Permafrost researchs report of Russia 2017

The main results

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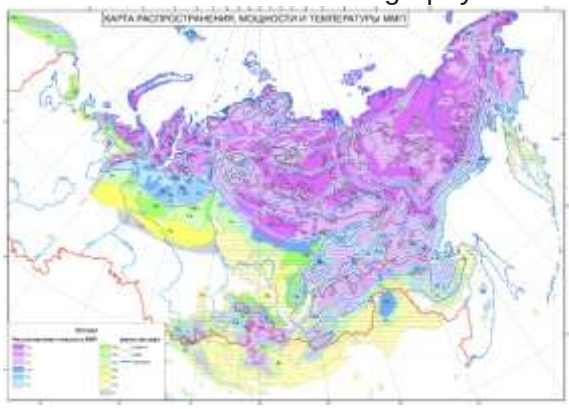
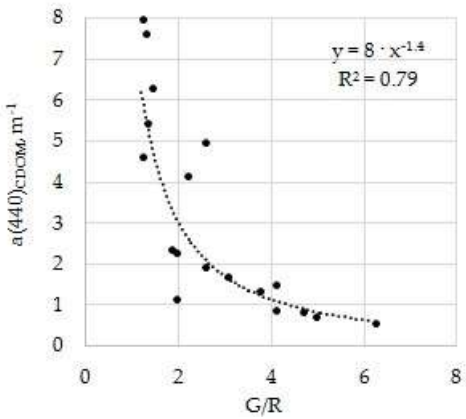
Earth Cryosphere Institute, Tyumen Scientific Centre, Siberian Branch, Russian Academy of Science (**ECI Tyumen Scientific Centre SB RAS**)

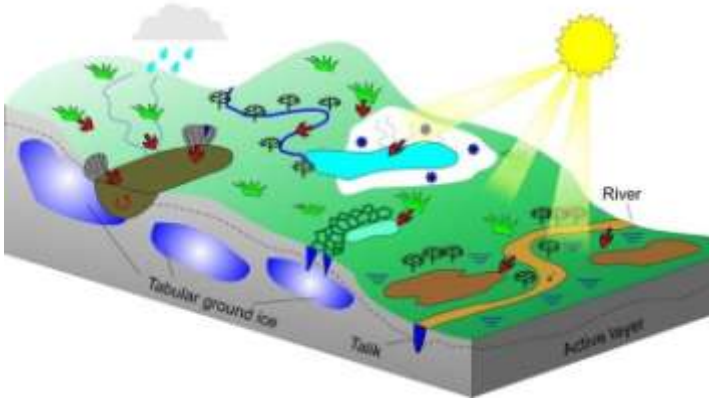
1. The set of geocryological small-scale maps (1: 16 000 000) for the Arctic Region of the Russian Federation and the cryolithozone of Eurasia inclusive the permafrost conditions at the beginning of the 21st century was compiled as a whole. The set was placed in the National Atlas of the Arctic. - Roscartography Moscow, 2017. - 496 p.



2. Occurrence of thermocirques in the coastal rim of lakes is the most important control on lake CDOM in the region (Yamal Peninsula). Terrestrial organic matter input from thawed permafrost makes the lakes with thermocirques outstanding compared with other lakes. It remains unclear what would be the lake CDOM of these impacted lakes after the stabilization of thermocirque development. Analysis also shows, that big floodplain lakes connected to the Mordy-Yakha river receive more organic matter, which should be studied further in detail. We didn't find a significant correlation between catchment slope and lake CDOM. But likely lakes significantly incorporated to the terrain through all geomorphological levels can also receive more organic matter due to higher topographical gradient.

Remote sensing and GIS are important techniques for retrieval of lake and lake catchment characteristics and this geospatial data is important as variables to investigate the statistical relationships within "lake – lake catchment" system. In this study we have used high resolution GeoEye-1 and WorldView-2 multispectral satellite images in order to derive a(440)CDOM values. Further application of freely available Landsat-8 and Sentinel-2 images with a sufficient radiometric and spatial resolution can be used for the assessments of terrestrial and water ecosystem interactions in a larger spatial extent. This can also be a source of lake parameters in a lake models.





(Dvornikov Yu., Leibman M., Heim B., Bartsch A., Herzschuh U., Skorospekhova T., Fedorova I., Khomutov A., Widhalm B., Gubarkov A. & Rößler S. (2018) Terrestrial CDOM in lakes of Yamal peninsula: connection to lake and lake catchment properties. Submitted to Remote Sensing)

3. A technique for microscopic study of the CO_2 hydrate formation and growth in the liquid phase has been developed. Experimental evidence confirmed the possibility of the CO_2 hydrate growth from the dissolved gas in the liquid phase is obtained. The rates of lateral growth of CO_2 hydrate along the liquid-gas interface and the normal growth of CO_2 hydrate in the volume of the liquid phase are measured.

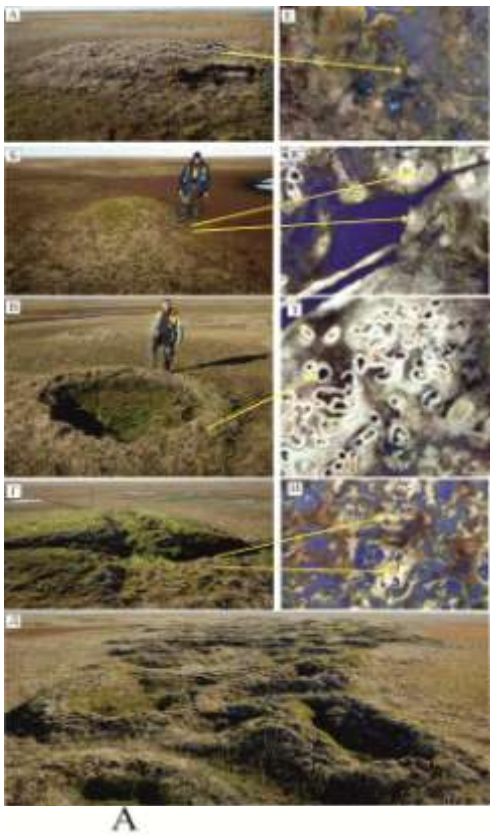
4. A technique for NMR analysis to determine the content of unfrozen water in frozen samples has been developed: the suspension of the microorganism cells which were isolated from permafrost (CMMW), the suspension of the CMMF metabolites and frozen aqueous solution of a high molecular weight cryoprotectant (PVA). It was established for the first time that the metabolites of microorganisms isolated from permafrost contained in frozen aqueous substance, can have a great influence on the content of unfrozen water than the well-known high-molecular cryoprotectants.

