We wish to thank academician V.V. Vlasov (Institute of Chemical Biology and Fundamental Medicine, Novosibirsk) for overall scientific support and discussions. Thanks are extended to people from the Ministry of Environment of Sakha Republic (Yakutia) who helped us with the field work.

References

Abyzov S.S., Bobin N.E., Kudryashov B.B., 1979. Microbiological studies of a glacier in Central Antarctica. Izv. AN SSSR. Ser. Biol., No. 6, 828–836.

Ashcroft F., 2000. Life at the Extremes. University of California Press, Berkeley, 326 pp.

Bakulina N.T., Spektor V.B., 2000. Paleoclimate reconstructions for the Neogene of Yakutia from spore-pollen data, in: G.N. Maksimov, A.N. Fedorov (Eds.), Climate and Permafrost [in Russian], Institute of Permafrost, Yakutsk, pp. 21–32.

Baranova Yu.P., Ilyinskaya I.A., Nikitin V.P., et al., 1976. The Miocene in the Area of Mamontova Gora [in Russian]. Nauka, Moscow, 284 pp. (Transactions, GIN SO AN SSSR, Issue 233).

Brushkov A.V., Vlasov A.N., Merzlyakov V.P., et al., 1995. The effect of local phase transitions on deformability of plastic-frozen soils. Geoekologiya. Inzh. Geologiya, Gidrogeologiya, Geokriologiya, No. 5, 71–77.

Clein J.S., Schimel J.P., 1995. Microbial activity of tundra and taiga soils at subzero temperatures. Soil Biol. Biochem., 27, 1231–1234.

Ershov E.D. (Ed.), 1988. Geocryology of the USSR. European Part [in Russian]. Nedra, Moscow, 358 pp.

Friedmann E.I., 1994. Permafrost as microbial habitat, in: Viable Microorganisms in Permafrost, Rus. Acad. Sci., Pushchino, pp. 21–26.

Greenblatt C.L., Davis A., Clement B.G., et al., 1999. Diversity of microorganisms isolated from amber. Microbial Ecol., 38, 58–68.

Katayama T., Tanaka M., Moriizumi J., et al., 2007. Phylogenetic analysis of bacteria preserved in a permafrost ice wedge for 25,000 years. Appl. Environ. Microbiol., 4, 2360–2363.

Lozina-Lozinsky L.K., 1972. Essays on Cryobiology [in Russian]. Nauka, Leningrad, 288 pp.

Markov K.K. (Ed.), 1973. Section of Modern Deposits of Mammoth Mountain [in Russian]. Moscow University Press, Moscow, 190 pp.

Nicholson W.L., Munakata N., Horneck G., et al., 2000. Resistance of Bacillus endospores to extreme terrestrial and extraterrestrial environments. Microbiol. Mol. Biol. Rev., 64, 548–572.

Repin V.E., Pugachev V.G., Taranov O.S., et al., 2008. Potential hazard from microorganisms coming from the past, in: G.G. Boeskorov, A.N. Tikhonov, N. Suzuki (Eds.), The Yukagir Mammoth [in Russian]. St. Petersburg University, St. Petersburg, pp. 183–190.

Schelchkova M.V., 2009. Thermodynamic indicators of active invertase from buried Late Pleistocene soils in northern Yakutia. Sib. Ekol. Zhurn., No. 2, 195–201.

Willerslev E., Cooper A., 2005. Ancient DNA. Proc. Roy. Soc. B., 272, 3–16.

Received
10 February 2011

Kriosfera Zemli, 2011, vol. XV, No. 4, pp. 87–90 **http://www.izdatgeo.ru**

ORGANIC COMPONENTS IN BOTTOM SEDIMENTS FROM THE LOWER YENISEI, THE GYDA BAY, AND THE KARA SEA SHELF

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Samples of bottom sediments from the Yenisei lower reaches, the Gyda Bay, and the Kara Sea shelf have been analyzed for organic carbon and nitrogen. The contents of both organic carbon and organic nitrogen depend on the grain size of sediments and are controlled by deposition conditions (sedimentation rates, provenance, etc.). The carbon-to-nitrogen ratios (C/N), as well as the carbon isotope composition ($\delta^{13}C$), indicate the terrigenous component in organic matter to decrease off the shore. The vertical patterns of the same parameters have implications for the steadiness of sedimentation.

