Laptev Sea System: Expeditions in 1994

Edited by Heidemarie Kassens

The TRANSDRIFT II Expedition to the Laptev Sea
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Expedition to the Lena River in July/August 1994
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Russian-German Cooperation:
The Transdrift II Expedition to the Laptev Sea

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THE TRANSDRIFT II EXPEDITION TO THE LAPTEV SEA

Summary

The role of river runoff for the modern and past environment of the Laptev Sea was investigated during the TRANSDRIFT II expedition in the summer of 1994. The primary objective of this expedition was the documentation of the pathways of river discharge by means of oceanographical, ecological, chemical, and sedimentological parameters. Onboard the Russian research vessel *Professor Multanovskiy* a comprehensive interdisciplinary working program was carried out on 102 stations between 10 and 55 m water depth. Preliminary shipboard results can be summarized as follows:

- High resolution salinity and temperature measurements along E-W and S-N transects in the Laptev Sea have shown a drastic reduction of freshwater discharge from the rivers Lena and Olenek to the Laptev Sea in comparison to the results of the TRANSDRIFT I expedition in 1993.
- The pathways of river runoff in the Laptev Sea were identified by its silicate concentrations. Zones of stagnant bottom water masses were determined at the eastern slopes of the western and eastern Lena valleys as well as north of the Lena Delta at 36 m water depth.
- For the first time, *in situ* hydrooptical measurements, e.g. light transmission and chlorophyll "a" fluorescence intensity, were carried out in the Laptev Sea. These high resolution records of the water column have shown an increase in chlorophyll "a" fluorescence intensity in river water outflow zones.
- Vertical profile optical backscatter data yield uni- to trimodal distributions of suspended matter. High values were often measured between 0 to 5 m and below 10 m water depth. The upper maxima are thought to be of biogenic origin whereas the deep maximum is likely to reflect benthic boundary layer conditions. Total amounts of suspended matter did not vary significantly between the eastern and western Laptev Sea.
- The macrobenthos distribution in the Laptev Sea is controlled by river runoff. In September 1994 a phytoplankton bloom followed by a maximum of zooplankton was observed in the northern Laptev Sea. At the same time the summer season of plankton development, marked by a decrease in phyto- and zooplankton after the spring maximum, was observed in the southern Laptev Sea.
- For the first time, long sediment cores (up to 5m) were taken in the Laptev Sea. The sedimentary records indicate that sediments from the eastern Laptev Sea differ from those in the west in grain-size, composition, and density. On this basis five facies have been identified. They refect a changing environment through time, and may be caused by (1) different sediment sources for the Laptev Sea, (2) different water masses, and (3) changing depositional environments, particularly from active delta to estuary and shallow marine. Remarkably, organic rich sediments occur in the Anabar-Khatangar Valley. These sediments are characterized by the hithero not reported presence of large ikaite nodules and layers of single crystals. The nodules are radial agglomerations reaching 8 cm in length, which are comprised of small (< 5mm) amber-colored crystals.

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Introduction

The Arctic system is a sensitive indicator of environmental changes. Understanding the evolution and the present state of this system as well as its impact on the global climate is therefore a necessary base to decipher the processes controlling climatic changes. For a realistic simulation of climatic models dealing with the future development of the earth's climate and for taking into account the greenhouse effect, it is necessary to reconstruct as precisely as possible the Arctic environment in the course of time.

Climate models as well as paleoclimatic reconstructions have shown that the waxing and waning of the continental ice caps and changes in sea-ice distribution influence the renewal of deep and intermediate water masses and, therefore, thermohaline ocean circulation. Global changes, such as a rise in the average temperature of the atmosphere, are expected to trigger drastic changes in the Arctic system in the near future. Hence, the Arctic Ocean might function as an early warning system for the greenhouse effect.

However, our knowledge of the climate impact in the Arctic Ocean, e.g., of the influence of climatic changes on sea-ice formation, is very limited, thus making it difficult to predict possible future global climatic changes. This holds true in particular for the Siberian shelf seas, which, for logistical and political reasons, have long been inaccessible to the international scientific community. Large amounts of Arctic sea ice are formed on these shelves, underscoring the central importance of these processes for the climate system. In its role as source area for the Transpolar Drift and of sediment-loaded sea ice, the Laptev Sea is of particular interest. It is a shallow shelf sea north of East Siberia between the Taymyr Peninsula and the New Siberian Islands (Fig. 1). Large amounts of sea ice (540 km^3) are formed in the Laptev Sea, which in this way plays an important role in the world climate (Timokhov, 1994). In this region it might be possible to demonstrate the extent to which global ocean circulation and, as a result, climate development are also influenced by extremely large amounts of freshwater transported into the Arctic Ocean through the Siberian river systems.

In 1994 a major multidisciplinary research program 'Laptev Sea System' was designed by Russian and German scientists to understand the Arctic environment and its significance for the global climate. Ongoing bilateral research activities in the scope of the 'Laptev Sea System' include land and marine expeditions to the Laptev Sea area during all seasons of the year, workshops, as well as the exchange of scientists. The GEOMAR Research Center for Marine Geosciences in Kiel, Germany, and the State Research Center for Arctic and Antarctic Research in St. Petersburg, Russia, are jointly responsible for organizing and coordinating the multidisciplinary project, which is funded by the Russian and German Ministries of Science and Technology.

Studies of the atmosphere, the water column and the sea floor were carried out already during the expeditions AMEIS'91 to Kotelneyy, ESARE'92 to the Lena Delta and the New Siberian Islands (Dethleff et al., 1993), and TRANSDRIFT I onboard RV *Ivan Kireyev* (Kassens et al., 1994) in the scope of the pilot phase. These investigations were placed upon dirty sea ice formation and the present and past environment of the Laptev Sea. However, strong seasonal and annual variations of this complex environmental system as well as the remote location, seasonal ice cover (9 months of the year) and harsh conditions make working in the Laptev Sea difficult. For example, the shallow off-shore permafrost level made it impossible to recover long sediment cores (Kassens et al., 1994), that is, paleoceanographic investigations could not be carried out. After these expeditions, however, there were more open scientific questions than before. Trying to answer to these questions and to understand this important key area we decided to organize the TRANSDRIFT II expedition in the summer of 1994.

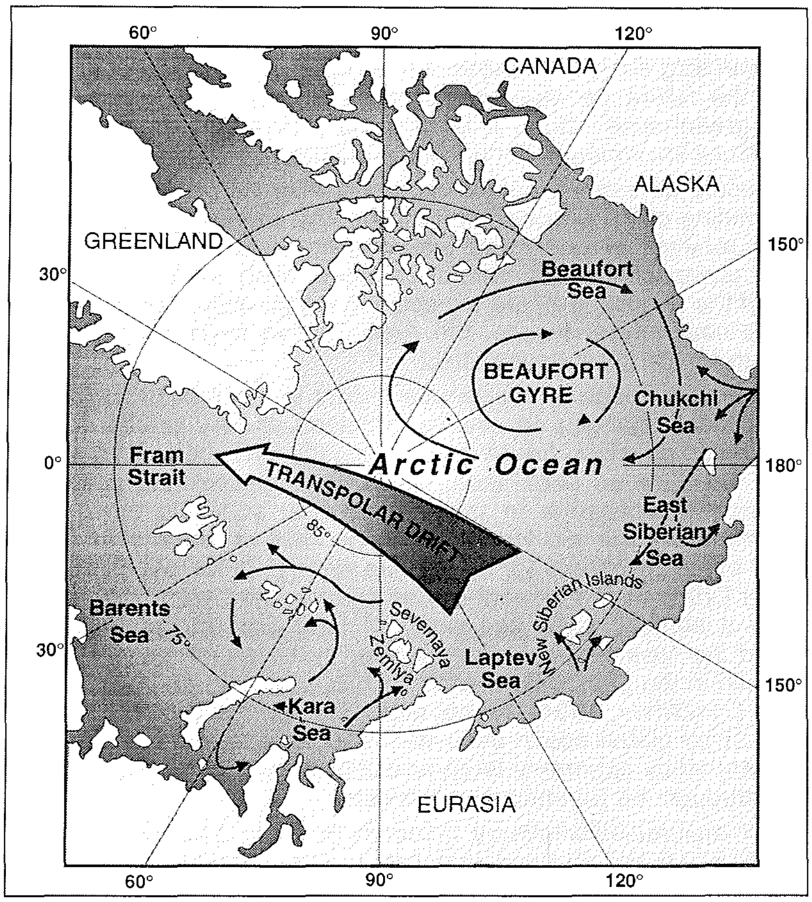


Fig. 1: Map showing the Arctic Ocean and main sea ice drift paths, such as the Transpolar Drift.

The role of river runoff for the modern and paleoenvironment of the Laptev Sea was the primary scientific goal of the TRANSDRIFT II expedition onboard the Russian research vessel *Professor Multanovskiy* from July 22 to October 16, 1994. The specific tasks of the expedition were:

- to identify the present pathways of river discharge by oceanographical, chemical, and ecological tracers,
- and to differentiate the sediments and variability of the rivers feeding the Laptev Sea during the Holocene.

The main target areas of the TRANSDRIFT II expedition were located in the eastern Laptev Sea, north of the Lena Delta, and in the Anabar-Khatangar Valley (Fig. 2). Initially it was planned to work in the Laptev Sea from the beginning of August until September 1994. But due to technical problems of *Professor*

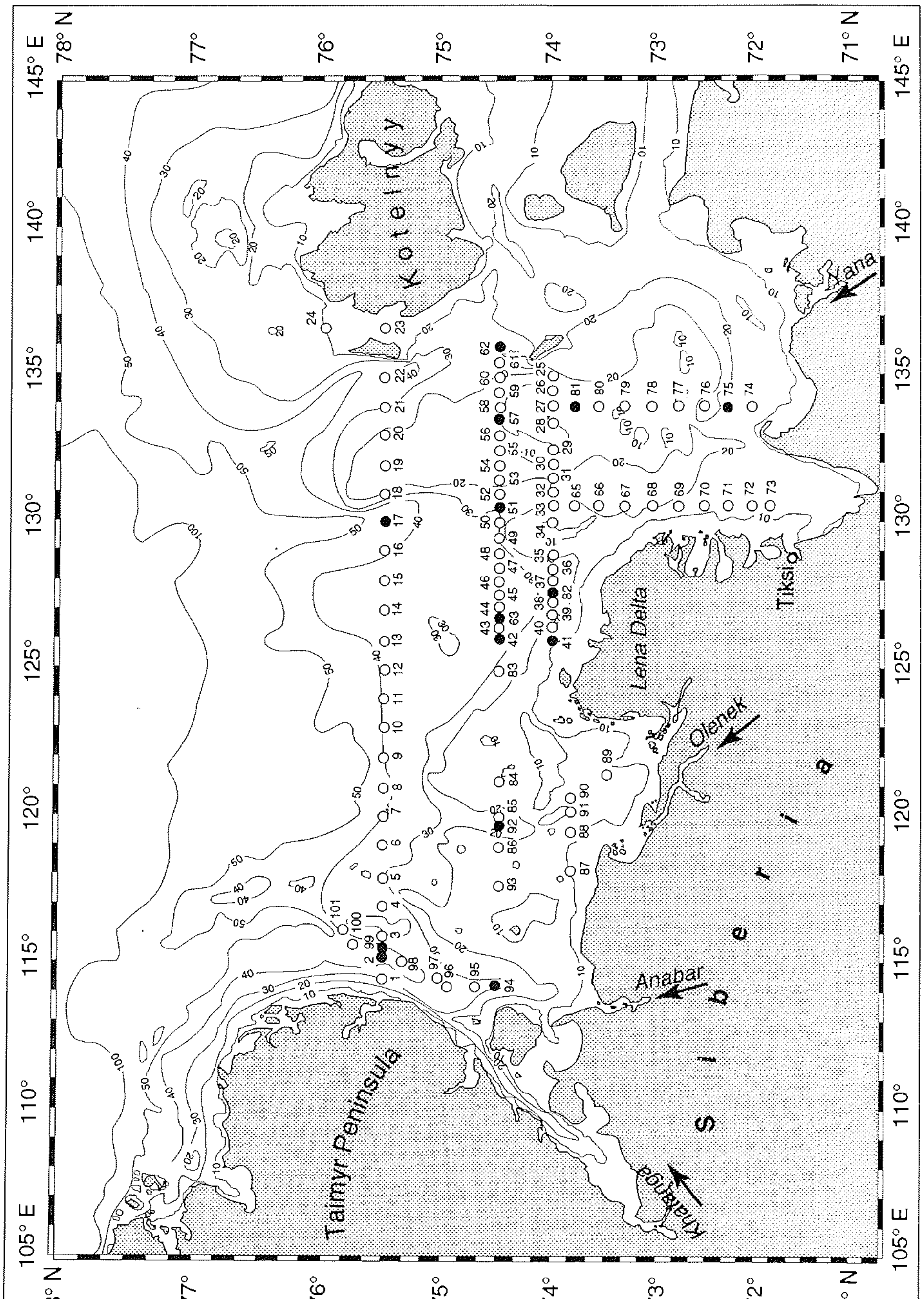


Fig. 2: Station map of the TRANSDRIFT II expedition to the Laptev Sea. Oceanographical, biological and marine chemical studies were carried out at every station. Filled circles indicate sedimentological stations.

Multanovskiy and very harsh weather and ice conditions the working time was cut down to only 3 weeks. Nevertheless, a comprehensive interdisciplinary working program was carried out on 102 stations in the Kara and the Laptev Sea between 10 and 55 m water depth (Fig. 2). Twenty Russian and thirteen German marine scientists participated in the expedition (Fig. 3; Tab. A1). *Professor Multanovskiy* (length over all 71.6 m; max. draft 4.5 m; cross tonnage 1754 GRT) is a Russian research vessel belonging to the Arctic and Antarctic Research Institute of St. Petersburg. It was built in 1983 in Finland and is especially equipped for work in oceanography and biology at high latitudes (class 3 ice capability).

H. Kassens and I. Dmitrenko

Fig. 3: Shipboard Scientific Party of the TRANSDRIFT II expedition.

The Course of the TRANSDRIFT II Expedition

H. Kassens and I. Dmitrenko

The RV *Professor Multanovskiy* departed from the port of St. Petersburg on July 22, and sailed via Kiel, where the German scientific equipment was loaded to Murmansk for custom declarations. From there we sailed to the Laptev Sea along the Northern Sea Route via Dikson, where the German scientists joined the expedition (Fig. 4). Due to engine trouble of the *Professor Multanovskiy* in Dikson and very harsh ice conditions in the Strait of Vilkitskiy - not even navigable for Russian nuclear icebreakers during August - we arrived much later than anticipated on September 3.

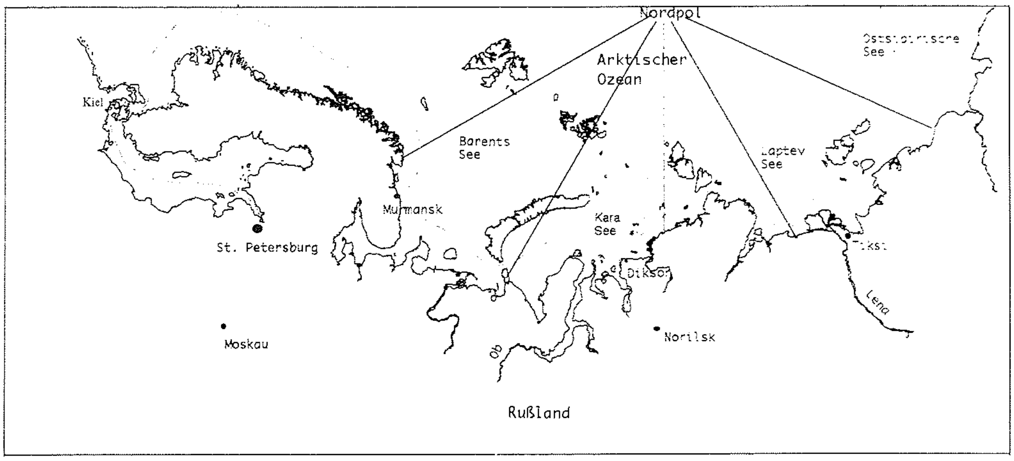


Fig. 4: Cruise track of *Professor Multanovskiy* during the TRANSDRIFT II expedition.

While waiting for icebreaker support we carried out a working program at the mouth of River Yenissey, north of the Bay of Mikhaylov, and west of the Strait of Vilkitskiy. Meanwhile the ice edge in the eastern Kara Sea developed to an international meeting-place. Hence, we visited the Russian icebreaker *Akademik Fedorov* (August 17), which has just finished the TUNDRA-94-expedition, and the Russian-Norwegian team onboard *Pavel Petrovitz* (August 25) working in the eastern Kara Sea. Furthermore, we met the Russian-American team onboard *Jakob Smirnitzky* (August 8), also waiting for ice support through the Strait of Vilkitskiy. Unfortunately, the *Smirnitzky* never reached the Laptev Sea because the ship´s propeller was crashed by ice putting an end to this expedition.

On September 2 after waiting for almost one month for favourable ice conditions we sailed with the support of I/B *Vaygach* through the Strait of Vilkitskiy. Finally, at 11:00 h on September 3 we reached the north-western Laptev Sea in less than 2 days. Compared to the Kara Sea ice conditions in the northern and north-eastern Laptev Sea were excellent during September. For that reason we started our interdisciplinary working program along the W/E-transect 75°30´ N (Fig. 5, Tab. A2). Thus, delayed we began our research activities with Station PM9401 at 2:00 h on September 4, in the vicinity of the ice edge in the western Laptev Sea.

After this transect we decided to continue the work in the north-eastern Laptev Sea because of favourable ice conditions there. Here we wanted to recover three moorings we deployed during the TRANSDRIFT I expedition in 1993 (Kassens et al., 1994). Unfortunately, all attempts to recover the moorings failed, because the northernmost mooring was still covered by pack ice, and the other moorings could not be released from the sea floor. The only possibility left to recover the moorings hopefully still storing important salinity and temperature data would be to release them by divers during further expeditions. After trying to recover them for more than 24 hours, we sailed to the southern Laptev Sea. Here we were very successfull in taking the first long sediment core (4.8 m) in the Laptev Sea at Station PM9462. Following one week of work north and north-east of the Lena Delta we planned a port call in Tiksi from September 16 to 18 in order to load fuel and water as well as to exchange scientific results with our colleagues from the Lena Delta Reserve and

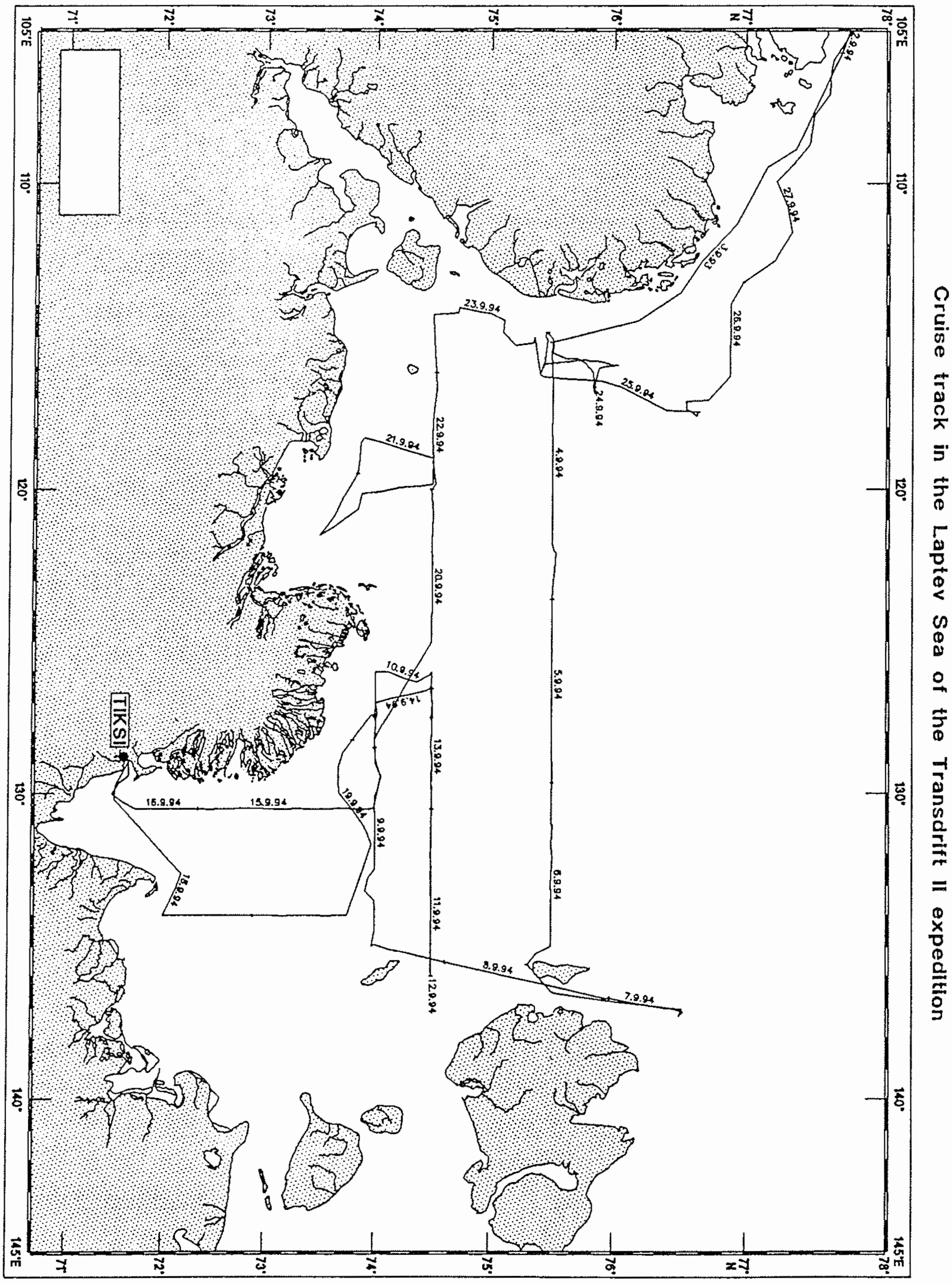


Fig. 5: Cruise track of *Professor Multanovskiy* in the Laptev Sea during the TRANSDRIFT II expedition.

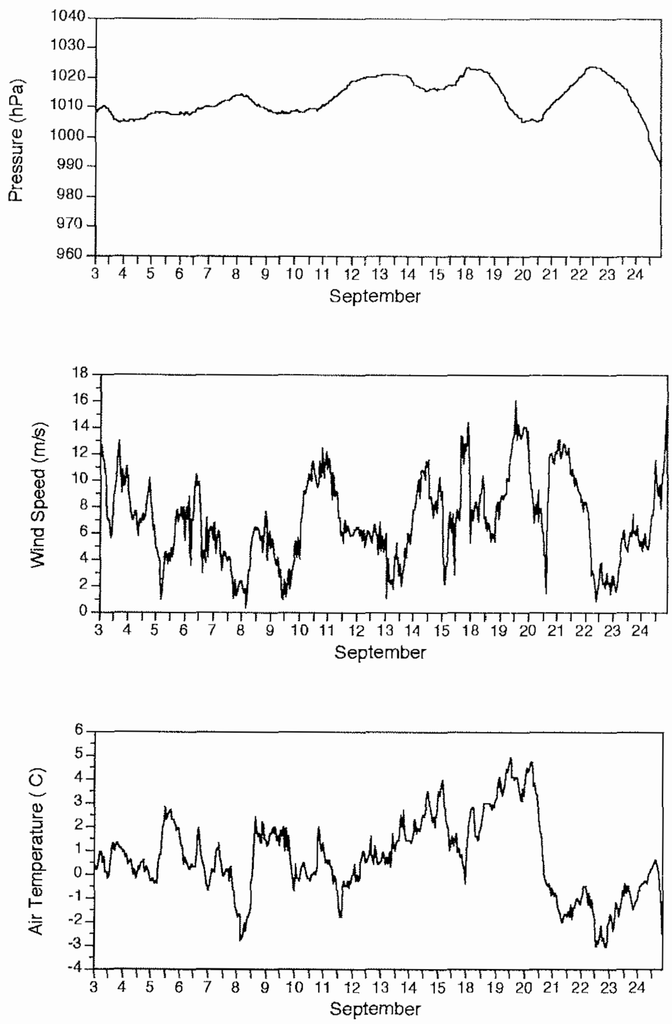


Fig. 6: Weather conditions in the Laptev Sea during the TRANSDRIFT II expedition (September 3 to 25, 1994).

the Hydrographic Department of Tiksi.

In general, the first leg of TRANSDRIFT II was very successfull. Thanks to good weather and ice conditions (Fig. 6) we had been able to make up some of the lost time and to carry out two-third of the working program.

In the early morning of September 8, we left Tiksi to continue the working program east of Tiksi at Station PM9475. But during these days the weather became stormy, putting an end to our Station work after two days. On September 19 and 20, we were forced to discontinue all station work and seek shelter in the area of the eastern Lena Delta.

On September 21 we sailed to the southern Olenek Valley, but again we were supposed to terminate our work because of a fresh gale. We took refuge from the strong north-easterly winds in the Bay of Kuba. Here in the mouth of the Olenek river we worked along the transect 73°50′ N at Stations PM9487 to PM9491. Only on September 22 the weather conditions improved so that we were able to sail again to the Olenek Valley. On September 25 after a successfull station work *Professor Multanovskiy* sailed further west to the Khatangar Valley. At Station PM94191 in the northern Khatangar Valley we completed our scientific program in the Laptev Sea because we received the order to sail to 76°30′ N and 117°00′ E in order to meet the I/B *Vaygach* escorting us back to Dikson on September 26. Anyway, the voyage along Taymyr Peninsula was accompanied by another strong gale. Thus, we arrived 10 hours later at the meeting point. At 20:00 h on September 26 we left the Laptev Sea with support of the Russian icebreaker *Vaygach*. While sailing in a convoy through the Strait of Vilkitskiy we took the unique chance to visit the impressive icebreaker.

On September 29 after a stop-over in Dikson to pick up a container and to store freshwater *Professor Multanovskiy* returned to Murmansk for custom declarations. Several strong gales and storms caused once more a delay. Thus, we arrived in Murmansk on October 4.

Due to a very accurate custom declaration and manœvres in the Kara Sea we were forced to stay in Murmansk for 4 days. On October 7 we left this port heading south-east. On our way along the Norwegian coast we had again strong gales and a storm reducing our speed to sometimes less than one knot. Moreover, on October 11 we had a major problem with our main engine which we were not able to repair at sea. After we repaired the engine during a port call in Bodø we sailed back to Kiel. At 11:45 h on October 16 we arrived at the GEOMAR pier in Kiel. Here, the German scientists said "do svidaniya" and their scientific equipment was unloaded. Three days later RV *Professor Multanovskiy* journeyed back home. After 3 months at sea, a comprehensive and successful working program in the Laptev Sea, and sailing a distance of more than 11,000 miles *Professor Multanovskiy* arrived in St. Petersburg on October 22.

Sea-Ice Conditions

V.N. Churun

The vast complex of oceanographic, geological, geochemical and biological works performed in the Laptev Sea during the joint Russian-German expedition aboard the RV *Professor Multanovskiy* was carried out in ice-free water and only in some cases in open floating ice.

The main features of the ice conditions observed during the expedition (September 3-24, 1994) were the following:

- the Severozemelskiy Ice Massif was developed higher than normal and thus blocked the Vilkitskiy Strait during the whole navigation period;
- the ice edge in the Laptev Sea was located nearly in its mean multiannual position;
- the Taimyr Ice Massif was weakly developed, its southern ice edge being located north of 78°00 N;
- the Yana Ice Massif in the eastern part of the Laptev Sea was absent.

The anomalous development of the Severozemelskiy Ice Massif led to increasing fast ice thicknesses in the Vilkitskiy Strait and in the near of it. The late beginning of fast ice fracturing dominated the ice conditions in the south-eastern part of the Kara Sea for the whole navigation period. Only due to icebreaker support it was possible to pass the more than 100 nm wide ice belt consisting of heavy ridges.

When the vessel reached the Kara Sea the Severozemelskiy Ice Massif was pressed towards the western coast of the Taimyr Peninsula and to numerous islands of the Nordenshel´d Archipelago. The fast ice in this region was fracturing and melting. The up to 180 cm thick fast ice in the Vilkitskiy Strait was also fracturing. After its fracturing close and partly very close floating ice was formed, which remaining there, made the passage difficult.

In August, the western ice edge of the Severozemelskiy Ice Massif moved eastward and reached 95°00' E (Fig. 7). It remained stable located until the beginning of ice formation at the end of September. As recommended by the naval staff of the Arctic Western Sector the RV *Professor Multanovskiy* started to sail supported by a nuclear icebreaker at the end of August. In the coastal regions of the Kara Sea, especially along the sea route Matisen Strait - Geyberg Islands - Chelyuskin Cape - Komsomolskaya Pravda Islands, the ice conditions kept heavy.

The continuous icebreaker assistance started on September 2 at 77°05' N, 99°13' E. Along the whole route the vessel was towed by the nuclear icebreaker *Vaygach*.

According to visual ice observations made on board the RV *Professor Multanovskiy*, the Severozemelskiy Ice Massif mainly consisted of 140-180 cm thick first-year ice formed in autumn and in winter. It consisted of small and medium floes with the melting stage being 3 to 4. The ice concentration was mainly 90% to100%. While approaching the Vilkitskiy Strait 10% to 30% of the old ice occured at the western side of the strait with a thickness exceeding 220 cm. It consisted of small floes. The hummock concentration increased and reached 3-4/10 remaining at the same melting stage. In the Vilkitskiy Strait floes and medium floes of fast ice with a low hummock concentration (1-2/10) were observed. Weak ice compactings were locally registered which were separated by diverging zones. In the eastern part the ice concentration decreased. In the vicinity of Faddey Island it was equal to 40-60%. The Taimyr Ice Massif mainly consisted of hummocked first-year ice including old ice. It occurred as small and medium floes. On September 3, the icebreaker finished supporting the vessel´s journey at 77° 06' N, 109°59' E. The ice edge was located north of 76° N (Fig. 8). During the third ten-day period of September the Taimyr Ice Massif moved towards the Maria Pronchishcheva Bay. Works were usually carried out in the ice-free area of the sea. Only north of Kotel´nyy Island the occurrence of ice made it impossible to search and hoist the annual stations which had been anchored by German specialists during the expedition Transdrift I.

As the vessel was leaving the Laptev Sea supported by the nuclear icebreaker *Vaygach* young ice formed within leads. The concentration of nilas partly attained 50% to 70%, the total ice concentration being 80% to 90%. Nevertheless, leaving the Laptev Sea was not particularly difficult.

The ice conditions most unfavourable to the expedition were observed in the south-eastern part of the Kara Sea and in the Vilkitskiy Strait. All in all, the ice conditions in the Laptev Sea can be estimated to be nearly the mean multiannual ones.

Weather Conditions

Y.M. Afanaseva and S.P. Kislitsin

Synoptical processes and weather conditions during the expedition in the Laptev Sea were not uniform. In analyzing the synoptical conditions four periods can be marked out in the Laptev Sea: September 3 to 8, September 9 to 15, September 16 to 20 and September 20 to 24. From September 3 to 8, the weather over the eastern Laptev Sea was dominated by a cyclone with low gradients of atmospheric pressure located above the Arctic Ocean and the Taimyr Peninsula. Gentle and moderate winds of mainly southern directions were typical of that period. The visibility deteriorated due to fogs. The atmospheric pressure field for September 5, 1994, represents the synoptical processes mentioned above (Fig. 9).

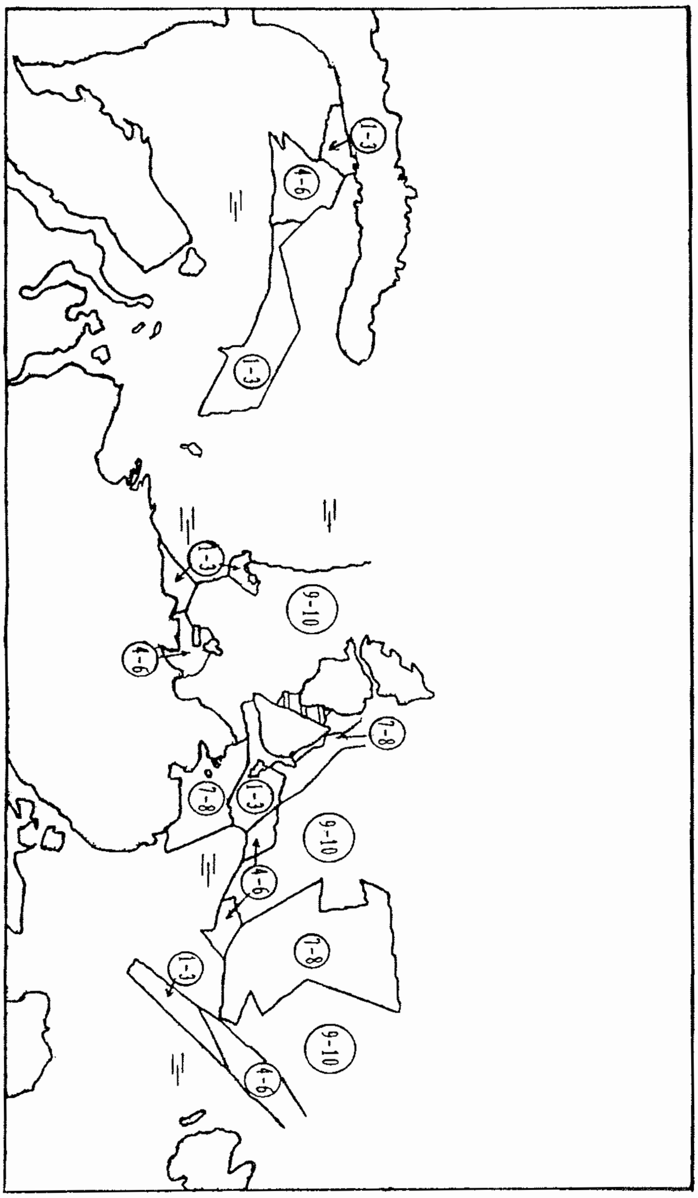


Fig. 7: Ice conditions on August 24, 1994.

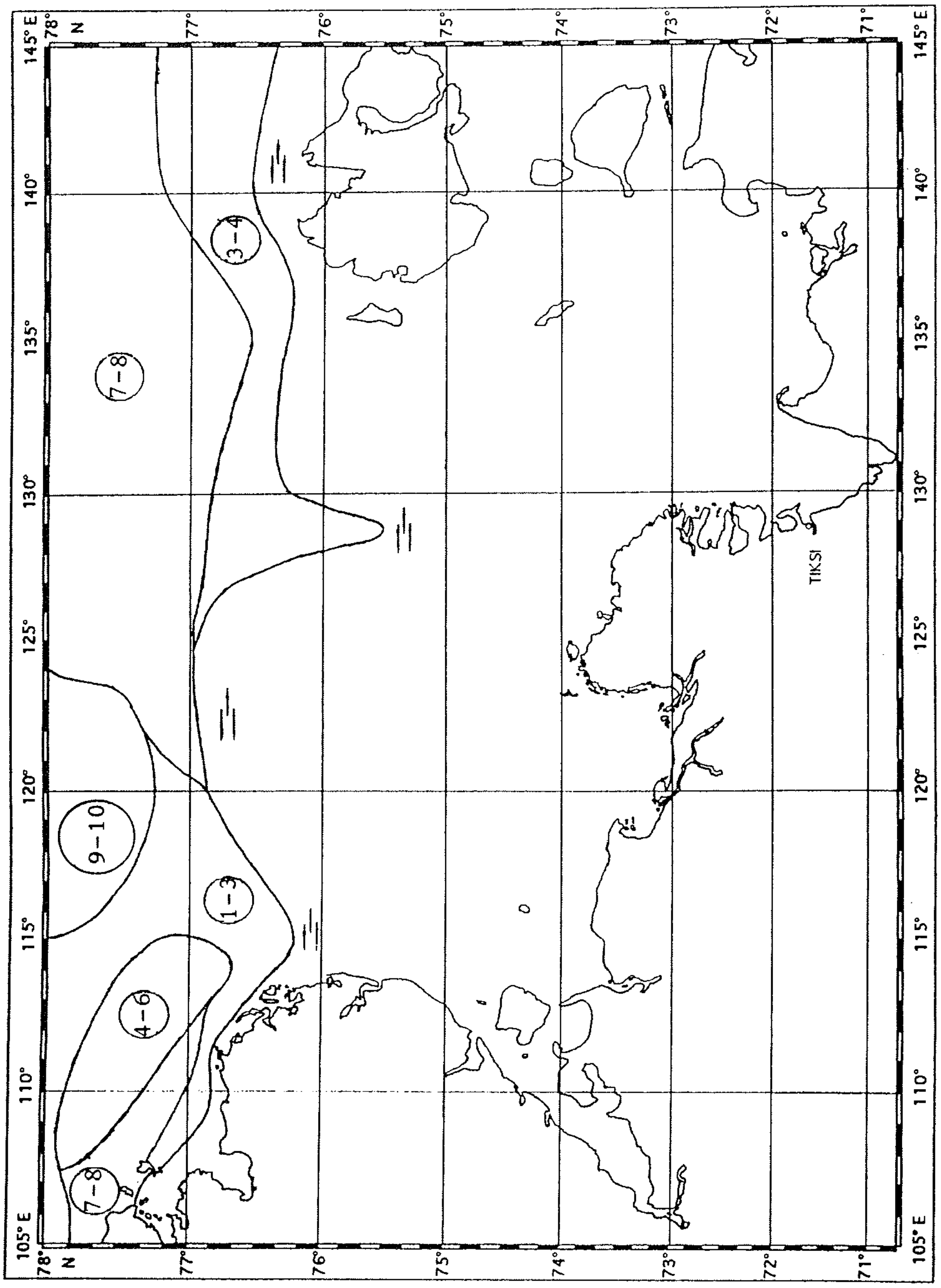


Fig. 8: Ice conditions in the Laptev Sea during the first decade of September, 1994.

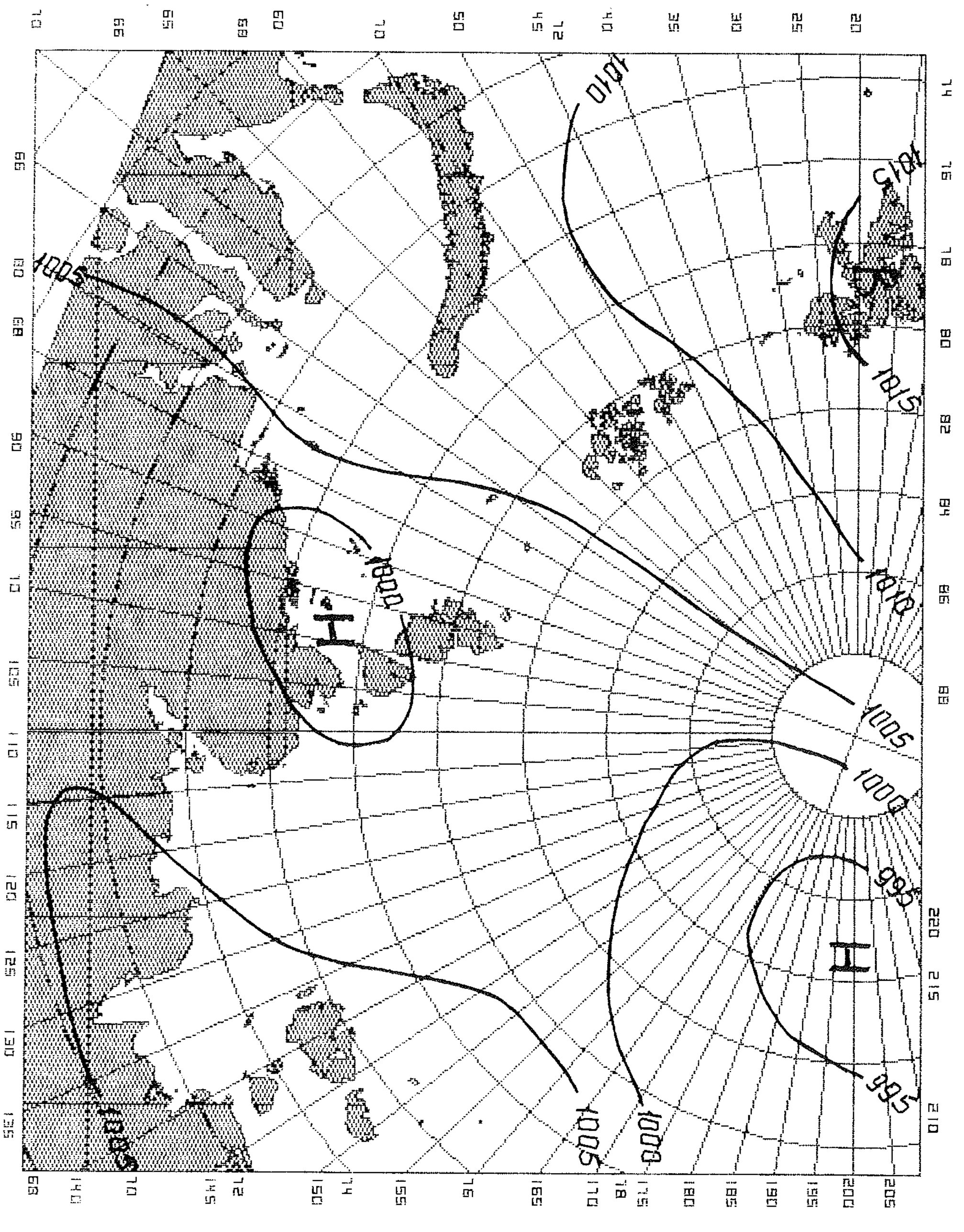


Fig. 9: Synoptical situation on September 5, 1994.

During the second period an anticyclone slowly shifted to the Taimyr Peninsula and the Laptev Sea in the south-eastern and southern parts of which the navigation was carried out. South-eastern winds with velocities less than 12 m/s prevailed. Shower-type precipitation often occurred in the form of snowfalls. The atmospheric pressure field typical of this period (September 13) is presented in Fig. 10.

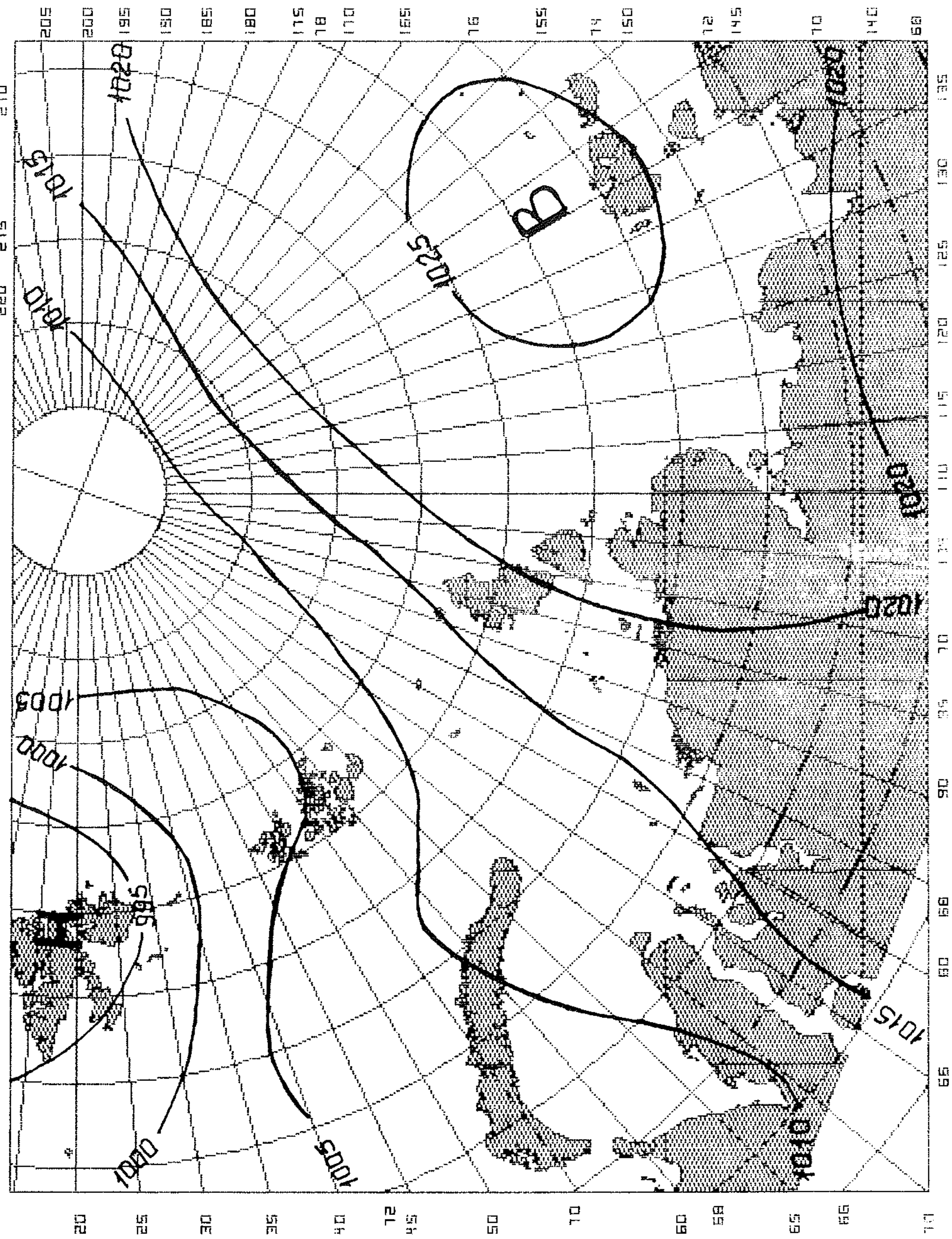


Fig. 10: Synoptical situation on September 13, 1994.

The depression of the atmospheric pressure field was typical of the weather over the Laptev Sea from September 16 to 20. This period was characterized by an increasing cyclonic activity (Fig. 11). The speed of the mainly south-western winds sometimes reached 14-16 m/s (September 16; September 19-20). The wave heigth was 3 m.

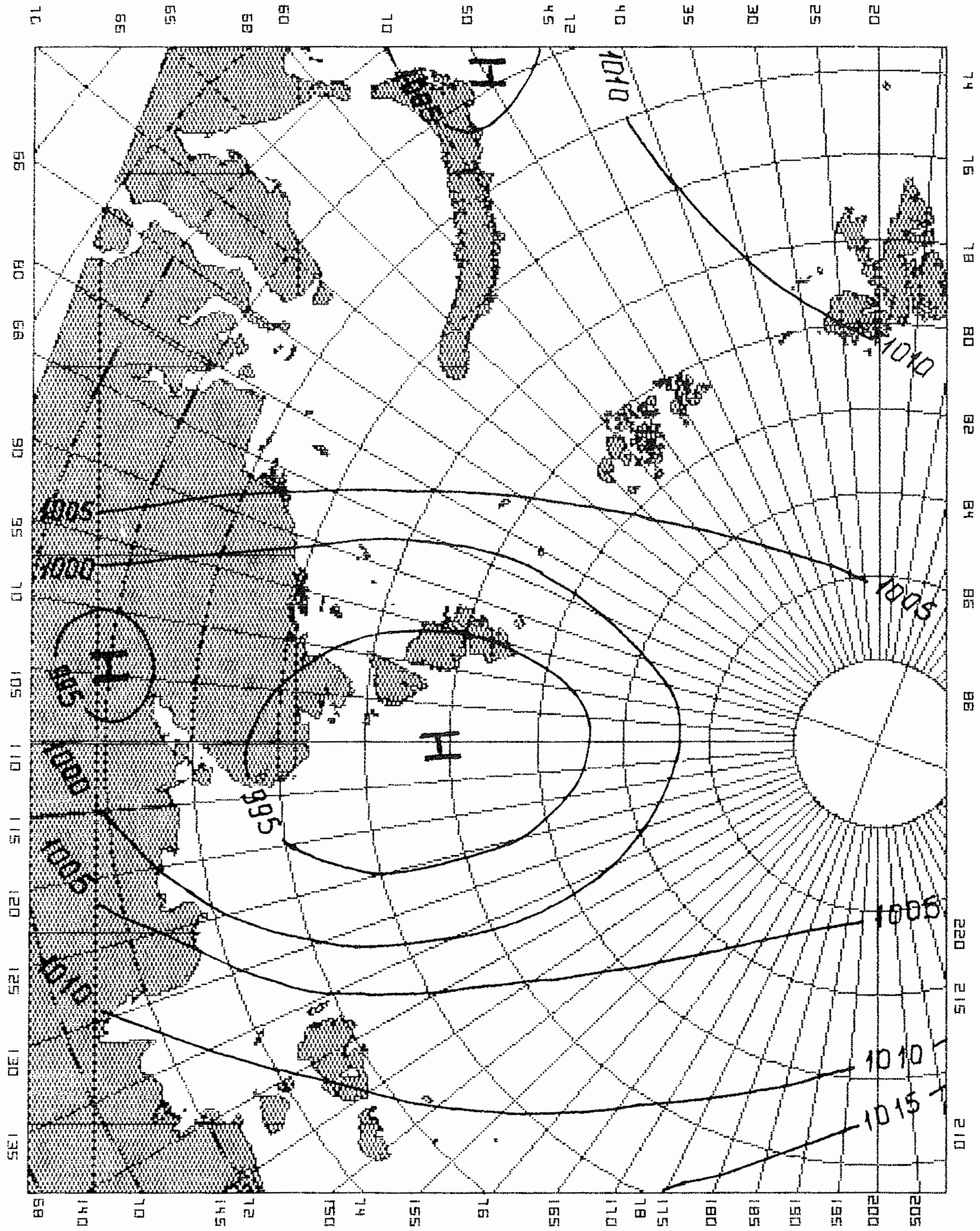


Fig. 11: Synoptical situation on September 19, 1994.

From September 20 to 24, the weather in the Laptev Sea was dominated by the ridge of the anticyclone its center being located above western Siberia. The speed of eastern and south-eastern winds did not exceed 7-9 m/s. Generally, the wave heigth did not exceed 1-2 m. The atmosphericc pressure field for this period is given in Fig. 12.

The air temperature during the expedition ranged from -3° to +3° C. There were no great changes in these characteristics.

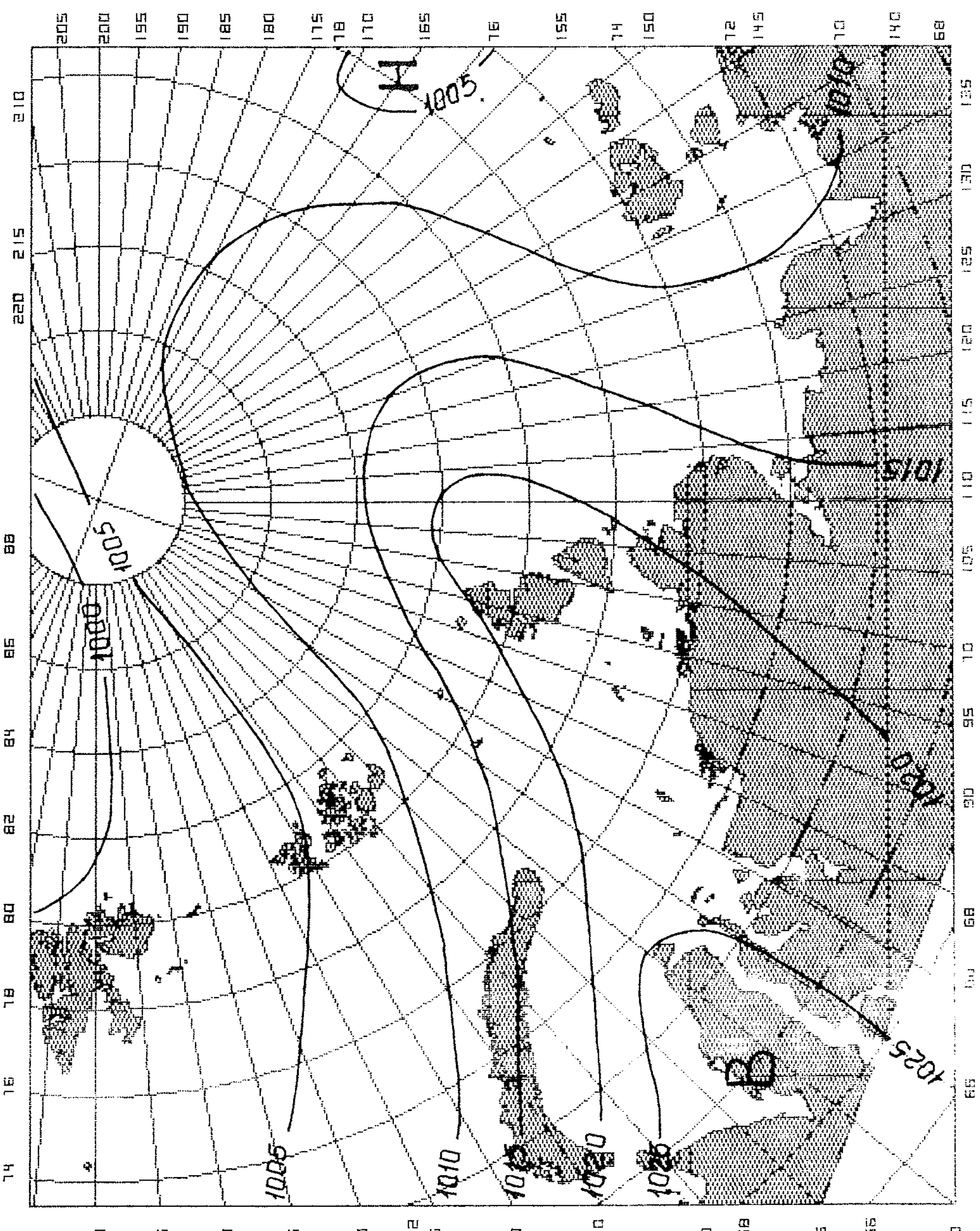


Fig. 12: Synoptical situation on September 21, 1994.

THE MODERN ENVIRONMENT OF THE LAPETV SEA

Meteorological Studies

M.V. Lamakin and V.F. Timachev

Scientific Program

The thermal irregularity of the Laptev Sea surface (the frontal zones and floating ice) essentially determines the spatial variability of ocean-atmosphere interaction. Hence, it is difficult to obtain representative estimates of energy and mass exchange in the subsurface layer which are temporally and spatially averaged. Shortwave solar radiation, which penetrates into the surface layer, is also of major importance for the heat storage of the upper layer. Its total heat storage is to a large extent controlled by solar radiation supply and the redistribution and balance of longwave radiation at the sea surface possibly even below the pycnocline. The amount of the heat stored significantly determines the terms of ice formation and ice thicknesses. The main goal of the present program is to determine the fluxes of shortwave and longwave radiation and the turbulent heat flux.

Since there is only few data available on the atmospheric transport of pollutants into the Arctic and on spatial and temporal variations of aerosol concentrations, it is impossible to obtain even rough estimates of anthropogenic climatic changes as well as of the ecology of the Arctic environment. The increasing aerosol contamination of the atmosphere in the Arctic during the last 10-15 years which is experimentally found underlines the necessity of further studies on this topic. The fact that there are no or only insufficient aerosol sources in the Arctic unambiguously shows that it is the outflow of contaminated air masses from temperate latitudes responsible for an increasing rate of aerosols. This deficit information on Russian side makes it impossible to judge objectively the claims of neighbouring countries to Russia concerning the pollution of the Arctic environment on Russian territory. The observations about aerosol particles made on board the RV *Professor Multanovskiy* will permit preliminarily estimating the aerosol contamination of the atmosphere above marginal seas and the coastal zone.

Based on the above considerations the following scientific program of meteorological studies is drawn up:

- investigations of temporal and spatial variations of heat and mass exchange as well as studies of those hydrometeorological processes the exchange depends on in summer;
- investigations of shortwave-radiation redistribution in the surface layer determined by its thermohaline structure and by floating ice;
- investigations of the aerosol contamination of the atmosphere.

Working Program

The working program has the following objectives:

- to obtain data on the spatial and temporal variations of heat balance components in the surface layer;
- to estimate shortwave radiation penetrating into the surface layer;
- to carry out a station lasting maximally 3 days in order to investigate temporal variations of the vertical distribution of thermohaline and dynamical characteristics and studying heat and mass exchange;
- to obtain an estimate of the penetrating solar radiation;

• to gain data on the level and concentration of aerosol contamination in summer.

Observations and Equipment

The following complex of meteorological observations was performed during the expedition (Tab. A2):

1. Hourly standard meteorological observations of the atmospheric conditions of sea surface.
2. Continuous registration of surface layer temperatures.
3. Continuous registration of total solar radiation.
4. Continuous registration of longwave radiation.
5. Observations of the penetrating shortwave radiations carried out in daytime during the oceanographic stations.
6. Observations of the surface aerosol concentration performed in case of favourable weather conditions.

The following equipment was used. For the standard meteorological observations:

1. Wind : direction (Block WAV-12 of the MIDAS-321 station), precision: 5.65 degrees speed (Block WAA-12 of the MIDAS-321 station) precision: 0.1 m/s
2. Air temperature: Pt-100 (Block DTS-12 of the MIDAS-321 station), precision 0.1° C, verification: August 1994.
3. Air humidity (Block HMP-14 of the MIDAS-321 station), precision 0.05%, verification: August 1994.
4. Atmospheric pressure: (Block 1201-F of the MIDAS-321 station), precision 0.3 HPa, verification: August 1994.
5. Total radiation (recorder CM-6), sensitivity: 8-11 mV/(kWT/m^2), precision 1.0%, verification: July 1994.

For the special meteorological observations:

1. Longwave radiometer (recorder ITP-1): sensitivity: 25 mcV/(WT/m^2), verification: September 1993.
2. Submarine pyranometer (recorder PP-2/2), sensitivity: 162 mcV/(WT/ m^2), precision 1.0%, verification: February 1994.
3. Water temperature (resistance thermometer), precision 0.1° C, verification: August 1994.
4. Ozonemeter (recorder M-124), precision 8.0%, verification: June 1994.
5. Aerosol counter, precision 10.0%, verification: January 1993.

Preliminary Results

1. In order to assess the energy characteristics of the air-ocean interaction, first of all, the values of the heat balance components of the surface were calculated. The heat balance is one of the most important physical parameters responsible for possible heat gains and losses of the upper layer. The total incoming shortwave radiation and the reflected longwave radiation of the atmosphere were measured. Turbulent sensible and latent heat fluxes were averaged for each hour. Mean daily values of all heat balance components were calculated as well.

The turbulent heat fluxes were calculated according to the method used in the Department of Ocean-Atmosphere Interaction at the AARI. While calculating solar radiation that remains at the sea surface the surface albedo was 0.24.

The values of the heat balance components and of the total balance are presented in Fig. 13. The negative values imply that the surface emits heat to the atmosphere. For the period beginning with September 20 there are no data on effective radiation because the observation data for this period require some additional processing. Temporal variations of these characteristics are given in Fig. 13. which demonstrates that the component controlling heat supply to the sea surface from the atmosphere (the solar radiation) monotonely decreases.

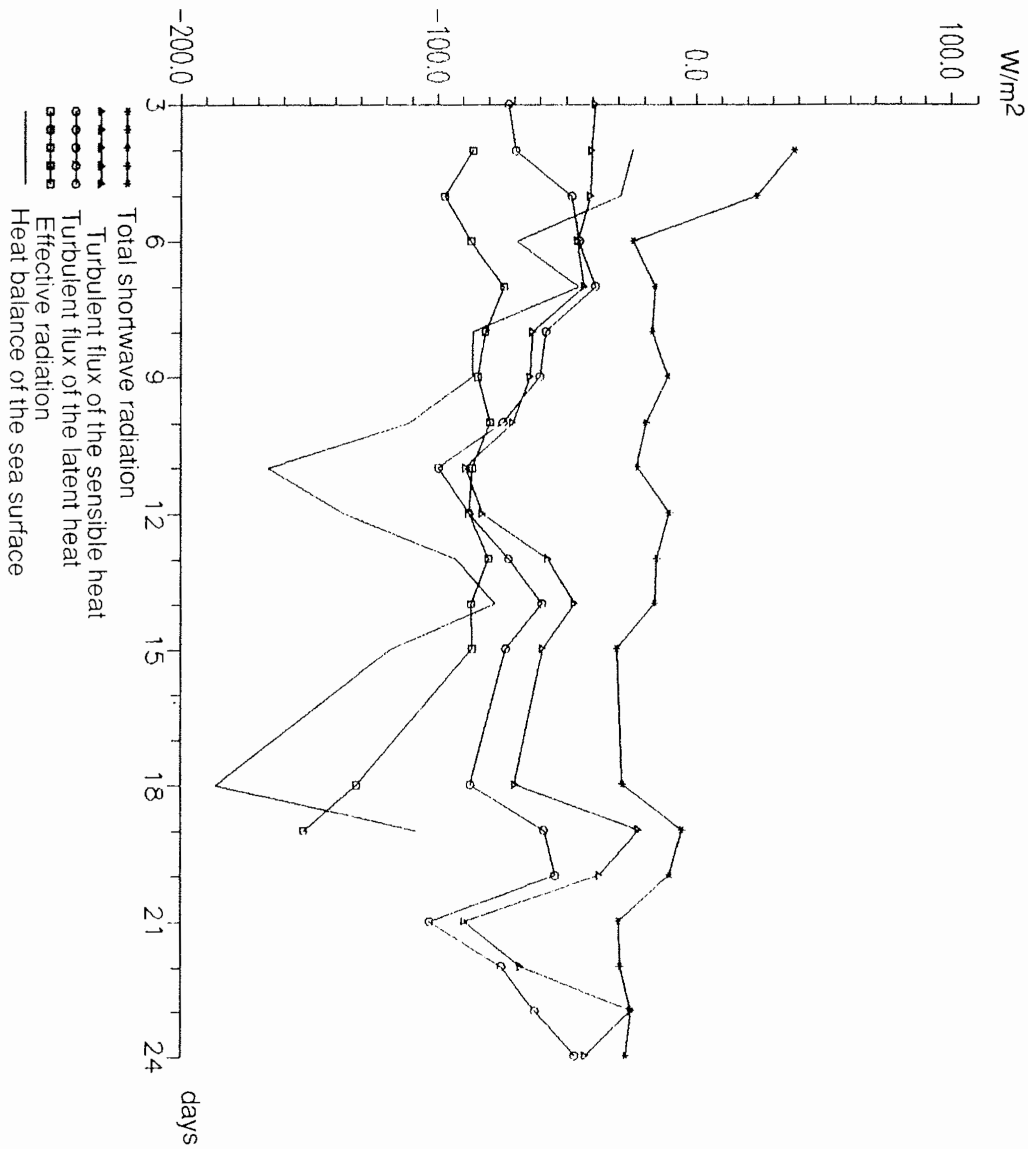


Fig. 13: Mean daily values of the heat balance component at the sea surface. Laptev Sea (September 1994).

The analysis indicates that the values of turbulent fluxes mainly depend on the dynamical state of the atmosphere. Maximums of these fluxes coincide with maximum wind speeds. In other periods their values are not large and their contribution to the heat balance is insignificant. The most important component of the heat balance for the period under observation is the effective radiation which is on average always negative. Thus, the heat loss of the surface layer is due to longwave radiation. The problem is to determine the intensity of this heat loss. In summer, when the upper atmosphere is rather warm and the surface temperature varies slightly, the effective radiation is rather small. When the upper atmosphere starts getting cold and the reflected radiation of the atmosphere decreases, the effective radiation increases. Its contribution to the heat balance turns out to be prevailing. Fig. 13. shows that the values for the balance and the effective radiation get very close. The heat balance values reach 15.8 (MJ/(days/m^2)).

2. The vertical distribution of the absorption of solar shortwave radiation was investigated. Episodic measurements in the surface layer were directly performed by means of a pyranometer. Unfortunately, due to low sun incidence angles and unfavourable weather conditions it was impossible to obtain sufficient data for stochastic estimates. The pyramometer was damaged in the middle of the observation period. Hence, measurements with the pyranometer could not be performed. To illustrate the results two example moorings were chosen. For these two moorings, during which the weather was calm, the sun was not covered by clouds and its angle of incidence equaled 21°, mean values are given in Fig. 14. It

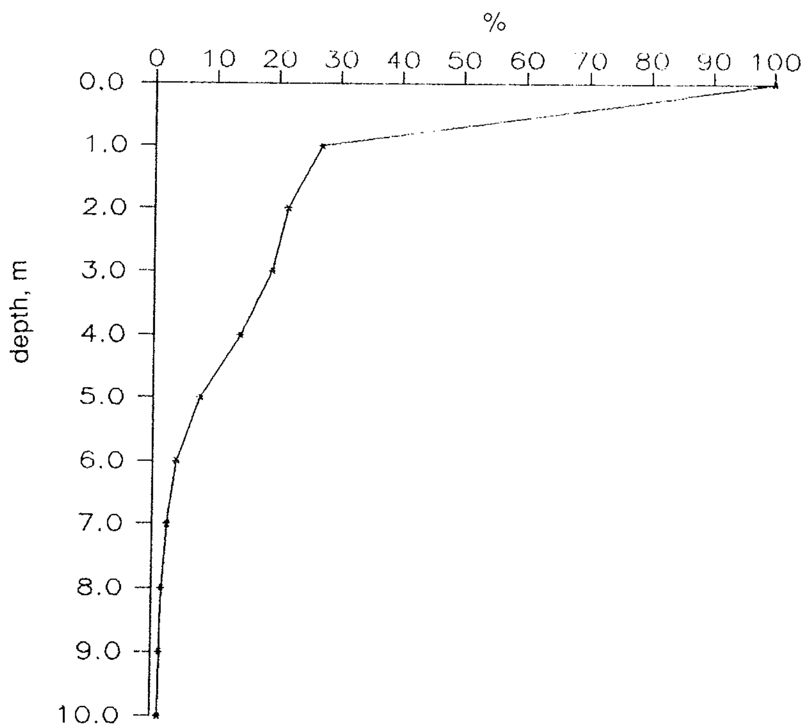


Fig. 14: Solar radiation absorption with depth. Laptev Sea (September 4 - 5, 1994).

is found that the uppermost layer (1 m) absorbs 75% of the radiation and only little more than 1% reaches 10 m depth. In order to obtain absolute values one should know the incoming solar radiation at the sea surface. On Septenber 4, the incoming solar radiation at the sea surface was, just before noon, equal to 195 W/m^2. The value at 1.0 m depth was 2.5 W/m^2.

3. The distribution of aerosole particle concentration in the atmosphere was obtained in the range from 0.4 to 4 mcm (Fig. 15). The whole range of particles trapped is within the limits of 0.4 to 1 mcm. Significant variations in the aerosole particle concentration were observed in this range. Maximum number of the particles was fixed on September 22 to 23. High north-eastern winds with rates of up to 13 m/s preceded these measurements. This maximum is caused by drops of water and salt that have been emitted from the disturbed sea surface to the atmosphere. According to estimates made by specialists, the sizes of aerosole particles of marine origin are equal to 0.1 to 1 mcm. Changes of the particle concentration of greater sizes were not observed during the expedition.

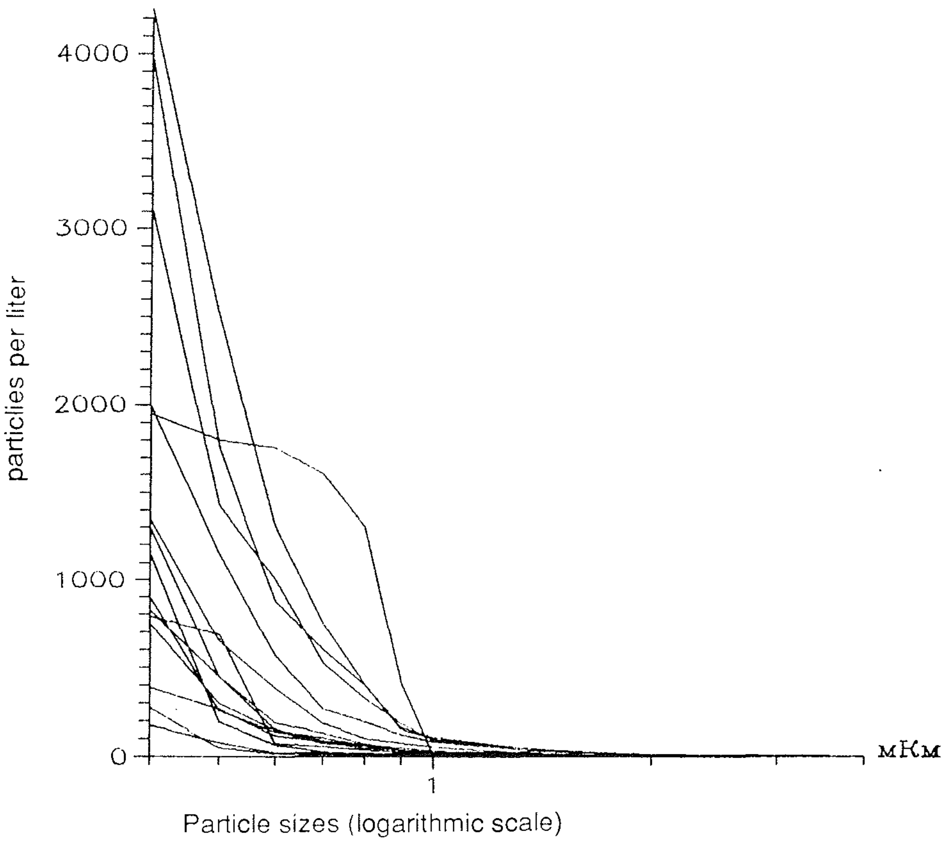


Fig. 15: The distribution of the numbers of particles per liter air. Laptev Sea (September 1994).

Satellite Observations

A.N. Golubev

Scientific Program

The goal of the satellite observations was to estimate radiation temperatures of the surface layer. Furthermore, it was aimed to assess the ice conditions in the Laptev Sea in order to plan the works to be carried out and to preliminarily determine the distribution of Lena river water masses. The satellite observations were also made in the North, the Norwegian and the Barents Sea along the course of the vessel.

Working Program

To realize the scientific program the following works were carried out:

- test of the expedition module of technical means for satellite information (SI) in ART regime;
- communication with satellites and data processing of remote sounding;
- quality investigation of received signals on board the vessel.

Observations and Equipment.

The daily observations included:

- preliminary calculation and choice of the satellite trajectory over the observation zones (9,11,12- for the NOAA satellites) by means of the program "ORBITA" which allows to choose a satellite.
- data processing by means of a PC using the programs "NOAA-11" and "VIDEOBOX".

The following equipment used for this work:

- IBM/PC AT;
- working model of the board station for the receipt of satellite information;
- oscillograph S1-94.

Preliminary Results

Several malfunctions were revealed when exploring the expedition module of the autonomous station for SI in field conditions. They concern the construction, the apparatus and the program. For example, poor contacts of the antenna system, insufficient filtration of the input signal of the antenna amplifier, increased potential of the output signal in the duplicating reciever and a separate software output made the application difficult.

Maps of the radiation temperatures of the surface layer and the ice conditions were not prepared during the cruise due to defects of the program "VIDEOBOX" in connecting the images received with real coordinates. Weather conditions (cloudness was nearly constant) also impeded these works. Therefore, we were not able to use SI for planning and correcting oceanographic experiments to study the Lena river runoff. The amassed images will be analyzed after the expedition in St. Petersburg.

In spite of the problems mentioned above 3 to 9 communications for the SI were daily received during the expedition. 35 images suitable for future processing in laboratory conditions were chosen and archived on data media. It must be emphasized that this complex of autonomous receiving and processing of SI offers several advantages over analogous systems:

- small overall dimensions of the complex and the fact that there is no complicated and expensive antenna system enable us to install the station nearly in every facility (220 V, 50 Hz). The images received are highly competitive with those obtained by other systems;
- receiving images immediately at the monitor display allows us to simplify information processing and to make it cheaper (sea ice charts, maps of the surface temperatures etc.);
- due to the IBM/PC AT, used for receiving and processing SI, the autonomous station can be applied to data communication by means of E-mail;
- the price of the equipment and computer programs for this complex is considerably lower, than the prices of all existing systems both in Russia and abroad.

Hence, it is possible to use this complex in practice in spite of the malfunctions revealed. For its further application it is necessary quickly to complete the program of receiving and processing SI.

Oceanographical Studies

I.A. Dmitrenko, V.I. Karpiy, and N.V. Lebedev

Scientific Program

The oceanographic studies that were carried out in summer 1993 within the program LAPEX-93 confirmed once more the leading role of the Lena river runoff in influencing not only oceanographic but also hydrobiological and sedimentary processes, the transportation and sedimentation of natural and industrial pollutants to the eastern part of the Laptev Sea. The river runoff essentially controls the main features of the complex environmental system. However, the main characteristics of river water distribution have not yet been studied. The hydrological structure of the outflow zone is uninvestigated either. This zone exerts direct influence on the sedimentation and the distribution of marine biota associations. After analyzing the observation data obtained during the expedition in summer 1993 the need of specialized comprehensive experiments in the outflow zone of the Lena became especially evident. The analysis of oceanographic information allowed us to formulate first hyptheses (Gribanov and Dmitrenko, 1994) and to plan further investigations in this region having been realized during the present expedition.

The main experiments in 1994 were supposed to concentrate on the outflow zone of Lena river water masses with the aim of:

- determining regions of river water distribution in the eastern part of the Laptev Sea; studying the main features of the outflow zone formation depending on environmental factors;
- studying the hydrodynamical stability of the river outflow, its transformation while spreading along the main stream;
- investigating temporal variations of the vertical thermohaline structure and its characteristics in the dynamically active zones of the sea that are influenced by river runoff;
- studying interrelations and mating features of the oceanographic, biological, hydrological, hydrochemical and sedimentary processes in the river water outflow zone.

Another goal of oceanographic work that is carried out in Siberian shelf seas is to obtain information and to prepare a review of the hydrological conditions and their variability in summer 1994 as well as to complete the databank.

Working Program

In order to study the main features river water distribution in the eastern part of the Laptev Sea, the following investigation were carried out (Tab. A2):

- oceanographic survey in the Lena river outflow zone with more frequent oceanographic stations (the distance between the stations ranges from 8 to 15 nm): these stations are situated along two transects across the outflow (approximately along 74° 00' N and 74° 30' N) and along two transects directed along the main stream of river water (approximately along 128° 00' E and 134° 00' E) starting from 10 m depth up to the ice edge.

To investigate the hydrodynamical stability of the movement in the outflow zone and its periphery the following works were planned:

- oceanographic observation in the frontal zone between the river waters and marine water masses;
- to carry out oceanographic long-term stations (lasting from 1 up to 3 days) at the outflow perihery to study vertical temporal variations of thermohaline characteristics;
- to carry out a series of long-term stations in different places of the outflow zone with increasing frequency;
- to measure currents, the thermohaline characteristics of the water column as well as the amount of sediments by means of a dynamical polygon which consists of three autonomous buoy stations. They were employed in the outflow zone for a period of up to 1 month.

For the monitoring of the environment it was intended to obtain background information along a transect along 75° 30' N with the distance between the stations being equal to 25 nm and, depending on the time available, at stations according to the standard scheme. In order to obtain background information on the state of the sea it was planned to conduct the transect along 75° 30' N. The distance between the stations was 25 nm. In addition, oceanographic survey was carried out.

It was planned to carry out a hydrological transect with an increasing number of stations along the valley of the Anabar and the Khatanga if the north-western part is ice-free. The distance between the stations is approximately 10 nm.

Observations and Equipment

During the expedition 102 hydrological stations were carried out, 59 of them having been performed in the Lena river outflow zone (Fig. 2, Tab. A2). Due to a defect receiving and decoding of satellite information, that had been intended to support the planning of the experiments, a prompt correction of the working scheme was impossible. To preliminarily evaluate the outflow direction in summer 1994 it was decided to carry out an increased number of oceanographic stations at a transect along 75° 30' N (24 stations with a distance between them being 15 sm). After analyzing the information gained we corrected the location of the western transect along 130° 30' E. Since the working period had been shortened we were not able to carry out the transects in the outflow zone up to the ice edge. These works were only performed in the south-eastern part of the sea, which is mostly influenced by the Lena runoff.

In the western part of the sea the oceanographic stations were done in accordance with the standard scheme of the oceanographic background survey.

Due to the ice conditions it was impossible to conduct this survey to the north off 75° 30' N. The hydrological transect was carried out in the western part of the sea along the valley of the Anabar and Khatanga rivers (stations 95-101).

In order to investigate the mesoscale temporal variability of oceanographic characteristics the long-term oceanographic stations 13, 17, 24, 45 and A51 were carried out for 8 to12 hours. Station 63 which lasted 24 hours was done in the frontal zone. The sounding intervals at these stations were 30 minutes.

The long-term stations were carried out when the vessel was kept on position, whereas the oceanographic survey was mainly made while drifting.

The mesoscale spatial variability of oceanographic characteristics was surveyed in the frontal zone at station 42 (8 soundings with 15-minute intervals while there was strong SE wind).

Because of the program having been shortened we were not able to deploy three mooring systems. Due to a defect deployment system and heavy ice conditions we did not succeed in recovering three autonomous annual bottom stations either. These stations were equipped with temperature and salinity sensors and sediment traps. They had been deployed in the north-eastern part of the Laptev Sea in summer 1993 (Kassens and Karpiy, 1994).

While waiting for the icebreaker's support in sailing through the Vilkitskiy Strait, 10 oceanographic stations were carried out along a transect which extended from Dikson Island to Belyy Island. 6 oceanographic stations were performed in the eastern part of the Kara Sea including two long-term stations which lasted 16.5 and 14 hours with a sounding interval of 30 minutes (Fig. 16 to 20).

The sounding set OTS-PROBE Serie 3 (Meerestechnik Electronic GmBH, Germany) was used for oceanographic observations including measurements of the water temperature and its electroconductivity, the pressure and the dissolved oxygen concentration. The sounding was carried out in combination with an IBM/PC AT 386. The main technical characteristics of the OTS-PROBE were the following:

- water temperature: the precision of measurements is 0.01°;
- electroconductivity: the precision of measurements is 0.02 mS/cm;
- hydrostatic pressure: the precision of measurements is 0.1%;
- oxygen concentration: the precision of measurements is 2%.

The vessel's location was determined by a satellite navigation system ("Flightmate PRO GPS", Trimble Navigation, USA). All navigation data were digitized.

Preliminary Results

1. In summer 1994, the hydrological conditions in the eastern part of the Laptev Sea depended on the Lena river runoff spreading in northern and north-western directions (Fig. 21, 22). As compared with 1993 the fresh-water discharge significantly decreased both in northern and north-eastern directions. In September 1993 the minimum salinity values were 3, 7, and 12.5 ppt, respectively, along the axis of the Lena river outflow at 74° 00' N, 74° 30' N, 75° 30' N (Kassens and Karpiy, 1994). In September 1994, the following values were measured: 9.5, 18.5 and 25.5 ppt (Fig. 23, 27, 31). In 1993 the salinity was 4 ppt at 134° E (Kassens and Karpiy, 1994) whereas in 1994 it was equal to 10 ppt (Fig. 39). A drastic decrease in runoff was observed in the outflow zone of the Olenek river and of the Olenek channel of the Lena river.

