EXPEDITION TO THE LENA AND YANA RIVERS
June-September 1995

by V. Rachold, E. Hoops, A.M. Alabyan, V.N. Korotaev and A.A. Zaitsev

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1. INTRODUCTION

Distribution, thickness and drift patterns of Arctic sea ice cover control the gas and heat exchange between atmosphere and ocean thus affecting ocean circulation and the global climate system (Aagaard et al., 1985; Clark, 1990). Today the major part of sea ice is formed in the broad Eurasian shelves, especially in the Laptev Sea that is the source area for the Transpolar Drift (Nürnberg et al., 1994; Wollenburg, 1993; Dethleff et al., 1993; Kassens & Karpiy, 1994) (Fig. 1). The Laptev Sea is strongly influenced by freshwater and sediment supply of the Siberian rivers mainly the Lena river. Sediments transported by those rivers are partly incorporated into sea ice entering the Transpolar Drift (Reimnitz et al., 1994 and 1995; Stein & Korolev, 1994). For this reason material derived from the Siberian continent contributes to the sedimentation in the Arctic ocean and the north Atlantic.

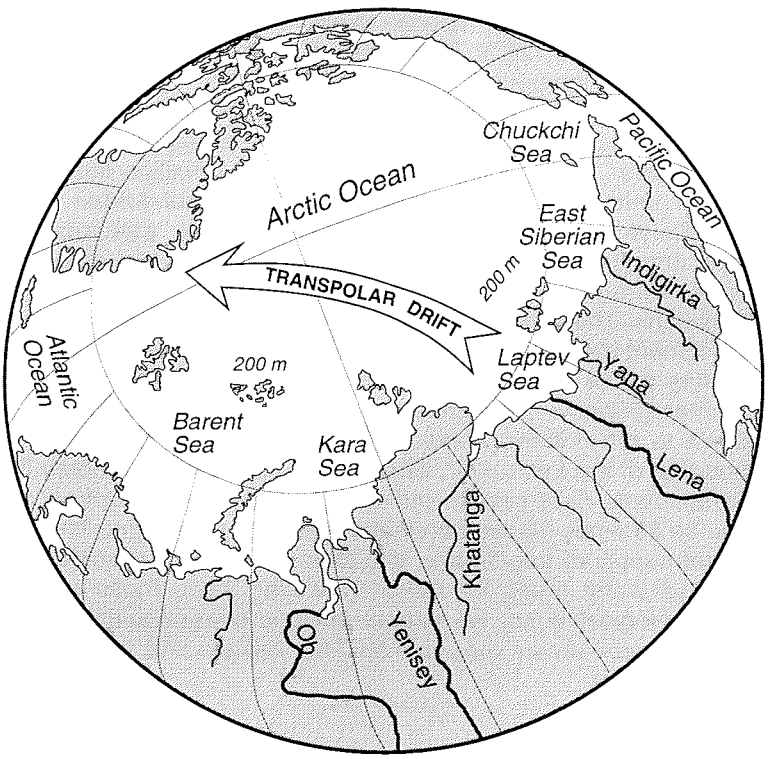

Fig. 1: Map of the Arctic Ocean showing the Transpolar Drift.

Within the framework of the Russian-German project "The Laptev Sea System", that is funded by the German ministry of education and research and the Russian ministry of research and technology, our group concentrates on the sediment transport of east Siberian rivers. The scientific goals of the investigations are

- to qualify and
- to quantify the recent and ancient material supply from the continent,
- to distinguish material transported by different rivers and
- to find characteristic signatures that allow the identification of this material in the marine sediments of the Laptev Sea shelf and the Arctic Ocean.

The Expedition to the Lena, Yana, Omoloy and Olenyok rivers organised by the Geographical Faculty of the Moscow State University in cooperation with the Alfred Wegener Institute, Research Department Potsdam, was carried from June 26 to September 7. It was the second expedition to the Siberian rivers; the first expedition took place in 1994 (Rachold et al., 1995).

