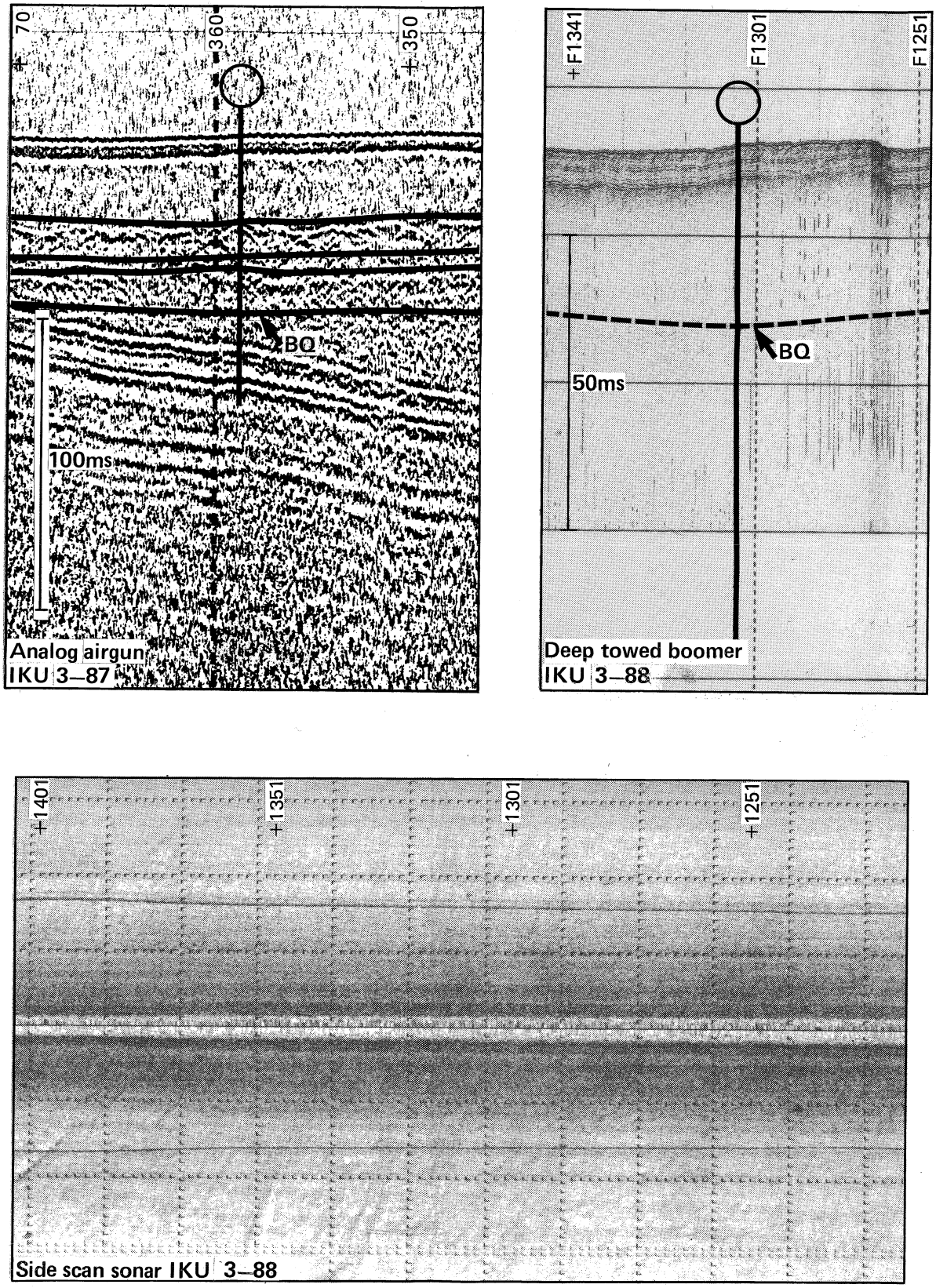
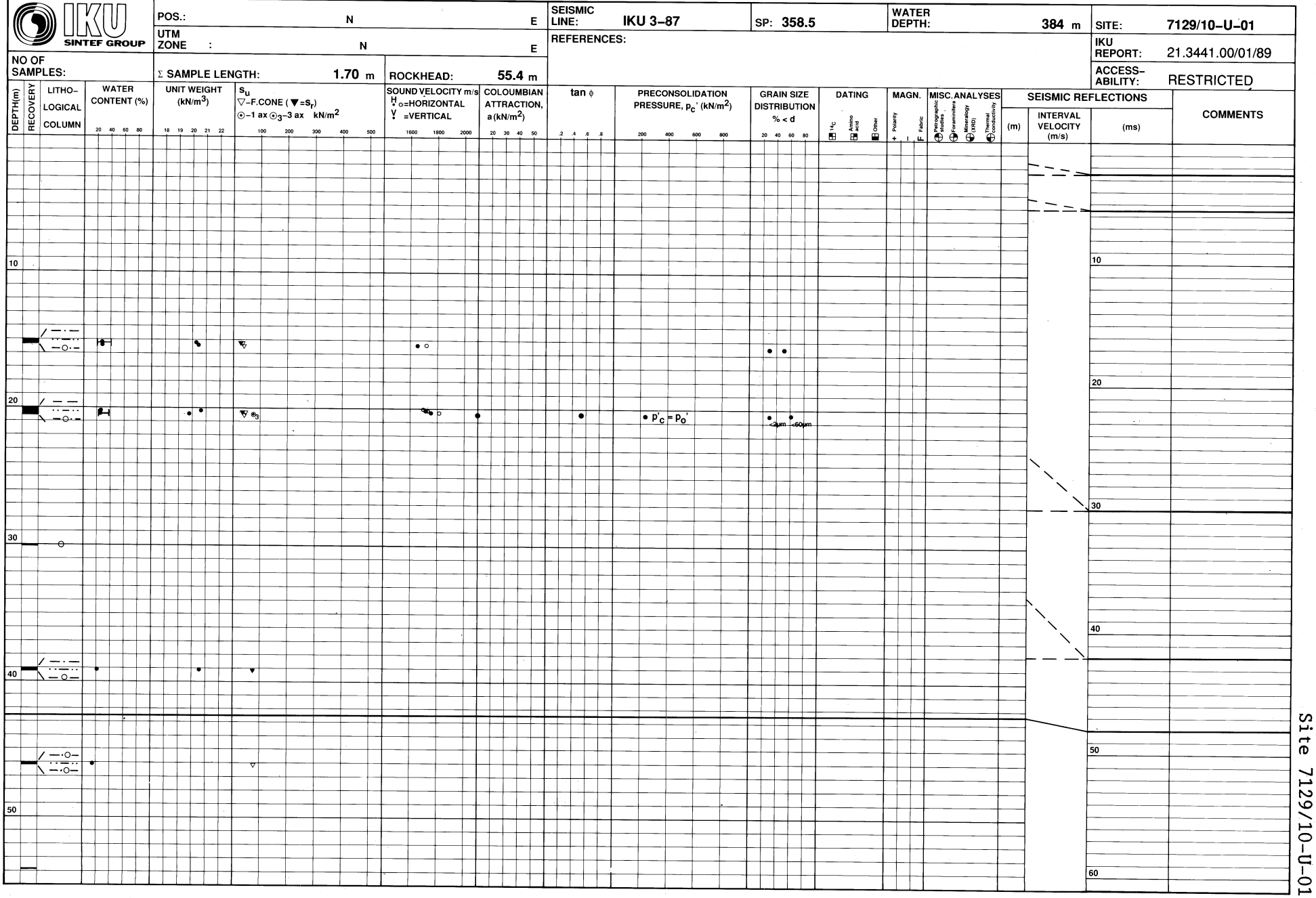


