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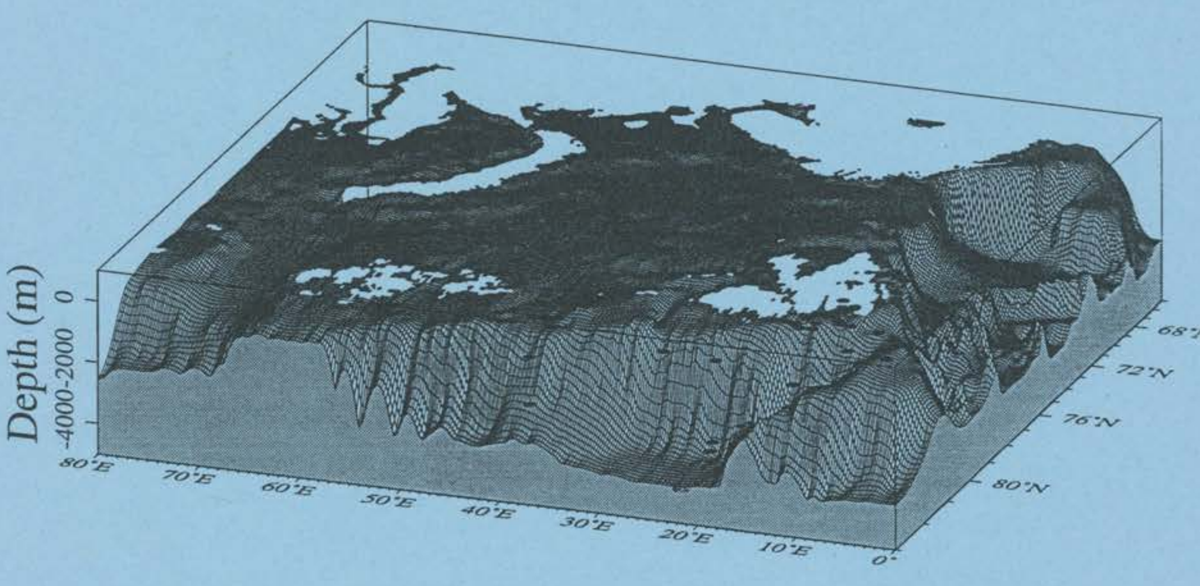
Anders Solheim and Carl Fredrik Forsberg (editors):

NORWEGIAN POLAR INSTITUTE's CRUISE TO THE NORTHERN MARGIN OF SVALBARD AND THE BARENTS SEA 25/7 - 2/9, 1994: MARINE GEOLOGY/ GEOPHYSICS AND PHYSICAL OCEANOGRAPHY

Cruise Report



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Front cover illustration: The Barents Sea region viewed from the north, with NP94 coring stations shown (dots).

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PART A.
OFFSHORE MARINE GEOLOGY AND GEOPHYSICS

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Summary

During the period July 25 - September 2, 1994, the Norwegian Polar Institute (NP) carried out marine geological and geophysical investigations, primarily along the northern margin opf Svalbard and the Barents Sea. Several sub-programs were included in the cruise, but the main focus was on the glacial evolution of the region, which formed the northern limit of the Svalbard- and Barents Sea ice sheets during the Plio- and Pleistocene. Acoustic profiles, using a range of frequencies, and sediment coring were carried out from the coasts of Svalbard and Franz Josef Land into the Arctic Ocean basin. All together nearly 4000 km of high resolution seismic profiles were collected, and 59 locations were cored, with core recovery of up to 7.5 m. All cores are placed on acouistic profiles. A physical oceanographic program was also carried out during the cruise, in which a total of 93 CTD casts were performed, most of which are at sediment coring locations. We expect the material collected during this cruise to bring important new information about this generally poorly investigated area.

Background and objectives

Through the European program Late Cenozoic Evolution of the Polar North Atlantic Margins (PONAM) and the Norwegian program "Svalbardtraversen", the knowledge of the glacial geological evolution of the western Svalbard- and Barents Sea margin has greatly improved. These studies have spanned from multichannel seismic data to detailed investigations of sediment cores. Hence the results comprise both the long term glacial history and the last interglacial - glacial cycle, as well as the Holocene.

PONAM and "Svalbardtraversen" were completed in 1993, but the results provided a great potential for a continuation, both thematically and geographically. Through the seismic stratigraphic correlation carried out for the entire western margin, from off northern Norway to central western Spitsbergen, we may now quantify the accumulations of glacial deposits along the margin. This in turn will give important background data for further modelling of the Late Cenozoic erosion of the Barents Sea and Svalbard.

The present state of knowledge about the northern margins of Svalbard and the Barents Sea is, however, considerably more sparse. Scattered seismic profiles, the regional bathymetry and isostatic modelling indicate large volumes of sediments on the north margin, particularly outside the main troughs running north from Svalbard and the Barents Sea. To enable a full quantification of the glacial erosion, and to fully understand the glacial evolution of the entire Svalbard- and Barents Sea region, an improved knowledge of the deposits along the northern margin is essential. This is the main background for Norsk Polarinstitutt's (NP) plans for a marine geological / geophysical cruise in this region during the summer of 1994.

Six regional seismic sequences, which can be correlated over nearly 1000 km, from the Bear Island Fan in the south to Isfjorden Fan in the north, comprises the presumed glacial part of the sedimentary section along the western margin. Major temporal and spatial differences in the depositional patterns can be recognized in the sequences. These are most likely related to geographical differences in the glacial evolution. The lack of chronostratigraphic tie points is, however, the most important problem in the interpretation of the presumed glacial stratigraphy along the margin. Seismic ties to a small number of scientific and commercial wells, in addition to identification of oceanic basement of known magnetic age, put some constraints on the lower and very upper parts of the section (Eidvin & Riis, 1989; Eidvin et al., 1993; Talwani, Udintsev et al., 1976; Sættem et al., 1994; Fiedler, 1992). For the internal sequence boundaries, no ground truth exists, and interpretations are based on general paleoclimatic evolution as interpreted from lower latitudes (e.g. Jansen & Sjøholm, 1991). To improve the chronostratigraphic control and thus provide a better base for interpretations of the paleoclimatic evolution, as well as quantification of erosional- and depositional rates, a drill site at the western Svalbard margin was proposed to, and subsequently accepted by the Ocean drilling Program (ODP), to be drilled during Leg 162 in the summer of 1995. During ODP Leg 151 (Myhre, Thiede, Firth, et al., 1995), three sites were drilled on the Yermak Plateau, while a fourth site (YERM-1) was inaccessible and remained to be drilled during Leg 162. The combination of these sites in the northwestern part of the Greenland Sea may provide the necessary age constraints for the glacial seismic sequences.

The program carried out during the present cruise, was to be tied to the drillsites on the Yermak Plateau, and carry the stratigraphy from these sites westwards along the margin, as far as possible towards the archipelago of Franz Josef Land. In addition, site surveys were planned around both the drill sites for Leg 162, both off western Svalbard, and on the Yermak Plateau. A deeper stratigraphic framework can be put together using existing multichannel seismic data (Eiken, 1994). These data are also used to tie the stratigraphy of the northern margin to that defined off western Svalbard. By using high resolution seismic equipment in addition to sediment coring, the idea was to obtain a data set comparable to that from the western margin, and hence a base for interpretations deducing both the long term glacial history and the last interglacial - glacial cycle in this considerably less accessible region as well.

The structure and distribution pattern of the shallow bedrock (above the first sea floor multiple) is another theme that has been addressed through several investigations in the northern Barents Sea, where the Quaternary cover is generally thin (Elverhøi & Lauritzen, 1983; Antonsen & Flood, 1987; Elverhøi et al., 1988; Antonsen et al., 1991; Solheim, 1993). Investigations were carried out southwest of Franz Josef Land in 1992, during a joint Norwegian - Russian effort (Solheim, 1993). Further control on the bedrock geology between Svalbard and Franz Josef Land is of importance, as major differences between the Mesozoic successions of the two archipelagos are well known (e.g. Ulmishek, 1985). Furthermore, the bedrock structure to the north of Svalbard is poorly known, and to map the boundary between the Hecla Hoek crystalline basement rocks and seaward dipping sedimentary strata towards the continental margin is important in understanding the preglacial depositional history of this region.

Based on the background briefly described above, the main objectives of the present marine geological and geophysical investigations can be summarized as follows:

- To understand the seismic stratigraphy of glacial sequences along the northern margin of Svalbard and the Barents Sea, and to tie this to the chronostratigraphic control provided by existant and future boreholes.

- To understand the extent and evolution of the last interglacial - glacial cycle along the northern boundary of the Svalbard- and Barents Sea ice sheet.
- To compile a more comprehensive data base for quantification of erosion and deposition in and around the Barents Sea, respectively.
- To augment site survey data for the ODP Leg 162 drill sites off Svalbard.
- To map the seismic structure of the upper bedrock below the glacial sediments.

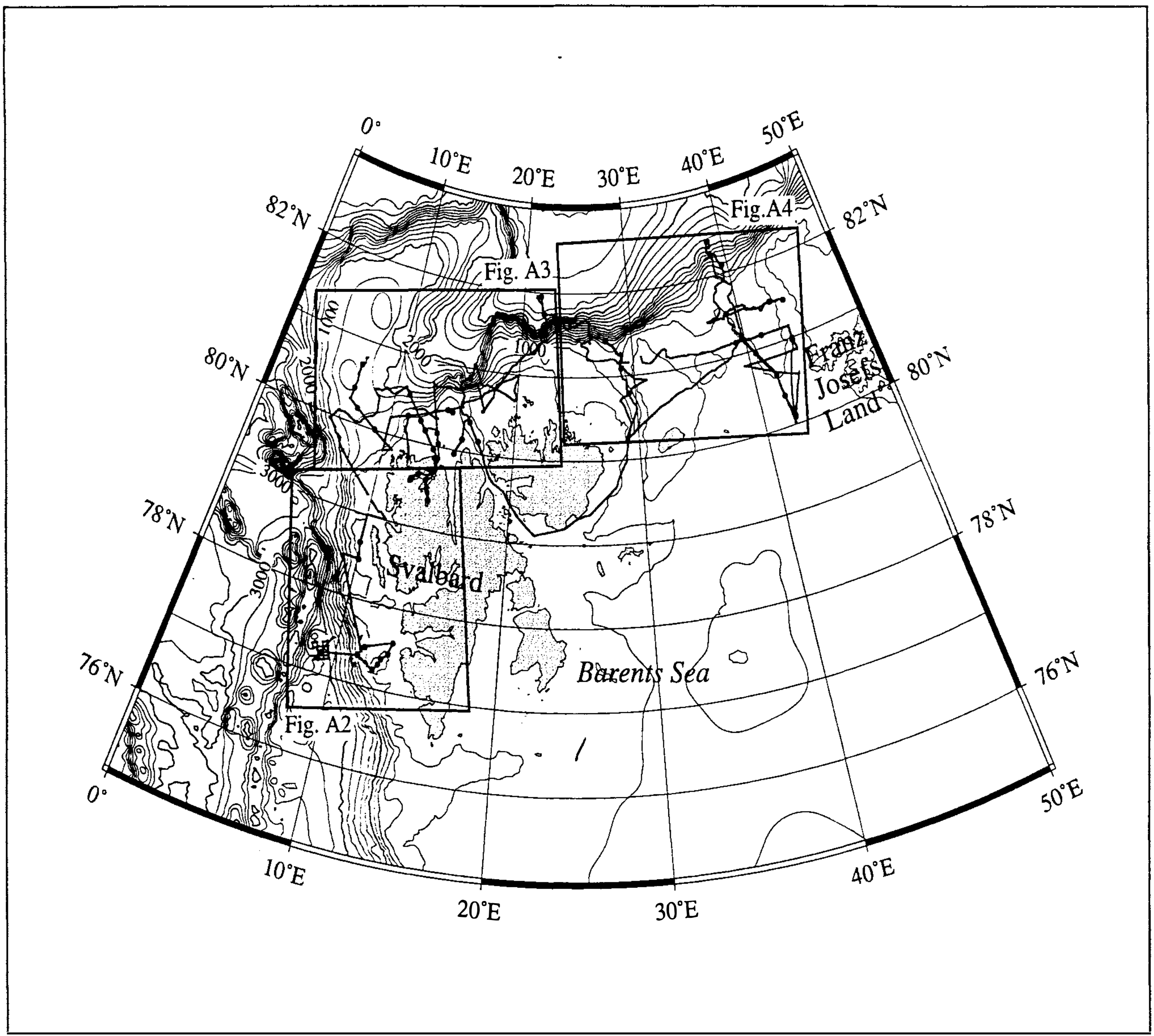

Figure A1. The NP94 cruise. Solid lines mark ship's tracks and dots are sediment coring stations. For details, see figures A2, A3 and A4 (frames). Bathymetric contour interval is 200 m.

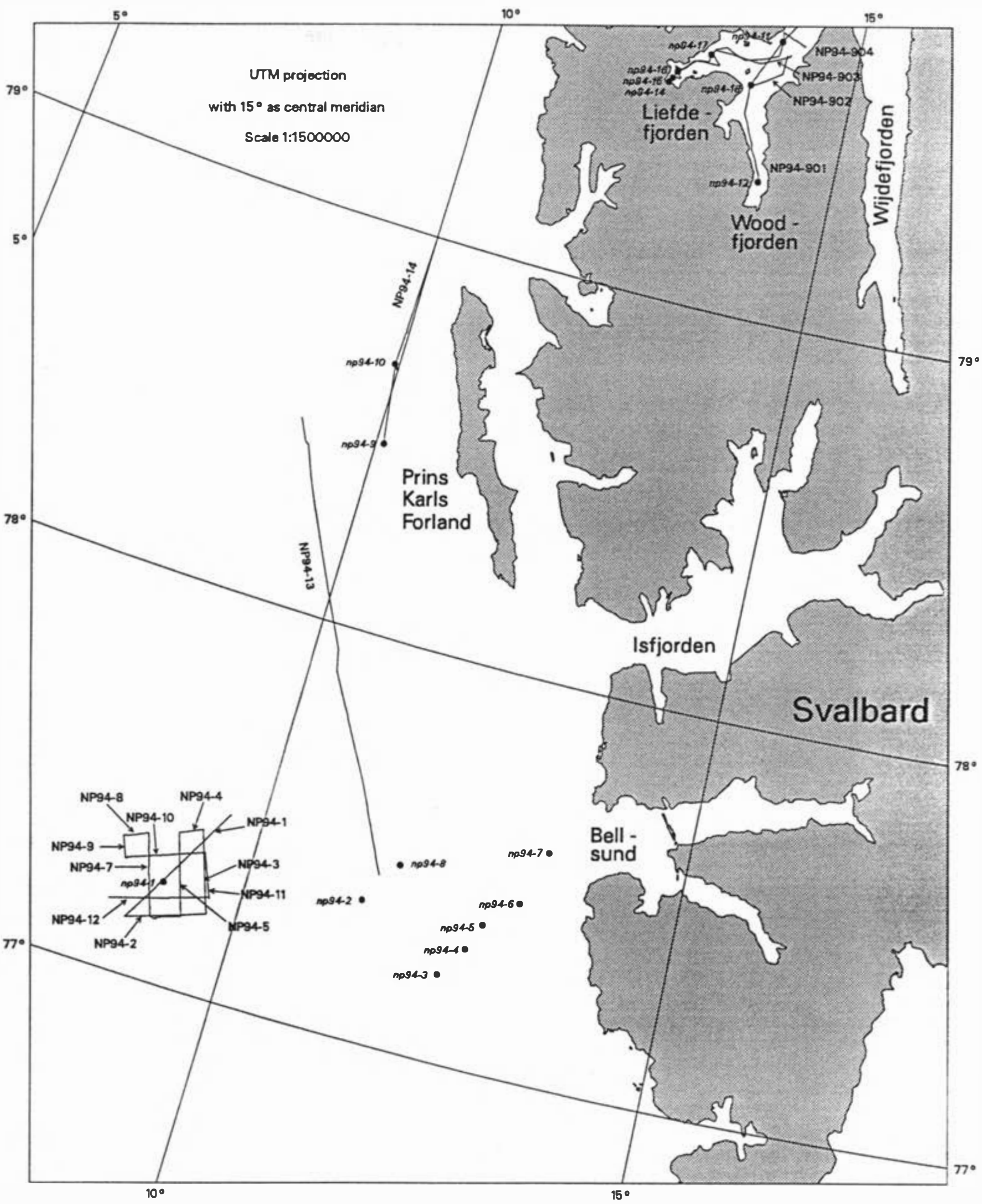

Figure A2. Seismic profiles (solid lines) and sediment coring sites (dots) from the western Svalbard margin during the NP94 cruise.

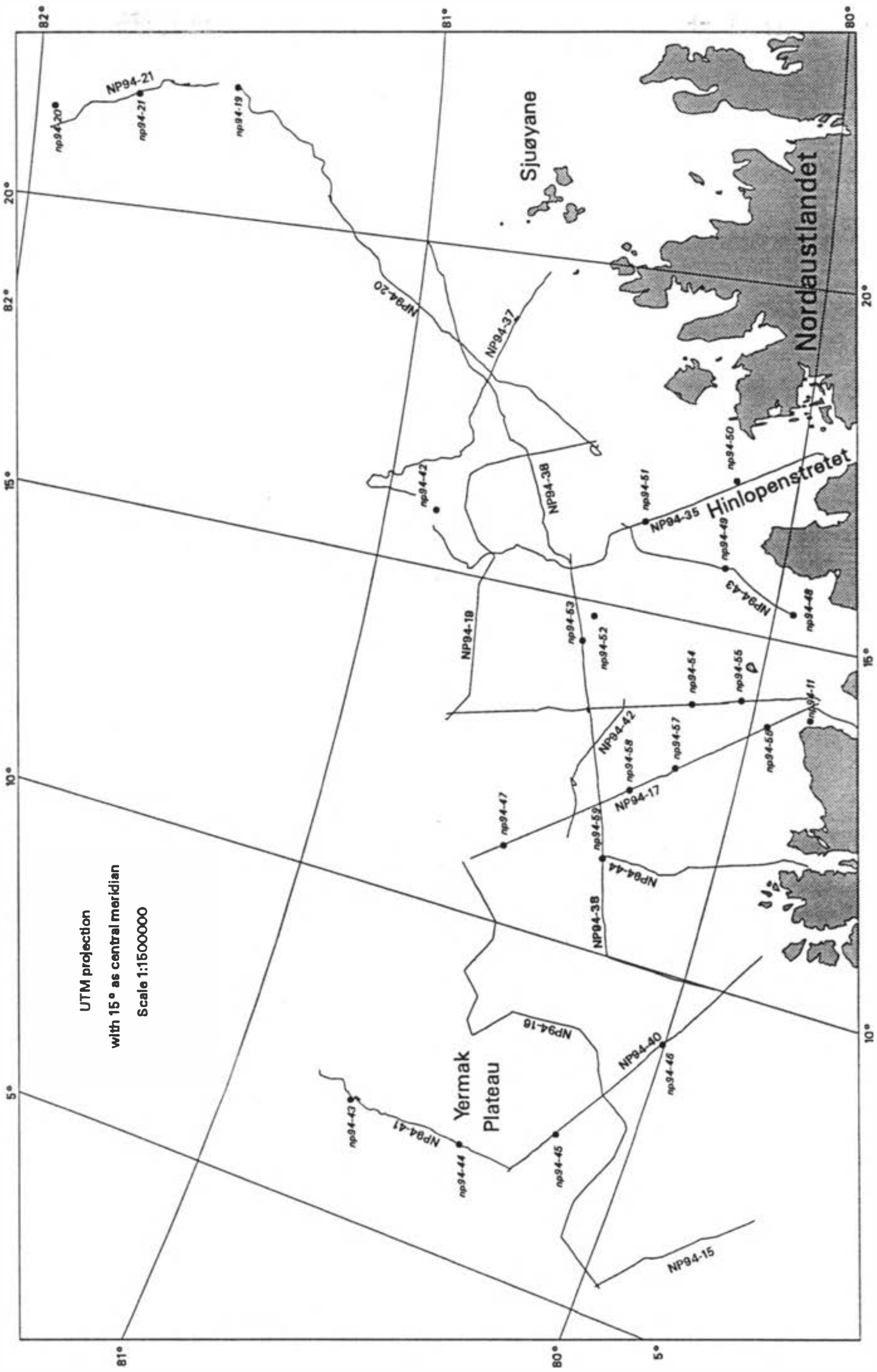

Figure A3. Seismic profiles (solid lines) and sediment coring sites (dots) from the Yermak Plateau and the northern Svalbard margin during the NP94 cruise.

