THIS FILE ALSO INCLUDES DATA FROM THE FOLLOWING:

MGGB09335001

OSADKI KARSKOGO MORYA

(Sediments of the Kara Sea)

by

T. I. Gorshkova

TRUDY VSESOYUZNOGO
GIDROBIOLOGICHESKOGO OBSHCHESTVA

Vol. VIII
Pp. 68-99

1957

Translator: M. Slessers
Editor : J. Kravitz

U. S. NAVAL OCEANOGRAPHIC OFFICE
WASHINGTON, D. C.

1967

ABSTRACT

(Conclusions)

1. The mechanical composition of Kara Sea sediments, as those of the other seas, depends largely on the bottom relief and currents, and less on the absolute depth of the sea in a given region.

2. According to the color of the upper layer, all the sediments are divided into:

(a) brown found in the center of the Kara Sea and in deep trenches--Zhelob St. Anny, running from the Arctic Basin between Zemlya Frantsa Iosifa and the northern shoal, and Zh. Voronina running along the eastern side of the northern shoal;

(b) yellowish sediments, occupying the shallow areas east of the northern tip of Novaya Zemlya, the northern shoal and coastal belt of p. Yamal, including Baydaratskaya Guba.

3. The color of Kara Sea sediments depends largely on their chemical composition (Te, Mn, P.) and on the character of water masses in a given area. The sediments occupying the areas that are affected by fluvial water and that of the Barents Sea assume yellowish and brownish-gray color. The sediments of deep trenches with a colder and more saline water have a brown color, whereby the thickness of the brown layer is in direct relationship with the depth of the location.

4. The content of carbonates in the sediments of the Kara Sea is determined mainly by the detritus brought by drift ice and by the terrigenous materials resulting from coast erosion. The greatest quantity of carbonates was found in sediments lying off the coast of Navaya Zemlya, which agrees well with the data of mineralogical analysis.

5. The quantity of organic matter makes up a relatively small percentage of the brown sediments, increasing in the yellow-gray sediments of the coastal belt of o. Dikson and Baydaratskaya Guba, which agrees well with data by Z. A. Filatova and L. A. Zenkevicha (1957) on the distribution of benthos biomass.

6. The faunal and mineralogical composition of sediments demonstrated a close connection with the distribution of water masses in the Kara Sea. It is seen that the fluvial water of the Ob' and Yenisy reach far into the sea along the northern shoal and turn southward under the impact of the Arctic and the Barents Sea water.

7. The layers in cores show that the rhizopods of our samples belong to the present species and that the sand rhizopods occur mainly in the upper layer. Their absence in the lower layer is undoubtedly the result of decomposition of organic matter that holds the sand particles. At some stations the calcareous rhizopods were observed in all the layers of cores, while at other stations the quantity of rhizopods was greater in the lower layers of cores than in the upper ones, which is undoubtedly associated with varying amount of Atlantic water in the Kara Sea during various geological eras and with the presence of free Co_2 in the upper layer.

8. The investigation of sediments in various layers of cores gives an insight into the history of the Kara Sea. Regrettably, our cores were relatively short (to 95 cm.) and, therefore, most of them represent only the recent sediments. But part of the cores taken from the eastern part of the Kara Sea (St. 18, etc.) contained clay in the lower strata which was very viscous, had little organic matter and no foraminifera. All these characteristics make it possible to appertain these sediments to older formations, probably of the ice age.

The similarity of sediments and the position of brown layers in the core of St. 30 with those investigated by M. M. Yermolayer (1948 a,b), which were taken in Zhelob St. Anny makes us assume that variations in the penetration of Atlantic water into the Kara Sea affected the Novaya Zemlya and St. Anna Trenches during the same time period.

9. The Kara Sea sediments demonstrate that the bottom sediments and the benthos biomass are closely associated. The wide distribution of pink sediments of the Kara Sea is closely associated with a decrease in the benthos biomass. The coastal belts of the sea with weakly-oxidized yellowish-gray and gray sediments are characterized by a large benthos biomass.

This can be explained by the following features typical of the brown sediments of the Kara Sea: 1) high percentage of Fe, Mn and P; 2) luxurious bactery life (Kalinenko, 1940), which affects the formation of iron-manganese concretions; 3) probably, a large quantity of free carbon which is confirmed by the dissolution of carbonates; 4) small percentage of organic matter.

All of these features evidently create conditions that do not support the life of benthic populations.

The author

OSADKI KARSKOGO MORYA

(Sediments of the Kara Sea)

The Kara scientific expedition of 1945, using the fishing trawler M. Gor'kiy and survey vessel Osetr, took sediment samples in the Kara Sea in addition to the other oceanographic work. Carrying out comprehensive studies, it was possible for us to compare the investigations of sediments with biological and hydrological data obtained in the same areas. As is known, the water of the Kara Sea is composed of the Atlantic, Barents Sea and pure water of Ob' and Yenisey. The bottom sediments, which are so sensitive to all the variations of the surrounding medium cannot but reflect the diverse characteristics of these waters. Therefore, the sediments sampled by us were subjected to mechanical, mineralogical, chemical and faunistic analyses.

Information of the Kara Sea sediments is available since the voyage of A. E. Nordenshel'd in the Vega during 1878-1880 (Nordenshel'd, 1881).

The 19 samples obtained near Novaya Zemlya in 1907 by the Belgica expedition are described by Thoulet (1910). A more detailed investigation of the Kara Sea, notably its bottom sediments, began with the first expedition of the Marine Scientific Institute in icebreaker Malygin which took place in 1921 (Samaylov and Gorshkova, 1924).

In 1927 and 1932, the same institute conducted oceanic survey in Persey, covering the entire SW part of the Kara Sea. The bottom samples have been partly processed and the results have been published (Klenova, 1936; Pakhomova, 1948a). On the basis of these samples, M. V. Klenova plotted a bottom chart of the investigated area.

More samples of Kara Sea sediments are in the possession of the Arctic Institute. We utilized the papers by M. M. Yermolayeva (1948 a,b) which deal with the Kara Sea for comparisons between the distribution of chemical elements and the determination of the age of sediments.

The M. Gor'kiy expedition in 1945 occupied 39 stations and took bottom samples with the Ekman corers, Peterson grab, Sigsley trawl and otter trawl; the Osetr expedition utilized the Peterson grab and took bottom samples at 5 stations (Fig. 1).

The bottom samples obtained by the Ekman corer were 8 to 95 cm. long in moist condition. In most of the cores the color of moist sediments differs sharply in the upper and lower layers. The upper layer, 1 to 18 cm. thick, had a brown color. The colors of underlying layers were greenish-gray, gray, bluish-gray and black. The density of sediments of the upper and lower layers also sharply /69 differed at various stations. As a rule, the upper layer contained liquid sediments 1-2 cm. thick; then followed denser layers; at some stations even viscous clay was observed.

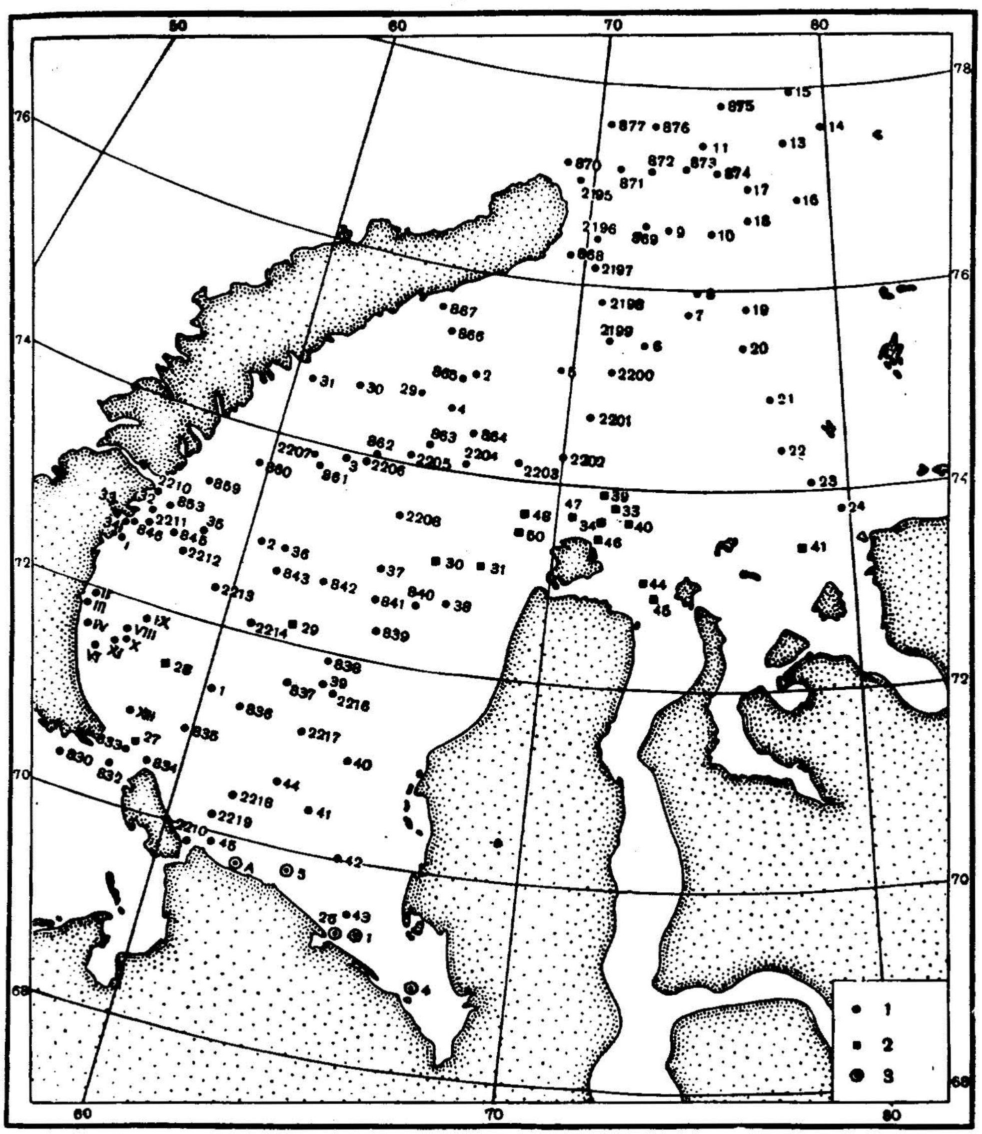

FIG. 1. Position and numbers of stations occupied for studying the Kara Sea.

1 - M. Gor'kiy stations (no. 1-45); Persey stations (no. 830-2219) and Belgica stations (I-XII);
2 - Malygin stations (no. 27-50);
3 - Osetr stations (1-5 and A).

1. Mechanical composition of sediments.

The sediments were analyzed by M. S. Kosova and A. I. Gorshkova who used the Osborn method (Klenova and Avilov, 1933).

The bottom classification, worked out by a GOIN commission (Klenova, 1931), was based on the content of fractions (particles) less than 0.01 mm. Depending on the quantity of fractions less than 0.01 mm., the bottom is divided into the following groups: /70

1.	Sand, fractions less than 0.01 mm.		<5%
2.	Muddy sand,	same	5-10%
3.	Sandy mud	"	10-30%
4.	Mud	"	30-50%
5.	Clayey mud	"	>50%

The results of analyses of Kara Sea sediments are listed in Table 1.

The Kara expedition of 1945 collected samples east and south of the areas covered by the preceding expeditions, and it also obtained several additional samples from the central part of the Kara Sea. On the basis of samples obtained by former expeditions and by us in 1945, we plotted a bottom chart of the Kara Sea (Fig. 2).

Usually the mechanical composition of sediments is in close relationship with relief; therefore, we shall briefly discuss the matter.

Dispensing with details, it is possible to plot such a chart for the distribution of bottom depth in the Kara Sea. A trench extends along Novaya Zemlya (from 76 to 71° N); its depth exceeds 300 m., and therefore, the 100 m. isobath runs near the coast of Novaya Zemlya. A shallow area lies off the coast of Yamal and to the north of it (to 81° 30' N); here are several islands, such as ostrov Uyedineniya, o. Vize and o. Ushakova; besides, a number of islands are found in the southern part of the Kara Sea. Due to it, the isobaths of 25 and 30 m. separate the Baydaratskaya Guba in the south of the Kara Sea and run far to the west and north of ostrov Belyy and other islands of this northern group. The 100 m. isobath forms a curved line off the east coast, penetrating in latitudinal direction deep into the central part of the Kara Sea. In addition, a belt with individual depressions with depths exceeding 100 m. runs along Yamal. Two deep trenches penetrate the Kara Sea from the Polar Basin; these trenches lie on both sides of the above mentioned shallow area. The western trench (Zhelob St. Anny), lying between Zemlya Frentsa Iosifa and the northern shallow of the Kara Sea with depth exceeding 300 m., extends to the northern tip of Novaya Zemlya. The 200 m. isobath reaches 76°30', then rises over the western side of the shallow area, forming a steep slope. Because the 200 m. isobath, which delimits the Novaya Zemlya Trench, reaches only to 76°15' but the bounding western trench of the Polar Basin reaches to 76°30', a shallow area with depths less than 200 m. is formed between the trenches, extending eastward from the tip of Novaya Zemlya. These basic features of bottom relief determine also the distribution of sediments on the Kara Sea floor.

