Permafrost researchs report of Russia 2018

The main results

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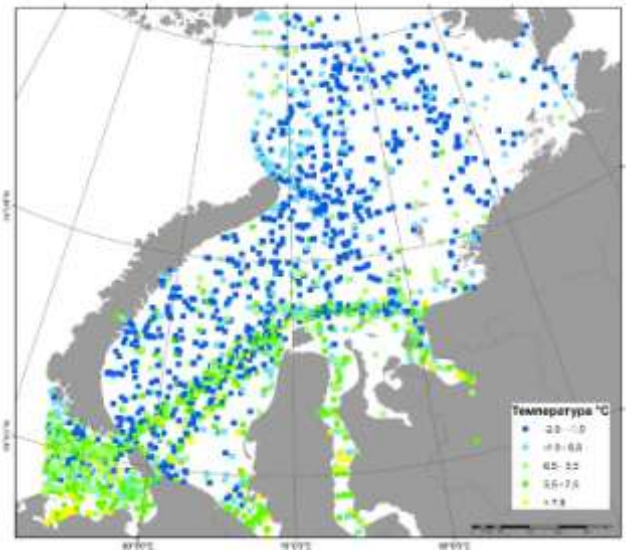
Earth Cryosphere Institute, Tyumen Scientific Centre, Siberian Branch, Russian Academy of Science (**ECI Tyumen Scientific Centre SB RAS**) **http://www.ikz.ru/**

1. For the first time, CO_2 hydrates with water conversion into hydrate more than 90% were formed in a quiescent reactor without any mixing. An additive of sodium dodecyl sulfate (SDS, anionic surfactant) in an amount of 0.1 mas% was used. The capillary-driven hydrate growth well-known for hydrocarbons gaseous was observed for the first time for CO_2 hydrate growth in the presence of SDS. Conditions of capillary-driven CO_2 hydrate growth were determined. The obtained data are important for further insights into mechanism of gas hydrate growth and may be used for increasing the efficiency of hydrate-based technologies for capture and sequestration of carbon dioxide as carbon dioxide hydrate.

References: *Molokitina N.S., Nesterov A.N., Podenko L.S., Reshetnikov A.M. Carbon dioxide hydrate formation with SDS: Further insight into mechanism of gas hydrate growth in the presence of surfactant // Fuel. -2019. -V.235. -P.1400-1411.*

2. A working version of the temperature distribution GIS map of the southeast part of Barents Sea seabed and also the Kara Sea was compiled under supervision of Prof. Dr. A.A. Vasiliev. This database and map will be used in the future for the analysis of current trends in the subaqual cryolithozone evolution of the western sector of Russian Arctic.



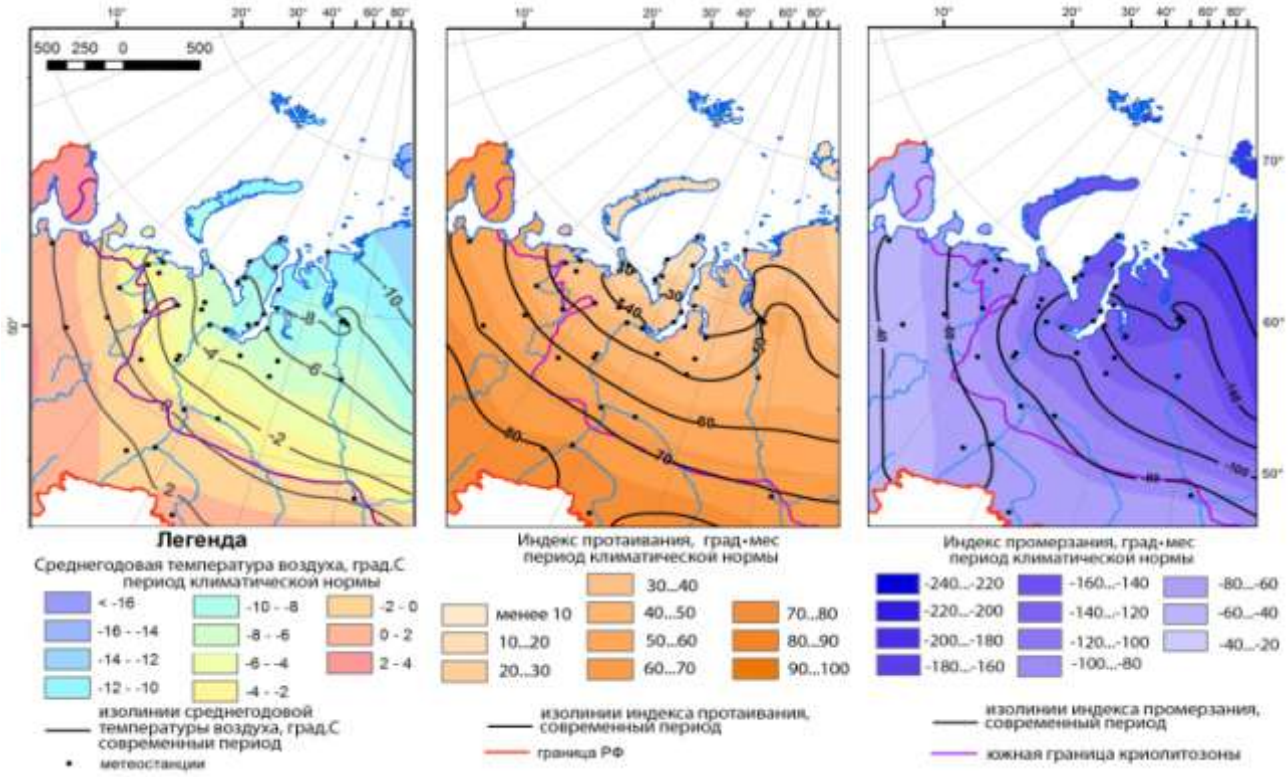
Map of the spatial temperature distribution of the southeast part of the Barents and Kara seas seabed

3. According to the study of frozen deposits in the territory south of the Taz Peninsula, geochemical processes are considered under the hydrocarbon migration from the lower productive complex. An analysis of the cryolithological structure of the frozen stratum was performed, and the composition of the gas and authigenic associations was studied. It was shown that the migration of gases is caused by shear deformations with the formation of cryogenic textures with the presence of gas-bearing ice crystallites on slip surfaces. It was found that the migration of hydrocarbons causes significant local changes in pH/Eh parameters in the frozen stratum and determines the micromosaic distribution of sulfate and iron reduction

processes that lead to the formation (including microbiological processes) of various forms of iron: sulphides, carbonates and oxides.

