DANMARKS OG GRØNLANDS GEOLOGISKE UNDERSØGELSE RAPPORT 2000/75

Survey Report

Geochemical seabed sampling
Licence 1/99

Steen Lomholt and Jørn Bo Jensen

GEOLOGICAL SURVEY OF DENMARK AND GREENLAND
MINISTRY OF ENVIRONMENT AND ENERGY

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Contents

1. Introduction

This survey report contains a short description of the field work, concerning acquisition and handling of a shallow seismic survey data and a Vibrocoring programme, carried out by GEUS in the period 15. August to 11. September 2000.

A seismic survey of 182,5 km. has been shoot during the period 18 – 21. of August consisting of a seismic grid of 112 km and 70,5 km of transit lines.

Samples for Head Space Gas analysis and Geochemical analysis have been send to Agip Milano on the 13. of September.

An attempt to collect samples of the uppermost 20 cm. of the Seabed has not been successful. 3 different Seabed samplers have been used with little or no recovery. Max. recovery has been 1 cm.

Instead of these samples, the uppermost 20 cm of each vibrocore has been send to Milano for further stratigraphical analyse. Due to the vibrocore sampling technique these samples may be surface samples but a mixture of the uppermost 0,5m often occurs.

2. Time schedule, seismic and coring

A time schedule for data collection and handling is presented in table 1. The seismic acquisition is listed in table 2 and core number and recovery is listed in table 3. A detailed activity log for the seismic and coring periods is shown in Appendix 1.

Mobilisation and Transfer	
14 – Aug.	Mobilisation Seismic and Vibrocorer
15 – Aug.	Mobilisation Seismic and Coring
16 – Aug.	Mobilisation Test of Vibrocorer
17 – Aug.	Mobilisation and transfer
18 – Aug.	Transfer and test of seismic equipment
Seismic acquisition	
19 – Aug.	Seismic acquisition (failure on Side Scan Sonar)
20 – Aug.	Seismic and waiting on weather
21 – Aug.	Seismic and transfer to Esbjerg
Coring	
30/31 August	Transit and Crane repair
01 – Aug.	Crane repair and Standby
02 – 03 Aug.	Standby
04 – Aug.	Standby (Transit to coring area)
05 – Aug.	Coring area S1, S2 and S3
06-aug	Wait on weather, Transit to Esbjerg
07-aug	Standby
08 – Aug	Standby
09 – Aug	Standby and transit to Area S5
10 – Aug	Coring area S5 and S6
11 – Aug	Coring area S6 and transit to Esbjerg
Demobilisation and Transfer	
12 – Aug	Transfer and demobilisation
13 – Aug	Demobilisation and transport of cores to Milano
14 – Aug	Demobilisation

Table 1 Timetable

Summery of Seismic survey:	Line no.	Km.
	Agip 02	20
	Agip 01	14,5
	Agip 03	15
	Agip 04	10
	Agip 06	28
	Agip 05	24,5
Total Seismic Lines		***112***
	Agip 02_01 (Line A)	6,5
	Agip 01_03 (Line B)	23,5
	Agip 03_04 (Line C)	24,5
	Agip 04_06 (Line D)	13
	Agip 06_05 (Line E)	3
Total Transfer lines		***70,5***
Total Seismic		**182,5**

Table 2 Seismic lines

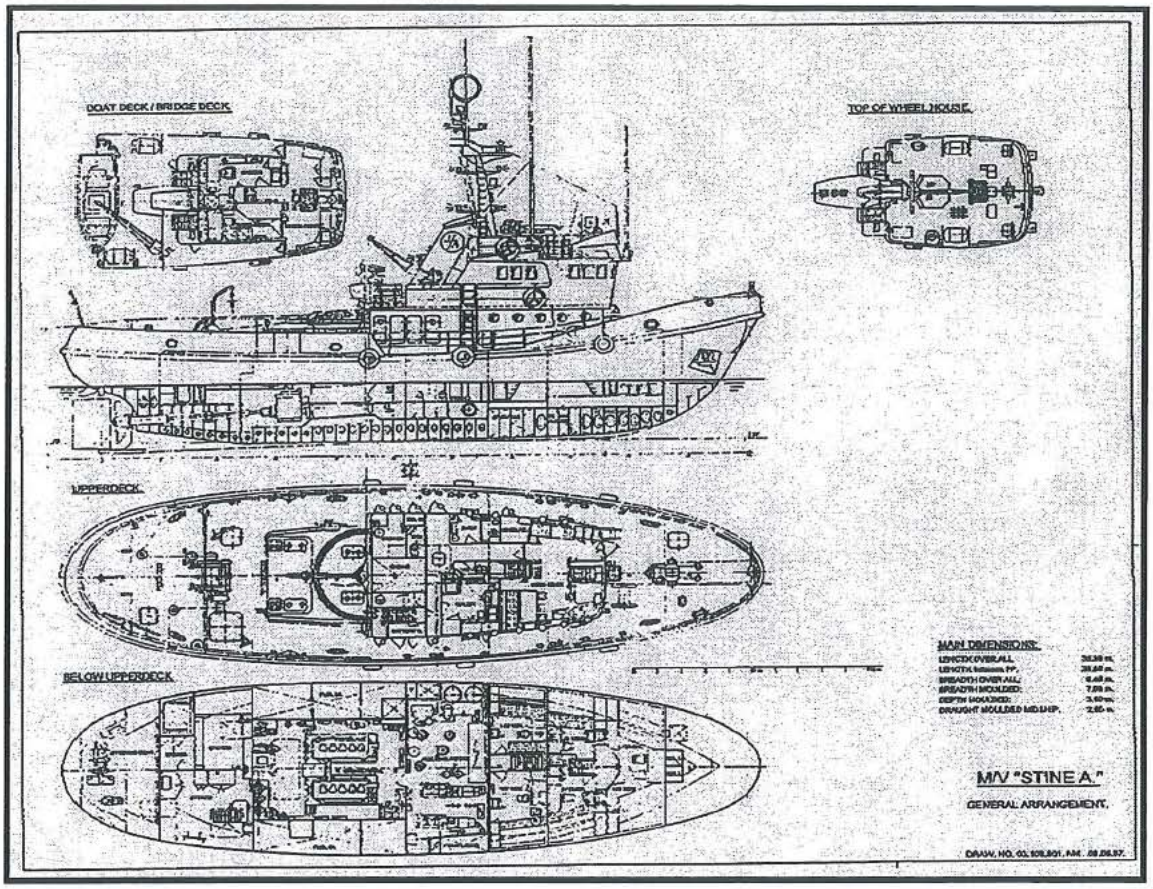
Summery of coring survey :	Core no.	Recovery in m.
	S1-1	5.75
	S1-2	5.35
	S1-3	5.70
	S1-4	5.30
	S1-5	5.88
	S1-6	5.72
	S1-7	5.78
	S2-1	5.60
	S3-3	5.72
	S3-4	5.68
	S3-5	5.35
	S5-1	5.62
	S5-3	5.35
	S5-4	5.72
	S5-5	5.74
	S5-6A	5.69
	S6-1	4.65
	S6-5	5.25
	S6-5A	5.85

Table 3 Cores

3. Technical details of the survey vessel

The survey vessel is a Tug build in 1975. Its overall length is 30 m and economic speed is 12 knot. The ship has been rebuild with an 11-meter long and 6 m wide deck to handle the Vibrocorer.

