

Description of vibrocores from four well sites in the Danish North Sea

Geological description of vibrocores from the NINI-4, SIRI-5
CECILIE-2 and JETTE-1 well sites,
Store Fisker Banke area and northern
Tail End area, Danish North Sea

Peter Konradi



Description of vibrocores from four well sites in the Danish North Sea

Geological description of vibrocores from the NINI-4, SIRI-5
CECILIE-2 and JETTE-1 well sites, Store Fisker Banke
area and northern Tail End area, Danish North Sea

Peter Konradi

Contents

Description of vibrocores from four well sites in the Danish North Sea	4
Geological description of vibrocores from the NINI-4, the SIRI-5, the CECILIE-2 and the JETTE-1 well sites, Store Fisker Banke area and northern Tail End area, Danish North Sea.....	4
Location.....	4
The NINI-4 site survey vibrocores.....	5
Geological setting.....	5
Sedimentological core log.....	5
Correlation between the vibrocores at the NINI-4 site.....	6
Interpretation of genesis	6
Correlation with seismics	6
Nearby cores	6
The SIRI-5 site survey vibrocores.....	7
Geological setting.....	7
Sedimentological core log.....	7
Correlation between the vibrocores at the SIRI-5 site.....	8
Interpretation of genesis	8
Correlation with seismics	9
Nearby cores	9
The CECILIE-2 site survey vibrocores.....	10
Geological setting.....	10
Sedimentological core log.....	10
Correlation between vibrocores at the CECILIE-2 site.....	11
Interpretation of genesis	11
Correlation with seismics	11
Nearby cores	11
The JETTE-1 site survey vibrocores.....	12
Geological setting.....	12
Sedimentological core log.....	12
Correlation between vibrocores at the JETTE-1 site.....	13
Interpretation of genesis	13
Correlation with seismics	13
Nearby cores	13
Core photos.....	14
Correlation between lithologies.....	14
Interpretation of genesis	14
Conclusion and suggested correlation to stratigraphy	15
Stored cores.....	15
Literature	16
Appendix	17
Geotechnical borehole at the SIRI-5 site.....	18

Enclosures 19

- 1: Location map of the four well sites
- 2: Location map of the four vibrocores at the NINI-4 well site
- 3: Sedimentological core log DGU 560510.10, vibrocore N 1
- 4: Sedimentological core log DGU 560510.11, vibrocore N 2
- 5: Sedimentological core log DGU 560510.12, vibrocore N3
- 6: Sedimentological core log DGU 560510.13, vibrocore N4
- 7: Location map of the five vibrocores at the SIRI-5 well site
- 8: Sedimentological core log DGU 560420.29, vibrocore VC 1
- 9: Sedimentological core log DGU 560420.30, vibrocore VC2
- 10: Sedimentological core log DGU 560420.31, vibrocore VC 3
- 11: Sedimentological core log DGU 560420.32, vibrocore VC 4
- 12: Sedimentological core log DGU 560420.33, vibrocore VC 5
- 13: Location map of the five vibrocores at the CECILIE-2 well site
- 14: Sedimentological core log DGU 560420.24, vibrocore C 1
- 15: Sedimentological core log DGU 560420.25, vibrocore C2
- 16: Sedimentological core log DGU 560420.26, vibrocore C3
- 17: Sedimentological core log DGU 560420.27, vibrocore C4
- 18: Sedimentological core log DGU 560420.28, vibrocore C5
- 19: Location map of the five vibrocores at the JETTE-1 well site
- 20: Sedimentological core log DGU 560429.16, vibrocore J 1
- 21: Sedimentological core log DGU 560429.17, vibrocore J 2
- 22: Sedimentological core log DGU 560429.18, vibrocore J 3
- 23: Sedimentological core log DGU 560429.19, vibrocore J 4
- 24: Sedimentological core log DGU 560429.20, vibrocore J 5
- 25: Legend to the lithologies of the sedimentological core logs
- 26a & b: Photos of core DGU no. 560510.11
- 27a & b: Photos of core DGU no. 560420.28
- 28a & b: Photos of core DGU no. 560420.33
- 29a & b: Photos of core DGU no. 560429.16

Desription of vibrocores from four well sites in the Danish North Sea

Geological description of vibrocores from the NINI-4, the SIRI-5, the CECILIE-2 and the JETTE-1 well sites, Store Fisker Banke area and northern Tail End area, Danish North Sea

Location

The vibrocorings were carried out as part of a site surveys at the NINI-4, the SIRI-5, the CECILIE-2 and the JETTE-1 hydrocarbon well sites by Gardline Surveys Ltd. (2002a, 2002b, 2002c, 2002d) for Dong Efterforskning og Produktion A/S. The sites are indicated on the location map, Enclosure 1.

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.

The positions of the vibrocores are indicated on the table below.

Site	Vibrocore no.	Northing	Easting
NINI-4	N 1	6278667.8	639757.1
	N 2	6279000.6	639993.4
	N 3	6279004	639464
	N 4	6278581	639321
SIRI-5	VC-1	6260970	622753
	VC-2	6261506	622286
	VC-3	6260997.5	621994.7
	VC-4	6360676	622347.9
	VC-5	6261384	622697
CECILIE-2	C-1	6252107.6	609487.5
	C-2	6252059.3	609026.0
	C-3	6252008.2	610015.9
	C-4	6252502.7	609504.7
	C-5	6251510.2	609455.8
JETTE-1	J-1	6215498	568080
	J-2	6215951	567586
	J-3	6215999	566993
	J-4	6216506	567996
	J-5	6215499	567497

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

The NINI-4 site survey vibrocores

At this site four vibrocores were carried out. The positions of the cores are indicated in table 1 and on the map, Enclosure 2.

Geological setting

According to the industrial report (Gardline Survey Ltd. 2002a) the sea floor at the NINI-4 site is practically flat. The seismic investigations identified a first reflector at <1 m - 4 m below seabed and is suspected to represent an erosion surface. The sediment above is fine silty sand. Below the first reflector fine to medium sand is suspected with cobble and gravel lag sediment at base. A second reflector is identified undulating from 5 - 8 m below seabed. At the base of the reflector a channel is identified reaching till ~40 m below seabed. A weak reflector at ~97 m below seabed is expected to indicate "near base Quaternary".

Sedimentological core log

A legend to the lithologies of the cores is found in Enclosure 25.

The result of the geological description of core DGU no. **560510.10** (Gardline Survey NINI-4 N1) is given in Enclosure 3.

This core has a length of 3.36 m and the top 0.52 m is made up of bioturbated, heterolithic clay and sand. The rest of the core is faintly laminated fine sand with few clayey laminae and with few shells and shell fragments and few, fine charred organic particles.

The result of the geological description of core DGU no. **560510.11** (Havb 131-31-590021, Gardline Survey NINI-4 N2) is given in Enclosure 4.

This core is 4.11 m and the upper 0.50 m is made up of a bioturbated, heterolithic clay and sand followed by 10 cm of fine sand with clayey seams and shell fragments. The rest of the core is slightly silty, fine sand with clayey and silty laminae in the lower part and with few shells and shell fragments plus fine charred organic particles.

The result of the geological description of core DGU no. **560510.12** (Gardline Survey NINI-4 N3) is given in Enclosure 5.

The core is 2.09 m long and the upper 0.62 m is made up of a bioturbated silty, sandy clay becoming heterolithic in the lower part and with shells and shell fragments. It is followed by 0.15 m of fine sand with many shell fragments. The lower 1.32 m of the core is made up of faintly laminated, slightly silty, fine sand with few shells and shell fragments plus some charred, fine organic particles.

The result of the geological description of core DGU no. **560510.13** (Gardline Survey NINI-4 N4) is given in Enclosure 6.

This core is 4.77 m long and the upper 0.51 m is made up of a bioturbated, laminated, silty clay becoming heterolithic with fine sand downcore and with few shells and shell fragments. The lower 4.26 m of the cores is faintly laminated fine sand with few clayey seams and very few shell fragments plus laminae with charred, fine organic particles.

Correlation between the vibrocores at the NINI-4 site

All four cores correlate well and have an upper part of bioturbated clay, which is either heterolithic or it is becoming heterolithic downcore with fine sand. It holds shells and shell fragments. In the two cores 560510.11 and 560510.12 the heterolith is followed by 10 - 15 cm of fine sand with clay seams and shell fragments. The lower part of all four cores is made up of faintly laminated, fine sand with few shells and shell fragments and with charred, fine organic particles. This sand may hold clayey seams.

Interpretation of genesis

The upper bioturbated to heterolithic clay holds shells and is of marine origin, probably deposited under the present environmental conditions. The sand bed with many shells and clay seams or clasts in the cores 560510.11 and 560510.12 possibly represent a basal erosional event. The lower part of laminated, fine sands with few shells and occasional charred, fine organic particles is also marine and possibly deposited under deltaic or tidal flat conditions.

Correlation with seismics

The upper heterolithic part of the cores are expected to correlate to the upper unit in the seismics and the comparatively thin shelly sand bed below in two of the cores probably represent the basal erosional contact. The lower faintly laminated fine sand with possible clayey seams is the second identified seismic unit.

Nearby cores

A vibrocore from the NINI-2 site (Konradi and Czako 2002a), about 1,25 km to the Eastnorth-east, include an upper clayey and sandy part with a gravely and shelly basal layer followed by laminated fine sand. The sediments in this core evidently correlate to the vibrocores at the NINI-4 site. Vibrocores at the NINI-3 site, about 9½ km to the Northeast, compare to the vibrocores at the NINI-2 site and thereby to the NINI-4 site.

Furthermore six vibrocores from the NOLDE-1 site, about 6 km to the West, correlates to the NINI-2 site and consequently to the NINI-4 site.

The SIRI-5 site survey vibrocores

At this site five vibrocores were carried out. The positions of the cores are indicated in table 1 and on the map, Enclosure 7.

Geological setting

According to the industrial report (Gardline Survey Ltd. 2002b) the sea floor at the SIRI-5 site is practically flat. The seismic investigations identified a first reflector at a depth of 2 - 4 m below seabed, which is suspected to represent an erosion event. The sediment above is silty clay and silty, fine sand with shells. Below the first reflector fine-grained silty sands is found with some clay and locally peat interbeds. A second reflector is expected to represent an erosion surface. Below the second reflector clayey and silty sands are expected. A third reflector is indicated at 18 m below seabed. A poorly defined channel is observed cutting the two lower units reaching 18 m below seabed. Three more channelling events are identified reaching 42 m, 89 m and 220 m below seabed respectively.

Sedimentological core log

A legend to the lithologies of the cores is found in Enclosure 25.

The result of the geological description of core DGU no. **560420.29** (Gardline Survey SIRI-5 VC1) is given in Enclosure 8.

This core has a length of 3.69 m. The upper 1.34 m is a bioturbated, laminated heterolith of silty clay and fine sand with shells and shell fragments. This is followed downcore by 0.36 m of sand, fine to medium with gravel and some stones plus few shells and many rounded shell fragments. Next comes 0.90 m of laminated sand, fine with downcore increasing number of laminae with medium sand and at base coarse sand. This sand is followed by 0.40 m of a heterolith of silty clay and clayey silt with a high content of organic material, and of fine sand. At the base of this a 0.14 m coarsening upwards section of clay, silt and sand with a high organic content is found. The lower 0.55 m of the core is made up of fine sand with laminae of medium to coarse sand.

The result of the geological description of core DGU no. **560420.30** (Havb 131-31-5840, Gardline Survey SIRI-5 VC2) is given in Enclosure 9.

This core is 3.34 m. The top of the core is made up of 10 cm of fine, silty sand with gyttja followed by 1.62 m of a laminated and strongly bioturbated heterolith of silty clay and fine sand with shells and shell fragments. At the base of this 0.14 m of silty, clayey fine sand is seen with shells and shell fragments. The lower 1.38 m of the core is made up of a very firm, slightly silty clay with rounded clasts of clay.

The result of the geological description of core DGU no. **560420.31** (Gardline Survey SIRI-5 VC3) is given in Enclosure 10.

The core is 2.40 m long and the uppermost 11 cm is a soft fine sand with shells and shell fragments followed by 1.60 m of a laminated and strongly bioturbated heterolithic silty clay and silty fine sand. Downcore this is followed by 0.21 m of soft fine sand with shells and shell fragments. Further downcore comes 0.24 m of faintly laminated, fine sand with gravel and pebble and many shells and shell fragments and a layer of shell hash. Next comes 5 cm of unsorted sand with clasts and many shell fragments. The lower 9 cm of the core is a firm, slightly silty clay with few clasts of charred organic material and traces of organic materials, possibly roots.

The result of the geological description of core DGU no. **560420.32** (Gardline Survey SIRI-5 VC4) is given in Enclosure 11.