References: *Kurchatova A. N., Rogov V.V., Slagoda E.A., Taratunina N.. Geochemical Anomalies of Frozen Ground due to HydrocarbonMigration inWest Siberian Cryolithozone //Geosciences 2018, 8, 430; doi:10.3390/geosciences8120430,// www.mdpi.com/journal/geosciences*

4. A group of scientists (Drozdov D.S., Malkova G.V.) developed maps of changes in average annual air temperature, thawing index and freezing index in the cryolithozone of the European North of Russia and Western Siberia. On the maps, the displacement of the isolines of the average annual air temperature occurs in the direction from South-West to North-East and reaches 100 ... 200 km (Fig.). Thawing index isolines moves North of about 100-150 km. Isolines of freezing index move due to climate warming in cold periods East, and East-North-East for a distance of 200 km (Fig.).



Changes in climatic parameters of permafrost zone of the European North of Russia and of the Western Siberia in the period of the climate standard (1960-1990) – colored fill; and in the 21st century (isolines)

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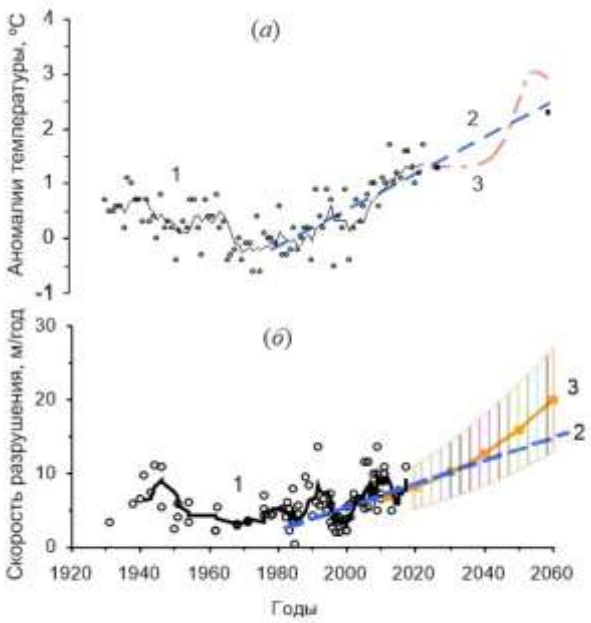
Melnikov Permafrost Institute, Siberian Branch, Russian Academy of Science (MPI SB RAS, Yakutsk) http://mpi.ysn.ru/en/

Selected Research Results

1. A mathematical model was developed to predict the dynamics of coastal permafrost along the Laptev and East-Siberian Seas during the first half of the 21st century. The model results predict that erosion rates along the coasts with ice contents of 30-70% will vary from 4-12 m/yr in 2015-2020 to 8-26 m/yr in 2050 (S.O. Razumov, MPI Laboratory of General Geocryology).



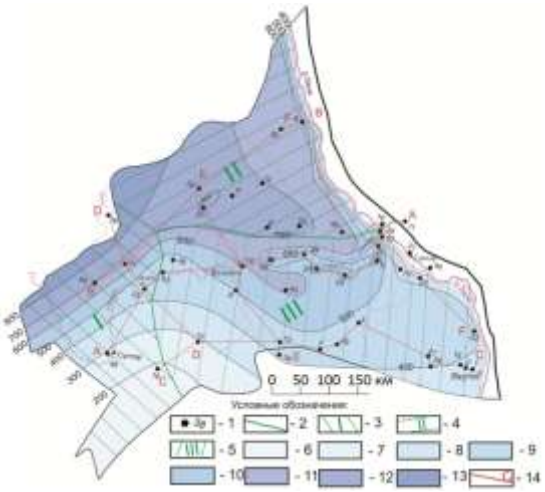
Changes in thaw-season (June-September) mean air temperature anomalies and ice-rich coastal erosion rates in the Laptev and East Siberian Seas. Cliff height 10-20 m, total ice content of coastal sediments 30-70%.
(a) Temperature anomalies: (1) measured, (2) predicted for an inertial (linear trend) climate change scenario; (3) predicted for an extreme scenario.
(b) Coastal erosion rates: (1) measured, (2) linear trend, (3) predicted average rates and spatial variations of thermal and mechanical erosion. The solid black line represent 5 point linear filtering.

Related Publications:

Razumov S.O. (2018). Peculiarities of reaction of coast in the east arctic seas of Russia on climatic changes. *Science and World* 9(61): 70-72.

Razumov S.O. Response of permafrost coasts in the Russia's eastern Arctic seas to extreme climatic changes in the first half of the 21st century. *In*: Georisk 2018: Analysis, Prediction and Management of Natural Risks Considering Global Climate Change, Proceedings of Int. Conf., 23-24 October 2018, Moscow.

2. Geothermal investigations were carried out to determine the distribution and thickness of disequilibrium permafrost in the Vilyui Basin. A map was compiled showing depths to the permafrost base in the region and thermal cross-sections were constructed for individual tectonic units, as well as for hydrocarbon and mineral deposits. The study results indicate that permafrost thicknesses vary over a wide range, from 45 to 820 m, generally decreasing from west to east. This is due to geothermal heat flow increasing in the same direction, as well as to paleoenvironmental conditions. Significant variations in the depth of the permafrost base, up to 200 m, occur even within small geostructural units or hydrocarbon and mineral deposits (V.P. Semenov, MPI Laboratory of Permafrost Geothermics).



Map showing depths of the permafrost base in the Vilyui Basin.
(1) Exploration borehole area and its number; (2) permafrost boundaries; (3) permafrost region I; (4) permafrost region II; (5) permafrost region III; 6 to 13 – permafrost thicknesses: (6) <200 m; (7) 200 to 300 m; (8) 300 to 400 m; (9) 400 to 500 m; (10) 500 to 600 m; (11) 600 to 700 m; (12) 700 to 800 m; (13) > 800 m; (14) Thermal cross-sections.

Semenov V.P., Zheleznyak M.N., Kirillin A.R., Zhizhin V.I. (2018). Thermal conductivity of sedimentary rocks in the Leno-Viluy oil-and-gas bearing province. *Kriosfera Zemli,* 5(XXII): 30-38.

Semenov V.P. (2018). Subsurface Temperature Distribution and Permafrost in the Vilyui Basin. PhD Thesis Abstract. Yakutsk: MPI SB RAS, 22 pp.

3. The ground temperature control system designed at the Vilyui Station in Chernyshevsky led by S.A. Velikin was implemented in *International*, the first underground diamond mine in permafrost. The system incorporates 1650 temperature sensors installed in 56 drill holes and 84 blast holes to provide a field digital model of multi-directed thermal pressures (climatic and anthropogenic) and associated seepage processes on frozen foundations. In March 2018, a Pattern Approval Certificate RU.C.32.004.A no. 69246 was granted by the Russian Federal Agency for Technical Regulation and Metrology for the CKTK-02 permafrost temperature control measuring system.

