6.4 Composition of fraction >63 μm of surface sediments from Ob, Taz, and Yenisei rivers and the southern Kara Sea

M.A.Levitan[1,2]

1 – Vernadsky Institute of Geochemistry and Analytical Chemistry RAS, Moscow, Russia;
2 – Shirshov Institute of Oceanology RAS, Moscow, Russia

Introduction

Facies pattern of recent sedimentation traditionally includes the results of joint study of environments and environments' reflection in lithology (grain-size, mineralogy, geochemistry, sedimentation rates, etc.) and taphocoenoses of recent sediments. In this relation a lot of information can be obtained by means of study the composition of sand (and gravel) fractions.

Facts and methods

During the SIRRO R/V "Akademik Boris Petrov" (2001) cruise we have sampled the surface-layer (0-1 cm) sediments of 41 stations (from 39 box-corers and 2 grab-samplers). The volume of individual sample was 50 cm^3. The samples have been undergone to wet sieving through sieves 63 and 125 μm. Then two grain-size fractions (63-125 and >125 μm) have been dried at 105^0C and examined separately under the binocular microscope. A counting has been done in semi-quantitative manner.

Table 6.6: Composition of fr. >125 mkm (%). Surface layer (0-1 cm). Cruise BP-01.

Station	1	2	3	4	5	6	7
17	1	2	10	20	20	35	7
16	1	5	10	7	20	45	7
14	5	20	10	15	20	25	2
12	1	1	2	1	2	3	90
3	0	0	4	5	15	35	40
24	2	2	4	8	31	50	2
26	1	2	2	5	37	48	0

Preliminary results

Our results are represented in Tables 6.5 and 6.6. In both fractions the main components are biogenic remains, rock fragments and mineral grains. The comparison revealed a strong difference between two studied fractions (Fig. 6.14): in general the fraction >125 μm has a much higher amount of biogenic remains and rock fragments than the fraction 63-125 μm. Only several samples of fraction 63-125 μm were enriched in biogenic remains, and in all cases they have been represented by plant remains. All these samples have been obtained from river sediments or from sediments of the marginal filter. In the mineral part of this fraction quartz and feldspars dominate; the amount of mica, black ore (opaque) minerals and coloured transparent minerals – as a rule – has a subordinate significance (Table 6.6). As the fraction >125 μm has a much more diverse composition, we will concentrate our efforts on results of just this fraction.

Table 6.7: Composition of fr. >125 mkm (%). Surface layer (0-1 cm). Cruise BP-01.

Station	6	4	3	2	Black ore	1	5	C.m.+ M	Color min.	Mica
75	42	22	20	10	0	3	0	3	2	1
73	30	20	14	30	0	4	0	4	2	2
72	15	50	23	8	0	4	0	4	3	1
80	8	26	10	15	1	5	35	5	5	0
70	0	7	7	5	0	0	80	0	0	0
82	2	40	30	20	0	4	3	4	3	1
68	0	50	37	3	1	6	2	6	4	2

It should be mentioned that during SIRRO BP01 we managed to reach a more northern latitude (Fig. 6.15) than during 49-th cruise of R/V "Dmitry Mendeleev" (1993) and SIRRO BP00. That is why we got samples from facies zone IID (Levitan et al. 1996) and can divide this zone on two subzones (IID/1 and IID/2). IID/1 sediments cover the northern and north-western slope and rise of the Ob-Yenisei shoal. They are represented by a rather thick (several meters of Holocene) sequence, and characterize the regime of accumulation. IID/2 sediments form a thin veneer (up to first dozen centimeters) drapping a typical glacial topography of the St. Anna Trough bottom northward from IID/1 area. These sediments characterize the regime of transition or very low sedimentation rates.

