Geologisch-Paläontologisches Institut
und Museum
Christian-Albrechts-Universität
Kiel, Deutschland

Berichte — Reports

Nr. 86

Stattegger, K.; Kuhnt, W.; Wong, H. K.;
Bühring, C.; Haft, C.; Hanebuth, T.; Kawamura, H.; Kienast, M.;
Lorenc, S.; Lotz, B.; Lüdmann, T.; Lurati, M.; Mühlhan, N.;
Paulsen, A.-M.; Paulsen, J.; Pracht, J.; Putar-Roberts, A.; Hung, N. Q;
Richter, A.; Salomon, B.; Schimanski, A.; Steinke, S.; Szarek, R.;
Nhan, N. V.; Weinelt, M.; Winguth, C.:

Cruise Report SONNE 115
SUNDAFLUT

Sequence stratigraphy, late Pleistocene-Holocene sea level fluctuations and high resolution record of the post-Pleistocene transgression on the Sunda Shelf

Sequenzstratigraphie, spätpleistozän-holozäne Meeresspiegelschwankungen und hochauflösende Rekonstruktion der postpleistozänen Transgression am Sunda Schelf

Kota Kinabalu — Singapore
December 13 1996 — January 25 1997

Berichte — Reports, Geol.-Paläont. Inst. Univ. Kiel, Nr. 86,
211 S., 34 Abb., 18 Tab., Kiel, (September) 1997

ISSN 0175-9302

CRUISE REPORT SONNE 115

SUNDAFLUT

SEQUENCE STRATIGRAPHY, LATE PLEISTOCENE-HOLOCENE SEA LEVEL FLUCTUATIONS AND HIGH RESOLUTION RECORD OF THE POST-PLEISTOCENE TRANSGRESSION ON THE SUNDA SHELF

Kota Kinabalu - Singapore
December 13 1996 - January 25 1997

Karl Stattegger, Wolfgang Kuhnt, How Kin Wong
Christian Bühring, Christiane Haft, Till Hanebuth, Hiroshi Kawamura, Markus Kienast, Stanislav Lorenc, Ben Lotz, Thomas Lüdmann, Matthias Lurati, Norbert Mühlhan, Alke-Marit Paulsen, Jan Paulsen, Jens Pracht, Ana Putar-Roberts, Nguyen Quang Hung, Andreas Richter, Brigitte Salomon, Alexander Schimanski, Stephan Steinke, Renata Szarek, Nguyen Van Nhan, Mara Weinelt, Cornelia Winguth

Kiel, September 1997

CONTENTS

1. ABSTRACT

The Sunda Shelf, the largest shelf area on earth (1,8 million km^2), was continental during the late Pleistocene sea level lowstand. It was a large coastal plain with important river systems that formed huge delta complexes along the southwestern margin of the South China Sea. During the postglacial global sea level rise, these delta complexes (Molengraaff Delta and paleo-Mekong Delta) and the entire Sunda shelf area were flooded. The main objective of Sonne cruise 115 is a detailed temporal and spatial reconstruction of this transgression to test sequence stratigraphic models by radiometric dating of the transgressive systems tract and maximum flooding surface from the continental rise to the inner shelf. Paleoceanographic records from continuous cores in the southwestern South China Sea will allow sea level-controlled changes in terrigenous and nutrient fluxes and their effect on the marine ecosystem to be monitored in a comparatively small marginal basin. A detailed reconstruction of the timing and geometry of this last giant marine transgression on a 400 km wide coastal plain may serve as a base for predictions of rate and effects of future sea level rises due to global warming.

Preliminary analyses of seismic data from the Sunda shelf show incised valleys which cut into the shelf during sea-level lowstand and are filled up with facies zonation during the subsequent transgression. Downlap surfaces are interpreted as maximum flooding surfaces. On the upper continental slope stacked slope fans developed during several regressions. The late Pleistocene continental-marine transition extends within a 150 km wide zone of modern water depths between 80 and 110 metres, taking into account the paleomorphology of the Molengraaff-valley system and isostatic subsidence due to strong terrigenous sediment supply.

More than 4000 kilometres of seismic profiles were recorded with the Parasound system, 3007 km with the air-gun-system and 1096 km with the Boomer-system. 76 sediment stations were sampled with 78 giant box cores and 12 multicorer operations for bottom surface sediments. 37 gravity cores, 26 vibrocores and one piston core yielded a total of 410 core-metres for stratigraphic, sedimentological and geochemical investigations. Magnetic susceptibility measurements were taken from all cores, gray-scale measurements from selected cores.

2. PARTICIPANTS AND TASK OF THE WORKING GROUPS

List of participants

Bühring, Christian, Dipl. Geol.	Sedimentology	GPI
Haft, Christine, Cand. Geol.	Seismic stratigraphy	IFBM
Halim Bin Mohd Ashari, Abdul, M. Sc.	Hydrography	ODCHB
Hanebuth, Till, Dipl. Geol.	Sedimentology	GPI
Kawamura, Hiroshi, B. Sc.	Micropaleontology	GPI
Kienast, Markus, Dipl. Geol.	Geochemistry	GPI
Kuhnt, Wolfgang, Prof. Dr.	Co-chief Scientist, Micropaleontology	GPI
Lorenc, Stanislav, Prof. Dr.	Sedimentology	IGPo
Lotz, Ben, Cand. Geol.	Seismic stratigraphy	IFBM
Lüdmann, Thomas, Dr.	Seismic stratigraphy	IFBM
Lurati, Matthias, Cand. Geol.	Seismic stratigraphy	IFBM
Mühlhan, Norbert, TA	Sedimentology	GPI
Pracht, Jens, Cand. Geol.	Geochemistry	GPI
Putar-Roberts, Ana, M. Sc.	Micropaleontology	CMG
Quang Hung, Nguyen, M. Sc.	Sedimentology	VNC
Richter, Andreas, Cand. Geol.	Sedimentology	GPI
Salomon, Brigitte, TA	Micropaleontology	GPI
Schimanski, Alexander, Cand. Geol.	Micropaleontology	GPI
Stattegger, Karl, Prof. Dr.	Chief-Scientist, Sedimentology	GPI
Szarek, Renata, M. Sc.	Micropaleontology	GPI
Van Nhan, Nguyen, Dr.	Sedimentology	VNC
Weinelt, Mara, Dr.	Micropaleontology	GPI
Winguth, Cornelia, Dipl. Geol.	Seismic stratigraphy	IFBM
Wong, How Kin, Prof. Dr.	Senior Scientist, Seismic stratigraphy	IFBM

Participating institutions

GPI	Geologisch-Paläontologisches Institut, Universität Kiel, Olshausenstraße 40, D-24118 Kiel, Germany.
IFBM	Institut für Biogeochemie und Meereschemie, Universität Hamburg, Bundesstraße 55, D-20146 Hamburg, Germany .
ODCHB	Oceanographic Data Centre Hydrographic Branch, Navy Headquarters, Ministry of Defence, Jalan Padang Tembak, 50634 Kuala Lumpur, Malaysia.
IGPo	Institute of Geology, Adam Mickiewicz Univ., Makow Polnych 16, PL-61606 Poznan, Poland.
CMG	Centre for Marine Geology, Dalhousie University , Halifax, Nova Scotia, Canada B3H 3J5.
VNC	Vietnam National Centre for Natural Science and Technology, Nghiado, Tuliem, Hanoi, Vietnam.

Crew SO-115

Kapitän	Andresen, Hartmut
1. Offizier	Oberländer, Michael
2. Offizier	Ladewich, Norbert
Funkoffizier	Köthe, Wolfgang
Schiffsarzt	Möller-Hartmann, Henning
Ltd. Ingenieur	Martin, Andreas
2. Ingenieur	Sandersfeld, Uwe
2. Ingenieur	Klinder, Klaus-Dieter
Ltd. Elektroniker	Duthel, Rainer
Elektroniker	Vöhrs, Helmut
Elektriker	Konrath, Rolf
System-Manager	Krause, Stefan
System-Manager	Angermann, Rudolf
Motorenwärter	Koch, Michael
Motorenwärter	Sosnowski, Werner
Motorenwärter	Szych, Uwe
Deckschlosser	Rosemeyer, Rainer
Koch	Grün, Franz
Kochsmaat	Götze, Rainer
1. Steward	Both, Michael
2. Steward	Eller, Peter
2. Steward	Hillmann, Klaus-Peter
Bootsmann	Hartwig, Karl-Heinz
Matrose	Vor, Hans-Jürgen
Matrose	Reichmacher, Wolfgang
Matrose	Klävemann, Kersten
Matrose	Hadamek, Peter
Matrose	Tamm, Stefan
Matrose	Lude, Günther

Tasks of participating working groups (shipboard)

SEDIMENTOLOGY, GEOCHEMISTRY AND CORING OPERATIONS, KIEL UNIVERSITY

- operating box-corer, multicorer, 12 m gravity corer and 26 m piston corer
- continuous magnetic susceptibility measurements
- gray scale and color digitizing of split cores and development of gray scale curves.
- initial core descriptions and sampling of box cores and multicorer cores for organic geochemistry. These analyses will provide the data base for calculations of terrigenous and marine organic matter flux rates.

SEISMIC STRATIGRAPHY, HAMBURG UNIVERSITY

For the seismic study, the shipboard Parasound-system, a high resolution air-gun-system with 1 or 2 GI-guns and a boomer system of the Hamburg University were used. Analog recording was carried out with a EPC-recorder and digital recording using a DAT-recorder and a computerized multichannel data acquisition system. Data processing will be carried out after the cruise in Hamburg University.

Carbonate Sedimentology, Institute of Geology, Adam Mickiewicz Univ. Poznan, Poland

Sedimentologic descriptions of cores and transmitted light microscopy of components.

Micropaleontology, Kiel University

Benthic foraminifera are used as proxy indicators of terrigenous supply and possible related changes in marine productivity. Reconstruction of the distribution of benthic foraminiferal and ostracode assemblages along the shelf transects.

Palynology (pollen and dinoflagellates) studies, in co-operation with the palynology group at GEOMAR, will aim to better understand climate changes in the hinterland.

Marine Geology (Vietnam National Centre for Natural Science and Technology, Hanoi, Vietnam)

Distribution patterns of sediments on the Vietnam Shelf and Sunda Shelf. Sediment description of box cores and comparison to exisiting sediment distribution maps.

Vibrocoring and Micropaleontology, Dalhousie University, Halifax (Canada)

The working group of David Scott (Dalhousie University, Halifax), which specialzes on the coastal record of Holocene sea level fluctuations participated in the expedition and deployed the 12 m vibrocorer of the Centre for Marine Geology (Halifax, Canada) for sampling of indurated shelf sediments. David Scott is co-chairman of the IGCP-Project 367 (late Quatenary and Holocene sea level fluctuations) and serves as a link to the international scientific community involved in this project .

3. GENERAL RESEARCH PROGRAM OF THE SO-115 CRUISE

Objectives

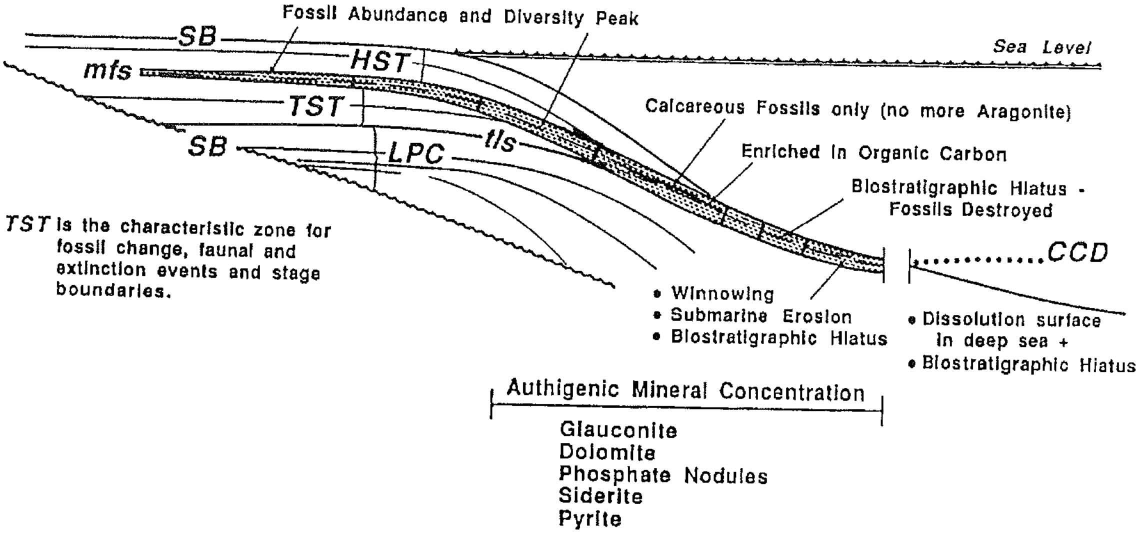
The main objective of the cruise is the high resolution reconstruction and modelling of the post-glacial transgression along several transects across the Sunda-Shelf and slope. The following studies are planned to achieve this objective:

- reconstruct and compare the geometry of the late Pleistocene and Holocene delta complexes off the Molengraaff river and the Mekong river including their fluviatile-marine transition;

- build up a high resolution stratigraphic framework based on stable isotope stratigraphy and AMS ^{14}C dates;

- use benthic foraminifera as regression/transgression indicators within the prodelta-area, and examine their distribution patterns from the prograding phase of the delta system to the end of the transgressive phase;

MAXIMUM FLOODING SURFACE CONDENSED SECTION (SEDIMENT STARVATION)



TRANSGRESSIVE SYSTEMS TRACT

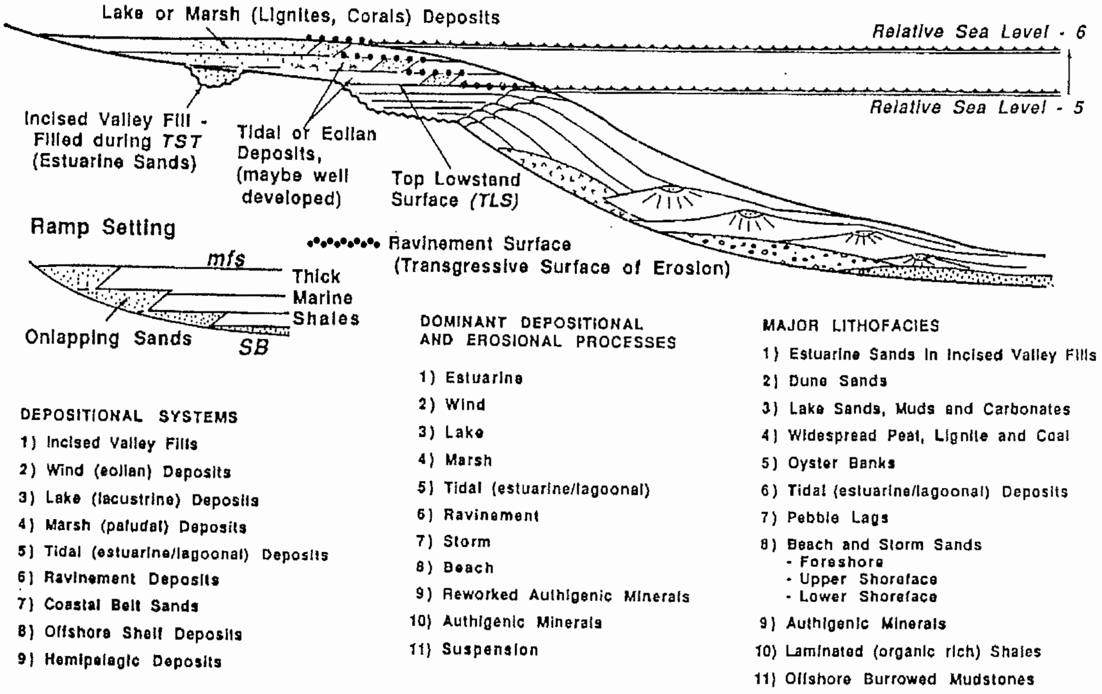


Fig. 1: Sequence stratigraphic scheme of a transgressive systems tract and sea level highstand (modified after Vail, 1988).

- calculate accumulation rates of terrigenous sediment and organic matter during the different transgressive stages and examine their influence on the marine ecosystem;

- test the sequence stratigraphy concept using a combination of seismic and high resolution stratigraphy. Focus on the development from the "transgressive systems tract" to the "maximum flooding surface";

- develop a high resolution sea level fluctuation curve for the late Pleistocene and Holocene of the southwestern South China Sea.

Relation to International Geologic Correlation Program (IGCP)-Project 367

IGCP Project 367 studies high frequency sea level fluctuations during the Holocene. The Holocene record on the Sunda Shelf obtained during the Sonne 115 cruise will be integrated within this framework that includes a global data base of Holocene high frequency sea level changes as well as numerous records of East Asian coastline data.

Relation to ODP proposal to drill the monsoonal history in the South China Sea

The distal end of the Sonne 115 seismic lines and the most basinward station of the coring program are identical with proposed Sites of the ODP proposal. Data acquired during the Sonne cruise are used as site survey data and the proposed ODP sites will provide the necessary stratigraphic control for the deeper part of the Sonne 115 seismic stratigraphy framework.

Research Program

1. Reflexion seismics to construct sequence stratigraphic framework of Pleistocene-Holocene sedimentary sequences on the Sunda Shelf and along its margin.

   The main objective is a three-dimensional model of the postglacial transgression surface and the tracing of the unconformity on the shelf into its corresponding conformity within the basinal sequences of the South China Sea. The seismic investigation concentrated on E-W and N-S transects across the former Molengraaff river and delta system. Additionally two long Parasound transects were planned from the inner shelf to deep water sites along the paleo-Molengraaff and Mekong river beds.
2. Sediment coring program using a giant box corer, multicorer, vibrocorer, gravity- and piston corer.

   Stations were selected according to the following criteria:

   (1) equidistant sampling of the seismic transects along the postglacial transgression surface.

   (2) closely spaced samples in the key areas, where shelf unconformities grade into basinal continuous sedimentation.

   (3) stations on pelagic highs with little terrigenous influence were sampled as paleoceanographic reference sites. Parallel to these reference sites, cores were taken within the channel and fan systems to monitor qualitative and quantitative changes in terrigenous sediment fluxes.

All cores were photographed, described and sampled for micropaleontology, stable isotopes, anorganic and organic geochemistry, sedimentology, clay mineralogy on board ship. Carbonate analyses, digital grayscale curves and continuous magnetic susceptibility curves were generated on board. Sampling and sample distribution to co-operating shorebased scientists was organized in accordance with the policies of the international Ocean Drilling Program.

The following analyses are planned after the cruise:

1. Generation of a seismic model of the transgression surface with the incised valleys of the paleo-Molengraaff and Mekong rivers, the delta complexes of these rivers and their pelagic prodelta sequences (type 1 discordance).
2. Documentation of the sedimentary record of the transgressive systems tract, including analyses of the subsequent sedimentary filling of the incised valley system and the destruction of the delta complex.
3. Detailed chronostratigraphy of the transgression events using AMS ^{14}C dating. Exposure surfaces below the transgressive sequence are traced into the basin using cathodo-luminiscence microscopy and the isotopic characteristics of the carbonate cements.
4. Quantification of late Pleistocene and Holocene changes in sediment fluxes caused by morphologic and climatic changes in the hinterland. To achieve this objective, we will quantitatively analyse the composition of the clastics (including the clay fraction) and the terrigenous organic matter.
6. Monitoring of changes in monsoonal circulation patterns after the post-Pleistocene transgression (paleoproductivity record of the pelagic sequences in front of the Mekong and Molengraaff river systems).
7. Monitoring of high frequency sea level fluctuations within the Holocene.
8. Reconstruction of a Pleistocene onlap-curve for the southern South China Sea based on quantitative reconstruction of aggradation and coastal encroachment, as well as precise dating of parasequence-boundaries.

4. PREVIOUS RESEARCH

Geometry and chronology of transgressive events are commonly described in a sequence stratigraphic framework (Boyd et al., 1989; Posamentier et al., 1988; Van Wagoner et al. 1990). A sedimentary sequence is composed of a succession of genetically similar sedimentary units between chronostratigraphically important sequence boundaries. Each sequence is composed of parasequences that are separated by flooding surfaces. Such a flooding surface is the post-glacial transgression surface above the late Pleistocene exposed land surface on the Sunda- and Vietnamese shelf, the largest shelf area of the world (1,8 million km^2). The Molengraaff and Mekong were incised within this 400 km wide coastal plain and formed huge delta systems along the South China Sea margin (Molengraaff and Weber, 1920; Molengraaff, 1922; Dickerson, 1941; Tjia, 1980; Sarnthein et al., 1994). The sea level rise was more than 60 m during this transgression and reached a maximum in the early Holocene (4000 - 6000 ^{14}C-years BP) of about 5 m above the present day sea level (Geyh et al., 1979; Tjia et al., 1977; Fontaine and Delibrias, 1974; Pirazzoli, 1991).

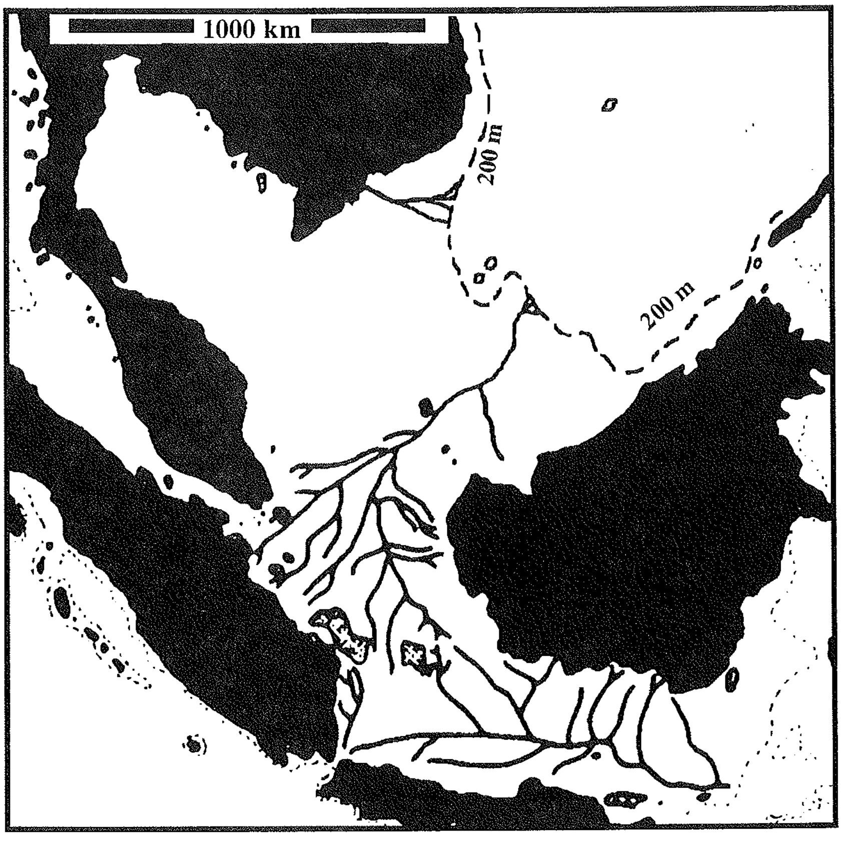
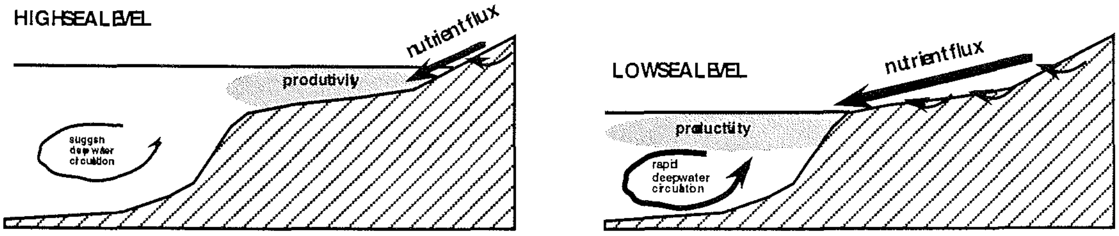


Fig.2: Pleistocene river systems on the Sunda- and Vietnam shelf (after Tjia, 1980 and Anonymous, 1984). The Molengraaff river entered the South China Sea in the south and the paleo-Mekong river in the north of the Sunda shelf margin.

The large river system of the Mekong originates from the Tibetan Plateau and enters the southern South China Sea close to Ho-Chi-Minh city. The shape of the Recent Mekong delta is controlled by the monsoonal wind direction towards the east. The continuation of the river system on the shelf and the Pleistocene delta system was also eastwards of the modern delta according to the present day shelf morphology and retrograded to the present position during the Holocene tansgression. The recent shelf edge off the Mekong is in a water depth of approx. 130 m. This is in the range of the maximum lowstand during the last glacial (Fairbanks, 1989; Schönfeld and Kudrass, 1993). If the sea level didn't fall below the shelf edge (offlap break) then, we expect a paleo-Mekong delta system as part of a shelf margin wedge during the lowstand. The lower boundary of this delta is a subaerial exposure unconformity with a basinward conformity (type 2-sequence boundary). The paleoshelf and the delta system were successively flooded at the end of the last glacial maximum. Each flooding event is marked by a single erosive transgression surface that together form a stepwise retrograding pattern. The Mekong delta retreated to the present day position, or even more landward, and has been prograding again as a tide and wave dominated delta on the Vietnamese shelf for about 6000 years (Galloway, 1975).



GLOBAL ENVIRONMENT	HIGH SEA-LEVEL EFFECT	LOW SEA-LEVEL EFFECT	ENCODER; PROXY
Climate	*warm, low temperature gradient*	*cool, high temperature gradient*	∂18O, biota
Ocean Circulation	*stratified, slack deep water circulation*	*mixed, vigorous deep water circulation*	TOC, ∂13C, biota
Productivity	*oligotrophic open ocean, high on shelfs*	*more eutrophic open ocean, shelfs exposed*	∂13C, biota
Planktic Life	*efficient, high diversity*	*opportunistic, low diversity*	biota
Benthic Life	*opportunistic, low diversity*	*efficient, high diversity*	biota
Ocean Chemistry	*shallow CCD* *expanded oxygen minimum* *high organic carbon accumulation*	*low CCD* *narrow oxygen minimum* *low organic carbon accumulation*	sediment composition TOC biota
Sediment	*low sedimentation rate* *fine-grained* *low terrigenous component*	*high sedimentation rate* *coarse-grained* *high terrigenous component*	age-thickness grain-size magnetic intensity grain composition
Hiatuses	*starved*	*mechanical*	stratal pattern

Fig. 3: Record of sea level lowstands and highstands within the ocean system. The marginal South China Sea with its huge Sunda Shelf is an ideal natural laboratory to test these concepts.

Detailed investigations of terrigenous fluxes have so far been only undertaken in the Gulf of Thailand (NEDECO, 1965) and within the Makasar-Strait between Borneo and Sulawesi (Eisma, 1990). The Sunda Shelf and its South China Sea margin with its huge dimensions and distinct morphology offers a unique opportunity to investigate short term construction and destruction of large river systems and delta complexes. Parallel investigation within the pelagic part of the South China Sea offers an opportunity to quantify terrigenous fluxes into the pelagic system and examine the response of the marine ecosystem to sea level fluctuations during the last glacial period and the early Holocene warming period (fig. 3).

Recent shallow seismic investigations of the SW part of the Sunda shelf revealed Pleistocene incised valley systems up to 50 m deep and a thickness of Holocene marine sediments averaging several meters (Evans et al., 1995, figs. 4 and 5) which allow high resolution studies of the Holocene sedimentary and sea level history. The 3,5 kHz seismic profiles of the French L'Atalante cruise 1993 (Campagne PONAGA) also show Holocene sediments with a thickness of several meters on the outer shelf and upper slope areas off the Vietnamese coast within the area of the paleo-Mekong delta, directly east of the working area 2 of the Sonne 115 cruise (seismic lines PONAGA 64-69).

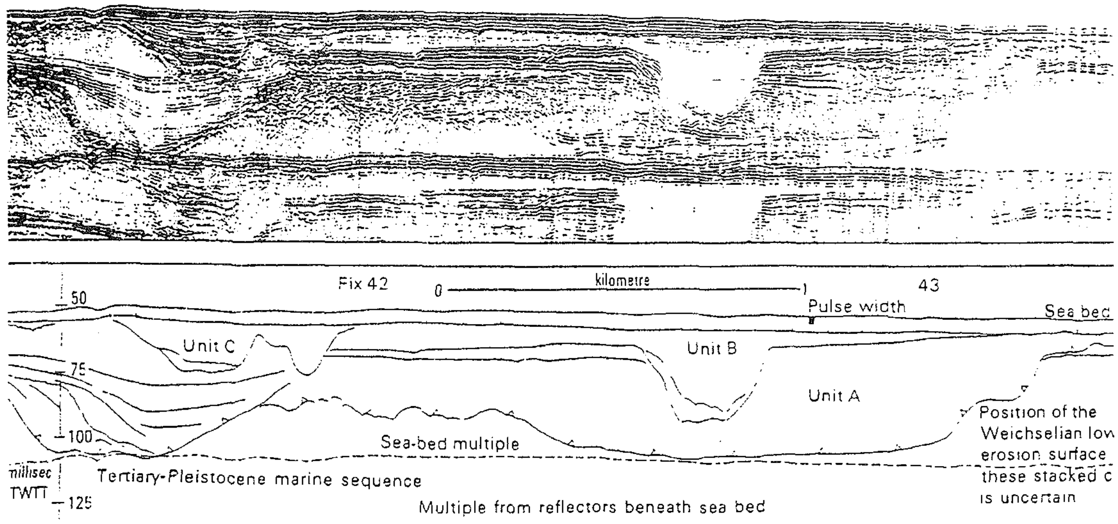
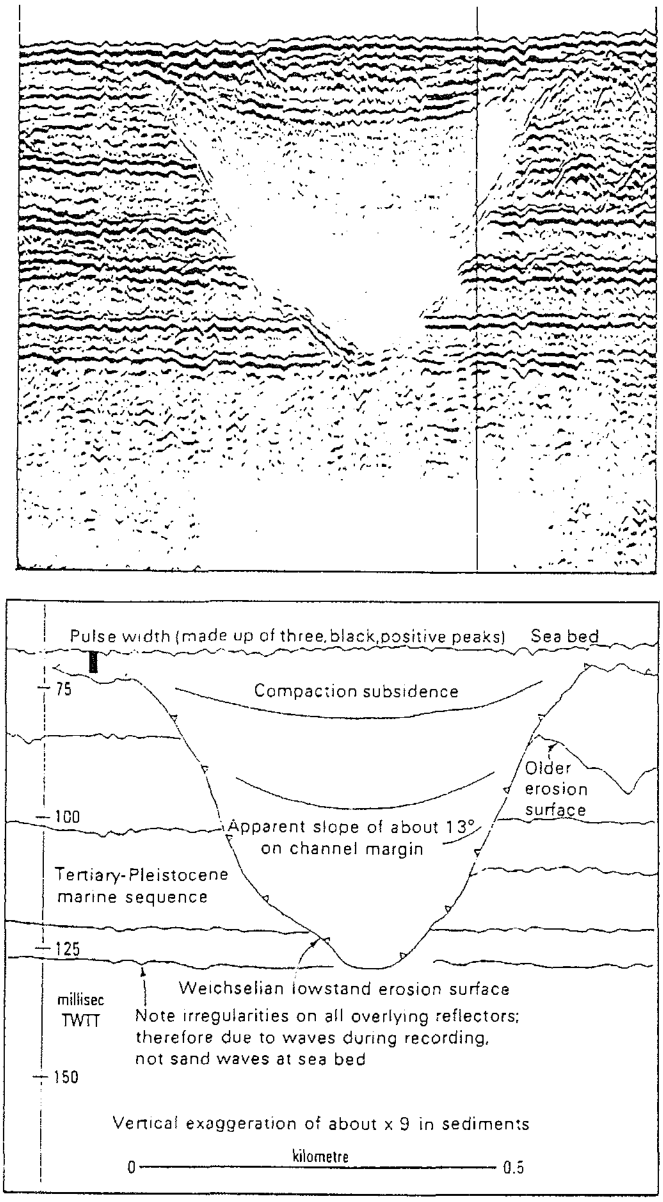


Fig. 4. Sparker profile across infilled Pleistocene channels in the Sunda Shelf east of peninsular Malaysia (from Evans et al., 1995).



Note irregularities on all overlying reflectors; therefore due to waves during recording, not sand waves at sea bed

Vertical exaggeration of about x 9 in sediments

Fig. 5. Sparker profile across infilled Pleistocene channels on the Sunda Shelf east of peninsular Malaysia (from Evans et al., 1995).

Sonne 95 Expedition

The pelagic part of the southwestern South China Sea and the most distal part of the Molengraaff delta system have been initially investigated during the Sonne 95 cruise (core 17964, Sarnthein et al., 1994). A high resolution stratigraphy, including stable isotope stratigraphy and AMS dates has been developed for the last 40 000 years for this area. Sedimentation rates are generally high (exceeding 20 cm / 1000 y) and allow a precise correlation of sea level events with changes in the pelagic system. In addition to the high sedimentation rates several ash layers from Indonesian and Philippine volcanoes have been reported in the southern South China Sea (Sarnthein et al., 1994) that may provide additional precise correlation tools towards the delta- and shelf sequences.

Sonne 24 Expedition

The Sonne 24 cruise investigated a transect between Sarawak and the Malayan Peninsula along 2°N. Incised valleys in the proximal part of the Sunda shelf up to 25 m depth were indicated by Kögler et al. (1982). The sediments within these valleys were cored at several positions. Box cores, gravity cores and wide diameter gravity cores up to 6 m length were obtained. Initial sedimentologic and micropaleontologic studies of this material indicated a complete early Holocene transgressive sequence followed by Recent shelf sediments with rich biota (Köhler, 1985; Mostafawi, 1992). Sediments within the incised valleys consisted of Holocene marine deposits with a characteristic resediment-sequence at the base (Kögler et al., 1982; Köhler, 1985). No detailed chronostratigraphy of these sediments was undertaken during Sonne 24. We are currently analysing sediment radiographies and micropaleontologic samples to built up a chronostratigraphic framework for the transgressive systems tract in the inner (proximal) part of the Sunda shelf.

5. OVERVIEW OF THE RESEARCH AREA

The investigations concentrated on the temporal and spatial reconstruction of the postglacial transgression on the Sunda- and Vietnamese shelf. Two key areas have been selected based on the existing maps of the Sunda shelf (Anonymous, 1984, Physiographic map of the South China Sea 1: 3 000 000; Admiralty London, 1986, China Sea-Southern Portion, 1: 1 550 000, Western Part 2660A, Eastern Part 2660B; seismics and cartography of the SO-24 and SO-95 expeditions).

Figs. 6 A-E: Cruise track and stations.

Table 1 A-B: Sediment stations along the Vietnam shelf and Sunda shelf transects (A), and seismic profiles (B).

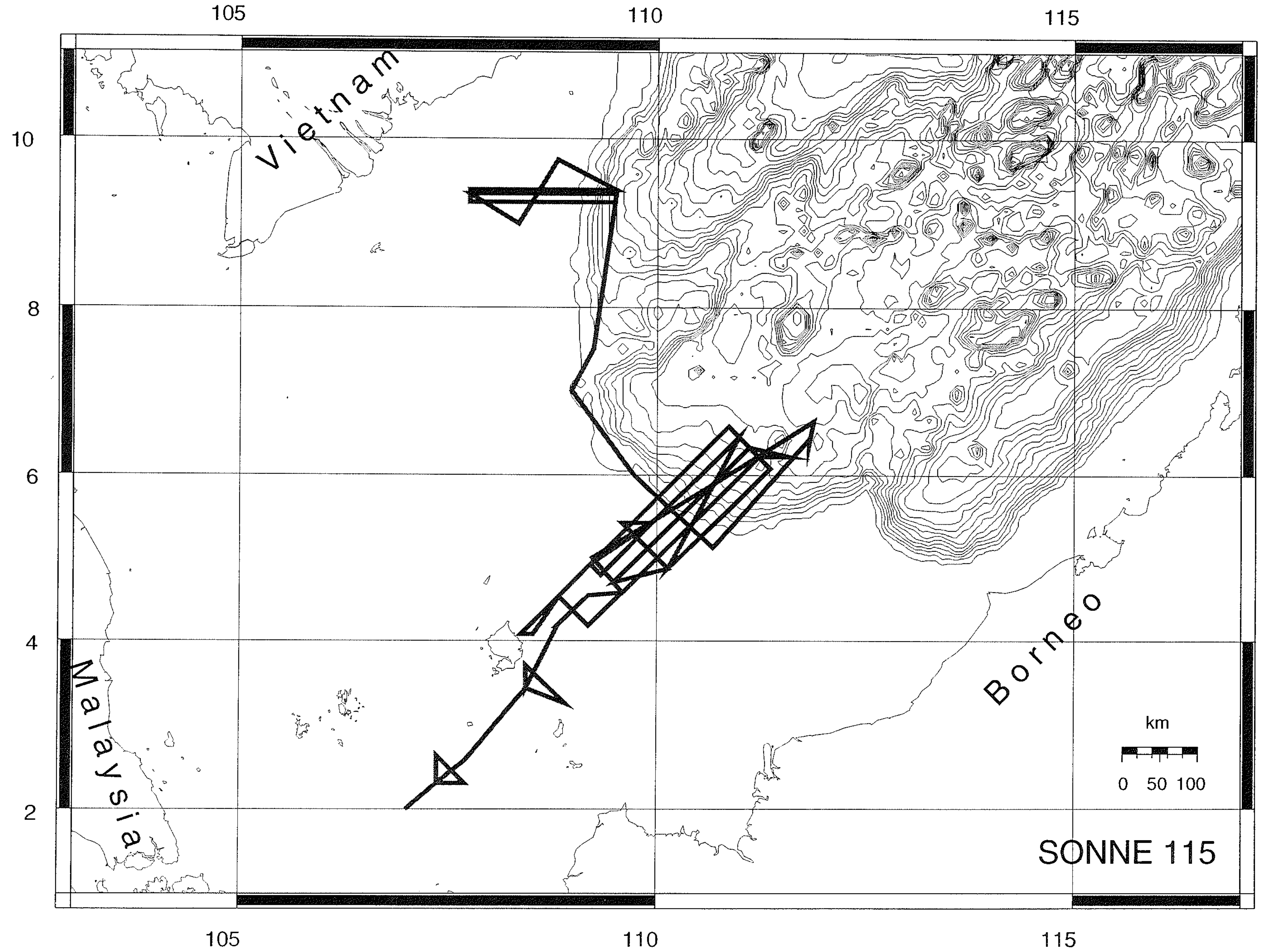


Fig. 6 A: Cruise track overview.

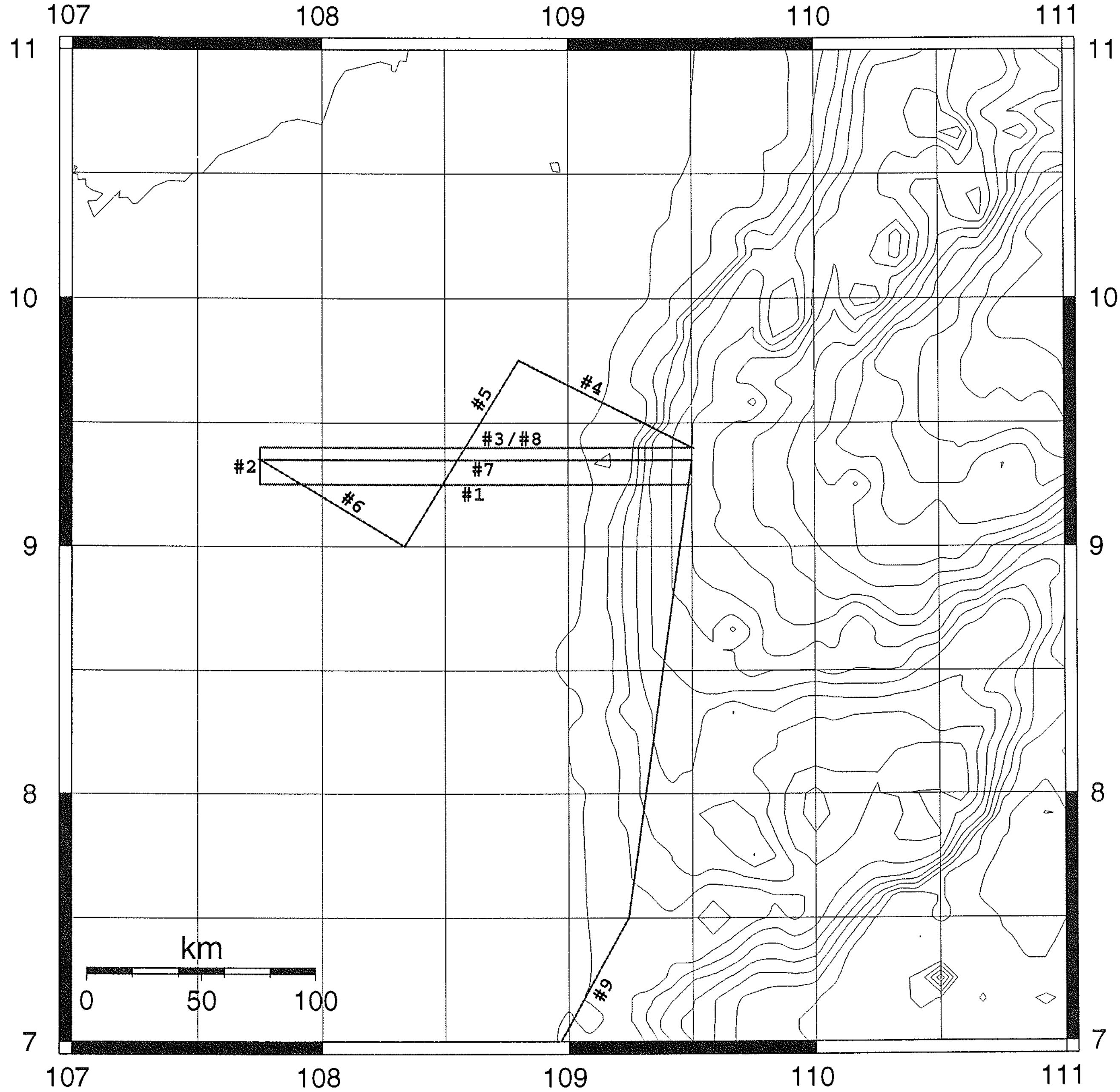


Fig. 6B: Profiles along the Vietnam shelf transect.

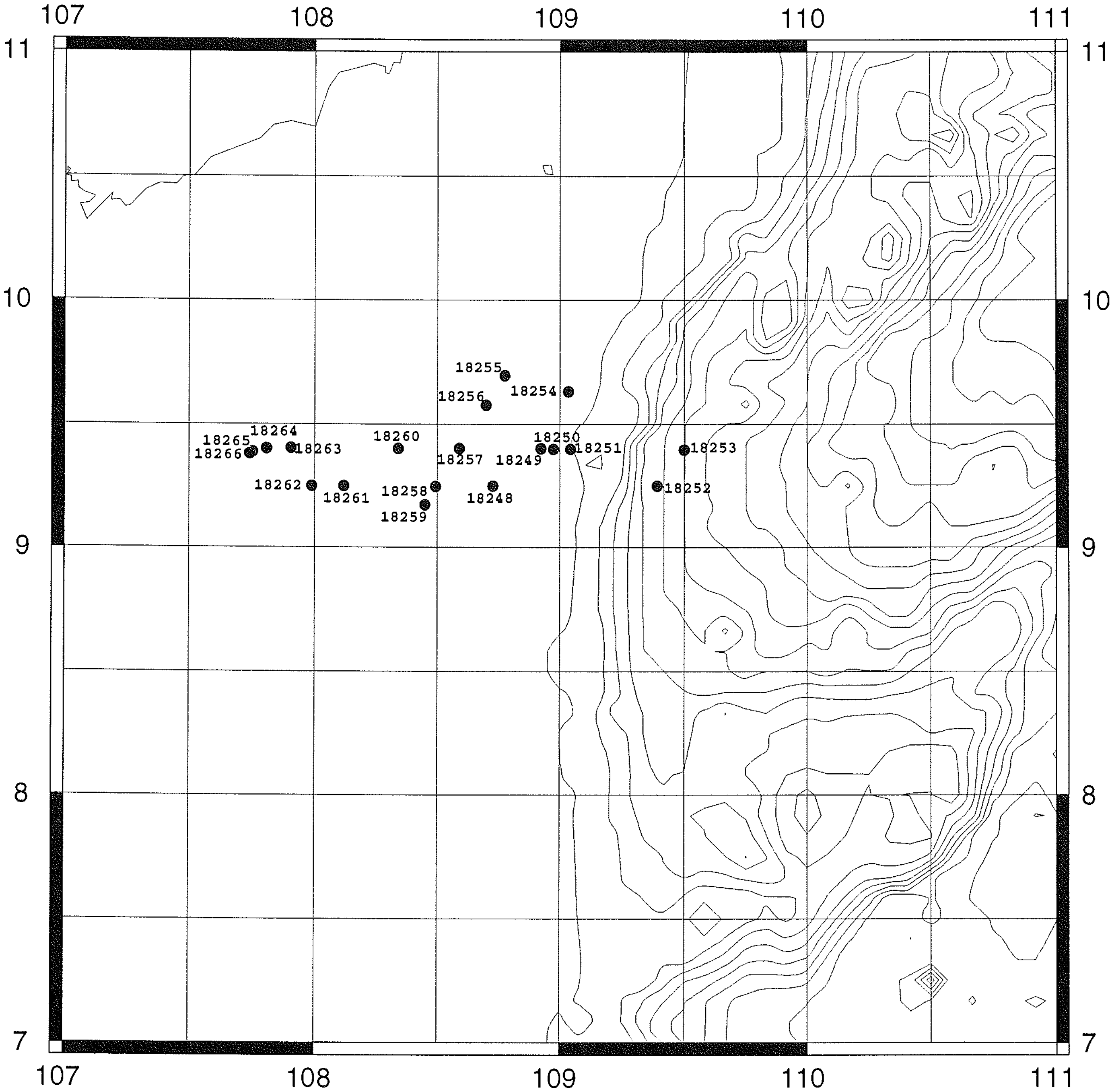


Fig. 6C: Statons along the Vietnam shelf transect.

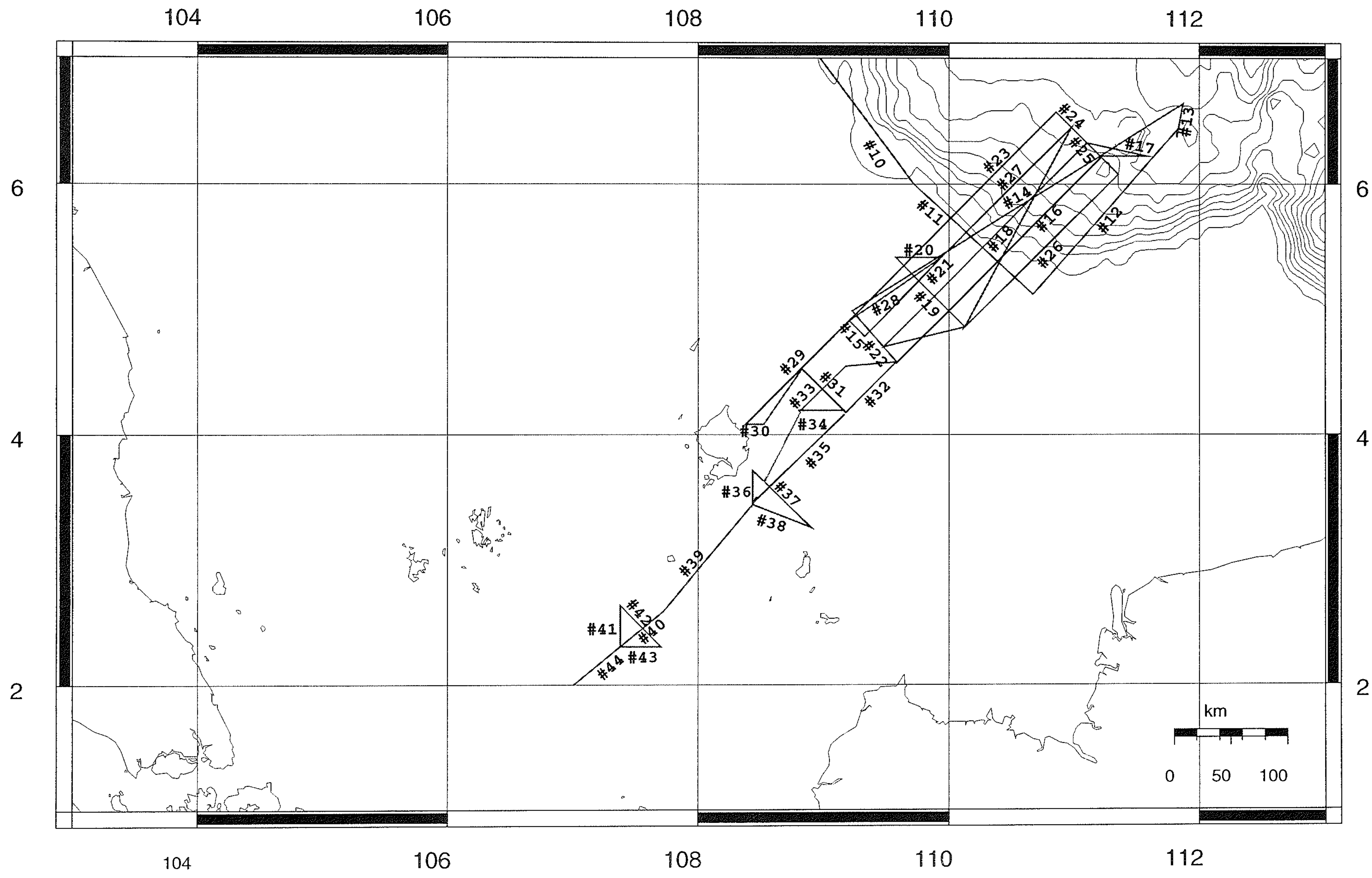


Fig. 6D: Profiles along the Sunda shelf transect .

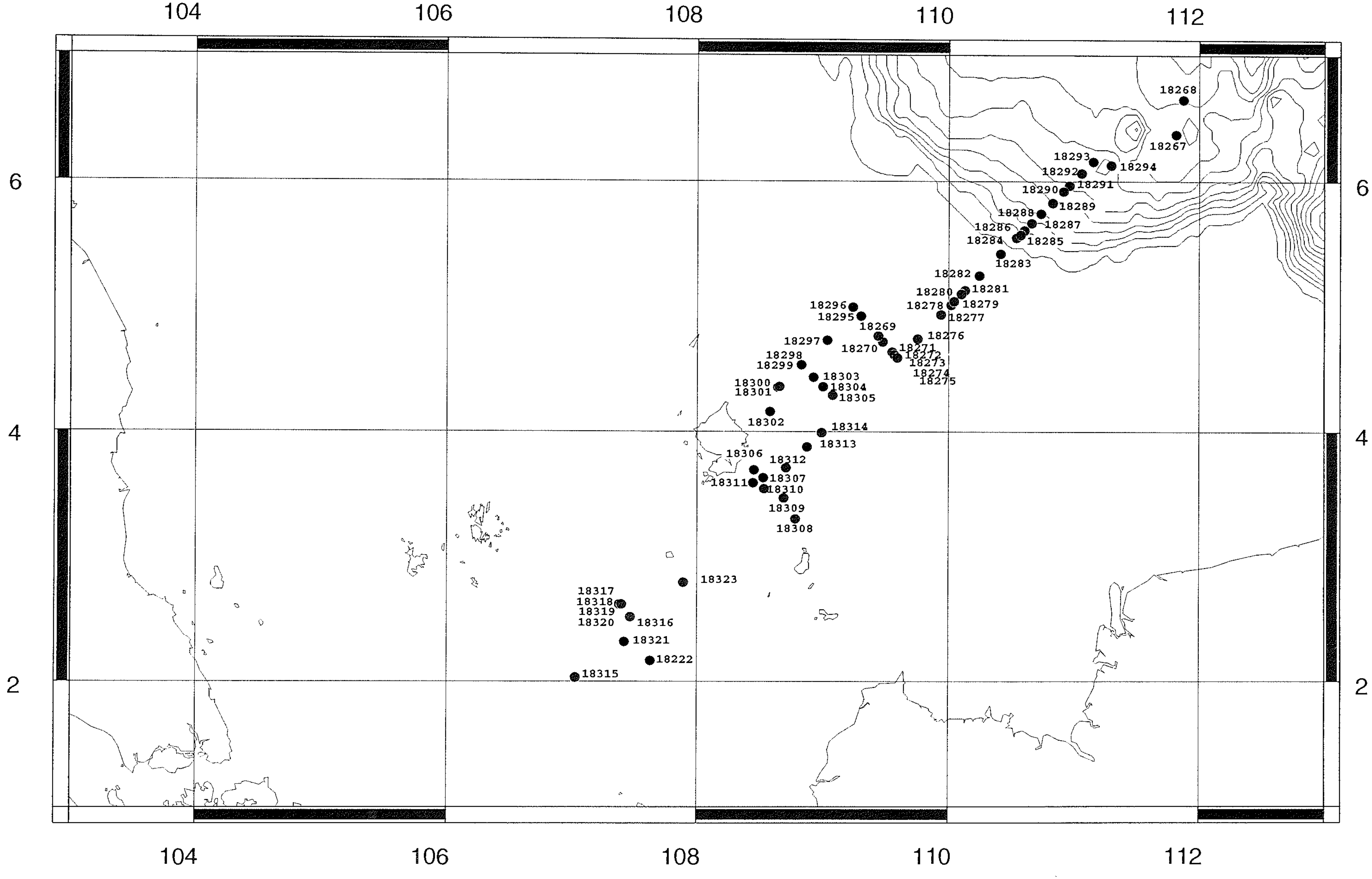


Fig. 6 E: Stations along the Sunda shelf.

STATIONS LIST SO-115
Vietnamese and Sunda Shelf

Station	GIK	Coring device	Lat.	Long.	Water depth	Recovery
SO-115-01	18248-1	GBC	9:14.984 N	108:43.622 E	103 m	23 cm
	18248-2	GC-5	9:14.984 N	108:43.622 E	103 m	empty
	18248-3	GC-5	9:14.984 N	108:43.622 E	103 m	empty
SO-115-02	18249-1	GBC	9:23.948 N	108:55.485 E	133 m	25 cm
	18249-2	GC-3	9:23.948 N	108:55.485 E	133 m	300 cm
SO-115-03	18250-1	GBC	9:23.923 N	108:58.425 E	148 m	35 cm
	18250-2	GC-3	9:23.876 N	108:58.382 E	148 m	300 cm
SO-115-04	18251-1	GBC	9:23.922 N	109:02.700 E	154 m	empty
	18251-2	GBC	9:23.891 N	109:02.694 E	154 m	empty
SO-115-05	18252-1	GBC	9:14.969 N	109:23.419 E	1277 m	52 cm
	18252-2	GC-8	9:14.998 N	109:23.441 E	1271 m	739 cm
	18252-3	GC-12	9:15.007 N	109:23.446 E	1273 m	1185 cm
SO-115-06	18253-1	GBC	9:23.733 N	109:30.000 E	1479 m	50 cm
	18253-2	GC-13	9:23.704 N	109:29.995 E	1479 m	859 cm
SO-115-07	18254-1	GBC	9:37.945 N	109:02.102 E	145 m	43 cm
	18254-2	GC-3	9:37.945 N	109:02.102 E	145 m	empty
	18254-3	GC-4	9:37.945 N	109:02.102 E	145 m	empty
SO-115-08	18255-1	GBC	9:41.871 N	108:46.527 E	102 m	41 cm
	18255-2	VC	9:41.871 N	108:46.527 E	102 m	558 cm
SO-115-09	18256-1	GBC	9:34.544 N	108:41.995 E	92 m	21 cm
	18256-2	VC-6	9:34.544 N	108:41.995 E	92 m	222 cm
	18256-3	VC-6	9:34.544 N	108:41.995 E	92 m	empty
SO-115-10	18257-1	VC	9:23.998 N	108:35.412 E	89 m	349 cm
	18257-2	GBC	9:23.996 N	108:35.410 E	88 m	21 cm
SO-115-11	18258-1	GBC	9:14.721 N	108:29.617 E	88 m	30 cm
	18258-2	VC	9:14.721 N	108:29.617 E	88 m	322 cm
SO-115-12	18259-1	VC	9:10.419 N	108:26.942 E	88 m	442,5 cm
	18259-2	GBC	9:10.404 N	108:26.944 E	88 m	36 cm
SO-115-13	18260-1	GBC	9:23.995 N	108:20.447 E	74 m	35 cm
	18260-2	VC	9:23.995 N	108:20.452 E	73 m	409 cm
SO-115-14	18261-1	VC	9:14.978 N	108:07.026 E	68 m	131 cm
	18261-2	VC	9:14.978 N	108:07.026 E	68 m	307 cm
	18261-3	GBC	9:14.978 N	108:07.026 E	68 m	36 cm
SO-115-15	18262-1	GBC	9:14.999 N	107:59.307 E	56 m	32 cm
	18262-2	VC	9:14.999 N	107:59.307 E	56 m	593 cm
	18262-3	GC	9:14.999 N	107:59.307 E	56 m	938 cm
SO-115-16	18263-1	GBC	9:24.181 N	107:54.257 E	51 m	18 cm
	18263-2	VC	9:24.181 N	107:54.257 E	51 m	loss
	18263-3	GBC	9:24.181 N	107:54.257 E	51 m	18 cm
SO-115-17	18264-1	GBC	9:24.022 N	107:48.414 E	48 m	28 cm
	18264-2	VC	9:24.022 N	107:48.429 E	49 m	128 cm
	18264-3	GC	9:24.006 N	107:48.434 E	48 m	352 cm
SO-115-18	18265-1	GBC	9:23.253 N	107:45.036 E	47 m	33 cm
	18265-2	VC-3	9:23.249 N	107:45.022 E	47 m	240 cm
	18265-3	GC	9:23.251 N	107:45.029 E	48 m	529 cm
SO-115-19	18266-1	GBC	9:22.795 N	107:44.450 E	47 m	29 cm
	18266-2	VC	9:22.800 N	107:44.459 E	47 m	281 cm
	18266-3	GC	9:22.797 N	107:44.458 E	46 m	535 cm

STATIONS LIST SO-115
Vietnamese and Sunda Shelf

Station	GIK	Coring device	Lat.	Long.	Water depth	Recovery
SO-115-20	18267-1	GBC	6:22.412 N	111:49.119 E	1852 m	54 cm
	18267-2	GC-12	6:22.461 N	111:49.085 E	1846 m	869 cm
	18267-3	PC-26	6:22.387 N	111:49.126 E	1855 m	1409 cm
SO-115-21	18268-1	GBC	6:38.748 N	111:52.230 E	1974 m	50 cm
	18268-2	GC-12	6:38.782 N	111:52.309 E	1975 m	837.5 cm
SO-115-22	18269-1	GBC	4:46.042 N	109:26.353 E	114 m	50 cm
	18269-2	GC-12	4:46.013 N	109:26.321 E	113 m	881.5 cm
SO-115-23	18270-1	GBC	4:43.481 N	109:28.607 E	106 m	48 cm
	18270-2	GC-12	4:43.461 N	109:28.576 E	107 m	92 cm
	18270-3	GC-6	4:43.518 N	109:28.629 E	104 m	empty
	18270-4	VC	4:43.516 N	109:28.630 E	106 m	140 cm
SO-115-24	18271-1	GBC	4:38.341 N	109:32.949 E	116 m	54 cm
	18271-2	GC-6	4:38.330 N	109:32.969 E	122 m	562 cm
	18271-3	GC-10.25	4:38.314 N	109:32.971 E	116 m	576 cm
	18271-4	GC-10.25	4:38.315 N	109:32.939 E	116 m	730 cm
SO-115-25	18272-1	GBC	4:37.635 N	109:33.607 E	121 m	46 cm
	18272-2	GC-6	4:37.597 N	109:33.632 E	118 m	338 cm
SO-115-26	18273-1	GBC	4:37.280 N	109:33.949 E	127 m	52 cm
	18273-2	GC-6	4:37.289 N	109:33.931 E	126 m	348 cm
SO-115-27	18274-1	GBC	4:36.324 N	109:34.824 E	117 m	51 cm
	18274-2	GC-6	4:36.318 N	109:34.833 E	118 m	561 cm
	18274-3	GC-10	4:36.313 N	109:34.818 E	117 m	755 cm
SO-115-28	18275-1	GBC	4:35.699 N	109:35.560 E	109 m	45 cm
	18275-2	GC-6	4:35.727 N	109:35.536 E	112 m	556 cm
	18275-3	GC-10	4:35.652 N	109:35.539 E	109 m	597 cm
SO-115-29	18276-1	GBC	4:44.946 N	109:44.862 E	120 m	48 cm
	18276-2	GC-10	4:44.897 N	109:44.837 E	116 m	721 cm
SO-115-30	18277-1	GBC	4:56.341 N	109:56.283 E	134 m	48 cm
	18277-2	GC-10	4:56.355 N	109:56.298 E	133 m	490 cm
SO-115-31	18278-1	GBC	5:01.021 N	110:00.962 E	137 m	50 cm
	18278-2	GC-10	5:01.033 N	110:01.002 E	138 m	empty
	18278-3	GC-6	5:01.046 N	110:01.015 E	137 m	534 cm
SO-115-32	18279-1	GBC	5:02.586 N	110:02.504 E	139 m	50 cm
	18279-2	GC-6	5:02.569 N	110:02.531 E	139 m	empty
	18279-3	GC-6	5:02.584 N	110:02.562 E	140 m	530 cm
SO-115-33	18280-1	GBC	5:05.975 N	110:06.007 E	144 m	52 cm
	18280-2	GC-6	5:06.007 N	110:05.939 E	144 m	556 cm
SO-115-34	18281-1	GBC	5:07.751 N	110:07.754 E	145 m	55 cm
	18281-2	GC-6	5:07.805 N	110:07.769 E	146 m	530 cm
SO-115-35	18282-1	GBC	5:14.702 N	110:14.643 E	152 m	46 cm
	18282-2	GC-9	5:14.687 N	110:14.605 E	151 m	634 cm
SO-115-36	18283-1	GBC	5:25.139 N	110:25.093 E	166 m	48 cm
	18283-2	GC-6	5:25.144 N	110:25.079 E	165 m	547.5 cm
SO-115-37	18284-1	GBC	5:32.506 N	110:32.424 E	226 m	32 cm
	18284-2	MUC	5:32.486 N	110:32.423 E	226 m	24 cm
	18284-3	GC-11	5:32.510 N	110:32.413 E	226 m	804 cm
SO-115-38	18285-1	MUC	5:34.464 N	110:34.369 E	291 m	31 cm
SO-115-39	18286-1	MUC	5:36.365 N	110:36.240 E	404 m	39 cm
SO-115-40	18287-1	MUC	5:39.759 N	110:39.691 E	595 m	empty
	18287-2	MUC	5:39.788 N	110:39.788 E	596 m	43 cm
	18287-3	GC-6	5:39.781 N	110:39.689 E	598 m	566 cm
SO-115-41	18288-1	MUC	5:44.401 N	110:44.324 E	790 m	42 cm
	18288-2	GC-11	5:44.388 N	110:44.335 E	788 m	680 cm
SO-115-42	18289-1	MUC	5:49.772 N	110:49.741 E	978 m	38 cm
	18289-2	GC-11	5:49.802 N	110:49.755 E	976 m	682 cm
SO-115-43	18290-1	MUC	5:55.025 N	110:54.939 E	1124 m	38 cm
SO-115-44	18291-1	MUC	5:57.923 N	110:57.717 E	1208 m	35 cm
SO-115-45	18292-1	MUC	6:03.564 N	111:03.515 E	1309 m	40 cm
SO-115-46	18293-1	MUC	6:09.419 N	111:09.411 E	1404 m	40 cm
SO-115-47	18294-1	MUC	6:07.806 N	111:18.148 E	842 m	empty
	18294-2	MUC	6:07.808 N	111:18.182 E	849 m	empty
	18294-3	GBC	6:07.806 N	111:18.182 E	846 m	50 cm
	18294-4	GC-11	6:07.809 N	111:18.183 E	849 m	694 cm
SO-115-48	18295-1	GBC	4:55.556 N	109:17.868 E	117 m	47 cm
	18295-2	GC-11	4:55.587 N	109:17.865 E	119 m	823 cm
SO-115-49	18296-1	GBC	4:59.754 N	109:14.435 E	118 m	42 cm
	18296-2	VC-3	4:59.754 N	109:14.446 E	118 m	244 cm
SO-115-50	18297-1	GBC	4:44.332 N	109:01.902 E	112 m	52 cm
	18297-2	VC-6	4:44.346 N	109:01.915 E	111 m	
	18297-3	SL-6	4:44.347 N	109:01.916 E	111 m	396 cm
SO-115-51	18298-1	GBC	4:31.962 N	108:49.504 E	103 m	53 cm
	18298-2	VC-6	4:31.987 N	108:49.508 E	102 m	587 cm

STATIONS LIST SO-115
Vietnamese and Sunda Shelf

Station	GIK	Coring device	Lat.	Long.	Water depth	Recovery
SO-115-52	18299-1	VC-6	4:32.004 N	108:49.537 E	102 m	580 cm
	18299-2	GBC	4:32.004 N	108:49.537 E	102 m	52 cm
SO-115-53	18300-1	GBC	4:21.770 N	108:39.211 E	94 m	52 cm
	18300-2	GC-11	4:21.778 N	108:39.215 E	91 m	885 cm
SO-115-54	18301-1	GBC	4:21.304 N	108:38.824 E	92 m	54 cm
	18301-2	VC-6	4:21.308 N	108:38.811 E	93 m	582 cm
SO-115-55	18302-1	GBC	4:09.588 N	108:34.531 E	83 m	52.5 cm
	18302-2	GC-11	4:09.585 N	108:34.535 E	83 m	598 cm
SO-115-56	18303-1	GBC	4:26.360 N	108:55.516 E	107 m	50 cm
	18303-2	GC-11	4:26.425 N	108:55.491 E	83 m	736 cm
SO-115-57	18304-1	GBC	4:21.788 N	109:00.155 E	104 m	56 cm
	18304-2	VC-6	4:21.790 N	109:00.157 E	104 m	228 cm
	18304-3	VC-6	4:21.791 N	109:00.156 E	104 m	222 cm
SO-115-58	18305-1	GBC	4:17.314 N	109:04.594 E	109 m	56 cm
	18305-2	VC-6	4:17.318 N	109:04.599 E	109 m	514 cm
SO-115-59	18306-1	GBC	3:35.277 N	108:26.540 E	88 m	>60cm
	18306-2	GBC	3:35.225 N	108:26.512 E	88 m	56 cm
	18306-3	VC-6				no core
	18306-4	VC-6	3:35.184 N	108:26.422 E	89 m	165 cm
SO-115-60	18307-1	GBC	3:37.620 N	108:31.630 E	100 m	38 cm
	18307-2	GC-11	3:37.626 N	108:31.648 E	100 m	943 cm
SO-115-61	18308-1	GBC	3:17.830 N	108:47.143 E	80 m	30 cm
	18308-2	GC-11				105 cm
SO-115-62	18309-1	GBC	3:27.958 N	108:41.196 E	84 m	38 cm
	18309-2	VC	3:27.959 N	108:41.174 E	83 m	597 cm
SO-115-63	18310-1	GBC	3:32.149 N	108:32.160 E	101 m	45 cm
	18310-2	VC-6	3:32.131 N	108:32.131 E	100 m	568 cm
SO-115-64	18311-1	GBC	3:41.163 N	108:27.105 E	60 m	31 cm
	18311-2	VC-6	3:41.191 N	108:27.093 E	60 m	468 cm
SO-115-65	18312-1	GBC	3:42.355 N	108:42.383 E	101 m	40 cm
	18312-2	GC-11	3:42.351 N	108:42.380 E	101 m	667 cm
SO-115-66	18313-1	GBC	3:52.183 N	108:52.231 E	99 m	38 cm
	18313-2	GC-11	3:52.194 N	108:52.226 E	98 m	620 cm
SO-115-67	18314-1	GBC	3:59.463 N	108:59.466 E	100 m	38 cm
	18314-2	GC-11	3:59.469 N	108:59.473 E	100 m	370 cm
SO-115-68	18315-1	GBC	2:01.672 N	107:02.016 E	69 m	empty
	18315-2	GC-11	2:01.658 N	107:02.011 E	69 m	583 cm
	18315-3	GBC	2:01.669 N	107:02.041 E	69 m	49 cm
SO-115-69	18316-1	GBC	2:29.262 N	107:22.527 E	71 m	37 cm
	18316-2	VC-6	2:29.263 N	107:27.522 E	71 m	597 cm
SO-115-70	18317-1	GBC	2:36.598 N	107:22.515 E	96 m	44 cm
	18317-2	VC-6	2:36.596 N	107:22.517 E	97 m	empty
	18317-3	VC-6	2:36.596 N	107:22.515 E	95 m	197 cm
SO-115-71	18318-1	GBC	2:36.609 N	107:22.505 E	86 m	20 cm
	18318-2	VC-6	2:36.608 N	107:22.507 E	86 m	empty
	18318-3	VC-6	2:36.609 N	107:22.508 E	87 m	406 cm
SO-115-72	18319-1	GBC	2:36.620 N	107:22.502 E	81 m	18 cm
	18319-2	VC-6	2:36.623 N	107:22.502 E	81 m	empty
	18319-3	VC-6	2:36.620 N	107:22.502 E	81 m	
SO-115-73	18320-1	GBC	2:36.725 N	107:22.491 E	76 m	40 cm
	18320-2	VC-6	2:36.726 N	107:22.491 E	76 m	492 cm
SO-115-74	18321-1	GBC	2:18.457 N	107:25.327 E	109 m	50 cm
	18321-2	VC	2:18.453 N	107:25.326 E	109 m	569 cm
SO-115-75	18322-1	GBC	2:18.410 N	107:37.911 E	70 m	45 cm
	18322-2	VC-6	2:18.405 N	107:37.881 E	70 m	493 cm
SO-115-76	18323-1	GBC	2:47.040 N	107:53.197 E	92 m	41 cm
	18323-2	VC-6	2:47.030 N	107:53.200 E	92 m	540 cm

Table 1 A: Profiles along the Vietnam shelf transect

Profile no.	Type	Starting point		Ending point	
		Latitude N	Longitude E	Latitude N	Longitude E
#1	Parasound	09:15.00	109:30.00	09:15.00	107:45.00
#2	Parasound	09:15.00	107:45.00	09:24.00	107:45.00
#3	Parasound	09:24.00	107:45.00	09:24.00	109:30.00
#4	Parasound	09:24.00	109:30.00	09:45.00	108:48.05
#5	Parasound	09:45.00	108:48.05	09:00.00	108:20.50
#6	Parasound	09:00.00	108:20.50	09:21.00	107:45.00
#7	Parasound	09:21.00	107:45.00	09:21.00	109:30.00
#8	Parasound/Air Gun/Boomer	09:21.00	107:45.00	09:21.00	109:30.00
#9	Parasound	07:30.00	109:14.50	07:00.00	108:58.00

Table 1 B: Profiles along the Sunda shelf transect

Profile no.	Type	Starting point		Ending point	
		Latitude N	Longitude E	Latitude N	Longitude E
#10	Parasound	07:00.00	108:58.00	06:00.00	109:43.00
#11	Parasound/Air Gun/Boomer	06:00.00	109:43.00	05:08.00	110:40.00
#12	Parasound/Air Gun/Boomer	05:08.00	110:40.00	06:26.00	111:49.10
#13	Parasound/Air Gun	06:2240	111:49.10	06:38.80	111:52.30
#14	Parasound	06:15.00	111:15.05	05:00.00	109:14.00
#15	Parasound	05:00.00	109:14.00	04:35.50	109:35.50
#16	Parasound/Air Gun/Boomer	04:35.00	109:35.50	06:13.00	111:13.00
#17	Parasound/Air Gun/Boomer	06:13.00	111:35.50	06:19.80	111:06.20
#18	Parasound/Air Gun/Boomer	06:19.80	111:06.20	04:42.95	109:28.65
#19	Parasound/Air Gun/Boomer	04:52.00	110:08.00	05:25.00	109:35.00
#20	Parasound/Air Gun/Boomer	05:25.00	109:35.00	05:25.00	109:56.86
#21	Parasound/Air Gun/Boomer	05:25.00	109:56.86	04:47.96	109:19.99
#22	Parasound/Air Gun/Boomer	04:47.96	109:19.99	04:55.18	109:12.79
#23	Parasound/Air Gun/Boomer	04:55.18	109:12.79	06:34.40	110:51.48
#24	Parasound/Air Gun/Boomer	06:34.40	110:51.48	06:27.16	110:58.71
#25	Parasound/Air Gun/Boomer	06:27.16	110:58.71	06:05.00	111:21.00
#26	Parasound/Air Gun/Boomer	06:05.00	111:21.00	04:52.00	110:08.00
#27	Parasound/Air Gun/Boomer	06:27.16	110:58.71	05:25.00	109:56.86
#28	Parasound/Air Gun/Boomer	05:25.00	109:56.86	04:55.18	109:12.79
#29	Parasound/Air Gun/Boomer	04:55.18	109:12.79	04:05.18	108:22.75
#30	Parasound/Air Gun/Boomer	04:05.25	108:22.75	04:32.10	108:49.75
#31	Parasound/Air Gun/Boomer	04:32.10	108:49.75	04:11.00	109:11.00
#32	Parasound/Air Gun/Boomer	04:11.00	109:11.00	04:35.50	109:35.00
#33	Parasound/Air Gun/Boomer	04:33.40	109:11.00	04:11.00	108:48.13
#34	Parasound/Air Gun/Boomer	04:11.00	108:48.13	04:11.00	109:11.00
#35	Parasound/Air Gun/Boomer	04:11.00	10:911.00	03:26.50	108:26.50
#36	Parasound/Air Gun/Boomer	03:26.50	108:26.50	03:42.80	108:26.50
#37	Parasound/Air Gun/Boomer	03:42.80	108:26.50	03:15.00	108:54.00
#38	Parasound/Air Gun/Boomer	03:15.00	108:54.00	03:26.50	108:26.50
#39	Parasound/Air Gun/Boomer	03:26.50	108:26.50	02:35.00	107:43.00
#40	Parasound/Air Gun/Boomer	02:35.00	107:43.00	02:18.50	107:22.50
#41	Parasound/Air Gun/Boomer	02:18.50	107:22.50	02:38.50	107:22.50
#42	Parasound/Air Gun/Boomer	02:38.50	107:22.50	02:18.50	107:42.50
#43	Parasound/Air Gun/Boomer	02:18.50	107:42.50	02:18.50	107:22.50
#44	Parasound/Air Gun/Boomer	02:18.50	107:22.50	02:00.00	107:00.00

6. TECHNICAL REPORT

Cruise overview

The SO-115 cruise departed from Kota Kinabalu, Sarawak on December 14, 1996, with 24 scientists from 6 nations on board. The target was the temporal and spatial reconstruction of the postglacial transgression on the Sunda- and Vietnamese shelfes and accompanying changes in sediment and nutrient fluxes. Two key areas have been selected based on the existing maps, one on the Vietnamese shelf (key area 1), the other on the Sunda shelf (key area 2) (compare Figure 2, and citations in prospectus).

We reached key area 1 on the Vietnamese shelf in the late evening of December 15. The area extends between 9° 00′ N and 9° 45′ N, 107° 45′ E and 109° 30′ E ranging from 50 m water depth in the west to 1500 m in the east on the continental slope. It covers the northern part of the drowned Pleistocene Mekong delta and surrounding former nearshore and shelf areas down to the continental slope. Heavy weather conditions (Beaufort 7 - 8,5) allowed no seismic survey except Parasound-profiling (December 16/17). From these records on 9 profiles, 19 sediment stations were sampled with 19 giant box cores, 11 vibrocores, and 8 gravity cores. 9 sediment stations were on the inner shelf, 8 on the outer shelf, and 2 on the continental slope at 1250 and 1450 metres water-depth. We left key area 1 in the evening of December 20.

Key area 2 on the Sunda shelf was reached in the early morning of December 22. This area ranges from 4° 05′ N to 6° 00′ N and from 108° 26′ E to 111° 00′ E covering the area of the Pleistocene Molengraaff delta, the adjacent former coastal plain and shelf, as well as the continental slope. This key area is completed by a NE-SW running profile starting at the continental slope at 6° 15′N, 111° 15′ E, ending on the inner shelf at 2°N, 107°E as „backbone" along the drowned Molengraaff valley.

After first seismic profiling ceased by heavy sea, two sediment cores including one 14 metres piston core were taken from the Sunda continental slope at 6° 22.4′ N, 111° 49.1′ E and 6° 38.8′ N, 111° 52.3′ E for an ODP-presite study on December 24.

Weather conditions calmed during Christmas, so that for the most part of key area 2 a complete seismic survey could be performed using air-gun, Boomer and Parasound systems. 22 seismic profiles were recorded in 3 legs, each leg followed by a sampling campaign with the different coring devices including a multicorer profile along the continental slope. 37 sediment stations were sampled in this area covering the continental slope, shelf and former coastal zone of the adjacent Pleistocene Sunda-land in the SW.

In the early morning of January 8 1997, we started the last part of the cruise with continuing calm weather following the lowest part of the Pleistocene Molengraaff valley-system upstream in SW direction. Cross-profiles SE of Natuna-Island and between 2° 20′ and

2° 30′ N completed the seismic survey and provided additional sampling sites for 18 sediment stations altogether.

We finished our work in the morning of January 14 and arrived at Singapore in the afternoon of January 15.

6.1. SEISMICS

During cruise 115 of the R/V SONNE, a total of 3007 km of air gun profiles and 1096 km of boomer profiles were run. These profiles were located within the depth range of 34 to 2025 m. Parasound records were obtained on almost all profiles of the cruise.

EQUIPMENT DEPLOYED

Reflection seismic system with an air gun cluster

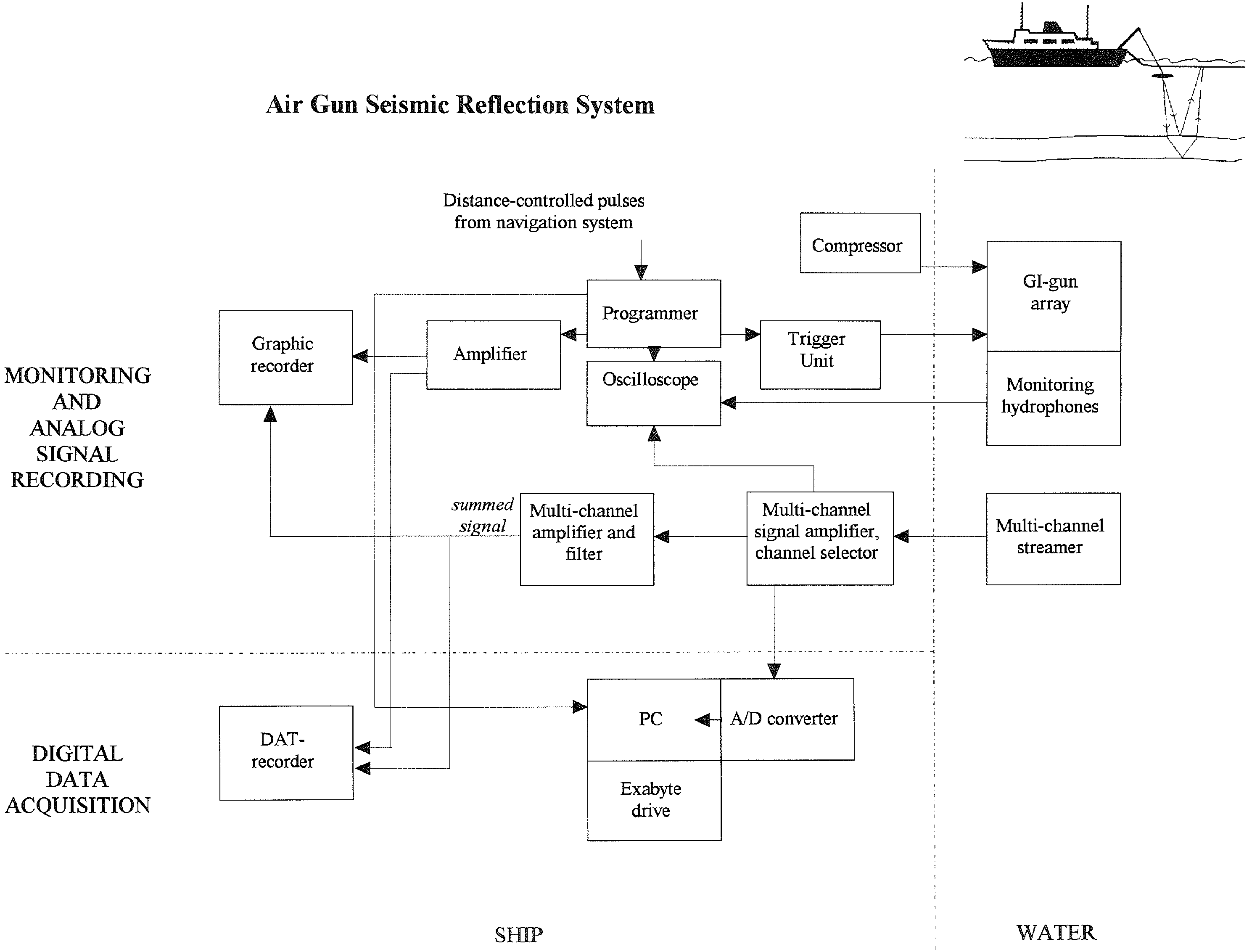
This system consists of (Fig. 7):

- a two GI-gun cluster with a maximum total volume of 420 in^3 (6,72 *l*); operating either in the GI-mode (primary amplitude/secondary amplitude >7) or in the harmonic mode (primary amplitude/secondary amplitude >4)
- a hydrophone for monitoring the near field source signal
- a streamer with four active sections, each 50 m in length, of which the first 25 m are inactive. This streamer can be configured selectively as a 4- or 8-channel array
- a trigger unit
- an amplifier and filter unit
- an EPC facsimile recorder for analog recording of the summed signal of all channels (for monitoring purposes)
- a DAT recorder for digital recording of the summed seismic signal of all channels, and
- a computer-controlled digital multi-channel data acquisition system with an EXABYTE drive as recording device; sampling rate: 1 kHz.

Functions implemented

- Transmission of acoustic signals which propagate as compressional waves through the water column and the subbottom to be reflected at interfaces with significant impedance contrasts
- Four-fold coverage for CMP-stacking of the seismic traces
- High resolution of approximately the uppermost 2 km of the subbottom
- Acquisition of seismic profiles with which seismic sequences and parasequences as well as unconformities can be recognized and seismic facies types differentiated.

Fig. 7: Schematic diagram of the seismic reflection system with an air gun cluster as sound source.



Air Gun Seismic Reflection System

Fig. 7

Acoustic and operational characteristics

- Source signal within the frequency range of ca. 10-250 Hz
- Profiling speed of the ship: ca. 4 knots
- Towing of the air gun cluster using the A-frame of the R/V SONNE approximately 25 m behind the ship and at a depth of ca. 2,5 m below the water surface
- Operation of the air gun cluster with a nominal pressure of 150 bar
- Operation of the air gun cluster in the GI-mode with a generator-to-injector volume ratio of 45:105 in^3; injector delay: 37 ms
- Distance-controlled triggering of the air gun cluster at 25 m intervals by means of TTL pulses derived from the shipboard navigation system
- Towing of the streamer from port approximately 175 m behind the ship at a depth of ca. 20 m beneath the water surface.

Boomer system

This system consists of (Fig. 8):

- a GEOPULSE boomer
- a mini-streamer with 20 hydrophones spaced at 15 cm intervals; the total length is approximately 7,5 m
- a power supply with a maximum power of 280 Joules, a maximum voltage of 4000 V, a minimum triggering interval of 150 ms
- an amplifier and filter unit
- a EPC facsimile recorder for analog recording of the seismic signal and
- a computer-controlled digital data acquisition system with a sampling rate of 10 kHz.

Functions implemented

- Transmission of acoustic signals which propagate as compressional waves through the water column and the subbottom to be reflected at interfaces with significant impedance contrasts
- High resolution of approximately the uppermost ca. 150 m of the subbottom
- Acquisition of seismic profiles with which in particular seismic parasequences and unconformities can be recognized and seismic facies types differentiated.

Acoustic and operational characteristics

- Source signal within the frequency range of 500 Hz to 14 kHz
- Towing of the boomer from a starboard winch approximately 5 m below the water surface
- Towing of the mini-streamer from starboard approximately 20 m behind the boomer
- Profiling speed of the ship: ca. 4 knots

Problems with the mini-streamer (multiple cable breaks) were encountered many times during the deployment of the boomer system. Our experience shows that this system is very sensitive to sea state.

Fig. 8: Schematic diagram of the high resolution boomer system.

GEOPULSE High Resolution Seismic Reflection System (Boomer)

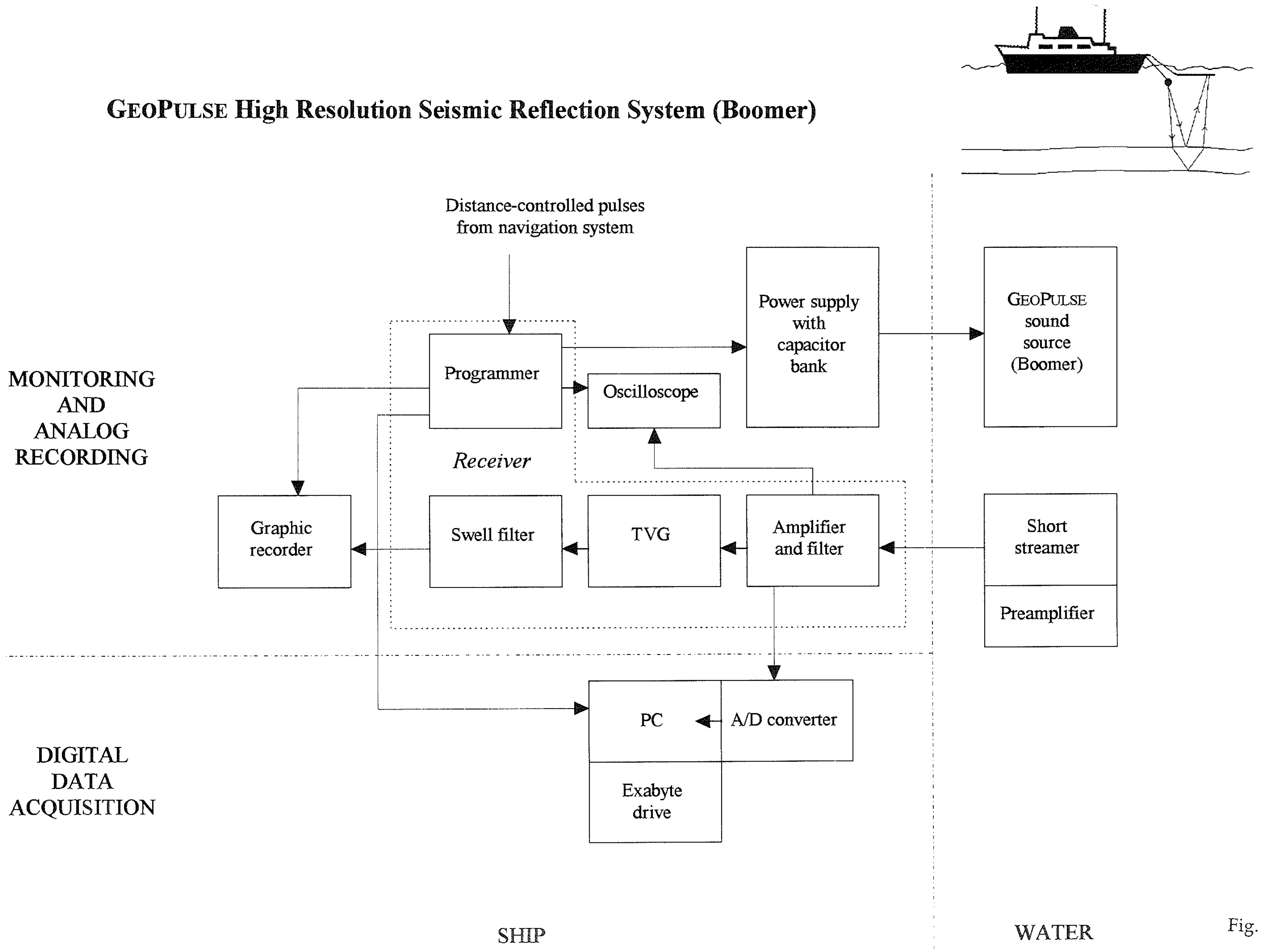


Fig. 8

Shipboard PARASOUND system

This system consists of:

- the PARASOUND system of ATLAS-Elektronik GmbH comprising:
    - a hull-mounted transducer
    - a model DESO 25 recording unit
    - an analog facsimile recorder
    - several control and monitoring units
- the PARADIGMA system for the digitization of the PARASOUND signals (sampling rate: 40 kHz) and coupling to a PC control system
- a color monitor and a color printer for data output
- a 9-track magnetic recorder for data storage, and
- a printer for data logging at 2 min. intervals.

Functions implemented

- Transmission of acoustic signals which propagate as compressional waves through the water column and the subbottom to be reflected at interfaces with significant impedance contrasts
- High resolution of approximately the uppermost ca. 100 m of the subbottom
- Acquisition of high resolution seismic profiles with which in particular seismic facies types can be differentiated.

Acoustic and operational characteristics

- Source signal within the frequency range of 2,5 to 5,5 kHz using the parametric effect whereby the constructive interference of two highly directional signals of similar frequencies (upper frequency: 18 kHz, lower frequency: 20,5 to 23,5 kHz) produces a low difference frequency
- Angle of the radiation cone: 4°
- Area irradiated: 7 % of the water depth
- Depth of penetration: up to ca. 150 m depending on the bottom characteristics
- Profiling speed of the ship: ca. 4 knots (when the air gun system is deployed simultaneously) to 12 knots

---

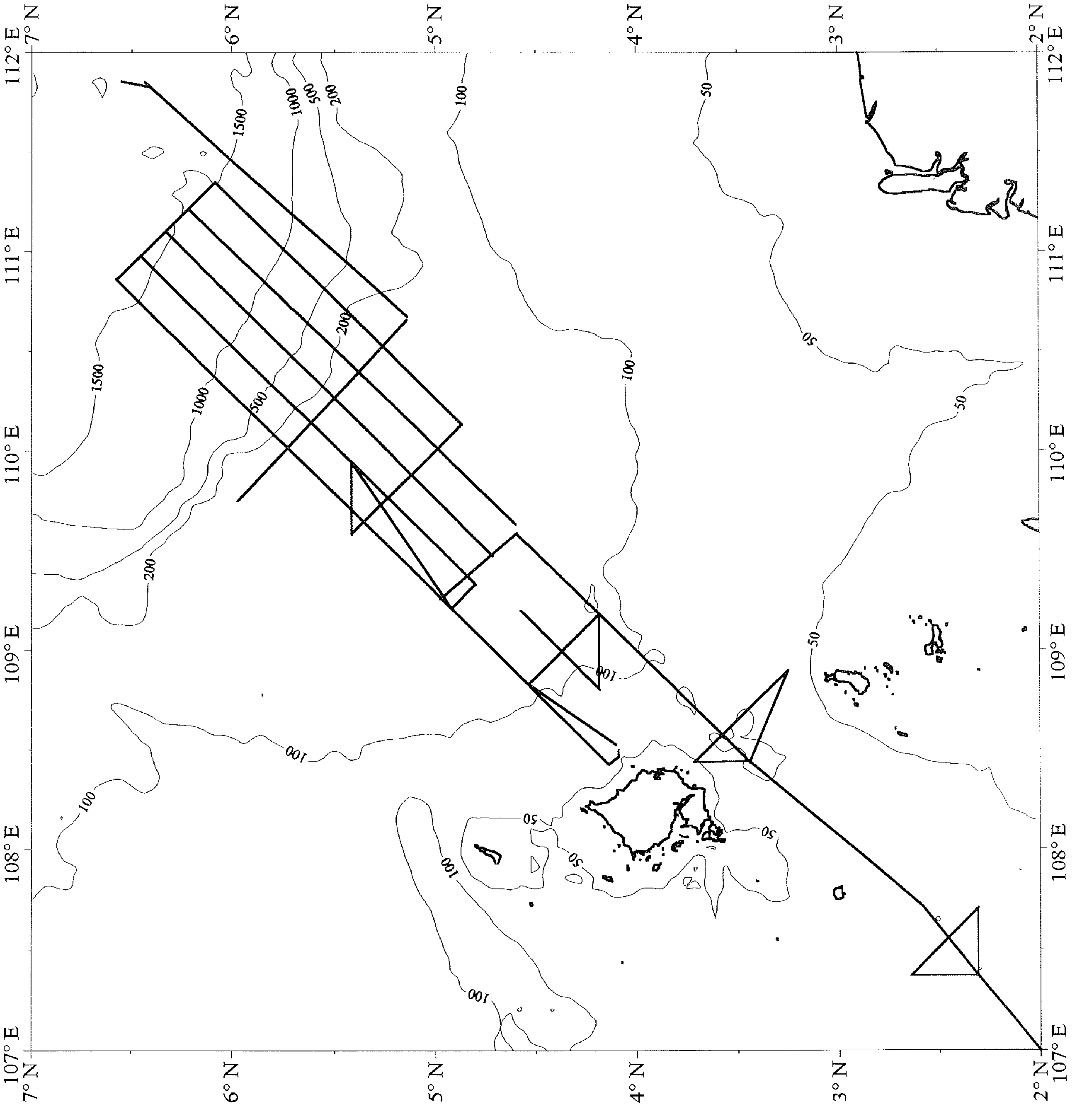
Fig. 9: Locations of the air gun profiles, cruise 115 of the R/V SONNE.

Fig. 10: Locations of the boomer profiles, cruise 115 of the R/V SONNE.

Fig. 11: Locations of the PARASOUND profiles in the study areas 1 (a) and 2 (b).

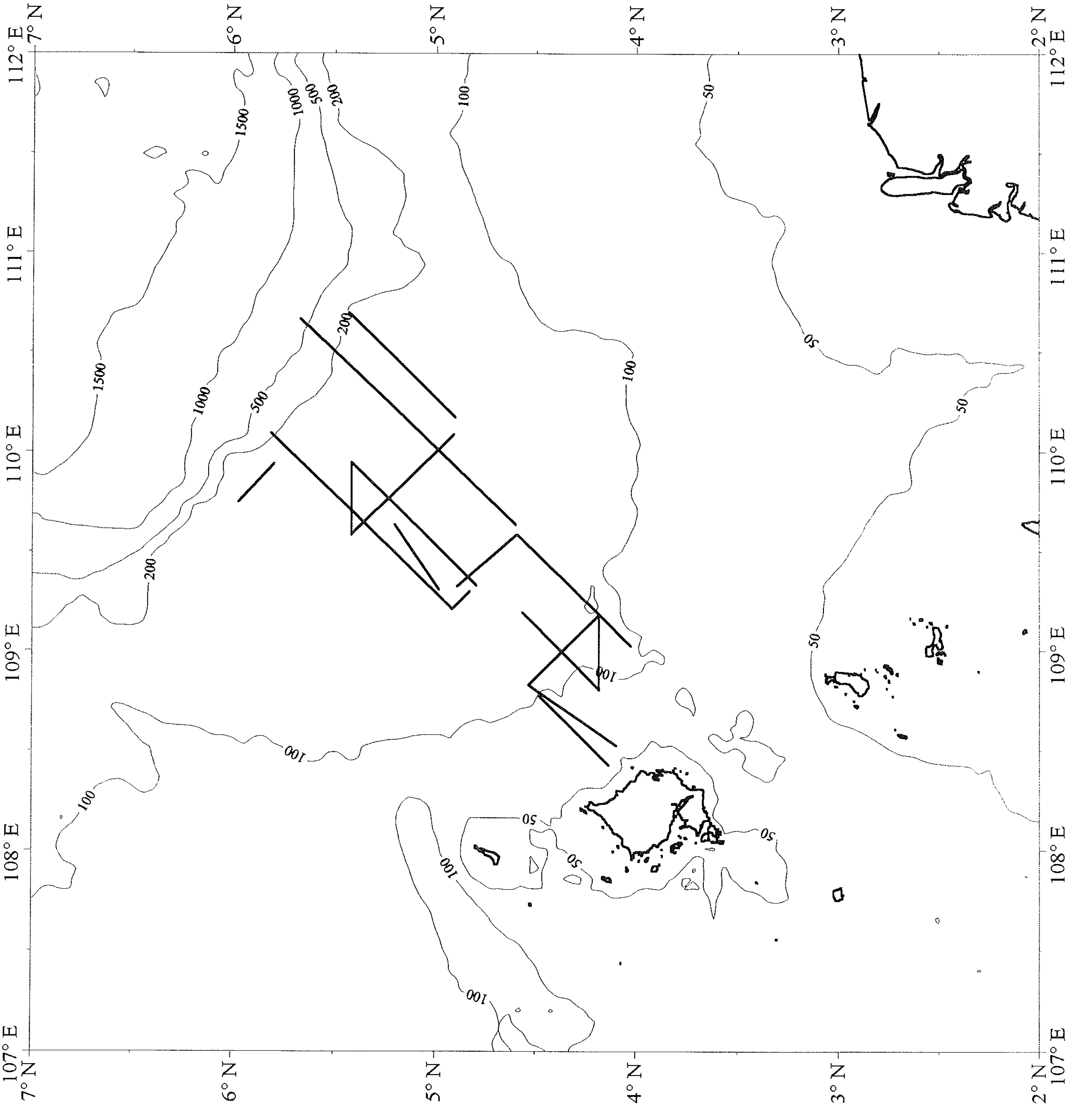
Table 2: Seismic reflection profiles with the air gun system.

Table 3: Boomer profiles.



7° N
6° N
5° N
4° N
3° N
2° N
107° E
108° E
109° E
110° E
111° E
112° E
1500
1000
500
200
100
50

Fig. 9



112° E
7° N
6° N
5° N
4° N
3° N
2° N
111° E
110° E
109° E
108° E
107° E
1500
1000
500
200
100
50

Fig. 10

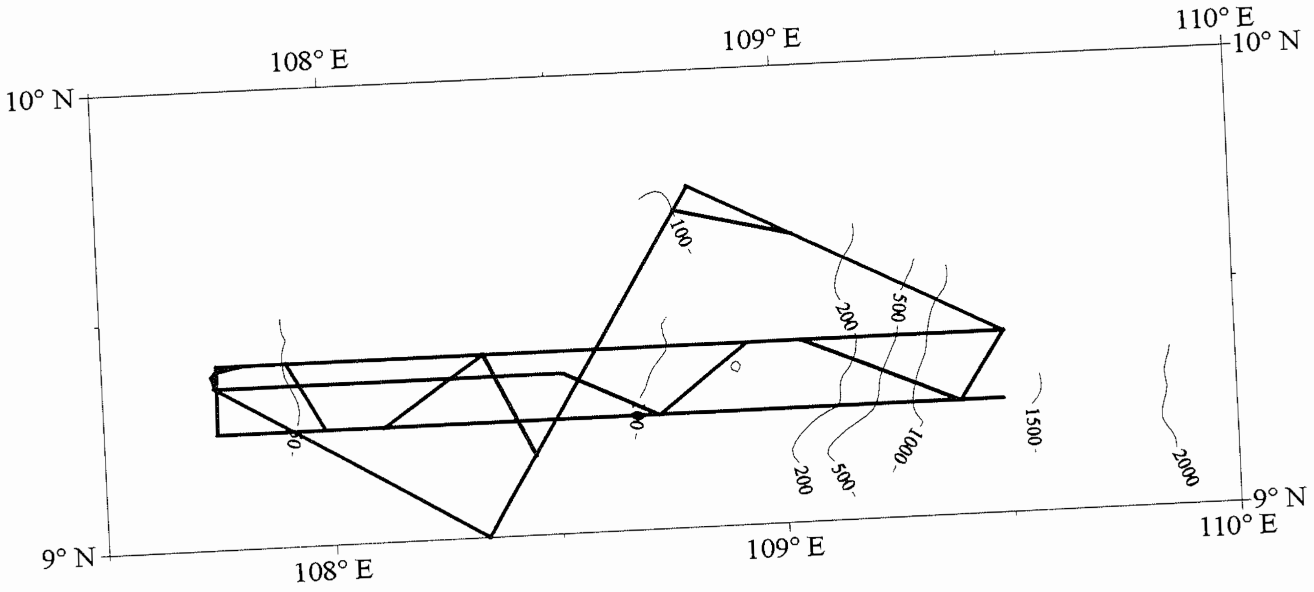

108° E
109° E
110° E
10° N
10° N
100
200
500
1000
1500
2000
200
500
9° N
108° E
109° E
9° N
110° E

Fig. 11a

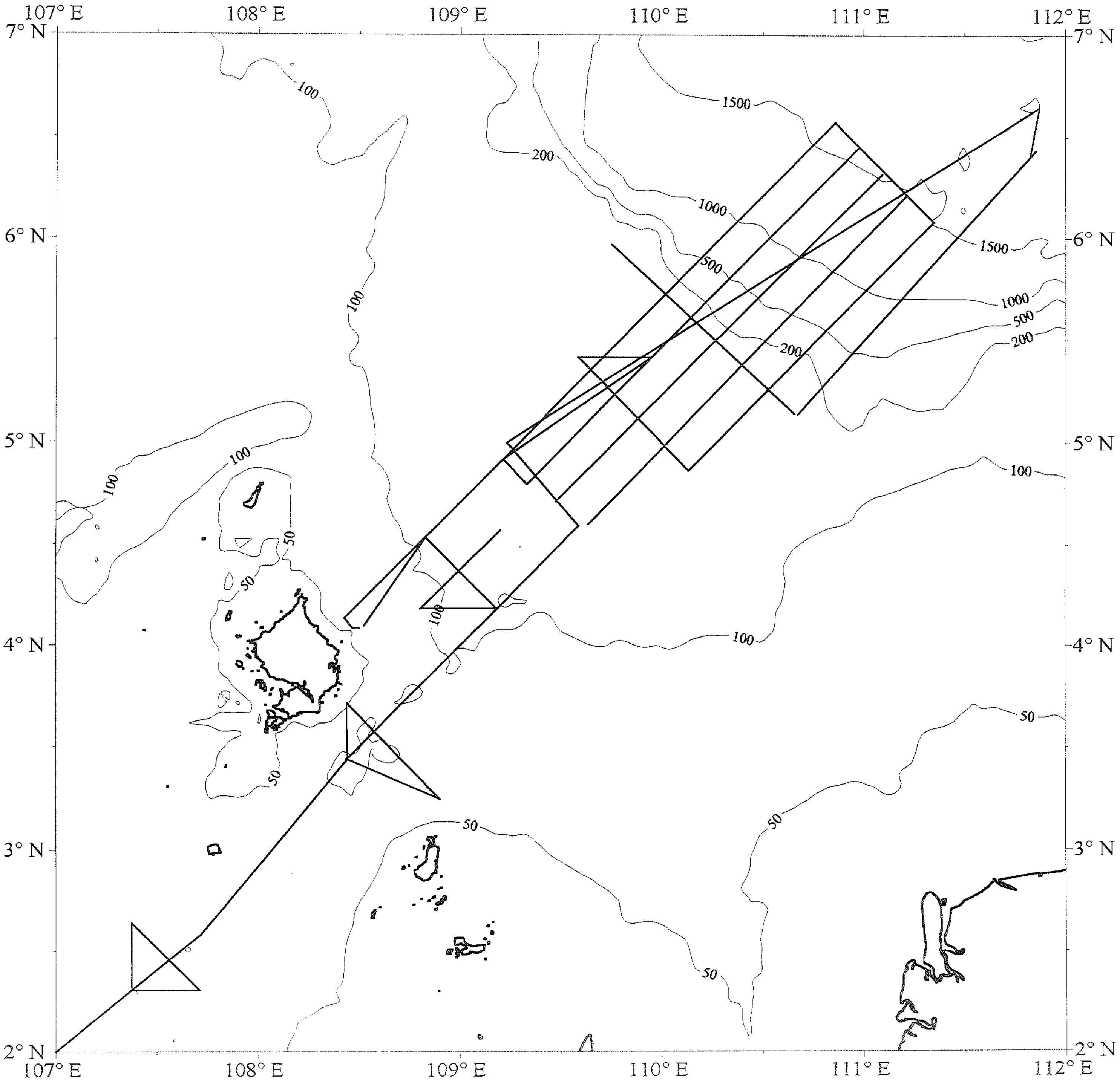

107° E
108° E
109° E
110° E
111° E
112° E
7° N
6° N
5° N
4° N
3° N
2° N
100
200
1500
1000
500
200
100
50
50
50
50
50
100
100
100
100
50
50
1000
500
200
1500

Fig. 11b

Tab. 2: **Seismic Reflection Profiles with an Air Gun System, Cruise 115 of the R/V SONNE, Project SUNDAFLUT**

Profil-No.	Start					End					Course	Duration	Profile length (km)
	Date (UTC)	Time (UTC)	Latitude	Longitude	Water depth (m)	Date (UTC)	Time (UTC)	Latitude	Longitude	Water depth (m)			
11	21.12.96	20:00	5°58.19 N	109°44.99 E	156	22.12.96	14:02	5°08.54 N	110°39.42 E	133	135°	18 h 2 min	136,1
12	22.12.96	14:13	5°08.33 N	110°40.46 E	131	23.12.96	11:16	6°26.00 N	111°51.00 E	1954	40°	21 h 3 min	193,5
13	23.12.96	19:35	6°24.05 N	111°49.43 E	1884	23.12.96	22:00	6°32.88 N	111°51.15 E	2025	10°	2 h 25 min	16,7
15	25.12.96	01:32	4°58.51 N	109°15.56 E	118	25.12.96	08:24	4°35.75 N	109°35.33 E	112	135°	6 h 52 min	55,2
16	25.12.96	08:37	4°36.01 N	109°38.08 E	112	26.12.96	15:20	6°12.78 N	111°12.79 E	1474	45°	30 h 43 min	250,9
17	26.12.96	15:30	6°13.46 N	111.07.42 E	1482	26.12.96	17:19	6°19.15 N	111°06.40 E	1520	315°	1 h 49 min	11,3
18	26.12.96	17:30	6°19.24 N	111°05.59 E	1516	27.12.96	21:51	4°42.90 N	109°28.62 E	108	225°	28 h 21 min	252,2
19	29.12.96	02:53	4°52.29 N	110°07.69 E	125	29.12.96	14:10	5°24.85 N	109°35.50 E	127	315°	11 h 17 min	86,3
20	29.12.96	14:29	5°24.99 N	109°34.99 E	128	29.12.96	19:51	5°25.00 N	109°56.80 E	151	90°	5 h 22 min	40,6
21	29.12.96	20:20	5°24.93 N	109°56.80 E	151	30.12.96	09:09	4°47.96 N	109°19.99 E	119	225°	12 h 49 min	96,7
22	30.12.96	10:17	4°47.99 N	109°19.94 E	119	30.12.96	12:47	4°55.13 N	109°12.83 E	116	315°	2 h 30 min	18,3
23	30.12.96	13:13	4°55.29 N	109°12.91 E	117	31.12.96	21:14	6°34.40 N	110°51.48 E	1615	45°	32 h 1 min	257,4
24/25	31.12.96	21:43	6°34.00 N	110°41.58 E	135	01.01.97	06:07	6°05.00 N	111°21.00 E	1500	135°	8 h 24 min	89,6
26	01.01.97	06:24	6°05.00 N	111°21.00 E	1500	02.01.97	05:32	4°52.00 N	110°08.00 E	125	225°	23 h 8 min	190,8
27	03.01.97	13:36	6°27.13 N	110°58.66 E	1573	04.01.97	07:54	5°25.00 N	109°56.86 E	151	225°	18 h 18 min	161,9
28	04.01.97	07:55	5°25.00 N	109°56.86 E	151	04.01.97	19:56	4°55.18 N	109°12.79 E	116	235°	12 h 1 min	98,3
29	04.01.97	19:56	4°55.18 N	109°12.79 E	116	05.01.97	13:45	4°05.28 N	108°22.75 E	75	225°	17 h 49 min	130,8
30a)	05.01.97	13:45	4°05.25 N	108°22.75 E	75	05.01.97	14:40	4°05.25 N	108°28.06 E	76	152°	55 min	5,5
30 b)	05.01.97	14:40	4°05.25 N	108°28.06 E	76	05.01.97	15:18	4°32.26 N	108.30.00 E	79	90°	38 min	4,5
30 c)	05.01.97	15:29	4°05.80 N	108°31.40 E	78	05.01.97	23:20	4°31.82 N	108°49.56E	104	35°	7 h 51 min	59,6

Profil-No.	Start					End					Course	Duration	Profile length (km)
	Date (UTC)	Time (UTC)	Latitude	Longitude	Water depth (m)	Date (UTC)	Time (UTC)	Latitude	Longitude	Water depth (m)			
31	05.01.97	23:25	4°32.10 N	108°49.75 E	102	06.01.97	06:53	4°11.11 N	109°10.90 E	109	135°	7 h 28 min	54,8
32	06.01.97	07:27	4°11.06 N	109°11.07 E	108	06.01.97	15:43	4°35.50 N	109°35.00 E	113	45°	8 h 16 min	64,1
33	07.01.97	21:13	4°34.37 N	109°12.01 E	108	08.01.97	05:20	4°11.04 N	108°48.35 E	92	225°	8 h 7 min	61,5
34	08.01.97	05:42	4°11.00 N	108°48.34 E	92	08.01.97	11:16	4°11.00 N	109°10.93 E	106	90°	5 h 34 min	42,4
35	08.01.97	11:49	4°11.00 N	109°11.00 E	109	09.01.97	02:20	3°26.48 N	108°26.47 E	100	225°	14 h 31 min	117,8
36	09.01.97	02:42	3°26.50 N	108°26.50 E	109	09.01.97	06:28	3°42.83 N	108°26.49 E	34	360°	3 h 46 min	29,6
37	09.01.97	06:45	3°42.77 N	108°26.53 E	36	09.01.97	15:43	3°15.00 N	108°54.00 E	73	135°	8 h 58 min	72,0
38	09.01.97	16:09	3°15.00 N	108°54.00 E	77	09.01.97	23:36	3°26.51 N	108°26.44 E	109	292°	7 h 27 min	56,3
39	11.01.97	00:56	3°26.50 N	108°26.50 E	101	11.01.97	17:32	2°35.00 N	107°43.00 E	97	220°	16 h 36 min	126,1
40	11.01.97	17:32	2°35.00 N	107°43.00 E	97	11.01.97	23:56	2°18.50 N	107°22.50 E	86	232°	6 h 24 min	47,4
41	12.01.97	00:24	2°18.51 N	107°22.50 E	92	12.01.97	05:18	2°38.54 N	107°22.50 E	77	1°	4 h 54 min	37,0
42	12.01.97	05:38	2°38.50 N	107°22.50 E	86	12.01.97	12:37	2°18.50 N	107°42.50 E	67	135°	6 h 59 min	52,4
43	12.01.97	12:58	2°18.52 N	107°42.47 E	67	12.01.97	17:59	2°18.45 N	107°22.41 E	95	270°	5 h 1 min	37,0
44	12.01.97	18:00	2°18.45 N	107°22.41 E	95	13.01.97	01:08	1°59.98 N	106°59.97 E	70	231°	7 h 8 min	52,6
											total:	15 d 13 h 27 min	3007,2

Tab. 3: **Boomer Profiles, Cruise 115 of the R/V SONNE, Project SUNDAFLUT**

Profil-No.	Start					End					Course	Duration	Profile length (km)
	Date (UTC)	Time (UTC)	Latitude	Longitude	Water depth (m)	Date (UTC)	Time (UTC)	Latitude	Longitude	Water depth (m)			
11	21.12.96	20:00	5°58.19 N	109°44.99 E	156	21.12.96	23:55	5°47.76 N	109°56.45 E	161	135°	3 h 55 min	27,4
15	25.12.96	03:00	4°53.68 N	109°19.59 E	113	25.12.96	08:20	4°35.96 N	109°35.09 E	114	135°	5 h 20 min	43,3
16	25.12.96	08:37	4°36.01 N	109°38.08 E	112	26.12.96	05:10	5°39.86 N	110°39.83 E	601	45°	20 h 33 min	164,6
19	29.12.96	03:40	4°54.63 N	110°05.35 E	128	29.12.96	14:10	5°24.85 N	109°35.50 E	127	315°	10 h 30 min	77,0
20	29.12.96	14:29	5°24.99 N	109°34.99 E	128	29.12.96	19:51	5°25.00 N	109°56.80 E	151	90°	5 h 22 min	40,6
21	29.12.96	20:20	5°24.93 N	109°56.80 E	151	30.12.96	09:09	4°47.96 N	109°19.99 E	119	225°	12 h 49 min	96,7
22	30.12.96	10:56	4°49.83 N	109°18.11 E	116	30.12.96	12:47	4°55.13 N	109°12.83 E	116	315°	1 h 51 min	13,0
23	30.12.96	13:13	4°55.29 N	109°12.91 E	117	31.12.96	07:34	5°48.44 N	110°05.59 E	211	45°	18 h 21 min	138,5
26	01.01.97	17:40	5°25.89 N	110°41.87 E	186	02.01.97	04:40	4°54.47 N	110°10.45 E	127	225°	11 h 0 min	83,7
28	04.01.97	12:27	5°12.33 N	109°38.13 E	128	04.01.97	18:20	4°59.17 N	109°18.69 E	117	235°	7 h 53 min	42,6
29	05.01.97	06:30	4°29.07 N	108°46.53 E	100	05.01.97	13:45	4°05.28 N	108°22.75 E	75	225°	7 h 15 min	62,8
30 c)	05.01.97	15:29	4°05.80 N	108°31.40 E	78	05.01.97	23:20	4°31.82 N	108°49.56E	104	35°	7 h 51 min	59,6
31	05.01.97	23:25	4°32.10 N	108°49.75 E	102	06.01.97	06:53	4°11.11 N	109°10.90 E	109	135°	7 h 28 min	54,8
32	06.01.97	07:27	4°11.06 N	109°11.07 E	108	06.01.97	15:43	4°35.50 N	109°35.00 E	113	45°	8 h 16 min	64,1
33	07.01.97	21:22	4°33.96 N	109°11.60 E	111	08.01.97	05:20	4°11.04 N	108°48.35 E	92	225°	7 h 58 min	61,5
34	08.01.97	05:42	4°11.00 N	108°48.34 E	92	08.01.97	11:16	4°11.00 N	109°10.93 E	106	90°	5 h 34 min	42,4
35	08.01.97	11:49	4°11.00 N	109°11.00 E	109	08.01.97	15:10	4°01.53 N	109°01.52 E	102	225°	3 h 22 min	23,5
											total	6 d 1 h 18 min	1096,1

DATA PROCESSING AND INTERPRETATION ON LAND

The main objective of the SUNDAFLUT project is the reconstruction and modeling of the post-glacial transgression on the Sunda shelf. Reflection seismic profiles of different resolutions (Fig. 9-11, Tables 2-3) oriented sub-perpendicular to the shelfedge permit: (1) mapping of the delta-fan complex of the former Molengraaff fluvial system which existed during the late Pleistocene and the early Holocene, as well as (2) reconstruction of a detailed sea level fluctuation curve for the southern South China Sea. By means of quantitative determinations of aggradation and coastal encroachment using the seismic profiles available, an onlap curve may be established. This curve can be converted to a relative sea level curve by using micropaleontological, biofacies and sediment facies estimates of the paleo-water depth and the amount of erosion as well as by using conventional and AMS-^{14}C dating.