A sketch of Stine A is shown in Figure 1



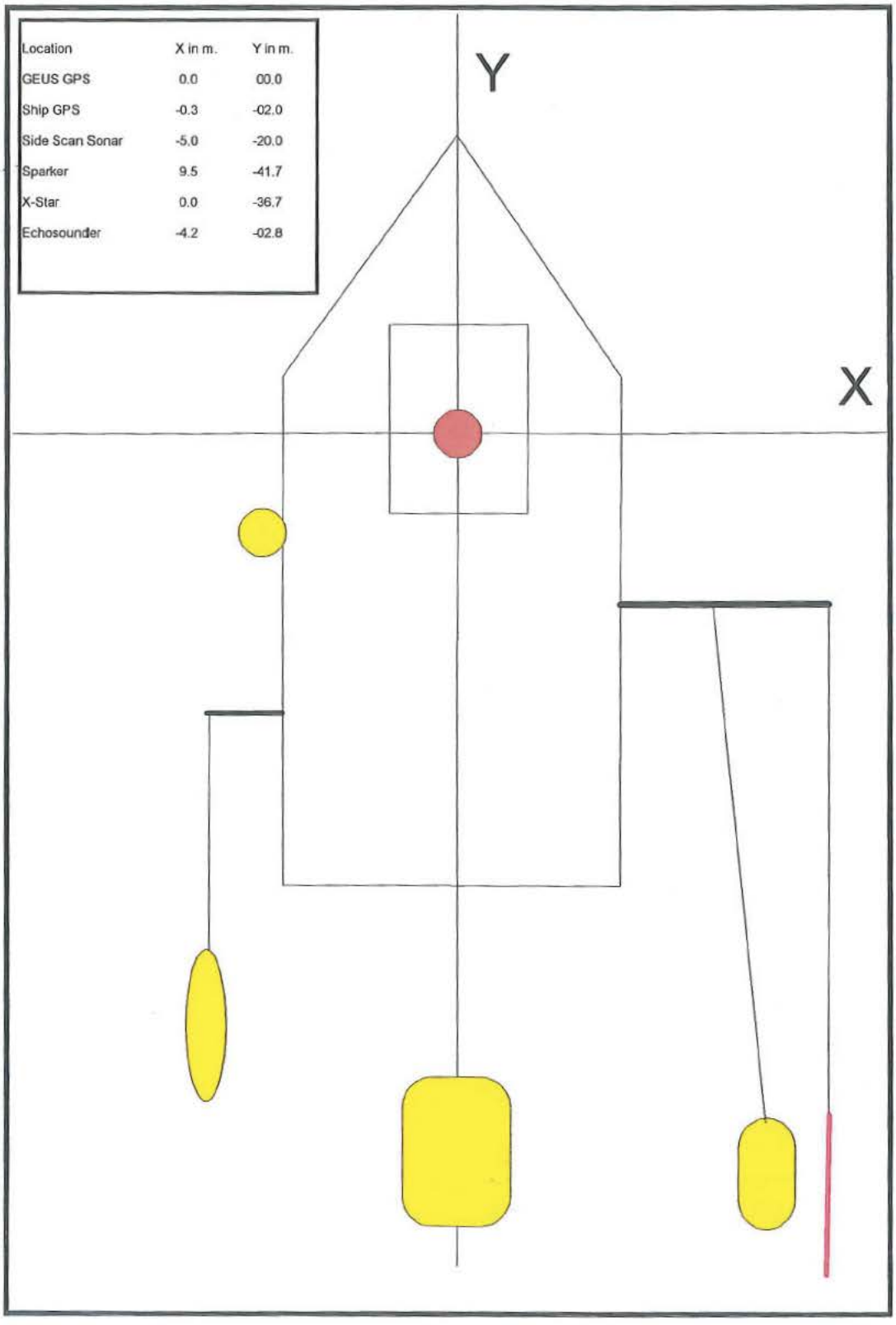
Technical data:
Gross Register Tonnage: 190

Build:	1975
Length overall:	30 meters
Beam:	8.5 meters
Draught:	3.5 meters
Economic speed:	12 knots

GPS PC , plotter

Nautical equipment:
Differential GPS
ARPA Radar.
GMDSS radio
GSM and Satellite telephone
GSM and Satellite fax

4. Survey set-up showing equipment onboard



5. Technical description of navigation set-up

To meet the demands of high navigation accuracy use of DGPS is necessary. GEUS holds a complete survey navigation package consisting of a Sercel Nr103 DGPS and a survey navigation software NaviPac. This will be described in the following text.

Sercel NR103 DGPS satellite positioning receiver.

A Sercel NR103 DGPS Receiver working with a network of permanent differential stations on shore, which covers the Danish seawater, gives us an accuracy of a few meters.

Specifications:

Accuracy:	Autonomous position(Observed horizontal accuracy, with PDOP<6 and S/A not activated. Obtainable accuracy is dependent on the U.S. D.o.D. policy). Differential position <5m/2 DRMS velocity <5cm/s + 1%
Available information:	3D position(WGS 84) and velocity Change of datum's & projection Attitude referred to ellipsoid or MSL
Update rate:	0.6 s
Maximum dynamics:	Acceleration 4g Speed 500 km/h
Output message types:	Position (Lat./Long or XY) Course, ground speed Raw data (pseudo-range and phase) Corrections received from the station GPS message, etc.
Type of corrections:	Pseudo range corrections, received from a RTCM station(1), a Sercel station(2) or a RS 232 C link(3). For (1)&(2), the receiver is fitted with R/F reception, corrections pre-processing (demodulation, parity check, etc.) and will automatically use valid corrections in the positioning solution.
Number of stations:	10 stations stored in permanent memory, 20 stations stored in volatile memory. Automatic selection of best station amongst authorised ones.