A	*B*	*c*	*d*

(a) International mine, (b) Control cabinet, (c) temperature borehole, (d) Pattern Approval Certificate.

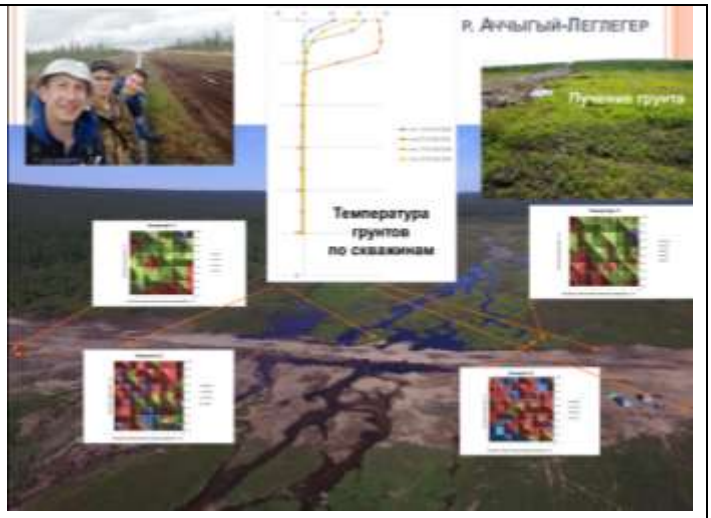
Velikin S.A. (2018). Application of 3D interpretation technologies to solving foundation monitoring problems at hydroprojects in permafrost. *In*: 5th European Conference on Permafrost regions, Book of Abstracts, p p. 914-915.

Expeditions

During 2018, MPI continued field studies in East Siberia, northern Tien Shan, Altai, and Verkhoyansk Mountains. The most important, large-scale field studies were conducted along

the Power of Siberia Pipeline corridor in southern Yakutia as part of a 2018-2020 research project to study changes to permafrost conditions and assess the potential effects of related hazards on linear infrastructure under changing climatic conditions (Project PI: V.V. Samsonova). In July-August 2018, a reconnaissance survey was undertaken from the Chayanda field to Skovorodino to identify permafrost-related problems areas along the pipeline corridor.

Five field teams worked in the Chayanda, Skovorodino, Nimnyr, Aldan and Tynda areas focusing on permafrost terrain features, icings, and rock streams. In total, 410 sites were examined, of which 30 were identified as the greatest problem areas requiring further drilling and geophysical investigations in 2019-2020. In addition to icings and rockstreams, potential hazards along the pipeline were found to be subsurface erosion, thermokarst and gullying. 1:5,000-scale permafrost terrain maps and permafrost indicator tables were compiled. Hazard assessment of thermokarst, subsurface erosion, thermal suffosion, icing development and associated processes was made for the construction and operation stages of the Power of Siberia Pipeline.



Meetings

On 4-29 June 2018, MPI organized the Fifth Forum for Young Permafrost Scientists. The Forum commemorating the 90th anniversary of the birth of Professor, Dr. Maria K. Gavrilova included two events: a conference held from 4-8 June 2018 under the title "*Permafrost Response to Climate Change"* and a field trip from 9-20 June 2018.

The conference was attended by 56 undergraduates, graduate students, and early-career scientists from the Melnikov Permafrost Institute, North-Eastern Federal University (Yakutsk), Moscow State University, 3 HYDEC Hydrological and Geoenvironmental Co. (Moscow), Earth Cryosphere Institute (Tyumen), Tomsk Oil and Gas Research and Design Institute, Institute of the Earth's Crust (Irkutsk), St. Petersburg State University, Trofimuk Institute of Petroleum Geology and Geophysics (Novosibirsk), Novosibirsk State University, North-East Interdisciplinary Scientific Research Institute (Anadyr), as well as 10 colleagues from the State Key Laboratory of Frozen Soil Engineering (Lanzhou, China) and Heilongjiang University (Harbin, China). The conference covered a wide range of permafrost-related topics, including regional and historical geocryology, permafrost thermal studies, periglacial processes and forms, landscape dynamics in permafrost regions, permafrost geochemistry, permafrost hydrology and hydrogeology, climate change and permafrost evolution, greenhouse gases and gas hydrates, permafrost microbiology, remote sensing of permafrost, and stability of engineering structures on permafrost.

The post-conference field trip to Amga, central Yakutia, was designed to examine permafrost processes and landforms (thermokarst, frost heaving, mass wasting, icings, thermal suffosion, etc.); surface and subsurface thermal regimes in different landscapes; permafrost-related engineering problems and mitigation techniques; mitigation and restoration measures for

degraded agricultural lands; and land suitability mapping and assessment for agriculture. Together with senior scientists from MPI, participants conducted field observations to assess the extent of permafrost degradation in different landscape settings. They took part in the establishment and instrumentation of observation sites to monitor ground temperatures, permafrost processes, groundwater, and geochemistry.

The Forum was held with financial support from the Russian Foundation for Basic Research (Grant 18-35-10015) and the Republic of Sakha/Yakutia Young Researchers Foundation.

	
Presentation by Yuri Dvornikov, PhD, Earth Cryopshere Institute, Tyumen.	*Field trip participants in the vicinity of Amga, central Yakutia.*

In 2018, MPI researchers participated in 32 international conferences in Russia and abroad, including Germany, France, Japan, China, South Korea and the USA.

International Cooperation

An important event in international cooperation in 2018 was the "20 Years of Lena Expeditions" International Symposium which took place on 17–19 October 2018 in St. Petersburg. The meeting was organized by the Arctic and Antarctic Research Institute (AARI), St. Petersburg; Melnikov Permafrost Institute (MPI SB RAS), Yakutsk; Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI), Bremerhaven and Potsdam; University of Hamburg, Institute of Soil Science (UHH); and German House of Science and Innovation Moscow (DWIH).

During the last 20 years, Russian-German joint expeditions have been working in the poorly studied East Siberian region of the Arctic. Russian and German research teams, including geomorphologists, geologists, paleogeographers, permafrost scientists, geophysicists, hydrologists, zoologists, botanists, and soil scientists carry out research within the framework of the Laptev Sea System project. Implementation of this joint project promotes international scientific exchange and the advancement of Arctic research. The expedition has resulted in hundreds of articles and dozens of monographs which explain the current and historic state of the Earth's geosphere and climate change in the Arctic. The Lena Delta expedition's research and logistical base on Samoylov Island is among the best Arctic research stations in the world.