The contents and changes of organic components in bottom sediments of the Arctic seas can provide clues to many issues, such as features of the organic carbon cycle in a given area, high-latitude lithogeny, paleogeography and past climate change, the contribution of the Arctic seas into the current methane cycle, etc. [*Romankevich and Vetrov, 2001; Levitan et al., 2007; Shahova et al., 2009*]. Although many publications on the subject have been available, any new information from the hardly accessible Arctic terrains is of special interest.

Below we report data on bottom sediment samples collected in August through October 2009 from the lower reaches of the Yenisei, the Gyda Bay, and the Kara Sea shelf. See Fig. 1 for the location map of sampling sites and main results. Sixty samples, in-

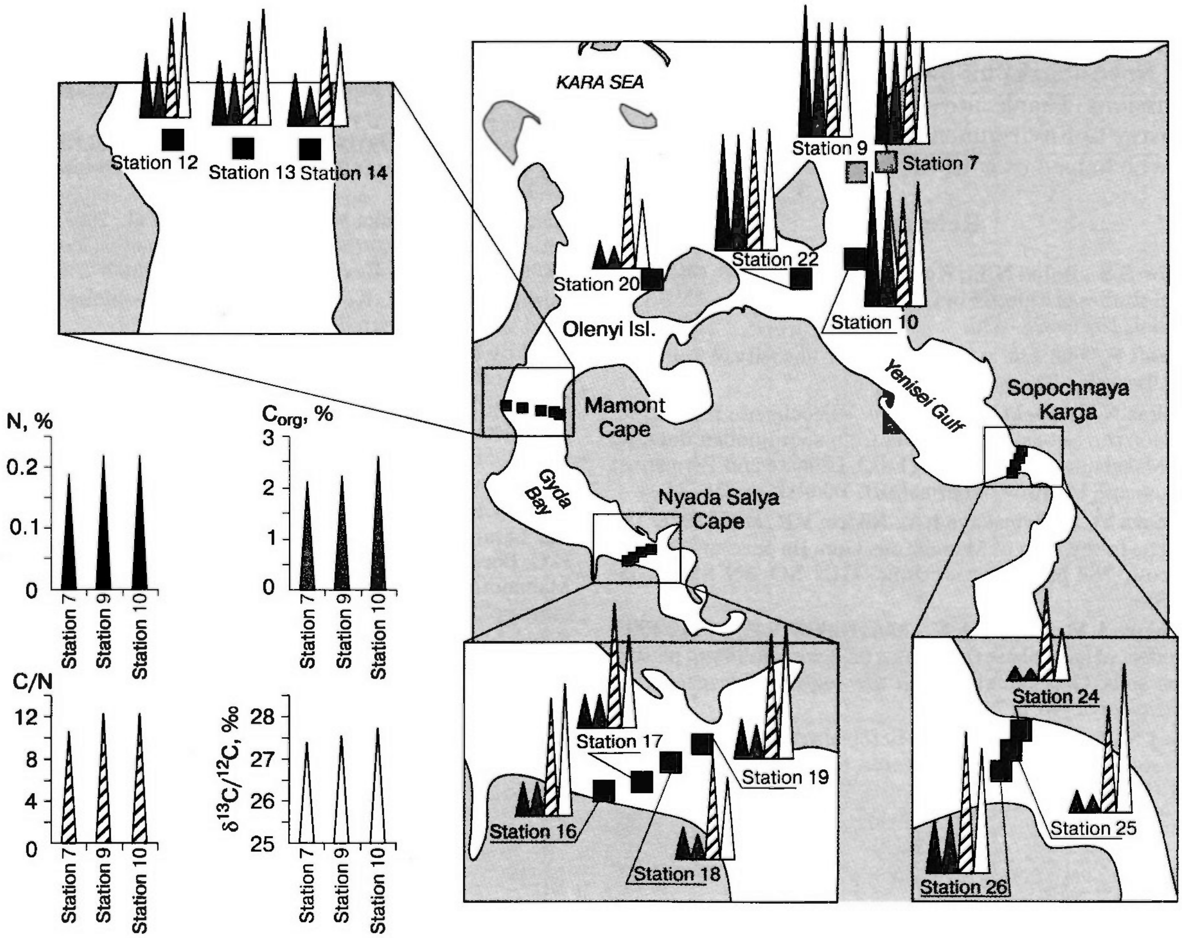

Fig. 1. Location map of sampling sites in lower Yenisei, Gyda Bay, and Kara shelf, with contents of organic nitrogen (N_{org}) and organic carbon (C_{org}), C_{org}/N_{org} ratios, and carbon isotope composition ($\delta^{13}C/^{12}C$) in surface bottom sediments.