The largest part of the Kara Sea is covered with mud containing from 30 to 50% of small fractions (less than 0.01 mm.). These sediments occupy the entire Novaya Zemlya Zhelob (Prinovozemelskiy Zhelob), the southern part of the Kara Sea and all the deep depressions off the Yamal. In the north, these sediments cover the larger part of both trenches extending from the Polar Basin. The deepest depressions of the Novaya Zemlya Trench (St. 30 with a depth of 370 m. and St. 35 with a depth of 395 m.) and the Vaygach Depression (Zavaygachskaya vpagina, St. 44 with a depth of 215 m.) are covered with clayey mud, which has not yet been investigated in detail due to lack of data.

It is possible that in the deep trenches of the Polar Basin the clayey mud is widely distributed, as shows a sample at the M. Gor'kiy St. 15. /73

The sandy mud is widely distributed on the shallow area intersecting the 200 m. isobath at the northern tip of Novaya Zemlya. Then the isobath runs south along the Poluostrov Yamal coast and enters the Bay Daratskaya Guba. West of ostrov Belyy one can observe mostly a sandy mud. SE off the Karskiye Vorota, the sandy mud reaches deep into the Kara Sea which is probably associated with a current flowing from the Barents Sea (Berezkin, 1939).

Station 39 with a depth of 90 m. was located near a submarine elevation with depths less than 50 m.; the bottom consisted of slightly sandy mud, which indicates that the sandy mud may also cover the shoaling area. /75

Muddy sand was found at depths less than 50 m. off the coast of Pol. Yamal and to the north and east of o. Belyy. The area of northern shoal is not described by us due to lack of data.

Table 1

Mechanical Composition of Sediments in the Kara Sea

No. of St.	Depth m	Layer from top of core	Fractions larger than 1 mm. (% of entire sample	Composition of fractions less than 1 mm. (%) 1 - 0.1 mm.	0.1 - 0.05 mm.	0.05 - 0.01 mm.	smaller than 0.01 mm.
			M. Gor'kiy				
1	104	0—4	—	6,2	13,4	33,7	46,7
1	104	28—30	—	1,0	15,6	33,0	50,4
1	104	28—30	—	7,1	18,0	26,2	48,7
1	104	58—60	—	3,4	19,6	32,6	44,4
1	104	88—90	—	4,2	15,1	29,8	50,9
2	114	* Верх	—	10,14	17,9	29,91	42,05
2	114	»	—	11,4	18,8	30,8	39,0
3	215	0—10	—	1,8	23,0	34,1	41,1
3	215	0—10	—	2,11	26,5	20,2	51,19
3	215	11—15	—	3,0	20,4	31,0	45,6
3	215	31—35	—	2,8	19,6	40,2	37,4
3	215	40—45	—	2,0	20,2	37,8	40,0
3	215	68—71	—	3,1	13,0	23,3	60,6
4	158	* Верх	—	4,8	38,2	14,8	42,2
4	158	18—20	—	7,7	15,0	32,8	44,5
5	145	0—5	—	5,0	33,3	24,1	37,6
5	145	30—34	—	4,0	28,6	36,6	30,8
5	145	60—65	—	1,6	25,6	32,2	40,6
5	145	90—95	—	1,1	17,4	49,1	32,4
6	62	* Верх	—	34,8	25,0	13,6	26,6
6	62	»	—	39,49	28,25	16,12	16,14
6	62	—10	—	4,4	44,8	23,3	27,5
6	62	9—10	—	6,7	41,6	32,8	18,9
7	62	* Верх	—	14,6	27,7	29,6	28,1
7	62	»	—	17,0	28,3	30,1	24,6
7	62	25—30	—	15,4	20,0	33,0	31,6
7	62	41—45	—	13,4	20,4	34,6	31,6
8	114	0—3	—	13,6	33,4	29,0	24,0
8	114	30—33	—	11,0	27,4	26,2	35,4
8	114	60—67	—	14,8	24,8	28,2	32,2
9	130	0—3	—	26,6	22,1	24,3	27,0
9	130	0—2	—	18,3	28,6	22,0	31,1
9	130	30—33	—	4,5	18,1	28,6	48,8
9	130	42—45	—	38,3	27,8	25,1	8,8
9	130	60—67	—	19,8	33,3	17,1	29,8
10	145	0—5	—	10,33	26,3	21,66	41,68
10	145	0—5	—	7,8	26,8	28,0	37,4
10	145	28—30	—	11,5	23,0	25,3	39,9
10	145	45—52	—	10,4	23,0	29,6	37,0
11	200	0—4	—	1,7	24,8	32,0	41,5
13	280	* Верх	—	3,4	33,8	34,8	28,0
13	280	28—30	—	8,0	23,4	32,9	35,7
14	72	0—5	—	26,1	13,0	35,0	25,4

* Up

Table 1
continued

14	72	0—5	—	28,2	25,7	26,6	19,5
14	72	11—14	—	3,6	43,1	19,1	34,2
15	170	0—5	—	3,5	15,2	32,2	49,1
15	170	30—36	—	3,0	22,6	34,2	40,2
15	170	30—36	—	8,8	23,8	26,0	41,4
16	104	* Верх	—	26,7	21,0	23,87	28,42
16	104	10—14	—	20,4	20,0	28,0	31,6
16	104	20—24	—	17,6	25,6	24,8	32,0
17	147	0—2	—	8,31	23,38	39,29	29,02
17	147	10—12	—	25,6	16,4	34,6	23,4
17	147	30—36	—	24,2	18,2	33,0	24,6
18	78	0—2	—	32,0	29,6	10,6	27,8
18	78	6—8	—	40,2	19,8	15,8	24,2
19	48	* Верх	—	42,87	25,62	12,87	18,64
19	48	20—22	—	10,8	27,0	24,3	37,9
19	48	38—42	—	46,0	22,5	15,1	16,4
20	41	* Верх	—	44,3	26,0	15,6	19,6
20	41	•	—	46,23	21,06	16,34	16,37
23	31	0—3	—	4,56	17,44	44,62	33,38
23	31	30—37	—	3,0	22,6	25,6	48,8
23	31	60—67	—	2,4	13,5	40,6	43,5
24	37	0—5	—	8,1	34,8	37,0	20,1
24	37	32—37	—	15,5	40,5	27,7	16,3
24	37	40—42	—	12,4	39,4	22,9	25,3
30	370	1—3	—	0,8	9,1	34,3	55,8
30	370	10—12	—	2,7	32,6	38,0	26,7
30	370	30—34	—	18,3	5,0	36,0	40,7
30	370	35- 39	—	3,3	10,0	33,3	53,4
30	370	60—66	—	1,1	9,8	37,5	51,6
31	230	0—5	—	7,6	28,3	31,2	33,7
31	230	30—35	—	2,5	10,5	40,0	47,0
32	90	0—3	—	11,2	32,8	25,0	31,0
32	90	20—24	—	1,1	13,1	28,4	57,4
32	90	39—43	2,4	13,0	21,6	35,1	30,3
33	22	10—14	—	0,3	12,8	44,1	42,8
34	70	0—4	—	25,0	14,2	31,4	29,4
34	70	10—14	—	10,3	11,6	43,3	34,8
34	70	30—34	—	19,0	23,0	34,1	23,9
35	395	0—5	—	5,3	9,5	16,7	68,5
35	395	30—35	—	5,5	4,7	19,1	70,7
35	395	50—70	—	3,5	12,8	29,3	54,4
36	177	0—8	—	2,0	26,4	29,6	42,0
36	177	0—5	—	3,2	35,8	18,8	42,2
36	177	30—33	—	1,6	30,4	20,2	47,8
36	177	60—67	—	0,6	15,0	44,0	40,4
37	59	0—2	—	56,15	26,16	10,66	7,03

* Up

Table 1
continued

37	59	0—2	—	55,0	27,0	10,0	8,0
37	59	15—17	—	23,4	19,2	29,6	27,8
38	75	0—2	—	31,4	22,2	17,8	28,6
38	75	17—26	—	29,8	17,8	26,7	25,7
38	75	29—31	—	8,2	36,4	26,2	29,2
39	90	0—2	—	23,9	28,1	18,2	29,8
39	90	0—5	—	14,9	23,4	28,2	33,5
39	90	0—3	—	19,5	37,0	12,5	31,0
39	90	23—26	—	6,4	34,6	27,8	31,2
39	90	43—47	—	1,8	16,2	32,2	47,8
40	32	*Средняя проба	—	50,7	22,5	20,1	6,6
40	32	1* То же	—	46,0	20,8	24,0	9,2
40	32	31—37	—	33,0	23,4	28,4	15,2
41	150	0—3	—	0,3	23,3	28,7	47,7
41	150	30—33	—	3,0	19,4	27,0	50,6
41	150	60—65	—	4,6	8,2	21,7	65,5
42	42	0—3	—	13,1	20,3	36,8	29,8
42	42	10—13	—	2,3	27,5	30,0	40,2
42	42	60—62	—	2,0	36,3	23,8	37,9
43	28	0—3	—	3,2	31,3	46,5	19,0
43	28	0—3	—	7,4	25,6	37,6	29,4
43	28	24—26	—	14,4	28,8	20,4	36,4
43	28	45—48	—	2,4	22,4	37,6	37,6
44	215	0—2	—	7,0	9,6	36,6	46,8
44	215	0—3	—	2,3	20,5	28,4	48,8
44	215	30—33	—	5,1	14,5	32,1	48,3
44	215	72—73	—	4,9	11,0	32,6	51,5
45	75	*Средняя проба	—	2,9	27,8	36,2	33,1

"Osetr"

A	14	*Средняя проба	18,7	31,5	33,6	12,5	22,4
1	9,8	1*То же	—	82,0	12,5	1,9	3,6
2	—	»	—	38,3	26,8	20,2	14,7
4	—	» »	—	5,2	25,7	40,1	29,0
5	40	» »	-	45,8	14,3	23,0	16,9

*Mean Sample
1*Same

The floor of the central part of the Kara Sea (St. 37) at a depth of 50 m. is also covered by muddy sand. /175

The sand area has been well investigated by the Malygin expedition off O. Belyy and by the Kara expedition in 1945 off the coast of O. Sverdrup as well as off the west coast of Baydaratskaya Guba.

