7.9 Variability of element concentrations in suspended matter and sediments of the Kara Sea and the Yenisei and Ob rivers

Schoster F.[1], Eulenburg A.[1], and Rachold V.[1]

[1]Alfred-Wegener-Institute for Polar- and Marine Research. Bremerhaven/Potsdam. Germany

Introduction

The variability of element concentrations in suspended matter and sediments of the Kara Sea and the Yenisei and Ob rivers is quite high (Lukashin et al. 1999. Schoster et al. 2000). The Ob and Yenisei rivers transport huge amounts of terrigenous material from their sources to the estuaries and into the Kara Sea. Both rivers have large. but different catchment areas. The Ob River mainly drains the Siberian Lowland and the Altai Mountains far south. the Yenisei River mainly the Putoran Mountains with its Triassic Trapp Basalts. which show a significant chemical and mineralogical composition (Churkin et al. 1981, Lightfoot et al. 1990). Therefore, the surface sediments of the Kara Sea show high smectite content and enhanced Ti/Al-, Mg/Al-, Fe/Al-, Cr/Al-, and Ni/Al-ratios compared to the continental crust composition (Taylor and McLennan 1985, Schoster et al. 2000).

Changes in the salinity lead to rapid precipitation of particulate and dissolved material in the estuaries. In this "marginal filter" area mainly fine sediments, organic material and authigenic minerals like Fe- and Mn-oxides accumulate. So we have to distinguish between variability in sediment composition based on different source rocks and variability based on grain size fractionation and chemical processes.

The main objectives of our investigations: 1. Understanding of the distribution of the elements due to exchange reactions between water, suspended matter (SPM). and surface sediments, 2. Determining of the variations of elemental concentrations in sediments of the southern Kara Sea during the time from the last Termination until present time.

1. Major and minor elements in water. suspended matter and surface sediments

In order to understand the distribution of the elements due to exchange reactions between water, suspended matter (SPM) and surface sediments in the Ob and Yenisei rivers and the southern Kara Sea, the distribution of major and minor elements in the different components, water, SPM. and surface sediments will be investigated. In the Kara-Sea Expedition 2000, samples were mainly taken in the Yenisei River and in the adjacent southern Kara Sea (Schoster and Beeskow 2001, Beeskow and Rachold subm.). In the Kara-Sea Expedition 2001, mainly the Ob River and the adjacent southern Kara Sea were sampled. The focus of the examination is to understand the chemical processes in the estuarine environment of the Ob River and to compare it with the processes in the Yenisei Estuary. Variations in element ratios, which are caused by the exchange between dissolved and particulate phases in the transition zone between fresh water and seawater will be studied and interpreted. These data will provide

characteristic signatures for the estuarine mixing zone, which will serve as a basis for paleoenvironmental reconstructions.

Sampling program

Water samples were taken on all stations in three depths:
- surface water: with bucket or a teflon water sampler;
- water of the pycnocline layer: with 24-bottles Niskin rosette sampler;
- bottom water: with 24-bottles Niskin rosette sampler and additional Multicorer-water.

All samples were immediately analyzed for conductivity, salinity, pH-value at 20°C, and alkalinity (Tab. 7.11, Fig. 7.20).

To obtain the river-transported SPM, surface water of every station was filtrated under slight vacuum through preweighted nucleopore filters with a pore size of 0.4 µm. The filters were dried at 40°C for two days. Depending on the sediment load, the volume of filtered water varied from 5 to 40 l. For river water SPM of three depths was separated. Surface sediments were sampled mainly by Multicorer (MUC), otherwise by Okeangrab or Large Box Corer. The samples are stored at 4°C.

Shipboard results

The values of conductivity and salinity increase towards the north, the alkalinity is lower in the river area than in the Kara Sea regions. Measured pH-values show no significant variance. In all regions depth profiles of the water column are mainly characterized by an increase in salinity, conductivity, and alkalinity (Fig. 7.20. Tab. 7.11).