2. Both in 1993 and 1994 the Lena river runoff was confined to local regions

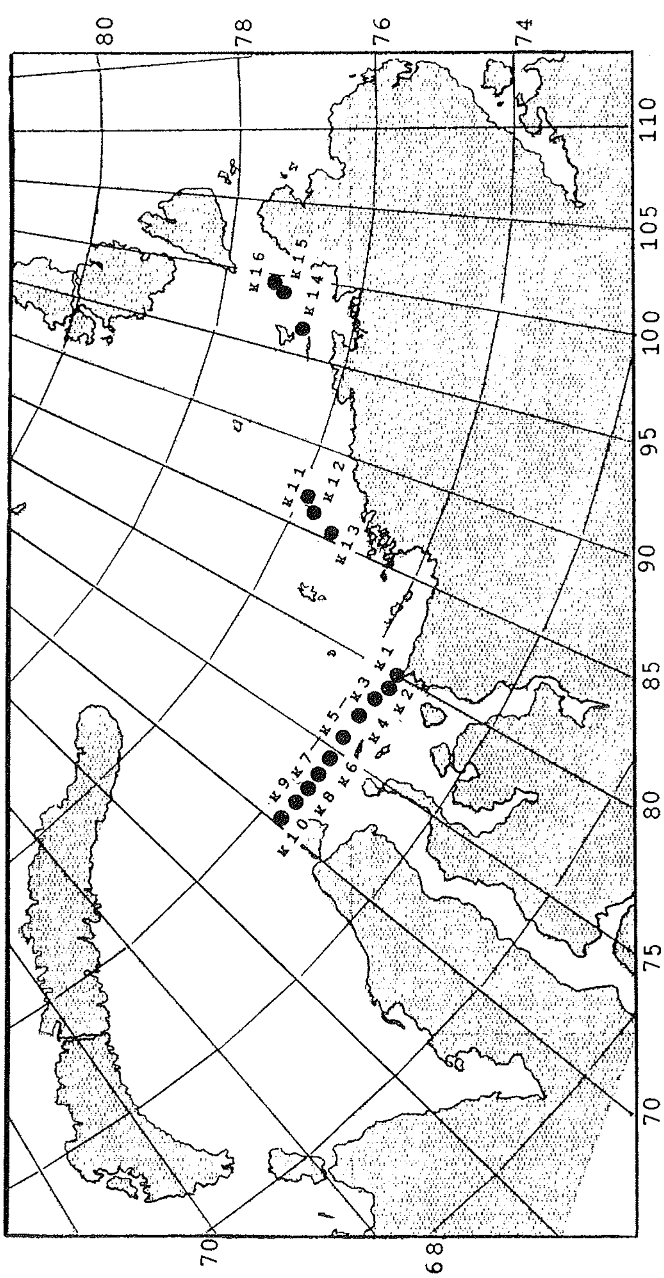


Fig. 16: Oceanographic stations in the Kara Sea (August 1994).

coinciding with the western and eastern Lena valleys and, to a lesser degree, with the Yana valley. The extended hydrological transects performed across the outflow zone along 74°0 00' N, 74° 30' N, 75° 30' N (Fig. 23 to 34, 43 to 45) confirm a hypothesis formulated in 1993 (Gribanov and Dmitrenko, 1994). According to it, the

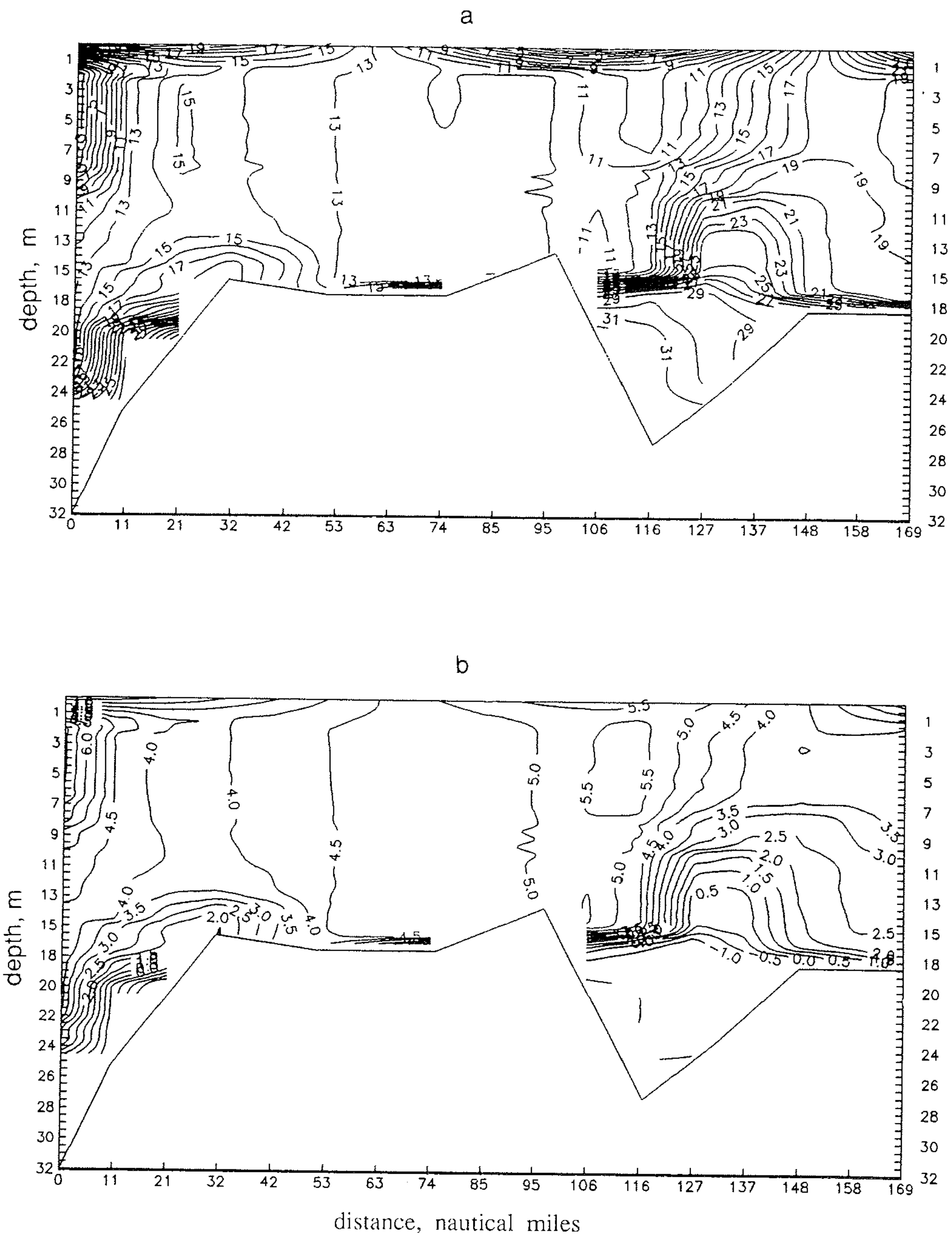


Fig. 17: Distribution of (a) salinity (ppt) and (b) temperature (°C) along the transect Dikson Island - Belyy Island, Kara Sea, from 73° 35´ N, 80° 01´ E to 73° 50´ N, 70° 15´ E (September 13 - 15, 1994).

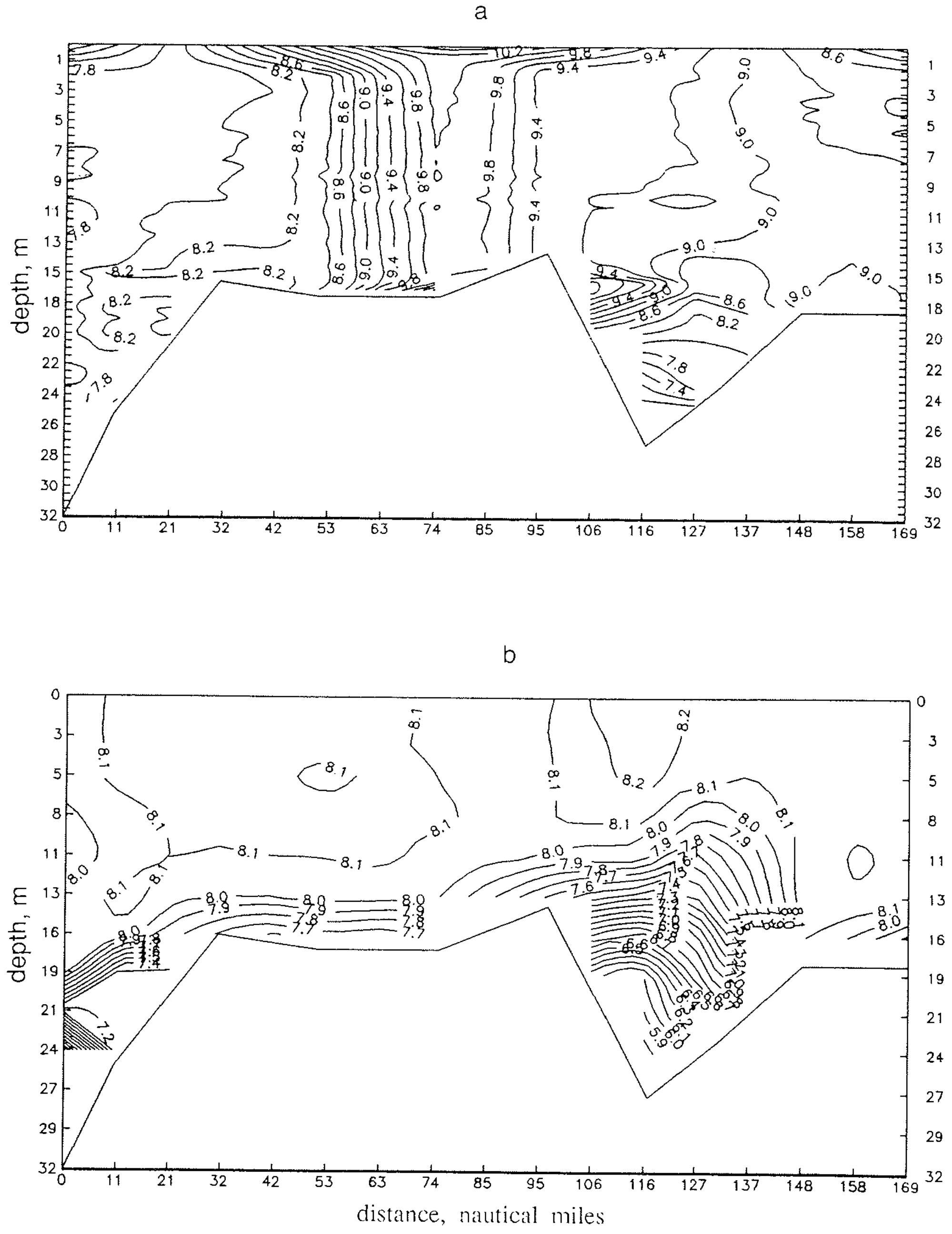


Fig. 18: Distribution of dissolved oxygen (ml/l) obtained by means of (a) CTD-soundings and (b) the Winkler method along the transect Dikson Island - Belyy Island, Kara Sea, from 73° 35´ N, 80° 01´ E to 73° 50´ N, 70° 15´ E (September 13 - 15, 1994).

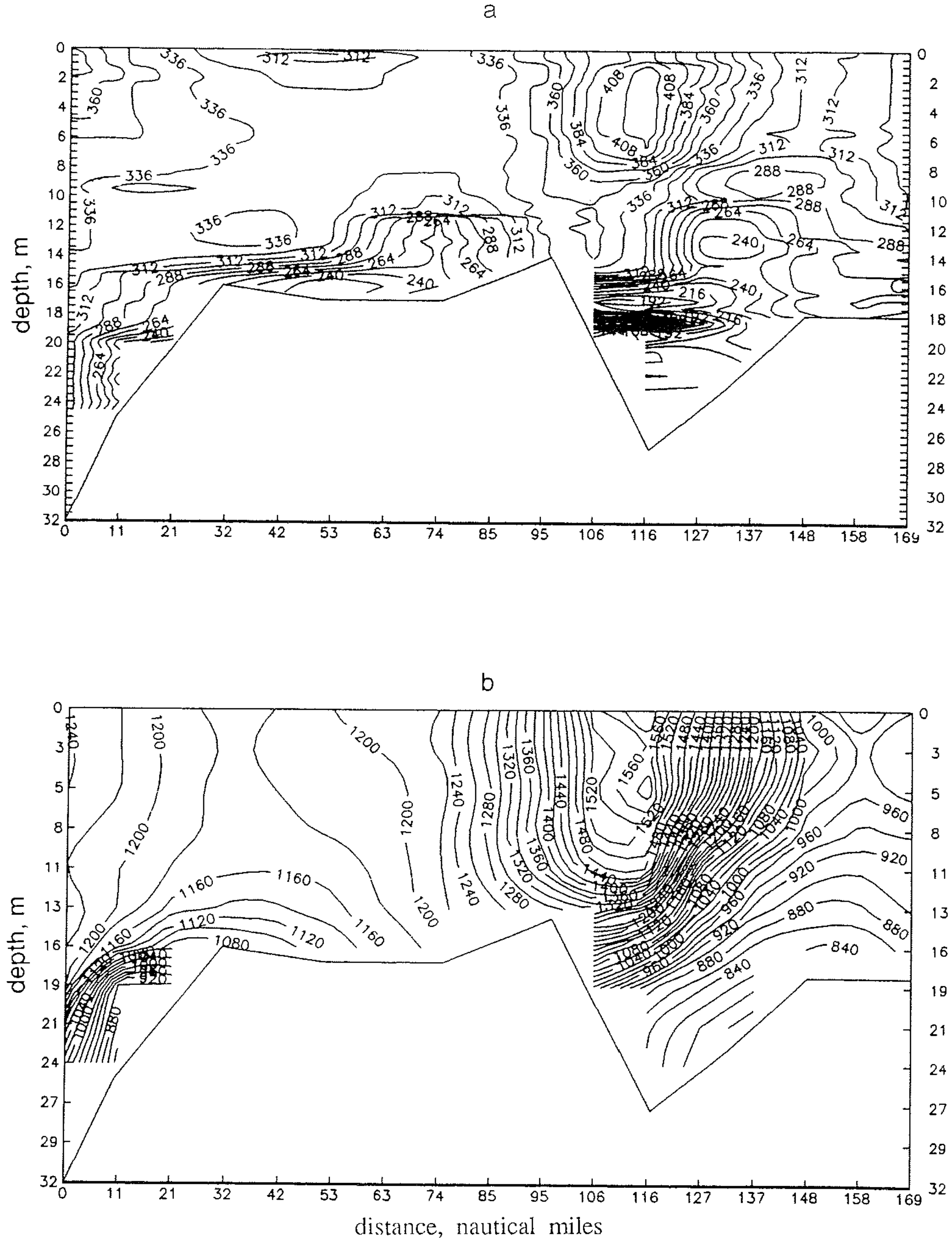


Fig. 19: Distribution of (a) fluorescence (conventional units) and (b) silicium (mcg/l) along the transect Dikson Island - Belyy Island, Kara Sea, from 73° 35´ N, 80° 01´ E to 73° 50´ N, 70° 15´ E (September 13 - 15, 1994).

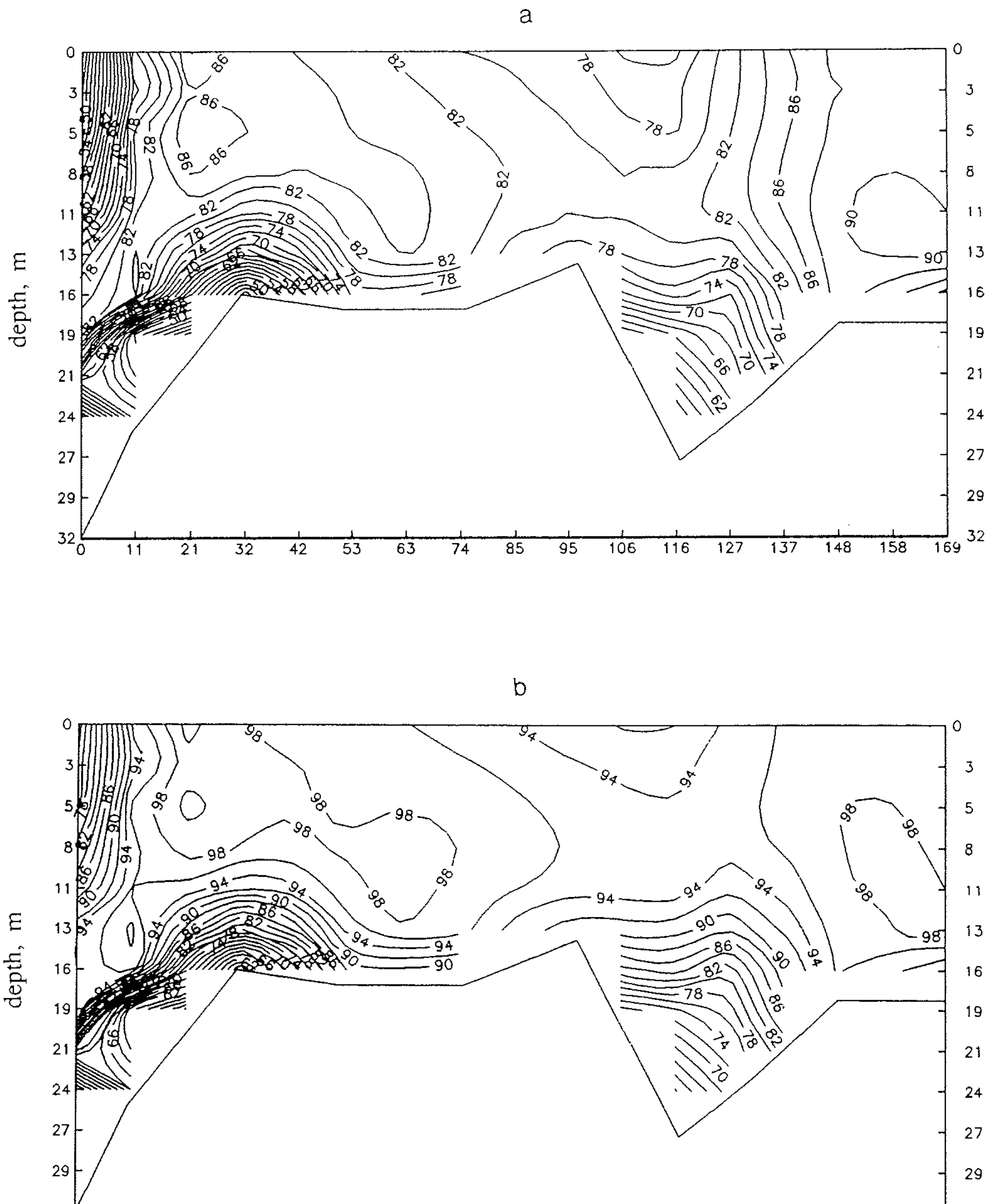


Fig. 20: Distribution of the light transmission at wave lengths of (a) 400 nm and (b) 750 nm along the transect Dikson Island - Belyy Island, Kara Sea, from 73° 35′ N, 80° 01′ E to 73° 50′ N, 70° 15′ E (September 13 - 15, 1994).

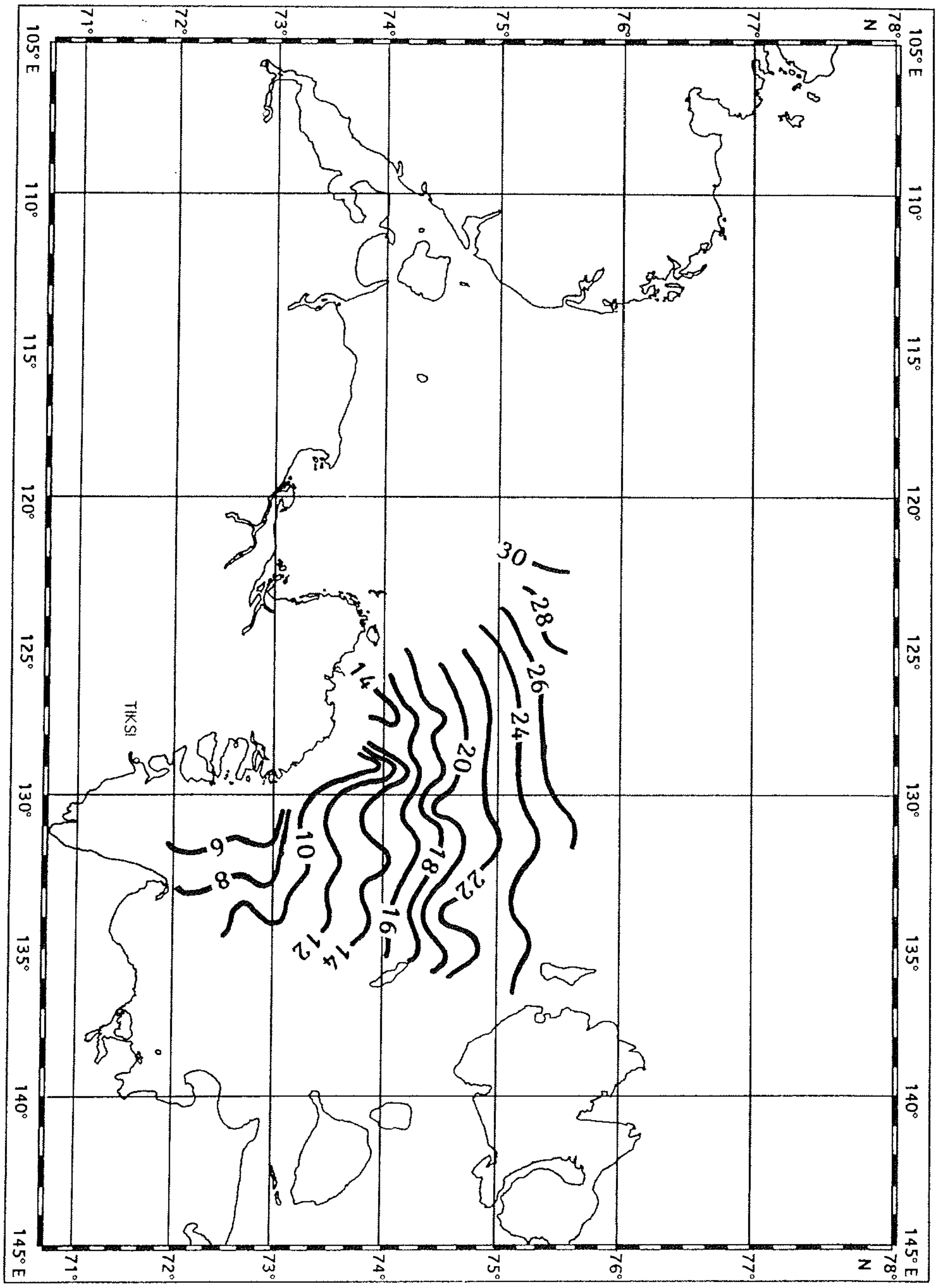


Fig. 21: Salinity distribution (ppt) at the sea surface (September 1994).

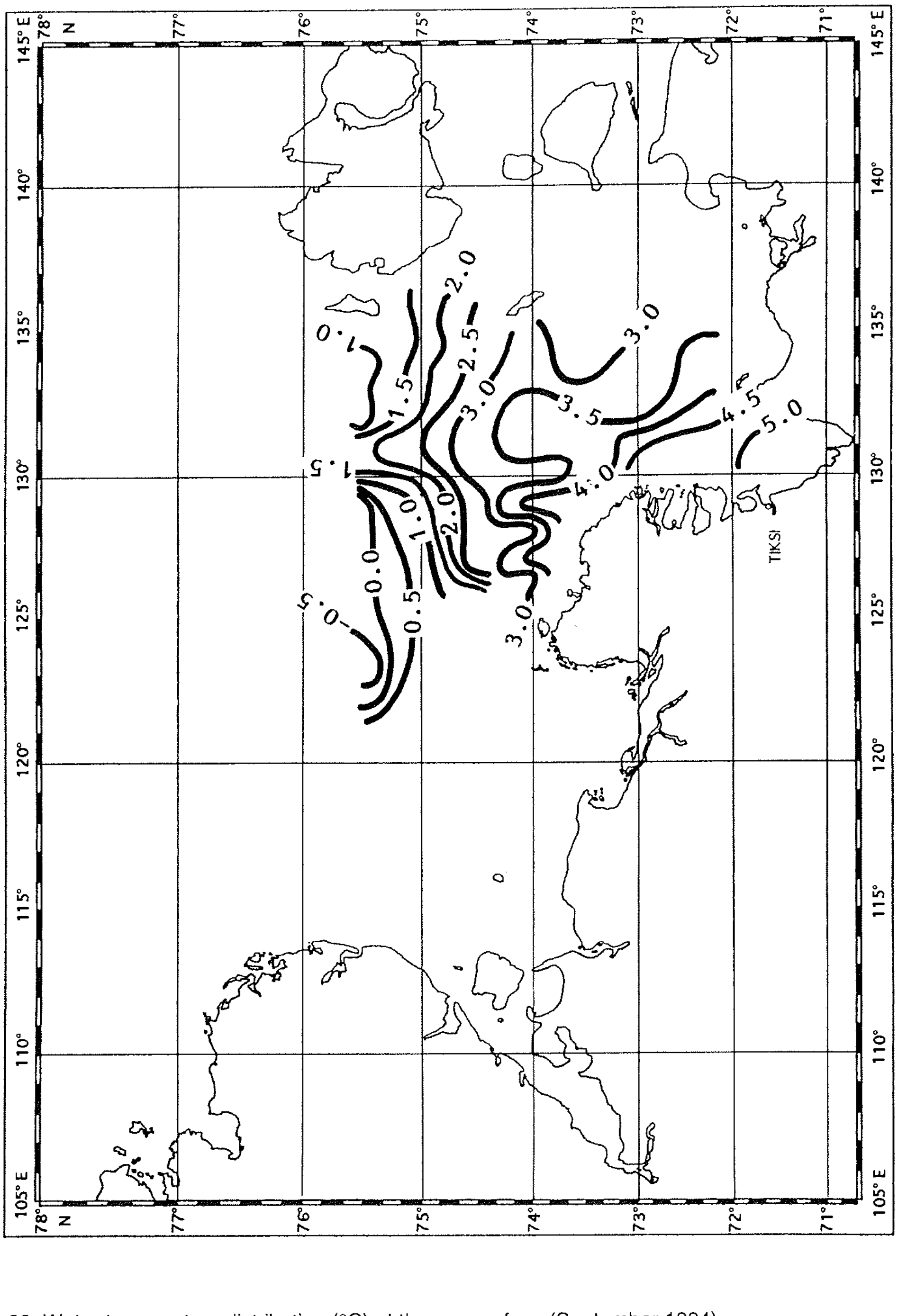


Fig. 22: Water temperature distribution (°C) at the sea surface (September 1994).

outflow jets practically coincide with the axes of valleys. For the first time it was experimentally found that the outflow jets deviate from the valley axes by 15-20 nm eastwards under the influence of the Coriolis force (Dmitrenko, in press). It was shown that, in case of a decrease in runoff, the river water mainly spreads along the eastern Lena valley and, to a much lesser degree, along the western one. It was much weakened in the Yana valley and could be traced only up to 75° N.

3. The hydrological structure of the outflow zone was revealed. It extends eastwards approximately from 126° E to Stolbovoy Island and from the Buor-Khaya Bay northwards (Fig. 23, 27). Its western boundary was defined by the outflow through the Tumatskaya channel of the Lena river. This outflow forms the main hydrological front, which separates river water masses from marine water masses. The outflow zone itself consists of a system of local hydrological fronts the location of which north-east of the Lena delta is completely determined by the location of the western and eastern valleys of the Lena river and of the Yana river valley. To the south-east of the Lena delta these local hydrological fronts coincide with river runoff through the Trofimovskaya and Bykovskaya channels (Fig. 35 to 42).

4. On the basis of the oceanographic stations carried out along transects in the outflow zone (Fig. 46 to 49), we were able to improve the results of the expedition in 1993 concerning the formation of inversions in the vertical temperature distribution as observed in the eastern Laptev Sea in case of an undisturbed stable density stratification (Gribanov and Dmitrenko, 1994). An example for the typical vertical distribution is given in Fig. 56. These inversions were due to an instable main hydrological front. The instability is caused by lateral isopycnic conversion. Due to an intersection of the isopycnics and isotherms at depths of 6-17 m the conditions within the main hydrological front are favourable to its development. These thermal interlayers with high temperature gradients are positive (warm) at the outer periphery of the hydrological front and are negative (cold) at the inner periphery. Their horizontal sizes can exceed 4 km (Fig. 50 to 52).

According to two long-term stations carried out in the eastern part of the Kara Sea (Fig. 58, 59) it was shown that cold interlayers with high gradients and high oxygen and chlorophyll A concentrations can appear under the main pycnocline due to the destruction of internal waves as well.

Another mechanism of hydrodynamical instability can occur in the zone of local hydrological fronts. This mechanism causes mesoscale hydrological "innerpycnic eddy-like" structures. The deformation of isotherms and isopycnics typical of these structures is presented in Fig. 46 and 47 (7-8 hours) and (6-6.5 hours). In contrast to warm and cold water lenses, which can due to isopycnic state exist for relatively long periods, the innerpycnic eddy-like structures are only episodically observed and are not likely to exist for longer periods.

5. The geographical zonation of the Laptev Sea, drawn up according to the results of the expedition in 1993 (Kassens and Karpiy, 1994) was basically approved by the main features of the distribution of river water in the Laptev Sea. Weak influence of the river runoff and a clearly defined two-layer stratification with relatively high surface values of salinity are typical of the western part of the Laptev Sea (Fig. 53).

The Lena river runoff, extending to the north of the delta depending on the intensity of runoff, spreads basically along the eastern valley and, to a lesser extent, along the western one. It is characterized by low salinity (Fig. 54). In 1994, the salinity increased from 5 ppt in the Trofimovskaya channel (Fig. 35) up to 25.5 ppt in the eastern Lena valley at 75° 30' N (Fig. 23). In addition to the two-layer stratification, there is a relatively vast layer with intermediate thermocline characteristics (if compared with the surface and bottom water masses) which is typical of this region. The formation of this layer is probably caused by vertical transformation of surface water masses originating from runoff.

The zone of river water transformation north-west of the Lena delta is characterized by intermediate temperature and salinity values as compared with river runoff and marine water masses (Fig. 55). The intermediate water is formed by the intensely transformed river runoff discharging from the Tumatskaya channel and along the western valley of Lena.

The periphery of the river runoff is characterized by isopycnic thermal interlayers with high gradients. They were formed due to the hydrodynamical instability of the main hydrological front (Fig. 56)

The axes of river runoff coincide with the eastern slopes of the river valleys. They differ from adjacent water masses in low salinities and high temperatures. The typical vertical distribution of oceanographic characteristics of these zones is given in Fig. 57.

7. The influence that the edge of floating ice with varying concentrations exerts on the hydrological structure of the subsurface layer was estimated.

Hydrooptical Studies

A.F. Anoshkin and I.Ye. Ushakov

Scientific Program

Light attenuation by sea water is governed by its properties such as light dispersion and absorption. The light absorption depends on the optical properties of three sea water components: fresh water, dissolved substances and suspension. Solar energy absorbed by sea water turns into chemical and heat energy. The light dispersion in the water column is influenced by separate photons changing their spreading direction.

The indices of the absorption and dispersion are qualitative characteristics of these processes. Together they form an index of the light attenuation in sea water. The transmission coefficient of a sea water layer with definite thickness is often used for a qualitative estimate of light attenuation. The minimum light attenuation for pure water lies in the blue-green part of the spectrum (wave length about 460-480 nm).

Presence of admixtures and pollutants in sea water causes changes of the attenuation index. The minimum of light attenuation is displaced, as a rule, to longer waves (the yellow-green and yellow parts). That depends on the fact that for the most admixtures increasing light attenuation with decreasing wave length is typical. The spectral dependency of the attenuation index is also changed.

The light attenuation index of sea water in the blue-green part of the spectrum varies on the average from 0.02 units m^{-1} in the most clear regions up to several units per meter in coastal zones. The typical river water has an attenuation index of about 10 units m^{-1} and more. Optical layers with decreasing transparency are formed by the accumulation of suspended particles, increased concentrations of dissolved substances as well as increased phyto- and zooplankton density.

Chlorophyll "a" is the main photosynthetical pigment being contained in phytoplankton cells and performing the function of absorption of solar energy, which is necessary to form organic substances. It is contained in all the most widespread species of phytoplankton and can be used as an indicator for the amount of photosynthetical activity.

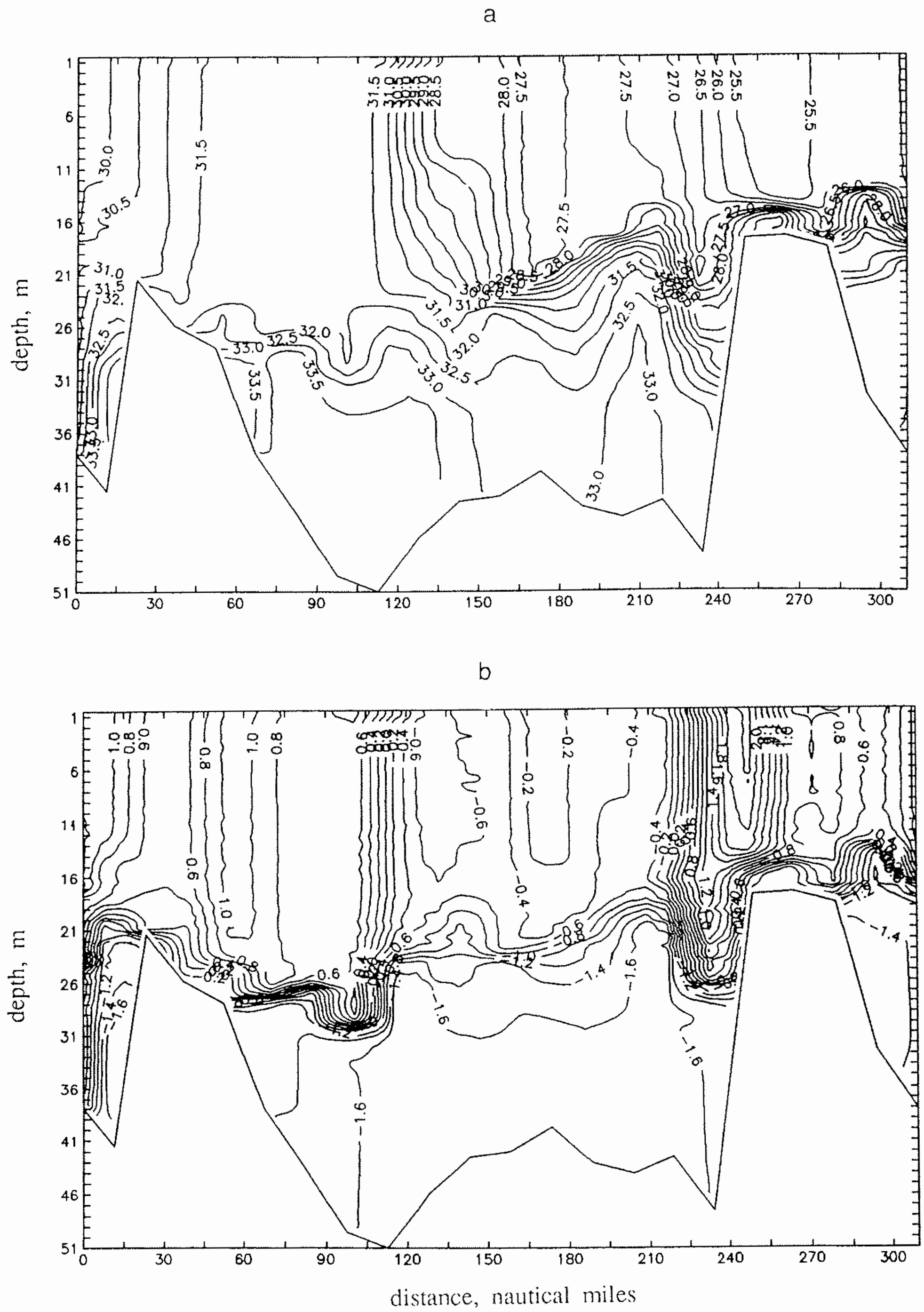


Fig. 23: Distribution of (a) salinity (ppt) and (b) temperature (°C) along 75° 30´ N from 114° 31´ E to 135° 00´ E (September 3 - 7, 1994).

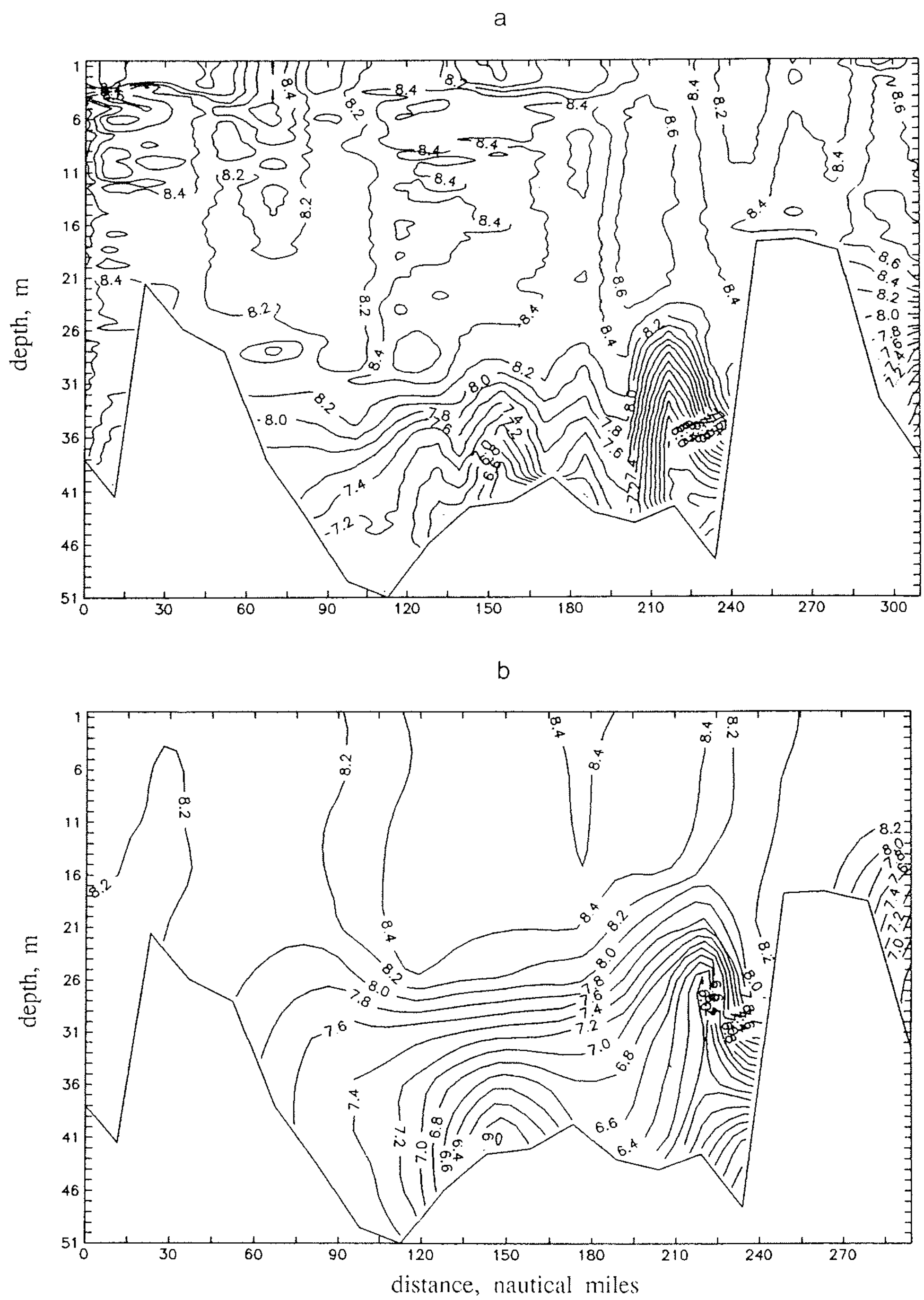


Fig. 24: Distribution of dissolved oxygen (ml/l) obtained by means of (a) CTD-soundings and (b) the Winkler method along 75° 30´ N from 114° 31´ E to 135° 00´ E (September 3 - 7, 1994).

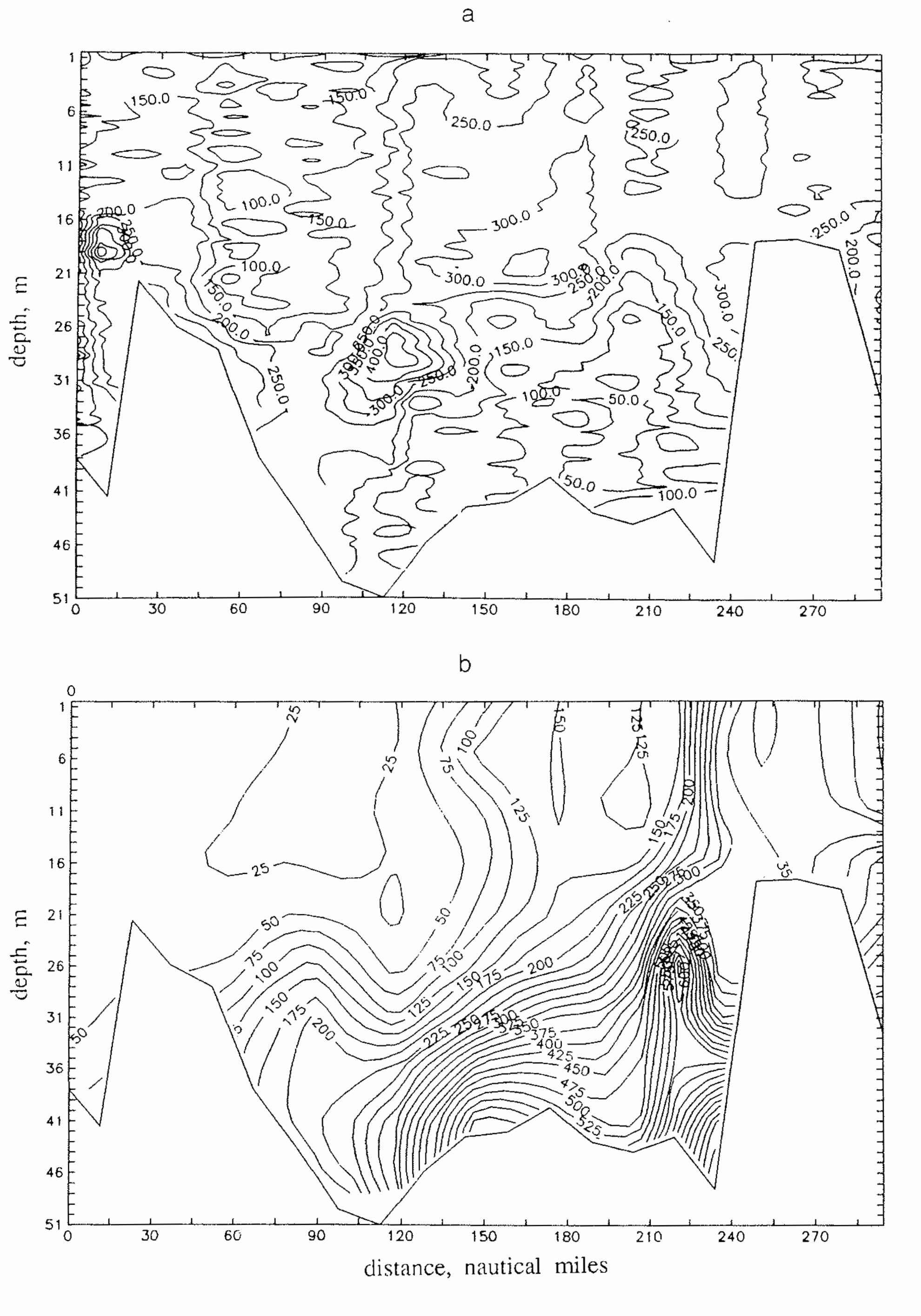


Fig. 25: (a) Fluorescence and (b) silicium distribution (mcg/l) along 75° 30´ N from 114° 31´ E to 135° 00´ E (September 3 - 7, 1994).

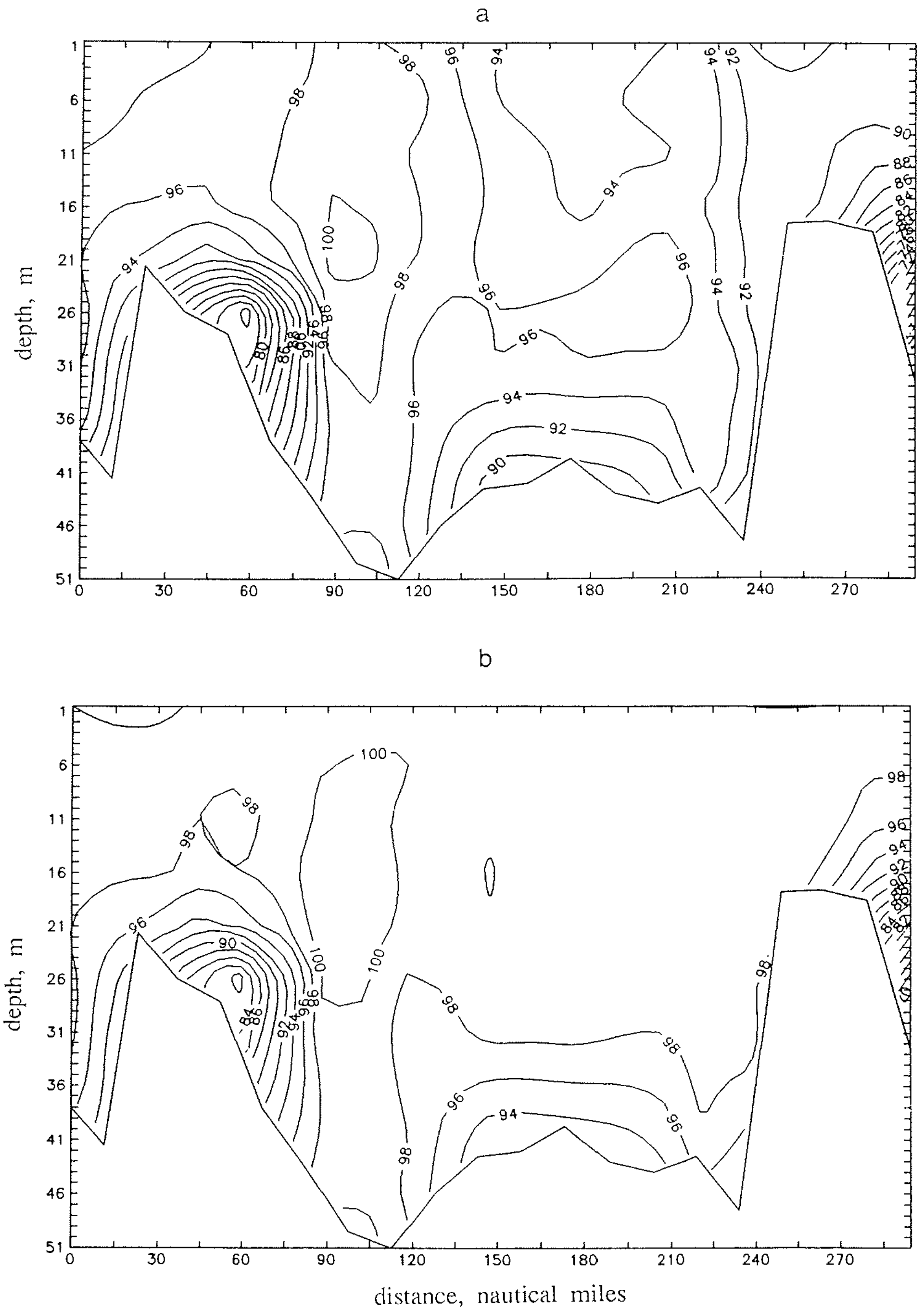


Fig. 26: Light transmission distribution (a: wave length 400 nm and b: 750 nm) along 75° 30´ N from 114° 31´ E to 135° 00´ E (September 3 - 7, 1994).

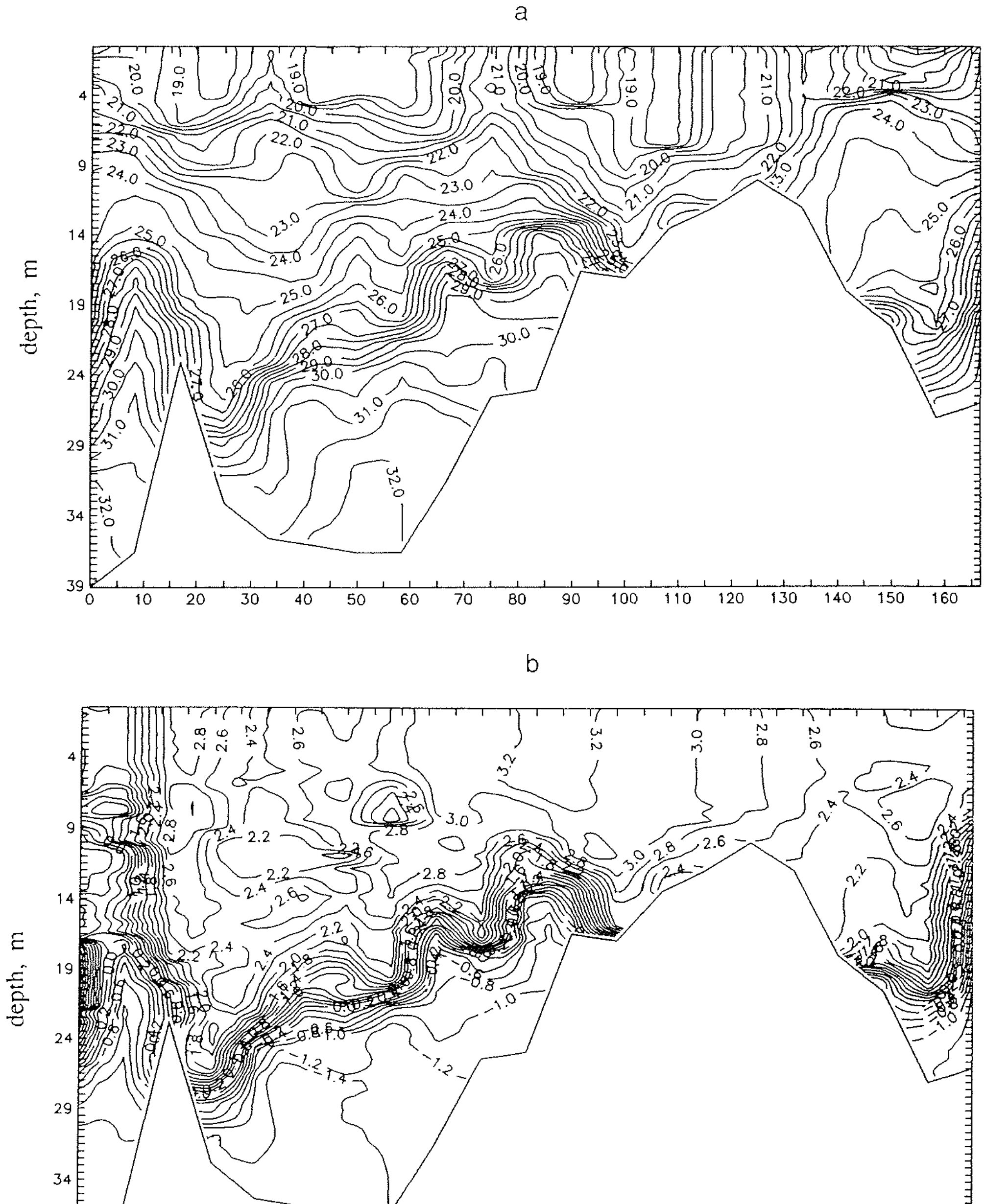


Fig. 27: Salinity distribution (ppt) (a) and water temperature (°C) (b) along 74° 30'N from 126° 00' E to 136° 00'E (September 10 -12, 1994).

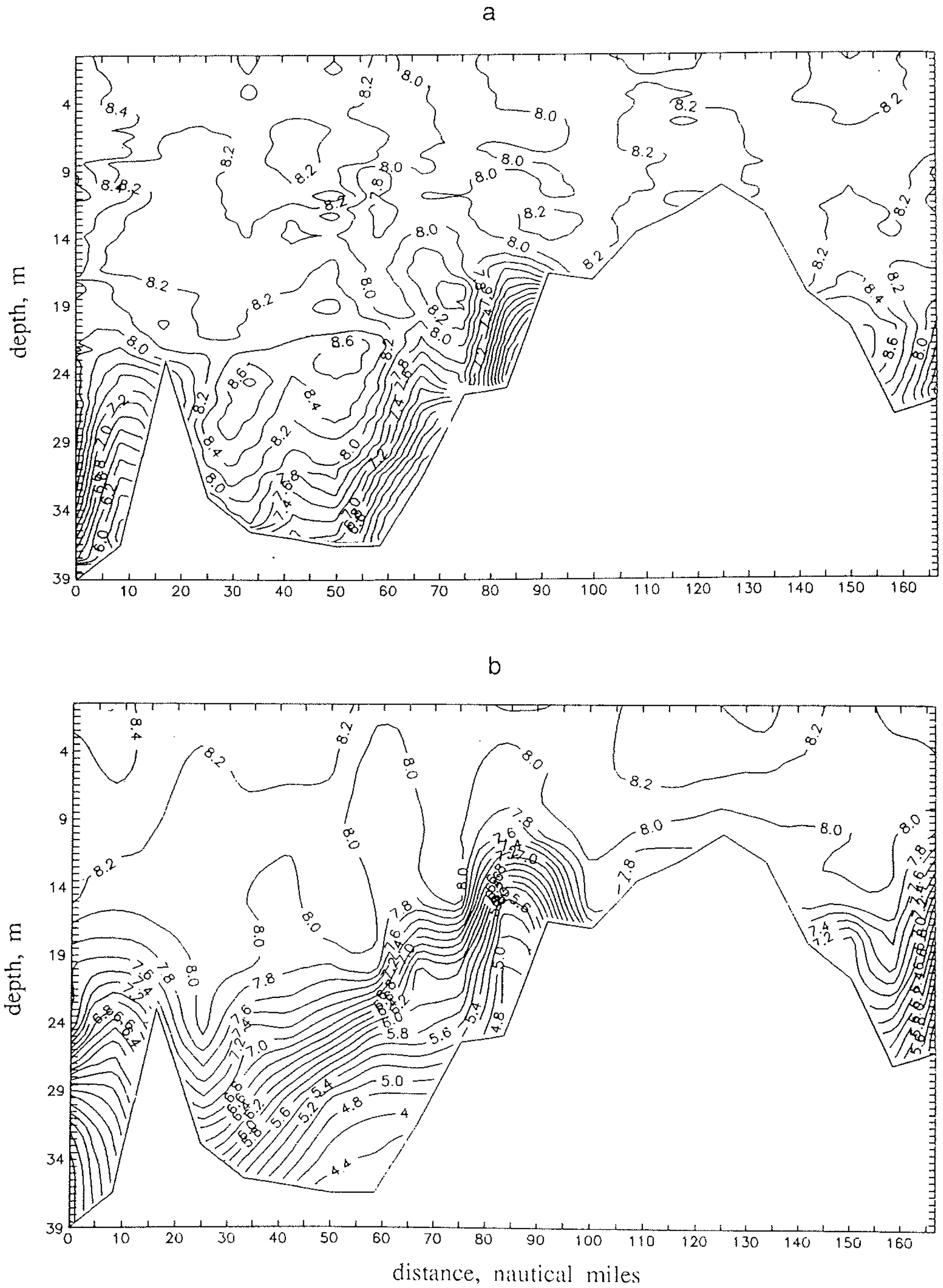


Fig. 28: Distribution of dissolved oxygen (ml/l) obtained by means of (a) CTD-soundings and (b) the Winkler method along 74° 30´ N from 126° 00´ E to 136° 00´ E (September 10 - 12, 1994).

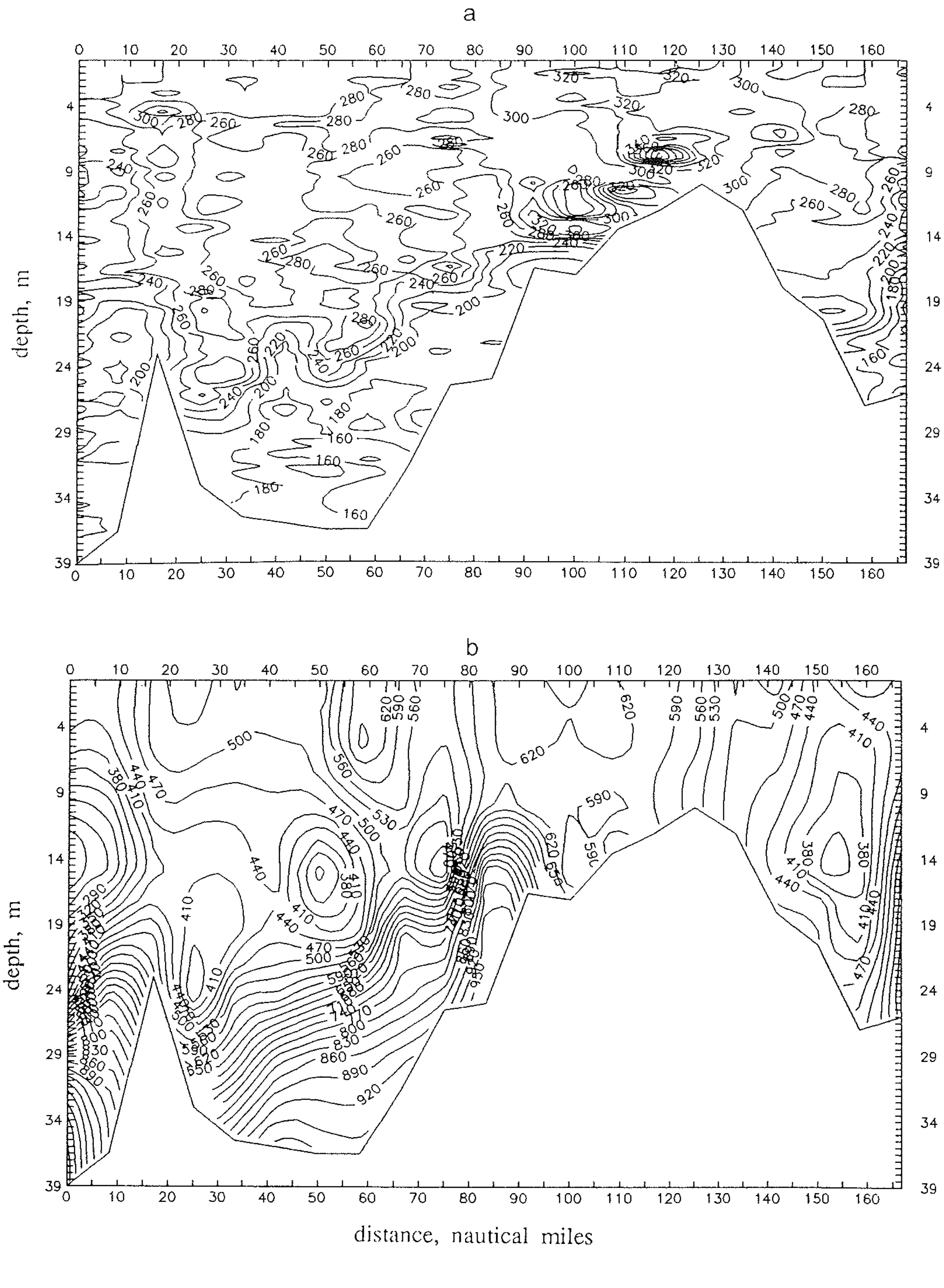


Fig. 29: (a) Fluorescence and (b) silicium distribution (mcg/l) along 74° 30´ N from 126° 00´ E to 136° 00´ E (September 10 - 12, 1994).

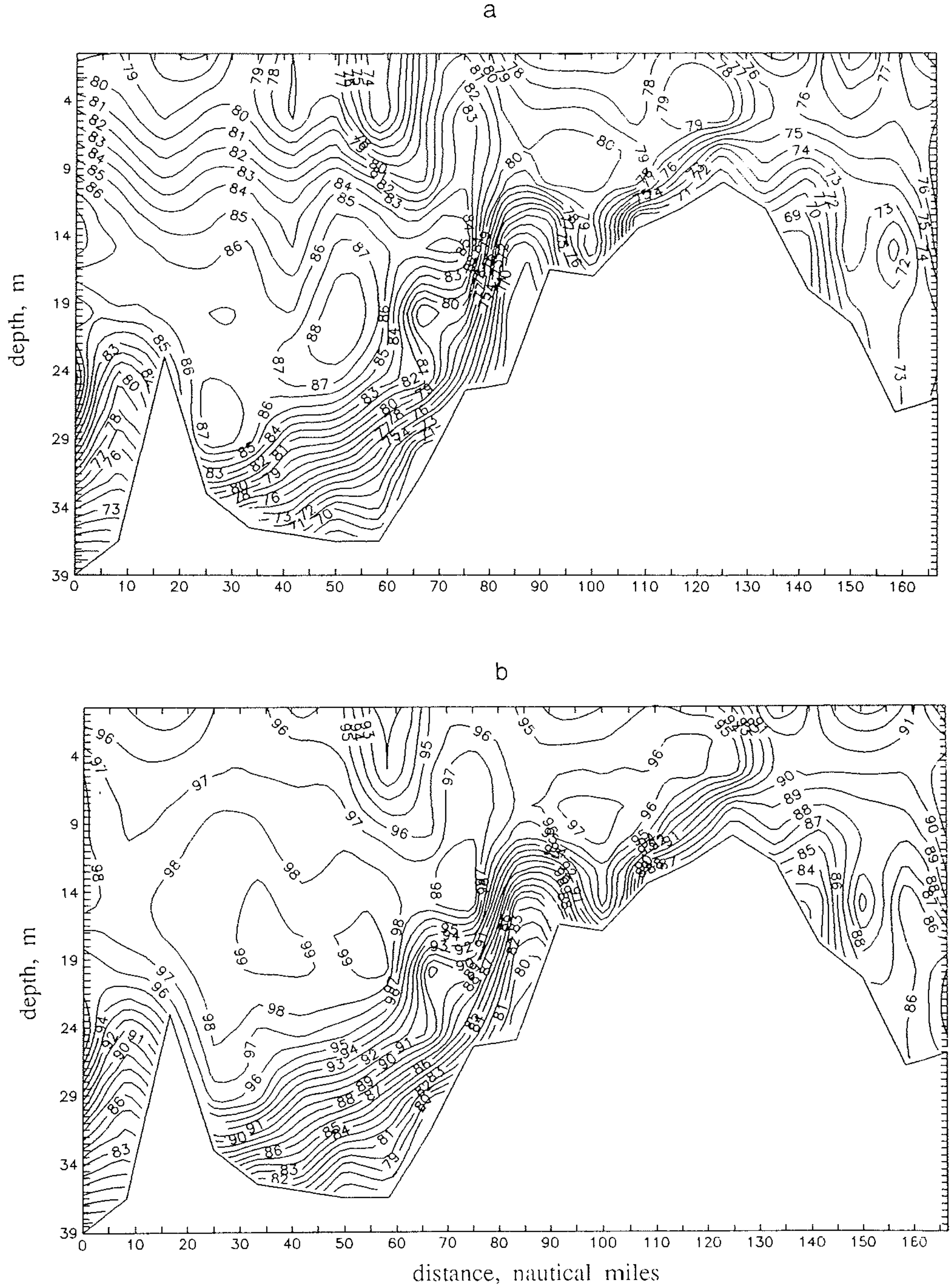


Fig. 30: The distribution of the light transmission (wave lengths of (a) 400 nm and (b) 750 nm) along 74° 30´ N from 126° 30´ E to 136° 00´ E (September 10 - 12, 1994).

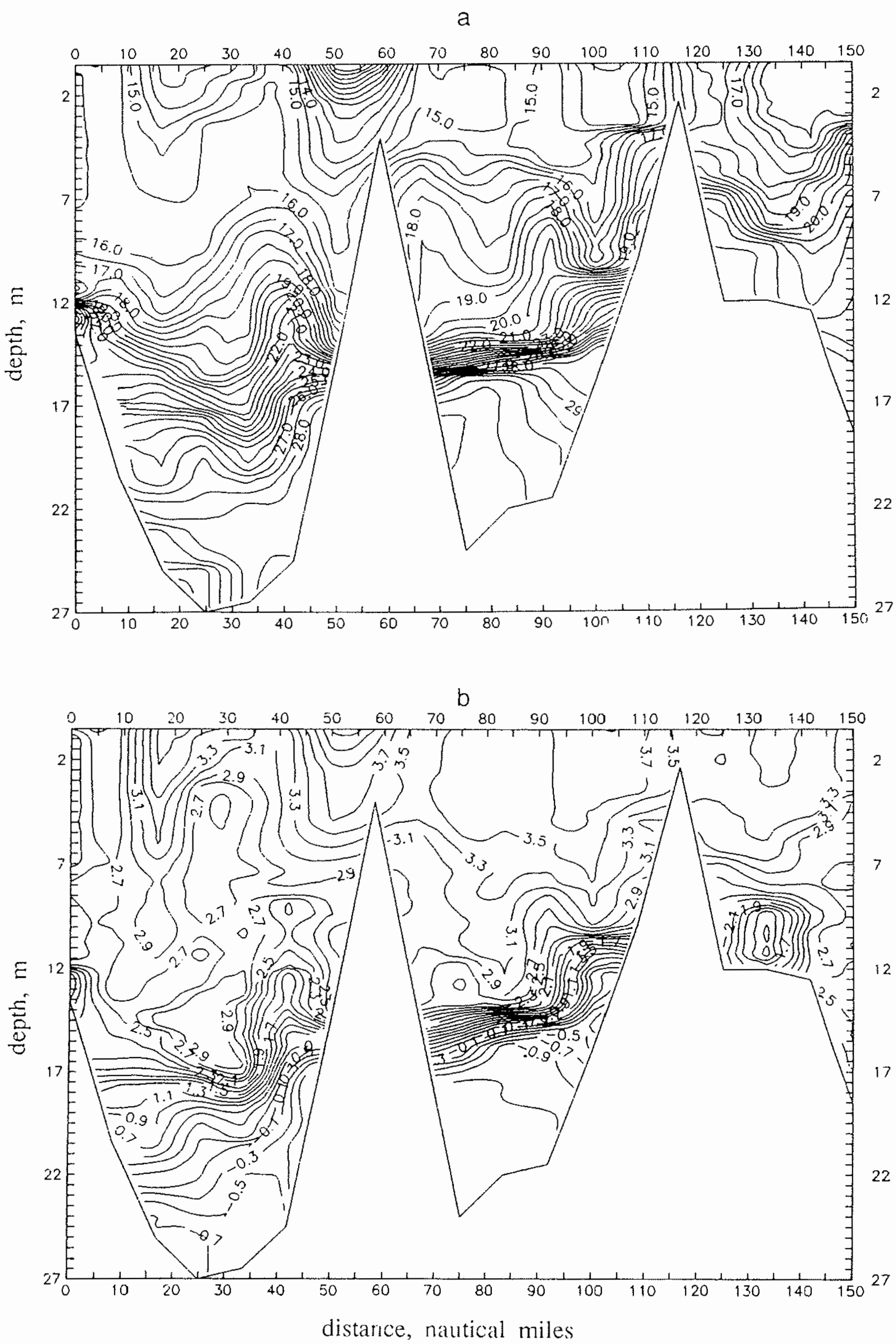


Fig. 31: Distribution of (a) salinity (ppt) and (b) temperature (°C) along 74° 00´ N from 126° 00´ E to 135° 00´ E (September 9 - 10, 1994).

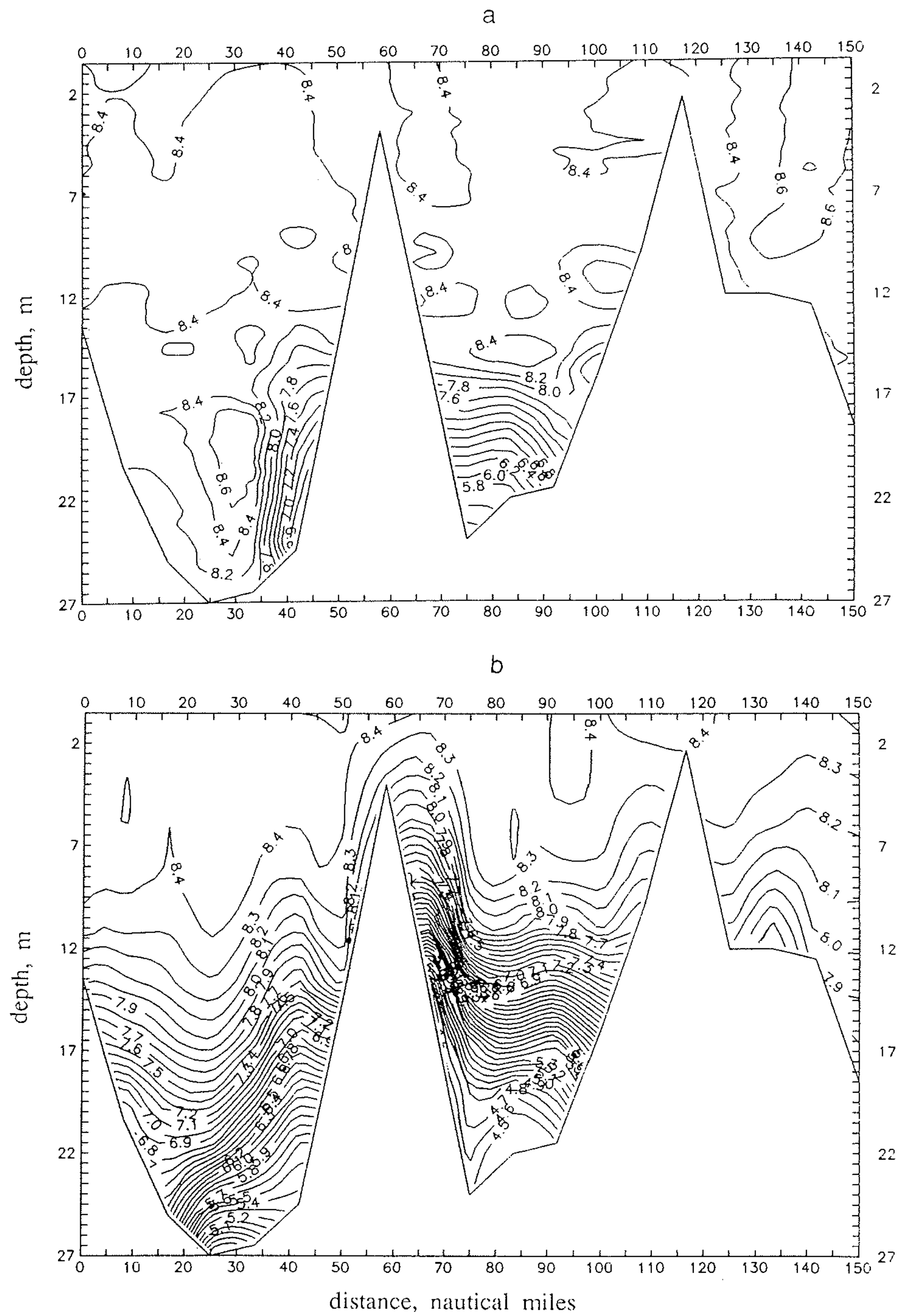


Fig. 32: Distribution of dissolved oxygen (ml/l) obtained by means of (a) CTD-soundings and (b) the Winkler method along 74° 00′ N from 126° 00′ E to 135° 00′ E (September 9 - 10, 1994).

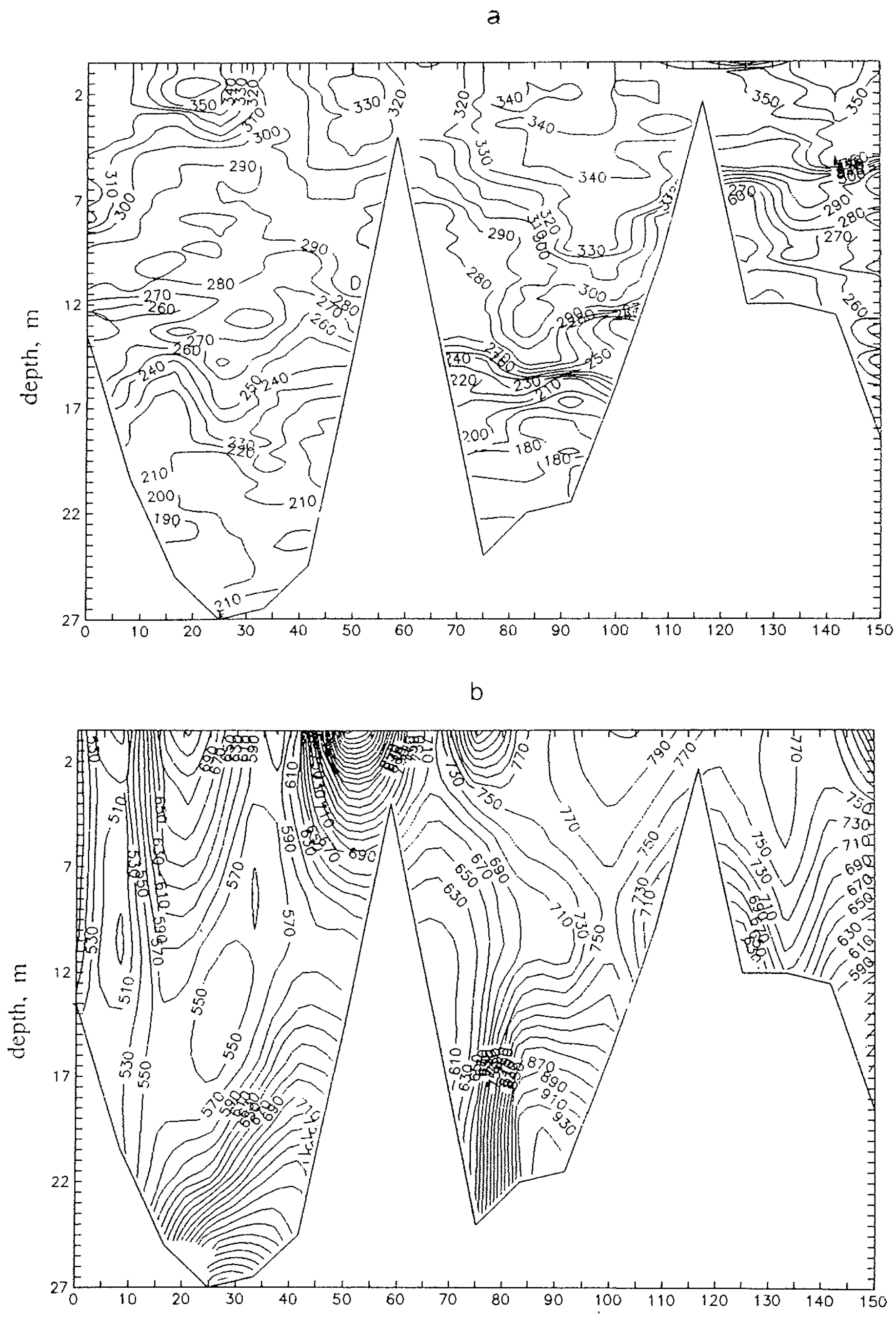


Fig. 33: (a) Fluorésence and (b) silicium distribution (mcg/l) along 74° 00´ N from 126° 00´ E to 135° 00´ E (September 9 - 10, 1994).

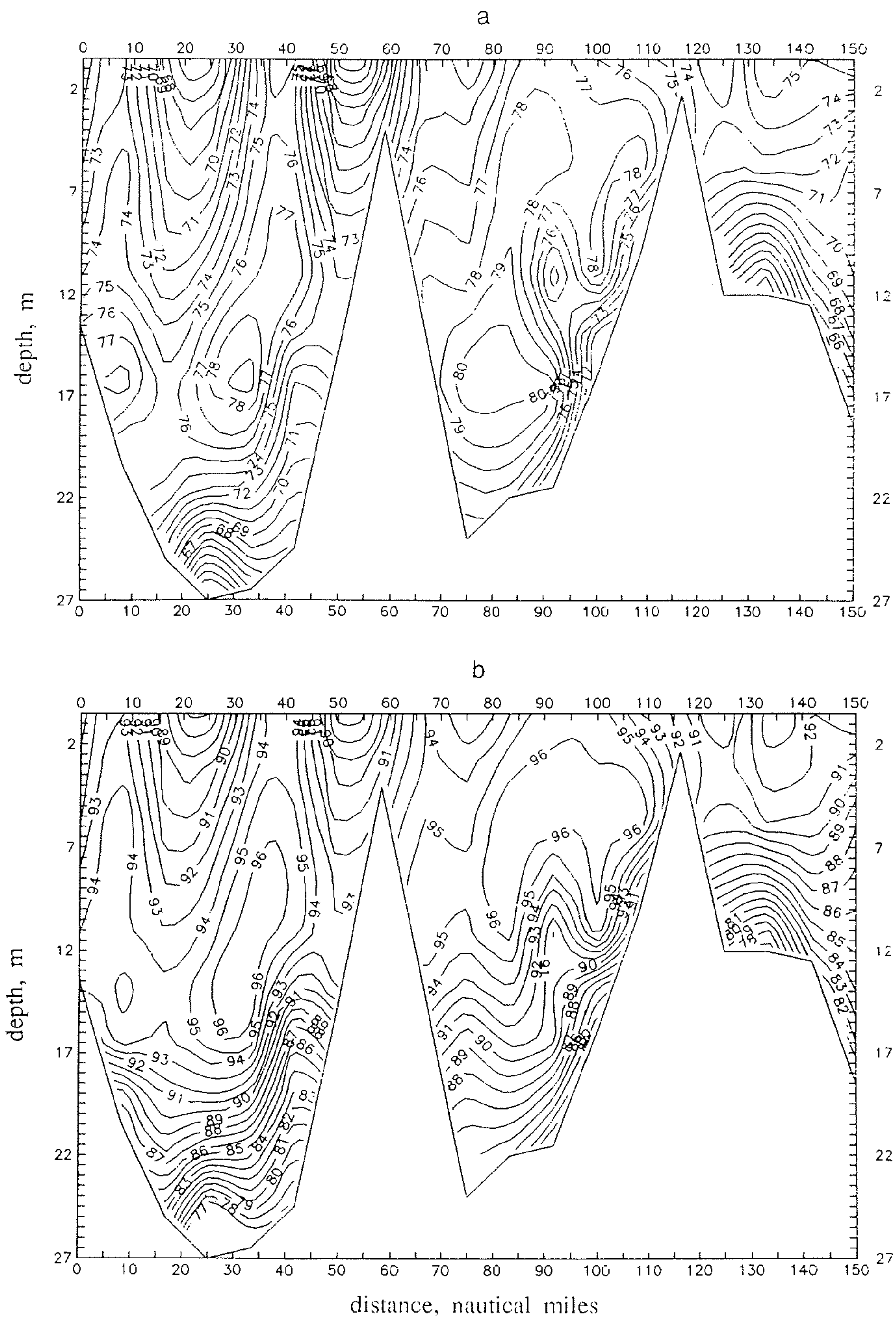


Fig. 34: Distribution of the light transmission (wave lengths of (a) 400 nm and (b) 750 nm) along 74° 00´ N from 126° 00´ E to 135° 00´ E (September 9 - 10, 1994).