2. BACKGROUND INFORMATION

In total the water supply of Siberian rivers to the Laptev Sea accounts for more than 700 km^3 per year. 27 million tons of suspended sediment per year are transported mainly by the Lena river (Fig. 2).

In terms of water discharge the Lena river (520 km^3 per year) is the eighth largest river in the world and the second largest of the Arctic rivers after the Yenisey (Milliman & Meade, 1983). The drainage area of 2.5 million km^2 is composed of three tectonic units: the Siberian platform, the Baikal folded region and the Verkhoyano-Kolymean folded region. Due to strong seasonal variations in temperature and precipitation (up to 100° C temperature difference between summer and winter) monthly water discharge and sediment transport exhibit extreme variations. The average concentration of suspended material is 40 mg/l.

The catchment area of the Yana is located in the Verkhoyano-Kolymean folded region and has a size of 0.24 million km^2. 99% of the sediments are transported during summer (June to September). On average once in four years the river freezes down to the bottom. Although the water discharge of the Yana is much smaller than that of the Lena river, its sediment supply to the Laptev Sea has to be taken into account. First results indicate that the concentration of suspended material can be 25 times higher than that of the Lena river (up to 1000 mg/l).

The water supply of the Omoloy and Olenyok rivers is of minor importance for the Laptev Sea water mass formation. However, since those rivers originate in remarkable geological units, we expect specific mineralogical and geochemical signals. The Olenyok drains the Siberian Trap basalts and the Omoloy cassiterite and gold ore deposits.

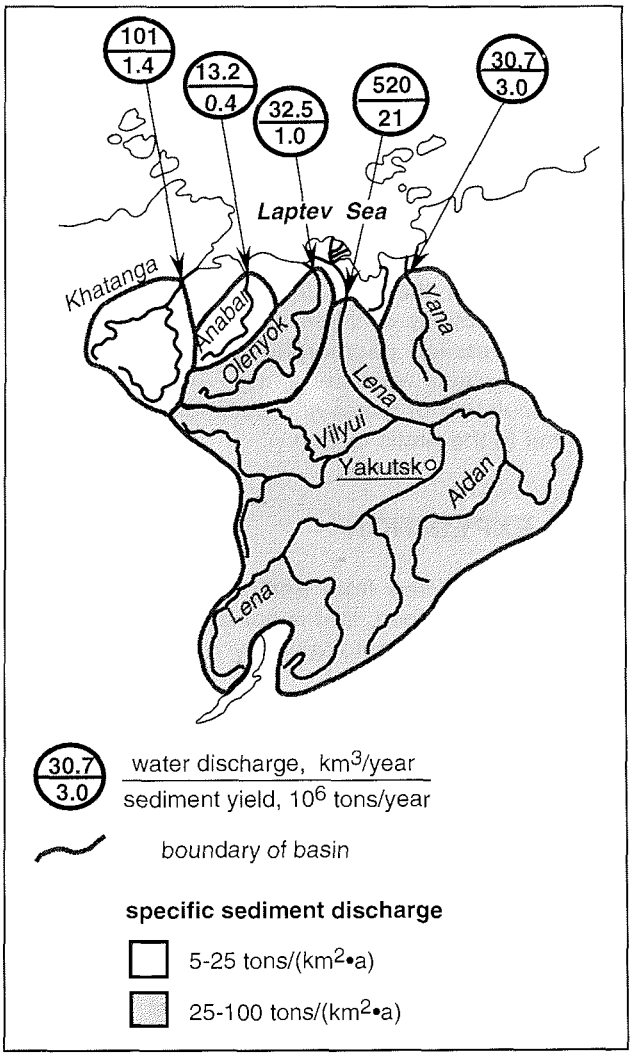

Fig. 2: Water and sediment supply to the Laptev Sea (from Alabyan et al., 1995).

3. RESEARCH PROGRAM

During the expedition water, surface sediments and suspended load of the Lena, Yana, Olenyok, Omoloy rivers and their tributaries were sampled. These samples will be analysed in the AWI by geochemical and mineralogical methods.