Analytical program

In the laboratory detailed geochemical analyses will be performed. The concentrations of major and minor elements in all components (water, SPM and surface sediments) will be analyzed by Inductive-coupled plasma atom emission spectrometer (ICP-AES), Inductive-coupled plasma mass spectrometer (ICP-MS), Ionic chromatograph (IC), and additionally for sediments by X-ray flourescence spectrometer (XRF).

2. Major and minor elements in sediments of the southern Kara Sea from the last Termination until present

In order to get information about the quality and amounts of input of material into the Kara Sea from the last Termination until the present time, sediment cores from the shelf area will be studied. Major and minor element concentrations and mineralogy are used to characterize the sediments. The surface sediments of the Kara Sea show high contents of smectite and enhanced Ni/Al-, Ti/Al-, Fe/Al-, and Cr/Al-ratios compared to the continental crust composition (Taylor and McLennan 1985). The K/Al- and Rb/Al-ratios are rather low in the Yenisei Estuary. In comparison with the sediment compositions of the Yenisei Estuary K/Al- and Rb/Al-ratios are increased in the Ob Estuary, the other mentioned element/Al-ratios are reduced (Schoster et al. 2000). Therefore, it should be possible to distinguish between major input from one river or

from the other in order to reconstruct the paleoenvironment in the Kara Sea region for the last 12 ka.

Sampling program

The sediment cores were taken with a 3 to 8 m long gravity corer and divided in one meter long sections. They were stored on board at ca. 5°C. At the Alfred-Wegner-Institute the cores will be measured for the magnetic susceptibility. According to this data samples for the determination of major and minor elements and the mineralogy will be taken.

Analytical Program

After drying and grinding the samples will be analysed by XRF to get the major and minor element concentrations. To analyse for clay minerals the samples will be divided into sand, silt and clay fractions by sieving and grain-size fractionating after Atterberg (1912). In the clay fraction the contents of clay minerals will be determined.

Table 7.11: Hydrochemical data (A: surface water. B: pycnocline water. C: bottom near water. D: Bottom-near water. MUC, Teflon-WS: Teflon-water-sampler)

Stationno.	Sampling-device	Depth in m	Salinity	Temperature /Sampling (°C)	Conductivity (mS/cm) $T_{Ref.}$20°C	pH at ca. 20 °C	HCO_3^- (mg/l)
BP 01-01A	Teflon-WS	0.0	26.7	6.3	37.9	7.89	122.38
BP 01-01B	CTD	18.0	29.4	1.3	41.4	7.83	134.96
BP 01-01C	CTD	38.0	33.4	-1.42	46.2	7.58	141.06
BP 01-01D	MUC	38.0	29.4	/	41.7	7.76	132.68
BP 01-03A	Teflon-WS	0.0	4.0	10.7	6.57	7.69	49.94
BP 01-04A	Teflon-WS	0.0	0.0	15.3	0.130	7.86	64.43
BP 01-04C	CTD	18.0	0.0		0.160	7.59	62.14
BP 01-05A	Teflon-WS	0.0	0.0	14.5	0.127	7.89	62.91
BP 01-05C	CTD	11.0	0.0		0.127	7.45	62.91
BP 01-06A	Teflon-WS	0.0	0.0	14.7	0.126	7.60	63.67
BP 01-06C	CTD	14.0	0.0		0.153	7.69	62.91
BP 01-08A	Teflon-WS	0.0	0.0	14.5	0.130	7.86	62.53
BP 01-08C	CTD	27.0	0.0	14.3	0.139	7.64	63.29
BP 01-09A	Bucket	0.0	0.0	13.0	0.169	7.77	51.85
BP 01-09C	CTD	7.0	0.0		0.155	7.80	52.23
BP 01-09C	Teflon-WS	8.0	0.0	12.9	0.171	7.76	51.47
BP 01-11A	Teflon-WS	0.0	0.0	12.8	0.153	7.87	51.85
BP 01-11B	CTD	7.0	0.6		1.335	7.68	-
BP 01-11C	CTD	8.3	0.2		0.782	7.71	-