Figure 5.9 *Seismic section across site 7129/10-U-01. The figure is continued on the following pages by a soil boring summary sheet, a description sheet and drawings of radiographs for each sample.*

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IKU SINTEF-GRUPPEN
Site 7129/10-U-01

IKU SINTEF GROUP

POS.: N E

UTM ZONE : N E

NO OF SAMPLES:

Σ SAMPLE LENGTH: 1.70 m

ROCKHEAD: 55.4 m

SEISMIC LINE: IKU 3-87

SP: 358.5

WATER DEPTH: 384 m

REFERENCES:

SITE: 7129/10-U-01 cont.

IKU REPORT: 21.3441.00/01/89

ACCESS-ABILITY: RESTRICTED

DEPTH(m)	RECOVERY	LITHO-LOGICAL COLUMN	WATER CONTENT (%) 20 40 60 80	UNIT WEIGHT (kN/m³) 18 19 20 21 22	s_u ▽-F.CONE (▼=s_r) ⊙-1 ax ⊙$_3$-3 ax kN/m² 100 200 300 400 500	SOUND VELOCITY m/s H =HORIZONTAL V =VERTICAL 1600 1800 2000	COLOUMBIAN ATTRACTION, a (kN/m²) 20 30 40 50	tan φ .2 .4 .6 .8	PRECONSOLIDATION PRESSURE, p_c' (kN/m²) 200 400 600 800	GRAIN SIZE DISTRIBUTION % < d 20 40 60 80	DATING ¹⁴C Amino acid Other	MAGN. Polarity + I - Fabric	MISC. ANALYSES Petrographic studies Foraminifera Mineralogy (XRD) Thermal Conductivity	SEISMIC REFLECTIONS (m)	INTERVAL VELOCITY (m/s)	(ms)	COMMENTS
55																	Top bedrock at 55,4m
65																	
75																	

IKU SINTEF-GRUPPEN Site 7129/10-U-01

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Seismic interpretation

The top bedrock reflection is found at 33 ms and the borehole penetrated top bedrock at 30.3 m. This corresponds to an average sound velocity of 1836 m/s. The entire Quaternary interval is acoustically transparent. This site is located on the southern flank of a depression where the neighboring 7129/10-U-01 is located. The upper acoustically stratified sediment is absent on the flank. this is apparently due to a lateral facies change and/or deformation of the aquivalent level by iceberg or glacial processes. A faint reflection at 7 ms may be an equivalent to the base of the stratified interval. Another faint reflection occur at 27 ms.

Lithology and mechanical properties

The two samples from this site both comprise silty, sandy clay with some gravel. The sample from 27 m is from below the reflection at 26 ms. Both samples have undrained shear strength in excess of 250 kPa, and are clearly overconsolidated. The sample from 15 m is nonstratified, but has a slight apparent horizontal "fabric". The sample from 27 m is clearly stratified, and has lamina with alternating fine sand and clay in < 0.1 mm-1 mm thickness with scattered drop clasts interbedded with 1 mm-2 cm thick layers of diamicton with rock fragments as well as clasts of the finegrained lamina. This is a rather unique sample compared with all other studied Quaternary samples in the Barents Sea, and it is interpreted as being deposited by a combination of rainout and drop from the watercolumn causing the fine lamina and mudflow/debris flow forming the diamict layers.