This core is 2.60 m long and the upper 10 cm is soft fine sand with some gyttja and shells and shell fragments. It is followed by 1.34 m of a heterolith of silty clay and fine sand with shells and shell fragments. The lower part of the core is made up of 0.46 m of fine to very fine sand with few gravel size clasts and much shell hash and of 0.60 m of homogeneous fining upwards fine and silty, very fine sand with few clasts.

The result of the geological description of core DGU no. **560420.33** (havb 131-31-590019, Gardline Survey SIRI-5 VC5) is given in Enclosure 12.

The core is 4.08 m long and the uppermost 11 cm is a bioturbated, soft, fine sand with shells and shell fragments. This is followed by 1.99 m of a laminated and distinctly bioturbated heterolith of silty clay and silty, fine sand with few shells and shell fragments in upper part and an increasing number downcore. The lower part of the core made up of a 0.16 m bed of medium to coarse sand with gravel and stone clasts and many shell fragments, followed downcore by 1.82 m of fine and very fine sand with streaks and laminae of fine to medium sand.

Correlation between the vibrocores at the SIRI-5 site

All five cores have an upper part of a heterolith of laminated, bioturbated silty clay and silty, fine sand with shells and shell fragments. In four of the cores it is topped by an uppermost fine sand with gyttja, shells and shell fragments with a thickness of around 10 cm. Below the heterolith one or several beds of sand are found, often with medium sand laminae with gravel-size clasts as well as many, often rounded shell fragments or shell hash. Underneath this shelly and gravelly beds fine and very fine sands are found sometimes with few odd sized clasts or with a high content of organic matter. In cores 560420.30 and 560420.31 the lowermost section in the core is a clay.

Interpretation of genesis

The upper heterolithic clay and fine sand with shells topped by an uppermost fine sand with gyttja probably reflects deposition in the recent marine environment where the top made up of fine sand with gyttja presumably represents the mobile layer. The underlying sands with gravel size clasts and rounded shell fragments possibly reflects deposition under a marine transgression. The fine and very fine sands below with a high content of organic matter is thought to have been deposited in a deltaic, lacustrine environment. The hard clay in the lowermost part of cores 560420.30 and 560420.31 possibly originates in a glacial environment.

Correlation with seismics

The upper heterolith including the top fine sand with gyttja correlates to the upper seismic unit, and the next section in the cores, made up of sands with gravel clasts, rounded shell fragments and shell hash, probably indicates the erosional surface of the first reflector. The fine and very fine sand below is the sediments of the second seismic unit. The clay in the cores 560420.30 and 560420.31 apparently do not show in the seismics (Gardline Ltd. 2002b).

Nearby cores

In the site survey reports from the nearby SIRI-1 site (Gardline Surveys 1995) as well as from the SIRI-2 site (Seateam 1996), about 4½ and 7 km to the West respectively, vibrocores are mentioned. They include an upper section of silty fine sands, which probably correlates to the heterolithic section of the present vibrocores. In the SIRI-1 and SIRI-2 vibrocores the upper section is followed downcore by a shelly gravel which probably correlates to the sandy beds with clasts and rounded shells of the present site. The SIRI-1 and SIRI-2 vibrocores have a basal unit with firm clay which probably correlate to the basal, firm clays of the SIRI-4 vibrocores 560420.30 and 560420.31.

At the SIRI-5 well site a geotechnical borehole were carried out till 31,38 m below seafloor (see Appendix, this report). The upper part of this borehole correlates with the vibrocores, VC3, VC4 and VC5.

The CECILIE-2 site survey vibrocores

At this site five vibrocores were carried out. The positions of the cores are indicated in table 1 and on the map, Enclosure 13.

Geological setting

According to the industrial report (Gardline Survey Ltd. 2002c) the sea floor at the CECILIE-2 site is practically flat. The seismic investigations identified a first reflector at a depth of 3m - 10 m below seabed with a shallow channel till 18 m below seabed. The sediment above is silty, fine sand with shells and localised peat horizons and possibly coarser sediments towards the base of the channel. Below the first reflector sandy and clayey sediments persist. A second reflector with a channel horizon is identified reaching down till ~38 m below seabed in laminated sediments of sand with minor clay interbeds and coarser lag sediments. The approximate base Quaternary is indicated at ~292 m below seabed.

Sedimentological core log

A legend to the lithologies of the cores is found in Enclosure 25.

The result of the geological description of core DGU no. **560420.24** (Gardline Survey CECILIE-2 C1) is given in Enclosure 14.

This core has a length of 2.73 m and is made up of well-sorted fine sand, which in the top is silty and include shells. A few streaks of clay are seen in the lower part.

The result of the geological description of core DGU no. **560420.25** (Gardline Survey CECILE-2 C2) is given in Enclosure 15.

This core is 3.40 m and is made up of well-sorted fine sand, which in the top is silty and holds shells. In the depth 1,50 - 2,12 m bioturbation is seen and at the depth 2.12 - 3.12 m many streaks of clay indicate lamination.

The result of the geological description of core DGU no. **560420.26** (Gardline Survey CECILIE-2 C3) is given in Enclosure 16.

The core is 1.62 m long and the upper 0.35 m is fine, silty sand with shells. The rest of the core is made up of faintly laminated well-sorted, fine sand.

The result of the geological description of core DGU no. **560420.27** (Gardline Survey CECILIE-2 C4) is given in Enclosure 17.

This core is 2.14 m long and the upper 0.55 m is fine, silty sand with shells. The core section to 1.80 m below top is faintly laminated, well sorted fine sand with one stone-sized clast. The lower 0.34 m of the cores is well-sorted fine and very fine sand.

The result of the geological description of core DGU no. **560420.28** (havb 131-31-590018, Gardline Survey CECILIE-2 C5) is given in Enclosure 18.

This core has the length of 4.00 m. The upper 1.00 m is very silty, fine sand with shells and the following 1.15 m downcore is well sorted, laminated fine sand with few streaks of shell fragments. The section 2.15 - 2.30 m is laminated fine sand and peat and the section 2.30 - 2.85 m is laminated fine sand with clayey streaks. The lower part of the core is a laminated heterolith of silty clay and silty sand with few laminae of peat.

Correlation between vibrocores at the CECILIE-2 site

All five cores correlate well and have an uppermost part of silty, fine sand with shells followed by well-sorted fine sand with faint lamination. It may hold few clasts or shells and in places can show bioturbation. In core 560420.28 a heterolithic clay and sand with few peat laminae underlies this sand.

Interpretation of genesis

The upper silty, fine sand with shells is thought to have been deposited under the present the marine environmental conditions. The underlying laminated fine sands are expected to have been deposited in a tidal flat or deltaic environment.

Correlation with seismics

The upper silty, fine sand with shells in the cores possibly is not identified in the seismics. The faintly laminated fine sand probably correlates to the upper seismic unit, while the second seismic unit apparently is not reached by the coring.

Nearby cores

At the CECILIE-1 site, located about 1100 metres Northwest of the CECILIE-2 site, two vibrocores were taken; both made up of silty, fine sand. They correlate reasonably well with the present vibrocores.

The JETTE-1 site survey vibrocores

Five vibrocores were presented from this site. The positions of the cores are indicated in table 1 and on the map, Enclosure 19.

Geological setting

According to the industrial report (Gardline Survey Ltd. 2002d) the sea floor at the JETTE-1 site is practically flat. The seismic investigations identified a first reflector at 1 - 3 m below seabed and is expected to represent a erosion surface. The sediment above is fine to medium, silty sand with suspected cobble and gravel lag sediment at base. Below the first reflector a sticky and hard clay is found with sand prone channels in top and possible internal sand prone pockets. A second undulating reflector is identified around 14 m below seabed. Below this clayey and silty sand with clay interbeds is expected with infilled channels, especially an intra Pleistocene channel with a base reflector around 117 m below seabed. An approximate base Quaternary reflector is interpreted at 380 - 435 m below seabed.

Sedimentological core log

A legend to the lithologies of the cores is found in Enclosure 25.

The result of the geological description of core DGU no. **560429.16** (Havb 131-31-590020, Gardline Survey JETTE-1 J1) is given in Enclosure 20.

This core has a length of 3.62 m and the upper 1.20 m is made up of fine to very fine sand, which, especially in the upper 20 cm, holds many shells and below that few shells and shell fragments. The next 0.61 m of the core is silty fine to very fine sand with few shells and shell fragments. The rest of the core is a firm, sticky, slightly silty clay with gravel- and pebble-sized clast of clay

The result of the geological description of core DGU no. **560429.17** (Gardline Survey JETTE-1 J2) is given in Enclosure 21.

This core is 3.72 m and the upper 2.06 m is made up of fine and very fine, slightly silty sand, which holds many shells in the upper part. To the depth 2.54 m faintly laminated fine to very fine sand occurs with shells and shell fragments, and to 3,59 m the very fine sand is silty and include very few shell fragments. The lowermost 13 cm of the core is laminated clay with silt laminae.

The result of the geological description of core DGU no. **560429.18** (Gardline Survey JETTE-1 J3) is given in Enclosure 22.

The core is 2.25 m long and is made up of bioturbated, partly laminated, slightly silty, fine and very sand with few clasts and shells and shell fragments.

The result of the geological description of core DGU no. **560429.19** (Gardline Survey JETTE-1 J4) is given in Enclosure 23.

This 2.59 m long core is made up of bioturbated, slightly silty, fine and very fine sand with few clasts and shells and shell fragments especially in the uppermost part.

The result of the geological description of core DGU no. **560429.20** (Gardline Survey JETTE-1 J5) is given in Enclosure 24.

This core has the length of 1.44 m and consists of a bioturbated, slightly silty, fine and very fine sand with few clasts and, especially in the uppermost part, shells and the shell fragments.

Correlation between vibrocores at the JETTE-1 site

All five cores correlate well as they are made up of a bioturbated, slightly silty, fine and very fine sand, which include few clasts and shells and shell fragments especially in the uppermost part. In the cores 560429.16 and 560429.17 the sand is underlain by a firm clay.

Interpretation of genesis

The slightly silty fine and very fine sand is expected to reflect the recent marine environmental conditions at the JETTE-1 site. The firm clay in the cores 560429.16 and 560429.17 probably were deposited in a glacio-lacustrine environment.

Correlation with seismics

The slightly silty, fine and very fine sand making up the sediment in the five vibrocores must correlate to the upper unit in the seismics. The expected erosion surface at the base of the unit in the depth of 2 - 3 m below seabed is not identified in the cores. The firm clay identified in the cores 560429.16 and 560429.17 correlates to the second seismic unit.

Nearby cores

From a site named South Pod, situated about 14 km to the Southeast of the JETTE-1 site, five vibrocores from the site survey were described (Konradi and Czako 2002b). They form a rather complex series of fine sands, heteroliths and clays. They do not immediately compare to the rather simple composition of the present cores. Nevertheless the slightly silty fine sands at the JETTE-1 site most probably correlate to the fine sands in the upper part of the cores at the South Pod site.

At the well site KIT-1x, situated approximately 8 km North of the JETTE-1 site, one cored, geotechnical borehole is described (Fugro Engineers 2001). The sediment is made up of 2.6 m of silty, fine sand overlying 4.9 m of firm to stiff clay becoming interbedded with silt and fine to medium sand the lower part. This is underlain by 13 m (limit of borehole) of very dense, silty, fine to medium sand with occasional seams of clay. The upper unit of silty, fine sand at the KIT-1x site most probably compares to the sediment at the JETTE-1 site.

Core photos

The photos of core DGU no. 560510.11 are presented in Enclosure 26a & Enclosure 26b. The photos of core DGU no. 560420.28 are presented in Enclosure 27a & Enclosure 27b. The photos of core DGU no. 560420.33 are presented in Enclosure 28a & Enclosure 28b. The photos of core DGU no. 560429.16 are presented in Enclosure 29a & Enclosure 29b.

Correlation between lithologies

The lithologies of vibrocores from the sites NINI-4 and SIRI-5 correlate fairly well. Both sites include an upper part of bioturbated and heterolithic clay with shells. This section most probably correlate to the upper part of silty, fine sand with shells in the vibrocores from the CECILIE-2 site. They are expected also to correlate to the silty, fine sand with shells in the upper part of the cores from the JETTE-1 site, as they all are expected to represent the present sedimentation at the sites. In two of the cores from the NINI-4 site, 560510.11 and 560510.12, a sandy bed with clay seams and shell fragments underlies the upper heterolithic clay. These beds most probably correlate to the bed of medium sand with clasts and rounded shell fragments in the cores at the SIRI-5 site. The lower part of the cores from the NINI-4 site and the SIRI-5 site, as well as from the CECILIE-2 site is made up of laminated, fine sand and most probably correlate. This most probably also correlate to the lower part of the sandy section in the cores from the JETTE-1 site. This fine sand in the cores from the NINI-4 site and in one of the cores from the CECILIE-2 site, 560420.27, though, holds few shells and shell fragments as well as occasional charred fine organic particles. The fine sand in the cores from the SIRI-5 site include a few odd-size clasts and a high content of organic matter and the core 560420.28 from the CECILIE-2 site even include a peat layer and peaty seams. The hard clay with sand pots forming the lowermost part of the cores 560420.30 and 560420.31 at the SIRI-5 site do not resemble the firm clay with clay clasts making up the base of the two cores 560429.16 and 560429.17 at the JETTE-1 site, and can not be correlated.