Detailed bathymetric maps have been compiled using navigational and HYDROSWEEP data of the SONNE cruise, as well as bathymetric data from GEODAS of the National Geophysical Data Center, Boulder, Colorado, USA and digitized coastlines from the GEBCO-Atlas of the British Oceanographic Data Centre, Birkenhead, UK. In addition, depth contours within the study area from the GEBCO-Atlas and from a bathymetric map of the South China Sea Institute of Oceanography of Academia Sinica (1:300000, 1984) have been taken into account.

The seismic data will be demultiplexed and converted into the SEGY-format using the MSEIS data acquisition program. Seismic processing including sorting, filtering, deconvolution, NMO, CMP-stacking and migration will be carried out using the iXL processing software package.

Interpretation of the processed data will make use of the seismic-stratigraphic concept. Seismic sequences as equivalents of depositional sequences can be recognized using unconformities and their correlative conformities as boundaries. Of particular importance are the reflection terminations such as onlap, downlap, toplap or truncation. By characterizing the internal reflection configuration, the external geometry, the lateral seismic facies transitions and the stacking pattern of parasequences as well as by assigning each seismic facies unit to a particular depositional environment, the sequences may be subdivided into systems tracts (lowstand, shelf margin, transgressive and highstand systems tracts). Recognition of the transgressive surfaces and the maximum flooding surfaces and quantitative determination of aggradation and coastal encroachment would permit a detailed reconstruction of the transgressive events.

The sequence stratigraphic delta-fan model deduced from our seismic reflection studies will be verified and put into a chronostratigraphic framework by correlation with results from the study of sediment samples. In addition, isopach maps and facies distribution maps for the various depositional units will be constructed. An attempt will be made to verify and fine-tune our reconstruction of the sea level events by stratigraphic modeling using programs such as STRATA.

6.2. SEDIMENT SAMPLING

BOX CORING

We used a standard spade box corer with the following technical specifications:

size of sample box: 50x50 cm in square, 60 cm high
net weight: about 1100 kg (deep sea version)
producer: Wuttke, Henstedt-Ulzburg, near Hamburg

Immediately after the box cores arrived on the deck of RV Sonne, temperature of the sediment 5 cm below surface and seawater in the box corer were measured using an AMA-digit AD 30 TH precision digital thermometer with a 0,1 °C precision. The sediment temperatures were generally consistent and provided a reasonable estimate of bottom water temperatures. However, the water temperatures in the box corer were strongly fluctuating and generally at least 10 °C higher than the sediment temperatures, indicating a significant water flow into the closed box corer during the hauling.
After the temperature measurement the seawater was carefully sucked off and filtered over a 63 µm sieve to save floating epifaunal organisms such as small komokiaceans (fragile agglutinating foraminifera living at the water-sediment interface) and benthic foraminifera that live within the fluffy layer above the sediment surface. Then the sediment box removed from the coring device. The morphology and composition of the sediment surface was described and the fluffy organic material in the remaining seawater above the sediment surface was sampled. The sediment surface was carefully surveyed for epifaunal benthic foraminifera. Large agglutinating forms were sampled, counted, examined, and partly photographed on board ship.

The following subsamples were removed from the sediment surface (* samples were immediately preserved in a seawater - methanol - Rose Bengal solution):

working group	*amount*	*purpose*
Kienast/Calvert	20 cc	organic geochemistry
Stattegger	100 cc	sedimentology
Pflaumann	20 cc	planktic foraminifers
Pracht/Stattegger	50 cc	anorganic geochemistry
Szarek/Kuhnt*	4x100 cc	benthic foraminifers
Kawamura	20 cc	pollen

Surface description and sampling scheme

The distance of the sediment surface to the top of the box corer was measured at the corners of the metal box to calculate the average recovery and to recognize a potential tilt of the corer during penetration. The penetration depth also provides preliminary information on water content, compaction and grain composition of the sediment.

The surface of the box corer was examined for the following features:

1. presence and abundance of organic fluff at the sediment water interface
2. grains size of sediment, winnowing
3. type of sediment (carbonate, foraminiferal ooze, mud)
4. sediment color
5. biogenic structures: worm tubes, burrows, epifaunal agglutinated foraminifers
6. macroscopically visible tests of foraminifera and pteropodes
7. morphology of the surface (flat, sloped, small scale hills and valleys)

Four metal frames of 10 x 10 cm size (A-D in the sampling scheme) were placed on the sediment surface according to morphologic and sedimentologic features to obtain subsamples of as many varieties of substrates as possible.

Vertical sections and downcore sampling scheme

The vertical section of each core was described at the opened front side of the box corer. Munsell color values were determined using the GSA Rock Color Chart. Each core sections was photographed for documentation and the core description recorded in scale 1:2 scale. For this cruise report we only give an abbreviated version of the core description in table 5 A-E.

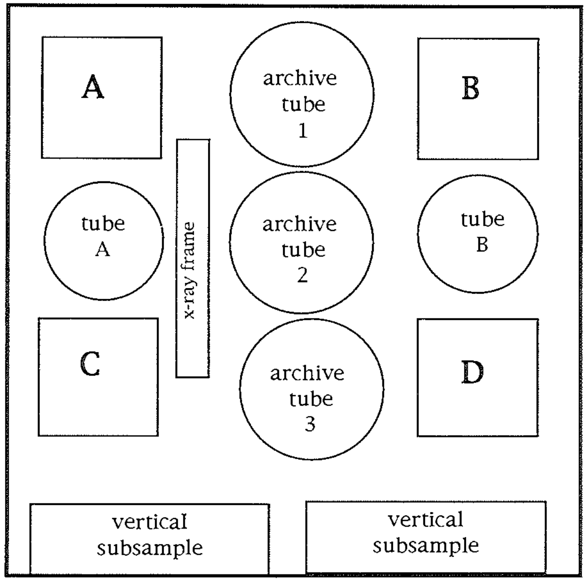
Pushcores of 10 (benthic foraminifera) and 12 cm diameter (archive) were pushed into the sediment, using a hand-hold piston to avoid extreme compaction. The pushcores taken for examination of the downcore distribution of living/dead benthic foraminifera were cut into 1 cm thick slices immediately after sampling. Each 80cc subsample from the uppermost 10 cm of the sediment column was immediately preserved in a methanol-seawater solution and treated with Rose Bengal to stain organisms that were alive at the time of collection.

After surface and push core sampling of the box cores the front of the metal frame was removed and the sediment profile was photographed and described. Special attention was given to changes in sediment colors, position of the redox boundary, and bioturbation features. After description the vertical profile was sampled in 5 cm intervals using 5cc and 10cc syringes. Part of the vertical profile was cut out with brick-shaped plastic boxes (30 x 15 x 10cm) as an additional archive core that will be used for X-ray photographs of bioturbational structures.

Fig. 12: Box core sampling scheme during cruise Sonne 115.

SO-115 BOXCORES

SURFACE SAMPLING SCHEME



front of boxcorer

1. A-D: 1cm thick surface samples taken with 10x10 cm metal frames "Lutze-spoon" samples in Methanol/Rose Bengal for micropaleontology

2. tubes A-B: 10 cm plastic pushcores, for extruding. Samples will be sliced in 1 cm slices. Uppermost 10 cm (or less, depending on sedimentology) are preserved in Methanol/Rose Bengal, the others are sealed in plastic bags

3. archive tubes 1-3: 12 cm plastic pushcores. Capped and sealed.

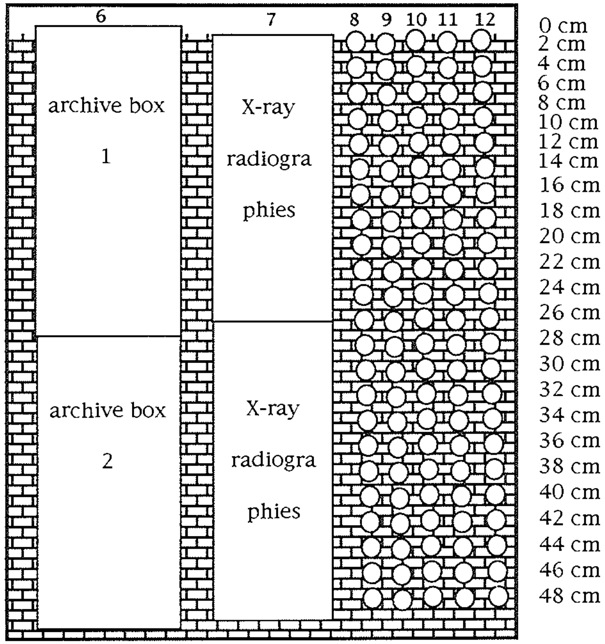
4. x-ray frame: metal frame pushed in boxcorer to get undisturbed sample for x-ray analysis. Opened and subsampled for x-ray-plastic frames

5. additional surface (1 cm) samples (taken with spoon between tubes and frames):

5a. 10 cc for planktic foraminiferal counts (Szintillation bottle, labelled "Pflaumann")
5b. 50 cc for clay mineralogy (small Kautex bottle or plastic bag)
5c. 20 cc for organic geochemistry (TOC) (Szintillation bottle, labelled TOC)
5d. 20 cc for palynology

SO-115 BOXCORES

DOWNCORE SAMPLING SCHEME



After photographs and description of the opened boxcore side:

6. archive boxes

7. x-ray samples

8. 1 set of syringe samples for palynology (label A)

9. 1 set of syringe samples for water and carbonate content (label B)

10. 1 set of syringe samples for TOC (label C)

11. 1 set of syringe samples for micropaleontologic studies of the < 63 micron fraction (i.e. nanno, siliceous plankton) (label D)

12. 1 set of syringe samples for oxygen isotope stratigraphy (label E)

Fig. 12

Table 4A

GIK station	water depth (m)	sedim. temp. (°C)	max./min. depth of surface	sediment type	surface morphology	biogenic structures and macrofauna	visible microfauna
18248-1	103		47/32 cm	sandy mud	disturbed, washed out	starfish, corals	
18249-1	133		38/22 cm	silty-fine sandy mud	disturbed (by coring), strong relief	burrows, living polychaete worms, gastropode and bivalve shells	
18250-1	148	22,7°	21/7cm	mud	disturbed, irregular, washed out	bivalve shells	
18251-2	154		50 cm	hardground		bryozoans	
18252-1	1277	3,4°	8/2 cm	mud	slightly disturbed, small relief		
18253-1	1479		6/5 cm	mud			
18254-1	145		21/12 cm	mud	disturbed (tilted by coring), strong relief, washed out	shell fragments	agglutinated tubular forams
18255-1	102		14/12 cm	sandy mud	smooth (partly tilted)	shell fragments	sponge spiculae, agglutinated „Nothia"-like forams
18256-1	92		47/35 cm	sandy-silty mud	oscillation ripples (amp. 1-2 cm)	shell fragments (0,5 cm ø)	
18257-2	88		44/36 cm	silty sand	oscillation ripples (amp. 1 cm)	shell fragments (0,4 cm ø)	
18258-1	88		33/24 cm	sandy-silty mud	smooth	traces, shell fragments	
18259-2	88		19 cm	sandy mud	flat, some fluff	shell fragments	
18260-1	74		23/19 cm	coarse sand	rough (significantly tilted)	shell fragments	
18261-3	68	26,2°	19/18 cm	silty-sandy mud			
18262-1	56	25,5°	26/22 cm	sandy-silty mud		shell fragments (0,5 cm ø)	
18263-1	51	25,1°	55/37 cm	sandy-silty mud	destroyed	shell fragments (0,5 cm ø)	
18264-1	48	24,7°	30/26 cm	sandy-silty mud	smooth, flat	gastropode shells (2 cm ø), shells and shell fragments	
18265-1	47		26/22 cm	fine-medium sand	flat, muddy patches (several cm ø)	lots of gastropodes (Turitella), bivalve shells	
18266-1	47		37/25 cm	sandy mud-sand	disturbed (strongly tilted), fine material washed out	polychaete worm-tube (1 cm ø), gastropodes (Turitella), bivalve shells	
18267-1	1852	2,5°	1 cm	mud	disturbed (deep penetration), some fluff mostly washed out	bioturbation mound	
18268-1	1974	2,1°	7/4 cm	mud	disturbed, washed out		planctic forams
18269-1	114	25,5°	6/4 cm	sandy mud	disturbed, relief	bivalve shells and shell fragments (<1 cm ø)	
18270-1	106	20,6°	7/4 cm	sand with silt	disturbed, relief	shells and shell fragments (1 cm ø)	
18271-1	116	20,0°	1 cm	clayey-silty sand	disturbed (deep penetration)	shell fragments	
18272-1	121	20,8°	0 cm	clayey sand	irregular with elevations (~2-3 cm)	numerous open burrows	
18273-1	127	21,0°	1 cm	sandy mud	slightly disturbed (deep penetration)	burrows, open worm tubes	agglutinated forams (Rhabdammina gr.)
18274-1	117	21,0°	8/0 cm	clayey sand	wavy with irregular relief	open worm tubes, shell fragments (3-4 mm ø)	agglutinated forams (Rhabdammina gr.)
18275-1	109	20,8°	9/8 cm	clayey sand	smooth	bivalve shells	pteropodes
18276-1	120	20,1°	3/1 cm	clayey sand	disturbed (deep penetration), oscillation ripples (1-2 dm wavelength, amp. 1-2 cm), fluff	open bioturbation holes, shell fragments	sponge spiculae
18277-1	134	19,1°	6/4 cm	sandy mud	irregular with strong relief (4-5 cm deep)	open worm burrows	planctic forams
18278-1	137	18,4°	6/2 cm	sandy mud	irregular with significant relief	small fish, worm tubes with living worms, traces	planctic forams
18279-1	139	18,3°	5/2 cm	silty-fine sandy mud	irregular with strong relief (amp. 5 cm), partly washed out	large burrows (few cm ø), living crustaceans in burrows	planctic forams
18280-1	144	21,4°	7/3 cm	silty-fine sandy mud	significant relief (caused by current (?)), oscillation ripples		
18281-1	145	18,8°	2/0 cm	silty-fine sandy mud	relief (amp. ~2 cm) caused by current (?)	large burrows	
18282-1	152	20,0°	8/7 cm	silty-fine sandy mud	strong relief (amp. 3 cm)	large burrows (2 cm ø)	
18283-1	166	22,7°	8/6 cm	silty-fine sandy mud	strong relief	large burrows (2 cm ø)	
18284-1	226	14,1°	25/23 cm	clayey-silty fine sand	strong relief	bioturbation mounds (12-15 cm ø), trace	
18284-2	226		24 cm rec.	silty-sandy mud	strong relief, some fluff	open burrows (>1 cm ø)	
18285-1	291		31 cm rec.	sandy-silty mud	undisturbed, relief, small elevated ridges (~1 cm), fluff	open worm tubes, hydrozoans	
18286-1	404		39 cm rec.	mud	flat, fluff		agglutinated forams (Saccorhiza ramosa in life position)
18287-2	596		43 cm rec.	mud	flat, small patches, fluff		agglutinated forams (Saccorhiza ramosa in life position)
18288-1	790		43 cm rec.	mud	smooth, fluff		agglutinated forams (Rhizammina sp.)
18289-1	978		36 cm rec.	mud	flat, fluff		pteropode shells
18290-1	1124		38 cm rec.	mud	smooth, fluff	hydrozoans (?)	agglutinated forams (Rhizammina sp.)
18291-1	1208		35 cm rec.	mud	flat, a lot of fluff		planctic forams
18292-1	1309		40 cm rec.	mud	irregular, a lot of fluff, fluff patches and clusters elevated several mm		pteropode shells
18293-1	1404		40 cm rec.	mud	flat, gently sloped, a lot of fluff, fluff pathes and clusters		

Table 4 B

GIK station	water depth (m)	sedim. temp. (°C)	max./min. depth of surface	sediment type	surface morphology	biogenic structures and macrofauna	visible microfauna
18294-3	849	13,2°	6/1 cm	mud	smooth	burrows, starfish (5 cm ø), polychaete worm burrow, traces, sponges (~1 cm ø)	pteropodes, planktic forams, common agglutinated forams
18295-1	117	20,9°	6/5 cm	sandy-silty mud	strong relief (amp. 2 cm)	burrows (1cm ø), shell fragments	
18296-1	118	22,9°	10/8 cm	silty mud	relief	open round mounds (1,5 cm high, 6 cm ø), open burrows, shell fragments	
18297-1	112	23,1°	3/0 cm	soft clayey silt	strong relief (2 cm deep, 15 cm ø)	open burrows, traces	
18298-1	103	23,4°	0 cm	clayey-silty sand	very strong relief (amp. 7 cm)	open burrows	
18299-2	102	23,1°	2/1 cm	clayey-silty sand	strong relief, some fluff partly washed out	intense bioturbation activity, open burrows (2 cm ø), starfish	agglutinated tubular forams
18300-1	94	24,1°	5/1 cm	clayey sand	disturbed (tilted penetration), irregular, strong relief (deep trench)	large open burrows, starfish (5 cm ø), tubular structures (1cm high,1-3 mm ø)	
18301-1	92	24,0°	1cm above	silty-clayey sand	relief (amp. ~2 cm), clay partly washed out	small mounds (10 cm ø), open burrows (lots of <1 cm ø, few 1-2 ø), shell fragments (ø 0,5 cm), small tubes (?)	
18302-1	83	24,3°	5/2,5 cm	clay-silt	undisturbed, strong relief (deep 5 cm)	open burrows (3 cm deep, >3 cm ø, and 0,5 cm deep, 1 cm ø), large shell fragments, bivalve shells (<1 cm ø)	
18303-1	107	23,1°	6/5 cm	clayey-silty sand	strong relief (amp. ~3 cm)	burrows, trace	
18304-1	104	23,2°	0/3 cm above	silty mud	strong relief (4 cm deep)	many open burrows	
18305-1	109	22,7°	2/5 cm above	mud	low relief (deep penetration), fine material washed out	open burrows (7 cm deep, 3 cm ø)	
18306-2	88	24,8°	5 cm above	water saturated mud	smooth	burrows (0,5 cm ø)	
18307-1	100	24,0°	15/13 cm	water saturated mud	wavy, significantly washed out	carbonate bioclasts, small burrows (0,3 cm ø)	agglutinated tubular forams
18308-1	80	25,6°	21/18 cm	silt-sand	mild relief	small bivalve shells (<0,8 cm ø)	
18309-1	84	25,3°	15/11 cm	sandy mud	disturbed, strong diagonal grooves (caused by coring?) covered by thin layer of biogenic sand, partly washed out	bivalve and gastropode shells (<1cm ø)	
18310-1	101	23,9°	12/3,5 cm	mud	disturbed (cracked by coring), strongly washed out	open burrows (5-8 cm ø)	
18311-1	60	25,8°	21/18 cm	water saturated mud	smooth	open burrows (<4 cm ø), crustacean burrows	large agglutinated forams (Rhizammina sp., Rhabdammina sp.)
18312-1	101	23,6°	13/5 cm	silty mud	disturbed (tilted by coring), strong slope, fine material washed out	open burrows (0,5 cm ø and 2-3 cm ø)	agglutinated forams
18313-1	99	23,1°	15/14 cm	sandy mud	relief, partly washed out	rare burrows, sponge	
18314-1	100	23,1°	17/15 cm	clayey sand	relief (amp. ~3 cm)	bivalve shells and shell fragments (<1 cm ø)	
18315-3	69	26,2°	5/1 cm	water saturated mud	smooth	mud clasts (<2 cm ø), burrows (<0,5 cm ø)	
18316-1	71	26,0°	15/12 cm	sandy-silty mud	smooth	few burrows (<2 cm ø), rare bivalve shells (2 mm ø)	
18317-1	96	26,2°	25/10 cm	mud	disturbed (tilted by coring), strong slope, washed out, small Fe2O3 concretions (~1mm ø)		
18318-1	86	26,0°	50/30 cm	water saturated mud	strongly disturbed (tilted by coring)	burrows (<1 cm ø)	
18319-1	81		55/38 cm	water saturated mud	destroyed (tilted by coring), washed out		
18320-1	76	25,7°	13/7 cm	water saturated mud	smooth, gap at the back part of box-corer -3 cm, washed out, some fluff	few burrows	
18321-1	109	25,9°	5/0 cm	water saturated mud	initial sedimentary relief (7 cm deep)	traces (Thalassinoides, 5 mm ø)	agglutinated forams (Dendrophrya?)
18322-1	70	25,9°	5/0 cm	mud	smooth, flat, slightly tilted, gap at the back part of box-corer -1 cm, fluff washed out	small open burrows (<0,5 cm ø), small shell fragments	
18323-1	92	25,3°	8,5/5,5 cm	sandy mud	tilted with gap at the back of box-corer, with depression, some fluff	common small burrows (~3 mm ø), shell fragments (<0,5 cm ø)	

Table 5A

GIK station	water depth (m)	recovery (cm)	layer thickness (cm)	colour	sediment type	biogenic structures	macrofauna and visible microfauna	stratal discontinuities	observations
18248-1	103	17	13	10YR 5/4	sand		bivalve shell fragments 5 mm ø, corals, bryozoans, few planktic and rare benthic forams	sharp contact	mud clasts 10YR 4/2, Fe_2O_3 concretions, homogenous, at 12-13 cm of core thin layer with coarse shell fragments
			4	5Y 4/1	sand		shells		few muddy lenses, to the base more shelly
18249-1	133	23,5	1,5	10YR 5/4	silty-fine sandy mud	burrows	numerous shells, living polychaete worms	distinct contact	oxidation zone, numerous pebbles
			22	5Y 4/1	silty/sandy mud	large burrows	shells, at 10 cm of core living worm		numerous pebbles
			~2				large shells		massive shell layer, at the base hardened
18250-1	148	46	1-2	10YR 5/4	mud		bivalve shell fragments	distinct contact	oxidation zone, small pebbles, sandy particles
			34	5Y 4/1	sandy/silty claystone		bivalve shell fragments	distinct contact	small pebbles
			10	N3					bituminous tonsteine with shells ???
18251-2	154	5	4-5		hardground		bryozoans		thickness estimated
18252-1	1277	52	~5	10YR 4/2/ 10YR 2/2	mud			continuous contact	oxidation zone
			47	5Y 5/2	fine grained mud				completely homogenized, high water content
18253-1	1479	49	9	10YR 4/2/ 10YR 2/2	mud			continuous contact	oxidation zone
			40	5GY 6/1	mud				completely homogenized
18254-1	145	43	~1	10YR 4/2	mud		small shell fragments, visible epifauna	distinct contact	oxidation zone
			29	grey	sandy-silty mud		small shell fragments, large bivalve shells at the bottom		end of core at the front of box-corer
			13	5GY 6/1	sand				glauconitic sand visible only in the back part of box corer
18255-1	102	41	3	10YR 6/2/ 10YR 5/4	sandy mud		shell fragments, "*Nothia* "-like aglutinated forams		oxidation zone
			38	5Y 5/2	sandy silt		shell fragments 5 mm ø		homogenous
18256-1	92	21	5	10YR 6/2	sandy-silty mud		numerous shell fragments 5 mm ø	continuous contact	oxidation zone
			16	5Y 5/2	sandy-silty mud		numerous bivalves and bivalve shell fragments 3 mm ø		homogenous, rarely shellsand
18257-2	88	21	3	10YR 6/2	silty sand		shell fragments 4 mm ø	turbulent contact	oxidation zone
			18	5Y 5/2	fine silty sand		numerous shell fragments 2mm ø		
18258-1	88	30	~1	10YR 6/2	fine sandy-silty mud		shell fragments		oxidation zone
			29	5Y 5/2	fine sandy-silty mud		few shell fragments 2mm ø		homogenous
18259-2	88	36	~2	10YR 6/2	sandy-silty mud		small shell fragments		oxidation zone
			~34	5Y 5/2	sandy-silty mud		small shell fragments		homogenous
18260-1	74	35	1	10YR 6/2	sand		shell fragments		oxidation zone
			34	5Y 5/2	silty-sandy mud		shell fragments 2-5 mm ø		homogenous
18261-3	68	36	1-2	10YR 6/2/ 10YR 5/4	silty-sandy mud				oxidation zone
			32	5Y 5/2	silty-sandy mud		few shell fragments 2-4 mm ø		homogenous
			~2				large shells		shell layer with pebbles
18262-1	56	32	1-2	10YR 6/2/ 10YR 5/4	sandy-silty mud		shell fragments 5 mm ø		oxidation zone
			16	5Y 5/2	sandy-silty mud		many shell fragments 2-5 mm ø, coral fragments 8 cm ø	erosive horison	at the bottom layer with large shells, flat pebbles and coral fragments
			14	N5	mud				homogenous
18263-1	51	18	3	10YR 5/4	sandy-silty mud		shell fragments 5 mm ø		oxidation zone
			15	5Y 5/2	sandy-silty mud		abundant shell fragments 5 mm ø		homogenous
18264-1	48	28	~8-10	10YR 6/2/ 10YR 5/4	sandy-silty mud		bivalve and gastropode shells 2 cm ø	turbulent contact	oxidation zone
			19	5Y 4/1	sandy-silty mud		shell fragments, large gastropodes 2-3 cm ø (*Turritella*)		homogenous, large shells concentrated in "pocket" of one side of box corer
18265-1	47	33	18-23	7YR 4/1	fine-medium grained carbonate sand		abundant gastropode (*Turritella*) shells and bivalve shell fragments	sharp erosive contact	grey muddy patches, lower part: greyish sand 5Y 4/1
			10-15	5YR 3/2	fine-grained mud				homogenous, intercalations of upper layer material
18266-1	47	29	10	7YR 4/1	sandy mud-sand		gastropode (*Turitella*) and bivalve shells, polychaete worm tube	continuous contact	homogenous

Table 5B

GIK station	water depth (m)	reco-very (cm)	layer thick-ness (cm)	colour	sediment type	biogenic structures	macrofauna and visible microfauna	stratal discontinuities	observations
18266-1	47	29	19	5YR 3/2	sandy mud		common shell fragments 5 mm ø, single big gastropode shells up to several cm ø		homogenous
18267-1	1852	54	2	10YR 6/2	mud				oxidation zone, mixed layer
			1	5YR 2/2	mud			fuzzy contact	redox horizon
			6	dark->light brown	mud			continuous contact	mottled mud containing remains of fossil redox horizons
			45	5Y 4/1	mud				homogenous
18268-1	1974	50	2-3	light brown	mud		planktic foram tests		oxidation zone
			3-4	brown	mud	dark brown bioturbation mottles			
			6	light brown	mud	bioturbation mottles			
			38	5Y 4/1	mud				homogenous
18269-1	114	50	2-3	light brown	sandy mud		shell fragments		oxidation zone
			47-48	grey	sandy mud-clayey sand		numerous bivalve shell fragments 5 mm ø		homogenous
18270-1	106	48	2	light beige	sand with silt		shells and shell fragments 1 cm ø		oxidation zone
			46	grey	sand with silt		bivalve shells and fragments 4 mm ø		homogenous
18271-1	116	54	3-6	light brown	clayey-silty sand		few shells		???
			26-29	light grey brown	sand	bioturbation load casts ?	bivalve shels and shell fragments 3mm ø, at the bottom "agglutinating" gastropodes	sharp erosive contact with strong relief (bioturbation, load casts?)	homogenous
			22	5Y 4/1	mud				homogenous with few fuzzy darker layers
18272-1	121	46	8	light brown	sand-clayey sand	numerous open burrows	small shells		oxidation zone
			20-26	grey beige	sand-clayey sand		small shell fragments, at the bottom large aglutinating gastropodes (*Xenophoria*)	turbulent erosive contact	homogenous, at the bottom mud clasts
			12-18	5BG 5/2	mud-mudstone	burrows (several cm ø)	planktic forams (>70%) and diverse benthic forams		in the upper part sand clasts
18273-1	127	52	3	pale brown	silt and mud	burrows	shell fragments, tubular agglutinated forams	continuous contact	oxidation zone
			49	grey	fine sand with silt and mud		shells and shell fragments 10 mm ø		homogenous
18274-1	117	51	~5	brown	clayey sand	open worm tubes	shell fragments 3-4 mm ø, tubular agglutinated forams	continuous contact	oxidation zone
			46	5Y 4/1	clayey sand		gastropode 1 cm ø, bivalve shells and fragments 2 cm ø		homogenous
18275-1	109	45	2-3	brown	clayey sand		bivalve shells and pteropodes	diffuse contact	oxidation zone???
			42-43	grey	clayey sand		gastropode and bivalve shell fragments 1 cm ø		
18276-1	120	48	7	brownish	clayey sand	bioturbation holes	shell fragments, sponge spicules		oxidation zone
			41	greyish	clayey sand		gastropode and bivalve shell fragments		clay content increases towards the bottom, clasts of stiff clay 4-5 cm ø at the bottom
18277-1	134	48	4	brown	sandy mud-clayey sand	open worm burrows	shell fragments, planktic forams	continuous contact	oxidation zone
			44	grey	clayey sand	burrows	gastropode and bivalve shell fragments		homogenous
18278-1	137	50	9	brown	silty-fine sandy mud	burrows, open worm tubes	small and rare shell fragments, living worms, planktic forams	relatively sharp contact	oxidation zone
			41	grey	sandy mud		small and rare shell fragments		homogenous, slightly coarser than upper layer
18279-1	139	50	8	brown	silty-sandy mud	large burrows, bioturbation mottles common in the lower part	living crustacean in burrow, planktic forams tests	continuous contact	oxidation zone
			42	grey	silty-sandy mud				homogenous, high water content
18280-1	144	52	5,5-8	light brownish	silty-fine sandy mud		few shell fragments	continuous contact	oxidation zone
			44-46,5	grey	silty-fine sandy mud		few shells and shell fragments 6 mm ø		homogenous
18281-1	145	55	12	light brown	silty-sandy mud	single burrows	shell fragments	continuous contact	oxidation zone
			43	grey	silty-sandy mud		few large shells 1 cm ø		homogenous, at 30-37 cm of core few coarse sand lenses ~1,5 cm thick

Table 5 C

GIK station	water depth (m)	reco-very (cm)	layer thick-ness (cm)	colour	sediment type	biogenic structures	macrofauna and visible microfauna	stratal discontinuities	observations
18282-1	152	46	~7	light brown	silty-fine sandy mud	burrows 2 cm ø	few shells	continuous contact	oxidation zone
			39	grey	silty-fine sandy mud		bivalve shells 2-3 mm ø, larger 10 mm ø		homogenous
18283-1	166	48	~1	brownish	mud	burrows 2 cm ø			oxidation zone
			47	grey	fine sandy-silty mud		numerous shell fragments 2 mm ø		homogenous, soft, water saturated
18284-1	226	32	4-5	light brown	clayey-silty sand		few shells		oxidation zone
			28	grey	clayey-silty sand		rare shell fragments 4 mm ø		stiff, darkened towards bottom of core
18284-2	226	24	~2	light brown	silty sandy mud	open burrows >1 cm ø		continuous contact	oxidation zone, brown staining reaching down to 4-5 cm
			22	grey	silty-sandy mud		small shell fragments		homogenous
18285-1	291	31	2	brownish	sandy-silty mud	open worm tubes	few shells		oxidation zone
			~2	brownish -greyish			few shells	continuous contact	contact partly smeared down
			27	grey	sandy-silty mud		small gastropode and bivalve shells 5 mm ø		homogenous
18286-1	404	39	1	brown	mud		agglutinated forams (*Saccorhiza*) in life position		oxidation zone, homogenous
			~0,5	10YR 2/2	mud				redox horizon
			~8	brownish and grey	mud	bioturbated		continuous contact	
			~30	10Y 6/2	mud				homogenous
18287-2	596	43	1,5	brown	mud		agglutinated forams (*Saccorhiza*) in life position		oxidation zone, homogenous, mixed layer
			~1	10YR 2/2	mud			irregular contact	redox horizon
			40,5	10Y 6/2	mud	burrows, bioturbation from redox layer			homogenous, some brown patches and burrows within uppermost 3 cm
18288-1	790	42	2	brown	mud		agglutinated forams (*Rhizammina*)		oxidation zone, homogenous, mixed layer
			~0,5-1	10YR 2/2	mud	bioturbated		irregular but distinct contact	redox horizon
			~3	brown and grey	mud	strongly bioturbated		continuous contact	mixed layer
			~36	10Y 6/2	mud	bioturbation mottles			homogenous, few brownish patches within the uppermost 5 cm
18289-1	978	36	2,5	brown	mud		rare pteropode shells		oxidation zone, homogenous
			~1	10YR 2/2	mud	bioturbation mottles		irregular contact	redox horizon
			~7	brownish and grey	mud	mottled bioturbation zone			mixed layer
			26	10Y 6/2	mud	several open burrows >1 cm ø			homogenous
18290-1	1124	37,5	2,5	brown	mud		hydrozoans, agglutinated forams (*Rhizammina*)	irregular contact	oxidation zone, homogenous, mixed layer
			~1	10YR 2/2	mud			irregular contact	redox horizon
			~4	brown and grey	mud	mottled bioturbation zone			mixed layer
			30	10Y 6/2	mud				homogenous
18291-1	1208	35	2,5	brown	mud		planktic forams tests		oxidation zone, homogenous, mixed layer
			~0,5	10YR 2/2	mud				redox horizon
			3	brown	mud	bioturbation mottles			
			6	grey	mud	bioturbation mottles		irregular contact	
			23	10Y 6/2	mud				homogenous
18292-1	1309	40	2,5-3,5	10YR 5/4	mud		few pteropode shells		oxidation zone, mixed layer
			~0,5	10YR 2/2	mud				redox horizon
			~6	brownish grey	mud	mottled bioturbation zone			at part of core a second redox-layer at 4-4,5 cm below surface
			~30,5	10Y 6/2	mud				homogenous
18293-1	1404	40	3	brown	mud				oxidation zone, homogenous, mixed layer
			~1	10YR 2/2	mud				redox horizon
			10-12	grey -brownish	mud	mottled bioturbation zone			
			24-26	10Y 6/2	mud				homogenous

Table 5D

GIK station	water depth (m)	reco-very (cm)	layer thick-ness (cm)	colour	sediment type	biogenic structures	macrofauna and visible microfauna	stratal discontinuities	observations
18294-3	846	50	~2	brown	mud	burrows 5 cm ø	sponge spicules, polychaetes, pteropodes, planktic and agglutinated forams		homogenous
			3-5	light brown	mud			continuous contact	oxidation zone
			43-45	5Y 4/1	mud		planktic forams tests		homogenous, high water content
18295-1	117	47	2-4	light brown	clayey-silty sand	burrows 1 cm ø	shell fragments		oxidation zone
			43- 45	grey	fine sandy-silty-clayey sand/mud		small shell fragments		homogenous, soft, water saturated
18296-1	118	42	3	light brown	silty mud	burrows	few shell fragments	continuous contact	oxidation zone
			39	grey	sandy-silty mud		few shell fragments <4 mm ø		homogenous, soft, water saturated
18297-1	112	52	2-4	7YR 4/1	clayey-silty sand	burrows	shell fragments	continuous contact	weakly developed oxidation zone, soft, water saturated
			48-50	grey	clayey-silty sand		shell fragments <2 cm ø (fraction <2 mm ø abundant)		homogenous, mud content increasing towards top (?)
18298-1	103	53	3-4	light brown	clayey-silty sand	burrows	shell fragments	continuous contact	weakly developed oxidation zone
			30-31		clayey-silty sand		few bivalve shells and shell fragments <3 mm ø	contact with strong relief, erosive features and/or load casts (?)	homogenous
			19	grey	mud				homogenous, soft, considerable water content
18299-2	102	52	4-7	brown	clayey-silty sand	open burrows <2 cm ø, bioturbation	shell fragments, agglutinated forams	continuous contact	oxidation zone
			42-45	grey	clayey-silty sand		shell fragments		organic-rich sandy patches
18300-1	94	52	~4	brownish to grey	clayey sand	open burrows	small shell fragments	continuous, gradiental contact 2-5 cm	
			~43	grey	clayey-silty sand		numerous small shell fragments	irregular contact	organic material aggregated as clusters in the lowermost 2-3 cm
			~5	5B 5/1	mud				large aggregates of organic matter (wood peat), ~2 cm thick, >5 cm wide
18301-1	92	54	2	brownish	silty-clayey sand	abundant open burrows <1 cm ø, few burrows 1-2 cm ø	shell fragments <5 mm ø	continuous contact	oxidation zone (?)
			48	5GY 5/2	clayey-silty sand		common shell fragments of several mm ø	irregular contact	
			4	5B 5/1	mud				
18302-1	83	52	4	brownish	clayey sand	deep burrows ≥3 cm ø and <1 cm ø	bivalve shells <1 cm ø and large shell fragments	continuous contact	oxidation zone
			44	5Y 4/1	clayey sand		common shell fragments of several mm ø	irregular contact not clearly defined	mud content increases towards bottom, mud clasts within lowermost part
			~4	5B 5/1	mud		large forams		some sandy lenses with large forams within uppermost part
18303-1	107	50	8-9	brown	clayey-silty sand	burrows	shell fragments	clear boundary, no Mn-redox horizon, wavy (load casts?)	oxidation zone, homogenous
			23-24	grey	clayey-sandy silt/ silty-sandy mud	open burrows ~1 cm ø	shell fragments	sharp contact with relief (erosion?, load casts?)	homogenous
			18	grey	mud				homogenous
18304-1	104	56	13	brownish	sandy mud	many open burrows	shell fragments	no sharp contact between all units	homogenous, fluctuations of mud/sand content in all units roughly estimated
			5	grey	clayey sand		shell fragments		homogenous
			15	grey	sandy mud		shell fragments		homogenous
			15	grey	clayey sand		shell fragments		homogenous
			8	grey	mud				homogenous
18305-1	109	56	2	brownish grey	mud	abundant open burrows up to 7 cm deep, <3 cm ø		continuous contact	weakly developed oxidation zone
			54	5Y 4/1	mud		shell fragments		high water content, sand grains, small lenticular bodies of sandy "lumachelles" at 21, 30 and 56 cm depth of core
18306-2	88	56	10	brownish	mud	some burrows <5 mm ø			soft, water saturated
			46	5Y 4/1	mud		large forams		homogenous, soft, water saturated, small "pockets" of biogenic sand containing numerous larger forams

Table 5E

GIK station	water depth (m)	recc-very (cm)	layer thick-ness (cm)	colour	sediment type	biogenic structures	macrofauna and visible microfauna	stratal discontinuities	observations
18307-1	100	38	4	slightly brownish	mud	burrows 3 mm ø	vertical tubes (forams)	continuous contact	oxidation zone, soft, water saturated, carbonate bioclasts
			34	5Y 4/1	mud		abundant larger forams (miliolids)		homogenous, not sharp defined biogenic sand "pockets" containing abundant larger forams (miliolids)
18308-1	80	30	3-4	light brownish	sand-silt		numerous bivalve shells <8 mm ø	distinct irregular contact	oxidation zone
			26-27	10Y 4/2	silty sand		abundant bivalve shells and fragments <1 cm ø		
18309-1	84	38	~1	brown	sandy mud		bivalve and gastropode shells and fragments <1 cm ø	continuous contact	oxidation zone, patches of biogenic sand
			37	5Y 4/1	sandy mud		few shell fragments <7 mm ø, common foram tests		soft, high water content
18310-1	101	45	2	brownish	silty mud	open burrows 5-8 mm ø	shell fragments	continuous contact	oxidation zone
			43	5Y 4/1	silty mud		shell fragments		homogenous, high water content, small bioclasts ~5 mm ø
18311-1	60	31	~1	brownish	mud	open burrows <4 cm ø	shell fragments, tubular forams (Rhizammina, Rhabdammina)	continuous contact	oxidation zone, soft, water saturated
			30	5Y 4/1	silty-fine sandy mud		bivalve shells <1cm ø, living worms		homogenous, high water content, almost water saturated
18312-1	101	40	3-4	brown	silty-sandy mud	few small ~5 mm ø and large~2-3 cm ø burrows	shell fragments, agglutinated forams		oxidation zone
			36-37	10Y 4/2	sandy mud		common bivalve and gastropode shell fragments <1cm ø		homogenous, high water content, sand content fairly high
18313-1	99	38	5-8	brownish	sandy mud	rare burrows	shell fragments	irregular-continuous contact	oxidation zone
			30-33	5Y 4/1	sandy mud		small shell fragments		homogenous, high water content, getting less sandy towards bottom
18314-1	100	38	6-7	brownish	sand		bivalve shells and shell fragments <1 cm ø	continuous contact	oxidation zone
			31-32	5Y 4/1	clayey sand		large shells (up to several cm ø) and shell fragments		homogenous, getting more clayey towards bottom
18315-3	69	49	5	5Y 6/4	mud	burrows <5 mm ø		distinct irregular contact	oxidation zone, soft, water saturated, mud clasts <2 cm ø
			44	5GY 5/2	mud		shell fragments		homogenous, soft, water saturated, with "pockets" of carbonate sand and shell fragments continuously grading into the mud
18316-1	71	37	2-3	5Y 6/4	sandy-silty mud	burrows <2 cm ø	rare bivalve shells 2 mm ø	irregular contact	diffuse oxidation zone
			34-35	5GY 5/2	sandy-silty mud		large forams		"pockets" enriched in large forams
18317-1	96	44	~2	light brownish	mud			irregular contact	oxidation zone, small brownish Fe_2O_3 concentrations ~1 mm ø
			22-32	5GY 5/2	mud		"pockets" of bivalve shells and shell fragments	sharp, irregular contact (erosive?)	
			0-20	5Y 3/2	mud		corals		stiff, with wood fragments and corals on the surface formed by a thin (mm) brownish band (hardground? or exposure surface?)
18318-1	86	20	5-7	5GY 5/2	mud	open burrows <1 cm ø	few shell fragments	sharp, erosive irregular contact	soft, water saturated
			13-15	5Y 4/1	mud				stiff, with "pockets" of lumachelle
18319-1	81	18	~2	brown	silty mud			discontinuity	soft, water saturated thin indurated crust with brown Fe_2O_3
			16	N3	claystone	"*Thalassinoides* " (?) type burrows on top of claystone	overgrown tubes (corals?)		stiff, indurated (Pleistocene or older); clay is completely compacted and shows surface parallel bedding planes (probably already experienced considerable overload), silty, contains mica and organic matter enrichments
18320-1	76	40	1	brownish	mud	burrows		continuous contact	oxidation zone, soft, water saturated
			39	5Y 4/1	sandy-silty mud		bivalve shells and shell fragments <1 cm ø		homogenous, high water content
18321-1	109	50	1	brown	mud		shell fragments, agglutinated forams (*Dendrophrya*)	continuous contact	oxidation zone, soft, water saturated
			32-39	5Y 4/1	sandy-silty mud	common burrows >1 cm ø	shells and shell fragments >1 cm ø		homogenous
			~10	5Y 4/1	sandy-silty mud	intensively bioturbated		erosion surface?	patchy intercalation of grey mud and olive grey sandy mud, grey mud dominating at the end of box core
18322-1	70	45	~1	pale brown	mud	open burrows	shell fragments <5 mm ø		oxidation zone
			~44	5Y 4/1	sandy-silty mud		shell fragments, larger forams		irregular "pockets" enriched in shell fragments and larger forams
18323-1	92	41	1-2	brownish	mud	common burrows ~3 mm ø	shell fragments <5 mm ø	continuous contact	oxidation zone
			39-40	5Y 4/1	sandy/silty mud		shell fragments and bivalve shells		two patches (~3 cm ø) of black organic material (lignite) at 28 cm

---

Table 4A-B: Surface observations on box cores.
Table 5A-E: Observations on opened side of the box corer.

MULTICORING

We used the new multiple corer version equipped with 12 plastic tubes of 65 cm length and 9,5 cm inner diameter. Technical description:

height: approx. 225cm
diameter: approx. 190cm
weight of head: approx. 180 kg
weight of frame: approx. 465 kg

The framework is made of galvanized steel pipes. It has eight supporting legs, the length of which can be adjusted, and it can be easily dismantled into component parts. The head of the multicorer is made of stainless steel and in the version we used designed for 12 core tubes. The tubes are sealed with plastic caps and rubber seals.

Eight multicorer tubes (planktic foraminifers, stable isotopes, AMS-dating, 5 cores for benthic foraminifers) were cut into 1 cm thick slices immediately after sampling. Each subsample from the uppermost 10 cm of the sediment column was immediately preserved in a methanol-seawater solution and treated with Rose Bengal to stain living organisms. The sediment below 10 cm depth in core was sliced in one or 2 cm slices and preserved in sealed plastic bags. One multicorer tube was slit in 1 cm slices for sedimentological and geochemical analyses. Three multicorer tubes were generally kept as archive, slit, described photographed and handled like the long cores.

GRAVITY AND PISTON CORING

We used the standard coring system of the GPI Kiel for sampling long gravity and piston cores on the Sonne 115 cruise. It consists of a combined gravity corer (GC) and piston corer (PC) system, type 446 with the following technical specifications:

weight stand: 2 metric tons
steel tubes: 14 cm outer diameter
length of tubes: 5,75 m
plastic liners: 12 cm inner diameter
maximum length of piston cores: 26 m
maximum length of gravity cores: 15 m
producer; Hydrowerkstätten, Kiel-Hassee.

The processing of gravity and piston cores was accomplished in the following way:

- as soon as cores were retrieved on deck they were carefully labelled and cut into sections of 1 m or less. Each section was sealed at the top and bottom by a plastic cap. Core catcher samples were collected in plastic bags.
- After magnetic susceptibility logging of the uncut core sections we split the cores longitudinally by a standard saw into working and archive halfes.
- gray code and color code logging was performed on the archive halfs, parallel to the description and sampling of the work half.
- after initial core description using the GSA Rock Color Chart each section of the working half was photographed and most of the archive sections were documented on digitally stored video files
- the sampling scheme of the work halves was variable, depending on sediment type and purpose of the core: deep water cores were sampled equidistantly in 10 cm increments according to a standard sampling scheme, described e.g. in Sarnthein et al. (1994); shelf cores were not routinely sampled, initial low resolution sampling concentrated on fine grained marine sediments for micropaleontology and protostratigraphy, and organic rich intervalls (e.g. wood fragments, peat layers) for radiocarbon dating, initial high resolution sampling concentrated on unconformities and other significant facies changes
- working and archive halves were preserved in D-tubes and are stored at the core repository of the GPI Kiel
- additional and more closely spaced sampling of the cores is performed according to the intial stratigraphic results by the Shipboard Scientific Party for the following purposes (each sample set represents a 2 cm core interval):

10 cc syringe samples for palynology (dinoflagellates and pollen)
35 cc plastic containers for micropaleontology (planktic foraminifers, benthic foraminifers, ostracodes), stable isotopes, and AMS datring
35 cc plastic containers for sedimentology (grain size analyses, clay and bulk mineralogy, inorganic geochemistry)
10 cc syringe samples for organic carbon analyses
10 cc syringe samples for physical properties (water content, bulk density) and carbonate content

Records of all sample sets are kept at the GPI Kiel.

VIBROCORING

Rossfelder P-5 Vibrocorer/General Description

The Rossfelder P-5 modular vibrocorer is the new version of the GEOMAREX P-4 vibrocorer (Geomarex is the predecessor company). It is designed for coring unconsolidated waterlogged sediments at sea, in lakes, rivers, harbors, ponds and wetlands. Its light weight enhances its vibratory performances and facilitates its delivery and operation in sites hard-to-reach. It is adaptable to various coring requirements through its modular components and it is well suited for hazardous environments as it is fully encapsulated without external moving parts. The main components of the vibrocoring system are:

* the vibrohead.
* the "buoyant frame" with its float-package and its weight stand.
* a coretube, equipped with or without a plastic liner.
* the underwater electrical cable coming from the surface support platform
* the control box located between the underwater cable and the power source.

The vibrohead consists of a pressure housing incorporating two contra-rotating motors of 3 HP each provided with eccentrics. These eccentrics enter into spontaneous synchronization and the force being delivered is null when they are in horizontal opposition and maximum when they reach the same vertical position, alternately directed up and down, completing close to 3000 cycles every minute (3000 cycles on 50 Hz). The pressure housing is rated for operation in ocean depths down to 600 m (2000 ft). Under proper voltage conditions the internal vibrator motors have a 1000 hour operating time before requiring service and lubrication. As a rule of thumb, at 2-3 minutes per core, this means some 20000 cores. The patented "buoyant frame" allows to handle the overall system with ease and with limited drawworks and deck space. It consists of two thin cables held taut underwater between a weight stand and a float package and guiding vertically the vibrocorer. The weight stand has provisions to accommodate an extension pad and two rigid legs topped with a cross-beam transforming the frame into a conventional rigid support unit for special situations, such as shallow swift waters. The P-5 can be implemented with or without the "buoyant frame". Usually, no frame is needed in calm waters to, say 30 m (100 ft) depths with an anchored platform. The unit can handle coretubes from 3" (76 mm) to 10" (254 mm) diameter with appropriate clamps and clamp-adapters. However it comes normally equipped with a 4" (102 mm) clamp for 4" diameter coretubes (100 mm if requested). Standard 4" coretubes are of steel with a wall thickness of 0,083" to 0,120" (2,1 mm to 3,1 mm) , equipped with expendable liners of clear plastic (cellulose butyrate or polycarbonate) of 86 mm inner diameter. The eccentric settings can be modified to low, medium and maximum settings. The medium setting is recommended for 60Hz current and the maximum setting for the 50Hz current. The depth of penetration of the coretube depends upon the force of the vibrohead, the characteristics of the coretube (material, length, wall thickness) and the characteristics of the sediment. With the vibrocorer using a 4" OD (102 mm) coretube, we generally expect penetrations of 6 to 15ft. (2 to 4,5m) in packed sands and 10 to 20ft. (3 to (6m) in mud, silt and some clays. Cores to 35ft (12m) have been obtained with the vibrocorer. The 20ft length often used as a standard for coretubes also corresponds to the common dimension of the off-the-shelf tubes or pipes and to the maximum dimension generally accepted for international airfreight.

Core processing and sampling was performed in the same way as for the gravity cores. The number of samples in a sample set was restricted due to the smaller diameter and hence smaller volume of vibrocores.

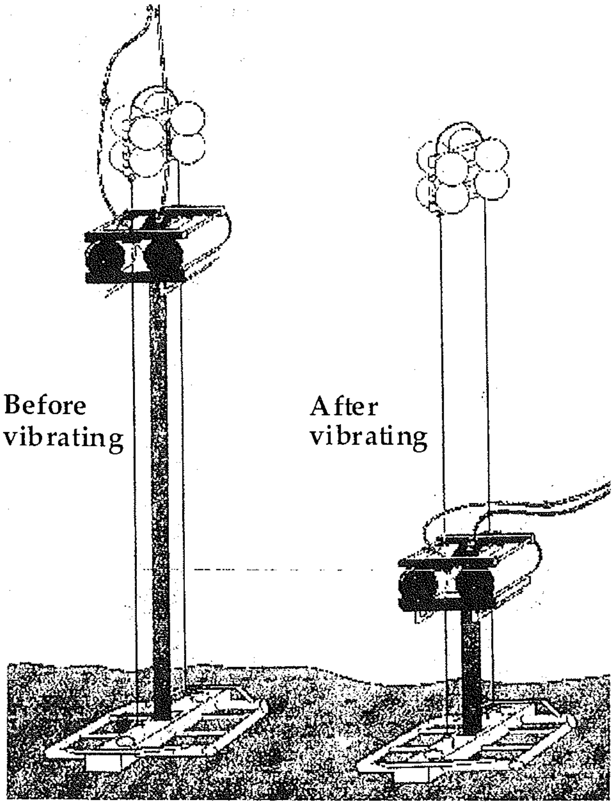


Fig. 13 : Operation of the Rossfelder P5 Vibrocorer at the seafloor.

6.3. ONBOARD LABORATORY INVESTIGATIONS

MAGNETIC SUSCEPTIBILITY

The magnetic susceptibility was measured on board of RV SONNE using the Multi-Sensor Core Logger (MSCL/016) designed and built by GEOTEC, Haslemere, UK. We measured magnetic susceptibility at unsplit core sections of 12 cm diameter and 100 cm or shorter length encased in cylindrical plastic liners. The sediment core was placed on rails of a conveyor system and aligned to start position. A core pusher moved the core section in increments of 1 cm along the rail track through the BARTINGTON MS2C sensor loop. A low intensity (ca. 80A/m RMS) non-saturating, alternating magnetic field (0,565 kHz) is produced by an oscillator circuit within the sensor. Any magnetic material in the near vicinity of the sensor will cause a change in the oscillator frequency, which is electronically converted into magnetic susceptibility values. Measuring conditions were defined as 1 sec, 1 Hz, 1 cm increments, measure unit cgs, and a starting position at 10 cm in front of the sensor loop. The instrument was controlled and the data were collected using a Macintosh Powerbook 180. Rawdata were collected with the MSQB1.BAS program of GEOTEC and then plotted and edited with Kaleidagraph and Mac Draw Pro.

COLOR CODE AND GRAY CODE LOGGING

Spectrophotometry

A Minolta CM2002 hand-held spectrophotometer was used to measure light reflectance on sediment cores opened on board the SONNE during the cruise. The spectrum of the reflected light is measured by a multi-segment light sensor. From the reflectance data, the standard colour-values X, Y, Z are calculated, which are displayed in the L*a* b* CIELAB colour coordinates. The L* -value represents brightness and can be directly correlated to gray-value measurements from a video-camera.

Due to unexpected software-hardware incompatibilities, only a minor number of cores could be processed on board. Measurements were done every 1 cm along the cores through a thin plastic foil directly on the sediment. Reflectance measurements were performed as soon as the cores had been split to prevent colour changes by oxidation. The data was recovered from the spectrophotometer by a IBM-compatible laptop computer and then processed on a Macintosh.

Video-Imaging

For a continuous record of colour changes, a video-camera system was brought aboard the R/V SONNE for the cruise 115. The technique had been used on the previous cruise SONNE 95 and allows an extremely high resolution of more than 3 measurements per millimeter. Video images of the archive-halves of the cores were taken at intervals of 25 cm by a tri-CCD colour camera. The image processing was done on a Macintosh computer. Illumination consisted of four daylight neon lights, and a polarizing filter was used to eliminate disturbing reflections caused by water on the sediment surface. The resulting very large video data files were stored on 128 MB magneto-optical disks and 640 MB CD-ROM. Due to the time pressure during the cruise, image digitizing and concatenation processes could not be achieved on board the SONNE.

GEOCHEMISTRY

A set of boxcore surface samples was analyzed for major element and selected trace element geochemistry with the X-ray fluorescence spectrometer on board (Philips PW 1480). The spectrometer was calibrated by international standards for the major elements SiO_2, TiO_2, FeO, Al_2O_3, MnO, CaO, Na_2O, K_2O, P_2O_5 and the trace elements Rb, Sr, Y, Zr, Nb. Sediment samples were desalted, grinded, and pressed to powder pellets before X-ray fluorescence analysis.

7. PRELIMINARY RESULTS

7.1. BATHYMETRY AND SEISMIC STRATIGRAPHY

Study area 1 on the Vietnamese shelf

The newly compiled bathymetric map in the study area off Vietnam (Fig. 14) is based almost exclusively on depth data obtained during cruise 115 of the R/V SONNE. Only in the southeast are additional data from the GEODAS data set available (Fig. 15).

The continental shelf extends up to 200 km in front of the Mekong delta to a depth of approximately 200 m. On the outer shelf between 50 and 200 m water depth, the bottom gradient was ca. 0,06° (ca. 1:1000). It steepens to over 1,5° (1:38) between 200 and 300 m depth, reaching 3,6° (1:16) between 300 and 1000 m depth on the upper continental slope. On the lower slope, the gradient of the seafloor decreases to 0,9° (1:64) between 1000 and 2000 m water depth. There is a pronounced valley incised into the continental slope in the southern part of the study area and two additional valleys north of it.

Study area 2 on the Sunda shelf (the primary area of study)

The bathymetric map we compiled (Fig. 16) using GEODAS data and the depth chart of the South China Sea Institute of Oceanography, Academia Sinica, in addition to our HYDROSWEEP data (Fig. 17) shows an extremely broad continental shelf (up to 200 m depth) around the Natuna Islands. Our study area is located largely on this shelf. Between 100-200 m water depth, the shelf gradient is only 0,05° (ca. 1:1150). The upper continental slope from 200-1000 m water depth has an average bottom gradient of about 1,0° (1:57). This gradient decreases to 0,5° (1:115) between 1000 and 1500 m depth and finally to 0,3° (1:191) and less basinward of the 1500 m isobath at the lower continental slope.

Valleys incised deeply into the seafloor are the most significant features at water depths up to approximately 1000 m. At least in the south, they probably represent relicts of the paleo-Molengraaff river system. In the northeastern part of the study area are two positive bathymetric features which are presumably paleo-reefs.

In the following, preliminary results from several air gun and boomer profiles will be described (see Fig. 18 for profile locations).

Figure 19 shows part of air gun profile 18 which runs sub-perpendicular to the shelf edge. In this figure, several faults which dissect all the sediment layers penetrated can be clearly recognized. They are part of a fault system which strikes subparallel to the shelf edge and is restricted to the outer shelf. These are growth faults, the displacements of which decrease upwards. Near the shelf edge is a reef-like structure which progrades basinward and is characterized by a chaotic seismic facies.

On the upper continental slope, several slope fans are stacked upon each other. Seismically they are marked by downlap terminations both proximally and distally and by their convex upwards upper boundaries (Fig. 20, air gun profile 23 sub-perpendicular to the shelf edge). These slope fans consist of channel-levee complexes and overbank deposits. Slumps and slides on the continental slope are represented by a seismically chaotic facies. Both the slope fans and the slumps and slides are assignable to the lowstand systems tract, i.e., they are deposited during relative sea level lowstands. The stacking of several slope fans suggests that regressions to below the shelf edge must have taken place repeatedly. The regional sea level cycles to which these regressions may be assigned are probably associated with repeated Pleistocene glaciations and with regional neotectonic activity.

In Fig. 21 (part of air gun profile 35), several downlap surfaces can be observed. They represent maximum flooding surfaces which separate a transgressive systems tract from the overlying highstand systems tract. The geometry of the downlap surfaces in the vicinity of the seafloor is very difficult to reconstruct using air gun profiles. However, the PARASOUND profiles which have a higher resolution (Fig. 22; the corresponding section in the air gun profile is marked in Fig. 21) permit mapping not only of the downlap surface but also of the overlying prograding deposits of the highstand systems tract. The reflectors which diverge basinwards (as seen in particular in air gun profiles, see Fig. 21 for an example) are probably a result of seaward-increasing subsidence rates.

Figure 23 (part of PARASOUND profile 31) shows several pronounced, filled, incised valleys on the continental shelf. The incision occurred probably during the last sea level lowstand when the shelf was subaerially exposed and the Molengraaff river system prograded in the direction of the shelf edge. Infilling probably took place during the post-glacial transgression and the current sea level highstand. Within the valley fills several facies units can be distinguished. For example, there is a lower homogeneous subunit and an upper obliquely layered subunit within the incised valley marked by an arrow. Adjacent to this marked valley is a transparent facies unit which grades into an area of well layered, basinwards prograding reflectors. The seafloor shows a high degree of roughness which may be traced to the erosional effects of bottom currents.

Figure 24 demonstrates by way of two examples the quality improvement achievable by seismic data processing. For the processing steps of NMO-correction, CMP-stacking and migration, layer velocities from sonobouy station 297C12 of LUDWIG *et al.* (1979) were used (see Fig. 18 for station location and Tab. 6 for velocity structure). The upper part of Fig. 24a shows the original data of part of profile 11 (a time section while the lower part gives the same profile processed but in the form of a depth section. Similarly, the original and processed sections of part of profile 18 are shown in Fig. 24b. It is obvious that processing has improved significantly the continuity of the reflectors. Several reflectors that were previously difficult to distinguish are now easily recognizable (see horizons marked in Figs. 24a and 24b). Because of the small offsets of 150 m (from the sound source to the first active channel) to 300 m (from the sound source to the last active channel) associated with the system geometry, and the system configuration of only four active channels, it was not possible to calculate a RMS-velocity function using the travel time differences between the signal and its multiples, so that multiple suppression is still not satisfactory.

Table 6: Sonobuoy-Velocities for the Sunda Shelf, Station 297C12 (after Ludwig et al., 1979)

Layer	Velocity (km/s)	Thickness (km)	TWT (s)
1	1,50	0,14	0,19
2	1,80	0,41	0,64
3	2,20	0,38	0,99
4	2,35	0,17	1,13
5	2,60	0,26	1,33
6	2,90	0,41	1,61
7	3,15	1,05	2,28
8	3,30	0,29	2,46
9	3,55		

Fig. 14: Bathymetric chart of the study area on the Vietnamese shelf.

Fig. 15: Data base for the compilation of the bathymetric chart of the study area on the Vietnamese shelf.

Fig. 16: Bathymetric chart of the study area on the northern Sunda shelf.

Fig. 17: Data base for the compilation of the bathymetric chart of the study area on the Sunda shelf.

Fig. 18: Locations of the profile sections shown in Figs. 19-24 and position of the sonobouy station 297C12 of LUDWIG *et al.* (1979).

Fig. 19: Fault system on the outer Sunda shelf and prograding reef-like structure near the shelf edge (part of air gun profile 18, see Fig. 18 for profile location).

Fig. 20: Stacking of several slope fans on the upper continental slope (part of air gun profile 23, see Fig. 18 for profile location).

Fig. 21: Downlap surfaces and reflectors diverging basinwards (part of air gun profile 35, see Fig. 18 for profile location).

Fig. 22: Downlap surface and prograding deposits of the Holocene highstand systems tract (part of PARASOUND profile 35, see Fig. 18 for profile location; the position of this profile is marked on air gun profile 35 in Fig. 21).

Fig. 23: Incised valley fills (part of PARASOUND profile 31, see Fig. 18 for profile location).

Fig. 24: Original (above) and processed (below) air gun profiles. Marked are several reflectors which become easily distinguishable after processing. (a) Part of profile 11. (b) Part of profile 18. See Fig. 18 for profile locations. Location of profile in Fig. 24b is also marked in Fig. 19.

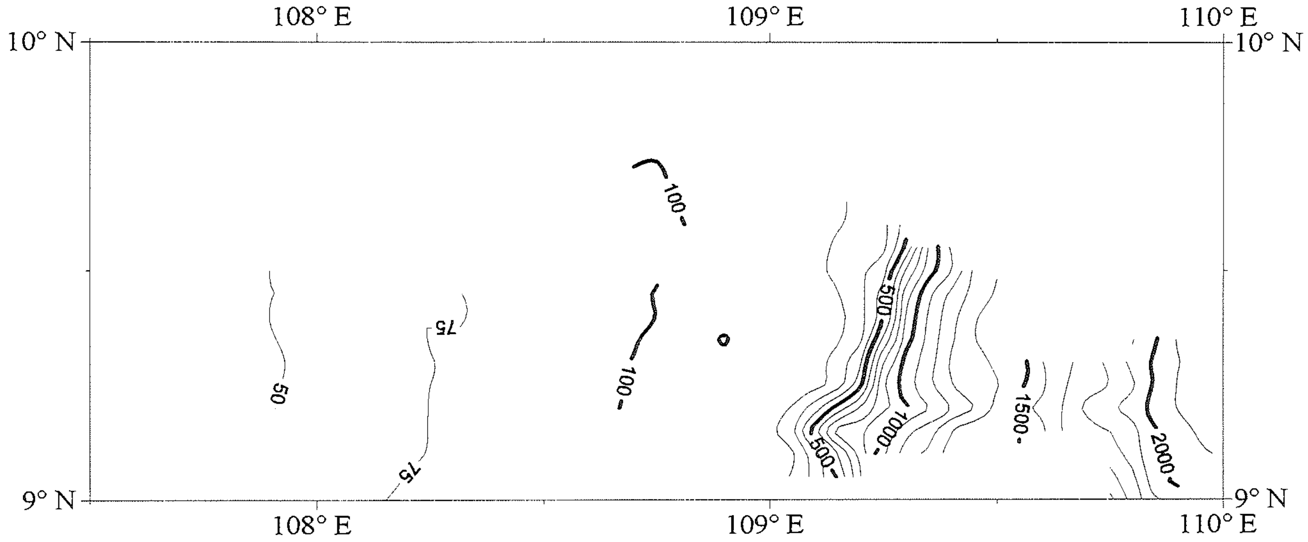

108° E
109° E
110° E
10° N
10° N
9° N
9° N
50
75
75
100
100
500
500
1000
1500
2000

Fig. 14

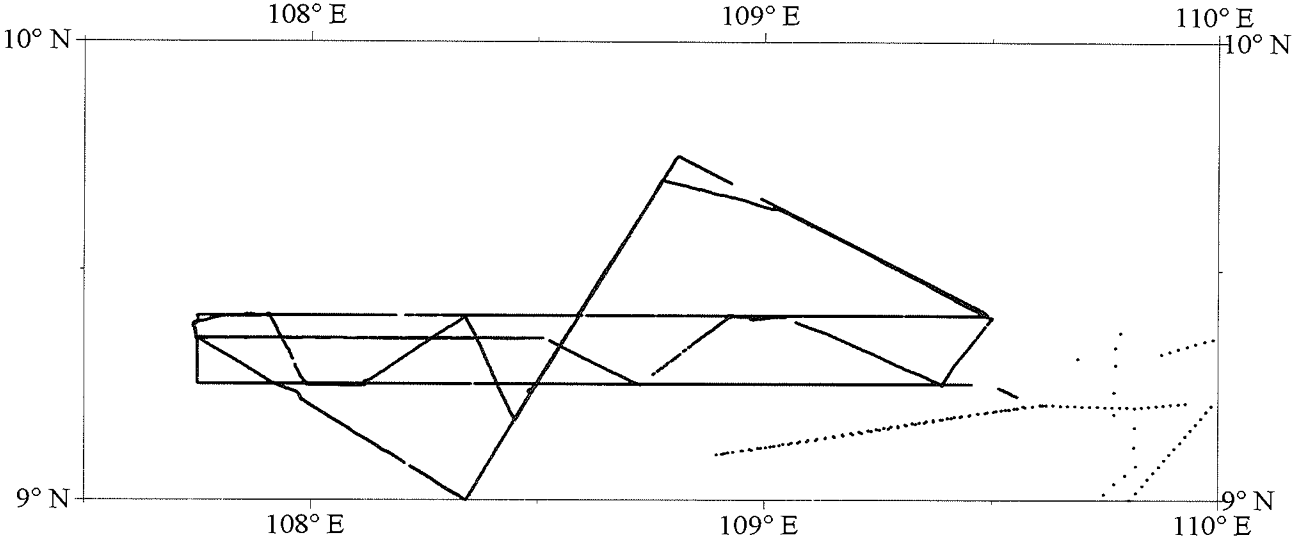
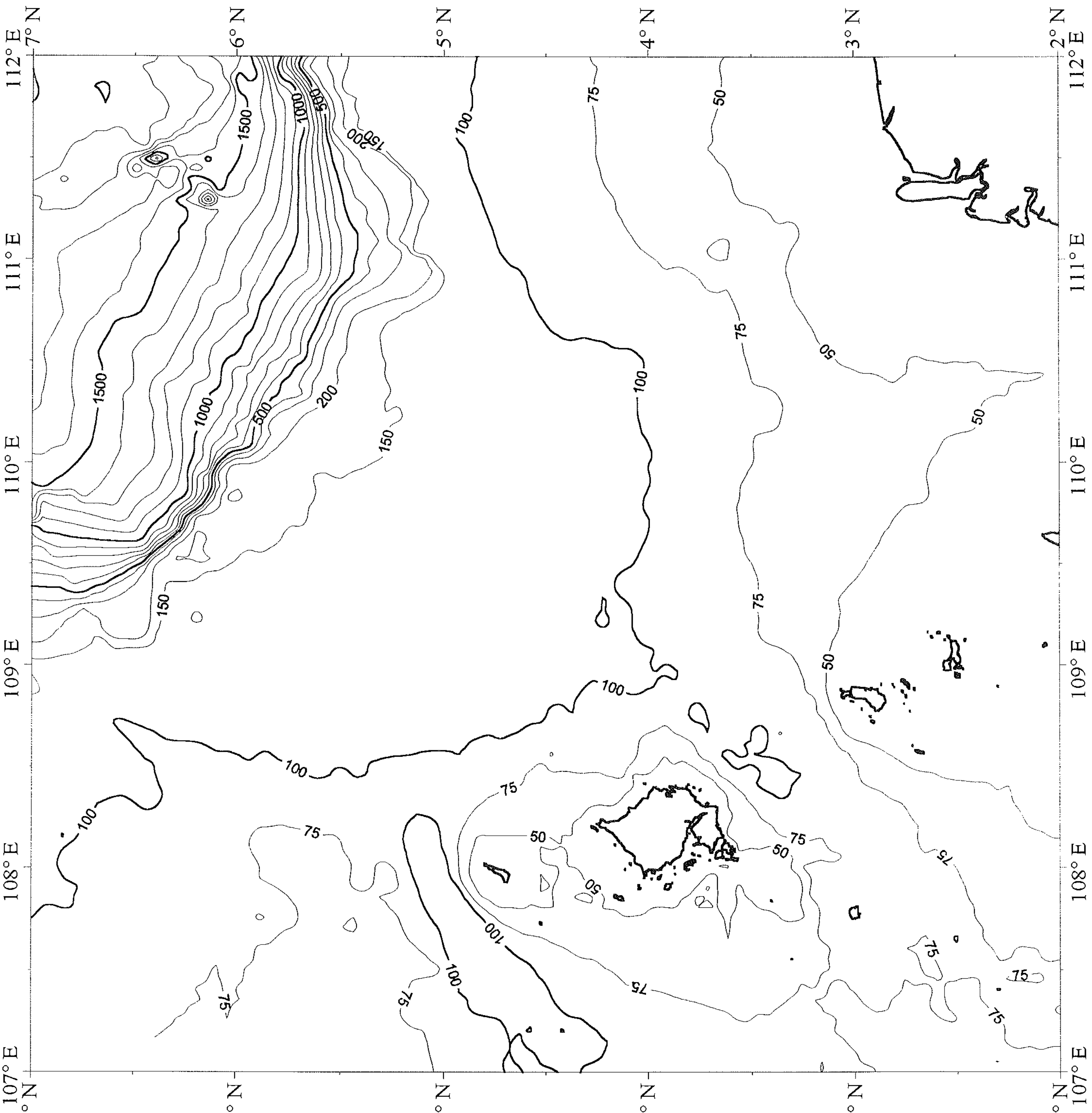


Fig. 15



112° E
111° E
110° E
109° E
108° E
107° E
7° N
6° N
5° N
4° N
3° N
2° N
1500
1000
500
200
150
100
75
50

Fig. 16

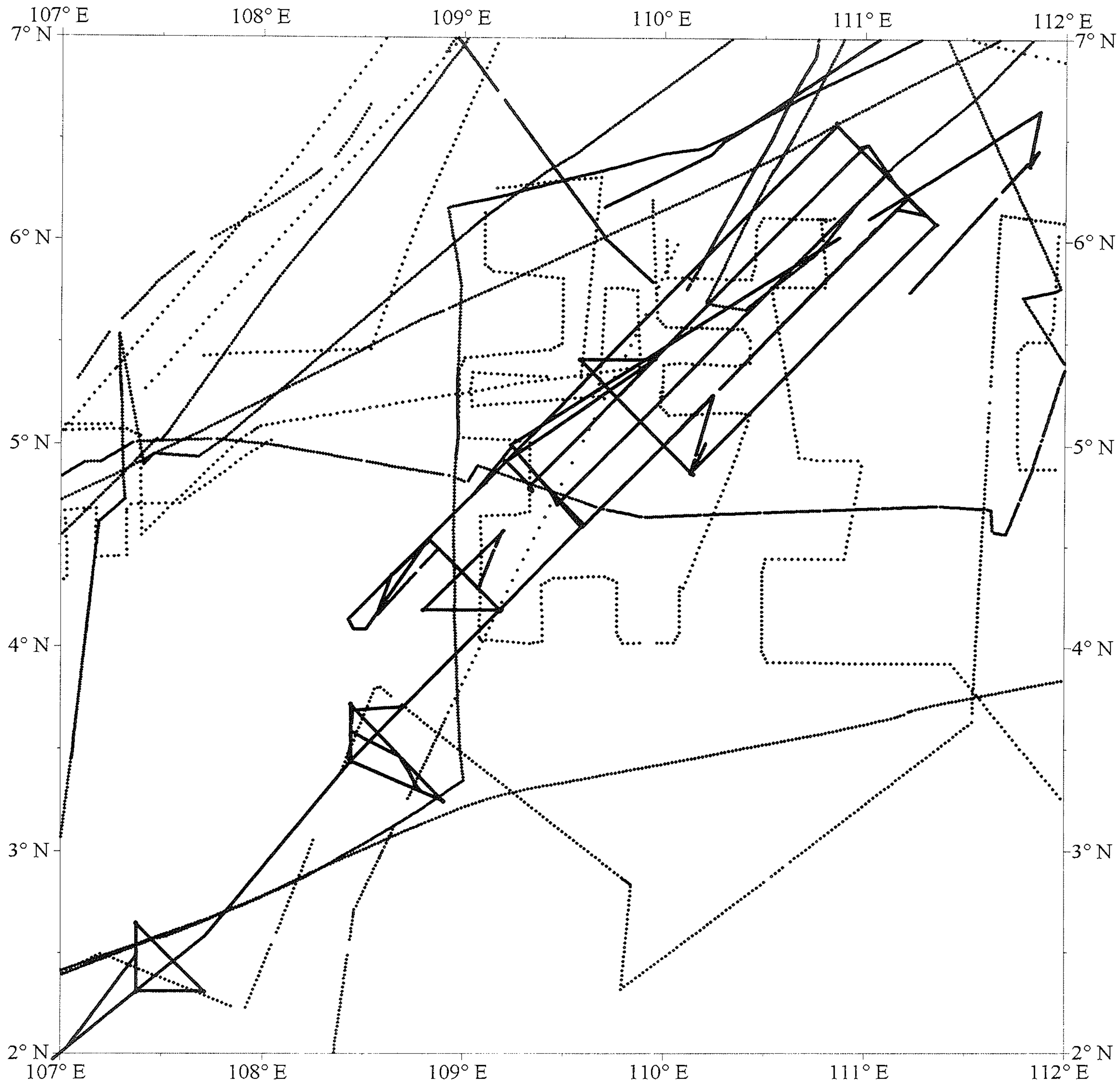


Fig. 17

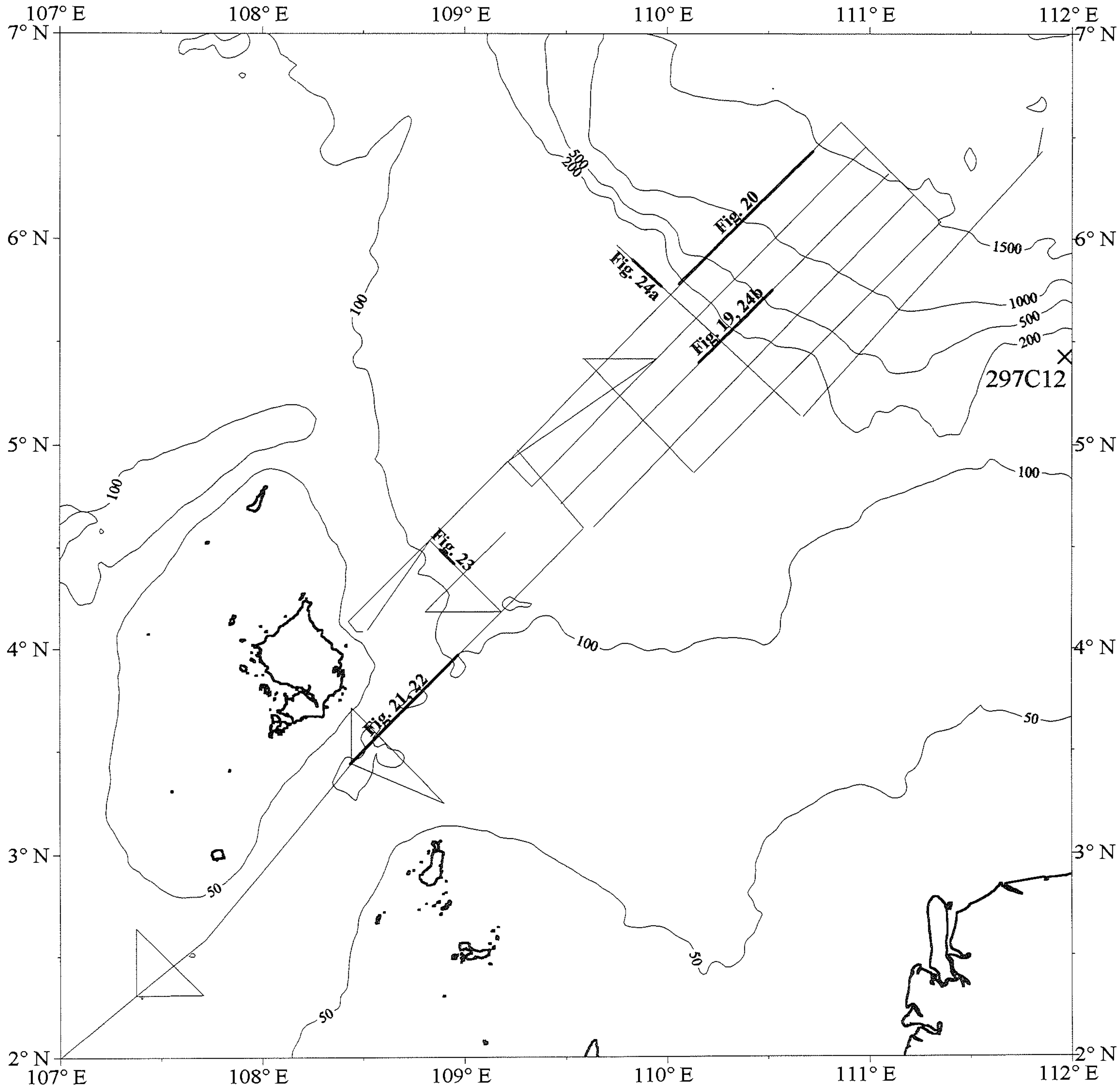

107° E
108° E
109° E
110° E
111° E
112° E
7° N
6° N
5° N
4° N
3° N
2° N
500
200
100
1500
1000
500
200
297C12
100
100
50
50
50
50
Fig. 20
Fig. 24a
Fig. 19, 24b
Fig. 23
Fig. 21, 22

Fig. 18

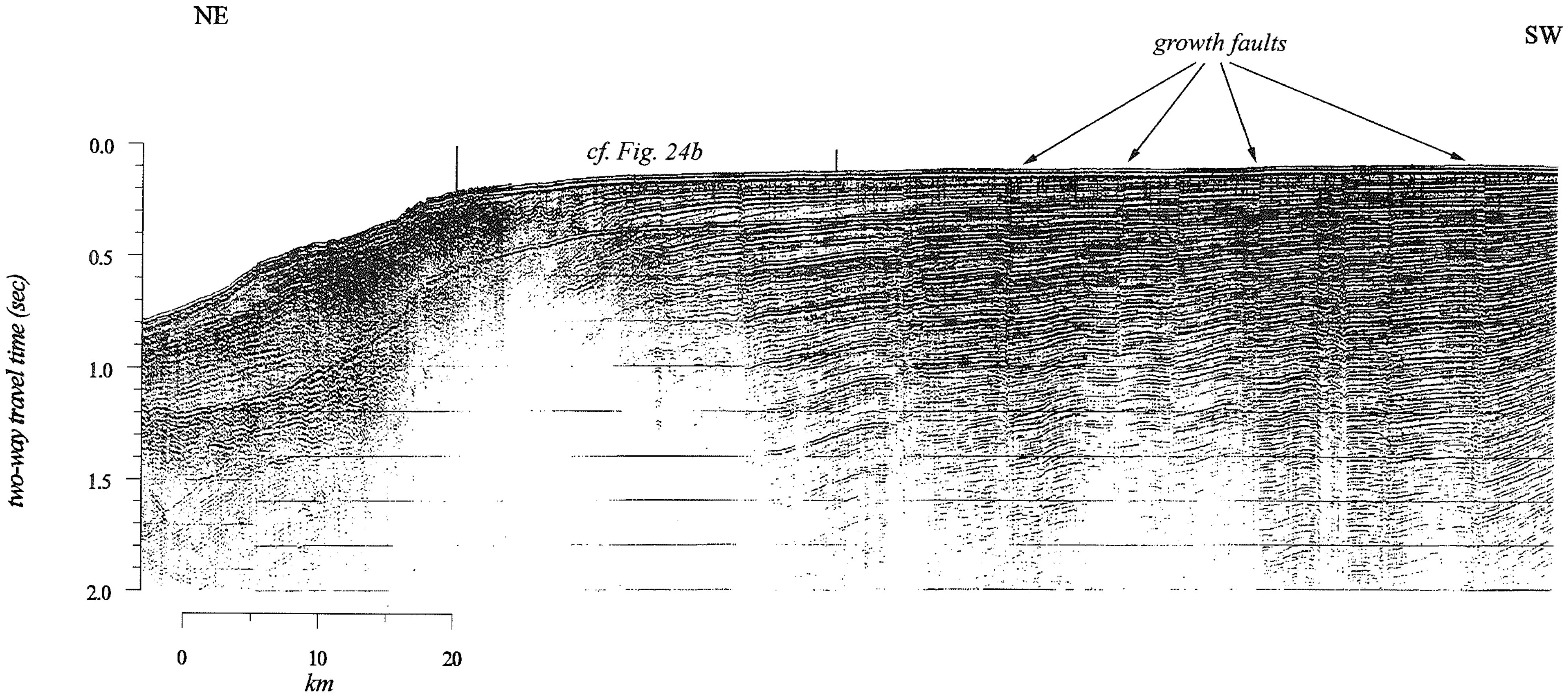

NE
SW
growth faults
cf. Fig. 24b
0.0
0.5
1.0
1.5
2.0
two-way travel time (sec)
0
10
20
km

Fig. 19

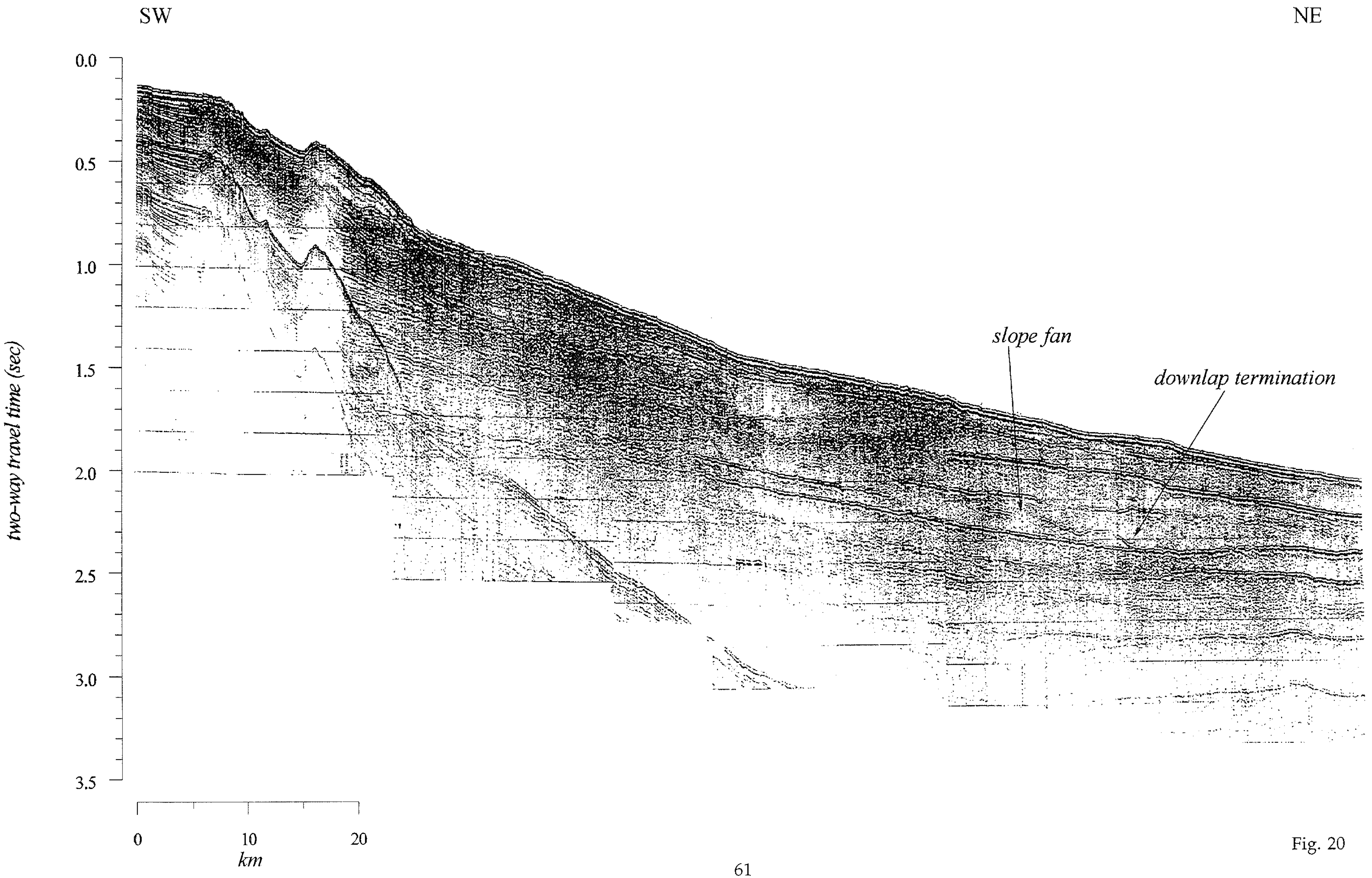

SW
NE
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
two-way travel time (sec)
slope fan
downlap termination
0
10
20
km

Fig. 20

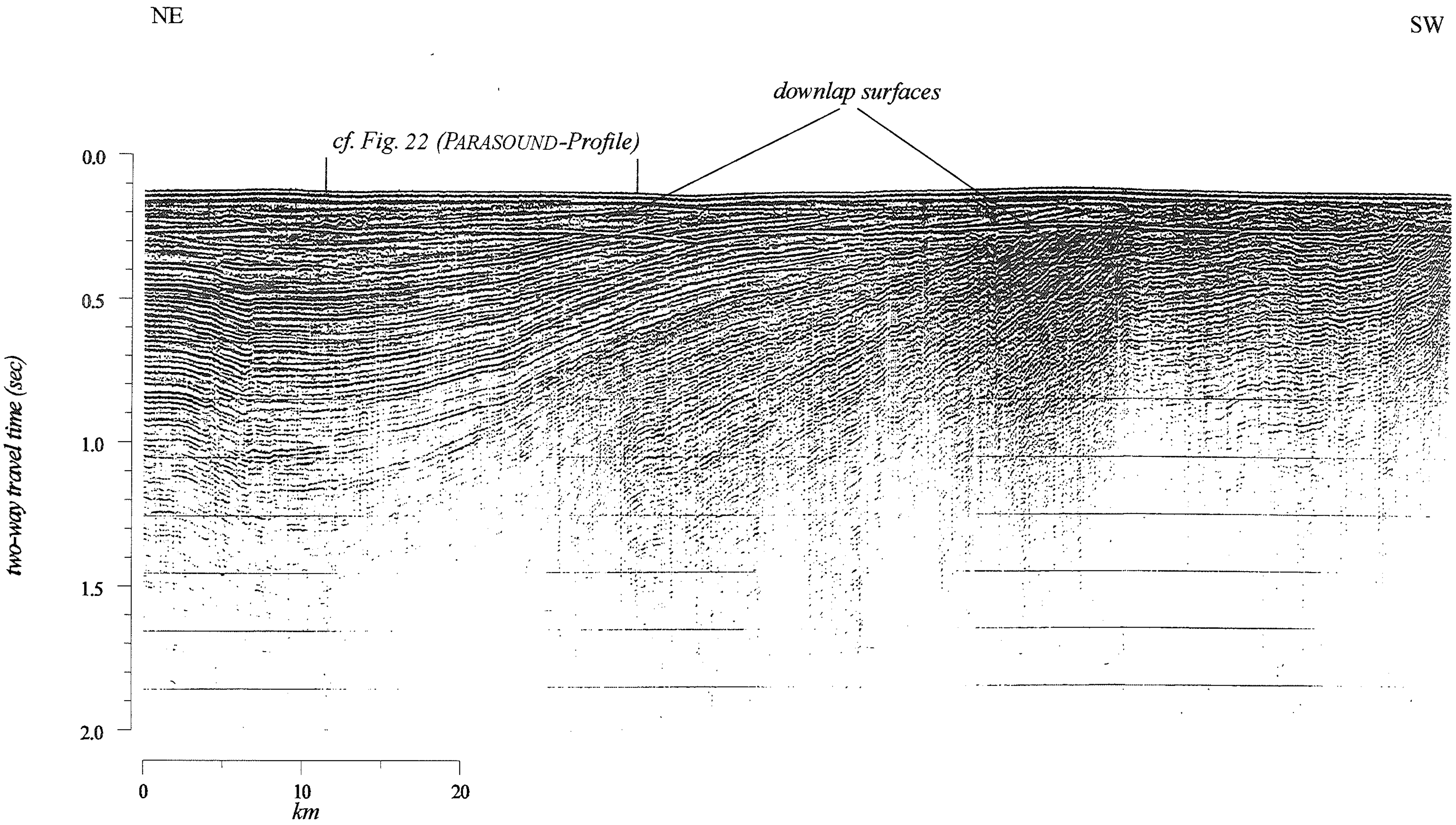

NE
SW
downlap surfaces
cf. Fig. 22 (PARASOUND-Profile)
0.0
0.5
1.0
1.5
2.0
two-way travel time (sec)
0
10
20
km

Fig. 21

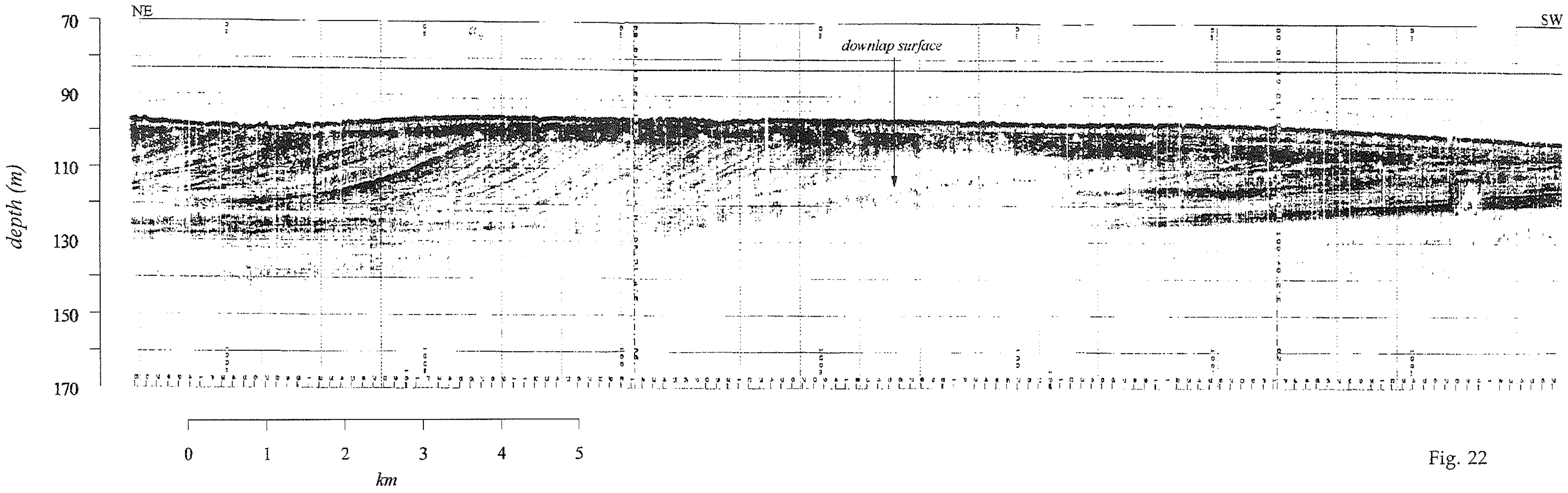


Fig. 22

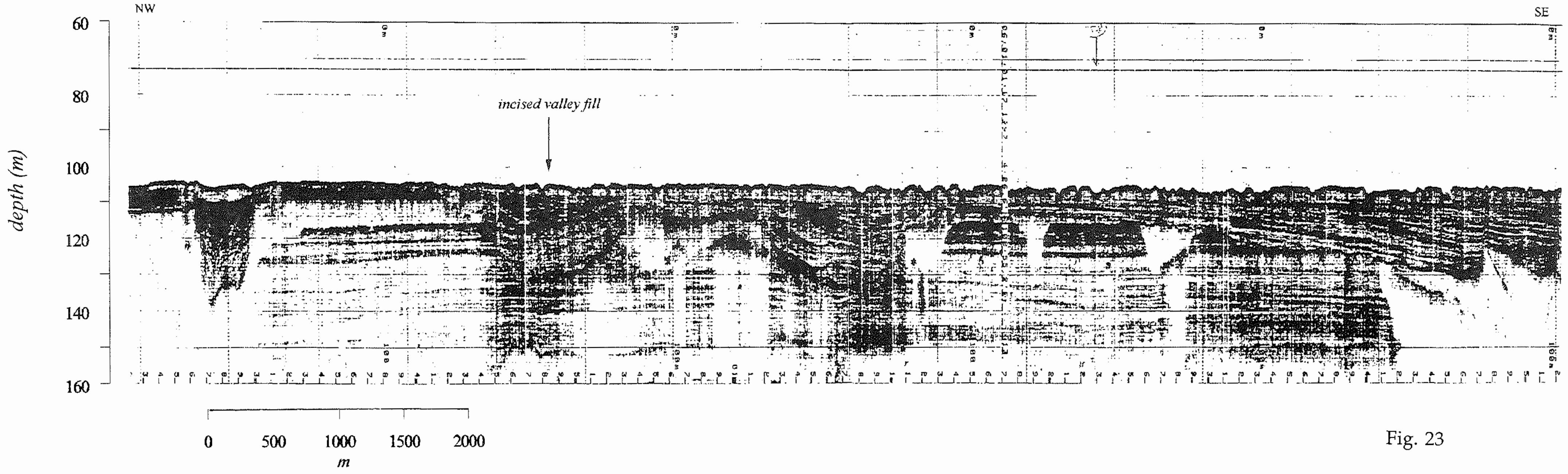

NW
SE
depth (m)
60
80
100
120
140
160
incised valley fill
0
500
1000
1500
2000
m

Fig. 23

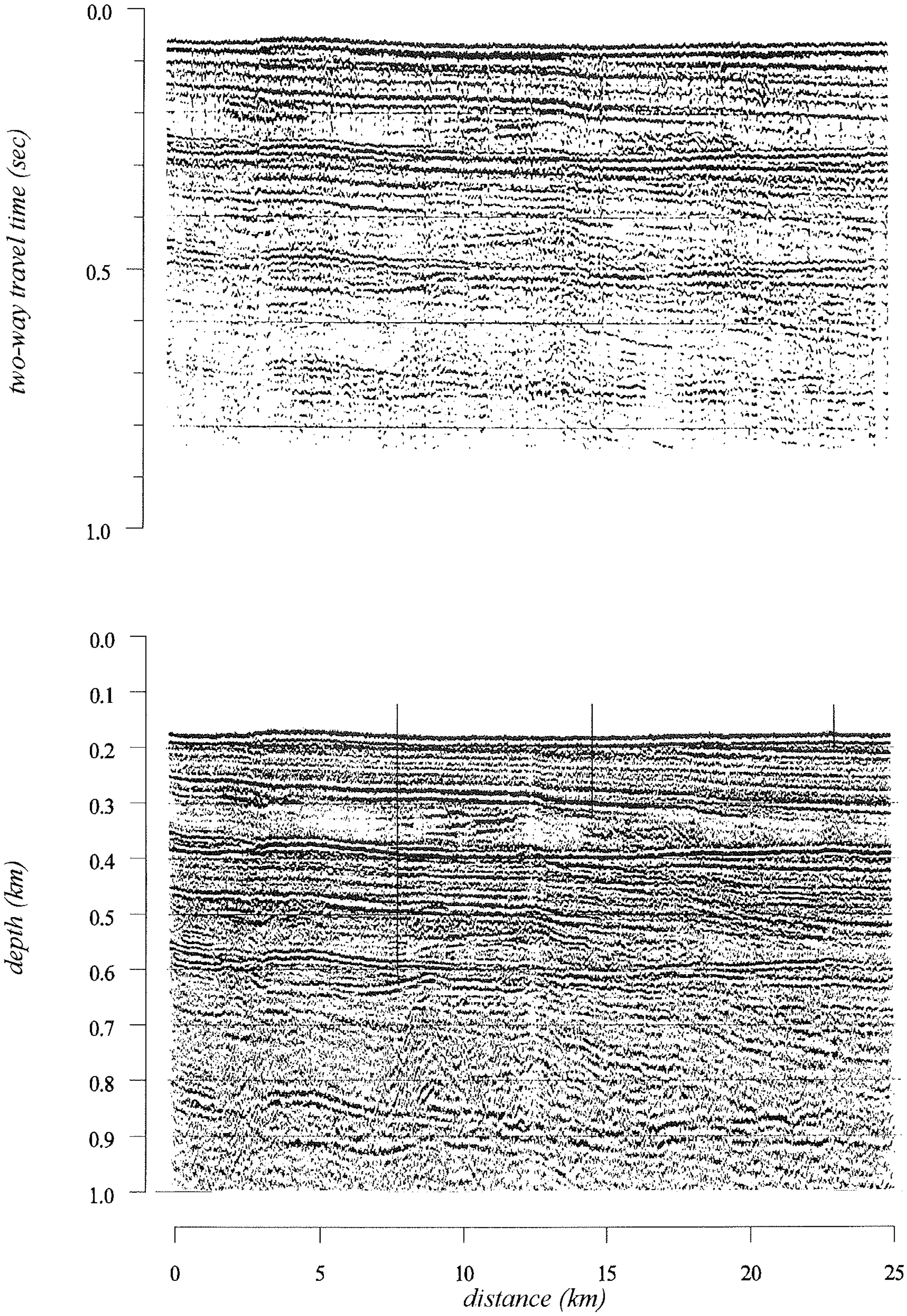

0.0
0.5
1.0
two-way travel time (sec)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
depth (km)
0
5
10
15
20
25
distance (km)

Fig. 24a

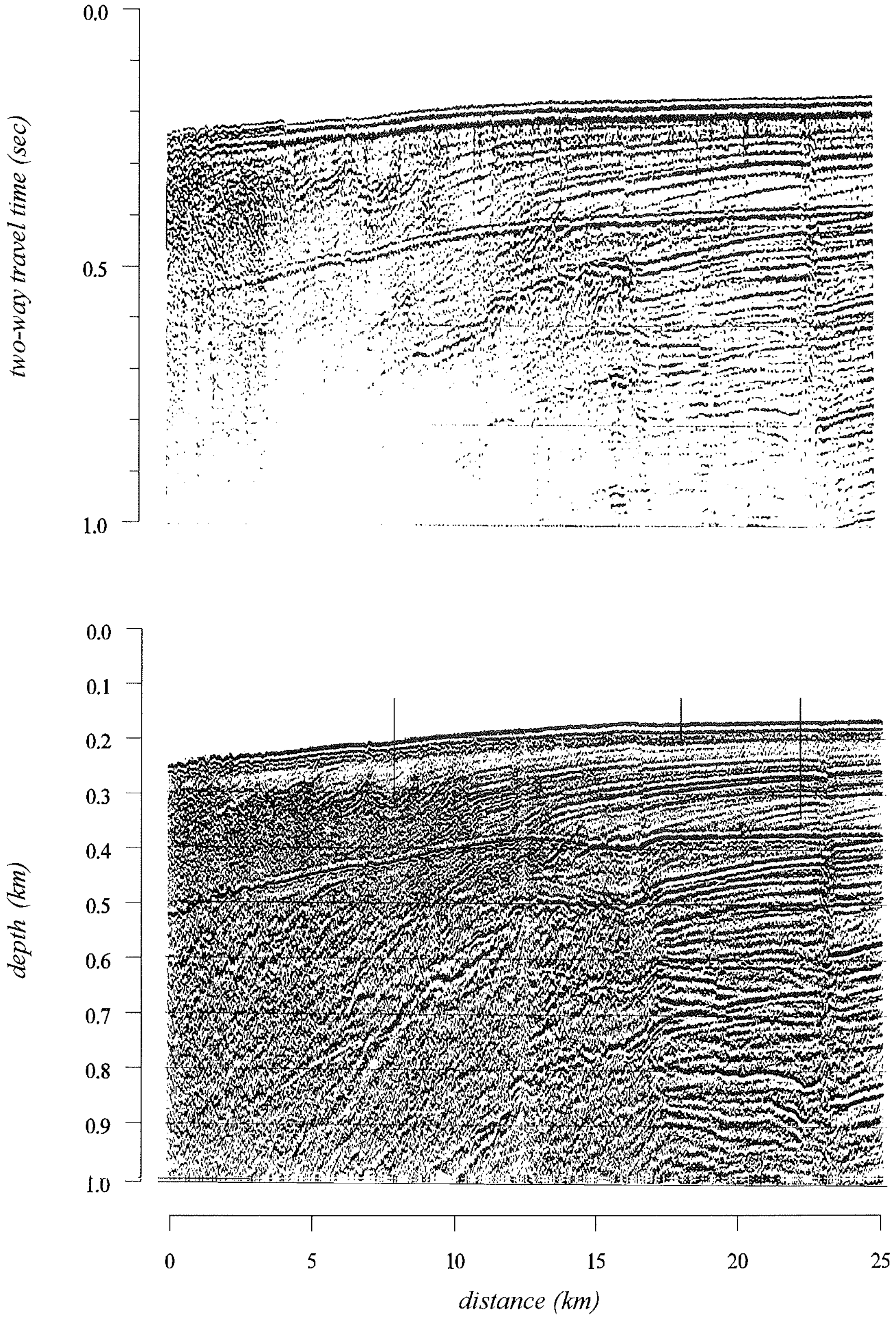

0.0
0.5
1.0
two-way travel time (sec)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
depth (km)
0
5
10
15
20
25
distance (km)

Fig. 24b

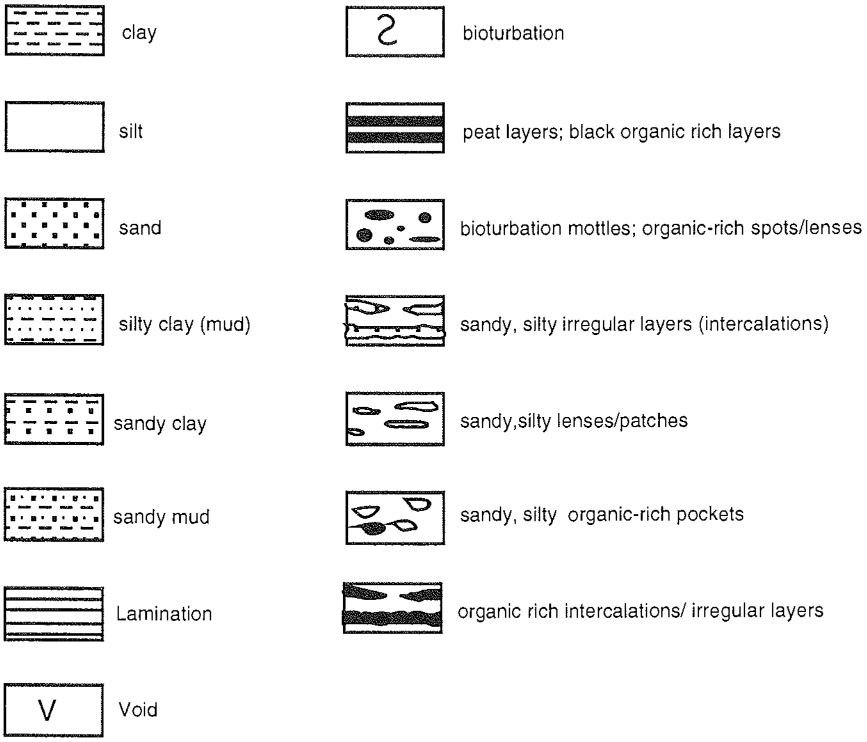
7.2. CORES

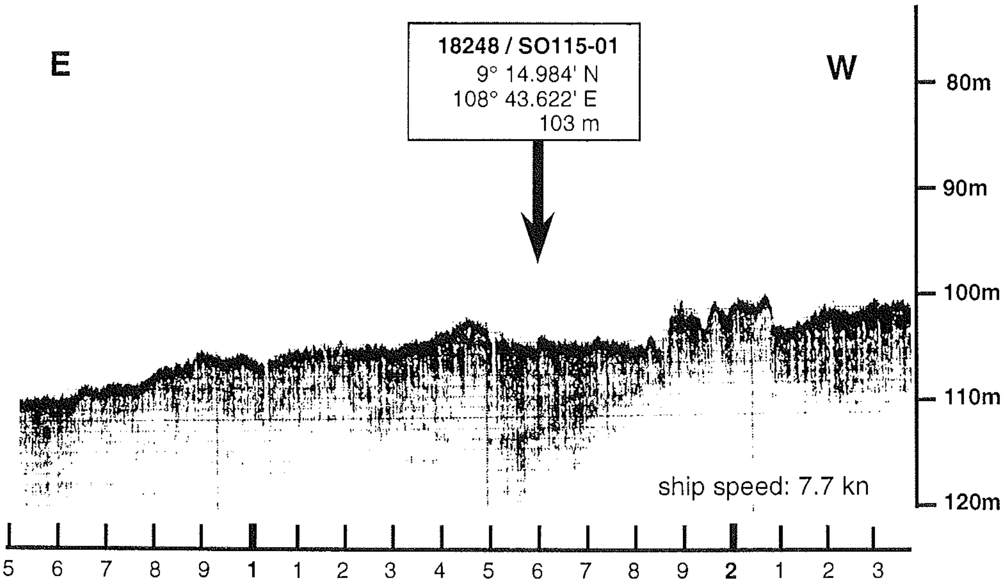
Coring on the Vietnamese Shelf extended from the inner shelf off the modern Mekong delta across the shelf to the continental slope between 9°10'N and 9°42' N. Main objective was to trace the Pleistocene Mekong river on the Vietnam Shelf, and its transition to the present day shelf delta conditions.

Coring in the Sunda shelf area concentrated on a NE-SW transect from 6°10'N, 111°10'E to 2°N, 107°E from the continental slope to the inner shelf including the late Pleistocene deltaic and fluvial part of the Molengraaff river. This NE-SW transect was completed by four NE-SW sections across the Molengraaff system. Main objective of the coring operations was a comprehensive coverage of the seismically recognized sedimentary sequences within the Molengraaff valley and delta system. Special attentation was paid to sites, were the transition from glacial to "modern" sedimentary conditions could be observed and sampled in stratigraphically complete (composite) sections and in high resolution. Sedimentation and biofacies distribution under the modern shelf conditions were surveyed as an endmeber of our study of the evolution of the Sunda shelf since the Late Pleistocene.

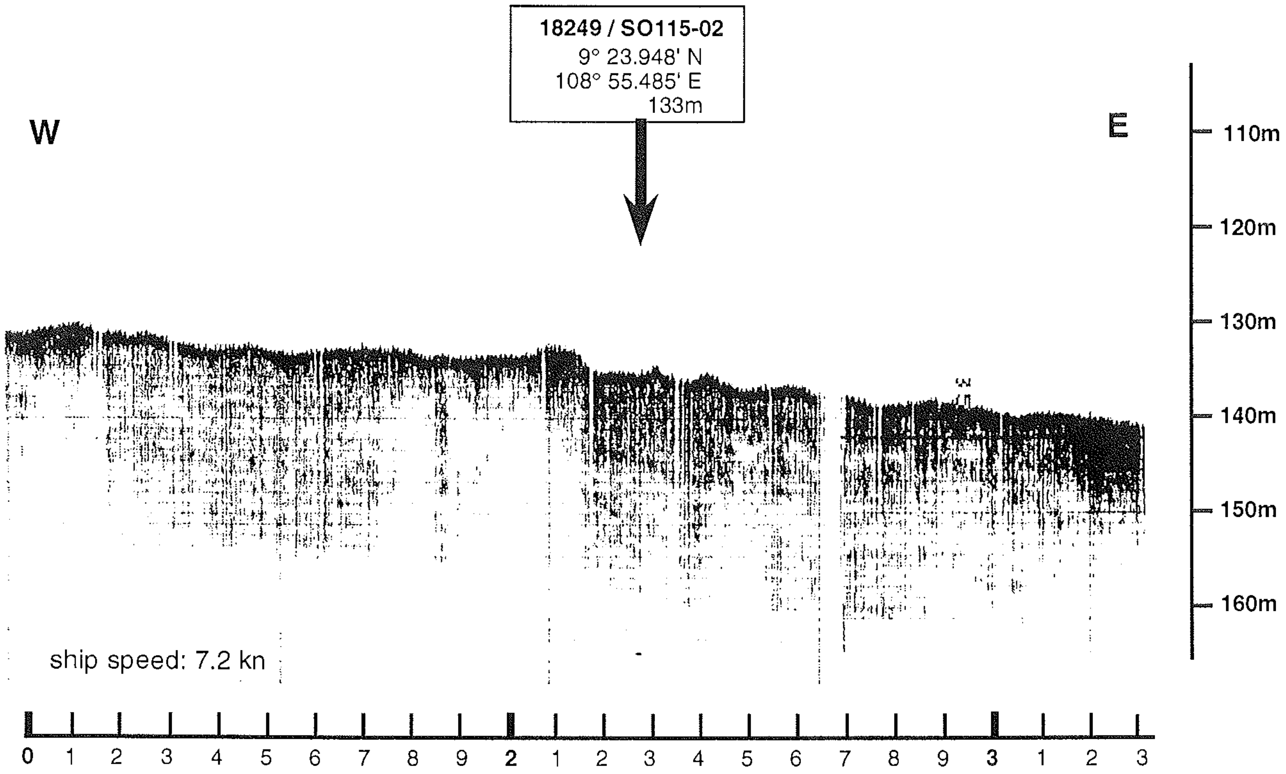
The survey along the shelf and slope was completed by two deep water stations at the continental rise, which give us the opportunity to monitor the paleoceanographic effects of the post-Pleistocene transgression within the pelagic system of the southeastern South China Sea. These stations are part of a pending ODP proposal, and deeper drilling of these sites will offer the opportunity to get stratigraphic control on the deeper seismic reflectors of our study.

In the following, parasound records, initial core descriptions, magnetic susceptibility and examples of grey scale core logs are combined for the best cores of each station. The following lithologic symbols have been generally used in the core descriptions:

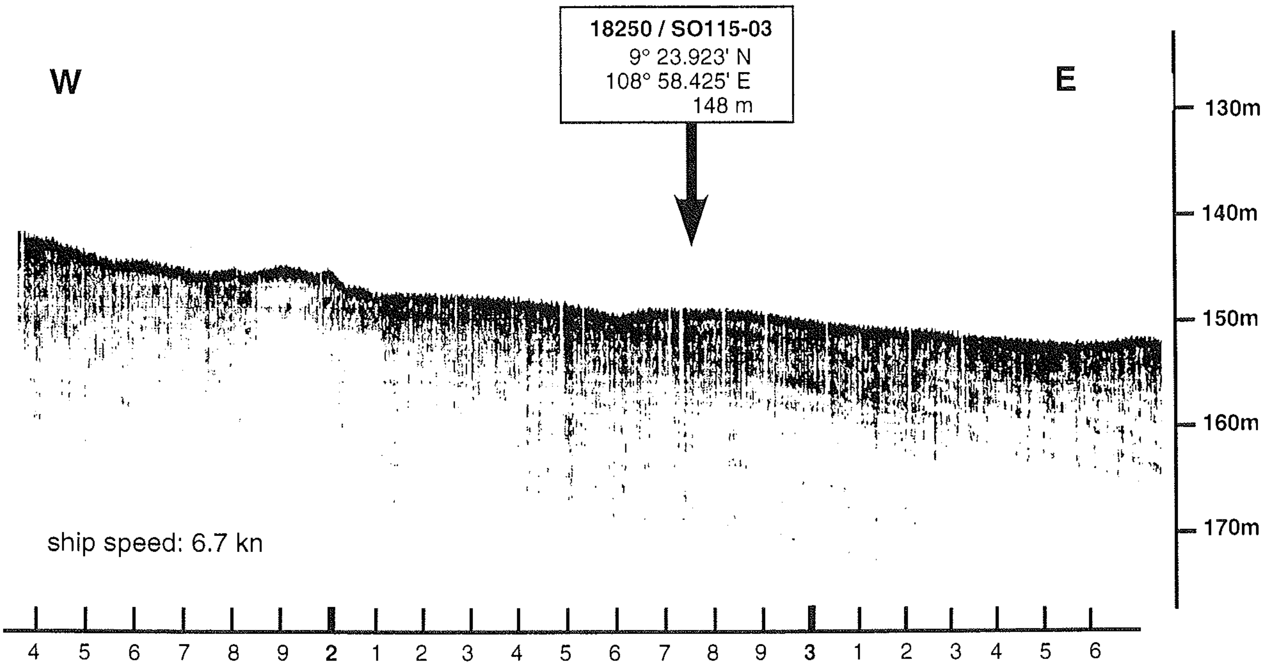




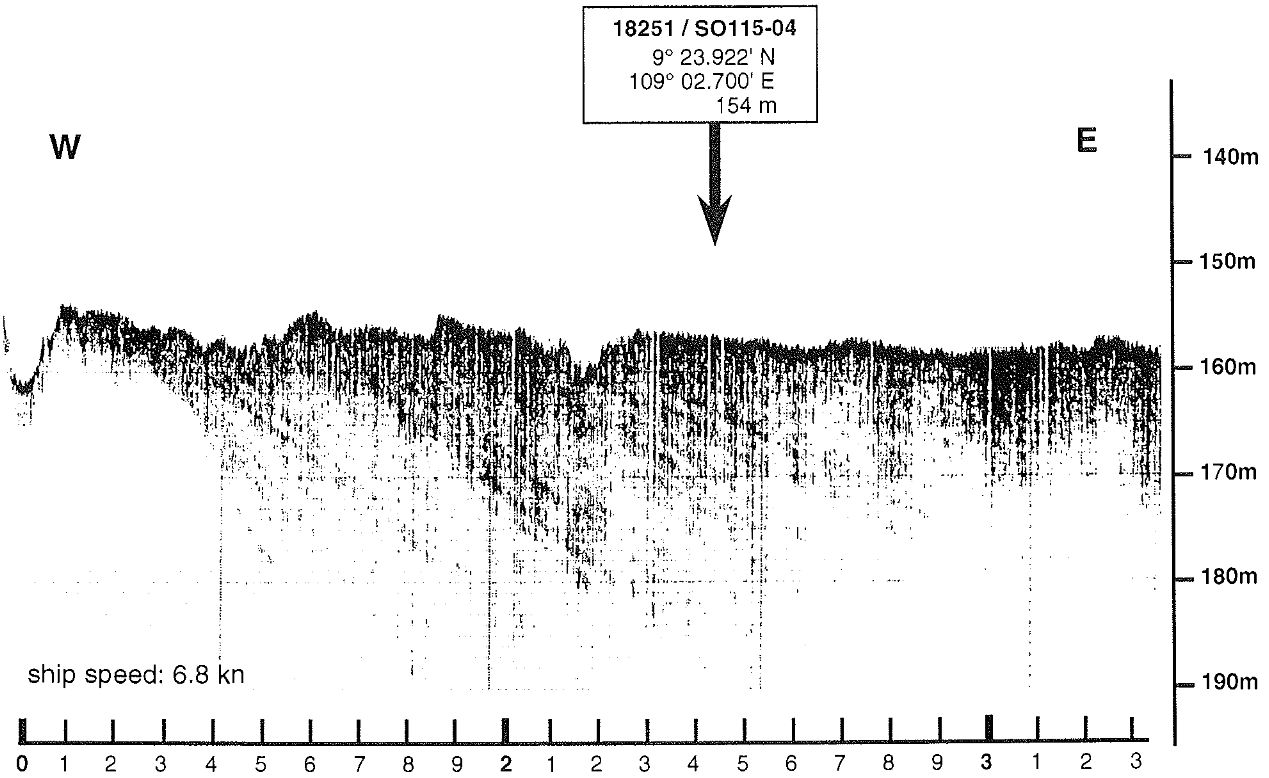
Consolidated sediment surface on the outer shelf. No penetration of gravity corer.