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IKU SINTEF-GRUPPEN	Project		Location
	21.3441.00: Quaternary samples Barents Sea 1987		7129/10 - U - 01
Equipment	**Water depth**	**Latitude**	**Longitude**	**Depth below seabed**
Hammer sampler	382.0 m	71°09.35'45"N	29°16'42.77"E	15.00 - 15.50 m

Analytical results	Subsample	m	Lith.	Core description	s_u	s_r
	Magn.	15.00		CLAY, sandy, silty, some gravel (f) 5Y - 4/1 Dark grey		
	XRD K_t	.10		Angular-Subangular crystalline pebbles, 2 cm and 1 cm Claystone dominate in coarse sand -fine gravel fraction		
w = 27.4% γ = 20.3 kN/m³		.20				
w_L = 40.3% w_P = 19.9%					33.8	27.0
		.30		Oblate shaped laminated siltstone fragment, 2 cm		
V_{SH}=1727m/s V_{SH}=1656m/s w = 27.5% γ = 20.5 kN/m³		.40				
					39.7	
	TOC/TC	15.50				

Comments:

Symbols:

K_t	= grain size distribution	T	= triaxial test
k_r	= thermal conductivity	TOC	= total organic carbon
XRD	= mineralogy	TC	= total carbon
w	= water content (% water of dry sample)	s_u	= undrained shear strength from falling cone test (kN/m²)
w_L-w_P	= liquid and plasticity limits		
γ	= unit weight of soil (kN/m³)	s_r	= remoulded shear strength
V_{SH}	= horizontal sound velocity (m/s)	Magn.	= magnetic fabric
V_{SV}	= vertical sound velocity (m/s)	OG	= organic geochemistry
Oe	= oedometertest	MPal	= micropaleontology

IKU SINTEF-GRUPPEN	Project		Location
	21.3441.00: Quaternary samples Barents Sea 1987		7129/10 - U - 01
Equipment	**Water depth**	**Latitude**	**Longitude**	**Depth below seabed**
Hammer sampler	382.0 m	71°09'35.45"N	29°16'42.77"E	20.00 - 20.59 m

Analytical results	Subsample	m	Lith.	Core description	s_u	s_r
	Magn.	20.00		CLAY, sandy, silty, some gravel (f) 5Y - 4/1 Dark grey		
V_{SH} = 1699 m/s	^{14}C	.10		SHELL FRAGMENT		
	TOC/TC					
V_{SH}=1728m/s V_{SV}=1718m/s w = 25.1% γ = 20.7kN/m³		.20				
		.30		Angular crystalline pebble, 2.5 cm		
V_{SH}=1815m/s V_{SV}=1756m/s				Limestone fragment, 1.5 cm Subangular crystalline pebble, 0.7 m	44.1	34.3
		.40				
w = 23.8% γ = 19.8%					40.7	
w_L = 37.1% w_P = 22.9%	Oe/T K_t	.50				
	TOC/TC	20.59				

Comments:

Symbols:

K_t	= grain size distribution	T	= triaxial test
k_r	= thermal conductivity	TOC	= total organic carbon
XRD	= mineralogy	TC	= total carbon
w	= water content (% water of dry sample)	s_u	= undrained shear strength from falling cone test (kN/m²)
w_L-w_P	= liquid and plasticity limits		
γ	= unit weight of soil (kN/m³)	s_r	= remoulded shear strength
V_{SH}	= horizontal sound velocity (m/s)	Magn.	= magnetic fabric
V_{SV}	= vertical sound velocity (m/s)	OG	= organic geochemistry
Oe	= oedometertest	MPal	= micropaleontology

IKU SINTEF-GRUPPEN	Project		Location
	21.3441.00: Quaternary samples Barents Sea 1987		7129/10 - U - 01
Equipment	**Water depth**	**Latitude**	**Longitude**	**Depth below seabed**
Hammer sampler	382.0 m	71°09´35.45"N	29°16´42.77"E	30.00 - 30.07 m

Analytical results	Subsample	m	Lith.	Core description	s_u	s_r
		30.00	X	Subangular quartzitic pebble		
		30.07				

Comments:

Symbols:

K_t	= grain size distribution	T	= triaxial test
k_r	= thermal conductivity	TOC	= total organic carbon
XRD	= mineralogy	TC	= total carbon
w	= water content (% water of dry sample)	s_u	= undrained shear strength from falling cone test (kN/m²)
w_L-w_P	= liquid and plasticity limits		
γ	= unit weight of soil (kN/m³)	s_r	= remoulded shear strength
V_{SH}	= horizontal sound velocity (m/s)	Magn.	= magnetic fabric
V_{SV}	= vertical sound velocity (m/s)	OG	= organic geochemistry
Oe	= oedometertest	MPal	= micropaleontology

IKU SINTEF-GRUPPEN	Project		Location
	21.3441.00: Quaternary samples Barents Sea 1987		7129/10 - U - 01
Equipment	**Water depth**	**Latitude**	**Longitude**	**Depth below seabed**
Hammer sampler	382.0 m	71°09´35.45"N	29°16´42.77"E	39.00 - 39.25 m

Analytical results	Subsample	m	Lith.	Core description	s_u	s_r
	MPal.	39.00		CLAY, silty, some sand and gravel (f) 5Y - 4/1 Dark grey		
	Magn.			Subangular silt -and claystone fragments		
w = 21.3% γ = 20.6kN/m³		.10		Subrounded sandstone fragment, 2 cm		
				Angular crystalline fragment		
					74.1	74.1
	TOC/TC	.20				
		39.25				

Comments:
Sample disturbed.

Symbols:

K_t	= grain size distribution	T	= triaxial test
k_r	= thermal conductivity	TOC	= total organic carbon
XRD	= mineralogy	TC	= total carbon
w	= water content (% water of dry sample)	s_u	= undrained shear strength from falling cone test (kN/m²)
w_L-w_P	= liquid and plasticity limits		
γ	= unit weight of soil (kN/m³)	s_r	= remoulded shear strength
V_{SH}	= horizontal sound velocity (m/s)	Magn.	= magnetic fabric
V_{SV}	= vertical sound velocity (m/s)	OG	= organic geochemistry
Oe	= oedometertest	MPal	= micropaleontology

IKU SINTEF-GRUPPEN

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IKU SINTEF-GRUPPEN	Project			Location
	21.3441.00: Quaternary samples Barents Sea 1987			7129/10 - U -01
Equipment	**Water depth**	**Latitude**	**Longitude**	**Depth below seabed**
Hammer sampler	382.0 m	71°09'35.45"N	29°16'42.77"E	46.00 - 46.18 m

