

# **Geological description of five vibrocores from the HANNE-1 site, Danish North Sea**

Geological description of five vibrocores from the  
HANNE-1 Site, Tail End area, Danish North Sea

Peter Konradi

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## **Geological description of five vibrocores from the HANNE-1 site, Danish North Sea**

### **Geological description of five vibrocores from the HANNE-1 site, Tail End area, Danish North Sea**

Five vibrocorings were carried out as part of a site survey by Gardline Surveys Ltd. for DONG Efterforskning og Produktion A/S in the Danish Block 5504/06 (Gardline Surveys Ltd. 2003).

The cores have been delivered to GEUS by DONG according to law no. 293, § 34, of 10. June 1981 and no. 13 of 7. January 1991.

### **Geological description of vibrocores**

#### **Location**

DONG E & P A/S presented five vibrocores to GEUS from block 5504/06 drilled at the HANNE-1 well site.

The HANNE-1 site is situated at 55°51'41,75" N, 04°23'51,95" E and indicated on the map enclosure 1.

The vibrocores are located in a 2 km x 2 km survey area. The area is situated in the western northern part of the Tail End area. The position of the cores is given on the table 1 and indicated on the map Enclosure 2.

Vibrocore No.	Northing	Easting
HANNE-1 site, VC 1	6 191 674	587 488
HANNE-1 site, VC 2	6 191 476	588 312
HANNE-1 site, VC 3	6 192 331	586 724
HANNE-1 site, VC 4	6 191 267	587 430
HANNE-1 site, VC 5	6 192 574	586 627

**Table 1.** *The positions of the investigated 5 vibrocores (UTM 31 N, ED 50)*



## Geological setting

According to the industrial report (Gardline Surveys Ltd. 2003) the seabed is practically flat, and water depths in the survey area range from 43.1 to 44.1 m.

A thin veneer of silty, shelly sand is expected to cover the seabed with a thickness of < 0.5 metre over much of the area, becoming thicker to the east with a maximum of 5 metres. This unit appears acoustically quiet and structureless. The sand overlies a stiff sandy clay, which appears as a seismically well-layered, higher amplitude unit. Its base reaches less than 1 meter below sea bed in the northwest and increases towards the southeast to a maximum of 12 m. The reflector geometry is often undulating and appears to have been deformed. This phenomenon is thought to relate to glacio-tectonics. The sediments below are represented by a series of laterally continuous, horizontal, seabed parallel reflectors and are expected to be interbedded sands and clays. Two separate episodes of channelling are observed. The shallower channel ranges from 59 m at its shoulders to 101 m below seabed in the axis, and is situated in the western part of the survey area. Slight increases in of amplitude at its base possibly represent coarser lag deposit. The deeper channel is part of the Intra-Pleistocene marker horizon. It appears as a large basin shaped feature with dimensions of 800x400 metres in the centre of the area. Its outer edges are at 144 metres and its center at 174 metres below seabed. A further channel feature is present in the southeast ranging from 138 m to 153 metres below seabed.

The interpreted Base Quaternary seismic horizon, gently dipping towards the southwest, occurs between 429 and 459 metres below seabed.

## Sedimentological core log

A legend to the lithologies of the cores is found in Enclosure 3.

The result of the geological description of the core **DGU no. 551606.1**, Gardline Survey Hanne-1 Site Survey, core-1, is given in Enclosure 4.

This 2.34 m core is made up of an upper 0.44 m of fine to medium sand with shells and shell fragments. The next 11 cm is a silty, very fine sand. This is followed downcore by 0.24 m of fine to medium sand with shells which is interpreted to have been injected during coring from the upper sand layer. The lower 1.57 m of the core is made up of a firm to hard clay with silty partings.

The result of the geological description of the core **DGU no. 551606.2**, Gardline Survey Hanne-1 site survey, core-3, is given in Enclosure 5.

This core is 2.23 m and the uppermost 0.07 m is a silty, very fine sand with shells and shell fragments. The rest of the core, 2.16 m, is made up of firm, silty clay, which is laminated with silty laminae and pots. At 1.6 m a 10 cm bed of laminated silt occurs. This silty bed is banded probably due to synsedimentary slumping.