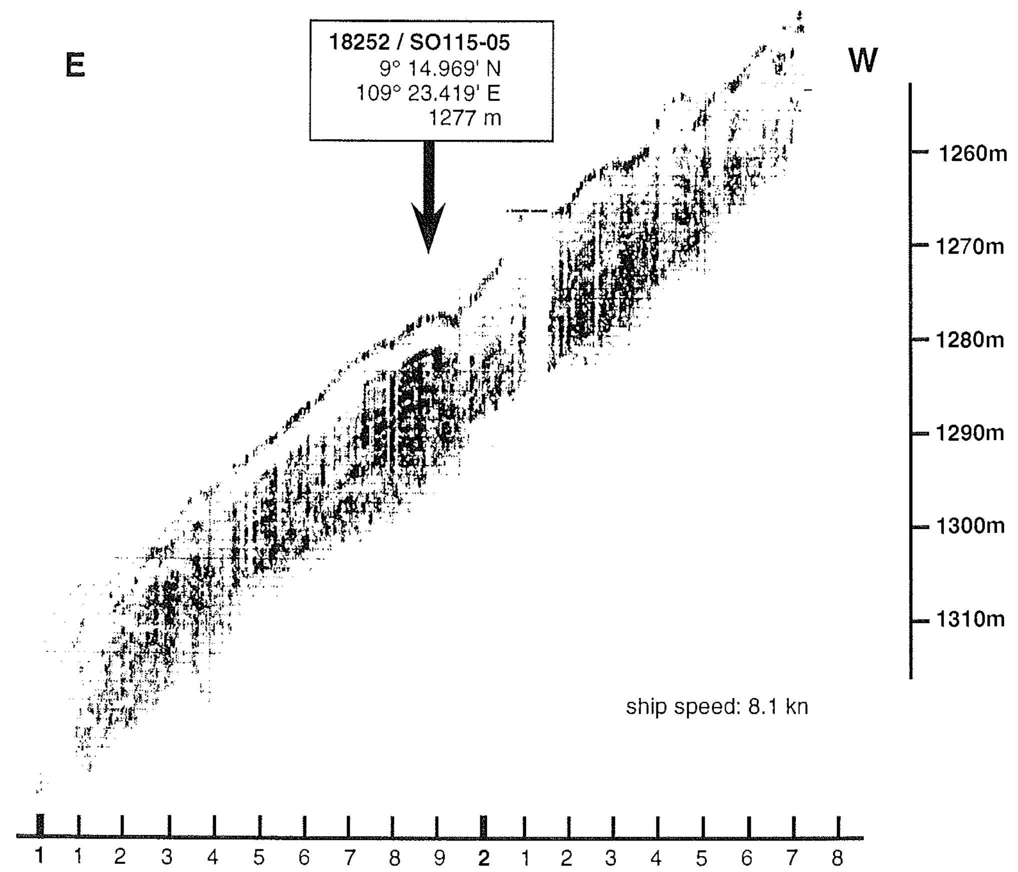
Consolidated sediment surface on the outer shelf. No penetration of gravity corer.

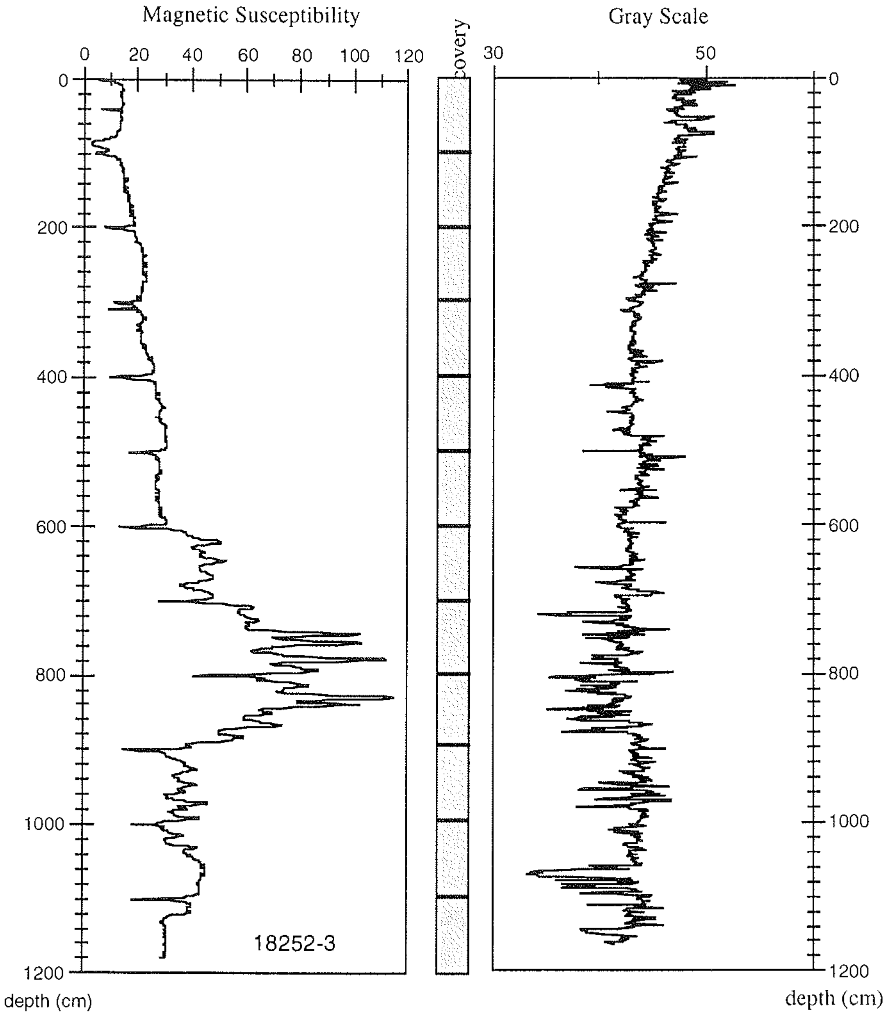


Consolidated sediment surface on the outer shelf. No penetration of gravity corer .



Consolidated sediment surface on the outer shelf. No penetration of gravity corer.





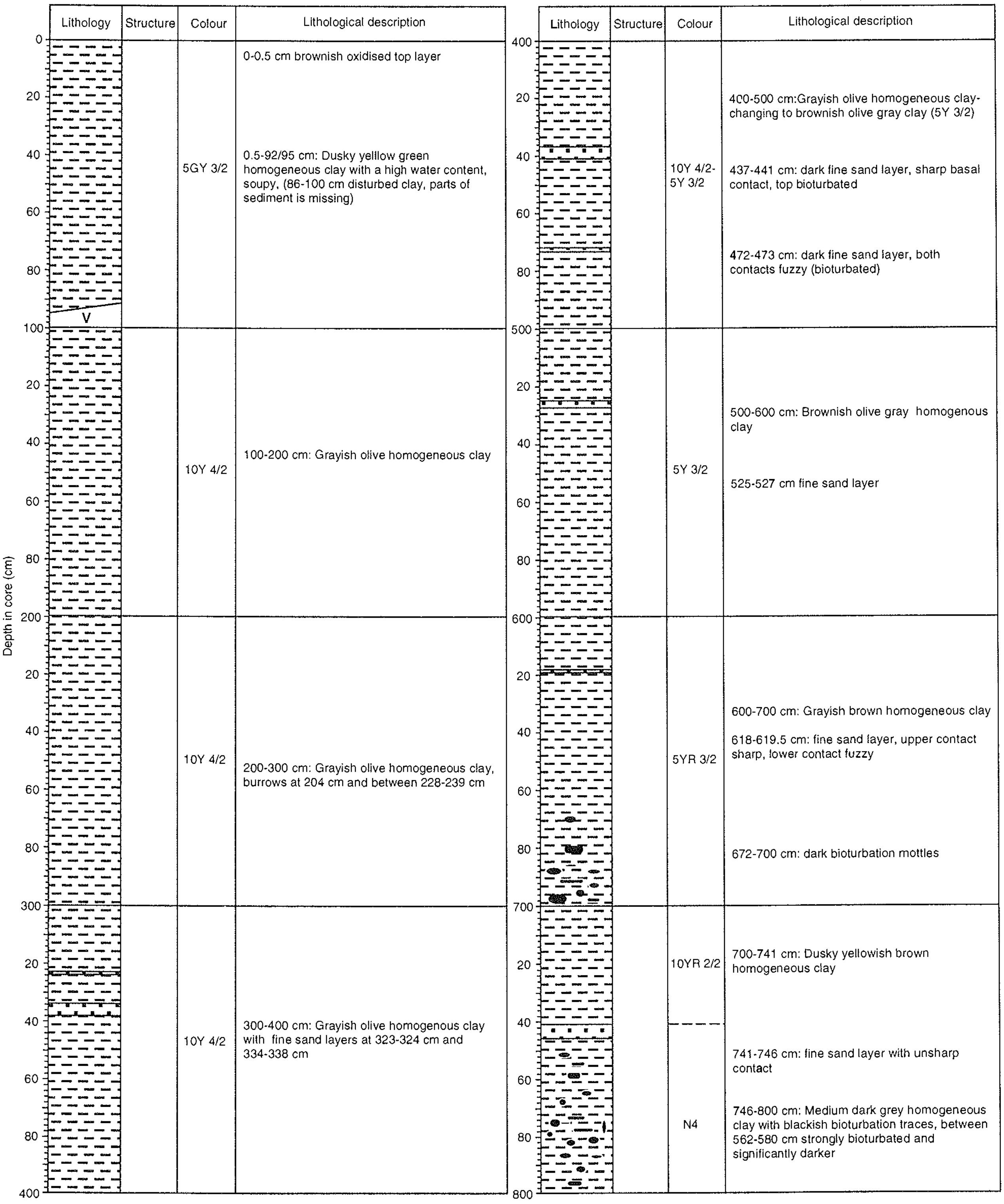
Objectives:

Long reference core on the continetal slope in intermediate water depth, to examine paleo-oceanographic changes during the Holocene/Pleistocene transition off the paleo-mouth of the Mekong river

The unit of the Magnetic Susceptibility is here and in all following figures cgs.

SONNE-115 **Water depth: 1273 m**
Station: SO-115-05
Position: 9° 15.007 N; 109° 23.446 E

Core: SL 18252-3 **Recovery: 1185 cm**

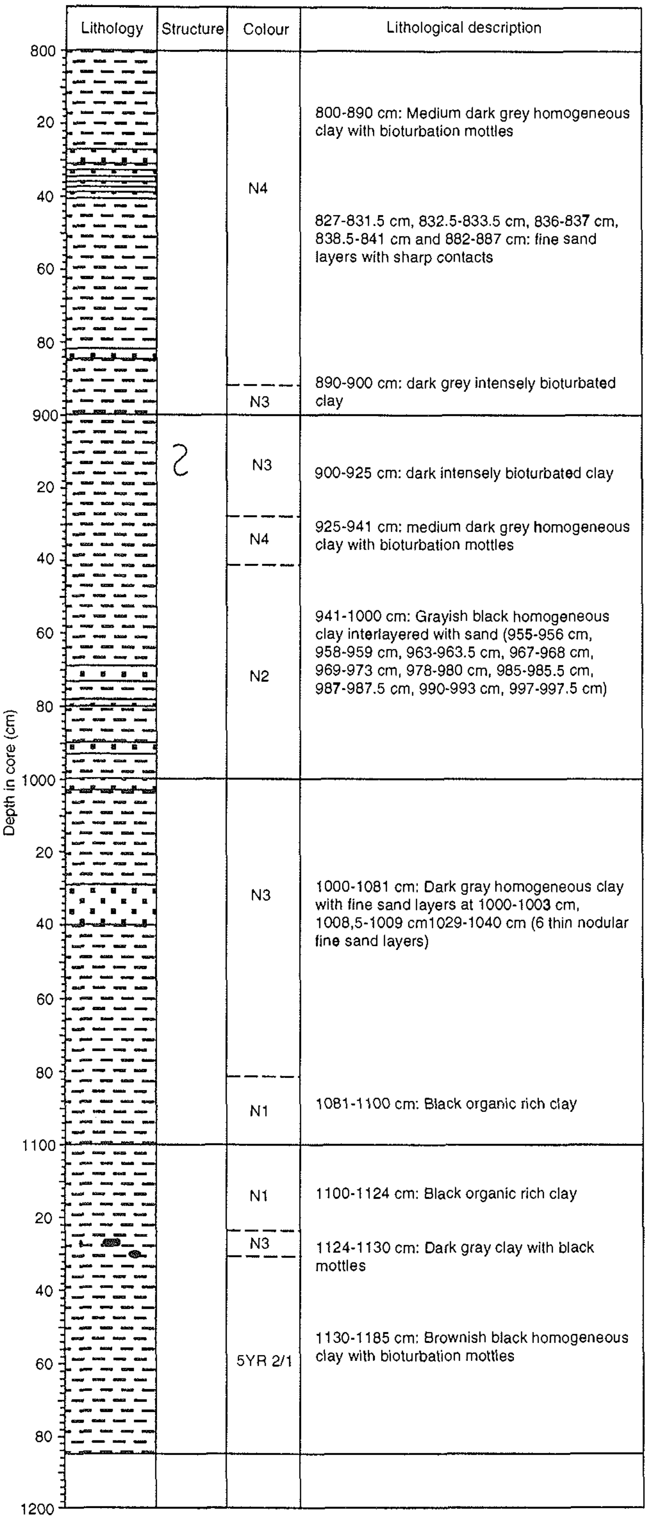


Lithology	Structure	Colour	Lithological description
			0-0.5 cm brownish oxidised top layer
		5GY 3/2	0.5-92/95 cm: Dusky yelllow green homogeneous clay with a high water content, soupy, (86-100 cm disturbed clay, parts of sediment is missing)
		10Y 4/2	100-200 cm: Grayish olive homogeneous clay
		10Y 4/2	200-300 cm: Grayish olive homogeneous clay, burrows at 204 cm and between 228-239 cm
		10Y 4/2	300-400 cm: Grayish olive homogenous clay with fine sand layers at 323-324 cm and 334-338 cm

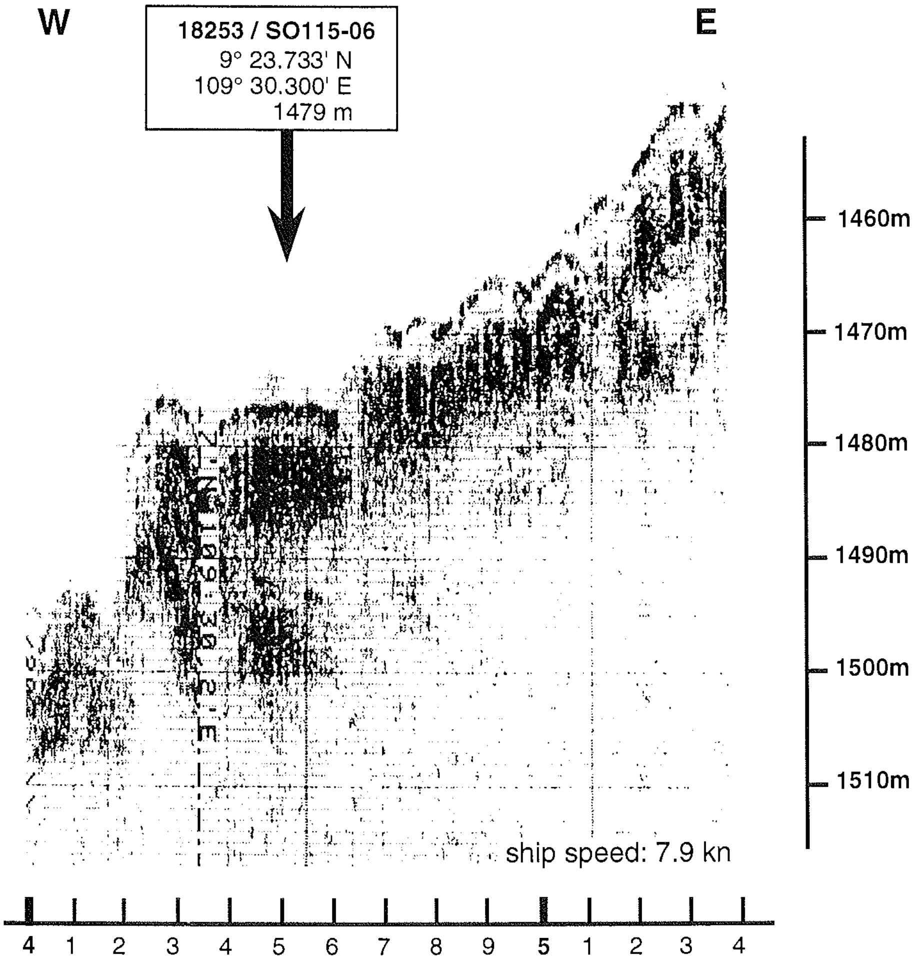
Lithology	Structure	Colour	Lithological description
		10Y 4/2- 5Y 3/2	400-500 cm:Grayish olive homogeneous clay-changing to brownish olive gray clay (5Y 3/2) 437-441 cm: dark fine sand layer, sharp basal contact, top bioturbated 472-473 cm: dark fine sand layer, both contacts fuzzy (bioturbated)
		5Y 3/2	500-600 cm: Brownish olive gray homogenous clay 525-527 cm fine sand layer
		5YR 3/2	600-700 cm: Grayish brown homogeneous clay 618-619.5 cm: fine sand layer, upper contact sharp, lower contact fuzzy 672-700 cm: dark bioturbation mottles
		10YR 2/2 N4	700-741 cm: Dusky yellowish brown homogeneous clay 741-746 cm: fine sand layer with unsharp contact 746-800 cm: Medium dark grey homogeneous clay with blackish bioturbation traces, between 562-580 cm strongly bioturbated and significantly darker

SONNE-115 **Water depth: 1273 m**
Station: SO-115-05
Position: 9° 15.007 N; 109° 23.446 E

Core: SL 18252-3 **Recovery: 1185 cm**



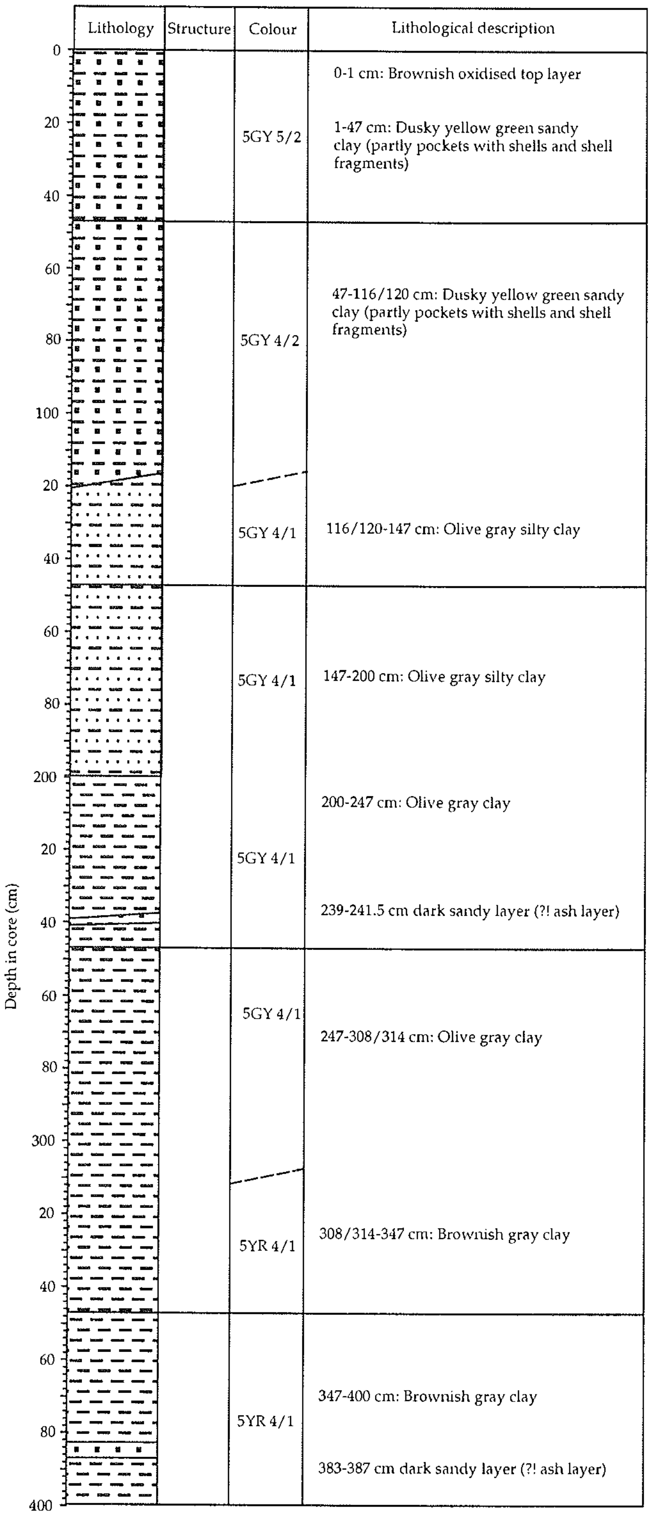
Colour	Lithological description
N4	800-890 cm: Medium dark grey homogeneous clay with bioturbation mottles 827-831.5 cm, 832.5-833.5 cm, 836-837 cm, 838.5-841 cm and 882-887 cm: fine sand layers with sharp contacts
N3	890-900 cm: dark grey intensely bioturbated clay
N3	900-925 cm: dark intensely bioturbated clay
N4	925-941 cm: medium dark grey homogeneous clay with bioturbation mottles
N2	941-1000 cm: Grayish black homogeneous clay interlayered with sand (955-956 cm, 958-959 cm, 963-963.5 cm, 967-968 cm, 969-973 cm, 978-980 cm, 985-985.5 cm, 987-987.5 cm, 990-993 cm, 997-997.5 cm)
N3	1000-1081 cm: Dark gray homogeneous clay with fine sand layers at 1000-1003 cm, 1008,5-1009 cm1029-1040 cm (6 thin nodular fine sand layers)
N1	1081-1100 cm: Black organic rich clay
N1	1100-1124 cm: Black organic rich clay
N3	1124-1130 cm: Dark gray clay with black mottles
5YR 2/1	1130-1185 cm: Brownish black homogeneous clay with bioturbation mottles



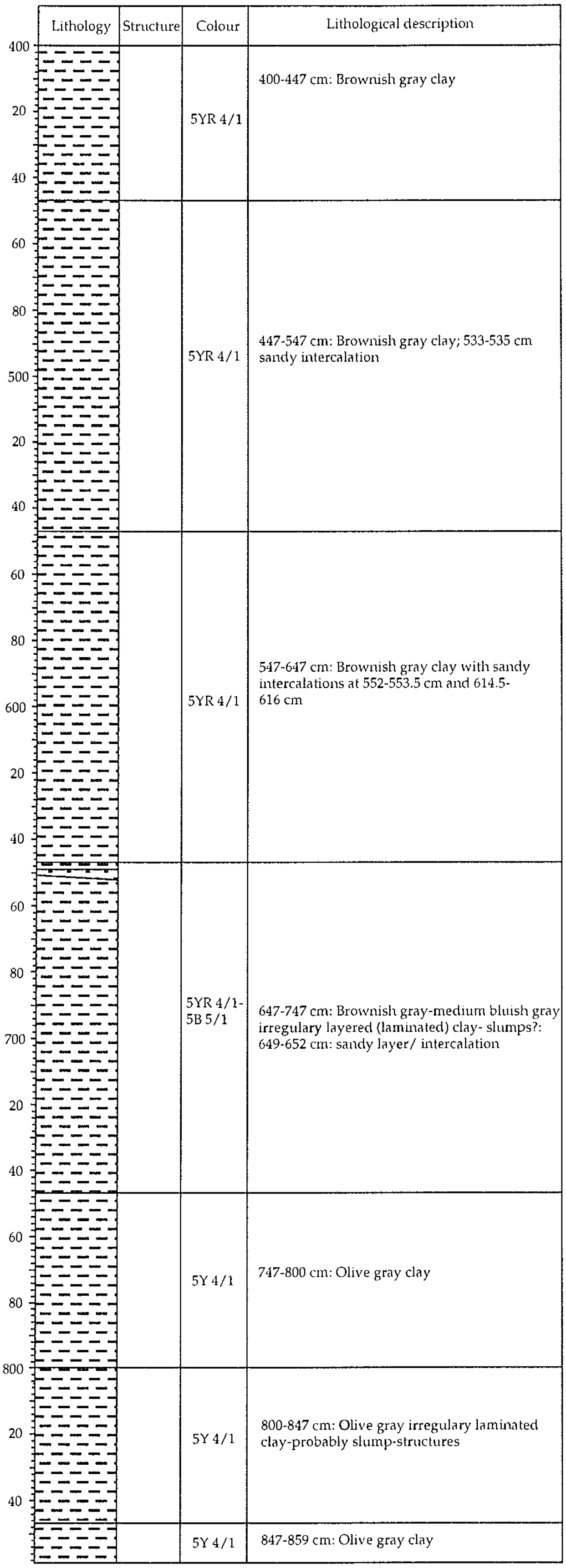
Objectives: Long reference core on the continetal slope in intermediate water depth, to examine paleo-oceanographic changes during the Holocene/Pleistocene transition off the paleo-mouth of the Mekong river.

SONNE-115 Water depth: 1479 m
Station: SO-115-06
Position: 9° 23.704 N; 109° 29.995 E

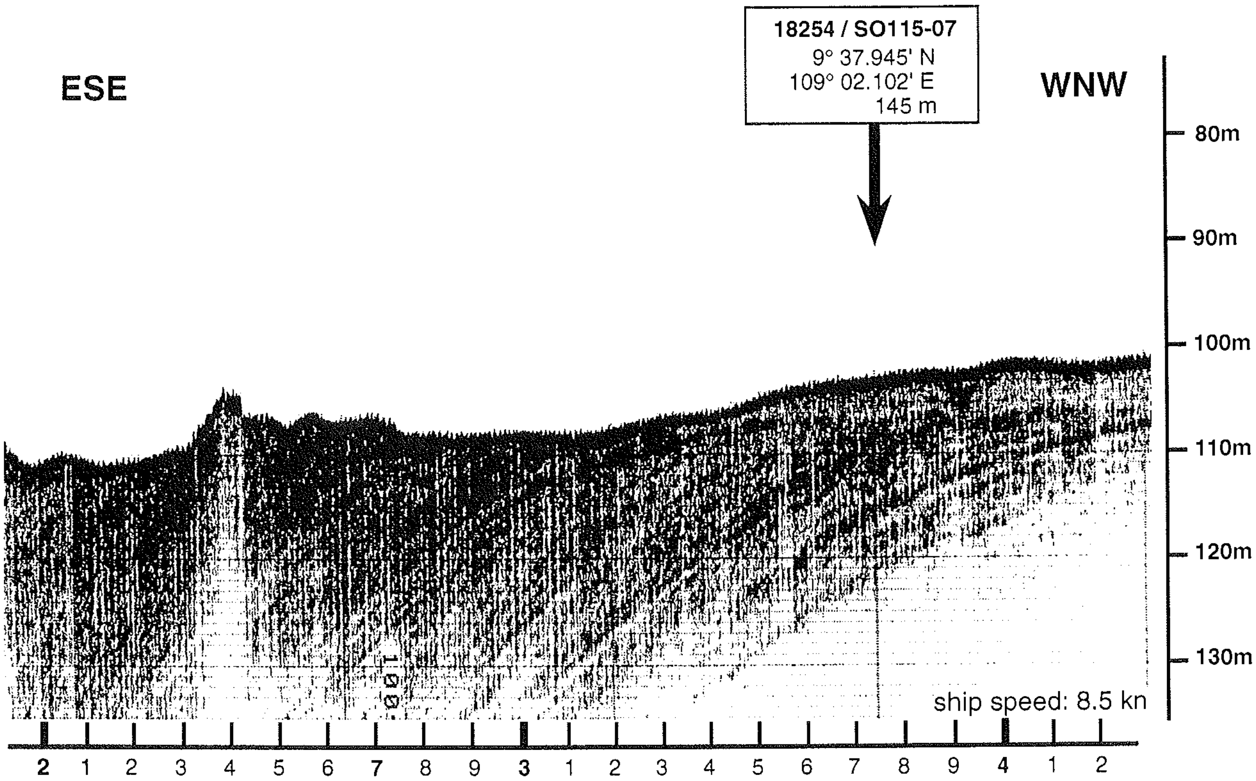
Core: SL 18253-2 Recovery: 859 cm



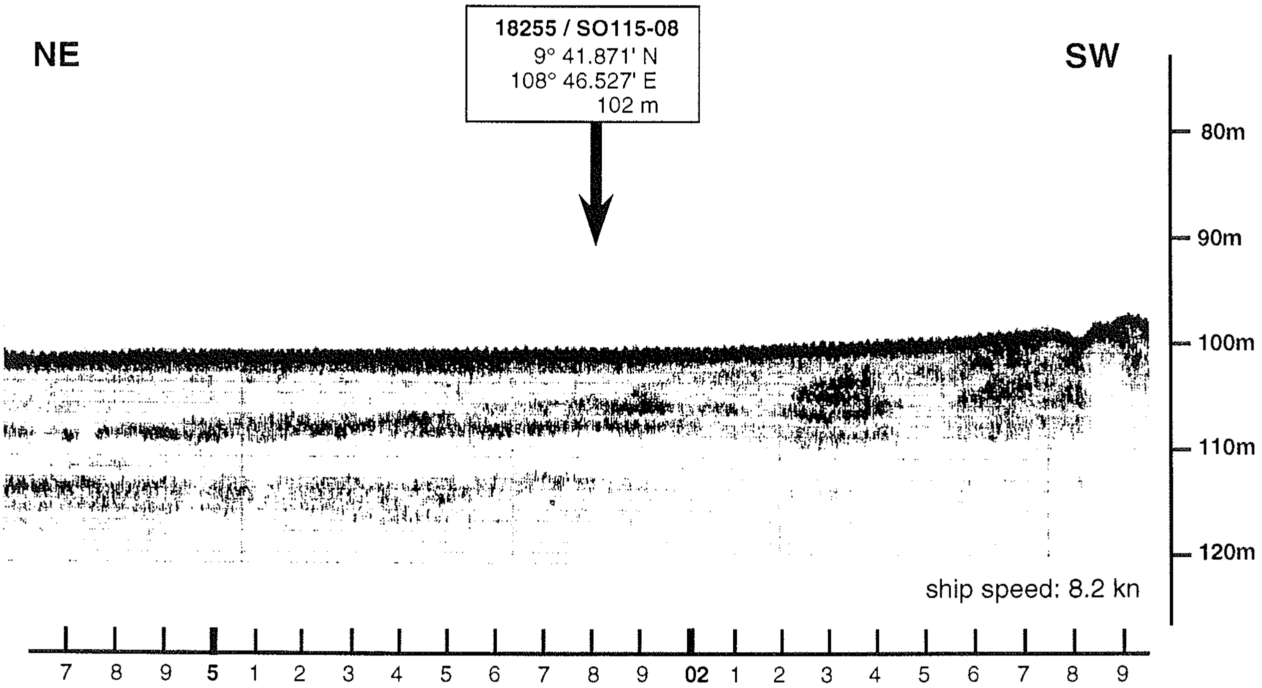
Colour	Lithological description
5GY 5/2	0-1 cm: Brownish oxidised top layer 1-47 cm: Dusky yellow green sandy clay (partly pockets with shells and shell fragments)
5GY 4/2	47-116/120 cm: Dusky yellow green sandy clay (partly pockets with shells and shell fragments)
5GY 4/1	116/120-147 cm: Olive gray silty clay
5GY 4/1	147-200 cm: Olive gray silty clay
5GY 4/1	200-247 cm: Olive gray clay 239-241.5 cm dark sandy layer (?! ash layer)
5GY 4/1	247-308/314 cm: Olive gray clay
5YR 4/1	308/314-347 cm: Brownish gray clay
5YR 4/1	347-400 cm: Brownish gray clay 383-387 cm dark sandy layer (?! ash layer)

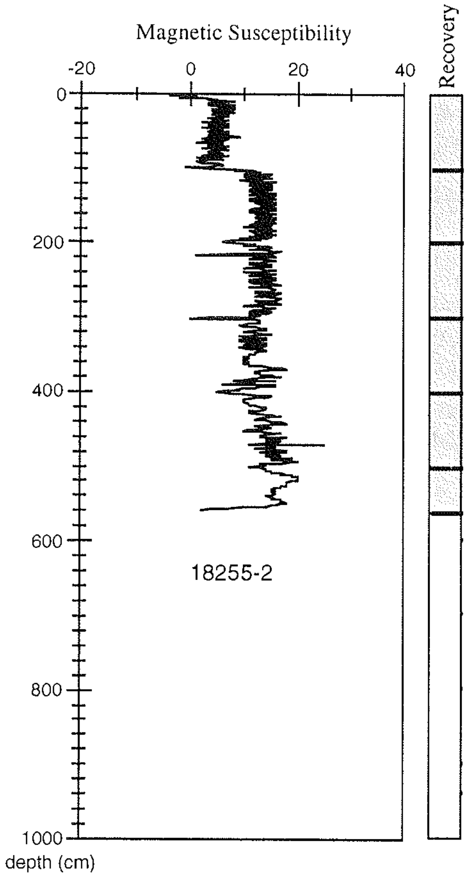


Colour	Lithological description
5YR 4/1	400-447 cm: Brownish gray clay
5YR 4/1	447-547 cm: Brownish gray clay; 533-535 cm sandy intercalation
5YR 4/1	547-647 cm: Brownish gray clay with sandy intercalations at 552-553.5 cm and 614.5-616 cm
5YR 4/1-5B 5/1	647-747 cm: Brownish gray-medium bluish gray irregulary layered (laminated) clay- slumps?: 649-652 cm: sandy layer/ intercalation
5Y 4/1	747-800 cm: Olive gray clay
5Y 4/1	800-847 cm: Olive gray irregulary laminated clay-probably slump-structures
5Y 4/1	847-859 cm: Olive gray clay



Objectives: Coring of discordant layer wedging out above inclined strata.
Remarks: Although surface sediment in boxcores was a unconsolidated sandy clay, gravity cores were without recovery.

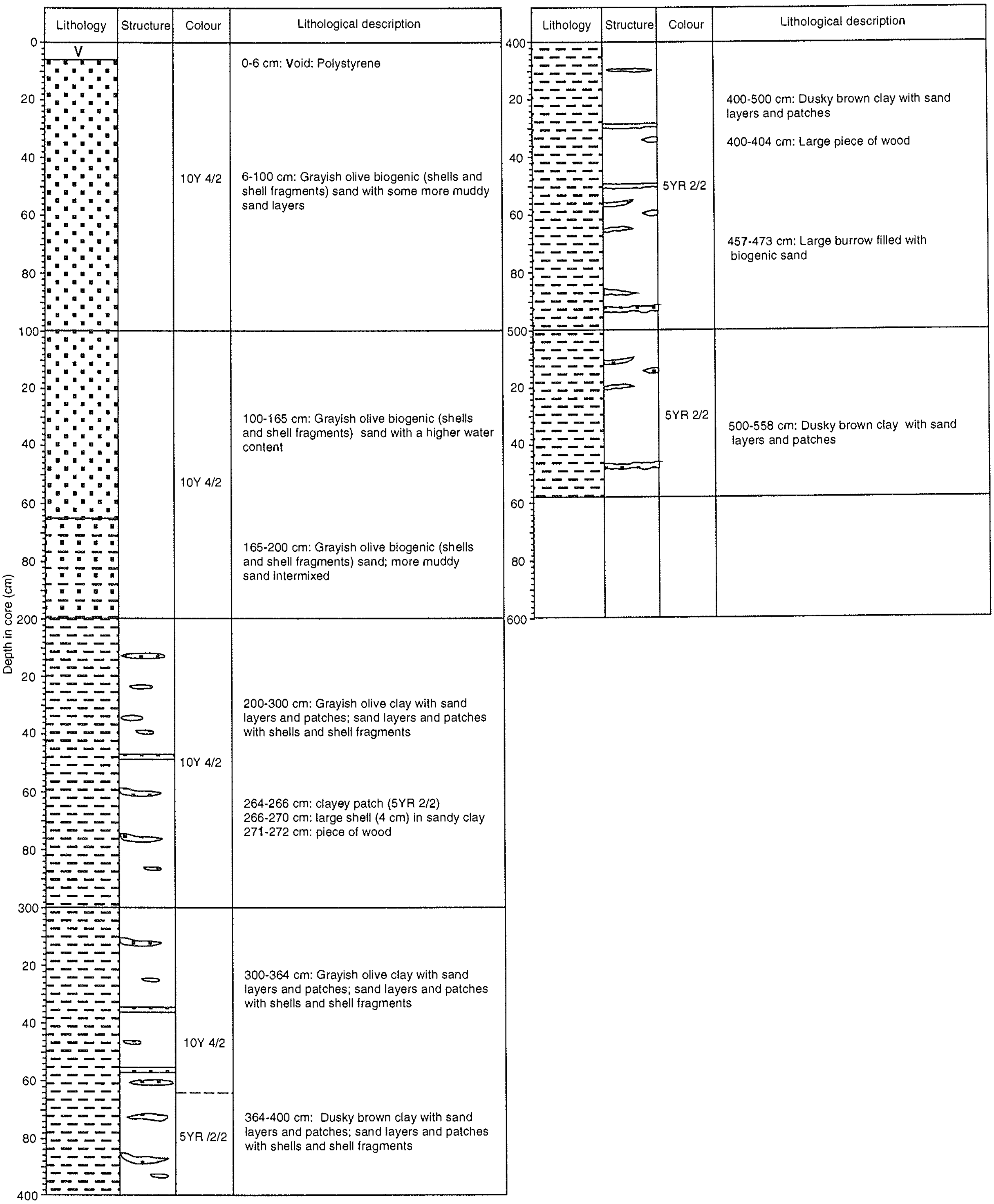




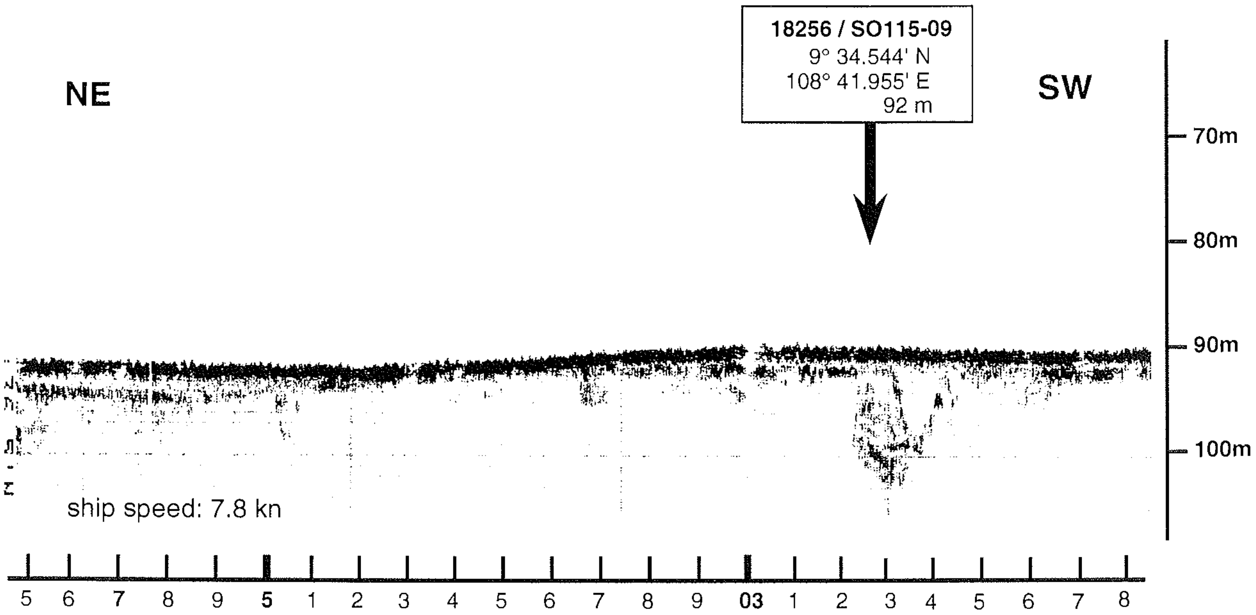
Objectives: Coring an acoustically transparent (Holocene?) layer above a deeper reflector approximately 4.5 m below seafloor in the middle part of the shelf transect.

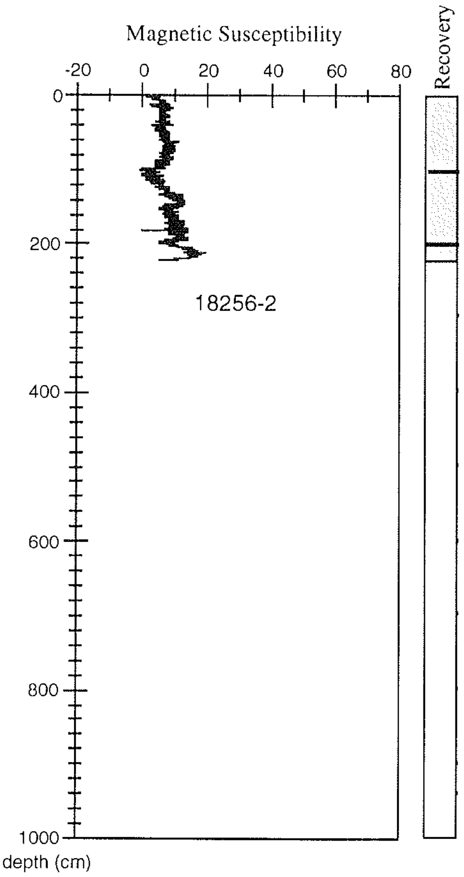
SONNE-115 **Water depth: 102 m**
Station: SO-115-08
Position: 9° 41.871 N; 108° 46.527 E

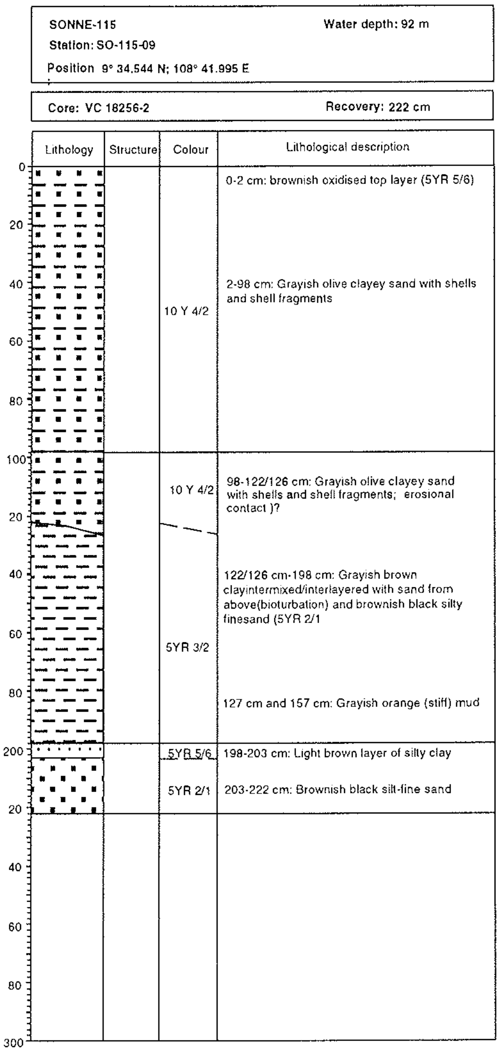
Core: VC 18255-2 **Recovery: 558 cm**



Colour	Lithological description
	0-6 cm: Void: Polystyrene
10Y 4/2	6-100 cm: Grayish olive biogenic (shells and shell fragments) sand with some more muddy sand layers
10Y 4/2	100-165 cm: Grayish olive biogenic (shells and shell fragments) sand with a higher water content 165-200 cm: Grayish olive biogenic (shells and shell fragments) sand; more muddy sand intermixed
10Y 4/2	200-300 cm: Grayish olive clay with sand layers and patches; sand layers and patches with shells and shell fragments 264-266 cm: clayey patch (5YR 2/2) 266-270 cm: large shell (4 cm) in sandy clay 271-272 cm: piece of wood
10Y 4/2	300-364 cm: Grayish olive clay with sand layers and patches; sand layers and patches with shells and shell fragments
5YR /2/2	364-400 cm: Dusky brown clay with sand layers and patches; sand layers and patches with shells and shell fragments
5YR 2/2	400-500 cm: Dusky brown clay with sand layers and patches 400-404 cm: Large piece of wood 457-473 cm: Large burrow filled with biogenic sand
5YR 2/2	500-558 cm: Dusky brown clay with sand layers and patches



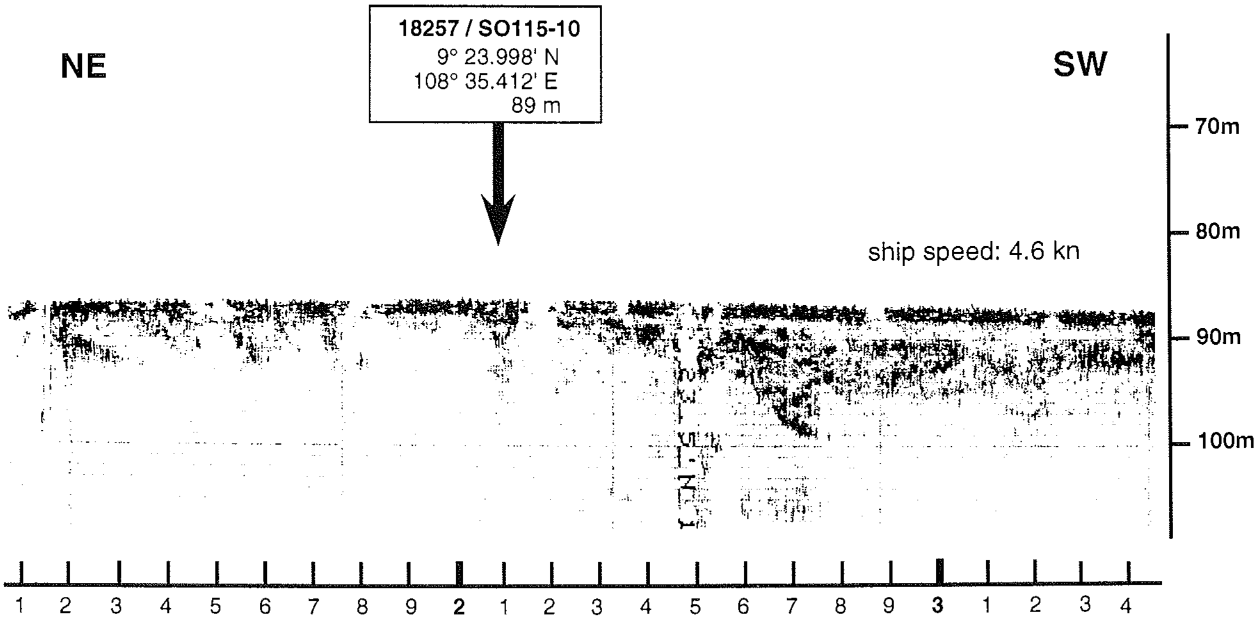


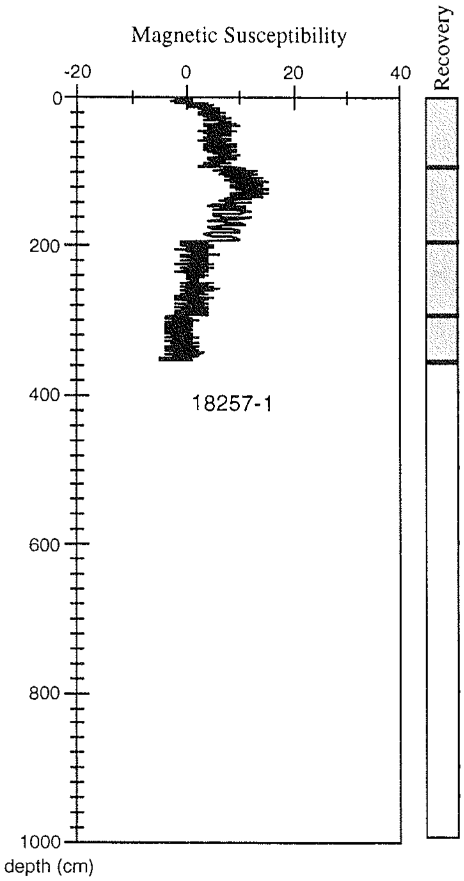

SONNE-115
Station: SO-115-09
Position 9° 34.544 N; 108° 41.995 E
Water depth: 92 m

Core: VC 18256-2
Recovery: 222 cm

Lithology	Structure	Colour	Lithological description
			0-2 cm: brownish oxidised top layer (5YR 5/6)
		10 Y 4/2	2-98 cm: Grayish olive clayey sand with shells and shell fragments
		10 Y 4/2	98-122/126 cm: Grayish olive clayey sand with shells and shell fragments; erosional contact)?
		5YR 3/2	122/126 cm-198 cm: Grayish brown clayintermixed/interlayered with sand from above(bioturbation) and brownish black silty finesand (5YR 2/1 127 cm and 157 cm: Grayish orange (stiff) mud
		5YR 5/6	198-203 cm: Light brown layer of silty clay
		5YR 2/1	203-222 cm: Brownish black silt-fine sand

Objectives: Coring the margin of an infilled incised valley. The comparatively short sediment core mainly recovered the acoustically transparent top layer.

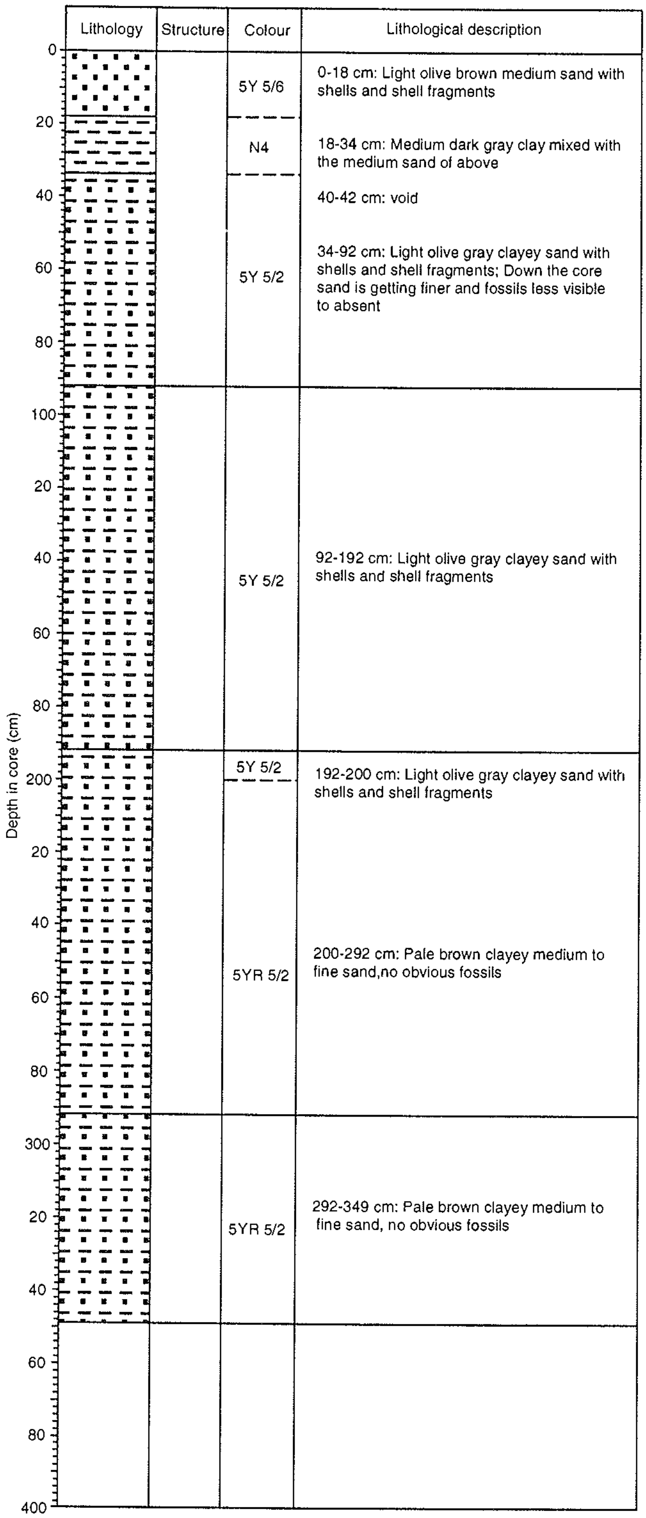




Objective: Coring the edge of an acoustically transparent layer at the margin of an infilled incised valley.

SONNE-115
Station: SO-115-10
Position: 9° 23.998 N; 108° 35.412 E
Water depth: 89 m

Core: VC 18257-1
Recovery: 349 cm



0-18 cm: Light olive brown medium sand with shells and shell fragments

18-34 cm: Medium dark gray clay mixed with the medium sand of above

40-42 cm: void

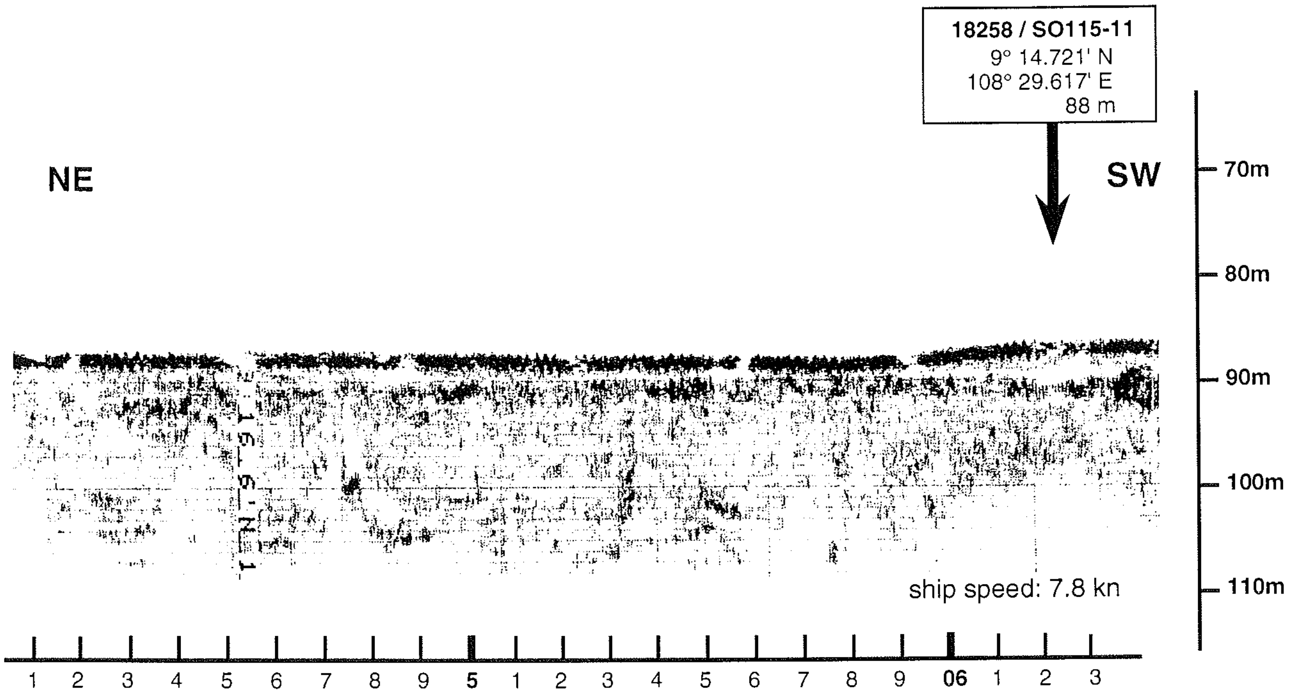
34-92 cm: Light olive gray clayey sand with shells and shell fragments; Down the core sand is getting finer and fossils less visible to absent

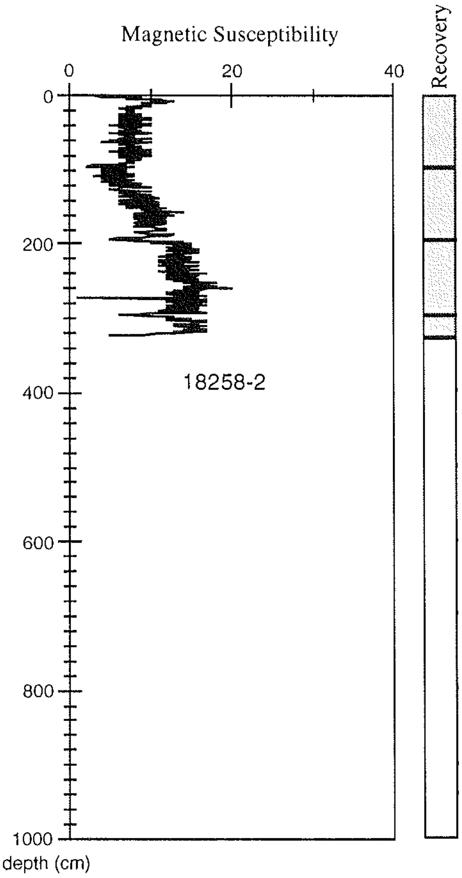
92-192 cm: Light olive gray clayey sand with shells and shell fragments

192-200 cm: Light olive gray clayey sand with shells and shell fragments

200-292 cm: Pale brown clayey medium to fine sand,no obvious fossils

292-349 cm: Pale brown clayey medium to fine sand, no obvious fossils



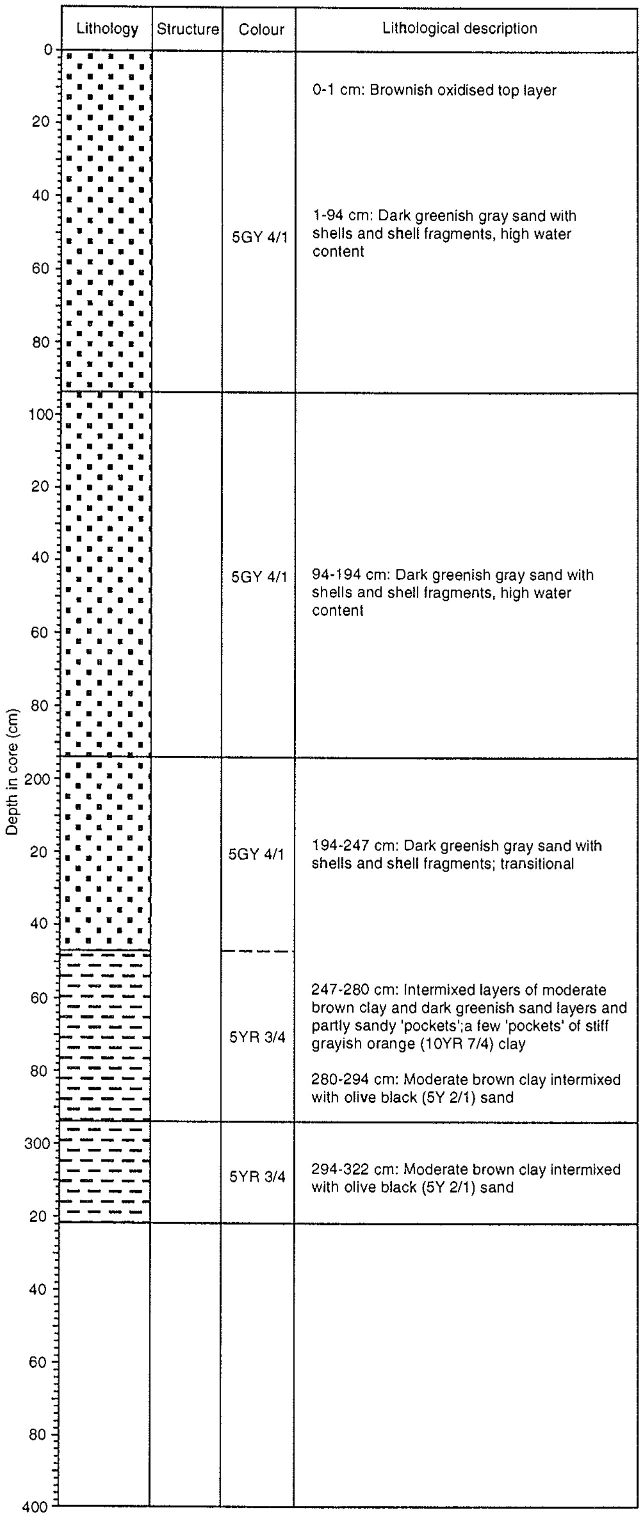


Objective:

Coring of an acoustically transparent small elevation above a distinct horizontal reflector in about 3 m depth below seafloor.

SONNE-115 **Water depth: 88 m**
Station: SO-115-11
Position: 9° 14.721 N; 109° 29.617 E

Core: VC 18258-2 **Recovery: 322 cm**



0-1 cm: Brownish oxidised top layer

1-94 cm: Dark greenish gray sand with shells and shell fragments, high water content

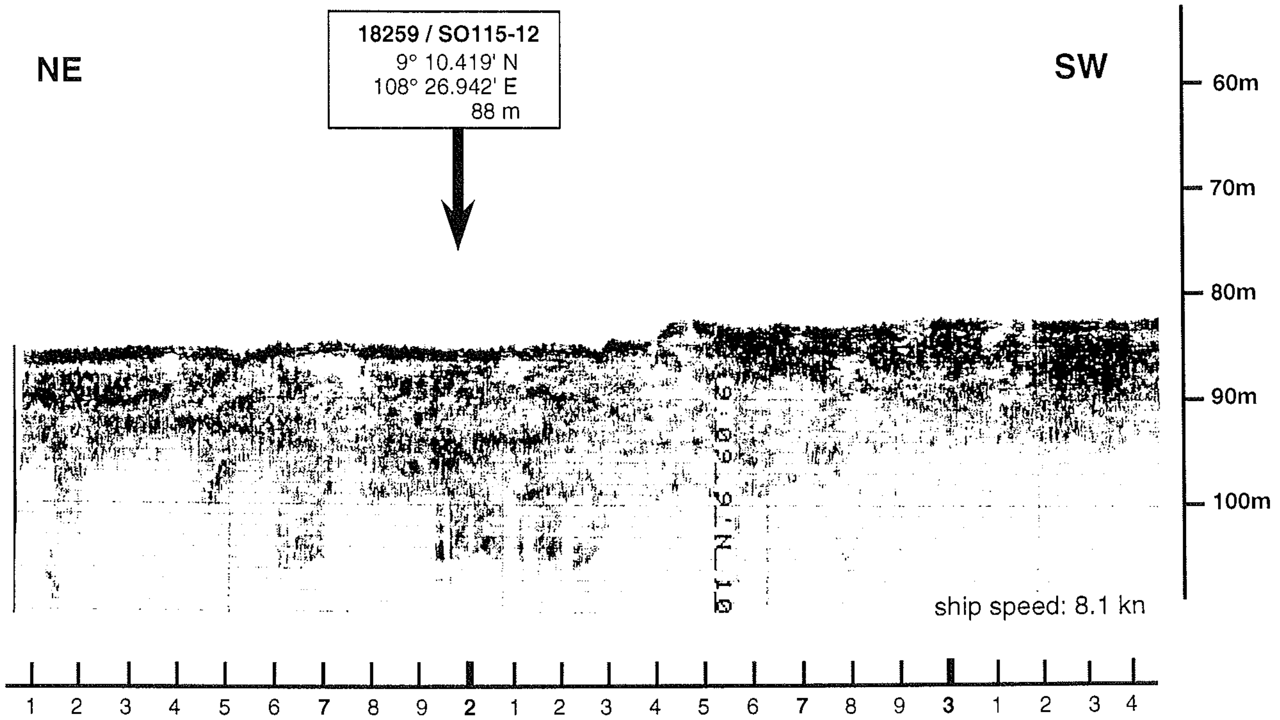
94-194 cm: Dark greenish gray sand with shells and shell fragments, high water content

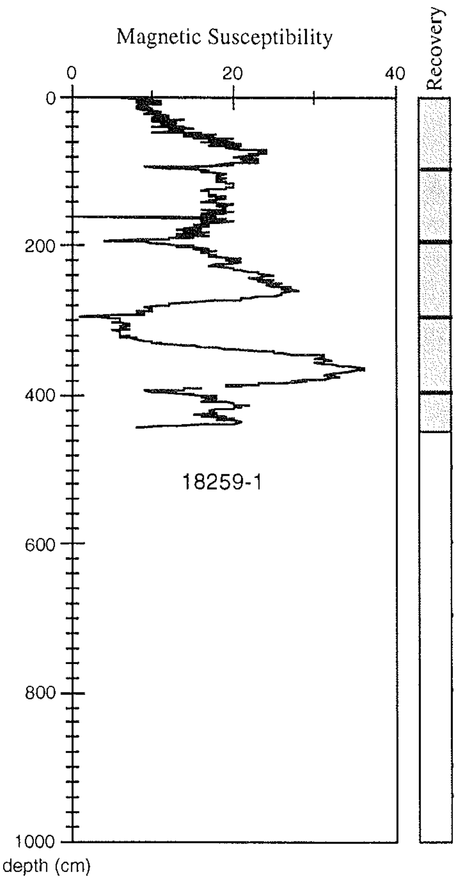
194-247 cm: Dark greenish gray sand with shells and shell fragments; transitional

247-280 cm: Intermixed layers of moderate brown clay and dark greenish sand layers and partly sandy 'pockets';a few 'pockets' of stiff grayish orange (10YR 7/4) clay

280-294 cm: Moderate brown clay intermixed with olive black (5Y 2/1) sand

294-322 cm: Moderate brown clay intermixed with olive black (5Y 2/1) sand

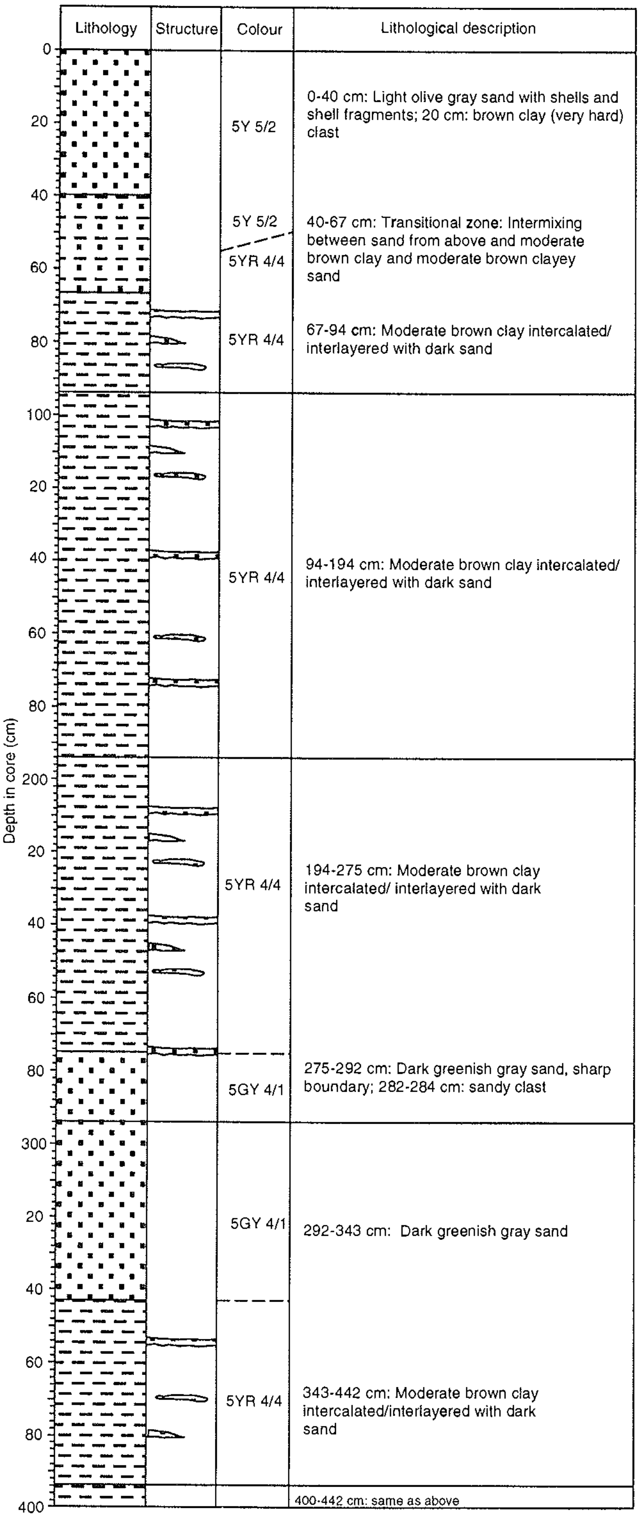




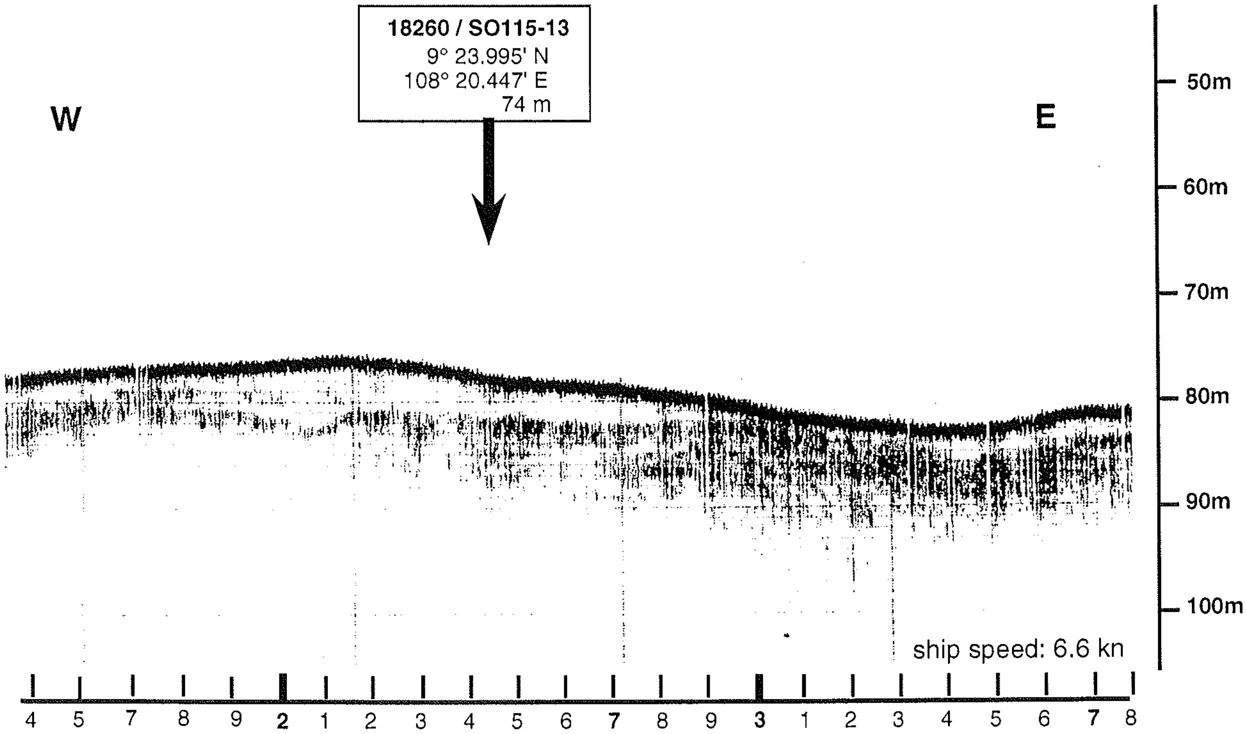
Objectives:
Coring an area with relatively deep penetration of the parasound.
A deeper sandy horizon is characterized by low magnetic susceptibility.

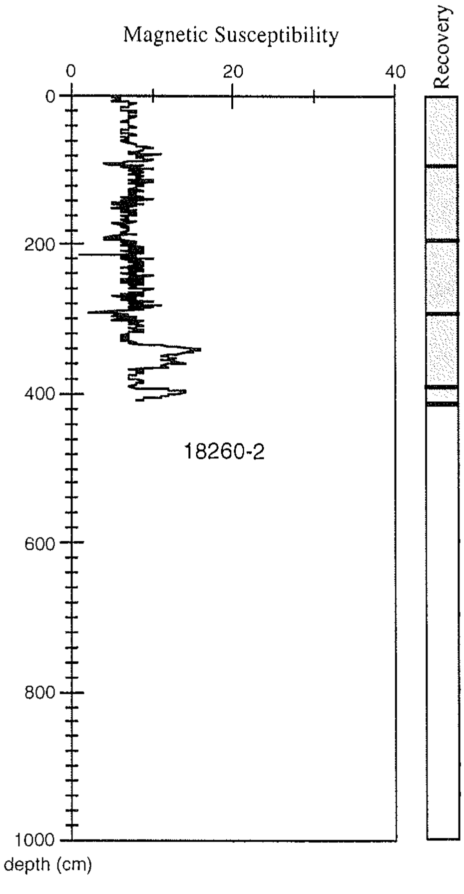
SONNE-115 **Water depth: 88 m**
Station: SO-115-12
Position: 9° 10.419 N; 108° 26.942 E

Core: VC 18259-1 **Recovery: 442 cm**



Colour	Lithological description
5Y 5/2	0-40 cm: Light olive gray sand with shells and shell fragments; 20 cm: brown clay (very hard) clast
5Y 5/2 5YR 4/4	40-67 cm: Transitional zone: Intermixing between sand from above and moderate brown clay and moderate brown clayey sand
5YR 4/4	67-94 cm: Moderate brown clay intercalated/ interlayered with dark sand
5YR 4/4	94-194 cm: Moderate brown clay intercalated/ interlayered with dark sand
5YR 4/4	194-275 cm: Moderate brown clay intercalated/ interlayered with dark sand
5GY 4/1	275-292 cm: Dark greenish gray sand, sharp boundary; 282-284 cm: sandy clast
5GY 4/1	292-343 cm: Dark greenish gray sand
5YR 4/4	343-442 cm: Moderate brown clay intercalated/interlayered with dark sand
	400-442 cm: same as above



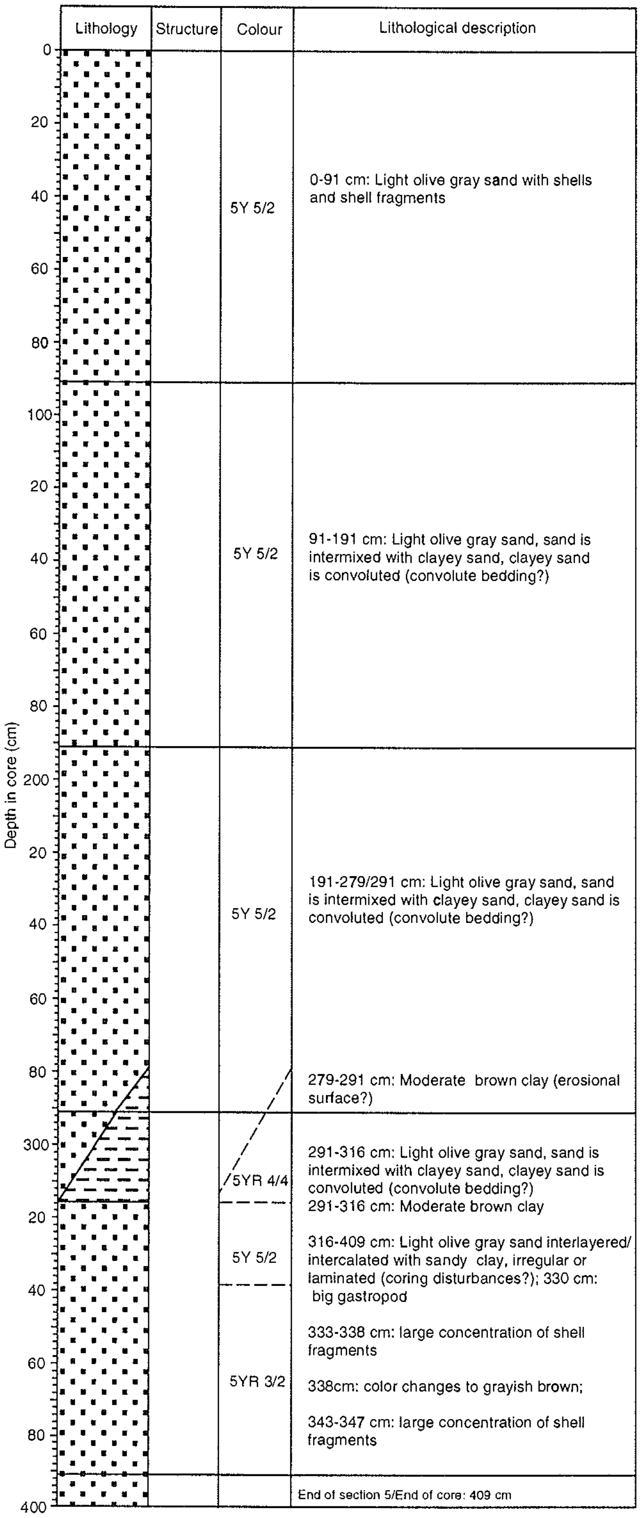


Objectives:

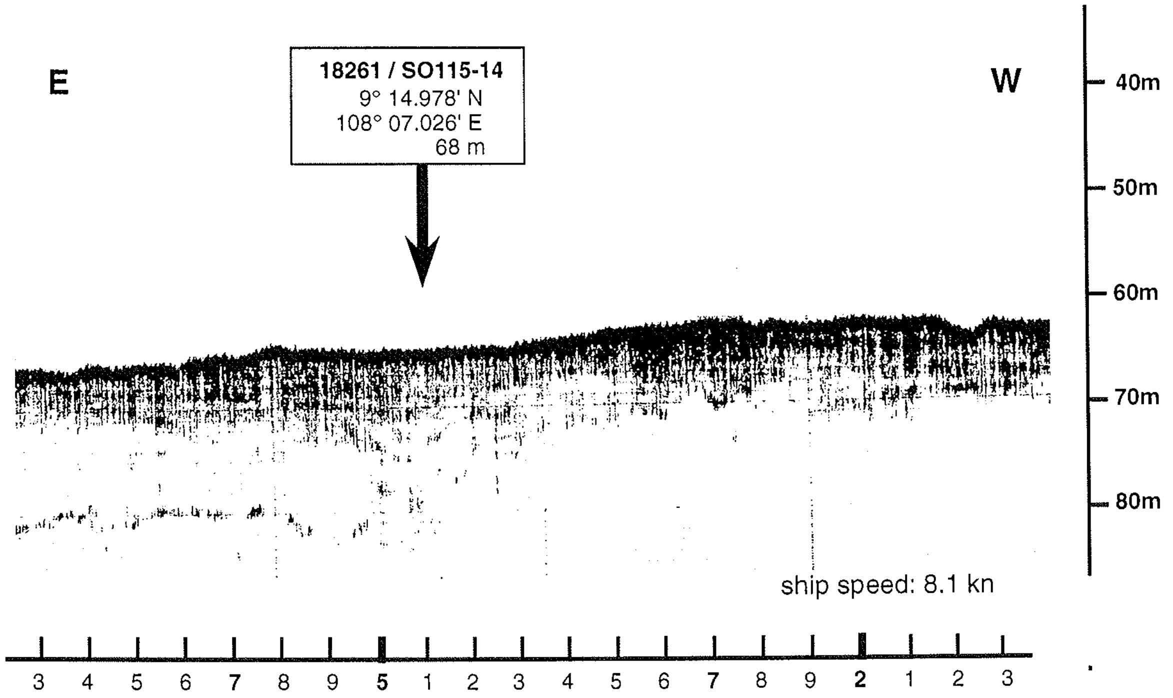
Coring of an acoustically transparent sediment drift body at a smooth topographic high. The bottom of the sediment drift was reached at about 3.5 m below seafloor and is characterized by concentrations of bivalve shells. The sediments below the acoustically transparent sand body are characterized by higher magnetic susceptibility values.

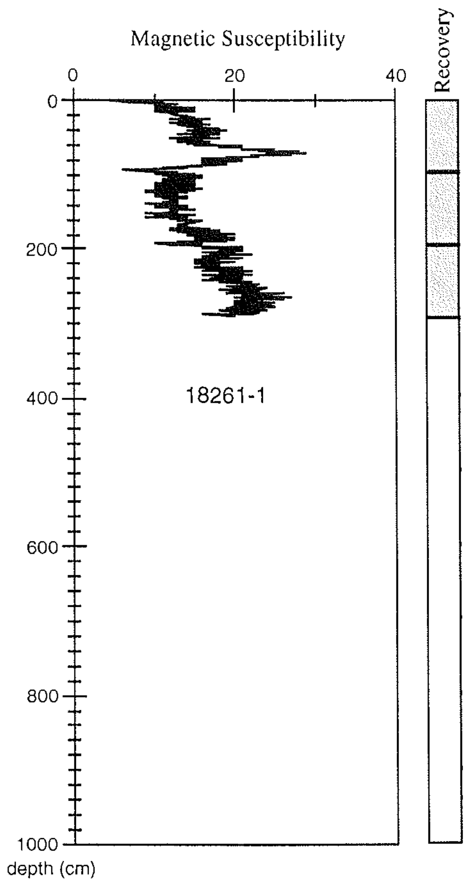
SONNE-115 **Water depth: 73 m**
Station: SO-115-13
Position: 9° 23.995 N; 108° 20.452 E

Core: VC 18260-2 **Recovery: 409 cm**



Lithology	Structure	Colour	Lithological description
		5Y 5/2	0-91 cm: Light olive gray sand with shells and shell fragments
		5Y 5/2	91-191 cm: Light olive gray sand, sand is intermixed with clayey sand, clayey sand is convoluted (convolute bedding?)
		5Y 5/2	191-279/291 cm: Light olive gray sand, sand is intermixed with clayey sand, clayey sand is convoluted (convolute bedding?) 279-291 cm: Moderate brown clay (erosional surface?)
		5YR 4/4 5Y 5/2 5YR 3/2	291-316 cm: Light olive gray sand, sand is intermixed with clayey sand, clayey sand is convoluted (convolute bedding?) 291-316 cm: Moderate brown clay 316-409 cm: Light olive gray sand interlayered/ intercalated with sandy clay, irregular or laminated (coring disturbances?); 330 cm: big gastropod 333-338 cm: large concentration of shell fragments 338cm: color changes to grayish brown; 343-347 cm: large concentration of shell fragments
			End of section 5/End of core: 409 cm

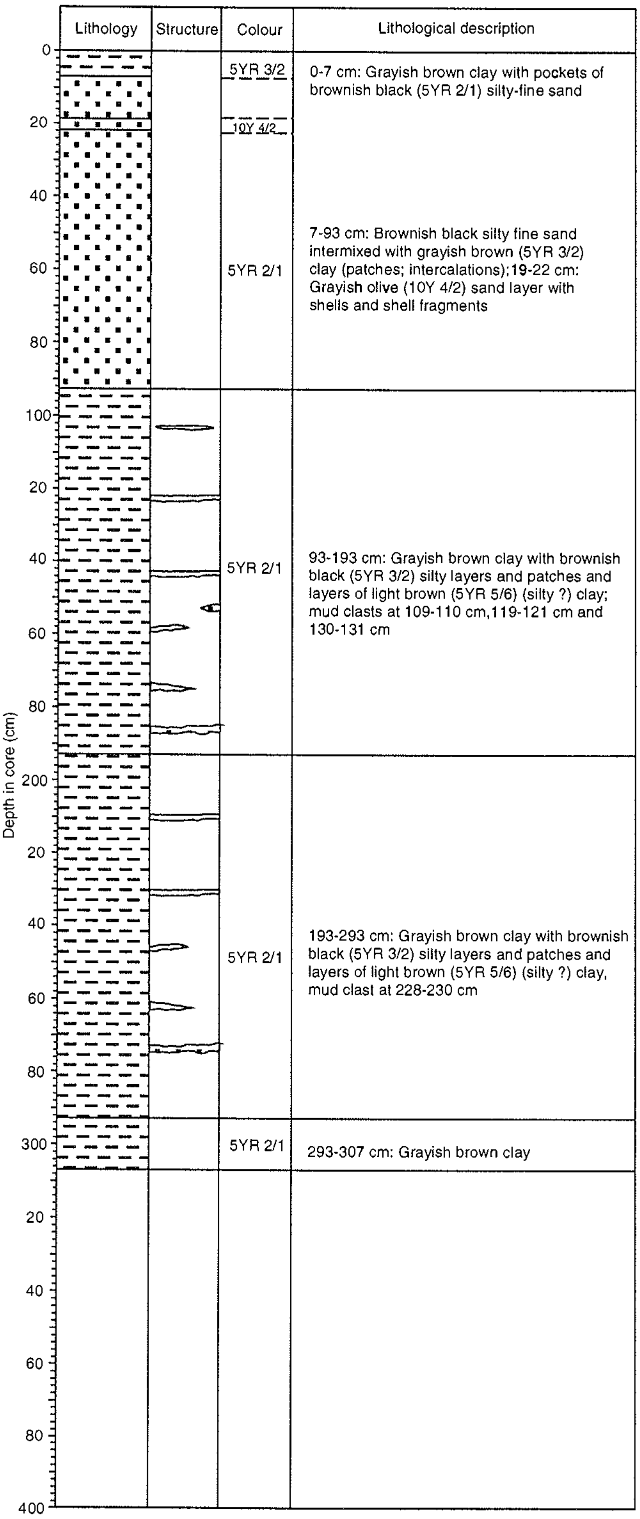




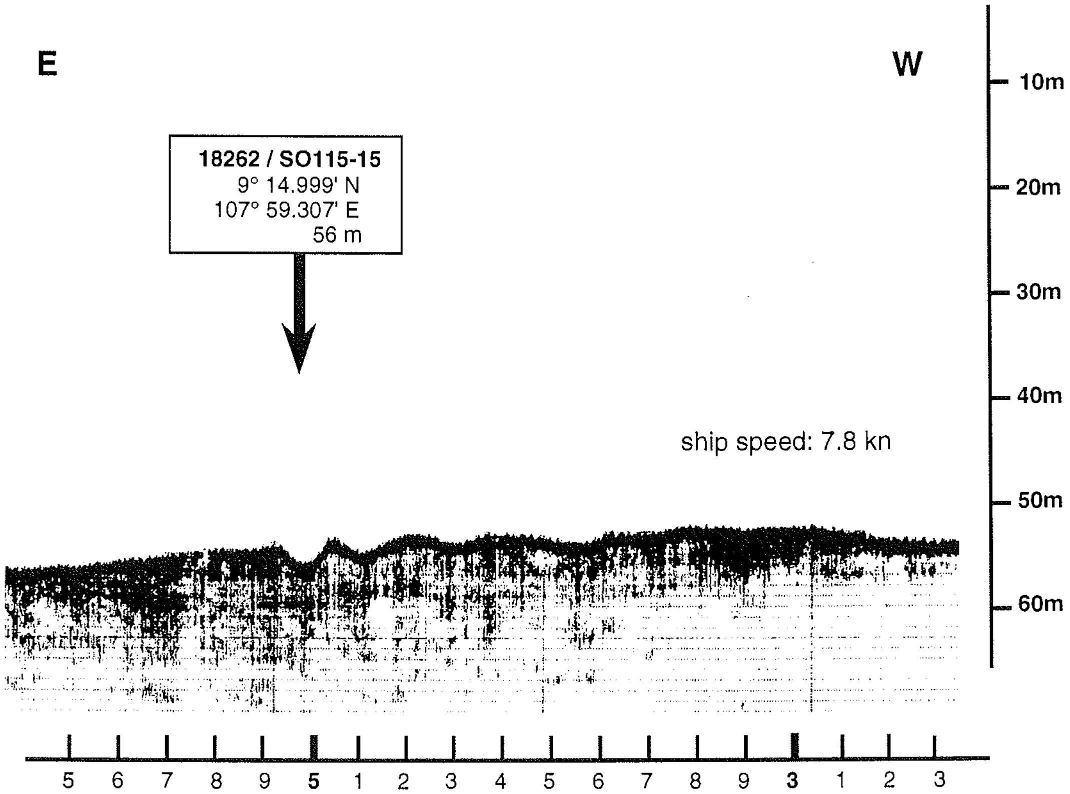
Objectives: Coring of an area of relatively deep penetration of parasound with several reflectors above a channel fill structure. The bottom of the sandy top layer is characterized by a magnetic susceptibility spike.

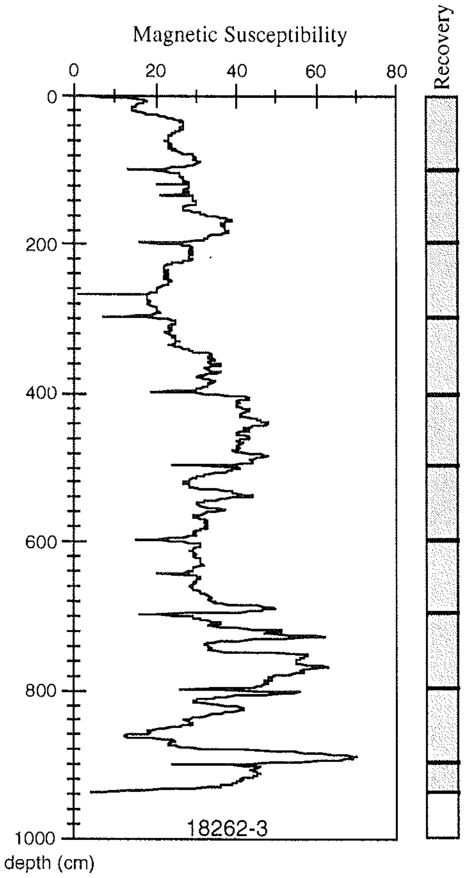
SONNE-115 **Water depth: 68 m**
Station: SO-115-14
Position: 9° 14.978 N; 108° 07.026 E

Core: VC 18261-2 **Recovery: 307 cm**



Colour	Lithological description
5YR 3/2	0-7 cm: Grayish brown clay with pockets of brownish black (5YR 2/1) silty-fine sand
10Y 4/2 5YR 2/1	7-93 cm: Brownish black silty fine sand intermixed with grayish brown (5YR 3/2) clay (patches; intercalations); 19-22 cm: Grayish olive (10Y 4/2) sand layer with shells and shell fragments
5YR 2/1	93-193 cm: Grayish brown clay with brownish black (5YR 3/2) silty layers and patches and layers of light brown (5YR 5/6) (silty ?) clay; mud clasts at 109-110 cm, 119-121 cm and 130-131 cm
5YR 2/1	193-293 cm: Grayish brown clay with brownish black (5YR 3/2) silty layers and patches and layers of light brown (5YR 5/6) (silty ?) clay, mud clast at 228-230 cm
5YR 2/1	293-307 cm: Grayish brown clay



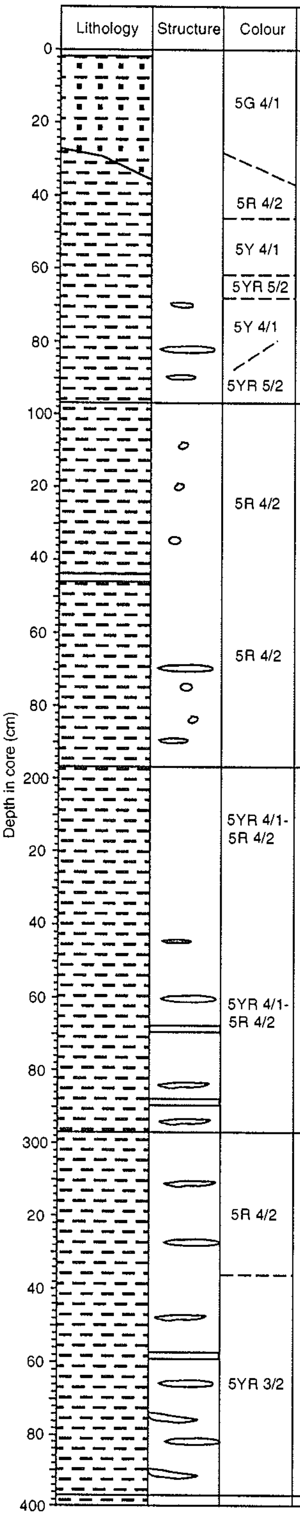


Objectives:

Coring a small morphologic depression (paleo - river channel) on the inner shelf; a deeper reflector in the parasound record has been reached with core 18262-3 and is reflected by layers with significantly increased magnetic susceptibility values.

SONNE-115 Water depth: 56 m
Station: SO-115-15
Position: 9° 14.999 N; 107° 59.307 E

Core: SL 18262-3 Recovery: 938 cm



Lithological description

0-2 cm: void (styrofoam)

2-27/36cm: Dark greenish gray sandy clay with large numbers of Turritella shellls and other shell fragments

27/36-66.5 cm: ± homogeneous clay with few silty patches: color: 27/36-47 cm: grayish red (5R 4/2); 47-61 cm: olive gray (5Y 4/1); 61-66.5 cm: pale brown (5YR 5/2)
66.5-67 cm: thin silty peat-layer

67-100 cm: ± homogeneous clay with silty lenses; upper part: mixed olive gray (5Y 4/1) - pale brown (5YR 5/2); lower part: pale brown (5YR 5/2);
(below 85 cm)

97-137 cm: Grayish red clay with round (up to 1.5-2 cm) patches of silty material (burrows?) otherwise homogeneous

137-144 cm: Grayish red clay with 'smeared out' silty lenses

144-146 cm: Silty-sandy layer with very unsharp contacts and some mixed-in grayish red clay material
146-154 cm: Grayxish red clay with silty ' burrows'
154-195 cm: Irregular laminated grayish red to dark gray clay with few silty patches and lenses; one distinctsilt-horizon occurs at 185 cm (up to 7 mm thick)
195-197 cm: Grayish red clay with nodules of yellowish gray carbonate clay

197-231cm: Brownish gray-grayish red clay with few weak grayish orange nodules or nodular layers

231-232 cm: Distinct yellowish gray band, irregular contacts to top and bottom

232-238 cm: Brownish gray-grayish red clay

238-242 cm: Brownish gray-medium gray silty layers and clay

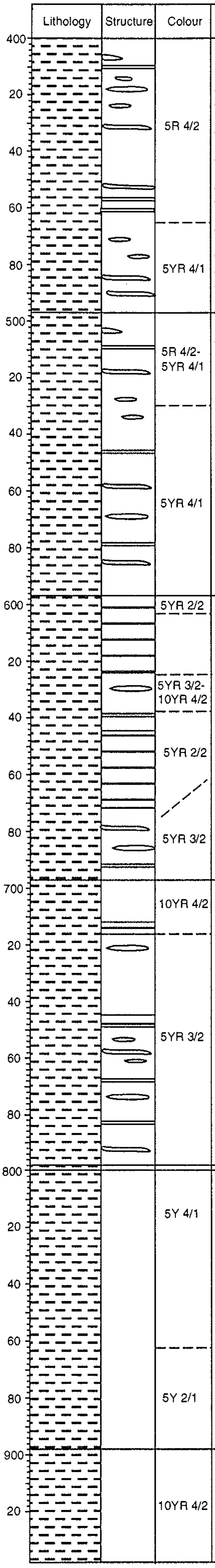
242-297 cm: Brownish gray-grayish red clay with irregular silty intercalations of up to 1 cm thickness (several color changes from grayish-red to medium gray; grayish orange nodular layers (up to1 cm thickness) at 262 cm, 276 cm and 286 cm

297-301/303 cm: Grayish red clay

301/303-302/304 cm: 1 cm thick grayish orange (10YR 7/4) clay

302/304-337 cm: Intercalation of grayish red clay, dark gray silty layers and grayish orange (10YR 7/4) nodular indurated clay; significant nodular-layers at 307 cm, 314 cm, 320 cm and 329 cm; thickest silty intercalation at 323-325 cm, distinct moderate red layer at 336-337 cm

337-397 cm: Grayish brown clay with grayish orange (10YR 7/4) nodules and large amounts of silty irregular lenses



Lithological description

397-448.5 cm: Grayish red clay with silty layers (medium gray N4); colour of clay changes to brownish gray (5YR 4/1) between 402-407.5 cm, 410-413 cm, 420-426 cm and 431-448.5 cm

448.5-451 cm: Intercalation of yellowish gray (5Y 7/2)
clay

451-465 cm: Grayish red and brownish gray clay with silty medium gray (N4) layers

465-497 cm: Brownish gray clay with silty medium gray (N4) lenses and layers; Pale yellowish brown (10YR 6/2) clayey patch at 471-475 cm and layers at 475-476 cm, 482-485 cm and at 487-487.5 cm

497-530 cm: Grayish red and brownish gray clay with silty medium dark gray (N3) lenses; irregular intercalation of yellowish gray (5Y 7/2) at 502-503 cm and 505-508.5 cm; irregular intercalation of grayish orange (10YR 7/4) at 415.5-416 cm, 417-418 cm and425-426 cm; layers are less than 0.5 cm thick

530-555 cm: Brownish gray clay with numerous layers (0.5-1 cm) and lenses of medium dark gray (N3) silt

555-597 cm: Brownish gray clay with intercalations of medium dark gray (N3) silty patches and lenses

597-603 cm: Dusky brown, finely laminated clay
603-609 cm: Brown clay, fuzzy lamination, with a lenticular silt-layer of up to 6 mm thickness in the lower part
609-624 cm: Finely laminated clay (colour changing from grayish (5YR 3/2) to dark yellowish brown (10 YR 4/2), very thin silty lenses (2-3mm thickness), sharp lower contact)
624-639 cm: Dusky brown (5YR 2/2) clay with thin silty layers/lenses
639-640 cm: Light clay
640-645 cm: Dusky brown homogeneous clay
645-672 cm: Finely laminated clay with colours changing from dusky brown (5YR 2/2) to grayish brown (5YR 3/2)
672-697 cm: Grayish brown (clour change at 675 cm) to dusky brown clay with very unclear fuzzy lamination in the upper part

697-716.5 cm: Dark yellowish brown clay with thin lenses of silt; lowermost 5 cm finely laminated

716.5-749 cm: Grayish brown homogeneous clay, lower 5 cm finely laminated; at 721 cm: thin silt lense of maximum 3 mm thickness; 727-729 cm: lense of organic material (N3); at 743.5 cm: thin layer of organic material

749-775.5 cm: Intercalations of dusky brown clay and olive gray silt-layers with fine sandy layers, flaser lamination

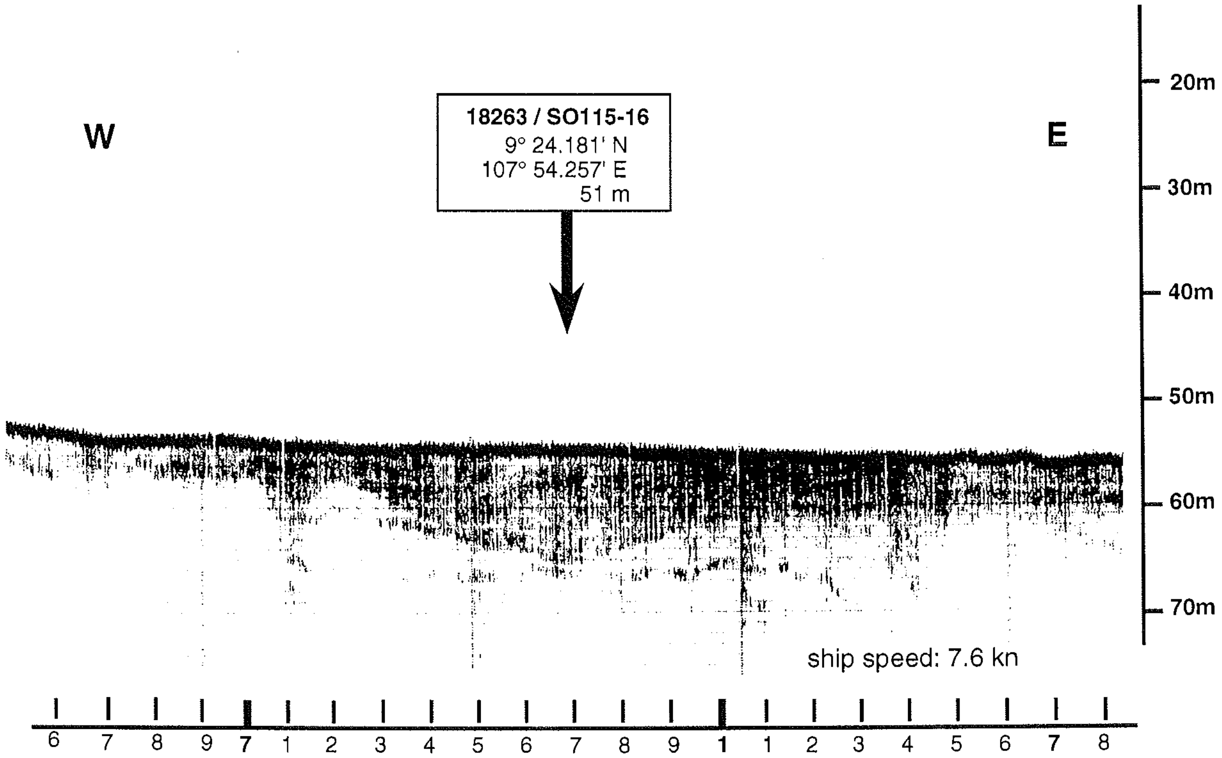
775.5-798 cm: Clay (5YR 3/2)-silt (5YR 4/1) intercalation, partly containing traces of organic material

798-800 cm: Brownish gray clayey silt

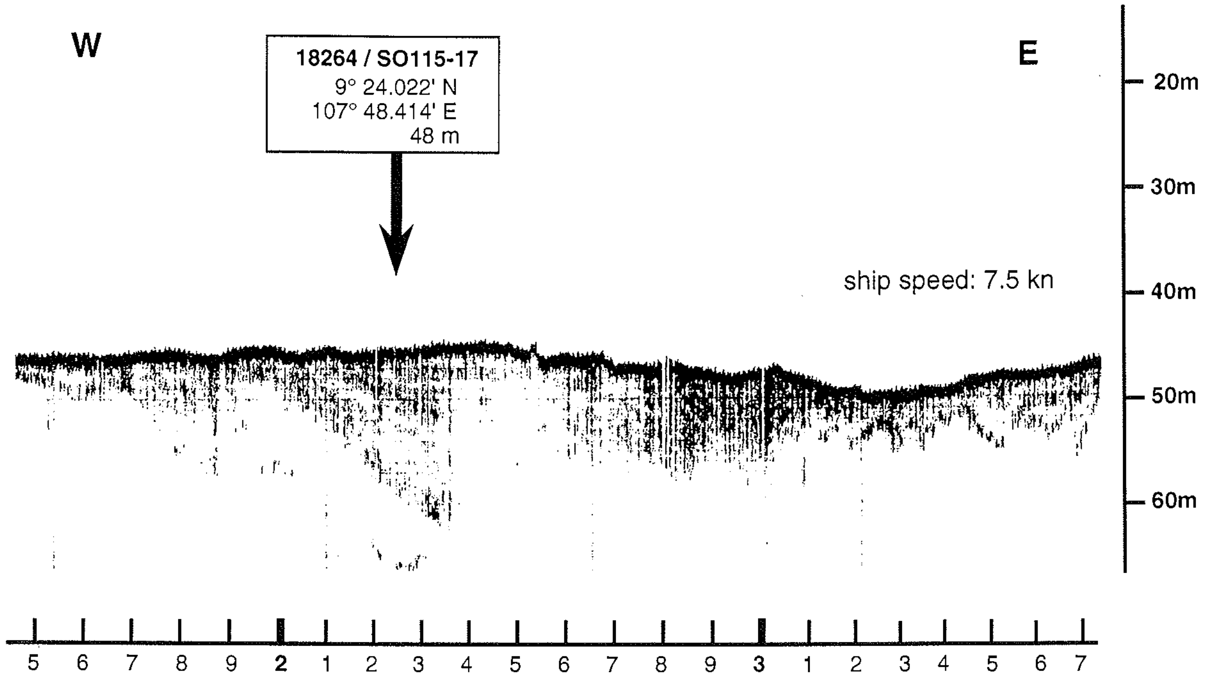
800-862 cm: Olive gray clay, rich in organic material, peat lenses and flasers getting darker towards the bottom, bioturbation mottles (?), lowermost 5 cm very rich in coarse organic material, Mangrove sedimentation (?)

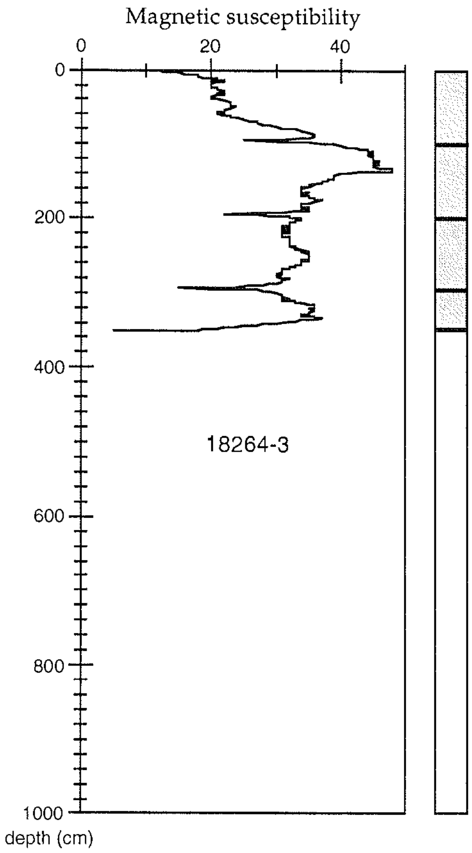
862-898 cm: Olive black (5Y 2/1) to dusky yellowish (10YR 2/2) clay with abundant organic material getting lighter towards the bottom , bioturbation mottles (?) filled with coarse grained (silty-fine sandy) material, lenticular shaped = Mangrove sedimentation (?)

898-938 cm: Dark yellowish brown homogeneous clay, black in the upper part (organic material) lighter towards the botttom with clusters of darker sediment; 924 cm: piece of wood, 935 cm: piece of wood



Objectives: Coring an infilled incised river valley on the inner shelf off the present day Mekong Delta.
Remarks: The sediment surface is strongly indurated, only the boxcorer had a small recovery of compacted clay.



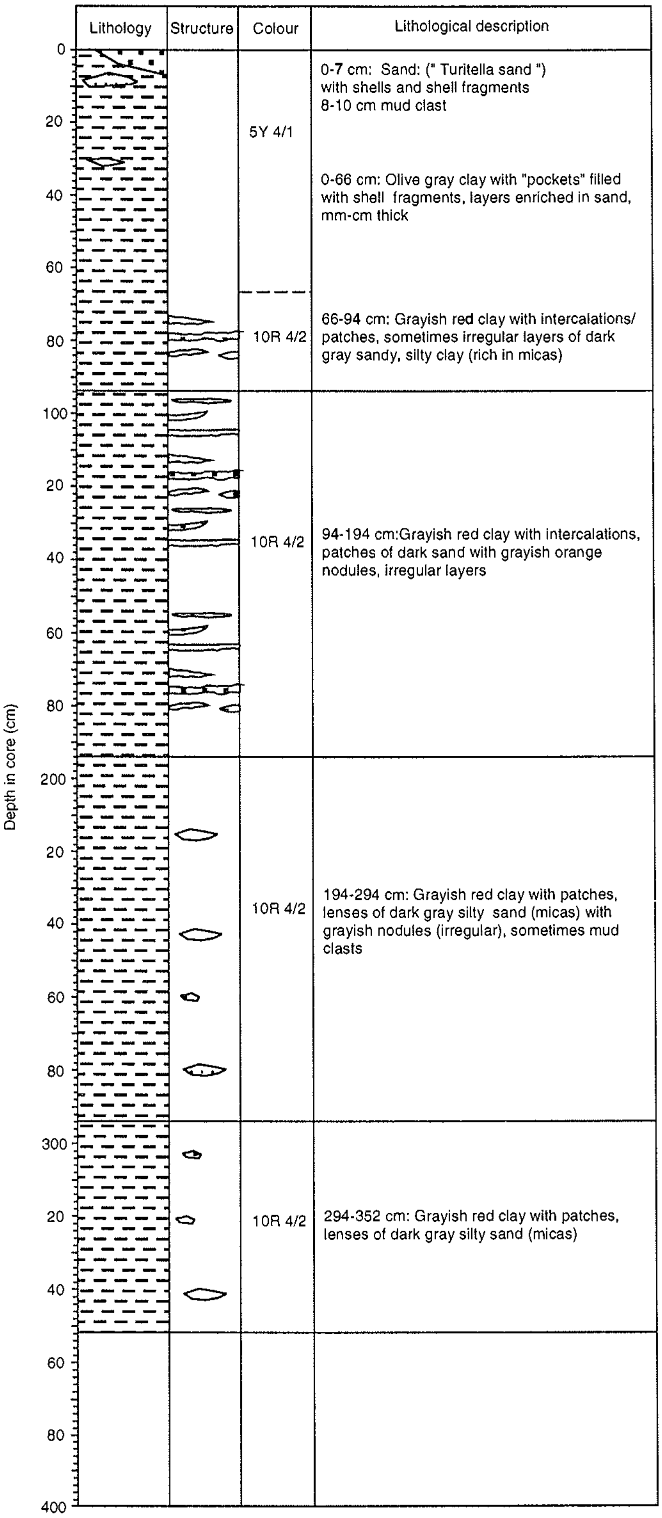


Objectives:

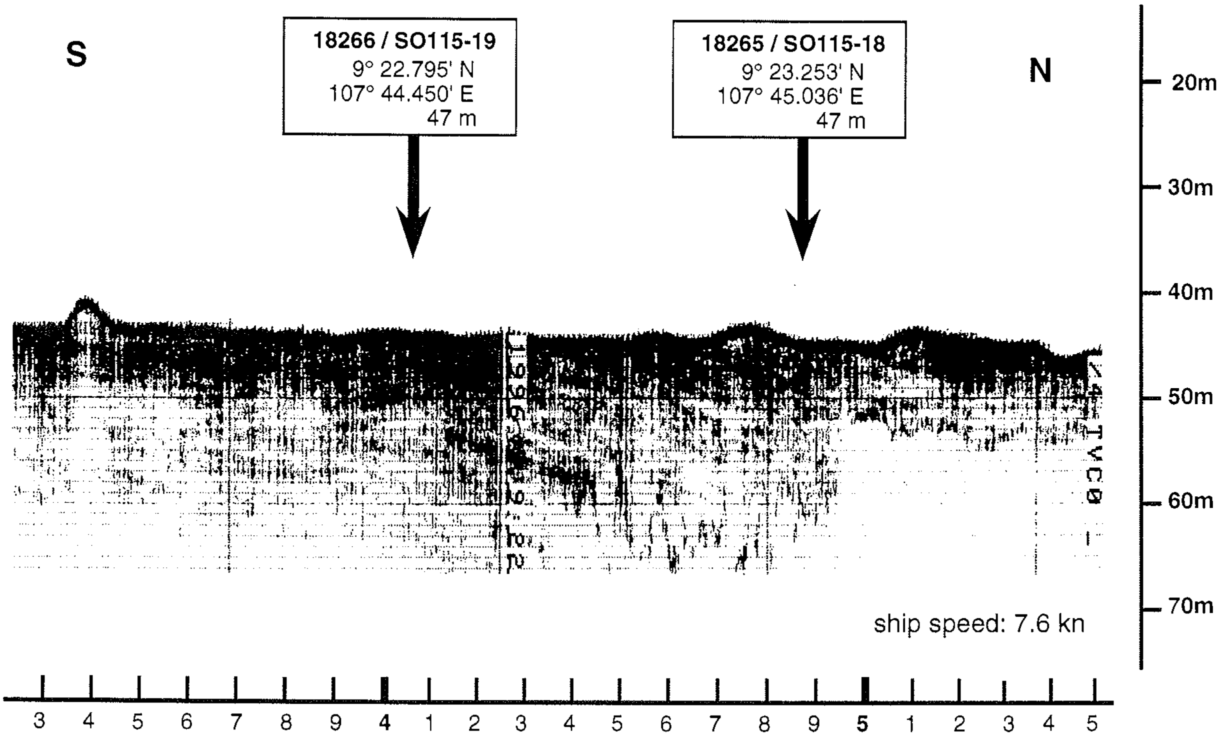
Coring of an incised valley fill (Paleo-Mekong) on the inner shelf off Vietnam.