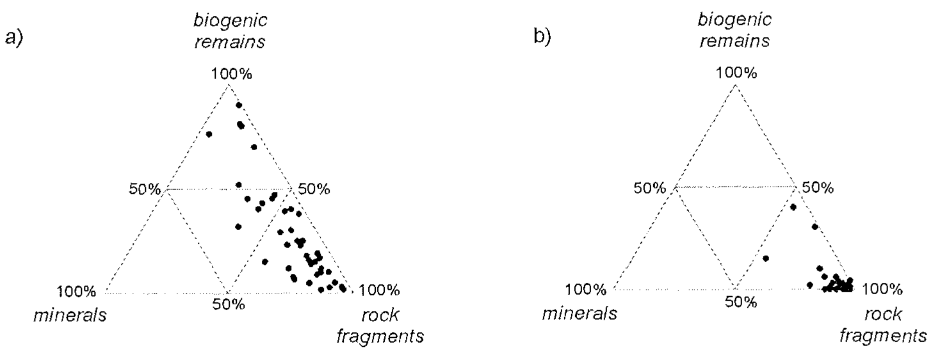

Figure 6.14. Composition of fraction >125 μm (a) and fraction 63-125 μm (b)

The mineral part of the fraction >125 μm consists of the same minerals as were listed above for the fraction 63-125 μm (Table 6.5). The rock fragments mainly include sedimentary and metasedimentary rocks (sandstones, siltstones, shales, schists, ferrigenous crusts, etc.) of sandy size. Rather often these fragments are hematite-stained. Biogenic remains include remains of macrozoobenthos, meiobenthos (polychaets, bivalves, calcareous and agglutinated benthic foraminifers, sponge spicules, ostracods, mollusk (bivalve) clutchs (Table 6.5), and terrestrial macroflora (plant remains, spores and pollen). The plant remains dominate among terrestrial macroflora absolutely. It is quite obvious that a comparison of our data of biogenic remains distribution with literature data on taphocoenoses distribution in trawls or box-corers (grab-samplers) has no sense because of methodical differences.

A composition of the fraction >125 µm is shown on Figure 6.15. An amount of biogenic remains *per se* (or biogenic remains/siliciclastics ratio) cannot be considered in the Kara Sea as the very important facies indicator because of too different nature of these remains (autochtonous for macro- and meiobenthos, and allochtonous for plant remains). The role of this indicator increases within of individual taphocoenosis areas which are shown on Figure 6.15. These areas are distinguished by the dominance of any group of biogenic remains. There are 7 large and 2 small taphocoenosis areas. The north-western area is characterized by the dominance of agglutinated benthic foraminifers (in IID/2 sediments – large (up to 2 mm) ball-like forms) which are accompanied by bivalves and ostracods mainly. For the north-eastern area the dominance of polychaets is typical (sometimes together with bivalves). The central (largest) area is distinguished by bivalves abundance. Bivalves here are accompanied by benthic foraminifers, ostracods, polychaets. The eastern area is characterized by calcareous benthic foraminifers with ostracods. In the western area polychaets are most typical. The northern part of Ob estuary is occupied by polychaets and plant remains. The surface sediments of southern Ob estuary and Taz river are characterized by plant remains (sometimes with ostracods and mollusk clutchs). Plant remains are also most typical for sediments of Yenisei river and Yenisei Gulf. In the sediments of St. BP01-56 polychaets form the dominate group, and St. BP01-66 sediments are characterized by dominance of mollusk clutch.

Such way, we would like to underline the importance of plant remains as facies indicator of sediments which are accumulated in rivers and mixing zones of fresh and sea water (Fig. 6.16) – facies IIa and IIB (Levitan et al. 1996). As we mentioned above, the same is also true for the fraction 63-125 µm. It is clear that this event is related to the land proximity and specific hydrodynamic regime. Other taphocoenoses are due to the peculiarities of food (it's quality and quantity) and feeding mode, sediment's character, hydrodynamics of bottom water, etc. An amount of biogenic remains is also influenced by the siliciclastics' dilution.