Receiver type:	S.P.S.(L1)1575.42MHz 10 parallel channels, C/A code & carrier phase Sensivity: -138dB□2DBm Noise figure: 4 dB Dynamic range: 40 dB Differential carrier frequency between 1.6 and 3.5 MHz

Physical specifications

Receiver	
Overall dimensions	143 x 295 x 235 mm
Weight	5 kg
Power voltage range	10 to 36 VDC floating
Consumption	< 12 watts
GPS Antenna	with integrated preamplifier
Height	136 mm
Diameter	110 mm
Weight	0.4 kg

Diff. Corrections HF Antenna	
with integrated preamplifier	
Whirp antenna housed in a radome	
Height	510 mm
Diameter	50 mm
Weight	0.68 kg

NaviPac On-line Navigation and Data Acquisition software

System Environment

The system is based on the following environment
Hardware Platform

- Pentium PC (Windows NT)
- TCP/IP Networking

Graphical Environment

- Microsoft Windows NT.

All programming is made in C/C++ and the GUI is based on recommendations specified in the Style Guides.
Furthermore, look-and-feel has been implemented following the similar principles as applied in other Eiva software products, resulting in common user interface in all EIVA systems.

System Description

The NaviPac on-line navigation and data acquisition software enables escalation of one or more positions from a variety of sensors.
The system features among other things:

- Easy-to-use windowing techniques allowing multiple displays
- Easy-to-use MMI through the use of mouse or trackball
- Distributed implementation allowing multiple access and presentation using network, allowing combinations of PCs and workstations
- Flexible interface towards NaviBat and NaviLine products
- Integrated control and monitoring of NMEA GPS
- Standard and user defined logging format
- Up to five navigation priority groups simultaneously
- Advanced QC package
- User configurable interface definition
- Client/server based set-up allowing presentation on more PC's (based on TCP/IP network)
- Calculation of tide based on GPS RTK and heave
- Advanced graphical helmsman's display with charts and line planning module.

The system encompasses a number of special features such as:

- Choice of many projections
- Flexible choice of navigation instruments
- Precise time tagging of all sensor data
- Kalman filter for position prediction
- Correction of antenna swing
- On-line transformation of WGS84 co-ordinates
- Advanced simulator for operator training.

The data interfacing in NaviPac is done in separate real-time processes (threads) and consequently not disturbed by user-activated functions.

Geodetic System

The NaviPac system offers an extensive number of projections:

- Transverse Mercator
- U.T.M.
- Mercator
- Polar Stereographic
- Equatorial Stereographic
- Oblique Stereographic
- Lamberts Conical
- Etc.

The major spheroids available are:

- International 1924
- Bessel 1841
- ED 50
- WGS 84

- EUREF 89
- Etc.

Data Handling

Before using a measurement in the position calculation, the following actions are taken:

- For each navigation cycle a line scale factor will be computed for each LOP using Bessel's method
- For each navigation cycle the convergence will be calculated
- Range will be multiplied with the appropriate line scale factor
- Conversion of Lat./Long. data from WGS 84 to the ellipsoid in use
- Bearing will be compensated for convergence if it is a true bearing
- Because the Lops are measured at different instants in time, the Lops are de-skewed to the same instant in time.

When a data set is completed, the measurements are checked for blunders by comparison of observed values and predicted values (average square error). The measurement is also corrected for layback, as ranges of direction are usually not measured to the ship's reference point for which primary co-ordinates are required, but to various antenna offsets on the vessel. Thus the relative position of the antenna to the ship's reference point and the roll, pitch and heading of the vessel must be taken into account. In NaviPac a rigorous treatment of this layback is performed and corrections to measured values are avoided.

Automatic Computations

Depending on the processor and number of Lops, the system can achieve a navigation cycle time of 0.1 to 1.0 seconds.

As the navigation sensors are sending data asynchronously, the NaviPac program will de-skew the data forward in time so all sensor can be used and compared at the same instant in time.

If motion sensor is available, the navigation data will be corrected for antenna swing. Again, because the measurements are done asynchronously it is important to use the correct roll and pitch with respect to age. The NaviPac system will collect and time tag all roll and pitch data available so the correct inclination value can be used for the correction.
If more than one navigation sensor is available, the NaviPac software can integrate many systems into one position or calculate many positions for comparison between systems.

When many systems are integrated into one position, the influence of each system can be controlled by the operator by inputting the weight of each LOP. Weight settings of each LOP can be stored on files for use next time the system is switched on.

Data Bases

When configuring the system, all parameters are stored on files. The files will automatically be read, the next time the system is started. The following parameters are stored on files:

The following parameters are stored in files:

- Station co-ordinates with antenna offsets and corrections (delay, calibration, etc.)
- Relative positions of echo sounders, transducers, etc.
- Geodetic parameters
- Vessel figures
- Interface definitions
- Run-lines/way-points
- Contour curves and coastlines

Calibration Features

Range calibration:

Calibration of Range/Range instruments using a laser range meter. Standard deviation and average values will be calculated and printed.

Position calibration:

This requires that the vessel is stationary. The operator must input the reference position. Standard deviation and average position is calculated.

USBL calibration:

The connected USBL System (Track point II, HPR or similar) can be calibrated using built-in Box-In and Spin routines.

Background Charts

ECDIS:

The NaviPac system features integrated support of ECDIS charts based on C-MAP products.

DXF:

NaviPac supports most CAD entries from e.g. DXF or DWG. Compatibility is secured through EIVA membership of the Open DWG association.

HP-Plot:

Simple vector charts can be defined using ordinary HP plotter commands.

Data Acquisition and Logging

NaviPac includes two high-level modules DataAcq for graphical presentation of data and LogData for control of data logging.

6. Core examination, logging and preservation of samples.

At each core position anchoring was done with three anchors, coring was made in the selected position, the core device was brought onboard the ship and the core processing procedure was carried out.

Core processing procedure

The core was processed from the bottom and Geochemical and archive samples (20cm core sections) were collected from bottom(typically 6m), Mid-bottom (typically 4,5/5m) and middle portion (typically 3/4m) of the stored core liner.

Three 5-cm core sections were sampled from the approximately same core depths in vials for headspace gas analysis provided by Norsk Agip. The vials were poisoned with NaCl (sodium chloride) solution (100 g/l) before sealing. A parallel set of samples were collected and stored at GEUS as a backup sample. The rest of the material was sampled in a ½ litre tin can and stored at GEUS.
All the headspace samples were stored onboard in a transportable freezer at a temperature of –20°C.

The remaining part of each core was cut into 1m pieces and transported to GEUS after the survey was completed.

At GEUS the 1m core pieces were described according to the standards for sedimentological log descriptions defined in the ZEUS/JUPITER geodatabase system and stored in the GEUS core-store as confidential cores.

Vibrocoring equipment

The VKG-6 is a German vibrocorer constructed for coring in water depths up to 100m.
The core length is maximum 6m and the core diameter is 100mm with optional core storage in plastic liners or a plastic hose.

Technical specifications for VKG-6:

Height of equipment	7430mm
Foot diameter	4600mm
Total weight	1000kg
Core inner diameter	100mm
Core max. length	6000mm

Vibration power	30kN
Frequency of vibration	28Hz

Core transportation

At return to harbour at the end of the cruise the core samples were moved to a truck and transported to:

ENI-Division AGIP-GEOC Laboratories
Via Maritano 26
20097 San Donato Milanese (MI)
Italy

During the transport the samples were kept at a temperature of –20° C.