Interpretation of genesis

The upper section of the cores, the bioturbated, heterolithic clay in the cores from the SIRI-5 site and the NINI-4 site, as well as the silty, fine sand in the cores from the CECILIE-2 site and the JETTE-1 site are expected to represent the present marine sedimentation at the sites. The underlying medium sand with few clasts at the SIRI-5 site as well as the sandy bed with clay seams and shell fragments in two of the cores, 560510.11 and 560510.12, at the NINI-4 site represent an erosional event. The underlying fine sands with a content of fine organic matter in the SIRI-5 site cores are expected to have been deposited in a deltaic, lacustrine environment like the core 560420.28 from the CECILIE-2 site. The laminated fine sand with few shells in the NINI-4 site cores and the CECILIE-2 site cores as well as the fine sand with few shells in the JETTE-1 site cores are expected to have been deposited in deltaic tidal flat environment. The hard clay with sand pots found in two of the cores, 560420.30 and 560420.31, at the SIRI-5 site and the firm clay with small clay clasts found in two of the cores, 560429.16 and 560429.17, at the JETTE-1 site are thought to originate in glacial environments, though different glacial environments.

Conclusion and suggested correlation to stratigraphy

The upper section of the cores, the heterolithic clay and fine sand and the silty, fine sand, is suggested to represent the present sedimentation at the sites. It is expected to belong to the Late Holocene comparable to the Western Mud Hole Member of the Nieuw Zeeland Gronden Formation (Laban, C. *et al.* 1995). The next section of the cores, the medium to coarse sand with shells, is suggested to represent a marine transgression at the base of the Nieuw Zeeland Gronden Formation. The underlying laminated fine sand is expected to represent the Early Holocene tidal flat to deltaic lacustrine deposits of the Elbow Formation (Oele 1969). The lowermost hard clay with sand pots seen in two of the cores at the SIRI-5 site is thought to represent either a facies of the Late Weichselian Twente Formation (Cameron *et al.* 1989) or a facies of the Late Weichselian Dogger Bank Formation (Jeffery *et al.* 1989). The lowermost firm clay with clay clasts seen in two of the cores from the JETTE-1 site is believed to represent a facies of the Late Weichselian Dogger Bank Formation (Jeffery *et al.* 1989). The existing generalised lithostratigraphy of the southern North Sea is given in table 2.

Holocene	Nieuw Zeeland Gronden Formation	Western Mud Hole Member
	Elbow Formation	
Weichselian	Twente Formation	
	Dogger Bank Formation	

Table 2. Generalised stratigraphy of the Late Weichselian and Holocene of the North Sea (after Cameron *et al.* 1989 and Jeffery *et al.* 1989).

Stored cores

The photographed cores: DGU no. 560510.11,
 DGU no. 560420.28,
 DGU no. 560420.33,
 DGU no. 560429.16

are stored at the GEUS core store for future comparison and stratigraphic investigation.

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*.
- Fugo Engineers B.V. 2001: Soil investigation and spudcan penetration analysis, Kit-1X location, Danish sector, North Sea, Februar 2001. GEUS report File no. 18185.
- Gardline Surveys 1995: Statoil Denmark A/S. 5604/20-A. Pre-drilling hazard survey. September 1995. Survey report. GEUS Report File no.13022.
- Gardline Survey Limited 2002a: DONG Efterforskning og Produktion A/S, NINI-4 Site Survey, Danish Block 5605/10, August 2002, Volume 1 - Results Report. GEUS Report File no 19432
- Gardline Survey Limited 2002b: DONG Efterforskning og Produktion A/S, SIRI-5 site Survey, Danish Block 5604/20, August 2002, Survey report. GEUS Report File no 25037
- Gardline Survey Limited 2002c: DONG Efterforskning og Produktion A/S, CECILIE-2 Site Survey, Danish Block 5604/20, August 2002, Volume 3 - Results Report. GEUS Report File no 19442
- Gardline Surveys Limited. 2002d: DONG Efterforskning og Produktion A/S. JETTE-1 Site Survey. Danish block 5604/29. August 2002. Volume 2 - Results report. GEUS Report File no.19480
- Jeffery, D.H., Frantzen, P., Laban, C. and Schüttenhelm, R.T.E. 1989: Silver Well. Sheet/Kaartblad 54°N–02°E. Quaternary Geology Geology/Geologie van het Kwartair. British Geological Survey/Rijks Geologische Dienst, 1:250.000 series.
- Konradi, P. and Czakó, T. 2002a: Geological description of vibrocores from the Nini-3 site, Store Fisker Banke area, Danish North Sea. Danmarks og Grønlands Geologiske Undersøgelse rapport 2002/2.
- Konradi, P. and Czakó, T. 2002b: Geological description of five vibrocores from the South Pod site, Store Fisker Bake area, Danish North Sea. Danmarks og Grønlands Geologiske Undersøgelse rapport 2002/41.
- Laban, C., van der Klugt, P.C.M. & Frantsen, P.J. 1995: Oyster Grounds. Sheet 54°N – 4°E. Holocene en oppervlakesedimenten. Rijks Geologische Dienst, 1:250.000 series.
- Oele, E. 1969: The Quaternary geology of the Dutch part of the North Sea, north of the Frisian Isles. *Geologie en Mijnbouw*, 48, 5, 467-480.
- Seateam 1996: Dansk operatørselskab i-s (Danop). SIRI-2 site survey. Danish continental shelf. Block 5605/20. Rig site survey. Final report GEUS Report File no.13353.

Geotechnical borehole at the SIRI-5 well site

GEUS was presented by 75 samples from a 31,38 m deep geotechnical borehole, named DGO2-SIRI-BH30-01, conducted by Norwegian Geotechnical Institute, at the SIRI-5 well site. This borehole is numbered: DGU no. 560420.34

The samples were described by Tibor Czáko, enclosure 30a - 30f.

The sediments include several alternating beds of sand and clay and some silt layers. Some sections of the borehole include shells or shellfragments.

At four levels samples were processed for foraminifer analysis. The results can be summarised as follows:

- | | |
|------------------------------|--|
| Sample depth: 9.00-9.17 m: | The fauna indicates deposition in an arctic environment. It is expected to have been deposited in a glaciomarine setting in the North Sea basin. |
| Sample depth: 15.22-15.43 m: | Very impoverished fauna, probably reworked and non-marine. |
| Sample depth: 21.00-21.18 m: | The rich fauna indicate deposition under boreal environmental conditions <i>i.a.</i> in an interglacial. |
| Sample depth: 25.00-25.14 m: | This rich fauna also indicate deposition under boreal environmental conditions <i>i.a.</i> in an interglacial. |

Correlation to seismic:

In the industrial report (Gardline Survey Ltd. 2002b) an upper seismic unit is identified till 2-4 m below seafloor. This correlate to the upper clayey beds between 0-2,13 m. The second seismic unit correlate to the next section of the borehole, the fine and medium sand and the heterolithic clay and sand. The seismic reflector 3, at 18 m below seafloor, must be the gravel with shells occurring at 18.00-18.03 m, which is probably a regressions surface of the top of the interglacial marine sediments.

Stratigraphy and correlation:

The sample from the depth 9.00-0.17 m is most probably of Weichselian age and belong to the Dogger Bank Formation, and the sample from 15.22-15.43 m probably also belong to a non-marine interval of the Weichselian Dogger Bank Formation.

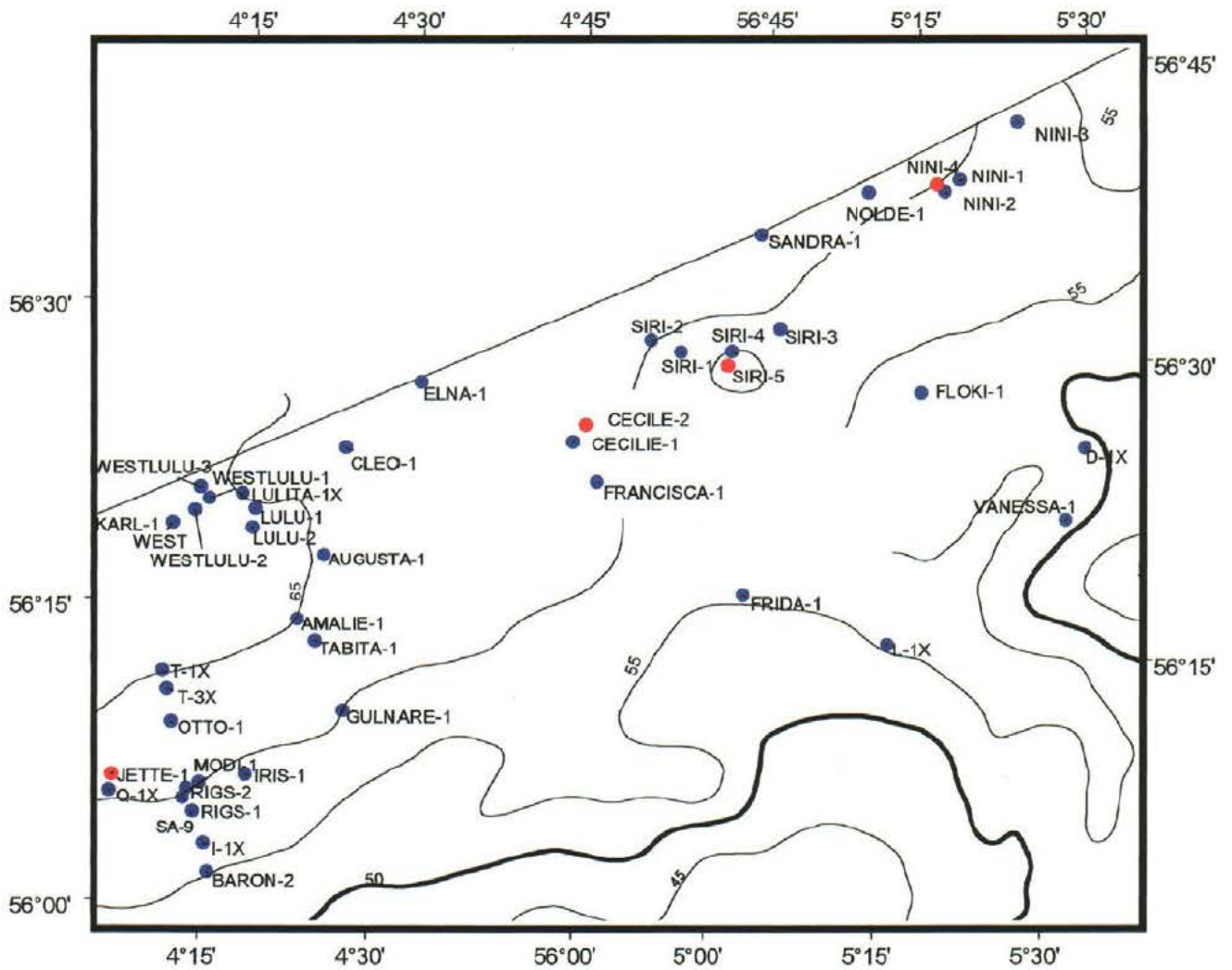
The samples from the intervals 21.00-21.18 m and 25.00-25.14 m respectively, must belong to the Eemian. Eemian deposits are found nearby in the North Sea at the Dan-site and the Roar-site (Knudsen 1985) and at the BH 89-7A, the Valdemar and the Dagmar sites (Salomonsen & Jensen 1994). In the SIRI-5 well site geotechnical borehole, though, the two species *Elphidium lidoense* and *E. translucens*, usually said to indicate the Eemian, are not identified, like in the BH89-7A borehole.

Literature:

Knudsen, K.L. 1985: Foraminiferal stratigraphy of Quaternary deposits in the Roar, Skjold and Dan fields central North Sea, *Boreas*, 14, 311-324.

Salomonsen, I. & Jensen, K.A. 1994: Quaternary erosional surfaces in the Danish North Sea. *Boreas*, 23, 244-253.