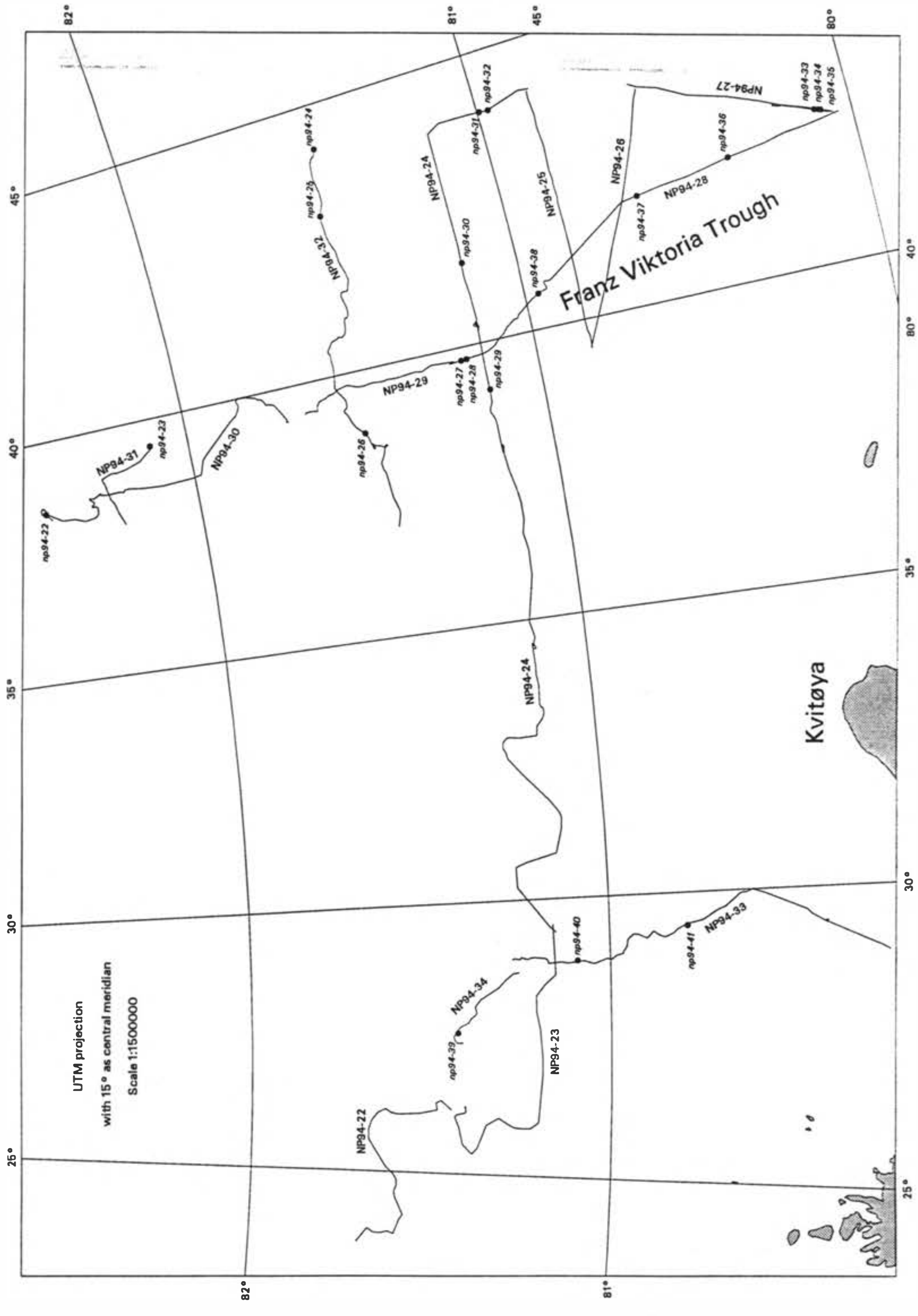

Figure A4. Seismic profiles (solid lines) and sediment coring sites (dots) from the northern Barents Sea margin during the NP94 cruise.

Funding

The cruise was carried out as a part of the regular expedition activities of the Norwegian Polar Institute (NP). Of a total budget of NOK 3,2 mill., NP covered NOK 2,9 mill., while NOK 300.000,- were kindly provided by the Norwegian Petroleum Directorate. Parts of the equipment were provided free of charge by the University of Bergen, the Geological Survey of Norway, the University of Kiel, Germany, and the Norwegian Hydrographic Survey (shipboard, permanently mounted equipment) (see below).

Original plans.

The variability of sea ice conditions entailed that no detailed plans for exact positions of seismic lines, coring stations etc. could be made prior to the cruise. The strategy was to start in the east, at the Yermak Plateau, and work as far east and north as the conditions would allow, with a combination of lines normal and parallel to the shelf break. In particular, we would attempt to cover as many of the transverse shelf troughs as possible. This was based on experiance from the western Svalbard margin, where the troughs gave most important information about the glacial history and the pattern of ice sheet drainage. Coring locations were to be chosen based on the acoustic records.

Subprograms

In addition to the main studies of the northern margin, several smaller subprograms were to be carried out. Of these, a program on physical oceanographic investigations was the largest. This program, as well as the fjord program in Liefdefjorden and Woodfjorden are reported separately later in the cruise report. The subprograms carried out were:

Site surveying for ODP drilling

Although this is directly related to the main objectives of the investigations, a separate site survey, consisting of detailed seismic grids and core locations was planned, to optimize the final positioning of the actual drillsites.

Coring on the shelf off Bellsund

A short coring program was planned along two of the seismic lines from the NP1990 cruise (Solheim et al., 1991), to augment the data base for a Ph.D. thesis at the Scott Polar Research Institute, University of Cambridge, U.K., including the study ofthe glacial and postglacial depositional history off this part of Spitsbergen.

Seismic profiling and coring off Prins Karls Forland

This is another small program which is ment to add to the NP1990 data base. From the previous investigations, it seems evident that the Late Weichselian ice front reached the shelf break in both the deep troughs off Isfjorden and Kongsfjorden, probably in the form of fast-flowing ice streams. The present coring and seismic line off Prins Karls Forland was planned in cooperation with the Byrd Polar Science Centre, Ohio State University, U.S.A., to investigate the glacial extent between the two troughs.

Acoustic profiling and coring in Woodfjorden and Liefdefjorden (see part B, below)

This 1-2 days program were carried out jointly with the University of Kiel, Germany and GEOMAR, also Kiel, Germany. It forms a continuation of fjord studies started during the three years German program SPE-90-93. The main theme of this program was to study recent processes in a terrestrial glacial environment, and only few studies were carried out in the fjords. A program to run seismic (sleeve guns) and 3.5 kHz PDR profiling, along with side scan sonar, in both the fjords was therefore planned as part of a Ph.D. thesis at the University of Kiel.

Sediment sampling for pollutants

Additional samples were to be taken from box cores in the region of the main investigations, in order to investigate the surface sediments for heavy metals, organic compounds and radionuclides. This subprogram were carried out in cooperation with Akvaplan-NIVA, Tromsø, Norway.

Physical oceanographic investigations (see part C, below)

CTD casts were to be carried out at most of the marine geological coring stations, in order to investigate the distribution of water masses in the northernmost Barents Sea and north of Svalbard. Of particular interest was investigations of possible bottom water formation and transport in the deeper troughs of the northern Barents Sea margin. In addition to the CTD work, sampling for investigations of particulate matter in sea ice, was to be carried out wherever feasible.

Participants

Anders Solheim	NP	Geologist (Co-chief scientist)
Carl Fredrik Forsberg	NP	Geologist (Co-chief scientist)
Hans Erik Lie	NP	Geologist
Sverre Henriksen	U.iTø.	Geologist
Alf Nilsen	U.iO.	Technician
Kristen Fossan	NP	Technician
Pekka Kiviranta	Selantic	Selcore-technician
Victoria Cadman	SPRI	Student, marine geology
Ruediger Schacht	U. Kiel	Student, marine geology (see Part B)
Cecilie Lier Nilsen	U.iO.	Student, marine geology
Torleif Lothe	U.iB.	Oceanographer (see Part C)
Vladimir V. Stanovoy	AARI	Oceanographer (see Part C)
Nikolai I. Fomitchev	AARI	Oceanographer (see Part C)

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U.iB.	University of Bergen, Geophysical Institute
SPRI:	Scott Polar Research Institute, University of Cambridge,
Selantic:	Selantic Subsea A/S.
U. Kiel:	University of Kiel, Germany
AARI:	Arctic and Antarctic Research Institute, St. Petersburg, Russia.

Vessel

The vessel used was NP's usual expedition vessel, m/s LANCE, a 60 m long, ice class 1C vessel. Due to an experienced crew and a good cooperation between the crew and the shipboard scientific party, most operations can be run smoothly from Lance. A serious noise problem has previously caused problems for high resolution seismic work. During the present cruise, this was overcome by reducing the revolution rate of the ship's main engines from 600 rpm to 400 rpm. The vessel is permanently equipped with a hull mounted 3.5 kHz PDR system and a side scan sonar. It was equipped with a PC network, using a micro-VAX computer as network server. The main computer is also used for logging of navigation and bathymetry.

Existing data

Geophysical investigations

The area north of Spitsbergen is covered by a relatively extensive regional grid of conventional multichannel seismic data. Particularly the continental shelf, upper slope and the southern part of the Yermak Plateau are well covered. The main surveys include:

- University of Bergen, The Seismological Observatory (later Institute for solid earth physics), in 1976, 1977, 1979 and 1981, using small air gun arrays and 12 - 24 fold coverage (Sundvor et al. 1977, 1978, 1979, 1982a, 1982b).
- University of Bergen, Institute for solid earth physics, 1987, using a large airgun array (7000 cu. inch), 240 channels and 16 seconds recording time, for deep crustal studies (Eiken, 1994)
- Norwegian Petroleum Directorate, 1992 and 1993 (confidential data).
- Alfred Wegener Institute for Marine and Polar Research, 1991 (Fütterer et al., 1991). Transect over the inner parts of the Yermak Plateau.
- Wide range side scan sonar survey (SeaMARC II) carried out as a joint program between the University of Bergen, Institute for solid earth physics, the Hawaii Institute of Geophysics and the Naval Research Laboratory. Some transects crossed the inner parts of the Yermak Plateau and the continental slope north of Svalbard Sundvor et al., 1991; Vogt et al., 1994; Crane & Solheim, 1995).

Sediment sampling

Compared to the seismic investigations, coverage of sediment cores along the northern margin of Svalbard and the Barents Sea has been sparse. The main efforts have been undertalen through:

- The Swedish Ymer 80 expedition. Approximately 15-20 piston cores were recovered in or adjecent to the present study area (Hoppe et al., 1987)
- German expeditions with R/V Polarstern in 1987 and 1991, which both recovered gravity- and piston cores along transects from the shelf northwards into the Arctic basin, roughly at 20° N and 40° N, respectively (Thiede et al., 1988; Fütterer et al., 1991).
- Ocean Drilling Program (ODP) Leg 151 drilled three locations (Sites 910, 911 and 912) on the Yermak Plateau in 1993 (Myhre, Thiede, Firth, et al., 1995). Maximum penetration was 500 meters, and Pliocene and Quaternary sediments were recovered.

Geological Setting

Bedrock

The bedrock geology of the study region can only be inferred by the use of seismic records and extrapolation from the exposed geology of the islands of northern Svalbard and Franz Josef Land.

Most of northern Svalbard is dominated by Caledonian and older crystalline rocks of the Hecla Hoek formation (Hjelle & Lauritzen, 1982, Hjelle, 1993). An exception from this is an area in central northern Spitsbergen, between Raudfjorden and Wijdefjorden, where upper Silurian to Devonian sedimentary rocks prevail.

The northwestern part of Spitsbergen is dominated by gneisses, migmatites and granites, of relatively high metamorphic grades, although metasediments and volcanics are also identified (Hjelle, 1993). The upper Silurian to Devonian sediments in the central parts consist primarily of unmetamorphosed, but folded sandstones and conglomerates of several kilometers total thickness. To the northeast, on northeastern Spitsbergen and on northwestern Nordaustlandet, a succession of mainly Proterozoic metasediments are found, with some lower Paleozoic in the upper parts. The rocks consist of metamorphosed and folded quartzites, shales, limestones and tillites, striking roughly north-south, with total thicknesses of several kilometers. Further east in northern Nordaustlandet, granites and various late Precambrian migmatites are predominant. Storøya, immediately to the east of Nordaustlandet consists mainly of Caledonian gabbroic intrusions, as does also the eastern part of Kvitøya, further to the east. At the western tip of Kvitøya, migmatites are exposed. To the north of Nordaustlandet, gneissic rocks and granites are found at the islands of Sjuøyane.

Little is known about the bedrock geology between the archipelagos of Svalbard and Franz Josef Land. The small Viktoria Island, in the Russian part of the northern Barents Sea, is repoprted to consist of lower Carboniferous carbonates (Dibner, 1970). On Franz Josef Land, Paleozoic rocks are only found in deep wells (Dibner, in press). The bedrock of the archipelago is dominated by Mesozoic sedimentary rocks, basaltic lavas and doleritic sills and dykes. A Triassic sedimentary section of more than 3 km, the thickest in the European Arctic, has been drilled on Franz Josef Land.

In the northeastern parts of the Barents Sea, predominantly Lower Cretaceous rocks occur in large synforms of the Northern Barents Basin and other structural depressions. Regional uplifts are mainly composed of Jurassic and Triassic rocks (Dibner, 1978; Gramberg & Pogrebitskyi, 1984; Gramberg, 1988; Okulitch et al, 1989; Musatov, 1991, 1992).Carbonaceous and clastic Paleozoic rocks, intensively folded during the Late Hercynian - Early Kimmerian tectonic phase (Johansen et al., 1993), are exposed near Novaya Zemlya. Lower Cretaceous basalts occur at the sea floor near Franz Josef Land. Recent investigations (Gustavsen, 1995; Solheim et al., in press) revealed subcropping Lower Cretaceous rocks between Franz Josef Land and Kong Karls land, up to 79°N. The bedrock further towards the north and along the continental margin is poorly known.

Unlithified sediments.

Northern Svalbard and the adjacent continental shelf are poorly understood with respect to the glacial history. Earlier investigations in Svalbard (Salvigsen and Nydal, 1981) indicate that the Late Weichselian ice did not extend significantly beyond the coast, whereas an early Weichselian glaciation may have covered the continental shelf north of Svalbard, reaching at least as far north as Sjuøyane. The pattern of raised beaches on Svalbard point towards a Late Weichselian ice maximum southeast of Kong Karls Land. Recent investigations on Franz Josef Land (Forman et al., 199?) seem to support this, and at least give no indications of thicker ice to the north or further east.

In general, the northern Barents Sea is characterized by a thin and patchy cover of Quaternary sediments over the bedrock (Solheim and Kristoffersen, 1984). Investigations between Franz Josef Land and Kong Karls Land (Solheim, 1993) show the same pattern of sediment distribution in this area, up to 79°N. No data were published further north, towards the continental margin of the northeastern Barents Sea, however. Similarly, occasional, unpublished seismic lines on the continental shelf north of eastern Svalbard show only a thin sediment cover, with occasional thicker pockets of unlithified sediments in depressions in the underlying crystalline bedrock.

Recent drilling on the Yermak Plateau during Ocean Drilling Program (ODP) Leg 151 (ODP Leg 151 Shipboard Scientific Party, 1994; Myhre, Thiede, Firth, et al., 1995) gave new information on the long-term glacial history of this northwestern part of the European Arctic. Sediments with ice-rafted detritus (IRD) was cored down to more than 500 meters below sea floor (mbsf), indicating glacially influenced deposition in this area at least since late Pliocene time. This is in accordance with results of seismic interpretations along the west coast of Svalbard (Andersen et al., 1994; Faleide et al., 1995). Furthermore, overconsolidated sediments reported at 15-20 mbsf on the crest of the southern Yermak Plateau may indicate grounded ice over the plateau in mid Pleistocene times (ODP Leg 151 Shipboard Scientific Party, 1994).

In summary, the glacial history for the northern margin of Svalbard and the Barents Sea is poorly known and there is, consequently, a great need for more studies in the region. Marine studies can be tied to the ODP wells on the Yermak Plateau, as well as to recent and planned land studies on both Svalbard and Franz Josef Land. A complete understanding of the glacial history of the European Arctic, as well as the erosional history of Svalbard and the Barents Sea, cannot be achieved until more information is obtained from the northern continental margin.

Methods

Navigation

The ship's GPS navigation system was used throughout the cruise. Data were logged at 10s intervals on both the hard disc of a PC, and on the ship's central VAX computer. No navigational problems were experienced during the cruise.

Coring stations were chosen based on the acoustic records. Because an exact positioning of the coring locations with respect to the seafloor geology was required, the hull-mounted 3.5 kHz echo sounder was a very important tool in order to find back to chosen coring locations.

Geophysics

Seismic equipment:

The seismic source consisted of 4 x 40 cubic inch Haliburton Ltd. sleeve guns, which were fired simultaneously. The guns were suspended from a frame, in a cubic arrangement with 0.5 m between individual guns. The array was towed approximately 20 m behind the ship, at a depth of 3 meters. Air of 100-140 kg/sq.cm pressure was supplied from two CompAir Reavell Model 5417 water cooled compressors.

Recording was done via a single channel streamer, mainly a Benthos Mod. 25/50, with 50 elements over an active length of 7.5 meters, along three different routes:

- Analogue recording on an analogue EPC Mod. 4800 recorder after filtering in the passband of 70 - 500 Hz, for shipboard display.
- Analogue recording of unfiltered data on a Tandberg Model 115 tape recorder.
- Digital recording on a PC using a 16 bit AD board and Data Response A/S acquisition software "Dracqula". An anti-aliasing filter of 900 Hz was applied before the data was sampled at a rate of 0.5 millisecond/sample and stored in SEG-Y format.

Low frequency echosounder:
O.R.E. 3.5 kHz echo sounder (PDR), hull mounted, with Mod. 140 tranceiver and analogue recording on an EPC Mod. 3200S graphic recorder. The PDR was run continuously during the entire cruise, also during the coring operations.

Side-scan sonar:
Side scan data were acquired in ice-free waters of less than 400 m waterdepth, using the ship's 100 kHz Klein Associates Ltd. transducer fish. Recording was done on an analogue Klein Associates Ltd. thermal paper recorder.

Magnetometer:
A Geometrics Model G-826A base station magnetometer, supported by a graphic recorder and a marine sensor towed approximately 150 m behind the vessel, provided total magnetic field intensity measurements throughout the profiling. The main purpose of this was to identify igneous rocks, which are widespread both on Franz Josef Land and on eastern Svalbard.

<u>Sediment coring and seafloor photography</u>
Coring:
Sediment coring was carried out using the following devices:

- Selantic Subsea Ltd. "Selcore". This is a pneumatic corer which uses a hammering action powered by the pressure difference between atmospheric pressure and hydrostatic pressure at the seafloor. The number of strokes possible increases with increasing pressure difference, i.e. with increasing water depth. The system used during the cruise was a prototype which could not operate at waterdepths less than 400 meters. The cores taken with this device had a diamter of 9 cm, and barrel lengths of up to 15 m were used.
- Piston corer with weight of ca. 1 ton, barrel length up to 9 m and liner diameter of 11 cm.
- Standard gravity corer with weight of ca. 1 ton, 3 m and 6 m barrels, and liner diameter of 11 cm.
- Plastic gravity corer, with 3 m plastic liner of 11cm diameter (no outer steel core barrel).
- Box corer (0.5 x 0.5 x 0.5 m).

Seafloor photography:

Bottom photography was carried out at selected stations (Table 3) using a Benthos Model 371 Camera and Mod. 381 Flash, mounted in a frame with a bottom contact switch.

Station work:

Two or more coring devices were used on most stations. An initial gravity core or plastic gravity core was usually taken before the Selcore or piston corer (only at 2 stations) were used. The latter devices were only used if the sediments recovered by gravity coring, combined with the character of the 3.5 kHz records, indicated that there was a potential for long cores at the site. At most sites, either a plastic gravity core or a box core was taken to provide good samples of the sediment surface and the upper layers. The plastic corer was kept vertical until the top was sealed to avoid loosing the sediment-water interface. In the box cores, the surface and a cut vertical section were photographed, and two or three cores were taken of the sediment in the box, before the remaining sediment was washed overboard. From selected box cores (Table 4), surface samples as well as cores were taken for pollution studies. This sampling followed special routines to avoid contamination. The samples were frozen immediately.

All cores were cut in 1 m sections and stored, as well as transported, vertically. Post-cruise, the cores are stored in temperatures of 1-2 °C, also in a vertical position. Because the core liners of the Selcore were pushed out through the base of the core and cut in sections as they were extruded, all core sections have been labelled A, B, C, etc. from base to top (A being the bottom section).

Shipboard laboratory work

Eight of the gravity and plastic gravity cores were split onboard, and preliminary, shipboard investigations of these cores included:

- Detailed visual description, including Munsell color.
- Photography.
- Undrained shear strength using Fall-Cone Apparatus and Pocket Penetrometers.
- Water content by weighing with a triple beam balance and drying in an oven at 100°C.
- Microscopy of sand fraction of some selected samples, mainly for preliminary biostratigraphic studies.

Results of these preliminary investigations are available in digital form at NP, and will be used as background data for shorebased work.

Operations

Day-by-day summary

Monday 25/7

Participants arrived Longyearbyen at 14.30. Boarded the vessel and checked equipment.

Tuesday 26/7

Weather: cloudy, no rain

Started to mount equipment and worked with that throughout the day.

Wednesday 27/7
Weather: cloudy, no rain, strong wind, gale on the coast.
Continued working with the geological and geophysical equipment.

Thursday 28/7
Weather: Cloudy, calm
Made everything ready and left port at 15.30. Testing seismic equipment out Adventfjorden and parts of Isfjorden. Everything works satisfactorily. Steaming towards the area of proposed ODP Site SVAL-1.

Friday 29/7
Weather: Misty, some fog, calm sea with a slight swell.
Started site surveying at SVAL-1 at 06.50. Ran lines NP94-1 to NP94-7. Everything works fine. Started magnetometer during line NP94-6, and started using it from line NP94-7. One CTD station between line NP94-5 and 6.

Saturday 30/7
Weather: Overcast, foggy, calm sea with a little swell.
Ran seismic lines NP94-8 through NP94-12, which completed the SVAL-1 seismic site survey. Did three Selcore (SC) attempts at the original SVAL-1 site (NP94-1), using 15m core barrel. Got nearly 15m penetration twice, but never recovered more than 6m core, due to core catcher problems.

Sunday 31/7
Weather: Overcast, slightly foggy, calm sea with slight swell.
Steamed towards the continental shelf off Bellsund. Gravity cored (GC) at stations NP94-2 to 7, including the first box core (BC) at NP94-5, and piston coring (PC) at NP94-6. Unsuccesssfull PC, with 3 m penetration and collapsed liner.