7. Description of Seismic equipment

The seismic survey set-up consisted of Sparker, X-Star, Side Scan Sonar and an echo-sounder but due to software breakdown the Side Scan Sonar did not come in function. A shot point location Map of the seismic survey is shown in Appendix 3, and location of the different instruments is shown in appendix 2.
GEUS holds all these types of seismic equipment and in the following description the technical specifications of the seismic equipment and digital seismic Acquisition software will be described.

Sparker

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

GEUS uses a surface towed Geo-Spark - High Resolution Multi-Tip Sparker. It uses a separate source and receiver with an operating speed up to six knots. Depending on conditions, the Sparker gives a penetration to 100m and a resolution of 0.5 - 1m.

The system uses an 8-hydrophone streamer. Which enhances the signal to noise ratio.

For data acquisition TEL Delph Seismic software is used.

Specifications:

The system allows the control of all essential source parameters: electrode spacing, source geometry, towing depth and energy per tip. Geo-Spark™ produces a very short stable pulse signature with a centre frequency ranging from 800 to 1200Hz (depending upon the energy selected)
Standard systems cover the entire 100 to 1000J range through a combination of different electrode types.

Technical Specification.	Length	1050 mm
	Width	1030 mm
	Height	380 mm
	Weight	37 kg
	Material	316 marine grade polished stainless steel.
Power Supply Requirements	Input Voltage	115/230Vac, 50/60Hz
	Output Voltage	3750Vdc (nominal)
	Output Energy	Switch selectable up to 1000J
Towcable	Length	50 m complete with high voltage connectors.

Overall Diameter	22 mm
Cores	3 high voltage, 6 mm
Strength Member	Kevlar
Breaking Load	500 kg

System Performance
General

Resolution:	0.5 - 1m
Penetration:	(Depending on seafloor material)
Shallow water:	to 50 meters
Operating speed:	to 6 knots
Tow Depth:	Surface tow
Source:	Unicom
Frequency Spectrum:	400 Hz to 14 KHz
Input energy:	300 joules
Repetition Rate:	2 pulses per second

Stealtharray Single Channel Hydrophone Array Serial No. 009610

Array:

Type Solid Flotation cable with Trout hydrodynamic housings

Elements Isosens single hydrophones

Hydrophone:

Type Isosens – single (s) piezo polymer type with amplifier; US Patent 5,361,240

Voltage Sensitivity -198db

Bandwith 6Hz – 7.4Hz

Elements 10

Element Spacing 0.5m

Active Length 4.5m

Depth, operation 1-100m

Depth, maximum 1000m

Sensitive Change
versus depth <1 db. over operation depth

Acceleration
Sensitivity -70 db. re: 1v/g

Temperature Range
operating -2 – 60° C
Storage -40 - 60° C

Amplifier Low noise differential Power required; 9 – 12vdc; 1 milliamp.
Quantity; one per

Housing Trout hydrodynamic noise reduction type, maximum outside diameter (1.8"), length 27cm (10.5")

TEI Delph Seismic Acquisition software

TEI Delph Seismic completes the transition between shallow and deep seismic imaging by providing greater understanding of the subsurface and by optimising sediment characterisation. The efficiency of the Windows 95/NT system gives maximum performance in marine geotechnical work and offshore mining investigation. Delph Seismic offers digital acquisition and online processing for up to 24 channels.
Delph Seismic offers unmatched spatial and temporal resolution, giving the user up to 24 channels, each with a sampling interval of up to 0.02 ms and user-defined shot rate. Delph Seismic offers real-time processing and quality control on this PC based menu-driven system. All channels of collected data can be displayed raw or processed in real-time on a high resolution screen.
The asynchronous mode in Delph Seismic allows the acquisition of two independent seismic channels without cross-interference. Delph Seismic allows versatile programming of the trigger timing for each channel and can generate up to two asynchronous triggers at user-definable shot rates based on time or distance. Two channels of data can be acquired and processed asynchronously according to two independent sets of parameters:
Distinct sampling rates (while respecting certain constraints)
Independent synchronisation of two sources (while respecting some operational constraints)

Delph Seismic Features

Key Features	Specifications
Real-time quality control and on-site processing	Optimises the use of survey time
Asynchronous mode	Allows survey optimisation
Interactive Horizon	Makes Delph Seismic ideal for interpretation of digital data

Picking	
User-defined Shot Rate	Can be set based on time or distance
Band pass filter	Allows the attenuation of spectral components between the user-defined upper and lower band limits
Swell filter	Carries out static corrections on each trace to attenuate the effect of the swell. A Seabed detector determines travel time of the first Seabed return echo for each shot
Automatic gain control	AGC allows improved visualisation of seismic signals to compensate for variations in the signal envelope
Special analysis (FFT)	Can be applied to a portion of the trace at the end of the processing sequence
Signature deconvolution	Used to improve the quality of seismic images by increasing the vertical resolution and stabilising the signature from one shot to another
Predictive deconvolution	Allows Seabed multiple echoes to be attenuated
Time varying filter (TVF)	Allows a band pass filter with characteristics varying over time to be applied to the digitised signal between the signal from the Seabed and the end of the recording time
Common depth point	Common depth point (CDP) processing is available when at least 6 channels are used, improving signal to noise ratio

Software

Key Features	Specifications
Input Channels	Offset correction system linked to the amplifier 70 dB programmable amplifier (1 mV increment) 16-bit delta-sigma analogue/digital converter
System Performance	Sampling frequency - 250 Hz to 48 KHz Recording length - Up to 15s (15,000 samples) Shot control Interface - TTL level (external or internal) Navigation Interface - RS232 serial port
Sensor Interface	Maximum input level - 5 V eff. Minimum input level - 1 mV eff. (full scale) Input impedance - 1 mOhm. Programmable gain - 0 to 70 dB Noise level at full scale - 3 microvolts (-110dB) Cross-talk - 81 dB at full scale

Delph seismic system

Key Features	Specifications
Host Processor	350 MHz Pentium II, 128 MB RAM; 10 serial ports, 1 parallel port
Graphics Processor	128-bit 16 MB SDRAM
Digital Signal Proces-	TI TMS320C31 (60 MHz); 30 MIPS/60 MFLOPS; 32-bit hardware floating

sor	point DSP

Mass storage

Key Features	Specifications
LS-120 Floppy Drive	Standard 3.5" 1.44 MB/120 MB LS-120 diskette
Hard disk drive	Standard 9 GB or optional 18 GB
Multi-function drive	Optional re-writable magneto-optical drive for data storage on 5.2 GB rewritable disk
Exabyte tape drive	Optional 8 mm SCSI tape drive, storage capacity up to 40 GB per tape