Analytical results	Subsample	m	Lith.	Core description	s_u	s_r
w = 15.3%		46.00 .10 46.18		SILT, sandy, gravelly (f-m) some clay 5YR - 4/1 Dark grey Subangular -angular fragments of crystalline rocks, sandstone and siltstone/claystone	77.0	

Comments:
Disturbed sample

Symbols:

K_i	= grain size distribution	T	= triaxial test
k_T	= thermal conductivity	TOC	= total organic carbon
XRD	= mineralogy	TC	= total carbon
w	= water content (% water of dry sample)	s_u	= undrained shear strength from falling cone test (kN/m²)
w_L-w_P	= liquid and plasticity limits		
γ	= unit weight of soil (kN/m³)	s_r	= remoulded shear strength
V_{SH}	= horizontal sound velocity (m/s)	Magn.	= magnetic fabric
V_{SV}	= vertical sound velocity (m/s)	OG	= organic geochemistry
Oe	= oedometertest	MPal	= micropaleontology

IKU SINTEF-GRUPPEN	Project			Location
	21.3441.00: Quaternary samples Barents Sea 1987			7129/10 - U - 01
Equipment	**Water depth**	**Latitude**	**Longitude**	**Depth below seabed**
Hammer sampler	382.0 m	71°09'35.45"N	29°16'42.77"E	53.77 - 53.83 m

Analytical results	Subsample	m	Lith.	Core description	s_u	s_r
		53.77 53.83		Dark grey metamorphic sandstone, subangular Small content of calcite		

Comments:

Symbols:

K_i	= grain size distribution	T	= triaxial test
k_T	= thermal conductivity	TOC	= total organic carbon
XRD	= mineralogy	TC	= total carbon
w	= water content (% water of dry sample)	s_u	= undrained shear strength from falling cone test (kN/m²)
w_L-w_P	= liquid and plasticity limits		
γ	= unit weight of soil (kN/m³)	s_r	= remoulded shear strength
V_{SH}	= horizontal sound velocity (m/s)	Magn.	= magnetic fabric
V_{SV}	= vertical sound velocity (m/s)	OG	= organic geochemistry
Oe	= oedometertest	MPal	= micropaleontology

Site 7129/10-U-01

IKU SINTEF-GRUPPEN

IKU SINTEF-GRUPPEN

Site 7129/10-U-01

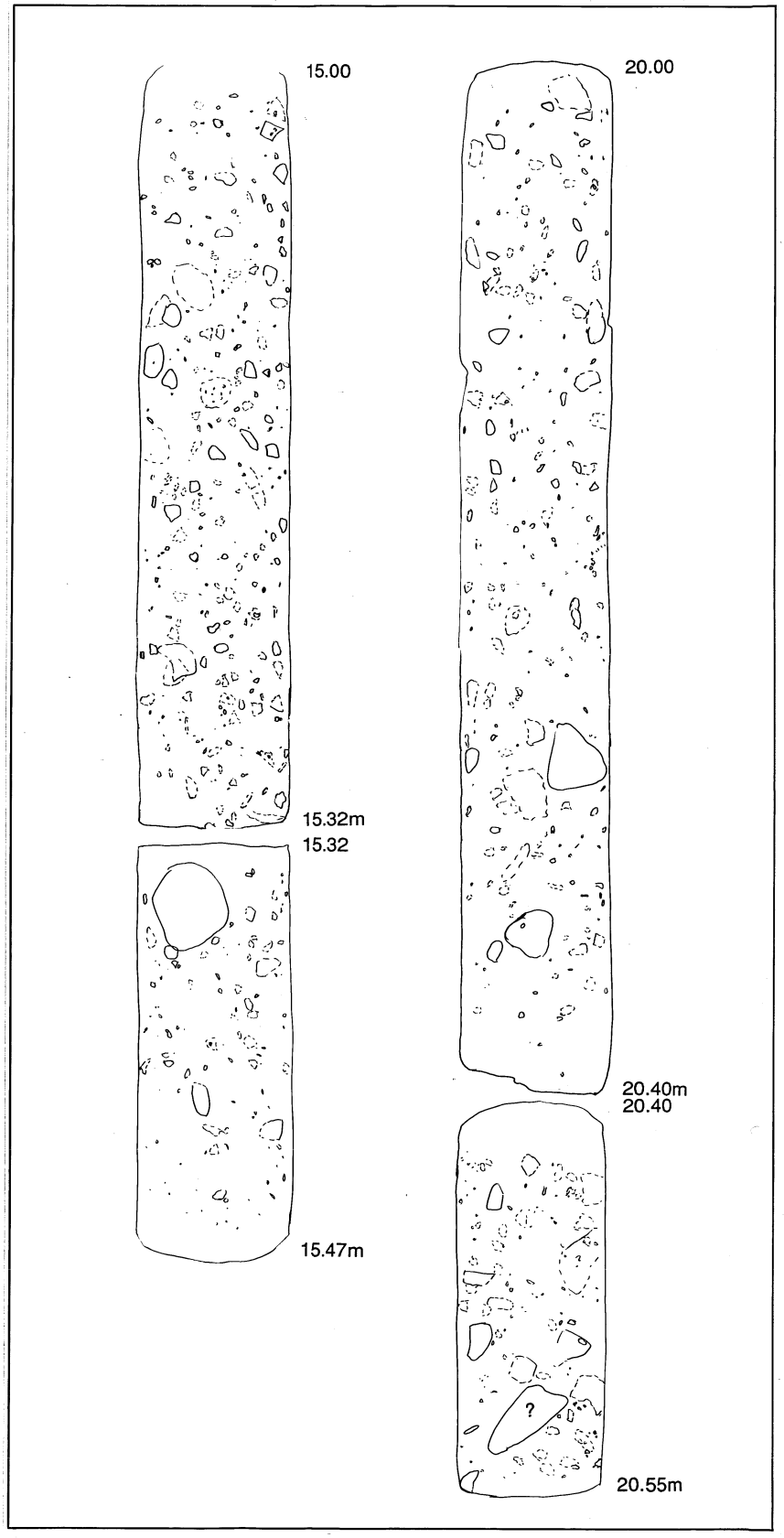
IKU SINTEF-GRUPPEN	Project		Location
	21.3441.00: Quaternary samples Barents Sea 1987		7129/10 - U - 01
Equipment	**Water depth**	**Latitude** / **Longitude**	**Depth below seabed**
Piggyback coring	382.0 m	71°09'35.45"N / 29°16'42.77"E	55.14 - 55.39 m