5. Development of ecologically clean heat-insulating material from diatomite and recommendations for using this material in adverse geocryological conditions

5.1. According to the research on ground frost heaving amount which were protected from freezing with a layer of granular foam-glass ceramics, in comparison with the material used traditionally as a heat insulator (extruded polystyrene foam) and with the ground without a heat-insulating layer, it was established:
- the use of heat-insulating layers of granular foam-glass ceramics and extruded polystyrene foam gives a similar pattern of temperature distribution in the ground and a reduction in the depth of freezing in comparison with sand without insulation from 26 to 7 cm;
- the deformation of the sand heaving without insulation was 1.65 mm, whereas in the experiments with extruded polystyrene foam and granulated foam-glass ceramics, on the contrary, compression of the ground was observed and the freezing rate of the upper layers is reduced 1.6 times.

5.2. During the annual monitoring of the experimental section of the motorway: Beskozobovo-Evsino-Lamensky, 47 + 540 km - 47 + 690 km (Golyshmanovsky district, Tyumen region) with frost protection layer made of granular foam-glass ceramics, the depth of ground freezing in the road structure was reduced from 187 up to 100 cm.

6. The pioneering study of the morphology and structure of frost mounds on Bely Island in the Kara Sea, which also includes radiocarbon dating of peat and determinations of carbon isotope composition of peat and gas inclusions in ice, crystalline structure of ice, and sediment particle size distributions. By their shape, the identifi ed frost mounds are grouped into cone-shaped, toroid-shaped, thaw-weakened frost mounds crosscut by polygonal network, and perennial fl at-topped palsas with ice core. Modern palsas are distributed in laida zones regularly fl ooded by sea waters. Cone- and toroid-shaped frost mounds represent relict permafrost landforms developed in the Late Holocene. Relict frost mounds in Western Yamal and on the Arctic islands can indicate coastal-marine settings of their growth on low elevations in the Late Holocene.



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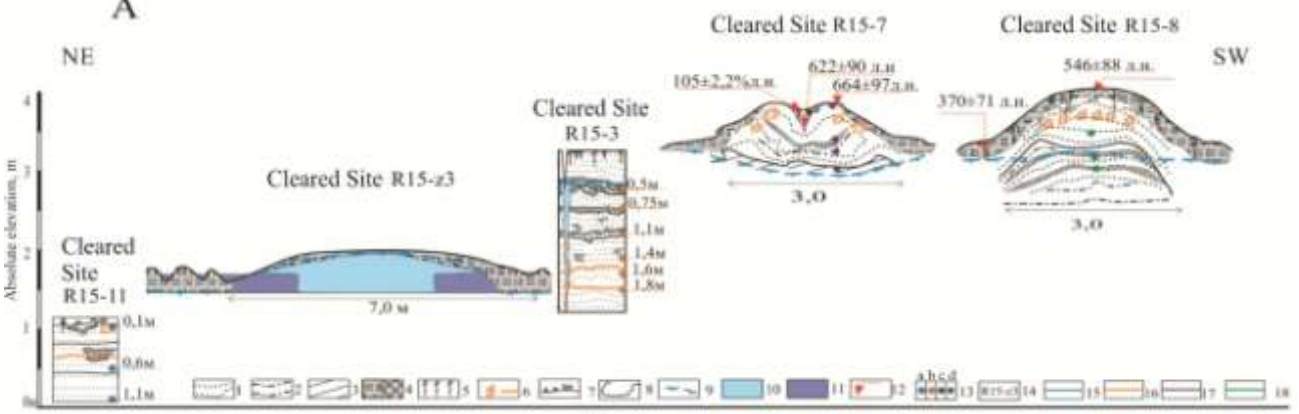

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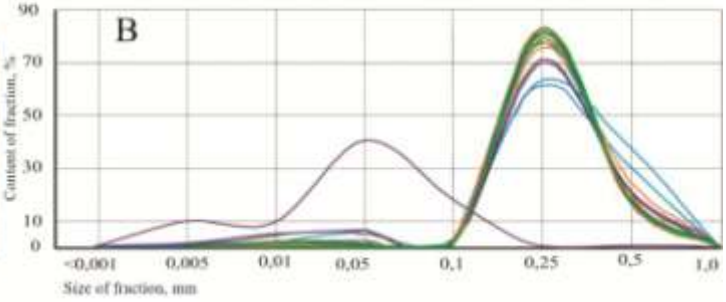
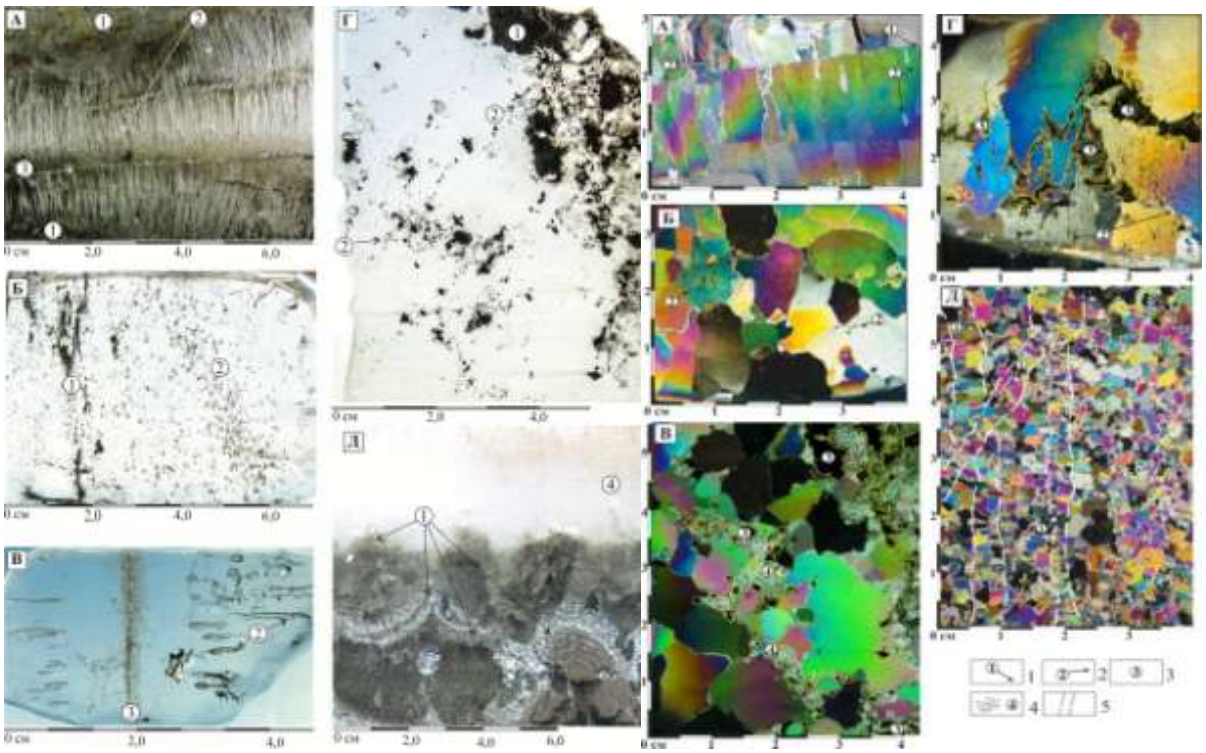


