EXPEDITION TO THE LENA RIVER
JULY/AUGUST 1994

CRUISE REPORT

BY

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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).

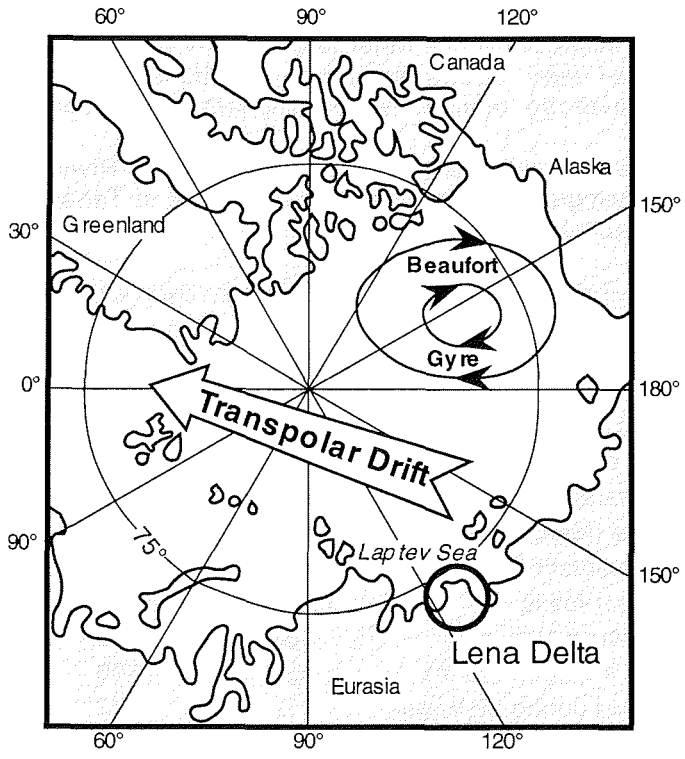

Fig. 1: Ice drift in the Arctic Ocean (after GORDIENKO & LAKTIONOV 1969).

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 $2.49 \cdot 10^6$ 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.