Stationno.	Sampling-device	Depth in m	Salinity	Temperature /Sampling (°C)	Conductivity (mS/cm) $T_{Ref.}$20°C	pH at ca. 20 °C	HCO_3^- (mg/l)
BP 01-11D	MUC	12.0	21.8		31.5	7.16	110.94
BP 01-16A	Bucket	0.0	0.0	12.8	0.129	7.81	62.14
BP 01-16B	CTD	13.0	0.0		0.121	7.85	59.48
BP 01-16C	CTD	27.0	0.0		0.120	7.84	61.00
BP 01-16D	MUC	28.0	0.0		0.123	7.91	61.76
BP 01-19A	Teflon-WS	0.0	6.0	9.8	9.63	7.70	56.04
BP 01-19B	CTD	5.0	27.6		39.6	7.66	127.72
BP 01-19C	CTD	23.0	32.0		44.9	7.54	139.16
BP 01-23A	Teflon-WS	0.0	4.7	9.8	7.67	7.79	56.81
BP 01-23B	CTD	7.0	17.7		26.1	7.74	91.50
BP 01-23C	CTD	18.0	33.3		46.1	7.64	142.21
BP 01-26A	Teflon-WS	0.0	12.3	8.0	18.57	7.78	77.78
BP 01-26B	CTD	5.5	17.8		26.3	7.73	94.17
BP 01-26C	CTD	30.0	33.1		46.3	7.69	141.83
BP 01-26D	MUC	33.0	25.3 ?		36.3	7.76	117.04
BP 01-28A	Bucket	0.0	23.0	3.6	33.1	7.87	109.42
BP 01-28B	CTD	17.0	29.4		41.4	7.81	133.82
BP 01-28C	CTD	50.0	33.7		46.7	7.82	141.83
BP 01-28D	MUC	51.0	33.7		46.6	7.83	141.44
BP 01-31A	Eimer	0.0	29.4	2.6	41.6	7.8	128.86
BP 01-31B	CTD	15.0	30.4		43.0	7.73	136.49
BP 01-31C	CTD	89.0	34.0		47.2	7.73	141.83
BP 01-31D	MUC	88.0	34.1		47.3	7.82	142.21
BP 01-35A	Bucket	0.0	28.8	3.2	40.2	7.82	128.10
BP 01-35B	CTD	17.0	32.4		44.8	7.85	135.34
BP 01-35C	CTD	150.0	34.7		47.4	7.67	142.21
BP 01-35D	MUC	160.0	34.7		47.4	7.76	143.35
BP 01-38A	Bucket	0.0	29.2	2.9	40.7	7.82	130.77
BP 01-38B	CTD	14.0	32.4		44.6	7.83	139.16
BP 01-38C	CTD	100.0	34.2		46.9	7.72	143.73
BP 01-38D	MUC	110.0	34.0		46.7	7.74	143.73
BP 01-43A	Bucket	0.0	20.6	5.5	30.4	7.83	103.32
BP 01-43B	CTD	10.0	23.9		35.1	7.81	115.90
BP 01-43C	CTD	40.0	33.4		47.5	7.75	142.97
BP 01-43D	MUC	48.0	33.7		46.9	7.78	145.26
BP 01-46A	Bucket	0.0	25.0	4.2	35.6	7.9	118.57
BP 01-46B	CTD	20.0	34.4		47.3	7.96	139.16
BP 01-46C	CTD	300.0	34.9		48.0	7.75	146.02
BP 01-46D	MUC	323.0	34.9		48.0	7.71	144.88