7. The features of texture and structure of new ice formed in the thawing cavities, some cracks were determined. The differences in structure of the late Holocene ground ices and ground ices of the early Holocene and late Pleistocene were defined. The quantitative parameters of the crystal structure can be
used to identify closed-cavity ice and crack ice in the composition of massive ice and determine mechanisms and conditions of formation before the Holocene ice wedges.



8. The first time received the data confirming ideas about the shift of typical tundra to the North during the Holocene climatic optimum.
The change of plant species diversity in buried turf of Bely Island reflects changes in the landscape under the influence of climatic conditions. The optimal conditions for the growth of birch - relatively warm and without excessive moisture, were gradually developing between 7820±130 and 5206±97 yr BP. Conditions were deteriorated between 3775±105 and 2924±102 yr BP. In the Atlantic period of the Holocene borders of birch existence were shifted [3], and subzone of typical tundra was moved to the north - on Bely Island.

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Melnikov Permafrost Institute, Siberian Branch, Russian Academy of Science (MPI SB RAS, Yakutsk) http://mpi.ysn.ru/en/

Selected Research Results

Ice-rich yedoma (ice complex) landscapes, which comprise 335,000 sq. km or about 11 percent of Yakutia, are highly sensitive to climate warming and anthropogenic disturbances. A study by the MPI's Laboratory of Permafrost Landscapes led by A. Fedorov estimated that loss of ice-rich permafrost in central Yakutia ranged from 0.09 m^3 in relatively undisturbed areas to 0.57 m^3 per

m^2 in disturbed areas since the early 1990s. The amount of carbon released from these thawing sediments was assessed to range from 0.23 to 1.44 kg per m^3. The group conducted physico-geographic regionalization of the permafrost landscapes underlain by permafrost with wedge ice and compiled a 1:1,500,000-scale map of yedoma distribution *(Fig. 1)*.

Ulrich M., Wetterich S., Rudaya N., Frolova L., Schmidt J., Siegert C., Fedorov A.N., Zielhofer C. (2017). Rapid thermokarst evolution during the mid-Holocene in Central Yakutia, Russia. The Holocene. doi:10.1177/0959683617708454 10.

Basharin N., Fedorov A. 2017. Evaluation of thermokarst development in Central Yakutia under changing climate. Cryosols in Perspective: A View from Permafrost Heartland. Proceeding of the VII International Conference on Cryopedology (August 21-28, Yakutsk, Sakha (Yakutia) Republic, Russia). Yakutsk, pp. 16-18.

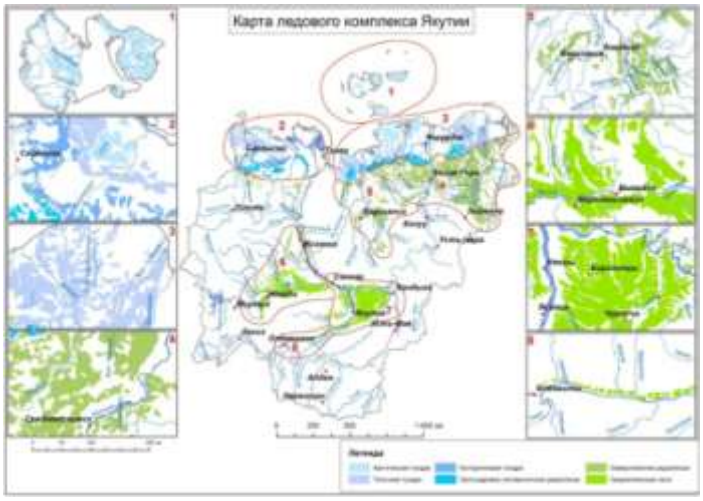


Fig. 1. Map showing the ice complex (yedoma) distribution in Yakutia.

Drilling from the ice surface of lagoons on the Bykovsky Peninsula in the Russian eastern Arctic (M. Grigoriev and G. Maximov, MPI Laboratory of General Geocryology) revealed the occurrence of unstable permafrost with complex interstratification of frozen and unfrozen ground below lagoons *(Fig. 2)*. In a relatively warm and highly saline environment, both frozen and unfrozen layers are on the brink of changing their state to thawed or frozen condition. Most lagoons are paleolakes which attained a lagoonal regime due to rapid erosion of ice-rich seacoasts.

Grigoriev M.N., Maximov G.T. (2017). The formation and distribution of permafrost under Arctic lagoons. 2017. Proceedings of the Russian National Conference, Environmental Processes in the Earth's Polar Regions in the Global Warming Epoch, Sochi, Russia, 9-11 October, 2017, p. 44 (in Russian).

Angelopoulos M., Overduin P.P., Grigoriev M., Westermann S., Grosse G. (2017): The effects of changing boundary conditions on modelled heat and salt diffusion in subaquatic permafrost offshore, Siberia. CSDMS Annual Meeting, Modeling Coupled Earth and Human Systems. The Dynamic Duo, Boulder Colorado, USA.