cluding six cores from 18.5 to 75 cm long and ten samples from the bottom surface, were analyzed for the concentrations of organic carbon (C_{org}) and nitrogen (N_{org}) and for $\delta^{13}C/^{12}C$ ratios ($\delta^{13}C$) relative to the VPDB (Vienna Pee Dee Belemnite) standard. The carbon and nitrogen contents were determined using gas chromatography with a catarometer (elemental analysis, Euro Vector Acetanilide) to an accuracy at least 0.01 % and 0.02 % (standard deviations for N_{org} and C_{org}, respectively); $\delta^{13}C$ was measured by isotope-ratio mass spectrometry, to a precision no worse than 0.12 ‰ (measured on the Aldrich citric acid standard). The results are reported as means of two runs for each sample.

The nitrogen and carbon concentrations vary from 0.015 to 0.221 % (N_{org}) and 0.14 to 2.60 % (C_{org}), the range spanning more than an order of magnitude. The C_{org} range approaches that in marine sediments from the southwestern Kara Sea (0.13 to 2.10 %) [*Belyaev et al., 2010*]. The minimum concentrations are from the bottom surface at a freshwater station (site 24) and the maximum ones are from marine sediments at site 10 (Fig. 1). Bottom sediments at offshore sites (7, 9, 10, 22) consist of pelitic material and, correspondingly, are notably richer in both elements relative to freshwater sediment sites. For instance, N_{org} and C_{org} in the core of site 9 are more than twice that in the Gyda Bay cores (Fig. 2). The only offshore site with low N_{org} and C_{org} is station 20 near Sibiryakov Island in rather sandy sediments. The sediments at freshwater site 24 which contain the lowest amounts of N_{org} and C_{org} likewise differ in a high sand percentage. These results agree with published evidence of rather high C_{org} in pelitic sediments from the relatively deepwater part of the Yenisei Gulf (up to 1.85 % [*Lein et al., 1996*]) and from the depocenter of the tidal mixing front of river-borne and transformed marine waters (up to 2.5–3.0 % [*Kodina et al., 2009*]).

The ratio of organic carbon to organic nitrogen (C/N) has implications for the origin of organic matter (OM) in bottom sediments. The C/N ratios we