Stationno.	Sampling-device	Depth in m	Salinity	Temperature /Sampling (°C)	Conductivity (mS/cm) $T_{Ref.}$20°C	pH at ca. 20 °C	HCO_3^-(mg/l)
BP 01-46F	CTD	50.0	34.6		47.5	7.8	133.44
BP 01-51A	Bucket	0.0	23.8	4.4	34.9	7.87	117.81
BP 01-51B	CTD	10.0	29.6		42.5	7.95	133.06
BP 01-51C	CTD	140.0	33.8		48.0	7.75	142.21
BP 01-51D	MUC	158.0	33.5		47.6	7.84	142.97
BP 01-52A	Bucket	0.0	25.0	4.3	36.1	7.83	120.48
BP 01-52B	CTD	12.0	29.4		42.5	7.84	133.44
BP 01-52C	CTD	65.0	33.2		47.1	7.74	139.54
BP 01-52D	MUC	75.0	34.1		46.8	7.74	140.30
BP 01-56A	Bucket	0.0	21.7	5.5	31.2	7.86	109.80
BP 01-56B	CTD	16.0	31.9		44.4	7.94	138.78
BP 01-56C	CTD	170.0	34.7		47.7	7.85	141.06
BP 01-56D	MUC	176.0	34.5		48.5	7.86	142.59
BP 01-59A	Bucket	0.0	22.0	5.3	31.4	7.84	114.38
BP 01-59B	CTD	16.0	29.9		41.4	7.83	135.73
BP 01-59C	CTD	165.0	34.5		47.1	7.75	141.06
BP 01-59D	MUC	176.0	34.4		47.0	7.71	143.35
BP 01-62A	Bucket	0.0	23.1	4.8	33.4	7.91	113.61
BP 01-62B	CTD	12.0	29.4		41.0	7.87	128.10
BP 01-62C	CTD	120.0	34.2		47.1	7.79	134.20
BP 01-62D	MUC	135.0	33.9		47.4	7.78	143.35
BP 01-65A	Bucket	0.0	18.9	6.5	27.5	7.88	105.23
BP 01-65B	CTD	8.0	26.9		37.9	7.87	125.05
BP 01-65C	CTD	50.0	33.6		46.3	7.69	141.06
BP 01-65D	MUC	63.0	33.3		46.2	7.66	143.35
BP 01-66A	Bucket	0.0	13.2	7.1	19.77	7.61	86.16
BP 01-66B	CTD	10.0	26.6		37.4	7.83	124.29
BP 01-66C	CTD	45.0	33.4		45.9	7.64	139.54
BP 01-66D	MUC	55.0	33.5		46.2	7.63	141.83
BP 01-67A	Bucket	0.0	11.2	7.5	16.69	7.92	86.93
BP 01-67B	CTD	6.0	23.8		34.1	7.88	117.43
BP 01-67C	CTD	40.0	32.8		45.6	7.65	140.30
BP 01-67D	MUC	49.0	33.3		46.0	7.66	138.01
BP 01-68A	Bucket	0.0	9.8	7.9	15.11	7.66	84.64
BP 01-68B	CTD	6.0	21.4		31.1	7.64	110.56
BP 01-68C	CTD	20.0	32.1		45.2	7.48	138.78
BP 01-68D	MUC	31.0	32.7		44.8	7.62	140.30
BP 01-70A	Teflon-WS	0.0	0.7	9.4	1.533	7.46	42.32
BP 01-70B	CTD	7.0	29.9		40.7	7.41	130.01

Stationno.	Sampling-device	Depth in m	Salinity	Temperature /Sampling (°C)	Conductivity (mS/cm) $T_{Ref.}20°C$	pH at ca. 20 °C	HCO_3^-(mg/l)
BP 01-70C	CTD	15.0	31.0		42.8	7.46	135.73
BP 01-70D	MUC	22.0	29.8		42.3	7.5	146.40
BP 01-72A	Teflon-WS	0.0	0.0	11.4	0.09	7.42	39.27
BP 01-72A	Bucket	0.0	0.0		0.10	7.61	38.89
BP 01-72C	CTD	20.0	0.0		0.116	7.53	39.65
BP 01-73A	Teflon-WS	0.0	0.0	12.4	0.099	7.51	54.14
BP 01-73C	CTD	9.0	0.0		0.101	7.64	53.76
BP 01-73D	MUC	15.0	0.0		0.119	7.42	67.86
BP 01-74A	Bucket	0.0	0.0	?	0.03	7.06	19.83
BP 01-75A	Bucket	0.0	0.0	10.4	0.04	7.37	22.11
BP 01-77A	Bucket	0.0	0.0	11.4	0.029	7.19	22.88
BP 01-78A	Bucket	0.0	0.0	12.4	0.116	7.55	73.58
BP 01-79A	Bucket	0.0	0.0	12.1	0.104	7.62	56.43
BP 01-80A	Teflon-WS	0.0	0.7	8.7	1.522	7.73	44.23
BP 01-80B	CTD	7.0	11.1		16.95	7.29	83.11
BP 01-80C	CTD	10.0	22.1		31.7	7.36	115.14
BP 01-80D	MUC	16.0	24.0		34.3	7.38	121.24
BP 01-82A	Teflon-WS	0.0	10.0	6.7	15.8	7.70	77.39
BP 01-82B	CTD	7.0	23.6		33.5	7.55	117.81
BP 01-82C	CTD	20.0	33.1		45.1	7.49	139.54
BP 01-82D	MUC	29.0	32.8		45.0	7.44	140.30