Analytical results	Subsample	m	Lith.	Core description		s_u	s_r
w = 19.4%		55.14		SAND (f-vf), silty, clayey, gravelly (f)	2.5Y - 5/1 Grey		
			+ +	Fragmented angular crystalline pebbles			
		.24	+ +				
			+ +				
		.34	+ +				
		55.39	+ +				

Comments:
The sample comprises gravel fragments from the interval 54.30 m - 55.39 m.

Symbols:

K_λ	= grain size distribution	T	= triaxial test
k_T	= thermal conductivity	TOC	= total organic carbon
XRD	= mineralogy	TC	= total carbon
w	= water content (% water of dry sample)	s_u	= undrained shear strength from falling cone test (kN/m²)
w_L-w_P	= liquid and plasticity limits		
γ	= unit weight of soil (kN/m³)	s_r	= remoulded shear strength
V_{SH}	= horizontal sound velocity (m/s)	Magn.	= magnetic fabric
V_{SV}	= vertical sound velocity (m/s)	OG	= organic geochemistry
Oe	= oedometertest	MPal	= micropaleontology


15.00
15.32m
15.32
15.47m
20.00
20.40m
20.40
?
20.55m

5.3.9 Site 7129/10-U-02

Seismic interpretation

The top bedrock reflection is found at 33 ms and the borehole penetrated top bedrock at 30.3 m. This corresponds to an average sound velocity of 1836 m/s. The entire Quaternary interval is acoustically transparent. This site is located on the southern flank of a depression where the neighboring 7129/10-U-01 is located. The upper acoustically stratified sediment is absent on the flank. this is apparently due to a lateral facies change and/or deformation of the aquivalent level by iceberg or glacial processes. A faint reflection at 7 ms may be an equivalent to the base of the stratified interval. Another faint reflection occur at 27 ms.

Lithology and mechanical properties

The two samples from this site both comprise silty, sandy clay with some gravel. The sample from 27 m is from below the reflection at 26 ms. Both samples have undrained shear strength in excess of 250 kPa, and are clearly overconsolidated. The sample from 15 m is nonstratified, but has a slight apparent horizontal "fabric". The sample from 27 m is clearly stratified, and has lamina with alternating fine sand and clay in < 0.1 mm-1 mm thickness with scattered drop clasts interbedded with 1 mm-2 cm thick layers of diamicton with rock fragments as well as clasts of the finegrained lamina. This is a rather unique sample compared with all other studied Quaternary samples in the Barents Sea, and it is interpreted as being deposited by a combination of rainout and drop from the watercolumn causing the fine lamina and mudflow/debris flow forming the diamict layers.