The result of the geological description of the core **DGU no. 551606.3**, Gardline Survey Hanne-1 Site Survey, core-5, is given in Enclosure 6.

The core is 2.72 m and the upper 0.40 m is a silty, very fine sand with few shell fragments. This sand is followed downcore by a hard to firm, silty clay with silty pots and a silt bed at 1.72 - 2.00 m.



The result of the geological description of the core **DGU no. 551606.4**, Gardline Survey Hanne-1 Site Survey, core 4, is given in Enclosure 7.

The core is 3.35 m and the uppermost 0.14 m is silty, very fine sand with shells and shell-fragments. The next 0.68 m of the core is hard, silty clay with injected minor layers of clayey, shelly sand from above. From 0.82 to 1.74 m the core is made up of fine-medium sand with few clay beds. The lower 1.61 m of the core is firm clay with few pots of silty finesand.

The result of the geological description of the core **DGU no. 551606.5**, Gardline Survey Hanne-1 Site Survey, core 2, is given in Enclosure 8.

This core is 4.10 m and the upper 1.74 m is very fine and fine-medium sand with shells and shellfragments. Below this the core is made up of about 1 m of laminated fine and fine to medium sand with shells and shell fragments. The next 1.19 m of the core is firm, silty clay with sandy laminae. The lower 10 cm of the core is firm clayey silt.

## **Correlation between cores**

All cores have an upper layer of varying thickness of silty, very fine sand with shells and shell fragments, which correlate well. This upper sand in core 551606.1 and core 551606.4 include a lower part of fine-medium sand. Downcore the fine sand is followed by a firm to hard clay, which may include silty partings and pots. It may also include beds of laminated silt or sand. The clays in the cores are expected to correlate.

## **Interpretation of genesis**

The upper fine sand includes marine shells and shell fragments in most cores. These strata are marine and of Holocene age. The laminated, silty, very fine sand with silty laminae in core 551606.1 is believed to be of lacustrine origin and to be of Lateglacial age. The lower part of the cores, which is made up of hard to firm clay with silty pots or partings, is thought to originate in a glacialolacustrine environment. This clay includes layers of sand, core 551606.4, or silt, cores 551606.2, 551606.3 and 551606.5. The bended bed of laminated silt in core 551606.2 is interpreted to be caused by slumping during deposition of the sediment basin.

## **Correlation with seismic**

The industrial report (Gardline Surveys Ltd. 2003) indicates an upper unit with a thickness of <0.5 m to a maximum of 12 m. This unit is the upper layer of shelly fine sand. The next unit is seismically well-layered and is made up of the lower part of the cores: the hard to firm clay with sand or clay beds. The indication in the industrial report (p. 21) of a possible glacio-tectonic disturbance of the bedding in this clay probably is not correct. After inspection of the cores is thought that slumping in the sedimentation basin during deposition causes the disturbances.

## Conclusion and suggested correlation to stratigraphy

The upper layer in the cores, the fine sand with shells or shell fragments, is expected to be equivalent to the Terschellingbank Member of the Nieuw Zeeland Gronden Formation (Cameron *et al.* 1989, Laban *et al.* 1995). The laminated, silty, very fine sand in core 551606.1 is believed to be equivalent to the Twente Formation (Laban 1995) deposited in a lake. The basal hard to firm clay with a sand bed or silt beds is interpreted to correlate to the Weichselian Dogger Bank Formation (Cameron *et al.* 1992).

Holocene	Nieuw Zeeland Gronden Formation	Terschellingbank Member
	Elbow Formation	
Weichselian	Dogger Bank Formation	