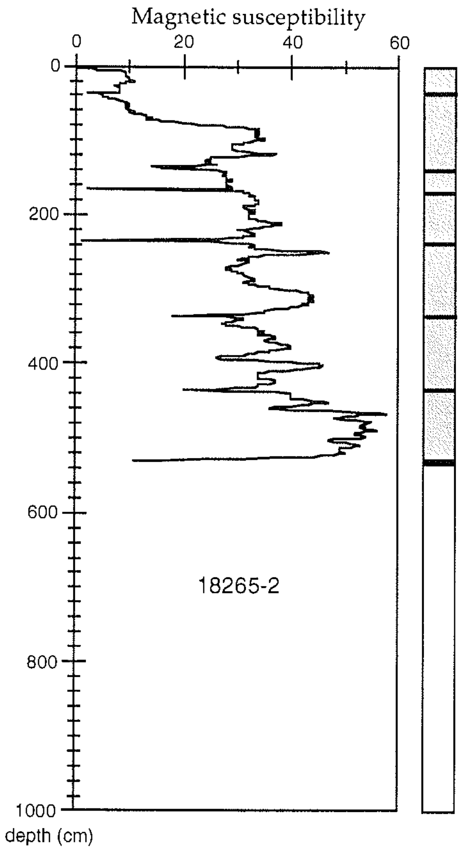
SONNE-115 **Water depth: 48 m**
Station:SO-115-17
Position: 9° 24.006 N; 107° 48.434 E

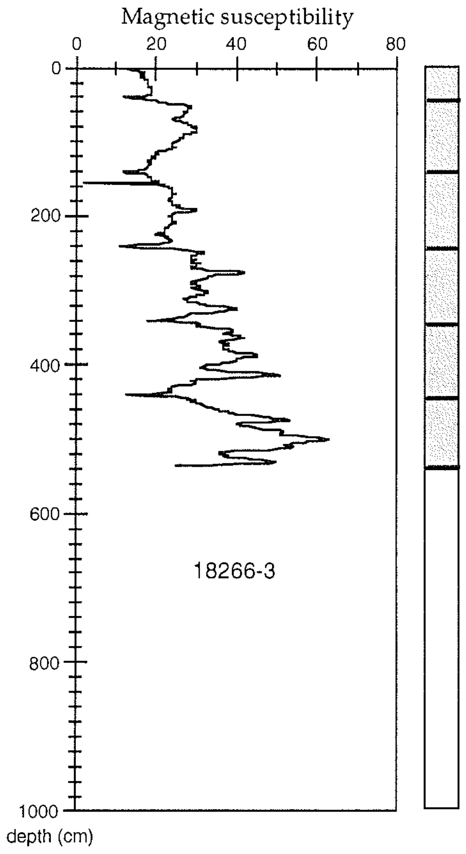
Core: SL 18264-3 **Recovery: 352 cm**



Colour	Lithological description
5Y 4/1	0-7 cm: Sand: (" Turitella sand ") with shells and shell fragments 8-10 cm mud clast 0-66 cm: Olive gray clay with "pockets" filled with shell fragments, layers enriched in sand, mm-cm thick
10R 4/2	66-94 cm: Grayish red clay with intercalations/ patches, sometimes irregular layers of dark gray sandy, silty clay (rich in micas)
10R 4/2	94-194 cm:Grayish red clay with intercalations, patches of dark sand with grayish orange nodules, irregular layers
10R 4/2	194-294 cm: Grayish red clay with patches, lenses of dark gray silty sand (micas) with grayish nodules (irregular), sometimes mud clasts
10R 4/2	294-352 cm: Grayish red clay with patches, lenses of dark gray silty sand (micas)



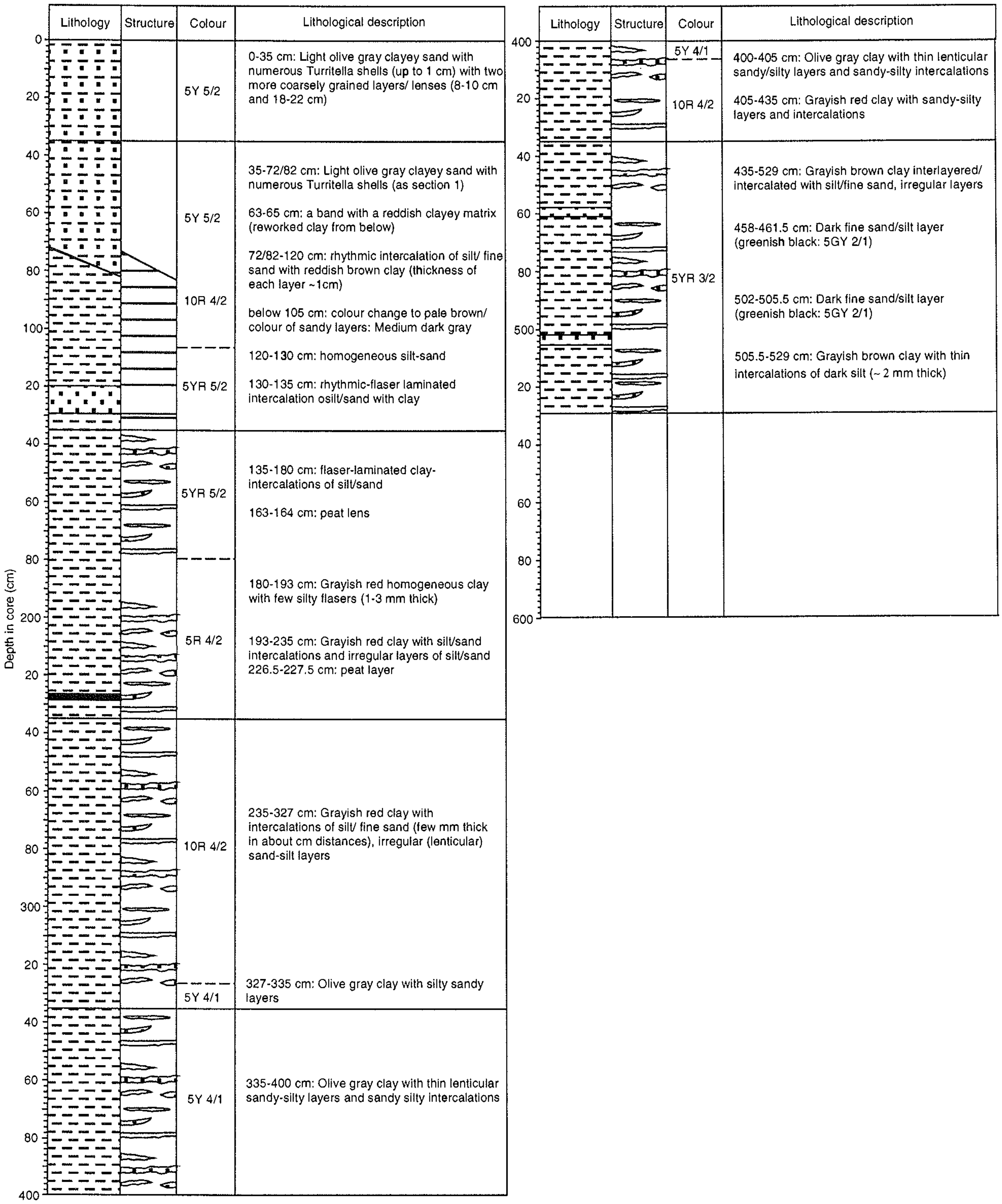




Objectives: Coring the most proximal stations to the present day Mekong delta. We examine the recent terrigenous flux at these proximal positions and the accumulation rates of post-transgressive sediments.

SONNE-115 **Water depth: 48 m**
Station: SO-115-18
Position: 9° 23.251 N; 107° 45.029 E

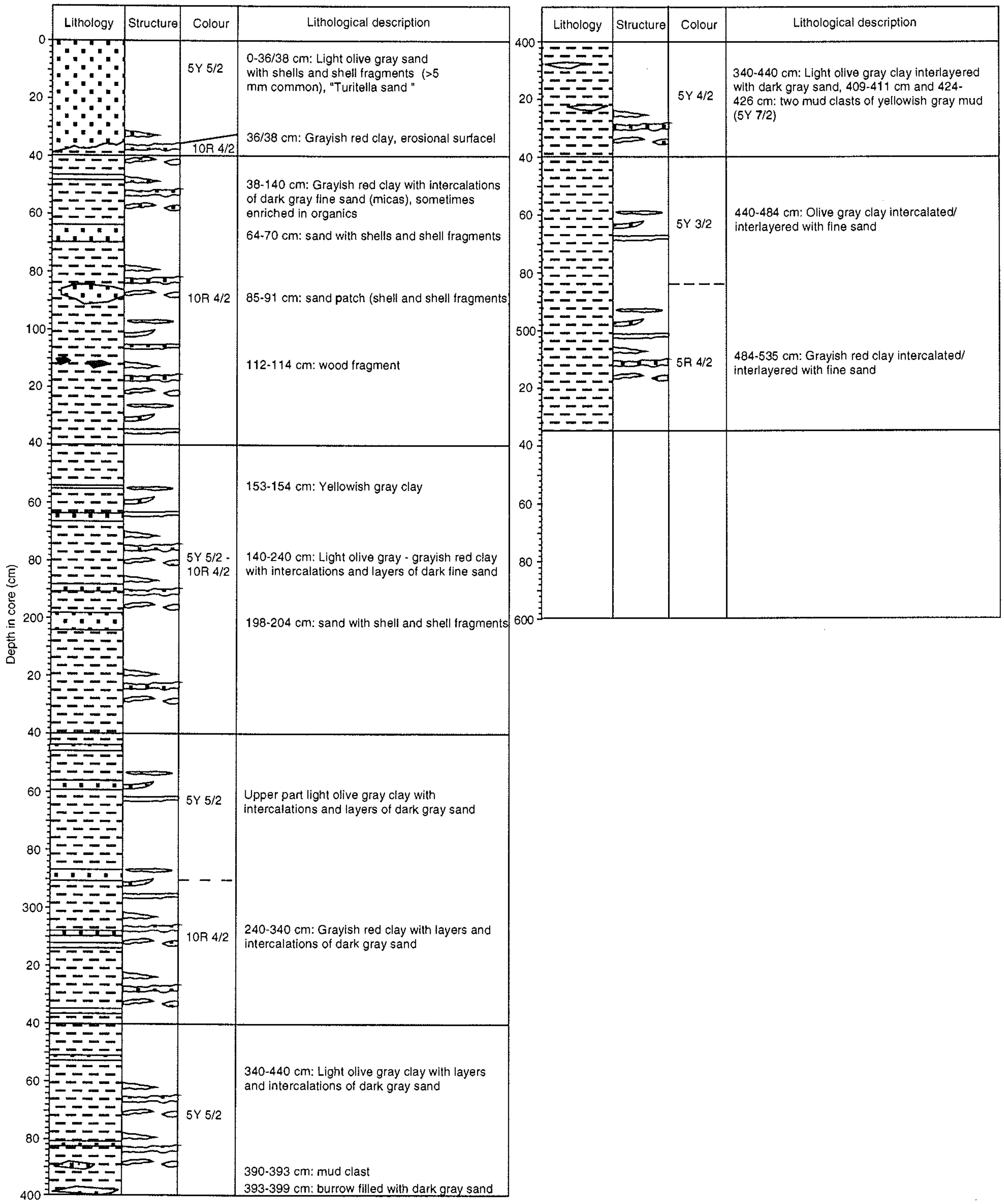
Core: SL 18265-3 **Recovery: 529 cm**

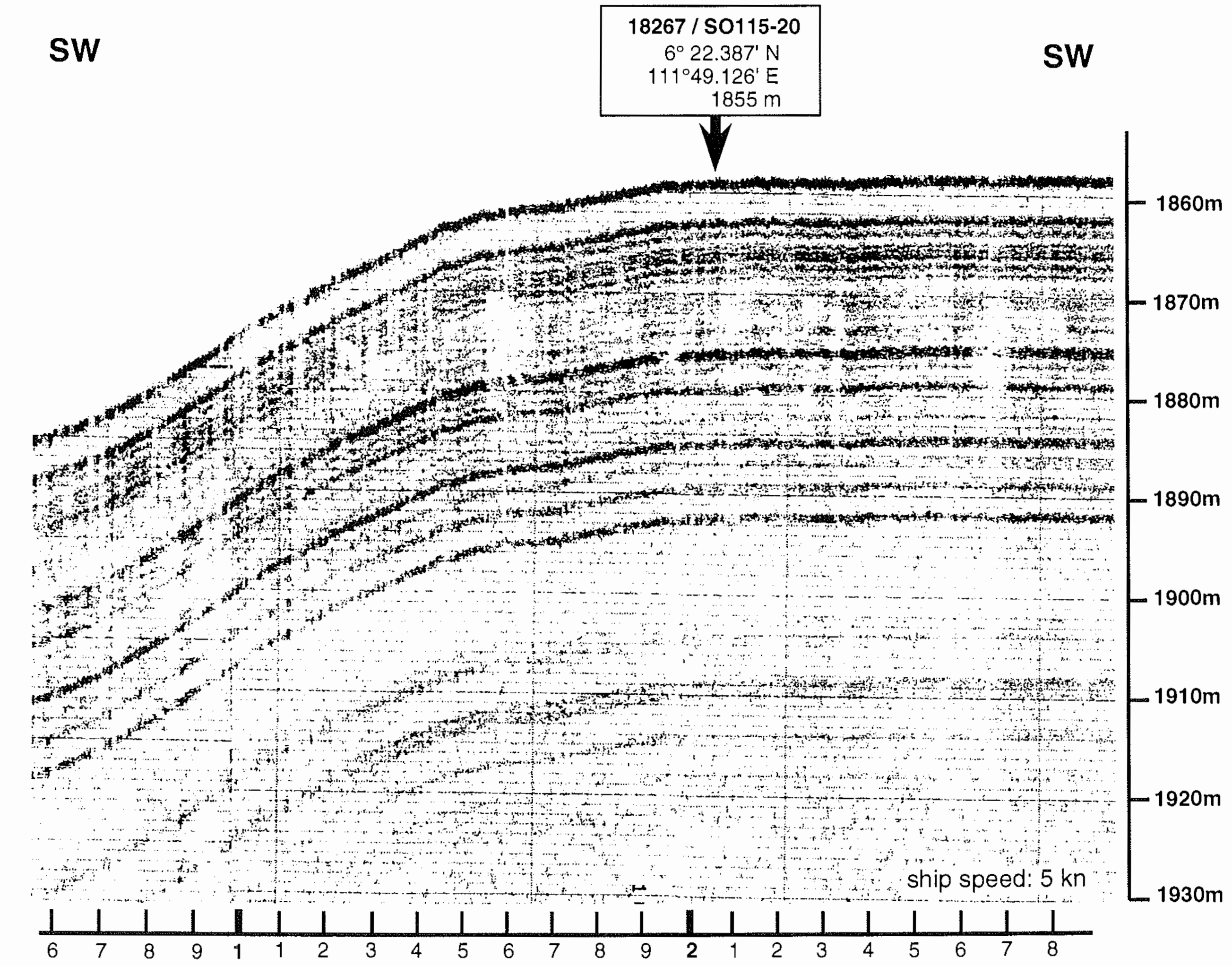


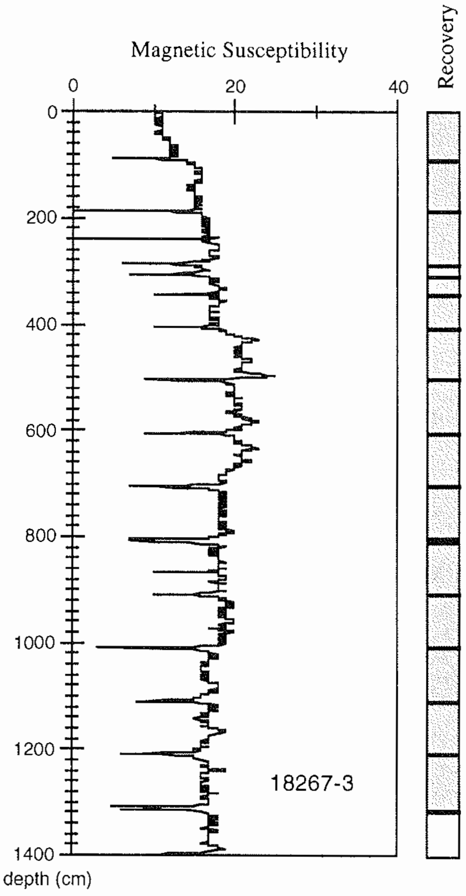
Colour	Lithological description
5Y 5/2	0-35 cm: Light olive gray clayey sand with numerous Turritella shells (up to 1 cm) with two more coarsely grained layers/ lenses (8-10 cm and 18-22 cm)
5Y 5/2	35-72/82 cm: Light olive gray clayey sand with numerous Turritella shells (as section 1) 63-65 cm: a band with a reddish clayey matrix (reworked clay from below)
10R 4/2	72/82-120 cm: rhythmic intercalation of silt/ fine sand with reddish brown clay (thickness of each layer ~1cm) below 105 cm: colour change to pale brown/ colour of sandy layers: Medium dark gray
5YR 5/2	120-130 cm: homogeneous silt-sand 130-135 cm: rhythmic-flaser laminated intercalation osilt/sand with clay
5YR 5/2	135-180 cm: flaser-laminated clay-intercalations of silt/sand 163-164 cm: peat lens
5R 4/2	180-193 cm: Grayish red homogeneous clay with few silty flasers (1-3 mm thick) 193-235 cm: Grayish red clay with silt/sand intercalations and irregular layers of silt/sand 226.5-227.5 cm: peat layer
10R 4/2	235-327 cm: Grayish red clay with intercalations of silt/ fine sand (few mm thick in about cm distances), irregular (lenticular) sand-silt layers
5Y 4/1	327-335 cm: Olive gray clay with silty sandy layers
5Y 4/1	335-400 cm: Olive gray clay with thin lenticular sandy-silty layers and sandy silty intercalations
5Y 4/1	400-405 cm: Olive gray clay with thin lenticular sandy/silty layers and sandy-silty intercalations
10R 4/2	405-435 cm: Grayish red clay with sandy-silty layers and intercalations
5YR 3/2	435-529 cm: Grayish brown clay interlayered/ intercalated with silt/fine sand, irregular layers 458-461.5 cm: Dark fine sand/silt layer (greenish black: 5GY 2/1) 502-505.5 cm: Dark fine sand/silt layer (greenish black: 5GY 2/1) 505.5-529 cm: Grayish brown clay with thin intercalations of dark silt (~ 2 mm thick)

SONNE-115 **Water depth: 46 m**
Station: SO-115-19
Position: 9° 22.797 N; 107° 44.458 E

Core: SL 18266-3 **Recovery: 535 cm**



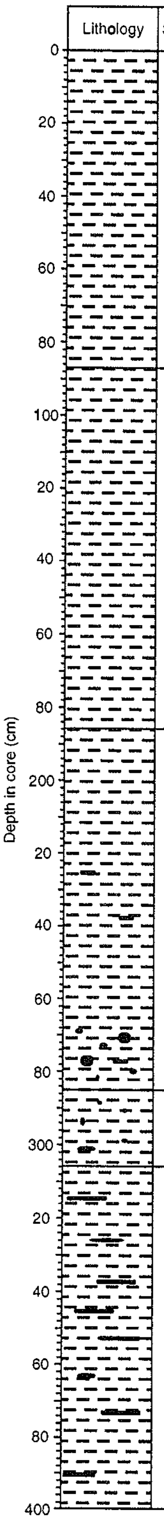


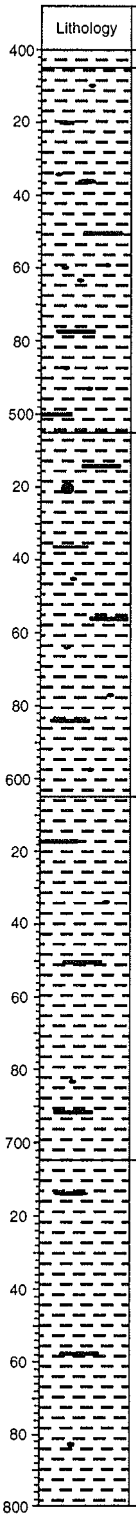


Objectives:
Site survey for the planned ODP Site SCS-6.
Coring a hemipelagic sediment sequence on a pelagic plateau off the paleo-Molengraaff-Delta. Most distal reference core of our Sunda Shelf transect.

SONNE-115 **Water depth: 1855 m**
Station: SO-115-20
Position: 6° 22.387 N; 111° 49.126 E

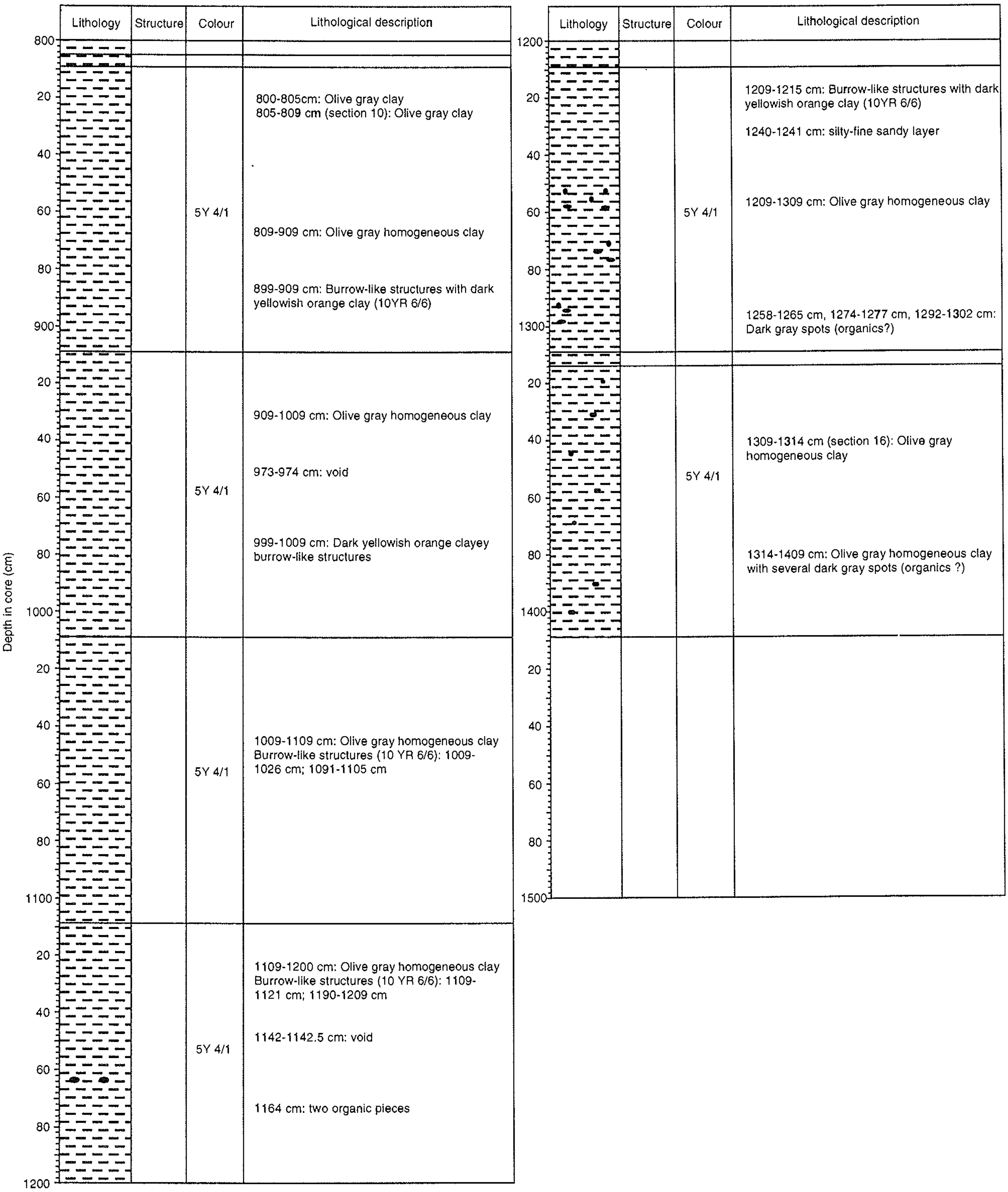
Core: PC 18267-3 **Recovery: 1409 cm**

Lithology	Structure	Colour	Lithological description
		10Y 6/2	0-87 cm: Pale olive homogeneous soupy clay (Section is very disturbed by coring operation) 38 cm: Patch of dusky yellow (5Y 6/4) clay with some organics
		5Y 4/1	87-186 cm: Olive gray homogeneous soft clay 144-150 cm: Small spots of organic material
		5Y 4/1	186-285 cm: Olive gray homogenous soft clay below 225 cm: organic content slowly increase below 274 cm: rich in organic material (spots/ lenses of organic rich clay)
		5Y 4/1	285-306 cm: Olive gray clay intercalated with organics
		5Y 4/1	306-400 cm: Olive gray clay interlayered/ intercalated with organic-rich clay

Lithology	Structure	Colour	Lithological description
			
		5Y 4/1	405-505 cm: Olive gray clay intercalated/ interlayered with organic rich layers (clay) and spots
		5Y 4/1	505-605 cm: Olive gray clay intercalated/ interlayered with organic rich layers (clay) and spots
		5Y 4/1	605-705 cm: Olive gray clay intercalated/ interlayered with organic rich layers (clay) and spots (organic rich clay less common)
		5Y 4/1	705-800 cm: Olive gray clay intercalated/ interlayered with organic rich layers (clay) and spots (organic rich clay less common)

SONNE-115 **Water depth: 1855 m**
Station:SO-115-20
Position: 6° 22.387 N; 111° 49.126 E

Core: PC 18267-3 **Recovery: 1409 cm**



800-805cm: Olive gray clay
805-809 cm (section 10): Olive gray clay

809-909 cm: Olive gray homogeneous clay

899-909 cm: Burrow-like structures with dark yellowish orange clay (10YR 6/6)

909-1009 cm: Olive gray homogeneous clay

973-974 cm: void

999-1009 cm: Dark yellowish orange clayey burrow-like structures

1009-1109 cm: Olive gray homogeneous clay
Burrow-like structures (10 YR 6/6): 1009-1026 cm; 1091-1105 cm

1109-1200 cm: Olive gray homogeneous clay
Burrow-like structures (10 YR 6/6): 1109-1121 cm; 1190-1209 cm

1142-1142.5 cm: void

1164 cm: two organic pieces

1209-1215 cm: Burrow-like structures with dark yellowish orange clay (10YR 6/6)

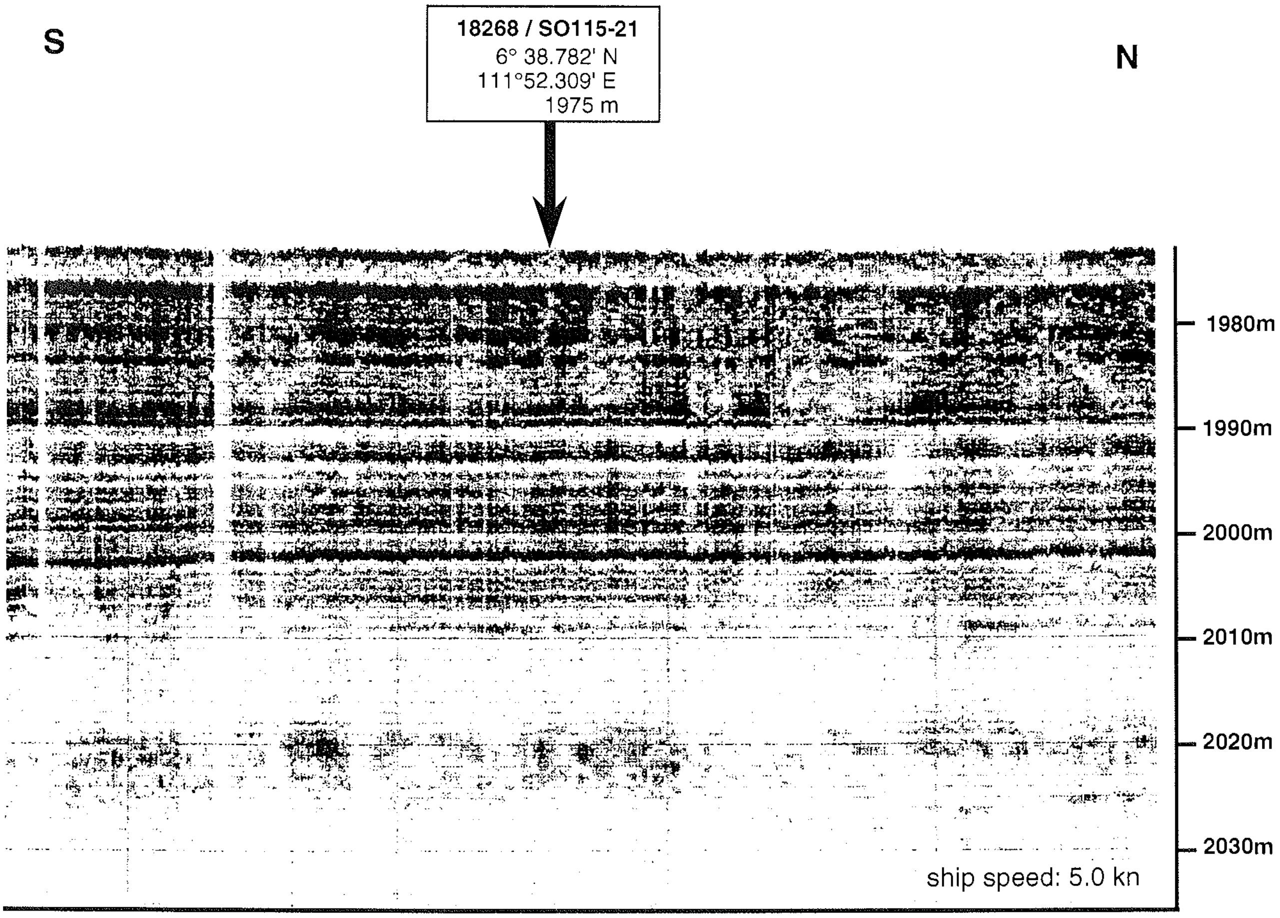
1240-1241 cm: silty-fine sandy layer

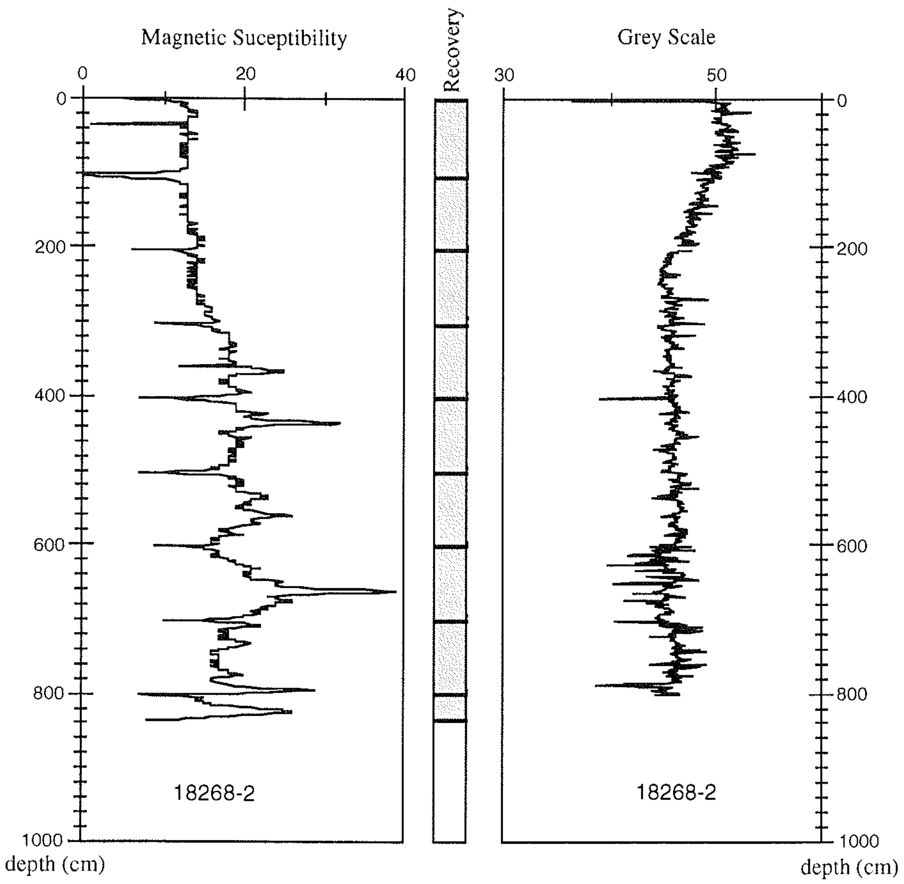
1209-1309 cm: Olive gray homogeneous clay

1258-1265 cm, 1274-1277 cm, 1292-1302 cm: Dark gray spots (organics?)

1309-1314 cm (section 16): Olive gray homogeneous clay

1314-1409 cm: Olive gray homogeneous clay with several dark gray spots (organics ?)





Objectives:

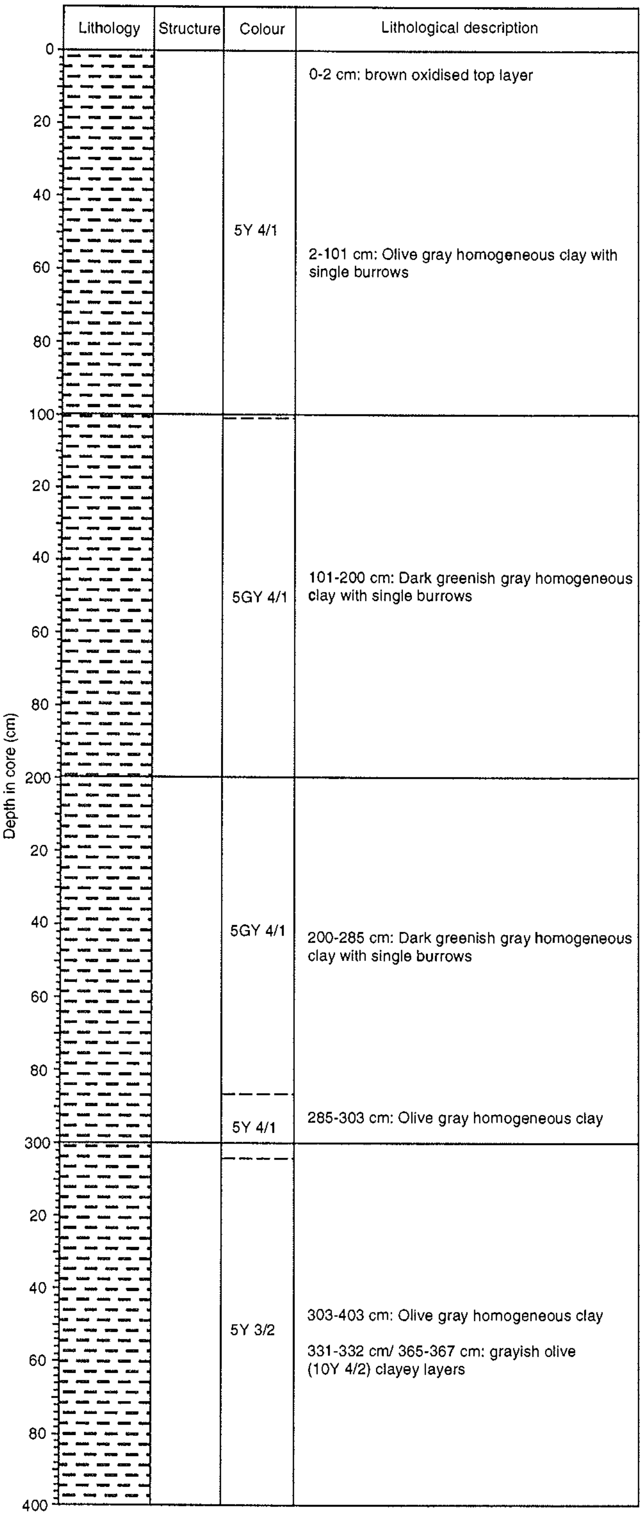
Site survey for the planned ODP Site SCS-7.

Coring a hemipelagic sediment sequence on a pelagic plateau off the paleo-Molengraaff-Delta.

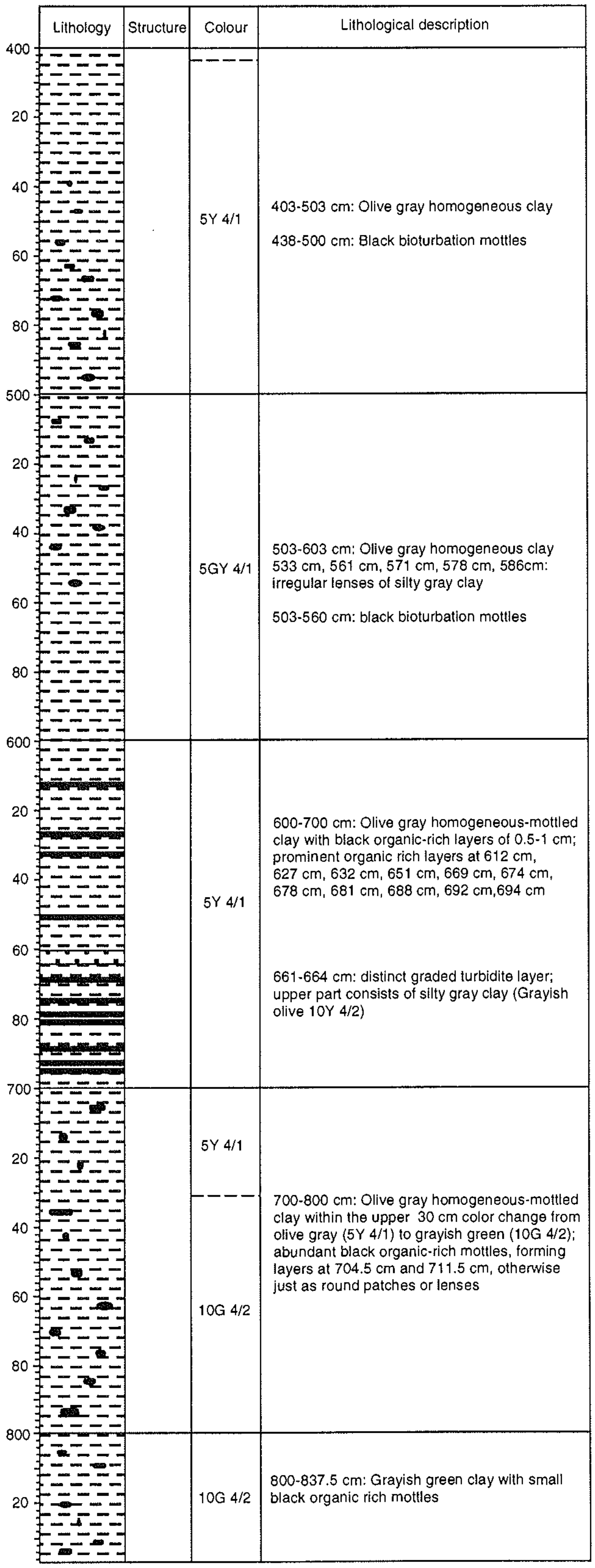
Most distal reference core of our Sunda Shelf transect.

SONNE-115 **Water depth: 1975 m**
Station: SO-115-21
Position: 6° 38.782 N; 111° 52.309 E

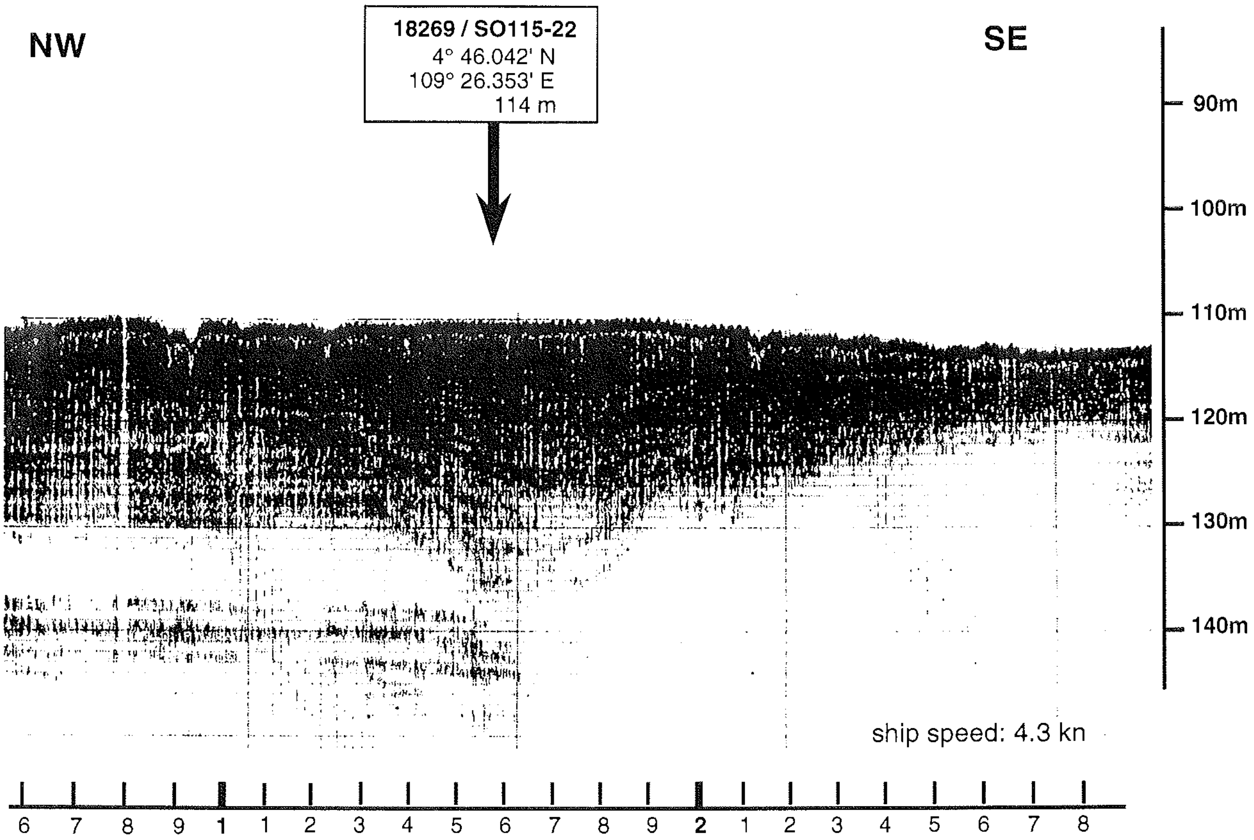
Core: SL 18268-2 **Recovery: 837.5 cm**

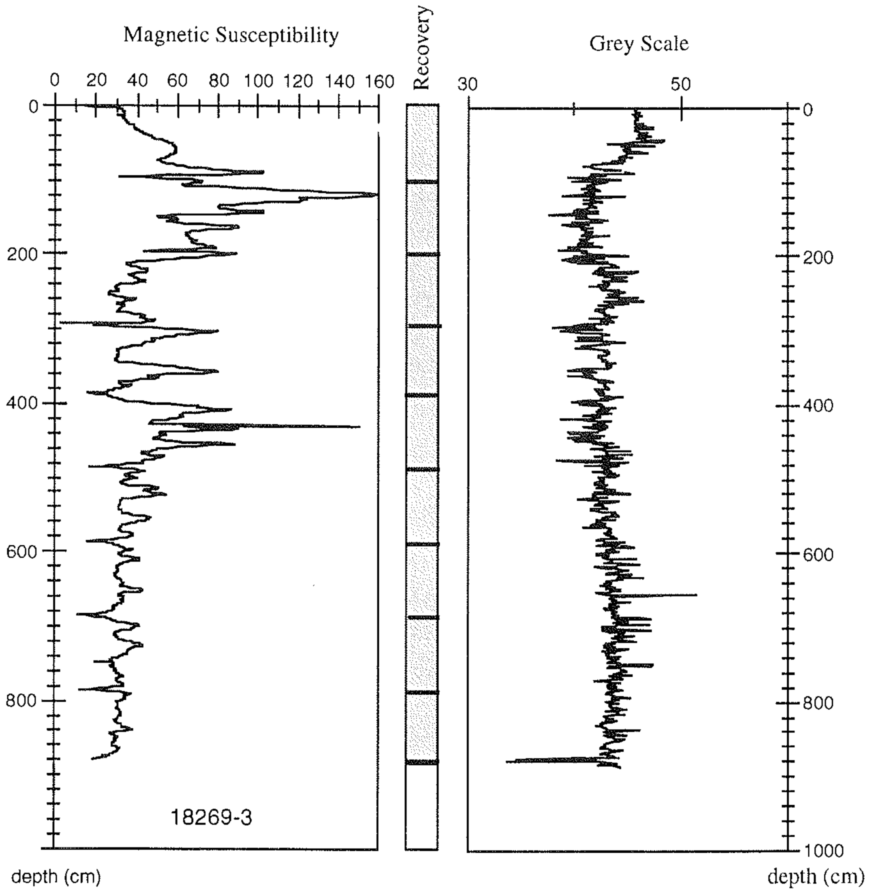


Lithology	Structure	Colour	Lithological description
		5Y 4/1	0-2 cm: brown oxidised top layer 2-101 cm: Olive gray homogeneous clay with single burrows
		5GY 4/1	101-200 cm: Dark greenish gray homogeneous clay with single burrows
		5GY 4/1	200-285 cm: Dark greenish gray homogeneous clay with single burrows
		5Y 4/1	285-303 cm: Olive gray homogeneous clay
		5Y 3/2	303-403 cm: Olive gray homogeneous clay 331-332 cm/ 365-367 cm: grayish olive (10Y 4/2) clayey layers



Lithology	Structure	Colour	Lithological description
		5Y 4/1	403-503 cm: Olive gray homogeneous clay 438-500 cm: Black bioturbation mottles
		5GY 4/1	503-603 cm: Olive gray homogeneous clay 533 cm, 561 cm, 571 cm, 578 cm, 586cm: irregular lenses of silty gray clay 503-560 cm: black bioturbation mottles
		5Y 4/1	600-700 cm: Olive gray homogeneous-mottled clay with black organic-rich layers of 0.5-1 cm; prominent organic rich layers at 612 cm, 627 cm, 632 cm, 651 cm, 669 cm, 674 cm, 678 cm, 681 cm, 688 cm, 692 cm,694 cm 661-664 cm: distinct graded turbidite layer; upper part consists of silty gray clay (Grayish olive 10Y 4/2)
		5Y 4/1 10G 4/2	700-800 cm: Olive gray homogeneous-mottled clay within the upper 30 cm color change from olive gray (5Y 4/1) to grayish green (10G 4/2); abundant black organic-rich mottles, forming layers at 704.5 cm and 711.5 cm, otherwise just as round patches or lenses
		10G 4/2	800-837.5 cm: Grayish green clay with small black organic rich mottles





Objectives:

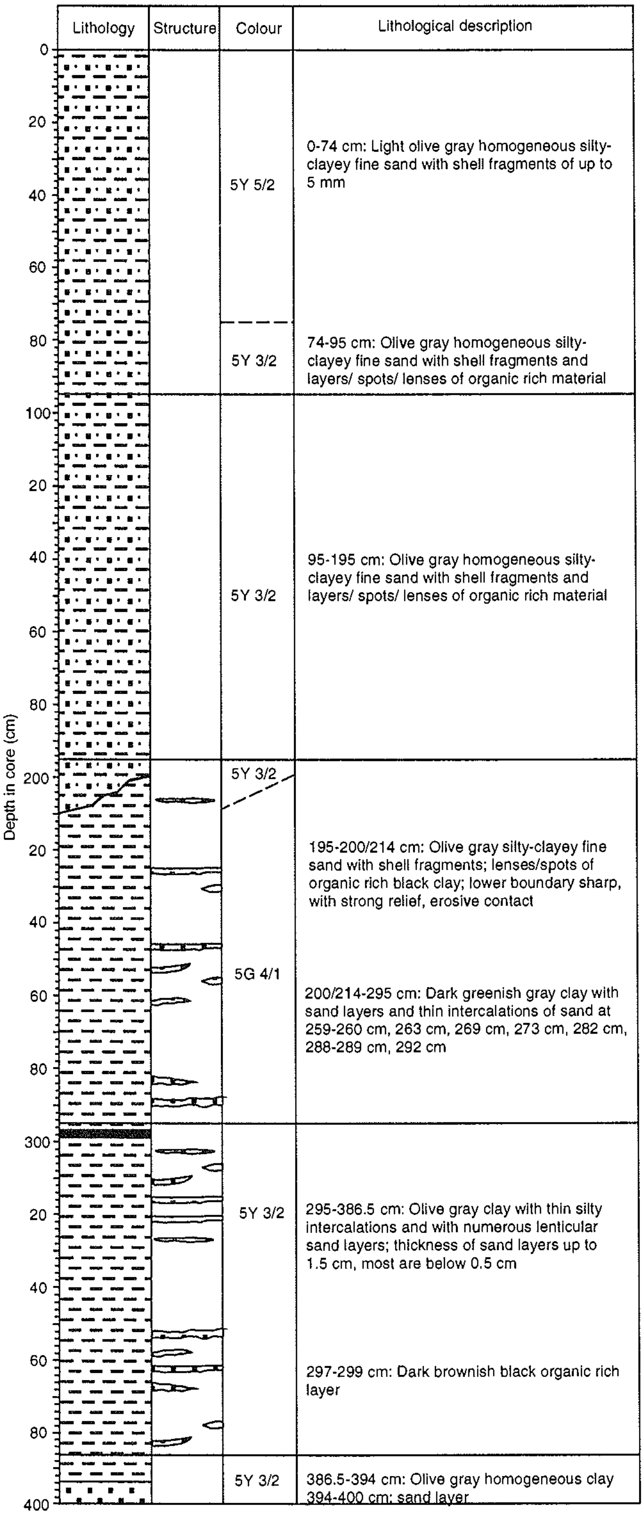
Coring an acoustically transparent layer and an underlying infilled channel structure.

The channel fill is characterized by significantly lower magnetic susceptibility values.

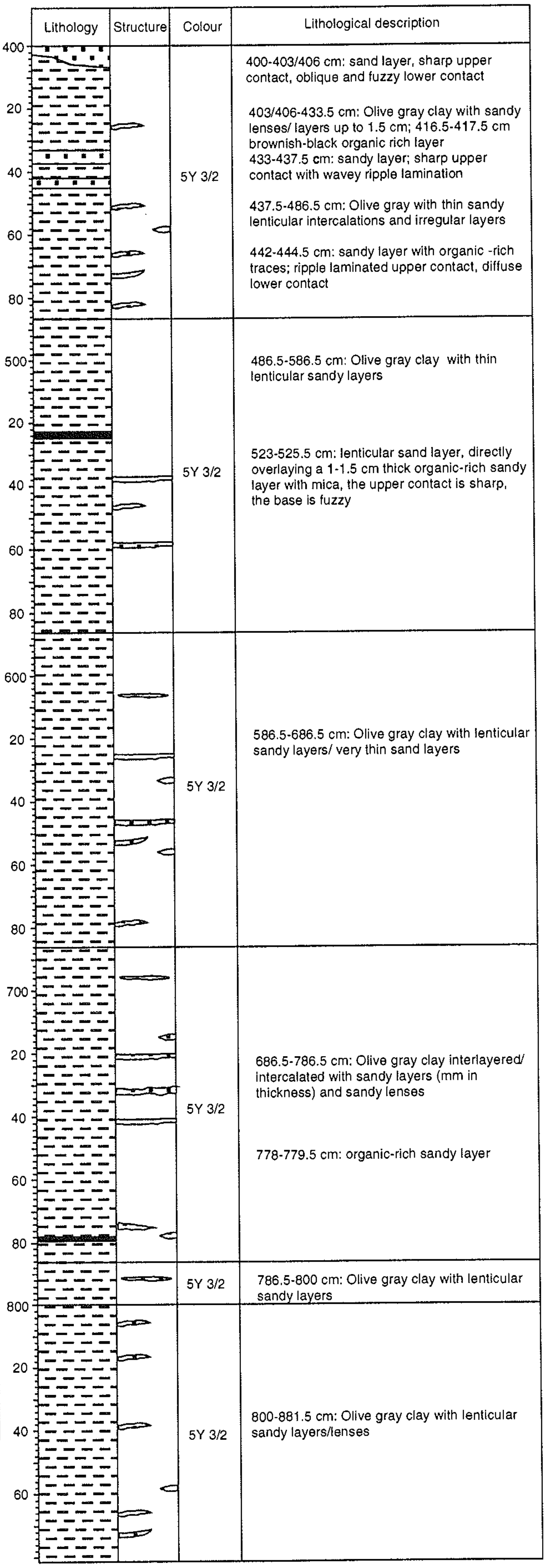
Extremely high magnetic susceptibility values indicate terrigenous sand layers

SONNE-115 **Water depth: 113 m**
Station: SO-115-22
Position: 4° 46.013 N; 109° 26.321 E

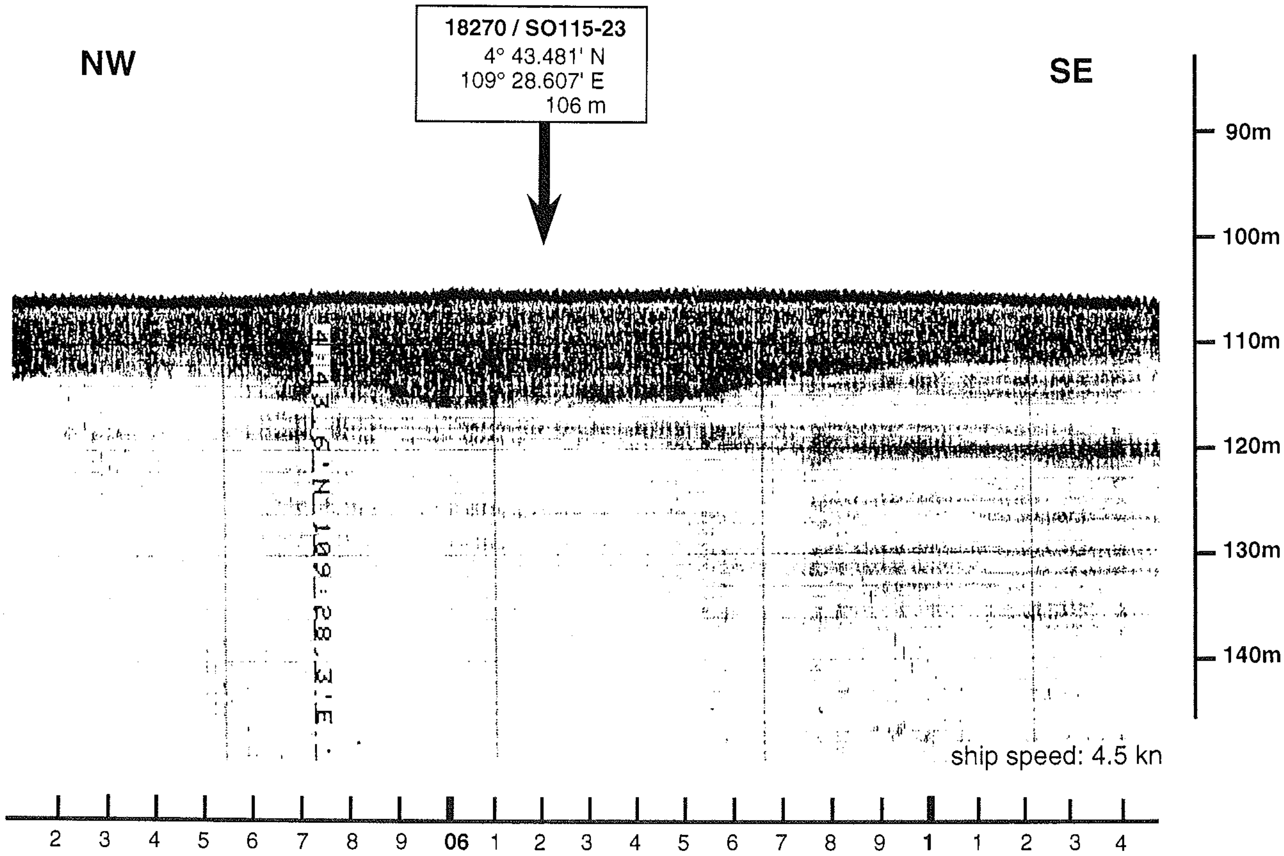
Core: SL 18269-2 **Recovery: 881.5 cm**

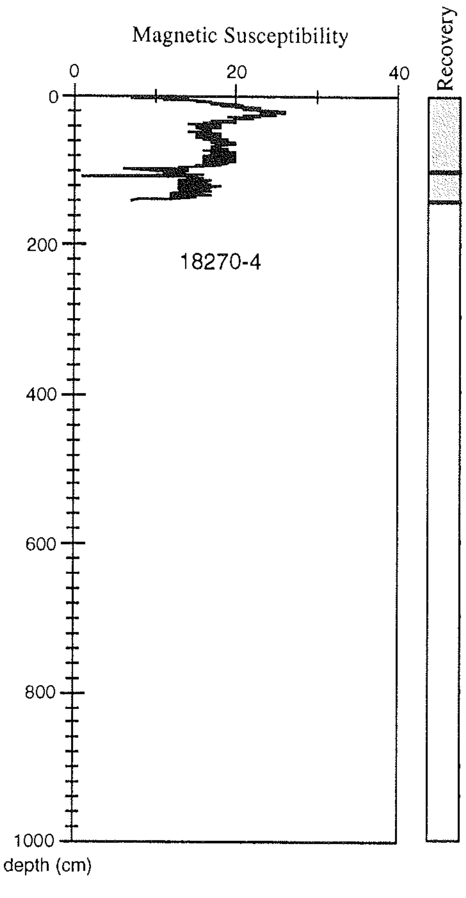


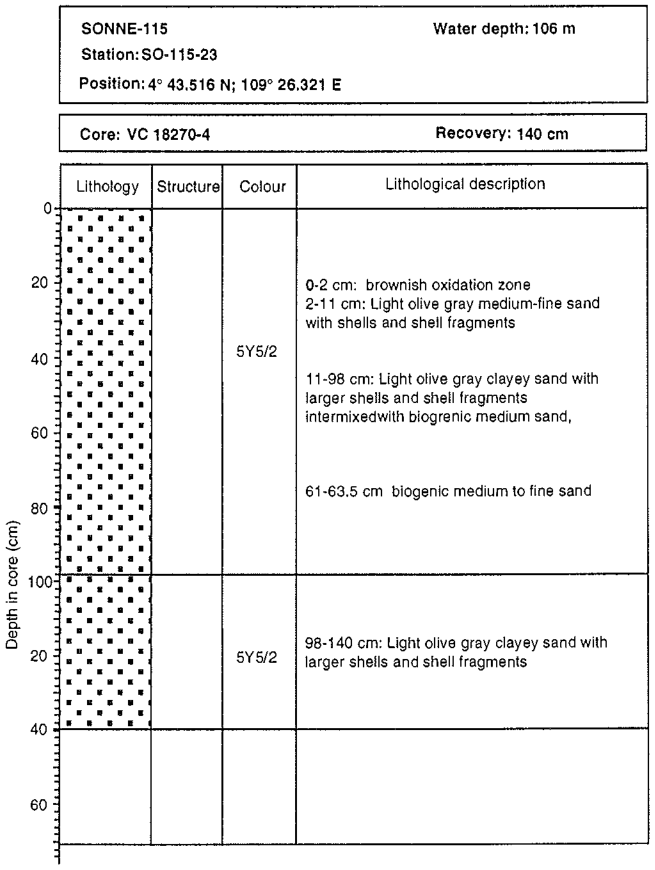
Colour	Lithological description
5Y 5/2	0-74 cm: Light olive gray homogeneous silty-clayey fine sand with shell fragments of up to 5 mm
5Y 3/2	74-95 cm: Olive gray homogeneous silty-clayey fine sand with shell fragments and layers/ spots/ lenses of organic rich material
5Y 3/2	95-195 cm: Olive gray homogeneous silty-clayey fine sand with shell fragments and layers/ spots/ lenses of organic rich material
5Y 3/2 5G 4/1	195-200/214 cm: Olive gray silty-clayey fine sand with shell fragments; lenses/spots of organic rich black clay; lower boundary sharp, with strong relief, erosive contact 200/214-295 cm: Dark greenish gray clay with sand layers and thin intercalations of sand at 259-260 cm, 263 cm, 269 cm, 273 cm, 282 cm, 288-289 cm, 292 cm
5Y 3/2	295-386.5 cm: Olive gray clay with thin silty intercalations and with numerous lenticular sand layers; thickness of sand layers up to 1.5 cm, most are below 0.5 cm 297-299 cm: Dark brownish black organic rich layer
5Y 3/2	386.5-394 cm: Olive gray homogeneous clay 394-400 cm: sand layer



Colour	Lithological description
5Y 3/2	400-403/406 cm: sand layer, sharp upper contact, oblique and fuzzy lower contact 403/406-433.5 cm: Olive gray clay with sandy lenses/ layers up to 1.5 cm; 416.5-417.5 cm brownish-black organic rich layer 433-437.5 cm: sandy layer; sharp upper contact with wavey ripple lamination 437.5-486.5 cm: Olive gray with thin sandy lenticular intercalations and irregular layers 442-444.5 cm: sandy layer with organic -rich traces; ripple laminated upper contact, diffuse lower contact
5Y 3/2	486.5-586.5 cm: Olive gray clay with thin lenticular sandy layers 523-525.5 cm: lenticular sand layer, directly overlaying a 1-1.5 cm thick organic-rich sandy layer with mica, the upper contact is sharp, the base is fuzzy
5Y 3/2	586.5-686.5 cm: Olive gray clay with lenticular sandy layers/ very thin sand layers
5Y 3/2	686.5-786.5 cm: Olive gray clay interlayered/ intercalated with sandy layers (mm in thickness) and sandy lenses 778-779.5 cm: organic-rich sandy layer
5Y 3/2	786.5-800 cm: Olive gray clay with lenticular sandy layers
5Y 3/2	800-881.5 cm: Olive gray clay with lenticular sandy layers/lenses



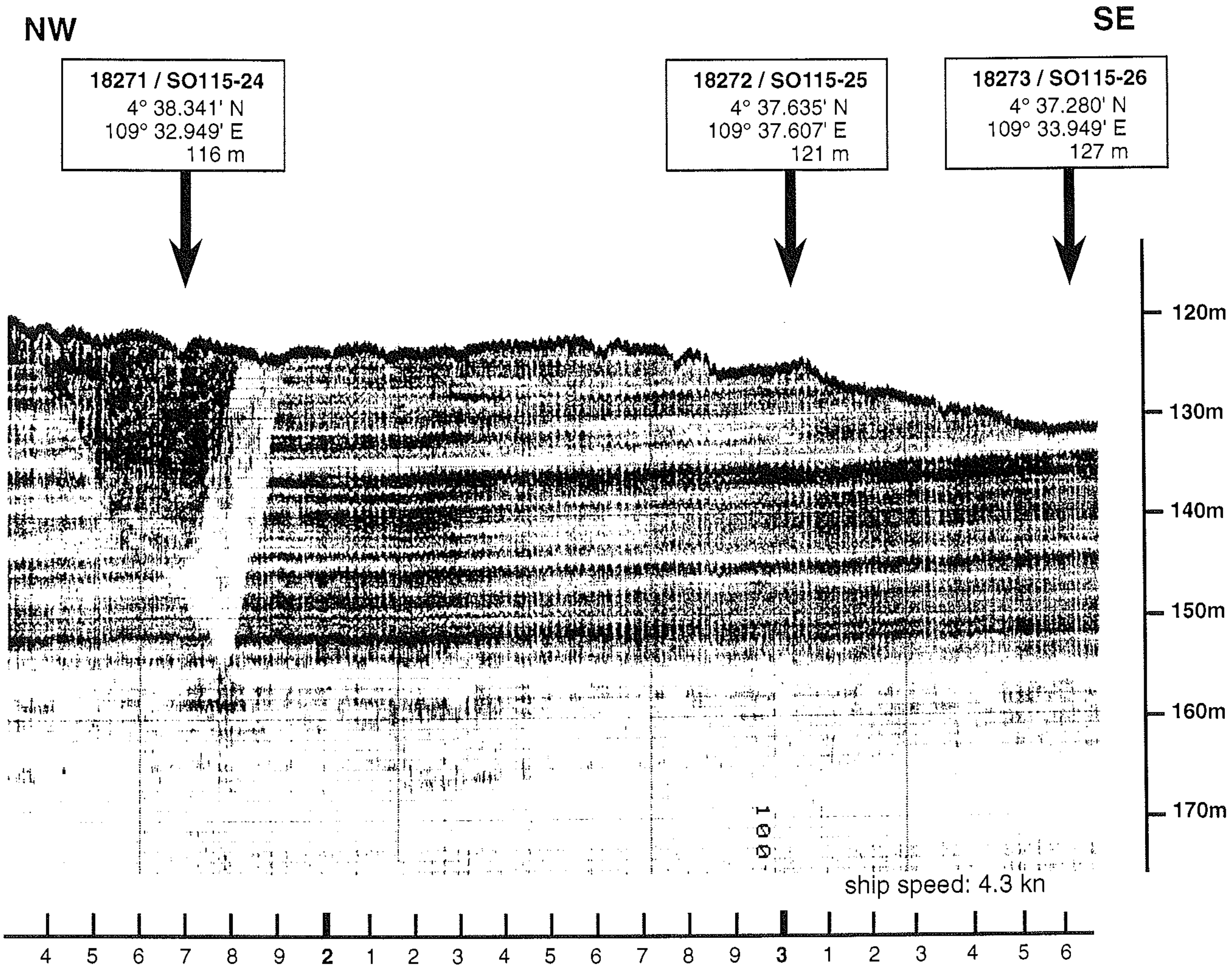



SONNE-115 Water depth: 106 m
Station: SO-115-23
Position: 4° 43.516 N; 109° 26.321 E

Core: VC 18270-4 Recovery: 140 cm

Lithology	Structure	Colour	Lithological description
		5Y5/2	0-2 cm: brownish oxidation zone 2-11 cm: Light olive gray medium-fine sand with shells and shell fragments 11-98 cm: Light olive gray clayey sand with larger shells and shell fragments intermixedwith biogrenic medium sand, 61-63.5 cm biogenic medium to fine sand
		5Y5/2	98-140 cm: Light olive gray clayey sand with larger shells and shell fragments

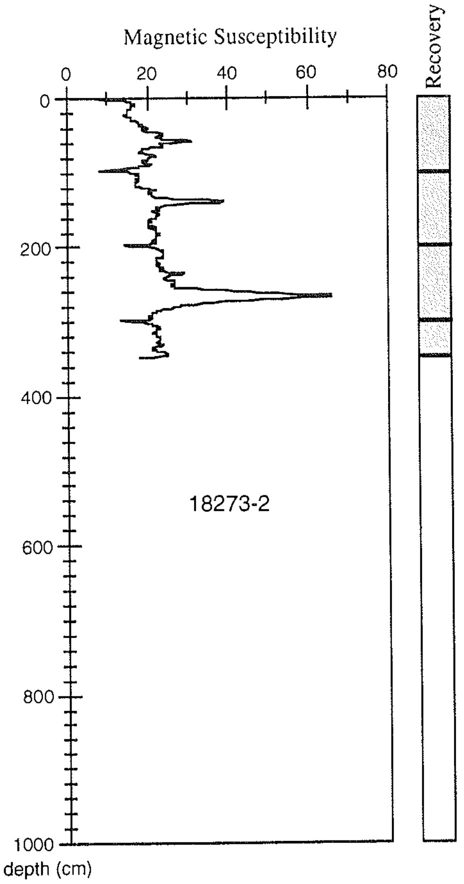
Objectives: Coring the sediment cover with several strong acoustic reflectors above a shallow gentle erosional surface.
Remarks: Penetration of gravity corer and vibrocorer were poor. Reflectors probably indicate hard sandy layers, rich in shell fragments.

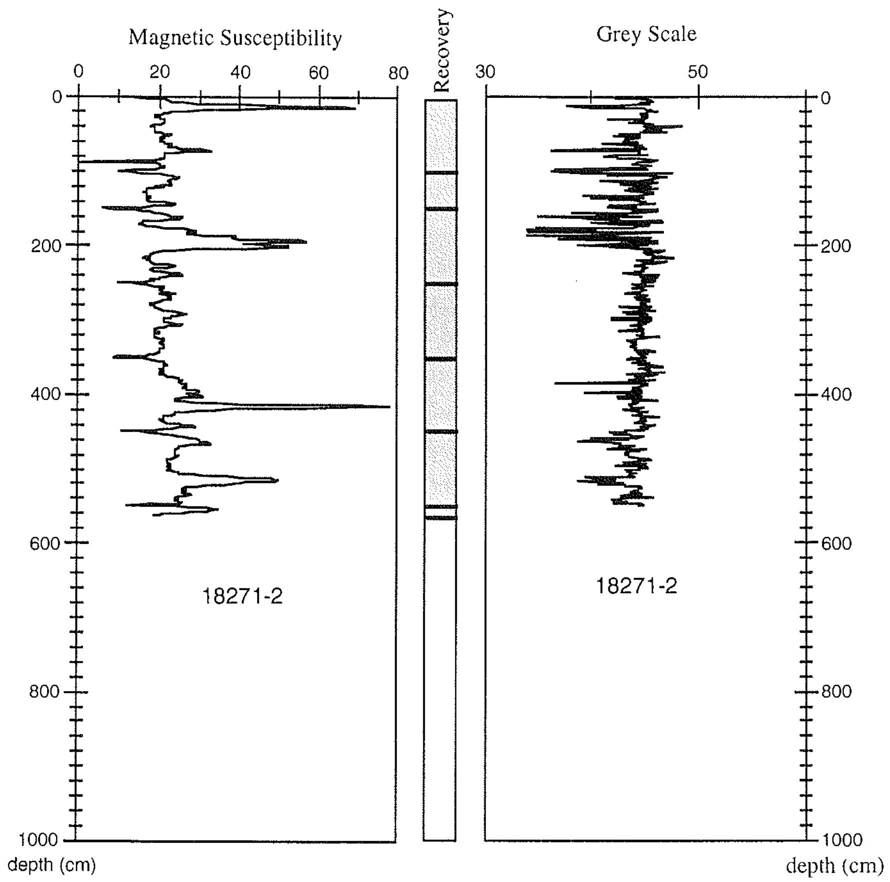


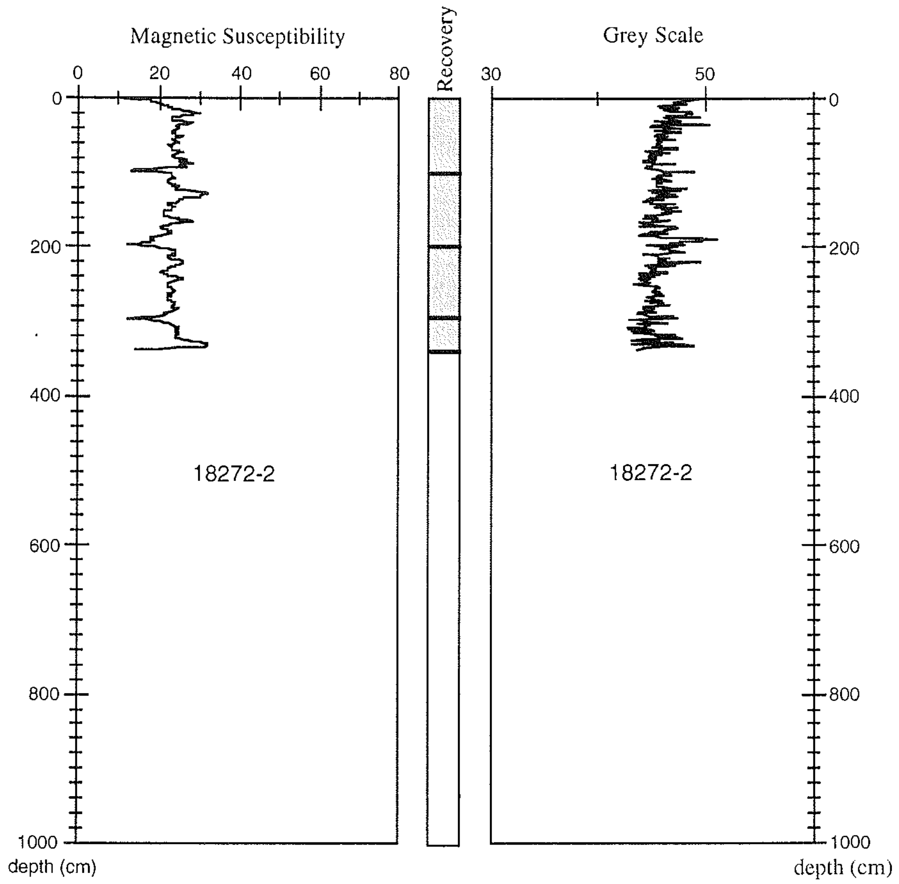
Objectives:

Coring an incised valley fill (station SO-115-24) below a (Holocene) erosional surface.

In the continuation of the erosional surface coring at stations SO-115-25 and 26 together with stations SO-115-27 and 28 recover a composite section of the pre-erosional horizontally stratified sequence.

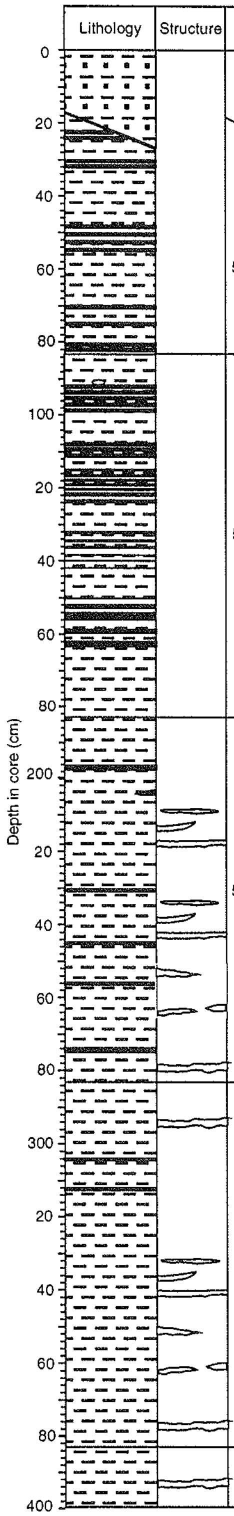



Magnetic Susceptibility
0
20
40
60
80
Recovery
Grey Scale
30
50
0
200
400
600
800
1000
depth (cm)
18271-2
18271-2
0
200
400
600
800
1000
depth (cm)

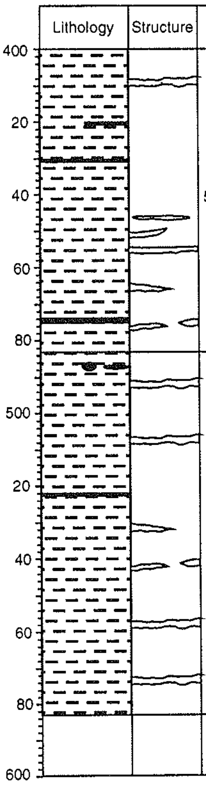

Magnetic Susceptibility
0
20
40
60
80
Recovery
Grey Scale
30
50
0
200
400
600
800
1000
depth (cm)
18272-2
18272-2
0
200
400
600
800
1000
depth (cm)

SONNE-115 **Water depth: 116 m**
Station: SO-115-24
Position: 4° 38.314 N; 109° 32.971 E

Core: SL 18271-3 **Recovery: 576 cm**



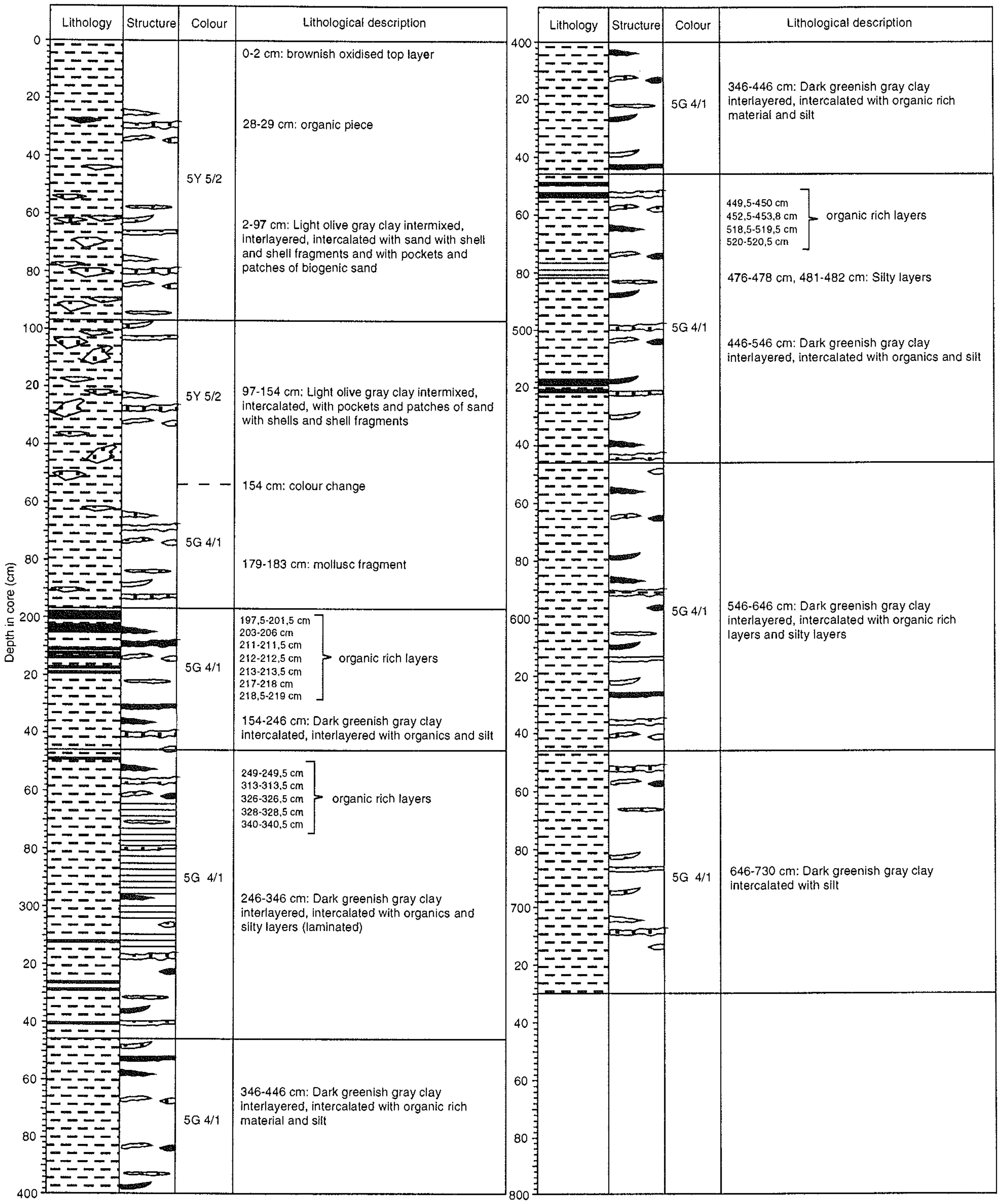
Colour	Lithological description
5Y 5/2 5 GY 6/1	0-17/28 cm:Light olive gray clayey sand with shells and shell fragments, soft, high water content, erosional contact 17/28-83 cm: Greenish gray clay interlayered with organics (Peat layers, 0.3 cm up to 2 cm thickness); 44-83 cm burrow-like structure filled with light olive gray clayey biogenic sand 23-24 cm organic rich layers 35-36 cm 48-54 cm 70 cm 75 cm 81-82 cm
5 GY 6/1	83-183 cm: Greenish gray clay interlayered with organics (Peat layers, 0.3 cm up to 2 cm thickness) 91-92 cm burrow-like structure filled with clayey biogenic sand 92-98 cm, 108-110 cm, 117-120 cm, 138-142 cm high concentration of organic layers (0.1-0.3 cm) 121-121.5 cm organic rich layers 122-122.5cm 123-124cm 132-132.5 cm 134-134.5 cm 136-136.5 cm 150-150.5 cm 152-153 cm 154-156 cm 158.5-160 cm 162-163.5 cm
5 GY 6/1	183-283 cm: Greenish gray clay interlayered with organics and thin intercalations/ layers of silt (up to 2 mm thickness) and lenticular silt layers 189-190 cm organic-rich layer 202.5-203 cm organic intercalation 230-230.5cm organic rich layers 245-245.5 cm 256-256.5 cm 274-275 cm
5 GY 6/1	283-383 cm: Greenish gray clay interlayered with organics and thin intercalations/ layers of silt (up to 2 mm thickness) and lenticular silt layers 304-304.5 cm organic rich layers 312-312.5 cm
5 GY 6/1	383-400 cm: Greenish gray clay with thin intercalations/ layers of silt (up to 2 mm thickness) and lenticular silt layers



Colour	Lithological description
5 GY 6/1	400-483 cm: Greenish gray clay interlayered with organics and thin intercalations/ layers of silt (up to 2 mm thickness), lenticular silt layers 420-421.5cm organic rich layers 430-431.5 cm 465.5-466.5 cm
5 GY 6/1	483-583 cm: Greenish gray clay interlayered with organics and thin intercalations/ layers of silt (up to 2 mm thickness), lenticular silt layers 488-488.5 cm organic patches 522-522.5 cm organic rich layer

SONNE-115 Water depth: 116 m
Station:SO-115-24
Position: 4° 38.315 N; 109° 32.939 E

Core: SL 18271-4 Recovery: 730 cm



0-2 cm: brownish oxidised top layer

28-29 cm: organic piece

2-97 cm: Light olive gray clay intermixed, interlayered, intercalated with sand with shell and shell fragments and with pockets and patches of biogenic sand

97-154 cm: Light olive gray clay intermixed, intercalated, with pockets and patches of sand with shells and shell fragments

154 cm: colour change

179-183 cm: mollusc fragment

197,5-201,5 cm
203-206 cm
211-211,5 cm
212-212,5 cm
213-213,5 cm
217-218 cm
218,5-219 cm
organic rich layers

154-246 cm: Dark greenish gray clay intercalated, interlayered with organics and silt

249-249,5 cm
313-313,5 cm
326-326,5 cm
328-328,5 cm
340-340,5 cm
organic rich layers

246-346 cm: Dark greenish gray clay interlayered, intercalated with organics and silty layers (laminated)

346-446 cm: Dark greenish gray clay interlayered, intercalated with organic rich material and silt

346-446 cm: Dark greenish gray clay interlayered, intercalated with organic rich material and silt

449,5-450 cm
452,5-453,8 cm
518,5-519,5 cm
520-520,5 cm
organic rich layers

476-478 cm, 481-482 cm: Silty layers

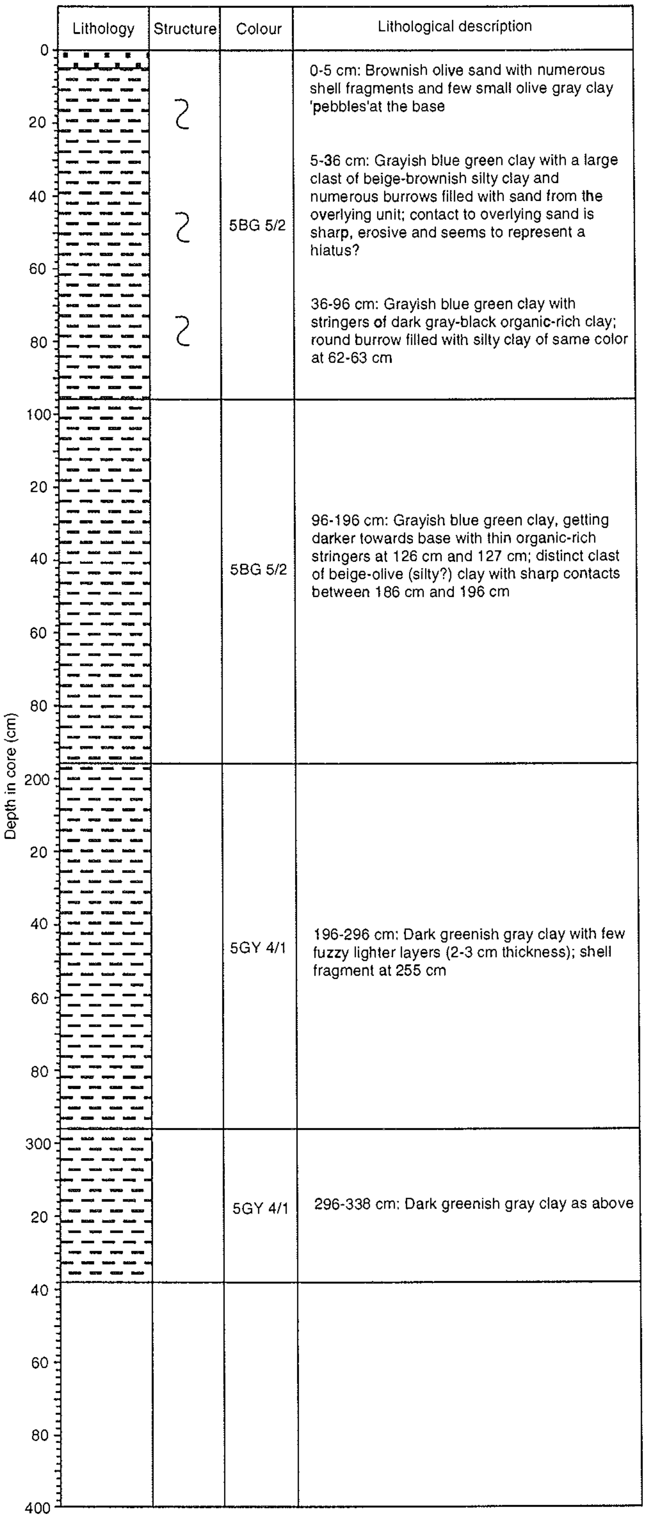
446-546 cm: Dark greenish gray clay interlayered, intercalated with organics and silt

546-646 cm: Dark greenish gray clay interlayered, intercalated with organic rich layers and silty layers

646-730 cm: Dark greenish gray clay intercalated with silt

SONNE-115 **Water depth: 118 m**
Station: SO-115-25
Position: 4° 37.597 N; 109° 33.632 E

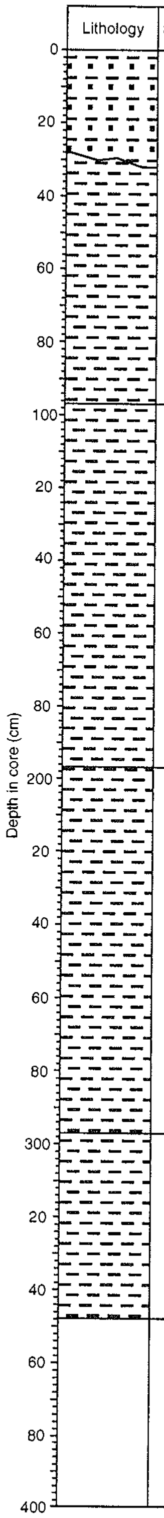
Core: SL 18272-2 **Recovery: 338 cm**



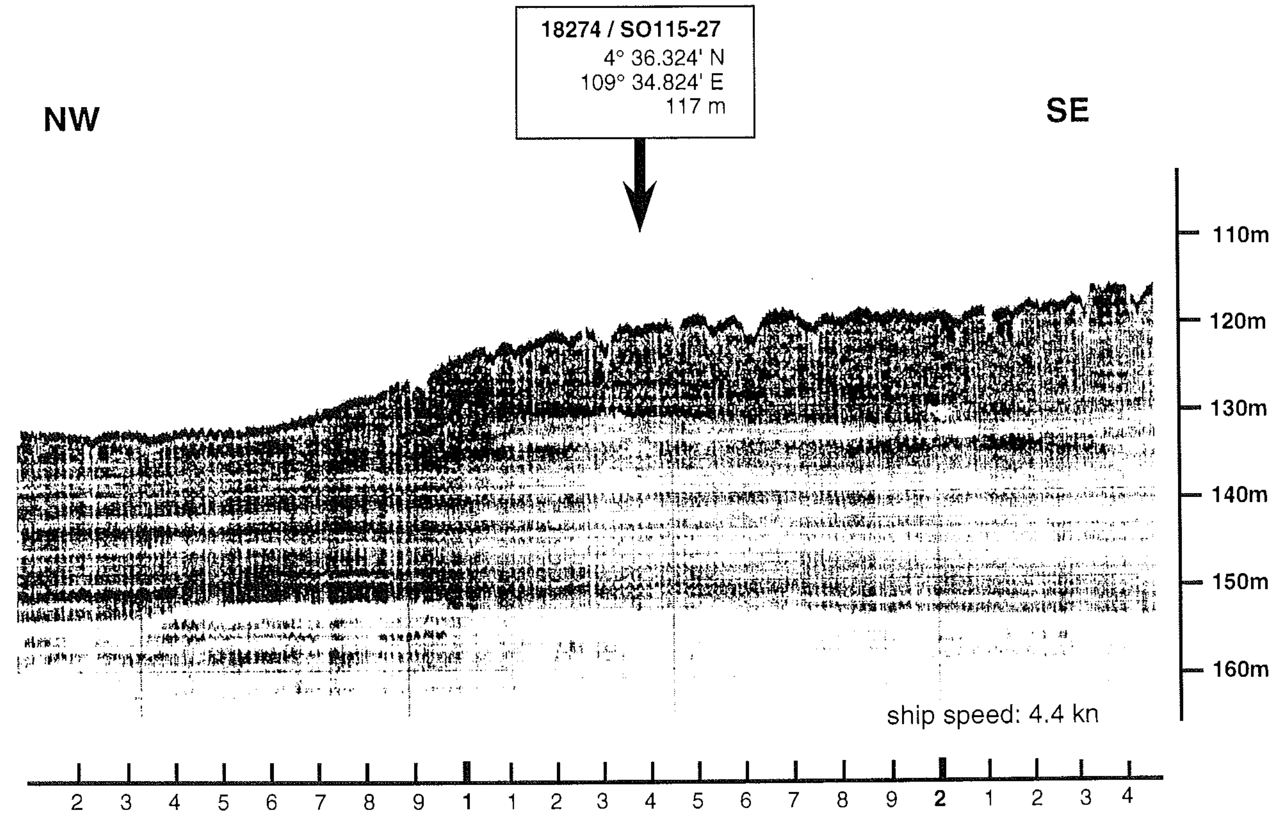
Colour	Lithological description
5BG 5/2	0-5 cm: Brownish olive sand with numerous shell fragments and few small olive gray clay 'pebbles'at the base 5-36 cm: Grayish blue green clay with a large clast of beige-brownish silty clay and numerous burrows filled with sand from the overlying unit; contact to overlying sand is sharp, erosive and seems to represent a hiatus? 36-96 cm: Grayish blue green clay with stringers of dark gray-black organic-rich clay; round burrow filled with silty clay of same color at 62-63 cm
5BG 5/2	96-196 cm: Grayish blue green clay, getting darker towards base with thin organic-rich stringers at 126 cm and 127 cm; distinct clast of beige-olive (silty?) clay with sharp contacts between 186 cm and 196 cm
5GY 4/1	196-296 cm: Dark greenish gray clay with few fuzzy lighter layers (2-3 cm thickness); shell fragment at 255 cm
5GY 4/1	296-338 cm: Dark greenish gray clay as above

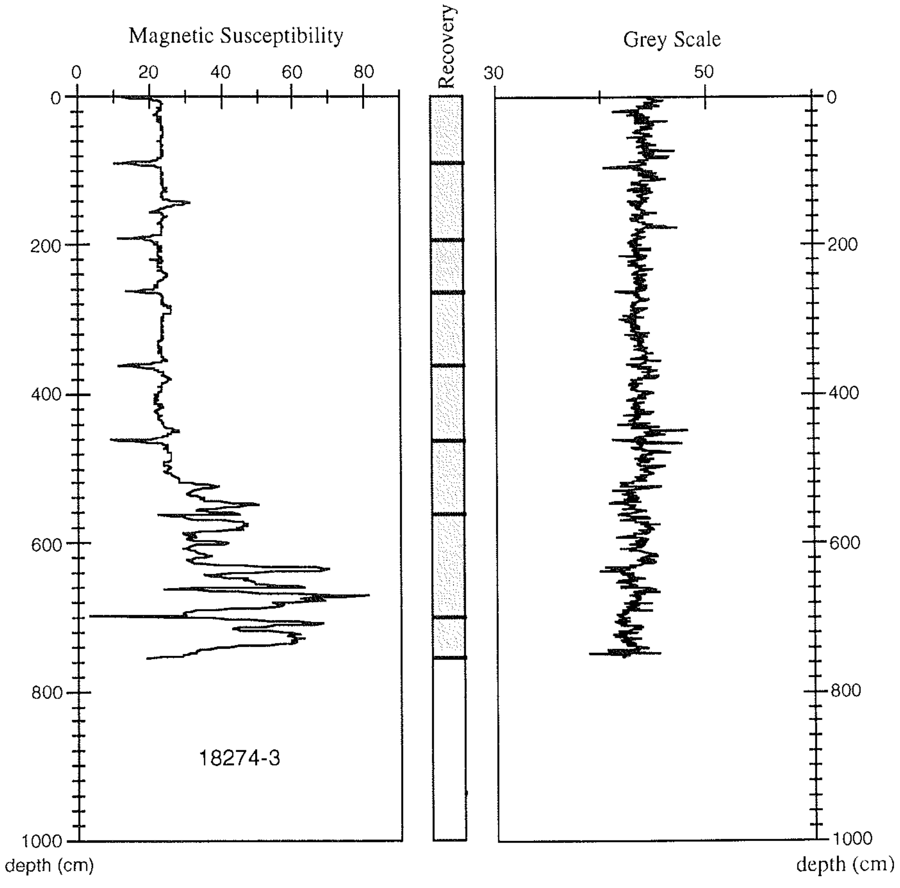
SONNE-115 **Water depth: 118 m**
Station: SO-115-26
Position: 4° 37.597 N; 109° 33.632 E

Core: SL 18273-2 **Recovery: 348 cm**



Lithology	Structure	Colour	Lithological description
		5Y 5/2 5G 4/1	0-1 cm: Brownish oxidised top layer 1-28/32 cm: Light olive gray clayey biogenic sand (shells and shell fragments), erosive contact 28/32-97 cm: Dark greenish gray homogeneous clay with several burrows filled with clayey biogenic sand
		5G 4/1	97-197 cm: Dark greenish gray homogeneous clay
		5G 4/1	197-297 cm: Dark greenish gray clay interlayerd/ intermixed with silty sand 241-242 cm, 261-278 cm, 282-287 cm: patches of silty sand
		5G 4/1	297-348 cm: Dark greenish gray clay with silty sandy patches/pockets (305-309 cm)





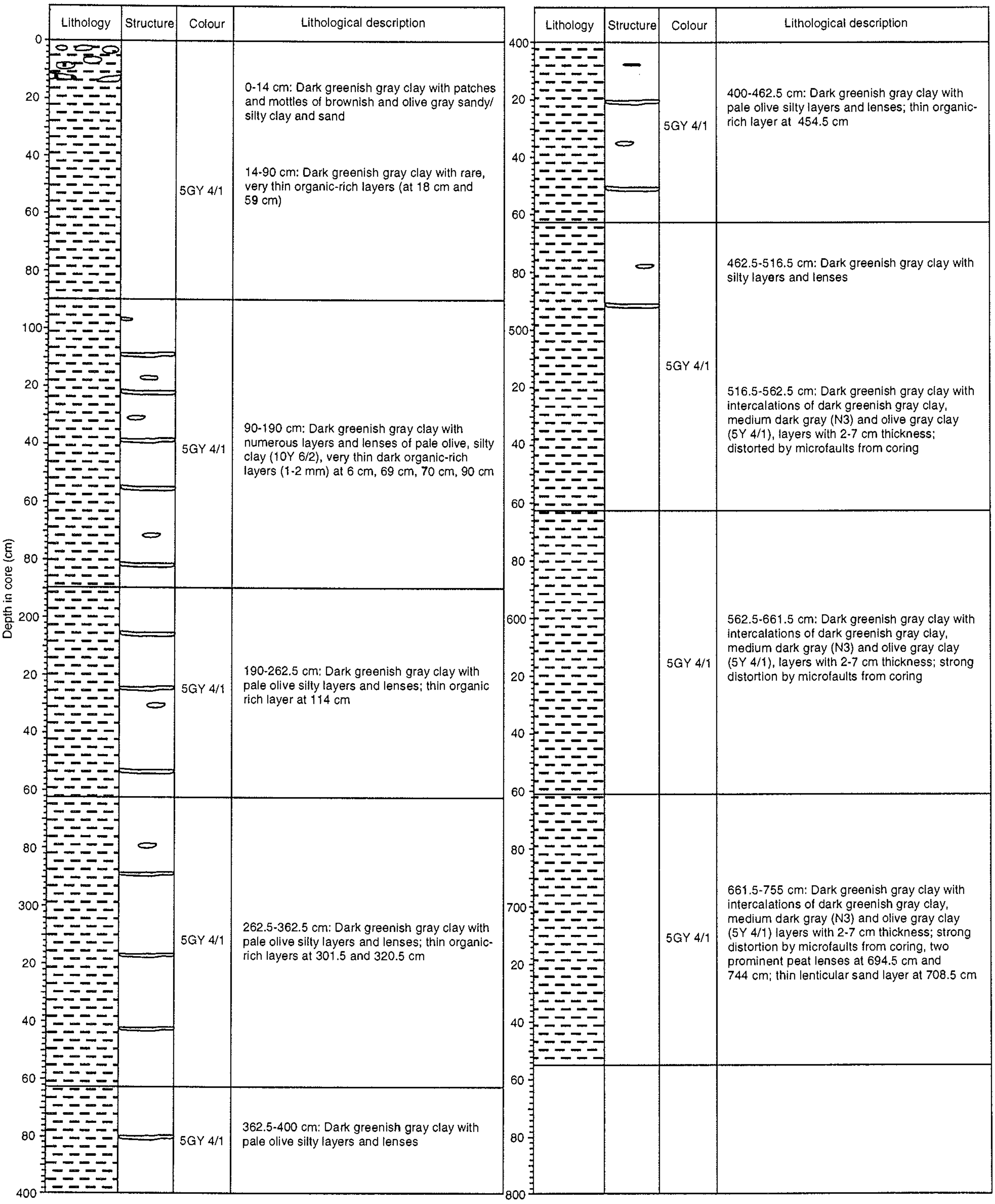
Objectives:

Continuation of the composite section of stations SO-115-25 and 26 at the opposite side of a larger erosional valley.

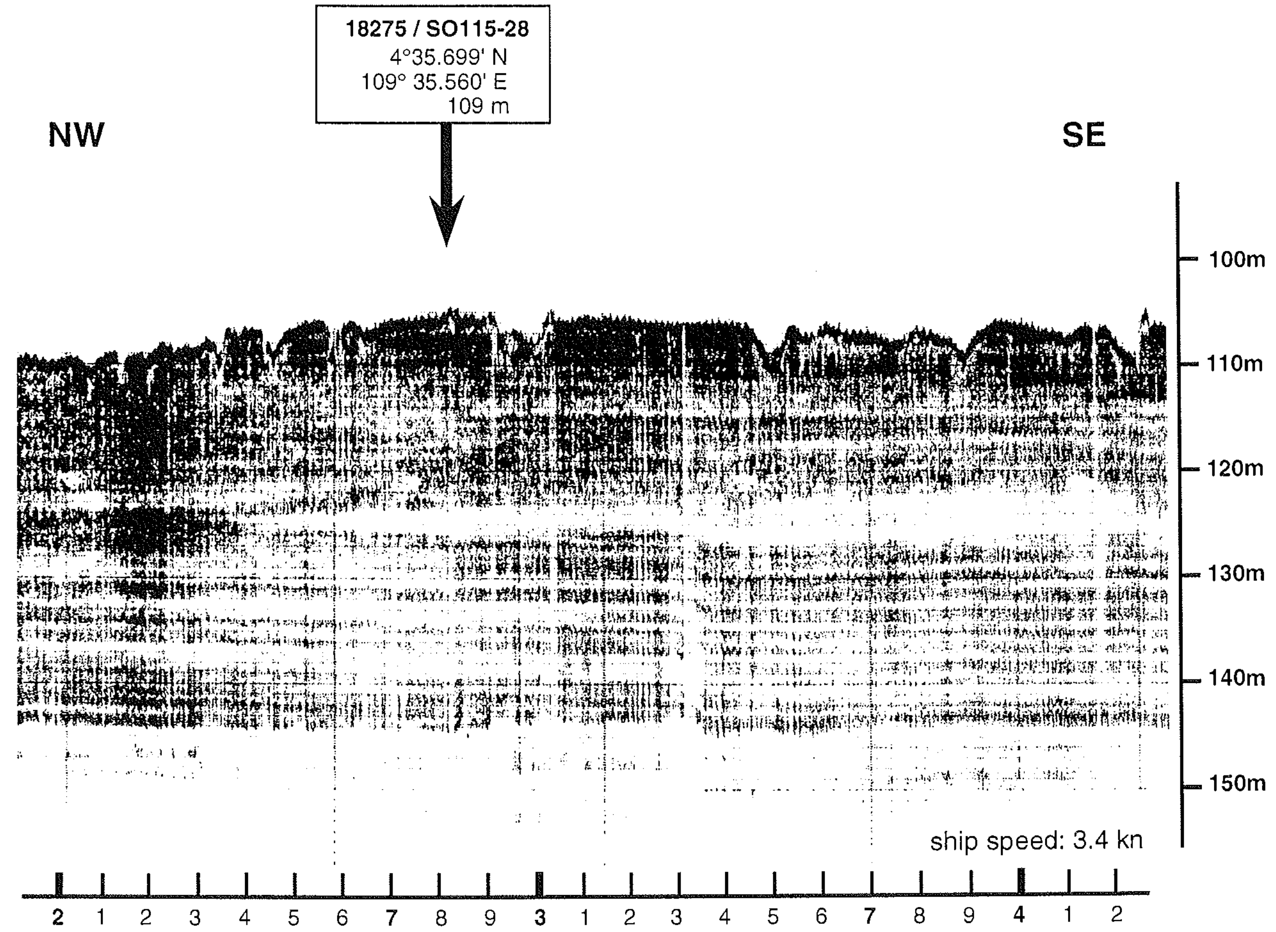
Wavy structure of the surface layer is an erosional feature; relict sands are lacking at this station.

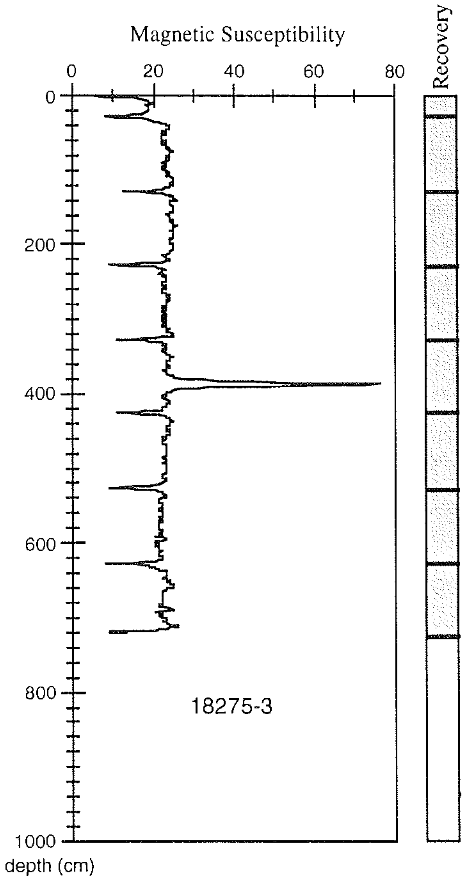
SONNE-115 **Water depth: 117 m**
Station: SO-115-27
Position: 4° 36.313 N; 109° 34.818 E

Core: SL 18274-3 **Recovery: 755 cm**



Colour	Lithological description
5GY 4/1	0-14 cm: Dark greenish gray clay with patches and mottles of brownish and olive gray sandy/ silty clay and sand 14-90 cm: Dark greenish gray clay with rare, very thin organic-rich layers (at 18 cm and 59 cm)
5GY 4/1	90-190 cm: Dark greenish gray clay with numerous layers and lenses of pale olive, silty clay (10Y 6/2), very thin dark organic-rich layers (1-2 mm) at 6 cm, 69 cm, 70 cm, 90 cm
5GY 4/1	190-262.5 cm: Dark greenish gray clay with pale olive silty layers and lenses; thin organic rich layer at 114 cm
5GY 4/1	262.5-362.5 cm: Dark greenish gray clay with pale olive silty layers and lenses; thin organic-rich layers at 301.5 and 320.5 cm
5GY 4/1	362.5-400 cm: Dark greenish gray clay with pale olive silty layers and lenses
5GY 4/1	400-462.5 cm: Dark greenish gray clay with pale olive silty layers and lenses; thin organic-rich layer at 454.5 cm
5GY 4/1	462.5-516.5 cm: Dark greenish gray clay with silty layers and lenses 516.5-562.5 cm: Dark greenish gray clay with intercalations of dark greenish gray clay, medium dark gray (N3) and olive gray clay (5Y 4/1), layers with 2-7 cm thickness; distorted by microfaults from coring
5GY 4/1	562.5-661.5 cm: Dark greenish gray clay with intercalations of dark greenish gray clay, medium dark gray (N3) and olive gray clay (5Y 4/1), layers with 2-7 cm thickness; strong distortion by microfaults from coring
5GY 4/1	661.5-755 cm: Dark greenish gray clay with intercalations of dark greenish gray clay, medium dark gray (N3) and olive gray clay (5Y 4/1) layers with 2-7 cm thickness; strong distortion by microfaults from coring, two prominent peat lenses at 694.5 cm and 744 cm; thin lenticular sand layer at 708.5 cm



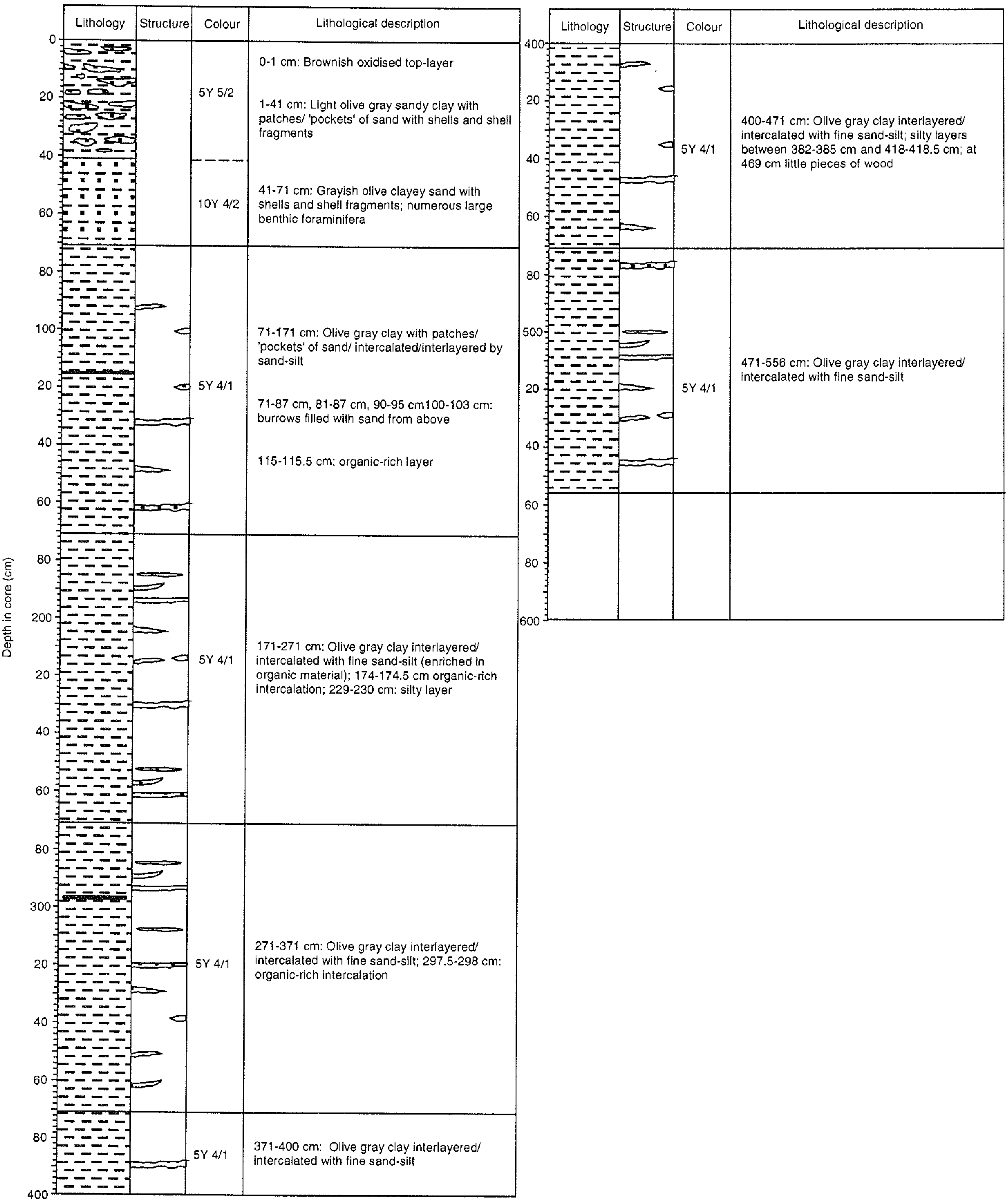


Objectives:

Coring an erosional surface at the seafloor. The erosion surface is at its morphologically highest position here and the coring reached the youngest pre-erosional sediments.