The symposium was attended by about 80 participants from the AARI, Melnikov Permafrost Institute, Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research, University of Hamburg, German House of Science and Innovation Moscow, German Research Centre for Geosciences, St. Petersburg State University, Max Planck Institute, Forestry Institute, and Institute of Petroleum Geology and Geophysics.

The speakers presented the main results of the Russian-German Lena expeditions over the past 20 years in the following areas: hydrology, geomorphology, geological reconstructions, permafrost monitoring, carbon and greenhouse gas cycles, geophysics, modeling, biology, coastal zone research, and others.

A commemorative volume, "20 Years of Terrestrial Research in the Siberian Arctic. The History of the Lena Expeditions", published in Russian, English and German was published to mark the anniversary and presented to all Symposium participants.

		
Participants of the 20 Years of Lena Expeditions Symposium, 17–19 October 2018, St. Petersburg.	*Mikhail Grigoriev, MPI Vice Director, talks about the beginning of terrestrial research in the Lena Delta and Laptev coastal zone and the history of the Samoylov station.*	*A poster is presented by Lyudmila Lebedeva, a junior scientist from MPI.*

Publications

Theoretical, experimental and field investigations carried out by MPI researchers resulted in about 300 publications, including three monographs and 82 articles in journals listed in Russian Ministry of Education and Science's VAK and Web of Science. Four papers published in *Earth's Cryosphere* were chosen by the journal's editorial board as best in 2018 and included in the Russia's report to the International Permafrost Association.

A 211-page monograph titled "*Cryoecosystems of the Alazeya River Basin*" by S.P. Gotovtsev, L.I. Kopyrina, A.P. Efimova et al. published in Novosibirsk by Geo Academic Publishers summarizes the results of multi-disciplinary investigations conducted in 2008-2009 in the Alazeya River basin, Kolyma Lowland. It presents data on permafrost conditions, river hydrological regime, surface water chemistry and biology, soil texture and structure, and flora and fauna diversity. The authors conclude that repeated catastrophic floods have resulted in significant degradation of the northern ecosystems and permafrost environment in the Alazeya basin.

Completed Degrees

In 2018, three MPI researchers successfully defended PhD dissertations: Valery Semenov (Subsurface temperature distribution and permafrost in the Vilyui Basin), Pavel Zabolotnik (Ground temperature regime at large heat power generation facilities on permafrost: Yakutsk CPP Plant), and Lyudmila Lebedeva (Streamflow generation in the East Siberian permafrost zone).

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Cryolithology and Glaciology Department, Geographical Faculty, Lomonosov Moscow State University
2018

The studies of 2018 were conducted in several areas, traditionally distinguished in the scientific research of the Department of Cryolitology and Glaciology.

Yu.B. Badu prepared and published a monograph “Cryogenic strata of gas-bearing structures of the Yamal Peninsula. About an influence of gas accumulations on cryogenic strata forming and development” (Badu, 2018). In this book, the author expounds the concept of his cryolithololologic paradigm developed at the result of the multi-year study of cryogenic gas-bearing strata forming conditions in the North of Western Siberia. It has been shown that in terms of structural geology, composition and conditions of rocks, the “cryogenic strata in a gas-bearing structure” is a special cryolithololologic system, which evolved during the Pleistocene-Holocene with the sedimentation conditions marked by sediment cooling and freezing, governed by heat fl ux and gas emission from gas deposits. It has been established that in the context of either modern or ancient accumulation, cryolithogenesis is manifest in the continued gas saturation of both deposited and accumulating marine sediment, while the specifi c cryolithololological features develop as sediment accumulation proceeds in the respective facies environment, until laida deposits crop out on the surface, with the subaqueous processes having ceased, and all of its phenomena are reported in the cryogenic structure of permafrost.

N.A. Shpolyanskaya released a revised and updated reissue of the textbook “Geocryology. Evolution of the cryolithozone and global climate change” (Shpolyanskaya, 2018).

I.D. Streletskaya continued the study of traces of paleopermafrost. Ground wedge structures were found in the sections of Srednyaya Akhtuba, Leninsk, Bataevka, Cherniy Yar and Kosika (Lower Volga). The ground wedge structures in Quaternary deposits were interpreted as evidence of the existence of permafrost and conditions of deep seasonal freezing earlier. The aim of the research was to analyze new data and to reconstruct the paleo-geographic situation of ground wedge structures. The position of the soil wedges in the section, their shape and size allow to conclude cryoarid conditions alternated with periods of warming in the Lower Volga region during the Pleistocene. Some of the vein wedges s thawed subaquately, indicating a changing sea level in the Pleistocene. The most severe conditions are reconstructed in the atelier time (MIS 4) (Streletskaya, Taratunina, Belayev, Kurbanov, 2018).

New unique data on the content and genesis of methane in ground ice, frozen Quaternary sediments and seasonally thawed layer at the Marre-Sale area (Western Yamal) was presented. Methane concentration in dominant landscapes of typical tundra of Western Yamal has been measured. The highest methane content in the active layer was measured in tundra bogs, wet gully bottoms, and polygonal tundra. A large content of methane (up to 10 ml/kg) is noted in the massive ice of the research area. Data on the determination of methane content in seasonally thawed layer for various types of landscapes are also presented. The layout of the map-scheme "Spatial distribution of methane content in the seasonal thawing layer in the Marre-Sale area" is constructed. Within typical tundra of Western Yamal, only 30 to 40% of the area may be considered to be a significant source of methane emission to the atmosphere. Methane fluxes measured in typical tundra of Western Yamal are approximately 2 times lower than those measured in Alaska (Streletskaya, Vasiliev, Oblogov, Semenov, Vanshtein, Rivkina, 2018).

New study proves that permafrost degradation of coastal and marine sediments of the Arctic Seas can result in large amount of methane emitted to the atmosphere. The value of methane emissions in the destruction of frozen sea shore with underground ice is high enough and comparable to the emission of methane from wetland ecosystems. The quantitative assessments of such emissions were analyzed data on methane content in permafrost sediments and ground ice. Gas was present in pores of sediments and in bubbles within the ice and the methane content is characterized by high variability (Streletskaya, Vasiliev, Oblogov, 2018).