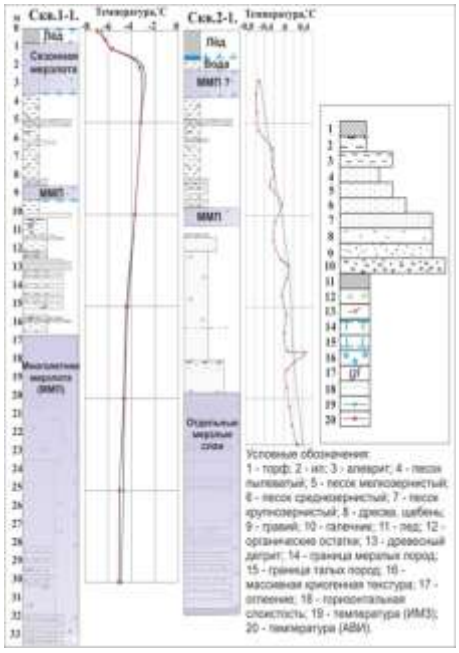


Fig. 2. Geological and permafrost profiles derived by drilling and geophysical surveying, Omulakh-Kel (1-1) and Pestsovaya (1-2) sea lagoons, April 2017.

The Vilyui Station of MPI in Chernyshevsky led by S. Velikin designed a new measurement system to control ground displacements in permafrost *(Fig. 3)*. The system consists of borehole inclinometer probes (accuracy ±0.01 angular deg.) and precision temperature sensors (±0.1°C). It has an advantage over standard geodetical and geophysical methods, which can only determine movements that have already occurred, in detecting early stages of ground displacement. Its high sensitivity makes it useful for ground movement control in open pit mines and dams.

Fig. 3. A component of the inclinomter system.

Dr. A. Gorbunov and Dr. E. Severskiy from the Kazakhstan Alpine Permafrost Laboratory of MPI estimated the volumes of ground ice in the Northern Tien Shan, including the Dzhungar Alatau (Table 1). Calculations indicate that the volume of ground ice is 56 km^3, comprising about 4.5% of the permafrost and 62% of the volume of glaciers in the Northern Tien Shan (approximately 90 km^3). More detailed estimates for the Bolshaya Almatinka River basin (Trans-Ili Alatau) based on the 1:25,000-scale geocryological map show that permafrost contains about 0.6 km^3 of ground ice with virtually no change, while the glaciers decreased in volume from 1.1127 km^3 in 1955 to 0.3889 km^3 in 2008.

Gorbunov A.P., Zhelezniak M.N., Severskiy E.V. (2017). Ground ice in the Tien Shan. Voprosy Geografii i Ecologii, 4: 19-30 (in Russian).

Table 1. Volume of permafrost and ground ice, km^3.

Region	Permafrost	Ground ice

	Rocks	Coarse soils	Subtotal	Rocks	Coarse soils	Subtotal
Ili, Kungey and Terskey Alatau, Ketmen (Lake Balkhash basin)	366.1	56.84	422.94	5.66	17.05	22.71
Ili and Kungey Alatau (Chu River basin)	143.1	12.84	155.94	1.47	3.85	5.32
Kungey Alatau (Issyk-Kol Lake basin)	160.0	4.5	164.5	1.6	4.8	6.4
Dzhungar Alatau	438.1	57.05	495.15	4.38	17.12	21.5
Total	107.3	131.23	**1238.53**	13.11	42.82	**55.93**

Field Activities

During 2017, MPI conducted wide-ranging field studies in East Siberia, Northern Tien Shan, Altay, and Verkhoyansk Mountains. Permafrost temperature observations were continued at monitoring sites in the Arctic, central and southern parts of Yakutia, in northern Krasnoyarsk region, Kazakhstan, Magadan region and Chukotka. Intensive hydrological, hydrogeological and geochemical studies were performed in Central Yakutia. Environmental and geotechnical monitoring and research programs were continued in support of the major engineering projects.

Field investigations under cooperative programs included:

- field work in the Bykovsky Peninsula under the project "Evolution of coastal and subsea permafrost in the Laptev and East Siberian seas", in cooperation with the Alfred Wegener Institute, Research Centre for Geosciences (Potsdam), Trofimuk Institute of Petroleum Geology and Geophysics (Novosibirsk), Arctic and Antarctic Research Institute (St. Petersburg), and North-Eastern Federal University (Yakutsk);

- a drilling and observation program of the Russian-German expedition Lena-2017 to study the development of permafrost and taliks beneath sea lagoons and coastal lakes, as well as the climate-driven evolution of coastal processes in the Laptev Sea and Lena Delta;

- streamflow studies in Central Yakutia for hydrological modeling with HYPE and HYDROGRAPH models (together with the Swedish Meteorological and Hydrological Institute);

- surface and subsurface water sampling in the Shestakovka River area near Yakutsk for the joint program of MPI, the Swedish Museum of Natural History and Oxford University on the biochemical studies of sub-catchments within the Lena River drainage basin;

- field studies of alas landscapes on the Abalakh and Tyungyulyu terraces of the Lena River, hydrological observations in lakes and streams, ground temperature and active-layer measurements, under the cooperative project with the Geosciences Paris Sud (GEOPS) Laboratory "High-resolution spatial and temporal studies of permafrost degradation in Central Siberia";

- monitoring observations at several sites near Yakutsk (Central Yakutia) and Tiksi (Arctic Yakutia) under the joint MPI-JAMSTEC project "Observational study of permafrost, vegetation, energy and water in Eastern Siberia towards elucidation of the impact of climate change in the geochemical cycle";