The analyses of the suspended load concentrate on

- major, trace and rare earth element geochemistry
- clay mineralogy,
- $\delta^{13}C$ values of the organic fraction and
- Sr isotope composition.

Surface sediments are studied for

- mineralogical composition, especially heavy minerals and
- bulk inorganic geochemistry of the fraction < 63 µm.

Water samples are analysed for

- oxygen and hydrogen isotopic composition.

Furthermore peat samples from the Lena and Yana delta are used for ^{14}C age determination.

The Research Laboratory of Soil Erosion and Channel Processes of the Geographical Faculty, Moscow State University investigated hydrological and geomorphological features of basins, channels, confluences and deltas of the Vilyui, the Aldan, the Kirenga, the Vitim, the Lena, the Omoloy and the Yana rivers. During 1969-1995 long sections of these rivers were covered by bathymetric and sedimentologic maps. Detailed geomorphological and hydrological analyses of river channels and delta plains were performed. All these data may be considered as a basis for the calculation of water and sediment transport from Siberia to the Laptev Sea and further to the Arctic Ocean.

4. COURSE OF EXPEDITION

The German participants flew from Berlin to Moscow on June 26. During the next day in Moscow additional food, that is not available in Yakutia was bought. On June 28 the German group accompanied by one Russian participant took the aeroplane to Yakutsk.

After two days of preparing the RV "Prof. Makkaveev" in Yakutsk the first part of the expedition with two Russian and two German participants started on June 30. The ship went upstream and reached Olekminsk, the southernmost point of the expedition, on July 5. During the trip samples were taken at 10 stations (Fig. 3).

On July 9 "Prof. Makkaveev" arrived back in Yakutsk and the third Russian scientist joined the group. The next day the second leg, the expedition to the lower Lena including the Lena delta, started. The ship went northward and sampling was carried out in approximately 100 km intervals.

To obtain surface sediments of the Vilyui river we had to go up the tributary, since the lower reach of the river cuts through old Lena sediments. After going upstream with "Prof. Makkaveev" for 120 km the last 100 km were covered by a small motor boat.

Sampling the main river and the tributaries between Yakutsk and the Lena delta took about 2 weeks and on July 27 the ship arrived at Stolb island in the delta.

In the Lena delta the participants split up into two groups. While one group was sampling the different channels of the delta the other group headed to the mouth of the Olenyok river through the Olenyokskaya channel with the pilot boat "Iceberg". However, the "Iceberg" could not reach the Olenyok river because of ice in the Laptev Sea and returned to Stolb island. Our samples from the Olenyok river were taken by the crew of "Iceberg" one week later, after the ice had disappeared.

After completing the work in the Lena delta on August 8 the participants left "Prof. Makkaveev" and moved to a trade ship heading to Nizhneyansk at the Yana mouth.

The third leg, the expedition to the Yana with a fast ship of the type "Sarya", started on August 10. During 10 days the Yana river was sampled between Nizhneyansk and Verkhoyansk. Furthermore samples of most of the tributaries could be retrieved (Fig. 3).