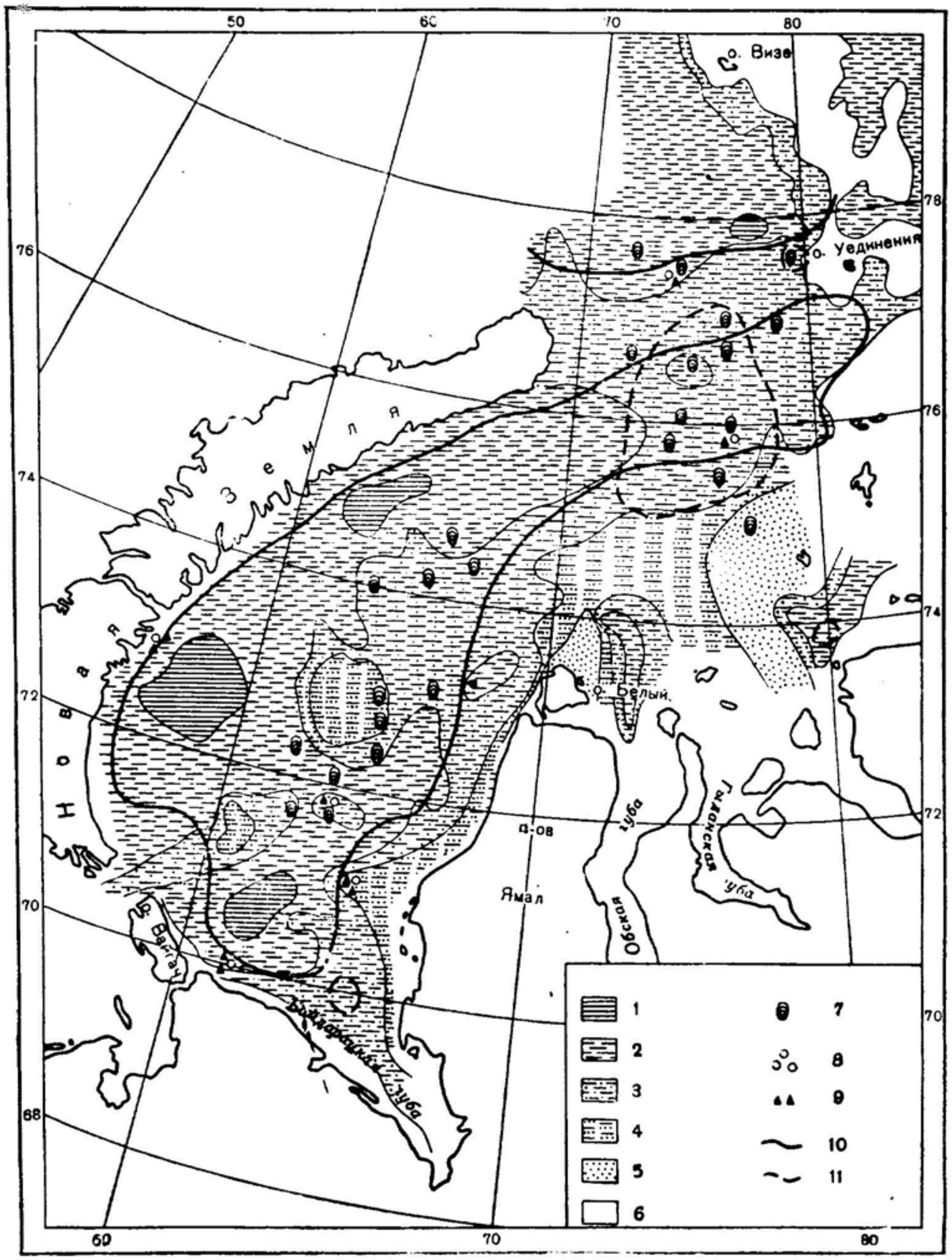

FIG. 2. Sediment chart of the Kara Sea.

1 - clayey mud
2 - mud
3 - sandy mud
4 - muddy sand
5 - sand
6 - places not investigated
7 - iron-manganese concretions
8 - boulders
9 - gravel
10 - boundary of pink sediments
11 - boundary underlying clay

The estuary areas of Ob' and Yenisey Rivers with a large number of islands must be carefully studied because of the existing microrelief and the currents that influence the character of bottom sediments.

As was already mentioned, the sediments of the Kara Sea vary considerably as to their color in vertical as well as in horizontal directions.

In the bottom chart (see Fig. 2) is shown the boundary of pink sediments in the upper bottom layer. By examining the chart, it is seen that the brown sediments occupy the entire central part of the Kara Sea which has mainly a soft bottom consisting of mud and clayey mud. The deep trenches, extending from the Polar Basin are also covered with pink sediments. The shoal between the Novaya Zemlya Trench and Polar Basin Trench (Zhelob Polyarnogo basseyna) is covered with pinkish-gray sediments. The color of sediments covering the shoal north of O. Belyy, the belt off the p. Yamal coast, Baydaratskaya Guba and the area off Karskiye Vorota is yellowish in the upper layer. The coastal sediments of the Novaya Zemlya have a distinctive graphite-gray color caused by the clay sehists lying on Novaya Zemlya, the decomposition of which forms these sediments.

In addition to the sediments of the upper layer, the chart also shows the area where we investigated the viscous sediments found in the lower layer at stations 6, 9, 11, 14, 17, 18, 19, 20, and 42.

As is known, the Kara Sea is characterized by a large quantity of iron manganese concretions which form mainly the cingula around boulders of various sizes. As to their chemical composition, these concretions are characterized by a large quantity of manganese and iron oxides.

During the Nordenshel'd expedition in Vega in 1878-1880, such materials were found north of Pristan' Diksow on a vast area (74-76°N and 78-80°E, not far from our stations 19-23) in such a quantity that they could be conveniently used for making cast iron, provided these places were more accessible (Nordenshel'd, 1881). SW of this area (within 71° 05' - 71° 45N and 62° 55' - 62° 20'E, not far from our station 39) were found iron-manganese concretions, similar to those described by Nordenshel'd, by a Netherlands' expedition in Dijmphna (1882-1883) at 33 stations with depths ranging from 91-160 m.

In 1930 the Arctic Institute expedition in icebreaker Sedov obtained iron-manganese concretions in area limited by 77° 21' - 78° 57'N

and 88° 52' - 88° 41'E. Part of the iron-manganese concretions collected by the Vega, Dijmphna and Sedov expeditions were analysed /76
for their chemical composition. The results of these analyses are presented in Table 2.

Table 2

Chemical Composition (incomplete) of the average samples of iron-manganese concretions of the Kara Sea (%)

Components of chemical analyses	Sedov collections (1937)				Vega collections (Senov, 1937)	Dijmphna collections 1887
	I	II	III	IV		
Fe_2O_3	22,16	21,29	21,69	23,77	16,63	13,79
Mn_2O_3	7,10	8,45	9,79	8,48	24,17	2,96
MnO_2	14,30	14,34	3,49	4,19	*Не указано	43,93
Al_2O_3	1,37	3,87	3,76	3,99	1,34	*Не указано
P_2O_5	1,48	2,79	3,55	3,28	2,22	» »
CaO	1,55	0,84	3,25	3,50	2,04	» »
MgO	1,86	1,38	1,69	1,44	1,70	» »
SiO_2	23,45	19,51	13,42	17,29	*Не указано	» »
H_2O	7,23	7,25	5,50	5,61	20,95	19,15
Organic substance	6,25	7,17	7,61	7,09	*Не указано	

*not indicated

As seem from the table, the quantity of iron and manganese fluctuates in the concretions; the concretions collected by the Dijmphna expedition in SE part of the Kara Sea are the richest in manganese, but the ones collected by the Vega and Sedov expeditions in the northeastern part of the Kara Sea contain more iron.

On the basis of collections obtained by the Malygin, Persey and M. Gor'kiy expeditions, we pointed out on our chart the areas where the iron-manganese concretions were obtained (See Fig. 2). It appeared that the iron-manganese concretions are confined mainly to sandy sediments.

As was pointed out above, the moist sediments of the Kara Sea differed by their color and composition. Together, with liquid and soft sediments constituting the upper layer, we found very viscous sediments in the lower layers which were observed at several stations underneath the pink sediments; at other stations, these sediments were observed only at the bottom of the core under a thick layer of soft sediments. These soft sediments stand out by their structure and chemical composition (which will be discussed later) and they probably constitute older sediments.

The investigation of Arctic Seas demonstrated that the bottom of these seas was, during the Post-tertiary era, subjected to numerous sinkings and upheavals. Such phenomena have also occurred in the White (Gorshkova, 1937 b), Barents (Samoylov and Klenova, 1927) and Greenland (Stetson 1933) seas. When investigating the sediments of the Arctic and Chukchi Basins, we also disclosed sandy sediments buried under soft clay.

2. Distribution of Mineralogical Complexes.

The sediments of the Kara Sea, as those of all the Arctic seas, are formed mainly from detritus brought by fluvial waters, by drift ice and wind.

Because the coast of the Kara Sea is composed of rocks with various petrographic composition, it is useful to examine the mineralogical composition of the sediment samples collected by us and try to deter- /77 mine the type of water that had brought them to the various areas of the Kara Sea.

For mineralogical examination, we selected fractions of sizes 0.1-0.05 mm. for muddy sediments and 0.25-0.1 mm. for sand. Division by the specific weight was done with the aid of the Tule liquid whose specific weight is 2.8. The determination and counting of minerals was done by K. F. Terent'yeva. The results of analyses are listed in Table 3.

As seen from the table, the percentage of heavy minerals in the analysed mechanical fractions fluctuates from 11.8 to 0.8%; the greatest percentage was noted off O. Dikson and O. Uyedineniya. By examining the table, it is readily seen that the sediments lying off the O. Dikson and along the entire shoaling northern ridge are enriched mainly by hornblende and pyroxene which make up 50% in the given fraction (St. 16,19, 22 and 24); for St. 24 these minerals are typical not only of the upper but also of the lower layer (40-42 cm.). Off the coast Novaya Zemlya and in Baydaratskaya Guba the hornblende and pyroxene constitute the smallest percentage, varying from 6 to 10 %.

The sediments at St. 20 and 21 are characterized by a large quantity of weathered minerals; their nature is difficult to determine, as is the case of the brown minerals; under microscope they look like translucent grains.

Mica makes up the largest quantity of minerals whose percentage is low. Stations at 15, 40 and 43, however, the percentage of mica reached 22%.

Epidote makes up a considerable percentage (from 11 to 33%) at St. 14, 21, 22, 24, 42 and 43. At other stations its quantity fluctuates from 1 to 7%.

Carbonates make up a small percentage or are absent at all the stations.

Of the minerals formed on sea bottom, we noted glauconite which was observed at St. 24, 30, 43 and A. Because the mentioned stations were situated in the coastal belt with shoaling areas, it can be assumed that the glauconite found here had been washed out of coastal rocks and brought by fluvial waters and is not a new formation for the given area. On the basis of mineralogical composition of sediments of the Kara Sea, one can say that their composition is closely associated with petrographic composition of rocks forming the surrounding shores. The enrichment of sediments off O. Dikson and along the entire shoaling area with hornblende, pyroxene and ore minerals is closely associated with diabases and diorites which form O. Dikson and the coast of the continent in this region.

The sediments lying off the south coast of the Kara Sea are enriched with such minerals as tourmaline, garnet, zircon, apatite and ore minerals, which is associated with the veined rocks on the south coast of the Kara Sea.

When examining our investigations of sediments, one can notice a considerable quantity of leading minerals--hornblende and pyroxene at stations situated far west of O. Dikson (St. 6,4 and 9). Consequently, it can be assumed that the waters of the Ob' and Yenisey Rivers flow not only eastward, according to the Coriolis' law, but also westward and northward; but under the pressure of the Barents Sea water, the fluvial water turns southward, entering the central region of the Kara Sea. These data agree well with the current chart of the Kara Sea (Berezkin, 1939).

The investigation of the light fraction of Kara Sea sediments was conducted only at 10 stations.

As seen from Table 3, the light fraction with specific weight <2.8 consists of quartz, feldspar, weathered minerals (mainly weathered feldspars and mica), colorless mica (muscovite) and, in very rare cases, glauconite and armours of diatom algae. The greatest quantity of quartz is contained by the sand at St. 21 and 22. The sediments sampled near P. Yamal (St. 40 and 43) are enriched mainly with fresh feldspar. The weathered minerals make up the smallest percentage. The sediments sampled at stations lying along the northern shoal contain a smaller percentage of fresh feldspar, but they are enriched with weathered minerals. The colorless mica makes up 1 to 10%, the richest being sediments at St. 14, 20 and 40.

3. Horizontal and Vertical Distribution of Chemical Elements of Sediments. /79

When investigating the Kara Sea sediments, we did not carry out complete chemical anaylses, but confined ourselves to those elements which are more mobile and reflect the character of various water masses and the life of the entire Kara Sea associated with them. Therefore, we determined the quantity of organic carbon, carbonic acid, manganese, phosphorus, iron and the insoluble residue. Carbon and carbonic acid were determined in the Knop apparatus by using a method deviced by us for marine sediments (Gorshkova, 1933). Manganese was determined from the whole sediment by the colorimetric method deviced by A. S. Pakhomova (1948a). Iron, phosphorus and the insoluble residue were determined from one batch which was heated with a 10% HCL for an hour without boiling. The insoluble residue was /80
heated and we determined iron and phosphorus in the solution by the colorimetric method. The sediments of the upper and lower layers of cores were analysed.

The results are listed in Table 4 and in figures 3-8.

In order to present clearly the distribution of manganese in the upper layer of sediments, we plotted a chart (Fig. 3) which was based on our observations and on the method discussed in a paper by A. S. Pokhomova (1948b) concerning the determination of manganese in the Kara Sea sediments. Thus, we utilized 25 determinations of manganese by Pakhomova and 34 by us for the plotting of a chart with respect /81
to the distribution of manganese in the upper layer of Kara Sea sediments.