X-Star full spectrum sub-bottom profiler

Features

6 cm or better resolution
Matched filter correlation
Real time sediment classification/navigation maps
20-30 dB improved SNR using swept FM pulse
No spatial side-lobes
Direct path deconvolution improves SNR 40 dB

Frequency Range 400 HZ-8kHz

Pulse Bandwidth 400-2400Hz
400-3500Hz
750-4500Hz
1-6 KHz
2-8 KHz

Vertical Resolution :
80cm 400Hz - 2400kHz
60cm 500Hx - 3500kHz
30cm 1kHz - 6kHz
20cm 2kHz-8kHz

Penetration (typical):

Coarse calcareous sand : 40m
Clay : 300m

Beam Width (depends on center freq.) 10º - 30º

Transmitters : 2
Receive Arrays: 8
Output Power 2KW
Size (cm) 249L x 214W x 91H
Weight (kg) 364
Cable Requirements 3 Shielded twisted pairs (all used)

Notes

300 m. maximum water depth
Requires dual channel X-STAR
topside processor Long cable amplifier

EG&G DF-1000 Digital Side Scan Sonar System

General Specifications

DF-1000 Digital Tow-fish	
Frequencies	Standard Resolution 100kHz ±10kHz High resolution 400kHz ±20kHz (referred to as 500kHz)
Pulse Length	100kHz - 0.1msec, 500kHz - 0.01msec
Peak Output	228dB reference one m Pascal at 1 meter
Horizontal Beam Width	100kHz - 1.2°, 500kHz - 0.5
Vertical Beam Width	50° tilted down 20°
TVG Range	100kHz - 60dB to 300msec 500kHz - 43dB to 120 msec
Processors	8031 controllers in a master/slave configuration
A/D Resolution	12bits/sample
High Speed Digital Up Link	Mbits/sec, 4 channels of side scan data, magnetometer and user channels
Sampling Rate	24kHz/channel
Heading	Built-in flux gate compass to 0.5° accuracy
User Ports	Serial - RS-232C, 9600 Baud (1)Parallel - 8 bit centronics Analogue - 25kHz
Optional Attachments	Magnetometer (interfaces to Geometrics 876), Sub-Bottom Profiler, Acoustic Responder, Custom Sensors
Operating Voltage	40 to 60 VDC
Operating Depth	1000 meters (3300ft.)
Tow Speed	knots maximum (for fully corrected data)
Operating Temperature	0°C to 45°C (32°F to 113°F)
Storage Temperature	-30°C to 60°C (-22°F to 140°F)
Size	11.4cm dia. X 158cm length (4.5" dia. X 5.2ft.)

Weight	30kgs. (67lbs)
Digital Control Unit	
Main Processor	Intel 8031
Operator Controls	Select 100/500kHz Select Port/Starboard Select Data Fusion Data Fusion Start Balance Port/Starboard Gain 100/500kHz for Equalisation Responder period Select range
LED Display	Towfish Heading Towfish Voltage Range Model 260 Recorder Status Magnetic Data Error Messages
Optional Interfaces	Magnetometer Processor, Acoustic Navigation
Data Outputs	Analogue DSP compatible serial DMA compatible parallel
Humidity	0-95% non-condensing
Model 260 Interface	Includes: I/O Board, Cables, EPROM's
Tow Cables	3000 meters (9900ft.) Rochester (A301241) 1000 meters (3300ft.) Rochester (A220499) 50m to 200m (150ft. to 650ft.) Kevlar coax
General Specifications	300dB maximum attenuation at 1 MHz 50ohms characteristic (nominal) impedance Total resistance 20 ohms
Size of Table Top	498mm W x 159mm H x 457mm D (19.6" W x 6.3" H 18" D)
Size of Rack Mount	483mm W x 135mm H x 457mm D (19" W x 5.3" H x 17.3" D)
Weight of Table Top	28kgs (60lbs)
Weight of Rack Mount	14kgs (30lbs)

TEI Isis Sonar

TEI Isis Sonar digitises, stores and processes side scan sonar signals and combines the sonar imagery with navigation inputs to geocode the data in real-time. Isis Sonar interfaces with most conventional analogue and digital side scan sonar's. It runs under the Microsoft Windows operating system. Isis Sonar is flexible and user friendly. TEI training maximises full use of system features.

Applications for Isis Sonar include:

Seafloor Search and Survey Pipeline Inspection
Q-route Surveillance
Seafloor Classification
Small Object Detection/Site Clearance
Cable/Pipeline Route Survey

Software

Key Features	Specifications
Operating System	MS Windows Microsoft Windows 95 or Windows NT
Image/signal processing	Slant-range correction and water column removal Selectable downsampling methods to fit application Automatic, manual or telemetry-based bottom tracking Fixed/variable range scale settings Contrast stretching Beam and Grazing Angle Compensation Spatial filters (pre-defined and User-configurable)
Data Log-ging	Q-MIPS, XTF, SEG-Y data formats Any number of samples per channel per ping (or shot) saved Data saved at either 8 or 16 bits/sample
Geocoding	Each pixel in the scan is given a geographic position according to the position of the scan's central pixel, the vessel (transducer) heading and the across-track resolution
Display Control	Multiple pre-defined colour look-up tables (LUT) Interactive Target/object detection Virtual resolution up to 2016 x 2016 pixels Waterfall, wiggle, oscilloscope, graphical and alphanumeric displays based on data type Individual windows for display parameters User-definable scale lines Image annotation
Image analysis	Measurement of object width, length, height and altitude Object geographical position from cursor location On-screen digitisation and interpretation

Interface

Key Features	Specifications
Digital Inputs	10M Baud synchronous serial port 2 x 230K Baud RS-232 serial ports 2 x 8-bit parallel & 1 DSP-link port
Analogue Inputs	Up to 8 channels per DSP board Bipolar input signal, +/- 5V range Input impedance: 1 mOhm
Dynamic Range	96 dB (16 bit) Sampling rate 400 KHz aggregate

PC/AT serial ports	Up to 16
Printers	All standard Windows printers plus Alden, EPC, TDU and Waverly models

ISIS sonar system

Key Features	Specifications
Host Processor	350 MHz Pentium II, 128 MB RAM; 2 serial ports, 1 parallel port
Graphics Processor	128-bit 16 MB SDRAM
Digital Signal Processor	TI TMS320C31 (40 MHz); 20 MIPS/40 MFLOPS; 32-bit hardware floating point DSP
Standard Configuration	Host CPU, Graphics and Digital Signal Processors, SCSI Controller, SIU and A/D board
Display Resolution	1280 x 1024
Display Size	Standard 17" or optional 20"