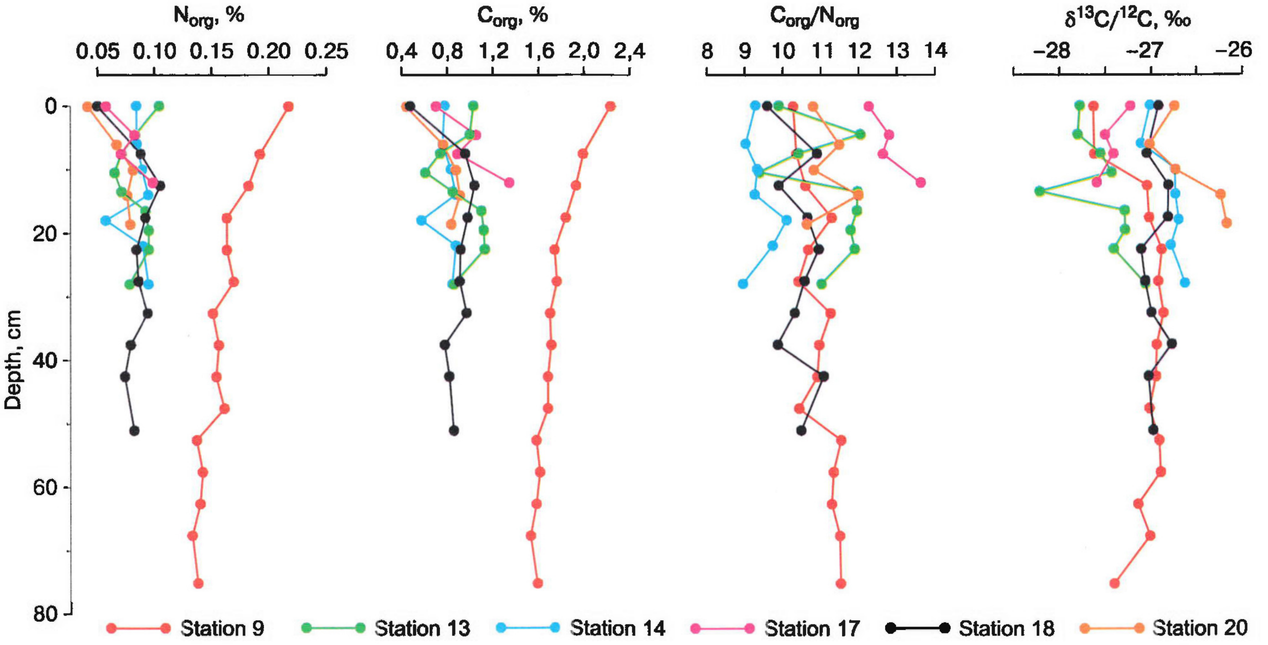

Fig. 2. Vertical patterns of organic carbon and nitrogen contents (C_{org} and N_{org}) and ratios (C_{org}/N_{org}), and carbon isotope composition ($\delta^{13}C/^{12}C$) in surface bottom sediments of lower Yenisei, Gyda Bay, and Kara shelf.

obtained vary from 8.9 at site 24 to 13.5 at site 26, both stations being located within the same Yenisei profile. The difference may be due to sediment provenance. Namely, sediments from site 26, which is located at the swampy Gyda Peninsula and, especially, on the shallower left bank of the Yenisei where most of river-borne particulate matter is deposited, contain a greater percentage of terrigenous OM. The high terrigenous input to sediments at station 26 is consistent also with the carbon isotope composition (see below). The C/N ratios at site 24 are low, possibly because both organic components (N_{org} and C_{org}) are very low there (see above). At the other stations, this ratio is markedly larger (10.0 to 11.5, see Figs. 1, 2) indicating quite a high percentage of terrigenous organic matter. High C/N ratios (12.3) were measured at site 13 where organic input is with the relatively large Gyda and Yuribei rivers and waters that drain the swampy land nearby.

The C/N ratio commonly increases with depth due to leading decomposition of nitrogen-bearing organic compounds. In the cores we analyzed, the downward increasing pattern is restricted to offshore site 9, where a steady sedimentation is supposed. C_{org} and N_{org} in the core from site 9 decrease with depth while the C/N ratio grows slowly (Fig. 2). The vertical patterns in all other cores are rather chaotic and record random changes in sedimentation conditions. In the Gyda Bay these changes may be associated with river-borne and paludal terrigenous fluxes, while at offshore station 20 the terrigenous input may be from neighbor Sibiryakov island.

The maximum and minimum $\delta^{13}C$ values were measured in bottom surface samples. They range from −28.5 ‰ in the lower Yenisei (site 26) to −26.2 ‰ in the Kara shelf (site 20) (Fig. 2) following the typical seaward $\delta^{13}C$ gradient. Low $\delta^{13}C$ are known to characterize terrestrial organic matter, but isotope data from high-latitude regions cannot provide unambiguous evidence of OM genesis [*Kodina et al., 2009*]. A similar $\delta^{13}C$ of −28.7 ‰ was reported from the Ob estuary (Kara Sea) [*Kodina et al., 2001*]. The seaward trend of progressively higher $\delta^{13}C$ in the zone of Yenisei influence (from −27.9 ‰ $\delta^{13}C$ in the estuary fresh water to −22.4 ‰ offshore [*Kodina et al., 2009*]) may result from metabolic activity of heterotrophic microorganisms in the stratified water column and from a notable input of secondary biological production. The vertical profile of $\delta^{13}C$ is quite uniform (Fig. 2).

Thus, the contents of organic nitrogen and carbon in the lower Yenisei, Gyda Bay, and Kara shelf sediments depend on the sediment provenance. The C/N ratios, as well as the carbon isotope composition, record a seaward decrease in the terrigenous input to organic matter. The vertical patterns of the same parameters indicate steady sedimentation to be restricted to a single offshore site in the Kara Sea. Deposition in the Gyda Bay occurred at changeable conditions, possibly, associated with riverine and paludal sediment input.