Monday 1/8
Weather: Rain, moderate breeze, some swell
Cored at site NP94-8, completing the Bellsund survey. Ran seismic profile NP94-13, along the outer shelf towards the Isfjorden Trough area. Had streamer problems and changed to U.iB. streamer before the line, due to defect preamplifier in the NP streamer. Cored station NP94-9 at Forlandsbanken.

Tuesday 2/8
Weather: Overcast, foggy, calm sea with slight swell.
Ran line NP94-14 along Prins Karls Forland to Kongsfjorddjupet. Deployed current meter rig and steamed towards the start of line NP94-15, beginning the survey of the Yermak Plateau. Received ice maps from NP in Longyearbyen. Met the first open drift ice, but it caused no problems

Wednesday 3/8
Weather: Overcast, calm sea, some fog.
Ended line NP94-15, and started NP94-16 from ODP Site 912 to go through site 910 to 911. However, we were forced to change course frequently by ice, and Site 910 was definitely out of reach. After a large eastwards bend, we came about 1 n. mile off Site

911, but were stopped by ice there. Went briefly into the ice to take a sample of dirty ice. Started line NP94-17, southeastwards towards Woodfjorden.

Thursday 4/8
Weather: Clear, windy (gale).
Finished line NP94-17, and started profiling in Woodfjorden, line NP94-901.Cored at stations NP94-11 and 12, started at 13. At station NP94-11, we tried both ordinary gravity corer and the Selcorer, but with no difference in result.

Friday 5/8
Weather: Clear, wind decreasing in the afternoon.
Completed work in Woodfjorden and Liefdefjorden, with lines NP94-902, 903 and PDR lines between stations. Cored at stations NP94-13, 14, 15, 16, 17 and 18. Ran a CTD transect acrosss the outer fjord, and started profile NP94-18 northwards across Norskebanken, also using side scan sonar.

Saturday 6/8
Weather: Overcast, some fog, calm sea, wind 15 knots from S. Ended line NP94-18 due to ice, and started line NP94-19 east- and southeastwards. Some turning because of ice. Guns were taken in for change of a buoy. CTD station at the end of line 18.

Sunday 7/8
Weather: Overcast, good visibility, calm sea.
Completed Line NP94-19 in the trough north of Brennevinsfjorden, Nordaustlandet, and started line NP94-20, northeastwards. Side scan problems and skipped side scan for this line. Came into open drift ice, but continued more or less on course. Took the magnetometer in and pulled both the airguns and the streamer in behind the stern.

Monday 8/8
Weather: Strong winds, up to 35-40 knots from SW, relatively calm sea due to drift ice, snow showers.
Finished coring at station NP94-19, 20 and started station 21. Had two attempts with bent barrel on the Selcorer, probably due to very stiff sediment and strong drift because of the wind. Profiled line NP94-21.

Tuesday 9/8
Weather: Calm sea, snow showers in the morning, and fair weather with flat sea in open drift ice in the evening.
Completed station NP94-21, with 4.8 m recovery in a Selcorer. Completed line NP94-22 and started NP94-23. Frequent course changes due to ice, but good data in the very calm sea.

Wednesday 10/8
Weather: Overcast, snow showers, winds picking up to 35 knots from N in the evening, rough sea.
Frequent course changes in the first part of the day, along lines NP94-23 and 24. Increased ice drift southwards due to the strong northerly winds. Continuing line NP94-24 eastwards along approximately 81° 07' N. Deployed magnetometer again at 2015

(local time). Seas are on the limit of being too rough, but the seismic data are of adequate quality so far.

Thursday 11/8
Weather: Overcast, strong gale, up to 35 knots N, but decreasing in the afternoon. Spent the whole day running seismic line NP94-24 eastwards. Marginal conditions for seismic during the night, but as the wind calmed down, we got good data when entering into Franz Viktoria Trough along 81° 09'N. Had some gun and compressor problems, but nothing serious. Ended the line at 44°E, with fast ice to the east of us.

Friday 12/8
Weather: Overcast, some fog, calm sea, winds of 12-20 knots.
Running seismic lines in Franz Viktoria Trough. Some cooling problems with one compressor, but this was solved by increasing the water pressure in the cooling system. Came into an area of surprisingly low penetration during line NP94-27. Strong seafloor return, but almost nothing below it. Did a small survey with side scan sonar at the end og line 27, to investigate the morphology of a couple of crater-like structures in the seafloor; gas-related?

Saturday 13/8
Weather: Misty, 12-15 knots W, calm sea.
Running seismic lines NP94-28 and 29 northwards. Good data clearly showing major boundaries in the underlying bedrock, as well as the distribution of Quaternary deposits. Met scattered ice from the crossing of line NP94-25.

Sunday 14/8
Weather: Misty, but relatively good visibility, calm sea.
Running lines NP94-29 and 30 northwards. Ice problems in some areas, but much open water northwards with good conditions for seismic. Passed 82°N with large areas of open water.

Monday 15/8
Weather, Misty, partly foggy, low visibility, calm sea.
Increasing ice problems with frequent course changes. Stopped line NP94-30 at 82° 28'N, and did station NP94-22. Selcorer penetrated 14 m, but recovered only 7 m. Also recovered a 3 m plastic gravity core at the site. Started line NP94-31, ment to be a strike-line along approximately 1500-1700 m waterdepth off Franz Viktoria Trough, but this proved impossible due to heavy ice. Were forced to go southwards again.

Tuesday 16/8
Weather: Overcast, low visibility, calm sea.
Piston cored at site NP94-23, and steamed to starting point of line NP94-32. Profiling along line 32 for the rest of the day. Some ice problems at the beginning, but surprisingly open ice in the eastern parts of the trough enabled relatively straight line segments.

Wednesday 17/8
Weather: Overcast, fog, calm, open sea ice.

Ended line NP94-32 and started station work around midnight. Cored at sites NP94-24, 25, 26 and 27, with CTD at all stations as well as at some additional sites. Recovery problems with the Selcorer at site 27.

Thursday 18/8
Weather: Overcast, calm, open sea ice, variable visibility.
Finished coring at site 28, lost the piston corer due to a broken wire during retrieval. Station work at sites NP94-29, 30, 31 and 32. PDR run continuously between core stations. Performed various tests to improve Selcore recovery.

Friday 19/8
Weather: Fair, calm, open sea ice.
Coring sites NP94-33 - 37.

Saturday 20/8
Weather: Fair, calm, open sea ice
Cored at station NP94-38, in the deepest part of the main basin of Franz Viktoria Trough. Excellent Selcore penetration, but only 40-50% recovery. Steamed westwards to start of line NP94-33 west of Kvitøya.

Sunday 21/8
Weather: Changing from misty/foggy to fair. Calm sea, increasing sea ice.
Profiled line NP94-33 out the trogh NW of Kvitøya. Finished line and started coring at station NP94-39.

Monday 22/8
Weather: Foggy, calm.
Cored stations NP94-39-41, and did a CTD section across the trough. Steamed around the south coast of Nordaustlandet, through Hinlopen Strait, rather than going around the north coast, due to likelyhood of ice problems in the north.

Tuesday 23/8
Weather: Fair, but with some fog. Calm sea, increasing ice.
Started line NP94-35 nothwards in the Hinlopen Trough. Ended the line at approximately 1900 m waterdepth on the continental slope, due to heavy sea ice. Cored at station NP94-42, at the end of this line. Recovered very stiff clay in the core catcher. Found more open water northwards and started line NP94-36 due north.

Wednesday 24/8
Weather: Overcast to fair, good visibility, calm sea, open to no sea ice.
Completed line NP94-36 and 37. Started line NP94-38 southwestwards slightly inside of the shelf break. Less sea ice towards the southwest, so we could deploy the magnetometer again.

Thursday 25/8
Weather: Fair, good visibility, calm sea.
Completed lines NP94-38 and 39. Started line NP94-40 NW-wards from Amsterdamøya towards ODP Site 910 at the Yermak Plateau. Did side scan profiling in

the southwestern part of line NP94-38. Had some problems with one compressor and the streamer. Both were repaired and worked properly by the start of line NP94-40.

Friday 26/8
Weather: Overcast, partly foggy, calm sea in open sea ice.
Prifiled line NP94-40 through ODP Site 910, and continued with line NP94-41 northwards towards ODP Site 911. Stopped by ice approximately 18 nmiles from the site. Started coring site NP94-43 on the Yermak Plateau.

Saturday 27/8
Weather: Overcast, calm in open sea ice.
Continued coring at site NP94-43. Lost a gravity corer modified for piston coring. Cored stations NP94-44, 45 and 46, and started at NP94-47.

Sunday 28/8
Weather: Overcast, snow showers, breeze but seas picking up in the evening.
Completed station NP94-47 and started profiling line NP94-42. Were forced south of planned track by ice. Guns hit ice or driftwood and had to be repaired. Ran line NP94-43 to the entrance of Wijdefjorden. Side scan sonar used from 09.45 z, when out of the ice. Helicopter operations in Mosselbukta in the afternoon, and started subsequently at the last part of the coring program, at station NP94-48.

Monday 29/8
Weather: Snow showers and strong gale during the night. Calming down in the morning.
Cored at stations NP94-49 to 56.

Tuesday 30/8
Weather: Overcast, light snow, strong breeze. Some scattered sea ice.
Cored at stations 57, 58 and 59. Ran seismic line NP94-44 towards and into Raudfjorden. Carried out seismic pulse test. Finished operations and started packing equipment.

Wednesday 31/8 - Friday 2/9.
Packing up data, samples and equipment, Picking up people and equipment from land field parties. Steaming for Longyearbyen.

Weather and ice conditions.

Weather conditions were generally favourable during the cruise and no close-down of operations was necessary for weather reasons. Only for one period, running seismic line NP94-24, eastwards between the area north of Kvitøya towards the Franz Viktoria Trough (Fig. 1), did the wind and sea state cause severe quality reduction of the data. Persistant fog for long periods, however, caused difficulties navigating in icy waters, and radar had to be used for finding leads.

The sea ice conditions varied from east to west in the survey area. Heavy ice prevented us from reaching as far north as planned north of Svalbard and on the Yermak Plateau. One goal of the Yermak Plateau work was to site survey the area of proposed ODP site YERM-1, at 81 ° 06'N, but heavy ice made it impossible to reach closer than 20 nautical miles south of the site, along line NP94-41. In the eastern areas, however, in the Franz Viktoria Trough, ice conditions were more favourable than expected, and we were able to reach almost to 82 ° 30'N (Fig. 1) in fairly dense ice, but with large open leads which mainly trended in north-south directions. Although this situation permitted us to reach far north, it prevented seismic lines running in east-west directions following the strike of the continental slope. On the continental shelf in this eastern area, there were few ice problems, and we were able to carry out a relatively extensive survey of the Franz Viktoria Trough.

Equipment performance.

No severe problems were encountered with the geophysical equipment. The sleeve guns were routinely taken in approximately every 12 hours for checking. The main problem was wear of shackles and chains. By this frequent checking, and by welding all shackles used in the gun suspensions, the problems were minimized. The sea ice situation caused some concern. However, by pulling the guns and the streamer as close together as possible behind the stern, no damage was made by sea ice, and the equipment had to be taken in only very few times while passing through dense ice. With respect to the other geophysical equipment, the ice conditions prevented us from using both the magnetometer and the side scan sonar system during large parts of the cruise.

The Selcore system obtained good penetration, up to 15 m. However, recovery never exceeded 50%, which was a disappointment. A lot of effort was placed in technical solutions to improve the recovery, but with little luck. As good recovery was obtained with the same system on the Antarctic continental margin a year earlier, the recovery problems may be related to sediment type. More research will have to be carried out on this new tool to ensure that it can be considered a reliable coring tool in Arctic regions.

Due to incorrect mounting, the Piston corer was lost during retrieval at station NP94-28, the third station on which it was used. In addition, one of the standard gravity corers were lost. The other standard gravity corer was lost at station NP94-43, towards the end of the cruise. The coring during the last part of the cruise, from station NP94-44, was therefore, even in shallow water, performed with the Selcore, in addition to the plastic gravity and box corers. The Selcore was then used as a gravity corer at depths where the hammering mechanism was inactive.

Preliminary results, forthcoming work and data storage/availability

A total of 3830 km of seismic profiles were recorded (Table A1). Due to the good weather conditions, the data are of generally good quality, although frequent turns enforced by the ice conditions cause problems in the interpretation of the data. All seismic profiles have 3.5 kHz coverage, but only a part of the lines have side scan sonar and magnetometer data, respectively. Sediment cores were recovered from 59 locations (Tables A2 and A3). Eight cores were split and described in the shipboard laboratory. Descriptions and results of physical properties measurements, as well as results of some preliminary smear slide studies are presented in appendixes 1 and 2, respectively.

Franz Viktoria Trough

Due to the unexpectedly favourable ice conditions we were able to carry out a relatively detailed survey of the northern part of this major Barents Sea trough. One long seismic line trending N-S from roughly N80° to N82° 30', and four crossing E-W trending lines give a good control of the overall distribution of both unlithified sediments and the uppermost bedrock in the area. Main bedrock boundaries can be identified and correlated with onshore geology of Franz Josef Land.

The acoustic character of the unlithified sediments can be differentiated, both spatially and with depth. The coring program appears to have reached the main units of the unlithified sediments, and the data therefore has a good potential with regards to interpreting the Late Weichselian and deglaciation history of this northeasternmost part of the Barents Sea. Local accumulations of acoustically transparent sediments reach a thickness of 180 ms (milliseconds, two-way reflection time). The northernmost seismic lines reveal an apparently glacial shelf progradation in the order of 15-18 km, and several main seismic shelf unconformities. Gravity-controlled down-slope transport mechanisms seem to be important on the continental slope.

Areas apparently influenced by shallow gas are identified by subdued returns from bub-bottom bedrock reflectors, frequent seafloor pockmarks and presence of crater-like structures, similar to structures reported by Solheim and Elverhøi (1993) from the western Barents Sea.

The northern Svalbard margin and the Yermak Plateau

The new seismic data, used together with older seismic data, provide a reasonably good base for regional mapping of the distribution of glacial sediments north of Svalbard. Due to the general sea ice conditions, the data base is sparse north of Nordaustlandet, while a relatively dense grid of seismic lines exists further west, on the Yermak Plateau and north of Spitsbergen. Main bedrock boundaries can be identified along several of the N - S trending lines, particularly boundaries between the homogeneous, crystalline basement rocks of northeastern Svalbard and the sedimentary strata dipping northwards towards the Arctic Ocean.

Emphasis was placed in obtaining seismic lines and sediment cores along profiles out the main transverse shelf troughs, such as the trough between Kvitøya and Nordaustlandet and the large Hinlopenrenna trough. Furthermore, seismic data and cores were collected from the main fjords and across the shelf. Although these data are not interpreted in any detail yet, the general impression is that of an inner shelf with an apparently sparse and patchy cover of glacial sediments. Ridge structures are mapped north of Nordaustlandet, but so far it is not possible to be conclusive on a Late Weichselian maximum ice extent.

Seismic lines shot through the ODP sites 910 and 912 and near site 911, on the Yermak Plateau, reveal an upper, homogeneous seismic unit at Site 910 and along the crest of the plateau. Towards deeper water the character of the unit changes gradually to stratified. Seen in relation to the coring of overconsolidated glacial sediments at Site 910 (Myhre, Thiede, Firth, et al., 1995) and the recent observations of deep iceberg ploughmarks in the same area (Vogt et al., 1994), the new seismic data will be important in interpreting the glacial history of northwestern Svalbard region.

Shorebased studies and data handling

Parts of the NP94 data set are included in two graduate (Cand. scient.) theses at the Department of geology, University of Oslo. These two projects will combine acoustic data and detailed work on a few, central cores to interpret the late glacial and depositional history of the Franz Viktoria Trough area and the area adjacent to northeastern Svalbard, respectively. The other cores from the cruise will also be split, and described, but the degree of detail in the core analyses will have to vary because of analysis capacity. We aim at having at least one core from each station split and described within three years postcruise. Both the core data and the geophysical data will be included in the marine geology data base at NP, and used for a number of different studies related to the sedimentological and paleoclimatical evolution of the northern Barents Sea and Svalbard region, in addition to regional mapping purposes.

The digital seismic data are processed, plotted stored on tape in SEG-Y format at NP, while the analogue data are copied on to transparent film. 3.5 kHz and sidescan sonar data are stored as original analogue records. Sediment cores are stored in vertical position at temperatures of 1-2 °C and relative humidity of around 70% prior to splitting. After splitting, the most of the cores will still be stored refrigerated for another 2-3 years, after which they will be stored at room temperatures. Analysis results and core descriptions are all entered and stored digitally as spreadsheets initially, and, subsequently, as parts of the NP marine geological data base. Geophysical data, analysis results and sediment samples may be made available on request.

Table A1. Seismic profiles run during the NP94 cruise.

Line	Start time	Stop time	Start position				Stop position				Duration	Length	Av. speed	
ID	date hrs:min	date hrs:min	deg	min	deg	min	deg	min	deg	min	days hrs:min	km	km/hr	kts
np94-1	29.07.94 04:53	29.07.94 08:08	77°	27,98	9°	36,78	77°	12,71	8°	58,24	0 03:15	31,4	9,7	5,2
np94-2	29.07.94 09:12	29.07.94 11:25	77°	8,51	8°	47,76	77°	12,50	9°	39,51	0 02:13	20,7	9,3	5,0
np94-3	29.07.94 11:37	29.07.94 14:06	77°	12,46	9°	39,82	77°	24,63	9°	20,67	0 02:29	22,9	9,2	5,0
np94-4	29.07.94 14:11	29.07.94 15:02	77°	25,00	9°	20,41	77°	22,97	9°	4,96	0 00:51	8,2	9,6	5,2
np94-5	29.07.94 15:05	29.07.94 17:34	77°	22,89	9°	1,59	77°	10,79	9°	24,08	0 02:29	25,5	10,3	5,5
np94-6	29.07.94 20:22	29.07.94 21:13	77°	10,93	9°	22,62	77°	9,59	9°	2,97	0 00:51	10,9	12,8	6,9
np94-7	29.07.94 21:28	29.07.94 23:36	77°	9,71	9°	3,30	77°	21,56	8°	45,74	0 02:08	23,4	11,0	5,9
np94-8	29.07.94 23:40	30.07.94 00:30	77°	21,94	8°	46,14	77°	20,02	8°	28,81	0 00:50	8,7	10,4	5,6
np94-9	30.07.94 00:34	30.07.94 01:17	77°	20,23	8°	27,79	77°	16,80	8°	36,17	0 00:43	7,6	10,6	5,7
np94-10	30.07.94 01:22	30.07.94 03:29	77°	16,65	8°	35,18	77°	21,32	9°	27,42	0 02:07	23,7	11,2	6,0
np94-11	30.07.94 03:33	30.07.94 04:52	77°	21,06	9°	27,27	77°	14,73	9°	39,17	0 01:19	14,4	10,9	5,9
np94-12	30.07.94 05:02	30.07.94 07:50	77°	15,03	9°	38,66	77°	10,47	8°	33,45	0 02:48	28,3	10,1	5,5
np94-13	01.08.94 06:09	01.08.94 19:20	77°	25,50	11°	28,82	78°	28,12	8°	59,61	0 13:11	148,7	11,3	6,1
np94-14	01.08.94 22:38	02.08.94 06:14	78°	27,99	10°	5,95	79°	0,56	10°	11,83	0 07:36	70,7	9,3	5,0
np94-15	02.08.94 18:51	02.08.94 23:25	79°	39,04	7°	4,50	79°	58,05	5°	23,93	0 04:34	49,3	10,8	5,8
np94-16	02.08.94 23:29	03.08.94 16:09	79°	57,99	5°	22,39	80°	36,89	10°	44,88	0 16:40	176,6	10,6	5,7
np94-17	03.08.94 19:45	04.08.94 06:38	80°	35,71	10°	48,45	79°	50,78	14°	15,55	0 10:53	108,0	9,9	5,4
np94-901	04.08.94 08:20	04.08.94 15:12	79°	51,86	14°	11,49	79°	21,81	13°	58,60	0 06:52	62,6	9,1	4,9
np94-902	04.08.94 23:46	05.08.94 01:46	79°	34,00	13°	35,09	79°	41,18	14°	1,07	0 02:00	18,0	9,0	4,8
np94-903	05.08.94 01:49	05.08.94 07:19	79°	41,08	14°	1,88	79°	32,35	12°	27,02	0 05:30	40,5	7,4	4,0
np94-904	05.08.94 07:28	05.08.94 19:16	79°	32,26	12°	27,07	79°	42,29	14°	12,74	0 11:48	88,8	7,5	4,1
np94-18	05.08.94 22:26	06.08.94 10:22	79°	50,13	14°	15,95	80°	43,18	12°	53,75	0 11:56	139,9	11,7	6,3
np94-19	06.08.94 11:57	06.08.94 22:34	80°	44,61	12°	46,33	80°	30,84	17°	20,85	0 10:37	107,2	10,1	5,5
np94-20	06.08.94 23:39	07.08.94 16:43	80°	30,45	17°	18,09	81°	29,85	22°	8,29	0 17:04	168,0	9,8	5,3
np94-21	07.08.94 20:41	08.08.94 03:50	81°	33,24	22°	13,27	81°	57,62	21°	12,35	0 07:09	59,3	8,3	4,5
np94-22	09.08.94 00:20	09.08.94 11:54	81°	44,84	21°	54,77	81°	24,84	26°	11,49	0 11:34	119,1	10,3	5,6
np94-23	09.08.94 13:12	10.08.94 00:00	81°	24,38	26°	15,75	81°	9,41	29°	32,45	0 10:48	112,2	10,4	5,6
np94-24	10.08.94 00:57	11.08.94 17:52	81°	9,09	29°	24,34	80°	51,37	44°	6,63	1 16:55	341,8	8,4	4,5
np94-25	11.08.94 19:28	12.08.94 03:30	80°	51,14	44°	4,36	80°	50,96	39°	29,76	0 08:02	82,4	10,3	5,5
np94-26	12.08.94 03:42	12.08.94 11:22	80°	51,09	39°	30,39	80°	33,66	43°	35,11	0 07:40	81,1	10,6	5,7
np94-27	12.08.94 12:28	12.08.94 22:48	80°	34,85	43°	42,42	80°	2,63	42°	20,85	0 10:20	106,3	10,3	5,6
np94-28	13.08.94 00:29	13.08.94 14:51	80°	2,34	42°	21,87	81°	14,75	39°	45,29	0 14:22	155,4	10,8	5,8
np94-29	14.08.94 07:37	14.08.94 13:03	81°	14,31	39°	47,15	81°	40,02	39°	25,38	0 05:26	52.9	9,7	5,3
np94-30	14.08.94 13:52	15.08.94 01:30	81°	42,86	39°	21,53	82°	24,48	38°	23,28	0 11:38	119,0	10,2	5,5
np94-31	15.08.94 12:31	15.08.94 15:47	82°	12,66	38°	1,37	82°	5,98	39°	26,94	0 03:16	34,6	10,6	5,7
np94-32	16.08.94 07:50	16.08.94 22:09	81°	28,10	37°	1,91	81°	27,80	44°	9,90	0 14:19	142,7	10,0	5,4
np94-33	20.08.94 17:05	21.08.94 07:39	80°	13,65	28°	56,04	81°	16,35	28°	55,83	0 14:34	138,2	9,5	5,1
np94-34	21.08.94 09:11	21.08.94 13:00	81°	15,19	28°	41,67	81°	24,84	27°	26,31	0 03:49	34,9	9,2	4,9
np94-35	23.08.94 03:23	23.08.94 16:38	79°	57,52	17°	41,86	80°	52,62	15°	37,79	0 13:15	129,8	9,8	5,3
np94-36	23.08.94 20:37	23.08.94 22:17	80°	56,03	16°	2,46	81°	3,18	16°	10,17	0 01:40	16,4	9,9	5,3
np94-37	23.08.94 22:18	24.08.94 09:34	81°	3,18	16°	10,17	80°	41,03	19°	46,16	0 11:16	95,2	8,5	4,6
np94-38	24.08.94 12:17	25.08.94 13:05	81°	0,02	20°	2,33	80°	11,95	9°	59,64	1 00:48	225,9	9,1	4,9
np94-39	25.08.94 13:06	25.08.94 17:40	80°	11,87	9°	59,55	79°	47,77	9°	59,68	0 04:34	45,1	9,9	5,3
np94-40	25.08.94 19:30	26.08.94 04:54	79°	49,94	10°	38,27	80°	16,18	6°	31,32	0 09:24	93,8	10,0	5,4
np94-41	26.08.94 05:08	26.08.94 12:55	80°	15,80	6°	35,40	80°	47,82	7°	1,77	0 07:47	69,4	8,9	4,8
np94-42	27.08.94 23:13	28.08.94 04:34	80°	22,63	11°	30,22	80°	19,30	13°	41,16	0 05:21	49,7	9,3	5,0
np94-43	28.08.94 08:25	28.08.94 14:00	80°	25,02	16°	12,05	79°	57,03	15°	22,95	0 05:35	59,8	10,7	5,8
np94-44	30.08.94 03:47	30.08.94 09:42	80°	17,16	11°	20,04	79°	46,85	12°	0,20	0 05:55	60.5	10,2	5,5
Totals											**16 10:11**	**3829,5**	**9,7**	**5,2**

