DANMARKS OG GRØNLANDS GEOLOGISKE UNDERSØGELSE RAPPORT 2006/60

Horns Rev II Offshore Windfarm

Geophysical Survey, Cable Route

Client: ENERGI E2 A/S, A. C. Meyers Vænge 9,
DK-2450 Copenhagen SV, DENMARK
On behalf of Energinet Danmark

Steen Lomholt, Jørn Bo Jensen
& Peter Gravesen

GEOLOGICAL SURVEY OF DENMARK AND GREENLAND
MINISTRY OF THE ENVIRONMENT

GEUS

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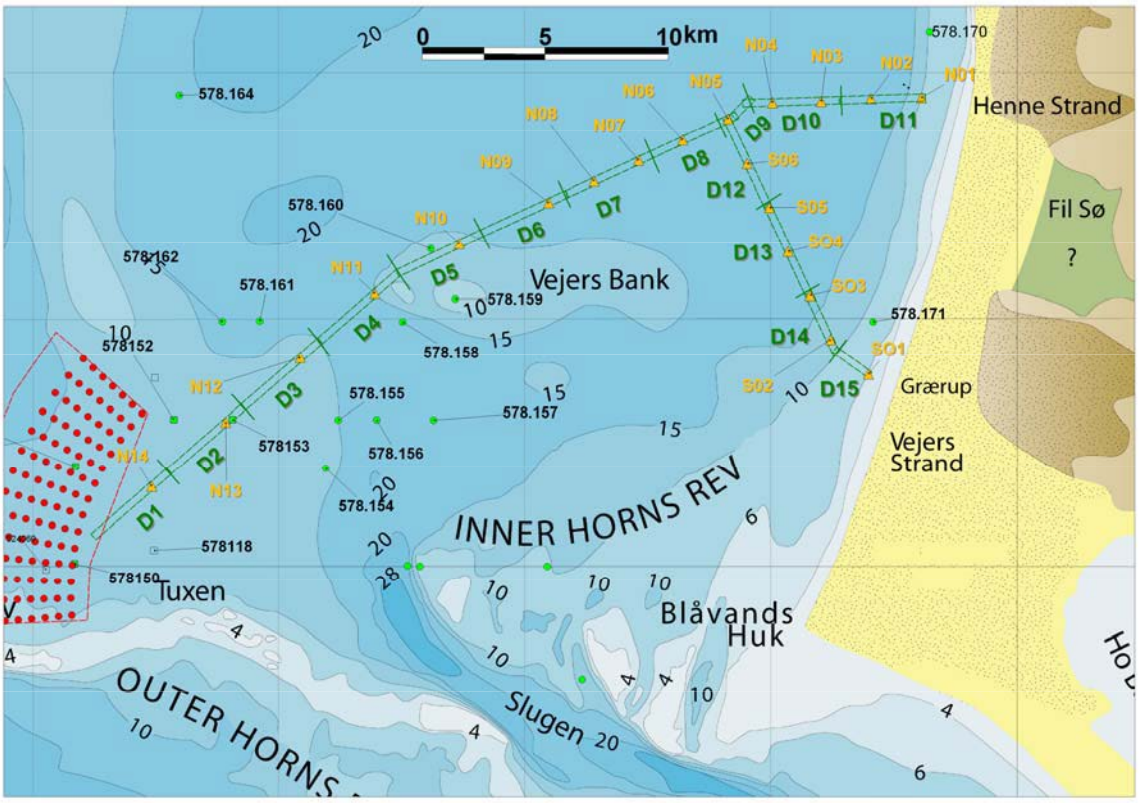
Geophysical Survey Horns Rev II

Cable Route



August 2006

Steen Lomholt
Jørn Bo Jensen
Peter Gravesen

Geological Survey of
Denmark and Greenland (GEUS)
Ministry of the Environment

Øster Voldgade 10
DK-1350 Copenhagen K
Denmark

Telephone +45 38 14 20 00
Telefax +45 38 14 20 50
E-mail geus@geus.dk

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1. Introduction

1.1 Aims and objectives of the geophysical survey

ENERGY E2 was awarded the concession for the offshore windfarm Horns Rev 2 in 2005 by the Danish Energy Authority. The installed capacity of the windfarm of approximately 215 MW will be exported to a connection point on land via a submarine cable. For the development of project a geophysical survey of the cable route has been conducted by The Geological Survey of Denmark and Greenland (GEUS) in May 2006. The brief objectives of the survey include for cable route, but are not limited to:

- To provide data for the ongoing environmental statement and the subsequent technical development on a various number of different subjects.
- To provide an accurate hydrographical chart of the potential development areas
- To map seabed features within the potential development areas including natural features and artefacts, obstructions and Ship Wrecks.
- To provide broad-based seabed classification of surface sediments for final design of a baseline benthic survey.
- To provide information on the shallow geology. Map variations in thickness of loose or mobile sediment cover, assessment of sand waves, dunes.
- To identify and locate any existing cable, pipelines, boulders, unexploded ordnance or other features that may impact on foundation or cable installation.
- To provide information and locate any existing ripples, boulders, visible fishing activities, inclinations or other features that may impact on foundation installation.
- To provide information on the geology of soil interfaces. Map variations in thickness of soil interfaces and provide information for the archaeological assessments of the area.

1.2 Scope of work

This report presents the final results of the survey programme of shallow seismic reflection acquisition, Side Scan Sonar, Magnetometer and seabed sampling investigating of the cable route from the HR2 Windfarm, plus the two proposed possible north and south routs, to the west coast of Jylland (Figure 1 and Appendix A1). Four windows (Appendix D1 – 15) are presented as the results of the investigations:

Upper window – Vessel track plot chart with shoot point annotations.

Second window – Bathymetric chart

Third window – Seabed Feature chart including sampling positions and magnometer targets.

Fourth window – Seismic reflection profile with interpretation of geological layers.

Figure 1. Site area for marine investigations.

2. Geophysical survey and sampling

The Geophysical survey and the seabed sampling was carried out during the period from 2006-04-21 to 2006-05-14.

In order to be able to evaluate the seabed and the subsoil in the Cable route area, a geophysical survey was carried out, including a variety of instruments. An EG&G Uniboom, a Benthos Side Scan Sonar, Marine Caesium Magnetometer and a Kongsberg EM 3002 Multibeam system.

The distribution of the seabed surface sediments and the subsoil has been mapped with the described combination of data acquisition systems, supplemented by 20 seabed samples, collected in the route.

To be sure to get a proper seismic penetration (>25m) it was decided to use a Boomer system with high power. That gives a seismic resolution in the order of less than 50 cm.

During all the survey activities, a RTK navigation system with a vertical resolution at less than $\pm$5 cm and with an accuracy of < 1m X Y direction was used.

The NaviPac software system has been used for acquisition of navigation data and offsets of instruments and the Quincy acquisition have been used fro the bathymetric survey.

The geophysical survey and the seabed sampling is done by GEUS, while Dansurvey has assisted GEUS with the Multibeam survey. During the project Dansurvey has change the organisation, and a new company, Scansurvey, has been established but the overall responsibility is still at Dansurvey.

2.1 EG&G Uniboom system

The boomer is used for high resolution subbottom profiling in shallow water surveys.

GEUS uses an EG&G Model 230 UNIBOOM surface-towed boomer. It uses a separate source and receiver with an operating speed up to six knots. Depending on conditions, the boomer gives a penetration to 50m and a resolution of 0.5m.

Figure 2. EG&G Boomer.

The system uses an 8-hydrophone streamer, which enhances the signal to noise ratio, and for data acquisition DELPH2 system of Elics is used.

Specifications:

System performance

General:	
Resolution:	Approaching 0.5m
Penetration:	(Depending on seafloor material)
Shallow water:	to 50 meters
Operating speed:	to 6 knots
Tow Depth:	Surface tow.
Source:	Uniboom.
Pulse length:	0.2 milliseconds (single pulse)
Frequency Spectrum:	400 Hz to 14 kHz.
Source level:	107 dB/microbar at 1meter at 300 joules
Input Power:	1 kilojoules/second max.

Input energy:	300 joules maximum.
Repetition Rate:	to 6 pulses per second.

Catamaran with sound source

Dimensions:	
Length:	1.58 meters
Width:	0.84 meters
Height:	0.59 meters
Weight:	90 kg
Cable Length:	60 meters
Towing speed:	1 to 6 knots
Receiver:	265 hydrophone array
Sensitivity:	-63 dB/volt/microbar
Bandwidth:	100 Hz - 10 kHz
Max Tow Speed:	15 knots
Tow Depth:	0 meter

Control unit

Channels:	1
Input power:	9 VDC, 2mA
Output Impedance:	2K ohms

Streamer:	
Length:	46 meters
Diameter:	12.5 mm
Weight:	8.3 kg

Active section.	
Number of Elements:	8
Length:	4.6 meters
Diameter:	25 mm/neutrally Buoyant

2.2 Side Scan Sonar

The Benthos SIS-1600 Series Side Scan Sonar is a fully integrated system that uses both advanced Chirp and conventional continuous wave (CW) technologies—single frequency or dual frequency—and an advanced high-speed communications link to acquire high resolution side scan sonar images.
The Benthos SIS-1600 is a complete side scan sonar survey system that includes a topside acquisition system and software, a 100-meter tow cable, the CL-160 Communications Link, and one of two available tow vehicles: the TTV-196 Tow Vehicle, which acquires long range, high resolution Chirp side scan sonar images in a single frequency band; and the TTV-196D Tow Vehicle, which acquires long range, high resolution Chirp side scan sonar images in two frequency bands simultaneously.

Figure 3. Benthos Side Scan Sonar.

System Highlights

▲ CL-160 Communications Link
▲ 100 kHz, 100 meter range
▲ 400 kHz, 100 meter range
▲ Topside sonar processor

System Features

The TTV-196D Tow Vehicle includes the transceiver electronics, the processing and communications electronics, the port and starboard side scan transducer arrays, the pitch, roll and heading sensors, and the optional sensors. The optional sensors include a water temperature sensor, a pressure sensor, a magnetometer, and a responder. Hydro dynamically stable tow vehicle with operating depth up to 1,750 meters.

Features

- Dynamic range - high frequency data up to 150 meters
- Enhanced resolution
- Repeatable transmitted waveforms
- Constant temporal resolution
- The pulse characteristics are programmable
- Stainless steel construction
- Seaconnet shipwreck, 400 kHz, 75 meter range

SYSTEM SPECIFICATIONS

Software
Application: Third party data acquisition and display (i.e.TEI “Isis Lite”, Chesapeake, “Sonarmap”)
Operating System: Microsoft® Windows® XP Professional

Hardware
Processor CPU: Intel® Pentium® 4 processor
Memory: 512 DDR SDRAM
I/O Ports: Wireless keyboard/mouse
RS-232 serial
Parallel
Ethernet 10/100 BaseT
Graphics Processor: Integrated high resolution graphics
Data Sorage: High capacity hard drive, CD/DVD-RW drive
CL-160 Communications Link

Physical Characteristics
Construction: 316 stainless steel
Dimensions: 11.4 cm (4.5 in.) outside diameter by 177.8 cm (70 in.) long
Weight in Air: 34 Kg (75 pounds)
Weight in Water: 25 Kg (55 pounds), approx.

Operating Depth: 1,750 meters
Towing Speed: 1 to 8 knots operational
Input Power: 144 VDC, 32 watts nominal

Side Scan Sonar
Acoustic Source Level: +225 dB re 1uPa @ 1 meter
Range: 25 to 500 meters each channel

Frequency Range
Chirp Frequency Range:
(TTV-196D): Simultaneously sweeps in the 110 kHz to 130 kHz and 370 kHz to 390 kHz bands
CW Frequency
(TTV-196D): Simultaneous 123 kHz and 383kHz
Transducer Radiation
(TTV-196D): 0.5 degrees horizontal, 55 degrees vertical (110 kHz to 130 kHz band), 0.5 degrees horizontal, 35 degrees vertical (370 kHz to 390 kHz band)

2.3 G-880 Marine Cesium Magnetometer

The Geometrics high resolution marine Caesium magnetometer system has been used for this survey. System features include very high sensitivity measurements of total field and gradient combined with rapid sampling.

A Larmor counter provides direct connection to a host CPU for integrated SideScan. The G-880 is completely digital, unaffected by shipboard noise, easily deployed and simple to operate.

A key element in the high performance of the system is the conditioning and the counting of the Larmor signal. Using a proprietary design mounted into the electronics pressure vessel, sensitivity, measurement rates, number of sensors and data format are selected by commands from the vessel. Counters from multiple sensors may be concatenated together to provide a sequential stream of RS232 data for transmittal through the tow cable.

Figure 4. G880 Magnetometer.

Features

- Sensitivity 0.02nT at 10 samples per second - selectable.
- Multi-sensor gradiometer arrays for precise search or diurnal corrected total field.
- Quick-connect integration to Side Scan Sonar systems with simultaneous data display.
- Tow cable lengths to 2500 ft. - digital data immune to shipboard noise.
- Petroleum - oceanographic - or search surveys.

Technical

Operating Principle: Self-oscillating split-beam Cesium Vapor (non-radioactive Cs133) with automatic hemisphere switching.
Operating Range: 17,000nT to 100,000 nT.
Heading Error: +/- 0.5 nT

Sensitivity: 90% of all readings will fall within the following Peak-to-Peak envelopes:

1. 0.05nT at 0.1 sec cycle rate
2. 0.03nT at 0.2 sec cycle rate
3. 0.01nT at 1.0 sec cycle rate

Operating Zones: For highest signal-to-noise ratio, the sensor long axis should be oriented at 45^{o}, +/- 30^{o} to the earth's field angle, but operation will continue through 45^{o}, +/- 35^{o}.
Gradient Tolerance: > 500nT / inch; >20,000nT / meter.
Three wire RS232, magnetic, up to 6 A/D channels for other sensors if present.

Larmor Counter:

1. Integrated into sensor electronics in 'fish'
2. Ref Osc: Nominal 22 MHz
3. Output data concatenated with other counters or data sources if present
4. A/D converters: 3 single and 3 differential, 12 bit resolution.

Control functions: Keyboard commands from surface

Tow Cable:

1. Shielded twisted pair of #12 conductors with 8 separate #20 conductors
2. Strain member: Kevlar, 10,000 lbs breaking strength
3. Maximum working load: 1250 lbs
4. Outside diameter: 0.65 inch
5. Bending diameter: 24 inch
6. Weight: Air: 215 lbs per 1000 ft. Water: 70 lbs per 1000 ft

lengths selectable to 2,500 ft (762 meters)

Power Supply:

1. Converts 115/220 50/60Hz AC to 28 to 32 VDC, 150 W
2. Provides cable junction for power & data

   8 x 9 x 4.5 inches, 6 lb

Environmental:

1. Operating / Storage Temperature: -45^{o}C to +60^{o} C (-40^{o} F to +140^{o} F)

   Depth: Pressure vessels in 'fish' rated to 4,000 ft (increased depth possible upon request)

Sensor 'Fish':

1. Heavy duty filament wound fiberglass,free flooded with stabilizer ring-fin assembly
2. Length:83 inches (cable stiffener and bulkhead termination adds 16 inches to length
3. Body outside diameter: 4.5 inches
4. Ring-fin outside diameter: 14.25 inches
5. weight in air: 38 lbs; in water: 12 lbs

2.4 Multibeam EM 3002.

The used system is a high resolution Kongsberg EM3002D dual head seabed mapping system. Each head delivers a 1.5° beam for transmission and reception, where the swath coverage of the dual head system can reach up to 10 times the water depth. In the high density mode of operation each head acquires up to 254 soundings per ping. The operating frequencies are 293 and 307 kHz to avoid interference between the two heads. The operation range of the system is from 1m to 150m, which is also a function of salinity and temperature. The depth resolution is very high (~1cm), the across track measurement accuracy is a function of depth and the distance from nadir position, a nominal range resolution of 5cm is reported.

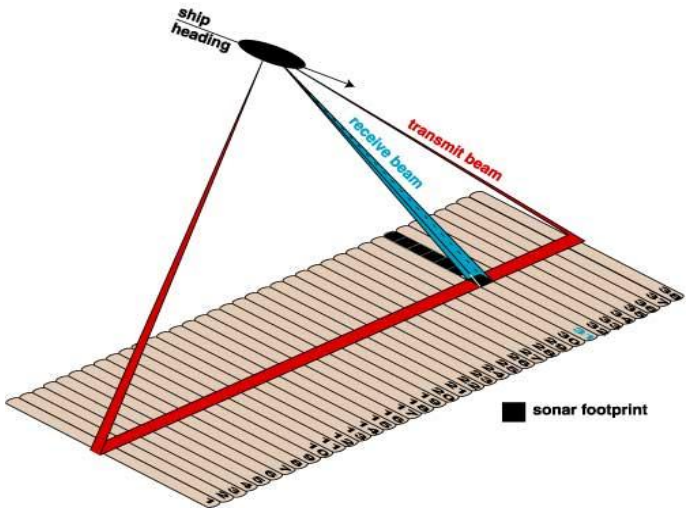


Figure 5. Schematic diagram of multibeam system operation.

Figur 6. The Kongsberg EM3002D side mounted at the survey vessel M/S Hans M.

Technical Specifications

Overall specifications per Sonar Head

Frequency: 293, 300 or 307 kHz

Maximum ping rate: 40 Hz

Number of beams per ping and sonar head: 160

Number of soundings per ping and sonar head: Up to 254

Beamwidth: 1.5 x 1.5 degrees

Beam spacing: Equidistant or equiangular

Coverage sector: 130 degrees per sonar head

Transmit beam steering: ±15 degrees in 0.5 degrees steps along track

Depth resolution: 1 cm

Pulse length: 150 µs

Range sampling rate: 14, 14.3 or 14.6 kHz (5 cm)

Beamforming method: Time delay with dynamic focusing in near-field.

Data storage rate: 50 to 400 MB/h (max at about 5-10 m depth)

Frequencies of 293 and 307 kHz are used in dual Sonar Head systems.

Receive beamwidth is inversely proportional with the cosine of the beam pointing angle with respect to the Sonar Head (i.e. beamwidth is 2.1° at ±45° beam pointing angle and 3.0° at ±60°).

Interfaces

• Serial lines with operator selectable baud rate, parity, data and stop bit length for:
- Motion sensor (roll, pitch, heave and optionally heading) in format supported by sensors from Applied Analytics, Seatex, TSS and IXSEA
- Gyrocompass in either NMEA 0183 HDT or SKR82/LR60 format
- Positions in either Simrad 90, NMEA 0183 GGA or GGK format
- Sonar head depth in Digiquartz compatible format
- External clock in NMEA 0183 ZDA format
- Sound speed sensor in AML Smartprobe format

EM 3002 / Base version

28 855-164929 / B

• Interface for a 1 PPS (pulse per second) clock sync signal

• Ethernet and serial line interface for input of tide and sound speed data and output of all data normally logged to disk.

Physical specifications

Sonar Head

Diameter: 332 mm
Height: 119 mm (+27 mm for connector)
Weight: 25 kg (15 kg in water)
Pressure rating: 500 m water depth
Diameter of cable to Sonar Head: 17 mm
Connector: Subconn LPBH9F
Material: Titanium
Power: 24 Vdc, 1 A (available from the Processing Unit)
A Sonar Head with pressure rating of 1500 m water depth is available with the same specifications except for height (121 mm) and a restriction in maximum swath width to 3.5 times depth (120° angular coverage sector).

Processing Unit

Height: 177 mm
Width: 427 mm (excluding rack fixing brackets)

Depth: 392 mm (excluding handles and connectors)
Weight: 14.5 kg
Power: 115 Vac (60 Hz) and 230 Vac (50 Hz), < 250 W

Operator Station
Height: 127 mm
Width: 427 mm (excluding rack fixing brackets)
Depth: 480 mm (excluding handles and connectors)
Weight: 20 kg
Power: 115 Vac (60 Hz) and 230 Vac (50 Hz), < 300 W

LCD monitor
Height: 400 mm (excluding mounting bracket)
Width: 460 mm (excluding mounting bracket)
Depth: 71 mm (excluding mounting bracket)
Weight: 9.2 kg
Power: 115 Va

2.5 NaviPac System

APPLICATIONS – The NaviPac software is integrated navigation and data acquisition software specifically suited for applications like:
● General navigation
● Hydrographic & oceanographic surveying
● Geophysical & seismic surveying

Modularity
NaviPac is modularity through use of multi tasking, multithreading and networking capabilities of the Windows NT, Windows 2000 and Windows XP operating system. The software is highly flexible and user configurable, and the user interface adheres to The Microsoft Interface Guidelines making it very intuitive and easy to operate.

Navigatio set-up
The NaviPac set-up module provides geodetic parameters, navigation systems, devices, offsets and port settings.

Device I/O drivers

A vast number of field-tested device I/O drivers are provided for most available positioning systems, GPS/DGPS receivers, gyros, motion/attitude sensors, tide-gauges, singlebeam echosounders, magnetometers, dynamic positioning systems, autopilots, etc. Generic I/O drivers allow definition or customization of own device I/O drivers. Data is interfaced via
RS232, a LAN or via a digital I/O interface

Time Synchronization

Time stamping of sensor data, incoming as well as utgoing, can be done in two ways, either by the internal computer clock or by he PPS output available from most GPS receivers. Using the PPS output data are synchronized relative to the GPS/UTC time frame, resulting in an accuracy of a few milliseconds.

Survey Planning

NaviPac allows for survey planning through quickly creation of planned survey area and survey lines. A variety of methods for creation of survey lines is provided, e.g. by click-and-drag (of mouse/trackball), input of survey line coordinates, offset (parallel) survey lines, cross lines, circles, arcs etc. Survey lines can easily be adapted to fit a defined survey area. Creation of templates allows input of other data formats.

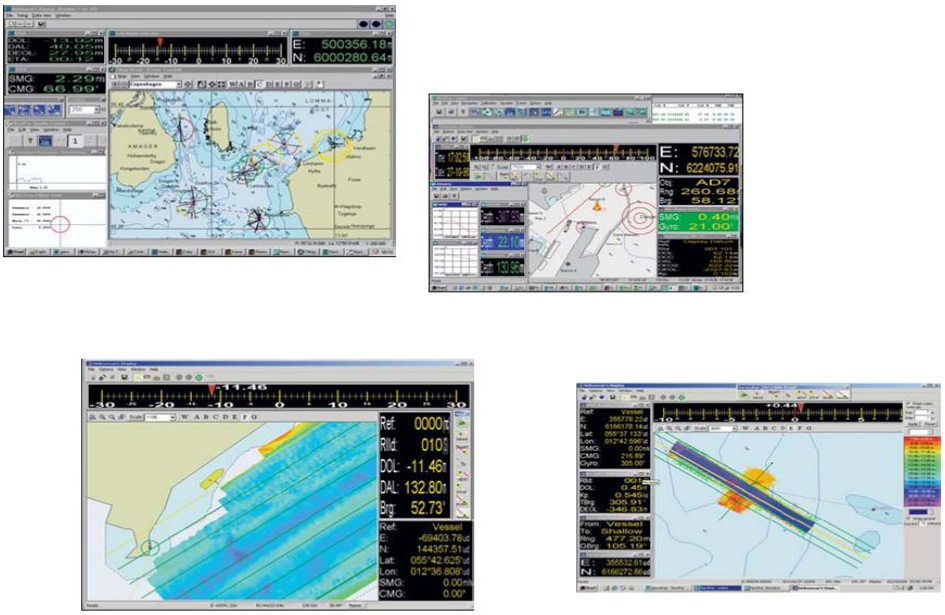


Figure 9. NaviPac.

2.6 QINSy System

Total Hydrographic Solution

QINSy is a turnkey solution for all types of marine navigation, positioning and surveying activities. From survey planning to data collection, data cleaning, volume calculations and chart production, QINSy has a seamless data flow from a large variety of hardware sensors, all the way to a complete chart product. QINSy runs on a standard PC platform under the Windows XP operating system. The software is not only independent of sensor manufacturer, but also hardware independent.

QINSy supports the following sensor types:

- Navigation Sensors
- NMEA
- GPS, DGPS and RTK
- Gyro's and Compasses
- Range/Range, Range/Bearing, Total Stations
- Motion Sensors
- ARPA and AIS
- LBL and USBL
- Inertial and Doppler
- User Defined :
    - Bathymetry Sensors
    - Singlebeam and Multibeam
    - Mechanical Profilers
    - SVP and Moving SV Profilers
- User Defined
    - Side Scan Sonar Sensors
    - Digital and Analog
    - Auto Pilot Sensors
    - NMEA
- User Defined
    - Magnetometer Sensors

- NMEA

- User Defined
  - Input and Output of Generic Sensors (analog, weather, rpm, environmental, etc.)
  - NMEA

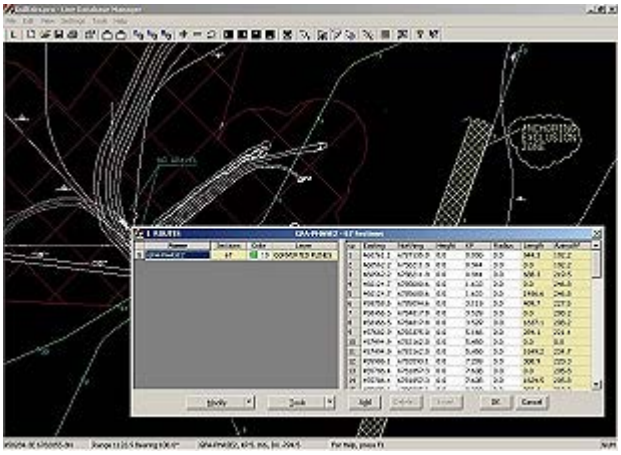
QINSy Console

Gathering and organizing the various QINSy 7 programs in a single desktop application, called the Console, makes navigation through the program suite at each phase of the project. guided through the various program modules designed specifically for survey planning, data collection, data processing and chart production. Program Managers provide a complete overview of project status at each phase. The main program modules are:

- Planning
- On-line
- Replay and SSS Processing
- Processing and Data Cleaning

Survey Lines

The Line Database Manager is a toolbox for survey planning, allowing the surveyor to manually define, automatically generate and/or import from ASCII and DXF files, the following line types:



- Targets and Symbols
- Single Lines
- Survey Grids
- Routes
- Wing Lines
- Cross Lines

Data can also be exported to ASCII or DXF

The Line Database Manager works interactively in real-time with the Online Navigation Display where points, lines and routes can be generated right in the Navigation Display during data ac Survey Configuration

Created at the planning stage with the Setup program, a Template Database contains all survey configuration parameters pertinent to the project. QINSy supports most of the datums, projections, US State Planes, units and geoidal models used world-wide. The template contains vessel shapes, administrative information, as well as vessel offsets and I/O parameters. It is a complete reflection of your current survey set up, and fully editable to kick-start your next project.

Real-Time Final Results - Data Collection and Output

Raw Sensor Data

All raw sensor data is logged and permanently stored in a fast relational database (*.db) to which the entire survey configuration is copied from the template. Raw data can be analysed and edited

using the Analyse program, making it ready for the Replay program and generation of new results if that is necessary. Results data (X,Y,Z and attributes) is stored to one of several formats, primarily the QPS internal format (*.qpd), but also to ASCII, FAU or Helical SDS format.

Data Storage

How raw and results data files are split up during acquisition is your choice. Data may be stored on a line-by-line basis, by file size, or by manual intervention. Whatever the method, data is normally stored in several separate databases for convenience in processing.

Accurate Timing and Ring Buffers

Supremely accurate timing is imperative in many survey situations. QINSy uses a very sophisticated timing routine based on the PPS option (Pulse Per Second) available on almost all GPS receivers. All incoming and outgoing data is accurately time stamped with a UTC time label. Internally, QINSy uses so-called "observation ring buffers", so that data values may be interpolated for the exact moment of the event or ping. Real-Time DTM Production

All computations of position are performed in 3D. In combination with RTK or real-time tide sensors, this means that all depth observations are immediately available in absolute survey datum coordinates. This unique technique is called "on-the-fly DTM production". QPS was the first company introducing the "delta heave" method, which means that the quality of the final DTM is not longer affected by heave drift caused by vessel turns.

Advanced Gridding Methods

For multibeam surveys, "gridding" is the predominant data reduction method. However, achieved reduction usually comes at the cost of loss of resolution. In QINSy there are two gridding methods, namely;

- An irregular gridding method in which the size of cells created in real-time is directly related to variation of the seafloor. In general, large cells, more appropriately called tiles, are created in flat seabed conditions and small tiles created in feature rich areas with slopes, wrecks, rocks, and sand ripples. This on-the-fly method effectively reduces the volume of data without loss of resolution.
- A regular multi-level gridding method. Based on the minimum cell size, 5 additional grids are generated on-the-fly. Grid file size is no longer an issue, since there is no limit to the number of grid cells. If the minimum cell size is selected to be 1 x 1 meter, then automatically the following grid levels are being generated:
  - 2 x 2

- 4 x 4
- 8 x 8
- 16 x 16
- 64 x 64 being the overview level

This grid can be used not only for bathymetry, but also for SSS Mosaicing, magnetometer data, seabed classifications, etc.

Both methods provide maximum flexibility in data acquisition since there is no longer any need to pre-define grid boundaries.

XYZ Data

Reduced point data output to tiles is accompanied in parallel with output of all soundings to a second file (*.qpd, *.sds, *.fau, *.pts or other).

Either reduced or full datasets are available for further DTM processing.

Processing - Validation, Editing, Calibration, Tide Reduction

Data Cleaning and Filtering

Applying various filters and corrections for motion, tide and refraction, QINSy is designed to output almost final results at the time of data acquisition. Moreover, the many quality assurance functions equip the surveyor with tools to qualify results data in real-time. Starting with cleaner and thinned data, effectively reduces time spent in post processing.

XYZ Attributes

All X, Y, Z and attributes are stored during data acquisition in a fast database, with the following attributes attached to each point:

- Identification (vessel name, system type, ping number, beam number, etc.)
- Status (accepted, rejected, filtered, manually edit, etc.)
- Backscatter
- Full 3D Geo-Referenced Side Scan Sonar (Snippet)
- User Defined On-line Flags
- Quality Parameters

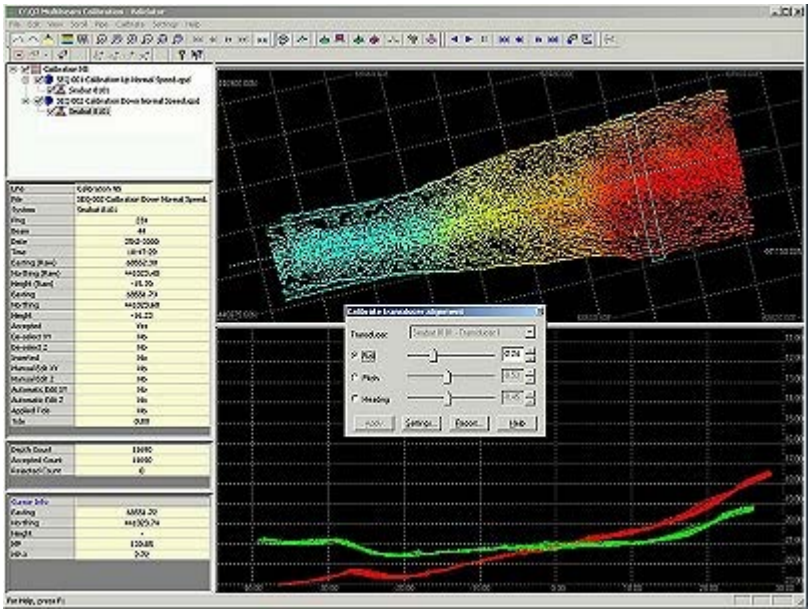
QINSy Processing Manager

All XYZ files are listed in the QINSy Processing Manager, tabulated against a history of processes performed on each file. This provides a complete overview of the project processing status. Processing programs are launched from the Processing Manager:

- The Tide Definition and Processing utility supports various methods for tidal reduction.
- The Validator supports both manual and automated data cleaning including advanced 3D splined surface cleaning

The QINSy Validator

Multibeam exploded the volume of point data and created data handling challenges both at the acquisition and processing phases. The Validator has 4 different views, 3 of which can be opened simultaneously:



- Plan View
- Cross View
- Profile View
- 3D View

Multibeam Calibration

Multibeam calibration with QINSy is inter-active and very easy. The Validator offers tools to calibrate for errors in:

- Roll
- Pith
- Yaw
- Timing

Singlebeam and Multibeam Data Editing

Editing of singlebeam or multibeam data. A variety of automated cleaning algorithms are available:

- Apply On-line Flags
- Clip Below / Clip Above
- Adaptive Clipping
- Median and Mean
- Butterworth
- 3D Spline Surface Despiker
- Multiply/Shift

The Validator adds fully automated pipeline detection features, such as:

- Top of Pipe Detection
- Bottom of Trench
- Mean Seabed Detection

2.7 RTK Navigation system

An AD Navigation DC202 GPS/GLONASS L1/L2 RTK long range receiver was used for the survey.

The RTK receivers from provide real time positioning data at the 1 cm level while attaining the highest reliability and stability possible. Seamless Combination GPS and GLONASS is the heart of the AD Navigation DC-202 RTK receiver. By seamlessly combining the GPS and GLONASS system, the RTK receivers access the total of 40 positioning satellites. During normal operation, the receiver track 30-50% more satellites than does a GPS-only system. Using diversity receiver techniques (dual antenna system), reception of the UHF signal is significantly improved compared to normal systems, even under difficult radio conditions.

The base station sends CMR corrections at up to 5Hz. The diversity receiver technique, in combination with high update rate of CMR correction broadcasts, results in operational RTK up to 80 kilometres from the RTK base station. With two GPS/GLONASS antennas installed, accuracies of 0.01 deg are achieved at 10 times per second. The unit contains no moving parts, and neither calibration nor maintenance is needed.

Technical specifications

Tracking: 20 Channel Dual Constellation (DC) GPS/GLONASS L1/L2

Cold start: < 60 secondsWarm

start: < 10 seconds

Reacquistion: < 1 second

Processing: Co-op Tracking and Advanced Multipath ReductionDC200 Series RTK Positioning1 and Heading

Accuracies2:Horizontal: 1 cm + 0.15 ppm RMS

Vertical: 1.5 cm + 0.15 ppm RMS (DC201/202)

Heading: 0.01 degrees RMS (DC202 only)Update Rate:

Positioning: 5Hz (DC201/202) 20Hz

Optional Heading: 10Hz (DC202 Only) 20Hz

Optional RTK Initialisation1: Typically 10-30 seconds

Operating Range3: Up to 80 km

Built-in UHF Radio

Modem: Frequency Range: 380-470 MHz25 Khz

Channel Separation19,200 bps on Air Transmission

Diversity Reception (Dual Antenna System)

Timing: External PPS Output PPS to TTL converted to RS232 Interrupt

Signal Output formats: GPS based NMEA-0183

Messages Proprietary ASCII and Binary

Output Formats CMR/RTCM, Differential Corrections

Input Formats: CMR/RTCM, Differential Corrections

Accessories:GPS/GLONASS L1/L2

Marine Antenna AC and DC Power Cables DB 9 Serial Cables Physical specifications

Power input: 12-28 VDC or 110-230 AC

Size: 2U 19” rack unit, 254 mm (d), 89 mm (h)Weight: 4.8 kg

Environmental: Vibration, EMI: EN 60945

Temperature:Operation: -20 to 55oC

Storage: -40 to 70oC

Communications: 4 x RS232 com ports, DB9, 115,200 bps1 x RS232 TTL, DB91 x PPS output, BNC-F1 x GPS antenna input, TNC-F (N optional) 2 x UHF antenna input, TNC-F (N optional)

1 Performance is dependent on GPS/GLONASS satellite geometry, environment, ionosphere conditions and distance to the base station

2 Antenna separation > 10 meter

3 Operating range is depending on availability of differential correction dataNote: Specifications subject to change without notice.

3. Summery of events

Date	Time	Activity	Comments
21-04-2006	08.00-20.00	Installing and mobilising Hans M	Work on ship
22-04-2006	08.00-20.00	Installing and mobilising Hans M	Work on ship
23-04-2006	08.00-20.00	Installing and mobilising Hans M	Work on ship
24-04-2006	08.00-20.00	Installing and mobilising Hans M	Work on ship
25-04-2006	08.00-20.00	Installing and mobilising Hans M	Work on ship
26-04-2006	08.00-20.00	Installing and mobilising Hans M	Work on ship
27-04-2006	08.00-20.00	Installing and Test of equipment	Work on ship
28-04-2006	08.00-18.00	Test of equipment in sea	
29-04-2006	08.00-18.00	Test of equipment in sea	
30-04-2006	08.00-18.00	Test of equipment in sea	
01-05-2006	08.00-18.00	Test of equipment in harbour	
02-05-2006	00.00-21.30	Test and calibration of equipment	Sea stat calm
12-05-2006	15.00-24.00	Surveying Cable Corridor	0-4 m/s NW, Waves:0,2-0,8m
13-05-2006	00.00-24.00	Surveying Cable Corridor + Grab sampling	6-10 m/s NW, Waves:0,5-1m
14-05-2006	00.00-01.00	Grab sampling	10 m/s ESE, Waves:1,5m
	00.10-06.00	Transit Esbjerg	
	06.00-10.00	Crew change and processing of Multibeam data.	

4. Health, Safety and Environment.

GEUS undertake full responsibility to provide for the safety, security and health of GEUS' personnel and to observe the respective laws and regulations of the area of operations.
GEUS tries continuously to improve the safety management skills of its personnel both ashore and aboard ships, including preparing for emergencies related both to safety and environmental protection. The target is zero level for injury, accidents, and lost time. The target is further to eliminate or control hazards by risk management at all workplaces.
GEUS covenants, warrants, and represents that its personnel and the personnel of its subcontractors are suitably trained to safely perform the service. The objectives of GEUS' Safety Management Manual are achieved by:

- Senior Management ownership of a Health & Safety Culture achieved by visible investment in GEUS' personnel.

- Maintaining high standards of safety consciousness, personal discipline and individual accountability by adherence to a comprehensive and documented system of training.

- Actively promoting employee participation in measures aimed at improving safety and protecting the environment including the right to stop work should the operational risk be found unacceptable. .

- Communications to personnel of known or potential hazards that may affect themselves, their colleagues, the ships equipment or the environment.

- Continuously reviewing all Health, Safety & Environmental mandatory rules, regulations, industry codes and guidelines that are relevant to our work sites, and business.

- Providing operational and health risk assessment.

- Maintaining a schedule of workplace auditing

All employees are required to comply with Safety and Pollution Prevention Regulations and Procedures at all times and to take the necessary precautions to protect themselves, their colleagues, the ship, its equipment, and the environment.
GEUS provides external assessed comprehensive safety training for its marine personnel as follows:

- Personnel Survival Techniques
- Fire prevention and fire fighting
- Elementary first aid
- Personal Safety and social responsibilities

4.1 Safety overview

There was one Safety Instruction meeting on board the ship before it left Esbjerg for the testing of equipment. The survey crew was instructed on the safety rules on board the ship. With crew change, new instructions were performed.

4.2 Accidents, near miss and unsafe Acts

Accidents

There were no accidents during the survey.

Near miss

There were no equipment miss reports during the survey.

Unsafe Acts

There were no unsafe acts reported.

Minor incidents.

There were neither equipment minor incidents reported nor personal minor incident.

4.3 Environmental incidents

There has been no environmental incident during the survey.

5. Survey Vessel

5.1 Ships configuration

The seismic survey and seabed sampling campaign included one ship - M/S Hans M. It was used for the combined shallow seismic, side scan and Multibeam Survey. M/S Hans M was hired by Esvagt, Esbjerg and it can be seen on figure 7.

Figure 7. M/S Hans M.

The survey configuration of M/S Hans M is shown in Figure 8.
Navigation was carried out by RTK DGPS connected to the NaviPac Navigation Acquisition computer distributing navigation data corrected for offset to the ISIS Side Scan data acquisition computer, Delph Seismic data acquisition computer and through QINSy, the Multibeam acquisition system. The mentioned data acquisition computers are connected to the sound sources in the water, via the individual power transmitters.

No tidal correction data are used during the survey. A RTK GPS system with high accuracy in x, y and z is used instead.

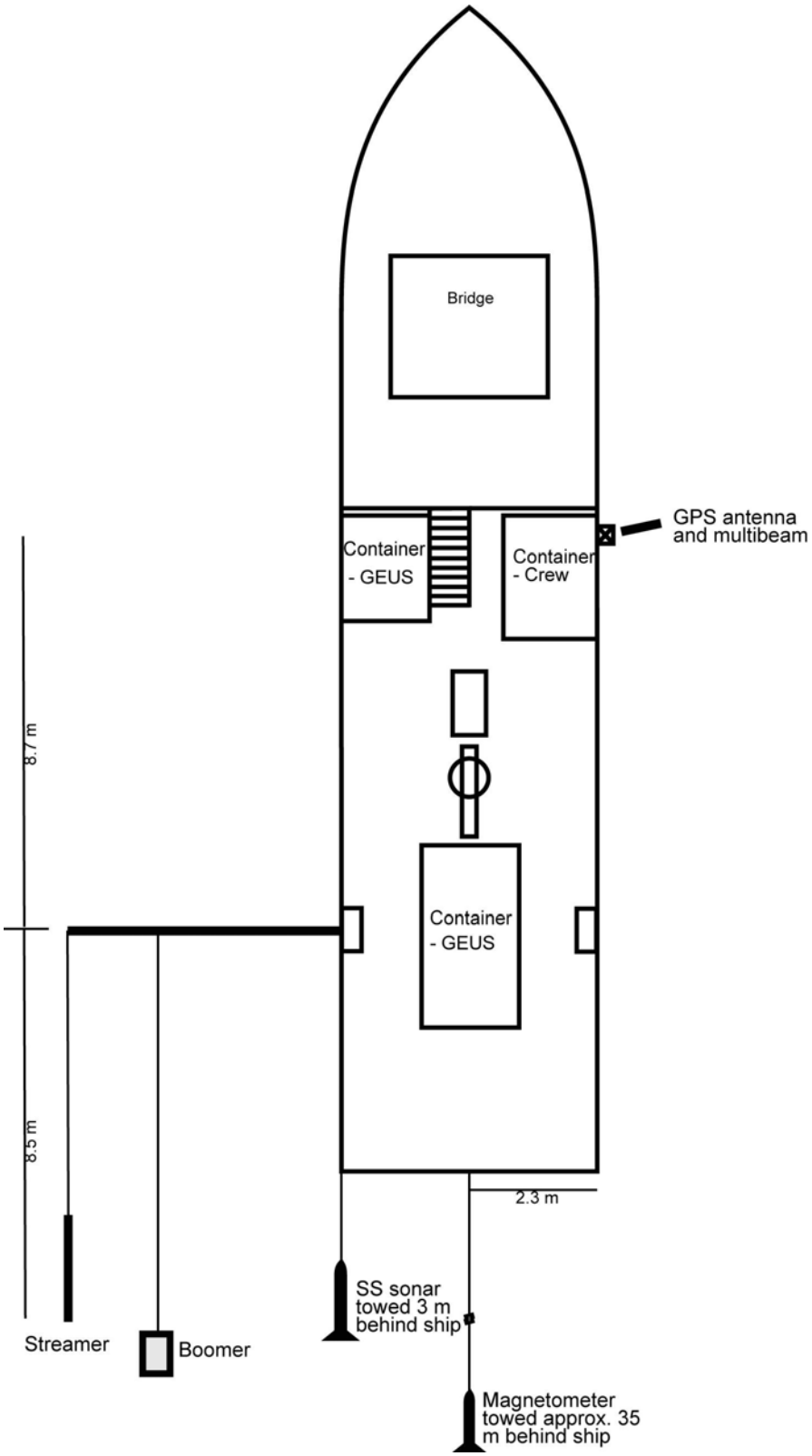


Figure 8. Acoustical equipment onboard M/S Hans M (not in scale).

The location and offsets of the acoustical equipment onboard M/S Hans M is shown in figure 8.
The Multibeam system was side mounted on M/S Hans M and the Side Scan sonar, the Boomer/Sparker catamaran and streamer and the Magnetometer was towed behind.
The Multibeam dual head Sonar system was side mounted with the GPS reference antenna on top, as shown in figure 9.

Figure 9. Multibeam acoustical equipment onboard M/S Hans M.

The side Scan System is towed behind the ship central with offsets of X=-4,6m Y=-16.7m.
The Boomer system was towed in the port site, with the catamaran offsets of X=-8.6m Y=-17.2m and the streamer offset of xx=-10.6m Y= -15.2m as shown on figure 8.
The Magnetometer is towed behind the ship central with offsets X=-2.3m Y=-48.7m.

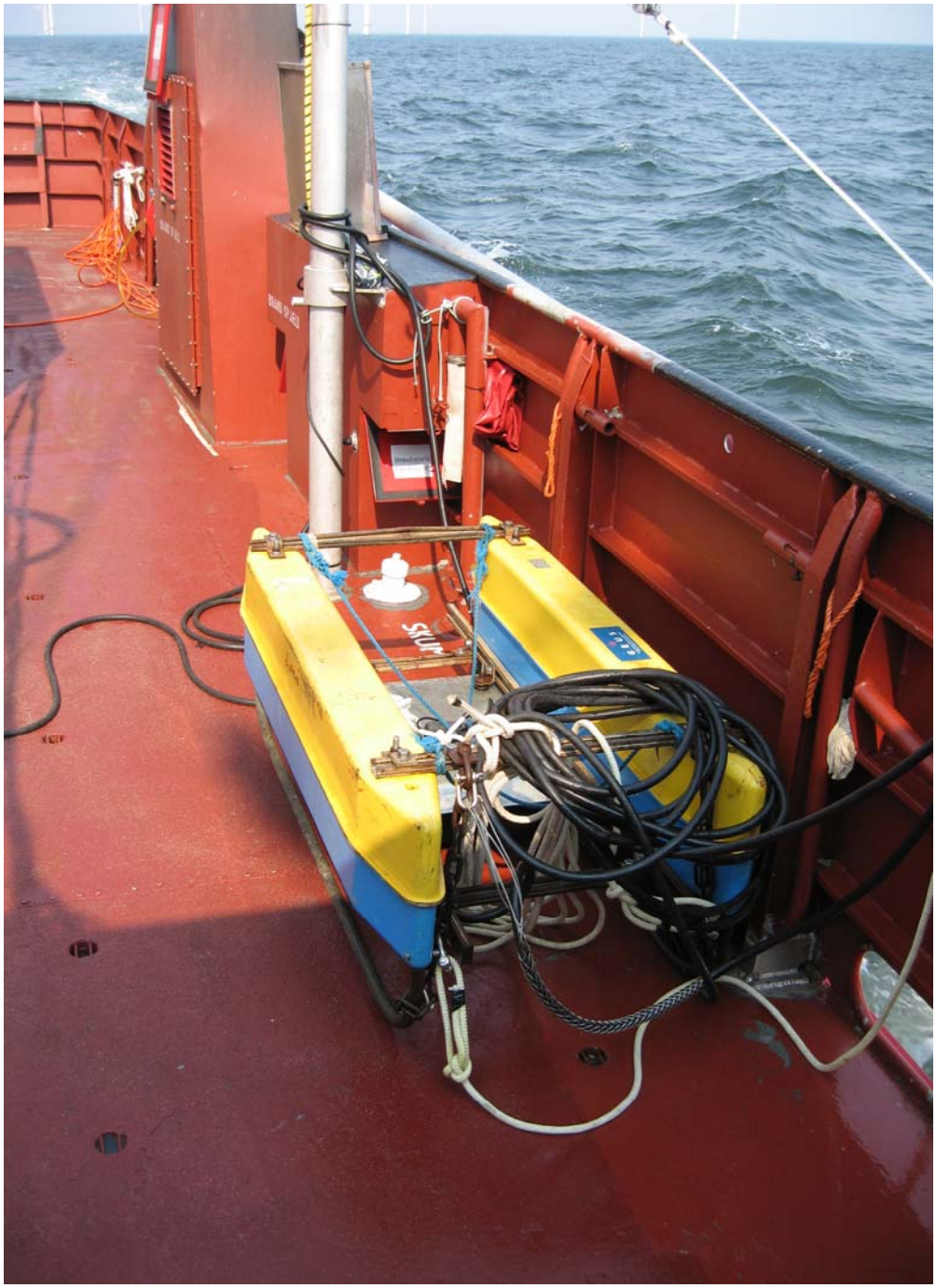


Figure10. Boomer seismic equipment onboard M/S Hans M.