Enclosures

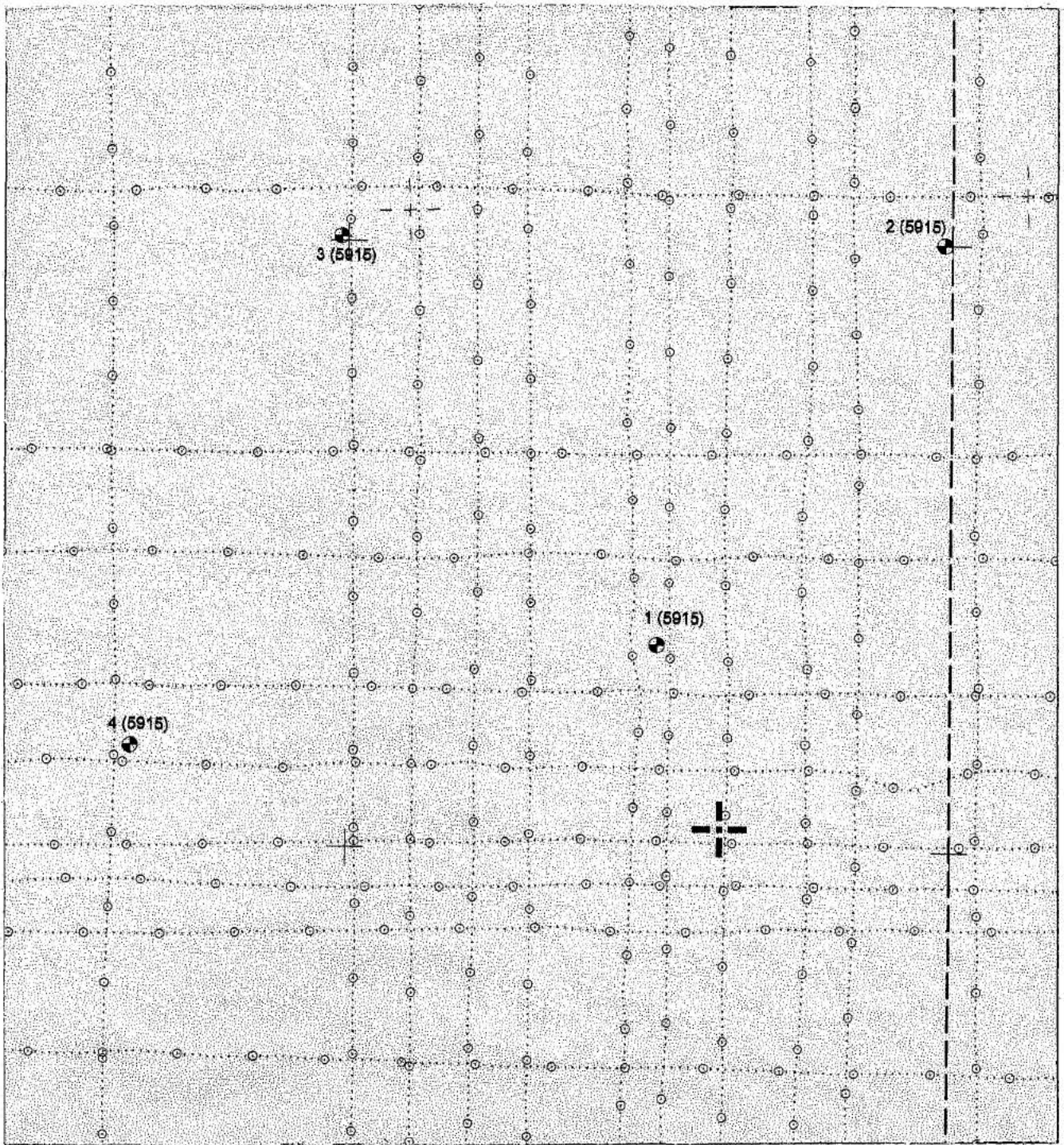


Skala: 1:650000
 0 4 8 Kilometers


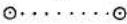
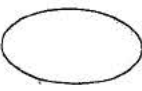




GEUS

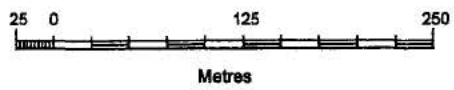
Kort fremstilling:
 GEUS/Lotte Møller/maj 2003.



Seabed Features (Extract of Chart 5)

- 
 PROPOSED NINI-4 LOCATION (639 810E, 6 278 518N)
- 
 SIDESCAN SONAR TRACK DURING ECHO SOUNDER, SIDESCAN SONAR AND DIGITAL SEISMIC LINES
- 
 LOW TO MODERATE REFLECTIVITY SEABED
- 
 CABLE- CLIENT SUPPLIED POSITION NOT OBSERVED DURING CURRENT SURVEY
- 
 1 (5915) VIBRO CORE (STATION NUMBER WITH REPORT NUMBER)

Scale 1 : 5 000



SEDIMENTOLOGICAL CORE LOG

Company: DONG, site survey NINI-4, BH N 2

Borehole id.: DGU nr. 560510.11

Water depth: 58.8 m Position: 6279000.6 N 639993.4E

havb 131-31-590021

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	0.00-0.51	[Lithology diagram: clay with silty laminae]										0.00-0.51: CLAY, slightly silty, soft, laminated, with laminae/lumps of sand, bioturbated, downcore: heterolithic: CLAY, slightly silty and SAND, few shells and shellfragments, worm tube, at base: layer of shell-hash, dark grey 5Y 4/1	HL/ HV
	-0.61											-0.61: SAND, fine, with clay clasts and -seams, shellfragments, dark grey 5Y 5/1	HS
II	0.90-1.00											- 4.11: SAND, fine, slightly silty, few shells and shellfragments, at: 1.17, 1.38 and 1.65: laminae with shellfragments, from: 1.92: fine charred organic particles, at: 3.56-3.60: CLAY, SILT, fine sand, laminated at: 3.65-3.70: oblique laminated fine-medium sand with organic particles, shell fragments and coarse sand-sized chert particles, dark grey 5Y 5/1	HS
	1.82-2.00												
III	2.82-3.00												
	3.82-4.00												
IV	4.11												
V	4.11												
	5.0												
	6.0												

Enclosure 4

Date: 08.10.2002

Described by: CSL/PK



Geological Survey of Denmark and Greenland

SEDIMENTOLOGICAL CORE LOG

Company: DONG, site survey NINI-4, BH N 3

Borehole id.: DGU nr. 560510.12

Water depth: 59.3 m Position: 6279004.8 N 639494.1E

havb

Core	Core depth m	Litho-logy	Grain size & sediment structures						Description	Envi-ron & age					
			Clay	Silt	Sand			Gr			Pb				
					vf	f	m	c	Vc						
I	0.00 0.94	I	S	S	S	S	S	S	S	S	S	S	S	0.00-0.62: CLAY, silty, sandy, laminated, bioturbated, upper 5 cm with gyttja, downcore: heterolithic CLAY, silty and SAND, very fine, silty, bioturbated, shells and shellfragments (Echinids sp.), dark grey 5Y 4/1 - 0.77: SAND, fine, slightly silty, faintly laminated, lens of clay, many shell fragments, dark grey 5Y 4/1 - 2.09: SAND, fine and very fine, faintly laminated, few shells and shellfragments, some minute, charred organic particles, grey 5Y 5/1	HL/ HV HS HS
II	1.94 2.09	II	S	S	S	S	S	S	S	S	S	S	S		
III	2.09	III	S	S	S	S	S	S	S	S	S	S	S		
	3.0 4.0 5.0 6.0														

Enclosure 5

Date: 08.10.2002

Described by: CSL/PK

SEDIMENTOLOGICAL CORE LOG

Company: DONG, site survey NINI-4, BH N 4

Borehole id.:DGU nr. 560510.13

Water depth: 60.4 m Position: 6275581 N 639321E

havb

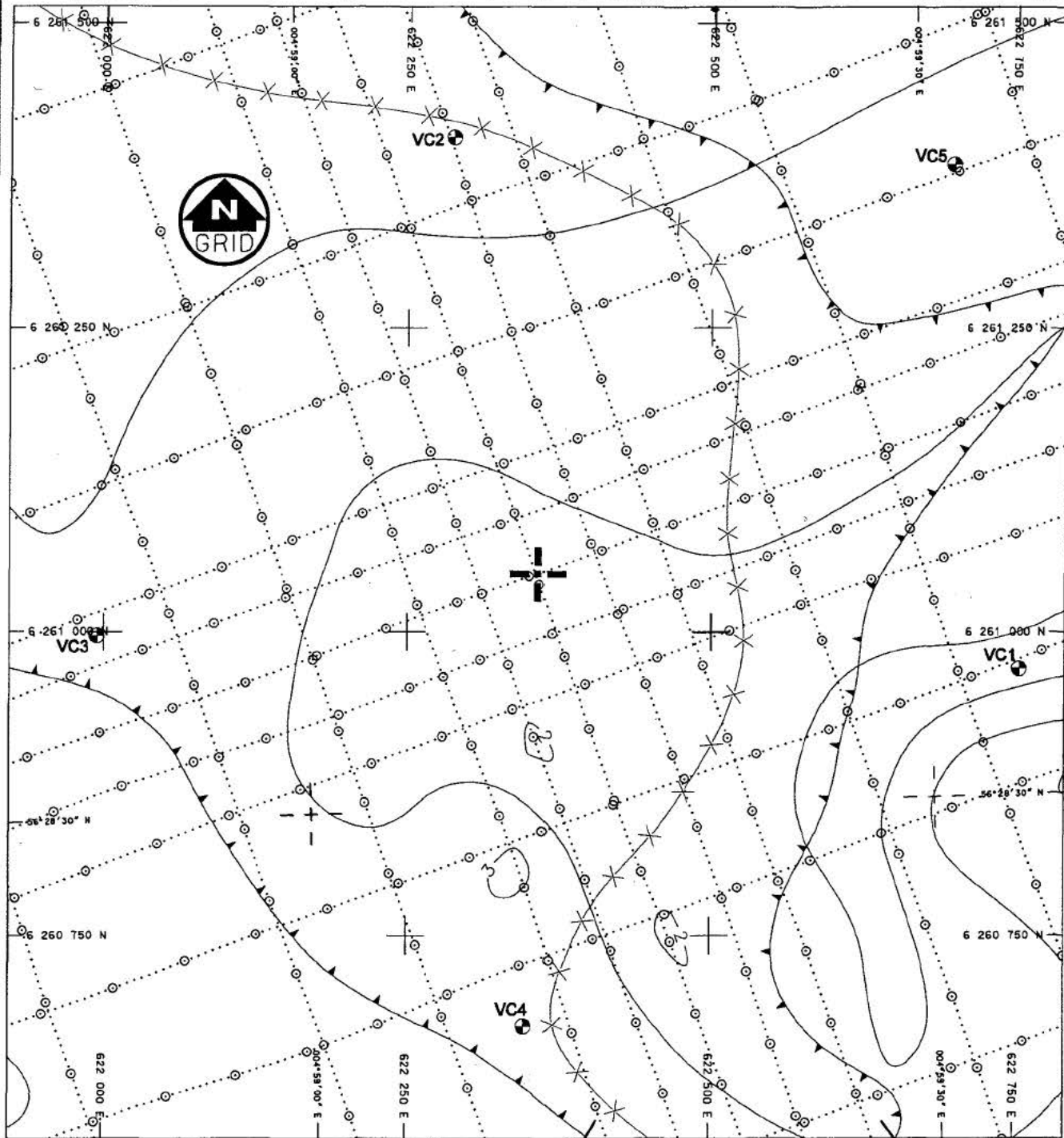
Core	Core depth m	Litho-logy	Grain size & sediment structures						Description	Envi ron & age								
			Clay	Silt	Sand			Gr			Pb							
					vf	f	m	c	vc									
I	0.77	1.0	II	1.77	2.0	III	2.77	3.0	IV	3.77	4.0	V	4.77	5.0	6.0	<p>0.00-0.51: CLAY, silty, slightly sandy, soft, laminated with layers/lamina of sand, bioturbated, downcore: heterolithic: CLAY, slightly silty and SAND, very fine, silty, clayey, few shells and shellfragments, dark grey 5Y 4/1</p> <p>- 4.77: SAND, fine and very fine, no visible lamination, bioturbated (?), shells and shellfragments, fine charred organic particles, spread and concentrated, twigs?, at 1.59: banded clay seam, below ~3.00: fine sand, faintly laminated, some laminae marked by fine charred organic particles, at 4.57 and 4.75: clayey lenses, in lower part: few fine gravel-size clasts, very few shells (<i>Mytilus</i> sp.), dark grey 5Y 4/1</p>	HL/ HV	HS

Enclosure 6

Date: 08.10.2002


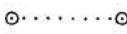




Described by: CSL/PK



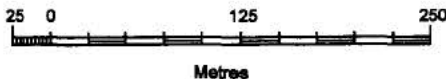


Shallow Soils (Extract of Chart 5)

PROPOSED SIRI-5 LOCATION (6 22 357E, 6 261 048N)