SONNE-115 **Water depth: 112 m**
Station: SO-115-28
Position: 4° 35.727 N; 109° 35.536 E

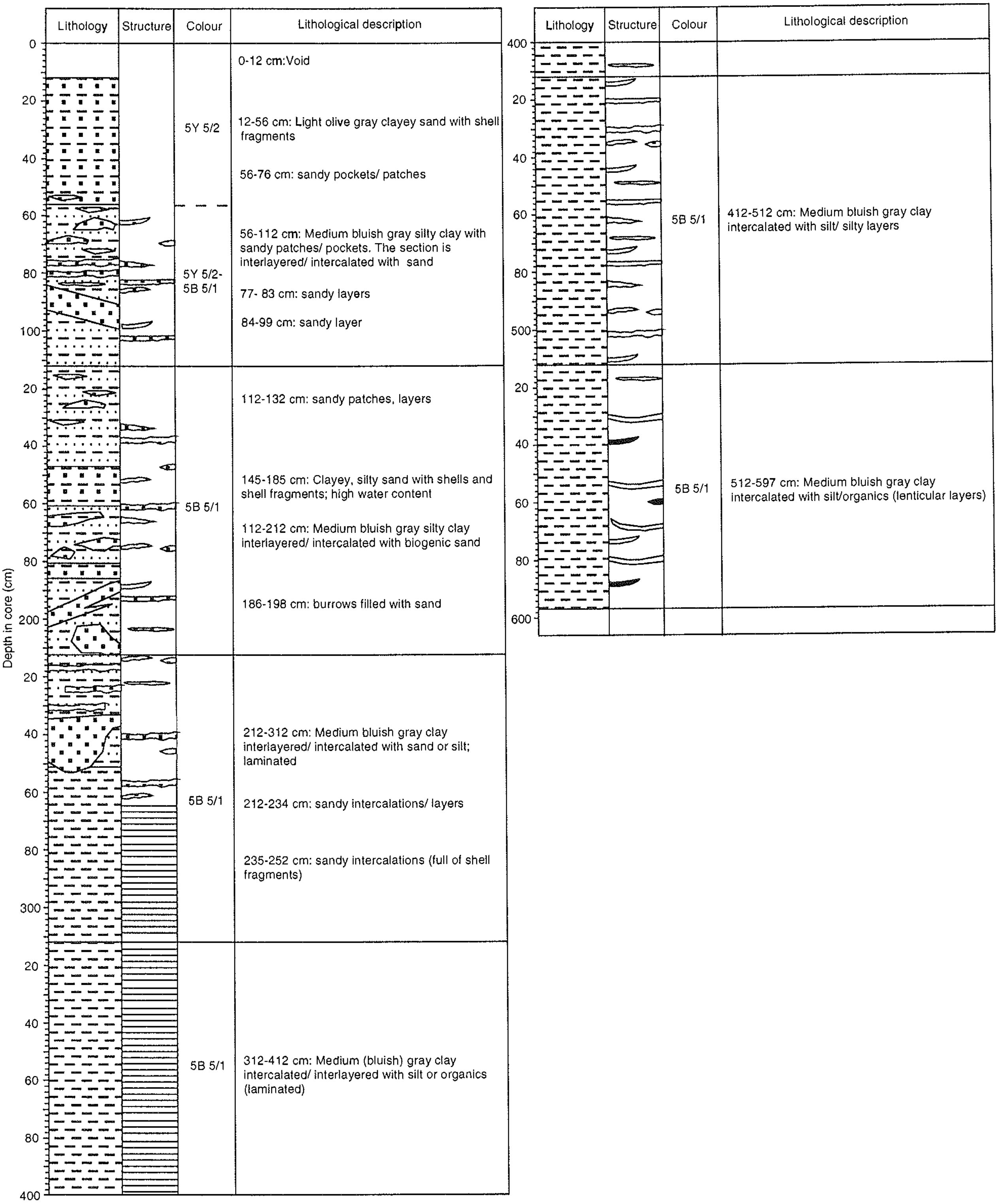
Core: SL 18275-2 **Recovery: 556 cm**



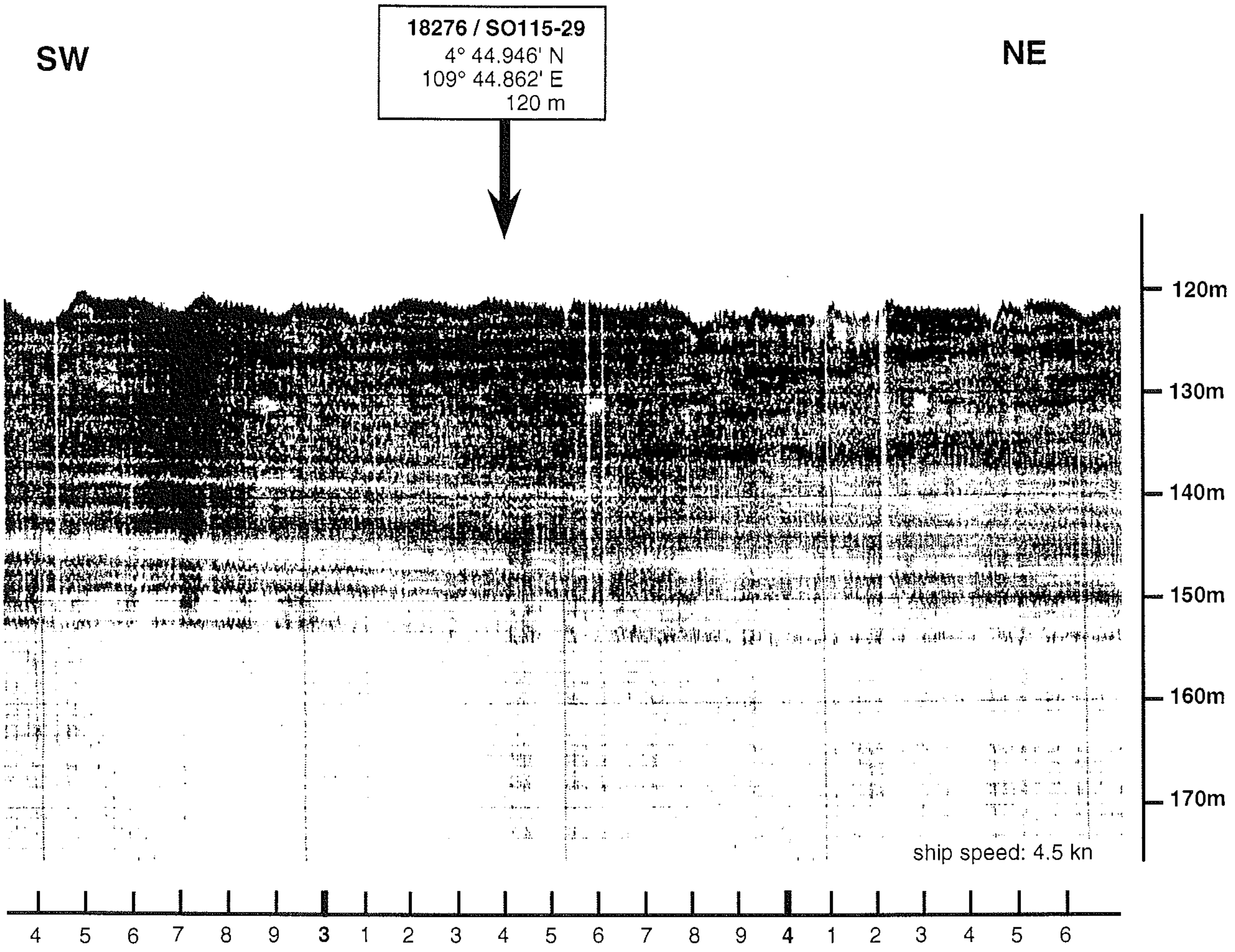
Colour	Lithological description
5Y 5/2	0-1 cm: Brownish oxidised top-layer 1-41 cm: Light olive gray sandy clay with patches/ 'pockets' of sand with shells and shell fragments
10Y 4/2	41-71 cm: Grayish olive clayey sand with shells and shell fragments; numerous large benthic foraminifera
5Y 4/1	71-171 cm: Olive gray clay with patches/ 'pockets' of sand/ intercalated/interlayered by sand-silt 71-87 cm, 81-87 cm, 90-95 cm100-103 cm: burrows filled with sand from above 115-115.5 cm: organic-rich layer
5Y 4/1	171-271 cm: Olive gray clay interlayered/ intercalated with fine sand-silt (enriched in organic material); 174-174.5 cm organic-rich intercalation; 229-230 cm: silty layer
5Y 4/1	271-371 cm: Olive gray clay interlayered/ intercalated with fine sand-silt; 297.5-298 cm: organic-rich intercalation
5Y 4/1	371-400 cm: Olive gray clay interlayered/ intercalated with fine sand-silt
5Y 4/1	400-471 cm: Olive gray clay interlayered/ intercalated with fine sand-silt; silty layers between 382-385 cm and 418-418.5 cm; at 469 cm little pieces of wood
5Y 4/1	471-556 cm: Olive gray clay interlayered/ intercalated with fine sand-silt

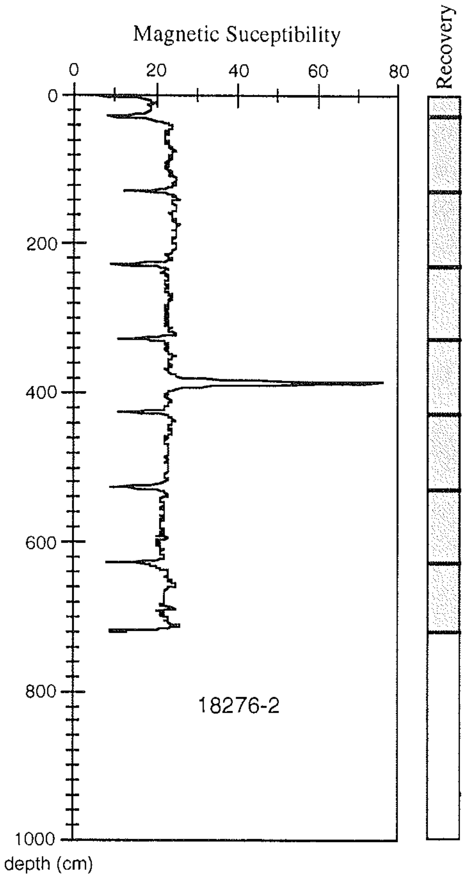
SONNE-115 **Water depth: 109 m**
Station: SO-115-28
Position: 4° 35.652 N; 109° 35.539 E

Core: SL 18275-3 **Recovery: 597 cm**



Colour	Lithological description
	0-12 cm:Void
5Y 5/2	12-56 cm: Light olive gray clayey sand with shell fragments 56-76 cm: sandy pockets/ patches
5Y 5/2- 5B 5/1	56-112 cm: Medium bluish gray silty clay with sandy patches/ pockets. The section is interlayered/ intercalated with sand 77- 83 cm: sandy layers 84-99 cm: sandy layer
5B 5/1	112-132 cm: sandy patches, layers 145-185 cm: Clayey, silty sand with shells and shell fragments; high water content 112-212 cm: Medium bluish gray silty clay interlayered/ intercalated with biogenic sand 186-198 cm: burrows filled with sand
5B 5/1	212-312 cm: Medium bluish gray clay interlayered/ intercalated with sand or silt; laminated 212-234 cm: sandy intercalations/ layers 235-252 cm: sandy intercalations (full of shell fragments)
5B 5/1	312-412 cm: Medium (bluish) gray clay intercalated/ interlayered with silt or organics (laminated)
5B 5/1	412-512 cm: Medium bluish gray clay intercalated with silt/ silty layers
5B 5/1	512-597 cm: Medium bluish gray clay intercalated with silt/organics (lenticular layers)

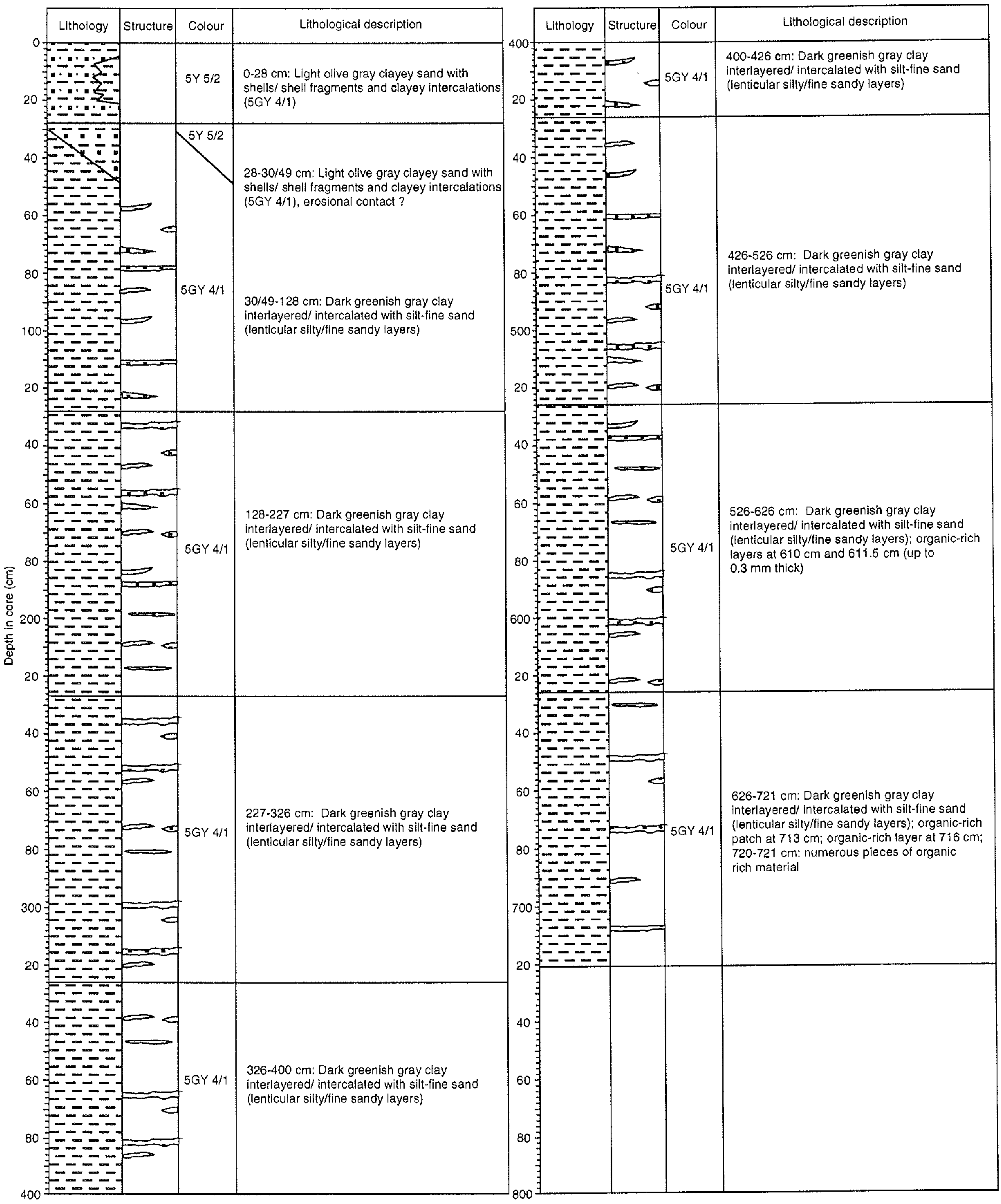




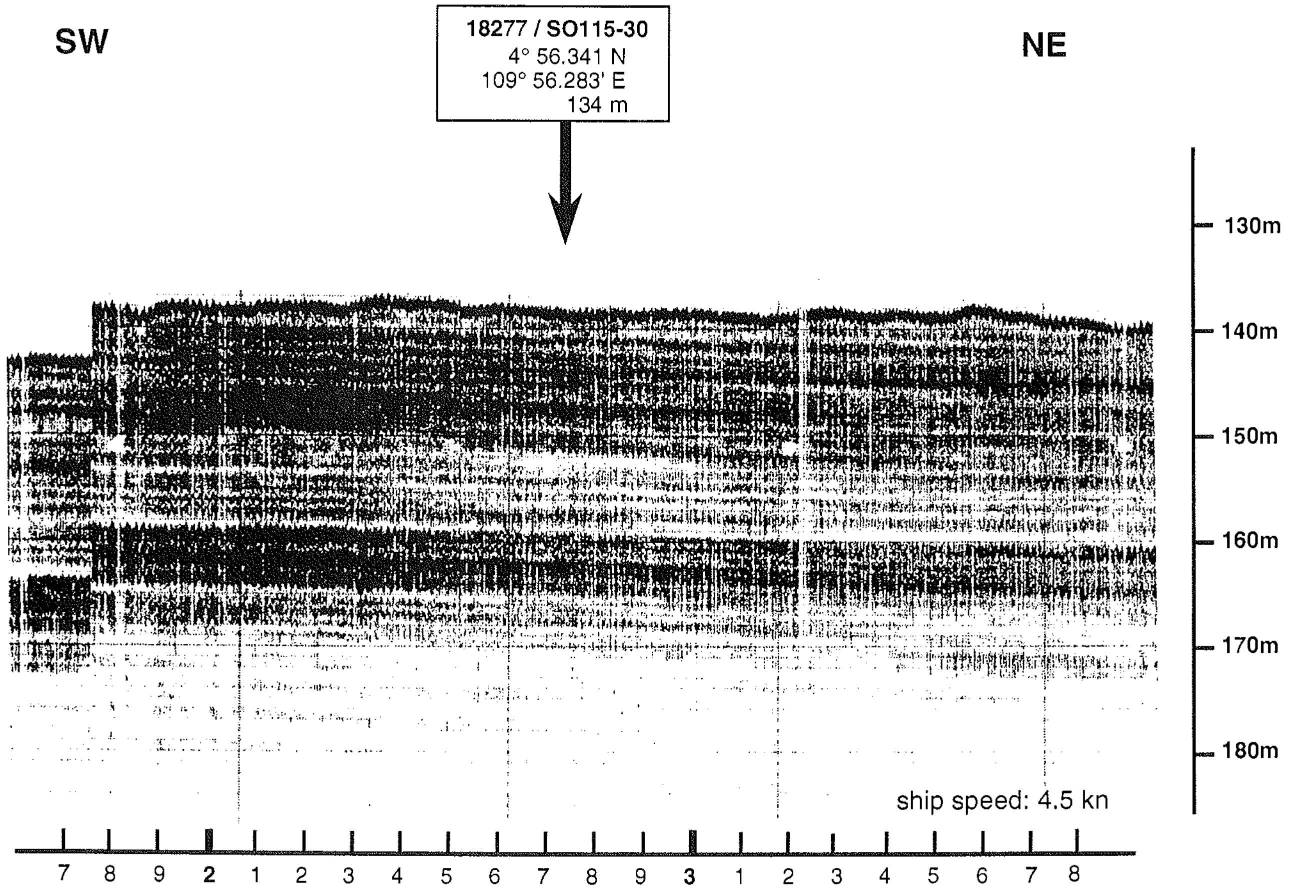
Objectives:
Most proximal station of a continous shelf-slope transect for sampling surface sediments and foraminiferal assemblages.
Coring is mainly dedicated to provide stratigraphic control for the more proximal stations. Combined with the following stations a longer stratigraphic record of the pre-erosional sedimentation is cored as a composite section.
A second objective is dating the erosional surface, that extends from approx. 110 m to 130 m water depth.

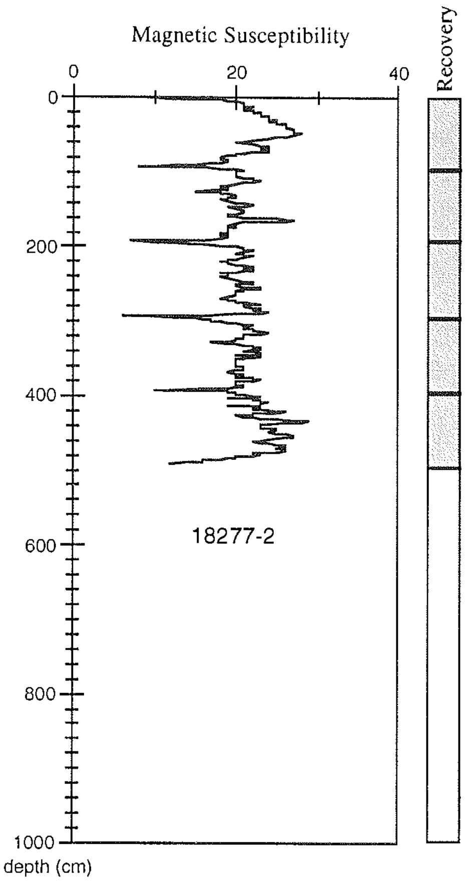
SONNE-115 **Water depth: 116 m**
Station: SO-115-29
Position: 4° 44.897 N; 109° 44.837 E

Core: SL 18276-2 **Recovery: 721 cm**



Colour	Lithological description
5Y 5/2	0-28 cm: Light olive gray clayey sand with shells/ shell fragments and clayey intercalations (5GY 4/1)
5Y 5/2	28-30/49 cm: Light olive gray clayey sand with shells/ shell fragments and clayey intercalations (5GY 4/1), erosional contact ?
5GY 4/1	30/49-128 cm: Dark greenish gray clay interlayered/ intercalated with silt-fine sand (lenticular silty/fine sandy layers)
5GY 4/1	128-227 cm: Dark greenish gray clay interlayered/ intercalated with silt-fine sand (lenticular silty/fine sandy layers)
5GY 4/1	227-326 cm: Dark greenish gray clay interlayered/ intercalated with silt-fine sand (lenticular silty/fine sandy layers)
5GY 4/1	326-400 cm: Dark greenish gray clay interlayered/ intercalated with silt-fine sand (lenticular silty/fine sandy layers)
5GY 4/1	400-426 cm: Dark greenish gray clay interlayered/ intercalated with silt-fine sand (lenticular silty/fine sandy layers)
5GY 4/1	426-526 cm: Dark greenish gray clay interlayered/ intercalated with silt-fine sand (lenticular silty/fine sandy layers)
5GY 4/1	526-626 cm: Dark greenish gray clay interlayered/ intercalated with silt-fine sand (lenticular silty/fine sandy layers); organic-rich layers at 610 cm and 611.5 cm (up to 0.3 mm thick)
5GY 4/1	626-721 cm: Dark greenish gray clay interlayered/ intercalated with silt-fine sand (lenticular silty/fine sandy layers); organic-rich patch at 713 cm; organic-rich layer at 716 cm; 720-721 cm: numerous pieces of organic rich material

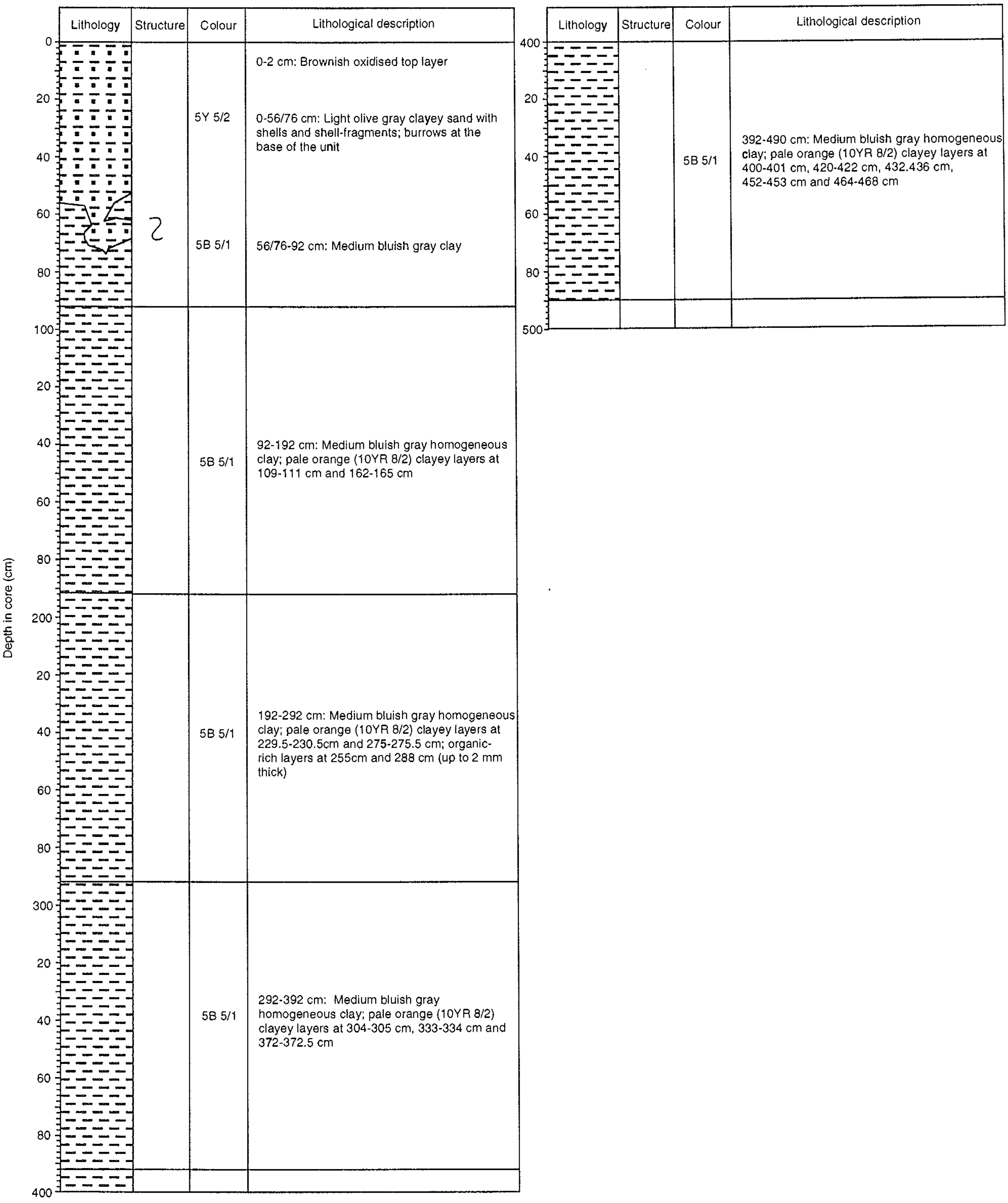




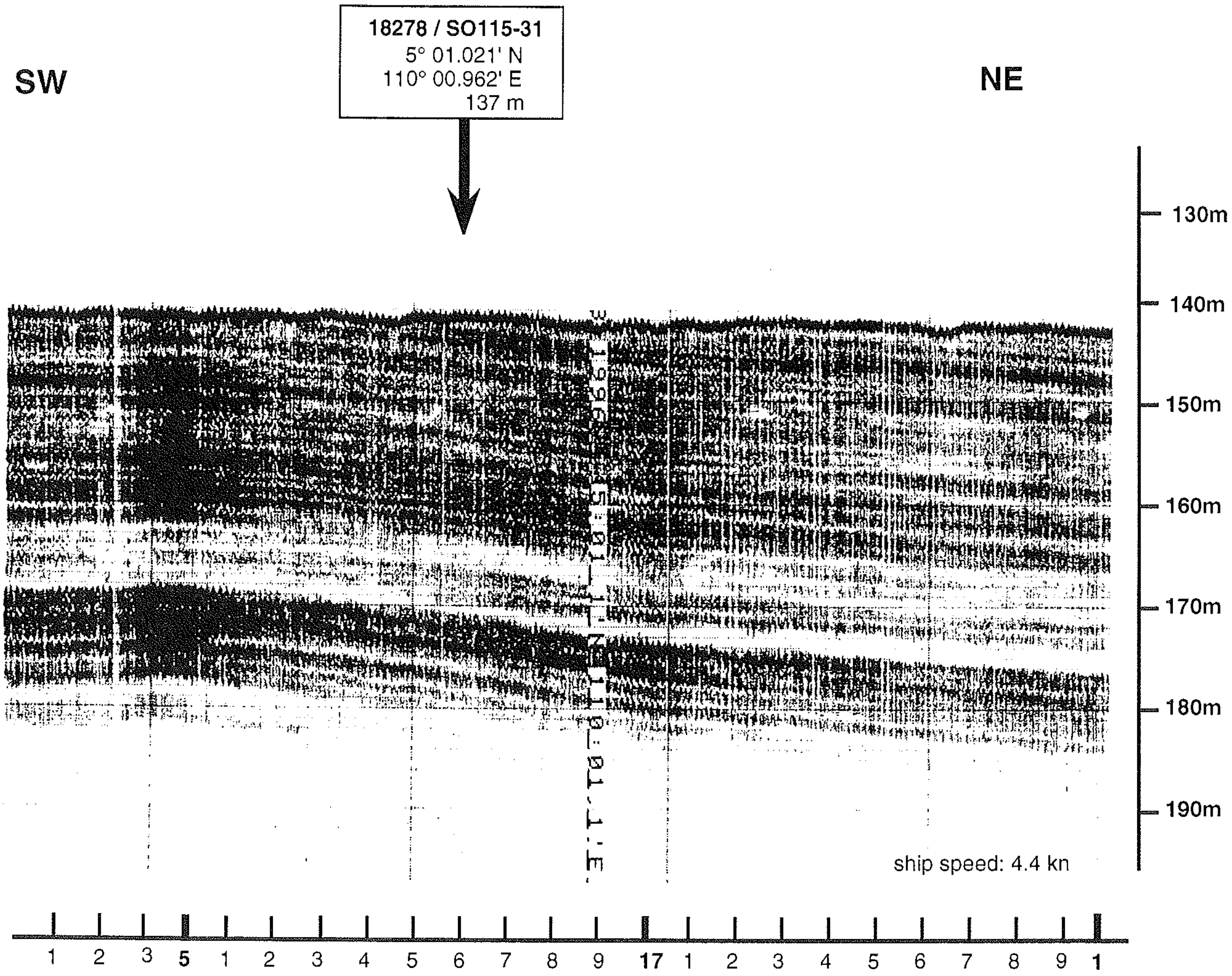
Objectives:
Continuation of the shelf-slope transect for sampling surface sediments and foraminiferal assemblages. Coring is mainly dedicated to provide stratigraphic control for the more proximal stations. Combined with the previous and following stations a longer stratigraphic record of the pre-erosional sedimentation is cored as a composite section.
A second objective is dating the distal termination of the erosional surface, that extends from approx. 110 m to 130 m water depth.

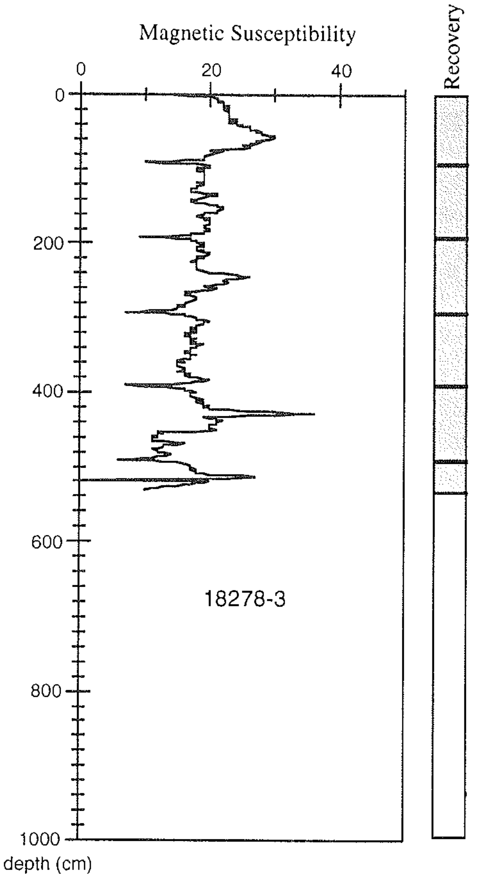
SONNE-115 **Water depth: 133 m**
Station: SO-115-30
Position: 4° 56.355 N; 109° 56.298 E

Core: SL 18277-2 **Recovery: 490 cm**



Colour	Lithological description
	0-2 cm: Brownish oxidised top layer
5Y 5/2	0-56/76 cm: Light olive gray clayey sand with shells and shell-fragments; burrows at the base of the unit
5B 5/1	56/76-92 cm: Medium bluish gray clay
5B 5/1	92-192 cm: Medium bluish gray homogeneous clay; pale orange (10YR 8/2) clayey layers at 109-111 cm and 162-165 cm
5B 5/1	192-292 cm: Medium bluish gray homogeneous clay; pale orange (10YR 8/2) clayey layers at 229.5-230.5cm and 275-275.5 cm; organic-rich layers at 255cm and 288 cm (up to 2 mm thick)
5B 5/1	292-392 cm: Medium bluish gray homogeneous clay; pale orange (10YR 8/2) clayey layers at 304-305 cm, 333-334 cm and 372-372.5 cm
5B 5/1	392-490 cm: Medium bluish gray homogeneous clay; pale orange (10YR 8/2) clayey layers at 400-401 cm, 420-422 cm, 432.436 cm, 452-453 cm and 464-468 cm

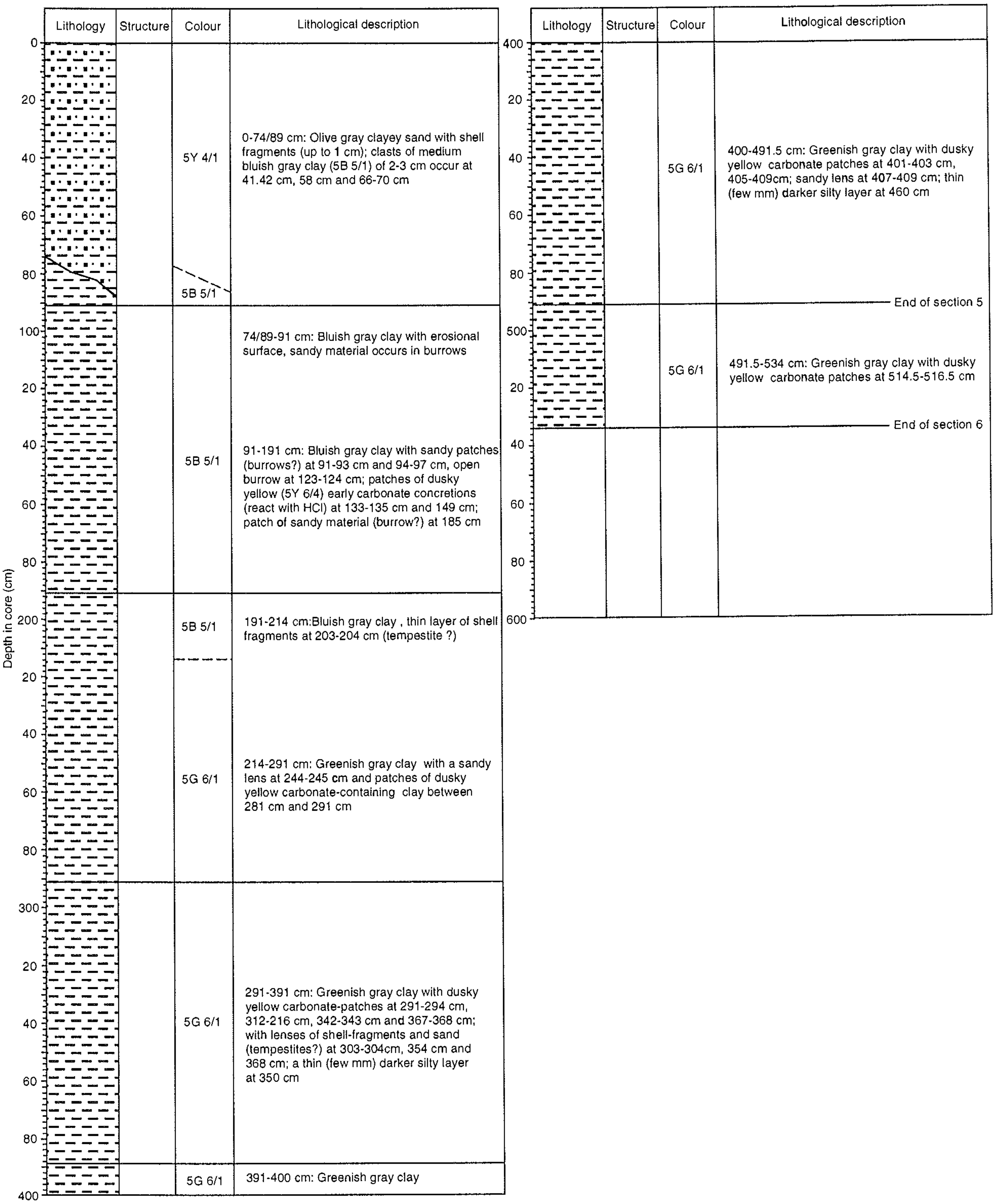




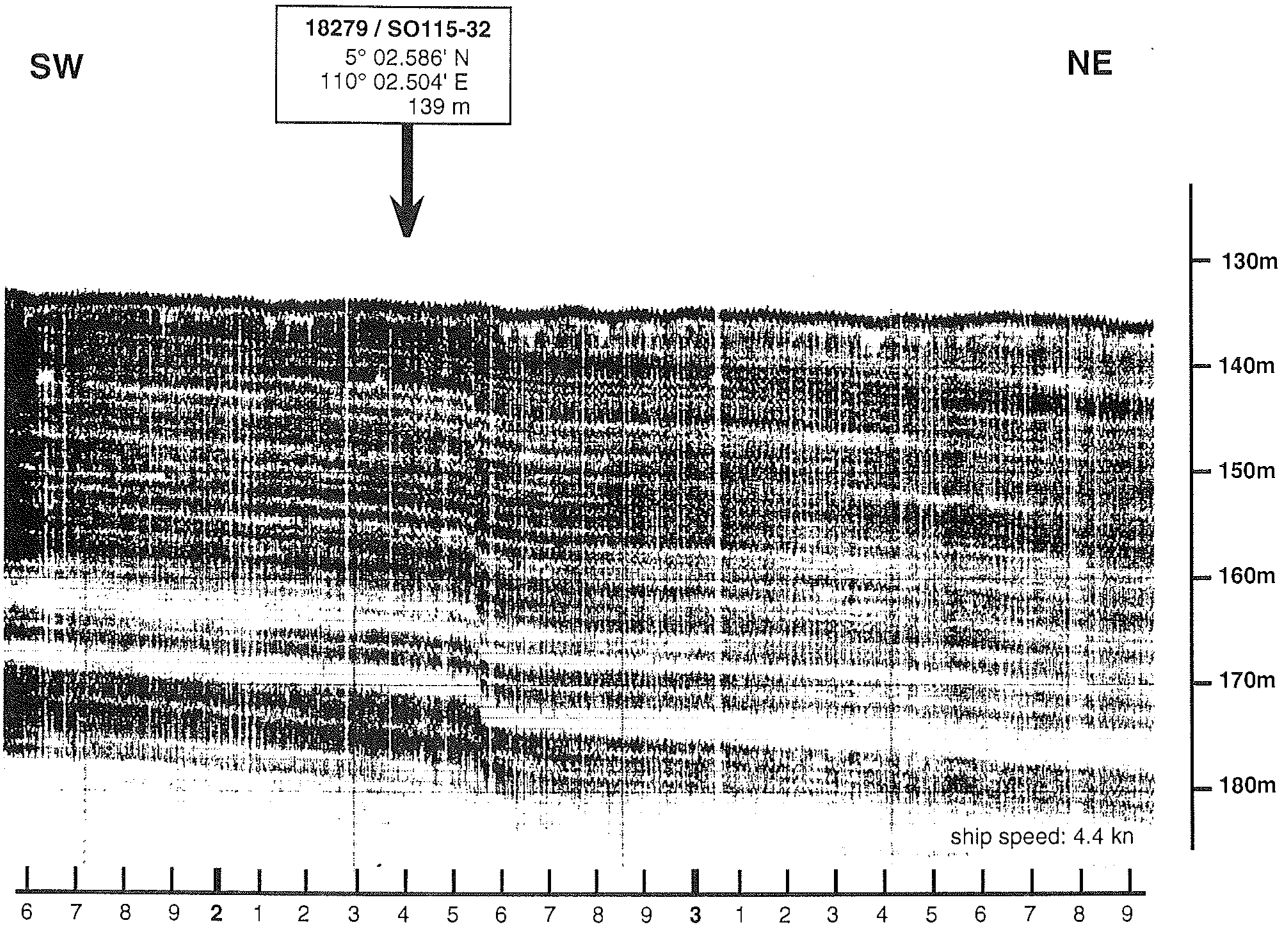
Objectives:
Coring the landward termination of a prominent onlap structure and continuation of the shelf-slope transect.
Combined with the previous and following stations a longer stratigraphic record of the pre-erosional sedimentation is cored as a composite section.

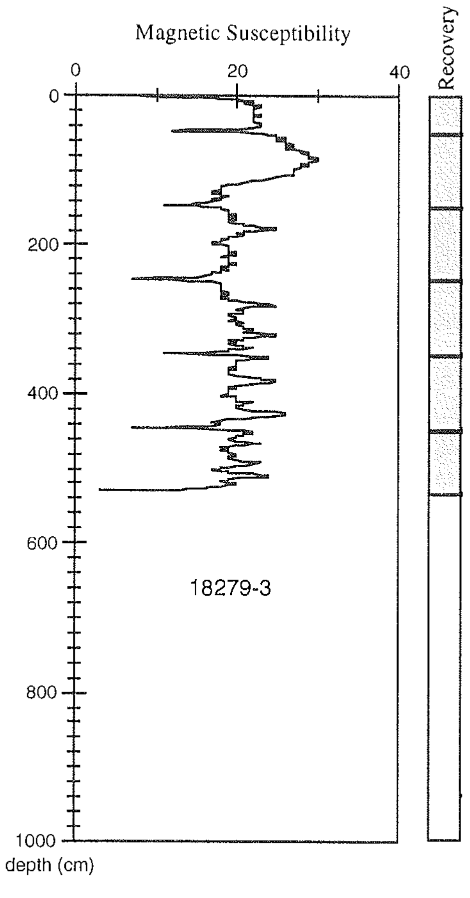
SONNE-115 **Water depth: 137 m**
Station: SO-115-31
Position: 5° 01.046 N; 110° 01.015 E

Core: SL 18278-3 **Recovery: 534 cm**



Colour	Lithological description
5Y 4/1 5B 5/1	0-74/89 cm: Olive gray clayey sand with shell fragments (up to 1 cm); clasts of medium bluish gray clay (5B 5/1) of 2-3 cm occur at 41.42 cm, 58 cm and 66-70 cm
5B 5/1	74/89-91 cm: Bluish gray clay with erosional surface, sandy material occurs in burrows 91-191 cm: Bluish gray clay with sandy patches (burrows?) at 91-93 cm and 94-97 cm, open burrow at 123-124 cm; patches of dusky yellow (5Y 6/4) early carbonate concretions (react with HCl) at 133-135 cm and 149 cm; patch of sandy material (burrow?) at 185 cm
5B 5/1 5G 6/1	191-214 cm:Bluish gray clay , thin layer of shell fragments at 203-204 cm (tempestite ?) 214-291 cm: Greenish gray clay with a sandy lens at 244-245 cm and patches of dusky yellow carbonate-containing clay between 281 cm and 291 cm
5G 6/1	291-391 cm: Greenish gray clay with dusky yellow carbonate-patches at 291-294 cm, 312-216 cm, 342-343 cm and 367-368 cm; with lenses of shell-fragments and sand (tempestites?) at 303-304cm, 354 cm and 368 cm; a thin (few mm) darker silty layer at 350 cm
5G 6/1	391-400 cm: Greenish gray clay
5G 6/1	400-491.5 cm: Greenish gray clay with dusky yellow carbonate patches at 401-403 cm, 405-409cm; sandy lens at 407-409 cm; thin (few mm) darker silty layer at 460 cm
5G 6/1	491.5-534 cm: Greenish gray clay with dusky yellow carbonate patches at 514.5-516.5 cm

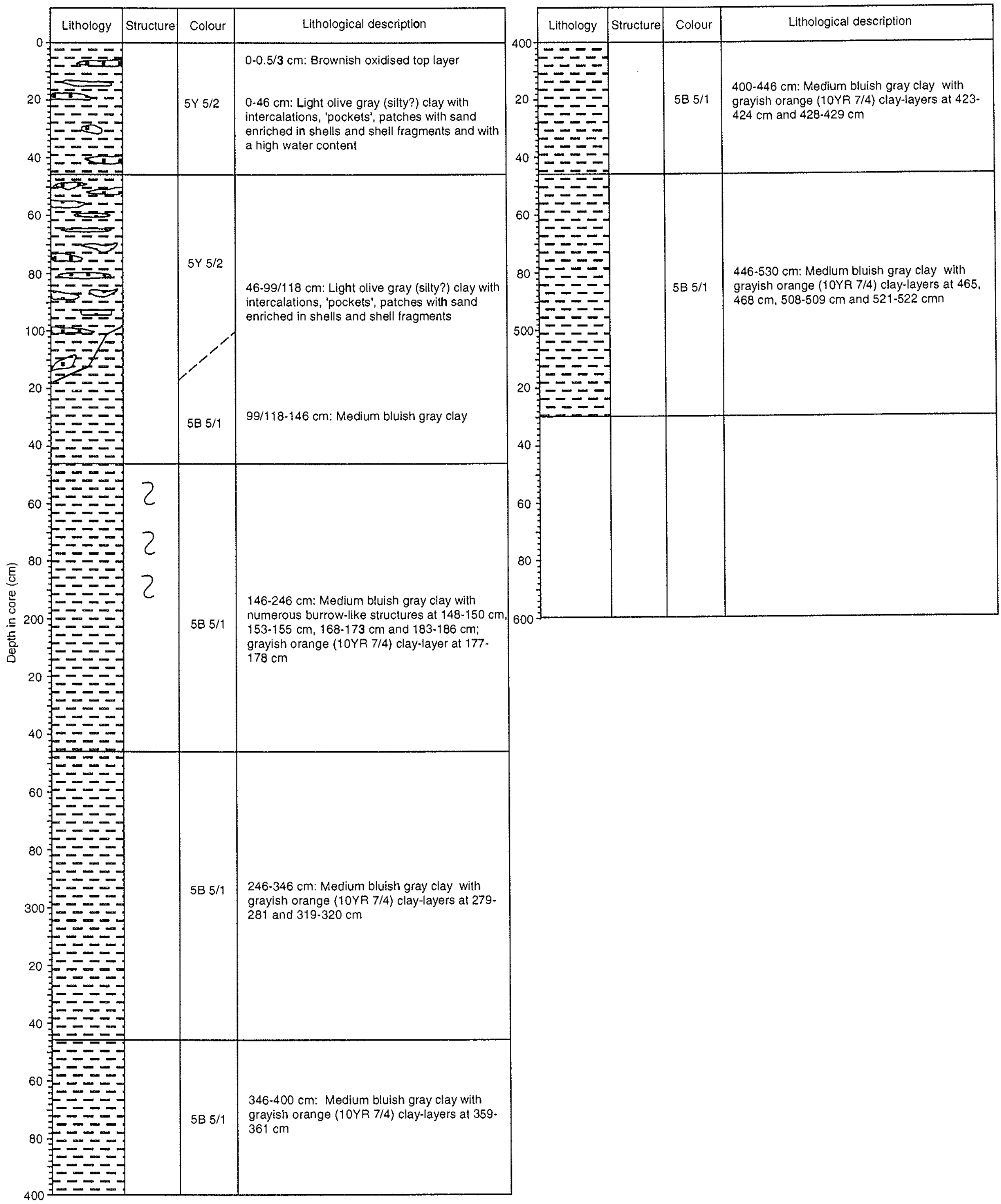




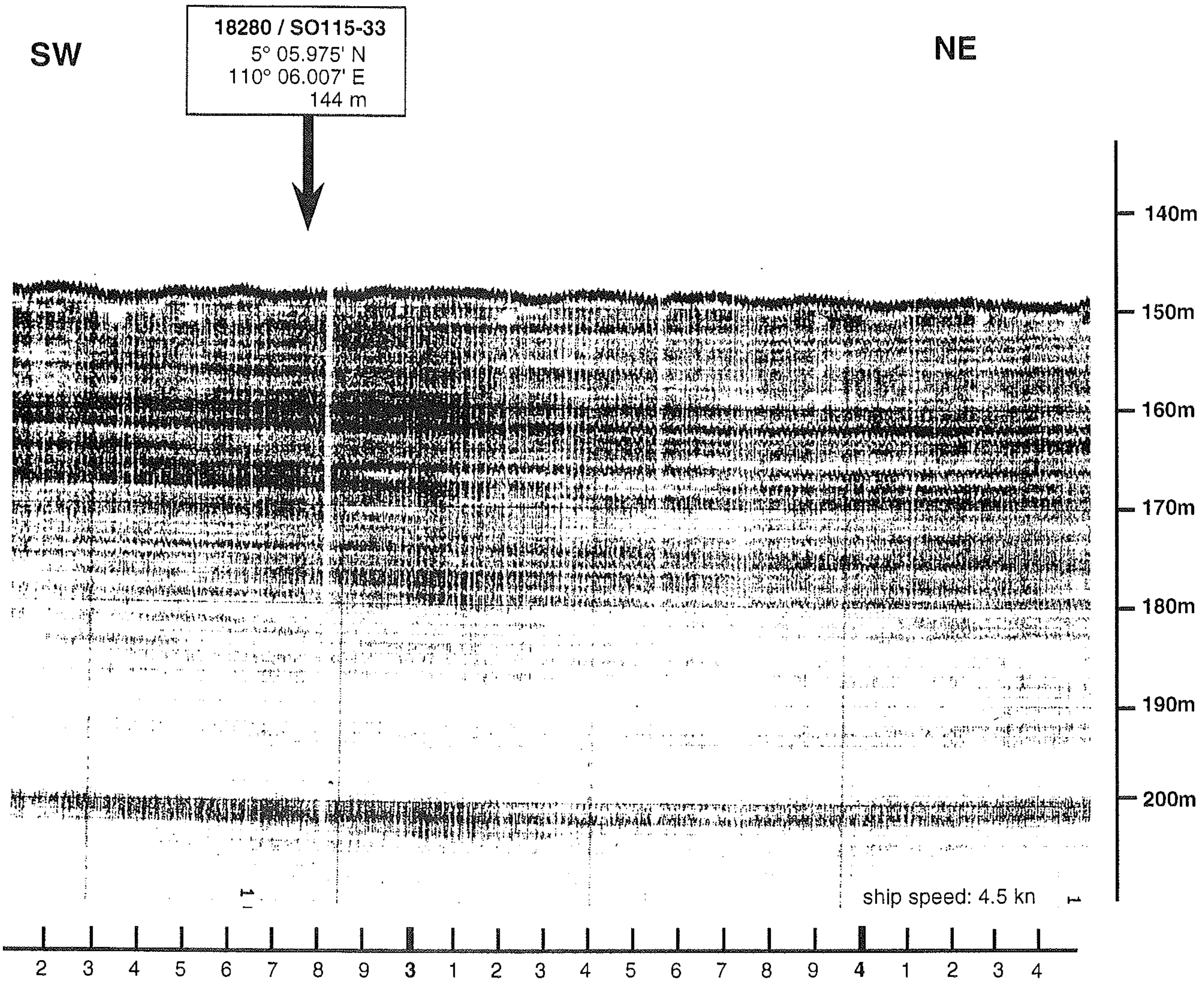
Objectives:
Continuation of the prominent onlap structure (station SO-115-31) bounded by a vertical fault NE of the coring position.
Combined with the previous and following stations a longer stratigraphic record of the pre-erosional sedimentation is cored as a composite section.

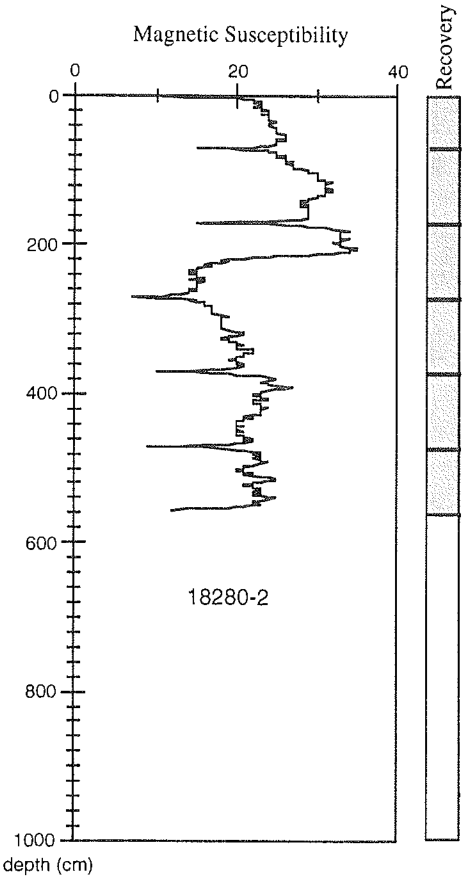
SONNE-115 **Water depth: 140 m**
Station: SO-115-32
Position: 5° 02.584 N; 110° 02.562 E

Core: SL 18279-3 **Recovery: 530 cm**



Lithology	Structure	Colour	Lithological description
		5Y 5/2	0-0.5/3 cm: Brownish oxidised top layer 0-46 cm: Light olive gray (silty?) clay with intercalations, 'pockets', patches with sand enriched in shells and shell fragments and with a high water content
		5Y 5/2	46-99/118 cm: Light olive gray (silty?) clay with intercalations, 'pockets', patches with sand enriched in shells and shell fragments
		5B 5/1	99/118-146 cm: Medium bluish gray clay
		5B 5/1	146-246 cm: Medium bluish gray clay with numerous burrow-like structures at 148-150 cm, 153-155 cm, 168-173 cm and 183-186 cm; grayish orange (10YR 7/4) clay-layer at 177-178 cm
		5B 5/1	246-346 cm: Medium bluish gray clay with grayish orange (10YR 7/4) clay-layers at 279-281 and 319-320 cm
		5B 5/1	346-400 cm: Medium bluish gray clay with grayish orange (10YR 7/4) clay-layers at 359-361 cm
		5B 5/1	400-446 cm: Medium bluish gray clay with grayish orange (10YR 7/4) clay-layers at 423-424 cm and 428-429 cm
		5B 5/1	446-530 cm: Medium bluish gray clay with grayish orange (10YR 7/4) clay-layers at 465, 468 cm, 508-509 cm and 521-522 cmn

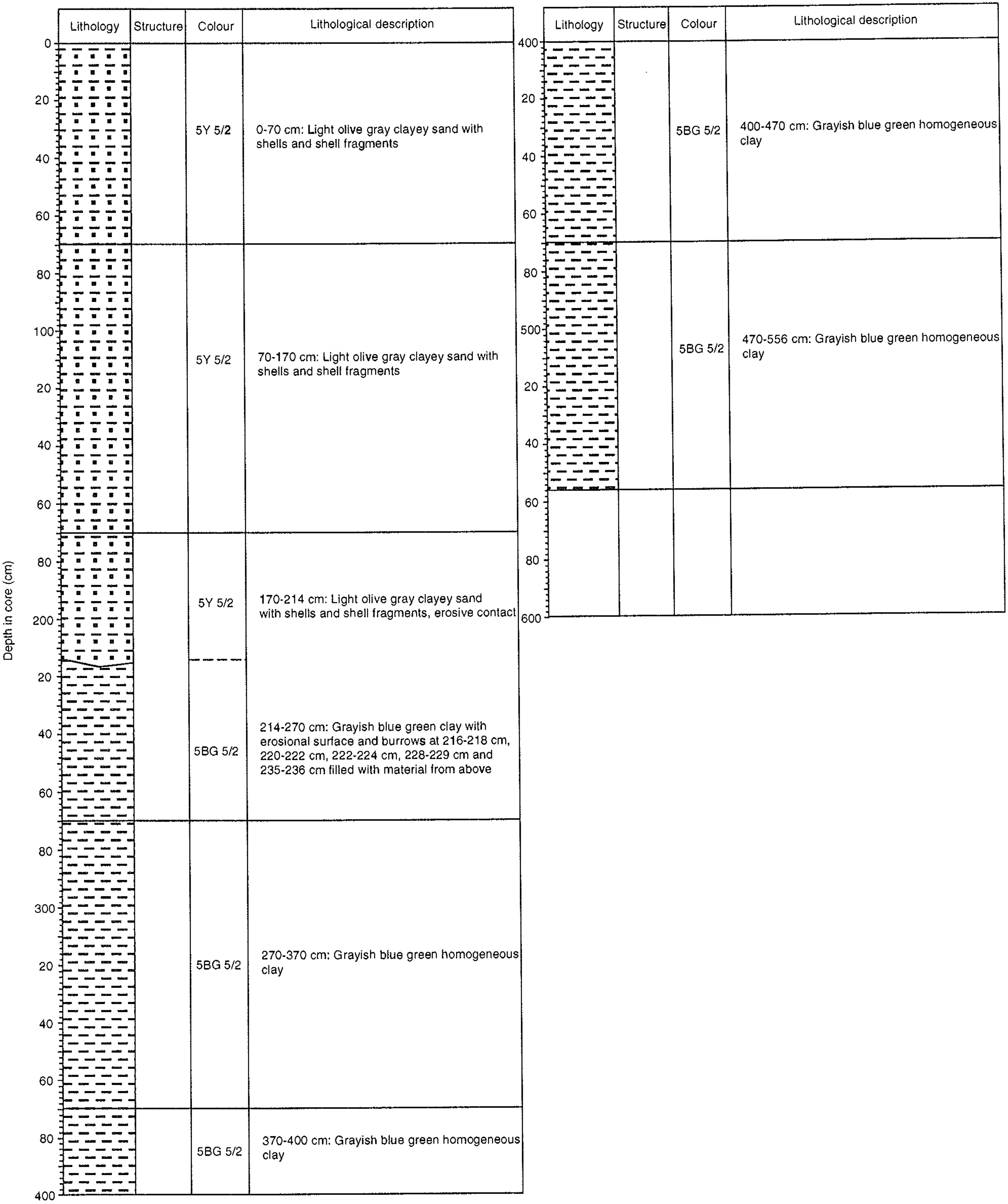




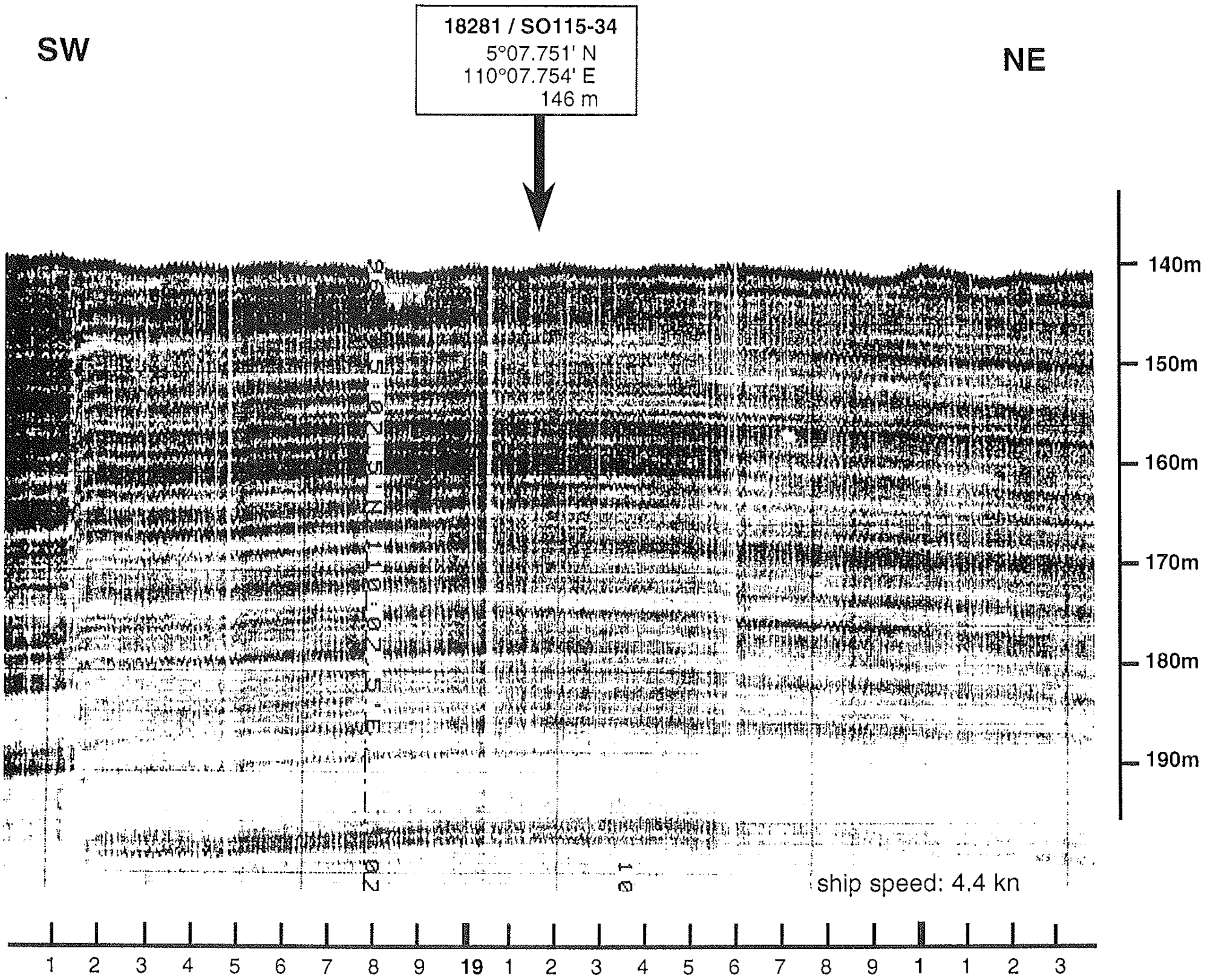
Objectives:
Continuation of the shelf-slope transect.
Combined with the previous and following stations a longer stratigraphic record of the pre-erosional sedimentation is cored as a composite section.
A significant change in magnetic susceptibility records and sediment composition from sand to clay is observed at 220 cm below seafloor, which probably correponds to the base of the wavy top layer (sediment waves) of the parasound record.

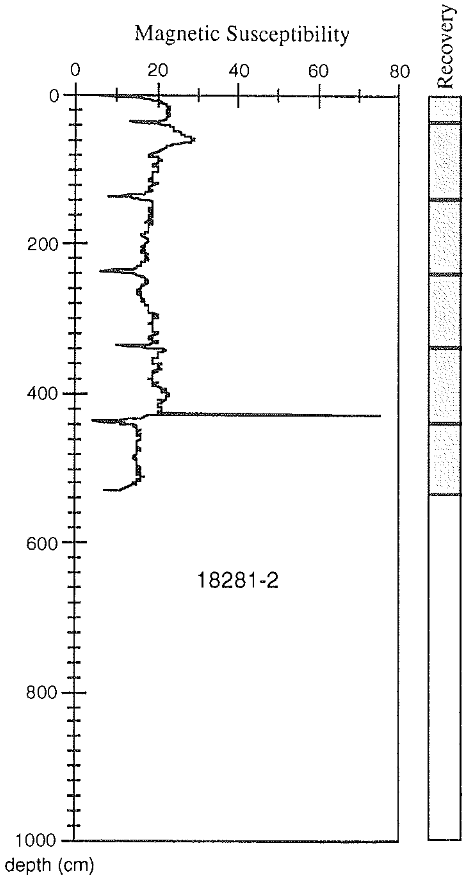
SONNE-115 **Water depth: 144 m**
Station: SO-115-33
Position: 5° 06.007 N; 110° 05.939 E

Core: SL 18280-2 **Recovery: 556 cm**



Lithology	Structure	Colour	Lithological description
		5Y 5/2	0-70 cm: Light olive gray clayey sand with shells and shell fragments
		5Y 5/2	70-170 cm: Light olive gray clayey sand with shells and shell fragments
		5Y 5/2	170-214 cm: Light olive gray clayey sand with shells and shell fragments, erosive contact
		5BG 5/2	214-270 cm: Grayish blue green clay with erosional surface and burrows at 216-218 cm, 220-222 cm, 222-224 cm, 228-229 cm and 235-236 cm filled with material from above
		5BG 5/2	270-370 cm: Grayish blue green homogeneous clay
		5BG 5/2	370-400 cm: Grayish blue green homogeneous clay
		5BG 5/2	400-470 cm: Grayish blue green homogeneous clay
		5BG 5/2	470-556 cm: Grayish blue green homogeneous clay



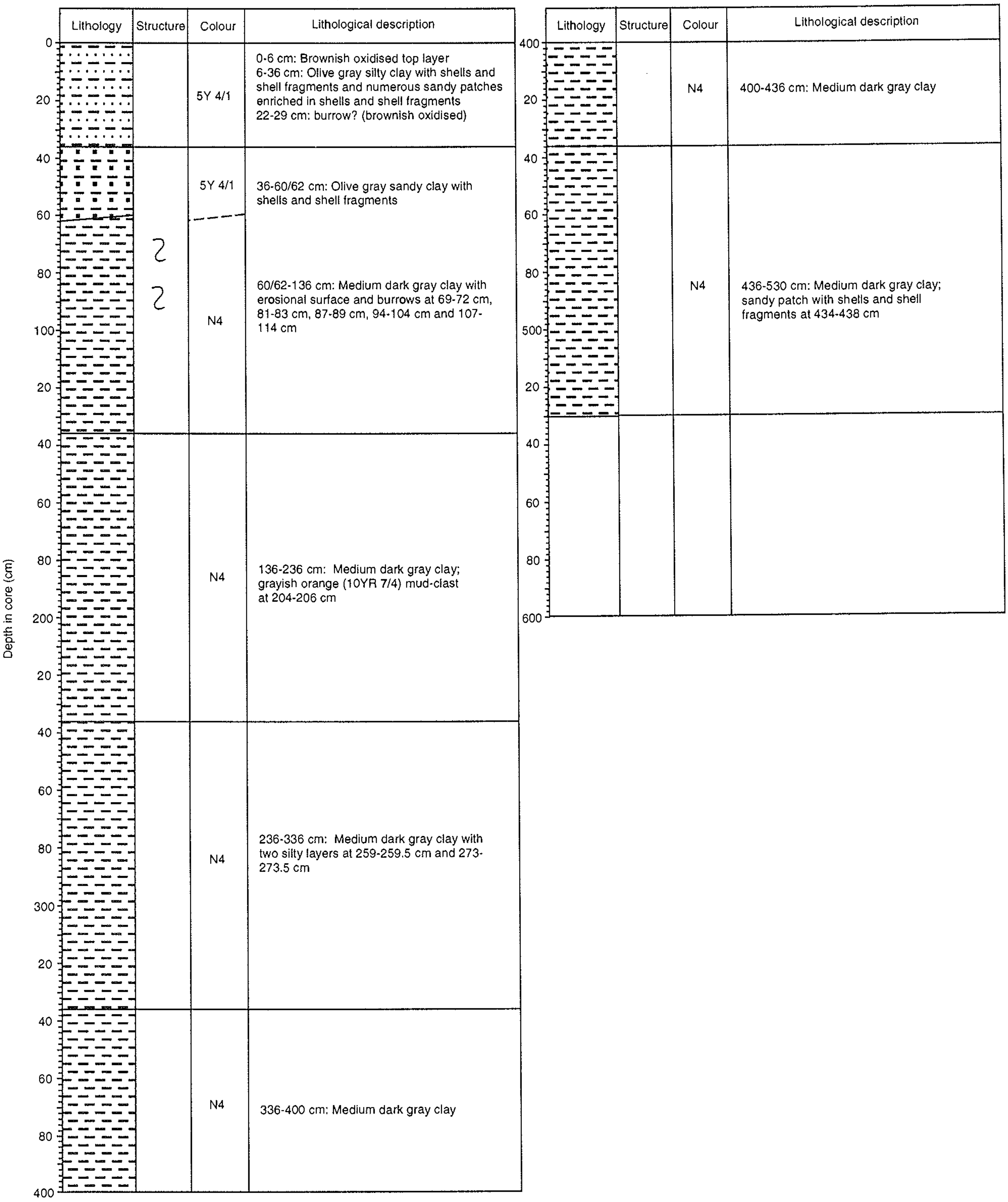


Objectives:

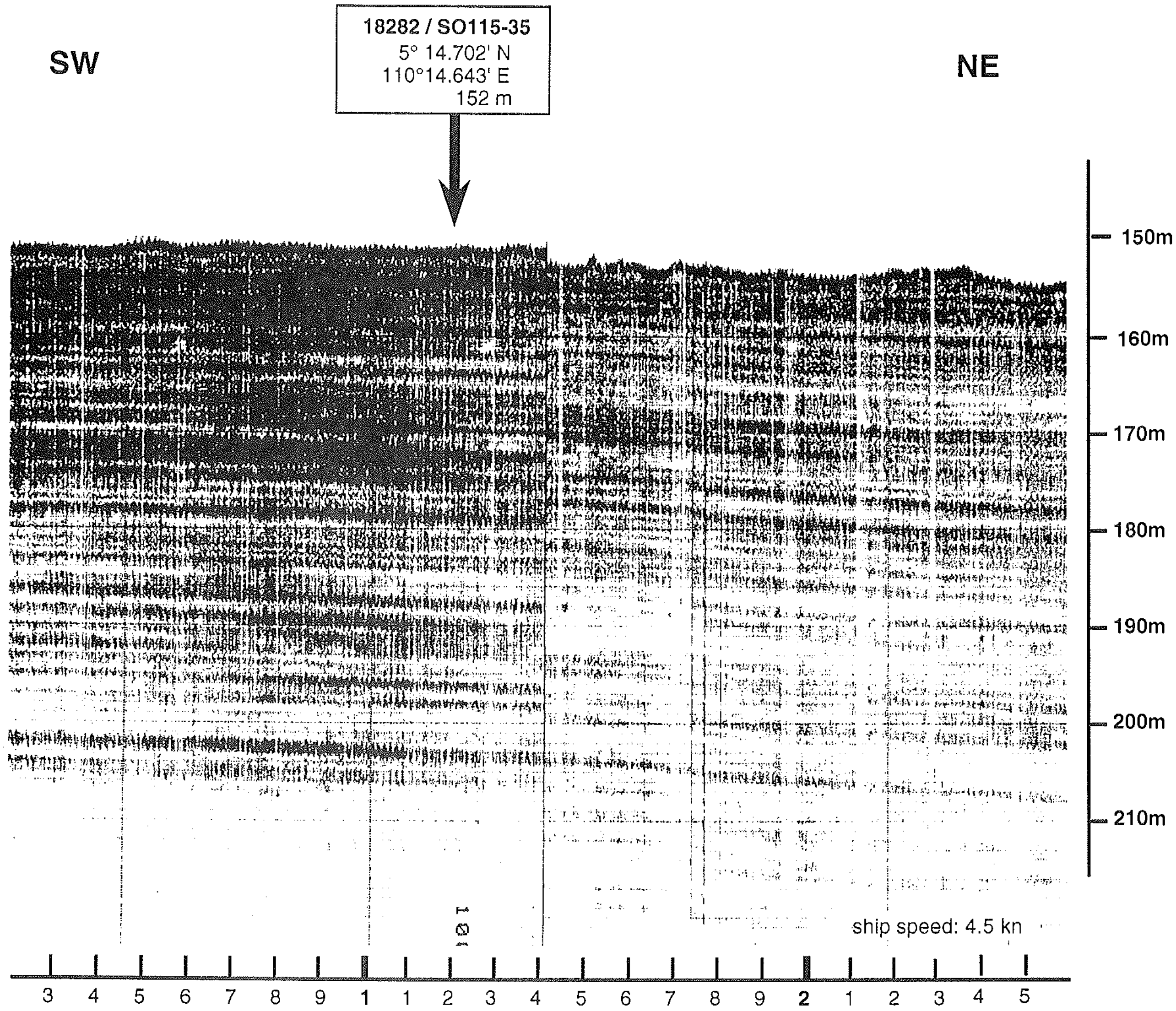
Coring of the center of a smooth antiform structure bounded by a vertical fault in the SW and continuation of the shelf-slope transect.
Combined with the previous and following stations a longer stratigraphic record of the pre-erosional sedimentation is cored as a composite section.
The parasound penetration in this part of the transect is unusually deep.

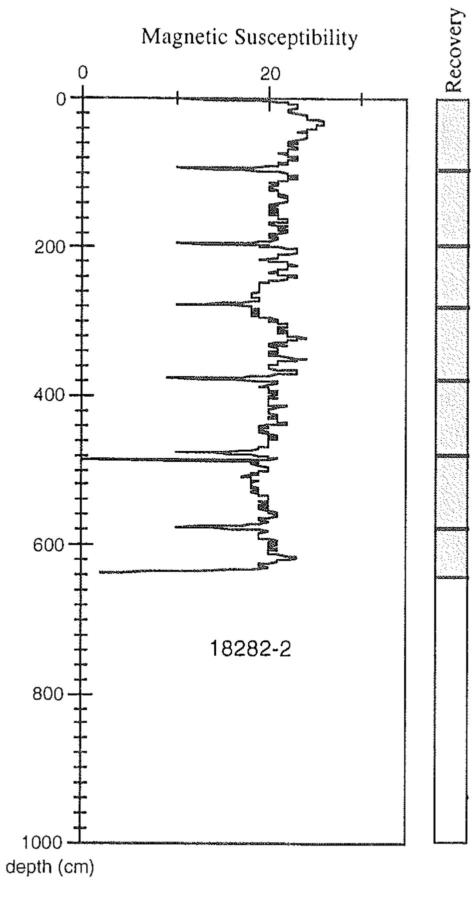
SONNE-115 **Water depth: 146 m**
Station:SO-115-34
Position: 5° 07.805 N; 110° 07.769 E

Core: SL 18281-2 **Recovery: 530 cm**



Lithology	Structure	Colour	Lithological description
		5Y 4/1	0-6 cm: Brownish oxidised top layer 6-36 cm: Olive gray silty clay with shells and shell fragments and numerous sandy patches enriched in shells and shell fragments 22-29 cm: burrow? (brownish oxidised)
		5Y 4/1	36-60/62 cm: Olive gray sandy clay with shells and shell fragments
		N4	60/62-136 cm: Medium dark gray clay with erosional surface and burrows at 69-72 cm, 81-83 cm, 87-89 cm, 94-104 cm and 107-114 cm
		N4	136-236 cm: Medium dark gray clay; grayish orange (10YR 7/4) mud-clast at 204-206 cm
		N4	236-336 cm: Medium dark gray clay with two silty layers at 259-259.5 cm and 273-273.5 cm
		N4	336-400 cm: Medium dark gray clay
		N4	400-436 cm: Medium dark gray clay
		N4	436-530 cm: Medium dark gray clay; sandy patch with shells and shell fragments at 434-438 cm

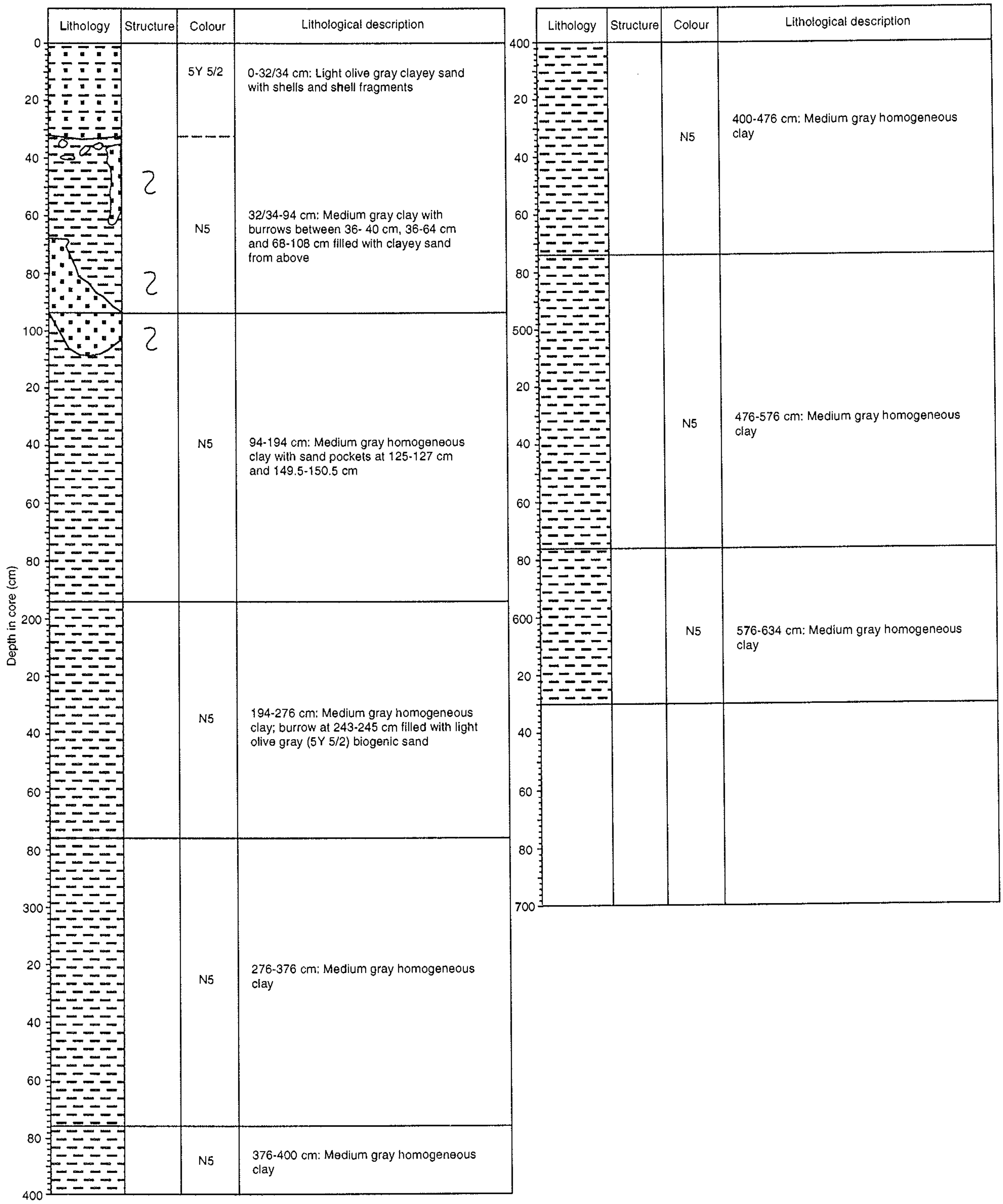




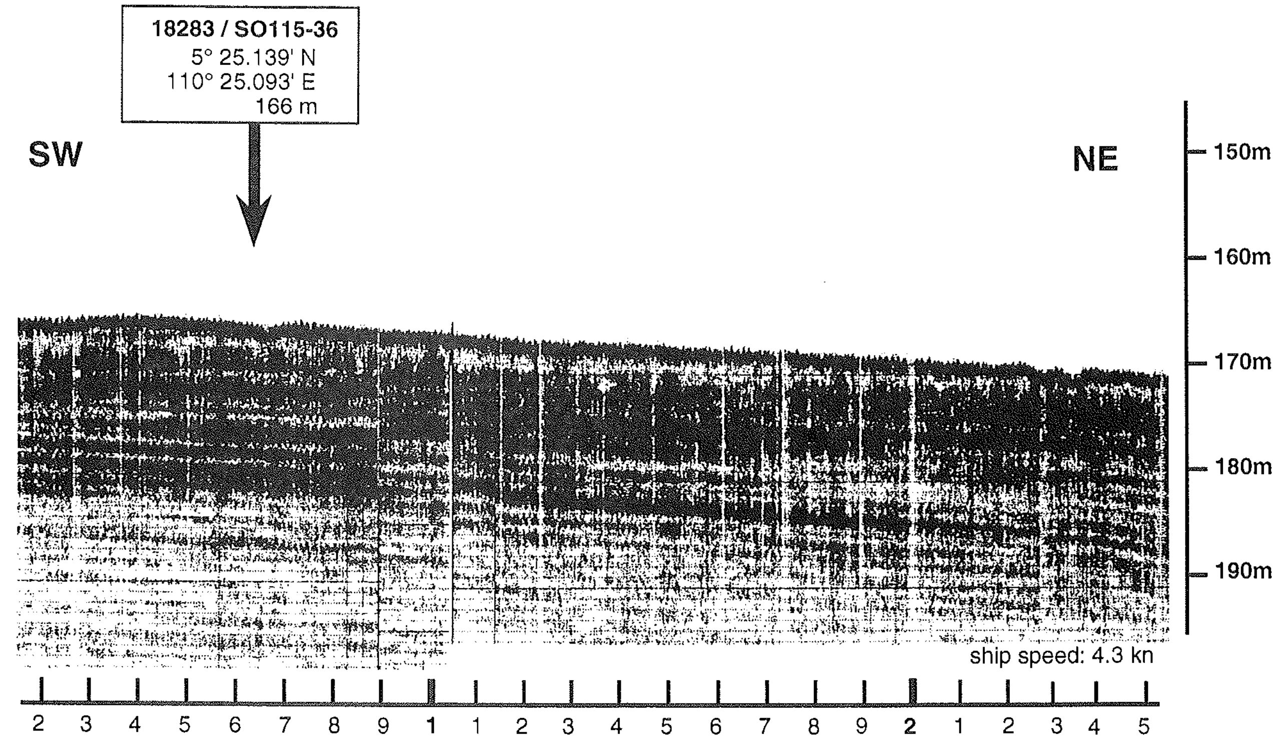
Objectives:
Coring of a morphologically slightly elevated block bounded by vertical faults and continuation of the shelf-slope transect.
Combined with the previous and following stations a longer stratigraphic record of the pre-erosional sedimentation is cored as a composite section.
The parasound penetration in this part of the transect is unusually deep.

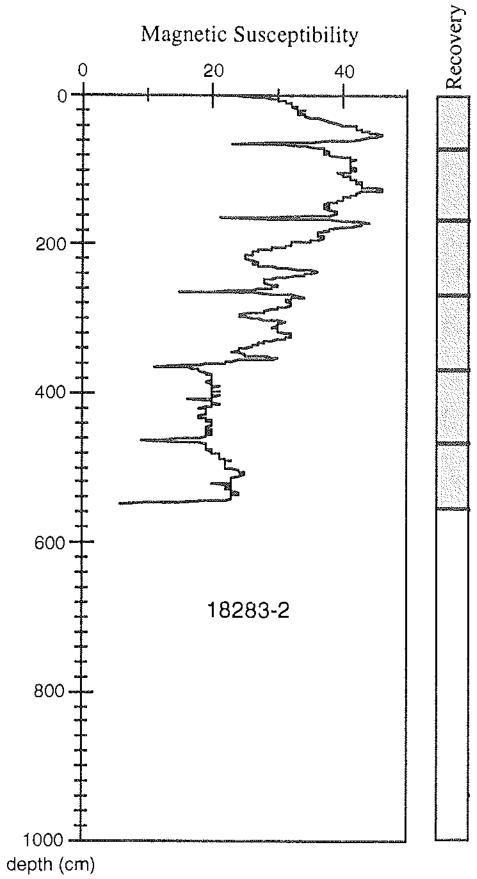
SONNE-115	**Water depth: 151 m**
Station: SO-115-35	
Position: 5° 14.687 N; 110° 14.605 E	

Core: SL 18282-2	**Recovery: 634 cm**



Colour	Lithological description
5Y 5/2	0-32/34 cm: Light olive gray clayey sand with shells and shell fragments
N5	32/34-94 cm: Medium gray clay with burrows between 36- 40 cm, 36-64 cm and 68-108 cm filled with clayey sand from above
N5	94-194 cm: Medium gray homogeneous clay with sand pockets at 125-127 cm and 149.5-150.5 cm
N5	194-276 cm: Medium gray homogeneous clay; burrow at 243-245 cm filled with light olive gray (5Y 5/2) biogenic sand
N5	276-376 cm: Medium gray homogeneous clay
N5	376-400 cm: Medium gray homogeneous clay
N5	400-476 cm: Medium gray homogeneous clay
N5	476-576 cm: Medium gray homogeneous clay
N5	576-634 cm: Medium gray homogeneous clay

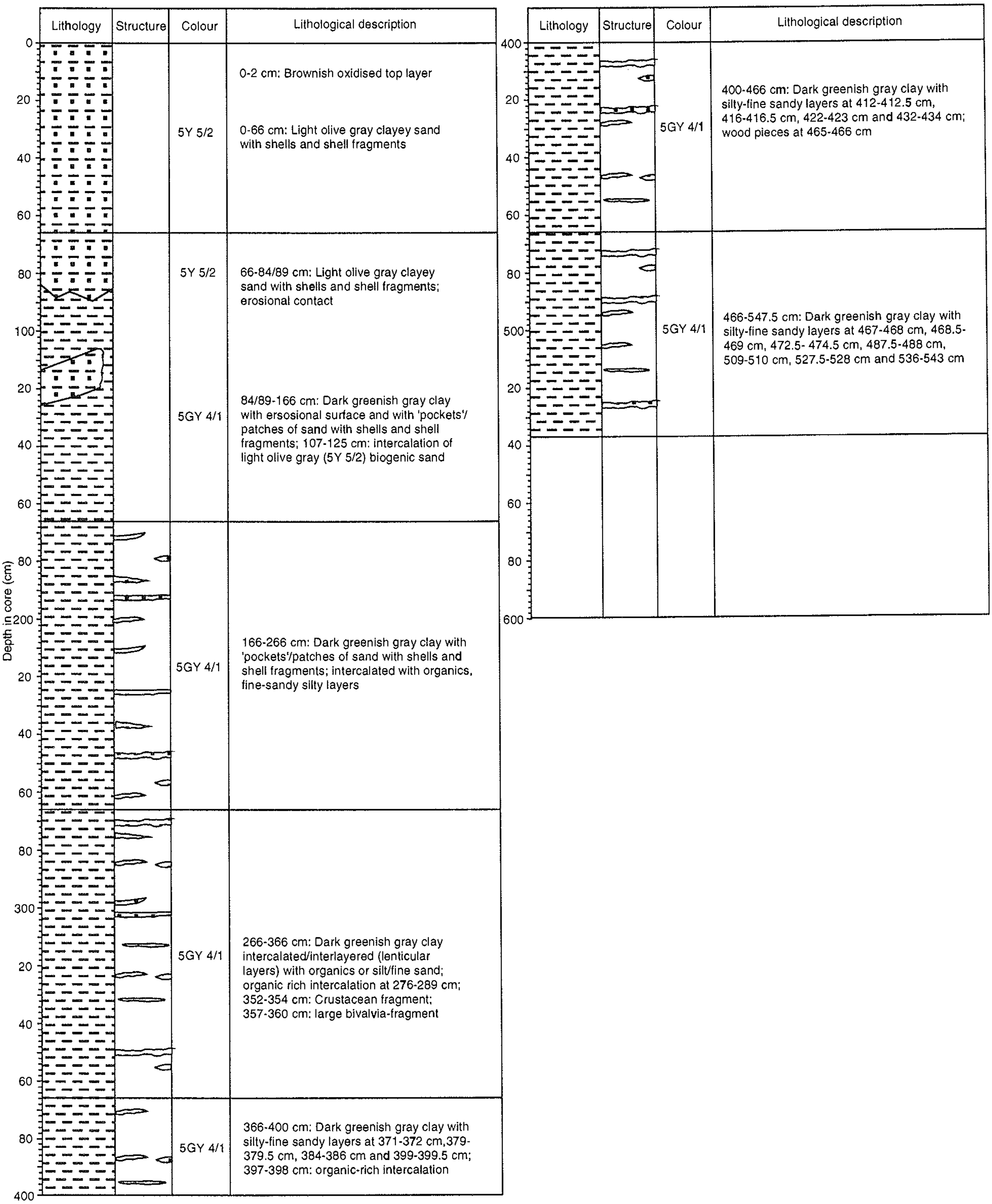




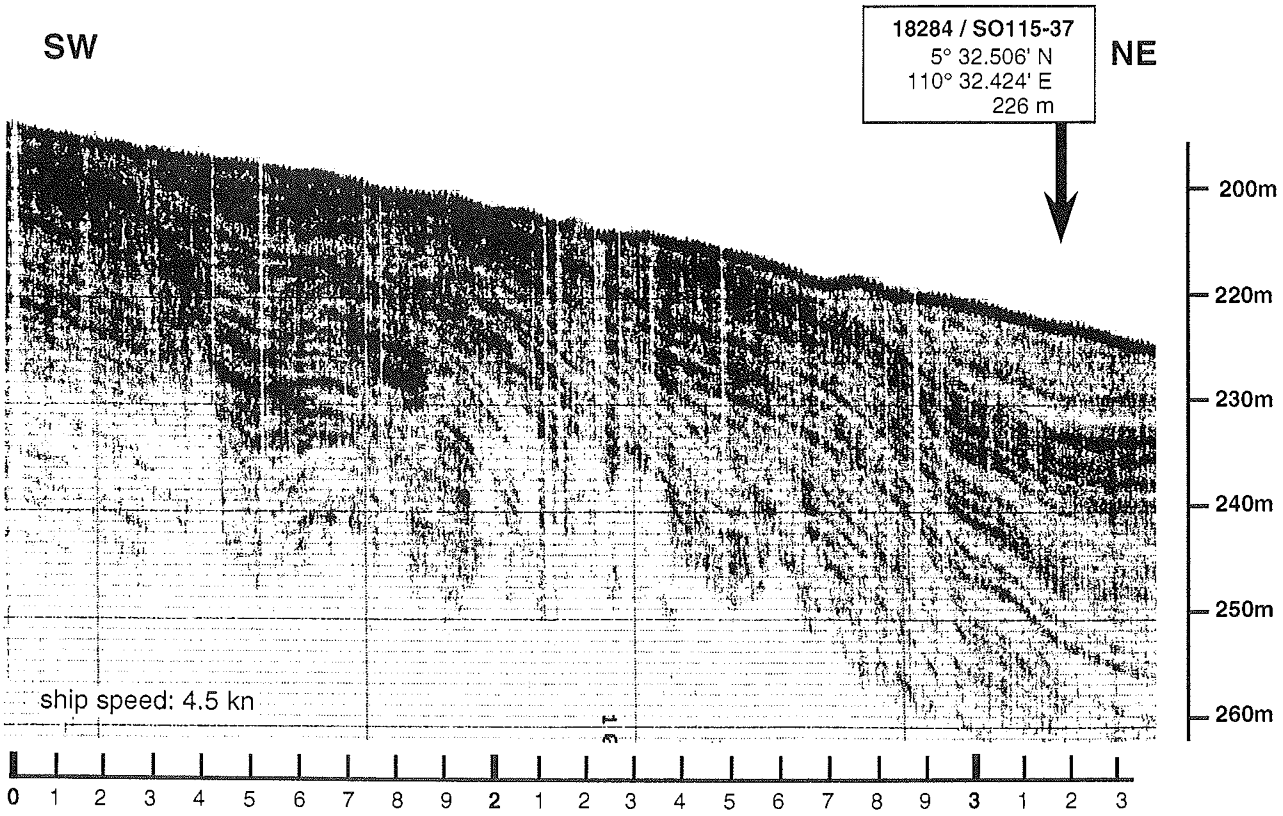
Objectives:
Coring of the transition to the shelf margin along the shelf-slope transect.
Combined with the previous and following stations a longer stratigraphic record of the pre-erosional sedimentation is cored as a composite section.

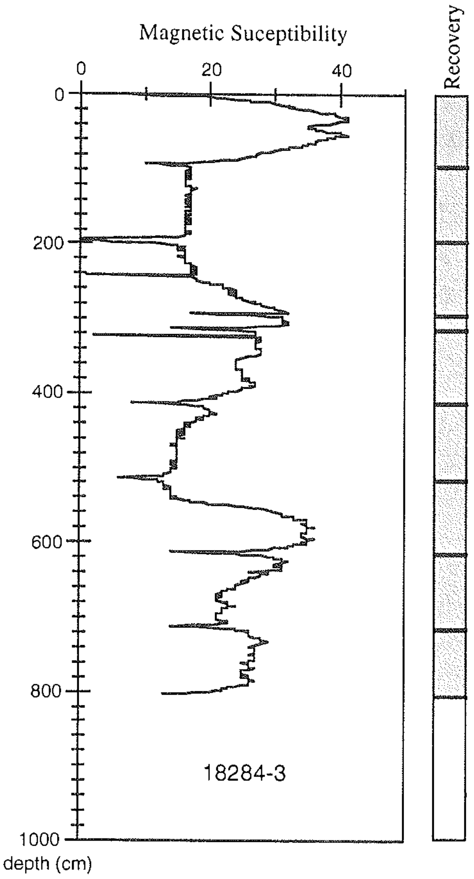
SONNE-115 **Water depth: 165 m**
Station: SO-115-36
Position: 5° 25.144 N; 110° 25.079 E

Core: SL 18283-2 **Recovery: 547.5 cm**



Colour	Lithological description
5Y 5/2	0-2 cm: Brownish oxidised top layer 0-66 cm: Light olive gray clayey sand with shells and shell fragments
5Y 5/2 5GY 4/1	66-84/89 cm: Light olive gray clayey sand with shells and shell fragments; erosional contact 84/89-166 cm: Dark greenish gray clay with ersosional surface and with 'pockets'/ patches of sand with shells and shell fragments; 107-125 cm: intercalation of light olive gray (5Y 5/2) biogenic sand
5GY 4/1	166-266 cm: Dark greenish gray clay with 'pockets'/patches of sand with shells and shell fragments; intercalated with organics, fine-sandy silty layers
5GY 4/1	266-366 cm: Dark greenish gray clay intercalated/interlayered (lenticular layers) with organics or silt/fine sand; organic rich intercalation at 276-289 cm; 352-354 cm: Crustacean fragment; 357-360 cm: large bivalvia-fragment
5GY 4/1	366-400 cm: Dark greenish gray clay with silty-fine sandy layers at 371-372 cm,379-379.5 cm, 384-386 cm and 399-399.5 cm; 397-398 cm: organic-rich intercalation
5GY 4/1	400-466 cm: Dark greenish gray clay with silty-fine sandy layers at 412-412.5 cm, 416-416.5 cm, 422-423 cm and 432-434 cm; wood pieces at 465-466 cm
5GY 4/1	466-547.5 cm: Dark greenish gray clay with silty-fine sandy layers at 467-468 cm, 468.5-469 cm, 472.5- 474.5 cm, 487.5-488 cm, 509-510 cm, 527.5-528 cm and 536-543 cm



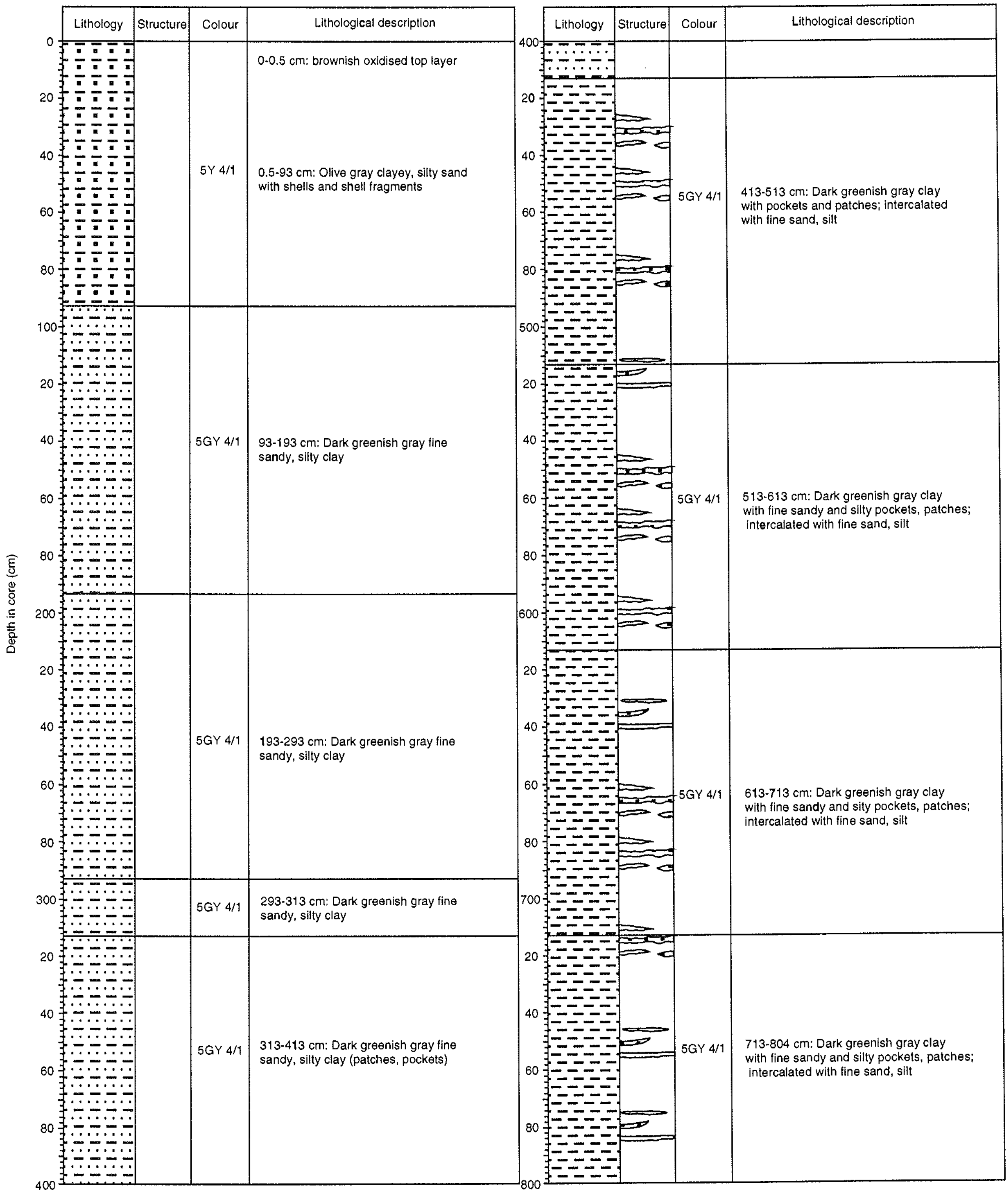


Objectives:

Coring a sediment-filled depression at the shelf-slope transition.

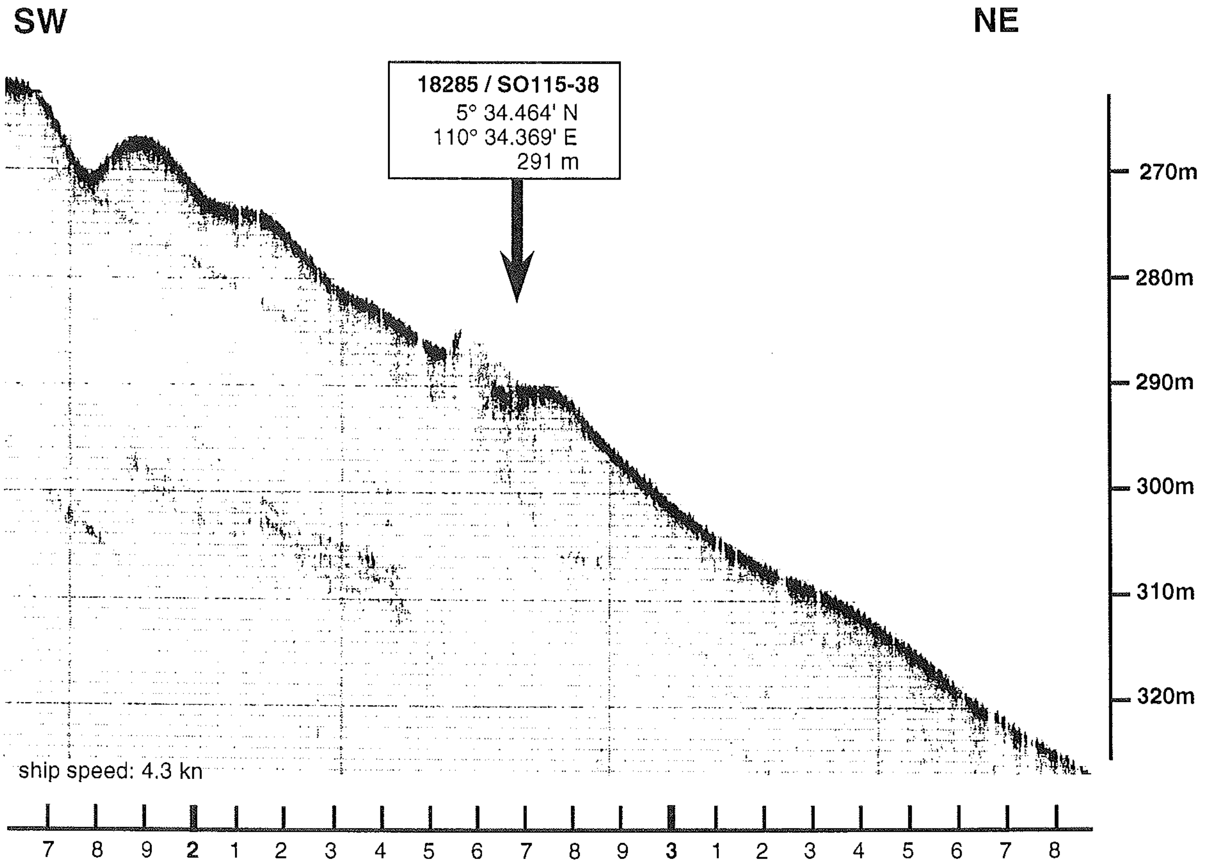
SONNE-115 **Water depth: 226 m**
Station: SO-115-37
Position: 5° 32.510 N; 110° 32.413 E

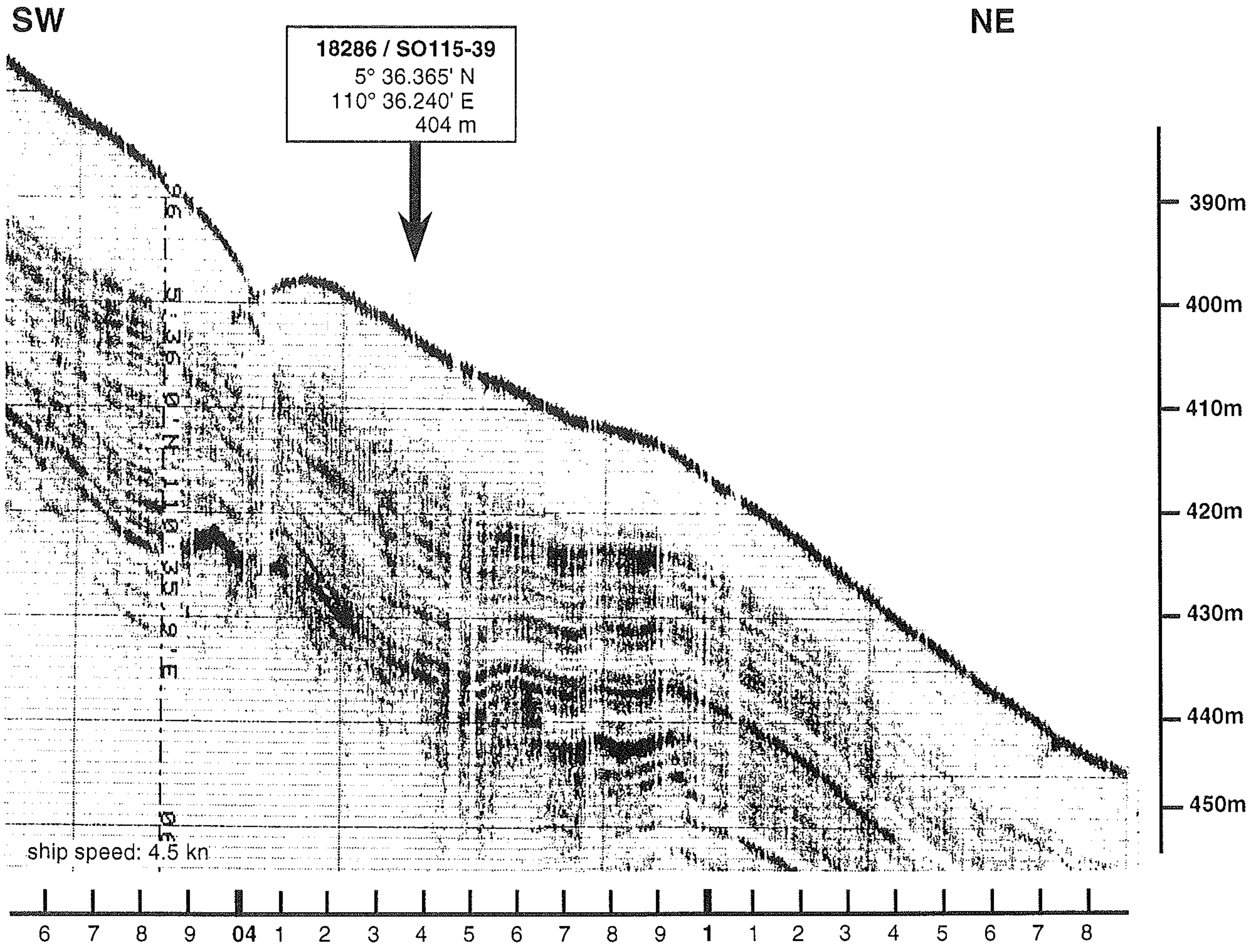
Core: SL 18284-3 **Recovery: 804 cm**



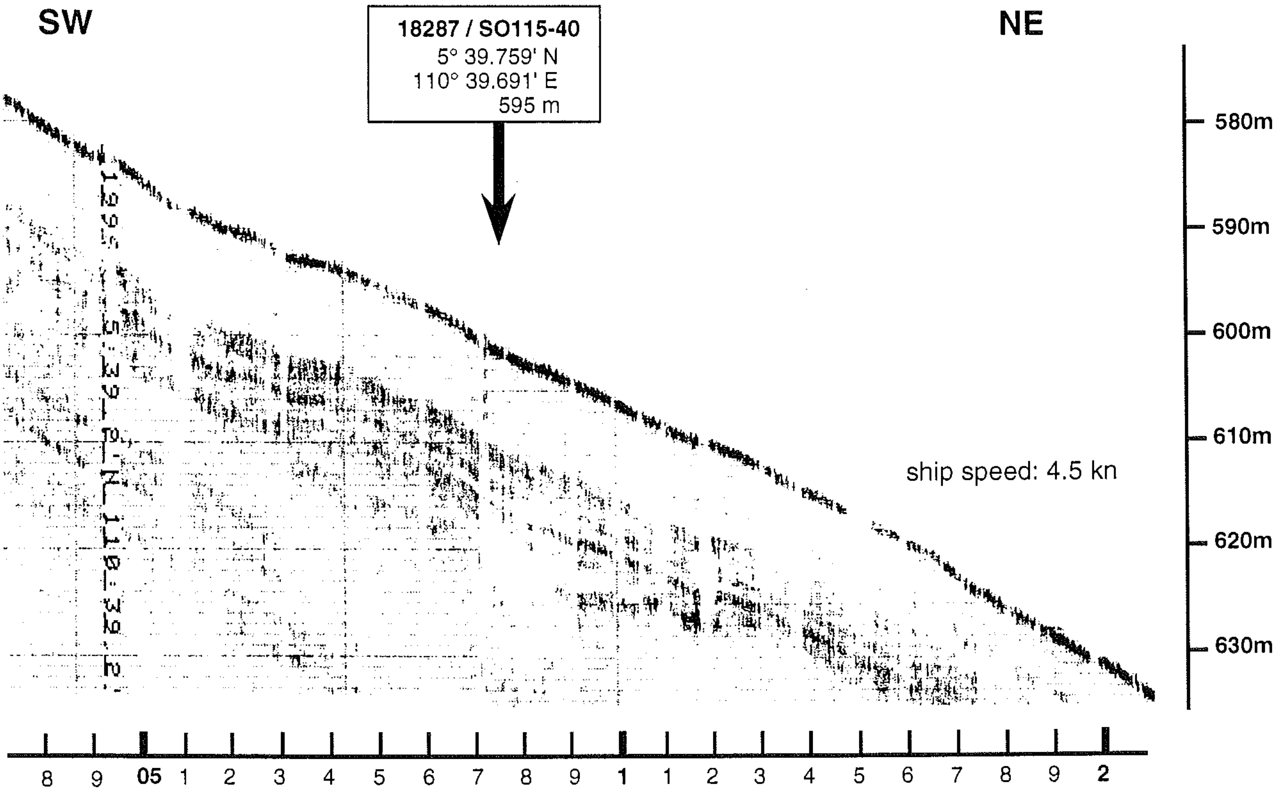
Lithology	Structure	Colour	Lithological description
			0-0.5 cm: brownish oxidised top layer
		5Y 4/1	0.5-93 cm: Olive gray clayey, silty sand with shells and shell fragments
		5GY 4/1	93-193 cm: Dark greenish gray fine sandy, silty clay
		5GY 4/1	193-293 cm: Dark greenish gray fine sandy, silty clay
		5GY 4/1	293-313 cm: Dark greenish gray fine sandy, silty clay
		5GY 4/1	313-413 cm: Dark greenish gray fine sandy, silty clay (patches, pockets)

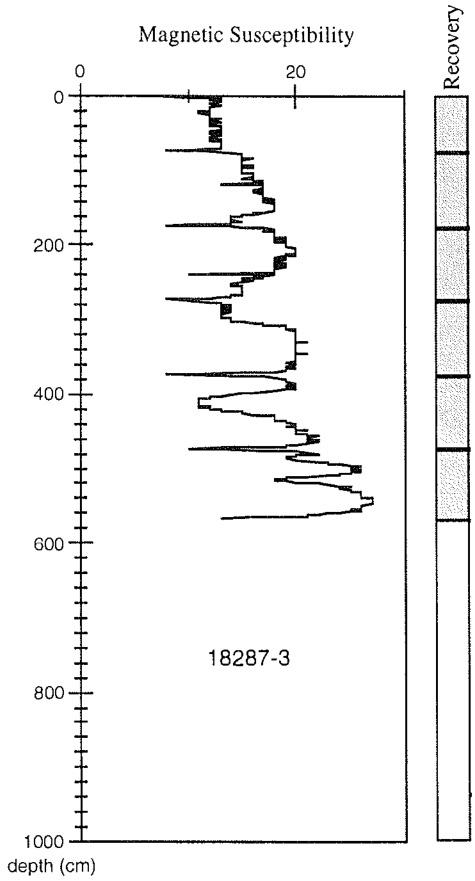
Lithology	Structure	Colour	Lithological description
		5GY 4/1	413-513 cm: Dark greenish gray clay with pockets and patches; intercalated with fine sand, silt
		5GY 4/1	513-613 cm: Dark greenish gray clay with fine sandy and silty pockets, patches; intercalated with fine sand, silt
		5GY 4/1	613-713 cm: Dark greenish gray clay with fine sandy and sity pockets, patches; intercalated with fine sand, silt
		5GY 4/1	713-804 cm: Dark greenish gray clay with fine sandy and silty pockets, patches; intercalated with fine sand, silt





Objectives: Sampling the surface sediment for a continuous sedimentologic and micropaleontologic depth transect of the continental slope. Undisturbed sediment -water interface samples were obtained with the multicorer

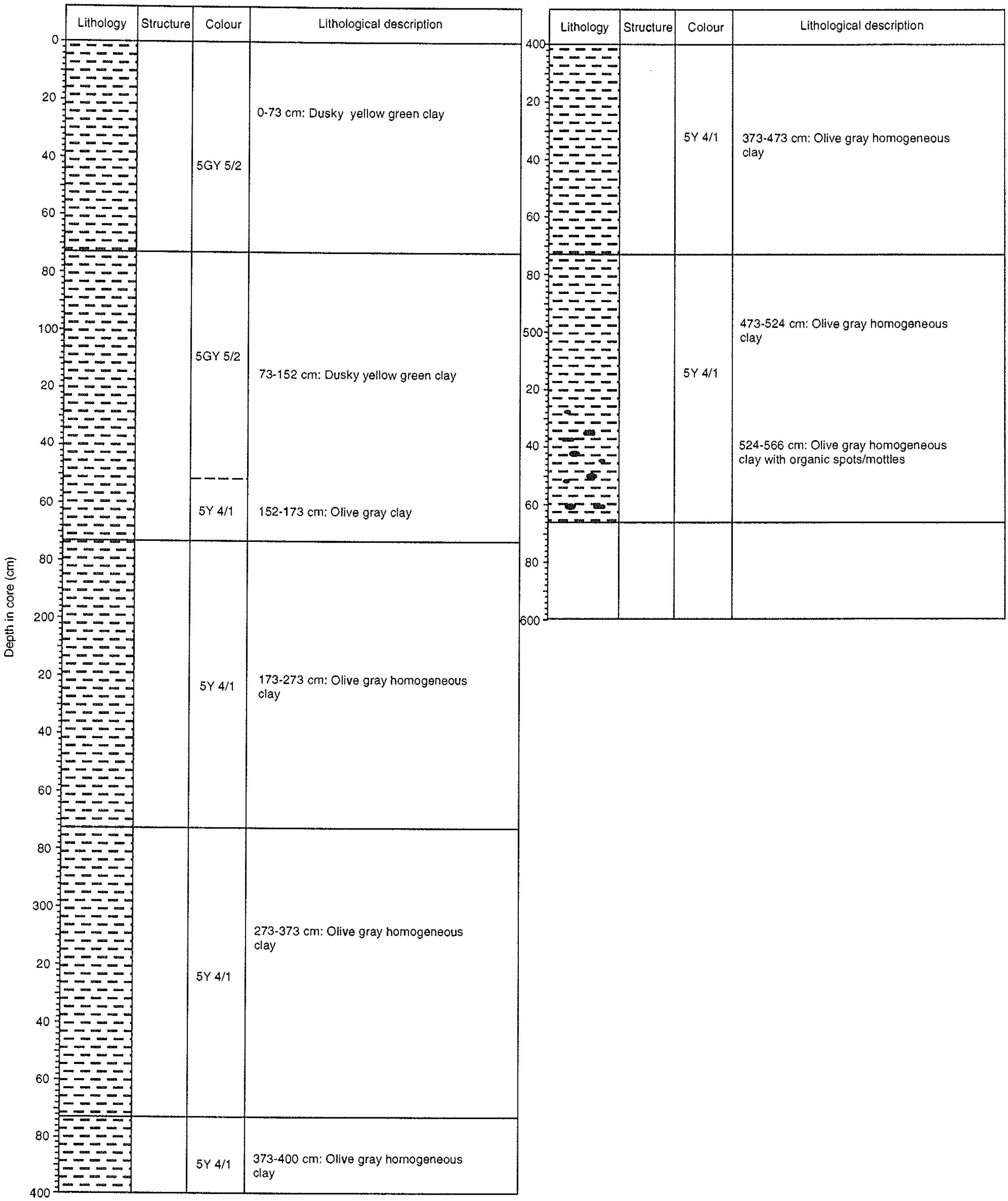




Objectives:
Sampling the surface sediment for a continuous sedimentologic and micropaleontologic depth transect of the continental slope. Undisturbed sediment - water interface samples were obtained with the multicorer.
Long stratigraphic reference core for comparison with the Vietnam slope.