Comparing the chart of manganese distribution with the chart of mechanical composition of sediments, where the boundary of pink sediments is marked, it appears that the isoline of 0.2% Mn. almost completely coincides with the boundary of the latter. In the central part of the Kara Sea we have three areas where Mn >1%. All

Table 3

Mineralogical Composition of Kara Sea Sediments

No. of stations	Layer from top of core (cm)	Analysed fraction		Percentage of fractions with spec. wt. more than 2.8 of analysed fraction	Composition of fractions with spec. weight exceeding 2.8																								Percentage of fractions with spec. weight less than 2.8						Diatoms (number)
		Size (mm)	% of entire sample		Hornblende	Pyroxene, monoclinic	Mica, colorless	Mica, green	Mica, brown	Garnet	Zirkon	Rutile	Epidote	Epidote, bubbly	Zoisite	Turmaline	Disthene	Staurolite	Leucoxene	Sphene	Apatite	Ore	Brown	Carbonates	Glauconite	Magnetite	Anatase	Weathered minerals	Quartz	Feldspar	Mica, colorless	Chalcedony	Glauconite	Weathered minerals	
M. Gor'kiy																																			
1	0—4	0,1—0,05	13,4	2,27	7	0,5	1	—	2	2	1	+	5	—	2	0,5	—	—	—	—	—	—	78	1	—	—	—	—							
4	Верх	0,1—0,05	38,2	7,6	7	36	—	1	1	1	3	—	5	—	—	+	—	—	—	—	—	—	46	—	—	—	—	—							
6	»	0,1—0,05	25,0	3,0	12	13	—	1	—	1	1	+	6	—	2	—	1	—	—	—	1	—	63	1	—	—	-	—							
9	42—45	0,1—0,05	27,8	3,3	13	24	—	1	—	1	2	+	7	—	—	+	—	—	—	—	—	—	51	1	—	—	-	—							
13	Верх	0,1—0,05	23,8	7,5	9	8	—	2	2	1	2	—	3	—	6	—	—	—	—	—	—	—	67	—	—	—	—	—							
14	0—5	0,1—0,05	35,70	10,1	19	5	1	1	—	1	4	—	11	—	—	—	—	—	1	—	1	17	29	1	—	—	—	—	12	37	5	—	1	46	—
15	0—5	0,1—0,05	15,2	3,6	12	13	10	—	11	1	1	—	1	—	4	1	—	-	—	—	—	—	46	—	—	—	—	—							
16	Верх	0,1—0,05	21,0	4,6	15	25	—	—	—	—	6	+	4	—	—	1	—	—	—	—	+	—	49	—	—	—	—	—							
17	0—5	0,1—0,05	17,38	6,6	8	18	6	1	2	1	0,5	0,5	3	—	0,5	1	0,5	—	1	1	—	15	42	1	—	—	—	—	18	26	—	—	—	56	—
18	0—3	0,1—0,05	19,8	6,2·	13	9	2	—	1	1	4	1	4	—	1	0,5	0,5	—	—	—	—	65	—	—	—	—	—	—	15	40	—	—	—	45	—
19	0—5	0,1—0,05	25,6	5,0	36	23	5	2	0,5	0,5	5	0,5	7	—	8	1	—	—	—	—	—	9	19	0,5	—	—	—	—	25	15	9	—	—	51	—
20	Верх	0,1—0,05	26,0	5,0	3	17	5	1	—	1	6	1	2	—	1	2	1	1	—	—	—	6	8	1	—	—	—	45	12	17	10	—	—	61	—
21	Средняя проба	0,25—0,1	65,55	0,8	8	29	—	1	1	—	2	—	26	—	—	—	—	1	—	—	—	—	7	—	—	—	—	27	78	9	—	—	—	13	—
22		0,25—0,1	76,92	6,6	4	48	—	1	—	1	1	2	10	1	0	1	1	—	4	—	—	2	24	—	—	—	—	—	47	29	—	—	—	24	—
24	0—5	0,1—0,05	34,8	6,6	20	30	1	1	—	1	6	—	11	0	2	3	—	1	—	—	1	16	5	1	1	—	—	—							
24	40—42	0,1—0,05	39,4		15	38	—	—	—	1	5	—	10	—	—	—	—	—	—	—	—	—	1	—	—	30	—	—							
34	1—4	0,1—0,05	14,2	2,5	8	2	6	1	1	2	5	2	1	—	1	—	1	—	—	—	—	—	67	4	—	—	—	—							
38	0—2	0,1—0,05	15,4	1,23	6	1	8	—	2	+	7	1	—	—	4	1	—	—	—	—	—	—	69	1	1	—	—	—							
																1	—	1	—	—	—	17	11	—	—	—	—	—	10	62	5	—	—	23	—
40	Дночерп. проба	0,1—0,05	20,8	10,2	20	9	6	8	2	2	6	—	—	—	17	1	—	—	—	1	—	—	58	—	—	—	—	—							
42	60—62	0,1—0,05	20,3	5,1	7	—	2	—	—	2	3	—	19	—	6	—	—	—	—	—	—	8	40	5	1	—	—	—	34	42	2	—	1	21	—
43	0—3	0,1—0,05	31,3	4,2	15	3	—	2	—	1	6	—	10	—	10																				
43	45—48	0,1—0,05	22,4	1,7	15	—	22	—	+	2	3	3	33	—	—	—	—	—	—	—	1	—	21	—	—	—	+	—							
Osetr																																			
A	Средняя проба	0,1—0,05	33,6	2,8	12	3,5	7	2,5	0,5	4	10	1	35	—	25	3	—	—	—	—	—	—	—	25	5	—	—	43							
1	То же	0,1—0,05	12,5	[illegible],8	6	4	1	1	—	8	20	0,5	16	—	—	5	0,5	0,5	—	—	0,5	32	5	—	—	—	—	—	19	62	1	—	—	18	1

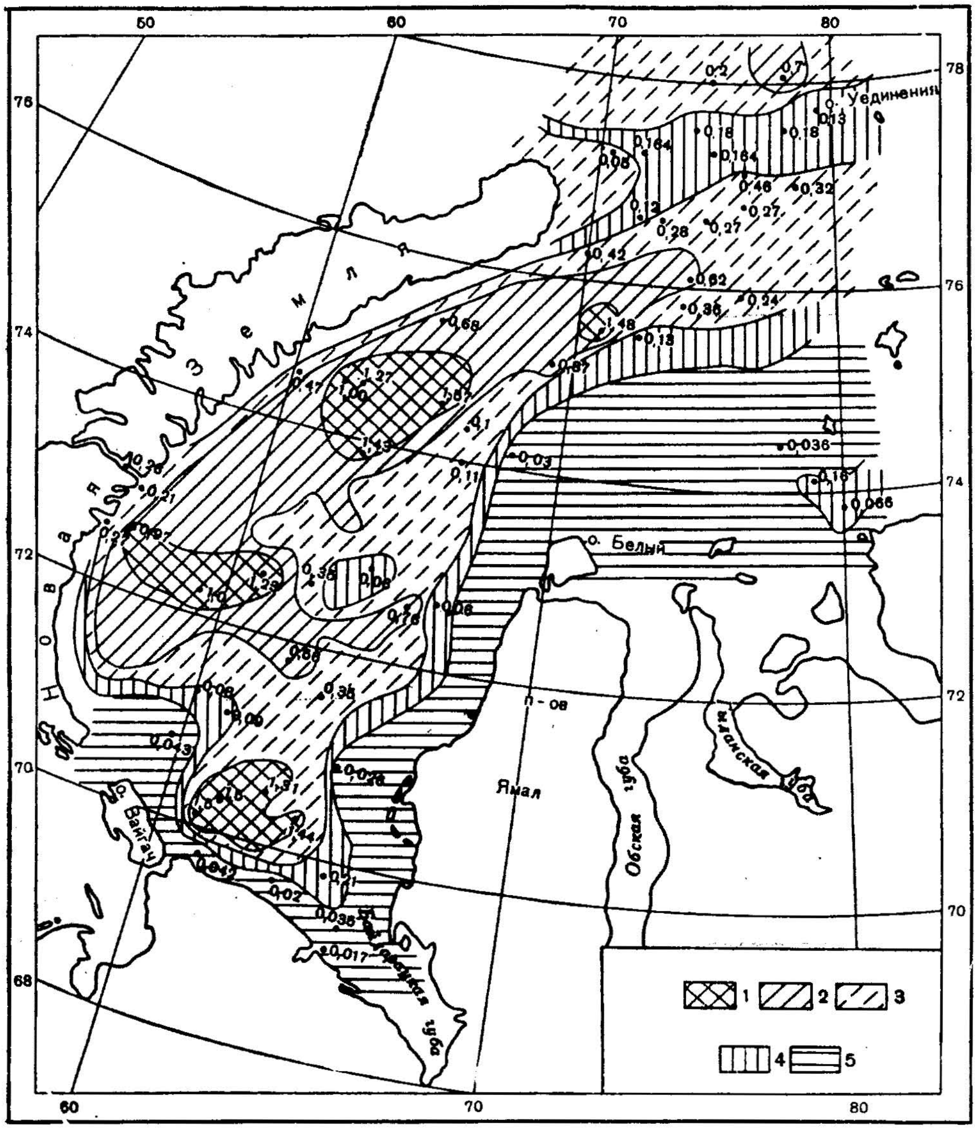

FIG. 3. Percentage of manganese in the upper layer of Kara Sea sediments

1-- >1.0
2-- 1.0-0.5
3-- 0.5-0.2
4-- 0.2-0.05
5-- <0.05

the areas coincide with the patches of clayey mud; further, the sediments of Vaygach (Zavaygachskiy) area are the richest in Mn--namely, 1.44%. In areas where the yellowish and brown-gray sediments are found, the clay mud contains 0.7% Mn, mud 0.164-0.196%, sandy mud 0.18-0.066% and muddy sand <0.03% Mn.

When examining the vertical distribution of Mn, it is seen that its quantity sharply changes with depth if the color of sediments varies. In pink sediments, the quantity of Mn is considerably greater than in the underlying layers of greenish-gray and gray sediments. The quantity of Mn in the underlying greenish-gray mud varies from 0.013 to 0.077%. Exceptions were noted at stations 31 and 34 which were located near Novaya Zemlya, where the upper layer consists of a somewhat smaller percentage of Mn than in the lower layers.

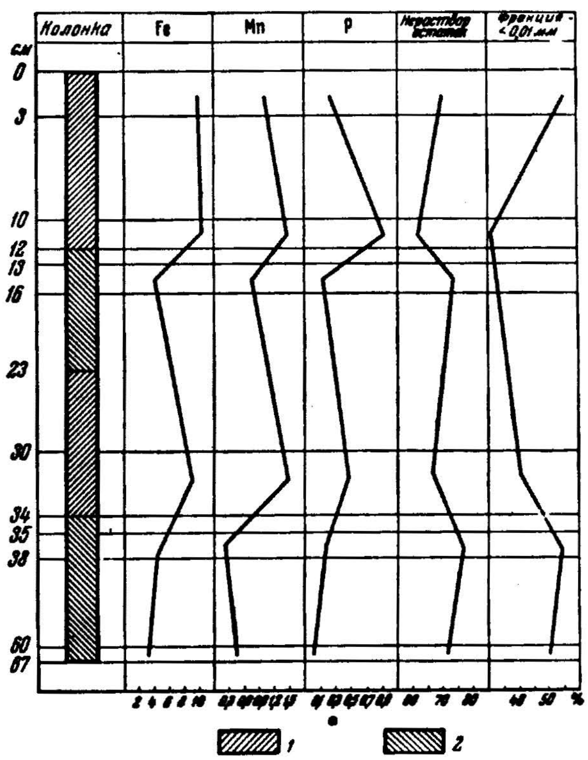

FIG. 4. Vertical variation of percentages of Fe, Mn, P, insoluble residue and fractions smaller than 0.01 mm. in sediment cores taken at M. Gor'kiy station 30.