-  PROPOSED SIRI-5 LOCATION (6 22 357E, 6 261 048N)
-  REFERENCE POINT TRACK DURING ECHO SOUNDER, SIDESCAN SONAR, PINGER AND DIGITAL SEISMIC LINES
-  CONTOURS TO BASE OF SUPERFICIAL SOFT CLAY
-  APPROXIMATE LIMIT OF CHANNEL INFILLED BY CHAOTIC SEDIMENTS (PRESUMED SANDS)
-  AXIS OF CHANNEL (APPROXIMATELY 19 TO 20m BELOW SEABED)
-  VIBRO CORES WITH STATION NUMBER

1 : 5000



Enclosure 7

SEDIMENTOLOGICAL CORE LOG

Company: DONG, site survey SIRI-5, BH VC 1

Borehole id.:DGU nr. 560420.29

Water depth: 58.8 m

Position: 6260970 N 622753 E

havb

Core	Core depth m	Litho-logy	Grain size & sediment structures							Description	Envi ron & age		
			Clay	Silt	Sand							Gr	Pb
					vf	f	m	c	vc				
I	0.90	1.0									0.00-1.34: Heterolith: SAND, very fine, slightly silty, clayey and CLAY, silty, laminated, bioturbated, shells and shellfragments, dark grey 5Y 5/1	HV	
II	1.84	2.0							x	x	-1.70: SAND, fine to medium, with gravel and some stones, few shells and many shellfragments, some rounded, dark grey 5Y 4/1	HS	
III	2.84	3.0									-2.60: SAND, fine, downcore: increasing numbers of laminae with sand, fine to medium, at bottom: sand, fine to coarse, at 2,27: sand, very fine and clay laminae, at 2.59: stone, grey 5Y 5/1	FS	
IV	3.69	4.0									-3.00: Heterolith: laminated, CLAY, silty, high organic content, SILT, clayey, high organic content, SAND, fine with silt and SAND, fine black GLEY1 2.5/N, very dark grey 10YR 2/2 and GREY 5Y 5/1	FV	
	5.0	6.0									-3.14: Coarsening upwards: CLAY and SILT with high organic content, and SAND, fine, black 10YR 2/1 and grey 5Y 5/1	FV	
											-3.69: SAND, fine with laminae of sand, medium to coarse, at 3.59: lens of clay with a high organic content, grey 5Y 5/1	FS	

Enclosure 8

Date: 09.10.2002

Described by: CSL/PK

SEDIMENTOLOGICAL CORE LOG

Company: DONG, site survey SIRI-5, BH VC 2

Borehole id.: DGU nr. 560420.30

Water depth: 59.2 m

Position: 6261406 N 622286 E

havb

Core	Core depth m	Litho-logy	Grain size & sediment structures						Description	Envi-ron & age		
			Clay	Silt	Sand			Gr			Pb	
					vf	f	m	c	vc			
I	0.00-0.10										0.00-0.10: SAND, fine, slightly silty, with gyttja, bioturbated, shells and shellfragments, dark grey 5Y 5/1	HS
	-1.82										-1.82: Heterolith: CLAY, silty and SAND, very fine, silty, laminated, strongly bioturbated, shells and shellfragments, grey 5Y 5/1	HV
II	0.89											
	1.0											
III	1.85											
	-1.96										-1.96: SAND, fine, silty, clayey, shells and shellfragments, grey 5Y 5/1	HS
IV	2.0											
	-3.34										-3.34: CLAY, slightly silty, hard, homogeneous, with gravel-size clasts of silty clay, pods of sand with gravel-size clasts, very few clasts of rounded shell-umbo, uppermost part disturbed due to coring, dark greyish brown 10YR 4/2	TL
	2.85											
	3.0											
	3.34											
	4.0											
	5.0											
	6.0											

Enclosure 9

Date: 10.10.2002

Described by: CSL/PK

SEDIMENTOLOGICAL CORE LOG

Company: DONG, site survey SIRI-5, BH VC 4

Borehole id.: DGU nr. 560420.32

Water depth: 59.0 m

Position: 6260676 N 622348 E

havb

Core	Core depth m	Lithology	Grain size & sediment structures							Description	Environ & age		
			Clay	Silt	Sand							Gr	Pb
					vf	f	m	c	vc				
I	0.93											0.00-0.10: SAND, fine and very fine, silty, slightly clayey, soft, with gyttja, shells and shellfragments, worm tubes, dark grey 5Y 5/1	HS
													-1.44: Heterolith: CLAY, silty and SAND, fine to very fine, silty, soft, at .62 - .64 clay layer, shells and shellfragments, grey 5Y 5/1	HV
II	1.88											-1.90: SAND, fine to very fine, slightly silty, few gravel-size clasts, much shell hash, grey GLEY1 5/N	HS
III	2.60												
													-2.60: SAND, fine to very fine, slightly silty in upper part, fining up, homogeneous, gravel-size clasts in upper 10 cm, at 2.05: one stone (8 cm), grey GLEY1 5/1	TS
	3.0												
	4.0												
	5.0												
	6.0												

Enclosure 11

Date: 10.10.2002

Described by: CSL/PK

SEDIMENTOLOGICAL CORE LOG

Company: DONG, site survey SIRI-5, BH VC 5

Borehole id.:DGU nr. 560420.33

Water depth: 59.3 m

Position: 6261384 N 622697 E

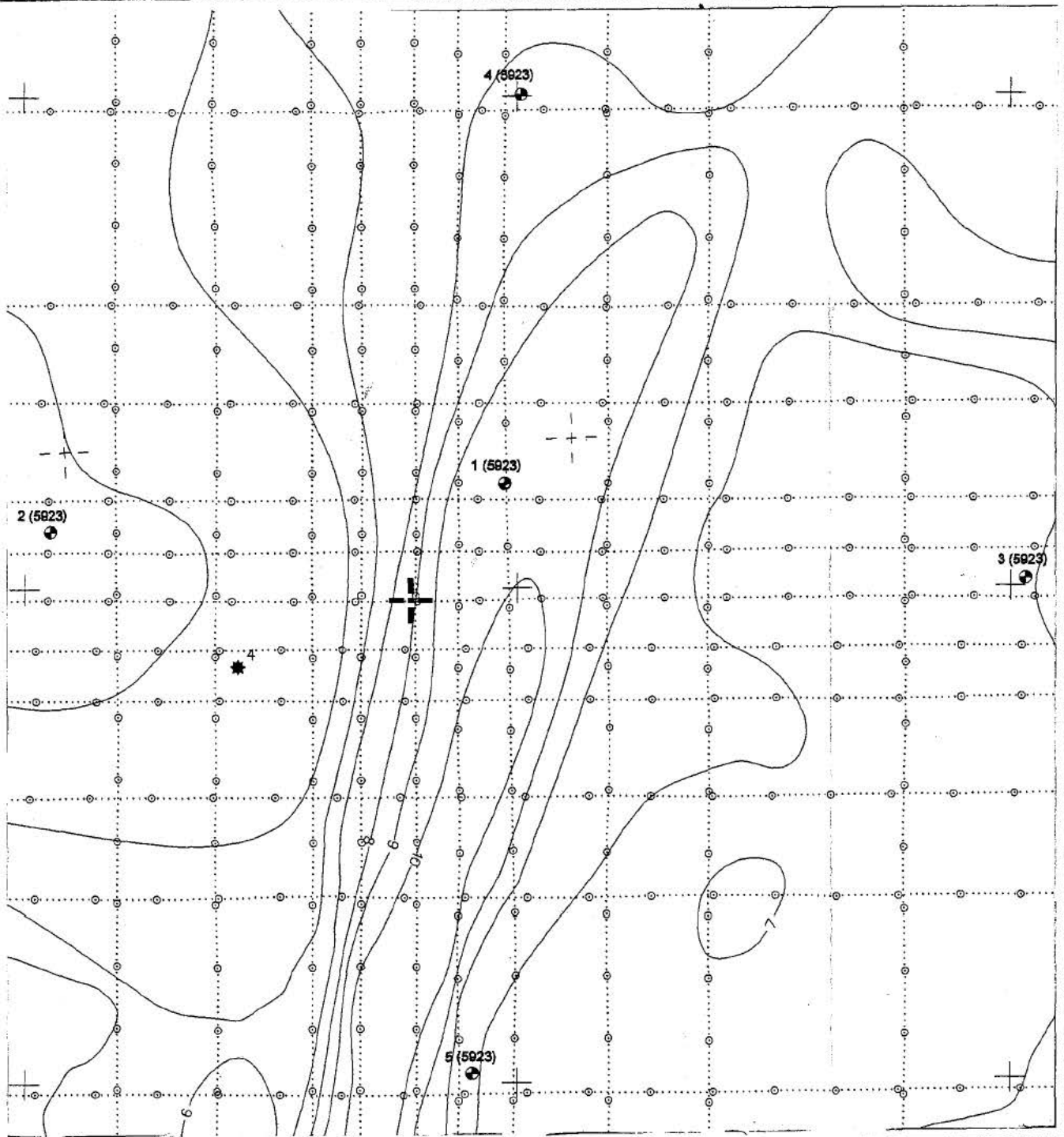
havb 131-31-590019

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	0.00										0.00-0.11: SAND, fine, silty and clayey, in upper 4 cm: with gyttja, bioturbated, shells and shellfragments, dark grey 5Y 5/1	HS	
	0.80										-2.10: Heterolith: CLAY, silty, soft and SAND, very fine, silty, laminated, distinctly bioturbated, few shells and shellfragments, downcore: apparently more shells and shellfragments, grey 5Y 5/1 oblique lower boudary due to coring	HV	
II	1.00												
	1.66												
III	2.00												
	2.62										-2.26: SAND, medium to coarse, fine and coarse gravel, two stones, many shellfragments, rounded, bed squeezed due to coring, dark grey 5Y 4/1	HS	
IV	3.00												
	3.60												
V	4.08												
	5.00												
	6.00												

Enclosure 12

Date: 09.10.2002

Described by: CSL/PK



Shallow soils (Extract of Chart 6)



PROPOSED CECILIE-2 LOCATION (609 392E, 6 251 988N)



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



DEPTHS IN METRES BELOW SEABED (CONTOURED AT 1 METRE INTERVALS) TO MAPPED REFLECTOR 1

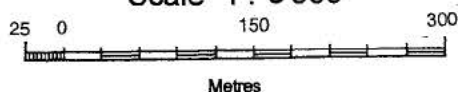


DISTINCT DIFFRACTION HYPERBOLA - PRESUMED BOULDER WITH DEPTH TO FEATURE IN METRES BELOW SEABED



VIBROCORE WITH SAMPLE NUMBER (JOB NUMBER IN BRACKETS)

Scale 1 : 6 000



Enclosure 13

SEDIMENTOLOGICAL CORE LOG

Company: DONG, site survey CECILIE-2, BH C 2

Borehole id.: DGU nr. 560420.25

Water depth: 60.6 m

Position: 6252059.3 N 609026.0 E

havb

Core	Core depth m	Litho-logy	Grain size & sediment structures						Description	Env iron & age		
			Clay	Silt	Sand						Gr	Pb
					vf	f	m	c				
I	1.00	1.00									0.00-3.40: SAND, fine, wellsorted, upper .30 m: silty with shells, at 1.50-2.00: bioturbation, at 2.00-3.00: many streaks of clay (1-2 cm), lamination, grey 2.5Y 5/1	HS
II	2.00	2.00										
III	3.00	3.00										
IV	3.40	3.40										
	4.00											
	5.00											
	6.00											

Enclosure 15

Date: 15.10.2002

Described by: TC/PK



Geological Survey of Denmark and Greenland

SEDIMENTOLOGICAL CORE LOG

Company: DONG, site survey CECILIE-2, BH C 3

Borehole id.: DGU nr. 560420.26

Water depth: 60.2 m

Position: 6252008.2 N 610015.9 E

havb

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	1.00	II									0.00-0.35: SAND, fine, silty, shells, dark greyish brown 2.5Y 4/2	HS	
	1.62										-1.62: SAND, fine, well sorted, faintly laminated, upper boundary sharp, grey 2.5Y 5/1	HS	
	2.0												
	3.0												
	4.0												
	5.0												
	6.0												

Enclosure 16

Date: 15.10.2002

Described by: TC/PK



Geological Survey of Denmark and Greenland

SEDIMENTOLOGICAL CORE LOG

Company: DONG, site survey CECILIE-2, BH C 4

Borehole id.:DGU nr. 560420.27

Water depth: 60.2 m

Position: 6252502.7 N 609504.7 E

havb

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											0.00-0.55: SAND, fine, silty, shells, greyish brown 2.5Y 5/2	HS
	1.00										-1.80: SAND, fine, well sorted, faint lamination, few shells, at 1,75: stone (6 cm), upper boundary: gradual transition, grey 2.5Y 5/1	HS
II												
	2.00											
III	2.14										-2.14: SAND, fine and very fine, well sorted, upper boundary in colour only, dark grey 2.5Y 4/1	FS
	3.0											
	4.0											
	5.0											
	6.0											