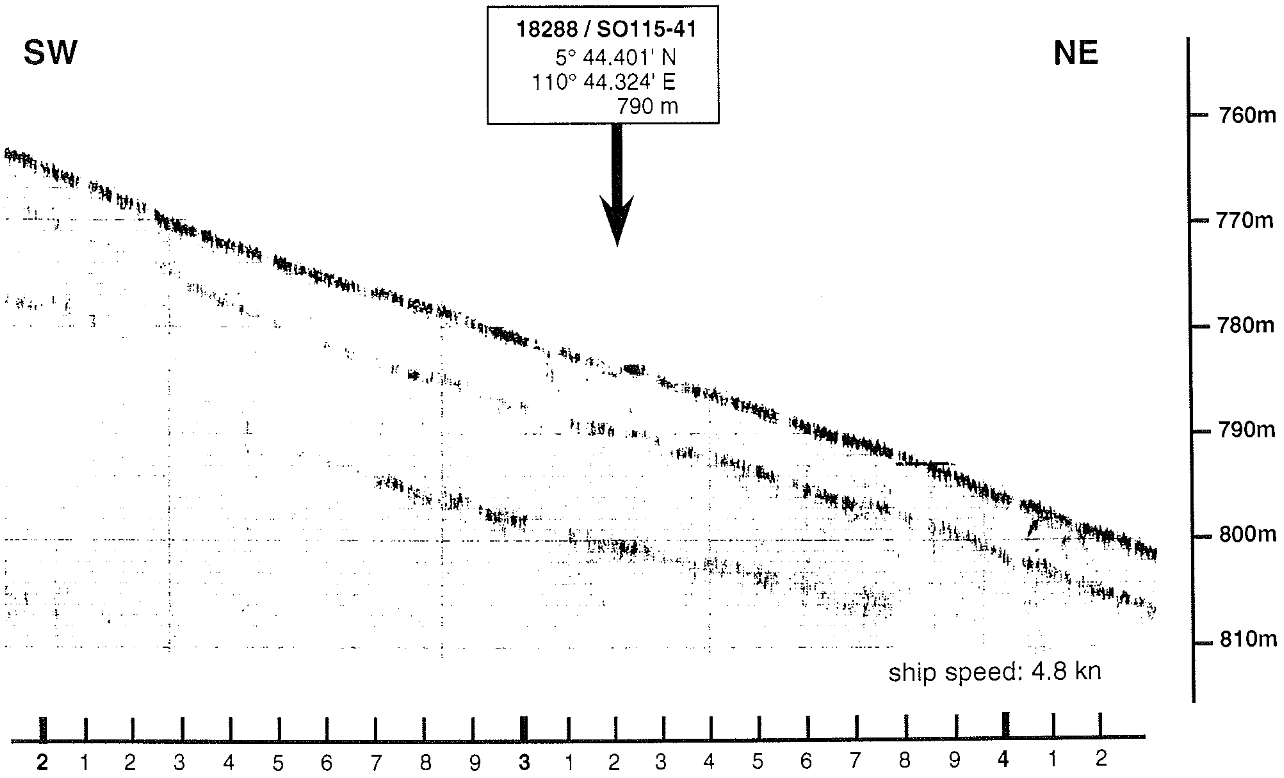
SONNE-115 **Water depth: 598 m**
Station: SO 115-40
Position: 5° 39.781 N; 110° 39.689 E

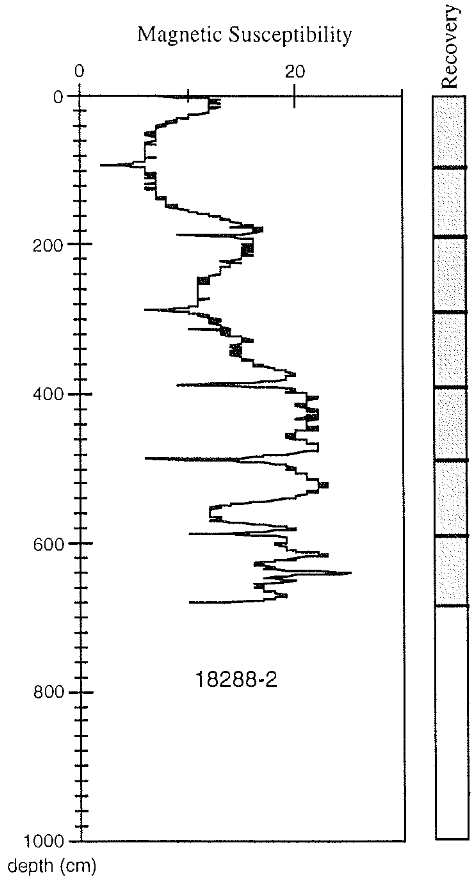
Core: SL 18287-3 **Recovery: 566 cm**



Lithology	Structure	Colour	Lithological description
		5GY 5/2	0-73 cm: Dusky yellow green clay
		5GY 5/2	73-152 cm: Dusky yellow green clay
		5Y 4/1	152-173 cm: Olive gray clay
		5Y 4/1	173-273 cm: Olive gray homogeneous clay
		5Y 4/1	273-373 cm: Olive gray homogeneous clay
		5Y 4/1	373-400 cm: Olive gray homogeneous clay

Lithology	Structure	Colour	Lithological description
		5Y 4/1	373-473 cm: Olive gray homogeneous clay
		5Y 4/1	473-524 cm: Olive gray homogeneous clay 524-566 cm: Olive gray homogeneous clay with organic spots/mottles

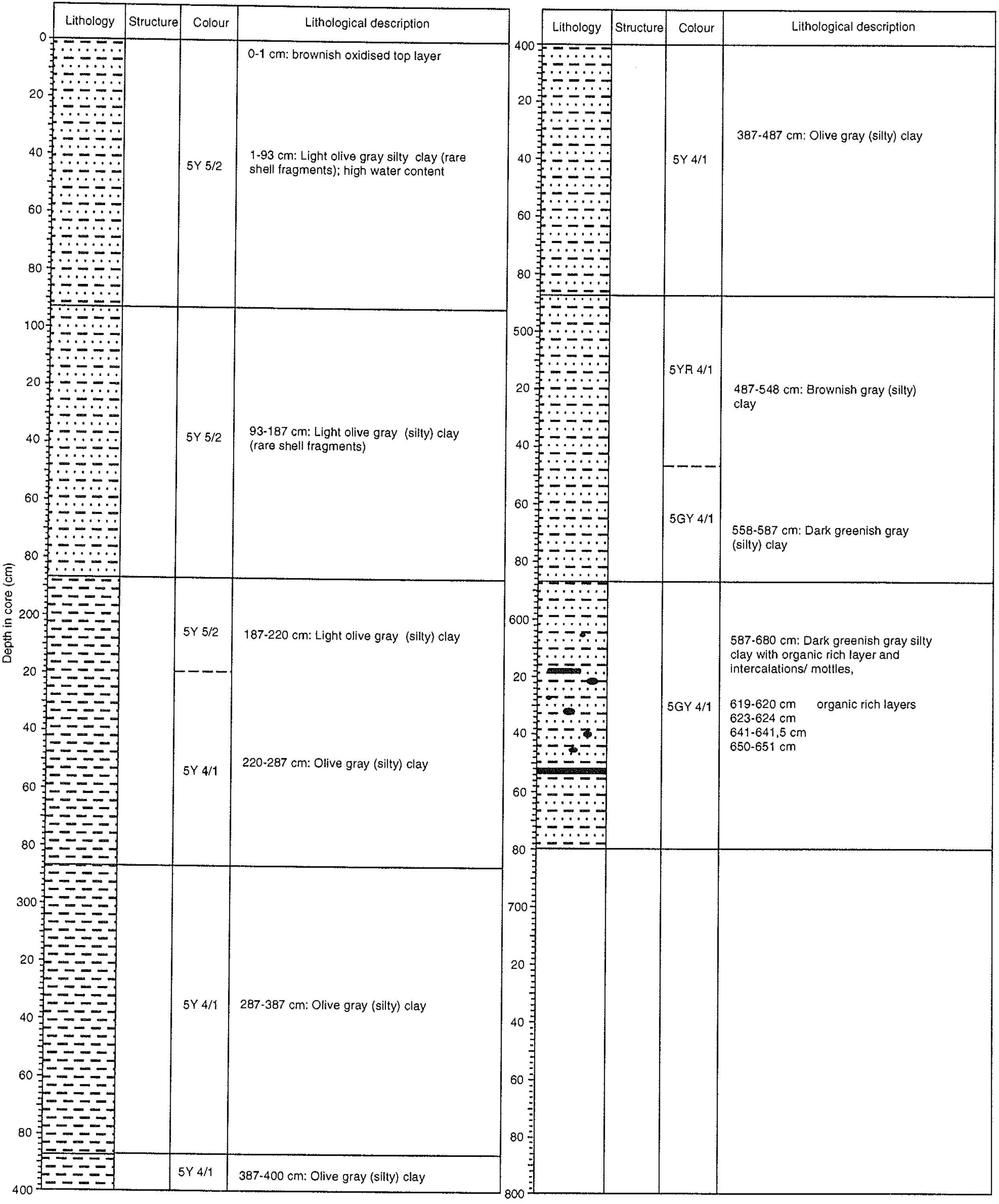




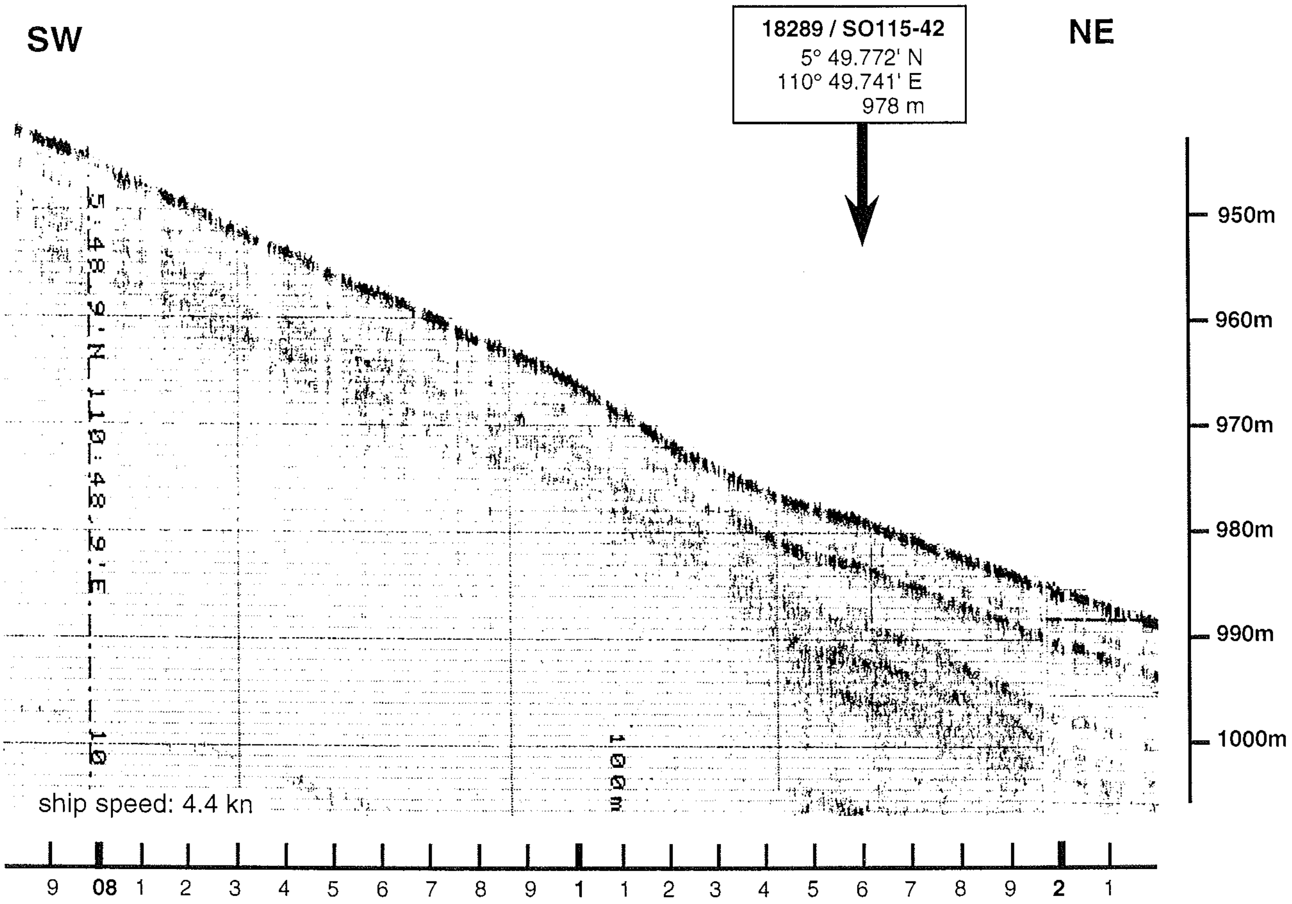
Objectives:
Sampling the surface sediment for a continuous sedimentologic and micropaleontologic depth transect of the continental slope. Undisturbed sediment - water interface samples were obtained with the multicorer.
Long stratigraphic reference core with complete penetration of the upper acoustically transparent layer.

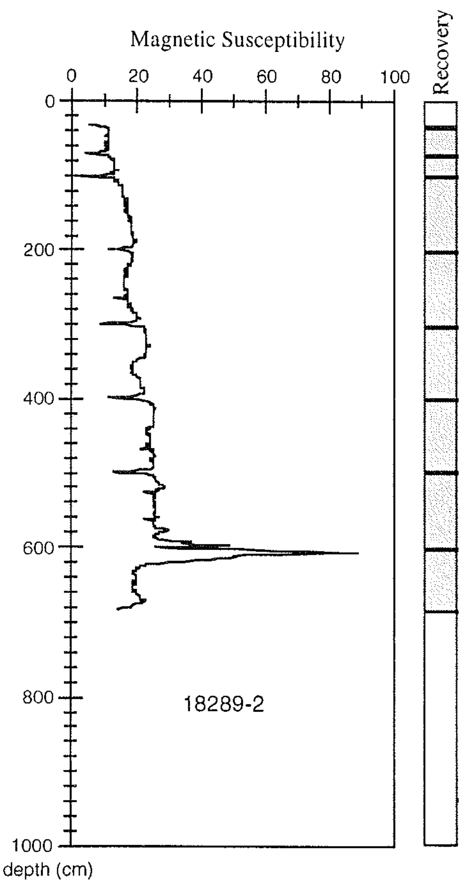
SONNE-115 **Water depth: 788 m**
Station: SO 115-41
Position: 5° 44.388 N; 110° 44.324 E

Core: SL 18288-2 **Recovery: 680 cm**



Colour	Lithological description
	0-1 cm: brownish oxidised top layer
5Y 5/2	1-93 cm: Light olive gray silty clay (rare shell fragments); high water content
5Y 5/2	93-187 cm: Light olive gray (silty) clay (rare shell fragments)
5Y 5/2	187-220 cm: Light olive gray (silty) clay
5Y 4/1	220-287 cm: Olive gray (silty) clay
5Y 4/1	287-387 cm: Olive gray (silty) clay
5Y 4/1	387-400 cm: Olive gray (silty) clay
5Y 4/1	387-487 cm: Olive gray (silty) clay
5YR 4/1	487-548 cm: Brownish gray (silty) clay
5GY 4/1	558-587 cm: Dark greenish gray (silty) clay
5GY 4/1	587-680 cm: Dark greenish gray silty clay with organic rich layer and intercalations/ mottles, 619-620 cm organic rich layers 623-624 cm 641-641,5 cm 650-651 cm

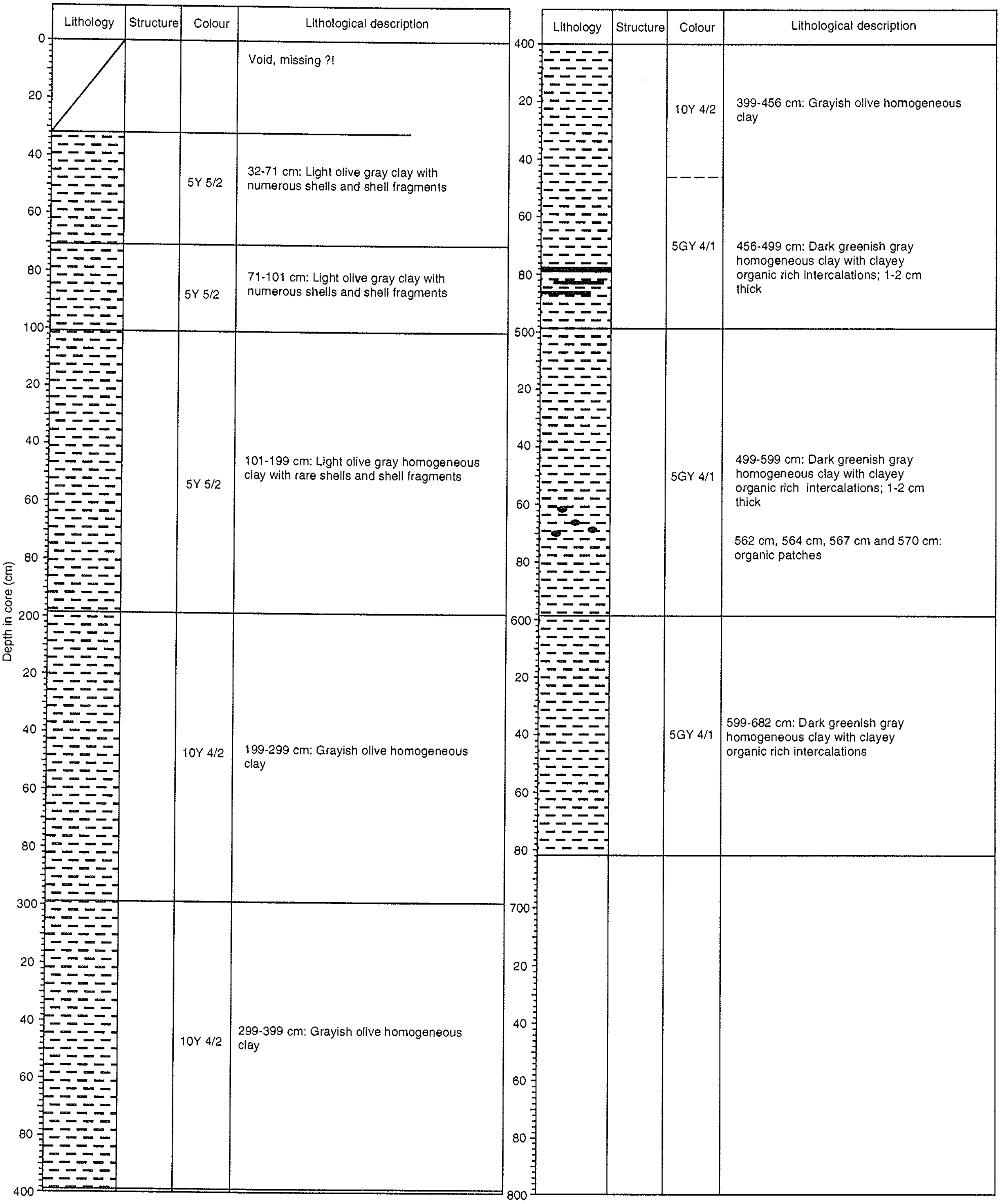




Objectives:
Sampling the surface sediment for a continuous sedimentologic and micropaleontologic depth transect of the continental slope. Undisturbed sediment - water interface samples were obtained with the multicorer.
Long stratigraphic reference core for comparison with the Vietnam slope. The acoustically transparent layer (Holocene?) was completely penetrated.

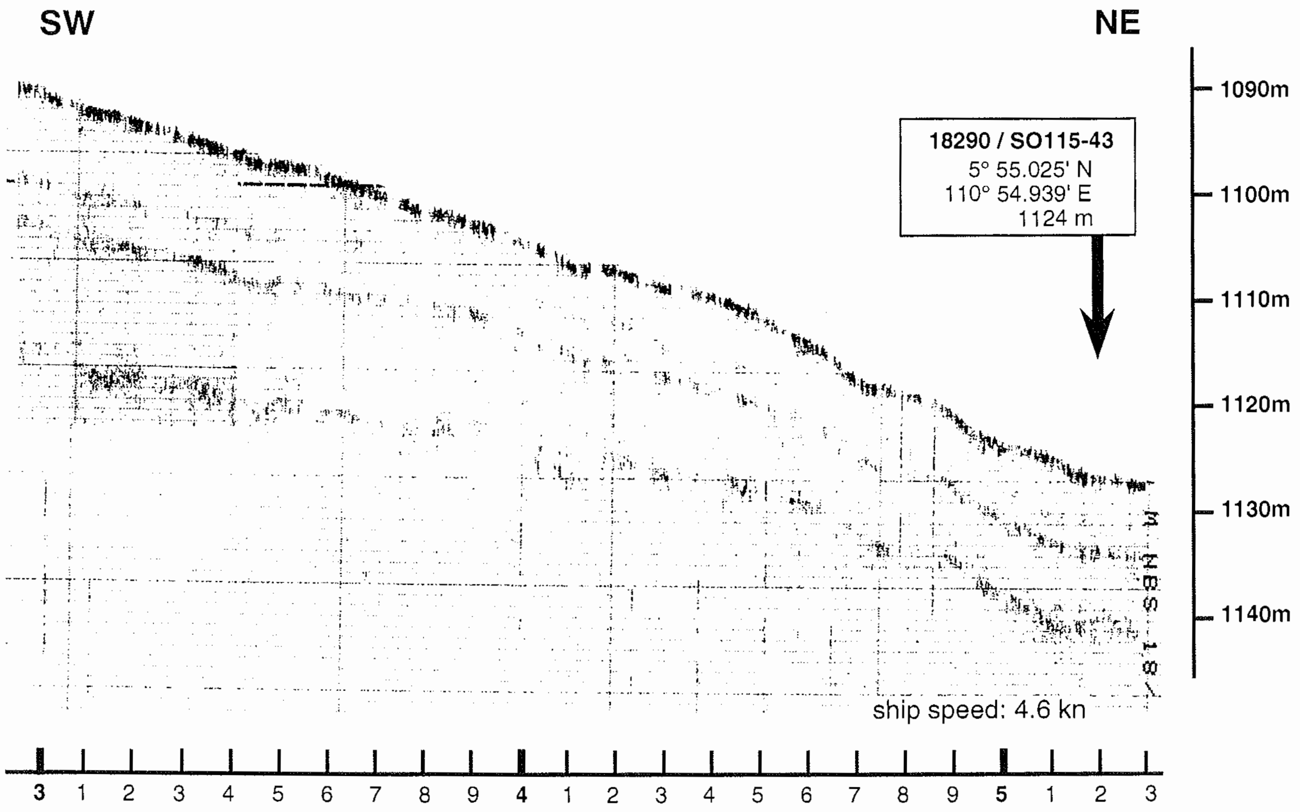
SONNE-115 **Water depth: 976 m**
Station: SO-115-42
Position: 5° 49.802 N; 110° 49.755 E.

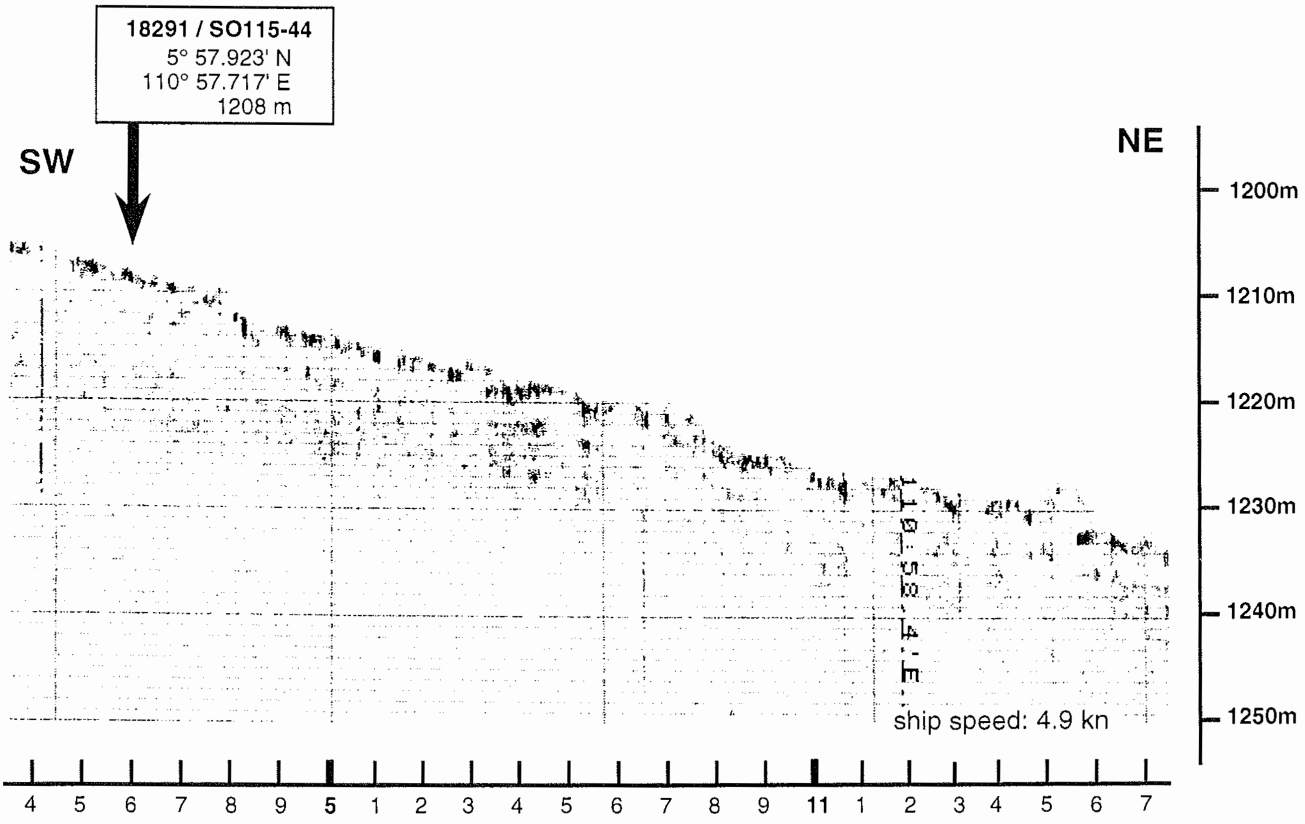
Core: SL 18289-2 **Recovery: 682 cm**



Lithology	Structure	Colour	Lithological description
			Void, missing ?!
		5Y 5/2	32-71 cm: Light olive gray clay with numerous shells and shell fragments
		5Y 5/2	71-101 cm: Light olive gray clay with numerous shells and shell fragments
		5Y 5/2	101-199 cm: Light olive gray homogeneous clay with rare shells and shell fragments
		10Y 4/2	199-299 cm: Grayish olive homogeneous clay
		10Y 4/2	299-399 cm: Grayish olive homogeneous clay

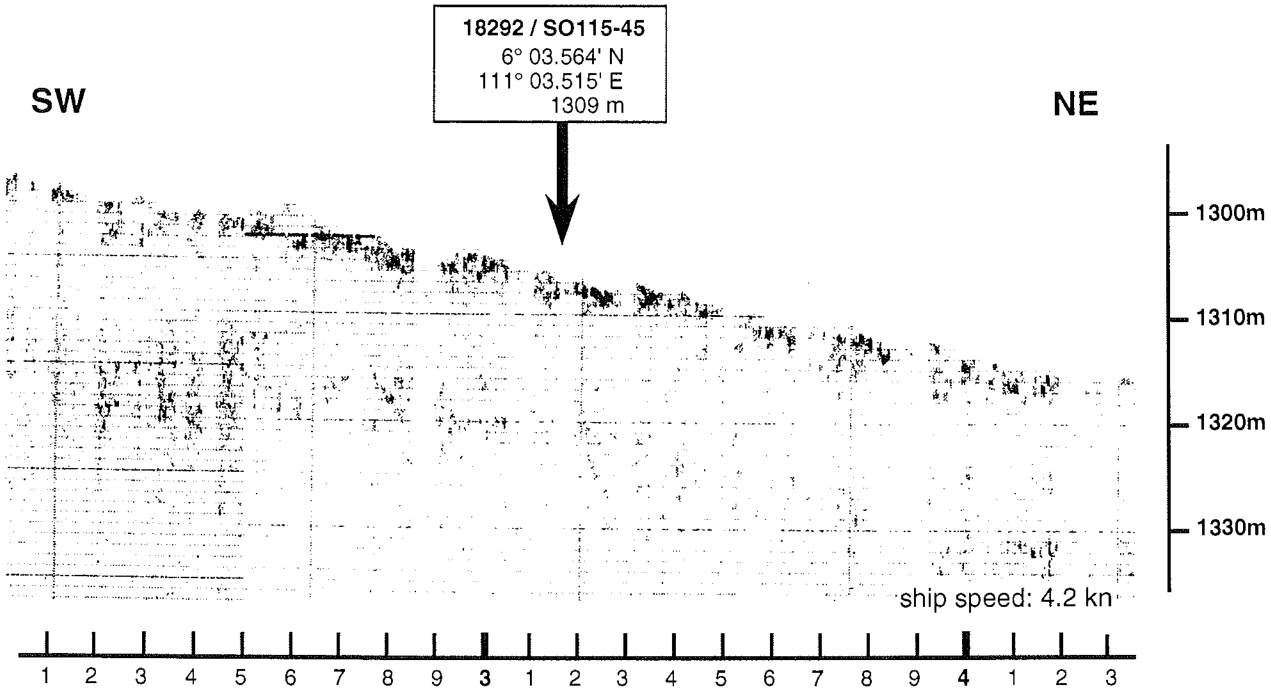
Lithology	Structure	Colour	Lithological description
		10Y 4/2	399-456 cm: Grayish olive homogeneous clay
		5GY 4/1	456-499 cm: Dark greenish gray homogeneous clay with clayey organic rich intercalations; 1-2 cm thick
		5GY 4/1	499-599 cm: Dark greenish gray homogeneous clay with clayey organic rich intercalations; 1-2 cm thick 562 cm, 564 cm, 567 cm and 570 cm: organic patches
		5GY 4/1	599-682 cm: Dark greenish gray homogeneous clay with clayey organic rich intercalations

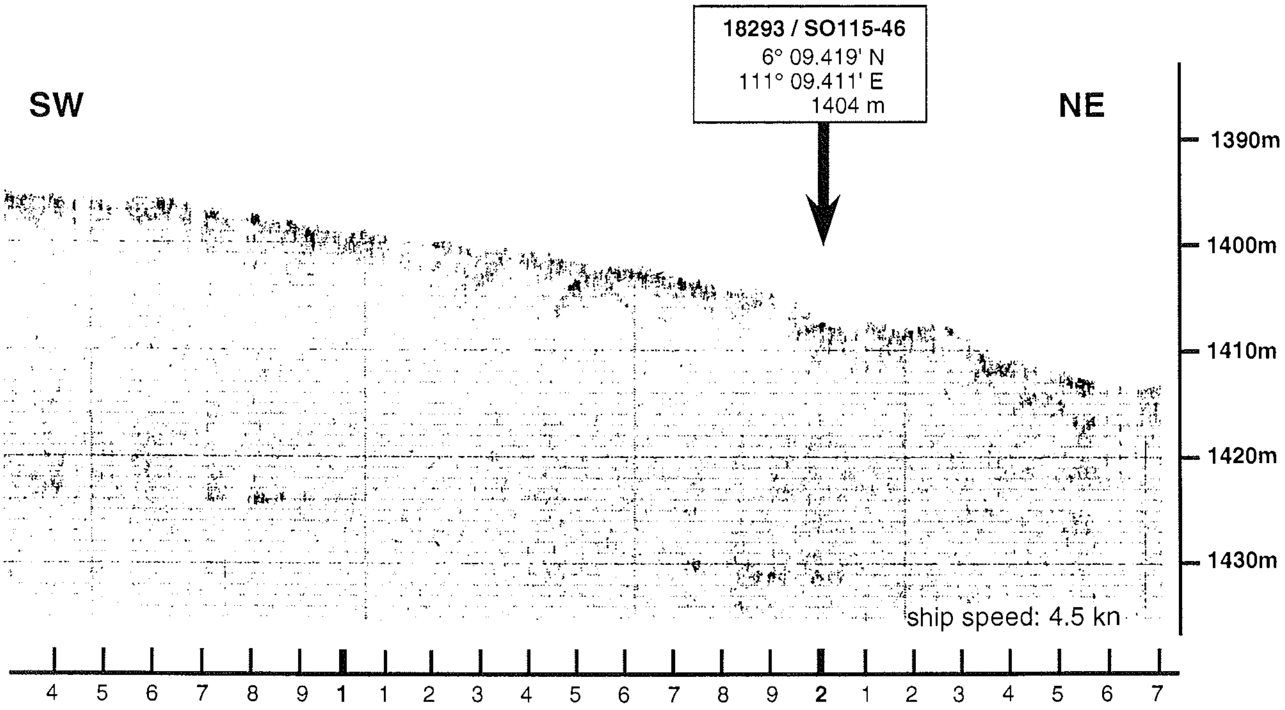




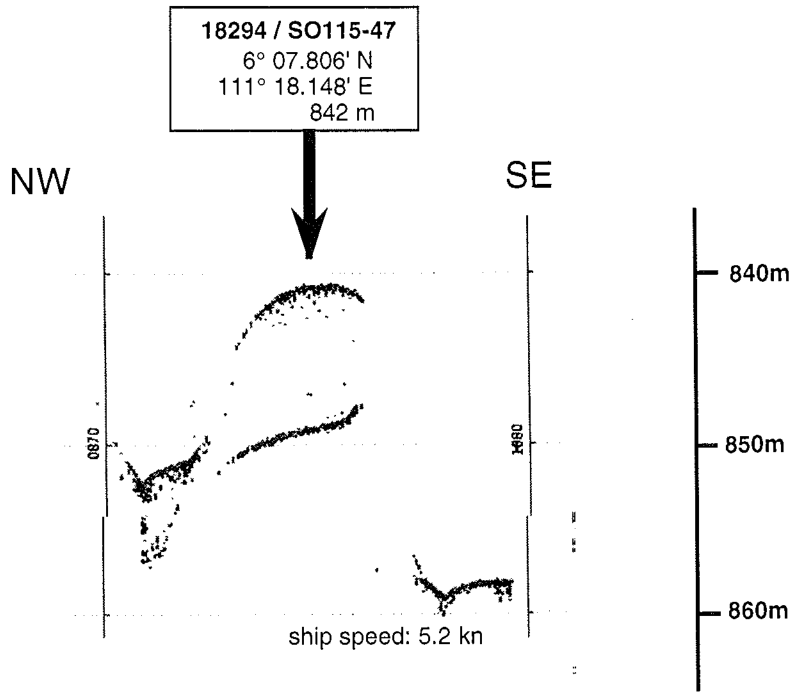
Objectives:

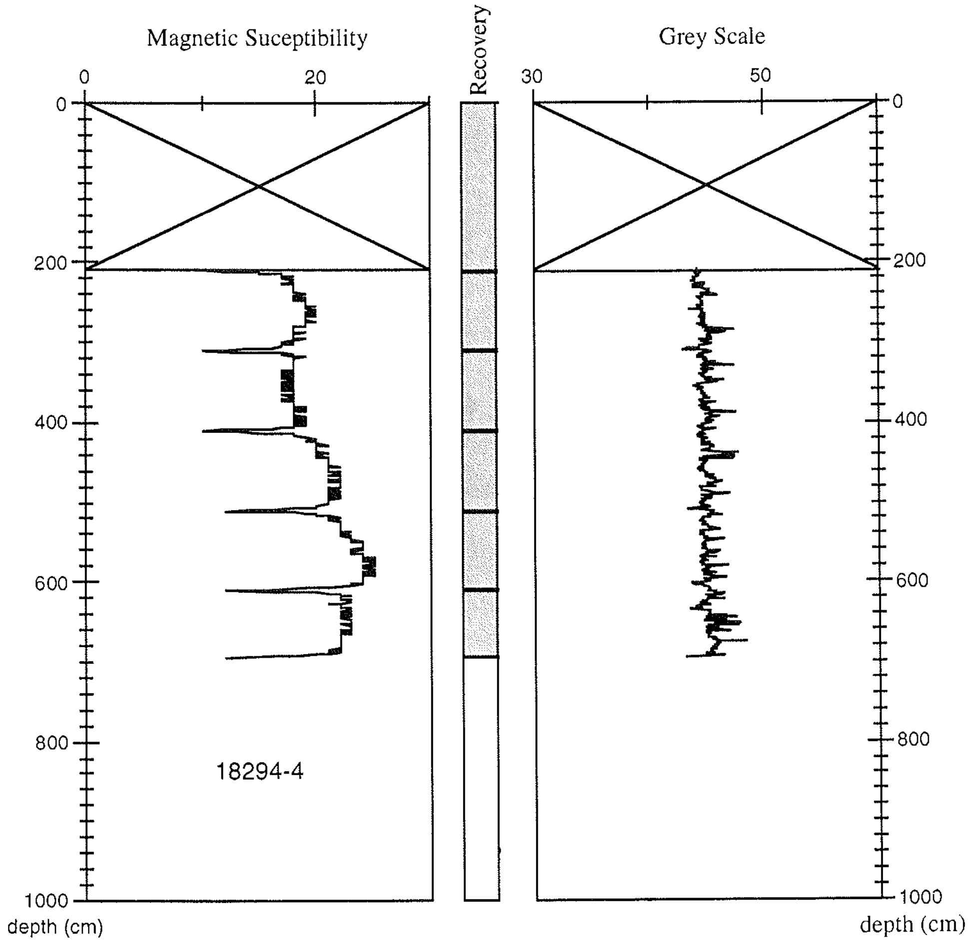
Sampling the surface sediment for a continuous sedimentologic and micropaleontologic depth transect of the less inclined lower part of the continental slope. Undisturbed sediment -water interface samples were obtained with the multicorer.





Objectives:
Sampling the surface sediment for a continuous sedimentologic and micropaleontologic depth transect of the less inclined lower part of the continental slope. Undisturbed sediment -water interface samples were obtained with the multicorer.



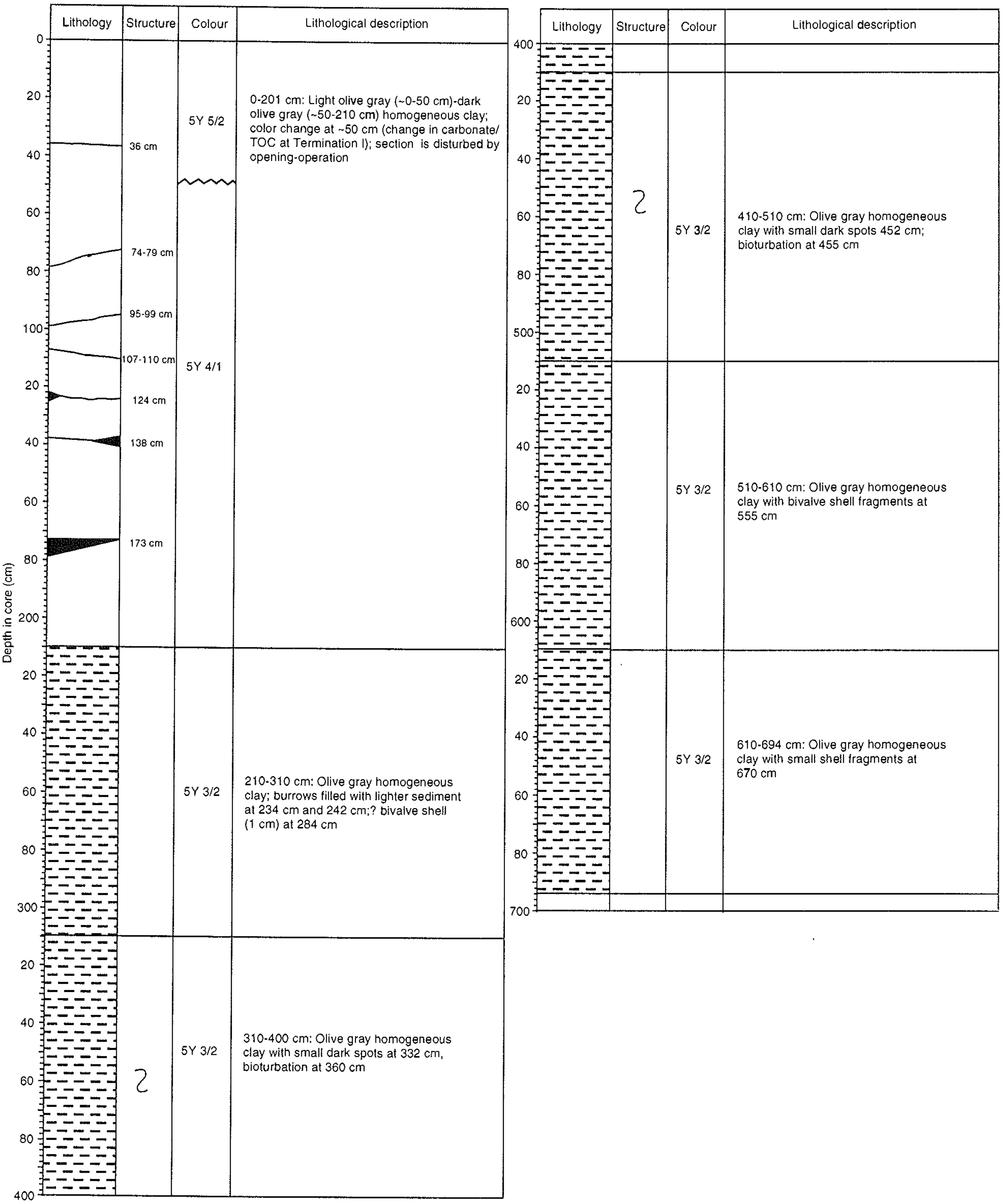


Objectives: Coring the top of an elevated, seamount-like structure along the slope of the Sunda shelf. This position provides the possibility to obtain an undisturbed pelagic record, which is not influenced by gravitationally redeposited sediments.

End of section 1

SONNE-115 **Water depth: 849 m**
Station: SO-115-47
Position: 6° 07.809 N; 111° 18.183 E

Core: SL 18294-4 **Recovery: 694 cm**



0-201 cm: Light olive gray (~0-50 cm)-dark olive gray (~50-210 cm) homogeneous clay; color change at ~50 cm (change in carbonate/ TOC at Termination I); section is disturbed by opening-operation

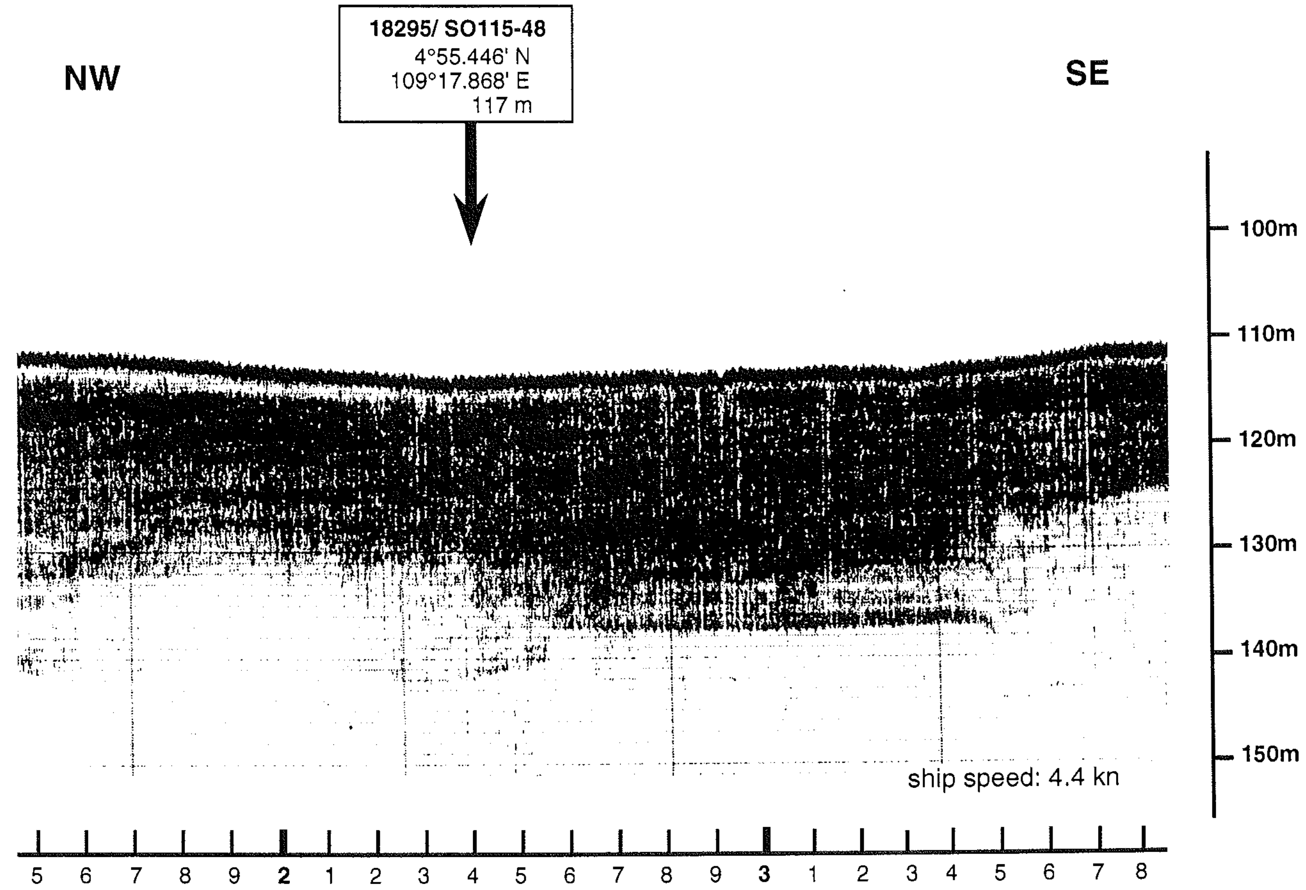
210-310 cm: Olive gray homogeneous clay; burrows filled with lighter sediment at 234 cm and 242 cm;? bivalve shell (1 cm) at 284 cm

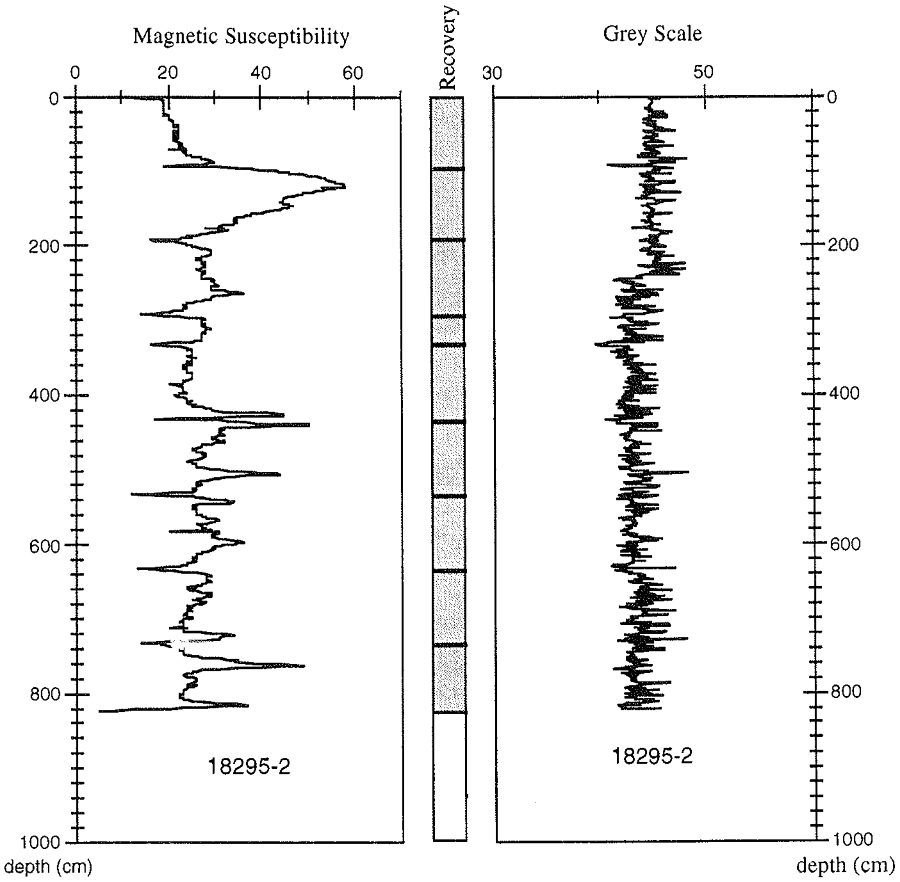
310-400 cm: Olive gray homogeneous clay with small dark spots at 332 cm, bioturbation at 360 cm

410-510 cm: Olive gray homogeneous clay with small dark spots 452 cm; bioturbation at 455 cm

510-610 cm: Olive gray homogeneous clay with bivalve shell fragments at 555 cm

610-694 cm: Olive gray homogeneous clay with small shell fragments at 670 cm



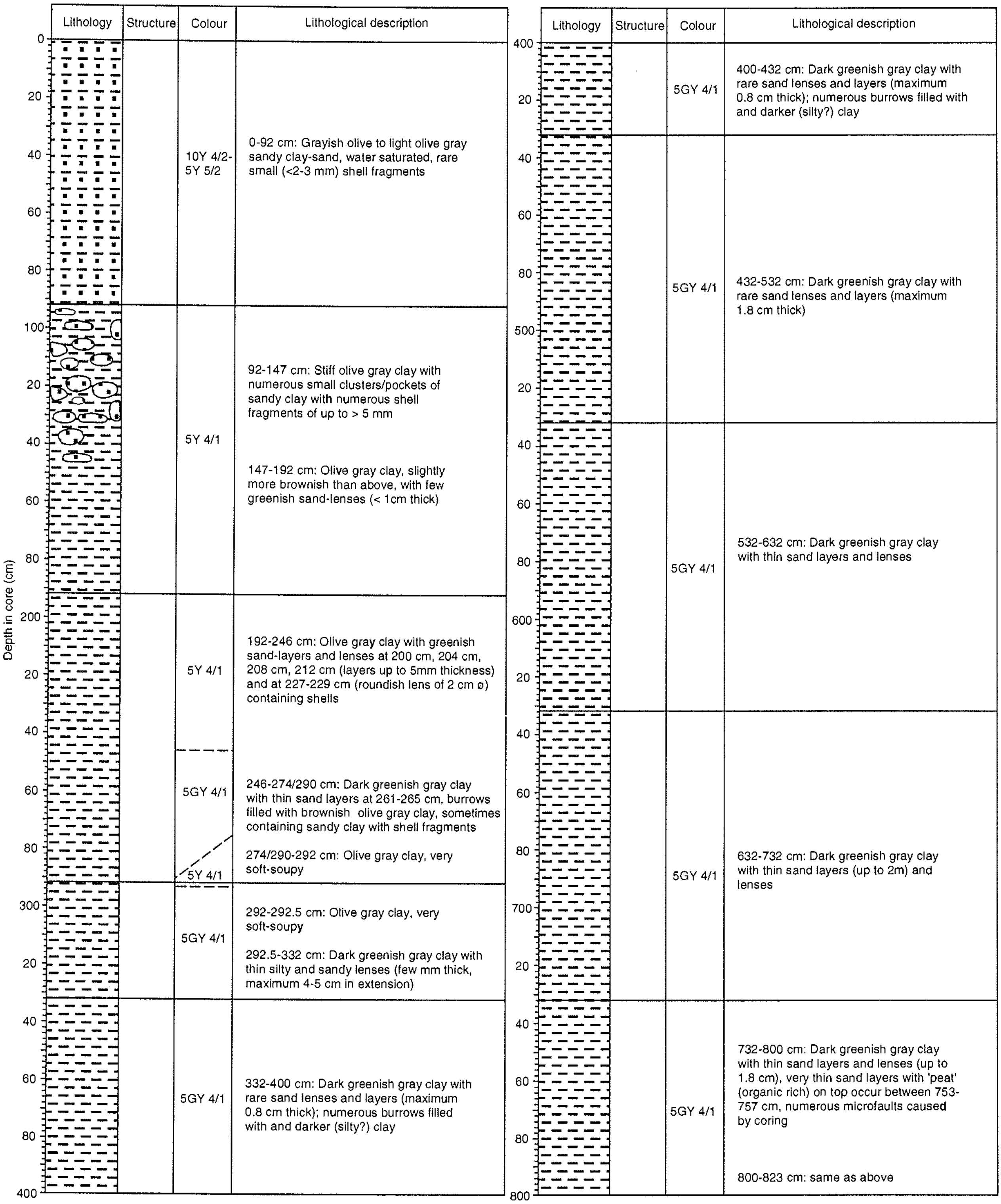


Objectives:

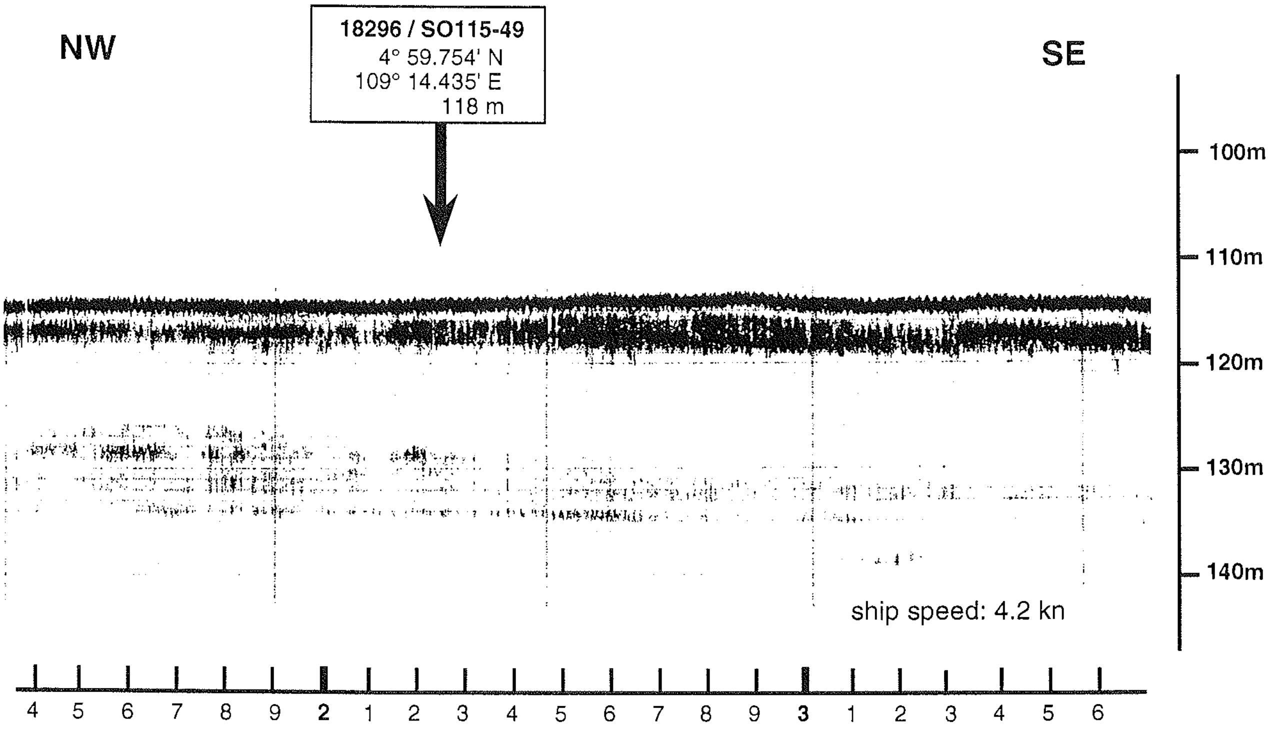
Coring a slight morphological depression with a thin acoustically transparent layer (water saturated clay-rich sand) at the sediment surface. Several distinct (moderately oblique) reflectors follow below.

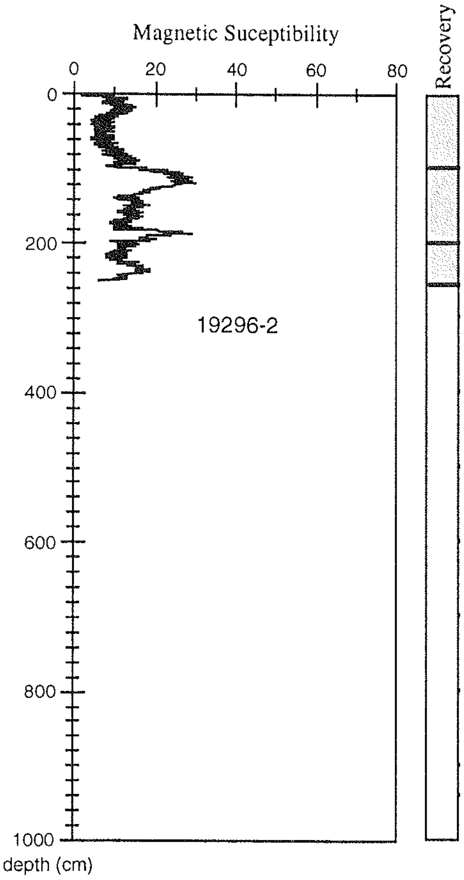
SONNE-115 **Water depth: 119 m**
Station: SO-115-48
Position: 4° 55.587 N; 109° 17.865 E

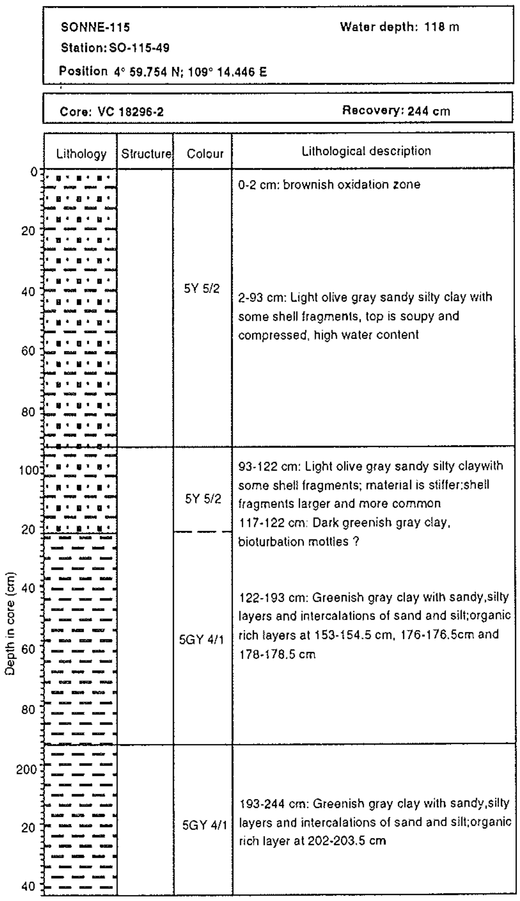
Core: SL 18295-2 **Recovery: 823 cm**



Lithology	Structure	Colour	Lithological description
		10Y 4/2- 5Y 5/2	0-92 cm: Grayish olive to light olive gray sandy clay-sand, water saturated, rare small (<2-3 mm) shell fragments
		5Y 4/1	92-147 cm: Stiff olive gray clay with numerous small clusters/pockets of sandy clay with numerous shell fragments of up to > 5 mm 147-192 cm: Olive gray clay, slightly more brownish than above, with few greenish sand-lenses (< 1cm thick)
		5Y 4/1	192-246 cm: Olive gray clay with greenish sand-layers and lenses at 200 cm, 204 cm, 208 cm, 212 cm (layers up to 5mm thickness) and at 227-229 cm (roundish lens of 2 cm ø) containing shells
		5GY 4/1 5Y 4/1	246-274/290 cm: Dark greenish gray clay with thin sand layers at 261-265 cm, burrows filled with brownish olive gray clay, sometimes containing sandy clay with shell fragments 274/290-292 cm: Olive gray clay, very soft-soupy
		5GY 4/1	292-292.5 cm: Olive gray clay, very soft-soupy 292.5-332 cm: Dark greenish gray clay with thin silty and sandy lenses (few mm thick, maximum 4-5 cm in extension)
		5GY 4/1	332-400 cm: Dark greenish gray clay with rare sand lenses and layers (maximum 0.8 cm thick); numerous burrows filled with and darker (silty?) clay
		5GY 4/1	400-432 cm: Dark greenish gray clay with rare sand lenses and layers (maximum 0.8 cm thick); numerous burrows filled with and darker (silty?) clay
		5GY 4/1	432-532 cm: Dark greenish gray clay with rare sand lenses and layers (maximum 1.8 cm thick)
		5GY 4/1	532-632 cm: Dark greenish gray clay with thin sand layers and lenses
		5GY 4/1	632-732 cm: Dark greenish gray clay with thin sand layers (up to 2m) and lenses
		5GY 4/1	732-800 cm: Dark greenish gray clay with thin sand layers and lenses (up to 1.8 cm), very thin sand layers with 'peat' (organic rich) on top occur between 753-757 cm, numerous microfaults caused by coring 800-823 cm: same as above





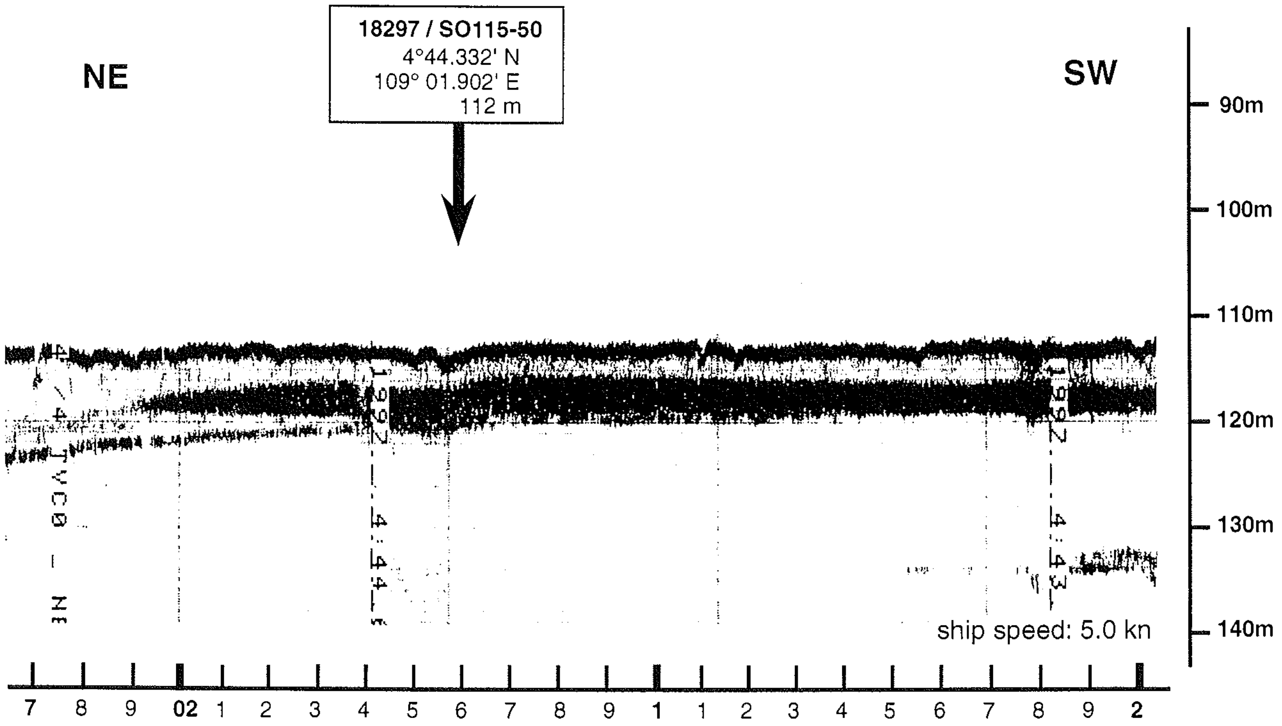


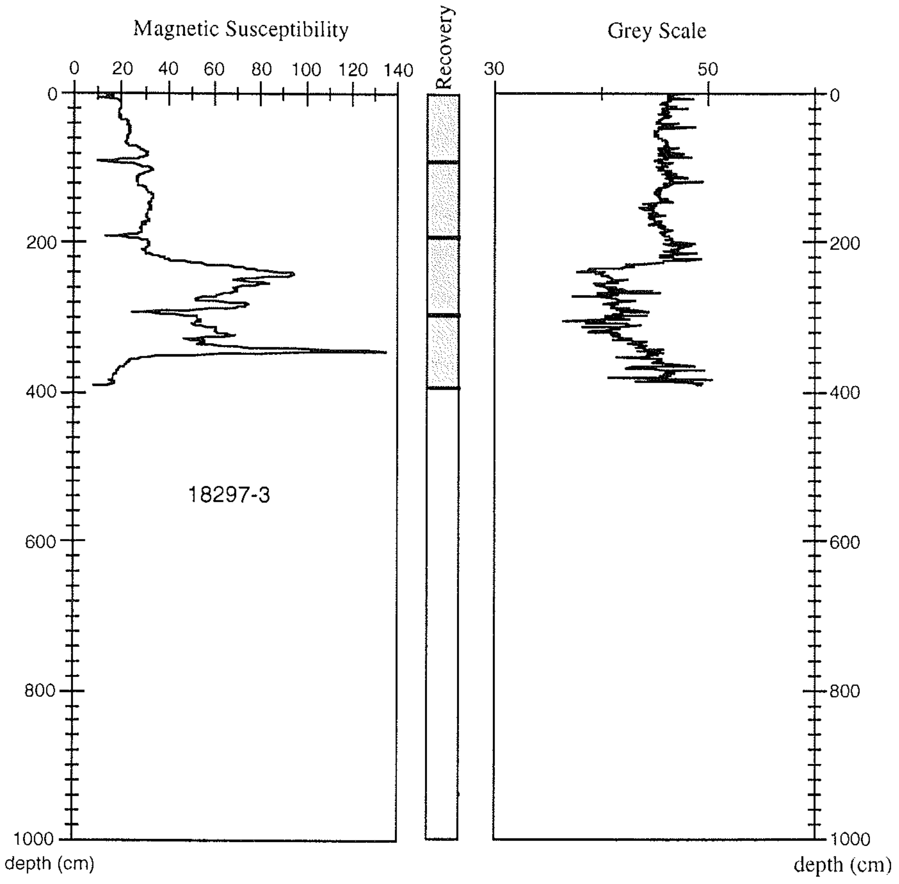
SONNE-115 Water depth: 118 m
Station: SO-115-49
Position 4° 59.754 N; 109° 14.446 E

Core: VC 18296-2 Recovery: 244 cm

Colour	Lithological description
5Y 5/2	0-2 cm: brownish oxidation zone 2-93 cm: Light olive gray sandy silty clay with some shell fragments, top is soupy and compressed, high water content
5Y 5/2	93-122 cm: Light olive gray sandy silty claywith some shell fragments; material is stiffer;shell fragments larger and more common 117-122 cm: Dark greenish gray clay, bioturbation mottles ?
5GY 4/1	122-193 cm: Greenish gray clay with sandy,silty layers and intercalations of sand and silt;organic rich layers at 153-154.5 cm, 176-176.5cm and 178-178.5 cm
5GY 4/1	193-244 cm: Greenish gray clay with sandy,silty layers and intercalations of sand and silt;organic rich layer at 202-203.5 cm

Objectives: Coring a thin but very distinct acoustically transparent layer above a hard reflector.
Remarks: The age of the hard reflector is dated with 9400 ^{14}C years (AMS date of benthic foraminifers within the core catcher).

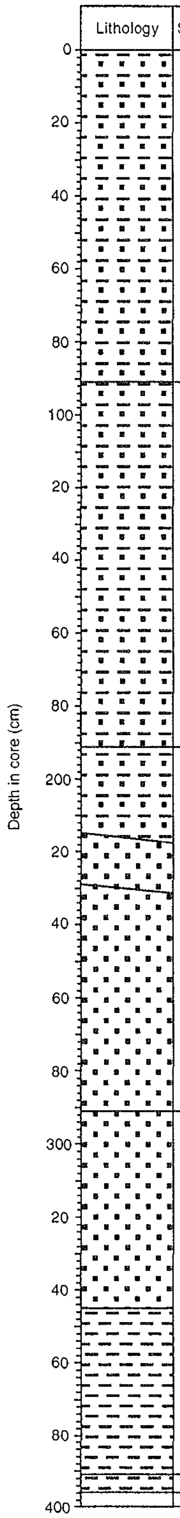




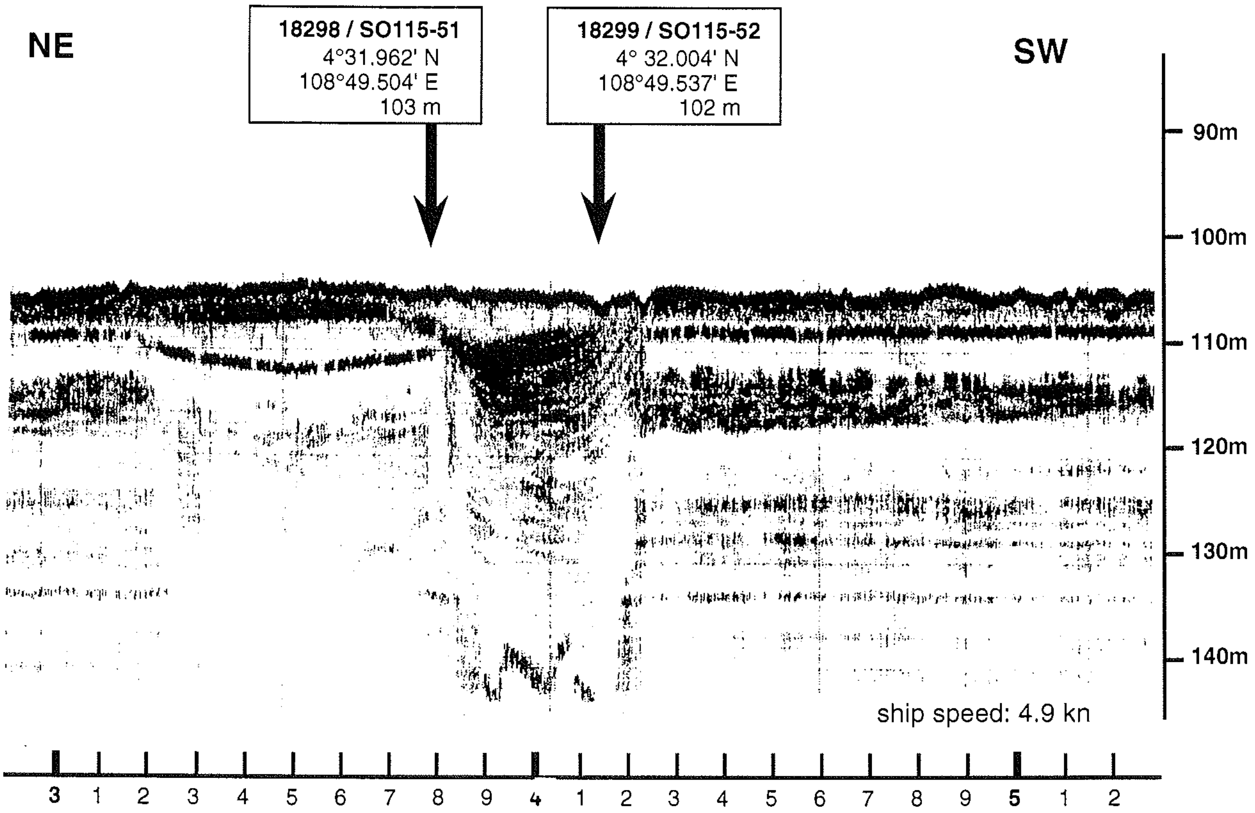
Objectives: Coring a thin but very distinct acoustically transparent layer above a hard reflector. The site is situated at the northwestern margin of the Molengraaff Delta.

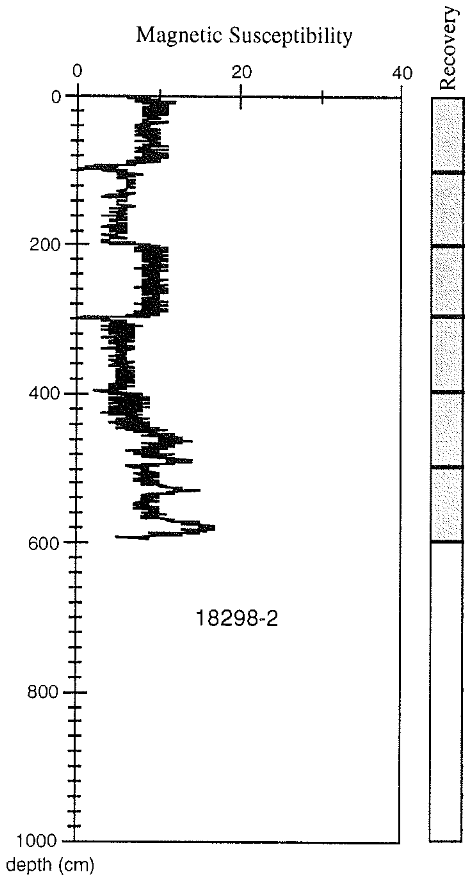
SONNE-115 **Water depth: 111 m**
Station: SO-115-50
Position: 4° 44.347 N; 109° 01.916 E

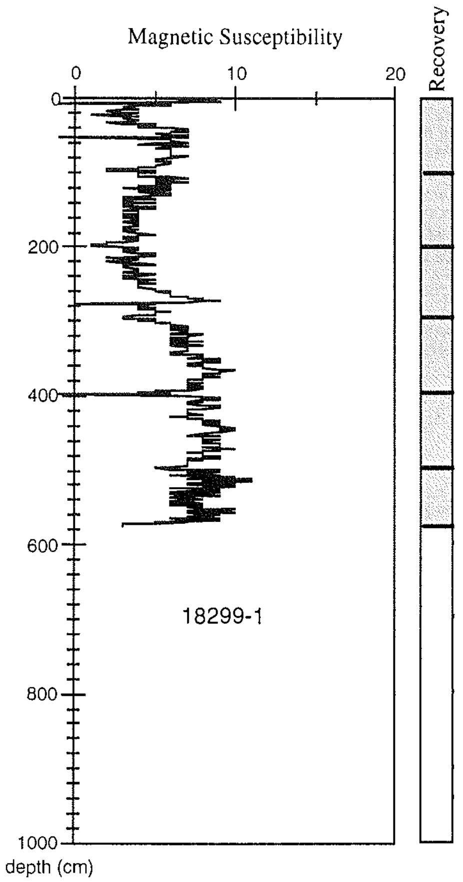
Core: SL 18297-3 **Recovery: 396 cm**



Lithology	Structure	Colour	Lithological description
		10Y 4/2	0-75 cm: Grayish olive sandy clay with abundant small shell fragments (sand fraction probably mainly carbonate sand, clay strongly dominating)
		10YR 6/2	75-91 cm: Pale yellowish brown sandy clay with abundant small shell fragments (carbonate sand, clay strongly dominating)
		10YR 6/2	91-191 cm: Pale yellowish brown sandy clay; sandy material in little lenses, roundish pockets (1-2 cm)
		10YR 6/2	191-215.5/218.5 cm: Pale yellowish brown sandy clay as in section 2
			215.5/218.5-229/231 cm: Pale yellowish brown clayey with shell fragments, quartz sand ?
		10GY 5/2	229/231-291 cm: Grayish green sand with very small whitish shell fragments; 2 layers of peat/wood fragments of 1cm thickness, very irregular occur at about 241 cm
		10GY 5/2	291-345 cm: Grayish green sand as above; peat/wood fragment layers are common between 315 cm and 345 cm
		5BG 5/2	345-391 cm: Grayish blue green clay with large shell fragments (bivalves up to 1.8 cm); clay contains significant amount of carbonate (reaction with HCl), stiff, low water content 391-396 cm (section 5): Grayish blue green clay as above





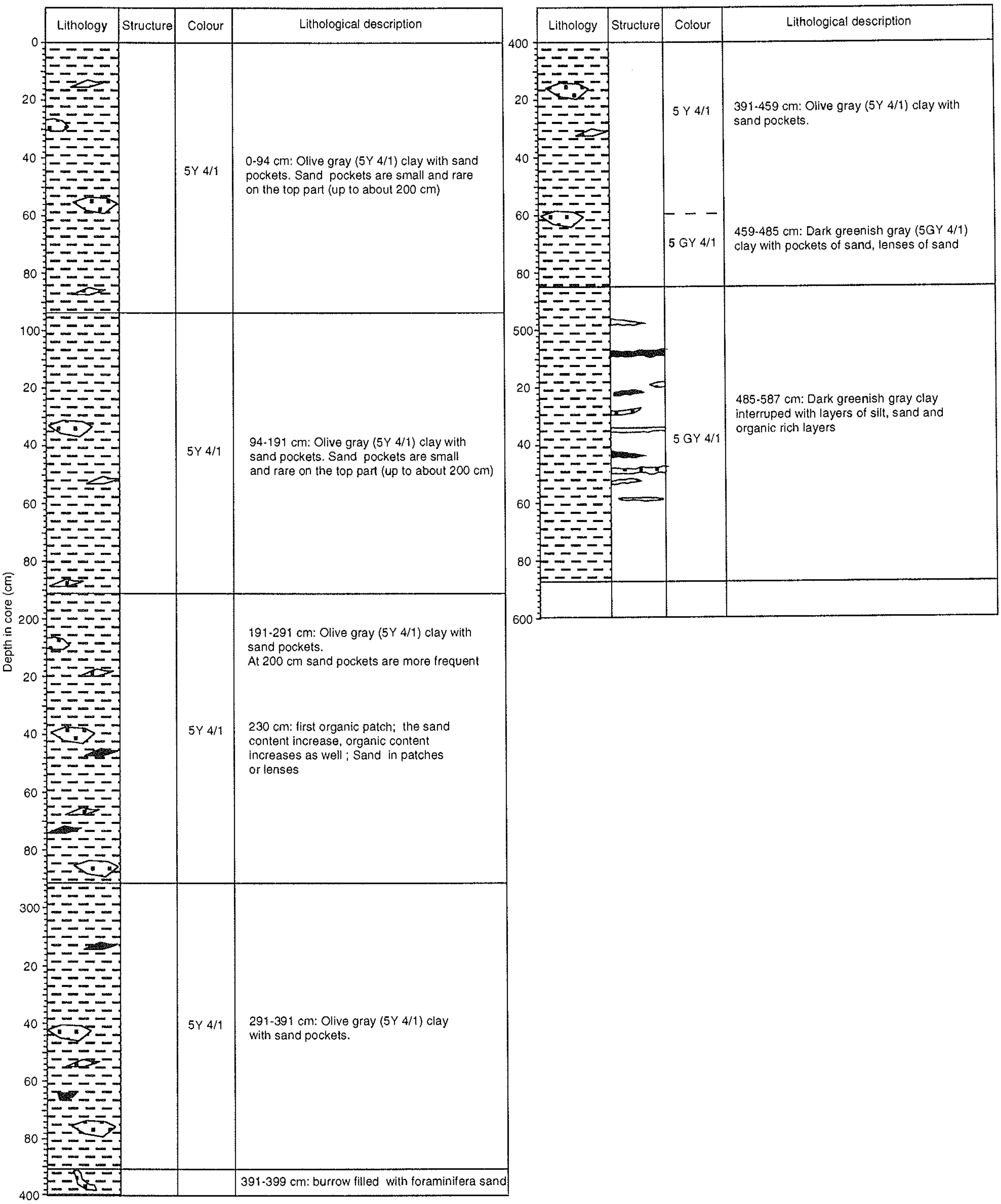


Objectives:
Coring a deeply incised infilled channel structure with steep margins. The cores were positioned at the edges of the channel structure in order to reach the base reflector.

Remarks:
An AMS ^{14}C age of 9400 years was determined at the base of core 18298-2, thus dating the oldest sedimentary fill of the channel as early Holocene.

SONNE-115 **Water depth: 102 m**
Station:SO-115-51
Position: 4° 31.987 N; 108° 49.508 E

Core: VC 18298-2 **Recovery: 587 cm**

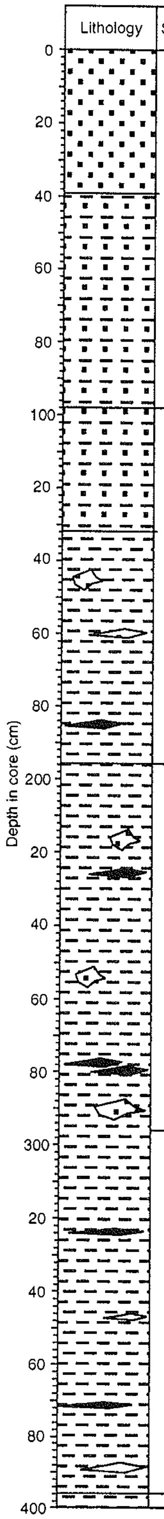


Lithology	Structure	Colour	Lithological description
		5Y 4/1	0-94 cm: Olive gray (5Y 4/1) clay with sand pockets. Sand pockets are small and rare on the top part (up to about 200 cm)
		5Y 4/1	94-191 cm: Olive gray (5Y 4/1) clay with sand pockets. Sand pockets are small and rare on the top part (up to about 200 cm)
		5Y 4/1	191-291 cm: Olive gray (5Y 4/1) clay with sand pockets. At 200 cm sand pockets are more frequent 230 cm: first organic patch; the sand content increase, organic content increases as well ; Sand in patches or lenses
		5Y 4/1	291-391 cm: Olive gray (5Y 4/1) clay with sand pockets.
			391-399 cm: burrow filled with foraminifera sand

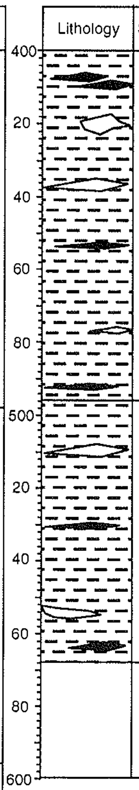
Lithology	Structure	Colour	Lithological description
		5 Y 4/1	391-459 cm: Olive gray (5Y 4/1) clay with sand pockets.
		5 GY 4/1	459-485 cm: Dark greenish gray (5GY 4/1) clay with pockets of sand, lenses of sand
		5 GY 4/1	485-587 cm: Dark greenish gray clay interruped with layers of silt, sand and organic rich layers

SONNE-115 **Water depth: 102 m**
Station: SO-115-52
Position: 4° 32.004 N; 108° 49.537 E

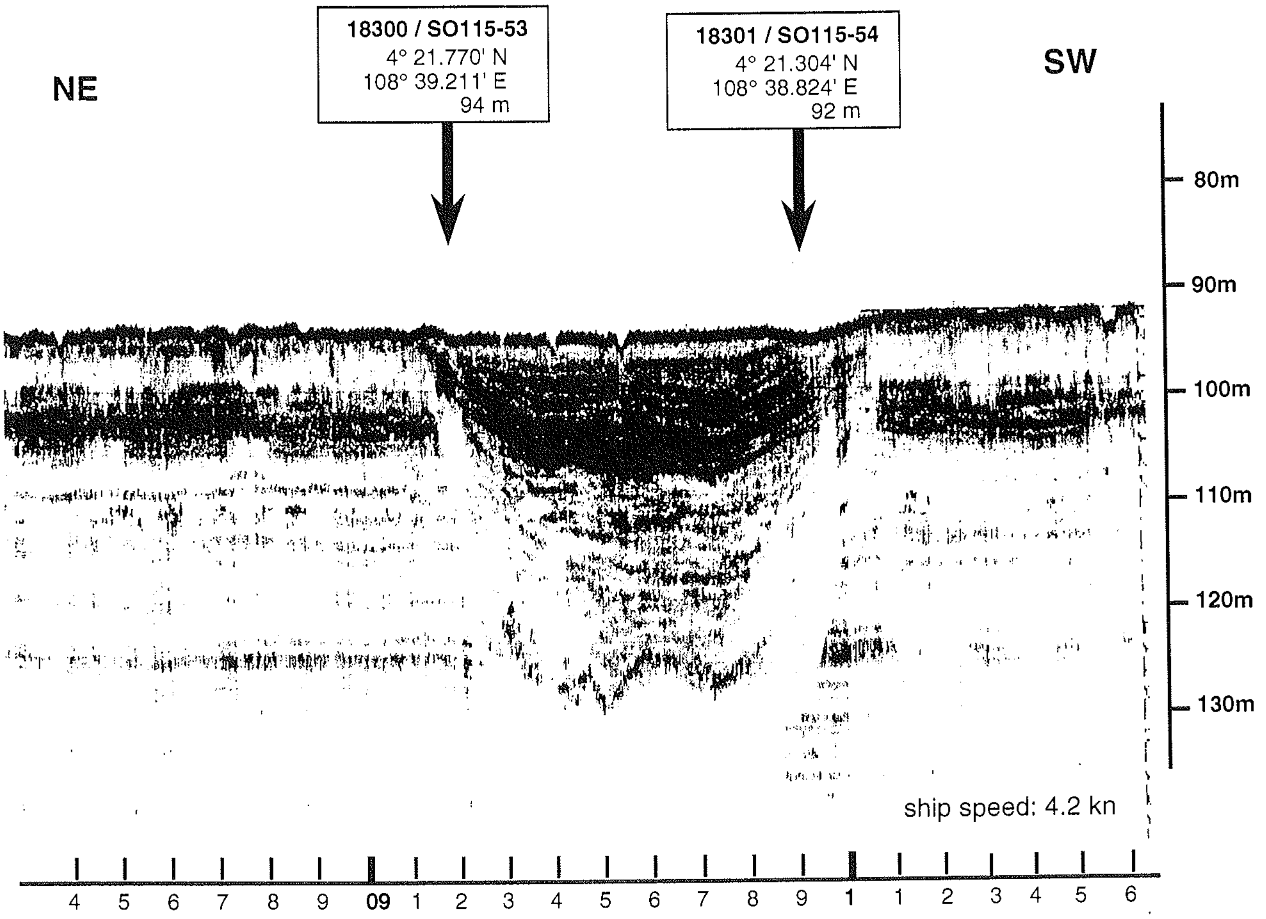
Core: VC 18299-1 **Recovery: 580 cm**

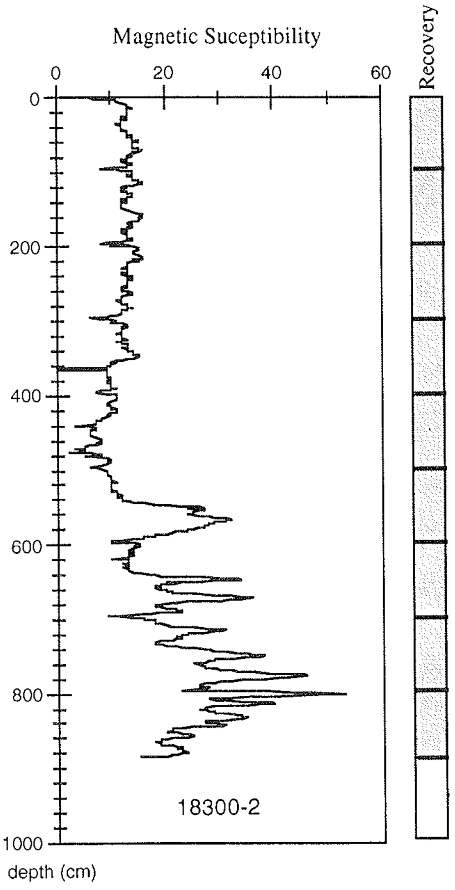


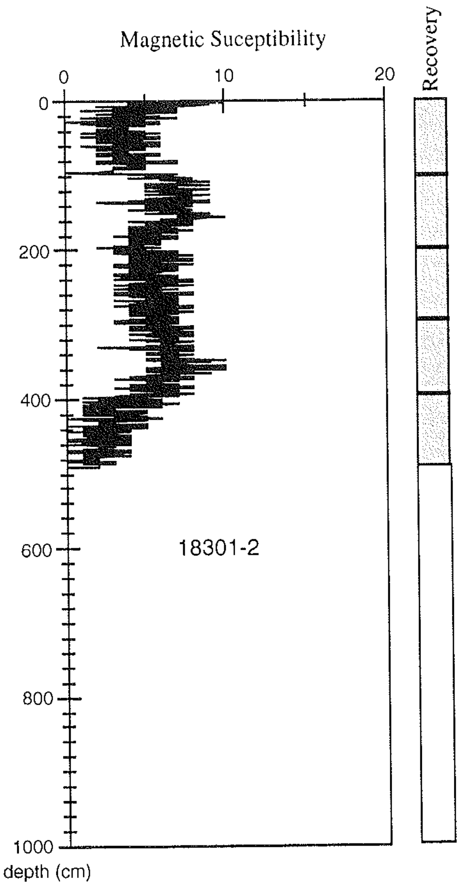
Lithology	Structure	Colour	Lithological description
		10YR 5/4	0-39 cm: Moderate yellowish brown homogeneous clayey sand with shells and shell fragments
			sharp boundary; erosional contact?
		5Y 5/2	39-61 cm: Light olive gray sandy clay
		N4 5Y 4/1 5YR 4/1	60-98 cm: Medium dark gray-olive gray (brownish gray) sandy clay and shell fragments (2-3 cm in the diameter) (bioturbation horizon)
		5Y 5/2	98-132 cm: Light olive gray sandy clay
			transitional boundary
		5YR 4/1- 5Y 4/1	132-196 cm: Brownish gray-olive gray clay with sand pockets and burrows (single) filled with shell fragments and peat lenses
		5YR 4/1- 5Y 4/1	196-296 cm: Brownish gray-olive gray clay with sand pockets and burrows (single) filled with shell fragments and peat lenses; 278-283 cm: peat lenses
		5YR 4/1- 5Y 4/1	296-396 cm: Brownish gray-olive gray clay with organic rich layers (peat layers) and silty layers



Lithology	Structure	Colour	Lithological description
		5YR 4/1- 5Y 4/1	396-496 cm: Brownish gray-olive gray clay with organic rich layers (peat layers) and silty layers
		5YR 4/1- 5Y 4/1	496-568 cm: Brownish gray-olive gray clay with organic rich layers (peat layers) and silty layers



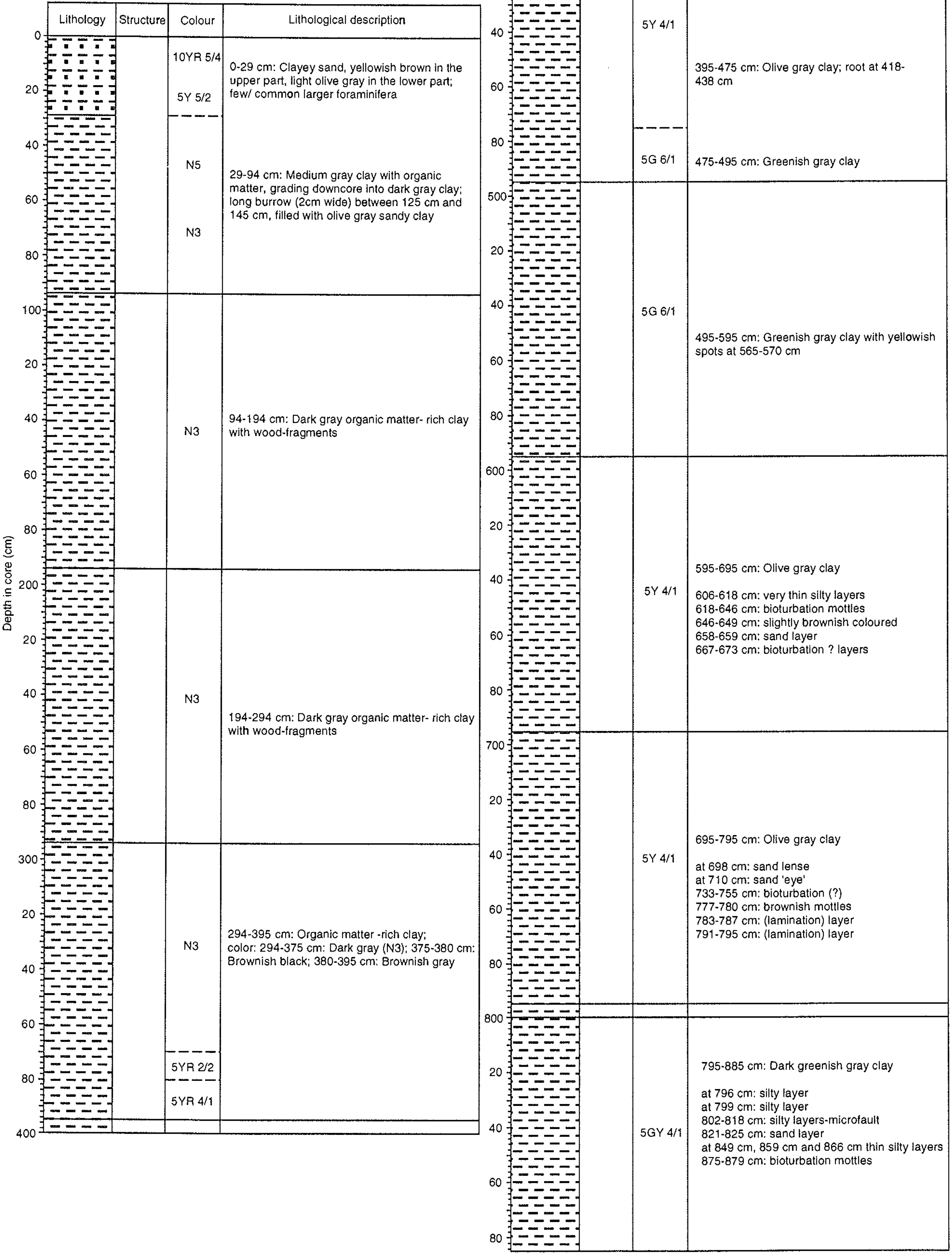




Objectives:
Coring a deeply incised infilled channel structure. The cores were positioned at the edges of the channel structure in order to reach the base reflector.

SONNE-115
Station:SO-115-53
Position: 4° 21.778 N; 108° 39.215 E
Water depth: 91 m

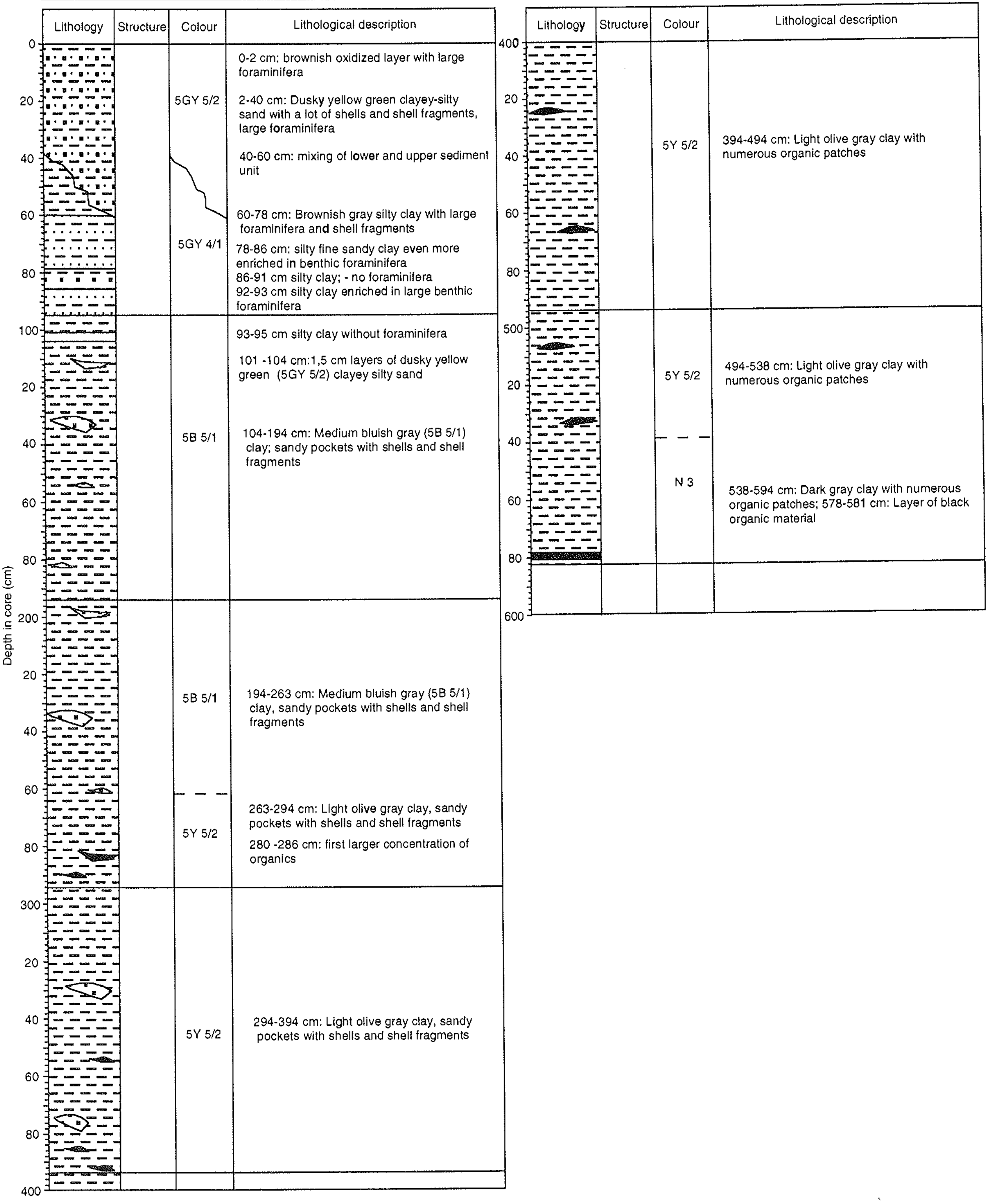
Core: SL 18300-2
Recovery: 885 cm



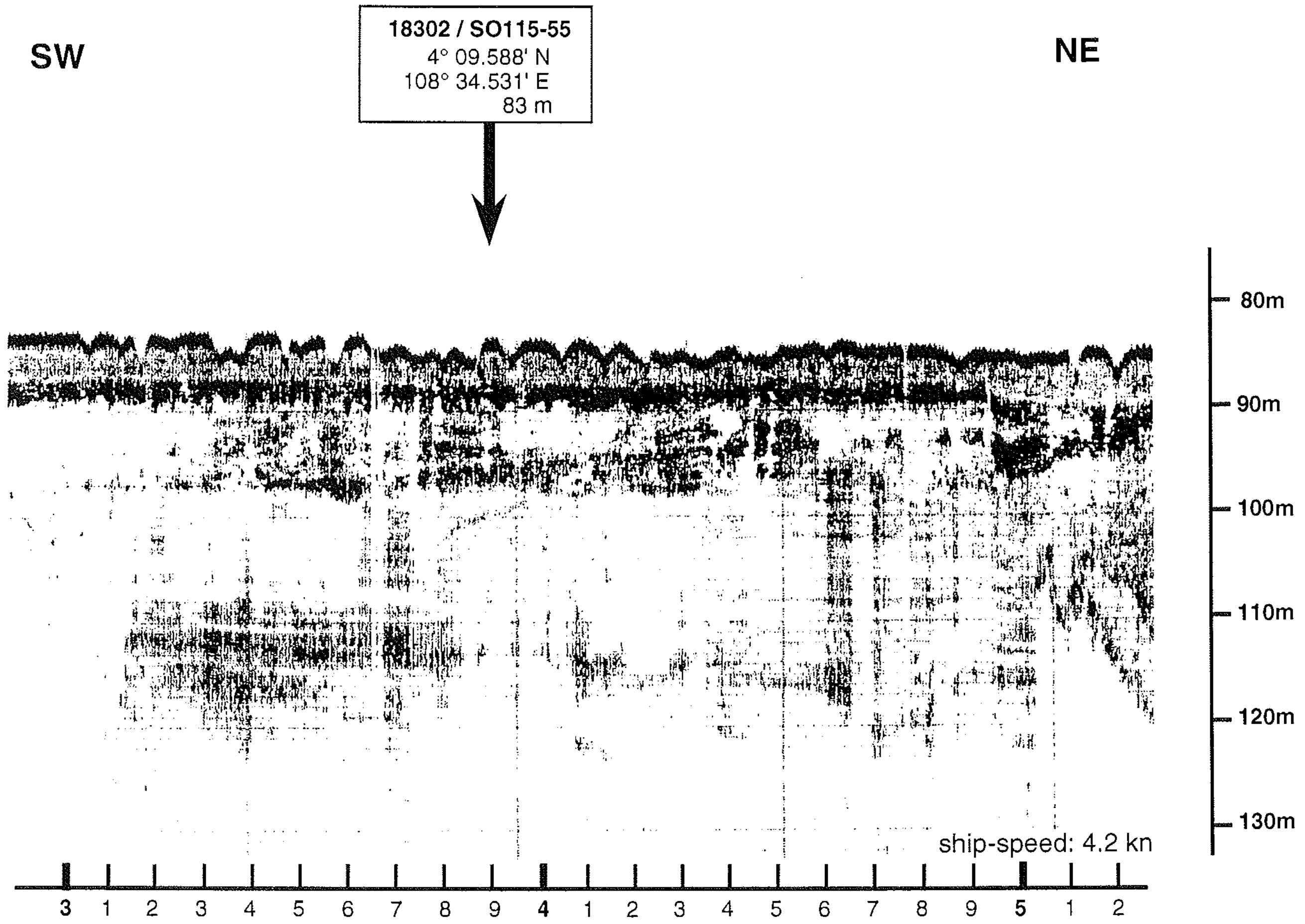
Lithology	Structure	Colour	Lithological description
		10YR 5/4 5Y 5/2	0-29 cm: Clayey sand, yellowish brown in the upper part, light olive gray in the lower part; few/ common larger foraminifera
		N5 N3	29-94 cm: Medium gray clay with organic matter, grading downcore into dark gray clay; long burrow (2cm wide) between 125 cm and 145 cm, filled with olive gray sandy clay
		N3	94-194 cm: Dark gray organic matter- rich clay with wood-fragments
		N3	194-294 cm: Dark gray organic matter- rich clay with wood-fragments
		N3 5YR 2/2 5YR 4/1	294-395 cm: Organic matter -rich clay; color: 294-375 cm: Dark gray (N3); 375-380 cm: Brownish black; 380-395 cm: Brownish gray
		5Y 4/1	395-475 cm: Olive gray clay; root at 418-438 cm
		5G 6/1	475-495 cm: Greenish gray clay
		5G 6/1	495-595 cm: Greenish gray clay with yellowish spots at 565-570 cm
		5Y 4/1	595-695 cm: Olive gray clay 606-618 cm: very thin silty layers 618-646 cm: bioturbation mottles 646-649 cm: slightly brownish coloured 658-659 cm: sand layer 667-673 cm: bioturbation ? layers
		5Y 4/1	695-795 cm: Olive gray clay at 698 cm: sand lense at 710 cm: sand 'eye' 733-755 cm: bioturbation (?) 777-780 cm: brownish mottles 783-787 cm: (lamination) layer 791-795 cm: (lamination) layer
		5GY 4/1	795-885 cm: Dark greenish gray clay at 796 cm: silty layer at 799 cm: silty layer 802-818 cm: silty layers-microfault 821-825 cm: sand layer at 849 cm, 859 cm and 866 cm thin silty layers 875-879 cm: bioturbation mottles

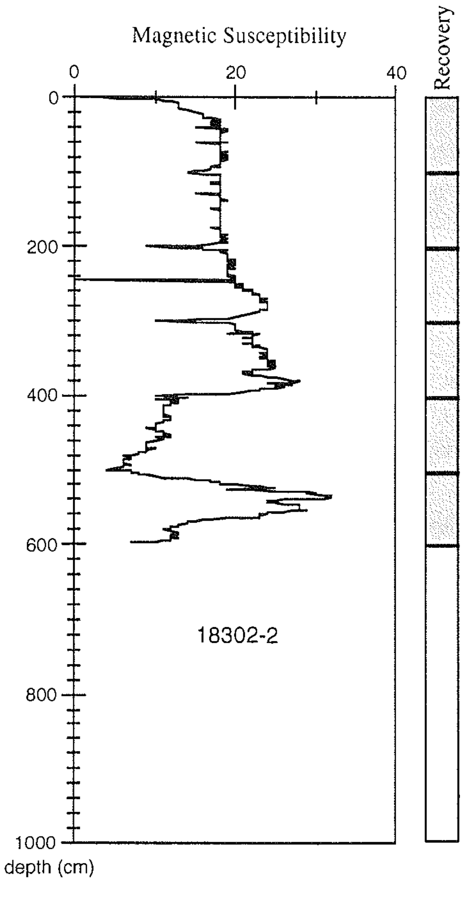
SONNE-115 **Water depth: 93 m**
Station: SO-115-54
Position: 4° 21.308 N; 108° 38.811 E

Core: VC 18301-2 **Recovery: 582 cm**



Colour	Lithological description
5GY 5/2	0-2 cm: brownish oxidized layer with large foraminifera 2-40 cm: Dusky yellow green clayey-silty sand with a lot of shells and shell fragments, large foraminifera 40-60 cm: mixing of lower and upper sediment unit
5GY 4/1	60-78 cm: Brownish gray silty clay with large foraminifera and shell fragments 78-86 cm: silty fine sandy clay even more enriched in benthic foraminifera 86-91 cm silty clay; - no foraminifera 92-93 cm silty clay enriched in large benthic foraminifera
5B 5/1	93-95 cm silty clay without foraminifera 101 -104 cm:1,5 cm layers of dusky yellow green (5GY 5/2) clayey silty sand 104-194 cm: Medium bluish gray (5B 5/1) clay; sandy pockets with shells and shell fragments
5B 5/1	194-263 cm: Medium bluish gray (5B 5/1) clay, sandy pockets with shells and shell fragments
5Y 5/2	263-294 cm: Light olive gray clay, sandy pockets with shells and shell fragments 280 -286 cm: first larger concentration of organics
5Y 5/2	294-394 cm: Light olive gray clay, sandy pockets with shells and shell fragments
5Y 5/2	394-494 cm: Light olive gray clay with numerous organic patches
5Y 5/2	494-538 cm: Light olive gray clay with numerous organic patches
N 3	538-594 cm: Dark gray clay with numerous organic patches; 578-581 cm: Layer of black organic material



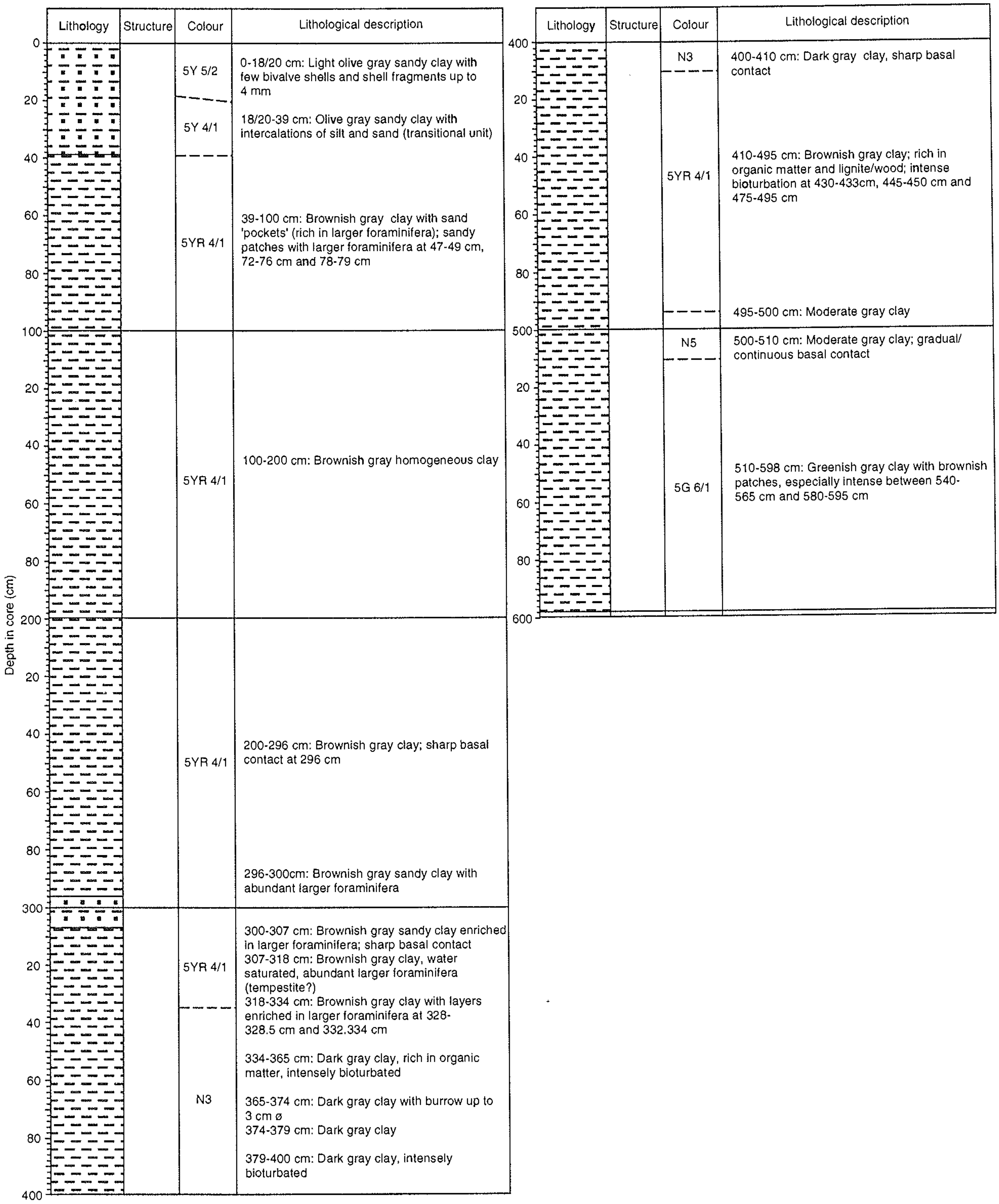


Objectives:

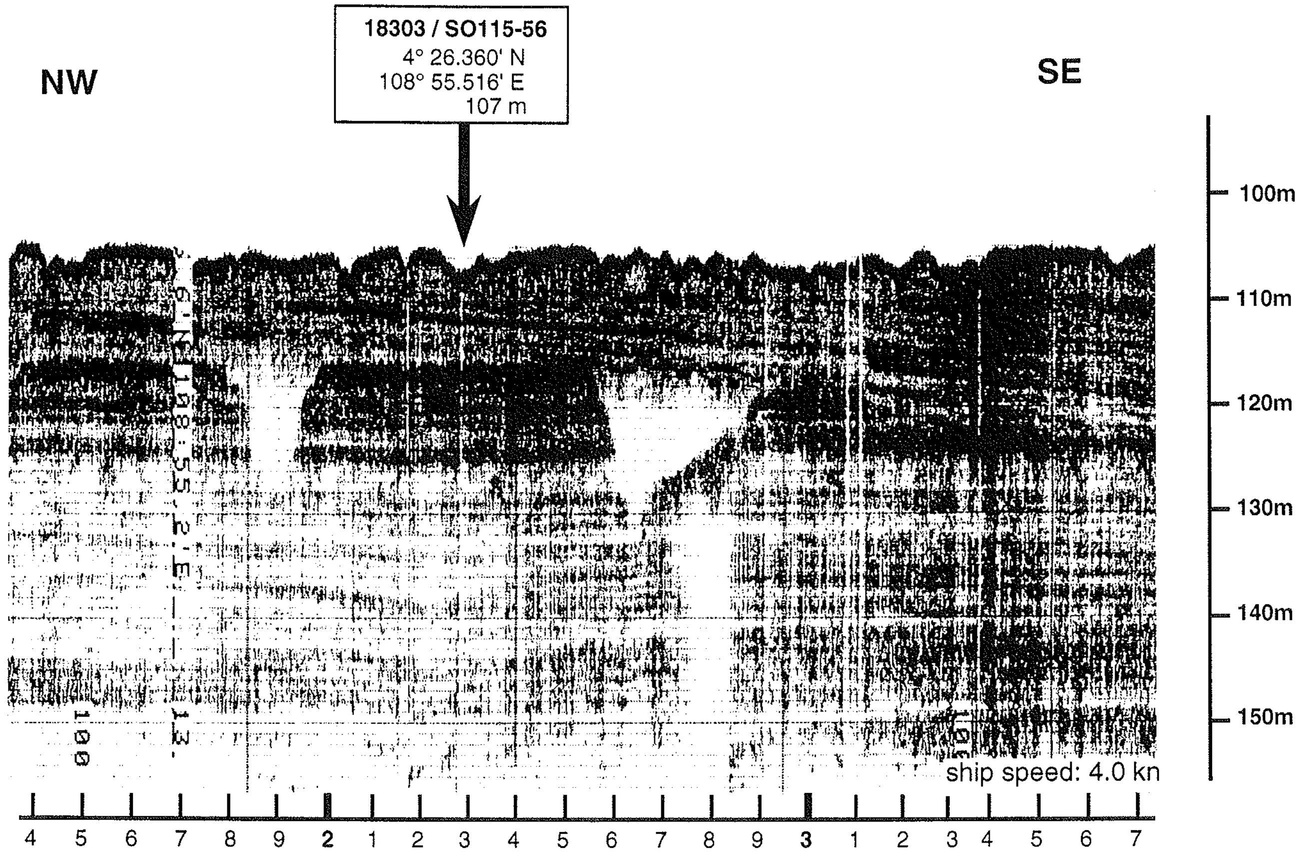
Coring a thin (approx. 4-5 m) acoustically semi-transparent layer, with a prominent hard bottom reflector and small scale erosive features on top.

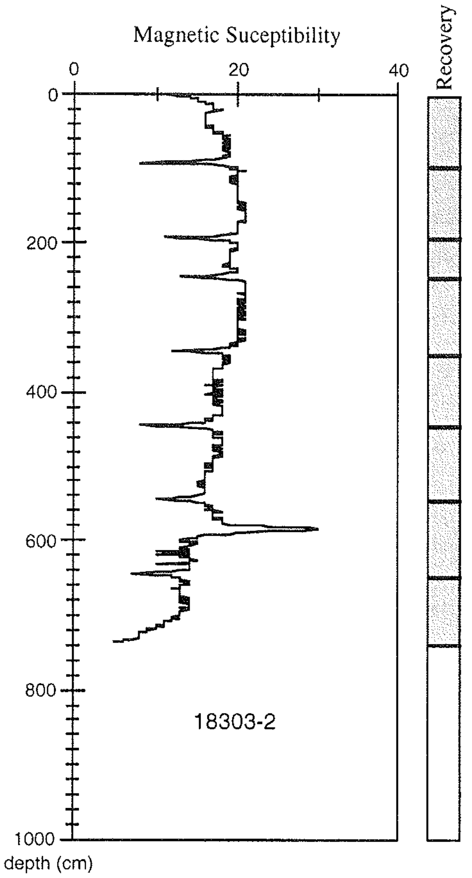
SONNE-115 **Water depth: 83 m**
Station:SO-115-55
Position: 4° 09.585 N; 108° 34.535 E

Core: SL 18302-2 **Recovery: 598 cm**



Colour	Lithological description
5Y 5/2	0-18/20 cm: Light olive gray sandy clay with few bivalve shells and shell fragments up to 4 mm
5Y 4/1	18/20-39 cm: Olive gray sandy clay with intercalations of silt and sand (transitional unit)
5YR 4/1	39-100 cm: Brownish gray clay with sand 'pockets' (rich in larger foraminifera); sandy patches with larger foraminifera at 47-49 cm, 72-76 cm and 78-79 cm
5YR 4/1	100-200 cm: Brownish gray homogeneous clay
5YR 4/1	200-296 cm: Brownish gray clay; sharp basal contact at 296 cm 296-300cm: Brownish gray sandy clay with abundant larger foraminifera
5YR 4/1	300-307 cm: Brownish gray sandy clay enriched in larger foraminifera; sharp basal contact 307-318 cm: Brownish gray clay, water saturated, abundant larger foraminifera (tempestite?) 318-334 cm: Brownish gray clay with layers enriched in larger foraminifera at 328-328.5 cm and 332.334 cm
N3	334-365 cm: Dark gray clay, rich in organic matter, intensely bioturbated 365-374 cm: Dark gray clay with burrow up to 3 cm ø 374-379 cm: Dark gray clay 379-400 cm: Dark gray clay, intensely bioturbated
N3	400-410 cm: Dark gray clay, sharp basal contact
5YR 4/1	410-495 cm: Brownish gray clay; rich in organic matter and lignite/wood; intense bioturbation at 430-433cm, 445-450 cm and 475-495 cm
	495-500 cm: Moderate gray clay
N5	500-510 cm: Moderate gray clay; gradual/ continuous basal contact
5G 6/1	510-598 cm: Greenish gray clay with brownish patches, especially intense between 540-565 cm and 580-595 cm



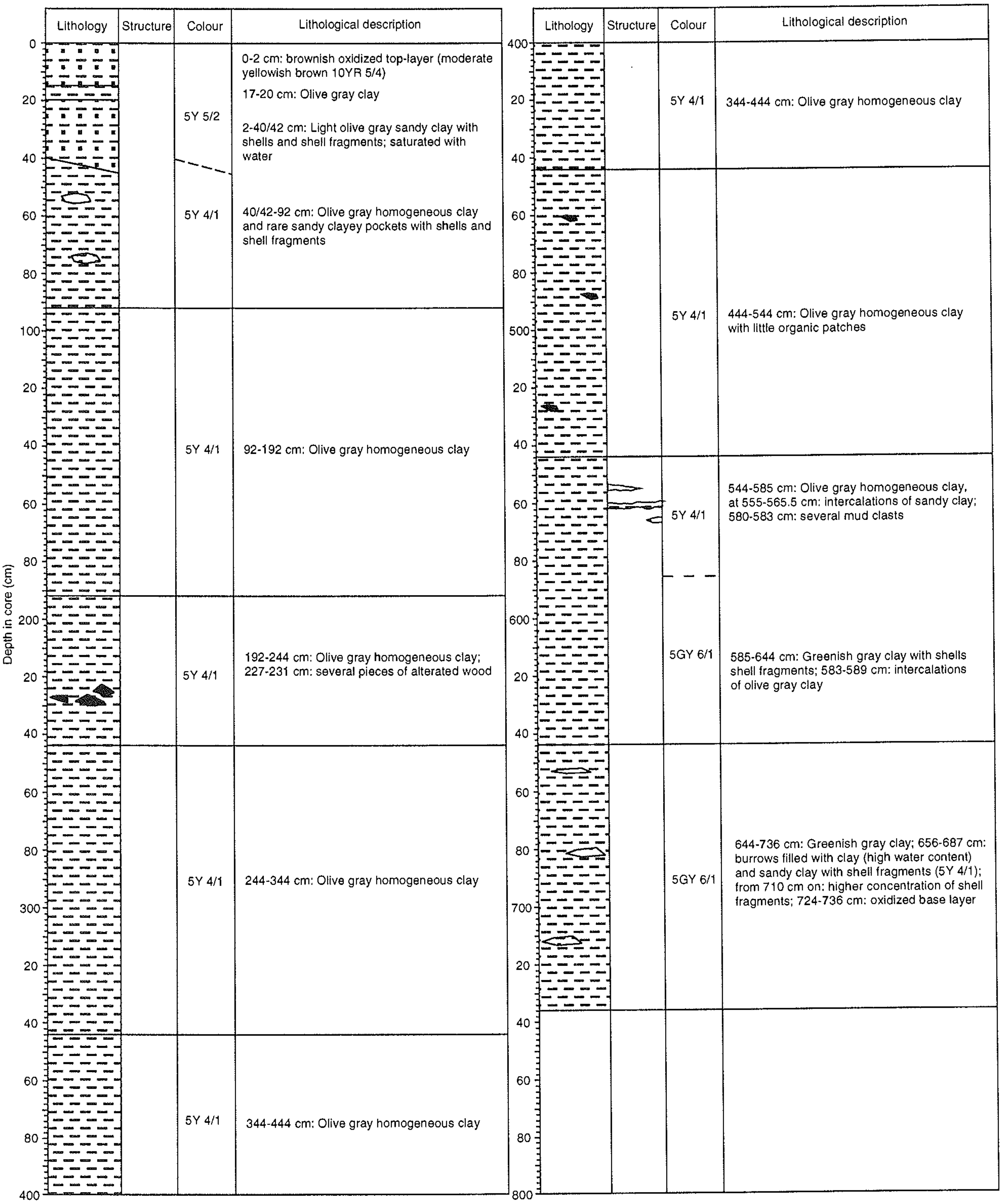


Objectives:

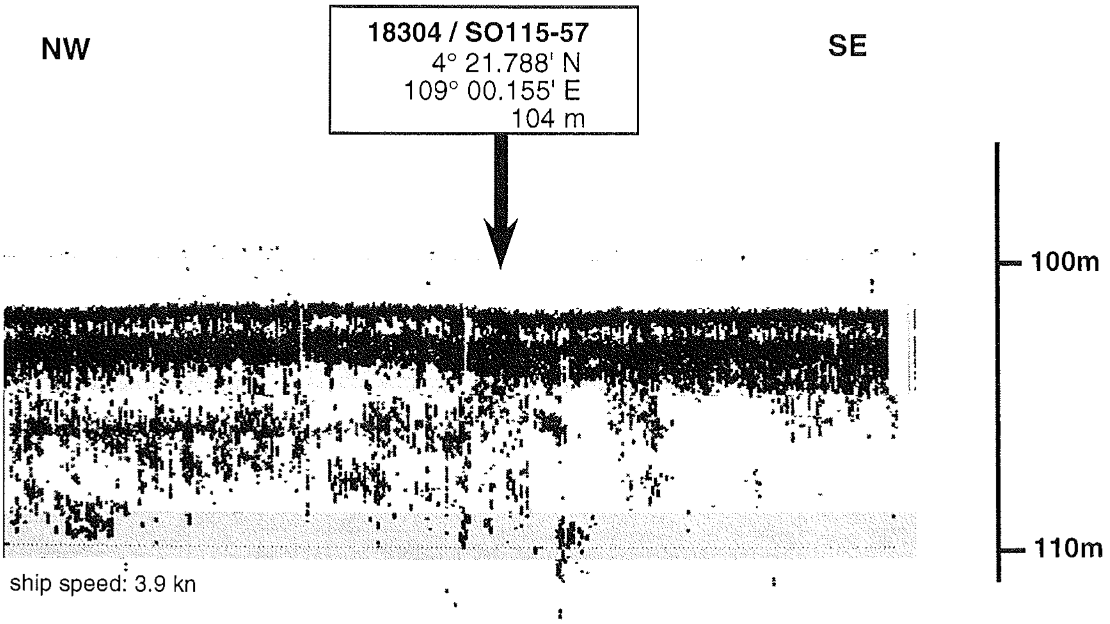
Coring an inclined onlap structure overlying a horizontally stratified sediment sequence. The core penetrated to the base of the onlapping sequence.