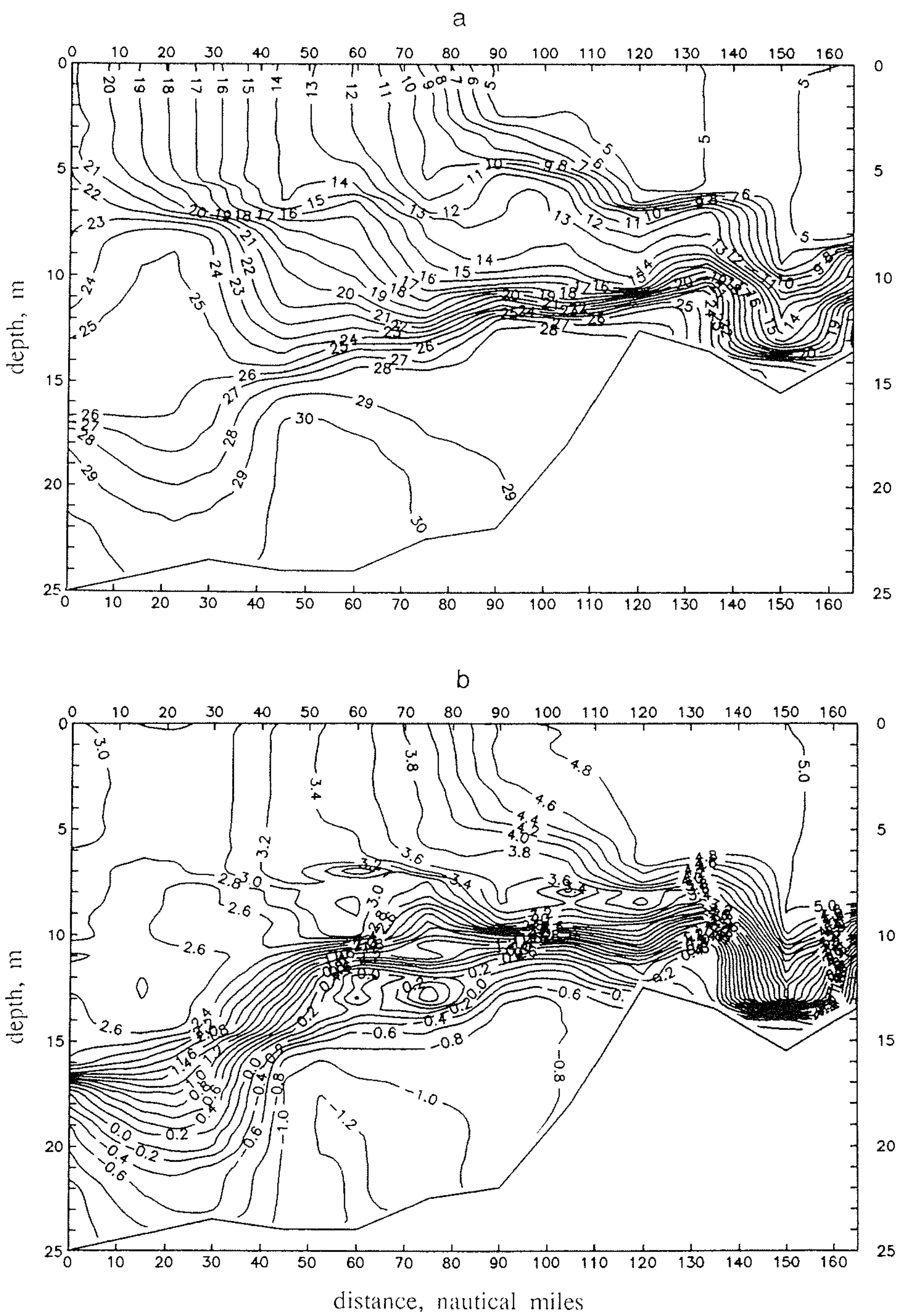


Fig. 35: Distribution of (a) salinity (ppt) and (b) temperature (°C) along 130° 30′ E from 71° 30′ N to 71° 45′ N (September 15 - 16, 1994).

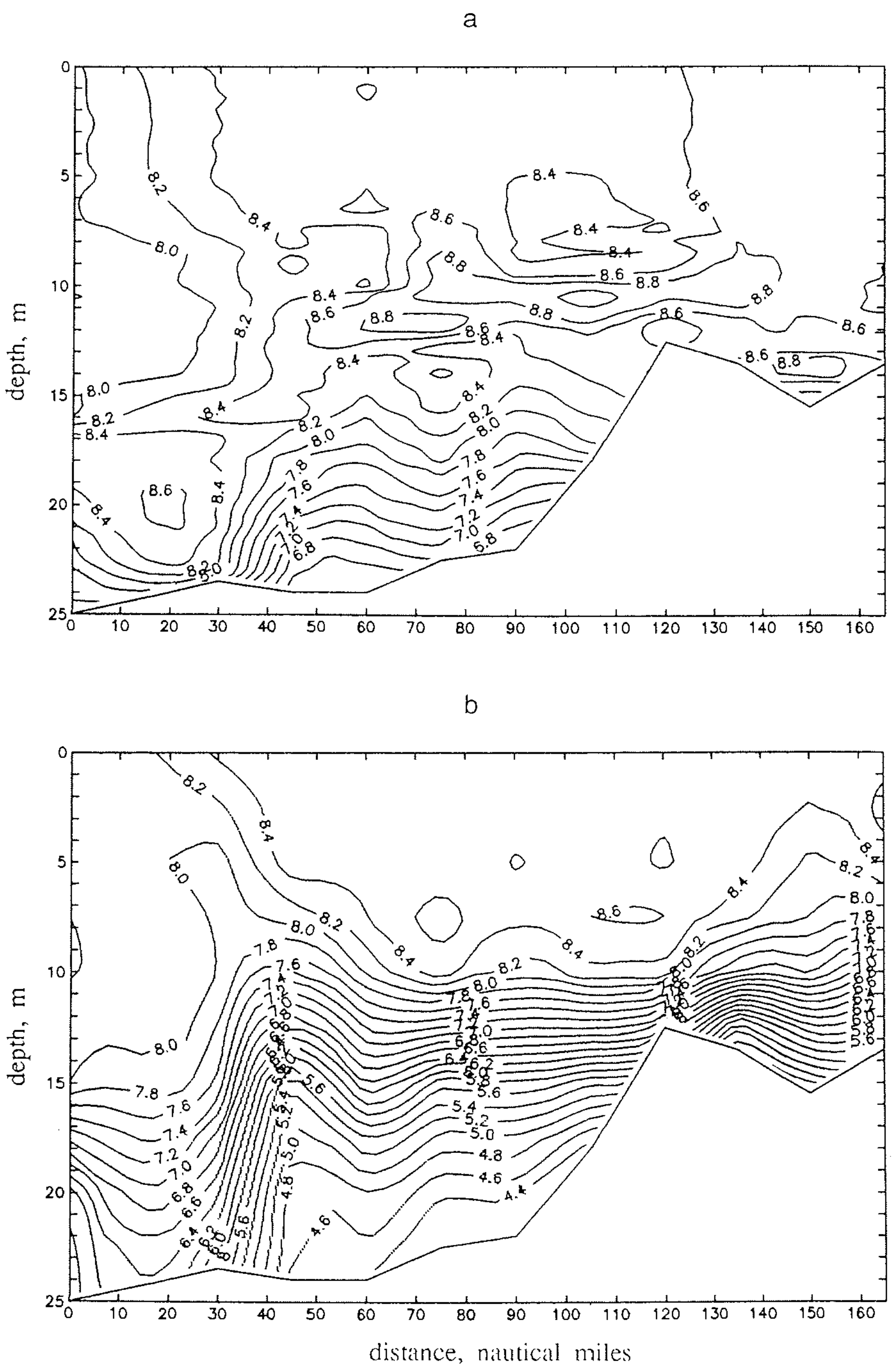


Fig. 36: Distribtuion of dissolved oxygen (ml/l) obtained by means of (a) CTD-soundings and (b) the Winkler method along 130° 30´ E from 74° 30´ N to 71° 45´ N (September 15 - 16, 1994).

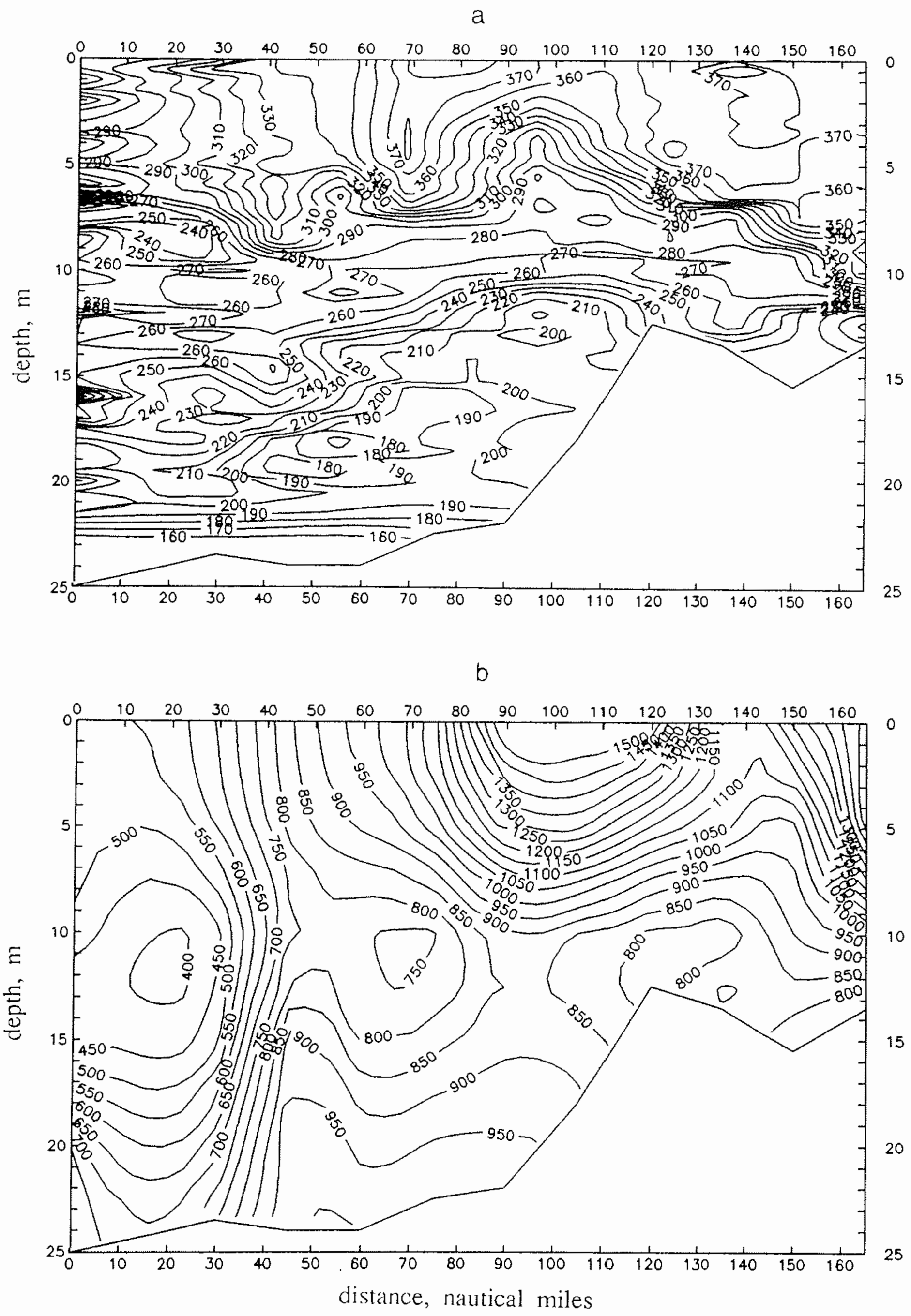


Fig. 37: (a) Fluorescence and (b) silicium distribution (mcg/l) along 130° 30´ E from 74° 30´ N to 71° 45´ N (September 15 - 16, 1994).

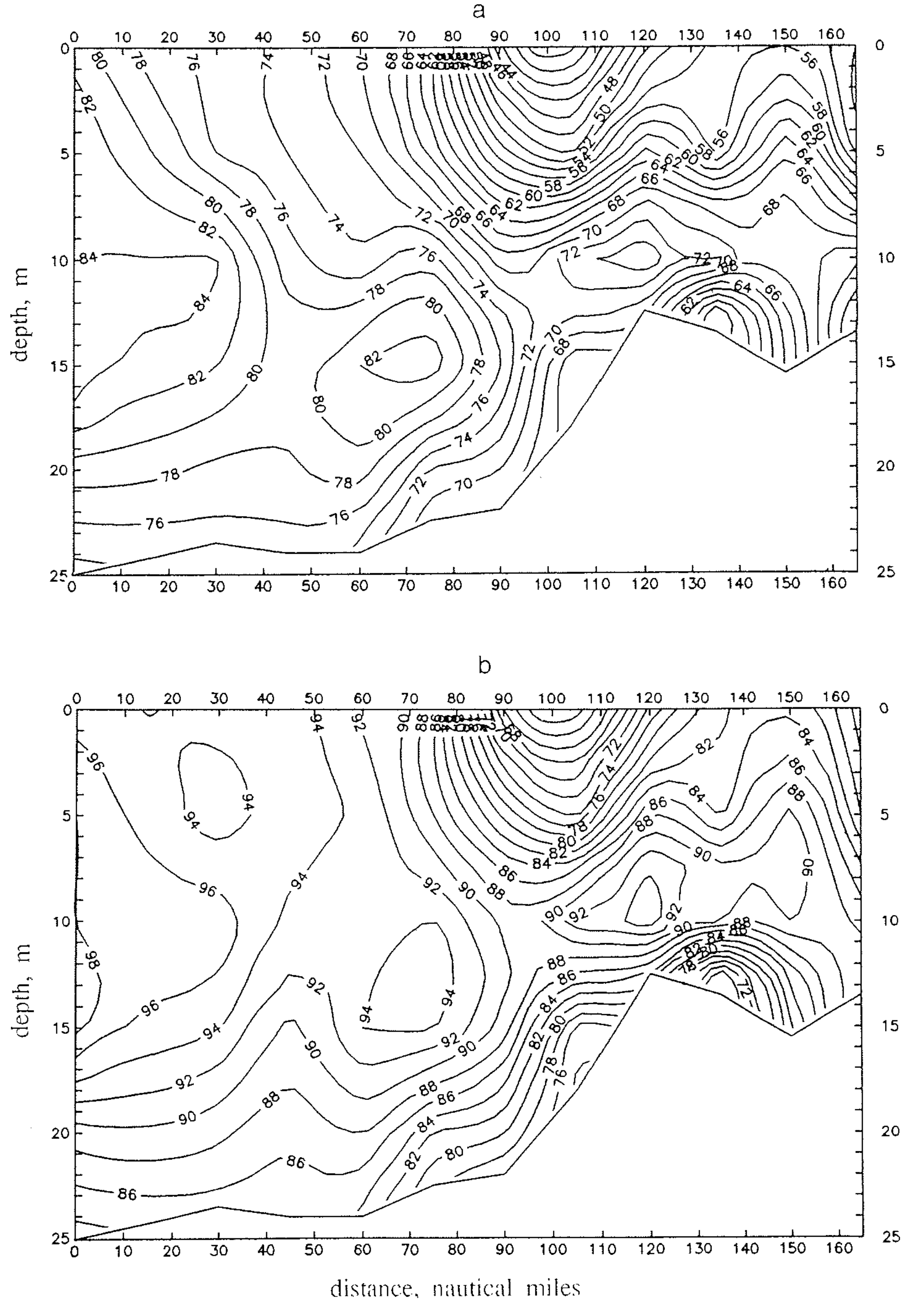
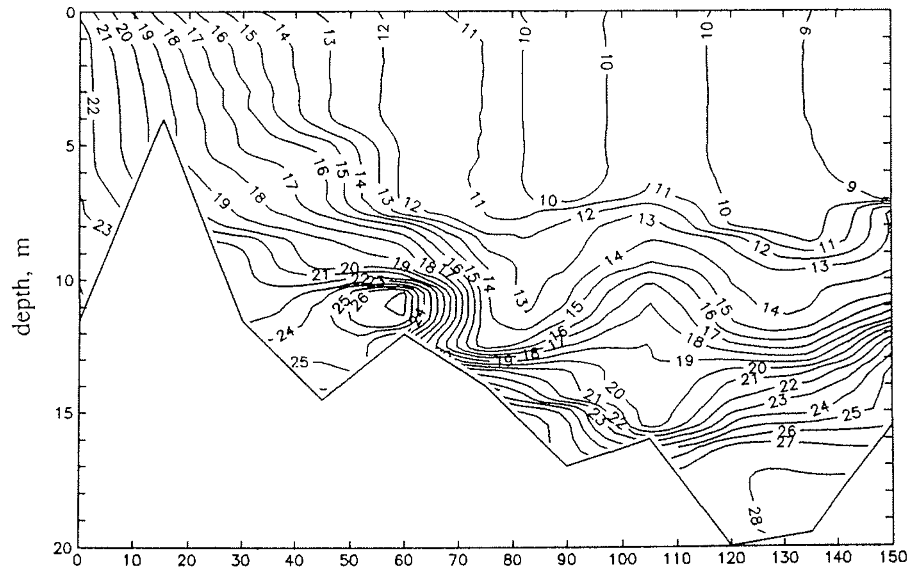


Fig. 38: Distribution of the light transmission (wave lenghts of (a) 400 nm and (b) 750 nm) along 130° 30´ E from 74° 30´ N to 71° 45´ N (September 15 - 16, 1994).

a



b

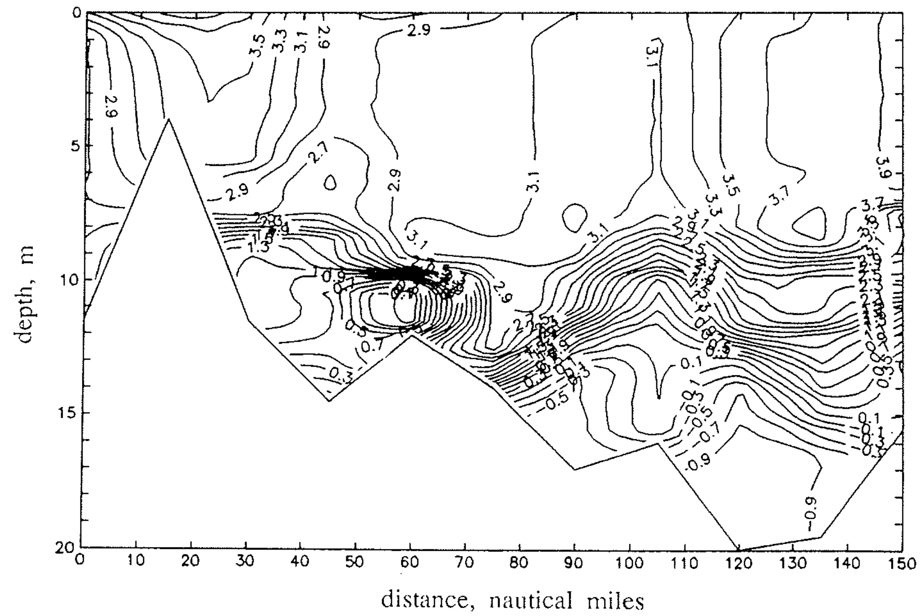


Fig. 39: Distribution of (a) salinity (ppt) and (b) temperature (°C) along 134° 00´ E from 74° 30´ N to 72° 00´ N (September 18- 19, 1994).

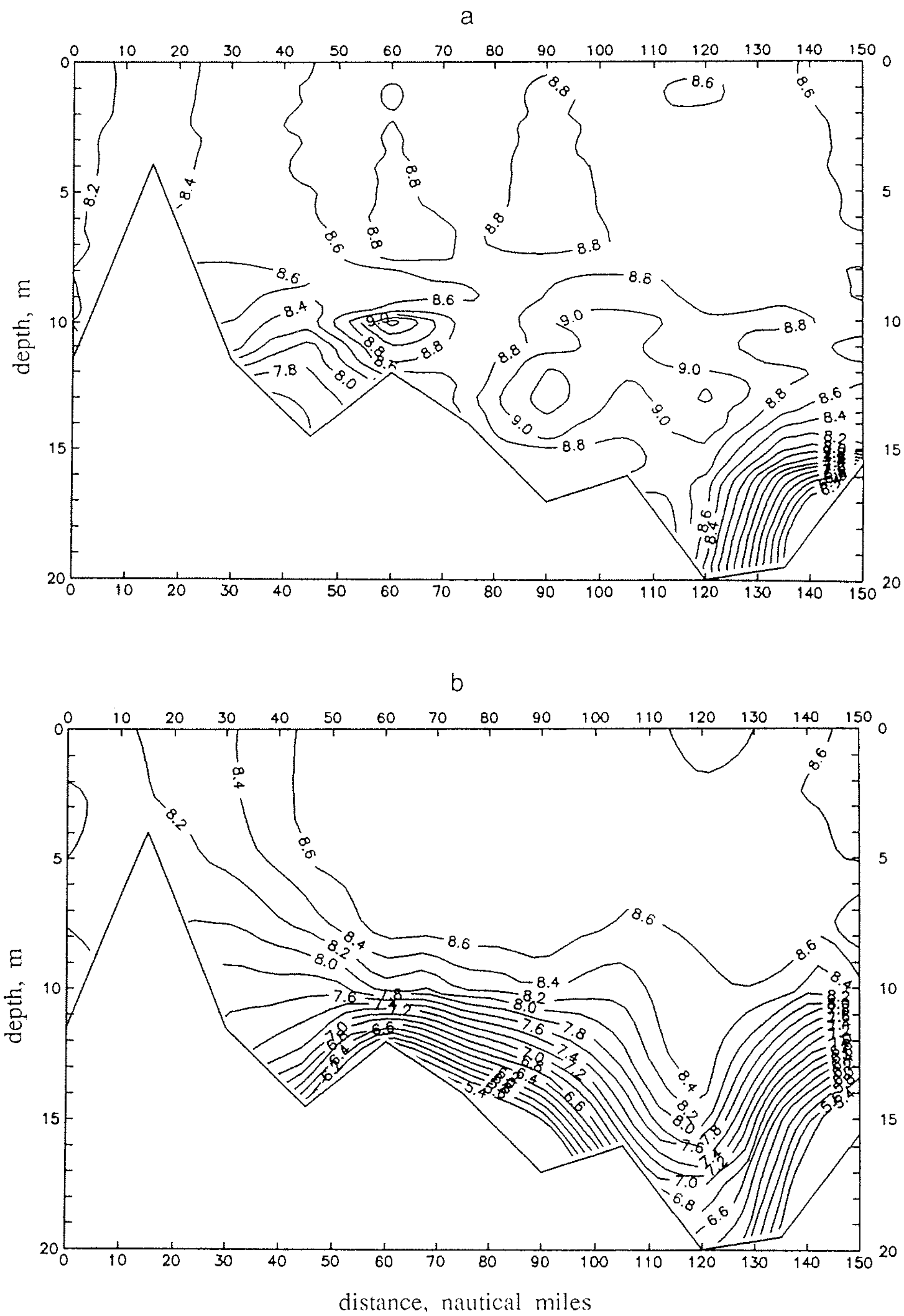


Fig. 40: Distribution of dissolved oxygen (ml/l) obtained by means of (a) CTD- soundings and (b) the Winkler Method along 134° 00´ E from 74° 30´ N to 72° 00´ N (September 18 - 19, 1994).

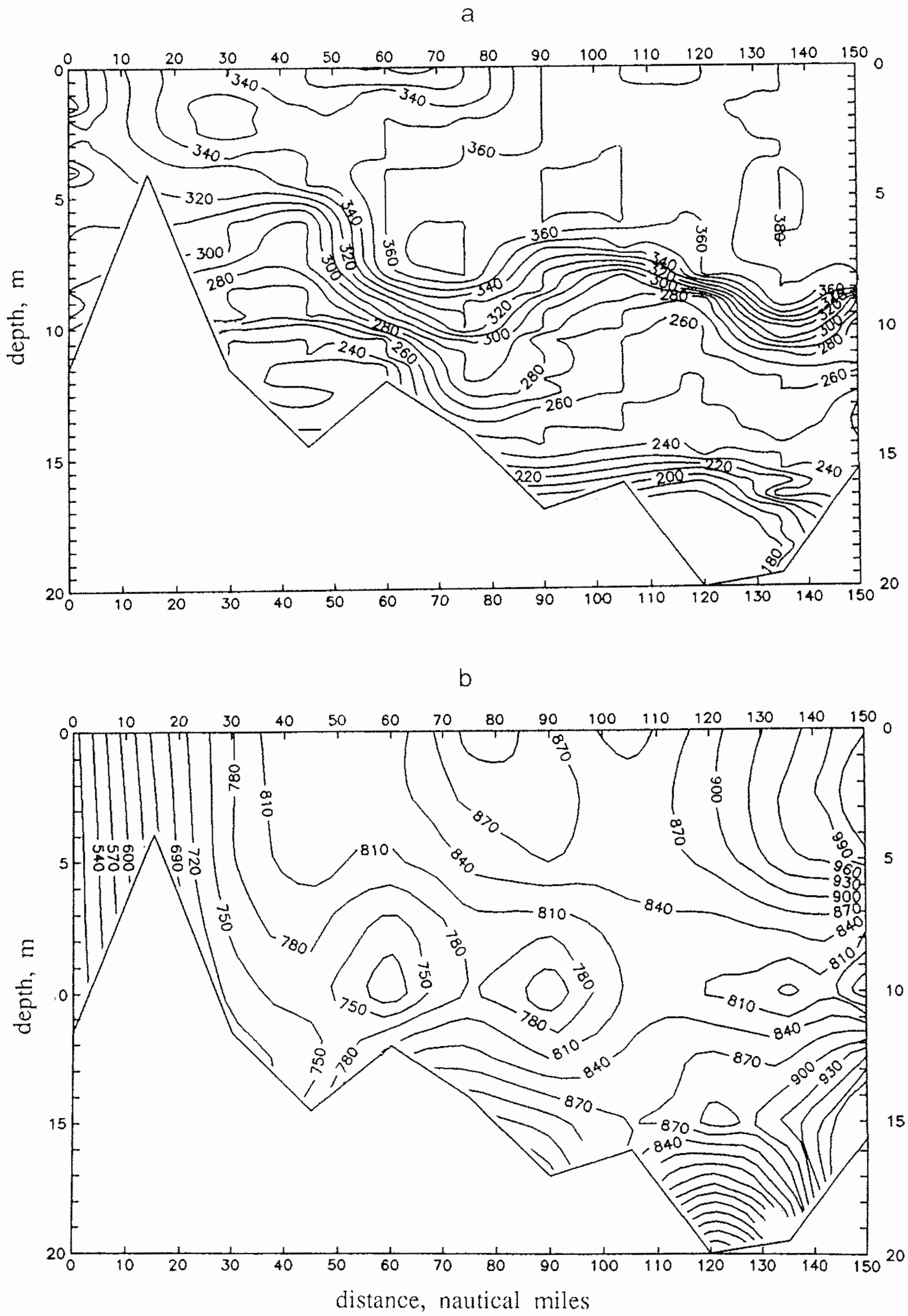


Fig. 41: (a) Fluorescence and (b) silicium distribution (mcb/l) along 134° 00´ E from 74° 30´ N to 72° 00´ N (September 18 - 19, 1994).

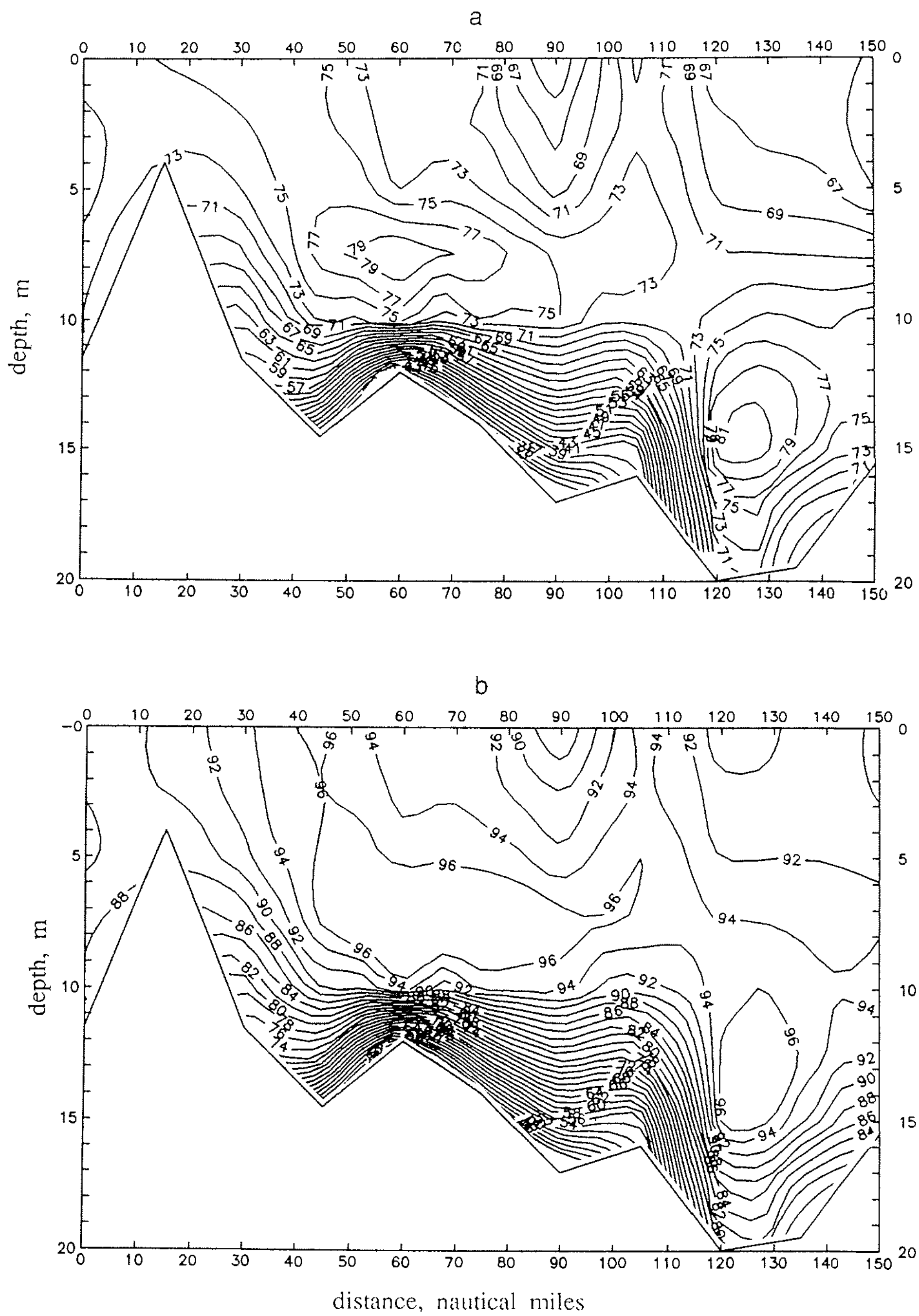


Fig. 42: Distribution of the light transmission (wave lengths of (a) 400 nm and (b) 750 nm) along 134° 30′ E from 74° 30′ N to 72° 00′ N (September 18 - 19, 1994).

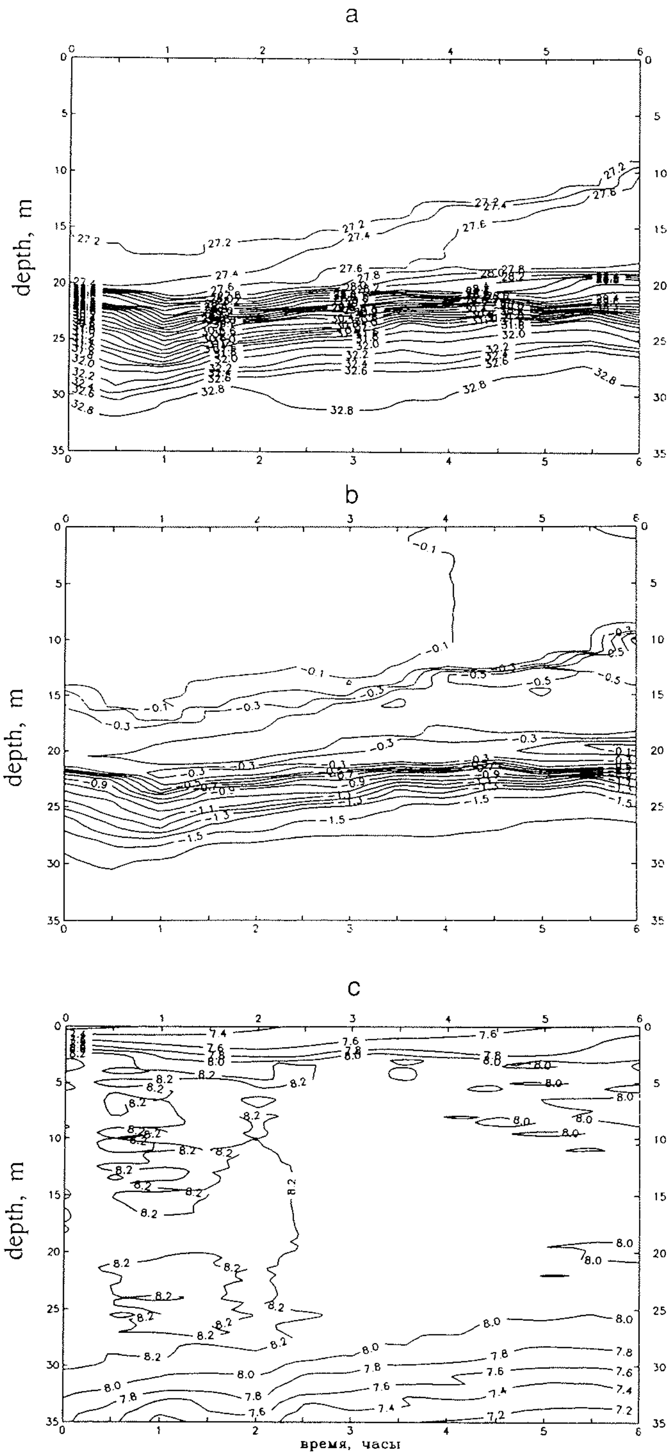


Fig. 43: Temporal variability of (a) salinity (ppt), (b) temperature (°C) and (c) dissolved oxygen (ml/l) by means of CTD-sounding at the long-term station PM 9413 (75° 30´ N, 126° 00´ E, September 5, 1994).

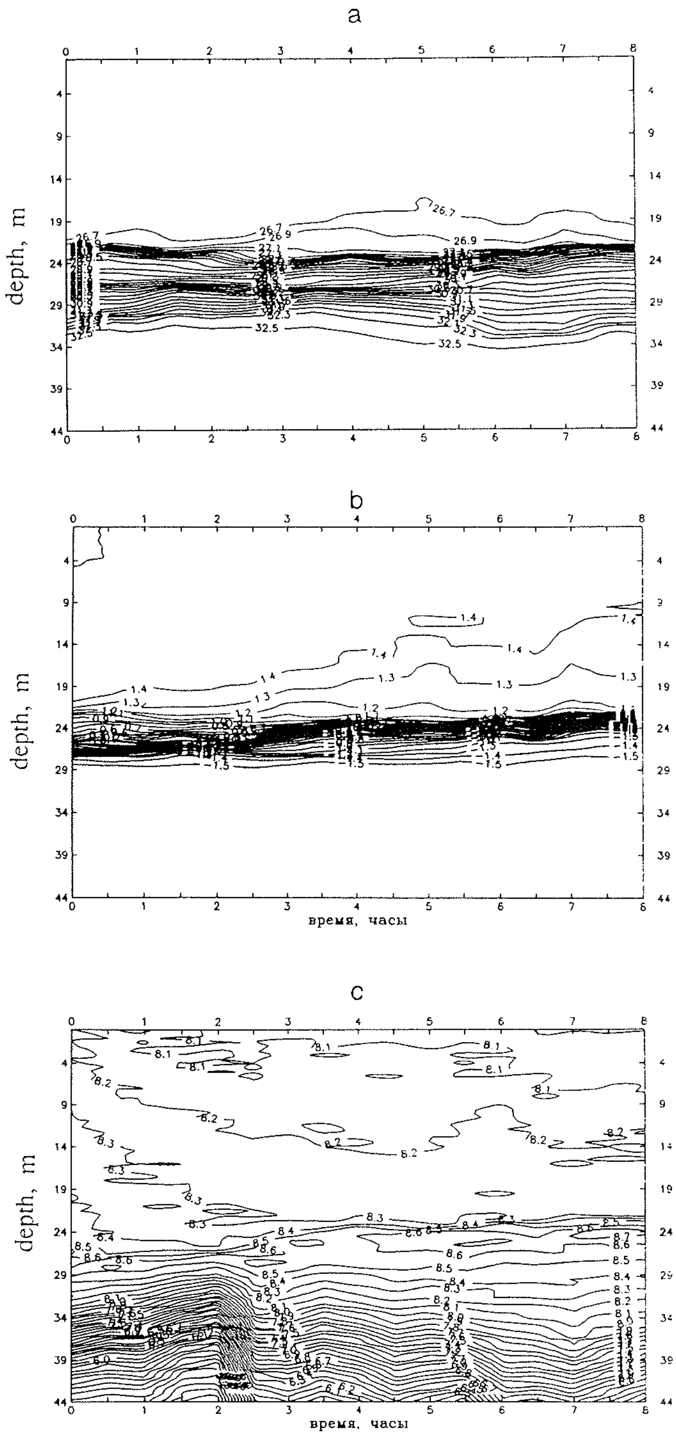


Fig. 44: Temporal variability of (a) salinity (ppt), (b) temperature (°C) and (c) dissolved oxygen (ml/l) by means of CTD-sounding at the long-term station PM 9417 (75° 30′ N, 130° 00′ E, September 6, 1994).

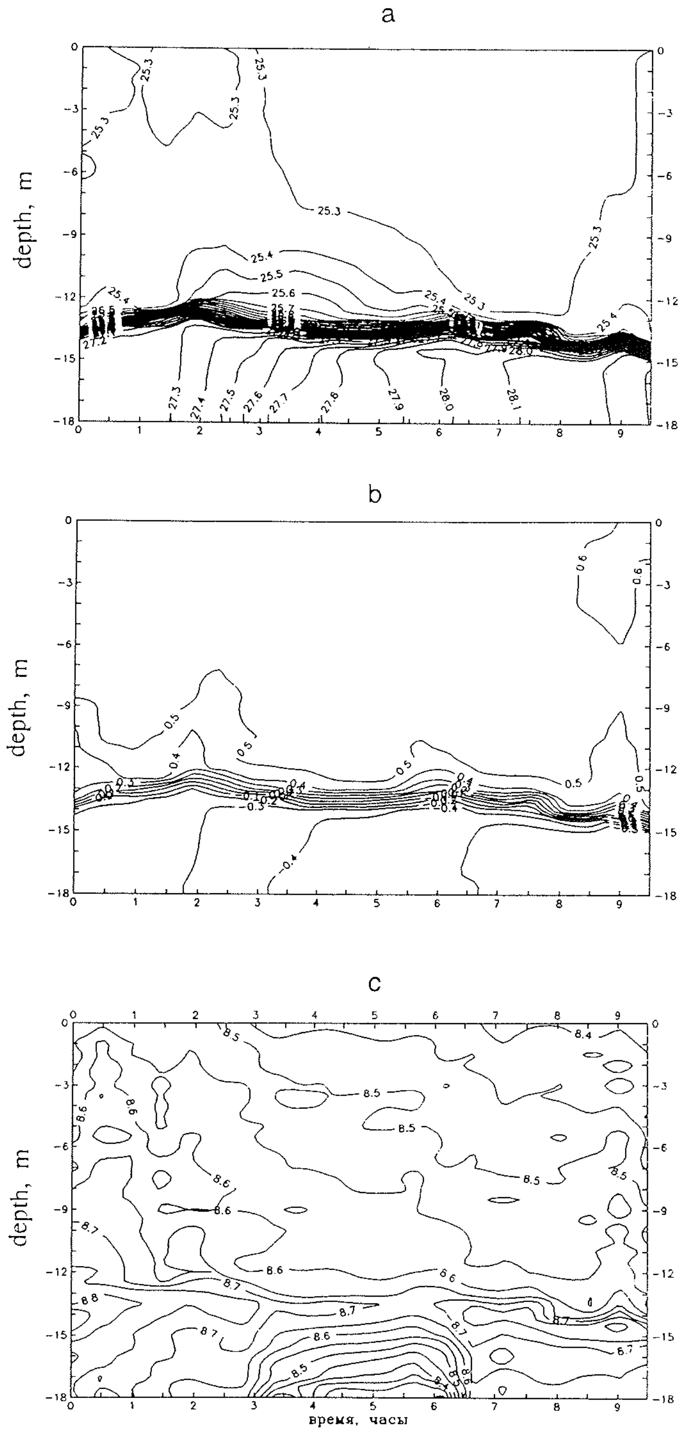


Fig. 45: Temporal variability of (a) salinity (ppt), (b) temperature (°C) and (c) dissolved oxygen (ml/l) by means of CTD-sounding at the long-term station PM 9424 (75° 57´ N, 136° 44´ E, September 7 - 8, 1994).

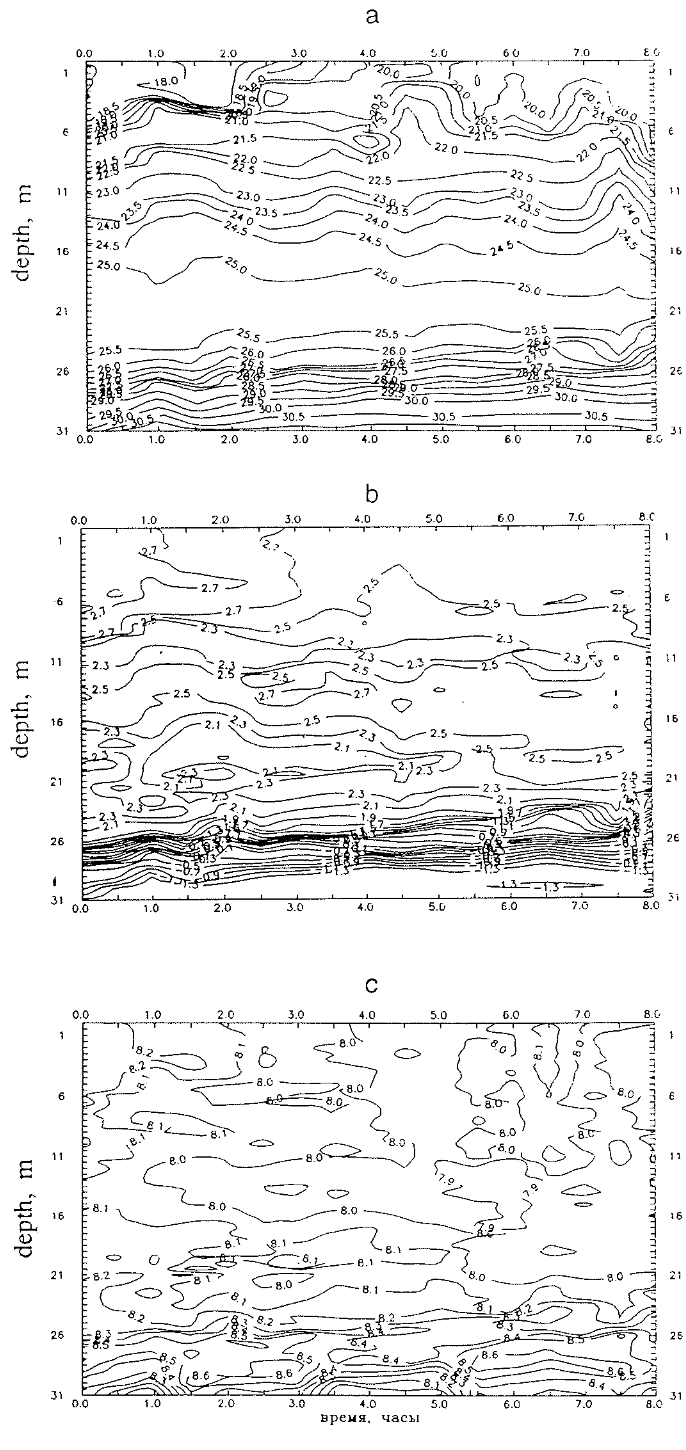


Fig. 46: Temporal variability of (a) salinity (ppt), (b) temperature (°C), dissolved oxygen (ml/l) by means of CTD-sounding at the long-term station Nb 45 (74° 30´ N, 127° 30´ E, September 10 - 11, 1994).

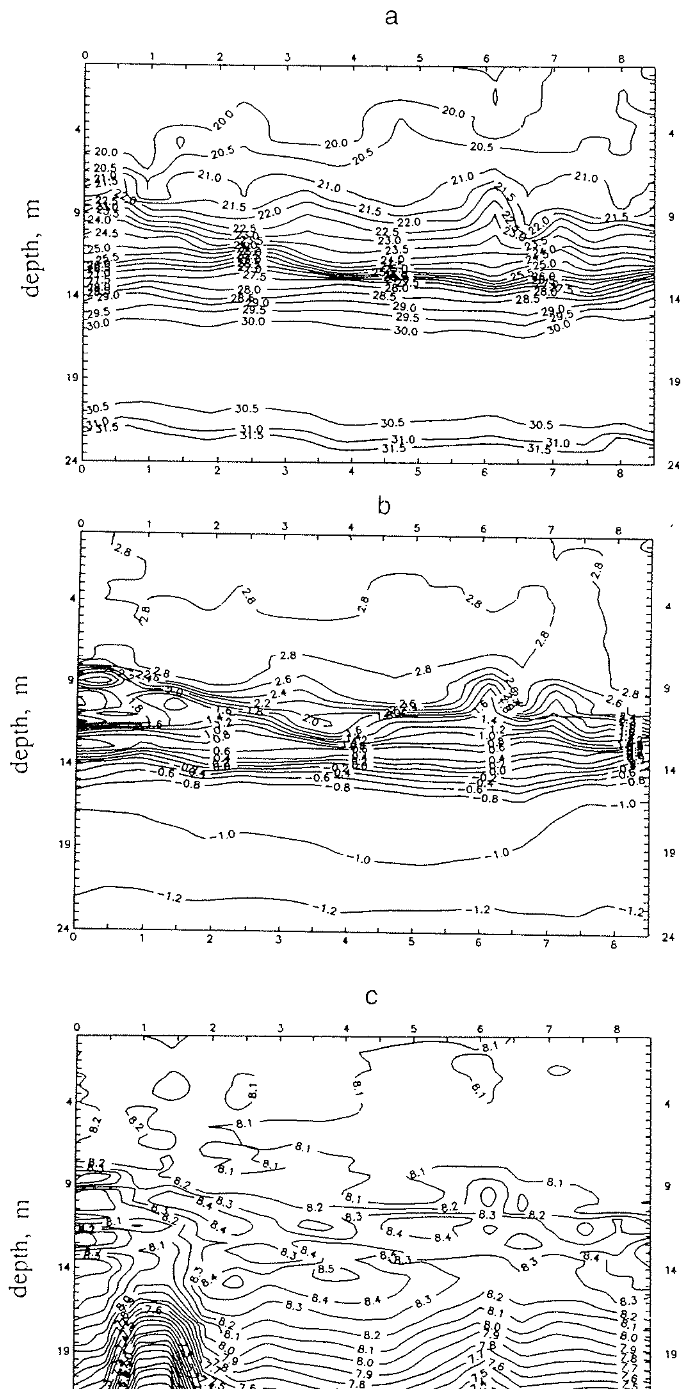


Fig. 47: Temporal variability of salinity (ppt) (a), temperature (°C) (b) and (c) dissolved oxygen (ml/l) by means of CTD-sounding at the long-term station PM 9451a (74° 30´ N, 130° 30´ E, September 13, 1994).

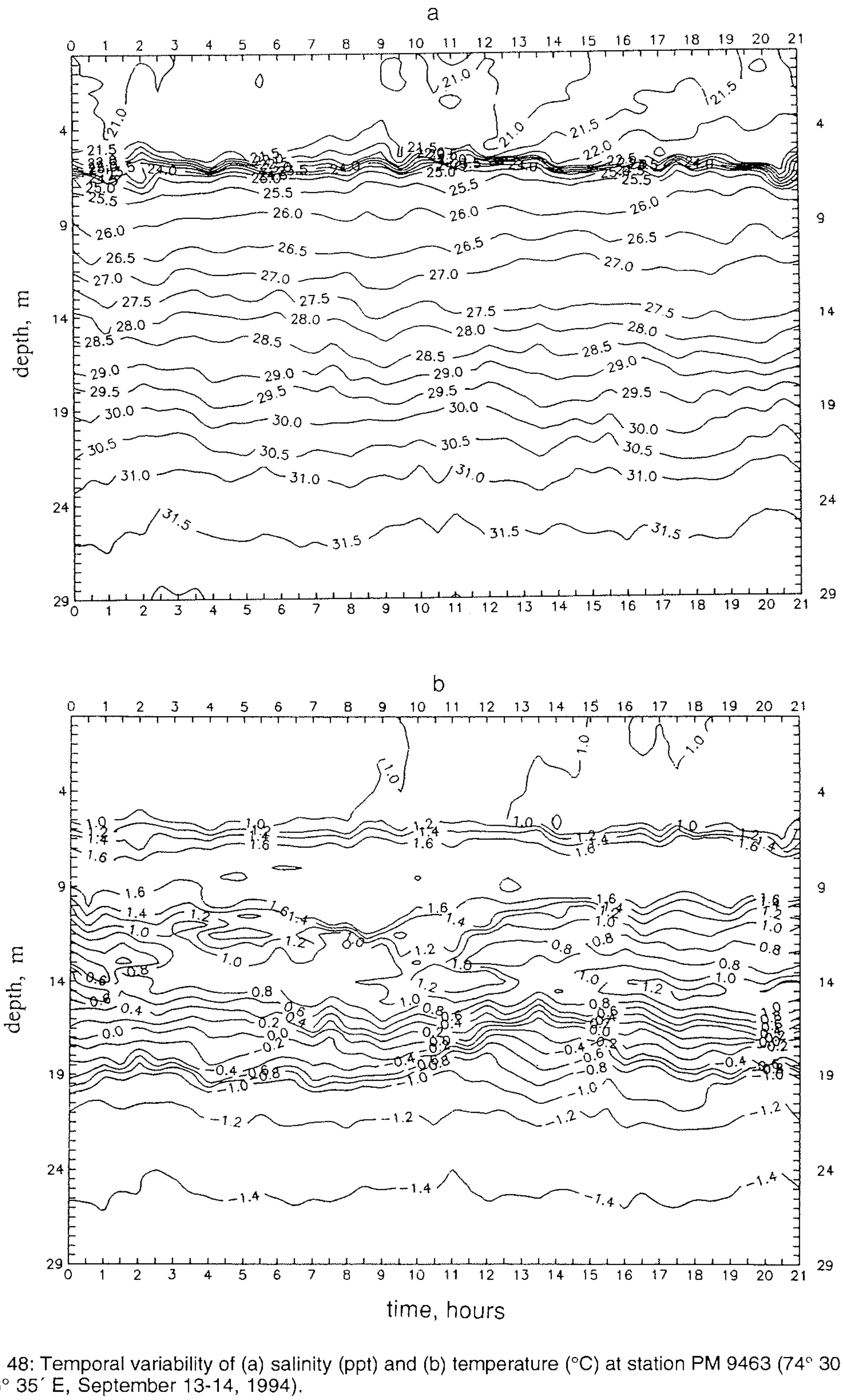


Fig. 48: Temporal variability of (a) salinity (ppt) and (b) temperature (°C) at station PM 9463 (74° 30´ N, 126° 35´ E, September 13-14, 1994).

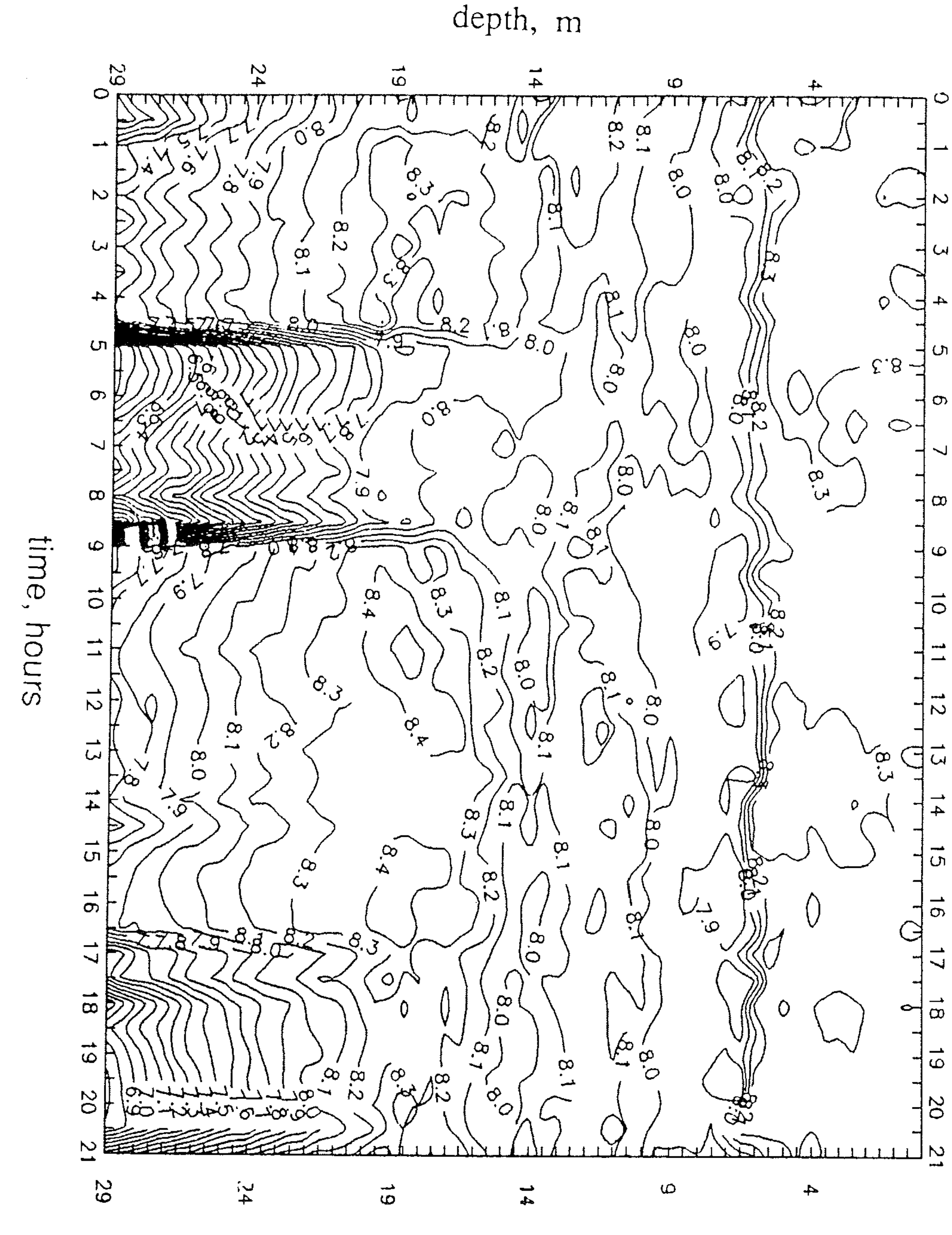


Fig. 49: Temporal variability of dissolved oxygen (ml/l) by means of CTD-sounding at station PM 9463 (74° 30´ N, 126° 35´ E, September 13-14, 1994).

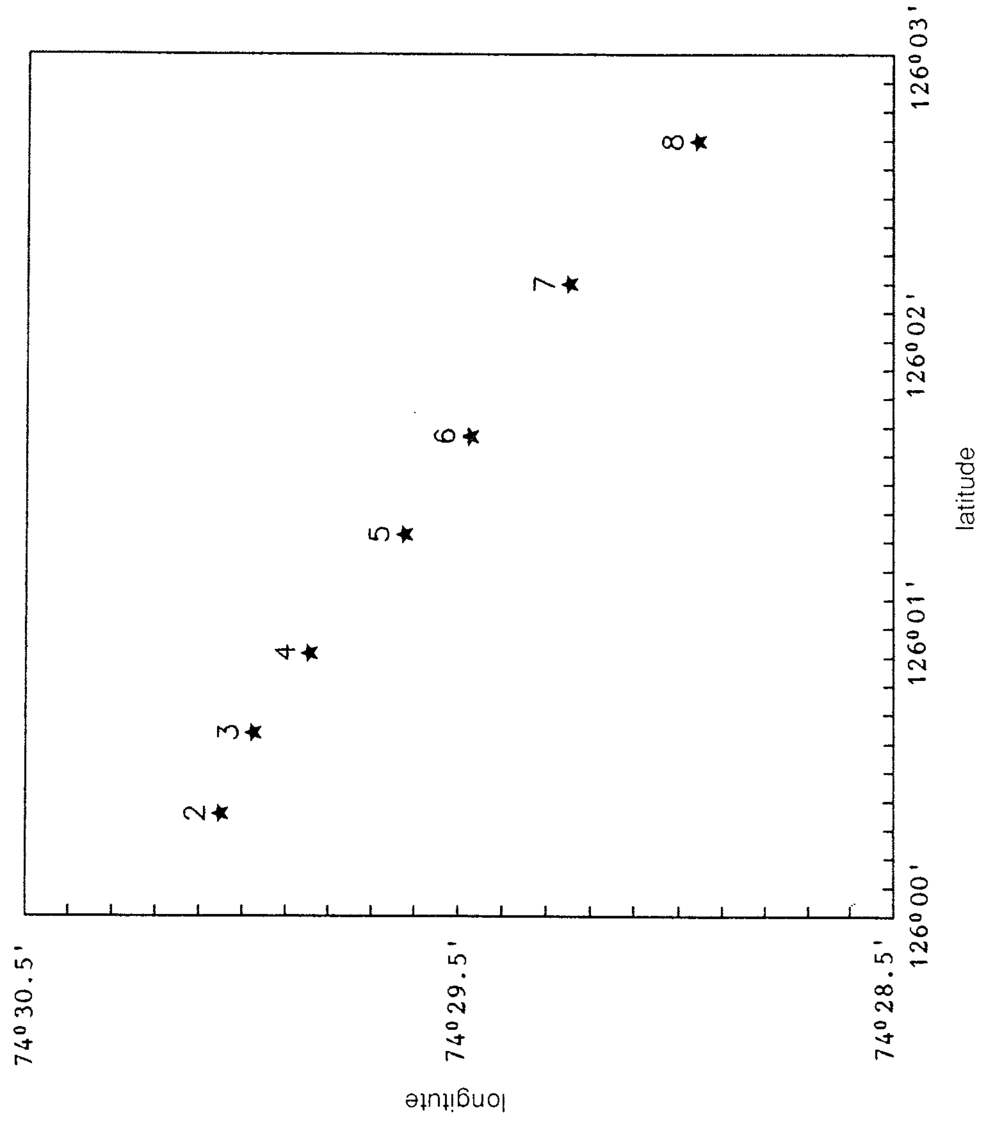


Fig. 50: The vessels´ drift during the long-term station PM 9442 (from 74° 29.106´ N, 126° 00.749´ E to 74° 28.957´ N, 126° 02.697´ E, September 10,1994).

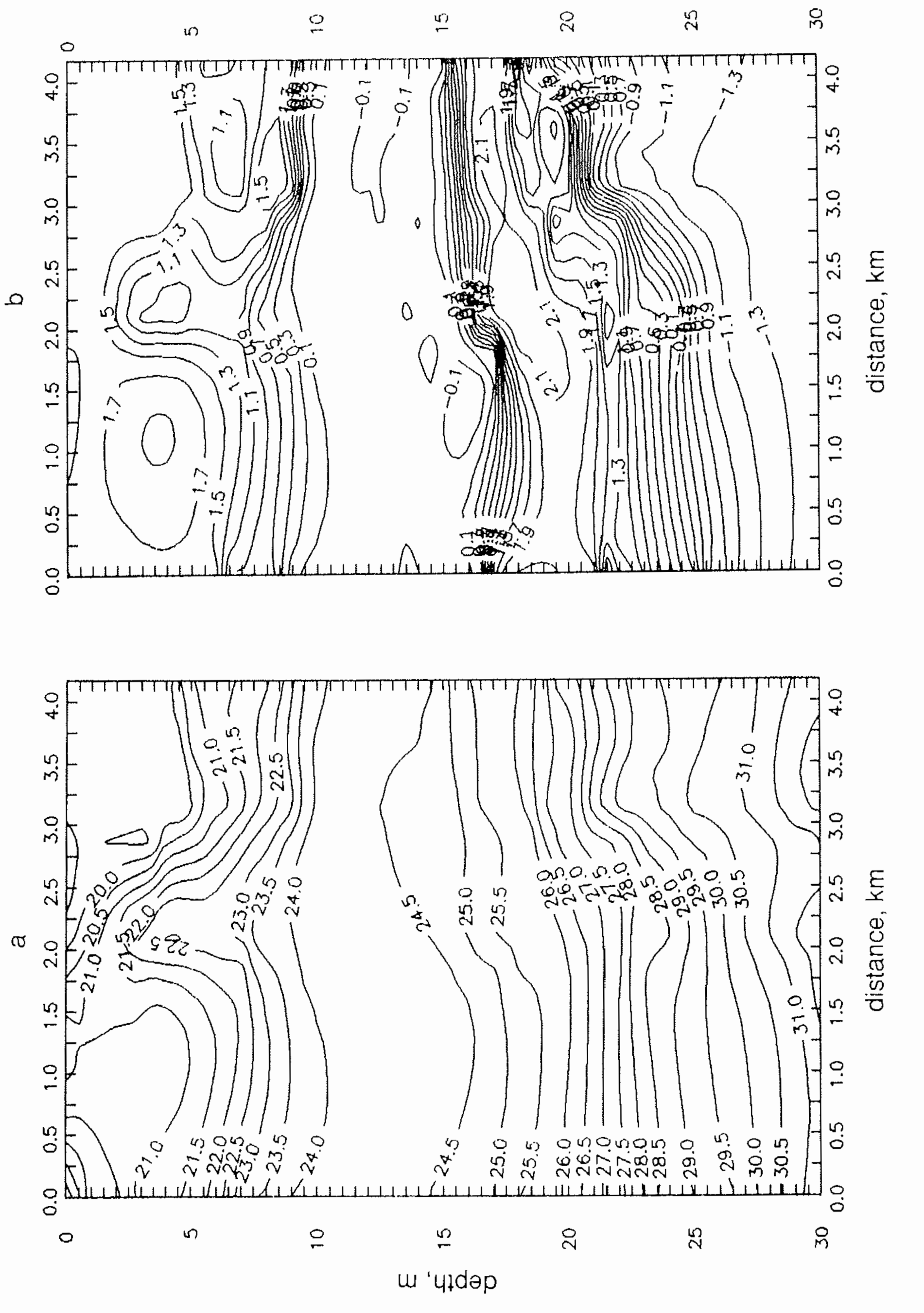


Fig. 51: Spatial variability of (a) salinity (ppt) and (b) termperature (°C) at the long-term station PM 9442 (from 74° 29.106´ N, 126° 00.749´ E to 74° 28.957´ N, 126° 02.697´ E, September 10,1994).

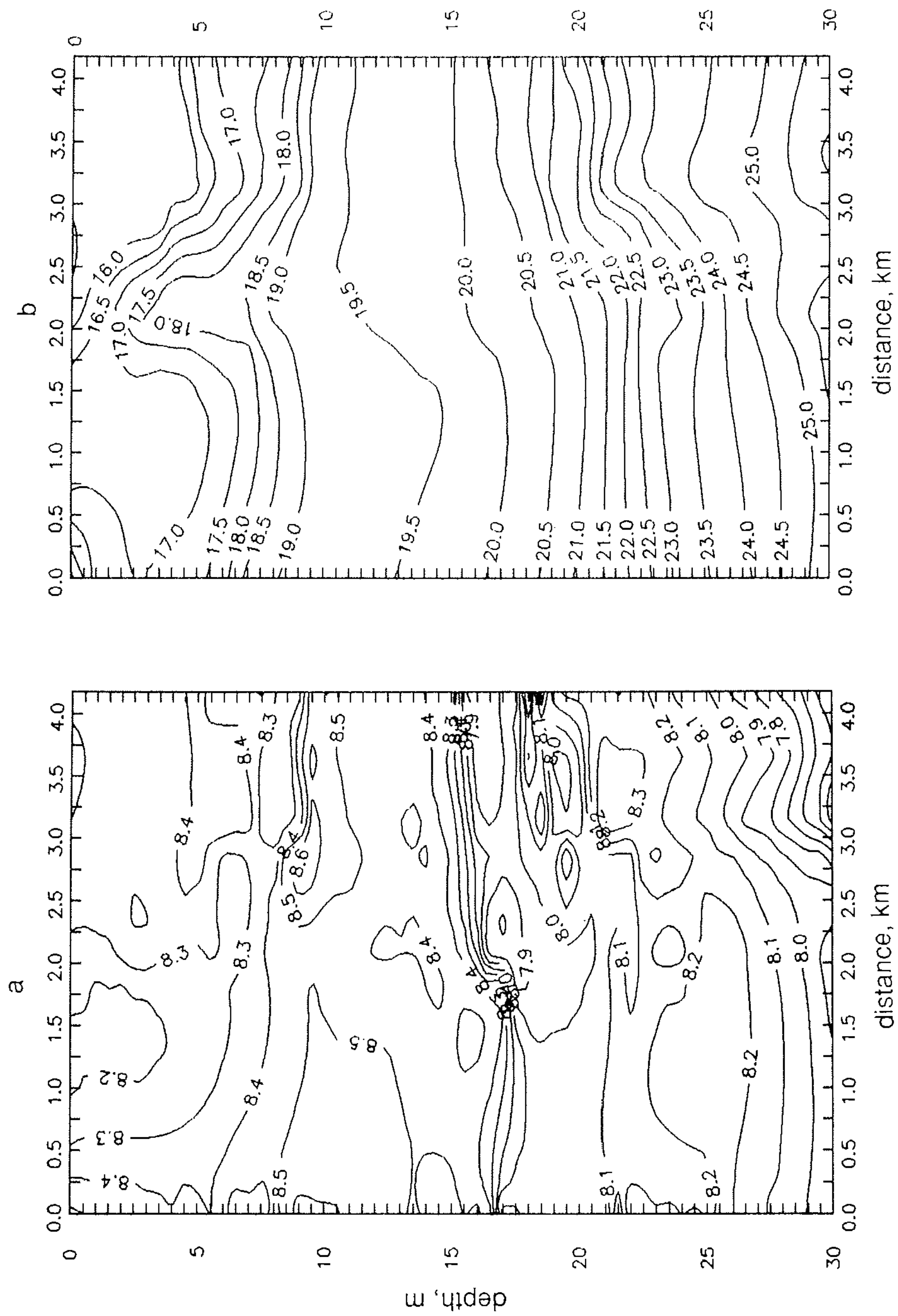


Fig. 52: Spatial variability of (a) dissolved oxygen (ml/l) and (b) conventional specific density at the long-term station PM 9442 (from 74° 29.106′ N, 126° 00.749′ E to 74° 28.957′ N, 126° 02.697′ E, September 10,1994).

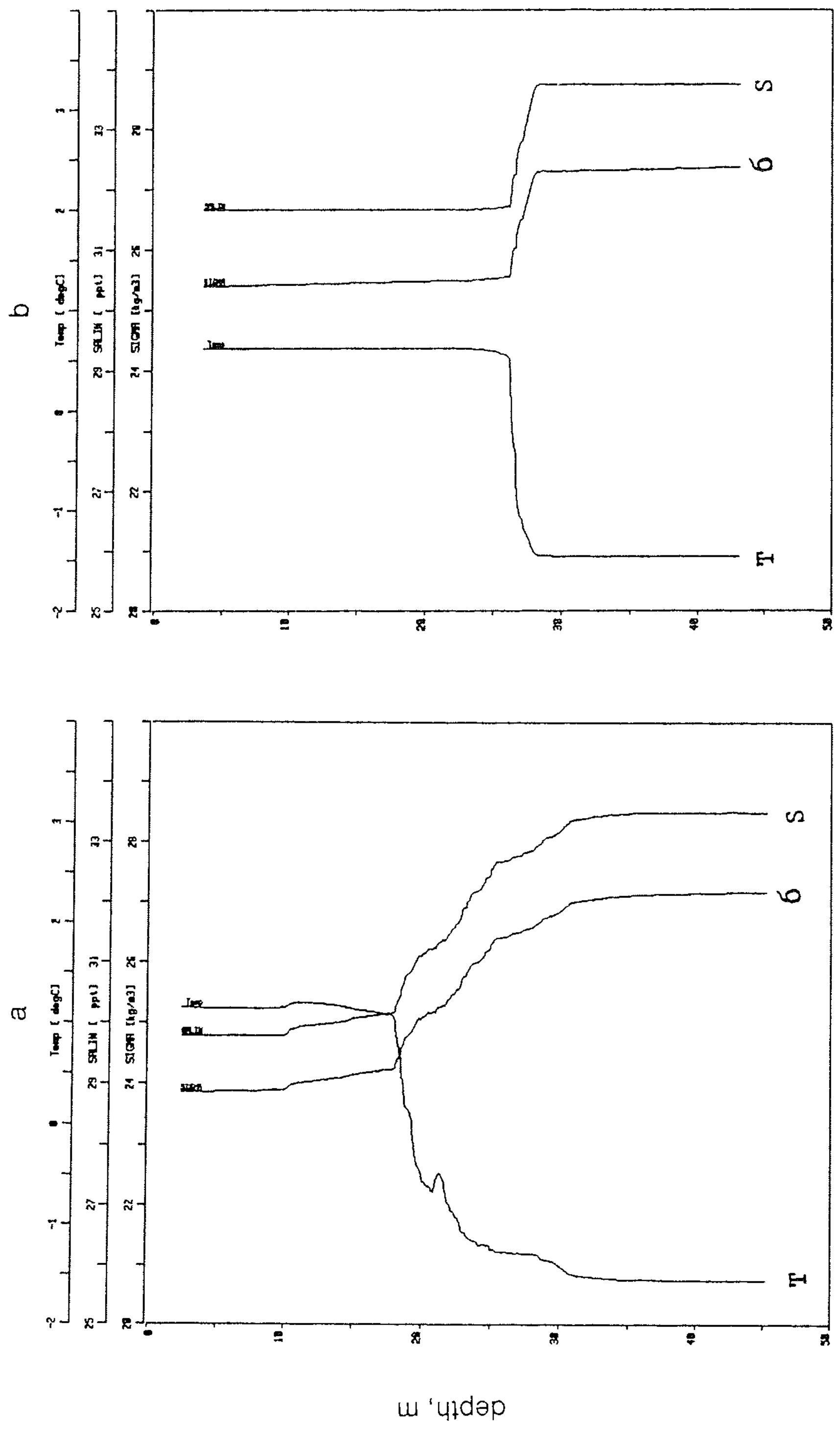


Fig. 53: Vertical distribution of temperature (°C), salinity (ppt) and density (conventional units) typical of the western Laptev Sea, (a) station PM 942/01, (b) station PM 947/01.

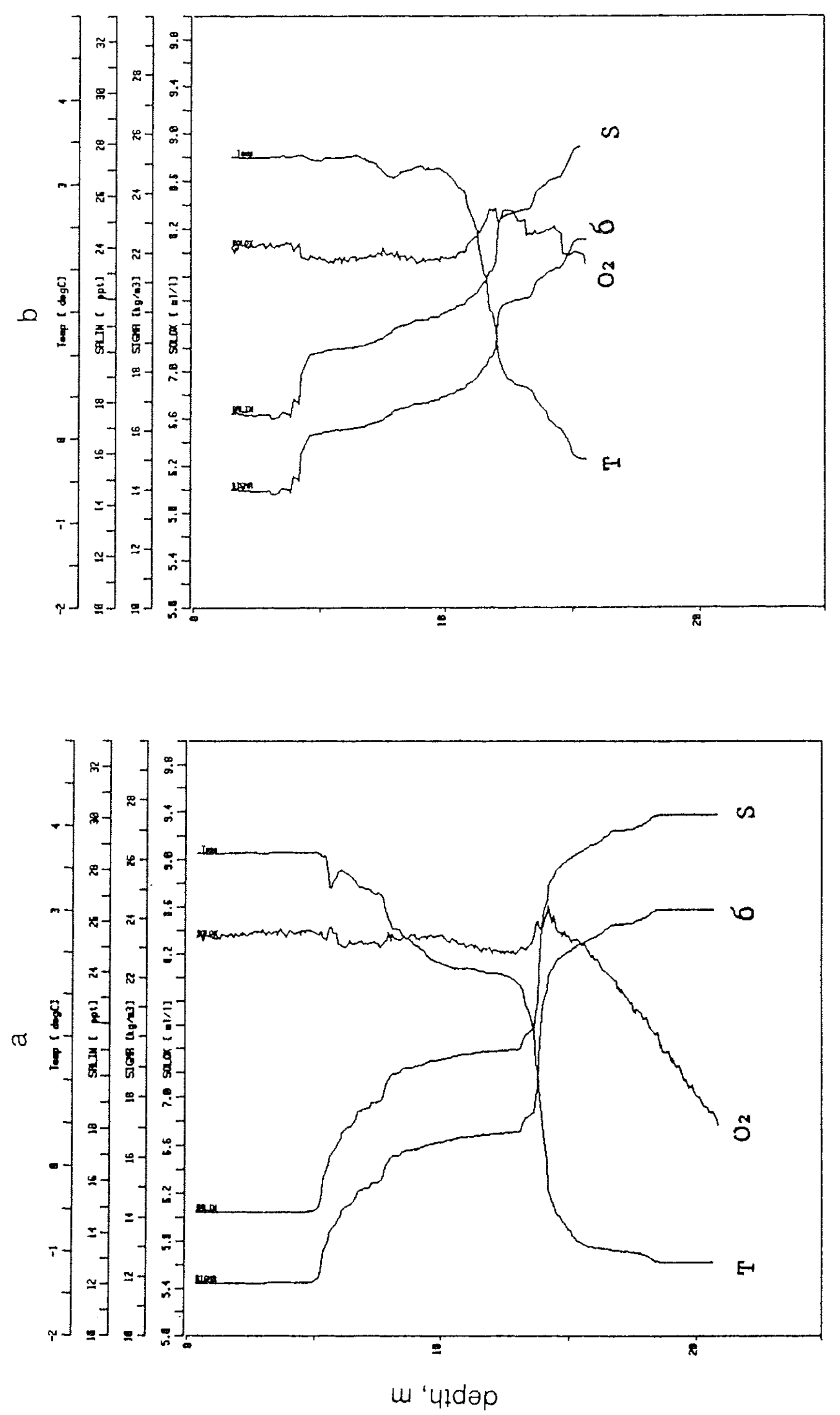


Fig. 54: Vertical distribution of temperature (°C), salinity (ppt), density (conventional units) and dissolved oxygen (ml/l) typical of the western Laptev Sea, (a) station PM 9431/01, (b) station PM 9453/02.

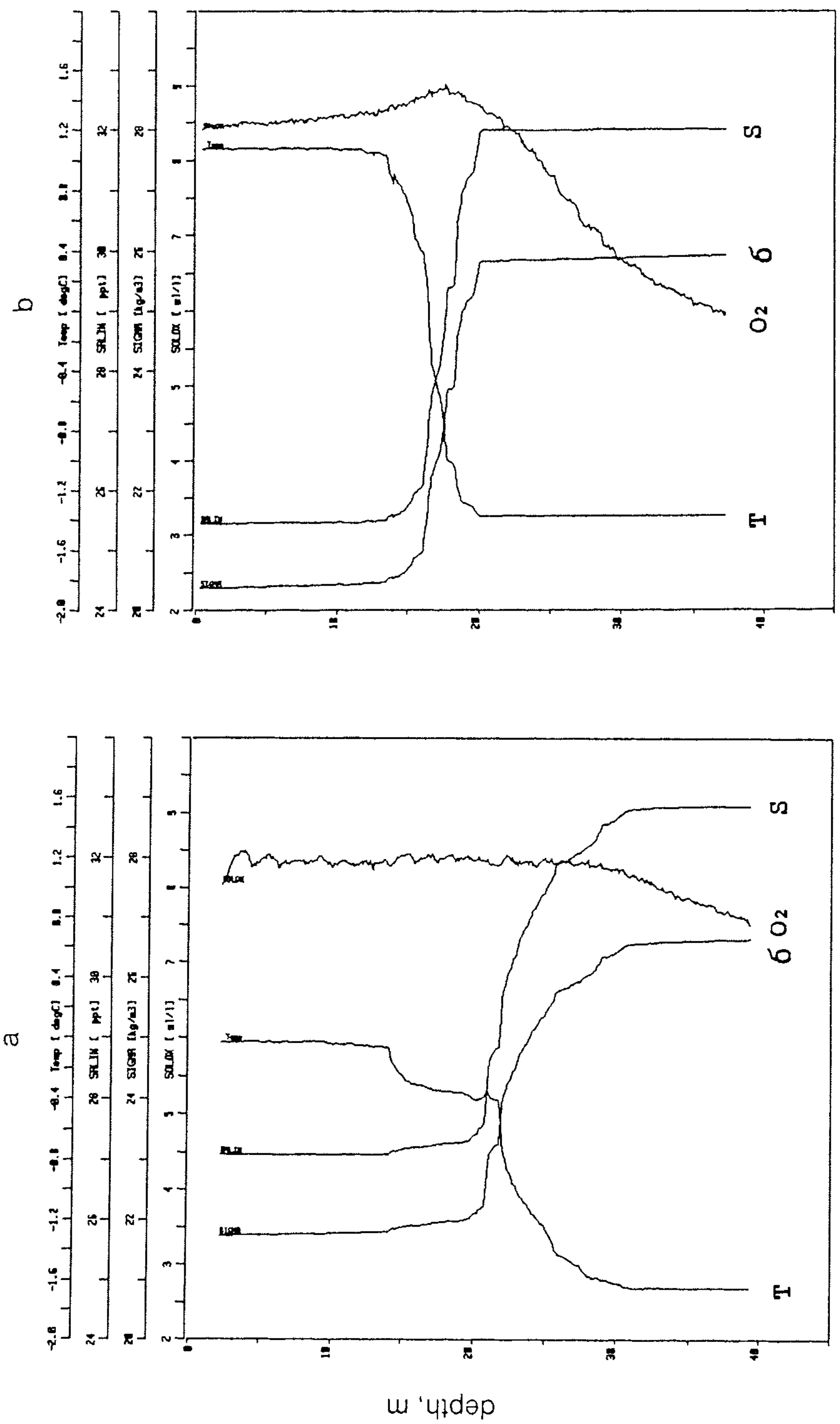


Fig. 55: Vertical distribution of temperature (°C), salinity (ppt), density (conventional units) and dissolved oxygen (ml/l) typical of zones of river water transformation, (a) station PM 9413/01, (b) station PM 9422/01.

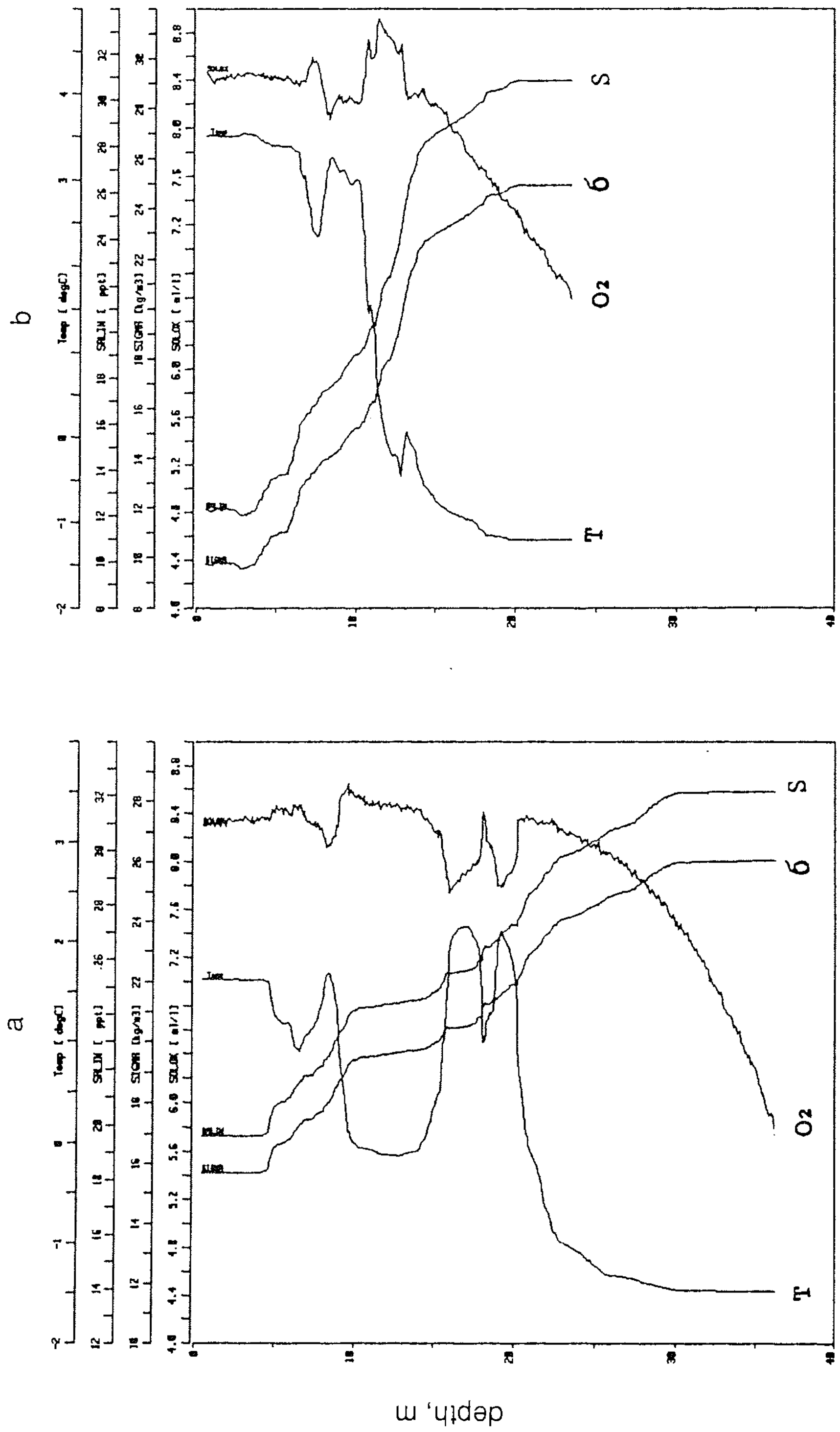


Fig. 56: Vertical distribution of temperature (°C), salinity (ppt), density (conventional units) and dissolved oxygen (ml/l) typical of the periphery of river water outflow, (a) station PM 9442/07, (b) station PM 9466/02.