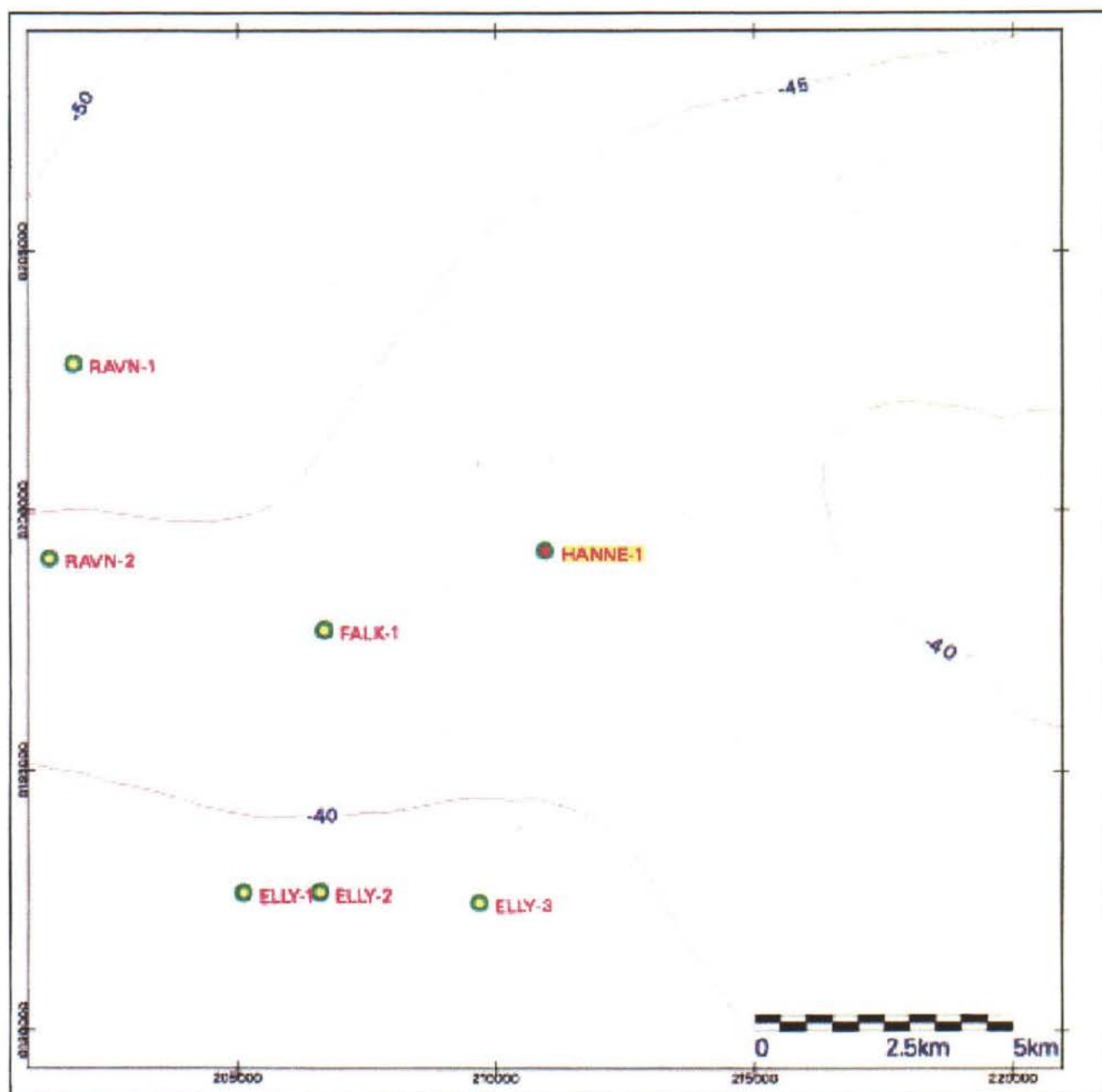
**Table 2.** Generalised stratigraphy of the Weichselian and Holocene of the southern North Sea (after Cameron *et al.* 1992).