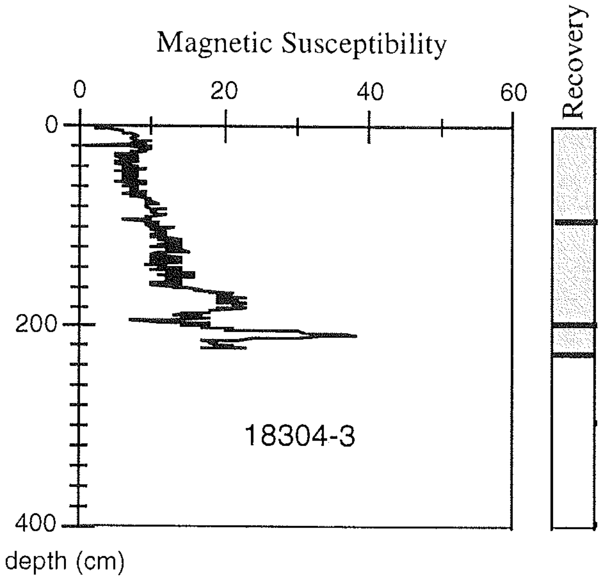
SONNE-115 **Water depth: 83 m**
Station:SO-115-56
Position: 4° 26.425 N; 108° 55.491 E

Core: SL 18303-2 **Recovery:** 736 cm

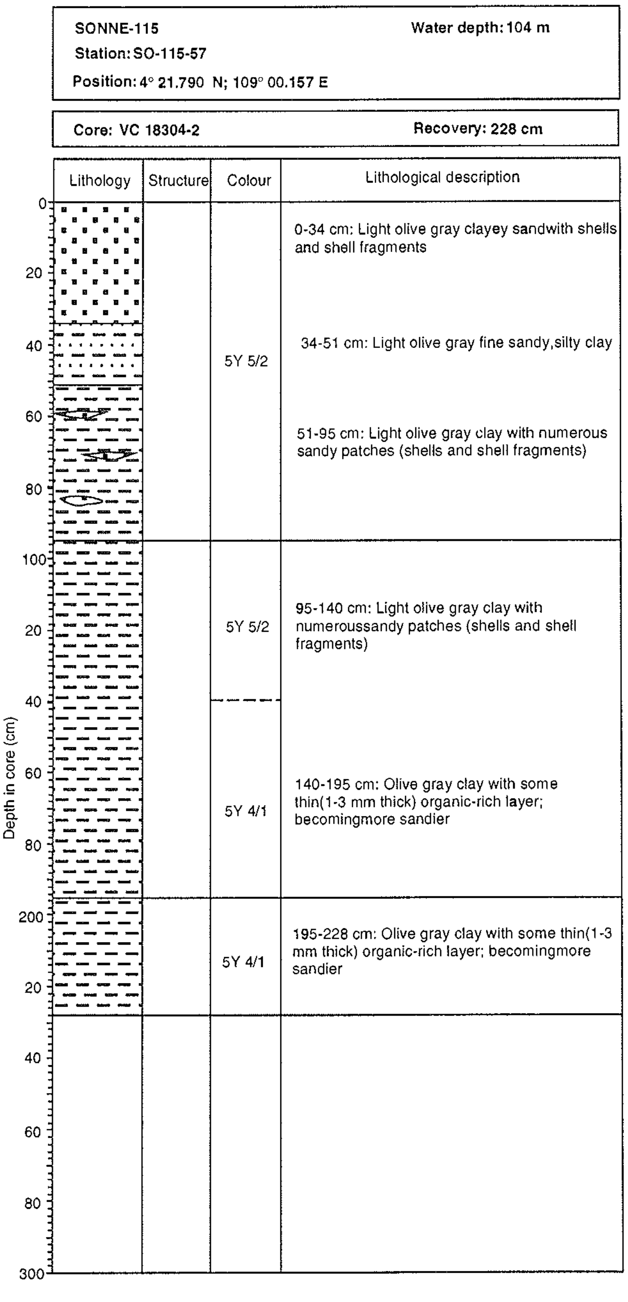


Colour	Lithological description
5Y 5/2	0-2 cm: brownish oxidized top-layer (moderate yellowish brown 10YR 5/4) 17-20 cm: Olive gray clay 2-40/42 cm: Light olive gray sandy clay with shells and shell fragments; saturated with water
5Y 4/1	40/42-92 cm: Olive gray homogeneous clay and rare sandy clayey pockets with shells and shell fragments
5Y 4/1	92-192 cm: Olive gray homogeneous clay
5Y 4/1	192-244 cm: Olive gray homogeneous clay; 227-231 cm: several pieces of alterated wood
5Y 4/1	244-344 cm: Olive gray homogeneous clay
5Y 4/1	344-444 cm: Olive gray homogeneous clay
5Y 4/1	344-444 cm: Olive gray homogeneous clay
5Y 4/1	444-544 cm: Olive gray homogeneous clay with little organic patches
5Y 4/1	544-585 cm: Olive gray homogeneous clay, at 555-565.5 cm: intercalations of sandy clay; 580-583 cm: several mud clasts
5GY 6/1	585-644 cm: Greenish gray clay with shells shell fragments; 583-589 cm: intercalations of olive gray clay
5GY 6/1	644-736 cm: Greenish gray clay; 656-687 cm: burrows filled with clay (high water content) and sandy clay with shell fragments (5Y 4/1); from 710 cm on: higher concentration of shell fragments; 724-736 cm: oxidized base layer





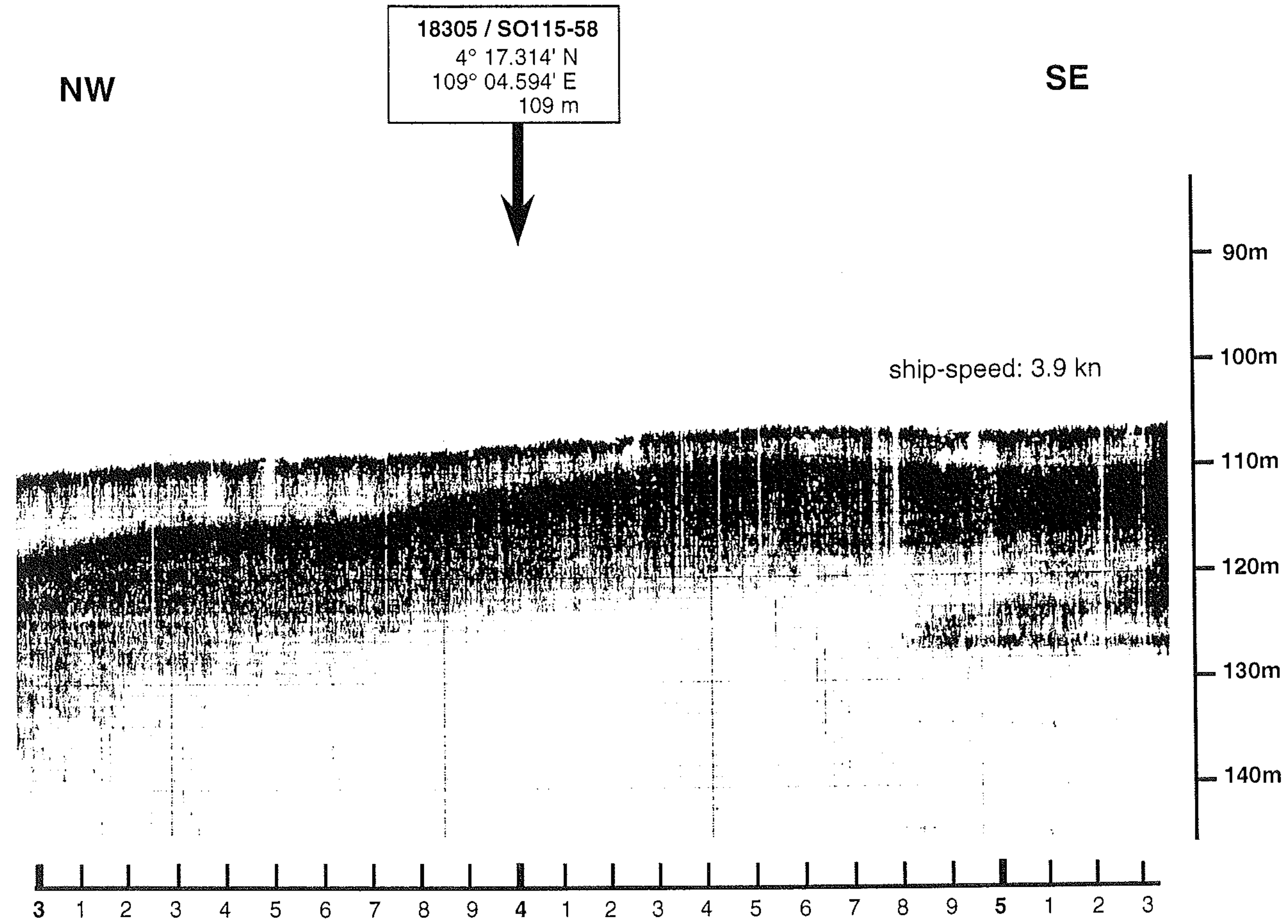
Objectives: Coring a prominent hard reflector (sequence boundary?) below a thin acoustically transparent layer.

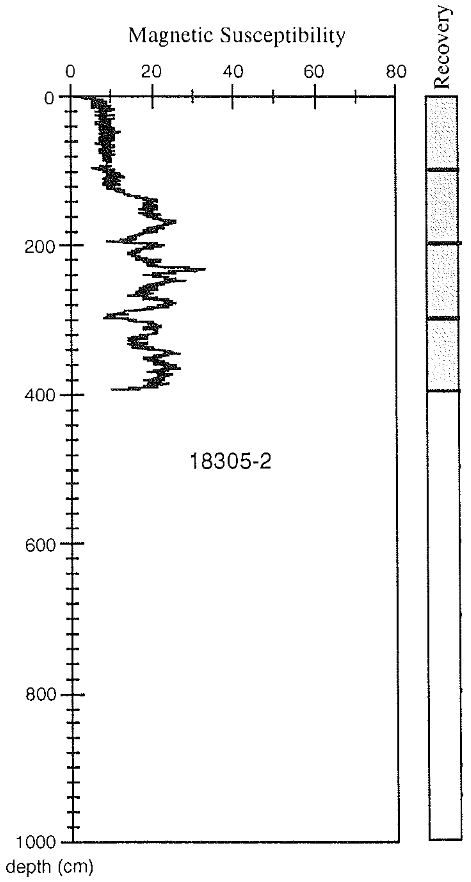


SONNE-115 Water depth: 104 m
Station: SO-115-57
Position: 4° 21.790 N; 109° 00.157 E

Core: VC 18304-2 Recovery: 228 cm

Lithology	Structure	Colour	Lithological description
			0-34 cm: Light olive gray clayey sandwith shells and shell fragments
		5Y 5/2	34-51 cm: Light olive gray fine sandy,silty clay
			51-95 cm: Light olive gray clay with numerous sandy patches (shells and shell fragments)
		5Y 5/2	95-140 cm: Light olive gray clay with numeroussandy patches (shells and shell fragments)
		5Y 4/1	140-195 cm: Olive gray clay with some thin(1-3 mm thick) organic-rich layer; becomingmore sandier
		5Y 4/1	195-228 cm: Olive gray clay with some thin(1-3 mm thick) organic-rich layer; becomingmore sandier



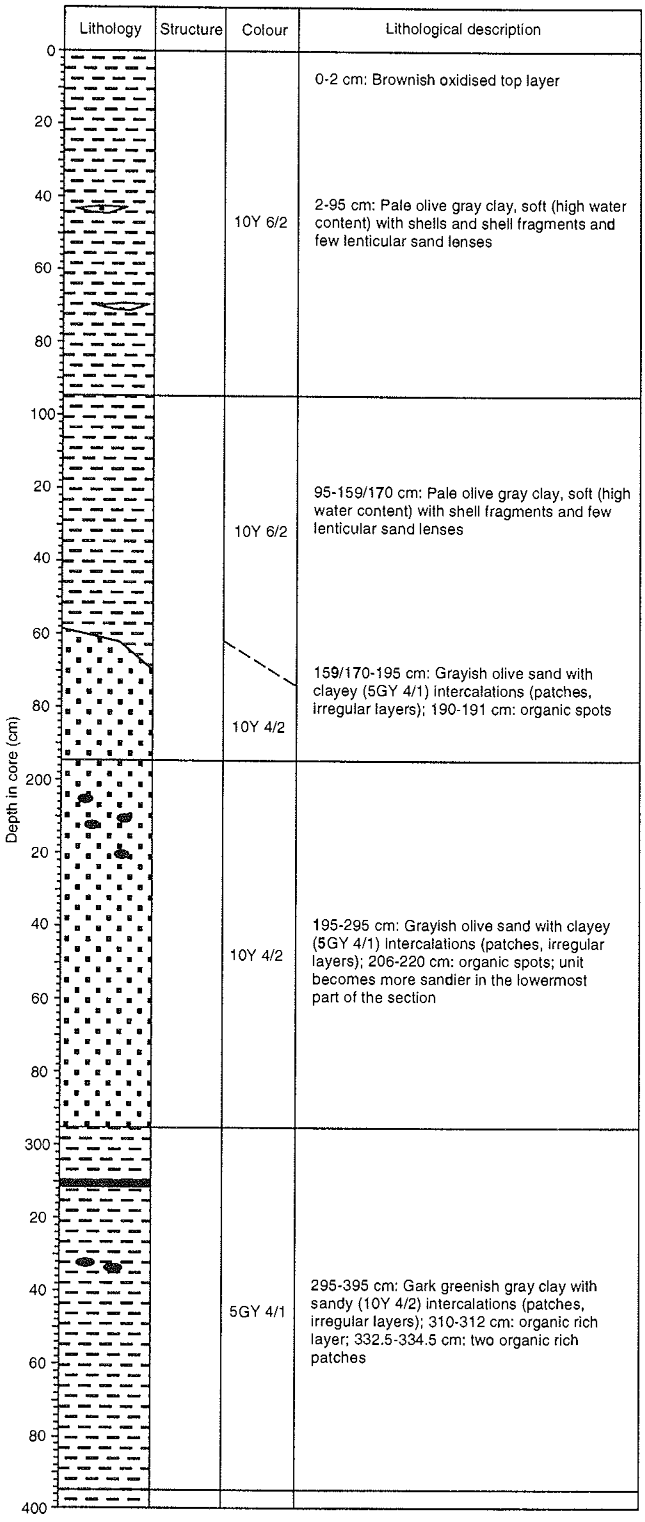


Objectives:

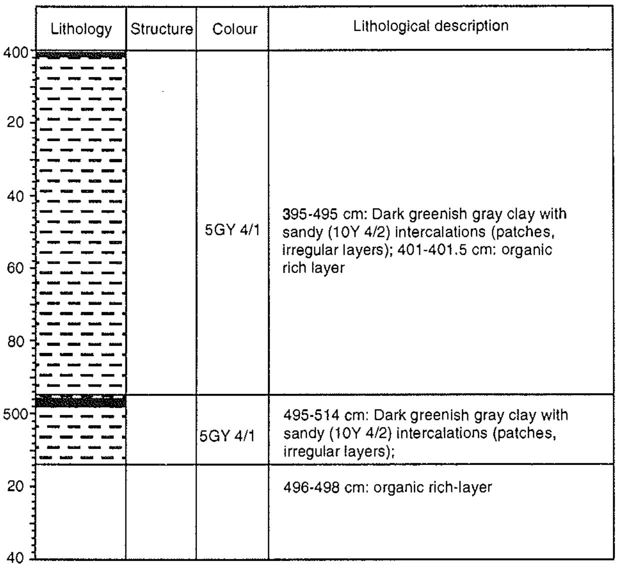
Coring the shoulder of a large incised valley structure with a prominent bottom reflector at about 3 m below seafloor.

SONNE-115 **Water depth: 109 m**
Station: SO-115-58
Position: 4° 17.318 N; 109° 04.599 E

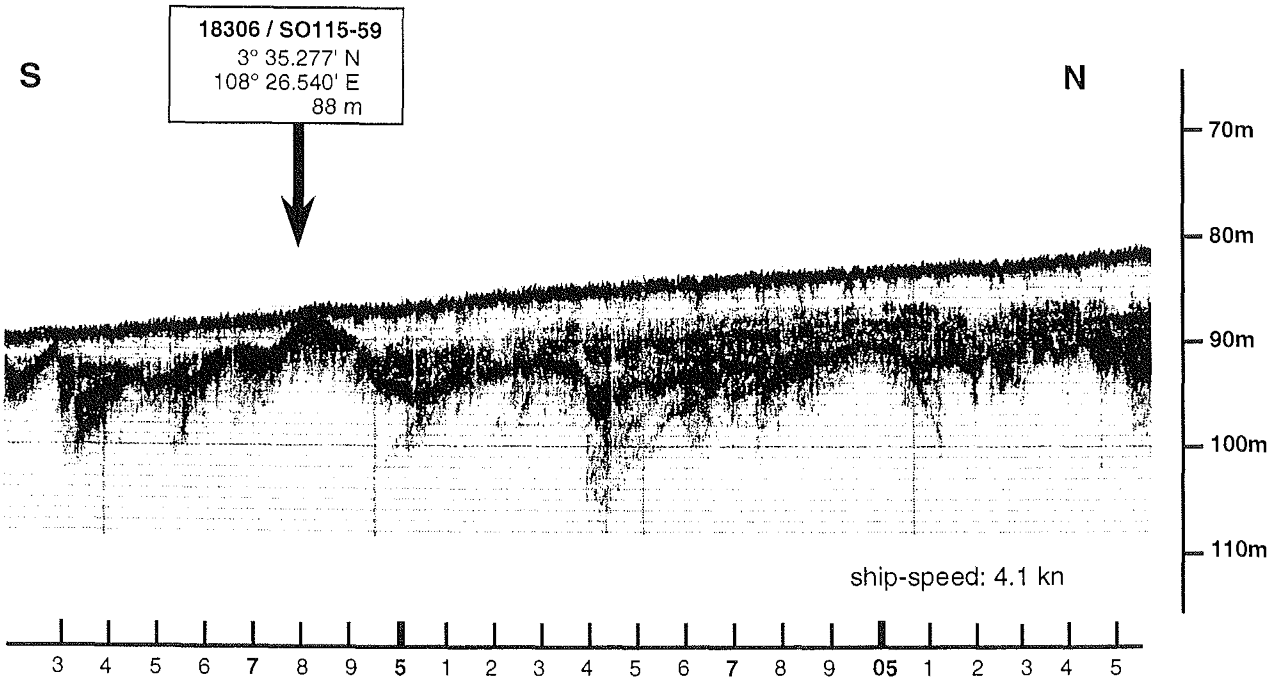
Core: VC 18305-2 **Recovery: 514 cm**

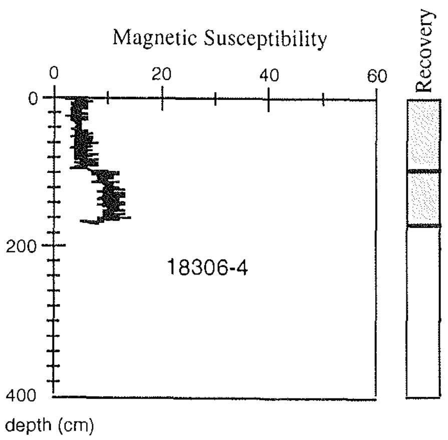


Lithology	Structure	Colour	Lithological description
			0-2 cm: Brownish oxidised top layer
		10Y 6/2	2-95 cm: Pale olive gray clay, soft (high water content) with shells and shell fragments and few lenticular sand lenses
		10Y 6/2	95-159/170 cm: Pale olive gray clay, soft (high water content) with shell fragments and few lenticular sand lenses
		10Y 4/2	159/170-195 cm: Grayish olive sand with clayey (5GY 4/1) intercalations (patches, irregular layers); 190-191 cm: organic spots
		10Y 4/2	195-295 cm: Grayish olive sand with clayey (5GY 4/1) intercalations (patches, irregular layers); 206-220 cm: organic spots; unit becomes more sandier in the lowermost part of the section
		5GY 4/1	295-395 cm: Gark greenish gray clay with sandy (10Y 4/2) intercalations (patches, irregular layers); 310-312 cm: organic rich layer; 332.5-334.5 cm: two organic rich patches

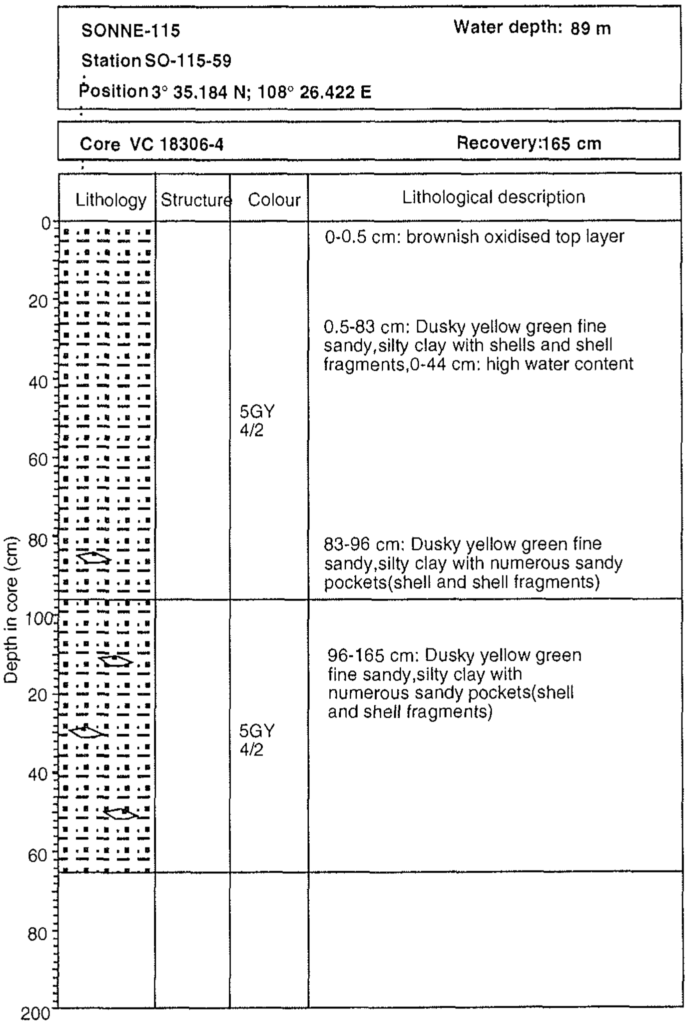


Lithology	Structure	Colour	Lithological description
		5GY 4/1	395-495 cm: Dark greenish gray clay with sandy (10Y 4/2) intercalations (patches, irregular layers); 401-401.5 cm: organic rich layer
		5GY 4/1	495-514 cm: Dark greenish gray clay with sandy (10Y 4/2) intercalations (patches, irregular layers);
			496-498 cm: organic rich-layer



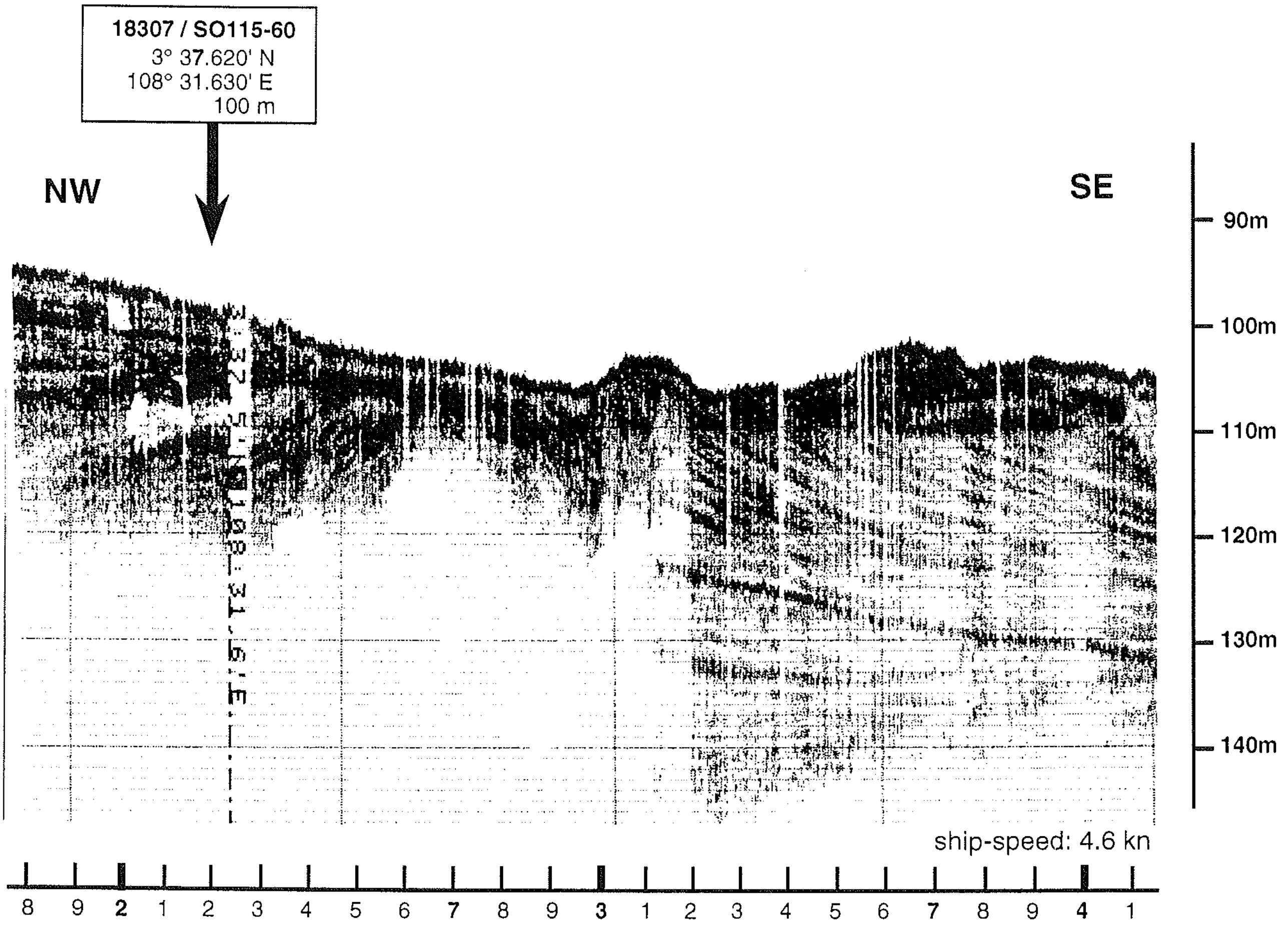


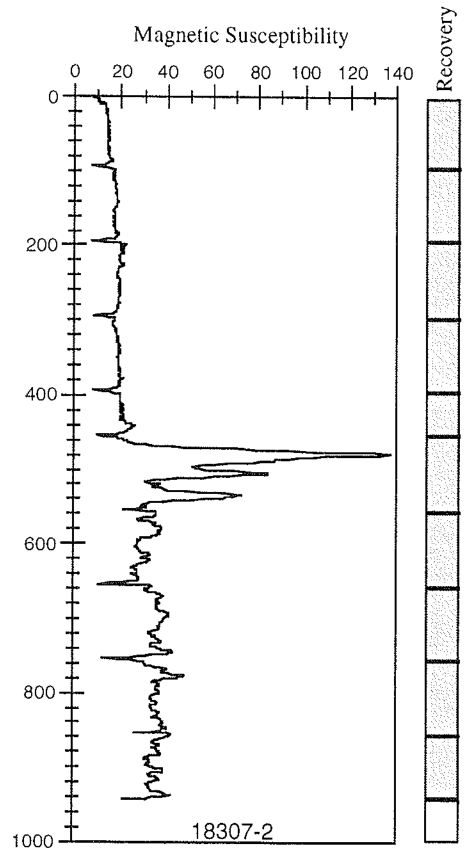
Objectives: Coring an erosional surface (post-Pleistocene sequence boundary?), which is close to the seafloor at the coring locality. Southern slope of Natuna Island.


SONNE-115 Water depth: 89 m
Station SO-115-59
Position 3° 35.184 N; 108° 26.422 E

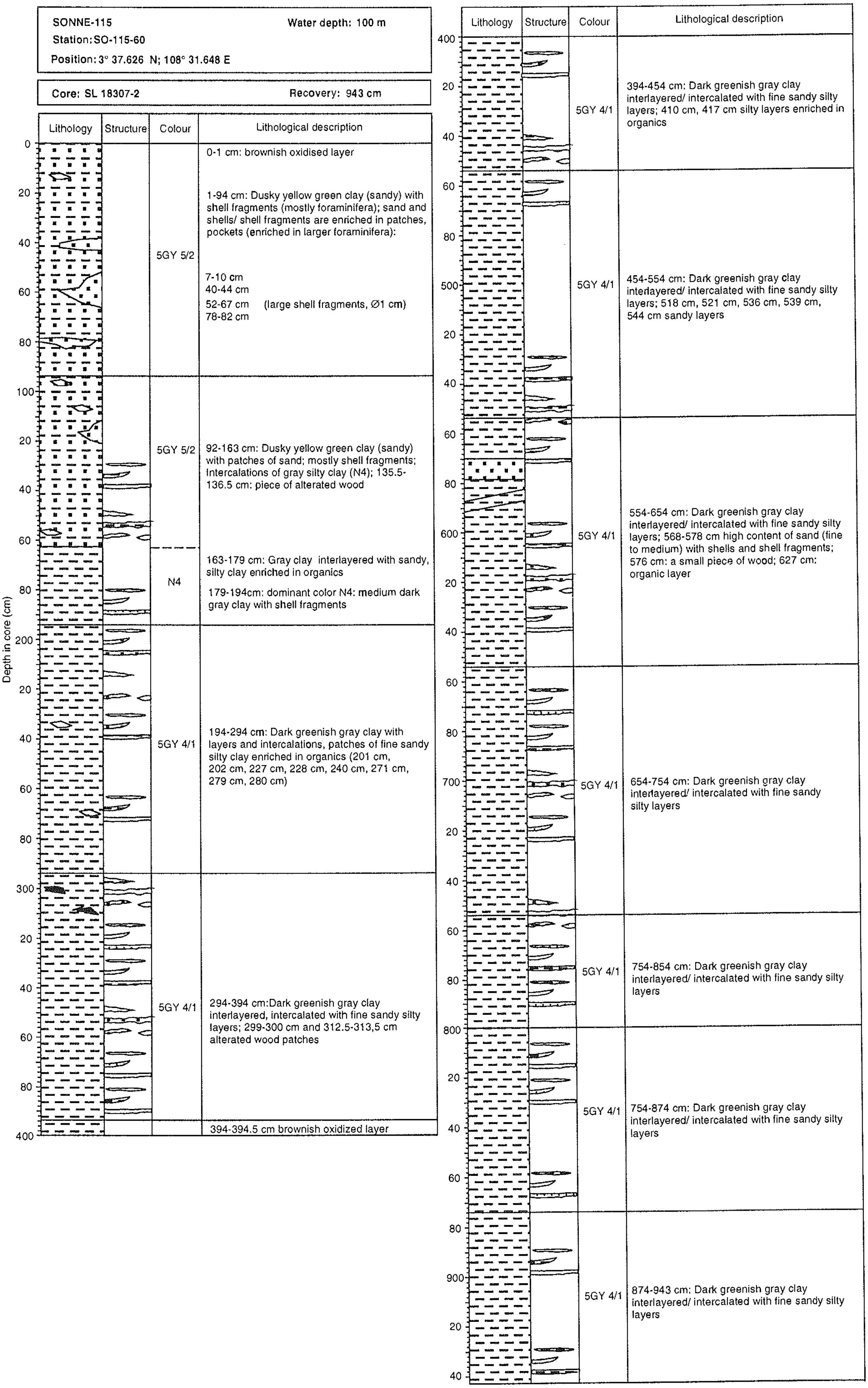
Core VC 18306-4 Recovery:165 cm

Lithology	Structure	Colour	Lithological description
		5GY 4/2	0-0.5 cm: brownish oxidised top layer 0.5-83 cm: Dusky yellow green fine sandy,silty clay with shells and shell fragments,0-44 cm: high water content 83-96 cm: Dusky yellow green fine sandy,silty clay with numerous sandy pockets(shell and shell fragments)
		5GY 4/2	96-165 cm: Dusky yellow green fine sandy,silty clay with numerous sandy pockets(shell and shell fragments)





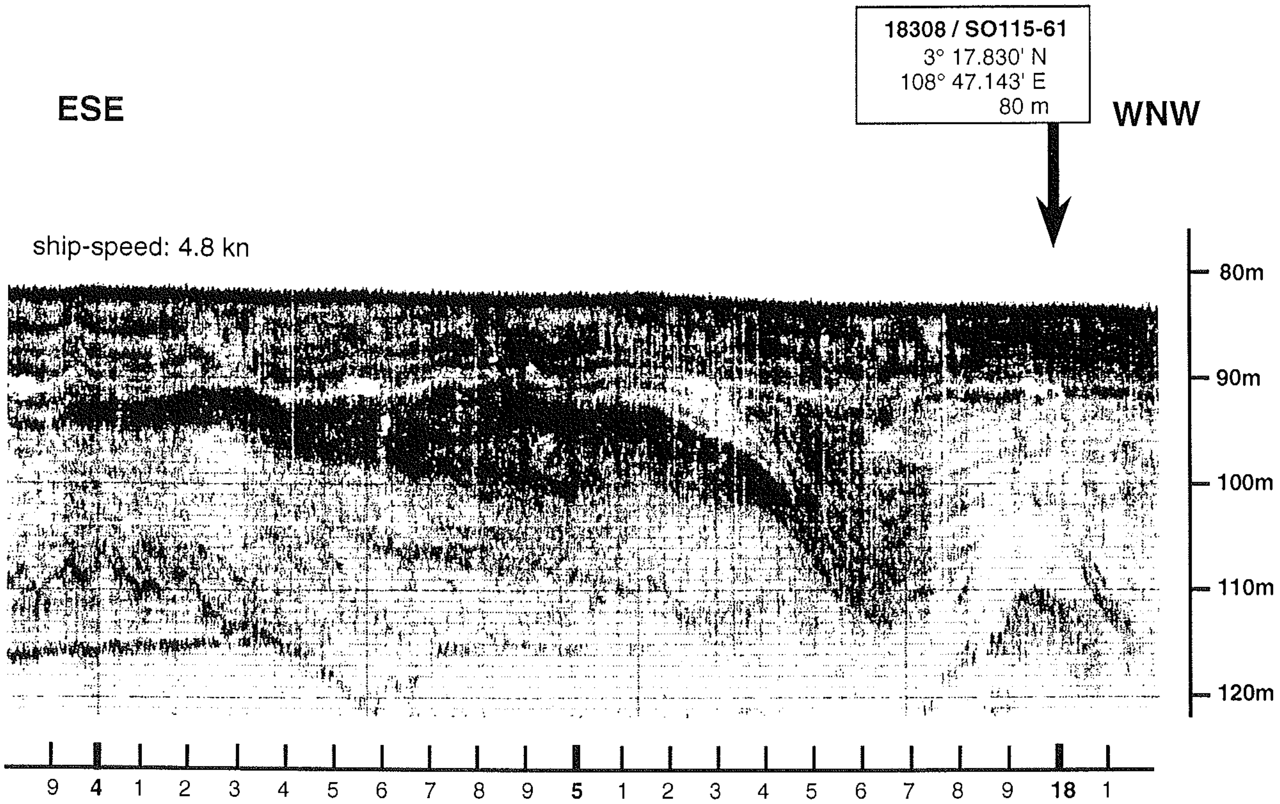
Objectives: Coring the foot of the slope SE of Natuna Island close to the margin of the Molengraaff river system.

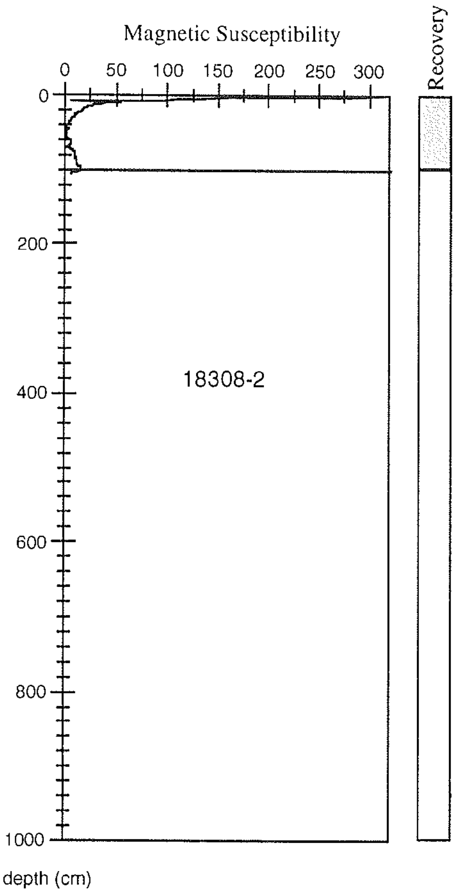


SONNE-115 **Water depth: 100 m**
Station: SO-115-60
Position: 3° 37.626 N; 108° 31.648 E

Core: SL 18307-2 **Recovery: 943 cm**

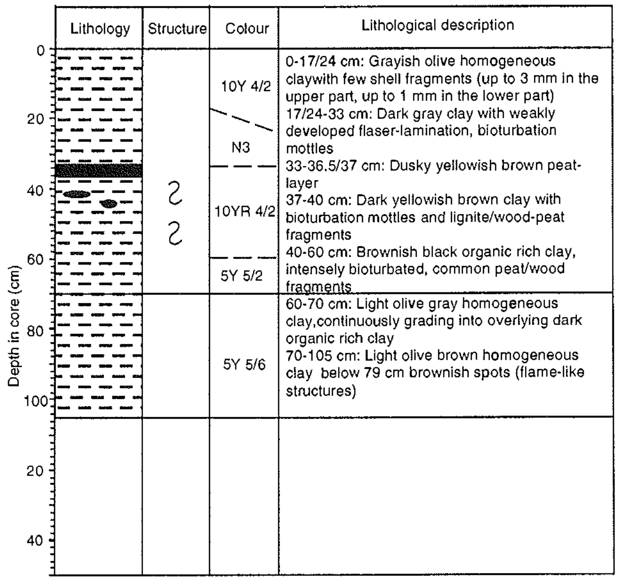
Colour	Lithological description
5GY 5/2	0-1 cm: brownish oxidised layer 1-94 cm: Dusky yellow green clay (sandy) with shell fragments (mostly foraminifera); sand and shells/ shell fragments are enriched in patches, pockets (enriched in larger foraminifera): 7-10 cm 40-44 cm 52-67 cm (large shell fragments, Ø1 cm) 78-82 cm
5GY 5/2	92-163 cm: Dusky yellow green clay (sandy) with patches of sand; mostly shell fragments; Intercalations of gray silty clay (N4); 135.5-136.5 cm: piece of alterated wood
N4	163-179 cm: Gray clay interlayered with sandy, silty clay enriched in organics 179-194cm: dominant color N4: medium dark gray clay with shell fragments
5GY 4/1	194-294 cm: Dark greenish gray clay with layers and intercalations, patches of fine sandy silty clay enriched in organics (201 cm, 202 cm, 227 cm, 228 cm, 240 cm, 271 cm, 279 cm, 280 cm)
5GY 4/1	294-394 cm:Dark greenish gray clay interlayered, intercalated with fine sandy silty layers; 299-300 cm and 312.5-313,5 cm alterated wood patches
	394-394.5 cm brownish oxidized layer
5GY 4/1	394-454 cm: Dark greenish gray clay interlayered/ intercalated with fine sandy silty layers; 410 cm, 417 cm silty layers enriched in organics
5GY 4/1	454-554 cm: Dark greenish gray clay interlayered/ intercalated with fine sandy silty layers; 518 cm, 521 cm, 536 cm, 539 cm, 544 cm sandy layers
5GY 4/1	554-654 cm: Dark greenish gray clay interlayered/ intercalated with fine sandy silty layers; 568-578 cm high content of sand (fine to medium) with shells and shell fragments; 576 cm: a small piece of wood; 627 cm: organic layer
5GY 4/1	654-754 cm: Dark greenish gray clay interlayered/ intercalated with fine sandy silty layers
5GY 4/1	754-854 cm: Dark greenish gray clay interlayered/ intercalated with fine sandy silty layers
5GY 4/1	754-874 cm: Dark greenish gray clay interlayered/ intercalated with fine sandy silty layers
5GY 4/1	874-943 cm: Dark greenish gray clay interlayered/ intercalated with fine sandy silty layers





SONNE-115 Water depth: 80 m
Station: SO-115-61
Position: 3° 17.867 N; 108°47.138 E

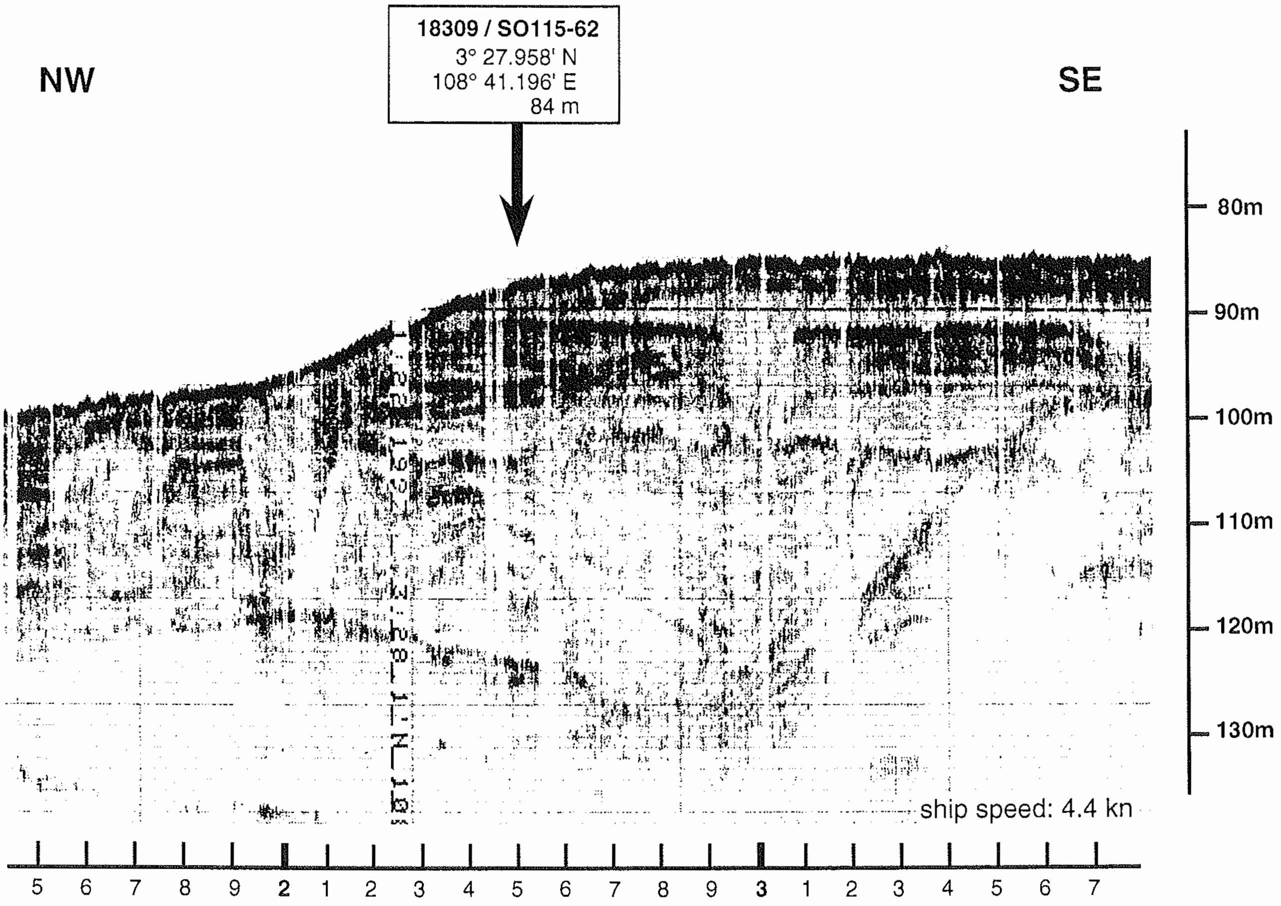
Core: SL 18308-2 Recovery: 105 cm

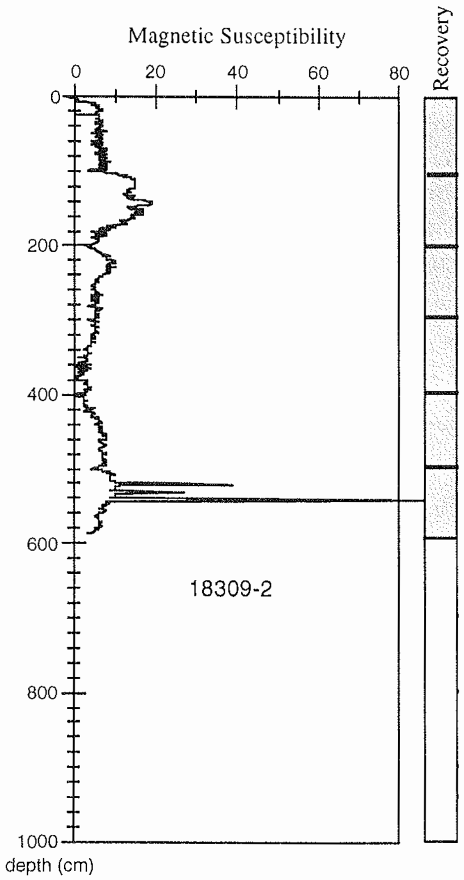


0-17/24 cm: Grayish olive homogeneous claywith few shell fragments (up to 3 mm in the upper part, up to 1 mm in the lower part)
17/24-33 cm: Dark gray clay with weakly developed flaser-lamination, bioturbation mottles
33-36.5/37 cm: Dusky yellowish brown peat-layer
37-40 cm: Dark yellowish brown clay with bioturbation mottles and lignite/wood-peat fragments
40-60 cm: Brownish black organic rich clay, intensely bioturbated, common peat/wood fragments
60-70 cm: Light olive gray homogeneous clay,continuously grading into overlying dark organic rich clay
70-105 cm: Light olive brown homogeneous clay below 79 cm brownish spots (flame-like structures)

Objectives: Coring the eastern part of the Molengraaff valley system. Several strong acoustic reflectors indicate highly consolidated sediment.

Remarks: Long (11m) gravity corer was bent at this station and had a poor recovery of 105 cm .

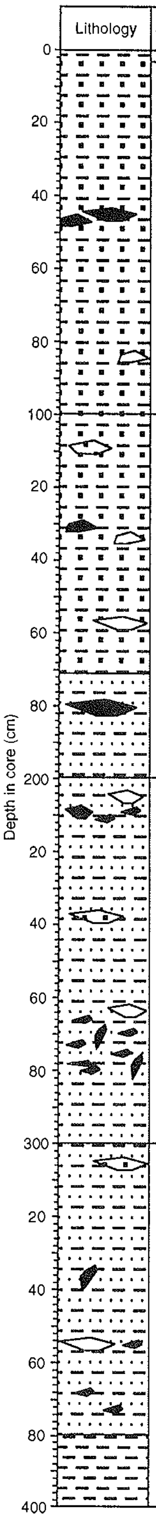




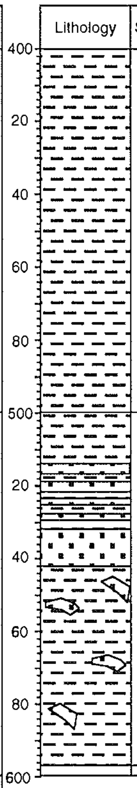
Objectives: Coring the eastern shoulder of the actual depression of the Molengraaff valley. The coring position was selected to penetrate several deeper reflectors.

SONNE-115 **Water depth: 83 m**
Station: SO-115-62
Position: 3° 27.959 N; 108° 41.174 E

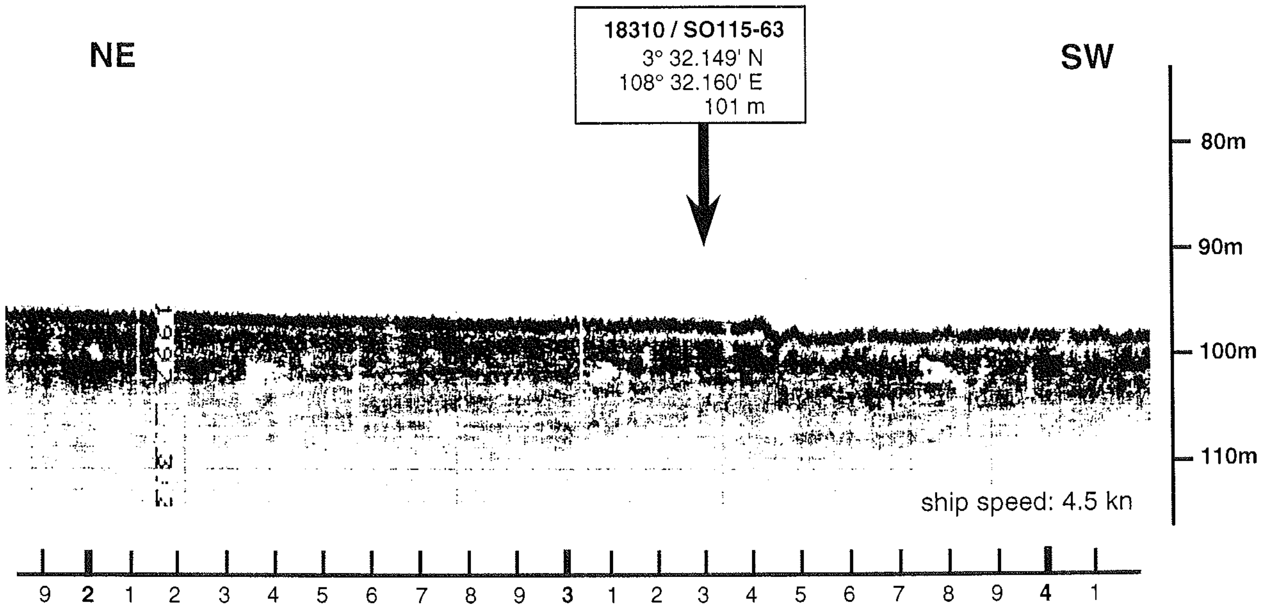
Core: VC 18309-2 **Recovery: 597 cm**

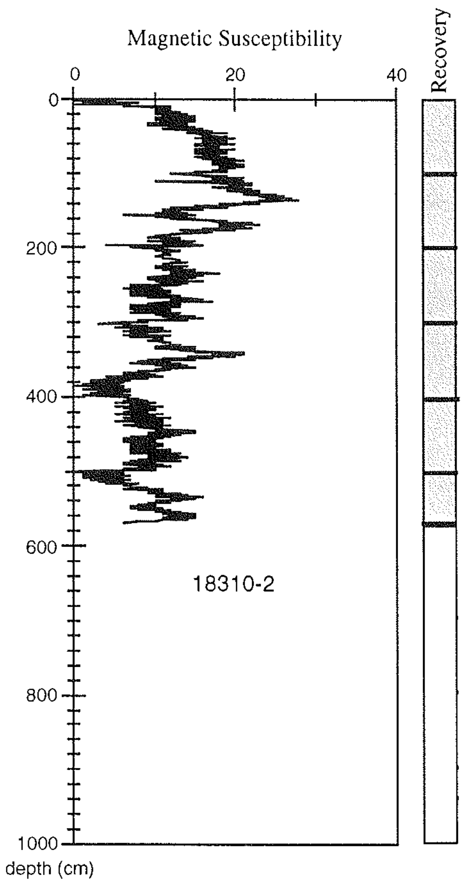


Lithology	Structure	Colour	Lithological description
	v	5GY 4/1	4-5 cm: soft, high water content, disturbed, brownish oxidized layer 0-100 cm: Dark greenish gray sandy clay with shells and shell fragments; 43-45 cm organic patches
		5GY 4/1	100-171 cm: Dark greenish gray sandy/ silty clay with sandy pockets;132-134 cm: high concentration of shells 171-200 cm: Dark greenish gray silty clay, finer than above, more organic material, still some sandy/silty pockets; 177-183 cm: root (in situ ?)
		5GY 4/1	200-300 cm: Dark greenish gray silty clay with sandy/silty pockets; 206-212 cm: numerous wood pieces and organic material; 258-281 cm: Large wood (root), in situ ?
		5GY 4/1	300-380 cm: Dark greenish gray silty clay with sandy/silty pockets; Unit ends with thick peat layer from 373-380 cm 380-400 cm: Dark greenish gray clay, very dry, banding througout the unit, probably due to coring



Lithology	Structure	Colour	Lithological description
		5GY 4/1	400-500 cm: Dark greenish gray clay, very dry, banding throughout the unit, probably due to coring, orange weathering patches
		5GY 4/1	500-597 cm: Dark greenish gray clay, very dry, layering throughout the unit, probably due to coring, orange weathering patches; 515-532 cm: sandy layers, 532-587 cm: sandy pockets; 532-542 cm: sandy layer





Objectives:

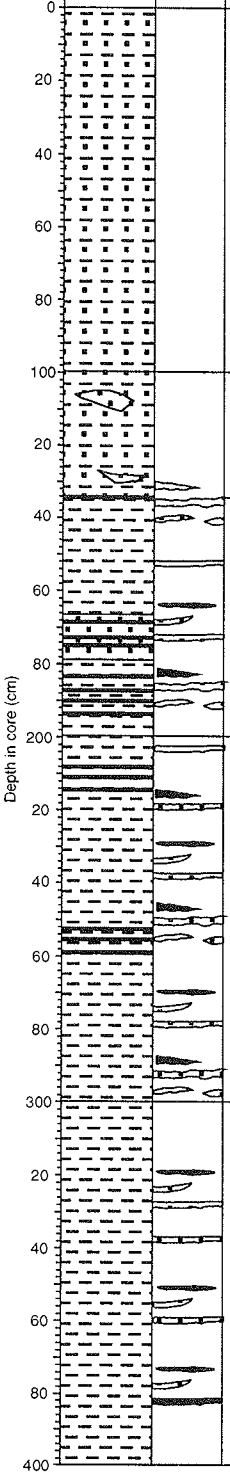
Coring an onlap structure in the center of the Molengraaff valley above downvalley dipping strata.

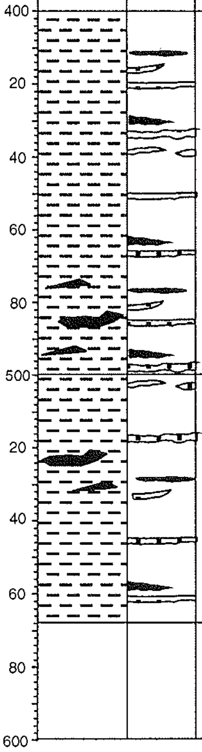
Remarks:

Convential ^{14}C dating of a larger wood fragment (mangrove root?) at 490-493 cm depth in core yielded an age of 13260 ^{14}C years.

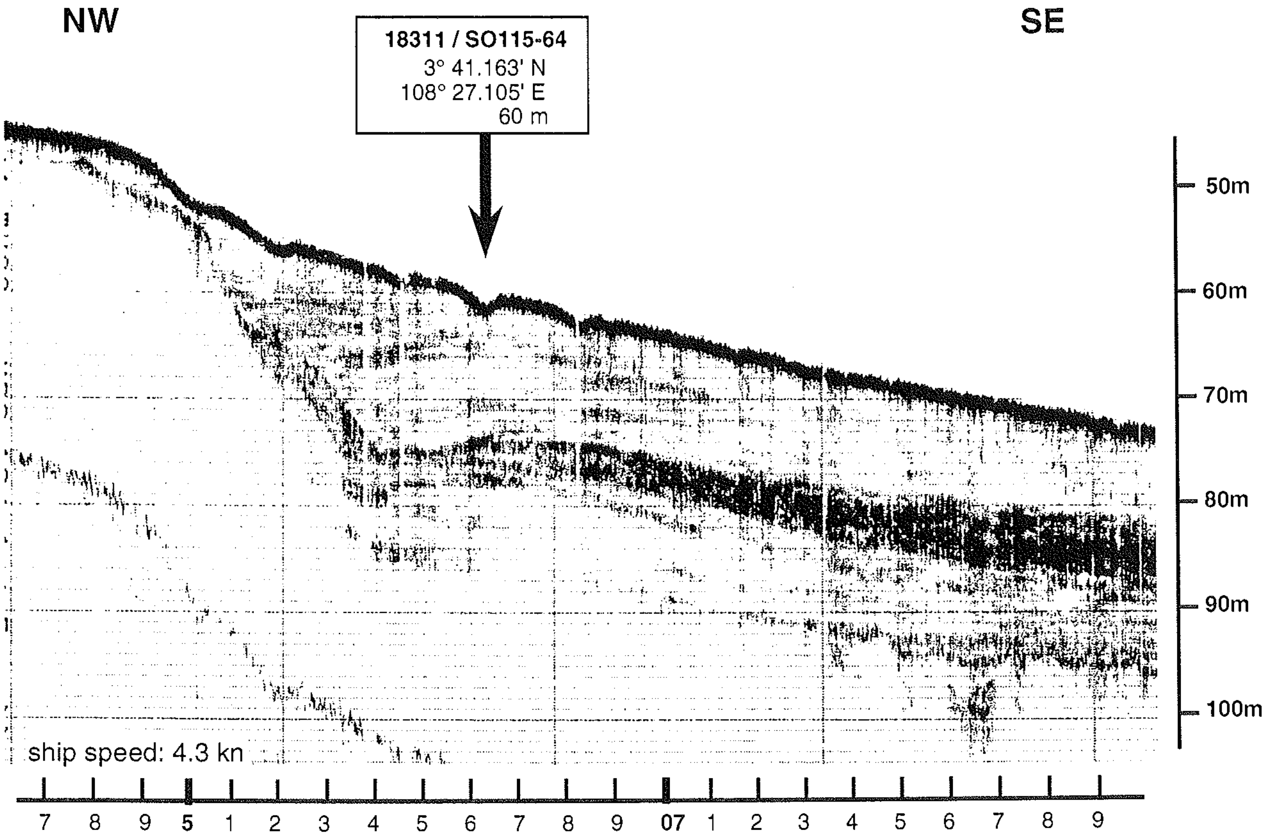
SONNE-115 **Water depth: 100 m**
Station: SO-115-63
Position: 3° 32.131 N; 108° 32.131 E

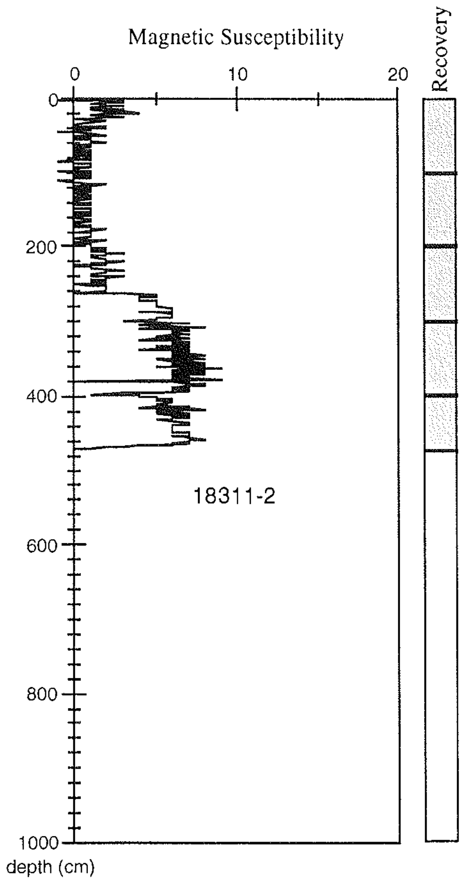
Core: VC 18310-2 **Recovery: 568 cm**





Lithology	Structure	Colour	Lithological description
		10Y 6/2	Brownish oxidised top layer 0-100 cm: Grayish olive sandy clay with shells and shell fragments, high water content
		10Y 6/2	100-134 cm: Grayish olive sandy clay with shells and shell fragments;111-124 cm sandy pockets with organics
		10Y 6/2	134-200 cm: Intermixing of grayish olive clay with sandy layers and organic layers; 134-135 cm and 166-179 cm: Olive gray sand with some thin organic layers, very high water content; 182-195cm: high concentration of organic-rich layers
		5Y 4/1	200-300 cm: Intermixing of olive gray clay with sandy layers and organic layers; 208-214.5 cm and 255-261 cm: high concentration of organic-rich layers :
		5Y 4/1	300-400 cm: Intermixing of olive gray clay with sandy layers with and organic layers, increasing sand content; 330-332 cm: Moderate brown wood (root)
		5Y 4/1	400-500 cm: Intermixing of olive gray clay with sandy layers and organic layers; 472-497.5 cm: numerous wood fragments (reddish brown - black)
		5Y 4/1	500-568 cm: Intermixing of olive gray clay with sandy layers and organic layer; 521-524 cm and 531-535 cm: wood fragments



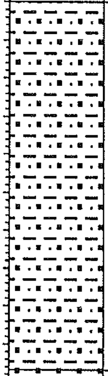
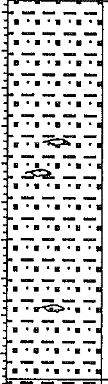
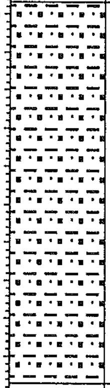
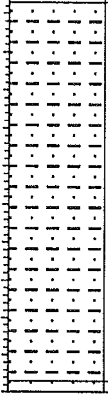
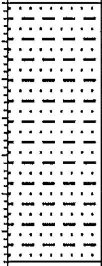


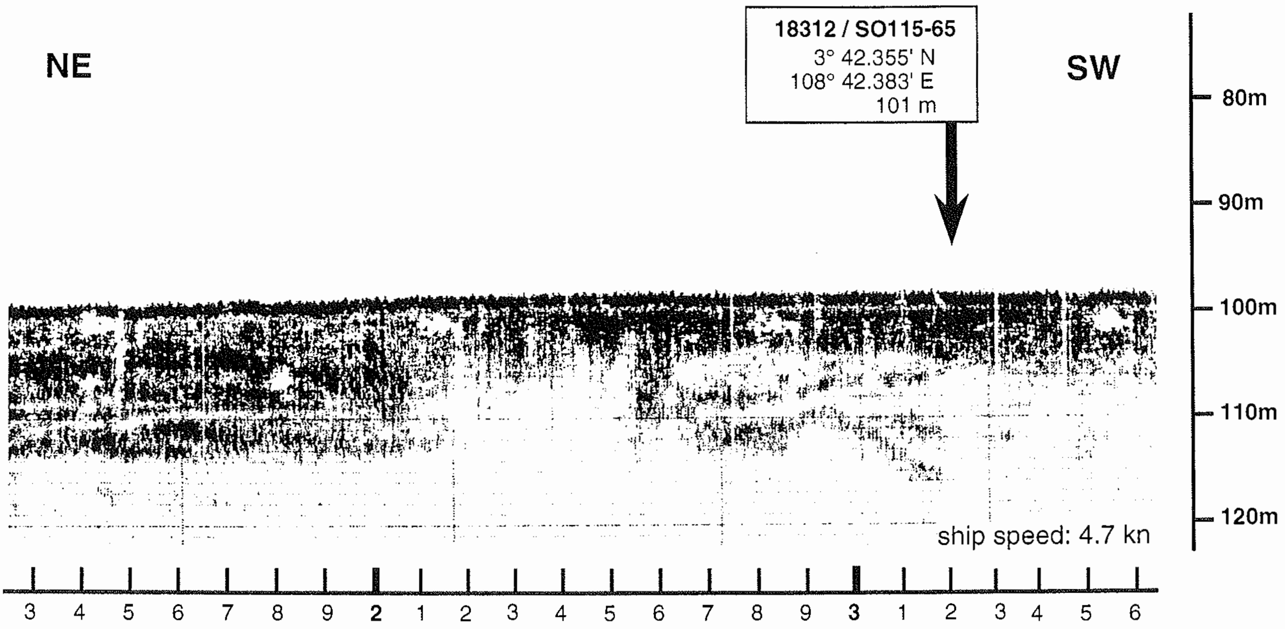
Objectives: Coring a thick acoustically transparent layer with several weak internal reflectors at the southeastern slope of Natuna Island.

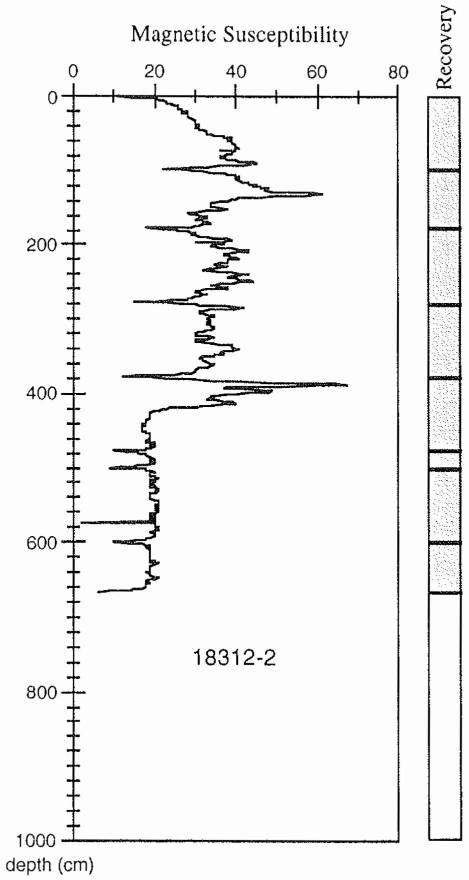
SONNE-115 Water depth: 60 m
Station: SO-115-64
Position: 3° 41.191 N; 108° 27.093 E

Core: VC 18311-2 Recovery: 468 cm

Depth in core (cm)

Lithology	Structure	Colour	Lithological description
		5Y 5/2	0-2 cm: Brownish oxidized top layer 2-97 cm: Light olive gray silty- fine sandy homogeneous clay
		5Y 5/2	97-197 cm: Light olive gray silty- fine sandy homogeneous clay with sandy 'pockets' (up to 0.5 cm) with shells and shell fragments (biogenic fragments) at 135-136 cm, 142-144 cm, 178-179 cm
	ƨ ƨ	5Y 5/2	197-264 cm: Light olive gray silty-fine sandy clay; in the lowermost part of this section increasing content of foraminifera, shells and shell fragments; 244-248 cm: large burrow filled with shells and shell fragments 264-281 cm: bioturbation horizon (burrows) 281-297 cm: Light olive gray silty-fine sandy clay
	ƨ	5Y 4/1- 5GY 4/1	297-397 cm: Olive gray-dark greenish gray silty homogeneous clay; single burrows in the uppermost part of the section 4 (302-308 cm, 319-328 cm)
		5Y 4/1- 5GY 4/1	400-468 cm: Olive gray- dark greenish gray homogeneous silty clay





Objective:

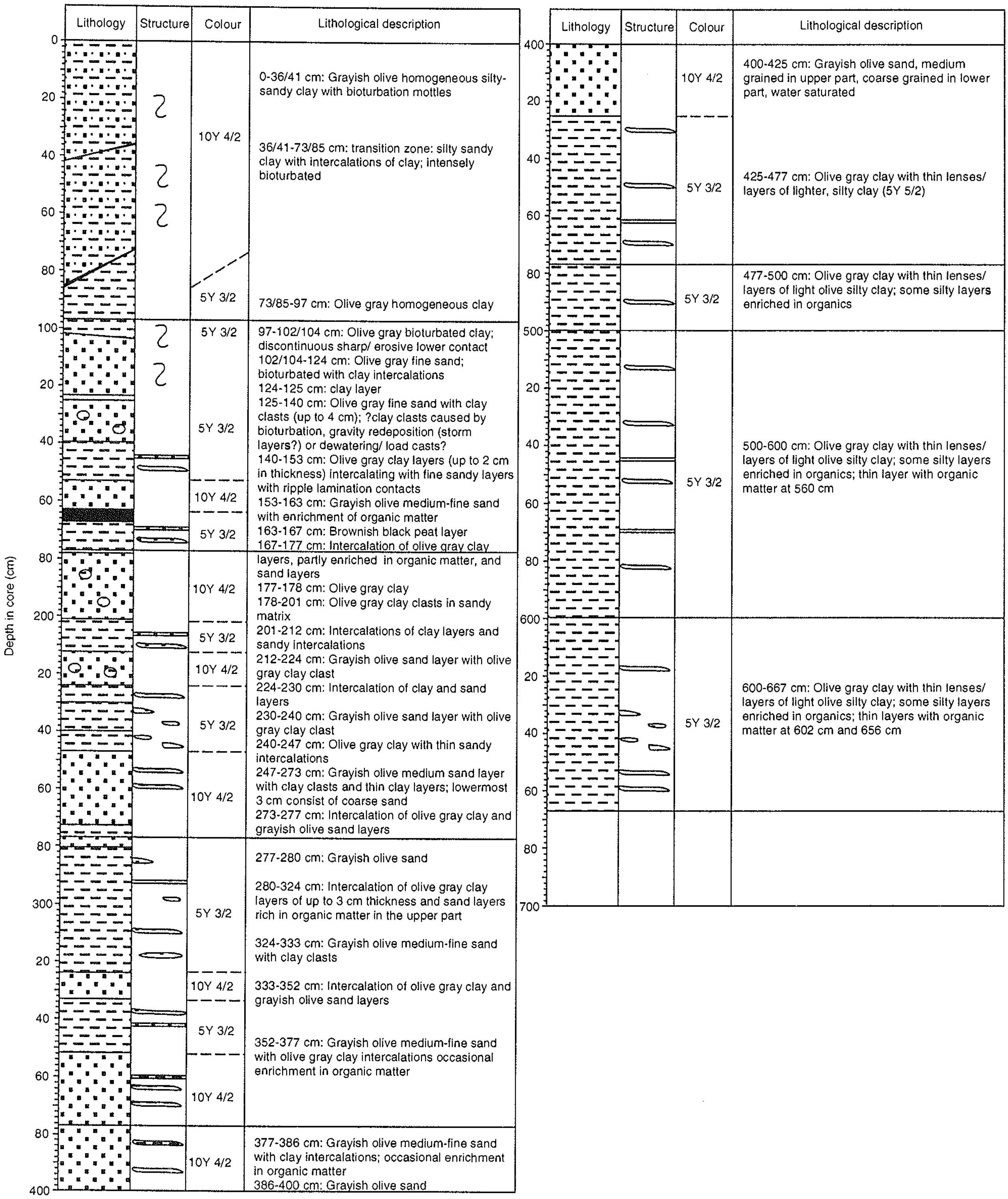
Coring the central part of the Molengraaff valley east of Natuna Island. Three strong acoustic reflectors (within the Holocene valley fill?) have been penetrated at this station.

SONNE-115
Station: SO-115-65
Position: 3° 42.351 N; 108° 42.380 E

Water depth: 101 m

Core: SL 18312-2

Recovery: 667 cm



0-36/41 cm: Grayish olive homogeneous silty-sandy clay with bioturbation mottles

36/41-73/85 cm: transition zone: silty sandy clay with intercalations of clay; intensely bioturbated

73/85-97 cm: Olive gray homogeneous clay

97-102/104 cm: Olive gray bioturbated clay; discontinuous sharp/ erosive lower contact
102/104-124 cm: Olive gray fine sand; bioturbated with clay intercalations
124-125 cm: clay layer
125-140 cm: Olive gray fine sand with clay clasts (up to 4 cm); ?clay clasts caused by bioturbation, gravity redeposition (storm layers?) or dewatering/ load casts?
140-153 cm: Olive gray clay layers (up to 2 cm in thickness) intercalating with fine sandy layers with ripple lamination contacts
153-163 cm: Grayish olive medium-fine sand with enrichment of organic matter
163-167 cm: Brownish black peat layer
167-177 cm: Intercalation of olive gray clay layers, partly enriched in organic matter, and sand layers
177-178 cm: Olive gray clay
178-201 cm: Olive gray clay clasts in sandy matrix
201-212 cm: Intercalations of clay layers and sandy intercalations
212-224 cm: Grayish olive sand layer with olive gray clay clast
224-230 cm: Intercalation of clay and sand layers
230-240 cm: Grayish olive sand layer with olive gray clay clast
240-247 cm: Olive gray clay with thin sandy intercalations
247-273 cm: Grayish olive medium sand layer with clay clasts and thin clay layers; lowermost 3 cm consist of coarse sand
273-277 cm: Intercalation of olive gray clay and grayish olive sand layers

277-280 cm: Grayish olive sand

280-324 cm: Intercalation of olive gray clay layers of up to 3 cm thickness and sand layers rich in organic matter in the upper part

324-333 cm: Grayish olive medium-fine sand with clay clasts

333-352 cm: Intercalation of olive gray clay and grayish olive sand layers

352-377 cm: Grayish olive medium-fine sand with olive gray clay intercalations occasional enrichment in organic matter

377-386 cm: Grayish olive medium-fine sand with clay intercalations; occasional enrichment in organic matter
386-400 cm: Grayish olive sand

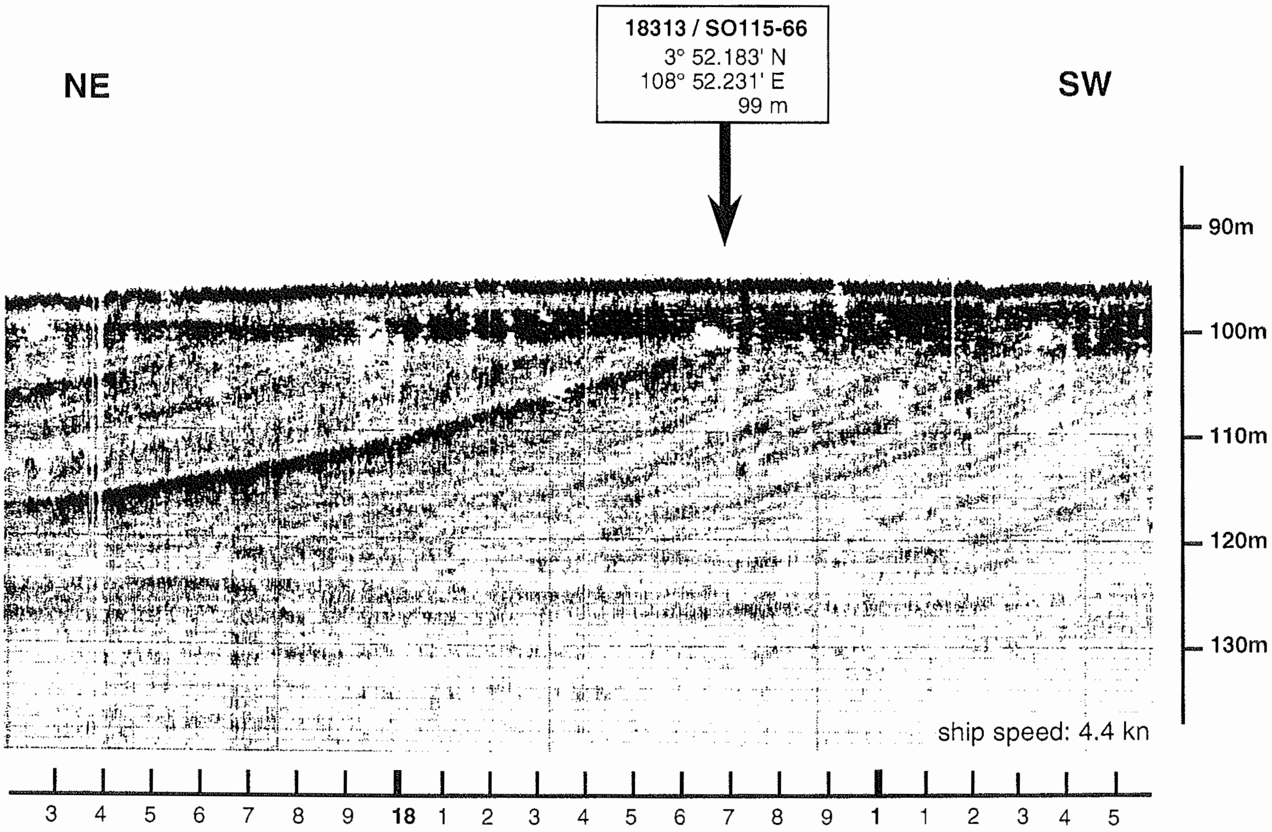
400-425 cm: Grayish olive sand, medium grained in upper part, coarse grained in lower part, water saturated

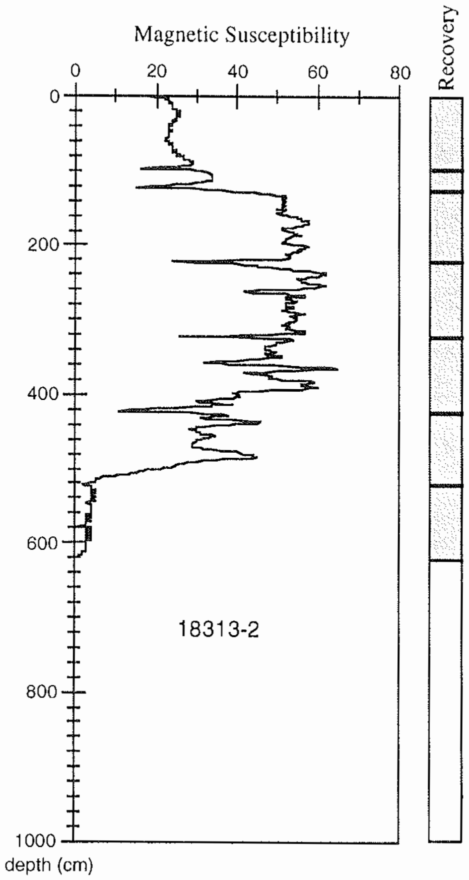
425-477 cm: Olive gray clay with thin lenses/ layers of lighter, silty clay (5Y 5/2)

477-500 cm: Olive gray clay with thin lenses/ layers of light olive silty clay; some silty layers enriched in organics

500-600 cm: Olive gray clay with thin lenses/ layers of light olive silty clay; some silty layers enriched in organics; thin layer with organic matter at 560 cm

600-667 cm: Olive gray clay with thin lenses/ layers of light olive silty clay; some silty layers enriched in organics; thin layers with organic matter at 602 cm and 656 cm





Objective:

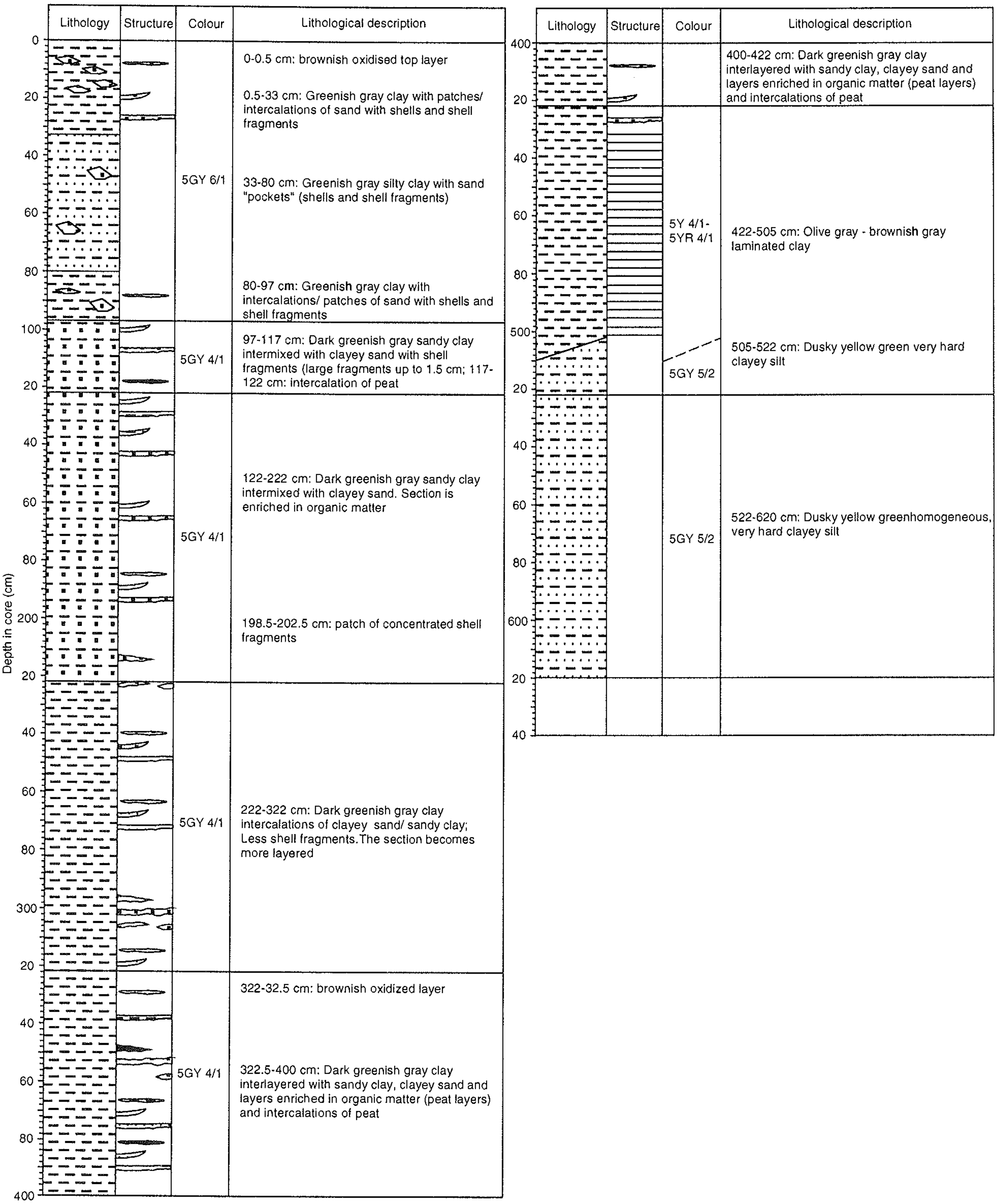
Coring the sequences in the center of the Molengraaff valley east of Natuna Island. The base of the upper acoustically transparent layer has been reached at about 220 cm in core 18313-2. The unconformity to the downvalley dipping older sequence corresponds to the sedimentation change at 505-522 cm in the core.

SONNE-115
Station:SO-115-66
Position: 3° 52.194 N; 108° 52.226 E

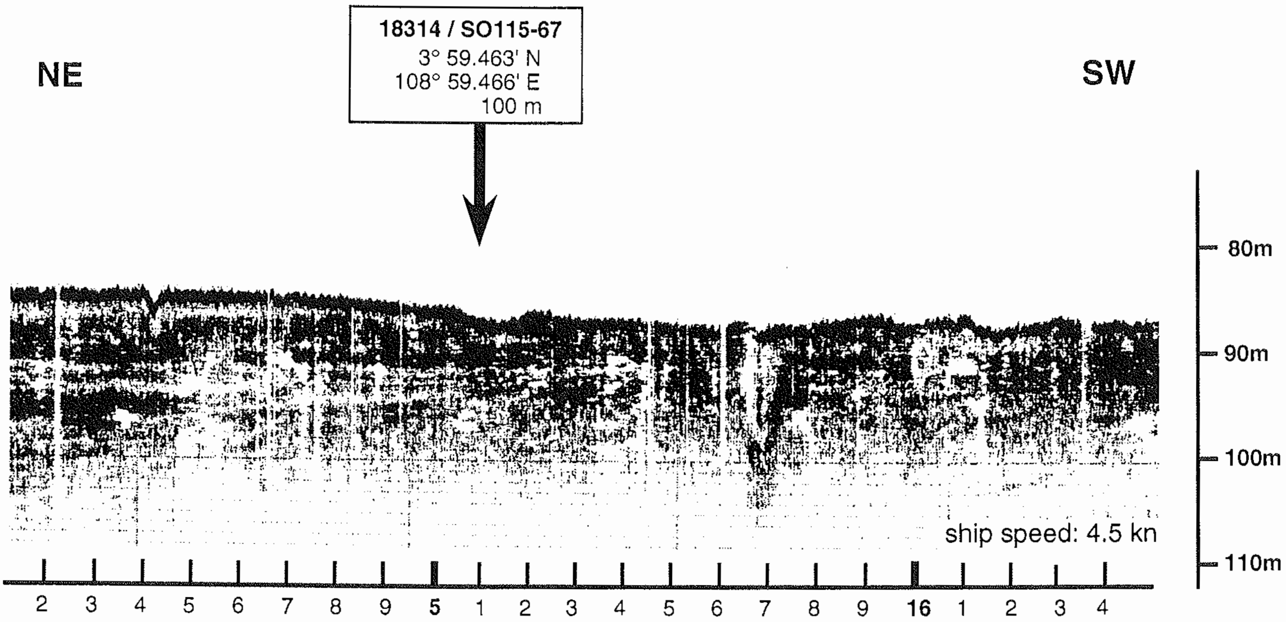
Water depth: 98 m

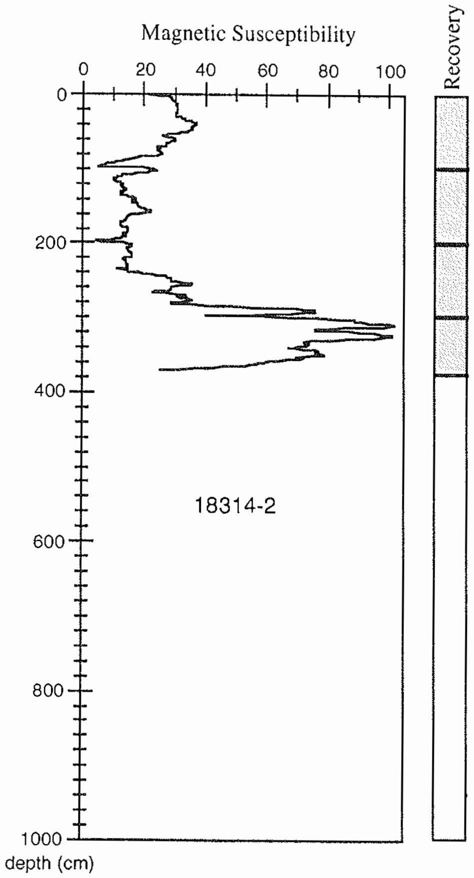
Core: SL 18313-2

Recovery: 620 cm



Colour	Lithological description
5GY 6/1	0-0.5 cm: brownish oxidised top layer
	0.5-33 cm: Greenish gray clay with patches/ intercalations of sand with shells and shell fragments
	33-80 cm: Greenish gray silty clay with sand "pockets" (shells and shell fragments)
	80-97 cm: Greenish gray clay with intercalations/ patches of sand with shells and shell fragments
5GY 4/1	97-117 cm: Dark greenish gray sandy clay intermixed with clayey sand with shell fragments (large fragments up to 1.5 cm; 117-122 cm: intercalation of peat
5GY 4/1	122-222 cm: Dark greenish gray sandy clay intermixed with clayey sand. Section is enriched in organic matter 198.5-202.5 cm: patch of concentrated shell fragments
5GY 4/1	222-322 cm: Dark greenish gray clay intercalations of clayey sand/ sandy clay; Less shell fragments.The section becomes more layered
5GY 4/1	322-32.5 cm: brownish oxidized layer 322.5-400 cm: Dark greenish gray clay interlayered with sandy clay, clayey sand and layers enriched in organic matter (peat layers) and intercalations of peat
	400-422 cm: Dark greenish gray clay interlayered with sandy clay, clayey sand and layers enriched in organic matter (peat layers) and intercalations of peat
5Y 4/1- 5YR 4/1	422-505 cm: Olive gray - brownish gray laminated clay
5GY 5/2	505-522 cm: Dusky yellow green very hard clayey silt
5GY 5/2	522-620 cm: Dusky yellow greenhomogeneous, very hard clayey silt



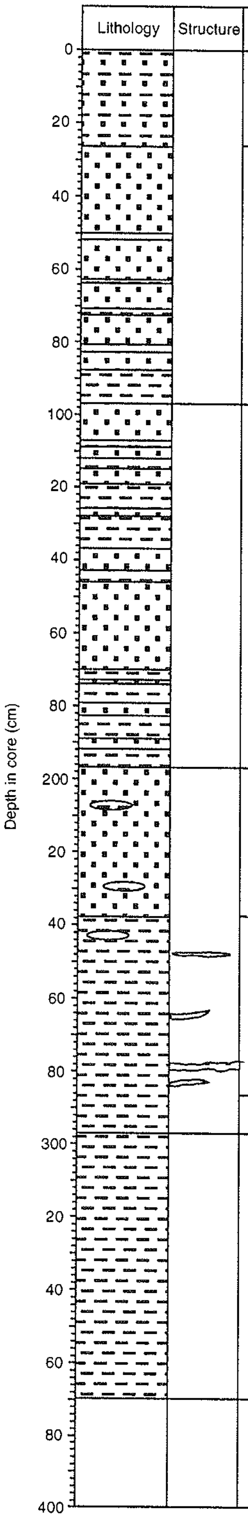


Objective:

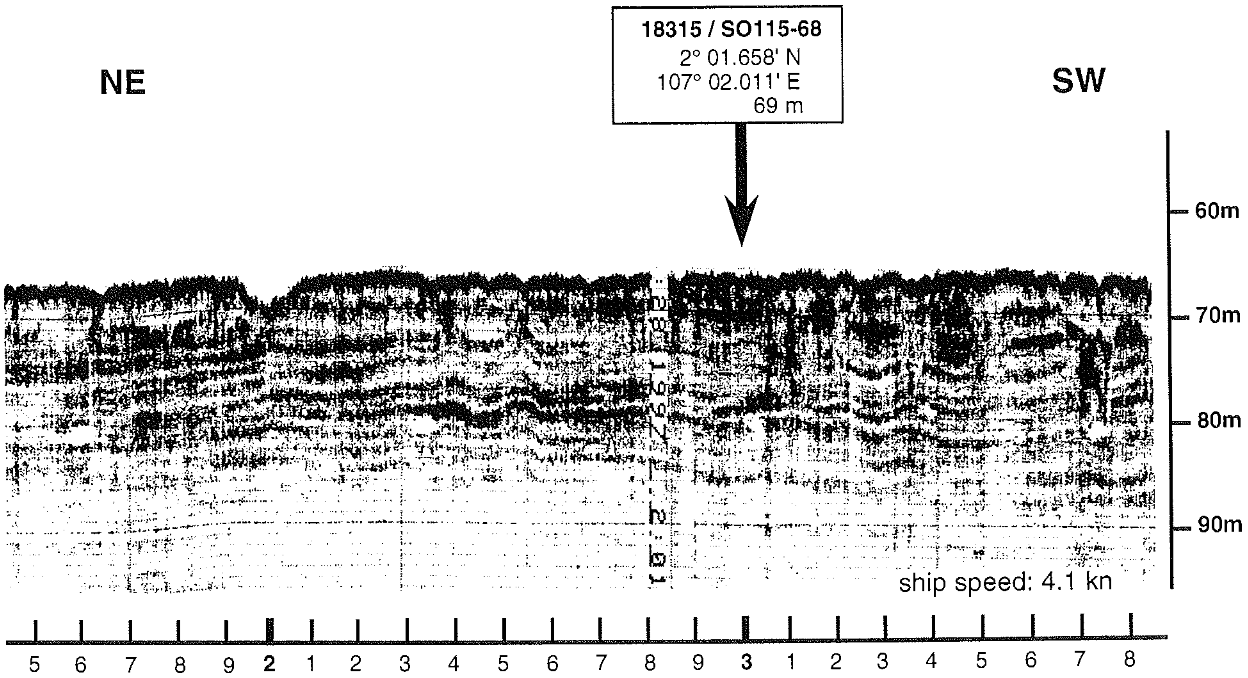
Coring a small surface depression at the edge of the upper acoustically transparent layer. The core reached two distinct deeper reflectors, which correspond to significant changes in grain size and magnetic susceptibility of the sediment.

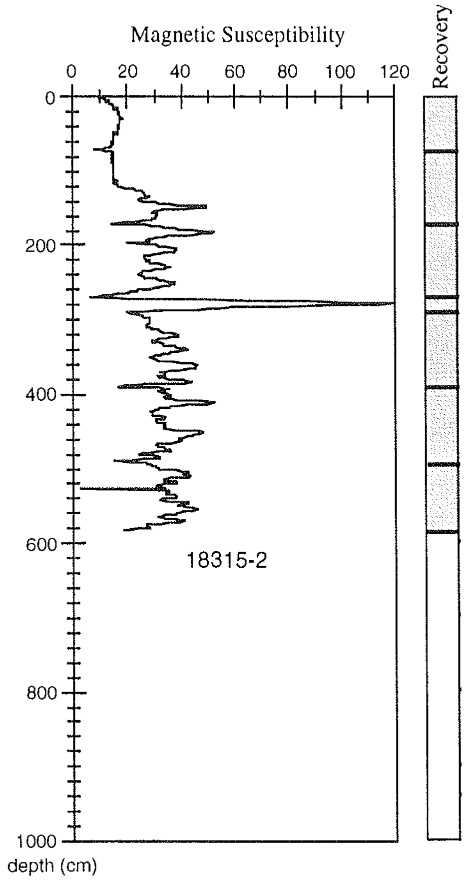
SONNE-115
Station: SO-115-67
Position: 3° 59.469 N; 108° 59.473 E
Water depth: 100 m

Core: SL 18314-2 **Recovery: 370 cm**



Colour	Lithological description
5Y 5/2	0-26 cm: Light olive gray clayey fine sand with shells and shell fragments of 1-2 mm up to 1 cm
5Y 4/1	26-52 cm: Olive gray fine sand
	52-97 cm: Olive gray fine sand intercalated with olive black (5GY 2/1) clayey layers at 52-53.5 cm, 63-64.5 cm, 67-68 cm, 70 cm, 71-72 cm, 72.5-73 cm, 75 cm, 79-80 cm, 81-83.5 cm and 88-97 cm; discontinuous contacts
5Y 4/1	97-197 cm: Olive gray fine sand intercalated with brownish black (5GY 2/1) clay layers at 107-109 cm, 112-115.5 cm, 119-126 cm, 128-137 cm, 143-146 cm, 161 cm, 170-173 cm, 174-179 cm, 183-189 cm and 192-197 cm
5Y 4/1	197-238 cm: Olive gray fine sand intercalated with brownish black (5GY 2/1) clay layers; thin greenish gray clay lenses (5G 6/1) at 217-218 cm, 233-234 cm and 243 cm
N5	238-286 cm: Medium gray homogeneous clay with thin fine sandy to silty layers (medium gray to brownish black)
5Y 4/1	286-297 cm: Olive gray clay
5Y 4/1	297-370 cm: Olive gray intercalations of clay and fine sand layers

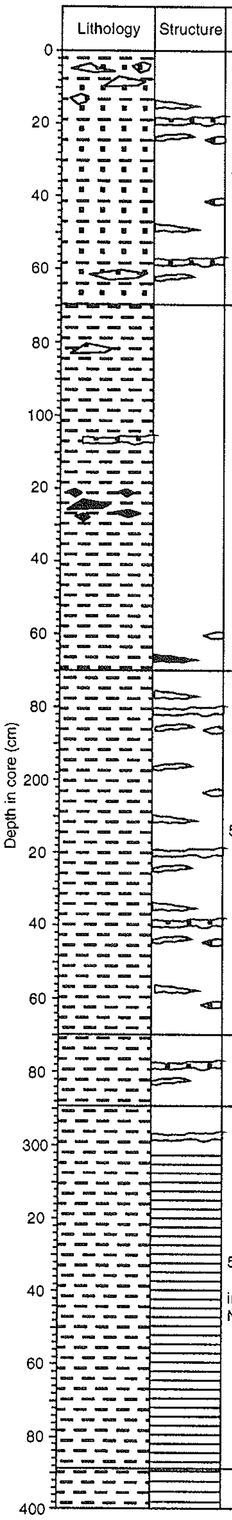




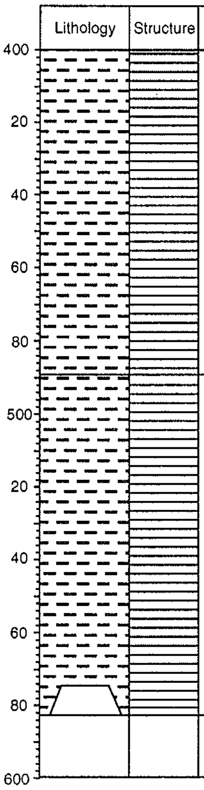
Objectives: Coring a wavy sediment surface with mutiple wavy reflectors in the center of the Molengraaff valley. This is the most proximal station of the examined part of the Molengraaff valley system.

SONNE-115 **Water depth: 69 m**
Station: SO-115-68
Position: 2° 01.700 N; 107° 02.000 E

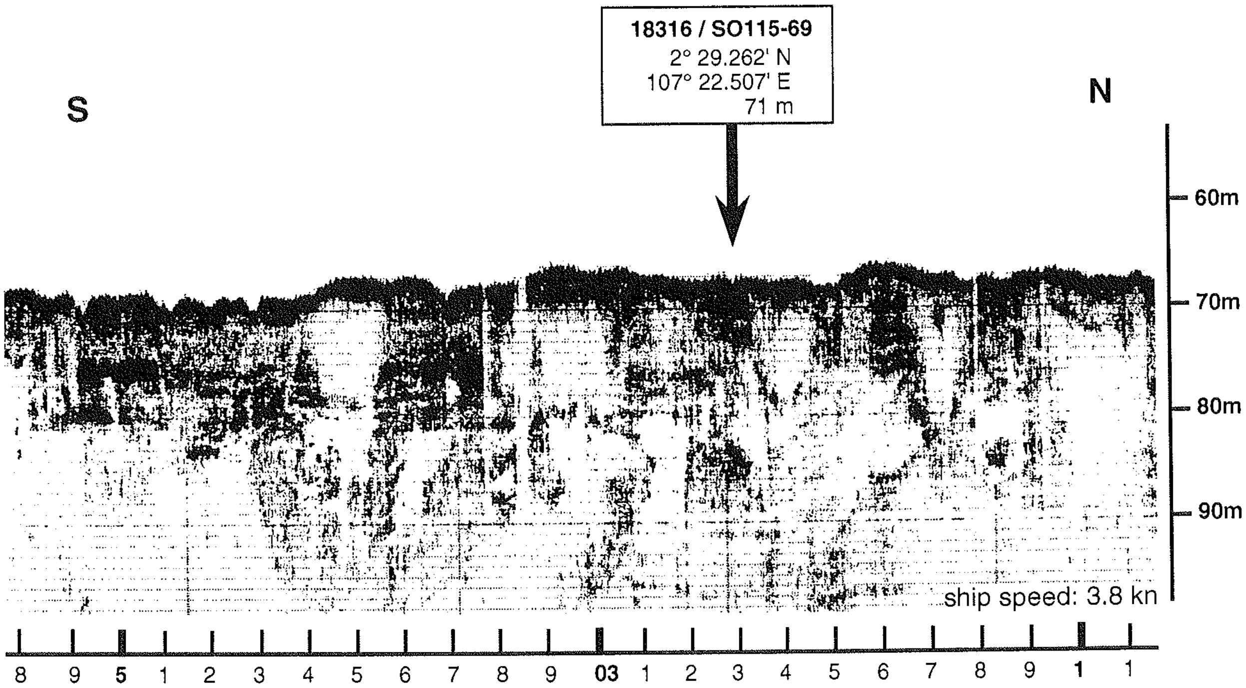
Core: SL 18315-2 **Recovery: 583 cm**

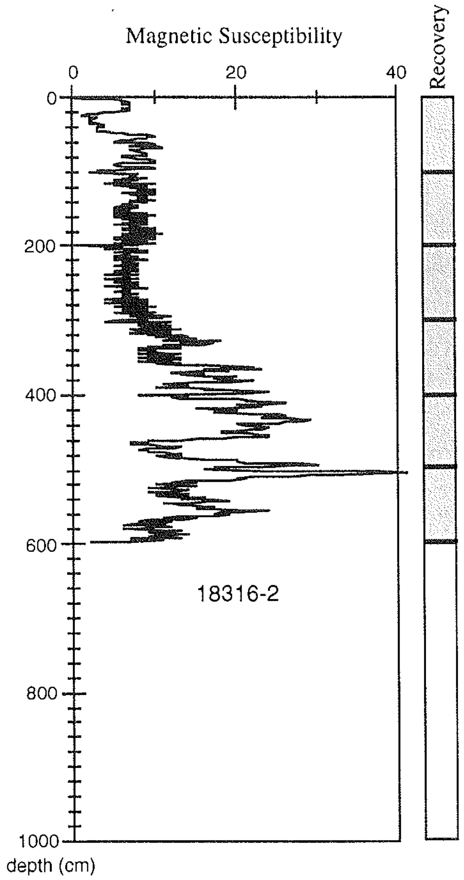


Colour	Lithological description
5GY 5/2	0-0.5 cm: brownish oxidised layer 0.5-70 cm: Dusky yellow green sandy clay with intercalations/patches of sand (shell fragments up to 1 cm)
5GY 5/2 5YR 4/1	70-131 cm: Dusky yellow green clay with patches/ pockets enriched in sand with shells and shell fragments 120-129 cm: layer enriched in shell fragments and several wood pieces Dusky yellow green clay enriched in shells and shell fragments 131-132 cm, 134-135 cm, 136-140 cm, 145-148 cm, 153-154 cm, 165-166 cm 166-170 cm: Brownish gray clay interlayered/ intercalated with silt, sometimes enriched in organics
5YR 4/1	170-270 cm: Brownish gray clay interlayered/ intercalated with silt and fine sand (0,5 cm)
5YR 4/1	270-275 cm:Brownish gray clay interlayered/ intercalated with silt and fine sand (0,5 cm) 275-280 cm: olive black clay (5Y 2/1)
5YR 4/1 in layers N4-N3	280-389 cm: Brownish gray clay - medium dark gray clay interlayered/ intercalated with silt and fine sand (laminated)
	389-400 cm: Brownish gray clay - medium dark gray clay interlayered/ intercalated with silt and fine sand



Colour	Lithological description
5YR 4/1 in layers N4-N3	400-489 cm: Brownish gray clay-medium dark gray clay interlayered/ intercalated with silt and fine sand (laminated ?)
5YR 4/1 in layers N4-N3	489-583 cm: Brownish gray clay- medium dark gray clay interlayered/ intercalated with silt and fine sand (laminated ?) 574-583 cm:void





Objectives:

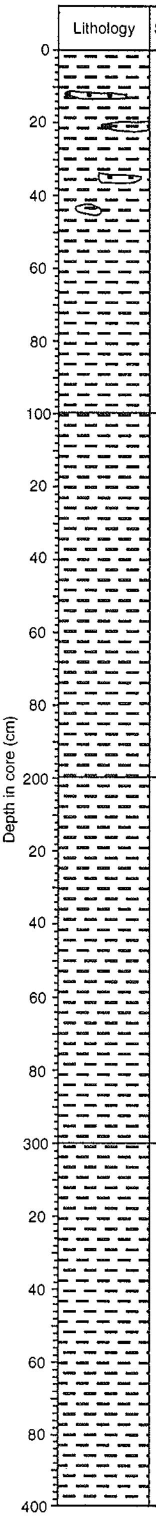
Coring the late Pleistocene land surface. The patchy structure of the sediment and the hard acoustic bottom reflector is characteristic of areas lacking stratified marine Holocene sediments.

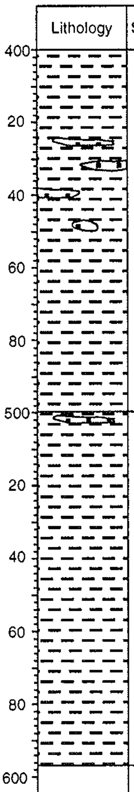
Remarks:

AMS dating of benthic foraminifera (*Rotalia* sp.) within the core catcher sediments indicated an age older than 50 ky.

SONNE-115 **Water depth: 71 m**
Station: SO-115-69
Position: 2° 29.300 N; 107° 27.500 E

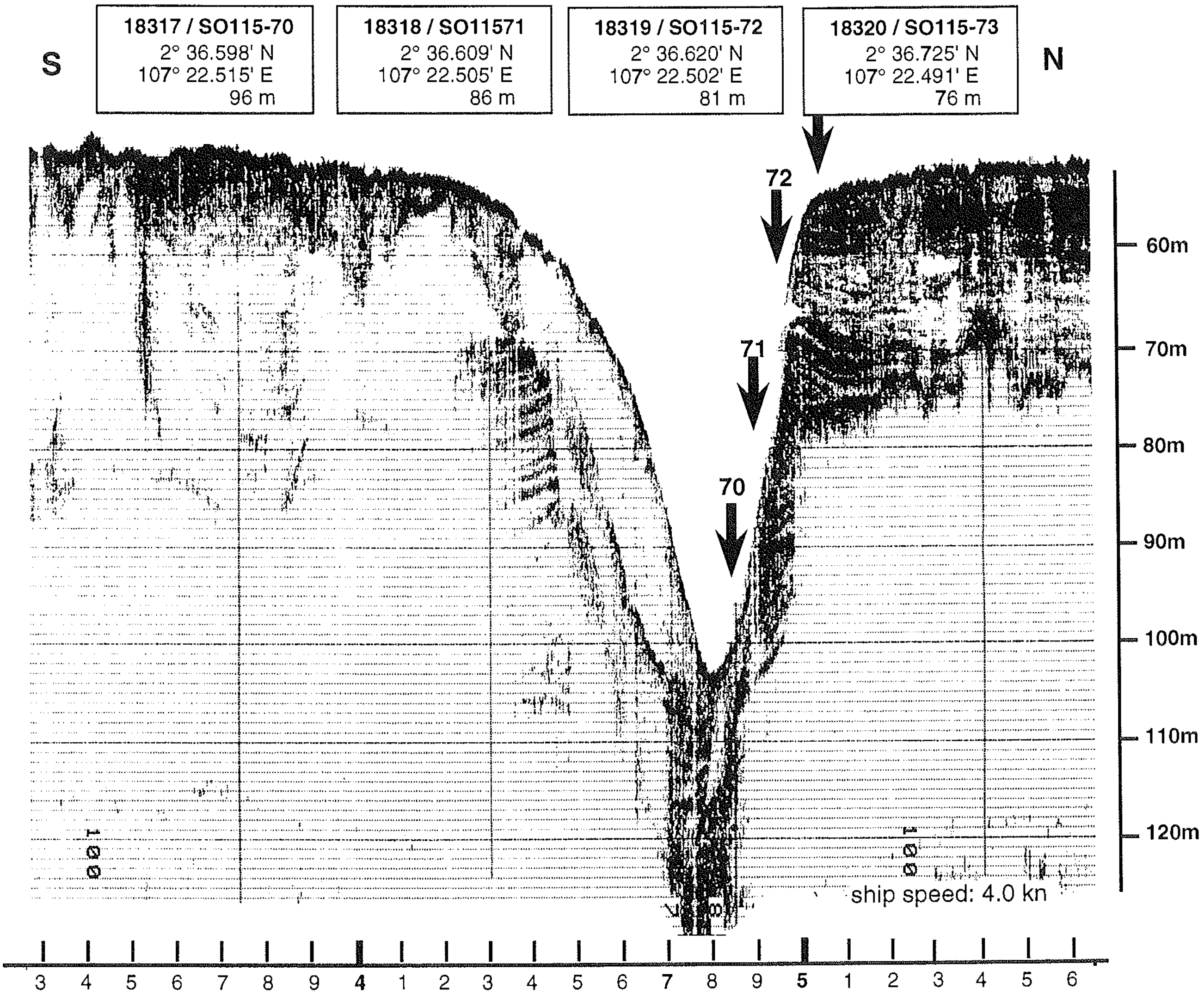
Core: VC 18316-2 **Recovery: 597 cm**

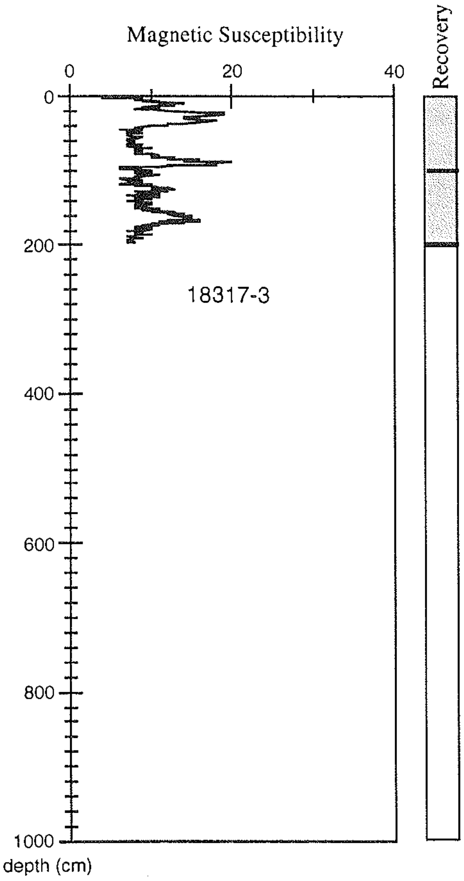


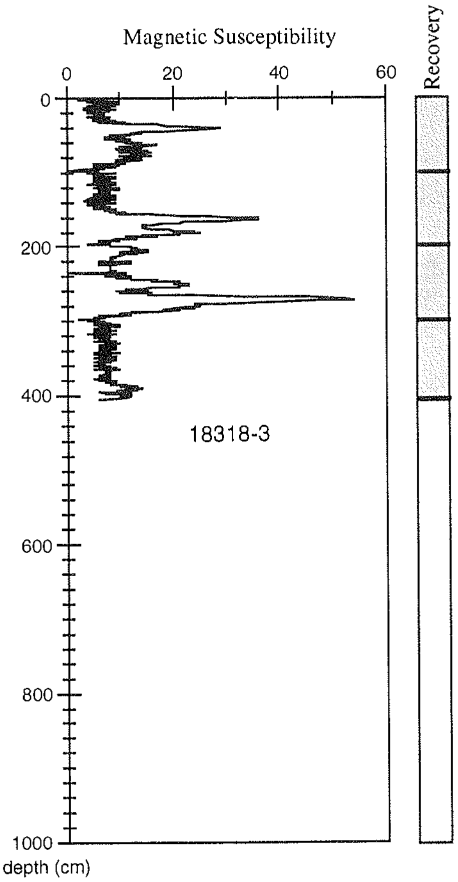


Lithology	Structure	Colour	Lithological description
		5GY 6/1	0-0.5 cm: Brownish oxidized top-layer 0.5-43 cm: Greenish gray clay with sandy clay pockets with larger foraminifera, partly with dark yellowish orange (10YR 6/6) to yellowish brown (10YR 5/4) alteration patches 43-100 cm: Greenish gray clay with layers of yellowish gray (5Y 7/2) clay; layers of yellowish gray clay at 50-50.5 cm, 58-58.3 cm, 68-70 cm and 87 cm diffused one
		5GY 6/1	100-200 cm: Greenish gray clay with the layers of yellowish gray (5Y 7/2) clay; layers of yellowish gray clay at 103-105 cm, 111-114 cm,127-128 cm, 138-140 cm, 155-156 cm, 165-166 cm, 179-181 cm, 197- 199 cm
		5GY 6/1	200-300 cm: Greenish gray clay with the layers of yellowish gray (5Y 7/2) clay; layers of yellowish gray clay between 205-241 cm (4 thin layers up to 1 cm)
		5GY 6/1	300-400 cm: Greenish gray homogeneous clay

Lithology	Structure	Colour	Lithological description
		5GY 6/1	400-500 cm: Greenish gray clay with sandy ' pockets' with larger foraminifera at 426-428 cm, 431-432 cm, 438-441 cm, 448.5-456.5 cm
		5GY 6/1	500-597 cm: Greenish gray clay with sandy ' pockets' with larger foraminifera at 500-502 cm





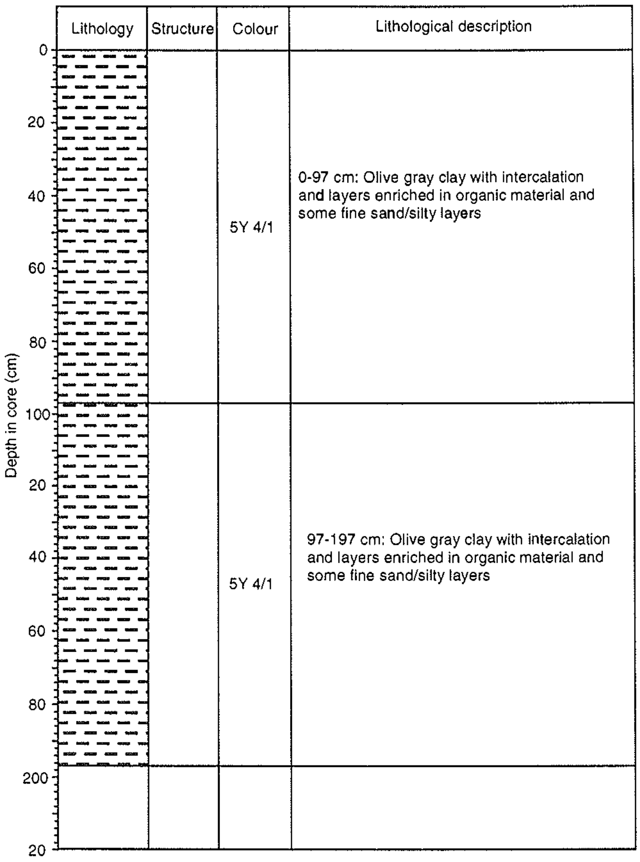


Objectives:
Coring a composite section of well stratified sediments along the slope of a deeply (more than 50 m) incised channel.