Table A2. Coring stations during the NP94 cruise.

Station	East	North	Depth(m)
NP94-1	9,092433	77,2542	2084
NP94-2	11,36167	77,35333	395
NP94 -3	12,41333	77,22	235
NP94-4	12,66167	77,29833	216
NP94-5	12,7915	77,36822	243
NP94-6	13,15667	77,44267	225
NP94-7	13,36	77,585	200
NP94-8	11,68667	77,46333	238
NP94-9	10,09833	78,465	172
NP94-10	9,940892	78,66355	235
NP94-11	13,97667	79,861	58
NP94-12	13,99167	79,34666	64
NP94-13	13,59	79,58	117
NP94-14	12,465	79,53833	90
NP94-15	12,5	79,55	95
NP94-16	12,54833	79,56834	107
NP94-17	12,94833	79,63	185
NP94-18	13,89667	79,70333	195
NP94-19	22,1559	81,5074	896
NP94-20	21,57783	81,95667	3500
NP94-21	21,91458	81,74979	3380
NP94-22	38,53033	82,422	2280
NP94-23	39,46305	82,10397	1010
NP94-24	44,17833	81,46333	217
NP94-25	42,945	81,49834	403
NP94-26	38,84317	81,5142	455
NP94-27	39,76852	81,21312	516
NP94-28	39,77532	81,19791	529
NP94-29	39,15983	81,14992	442
NP94-30	41,46213	81,151	464
NP94-31	43,96	80,995	502
NP94-32	43,94833	80,97	493
NP94-33	42,48167	80,10167	387
NP94-34	42,46333	80,09	388
NP94-35	42,45	80,085	390
NP94-36	42,08167	80,365	376
NP94-37	41,83608	80,63525	425
NP94-38	40,618	80,96328	594
NP94-39	27,62078	81,42782	880
NP94-40	28,88667	81,09167	350
NP94-41	29,4376	80,78493	473
NP94-42	15,87833	80,87666	1900
NP94-43	6,759567	80,699	824
NP94-44	6,673617	80,4049	614
NP94-45	7,2957	80,18643	558
NP94-46	9,038234	80,00552	491
NP94-47	11,13368	80,52467	850
NP94-48	15,39065	79,95596	170
NP94-49	15,85235	80,1419	200
NP94-50	17,11917	80,1513	453
NP94-51	16,29908	80,35782	399
NP94-52	14,78753	80,43892	310
NP94-53	14,39655	80,45472	106
NP94-54	13,8362	80,15455	46
NP94-55	14,045	80,03667	51
NP94-56	13,75823	79,95997	161
NP94-57	12,87332	80,1585	160
NP94-58	12,405	80,25667	182
NP94-59	11,34167	80,27834	194

Table A3. Station work during the NP94 cruise. SC= Selcore, GC= gravitycore, PGC= plastic gravitycore, BC= box core.

Station	Device-no.	CTD - no.	Date	Time (UTC)	Waterdepth	Latitude	Longitude	Penetrat.	Recovery	Comments
NP94-1	SC-1	CTD-1/2	30.07.`94	11:35	2084m	77°15.232	09°05.451	15m	6m	Cable problems during CTD st.
(SVAL-1)										Corecatcher did not close.
	SC-2		30.07.`94	11:35	2084m	77°15.252	09°05.546			SC did not hammer.
NP94-2	GC-1	CTD-4	31.07.`94	01:45	395m	77°21.2	11°21°7		85cm	No catcher sample (empty).
NP94 -3	GC-1	CTD-5	31.07.`94	05:10	235m	77°13.231	12°24.849	5m		Catcher sediment quite firm.
	GC-2		31.07.`94	05:50	236m	77°13.25	12°25.18	5m	1,25m	
NP94-4	GC-1	CTD-7	31.07.`94	07:00	216m	77°17.984	12°39.728	4-4,5m	3,10m	Core bottom with soft gravelly mud.
NP94-5	GC-1	CTD-8	31.07.`94	09:00	243m	77°22.093	12°47.49	6m	3m	Soft fine grained mud in the bottom of core.
	BC-1		31.07.`94	09:30	243m	77°22.093	12°47.49		50cm	2 samples.
NP94-6	GC-1	CTD-9	31.07.`94	11:30	225m			4,5m	2,96m	
	PC-1		31.07.`94	15:00	225m			3m	10cm	
NP94-7	GC-1	CTD-10	31.07.`94	17:00		77°35.136	13°21.685	4,5m	3,75m	
NP94-8	GC-1	CTD-11	31.07.`94	22:15	238m	77°27.875	11°41.298	6m		
	BC-1		31.07.`94	22:30	238m	77°27.875	11°41.298			2 samples, 1 surface sample (0-2cm).
	BC-2		31.07.`94	22:56	238m	77°27.86	11°41.05			2 samples, 1 surface sample (0-2cm).
NP94-9	GC-1	CTD-12	01.08.`94	21:40	172m	78°27.973	10°05.914		1,35m	
NP94-10	GC-1	CTD-13	02.08.`94	01:45	235m			2,30m	1,04m	Base consists of "sticky" grey mud.

Station	Device-no.	CTD - no.	Date	Time (UTC)	Waterdepth	Latitude	Longitude	Penetrat.	Recovery	Comments
	BC-1		02.08.`94	01:55	235m				30cm	2 samples, 1 surface sample (0-2cm).
										Surface with abundant benthic fauna.
										Dark clay with dark grey bands.
NP94-11	GC-1	CTD-17	04.08.`94					5,60m	2,46m	Redish-brownish silty clay with dark bands.
										Relatively stiff mud.
NP94-11	SC-1		04.08.`94			79°51.66	13°58.60	6-7m	2,75m	Reddish soft mud.
	Camera		04.08.`94							3 photos taken.
NP94-12	GC-1		04.08.`94	06:27	64m	79°20.828	13°59.564	4m	2,33m	
	BC-1		04.08.`94	06:51	64m	79°20.831	13°59.708		0m	Empty.
	BC-2		04.08.`94	19:07	64m	79°20.846	13°59.660		50cm	2 samples.
										Reddish undisturbed surface with poly
										chaets.
NP94-13	GC-1	CTD-18	04.08.`94	22:06	117m	79°34.835	13°35.455	2,50m	0,98m	Firm, gravelly sediment in the bottom of the
										core.
	BC-1		04.08.`94	22:20	118m	79°34.902	13°35.364			2 samples.
	Camera		04.08.`94	22:45		79°35.005	13°35.947			3 photos.
NP94-14	Camera	CTD-19	05.08.`94	07:50	90m	79°39.452	12°28.469			3 photos taken. 0,46nmiles from the glacier
										front meltwater outlet, sediment plumes.
	GC-1		05.08.`94	08:04	86m	79°32.311	12°27.917	2m	30-40cm	Sandy sediment.
	BC-1		05.08.`94	08:34	94m	79°32.328	12°27.141		50cm	2 bag-samples. Box full of soft and sandy
										sediment.
NP94-15	BC-1	CDT-20	05.08.`94	09:45	95m	79°32.999	12°30.088		50cm	1,01 nmiles off glacier front. 2 bag samples
										(bottom and top). Soft greyish sediment.
	Camera		05.08.`94	10:00	95m	79°32.999	12°30.088			3 photos.

Station	Device-no.	CTD - no.	Date	Time (UTC)	Waterdepth	Latitude	Longitude	Penetrat.	Recovery	Comments
	GC-1		05.08.`94	10:17	95m	79°33.003	12°30.028	3m	2,20m	Top of the core flooded out during retrieval.
										Core bottom grey, fine grained, sandy mud.
NP94-16	Camera	CTD-21	05.08.`94	11:25	107m	79°34.1	12°32.9			3 photos.
	GC-1		05.08.`94	11:41	107m	79°34.1	12°32.9	5m	3,10m	Core catcher material lost.
NP94-17	Camera	CTD-22	05.08.`94	13:40	151m	79°37.868	12°57.313			3 photos.
	GC-1		05.08.`94	14:02	183m	79°37.827	12°56.969	5,50m	3,65m	Core catcher empty. Reddish brown, silty
										clay.
NP94-17	BC-1		05.08.`94	14:23	185m	79°37.809	12°57.125		50cm	2 samples.
NP94-17	BC-1									Reddish brown silty clay on top, mottled
										brown silty clay further down.
NP94-18	Camera	CTD-18	05.08.`94	16:40	190m	79°42.248	13°54.401			3 photos.
	GC-1		05.08.`94	16:50	195m	79°42.289	13°53.858	5,50m	4,50m	Fine grained clay in the bottom of the core.
	BC-1		05.08.`94	17:00	195m	79°42.277	13°54.045		15cm	2 samples, a lot of worm tubes and an
										unidentified animal (photographed).
NP94-19	GC-1	CTD-32	07.08.`94	17:53	847m	81°30.333	22°10.39	5m	3,65m	Greyish mud in the bottom, more reddish
										on the top.
	SC-1		07.08.`94	18:41	912m	81°30.444	22°09.354	7m	4m	
	BC-1		07.08.`94	19:20	896m	81°30.246	22°10.594		30cm	Undisturbed surface with many worm tubes
										4-5cm brownish sediment above dark grey.
NP94-20	SC-1	CTD-34	08.08.`94	07:40	3500m	81°56.451	21°13.620	3m	1,78m	Core barrel partly bent. Very firm light grey silty

Station	Device-no.	CTD - no.	Date	Time (UTC)	Waterdepth	Latitude	Longitude	Penetrat.	Recovery	Comments
										clay and scattered gravel in the bottom.
										Top greyish-greenish, rich in silt-fine sand.
										0- 90cm light grey, soft sediment
	BC-1		08.08.`94	09:30	3500m	81°57.099	21°21.604		0m	Empty.
	SC-2		08.08.`94	12:35	3500m	81°97.4	21°34.67	4m	1,55m	Core barrel partly bent. Bottom with greyish, very
										stiff, sandy, silty clay.
NP94-21	GC-1	CTD-35	08.08.`94	17:33	3456m	81°46.19	21°50.75	2m	0m	Empty.
	SC-1		08.08.`94	19:31	3380m	81°45.113	21°55.863	6m	3,80m	Soft, olive grey mud in the top. Firm to stiff
										bottom, olive-greyish.
	BC-1		08.08.`94	21:06	3380m	81°45.028	21056,59		30cm	Undisturbed surface with shells and large
										forams, sand/gravel layer at the base.
										2 samples, 1 surface sample (0-2cm),
										3 samples taken for pollution inv.
NP94-21	SC-2		08.08.`94	22:52	3380m	81°44.987	21°54.875	9,5m	4,8m	Very sandy grey mud on the top of the
										catcher, becoming muddy towards the
										base at the core cutter. Top of the catcher
NP94-21	SC-2									sample very soft olive green silty clay.
NP94-22	PGC-1	CTD-44	15.08`94	04:35	2280m	82°25.8	38°39.79	3m	3m	
	SC-1		15.08`94	06:28	2276m	82°25.68	38°39.97	14,5m	7m	Relatively firm, dark grey mud in the core
										bottom.
	SC-2		15.08`94	08:55	2256m	82°25.32	38°31.82	12-14m	4,8m	
NP94-23	GC-1	CDT-45	15.08.`94	17:09	1016m	82°06.299	39°29.173	5m	3,38m	
	PC-1		15.08.`94	18:35	999m	82°06.308	39°33.832			Lost core barrel

Station	Device-no.	CTD - no.	Date	Time (UTC)	Waterdepth	Latitude	Longitude	Penetrat.	Recovery	Comments
	BC-1		15.08.`94	19:55	1010m	82°06.20	39°29.10		0m	Empty.
	BC-2		15.08.`94	20:35	1014m	82°06.29	39°28.17		35cm	
	PC-2		15.08.`94	23:58	1013m	82°06.238	39°27.783	6-7m	6,70m	Dark grey, clast free mud in the catcher,
										reddish brown mud in the top.
NP94-24	GC-1	CTD-48	17.08.`94	08:50	217m	81°27.8	44°10.7		0m	Empty.
NP94-25	PGC-1	CTD-50	17.08.`94	02:15	403m	81°29.977	42°56.776	1,5m	1,25m	Dark grey silty mud in the catcher, dark
										reddish brown on top. Positioned between
										Iceberg ploughmarks.
NP94-26	GC-1	CTD-53	17.08.`94	09:22	455m	81°30.892	38°50.143	1m	0m	Empty, catcher was squeezed out.
	GC-2		17.08.`94	09:53	455m	81°30.886	38°50.457	1,5m	0m	Empty.
	GC-3		17.08.`94	10:53	448m	81°30.826	38°50.625	2,5m	1,68m	Attempt with 2 catchers. Cutter lost. Top:
										dark red brown silty clay with polychaets.
										Bottom: dark grey silty clay with sand.
	GC-4		17.08.`94	11:50	453m	81°30.850	38°50.703	2m	1,05m	Stiff, silty, sandy clay inside of the cutter.
	SC-1		17.08.`94	13:13	455m	81°30.852	38°50.590	3,5m		bottom: very stiff, silty, sandy clay (pocket
										penetrometer: 175KPa), top: dark reddish
										brown silty clay.
NP94-27	GC-1	CTD-54	17.08.`94	18:02	516m	81°12.727	39°45.934	3m	2,57m	Soft greyish mud in the top, hard sandy
										with gravels in the cutter and the lower part
										of the core. Pocket penetrometer : 175-250
										KPa. Disturbed surface sample.

Station	Device-no.	CTD - no.	Date	Time (UTC)	Waterdepth	Latitude	Longitude	Penetrat.	Recovery	Comments
NP94-27	SC-1		17.08.`94	18:45	516m	81°12.790	39°45.995	2,5m	2,10m	Lost upper 10cm of the core. Catcher was
	SC-1									squeezed out.
	SC-2		17.08.`94	19:42	515m	81°12.787	39°46.111	3m		Catcher almost squeezed out, but recover-
										ed dark grey, stiff material.
NP94-28	PGC-1		17.08.`94	20:35	529m	81°11.826	39°47.037	4m	3,70m	
	SC-1		17.08.`94	21:29	533m	81°11.601	39°47.240	9,5-10m	4,5m	Sample fell out.
	SC-2		17.08.`94	23:22	532m	81°11.604	39°46.781	6m	4,9m	15m barrel bent.
	SC-3		18.08.`94	02:15	527m	81°11.534	39°44.902	10,5m	4,5m	
	PGC-1		18.08.`94	04:13	527m	81°11.947	39°46.059			Lost core.
	SC-4		20.08.`94	03:31	527m	81°11.875	39°46.519	10m	4,82m	Bottom: normally consolidated dark grey
										silty, sandy clay with coarse sand/gravel.
NP94-29	GC-1	CTD-55	18.08`94	06,19	442m	81°09.002	39°09.536	2,5m	1,75m	Navigation down during coring.
	BC-1		18.08.`94	06:37	442m	81°08.995	39°09.590		30cm	Surface pollution sample taken.
	GC-2		18.08.`94	06:56	443m	81°09.039	39°09.741	2-3m		Firm, gravely sediment in bottom of the
										core (apparently overconsolidated).
NP94-30	GC-1	CTD-56	18.08.`94	10:00	464m	81°09.084	41°17.910			Core cutter damaged, empty.
	BC-1		18.08.`94	10:26	464m	81°09.06	41°27.728	40cm	38cm	Top: dark reddish brown Bottom: lighter
										grey, silty clay. 2 subsamples taken.
	GC-2		18.08.`94	10:55	463m	81°09.122	41°27.959	2m	90cm	Dark reddish brown, soft, silty clay on top,
										grey at base.
NP94-31	GC-1	CTD-61	18.08.`94	16:49	502m	80°59.704	43°57.623	5m	3,25m	Bottom: dark grey, relatively firm mud in the
										catcher/cutter. Pocket penetrometer with
										large adapter: 12KPa. Top: brownish with
										benthos, undisturbed, very soft.

Station	Device-no.	CTD - no.	Date	Time (UTC)	Waterdepth	Latitude	Longitude	Penetrat.	Recovery	Comments
	BC-1		18.08.`94						0m	Empty.
	BC-2		18.08.`94	17:24	501m	80°59.605	43°57.390		30cm	2 subsamples taken.
NP94-32	PGC-1		18.08.`94	18:05	493m	80°58.293	43°56.938			
	SL-1		18.08.`94	20:44	493m	80°58.33	43°56.963	7-8m	3,70m	
NP94-33	Camera	CTD-62	19.08.`94	05:24	387m					
NP94-33	GC-1		19.08.`94	05:31	387m	80°31.40	42°29.267	2m	1,05m	Cutter and catcher sample washed out.
	GC-2		19.08.`94	05:54	386m	80°06.134	42°28.912	2-3m		Ca. 0,5m core fell out of the liner.
NP94-34	Camera		19.08.`94	06:52	387m	80°05.489	42°27.943			
	GC-1		19.08.`94	07:10	388m	80°05.412	42°27.895	4m	2m	
NP94-35	Camera		19.08.`94	07:56	389m	80°05.197	42°26.998			In the seafloor crater.
	GC-1		19.08.`94	08:15	391m	80°05.152	42°27.073			Dark, sharply broken shales/mudstones
										in the core cutter.
NP94-36	GC-1	CTD-63	19.08.`94	11:13	376m	80°21.902	42°04.906	4m	2,65m	Bottom: dark grey, gravelly clay with a
										strong smell of H2S. 3x3cm stone in the
										cutter. Top: dark reddish brown.
	BC-1		19.08.`94	11:32	377m	80°21.861	40°04.797	40cm	40cm	Surface sample taken for pollution inv., 2 subsamples.
										Dark reddish brown silty clay on top.
NP94-37	PGC-1	CTD-64	19.08.`94	14:26	425m	80°38.067	41°50.345			Core barrel broken.
	SC-1		19.08.`94	15:00	425m	80°38.115	41°50.165	7m	2,70m	Core barrel slightly bent.
	BC-1		19.08.`94	15:32	424m	80°38.103	41°50.175		30cm	Appr. 10cm brownish, soft mud in the top,
										grey, stiffer mud in the base.