A concentration of rock fragments in the fraction >125 µm (Fig. 6.15) can be explained by different mechanisms: riverine supply, coastal abrasion, bottom erosion, sea ice and iceberg melting, dilution by biogenic remains and minerals. For example, amount of rock fragments ca. 20% and higher (Table 6.5; Fig. 6.15, 6.16) in Ob estuary and Yenisei river is due to riverine supply and bottom erosion; in the northernmost part of Ob estuary – to coastal abrasion (?); in St. BP01-28 sediments – to coastal abrasion and first ice melting; in St. BP01-67 sediments – to bottom erosion; in the sediments of north-western and northern slope of Ob-Yenisei shoal (St. BP01-56, 35, 38) – to bottom erosion and high hydrodynamic activity of bottom water. A dilution by biogenic remains can be avoided by recalculation on biogenic-free matter. The results of this operation showed that biogenic dilution was a factor of secondary importance – all listed above areas of enhanced rock fragment abundance remained their locality. Only in the northern part of Ob estuary the area with more than 20% of rock fragments became much larger and occupied this region entirely. We cannot describe the provenance of studied area based on petrography of rock fragments: in most cases these particles are too small for correct determination of the rock type.

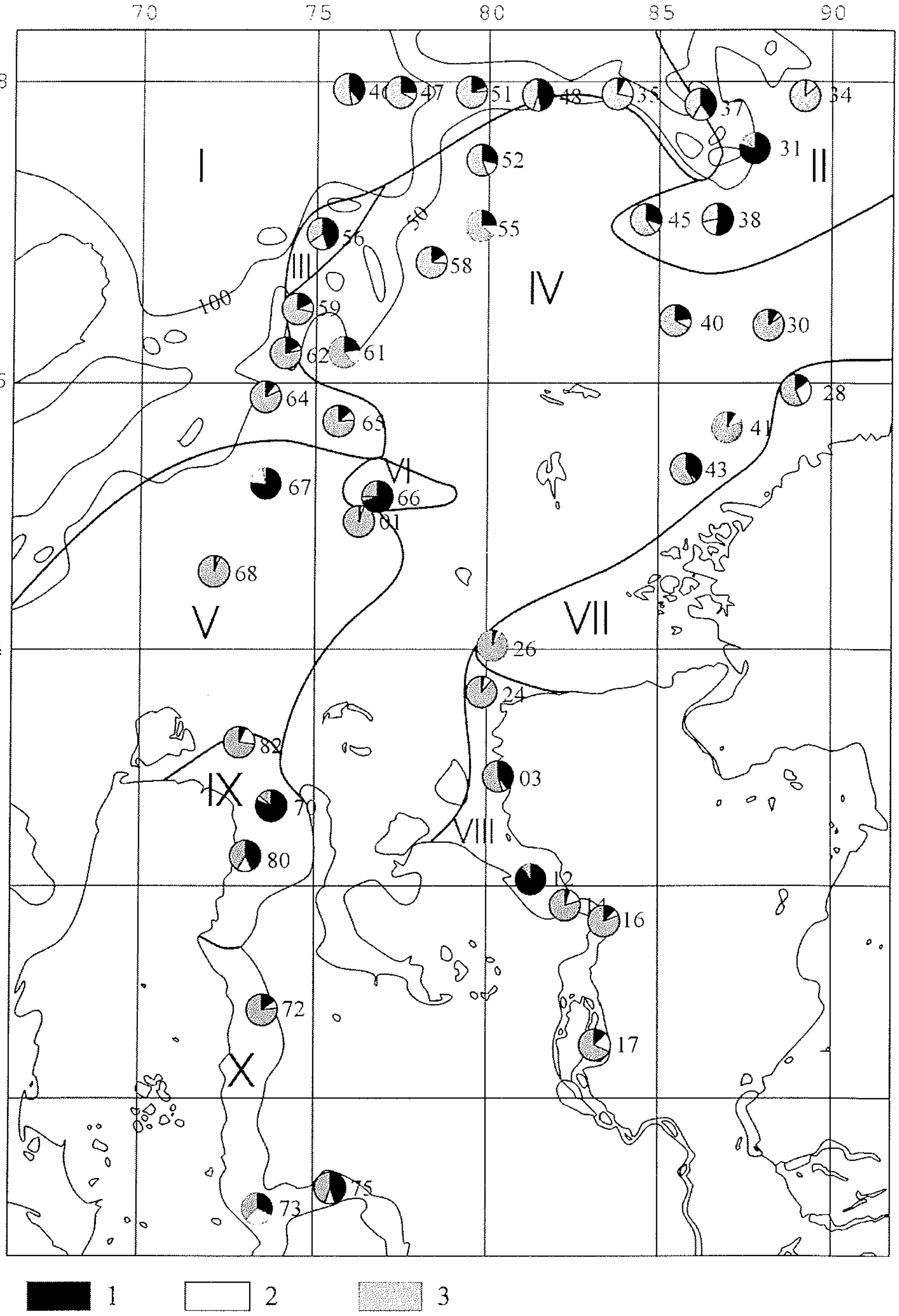

Fig. 6.15. Taphocoenoses and composition of fr. >125 μm. 1 – biogenic remains; 2 – rock fragments; 3 – minerals. Taphocoenoses with dominance of: I – agglutinated benthic foraminifers; II – polychaets; III – polychaets and agglutinated benthic foraminifers; IV – bivalves; V – polychaets; VI – mollusk clutchs; VII – agglutinated benthic foraminifers; VIII – plant remains; IX – polychaets and plant remains; X – plant remains