V.I. Grebenets with colleagues on the basis of field observations, research of stock sources and analysis of satellite images for the first time evaluated the effect of storage of solid waste on the state of permafrost (Grebenets et al., 2018). The analysis was carried out for 5 types: 1) solid household waste, including the accumulation of barrels, 2) frozen moving dumps

of rock; 3) accumulators of sludge, slags, ash dumps, tailing dumps, 4) construction waste, including in deformed abandoned settlements in the permafrost, 5) wood waste. It has been established that due to thermal and physicochemical processes, permafrost degradation occurs, erected after engineering training in these territories, buildings and structures are quickly deformed, and storage sites for industrial waste and displacement zones of frozen dumps (man-made rock-glaciers) become completely unsuitable for further usage. For 6 types of linear systems in Russia V.I.Grebenets with colleagues analyzed the negative impact of dangerous cryogenic processes, including the fact that about 70% of underground utilities in the largest Arctic cities of Russia are in poor condition, 30-40% of main pipelines in discontinuous permafrost zones become deformed after 5-10 years of operation.

In July 2018, in the lower reaches of the Ob and in the south of the Yamal Peninsula, a comprehensive training practice in cryolithology was conducted (heads - V.I.Grebenets and V.A.Tolmanov). It was collected a large amount of data on transformation of landscape-frozen conditions under climate warming, as well as carried out several hundred thermometric measurements to assess the thermal effect of various plant-soil tundra covers on the depth of seasonal thawing and thermo-conditions of permafrost soils.

A.I.Kizyakov with colleagues from the Earth Cryosphere Institute TSC of the Siberian Branch of the Russian Academy of Sciences performed studies on the assessment of the relief-forming role of gas emission craters (GEC) (Kizyakov et al., 2018). The role of GEC in relief changes is local, incomparable in terms of the movement of rocks with other destructive cryogenic processes.

However, the relief-forming role of GECs is not limited to the appearance of the crater itself, but also results in positive and negative microforms as well. Negative microforms are rounded hollows, surrounded by piles of ejected or extruded deposits. Hypotheses related to the origin of these forms are put forward and supported by an analysis of multi-temporal satellite images, field observations and photographs of GECs. Remote sensing data specifically was used for interpretation of landform origin, measuring distances and density of material scattering, identifying scattered material through analysis of repeated imagery. Remote-sensing and field data reliably substantiate an impact nature of the hollows around GECs. Hollows formation is associated with the impact of large blocks of frozen deposits and ice ejected from the crater during its formation. It is found that scattering of frozen blocks at a distance of up to 293 m from a GEC is capable of creating an impact hollow. This study aims at the prediction of risk zones.

In July 2018, A.I.Kyzyakov took part in the Russian-German expedition “Lena-2018” as part of a field team led by S.Wetterich (AWI). This team study exposures of ice-wedges and frozen deposits of the ice complex, on Sobo-Sise Island in the Lena delta, as well as measurements of the of seasonal thawing depth were performed.

Complex glacio-meteo-hydrological monitoring was carried out by V.V.Popovnin at the Djankuat Glacier, a representative object for the Central Caucasus. A 2017/18 balance year turned out to reveal a number of anomalies and peculiarities. For instance, a tremendous sand influx from Sahara Desert was detected in the springtime; it resulted in unusual concentration of transported impurities in the deposited snowpack that led to distorted albedo values which consequently caused the increased ablation (about 3370 mm w.e.). However, It could not compensate for rather high winter snow accumulation that equaled ca. 3810 mm w.e. – mainly at the expense of extraordinarily high snow density (up to 0.60 and 0.65 g•cm3 on the snow and in the firn basin, correspondingly, by the date of seasonal accumulation maximum). Thus, a moderate positive mass balance value of +440 mm was preliminarily derived for 2017/18 – the first positive value throughout the last 14 years.

Two methodical innovations were introduced into the traditional monitoring observational programme at the Djankuat Glacier. First, snow accumulation survey was partly made by means of radar sounding that revealed good compatibility with the direct measurements even in the firn basin. Second, in the end of the balance year some ablation stake readings within inaccessible areas of the glacier were made with the help of drone; the drone was also successfully applied for snow coverage surveys and concomitant geodetic tasks.

Mass balance monitoring of 3 reference glaciers (Karabatkak, Sary-tor and Bordu) in the Inner Tien Shan, Kyrgyzstan, was continued. In 2017/18 balance year all of them revealed a strong mass loss (-810, -540 and -870 mm w.e., correspondingly), though this year was a bit

better than average for the state of the Karabatkak and the Bordu Glaciers and the best for the Sary-tor Glacier since the resumption of mass balance programme here.

Another object of long-term monitoring, Glaciar de los Tres in Patagonia, Argentina, was surveyed as well. It was the 7th field season since the start of direct terrestrial observations in 1995/96 by Russian glaciologists. The continuous ongoing glacier terminus recession was corroborated by laser ranger. Its total retreat of 223 m during 1995-2018 was estimated, while application of earlier remote sensing data reveals the value of 321 m for the longer 1963-2018 period. The overall mean retreat rate comes to 5.8 m/yr for the entire 55-year-long time span whereas evident signs of its acceleration can be derived when analyzing results of front positioning inside this time interval. The adjacent lake Laguna Ira has lost its proglacial status 3 years ago. Today its aquatory is estimated as 2.060 ha that is approximately 3.3 times larger than in 1995/96. Frontal recession rate along the rocky slope seems to decelerate in comparison with its dynamics at the floating stage. Glacier area, which is currently as small as 0.753 sq.km in orthogonal projection, reduced by 17 per cent since 1998 and by 21 per cent since 1963. The obtained values witness for acceleration of deglaciation trends in the Patagonian Andes over the last decades.

Using a variety of techniques including tacheometry, airborne and terrestrial close-range photogrammetry, high-resolution satellite DEMs D.A.Petrakov and N.V.Kovalenko with colleagues reported on fast regeneration of the Kolka glacier (Caucasus) after Kolka-Karmadon glacial disaster in 2002 (Petrakov et al., 2018). Since the disaster volume of the glacier has been increased up to 50 mln. m^3 which is about half of precatastrophic volume. Rapid growth of the Kolka contradicts completely to dramatic downwasting of the representative Caucasian glaciers, Djankuat and Garabashi.

N.V. Kovalenko analyzed the photographic material from the tracking camera, which removes the accumulation basin of the Kolka glacier at intervals of 3 hours starting in August 2017. The data of the ground radar survey of the largest Caucasus glacier, Bezengi, undertaken by first time, was processed and analyzed. The data obtained revealed the largest ice thickness in the Caucasus - up to 425 m and 197 as an average. The ice volume of the explored part of the Bezengi glacier reaches 1.4 km^3.

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Badu Yu.B. Cryogenic strata of gas-bearing structures of the Yamal Peninsula. About an influence of gas accumulations on cryogenic strata forming and development. Moscow, Scientific World, 2018. 232 p. [In Russian].