6. Survey preparation

6.1 Mobilisation Trials

Checks was performed on each instrument before survey commencement to ensure that all the sensors and processing equipment specified are functioning correctly and performing within the manufacturer's specifications.

All checks were performed with supervision of the Employer's Representative, in order to establish any requirements for additional calibrations and any corrections that shall be applied to the gathered data. The Boomer seismic equipment was selected for the cable route survey.

Calibration of the Multibeam system was conducted in presence of the Employer's Representative on the 2nd of May 2006. (See the attached “Patch test 02052006, appendix C)

6.2 Positioning Systems

The surface positioning system was available during all phases of the survey and it provided an absolute accuracy of better than 3m. The system is an AD Navigation DC202 GPS/GLONASS L1/L2 RTK long range system, and it is based upon the differential Global Positioning System (DGPS). The positioning system was displayed onboard and real time quality control was maintained.
Before the mobilisation, the dGPS positioning system was checked against a calibrated reference point, the top of Blåvands Huk Lighthouse, where the antenna was located (See appendix C) and the controlpoints 1000 and 1001 established by "Landinspektørerne Syd I/S" the 25th of April 2006 on Pier in fishery harbour in Esbjerg (See report, Position check Esbjerg, Appendix C).

6.3 Compass

The vessel heading was be measured by compass and logged on the navigation
computer to enable the offsets to the various fixed and towed sensors to be computed.
The compass calibration carried out alongside pier by means of coordinated points.

6.4 Bathymetry

The transducer was side mounted as described in section 5. The multibeam echo sounder was compensated for heave in order to obtain heave corrected echo sounder records. Data was digitally recorded and displayed in analogue form for QC purposes.
A comprehensive report on test procedures is attached in appendix C.

6.4.1 Velocity test (SVP)

During the survey, SVP tests have been carried out at least twice every day and the results have been used for calibration of the echo sounder, if data shows change in sound velocity in the sea, supplementary SVP was carried out.

Figure 11. The SVP probe is made ready for a sound velocity profile.

6.5 Side Scan sonar

A test of the side scan sonar equipment was carried out with supervision of the Employer's Representative, in order to establish any requirements for additional calibrations and any corrections that shall be applied to the gathered data.
The side-scan sonar was a dual frequency hydrographic sonar and was able to identify objects as small as 1 m in horizontal dimension. Data was recorded digitally with all data automatically referenced for position and event data.
The system shall be operated at a range of 50 metres. During mobilisation the system was rub tested and wet tested for a 15 minute period to ensure that the system is operating to the manufacturer’s specifications.
The side scan sonar was tested in sea to localise seabed features at the seabed.

6.6 Boomer survey

The boomer instrument turned out to be the best suited equipment for the cable route survey, because the relative low frequency band allowed acceptable deep penetration. The system is described in detail in section 2.1. It is surface a towed boomer and seabed conditions were determining the choice of system.
The system is capable of delineating hard and soft layers in the first 25 metres sub seabed with a definition of 0.5 metres near the seabed and 1.5 metres at depth. It is understood that penetration may be less in the event that the sub seabed is dense. The boomer system has a reliable performance record, with sharp signature at input energy at 300 Joules, and be capable of operating at the maximum firing rates specified by the manufacturer.
All data was recorded digitally for subsequent processing and interpretation in SEGY format and was automatically referenced for position and event data (record lengthshall be 150ms). Signal processing on board the survey vessel was provided, including (but not limited to) time varying gain, band-pass filtering, stacking and heave or swell compensation.
The boomer/sparker and hydrophone was towed in such a configuration as to minimise the effects of propeller wash, ship's noise and vessel motion, the hydrophone shall be balanced to maximise data quality. The Employer's Representative agreed that the selected configuration gives the best results.
As part of the quality control, a pulse test from the boomer was performed in the harbour. Prior to the commencement of reporting the seismic horizons were selected as the key strata for reporting shall be determined in consultation between Contractor and Employer's Representative.
A test was prepared during the start up of the survey and supervised by the Employer's Representative

6.7 Magnetometer

The marine magnetometer was a Caesium Vapour type and capable of recording variations in magnetic field strength during survey to an accuracy of better than 0.1nTesla. All measurements are recorded in Gamma which is equal to Tesla.

The system has repetition rate selectable between 0.5 and 10 seconds and all data was recorded digitally via NaviPac (including sensor offset and tow depth).

Prior to commencing fieldwork, sea trials were conducted in an area of demonstrably low magnetic gradient to establish the optimum deployment location for the magnetometer, such that vessel heading errors are less than 10 nT. The marine magnetometer data is presented as a data listing of targets determined.

7. Seabed Sampling

20 seabed samples have been collected during the cable route survey. The purposes of the sea-bed sampling are to determine the seabed sediment composition and to help interpretation of the side scan sonar data, acquired during the seismic survey. The samplings have been conducted with a small Van Veen grab. It is hot-coated, galvanized steel except for the doors, suspension release and moving parts, which are stainless-steel. Its capacity is approximately 8 liters and, when open, it covers a surface area of 0.07 m^2. With 4 detachable, machined, lead weights, it weighs 26 kg; without weights it is 14 kg.

Results from the standard grain size analysis and loss on ignition from the surface seabed sample analysis are in appendix B.

The mean diameters of the samples are listed in table 1.

Size Classes	Sample no.	S-01	S-02	S-03	S-04	S-05	S-06
Silt and clay	(< 0,063 mm):	1.55	3.22	3.28	4.79	8.77	2.99
Sand, fine	(0,063 - 0,200 mm):	97.70	94.21	83.73	77.59	83.17	92.34
Sand, medium	(0,2 mm - 0,6 mm):	0.61	2.13	12.44	16.08	7.48	3.82
Sand, coarse	(0,6 mm - 2 mm):	0.11	0.31	0.27	0.88	0.28	0.67
Gravel	(> 2 mm):	0.03	0.13	0.28	0.66	0.30	0.18
	Median	0.12	0.13	0.14	0.15	0.14	0.14

Size Classes	Sample no.	N-01	N-02	N-03	N-05	N-06	N-07	N-08	N-09	N-10	N-11	N-13	N-14
Silt and clay	(< 0,063 mm):	1.92	6.94	4.68	2.44	4.01	3.75	3.12	4.73	1.66	0.68	1.14	1.23
Sand, fine	(0,063 - 0,200 mm):	42.63	87.09	81.04	88.21	90.10	79.71	86.01	73.05	66.66	22.04	5.02	22.14
Sand, medium	(0,2 mm - 0,6 mm):	53.34	5.37	11.95	8.95	5.57	15.57	10.40	21.75	29.87	75.96	89.92	72.40
Sand, coarse	(0,6 mm - 2 mm):	1.81	0.36	0.85	0.18	0.26	0.55	0.20	0.37	1.39	1.29	3.89	4.20
Gravel	(> 2 mm):	0.30	0.24	1.49	0.21	0.05	0.41	0.28	0.09	0.42	0.03	0.03	0.04
	Median	0.22	0.12	0.14	0.14	0.14	0.14	0.14	0.15	0.17	0.24	0.32	0.26

Table 1. Grain size classes in % and median diameter of the seabed samples from the Cable-Route.

As it can be seen from table 1, all samples are fine grained sand except N-01, N-11, N-13 and N-14. The Loss on ignition is also low, less than 0.5 % in the same four samples (Appendix B).

8. Generel geology

8.1 Geological setting

8.1.1 Topography

The Horns Rev is a series of seabed structures located offshore west of Blåvands Huk. They can be followed into the North Sea to at least 7^{o} 20` E. The Horns Rev consists broadly of the Inner Horns Rev and the Outer Horns Rev separated by the 20 m deep channel Slugen (Figure 12, ref. 1and ref. 2).

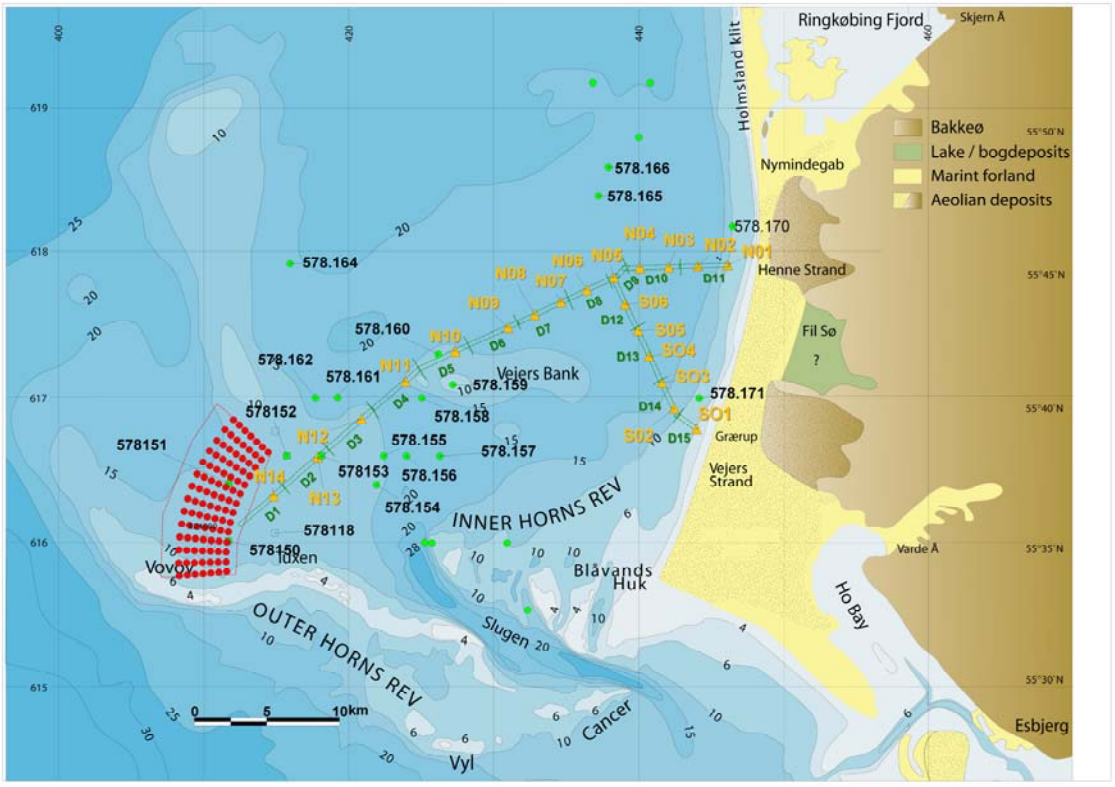


Figure 12. Overview map showing the cable corridor and the Wind Farm areas
(Detailed map Figure 13)

The Inner Horns Rev just west of Jylland is a 6 km wide sand bank which reaches 16 km out into the North Sea. In some areas the top of the bank is situated only 1 m below sea level, but generally the water depth is between 2-7 m. West of the Slugen deep the Outer Horns Rev extends approx.

40 km westwards into the North Sea. The water depth is often between 4 and 10 m but can be lesser.
Along the coastline between Blåvands Huk and Henne Strand the seabed is a 5-10 km broad flat area which slobes regular from 0 m to 15 m below sea level towards the west. Most of the seabed area north of the Horns Rev is a rather flat area with water depths mainly between 10 and 15 m. The Vejers Bank is a small more shallow area with water depths below 10 m.
The cable route is oriented north east from the Outer Horns Rev´s Vovov high (water depths 7-18 m below sea level) crossing the Vejers Bank and continuing as northern branch to Henne Strand at the coast of Jylland. A southern branch is separated approx. 10 km from Jylland and the southern branch reaches the coast of Jylland at Vejers Strand.

8.1.2 Pre-Quaternary deposits

Tertiary strata - most likely of Miocene age - form the basis of the Quaternary deposits at a depth of generally more than 50 m below the seabed. The level of this surface, however, is beyond the relevance level for the wind park project. Therefore, the focus in the present mapping is the Quaternary deposits overlying the Tertiary deposits.

8.1.3 Quaternary deposits

The following deposits from the Quaternary have been recognised below the seabed: Older interglacial (Holsteinian) (More than 240.000 years from present), the Saalian glacial (Between 240.000 and 130.000 years from present), the Eemian interglacial (Between 130.000 and 117.000 years from present), the Weichselian glacial (Between 117.000 and 11.500 years from present) and the Holocene (postglacial) (From 11.500 years from present to present).
The Quaternary succession can be divided into several units based on marked seismic reflectors and the seismic pictures of the units. The cable route cross section (Figure 13) nicely illustrates the general stratigraphy which will be described in the following sections.

8.1.4 Older interglacial (Holsteinian)

Marine interglacial deposits older than the Saalian are recognised in the central North Sea (Ref. 3) and onshore Jylland between Varde and Skærbæk up to 130m thick marine clay deposits from the late Elsterian – Holsteinian are known from many drill holes (Ref. 4). The climate and environment conditions during this period have been similar to the present day North Sea. The occurrence of these types of deposits cannot be excluded in the Horns Rev area and perhaps older glacial deposits (Elsterian) can occur as well.

8.1.5 Saalian glacial

The most important Quaternary deposits in the area are probably of Saalian age.
The top of the glacial deposits is represented by a regional erosion surface shown as a marked seismic unconformity on top of the glacial deposits (Figure 14).
This reflector is correlated to the surface of the Saalian, Varde hill island (bakke-ø) landscape onshore and the Vovov hill island located below and north of Outer Horns Rev. The old Saalian landscape onshore protrudes above the flat post-glacial (Weichselian) melt water deposits.
Due to re-advances of the ice sheets the older deposits within the Horns Rev bakke-ø landscape has been truncated. Below the unconformity and truncation surface chaotic seismic signals displays small-scale hummocky clinoforms, vertical and subhorisontal reflectors and channel like features. In the offshore region similar structures have been recognised in the southern North Sea.

In the cable crossing area north of the Horns Rev a succession of seismic units have been found above the erosion reflector. These units are deposited where the Saalian landscape forms a wide depression / basin down to at least 35 m below sea level. The oldest unit in the basin is the Upper Saalian Melt water Unit with a maximum thickness of up to 20 m, which consists of fine-medium gravely sand known from a few boreholes.
In some areas the erosion reaches down to about 50 m below sea level between the Vovov Bakkeø and the onshore Saalian landscape. The units yield evidences of the different stages of development such as sea level fluctuations since the end of the Saalian glacial period.

On Vovov hill island the glacial top surface lies from to 18 to 20 m below sea level.

A few boreholes from the area have information about the Saalian hill island deposits from which it is demonstrated that melt water sand and gravel are found inside the Bakkeø. The Saalian consists mainly of medium and coarse-grained sand and gravel with subordinate fine-grained sand with silt layers but also mainly fine-grained and silty sand with mica and plant fragments occur. This is very similar to the onshore Danish hill islands in western Jylland where the deposits also are very sandy (ref. 2, ref. 5). Sandy and clayey tills and diamictons with gravels, stones and boulders may also be expected even though only one borehole has encountered a thin layer of sandy clay till. In the Vovvov area west of the cable crossing many large boulders have been observed at the seabed which indicate that tills are located below the seabed in the area as the boulders perhaps have been washed out of the tills.

The chaotic seismic picture points to strongly disturbed deposits and that whole Saalian consist of glaciotectonic deformed sand and gravel (and tills) which have been eroded at the end of the Saalian (ref.3). The seismic sections also show several channels and valleys cut down into the

Bakkeø. The reflectors inside these structures have parallel features and points to water deposited sediments. Therefore, the valleys have probably been filled of melt water sand and gravel during the last phase of the Saalian when the large glacier melted (ref.7). Valleys in the Horn Rev area and the surroundings have been mapped (ref. 9) and an Elsterian or Saalian age has been suggested. It may, however, not be excluded that the top deposits in these valleys also be can be younger.

Onshore Jylland the Saalian Varde hill island is situated close to the coast and it reach highs of + 25 m above sea level. In the areas very near the shoreline the hill island deposits is found below younger deposits but the Varde Bakkeø slobes from + 25 m above sea level to – 20 m below sea level just outside the coastline. The whole area is regarded as one connected hill island which along the rim towards the west has been severe eroded (ref. 2).

8.1.6 Eemian interglacial

The Eemian unit has been mapped based on weakly, light structure reflectors on the seismograms and the top is often a marked reflector fig. 3 (ref. 2, ref. 6). The lower boundary of the deposits is often marked by reflectors which show small channel structures eroded into the layers below. The Eemian deposits are suggested to overlie the Saalian hill island and/or melt water Unit.

The unit is up to 13 m thick and the top has been found between 11-14 m below sea level. The top slopes gently towards the west. The deposition of the unit is related to the highest sea level of the Eemian period. This shallow Eemian sea covered almost the whole area but only partly flooded the Saalian glacial deposits such as the Vovov Bakkeø. Between Vovov hill island and Jylland occasionally Eemian freshwater sediments with plant material are deposited in depressions and occur below younger Eemian marine clays and sands.

A few boreholes shows that the Eemian deposits consist of olive grey silty clay and sandy silt with sand lenses, which often are bioturbated and contain shells and shell fragments. Also fine-medium grained, weakly silty and laminated sand occurs. The marine Eemian layers form a wedge which is onlapping the Vovov hill island but channels or erosion scours may occur at the bottom of the unit as known from other localities in Horns Rev area (ref. 2, ref. 8)
Eemian fresh water lake deposits are found below marine layers and fresh water layers with plant content.

8.1.7 Weichselian glacial

The Weichselian deposits show a seismic signature characterised by short wavy reflections and hummocky clinoforms pointing to channels and small lakes. The thickness is from 3 to 11 m. Meltwater deposits from the Weichselian have been found in restricted areas east of the Vovov Bakkeø and as a meltwater sandur cone that represent remnants of a distal river system outlet probably from the Skjern River to the northeast of Inner Horns Rev, as a continuation of the onshore sandur deposits. From regional studies it is known that the area was ice-free during the Weichselian. Intense erosion and re-deposition in the Late Weichselian and the Holocene melt water and flood-plain deposits from the Weichselian period have diminished the Weichselian deposits in the area.
A northweast – southeast trending Weichselian valley (from Vejers Banke and across Horns Rev), the 5 km wide and 10 m deep so-called Horns Rev Valley, has been found cutting the Eemian as well as the Saalian deposits to at least 38 m below the seabed. Borehole data shows that the valley is filled with Weichselian fine and medium grained well sorted melt water sand (ref. 2). The sand is covered by Holocene sand.

8.1.8 Holocene deposits

The base of the Holocene marine deposits is defined and characterised as a regional erosional surface (Figure 3 and ref.2) and the seismic pattern shows a horizontal layering. In some parts of the area inclined reflectors can be interpreted as spit deposit or basin fill deposits. The surface cut into the Saalian deposits and when present also into the Eemian marine deposits and the Weichselian melt water deposits.

The Holocene marine deposits form a relatively thin sand cover over all the glacial and interglacial sediments in the whole survey area. In small depressions Early Holocene freshwater with plant material can occur.
The thickness of the Holocene sand layers is between 1 and 2 m in many areas as on parts of the Vovov Hill island but the thickness of the Holocene deposits can increase to 6-8 m. In the Horns Rev Valley the Holocene deposits can reach a thickness of 25 m. Along the west coast of Jylland the thickness of the deposits increases to 20 m.
The mobile sediments on the seabed are the top Holocene sediments and these thin deposits shows a variation in grain size over the area. From the west coast of Jylland and approx. 25 km to the west the sand is fine-to very fine grained and silty. Further to the west the sand is fine-to medium grained but with larger areas of medium to coarse grained gravely sand and gravel at Vejers Bank and north of the Vovov hill island.
Several boreholes also show a variation in grain size in the area. In most boreholes the sand is medium and coarse grained, often with gravel, burrows and shells and shell fragments at all levels

which demonstrate the marine origin of the deposits. Also fine grained silty sand and thin silt and clay layers which are strongly bioturbated are found often intercalated with the more coarse grained deposits.

9. Description of cable route sections

The cable route is split into to two branches, a northern and a southern. (Figure 13 and 14).
The northern branch is located from the windfarm, close at Vovvov in a southwest-northeast direction to the Jutland coast at Henne Strand, while the southern branch is connected to the northern branch about 10km west of Henne Strand and with an orientation southeast to end at Grærup (Vejers Strand).
In the following paragraphs, the northern cable route is described in approximately 6km intervals, with the numbers D1 - D11 and the southern branch in the sections D12- D15. The general geology described in the previous paragraph is illustrated in the overview profile of the cable route (Figure. 14), which shows the stratigraphy of the seismic units.

The results of the survey are presented in 15 drawings Appendix D1 to D15 with four windows:

- The upper window shows a track plot of the 3 seismic lines (4 in the northern branch near the shore line) with annotation at the centreline for every 10th shoot point location. The UTM grid is shown in the window. The survey line spacing is approximately 150 m. The scale is 1:5000.

- The second window shows water depths with contour lines with 1 m equidistance and annotated depths and annotated soundings with an approximately density of 50 m in radius. The UTM grid is shown in the window. The scale is 1:5000.

- The third windows show the seabed sediment with results from the magnetometer survey and grab sampling positions. The UTM grid is shown in the window. The scale is 1:5000.

- The fourth window shows an interpretation of the seismic reflection centreline. The horizontal scale is 1:5000 and the vertical scale 1:250.

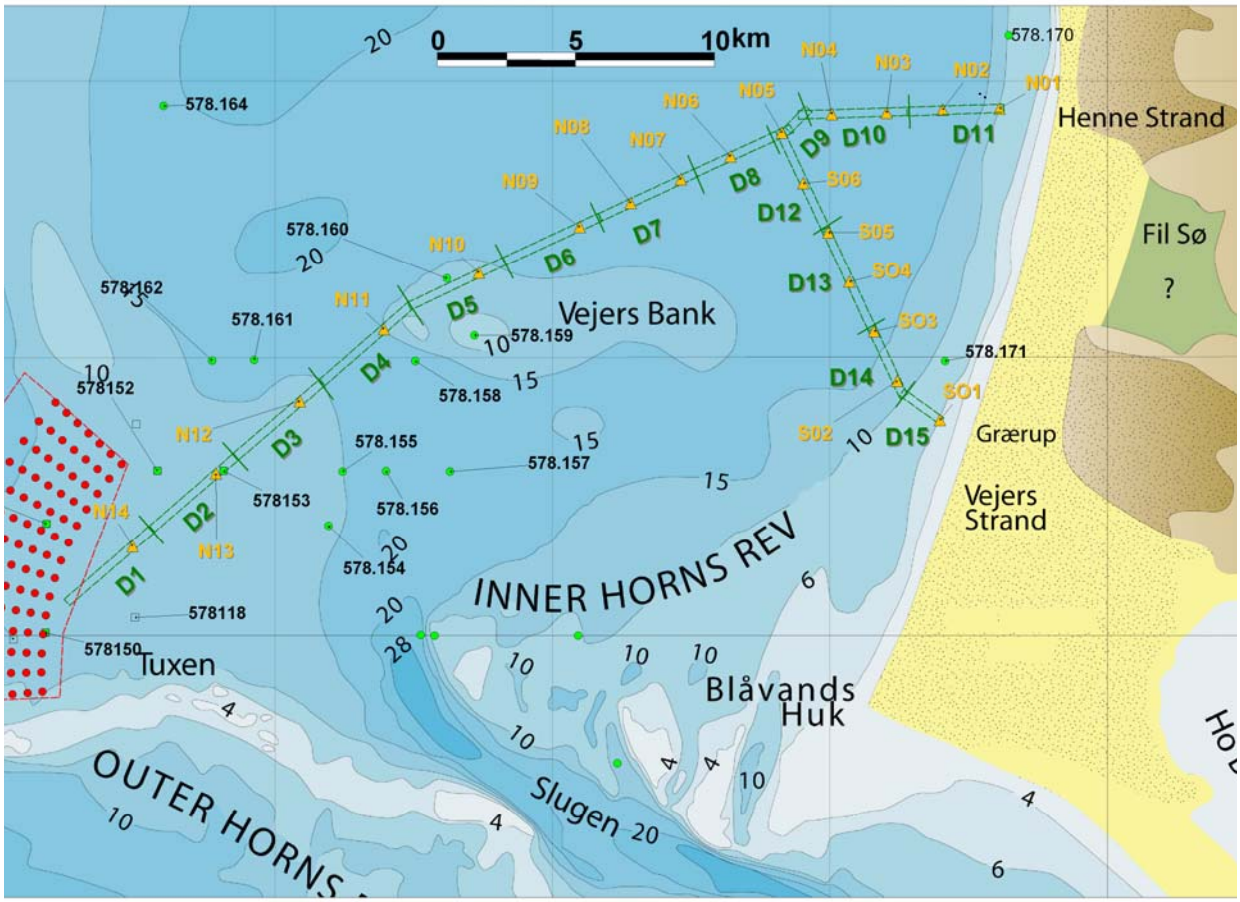


Figure 13. Detailed Cable route E-2 Horns Rev. Black numbers are existing vibrocores, yellow numbers are grab sample positions and green numbers are cable corridor sections.
The windmillfarm is illustrated by read dots.

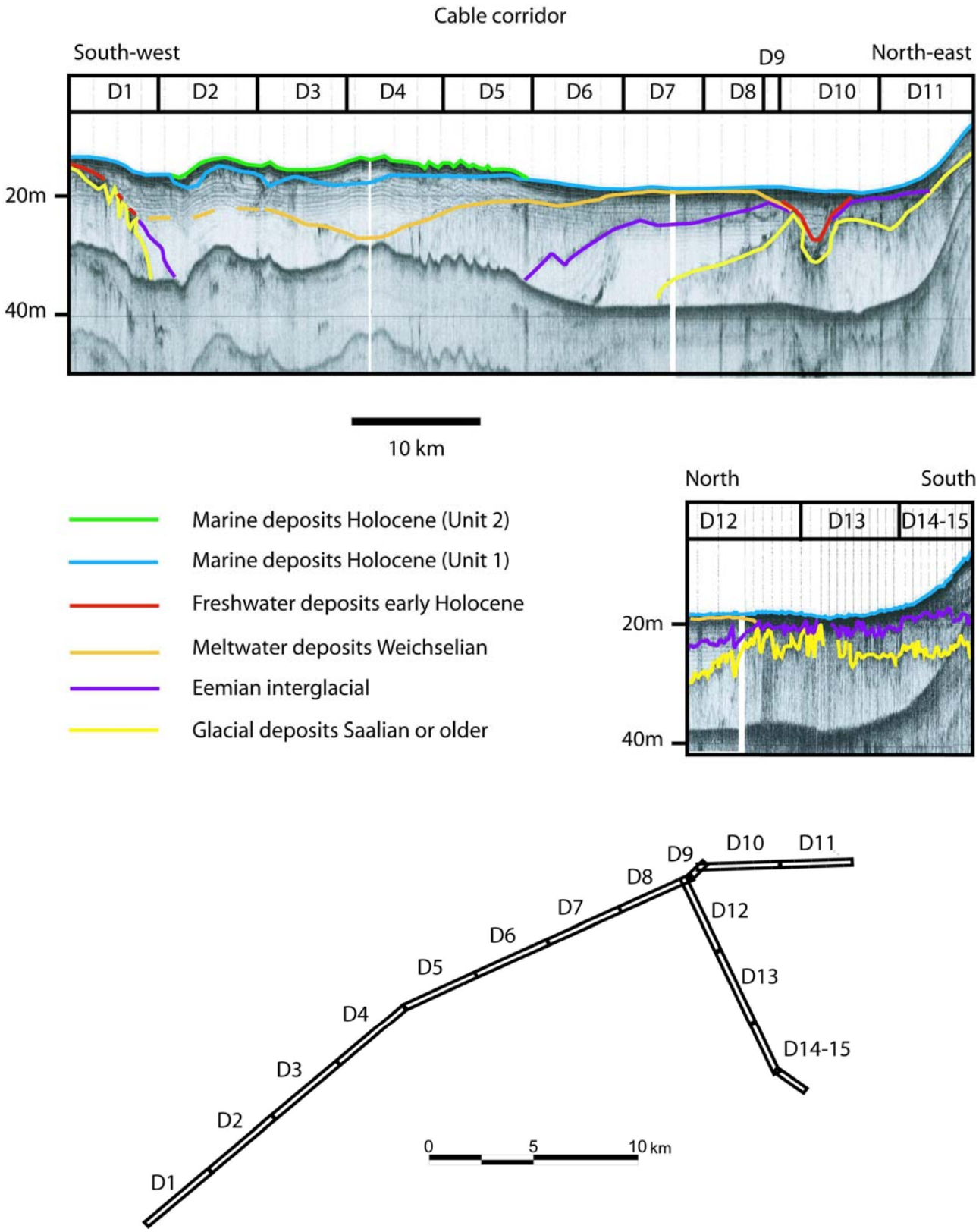


Figure 14. Cable route northern and southern branches, Sections D1 – D15 are indicated.

9.1 Northern branch Section D1

Section D1 (Appendix D1) is the westernmost of the sections, located close to the windfarm. A gentle eastward slope with water depths from 12.3m to 14.9m is observed. The seismic section shows that the Saalian glacial deposits are located few meters below the seabed in the western part, increasing to more than 20m in the eastern part. In the central part a channel like depression is observed.

The infill of the channel and up to 20m of sediments in the eastern part of the section is interpreted as marine Eemian.

In the easternmost part of the section, an about 1m thick Weichselian melt water unit exists.

In the westernmost part of the section infill of small depressions are interpreted as Holocene freshwater deposits, most likely including peat and shallow lake deposits, which could give geo-technical problems in relation to offshore installations.

The uppermost seismic unit increases in thickness from few meters in the western part to more than 10m in the eastern most part of the section. Few existing vibrocores and grab sample N14 from the area (Figure 13) indicates that the unit consist of Holocene marine sand fine – medium, often coarsening upwards and sand mega ripple features often occurs.

9.2 Northern branch sections D2, D3, D4 and D5

The four sections (Appendixes D2, D3, D4 and D5) are similar in composition, with a seabed characterised by an undulating bathymetry. The range of water depths is 12 – 15m, with the shallowest area in the central part called Vejers Banke (Figure 13). The Saalian deposits are only represented in the westernmost part dipping below the seismic section bottom level of -40m in the area named as the Horns Rev Valley in the general geological description. The Eemian deposits likewise dips below the seismic section, while the Weichselian melt water deposits increases in thickness to more than 20m.

The Holocene deposits are separated in two marine units. A lower unit, 5 to 8m in thickness, that represents the same unit as in section D1, which in the central part shows typical prograding internal reflectors as is interpreted as prograding coastal deposits of sand and gravel. The upper unit is few meters thick and is likewise marine, but related to sub recent deposition. Grab samples N10, N11, N12 and N13 contain medium to fine sand, which is the coarsest seabed sediments along the cable corridor.

9.3 Northern branch sections D6, D7 and D8

The sections D6, D7 and D8 (Appendixes D6, D7 and D8) is located on a rather even bottom of about 15 - 16m water depth. The sections are located at the eastern margin of the Horns Rev Valley, which means that the Eemian and Saalian Glacial deposits gradually emerges again, below the Weichselian melt water sandur deposits. The Holocene uppermost marine unit disappears while the lower Holocene marine unit thins, to be less than 1m in thickness. The seabed sediments are documented by the grab samples N6, N7, N8, N9 as fine to medium sand.

9.4 Northern branch sections D9 and D10.

In the sections D9 and D10 (Appendix D9 and D10) a depression is incised into the Saalian glacial deposits to a depth of about 30m below sea level and the infill consist of few meters of what is believed to be Holocene freshwater sediments (peat and shallow lake deposits), covered by Holocene marine sediments with a thickness of up to 10m. In the easternmost part of D10, Eemian marine sediments exists below the Holocene deposits. Grab samples N4 and N5 shows, that the sea bed sediments area in the area are fine grained sands.

9.5 Northern branch section D11

In the easternmost section D11 (Appendix D11), the water depths shallow up eastward in the vicinity of the coast from 16.5m to 8m. The Saalian glacial deposits likewise shallow up and near the coast the Eemian deposits disappears. Only up to 5m of Holocene marine fine grained sand covers the Saale glacial deposits.

9.6 Southern branch section D12

Section D12 (Appendix D12) is very much alike the sections D6, D7 and D8 with a very even sea bed of about 15 - 16m water depth. The section is located on the eastern margin of the Horns Rev Valley, which means that the Eemian and Saalian Glacial deposits exists below the Weichselian melt water sandur deposits. The Holocene uppermost marine unit disappears, while the lower Holocene marine unit thins to be less than 1m in thickness. The seabed sediments are documented by the grab sample S6, as fine sand.

9.7 Southern branch section D13

D13 (Appendix D13) is like D12 characterised by a rather even sea bed with a water depth of about 15 - 16m.

The Saalian glacial deposits show a very uneven surface, covered with Eemian sediments with a thickness between 0 and 5m. Only up to 5m of Holocene marine fine grained sand covers the Eemian deposits. The seabed sediments are documented as fine sand, S3, S4 and S5.

9.8 Southern branch sections D14 and D15

Sections D14 and D15 (Appendixes D14 and D15) are very much alike the section D11. In the north easternmost part, the water depths shallow up south eastward in the vicinity of the coast from 16.5m to 8m. But unlike D11 the Saalian glacial deposits does not shallows up and near the coast the Eemian deposits continues below the Holocene sediments in a level of about 20m below present sea surface. The Holocene marine fine grained sand increases in thickness from few meters in the north-western part to about 20m in the near coast area.

9.9 Cable Route extension to shore

The final lineament from sea to shore has not been surveyed with Multibeam and geophysical instruments. A set of coastal profiles, surveyed by the Danish Coastal Authority, have been used to connect the present survey to shore.

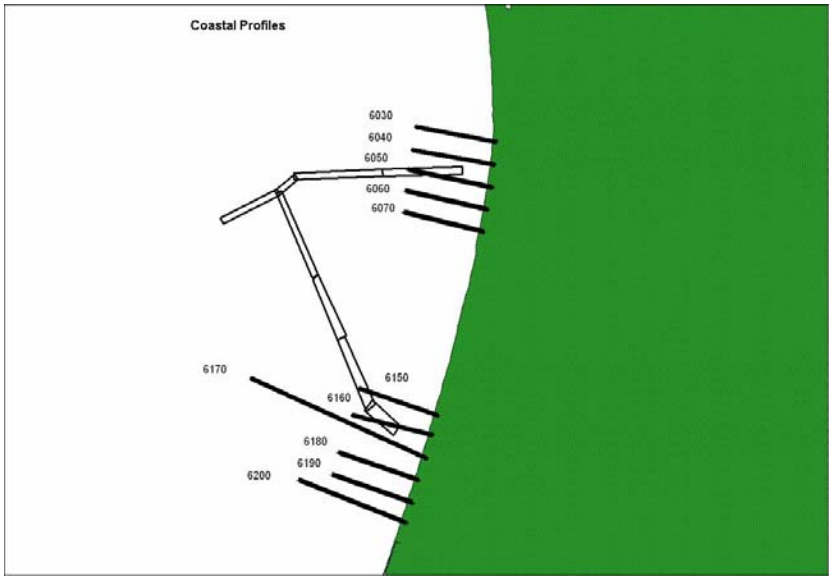


Figure 15 Coastal profiles for landward extension of geophysical survey

A set of 5 lines have been used for the northern extension and 6 lines have been used for the southern, as shown on figure 15.

The profiles from the northern corridor are shown in figure 22A and 22B. As it can be seen, the innermost approximately 1000 m of the profiles shows great variation in water depths throughout the period from 1990 to 2002 that is cover by the data set provided by the Danish Coastal Authority.

Seawards of this zone there are only minor variations in water depth, throughout this period of measurements. The variations in the deeper part is mostly less than 10 cm except for 2 areas: One area is shown on profile 6040 from 3- 4000 m, where the variations are up to 1 m and, and another is on profile 6050, where the variation in water depth is in the same order of about 1 m between 2000 and 2600 m.

The zone of great variation in water depths throughout the examined period is illustrated in figure 16.

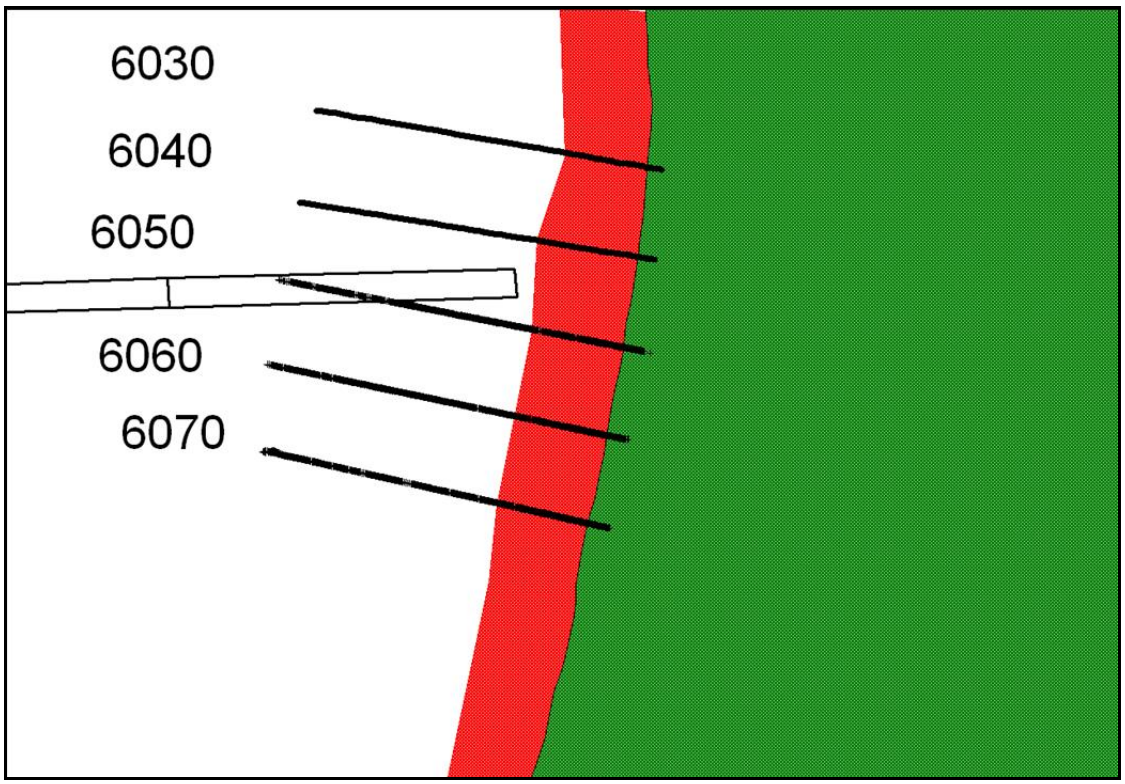


Figure 16. Zone of great variation in water depths illustrated in red.

A more thoroughly examination of data shows that the variation in water depth in the same zone can be as high as 5 m and the deepest depth of disturbance is approximately 7 m below MSL. See example in figure 17.

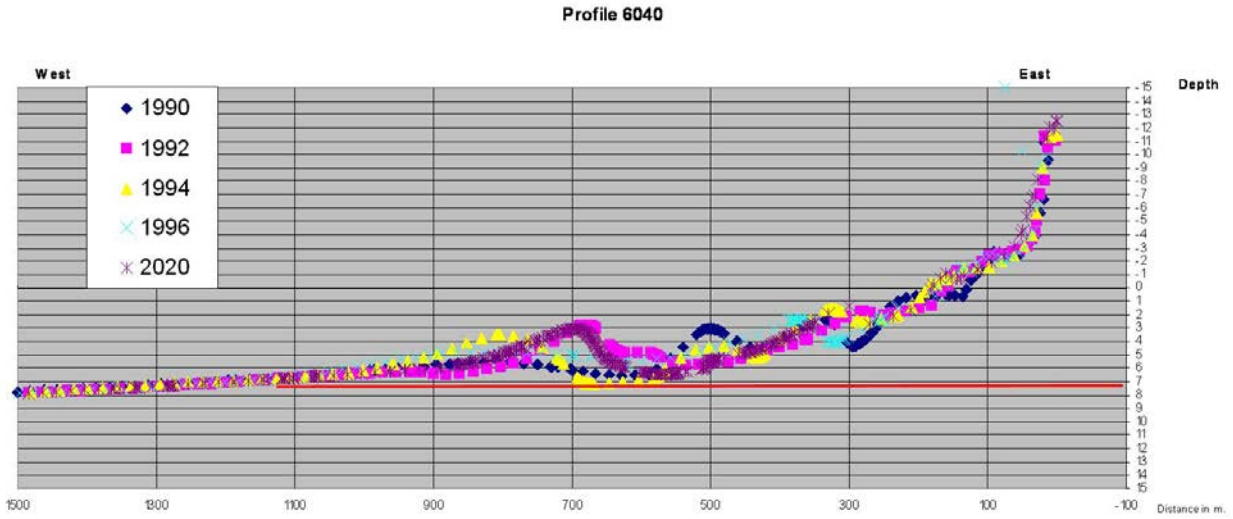


Figure 17. Depth of erosion and redeposition due to variation in water depth. (Part of fig. 22A profile 6040).

The eastern end of the northern cable route is shown on figure 18. The reed arrow marks the innermost part of the Multibeam bathymetric survey acquired during the geophysical survey, and the black arrow indicate where the overlap between profile measurements and Multibeam survey stops (Figure 18).

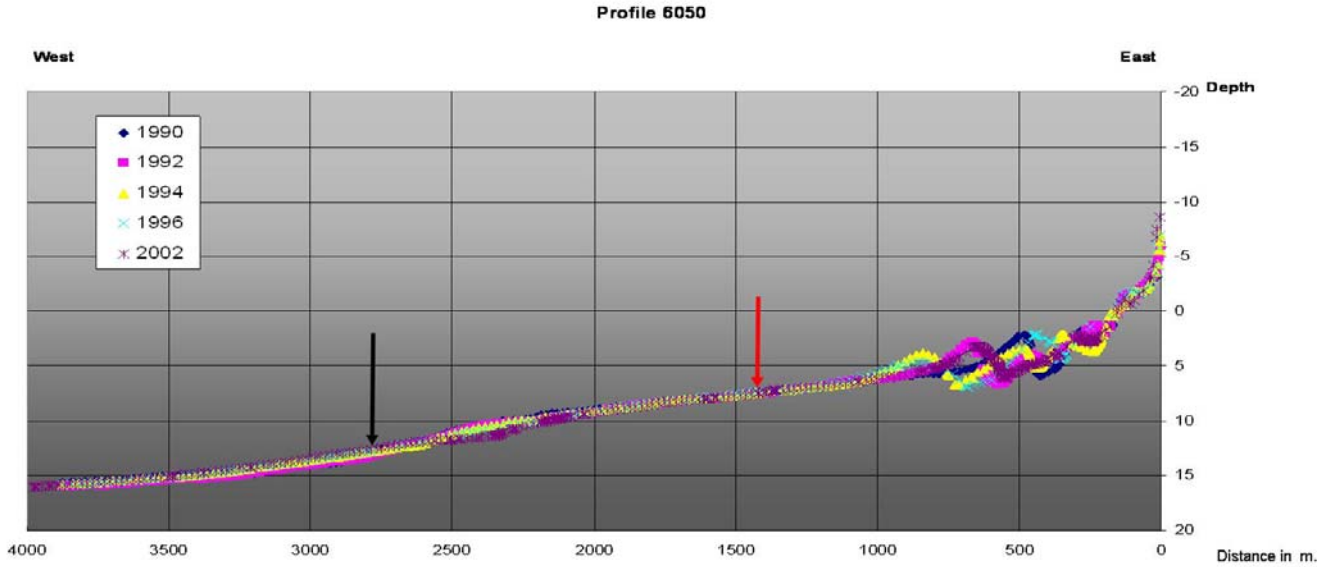


Figure 18. Overlay between profile measurements and multibeam bathymetric data (se text).

The 6 profiles from the Southern corridor extension are shown in figure 23A and 23B.

As it can be seen, the innermost approximately 1000 m of the profiles shows great variation in water depths throughout the period from 1990 to 2002 that is cover by the data set provided by the Danish Coastal Authority.

Seawards of this zone there are only minor variations in water depth, throughout this period of measurements. The variations in the deeper part are mostly less than 10 cm.

The zone of great variation in water depths throughout the examined period is illustrated in figure 19.

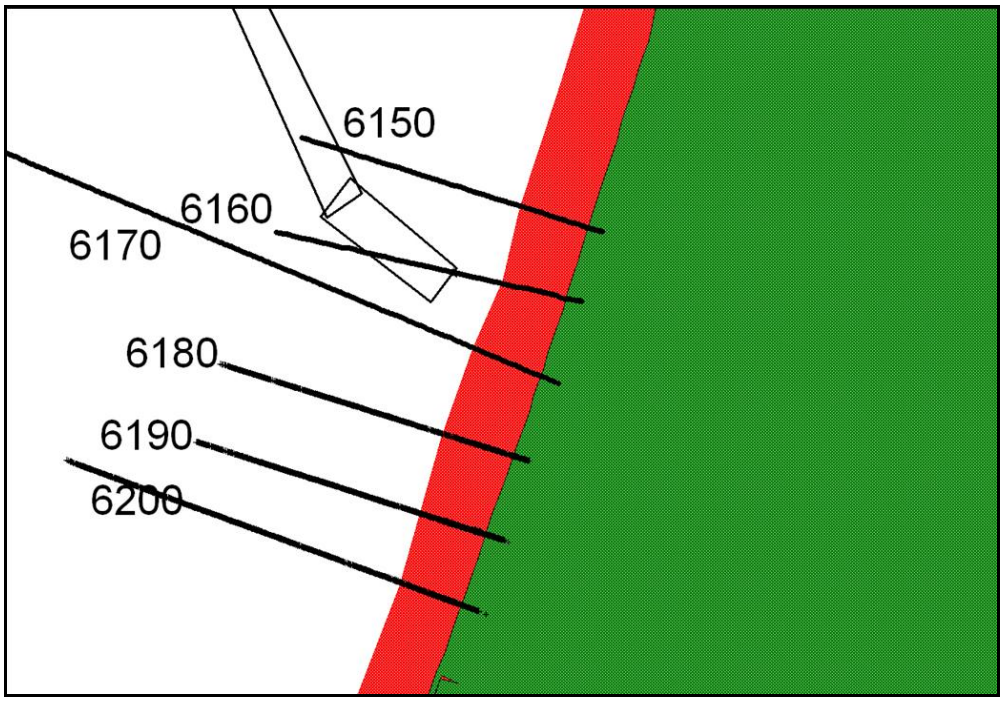


Figure 19. Zone of great variation in water depths illustrated in red.

An examination of data shows that the variation in water depth in this area is more than 4 m and the deepest depth of erosion is approximately 7 m below MSL as illustrated on figure 20.

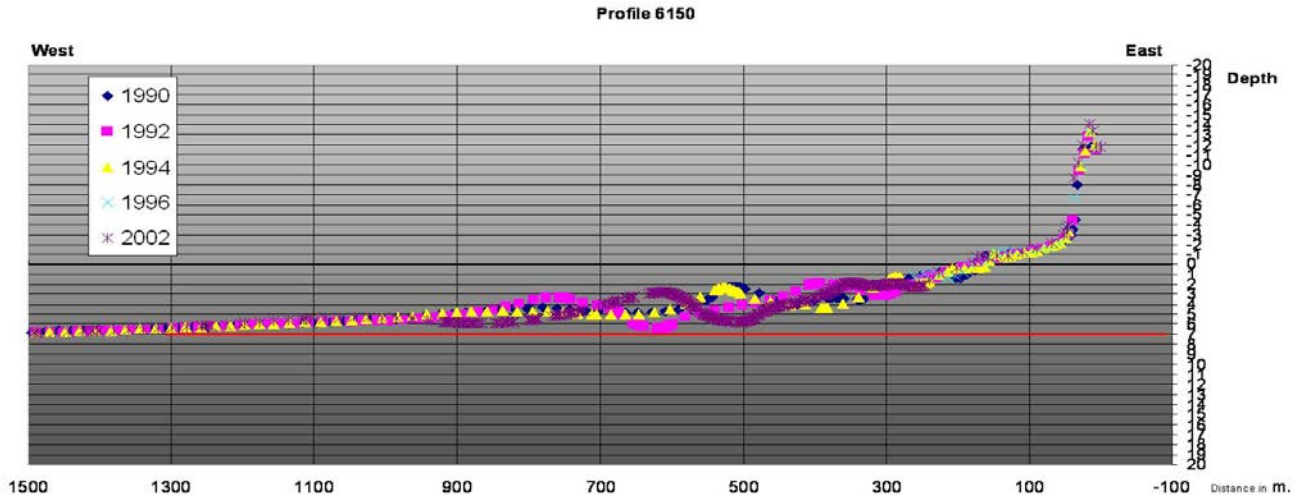


Figure 20. Depth of erosion of seabed due to variation in water depth. (Part of fig. 23A, Profile 6150).