1 - brown sediments   2 - greenish-gray sediments

Chemical Composition of Kara Sea Sediments

No. of stations	Surface layer of core	Insoluble residue	Fe	Fe_2O_3	P	P_2O_5	Mn
1	2	3	4	5	6	7	8
							M.
1	0—4	71,89	4,91	7,04	0,29	0,66	0,078
2	Bepx	—	—	—	—	—	—
3	0—5	—	—	—	—	—	—
4	Bepx	67,8	9,35	13,35	0,19	0,43	1,57
5	0—5	73,52	6,88	9,83	0,19	0,43	0,87
5	90—95	76,68	3,77	5,38	0,11	0,25	0,072
6	Bepx	79,43	2,31	3,43	0,15	0,35	0,134
7	»	80,55	3,99	5,70	0,039	0,20	0,365
7	»	—	—	—	—	—	—
8	0—2	79,49	4,74	6,77	0,093	0,21	0,62
8	30—33	—	—	—	—	—	—
8	60—65	86,05	2,2	3,14	0,032	0,07	0,022
9	0—3	85,49	4,0	5,71	0,083	0,19	0,287
9	30—33	74,44	3,47	4,96			0,038
9	42—45	80,41	4,30	6,14	0,138	0,310	0,078
9	60—64	84,49	2,71	3,87	0,046	0,11	0,02
10	0—5	70,42	3,89	5,56	0,106	0,24	0,27
11	0—4	74,35	5,85	8,35	0,10	0,23	0,186
13	Bepx	75,61	3,09	4,41	0,094	0,21	0,18
14	0—5	87,9	2,04	2,91	0,052	0,12	0,13
14	11—14	—	—	3,00	—	—	—
14	25—30	76,93	2,31	3,30	0,04	0,09	0,036
15	0—10	78,16	4,19	5,98	0,094	0,21	0,706
15	30—36		3,01	4,30			0,056
16	Bepx	83,81	3,26	4,25	0,07	0,16	0,32
17	0—2	79,1	4,21	6,01	0,116	0,26	0,467
17	10—12	—	—	—	—	—	—
17	30—36	79,82	2,37	3,38	0,044	0,10	0,065
18	0—2	86,28	28,22	4,03	0,063	0,14	0,276
18	6—8	88,50	2,62	3,74	0,067	0,15	0,047
19	Bepx	79,62	2,74	3,91	0,077	0,17	0,237
19	20—22	—	—	—	—	—	—
19	38—42	87,14	2,63	3,76	0,043	0,098	0,24
20	Bepx	87,16	2,71	3,87	0,049	0,11	—
22	»	87,01	1,44	2,05	0,035	0,08	0,036
23	0—3	70,0	6,63	9,47	0,11	0,25	0,16
23	30—33	—	—	—	—	—	—
23	30—33	—	—	—	—	—	—
23	40—43	—	—	—	—	—	—
23	64—67	73,16	2,87	4,1	0,05	0,11	0,04
24	0—5	74,34	5,46	7,8	0,052	0,12	0,066
30	0—3	69,49	9,10	13,0	0,217	0,50	0,93
30	10—12	62,24	9,72	13,88	0,90	2,00	1,27
30	13—15	73,48	3,47	4,96	0,11	0,25	0,80
30	30—34	67,66	8,11	11,60	0,49	0,67	1,39

CONTINUED ON NEXT PAGE

Table 4

(in % relative to the Absolute Dry Weight)

CO_2	C	Percentage of fractions less than 0.01 mm. in sediments	$\frac{C}{100}$ fractions <0.01 mm.	Characteristics of sediments
9	10	11	12	13
Gorkiy				
1,01	0,86	46,7	1,84	Brown mud
0,88	0,92	36,0	1,55	"
0,63	1,34	37,6	3,56	"
0,54	1,01	42,2	2,39	"
0,30	1,02	37,6	2,7	"
0,33	0,85	32,4	2,62	Greenish-gray mud
0,54	0,93	26,62	3,5	Brown-gray sandy mud
0,30	0,70	24,6	2,84	Brown sandy mud
0,35	0,75	28,1	2,66	"
0,21	0,54	24,0	2,25	"
0,33	0,70	35,4	1,97	Greenish-gray mud
0,17	0,50	32,2	1,55	"
0,17	0,47	23,0	1,74	Brown mud
0,53	0,88	50,38	1,74	Greenish-gray mud
0,34	0,40	8,0	4,5	Brown muddy sand
0,71	0,45	29,8	1,51	Sandy mud
0,91	0,85	37,4	2,28	Brown mud
0,43	1,01	41,5	2,43	"
0,55	0,94	28,0	3,35	Yellowish sandy mud
0,22	0,27	18,5	1,46	"
0,25	0,55	34,2	1,6	Clay
0,62	0,51	—	—	
0,21	0,66	49,1	1,34	Brown clayey mud
0,32	0,75	41,7	1,84	Greenish-gray mud
0,26	0,69	28,42	2,42	Brown sandy mud
0,48	0,58	35,02	1,65	Brown mud
0,36	0,35	23,4	1,49	Greenish-gray mud
0,74	0,44	24,6	1,74	Sandy mud
0,22	0,41	27,6	1,48	Brown sandy mud
0,0	0,06	24,2	0,24	Clay
0,42	0,97	18,64	5,2	Brown sandy mud
0,48	0,51	37,90	1,34	Greenish-gray mud
0,37	0,44	18,1	2,43	Greenish-gray sandy mud
0,21	0,53	15,83	3,35	Yellowish sandy mud
0,09	0,23	5,0	4,6	Sand
0,25	1,99	33,38	5,96	Yellowish mud
—	0,89	48,8	1,82	Greenish-gray mud
1,0	1,09	—	—	"
0,67	0,32	—	—	"
0,15	1,12	43,5	2,57	"
0,14	1,21	20,1	6,02	Yellowish sandy mud
0,66	1,01	55,8	1,81	Brown clayey mud
0,66	0,79	26,67	2,95	Grainy brown mud
—	—	—	—	
2,0	0,79	40,8	1,93	Brown mud

Table 4 continued

No. of stations	Surface layer of core	Insoluble residue	Fe	Fe_2O_3	P	P_2O_5	Mn	CO_2	C	Percentage of fractions less than 0.01 mm. in sediments	$\frac{C}{100}$ fractions <0.01 mm.	Characteristics of sediments
1	2	3	4	5	6	7	8	9	10	11	12	13
30	34—38	76,71	4,17	5,96	0,14	0,32	0,13	2,67	0,76	55,4	1,37	Greenish-gray mud
30	60—66	72,8	2,53	3,61	0,056	0,13	0,42	1,75	0,95	51,6	1,84	"
31	1—5	70,04	5,24	7,48	0,104	0,38	0,47	1,13	1,35	33,7	4,00	Gray mud
31	30—35	72,41	5,67	8,1	0,096	0,22	0,119	1,31	1,20	47,0	2,55	"
33	Верх	—	—	—	—	—	—	0,24	1,16	—	—	"
33	10—14	—	—	—	—	—	—	0,36	1,22	42,8	2,85	"
34	1—4	73,22	3,47	4,97	0,103	0,30	0,27	0,03	1,40	29,4	4,76	Brownish-gray mud
34	10—14	75,23	3,13	4,47	0,065	0,116	0,31	1,22	1,17	34,8	3,39	Gray mud
35	0—5	80,71	5,04	7,2	0,19	0,43	0,71	0,82	1,14	68,5	1,66	Brown clayey mud
35	25—30	—	—	—	—	—	0,23	3,77	1,00	70,7	1,41	Bluish-gray clayey mud
35	72—77	72,38	3,74	5,34	0,086	0,19	—	0,76	0,93	54,4	1,71	"
36	0—3	—	—	—	—	—	—	0,64	1,21	42,0	3,00	Brown mud
36	30—33	—	—	—	—	—	—	0,32	1,22	47,8	2,55	Greenish-gray mud
36	60—62	—	—	—	—	—	—	0,87	0,80	40,4	2,00	"
37	0—5	90,87	1,89	2,7	0,068	0,15	0,064	0,11	0,36	8,0	4,5	Brown muddy sand
37	15—17	93,23	1,81	2,6	0,034	0,08	0,113	0,18	0,35	27,8	1,25	Greenish-gray mud
												Sandy mud
38	0—2	80,24	2,86	4,08	0,084	0,19	0,064	0,06	0,72	31,6	2,27	Brown sandy mud
38	29—31	90,72	1,7	2,43	0,03	0,07	0,016	0,17	0,33	29,2	1,12	Greenish-gray sandy mud
40	Верх	86,48	2,18	3,1	0,05	0,11	0,026	0,29	0,51	9,3	5,48	Yellowish muddy sand
41	0—3	66,36	5,25	7,5	0,183	0,41	1,44	0,97	1,66	46,6	3,56	Brown mud (almost claye
42	1—3	78,01	3,4	4,85	0,16	0,36	0,21	0,93	1,22	29,8	4,09	Yellowish sandy mud
42	10—13							0,59	0,93	40,2	2,31	Gray mud
42	60—62	78,04	2,91	4,15	0,064	0,14	0,027	0,81	0,92	37,9	2,42	"
43	0—5	84,86	2,24	3,2	0,069	0,16	0,035	1,15	0,57	29,4	3	Yellowish mud, slightly sand
43	45—48	84,04	2,36	3,37	0,053	0,12		0,88	0,72	37,6	1,9	Greenish-gray mud
44	0—2	68,41	4,84	7,64	0,13	0,32	1,31	0,52	1,43	48,8	2,90	Brown clayey mud
45	Средняя проба	79,74	2,53	3,61	0,072	0,16	0,042	0,74	1,05	33,1	3,17	Yellowish mud
							Osetr					
26	Средняя проба	90,59	2,37	3,4	0,036	0,082	0,017	—	—	14,7	—	Greenish-gray sandy mud
4	То же	86,98	2,18	3,11	0,046	0,105	0,21	—	—	36,1	—	"
5	» »	86,22	2,87	4,1	0,046	0,105	0,02	—	—	16,9	—	"

Evidently, here Mn is of fragmental origin and therefore it does not migrate rapidly from lower layers to the upper ones, as is the case in deep locations where Mn is found in the form of slightly mobile oxides.

St. 30 is of special interest with respect to the vertical distribution of Mn. This was the only bottom sample that had the second brown layer at depths from 23 to 35 m. The quantities of Mn, Fe and P are listed in Table 4 and Fig. 4. The table and figure show that in layer 10-12 cm. the content of Mn, P and Fe_2O_3 is richer than in layer 0-2 cm. The reason for this is that the layer 10-12 cm. has a grainy structure, which is associated with the separation of /85
hydrates of Mn, P and Fe_2O_3. The formation of the lower brown layer is difficult to explain at the present time. It can be assumed that the appearance of the greenish-gray layer at the depth of 13-23 cm. may be associated with specific local conditions creating the restoration of Mn, P and Fe oxides in this layer. This assumption is also confirmed by the fact that in layer 13-15 cm. the quantity of Mn was relatively high, namely, 0.8%. The grainy bottom structure noted in layer 10-12 cm. is associated with the beginning of formation of iron-manganese concretions, which is confirmed by a higher percentage of P and Fe.

The Sadko expedition in 1935 collected bottom sediments in the N part of the Kara Sea. These materials have been partly processed and published in papers by M. M. Yermolayeva (1948 a,b). Several /86
cores whose upper layer contained a brown layer 20 to 30 cm. were taken from St. Anna Trench (Zhelob St. Anny) on meridional cross section from 80° to 81° 10'N along long. 69-70°E. In addition to the upper brown layer, several cores contained another brown layer separated from the upper brown layer by a greenish-gray layer. The lower part of the oxidized upper layer bounding on gray mud, has a grainy structure and a bright orange color. Consequently, the sediments of this cross section are similar to those in the core obtained by us at St. 30.

The Mn, Fe and Ra found St. Anna Trench disclosed increases of these elements in brown layers, especially in layers with a grainy structure, which was also noted by us in sediments at St. 30. On the basis of variations in the quantity of Ra, M. M. Yermolayev assumes that the shifts in brown and gray sediments is associated with variations in the water regime of the Kara Sea; the formation of the upper brown layer may require 3-5 thousand years, while the formation of the second intermediate brown layer may require 10-12 thousand years. This assumption suggested by Yermolayev is, however, not supported by faunal data.

The iron content dissolved in 10% HCL solution was reduced to Fe_2O_3 for these sediments, which corresponds to the status of iron in predominent quantity in the upper layer. Tables 4 and 5 demonstrate that the quantity of iron in the upper sediment layer, as in the case of manganese, is closely associated with mechanical composition and color of sediments. The greatest quantity of iron (more than 10% Fe_2O_3) coincides with the patch of clayey mud lying above the 74th parallel, which characterizes the quantity of manganese in excess of 1%. The remaining part of the Novaya Zemlya Trench is covered by sediments containing more than 5% Fe_2O_3. The same amount of Fe_2O_3 characterizes the sediments lying at the end of St. Anna Trench near the northern tip of Novaya Zemlya, and the sediments at St. 23 and 24 north of O. Dikson, which are also characterized by soft bottom. However, the sediments lying in the southern part of the Kara Sea and in Baydaratskaya Guba, like the yellowish sandy sediments lying north of O. Belyy, contain 2-5% of Fe_2O_3.

According to Table 4 and figures 6 and 4, the brown grainy mud (layer 10-12 cm. at St. 30) contains the highest amount of P--namely, 0.9%, which is probably associated with the grainy structure caused by the concretions of Fe, Mn and P hydrates. In the upper sediments of the Kara Sea bottom, the greatest quantity of P was found in the Novaya Zemlya Trench, where the values vary from 0.19 to 0.27%. Eastward, the P content in sediments decreases to 0.035%. The muddy sediments in the southern tip of St. Anna Trench contain about 0.1% of P, while the yellowish sandy mud of shoaling areas contains 0.049 to 0.093% of P. The great amount of P in the SW part of the Kara Sea was also mentioned in a study written by M. V. Klenova and M. L. Budyanskaya (1940).