As a rule, quartz and feldspars dominate among mineral grains in the fraction>125 μm (Table 6.5). We should mention that transparent colourless grains of quartz are the most numerous ones among the quartz grains. This observation is in accordance with the conclusion of Levitan et al. (1998). Mica group is represented by muscovite, biotite and – very rare – by plates of green mica. Usually their abundance doesn't exceed several percent but sometimes (especially, in the fraction 63-125 μm – St. BP01-12) it reachs 15%. The reasons of such event are still unknown.

An important problem is connected with black ore minerals (Table 6.14; Fig. 6.16). They are absent in both sand fractions of Taz, Ob rivers, and Ob estuary sediments. In general there is a positive correlation between amount of opaque minerals in both fractions. We can pay attention to two main areas of black ore minerals concentration in fraction >125 μm. The first area is located in Yenisei river sediments (St. BP01-17) and related to direct supply of these minerals from Putoran basalts. The second area occupies a vast region near Ob-Yenisei shoal break and slope, and probably is related to processes of active reworking of bottom sediments in high energetic environment due to enhanced hydrodynamic activity of bottom water. Recalculation of black ore minerals on biogenic-free matter confirmed this idea.

It is well known that coloured transparent minerals form more rich assemblage in the fraction 63-125 μm than in the fraction >125 μm. The study of heavy minerals in the fraction 63-125 μm now is in progress. The results will be presented later.

Conclusions

Such way, the study of fractions 63-125 and >125 μm brought a lot of information in the understanding of facies pattern in the eastern Kara Sea. Here we would like to underline the role of plant remains as a facies indicator of Taz, Ob and Yenisei fresh waters, and the lack of black ore minerals in Taz and Ob sediments in contrast to Yenisei sediments.

Acknowledgements
The assistance of J.Simstich in sampling is greatly appreciated.
This is grant RFBR # 02-05-64017.