Grebenets V.I., Tolmanov V.A., Khayredinova A.G., Yurov F.D. The problem of storage of solid waste in the cryolithozone // In coll. Sergeyev readings: vol.20: Waste management: tasks of geo-ecology and engineering geology. Materials of the annual Scientific Council of the RAS on the problems of geoecology, engineering geology and hydrogeology. Moscow: PFUR, 2018. P.227-234. [In Russian].

Petrakov D.A., Aristov K.A., Aleynikov A.A., Boyko E.S., Drobyshev V.N., Kovalenko N.V., Tutubalina O.V., Chernomorets S.S. Rapid regeneration of kolka glacier (caucasus) after the 2002 glacial disaster. Earth's Cryosphere, 22(1):58–71, 2018. DOI: 10.21782/KZ1560-7496-2018-1(58-71)

Streletskaya I.D., Taratunina N.A., Belayev V.R., Kurbanov R.N. SOIL WEDGES AS A PROXY OF RELICT PERMAFROST IN LOWER VOLGA RIVER REGION. Abstracts of the International conference “Loessfest2018: Diversity of loess: properties, stratigraphy, origin and regional features”. Moscow-Volgograd, September 23-29, 2018, Volgograd State University Volgograd, p. 111-112

Streletskaya I.D., Vasiliev A.A., Oblogov G.E., Semenov P.B., Vanshtein B.G., Rivkina E.M. Methane in ground ice and frozen sediments in thecoastal zone and on the shelf of Kara Sea. Led i Sneg. Ice and Snow. 2018. 58 (1): 65–77. [In Russian].

Shpolyanskaya N.A. Geocryology. Cryolithozone evolution and global climate change. Moscow: KDU, Dobrosvet, 2018. 188 p. [In Russian].

Streletskaya I.D., Vasiliev A.A., Oblogov G.E. COASTAL RETREAT AND METHANE EMISSION IN THE WESTERN YAMAL // Proceedings of Abstracts 11th International Conference on Air Quality – Science and Application, место издания Published by the Air Quality Conference College Lane Hatfield AL10 9AB United Kingdom, 2018. с . 208

Kovalenko N., Petrakov D., Alexandrin M., Lavrentiev I., Kutuzov S. New data on glacier thickness in Central Caucasus from recent radar surveys – Presentation on Practical Geography and XXI Century Challenges. International Geographical Union Thematic Conference dedicated to the Centennial of the Institute of Geography of the Russian Academy of Sciences, Moscow, Russia, 4-6 June 2018

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Books:

1. Coastal processes: monitoring and innovative complex research: Tutorial / V.S. Isaev, A.V. Koshurnikov, E.I. Ignatov, E.S. Kashirina, A.A. Novikov, A.I. Gushchin, O.I. Komarov, P.Yu. Pushkarev, M.L. Vladov, P.I. Kotov, V.V. Verbovsky, R.M. Amanzhurov, E.I. Gorshkov; Edited by Professor E.I. Ignatov, associate professor V.S. Isaev. - Sevastopol: ECOSY-Hydrophysics, 2018-246 pp.

In the field of geology, geophysics and geography, innovative technologies are to a greater or lesser extent connected with the solution of various important practical problems and tasks, which includes the search and exploration of mineral deposits, an assessment of the ecological situation in different regions, including forecasting and assessing the risk of catastrophic processes and phenomena. This manual is intended for students and young scientists of geological, geographical, geoecological and engineering specialties.

2. *Roman L.T., Tsarapov M.N., Kotov P.I., Volokhov S.S., Motenko R.G., Cherkasov A.M., Stein A. I. and Kostousov A.I.* Manual on the determination of the mechanical properties of freezing, frozen and thawing soils. Publishing house "Book House" University ", 2018, 188 p.

The manual discribes the main field and laboratory methods for determining the physical, thermal and mechanical properties of freezing, frozen and thawing soils. For the first time, updated standards, regulatory documents and publications on methodological issues of testing are analyzed. The influence of the main characteristics of the composition, physical properties, as well as temperature conditions on the formation of deformations and strength of freezing, frozen and thawing soils is considered.

Articles – Top 25 on the web of science:

1. Cryovolcanism on the Earth: Origin of a Spectacular Crater in the Yamal Peninsula (Russia)/ *Buldovicz S.N., Khilimonyuk V.Z., Bychkov A.Y., Ospennikov E.N., Vorobyev S.A., Gunar A.Y., Gorshkov E.I., Chuvilin E.M., Cherbunina M.Y., Kotov P.I.,Lubnina N.V., Motenko R.G., Amanzhurov R.M.* **//**Scientific reports, Nature Publishing Group (United Kingdom), DOI

Geological activity on ice planets and planetoids includes cryovolcanism. Until recently, most research in terrestrial permafrost has been engineering-oriented, and many phenomena have received too little consideration and thought. Although fast processes in the Earth's cryosphere were known before, they have never been attributed to cryovolcanism. The discovery of a huge crater in the Yamal Peninsula aroused numerous hypotheses of its origin, including a meteorite impact or migration of deep gas as a result of global warming. The origin of the Yamal crater can be explained in terms of cryospheric processes. Thus, the Yamal crater appears to result from collapse of a large pingo which formed within a thaw lake when it shoaled and dried out allowing a large talik below it to freeze back. The pingo collapsed under cryogenic hydrostatic pressure built-up in the closed system of the freezing talik. This had happened before the freezing completed, when a core of wet ground remained unfrozen and stored a huge amount of carbon dioxide dissolved in pore water, eventually reaching gas-phase saturation, and overpressure exceeded the lithospheric confining stress and the strength of the overlying ice. As the pingo exploded, the crater followed the cylindrical shape of the remnant talik core. Researches are executed on projects: Geodynamics of the polar and subpolar regions of the Russian Federation; Scientific basis for the creation of the National Depositary Bank of Living Systems.