Station	Device-no.	CTD - no.	Date	Time (UTC)	Waterdepth	Latitude	Longitude	Penetrat.	Recovery	Comments
	GC-1		19.08.`94	15:52	425m	80°38.092	41°49.94	3,5m	2,30m	
	SC-2		19.08.`94	16:28	426m	80°38.141	41°50.354	4m	2,20m	Grey, firm, very sticky material in the base.
NP94-38	SC-1	CTD-65	19.08.`94	22:04	594m	80°57.993	40°36.262	12m	6,5m	Silty, sandy clay in the bottom.
	PGC-1		19.08.`94	22:41	594m	80°58.003	40°36.496	4m	0m	Core catcher turned inside out, material lost.
	PGC-2		19.08.`94	23:05	515m	80°58.002	40°36.432	3m	1,6m	Material lost on the way up.
	BC-1		19.08.`94	23:35	594m	80°57.936	40°36.548		0m	Empty.
	BC-2		19.08.`94	23:55	594m	80°57.969	40°36.240			Surface sample taken for pollution inv., 2 subsamples.
	SC-2		20.08.`94	13:05	598m	80°57.797	40°37.080	13,5m	6,9m	Core cutter with firm dark grey,
										silty clay with fine gravel.
NP94-39	GC-1	CDT-69	21.08.`94	14:45	922m	81°25.980	27°36.775	4m	2,52m	Dark sandy, siltyclay in the core cutter.
	BC-1		21.08.`94	15:06	911m	81°25.883	27°37.170		0m	Empty.
	BC-2		21.08.`94	15:26	901m	81°25.766	27°37.345			2 subsamples taken.
	SC-1		21.08.`94	15:55	881m	81°25.599	27°37.575	10m	4,75m	
	SC-2		21.08.`94	17:43	888m	81°25.669	27°37.247	11m		
NP94-40	GC-1		21.08.`94	21:21	356m	81°05.732	28°51.808	4-4,5m	2,69m	Firm clay with gravel in the bottom.
	BC-1		21.08.`94	21:30	355m	81°05.7	28°51.9		0m	Empty.
	BC-2		21.08.`94	21:52	356m	81°05.577	28°52.720			2 subsamples taken.
	GC-2		21.08.`94	22:05	259m	81°05.545	28°53.201	4m	2,80m	Gravelly, sandy clay in the bottom.
NP94-41	PGC-1	CTD-72	22.08.`94	04:12	473m	80°47.106	29°17.219	3,5m	2,20m	
	SC-1		22.08.`94	04:45	473m	80°47.096	29°26.256	8m	4,70m	Relatively firm, grey sedmint in the bottom.
NP94-42	GC-1		22.08.`94	18:32	1900m	80°52.630	15°52.750	0,75m	0,5m	Top: Soft clay. Bottom: grey, stiff, sandy mud
										(pocket pen. 125 kPa). Middle: loose sand between the top and the stiff mud at the base

Station	Device-no.	CTD - no.	Date	Time (UTC)	Waterdepth	Latitude	Longitude	Penetrat.	Recovery	Comments
NP94-43	PGC-1		26.08.`94	17:34	824m	80°41.928	06°47.912	3m	1,75m	Lost upper 2cm during cutting of liner.
	SC-1		26.08.`94	18:16	825m	80°41.940	06°45.574	13m	5,50m	Echosounder indicated full penetration of
										the core down to the head.
	BC-1		26.08.`94	19:08	824m	80°41.895	06°48.545			Empty.
	BC-2		26.08.`94	19:24	824m	80°41.880	06°48.772			Empty.
	BC-3		26.08.`94	19:45	825m	80°41.825	06°49.424			Empty.
	BC-4		26.08.`94	20:15	825m	80°41.863	06°49.539		35cm	Surface sample taken for pollution inv., 2 subsamples.
										Undisturbed surface with shell fragments.
	PC-1		26.08.`94	21:23	824m	80°41.657	06°50.360	6m	0m	Did not release.
	PC-2		26.08.`94	12:56	822,9m	80°41.09	06°48.197			Triggered on the way down. Wire broke,
										corer lost.
NP94-44	SC-1	CTD-81	27.08.`94	05:24	614m	80°24.294	06°40.417	6,5m	3,20m	SC with 6m barrel.
	BC-1		27.08.`94	06:07	612m	80°24.293	06°39.912			
NP94-45	PGC-1	CTD-82	27.08.`94	09:04	558m	80°11.342	07°18.150			Liner broken and lost.
	PGC-2		27.08.`94	09:50	558m	80°11.300	07°18.169	3m	2,80m	
	SC-1		27.08.`94	10:34	558m	80°11.186	07°17.742	7,5m	4,2m	Core barrel slightly bent. Dark grey silty sandy clay in the core cutter, normally consolidated.
NP94-46	BC-1	CTD-83	27.08.`94	14:04	491m	80°00.396	09°02.560	30cm	30cm	Dark olive grey, silty sandy clay. Quite firm.
	SC-1		27.08.`94	14:25	491m	80°00.331	09°02.294	5,5m	2,65m	Overconsolidated silty (sandy?) clay in the
										core cutter. Pocket penetrometer: 75kPa.
NP94-47	PGC-1		27.08.`94	20:18	850m	80°31.447	11°08.144	3m	2,60m	
	SC-1		27.08.`94	21:33	851m	80°31.480	11°08.021	12,5m	4,7m	Dark, normally consolidated clay.

Station	Device-no.	CTD - no.	Date	Time (UTC)	Waterdepth	Latitude	Longitude	Penetrat.	Recovery	Comments
NP94-48	BC-1	CTD-85	28.08.`94	18:41	170m	79°57.341	15°24.024			Only one little piece of soft mud recovered.
	BC-2		28.08.`94	18:59	169m	79°57.320	15°24.082			Only one little piece of soft mud recovered.
	SC-1		28.08.`94	19:16	170m	79°57.309	15°23.934	15-20cm		Empty. Core barrel covered with soft mud.
										SC used as Gravity corer.
	SC-2		28.08.`94	19:24	171m	79°57.358	15°23.439			Lump of sandy, silty mud in the barrel.
NP94-49	SC-1	CTD-86	28.08.`94	21:22	199m	80°08.830	15°51.168	1,5m	20-30cm	Reddish soft sediment recovered. Sedi-
										ment fell out of the cutter during retrival.
	SC-2		28.08.`94	21:50	204m	80°08.514	15°51.141	2,5m	1,66m	Bottom: gravelly, firm, dark grey sediment.
										Top: soft, dark grey mud. Outside barrel:
										reddish mud, which apparently did not
										enter the liner.
	BC-1		28.08.`94	22:19	204m	80°08.599	15°51.206	30cm	30cm	Surface: dark olive grey silty,sandy clay
										with gravel. More reddish further down.
										Subcoring due to a high number of stones
										difficult. Surface was displaced (10cm).
NP94-50	SC-1	CTD-87	29.08.`94	01:11	453m	80°09.078	17°07.150	10m	5,30m	Bottom: dark grey silty clay, normally
										consolidated. Ice drift: 1,1kts; wind: 24kts.
	BC-1		29.08.`94	01:30	460m	80°08.628	17°11.001	30cm	30cm	2 subsamples taken.
NP94-51	PGC-1	CTD-88	29.08.`94	06:41	399m	80°21.411	16°17.942	2,5m	2,05m	
	BC-1		29.08.`94	07:10	398m	80°21.403	16°18.125		35-40cm	Surface sample taken for pollution inv., 2 subsamples.
										Undisturbed surface.
	SC-1		29.08.`94	07:24	399m	80°21.346	16°17.970	9,5m	4m	Dark grey, normaly consolidated mud in
										the bottom.

Station	Device-no.	CTD - no.	Date	Time (UTC)	Waterdepth	Latitude	Longitude	Penetrat.	Recovery	Comments
	SC-2		29,08,`94	08:48	400m	80°21.469	16°17.945	13,5m	7,5m	
NP94-52	SC-1	CTD-89	29.08.`94	11:04	310m	80°26.335	14°47.252	4,5m	60cm	Ice fide above location. Equivalent depth
										found on slope about 600m from original
										choice.
NP94-53	SC-1		29.08.`94	14:23	106m	80°27.283	14°23.793	1,6m	1,48m	Gravely, silty, dark grey clay in the core
										cutter. Overconsolidated silty clay in
										middle of cutter. Stone in top of core.
	BC-1		29.08.`94	14:35	107m	80°27.379	14°23.871	30cm	15cm	
	BC-2		29.08.`94	14:45	107m	80°27.334	14°23.650	30cm	15cm	Big subangular stones (20x20cm) in top.
NP94-54	BC-1		29.08.`94		46m	80°09.273	13°50.172			Gravel, 5-10cm pebbles and shells.
NP94-55	BC-1		29.08.`94	18:38	51m	80°02.069	14°02.285	20cm		Very sandy sediment. Being washed out
	BC-2		29.08.`94	18:50	51m	80°02.069	14°02.285	20cm		of the box both times. Photo and 1 core.
	GC-1		29.08.`94	19:00	47m	80°02.202	14°02.755			Empty.
NP94-56	GC-1		29.08.`94	19:50		79°57.517	13°45.280	3m		Empty.
	BC-1		29.08.`94	20:04	161m	79°57.598	13°45.494		20cm	Surface coverd by clean, fist-sized stones.
	SC-1		29.08.`94	21:10	161m	79°57.598	13°45.494	3m	2m	
NP94-57	BC-1		29.08.`94	23:22	160m	80°09.404	12°51.858	25cm		Firm dark olive grey silty, sandy clay with
										dark mottling on the top, above silty
										dark greyish clay.
	SC-1		29.08.`94	23:40	156m	80°09.510	12°52.399	2,5m	1m	Cutter: dark greyish, gravelly clay. Very
										hard (pocket penetrometer: 300-400kPa).
										Soft material above the hard in the catcher.

Station	Device-no.	CTD - no.	Date	Time (UTC)	Waterdepth	Latitude	Longitude	Penetrat.	Recovery	Comments
NP94-58	GC-1		30.08.`94	01:09	182m	80°15.491	12°24.333	1,5-2m	1,53m	Dark silty clay with gravel (stone) in the
										cutter. Normaly consolidated.
	BC-1		30.08.`94	01:20	182m	80°15.499	12°24.186	30cm	25cm	Gravelly sandy clay, dark grey. Quite
										firm.
NP94-59	GC-1		30.08.`94	02:58	194m	80°16.767	11°20.682			Empty.
	GC-2		30.08.`94	03:04	194m	80°16.702	11°20.543			Empty.
	BC-1		30.08.`94	03:15	196m	80°16.629	11°20.084		1cm	1cm of sand and gravel.

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PART B:

THE WOOD- AND LIEFDEFJORDEN MARINE GEOLOGY AND GEOPHYSICS PROGRAM

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Summary

The scientific objective of the fjord work was the glaciation and deglaciation history of these areas and a better understanding of the processes involved. The NP'94 expedition continued the fjord work started in 1992 with the German SPE'92 expedition. High resolution seismic (airgun and 3,5 kHz precission depth recorder (PDR)), sonographic surveys (100 kHz side scan sonar), sediment coring (Sel-, gravity- and box corer), bottom photography and CTD-measurements were carried out in the two fjords. A total of 210 kilometers of acoustic records was acquired. 16 sediment cores with a total recovery of 25m and 7 bottom photographs were taken at 8 locations. Additionally, 13 CTD casts were carried out. The participitation on the NP'94 cruise became possible by an invitation from the Norwegian Polar Research Institute (NP) and the financial sponsoring of the German Research Foundation (DFG).

Introduction

Regional setting

The investigation area is situated in northwest Spitsbergen. It is comprised of the Woodfjord, the Liefdefjord and the Bockfjord. The Liefde- and Bockfjords are join the N-S extending Woodfjord from the west (Fig. B1). The whole area extends more than 60km in N-S and W-E direction. The fjord system shows well developed morphology of a glacial influenced valley (Fig. B2) with sills, steep walls and distinct overdeepened basins. Water depths of more than 200m occur in the outer basins of the fjords. Several valley glaciers are situated near to the shoreline of the fjord system, but at present only the tidewater glacier in the head of the Liefdefjord (Monacobreen) calves into the fjord.

Investigations of the glacial history of the fjord sytem have been presented by several authors (e.g. Furrer et al. 1991, Salvigsen 1977, Salvigsen & Nydal 1981, Salvigsen & Österholm 1982, Stäblein 1992). These studies were mainly base on investigations of isostatic rebound effects of the whole area as documented by raised beaches and the distribution of moraine ridges. Salvigsen & Österholm (1982) defined principally two raised beach sequences with ages of about 40ky for the higher one (about 80m a.m.s.l.) and about 9-11ky for the lower (4-5m a.m.s.l.) one. They suggest an early deglaciation of the Woodfjord areas after about 40ky and document a maximum ice extent of the late Weichselian in the confluence area of the Wood- and Liefdefjord.

The Holocene evolution of the region is described by Furrer et al. (1991). They were able to define 7 Holocene glacier advances in the Liefdefjord area. According to radiocarbon data from moraine ridges they conclude a maximum Holocene extension of the glaciers during the „Little Ice Age".

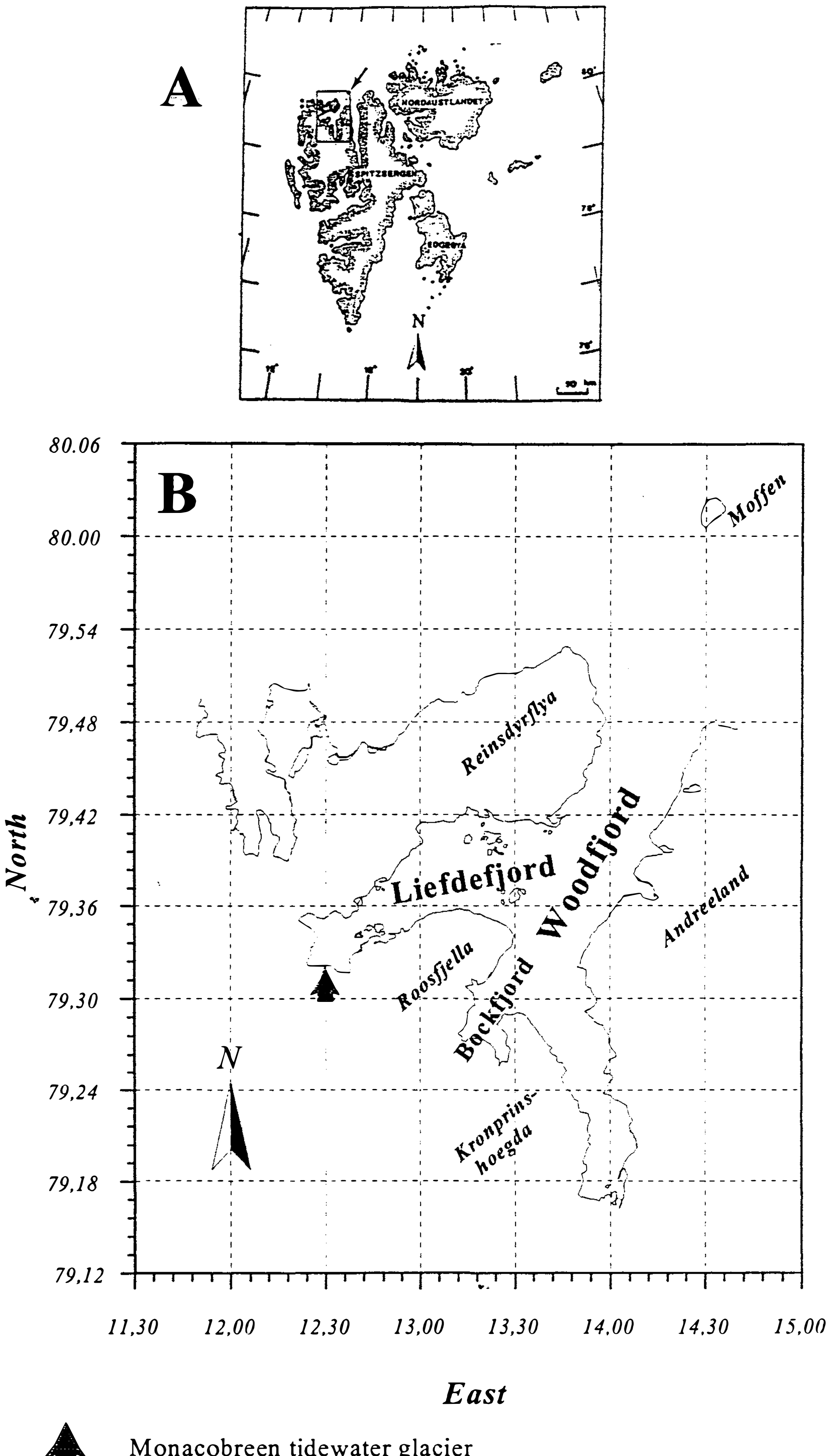

Figure B1. The study area for subprogramme B.

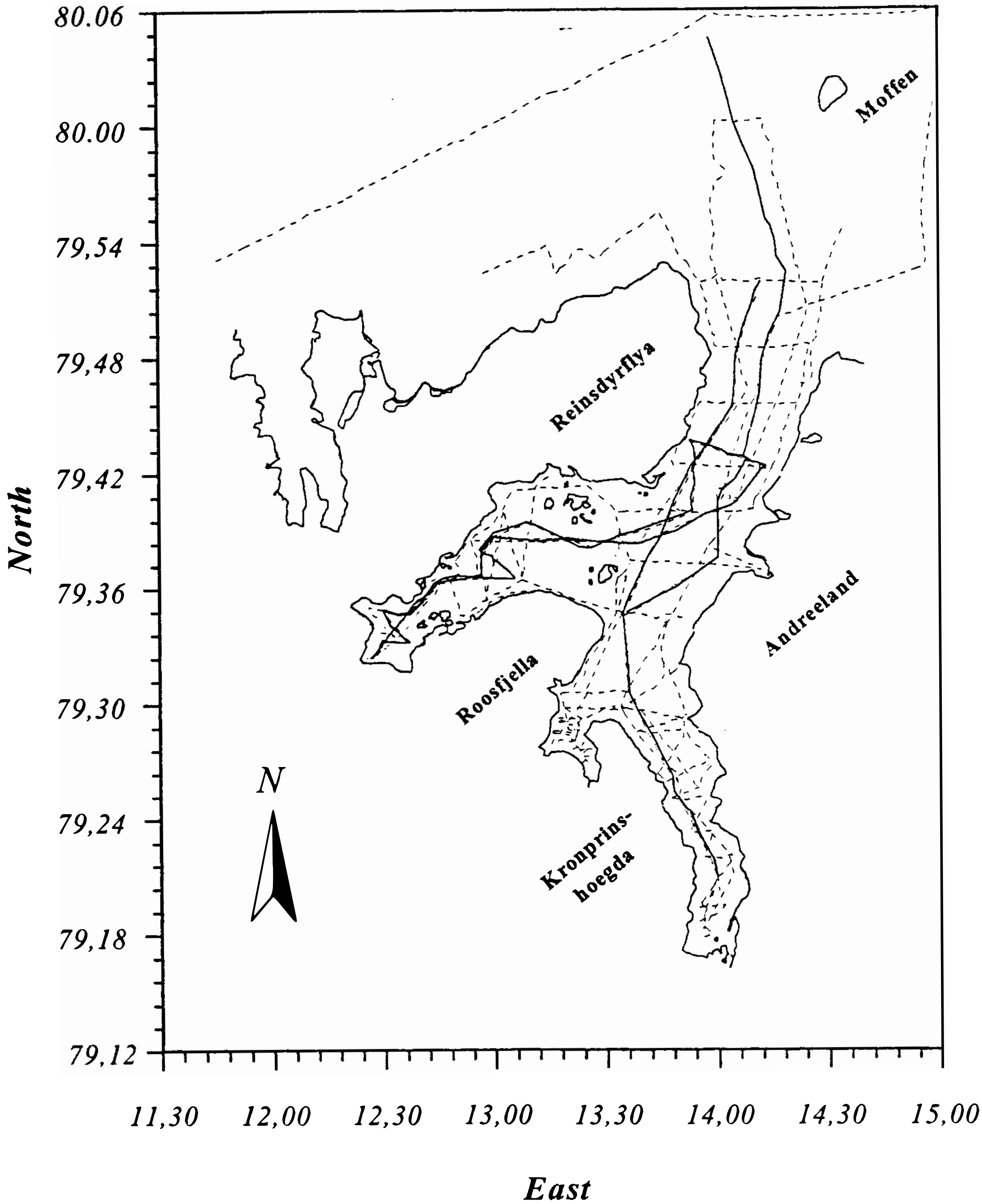

Fig. B2. Seismic lines of the SPE´92 und NP´94 expeditions.