Remarks:
The dynamic positioning system of R/V Sonne allowed for a precise location of the cores along a extremely short (less than 200 m) and steep slope transect.

SONNE-115 **Water depth: 95 m**
Station: SO 115- 70
Position: 2° 36. 600 N; 107° 22. 500 E

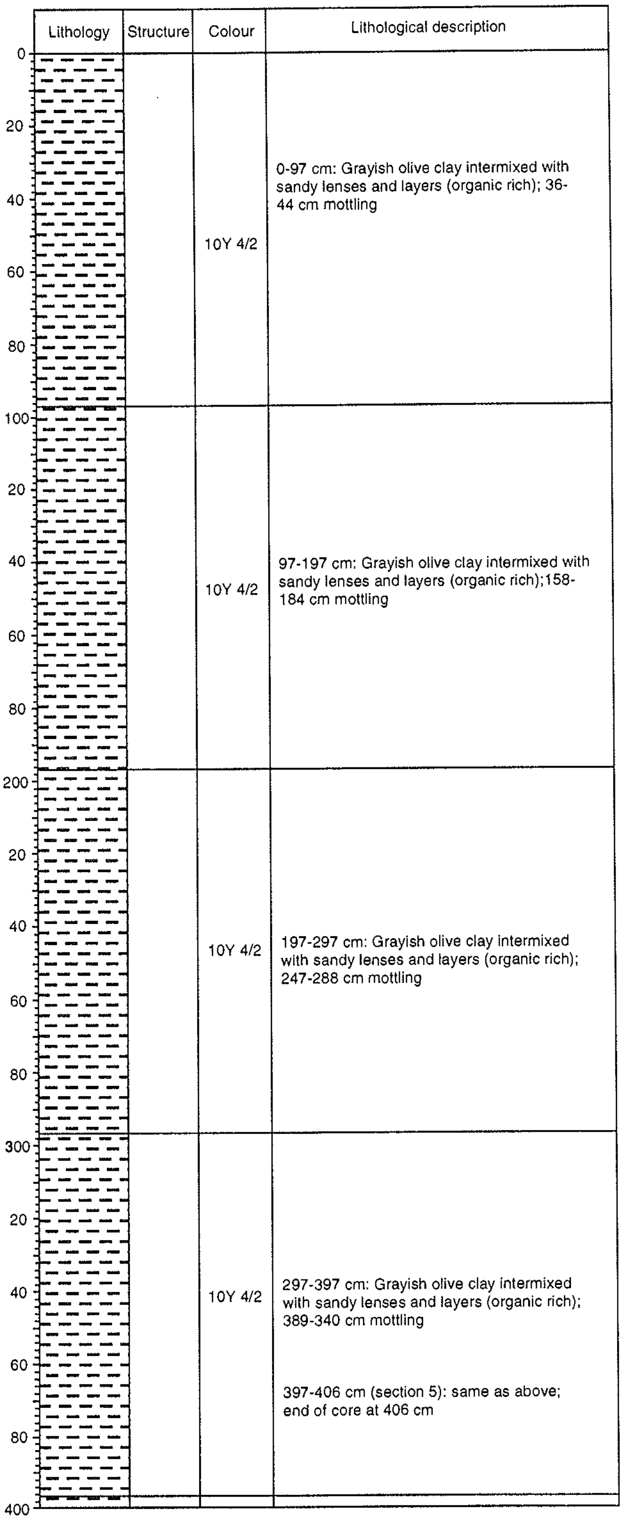
Core: VC 18317- 3 **Recovery: 197 cm**



Lithology	Structure	Colour	Lithological description
		5Y 4/1	0-97 cm: Olive gray clay with intercalation and layers enriched in organic material and some fine sand/silty layers
		5Y 4/1	97-197 cm: Olive gray clay with intercalation and layers enriched in organic material and some fine sand/silty layers

SONNE-115 **Water depth: 87 m**
Station: SO-115-71
Position: 2° 36. 600 N; 107° 22. 500 E

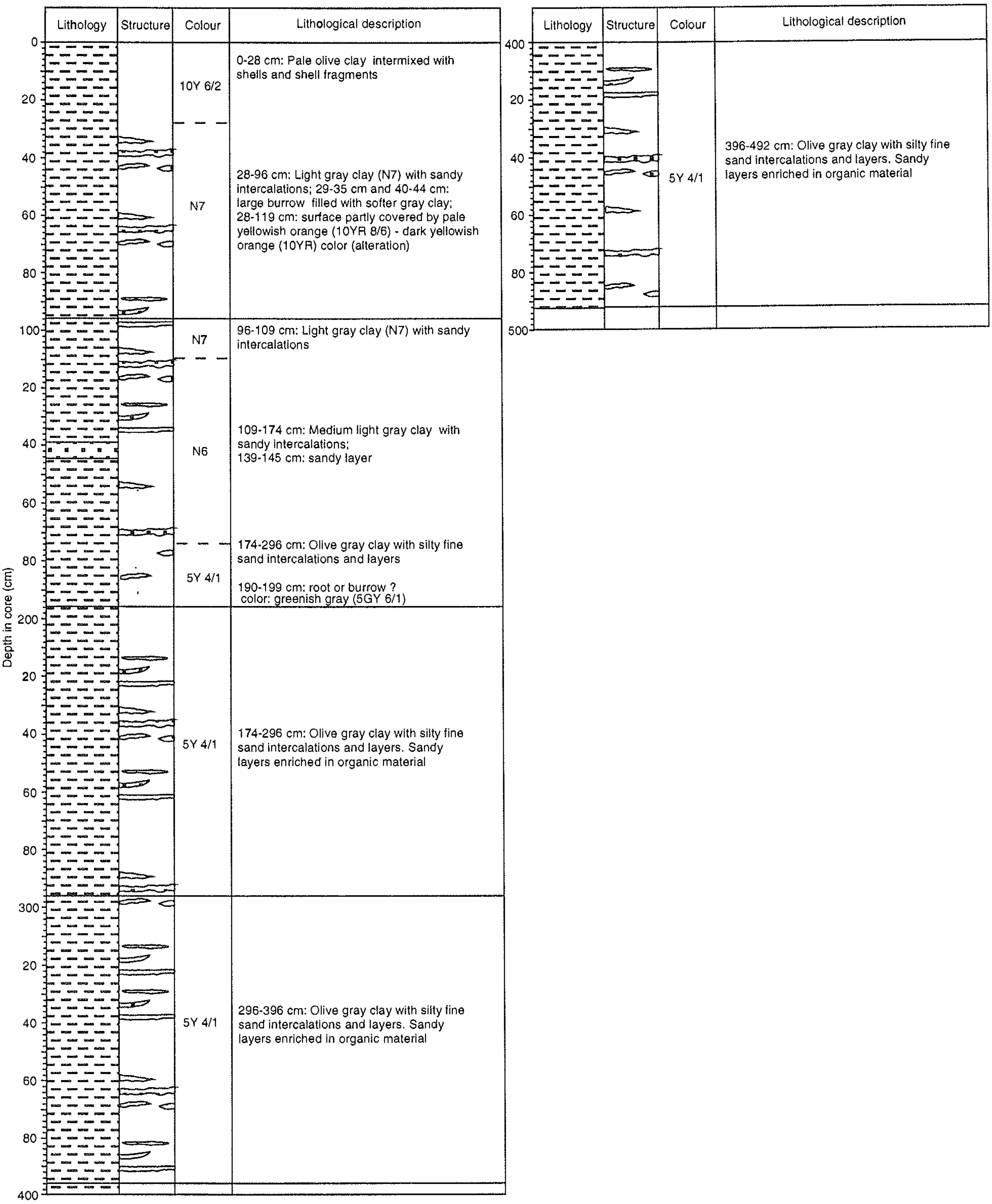
Core: VC 18318-3 **Recovery: 406 cm**



Lithology	Structure	Colour	Lithological description
		10Y 4/2	0-97 cm: Grayish olive clay intermixed with sandy lenses and layers (organic rich); 36-44 cm mottling
		10Y 4/2	97-197 cm: Grayish olive clay intermixed with sandy lenses and layers (organic rich);158-184 cm mottling
		10Y 4/2	197-297 cm: Grayish olive clay intermixed with sandy lenses and layers (organic rich); 247-288 cm mottling
		10Y 4/2	297-397 cm: Grayish olive clay intermixed with sandy lenses and layers (organic rich); 389-340 cm mottling 397-406 cm (section 5): same as above; end of core at 406 cm

SONNE-115 **Water depth: 76 m**
Station: SO-115-73
Position: 2° 36.700 N; 107° 22.500 E

Core: VC 18320-2 **Recovery: 492 cm**



0-28 cm: Pale olive clay intermixed with shells and shell fragments

28-96 cm: Light gray clay (N7) with sandy intercalations; 29-35 cm and 40-44 cm: large burrow filled with softer gray clay; 28-119 cm: surface partly covered by pale yellowish orange (10YR 8/6) - dark yellowish orange (10YR) color (alteration)

96-109 cm: Light gray clay (N7) with sandy intercalations

109-174 cm: Medium light gray clay with sandy intercalations;
139-145 cm: sandy layer

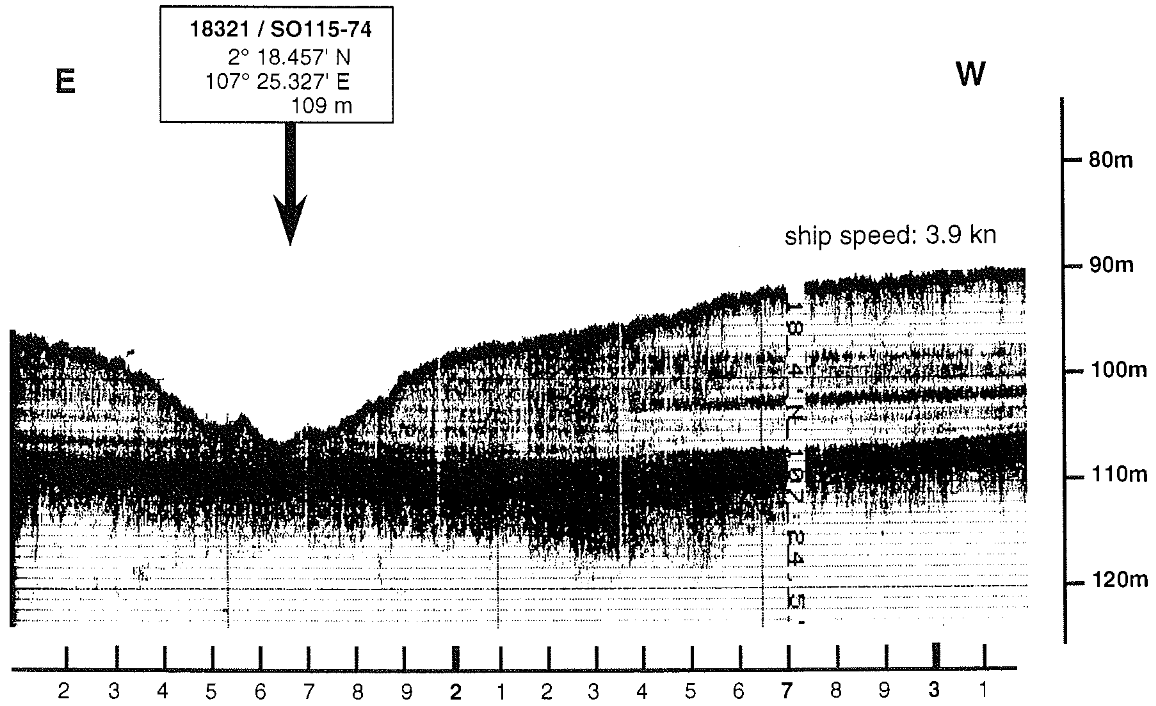
174-296 cm: Olive gray clay with silty fine sand intercalations and layers

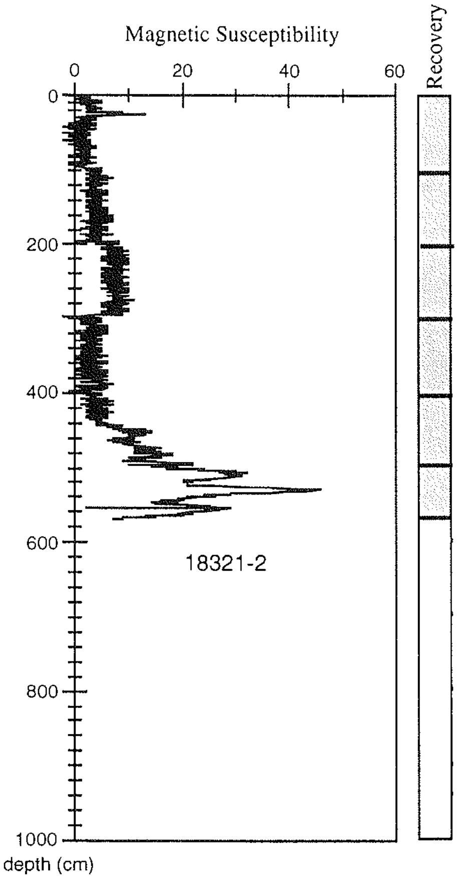
190-199 cm: root or burrow ?
color: greenish gray (5GY 6/1)

174-296 cm: Olive gray clay with silty fine sand intercalations and layers. Sandy layers enriched in organic material

296-396 cm: Olive gray clay with silty fine sand intercalations and layers. Sandy layers enriched in organic material

396-492 cm: Olive gray clay with silty fine sand intercalations and layers. Sandy layers enriched in organic material



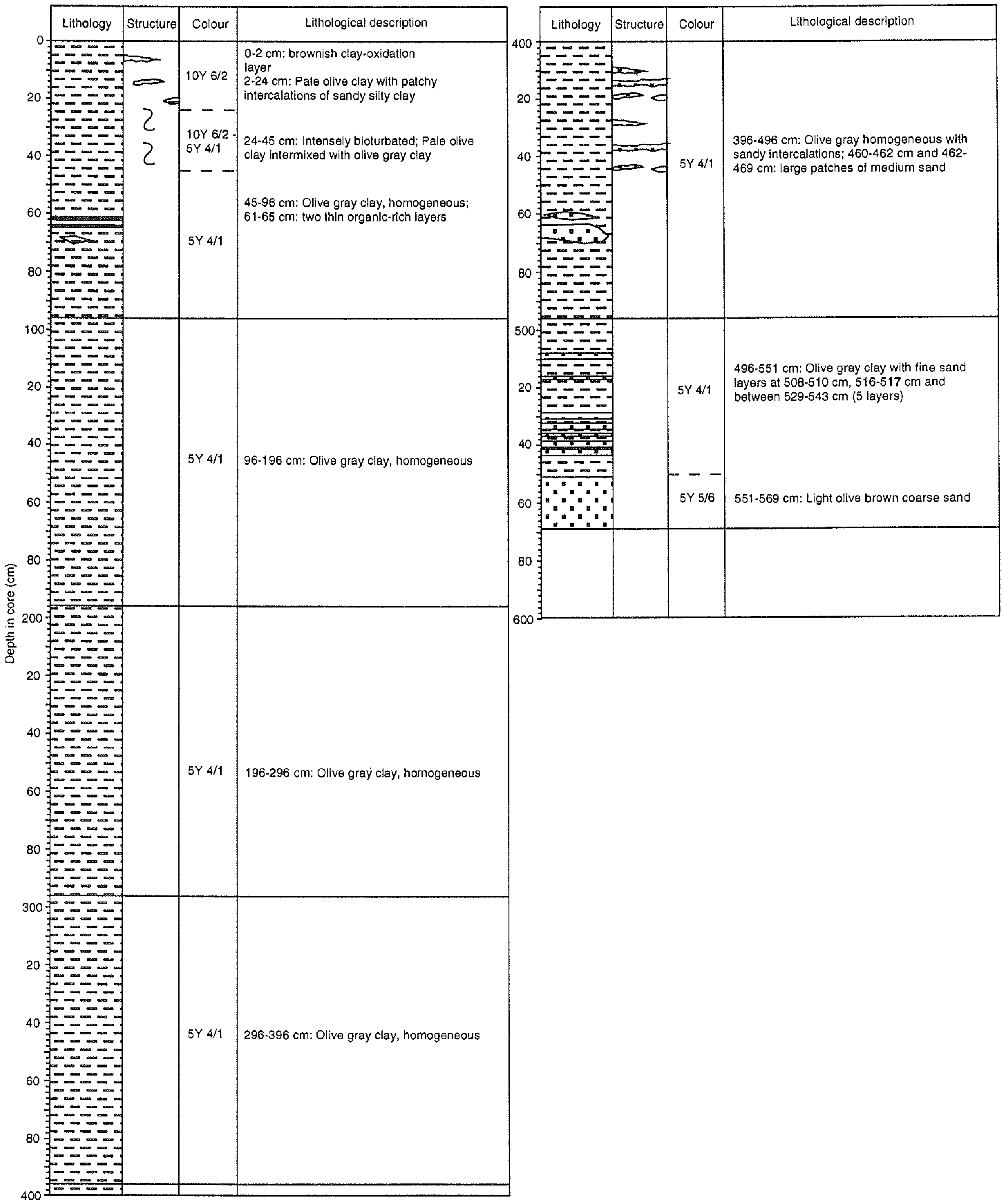


Objectives:

Coring in the center of a young channel structure, were the base of a more than 15 m thick marine sequence could be reached.

SONNE-115 **Water depth: 109 m**
Station: SO-115-74
Position: 2° 18.500 N; 107° 25.300 E

Core: VC 18321-2 **Recovery: 569 cm**



0-2 cm: brownish clay-oxidation layer
2-24 cm: Pale olive clay with patchy intercalations of sandy silty clay

24-45 cm: Intensely bioturbated; Pale olive clay intermixed with olive gray clay

45-96 cm: Olive gray clay, homogeneous; 61-65 cm: two thin organic-rich layers

96-196 cm: Olive gray clay, homogeneous

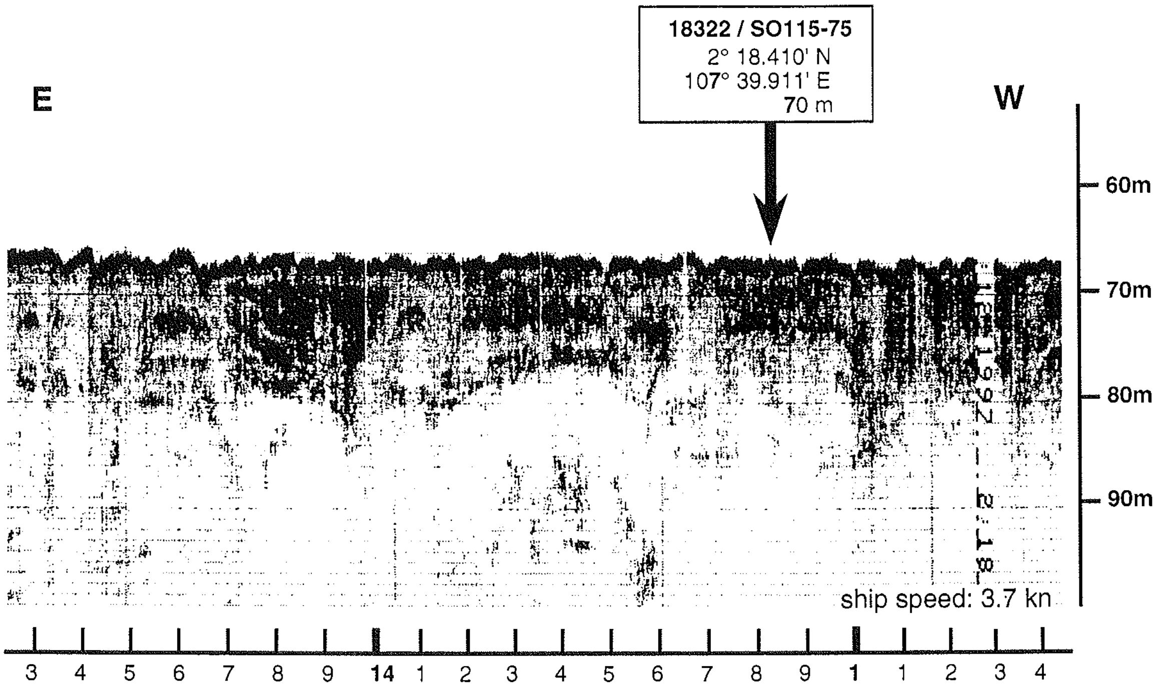
196-296 cm: Olive gray clay, homogeneous

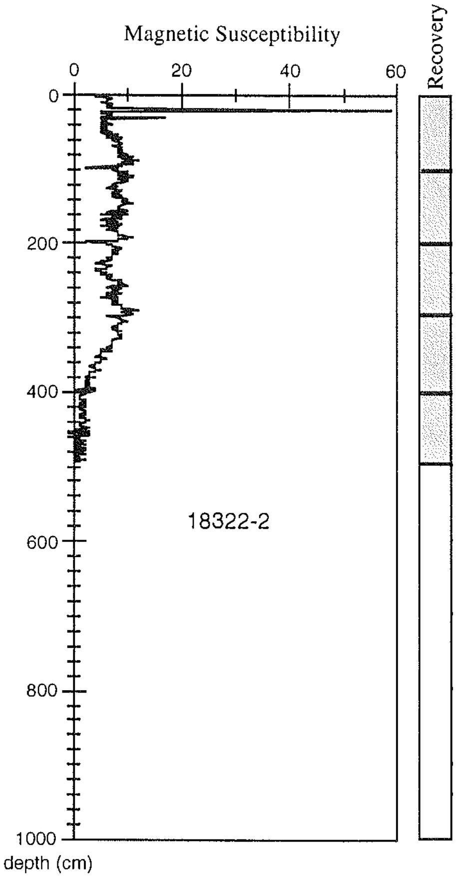
296-396 cm: Olive gray clay, homogeneous

396-496 cm: Olive gray homogeneous with sandy intercalations; 460-462 cm and 462-469 cm: large patches of medium sand

496-551 cm: Olive gray clay with fine sand layers at 508-510 cm, 516-517 cm and between 529-543 cm (5 layers)

551-569 cm: Light olive brown coarse sand



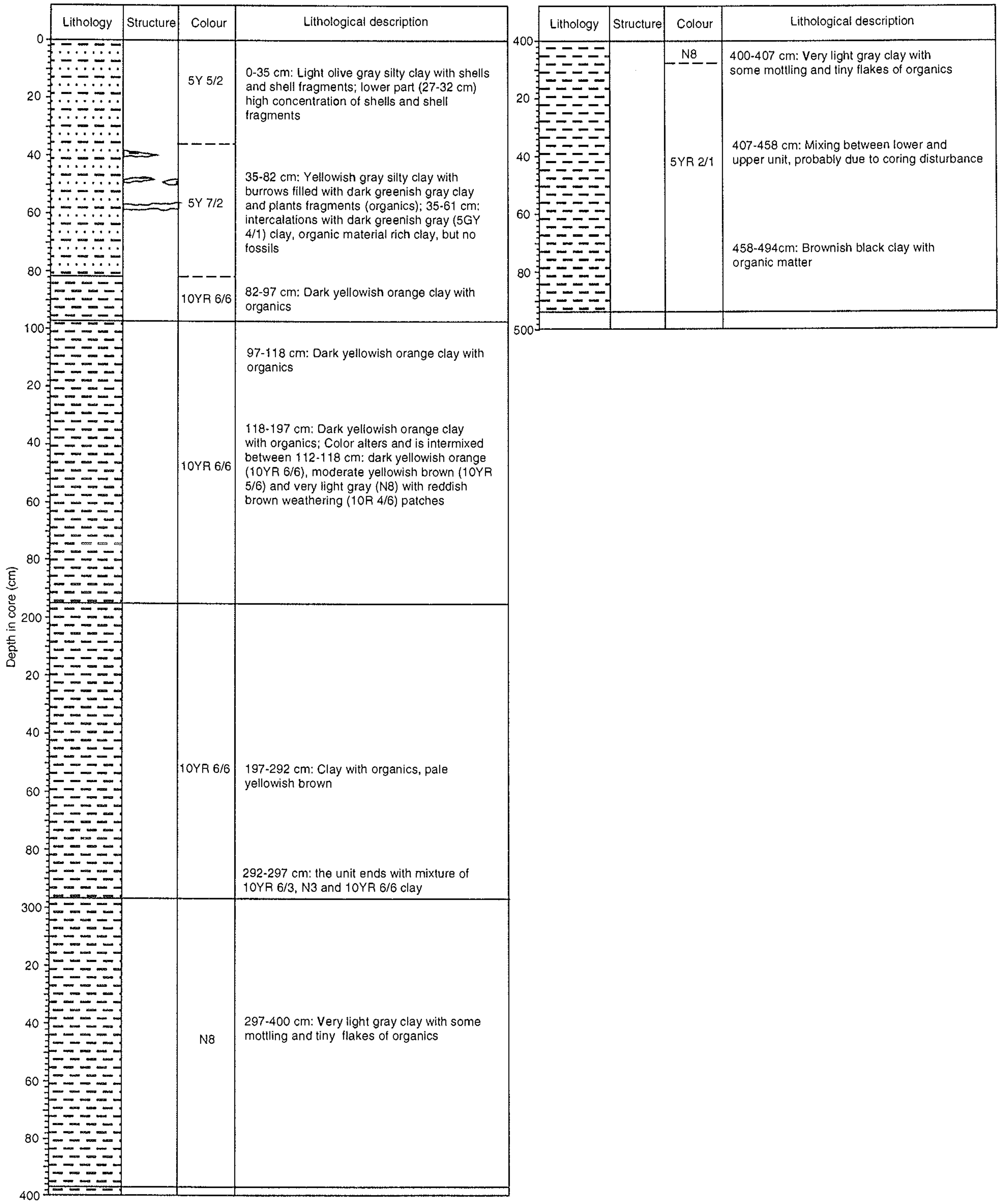


Objectives:

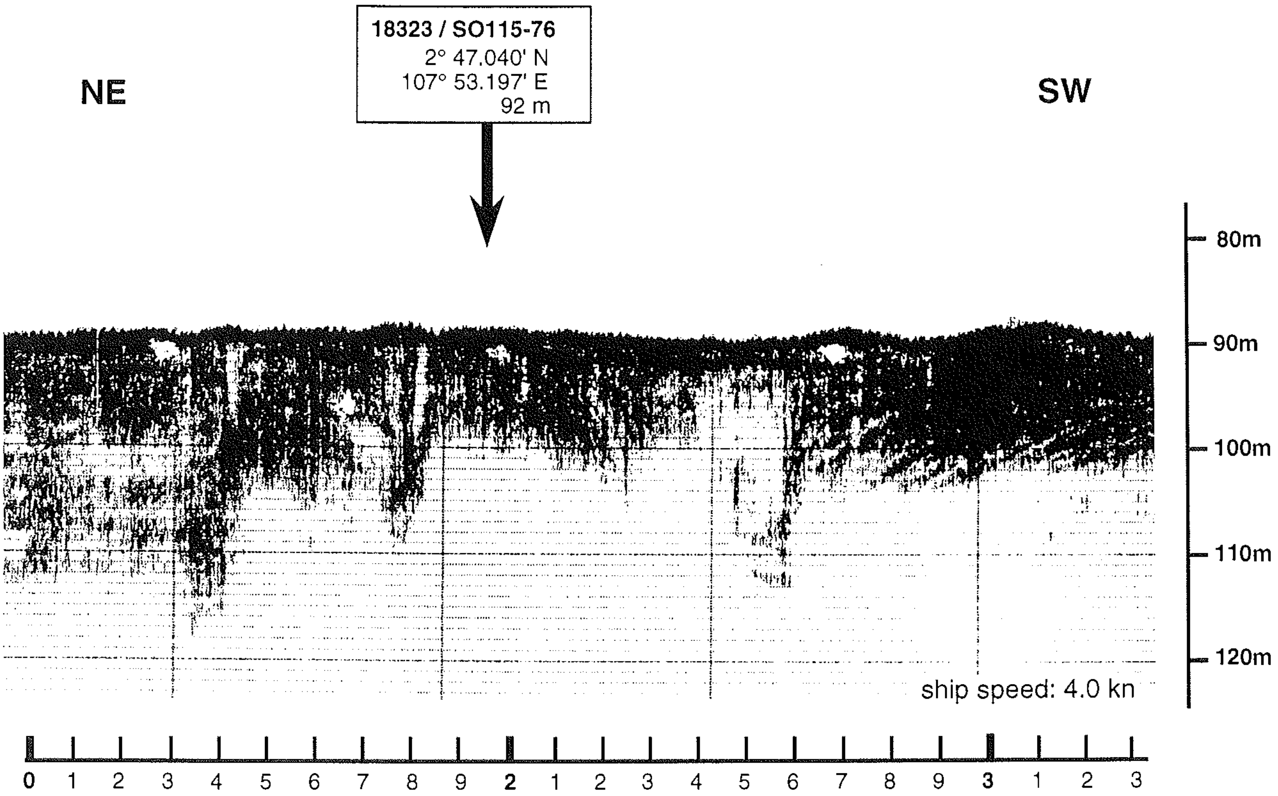
Coring the eroded late Pleistocene land surface.

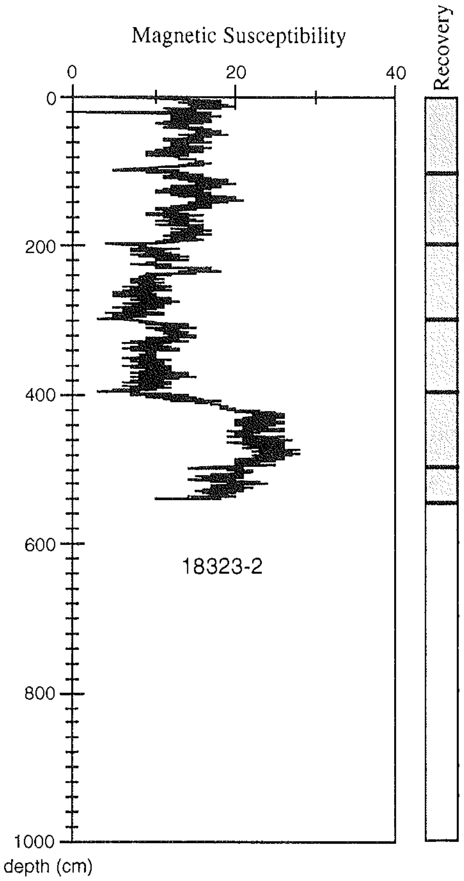
SONNE-115 **Water depth:** 70 m
Station: SO-115-75
Position: 2° 18.400 N; 107° 37.900 E

Core: VC 18322-2 **Recovery:** 493 cm



Colour	Lithological description
5Y 5/2	0-35 cm: Light olive gray silty clay with shells and shell fragments; lower part (27-32 cm) high concentration of shells and shell fragments
5Y 7/2	35-82 cm: Yellowish gray silty clay with burrows filled with dark greenish gray clay and plants fragments (organics); 35-61 cm: intercalations with dark greenish gray (5GY 4/1) clay, organic material rich clay, but no fossils
10YR 6/6	82-97 cm: Dark yellowish orange clay with organics
10YR 6/6	97-118 cm: Dark yellowish orange clay with organics 118-197 cm: Dark yellowish orange clay with organics; Color alters and is intermixed between 112-118 cm: dark yellowish orange (10YR 6/6), moderate yellowish brown (10YR 5/6) and very light gray (N8) with reddish brown weathering (10R 4/6) patches
10YR 6/6	197-292 cm: Clay with organics, pale yellowish brown 292-297 cm: the unit ends with mixture of 10YR 6/3, N3 and 10YR 6/6 clay
N8	297-400 cm: Very light gray clay with some mottling and tiny flakes of organics
N8	400-407 cm: Very light gray clay with some mottling and tiny flakes of organics
5YR 2/1	407-458 cm: Mixing between lower and upper unit, probably due to coring disturbance 458-494cm: Brownish black clay with organic matter



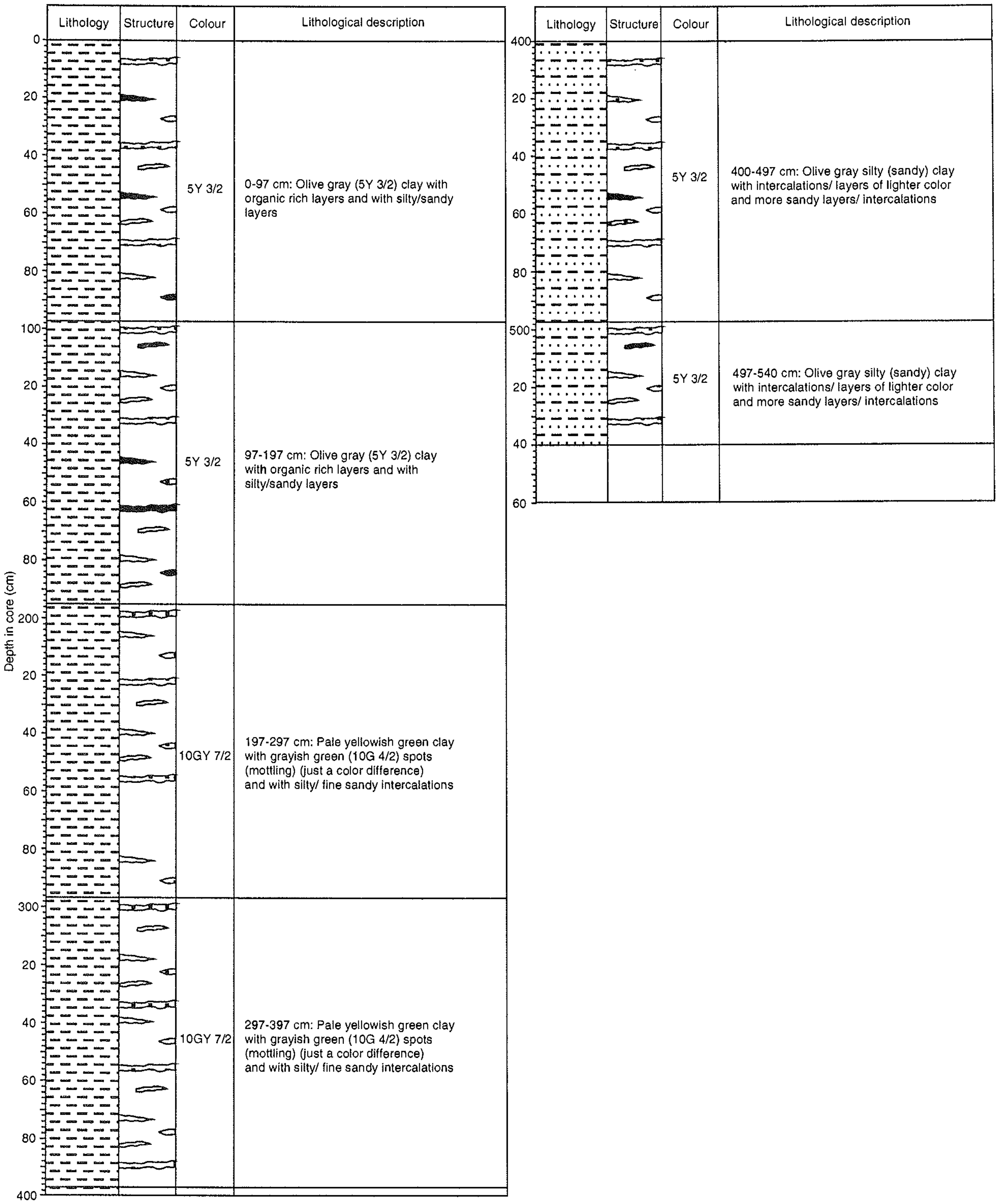


Objectives:

Coring the central part of the Molengraaff valley in the marginal part of an infilled incised channel structure.

SONNE-115 **Water depth: 92 m**
Station: SO-115-76
Position: 2° 47.000 N; 107° 53.200 E

Core: VC 18323-2 **Recovery: 540 cm**



Colour	Lithological description
5Y 3/2	0-97 cm: Olive gray (5Y 3/2) clay with organic rich layers and with silty/sandy layers
5Y 3/2	97-197 cm: Olive gray (5Y 3/2) clay with organic rich layers and with silty/sandy layers
10GY 7/2	197-297 cm: Pale yellowish green clay with grayish green (10G 4/2) spots (mottling) (just a color difference) and with silty/ fine sandy intercalations
10GY 7/2	297-397 cm: Pale yellowish green clay with grayish green (10G 4/2) spots (mottling) (just a color difference) and with silty/ fine sandy intercalations
5Y 3/2	400-497 cm: Olive gray silty (sandy) clay with intercalations/ layers of lighter color and more sandy layers/ intercalations
5Y 3/2	497-540 cm: Olive gray silty (sandy) clay with intercalations/ layers of lighter color and more sandy layers/ intercalations

7.3. SEDIMENTOLOGY

Initial results from core description, X-ray radiography and preliminary qualitative component analyses (> 63 µm).

The gravity cores and vibrocores collected in the area of the paleo-Mekong on the Vietnamese shelf mainly consist of a brown-reddish clay facies. This brown clay (unit 2) is intercalated with silty, sandy or organic-rich ('peat') lenses, patches and irregular layers. Flaser-laminated and millimeter-scale laminated sandy/silty layers, including microscale cross-stratification are very conspicuous in X-ray radiographs.

Unit 2 is covered by a up to 1 m thick sandy unit (unit 1) with numerous shells and shell fragments (planktic and benthic foraminifers, ostracods, gastropods, echinid fragments), as well as numerous lithoclasts (e. g. quartz, feldspar, pyroxene, amphibole). The color of this unit is light olive gray. The contact between unit 1 and unit 2 is an erosional unconformity.

Two gravity cores (GC 18252-3 and GC 18253-2) from the Vietnamese slope (water depth: 1273 m and 1479 m) consist of homogeneous olive gray clay with rare sandy layers. The lowermost part of the gravity cores are richer in organic material and show numerous dark bioturbation mottles as well as organic-rich spots or lenses. A similar organic rich facies characterizes the Pleistocene from mid-water cores of the southern part of the South China Sea obtained during the SO-95 cruise (Sarnthein et al., in press).

Sediments of cores recovered along the Sunda shelf transect in the area of the Pleistocene Molengraaff river system exhibit distinctly different distal and proximal facies.

In general the distal deposits consist of marine clay interbedded with thin sandy-silty beds and contain rare small organic-rich layers and lenses. Sediment colors are dominantly dark greenish gray to olive gray. The superficially homogenous clay exhibits microscale lamination and rare ripple cross lamination in X ray radiographs (Fig. 25A,B).

A shallow marine sandy facies, consisting of olive gray, carbonate-rich sand is developed within the proximal part of the transect. This facies (unit 1) is characterized by biogenic components (foraminifers, gastropodes, and bivalves). Unit 1 is 0,5 to 2 m thick and unconformably overlies a terrigenous clay unit (unit 2). Unit 2 includes two different facies types:

1. organic-rich clay with high amounts of plant material:

- small peaty fibres build up 'peat layers' (not used as a genetic term), lenses, and are widely distributed in the sediment (e. g., most of the > 63 µm fraction of core GC 18 271-2 consists of these plant fibres),
- well preserved pieces of wood with diameters up to several centimeters (Fig. 25C)

- fibrous material is sometimes preserved in inclined or vertical oriented clay-filled holes (see photo), that may represent remnants of roots (Fig. 25D),
- intercalations include sandy layers/lenses consisting predominantly of plant material and quartz, and randomly distributed single shell fragments, amber pebbles and lithoclasts
-the primary sedimentary structure is often destroyed by roots.

2. homogenous, strongly consolidated greenish gray clay with characteristic orange patches (Pleistocene? continental deposits)

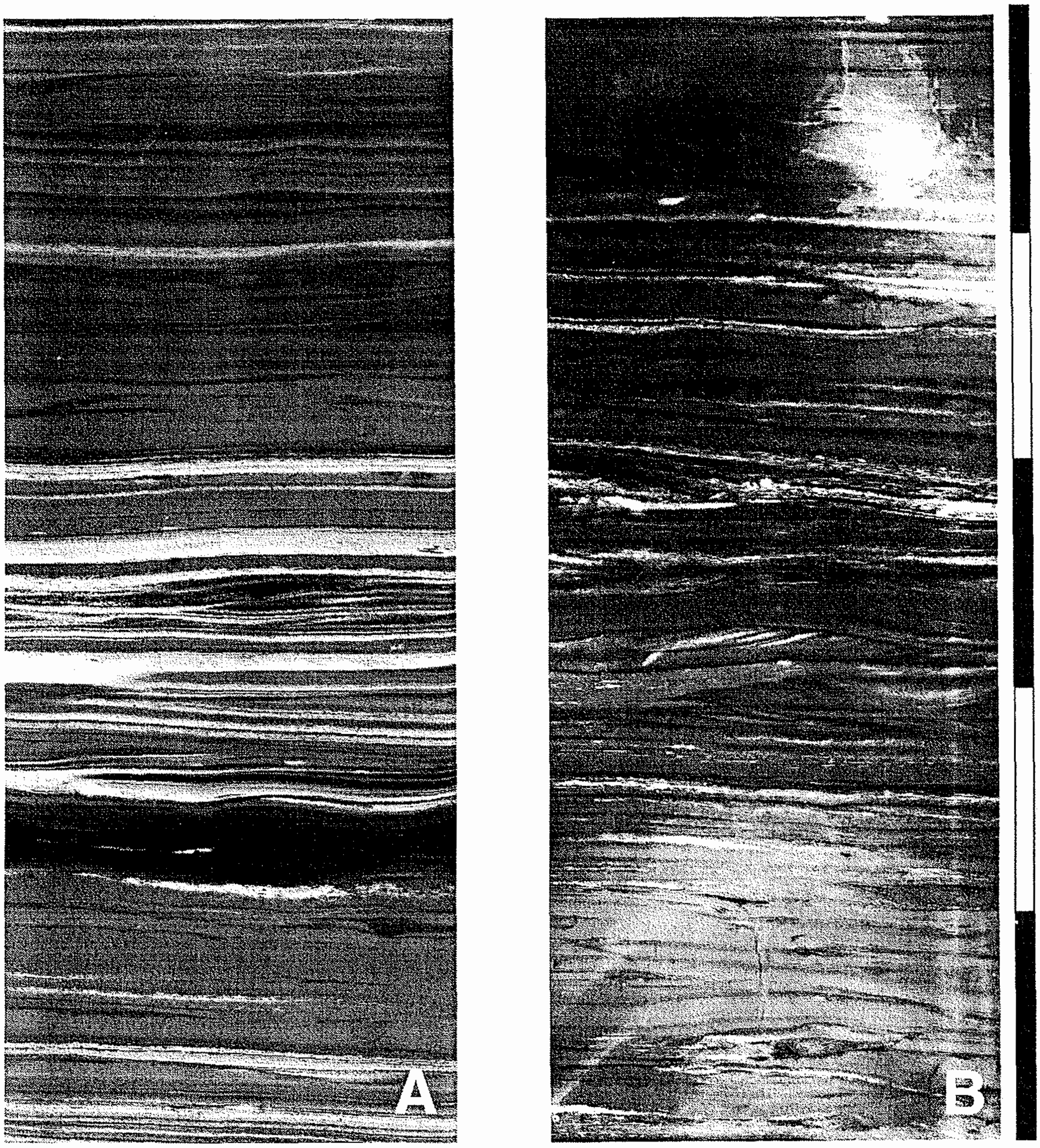


Fig. 25 A, B: Microscale lamination and ripple cross bedding in unit 2 of the Sunda shelf tansect X-ray radiographs. Core 18271-2, 448-473 cm (A) from the outer shelf and core 18314-2, 297-322 cm (B) from the inner shelf. Light layers correspond to organic-rich intervals. Scale bar corresponds to 5 cm.

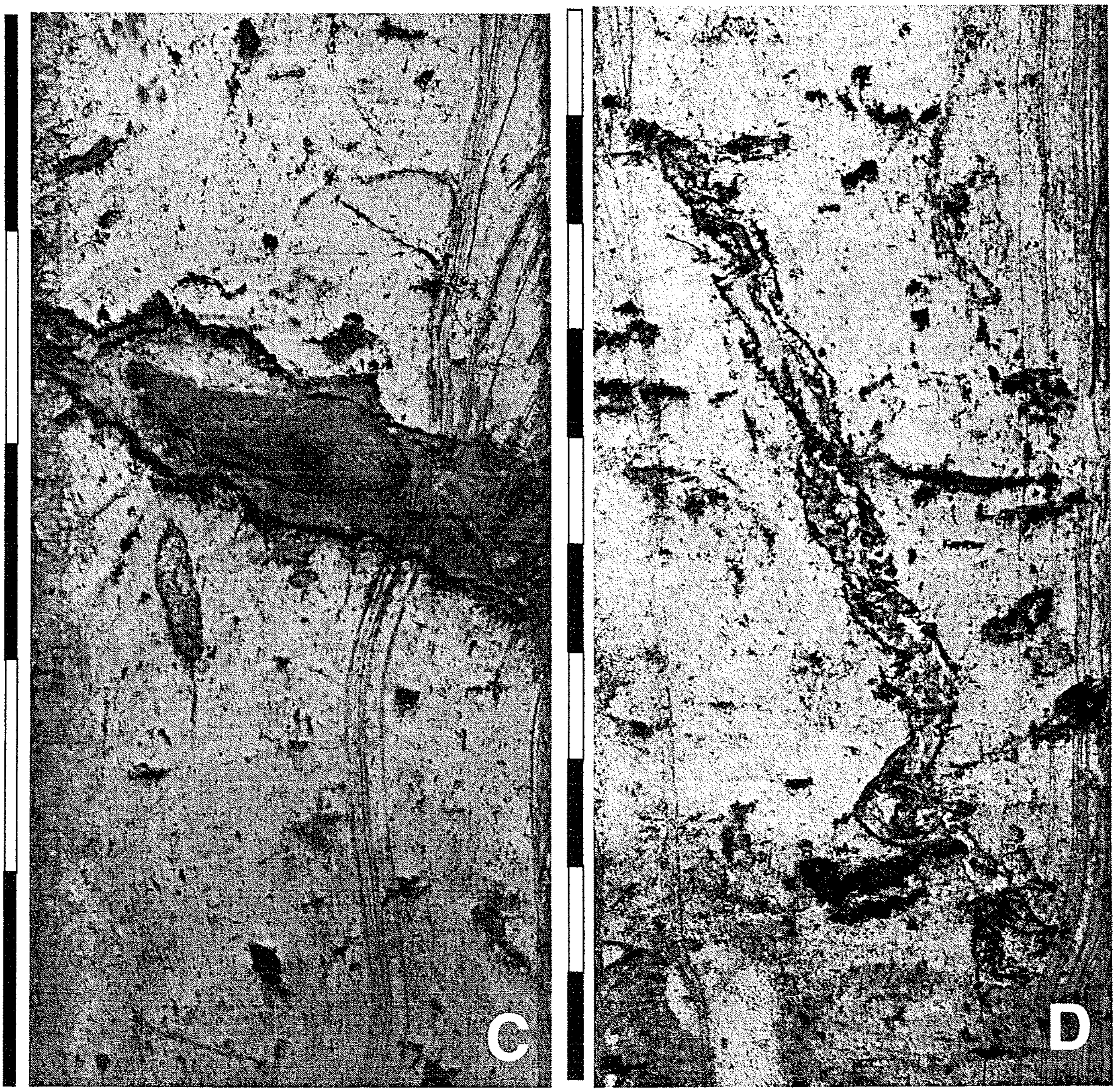


Fig. 25C-D: Wood fragment and fossil root(in situ) within Unit 2 of the Sunda shelf transect. Core 18300-2, photographs. C: 210-220cm depth in core, D: 415-435 cm depth in core. Scale bar corresponds to 2 cm.

The Unconformity 1

One of the most striking disconformities that was observed in most of the long cores is a prominent erosive contact between marine carbonate sands, that at present largely cover the Vietnam and Sunda shelf areas and underlying open marine blueish gray clays of possibly middle Holocene (climate optimum?) age. The contact of these two main units could be examined in detail within one boxcore section at the Vietnam shelf (station 18265) and in one boxcore at the Sunda shelf (station 18272) (Fig. 26).

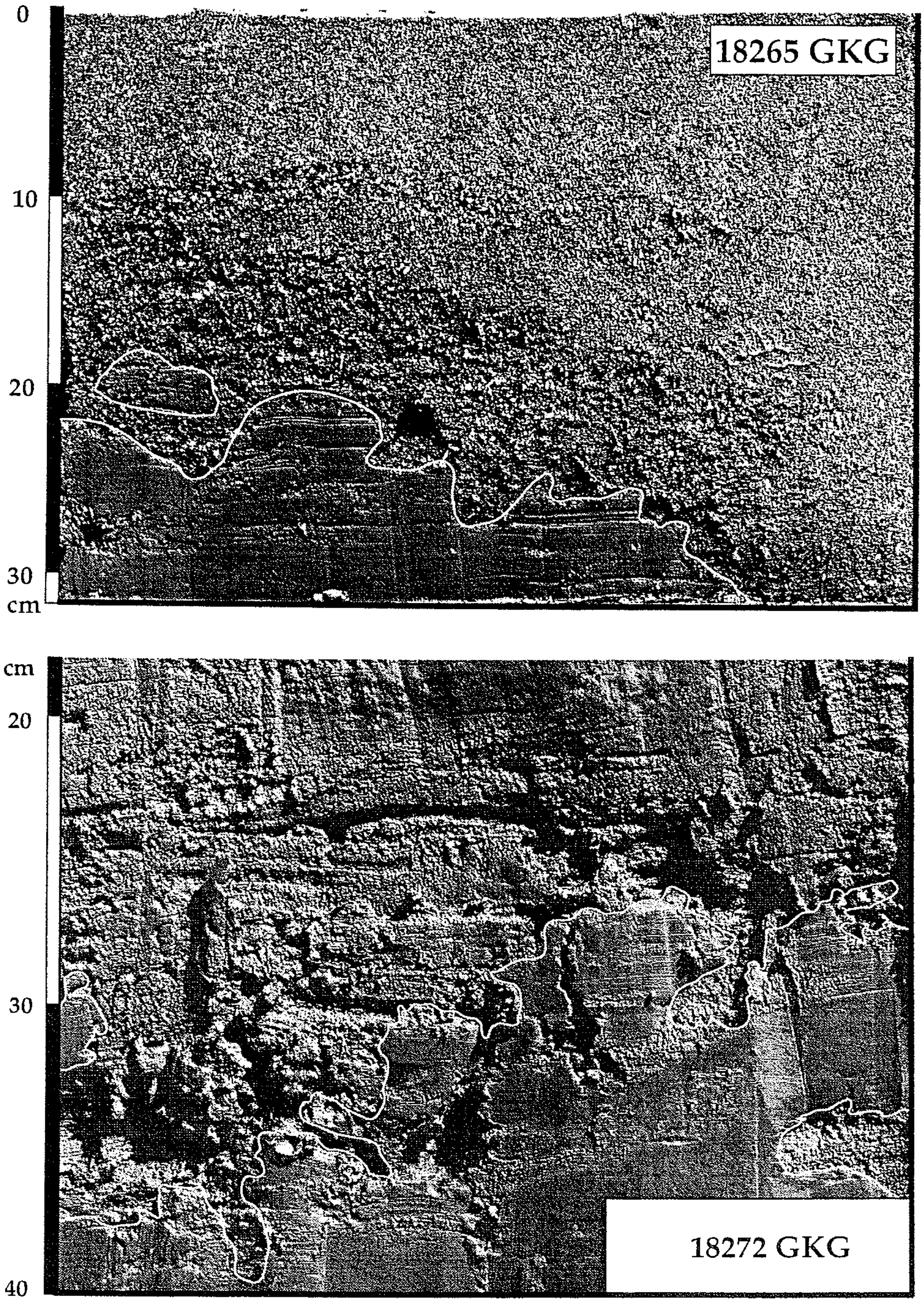


Fig. 26A, B: Erosive contact of Unit I (recent marine carbonate sands) and Unit II (?Holocene marine clay) in boxcores 18265-1 (Vietnam Shelf) and 18272-1 (Sunda Shelf).

7.4. MICROPALEONTOLOGY AND PROTOSTRATIGRAPHY

Surface samples

An initial quantitative examination of the living and dead benthic foraminiferal assemblages concentrated on the present day Sunda Shelf transect has been carried out. The objective of the research is ultimately to develop a model of the paleobathymetric distribution of benthic foraminiferal assemblages that is related to organic carbon flux, and may serve as a basis for interpreting the late Pleistocene benthic foraminiferal distribution patterns. As a first step towards providing this model, the transect from the shelf edge of the Sunda Shelf at 226 m depth (very deep shelf; Biswas, 1976) down the slope to 1404 m depth was chosen (stations 18284–18293). All multicore samples from the uppermost centimeter were sliced into two parts 0–0,2 cm (volume 13 cc) and 0,2–1 cm (volume 51 cc). For each sample the total number of "live" (stained with Rose Bengal, Walton, 1952) and "dead" (including fossil tests) foraminifera was counted in each 64 cc volume. The preliminary results from 20 surface samples are outlined below:

—At depths down to 300 m calcareous benthic foraminifera represent 80% of the total benthic assemblage. Down the slope the number of agglutinated foraminifera increases rapidly (representing up to 60% of the assemblage at 600 m depth) and reaches 65% at 1400 m (Fig. 27a).

—The comparison between "living" and "dead" foraminifera, in samples 0–0,2cm, shows that the number of stained foraminifera increases with water depth. In samples down to 300 m depth the number of "live" individuals represents only 1% of the total benthic assemblage. Below 600 m the ratio "alive" to "dead" tests is 40-50% (Fig. 27b).

—The ratio of calcareous and agglutinated foraminifera in "live" foraminifera assemblages is almost equal (~40–50% of calcareous) down to 200 m. At about 300 m, calcareous foraminifera represent approximately 65% of the total benthic assemblage, then a rapid decrease occurs at 600 m depth (to 35%). Between 600 m and 900 m, the ratio is more or less equal. In samples from deeper locations, the proportion of agglutinated foraminifera reaches up to 75% of the "live" benthic assemblage (Fig. 27c).

—Tubular forms (representing approximately 10-20% of the total surface population) were not included in the preliminary counts, which consequently depresses the abundance of agglutinated foraminifera presented in the graphs. Large tubular agglutinated foraminifera were observed in all surface samples, the most common species being *Rhizammina algaeformis, R. indivisa, Saccorhiza ramosa, Tolypammina vagans, Rhabdammina abyssorum.* Small attached agglutinated foraminifera were also common in all samples.

Table 7: Distribution of common benthic foraminifera in samples 18284-18293 (• more than 2% of the total benthic foraminiferal assemblage).

station	18284	18285	18286	18287	18288	18289	18290	18291	18292	18293
water depth	226 m	291 m	404 m	595 m	790 m	978 m	1124 m	1208 m	1309 m	1404 m
species										
Adercotryma glomerata						•	•	•	•	•
Ammobaculites filiformis						•	•	•	•	•
Ammobaculites agglutinans								•	•	•
Ammodiscus cretaceus				•	•	•	•	•	•	•
Ammomassilina alveoliniformis	•		•	•						
Ammonia beccarii			•	•	•					
Aschemonella scabra							•		•	•
Asterorotalia pulchella	•	•								
Bolivina subreticulata	•	•	•	•	•	•				
Bulimina aculeata	•	•		•				•	•	•
Bulimina mexicana			•	•	•	•	•		•	•
Buzasina ringens				•		•	•	•	•	•
Cassidulina laevigata		•					•	•	•	•
Ceratobulimina jonesiana					•	•	•		•	•
Cibicides lobatulus	•		•	•			•			
Cibicidoides kullenbergi	•	•				•	•	•	•	•
Cibicidoides pseudoungerianus						•			•	•
Cibicidoides robertsonianus			•	•	•	•	•	•	•	•
Cibicidoides wuellerstorfi					•	•		•	•	•
Cribrostomoides subglobosum			•	•	•		•		•	•
Cyclammina cancelata						•	•	•	•	•
Eggerella bradyi			•		•	•	•	•	•	•
Ehrenbergina undulata				•	•					
Eratidus foliaceus			•			•	•	•	•	•
Fissurina spp.						•		•	•	•
Globocassidulina subglobosa		•	•		•	•	•			
Glomospira glomerata				•	•		•	•	•	
Glomospirella sp.			•	•	•	•	•	•		•
Gyroidina sp.						•	•			•
Haplophragmoides bulloides					•					•
Haplophragmoides sphaeriloculum			•	•					•	•
Hoeglundina elegans			•	•	•		•		•	•
Karreriella bradyi				•	•		•		•	•
Karreriella pupiformis			•	•	•	•	•		•	
Laticarinina pauperata					•	•		•		•
Lenticulina sp.	•	•	•	•	•					
Martinotiella communis				•	•	•	•	•	•	•
Melonis barleeaneum	•	•	•		•	•	•	•	•	•
Oridorsalis umbonatus						•	•	•	•	•
Planodiscorbis sp.	•	•								
Planulina sp.	•	•	•							
Praeglobobulinina ovata		•	•				•	•	•	•
Pseudogaudryina pacifica		•	•	•						
Pseudonodosinella bacillaris				•	•	•				
Pullenia bulloides	•	•	•				•	•	•	
Pyrgo sp.	•				•			•	•	•
Quinqueloculina sp.	•	•	•			•		•	•	•
Recurvoides scitulus									•	•
Reophax dentaliniformis	•		•	•	•	•			•	•
Reophax difflugiformis			•		•	•	•	•	•	•
Reophax scorpiurus										•
Reophax subfusiformis										•
Reophanus oviculus					•		•		•	
Reticulophragmium trullissatum					•	•	•	•	•	•
Sigmoilopsis schlumbergeri		•	•		•	•	•	•	•	•
Siphogenerina striatula	•	•								
Siphonina bradyana	•		•	•						
Siphotextularia flintii	•	•								
Textularia porrecta						•				•
Trochammina globigeriniformis gr.			•	•	•	•	•	•	•	•
Uvigerina auberiana		•	•	•	•	•	•	•	•	•
Uvigerina peregrina	•	•	•	•	•	•	•	•	•	•
Uvigerina schwageri	•	•								

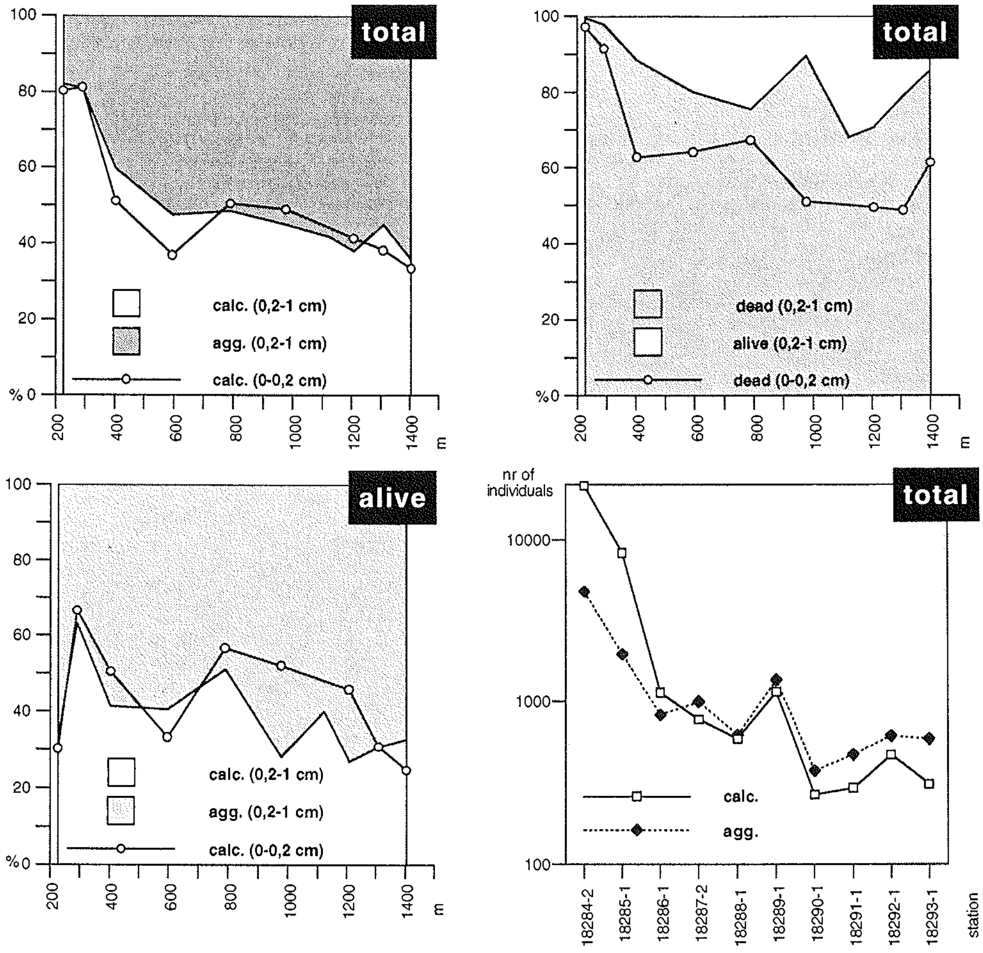


Fig. 27 **a-c:** Percentage of agglutinated, calcareous and stained foraminifera within benthic assemblages from surface samples 18284-18293. For comparison in each graph results from two samples 0-0.2 cm and 0.2-1 cm are presented; **d:** Number of individuals in 64 ccm volume of surface sediment samples 18284-18293.

—It is significant that the most dramatic changes in the composition of the benthic foraminiferal assemblage take place at the 300-600 m depth. The number of individuals counted in 1 cc volume of sediment also changes rapidly,: down to 300 m approximately 400 individuals are counted, at 600-900 m approximately 32 individuals and below 900 m the number of tests drops to 9 to 16 (Fig. 27d).

— Generally the specific diversity of this set of slope samples is very high, ranging from 80 to 140 species per sample.

Core catcher samples

Small splits of about 50cc of the core catcher samples were washed on board ship over a 63 µm screen, examined, and representative assemblages mounted on cardboard slides. Characteristic foraminifers were identified in most cases only to the generic level and semiquantitatively recorded. Main objective of this study was to roughly estimate paleo-water depths from the assemblages and discriminate cores that reached the pre-transgressive sequences from cores that only recovered (late) Holocene sediments. As a base for the paleo-water depth estimates from foraminiferal assemblages the study of Tu & Zheng (1991) was used, that discriminates four depth characteristic assemblages between the inner shelf and the shelf edge and upper slope in the Nansha Island area. These assemblages are characterized by the following dominant taxa:

0-50 m	*Amphistegina*-assemblage	*Amphistegina radiata*
		Operculina complanata
		Operculina ammonoides
50-100m	*Pseudorotalia*-assemblage	*Pseudorotalia* spp.
		Textularia foliacea
		Operculina venosa
		Anomalina colligera
		Cibicides spp.
		Bigenerina spp.
100-200 m	*Uvigerina-Bulimina*-assemblage	*Uvigerina porrecta*
		Robulus calcar
		Uvigerina schwageri
		Bulimina marginata
		Elphidium advenum
		Spirorutilis fistulus
		Sigmoilopsis asperula
>200 m	*Uvigerina asperula*-assemblage	*Uvigerina asperula*
		Lituola hispida
		Sphaeroidina bulloides
		Hoeglundina elegans
		Pullenia bulloides

In the first examination of the core catcher samples we were able to discrimante five biofacies types (Tables 8 and 9A,B):

1. samples that were barren of foraminifera and/or contain small, often strongly etched tests of miliolids and indeterminable small spiral calcareous benthic foraminifera, that are obviously size sorted and possibly reworked were interpreted as representing Late Pleistocene lacustrine/or terrestrial environments

2. a biofacies dominated by larger foraminifera of the genera Amphistegina and Operculina indicate inner shelf conditions with water depth close to or shallower than 50m

3. assemblages dominated by rotaliids (*Asterorotalia, Ammonia, Rotalia* and *Pseudorotalia*) lived probably in water depths below 100 m.

Core Catcher Samples: Vietnam Shelf Transect

Station	GIK	Coring device	Latitude	Longitude	Water depth	Recovery	% planktic foraminifers	indet. small spiral benthics	Quinqueloculina spp.	Bulimina spp.	Bolivina spp.	Bolivina pseudobeyrichi	Suggrunda eckisi	Uvigerina spp.	Tubinella funalis	Textularia spp.	Elphidium spp.	Nonionella spp.	Rotalia spp.	Asterorotalia pulchella	Peneroplitidae	Amphistegina lessoni	Operculina complanata	size sorting recognizsable	Assemblage Type
SO-115-03	18250-2	GC-3	9:23.876 N	108:58.382 E	148 m	300 cm	19	c	a	a	c	.	.	.	.	.	.	.	.	.	.	.	.	x	inner shelf
SO-115-05	18252-2	GC-8	9:14.998 N	109:23.441 E	1271 m	739 cm	21	a	a	f	f	.	f	r	r	.	.	.	.	.	.	.	.	.	O_2 minimum
	18252-3	GC-12	9:15.007 N	109:23.446 E	1273 m	1185 cm	30	a	.	f	f	f	c	.	.	.	.	.	.	.	.	.	.	.	O_2 minimum
SO-115-06	18253-2	GC-13	9:23.704 N	109:29.995 E	1479 m	859 cm	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
SO-115-08	18255-2	VC	9:41.871 N	108:46.527 E	102 m	558 cm	5	.	a	.	.	.	.	.	.	f	c	c	c	r	r	.	.	.	Asterorotalia-Fauna
SO-115-09	18256-2	VC-6	9:34.544 N	108:41.995 E	92 m	222 cm																			
SO-115-10	18257-1	VC	9:23.998 N	108:35.412 E	89 m	349 cm								barren											
SO-115-11	18258-2	VC	9:14.721 N	108:29.617 E	88 m	322 cm																			
SO-115-12	18259-1	VC	9:10.419 N	108:26.942 E	88 m	442,5 cm																			
SO-115-13	18260-2	VC	9:23.995 N	108:20.452 E	73 m	409 cm	1	.	c	.	.	.	.	.	.	.	.	.	c	.	r	.	.	.	reworked?
SO-115-14	18261-1	VC	9:14.978 N	108:07.026 E	68 m	131 cm	o	f	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	x	reworked?
	18261-2	VC	9:14.978 N	108:07.026 E	68 m	307 cm								barren											
SO-115-15	18262-2	VC	9:14.999 N	107:59.307 E	56 m	593 cm	r	f	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	x	reworked?
	18262-3	GC	9:14.999 N	107:59.307 E	56 m	938 cm								barren											
SO-115-17	18264-2	VC	9:24.022 N	107:48.429 E	49 m	128 cm	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	x	reworked?
	18264-3	GC	9:24.006 N	107:48.434 E	48 m	352 cm	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
SO-115-18	18265-2	VC-3	9:23.249 N	107:45.022 E	47 m	240 cm								barren											
	18265-3	GC	9:23.251 N	107:45.029 E	48 m	529 cm	o	c	c	.	.	.	.	.	.	.	.	.	.	.	.	.	r	x	photic zone
SO-115-19	18266-2	VC	9:22.800 N	107:44.459 E	47 m	281 cm	o	f	r	.	.	.	.	.	.	f	.	.	.	.	.	.	f	.	photic zone
	18266-3	GC	9:22.797 N	107:44.458 E	46 m	535 cm								barren											

Core Catcher Samples: Sunda Shelf Transect-1

Station	GIK	Coring device	Latitude	Longitude	Water depth	Recovery	% planktic foraminifers	Lenticulina sp.	Pyrgo spp.	Quinqueloculina spp.	Triloculina sp.	Martinottiella spp.	Spirotextularia sp.	Textularia spp.	Uvigerina spp.	Bulimina spp.	Bolivina spp.	Bolivina pseudobeyrichi	Globobulimina spp.	Amphistegina lessoni	Operculina complanata	Rotalia spp.	Cibicidoides spp.	Miliammina spp.	Oridorsalis umbonatus	Planodiscorbis sp.	Cassidulina laevigata	Hoeglundina elegans	Cancris sp.	Nonion sp.	Elphidium sp.	Neoeponides margaritifer	Cibicidoides wuellerstorfi	Asterorotalia pulchella	Pseudorotalia schroeteriana	Assemblage Type
SO-115-20	18267-2	GC-12	6:22.461 N	111:49.085 E	1846 m	869 cm	>90	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	18267-3	PC-26	6:22.387 N	111:49.126 E	1855 m	1409 cm	>90	.	c	f	.	c	.	.	f	c	c	.	r	.	.	.	.	.	r	.	f	.	.	.	.	.	c	.	.	
SO-115-21	18268-2	GC-12	6:38.782 N	111:52.309 E	1975 m	837.5 cm	>90	.	f	c	.	c	.	.	c	a	r	.	c	.	.	.	.	f	c	.	r	.	.	.	.	.	f	.	.	
SO-115-22	18269-2	GC-12	4:46.013 N	109:26.321 E	113 m	881.5 cm															barren															
SO-115-23	18270-2	GC-12	4:43.461 N	109:28.576 E	107 m	92 cm	.	.	.	f	.	.	.	.	f	.	.	.	.	f	f	.	f	.	.	.	.	.	.	.	.	.	.	.	c	
	18270-4	VC	4:43.516 N	109:28.630 E	106 m	140 cm	>75	f	.	f	.	r	r	f	f	.	.	.	.	f	f	c	f	.	.	.	.	r	.	.	.	r	.	r	.	Asterorotalia-Fauna
SO-115-24	18271-2	GC-6	4:38.330 N	109:32.969 E	122 m	562 cm	o	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	18271-3	GC-10.25	4:38.314 N	109:32.971 E	116 m	576 cm	o	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	18271-4	GC-10.25	4:38.315 N	109:32.939 E	116 m	730 cm	>50	r	.	r	.	r	f	f	r	r	r	.	.	.	r	f	c	.	.	r	.	.	.	.	.	.	.	r	f	Asterorotalia-Fauna
SO-115-25	18272-2	GC-6	4:37.597 N	109:33.632 E	118 m	338 cm	<5	.	.	a	.	.	.	r	r	.	r	.	.	.	.	c	.	.	.	.	.	.	.	.	.	.	.	c	.	Asterorotalia-Fauna
SO-115-26	18273-2	GC-6	4:37.289 N	109:33.931 E	126 m	348 cm	>50	.	.	.	.	r	.	r	r	r	r	.	.	.	.	f	f	.	.	.	.	.	.	.	.	.	.	r	f	Asterorotalia-Fauna
SO-115-27	18274-2	GC-6	4:36.318 N	109:34.833 E	118 m	561 cm	>50	r	.	r	.	.	.	f	r	r	r	.	.	.	.	r	f	.	.	.	.	.	.	.	.	r	.	.	f	
	18274-3	GC-10	4:36.313 N	109:34.818 E	117 m	755 cm	>50	.	.	f	.	r	r	.	r	r	.	.	.	.	r	f	c	.	.	.	.	.	.	.	.	.	.	.	f	
SO-115-28	18275-2	GC-6	4:35.727 N	109:35.536 E	112 m	556 cm	<50	r	.	r	.	.	.	r	r	.	r	.	.	r	.	f	f	.	.	.	.	.	.	.	.	.	.	r	r	Asterorotalia-Fauna
	18275-3	GC-10	4:35.652 N	109:35.539 E	109 m	597 cm	>50	.	.	r	.	.	r	.	.	.	.	.	.	.	.	r	r	.	.	.	.	.	.	.	.	.	.	r	r	Asterorotalia-Fauna
SO-115-29	18276-2	GC-10	4:44.897 N	109:44.837 E	116 m	721 cm	o	.	.	.	.	.	.		.	.	.	.	.	r	r	r	.	.	.	.	.	.	.	.	.	.	.	.	r	photic zone
SO-115-30	18277-2	GC-10	4:56.355 N	109:56.298 E	133 m	490 cm	<2	.	.	f	.	.	.	f	.	.	.	.	r	.	.	a	.	.	.	.	.	.	.	f	.	.	.	a	f	Asterorotalia-Fauna
SO-115-31	18278-3	GC-6	5:01.046 N	110:01.015 E	137 m	534 cm	<5	.	.	c	.	.	.	r	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	f	.	.	.	a	.	Asterorotalia-Fauna
SO-115-32	18279-3	GC-6	5:02.584 N	110:02.562 E	140 m	530 cm	>5	r	.	c	.	.	.	.	r	.	c	.	.	.	.	.	r	f	.	.	.	.	.	c	r	.	.	a	.	Asterorotalia-Fauna
SO-115-33	18280-2	GC-6	5:06.007 N	110:05.939 E	144 m	556 cm	20	.	.	f	r	.	r	.	.	r	f	r	.	.	.	c	.	r	.	.	.	.	.	r	f	.	.	c	.	Asterorotalia-Fauna
SO-115-34	18281-2	GC-6	5:07.805 N	110:07.769 E	146 m	530 cm	3	.	.	r	.	.	.	.	.	.	r	.	.	.	.	.	.	r	.	.	.	.	.	c	f	.	.	a	.	Asterorotalia-Fauna
SO-115-35	18282-2	GC-9	5:14.687 N	110:14.605 E	151 m	634 cm	>50	.	r	.	.	.	.		f	.	f	.	.	.	.	f	.	r	.	.	.	.	.	.	.	.	.	r	.	Asterorotalia-Fauna
SO-115-36	18283-2	GC-6	5:25.144 N	110:25.079 E	165 m	547.5 cm	o	.	.	a	.	r	.	r	.	.	f	.	.	.	.	a	.	c	.	r	.	.	r	r	c	.	.	c	.	Asterorotalia-Fauna
SO-115-37	18284-3	GC-11	5:32.510 N	110:32.413 E	226 m	804 cm	<2	.	.	.	.	.	.	.	.	.	c	r	.	.	.	c	.	.	.	.	.	.	.	.	.	.	.	.	.	
SO-115-40	18287-3	GC-6	5:39.781 N	110:39.689 E	598 m	566 cm	50	r	.	.	.	.	.	.	f	f	a	.	.	.	f	r	c	.	.	.	.	.	r	r	.	.	.	.	f	
SO-115-41	18288-2	GC-11	5:44.388 N	110:44.335 E	788 m	680 cm	25	.	.	f	.	.	.	.	f	c	c	.	.	.	.	.	.	.	.	.	f	.	.	.	.	.	.	.	.	
SO-115-42	18289-2	GC-11	5:49.802 N	110:49.755 E	976 m	682 cm	>50	.	.	.	.	.	.	.	r	c	c	f	.	.	.	f	.	.	.	.	f	.	.	r	.	.	.	.	.	O_2 minimum
SO-115-47	18294-4	GC-11	6:07.809 N	111:18.183 E	849 m	694 cm	>50	r	f	.	r	.	.	.	c	f	a	.	r	.	.	f	f	.	.	.	.	.	.	.	.	.	.	.	.	
SO-115-48	18295-2	GC-11	4:55.587 N	109:17.865 E	119 m	823 cm		.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	
SO-115-49	18296-2	VC-3	4:59.754 N	109:14.446 E	118 m	244 cm	>50	r	.	c	r	f	.	f	f	.	r	.	.	.	.	f	c	r	.	.	.	.	.	.	.	.	.	.	f	
SO-115-50	18297-2	VC-6	4:44.346 N	109:01.915 E	111 m		25	.	.	c	r	.	r	f	.	r	f	.	.	.	.	.	a	.	.	.	.	.	.	.	f	.	.	.	c	
	18297-3	SL-6	4:44.347 N	109:01.916 E	111 m	396 cm	30	r	.	.	.	r	.	c	c	c	c	.	.	.	c	c	c	.	.	.	.	.	.	.	r	r	.	.	f	
SO-115-51	18298-2	VC-6	4:31.987 N	108:49.508 E	102 m	587 cm	<5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	f	.	.	.	.	.	.	.	.	.	.	.	.	.	

Core Catcher Samples: Sunda Shelf Transect-2

Station	GIK	Coring device	Latitude	Longitude	Water depth	Recovery	% planktic foraminifers	Lenticulina sp.	Pyrgo spp.	Quinqueloculina spp.	Triloculina sp.	Martinottiella spp.	Spirotextularia sp.	Textularia spp.	Uvigerina spp.	Bulimina spp.	Bolivina spp.	Bolivina pseudobeyrichi	Globobulimina spp.	Amphistegina lessoni	Operculina complanata	Rotalia spp.	Cibicidoides spp.	Miliammina spp.	Oridorsalis umbonatus	Planodiscorbis sp.	Cassidulina laevigata	Hoeglundina elegans	Cancris sp.	Nonion sp.	Elphidium sp.	Neoeponides margaritifer	Cibicidoides wuellerstorfi	Asterorotalia pulchella	Pseudorotalia schroeteriana	Assemblage Type
SO-115-52	18299-1	VC-6	4:32.004 N	108:49.537 E	102 m	580 cm	10	.	.	f	r	r	.	.	r	f	c	.	.	.	.	c	f	.	.	c	.	.	.	.	.	.	.	f	.	Asterorotalia-Fauna
SO-115-53	18300-2	GC-11	4:21.778 N	108:39.215 E	91 m	885 cm	30	r	.	c	.	.	r	c	c	c	c	.	.	.	f	f	c	.	.	.	r	.	.	.	.	.	.	f	.	Asterorotalia-Fauna
SO-115-54	18301-2	VC-6	4:21.308 N	108:38.811 E	93 m	582 cm																barren														
SO-115-55	18302-2	GC-11	4:09.585 N	108:34.535 E	83 m	598 cm	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
SO-115-56	18303-2	GC-11	4:26.425 N	108:55.491 E	83 m	736 cm	70	r	.	c	r	c	f	c	c	c	c	.	.	.	r	a	c	.	.	r	.	f	r	.	f	f	.	.	.	
SO-115-57	18304-2	VC-6	4:21.790 N	109:00.157 E	104 m	228 cm	<5	.	.	.	.	f	.	r	.	.	.	.	.	.	.	a	r	.	.	.	.	.	.	.	.	.	.	f	.	Asterorotalia-Fauna
	18304-3	VC-6	4:21.791 N	109:00.156 E	104 m	222 cm	50	.	.	.	.	.	.	.	.	.	.	.	.	.	.	c	r	.	.	.	.	.	.	.	.	.	.	.	.	
SO-115-58	18305-2	VC-6	4:17.318 N	109:04.599 E	109 m	514 cm	>50		.	.	.	f	.	.	.	.	.	.	.	.	.	c	.	.	.	.	.	.	.	.	.	.	.	.	.	
SO-115-59	18306-4	VC-6	3:35.184 N	108:26.422 E	89 m	165 cm	>30	.	.	c	r	f	.	c	c	c	f	.	.	.	.	c	c	.	.	.	.	.	.	.	.	.	.	.	.	
SO-115-60	18307-2	GC-11	3:37.626 N	108:31.648 E	100 m	943 cm																barren														
SO-115-61	18308-2	GC-11	3:17.830 N	108:47.143 E	80 m	105 cm	20		.	.	r	.	r	c	r	r	r	.	.	.	.	f	c	.	.	.	.	.	.	.	.	.	.	f	.	Asterorotalia-Fauna
SO-115-62	18309-2	VC	3:27.959 N	108:41.174 E	83 m	597 cm																barren														
SO-115-63	18310-2	VC-6	3:32.131 N	108:32.131 E	100 m	568 cm																barren														
SO-115-64	18311-2	VC-6	3:41.191 N	108:27.093 E	60 m	468 cm	25	.	.	f	f	f	.	c	.	.	f	.	.	.	r	f	f	.	.	.	.	.	r	r	r	.	.	c	.	Asterorotalia-Fauna
SO-115-65	18312-2	GC-11	3:42.351 N	108:42.380 E	101 m	667 cm																barren														
SO-115-66	18313-2	GC-11	3:52.194 N	108:52.226 E	98 m	620 cm																barren														
SO-115-67	18314-2	GC-11	3:59.469 N	108:59.473 E	100 m	370 cm	<5	.	.	.		f	.	f	.	.	r	.	.	.	.	c	c	.	.	.	.	f	r	.	r	.	.	c	.	Asterorotalia-Fauna
SO-115-68	18315-2	GC-11	2:01.658 N	107:02.011 E	69 m	583 cm	10		.	c	.	f	.	.	.	r	c	.	.	.	.	c	c	f	.	.	.	.	r	.	.	.	.	f	.	Asterorotalia-Fauna
SO-115-69	18316-2	VC-6	2:29.263 N	107:27.522 E	71 m	597 cm	<5	.	.	.	.	c	.	f	.	.	f	.	.	.	.	c	a	.	.	.	.	.	r	.	r	.	.	f	f	Asterorotalia-Fauna
SO-115-70	18317-3	VC-6	2:36.596 N	107:22.515 E	95 m	197 cm	o	.	.	f	.	.	.	.	.	.	.	.	.	.	.	f	f	.	.	.	.	.	.	.	.	.	.	.	.	
SO-115-71	18318-2	VC-6	2:36.609 N	107:22.508 E	87 m		>10	.	.	r	.	.	.	f	.	.	.	.	.	.	.	f	f	.	.	.	.	.	.	.	r	.	.	.	.	
SO-115-71	18318-3	VC-6	2:36.609 N	107:22.508 E	87 m	406 cm	<5	.	.	.	.	r	.	r	.	.	.	.	.	.	.	f	r	.	.	.	.	.	.	.	.	.	.	.	.	
SO-115-72	18319-2	VC-6	2:36.620 N	107:22.502 E	81 m		o	.	.	r	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	
SO-115-72	18319-3	VC-6	2:36.620 N	107:22.502 E	81 m		o		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
SO-115-73	18320-2	VC-6	2:36.726 N	107:22.491 E	76 m	492 cm																														
SO-115-74	18321-2	VC	2:18.453 N	107:25.326 E	109 m	569 cm																														
SO-115-75	18322-2	VC-6	2:18.405 N	107:37.881 E	70 m	493 cm																barren														
SO-115-76	18323-2	VC-6	2:47.030 N	107:53.200 E	92 m	540 cm																														

Table 8: Results of shipboard examination of core catcher samples along the Vietnam shelf transect.

Table 9A,B: Results of shipboard examination of core catcher samples along the Sunda shelf transect.

---

4. Outer shelf biofacies assemblages are characterized by high percentages of planktic foraminifera and an important component of uvigerinids, buliminds and bolivinids
5. Upper slope assemblages (200-500 m water depth) have planktonic percentages often higher than 90% and a highly diversified benthic foraminiferal fauna
6. Oxygen minimum assemblages may have lower planktonic percentages and are dominated by *Globobulimina, Bolivina, Bulimina* and *Uvigerina*. They seem to characterize late Pleistocene slope environments off both the Vietnam and Sunda shelf transects.

First AMS-^{14}C and stable isotope results

To test where Pleistocene sediments have been cored, first AMS- and conventional ^{14}C-datings have been performed on core catcher samples. Samples include monospecific foraminifera samples (*Ammonia* sp.), plant remains from laminated sections and wood isolated from Mangrove swamp sediments (Table 10).

Foraminifera tests indicating shallow marine conditions date to the earliest Holocene in core 18296-2, and to an age slightly prior to Termination Ia in core 18298-2. In contrast, the foraminifera sample of core 18316-2 is older than the ^{14}C dating range, thus has a minimum age of early δ^{18}O stage 3.

The wood from the lower section of core 18310-2 dates back to the end of Termination Ia.

Additional AMS ages were produced from benthic foraminifers of cores from the inner part of the Sunda Shelf at 2° N (Sonne 24 material). Three samples from the lowermost part of the marine sequence in core 24501-2 dated the age of the marine transgression at this point at about 7800 ^{14}C years, which fitted fairly well to the global sea level curves of Fairbanks (1989) and Bard et al. (1996).

The age of Pleistocene marine sediments in this part of the shelf is older than the range of ^{14}C dating (>47140 ^{14}C years in core 24506-2).

To establish a preliminary stratigraphic framework for the Sunda transect, stable isotope records have been measured on two cores from a morphological high on the slope (core 18294-3/4) at 849 m water depth and from the deep shelf (18282-2) at 151 m water depth. Whereas the deeper core provides a continuous record of the planktonic foraminifer *G. ruber* (white variety), in the shallow core planktonic foraminifera are present only in the upper 250cm. For a continuous record we have chosen the benthic species *Asterorotalia pulchella*, which occurs throughout the whole sediment section. Furthermore it still occurs in the cores from shallower waterdepth, and its abundance often is sufficient to provide monospecific samples for AMS-^{14}C-datings.

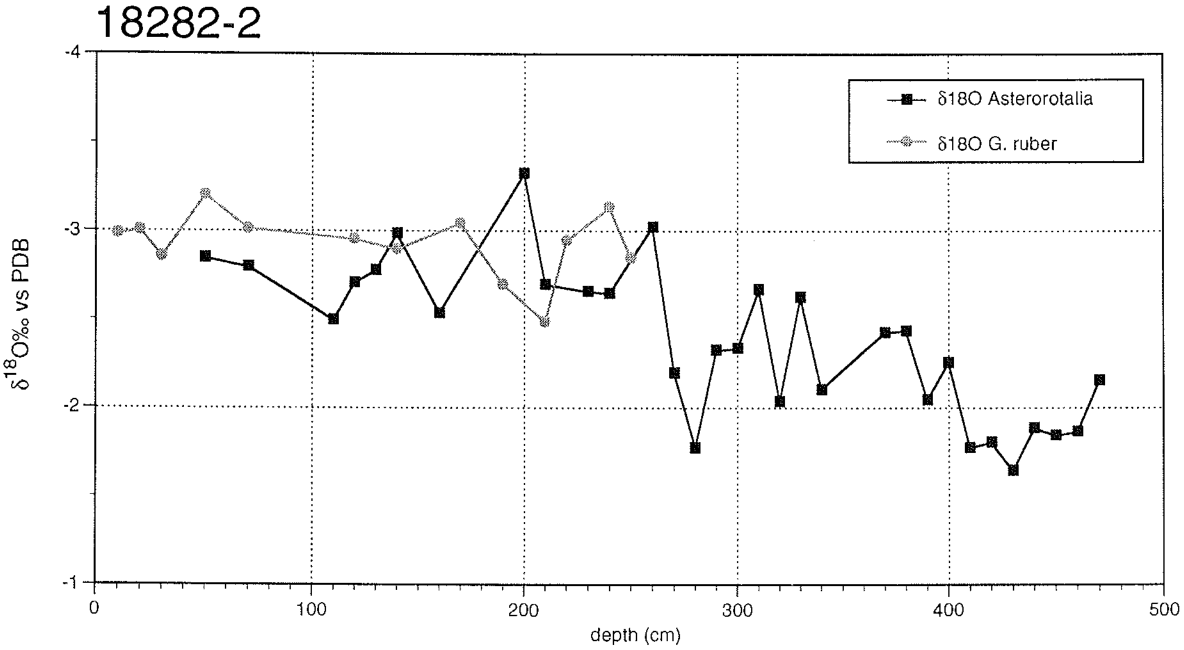
Core no	Water Depth (m)	Sampling Depth (cm)	Material	Age (^{14}C-yrs. BP)	Method
18296-2	118	244	Ammonia sp1	9360±50	AMS
18298-2	102	587	Ammonia sp2	11400±50	AMS
18310-2	100	490-493	wood	13260±120	conventional
18316-2	71	597	Ammonia sp2	>50370	AMS
24501-2	25	200-211	Ammonia sp	7470 ±60	AMS
24501-2	25	233-244	Ammonia sp	7810 ±60	AMS
24501-2	25	266-277	Ammonia sp	7750 ±40	AMS
24506-2	50	268-279	Ammonia sp	>47140	AMS
24514-2	77	170-187	Ammonia sp	6380 ±50	AMS
24514-2	77	310-325	Ammonia sp	9600 ±50	AMS

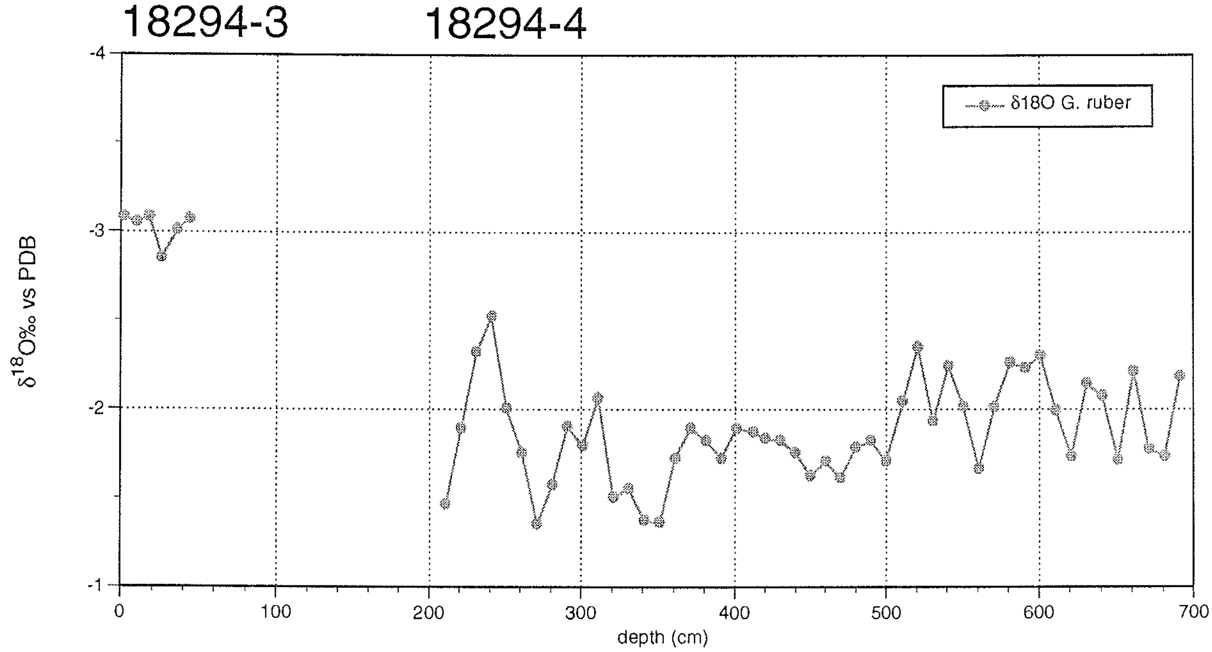
Table 10: AMS and conventional ^{14}C ages measured at the Leibniz Labor für Alters und Isotopenforschung, Universität Kiel. Numbers 245xx refer to samples from the SONNE 24 cruise on a W-E transect along 2°N, inner Sundashelf.

The δ^{18}-O record of core 18294-4 covers the last glacial maximum and about the half of stage 3, samples from the Holocene and Termination I sections (0-210cm) have not yet been measured. The younger Holocene section is recorded in boxcore 18294-3 (Fig. 28a).

Unexpectedly, the δ ^{18}-O record of the shallow core 18282-2 (Fig. 28b) probably covers a continuous sequence ranging back to the LGM, followed by a two-step Termination (Duplessy, 1988) and the Holocene section. The distinct δ ^{18}-O decrease of about 1,5‰ between the lower section and the upper half slightly exceeds the 1,2‰ δ ^{18}-O decrease linked to the global sea level increase at Termination I (Fairbanks, 1989). The amplitude of 1,5‰ is in agreement with that found in dated δ ^{18}-O records from the southern South China Sea (Wang et al., in press; Kienast, 1996).

Fig. 28a,b: δ ^{18}-O records of cores 18294-4 (slope, **a**) and 18282-2 (shelf, **b**).


18282-2


18294-3 18294-4

7.5. GEOCHEMISTRY OF SURFACE SAMPLES

A set of surface samples along the Vietnam Shelf and Sunda Shelf transects was analyzed with the objective to get a reference data set for downcore geochemistry (Tables 11 and 12).

Table 11: LECO-analyser data of total carbon (C) organic carbon (C_{org}) and carbonate ($CaCO_3$) for the surface samples.

GIK	% C	% C_{org}	% $CaCO_3$
18249	3,403	0,251	26,25616
18250	2,625	0,726	15,81867
18252	1,981	0,831	9,5795
18253	3,051	1,11	16,16853
18254	3,231	0,737	20,77502
18255	2,582	0,443	17,81787
18256	2,565	2,367	1,64934
18257		0,245	
18258		0,252	
18259	1,499	0,19	10,90397
18260	1,358	0,316	8,67986
18261	1,574	0,291	10,68739
18262	3,314	0,226	25,72304
18263	5,361	0,324	41,95821
18265	6,443	0,26	51,50439
18266	3,841	0,239	30,00466
18267	3,437		28,63021
18268	3,286	1,274	16,75996
18269	3,003	0,446	21,29981
18270	2,631	0,554	17,30141
18271	4,115	0,276	31,97887
18272	4,758	0,721	33,62821
18273	4,601	0,633	33,05344
18274	3,983	0,333	30,4045
18275	2,525	0,264	18,83413
18276	3,347	0,416	24,41523
18277	3,676	0,68	24,95668
18278	3,617	0,63	24,88171
18279	5,949	2,396	29,59649
18280	3,776	0,659	25,96461
18281	3,639	0,527	25,92296
18283	3,05	0,466	21,52472
18284	2,559	0,418	17,83453
18285	2,026	0,46	13,04478
18286	3,628	1,151	20,63341
18287	5,115	1,281	31,93722
18288	3,731	1,066	22,19945
18289	3,717	1,288	20,23357
18290	3,321	1,025	19,12568
18291	3,228	1,145	17,35139
18292	3,817	1,263	21,27482
18293	3,587	1,244	19,51719
18294	4,343	1,129	26,77262
18295	3,85	0,436	28,43862
18296	4,011	0,587	28,52192
18297	3,677	0,567	25,9063
18298	4,618	0,459	34,64447
18300	4,58	0,547	33,59489
18301	5,277	0,438	40,30887
18302	5,486	0,425	42,15813
18303	5,993	0,46	46,08989
18304	3,605	1,33	18,95075
18305	3,499	0,603	24,12368
18306	4,689	0,735	32,93682
18307	5,066	0,755	35,91063
18308	3,907	0,328	29,81307
18309	2,198	0,32	15,64374
18310	4,064	0,44	30,18792
18311	8,48	0,439	66,98153
18312	4,426	0,484	32,83686
18313	2,701	0,237	20,52512
18314	3,342	0,412	24,4069
18315	3,886	0,63	27,12248
18316	4,45	0,579	32,24543
18317	3,584	0,671	24,26529
18318	3,456	0,741	22,61595
18320	3,976	0,679	27,46401
18321	3,3	0,699	21,66633
18322	4,094	0,599	29,11335
18323	3,729	0,587	26,17286

Generally the C_{org} and carbonate contents are higher on the Sunda Shelf, which is not surprising, since the present day terrigenous supply is mainly originating from the Mekong river. Along both transects the slope samples have significantly higher (generally above 1%) C_{org} values (Tab.11). The preliminary RFA data set shows two groups of variables. Calcium and Magnesium have higher values in the carbonate-rich samples from the Sunda shelf transect, whereas "terrigenous" elements (Fe, Al, Si, Zr) strongly depend on the grain size and sand/clay ratio. We observe a tendency of higher values of these "terrigenous" elements along the Vietnam transect and in the most proximal samples of the Sunda shelf transect (Tab.12).

Table 12: RFA data of major elements and some trace elements of surface samples along the Vietnam and Sunda shelf transects

GIK	SiO2 (%)	TiO2 (%)	FeO (%)	Al2O (%)	MnO (%)	MgO (%)	CaO (%)	Na2((%)	K2O (%)	P2O5 (%)	Rb (ppm	Sr (ppm	Y (ppm	Zr (ppm	Nb (ppm	Ba (ppm
18249-1	63,62	0,49	3,28	7,23	0,09	2,27	19,99	0,89	1,79	0,18	89	903,1	25,4	708	10,9	
18250-1	59,14	0,83	5,53	16,01	0,16	3,1	11,44	0,83	2,6	0,23	147	560,4	33	595,5	16,5	
18253-1	54,68	0,82	6,58	17,61	1,99	3,15	11,13	0,76	2,96	0,22	199,5	517	35,2	158,8	15,9	
18254-1	62,72	0,71	4,67	10,65	0,1	2,93	14,59	1,02	2,24	0,2	120,5	814,5	31,8	818,2	15,8	
18257-2	79,52	0,18	2,59	5,05	0,12	1,66	8,06	0,87	1,72	0,17	74,4	330,8	14,2	53,6	4,2	
18258-1	79,91	0,35	2,59	6,84	0,08	1,88	5,23	0,96	1,98	0,13	77,2	233,7	15	223,6	6,9	
18259-2	77,23	0,46	2,9	7,03	0,07	2,1	7,09	0,97	1,91	0,14	81,8	322	18,9	544,8	8,9	
18260-1	79,01	0,34	2,37	6,64	0,06	1,96	6,74	0,84	1,8	0,17	77,4	287,4	16,2	258,8	7,6	
18261-3	73,1	0,45	3,42	8,49	0,08	2,5	8,83	0,99	1,92	0,15	90,6	355	20,4	344,8	9,8	
18262-1	65,59	0,29	3,17	5,78	0,09	2,77	19,49	0,98	1,57	0,18	79	793,4	16,3	81,3	6,2	
18262-1*	65,42	0,29	3,18	5,94	0,09	2,65	19,64	0,97	1,54	0,18	80	798,3	16,6	93	6,5	
18263-1	51,2	0,27	2,99	4,69	0,1	3,68	34,82	0,88	1,03	0,17	56,5	1563	16,1	48,1	4,3	
18263-3	51,2	0,27	2,99	4,69	0,1	3,68	34,82	0,88	1,03	0,17	56,5	1563	16,1	48,1	4,3	
18265-1	44,34	0,21	3,27	3,75	0,12	3,95	42,54	0,97	0,85	0,17	48,5	1998	15,8	121,5	4	
18266-1	65,1	0,22	2,77	4,24	0,09	2,74	22,79	0,77	1,04	0,13	52,9	970,2	12,6	39,4	4,6	
18267-1	54,04	0,78	6,25	16,55	1,33	3,02	14,21	0,7	2,75	0,26	190,8	651,8	35,3	136	14	
18268-1	53,73	0,754	6,62	18,08	0,9	2,65	12,96	0,578	2,88	0,227						709
18269-1	61,16	0,64	3,6	9,91	0,1	2,53	19,01	0,98	1,7	0,24	98,5	711,7	26,6	412,3	12,8	
18270-1	73,13	0,47	2,81	6,03	0,13	1,79	13,49	0,82	1,06	0,18	54,6	506,9	15,5	343,5	8,5	
18271-1	52,34	0,67	5,82	10,7	0,13	2,73	24,69	0,82	1,66	0,3	97,7	864,6	27,4	359,3	12,1	
18272-1	49,79	0,71	5,44	11,91	0,15	2,95	25,87	0,86	1,87	0,29	122,3	995,4	32,2	276,4	13,7	
18273-1	49,1	0,75	4,82	12,47	0,11	0,01	26,45	0,88	1,99	0,26	129,4	996,4	33,4	339,8	15,1	
18274-1	62,71	0,52	3,24	5,98	0,08	1,99	23,27	0,8	1,06	0,21	60,6	839,3	19,6	475,3	9	
18275-1	72,94	0,47	2,51	5,51	0,1	1,73	14,83	0,73	0,9	0,19	43,7	520,5	12,9	433,5	7,4	
18276-1	62,13	0,53	4,22	8,43	0,09	2,3	19,78	0,81	1,32	0,27	73,2	730	20,7	381,2	10,3	
18277-1	57,58	0,75	4,56	12,46	0,11	2,83	18,21	1	2,12	0,25	133,4	747,4	33,3	388,1	15,8	
18278-1	56,48	0,72	4,33	12,1	0,1	2,8	20,07	0,96	2,04	0,26	130,5	796,9	33,6	417,8	15,3	
18279-1	51,56	0,68	4,21	10,35	0,1	2,66	27,34	0,98	1,7	0,26	112,1	963,2	31,9	493,3	13,8	
18280-1	54,95	0,72	4,22	11,28	0,1	2,71	22,64	1,04	1,92	0,27	121	845,7	33,7	435,7	15	
18281-1	58,77	0,71	4,09	11,17	0,1	2,62	19,08	1,07	2,01	0,24	123,4	776,5	33	396	14,7	
18283-1	57,81	0,72	4,41	11,13	0,09	2,45	20,16	0,99	1,81	0,27	110,8	725	32	678,5	14,6	
18284-1	63,75	0,69	3,64	9,82	0,07	2,19	16,92	0,95	1,57	0,24	85,8	578,4	25,3	1005	13,6	
18294-3	50,35	0,76	5,94	15,84	0,3	2,8	20,19	0,84	2,63	0,25	179,6	792,1	34	101,3	13,8	
18295-1	61,96	0,563	3,67	8,92	0,08	1,74	19,89	0,925	1,764	0,178						268
18296-1	53,21	0,65	4,13	11,06	0,11	2,67	24,81	1,05	1,92	0,24	123,9	924,8	30,9	357,7	13,6	
18297-1	55,32	0,69	4,2	12,4	0,1	2,78	21	1	2,12	0,25	133,6	810,3	33,7	389,9	15,2	
18302-1	51,06	0,568	3,63	8,91	0,07	2,52	29,83	0,747	1,595	0,166						203
18304-1	59,93	0,693	4,53	11,71	0,09	2,09	16,39	0,861	2,102	0,188						281
18305-1	56,49	0,74	4,33	12,58	0,1	2,8	19,49	0,95	2,13	0,25	132	815,5	34,7	341,2	15	
18306-2	53,14	0,644	4,5	11,66	0,09	2,75	23,53	0,574	1,837	0,242						239
18309-1	67,95	0,61	2,82	8,91	0,11	2,35	14,9	0,76	1,24	0,22	58,6	671,4	18,5	528,8	10	
18310-1	62,55	0,555	3,54	8,12	0,08	1,74	20,47	0,546	1,348	0,186						181
18313-1	75,51	0,381	2,14	4,58	0,06	1	13,45	0,496	0,879	0,116						125
18314-1	59,06	0,57	3,39	7,24	0,13	2,42	24,9	0,82	1,07	0,24	57,6	932,8	18,6	468,8	8,3	
18323-1	59,83	0,727	4,83	11,41	0,08	2,08	18,07	0,525	1,735	0,22						226

8. SCIENTIFIC HIGHLIGHTS OF THE SO-115 CRUISE

The Sonne 115 cruise had the first possibility since more than thirty years to obtain high resolution shallow seismic data and long sediment cores directly offshore the Mekong delta.

We observed major differences between the paleo-Mekong and the Molengraaff river transects: A comparably thin Holocene cover characterizes the Vietnam shelf - whereas the post-pleistocene marine sedimentary infill of the Molengraaff river-system partly was thick enough, that the base was not reached by our coring systems.

We found a major infilled incised valley system on the Sunda Shelf, that corresponds to the Late Pleistocene Molengraaff valley system, but only small older channel structures off the modern Mekong Delta.

A sequence stratigraphic delta-fan model is deduced from our seismic reflection studies and will be put into a chronostratigraphic framework.

The late Pleistocene continental-marine transition on the Sunda shelf extends within a 150 km wide zone of modern water depths between 80 and 110 metres taking into account the paleo-morphology of the Molengraaff-valley system and isostatic subsidence due to strong terrigenous sediment supply.

First AMS and conventional ^{14}C datings give evidence of a timing of the early Holocene sea level rise along the shelf transects, that is in rough accordance with the recently published sea level curves of Bard et al. (1996). Our long transect across the Sunda shelf, documented with a large number of coring stations, will allow for significantly higher resolution of the sea level events at the Pleistocene/Holocene transition than previously published data.

The possibility to date marine microfossils and shortly drifted or even autochthonous wood fragments in the same cores may provide a possibility to evaluate the reservoir effect of the ocean on ^{14}C ages for several time slices.

The effects of the transgression on the paleoceanography of the South China Sea (SCS) can be studied along a continuous transect of cores from the shelf down to about 2000 m water depth. Modelling the terrigenous flux from the Molengraaff river system into the southern part of the SCS may allow us to answer the still open question whether the significantly enhanced paleoproductivity during the late Pleistocene is caused by terrigenous nutrient supply or enhanced winter monsoonal upwelling in this area.

ACKNOWLEDGEMENTS

The scientific party would like to take this opportunity first and foremost to thank Captain Andresen, his officers and crew for their outstanding work during the SO-115 cruise. The fact that we performed more than 4000 km of seismic profiling and 76 sediment stations with no loss of equipment or time is a tribute to them all - even more since we experienced the special hospitability at Christmas and New Years Eve in addition to the calm everyday professionalism.

Colleagues at Dalhousie Universtiy, Halifax, provided a vibrocorer which made it possible for us to core many stations we could not do otherwise.

The support of the SO-115 project by the BMBF is greatly appreciated, and assures an effective study of the seismic records and sediment cores at the Universities of Kiel and Hamburg as well as a fruitful cooperation with the other institutions participating in and contributing to this project.

We are also grateful to Helmut Erlenkeuser and Pieter Grootes for the stable isotope and AMS-^{14}C-analysis .

9.REFERENCES

Anonymous, 1984. Physiographic Map of the South China Sea. Scale 1:4 000 000. (Academia Sinica (Ed.), Tianjin Peoples' Printing Co.), pp.

Admiralty London, 1986. China Sea-Southern Portion, 1: 1 550 000, Western Part 2660A, Eastern Part 2660B.

Bard, E.; Hamelin, B.; Arnold, M.; Montaggioni, L.; Cabioch, G.; Faure, G.; Rougerie, F., 1996. Deglacial sea-level record from Tahiti corals and the timing of global meltwater discharge. *Nature*, 382, 241-244.

Biswas, B., 1976. Bathymetry of Holocene foraminifera and Quaternary sea level changes on the Sunda Shelf. *J. Foraminif. Res. (U.S.A.), 6 (2), 107-133, 4 Abb.,*

Boyd, R., Suter, J., and Penland, S., 1989. Relation of sequence stratigraphy to modern sedimentary environments. *Geology*, 17: 926-929.

Dickerson, R.E., 1941. Molengraaff River: a drowned Pleistocene stream. *In Shiftings of sea floors and coastlines*: Univ. Penn. Bicentennial Conf. 1940. 13-30.

Duplessy, J.C., Labeyrie, L. & Blanc, P.L. (1988a): Norwegian Sea deep water variation over the last climatic cycle: Paleo-oceanographical Implications.- In: Wanner, H. & U. Siegenthaler (eds.), *Long and short term variability of climate*, Springer Verlag.

Eisma, D., 1990. Dispersal of Mahakam river suspended sediment in Makasar Strait, Indonesia. In: Ittekott, V., Kempe, S., Michaelis, W. and Spitzy, A., *Facets of Modern Biogeochemistry, Festschrift for E.T. Degens*, Springer-Verlag, Berlin, 127-137.

Evans, C.D.R., Brett, C.P., James, J.W.C., and Holmes, R., 1995. Shallow seismic reflection profiles from the waters of East and Southeast Asia an interpretation manual and atlas. *British Geological Survey, Technical Report WC/94/60, Overseas Geology Series*, , 66-67.

Fairbanks, R.G., 1989. A 17000-year glacio-eustatic sea level record: Influence of glacial melting rates on Younger Dryas event and deep ocean circulation. *Nature* 342:637-642.

Flemings, P.B. and Grotzinger, I.P., 1996. STRATA: freewave for analyzing classic stratigraphic problems. *GSA today*, 6, 12: 1-7.

Fontaine, H. and Delibrias, G., 1974. Niveaux marins pendant le Quaternaire au Viet-Nam. *Arch Géol. Viet-Nam*, 17: 35-44.

Galloway, W.E., 1975. Process framework for describing the morphologic and stratigraphic evolutionm of deltaic depositional systems. In: Broussard, M.L. (ed.): *Deltas, models for exploration*, 87-98, Houston Geol. Soc., Houston.

Geyh, M.A., Kudrass, H.-R., and Streif, H., 1979. Sea-level changes during the late Pleistocene and Holocene in the Strait of Malacca. *Nature, 278: 441-443*

Kienast, M. 1996. Geschichte des Flußeintrags vom Sunda-Shelf: Abbild in hemipelagischen Sedimenten aus dem Südchinesischen Meer. - Unpubl. Diplomarbeit, Univ. Kiel, 53pp.

Ludwig, W.J., Kumar, N., and Houtz, R.E., 1979. Profiler-sonobouy measurements in the South China Sea Basin. *Journal of Geophysical Research*, 84: 3505-3518.

Kögler, F. C., Andresen, H. and Lincke C., 1982. Final report SO 24. 166 S., RF Reedereigemeinschaft Forschungsschiffahrt GmbH.

Köhler, B., 1985. Sedimentologie und Mineralogie der Oberflächensedimente im mittleren Sunda-Schelf (ein W-E-Profil zwischen Malaysia und Borneo). Unveröffentlichte Diplomarbeit Christian-Albrechts-Universität, 76 S.

Molengraaff, G.A.F., 1922. De Geologie der Zeeen van Nederlandsch Oost Indiee. *in: Koninkliik Nederlandsch Aadrijkskundig Genootschap (ed.) De Zeeen van Nederlandsch Oost Indiee: 272-357; Leiden (Brill).,*

Molengraaff, G.A.F., and Weber, M., 1920. On the Relation between the Pleistocene Glacial Period and the Origin on the Sunda Sea (Java and South China Sea), and its Influence on the Distribution of Coralreefs and on the Land- and Freshwater Fauna.

Koninklijke Akademie van Wetenschappen -Te Amsterdam-, Proc. of the Section of Sciences, 23, 1st part, No. 2 und 3: 395-439..

Mostafawi, N., 1992. Rezente Ostracoden aus dem mittleren Sunda-Schelf, zwischen der Malaiischen Halbinsel und Borneo. *Senckenbergiana lethea*, 72: 129-168.

NEDECO, 1965. A study on the siltation of the Bangkok Port Channel, II, the field investigation. Den Haag 474 pp.

Pirazzoli, P.A., 1991. World Atlas of Holocene sea-level changes. *Elsevier Oceanogr. Series*, 58: 300 S.

PONAGA, 1993. (Huchon, P., Phan Truong, T. und Le Pichon, X.). Campagne PONAGA (N/O L'Atalante). *Rapport de bord, fait à Nha Trang le 31 May 1993.*

Posamentier, H. W., Jervey und Vail, P. R. (1988). Eustatic controls on clastic deposition I - Conceptual framework. In: C.K. Wilgus et al. (Eds.*), Sea-level changes: an integrated approach. SEPM Spec. Publ.* 42: 109-124.

Sarnthein, M., Pflaumann, U., Wang, P.X., and Wong, H.K., 1994. Preliminary report on Sonne-95 cruise "Monitor Monsoon" to the South China Sea. *Berichte-Reports, Geol. Pal_ont. Inst. Univ. Kiel*, 68: 1-224.

Schönfeld, J., and Kudrass, H.-R., 1993. Hemipelagic sedimentation rates in the South China Sea related to Late Quaternary sea-level changes. *Quaternary Res.*, 40: 368-379.

Tjia, H.D., 1980. The Sunda Shelf, Southeast Asia. *Z. Geomorphol., 24 (4), 405-427, 9 Abb.,*

Tjia, H.D., Fujii, S. and Kigoshi, K., 1977. Changes of sea-level in the southern South China Sea area during Quaternary times. In: *Proc. Symp. Quat. Geol. Malay-Indon. Coast. Offshore Areas, CCOP/TP5,* 11-36.

Tu, X., and Zheng, F., 1991. Foraminifera in surface sediments of the Nansha Sea Area. *In* T.M.O.E.T.o.A.S.t.t.N. Islands (Ed.), *Quaternary Biological Groups of the Nansha Islands and Neighbouring Waters*: Guangzhou, China (Zhongshan University Publishing House), 129-198.

Vail, P.R., 1988. Sequence stratigraphy workbook, fundamentals of sequence stratigraphy: 1988 AAPG Annual Convention Short Course. Sequence stratigraphy interpretation of seismic well and outcrop data, presented by P.R. Vail and J.B. Sangree, March 19, 1988, Houston.

Van Wagoner, J.C., Mitchum, R.M., Campion, K.M., and Rahmanian, V.D., 1990. Siliciclastic Sequence Stratigraphy in Well Logs, Cores, and Outcrops: Concept for High-Resolution Correlation of Time and Facies. *AAPG Methods in Exploration Ser.* 55 pp.

Walton, W.R., 1952. Techniques for recognition of living Foraminifera, *Contr. Cushman Found. Foram. Research,* III: 56-60.

Wang, L., Sarnthein, M., Erlenkeuser, H., Grootes, P.M. Grimalt, J., Pelejero, C., and Linck, G. (manuscript for Paleoceanography): Holocene Variations in Asian Monsoonal Moisture - a Sediment Record from the South China Sea on bidecadal Time Scale.