The area covered only by coastal profiles at the eastern end of the northern cable route is shown on figure 21. The reed arrow marks the innermost part of the Multibeam bathymetric survey acquired during the geophysical survey

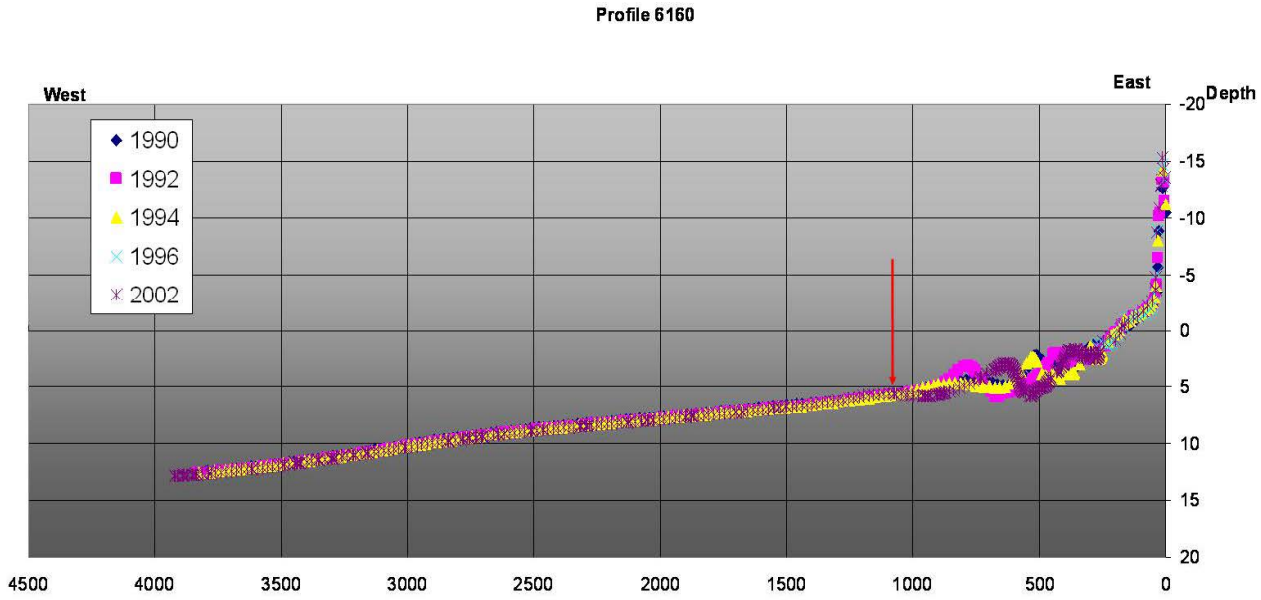


Figure 21. Profile measurements and multibeam.

9.9.1 Seabed profiles

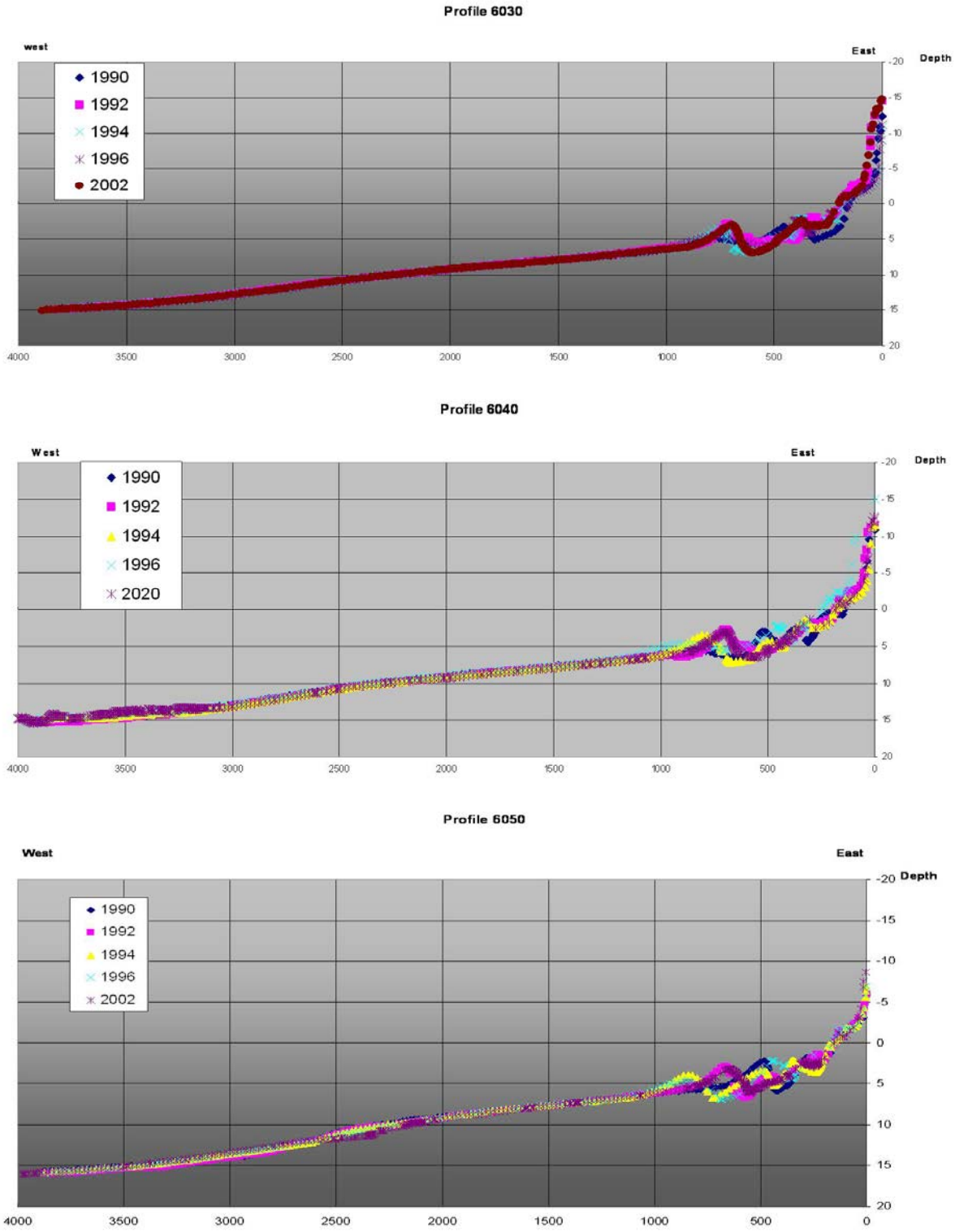


Figure 22 A. Profile 6030-6050 Northern Cable Route.

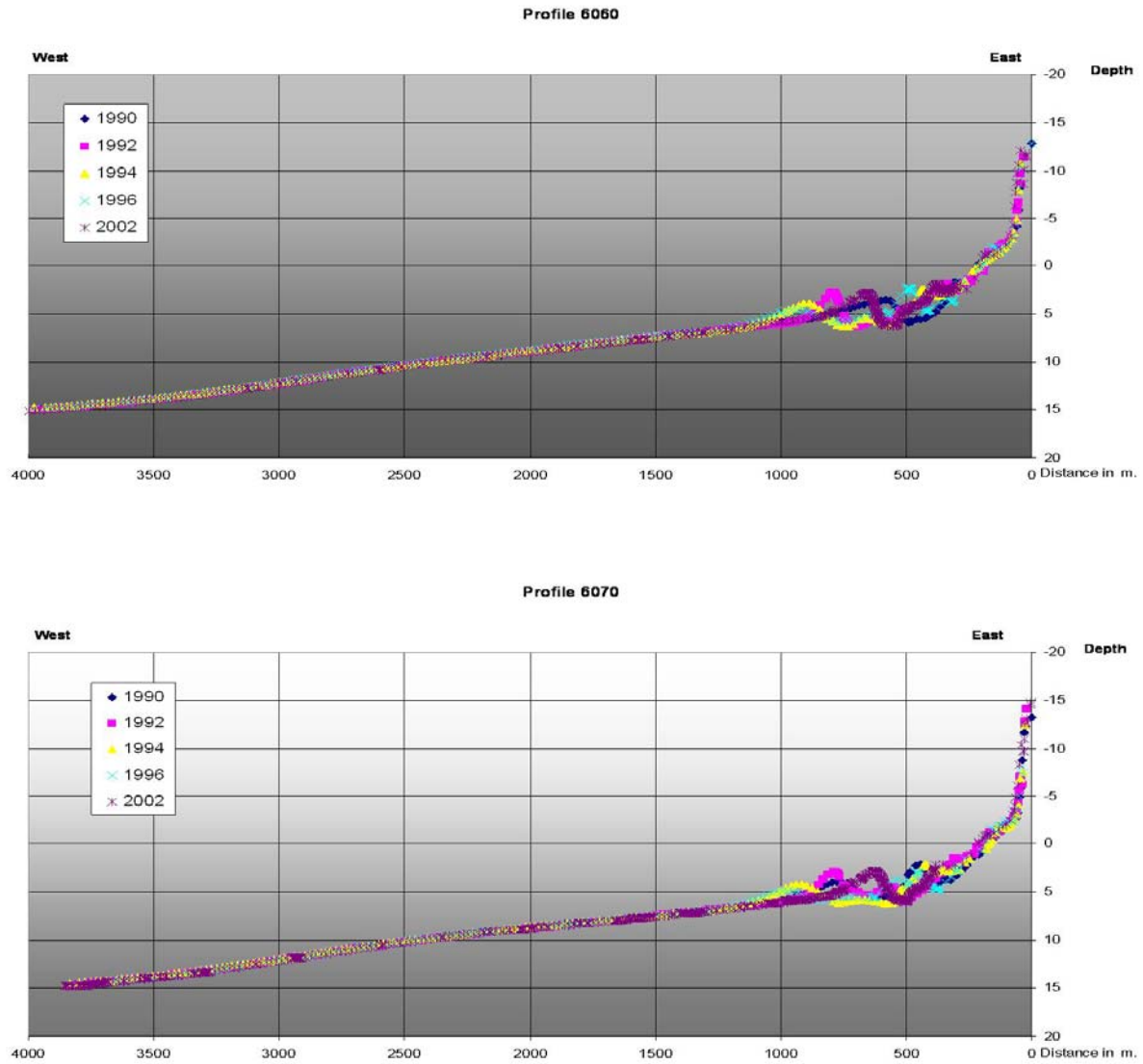


Figure 22 B. Profile 6060-6070 Northern Cable Route.

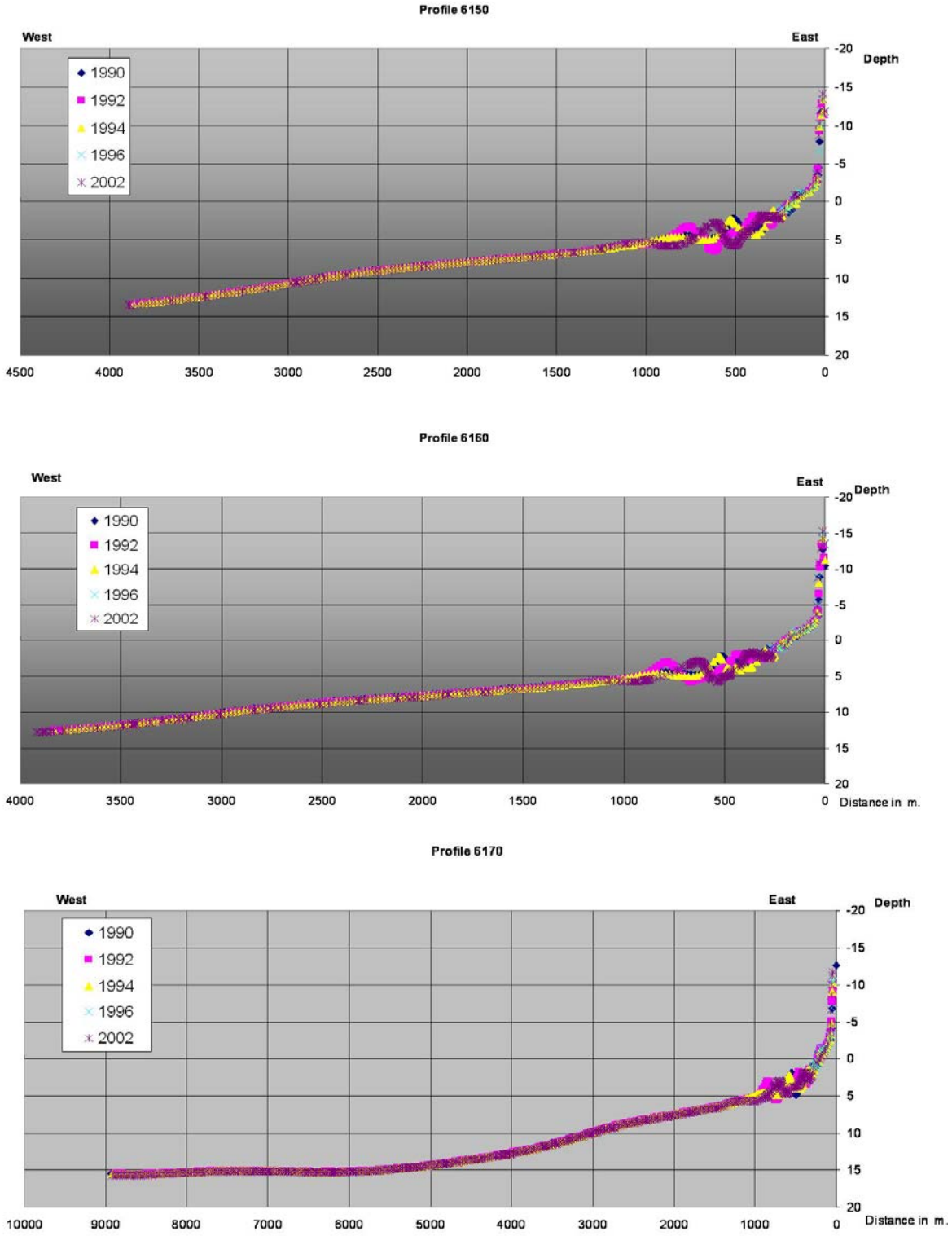


Figure 23A. Profile 6150-6170 Southern Cable Route.

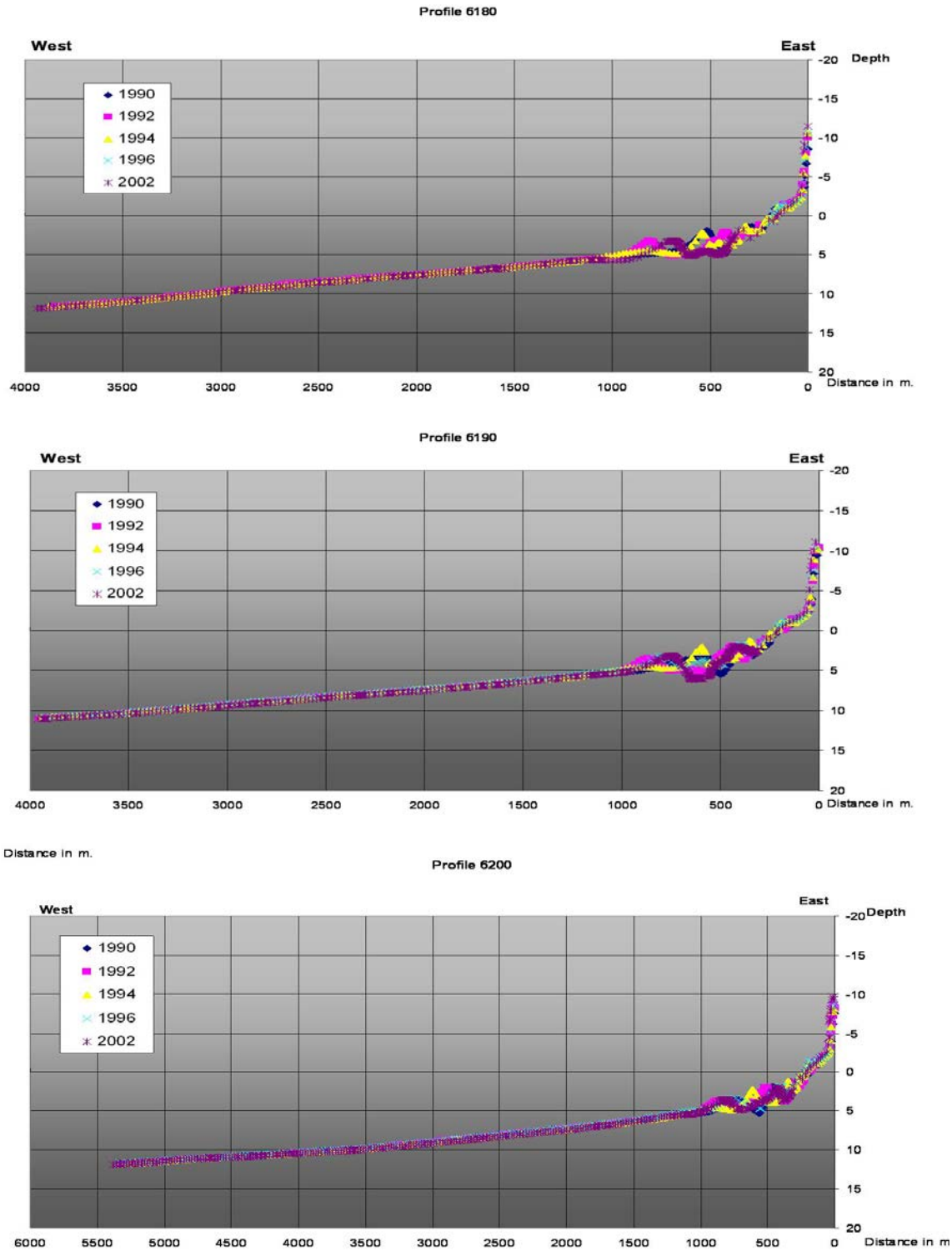


Figure 23 B. Profile 6180-6200 Southern Cable Route.

10. Magnetometer measurements

Magnetometer anomalies indicating archaeological and/or safety objects.

10.1 Archaeological objects

This part of the magnetometer investigation and reporting has been carried out by Jens Schou Hansen, Vikingeskibsmuseet, Roskilde, who has written the following text (English translation by GEUS):

In connection with the establishment of the Windfarm Horns Rev 2 existing material and information have been treated. Also Side Scan Sonar measurement data and the magnetic data from the area have been investigated with the respect to point out possible marine archaeological objects.

Presentation of the magnetic anomalies is performed with the Golde Software “Surfer”. Cleaning of “spikes” is done with Excel.
The magnetic data have not been calculated by comparing with reference data from onshore.

From the cable route the following lines were investigated:
HR_N(0)a, N(0)aa
HR_N(50), N(50)a
HR_N(100), N(100)a
HR_N_(50)b
HR_N_0
HR_N(-50), N(-50)a
HR_S(-50)
HR_S_(0)
HR_S_(50)
A large anomaly is found in one position with radius of approx. 80 m. It was originally interpreted as a ship wreck at position: E 438 775m N: 6 178 700m. The anomaly is shown in figure 24 and 25, But, as it can be seen on figure 26, this anomaly coincide with the crossing of the oil and gas pipes from the oil and gas fields in the North Sea.
A list of magnetic anomalies can be found in table 1.

Horns Rev
Side Scan Sonar Target List, Cable Corridor

Targets defined as objects with any dimension > 1m

Target number	Line	Time	Position Lat.	Position Long.	Description
1	HR_N50A.XTF	02:48:19	55,6201573	7,6727569	Unidentified obj. 4 m long
2	HR_N100A.XTF	04:31:11	55,7214996	7,9291083	Unidentified obj. 5 m long
3	HR_N50A.XTF	02:48:19	55,6201626	7,6727558	Unidentified obj. 1 m x 3.7m x 0.4 m

Table 1. List of magnetic anomalies

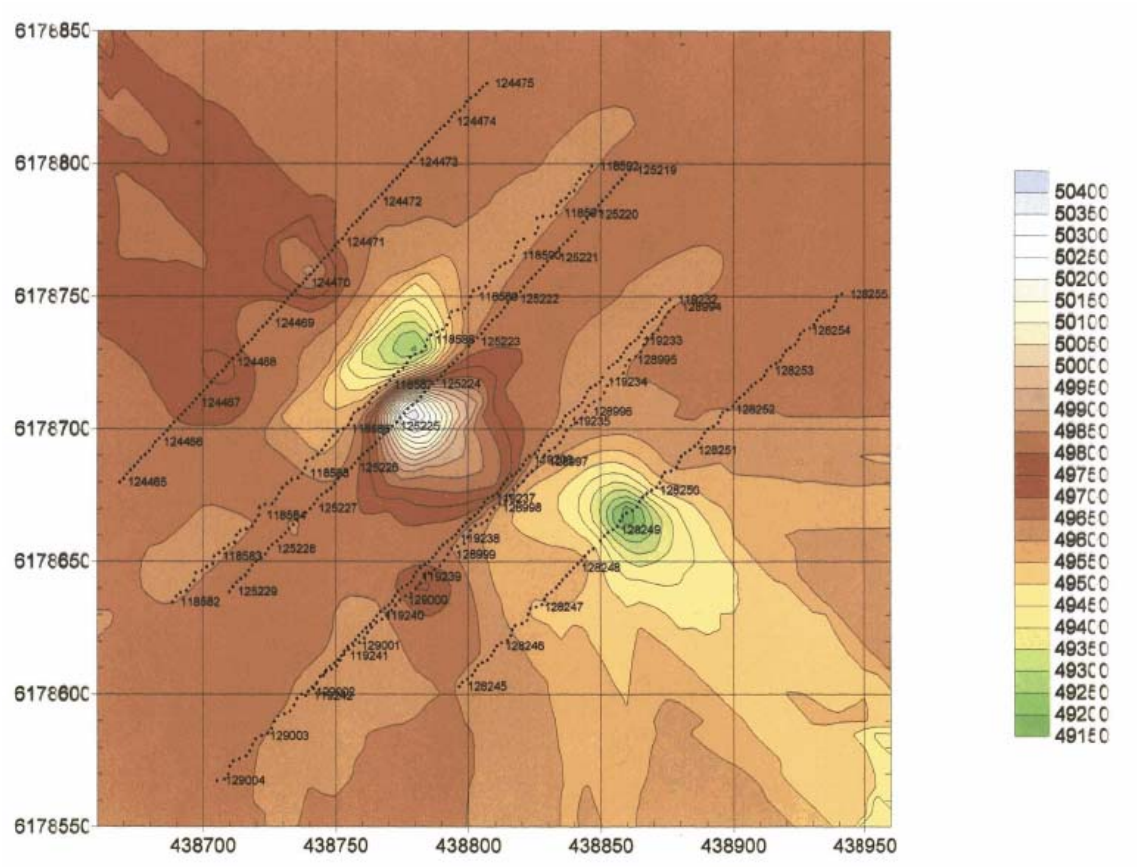


Figure 24 Contour map of magnetic anomaly in section D9. Values in gamma.

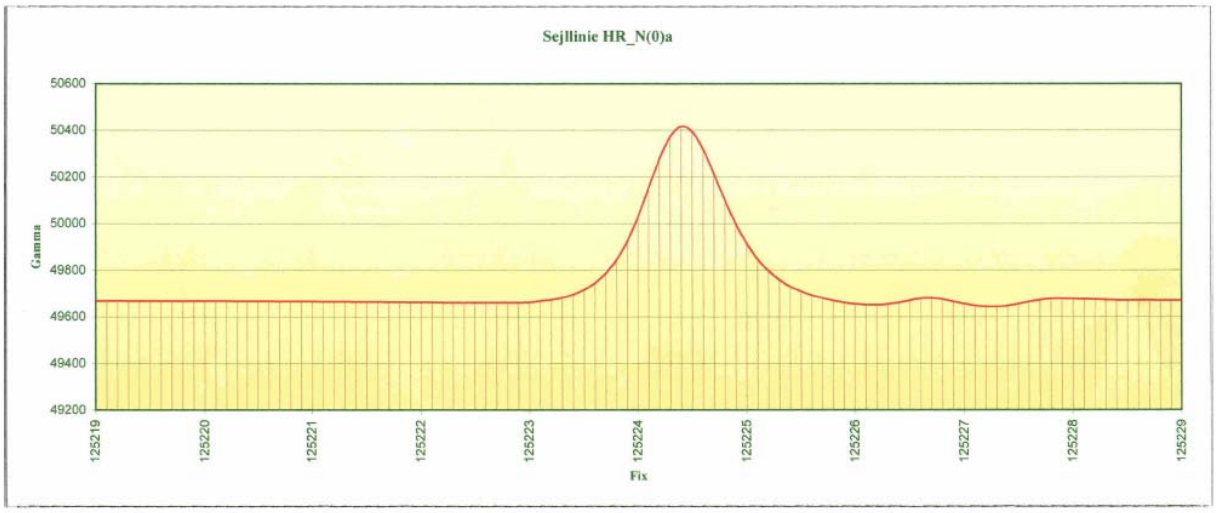


Figure 25. Magnetic profile of magnetic anomaly position E 438 775m N: 6 178 700m. in section D9. Values in gamma.

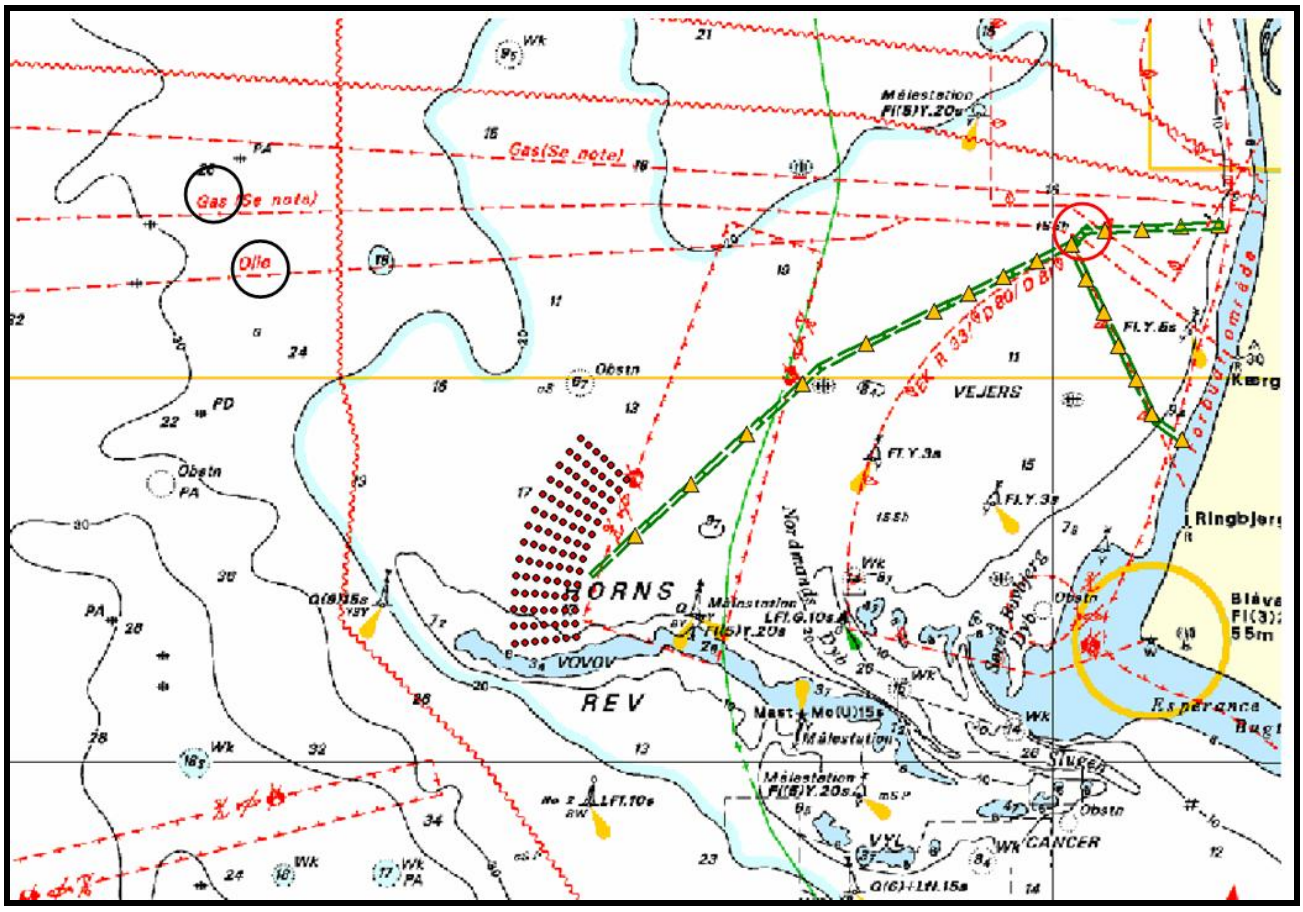


Figure 26. Navigation map from the cable route survey. Red circle shows the crossing of oil and gas pipes with the northern cable corridor.

10.2 Other objects

The magnetic data from the cable route have furthermore been detailed examinated by GEUS to locate possible minor events and sparks that could be connected to possibly fragments of fire arms, ammunitions, mines etc.

Reference data from onshore have been used to compare the actual magnetic data with background reference data, to be able to evaluate possible influence from local geological layers.

Small objects at the seabed can only be detected on the single line with the present line spacing, and will only be detected if they are situated in the actual magnetometer track line.

Magnetic data from the cable route survey is shown in figure 27. The magnetic anomaly from the pipeline crossings is very pronounced at the magnetic data, with anomalies at ± 50 nT or more.

As it can be seen there are numerous of minor magnetic peaks along the cable route. These data have been examined to evaluate if they are real magnetic anomalies coursed by minor objects at the seabed.

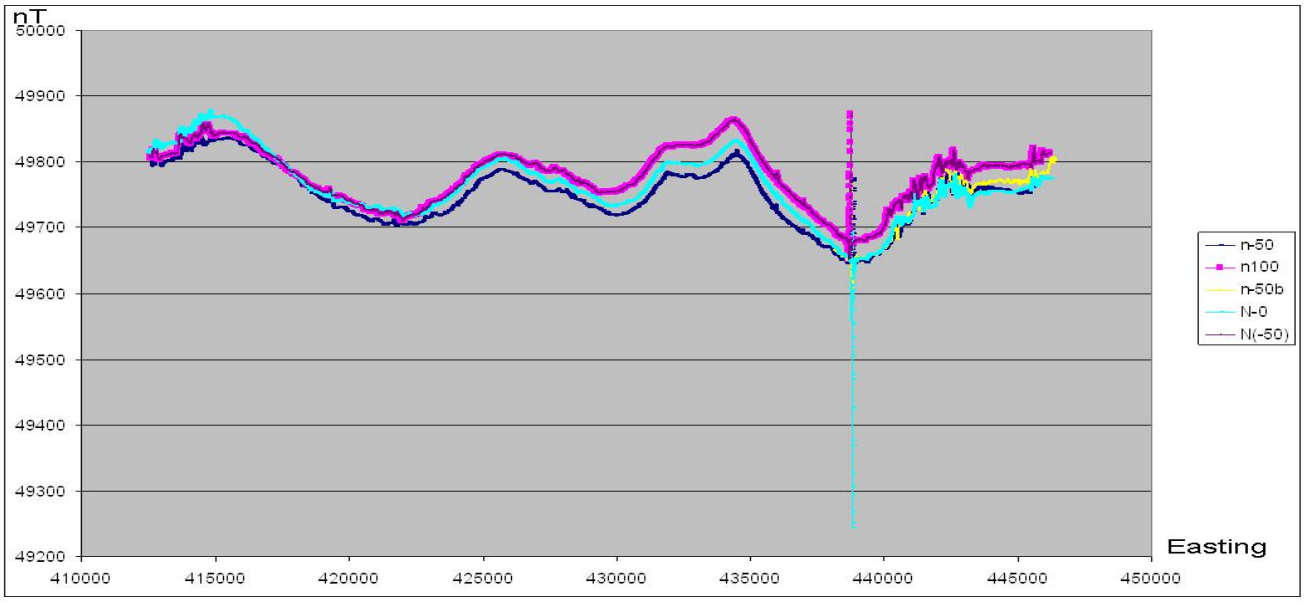


Figure 27. Magnetic data from the cable route.

The areas with magnetic spikes and anomalies are concentrated in the western and in the easternmost part of the area. The eastern part of the area have been chosen too illustrate the significance of these data, figure 27.

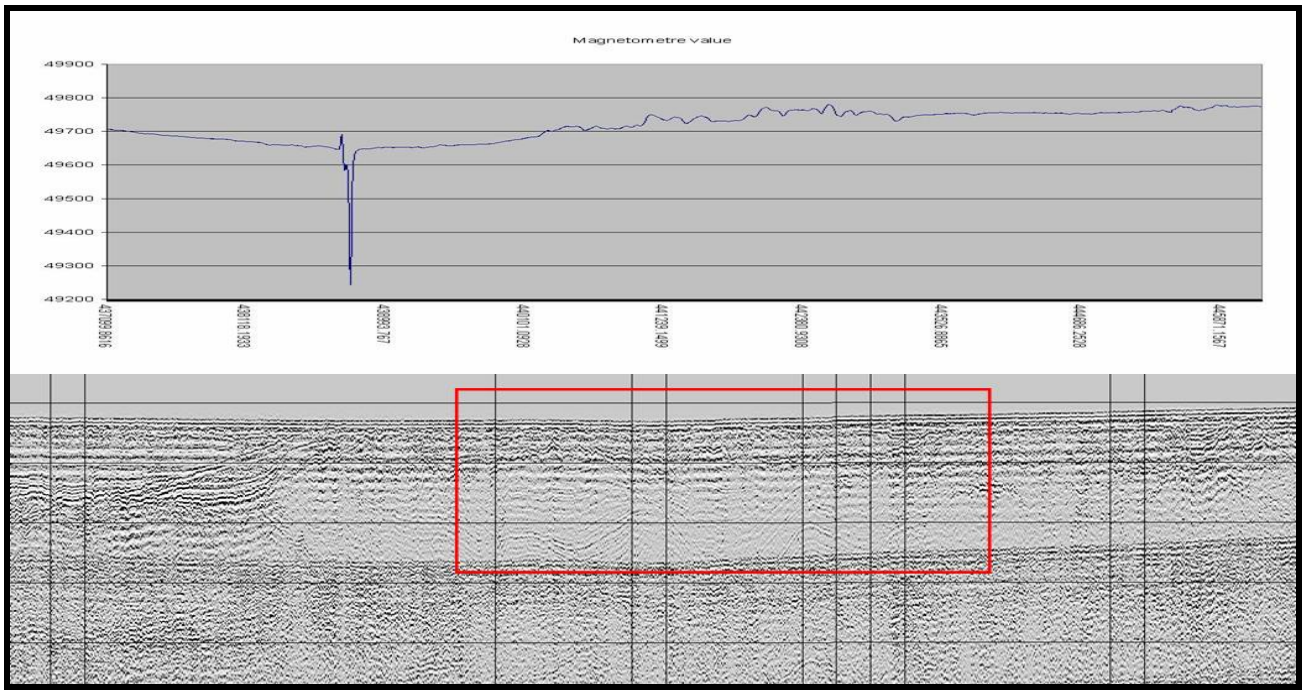


Figure 28. Magnetic data from the cable route.

As it can be seen in the upper part of figure 28, the magnetic anomalies are not strong, sharp peaks, but slightly changes in magnetic values, that cannot be connected to minor magnetic elements at the seabed. These kinds of elements will be shown on magnetic data as strong, sharp peaks with high value of change in magnetic flux (Δ nT).

The seismic section in lower part of figure 28 shows that the magnetic anomalies are located in an area with change in the sedimentary sequences in the subsurface, an underlying geological layer, possibly Eemian, are folding up just beneath the seabed. The magnetic anomalies in this zone can be explained by change in geological conditions in the seabed. The westernmost part of the Cable route has the same kind of change in sedimentological conditions.

The magnetic anomalies can be seen on all the magnetic track lines in the same area. This will not be the case, if it was a response of a single element at the seabed. These observations confirm the above mentioned observations, that the anomalies are connected to areas with changes in sediment composition.

To evaluate magnetic peaks and strong and sharp changes in magnetic flux, an analysis of changes in magnetic flux (Δ nT) is performed to select possibly peaks in the areas along the total cable route (Figure 29).

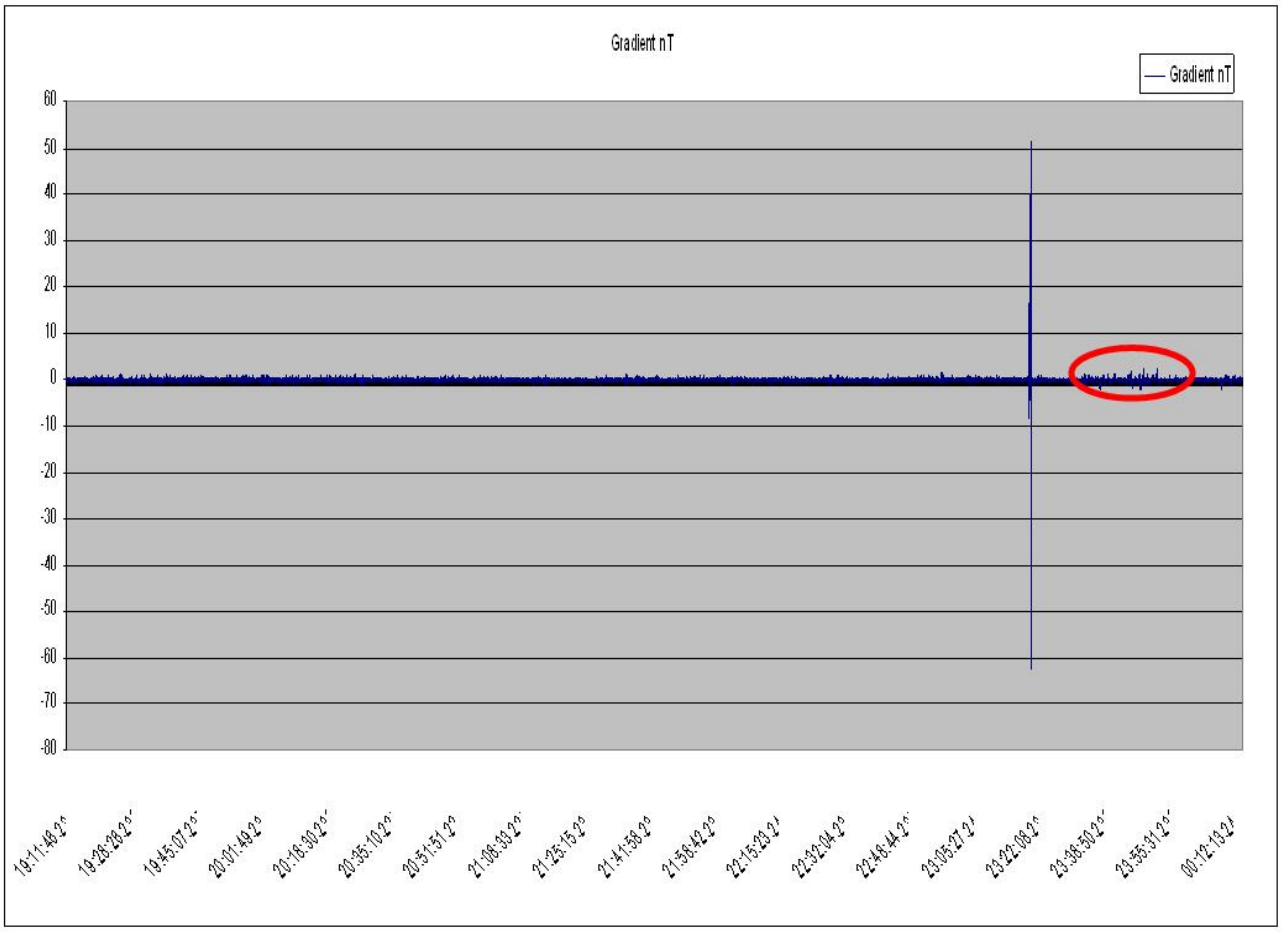


Figure 29 Changes in magnetic flux (Δ nT) along the northern centreline HR N(0).

10.3 Magnetometer data conclusion

The previous mentioned pipeline crossings are very obvious in this presentation of data with Δ nT values at 60. The above examined area is shown with the red circle with maximum Δ nT values at 3 nT.

Reference data from Rømø onshore; have been used to compare the actual magnetic data with background reference data in figure 30. The data have been provided by the Danish Meteorological Institut on request by GEUS.

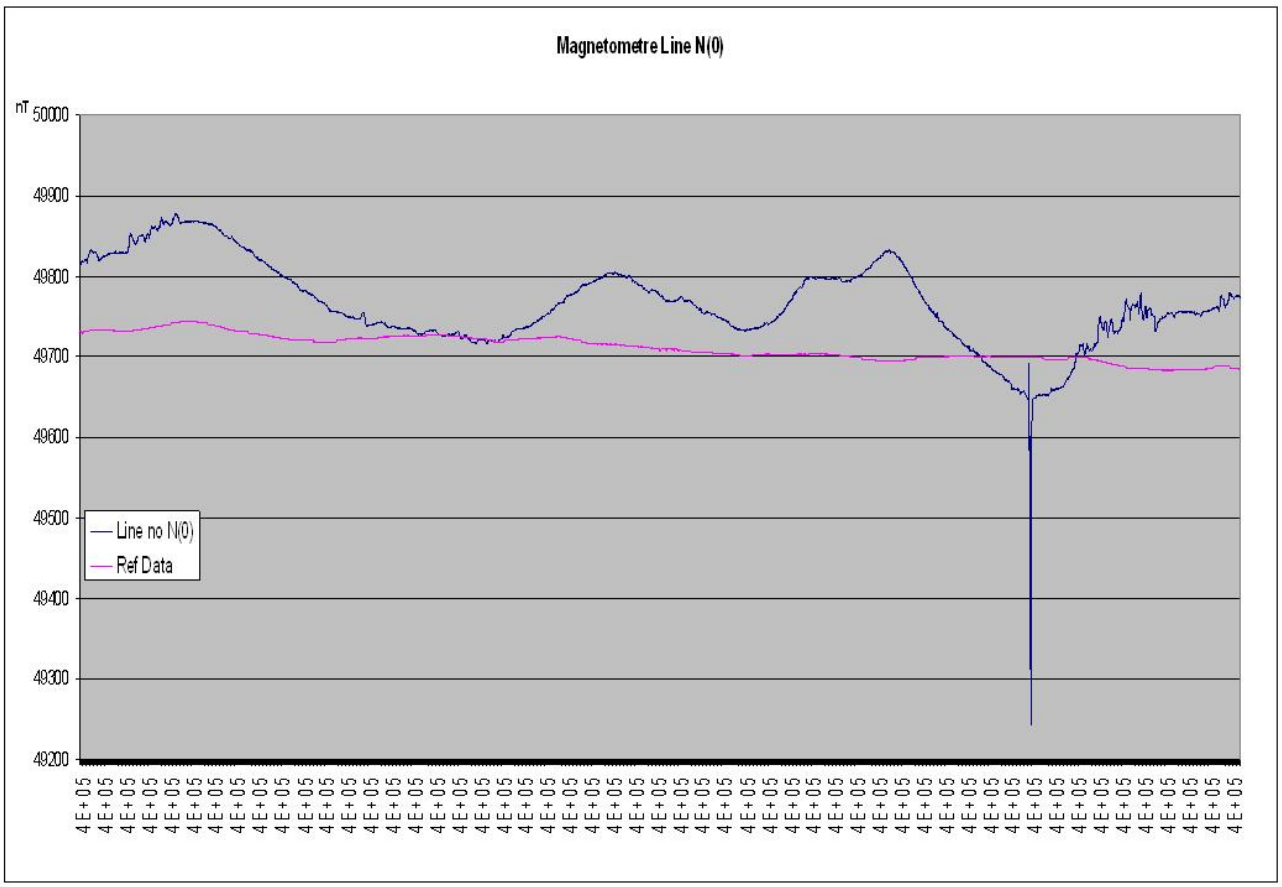


Figure 30. Magnetic data along the northern centreline HR N(0), compared with reference data from Rømø.

The comparison with reference data, acquired parallel to the actual acquisition of geophysical data in the cable route is shown in figure 30. The variation in magnetic data in the route, shows an over-print of local geological setting.
One major peak is correlated with the crossing of oil and gas pipes.

A systematic analysis of the magnetic data in the northern and southern cable corridor, have not given further anomalies than the previous mentioned strong anomaly, located on section D 9.

11. Conclusions

An area with dynamic active sand is found in the westernmost part of the Cable Route, with medium grained sand.

The seismic reflection data shows, that the Holocene deposits are separated in two marine units. A lower unit, 0 to 10m in thickness, which in the part of the area shows typical prograding internal reflectors as is interpreted as prograding coastal deposits of sand and gravel. An upper unit is few meters thick and is likewise marine, but related to sub recent deposition.

In the southern extension of the possibly Cable route landfall, the upper unit related to sub recent deposition disappear. while the lower Holocene marine unit thins to be less than 1m in thickness, covering the Weichselian melt water sandur deposits .

12. References

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Ref. 8. Kuijpers , A., 1995: Late Quaternary sediment distribution in the DK Sector of the North Sea: Area 582 and 524. Geological Survey of Denmark. Datadocumentation no.13.

Ref. 9. Huuse, M & Lykke-Andersen, H, 2000: Overdeepened Quaternary valleys: eastern Danish North Sea. Quaternary Science Reviews 19.