——————— NP´94

- - - - - - - - SPE´92

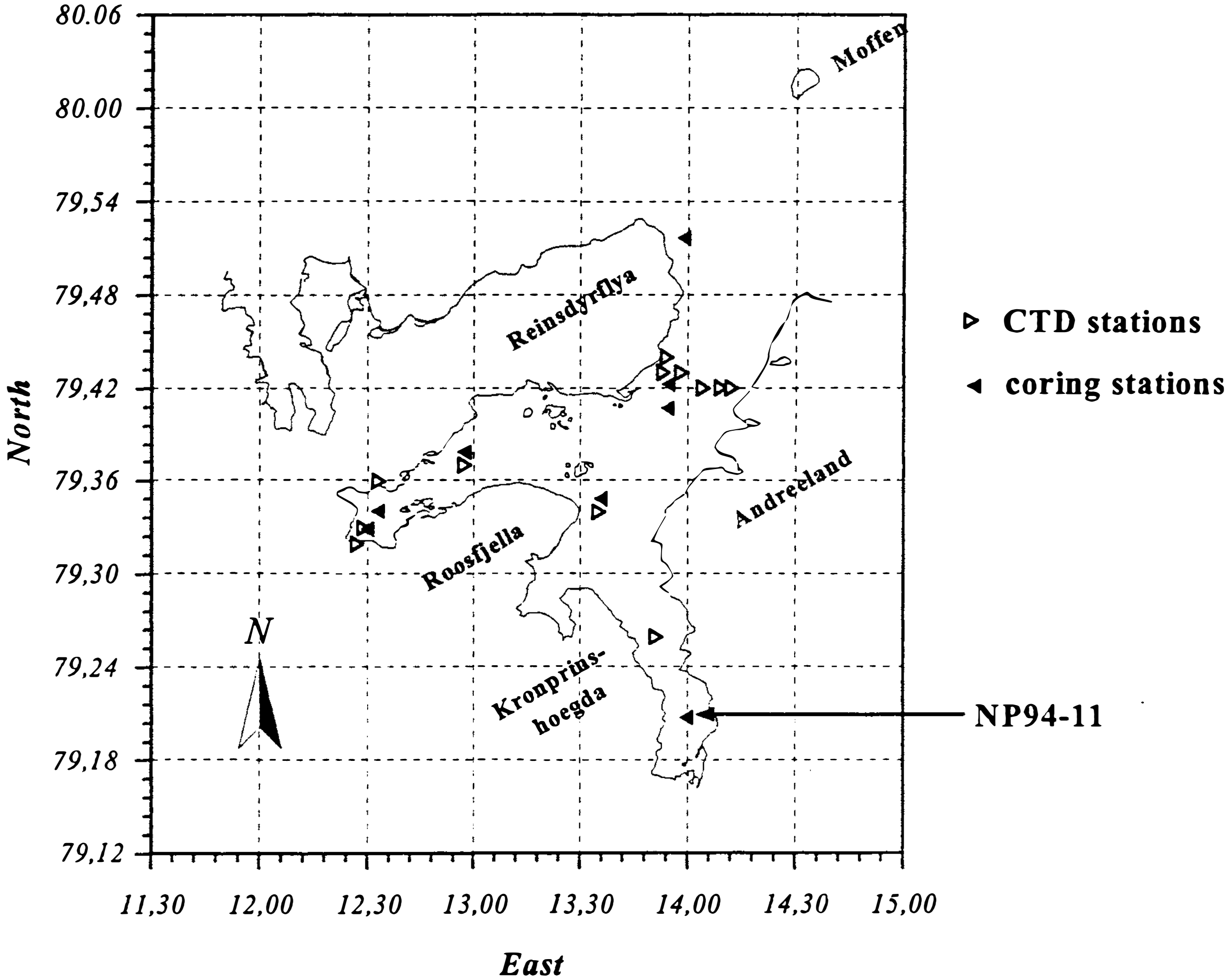

Fig. B3. CTD stations and coring locations

Previous fieldwork, SPE project

The work in the Wood- and Liefdefjord areas is embedde in the activities of the „SPE“ project („**SP**itzbergen **E**xpedition“). This project was an international research program initiated and organized by the „German Society for Polar Geography“. The main scientific objective of this project was to establish a broad database for a better understanding of the recent terrestrial glacier and permafrost related mass movement processes in high arctic regions. The relations and interactions of the terrestrial processes with the fjord environment have been another focus of interest.

During the summer periods of ´90, ´91 and ´92, intense geographical, biological, meteorological and geological onshore field work took place in the Wood- and Liefdeford areas. Due to the scarcity of geological data from the fjords, a marine geological fieldparty was organized in 1991. Acoustic surveys (boomer, 3,5kHz and side-scan sonar) and sediment sampling were carried out in summer of 1992 (SPE´92). A good base of acoustic data consisting of widespread acoustic profiles and sediment sample locations was collected.

Due to technical problems during the SPE´92 it was impossible to get side scan sonar information in regions with water detphs greater than about 120m. Although the shallow seismic records generally showed good penetration (in particular the boomer) the energy output of the available equipment (ORE GEOPULSE boomer and ORE (2x2) 3,5 kHz subbottom profiler) was not sufficient to reach the top of the paleozoic basement of the stiff fjord sediments. It was therefore not possible to achieve a complete volumetric analysis of the fjord sediments.
For a better understanding of the sediment transport mechanisms it seemed important to get some additional information about the oceanographic processes of the fjord environment. Up to the NP-94 expedition, the only available CTD-information of this area was taken during a cruise of the Tormsø University (M. Hald, unpubl. data) in 1991.

Scientific program

Returning to the area of interest after 2 years with new survey equipment, the NP-94 work continued the SPE works. Moreover we had the unique chance to document short time changes in the fjord environment by repeating selected seismic lines in ´94.

Objectives

1) The exploration of the deepwater regions (>100m) with the side scan sonar including the following tasks:

   a. To identify indications of bottom currents (e.g. ripple marks) and deepwater exchange processes.

   b. To identify effects of mass movement, in particular to trace and correlate the deep water events with the shallower regions.

   c. To identify concentrations of coarser sediments (e.g., ice rafted detritus or lag sediments).

2) The description of the overall sediment thickness by means of the airgun. Reaching the surface of the paleozoic basement rocks, it was possible to define a „base layer“

for volumetric calculations. Another focus of interest was the regional distribution of basement and moraine ridges in particular the identification of morainic ridges with the airgun, because those seemend to be opaque in the boomer and 3,5kHz records of the SPE'92 expedition.

3) The interpretation and classification of the small moraine steps in the middle and inner Woodfjord areas.
4) To sample dateable material from the tills.
5) To study the structural and lithological composition of the sediments by sediment samples and underwater photos.
6) To obtain acoustic and lithologic information about the evolution of glacier proximal facies. Of particular interest is a surge of the fjords' tidewater glacier in 1992 (O. Salvigsen, pers. comm., 1994).
7) To obtain information on the structure of the fjord water masses with respect to the density, salinity and temperature distribution using CTD measurements.
8) To investigate the possible influence of atlantic watermasses on the fjord environment.

Methods

See section A for description of instrumentation and methodolgy.

Operations

The fjord work was carried out from 06:00 (GMT) 04.08.`94 up to 18:00 05.08.`94. On 04.08.`94 the weather was sunny with approximately 4kts wind. Later the wind increased to 29kts, blowing directly out of the fjord (205-250°). The temperature varied from +4°C to 0°C.

All survey activities (seismic lines, geological stations and CTD-measurements) were discussed with the chief scientist (Dr. Anders Solheim) at the beginning of the cruise. All acoustic methods(sleeve gun, 3,5kHz and side scan sonar) were to be used in the fjords. The seismic line was to be stopped at the fjord head, before station work started. Travelling between the stations was to be carried out with a ship speed of about 10kts, running zig-zag 3,5kHz lines in order to get a better overlap of acoustic profiles.

The positions of the acoustic profiles were defined on the base of seismic records from the SPE'92 expedition covering the deepwater regions (>100m). In search of the surge event of the Monacobreen we decided to repeat several profiles in the intermediate and inner parts of the fjords. Moreover, we also tried to get a better overlapping of seismic lines by avoiding too many duplications and by running zig-zag 3,5kHz lines on the way out of the fjord system (Fig. B2).

The coring locations were selected partly on the base of the SPE'92 records, and partly based on the new 3.5 kHz data. Table 2 shows all core and CTD positions and numbers, the used coring devices and numbers, the penetration and recovery. The 3,5kHz recorder was operated during the entire fjord program (station work included). Due to the lack of oceanographic data from the fjord environment up to now it was planned to combine CTD stations with geological stations. As one objective was to look for a possible influence of atlantic watermasses on the fjord environment, a CTD transect was planned. This transect is situated in the mixing area of the watermasses from the two fjords in the outer Woodfjord (Fig. B3.).

Preliminary results

Bathymetry

Using the echo sounding information of both expeditions it is now possilble to generate a bathymetric map of the fjord system (Fig. B4.). The fjord system shows a morphological differentiation into 8 distinct basins. In detail these are the three basins of the Liefdefjord with water depths of 100, 180 and 214m (W-E), the four Woodfjord basins with water depths of 60, 120, 221 and 160m (S-N) and the lateral Bockfjord (95m) basin. The greatest water depths are reached in the outer area of the Woodfjord (221m) and in the intermediate Liefdefjord area (214m).

Seismic surveys

A first evaluation of the seismic surveys of this cruise included following results:

1) The airgun signal has reached the paleozoic basement almost everywhere. Therefore it is possible now to estimate the whole sediment thickness and the internal acoustic layering. Reaching the paleozoic basement it is possible now to define a „base level" for volumetric calculations of the sediment input.
2) Some structures interpreted by the SPE´92 records as „basement" ridges now could clearly been identified as moraine ridges. This requires a new interpretation of the retreat and advance movements of the fjord glaciers and the deglaciation history of the whole area.
3) New information about special features located in the intermediate and inner Woodford are found as well. In these regions small scale (retreat ?) moraines appear, being semitransparent to opaque to the 3,5kHz signal and transparent to the airgun signal. A new information on these features is that they are definitively not parts of the bedrock (i.e. basement outcrops), which because of the smaller penetration of the boomer and PDR signals in 1992 was not clear at all.
4) The appearance of a new transparent - semitransparent surface layer in the inner Liefdefjord could be related to the Monacobreen surge event in 1993.

Side scan sonar surveys

First shipboard evaluation of the side scan sonar records during the cruise included:

1) That the insonified areas usually show low backscatter energy of the 100kHz signal, indicating a very soft fjord bottom.
2) No indications of bottom currents (e.g. current ripples) could be identified.
3) Any enrichment of obviously ice rafted debris (IRD) especially in the outer and intermediate fjord areas could not be observed.
4) Iceberg ploughmarks (IPMs) are rare. The deepest observed IPMs are found in 120m water depth.
5) Slump lobes are common features in the deep water regions.

Core work

Some results of the onboard measurements of core NP94-11 (for location see Fig. B3) are presented in Fig. B5. In general the results from the measurements of the physical properties and the description of the core shows a smooth curve to a core depth of about 190-200cm. The contents of the grain size fraction >63µm and the shear strength are slowly increasing with depth. This trend is interrupted at a depth of 70cm by a stiffer layer, characterised by lower water and >63µm content. Reaching 200cm depth, a distinct break in all parameters appears. The water content and of the coarse fraction (>63µm) decrease and the shear strength increases.

The sediment shows almost everywhere the same color. In a few core sections some enrichments of shells and dropstones could be observed.
Comparing SPE´92 boomer data from the core location (Fig. B6) with the shipboard measurements of the physical properties, a prominent shallow reflector, R1, can be correlated with the marked change of the physical properties at 200cm in core NP94-11.

Oceanography

The positions of the CTD stations and some results of the temperature and salinity measurements are presented in figures B7 and B8.
Main results include the following: Cold, meltwater laden three layered water column of the Liefdefjord can clearly be seperated from the 1,5 - 1,8°C warmer and two layered water column of the Woodfjord. Strong winds caused total mixing of the upper 18 meters at station 17. In the outer fjord, the CTD transect show trends in the salinity and temperature profiles that indicate a morphologically controlled current distribution in the area.
Increasing temperature and salinity in the bottom layer indicate an inflow of the warmer and higher saline watermasses derived from the Northwest Spitsbergen Current.

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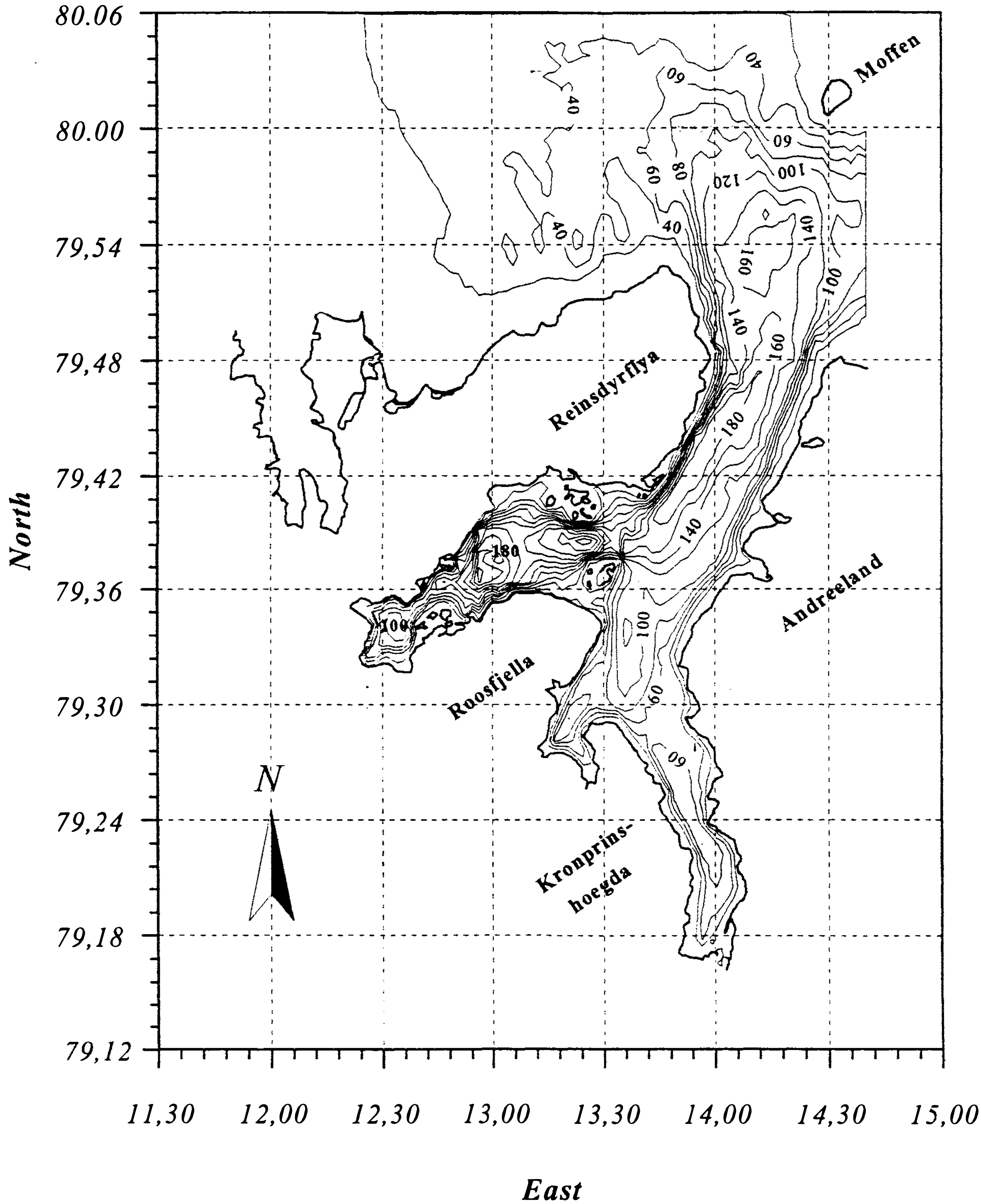


Fig. B4. Bathymetric map of the Wood- und Liefdefjord areas.

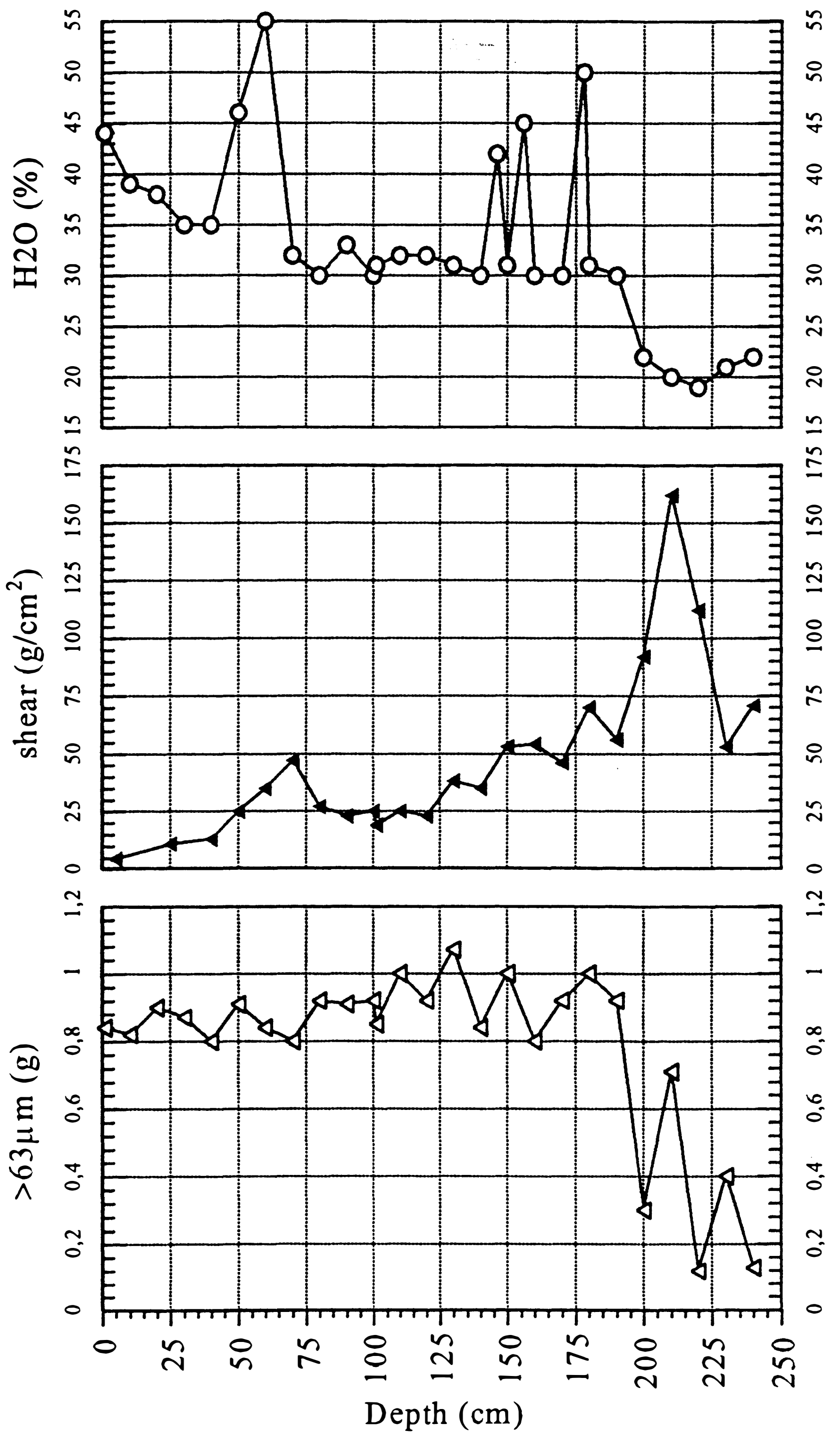


Fig. B5. Coarse fraction (>63µm) , shear strength (shear) water content (H2O) of gravity corer NP94-11.

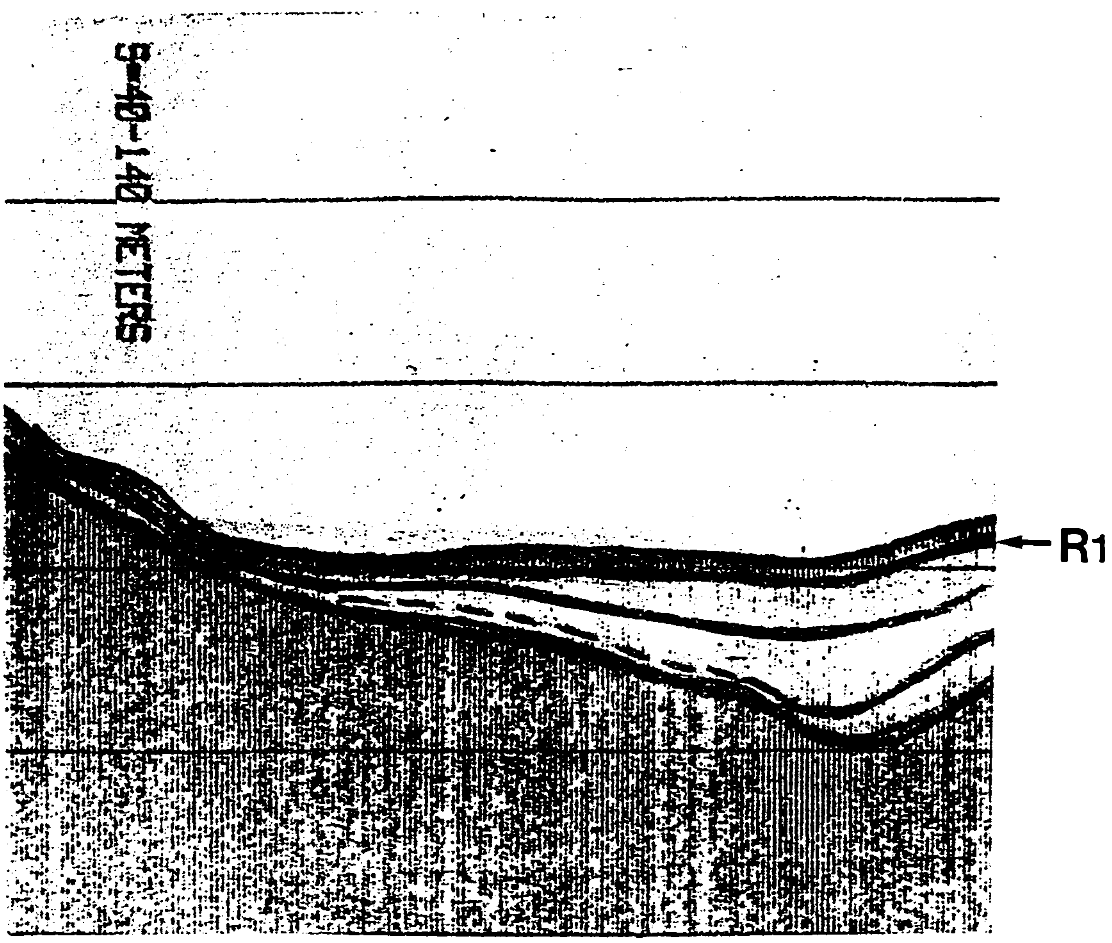


Fig. B6. boomer record (SPE'92) from core location NP94-11.
Reflector R1 could be correlated with the distinct changes of physical properties in 200cm core depth.