## Literature

- Cameron, T.D.J., Schüttenhelm, R.T.E. & Laban, C. 1989: Middle and Upper Pleistocene and Holocene stratigraphy in the southern North Sea between 52° and 54° N, 2° to 4° E. *In*: Henriët J.P. & de Moor, G. (Eds.) The Quaternary and Tertiary geology of the Southern Bight, North Sea.
- Cameron, T.D.J., Crosby, A.; Balson, P.S., Jeffery, D.H., Lott, G.K., Bulat, J. and Harrison, D.J. 1992: The Geology of the southern North Sea, United Kingdom Offshore Regional Report, British Geological Survey.
- Gardline Surveys Ltd. 2003: DONG Efterforskning og Produktion A/S, HANNE-1 Site Survey, Danish Block 5604, March 2003, Survey Report. GEUS Report File No. 25187.
- Laban, C., van der Klugt, P.C.M. & Frantsen, P.J. 1995: Oyster Grounds. Kaartblad/Sheet 54° N-04° E. Holocene en oppervlakesedimenten/Sea Bed Sediments & Holocene. Rijks Geologische Dienst. 1:250.000 series.
- Laban, C. 1995: The Pleistocene glaciations in the Dutch sector of the North Sea. A synthesis of sedimentary and seismic data. Thesis University of Amsterdam.