13. Appendix A: Overview Map Wind farm and Cable Route

14. Appendix B: Loss of ignition and grain size analysis

Horns Rev E2

Projekt: 10239

Loss of ignition

DS 204

Prøve nr.	Glødetab i %	Gløderest i %
S-01	0,75	99,25
S-02	1,40	98,60
S-03	1,04	98,96
S-04	1,30	98,70
S-05	1,38	98,62
S-06	1,14	98,86
N-01	0,83	99,17
N-02	2,25	97,75
N-03	1,19	98,81
N-05	0,96	99,04
N-06	1,48	98,52
N-07	0,84	99,16
N-08	0,95	99,05
N-09	1,71	98,29
N-10	0,47	99,53
N-11	0,45	99,55
N-13	0,30	99,70
N-14	0,33	99,67

juni 2006

Grain Size Distribution

Geotechnical

Sample Id: S-01
Lab. Id: 060755
Submitter: J. Leth
Subject: Horns Rev E 2
Date: Juni 2006
Executed: I. Nørgaard
Remarks: For mat.< 2 mm

GEUS

Total Weight 102,13 g

Size Fractions

Sieve Analysis

	Size	Size	Weight	Weight	Cumulated amount passing
	mm	Φ	g	%	%
Gravel	16,00	-4,00	0,00	0,00	100,00
	8,00	-3,00	0,00	0,00	100,00
	4,00	-2,00	0,00	0,00	100,00
	2,80	-1,49	0,01	0,01	99,99
	2,00	-1,00	0,02	0,02	99,97
Sand	1,40	-0,49	0,01	0,01	99,96
	1,00	0,00	0,06	0,06	99,90
	0,710	0,49	0,03	0,03	99,87
	0,500	1,00	0,03	0,03	99,84
	0,355	1,49	0,04	0,04	99,80
	0,250	2,00	0,10	0,10	99,71
	0,180	2,47	0,65	0,64	99,07
	0,125	3,00	38,63	37,82	61,25
	0,090	3,47	55,52	54,36	6,88
	0,075	3,74	4,14	4,05	2,83
	0,063	3,99	1,31	1,28	1,55
	< 0,063	> 3,99	1,58	1,55	0,00

Size Classes (DGF-Bulletin 1 1988)

		Weight %
Silt and clay	(< 0,063 mm):	1,55
Sand, fine	(0,063 mm - 0,200 mm):	97,70
Sand, medium	(0,2 mm - 0,6 mm):	0,61
Sand, coarse	(0,6 mm 2 mm):	0,11
Gravel	(> 2 mm):	0,03
Sum.		100,00

Moments Measures (Folk and Wards)

Percentile	Percentile		
Amount in sieve	Amount passing	d(mm)	Φ
5%	95%	0,17	2,52
16%	84%	0,16	2,66
25%	75%	0,15	2,79
40%	60%	0,12	3,01
Median 50%	50%	0,12	3,09
75%	25%	0,10	3,30
84%	16%	0,10	3,38
90%	10%	0,09	3,44
95%	5%	0,08	3,59

Moments Statistics

Mean	3,04
Sorting	0,34
Skewness	-0,12
Kurtosis	0,85
Uniformity Coefficient	1,35

The analysis is executed according to DS 405.9 extended by sieves to the ½ phi scale

Size Classes and Percentiles are found by linear interpolation

Formulas

Mean (ϕ16%+ϕ84%+ϕ50%) / 3 (Folk and Ward 1957)

Sorting (ϕ84%-ϕ16%) / 4 + (ϕ95%-ϕ5%) / 6,6 (Folk and Ward 1957)

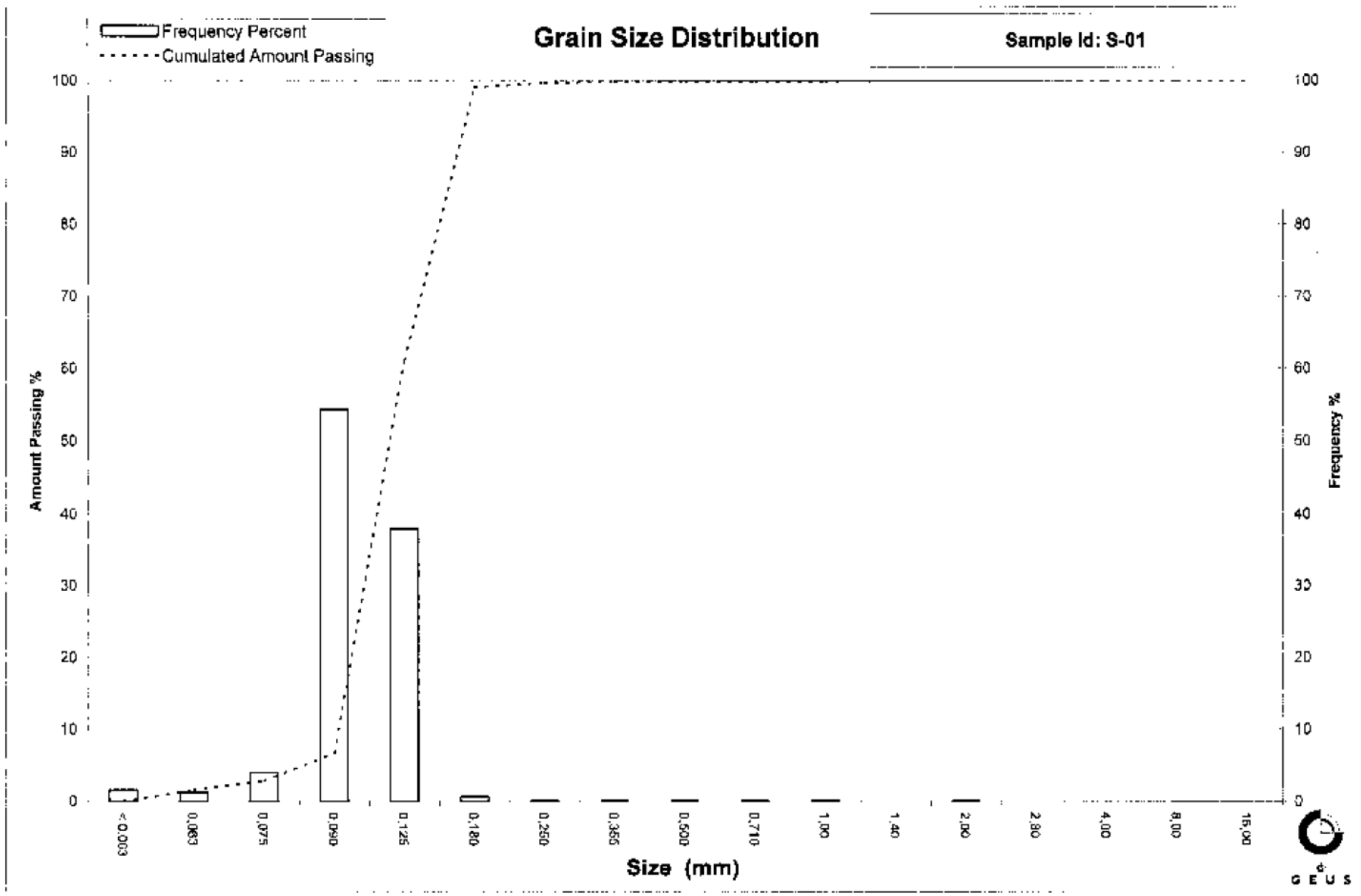
Kurtosis (ϕ95% - ϕ5%) / (2,44 * (ϕ75% - ϕ25%)) (Folk and Ward 1957)

Skewness (ϕ16%+ϕ84% - 2*ϕ50%) / (2*(ϕ84%-ϕ16%)) + (ϕ5%+ϕ95% - 2*ϕ50%) / (2*(ϕ95%-ϕ5%)) (Folk and Ward 1957)

Uniformity Coefficient (d60% / d10%) (dgf-Bulletin 1988)

Mean, sorting, skewness and kurtosis are based on "Amount in sieve". Uniformity coefficient is based on "Amount passing".

Øster Voldgade 10 1350 København K
Tel.: +45 38 14 20 00 Telefax: +45 38 14 20 50
Email: GEUS@geus.dk
www.geus.dk


Frequency Percent
Cumulated Amount Passing
Grain Size Distribution
Sample Id: S-01
Amount Passing %
Frequency %
Size (mm)
100
90
80
70
60
50
40
30
20
10
0
<0,003
0,063
0,075
0,090
0,125
0,180
0,250
0,355
0,500
0,710
1,00
1,40
2,00
2,80
4,00
8,00
16,00
GEUS

Grain Size Distribution

Geotechnical

Sample Id: S-02
Lab. Id: 060756
Submitter: J. Leth
Subject: Horns Rev E 2
Date: Juni 2006
Executed: I. Nørgaard
Remarks: For mat.< 2 mm

GEUS

Total Weight 101,01 g

Size Fractions

Sieve Analysis

	Size	Size	Weight	Weight	Cumulated amount passing
	mm	Φ	g	%	%
Gravel	16,00	-4,00	0,00	0,00	100,00
	8,00	-3,00	0,00	0,00	100,00
	4,00	-2,00	0,00	0,00	100,00
	2,80	-1,49	0,08	0,08	99,92
	2,00	-1,00	0,05	0,05	99,87
	1,40	-0,49	0,02	0,02	99,85
Sand	1,00	0,00	0,22	0,22	99,63
	0,710	0,49	0,05	0,05	99,58
	0,500	1,00	0,05	0,05	99,53
	0,355	1,49	0,15	0,15	99,39
	0,250	2,00	0,26	0,26	99,13
	0,180	2,47	2,41	2,39	96,74
	0,125	3,00	48,35	47,87	48,88
	0,090	3,47	42,22	41,80	7,08
	0,075	3,74	3,25	3,22	3,86
	0,063	3,99	0,65	0,64	3,22
	< 0,063	> 3,99	3,25	3,22	0,00

Size Classes (DGF-Bulletin 1 1988)

		Weight %
Silt and clay	(< 0,063 mm):	3,22
Sand, fine	(0,063 mm - 0,200 mm):	94,21
Sand, medium	(0,2 mm - 0,6 mm):	2,13
Sand, coarse	(0,6 mm - 2 mm):	0,31
Gravel	(> 2 mm):	0,13
Sum:		100,00

Moments Measures (Folk and Wards)

Percentile Amount in sieve	Percentile Amount passing	d(mm)	Φ
5%	95%	0,18	2,49
16%	84%	0,17	2,60
25%	75%	0,16	2,69
40%	60%	0,14	2,86
Median 50%	50%	0,13	2,99
75%	25%	0,11	3,25
84%	16%	0,10	3,36
90%	10%	0,09	3,44
95%	5%	0,08	3,64

Moments Statistics

Mean	2,98
Sorting	0,36
Skewness	0,06
Kurtosis	0,84
Uniformity Coefficient	1,49

The analysis is executed according to DS 405.9 extended by sieves to the ½ phi scale

Size Classes and Percentiles are found by linear interpolation

Formulas

Mean (ϕ16%+ϕ84%+ϕ50%) / 3 (Folk and Ward 1957)

Sorting (ϕ84%-ϕ16%) / 4 + (ϕ95%-ϕ5%) / 6,6 (Folk and Ward 1957)

Kurtosis (ϕ95% - ϕ5%) / (2,44 * (ϕ75% - ϕ25%)) (Folk and Ward 1957)

Skewness (ϕ16%+ϕ84% - 2*ϕ50%) / (2*(ϕ84%-ϕ16%)) + (ϕ5%+ϕ95% - 2*ϕ50%) / (2*(ϕ95%-ϕ5%)) (Folk and Ward 1957)

Uniformity Coefficient (d60% / d10%) (dgf-Bulletin 1988)

Mean, sorting, skewness and kurtosis are based on "Amount in sieve". Uniformity coefficient is based on "Amount passing".

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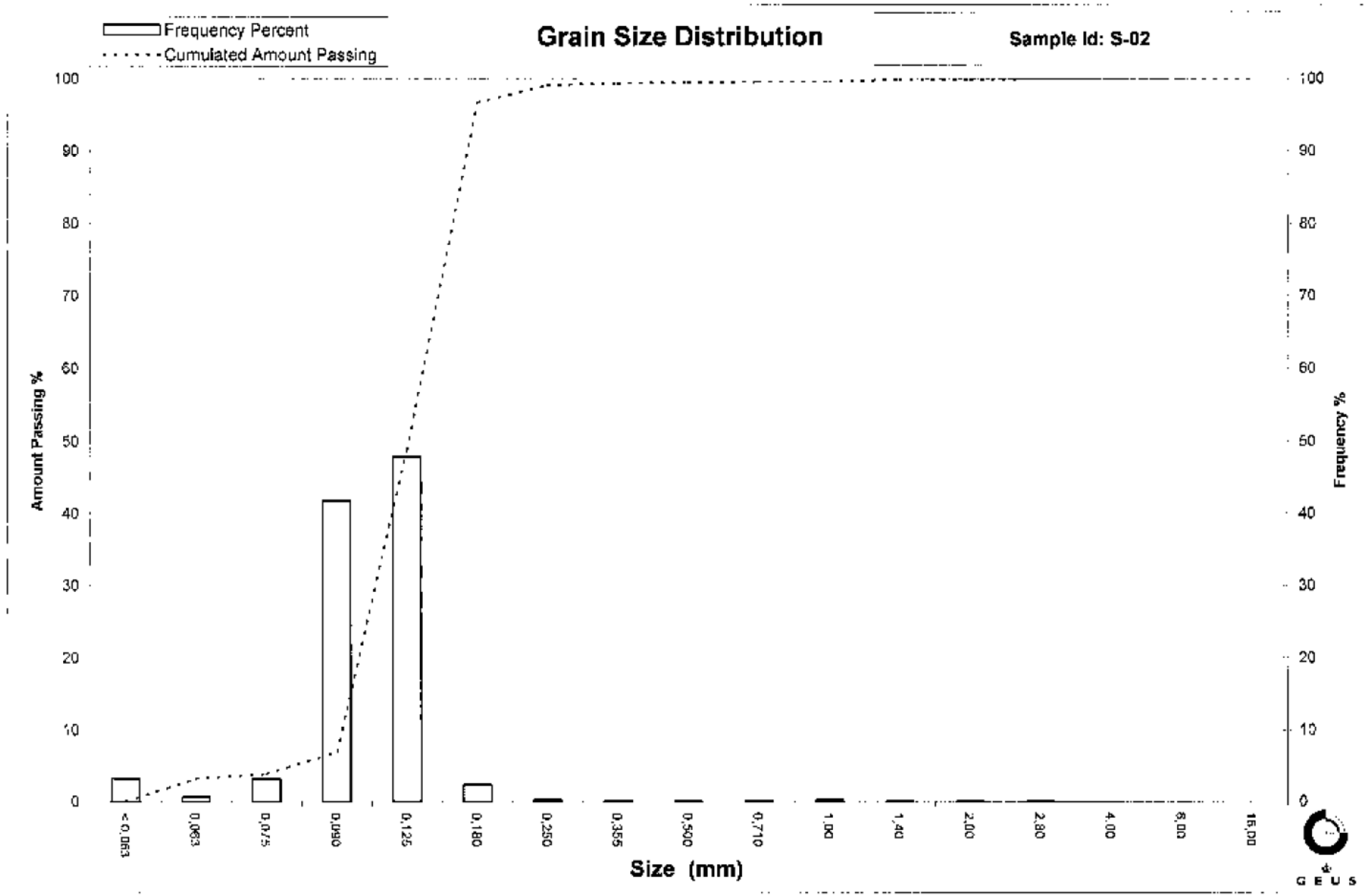
Frequency Percent
Cumulated Amount Passing
Grain Size Distribution
Sample Id: S-02
Amount Passing %
Frequency %
100
90
80
70
60
50
40
30
20
10
0
< 0,063
0,063
0,075
0,090
0,125
0,180
0,250
0,355
0,500
0,710
1,00
1,40
2,00
2,80
4,00
8,00
16,00
Size (mm)
GEUS

Grain Size Distribution

Geotechnical

Sample Id: S-03
Lab. Id: 060757
Submitter: J. Leth
Subject: Ioms Rev E 2
Date: Juni 2006
Executed: I. Nørgaard
Remarks: For mat.< 2 mm

GEUS

Total Weight 103,72 g

Size Fractions

Sieve Analysis

	Size	Size	Weight	Weight	Cumulative amount passing
	mm	Φ	g	%	%
Gravel	16,00	-4,00	0,00	0,00	100,00
	8,00	-3,00	0,00	0,00	100,00
	4,00	-2,00	0,00	0,00	100,00
	2,80	-1,49	0,15	0,14	99,86
	2,00	-1,00	0,14	0,13	99,72
Sand	1,40	-0,49	0,08	0,08	99,64
	1,00	0,00	0,08	0,08	99,57
	0,710	0,49	0,06	0,06	99,51
	0,500	1,00	0,12	0,12	99,39
	0,355	1,49	0,39	0,38	99,02
	0,250	2,00	3,13	3,02	96,90
	0,180	2,47	13,05	12,58	83,42
	0,125	3,00	42,72	41,19	42,23
	0,090	3,47	35,91	34,62	7,61
	0,075	3,74	3,70	3,57	4,04
	0,063	3,99	0,79	0,76	3,28
	< 0,063	> 3,99	3,40	3,28	0,00

Size Classes (DGF-Bulletin 1 1988)

		Weight %
Silt and clay	(< 0,063 mm):	3,28
Sand, fine	(0,063 mm - 0,200 mm):	83,73
Sand, medium	(0,2 mm - 0,6 mm):	12,44
Sand, coarse	(0,6 mm - 2 mm):	0,27
Gravel	(> 2 mm):	0,28
Sum:		100,00

Moments Measures (Folk and Wards)

Percentile	Percentile		
Amount in sieve	Amount passing	d(mm)	Φ
5%	95%	0,24	2,03
16%	84%	0,18	2,45
25%	75%	0,17	2,57
40%	60%	0,15	2,75
Median 50%	50%	0,14	2,88
75%	25%	0,11	3,22
84%	16%	0,10	3,34
90%	10%	0,09	3,44
95%	5%	0,08	3,66

Moments Statistics

Mean	2,89
Sorting	0,47
Skewness	-0,01
Kurtosis	1,03
Uniformity Coefficient	1,61

The analysis is executed according to DS 405.9 extended by sieves to the ½ phi scale

Size Classes and Percentiles are found by linear interpolation

Formulas

Mean (ϕ16%+ϕ84%+ϕ50%) / 3 (Folk and Ward 1957)

Sorting (ϕ84%-ϕ16%) / 4 + (ϕ95%-ϕ5%) / 6,6 (Folk and Ward 1957)

Kurtosis (ϕ95% - ϕ5%) / (2,44 * (ϕ75% - ϕ25%)) (Folk and Ward 1957)

Skewness (ϕ16%+ϕ84% - 2*ϕ50%) / (2*(ϕ84%-ϕ16%)) + (ϕ5%+ϕ95% - 2*ϕ50%) / (2*(ϕ95%-ϕ5%)) (Folk and Ward 1957)

Uniformity Coefficient (d60% / d10%) (dgf-Bulletin 1988)

Mean, sorting, skewness and kurtosis are based on "Amount in sieve". Uniformity coefficient is based on "Amount passing".

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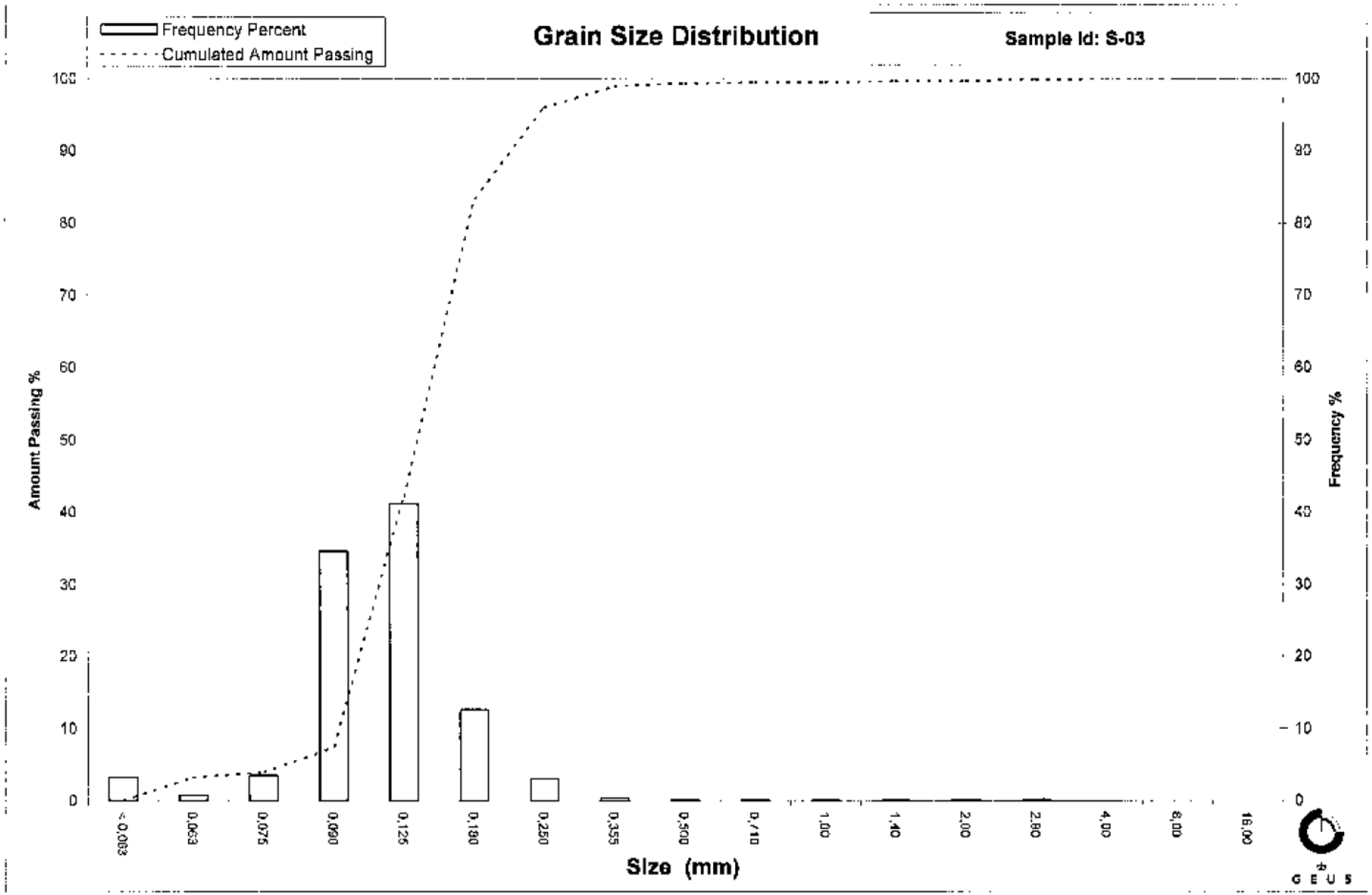
Frequency Percent
Cumulated Amount Passing
Grain Size Distribution
Sample Id: S-03
Amount Passing %
Frequency %
100
90
80
70
60
50
40
30
20
10
0
< 0,063
0,063
0,075
0,090
0,125
0,180
0,250
0,355
0,500
0,710
1,00
1,40
2,00
2,80
4,00
8,00
16,00
Size (mm)
GEUS

Grain Size Distribution

Geotechnical

Sample Id: S-04
Lab. Id: 060758
Submitter: J. Leth
Subject: Horns Rev E 2
Date: Juni 2006
Executed: I. Nørgaard
Remarks: For mat.< 2 mm

GEUS

Total Weight 109,76 g

Size Fractions

Sieve Analysis

	Size	Size	Weight	Weight	Cumulated amount passing
	mm	Φ	g	%	%
Gravel	16,00	-4,00	0,00	0,00	100,00
	8,00	-3,00	0,00	0,00	100,00
	4,00	-2,00	0,13	0,12	99,88
	2,80	-1,49	0,24	0,22	99,66
	2,00	-1,00	0,35	0,32	99,34
Sand	1,40	-0,49	0,25	0,23	99,12
	1,00	0,00	0,28	0,26	98,86
	0,710	0,49	0,21	0,19	98,67
	0,500	1,00	0,43	0,39	98,28
	0,355	1,49	1,16	1,06	97,22
	0,250	2,00	4,13	3,76	93,46
	0,180	2,47	17,02	15,51	77,95
	0,125	3,00	51,02	46,48	31,47
	0,090	3,47	26,10	23,78	7,69
	0,075	3,74	2,38	2,17	5,52
	0,063	3,99	0,80	0,73	4,79
	< 0,063	> 3,99	5,26	4,79	0,00

Size Classes (DGF-Bulletin 1 1988)

		Weight %
Silt and clay	(< 0,063 mm):	4,79
Sand, fine	(0,063 mm - 0,200 mm):	77,59
Sand, medium	(0,2 mm - 0,6 mm):	16,08
Sand, coarse	(0,6 mm - 2 mm):	0,88
Gravel	(> 2 mm):	0,66
Sum:		100,00

Moments Measures (Folk and Wards)

Percentile Amount in sieve	Percentile Amount passing	d(mm)	Φ
5%	95%	0,29	1,77
16%	84%	0,21	2,27
25%	75%	0,18	2,50
40%	60%	0,16	2,66
Median 50%	50%	0,15	2,77
75%	25%	0,12	3,11
84%	16%	0,10	3,29
90%	10%	0,09	3,42
95%	5%	0,07	3,91

Moments Statistics

Mean	2,78
Sorting	0,58
Skewness	0,05
Kurtosis	1,43
Uniformity Coefficient	1,70

The analysis is executed according to DS 405.9 extended by sieves to the ½ phi scale

Size Classes and Percentiles are found by linear interpolation

Formulas

Mean (ϕ16%+ϕ84%+ϕ50%) / 3 (Folk and Ward 1957)

Sorting (ϕ84%-ϕ16%) / 4 + (ϕ95%-ϕ5%) / 6,6 (Folk and Ward 1957)

Kurtosis (ϕ95% - ϕ5%) / (2,44 * (ϕ75% - ϕ25%)) (Folk and Ward 1957)

Skewness (ϕ16%+ϕ84% - 2*ϕ50%) / (2*(ϕ84%-ϕ16%)) + (ϕ5%+ϕ95% - 2*ϕ50%) / (2*(ϕ95%-ϕ5%)) (Folk and Ward 1957)

Uniformity Coefficient (d60% / d10%) (dgf-Bulletin 1988)

Mean, sorting, skewness and kurtosis are based on "Amount in sieve". Uniformity coefficient is based on "Amount passing".

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Email: GEUS@geus.dk
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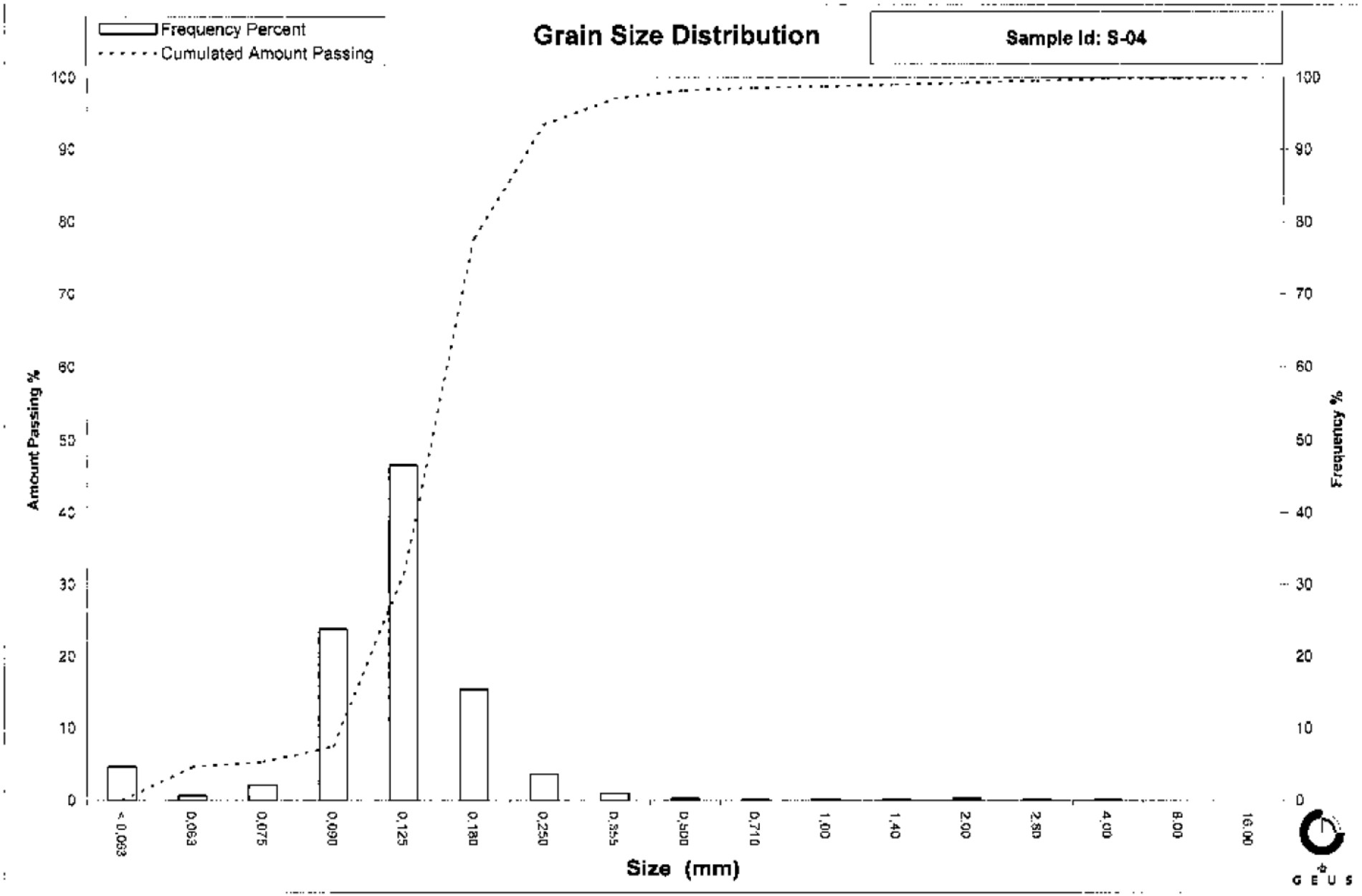
Grain Size Distribution
Sample Id: S-04
Frequency Percent
Cumulated Amount Passing
Amount Passing %
Frequency %
Size (mm)
< 0.063
0.063
0.075
0.090
0.125
0.180
0.250
0.355
0.500
0.710
1.00
1.40
2.00
2.80
4.00
8.00
16.00
GEUS

Grain Size Distribution

Geotechnical

Sample Id: S-05
Lab. Id: 060759
Submitter: J. Leth
Subject: Horns Rev E 2
Date: Juni 2006
Executed: I. Nørgaard
Remarks: For mat.< 2 mm

G E U S

Total Weight 104,68 g

Size Fractions

Sieve Analysis

	Size	Size	Weight	Weight	Cumulated amount passing
	mm	Φ	g	%	%
Gravel	16,00	-4,00	0,00	0,00	100,00
	8,00	-3,00	0,00	0,00	100,00
	4,00	-2,00	0,13	0,12	99,88
	2,80	-1,49	0,08	0,08	99,80
	2,00	-1,00	0,10	0,10	99,70
Sand	1,40	-0,49	0,09	0,09	99,62
	1,00	0,00	0,09	0,09	99,53
	0,710	0,49	0,06	0,06	99,47
	0,500	1,00	0,11	0,11	99,37
	0,355	1,49	0,32	0,31	99,06
	0,250	2,00	1,12	1,07	97,99
	0,180	2,47	8,88	8,48	89,51
	0,125	3,00	59,82	57,15	32,37
	0,090	3,47	21,95	20,97	11,40
	0,075	3,74	2,02	1,93	9,47
	0,063	3,99	0,73	0,70	8,77
	< 0,063	> 3,99	9,18	8,77	0,00

Size Classes (DGF-Bulletin 1 1988)

		Weight %
Silt and clay	(< 0.063 mm):	8,77
Sand, fine	(0,063 mm - 0,200 mm):	83,17
Sand, medium	(0,2 mm - 0,6 mm):	7,48
Sand, coarse	(0,6 mm - 2 mm):	0,28
Gravel	(> 2 mm):	0,30
Sum:		100,00

Moments Measures (Folk and Wards)

Percentile	Percentile		
Amount in sieve	Amount passing	d(mm)	Φ
5%	95%	0,23	2,15
16%	84%	0,17	2,52
25%	75%	0,17	2,59
40%	60%	0,15	2,72
Median 50%	50%	0,14	2,82
75%	25%	0,11	3,15
84%	16%	0,10	3,36
90%	10%	0,08	3,66
95%	5%	----	----

Moments Statistics

Mean	2,90
Sorting	-
Skewness	----
Kurtosis	----
Uniformity Coefficient	1,92

The analysis is executed according to DS 405.9 extended by sieves to the ½ phi scale

Size Classes and Percentiles are found by linear interpolation

Formulas

Mean (ϕ16%+ϕ84%+ϕ50%) / 3 (Folk and Ward 1957)

Sorting (ϕ84% ϕ16%) / 4 + (ϕ95%-ϕ5%) / 6,6 (Folk and Ward 1957)

Kurtosis (ϕ95% - ϕ5%) / (2,44 * (ϕ75% - ϕ25%)) (Folk and Ward 1957)

Skewness (ϕ16%+ϕ84% - 2*ϕ50%) / (2*(ϕ84%-ϕ16%)) + (ϕ5%+ϕ95% - 2*ϕ50%) / (2*(ϕ95%-ϕ5%)) (Folk and Ward 1957)

Uniformity Coefficient (d60% / d10%) (dgf-Bulletin 1988)

Mean, sorting, skewness and kurtosis are based on "Amount in sieve". Uniformity coefficient is based on "Amount passing".

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Tel.: +45 38 14 20 00 Telefax: +45 38 14 20 50
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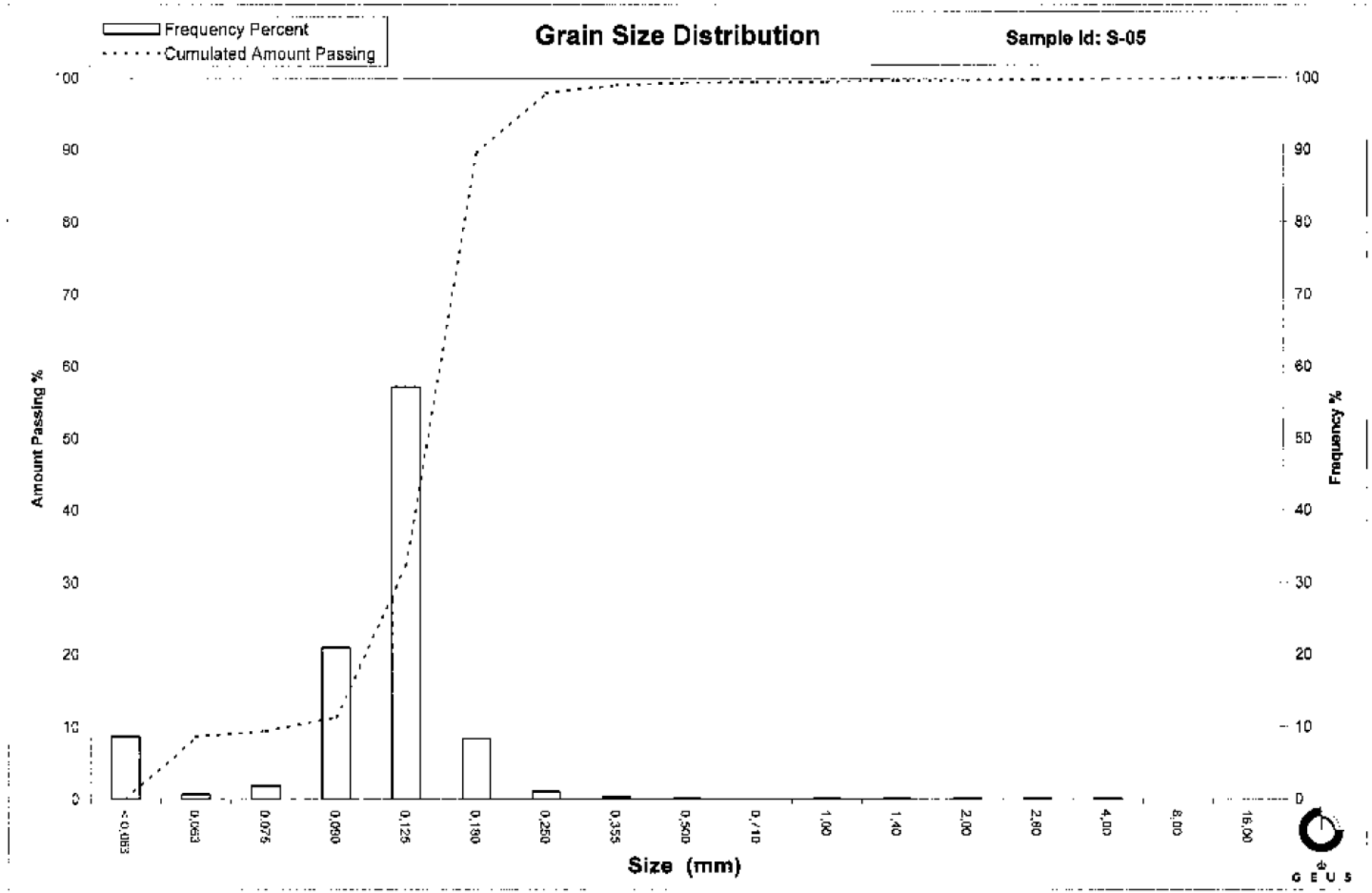
Frequency Percent
Cumulated Amount Passing
Grain Size Distribution
Sample Id: S-05
Amount Passing %
Frequency %
100
90
80
70
60
50
40
30
20
10
0
< 0,063
0,063
0,075
0,090
0,125
0,180
0,250
0,355
0,500
0,710
1,00
1,40
2,00
2,80
4,00
8,00
16,00
Size (mm)
GEUS

Grain Size Distribution

Geotechnical

Sample Id: S-06
Lab. Id: 060760
Submitter: J. Leth
Subject: Horns Rev E 2
Date: Juni 2006
Executed: I. Nørgaard
Remarks: For mat < 2 mm for lidt mat. ifig. DS

G E U S

Total Weight 43,87 g

Size Fractions

Sieve Analysis

	Size	Size	Weight	Weight	Cumulated amount passing
	mm	Φ	g	%	%
Gravel	16,00	-4,00	0,00	0,00	100,00
	8,00	-3,00	0,00	0,00	100,00
	4,00	-2,00	0,00	0,00	100,00
	2,80	-1,49	0,03	0,07	99,93
	2,00	-1,00	0,05	0,11	99,82
Sand	1,40	-0,49	0,05	0,11	99,70
	1,00	0,00	0,16	0,36	99,34
	0,710	0,49	0,04	0,09	99,25
	0,500	1,00	0,08	0,18	99,07
	0,355	1,49	0,10	0,23	98,84
	0,250	2,00	0,21	0,48	98,36
	0,180	2,47	1,86	4,24	94,12
	0,125	3,00	26,16	59,63	34,49
	0,090	3,47	12,59	28,70	5,79
	0,075	3,74	0,92	2,10	3,69
	0,063	3,99	0,31	0,71	2,99
	< 0,063	> 3,99	1,31	2,99	0,00

Size Classes (DGF-Bulletin 1 1988)

		Weight %
Silt and clay	(< 0,063 mm):	2,99
Sand, fine	(0,063 mm - 0,200 mm):	92,34
Sand, medium	(0,2 mm - 0,6 mm):	3,82
Sand, coarse	(0,6 mm - 2 mm):	0,67
Gravel	(> 2 mm):	0,18
Sum:		100,00

Moments Measures (Folk and Wards)

Percentile	Percentile		
Amount in sieve	Amount passing	d(mm)	Φ
5%	95%	0,19	2,36
16%	84%	0,17	2,55
25%	75%	0,16	2,62
40%	60%	0,15	2,75
Median 50%	50%	0,14	2,84
75%	25%	0,11	3,14
84%	16%	0,10	3,29
90%	10%	0,10	3,39
95%	5%	0,08	3,57

Moments Statistics

Mean	2,89
Sorting	0,37
Skewness	0,20
Kurtosis	0,95
Uniformity Coefficient	1,56

The analysis is executed according to DS 405.9 extended by sieves to the ½ phi scale

Size Classes and Percentiles are found by linear interpolation

Formulas

Mean (ϕ16%+ϕ84%+ϕ50%) / 3 (Folk and Ward 1957)

Sorting (ϕ84%-ϕ16%) / 4 + (ϕ95%-ϕ5%) / 6,6 (Folk and Ward 1957)

Kurtosis (ϕ95% - ϕ5%) / (2,44 * (ϕ75% - ϕ25%)) (Folk and Ward 1957)

Skewness (ϕ16%+ϕ84% - 2*ϕ50%) / (2*(ϕ84%-ϕ16%)) + (ϕ5%+ϕ95% - 2*ϕ50%) / (2*(ϕ95%-ϕ5%)) (Folk and Ward 1957)

Uniformity Coefficient (d60% / d10%) (dgf-Bulletin 1988)

Mean, sorting, skewness and kurtosis are based on "Amount in sieve". Uniformity coefficient is based on "Amount passing"

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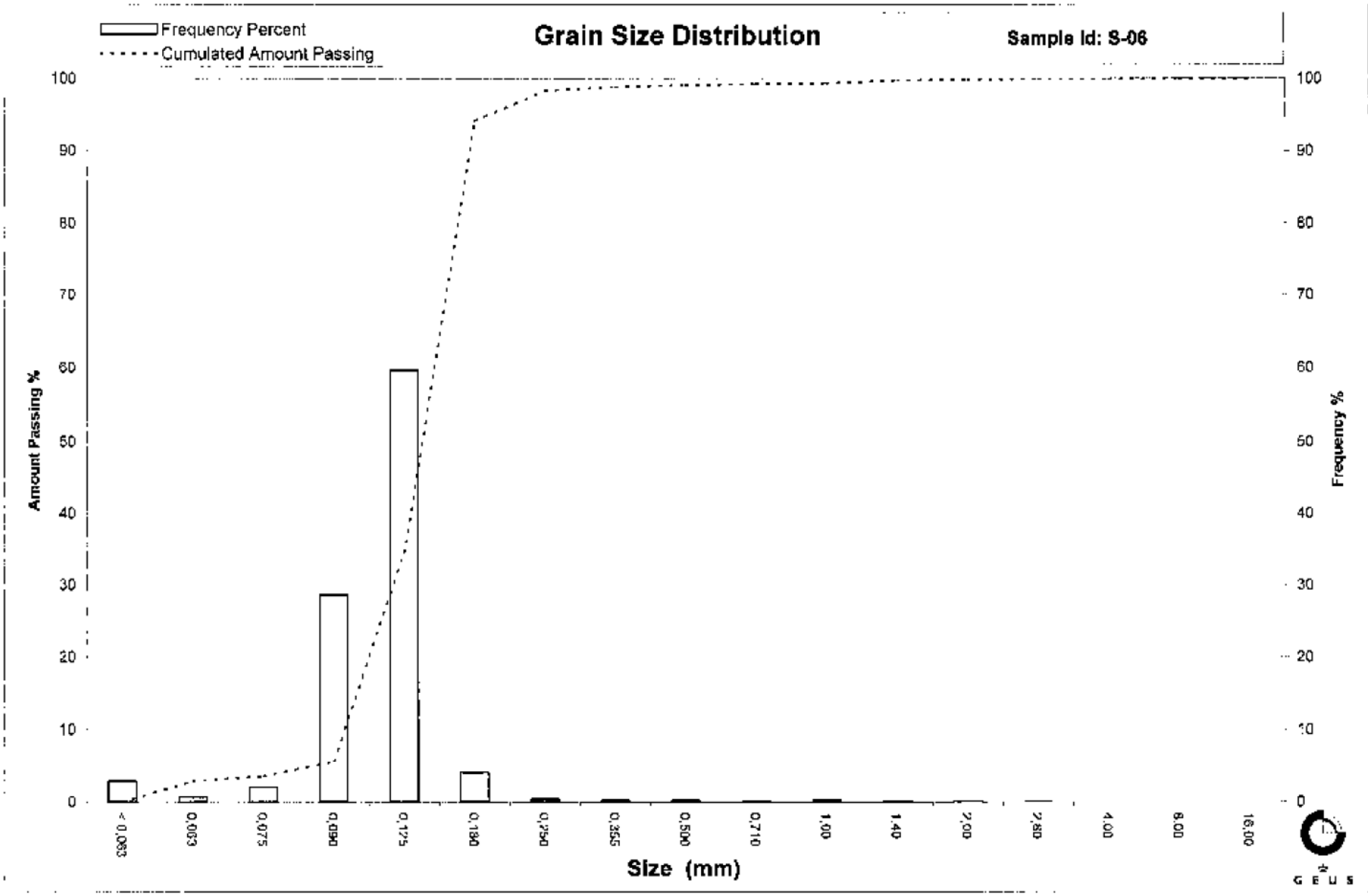
Frequency Percent
Cumulated Amount Passing
Grain Size Distribution
Sample Id: S-06
Amount Passing %
Frequency %
100
90
80
70
60
50
40
30
20
10
0
< 0,063
0,063
0,075
0,090
0,125
0,180
0,250
0,355
0,500
0,710
1,00
1,40
2,00
2,80
4,00
8,00
16,00
Size (mm)
GEUS

Grain Size Distribution

Geotechnical

Sample Id: N-01
Lab. Id: 060761
Submitter: J. Leth
Subject: Horns Rev E 2
Date: Juni 2006
Executed: I. Nørgaard
Remarks: For mat.< 2 mm

GEUS

Total Weight 103,37 g

Size Fractions

Sieve Analysis

	Size	Size	Weight	Weight	Cumulated amount passing
	mm	ϕ	g	%	%
Gravel	16,00	-4,00	0,00	0,00	100,00
	8,00	-3,00	0,00	0,00	100,00
	4,00	-2,00	0,14	0,14	99,86
	2,80	-1,49	0,06	0,06	99,81
	2,00	-1,00	0,11	0,11	99,70
	1,40	-0,49	0,08	0,08	99,62
	1,00	0,00	0,15	0,15	99,48
Sand	0,710	0,49	0,42	0,41	99,07
	0,500	1,00	2,34	2,26	96,81
	0,355	1,49	9,63	9,32	87,49
	0,250	2,00	26,71	25,84	61,65
	0,180	2,47	24,76	23,95	37,70
	0,125	3,00	20,19	19,53	18,17
	0,090	3,47	14,94	14,45	3,71
	0,075	3,74	1,62	1,57	2,15
	0,063	3,99	0,24	0,23	1,92
	< 0,063	> 3,99	1,98	1,92	0,00

Size Classes (DGF-Bulletin 1 1988)

		Weight %
Silt and clay	(< 0,063 mm)	1,92
Sand, fine	(0,063 mm - 0,200 mm):	42,63
Sand, medium	(0,2 mm - 0,6 mm):	53,34
Sand, coarse	(0,6 mm - 2 mm):	1,81
Gravel	(> 2 mm).	0,30
Sum:		100,00

Moments Measures (Folk and Wards)

Percentile	Percentile		
Amount in sieve	Amount passing	d(mm)	ϕ
5%	95%	0,47	1,08
16%	84%	0,34	1,55
25%	75%	0,30	1,72
40%	60%	0,25	2,03
Median 50%	50%	0,22	2,21
75%	25%	0,14	2,79
84%	16%	0,12	3,06
90%	10%	0,11	3,25
95%	5%	0,09	3,42

Moments Statistics

Mean	2,28
Sorting	0,73
Skewness	0,08
Kurtosis	0,89
Uniformity Coefficient	2,33

The analysis is executed according to DS 405.9 extended by sieves to the ½ phi scale

Size Classes and Percentiles are found by linear interpolation

Formulas

Mean (ϕ16%+ϕ84%+ϕ50%) / 3 (Folk and Ward 1957)

Sorting (ϕ84%-ϕ16%) / 4 + (ϕ95%-ϕ5%) / 6,6 (Folk and Ward 1957)

Kurtosis (ϕ95% - ϕ5%) / (2,44 * (ϕ75% - ϕ25%)) (Folk and Ward 1957)

Skewness (ϕ16%+ϕ84% - 2*ϕ50%) / (2*(ϕ84%-ϕ16%)) + (ϕ5%+ϕ95% - 2*ϕ50%) / (2*(ϕ95%-ϕ5%)) (Folk and Ward 1957)

Uniformity Coefficient (d60% / d10%) (dgf-Bulletin 1988)

Mean, sorting, skewness and kurtosis are based on "Amount in sieve". Uniformity coefficient is based on "Amount passing".