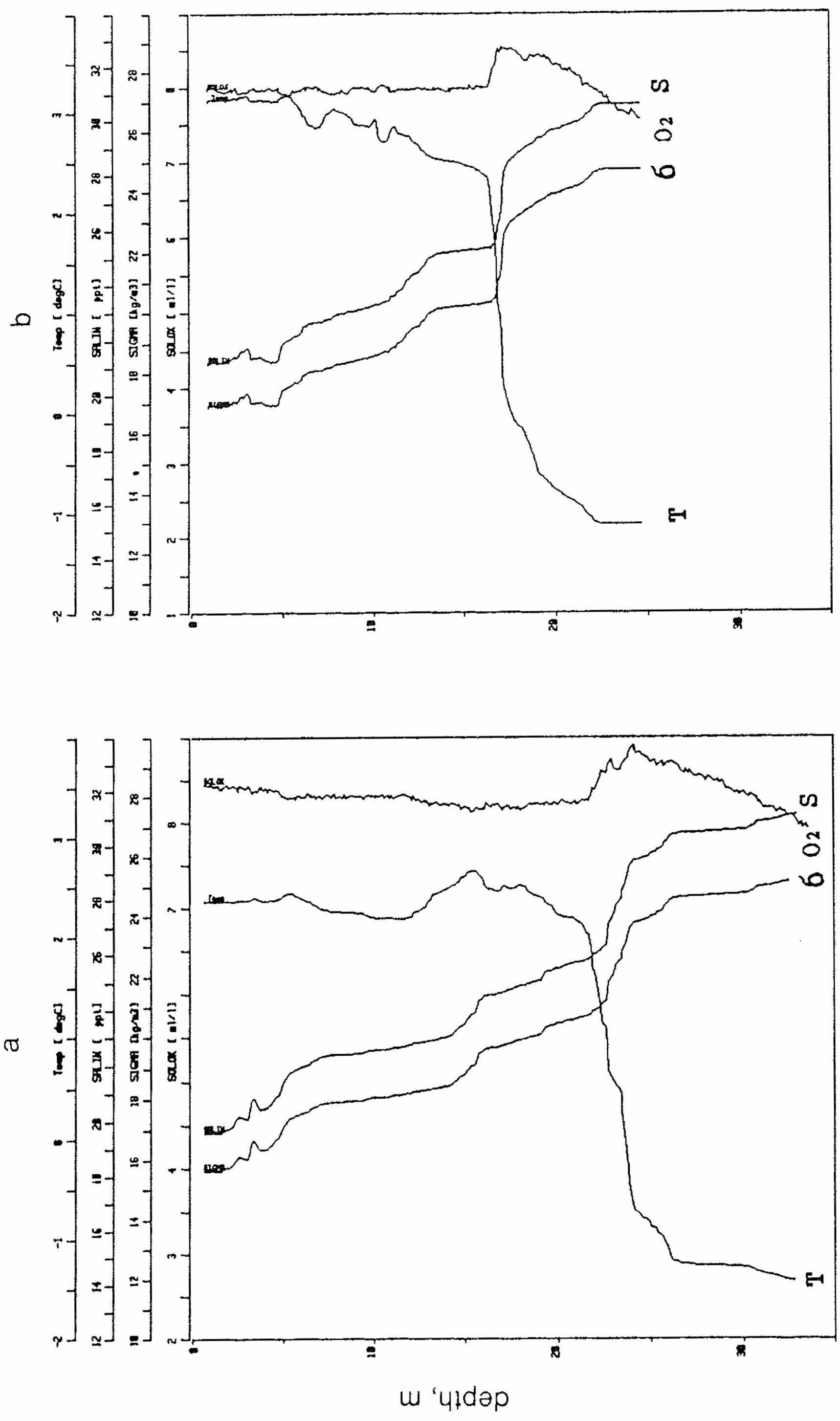


Fig. 57: Vertical distribution of temperature (°C), salinity (ppt), density (conventional units) and dissolved oxygen (ml/l) typical of the axis of river water outflow, (a) station PM 9446/01, (b) station PM 9451/01.

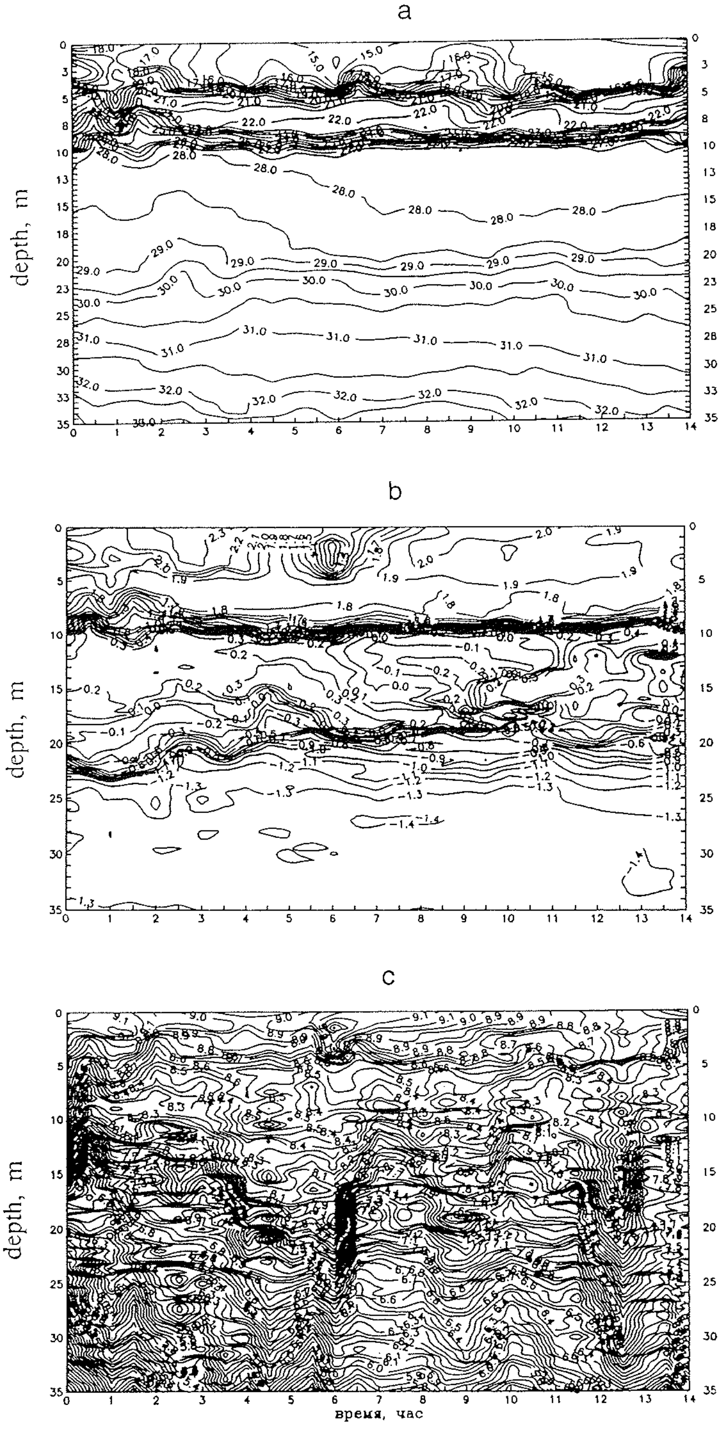


Fig. 58: Temporal variability of (a) salinity (ppt), (b) temperature (°C) and (c) dissolved oxygen (ml/l) obtained by means of CTD-soundings at the long-term station PM 94K12 (74° 30′ N, 126° 35′ E, August 23 -24, 1994).

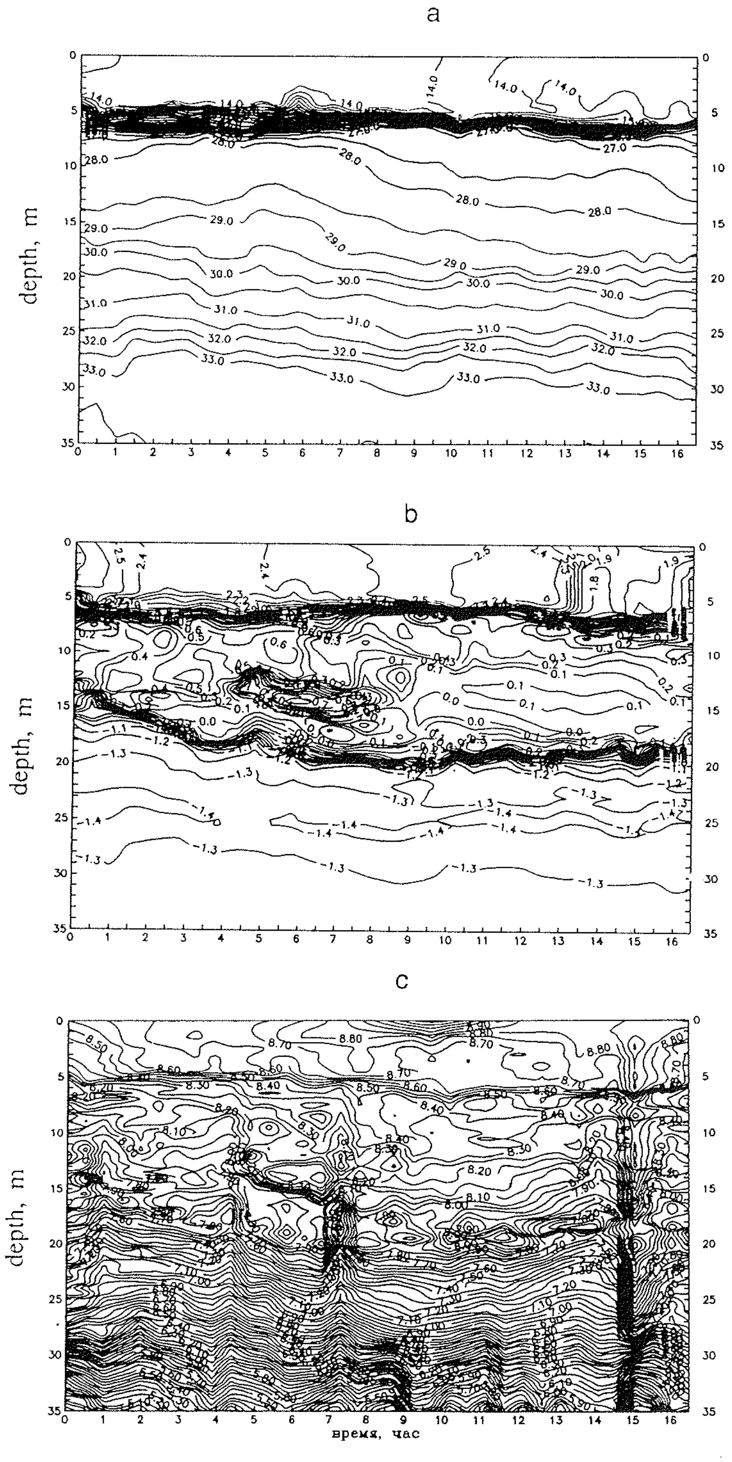


Fig. 59: Temproal variability of (a) salinity (ppt), (b) temperature (°C) and (c) dissolved oxygen (ml/l) obtained by CTD-soundings at the long-term station PM 94K13 (74° 30´ N, 126° 35´ E, August 24, 1994).

A considerable increase in data on chlorophyll "a" distribution is obtained using the method, which is based on measurement of its fluorescence in optical range after it is influenced by radiation.

The measurement of the chlorophyll "a" fluorescence can be taken to quantifiy its distribution in sea water. For the qualitative measurement it is necessary to carry out in parallel several measurements by extracting water samples in each part of the sea, which differs by its hydrological characteristics. The concentration dependency can vary due to e.g. variability of phytoplankton species.

The hydrological properties are, therefore, controlled by hydrophysical, hydrochemical and biological processes, which take place in the ocean, and these properties should significantly vary under influence of the river water outflow.

There exist detailed investigations made about the distribution of hydrooptical characteristics in southern seas and oceans (Erlov, 1970, Ivanov, 1975, Karabashev, 1987) whereas hydrooptical characteristics of the northern seas are still unknown (Martyshenko and Ushakov, 1993).

Goals of the expedition were the following:

- to obtain the distribution of the light transmission coefficient in sea water and of the chlorophyll "a" fluorescence intensity in the Laptev Sea;
- to study the influence of the river water outflow on the hydrooptical characteristics of sea water in the eastern part of the Laptev sea;
- study relations between hydrooptical characteristics and oceanographic, biological, hydrochemical properties especially in the outflow zone.

Working Program

The working program involved the following goals:

- to carry out two transects of the Lena outflow (along 74° 00' N, 74° 30' N with distances between the stations of 8 nm), and two along 129°00' E and 134°00' E (with a distance between the stations of 30 nm) from 10 m depth to the northern boundary of the river water or up to the ice edge;
- to fulfill observations in the frontal zone between river runoff and marine water masses;
- to carry out hydrooptical observations every 3-4 hours during the long-term stations.

Observations and Equipment

The measurements of the light transmission coefficient were made during the expedition at 93 oceanographic stations (Tab. A2). 59 stations were carried out in the Lena outflow zone (Fig. 2, Tab. A2). The measurements of the chlorophyll "a" fluorescence intensity were carried out at all oceanographic stations exept of the stations PM94100 and PM94101.

Five measurements of the vertical distribution of the light transmission coefficient were carried at station 63 (time interval 2-8 hours). Seven soundings with a fluoremeter were fulfilled every 1-8 hours.

At 10 oceanographic stations in the Kara Sea near Dikson and Belyy Island and at stations k12-k16 (Fig. 16) near the ice edge hydrooptical measurements were fulfilled. Three measurements of the vertical distribution of the transmission coefficient with a time interval of 6 hours and 6 soundings by the fluorometer with intervals 2-4 hours were carried out at the long-term stations k12 and k13.

Sea water samples were used for measurements of the transmisson coefficient .

These samples were obtained at standard horizons by means of the bathometers (BM-48). The light transmission coefficient was determined in the visible range (400-750 nm).

For the transmission coefficient measurements (CPC-2) a photoelectric concentration colourmeter was used with the following technical characteristics:

- the spectrum range is 315-980 nm;
- the limits of the transmission coefficient measurements are from 100 to 1%;
- the limit of the allowable value of the main absolute error is 1%.

Cuvettes with a working length of 10 cm were applied for these measurements. The transmisson coefficient of distilled water was taken as 100%.

The fluorescence intensity was measured by means of the fluoremeter "VARIOSENS II" (Impulsphysik GmbH, Germany). Special light filters were installed in its radiator and reciever with transmission maximums at wave lenghts of 460 nm and 680 nm respectively.

The logarithmic amplifier within the electronic scheme of the fluoremeter permits registering fluorescence in a wide range of intensity. This range corresponds to limits of varying chlorophyll "a" concentrations in 4 ten-day periods. An impulse xenon lamp which gives 10 flashes per second is used as a source of radiation. The powerful light impulse of the xenon lamp allows us to ignore the influence of sea water turbidity, which is insignificant at least for values of the transmission coefficient up to 10% as shown by special tests.

The error in measuring the concentration of the chlorophyll "a" does not exceed 10% if we have additional information on the phytoplankton species.

A silicon photodiode was used as radiation receiver. Its electronic scheme is opened by a special impulse of the lamp flash. It reduces hindrances caused by natural light of the receiver. The fluoremeter is applied to chlorophyll "a" extracted from chlorella.

The value of the output tension was taken as a conventional unit while representing results of the measurements.

Preliminary Results

1. For the first time, hydrooptical measurements were carried out in the ice-free part of the Laptev Sea. In addition, the distribution of the light transmisson coefficient of sea water (Fig. 20, 26, 30, 34, 38, 42, 60) and of chlorophyll "a" fluorescence intensity (Fig. 19, 25, 29, 33, 37, 41, 61) were obtained.

2. The obtained distribution shows us that river water in the outflow zone is characterized by reduced chlorophyll "a" fluorescence intensities.

The regions of river water outflow, which were determined according to the hydrooptical characteristics, coincided with regions which were marked out by hydrological and hydrochemical observations (Manual, 1993).

3. A reduced light transmission coefficient was revealed at a wave length exceeding 540 nm typical of all stations. In order to explain this phenomenon for subsurface and nearbottom water samples special measurements of the transmission coefficient were carried out. The same measurements were carried out after filtering particles exceeding 450 nm. The decrease in the transmission coefficient in the longwave part of the spectrum is related to the influence of the particles and is probably controlled by the light absorption of phytoplankton.

4. A correlation between the vertical distribution of the fluorescence intensity with the vertical thermohaline structure of the water column was revealed. Regions dominated by river runoff have a maximum of fluorescence at the sea surface

whereas the fluorescence is decreasing with depth.

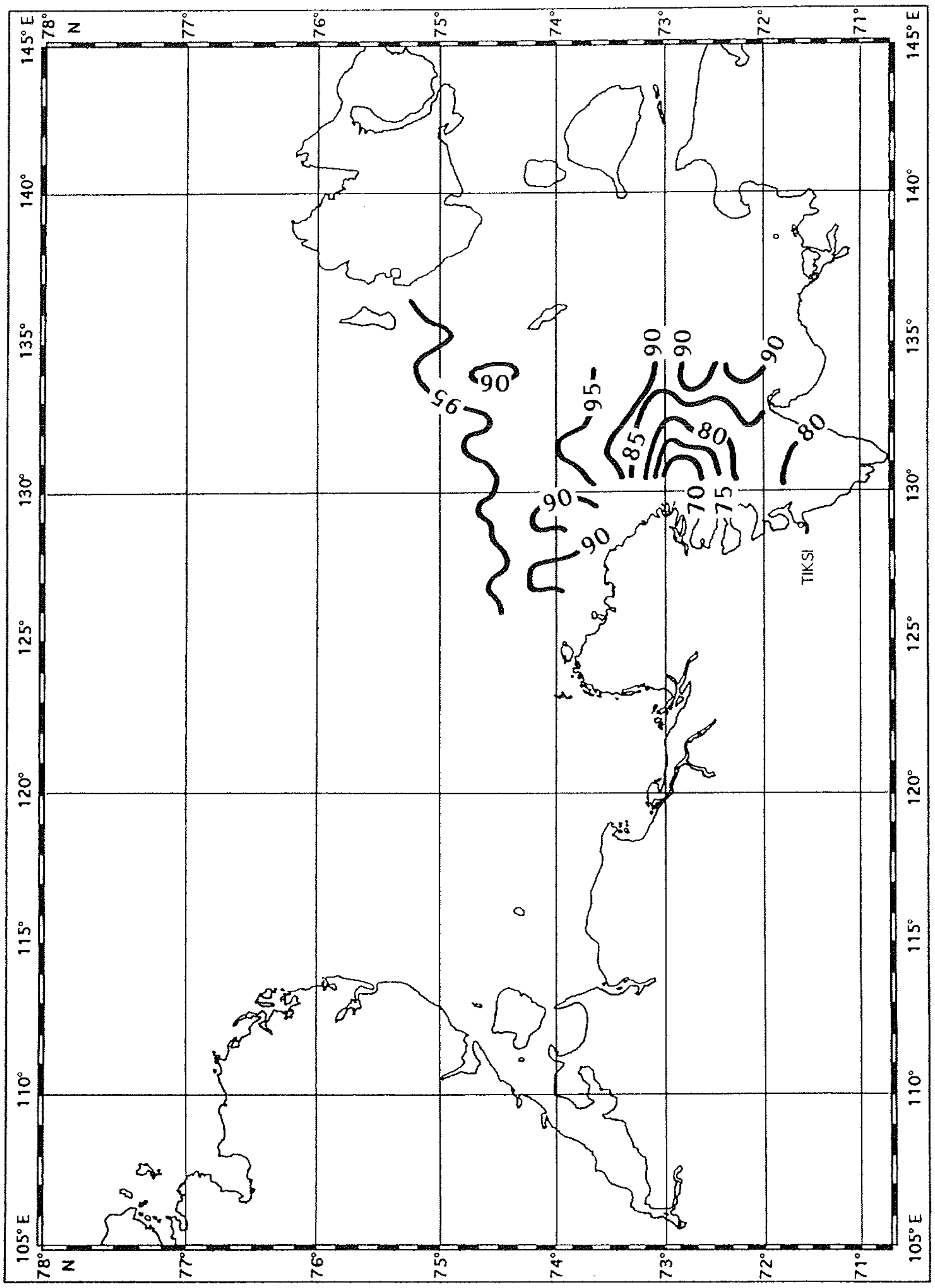


Fig. 60: Light transmission (wave length 400 nm) distribution at the sea surface (September 194).

A surface and another maximum are observed in zones of river runoff transformation and in the frontal zones along the transect 75° 30' N.

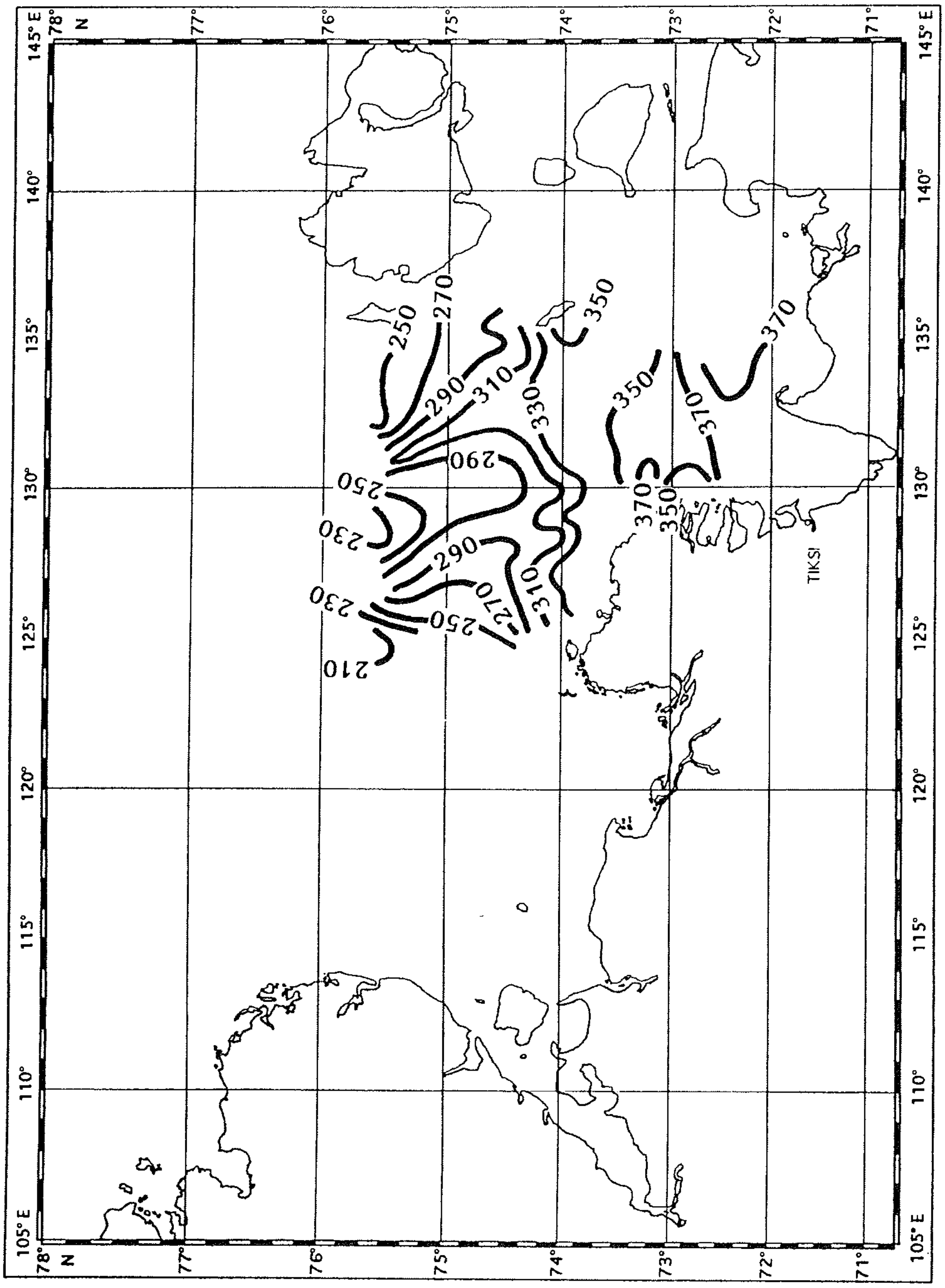


Fig. 61: Fluorescence distribution (conventional units) at the sea surface (September 1994).

Reduced fluorescence values (as compared with the mixed water masses) are typical of zones of Arctic water masses. Both the horizontal and the vertical variability of the chlorophyll "a" fluorescence correlate with the thermohaline structure. The temporal variability of chlorophyll "a" fluorescence depends on variations of the thermohaline structure of the water masses.

Hydrochemical Observations

S.V. Pivovarov

Scientific Program

Hydrochemical observations are necessary for:

- a detailed vertical and horizontal distribution of the chemical and oceanographic characteristics of the Laptev Sea;
- monitoring the sea medium state;
- drawing up causes of temporal and spatial variability of the main biohydrochemical indices.

Dissolved oxygen in sea water and silicate concentration are good indicators of water mass origin and of its distribution. Furthermore, these indices together with other nutrients (phosphates, nitrates, nitrites) allow us to estimate the productivity of the surface layer and the biological and biochemical processes at different depths. The relationship between hydrophysical, hydrobiological and hydrochemical indices of the Laptev sea water masses in combination with peculiarities of hydrochemical element distribution in the outflow zones and varying concentrations of transported substances are important goals of these investi- gations.

Working Program

The concentration of dissolved oxygen and silicates at standard levels at the oceanographic survey stations was determined. The concentration of phosphates, nitrates and nitrites was determined also at all hydrobiological stations. Oxygen, phosphates, nitrates and nitrites were determined at 0 m , 5 m and 10 m water depths (Tab. A2). Silicate was measured every 2 m in the frontal zone between river and marine water masses (Tab. A2).

Observations and Equipment

The following work was fulfilled at 16 stations in the Kara Sea (Fig. 16) and 93 stations in the Laptev Sea (Fig. 2, Tab. A2):

- 634 measurements of dissolved oxygen concentration;
- 629 measurements of silicate concentration.

In addition, 161 phosphate measurements were carried out at 5 stations in the Kara Sea and at 22 stations in the Laptev Sea. 146 nitrite and nitrate measurements were conducted at 2 stations in the Kara sea and 22 stations in the Laptev Sea.

The dissolved oxygen concentration was determined by means of a modified Winkler method (Manual, 1993) using the automatic electronic burette ABU 80. In 1993, the oxygen phials and the other calibrated bottles were verified in the hydrochemical laboratory RC "Arctic monitoring". The silicate concentration was determined by a colorimetric method using ascorbin acid for reducing the silicium-molybdenum complex [20]. The phosphate concentration was determined by the colorimetric method of Murphy and Riley [20]. A photoelectrocolorimeter КФК-2 was used verified in July 1994. Calibrating plots were constructed before the beginning of the work using sea water with low concentration of phosphates and silicate.

The nitrite and nitrate concentrations were determined by means of the colorimetric method using the automatic analyzer AKEA (Wood, Armstrong and Richards according to instruction). Before analyzing each sampling group the device was calibrated with standard solutions.

Preliminary Results

1. The boundary of river runoff influence in the Laptev Sea was determined by silicate concentration. The distribution of hydrochemical elements in the outflow zones and the variations of concentrations of transported substance were revealed.

In September 1994, the river runoff influence was limited by the inflow of water masses from north-west. This fact is confirmed by a zone with minimum of silicates in the north-western Laptev Sea.

The oxygen in the surface layer of the outflow zone was in the range from 8.06 to 8.75 ml/l and varied according to temperature and salinity changes and to mixing conditions with underlying layers and photosynthetic activity of phytoplankton. The amount of nitrates in the surface layer of this zone was nearly utilized. The phosphate concentration was equal to an average of 3 μg/l and it was twice as low compared with other parts of the Laptev Sea.

2. Zone of stagnant water masses and spatial variations of hydrochemical indices in this zone were determined. The minimum oxygen concentration (45% of saturation) was observed at a depth of 36 m in a little valley between two submarine hills at station 42 (74° 29' N,126° 01' E). It turned out that the concentration of oxygen and nutrients in stagnant water masses and the relationship between these parameters varied with regard to their movement from their formation sources.

3. The vertical hydrochemical structure of the sea was adjusted. Unusual was the great thickness of the mixed layer marked out in the western part of the Laptev Sea. A clearly pronounced layer of minimum silicate concentrations was traced between 10-15 m water depths, i.e. everywhere in the river water outflow zone (Fig. 62). This layer corresponded to temperature anomalies in the upper part of the main pycnocline. Intermediate extreme values of nitrate concentration were observed in the frontal zone.

4. Data on mesoscale variations of the hydrochemical indices in different layers were obtained in the frontal zone and near the ice edge.

5. Correlations were determined:

- between sea water salinity and silicate concentrations in the Laptev Sea surface water masses;
- between hydrochemical indices in the stagnant near-bottom zone;
- between two hydrochemical and hydrobiological indices.

6. A comparative analysis of the observations in 1994 and of the preceding observations allows a conclusion about the significant interannual variability of the hydrochemical structure and the causes of this variability.

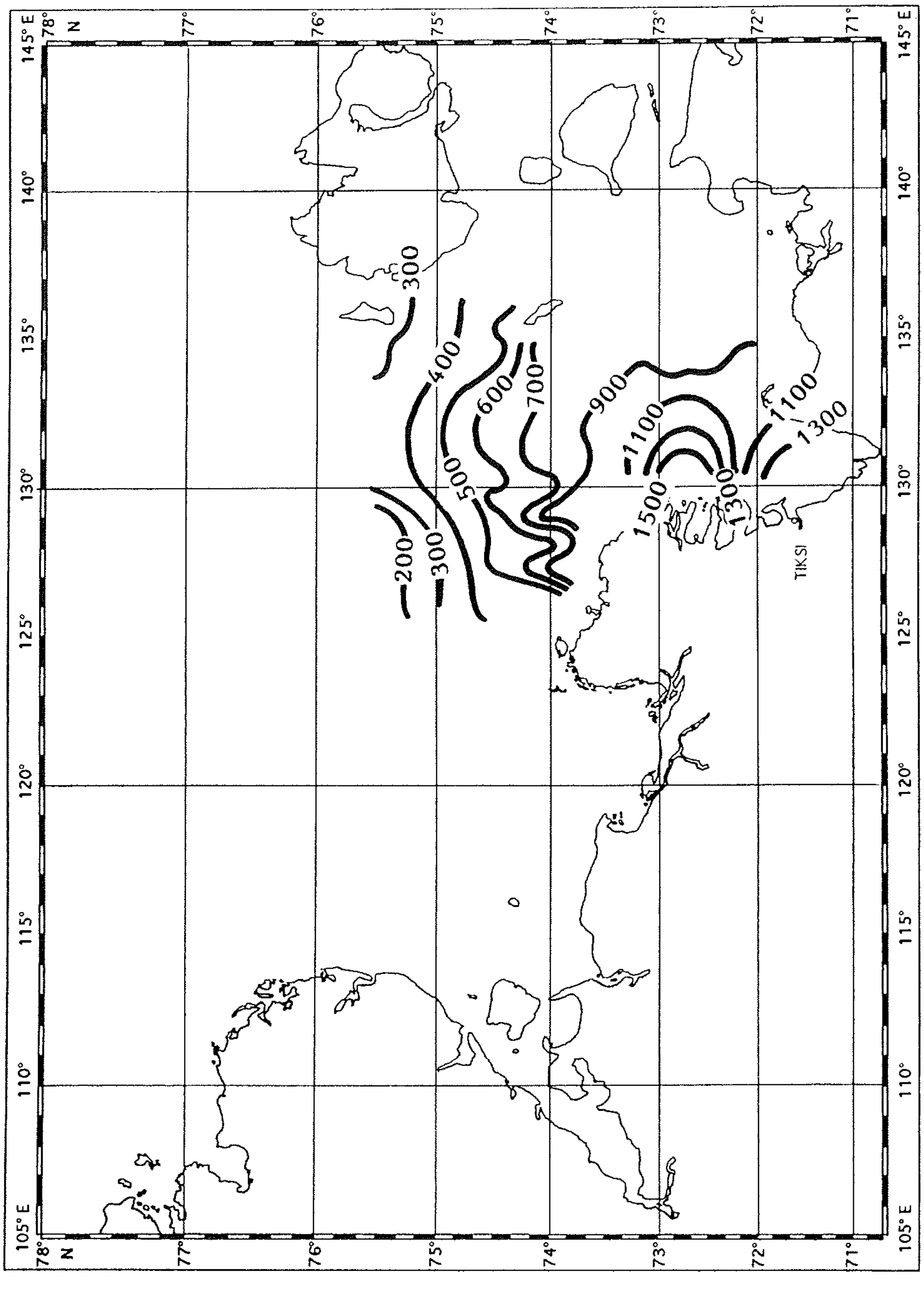


Fig. 62: Silicium distribution (mcg/l) at the se surface (September 1994).

Hydrobiological Studies

A.V. Novoshilov and V.V. Petryashev

Scientific Program

Investigations of Laptev Sea biota became more important during the last years. From 450 stations which have been fulfilled in the Laptev Sea, nearly 100 stations were fulfilled during the ARCTIC expedition on board the RV *Ivan Kireyev*, *Polarstern* and on board the *Lot*. The combined approach permits studying the interrelations of biological and sedimentary processes.

Nevertheless, results have shown that data on the diversity of benthos and plankton as well as the distribution of macrobenthos species of the estuary-arctic complex have to be improved. That refers especially to those parts influenced by fresh water masses. In addition, the impact of environmental conditions on biota requires further investigations.

Working Program

The main goal of the TRANSDRIFT II expedition in the Laptev Sea was biological sampling at oceanographic stations in the Laptev Sea with the aim of:

- specifying macrobenthos and plankton species;
- clarifying the distribution of biocoenoses;
- establishing a correlation between the distribution of biocenoses and hydrological characteristics;
- determining distribution patterns of estuary-arctic species to indicate the mean multiannual distribution of river water spreading in the Laptev Sea.

Observations and Equipment

Qualitative benthos samples were collected in accordance with the standard procedure (Golikov and Skarlato, 1965). The macrobenthos samplings were done by means of a Van Veen grab (0.1 m^2), a Sigsby trawl and a grab (0.25 m^2). Meiobenthos was collected with meiobenthos glasses (claw area 78.5 cm^2, height 3.5 cm).

The plankton sampling was done according to the results of the hydrological and optical soundings. One of the samples was taken from the bottom to the surface (both for phyto- and zooplankton) and a second sample was taken in the upper mixed layer. Phytoplankton was collected with a phytoplankton net (diameter 37 cm, cell of silk sieve 13 m $*$ 10^{-6}). Zooplankton was collected with a Jedy net (inlet diameter 37 cm, cell of silk sieve 26 m$*$ 10^{-6}).

28 biological stations were fulfilled during the expedition (Tab. A2). Plankton was collected at 11 stations and benthos at 28 stations 6 stations of which were done in the Kara Sea (3 along a transect drom Dikson to Belyy Island and 3 stations in the Laptev Sea east of the Pyasina River; Fig. 16). All biological stations in the Laptev Sea are presented in Fig. 63. During the cruise the following samples were taken: 16 phytoplankton samples , 20 zooplankton samples, 8 meiobenthos samples and 61 macrobenthos samples as well as 49 samples collected with a Van Veen grab, 7 samples with a Sigsby trawl and 1 sample with a grab.

The phytoplankton and meiobenthos samples were fixed for further laboratory processing. The zooplankton samples were filtered through silk sieve filters in order to determermine zooplankton biomass.

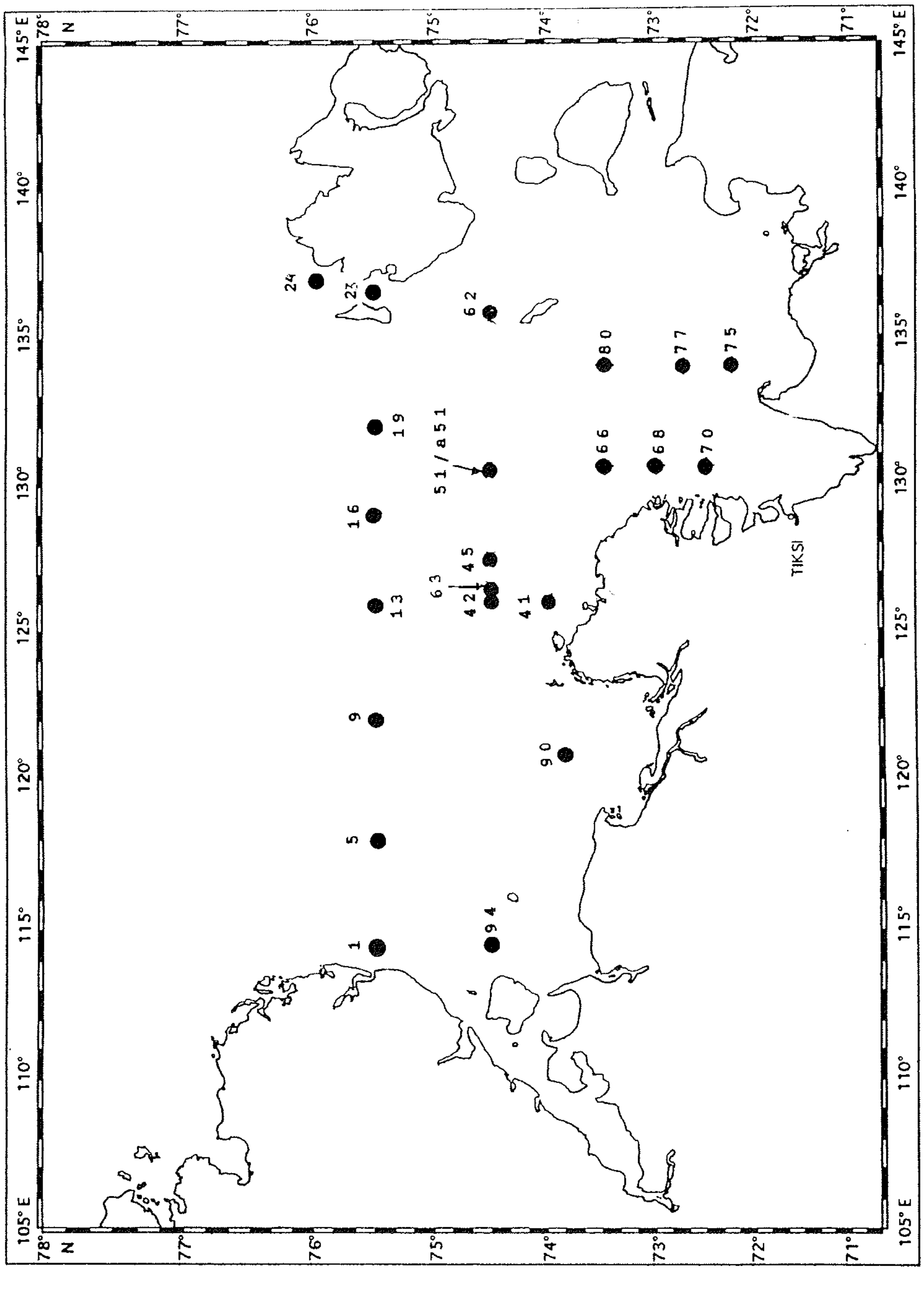


Fig. 63: Biological stations of the TRANSDRIFT II expedition (September 1994).

The macrobenthos samples were analyzed on board the vessel. Each taxon was identified, if possible, up to species. After determining the number of specimens and biomass of each taxon in the sample, the specimens were bottled. On the basis of the data the mean population density and the biomass at 1 m^2 of the bottom surface for the specimens of each taxon as for the whole macrobenthos association at each station were determined. The species or taxons of a higher rank dominating by their biomass this biocoenosis were also identified. The collected material will finally be processed in laboratories at the ZIN RAS and AARI.

Preliminary Results

The distribution of the bottom biocoenosis and their main characteristics (the population density and the macrobenthos biomass at each station generally correspond with the results obtained during the TRANSDRIFT I expedition in 1993 (Fig. 64).

The biocoenosis *Tridonta borealis* and its modifications *T. borealis* and *Polychaeta gen. sp.* were collected near the Taimyr Peninsula and along 75° 30' N to 132° E between water depths of 18 to 42 m (St. 1, 13, 41, 94). The biocoenosis *T. borealis* and *Portlandia arctica* or *T. borealis* and *Saduria entomon sibirica* was located in bottom depressions and along the axes of river water outflow (St. 13 and 90). Different modifications of the biocoenosis *Leionucula bellotii* were collected in the eastern and south-eastern Laptev Sea (St. 24, 45, 63). The biocoenosis *Crustacea* of the *Saduria genus* and the bivalve shell *Portlandia arctica* were found at the eastern stations with silty sediments between 14-25 m water depths (St. 62, 75, 77). *Tridonta borealis* was found at station 80.

These data differ insufficiently from the obtained data of the TRANSDRIFT I expedition in 1993. For example, a very high benthos population (2833.32 individuals per m^2, biomass 108 g/m^2) was estimated at station 51. This station is close to station IK 9344 (Kassens and Karpiy, 1994) where also a very high macrobenthos biomass (370.8 g/mm^2) was collected (population of about 1000 individuals per m^2). Remarkable are the different taxa dominating: in 1993 it was *Saduria entomon sibirica* and *Ophiuroidea gen. sp.* whereas in 1994 it was *Polychaeta gen. sp.*, *Gammaridea gen. sp.*, *Ophiuroidea gen. sp.*, *Holothuroidea gen.* An unusually low benthos biomass (8.765 g/m^2) was collected at station 77 located on a shoal isolated from the coast by a bottom depression. Furthermore, this station was located in a zone of anti-cyclonic circulation so that there was a distinct influence of fresh water.

Data on the biomass of benthos biocoenoses in the Laptev Sea and in the Kara Sea correspond with the relationship determined in 1993. For instance, the benthos biomass depends on near-bottom salinities and densities of sea water except of station 77 (Petryashov, 1993, Petryashov and Sirenko, in prep.).

The distribution of zooplankton biomass significantly differs in the northern and southern part of the Laptev Sea (Fig. 65).

The spring season of plankton development connected with the phytoplankton bloom followed by a maximum of zooplankton development was probably observed in the northern part of the Laptev Sea (stations at 75° 30' N and st. 63 at 74° 30' N and at station K12 in the Kara sea). The mean biomass for the whole water column was equal to 0.6-3.45 g/m^3. Zooplankton biomass values of up to 0.2 g/m^3 were previously collected in these regions in summer seasons of the plankton development (Yashnov, 1940). It should be mentioned that for stations with an intensive phytoplankton bloom the data on zooplankton biomass should be taken as as the total biomass for the whole plankton association. This is caused by the

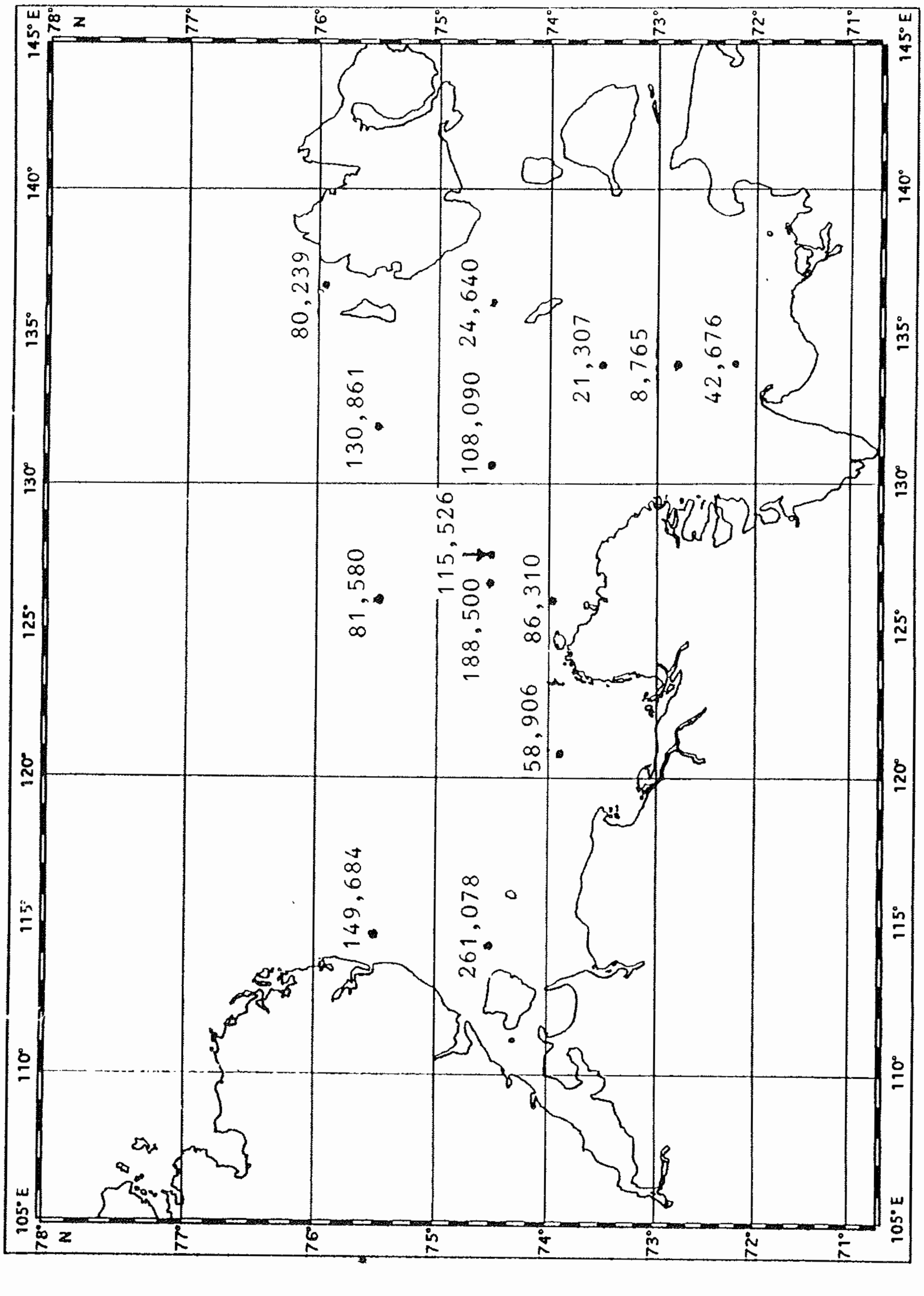


Fig. 64: Biomass distribution of macrobenthos in the Laptev Sea (September 1994).

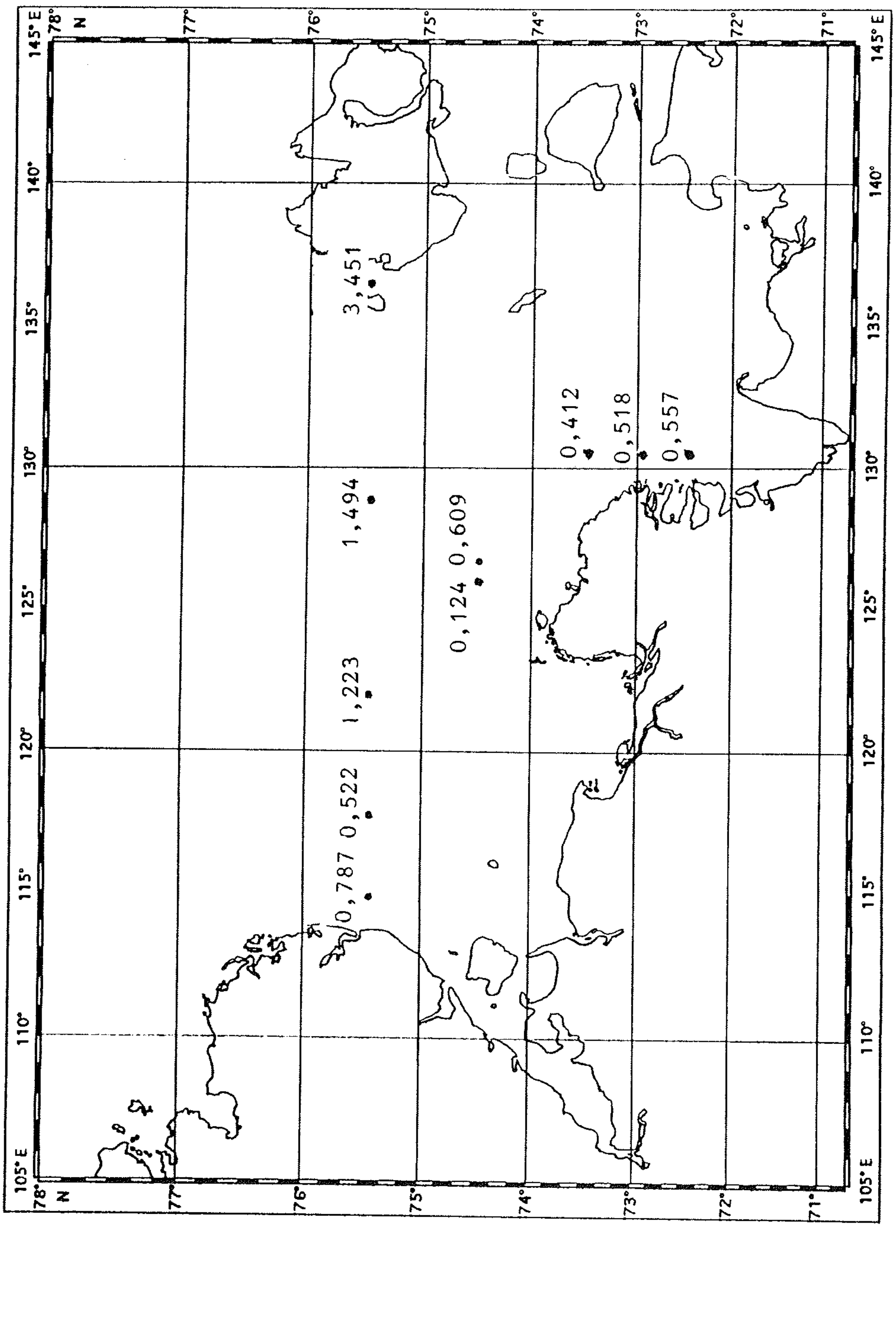


Fig. 65: Distribution of the zooplankton biomass in the water column (bottom - surface) of the Laptev Sea (September 1994).

fact that the density of phytoplankton was so high that it was impossible to sieve it through the zooplankton net. The summer season of the plankton development was probably observed in the southern part of the Laptev Sea. Typical of this season is the quantitative decrease of phyto- and zooplankton after the spring maximum. In general, the zooplankton biomass water column was lower than in the north (0.124-0.557 g/m^3). As mentioned earlier (Pavshtiks, 1990), there is abundant zooplankton in the mixed layer. In contrast, our data show a reverse distribution: the maximum biomass was observed under the pycnocline in all regions without any intensive phytoplankton bloom.

In summary, the macrobenthos distribution in the Laptev Sea is influenced by the Lena river runoff. Species indicating salty and marine water masses were determined. *Bivalvia Gastropoda*, *Malacostraca*, *Echinodermata* fauna are reflecting the main water masses of the Laptev Sea. Hence, the biogeographical distribution patterns and the according near-bottom salinities and densities were identified. The hydrobiological informations are confirming the hypothesis that the distribution of river water in the eastern Laptev Sea is connected with the location of the Lena river valleys.

The qualitative benthos sampling in the Kara Sea is a very important result of the expedition. Until the expedition scarce data on macrobenthos were available for Dikson and Belyy Island, and for the eastern Kara Sea, which is usually ice-covered, there were no data at all.

Sea-Water Pollution Studies

E.O. Teplits

Scientific Program

The scientific program for the investigation of the level of environmental pollution of the Laptev Sea involved the following:

- to obtain informations on the main groups of pollutants: chlororganic compounds (COC), heavy metals (HM), oil hydrocarbons (OH), polycyclic aromatic hydrocarbons (PAH), phenols, radionucleids in the surface and near-bottom layers. In addition, the accumulation of pollutants in the Laptev Sea and their spatial and temporal variations were studied;
- to obtain data on the acidity of precipitations and on the aerosole pollution of the atmosphere over the Laptev Sea. Furthermore, the concentration of components of the mineral composition (CMC) and of COC, HM, OH, PAH were investigated.

Working Program

In order to determine the concentration of the main groups of pollutants sea water sampling was carried out at all stations of the monitoring net from subsurface to near-bottom horizons:

- chlororganic combinations(α –, β –, γ- HCH's, polychlorbenzols, heptachlorine, heptachlorepoxid, dieldrines, chlorans, nonachlores, toxaphen, DDE's, DDD's, DDT's, mirex, metoxychlorine, polychlorinated biphenyls, polychlorinated dibensodioxynes');
- heavy metals (Fe, Mn, Ni, Co, Zn, Cu, Cd, Pb, Cr, Sn, Mo);
- oil hydrocarbons (total concentration);
- polycyclic aromatic hydrocarbons (total concentration and individual

concentration of 3,4-benzpyrene and of other cancerous components);

- phenoles (total concentration).

At the geological stations, sediment sampling was obtained to determine the granulometric composition and the concentrations of COC, HM, OH, PAH, phenoles and radionucleides. In the coastal zones, the total concentration of nitrogen, nitrates, nitrites, ions of ammonium, phosphorous and phosphates were determined.

For determining the concentration of COC, HM, PAH, CMC (Na, K, Ca, Mg, Cl, SO_4, PO_4, NO_2, NO_3, pH) precipitations were sampled on days of intensive precipitations (in amounts sufficient for the analysis). Aerosoles were sampled within three precipitation-free days.

Weather observations and the positions, course and speed of the vessel were recorded during days of precipitation sampling in order to interprete the chemical results.

Observations and Equipment

The sampling of the sea water and sediment was carried out at 29 oceanographic stations presented in Figure 66 and Table A2.

6 samples of precipitation were taken which were extracted on board. They will finally be processed in the laboratory for chemical analysis of the Regional Center "Arctic Monitoring". The following equipment was used for the sampling and the extraction of the above mentioned pollutants:

- sampling fluorineplast system PSG-4 intended for sea water sampling from the subsurface layer;
- sampling system MN-1 (Cyclone) for precipitation sampling (rain, snow, fog, aerosole, dust);
- universal mixing device UPU-001 for long-term mixing of fluids by chemical extraction;
- box for extract evaporation.

Special containers are used for keeping and transporting the extracted samples.

Expected Results.

The realization of the goals described above will allow us :

- to provide informations to state agencies on scales, character and trends of variations of the environmental pollution in the Arctic. Furthermore, they can be provided for the AMAP group´s annual review;
- to complete the database on Arctic Ocean pollution in the region of the Laptev Sea because the Laptev Sea is an important area in terms of exploration of natural resources;
- to estimate the pollution of the Arctic atmosphere as well as the transportation of the pollutants.

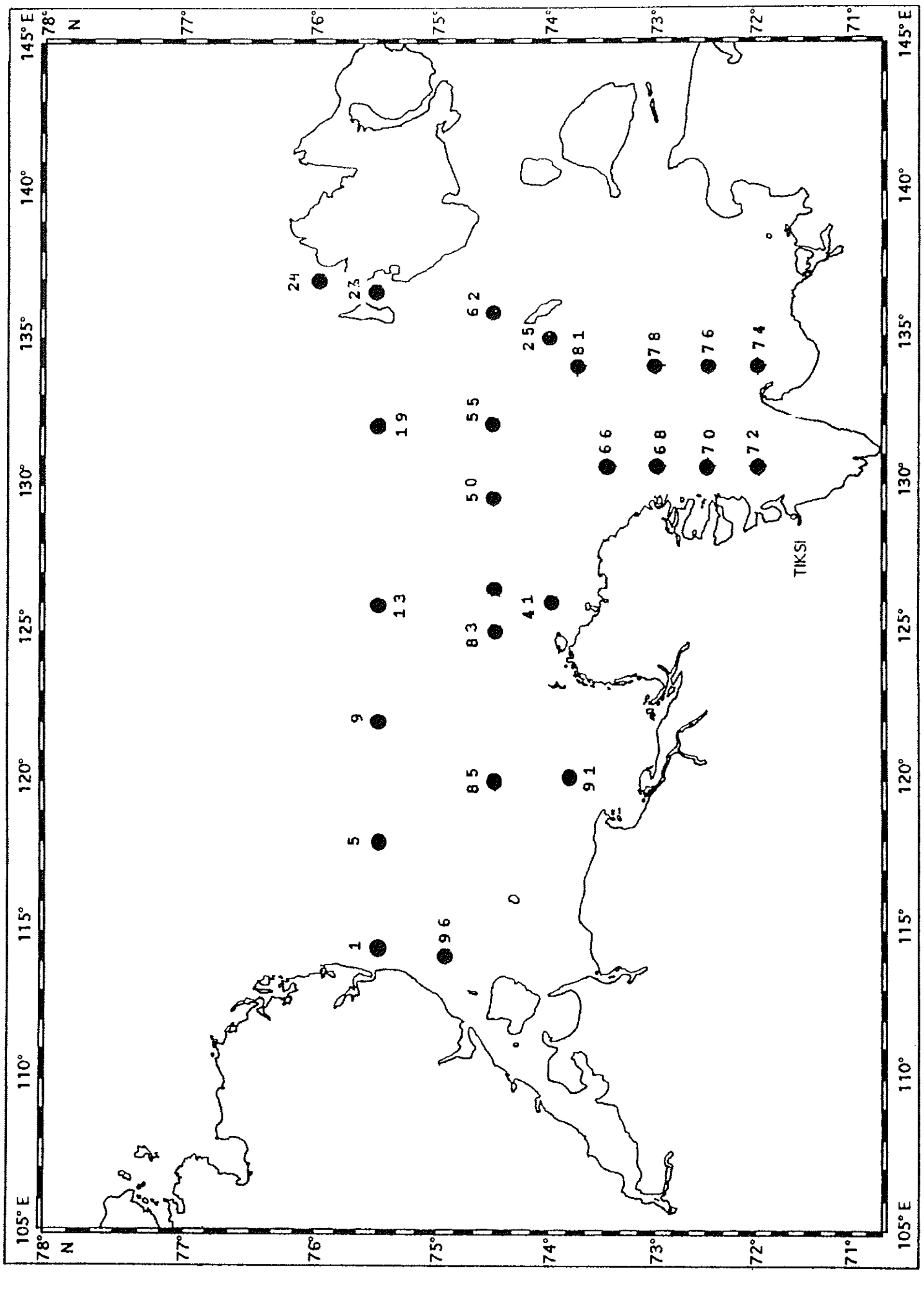


Fig. 66: Stations included in the environmental pollution monitoring program of the Laptev Sea (September 1994).

THE DEPOSITIONAL ENVIRONMENT OF THE LAPTEV SEA

H. Kassens, H. Bauch, H. Cremer, J. Dehn, J. Hölemann, M. Kunz-Pirrung, and B. Peregovich

The remarkably shallow shelf region of the Laptev Sea, which is characterized by high amounts of river run-off from the large Siberian river systems such as the River Lena, the third largest river on earth, is a key region for gaining an understanding of global change. During winter the majority of Arctic sea ice for the Transpolar Drift is produced here, thus explaining why the Laptev Sea is also called the ice factory of the Arctic Ocean. The ice produced here is carried with the Transpolar Drift across the Arctic Ocean and through Fram Strait into the Norwegian-Greenland Sea for two to three years. Pack ice of the Transpolar Drift is also a vehicle for sediments, biogenic material and pollutants that were incorporated during the ice formation on the Siberian shelves. Thus sea-ice sediments play an important role in the sediment budget of the Arctic Ocean. Climatic changes affecting river runoff, sea level and ice formation processes on the Siberian Shelves have a direct impact on global ocean circulation.

During the late Pleistocene, the close vicinity of the Laptev Sea shelf to previously glaciated landmasses renders this area a key region to monitor postglacial sea-level changes as well as the Holocene water mass/climatic interactions. Its relatively modest water depth today, on the average less than 50m, indicates that the Laptev Sea shelf was dry during glacial periods. During the times of retreat of the northern hemisphere icemasses, the modern circulation pattern of the eastern Arctic Ocean evolved contemporaneously, and is today dominated by an inflow of Atlantic and to a lesser degree by Pacific water masses. This inflow is in part compensated by an outflow of surface water (via Transpolar Drift) through the Fram Strait and is strongly tied to the immense freshwater output of the Siberian tributaries (ca. 2500 km^3 per year, Aagard and Carmack, 1989). Therefore, the paleoceanographic investigations of the Laptev-Sea are a subtle tool to record even minor climatic changes, e.g. Little Ice Age. Emphasis will be placed on detailed micropaleontological studies, which ultimately need to be supported by a sound stratigraphic age frame and certain water mass specifications.

Today, the sedimentary environment of the Laptev Sea is controlled in the winter by ice formation, pack ice, and fast ice; and in the summer by river run-off. Side scan sonar records and 30 kHz echograms demonstrate that at some localities (e.g. the mouth of the Anabar River and southwest of Kotelny Island) the sediments of the shallow shelf area are highly disturbed by the action of grounding ice. Nevertheless undisturbed sediment cores were recovered at many sites in the Laptev Sea (Fig. 2). During TRANSDRIFT I sediment cores longer than 2.5 meters were not recovered because of offshore permafrost, as indicated by the low (-1.8 to -2.3 °C) sea-floor temperatures. Therefore, investigations of the modern depositional environment are limited, particularly with respect to age. One goal of the TRANSDRIFT II expedition was the recovery of longer (up to the Pleistocene) sediment cores for paleoenvironmental studies. For this, emphasis will be on four major 'groups': a) diatoms, b) dinoflagellates/chlorophycees, c) benthic foraminifers/ostracodes, d) spores/pollen. First results from the TRANSDRIFT I expedition indicate that the distribution of the benthic macrofauna of the Laptev Sea is water mass dependent, and should be reflected within the microfaunal realm. Main objectives of these studies will focus on the identification of freshwater and its temporal variability. For this purpose benthic as well as planktic diatoms are used, of which both exhibit a wide ecological habitat (marine to freshwater). Due to the high amount of river transported suspension sediments in the Laptev Sea, limnic chlorophycees (green algae) represent another valuable tool for monitoring the freshwater input. Based on their good preservational mode, their paleoecological and paleoclimatological significance dinoflagellates and their cysts are most important for interpreting Holocene variabilities as recorded in sediment cores. Ostracodes and their ecology (euryhaline to freshwater) are a benthic group that can be used not only for assemblage analyses, but also yield information about specific water mass parameters. Furthermore, together with benthic foraminifers, their calcareous shells are a main basis for oxygen isotopes, and thus, for the stratigraphic framework. Previous investigations have shown that spores and pollen can serve as stratigraphic indicator for the post-glacial climatic evolution of the boreal vegetation of Siberia, which reached its maximum during the Atlantikum.

In order to gain a wide-ranged view of the sedimentary environment of the Laptev Sea, investigations of the water column and the sea floor were carried out by the geological working group on board the RV *Multanovskiy*. The working program was conducted at a total of 102 stations in the ice-free shelf area (Fig. 2 and Tab. A2).

The following investigations were carried out during the TRANSDRIFT II expedition on board the RV *Multanovskiy* :

- Site survey and mapping of the horizontal and vertical distribution of the young sediment cover by means of continuous subbottom profiling (ATLAS-DESO 10, KRUPP ATLAS-Elektronik Germany) and Side Scan Sonar (HYDROSCAN).
- Multi-probe suspension and current-speed measurements.
- Water sampling for micropaleontological analysis with plankton nets (45 µm mesh size).
- Sampling of the water column for geochemical analysis of the dissolved and particulate phases. Water samples for trace element analysis were obtained using a Teflon water sampler hung on a plastic coated hydrowire.
- Sampling of undisturbed near surface sediments with a spade box core (penetration weight 700 kg, 50*50*60 cm).
- Coring of undisturbed long sediment cores at selected key stations, such as the Lena Valley, with vibro and gravity corer. Two types were employed: (1) a gravity corer (rectangular cross-section of 15*15 cm) with a penetration weight of 2 t and a core barrel segment of 3 to 5 m in length (HYDROWERKSTÄTTEN Kiel, Germany), and (2) a vibro corer (rectangular cross-section of 10*10 cm; HYDROWERKSTÄTTEN Kiel, Germany). The great advantage of the vibro corer is the possibility to recover sandy sediments as well frozen, i.e. stiff, sediments. The vibrocorer was kindly provided by Dr. Fritz Kögler, Geologisch-Paläontologisches Institut, Kiel.

The sedimentological working and sampling programs are summerized in Table A2, A3, A4, and A5.

Temporal and Regional Changes in the Sedimentary Environment of the Laptev Sea

J. Dehn and H. Kassens

Introduction

Modern investigations in the Arctic Ocean emphasize the importance of the broad Siberian shelves for shelf-to-basin sediment transport processes, in particular for the formation of 'dirty' sea ice. The Laptev Sea, which belongs to the world's largest and shallowest shelf areas, acts as an important source area for fine-grained sediments transported to the deep Arctic Ocean (e.g. Wollenburg, 1993, Nuernberg et al., 1994). The Laptev Sea is a shallow shelf sea north of East Siberia between the Taymyr Peninsula and the New Siberian Islands (Figure 1). Sediment transport in the Laptev Sea is related to (i) specific ice formation processes, such as anchor ice or suspension freezing, and to (ii) hydrological and geomorphological phenomena, such as currents or transport of suspended particulate matter. As a result, even short-term climatic fluctuations will have a significant impact on the cross-shelf sediment transport. A controlling factor of the depositional environment of the Laptev Sea is river run-off of the large Siberian river systems, such as the Yana, Lena, Olenek, Anabar and Khatanga Rivers (Figure 2). These rivers have a drainage basin of 3,6 million km^2 and contain numerous industrial sites, have an average river discharge of 552 km^3/year (Alabyan et al., 1995, in press). The Lena River is the second largest river discharging to the Arctic Ocean and the eighth largest of the world (Gordeyev and Sidorov, 1993). The Lena run-off accounts for more than 70% of the overall inflow of riverine waters into the Laptev Sea. On its way through swampy lowlands, the river accumulates a high dissolved organic load and loses the suspended sediment load. The Lena River annual discharge of total organic carbon is 5,0 million tons, which is about 30% of the overall organic carbon transport to the Arctic Ocean (Romankevich and Artemyev, 1985). This is by far the highest discharge of all Arctic rivers. However, little is known in detail about the relationship between morphology, river run-off and discharge, erosion, sediment transport and sea ice formation in the Laptev Sea area (e.g. Holmes and Creager, 1974; Dethleff et al., 1993; Martin et al., 1993; Kassens et al., 1994a; Kassens et al., 1994b; Kassens et al., 1994c; Reimnitz et al., 1994; Dethleff, 1995).

Quantification of the source, transport, and depositional regimes is a key step in understanding the environmental significance of the Arctic Oceans and in particular the Laptev Sea. The specifc tasks of TRANSDRIFT II were, to differentiate the sediments and variability of the rivers feeding the Laptev Sea and thus to recover first "long" sediment cores.

Challenges Overcome During TRANSDRIFT I and II

Technical problems with the recovery of long sediment cores arose during the cruises in 1993 and 1994. The foremost was penetration of the permafrost level at 12 cm below the sea floor (Kassens et al., 1994b, Kassens et al., 1994c). The increased yield strength of the sediments provided by the ice was enough to withstand penetration from the gravity corer on board the IVAN KIREYEV during TRANSDRIFT I (1 ton). In order to overcome this problem, a larger weight (2,5 tons) was used during TRANSDRIFT II, as well as an elaborate vibrocoring device (Figure 67). The surface sediments were recovered with a large spade box corer (50 x 50 x 60 cm).

Each device had its own sampling scheme. For each box core, samples were taken for immediate study, as well as two archive liners. Surface samples were taken for biogenic study and clay mineralogy. A profile was taken whenever possible for later X-ray to define the fine sturctures in the sediments. The sediment was described on deck, immediately after recovery, often in inclement conditions. Samples were then taken and prepared at the earliest opportunity. Macroscopic description of the sediments was primarily concerned with color, structure, and macroscopic components which would not appear in a smear slide, such as drop stones and large organisms. A minolta CM 2002 scanner was used to classify the colors on board, thus eliminating bias due to conditions or lighting. The sediments were scanned immediately after recovery to ensure accurate color readings. The color readings were not taken at a regular intervals since small variations in the color of the surface can seriously effect the results. A flecked or speckled core often gave erroneous results based on how many specks were present in the scanning field. Thus a qualitative effort was given to choose areas which had the most homogenous and representative color of the core.

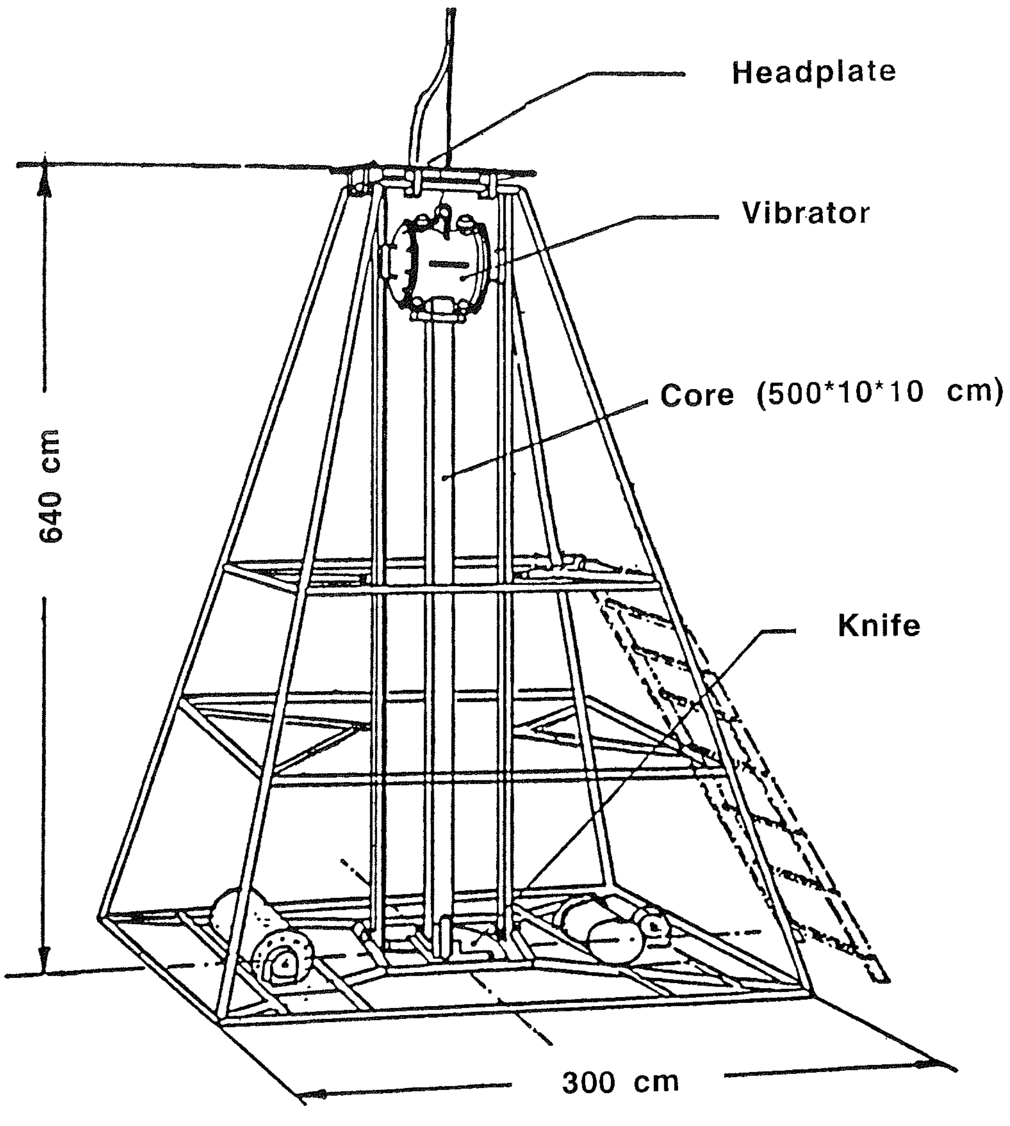


Fig. 67: Schematic diagram of the vibro corer used during the TRANSDRIFT II expedition. The entire apparatus is lowered on to the ocean floor, the core barrel is driven into the sediments and then extracted by the machine. The entire apparatus with sediment is then hoisted back aboard.

On board smear slides were made in order to better classify the sediments. Smear slides were taken where there was an obvious change in the sediments, where a minor lithology was present, or every meter when the sediment appeared homogeneous (Tab. A4, A5). On the basis of other shipboard analyses, smear slides were sometimes taken later as a control of these results. Each slide was examined in detail at a minimum a three spots radially from the center of the slide to help eliminate the error caused by sorting and cohesion of the sample during preparation. At each spot the percent of each mineral type was estimated using scatter charts. The results of each location are then averaged to yield a value for the entire sample. The name of the sediment is based on these analyses. The nomenclature used varies from that of the Ocean Drilling Program for terrigenous sediments, but more closely resembles the naming convention for biogenic sediments. The name is based entirely on the composition of the sediments, the grain size is noted independently. This provides a more accurate name as well as a better basis of comparison to biogenic sediments, allowing separate comparison of composition and grain size. The macroscopic descriptions were annoted with the proper sediment name after the smear slide analysis was complete for each sample.

Physical property measurements were made on the box cores (sampling frequency, 2 cm) and gravity cores (sampling frequency of 2-5 cm) Because the quality of physical property measurements is strongly affected by sample disturbance (e. g. moisture loss), all measurements have been carried out on board immediately after core retrieval. The measurements were made only on fine-grained (silt and finer) sediments.

Physical properties measured on board included water content, and wet bulk density. From these basic properties, other sediment phase relationships can be derived (e. g. void ratio, porosity, dry density). The so called index properties can be determined from the direct measurement of the total mass of the sample (M_t), the dry mass of the sample (M_d), and the total volume of the saturated sample (V_t).

To compensate for the ship's motion, mass is determined by means of a technique of differential counterbalancing on twin top loading electronic balances. The ship's motion is partially compensated by a reference balance (A), which has a matched load to the sample balance (B) with the sample of unknown mass (M_t). The balances are configured with an analogic 0-5 volt output over a 50 g range. The voltage output of each balance is directed to a differential amplifier. The voltage difference is digitized and then processed on a microcomputer. This method of differential counterbalancing is described by Childress and Mickel (1980).

A known mass (M_k), ideally within 1 g of the unknown mass, is placed on balance A. The unknown (M_t) is placed on balance B. Then the differential signal is assumed to be the difference (in volts) between M_k and M_t. This differential voltage is averaged over time (several cycles of ship's roll period). The differential mass (M_{diff}) is calculated by linear regression from the calibration curve. The unknown mass is then $M_t = M_{diff} + M_k$. The balance system was used in a non-counterbalance mode simply by using zero as the known mass.

Sample volume was determined according to the constant volume method (tube of 10cc). The tube was carefully pushed into the sediment, then cut out, trimmed and weighed.

After the determination of the total (wet) mass and volume, the samples were dried. Water content is reported as a percent ratio of water to dry mass (w_d). In addition, because any dissolved salts contained in the pore fluid will change phase during the drying of the sample, a correction for pore fluid salinity (r) must be included in both calculations of water content (Noorany, 1984). If, for example, pore fluid salinity is 35 ‰, then r =0.035. The formulations are as follows:

$$w_t = (M_t - M_d)(1 + r)/M_t \qquad (1)$$

$$w_d = (M_t - M_d)/(M_d - rM_t) \qquad (2)$$

Bulk density (r) is the density of the total sample, including pore fluid or:

$$r = M_t/V_t \qquad (3)$$

No corrections are required for this calculation.

Results of the Sedimentological Study

Based on the smear slides made during and after TRANSDRIFT II and macroscopic sediment descriptions, the sediments were classified into 5 facies. The results are summarized in Figure 68.

The surface sediments of the Laptev Sea (Facies 1) are very dark gray or olive gray clay to silty clay, with various clays as their main component (15 to 75%). Secondary components are primarily quartz (50% or less) and chlorite (<25%). Facies 1 generally exhibits a large variety of minor components, dominated by opaque minerals. This opaque material can be found ringing the dropstones found on the ocean floor, and is a magnesium/manganese/iron/titanium oxide precipitate. During TRANSDIRIFT II massive occurances of the oxides were found in the western Laptev Sea, lesser occurences are restricted to fine grained sediments forming a zone, also described by Yakolev (1995, in press). Site PM9492 differs from the others since quartz dominates clay, and the overall grain size increases to sand. This is probably due to the location of the site, in the Olenek valley, a place where finer material would be absent due to higher current speeds. Despite its grain size, this sediment here resembles Facies 1 in its diversity of minor components, dominated by opaque minerals. Facies 1 ranges in thickness from 30 to 80 cm. At Sites PM9441-4, PM9451-7, PM9457-5 tourmaline needles were observed in rounded quartz grains. All of these Sites are located off the Lena Delta (Figure 2) and suggest a highly evolved igneous province as the source area for the sediments.

Facies 2 is a silty unit, composed primarily of rounded to sub-rounded quartz grains (40-90%). The sediments range in color from dark gray with black mm-size flecks to dark greenish gray with cm size darker mottles. Secondary components are alternately clay or potassium feldspars. The feldspar grains exhibit clear pericline twinning, suggesting that they are microcline. In the western Laptev Sea this sediment becomes increasingly rich in organic debris (up to 20%). The source area for this material seems to be the Anabar and Khatanga Rivers. Facies 2 ranges from 50 to 350 cm in thickness. The general trend indicates a thickening to the eastern Laptev Sea, this may be the result of higher sedimentation rates, particularly at site PM9462 which is located in the Yana Valley, east of Stolbovoy Island. This facies is present every where except at Site PM9463, in the western Lena Valley. A scour surface is documented in the core at this point, suggesting that this sediment was removed before deposition of Facies 4. Here a finer grained sediment is present. This unit more resembles Facies 1, though if indeed the same unit, there is an assymetrical distribution of this sediment or higher sedimentation rates in the western Lena Valley and on the topographic high between the eastern and western Lena valleys north of the delta. For now, this unit is designated Facies 4.