It follows from the discussion that the Fe, Mn and P content in sediments is closely associated with themselves and the content of small fractions. Such a conclusion was derived by us also with respect to the sediments of the Barents and White Seas, where we established relationship between the color and chemical composition of sediments (Gorshkova, 1931). It need be noted that, while the quantity of Mn fluctuates from 1.57 to 0.017%, i.e. almost 100 times, the fluctuations in the content of Fe_2O_3 ranges only from 13.35 to 2%, i.e. 6 or 7 times. The P content in sediments varies /87
from 0.9 to 0.035%, i.e. 26 times. In all stations, except for St. 30, the P content decreased with depth, but not so sharply as the Mn content, which was observed by us also in the Barents and White Seas.

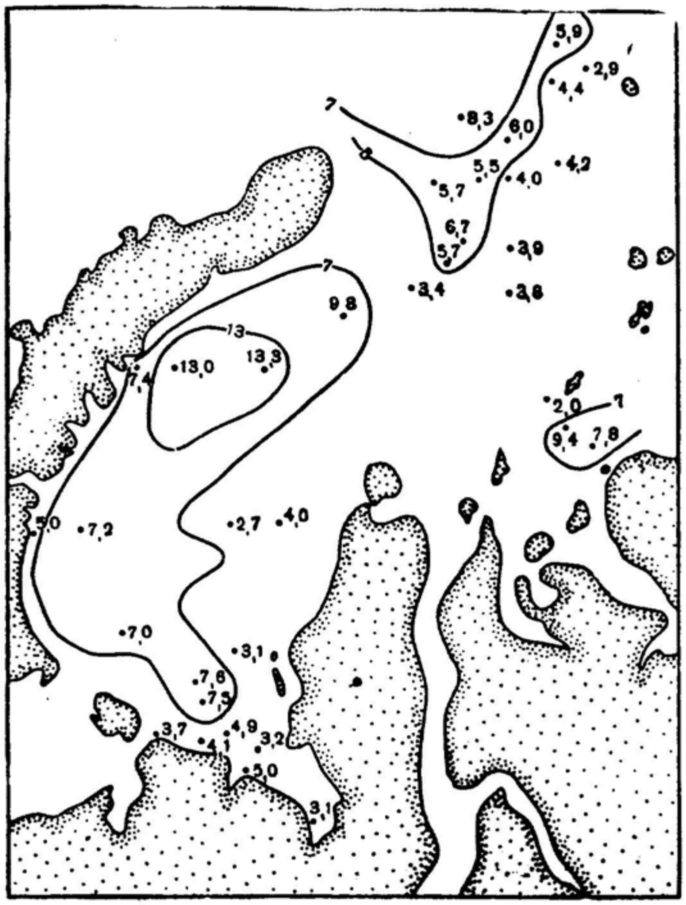

FIG. 5. Percentage of Fe_2O_3 in the upper layer of Kara Sea floor

In addition to Mn, Fe and P, V. I. Kalinenko (1946) found iron bacteria at stations 3, 30 and 35; these bacteria undoubtedly are significant in the formation of iron-manganese concretions, which was noted by V. S. Butkevich for the Barents Sea.

With respect to the investigation of carbonates and organic matter in the Kara Sea, we had the following goals: 1) to find the quantity of carbonates and organic matter in the surface layer of Kara Sea sediments and to investigate their quantitative variations with increase in depth; 2) to associate the concentration of these elements with productivity of the water basin and the color of bottom sediments so that a comparison with the Barents Sea could be made.

The carbon dioxide and organic carbon were determined in the upper bottom layer for 35 stations and in the lower layers for 34 stations. The data of analysis are listed in Table 4 and figures 7 and 8. When examining the chart of carbon distribution in the upper sediment layer (Fig. 7), it need be noted that the quantity of carbon dioxide was insignificant in all the sediments, varying from 1.15 to 0.09%. Near O. Dikson and all the other islands north of it the content of CO_2 was very insignificant, which indicates the absence of carbonaceous rocks on these islands. From Novaya Zemlya toward the center of Kara Sea we observed a decrease in carbonates. The faunal analysis listed below demonstrates that the quantity of calcareous rhizopods is here insignificant indeed. /88

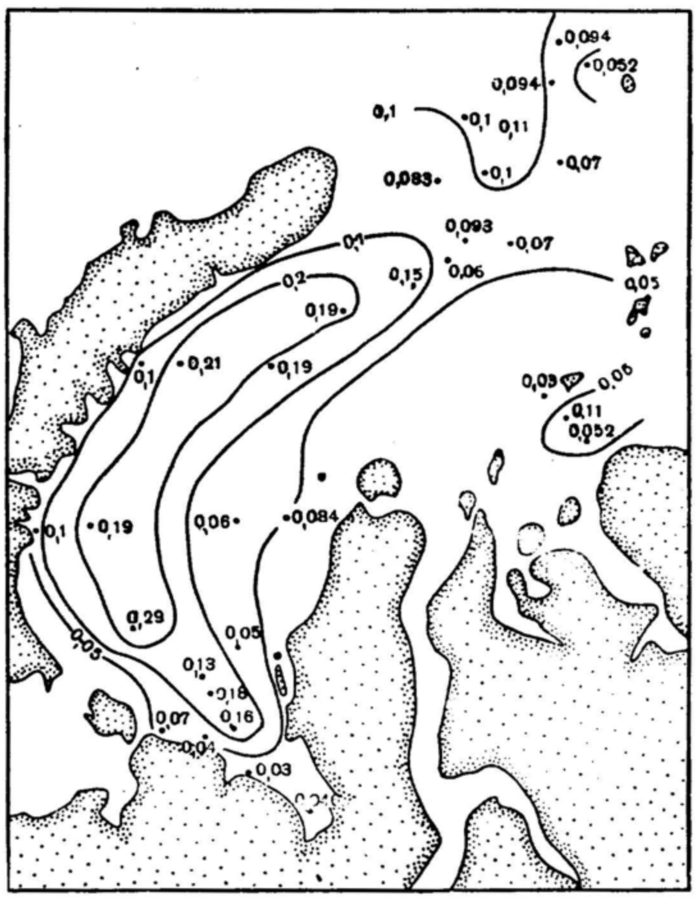

FIG. 6. Percentage of P in the upper layer of Kara Sea sediments

When investigating the variations of carbonates with depth, it is seen that the percentage of CO_2 carbonates is everywhere small. However, at almost all the stations where the upper layer is represented by brown sediments the quantity of carbonates is smaller than in the underlying greenish-gray and gray sediments. Consequently, this situation also confirms our supposition (Gorshkova, 1931) /89 that the quantity of free carbon dioxide in the brown upper layer is greater than in the lower greenish-gray layers, which was proven by A. V. Trofimov (1939) using the actual data. This is very clearly noticeable at St. 30 where 0.66% of CO_2 was observed in the brown layer (0-2 and 10-12 cm.), while in the underlying layers consisting of greenish-gray mud 35-39 and 60-66 cm. thick the values were 2.67 and 1.75% of CO_2, respectively.

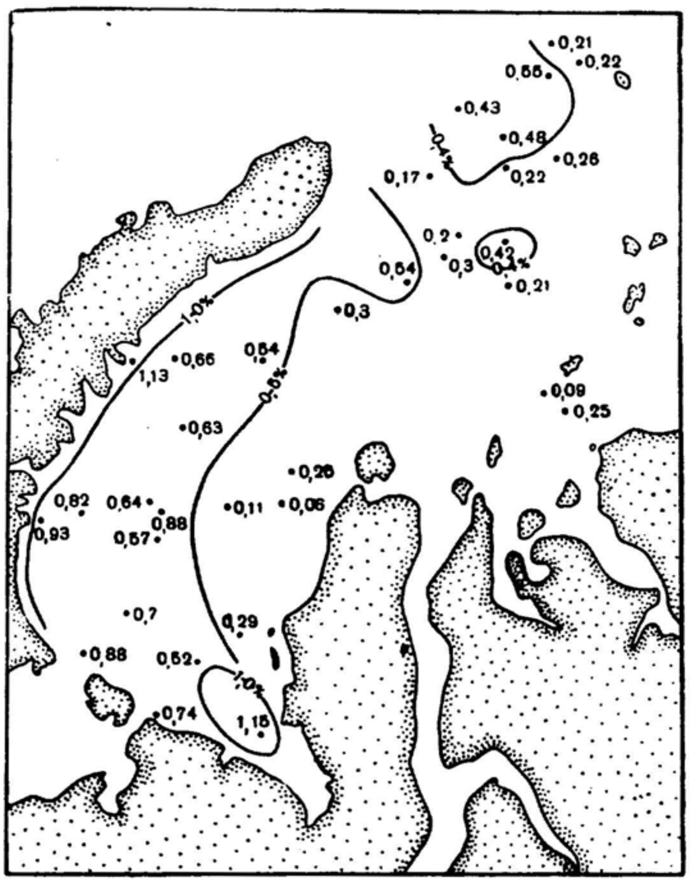

FIG. 7. Percentage of CO_2 in the upper layer of Kara Sea sediments

The quantity of organic matter in the upper layer of Kara Sea sediments is shown in Fig. 8 where one can see that the overall percentage of organic carbon is relatively insignificant, fluctuating from 1.99 to 0.27; further, as in all the other basins, the distance from coast, the mechanical composition and color of sediments is felt here (Gorshkova, 1936, 1937a, 1938). The largest quantity of organic carbon pertains to the coastal stations with brownish-gray sediments.

When investigating the organic matter in various parts of cores, we noticed a trend common for all the seas, i.e. the quantity of organic matter decreases with depth. A very sharp difference from surface layer was observed at St. 18 in layer 6-8 cm., where the /90
presence of clay was noted. The quantity of organic carbon reaches here only 0.06%, and we attributed it to the glacial clay as in the case of the White Sea.

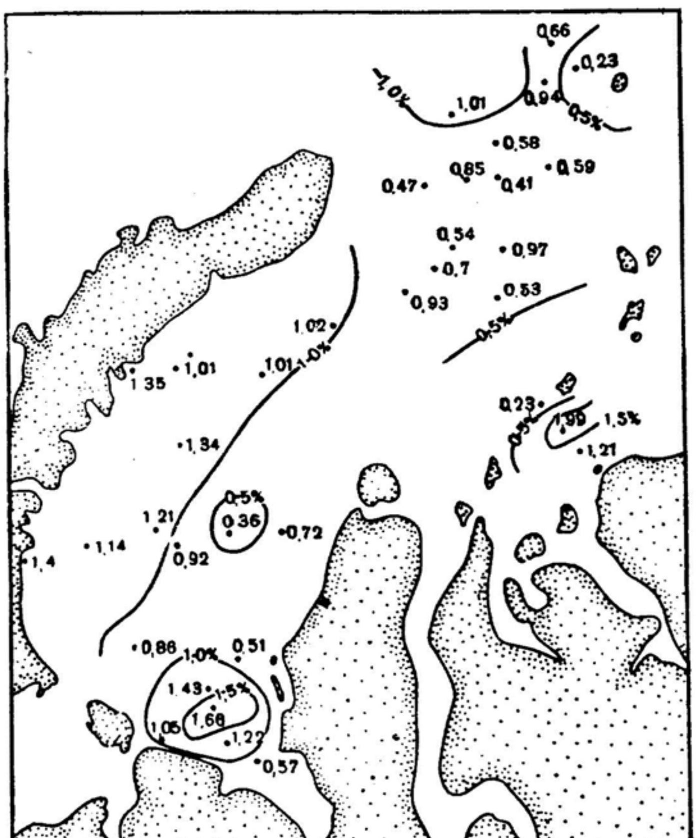

FIG. 8. Percentage of organic carbon in the upper layer of Kara Sea sediments.

Resuming the discussion of carbonates and organic matter, it can be noted that the quantity of carbonates in the sediments of the Kara Sea is similar to that in the sediments of the Barents and White Seas; further, the sources of concentration are here the same as in the Barents and White Seas, i.e. mainly water borne detritus brought from the coast.

When comparing our data on organic carbon in the sediments of the Kara Sea with the benthos biomass listed in a study by Z. A. Filatova and L. A. Zenkevich (1957), one can readily notice a complete relationship between these magnitudes. The same relationship between the organic matter and benthos biomass was found to exist in Motovskiy Zaliv and in the entire Barents Sea (Gorshkova, 1937a, 1938).