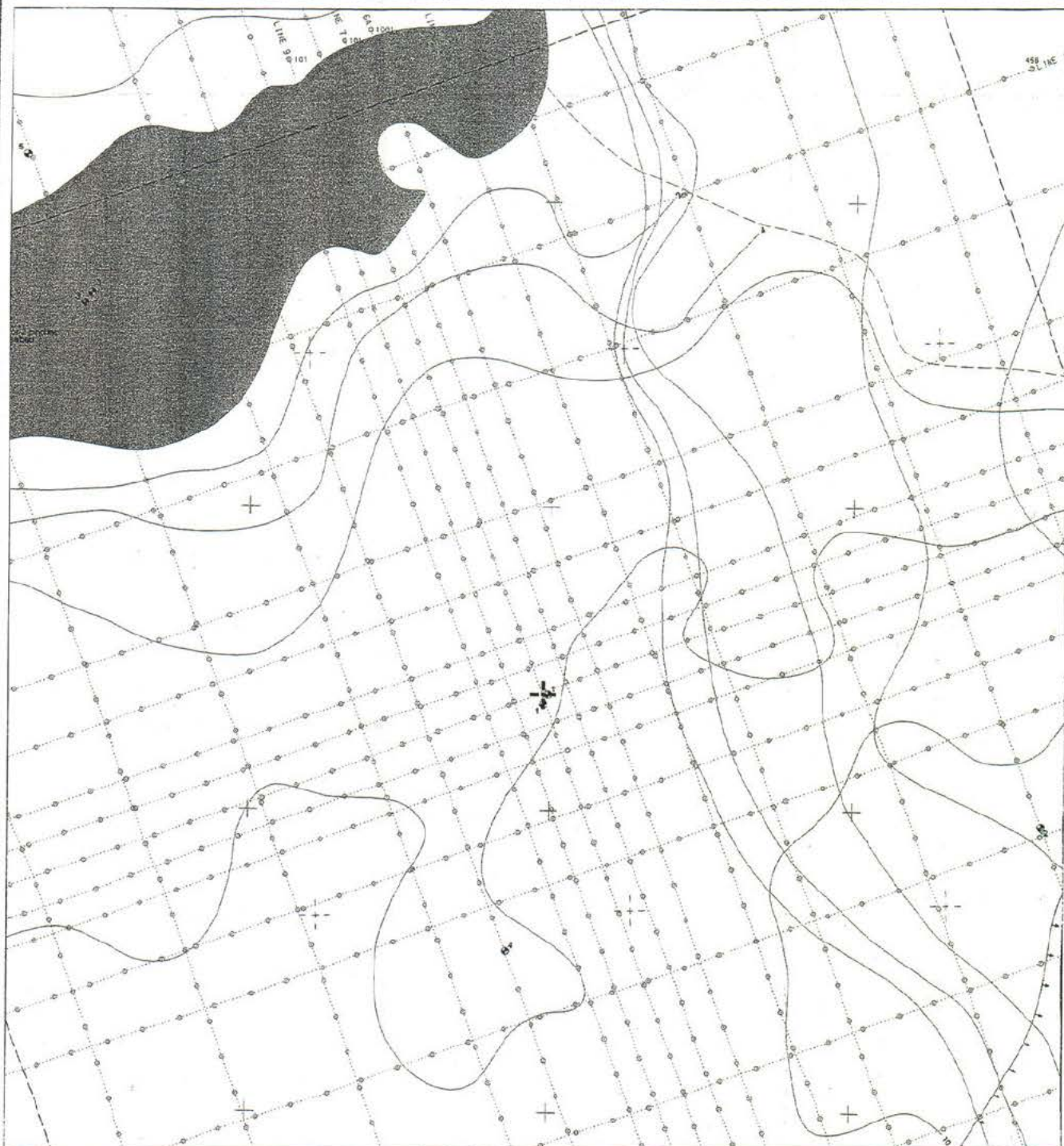
**Enclosures**





UTM ZONE 31 ED50

Enclosure 1



### Shallow soils (Extract of Chart 6)

PROPOSED HANNE-1 LOCATION (587 488E, 6 191 690N)



5 ———

10 ———



REFERENCE POINT TRACK DURING ECHO SOUNDER, SIDESCAN SONAR,  
PINGER AND DIGITAL SEISMIC LINES

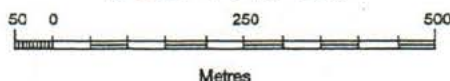
MAPPED REFLECTOR 1 - DEPTH TO BASE OF SILTY SHELLY SAND LENS  
(OVERLYING WELL LAYERED CLAYS) IN METRES, CONTOURED AT 1 METRE INTERVALS

MAPPED REFLECTOR 2 - DEPTH TO BASE OF WELL LAYERED CLAY UNIT IN METRES,  
CONTOURED AT 2 METRE INTERVALS

VIBROCORES WITH STATION NUMBER

PISTON CORES WITH STATION NUMBER

Scale 1 : 10 000



Enclosure 2

## LEGEND

### LITHOLOGY



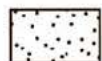
Gravel



Sand and gravel  
(conglomeratic)



Sand, coarse



Sand, medium



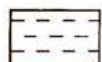
Sand, fine



Heterolith,  
clay/fine sand



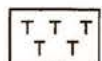
Heterolith,  
clay/silt



Silt



Clay

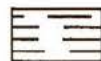


Peat

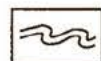
### PRIMARY SEDIMENT STRUCTURES



Parallel lamination



Indistinct  
parallel lamination



Disturbed  
parallel lamination



Sharp boundary



Gradual boundary

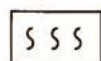


Unconformity,  
(erosions boundary, hiatus)

### FOSSILS



Shells



Bioturbation

### ENVIRONMENT AND AGE

HL : Holocene marine clay  
 HS : Holocene marine sand  
 HV : Holocene marine  
 clay and sand  
 FS : Holocene freshwater  
 sand  
 FV : Holocene freshwater  
 clay and sand  
 TL : Lateglacial clay  
 TS : Lateglacial sand  
 DL : Glacial clay  
 DI : Glacial silt  
 DS : Glacial sand

Enclosure 3



# SEDIMENTOLOGICAL CORE LOG

Company: DONG, site survey HANNE-1, VC 1

Borehole id.: DGU nr. 551606.1

Water depth: 44.2 m

Position 55°51'41.05" N 04°23'51.93 E

Core	Core depth m	Litho-logy	Grain size & sediment structures								Description	Env iron & age	
			Clay	Silt	Sand					Gr			Pb
					vf	f	m	c	vc				
I												0.0-0.44: SAND, fining up, medium to very fine, in upper part: few shells and shellfragments, in lower part: rich in shells, disrupted silty partings = bioturbated, upper part:: grey 5Y 5/1-6/1, lower part: dark grey 5Y 4/1	HS
												- 0.53: SAND, very fine, silty, laminated, silty laminae, grey 10YR 5/1	TS
1.0	1.0											- 0.77: injection of (from above): SAND, fine-medium, faintly laminated, contorted, shells, very dark grey & black 5Y 3/1 & 2.5/1	HS
II												- 1.28: CLAY, silty, hard, silty partings, dark grey 10YR 4/2	DL
												- 1.76: CLAY, slightly silty, firm, partings of silt and silty finesand, dark grey 10YR 4/2	DL
												- 2.34: CLAY silty, hard, dark greyish brown 10YR 4/2	DL
2.0	2.0												
III													
2.34	2.34											2.34-2.44: bag sample: do.	DL
3.0	3.0												
	4.0												
	5.0												
	6.0												