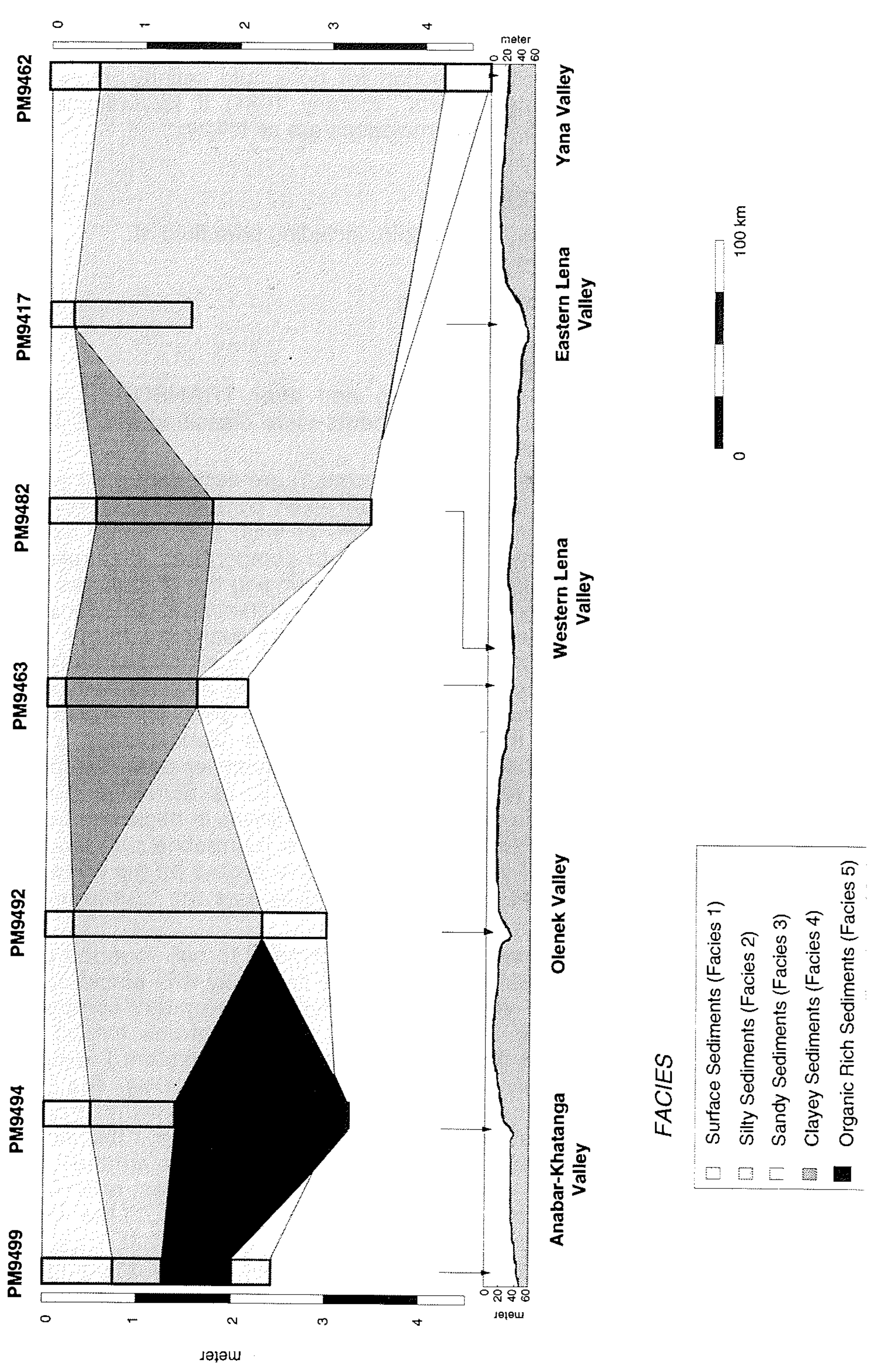


Fig. 68: Lithostratigraphic sketch of the Laptev Sea. The sediments are divided into 5 facies. Note the abscence of facies 3 at site PM9463. An erosional boundary was observed in the core at this depth, indicating removal of facies 3.

Facies 3 is a coarser unit of primarily brown to very dark brown silty to sandy sediments. It is also pervasive though absent at site PM9417 (due to very shallow penetration) and PM9482. Quartz is the primary component and exceeds 75% in all recovered cores. A secondary clay component is as high as 20%, but usually is present only as a minor component. The thickness of this unit is unknown since it represents the maximum penetration at all sites where it was recovered.

Facies 4, as described above, closely resembles Facies 1. It is a dark greenish gray silty clay. The primary difference is a depletion in opaque material and minor components relative to Facies 1. This sediment is virtually composed of only two components, ca. one third silty quartz, and two-thirds clay minerals.

Facies 5 is an organic rich very dark gray sandy silt present only in the western Laptev Sea. The organic material, composed primarily of mm size wood fragments, reaches a maximum of 20% at Site PM9494-4. The entire facies is nearly black, and issued a sulphurous odor. The organic material was often concentrated in layers ca. 1 cm in thickness. These layers were an area of structural weakness in the cores, and the core at Site PM9494-4 broke off on one such layer. This unit had a minimum thickness of 75 cm at Site PM9499, the thickness at Site PM9494-4 is unknown. Crystalline nodules were present in Facies 5 (Figure 69). These nodules reached a maximum length of 8 cm, and were generally less than 5 cm in diameter.

Fig. 69: Photograph of hydrated calcite crystal nodule found at site PM9494-4VC at 120cm depth.

The nodules are composed of clusters of up to 6 mm long monoclinic orange crystals. The crystals rapidly turned to a white ($CaCO_3$) powder when heated. These hydrated calcium carbonates have a neutral refractive index (ca. 1.55). This mineral was thought to be ikaite, the predecessor of the pseudomorph glendonite, m water depth (Suess et al., 1982). Ongoing crystallographical (e.g. deep temperature x-ray diffraction and differential thermal analysis) and isotopical ($\partial^{18}O$, $\partial^{13}C$) studies will determine if this is a new mineral and/or a new paleoceanographic indicator (or tool) for extreme environments such as the Laptev Sea.

Discussion

In general, the sediments of the eastern Laptev Sea differ from those of the west. In addition, the sediments show a significant change through time. These changes reflect changing environments not only in the Laptev Sea, but in the source regions of the sediments. The western Laptev Sea seems richer in organic sediments than the east. This comes intially as a surprise since the dissolved organic carbon value is so high in the Lena River (eastern Laptev Sea). One explanation for this may be a nearer source region for the organic material in the western Laptev Sea. The material is largely whole, leaf fragments and wood chips are common. The material has not been dissolved or altered by long transport distances.

The central Laptev Sea is dominated by the fine grained sediments. This may be the result of the source for this region, presumably the Lena Delta, or by a higher sedimentation rate for these sediments at this location. A decrease in flux from the northern Lena Delta would favor a lower energy depositional regime, and deposit clay sized material as seen on the topographic high between the Lena valleys north of the delta. The eastern Laptev Sea has a larger component of silty sediments, perhaps again either a result of a depositional regime favoring these sediments, and/or a higher sedimentation rate. This distribution of sediments is characteristic for the river systems feeding the Laptev Sea at these points. Present activity at the Lena Delta indicates that the largest influx of water takes place on its eastern side (Alabyan et al., 1995, in press). The slightly higher energy regime favors the deposition of silty sediments, and might account for a potentially higher rate of deposition. The distribution of surface sediments (Figure 70) on the basis of their grain sizes supports the conculsions drawn from each individual site. A large area of coarse grained material is seen to the west of the Lena Delta. The contour turns sharply coastward as it passes to the north, suggesting a lower energy regime.

Categorizing the sediments through time is difficult since there is - up to now - no reliable high resolution age control on these young shelf sediments. However, the Laptev Sea surface sediments show normal to underconsolidated behavior, that is, physical-property profiles (Figure 71) exhibit no evidence for desiccation, past erosional or seabed loading events. For instance, the porosity records show only little negative trend with depth indicating high sediment accumulation rates.

The porosity of the sediments correlates to sediment composition and grain size (Figure 72). At site PM9463 the sediments show a marked decrease in porosity (80-35%) at ca. 175 cm depth. Correspondingly, at this depth the silt component of the sediment decreases, the quartz content rises drastically, and potassium feldspar appears. This change corresponds to an erosional surface documented in the core. This explains the lack of Facies 2 at this site. It may also explain the prescence of Facies 4. Facies 2 was a widespread unit in the Laptev Sea and represented a stable depositional environment and a petrologically similar sediment source region for the rivers. The western Lena river became more energetic where erosion removed Facies 2 and scoured the surface of Facies 3. This change in river and sediment transport continued, leading to a lower energy regime, dominated by finer grained sediments. Since these changes were not observed in the eastern Lena Delta, it is suggested that the changing factor was not far afield, which would have

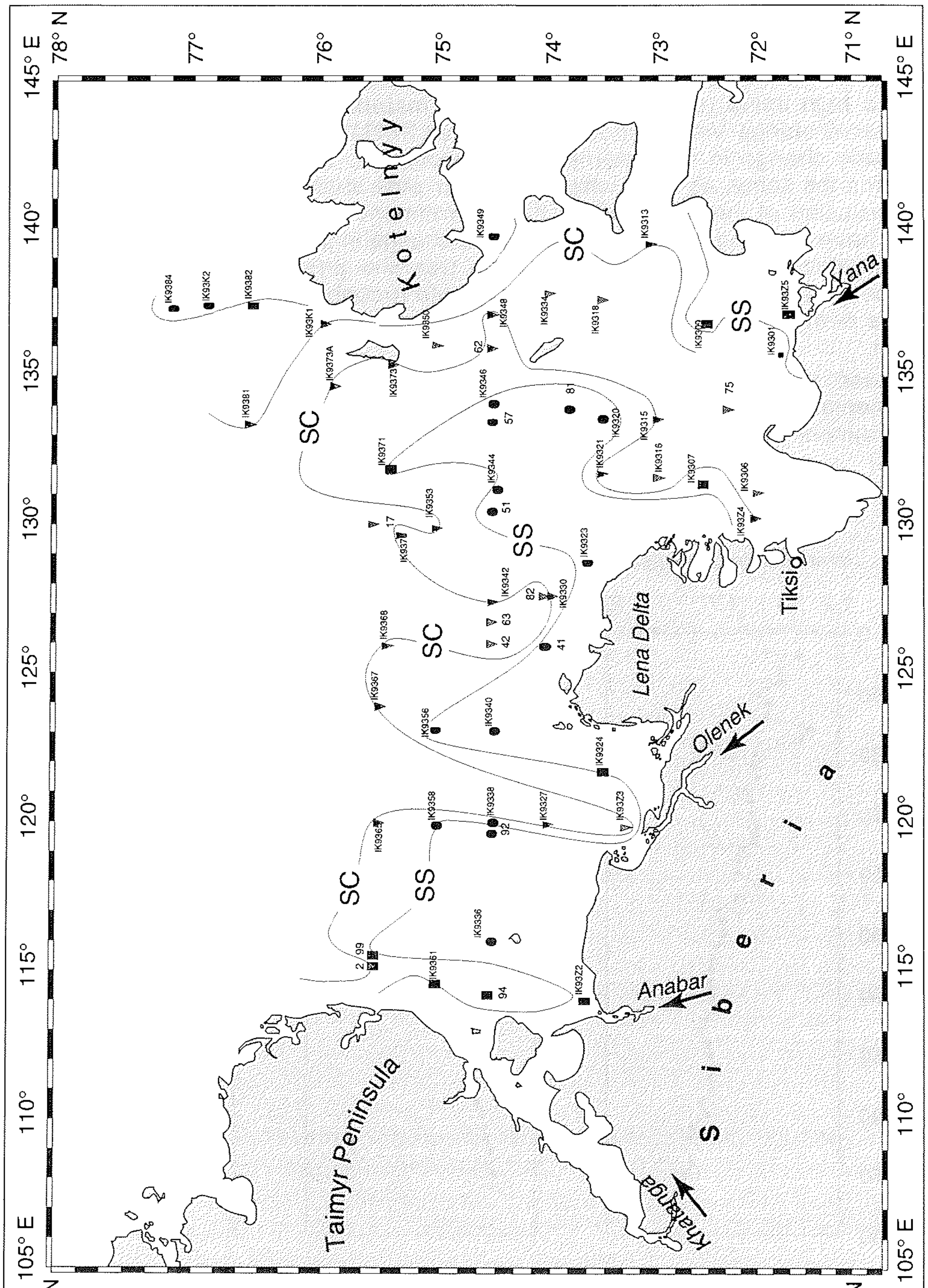


Fig. 70: Distribution of grain-sizes in the Laptev Sea based on smear slide analyses. SS denotes the sand to silt contour, SC the silt to clay contour. Triangles indicate predominately clayey sediments, boxes are for silty sediments, and circles for sandy sediments. Note that the sites from transdrift II are noted only as station numbers.

affected the entire Lena river. This change represents a factor in or near the delta itself.

The high influx (up to 20%) of organic material observed in facies 5 in the Anabar-Khatanga Valley, specifically at sites PM9494 and PM9499, also shows a dramatic change in the sedimentary environment. Though the source sediment remains the same, as seen when the smear slide analyses are normalized without the inclusion of the plant debris, the environment through which the river flowed must have changed. We interpret this as a change in the tree line, i.e. the source of the organic material. At some time the tree line progressed into the sediment source area, and then receeded. This would probably be due to a warm period, and is perhaps related to the Holocene climatic optimum (Houghton and Jenkins, 1990).

These changes in sedimentary environment support the conclusion that the sedimentation rates in the Laptev Sea were not constant and that the sedimentary environment changed drastically with time.

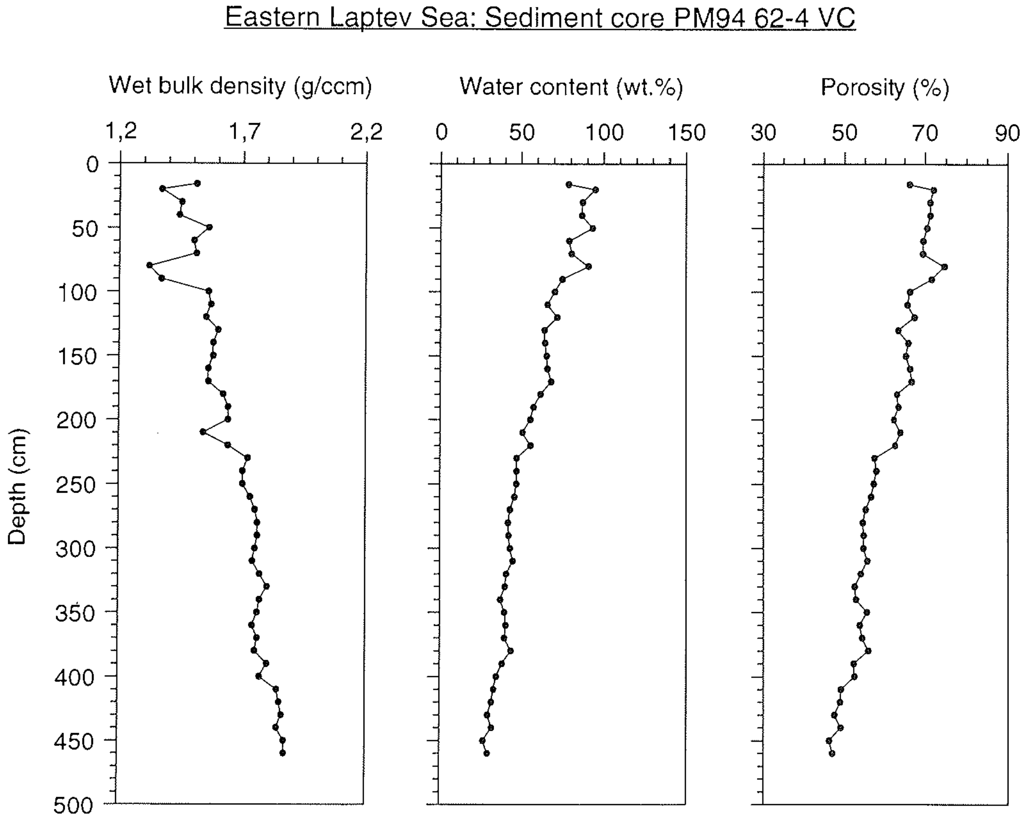


Fig. 71: Physical properties of sediments from site PM9562-4. Down hole water content and porosity show only small negative trends. This suggests a high sedimenation rate for this site.

Conclusions

One of the objectives of the TRANSDRIFT II expedition to the Laptev Sea during summer of 1994 was to identify transport paths and depositional center of river discharge in order to quantify the runoff patterns of North Siberian rivers through time and space. During the expedition a sedimentological working program was conducted on a total of 16 stations on the shelf area.

The modern sedimentary regime of the Laptev Sea is characterized by Holocene normal consolidated fine-grained near surface sediments. Ongoing sedimentological studies indicate that sediments from the eastern Laptev Sea differ from those in the west in grain-size, composition and density. Five facies have been identified on the basis of these changes by smear slide analyses. The eastern-most site (PM9462) in the Yana Valley exhibits clayey surface sediments (0-5 cm, facies 1) overlying a silty to clayey unit (facies 2) ending on a sandy layer (430 cm, facies 3). This is also observed in the Lena Valleys of the central Laptev Sea (sites PM9463 & PM9442). In these sites a new unit (facies 4) rich in clay (>70 %) is present between facies 1 and 2. This unit is absent in the Anabar-Khatanga Valley to the west (sites (PM9494 & PM9499) where the older (> 1.2 m depth) sediments are rich (ca. 20%) in organic material, and make up facies 5.

These changes are indicators of changing environments through time, particularly, (1) different sediment sources for the Laptev Sea, (2) different water masses, and (3) changing depositional environments, particularly from active delta to estuary and shallow marine. The basal sandy sediments in the central and eastern regions mark the active Lena Delta, now submerged. The terrigenous, organic rich sediments to the west are indicators of either a change in the course of the Khantanga or Anabar rivers, or in the temporal position of the tree line.

Eastern Lena Valley: Sediment core PM94 63-4 VC

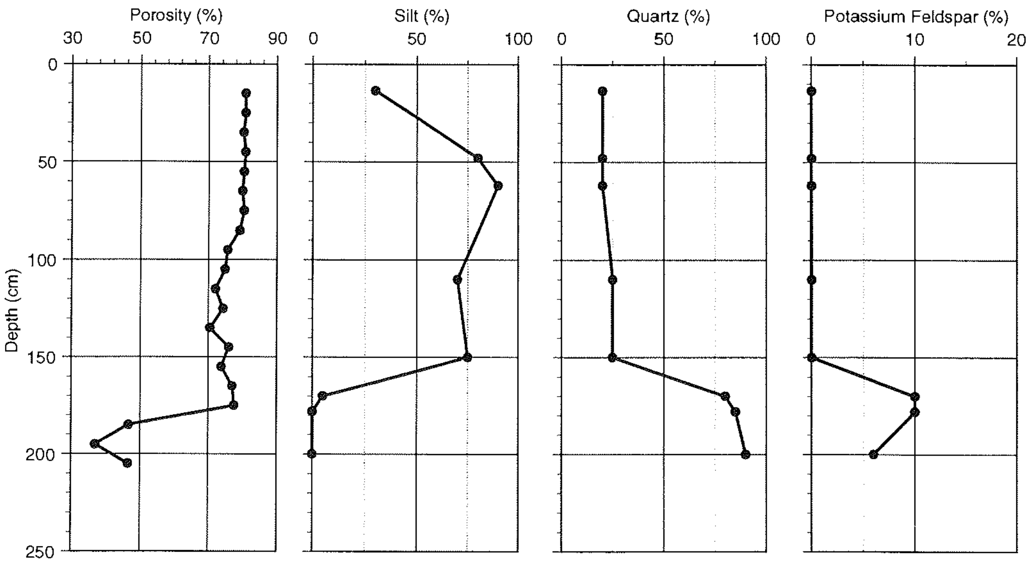


Fig. 72: Comparison of sediment porosity, grain-size and sediment composition for site PM9463. Note the marked change at ca. 170 cm. This postion correlates to the change in sediment type in figure 3, and the occurence of an erosional surface. The slight discrepancy in the facies change between the porosity plot and the other graphs is the result of a small (<1 cm) sand layer picked out for smear slide analysis, but between regular intervals in the physical properties sampling scheme.

Micropaleontological Studies

H. Cremer and M. Kunz-Pirrung

Previous Studies and Scientific Goals

The paleoenvironment of the Laptev Sea shelf will be studied by micropaleontological investigations finally yielding in a reconstruction of its environmental history. Presently the Laptev Sea and its fauna and flora are influenced by different water masses: Atlantic Water, Pacific Water, Arctic Water and freshwater from various streams (Khatanga, Anabar, Olenek, Lena and Yana). The Lena River being the largest of them is well known to affect oceanographical, sedimentological and biological processes in the Laptev Sea (Holmes and Creager, 1974; Dethleff et al., 1993; Létolle et al, 1993; Kassens et al., 1994).

At present our knowledge about the microplankton assemblages in the Laptev Sea is fairly sparse. While a good data basis is available for other Siberian shelf seas (e.g. Kara Sea, Chukchi Sea; see references in Polyakova, 1989) micropaleontological investigations are lacking nearly totally for the Laptev Sea shelf. Merely some older hardly obtainable articles in Russian language dealing with microplankton are published in the 1930/40s. The last extensive oceanographic work (Holmes and Creager, 1974) was published 20 yrs. ago.

Our investigations will mainly focus on two microfloral groups: diatoms and dinoflagellates. Diatoms, both benthic and planktic forms, exhibit a wide ecological range (marine to brackish to freshwater). Therefore they are an outstanding group to identify different water masses especially the freshwater distribution. Based on the good preservation mode and their paleoecological significance dinoflagellate cysts are important indicators for interpreting Holocene variabilities as recorded in long sediment cores.

Main objective of the study is the identification of temporal and spatial distribution patterns of diatoms and dinoflagellates in both the water column and the sediment. The identification of river transported sediments and typical freshwater algae (e.g. freshwater diatoms, chlorophycees) give evidence for the variability of freshwater influence in present and past.

Macrobenthos investigations during the TRANSDRIFT I Expedition in 1993 have shown a close relationship between macrobenthos and its distribution at different water masses (Petrjaschev, 1994; see also Sirenko & Piepenburg, 1994). This water mass dependance of organism assemblages should similarly be reflected in the microplankton realm.

Additional investigations of other planktic and benthic groups (e.g. radiolarians, foraminifers and ostracodes) will contribute to the understanding of the depositional history of the Laptev Sea.

However, one of our main goals is to establish a data basis with regard to the:

a) microplankton (especially diatoms and dinoflagellates and their cysts) content in both the water column and the sediment species composition.

b) microplankton distribution within the Laptev Sea in order to characterize the water mass related distribution of different microplankton assemblages.

Sampling Program

To get a general view on quality and quantity of the microplankton in the water column water samples (300 to 400 ml) were taken at 45 localities on several transects throughout the entire Laptev Sea (Tab. A2). Most sampling was carried out east and north of the Lena Delta. A plankton net (20 µm mesh size, 40 cm section) was used for surface water sampling (0-3 m depth). Furthermore, at 21 of these stations water samples were taken at 10 m water depth by filtering a 3 l volume with a 6 µm GAZE filter. The phytoplankton samples were preserved with 2 % formalin, buffered with Borax.

To characterize temporal and spatial variabilities of all microplankton groups in the Laptev Sea sediment samples were taken from all sediment cores gained during the expedition. From each box core surface samples (10x10x1 cm) were taken. Furthermore the sediment profile was sampled in 2 cm intervals. Longer sediment cores were sampled temporarily in 10 cm intervals. Short interval sampling as well as all further analyses will be carried out in our laboratories at GEOMAR in Kiel.

Preliminary Results of Multi Probe Suspension and Current Speed Measurements on the Laptev Sea Shelf

M. Antonow, H.C. Hass and V. Haase

Introduction and Scientific Goals

At present the Laptev Sea shelf is a differentiated environment of erosion, particle transport and deposition. Tidal, wind-driven and storm-wave processes as well as density stratification, geostrophic and other oceanic currents are prominent features of the inner and outer shelf regions (Holmes, 1967). According to side scan sonar data ice appears to be an important geological agent in both shelf regions (Antonow and Lindemann, 1994). The Laptev Sea is strongly affected by big river systems draining large parts of Siberia. Huge amounts of suspended matter are discharged into the Laptev Sea by these rivers (see Létolle et al., 1993). Part of the sediment remains where it settles or is going to be resuspended by bottom currents. Another part, however, will be incorporated into the sea ice to begin its journey throughout the Arctic Ocean (e.g. Dethleff et al., in press).

Investigations of sediment and current dynamics of the Laptev Sea shelf will provide basic parameters for all research groups joining the TRANSDRIFT II Expedition.

The main scientific goals are:

- characterization of the present current regime
- evaluation of present and past sediment and hydro-dynamic shelf processes (in cooperation with other working groups).

A combination of sedimentological and oceanographic methods was carried out to answer questions regarding surficial circulation patterns and bottom current regimes as well as suspended matter content in the water column.

Material and Methods

A specialized probe was designed in order to measure the properties of the water column. Besides temperature and conductivity these include the amount of supended matter in the water column and direction and velocity of currents. This probe (MUM = "Modulares Umweltmessystem" built by ADM Elektronik GmbH, Warnau, Germany) combines up to 11 individual sensor units in one housing. Energy is supplied by 9 LR20 1.5V batteries in a water and pressure resistant housing together with the electronic CPU (central processing unit). The CPU carries 3 memory chips: one 64 kb program EPROM, one 8 kb RAM for individual batch commands and one 248 kb RAM as a static data store for up to 124,000 data.

The CPU allows individual programming of measuring intervals and an additional variety of sub- and burst cycles within one measuring interval. The MUM is armed with a V4A steel cage to shield it from damage.

The following sensors are fixed to the CPU housing: a piezoresistive pressure-gauge, a Pt 100 temperature sensor, a 7 pin conductivity cell, an AANDERAA INSTRUMENTS compass, and a piezoelectrical ultrasonic oscillator device for measurements of the current velocity in X, Y and Z directions. The following individual sensors can be placed where ever it is necessary (i.e. on the CPU housing, the cage or even the cable depending on the length of the data cable): one calorimetric thermistor for current velocity measurements, and three optical backscatter systems to measure the amount of suspended matter in the water column. These latter four devices are connected with the CPU via data cables and plugs. After each deployment data are recovered via a laptop computer. The data are given in ASCII format (integer values between 0 and 60,000) and need to be parsed, calibrated and statistical treated before any further interpretation.

During the first deployments it appeared that the probe slightly revolved on the cable due to current activity. Since this is likely to affect measurements of current vectors a rudder was constructed and fixed at one side of the probe to guarantee a stable position of the probe within the water column. A rudder, however, would not have been necessary for the planned mooring since the mooring probe would have been fixed with tight cables on top and bottom of the probe. Since the rudder always oriented the probe parallel to the current direction, measurements of current velocity vectors in X, Y and Z direction (piezoelectrical ultrasonic oscillator device, see above) were meaningless. They were thus replaced by a combination of thermistor and compass data.

Field Work

It was originally planned to set out one of the two MUMsystems as a mooring in a key region of the Laptev Sea (e.g. in one of the drowned valleys within the freshwater fetch a few 60 miles offshore the Lena or Khatanga river mouths) to record the dynamics of water mass movement and associated features of sediment transport during a couple of weeks in the late Arctic summer. However, heavy ice conditions due to an extreme cold summer made it impossible to foresee future ice conditions and, thus, a retrieval of the mooring at the end of the expedition was not guaranteed. Therefore continuous measurements were performed along some 9 profiles throughout the entire Laptev Sea (Fig. 73, Tab. A2). Most of the measurements were hooked on oceanographic transects taken by the Russian scientific party allowing combination of the data to yield a thorough insight into the Laptev Sea system by means of oceanographic and in situ sedimentological studies.

Preliminary Results

Besides some 4 test stations a total of 74 stations were measured. Although the data obtained require some additional treatment (absolute values may vary after calibration). Figure 74 shows station PM94 26 measured in the course of Transect III at 13 m water depth as an example. The water column is composed of three water masses clearly seperated by 2 pycnoclines at 6-7 m and 9-11 m depth. Salinity and temperature changes with water depth appear to be in good accordance thus producing a stable water mass stratification. Although, at various locations the water temperature beyond the first pycnocline tends to slightly exceed the surface water temperatures, an instable stratification of the water column could never be observed.

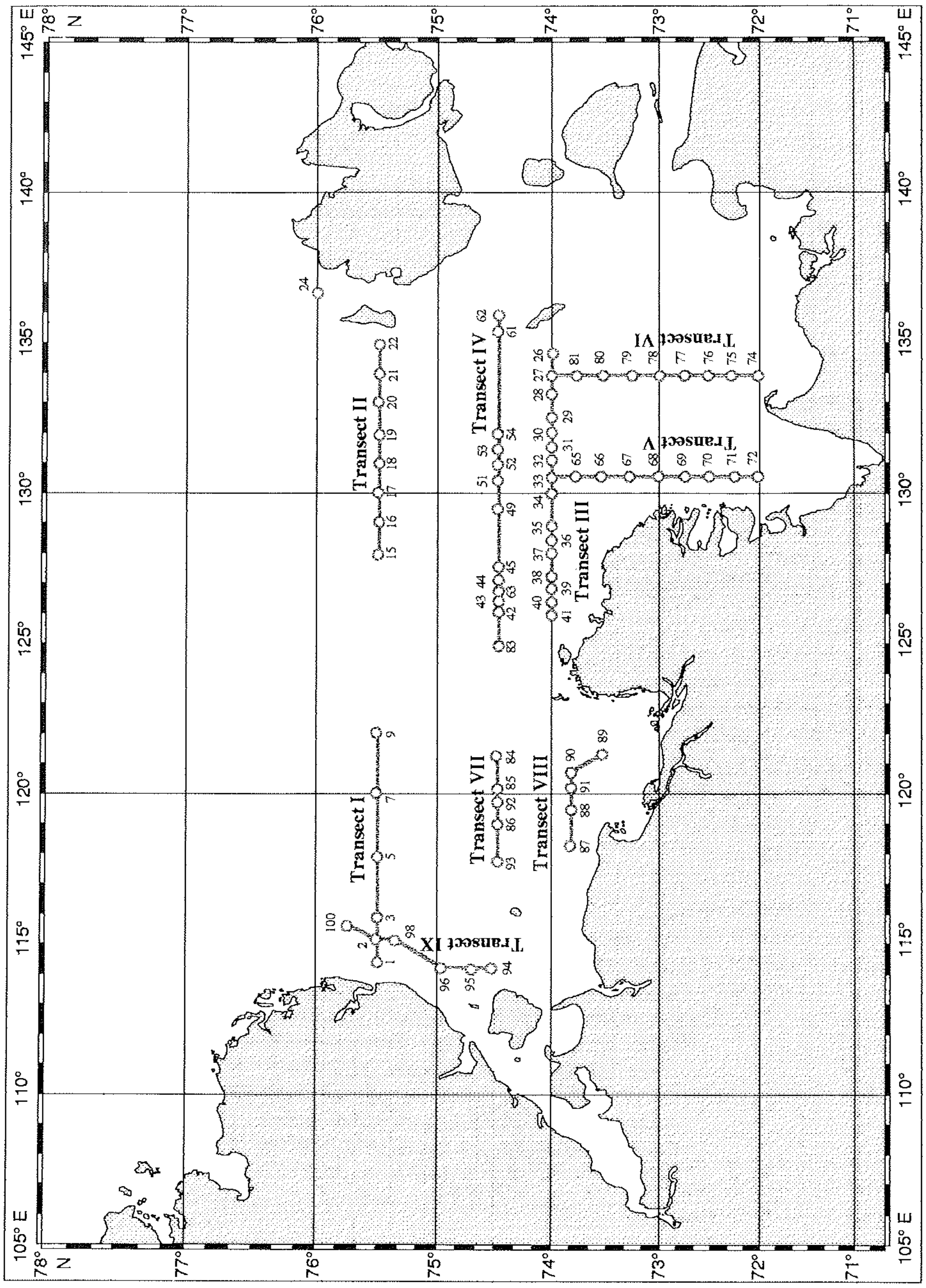


Fig. 73: Transects of MUM-deployments during the TRANSDRIFT II in the Laptev Sea (Station numbers are indicated without the prefix PM94).

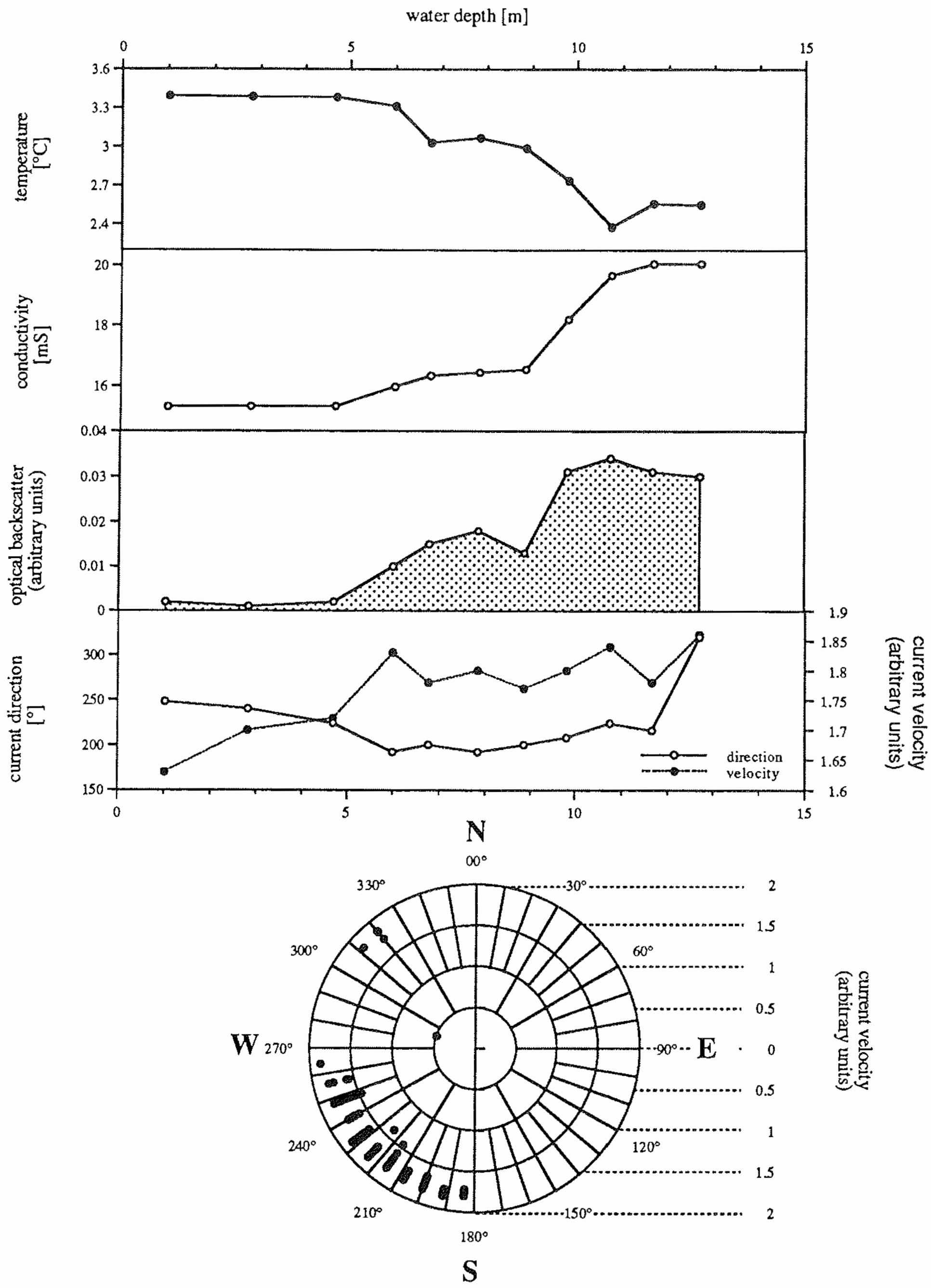


Fig. 74: Example from Station PM9426 (Transect III). Note that data are not yet calibrated. Direction rose (bottom): radius = current velocity (arbitary units), angle = current direction (degrees).

It can be inferred that the uppermost water layer is fueled by temperate freshwater of the Lena River, whereas the lowermost layer represents normal brackish-marine conditions which are comparable to other epicontinental seas. Thus, the absolute temperature and the thickness of the surface layer appears to be a measure for the influence of river discharge. Decreasing surface temperature and salinity combined with increasing thickness of the transitional layer (between 7 and 9 m water depth at our example) can therefore be explained as a consequence of the cooling of the surface water which then sinks into the transitional layer until it reaches a stable level with regard to temperature and salinity. Sometimes (e.g. station PM9496) observed trends of increasing temperatures within the transitional water layer are explained by stronger cooling of very low saline surface water which, however, is not able to penetrate the underlying water layer because of its lower salinity thus producing a temperature inversion. The bottom water mass mostly appeared to be clear cut separated by higher salinities and lower temperatures.

The absolute amount of suspended matter cannot yet be given since a set of calibration measurements is required to transform OBS (optical backscatter system) raw data into quantitative suspension data. However, data given in Fig. 74 provide an image of the relative distribution of suspended particles within the water column. As shown in the example the amount of suspended matter down to 5 m water depth is very low. Backscatter values then increase until the bottom of the transitional layer. At 9-10 m, however, shortly before the second pycnocline (9-11 m), the backscatter curve shows a prominent depression (an often observed feature, e.g. at stations PM94 26-32). At the beginning of this pycnocline backscatter values rise, indicating an increased suspension load within the lowermost water layer. Increasing backscatter values at roughly 5 m water depth parallel changes in every other parameter measured. Current velocities also show increased values. Whether increasing current speed is responsible for the increase of the suspension load can not yet be substantiated. It is also possibility that the suspension load supplied by riverine waters precipitates after slight mixing with higher salinity waters. Higher amounts of suspended matter in the lowermost water layer (up to the lower pycnocline) may be caused by a mixture of turbulent re-suspension of particles in the near-bottom zone (which cannot surmount the lower pycnocline) and particles incoming from surficial and transitional water layers. Current velocity does not affect the distribution of suspended matter in the water column below 6 m water depth (see example).

Though the current direction degrees are not absolute rather values relative to the true direction, it is clear that at station PM94 26 current directions do not change significantly throughout the water column. Thus, they can be depicted in form of a direction-rose (see lower part of Figure 74).

Conclusions and Outlook

The Laptev Sea is a sensitive estuarine system composed of surficial freshwater originating from large streams such as the Lena River and bottom waters of various origin (e.g. the Arctic Ocean). As far as the data obtained during the TRANSDRIFT II Expedition could be evaluated the following preliminary conclusions can be drawn for the period of the expedition. In the eastern Laptev Sea SSTs (sea surface temperatures) vary roughly between 0 and +2°C. They increased significantly due to the influence of the Lena. A similar SST increase in the reach of other rivers such as the Khatanga or Olynyok could not be measured. The western Laptev Sea is characterized by SSTs at or below 0°C showing a frequent and prominent trend to increasing water temperatures down to water depths where conductivity values mark the beginning of the bottom water mass. However, despite such vertical temperature inversions no instable layering of the water column could be observed (see also Karpiy et al., 1994).

Current velocities appear to be slightly higher in the eastern Laptev Sea. Irregeular changes in current velocity and current direction throughout the water column were observed at various stations.

Vertical profile optical backscatter data yield uni- to trimodal distributions of suspended matter. A very small maximum could often be measured from 0 to 5 m water depth; another maximum was mostly below 10 m. Highest amounts of suspended matter are suggested by a strong increase beginning at 5 to 1 m over the seafloor. The upper 2 OBS maxima are thought to be at least partly of biogenic origin (phytoplankton) whereas the deep maximum is likely to reflect benthic boundary layer conditions (see also Anoshkin & Ushakov, this volume). Total amounts of suspended matter do not change significantly between the eastern and western Laptev Sea. However, there are some differences between single locations which need further interpretation.

Preliminary data of the multisensor MUM probe show features which provide together with other investigations a thorough insight into the Laptev Sea System. Further processing of the MUM data will enable us to describe and interprete in situ sedimentary processes (e.g. sediment transport in different water layers) and their relation to water mass properties and oceanographic features of the Laptev Sea.

Side Scan Sonar Survey on the Laptev Sea Shelf

M. Antonow, V. Haase, H.C. Hass, and H. Kassens

Scientific Goal

Grounding ice has a great influence on the sediment dynamics of Arctic shelves by processes of erosion, bulldozing, and resuspension of sediment particles. Tracks on the shelf bottom give evidence of this geological agent. Side scan sonar investigations enable a close insight into the small scale topography and reveal a visual impression of the underwater landscape. Since sediment distribution as well as benthic life is closely tied to topographic features, side scan sonar surveys provide an important data set for further interpretations of the ecologic and sedimentary environments.

Approach and Working Area

During the expedition TRANSDRIFT II with RV *Professor Multanovskiy* side scan survey was carried out using a "Hydroscan" equipment by Klein Associates, Inc., New Hampshire, U.S.A. The Klein three channel model 530 combines a 100 kHz Towfish (model 422 S) with a 3.5 kHz Sub-bottom Profiler (model 532 S). The sonar unit (1° horizontal beam) was trawled between 5 and 8 m over ground with a total observation range of 100 m. The trawling velocity of the tow fish was about 4 knots over ground. Due to the heavy weather and ice conditions only one profile was chosen. This transect is situated as follows:

Profile		Latitude	Longitude	Water depth	Location
PM 94Sc-1	start	75°30.2' N	130°04.0' E	43 m	western Stolbovoy shoal
	end	75°30.1' N	132°00.6' E	14 m	

Preliminary Results

The side scan sonar profiling across the western slope of Stolbovoy Shoal exhibits a relativly monotonous bottom topography. Gouges are rare and occure single. The incision depth of these single plough marks is up to about 5 metres. However, they are characterized by a diffuse shape and occur only in water depths about 30-35 m.

Due to the absence of gouges in shallower regions they are not related to the position of the recent fast ice edge. Thus, and according to their preservation it can be considered that these marks are relicts of ice gouging activity during former regressions. This would coincide with proposed low sea-level stands (about 20 m below present sea-level) during the period from 8700 to 7900 years B.P. (Holmes & Creager, 1974).

The results of the expeditions TRANSDRIFT I (Lindemann et al., 1994; Kassens & Karpyi, 1994) and TRANSDRIFT II and further investigations by side scan sonar means will give an idea of the action of grounded ice and the ice influenced Laptev Sea shelf morphodynamics in this Arctic region.

Dissolved and Particulate Trace Elements in the Laptev Sea: Sources, Occurrence and Pathways

J.A. Hölemann

Little is known about the processes and complex interactions between sediment, water and ice and their influence on the transport of trace metals and organic compounds from the Siberian shelf seas into the Arctic Ocean. The Lena river is the second largest river discharging into the Arctic. Although, recent studies place particular emphasis on the pristine aquatic environment of the Lena river (Martin et al., 1993), detailed geochemical investigations carried out in the Laptev Sea during the German-Russian expeditions ESARE and TRANSDRIFT I point to unexpectedly high concentrations of chlorobiphenyls (CB) in solution and suspended matter. The high concentration of these organic compounds are attributed to intense anthropogenic inputs.

Weathering, erosion, and anthropogenic input are the major sources of particulate and dissolved trace elements entering the Laptev Sea with the fresh water outflow of the Lena, Khatanga, Yana and other rivers. Beside these point sources, the diffuse input via atmospheric transport, the influence of pore water diffusion into the water column and the admixture of ocean water masses control the trace element distribution in the waters of the Laptev Sea.

High concentrations of dissolved Fe, Mn, Ni, Cu, and Zn are directly connected with the fresh water discharge of the rivers. In contrast, elements like U and Mo and Cd show highest concentrations in more saline surface waters. A well studied phenomena is, for example, the very close correlation between salinity and Mo.

Highest concentrations of specific metals in the suspension and in the surface sediments were not found near the river mouth, but in specific regions of the Central Laptev Sea. It is presumed that the transport and distribution of trace metals is largely controlled by the complex hydrodynamic system in the Laptev Sea. Another important factor is the cycling of manganese and iron which has a strong effect on the distribution of other trace metals due to comigration. Evidence for this process is given by surface Fe/Mn-accumulates with strong enrichment of e.g. As, Co, Mo, V, Ni, Cu and sometimes Cd.

Main objective of the geochemical research program during TRANSDRIFT II is to identify the sources, pathways and sinks of trace metals during the summer season. Therefore, the scientific program focusses on investigations of the areas of the river water outflow and the frontal zones in the south-eastern Laptev Sea.

The geochemical studies will be completed by detailed investigations of the concentration and character of suspended matter in these areas.

Together with the research programm which will be carried out during spring (river break up) and late autumn (sea ice formation and polynya studies) the comparative geochemical studies should lead to a better understanding of the cycling of trace elements within the Arctic. These investigations provide a key to the interpretation of geochemical tracers in the water masses and the pack ice of the Arctic Ocean.

Working Program

During the cruise, 11 sediment samples (upper 2 cm), 46 suspended matter and 46 water samples were taken to analyse their major and trace element composition (Tab. A2). In addition, suspended particulate matter samples were taken at about 50 sites for the determination of suspended particulate matter concentration (SPM), particulate organic carbon (POC) and for scanning electron microscopy (SEM) observations combined with energy-dispersive spectrometry (EDS). The sampling program is completed by 30 water samples taken near the mouth of the river Lena for analysis of dissolved organic carbon (DOC).

At all locations water samples were taken 2m below the sea surface and 5m above seafloor. Sediment samples were taken from the undisturbed upper two centimeters of a spade box core. Positions of all sampling sites are given in Table A2.

Water samples for trace element analysis were taken using Teflon water samplers (Hydro-Bios) with 2l pre-cleaned polyehylene (surface sample) and two 1l pre-cleaned teflon bottles (bottom sample) hung on a plastic coated hydrowire. Sampling was carried out from the bow of the vessel. Two liter of sea water were filtered through acid pre-treated 0.4µm Nuclepore filters to collect particulate matter. For this purpose a pressure filtration (Nitrogen 5.0) in a transportable Class 100 clean air cabinet was used. Filters were stored frozen for subsequent analysis while the filtrate was acidified.

Final analysis will be done at the Research Center Geesthacht (Germany) including salt-matrix separation and pre-concentration of the water samples followed by analysis with Total Reflection X-Ray Fluorescence (TXRFA) and complementary measurements using Atomic Absorption Spectroscopy (AAS) and Inductively Coupled Plasma Mass Spectrometry (ICP-MS). Elements measured in sea water include V, Mn, Fe, Co, Ni, Cu, Zn, Se, Mo, Cd, U and Pb. In the sediments (< 20 µm fraction) and the suspended particulate matter about 30 elements can be measured.

SPM, POC measurements and scanning electron microscopy in combination with EDS will be carried out at GEOMAR in Kiel. Determination of DOC will be performed at the Institute of Biogeochemistry and Marine Chemistry in Hamburg

Geochemical Pathways of 10-Beryllium in the Laptev Sea

Chr. Strobel

Today the cosmogenic radionuclide ^{10}Be is of major interest for the palaeoclimatology since remarkable maxima of ^{10}Be concentration have been measured in deep sea sediments of the Nordic Seas [Eisenhauer et al.,1994]. Sedimentary records have shown, that high concentrations of ^{10}Be are related to interglacial stages contrasting to lower values in glacial sections. This distinct change in ^{10}Be has become an important dating tool for sediments from high northern latitudes with low or negligible content of biogenic carbonate. However, up to now the reasons of these interglacial maxima are not exactly determined but there is evidence that the main source could be an enhanced delivery of continental ^{10}Be with the discharge of the River Lena during periods of deglaciation. To prove this hypothesis it is necessary to investigate the pathways of ^{10}Be from the Lena into the sediments of the Arctic Ocean. Further, a comparison of modern riverine ^{10}Be supply with the paleo-fluxes determined in sediment cores from different localities of the shelf will to be carried out. These studies will lead to a better understanding of the geochemical behaviour of ^{10}Be in the water column and in the sediment.

Working Program

Water samples (30 l) were taken near to the mouth of the River Lena and from high salinity water masses of the central Laptev Sea at the surface (2 m water depth) and 5 m above the seafloor (Tab. A2). In addition sediment cores for the determination of sedimentary ^{10}Be fluxes were recovered during the expeditions TRANSDRIFT I and TRANSDRIFT II.

All water samples were spiked with the stable ^{9}Be-Isotope (1 ml) and precipitated with NH_4OH. Afterwards they were reduced from 30 to 2 l. After the chemical preparation of the water samples and sediments at the "Arbeitsstelle fuer radiometrische Altersbestimmmung der Heidelberger Akademie der Wissenschaften", ^{10}Be will be measured via accelerator mass spectrometry (AMS) at the tandem facility of the ETH Zuerich.

Organic Pollutants in the Laptev Sea

D. Schulz-Bull and S. Schultz

Introduction

Polychlorinated biphenyls (PCB) are ubiquitous contaminants. Their presence in the marine environment has important repercussions. Firstly, several congeners are persistent and toxic and they accumulate in lipid tissues of marine organisms. Further, chlorobiphenyls (CB) are a series of chemically similar compounds with a large range of physico-chemical properties. Their environmental levels and the compositions of CB mixtures can be used to identify water bodies and to find out the origin of the contaminants.

During "ESARE" and "TRANSDRIFT I" expeditions unexpected high CB concentrations in solution and in suspended matter were measured in the Laptev Sea. The aim of the "TRANSDRIFT II" is to verify these values and to identify the source of PCB, wich is presumably the river Lena.

Working Program

During this expedition sediment and water samples were taken at stations near the Lena delta and in the central part of the Laptev-Sea (Tab. A2).

Sediments for analysis of polychlorinated biphenyls (PCB) were taken with a spade box corer. Sampling was carried out in 2 cm intervals from the sediment surface down to 25 cm. All samples were stored in pre-cleaned petri dishes or aluminium foil and kept frozen (-20°C).

To study the present PCB contamination in the water column of the Laptev Sea samples of the dissolved and particulate phases were taken by an in situ pumping system. This pumping system is equiped with a teflonfilterbox including a pretreated glassfibrefilter to get the particular matter and a XAD-column, filled with polystyrol, were dissolved PCB's were adsorbed. At each pumping station 181 to 337 liters of seawater were filtered from water dephts between seven and ten meters. Immediately after sampling, glassfibrefilters were frozen at -20°C and the XAD-columns were stored cool.

All samples will be analysed by means of Liquid Chromatography (LC) and High Performance Liquid Chromatography (HPLC) with an Electron-Capture-Detector in connection with Multidimensional Gaschromatography (MDGC/ECD). All measurements will be carried out at the Institute of Marine Research in Kiel.

ACKNOWLEDGEMENTS

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APPENDIX

Table A1: List of Participants of the TRANSDRIFT II expedition

Scientific Party			
Dmitrenko, Dr.	Igor A.	AARI	Co-chief Scientist, Oceanography
Kassens, Dr.	Heidemarie	GEOMAR	Co-chief Scientist, Geology
Afanaseva,	Julia M.	AARI	Meteorology
Anoshkin, Dr.	Andrej F.	CRIMF	Hydrooptics
Antonow,	Martin	TU BAF	Geology
Churun,	Vladimir N.	AARI	Oceanography
Cremer,	Holger	GEOMAR	Paleontology
Dehn, Dr.	Jonathan	GEOMAR	Geology
Golowyn,	Pavel N.	AARI	Oceanography
Golubev,	Alexander N.	AARI	Satellite Imaging
Haase,	Veit	TU BAF	Geology
Hass, Dr.	Christian	TU BAF	Geology
Heinze,	Bertram	GEOMAR	Geology
Hölemann, Dr.	Jens A.	GEOMAR	Geochemistry
Ipatov,	Alexander Y.	AARI	Oceanography
Karpiy,	Valery Y.	AARI	Oceanography
Kolyesov,	Sergej A.	AARI	Oceanography
Kunz-Pirrung,	Martina	GEOMAR	Geology
Lamakin,	Michail V.	AARI	Meteorology
Lebedev,	Nikolay V.	AARI	Oceanography
Neufeld,	Sergej	GTG	Technician
Novoshilov, Dr.	Anatoli V.	AARI	Biology
Petryashov, Dr.	Viktor V.	ZISP	Biology
Peregovich,	Bernhard	GEOMAR	Geology
Pivovarov, Dr.	Sergey V.	AARI	Hydrochemistry
Rumjanzev,	Andrej L.	JEMR	Electronics
Schultz,	Stefanie	IFM	Marine Chemistry
Strobl,	Christopher	AdW	Marine Chemistry
Teplitz,	Jevgeni O.	MOARC	Marine Chemistry
Timachev,	Valeriy F.	AARI	Meteorology
Timokhov, Dr.	Leonid A.	AARI	Oceanography
Ushakov, Dr.	Ivan E.	NWPI	Hydrooptics
Yakovlev,	Alexander V.	VNIIO	Geology
Ships Crew			
Danilenko,	Vladimir V.	AARI	Captain
Linjayev,	Yuri S.	AARI	Chief Mate
Mjaschistov,	Kasim H.	AARI	2nd Officer
Nesterov,	Sergej V.	AARI	3rd Officer
Dorofeyev,	Nikolay G.	AARI	Radio Officer
Lysenko,	Boris I.	AARI	Physician

Ships Crew

Turlakov,	Vladimir A.	AARI	Chief Engineer
Fedorov,	Nikolay A.	AARI	2nd Engineer
Timoschen,	Alexander V	AARI	3rd Engineer
Novikov,	Vladimir A.	AARI	4th Engineer
Savelyev,	Viktor N.	AARI	Chief Electromechanic
Maksimov,	Arkadi I.	AARI	Mechanic
Mingaleyev,	Tagyr Sh.	AARI	Mechanic
Voronin,	Leonid V.	AARI	Engineer
Panteleyev,	Dennis V.	AARI	Engineer
Trofimenko,	Dmitry G.	AARI	Engineer
Berestnev,	Igor B.	AARI	Electrical Engineer
Tarasov,	Andrej B.	AARI	Oceanographer
Kislizyn,	Sergej P.	AARI	Meteorologist
Nikankin,	Alexander K.	AARI	Oceanographer
Lukyanchikov,	Alexander A.	AARI	Oceanographer
Gusev,	Igor V.	AARI	Hydrochemist
Rubzov,	Vjatscheslav	AARI	Engineer
Kotchetygov,	Yuri A.	AARI	Electronical Engineer
Vladimirow,	Vasily G.	AARI	Boatswain
Litvinov,	Vladimir S.	AARI	Sailor
Vasilyev,	Yuri V.	AARI	Sailor
Gribkov,	Vladimir G.	AARI	Sailor
Chernaya,	Elena A.	AARI	Sailor
Lechkiy,	Oleg V.	AARI	Chef
Belopaszew,	Alexander N.	AARI	Cook
Darkicheva,	Valentina N.	AARI	Stewardess
Savalova,	Tamara V.	AARI	Stewardess
Nikolayeva,	Olga A.	AARI	Stewardess
Schishkova,	Antonina I.	AARI	Stewardess

AARI	Arctic and Antarctic Research Institute, Uliza Beringa 38, St. Petersburg 199226, Russia
GEOMAR	Forschungszentrum für marine Geowissenschaften, Wischhofstraße 1-3, D-24148 Kiel
GTG	GEOMAR Technologie Gmbh, Wischhofstraße 1-3, D - 24148 Kiel
HAW	Heidelberger Akademie der Wissenschaften, INF 366, D - 69120 Heidelberg
IFM	Institut für Meereskunde, Düsternbrooker Weg 20, D - 24105 Kiel
JEMR	Joint Enterprises, Mitas & Radex, per. Boytsova 4, St. Petersburg 19065
KSRI	Krylov Shipbuilding Research Institute, Moskovskoe chaussee 20, St. Petersburg 196158
MOARC	Monitoring of Arctic, Uliza Beringa 38, St. Petersburg 199226
NWPI	North-West Polytechnical Institute, Uliza Millionnaya 5, St. Petersburg 191065
TU BAF	TU Bergakademie Freiberg, Institut für Geologie, Cotta-Str. 2, D - 09596 Freiberg
VNIIO	All-Russian Research Institute for Geology and Mineral Resources of the World Ocean, VNIIOkeanologia, Uliza Maklina 1, St. Petersburg 190121
ZISP	Zoological Institute, Russian Academy of Sciences, Universitetskaya nab. 1, St. Petersburg 199034

Table A2: Station list of the TRANSDRIFT II expedition

Station #		Date	Time (GMT)	Latitude (° N)	Longitude (° E)	Depth (m)	Activity
PM94K01		13.08.	17:40-18:48	73°33′	80°02′	44	CTD; Ho; HCh: Oxy,Si
PM94K02		13.08.	20:40-21:21	73°35′	79°29′	26	CTD; Ho; HCh: Oxy,Si
PM94K03		14.08.	00:23-00:55	73°40′	78°21′	18	CTD; Ho; HCh: Oxy,Si
PM94K04		14.08.	03:55-04:38	73°44′	77°08′	20	CTD; Ho; HCh: Oxy,Si
PM94K05		14.08.	07:15-08:27	73°50′	75°46′	20	CTD; Ho; HCh: Oxy,Si,Phos; Bio-BC: VVG,SD
PM94K06		14.08.	10:57-11:27	73°50′	74°30′	16	CTD; Ho; HCh: Oxy,Si
PM94K07		14.08.	13:48-14:57	73°50′	73°20′	29	CTD; Ho; HCh: Oxy,Si,Phos; Bio-BC: VVG,SD
PM94K08		14.08.	16:43-17:18	73°50′	72°27′	24	CTD; Ho; HCh: Oxy,Si
PM94K09		14.08.	19:14-20:35	73°50′	71°30′	19	CTD; Ho; HCh: Oxy,Si,Phos; Bio-BC: VVG,SD
PM94K10		14.08.	23:10-23:45	73°50′	70°16′	22	CTD; Ho; HCh: Oxy,Si
PM94K11		23.08.	04:50-05:00	75°47′	86°47′	40	CTD
PM94K12		23.08.	06:56-20:26	75°42′	86°47′	50	CTD; Ho; HCh: Oxy,Si,Phos,Nitr; Bio-BC: VVG; Bio-PC: PT,JT
PM94T1	-1	23.08.	09:46	75°41.52′	86°03.01′	51	GKG (39 cm)
	-2	23.08.	10:53	75°41.52′	86°03.04′	51	GKG (40 cm)
PM94K13		24.08.	00:55-17:30	75°25′	85°24′	49	CTD; Ho; HCh: Oxy,Si
PM94T2	-1	24.08.	11:20	75°25.31′	85°24.64′	50	GKG (50 cm)
	-2	24.08.	12:07	75°25.35′	85°24.71′	50	KAL (445+20 cm CC)
PM94K14		29.08.	08:55-11:05	76°39′	96°43′	60	CTD; Ho; HCh: Oxy,Si,Phos,Nitr; Bio-BC: VVG
PM94K15		01.09.	05:20-06:00	77°13′	99°12′	109	CTD; Ho; Bio-BC: VVG,SD
PM94T3	-1	01.09.	05:37	77°04.42′	99°13.44′	113	GKG (over-penetration)
	-2	01.09.	07:07	77°04.16′	99°13.18′	110	GKG (55 cm)
PM94K16		01.09.	10:25-10:40	77°04′	99°20′	100	CTD; Ho
PM94T4	-1	02.09.	10:03-11:20	76°59.50′	99°08.20′	53	MUM
PM9401		03.09.	19:30-21:20	75°30′	114°30′	38	CTD; Ho; HCh: Oxy,Si,Phos,Nitr; Bio-BC: VVG,SD; Bio-PC: PT,JT; GM: W
	-1	03.09.	19:33-20:30	75°29.93′	114°31.62′	39	MUM
	-2	03.09.	20:05-20:15	75°30.33′	114°31.62′	2+34	WSS
PM9402		03.09.	22:40-00:36	75°30′	115°15′	46	CTD; Ho
	-1	03.09.	22:42-23:29	75°29.91′	115°14.66′	48	MUM
	-2	03.09.	22:42-23:01	75°29.91′	115°14.66′	2+43	WSS
	-3	03.09.	23:42	75°29.44′	115°14.94′	47	GKG (39 cm)
	-4	03.09.	01:00	75°29.45′	115°15.00′	47	KAL (no recovery)
	-5	04.09.	01:55-02:25	75°29.46′	115°15.01′	48	MUM

Table A2: Station list of the TRANSDRIFT II expedition

Station #		Date	Time (GMT)	Latitude (° N)	Longitude (° E)	Depth (m)	Activity
PM9403		04.09.	04:00-05:55	75°30′	116°00′	23	CTD; Ho; HCh: Oxy,Si
	-1	04.09.	04:10-04:40	75°30.18′	116°00.38′	2+19	WSS,13-C
	-2	04.09.	04:10-04:50	75°30.18′	116°00.38′	24	MUM
PM9404		04.09.	07:30-08:00	75°30′	117°00′	26	CTD; Ho
PM9405		04.09.	09:27-11:30	75°30′	118°00′	30	CTD; Ho; HCh: Oxy,Si,Phos,Nitr; Bio-PC: PT,JT; GM: W
	-1	04.09.	10:39-11:11	75°30.00′	118°00.07′	29	MUM
	-2	04.09.	10:40-10:55	75°30.00′	118°00.07′	28-30	WSS
PM9406		04.09.	12:43-13:00	75°30′	119°00′	39	CTD; Ho
PM9407		04.09.	14:40-15:49	75°30′	119°59′	44	CTD; Ho; HCh: Oxy,Si
	-1	04.09.	14:45-15:30	75°29.99′	119°59.32′	44	MUM
	-2	04.09.	15:05-15:20	75°30.13′	119°59.87′	2+39	WSS
PM9408		04.09.	17:24-17:45	75°30′	121°00′	49	CTD; Ho
PM9409		04.09.	19:20-21:00	75°30′	122°00′	51	CTD; Ho; HCh: Oxy,Si,Phos,Nitr; Bio-PC: PT,JT; GM: W
	-1	04.09.	19:30-20:25	75°30.38′	122°00.55′	52	MUM
	-2	04.09.	19:40-19:55	75°31.26′	122°04.05′	2+48	WSS,13-C
PM9410		04.09.	22:37-23:06	75°30′	123°00′	46	CTD; Ho
PM9411		05.09.	00:35-01:38	75°30′	124°00′	44	CTD; Ho; HCh: Oxy,Si
	-1	05.09.	00:52-01:05	75°30.00′	124°00.00′	2+40	WSS,13-C
	-2	05.09.	00:51-01:27	75°30.00′	124°00.00′	44	MUM
PM9412		05.09.	03:07-03:28	75°30′	125°00′	45	CTD; Ho
PM9413		05.09.	05:06-11:43	75°30′	126°00′	40	CTD; Ho; HCh: Oxy,Si,Phos,Nitr; Bio-BC: VVG; GM: W,S
	-1	05.09.	06:00-07:00	75°29.94′	126°00.12′	3+36	WSB
	-2	05.09.	08:30-09:30	75°30.09′	126°00.48′	2+36	WSS,WSM,WSP
	-3	05.09.	08:30-08:50	75°30.09′	126°00.48′	2	PN
	-4	05.09.	06:00 to 10:30	75°30.09′ 75^30.09′	126°00.48′ 126°00.46′	10	WP-PCB (no data, technical failure)
PM9414		05.09.	13:30-13:50	75°30′	127°00′	43	CTD; Ho
PM9415		05.09.	15:27-16:22	75°30′	128°00′	44	CTD; Ho; HCh: Oxy,Si
	-1	05.09.	15:45-16:49	75°30.10′	128°01.28′	44	MUM
	-2	05.09.	15:43-15:49	75°30.00′	128°00.48′	2+42	WSS,13-C
PM9416		05.09.	18:13-19:26	75°30′	129°00′	43	CTD; Ho; HCh: Oxy,Si,Phos,Nitr; Bio-PC: PT,LT
	-1	05.09.	18:14-19:10	75°30.00′	129°01.02′	45	MUM
PM9417		06.09.	21:37-06:00	75°30′	130°00′	49	CTD; Ho; HCh: Oxy,Si; GM: S
	-1	06.09.	02:10-02:30	75°30.03′	130°00.75′	2+46	WSS,WSM,WSP
	-2	06.09.	02:30-03:00	75°30.03′	130°00.75′	3+37	WSB
	-3	06.09.	02:40-03:00	75°30.03′	130°00.75′	2+3	PN
	-4	06.09.	03:56	75°30.17′	130°00.83′	51	GKG (45 cm)
	-5	05.06.	21:40-22:20	75°30.04′	130°00.84′	51	MUM
	-6	06.09.	05:05	75°30.07′	130°00.70′	51	KAL (148 cm)
PM94Sc1	-7	06.09.	06:24 to 09:45	75°30.18′ 75°30.08′	130°04.03′ 132°00.60′		Side Scan Sonar Survey

Table A2: Station list of the TRANSDRIFT II expedition

Station #		Date	Time (GMT)	Latitude (° N)	Longitude (° E)	Depth (m)	Activity
PM9418		06.09.	10:08-10:50	75°30′	130°59′	18	CTD; Ho
	-1	06.09.	10:13-10:35	75°30.66′	130°59.67′	18	MUM
PM9419		06.09.	12:30-13:50	75°30′	132°00′	19	CTD; Ho; HCh: Oxy,Si,Phos,Nitr; Bio-BC: WG,SD; GM: W
	-1	06.09.	13:01-13:08	75°30.08′	132°00.60′	2+10	WSS,WSM,13-C
	-2	06.09.	12:39-13:00	75°30.58′	132°01.15′	15	MUM
PM9420		06.09.	15:30-16:24	75°30′	133°00′	18	CTD; Ho
	-1	06.09.	15:53-16:14	75°29.89′	132°58.99′	17	MUM
PM9421		06.09.	18:08-18:53	75°30′	134°00′	33	CTD; Ho; HCh: Oxy,Si
	-1	06.09.	18:11-18:46	75°30.75′	133°58.86′	34	MUM
	-2	06.09.	18:15-18:25	75°30.01′	134°00.01′	2+29	WSS, 13-C
PM9422		06.09.	20:50-21:40	75°30′	135°00′	40	CTD; Ho
	-1	06.09.	21:01-21:35	75°30.38′	134°58.77′	41	MUM
PM9423		06.09.	01:48-03:00	75°30′	136°31′	19	CTD; Ho; HCh: Oxy,Si,Phos,Nitr; Bio-PC: PT,JT; GM: W
PM9424		07.-08.09.	17:34-15:55	75°57′	136°44′	20	CTD; Ho; HCh: Oxy,Si,Phos,Nitr; Bio-BC: VVG,MS; GM: W,S
	-1	07.09.	16:40	75°57.02′	136°45.62′	0 - 3	PN
	-2	07.09.	18:02-18:29	75°56.80′	136°44.82′	19	MUM
	-3	07.09.	18:50-22:00	75°56.80′	136°44.82′		life boat: attempted retrieval of mooring IK93K1
	-4	08.09.	05:10-05:30	75°56.90′	136°44.51′	2 +10+13	WSS,WSP,13-C
	-5	08.09.	05:50	75°56.90′	136°44.51′	18	GKG (no recovery)
	-6	08.09.	06:20-11:13	75°56.87′	136°44.48		life boat: attempted retrieval of mooring IK93K1
	-7	08.09.	06:24	75°56.87′	136°44.48′	18	GKG (no recovery)
	-8	08.09.	09:29	75°56.82′	136°44.05′	20	VC (no recovery)
			10:20	75°56.82′	136°44.05′	20	VC (no recovery)
	-9	08.09.	12:40-12:55	75°56.92′	136°44.48′	20	VC (no recovery)
	-10	08.09.	14:30-16:00	75°56.95′	136°44.52′		life boat: attempted retrieval of mooring IK93K1
PM9425		09.09.	04:20-04:51	74°00′	135°00′	19	CTD; Ho; HCh: Oxy,Si; GM: W
	-1	09.09.	04:50-05:00	74°00.00′	135°00.04′	0 - 3	PN
	-2	09.09.	05:00-05:20	74°00.00′	135°00.04′	2+10+14	WSS,WSM,WSP,13-C
PM9426		09.09.	05:52-06:20	74°00′	134°30′	13	CTD; Ho; HCh: Oxy,Si
	-1	09.09.	05:55-06:05	74°00.00′	134°30.00′	0 - 3	PN
	-2	09.09.	06:15-06:23	74°00.00′	134°30.00′	2+9+10	WSS,WSP,13-C
	-3	09.09.	05:55-06:20	73°59.96′	134°29.40′	14	MUM
PM9427		09.09.	07:14-07:35	74°00′	134°00′	12	CTD; Ho; HCh: Oxy,Si
	-1	09.09.	07:20-07:30	73°59.98′	133°59.80′	0 - 3	PN
	-2	09.09.	07:16-07:34	73°59.98′	133°59.80′	13	MUM
PM9428		09.09.	08:32-08:58	74°00′	133°30′	12	CTD; Ho; HCh: Oxy,Si
	-1	09.09.	08:35-08:45	73°59.83′	133°30.01′	2+6+8	WSP,WSS,13-C
	-2	09.09.	08:32-08:51	73°59.83′	133°30.01′	11	MUM
	-3	09.09.	08:32-08:37	73°59.83′	133°30.01′	0 - 3	PN
PM9429		09.09.	11:40-12:00	74°00′	132°30′	10	CTD; Ho; HCh: Oxy,Si
	-1	09.09.	11:45-11:55	73°59.91′	132°30.54′	0 - 3	PN
	-2	09.09.	11:55-12:10	73°59.91′	132°30.54′	2+6	WSS,WSM,WSP,13-C

Table A2: Station list of the TRANSDRIFT II expedition

Station #		Date	Time (GMT)	Latitude (° N)	Longitude (° E)	Depth (m)	Activity
PM9429	-3	09.09.	11:36-11:57	73°59.91′	132°30.54′	10	MUM
PM9430		09.09.	13:00-13:30	74°00′	132°00′	16	CTD; Ho; HCh: Oxy,Si
	-1	09.09.	13:07-13:28	74°00.02′	131°59.84′	16	MUM
PM9431		09.09.	14:25-15:00	74°00′	131°30′	22	CTD; Ho; HCh: Oxy,Si
	-1	09.09.	14:35-14:45	74°00.03′	131°30.05′	0 -3	PN
	-2	09.09.	14:50-15:00	74°00.03′	131°30.05′	2+10+17	WSS,WSM,WSP,13-C
	-3	09.09.	14:33-14:57	74°00.03′	131°30.05′	21	MUM
PM9432		09.09.	16:00-16:30	74°00′	131°00′	22	CTD; Ho; HCh: Oxy,Si
	-1	09.09.	16:02-16:30	74°00.01′	130°59.87′	22	MUM
PM9433		09.09.	17:33-18:11	74°00′	130°30′	25	CTD; Ho; HCh: Oxy,Si
	-1	09.09.	17:40-17:50	73°59.92′	130°30.06′	0 - 3	PN
	-2	09.09.	17:55-17:10	73°59.92′	130°30.06′	2+10+20	WSS,WSM,WSP,13-C
	-3	09.09.	17:44-18:11	73°59.92′	130°30.00′	24	MUM
(A33)		15.09.	08:26-08:56	74°00′	130°30′	25	CTD; Ho
PM9434		09.09.	19:13-19:44	74°00′	130°00′	15	CTD; Ho; HCh: Oxy,Si
	-1	09.09.	19:17-19:37	74°00.01′	129°59.79′	16	MUM
	-2	09.09.	19:15-19:25	74°00.01′	129°59.79′	0 - 3	PN
PM9435		09.09.	21:52-22:21	74°00′	129°00′	15	CTD; Ho; HCh: Oxy,Si
	-1	09.09.	21:43-21:49	73°59.96′	129°00.00′	0 - 3	PN
	-2	09.09.	21:45-21:55	73°59.96′	129°00.00′	2+7+10	WSS,WSM,WSP,13-C
	-3	09.09.	21:47-22:18	73°59.96′	129°00.00′	15	MUM
PM9436		09.09.	23:20-00:00	74°00′	128°30′	25	CTD; Ho; HCh: Oxy,Si
	-1	09.09.	23:20-23:31	74°00.01′	128°30.92′	0 - 3	PN
	-2	09.09.	23:25-23:35	74°00.01′	128°30.92′	2+10 +21	WSS,WSP
	-3	09.09.	23:20-23:40	74°00.01′	128°30.92′	26	MUM
PM9437		10.09.	00:50-01:30	74°00′	128°00′	26	CTD; Ho; HCh: Oxy,Si
	-1	10.09.	00:54-01:20	73°59.95′	127°59.69′	27	MUM
PM9438		10.09.	02:25-03:05	74°00′	127°30′	26	CTD; Ho; HCh: Oxy,Si
	-1	10.09.	02:35-02:45	74°00.00′	127°29.87′	0 - 3	PN
	-2	10.09.	02:45-02:55	74°00.00′	127°29.87′	2+10+23	WSS,WSM,WSP,13-C
	-3	10.09.	02:30-03:03	74°00.00′	127°29.87′	27	MUM
PM9439		10.09.	04:00-04:33	74°00′	127°00′	25	CTD; Ho; HCh: Oxy,Si
	-1	10.09.	04:04-04:28	74°00.00′	126°59.96′	27	MUM
PM9440		10.09.	05:40-06:04	74°00′	126°30′	20	CTD; Ho; HCh: Oxy,Si
	-1	10.09.	05:40-06:03	73°59.99′	126°29.83′	20	MUM
PM9441		10.09.	07:05-08:15	74°00′	125°59′	13	CTD; Ho; HCh: Oxy,Si,Phos,Nitr; Bio-BC: VVG,MS; GM: W
	-1	10.09.	07:52-07:55	74°00.00′	125°59.29′	0 - 3	PN
	-2	10.09.	07:10-07:35	74°00.00′	125°59.29′	2+8	WSS,WSM,WSP,13-C
	-3	10.09.	07:06-07:35	74°00.00′	125°59.29′	13	MUM
	-4	10.09.	07:41	74°00.00′	125°59.29′	14	GKG (19 cm)
PM9442		10.09.	12:20-14:20	74°30′	125°59′	40	CTD; Ho; HCh: Oxy,Si,Phos,Nitr; Bio-PC: PT,LT; GM: S
	-1	10.09.	12:25-12:47	74°29.98′	125°59.81′	39	MUM
	-2	10.09.	12:20-12:30	74°29.98′	125°59.81′	0 - 3	PN
	-3	10.09.	12:53	74°29.93′	126°00.20′	40	GKG (47 cm)

Table A2: Station list of the TRANSDRIFT II expedition

Station #		Date	Time (GMT)	Latitude (° N)	Longitude (° E)	Depth (m)	Activity
PM9442	-4	10.09.	13:57	74°29.35′	126°02.40′	40	KAL (no recovery)
PM9443		10.09.	15:15-15:55	74°30′	126°30′	37	CTD; Ho; HCh: Oxy,Si; GM: W
	-1	10.09.	15:15-15:23	74°30.05′	126°29.94′	0 - 3	PN
	-2	10.09.	15:15-15:56	74°30.05′	126°29.94′	40	MUM
	-3	10.09.	15:15-15:35	74°30.05′	126°29.94′	2+33	WSS,WSM,13-C
PM9444		10.09.	16:54-17:27	74°30′	127°00′	24	CTD; Ho; HCh: Oxy,Si
	-1	10.09.	17:02-17:23	74°30.20′	127°00.28′	24	MUM
(A44)		13.09.	13:25-13:40	74°30′	127°00′	20	CTD
PM9445		10.09.	18:30-03:35	74°30′	127°30′	34	CTD; Ho; HCh: Oxy,Si,Phos,Nitr; Bio-BC: VVG; GM: S
	-1	10.09.	18:32-19:07	74°29.99′	127°30.18′	33	MUM
	-2	10.09.	18:82-18:38	74°29.99′	127°30.18′	0 - 3	PN
	-3	10.09.	18:45-18:55	74°29.99′	127°30.18′	2+30	WSS,13-C
	-4	10.09.	19:00-19:15	74°29.99′	127°30.18′	2+30	WSB
	-5	10.09.	21:40	74°30.01′	127°30.32′	10	WP-PCB
		11.09.	to 02:24	74°30.02′	127°30.24′		
	-6	11.09.	03:09-03:35	74°29.92′	127°30.13′	35	GKG (no recovery)
PM9446		11.09.	04:34-05:00	74°30′	128°00′	36	CTD; Ho; HCh: Oxy,Si
	-1	11.09.	04:50-05:00	74°30.21′	128°00.88′	37	MUM (no data)
PM9447		11.09.	06:09-06:39	74°30′	128°30′	37,0	CTD; Ho; HCh: Oxy,Si
	-1	11.09.	06:15-06:30	74°30.04′	128°30.33′	2+32	WSS,WSM,13-C
PM9448		11.09.	07:38-08:05	74°30′	129°00′	37	CTD; Ho; HCh: Oxy,Si
	-1	11.09.	07:42-7:50	74°30.14′	129°00.44′	26	MUM
PM9449		11.09.	09:00-09:35	74°30′	129°30′	37	CTD; Ho; HCh: Oxy,Si; GM: W
	-1	11.09.	09:05-09:20	74°30.06′	129°29.92′	2+33	WSS,13-C
	-2	13.09.	08:50-09:00	74°29.94′	129°29.61′	0 - 3	PN
	-3	13.09.	08:50-09:20	74°29.94′	129°29.61′	38	MUM
PM9450		11.09.	10:35-11:00	74°30′	130°00′	32	CTD; Ho; HCh: Oxy,Si
PM9451		11.09.	12:00-12:47	74°30′	130°30′	25	CTD; Ho; HCh: Oxy,Si; GM: S
	-1	11.09.	12:10-12:30	74°30.00′	130°30.00′	2+20	WSS,WSM,13-C
	-2	11.09.	12:35-12:45	74°30.00′	130°30.00′	2+20	WSB
	-3	12.09.	22:00-22:30	74°30.02′	130°29.33′		MUM
	-4	12.09.	23:36-04:34	74°30.02′	130°29.33′	10	WP-PCB
	-5	13.09.	04:55-05:05	74°30.14′	130°29.73′	0 - 3	PN
	-6	13.09.	05:39	74°30.10′	130°29.74′	25	GKG (no recovery)
	-7	13.09.	06:15	74°30.16′	130°29.70′	25	GKG (18 cm)
(A51)		12.09.	22:10	74°30′	130°30′	25	CTD; HCh: Oxy,Si,Phos,Nitr;
		to 13.09.	to 07:00	74°30′	130°30′		Bio-BC: VVG,MS
PM9452		11.09.	13:50-14:15	74°30′	131°00′	25	CTD; Ho; HCh: Oxy,Si
	-1	12.09.	20:50-21:07	74°29.87′	130°59.63′	30	MUM
PM9453		11.09.	15:15-15:40	74°30′	131°30′	16	CTD; Ho; HCh: Oxy,Si
	-1	11.09.	15:15-15:30	74°30.13′	131°30.55′	2+13	WSS,13-C
	-2	12.09.	07:35-07:55	74°29.95′	131°29.61′	18	MUM
PM9454		11.09.	16:34-17:03	74°30′	132°00′	17	CTD; Ho; HCh: Oxy,Si; GM: W
	-1	12.09.	18:25-18:35	74°29.95′	131°29.99′	0 - 3	PN
	-2	12.09.	18:28-18:43	74°29.95′	131°29.99′	18	MUM