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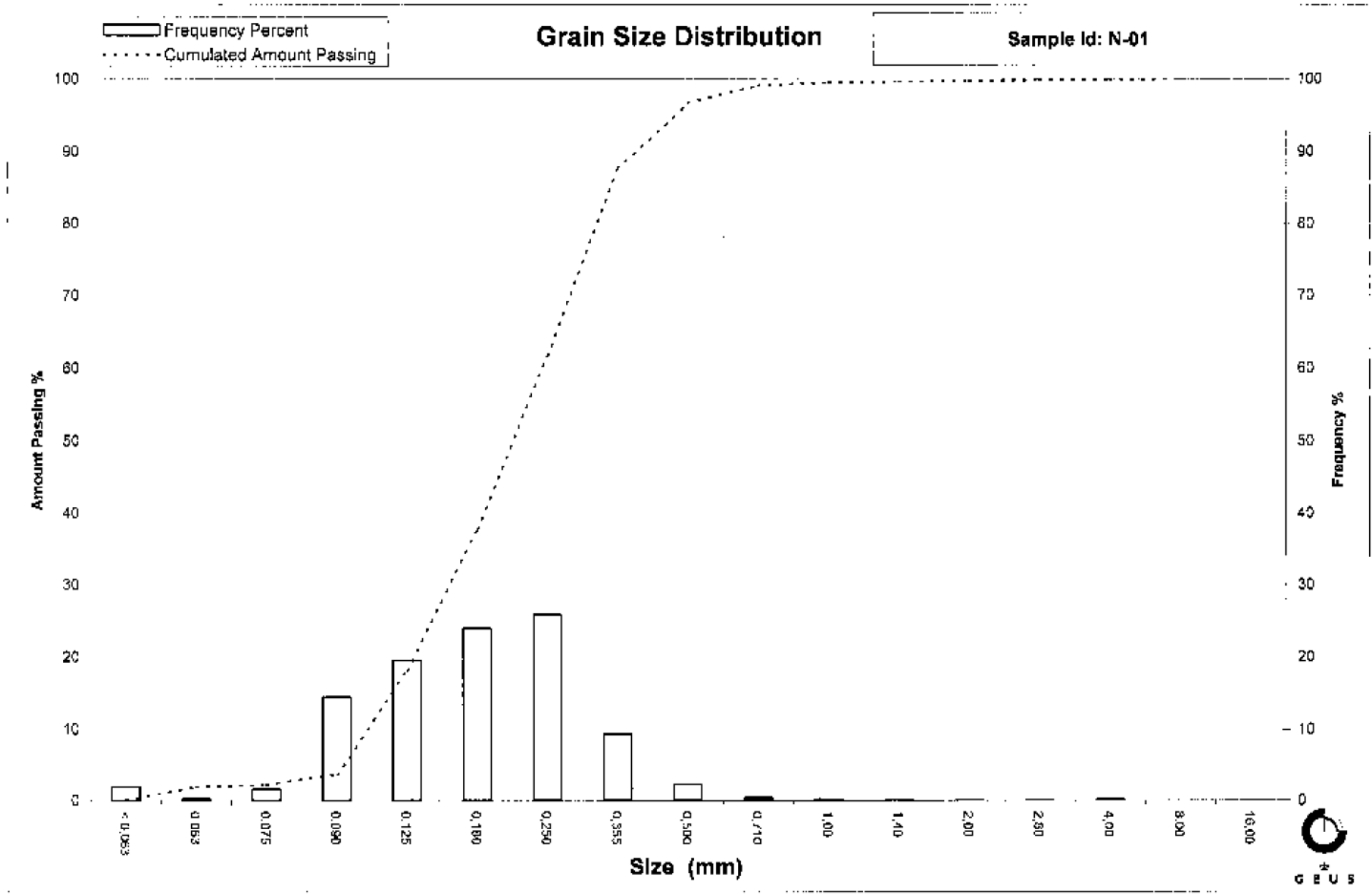
Frequency Percent
Cumulated Amount Passing
Grain Size Distribution
Sample Id: N-01
Amount Passing %
Frequency %
100
90
80
70
60
50
40
30
20
10
0
< 0.063
0.063
0.075
0.090
0.125
0.180
0.250
0.355
0.500
0.710
1.00
1.40
2.00
2.80
4.00
8.00
16.00
Size (mm)
GEUS

Grain Size Distribution

Geotechnical

Sample Id: N-02
Lab. Id: 060762
Submitter: J. Leth
Subject: Horns Rev E 2
Date: Juni 2006
Executed: I. Nørgaard
Remarks: For mat.< 2 mm

G E U S

Total Weight 103,77 g

Size Fractions

Sieve Analysis (Gravel, Sand)

Size	Size	Weight	Weight	Cumulated amount passing
mm	Φ	g	%	%
16,00	-4,00	0,00	0,00	100,00
8,00	-3,00	0,00	0,00	100,00
4,00	-2,00	0,10	0,10	99,90
2,80	-1,49	0,07	0,07	99,84
2,00	-1,00	0,08	0,08	99,76
1,40	-0,49	0,03	0,03	99,73
1,00	0,00	0,20	0,19	99,54
0,710	0,49	0,07	0,07	99,47
0,500	1,00	0,14	0,13	99,34
0,355	1,49	0,43	0,41	98,92
0,250	2,00	1,44	1,39	97,53
0,180	2,47	5,09	4,91	92,63
0,125	3,00	34,88	33,61	59,02
0,090	3,47	48,77	47,00	12,02
0,075	3,74	4,38	4,22	7,80
0,063	3,99	0,89	0,86	6,94
< 0,063	> 3,99	7,20	6,94	0,00

Size Classes (DGF-Bulletin 1 1988)

		Weight %
Silt and clay	(< 0,063 mm)	6,94
Sand, fine	(0,063 mm - 0,200 mm):	87,09
Sand, medium	(0,2 mm - 0,6 mm):	5,37
Sand, coarse	(0,6 mm - 2 mm):	0,36
Gravel	(> 2 mm)	0,24
Sum:		100,00

Moments Measures (Folk and Wards)

Percentile Amount in sieve	Percentile Amount passing	d(mm)	Φ
5%	95%	0,21	2,23
16%	84%	0,17	2,59
25%	75%	0,15	2,73
40%	60%	0,13	2,98
Median 50%	50%	0,12	3,08
75%	25%	0,10	3,33
84%	16%	0,09	3,43
90%	10%	0,08	3,59
95%	5%	----	----

Moments Statistics

Mean	3,03
Sorting	----
Skewness	----
Kurtosis	----
Uniformity Coefficient	1,53

The analysis is executed according to DS 405.9 extended by sieves to the ½ phi scale

Size Classes and Percentiles are found by linear interpolation

Formulas

Mean (ϕ16%+ϕ84%+ϕ50%) / 3 (Folk and Ward 1957)

Sorting (ϕ84%-ϕ16%) / 4 + (ϕ95%-ϕ5%) / 6,6 (Folk and Ward 1957)

Kurtosis (ϕ95% - ϕ5%) / (2,44 * (ϕ75% - ϕ25%)) (Folk and Ward 1957)

Skewness (ϕ16%+ϕ84% - 2*ϕ50%) / (2*(ϕ84%-ϕ16%)) + (ϕ5%+ϕ95% - 2*ϕ50%) / (2*(ϕ95% ϕ5%)) (Folk and Ward 1957)

Uniformity Coefficient (d60% / d10%) (dgf-Bulletin 1988)

Mean, sorting, skewness and kurtosis are based on "Amount in sieve" Uniformity coefficient is based on "Amount passing".

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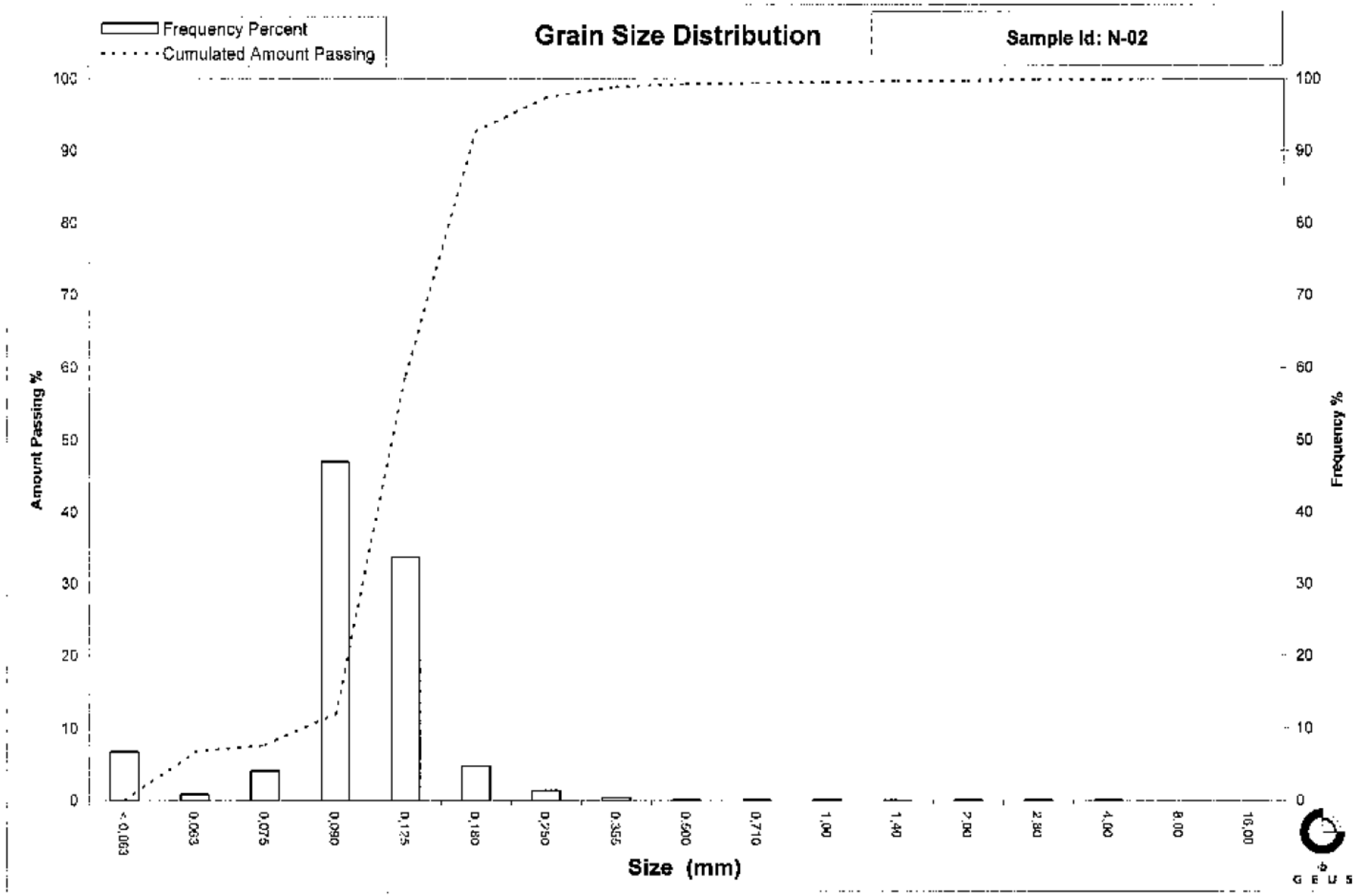
Frequency Percent
Cumulated Amount Passing
Grain Size Distribution
Sample Id: N-02
Amount Passing %
Frequency %
100
90
80
70
60
50
40
30
20
10
0
< 0,063
0,063
0,075
0,090
0,125
0,180
0,250
0,355
0,500
0,710
1,00
1,40
2,00
2,80
4,00
8,00
16,00
Size (mm)
GEUS

Grain Size Distribution

Geotechnical

Sample Id: N-03
Lab. Id: 060763
Submitter: J. Leth
Subject: Horns Rev E 2
Date: Juni 2006
Executed: I. Nørgaard
Remarks: For mat.< 2 mm

GEUS

Total Weight 100,21 g

Size Fractions

Sieve Analysis

	Size	Size	Weight	Weight	Cumulated amount passing
	mm	Φ	g	%	%
Gravel	16,00	-4,00	0,00	0,00	100,00
	8,00	-3,00	0,00	0,00	100,00
	4,00	-2,00	0,63	0,63	99,37
	2,80	-1,49	0,54	0,54	98,83
	2,00	-1,00	0,32	0,32	98,51
Sand	1,40	-0,49	0,08	0,08	98,43
	1,00	0,00	0,45	0,45	97,98
	0,710	0,49	0,15	0,15	97,83
	0,500	1,00	0,32	0,32	97,52
	0,355	1,49	1,17	1,17	96,35
	0,250	2,00	4,08	4,07	92,28
	0,180	2,47	9,20	9,18	83,10
	0,125	3,00	43,76	43,67	39,43
	0,090	3,47	32,35	32,28	7,14
	0,075	3,74	1,96	1,96	5,19
	0,063	3,99	0,51	0,51	4,68
	< 0,063	> 3,99	4,69	4,68	0,00

Size Classes (DGF-Bulletin 1 1988)

		Weight %
Silt and clay	(< 0,063 mm):	4,68
Sand, fine	(0,063 mm - 0,200 mm):	81,04
Sand, medium	(0,2 mm - 0,6 mm):	11,95
Sand, coarse	(0,6 mm - 2 mm):	0,85
Gravel	(> 2 mm):	1,49
Sum:		100,00

Moments Measures (Folk and Wards)

Percentile Amount in sieve	Percentile Amount passing	d(mm)	Φ
5%	95%	0,32	1,64
16%	84%	0,19	2,42
25%	75%	0,17	2,56
40%	60%	0,15	2,73
Median 50%	50%	0,14	2,85
75%	25%	0,11	3,19
84%	16%	0,10	3,33
90%	10%	0,09	3,43
95%	5%	0,07	3,63

Moments Statistics

Mean	2,87
Sorting	0,56
Skewness	-0,03
Kurtosis	1,41
Uniformity Coefficient	1,62

The analysis is executed according to DS 405.9 extended by sieves to the ½ phi scale

Size Classes and Percentiles are found by linear interpolation

Formulas

Mean (ϕ16%+ϕ84%+ϕ50%) / 3 (Folk and Ward 1957)

Sorting (ϕ84%-ϕ16%) / 4 + (ϕ95%-ϕ5%) / 6,6 (Folk and Ward 1957)

Kurtosis (ϕ95% - ϕ5%) / (2,44 * (ϕ75% - ϕ25%)) (Folk and Ward 1957)

Skewness (ϕ16%+ϕ84% - 2*ϕ50%) / (2*(ϕ84%-ϕ16%)) + (ϕ5%+ϕ95% - 2*ϕ50%) / (2*(ϕ95%-ϕ5%)) (Folk and Ward 1957)

Uniformity Coefficient (d60% / d10%) (dgf-Bulletin 1988)

Mean, sorting, skewness and kurtosis are based on "Amount in sieve" Uniformity coefficient is based on "Amount passing".

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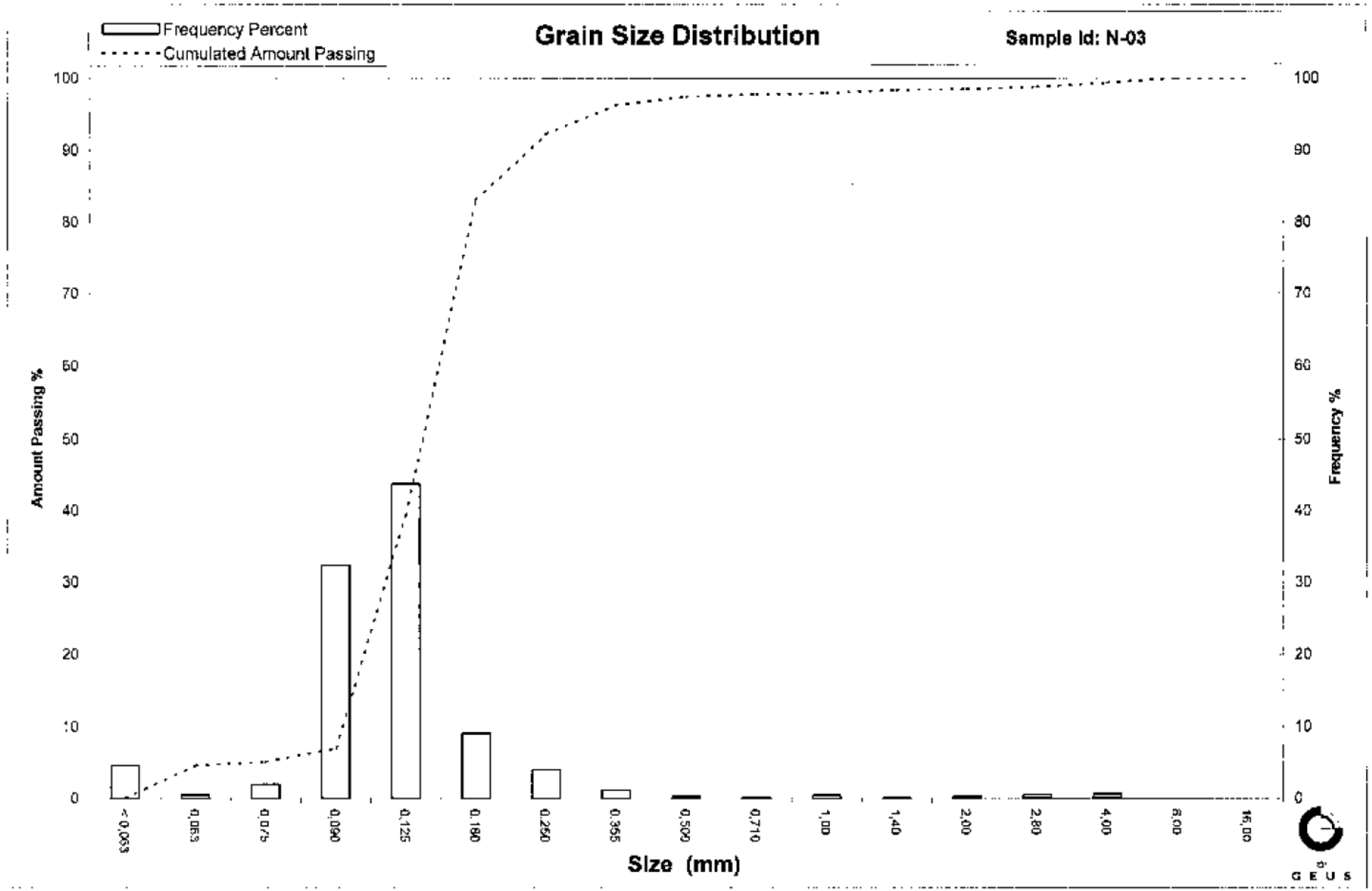
Frequency Percent
Cumulated Amount Passing
Grain Size Distribution
Sample Id: N-03
Amount Passing %
Frequency %
100
90
80
70
60
50
40
30
20
10
0
< 0,063
0,063
0,075
0,090
0,125
0,180
0,250
0,355
0,500
0,710
1,00
1,40
2,00
2,80
4,00
8,00
16,00
Size (mm)
GEUS

Grain Size Distribution

Geotechnical

Sample Id: N-05
Lab. Id: 060764
Submitter: J. Leth
Subject: Horns Rev E 2
Date: Juni 2006
Executed: I. Nørgaard
Remarks: For mat.< 2 mm

GEUS

Total Weight 103,48 g

Size Fractions

Sieve Analysis

	Size	Size	Weight	Weight	Cumulative amount passing
	mm	Φ	g	%	%
Gravel	16,00	-4,00	0,00	0,00	100,00
	8,00	-3,00	0,00	0,00	100,00
	4,00	-2,00	0,04	0,04	99,96
	2,80	-1,49	0,10	0,10	99,86
	2,00	-1,00	0,08	0,08	99,79
Sand	1,40	-0,49	0,07	0,07	99,72
	1,00	0,00	0,05	0,05	99,67
	0,710	0,49	0,05	0,05	99,62
	0,500	1,00	0,04	0,04	99,58
	0,355	1,49	0,24	0,23	99,35
	0,250	2,00	2,45	2,37	96,98
	0,160	2,47	9,17	8,86	88,12
	0,125	3,00	54,25	52,43	35,70
	0,090	3,47	30,60	29,57	6,13
	0,075	3,74	3,11	3,01	3,12
	0,063	3,99	0,70	0,68	2,44
	< 0,063	> 3,99	2,53	2,44	0,00

Size Classes (DGF-Bulletin 1 1988)

		Weight %
Silt and clay	(< 0,063 mm):	2,44
Sand, fine	(0,063 mm - 0,200 mm):	88,21
Sand, medium	(0,2 mm - 0,6 mm):	8,95
Sand, coarse	(0,6 mm - 2 mm):	0,18
Gravel	(> 2 mm):	0,21
Sum:		100,00

Moments Measures (Folk and Wards)

Percentile	Percentile		
Amount in sieve	Amount passing	d(mm)	Φ
5%	95%	0,23	2,09
16%	84%	0,18	2,51
25%	75%	0,17	2,59
40%	60%	0,15	2,73
Median 50%	50%	0,14	2,84
75%	25%	0,11	3,15
84%	16%	0,10	3,30
90%	10%	0,09	3,40
95%	5%	0,08	3,57

Moments Statistics

Mean	2,88
Sorting	0,42
Skewness	0,08
Kurtosis	1,07
Uniformity Coefficient	1,59

The analysis is executed according to DS 405.9 extended by sieves to the ½ phi scale

Size Classes and Percentiles are found by linear interpolation

Formulas

Mean (ϕ16%+ϕ84%+ϕ50%) / 3 (Folk and Ward 1957)

Sorting (ϕ84%-ϕ16%) / 4 + (ϕ95%-ϕ5%) / 6,6 (Folk and Ward 1957)

Kurtosis (ϕ95% - ϕ5%) / (2,44 * (ϕ75% - ϕ25%)) (Folk and Ward 1957)

Skewness (ϕ16%+ϕ84% - 2*ϕ50%) / (2*(ϕ84%-ϕ16%)) + (ϕ5%+ϕ95% - 2*ϕ50%) / (2*(ϕ95%-ϕ5%)) (Folk and Ward 1957)

Uniformity Coefficient (d60% / d10%) (dgf-Bulletin 1988)

Mean, sorting, skewness and kurtosis are based on "Amount in sieve". Uniformity coefficient is based on "Amount passing".

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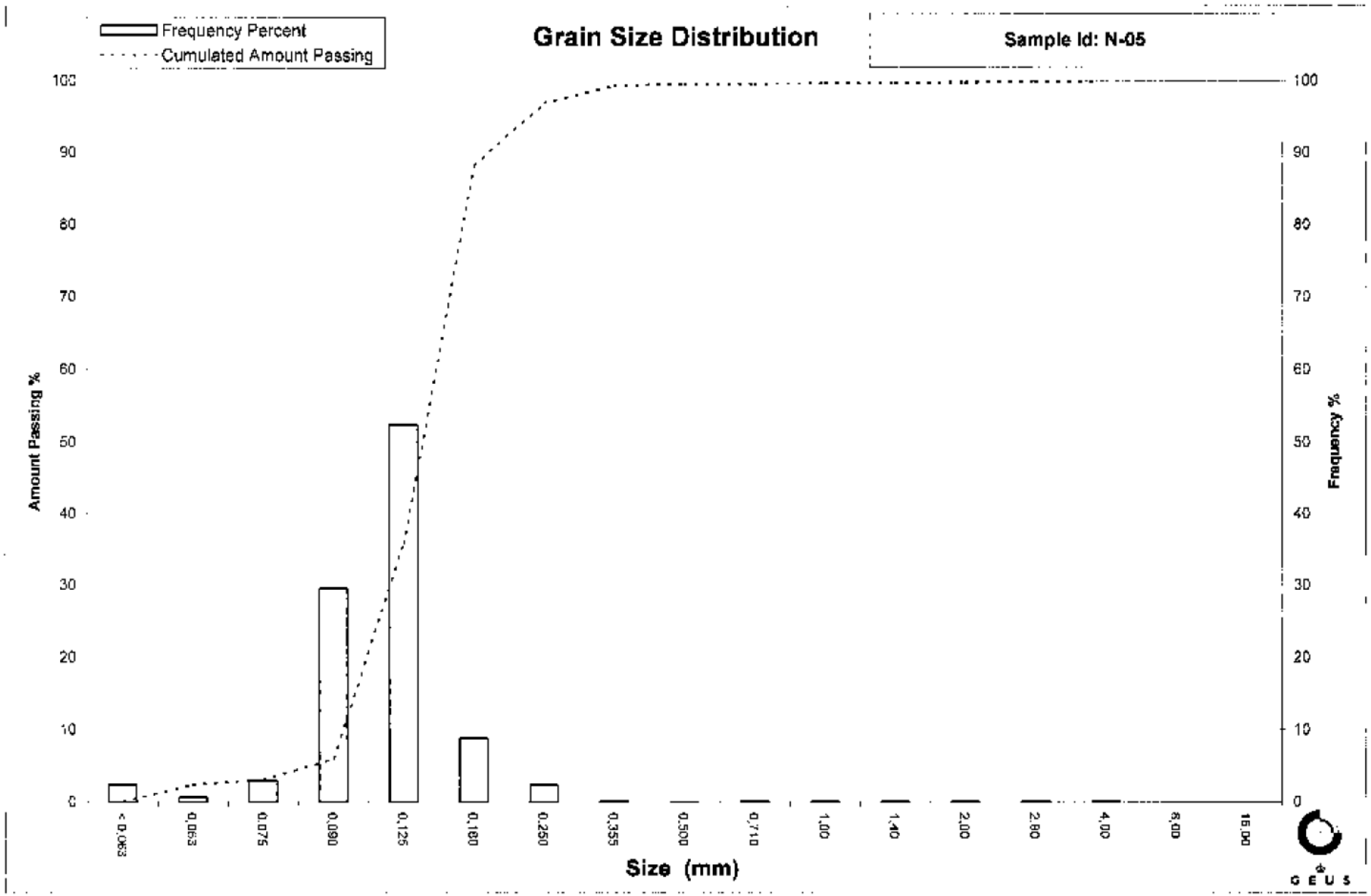
Frequency Percent
Cumulated Amount Passing
Grain Size Distribution
Sample Id: N-05
Amount Passing %
Frequency %
Size (mm)
< 0,063
0,063
0,075
0,090
0,125
0,180
0,250
0,355
0,500
0,710
1,00
1,40
2,00
2,80
4,00
8,00
16,00
GEUS

Grain Size Distribution

Geotechnical

Sample Id: N 06
Lab. Id: 060765
Submitter: J. Leth
Subject: Horns Rev E 2
Date: Juni 2006
Executed: I. Nørgaard
Remarks: For mat.< 2 mm

G E U S

Total Weight 109,82 g

Size Fractions

Sieve Analysis

	Size	Size	Weight	Weight	Cumulated amount passing
	mm	Φ	g	%	%
Gravel	16,00	-4,00	0,00	0,00	100,00
	8,00	-3,00	0,00	0,00	100,00
	4,00	-2,00	0,00	0,00	100,00
	2,80	-1,49	0,03	0,03	99,97
	2,00	-1,00	0,03	0,03	99,95
Sand	1,40	-0,49	0,03	0,03	99,92
	1,00	0,00	0,20	0,18	99,74
	0,710	0,49	0,03	0,03	99,71
	0,500	1,00	0,05	0,05	99,66
	0,355	1,49	0,20	0,18	99,48
	0,250	2,00	1,35	1,23	98,25
	0,180	2,47	6,36	5,79	92,46
	0,125	3,00	62,27	56,70	35,76
	0,090	3,47	31,03	28,26	7,50
	0,075	3,74	3,05	2,78	4,72
	0,063	3,99	0,78	0,71	4,01
	< 0,063	> 3,99	4,41	4,01	0,00

Size Classes (DGF-Bulletin 1 1988)

		Weight %
Silt and clay	(< 0,063 mm).	4,01
Sand, fine	(0,063 mm - 0,200 mm):	90,10
Sand, medium	(0,2 mm - 0,6 mm):	5,57
Sand, coarse	(0,6 mm - 2 mm).	0,26
Gravel	(> 2 mm).	0,05
Sum:		100,00

Moments Measures (Folk and Wards)

Percentile	Percentile		
Amount in sieve	Amount passing	d(mm)	Φ
5%	95%	0,21	2,25
16%	84%	0,17	2,54
25%	75%	0,16	2,62
40%	60%	0,15	2,75
Median 50%	50%	0,14	2,85
75%	25%	0,11	3,16
84%	16%	0,10	3,31
90%	10%	0,09	3,43
95%	5%	0,08	3,71

Moments Statistics

Mean	2,90
Sorting	0,41
Skewness	0,19
Kurtosis	1,10
Uniformity Coefficient	1,60

The analysis is executed according to DS 405.9 extended by sieves to the ½ phi scale

Size Classes and Percentiles are found by linear interpolation

Formulas

Mean (ϕ16%+ϕ84%+ϕ50%) / 3 (Folk and Ward 1957)

Sorting (ϕ84%-ϕ16%) / 4 + (ϕ95%-ϕ5%) / 6,6 (Folk and Ward 1957)

Kurtosis (ϕ95% - ϕ5%) / (2,44 * (ϕ75% - ϕ25%)) (Folk and Ward 1957)

Skewness (ϕ16%+ϕ84% - 2*ϕ50%) / (2*(ϕ84%-ϕ16%)) + (ϕ5%+ϕ95% - 2*ϕ50%) / (2*(ϕ95%-ϕ5%)) (Folk and Ward 1957)

Uniformity Coefficient (d60% / d10%) (dgf-Bulletin 1988)

Mean, sorting, skewness and kurtosis are based on "Amount in sieve". Uniformity coefficient is based on "Amount passing".

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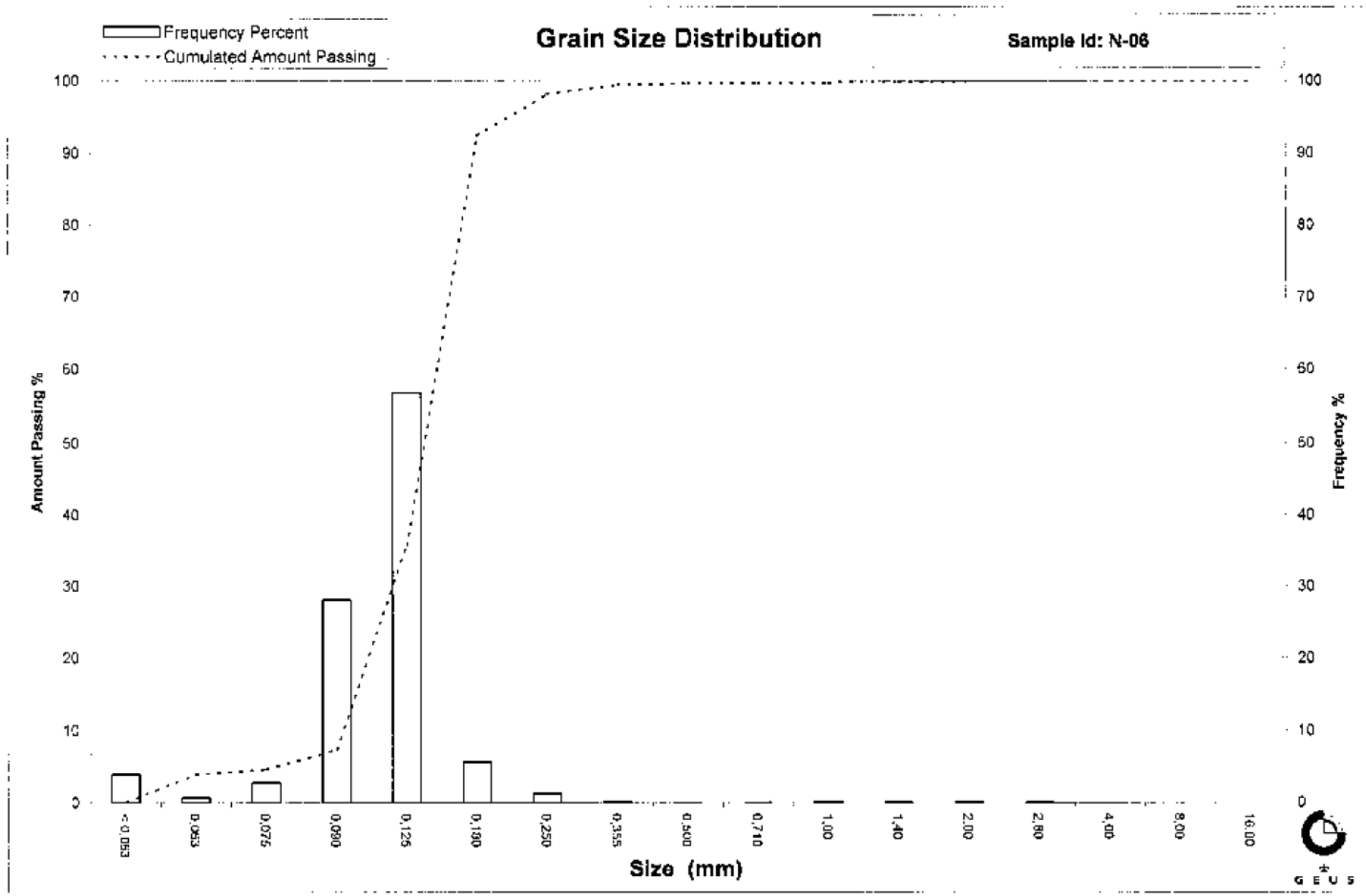
Frequency Percent
Cumulated Amount Passing
Grain Size Distribution
Sample Id: N-06
Amount Passing %
Frequency %
100
90
80
70
60
50
40
30
20
10
0
< 0,053
0,053
0,075
0,090
0,125
0,180
0,250
0,355
0,500
0,710
1,00
1,40
2,00
2,80
4,00
8,00
16,00
Size (mm)

Grain Size Distribution

Geotechnical

Sample Id: N-07
Lab. Id: 060766
Submitter: J. Leth
Subject: Horns Rev E 2
Date: Juni 2006
Executed: I. Nørgaard
Remarks: For mat.< 2 mm

G E U S

Total Weight 104,7 g

Size Fractions

Sieve Analysis

	Size	Size	Weight	Weight	Cumulated amount passing
	mm	Φ	g	%	%
Gravel	16,00	-4,00	0,00	0,00	100,00
	8,00	-3,00	0,00	0,00	100,00
	4,00	-2,00	0,22	0,21	99,79
	2,80	-1,49	0,12	0,11	99,68
	2,00	-1,00	0,09	0,09	99,59
Sand	1,40	-0,49	0,19	0,18	99,41
	1,00	0,00	0,16	0,15	99,26
	0,710	0,49	0,11	0,11	99,15
	0,500	1,00	0,22	0,21	98,94
	0,355	1,49	1,55	1,48	97,46
	0,250	2,00	7,70	7,35	90,11
	0,180	2,47	9,73	9,29	80,81
	0,125	3,00	49,61	47,38	33,43
	0,090	3,47	27,94	26,69	6,74
	0,075	3,74	2,52	2,41	4,34
	0,063	3,99	0,61	0,58	3,75
	< 0,063	> 3,99	3,93	3,75	0,00

Size Classes (DGF-Bulletin 1 1988)

		Weight %
Silt and clay	(< 0,063 mm):	3,75
Sand, fine	(0,063 mm - 0,200 mm):	79,71
Sand, medium	(0,2 mm - 0,6 mm):	15,57
Sand, coarse	(0,6 mm - 2 mm):	0,55
Gravel	(> 2 mm):	0,41
Sum:		100,00

Moments Measures (Folk and Wards)

Percentile Amount in sieve	Percentile Amount passing	d(mm)	Φ
5%	95%	0,32	1,64
16%	84%	0,20	2,29
25%	75%	0,17	2,53
40%	60%	0,16	2,68
Median 50%	50%	0,14	2,79
75%	25%	0,11	3,13
84%	16%	0,10	3,29
90%	10%	0,09	3,41
95%	5%	0,08	3,66

Moments Statistics

Mean	2,79
Sorting	0,55
Skewness	-0,07
Kurtosis	1,37
Uniformity Coefficient	1,65

The analysis is executed according to DS 405.9 extended by sieves to the ½ phi scale

Size Classes and Percentiles are found by linear interpolation

Formulas

Mean (ϕ16%+ϕ84%+ϕ50%) / 3 (Folk and Ward 1957)

Sorting (ϕ84%-ϕ16%) / 4 + (ϕ95%-ϕ5%) / 6,6 (Folk and Ward 1957)

Kurtosis (ϕ95% - ϕ5%) / (2,44 * (ϕ75% - ϕ25%)) (Folk and Ward 1957)

Skewness (ϕ16%+ϕ84% - 2*ϕ50%) / (2*(ϕ84%-ϕ16%)) + (ϕ5%+ϕ95% - 2*ϕ50%) / (2*(ϕ95%-ϕ5%)) (Folk and Ward 1957)

Uniformity Coefficient (d60% / d10%) (dgf-Bulletin 1988)

Mean, sorting, skewness and kurtosis are based on "Amount in sieve" Uniformity coefficient is based on "Amount passing".

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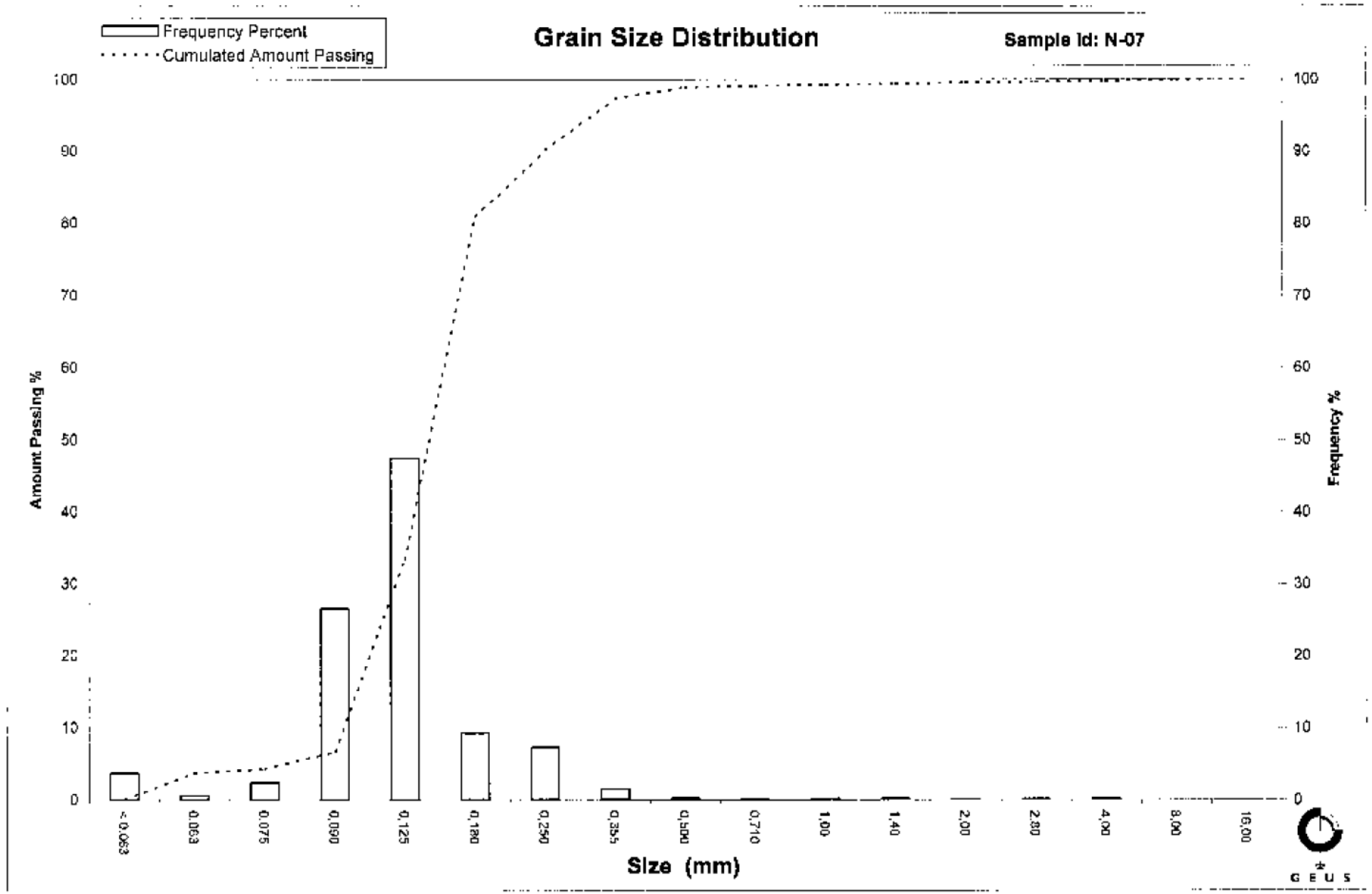
Frequency Percent
Cumulated Amount Passing
Grain Size Distribution
Sample Id: N-07
Amount Passing %
Frequency %
100
90
80
70
60
50
40
30
20
10
0
< 0,063
0,063
0,075
0,090
0,125
0,180
0,250
0,355
0,500
0,710
1,00
1,40
2,00
2,80
4,00
8,00
16,00
Size (mm)
GEUS

Grain Size Distribution

Geotechnical

Sample Id: N 08
Lab. Id: 060767
Submitter: J. Leth
Subject: Horns Rev E 2
Date: Juni 2006
Executed: I. Nørgaard
Remarks: For mat.< 2 mm

GEUS

Total Weight 103,96 g

Size Fractions

Sieve Analysis

	Size	Size	Weight	Weight	Cumulated amount passing
	mm	Φ	g	%	%
Gravel	16,00	-4,00	0,00	0,00	100,00
	8,00	-3,00	0,00	0,00	100,00
	4,00	-2,00	0,00	0,00	100,00
	2,80	-1,49	0,22	0,21	99,79
	2,00	-1,00	0,07	0,07	99,72
Sand	1,40	-0,49	0,02	0,02	99,70
	1,00	0,00	0,10	0,10	99,61
	0,710	0,49	0,02	0,02	99,59
	0,500	1,00	0,12	0,12	99,47
	0,355	1,49	1,33	1,28	98,19
	0,250	2,00	4,35	4,18	94,01
	0,180	2,47	7,11	6,84	87,17
	0,125	3,00	53,08	51,06	36,11
	0,090	3,47	29,12	28,01	8,10
	0,075	3,74	4,25	4,09	4,01
	0,063	3,99	0,93	0,89	3,12
	< 0,063	> 3,99	3,24	3,12	0,00

Size Classes (DGF-Bulletin 1 1988)

		Weight %
Silt and clay	(< 0,063 mm):	3,12
Sand, fine	(0,063 mm - 0,200 mm):	86,01
Sand, medium	(0,2 mm - 0,6 mm):	10,40
Sand, coarse	(0,6 mm - 2 mm):	0,20
Gravel	(> 2 mm):	0,28
Sum:		100,00

Moments Measures (Folk and Wards)

Percentile	Percentile		
Amount in sieve	Amount passing	d(mm)	Φ
5%	95%	0,27	1,86
16%	84%	0,18	2,50
25%	75%	0,17	2,58
40%	60%	0,15	2,73
Median 50%	50%	0,14	2,84
75%	25%	0,11	3,17
84%	16%	0,10	3,32
90%	10%	0,09	3,44
95%	5%	0,08	3,67

Moments Statistics

Mean	2,89
Sorting	0,48
Skewness	0,05
Kurtosis	1,26
Uniformity Coefficient	1,63

The analysis is executed according to DS 405.9 extended by sieves to the ½ phi scale

Size Classes and Percentiles are found by linear interpolation

Formulas

Mean (ϕ16%+ϕ84%+ϕ50%) / 3 (Folk and Ward 1957)

Sorting (ϕ84%-ϕ16%) / 4 + (ϕ95%-ϕ5%) / 6,6 (Folk and Ward 1957)

Kurtosis (ϕ95% - ϕ5%) / (2,44 * (ϕ75% - ϕ25%)) (Folk and Ward 1957)

Skewness (ϕ16%+ϕ84% - 2*ϕ50%) / (2*(ϕ84%-ϕ16%)) + (ϕ5%+ϕ95% - 2*ϕ50%) / (2*(ϕ95%-ϕ5%)) (Folk and Ward 1957)

Uniformity Coefficient (d60% / d10%) (dgf-Bulletin 1988)

Mean, sorting, skewness and kurtosis are based on "Amount in sieve". Uniformity coefficient is based on "Amount passing".

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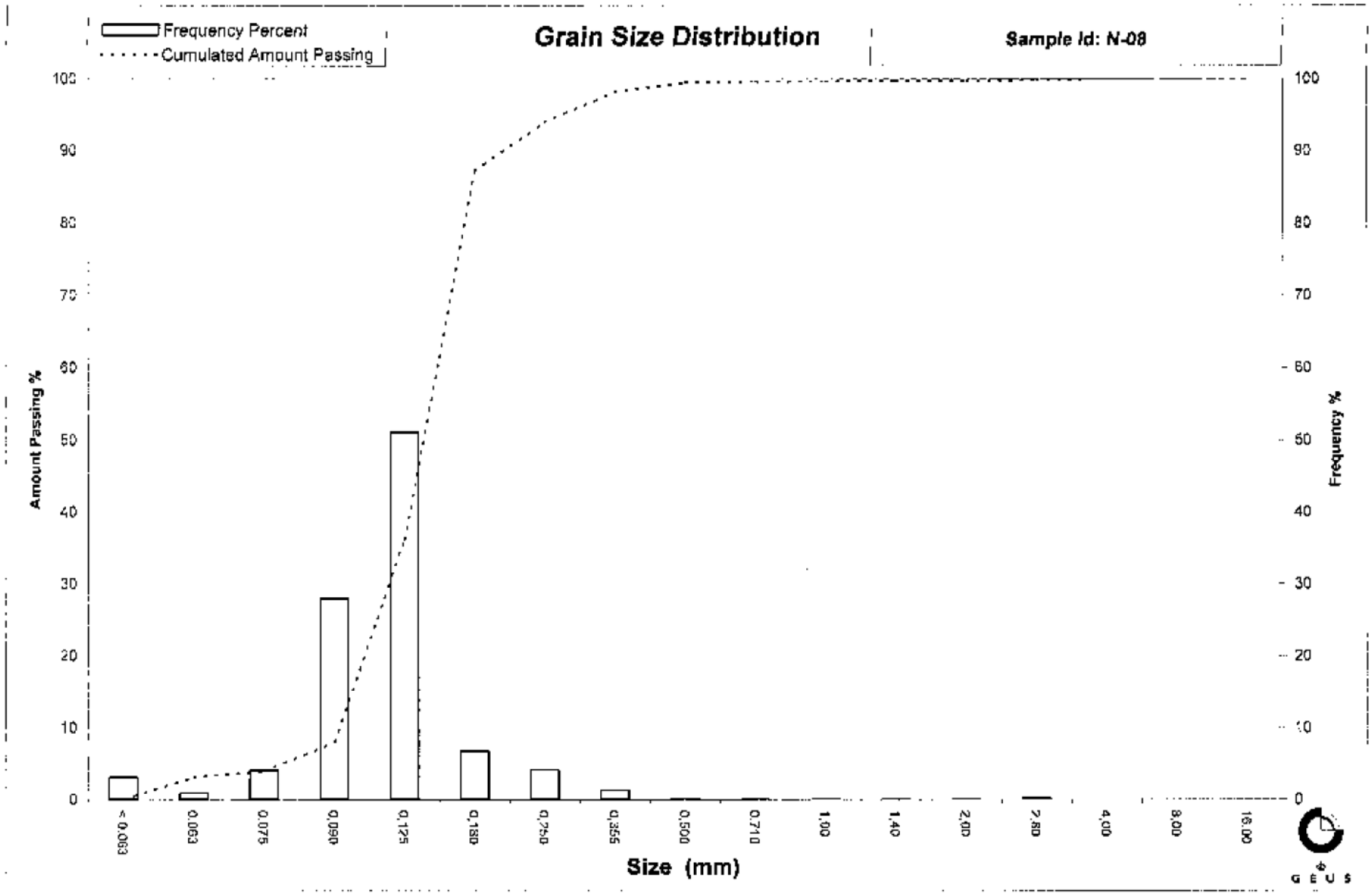
Frequency Percent
Cumulated Amount Passing
Grain Size Distribution
Sample Id: N-08
Amount Passing %
Frequency %
Size (mm)
< 0,063
0,063
0,075
0,090
0,125
0,180
0,250
0,355
0,500
0,710
1,00
1,40
2,00
2,80
4,00
8,00
16,00

Grain Size Distribution

Geotechnical

Sample Id: N-09
Lab. Id: 060768
Submitter: J. Leth
Subject: Horns Rev E 2
Date: Juni 2006
Executed: I. Nørgaard
Remarks: For mat.< 2 mm

GEUS

Total Weight 108,64 g

Size Fractions

Sieve Analysis

	Size	Size	Weight	Weight	Cumulated amount passing
	mm	Φ	g	%	%
Gravel	16,00	-4,00	0,00	0,00	100,00
	8,00	-3,00	0,00	0,00	100,00
	4,00	-2,00	0,00	0,00	100,00
	2,80	-1,49	0,04	0,04	99,96
	2,00	-1,00	0,06	0,06	99,91
Sand	1,40	-0,49	0,07	0,06	99,84
	1,00	0,00	0,07	0,06	99,78
	0,710	0,49	0,05	0,05	99,73
	0,500	1,00	0,41	0,38	99,36
	0,355	1,49	3,52	3,23	96,12
	0,250	2,00	10,16	9,33	86,79
	0,180	2,47	13,72	12,61	74,18
	0,125	3,00	51,56	47,37	26,81
	0,090	3,47	21,12	19,40	7,41
	0,075	3,74	2,40	2,21	5,20
	0,063	3,99	0,51	0,47	4,73
	< 0,063	> 3,99	5,15	4,73	0,00

Size Classes (DGF-Bulletin 1 1988)

		Weight %
Silt and clay	(< 0,063 mm):	4,73
Sand, fine	(0,063 mm - 0,200 mm):	73,05
Sand, medium	(0,2 mm - 0,6 mm):	21,75
Sand, coarse	(0,6 mm - 2 mm):	0,37
Gravel	(> 2 mm):	0,09
Sum:		100,00

Moments Measures (Folk and Wards)

Percentile Amount in sieve	Percentile Amount passing	d(mm)	Φ
5%	95%	0,34	1,55
16%	84%	0,23	2,09
25%	75%	0,18	2,44
40%	60%	0,16	2,61
Median 50%	50%	0,15	2,72
75%	25%	0,12	3,04
84%	16%	0,11	3,24
90%	10%	0,09	3,40
95%	5%	0,07	3,84

Moments Statistics

Mean	2,69
Sorting	0,64
Skewness	-0,05
Kurtosis	1,57
Uniformity Coefficient	1,73

The analysis is executed according to DS 405.9 extended by sieves to the ½ phi scale

Size Classes and Percentiles are found by linear interpolation

Formulas

Mean (ϕ16%+ϕ84%+ϕ50%) / 3 (Folk and Ward 1957)

Sorting (ϕ84%-ϕ16%) / 4 + (ϕ95%-ϕ5%) / 6,6 (Folk and Ward 1957)

Kurtosis (ϕ95% - ϕ5%) / (2,44 * (ϕ75% - ϕ25%)) (Folk and Ward 1957)

Skewness (ϕ16%+ϕ84% - 2*ϕ50%) / (2*(ϕ84%-ϕ16%)) + (ϕ5%+ϕ95% - 2*ϕ50%) / (2*(ϕ95%-ϕ5%)) (Folk and Ward 1957)

Uniformity Coefficient (d60% / d10%) (dgf Bulletin 1988)

Mean, sorting, skewness and kurtosis are based on "Amount in sieve". Uniformity coefficient is based on "Amount passing".