2. Cliff retreat of permafrost coast in south-west Baydaratskaya Bay, Kara Sea, during 2005–2016**.** *Isaev VS, Koshurnikov AV, Pogorelov A, et al.* Permafrost and Periglacial Processes. USA, 2018; 1–12. https://doi.org/10.1002/ ppp.1993

Recent years of increasing air temperature in the Arctic have known to lead a significant increase in the retreat speed of permafrost coast, which has threatened livelihoods and infrastructure along the coasts. The Kara Sea hosts more than 25% of the total length of Arctic coasts. Yet, little is known about how coastal erosion in the Kara Sea may have changed through time and what the climatic and environmental drivers are. We study coastal dynamics along a 4 km stretch of permafrost and sea-ice affected coastline in the southwest Baydaratskaya Bay of Kara Sea, Western Siberia, between 2005 and 2016, by handheld differential GPS mapping and satellite imagery. We find temporal and spatial variations in the retreat rates, ranging between 1.0 (+0.1/–0.6) m/yr and 1.9 (+0.7/–1.3) m/yr over the studied coastline during 2005–2016. We also perform ground temperature measurements, subsurface resistivity measurements, and estimation of wave energy flux of wind-driven ocean wave, to investigate the dominant climatic factors influencing the observed retreat rates through time. The results reveal that the wind-driven wave

activity during the sea ice-free days influences the magnitude of coastal retreat in the study area, while that recent temperature rise less contributes to enhancing coastal retreat during the study period. This suggests that quantities of the eroded sediment and the associated release of nutrient to the nearshore zone are controlled by the magnitude of wave activity, which might result in influencing infrastructure along the permafrost coast and marine ecosystem in the proximal ocean.
The activity is supported by the RuNoCORE CPRU-2017/10015
https://www.siu.no/eng/content/view/full/81242 & the SAMCoT WP6
https://www.ntnu.edu/web/samcot/home

Reports at high-rating international conferences:

At the 5th EUCOP Conference 2018, in Chamonix, France, the Geocryology Department staff delivered a series of reports on research and teaching activities on the Yamal Peninsula and on the Svalbard archipelago.

1*. Agapkin, I. A., Kotov, P. I., and Koshurnikov, A. V.* Application of geophysical methods to estimate mechanical properties of frozen saline soils (based on experimental data). In Book of abstracts 5 th European Conference on Permafrost (2018), Laboratoire EDYTEM - UMR5204 Université Savoie Mont Blanc, France, pp. 867–868.

The research is aimed at establishing interrelations (functional and correlation) between electrical, acoustic and strength properties frozen saline soil. Testing were conducted on two soil types (fine sand, lean clay), different salinity (from 0.07% to 1.42%), temperature (-2 oC, -4 oC,-6 oC) and water content. Strength properties determined by uniaxial compression and spherical template indenter test A total of 110 tests were conducted. As a result of generalization, the regression equation of the dependence of the strength on the wave velocity was obtained. The coefficients of this equation are functions of temperature. Factor analysis showed that the specific electrical resistance is inversely proportional to the concentration of the pore solution. With increasing salinity, electrical properties change more intensively than wave velocities.

2. *Sinitsyn, A., Kotov, P. I., Aalberg, A., and Beutner, K.* Monitoring of arctic infrastructure in svalbard. In 5th European Conference on Permafrost – Book of Abstracts, Eds. Deline P., Bodin X. and Ravanel L., 23 June - 1 July 2018 (2018), Chamonix, France, pp. 839–840.A

Settlement monitoring campaign for foundations in small cities Longyearbyen, Barentsburg, Svea and Pyramiden in Svalbard was initiated in summer 2017. Svalbard located in permafrost. Recent time-series observations and climate model predictions show that significant climate warming will occur in Svalbard in 21st century. The objective is to document the state of the selected foundations, and to provide a basis for repeated survey of the settlements in a 10-20 years perspective. Combined with long time data series of air and ground temperatures survey may provide valuable information on settlement rate of various buildings and foundations, useful for decision making for maintenance of existing structures and selection of foundation materials and design for future constructions. A systematic set of reference points was established on the foundation of selected buildings (older buildings and recent buildings, comprising different load carrying structural systems and different types of foundations). Survey was conducted by differential leveling.

3. *Kotov, P.I., Tsarapov, M.N., Green, E., Stanilovskaya, Y.V.* Selection of equations for long-term strength calculation of frozen saline soils. In 5th European Conference on Permafrost, June 23 – July 1, 2018, Chamonix, France (2018), Université Savoie Mont-Blanc France, pp. 174–175.

Frozen saline soils are sensitive to any impact and characterized by significant changes of physical, chemical, and mechanical properties afterwards. Strength decreases in time but the equations of long-term strength cannot take into account all the factors. However, almost all existing equations were obtained for non-saline soils. The selection of the equation was carried out on the basis of spherical template indenter test on artificial samples of two soil types (fine sand, lean clay), with different salinity (from 0.07% to 1.42%), temperature (-2 oC, -4 oC,-6 oC) and water content. A total of 200 tests were conducted. The data was processed using 10 equations. As a result of the analysis, only 4 equations satisfied the selection criteria. Determined equations can be used to calculate the long-term strength of saline frozen soils depending on soil type and temperature.

4. Engineer-geocryological scientific-educational field work of Moscow university Master of Science students at polar regions of European Russian arctic/ *Andrey Koshurnikov, Komarov O.I., Sergeev D.O., Vladislav Isaev*. 5th European Conference on Permafrost (EUCOP 2018), Chamonix-Mont Blanc, France, 23th June - 1st July 2018

Engineer-geocryological scientific-educational field work of Moscow state university masters students at polar regions of European Russian arctic had been founded in 2012 and on previous step had based on the program of complex researches by the field geocryological methods. The main sites of researches were situated close to Vorkuta city and the coastal site Yary on the Baydara Bay at Kara sea. In 2014 the

field work program was changed and the main idea of it had became the training and working out of the geocryological mapping in geocriologically differ sites. It was choosing some new sites:
– the Hanovey station surrounding on the river Vorkuta high coast located in Bolshezemlskaya tundra;
– the 110 km railway station at the Sot' river valley in Polar Ural mountain area.
– the western coastal area at Baydara Bay of Kara sea with total extension close 6,5 km.
The activity is supported by the RuNoCORE CPRU-2017/10015
https://www.siu.no/eng/content/view/full/81242 & the SAMCoT WP6
https://www.ntnu.edu/web/samcot/home

International projects:
Russian-Norwegian Research-based education in Cold Regions Engineering (RuNoCORE) project. CPRU-2017/10015 https://www.siu.no/eng/content/view/full/81242
Participants: NTNU- Norwegian University of Science and Technology (NO-NTNU) Department of Civil and Environmental Engineering; Lomonosov Moscow State University (MGU) (RU-MGU) Department of geocryology, Geology Faculty.
The northern part of Europe is becoming increasingly important from an economic point of view. However, for the sustainable development of this region, engineers need to improve their understanding of the mechanisms associated with the freezing and thawing of soils.
Moscow State University and NTNU have a long history of scientific cooperation in the field of the Arctic and cold regions, which can provide a better education for students of both universities. Through this collaboration, we better understand the culture and traditions that should be distributed to students. The project manager received a Ph.D. in geology engineer at Moscow State University and has worked in Norway for six years at SINTEF and NTNU.
The main activity of the project is to invite Norwegian students for field work in the northern part of Russia and to organize an intensive course in both countries for students from Russia and Norway. The courses will provide a very good basis for work as an engineer in the arctic climate. A significant part of the project is devoted to the financing of student scholarships and travel expenses. Project leaders rely on a solid foundation of research and make it available to more students from Norway and Russia.
To facilitate student mobility, the administrative staff of both universities is involved, which should contribute to an understanding of the principles of operation of these two systems and allow for promptly solving administrative problems.
The subject of this project is a priority both in the participating universities and in partner governments.
This project will be important for creating a good platform for student mobility, making it easier for students to find funding for future mobility and cooperation.
Areas of education and training:
1. Construction equipment, architecture
2. Ecological technologies
3. Other engineering and technology
4. Earth Sciences