Table A2: Station list of the TRANSDRIFT II expedition

Station #		Date	Time (GMT)	Latitude (° N)	Longitude (° E)	Depth (m)	Activity
PM9455		11.09.	18:06-18:42	74°30´	132°30´	14	CTD; Ho; HCh: Oxy,Si
	-1	11.09.	18:10-18:25	74°29.90´	132°30.07´	2+10	WSS,WSM,13-C
PM9456		11.09.	19:45-20:00	74°30´	133°00´	12	CTD; Ho; HCh: Oxy,Si
PM9457		11.09.	21:00-21:23	74°30´	133°30´	10	CTD; Ho; HCh: Oxy,Si
	-1	11.09.	21:10-21:20	74°29.96´	133°30.09´	2+5	WSS,13-C
	-2	12.09.	13:55-14:05	74°30.10´	133°29.99´	0 - 3	PN
	-3	12.09.	14:05-14:15	74°30.10´	133°29.99´	2+5	WSB
	-4	12.09.	13:56-14:08	74°30.10´	133°29.99´	11	MUM
	-5	12.09.	14:35	74°30.10´	133°29.99´	11	VC (92 cm)
(A57)		12.09.	13:50-16:00	74°30´	133°30´	10	CTD; HCh: Oxy,Si,Phos,Nitr
PM9458		11.09.	22:20-22:35	74°30´	134°00´	12	CTD; Ho; HCh: Oxy,Si
PM9459		11.09.	23:30-23:55	74°30´	134°30´	18	CTD; Ho; HCh: Oxy,Si
	-1	11.09.	23:30-23:40	74°30.00´	134°30.00´	2+13	WSS
PM9460		12.09.	00:50-01:10	74°30´	135°00´	21	CTD; Ho; HCh: Oxy,Si
PM9461		12.09.	02:05-02:35	74°30´	135°30´	27	CTD; Ho; HCh: Oxy,Si
	-1	12.09.	02:15-02:25	74°29.99´	135°30.61´	2+22	WSS
	-2	12.09.	10:07-10:26	74°29.90´	135°30.04´	27	MUM
PM9462		12.09.	03:27-09:15	74°30´	136°00´	26	CTD; Ho; HCh: Oxy,Si,Phos,Nitr; Bio-BC: VVG,MS; GM: W,S
	-1	12.09.	04:29	74°30.13´	136°00.23´	27	GKG (53 cm)
	-2	12.09.	05:55-06:05	74°30.13´	136°00.23´	0 - 3	PN
	-3	12.09.	05:05-05:27	74°30.13´	136°00.23´	27	MUM
	-4	12.09.	07:44-18:15	74°30.18´	136°00.32´	27	VC (467 cm)
PM9463		13.-14.09.	14:39-12:40	74°30´	126°30´	36	CTD; Ho; HCh: Oxy,Si,Phos,Nitr; Bio-BC: VVG,MS; Bio-PC: PT,JT; GM: S
	-1	13.09.	15:50-16:30	74°30.07´	126°35.06´	2+31	WSB
	-2	13.09.	15:56-16:20	74°30.07´	126°35.06´	36	MUM
	-3	13.09.	18:05-01:59	74°30.07´	126°35.06´	7	WP-PCB
	-4	14.09.	05:40	74°30.10´	126°34.79´	36	VC (213 cm)
	-5	14.09.	06:40-06:48	74°30.10´	126°34.79´	0 - 3	PN
	-6	14.09.	07:05-07:15	74°30.10´	126°34.79´	10	WSP
	-7	14.09.	09:06	74°30.28´	126°34.90´	36	GKG (over-penetration)
	-8	14.09.	10:08	74°30.21´	126°34.91´	36	GKG (44 cm)
PM9464	-1	14.09.	18:19-05:45	73°59.90´	127°34.90´	10	WP-PCB
	-2	15.09.	05:55-06:15	73°59.90´	127°34.90´	2+23	WSB
PM9465		15.09.	10:35-10:57	73°45´	130°30´	25	CTD; Ho; HCh: Oxy,Si
	-1	15.09.	10:35-10:50	73°44.98´	130°29.87´	2+20	WSS
	-2	15.09.	10:45-10:55	73°44.98´	130°29.87´	0 - 3	PN
	-3	15.09.	10:35-10:52	73°44.98´	130°29.87´	24	MUM
PM9466		15.09.	12:35-13:30	73°30´	130°30´	25	CTD; Ho; HCh: Oxy,Si,Phos,Nitr; Bio-PC: PT,LT; GM: W
	-1	15.09.	12:45-12:52	73°29.96´	130°29.91´	0 - 3	PN
	-2	15.09.	12:55-13:10	73°29.96´	130°29.91´	2 +17	WSS,WSM,13-C
	-3	15.09.	12:35-12:59	73°29.96´	130°29.91´	23	MUM
PM9467		15.09.	15:10-15:53	73°15´	130°30´	24	CTD; Ho; HCh: Oxy,Si
	-1	15.09.	15:15-15:30	73°14.87´	130°29.92´	24	MUM
	-2	15.09.	15:15-15:20	73°14.87´	130°29.92´	0 - 3	PN

Table A2: Station list of the TRANSDRIFT II expedition

Station #		Date	Time (GMT)	Latitude (° N)	Longitude (° E)	Depth (m)	Activity
PM9467	-3	15.09.	15:15-15:23	73°14.87´	130°29.92´	2+10+20	WSS,WSP
PM9468		15.09.	17:27-18:15	73°00´	130°30´	22	CTD; Ho; HCh: Oxy,Si,Phos,Nitr; Bio-PC: PT,LT; GM: W
	-1	15.09.	17:30-17:45	72°59.97´	130°29.98´	2+17	WSS,WSM,13-C
	-2	15.09.	17:30-17:40	72°59.97´	130°29.98´	0 - 3	PN
	-3	15.09.	17:30-17:56	72°59.97´	130°29.98´	23	MUM
PM9469		15.09.	19:57-20:27	72°45´	130°30´	18	CTD; Ho; HCh: Oxy,Si
	-1	15.09.	20:02-20:16	72°44.97´	130°29.61´	18	MUM
	-2	15.09.	20:05-20:15	72°44.97´	130°29.61´	0 - 3	PN
	-3	15.09.	20:20-20:30	72°44.97´	130°29.61´	2+10+13	WSS,WSM,WSP
PM9470		15.09.	22:05-22:58	72°30´	130°30´	13	CTD; Ho; HCh: Oxy,Si,Phos,Nitr; Bio-PC: PT,LT; GM: W
	-1	15.09.	22:12-22:18	72°29.97´	130°29.93´	0 - 3	PN
	-2	15.09.	22:12-22:25	72°29.97´	130°29.93´	13	MUM
	-3	15.09.	22:15-22:22	72°29.97´	130°29.93´	2+9	WSS,WSM,13-C
	-4	15.09.	22:23-22:38	72°29.97´	130°29.93´	2+9	WSB
PM9471		16.09.	00:43-01:13	72°15´	130°30´	14	CTD; Ho; HCh: Oxy,Si
	-1	16.09.	00:45-00:59	72°14.94´	130°29.77´	13	MUM
	-2	16.09.	00:45-01:00	72°14.94´	130°29.77´	0 - 3	PN
	-3	16.09.	00:50-01:10	72°14.94´	130°29.77´	2+9	WSS,WSM,WSP
PM9472		16.09.	02:55-03:45	72°00´	130°30´	16	CTD; Ho; HCh: Oxy,Si; GM: W
	-1	16.09.	02:57-03:15	71°59.85´	130°30.77´	15	MUM
	-2	16.09.	03:05-03:10	71°59.85´	130°30.77´	0 - 3	PN (no data)
	-3	16.09.	03:10-03:40	71°59.85´	130°30.77´	2+11	WSB
	-4	16.09.	03:40-03:45	71°59.85´	130°30.77´	10	WSP
PM9473		16.09.	05:25-05:45	71°45´	130°30´	14	CTD; Ho; HCh: Oxy,Si
PM9474		18.09.	13:05-15:07	72°00´	134°00´	16	CTD; Ho; HCh: Oxy,Si; GM: W
	-1	18.09.	13:10-13:18	72°00.20´	133°59.80´	0 - 3	PN
	-2	18.09.	13:10-13:30	72°00.20´	133°59.80´	14	MUM
	-3	18.09.	15:05-15:15	72°00.20´	133°59.80´	2+11	WSS,13-C
PM9475		18.09.	17:00-18:45	72°15´	134°00´	21	CTD; Ho; HCh: Oxy,Si,Phos,Nitr; Bio-BC: GG; GM: S
	-1	18.09.	17:05-17:35	72°15.00´	133°59.70´	19	MUM
	-2	18.09.	17:35	72°15.00´	133°59.70´	21	GKG (25 cm)
	-3	18.09.	18:11	72°15.00´	133°59.70´	21	GKG (29 cm)
PM9476		18.09.	20:25-21:00	72°30´	134°00´	20	CTD; Ho; HCh: Oxy,Si; GM: W
	-1	18.09.	20:20-20:25	72°29.73´	134°00.23´	0 - 3	PN
	-2	18.09.	20:25-20:46	72°29.73´	134°00.23´	21	MUM
	-3	18.09.	20:20-20:30	72°29.73´	134°00.23´	2+18	WSS,WSM,13-C
	-4	18.09.	20:30-20:40	72°29.73´	134°00.23´	2	WSB
PM9477		18.09.	22:30-23:11	72°45´	134°00´	16	CTD; Ho; HCh: Oxy,Si,Phos,Nitr; Bio-BC: VVG
	-1	18.09.	22:30-23:10	72°45.06´	133°59.55´	14	MUM
PM9478		19.09.	00:43-01:10	73°00´	134°00´	17	CTD; Ho; HCh: Oxy,Si; GM: W
	-1	19.09.	00:45-00:50	73°00.17´	133°59.99´	0 - 3	PN
	-2	19.09.	00:47-01:05	73°00.17´	133°59.99´	16	MUM
	-3	19.09.	00:50-00:55	73°00.17´	133°59.99´	2+13	WSS,13-C

Table A2: Station list of the TRANSDRIFT II expedition

Station #		Date	Time (GMT)	Latitude (° N)	Longitude (° E)	Depth (m)	Activity
PM9479		19.09.	02:40-03:00	73°15´	134°00´	14	CTD; Ho; HCh: Oxy,Si
	-1	19.09.	02:43-02:58	73°15.08´	133°59.75´	15	MUM
PM9480		19.09.	05:00-05:50	73°30´	134°00´	14	CTD; Ho; HCh: Oxy,Si; Bio-BC: VVG
	-1	19.09.	05:02-05:20	73°30.14´	133°59.78´	16	MUM
	-2	19.09.	05:10-05:20	73°30.14´	133°59.78´	0 - 3	PN
	-3	19.09.	05:10-05:20	73°30.14´	133°59.78´	2+18	WSS,13-C
PM9481		19.09.	07:40-09:05	73°45´	134°00´	14	CTD; Ho; HCh: Oxy,Si; GM: S;W
	-1	19.09.	07:50-08:15	73°45.00´	134°00.25´	17	MUM
	-2	19.09.	08:20	73°45.00´	134°00.25´	17	GKG (35 cm)
PM9482		20.09.	04:30-08:05	74°00´	128°10´	27	GM: S
	-1	20.09.	05:25	73°59.94´	128°10.47´	27	GKG (56 cm)
	-2	20.09.	06:37	73°59.94´	128°10.47´	27	VC (341 cm)
PM9483		20.09.	14:08-14:59	74°30´	125°00´	34	CTD; Ho; HCh: Oxy,Si; GM: W
	-1	20.09.	14:10-14:35	74°29.91´	125°00.30´	33	MUM
PM9484		20.09.	21:00-21:25	74°30´	121°15´	14	CTD; Ho; HCh: Oxy,Si
	-1	20.09.	21:00-21:25	74°30.15´	121°15.00´	14	MUM
PM9485		21.09.	00:00-00:35	74°30´	120°00´	36	CTD; Ho; HCh: Oxy,Si; GM: W
	-1	21.09.	00:04-00:35	74°30.10´	120°00.40´	37	MUM
PM9486		21.09.	03:15-03:38	74°30´	118°59´	16	CTD; Ho; HCh: Oxy,Si
	-1	21.09.	03:16-03:45	74°29.82´	118°59.34´	17	MUM
PM9487		21.09.	21:10-21:40	73°53´	118°18´	13	CTD; Ho; HCh: Oxy,Si
	-1	21.09.	21:20-21:35	73°52.50´	118°17.52´	13	MUM
PM9488		22.09.	00:00-00:15	73°50´	119°30´	13	CTD; Ho; HCh: Oxy,Si
	-1	22.09.	00:00-00:16	73°50.07´	119°29.87´	14	MUM
	-2	22.09.	00:00-00:10	73°50.07´	119°29.87´	0 - 3	PN
	-3	22.09.	00:10-00:20	73°50.07´	119°29.87´	10	WSP
PM9489		22.09.	04:27-04:57	73°30´	121°30´	13	CTD; Ho; HCh: Oxy,Si
	-1	22.09.	04:20-04:50	73°30.07´	121°30.16´	12	MUM
	-2	22.09.	04:05-04:10	73°30.07´	121°30.16´	0 - 3	PN
	-3	22.09.	04:15-04:20	73°30.07´	121°30.16´	10	WSS/WSM/WSP
	-4	22.09.	04:20-04:25	73°30.07´	121°30.16´	10	WSB
PM9490		22.09.	07:44-08:32	73°50´	120°40´	15	CTD; Ho; HCh: Oxy,Si,Phos,Nitr; Bio-BC: VVG,SG
	-1	22.09.	07:45-07:56	73°50.07´	120°40.06´	14	MUM
	-2	22.09.	07:45-07:55	73°50.07´	120°40.06´	0 - 3	PN
	-3	22.09.	07:50-08:00	73°50.07´	120°40.06´	10	WSP
PM9491		22.09.	09:26-09:50	73°50´	120°10´	26	CTD; Ho; HCh: Oxy,Si; GM: W
	-1	22.09.	09:25-09:50	73°50.18´	128°10.38´	26	MUM
	-2	22.09.	09:25-09:35	73°50.18´	128°10.38´	10	WSM
PM9492		22.09.	13:45-17:20	74°30´	119°50´	34	Bio-BC: GG; GM: S
	-1	22.09.		74°30.05´	119°50.10´	34	MUM
	-2	22.09.	14:00-14:05	74°30.05´	119°50.10´	0 - 3	PN
	-3	22.09.	14:26	74°30.05´	119°50.10´	34	GKG (41 cm)
	-4	22.09.	15:34	74°30.05´	119°50.10´	34	VC (300 cm)

Table A2: Station list of the TRANSDRIFT II expedition

Station #		Date	Time (GMT)	Latitude (° N)	Longitude (° E)	Depth (m)	Activity
PM9493		22.09.	21:00-21:25	74°30´	117°45´	19	CTD; Ho; HCh: Oxy,Si
	-1	22.09.	23:00-23:20	74°29.91´	117°44.96´	19	MUM
PM9494		23.09.	04:00-07:12	74°30´	114°17´	36	CTD; Ho; HCh: Oxy,Si,Phos,Nitr; Bio-BC: VVG; GM: S
	-1	23.09.	04:02-04:35	74°30.06´	114°17.05´	37	MUM
	-2	23.09.	04:10-04:15	74°30.06´	114°17.05´	0 - 3	PN
	-3	23.09.	04:15-04:40	74°30.06´	114°17.05´	2	WSB
	-4	23.09.	05:08	74°30.06´	114°17.05´	37	VC (324 cm)
	-5	23.09.	06:07	74°30.06´	114°17.05´	37	GKG (47 cm)
PM9495		23.09.	08:45-11:50	74°43´	114°15´	38	CTD; Ho; HCh: Oxy,Si
	-1	23.09.	08:50-09:50	74°42.86´	114°11.69´	37	MUM
	-2	23.09.	11:00-11:05	74°43.51´	114°05.81´	0 - 3	PN
PM9496		23.09.	13:20-14:00	74°58´	114°15´	41	CTD; Ho; HCh: Oxy,Si; GM: W
	-1	23.09.	13:23-13:53	74°58.24´	114°15.11´	42	MUM
	-2	23.09.	13:25-13:30	74°58.24´	114°15.11´	0 - 3	PN
PM9497		23.09.	14:53-15:17	75°06´	114°28´	43	CTD; Ho; HCh: Oxy,Si
	-1	23.09.	14:10-14:15	75°06.23´	114°28.46´	0 - 3	PN
PM9498		23.09.	18:21-19:03	75°22´	115°06´	45	CTD; Ho; HCh: Oxy,Si
	-1	23.09.	18:25-18:30	75°21.64´	115°05.46´	0 - 3	PN
	-2	23.09.	18:25-18:55	75°21.64´	115°05.46´	46	MUM
PM9499		24.09.	00:30-01:30	75°30´	115°00´	48	CTD; HCh: Oxy,Si
	-1	24.09.	07:08	75°30.06´	115°32.70´	48	GKG (48 cm)
	-2	24.09.	07:48	75°30.06´	115°32.70´	48	KAL (235+10 cm CC)
PM94100		24.09.	05:45-06:16	75°42´	115°45	50	CTD
	-1	24.09.	05:51-06:14	75°42.14´	115°44.37´	44	MUM
	-2	24.09.	05:55-06:00	75°42.14´	115°44.37´	0 - 3	PN
PM94101		24.09.	05:30-06:09	76°33´	117°18´	55	CTD
	-1	24.09.	14:14-20:00	75°50.45´	116°15.21´	10	WP-PCB
			end:	75°49.19´	116°15.91´		

Abbreviations:

CTD: Conductivity, Temperature, Depth
Ho: Hydrooptical measurements
HCh: Hydrochemistry
- Oxy: Oxygen
- Si: Silicon
- Phos: Phosphates
- Nitr: Nitrites & Nitrates

Bio-BC: Biology: sampling of benthos
- VVG: Van-Vin´s grab
- SD: Sigsby dredge
- GG: Geological Greifer
- MS: Maiobenthos sampler

Bio-PC: Biology: sampling of plankton
- PT: Phytoplankton townet
- JT: Jedy´s townet

GM: Geochemical monitoring
- W: Water samples
- S: Sediment samples

KAL: Kasten corer
GKG: Spade box core
VC: Vibro corer
WSS: Water sampling-SPM
WSM: Water sampling-trace metals
WSP: Water sampling-plankton
WSB: Water sampling-Beryllium
PN: Plankton net
WP-PCB: Water pumping-polychlorinatec biphenyles
MUM: Modulares Umwelt Meßsysterr

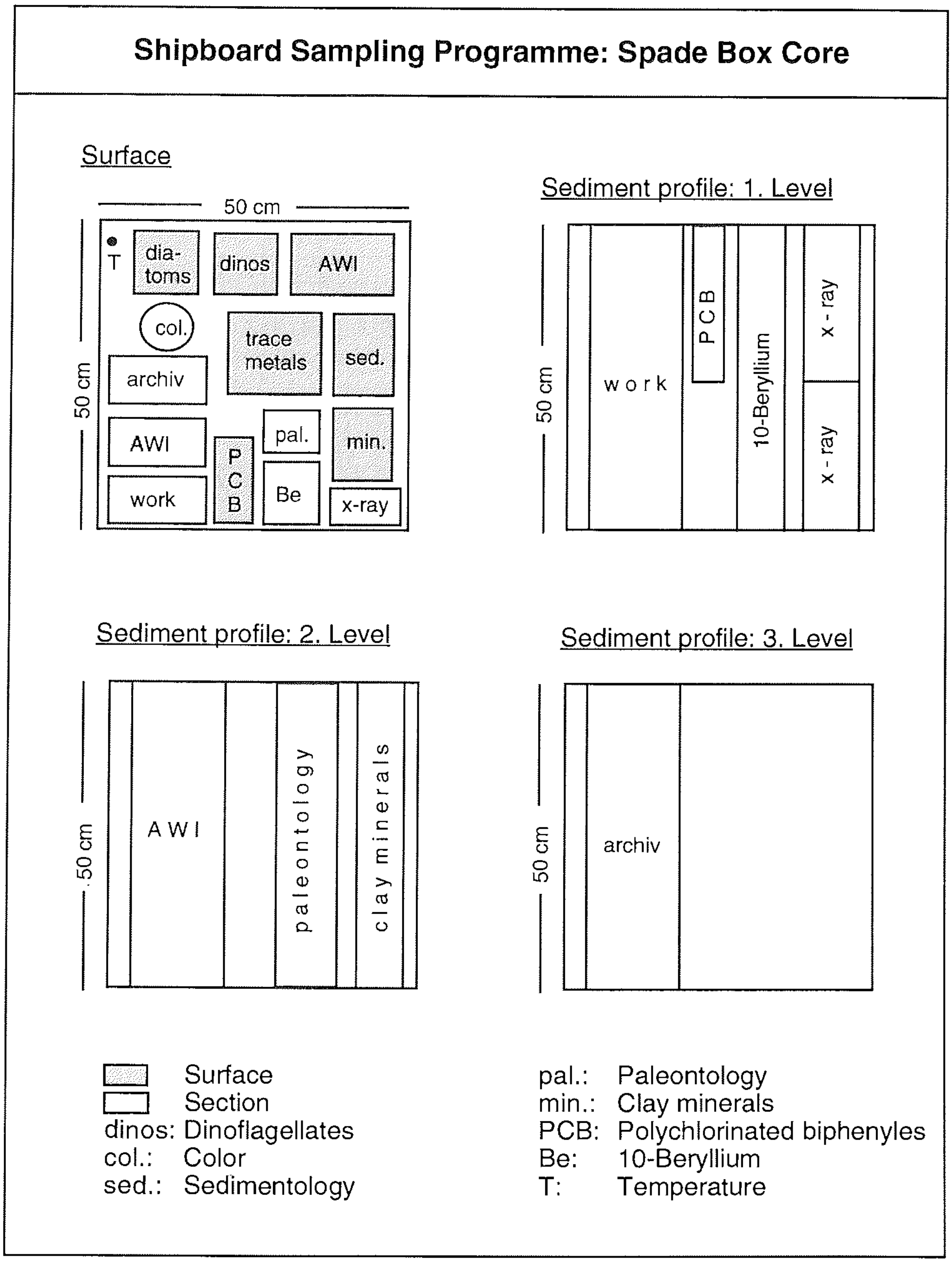


Fig. A1: Sedimentological sampling program of the TRANSDRIFT II expedition.

Table A3: Sedimentological and geochemical samples taken during the TRANSDRIFT II expedition.

		Water column							Sediments						Surface sedi.					Sediment section								
Station	Equipment	Optical backscatter	Suspended matter	Trace metals	Beryllium	13-C	PCB	Plankton	Core description	Photography, color	Smear slides	Temperature	No sampling	No recovery	Sedimentology	Paleontology	Trace metals	PCB	Organic carbon	Work box	Archiv box	AWI-box	x-ray	Paleontology	Physical properties	PCB	Beryllium	Clay mineralogy
PM94T1-1	GKG												x															
PM94T1-2	GKG								x	x	x	x			x	x			x	x	x	x	x				x	
PM94T2	WS		x			x																						
PM94T2-1	GKG								x	x	x	x								x	x	x	x				x	
PM94T2-2	KAL								x	x	x	x								x	x			x				
PM94T3-1	GKG								x	x	x	x			x	x	x	x	x	x	x	x	x	x	x	x	x	x
PM94T4-1	MUM	x																										
PM9401-1	MUM	x																										
PM9401-2	WS		x																									
PM9402-1	MUM	x																										
PM9402-2	WS		x																									
PM9402-3	GKG								x	x	x	x			x	x	x		x	x	x	x	x	x	x		x	x
PM9402-4	KAL													x														
PM9403-1	WS		x			x																						
PM9403-2	MUM	x																										
PM9405-1	MUM	x																										
PM9405-2	WS		x																									
PM9407-1	MUM	x																										
PM9407-2	WS		x																									
PM9409-1	MUM	x																										
PM9409-2	WS			x		x																						
PM9411-1	WS			x		x																						
PM9411-2	MUM	x																										
PM9413-1	WSB				x																							
PM9413-2	WS			x				x																				
PM9413-3	WP						x							x														
PM9413-4	PN							x																				
PM9415-1	MUM	x																										
PM9415-2	WS			x		x																						
PM9416-1	MUM	x																										
PM9417-1	WS		x	x				x																				
PM9417-2	WSB				x																							
PM9417-3	PN							x																				
PM9417-4	GKG								x	x	x	x			x	x	x	x	x	x	x	x	x	x	x	x	x	x
PM9417-5	MUM	x																										
PM9417-6	KAL								x	x	x									x	x				x			
PM9417-7	SISC																											
PM9418-1	MUM	x																										
PM9419-1	WS		x	x		x																						
PM9419-2	MUM	x																										
PM9420-1	MUM	x																										
PM9421-1	MUM	x																										
PM9421-2	WS		x			x																						
PM9422-1	MUM	x																										
PM9424-1	PN							x																				
PM9424-2	MUM	x																										
PM9424-3	Moor.													x														
PM9424-4	WS		x			x		x																				

Table A3: Sedimentological and geochemical samples taken during the TRANSDRIFT II expedition.

		Water column							Sediments						Surface sedi.					Sediment section								
Station	Equipment	Optical backscatter	Suspended matter	Trace metals	Beryllium	13-C	PCB	Plankton	Core description	Photography, color	Smear slides	Temperature	No sampling	No recovery	Sedimentology	Paleontology	Trace metals	PCB	Organic carbon	Work box	Archiv box	AWI-box	x-ray	Paleontology	Physical properties	PCB	Beryllium	Clay mineralogy
PM9424-5	GKG												x															
PM9424-6	Moor.													x														
PM9424-7	GKG												x															
PM9424-8	VC													x														
PM9424-9	VC													x														
PM9425-1	PN							x																				
PM9425-2	WS		x	x		x		x																				
PM9426-1	PN							x																				
PM9426-2	WS		x			x		x																				
PM9426-3	MUM	x																										
PM9427-1	PN							x																				
PM9427-2	MUM	x																										
PM9428-1	WS		x	x		x		x																				
PM9428-2	MUM	x																										
PM9428-3	PN							x																				
PM9429-1	PN							x																				
PM9429-2	WS		x	x		x		x																				
PM9429-3	MUM	x																										
PM9430-1	MUM	x																										
PM9431-1	PN							x																				
PM9431-2	WS		x	x		x		x																				
PM9431-3	MUM	x																										
PM9432-1	MUM	x																										
PM9433-1	PN							x																				
PM9433-2	WS		x	x		x		x																				
PM9433-3	MUM	x																										
PM9434-1	MUM	x																										
PM9434-2	PN							x																				
PM9435-1	PN							x																				
PM9435-2	WS		x	x		x		x																				
PM9435-3	MUM	x																										
PM9436-1	PN							x																				
PM9436-2	WS		x					x																				
PM9436-3	MUM	x																										
PM9437-1	MUM	x																										
PM9438-1	PN							x																				
PM9438-2	WS		x	x		x		x																				
PM9438-3	MUM	x																										
PM9439-1	MUM	x																										
PM9440-1	MUM	x																										
PM9441-1	PN							x																				
PM9441-2	WS		x	x		x		x																				
PM9441-3	MUM	x																										
PM9441-4	GKG								x	x	x	x			x	x	x		x	x	x	x	x	x	x		x	x
PM9442-1	MUM	x																										
PM9442-2	PN							x																				
PM9442-3	GKG								x	x	x	x			x	x	x	x	x	x	x	x	x	x	x			
PM9442-4	KAL													x														

Table A3: Sedimentological and geochemical samples taken during the TRANSDRIFT II expedition.

		Water column							Sediments						Surface sedi.					Sediment section								
Station	Equipment	Optical backscatter	Suspended matter	Trace metals	Beryllium	13-C	PCB	Plankton	Core description	Photography, color	Smear slides	Temperature	No sampling	No recovery	Sedimentology	Paleontology	Trace metals	PCB	Organic carbon	Work box	Archiv box	AWI-box	x-ray	Paleontology	Physical properties	PCB	Beryllium	Clay mineralogy
PM9443-1	PN							x																				
PM9443-2	MUM	x																										
PM9443-3	WS		x	x				x																				
PM9444-1	MUM	x																										
PM9445-1	MUM	x																										
PM9445-2	PN							x																				
PM9445-3	WS		x			x																						
PM9445-4	WSB				x																							
PM9445-5	WP						x																					
PM9445-6	GKG													x														
PM9446-1	MUM													x														
PM9447-1	WS		x	x		x																						
PM9447-2	PN													x														
PM9447-3	MUM													x														
PM9448-1	MUM													x														
PM9449-1	WS		x			x																						
PM9449-2	PN							x																				
PM9449-3	MUM	x																										
PM9451-1	WS		x	x				x																				
PM9451-2	WSB				x																							
PM9451-3	MUM	x																										
PM9451-4	WP						x																					
PM9451-5	PN							x																				
PM9451-6	GKG												x															
PM9451-7	GKG								x	x	x	x			x	x		x	x	x	x	x	x	x	x		x	x
PM9452-1	MUM	x																										
PM9453-1	WS		x			x																						
PM9453-2	MUM	x																										
PM9454-1	PN							x																				
PM9454-2	MUM	x																										
PM9455-1	WS		x	x		x																						
PM9457-1	WS		x			x																						
PM9457-2	PN							x																				
PM9457-3	WSB				x																							
PM9457-4	MUM	x																										
PM9457-5	VC								x	x	x									x								
PM9459-1	WS		x																									
PM9461-1	WS		x																									
PM9461-2	MUM	x																										
PM9462-1	GKG								x	x	x	x			x	x	x	x	x	x	x	x	x	x	x		x	x
PM9462-2	PN							x																				
PM9462-3	MUM	x																										
PM9462-4	VC								x	x	x									x					x			
PM9463-1	WSB				x																							
PM9463-2	MUM	x																										
PM9463-3	WP						x																					
PM9463-4	VC								x	x	x									x				x	x			
PM9463-5	PN							x																				

Table A3: Sedimentological and geochemical samples taken during the TRANSDRIFT II expedition.

		Water column							Sediments						Surface sedi.					Sediment section								
Station	Equipment	Optical backscatter	Suspended matter	Trace metals	Beryllium	13-C	PCB	Plankton	Core description	Photography, color	Smear slides	Temperature	No sampling	No recovery	Sedimentology	Paleontology	Trace metals	PCB	Organic carbon	Work box	Archiv box	AWI-box	x-ray	Paleontology	Physical properties	PCB	Beryllium	Clay mineralogy
PM9463-6	WS							x																				
PM9463-7	GKG												x															
PM9463-8	GKG								x	x	x	x			x	x	x	x	x	x	x	x	x	x	x	x	x	x
PM9464-1	WP						x																					
PM9464-2	WSB				x																							
PM9465-1	WS		x																									
PM9465-2	PN							x																				
PM9465-3	MUM	x																										
PM9466-1	PN							x																				
PM9466-2	WS		x	x		x																						
PM9466-3	MUM	x																										
PM9467-1	MUM	x																										
PM9467-2	PN							x																				
PM9467-3	WS		x					x																				
PM9468-1	WS		x	x		x																						
PM9468-2	PN							x																				
PM9468-3	MUM	x																										
PM9469-1	MUM	x																										
PM9469-2	PN							x																				
PM9469-3	WS		x	x				x																				
PM9470-1	PN							x																				
PM9470-2	MUM	x																										
PM9470-3	WS		x	x		x																						
PM9470-4	WSB				x																							
PM9471-1	MUM	x																										
PM9471-2	PN							x																				
PM9471-3	WS		x	x				x																				
PM9472-1	MUM	x																										
PM9472-2	PN												x															
PM9472-3	WSB				x																							
PM9472-4	WS							x																				
PM 9474-1	PN							x																				
PM 9474-2	MUM	x																										
PM 9474-3	WS		x			x																						
PM9475-1	MUM	x																										
PM9475-2	GKG												x															
PM9475-3	GKG								x	x	x	x			x	x			x	x	x	x	x	x	x		x	x
PM9476-1	PN							x																				
PM9476-2	MUM	x																										
PM9476-3	WS		x	x		x																						
PM9476-4	WSB				x																							
PM9477-1	MUM	x																										
PM9478-1	PN							x																				
PM9478-2	MUM	x																										
PM9478-3	WS		x			x																						
PM9479-1	MUM	x																										
PM9480-1	MUM	x																										
PM9480-2	PN							x																				

Table A3: Sedimentological and geochemical samples taken during the TRANSDRIFT II expedition.

		Water column							Sediments						Surface sedi.					Sediment section								
Station	Equipment	Optical backscatter	Suspended matter	Trace metals	Beryllium	13-C	PCB	Plankton	Core description	Photography, color	Smear slides	Temperature	No sampling	No recovery	Sedimentology	Paleontology	Trace metals	PCB	Organic carbon	Work box	Archiv box	AWI-box	x-ray	Paleontology	Physical properties	PCB	Beryllium	Clay mineralogy
PM9480-3	WS		x			x																						
PM9481-1	MUM	x																										
PM9481-2	GKG								x	x	x	x			x	x		x	x	x	x	x	x	x	x		x	x
PM9482-1	GKG								x	x	x	x			x	x		x	x	x	x	x	x	x	x	x	x	x
PM9482-2	VC																							x				
PM9483-1	MUM	x																										
PM9484-1	MUM	x																										
PM9485-1	MUM	x																										
PM9485-2	PN												x															
PM9486-1	MUM	x																										
PM9487-1	MUM	x																										
PM9488-1	MUM	x																										
PM9488-2	PN							x																				
PM9488-3	WS							x																				
PM9489-1	MUM	x																										
PM9489-2	PN							x																				
PM9489-3	WS		x	x				x																				
PM9489-4	WSB				x																							
PM9490-1	MUM	x																										
PM9490-2	PN							x																				
PM9490-3	WS							x																				
PM9491-1	MUM	x																										
PM9491-2	WS			x																								
PM9492-1	MUM	x																										
PM9492-2	PN							x																				
PM9492-3	GKG								x	x	x	x			x	x		x	x	x	x	x	x	x	x		x	x
PM9492-4	VC								x	x	x									x				x				
PM9493-1	MUM	x																										
PM9494-1	MUM	x																										
PM9494-2	PN							x																				
PM9494-3	WSB				x																							
PM9494-4	VC								x	x	x									x								
PM9494-5	GKG								x	x	x	x			x	x		x	x	x	x	x	x	x	x	x	x	x
PM9495-1	MUM	x																										
PM9495-2	PN							x																				
PM9496-1	MUM	x																										
PM9496-2	PN							x																				
PM9497-1	PN							x																				
PM9498-1	PN							x																				
PM9498-2	MUM	x																										
PM9499-1	GKG								x	x	x	x			x	x	x	x	x	x	x	x	x	x	x		x	x
PM9499-2	KAL								x	x	x	x								x	x		x					
PM94100-1	MUM	x																										
PM94100-2	PN							x																				
PM94101-1	WP						x																					

Table A4: Descriptions of sediment cores taken during the TRANSDRIFT II expedition.

PM94T1-2 GKG	Loc.: Ostrova Mona	**TRANSDRIFT II**
Recovery: 0.14 m	75°41.52´ N 86°03.04´ E	Water depth: 51,4 m

Surface — T= - 1,3 °C

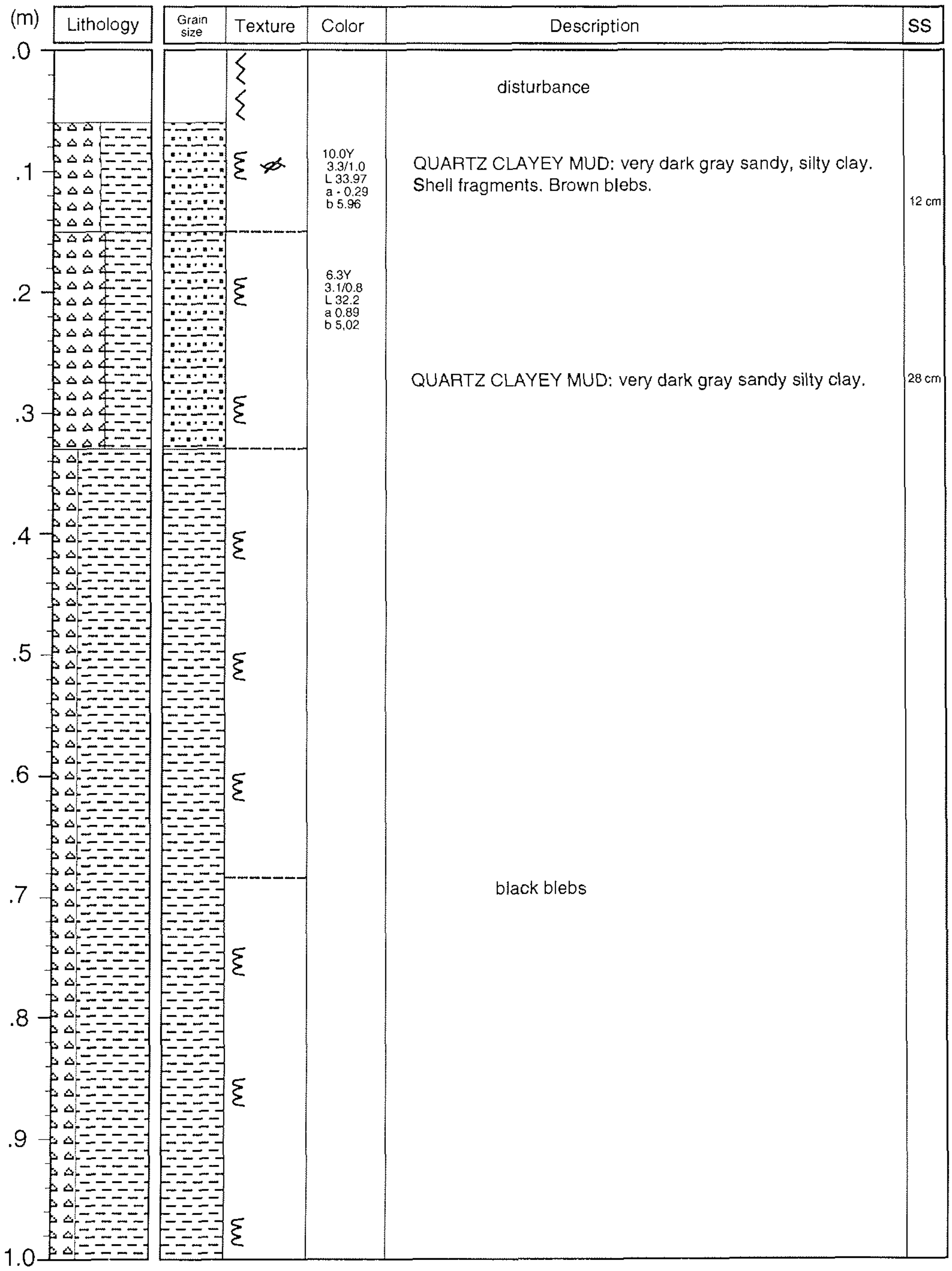
CLAYEY MUD WITH QUARTZ: very dark grayish brown silty clay. Rough surface with common polychaets, one bivalve and one isopode.

Color 9.2 YR 2.6/1.7 ; L 27.26 a 6.24 b 10.90

Depth in core (cm)	Lithology	Grain size	Texture	Color	Description	ss
0					as surface	surf.
				9.4 Y 3.4/1.1	CLAYEY MUD WITH QUARTZ: homogenous very dark gray silty clay.	8 cm
10				5.1 GY 2.6/0.5	CLAYEY MUD WITH QUARTZ: dark greenish gray sandy silt mottled with dark spots	13 cm
					end of core	
20						
30						
40						
50						

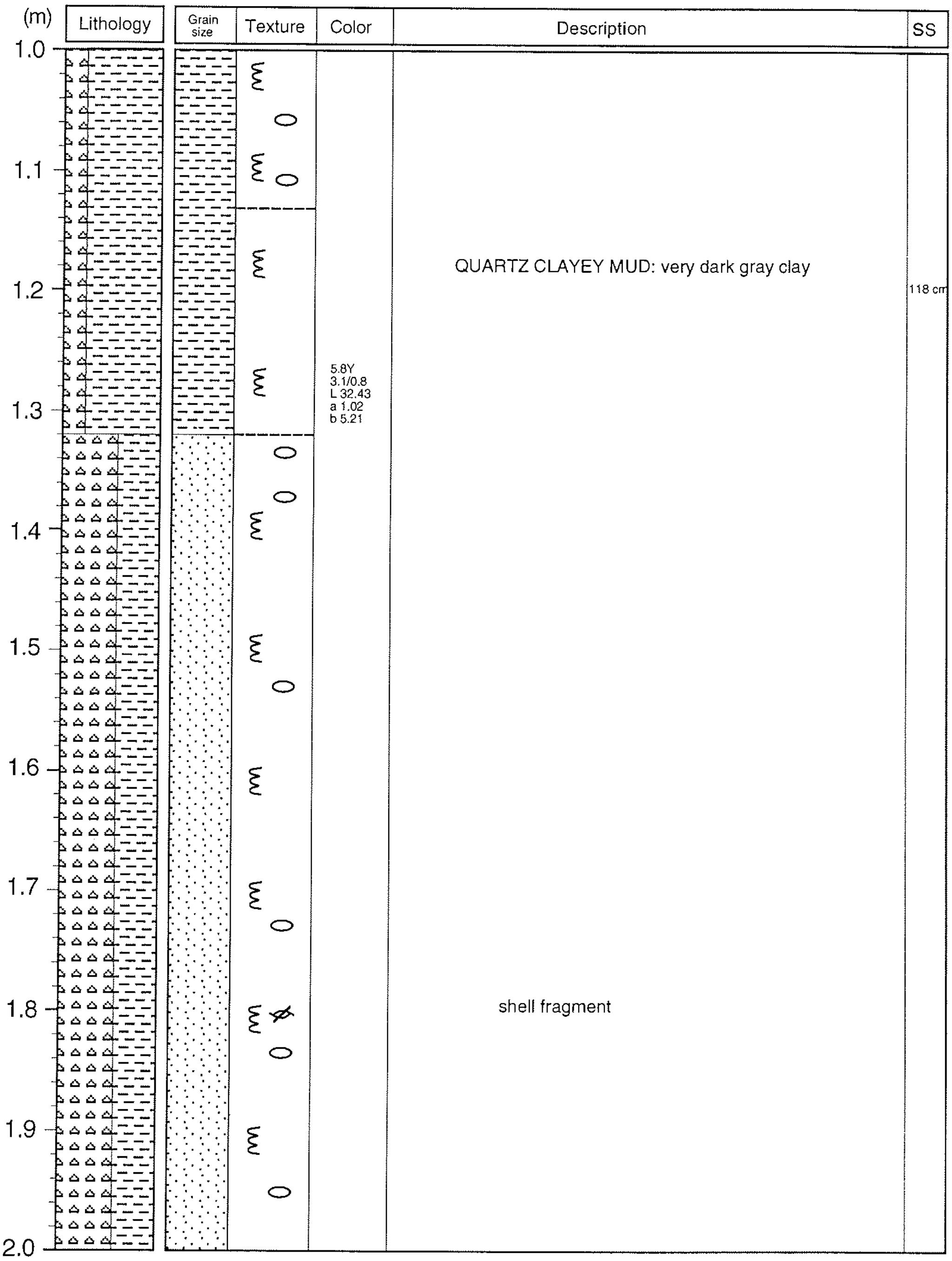
PM94T2-2 KAL LOC.: Ostrova Mona **TRANSDRIFT II**

Recovery: 4.45 m + 20 cm 75°25.35´ N 85°24.71´ E Water depth: 50.1 m



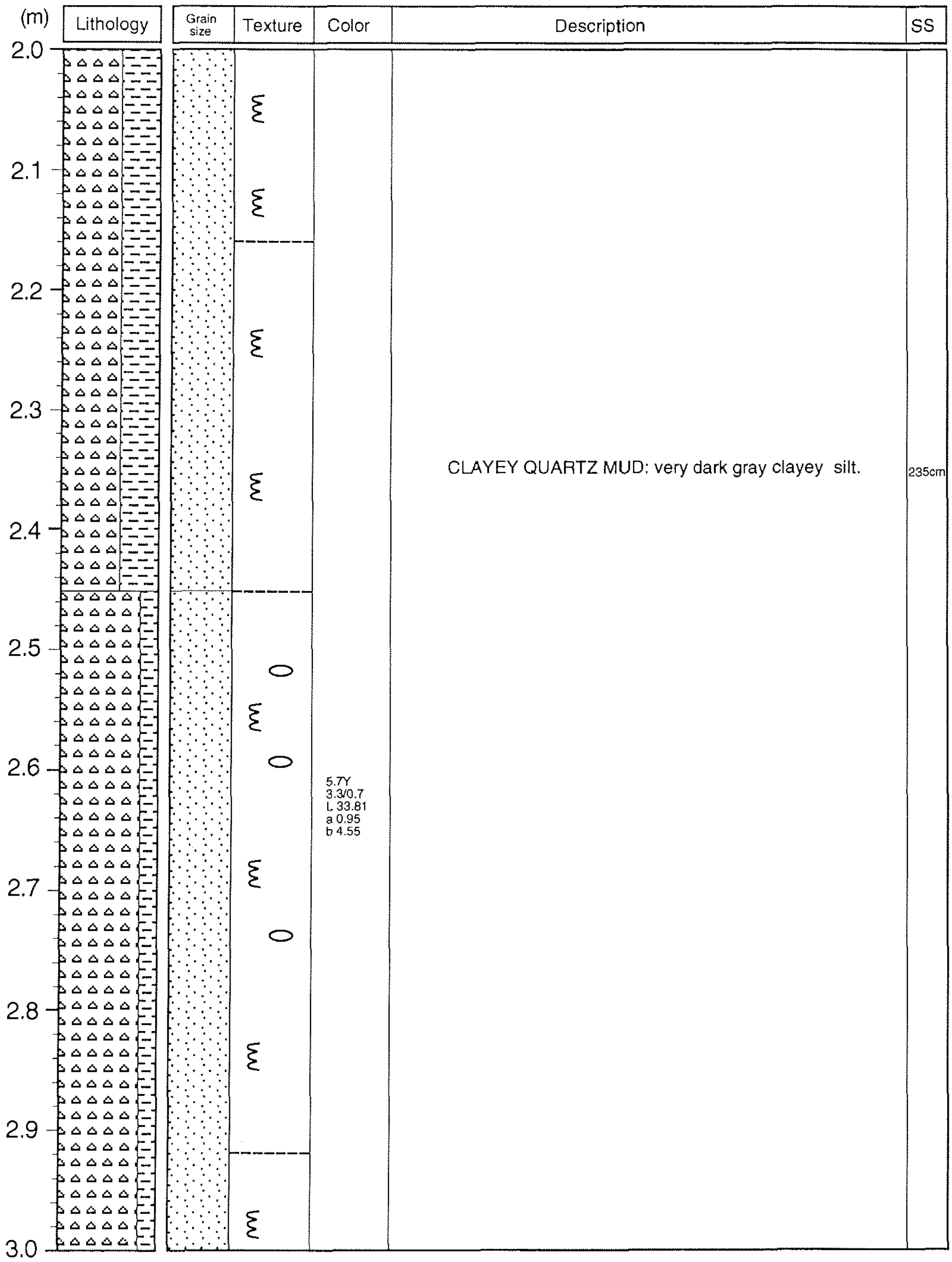
PM94T2-2 KAL LOC.: Ostrova Mona **TRANSDRIFT II**

Recovery: 4.45 m + 20 cm 75°25.35´ N 85° 24.71´ E Water depth: 50.1 m



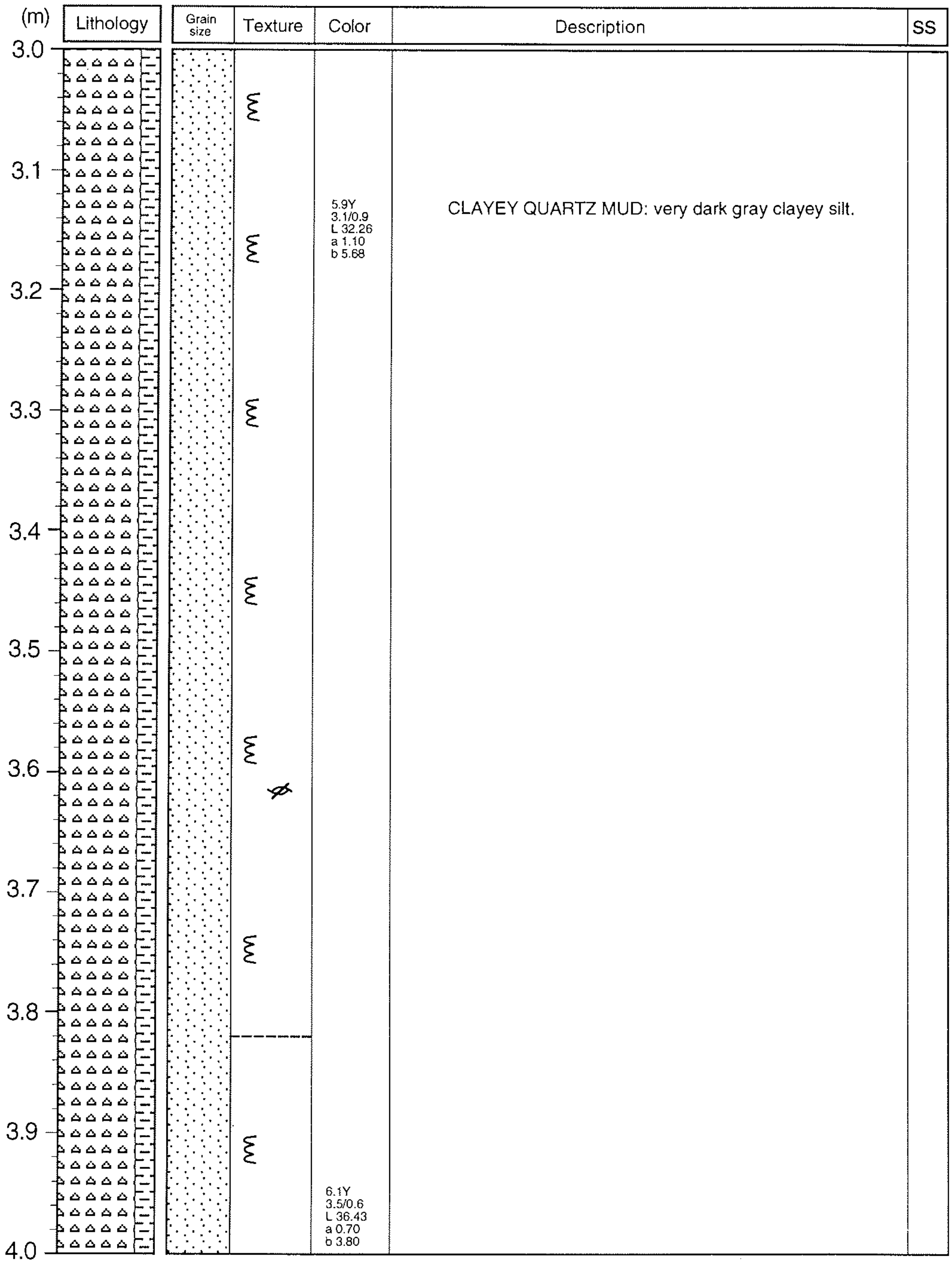
PM94T2-2 KAL LOC.: Ostrova Mona **TRANSDRIFT II**

Recovery: 4.45 m + 20 cm 75°25.35´N 85°24.71´ E Water depth: 50.1m



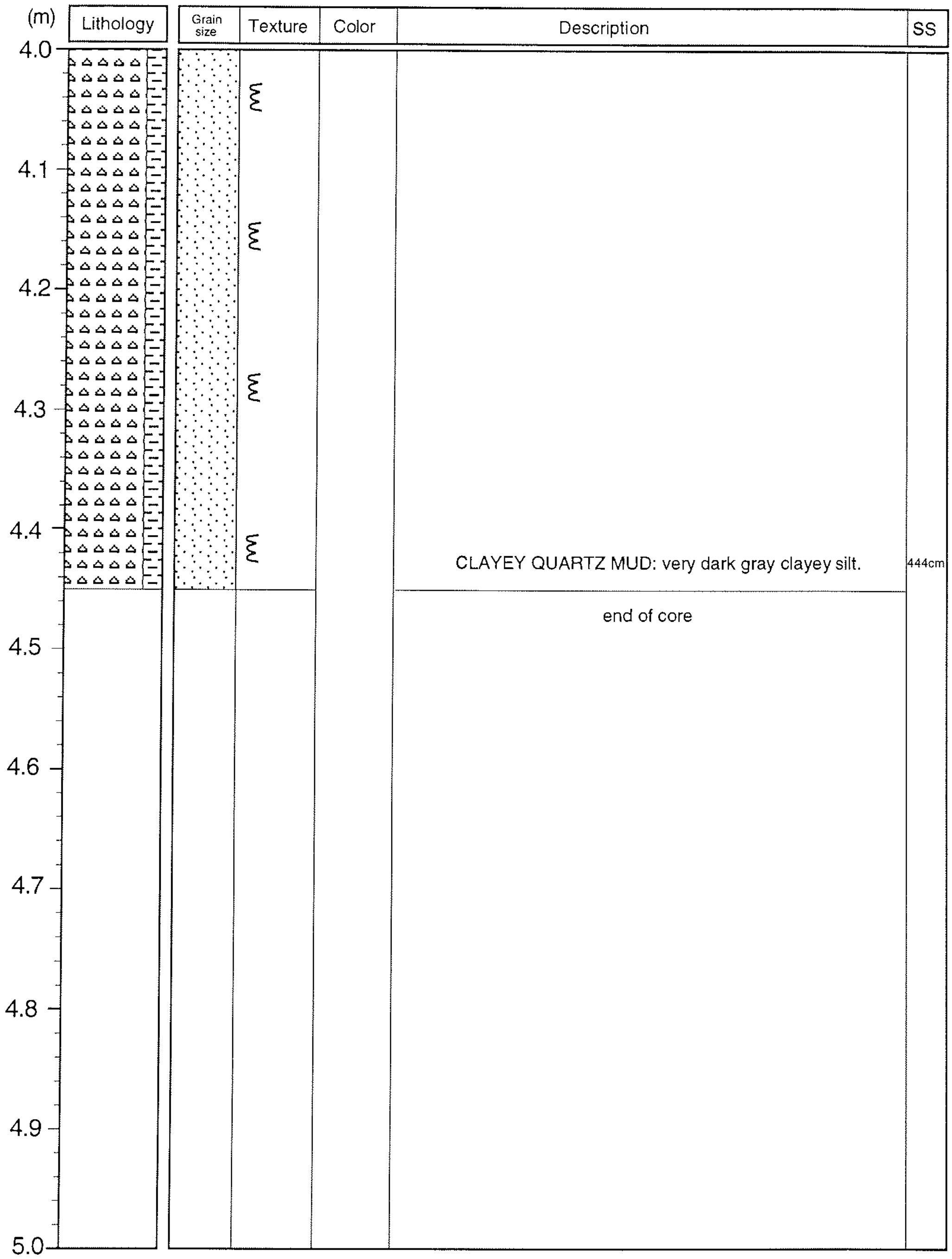
PM94T2-2 KAL LOC.: Ostrova Mona **TRANSDRIFT II**

Recovery: 4.45 m + 20 cm 75°25.35´N 85°24.71´E Water depth: 50.1m



PM94T2-2 KAL LOC.:Ostrova Mona **TRANSDRIFT II**

Recovery: 4.45 m + 20 cm 75°25.35´N 85°24.71´E Water depth: 50.1 m



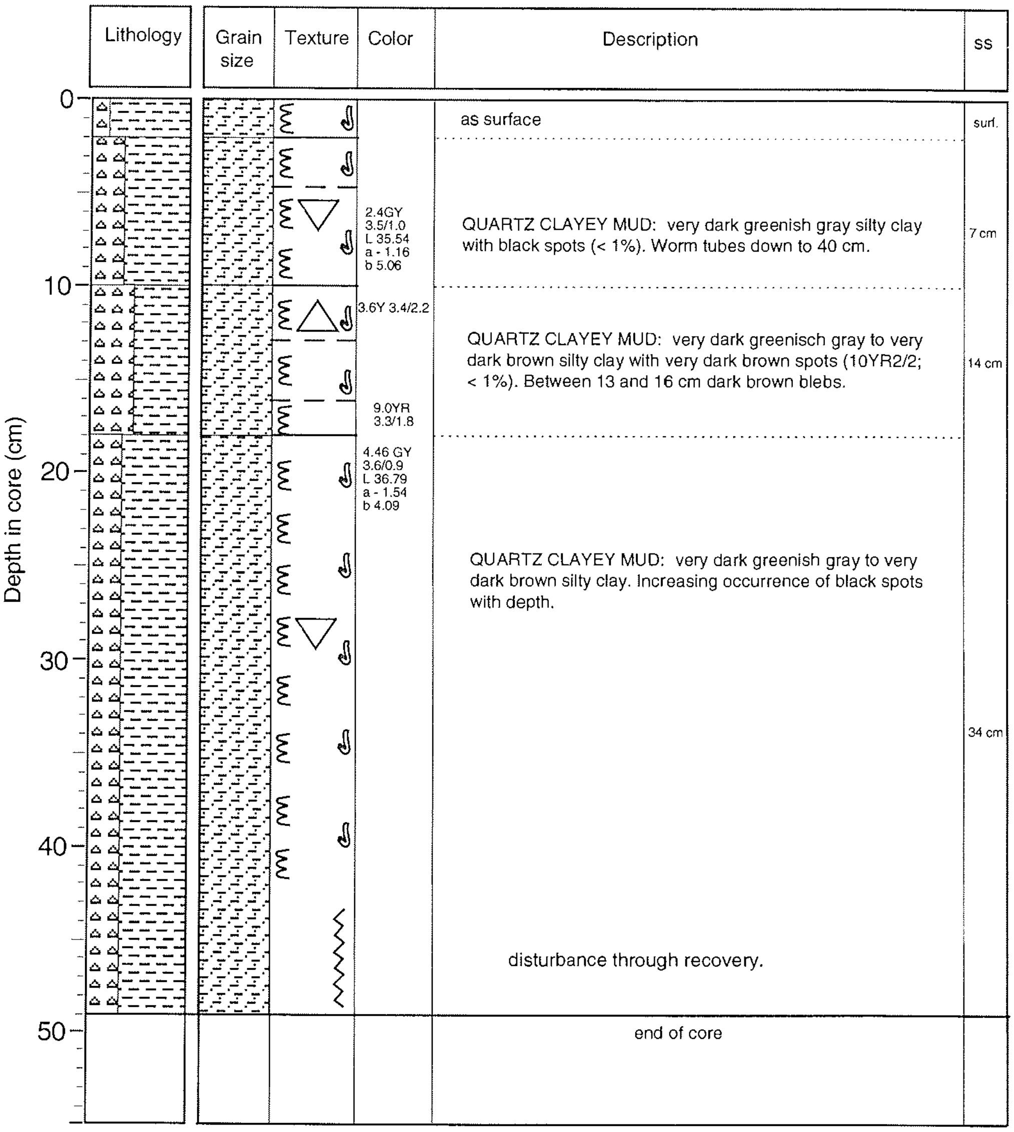
PM94T3-2 GKG Loc.: Eastern Kara Sea **TRANSDRIFT II**

Recovery: 0.49 m 77°04.16´ N 99°13.18´ E Water depth: 110,5 m

Surface T= - 1.3 °C

QUARTZ CLAYEY MUD: very dark brown clay. Even, homogenous surface. Isopods.

Color 8.8 YR 2.0/1.5 ; L 21.74 a 5.64 b 9.06

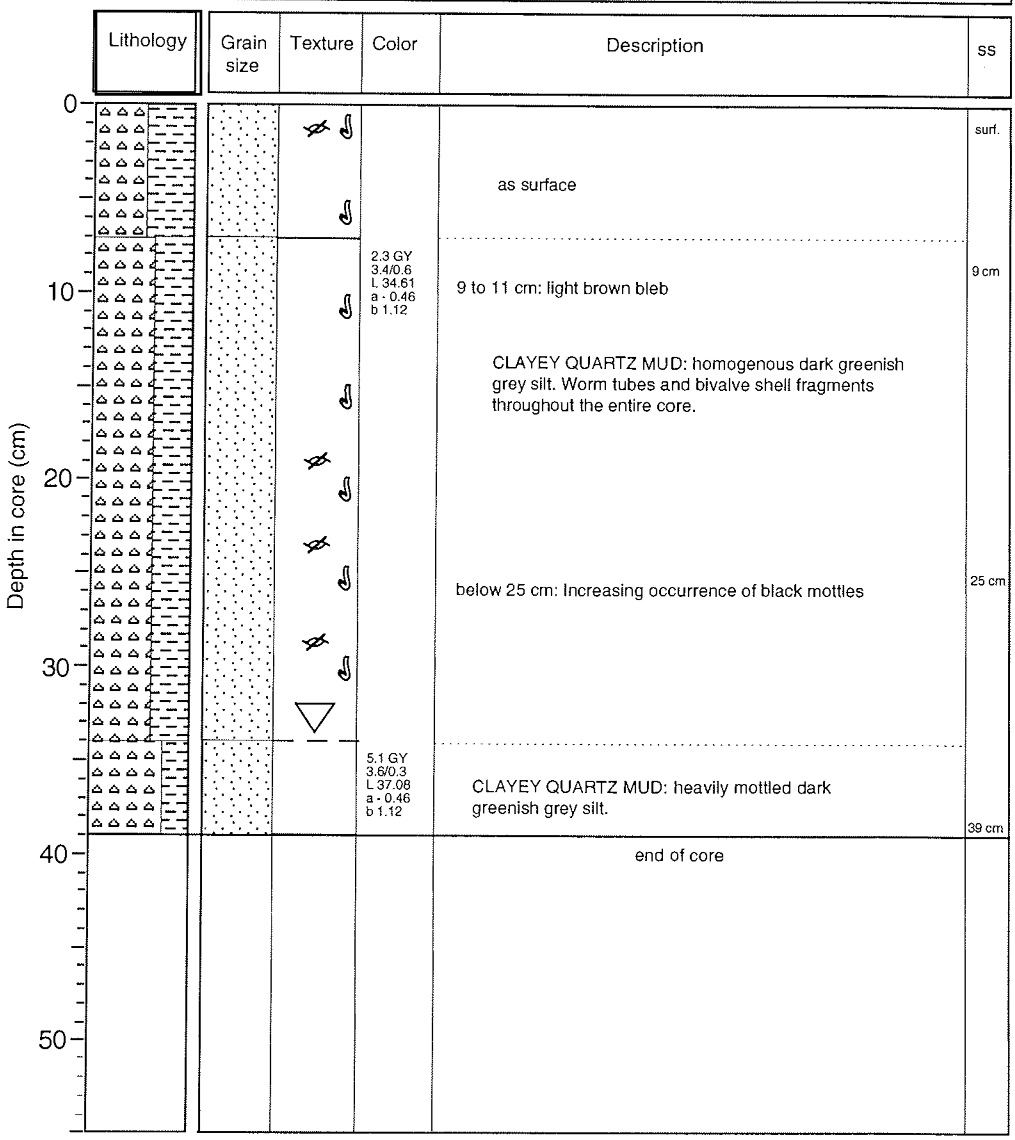


PM942-3 GKG Loc.: Anabar-Khatanga Valley **TRANSDRIFT II**

Recovery: 0.39 m 75°29.44´ N 115°14.94´ E Water depth: 47,3 m

Surface CLAYEY QUARTZ MUD: very dark gray silt. Homogenous sediment with clumps of biogenic material. Abundant macroscopic fauna especially ophiuroideans and polychaets. One whole bivalve shell. T= - 1.2 °C

Color 2.9 Y 2.3/0.4

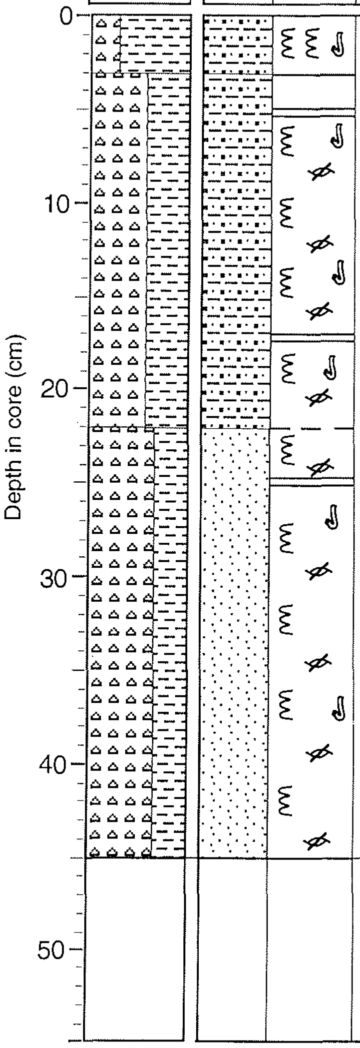


PM9417-4 GKG Loc.: Eastern Lena Valley **TRANSDRIFT II**

Recovery: 0.45 m 75°30.17´N 130°00.83´E Water depth: 51 m

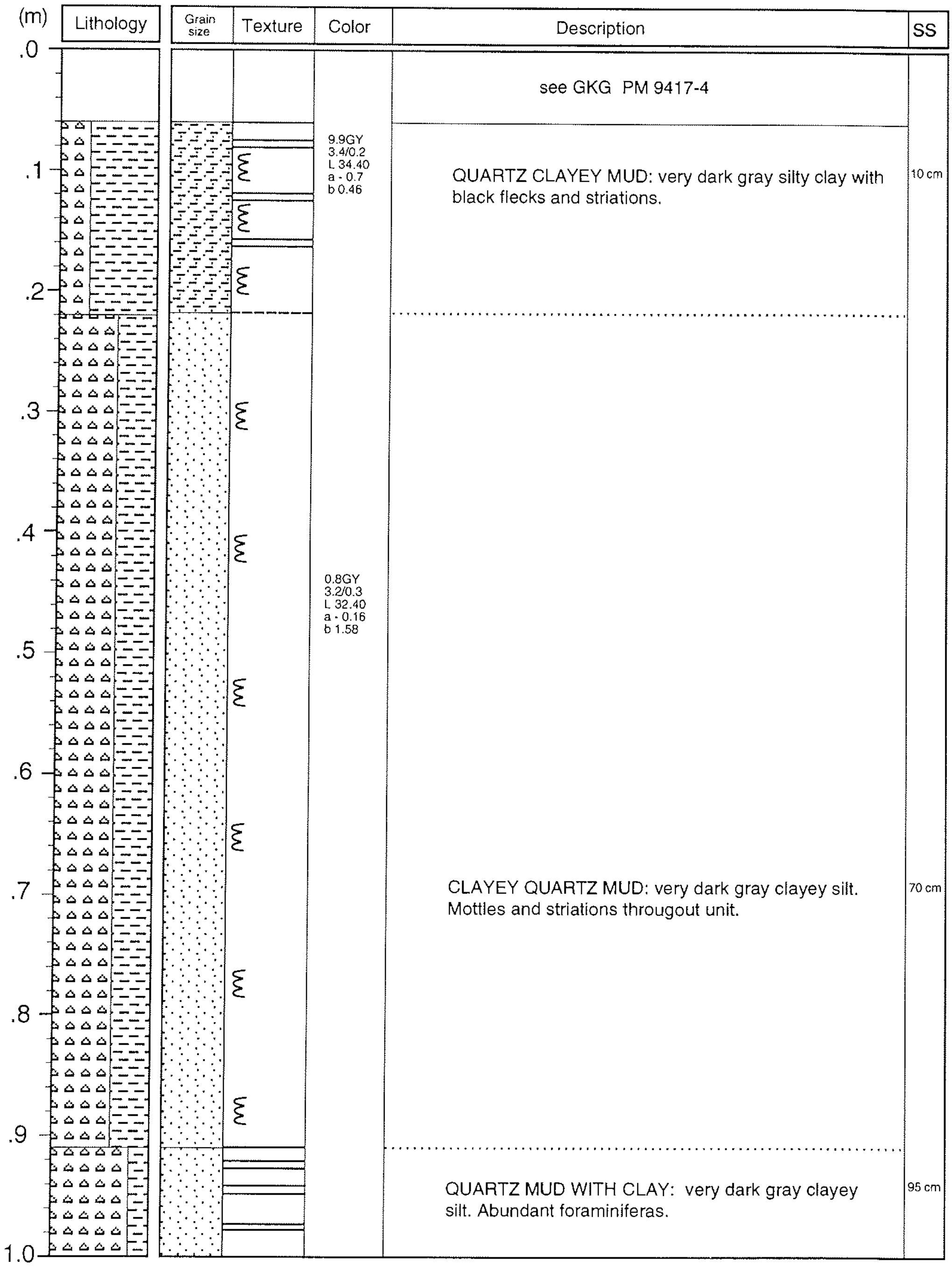
Surface	QUARTZ CLAYEY MUD: very dark greyish brown sandy silty clay. Surface with black spots (< 1%) covered by ophiuroideans, holothurians and bivalves. Abundant worm tubes (up to 6 cm length).	T= - 0.8 °C
Color: 2.4 Y 2.3/1.2 ; L 24.19 a 2.97 b 7.77		

Lithology	Grain size	Texture	Color	Description	ss
				as surface	Surf.
			2.9 GY 3.2/0.5 L 32.70 a - 0.56 b 2.34	CLAYEY QUARTZ MUD: bioturbated dark greenish gray sandy silty clay. Small black spots and streaks (mm size) decreasing in occurrence with depth, ending at 22 cm. Common bivalve shell fragments. Coherent worm tubes up to 10 cm length throughout the entire core.	
				15 to 20 cm: occurrence of brown blebs.	17 cm
				23 to 25 cm: weak light gray lenses of higher water content.	
			2.1 GY 3.2/0.4 L 32.60 a - 0.32 b 1.83	CLAYEY QUARTZ MUD: bioturbated dark greenish grey silt. Common bivalve shell fragments (up to 1.5 cm in size).	36 cm
				end of core	



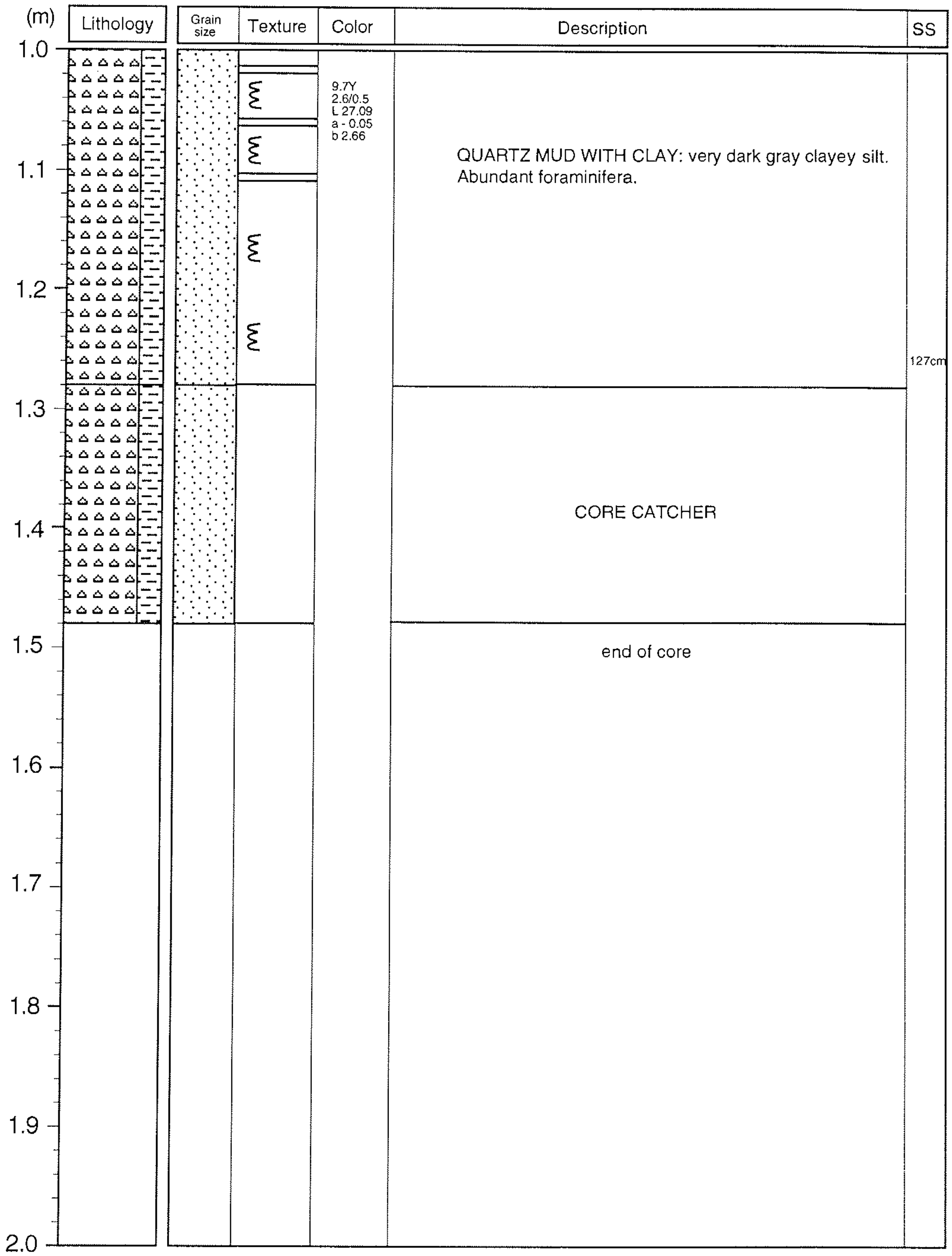
PM9417-6 KAL LOC.: Eastern Lena Valley **TRANSDRIFT II**

Recovery: 1.48 m 75°30.07´ N 130°00.70´ E Water depth: 51 m



PM9417-6 KAL LOC.: Eastern Lena Valley **TRANSDRIFT II**

Recovery: 1.48 m 75°30.07´ N 130°00.70´ E Water depth: 51 m



PM9441-4 GKG Loc.: North of Lena Delta **TRANSDRIFT II**

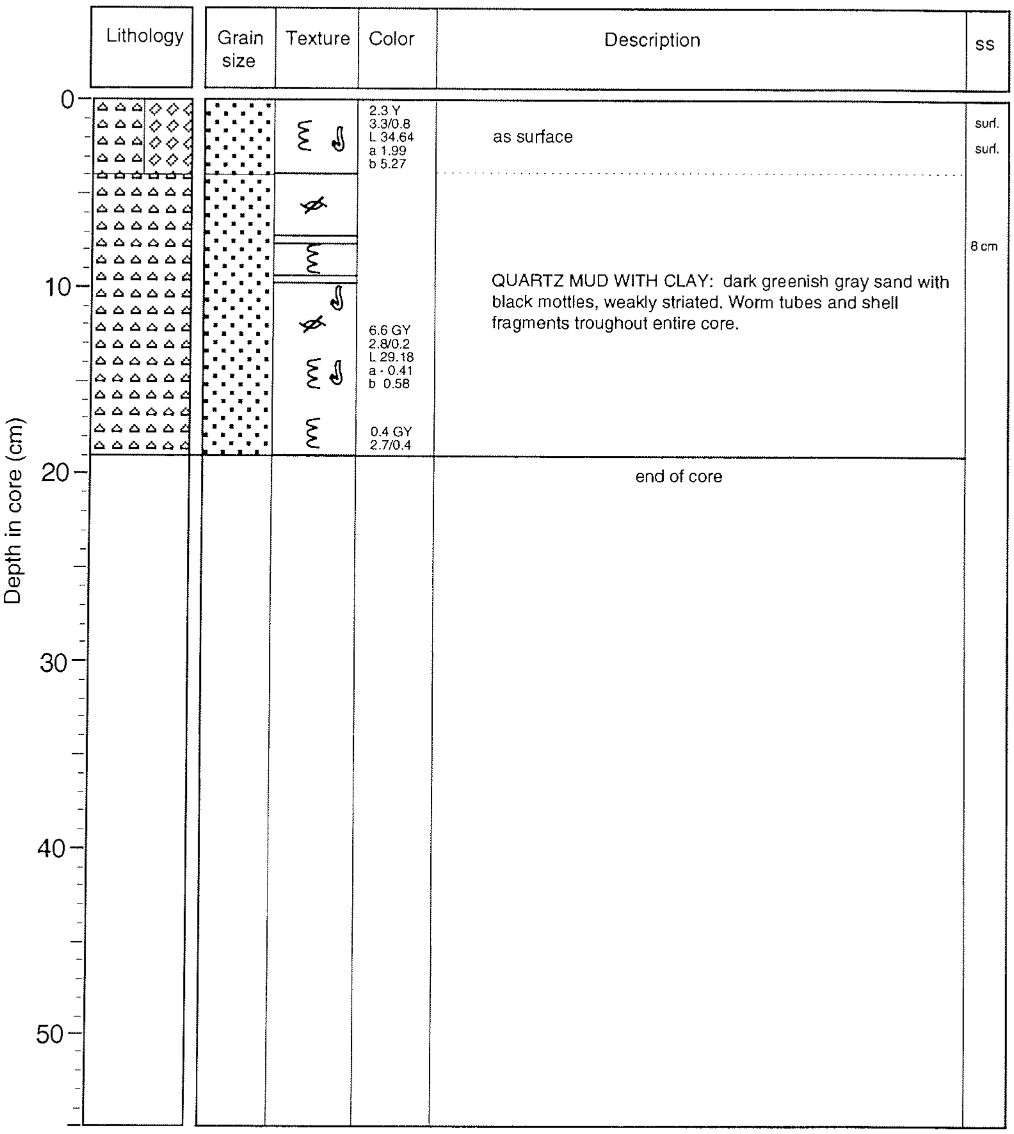
Recovery: 0.19 m 74°00.01´N 125°59.35´E Water depth: 14,1 m

Surface

QUARTZ FELDSPAR MUD: very dark grayish brown sand. Surface with dark areas of heavy minerals and worm tubes. Macroscopic fauna consisting of isopods, bivalves (3 cm in size) and polychaets.

T= 1.1 °C

Color: 2.3 Y 2.8/0.9 ; L 29.39 a 2.32 b 5.92



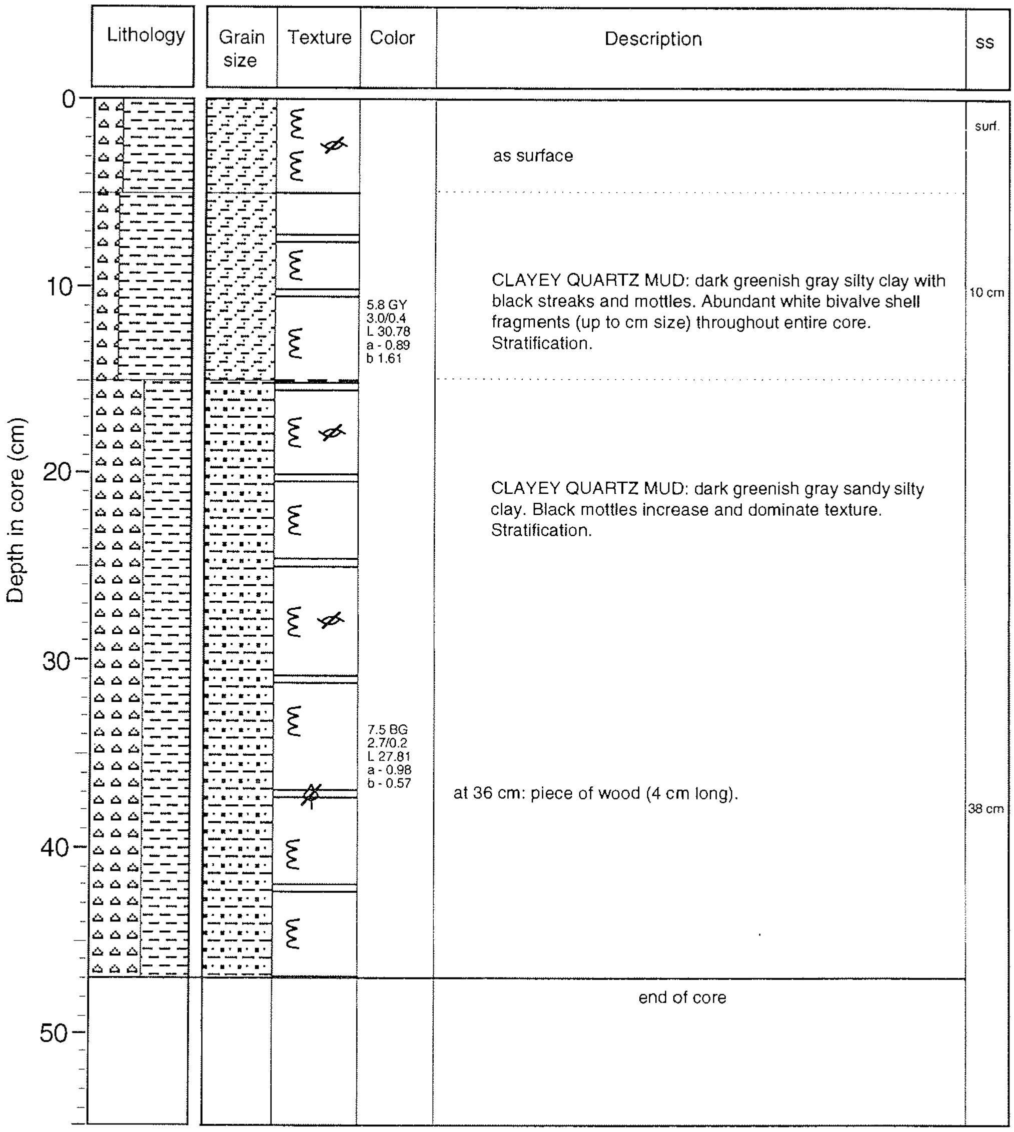
PM9442-3 GKG Loc.: Western Lena Valley **TRANSDRIFT II**

Recovery: 0.47 m 74°29.93´N 126°00.20´E Water depth: 40 m

Surface T= - 1.6 °C

QUARTZ CLAYEY MUD: homogenous very dark gray silty clay. Common ophiurideans (up to 12 cm in size) and polychaets.