We wish to thank A.A. Fedotov and I.V. Tomberg from the Limnological Institute, Irkutsk for the sampling work. The study was carried out as part of Project 20.7 ("Integrate studies of the Arctic shelf. Permafrost and Arctic shelf in a changing climate; stability of ecosystems and gas hydrates; organic matter disposal") of Program 20 of the Presidium of the Russian Academy of Sciences.

References

Belyaev N.A., Peresypkin V.I., Ponyaev M.S., 2010. Organic carbon in water, particulate matter, and surface bottom sediments in the western Kara Sea. Okeanologiya, 50 (5), 748–757.

Kodina L.A., Lyutsarev S.V., Bogacheva M.P., 2001. The isotope composition of organic carbon in ice-rafted material as a provenance indicator for the Arctic drift ice, in: An Experience of Systematic Oceanographic Studies in the Arctic [in Russian]. Nauchnyi Mir, Moscow, pp. 244–255.

Kodina L.A., Stepanets O.V., Galimov E.M., 2009. Isotope geochemistry of organic matter and radioactivity in the Kara Sea, in: The System of the Laptev Sea and the Arctic Fringing Seas [in Russian]. Moscow University, Moscow, pp. 122–136.

Levitan M.A., Lavrushin Yu.A., Shtain R., 2007. The History of Deposition in the Arctic and in the Subarctic Seas for the Past 130 kyr [in Russian]. GEOS, Moscow, 404 pp.

Lein A.Yu., Rusanov I.I., Savvichev A.S., et al., 1996. Biogeochemical processes associated with sulfur and carbon cycles in the Kara Sea. Geokhimiya, No. 11, 1027–1044.

Romankevich E.A., Vetrov A.A., 2001. Organic fluxes into the Russian Arctic seas, in: An Experience of Systematic Oceanographic Studies in the Arctic [in Russian]. Nauchnyi Mir, Moscow, pp. 227–243.

Shakhova N.E., Sergienko V.I., Semiletov I.P., 2009. The contribution of the East Siberian shelf into the present methane cycle. Vestnik RAN, 79 (6), 507–518.

Received
13 February 2011

Kriosfera Zemli, 2011, vol. XV, No. 4, pp. 90–92 **http://www.izdatgeo.ru**

WATER CHEMISTRY AND PHYTOPLANKTON IN THE GYDA BAY (KARA SEA)

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Presented are water chemistry and phytoplankton (abundance and biomass) data from the Gyda Bay, an underexplored area of the Kara Sea. Water chemistry varies over the bay being controlled by the tributary rivers in its southern and central parts and by the Kara Sea in the northern part. Correspondingly, the water has extremely low total dissolved solids (32 to 250 mg/l) in the former and a much higher salinity (up to 6600 mg/l) in the latter. Phytoplankton consists mostly of diatoms. Its distribution patterns correlate with the seawater salinity, the highest abundance and biomass of algae being found in the more freshwater part of the Gyda Bay.

The Gyda Bay located in the southern Kara Sea between the Ob Bay and the Yenisei Gulf is a ~200 km long and ~62 km wide gulf that cuts deep into the Gyda Peninsula. The sea in the Gyda Bay is rather shallow (5–8 m), with many banks. This is an area of harsh Arctic climate, with an open-water season shorter than 80 days. The bay receives water from the Gyda (Nyarmesalya) River and other smaller tributaries flowing into it from the south [*Treshnikov, 1985*].

Integrate offshore studies in the Gyda Bay were carried out in September 2009. Surface and bottom waters were sampled from the more freshwater southern part (sites 16–19) and the more saline northern part (sites 11–15) of the bay (Fig. 1).

Water chemistry was analyzed following the classical procedures [*Bordovsky and Ivanenkov, 1978; Wetzel and Likens, 1991; Baram et al., 1999*]. The phytoplankton samples were collected and studied with common hydrobiological methods [*Utermöhl, 1958; Guseva, 1959; Kozhov and Melnik, 1978*] and with scanning electron microscopy (on a *Phillips SEM 525* microscope).

Water chemistry in the Gyda Bay varies over the area. Water is of low salinity in the southern part, which is fed by the Gyda and Yuribei rivers as well as by numerous brooks flowing out of lakes. Total dissolved ions measured in samples from stations in the middle of the southern profile (17, 18) varied from 32 to 56 mg/l, and the ion composition was