LOC. 7129/10-U-02

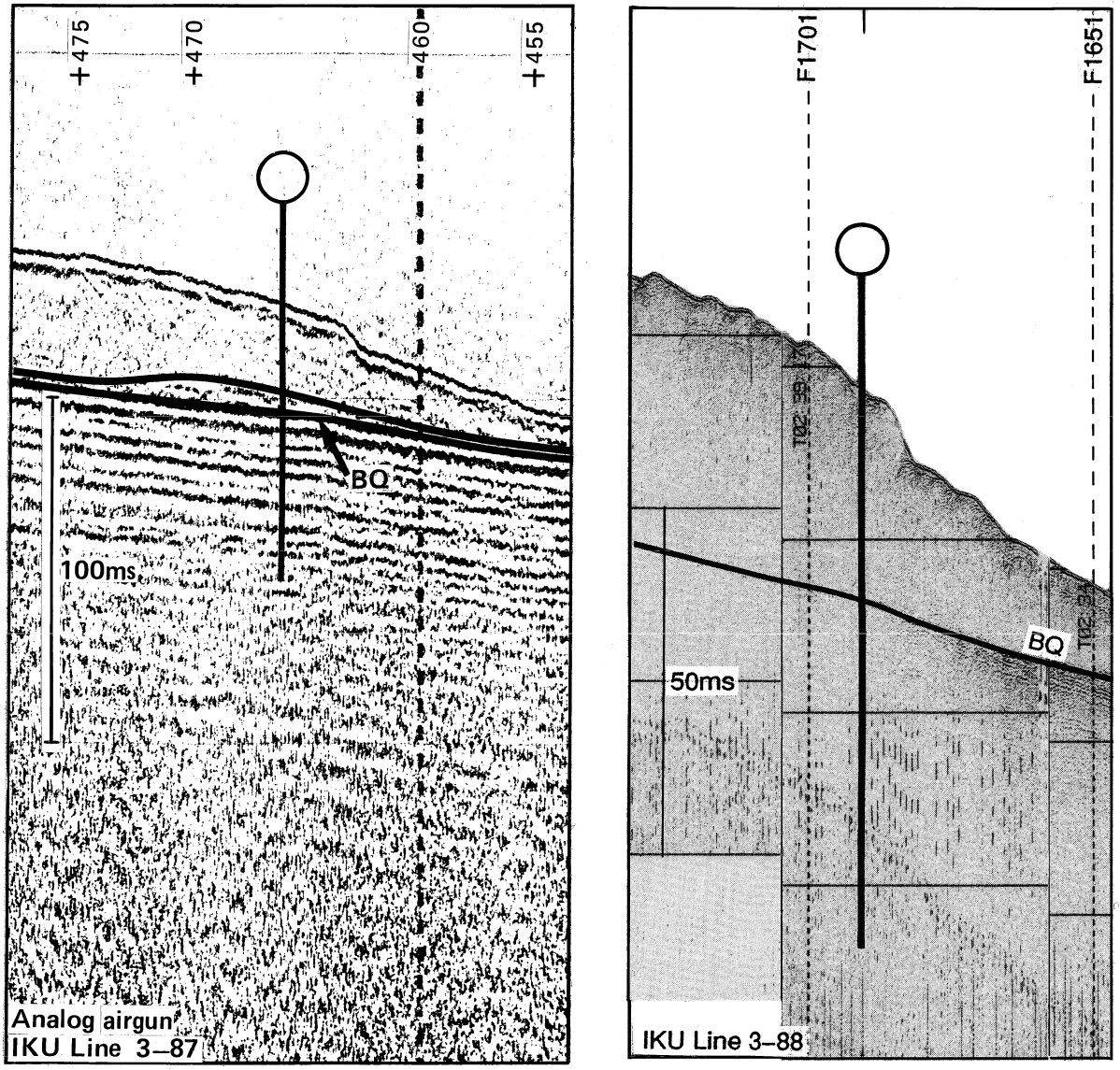


Figure 5.10 *Seismic section across site 7129/10-U-02. The figure is continued on the following pages by a soil boring summary sheet, a description sheet and drawings of radiographs for each sample.*

IKU SINTEF GROUP

POS.: N E

UTM ZONE : N E

NO OF SAMPLES:

Σ SAMPLE LENGTH: 0.6 m

ROCKHEAD: 30.3 m

SEISMIC LINE: IKU 3–87

SP: 466

WATER DEPTH: 336 m

REFERENCES:

SITE: 7129/10–U–02

IKU REPORT: 21.3441.00/01/89

ACCESS–ABILITY: RESTRICTED

DEPTH(m)	RECOVERY	LITHO–LOGICAL COLUMN	WATER CONTENT (%) 20 40 60 80	UNIT WEIGHT (kN/m³) 18 19 20 21 22	s_u ▽–F.CONE (▼=s_r) ⊙–1 ax ⊙$_3$–3 ax kN/m² 100 200 300 400 500	SOUND VELOCITY m/s H ∘=HORIZONTAL V •=VERTICAL 1600 1800 2000	COLOUMBIAN ATTRACTION, a (kN/m²) 20 30 40 50	tan ϕ .2 .4 .6 .8	PRECONSOLIDATION PRESSURE, p_c' (kN/m²) 200 400 600 800	GRAIN SIZE DISTRIBUTION % < d 20 40 60 80	DATING ¹⁴C Amino acid Other	MAGN. Polarity + – Fabric F	MISC. ANALYSES Petrographic studies Foraminifera Mineralogy (XRD) Thermal conductivity	SEISMIC REFLECTIONS (m)	INTERVAL VELOCITY (m/s)	(ms)	COMMENTS
10																10	
20																20	
30																30	
40																40	
50																50	
																60	

IKU SINTEF-GRUPPEN Site 7129/10–U–02

IKU SINTEF-GRUPPEN	Project			Location
	21.3441.00: Quaternary samples Barents Sea 1987			7129/10 - U - 02
Equipment	**Water depth**	**Latitude**	**Longitude**	**Depth below seabed**
Hammer sampler	336.0 m	71°07´13.47"N	29°13´23.12"E	15.00 - 15.26 m

Analytical results	Subsample	m	Lith.	Core description	s_u	s_r
	K_t XRD Magn.	15.00		CLAY, silty, sandy, some gravel (f) 5Y - 3/1 Very dark grey		
w = 18.3% γ = 22.2kN/m³				Subangular silt -and claystone fragments		
w_L = 48.0% w_P = 23.4% V_{SH}=1949m/s V_{SV}=1881m/s	TOC/TC	.10			>250.0	
		.20				
	TOC/TC					
	TOC/TC	15.26				

Comments:

Symbols:

K_t	= grain size distribution	T	= triaxial test
k_T	= thermal conductivity	TOC	= total organic carbon
XRD	= mineralogy	TC	= total carbon
w	= water content (% water of dry sample)	s_u	= undrained shear strength from falling cone test (kN/m²)
w_L-w_P	= liquid and plasticity limits	s_r	= remoulded shear strength
γ	= unit weight of soil (kN/m³)	Magn.	= magnetic fabric
V_{SH}	= horizontal sound velocity (m/s)	OG	= organic geochemistry
V_{SV}	= vertical sound velocity (m/s)	MPal	= micropaleontology
Oe	= oedometertest		