Color: 4.0 Y2.7/1.2 ; L 27.66 a 2.33 b 7.92



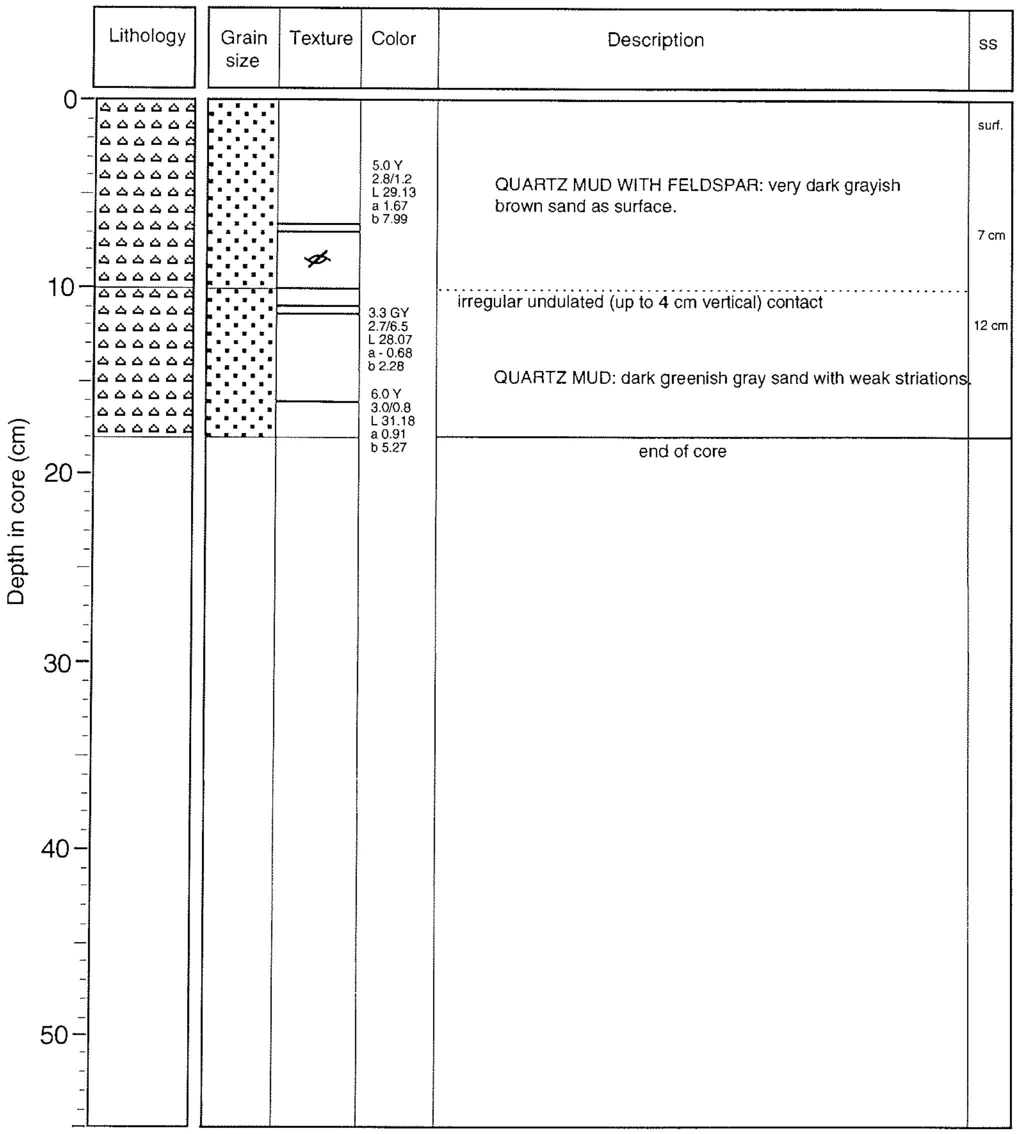
PM9451-7 GKG Loc.: Eastern Lena Valley **TRANSDRIFT II**

Recovery: 0.18 m 74°30.16´N 130°29.70´E Water depth: 25 m

Surface T= / °C

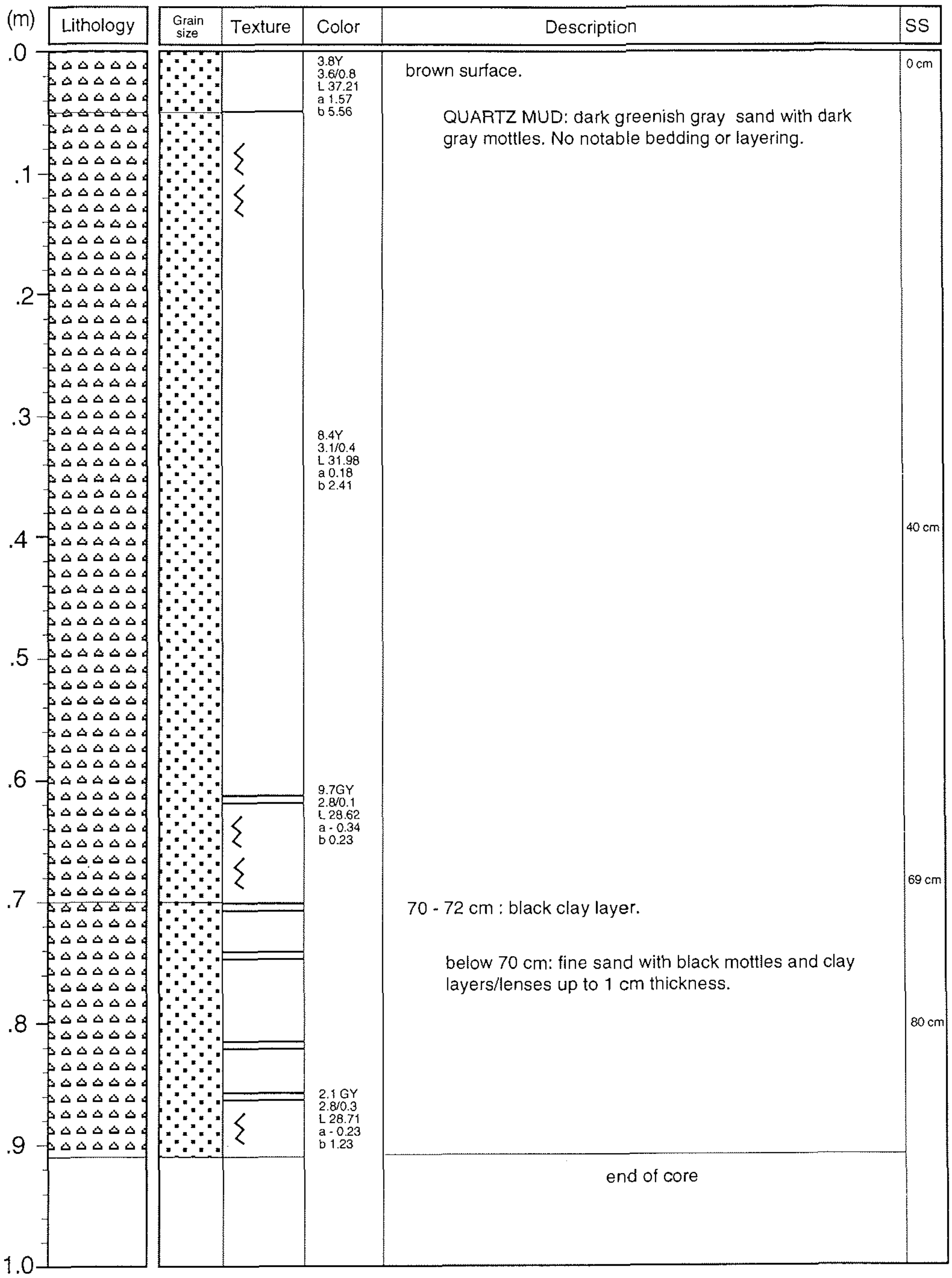
QUARTZ MUD WITH FELDSPAR: very dark grayish brown sand. Strongly disturbed surface. Small worm holes. Common isopods and polychaets. No temperature measured due to severe disturbance during recovery.

Color: 2.3 Y 2.5/1.3 ; L 26.58 a 3.13 b 8.27



PM9457-5 VC LOC.: Stolbovoy Shoal **TRANSDRIFT II**

Recovery: 0.92 m 74°30.10´ N 133°29.99´ E Water depth: 11 m



PM9462-1 GKG | Loc.: Yana Valley | **TRANSDRIFT II**

Recovery: 0.53 m | 74°30.13´N 136°00.23´E | Water depth: 27 m

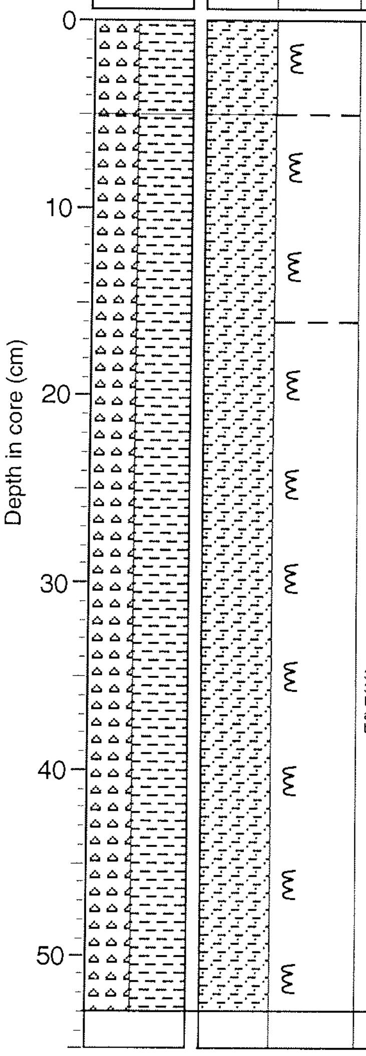
Surface

QUARTZ CLAYEY MUD: very dark gray silty clay. Surface with small pockets (4 cm diameter) with coarser opaque minerals and quartz. Pockets are redder brown in the center with gray rim. Rare macroscopic fauna.

T= - 0.7 °C

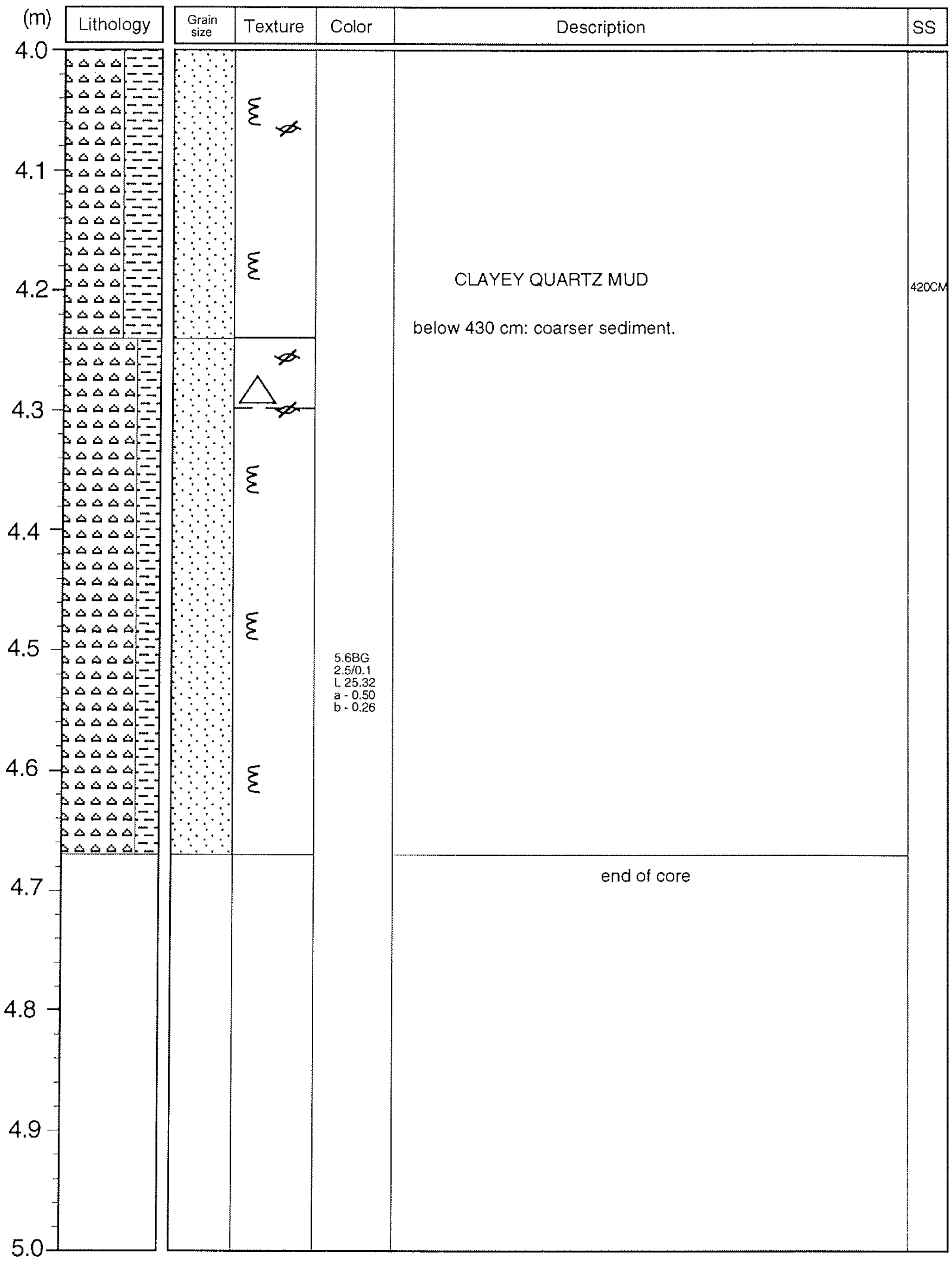
Color: 2.3 Y 2.3/1.1 ; L 23.98 a 2.68 b 6.84

Lithology	Grain size	Texture	Color	Description	ss
				as surface	surf.
			3.9 Y 3.9/1.4 L 32.46 a 2.96 b 0.27	QUARTZ CLAYEY MUD: homogenous very dark gray silty clay. Some black spots with diameters up to 8 mm. Below 16 cm increasing occurrence of black spots.	
			3.7 GY 3.2/0.6 L 32.87 a - 0.77 b 2.62		40 cm
				end of core	



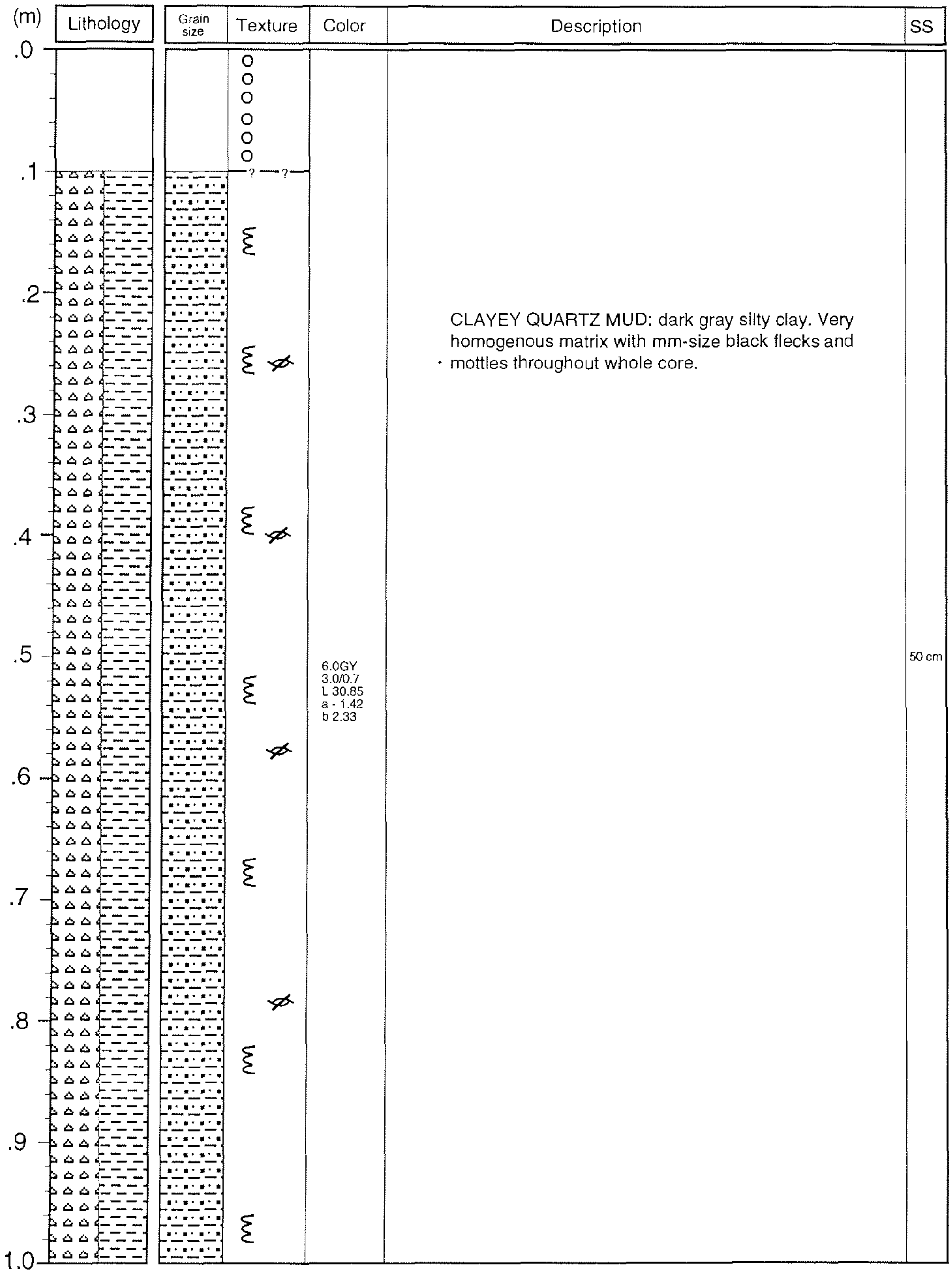
PM9462-4 VC LOC.: Yana Valley **TRANSDRIFT II**

Recovery: 4.67 m 74°30.18´ N 136°00.32´ E Water depth: 27 m



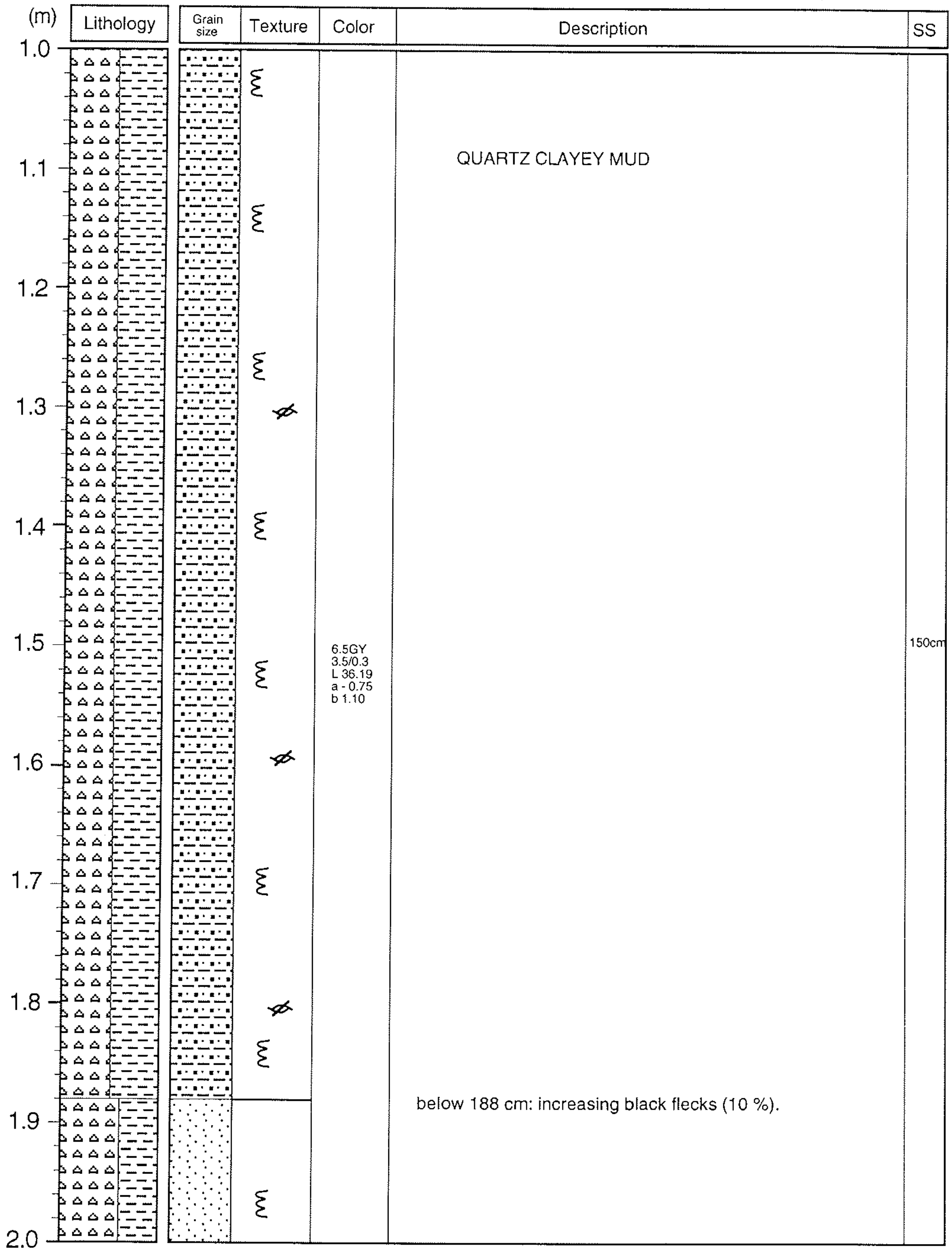
PM9462-4 VC LOC.: Yana Valley **TRANSDRIFT II**

Recovery: 4.67 m 74°30.18´ N 136°00.32´ E Water depth: 27 m



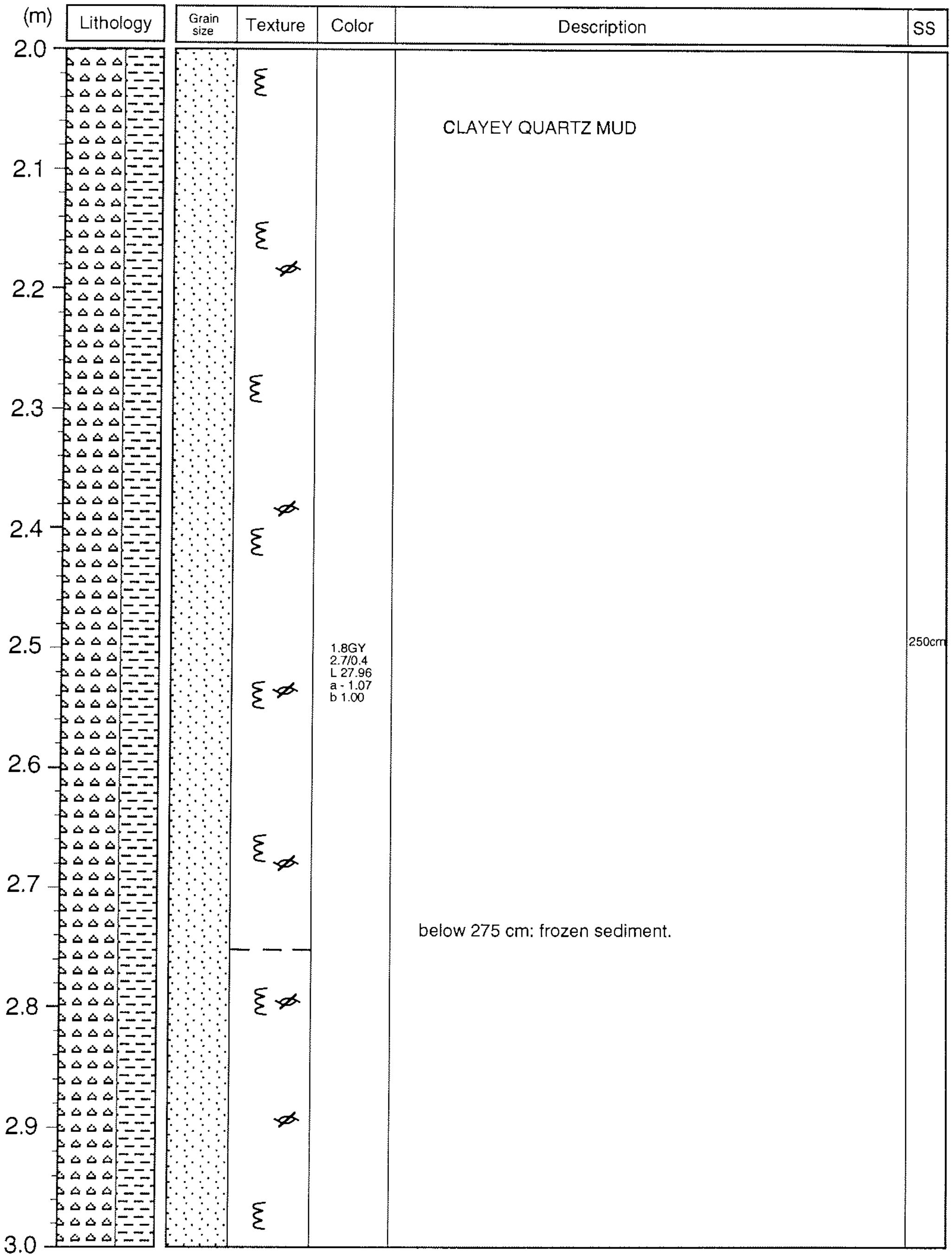
PM9462-4 VC LOC.: Yana Valley **TRANSDRIFT II**

Recovery: 4.67 m 74°30.18´ N 136°00.32´ E Water depth: 27 m



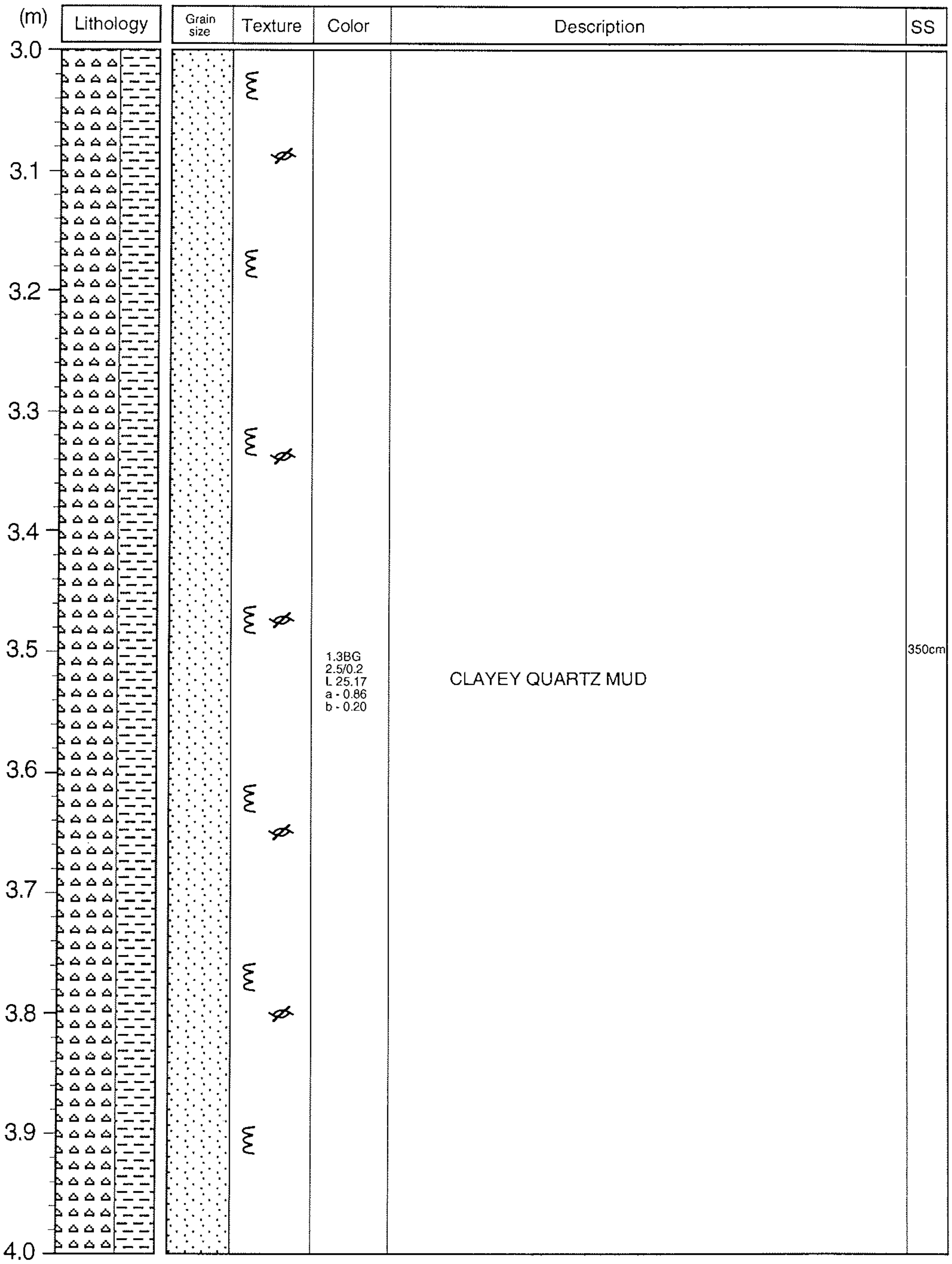
PM9462-4 VC LOC.: Yana Valley **TRANSDRIFT II**

Recovery: 4.67 m 74°30.18´ N 136°00.32´ E Water depth: 27 m



PM9462-4 VC LOC.: Yana Valley **TRANSDRIFT II**

Recovery: 4.67 m 74°30.18´ N 136°00.32´ E Water depth: 27 m



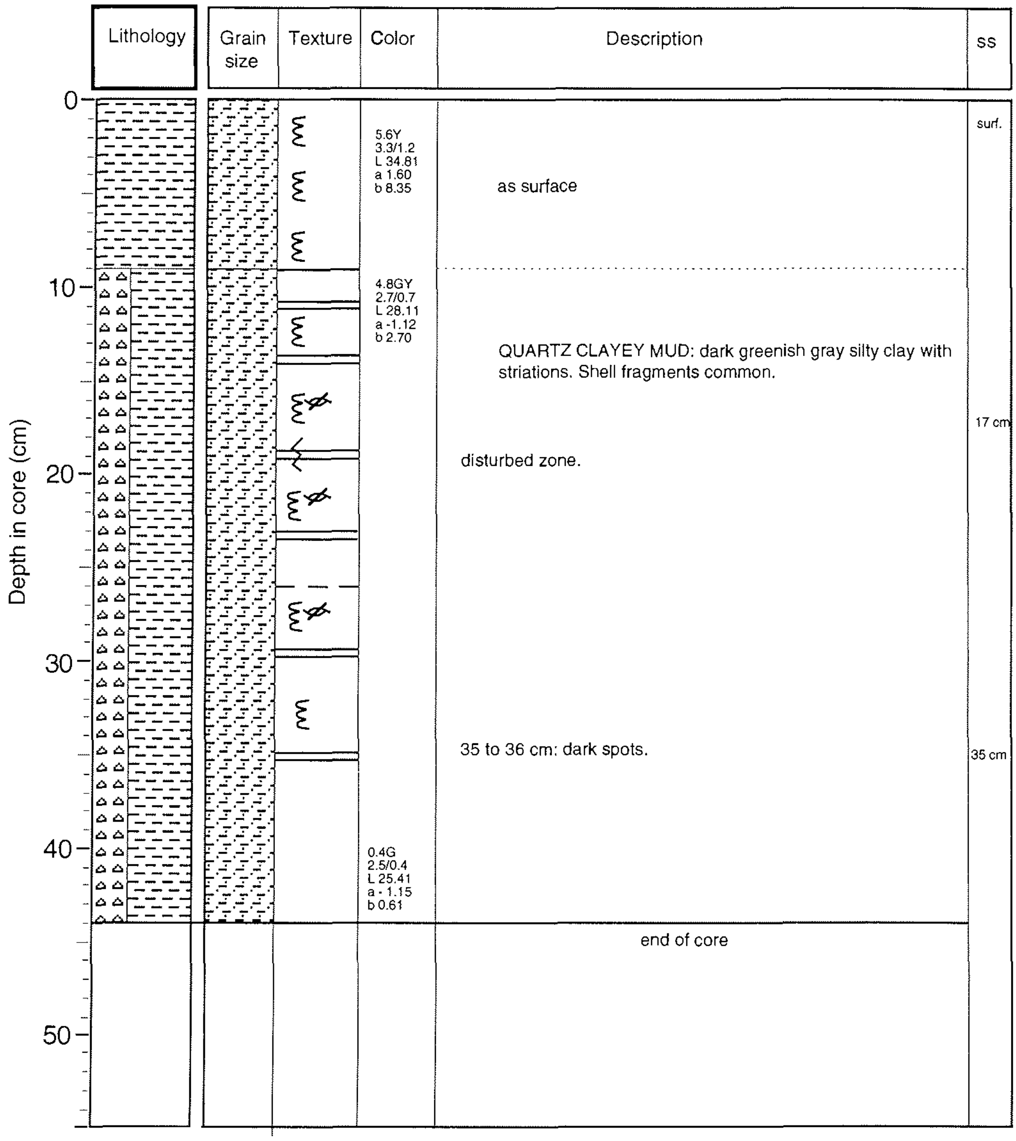
PM9463-8 GKG Loc.: Western Lena Valley **TRANSDRIFT II**

Recovery: 0.44 m 74°30.21´N 126°34.91´E Water depth: 36 m

Surface T= - 1.0 °C

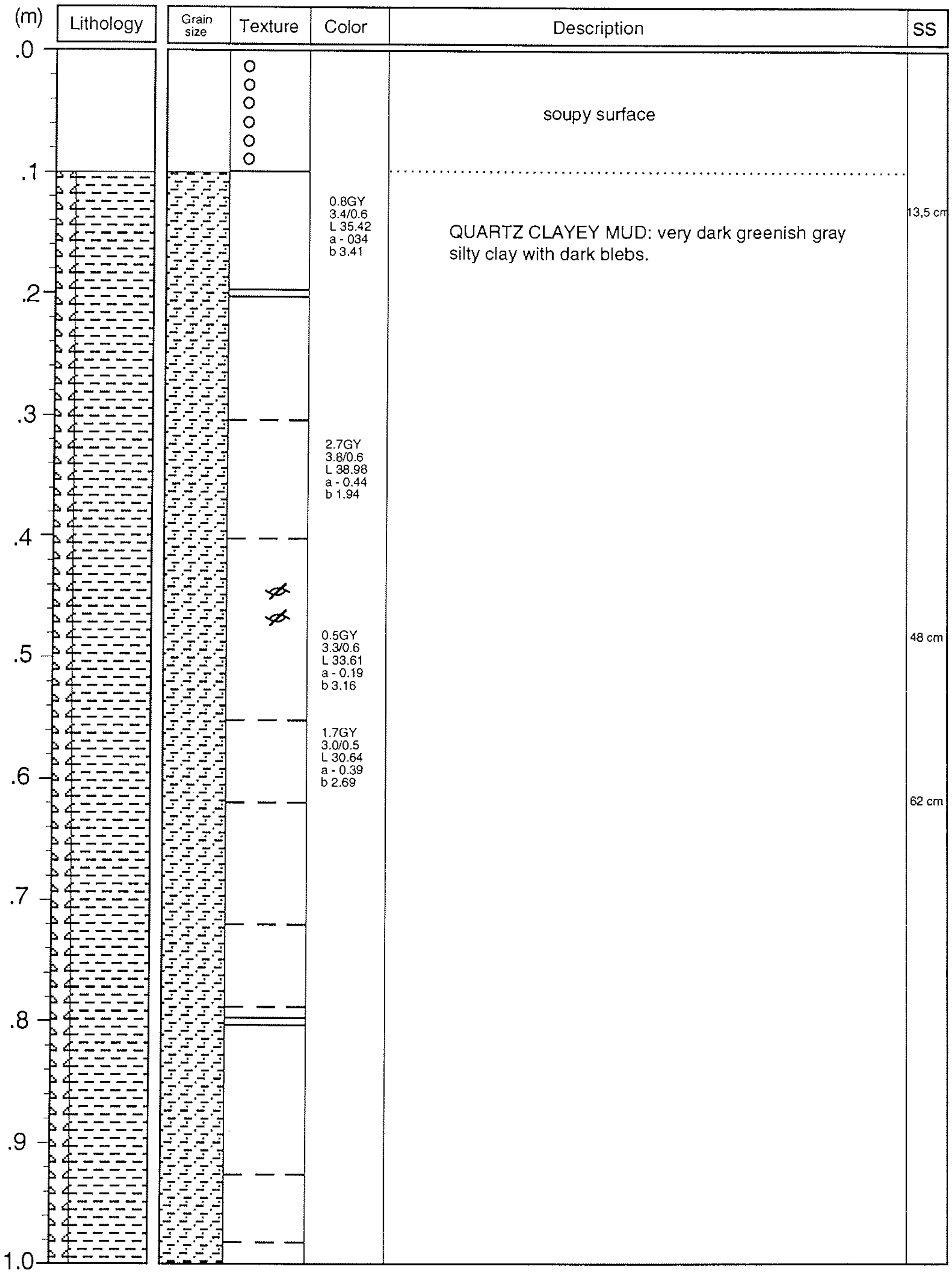
CLAYEY MUD WITH QUARTZ: homogenous dark olive gray silty clay. Macroscopic fauna consists of polychaets (with tubes) and isopods.

Color: 4.8 Y 2.3/1.9 ; L 24.32 a 1.54 b 6.10



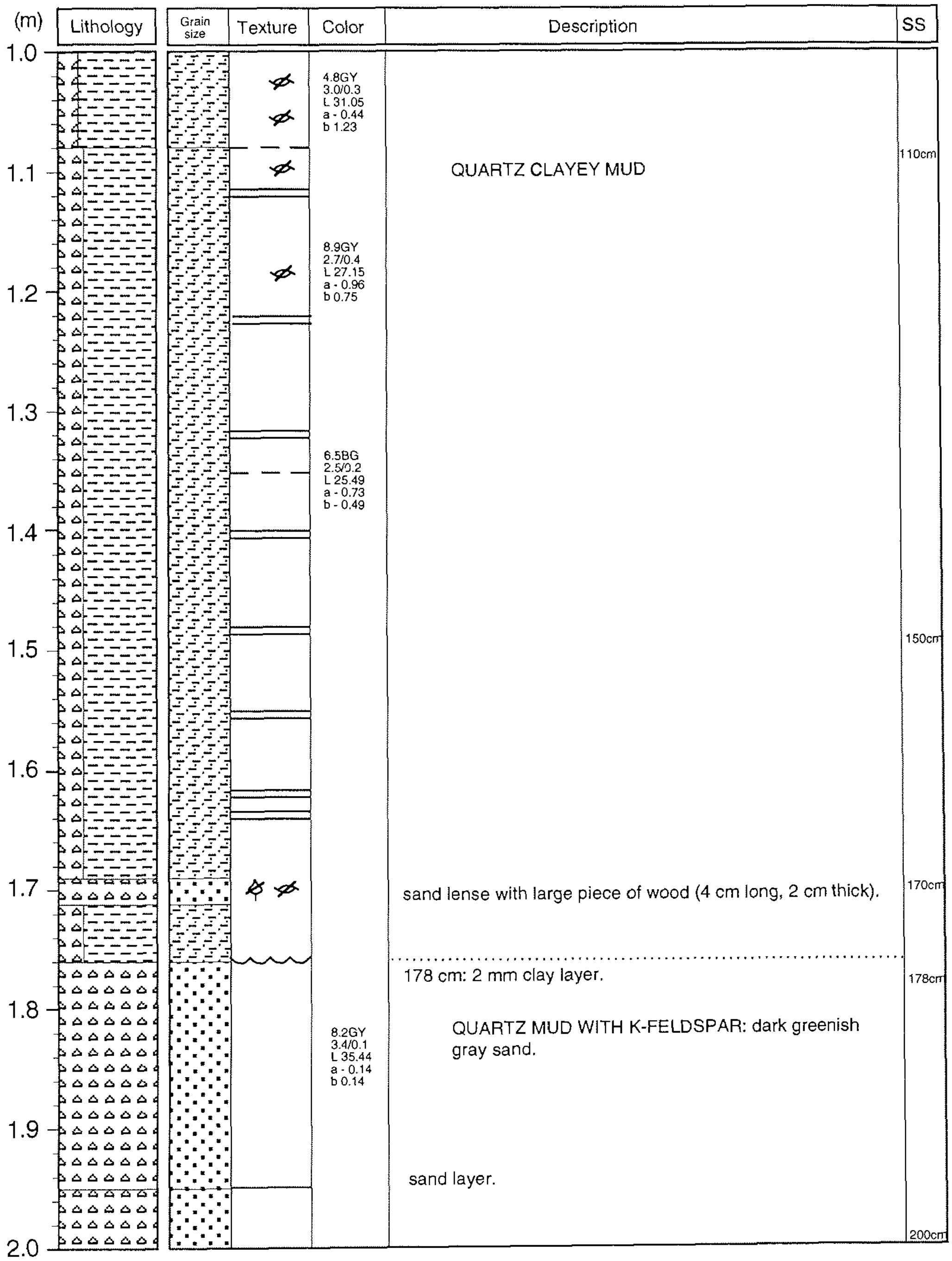
PM9463-4 VC LOC.: Western Lena Valley **TRANSDRIFT II**

Recovery: 2.13 m 74°30.10´ N 126°34.79´ E Water depth: 36 m



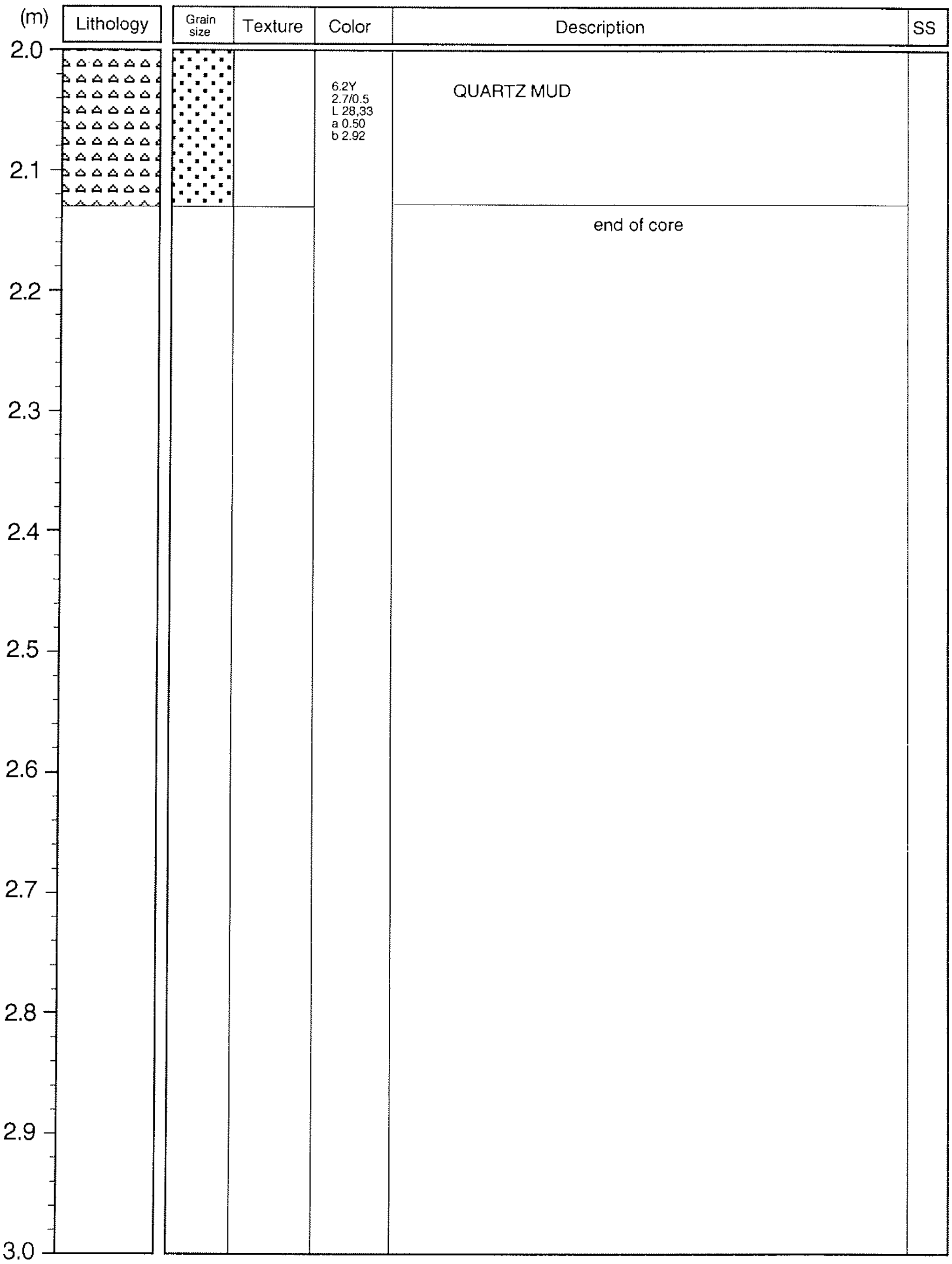
PM9463-4 VC LOC.: Western Lena Valley **TRANSDRIFT II**

Recovery: 2.13 m 74°30.10´ N 126°34.79´ E Water depth: 36 m



PM9463-4 VC LOC.: Western Lena Valley **TRANSDRIFT II**

Recovery: 2.13 m 74°30.10´ N 126°34.79´ E Water depth: 36 m



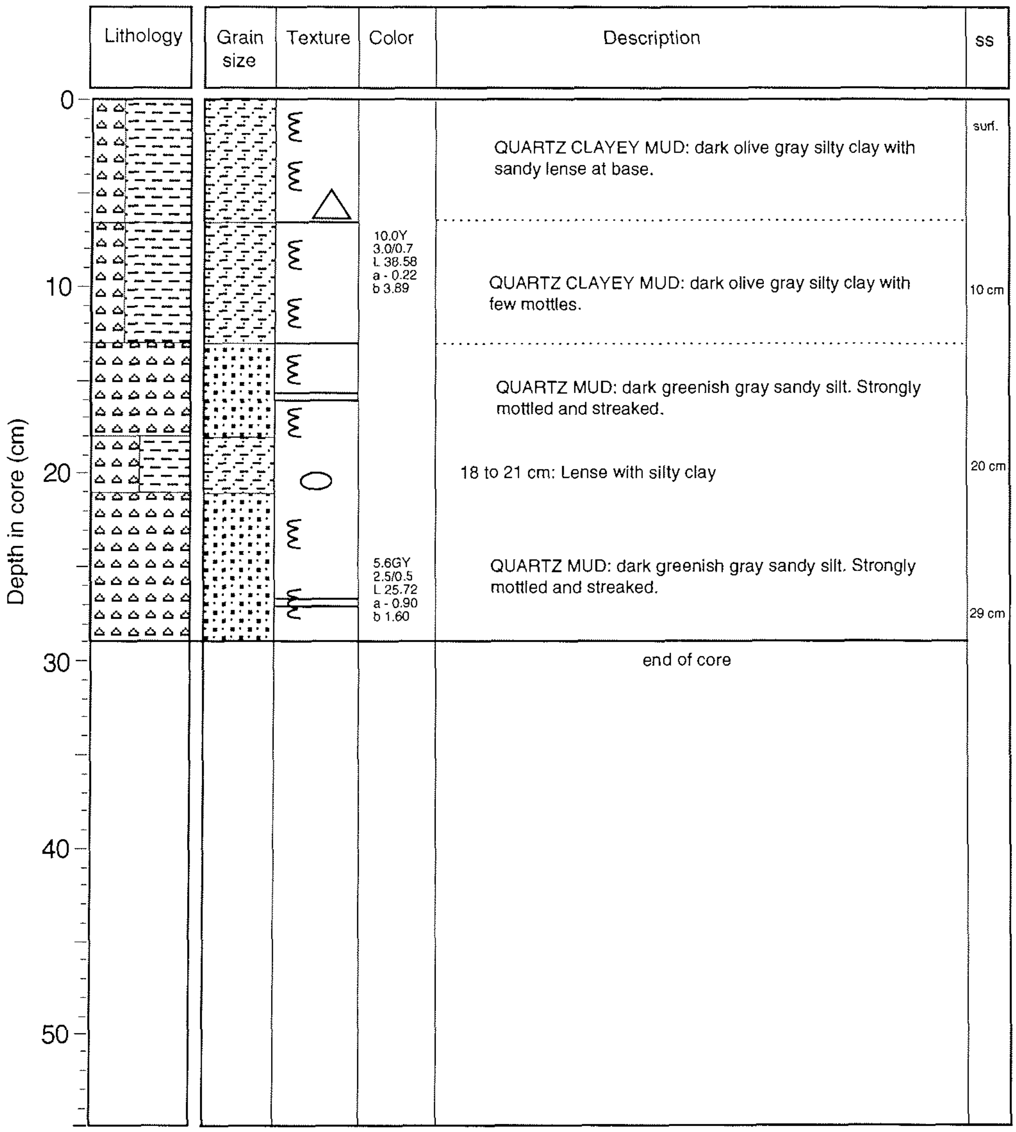
PM9475-3 GKG Loc.: Southeastern Laptev Sea **TRANSDRIFT II**

Recovery: 0.29 m 72°15.00´N 133°59.70´E Water depth: 21 m

Surface T= - 1.1 °C

QUARTZ CLAYEY MUD: dark olive gray silty clay. Surface heavily disturbed.

Color: 5.0Y 2.9/1.3 ; L 30.21 a 1.85 b 8.66



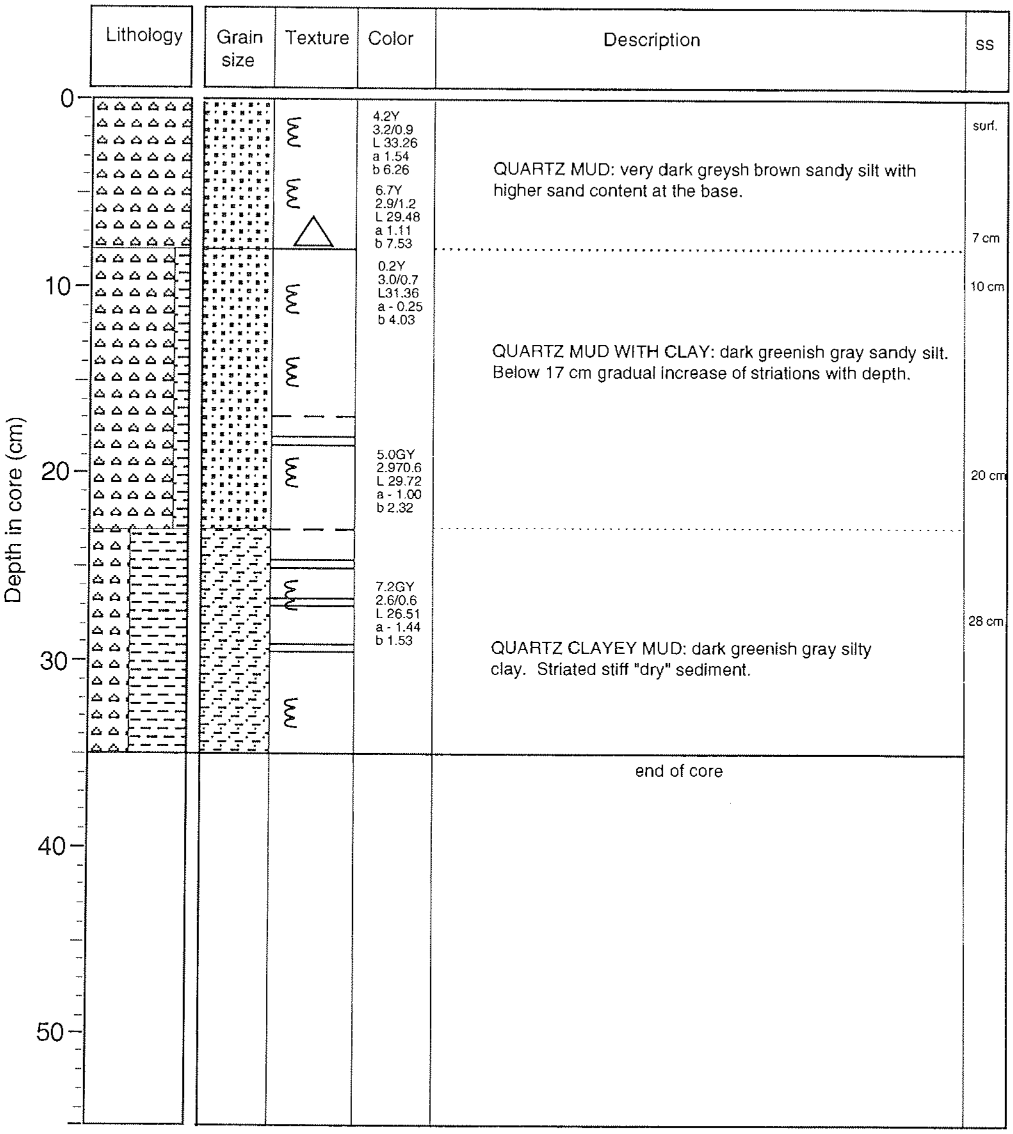
PM9481-2 GKG | Loc.: Stolbovoy Shoal | **TRANSDRIFT II**

Recovery: 0.35 m | 73°45.00´N 134°00.25´E | Water depth: 17 m

Surface — T= - 0.9 °C

QUARTZ MUD: homogenous very dark greysh brown sandy silt. Slightly disturbed surface. No macroscopic fauna.

Color: 3.1Y 2.2/1.0 ; L 22.89 a 2.08 b 5.87



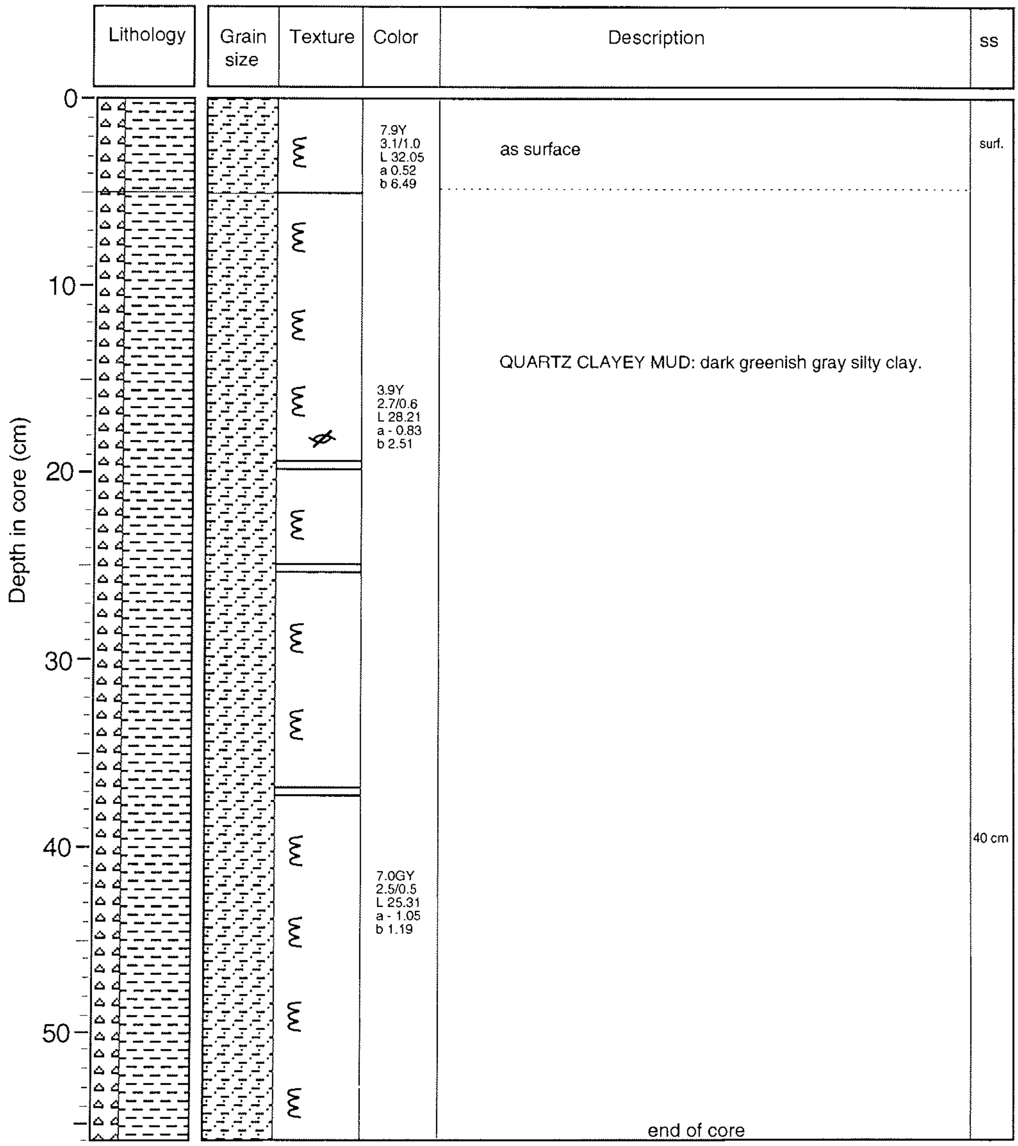
PM9482-1 GKG Loc.: North Lena Delta **TRANSDRIFT II**

Recovery: 0.56 m 73°59.94´N 128°10.47´E Water depth: 27 m

Surface T= - 1.5 °C

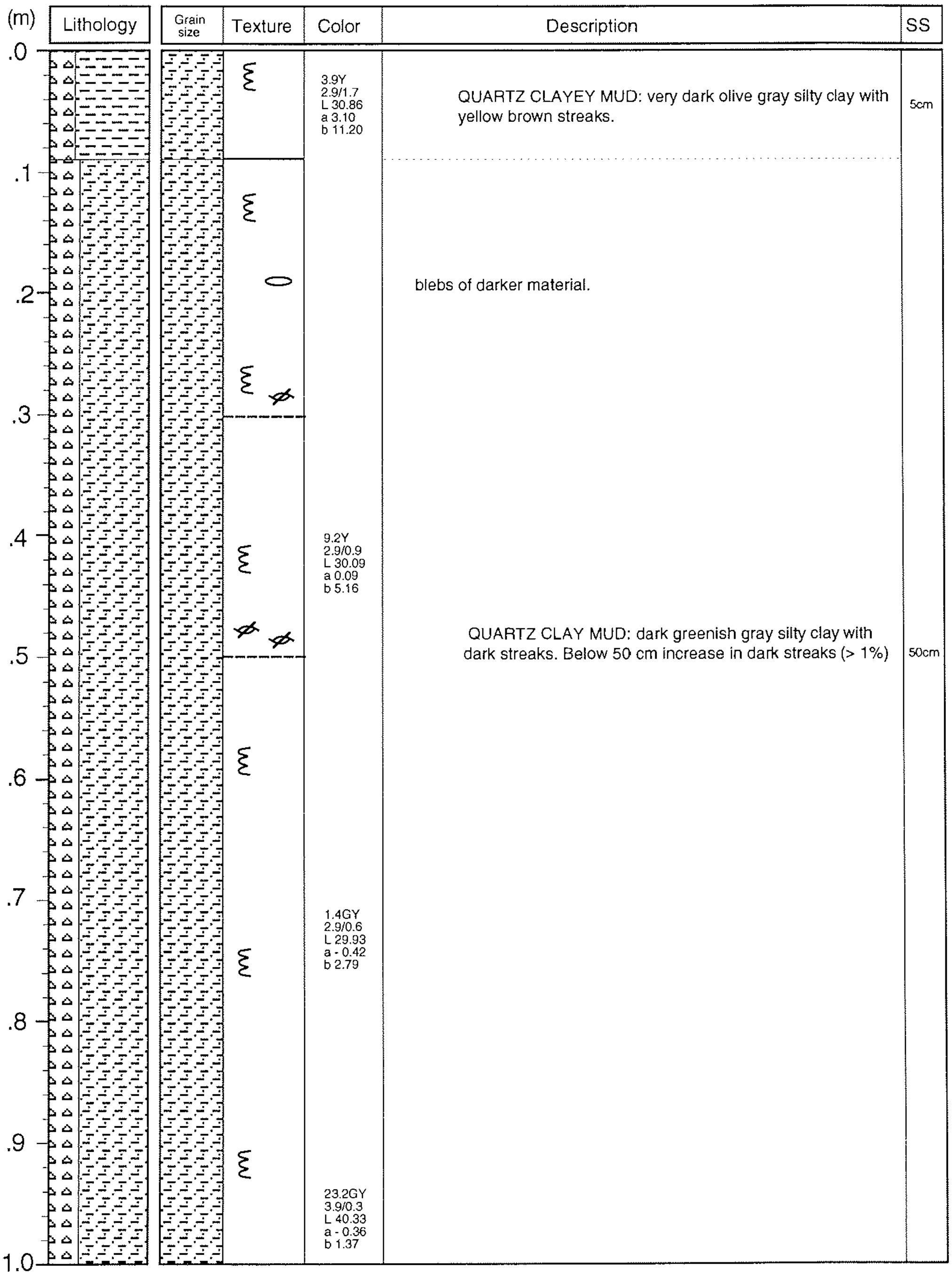
QUARTZ CLAYEY MUD: homogenous very dark greysh brown silty clay. No macroscopic fauna. One 4 cm long worm tube.

Color: 3.2Y 1.7/1.1 ; L 18.33 a 2.58 b 7.44



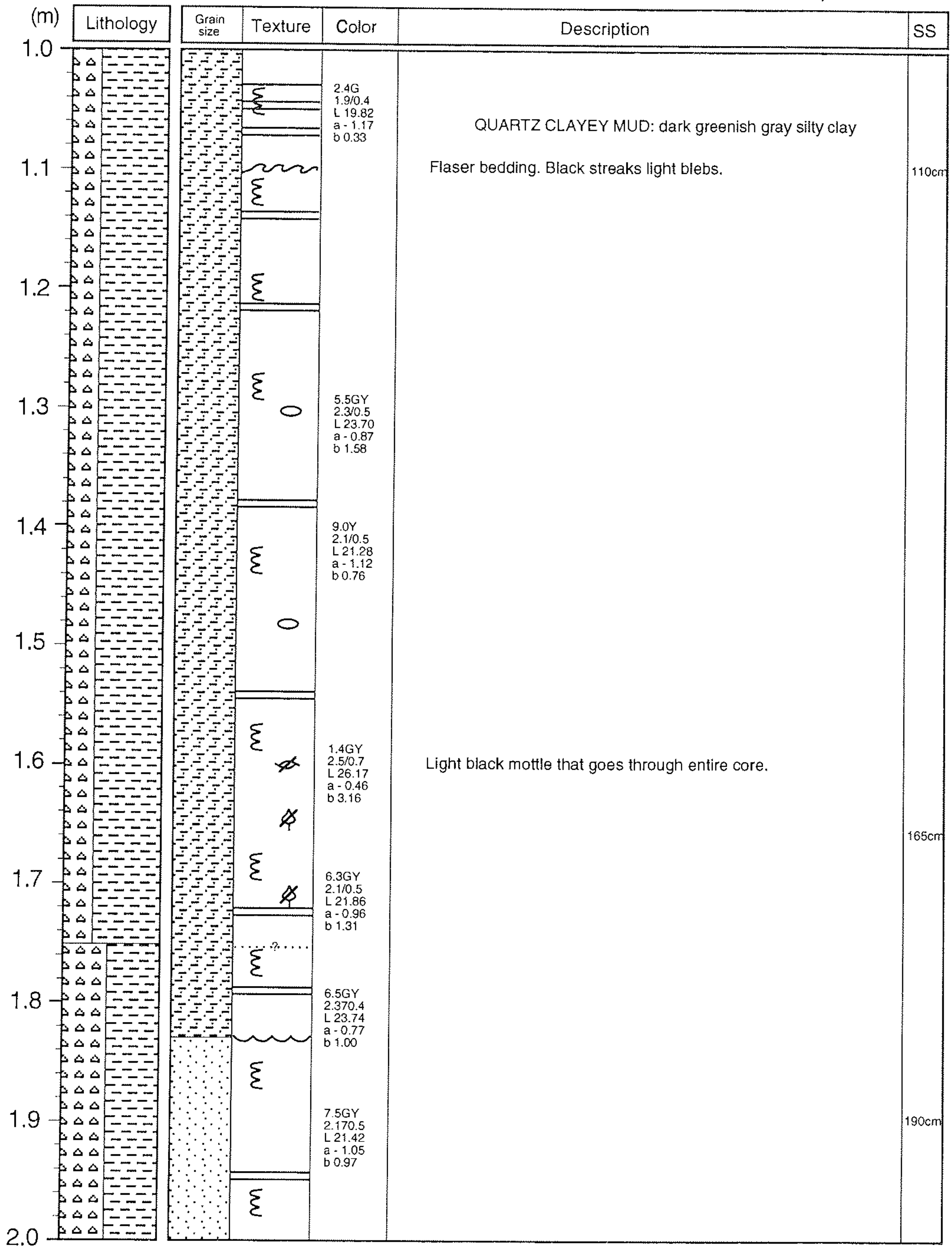
PM9482-2 VC LOC.: North of Lena Delta **TRANSDRIFT II**

Recovery: 3.41 m 73°59.94´ N 128°10.47´ E Water depth: 27 m



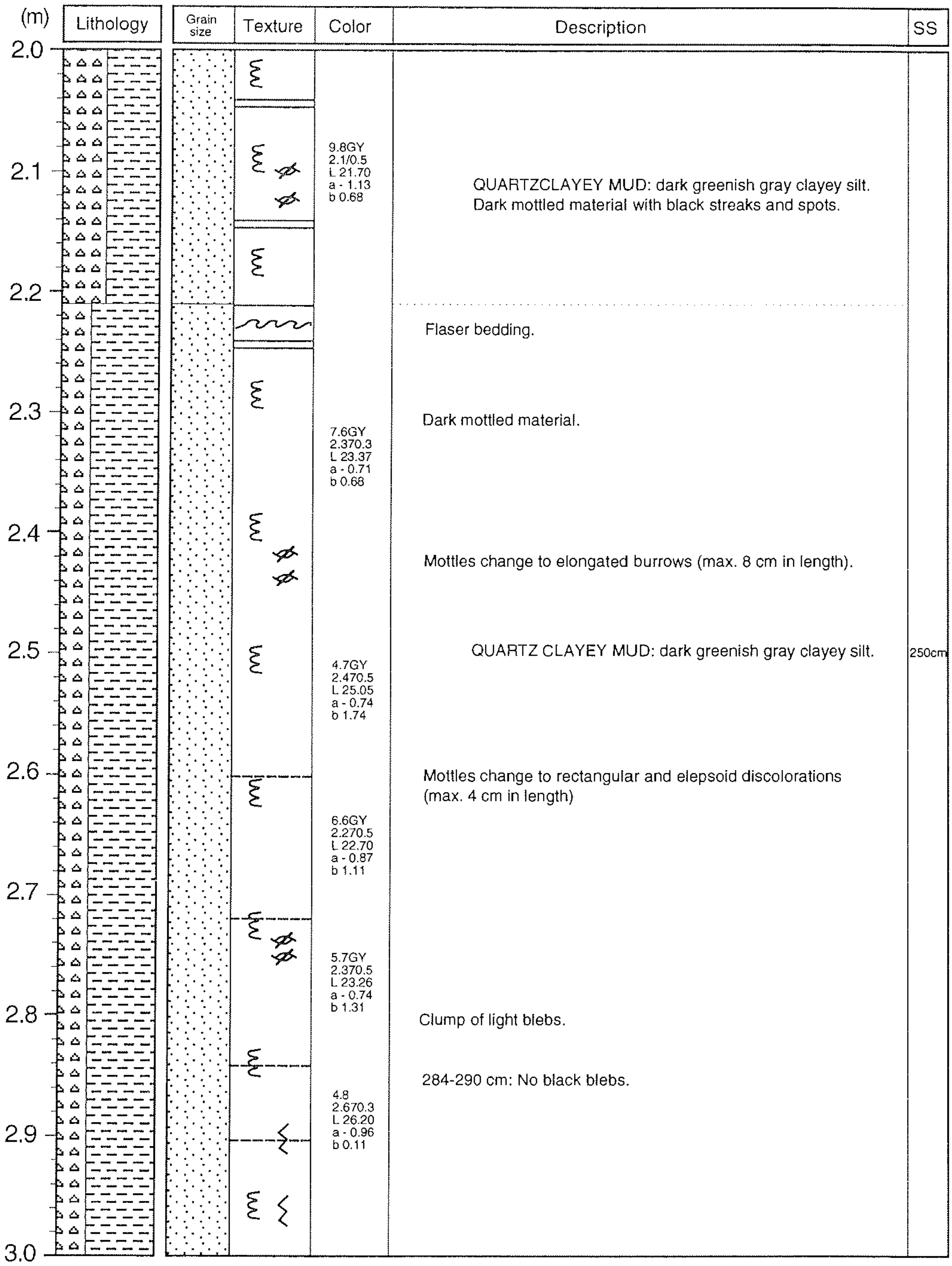
PM9482-2 VC LOC.: North of Lena Delta **TRANSDRIFT II**

Recovery: 3.41 m 73°59.94´ N 128°10.47´ E Water depth: 27 m



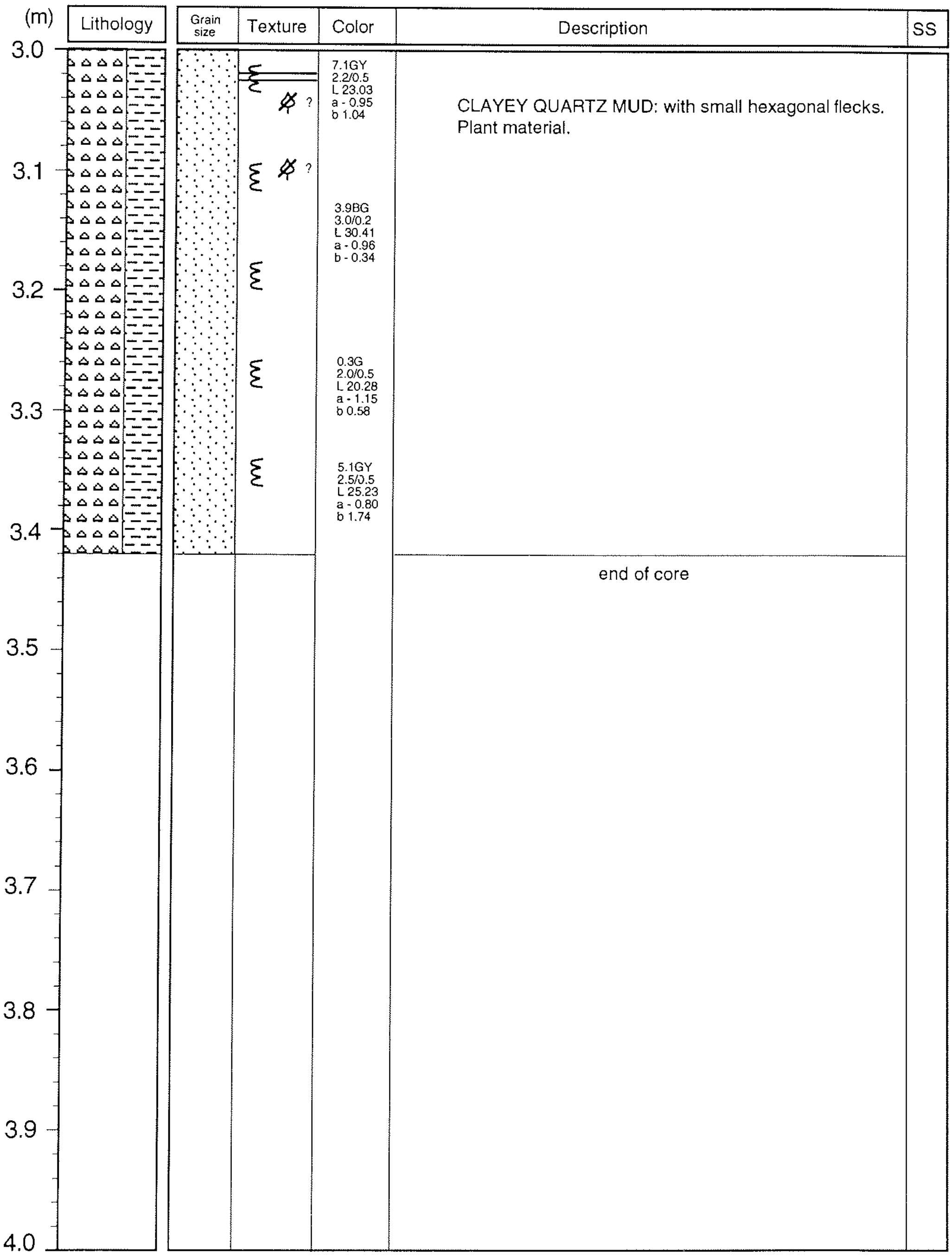
PM9482-2 VC LOC.: North of Lena Delta **TRANSDRIFT II**

Recovery: 3.41 m 73°59.94´ N 128°10.47´ E Water depth: 27 m



PM9482-2 VC LOC.: North of Lena Delta **TRANSDRIFT II**

Recovery: 3.41 m 73°59.94′ N 128°10.47′ E Water depth: 27 m

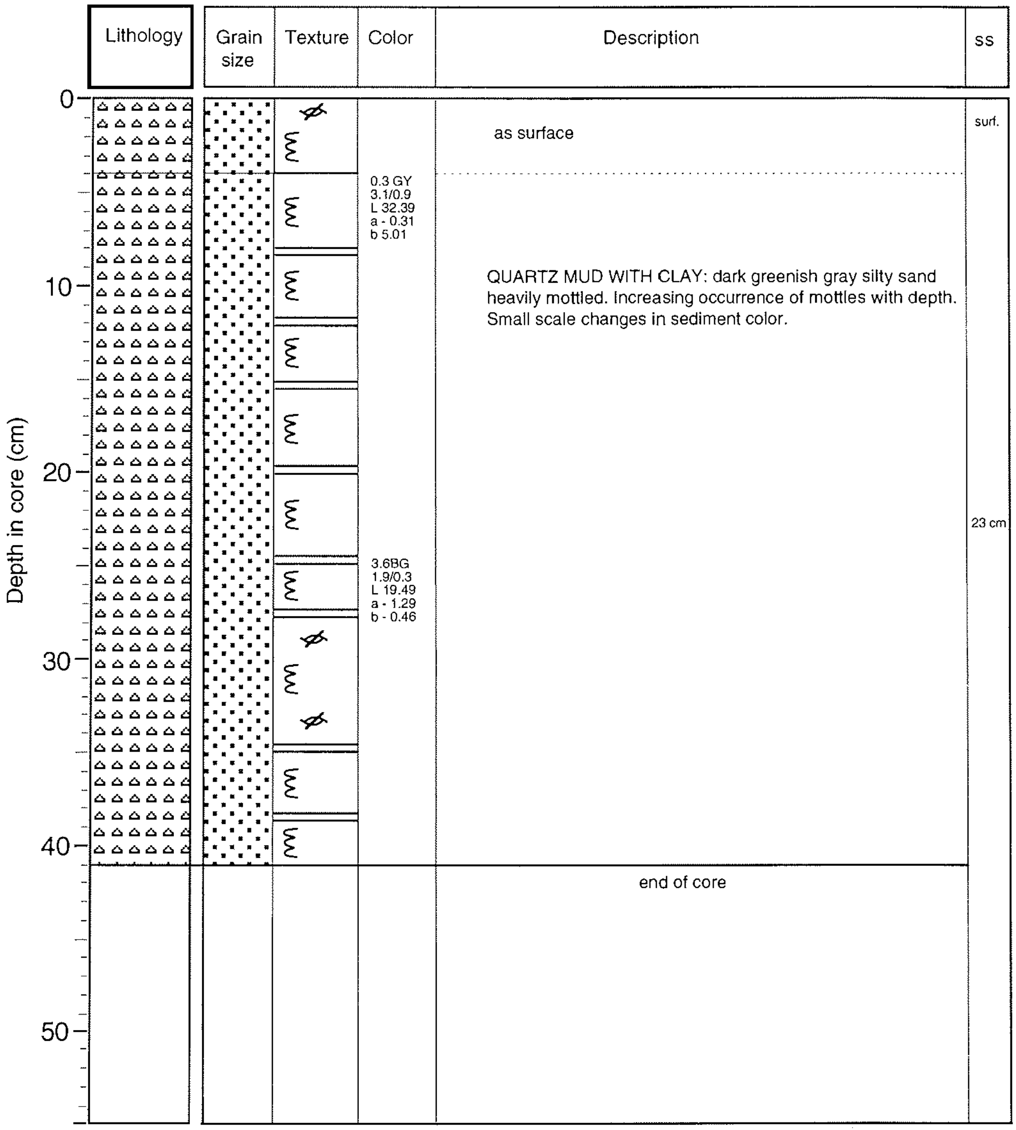


PM9492-3 GKG Loc.: Olenek Valley **TRANSDRIFT II**

Recovery: 0.41 m 74°30.05´N 119°50.10´E Water depth: 34 m

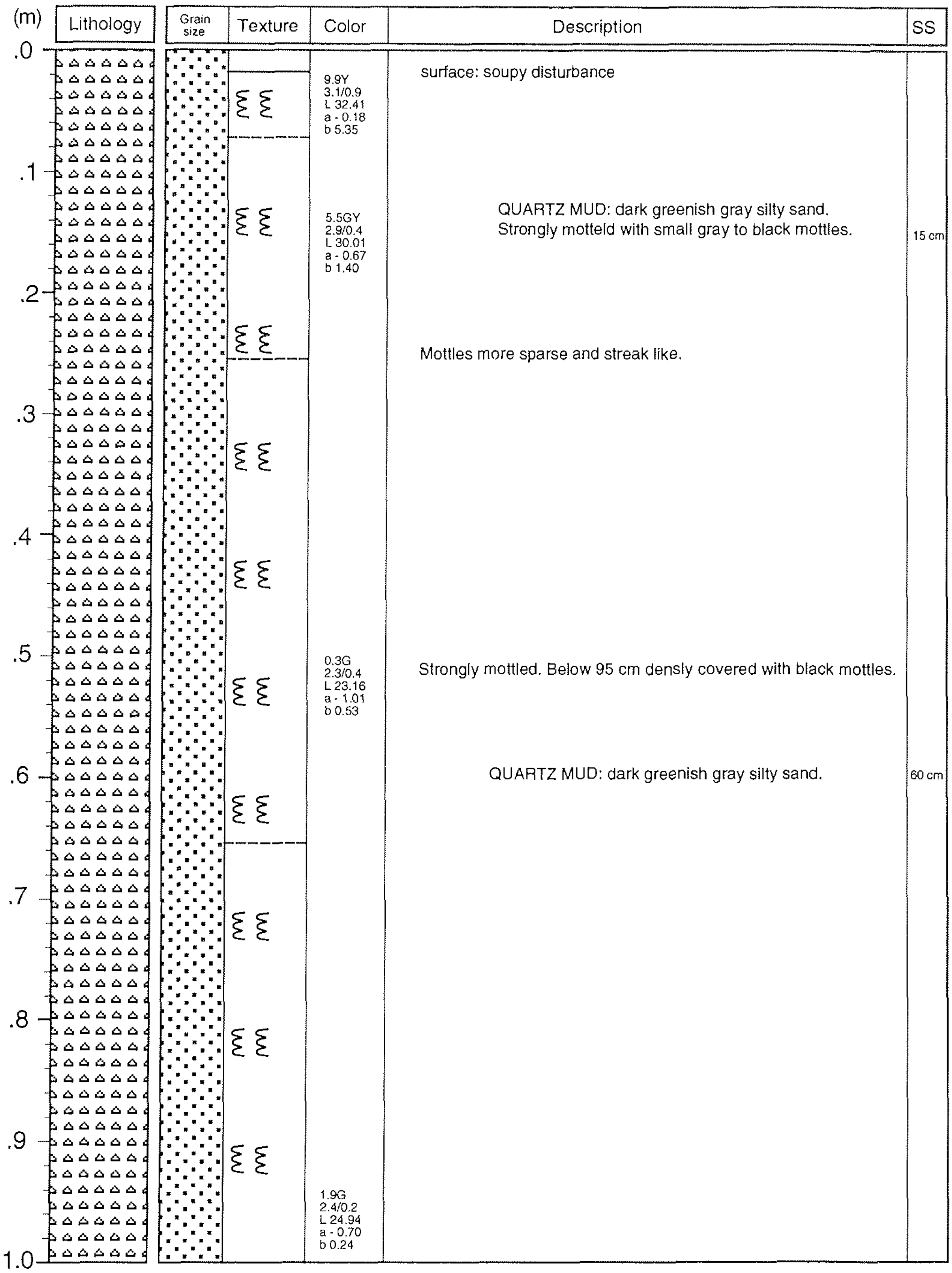
Surface QUARTZ MUD WITH CLAY: very dark greyish brown silty sand. Light overgrowth with black iron/manganese precipitates. Uneven surface with abundant macroscopic fauna i.e. ophiuredeans, bivalves, polychaet and crustacean tubes, sponges and soft corals. T= - 1.7 °C