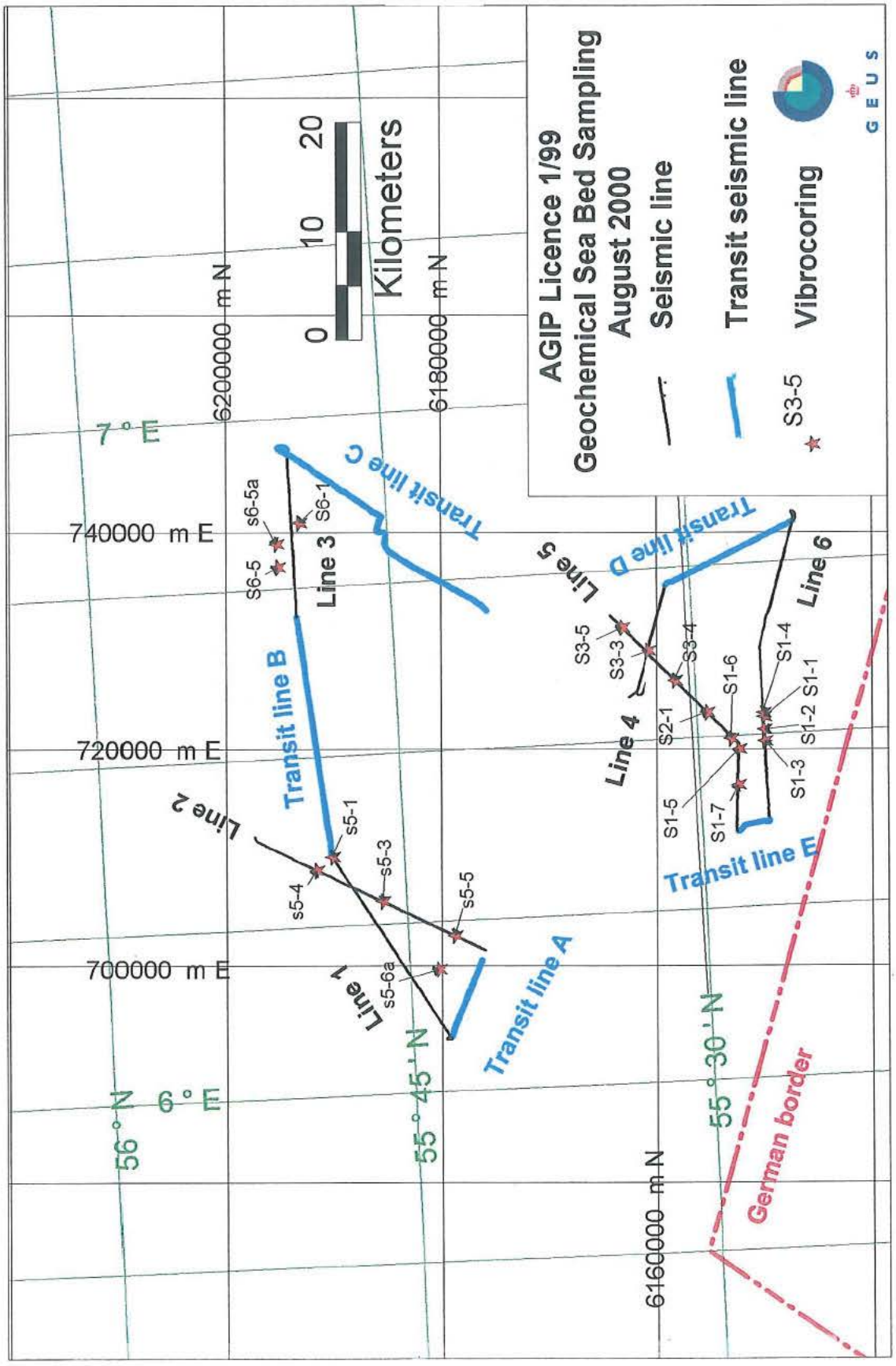
Mass storage

Key Features	Specifications
LS-120 Floppy Drive	Standard 3.5" 1.44 MB diskette/LS-120 120 MB diskette
Hard disk drive	Standard 9 GB or optional 18 GB
Multi-function drive	Optional rewritable Magneto-optical drive for data storage on 5.2 GB rewritable disk
Exabyte tape drive	Optional 8 mm SCSI tape drive, storage capacity up to 40 GB per tape

Echosounder:

Simrad EA300P echosounder
Frequency 200kHz
Depth interval: 0,6 m to 200m.
Print: HP PaintJet model 3630A.
Storage: Digital storage in 3 times pr. second in the survey programme; NaviPac.

8. Overview Map of seismic grid and core positions



9. List of core positions

AGIP Licence 1/99 - Geochemical Sea Bed Sampling
CORE POSITIONS

	Well name	Latitude geographical ED50	Longitude geographical ED50
1	S1-1	55 26,7306'	06 31,5722'
2	S1-2	55 26,7339'	06 30,4682
3	S1-3	55 26,7317'	06 29,4773'
4	S1-4	55 26,7257'	06 31,9802'
5	S1-5	55 28,0707'	06 28,9303'
6	S1-6	55 28,4126'	06 29,8733'
7	S1-7	55 28,1797'	06 25,7394'
8	S2-1	55 29,5537'	06 32,2531'
9	S3-3	55 32,3415'	06 37,9393'
10	S3-4	55 31,0814'	06 35,1983'
11	S3-5	55 33,6153'	06 40,0943'
12	S5-1	55 48,6920'	06 21,2343'
13	S5-3	55 46,2952'	06 17,0603'
14	S5-4	55 49,5081'	06 20,0824'
15	S5-5	55 42,1544'	06 13,7463'
16	S5-6A	55 43,6437'	06 10,8794'
17	S6-1	55 49,4392'	06 50,7461'
18	S6-5	55 50,4525'	06 46,9228'
19	S6-5A	55 50,4927'	06 48,9397'

10. List of Crew and GEUS personnel

Crew and GEUS-personal were at a given time in total 11 persons. During the survey the following persons participated.