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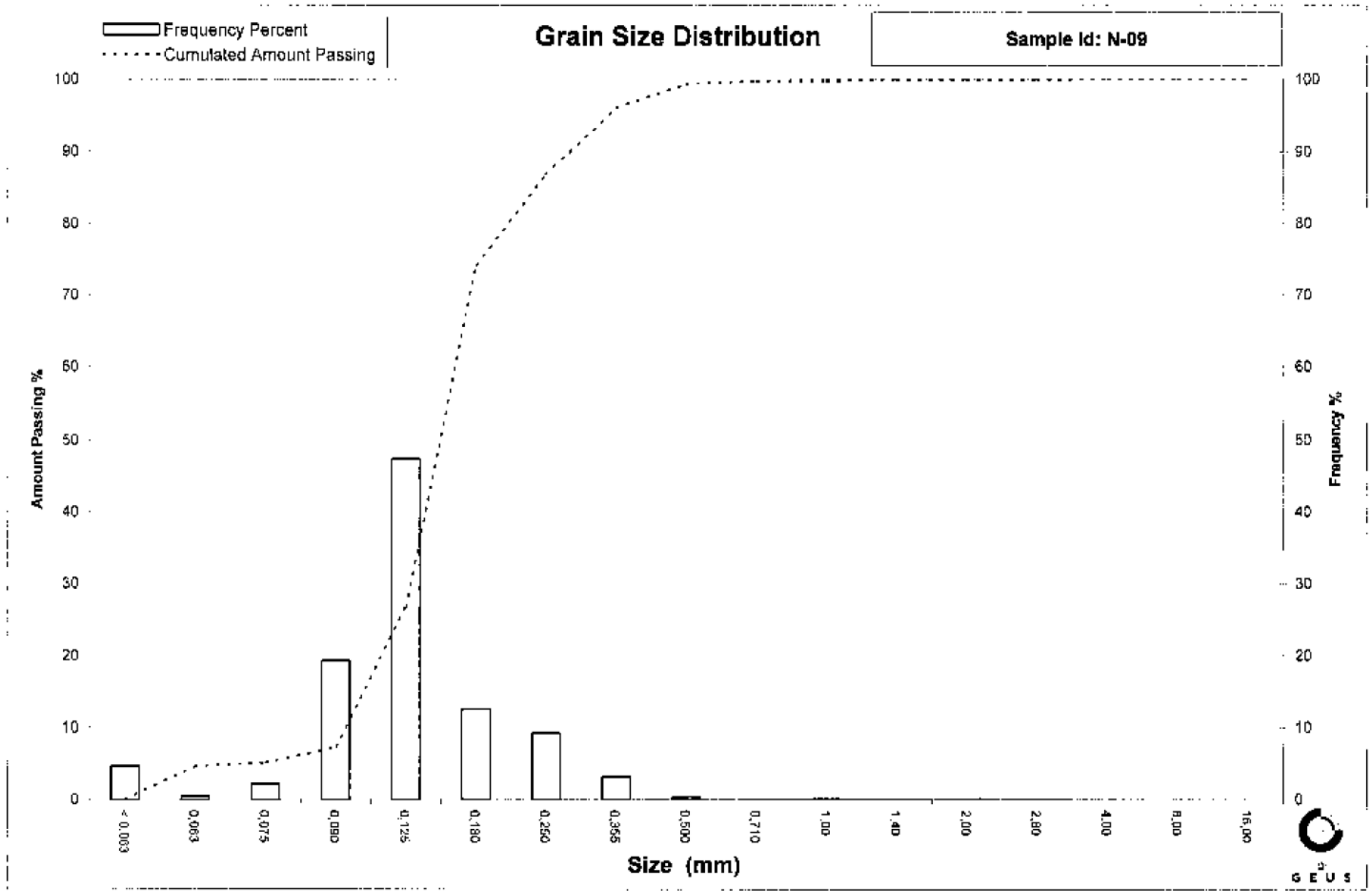
Frequency Percent
Cumulated Amount Passing
Grain Size Distribution
Sample Id: N-09
Amount Passing %
Frequency %
100
90
80
70
60
50
40
30
20
10
0
< 0,063
0,063
0,075
0,090
0,125
0,180
0,250
0,355
0,500
0,710
1,00
1,40
2,00
2,80
4,00
8,00
16,00
Size (mm)
GEUS

Grain Size Distribution

Geotechnical

Sample Id: N-10
Lab. Id: 060769
Submitter: J. Leth
Subject: Horns Rev E 2
Date: Juni 2006
Executed: I. Nørgaard
Remarks: For mat < 2 mm

GEUS

Total Weight 103,34 g

Size Fractions

Sieve Analysis

	Size	Size	Weight	Weight	Cumulated amount passing
	mm	Φ	g	%	%
Gravel	16,00	-4,00	0,00	0,00	100,00
	8,00	-3,00	0,00	0,00	100,00
	4,00	-2,00	0,28	0,27	99,73
	2,80	-1,49	0,13	0,13	99,60
	2,00	-1,00	0,02	0,02	99,58
Sand	1,40	-0,49	0,02	0,02	99,56
	1,00	0,00	0,16	0,15	99,42
	0,710	0,49	0,40	0,39	99,03
	0,500	1,00	1,65	1,60	97,44
	0,355	1,49	3,45	3,34	94,10
	0,250	2,00	6,22	6,02	88,08
	0,160	2,47	28,58	27,66	60,42
	0,125	3,00	53,52	51,79	8,63
	0,090	3,47	6,72	6,50	2,13
	0,075	3,74	0,36	0,35	1,78
	0,063	3,99	0,12	0,12	1,66
	< 0,063	> 3,99	1,72	1,66	0,00

Size Classes (DGF-Bulletin 1 1988)

		Weight %
Silt and clay	(< 0,063 mm):	1,66
Sand, fine	(0,063 mm - 0,200 mm):	66,66
Sand, medium	(0,2 mm - 0,6 mm):	29,87
Sand, coarse	(0,6 mm - 2 mm):	1,39
Gravel	(> 2 mm):	0,42
Sum:		100,00

Moments Measures (Folk and Wards)

Percentile	Percentile		
Amount in sieve	Amount passing	d(mm)	Φ
5%	95%	0,39	1,34
16%	84%	0,24	2,06
25%	75%	0,22	2,20
40%	60%	0,18	2,48
Median 50%	50%	0,17	2,57
75%	25%	0,14	2,81
84%	16%	0,13	2,91
90%	10%	0,13	2,98
95%	5%	0,11	3,25

Moments Statistics

Mean	2,51
Sorting	0,50
Skewness	-0,24
Kurtosis	1,28
Uniformity Coefficient	1,42

The analysis is executed according to DS 405.9 extended by sieves to the ½ phi scale

Size Classes and Percentiles are found by linear interpolation

Formulas

Mean (ϕ16%+ϕ84%+ϕ50%) / 3 (Folk and Ward 1957)

Sorting (ϕ84% ϕ16%) / 4 + (ϕ95%-ϕ5%) / 6,6 (Folk and Ward 1957)

Kurtosis (ϕ95% - ϕ5%) / (2,44 * (ϕ75% - ϕ25%)) (Folk and Ward 1957)

Skewness (ϕ16%+ϕ84% - 2*ϕ50%) / (2*(ϕ84%-ϕ16%)) + (ϕ5%+ϕ95% - 2*ϕ50%) / (2*(ϕ95%-ϕ5%)) (Folk and Ward 1957)

Uniformity Coefficient (d60% / d10%) (dgf-Bulletin 1988)

Mean, sorting, skewness and kurtosis are based on "Amount in sieve". Uniformity coefficient is based on "Amount passing".

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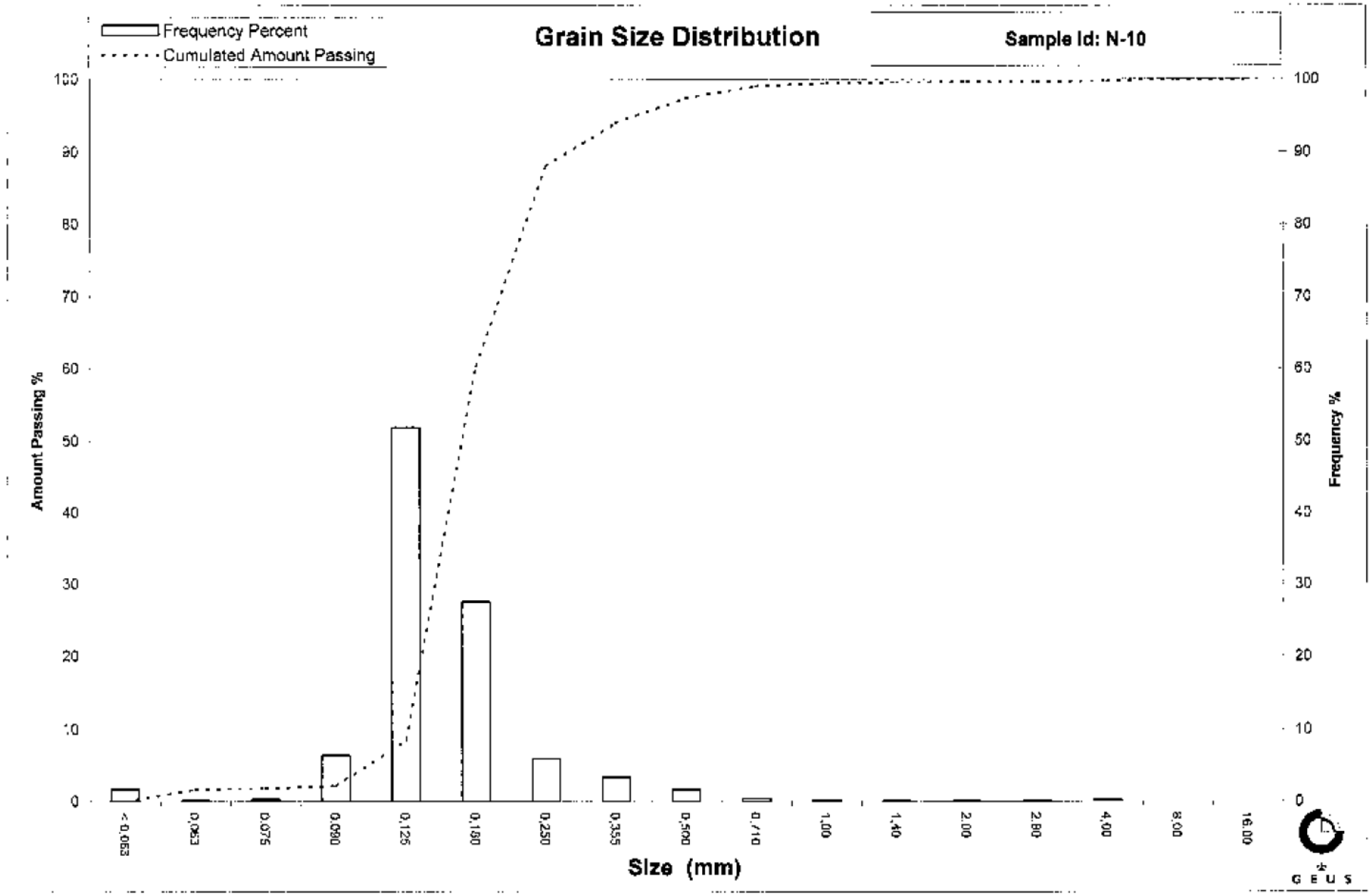
Frequency Percent
Cumulated Amount Passing
Grain Size Distribution
Sample Id: N-10
Amount Passing %
Frequency %
Size (mm)
< 0.063
0.063
0.075
0.090
0.125
0.180
0.250
0.355
0.500
0.710
1.00
1.40
2.00
2.80
4.00
8.00
16.00
GEUS

Grain Size Distribution

Geotechnical

Sample Id: N 11
Lab. Id: 060770
Submitter: J. Leth
Subject: Horns Rev E 2
Date: Juni 2006
Executed: I. Nørgaard
Remarks: For mat.< 2 mm

GEUS

Total Weight 100,67 g

Size Fractions

Sieve Analysis — Gravel / Sand

Size	Size	Weight	Weight	Cumulated amount passing
mm	Φ	g	%	%
16,00	-4,00	0,00	0,00	100,00
8,00	-3,00	0,00	0,00	100,00
4,00	-2,00	0,00	0,00	100,00
2,80	-1,49	0,02	0,02	99,98
2,00	-1,00	0,01	0,01	99,97
1,40	-0,49	0,04	0,04	99,93
1,00	0,00	0,08	0,08	99,85
0,710	0,49	0,28	0,28	99,57
0,500	1,00	1,72	1,71	97,86
0,355	1,49	6,07	6,03	91,83
0,250	2,00	30,45	30,25	61,59
0,180	2,47	54,78	54,42	7,17
0,125	3,00	6,01	5,97	1,20
0,090	3,47	0,30	0,30	0,90
0,075	3,74	0,21	0,21	0,70
0,063	3,99	0,02	0,02	0,68
< 0,063	> 3,99	0,68	0,68	0,00

Size Classes (DGF-Bulletin 1 1988)

		Weight %
Silt and clay	(< 0,063 mm):	0,68
Sand, fine	(0,063 mm - 0,200 mm):	22,04
Sand, medium	(0,2 mm - 0,6 mm):	75,96
Sand, coarse	(0,6 mm - 2 mm)	1,29
Gravel	(> 2 mm)	0,03
Sum:		100,00

Moments Measures (Folk and Wards)

Percentile	Percentile		
Amount in sieve	Amount passing	d(mm)	Φ
5%	95%	0,43	1,21
16%	84%	0,33	1,61
25%	75%	0,30	1,75
40%	60%	0,25	2,01
Median 50%	50%	0,24	2,09
75%	25%	0,20	2,30
84%	16%	0,19	2,39
90%	10%	0,18	2,45
95%	5%	0,16	2,64

Moments Statistics

Mean	2,03
Sorting	0,41
Skewness	-0,23
Kurtosis	1,07
Uniformity Coefficient	1,35

The analysis is executed according to DS 405.9 extended by sieves to the ½ phi scale

Size Classes and Percentiles are found by linear interpolation

Formulas

Mean (ϕ16%+ϕ84%+ϕ50%) / 3 (Folk and Ward 1957)

Sorting (ϕ84%-ϕ16%) / 4 + (ϕ95%-ϕ5%) / 6,6 (Folk and Ward 1957)

Kurtosis (ϕ95% - ϕ5%) / (2,44 * (ϕ75% - ϕ25%)) (Folk and Ward 1957)

Skewness (ϕ16%+ϕ84% - 2*ϕ50%) / (2*(ϕ84%-ϕ16%)) + (ϕ5%+ϕ95% - 2*ϕ50%) / (2*(ϕ95% ϕ5%)) (Folk and Ward 1957)

Uniformity Coefficient (d60% / d10%) (dgf-Bulletin 1988)

Mean, sorting, skewness and kurtosis are based on "Amount in sieve". Uniformity coefficient is based on "Amount passing"

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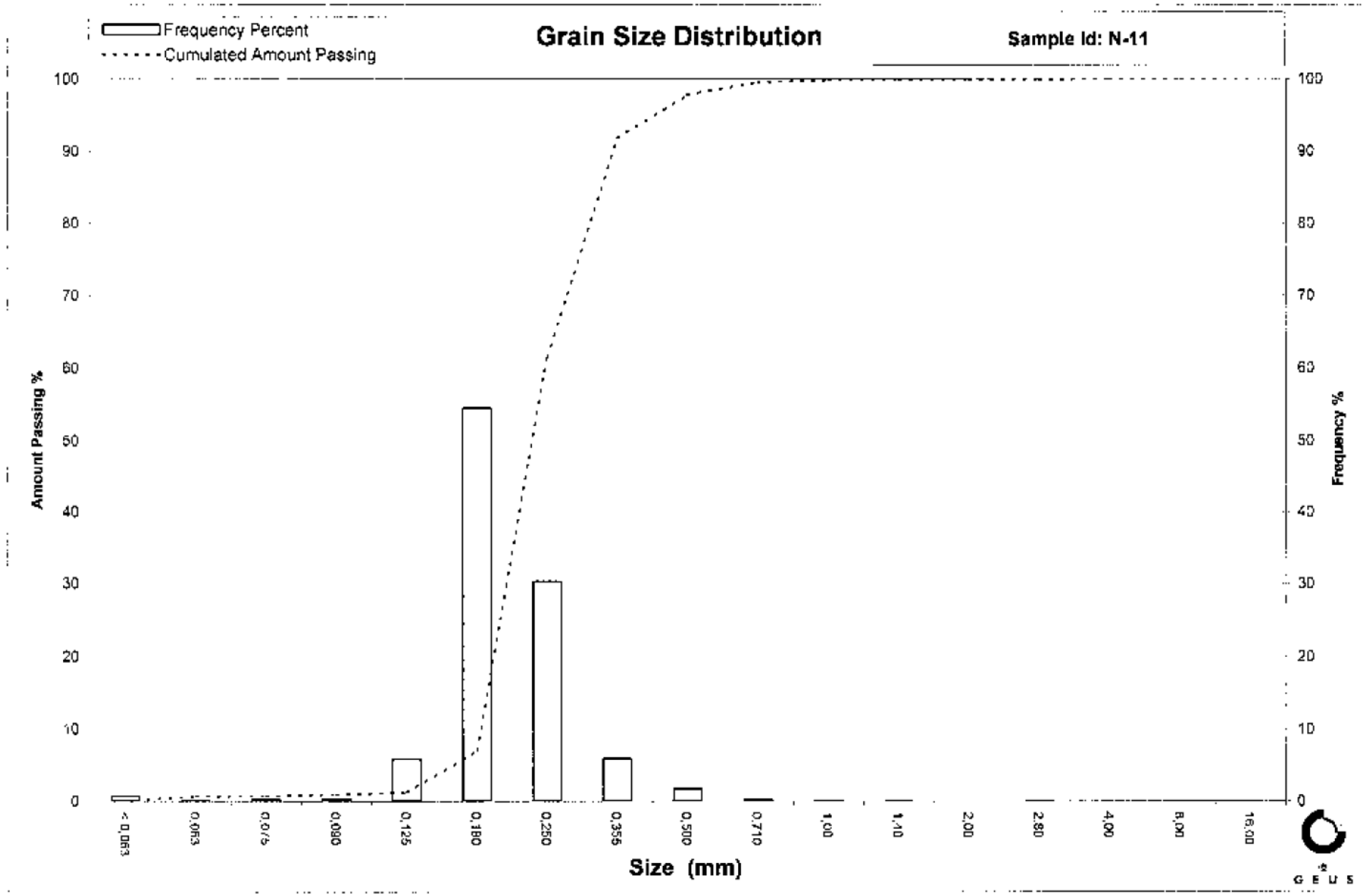
Frequency Percent
Cumulated Amount Passing
Grain Size Distribution
Sample Id: N-11
Amount Passing %
Frequency %
100
90
80
70
60
50
40
30
20
10
0
< 0,063
0,063
0,075
0,090
0,125
0,180
0,250
0,355
0,500
0,710
1,00
1,40
2,00
2,80
4,00
8,00
16,00
Size (mm)
G E U S

Grain Size Distribution

Geotechnical

Sample Id: N-13
Lab. Id: 060771
Submitter: J. Leth
Subject: Horns Rev E 2
Date: Juni 2006
Executed: I. Nørgaard
Remarks: For mat < 2 mm

GEUS

Total Weight 102,85 g

Size Fractions

Sieve Analysis

	Size	Size	Weight	Weight	Cumulated amount passing
	mm	Φ	g	%	%
Gravel	16,00	-4,00	0,00	0,00	100,00
	8,00	-3,00	0,00	0,00	100,00
	4,00	-2,00	0,00	0,00	100,00
	2,80	-1,49	0,01	0,01	99,99
	2,00	-1,00	0,02	0,02	99,97
Sand	1,40	-0,49	0,05	0,05	99,92
	1,00	0,00	0,25	0,24	99,68
	0,710	0,49	1,08	1,05	98,63
	0,500	1,00	5,01	4,87	93,76
	0,355	1,49	22,41	21,79	71,97
	0,250	2,00	61,39	59,69	12,28
	0,180	2,47	8,81	8,57	3,71
	0,125	3,00	1,99	1,93	1,78
	0,090	3,47	0,50	0,49	1,29
	0,075	3,74	0,12	0,12	1,18
	0,063	3,99	0,04	0,04	1,14
	< 0,063	> 3,99	1,17	1,14	0,00

Size Classes (DGF-Bulletin 1 1988)

		Weight %
Silt and clay	(< 0,063 mm):	1,14
Sand, fine	(0,063 mm - 0,200 mm):	5,02
Sand, medium	(0,2 mm - 0,6 mm):	89,92
Sand, coarse	(0,6 mm - 2 mm):	3,89
Gravel	(> 2 mm):	0,03
Sum:		100,00

Moments Measures (Folk and Wards)

Percentile	Percentile		
Amount in sieve	Amount passing	d(mm)	Φ
5%	95%	0,55	0,85
16%	84%	0,44	1,20
25%	75%	0,38	1,41
40%	60%	0,33	1,58
Median 50%	50%	0,32	1,66
75%	25%	0,27	1,88
84%	16%	0,26	1,96
90%	10%	0,23	2,11
95%	5%	0,19	2,39

Moments Statistics

Mean	1,61
Sorting	0,42
Skewness	-0,13
Kurtosis	1,37
Uniformity Coefficient	1,44

The analysis is executed according to DS 405.9 extended by sieves to the ½ phi scale

Size Classes and Percentiles are found by linear interpolation

Formulas

Mean (ϕ16%+ϕ84%+ϕ50%) / 3 (Folk and Ward 1957)

Sorting (ϕ84%-ϕ16%) / 4 + (ϕ95%-ϕ5%) / 6,6 (Folk and Ward 1957)

Kurtosis (ϕ95% - ϕ5%) / (2,44 * (ϕ75% - ϕ25%)) (Folk and Ward 1957)

Skewness (ϕ16%+ϕ84% - 2*ϕ50%) / (2*(ϕ84%-ϕ16%)) + (ϕ5%+ϕ95% - 2*ϕ50%) / (2*(ϕ95%-ϕ5%)) (Folk and Ward 1957)

Uniformity Coefficient (d60% / d10%) (dgf-Bulletin 1988)

Mean, sorting, skewness and kurtosis are based on "Amount in sieve". Uniformity coefficient is based on "Amount passing".

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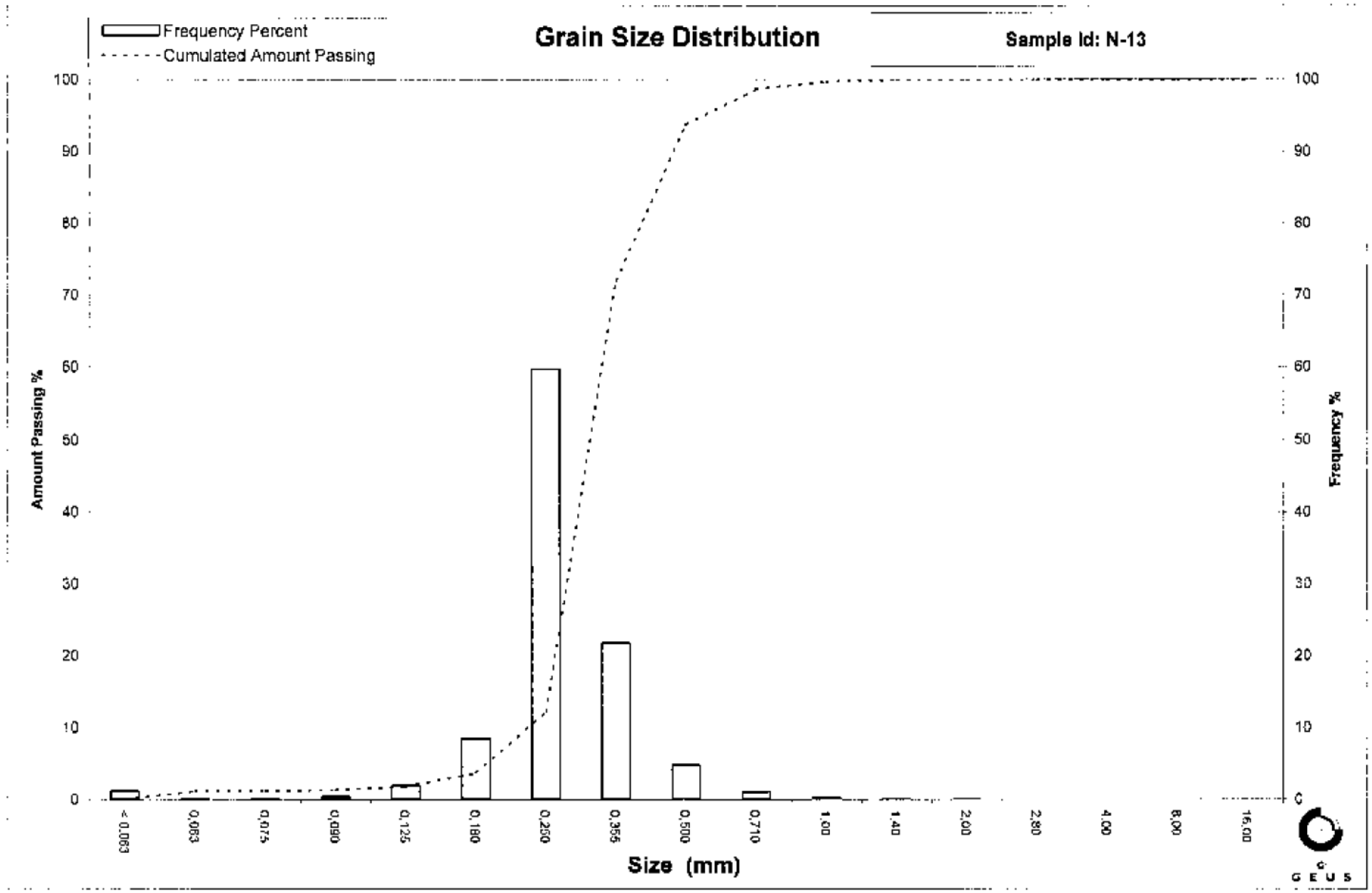
Frequency Percent
Cumulated Amount Passing
Grain Size Distribution
Sample Id: N-13
Amount Passing %
Frequency %
100
90
80
70
60
50
40
30
20
10
0
< 0.063
0.063
0.075
0.090
0.125
0.180
0.250
0.355
0.500
0.710
1.00
1.40
2.00
2.80
4.00
8.00
16.00
Size (mm)
GEUS

Grain Size Distribution

Geotechnical

Sample Id: N-14
Lab. Id: 060772
Submitter: J. Leth
Subject: Horns Rev E 2
Date: Juni 2006
Executed: I. Nørgaard
Remarks: For mat.< 2 mm

GEUS

Total Weight 106,45 g

Size Fractions

Sieve Analysis

	Size	Size	Weight	Weight	Cumulated amount passing
	mm	Φ	g	%	%
Gravel	16,00	-4,00	0,00	0,00	100,00
	8,00	-3,00	0,00	0,00	100,00
	4,00	-2,00	0,00	0,00	100,00
	2,80	-1,49	0,01	0,01	99,99
	2,00	-1,00	0,03	0,03	99,96
	1,40	-0,49	0,01	0,01	99,95
	1,00	0,00	0,17	0,16	99,79
	0,710	0,49	0,75	0,70	99,09
	0,500	1,00	6,75	6,34	92,75
Sand	0,355	1,49	16,70	15,69	77,06
	0,250	2,00	30,61	28,76	48,30
	0,180	2,47	37,16	34,91	13,40
	0,125	3,00	10,82	10,16	3,23
	0,090	3,47	1,72	1,62	1,62
	0,075	3,74	0,33	0,31	1,31
	0,063	3,99	0,08	0,08	1,23
	< 0,063	> 3,99	1,31	1,23	0,00

Size Classes (DGF-Bulletin 1 1988)

		Weight %
Silt and clay	(< 0,063 mm):	1,23
Sand, fine	(0,063 mm - 0,200 mm):	22,14
Sand, medium	(0,2 mm - 0,6 mm):	72,40
Sand, coarse	(0,6 mm - 2 mm):	4,20
Gravel	(> 2 mm):	0,04
Sum:		100,00

Moments Measures (Folk and Wards)

Percentile	Percentile		
Amount in sieve	Amount passing	d(mm)	Φ
5%	95%	0,57	0,80
16%	84%	0,42	1,25
25%	75%	0,35	1,53
40%	60%	0,29	1,77
Median 50%	50%	0,26	1,96
75%	25%	0,20	2,30
84%	16%	0,19	2,43
90%	10%	0,16	2,63
95%	5%	0,13	2,89

Moments Statistics

Mean	1,88
Sorting	0,61
Skewness	-0,16
Kurtosis	1,11
Uniformity Coefficient	1,81

The analysis is executed according to DS 405.9 extended by sieves to the ½ phi scale

Size Classes and Percentiles are found by linear interpolation

Formulas

Mean (ϕ16%+ϕ84%+ϕ50%) / 3 (Folk and Ward 1957)

Sorting (ϕ84%-ϕ16%) / 4 + (ϕ95%-ϕ5%) / 6,6 (Folk and Ward 1957)

Kurtosis (ϕ95% - ϕ5%) / (2,44 * (ϕ75% - ϕ25%)) (Folk and Ward 1957)

Skewness (ϕ16%+ϕ84% - 2*ϕ50%) / (2*(ϕ84%-ϕ16%)) + (ϕ5%+ϕ95% - 2*ϕ50%) / (2*(ϕ95%-ϕ5%)) (Folk and Ward 1957)

Uniformity Coefficient (d60% / d10%) (dgf-Bulletin 1988)

Mean, sorting, skewness and kurtosis are based on "Amount in sieve". Uniformity coefficient is based on "Amount passing".

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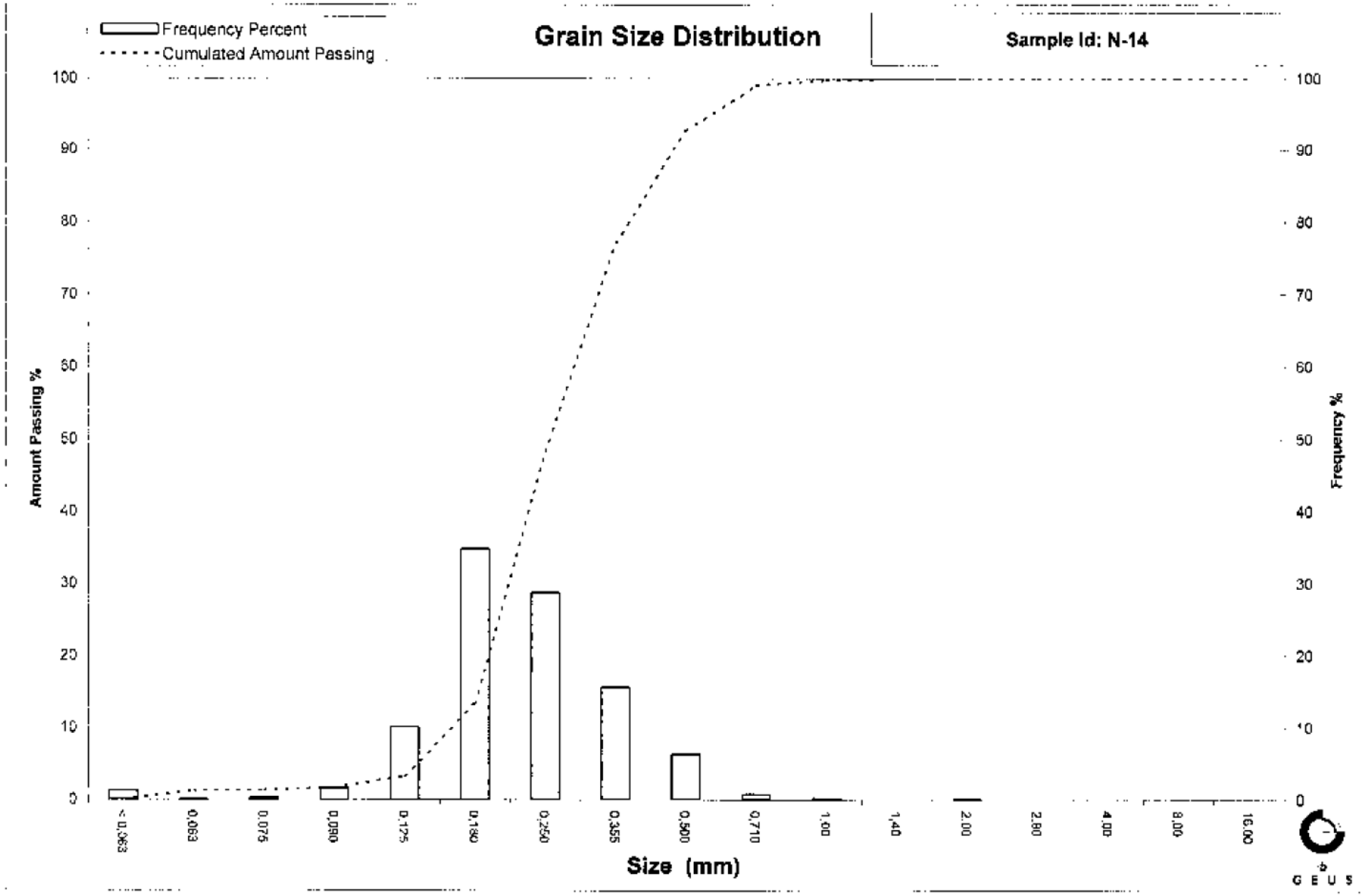

Frequency Percent
Cumulated Amount Passing
Grain Size Distribution
Sample Id: N-14
Amount Passing %
Frequency %
100
90
80
70
60
50
40
30
20
10
0
< 0,063
0,063
0,075
0,090
0,125
0,180
0,250
0,355
0,500
0,710
1,00
1,40
2,00
2,80
4,00
8,00
16,00
Size (mm)
GEUS

15. Appendix C: Dansurvey multibeam documentation

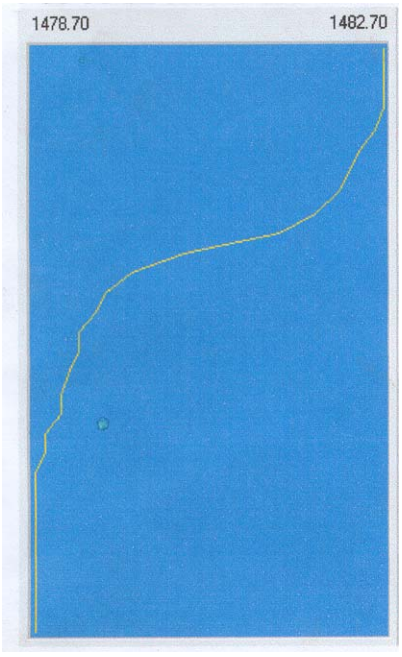
PATCH TEST

Calibration of EM 3002D system for

GEUS

02. May 2006

Sound Velocity Profile used: 02052006_1715
Pos 55 22 38.4 N 008 13 56.7 E
0.5 – 15.4 metres

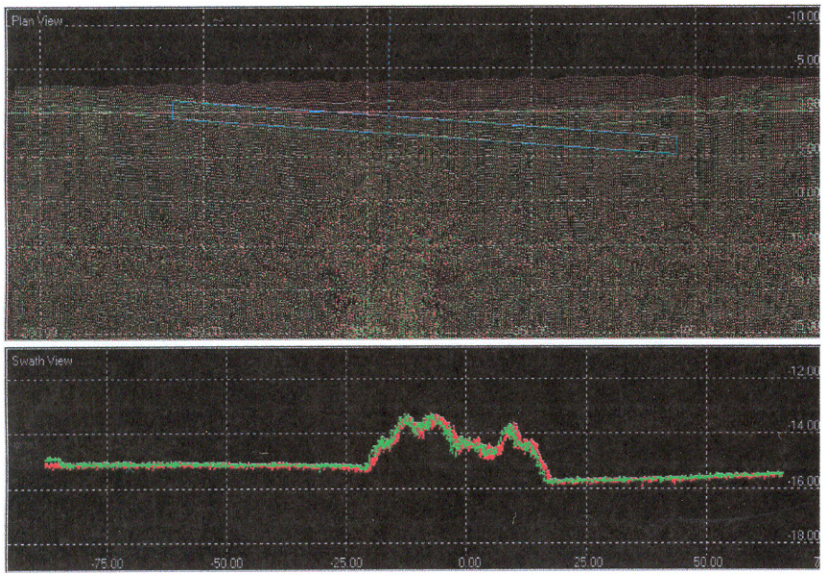


0.5 – 15.4 metres

Calibration of EM3002D Port Head

Latency Check:

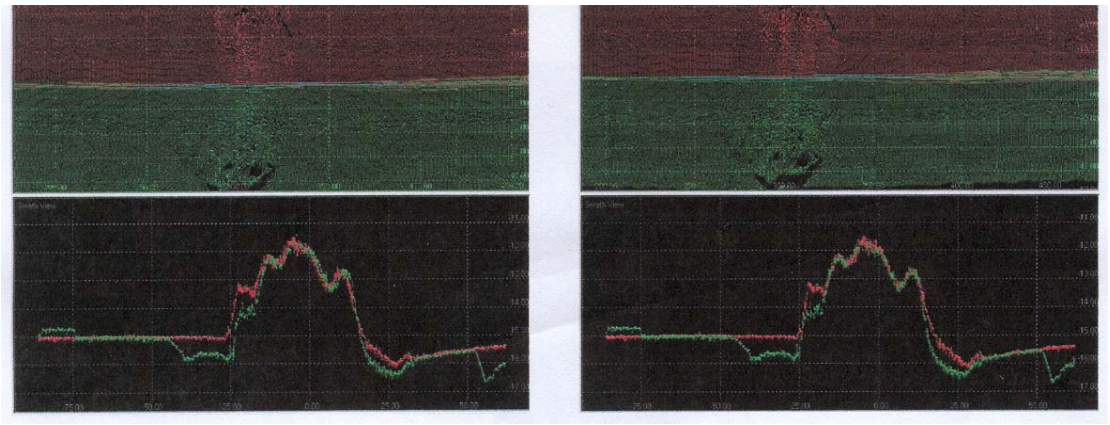
Latency Line **0004 – Centre Wreck (-40) PORT 4.3 knot**
0005 – Centre Wreck (-40) PORT 8 knot



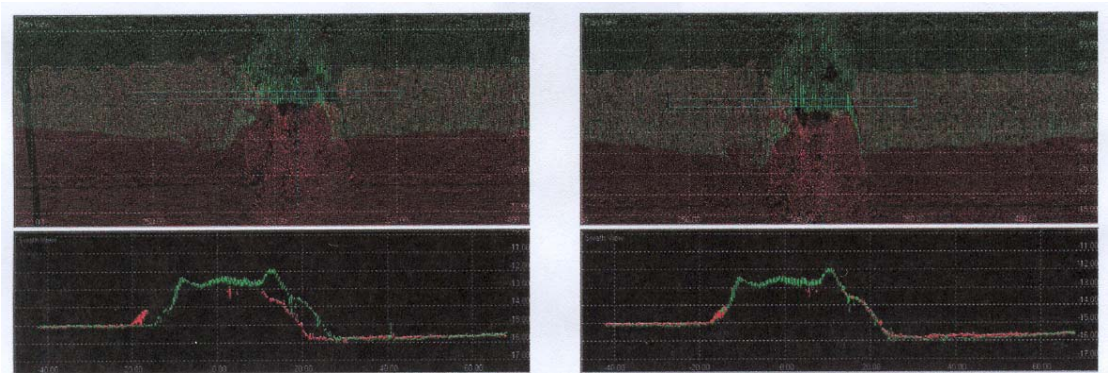
By measuring the variation between the “fast” and “slow” line the latency appeared to be negligible. The PPS time tagging of data strings are fully operational on data from PORT sonar head.

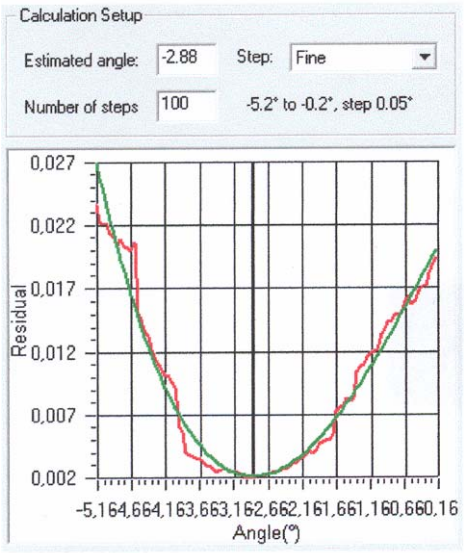
Roll Lines **0002 – Centre Wreck PORT**
0003 – Centre Wreck (40) PORT Roll = -0.12°

Pitch Lines **0009 – Centre Wreck (25) PORT**
0012 – Centre Wreck (25) PORT Pitch = -3.26°



Yaw Lines **0003 – Centre Wreck (40) PORT**
0006 – Centre Wreck (40) PORT Yaw = -2.88°

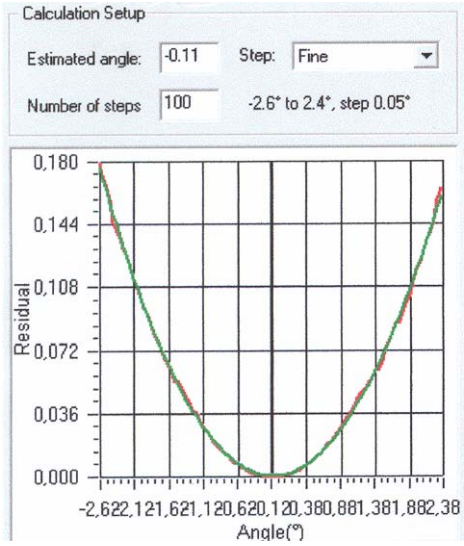




1. iteration (using values from 1. calculation):

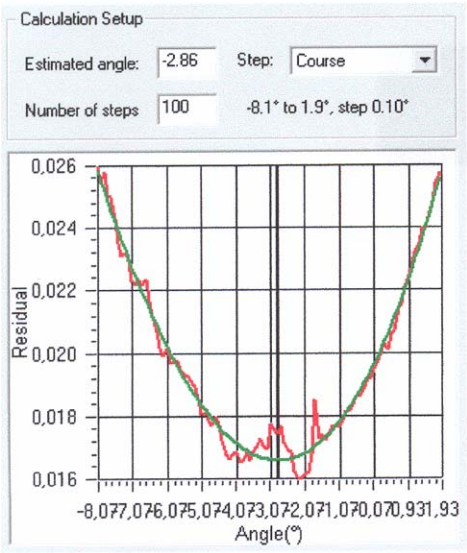
Roll Lines **0002 – Centre Wreck PORT**
0003 – Centre Wreck (40) PORT

Pitch = -3.26° Yaw = -2.88°
New Roll = -0.11



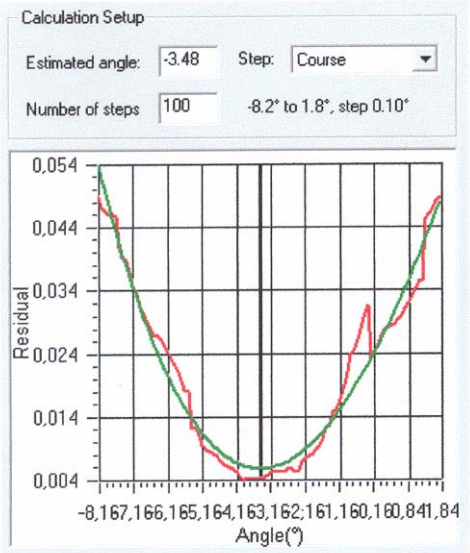
Pitch Lines 0009 – Centre Wreck (25) PORT
0012 – Centre Wreck (25) PORT

Roll - -0.11° Yaw = -2.88°
New Pitch = -2.86°



Yaw Lines 0003 – Centre Wreck (40) PORT
0006 – Centre Wreck (40) PORT Yaw = -2.88°

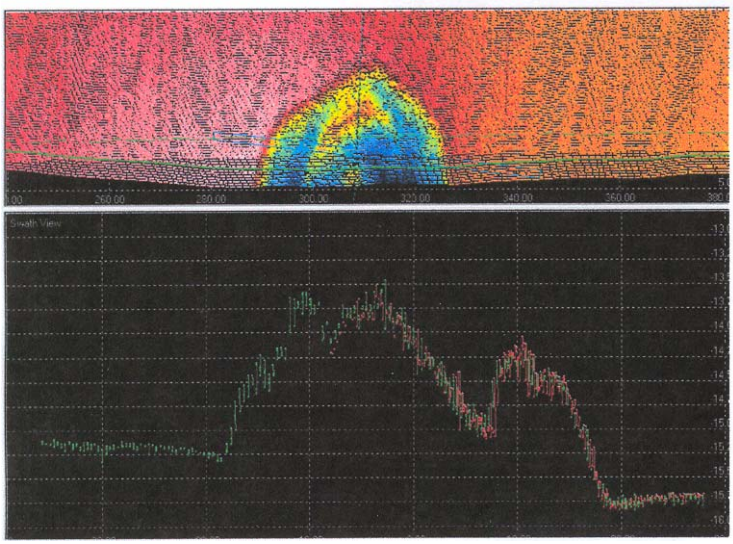
Roll = -0.11° Pitch = -2.86°
New Yaw = -3.42°



Final result PORT Head: Roll = -0.11° Pitch = -2.86° Yaw = -3.48°

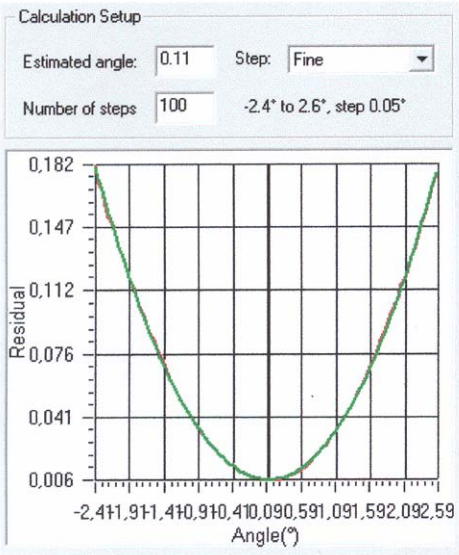
Latency Check:

Latency Line **0004 – Centre Wreck (-40) STBD 4.3 knot**
0005 – Centre Wreck (-40) STBD 8 knot

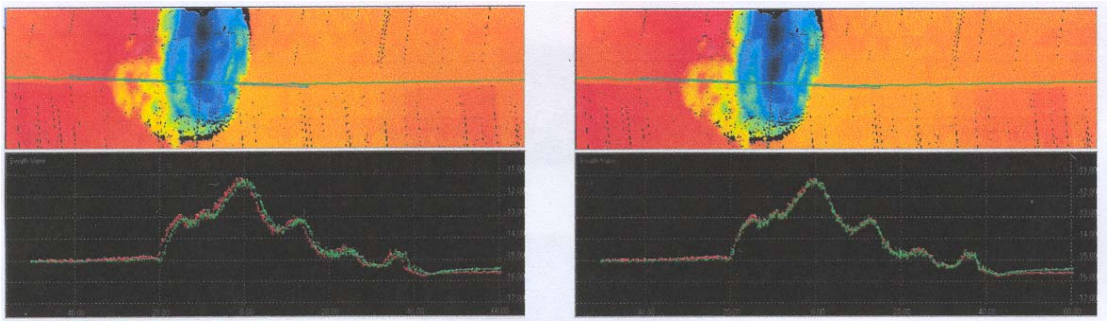


By measuring the variation between the “fast” and “slow” line the latency appeared to be negligible. The PPS time tagging of data strings are fully operational on data from STBD sonar head.