Color: 2.6Y 2.5/1.4 ; L 26.74 a 3.44 b 9.31



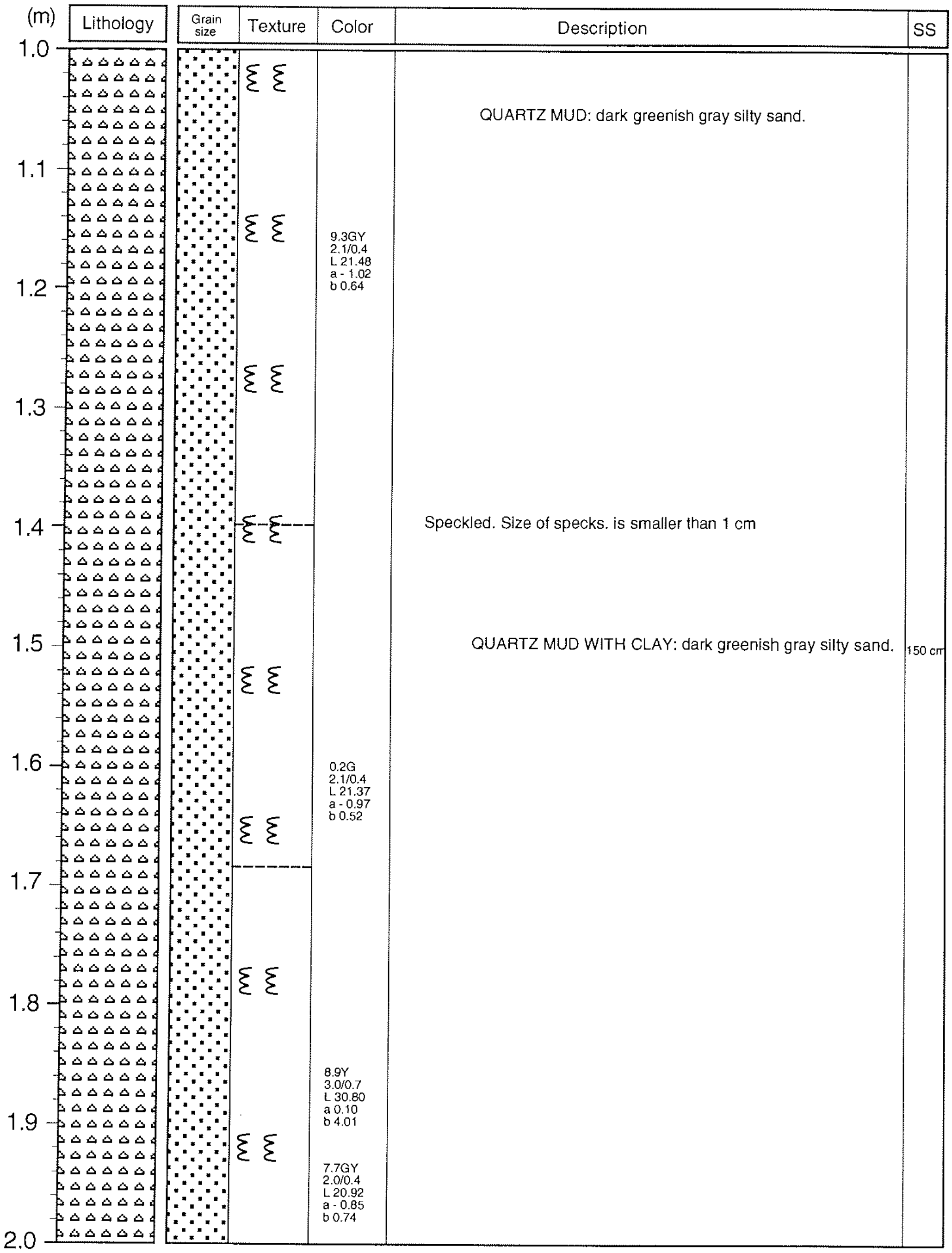
PM9492-4 VC LOC.: Olenek Valley **TRANSDRIFT II**

Recovery: 3.00 m 74°30.05´ N 119°50.10´ E Water depth: 34 m



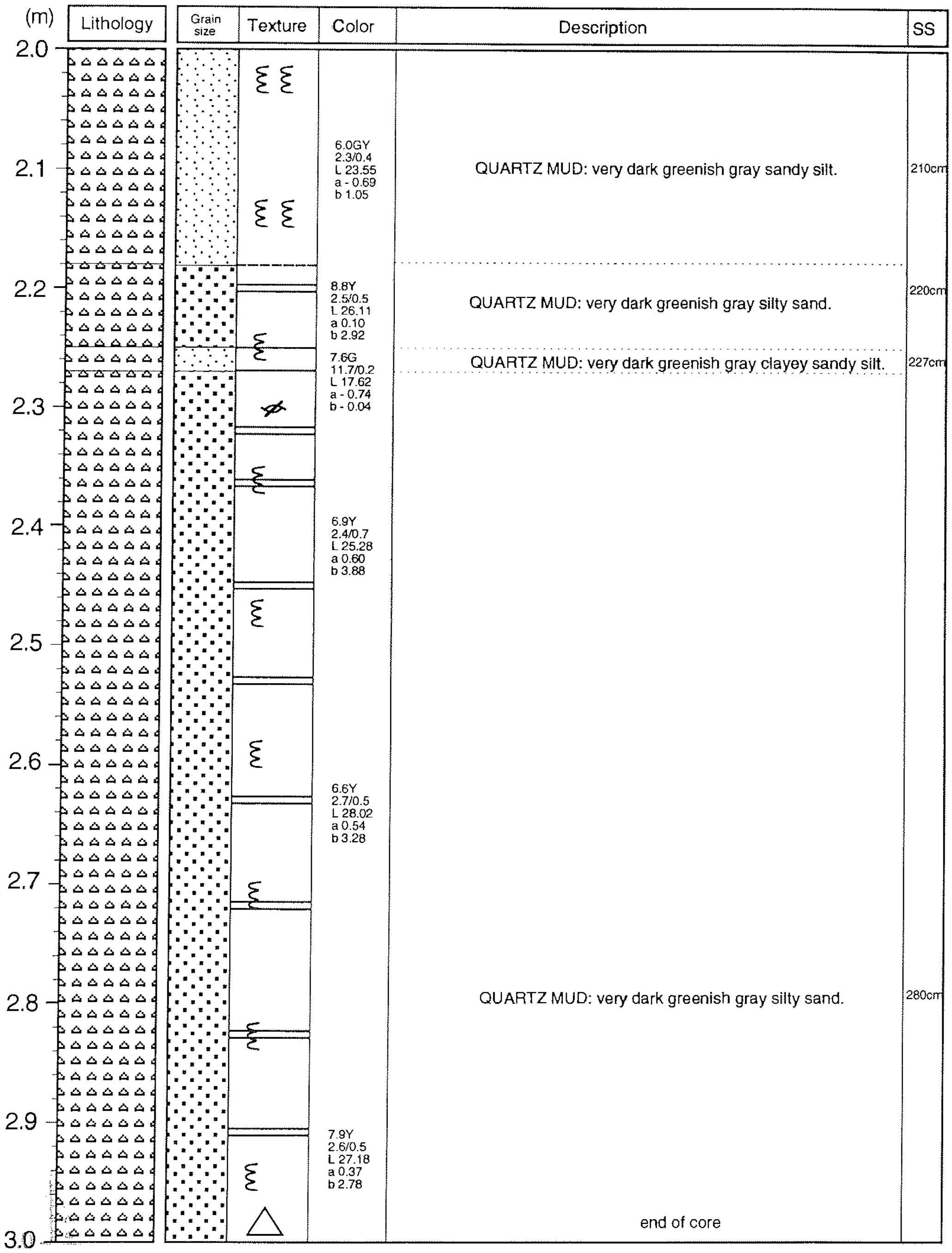
PM9492-4 VC LOC.: Olenek Valley **TRANSDRIFT II**

Recovery: 3.00 m 74°30.05´ N 119°50.10´ E Water depth: 34 m



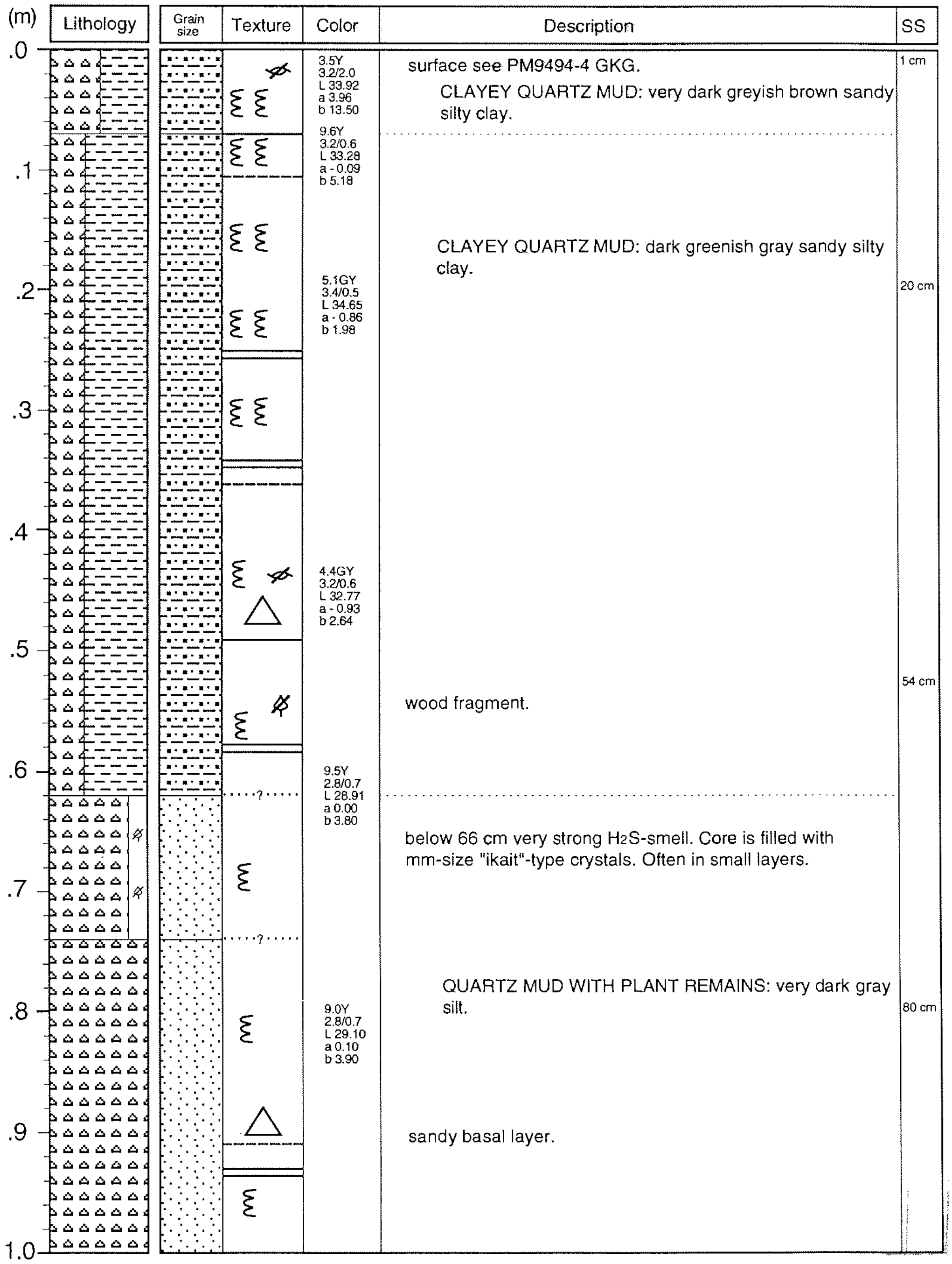
PM9492-4 VC LOC.: Olenek Valley **TRANSDRIFT II**

Recovery: 3.00 m 74°30.05´ N 119°50.10´ E Water depth: 34 m



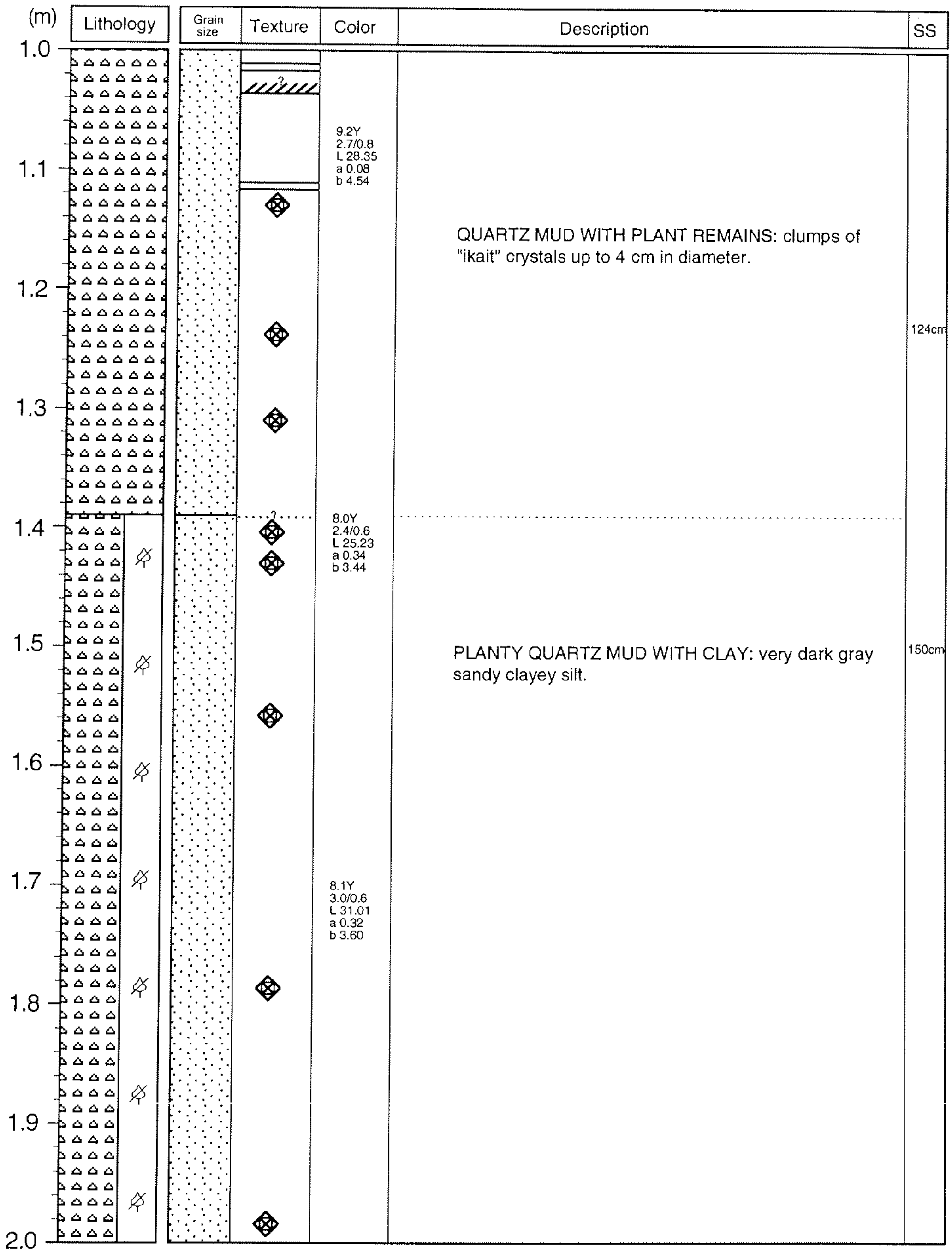
PM9494-4 VC LOC.: Anabar-Khatanga Valley **TRANSDRIFT II**

Recovery: 3.24 m 74°30.06´ N 114°17.05´ E Water depth: 37 m



PM9494-4 VC LOC.: Anabar-Khatanga Valley **TRANSDRIFT II**

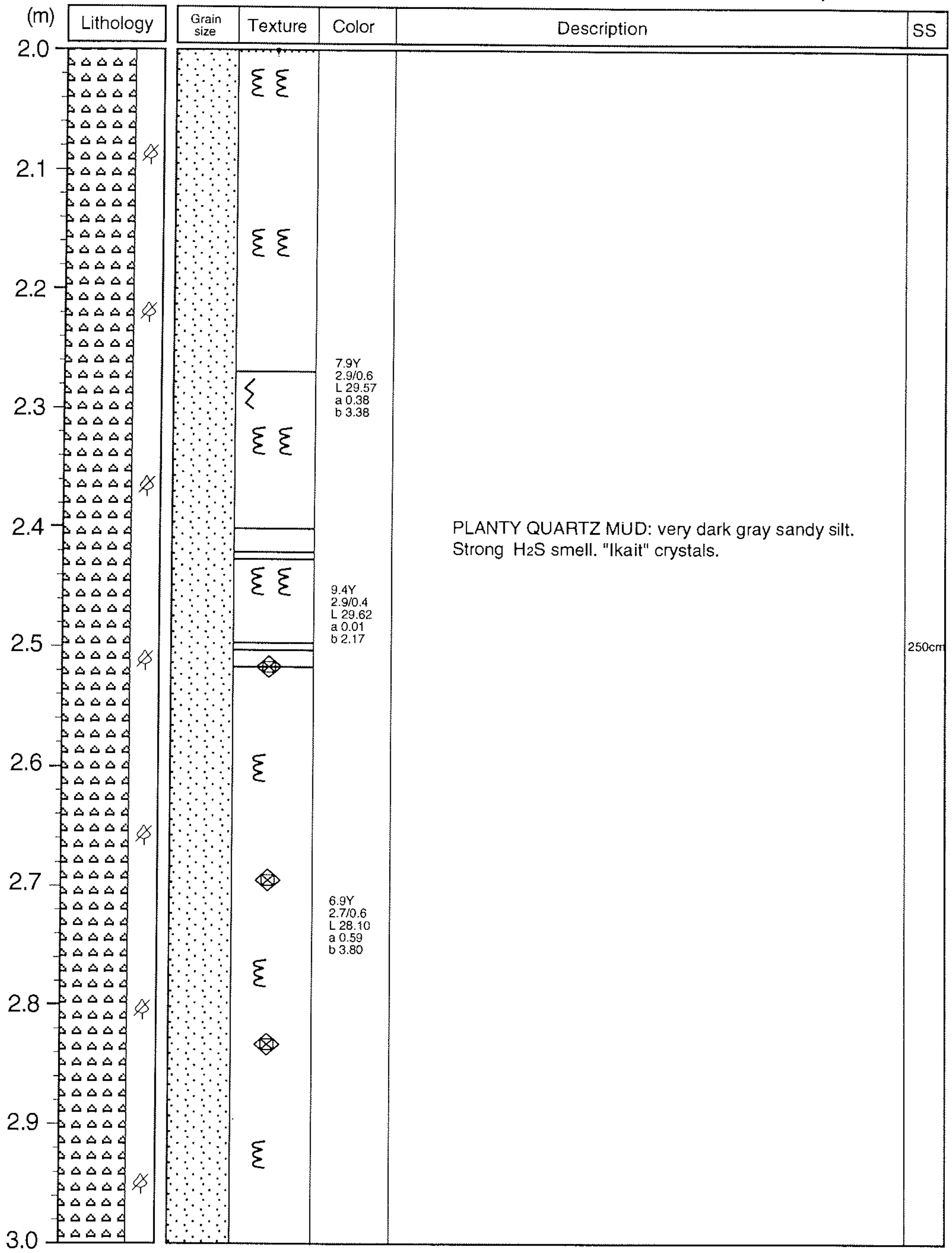
Recovery:: 3.24 m 74°30.06´ N 114°17.05´ E Water depth: 37 m



PM9494-4 VC Recovery: 3.24 m

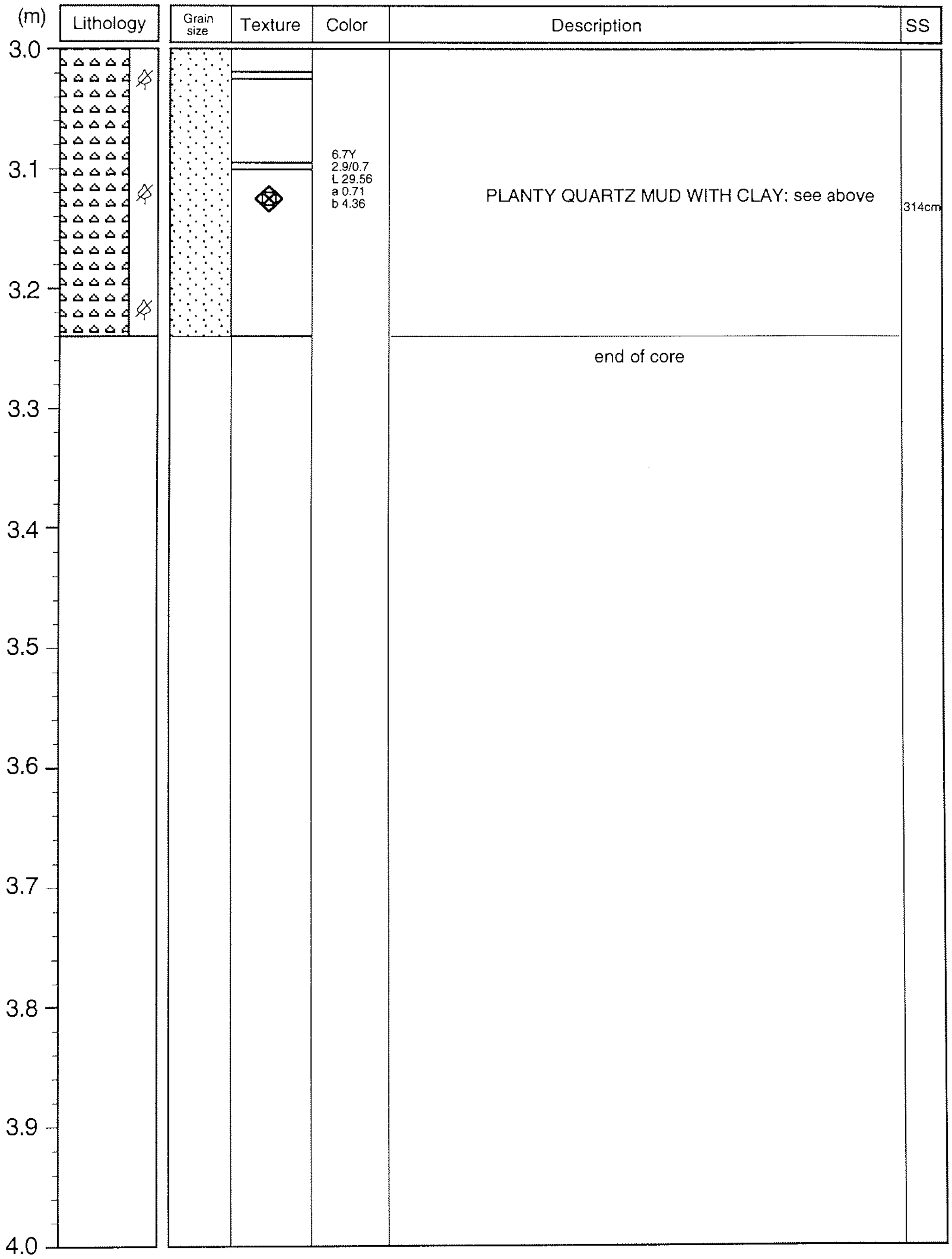
LOC.: Anabar-Khatanga Valley 74°30.06´ N 114°17.05´ E

TRANSDRIFT II Water depth: 37 m



PM9494-4 VC LOC.: Anabar-Khatanga Valley **TRANSDRIFT II**

Recovery: 3.24 m 74°30.06´ N 114°17.05´ E Water depth: 37 m



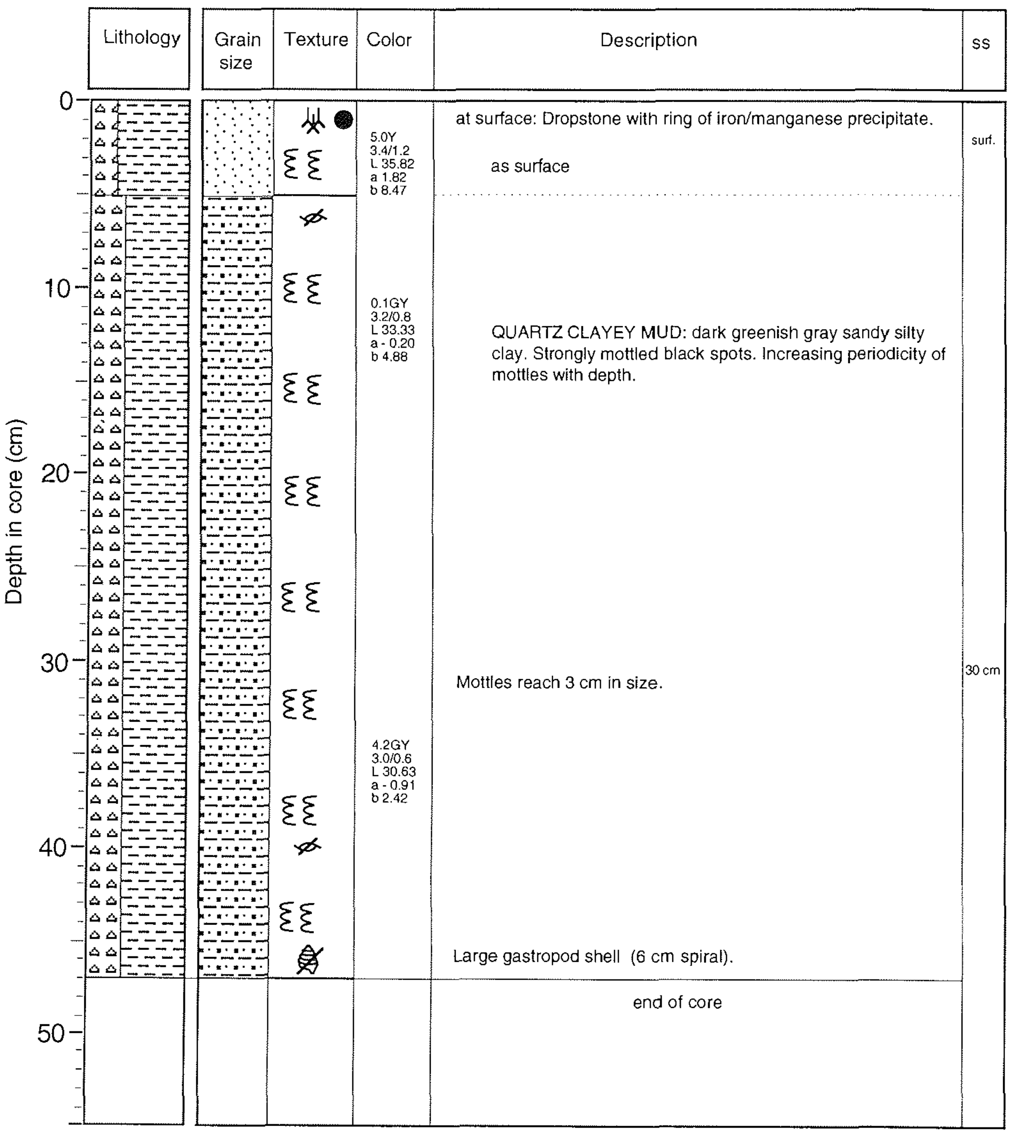
PM9494-5 GKG Loc.: Anabar-Khatanga Valley **TRANSDRIFT II**

Recovery: 0.47 m 74°30.06´N 114°17.05´E Water depth: 37 m

Surface T= - 1.1°C

QUARTZ CLAYEY MUD: very dark gray sandy clayey silt with black iron/manganese precipitates. Uneven surface with pockets. Abundant macroscopic fauna including ophiurideans, gastropodes and bivalves.

Color: 2.4Y 2.4/1.0 ; L 24.78 a 2.62 b 6.59



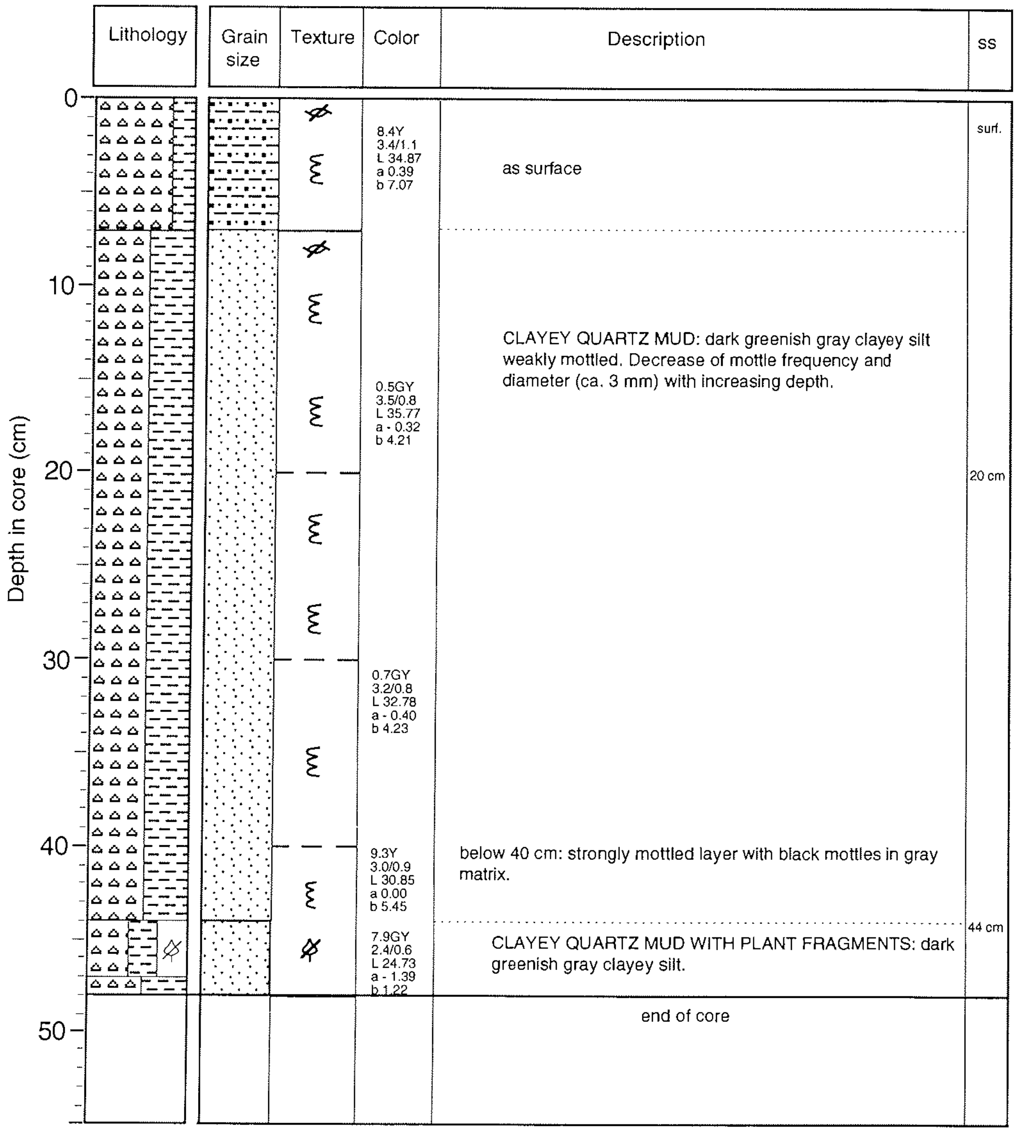
PM9499-1 GKG Loc.: Anabar-Khatanga Valley **TRANSDRIFT II**

Recovery: 0.48 m 75°30.06´N 115°32.70´E Water depth: 48 m

Surface T= - 1.8 °C

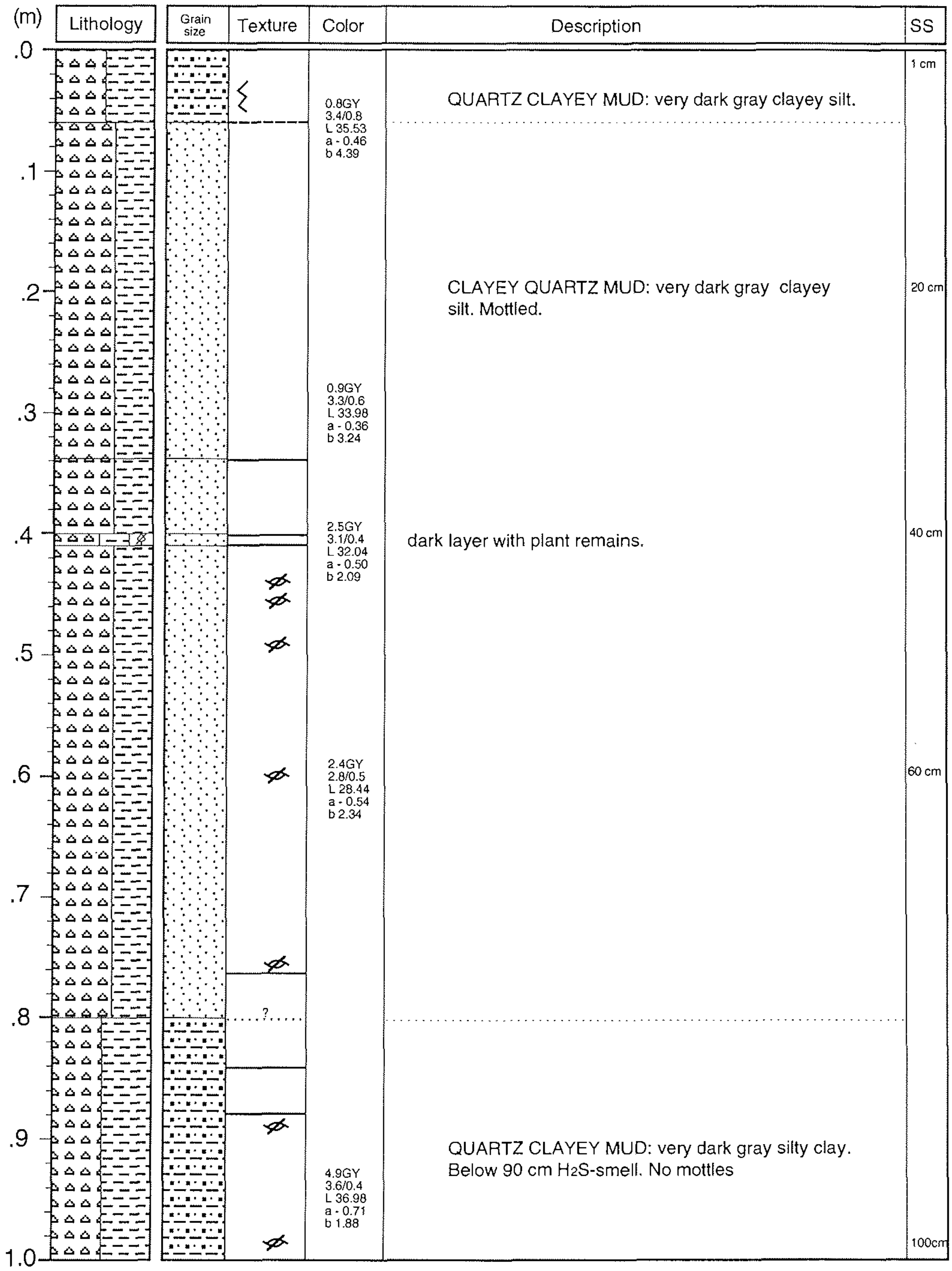
CLAYEY QUARTZ MUD: very dark grayish brown sandy silty clay. Irregular surface. Abundant macroscopic fauna including ophiurideans and sponges.

Color: 2.7Y 2.6/0.9 ; L 26.71 a 2.12 b 5.70



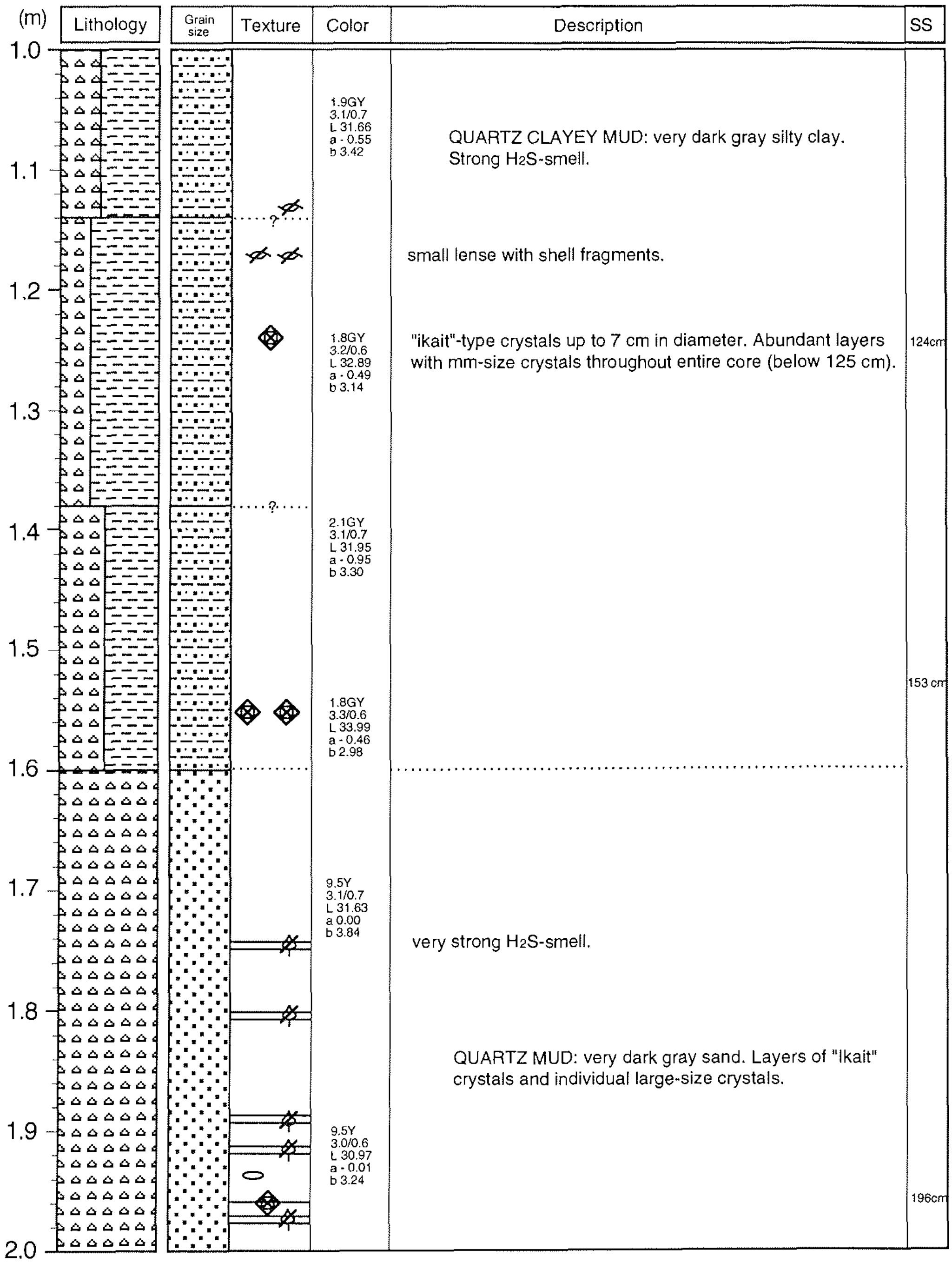
PM9499-2 KAL LOC.: Anabar-Khatanga Valley **TRANSDRIFT II**

Recovery: 2.35 m + 10 cm 75°30.06´ N 115°32.70´ E Water depth: 48 m



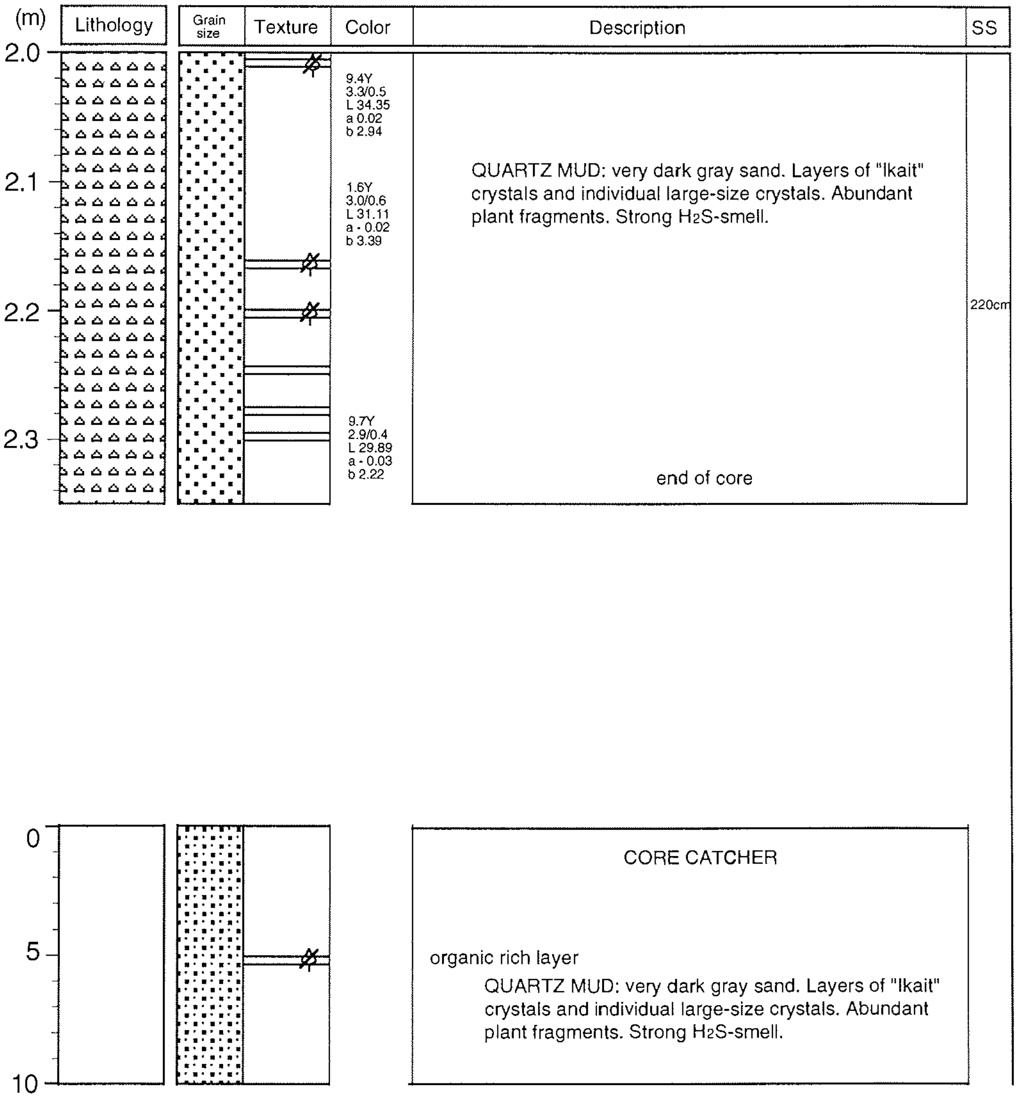
PM9499-2 KAL LOC.: Anabar-Khatanga Valley **TRANSDRIFT II**

Recovery: 2.35 m + 10 cm 75°30.06´ N 115°32.70´ E Water depth: 48 m



PM9499-2 KAL LOC.: Anabar-Khatanga Valley **TRANSDRIFT II**

Recovery: 2.35 m + 10 cm 75°30.06´ N 115°32.70´ E Water depth: 48 m



Symbols used in graphical core descriptions

Lithology

- quartz
- clay
- silt
- sand
- silty clay
- sandy silty clay
- sandy silt
- feldspar

Texture

- sharp boundary
- boundary (2 cm)
- fuzzy boundary (4 cm)
- stratification
- gradational boundary
- lamination
- broken disturbance
- flaser bedding
- cross bedding
- fining upwards
- fining downwards
- soupy disturbance
- erosive surface
- ss smear slide
- lense
- dropstone
- sponge spicules
- "ikaite" crystals
- wormtube
- plant fragments
- shell fragments
- slight bioturbation
- moderate bioturbation
- strong bioturbation

Table A5: Results of smear slide analyses carried out during the TRANSDRIFT II expedition.

		Grain Size (%)			Inorganic Components (%)																		Organic Components (%)						(%)
Sample	Depth (cm)	Sand	Silt	Clay	Quartz	Clay	Chlorite	Opaque	Orthoclase	Plagioclase	Zircon	Amphibole	Biotite	Pyrolusite	Magnetite	Pyroxene	Glauconite	Muscovite	Tourmaline	Micrite	Hydr. CaCO3	Spheres	Bent. Forams	Plankt. Forams	Sponge Spicu.	Diatoms	Plant Debris	Fish Remains	Total Comp.
PM94T1-2-GKG	0	5	30	65	10	85	2	*?		*					*?									*	*	*			97
PM94T1-2-GKG	7	15	45	40	20	70	3	2	*	5															*	*			100
PM94T1-2-GKG	13	65	20	15	80	15	3	2	*	*							*												100
PM94T2-1-GKG		15	30	55	32	65		2	*		*														*				99
PM94T2-1-GKG	5	10	30	60	27	72		1			*														*	*	*		100
PM94T2-1-GKG	19	20	40	40	49	49	*	1		*	*	*												*	*				99
PM94T2-1-GKG	40	20	40	40	45	53		1		1	*														*				100
PM94T2-2-KAL	12	25	25	50	40	50	5	*	*	2						*	*							*	*	1			98
PM94T2-2-KAL	28	35	30	35	45	50	*	3	*	*							*												98
PM94T2-2-KAL	118	0	10	90	20	65	4	10	*	*														*	*				99
PM94T2-2-KAL	235	10	70	20	60	30	10	*	*	*	*													*					100
PM94T2-2-KAL	444	10	60	30	70	20	10	*		*	*				*										*	*			100
PM94T3-2-GKG	0	5	10	85	20	75		5		*			*											*	*	*			100
PM94T3-2-GKG	7	5	10	85	27	70		2	*		*		*													1			100
PM94T3-2-GKG	14	0	10	90	40	57	1	1					*												*				99
PM94T3-2-GKG	34	0	20	80	32	65	*	3			*		*												*				100
PM9402-3-GKG		5	65	30	55	40	*	*	*		*														*	*			95
PM9402-3-GKG	9	2	80	18	66	33	*	*		*	*														*	*			99
PM9402-3-GKG	25	5	60	35	60	40		*		*	*		*											*		*			100
PM9402-3-GKG	39	0	60	40	70	30	*	1			*		*												*	*			101
PM9417-4-GKG	0	12	8	80	30	70	*		*	*			*											*					100
PM9417-4-GKG	17	20	40	40	60	40		*	*	*	*	*													*				100
PM9417-4-GKG	36	0	60	40	70	20	*	*	10	*	*		*									1			*	1			102
PM9417-6-KAL	10	5	10	85	30	50	12	8		*														*	*				100
PM9417-6-KAL	60	5	75	20	60	20	10	10	*	*	*	*	*			*									*				100
PM9417-6-KAL	95	10	75	15	60	15	8	8	2	*		3				*									*				96
PM9417-6-KAL	127	10	70	20	77	15	4	3	*	*															*	*			99
PM9441-4-GKG	0	85	10	5	55	5		*	30		2	5														*			97

Table A5: Results of smear slide analyses carried out during the TRANSDRIFT II expedition.

		Grain Size (%)			Inorganic Components (%)																		Organic Components (%)						(%)
Sample	Depth (cm)	Sand	Silt	Clay	Quartz	Clay	Chlorite	Opaque	Orthoclase	Plagioclase	Zircon	Amphibole	Biotite	Pyrolusite	Magnetite	Pyroxene	Glauconite	Muscovite	Tourmaline	Micrite	Hydr. CaCO3	Spheres	Bent. Forams	Plankt. Forams	Sponge Spicu.	Diatoms	Plant Debris	Fish Remains	Total Comp.
PM9441-4-GKG	0	80	15	5	80	5		2	10	*	1							*								*			98
PM9441-4-GKG	8	75	10	15	75	15	4	*	6	*	*	*				*?										*			100
PM9442-3-GKG	0	2	18	80	23	70	1	1	4																*	*			99
PM9442-3-GKG	10	5	20	75	20	80	*	*	*	*	*												*		*				100
PM9442-3-GKG	38	30	20	50	50	45	5	*		*	*														*	*			100
PM9451-7-GKG	0	90	5	5	85		3		7	*	*	5		*															100
PM9451-7-GKG	7	90	5	5	85		1	8	1	*		*																	95
PM9451-7-GKG	12	90	5	5	85		4	4	4		*																		97
PM9457-5-VC	0	95	4	1	90		5	1	3	*																			99
PM9457-5-VC	40	90	10	0	85		7	1	2	3	*								*										98
PM9457-5-VC	69	60	30	10	90		3	1	3	1	*		*													*	*		98
PM9457-5-VC	80	90	10	0	90		5	2	1	1	*						*								*				99
PM9462-1-GKG	0	0	40	60	35	60	*	3			*														*	*			98
PM9462-1-GKG	40	5	40	55	40	55	3	*		2	*																		100
PM9462-4-VC	50	5	30	65	50	45	3	1	1	*															*				100
PM9462-4-VC	150	5	40	55	55	40	2	*		*	*															*			97
PM9462-4-VC	250	5	60	35	60	35	*	1		1	*															*			97
PM9462-4-VC	350	5	65	30	65	30	2	2		*	*																		99
PM9462-4-VC	420	5	55	40	60	37	1	1	*	*															*	*			99
PM9462-4-VC	450	30	60	10	75	20	1	1	1	1															*				99
PM9463-4-VC	13,5	0	30	70	20	68	2	8			*														*	*			98
PM9463-4-VC	48	0	20	80	20	80	*	*			*														*				100
PM9463-4-VC	62	0	10	90	20	80	*	*		*	*														*	1			101
PM9463-4-VC	110	0	30	70	25	75	*	*		*																			100
PM9463-4-VC	150	5	20	75	25	73		2																	*	*			100
PM9463-4-VC	170	55	40	5	80	5	*	2	10					*											*	*			97
PM9463-4-VC	178	90	10	0	85		*	2	10	*																			97
PM9463-4-VC	200	90	10	0	90		*	2	6	2	*																		100

Table A5: Results of smear slide analyses carried out during the TRANSDRIFT II expedition.

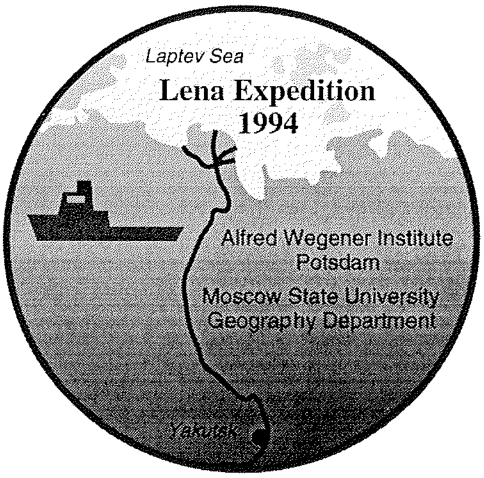
		Grain Size (%)			Inorganic Components (%)																		Organic Components (%)						(%)
Sample	Depth (cm)	Sand	Silt	Clay	Quartz	Clay	Chlorite	Opaque	Orthoclase	Plagioclase	Zircon	Amphibole	Biotite	Pyrolusite	Magnetite	Pyroxene	Glauconite	Muscovite	Tourmaline	Micrite	Hydr. CaCO3	Spheres	Bent. Forams	Plankt. Forams	Sponge Spicu.	Diatoms	Plant Debris	Fish Remains	Total Comp.
PM9463-8-GKG	0	0	30	70	12	85	*	2		*															*	*			99
PM9463-8-GKG	17	10	30	60	30	67	*	1	1	*				*									*		*	*			99
PM9463-8-GKG	35	5	40	55	30	69	*	1			*							*							*				100
PM9475-3-GKG	0	5	20	75	34	63	*	2	*																*	*			99
PM9475-3-GKG	10	5	20	75	30	68	1	1		*															*				100
PM9475-3-GKG	20	5	45	50	43	54	1	1																	*	*			99
PM9475-3-GKG	29	40	50	10	87	5	1	3	*	1	1											1		*	*		1		100
PM9481-2-GKG	0	75	20	5	86	2	4	4	1	*	3														**				100
PM9481-2-GKG	7	30	60	10	88	3	4	3	1	*	*						*									*			99
PM9481-2-GKG	10	30	50	20	77	16	1	1	1	*	2																		98
PM9481-2-GKG	20	30	50	20	88	8	*	*	*	*	*														*				96
PM9481-2-GKG	28	5	35	60	40	56	*	3																	*	*			99
PM9482-1-GKG	0	0	25	75	26	73	*	1	*																*	*		*	100
PM9482-1-GKG	40	0	30	70	18	81	*	1																	*	*			100
PM9482-2-VC	5	0	35	65	25	69	1	5			*														*	*			100
PM9482-2-VC	50	5	45	50	28	68	1	2			*														*	*			99
PM9482-2-VC	110	10	45	45	34	63	1	2		*	*		*												*	*	*		100
PM9482-2-VC	165	2	30	68	24	73	*	2	*		*														**	**			99
PM9482-2-VC	190	10	50	40	45	54	*	1			*														*	*			100
PM9482-2-VC	250	5	55	40	30	69	*	1																	*	*			100
PM9482-2-VC	310	5	50	45	56	42	1	*	*		*														*	*			99
PM9482-2-VC	340	10	70	20	70	27	*	1			*															1			99
PM9492-3-GKG	0	65	30	5	85	10	2	2	*	*	*	*					*								*	*			99
PM9492-3-GKG	23	60	35	5	85	10	1	*	*	*	1														*				97
PM9492-4-VC	15	50	40	10	88	7	1	1	*	*	1					*									*				98
PM9492-4-VC	60	65	20	15	95	4	1	*	*	*	*		*																100
PM9492-4-VC	150	50	40	10	78	18	1	2	*	1	*																		100
PM9492-4-VC	210	10	80	10	90	8	*	2	*	*	*		*																100

Table A5: Results of smear slide analyses carried out during the TRANSDRIFT II expedition.

		Grain Size (%)			Inorganic Components (%)																		Organic Components (%)						(%)
Sample	Depth (cm)	Sand	Silt	Clay	Quartz	Clay	Chlorite	Opaque	Orthoclase	Plagioclase	Zircon	Amphibole	Biotite	Pyrolusite	Magnetite	Pyroxene	Glauconite	Muscovite	Tourmaline	Micrite	Hydr. CaCO3	Spheres	Bent. Forams	Plankt. Forams	Sponge Spicu.	Diatoms	Plant Debris	Fish Remains	Total Comp.
PM9492-4-VC	220	55	40	5	88	3	1	1	1	1	1	1												*		*	*		97
PM9492-4-VC	227	20	60	20	87	7	1	1			*														*				96
PM9492-4-VC	280	75	20	5	87	2	2	2	1		*			1											*		1		96
PM9494-4-VC	0	33	33	33	49	48	*	2	1		*														*	*			100
PM9494-4-VC	20	5	35	60	37	60	2	1	*	*															*				100
PM9494-4-VC	54	30	30	40	33	65	1	1	1	*	*																*		101
PM9494-4-VC	69	5	75	20	67	8	1	4	*	*	*	*															20		100
PM9494-4-VC	80	5	85	10	70	9	3	2	*	2	*															*	12		98
PM9494-4-VC	124	30	60	10	80	8	*	2	*	1										5	*					*	4		100
PM9494-4-VC	150	20	50	30	50	13	2	4	*	*										8	*				*		21		98
PM9494-4-VC	250	30	60	10	66	6	2	5	*	1	*										*						20		100
PM9494-4-VC	314	10	65	25	58	16	1	5		*											*					*	20		100
PM9494-5-GKG	0	15	65	20	25	72	*	1			*														*	*	*		98
PM9494-5-GKG	30	15	25	60	36	62	1	1	*	*	*														*				100
PM9499-1-GKG	0	20	40	40	76	22	1	*		*		*		*											*	*			99
PM9499-1-GKG	20	10	50	40	63	35	*	1	*	1	*														*	*			100
PM9499-1-GKG	44	5	60	35	40	25	*	*		*										13			1			*	20		99
PM9499-2-KAL	0	20	40	40	44	55	*	*		*															**	*			99
PM9499-2-KAL	20	10	60	30	63	35		1		*															*	*			99
PM9499-2-KAL	40	5	55	40	45	32	1	2																	*		19		99
PM9499-2-KAL	60	5	75	20	60	30	1	1																			8		100
PM9499-2-KAL	100	5	40	55	40	49	*	7	*	*					*?										*	*	2		98
PM9499-2-KAL	124	0	40	60	30	45	2	5												15	*								97
PM9499-2-KAL	153	5	40	45	42	53	1	4	*												*						*		100
PM9499-2-KAL	196	85	10	5	82	3	4	7	*		*						*?				*						3		99
PM9499-2-KAL	220	75	20	5	75	4	3	5	*	1	*										*						11		99

EXPEDITION TO THE LENA RIVER

JULY/AUGUST 1994



CRUISE REPORT

BY

VOLKER RACHOLD, JÖRG HERMEL, AND VLADISLAV KOROTAEV

Expedition to the Lena River July/August 1994

EXPEDITION TO THE LENA RIVER JULY/AUGUST 1994

V. Rachold, J. Hermel, and V. N. Korotaev

1. Introduction

The Eurasian shelves especially the Laptev Sea are the main source areas for Arctic sea ice and the Transpolar Drift thus exerting an important influence on global ocean circulation and climate. The Laptev Sea in particular is of special interest because large quantities of fresh water and of suspended material are supplied by the east Siberian rivers. The sediment material is partially incorporated into sea ice, transported via the Transpolar Drift, and contributes to marine sediments in the Central Arctic Ocean (KASSENS *et al.* 1994) (Fig. 1).

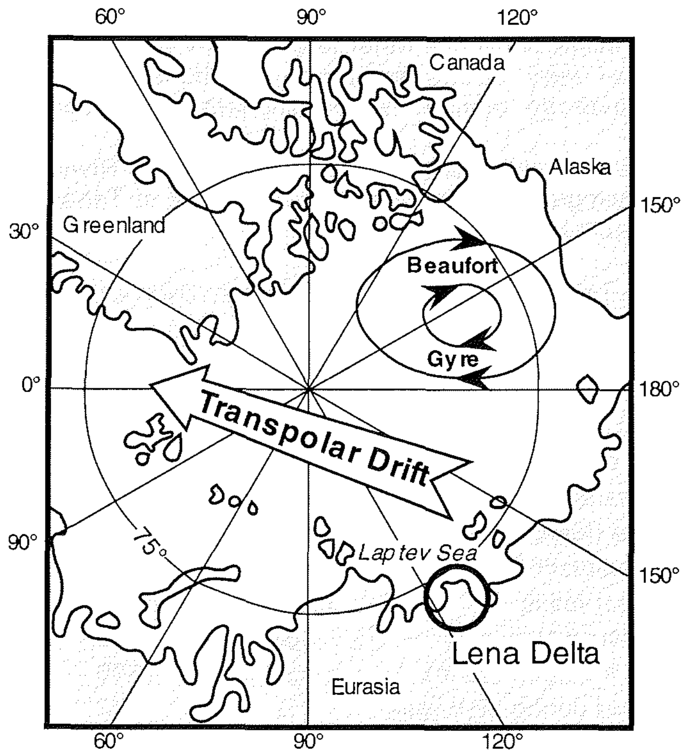


Fig. 1: Ice drift in the Arctic Ocean (after GORDIENKO & LAKTIONOV 1969).

Within the scope of the BMBF project "System Laptev Sea" river sediments and suspended material of the most important east Siberian rivers are analysed by mineralogical and geochemical methods. The aims are to qualify and to quantify the material flow to Laptev Sea and to find characteristic signals (chemical or mineralogical tracers) for each river. Parallel investigations of Laptev Sea sediments carried out by Geomar (Kiel) and Alfred Wegener Institute (Bremerhaven) will enable the identification of material supplied by different rivers in the

marine environment.
The first expedition to the Lena River organised by the Geographical Faculty of the Moscow State University in cooperation with the Alfred Wegener Institute, Research Department Potsdam took place from July 5 to August 3. Logistics and most of the sampling equipment was provided by Moscow State University. 2 participants from AWI Potsdam and 1 from Moscow State University joined the expedition on the small river research vessel "Professor Makkaveev" from Yakutsk to the Lena Delta and back to Yakutsk. Samples of sediment, water and suspended material were obtained along the 1600 km distance from Yakutsk to Cape Bykovsky in the Lena Delta (Fig. 2).

2. Background Information

In terms of water discharge the Lena River is the eighth largest river in the world and after the Yenisei the second largest among the Arctic rivers. It accounts for 70 % of the overall inflow of riverine water to the Laptev Sea (GORDEEV & SIDOROV 1993). Because of very strong seasonal variations in temperatures and precipitation the average monthly water discharge, however, exhibits large variations.
Table 1 presents some typical characteristics of the Lena River. The data were recorded by the Leningrad Hydrometeorological Service in Tabaga near Yakutsk, in Kyusyur and at Stolb Island (see fig. 2).

Table 1: Characteristics of the Lena River (LENINGRAD HYDROMETEOROLOGICAL SERVICE 1987).

		Tabaga	Kyusyur	Stolb
water mass	*mio cbm/a*	224000	520000	456000
medium discharge	*cbm/s*	7090	16500	15100
max. discharge (June)	*cbm/s*	35900	96600	
min. discharge (March, April)	*cbm/s*	606	4429	
medium sediment load	*mg/l*	36	40	29
sediment mass	*1000 t/a*	8000	21000	14000
medium sediment transport	*kg/s*	250	680	440
max. sediment transport (June)	*kg/s*	3600	9300	
sediment transported during high water	*%*	72	82.5	92.3
max. ice thickness	*cm*	213	246	214

The Lena River supplies large quantities of sediment to the Laptev Sea with more than 70 % of the material transported during high water in May., June and July (Table 1). The water originates from a large drainage basin of 2.49 • 10^6 km^2 consisting of three major tectonic structures: the Siberian platform, and the Baikal and the Upper Lena folded regions (GORDEEV & SIDOROV 1993).
From Yakutsk to Zhigansk the Lena River, forming wide and developed floodplains with complicated divided and shifting channels, has a width of approximately 20-30 km. Recent bottom sediments only consist of sand.
In the so called Lena pipe north of Kyusyur the river narrows down to less than

2 km, flowing relatively straight forward and cutting through rocks of the Charaulach Range. The bottom in this area is covered solely by pebbles (CHALOV *et al.* 1976 and 1989).

In the delta area the Lena River is forming a huge deltaic protruding cone. The Lena Delta consists of 6089 deltaic arms forming a complicated and shifting river network (KOROTAEV 1984, 1986, and 1992).

Although trace metal data of the Lena River suggest nonpolluted water (MARTIN *et al.* 1993) first results of anthropo-chemical pollutant studies in the Laptev Sea show high concentrations of PCB, HCH, DDT group, and PHC (DETHLEFF *et al.* 1993). These pollutants are probably supplied by the Lena River.

3. Research Program

Sampling of surface sediments, water, and suspended material was performed along the Lena River from Yakutsk to Cape Bykovsky at 24 stations (see Appendix 1 & 2).

Sediments will be analysed on mineralogy, grain size patterns, major and minor element geochemistry and on isotopic composition ($\delta^{13}C$ and $\delta^{15}N$) of the organic fraction. Main research objectives are the chemical composition of separated mineral phases and the distribution of heavy minerals.

For quantification of sediment transport suspended material was obtained by vacuum filtration. Amount and composition of suspended material furnish information about the mass flow of specific chemical elements.

In addition water samples (water and filtered water) were taken for the analysis of $\delta^{18}O$ and δD values and dissolved nutrients.

4. Course of Expedition

The expedition started on July 5 on a swimming base of the Moscow State University near Yakutsk. After one week of preparation and repairing the "Professor Makkaveev" the ship went northward pulling the base. During this transport sampling was carried out from a small motor boat.

Having arrived in the working area of the Moscow State University near Sangar vessel and base separated on July 17 and the "Professor Makkaveev" went on heading to the Lena Delta.

On July 18 and 19 the vessel had to stop in the shelter of Zhigansk harbour because of storm and high waves. Despite some problems with the diesel engine, very strong winds, and fog in the delta the expedition could be continued and Cape Bykovsky was reached on July 24. During the cruise samples were taken in approximately 100 km intervals and in the three main channels of the Lena Delta (Bykovskaya Channel, Trofimovskaya Channel, and Olenyokskaya Channel). Furthermore 2 cross sections near Stolb Island and Kyusyur were sampled (see Fig. 2 and Appendix 2).

The way back started on July 26 and the expedition ended on August 3 in Yakutsk.

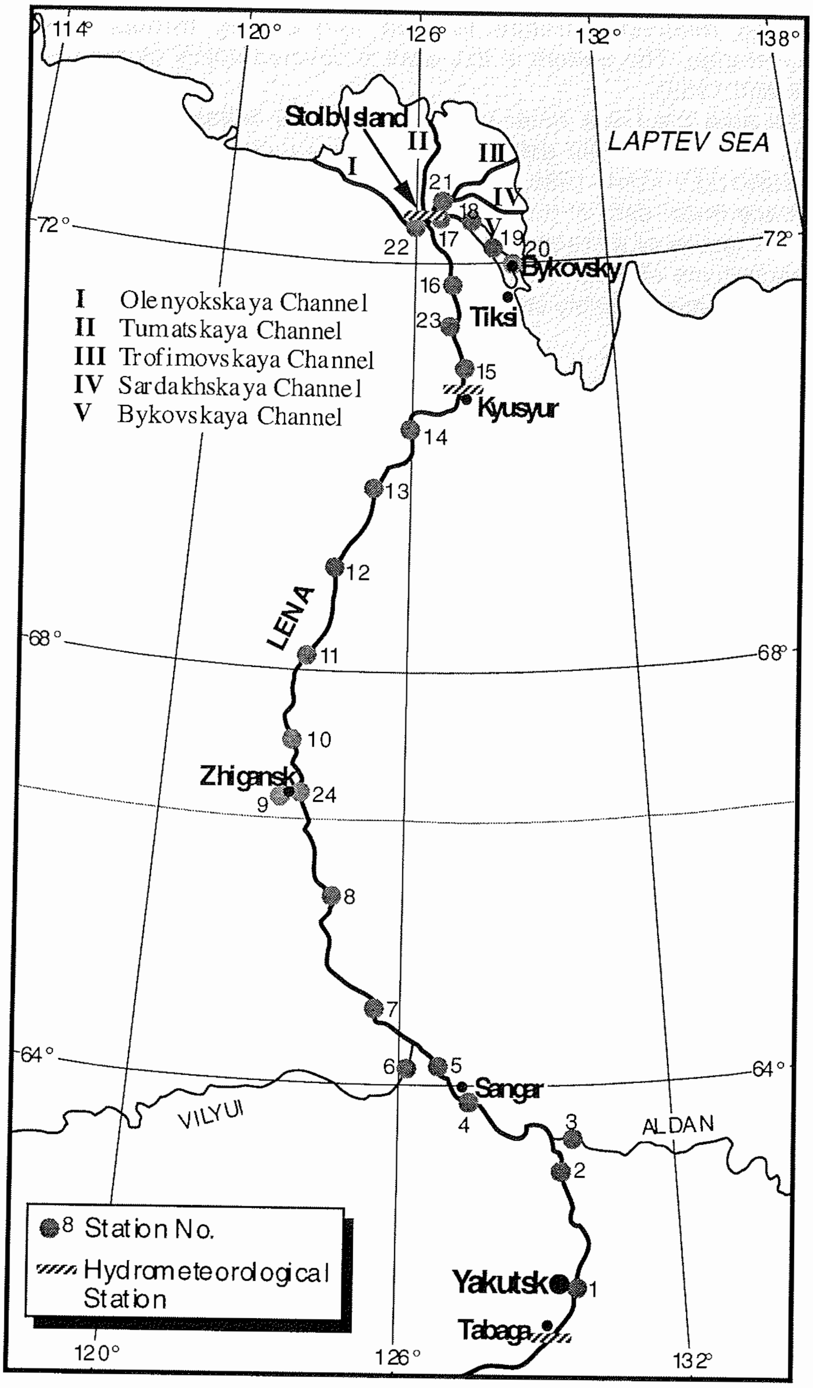


Fig. 2: Location map.

5. Sampling and Methods

Because of the very short preparation time of 4 weeks the complete sampling equipment had to be transported by aeroplane in the personal luggage. Therefore the material was reduced to a minimum and sampling instruments onboard the RV "Professor Makkaveev" were applied.

5.1. Sediment samples

A box corer for sampling surface sediments and a piston corer for 25 cm long cores were available onboard the ship. However, both instruments had been constructed for lake sediment sampling and did not work satisfactorily in the strong current of the Lena River. For this reason disturbed surface sediments were obtained by a simple pail yielding very good results for the mostly sandy sediments.
Approximately 50 sediment samples of 24 stations were retrieved. Among these have been 2 river cross sections and 2 sediment profiles on small islands (see Appendix 2).

5.2. Water samples

River water was sampled at 20 stations. For this purpose a 1 l bottle placed inside of a 50 kg weight was applied. The device has been run by a small manual operating winch system. Because of its small size and weight the instrument including winch could even be installed on a fast motor boat.
The construction of the water bottle enabled a continuous inflow of water, so that integrated samples from the surface to the bottom could be gained (see Fig. 3).

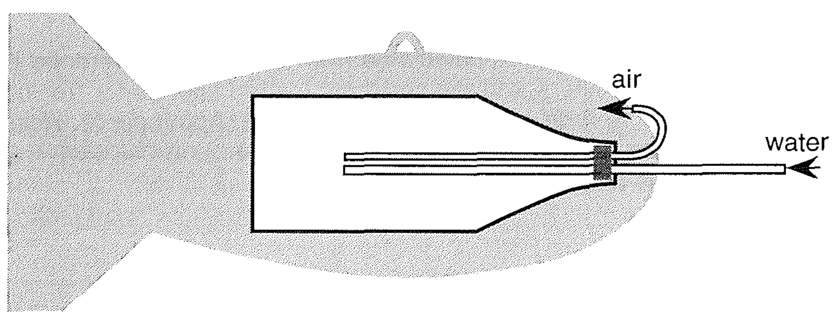


Fig. 3: Bottle for water sampling obtainable onboard RV "Professor Makkaveev".

100 ml of the water were conserved for oxygen and hydrogen isotope studies, the remainder was used for filtration of suspended material.
Additionally surface water samples for the analysis of dissolved nutrients were retrieved.

5.3. Suspended material

A German instrument for filtration operating by a small vacuum pump was applied for sampling suspended sediment load. Especially for this purpose 220 V power supply was installed onboard the RV "Professor Makkaveev".

Cellulose acetate filters (47 mm diameter, 0.45 µm pore size) and glass fibre filters (47 mm diameter, 0.7 µm pore size), that will be analysed on inorganic and organic geochemistry, respectively, were utilised. The filtered volume varied between 500 and 1500 ml depending on sediment load.

6. Preliminary Results

6.1. Bottom sediments

In general, the sediments do not exhibit large variations macroscopically. Except for some samples from the Lena pipe that contain gravel the sediments are dominated by sand. At two stations in the Lena pipe (station 12 and 13) sediment sampling was impossible since the bottom in this area probably consists of stones or maybe even rock.
Differences between Lena sediments and one sample retrieved from the Aldan River (station 3) are observable with the naked eye: Aldan sediments are more fine grained and carry a larger fraction of dark minerals. However, the sediments of the Aldan and the Vilyui do not have a strong influence on the size of the river alluvium and the mineral composition of the bottom sediments, except for the mouth areas of these rivers. The mineral spectrum of the Lena alluvium mainly contains an amphibole-pyroxene assemblage, while the Vilyui alluvium consists of siliceous and basaltic pebbles.
From the upper region to the mouth of the Lena River bottom sediments are dominated by Cretaceous sandstone and limestone from the Verkhoyansk region.

6.2. Sediment load

The suspended sediment load was calculated from the weight difference between the pure cellulose acetate filters and the sediment loaded filters after freeze drying. The data vary between 10 mg/l and more than 100 mg/l (Appendix 3). However, in accordance with the data of the LENINGRAD HYDROMETEOROLOGICAL SERVICE (1987), presented in table 1, the average value is 42 mg/l.

7. Acknowledgements

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9. Appendix

Appendix 1: List of stations.

no.	date	time (GMT)	latitude	longitude
1	09:07:1994	09:00	62°01´ N	129°49´ E
2	13:07:1994	21:30	63°13´ N	129°38´ E
3	13:07:1994	22:15	63°25´ N	129°40´ E
4	14:07:1994	11:30	63°55´ N	127°23´ E
5	15:07:1994	12:30	64°09´ N	126°55´ E
6	16:07:1994	03:00	64°15´ N	126°24´ E
7	16:07:1994	23:00	64°47´ N	125°24´ E
8	17:07:1994	06:30	65°42´ N	124°18´ E
9	18:07:1994	02:00	66°45´ N	123°19´ E
10	20:07:1994	04:00	67°14´ N	123°12´ E
11	20:07:1994	08:30	68°09´ N	123°47´ E
12	20:07:1994	12:30	68°51´ N	124°00´ E
13	21:07:1994	04:00	69°45´ N	125°03´ E
14	21:07:1994	09:00	70°20´ N	125°55´ E
15	22:07:1994	02:00	70°52´ N	127°28´ E
16	22:07:1994	05:15	71°45´ N	127°13´ E
17	23:07:1994	00:00	72°23´ N	126°53´ E
18	23:07:1994	02:00	72°16´ N	127°52´ E
19	23:07:1994	05:00	72°03´ N	128°44´ E
20	24:07:1994	02:00	72°01´ N	129°08´ E
21	25:07:1994	07:00	72°26´ N	126°43´ E
22	25:07:1994	07:30	72°21´ N	126°32´ E
23	26:07:1994	14:00	71°36´ N	126°43´ E
24	28:07:1994	08:00	66°44´ N	123°25´ E

Appendix 2: List of samples.

no. of station	sample	comment
1	suspended material	water depth: 9 m, samples from 8, 6, 4, 2 m, and surface
	sediment	surface sediment
	filtered water	surface
	water	surface
2	suspended material	water depth: 6.5 m, integrated samples
	sediment	surface sediment
	filtered water	integrated
	water	integrated
3	suspended material	water depth: 7.5 m, integrated samples
	sediment	surface sediment
	filtered water	integrated
	water	integrated
4	suspended material	water depth: 10 m, integrated samples
	sediment	surface sediment
	filtered water	integrated
	water	integrated
5	sediment profile	section on island
6	suspended material	water depth: 4-9 m (drift of boat), integrated samples
	sediment	surface sediment
	filtered water	integrated
	water	integrated
7	suspended material	water depth: 7-9 m (drift of boat), integrated samples
	sediment	surface sediment
	filtered water	integrated
	water	integrated
8	suspended material	water depth: 8-10 m (drift of boat), integrated samples
	sediment	surface sediment
	filtered water	integrated
	water	integrated
9	sediment	sand bank in small river near Zhigansk
	coal	section in Zhigansk
10	suspended material	water depth: 9 m, integrated samples
	sediment	surface sediment
	filtered water	integrated
	water	integrated
11	suspended material	water depth: 11 m, integrated samples
	sediment	surface sediment
	filtered water	integrated
	water	integrated
12	suspended material	water depth: 15 m, integrated samples
	sediment	no bottom sediment (stones), beach sand
	filtered water	integrated
	water	integrated
13	suspended material	water depth: 12 m, integrated samples
		no bottom sediment (stones)
	filtered water	integrated
	water	integrated

Appendix 2: List of samples (continued)

no. of station	sample	comment
14	suspended material sediment filtered water water	water depth: 13 m, integrated samples surface sediment integrated integrated
15	suspended material sediment filtered water water	cross section: water depth: 9 - 17 m, integrated samples cross section: surface sediment integrated integrated
16	suspended material sediment filtered water water	water depth: 10-12 m (drift of boat), integrated samples surface sediment integrated integrated
17	suspended material sediment filtered water water	cross section: water depth: 7-10.5 m, integrated samples cross section: surface sediment integrated integrated
18	suspended material sediment filtered water water	water depth: 5 m, integrated samples surface sediment integrated integrated
19	sediment	beach sand, 20 cm depth
20	suspended material sediment filtered water water	water depth: 24 m, integrated samples down to 17 m surface sediment integrated integrated
21	suspended material sediment filtered water water	water depth: 15 m, integrated samples surface sediment integrated integrated
22	suspended material sediment filtered water water	water depth: 10.5 m, integrated samples surface sediment integrated integrated
23	sediment profile	section on island
24	sediment	water depth 5 m

Appendix 3: Sediment load.

no. of station	load (mg/l)	sample depth (m)	water depth (m)	comment
1	17.0		9	aver. of 5 samples
2	12.6	integrated	6.5	
3	31.9	integrated	7.5	
4	26.7	integrated	10	
6	28.9	integrated	4 to 9 (drift of boat)	
7	74.4	integrated	7 to 9 (drift of boat)	
8	62.6	integrated	8 to 10 (drift of boat)	
10	67.4	integrated	9	
11	77.4	integrated	10	
12	54.8	integrated	15	
13	30.1	integrated	12	
14	162.4	integrated	13	
15	23.7	integrated	9.5	river cross section
15	30.6	integrated	9.5	river cross section
15	37.5	integrated	15 to 17 (drift of boat)	river cross section
15	66.1	integrated	9	river cross section
15	100.3	integrated	9	river cross section
16	17.4	integrated	10 to 12 (drift of boat)	river cross section
17	10.7	integrated	7	river cross section
17	15.7	integrated	10.5	river cross section
17	14.2	integrated	9	river cross section
18	10.9	integrated	5	
20	8.7	integrated	24	
21	33.8	integrated	15	
22	37.2	integrated	10.5	