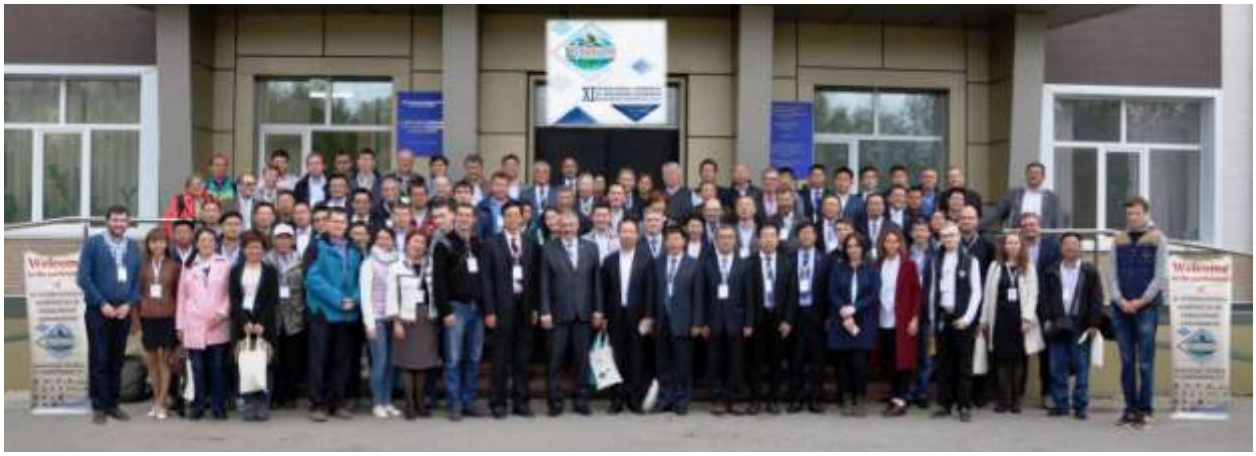
Following the establishment of the International Research Center for Asian Cold Regions Environment and Engineering, which was officially opened in April 2017, the co-founders - the State Key Laboratory of Frozen Soil Engineering (SKLFSE), Northwest Institute of Eco-Environment and Resources, Chinese Academy of Sciences and the Melnikov Permafrost Institute - conducted a range of joint activities during the summer of 2017. Six young scientists from MPI stayed for a month at SKLFSE in Lanzhou for training and discussions. Together with their potential research partners, they visited field sites on the Qinghai-Tibet Plateau and took part in experimental work. Dr. Alexey Galanin and Dr. Ivan Khristoforov were invited to SKLFSE as visiting scholars under the State Administration of Foreign Experts Affairs (SAFEA) program. A team from SKLFSE, including Profs. Wu Qingbai, Ma Wei, Jin Huijun and Zhang Ze, and from

MPI, including Dr. Mikhail Zhelezniak, Andrey Litovko and Leonid Gagarin, conducted a field trip from Yakutsk to Tynda along the Lena Federal Road and the Nizhny Bestyakh–Tynda Railroad to examine the problem sections over ice-rich permafrost in Central Yakutia. The active interaction and idea sharing resulted in four joint project proposals submitted to the RFBR-NNSF Call 2018. If approved, the first joint studies will focus on the effects of zonal and azonal factors on thermokarst, Middle and Late Pleistocene paleoenvironments inferred from syngenetic ice-rich permafrost studies in Asia, permafrost issues of the Lena River bridge site near Yakutsk, and the influence of precipitation infiltration and water vapor condensation on the ground thermal regime.

Drilling from the ice surface, Omulyakh lagoon, northern Yakutia.

Meetings

The XI International Symposium on Permafrost Engineering was held in Magadan, Russia on September 5-8, 2017. Organized by the Melnikov Permafrost Institute and its Magadan station in coordination with the State Key Laboratory of Frozen Soil Engineering, CAS (Lanzhou) and the Heilongjiang Province Academy of Cold Area Building Research (Harbin), the symposium provided a forum for over 100 researchers to discuss advancements, ideas and theories in the field of frozen ground engineering research and practice. The participants included researchers from 20 Russian, 1 Byelorussian and 13 Chinese organizations, as well as representatives from business and engineering community. The Symposium involved one plenary and three concurrent sessions with a total of 71 oral and 34 poster presentations. A round-table discussion chaired by Igor Ozimok, Vice Governor of Magadan Province, drew attention to the current permafrost-related problems in the region. A PYRN meeting was organized during the Symposium attended by approximately 40 young researchers. A book of abstracts (http://mpi.ysn.ru/images/Eng/ISPE/ISPE_2017_Magadan_Abstracts.pdf) was published before the meeting. Selected full papers were published in several journals, including *Sciences in Cold and Arid Regions*, *Earth's Cryosphere*, *Russian Geology and Geophysics*, and *Ice and Snow*. Symposium photographs can be viewed at: https://yadi.sk/d/gm9kYvVR3N38Ff\.



Participants of the XI International Symposium on Permafrost Engineering.

The 21st Northern Research Basins Symposium and Workshop were successfully held in Yakutsk, Russia from 6th to 12th of August 2017 under the theme of “Cold-Region Hydrology in Non-Stationary World”. The meeting organized jointly by the Institute of Water Problems (Moscow) and the Melnikov Permafrost Institute addressed the issues of hydrological research in cold regions, both in fundamental scientific and applied aspects, including the studies of snow, glaciers, permafrost, frozen ground, groundwater, seasonally frozen rivers and lakes. The topics discussed by delegates from Russia, Canada, Sweden, France, Finland and Germany covered observational evidences of change in coupled permafrost-hydrology system; present state and future projections of local, regional and pan-Arctic hydrology; modeling studies representing landscape evolution, dynamics of water storages and permafrost degradation, and impacts of permafrost hydrology changes on local communities. The symposium program included tours to the Mammoth Museum in Yakutsk and a field excursion to the MPI's underground water research site on the Lena River terrace and completed with a cruise to the Lena Pillar Natural Park. The Proceedings of the 21st NRB Symposium and Workshop and the photographs can be downloaded from the Symposium website http://nrb2017.ru/.

MPI Dissertation Council meeting. The Dissertation Council D003.025.01, now consisting of 26 members, was established at MPI in 1984 and authorized by the Russian Ministry of Education and Science's Higher Attestation Committee to award degrees in geography, geology & mineralogy, and engineering (qualification standard 25.00.08 – engineering geology, geocryology and geotechnical engineering). The Council held its meeting on November 28-29, 2017 for a public defense of two dissertations. Igor Syromyatnikov and Nikolay Torgovkin from MPI successfully defended their Kandidat Nauk (PhD) dissertations titled respectively "Structure and Temperature of Permafrost Foundations in Urban Landscapes" and "Geochemical Features of Human Modified Soils in Permafrost Regions", both focusing on the city of Yakutsk.

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Cryolithology and Glaciology Department, Geographical Faculty, Lomonosov Moscow State University

In 2017 fundamental studies of changes in the Earth’s cryosphere under the influence of natural factors and technogenesis were carried out at the Department of Cryolithology and Glaciology, Faculty of Geography, Lomonosov Moscow State University.