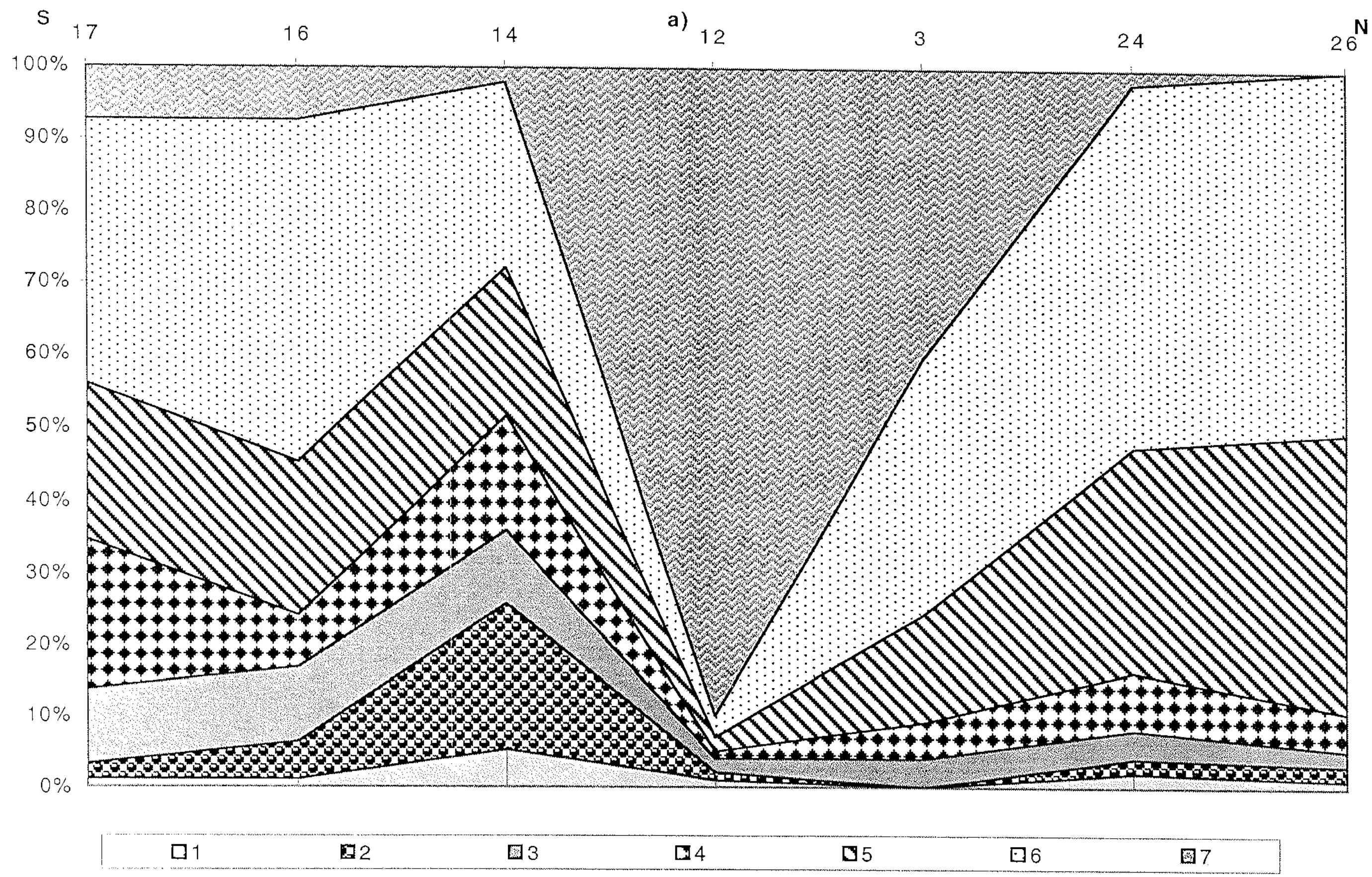

Fig. 6.16. Composition of fr. >125 μm along Yenisei (a) and Ob (b) transects. Fig. 6.16a: 1 – mica; 2 – coloured minerals; 3 – black ore minerals; 4 – rock fragments; 5 – feldspars; 6 – quatrz; 7 – plant remains.