Enclosure 17

Date: 15.10.2002

Described by: TC/PK



Geological Survey of Denmark and Greenland

SEDIMENTOLOGICAL CORE LOG

Company: DONG, site survey CECILIE-2, BH C 5

Borehole id.: DGU nr. 560420.28

Water depth: 60.6 m

Position: 6251510.2 N 609455.8 E

havb 131-31-590018

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	0.00-1.00											0.00-1.00: SAND, fine, very silty, shells, upper .25 m: many shells, dark greyish brown 2.5Y 4/2	HS
II	1.00-2.00											-2.15: SAND, fine, well sorted, laminated, streaks of silty sand, few streaks with shell fragments, upper boundary gradual transition, grey 2.5Y 5/1	HS
III	2.00-3.00											-2.30: SAND, fine and peat, horizontal laminated, very dark greyish brown 2.5Y 3/2 -2.85: SAND, fine, clayey streaks, horizontal laminated, grey 2.5Y 5/1	FS
IV	3.00-4.00											-3.60: Heterolith: CLAY, silty and SAND, silty, horizontal laminated, at 3.18: thin streaks of peat, dark greyish brown 2.5Y 4/2 -4.00: SAND, fine, many streaks of clay, heterolithic, horizontal lamination, upper boundary sharp, dark greyish brown 2.5Y 4/2	FV
	4.00-5.00												
	5.00-6.00												

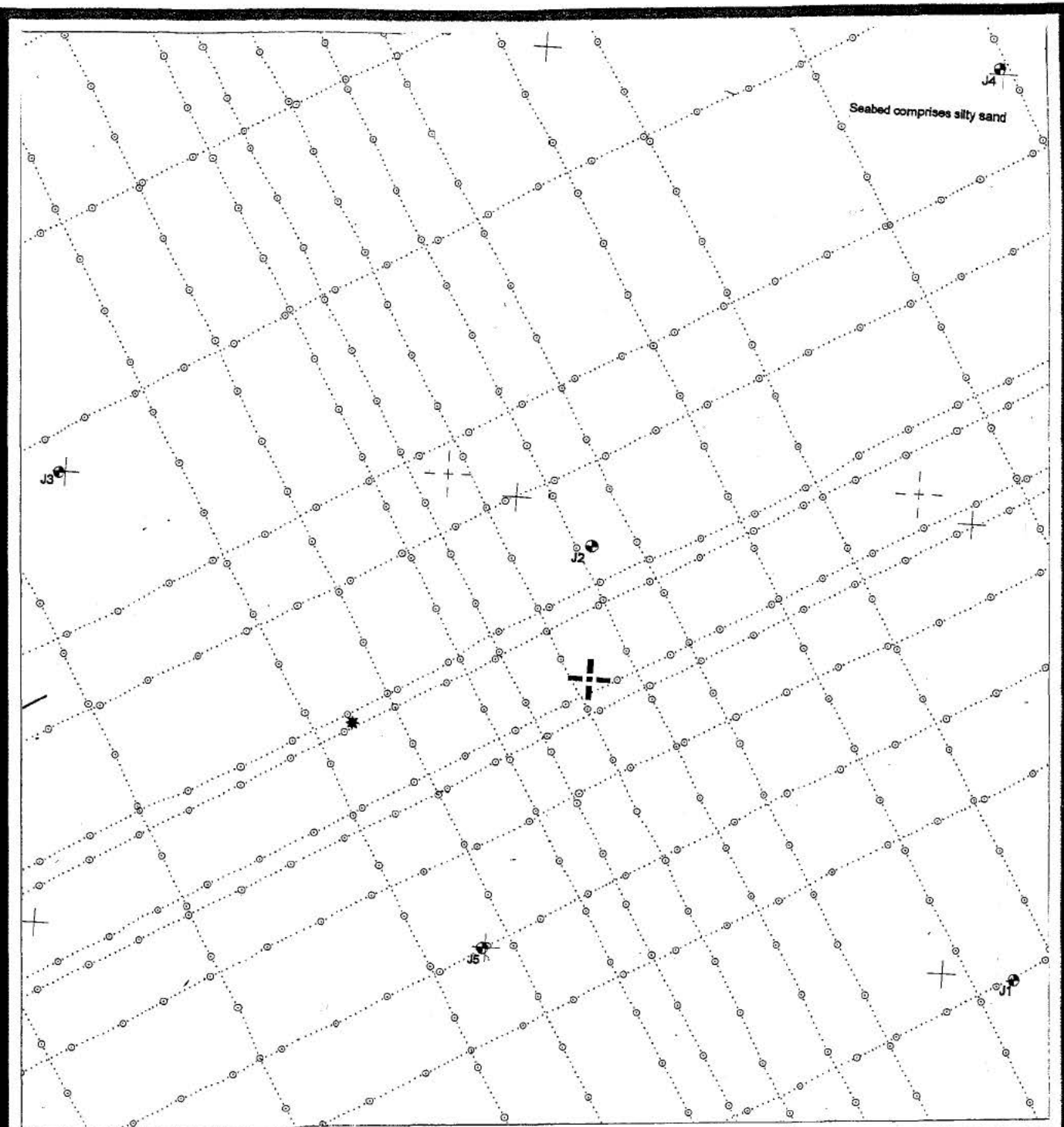
Enclosure 18

Date: 15.10.2002

Described by: TC/PK



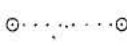





Geological Survey of Denmark and Greenland

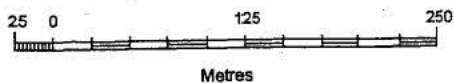


Seabed comprises silty sand

Seabed Features (Extract of Chart 5)

-  PROPOSED JETTE-1 LOCATION
(567 593E, 6 215 803N)
-  AREAS OF MODERATE REFLECTIVITY
EXPECTED TO COMPRISE AREAS OF SHELL
-  SIDESCAN SONAR TRACK DURING
ECHO SOUNDER, SIDESCAN SONAR
AND DIGITAL SEISMIC LINES
-  J1
VIBROCORE WITH STATION NUMBER
-  POINT CONTACT
-  SEABED COMPRISING SILTY SAND

Scale 1 : 6 000



Enclosure 19

SEDIMENTOLOGICAL CORE LOG

Company: DONG, site survey JETTE-1, BH J 1

Borehole id.:DGU nr. 560429.16

Water depth: 60.1 m

Position: 6215498 N 568080 E

havb 131-31-590020

Core	Core depth m	Litho-logy	Grain size & sediment structures							Description	Envi-ron & age		
			Clay	Silt	Sand							Gr	Pb
					vf	f	m	c	Vc				
I	0.00-1.20	(Symbolic representation of sand with shells)									0.00-1.20: SAND, fine and very fine, slightly silty, few gravel-size clats, above 0.20: shells and shell fragments (<i>Arctica islandica</i> , a.o.), dark grey 5Y 4/1, below 0.20: few shells and shell fragments, dark grey 5Y 5/1	HS	
II	1.81-2.00	(Symbolic representation of silty sand)									- 1.81: SAND, fine and very fine, silty, few lenses of clayey sand, bioturbated, few shells and shellfragments, dark grey 5Y 4/1	HS	
III	2.00-2.95	(Symbolic representation of clay)									- ~2.00: CLAY, slightly silty, sticky, with fine gravel-size clasts of lighter clay, dark greyish brown 10YR 4/2	TL	
	2.95-3.62	(Symbolic representation of clay)									- 3.62: CLAY, slightly silty, sticky, hard, many fine gravel-size clasts of lighter clay and coarse gravel-sizes clasts of dark clay, often with a rim of lighter colour, in lower part: clay-matrix with a little fine sand, few sand-sized clasts of Quarts, minute clasts of charred, organic particles, dark greyish brown 10YR 4/2	TL	
IV	3.62-6.0	(Symbolic representation of clay)											

Enclosure 20

Date: 02.10.2002

Described by: CSL/PK

SEDIMENTOLOGICAL CORE LOG

Company: DONG, site survey JETTE-1, BH J 2

Borehole id.: DGU nr. 560429.17

Water depth: 60.4 m

Position: 6215951 N 567586 E

havb

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	0.93	1.0							x		0.00-2.06: SAND, fine and very fine, slightly silty, upper 6 cm with gyttja, dark grey 5Y 3/1, above 0.4: shells and shellfragmets, at 0.35: few gravel-size clast, below 0.40: few shells and shell fragments, few coarse sand-size clasts, bioturbated?, minute charred organic particles, at base: clayey streaks and clayey layer, dark grey 5Y 5/1	HS	
II	1.93	2.0									- 2.54: SAND, fine and very fine, faintly laminated, few coarse sand-sized clasts, shells and shellfragments, lower 10 cm laminated with clayey laminae/layers, at base: rounded shellfragments and coarse sand clasts dark grey GLEY 1 3/N and grey 5Y 5/1	HS	
III	2.93	3.0									- 3.59: SAND, very fine, silty, faintly laminated, few clayey laminae, disturbed, few shell fragments, dissiminated minute, organic particles, at: 3,40 - 3.55: clayey sand and clay layers, disturbed, greyish brown 10YR 5/2	HS	
IV	3.72	4.0									- 3.72: CLAY, laminated, silt laminae, layers of clayey fine sand, dark greyish brown 10YR 4/2	TL	
	6.0												

Enclosure 21

Date: 03.10.2002

Described by: CSL/PK

SEDIMENTOLOGICAL CORE LOG

Company: DONG, site survey JETTE-1, BH J 3

Borehole id.:DGU nr. 560429.18

Water depth: 60.5 m

Position: 6215999 N 566993 E

havb

Core	Core depth m	Litho-logy	Grain size & sediment structures						Description	Envi-ron & age				
			Clay	Silt	Sand						Gr	Pb		
					vf	f	m	c	vc					
I	0.91	1.0	/	/	/	/				x		0.00-2.25: SAND, fine and very fine, slightly silty, upper 10 cm with gyttja, mottled and bioturbated, at 0.35 - 0.40 and 1.28 - 1.29: oblique laminae with gravel-size clasts of rock- and shell- fragments, few gravel-size and coarse sand-sized clasts, at 1.30-1.40: more silty, lower 0.35 m: very few clasts, shells and shellfragments, minute charred, organic particles, dark grey 10YR 4/1	HS	
II			/	/	/	/				x				
III	1.91	2.0								x				
2.25										x				
	3.0													
	4.0													
	5.0													
	6.0													

Enclosure 22

Date: 03.10.2002

Described by: CSL/PK

SEDIMENTOLOGICAL CORE LOG

Company: DONG, site survey JETTE-1, BH J 4

Borehole id.: DGU nr. 560429.19

Water depth: 60.7 m

Position: 6216506 N 567996 E

havb

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	0.94	1.0							γ	0.00-2.59: SAND, fine and very fine, slightly silty, upper 20 cm with gyttja and large shells (<i>Arctica islandica</i> , <i>Cardium echinatum</i> , <i>Astarte</i> sp., <i>Littorina</i> sp. a.o.), few gravel-size clasts, at 1.08, 1.81 and 1.89: shell hash, partly mottled = bioturbated, shells and shellfragments, dark grey 10YR 4/1	HS		
II	1.94	2.0						γ					
III	2.59	3.0							γ				
	4.0												
	5.0												
	6.0												

Enclosure 23

Date: 03.10.2002

Described by: CSL/PK

SEDIMENTOLOGICAL CORE LOG

Company: DONG, site survey JETTE-1, BH J 5

Borehole id.: DGU nr. 560429.20

Water depth: 60.4 m

Position: 6215499 N 567497 E

havb

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	0.91	1.0								γ		0.00-1.44: SAND, fine and very fine, slightly silty, upper 10 cm with gyttja and many large shells (<i>Arctica islandica</i> , <i>Cardium echinatum</i> , <i>Astarte</i> sp., <i>Littorina</i> sp. a.o.), few gravel-sized clasts of rock fragments, shells and shellfragments, mottled = bioturbated, at 1.40: shell hash, downcore fewer shells, dark grey 10YR 4/1	HS
II	1.44									γ			
										γ			
	2.0												
	3.0												
	4.0												
	5.0												
	6.0												

Enclosure 24

Date: 03.10.2002

Described by: CSL/PK

LEGEND

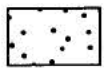
LITHOLOGY



Gravel



Sand and gravel
(conglomeratic)



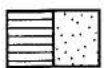
Sand, coarse



Sand, medium



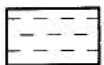
Sand, fine



Heterolith,
clay/fine sand



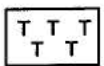
Heterolith,
clay/silt



Silt

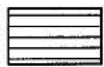


Clay

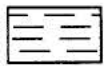


Peat

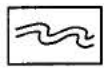
PRIMARY SEDIMENT STRUCTURES



Parallel lamination



Indistinct
parallel lamination



Disturbed
parallel lamination



Sharp boundary



Gradual boundary

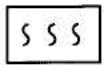


Unconformity,
(erosions boundary, hiatus)