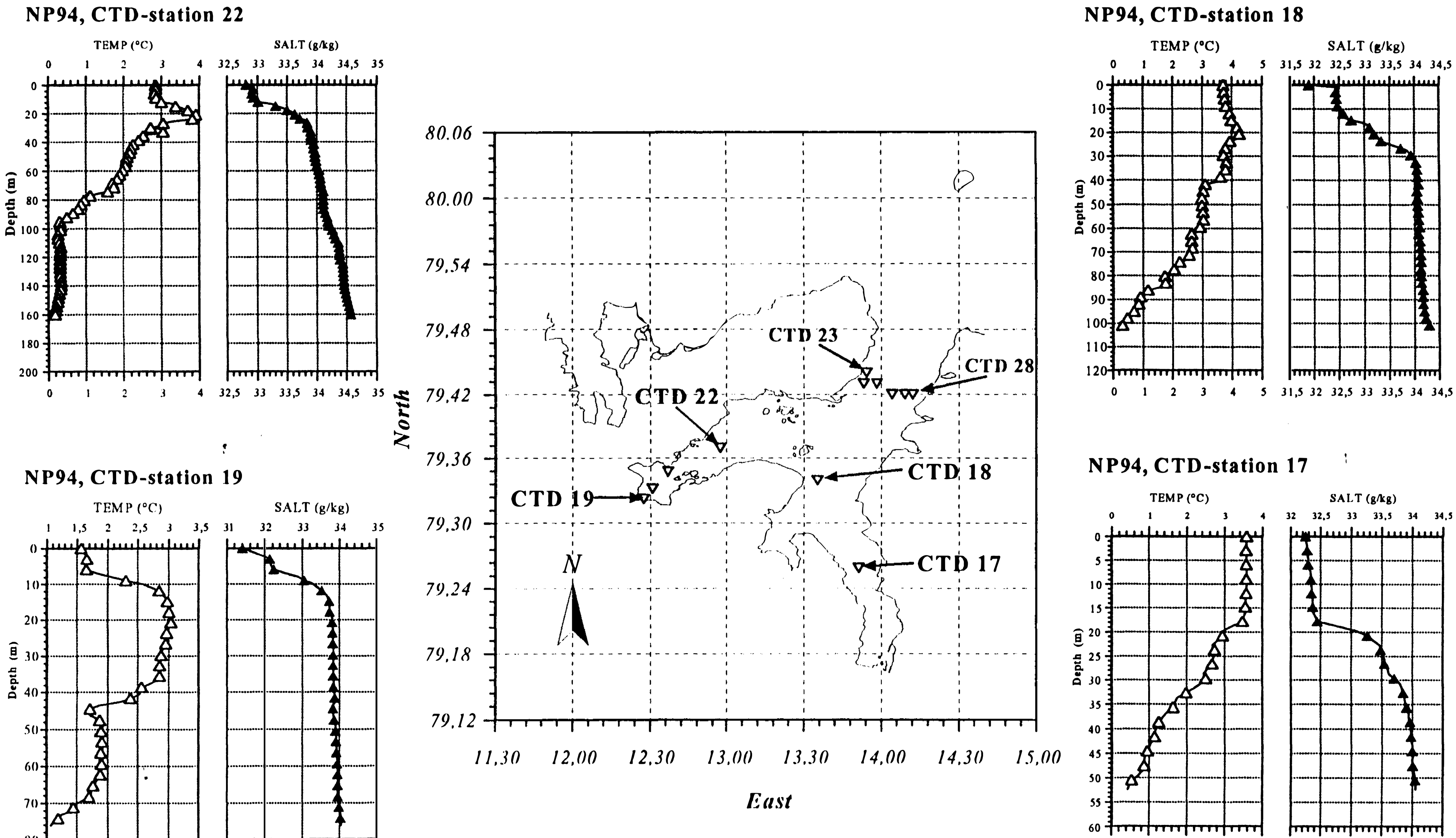
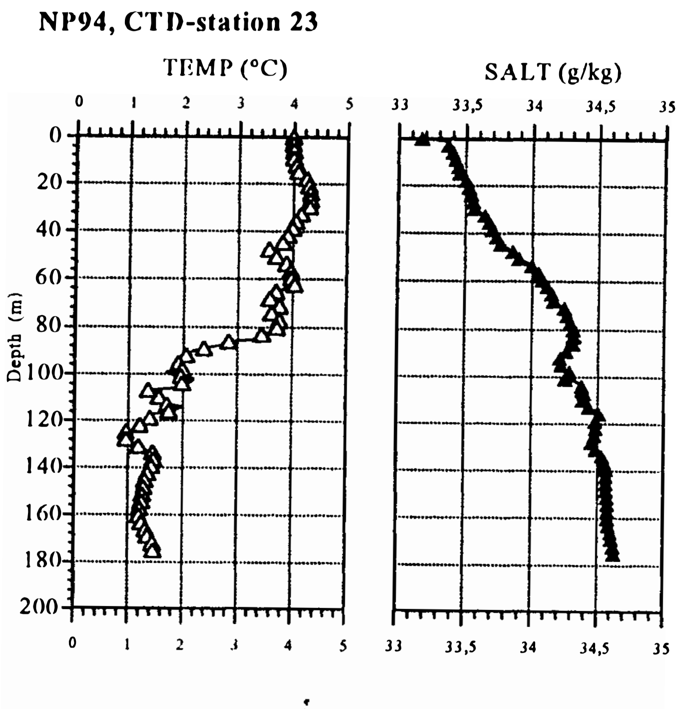
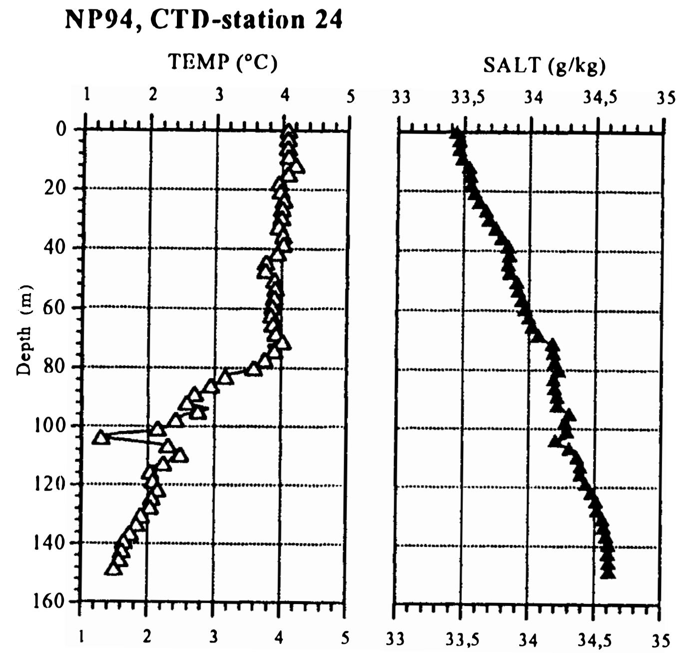
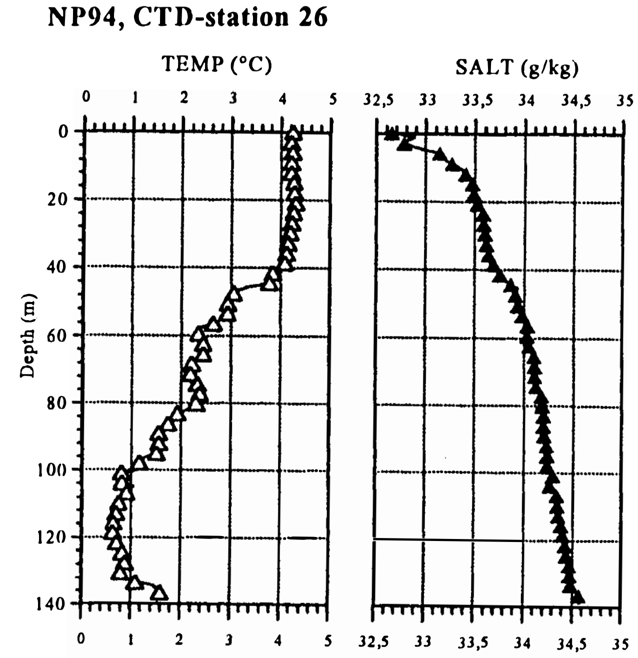
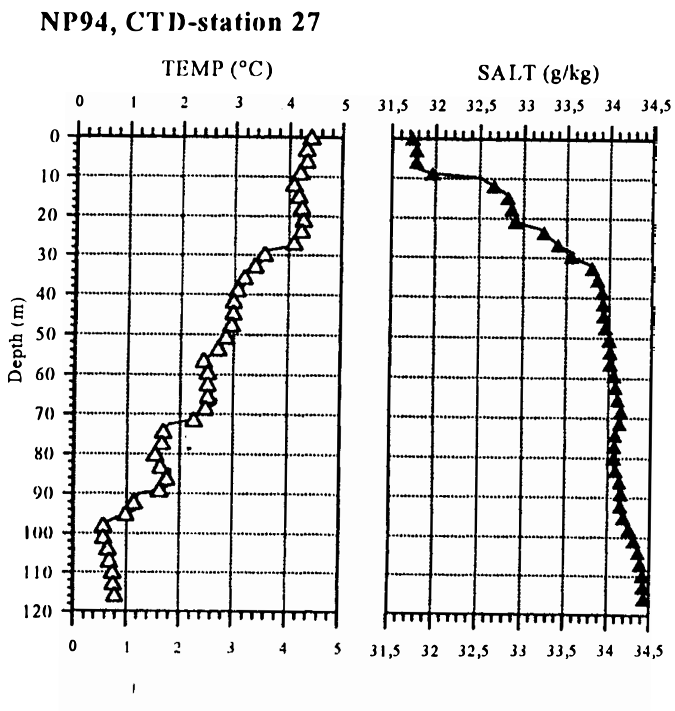


Fig. B7. Temperature (Temp) and salinity (Salt) measurements of selected locations.









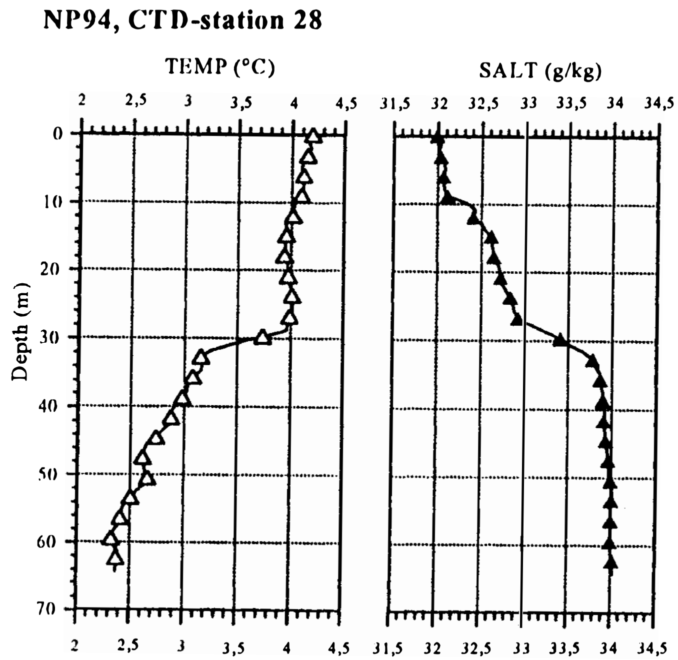


Fig. B8.
Temperature (Temp) and salinity (Salt)
W-E transect (for location, see Fig. B7)

PART C:
PHYSICAL OCEANOGRAPHY

Torleif Lothe[1] , Vladimir V. Stanovoy[2] , Nikolai I. Fomitchev[2]

Summary

Despite the clear marine geological emphasis of the Lance Aug.-94 cruise, sufficient time was spared to complete oceanographic work. Altogether 93 CTD casts and 3 ice stations were made, and one moored oceanographic rig was deployed. Additionally, one damaged moored rig was recovered.

Ice sample stations-RUNOP[3]

Ice samples were collected at 3 different sites during the cruise. The positions are shown in figure C1, and given in table C1, summarising the number of samples collected and their UTC time of collection.

Time	Latitude	Longitude	Number of samples
3. Aug. 1994, UTC 1900	N 80° 37.8'	E 10° 45.4'	2
15. Aug. 1994 UTC 0830	N 82° 25.2'	E 38° 42.3'	3
26. Aug. 1994 UTC 1415	N 80° 47.4'	E 06° 53.3'	5

Table C1. Time, position and number of samples at the ice stations.

A manual core drill was used to collect ice samples of diameter 12 cm and length about 20 cm. Samples were taken from the surface of sea ice with high concentration of impurities (fine grained sand or silt) only. The samples were handled with disposable examination gloves, put in air tight plastic bags in a cooling bag, and stored at -30°C in the freezer on board.
The samples are to be analysed for a number of parameters as suggested under the AMAP.

Collection of samples was performed as outlined by T. Vinje[4] 22. July 1994.

Retrieval and deployment of moored rigs.

One moored rig with 3 Aanderaa RCM 7 and 1 RCM 8 was deployed in Kongsfjorden (position marked on figure C1). The rig is an 8 mm steel wire, with a 600 kg anchor weight and an iron buoy with 430 kg buoyancy at the top. The rig has acoustic release 10 metres above the anchor, and is also equipped with an extra rope,

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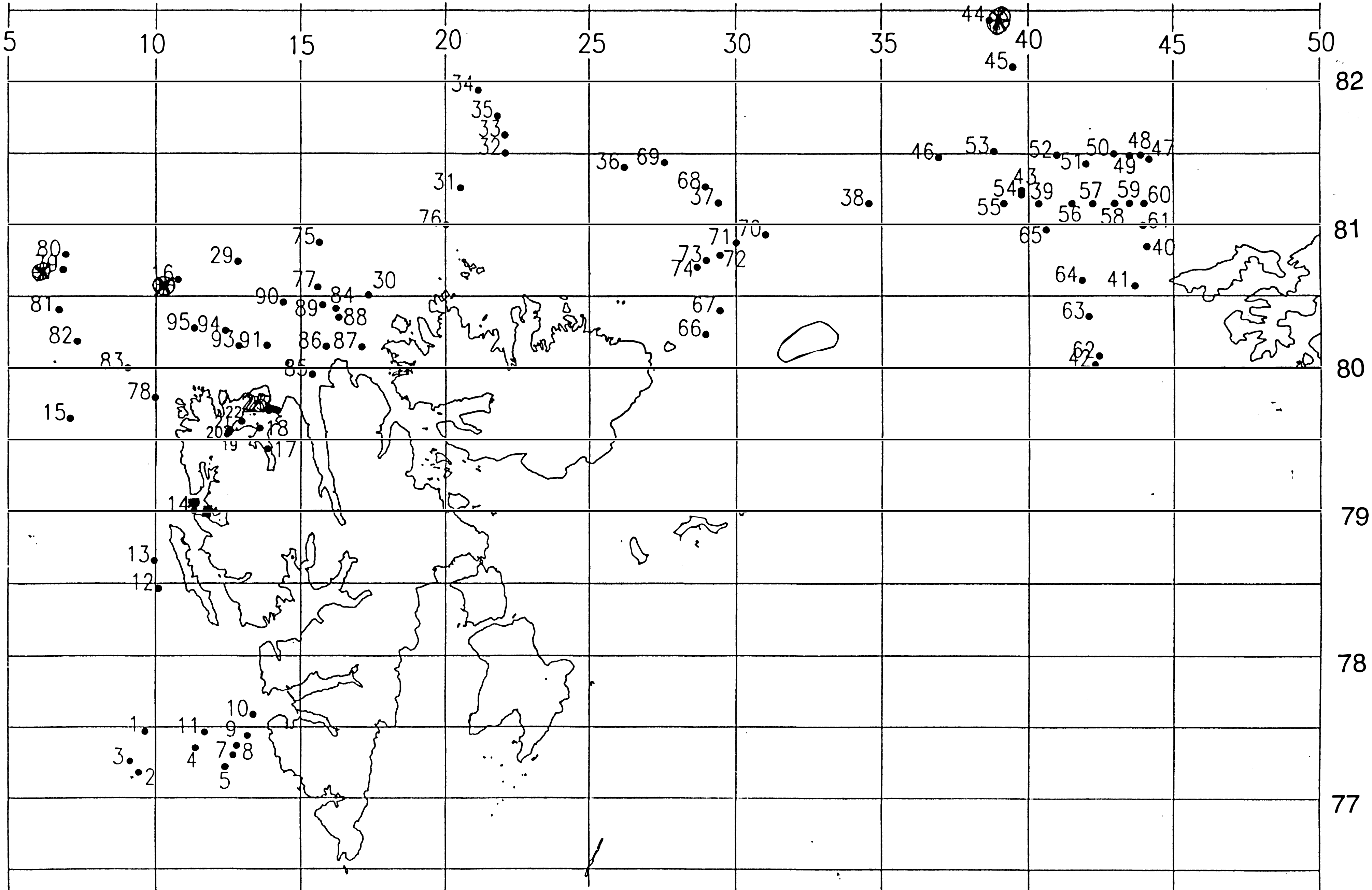
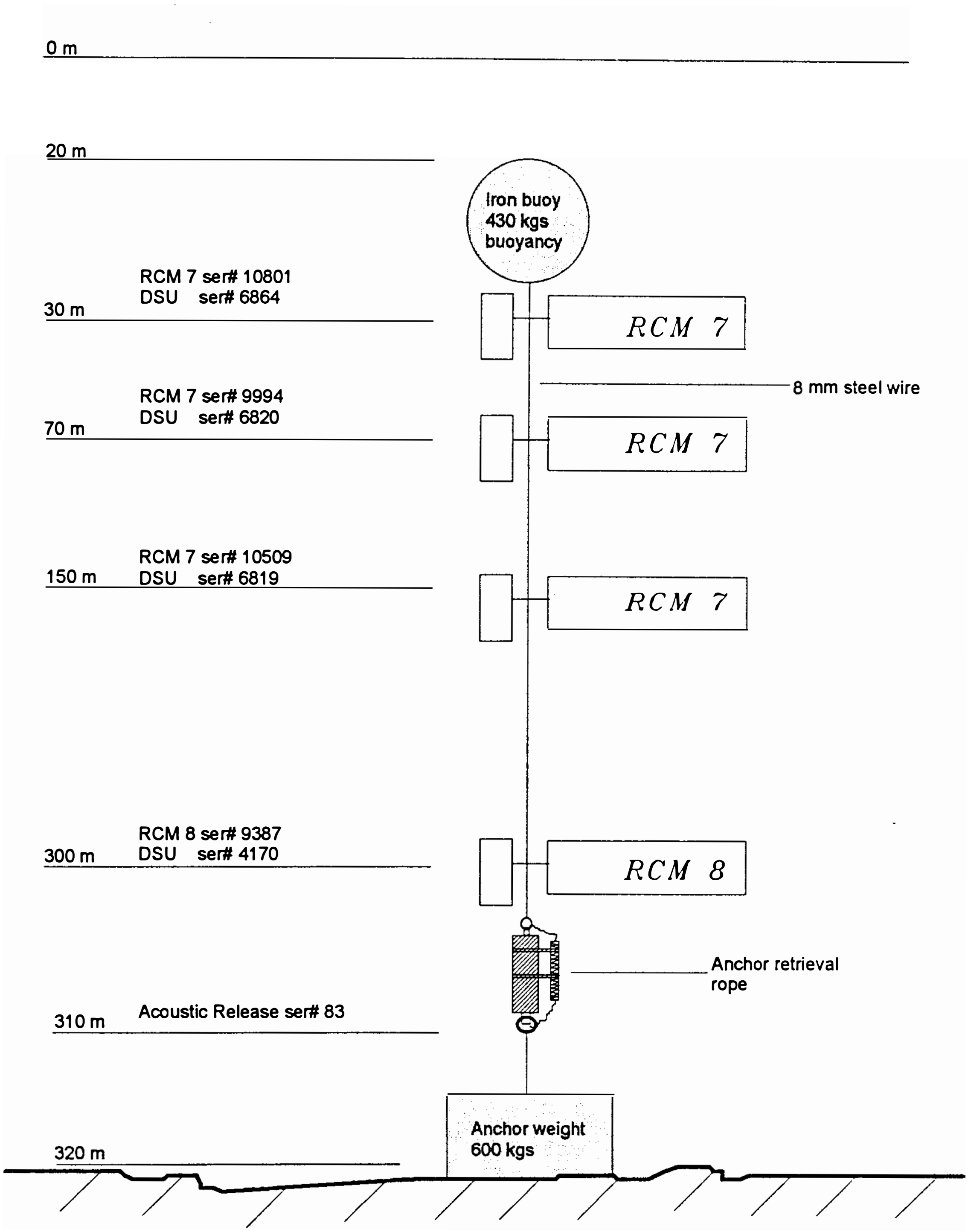


Figure C1. Map showing the CTD casts (●), ice stations (⊛) and retrieved/deployed moored rigs(■). Numbers are CTD cast numbers.



Mooring deployed at:
Time:2. Aug. 1994 UTC 0930 Lat: N 79 00.225' Lon: E 11 18.081' Depth: 323 m
Instruments started at UTC 0318 2: Aug. 1994

Figure C2. The moored rig deployed in Kongsfjorden.

connecting the rig and anchor over and under the acoustic release. The rope is wound up inside a cartridge attached to the acoustic release. When the anchor is released, the rope runs out of the cartridge giving the rig free rise to the surface, while retrieval of the anchor still is possible. The principle is illustrated in figure C2
The instruments were deployed as given in table C2 and in figure C2.