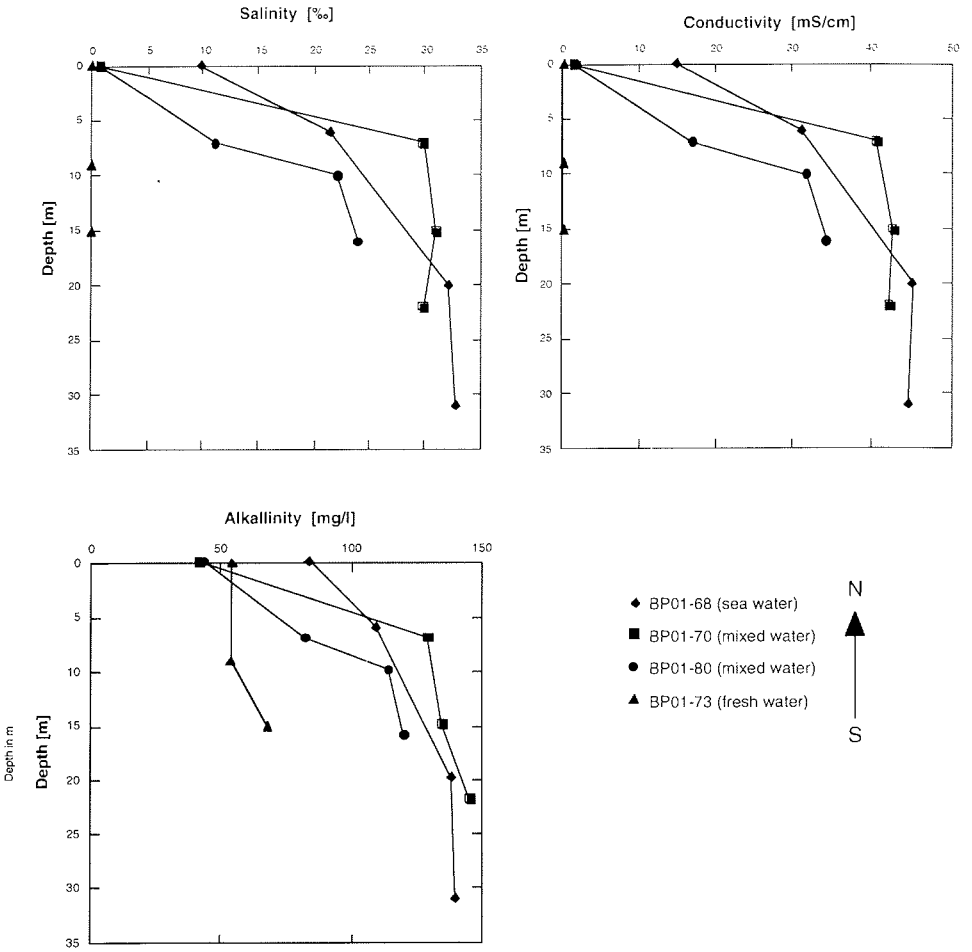

Figure 7.20: Hydrochemical parameter of the Ob Estuary.