FOSSILS



Shells



Bioturbation

ENVIRONMENT AND AGE

HL : Holocene marine clay

HS : Holocene marine sand

HV : Holocene marine
clay and sand

FS : Holocene freshwater
sand

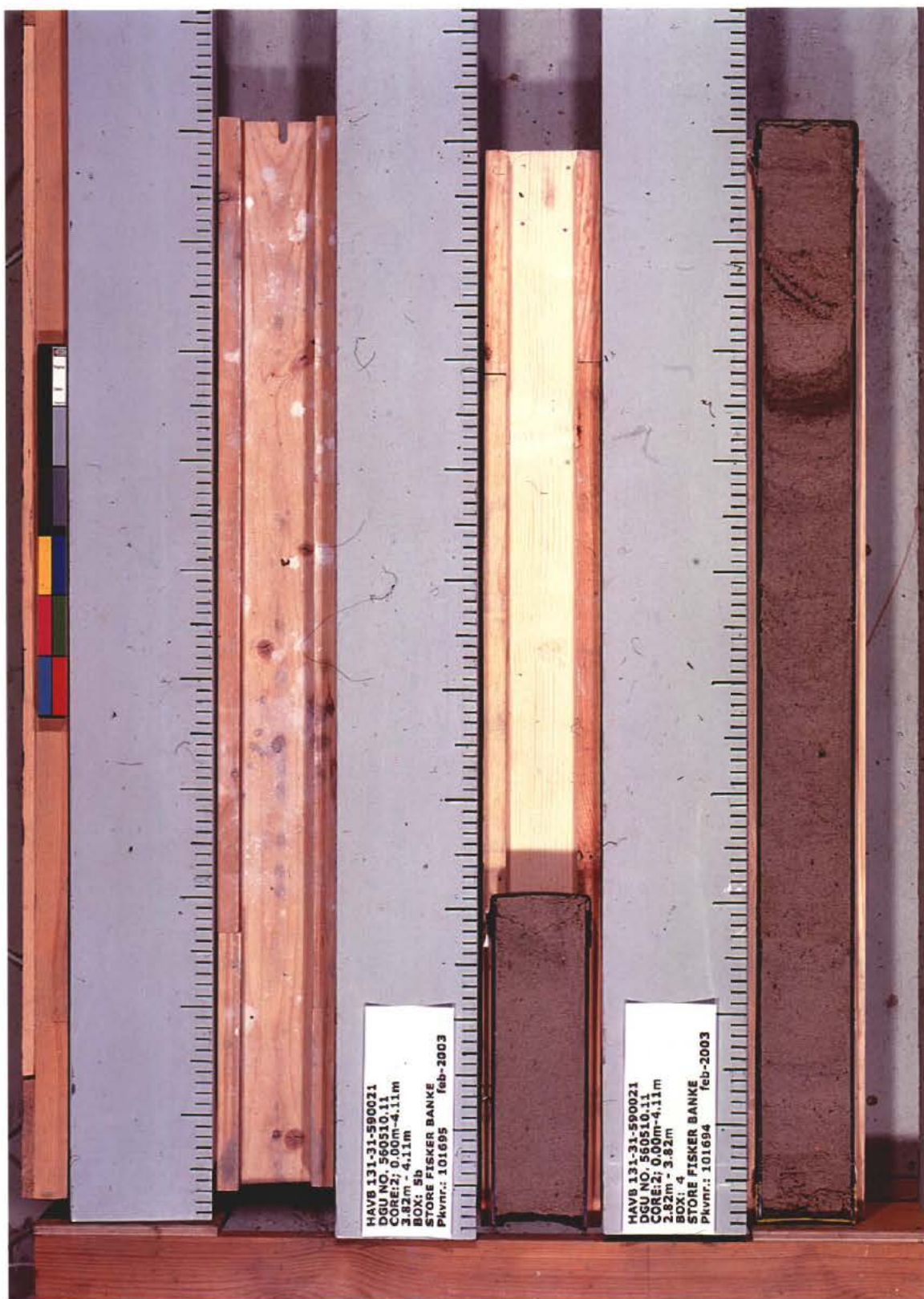
FV : Holocene freshwater
clay and sand

TL : Lateglacial clay

TS : Lateglacial sand

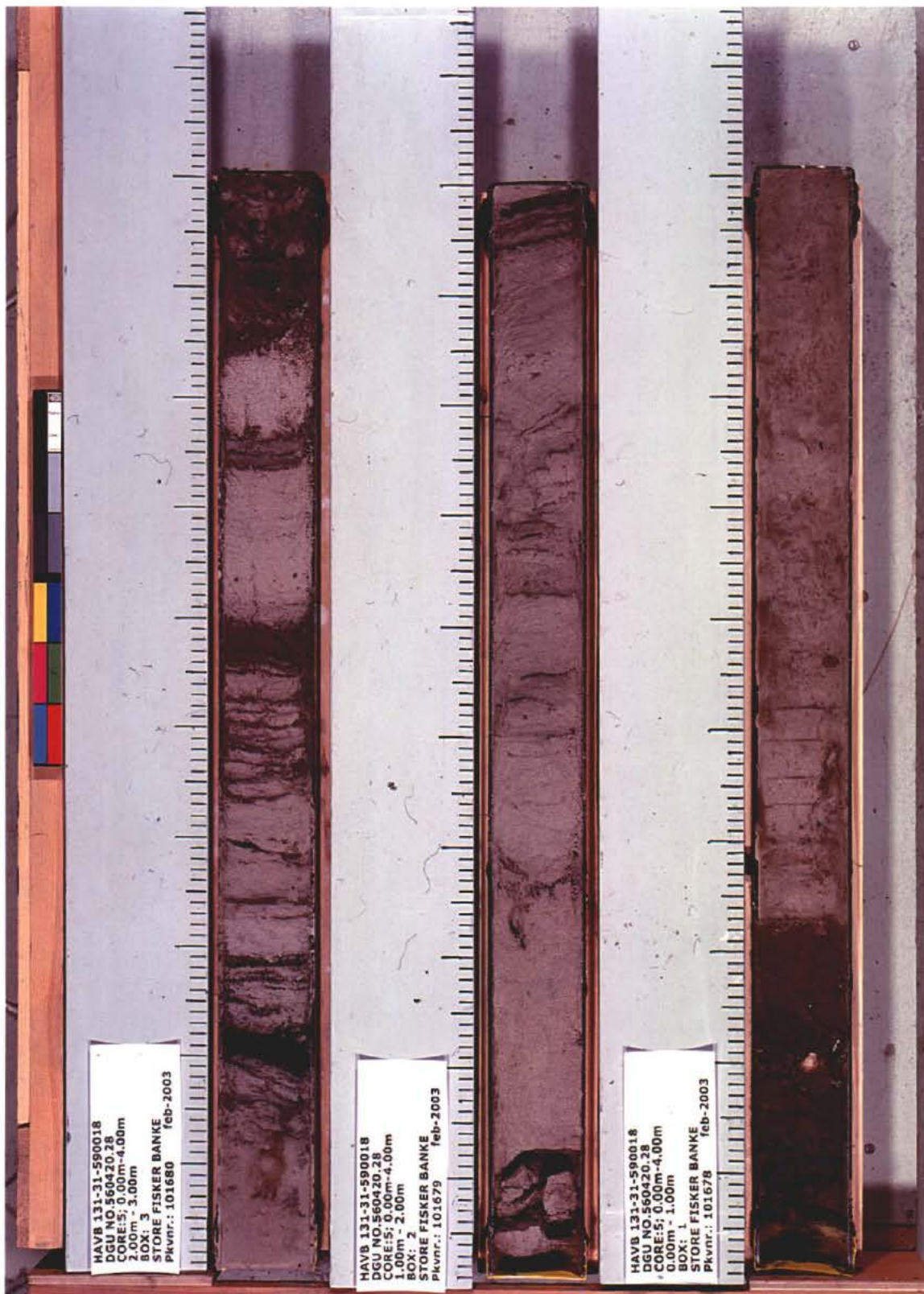


Enclorure 26a



HAVS 131-31-590021
DQU NO. 560510.11
CORE:2; 0.00m-4.11m
BOX: 5b
STORE FISKER BANKE
Plavn.: 101695 feb-2003

HAVS 131-31-590021
DQU NO. 560510.11
CORE:2; 0.00m-4.11m
2.82m - 3.82m
BOX: 4
STORE FISKER BANKE
Plavn.: 101694 feb-2003



HAVB 131-31-590018
DGU NO. 560420.28
CORE: 5; 0.00m-4.00m
BOX: 3
STORE FISKER BANKE
PKvnr.: 101680 feb-2003

HAVB 131-31-590018
DGU NO. 560420.28
CORE: 5; 0.00m-4.00m
BOX: 2
STORE FISKER BANKE
PKvnr.: 101679 feb-2003

HAVB 131-31-590018
DGU NO. 560420.28
CORE: 5; 0.00m-4.00m
BOX: 1
STORE FISKER BANKE
PKvnr.: 101678 feb-2003



Enclosure 27b

HAVB 131-31-590019
DGU NO. 560420.33
CORE:5; 0.00m-4.08m
1.66m - 2.62m
BOX: 3
STORE FISKER BANKE
Pkvnr.: 101684 feb-2003

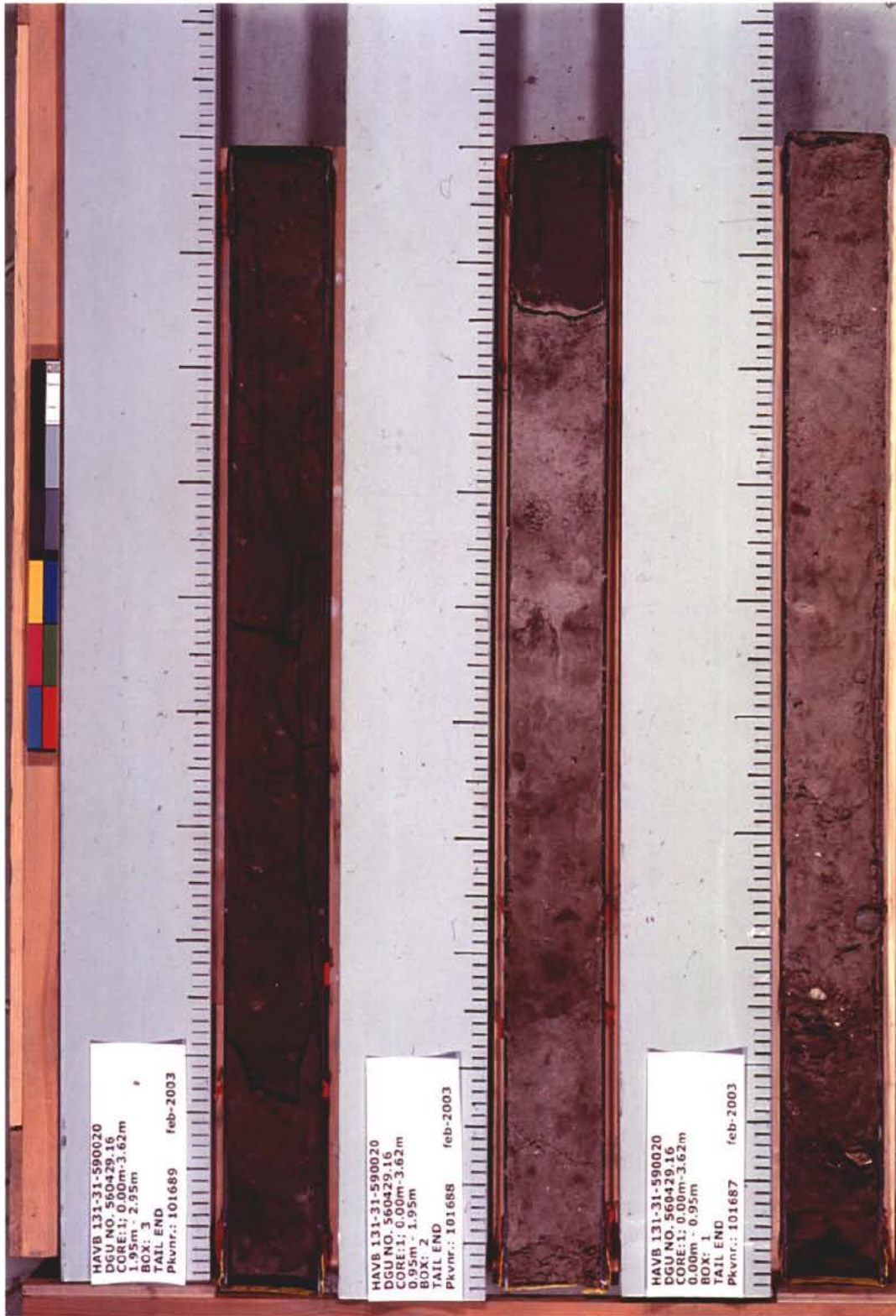
HAVB 131-31-590019
DGU NO. 560420.33
CORE:5; 0.00m-4.08m
0.80m - 1.66m
BOX: 2
STORE FISKER BANKE
Pkvnr.: 101683 feb-2003