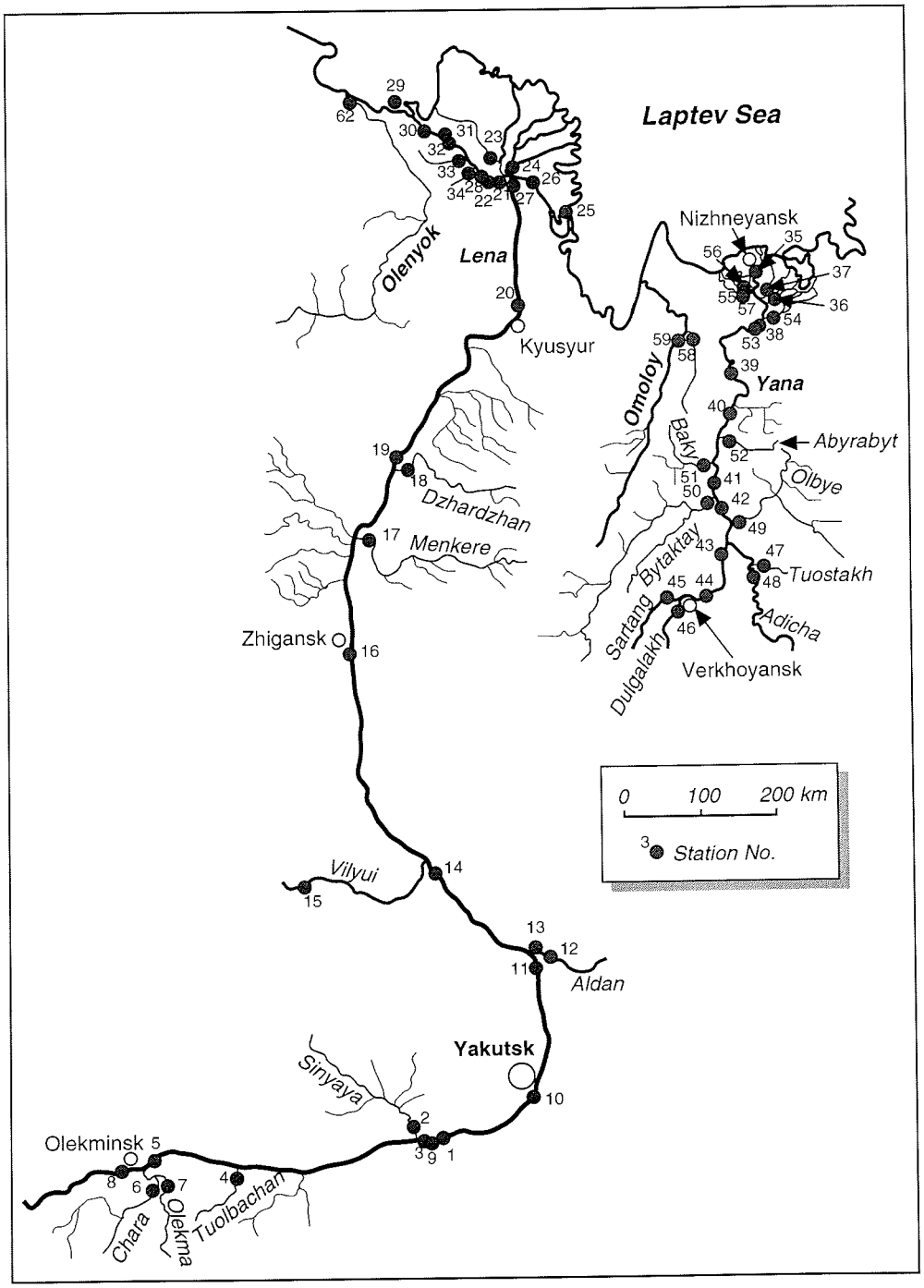

Fig. 3: Course of the expedition and locations of sampling.

To reach the Omoloy river a tank was used to cover the 90 km distance across the tundra. Since there is no road one way of the trip took us about 8 hours.

Sampling on the Yana river was completed on August 23 and two days later we flew from Nizhneyansk back to Yakutsk. After one week of preparing samples and equipment for customs we took the aeroplane to Moscow. The expedition ended in Berlin on September 7.

5. SAMPLING AND METHODS

Surface sediments, suspended load and river water were sampled at 62 stations. In general stations on the main rivers were performed as river cross sections, at which sediments were collected at 5 points and river water at 3 points. Small tributaries on the other hand were only sampled at one spot.

5.1. Water samples

For ultra-clean water sampling a Teflon watersampler with four 1l bottles was applied (Fig. 4). The sampler was lowered into the water in closed condition and opened by the fall weight. Water samples were taken at constant depth of 1.5 m.