Shipping Company: Jens Alfatsen Rederiet

Captain :

Anders Jørgensen
Ove poulsen
Henning Iversen

Mate :

Michael Mikkelsen
Henning Iversen
Jesper Hansen

Crew :

John Petersen
Rolf Jakobsen
Frants Mortensen
Bettina Westergård
Kim Alfatsen
Tom Larsen
Søren Pedersen
Preben Svendsen

GEUS

Geologist :

Steen Lomholt
Jørn Bo Jensen

Technician:

Peter Trøst Jørgensen
John Boserup
Sune Westh
Steffen Andersen

JBJ Dykker og Transport Service

Drilling Technician:

Johnny B Jørgensen
Dan Ottesen
Jan Frederiksen
Flemming Holst

11. Appendix 1 Activity Log

AGIP Licence 1/99 - Geochemical Sea Bed Sampling
Activity log

Date	Time	Activity
18/8	22.00	Transit to survey area
19/8	06.00	Start on line Agip 02
19/8	06.15	Stop on line Agip 02 Side scan sonar out of function
19/8	08.00	Malfunction of echosounder
19/8	16.00	Restart on line Agip 02
19/8	19.50	End of line Agip 02
19/8	20.20	Start on line 02_01 (A)
19/8	21.30	End of line 02_01 (A)
19/8	21.40	Start on line 01
19/8	21.47	End of line 01
19/8	21.48	Start on line 01_03 (B)
20/8	00.13	End of line 01_03 (B)
20/8	00.14	Start on line 03
20/8	02.00	End of line 03
20/8	02.03	Start on line 03_04 (C)
20/8	06.20	Stop surveying line 03_04 (C) Weather: Wind: 15 m/s Wave height: 4m.
20/8	14.03	Break rope to x-star. Secure x-star in sea.
20/8	20.00	Repair equipment, x- star out of sea.
20/8	20.40	X-Star in sea again.
20/8	21.00	Start on line 04
20/8	21.36	Restart on line 04
20/8	23.08	End of line 04
20/8	23.09	Star on line 04_06 (D)
21/8	00.34	End of line 04_06 (D)
21/8	00.35	Start on line 06
21/8	02.33	End of line 06
21/8	02.34	Start on line 06a
21/8	04.35	End of line 06a
21/8	04.40	Start on line 06_05 (E)
21/8	05.00	End of line 06_05 (E)
21/8	05.03	Start on line 05
21/8	06.02	End of line 05
21/8	06.03	Start on line 05a

21/8	08.30	End of line 05a
21/8	08.40	Secure seismic instruments
21/8	10.00	Transit to Esbjerg
21/8	18.00	Hand over ship for other activities to GEUS
30/8	20.00	Took over ship from GEUS
30/8	21.00	Transit to area S1
31/8	06.30	Arrival area S1
31/8	07.00	Arrival position S 1-4
31/8	07.45	Start coring S 1-4
31/8	07.50	Crane failure
31/8	07.55	Repair on crane, no function. Vibrocorer still at Seabed
31/8	11.45	Vibrocorer recovered with material in core-liner (aborted coring programme 9.00)
31/8	12.00	Return to harbour to repair crane.
31/8	21.00	Arrival Esbjerg harbour
01/9		Repair Crane
02/9	08.00	Ship ready to resume core operation
02/9	08.00	Core operation aborted due to weather conditions. Wait on weather. Standby
03/9	00.00	Wait on weather. Standby
03/9	21.00	Transit to area S1
04/9	05.00	Arrival area S1
04/9	06.45	Arrival position S 1-4
04/9	07.15	Start coring S 1-4, Technical problems with equipment
05/9	02.55	Restart core no. S 1-4
05/9	03.05	Recover core no. S 1-4
05/9	05.30	Recover core no. S 1-1
05/9	07.45	Recover core no. S 1-2
05/9	10.00	Recover core no. S 1-3
05/9	11.40	Recover core no. S 1-7
05/9	13.30	Recover core no. S 1-5
05/9	14.50	Recover core no. S 1-6
05/9	16.45	Recover core no. S 2-1
05/9	18.35	Recover core no. S 3-4
05/9	20.05	Recover core no. S 3-3
05/9	22.25	Recover core no. S 3-5
05/9	24.00	Wait on weather
06/9	10.00	Transit to Esbjerg harbour
06/9	17.00	Arrival Esbjerg harbour
06/9	17.00	Standby
07/9	00.00	Ship transfer to local job near Esbjerg, while waiting on weather. (Coring aborted at 00.00)
09/9	00.00	Ship back from local job. Standby

09/9	21.00	Departure Esbjerg harbour.
10/9	07.00	Arrival area S 5
10/9	08.45	Arrival core position S 5-6a
10/9	09.20	Recover core no. S 5-6a
10/9	11.15	Recover core no. S 5-5
10/9	13.20	Recover core no. S 5-3
10/9	15.30	Recover core no. S 5-4
10/9	16.50	Recover core no. S 5-1
10/9	19.40	Recover core no. S 6-5
10/9	20.45	Recover core no. S 6-5a
10/9	22.10	Recover core no. S 6-1
10/9	23.00	Transit to Esbjerg Harbour
11/9	09.00	Arrival Esbjerg Harbour. Unloading core material
11/9	10.00	Ship hand over for transfer to Juelsminde for demobilisation

12. Appendix 2 List of Head Space Gas Samples

AGIP Licence 1/99 - Geochemical Sea Bed Sampling
Mini Head space samples

	Well name	Depths m
1	S1- 1 GAS I	5,70 - 5,75
2	S1- 1 GAS II	4,70 - 4,75
3	S1- 1 GAS III	3,70 - 3,75
4	S1- 2 GAS I	5,30 - 5,35
5	S1- 2 GAS II	4,30 - 4,35
6	S1- 2 GAS III	3,30 - 3,35
7	S1- 3 GAS I	5,65 - 5,70
8	S1- 3 GAS II	4.65 - 4,70
9	S1- 3 GAS III	3,65 - 3,70
10	S1- 4 GAS I	5,25 - 5,30
11	S1- 4 GAS II	4,25 - 4,30
12	S1 - 4 GAS III	3,25 - 3,30
13	S1 - 5 GAS I	5,83 - 5,88
14	S1 - 5 GAS II	4,83 - 4,88
15	S1 - 5 GAS III	3,83 - 3,88
16	S1 - 6 GAS I	5,67 - 5,72
17	S1 - 6 GAS II	4,67 - 4,72
18	S1 - 6 GAS III	3,67 - 3,72
19	S1 - 7 GAS I	5,73 - 5,78
20	S1 - 7 GAS II	4,73 - 4,78
21	S1 - 7 GAS III	3,73 - 3,78
22	S2 - 1 GAS I	5,55 - 5,60
23	S2 - 1 GAS II	4,55 - 4,60
24	S2 - 1 GAS III	3,55 - 3,60
25	S3 - 3 GAS I	5,67 - 5,72
26	S3 - 3 GAS II	4,67 - 4,72
27	S3 - 3 GAS III	3,67 - 3,72
28	S3 - 4 GAS I	5,63 - 5,68
29	S3 - 4 GAS II	4,63 - 4,68
30	S3 - 4 GAS III	3,63 - 3,68
31	S3 - 5 GAS I	5,30 - 5,35
32	S3 - 5 GAS II	4,30 - 4,35
33	S3 - 5 GAS III	3,30 - 3,35
34	S5 - 1 GAS I	5,57 - 5,62
35	S5 - 1 GAS II	4,57 - 4,62
36	S5 - 1 GAS III	3,57 - 3,62