Instrument	Depth	Instrument serial no.	DSU serial no.
RCM 7	30 m	10801	6864
RCM 7	70 m	9994	6820
RCM 7	150 m	10509	6819
RCM 8	300 m	9387	4170
Acoustic release	310 m	83	-

Table C2 Specifications for the instruments on the rig deployed in Kongsfjorden.

The moored rig was deployed at:
Time : 2. August 1994 UTC 0930
Latitude : N 79°00.225'
Longitude : E 11°18.081'
Depth : 323 m
The instruments were started at UTC 0318 2. August 1994.

One moored rig was retrieved in position N 78°57.263' E 11°59.222', outside Ny-Ålesund. The rig was grappled for with an about 10 meters long chain with 40 cm iron bars welded on. The rig was hooked on at first attempt, but only the dredge rope, the anchor, the chain between the anchor and the downmost current meter, a current meter (ser# 9924) and about 2 meters of the chain above the current meter was retrieved. The rest of the rig, i.e. 200 meters of rope, a sediment trap and a current meter (ser#9874) and the buoyancy was lost. The retrieved chain was considerably weakened by corrosion, but hardly enough to be torn of by the buoyancy of the rig itself. The broken link was not found, hence no conclusion could be made concerning weather the link broke due to improper isolation between the chain and stainless steel parts of the rig, or due to some other reason e.g. taken by a trawl or ice. Preliminary investigation of the data storing unit from the retrieved current meter suggests that the rig was lost 1/1-94. An about 1 hour survey for the lost part of the rig was performed, in case the rig was lost during the retrieval. No new rig was deployed.

CTD programme

Description of the CTD dataset.

The dataset covers a relatively large geographical area, and also several oceanographic regimes. It is therefore convenient to divide the data into the following:

The Bellsund area
The Woodfjorden area
The Yermak Plateau area
The Northern Svalbard margin area
The Franz-Victoria trough area

It was attempted to organise the CTD stations from all the above areas in such a way as to make cross-section analysis possible (in the following, refer to figure C1).

Due to good ice conditions we were able to obtain a N-S section along the Franz-Victoria trough from approximately N 80° to 82° 26'. Two E-W sections were also made across the trough. In the Bellsund area, a roughly E-W section was made over the continental slope and shelf, from E 10° 00' to E 14° 00'. The stations in the Yermak Plateau and Northern Svalbard margin area allows several sections to be constructed, among them a SW-NE transect of the "Kvitøya trough", between Kvitøya and Nordaustlandet. In addition to the stations in Woodfjorden in common with the geology group, an E-W section was made across the outlet of the fjord. Wind readings were made every hour, from 24 hours prior to the transect. Strong winds (30-40 kts.) were blowing out the fjord for the first 12 hours of the period, decreasing to 4-5 knots as the section was made. The wind measurements were obtained from the onboard-mounted weather station, with anemometer 24 meters above sea level.

Instrumentation

CTD casts were made by a Neil Brown Mk IIIB (serial no. 01-2826-01) CTD, and water samples by a single Niskin water sampler. The Niskin bottle was triggered by release weight. Two additional casts were made by the backup CTDs, a SEACAT SBE19 (serial no.198048-1453), and a SD-202 MINI STD (serial no.84). The water samples were analysed on board with a Guildline Portasal 8410 salinometer (serial no. 60 651). The salinometer was installed in the laboratory in the cargo room onboard. Despite the less than ideal temperature conditions in this laboratory, some high quality measurements were made. Unfortunately, after having analysed the first 34 samples, the salinometer malfunctioned, as did the reversing thermometer (RTM 4002, serial no.T664) after the first CTD cast. Both the salinometer and the reversing thermometer were investigated by the ship's electrician, and found not to be immediate repairable. The reversing thermometer was replaced at the end of the cruise (28. Aug. -94) Water samples for analysis of oxygen isotopes and salinity were taken at most stations.

Data quality

The NB CTD was calibrated prior to the cruise at the calibration laboratory at Geophysical Institute, Bergen, and will be calibrated after the cruise. With basis in the pre-cruise calibration, the temperature measurements are believed to have accuracy as given by the factory (0.005°C or better). Due to the malfunction of the reversing thermometer, very little can be said prior to post-cruise calibration about the temporal stability of the temperature sensor. However, comparison of the potential temperature at the deepest station (st.34, -0.941°C), with previous measurements from the Nansen

Basin, made by R/V Polarstern in 1988 [5] (-0.94°C, Thiede et. al [1988]) suggests high quality temperature measurements.

The salinometer analyses of the first 34 water samples showed signs of both drift in time and increasing error with pressure for the conductivity sensor. For the deepest station (st.34) the salinometer gave a salinity value of 34.949, while Thiede et. al [1988] found the salinity of the bottom water to be between 34.936 and 34.943[6]. The CTD, however, gave a value of 34.992, giving a deviation of -0.043 from the salinometer value. The final calibration of the conductivity sensor will be performed after a complete analysis of the water samples.

At the deepest station, the pressure sensor was compared with the PDR (Precision Depth Recorder). The sound speed was calculated from the CTD data, and multiplied by half the PDR time signal, and compared with the calculated CTD depth, showing agreement to within 10 metres.

Preliminary results

From the bathymetry of the northern Barents Sea it is evident that there is a possibility of water mass exchange with the polar ocean through the troughs in the north, i.e. the Hinlopen Strait, the Franz-Victoria trough, and the "Kvitøya trough" between Nordaustlandet and Kvitøya, and in the areas east of Franz Josef Land. This dataset gives an impression of the water mass exchange in the three first areas. For this reason it was attempted to locate the CTD stations across and along these troughs.

In the Franz-Victoria trough 27 CTD casts were made, allowing several sections to be constructed, among them two sections across the trough, and one section along. The section along the Franz-Victoria trough (not shown in this report) clearly shows that warm and salty water from the Arctic Intermediate layer is present in the trough, at least as far south as to station 42 (figure C1). The northernmost section across the trough (figure C3) shows a core of warm and salty water between 100 and 300 meters. The core is tongue-shaped, with the thickest end in the west, giving the impression that this water is flowing southwards, topographically steered by the trough. The surface water is fresh and cold, with a temperature minimum at 20-30 meters depth. At the bottom, water with temperature below 0°C and salinity 34.8-34.9 is found. Following Carmack [1990], this water is classified as upper Arctic Intermediate Water (uAIW). In the east a colder and fresher water type is found, giving rise to the baroclinic structure at 200 meters depth in 3ure C2 c).

The "Kvitøya Trough" section, shown in figure C4 a-c), is the N-S section along the trough. No signs of a southward transport of warm and salty water can be seen. Water with Arctic Intermediate Water characteristics is found at the bottom and intermediately in the northernmost half of the trough. A core of Atlantic Water (T >° 0, S > 35.0) is seen intermediately in the north between 100 and 200 meters. The density structure is strongly baroclinic, suggesting an eastward flow at the shelf break.

Atlantic Water with temperature well above 3°C is found at all stations near the northern outlet of Hinlopen Strait, but no measurements were made in the strait.

With validity restricted to the areas surveyed and the time of measurement, the following preliminary conclusion can be drawn: The main area in which the Barents Sea exchanges intermediate water with the Polar Ocean is the Franz-Victoria Trough

[5] Preliminary data

[6] Preliminary data

and the Hinlopen Strait. Warm and salty water with Atlantic origin flows intermediately from the Polar Ocean into the Northern Barents Sea in these areas, at least as far south as 80°N through the Franz-Victoria Trough.

List of CTD casts R/V Lance 28. July-1.September 1994

st	date	time (UTC)	longitude (deg:min:sec)	latitude (deg:min:sec)	echo depth (m)
1	29.07	2.00	77° 28'13"	09° 38'10"	1836
2	29.07	17.45	77° 10'40"	09° 24'58"	2095
3	30.07	09.15	77° 15'30"	09° 06'26"	2089
4	31.07	00.43	77° 20'58"	11° 22'23"	349
5	31.07	04.44	77° 13'05"	12° 24'12"	228
7	31.07	07.05	77° 18'02"	12° 40'05"	216
8	31.07	09.00	77° 22'05"	12° 47'21"	243
9	31.07	12.00	77° 26'30"	13° 09'12"	235
10	31.07	17.05	77° 35'16"	13° 21'36"	145
11	31.07	21.45	77° 27'50"	11° 41'16"	239
12	01.08	21.07	78° 28'07"	10° 06'03"	174
13	02.08	01.15	78° 39'30"	09° 57'00"	208
14	02.08	10.07	79° 00'05"	11° 19'31"	372
15	02.08	17.07	79° 38'59"	07° 04'52"	909
16	03.08	16.30	80° 37'00"	10° 46'15"	936
17	04.08	19.54	79° 26'11"	13° 51'20"	69
18	04.08	21.32	79° 34'54"	13° 35'11"	121
19	05.08	07.32	79° 32'13"	12° 27'09"	96
20	05.08	09.13	79° 33'13"	12° 30'05"	87
21	05.08	11.08	79° 34'06"	12° 33'12"	107
22	05.08	13.20	79° 37'50"	12° 57'01"	187
23	05.08	16.15	79° 42'26"	13° 54'07"	197
24	05.08	17.35	79° 43'37"	13° 53'22"	171
25	05.08	17.58	79° 43'11"	13° 58'53"	189
26	05.08	18.22	79° 42'54"	14° 04'06"	158
27	05.08	18.44	79° 42'28"	14° 09'16"	132
28	05.08	19.06	79° 42'17"	14° 12'18"	91
29	06.08	09.42	80° 44'43"	12° 50'31"	1359
30	06.08	22.51	80° 30'37"	17° 18'38"	84
31	07.08	11.18	81° 15'31"	20° 31'29"	494
32	07.08	17.02	81° 30'14"	22° 08'42"	909
33	07.08	22.15	81° 37'45"	22° 07'45"	2019
34	08.08	04.20	81° 56'31"	21° 09'15"	3530
35	08.08	14.25	81° 45'48"	21° 51'31"	3350
36	09.08	12.19	81° 24'22"	26° 12'12"	820
37	10.08	00.30	81° 09'21"	29° 23'49"	340
38	10.08	14.23	81° 09'01"	34° 33'50"	184

39	11.08	04.35	81° 08'56"	40° 21'16"	547
40	11 08	16.59	80° 50'37"	44° 05'27"	-400
41	12.08	11.50	80° 34'15"	43° 40'20"	376
42	12.08	23.28	80° 01'24"	42° 17'54"	384
43	14.08	06.58	81° 14'41"	39° 45'26"	499
44	15.08	02.05	82° 25'59"	38° 41'12"	2292
45	15.08	16.04	82° 06'11"	39° 28'01"	1008
46	16.08	06.50	81° 28'18"	36° 57'16"	371
47	16.08	22.30	81° 27'42"	44° 10'27"	217
48	17.08	00.00	81° 29'24"	43° 52'51"	312
49	17.08	00.45	81° 29'07"	43° 30'24"	408
50	17.08	01.45	81° 29'57"	42° 58'21"	405
51	17.08	04.10	81° 25'46"	41° 59'54"	422
52	17.08	05.53	81° 29'19"	40° 58'59"	412
53	17.08	08.45	81° 30'52"	38° 49'25"	444
54	17.08	16.55	81° 12'48"	39° 45'31"	514
55	18.08	05.26	81° 08'57"	39° 09'06"	441
56	18.08	09.21	81° 09'01"	41° 30'41"	461
57	18.08	11.59	81° 08'58"	42° 14'17"	480
58	18.08	13.02	81° 08'59"	42° 59'30"	459
59	18.08	13.55	81° 08'57"	43° 30'28"	464
60	18.08	14.45	81° 09'00"	44° 00'00"	427
61	18.08	16.07	80° 59'42"	43° 57'18"	501
62	19.08	03.15	80° 04'48"	42° 26'36"	387
63	19.08	10.15	80° 21'10"	42° 05'12"	375
64	19.08	13.25	80° 36'33"	41° 51'36"	425
65	19.08	21.02	80° 57'48"	40° 35'55"	594
66	20.08	16.28	80° 13'57"	28° 57'05"	269
67	20.08	19.30	80° 23'43"	29° 25'59"	426
68	21.08	07.55	81° 16'12"	28° 57'45"	301
69	21.08	13.40	81° 26'13"	27° 34'31"	958
70	22.08	00.51	80° 55'50"	31° 01'10"	173
71	22.08	02.22	80° 52'25"	30° 00'10"	172
72	22.08	03.40	80° 47'14"	29° 27'14"	470
73	22.08	06.05	80° 45'00"	28° 59'00"	491
74	22.08	07.00	80° 42'10"	28° 40'09"	395
75	23.08	16.45	80° 52'39"	15° 39'27"	1934
76	24.08	11.45	81° 00'03"	20° 00'49"	161
77	24.08	23.12	80° 33'59	15° 35'12"	327
78	25.08	17.54	79° 47'48"	09° 58'30"	390
79	26.08	10.25	80° 41'14	06° 49'42"	818
80	26.08	14.29	80° 47'35"	06° 55'15"	898
81	27.08	03.08	80° 24'15"	06° 41'49"	628
82	27.08	08.34	80° 11'13"	07° 18'54"	560
83	27.08	13.25	80° 00'09"	09° 02'41"	489
84	28.08	07.45	80° 24'48"	16° 11'56"	440
85	28.08	18.32	79° 57'27"	15° 23'11"	173
86	28.08	21.10	80° 08'54"	15° 51'01"	194
87	29.08	03.20	80° 08'46"	17° 03'53"	451

88	29.08	05.59	80° 21'04"	16° 17'58"	392
89	29.08	10.20	80° 26'16"	15° 44'47"	241
90	29.08	14.18	80° 27'18"	14° 23'48"	107
91	29.08	11.49	80° 09'02"	13° 49'44"	47
93	29.08	23.13	80° 09'34"	12° 52'03"	158
94	30.08	00.59	80° 15'35"	12° 23'47"	182
95	30.08	02.46	80° 16'32"	11° 19'26"	195

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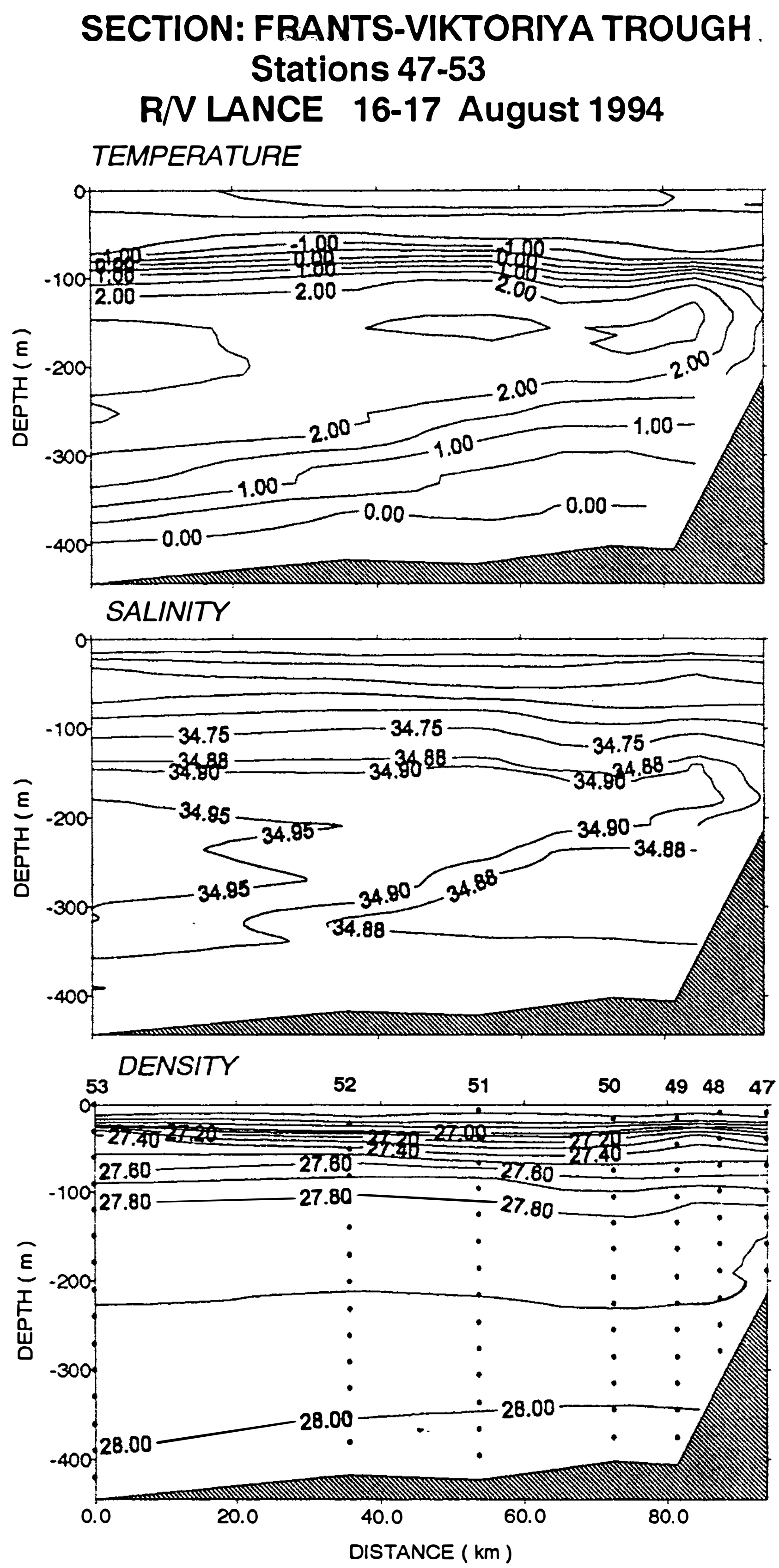

Figure C3. The northmost E-W cross section in the Franz-Victoria Trough, stations 53, 52, 51, 50, 49, 48, 47. Figure a) shows temperature, figure b) salinity and figure c) density anomaly.

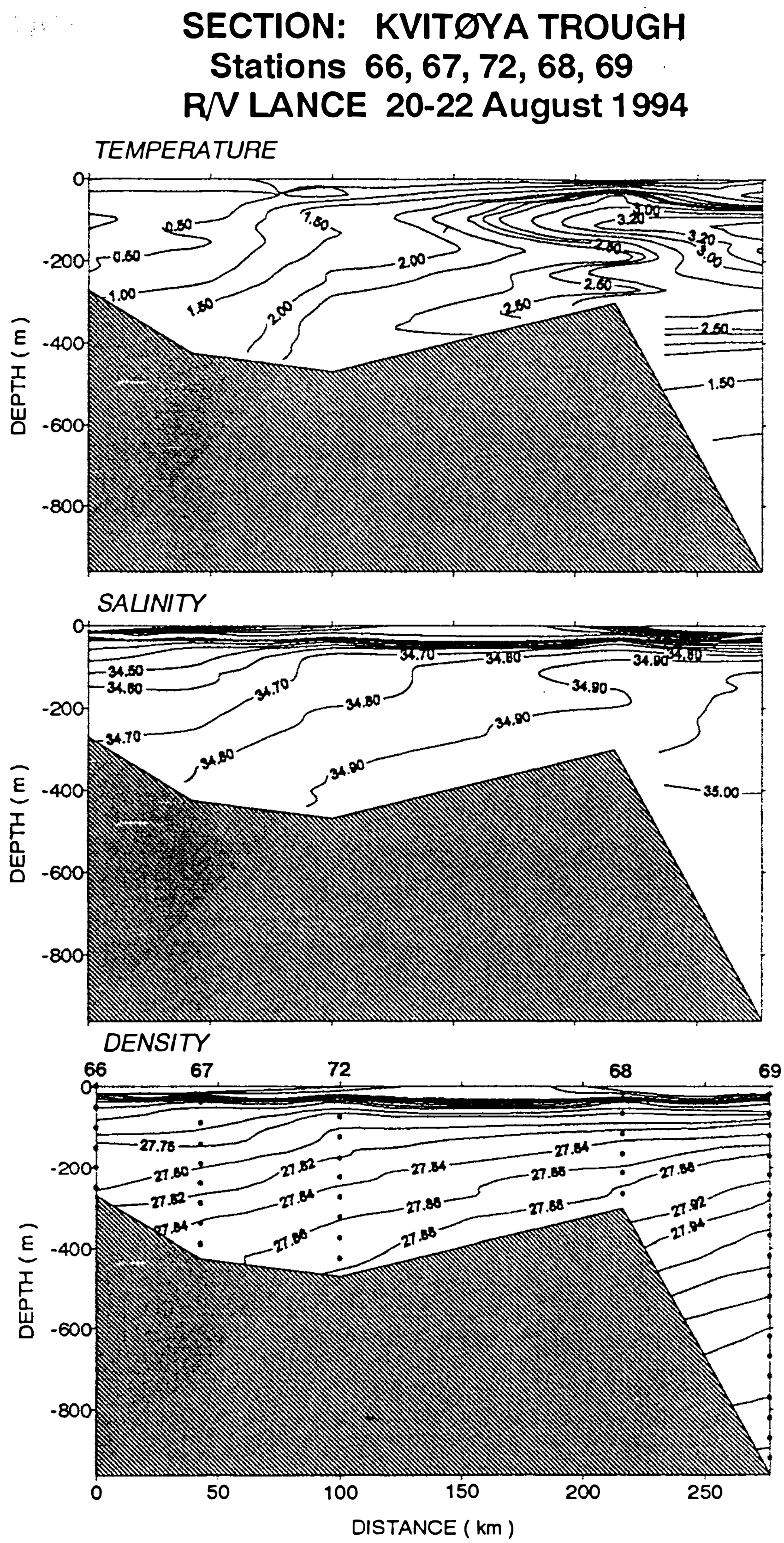

Figure C4. The N-S section along the "Kvitøya Trough", stations 66,67,72,68,69. Figure a) shows temperature, figure b) salinity and figure c) density anomaly.