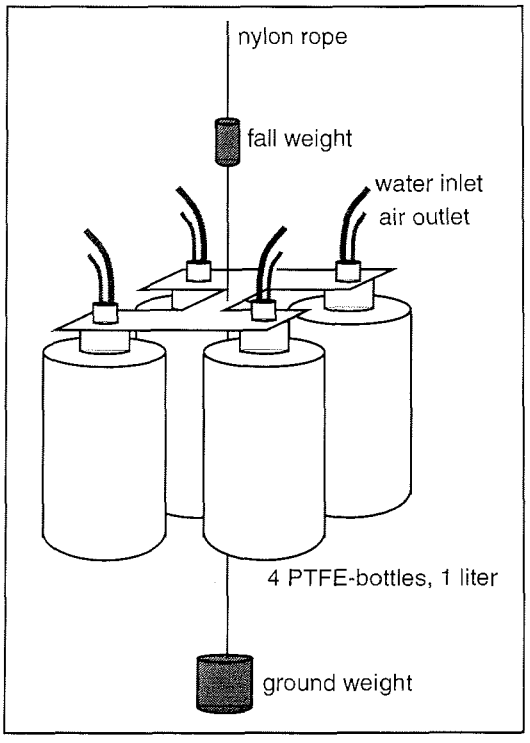

Fig. 4: PTFE water sampler.

The filtered water (0.45 µm Nucleopore filters, see below) was stored in pre-cleaned HDPE bottles for stable isotope analyses and in pre-cleaned, acidified HDPE bottles for inorganic analyses, respectively.

5.2. Suspended material

The suspended material was separated immediately after sampling by vacuum filtration. The filtered water volume varied between 0.25 and 4 l depending on sediment load. Three different types of filters were used:

- Nucleopore filters (pore size 0.45 µm) for inorganic geochemical analyses,
- cellulose acetate filters (pore size 0.45 µm) for clay mineral studies and
- glass fibre filters (pore size 0.7 µm) for analyses of the organic material.

All filters had been pre-weighted to calculate the sediment load. After air-drying the sediment loaded filters were stored dry and cold.

5.3. Sediment samples

The same heavy pale available on board RV "Professor Makkaveev", that was used during the last expedition (Rachold et al., 1995), was applied for sediment sampling. The instrument worked reasonably in the strong current of the Lena and Yana rivers and we obtained samples of disturbed surface sediments. However, the rivers have to be regarded as a dynamic system. While in one year sediments accumulates in the next year sediments are eroded at the same location. For this reason we think that the application of special equipment for sampling of undisturbed surface sediments is not required.