Rogov V.V. and Konishchev V.N., using the example of the sections of the loess deposits of the Russian Plain and the Loess Plateau of China, shows the promise of the cryolithological method applying for mineral matter analysis. It was shown that, not only within the periglacial permafrost zone, but also under conditions of seasonal freezing in the Pleistocene, processes of cryogenic transformation of sediments took place, which involved the formation of the composition and properties of loesses of sufficiently high thickness (Konishchev and Rogov, 2017).

Rogov V.V. conducted studies of frozen ground and soils structure using the method of X-ray computed tomography (Romanenko et al., 2017). The dynamics of frozen ground and soils structure in freeze-thaw cycles was characterized. The prospects of using X-ray computed tomography in the study of cryogenic processes are revealed.

In the paper «The gas-bearing structures and cryogenic strata of the Yamal peninsula cryolithology provinces» the main geocryological parameters of the cryogenic strata in gas-bearing cuts, dislocated in cryolithology provinces of Jamal peninsula, are shown in the original author classification (Badu, 2017a). Stages of submarine cryolithogenesis development in marine deposits in the Pleistocene, peculiarities its development in a sequential change in facial conditions of sedimentation and freezing bottom sediments of the shelf are shown (Badu, 2017b).

Based on direct observations aimed by Streletskaya I.D. and colleagues, the mean annual temperature of saline sediments is found to be about freezing point in areas where permafrost is subject to degradation, with the depth of zero annual amplitude occurring at 2.5–3.5 m. Permafrost continues to form at low marine laidas, where mean annual temperature of

sediments average –3.9 °C. The depth of layer with zero annual amplitude in this area is less than 3–4 m.

Various wedge structures have been studied in detail in sediments of Leningrad region. (Streletskaya, 2017). Primary soil, sand, and ice wedges formed as a consequence of frost cracking 15.5 kyr ago. The obtained disagree with refute the seismic origin of the soil wedges.

The carcass of Mammuthus primigenius named Zhenya was found near the mouth of the Yenisey River in eastern Siberia (Maschenko et al., 2017). It has been dated to 48,000 cal BP. The mineralogical analysis of site sediments revealed that the mammoth's burial in situ took place in the Yenisey River valley seasonally inundated by the river, which together with Fall's freezing temperatures protected the carcass from scavengers.

Commonalities and differences in the relief position and the geomorphic effects of the Yamal (GEC-1) and Gydan (AntGEC) gas-emission crater formations were revealed (Kizyakov et al., 2017a). Digital elevation models were created based on processing very-high spatial resolution stereo pairs both before and after the formation of the craters formation to characterize the relief changes (Kizyakov et al., 2017b). The morphometric features of mounds–predecessors and craters are revealed, as well as the dynamics of the development of these forms.

Similarity in the isotopic and ionic composition of the crater tabular ground ice and stratified tabular ice of Marre-Sale area was found by Streletskaya I.D., in contrast to the ionic and isotopic composition of surface and atmospheric waters, as well as polygonal ice wedges in the region (Streletskaya et al., 2017). Comparison of the results of the analysis confirms the conclusion concerning the nature of the craters as resulting from the emission of methane accumulated in the upper horizons of frozen rocks and ground ice.

Tumel N.V. and Zotova L.I. performs an updated textbook reveals a number of conceptual provisions for the assessment, forecasting and mapping of the permafrost environment in the northern regions development from the standpoint of the landscapes stability to the manifestation of dangerous cryogenic processes (Tumel and Zotova, 2017).

On the basement of long-term observations, dedicated to thermal regime of the ground basement, activation of cryogenic processes, character of the object deformations, with consideration and analysis of satellite images, done by Grebenets V.I. and co-authors (Shiklomanov et al., 2017), changing trends of permafrost degradation near the largest industrial center in permafrost zone - Norilsk were revealed. Found the common trend of permafrost degradation over the past decade, number of deformed buildings constantly rises. 17 types of the special natural-technogenic geo-cryological complexes, formed on urbanized territories. The analysis showed, that “contribution” in ground temperature increasing (permafrost degradations), in the object basements (10-15%), connected with regional climate warming trends and the negative impacts of technogenesis (80-85%).

International Arctic field courses have been conducted in July 2017 in the North of Siberia. The organizers were department of Cryolitology and Glaciology, Geographical faculty, MSU (Russia) and George Washington University (USA). 24 participants took part in the courses, 9- from MSU, Russia, 15- from USA, Switzerland, Germany, Spain. Objectives of the courses were investigations of permafrost features, pleistocen-holocenic stratas (paleogeographic methods), landscape-permafrost conditions in tundra and forest tundra, depth of ALT in different landscape conditions, thermal regime of permafrost. Important aspects were dedicated to engeneeric-geocryological problems of the territory, geoecological features, methods of rational construction on permafrost. The results of the courses were presented in two volumes.

Field practice for our third-year students have been conducted at first time on Svalbard from July 24 to August 5, 2017. This event was organized within the framework of the agreement on scientific cooperation between Arctic and Antarctic Research Institute «AARI» and the Faculty of Geography of Lomonosov Moscow State University. Students under the leadership of Kizyakov A.I. participated in the permafrost research around Barentsburg area as part of the seasonal group of the Russian Arctic Expedition «Spitsbergen-2017».

As part of an international group of researchers, Petrakov D.A. analyzed the causes of the formation of a catastrophic glacial mudflow in the Ala-Archa basin on July 31, 2012. It is established the high threat of breakthroughs in unsteady glacial lakes in Tien-Shan (Erokhin et al., 2017). Based on the synthesis of field and remote methods, the Catalog of Glacial Lakes of

Uzbekistan was compiled, the probability of breakthrough of each of the lakes was estimated (Petrov et al., 2017).

Ground-based radar studies of the largest Caucasus glacier Bezengi were undertaken with participation of Kovalenko N.V. Fundamentally new results on the thickness of ice are obtained, which make it possible to build a map of the glacier thickness and preliminary estimate its volume. The total length of radiosounding profiles was about 75 km, before such studies were not conducted on the Bezengi glacier, only attempts were made.

Fieldwork (Popovnin V.V.) resulted in obtaining data for mass balance estimation for Djankuat, the representative glacier in the Caucasus, and for 3 glaciers (Karabatkak, Sary-tor and Bordu) in Tien Shan, Kyrgyzstan. The reported year turned out quite unfavourable for all of them, so that mass balance was negative, in spite of increased accumulation on Djankuat and Karabatkak Glaciers: ablation exceeded its norm everywhere, while in Kyrgyzstan it represented its absolute maxima for the entire period after the resumption of direct monitoring. Duration of continuous mass balance series at the Djankuat Glacier reached 50 years though exact values for 2016/17 balance year are not calculated yet. Mass balance of the above-mentioned glaciers of Tien Shan came to -1120, -1480 and -1340 mm w.e., correspondingly. These are the most negative values which have ever been registered here since restoration of the measurement program.