Enclosure 4

Date: 28.05.2003

Described by: PK

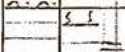

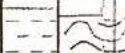
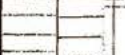
# SEDIMENTOLOGICAL CORE LOG

Company: DONG, site survey HANNE-1, VC 3

Borehole id.: DGU nr. 551606.2

Water depth: 44.2 m

Position 55°52'2.8" N 04°23'8.8" E

Core	Core depth m	Litho-logy	Grain size & sediment structures								Description	Env iron & age	
			Clay	Silt	Sand					Gr			Pb
					vf	f	m	c	vc				
I												0.0-0.07: SAND, very fine, silty, many shells and shell fragments, dark grey 5Y 4/1	HS
	1.0											2.23 : CLAY, silty, firm, laminated, with silty bands and pots, bioturbated in upper 8 cm (probably from above), with dark specks, mottled, at 1.55 - 1.65: oblique whitish, interbedded, silty laminae, banded, greyish brown and black 10YR 5/2 and 10YR 2/1	DL
II	2.0												
	2.23											2.23-2.33: bag sample: do.	DL
	3.0												
	4.0												
	5.0												
	6.0												

Enclosure 5

Date: 28.05.2003

Described by: PK







# SEDIMENTOLOGICAL CORE LOG

Company: DONG, site survey HANNE-1, VC 4

Borehole id.: DGU nr. 551606.4

Water depth: 44.0 m

Position 55°51'27.93" N 04°23'48.13 E

Core	Core depth m	Litho- logy	Grain size & sediment structures								Description	Env iron & age	
			Clay	Silt	Sand					Gr			Pb
					vf	f	m	c	vc				
I												0.0-0.14: SAND, very fine, silty, many shells and shell fragments, dark grey with black specks 5Y 4/1 with 5Y 2.5/1	HS
												-0.82: CLAY, silty, hard, at 0.31-0.36, 0.41, 0.48-0.49 & 0.79: injected layers of clayey sand with shell fragments (probably from above due to coring), dark greyish brown 10YR 4/2	DL
1.0	1.0											-1.74: SAND, fine - medium, faintly laminated, few pots with charred organic material, at 1.53-1.54 & 1.61: clay beds, light olive brown 2.5Y 5/3	DS
II													
2.0	2.0											- 3.35: CLAY, firm, few small pots with silty finesand, very dark brown 10YR 3/2	DL
III													
3.0	3.0												
IV													
3.35												3.35.3.45: bag sample: do	DL
	4.0												
	5.0												
	6.0												

Enclosure 7

Date: 28.05.2003

Described by: PK

# SEDIMENTOLOGICAL CORE LOG

Company: DONG, site survey HANNE-2, VC 2

Borehole id.: DGU nr. 551606.5

Water depth: 43.9 m

Position 55°51'34.11" N 04°24'39.08" E

Core	Core depth m	Litho-logy	Grain size & sediment structures								Description	Env iron & age
			Clay	Silt	Sand				Gr	Pb		
					vf	f	m	c	vc			
I	1.0										0.0-1.74: SAND, very fine, silty, shells and shellfragments, at 0.15 & 0.34: shell rich, faintly mottled = bioturbated dark grey 5Y 4/1	HS
II	2.0										- 2.71: SAND, fine and fine-medium, laminated, shellfragments, at 2.61 & 2.65: laminae with charred organic particles, grey 5Y 5/1	HS
III	3.0										- ~3.90: CLAY, silty, firm, sandy laminae, downcore: increasing content of silt, dark greyish brown 10YR 4/1 downcore: dark grey 10YR 4/1	DL
IV	4.1										- 4.1: SILT, clayey, slightly finesandy, dark grey 10YR 4/1 4.1-4.2: bag sample: do.	DI DI
	5.0											
	6.0											

Enclosure 8

Date: 28.05.2003

Described by: PK