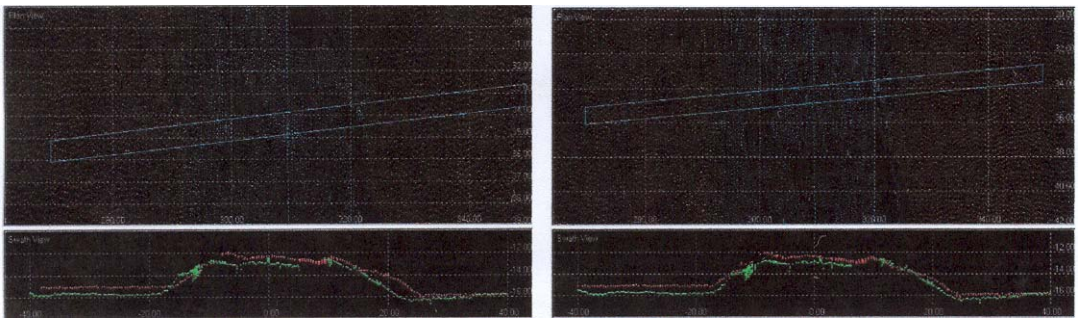
Roll Lines **0002 – Centre Wreck STBD**
0011 – Centre Wreck (-40) STBD Roll = 0.11°



Pitch Lines **0003 – Centre Wreck (40) STBD**
0008 – Centre Wreck (40) STBD Pitch = -2.88°

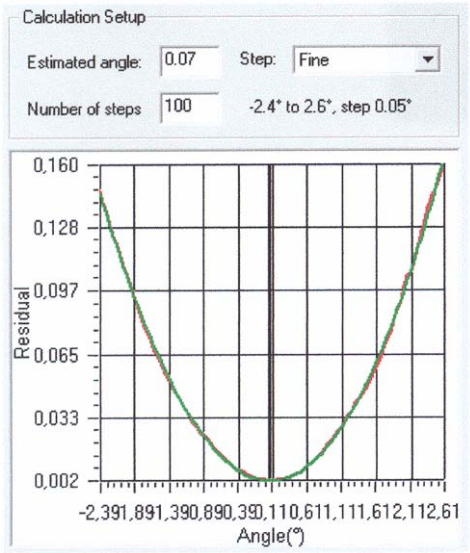


Yaw Lines **0011 – Centre Wreck (-40) STBD**
0012 – Centre Wreck (25) STBD Yaw = -3.00°



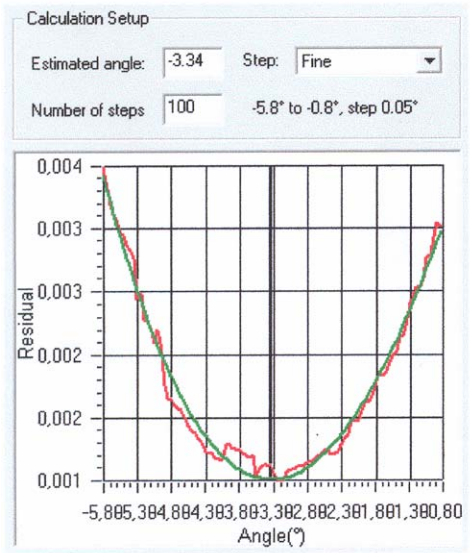
1. iteration (using values from 1. calculation):

Roll Lines **0002 – Centre Wreck STBD**
0011 – Centre Wreck (-40) STBD Roll = 0.11°



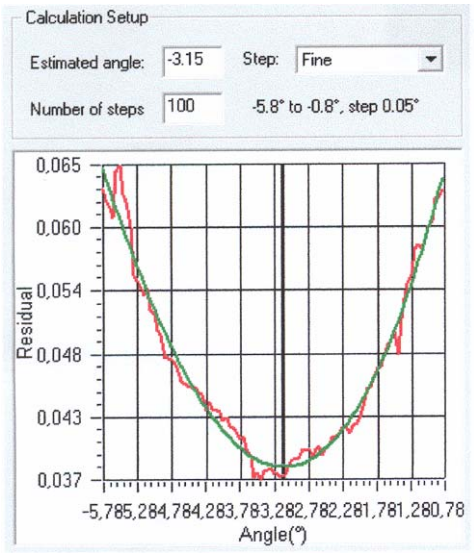
Pitch Lines **0003 – Centre Wreck (40) STBD**
0008 – Centre Wreck (40) STBD Pitch = -2.88°

Roll = 0.07° Yaw = -3.00°
New Pitch = -3.34°



Yaw Lines **0011 – Centre Wreck (-40) STBD**
0012 – Centre Wreck (25) STBD Yaw = -3.00°

Roll = 0.07° Pitch = -3.34°
New Yaw = -3.15°



Result of Patch test of GEUS EM3002D multibeam system on board Hans-M on Tuesday the 2nd of May 2006.

Final result STBD Head: **Roll = -0.07° Pitch = -3.34° Yaw = - 3.15°**
Final result PORT Head: **Roll = -0.11° Pitch = -2.86° Yaw = -3.48°**

Kort & Matrikelstyrelsen

Rentemestervej 8, København NV
Tlf. 35 87 50 50 - Fax 35 87 50 55

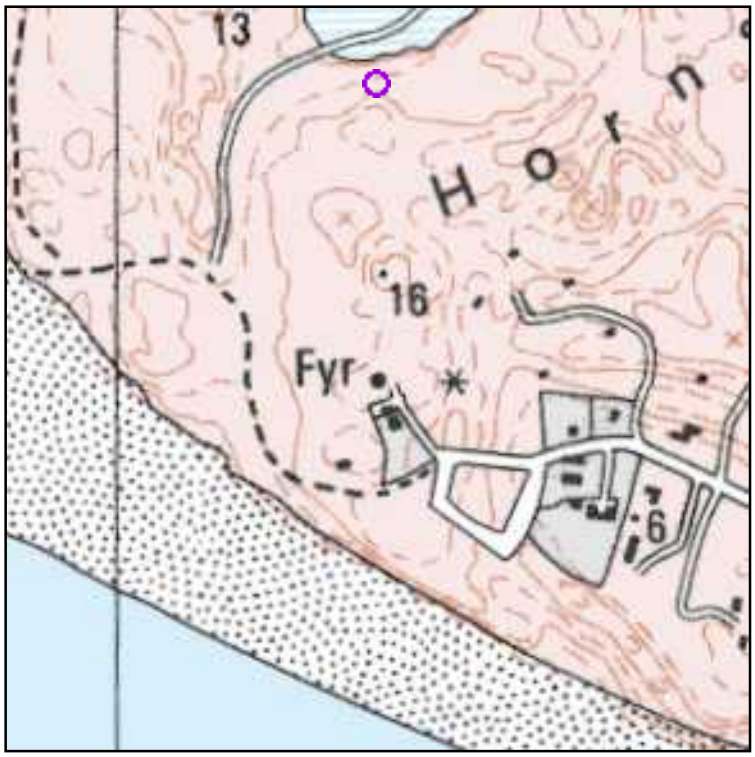
Fikspunktsbeskrivelse

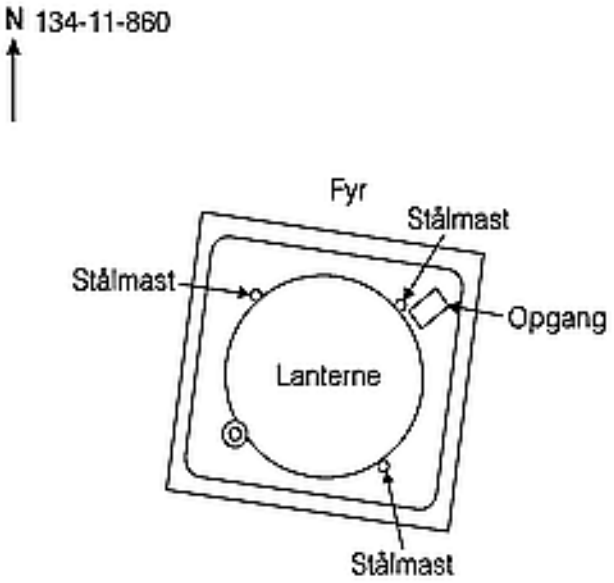
For	134-11-00860
Udskrevet	2006 04 24, 14.10

Permanent GPS station.
Punkt i top af Blåvandshuk Fyr.
Udfærdiget 2003

Koordinater

System	geoEeuref89
N	55 33 28.12874 sx
E	8 04 59.64456 sx
Ellipsoidehøjde	99.968 m
Beregnet	2002 03 20, 16.32


13
Horn
16
Fyr
6


N 134-11-860
Fyr
Stålmast
Stålmast
Opgang
Lanterne
Stålmast

SCANSURVEY
HYDROGRAPHIC CONSULTANCY

Position check carried out on the 2nd of May 2006

System description:

DC202 from AD Navigation
Technical specifications
Tracking:
20 Channel Dual Constellation (DC) GPS/GLONASS L1/L2
Cold start: < 60 seconds
Warm start: < 10 seconds
Reacquistion: < 1 second
Processing: Co-op Tracking and Advanced Multipath Reduction
DC200 Series RTK Positioning1 and Heading Accuracies2:
Horizontal: 1 cm + 0.15 ppm RMS (DC201/202)
Vertical: 1.5 cm + 0.15 ppm RMS (DC201/202)
Heading: 0.01 degrees RMS (DC202 only)
Update Rate:
Positioning: 5Hz (DC201/202) 20Hz Optional
Heading: 10Hz (DC202 Only) 20Hz Optional
RTK Initialisation1: Typically 10-30 seconds
Operating Range3: Up to 80 km
Built-in UHF Radio Modem:
Frequency Range: 380-470 MHz
25 Khz Channel Separation
19,200 bps on Air Transmission
Diversity Reception (Dual Antenna System)
Timing:
External PPS Output
PPS to TTL converted to RS232 Interrupt Signal
Output formats:
GPS based NMEA-0183 Messages
Proprietary ASCII and Binary Output Formats
CMR/RTCM, Differential Corrections
Input Formats:
CMR/RTCM, Differential Corrections

RTK base station setup position in official KMS point 134-11-00860 (use of KMS GPS receiver antenna) in Blaavandshuk lighthouse.

Referencestation setup position geoEuref89:

55 33 28.12874 sx 8 04 59.64456 sx 99.968 m

Controlpoints 1000 and 1001 established by "Landinspektørerne Syd I/S" the 25th of April 2006 on Pier in fishery harbour in Esbjerg.

KmsTrans Thursday, April 27, 2006 15:34

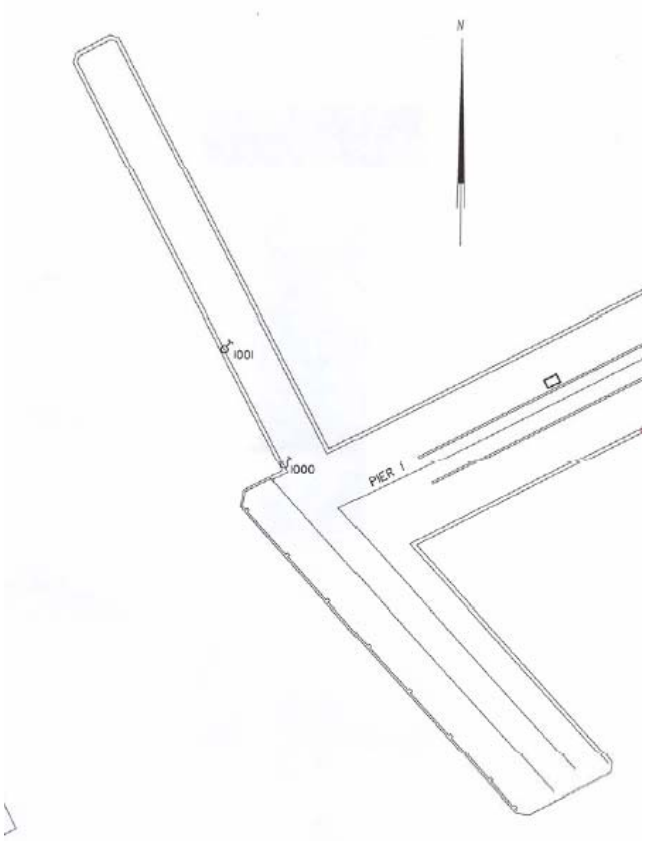
Transformation from s34j_h_dvr90 to utm32Eeuref89

1001

Input :	333441.94 m	117499.39 m	3.370 m
Output:	6 147 609.58 m	463 531.31 m	44.148 m

GPS Antenna height: 1.035 m

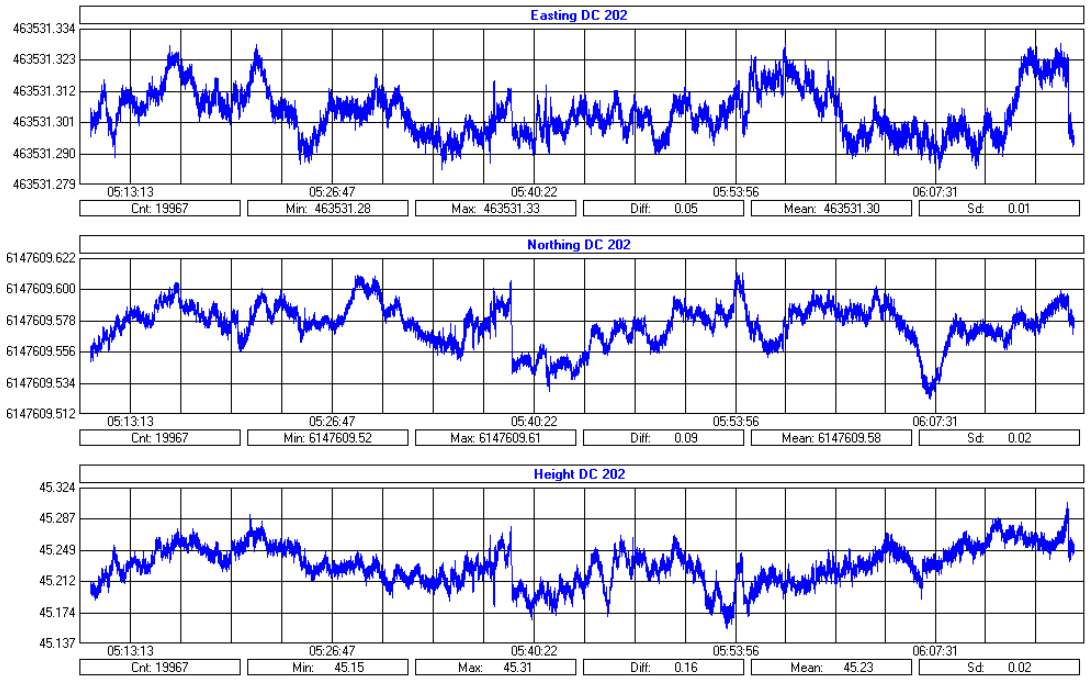
GPS Antenna ellipsoidal height (44.148 + 1.035) 45.183 m



Expected position 6 147 609.58 m 463 531.31 m

Expected height 44.148 m + 1.035 - 45.183 m

Measured position 6 147609.58 m 463 531.30 m (mean over 68 minuttes)
Measured height 45.23 m (mean over 68 minuttes)



SETTINGS SUMMARY

Database

C:\Data\Database\0015 - HR_001 - 0004.db

Objects

Number of objects	:	1

Object name	:	Hans M
Reference node	:	CoG
Reference node	:	CoG

Adjustments

Number of adjustments	:	1

Adjustment name	:	DC 202	Adjustment type	:	No GPS | No DCS
Connected objects	:	1	System observations	:	4
Connected nodes	:	5	Offset observations	:	12

OBSERVATION FILTER SETTINGS

Count	System | Observation Observation Output	Status Obs. SD	Type Model SD	Obs.Age Spike Time	Skewing Parameter
1	DC 202	Input			
1	Latitude DC 202	Inactive	None	10.00	0.00
2	Longitude DC 202	Inactive	None	10.00	0.00
3	Height DC 202	Inactive	None	10.00	0.00
4	Height Node DC Main antenna	Inactive	None	10.00	0.00
2	MRU5	Input			
5	Pitch MRU5	Inactive	None	10.00	0.00
6	Roll MRU5	Inactive	None	10.00	0.00
7	Heave MRU5	Inactive	None	10.00	0.00
3	DC heading	Input			
8	DC heading	Inactive	None	10.00	0.00
4	SEAPATH 20 GYRO	Input			
9	SEAPATH 20 GYRO	Inactive	None	10.00	0.00
5	AML SV	Input			
10	Sound Velocity	Inactive	None	10.00	0.00

ECHOSOUNDER SETTINGS

Echosounder system	:	EM3002D_PORT			
Adjustment name	:	DC 202			
DTM storage	:	Enabled	Layer *.pro file	:	EM3002Port
DTM type	:	Absolute depths	Delta height obs	:	Heave MRU5
Heave blocking	:	Disabled			
Depth blocking	:	Disabled			
Range blocking	:	Disabled			
Sector blocking	:	Enabled	Minimum angle	:	-75.000 m
			Maximum angle	:	75.000 m
Excluded beams	:	8-104,110-115			
Despike swath data	:	Cross validation	Bottom type	:	Normal
			Despike direction	:	Both Directions
Reduce swath data	:	Disabled			
Brightness test	:	Disabled			
Colinearity test	:	Disabled			
Refraction	:	Use defined profile to correct for refraction			

ECHOSOUNDER SETTINGS

Echosounder system	:	EM3002D_STBD			
Adjustment name	:	DC 202			
DTM storage	:	Enabled	Layer *.pro file	:	EM3002STBD
DTM type	:	Absolute depths	Delta height obs	:	Heave MRU5
Heave blocking	:	Disabled			
Depth blocking	:	Disabled			
Range blocking	:	Disabled			
Sector blocking	:	Enabled	Minimum angle	:	-75.000 m
			Maximum angle	:	75.000 m
Excluded beams					
Despike swath data	:	Cross validation	Bottom type	:	Normal
			Despike direction	:	Both Directions
Reduce swath data	:	Disabled			
Brightness test	:	Disabled			
Colinearity test	:	Disabled			
Refraction	:	Use defined profile to correct for refraction			

SURVEY DEFINITIONS

General Definitions

Line sequence number	:	15
Line description	:	
UTC to GPS time correction	:	14.00 s
Survey Unit Name	:	Meters
Conversion factor to meters	:	1.00000000

Geodetic Definitions

Magnetic Variation Information

Undefined

Datum Definitions

Survey Datum	:	WGS84
Spheroid name	:	WGS 1984
Semi-major axis (a)	:	6378137.000 m
Semi-minor axis (b)	:	6356752.314 m
Conversion factor to meters	:	1.000000
Inverse flattening (1/f)	:	298.25722356
First eccentricity (e**2)	:	0.00669438
Second eccentricity (e'**2)	:	0.00673950

Datum Shift Definitions

Undefined

Height Datum Definition

Vertical datum	:	EGG97 (North Sea)
Height file	:	EGG-NSEA.BIN
Height level	:	No Level Correction
Height file	:	N/A
Height offset	:	0.000 m
MSL model	:	Manual Offset
MSL file	:	N/A
MSL level	:	No Level Correction
MSL file	:	N/A
MSL offset	:	37.950 m
MSL st.dev.	:	0.141 m
DTM mode	:	Absolute DTM's
DTM datum	:	EGG97 (North Sea)
DTM file	:	EGG-NSEA.BIN
DTM level	:	No Level Correction
DTM file	:	N/A
DTM offset	:	0.000 m

Projection Definition

Projection name	:	Universal Transverse Mercator (North Oriented)
Conversion factor to meters	:	1.000000
UTM zone number	:	32
Latitude of grid origin	:	0;00;00.000 N
Longitude of grid origin	:	9;00;00.000 E
Grid Easting at grid origin	:	500000.000 E
Grid Northing at grid origin	:	0.000 N
Scale factor at longitude of origin	:	0.999600

Offset Convention

Offset mode	:	Rectangular
Offset distances units	:	Meters
Offset angles units	:	Degrees

OBJECT DEFINITIONS

General Summary Information

Number of survey vessels or objects	:	1
Number of relay vessels or buoys	:	0
Number of external network nodes	:	0
Number of datums/spheroids defined	:	1

Vessel Definitions

Hans M

Streamers	:	0	Gun arrays	:	0
Buoys	:	0	Echosounders	:	0
Satellite receivers	:	0	USBL systems	:	0
Network nodes	:	5	Pitch/Roll/Heave sensors		

Correction to GMT	:	0.00 h
Correction to master vessel's time	:	0.000000 s
Height above draft reference	:	0.000 m

CoG

SHAPE	Point	X	Y	Z	Pen	Fill	Style
	1	-3.5	17.0	0.0	Up	On	Solid
	2	-5.7	14.5	0.0	Down	On	Solid
	3	-6.3	13.0	0.0	Down	On	Solid
	4	-7.0	11.0	0.0	Down	On	Solid
	5	-7.0	0.0	0.0	Down	On	Solid
	6	-6.3	-14.5	0.0	Down	On	Solid
	7	-0.6	-14.5	0.0	Down	On	Solid
	8	0.0	0.0	0.0	Down	On	Solid
	9	0.0	11.0	0.0	Down	On	Solid
	10	-0.7	13.0	0.0	Down	On	Solid
	11	-1.3	14.5	0.0	Down	On	Solid

Gun Array Definitions

NETWORK DEFINITIONS

Fixed Node Definitions

Variable Node Definitions

CoG

Object location	:	Hans M
X (Stbd = Positive):	:	0.000 m
Y (Bow = Positive):	:	0.000 m
Z (Up = Positive):	:	0.000 m

DC Main antenna

Object location	:	Hans M
X (Stbd = Positive):	:	0.000 m
Y (Bow = Positive):	:	0.210 m
Z (Up = Positive):	:	8.232 m

1000

Object location	:	Hans M
X (Stbd = Positive):	:	0.000 m
Y (Bow = Positive):	:	0.000 m
Z (Up = Positive):	:	-1.087 m

STBD EM3002 HEAD

Object location	:	Hans M
X (Stbd = Positive):	:	0.224 m
Y (Bow = Positive):	:	0.265 m
Z (Up = Positive):	:	-0.211 m

PORT EM3002 HEAD

Object location	:	Hans M
X (Stbd = Positive):	:	-0.190 m
Y (Bow = Positive):	:	0.251 m
Z (Up = Positive):	:	-0.232 m

Observation Definitions

DC heading	:	Bearing (True)
"At" node	:	CoG
"To" node 1	:	
Measurement unit code	:	Degrees
Positioning system description	:	DC heading
Propagation speed	:	0.0000000000 m/s
Lanewidth on baseline	:	0.0000000000 m/s
Scale factor	:	1.0000000000
Fixed system (C-O)	:	4.32000000 °
Variable (C-O)	:	0.000000 °
A priori SD	:	0.50 °
Quality indicator	:	No quality info recorded

SEAPATH 20 GYRO

Bearing (True)	:	
"At" node	:	CoG
"To" node 1	:	
Measurement unit code	:	Degrees
Positioning system description	:	SEAPATH 20 GYRO
Propagation speed	:	0.0000000000 m/s
Lanewidth on baseline	:	0.0000000000 m/s
Scale factor	:	1.0000000000
Fixed system (C-O)	:	2.00000000 °
Variable (C-O)	:	0.000000 °
A priori SD	:	0.50 °
Quality indicator	:	No quality info recorded

Observation Definitions (continued)

Sound Velocity	:	Sound Velocity
"At" node	:	STBD EM3002 HEAD
Measurement unit code	:	Meters / Second
Positioning system description	:	AML SV
Propagation speed	:	0.0000000000 m/s
Lanewidth on baseline	:	0.0000000000 m/s
Scale factor	:	1.0000000000
Fixed system (C-O)	:	0.00000000 m/s
Variable (C-O)	:	0.000000 m/s
A priori SD	:	0.05 m/s
Quality indicator	:	No quality info recorded

Reference Station Definitions

SYSTEM DEFINITIONS

Position Navigation System

DC 202

Interfacing

Type	:	Position Navigation System			
Driver	:	ad Navigation DC-Series (Position)			
Port	:	7			
Baud rate	:	115200	Data bits	:	8
Parity	:	None	Stop bits	:	1
Update rate	:	0.000 s	Latency	:	0.000 s

Satellite System Definition

Position datum	:	WGS84
Satellite system name	:	WGS84

Satellite Receiver Definition

Receiver number	:	0
Receiver description	:	
Node identifier	:	DC Main antenna
Object location	:	Hans M
X (Stbd = Positive):	:	0.000 m
Y (Bow = Positive):	:	0.210 m
Z (Up = Positive):	:	8.232 m

Horizontal datum	:	WGS84
Vertical datum	:	WGS84
Height file	:	N/A
Height level	:	No Level Correction
Height file	:	N/A
Height offset	:	0.000 m

Connected Observations

Connected Nodes

Pitch, Roll and Heave Sensor

MRU5

Interfacing

Type	:	Pitch, Roll and Heave Sensor			
Driver	:	Simrad EM3000 R-P-H			
Port	:	6			
Baud rate	:	19200	Data bits	:	8
Parity	:	None	Stop bits	:	1
Update rate	:	0.000 s	Latency	:	0.000 s

System Parameters

MRU5

Object	:	Hans M
Location on object (Lever arm)	:	CoG
PRH sensor reference number	:	1
Rotation convention pitch	:	Positive bow up
Rotation convention roll	:	Positive heeling to starboard
Angular variable measured	:	HPR (roll first)
Angular measurement units	:	Degrees
Sign convention heave	:	Positive upwards
Measurement units heave	:	Meters
Quality indicator type pitch and roll	:	No quality info recorded
Quality indicator type heave	:	No quality info recorded
(C-O) pitch offset	:	0.000000
(C-O) roll offset	:	0.000000
(C-O) heave offset	:	0.000000

Description of pitch, roll and heave system

MRU5

Offset System

Offset System

Interfacing

Type	:	Offset System
Driver	:	
IP address	:	0. 0. 0. 0
Port	:	0
Update rate	:	0.000

Gyros and Compasses

DC heading

Interfacing

Type	:	Gyros and Compasses			
Driver	:	NMEA Compass ($--HDT)			
Port	:	5			
Baud rate	:	19200	Data bits	:	8
Parity	:	None	Stop bits	:	1
Update rate	:	0.000 s	Latency	:	0.000 s

Connected Observations

DC heading : Bearing (True)

Connected Nodes

CoG : Hans M

Gyros and Compasses

SEAPATH 20 GYRO

Interfacing

Type	:	Gyros and Compasses			
Driver	:	NMEA Compass ($--HDT)			
Port	:	11			
Baud rate	:	9600	Data bits	:	8
Parity	:	None	Stop bits	:	1
Update rate	:	0.000 s	Latency	:	0.000 s

Connected Observations

SEAPATH 20 GYRO : Bearing (True)

Connected Nodes

CoG : Hans M

Output System

AUTOPILOT

Interfacing

Type	:	Output System			
Driver	:	NMEA Autopilot $CCAPA (Steered Point)			
Port	:	13			
Baud rate	:	1200	Data bits	:	8
Parity	:	None	Stop bits	:	1
Update rate	:	1.000 s	Latency	:	0.000 s

PPS System

PPS Timetagging

Interfacing

Type	:	PPS System			
Driver	:	NMEA ZDA PPS (COM1)			
Port	:	18			
Baud rate	:	9600	Data bits	:	8
Parity	:	None	Stop bits	:	1
Update rate	:	0.000 s	Latency	:	0.000 s

Output System

ZDA to PU COM 3

Interfacing

Type	:	Output System			
Driver	:	NMEA GPZDA			
Port	:	15			
Baud rate	:	9600	Data bits	:	8
Parity	:	None	Stop bits	:	1
Update rate	:	1.000 s	Latency	:	0.000 s

Multibeam Echosounder

EM3002D_PORT

Interfacing

Type	:	Multibeam Echosounder
Driver	:	Simrad EM3002 XTF (R-Theta Format)
IP address	:	0. 0. 0. 0
Port	:	16101
Update rate	:	0.000

System Parameters

EM3002D_PORT

Object	:	Hans M
Number of transducers	:	Single
Transducer node 1	:	PORT EM3002 HEAD
Heading offset	:	-3.480 °
Roll offset	:	40.110 °
Pitch offset	:	-2.860 °
Maximum number of beams per ping	:	508
Unit is roll stabilized	:	No
Unit is pitch stabilized	:	No
Unit is heave compensated	:	No
Use sound velocity from unit	:	Yes

Underwater Sensor

AML SV

Interfacing

Type	:	Underwater Sensor			
Driver	:	Sound Velocity - Smart SV (AML, ASCII) (Active)			
Port	:	12			
Baud rate	:	9600	Data bits	:	8
Parity	:	None	Stop bits	:	1
Update rate	:	0.000 s	Latency	:	0.000 s

Connected Observations

Sound Velocity	:	Sound Velocity

Connected Nodes

STBD EM3002 HEAD	:	Hans M

Multibeam Echosounder

EM3002D_STBD

Interfacing

Type	:	Multibeam Echosounder
Driver	:	Simrad EM3002D Head II XTF (R-Theta Format)
IP address	:	0. 0. 0. 0
Port	:	16103
Update rate	:	0.000

System Parameters

EM3002D_STBD

Object	:	Hans M
Number of transducers	:	Single
Transducer node 1	:	STBD EM3002 HEAD
Heading offset	:	-3.150 °
Roll offset	:	-39.930 °
Pitch offset	:	-3.340 °
Maximum number of beams per ping	:	508
Unit is roll stabilized	:	No
Unit is pitch stabilized	:	No
Unit is heave compensated	:	No
Use sound velocity from unit	:	Yes

Sidescan Sonar

EM3002D SSS PORT

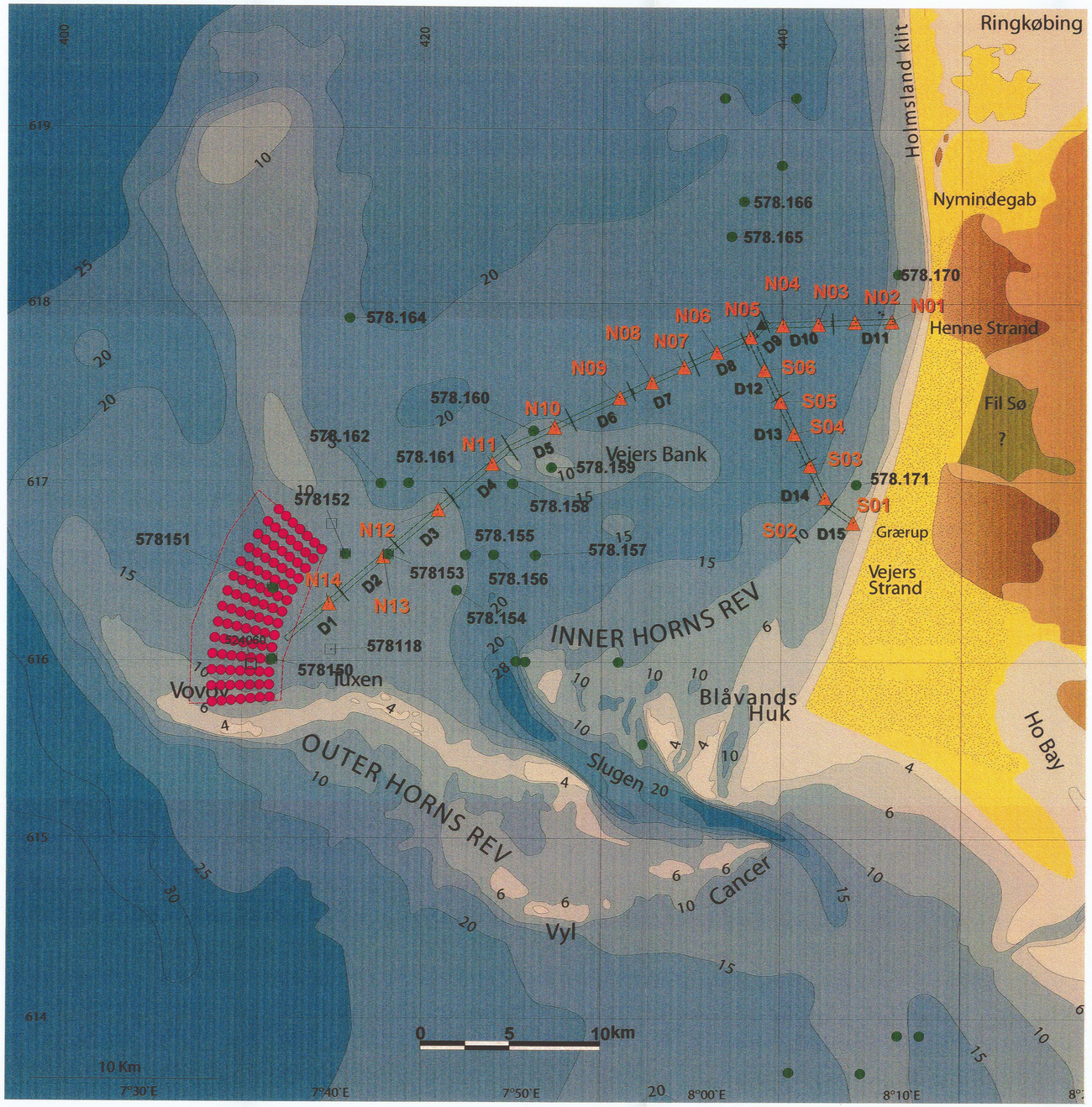
Interfacing

Type	:	Sidescan Sonar
Driver	:	Simrad EM3002D (Dual Head) Seabed Image
IP address	:	0. 0. 0. 0
Port	:	16102
Update rate	:	0.000

System Parameters

Manufacturer	:	Simrad
Model	:	Simrad EM3000
Number of beams	:	1
Number of channels	:	2
Associated multibeam system	:	EM3002D_PORT
Object location	:	Hans M

16. Appendix D: Cable route sections D1 – D15



Map legend Offshore

- Windpark area
- Cable corridor sections
- 578118 — Existing vibrocore
- 578.166 — Existing vibrocore
- N05 — Grab samples
- Magnetic anomaly

Map legend Onshore

- Varde Bakkeø
- Lake / bogdeposits
- Marine deposits
- Aeolian deposits

UTM Zone 32, EUREF 89

Employer

Energi E2 A/S
A.C Meyers Vænge 9
DK-2450 Copenhagen SV
Denmark

Contrac Title

Horns Rev II offshore windfarm

Drawing Title

Overview Windfarm and Cable Route

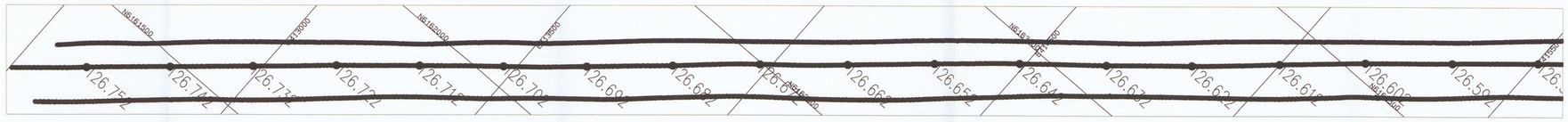
Scale at A0 size	1:100000		
Drawn		Approved	
Stage 1 check	Stage 2 check	Originated	Date

Geological Survey of Denmark and Greenland
Østervoldgade 10
DK-1350 Copenhagen
Denmark

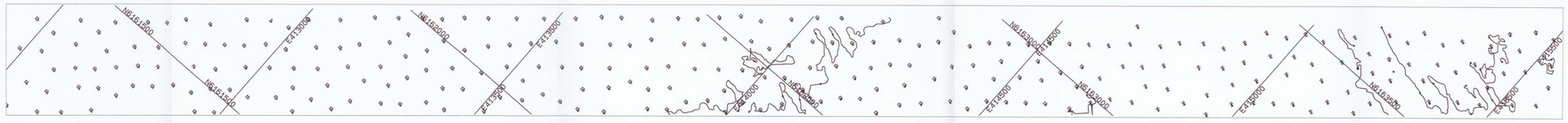
GEUS

Drawing Number

A1

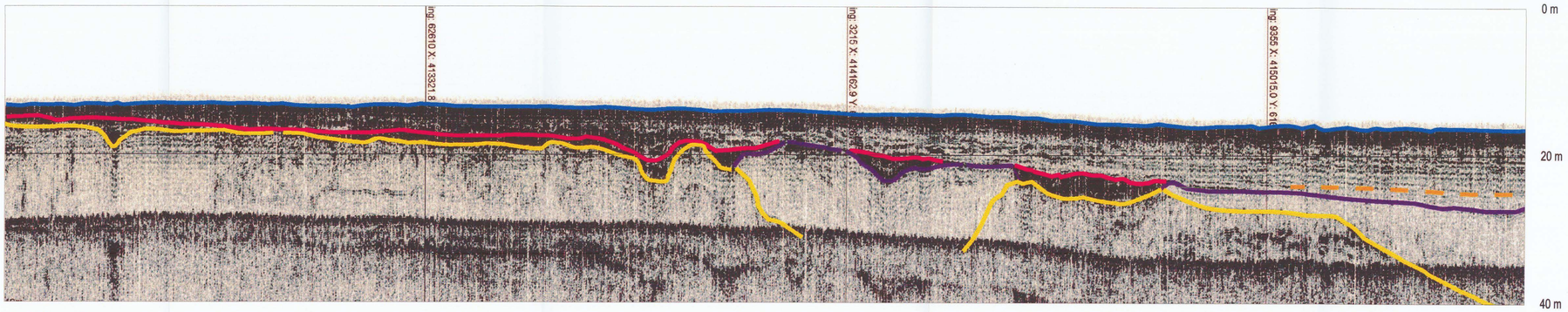


Shoot point location map



Bathymetry

Seabed features



Seismic profile

LEGEND

Shoot point location map

- Shot point (126.57Z)
- Seismic line

Bathymetry

- Depth contour
- Depth

Seabed features

- Sand medium
- Sand fine medium
- Sand fine
- Mega Ripples
- Sampling position
- Magnetic anomaly

Top of seismic unit

- Marine deposits Holocene (Unit 2)
- Marine deposits Holocene (Unit 1)
- Freshwater deposits early Holocene
- Meltwater deposits Weichsel
- Eem interglacial
- Glacial deposits Saale or older

Depth below msl: DVR_90

UTM Zone 32 Euref89

0 0.5 km

Employer

ENERGI E2 A/S
A.C. Meyers Vænge 9
DK-2450 Copenhagen SV
DENMARK
on behalf of Energinet Danmark

Contract Title

Horns Rev II Offshore Windfarm

Drawing Title

Cable Route Horns Rev II

Scale at A0 size: 1:5000 - Seismic profile vertical scale: 1:250

Drawn		Approved SLO	
Stage 1 check	Stage 2 check	Originated	Date

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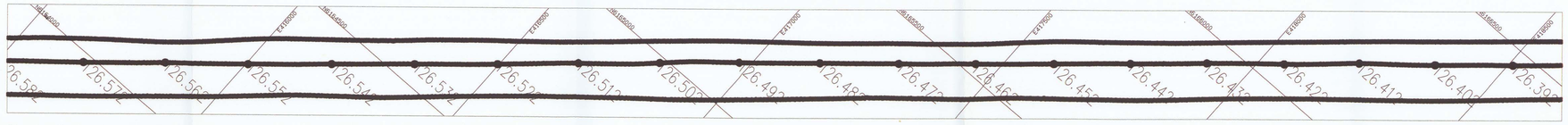
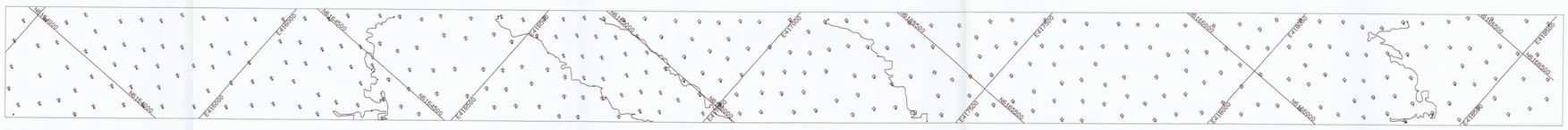
Øster Voldgade 10
DK-1350 Copenhagen K
Denmark

Drawing Number

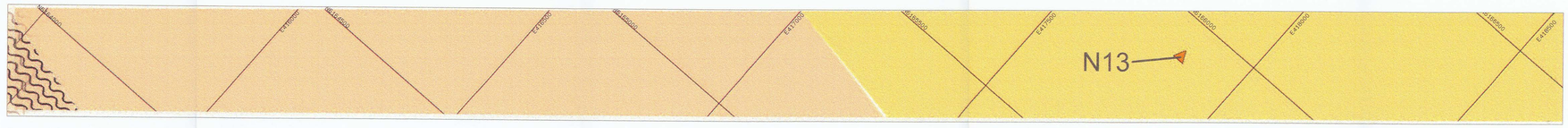
D1



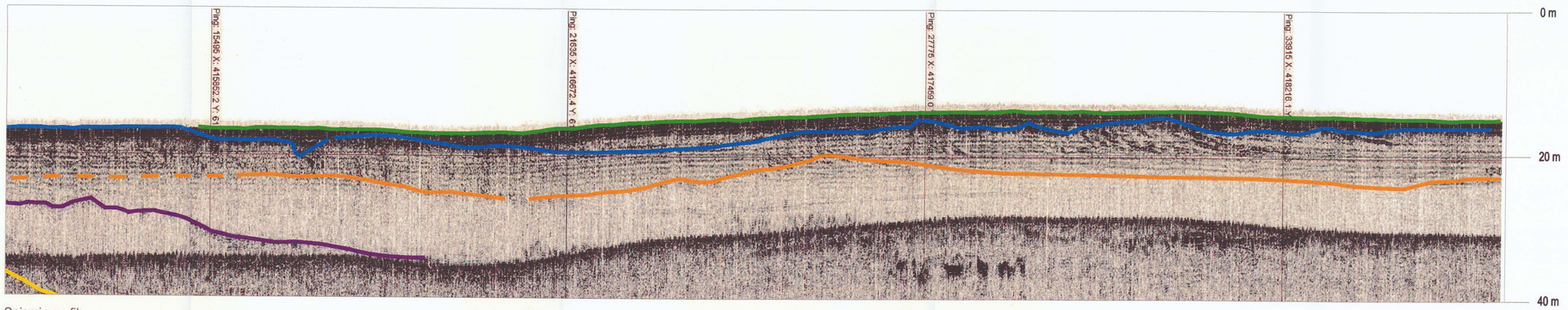
Shoot point location map



Bathymetry



Seabed features



Seismic profile

LEGEND

Shoot point location map

- Shot point (26.572)
- Seismic line

Bathymetry

- Depth contour
- Depth

Seabed features

- Sand medium
- Sand fine medium
- Sand fine
- Mega Ripples
- Sampling position
- Magnetic anomaly

Top of seismic unit

- Marine deposits Holocene (Unit 2)
- Marine deposits Holocene (Unit 1)
- Freshwater deposits early Holocene
- Meltwater deposits Weichsel
- Eem interglacial
- Glacial deposits Saale or older

Depth below msl: DVR_90

UTM Zone 32 Euref89

0 0.5 km

Employer

ENERGI E2 A/S
A.C. Meyers Vænge 9
DK-2450 Copenhagen SV
DENMARK
on behalf of Energinet Danmark

Contract Title

Horns Rev II Offshore Windfarm

Drawing Title

Cable Route Horns Rev II

Scale at A0 size: 1:5000 - Seismic profile vertical scale: 1:250

Drawn		Approved SLO	
Stage 1 check	Stage 2 check	Originated	Date

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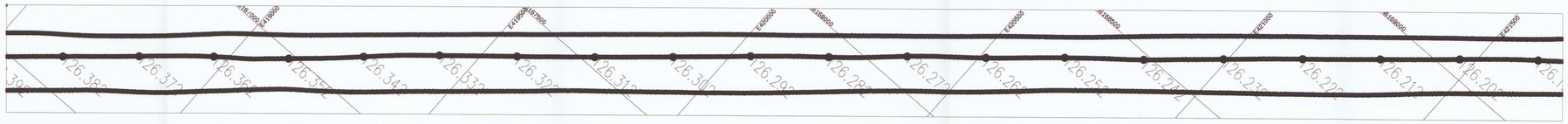
Denmark

Drawing Number

D2



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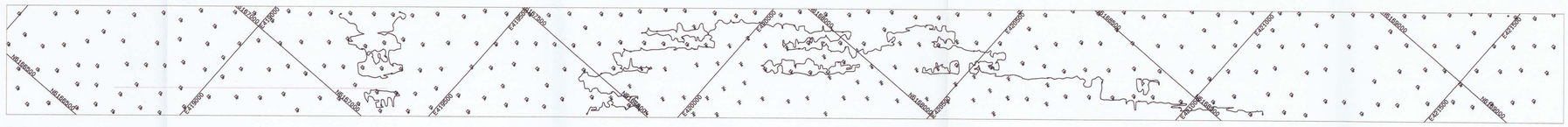
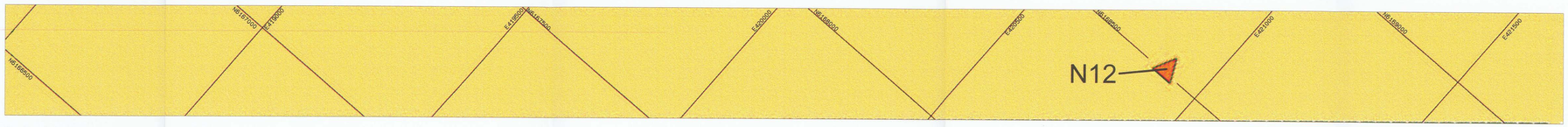
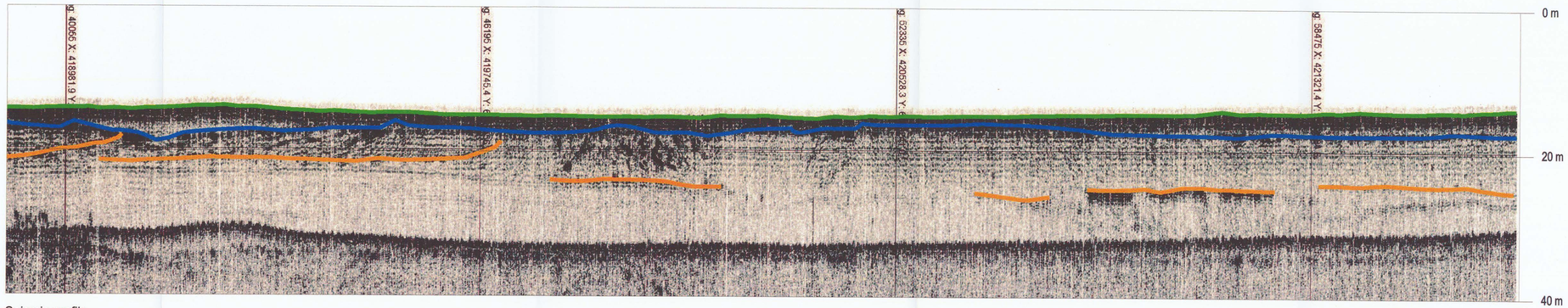


Bathymetry



Seabed features



Seismic profile

LEGEND

Shoot point location map

- Shot point
- Seismic line

Bathymetry

- Depth contour
- Depth

Seabed features

- Sand medium
- Sand fine medium
- Sand fine
- Mega Ripples
- Sampling position
- Magnetic anomaly

Top of seismic unit

- Marine deposits Holocene (Unit 2)
- Marine deposits Holocene (Unit 1)
- Freshwater deposits early Holocene
- Meltwater deposits Weichsel
- Eem interglacial
- Glacial deposits Saale or older