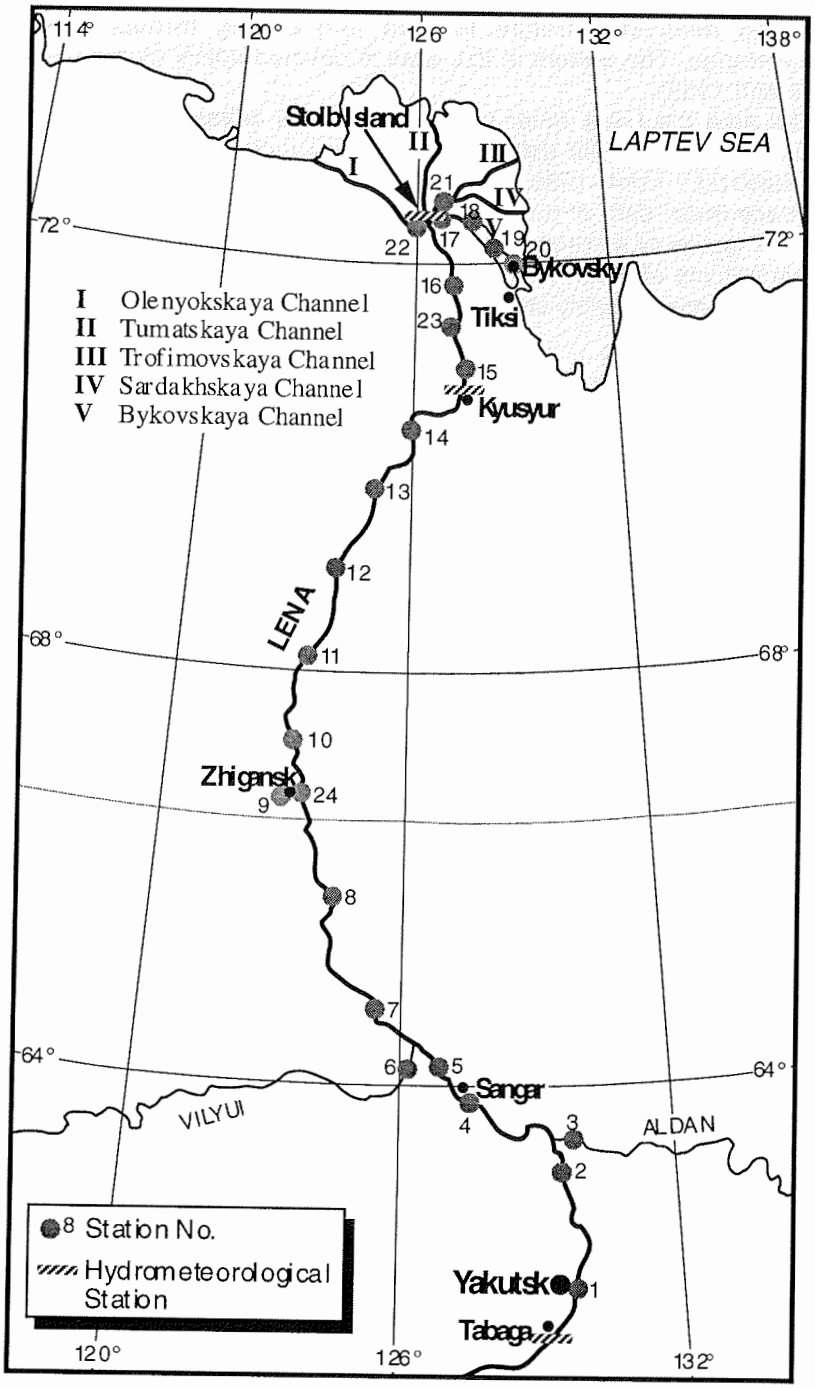

Fig. 2: Location map.

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).

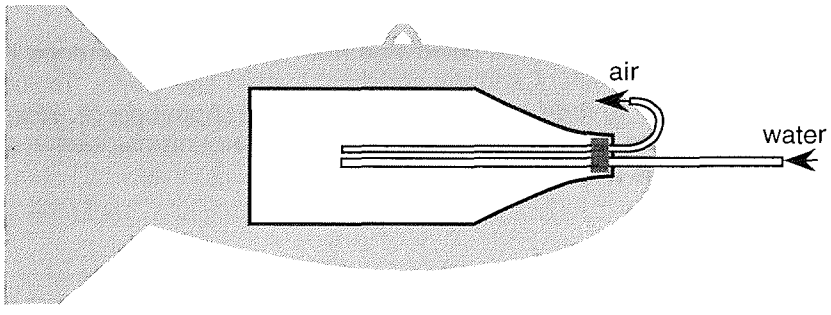

Fig. 3: Bottle for water sampling obtainable onboard RV "Professor Makkaveev".

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	water depth: 13 m, integrated samples
	sediment	surface sediment
	filtered water	integrated
	water	integrated
15	suspended material	cross section: water depth: 9 - 17 m, integrated samples
	sediment	cross section: surface sediment
	filtered water	integrated
	water	integrated
16	suspended material	water depth: 10-12 m (drift of boat), integrated samples
	sediment	surface sediment
	filtered water	integrated
	water	integrated
17	suspended material	cross section: water depth: 7-10.5 m, integrated samples
	sediment	cross section: surface sediment
	filtered water	integrated
	water	integrated
18	suspended material	water depth: 5 m, integrated samples
	sediment	surface sediment
	filtered water	integrated
	water	integrated
19	sediment	beach sand, 20 cm depth
20	suspended material	water depth: 24 m, integrated samples down to 17 m
	sediment	surface sediment
	filtered water	integrated
	water	integrated
21	suspended material	water depth: 15 m, integrated samples
	sediment	surface sediment
	filtered water	integrated
	water	integrated
22	suspended material	water depth: 10.5 m, integrated samples
	sediment	surface sediment
	filtered water	integrated
	water	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	