HAVB 131-31-590019
DGU NO. 560420.33
CORE:5; 0.00m-4.08m
0.00m - 0.80m
BOX: 1
STORE FISKER BANKE
Pkvnr.: 101682 feb-2003



HAVB 131-31-590019
DQU NO. 560420.33
CORE S; 0.00m-4.08m
3.60m - 4.08m
BOX: 5b
STORE FISKER BANKE feb-2003
Pkvnr.: 101686

HAVB 131-31-590019
DQU NO. 560420.33
CORE S; 0.00m-4.08m
2.62m - 3.60m
BOX: 4
STORE FISKER BANKE
Pkvnr.: 101685 feb-2003



HAVB 131-31-590020
DGU NO. 560429.16
CORE: 1; 0.00m-3.62m
1.95m - 2.95m
BOX: 3
TAIL END
Pkvnr.: 101689 feb-2003

HAVB 131-31-590020
DGU NO. 560429.16
CORE: 1; 0.00m-3.62m
0.95m - 1.95m
BOX: 2
TAIL END
Pkvnr.: 101688 feb-2003

HAVB 131-31-590020
DGU NO. 560429.16
CORE: 1; 0.00m-3.62m
0.00m - 0.95m
BOX: 1
TAIL END
Pkvnr.: 101687 feb-2003



Enclosure 29b

SEDIMENTOLOGICAL CORE LOG

CORE NO.: DGU no. 560420.34
SIRI-5 well site, BH30-01

POSITION: E622.324
N6.261.031

Water depth: 58,3 m

Environment and age

Lab. sample	Core	PKV no.	Scale	Lithology	Grain size and Sedimentary structure	Description	Environment and age
	m						
0,38				/ / / / /		0,00-0,38 Clay, sandy, very soft, occ. Shell frag. Dark olive grey (2,5Y 4/2)	HS
0,50				- - - - -		0,38-0,50 Sand, fine, silty, clayey, occ. Shell frag. Dark olive grey (2,5Y 4/2)	L
0,66				/ / / / /		0,50-0,66 Clay, more sandy, than above, no shell, dark olive grey (2,5Y 4/2)	
1,00			1	/ / / / /		1,00-1,50 Clay, slightly sandy, silty, homogeneous, dark olive grey (2,5Y 4/2)	L
1,50				/ / / / /		1,50-1,66 Clay, more sandy than above, silty, occ. Shell frag. Dark olive grey (2,5Y 4/2)	
2,00			2	/ / / / /		2,00-2,13 Clay, sandy, hard, sticky, one shell, dark greyish brown (10YR 4/2)	S
2,13				. . . . .		2,13-2,39 Sand, fine to medium, dense, no shell, dark greyish brown (10YR 4/2)
2,39						S
3,00			3	. . . . .		3,00-3,59 Sand, fine to medium, dense, no shell, dark greyish brown (10YR 4/2)
3,30						
3,59						I
4,00			4	. . . . .		4,00-4,23 Sand, medium, no shell, dark minerals, olive grey (5Y 4/2)
4,23				- - - - -		4,23-4,52 Silt, sandy, clayey, no shell, dark grey (5Y 4/1)	
4,52				- - - - -			S
5,00			5	. . . . .		5,00-5,25 Sand/Silt mixture, medium to fine sand, occ. Shell and gravel, heterolithic, lamination of clay, olive grey (5Y 4/2)
5,25				. . . . .		5,25-5,29 Clay, silty, hard, lamination of organic material and of sand, olive grey (5Y 4/2)
5,29				. . . . .		5,29-5,42 Sand, fine to medium, no shell, organic in the bottom, dark grey (5Y 4/1)
5,42						S
6,00			6			

Master Grafsk	9/1/2003 TC	Date: _____ Described by: _____	Clay Silt F M C F C Sand Gravel	Enclosure 30 a (1-6)	Geological Survey of Denmark and Greenland
			0.002 0.02 0.06 0.2 0.6 2 6 20 mm		

DND402K001.04.01 - Master eng

SEDIMENTOLOGICAL CORE LOG

CORE NO.: DGU no. 560420.34
SIRI-5 well site, BH30-01

POSITION: E622.324
N6,261.031

Water depth: 58.3 m

Environment and age

Lab. sample	Core	PKVno.	Scale	Lithology	Grain size and Sedimentary structure	Description	Environment and age
6,00			6			6.00-6.42 Sand, fine to medium, seams of silty clay at 6.1 and at 6.37, dark grey (5Y 4/1)	S
6,42							
7,00			7X			7.00-7.44 Sand, fine to medium, seams of silty clay, no shell, dark minerals, dark grey (5Y 4/1)	
7,44						7.44-7.73 Clay, hard, very sticky, few gravels, occ shell and black spots, dark greenish grey (Gley 4/1)	L
7,55							
7,73							
8,00			8X			8.00-8.35 Clay, hard, very sticky, dark greenish grey (Gley 4/1)	L
8,15							
8,35						8.35-8.47 Silt with clay layers, heterolithic, more clayey in bottom, organic material, dark grey (5Y 4/1)	I
8,47							
9,00			9X			9.00-9.17 Sand, fine, silty, seams of clay, heterolithic, many shell frag., dark grey (5Y 4/1)	S
9,17							
9,59						9.17-9.59 Silt, sandy, seams of sand makes the sample crack, clay beds, heterolithic, no shell, dark grey (5Y 4/1)	I
10,00			10X			10.00-10.3 Silt, as above	
10,30						10.30-10.58 Silt, as above, with lamination	
10,58							
11,00			11X			11.00-11.39 Sand, fine, silty, with seams of silty clay at 11.18 and 11.28. heterolithic, horizontal lamination, dark grey (5Y 4/1)	S
11,39							
12,00			12X				
				Clay	Silt	F M C F C	Enclosure 30b (2-6)
						Sand Gravel	
				0.002	0.02	0.06 0.2 0.6 2 6 20	
						mm	

Master Grafisk

10/1/2003

TC

Date:

Described by:

Geological Survey of Denmark
and Greenland



SEDIMENTOLOGICAL CORE LOG

CORE NO.: DGU no. 560420.34
SIRI-5 well site, BH30-01

POSITION: E622.324
N6,261.031

Water depth: 58.3 m

Lab. sample	Core	PKV no.	Scale	Lithology	Grain size and Sedimentary structure	Description	Environment and age
12,00			12,0	□		12,00-12,30 Sand, fine, silty, no shell, dark grey (5Y 4/1)	S
12,30							
13,00			13,0	▨		13,00-13,74 Clay, silty, hard, seams of sand, occ. Shell frag., almost vertical lamination, dark grey (5Y 4/1)	L
13,16							
13,40							
13,74							
14,00			14,0	□	▬	14,00-14,40 Sand, silty, seams of silt, heterolithic, lamination, the seams of silt is not horizontal in top, dark grey (5Y 4/1)	S
14,40						14,40-14,73 Sand, as above, but with horizontal seams of silt, heterolithic, horizontal lamination, dark grey (5Y 4/1)	
14,73							
15,00			15,0	□	▬	15,00-15,23 Sand, fine to medium, one shell frag. Grey (5Y 5/1)	S
15,23						15,23-15,60 Sand/Silt, interlayered, fine to medium, seams of clay, heterolithic, lamination, shell and coarser sand in bottom, dark grey (5Y 4/1)	V
15,60							
16,00			16,0	▨		16,00-16,13 Clay, silty, very stiff, sticky, seams of fine sand, coarse gravel in bottom, horizontal lamination, dark grey (5Y 4/1)	
16,13							
16,50				□		16,50-16,65 Sand, fine to medium, no shell, dark grey (5Y 4/1)	S
16,65							
17,00			17,0	□		17,00-17,40 Sand, fine, slightly silty, no shell, dark grey (5Y 4/1)	S
17,40							
18,00			18,0	m			

Master Gridsk

Date: 13/1/2003
Described by: TC

Clay	Silt	Sand			Gravel		
0.002	0.02	0.06	0.2	0.6	2	6	20
							mm

Enclosure **30c**

(3-6)

Geological Survey of Denmark
and Greenland



SEDIMENTOLOGICAL CORE LOG

CORE NO.: DGU no. 560420.34
SIRI-5 well site, BH30-01

POSITION: E622,324
N6,261,031

Water depth: 58.3 m

Environment and age

Lab. sample	Core	PKVno.	Scale	Lithology	Grain size and Sedimentary structure	Description	Environment and age
18,00 18,12			18			18,00-18,12 Gravel, coarse; sandy, silty, slightly clayey, one large stone, many shells, dark grey (5Y 4/1)	QG
18,12 18,59						18,12-18,59 Sand, fine, occ. Shell and gravel at 18.2. 1 cherty gravel, dark grey (5Y 4/1)	QS
19,00 19,12			19 X			19,00-19,12 Sand, fine, with one clay lump, with shell and gravel, dark grey (5Y 4/1)	
19,12 19,46						19,12-19,46 Sand, fine to medium, grey (5Y 5/1)	
20,00 20,40			20 X			20,00-20,40 Sand, as above	
21,00 21,18			21 X			21,00-21,18 Sand, medium and coarse, silty, clayey, gravel, shell, grey (5Y 5/1)	QL
21,18 21,35						21,18-21,35 Sand, fine to medium, occ. Shell frag., grey (5Y 5/1)	QS
22,00 22,04			22 X			22,00-22,04 Sand, fine silty, shells, grey (5Y 5/1)	
22,04 22,19						22,04-22,19 Sand, fine to medium, occ. Shell frag., grey (5Y 5/1)	
23,00 23,04			23 X			23,00-23,04 Sand, fine to medium, silty, many shell frag., grey (5Y 5/1)	IS
23,04 23,49						23,04-23,49 Sand, medium, occ. Plant frag., grey (5Y 5/1)	
24,00			24 X				

Master Urofsk

14/1/2003

TC

Date:

Described by:

Clay	Silt	F	M	C	F	C	2	6	20

Enclosure 30d

(4-6)

Geological Survey of Denmark
and Greenland



DN0402K-001.0401 - Master eng

SEDIMENTOLOGICAL CORE LOG

CORE NO.: DGU no. 560420.34
SIRI-5 well site, BH30-01

POSITION: E622,324
N6,261,031

Water depth: 58,3 m

Environment and age

Lab. sample	Core	PKV no.	Scale	Lithology	Grain size and Sedimentary structure	Description	Environment and age							
30,00 30,10			30				DL							
30,35														
30,50 30,54						30,50-30,54 Clay, sample is missing								
30,80 30,90						30,54-31,38 Clay, silty, hard, interlayered fine sand and silt, heterolithic, horizontal lamination, dark grey (5Y 4/1)	DL							
31,40			31											
31,38														
			32			Environment - age								
						0,00-0,50 marine-Holocene								
						0,50-1,50 glaciolacustrine-glacial								
						1,50-2,13 glaciomarine-glacial								
						2,13-4,23 glaciofluvial-glacial								
						4,23-4,52 glaciolacustrine-glacial								
						5,00-5,25 glaciomarine-glacial								
						5,25-5,29 glaciolacustrine-glacial								
						5,29-7,44 glaciofluvial-glacial								
						7,44-7,73 glaciomarine-glacial								
						8,00-8,47 glaciolacustrine-glacial								
			3			9,00-9,17 glaciomarine-glacial								
						9,17-12,30 glaciolacustrine-glacial								
						13,00-13,74 glaciomarine-glacial								
						14,00-14,73 glaciolacustrine-glacial								
						15,00-15,23 glaciomarine-glacial								
						15,23-16,13 glaciolacustrine-glacial								
						16,50-16,65 glaciofluvial-glacial								
						17,00-17,40 glaciolacustrine-glacial								
						18,00-23,04 marine-interglacial								
			4			23,04-23,49 limnic-interglacial								
						24,00-24,10 marine-interglacial								
						24,10-24,60 limnic-interglacial								
						25,00-25,14 marine-interglacial								
						25,14-25,53 limnic-interglacial								
						26,00-27,69 glaciolacustrine-glacial								
						28,02-28,72 glaciofluvial-glacial								
						28,72-31,38 glaciolacustrine-glacial								
			5											
			6											
			m	Clay	Silt	F M C Sand Gravel	Enclosure 30f (6-6)							
Master Grafisk				0.002	0.02	0.06	0.2	0.6	2	6	20	mm	Geological Survey of Denmark and Greenland	
14/1/2003		TC												
Date:		Described by:												

DN0102K-001.04.01 - Master eng