37	S5 - 3 GAS I	5,30 - 5,35
38	S5 - 3 GAS II	4,30 - 4,35
39	S5 - 3 GAS III	3,30 - 3,35
40	S5 - 4 GAS I	5,67 - 5,72
41	S5 - 4 GAS II	4,67 - 4,72
42	S5 - 4 GAS III	3,67 - 3,72
43	S5 - 5 GAS I	5,69 - 5,74
44	S5 - 5 GAS II	4,69 - 4,74
45	S5 - 5 GAS III	3,69 - 3,74
46	S5 - 6A GAS I	5,64 - 5,69
47	S5 - 6A GAS II	4,64 - 4,69
48	S5 - 6A GAS III	3,64 - 3,69
49	S6 - 1 GAS I	4,60 - 4,65
50	S6 - 1 GAS II	3,60 - 3,65
51	S6 - 1 GAS III	2,60 - 2,65
52	S6 - 5 GAS I	5,20 - 5,25
53	S6 - 5 GAS II	4,20 - 4,25
54	S6 - 5 GAS III	3,20 - 3,25
55	S6 - 5A GAS I	5,80 - 5,85
56	S6 - 5A GAS II	4,80 - 4,85
57	S6 - 5A GAS III	3,80 - 3,85

13. Appendix 3 List of Geochemical samples

AGIP Licence 1/99 - Geochemical Sea Bed Sampling
Geochemical and Archive samples

	Well name	Depths below bottom in meters
1	S1 - 1 KEM I	5,50 - 5,70
2	S1 - 1 KEM II	4,50 - 4,70
3	S1 - 1 KEM III	3,50 - 3,70
4	S1 - 2 KEM I	5,10 - 5,30
5	S1 - 2 KEM II	4,10 - 4,30
6	S1 - 2 KEM III	3,10 - 3,30
7	S1 - 3 KEM I	5,45 - 5,65
8	S1 - 3 KEM II	4,45 - 4,65
9	S1 - 3 KEM III	3,45 - 3,65
10	S1 - 4 KEM I	5,05 - 5,25
11	S1 - 4 KEM II	4,05 - 4,25
12	S1 - 4 KEM III	3,05 - 3,25
13	S1 - 5 KEM I	5,63 - 5,83
14	S1 - 5 KEM II	4,63 - 4,83
15	S1 - 5 KEM III	3,63 - 3,83
16	S1 - 6 KEM I	5,47 - 5,67
17	S1 - 6 KEM II	4,47 - 4,67
18	S1 - 6 KEM III	3,47 - 3,67
19	S1 - 7 KEM I	5,53 - 5,73
20	S1 - 7 KEM II	4,53 - 4,73
21	S1 - 7 KEM III	3,53 - 3,73
22	S2 - 1 KEM I	5,35 - 5,55
23	S2 - 1 KEM II	4,35 - 4,55
24	S2 - 1 KEM III	3,35 - 3,55
25	S3 - 3 KEM I	5,47 - 5,67
26	S3 - 3 KEM II	4,47 - 4,67
27	S3 - 3 KEM III	3,47 - 3,67
28	S3 - 4 KEM I	5,43 - 5,63
29	S3 - 4 KEM II	4,43 - 4,63
30	S3 - 4 KEM III	3,43 - 3,63
31	S3 - 5 KEM I	5,10 - 5,30
32	S3 - 5 KEM II	4,10 - 4,30
33	S3 - 5 KEM III	3,10 - 3,30
34	S5 - 1 KEM I	5,37 - 5,57
35	S5 - 1 KEM II	4,37 - 4,57
36	S5 - 1 KEM III	3,37 - 3,57

37	S5 - 3 KEM I	5,10 - 5,30
38	S5 - 3 KEM II	4,10 - 4,30
39	S5 - 3 KEM III	3,10 - 3,30
40	S5 - 4 KEM I	5,47 - 5,67
41	S5 - 4 KEM II	4,47 - 4,67
42	S5 - 4 KEM III	3,47 - 3,67
43	S5 - 5 KEM I	5,49 - 5,69
44	S5 - 5 KEM II	4,49 - 4,69
45	S5 - 5 KEM III	3,49 - 3,69
46	S5 - 6A KEM I	5,44 - 5,64
47	S5 - 6A KEM II	4,44 - 4,64
48	S5 - 6A KEM III	3,44 - 3,64
49	S6 - 1 KEM I	4,40 - 4,60
50	S6 - 1 KEM II	3,40 - 3,60
51	S6 - 1 KEM III	2,40 - 2,60
52	S6 - 5 KEM I	5,00 - 5,20
53	S6 - 5 KEM II	4,00 - 4,20
54	S6 - 5 KEM III	3,00 - 3,20
55	S6 - 5A KEM I	5,60 - 5,80
56	S6 - 5A KEM II	4,60 - 4,80
57	S6 - 5A KEM III	3,60 - 3,80

14. Appendix 4 List of Stratigraphical Samples

AGIP Licence 1/99 - Geochemical Sea Bed Sampling
Stratigraphical Surface samples

	Well name	Depths below bottom in meters
1	S1-1	0,00 - 0,20
2	S1-2	0,00 - 0,20
3	S1-3	0,00 - 0,20
4	S1-4	0,00 - 0,20
5	S1-5	0,00 - 0,20
6	S1-6	0,00 - 0,20
7	S1-7	0,00 - 0,20
8	S2-1	0,00 - 0,20
9	S3-3	0,00 - 0,20
10	S3-4	0,00 - 0,20
11	S3-5	0,00 - 0,20
12	S5-1	0,00 - 0,20
13	S5-3	0,00 - 0,20
14	S5-4	0,00 - 0,20
15	S5-5	0,00 - 0,20
16	S5-6A	0,00 - 0,20
17	S6-1	0,00 - 0,20
18	S6-5	0,00 - 0,20
19	S6-5A	0,00 - 0,20

15. Appendix 5 Shot point location Map

680000 mE
6° E
700000 mE
720000 mE
740000 mE
7° E
760000 mE
780000 mE
6220000 mN
56° N
6200000 mN
55° 45' N
6180000 mN
55° 30' N
6160000 mN

Line 1
Line 2
Line 3
Line 4
Line 5
Line 6
Transit line A
Transit line B
Transit line C
Transit line D
Transit line E

s5-4
s5-6a
s5-1
s5-3
s5-5
S6-5
s6-5a
S6-1
S3-5
S3-3
S3-4
S2-1
S1-5
S1-7
S1-6
S1-4
S1-3
S1-2
S1-1

0 5 10
Kilometers

Seismic line (with timemarkes)
Transit seismic line (with timemarkes)
Vibrocore position
German border

Geographical ED50

GEUS
Report file no.
Enclosure
17758 (01/01)

GEUS

AGIP Licence 1/99
Geochemical Sea Bed Sampling
August 2000

Appendix 5
Shotpoint location Map