In Table 4 are listed data on the quantity of insoluble residue obtained by processing the sediments with the aid of 10% HCL. The quantity of insoluble residue is an inversed value with respect to the quantity of Mn, Fe and P. The smallest quantity (<70%) of /91
dissoluble residue was observed in the patches of clayey mud lying north of 74th parallel and in the Vaygach Trench (Zavaygachskaya vpadina). The largest quantities of insoluble residue, equalling 90%, are contained by sand and muddy sand, which, according to data of mineralogical analysis, are characterized by a predominance of quartz.

4. Horizontal and Vertical Distribution of Microfauna in Sediments.

Z. G. Shchedrina identified foraminifera contained in the upper layer of cores obtained at 24 stations and in the underlying layers of cores obtained at 25 stations. In the larger part of samples the number of identified rhizopods was as follows: a single individual (<2 ind. in a sample*), seldom (2-5 ind.), usually (15-10 ind.), many (11-20 ind.), very many (>20 ind.). In 10 samples all the rhizopods were counted. The data are presented in Table 5 and Fig. 9.

The determination of species of rhizopods enabled us to utilize them as indicators of water masses in the Kara Sea.

*5 g of sediment was considered as a sample.

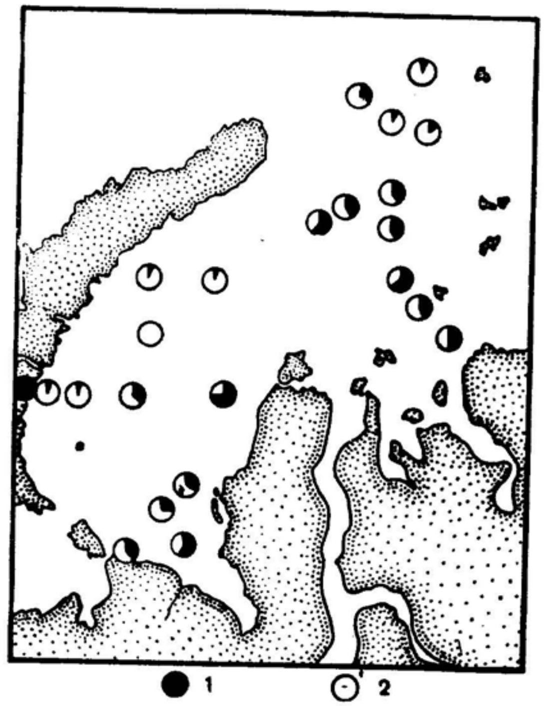

FIG. 9. Distribution of calcareous (1) and sandy (2) foraminifera in the upper layer of Kara Sea sediments.

Table 5 shows the representatives of various complexes singled out by Z. G. Shchedrina (1938) and in her study on foraminifera of the Kara Sea.

I complex of species is typical of shallow cold seas, littoral belts and estuaries of rivers. This complex is represented by Ammobaculites cassis, Verneulina polystropha, Spiroplectammina biformis, Textularia sp., Elphidium gorbunovi, Reophax curtus, which were found at stations 6, 7, 17, 19, 20, 21, 22, 24, 38, 40, 42, 44 and 45, i.e. at stations located in the northern shoal belt and in Baydaratskaya guba.

II complex consists cryophilic forms widely represented in the Kara Sea--namely: Trochammina turbinata, Nonion labradoricum, Nonion orbiculare, Elphidium arcticum, found at stations 2, 4, 6, 7, 11, 13, 19, 20, 21, 22, 24, 32, 35, 38, 40, 42, 44, and 45.

III complex consists of boreal-arctic and boreal forms which are widely distributed in the North Atlantic Ocean and in the abyssal of the Pacific Ocean.

Table 5

Foraminifera in the Sediments of the Kara Sea

No. of Stations	2		3		4		6		7		11		13	16		17		19	20		21	22	24		30	32		35		38		40	42	44		45
Part of core	B	H	B	H	B	H	B	H	B	H	B	H	B	B	H	B	H	B	B	H	cp	cp	B	H		B	H	B	H	B	H	cp	cp	B	H	cp
SAND																																				
Proteonina difflugiformis (Br.)	I	I	—	I	III	—	III	—	—	I	—	—	V	IV	—	II	—	III	III	I	—	—	—	—	I	II	II	I	—	—	—	—	I	II	—	—
Hyperammina laevigata Wright	I	—	—	—	—	—	—	—	II	I	—	—	IV	—	—	II	—	—	—	—	—	—	—	—	II	I	—	I	—	—	—	—	—	—	—	—
H. bradyi Stschedrina	—	—	—	—	I	—	—	—	—	—	—	—	—	II	—	—	—	—	I	—	—	—	—	—	—	II	—	—	—	—	—	—	—	—	—	—
Saccorhiza ramosa (Br.)	III	II	III	—	II	—	II	—	—	—	—	—	III	—	—	III	—	—	—	—	—	—	—	—	II	—	—	V	—	—	—	—	—	—	—	—
Psammatodendron arborescens Norman	II	—	—	—	—	—	II	—	—	—	—	—	—	—	—	—	—	II	—	—	—	—	I	—	—	—	—	—	—	—	—	—	—	—	—	—
Haplophragmoides canariensis (d'Orb)	III	II	—	—	—	—	—	—	—	—	—	—	—	—	—	II	—	—	—	—	—	—	—	—	—	I	—	—	—	—	—	—	—	—	—	—
H. glomeratus (Br.)	—	—	—	—	—	—	—	—	—	I	II	I	V	—	—	II	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Textularia pervula Cushman	II	—	—	—	II	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	III	—	—
Alveolophragmium orbiculatum Stschedr.	—	I	III	I	III	II	II	—	II	—	II	I	IV	IV	III	V	—	II	II	II	II	I	—	—	II	IV	II	III	II	II	II	II	—	III	I	II
Trochammina nana (Brady)	II	—	—	—	II	—	—	—	—	—	—	—	II	—	—	—	—	—	—	—	—	—	—	—	—	I	—	I	—	—	—	—	—	—	—	—
T. karica Stschedrina	II	—	II	II	IV	I	II	—	IV	III	II	—	I	II	—	III	—	III	II	I	—	—	II	I	—	II	I	II	—	—	II	—	—	IV	—	—
T. turbinata (Br.)	—	—	—	—	II	—	—	—	III	II	—	—	II	—	—	—	—	III	II	II	—	—	I	—	—	—	—	—	—	—	—	—	—	III	—	II
Reophax scorpiurus Montf.	—	—	II	II	III	—	—	—	—	—	—	—	V	IV	III	IV	—	III	—	—	—	—	—	—	II	III	—	—	—	II	—	—	I	III	—	—
R. curtus Cushman	—	—	—	—	—	—	II	—	—	—	—	—	—	—	—	—	—	III	III	III	III	III	II	—	—	—	—	—	—	—	—	—	—	—	—	II
Spiroplectammina biformis Park. et Jon.	—	—	—	—	—	—	I	—	III	I	—	—	—	—	—	I	—	II	II	—	—	—	I	—	—	—	—	—	—	II	II	II	II	III	—	II
Verneulina polystropha Reuss	—	—	—	—	—	—	I	—	II	—	—	—	—	—	—	—	—	—	—	—	—	—	I	I	—	—	—	—	—	—	—	IV	II	—	—	IV
Ammobaculites cassis (Daws.)	—	—	—	—	—	—	—	—	II	—	—	—	—	—	—	—	—	III	III	II	—	II	II	—	—	—	—	—	—	—	—	I	—	—	—	II
Rhabdammina abyssorum Carpenter	—	—	—	—	—	—	—	—	—	—	—	—	II	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	II	—	—
Hormosina ovicula Br.	—	—	—	—	—	I	—	—	—	—	—	—	III	II	—	III	—	—	—	—	—	—	—	—	I	I	—	—	—	—	—	—	—	—	—	—
H. globulifera Br.	—	—	—	—	II	—	—	—	—	—	—	—	V	III	—	II	—	—	—	—	—	—	—	—	II	III	—	—	III	—	—	—	—	—	—	—
CALCAREOUS																																				
Nonion umbilicatulus (Walker et Jacob)	II	I	—	II	—	II	—	—	—	—	—	II	I	II	II	I	I	—	—	—	—	—	—	—	—	I	III	I	I	—	—	—	—	—	—	—
N. orbuculare (Br.)	—	—	—	—	—	—	II	I	—	—	—	—	—	—	—	—	—	II	—	II	III	II	—	II	—	—	I	—	—	—	II	II	—	II	—	—
N. labradoricus (Dawson)	—	—	—	—	—	—	I	—	II	II	II	II	I	—	—	—	—	II	—	—	—	—	—	—	—	—	—	—	—	—	I	—	—	I		II
Elphidium arcticum (Parker et Jones)	—	II	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	II	—	—	—	—	—	—	—	—	—
E. goësi Stschedrina	II	—	—	II	—	—	IV	II	II	III	—	—	—	—	—	—	—	II	III	III	III	I	II	II	—	—	III	—	—	III	II	—	II	—	—	—
E. incertum (Will). v. *clavatum* Cush.	II	II	—	II	—	III	II	—	II	II	—	II	I	—	—	—	—	II	—	—	II	II	II	I	—	—	II	—	III	II	—	—	II	—	—	III
E. gorbunovi Stschedrina	—	—	—	—	—	—	—	—	I	—	—	—	—	—	—	—	—	—	I	II	I	II	—	I	—	—	—	—	—	—	—	—	—	—	—	—
Virgulina schreibersiana Czyzec.	—	I	—	—	—	—	III	I	III	II	—	—	—	—	—	—	I	II	II	I	—	—	—	—	—	—	II	—	—	—	—	—	—	I	I	I
Pulvinulina sp.	II	—	—	II	—	II	—	—	—	—	—	—	—	—	II	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cassidulina crassa d'Orbigny	I	—	—	—	—	II	—	—	II	II	—	—	—	—	I	—	—	V	—	—	—	—	II	II	—	—	III	—	II	II	II	—	II		II	III
C. norcrossi Cushman	I	I	—	I	—	IV	—	—	III	II	II	III	—	II	—	—	—	IV	III	I	I	—	—	—	—	II	IV	—	II	II	II	—	—	III	I	II
Cibicides lobatulus (Walker et Jacob)	III	II	—	—	—	I	I	—	—	—	—	—	—	—	—	I	II	—	—	—	—	—	—	—	—	—	V	—	I	I	II	—	—	—	—	—
Eponides karsteni (Reuss)	—	—	—	I	—	II	—	—	—	—	—	II	—	—	—	—	—	—	—	—	—	—	I	—	—	—	III	—	II	—	II	—	—	—	—	—
Globigerina pachyderma Ehrenb.	—	—	—	I	—	—	—	—	—	—	—	II	—	—	—	—	I	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Miliolina herzensteini (Schlumberger)	—	—	—	—	II	—	II	—	—	—	—	—	—	—	—	—	—	—	II	I	—	—	—	—	—	—	II	—	—	—	—	—	—	—	—	—

Designations: I-- less than 2 ind. in 5 g of sediments; II-- 2-5 ind.; III-- 5-10 ind.; IV-- 10-20 ind.; V-- more than 20 ind.; B--upper part of core; H--lower part of core; cp--middle part of core.

In our samples they were represented by Hormosina globulifera (abundant), Haplophragmoides canariensis, Cibicides lobatulus, Rhabdammina abyssorum, Saccorhiza ramosa (abundant), and Reophax scorpiurus, found at stations 2, 3, 4, 6, 13, 16, 17, 19, 21, 30, 32, 35, 38, 42, 44. The presence of these foraminifera shows that they inhabit mostly deep areas of the Novaya Zemlya Trench; /93
only a small number of the animals does reach the southern part of the Kara Sea (St. 44 and 42).

IV complex, the so-called Atlantic group, consists of the following forms, according to our samples: Nonion stelliger, N. umbilicatulus, Cassidulina norcrossi, Globigerina pachyderma, Hormosina ovicula, Haplophragmoides glomeratus, Trochammina globigeriniformis, Elphidium incertum. These species were found at stations 2, 3, 4, 7, 11, 13, /94
16, 17, 19, 20, 21, 22, 30, 32, 35, 38, 44, 45, 30. Like the forms of III group, the representatives of IV group are widely distributed in the areas of our northern stations 11 and 13 and in the Novaya Zemlya Trench, and they reach the southern stations of the Kara Sea, 44 and 45.

On the basis of faunal analysis it is clearly seen that the Atlantic water entering the Kara Sea from the Polar Basin is found in the Novaya Zemlya Trench and in the southern part of the Kara Sea. A small part of the water enters the belt extending along the northern shoals. The fluvial water of the Ob' and Yenisey is distributed mainly along the northern shoal, which was observed by us at St. 17 in the north and at St. 7 in the west.