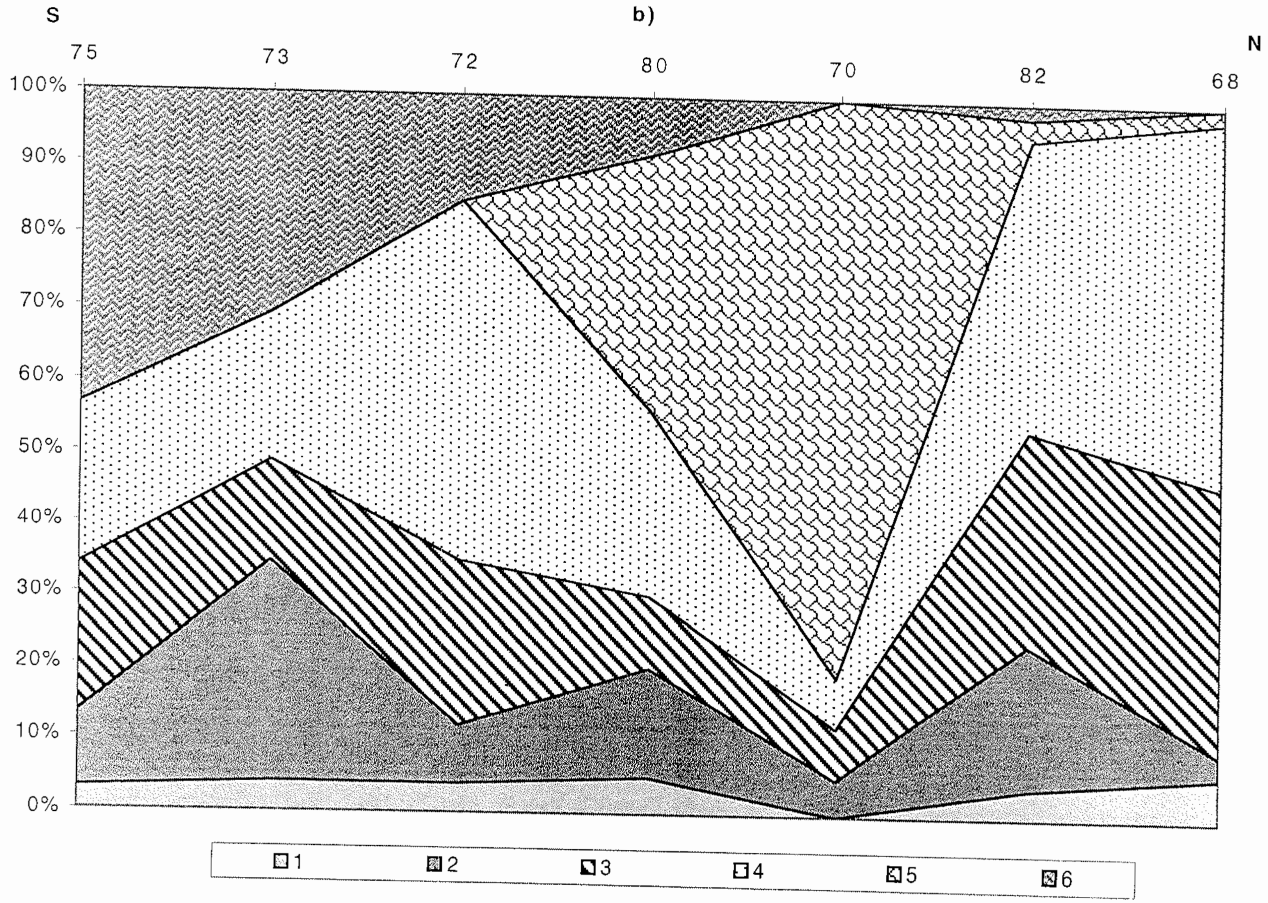

Fig. 6.16b: 1 – sum of mica, coloured and black ore minerals; 2 – rock fragments; 3 – feldspars; 4 – quartz; 5 – polychaets; 6 – plant remains