6. ACKNOWLEDGEMENTS

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APPENDIX

Appendix 1: List of stations

Station	Date	Time (GMT)	Position		Description
1	01.07.1995	13:00	61°09.7′	127°23.3′	Lena R.
2	02.07.1995	1:00	61°10.5′	126°50.0′	Sinyaya R.
3	02.07.1995	6:00	61°08.1′	126°58.3′	Lena R.
4	04.07.1995	3:00	60°30.6′	122°52.6′	Tuolbachan R.
5	05.07.1995	3:00	60°27.4′	120°37.8′	Lena R.
6	05.07.1995	3:00	60°16.1′	120°59.2′	Chara R.
7	05.07.1995	3:30	60°16.1′	121°09.0′	Olyekma R.
8	06.07.1995	0:30	60°19.5′	120°15.8′	Lena R.
9	07.07.1995	8:30	61°08.1′	126°58.3′	Lena R.
10	07.07.1995	23:30	61°47.8′	129°39.4′	Lena R.
11	11.07.1995	1:30	63°16.2′	129°34.9′	Lena R.
12	11.07.1995	6:00	63°24.3′	129°50.9′	Aldan R.
13	15.07.1995	9:00	63°25.1′	129°36.4′	Aldan R.
14	17.07.1995	9:00	64°22.6′	126°30.0′	Lena R.
15	18.07.1995	12:30	63°57.8′	123°17.5′	Vilyuy R.
16	21.07.1995	5:00	66°41.1′	123°29.5′	Lena R.
17	24.07.1995	1:00	68°01.6′	123°32.1′	Menkere R.
18	24.07.1995	8:00	68°47.0′	124°06.7′	Dzhardzhan R.
19	24.07.1995	16:30	68°51.1′	123°57.8′	Lena R.
20	26.07.1995	8:00	70°81.5′	127°33.1′	Lena R.
21	27.07.1995	5:00	72°22.6′	126°29.3′	Lena Delta
22	27.07.1995	8:30	72°19.3′	126°00.0′	Lena Delta
23	27.07.1995	9:30	72°24.9′	126°26.7′	Lena Delta
24	29.07.1995	2:00	72°29.0′	126°40.0′	Lena Delta
25	30.07.1995	2:30	72°01.6′	129°07.8′	Lena Delta
26	31.07.1995	1:30	72°20.9′	127°28.7′	Lena Delta
27	02.08.1995	5:00	72°21.8′	126°41.7′	Lena River
28	02.08.1995	11:00	72°20.1′	125°44.0′	Lena Delta
29	30.07.1995	15:00	73°01.0′	121°47.0′	Laptev Sea
30	31.07.1995	15:15	72°52.7	123°20.2	Lena Delta
31	01.08.1995	15:45	72°36.2′	124°27.3′	Lena Delta
32	01.08.1995	16:45	72°40.3′	124°19.1′	Khmuraya R.
33	02.08.1995	7:00	72°35.8′	124°52.1′	Bolshaya R.
34	02.08.1995	11:00	72°26.3′	125°21.7′	Gagarya R.
35	08.08.1995	10:00	71°18.1′	135°59.8′	Yana Delta
36	09.08.1995	0:00	70°58.4′	136°29.4′	Yana Delta
37	09.08.1995	1:00	71°04.4′	136°17.1′	Yana Delta

Appendix 1: List of stations (continued)

Station	Date	Time (GMT)	Position		Description
38	09.08.1995	2:30	70°45.5′	136°04.0′	Yana Delta
39	09.08.1995	11:00	70°13.4′	135°06.9′	Yana R.
40	10.08.1995	8:00	69°43.1′	135°04.4′	Yana R.
41	11.08.1995	4:00	68°57.2′	134°27.8′	Yana R.
42	12.08.1995	2:00	68°36.4′	134°39.6′	Yana R.
43	12.08.1995	8:30	68°12.3′	134°54.7′	Yana R.
44	13.08.1995	0:30	67°32.9′	134°01.9′	Yana R.
45	13.08.1995	6:30	67°27.3′	133°13.1′	Sartang R.
46	13.08.1995	7:00	67°29.6′	133°14.5′	Dulgalakh R.
47	17.08.1995	5:00	67°51.9′	135°40.4′	Tuostakh R.
48	17.08.1995	5:30	67°48.7′	135°27.3′	Adicha R.
49	18.08.1995	3:00	68°24.3′	134°58.9′	Olbye R.
50	18.08.1995	12:30	68°44.6′	134°20.4′	Bytaktay R.
51	18.08.1995	23:00	69°07.3′	134°15.9′	Baky R.
52	19.08.1995	2:00	69°24.3′	134°45.5′	Abyrabyt R.
53	21.08.1995	7:30	70°45.4′	136°04.0′	Yana Delta
54	21.08.1995	8:30	70°47.0′	136°20.0′	Yana Delta
55	21.08.1995	11:00	71°47.5′	135°08.1′	Yana Delta
56	21.08.1995	22:30	71°09.7′	135°57.7′	Yana Delta
57	21.08.1995	22:50	71°07.3′	135°47.5′	Yana Delta
58	21.08.1995	12:30	70°42.3′	133°28.6′	Kyugyulyur R.
59	21.08.1995	13:00	70°42.6′	133°24.1′	Omoloy R.
60	23.08.1995	4:00	71°35.0′	136°46.5′	Laptev Sea
61	23.08.1995	4:30	71°39.5′	136°50.3′	Laptev Sea
62	13.08.1995	11:30	72°57.9′	119°57.2′	Olenyek R.