Depth below msl: DVR_90

UTM Zone 32 Euref89

0 0.5 km

Employer

ENERGI E2 A/S
A.C. Meyers Vænge 9
DK-2450 Copenhagen SV
DENMARK
on behalf of Energinet Danmark

Contract Title

Horns Rev II Offshore Windfarm

Drawing Title

Cable Route Horns Rev II

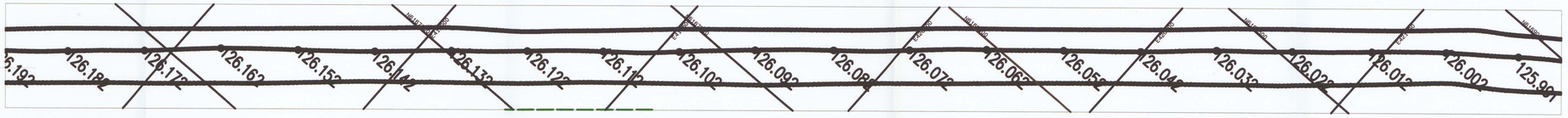
Scale at A0 size: 1:5000 - Seismic profile vertical scale: 1:250

Drawn		Approved SLO	
Stage 1 check	Stage 2 check	Originated	Date

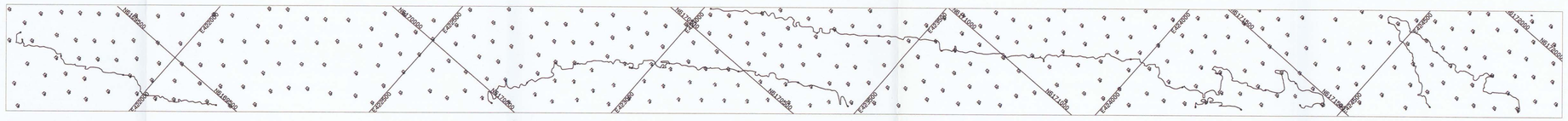
Geological Survey of Denmark and Greenland
Øster Voldgade 10
DK-1350 Copenhagen K
Denmark

Drawing Number

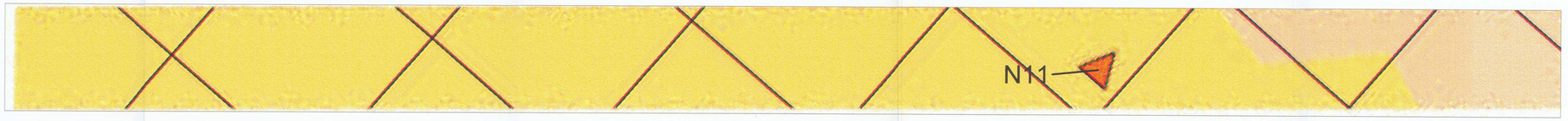
D3



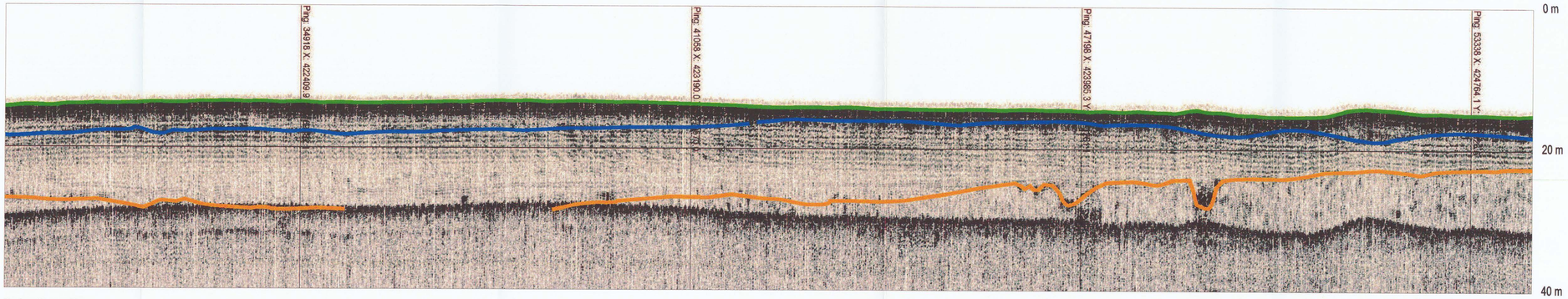
Shoot point location map



Bathymetry



Seabed features



Seismic profile

LEGEND

Shoot point location map

- Shot point (126.572)
- Seismic line

Bathymetry

- Depth contour
- Depth

Seabed features

- Sand medium
- Sand fine medium
- Sand fine
- Mega Ripples
- Sampling position
- Magnetic anomaly

Top of seismic unit

- Marine deposits Holocene (Unit 2)
- Marine deposits Holocene (Unit 1)
- Freshwater deposits early Holocene
- Meltwater deposits Weichsel
- Eem interglacial
- Glacial deposits Saale or older

Depth below msl: DVR_90

UTM Zone 32 Euref89

0 0.5 km

Employer

ENERGI E2 A/S
A.C. Meyers Vænge 9
DK-2450 Copenhagen SV
DENMARK
on behalf of Energinet Danmark

Contract Title

Horns Rev II Offshore Windfarm

Drawing Title

Cable Route Horns Rev II

Scale at A0 size: 1:5000 - Seismic profile vertical scale: 1:250

Drawn		Approved SLO	
Stage 1 check	Stage 2 check	Originated	Date

Geological Survey of Denmark and Greenland
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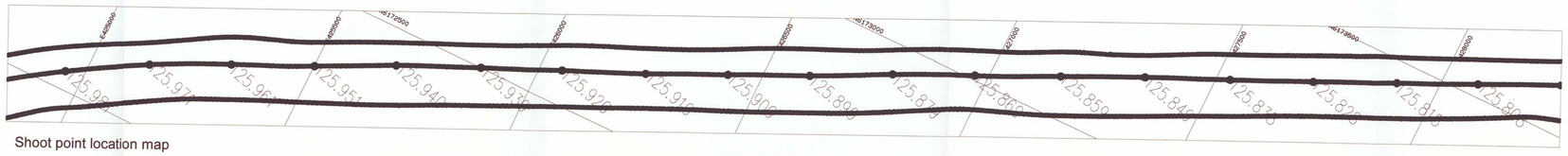
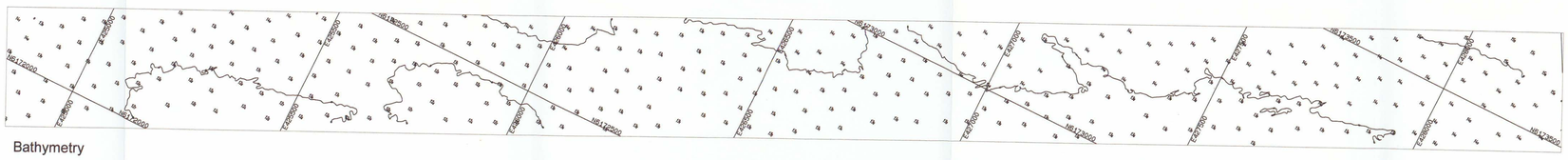
Denmark

Drawing Number

D4

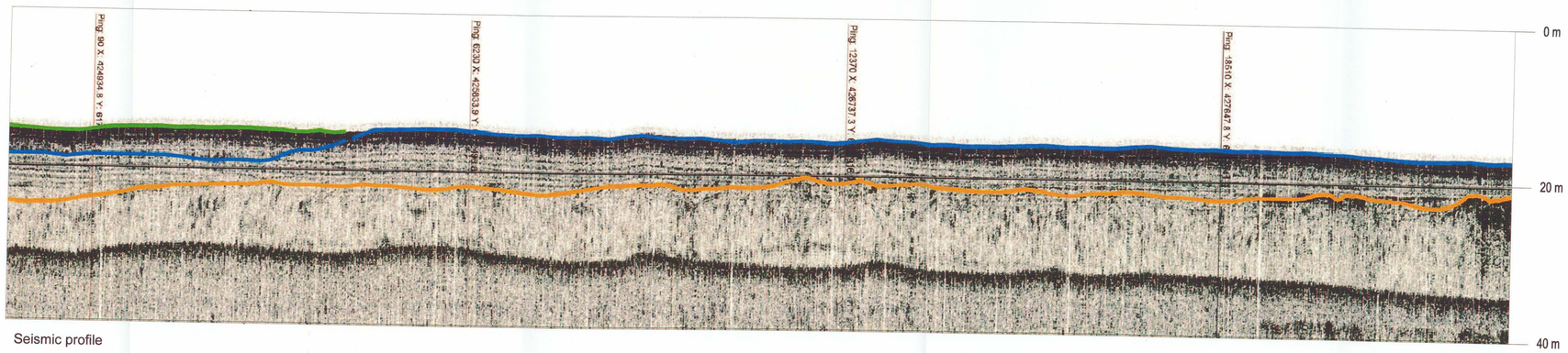


Shoot point location map



Bathymetry

Seabed features



Seismic profile

LEGEND

Shoot point location map

- Shot point (126.572)
- Seismic line

Bathymetry

- Depth contour
- Depth

Seabed features

- Sand medium
- Sand fine medium
- Sand fine
- Mega Ripples
- Sampling position
- Magnetic anomaly

Top of seismic unit

- Marine deposits Holocene (Unit 2)
- Marine deposits Holocene (Unit 1)
- Freshwater deposits early Holocene
- Meltwater deposits Weichsel
- Eem interglacial
- Glacial deposits Saale or older

Depth below msl: DVR_90

UTM Zone 32 Euref89

0 0.5 km

Employer

ENERGI E2 A/S
A.C. Meyers Vænge 9
DK-2450 Copenhagen SV
DENMARK
on behalf of Energinet Danmark

Contract Title

Horns Rev II Offshore Windfarm

Drawing Title

Cable Route Horns Rev II

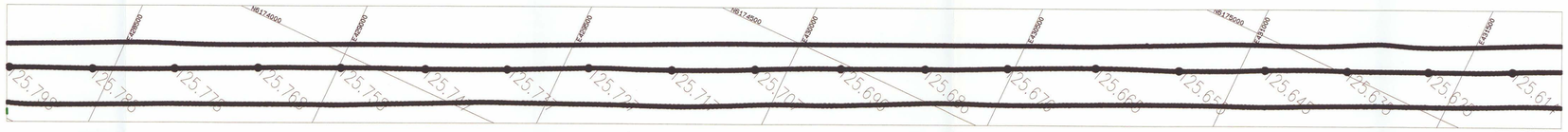
Scale at A0 size: 1:5000 - Seismic profile vertical scale: 1:250

Drawn		Approved SLO	
Stage 1 check	Stage 2 check	Originated	Date

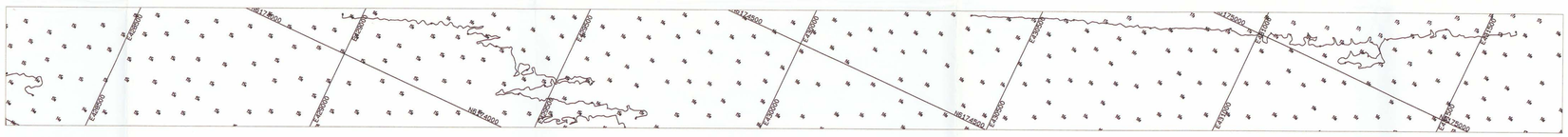
Geological Survey of Denmark and Greenland
Øster Voldgade 10
DK-1350 Copenhagen K
Denmark

Drawing Number

D5

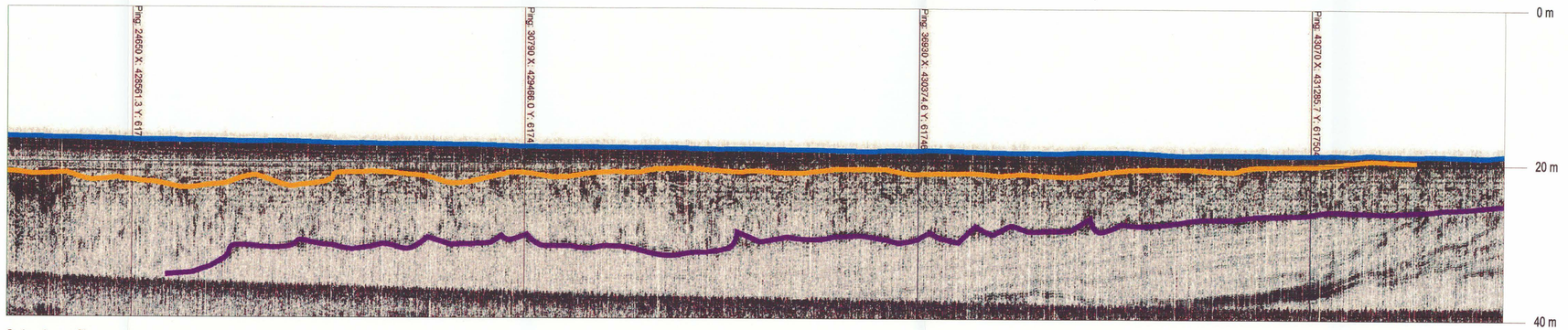


Shoot point location map



Bathymetry

Seabed features



Seismic profile

LEGEND

Shoot point location map

Shot point

Seismic line

Bathymetry

Depth contour

Depth

Seabed features

Sand medium

Sand fine medium

Sand fine

Mega Ripples

Sampling position

Magnetic anomaly

Top of seismic unit

Marine deposits Holocene (Unit 2)

Marine deposits Holocene (Unit 1)

Freshwater deposits early Holocene

Meltwater deposits Weichsel

Eem interglacial

Glacial deposits Saale or older

Depth below msl: DVR_90

UTM Zone 32 Euref89

0 0.5 km

Employer

ENERGI E2 A/S
A.C. Meyers Vænge 9
DK-2450 Copenhagen SV
DENMARK
on behalf of Energinet Danmark

Contract Title

Horns Rev II Offshore Windfarm

Drawing Title

Cable Route Horns Rev II

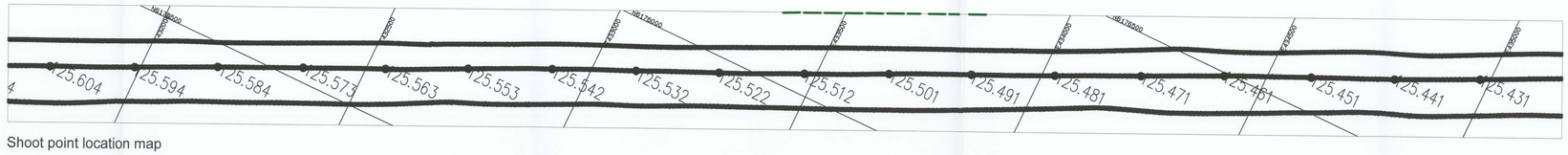
Scale at A0 size: 1:5000 - Seismic profile vertical scale: 1:250

Drawn		Approved SLO	
Stage 1 check	Stage 2 check	Originated	Date

Geological Survey of Denmark and Greenland
Øster Voldgade 10
DK-1350 Copenhagen K
Denmark

Drawing Number

D6



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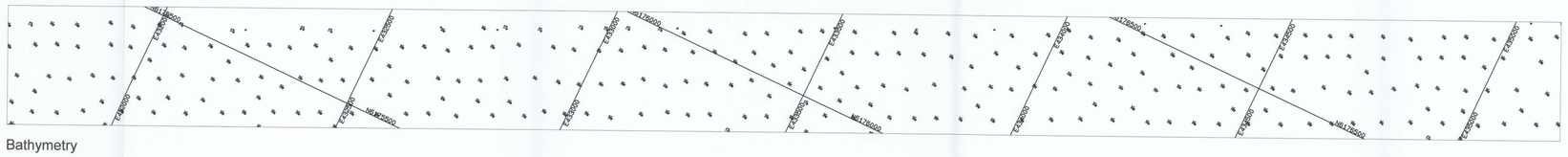
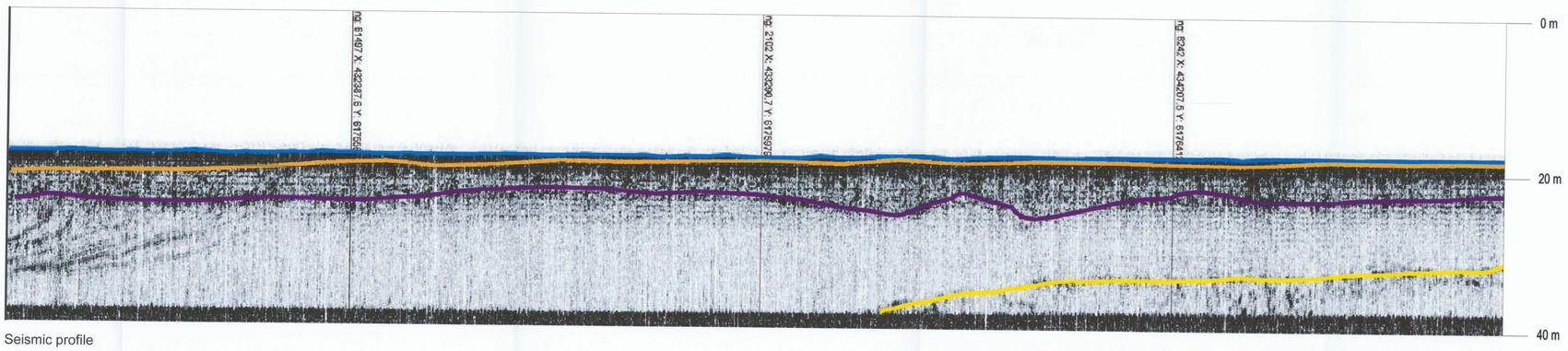


Bathymetry

Seabed features



Seismic profile

N

LEGEND

Shoot point location map

- Shot point
- 126.572
- Seismic line

Bathymetry

- Depth contour
- Depth

Seabed features

- Sand medium
- Sand fine medium
- Sand fine
- Mega Ripples
- Sampling position
- Magnetic anomaly

Top of seismic unit

- Marine deposits Holocene (Unit 2)
- Marine deposits Holocene (Unit 1)
- Freshwater deposits early Holocene
- Meltwater deposits Weichsel
- Eem interglacial
- Glacial deposits Saale or older

Depth below msl: DVR_90

UTM Zone 32 Euref89

0 0.5 km

Employer

ENERGI E2 A/S
A.C. Meyers Vænge 9
DK-2450 Copenhagen SV
DENMARK
on behalf of Energinet Danmark

Contract Title

Horns Rev II Offshore Windfarm

Drawing Title

Cable Route Horns Rev II

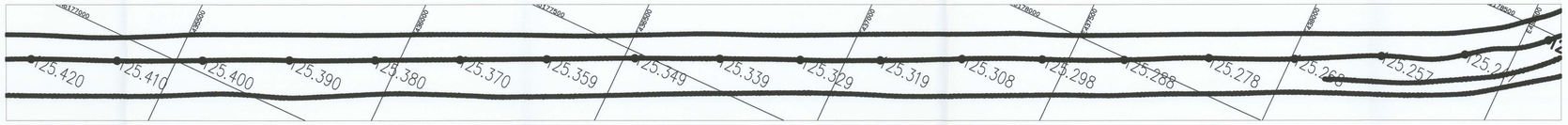
Scale at A0 size: 1:5000 - Seismic profile vertical scale: 1:250

Drawn		Approved SLO	
Stage 1 check	Stage 2 check	Originated	Date

Geological Survey of Denmark and Greenland
Øster Voldgade 10
DK-1350 Copenhagen K
Denmark

Drawing Number

D7



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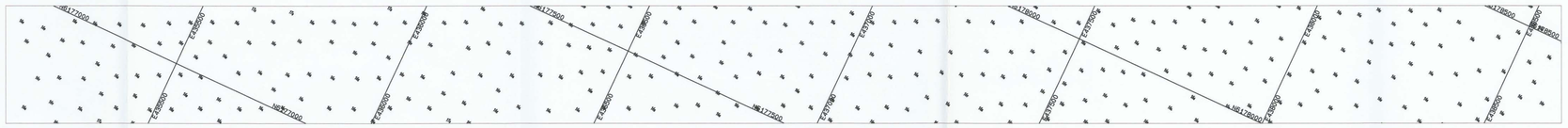
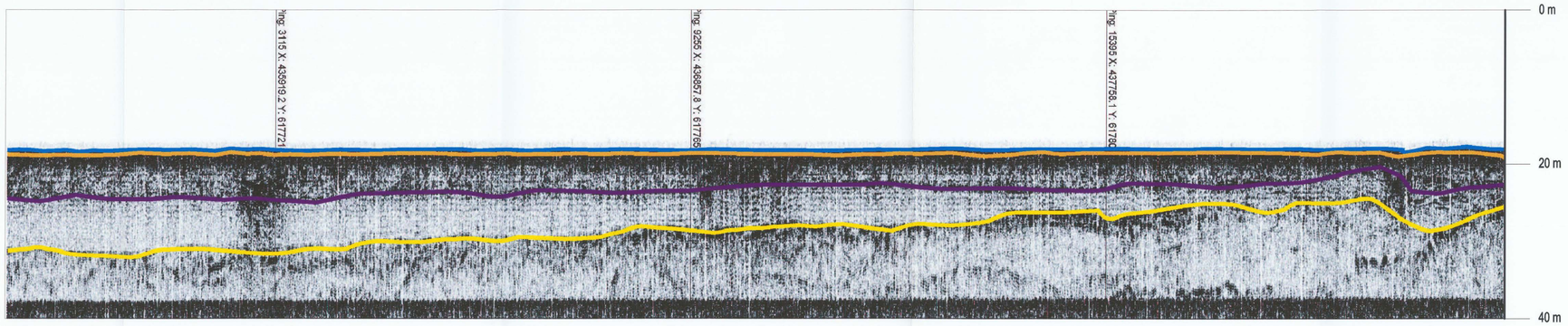


Bathymetry

Seabed features



Seismic profile

LEGEND

Shoot point location map

- Shot point (126.572)
- Seismic line

Bathymetry

- Depth contour
- Depth

Seabed features

- Sand medium
- Sand fine medium
- Sand fine
- Mega Ripples
- Sampling position
- Magnetic anomaly

Top of seismic unit

- Marine deposits Holocene (Unit 2)
- Marine deposits Holocene (Unit 1)
- Freshwater deposits early Holocene
- Meltwater deposits Weichsel
- Eem interglacial
- Glacial deposits Saale or older

Depth below msl: DVR_90 UTM Zone 32 Euref89

0 0.5 km

Employer

ENERGI E2 A/S
A.C. Meyers Vænge 9
DK-2450 Copenhagen SV
DENMARK
on behalf of Energinet Danmark

Contract Title

Horns Rev II Offshore Windfarm

Drawing Title

Cable Route Horns Rev II

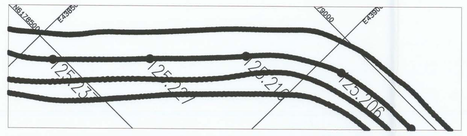
Scale at A0 size: 1:5000 - Seismic profile vertical scale: 1:250

Drawn		Approved SLO	
Stage 1 check	Stage 2 check	Originated	Date

Geological Survey of Denmark and Greenland
Øster Voldgade 10
DK-1350 Copenhagen K
Denmark

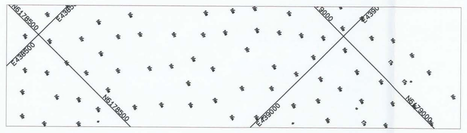
Drawing Number

D8

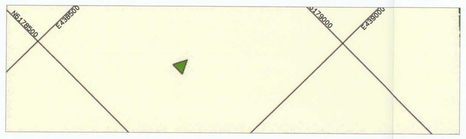


Shoot point location map

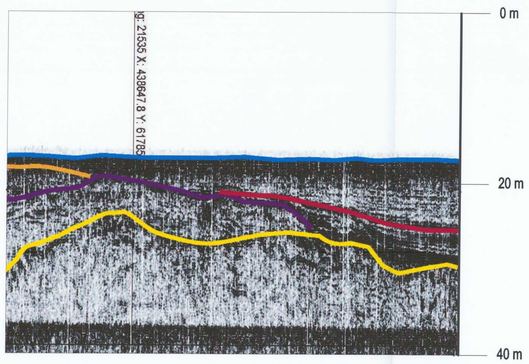
N



Bathymetry



Seabed features



Seismic profile

LEGEND

Shoot point location map

- Shot point (126.572)
- Seismic line

Bathymetry

- Depth contour
- Depth

Seabed features

- Sand medium
- Sand fine medium
- Sand fine
- Mega Ripples
- Sampling position
- Magnetic anomaly

Top of seismic unit

- Marine deposits Holocene (Unit 2)
- Marine deposits Holocene (Unit 1)
- Freshwater deposits early Holocene
- Meltwater deposits Weichsel
- Eem interglacial
- Glacial deposits Saale or older

Depth below msl: DVR_90

UTM Zone 32 Euref89

0 0.5 km

Employer

ENERGI E2 A/S
A.C. Meyers Vænge 9
DK-2450 Copenhagen SV
DENMARK
on behalf of Energinet Danmark

Contract Title

Horns Rev II Offshore Windfarm

Drawing Title

Cable Route Horns Rev II

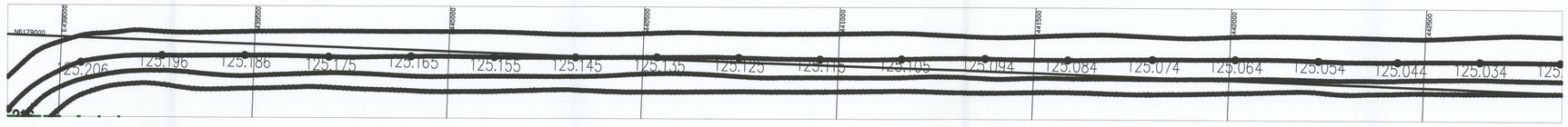
Scale at A0 size: 1:5000 - Seismic profile vertical scale: 1:250

Drawn		Approved SLO	
Stage 1 check	Stage 2 check	Originated	Date

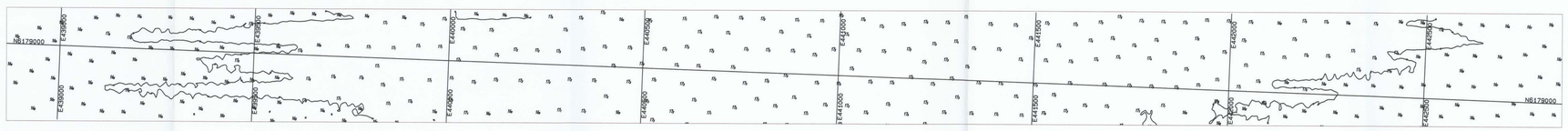
Geological Survey of Denmark and Greenland
Øster Voldgade 10
DK-1350 Copenhagen K
Denmark

Drawing Number

D9

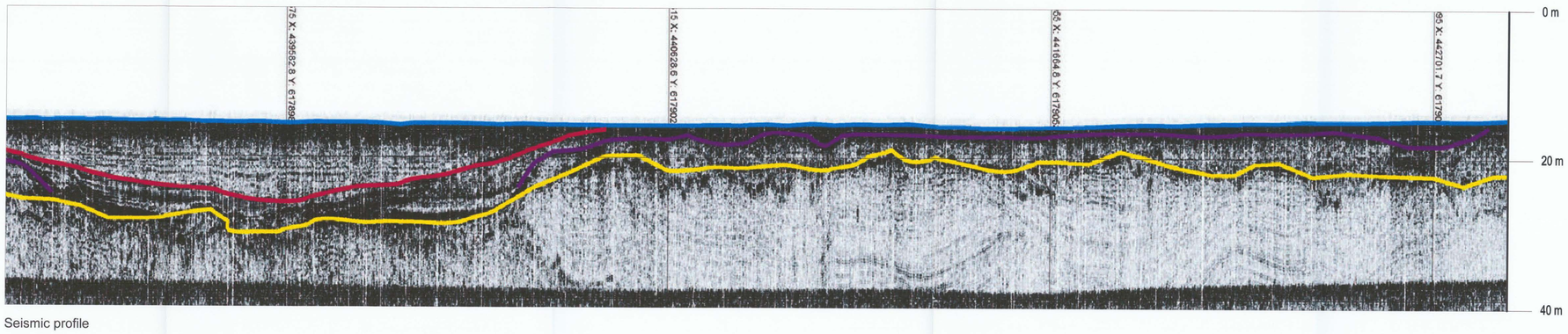


Shoot point location map



Bathymetry

Seabed features



Seismic profile

LEGEND

Shoot point location map

- Shot point (126.572)
- Seismic line

Bathymetry

- Depth contour
- Depth

Seabed features

- Sand medium
- Sand fine medium
- Sand fine
- Mega Ripples
- Sampling position
- Magnetic anomaly

Top of seismic unit

- Marine deposits Holocene (Unit 2)
- Marine deposits Holocene (Unit 1)
- Freshwater deposits early Holocene
- Meltwater deposits Weichsel
- Eem interglacial
- Glacial deposits Saale or older

Depth below msl: DVR_90

UTM Zone 32 Euref89

0 0.5 km

Employer

ENERGI E2 A/S
A.C. Meyers Vænge 9
DK-2450 Copenhagen SV
DENMARK
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Contract Title

Horns Rev II Offshore Windfarm

Drawing Title

Cable Route Horns Rev II

Scale at A0 size: 1:5000 - Seismic profile vertical scale: 1:250

Drawn		Approved SLO	
Stage 1 check	Stage 2 check	Originated	Date

Geological Survey of Denmark and Greenland
Øster Voldgade 10
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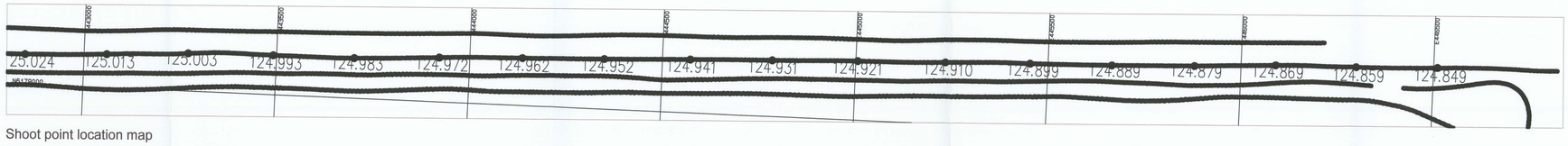
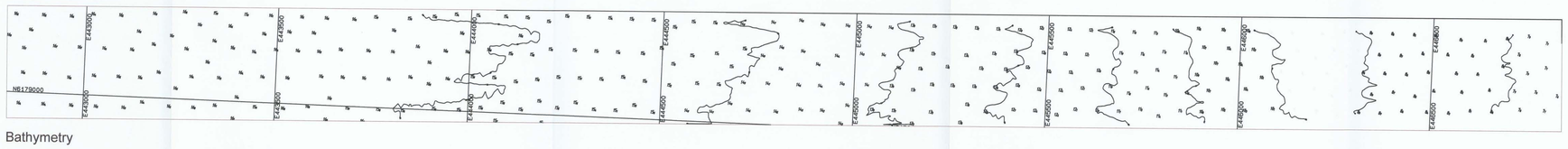
Denmark

Drawing Number

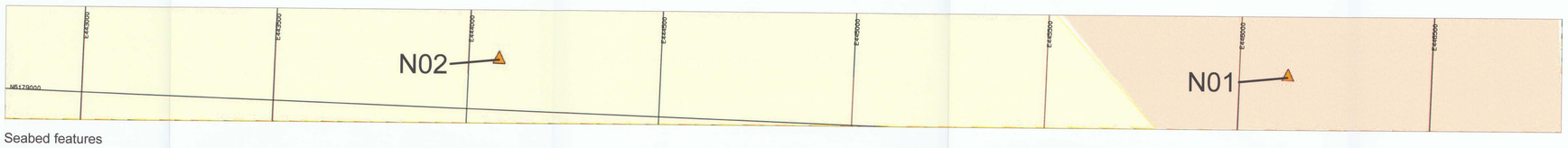
D10



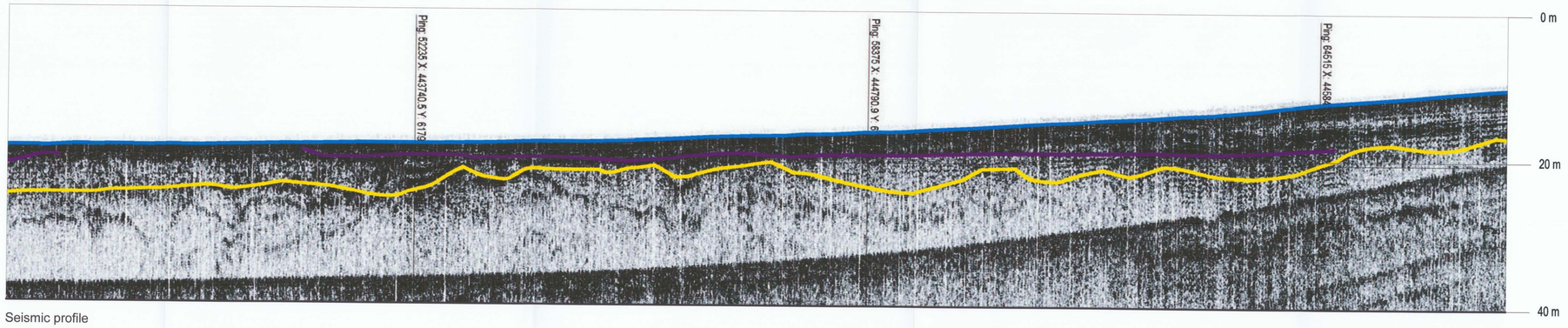
Shoot point location map



Bathymetry



Seabed features



Seismic profile

LEGEND

Shoot point location map

- Shot point
- Seismic line

Bathymetry

- Depth contour
- Depth

Seabed features

- Sand medium
- Sand fine medium
- Sand fine
- Mega Ripples
- Sampling position
- Magnetic anomaly

Top of seismic unit

- Marine deposits Holocene (Unit 2)
- Marine deposits Holocene (Unit 1)
- Freshwater deposits early Holocene
- Meltwater deposits Weichsel
- Eem interglacial
- Glacial deposits Saale or older

Depth below msl: DVR_90

UTM Zone 32 Euref89

0 0.5 km

Employer

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Contract Title

Horns Rev II Offshore Windfarm

Drawing Title

Cable Route Horns Rev II

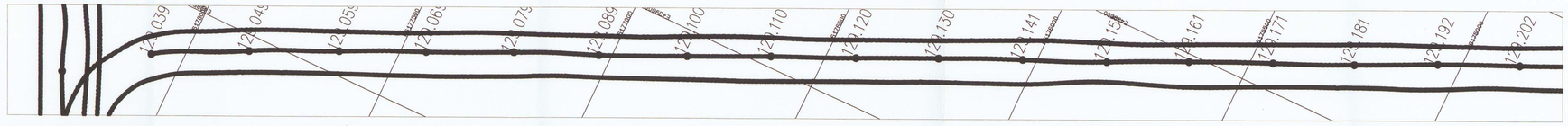
Scale at A0 size: 1:5000 - Seismic profile vertical scale: 1:250

Drawn		Approved SLO	
Stage 1 check	Stage 2 check	Originated	Date

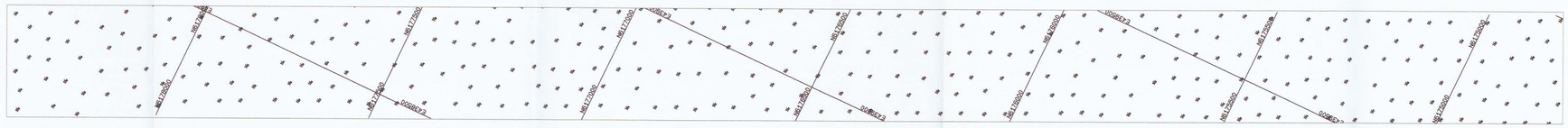
Geological Survey of Denmark and Greenland
Øster Voldgade 10
DK-1350 Copenhagen K
Denmark

Drawing Number

D11

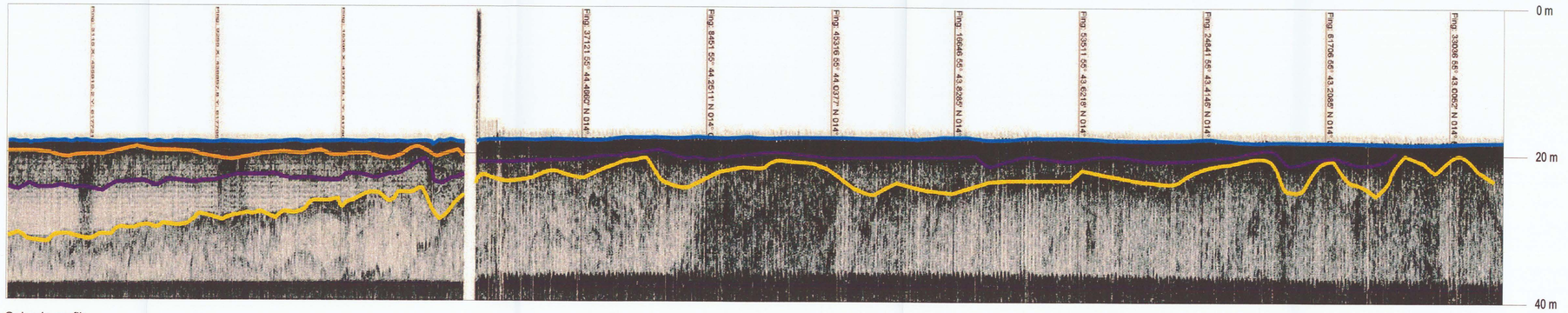


Shoot point location map



Bathymetry

Seabed features



Seismic profile

LEGEND

Shoot point location map

- Shot point (126.5772)
- Seismic line

Bathymetry

- Depth contour
- Depth

Seabed features

- Sand medium
- Sand fine medium
- Sand fine
- Mega Ripples
- Sampling position
- Magnetic anomaly

Top of seismic unit

- Marine deposits Holocene (Unit 2)
- Marine deposits Holocene (Unit 1)
- Freshwater deposits early Holocene
- Meltwater deposits Weichsel
- Eem interglacial
- Glacial deposits Saale or older

Depth below msl: DVR_90

UTM Zone 32 Euref89

0 — 0.5 km

Employer

ENERGI E2 A/S
A.C. Meyers Vænge 9
DK-2450 Copenhagen SV
DENMARK
on behalf of Energinet Danmark

Contract Title

Horns Rev II Offshore Windfarm

Drawing Title

Cable Route Horns Rev II

Scale at A0 size: 1:5000 - Seismic profile vertical scale: 1:250

Drawn		Approved SLO	
Stage 1 check	Stage 2 check	Originated	Date

Geological Survey of Denmark and Greenland
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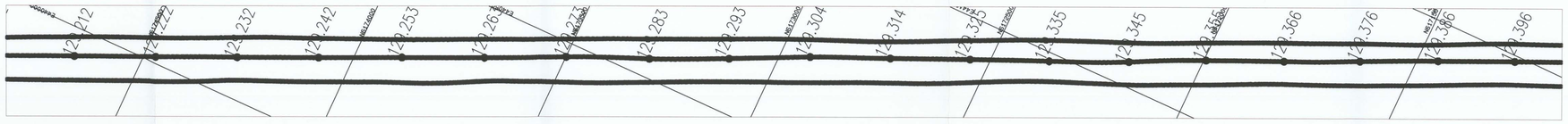
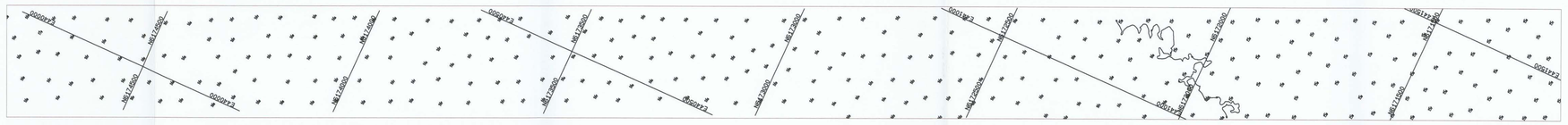
Denmark

Drawing Number

D12

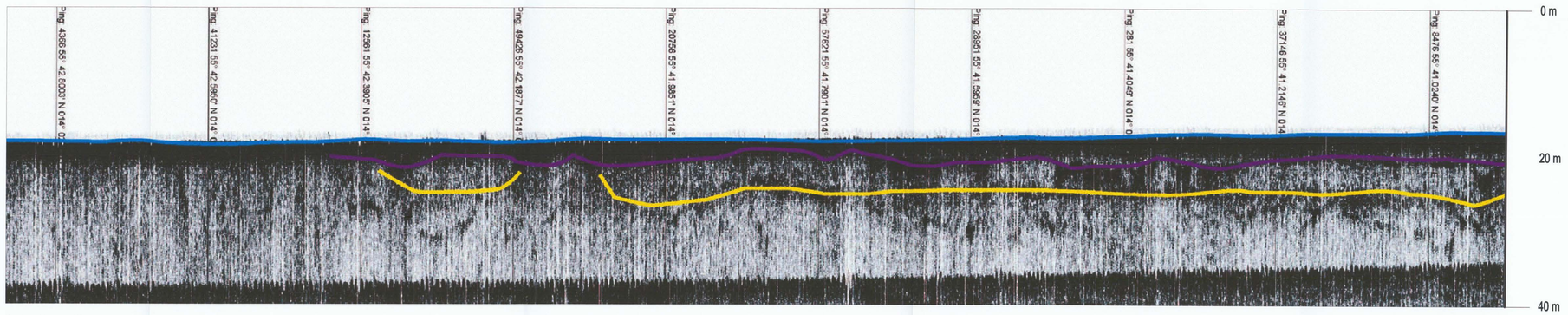


Shoot point location map



Bathymetry

Seabed features



Seismic profile

LEGEND

Shoot point location map

- Shot point
- Seismic line

Bathymetry

- Depth contour
- Depth

Seabed features

- Sand medium
- Sand fine medium
- Sand fine
- Mega Ripples
- Sampling position
- Magnetic anomaly

Top of seismic unit

- Marine deposits Holocene (Unit 2)
- Marine deposits Holocene (Unit 1)
- Freshwater deposits early Holocene
- Meltwater deposits Weichsel
- Eem interglacial
- Glacial deposits Saale or older

Depth below msl: DVR_90

UTM Zone 32 Euref89

0 0.5 km

Employer

ENERGI E2 A/S
A.C. Meyers Vænge 9
DK-2450 Copenhagen SV
DENMARK
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Contract Title

Horns Rev II Offshore Windfarm

Drawing Title

Cable Route Horns Rev II

Scale at A0 size: 1:5000 - Seismic profile vertical scale: 1:250

Drawn		Approved SLO	
Stage 1 check	Stage 2 check	Originated	Date

Geological Survey of Denmark and Greenland
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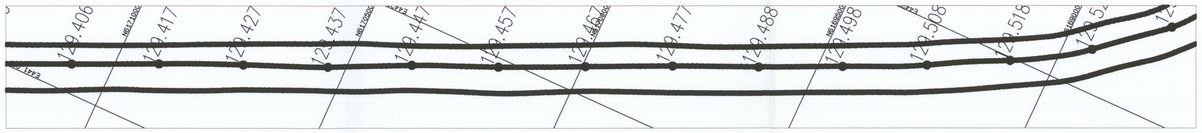
Drawing Number

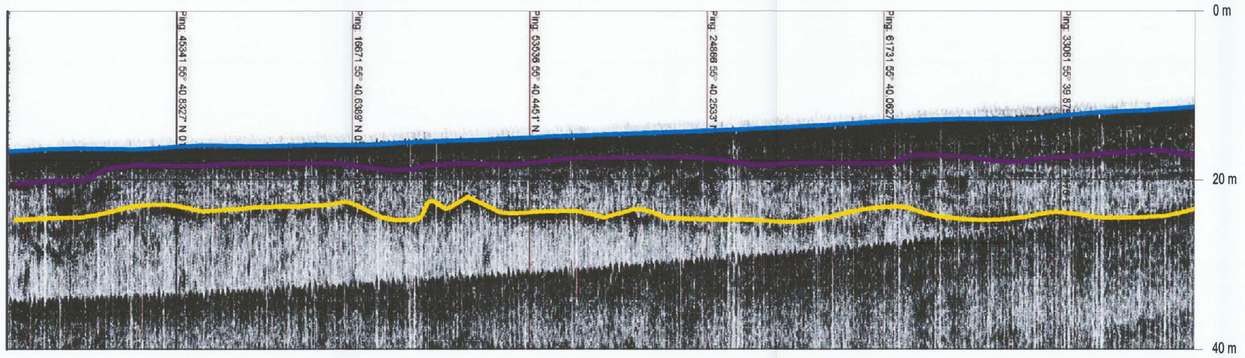
D13



Shoot point location map

Bathymetry

Seabed features



Seismic profile

LEGEND

Shoot point location map

- Shot point
- 126.572
- Seismic line

Bathymetry

- Depth contour
- Depth

Seabed features

- Sand medium
- Sand fine medium
- Sand fine
- Mega Ripples
- Sampling position
- Magnetic anomaly

Top of seismic unit

- Marine deposits Holocene (Unit 2)
- Marine deposits Holocene (Unit 1)
- Freshwater deposits early Holocene
- Meltwater deposits Weichsel
- Eem interglacial
- Glacial deposits Saale or older

Depth below msl: DVR_90 UTM Zone 32 Euref89

0 0.5 km

Employer

ENERGI E2 A/S
A.C. Meyers Vænge 9
DK-2450 Copenhagen SV
DENMARK
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Contract Title

Horns Rev II Offshore Windfarm

Drawing Title

Cable Route Horns Rev II

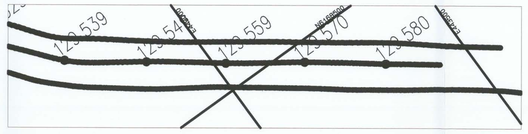
Scale at A0 size: 1:5000 - Seismic profile vertical scale: 1:250

Drawn		Approved SLO	
Stage 1 check	Stage 2 check	Originated	Date

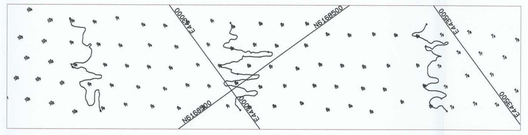
Geological Survey of Denmark and Greenland
Øster Voldgade 10
DK-1350 Copenhagen K
Denmark

Drawing Number

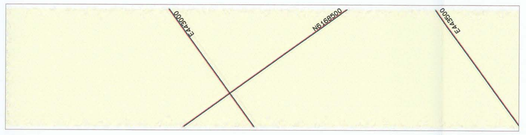
D14



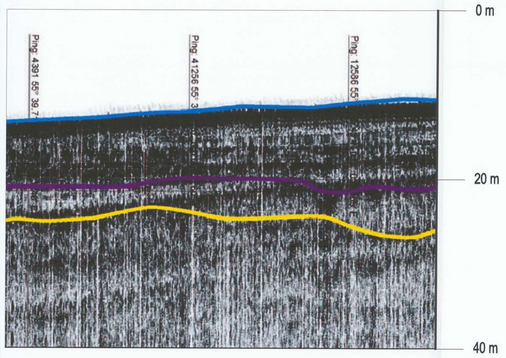
Shoot point location map



Bathymetry



Seabed features



Seismic profile

LEGEND

Shoot point location map

126572 — Shot point

Seismic line

Bathymetry

Depth contour

Depth

Seabed features

Sand medium

Sand fine medium

Sand fine

Mega Ripples

Sampling position

Magnetic anomaly

Top of seismic unit

Marine deposits Holocene (Unit 2)

Marine deposits Holocene (Unit 1)

Freshwater deposits early Holocene

Meltwater deposits Weichsel

Eem interglacial

Glacial deposits Saale or older

Depth below msl: DVR_90

UTM Zone 32 Euref89

0 — 0.5 km

Employer

ENERGI E2 A/S
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DK-2450 Copenhagen SV
DENMARK
on behalf of Energinet Danmark

Contract Title

Horns Rev II Offshore Windfarm

Drawing Title

Cable Route Horns Rev II

Scale at A0 size: 1:5000 - Seismic profile vertical scale: 1:250

Drawn		Approved SLO	
Stage 1 check	Stage 2 check	Originated	Date

Geological Survey of Denmark and Greenland
Øster Voldgade 10
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Denmark

Drawing Number

D15