When examining Table 5 and Fig. 9, it is readily seen that calcareous rhizopods are either absent or found in very small quantities in the upper layer of pink sediments; this is undoubtedly closely associated with the enrichment of pink sediments with the free carbon dioxide which facilitates the dissolution of calcareous skeletons. In the yellowish sediments, on the other hand, the calcareous rhizopods make up a considerable percentage, sometimes even 100% (St. 33). The sand rhizopods in the upper layer constitute the predominant percentage in pink sediments. In the underlying layers the number of sand rhizopods is considerably smaller than in the upper layer; sometimes they are absent. This phenomenon is explained by the dissolution of organic matter that holds the particles of rhizopods.

BIBLIOGRAPHY

1. BEREZKIN, V. A. GRENLANDSKOYE MORE I POLYARNYY BASSEYN, (Greenland Sea and Arctic Basin). Trudy Vysokoskir. eksp. na Sadko v 1935g, Vol. 1, No. 1, 1939.

2. BUTKEVICH, V. S. OBRAZOVANIYE MORSKIKH ZHELEZOMARGANTSEVYKH OTLOZHENIY I UCHASTVUYUSHCHIYE V NEM MIKROORGANIZMY, (The Formation of Marine Iron-manganese Sediments and the Microorganisms Found in Them). Trudy Ilov. Morsk. Nauch. In-ta, Vol. 3, No. 3, 1928.

3. GORSHKOVA, T. I. KHIMIKO-MINERALOGICHESKOYE ISSLEDOVANIYE OSADKOV BERENTSEVA I BELOGO MOREY, (Chemical-mineralogical Investigation of Sediments in the Barents and White Seas). Trudy Gos. Okean. In-ta, Vol. 1, No. 2-3, 1931.

4. ____________. INSTRUKTSIYA PO KHIMICHESKOMY ANALIZY MORSKIKH /96
OSADKOV, (Instructions in the Chemical Analysis of Marine Sediments). Instr. Gos. Okean. In-ta, No. 11, 1933.

5. ____________. KARBONATY I ORGANICHESKOYE VESHCHESTVO V OSADKAKH BARENTSEVA MORYA, (Carbonates and organic Matter in the Sediments of the Kara Sea). Trudy VNIRO, Vol. IV, 1937a.

6. ____________. OSADKI BELOGO MORYA, (Sediments of the White Sea). Pishchepromizdat, 1937b.

7. ____________. ORGANICHESKOYE VESHCHESTVO V OSADKAKH MOTOVSKOGO ZALIVA, (Organic Matter in the Sediments of Motovskiy Zaliv). Trudy VNIRO, Vol. V, 1938.

8. YERMOLAYEV, M. M. O LITOGENEZE PLASTICHESKIKH GLINISTYKH MORSKIKH OSADKOV, (Lithogenesis of the Viscous Clay Sediments in Seas). Izv. AN SSSR, Seriya Geol., No. 1, 1948a.

9. ____________. PROBLEMY ISTORICHESKOY GIDROLOGII MOREY I OKEANOV, (Problems of Historical Geology of Seas and Oceans.) Voprosy Geogr., Vol. 7, 1948b.

10. KALINENKO, V. I. ROL' BAKTERII V FORMIROVANII ZHELEZO-MARGANTSEVYKH KONKRETSIY, (Significance of Bacteria in the Formation of Iron-manganese Concretions). MIKROBIOLOGIYA, Vol. XV, No. 5, 1946.

BIBLIOGRAPHY continued

11. KLENOVA, M. V. OTCHET O RABOTE KOMISSII PO MEKHANICHESKOMU ANALIZU PRI GOSUDARSTVENNOM OKEANOGR. INSTITUTE, (Review of work of Committee on Mechanical Analysis at the State Oceanographic Institute). Byull. Gos. Okean In-ta, Vol. 1, 1936.

12. ___________. OSADKI KARSKOGO MORYA, (Sediments of the Kara Sea). DAN SSSR, Vol. 4(13), No. 4, 1936.

13. ___________ and AVILOV, I. I. INSTRUKTSIYA PO MEKHANICHESKOMU ANALIZU, (Instructions in Mechanical Analysis). Instruktsiya Gos. Okean. In-ta, No. 8, 1933.

14. ___________ and BUDYANSKAYA, M. L. FOSFOR V OSADKAKH SEVERNYKH MOREY, (Phosphorus in the Sediments of North Seas). DAN SSSR, Vol. 28, No. 1, 1940.

15. NORDENSHEL'D, A. PUTESHESTVIYE VOKRUG LEVROPY I AZII NA PAROKHOGE VEGA V 1878-1880 GG., (Travel Around Europe and Asia in Vega During 1878-1880). Translation from Swedish. CPb. 1881.

16. PAKHOMOVA, A. S. KOLORIMETRICHESKIY METOD OPREDELENIYA MARGANTSA N MORSKIKH OSADKAKH, (Colorimetric Method of Determining Manganese in Sea Water). Trudy Gos. Okean. In-ta, Vol. 5(17), 1948a.

17. ___________. MARGANETS V MORSKIKH OSADKAKH, (Manganese in Marine Sediments). Trudy Gos. Okean In-ta, Vol. 5(17), 1948b.

18. SAMOYLOV, YA. V. and GORSHKOVA, T. I. OSADKI BARENTSEVA I KARSKOGO MOREY, (Sediments of the Kara and Barents Seas). Trudy Plov. Morsk. Nauchn. In-ta, Vol. IV, 1924.

19. SAMOYLOV, YA. V. and KLENOVA, M. V. K LITOLOGII BARENTSEVA MORYA, (Lithology of the Barents Sea). Trudy Plov. Morsk. Nauchn. In-ta, Vol. II, No. 3, 1927.

20. SENOV, P. A. K METODIKE ISSLEDOVANIYA KONKRETSIY KARSKOGO MORYA, (The Method of Investigation of Kara Sea Concretions). Problemy Arktiki, No. 2, 1937.

21. TROFIMOV, A. V. OKISLITEL'NAYA AKTIVNOST' I pH of the Brown Sediments of the Kara Seas). DAN SSSR, Vol. 23, No. 9, 1939.

22. FILATOVA, Z. A. and ZENKEVICH, L. A. KOLICHESTVENNOYE RASPREDELENIYE DONNOY FAUNY KARSKOGO MORYA, (Quantitative Distribution of Bottom Fauna in the Kara Sea). In this issue.

23. SHCHEDRINA, Z. G. RASPREDELENIYE FORAMINIFER V KARSKOM MORE, (Distribution of Foraminifera in the ~~Kara Sea).~~ DAN SSSR, Vol. 19, No. 4, 1938.

24. STETSON, N. C. "The Bottom Deposits Scientific Results on the 'Nautilus' Expedition 1931." Papers in physical Oceanography and Meteorology, Vol. III, No. 3, 1933.

25. THOULET, I. ETUDE LITOLOGIQUE DES FONDS RECUEILLIS DANS LES PARAGES DE LA NOUVELLE ZEMBLE. Compagne Arctique de 1907. Brux. 1910.

APPENDIX

Morphological Description of Bottom Cores
obtained by the Kara Expedition in 1945

No. of stations	Depth, m	Coordinates N. L.	Coordinates E. L.	Length of core (cm)	Thickness of core (cm)	Character of sediments
			M. Gor'kiy Stations			
1	104	71°26′	60°15′	90	2	Brown liquid mud
					2	Dense brownish-gray mud
					86	Gray mud with black spots
2	114	72°53′	60°59′	71	3	Brown liquid mud
					68	Greenish-gray mud
3	215	73°54′	62°34′	71	11	Brown mud (dark-brown and grainy at the depth of 10 cm.)
					60	Greenish-gray mud
4	158	74°36′	65°49′	70	2	Brown liquid mud with concretions
					2	Dense brown mud
					66	Greenish-gray mud
5	145	75°13′	69°42′	96	5	Brown mud
					91	Greenish gray mud
6	62	75°28′	72°33′	11	1	Slightly sandy brownish-gray mud
					10	Viscous gray mud (clay)
7	62	75°45′	74°20′	45	5	Brown slightly sandy mud with concretions
					40	Dense greenish-gray mud with black spots
8	114	76°00′	74°23′	67	5	Brown slightly sandy mud
					62	Greenish-gray mud
9	130	76°33′	73°10′	64	5	Brown slightly sandy mud
					38	Greenish-gray mud
					2	Viscous sandy clay
					19	Greenish-gray mud
10	145	76°33′	75°00′	50	5	Liquid brownish-gray mud with stones and concretions
					51	Greenish-gray mud
11	200	77°14′	74°33′	53	1	Liquid brownish mud with stones and concretions
					2	Dense brownish-gray mud
					50	Greenish-gray mud
13	280	77°28′	78°18′	57	3	Liquid brownish-gray mud
					54	Greenish-gray mud
14	72	77°37′	[illegible]°45′	30	1	Brown sandy mud with concretions
					29	Gray clay
15	170	77°56′	78°38′	36	10	Brown clayey mud
					26	Greenish-gray mud
16	104	76°50′	78°46′	43	4	Brown slightly sandy mud with concretions
					39	Greenish-gray mud
17	147	77°00′	76°38′	36	2	Brown sandy mud

APPENDIX continued

No. of stations	Depth, m	Coordinates N. L.	Coordinates E. L.	Length of core (cm)	Thickness of core (cm)	Character of sediments
18	75	76°43′	76°40′	8	2	Brown sandy mud
					2	Brownish-gray mud
					4	Gray clay
19	48	75°54′	76°36′	42	3	Slightly sandy brown mud with large quantities of concretions
					36	Viscous greenish-gray mud
					3	Sandy mud
20	41	75°25′	76°16′	33	0,5	Brownish-gray sandy mud with concretions
					32,5	Viscous greenish-gray mud
21	28	74°52′	77°28′	Bottom grab sample		Fine sand: upper 2 cm. brown, lower--greenish-gray with a small quantity of concretions
22	28	74°22′	77°48′	"		Fine sand
23	31	74°03′	78°46′	67	3	Brown mud
					30	Greenish-gray mud
					34	Mud with black spots
24	37	73°47′	79°46′	44	1	Brownish-gray slightly sandy mud
					43	Greenish-gray slightly sandy mud
30	370	74°38′	62°20′	67	12	Brown clayey mud (at 12 cm. a grainy stratum)
					11	Greenish-gray mud
					12	Brown mud
					32	Bluish-gray clayey mud
31	230	74°37′	60°42′	35	35	Gray mud
32	90	72°54′	56°37′5″	43	3	Brownish-gray mud with stones and concretions
					40	Gray mud
33	22	*Залив Шуберта (кут)		16	10	Gray mud with stones
					6	Gray clay
34	70	72°48′	55°52″5′	34	4	Brownish-gray mud
					20	Gray mud
					10	Viscous clay
35	395	72°48′	58°32′	77	15	Brown clayey mud
					62	Bluish-gray clayey mud
36	177	72°54′	61°20′	62	10	Brown mud
					52	Greenish-gray mud
37	59	72°54′	64°26′	17	1	Brown clayey sand
					16	Greenish-gray slightly sandy mud
38	75	72°42′	66°48′	31	1	Brownish-gray slightly sandy mud

*Zaliv Shuberta

APPENDIX continued

No. of stations	Depth, m	Coordinates N. L.	Coordinates E. L.	Length of core (cm)	Thickness of core (cm)	Character of sediments
38	75	72°42′	66°48′	31	30	Greenish-gray slightly sandy mud
39	90	71°42′	63°29′	47	1	Brown slightly sandy mud with concretions and stones
					46	Greenish-gray mud
40	32	71°00′	64°45′	37	3	Yellowish muddy sand with shells
					34	Gray sandy mud
41	150	70°28′	63°55′	65	3	Liquid brown mud with shells
					62	Greenish-gray mud
42	42	70°00′	64°57′	63	1	Brownish-gray sandy mud
					62	Gray viscous mud
43	28	69°35′	66°10′	48	1	Brownish-gray sandy mud
					47	Gray mud
44	215	70°40′	62°50′	77	10	Brown clayey mud
					67	Black clayey mud
45	75	69°55′	61°25′	Bottom grab sample		Greenish-gray mud with stones
Station Osetr						
A	14	69°48′	61°45′	Bottom grab sample		Viscous sandy mud with stones and shells
B 1	9,8	69°18,7′	65°55′			Sand
C 2	10	69°16′	65°3′			Sandy greenish-gray mud
D 4	8	68°52′	67°30,2′			Same
E 5	40	69°48′	63°36′			"

oo0oo