Appendix 2: List of samples

station	sample	comment
1	sediment	sandbank
2	water, sediment , filtered water, suspended material	tributary Sinyaya R.
3	water, sediment, filtered water, suspended material	river cross section Lena R.
4	water, filtered water, suspended material	tributary Tuolbachan R.
5	water, sediment , filtered water, suspended material	river cross section Lena R.
6	water, sediment , filtered water, suspended material	tributary Chara R.
7	water, sediment , filtered water, suspended material	tributary Olyekma R.
8	water, sediment , filtered water, suspended material	river cross section Lena R.
9	water, filtered water, suspended material	Lena R.
10	water, Sediment, filtered water, suspended material	river cross section Lena R.
11	water, sediment , filtered water, suspended material	river cross section Lena R.
12	water, sediment , filtered water, suspended material	river cross section Aldan R.
13	sediment	Aldan R.
14	water, sediment , filtered water, suspended material	river cross section Lena R.
15	water, sediment , filtered water, suspended material	river cross section Lena R.
16	water, sediment , filtered water, suspended material	river cross section Lena R.
17	water, sediment , filtered water, suspended material	tributary Menkere R.
18	water, sediment , filtered water, suspended material	tributary Dzhardzhan R.
19	water, sediment , filtered water, suspended material	river cross section Lena R.
20	water, sediment , filtered water, suspended material	river cross section Lena R.
21	sediment , peat	island Lena Delta
22	water, sediment , filtered water, suspended material	Lena Delta
23	water, sediment , filtered water, suspended material	Lena Delta
24	water, sediment , filtered water, suspended material	Lena Delta
25	water, sediment , filtered water, suspended material	Lena Delta
26	water, sediment , filtered water, suspended material	Lena Delta
27	water, sediment , filtered water, suspended material	Lena R.
28	sediment , peat	Lena Delta
29	sediment	Laptev Sea
30	sediment	Lena Delta
31	water, sediment , filtered water, suspended material	Lena Delta
32	sediment	tributary Khmuraya R.
33	sediment	tributary Bolshaya R.
34	sediment	tributary Gagarya R.
35	water, sediment , filtered water, suspended material	Yana Delta
36	water, sediment , filtered water, suspended material	Yana Delta
37	sediment	Yana Delta

Appendix 2: List of samples (continued)

station	sample	comment
38	water, sediment , filtered water, suspended material	Yana Delta
39	water, sediment , filtered water, suspended material	river cross section Yana R.
40	water, sediment , filtered water, suspended material	river cross section Yana R.
41	water, sediment , filtered water, suspended material	river cross section Yana R.
42	water, sediment , filtered water, suspended material	river cross section Yana R.
43	water, sediment , filtered water, suspended material	river cross section Yana R.
44	water, sediment , filtered water, suspended material	river cross section Yana R.
45	water, sediment , filtered water, suspended material	tributary Sartang R.
46	water, sediment , filtered water, suspended material	tributary Dulgalakh R.
47	water, sediment , filtered water, suspended material	tributary Tuostakh R.
48	water, sediment , filtered water, suspended material	tributary Adicha R.
49	water, sediment , filtered water, suspended material	tributary Olbye R.
50	water, sediment , filtered water, suspended material	tributary Bytaktay R.
51	water, filtered water, suspended material	tributary Baky R.
52	sediment	tributary Abyrabyt R.
53	peat	Yana Delta
54	sediment	Yana Delta
55	sediment	Yana Delta
56	sediment	Yana Delta
57	sediment	Yana Delta
58	water, sediment , filtered water, suspended material	tributary Kyugyulyur R.
59	water, sediment , filtered water, suspended material	Omoloy R.
60	sediment	Laptev Sea
61	sediment	Laptev Sea
62	sediment, suspended material	Olenyek R.