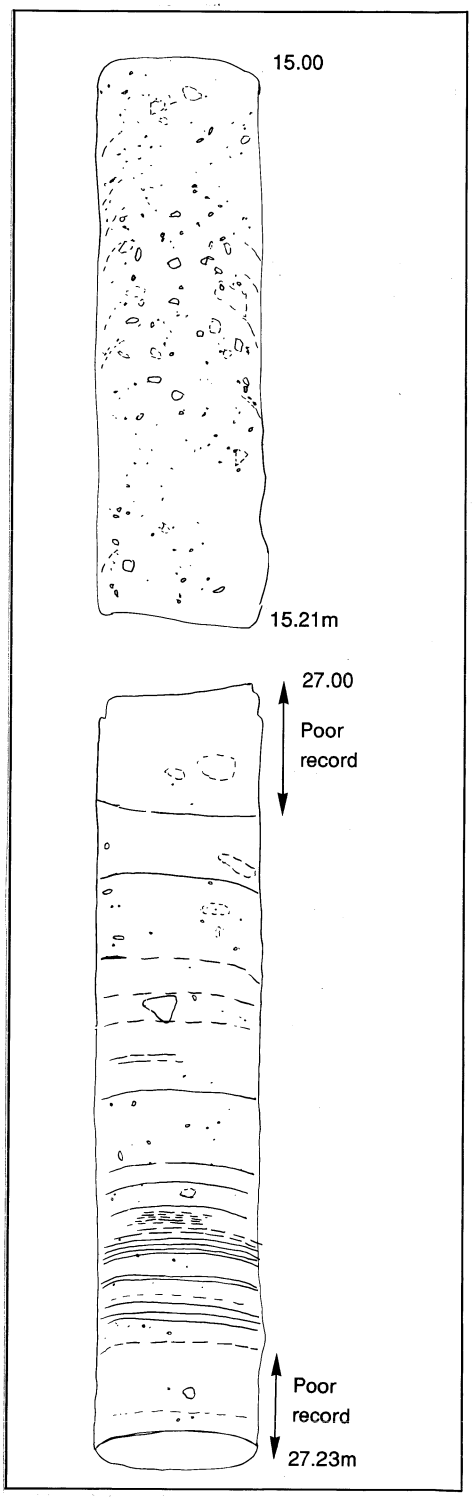
IKU SINTEF-GRUPPEN	Project			Location
	21.3441.00: Quaternary samples Barents Sea 1987			7129/10 - U - 02
Equipment	**Water depth**	**Latitude**	**Longitude**	**Depth below seabed**
Hammer sampler	336.0 m	71°07´13.47"N	29°13´23.12"E	27.00 - 27.34 m

Analytical results	Subsample	m	Lith.	Core description	s_u	s_r
		27.00		CLAY, silty, some sand and gravel (f-m)		
				5Y - 3/1 Very dark grey		
	MR			Subangular silt -and claystone fragments		
V_{SH}=1924m/s V_{SV}=1544m/s		.10			250.0	
		.20				
		.30				
	TOC/TC	27.34				

Comments:
MR = Magnetic resonance

Symbols:

K_t	= grain size distribution	T	= triaxial test
k_T	= thermal conductivity	TOC	= total organic carbon
XRD	= mineralogy	TC	= total carbon
w	= water content (% water of dry sample)	s_u	= undrained shear strength from falling cone test (kN/m²)
w_L-w_P	= liquid and plasticity limits	s_r	= remoulded shear strength
γ	= unit weight of soil (kN/m³)	Magn.	= magnetic fabric
V_{SH}	= horizontal sound velocity (m/s)	OG	= organic geochemistry
V_{SV}	= vertical sound velocity (m/s)	MPal	= micropaleontology
Oe	= oedometertest		


15.00
15.21m
27.00
Poor
record
Poor
record
27.23m

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APPENDIX 1

FIELD WORK

A.1 General

The field work commenced 22.07.87 and lasted until 09.09.87.

The contractor for the drilling operations was Offshore Support Services A/S in Oslo, using the drill ship M/S "Bucentaur" (Figure A.1.1). As bedrock coring machine the DB 1500S from Diamant Boart, Belgium/Norway was used, and Dia-Team, Norway provided diamond drilling staff.



Figure A.1.1 The drill ship M/S "Bucentaur".

A.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 1/min at 20 bar).

Main drill string

Drill pipe:	2000 m of API-5" Grade E, range II, 19.51 lbs/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 HP Heavy duty rods O.D. 88.9 mm, mI.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 diameters:	HR triple tube 54.2 mm, NR triple tube 38.1 mm.
Drilling capacities:	HR-1000 m, NT 1500 m.
Seabed template:	Fugro SEACLAM with hydraulic pipe clamping system, inclinometers and underwater Tv camera.

A.3 Standard drilling operation (Figure A.1.2)

(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. Samples of Quaternary sediments are recovered during drilling.

(e) The powerswivel heave compensator is then set to give the chosen bit weight on the API string (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 piggyback coring 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 1.5-3.0 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.