References:

Badu Yu.B. The gas-bearing structures and cryogenic strata of the Yamal Peninsula cryolithology provinces // Engineering Geology, № 1. 2017a. p. 39-52.

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Sergeev Institute of Environmental Geoscience RAS (Moscow)

Monitoring geocryological observations were continued at sites without anthropogenic disturbances in the Torthern Transbaikalia Region. Obtained will be submitted to the international database of GTN-P Project. In cooperation with Institute of Water Problems of the Russian Academy of Sciences, a map of the manifestations of geocryological processes with which economic or economic problems were associated for the period 2000-2015 for the territory of Russia was drown-up. In cooperation with the Geological Faculty of the Moscow State University, the geocryological observatory in vicinity of Vorkuta (European North) were developed with mapping and geophysical works. This observatory was established by professor V.A. Kudryavtsev in the fifties of XX century.

MSU students in the fieldwork in Northern Tansbaikalia (Eastern Siberia). The bond-failure crack at the shore of thermokarst lake is in center of the picture.

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2017 June 4-8 (*Pushchino)*: Permafrost Conference «Earth's Cryosphere: Past, Present and Future» was organized by Federal Agency for Scientific Organizations, Russian Foundation for Basic Research, Institute of Physico-chemical and Biological Problems in Soil Science RAS, OOO «Bioarsenal». Partner of the conference: Earth Cryosphere Institute (ikz.ru) and «Beta Analytic radiocarbon dating lab» (radiocarbon.com). All current information is available at http://cryosol.ru/en/cryoconference2017.html .

Most important publications – 2017:

Shmelev, Denis, Alexandra Veremeeva, Gleb Kraev, Alexander Kholodov, Robert GM Spencer, Wayne S. Walker, and Elizaveta Rivkina. Estimation and Sensitivity of Carbon Storage in Permafrost of North-Eastern Yakutia. *Permafrost and Periglacial Processes*. 2017. 28, no. 2: 379-390.

Kraev, Gleb, Ernst-Detlef Schulze, Alla Yurova, Alexander Kholodov, Evgeny Chuvilin, and Elizaveta Rivkina. Cryogenic Displacement and Accumulation of Biogenic Methane in Frozen Soils. *Atmosphere*. 2017, 8 (6):105-124. doi:10.3390/atmos8060105

Spirina E.V., E.V. Durdenko, N.E. Demidov, A.A. Abramov, V.E. Romanovsky, E.M. Rivkina. Halophilic–psychrotrophic dacteria of Alaskan c ryopeg—a model for astrobiology. // *Paleontological Journal*, 2017, Vol. 51, No. 12, pp. 45–57, DOI: 10.1134/S0031030117120036

Organic carbon derived from permafrost can provide a substrate for greenhouse gas production where the buried carbon pool thaws and mobilizes into biogeochemical cycles. Much attention has focused on the permafrost carbon of the Yedoma region of Siberia due to the wide distribution of organic and ice-rich deposits. Here, we present a new estimation of carbon storage in the upper 25m of permafrost in north-eastern Yakutia based on a novel database of total carbon (TC) content, bulk density and ice content of permafrost, and a new map of Quaternary deposits derived from drilling data. The stratigraphic units contain 0.6–2.1% TC, with the highest concentrations in the Holocene cover layer and Late Pleistocene Yedoma superhorizon. The largest carbon pool is found in the Pliocene/MiddlePleistocene Olyor superhorizon. The TC pool of Yedoma is estimated to be 1.5–2 times less than that calculated previously. The TC pool of the study area is 31.2 ± 15.2 Pg C spread across 88 000 km^2, with a mean specific carbon content of approximately 14.3 kg C m^{-3}. Carbon storage is estimated excluding the ice-wedge volume and, due to the limited data for Yedoma and Alas deposits, we present a maximal assessment of the carbon pool for the Yedoma region. Refinement of the size of the Yedoma TC pool is critical for quantifying the scale of permafrost feedback to the carbon cycle.

Cryopegs, lenses of hypersaline unfrozen soil or water within permafrost, are a model for astrobiology, since free water can only be present on cryogenic bodies and planets in the form of brine. In this paper the diversity of aerobic halophilic-psychrotrophic microorganisms from an Alaskan cryopeg (Barrow Cape) were studied and described for the first time. This cryopeg is characterized by a constant subzero temperature (–7°C**)**, high salinity (total mineralization is about 120 g/L) and isolation from external influences for a geologically significant period of time. Our study has revealed a large number of microorganisms capable of growth at low temperature (4°C) in a wide range of salinities from 5 to 250 g/L of NaCl, the latter being 3 times higher than the natural salt concentration of the Alaskan cryopeg. The microorganisms identified are comprised of four major phyla: Actinobacteria (genera *Brevibacterium*,*Citricoccus*, *Microbacterium*), Firmicutes (genus *Paenibacillus*), Bacteroidetes (genus *Sphingobacterium*), and Proteobacteria (genus *Ochrobactrum*).

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The results of the most fundamental and advanced investigations, important results on the programs of the Earth Cryosphere Institute (ECI SB RAS) and of the many others Institutes and organizations specializing on permafrost/cryosphere researches are presented in the journal "Earth's Cryosphere" ("Kriosfera Zemli"). Journal is translated into English since 2014, all the articles are available online for free at the website of the journal:http://www.izdatgeo.ru/index.php?action=journal&id=8&lang_num=2. The abstracts of the most interesting papers are submitted for the consideration of readers.

Dvornikov Yu.A.[1], Leibman M.O.[1,2], Heim B.[3], Khomutov A.V.[1,2], Roessler S.[4], Gubarkov A.A.[5] Thermodenudation on Yamal peninsula as a source of the dissolved organic matter increase in thaw lakes /DOI: 10.21782/EC2541-9994-2017-1(28-37)

[1] Earth Cryosphere Institute, SB RAS, Tyumen, Russia; [2] Tyumen State University, Russia; [3] Alfred Wegener Institute for Polar and Marine Research, Potsdam, Germany; [4] FIELAX, Bremerhaven, Germany; [5] Tyumen Industrial University, Russia

This paper is devoted to the study of thermodenudation impact on concentration of dissolved organic matter in lake water. We present results of measured concentration of colored dissolved organic matter in

water samples collected from the lakes in Central Yamal. We show the difference of colored dissolved organic matter concentration in lakes with thermo-denudational coasts and in intact lakes. Buried peat layers discovered in thermocirque exposures appeared to have high concentration of dissolved organic carbon. We found average concentration of colored dissolved organic matter 3.5–4.5 times higher in lakes with thermocirques than in intact lakes.
This paper is devoted to the study of thermodenudation impact on concentration of dissolved organic matter in lake water. We present results of measured concentration of colored dissolved organic matter in water samples collected from the lakes in Central Yamal. We show the difference of colored dissolved organic matter concentration in lakes with thermo-denudational coasts and in intact lakes. Buried peat layers discovered in thermocirque exposures appeared to have high concentration of dissolved organic carbon. We found average concentration of colored dissolved organic matter 3.5–4.5 times higher in lakes with thermocirques than in intact lakes.

Manakov A.Yu., Ildyakov A.V., Lipenkov V.Ya*,, Ekaykin A.A.*, Khodzher T.V.**** Formation of clathrate hydrates of hydrochlorofluorocarbon 141b in the deep borehole at Vostok Station (Antarctica) in the course of the unsealing of subglacial Lake Vostok / DOI: 10.21782/KZ1560-7496-2017-3(32-40)
Nikolaev Institute of Inorganic Chemistry, SB RA, Novosibirsk; * Arctic and Antarctic Research Institute, St. Petersburg; ** Limnological Institute, SB RAS, Irkutsk; *** Institute of Earth Sciences, St. Petersburg State University
We have presented the results of a study of core samples which had been recovered from a deep borehole after the second unsealing of subglacial Lake Vostok in 2015 (borehole 5G-3, in which a mixture of kerosene and HCFC-141b densifier had been used as the drilling fluid). The intensive mixing of the subglacial water and the drilling fluid resulted in the formation of a solid plug that filled the volume of the borehole and blocked the access to the lake. We have demonstrated that this solid plug consists of kerosene, ice and clathrate hydrate of HCFC-141b. The obtained data suggests that the drilling fluid presently used at Vostok should be replaced, at least in the bottom section of the hole, by another fluid which does not react with subglacial water.

Sudakova M.S., Sadurtdinov M.R.*, Malkova G.V. ****, Skvortsov A.G.*, Tsarev A.M.*** *Application of ground penetrating radar in permafrost investigations / DOI: 10.21782/KZ1560-7496-2017-3(69-82)
* Earth Cryosphere Institute, SB RAS, Tyumen; ** Lomonosov Moscow State University, Department of Geology; *** Tyumen Industrial University.
The paper presents results of GPR investigations on the territory of Russia's European North carried out in the areas of different lithologies and permafrost conditions in the upper part of the geological section. The GPR surveys were part of the integrated geological and geophysical studies that also included seismic surveying, lithological differentiation of nearsurface deposits, measurement of active layer thickness, and weight rock moisture determination. The GPR was the most effective for the study of sandy and sand-peat geological sections, whereas in loamy environments its efficiency was low. Providing the upper limit of permafrost occurs at shallow depths (less than 1.5 m), which allows direct measurements, GPR can be used as supplementary method for more detailed description of spatial variability of the active layer thickness and other properties, including volumetric moisture estimates calculated from velocities of electromagnetic waves. Alternatively, with the permafrost table occurring deeper than 1.5 m, the GPR proves to be the main method for determining its position in the section. For more accurate geological and geocryological identification of the boundaries, the GPR data interpretation ought to be constrained by seismic results. Application of the GPR in combination with geocryological and seismic methods is ascertained to be highly perspective for solving various engineering problems, which will contribute to the existing permafrost monitoring frameworks.

Fotiev S.M. Arctic peatlands of the Yamal-Gydan province of Western Siberia / DOI: 10.21782/KZ1560-7496-2017-5(3-15)
Earth Cryosphere Institute, Tyumen
Based on the seminal works of the foregoing researchers, this paper focuses on peat formation processes that occur under the extreme climatic and permafrost conditions of the northern part of Western Siberia. It has been shown that in spite the extreme climatic and permafrost conditions, but more likely because of them, peatlands up to 7.5 m thick reinforced with large ice wedges occupy extensive areas in the tundra zone. Vertical growth of peatlands was found to be most intensive (at a rate 1.5–4.4 mm/year) in a limited time period from 9 to 6 ky BP, which suggests that lower horizons of peatlands up to 3.0–4.5 m thick accumulated in just 1500 years. The three reasons that determined the active vertical growth of peatlands have been identifi ed and thoroughly discussed in this research: huge ice content, abundance of wood residues in peatlands, and intense frost heaving during the freezing of a newly

formed peat layer. Premised on our fi nding that birch stands with high bonitet level grew in the tundra only locally, in the areas underlain by insulation-radiogenic taliks, it is proved that in the Holocene, there was no northward shift of 400–500 km in the northern boundary of the forest tundra.

Domanskaya O.V.*, Melnikov V.P.*⁻, Ogurtsova L.V.*, Soromotin A.V.*, Domanskii V.O.***, Polyakova N.V.*** Some features of enzyme activity in different strains of the *Bacillus* genus isolated from Permafrost / DOI: 10.21782/KZ1560-7496-2017-5(63-71)

Tyumen State University; **Tyumen Scientific Centre, SB RAS;*Tyumen Industrial University*

The kinetics of growth and activity of enzymes in bacterial strains of the *Bacillus* genus isolated from permafrost are studied as a function of incubation temperatures. Viable bacteria were found in permafrost in the area of Tarko-Sale in northern West Siberia. The selected permafrost core samples are Upper and Middle Pleistocene alluvial and lacustrine deposits of marine terrace IV ($mIII_1$, $mII_{2–4}$). The *Bacillus* spp. strains change notably in growth kinetics and enzyme activity as temperatures vary from 5 to 45 °C, which is evidence of their adaptation ability. Activity of catalase, dehydrogenase, amylase, protease and lipase enzymes is high at low temperatures in most of the analyzed bacterial strains, which has important biotechnological implications.