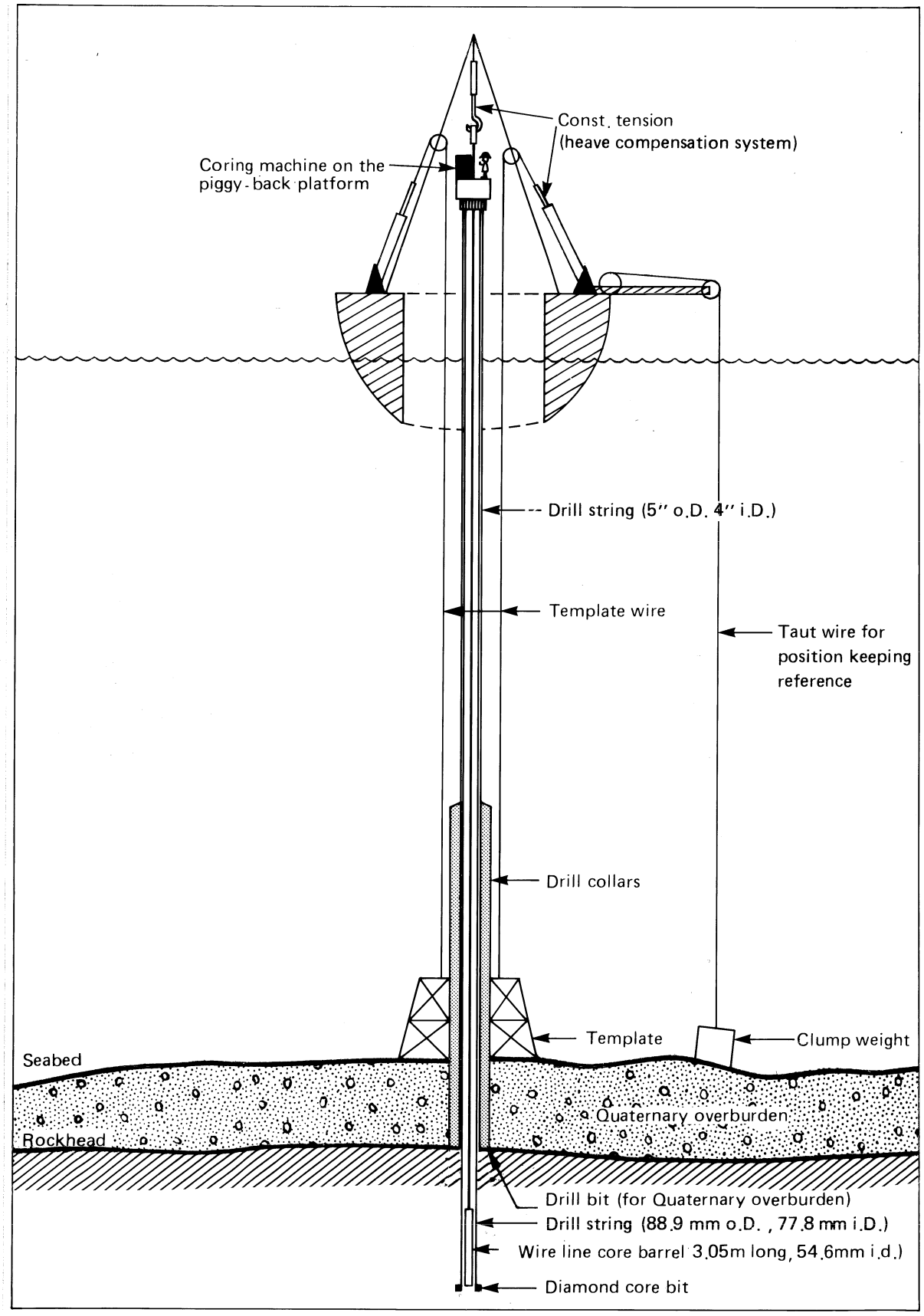


Figure A.1.2 Sketch showing the drilling operation for M/S "Bucentaur".

Two types of standard soil sampling equipment were used in addition to the piggyback coring. These were: The Fugro Wip sampler and a hammersampler. These two systems were combined with 3 inch and 2 inch steel sampling tubes, respectively.

The Wip system comprises a hydraulically operated jack that is lowered down inside the drill string and latched with the sampling tube cutter at drill bit level. The sampling tube is then pushed down into undisturbed sediments and cuts a cylindrical sample.

The hammersampler is mechanically operated from a winch on the main deck and comprises a load that can move freely a certain distance up and down along a shaft which on the lower end is connected to the tube. During sampling the load is pulled up and allowed to drop freely down about 10-30 times and by this the sampling tube is hammered into the sediment.

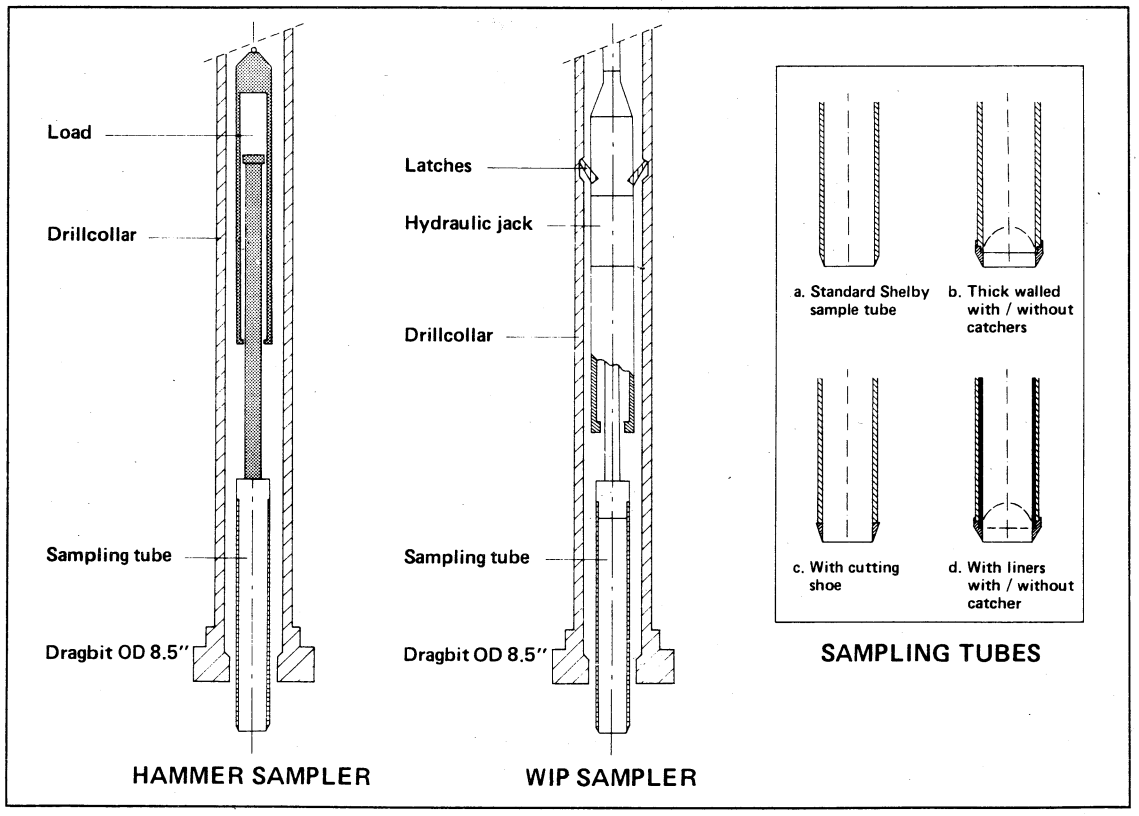


Figure A.1.3 Hammer sampler and wip sampler.