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Sergeev Institute of Environmental Geoscience RAS (Moscow)

http://geoenv.ru/index.php/ru/

The Institute of Environmental Geoscience of the Russian Academy of Sciences (RAS), together with the Institute of Atmospheric Physics of RAS, the Institute of Earth Cryosphere of the Siberian Branch of RAS, the Institute of Petroleum Geology and Geophysics of the Siberian Branch of RAS and the Institute of Applied Mechanics RAS launched a large-scale project to develop principles and technological approaches to the adaptation of the Gazprom Corporation to climate change and geocryological conditions in the permafrost territory of Russian Federation.

Specialists continued the natural condition permafrost monitoring in the Northern Transbaikalia to provide the temperature data to GTN-P database. The fieldworks at the geocryological observatory in the vicinity of Vorkuta was continued – together with the

Geological Faculty of Moscow State University. This observatory was founded in the 50s with the participation of V.A.Kudryavtsev.

Most important publications – 2018:

*Khimenkov A.N., Sergeev D.O., Stanilovskaya J.V., Vlasov A.N., Volkov-Bogorodsky D.B., Merzlyakov V.P., Tipenko G.*S. Structural reorganizations in frozen grounds within the gaz emission crater formation / Innovation and Discovery in Russian Science and Engineering. Springer International Publishing, 2018, p. 305-316. https://doi.org/10/1007/978-3-319-91833-4.

Sergeev D. Permafrost-Related Geohazards in Cold Russian Regions / Oxford Research Encyclopedia of Natural Hazard Science. Retrieved 25 Jan. 2018, from http://naturalhazardscience.oxfordre.com/view/10.1093/acrefore/9780199389407.001.0001/acrefore-9780199389407-e-291. DOI: 10.1093/acrefore/9780199389407.013.291.

Khimenkov A., Stanilovskaya J., Sergeev D., Vlasov A., Volkov-Bogorodsky D. The fluid dynamics role of gases in the cryogenic craters formation / Deline P., Bodin X. and Ravanel L. (Eds.) (2018): 5 th European Conference On Permafrost – Book of Abstracts, 23 June - 1 July 2018, Chamonix, France, < https://hal.archives-ouvertes.fr/hal-01816115/ >, p. 168-169.

Isaev V., Koshurnikov A., Komarov O., Sergeev D. Engineer-geocryological scientific-educational field work of Moscow university Master of Science students at polar regions of European Russian Arctic / Deline P., Bodin X. and Ravanel L. (Eds.) (2018): 5 th European Conference On Permafrost – Book of Abstracts, 23 June - 1 July 2018, Chamonix, France, < https://hal.archives-ouvertes.fr/hal-01816115/ >, p. 247-248.

Sergeev D., Chesnokova I. Identification of the Active Layer Heat Exchange Mechanisms in Mountain Permafrost Conditions by using GTN-P data / Deline P., Bodin X. and Ravanel L. (Eds.) (2018): 5 th European Conference On Permafrost – Book of Abstracts, 23 June - 1 July 2018, Chamonix, France, < https://hal.archives-ouvertes.fr/hal-01816115/ >, p. 605-606.

Development of the natural and technical system during the operation of the railway (Pesets-Hanovei, Russian Federation) / Deline P., Bodin X. and Ravanel L. (Eds.) (2018): 5 th European Conference On Permafrost – Book of Abstracts, 23 June - 1 July 2018, Chamonix, France, < https://hal.archives-ouvertes.fr/hal-01816115/ >, p. 217-218.

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Institute of Physicochemical and Biological Problems in Soil Science, RAS (Soil Cryology Laboratory)(Pushchino, Russia) http://www.issp.psn.ru/

1. It has been shown, that Cenozoic permafrost is a unique ecosystem not impacted by anthropogenic factors. The genes and metabolic products of viable microbial cells have persisted over geological time. Microbiological and molecular biological studies of paleobiological objects in permafrost extend our knowledge of the biosphere's spatial and temporal boundaries and set a new direction in Quaternary geology, geocryology, bacterial paleontology and exobiology. Furthermore, the ability of viable microor- ganisms in permafrost to carry out metabolic reactions at subzero temperatures and produce cold-active enzymes makes the Earth's permafrost one of only a few natural models for exobiology.

2. It has been obtained the first data demonstrating the capability of multicellular organisms for long- term cryobiosis in permafrost deposits of the Arctic. The viable soil nematodes *Panagrolaimus* aff. *detritoph- agus* (Rhabditida) and *Plectus* aff. *parvus* (Plectida) were isolated from the samples of Pleistocene permafrost deposits of the Kolyma River Lowland. The duration of natural cryopreservation of the nematodes corre- sponds to the age of the deposits, 30 000–40 000 years.

3. Samples Ant1 and Ant2, collected in Antarctic Miers Valley from permafrost sediments, with and without biogenic methane, respectively, were evaluated for methanogenic activity and

presence of methanogens. After a one-year incubation of both samples under anaerobic conditions, methane production was observed only at room temperature in microcosm Ant1 with CO2/H2 (20/80) as carbon and energy sources and was monitored during the subsequent 10 years. The concentration of methane in the headspace of microcosm Ant1 changed from 0.8% to a maximum of 45%. Archaeal 16S rRNA genes from microcosm Ant1 were related to psychrotolerant *Methanosarcina lacustris*. Repeated efforts at achieving a pure culture of this organism were unsuccessful. Metagenomic reads obtained for the methane-producing microcosm Ant1 were assembled and resulted in a 99.84% complete genome affiliated with the genus Methanosarcina. The metagenome assembled genome contained cold-adapted enzymes and pathways suggesting that the novel uncultured Methanosarcina sp. Ant1 is adapted to sub-freezing conditions in permafrost. This is the first methanogen genome reported from the 15 000 years old permafrost of the Antarctic Dry Valleys.

4. Soil profile temperatures in Northern Yakutia depend on their location in tundra or taiga zones and subzones, water content (drainage conditions), ice content in the underlying permafrost, vegetation cover, as well as soil particle size (texture) and thickness of organic horizons. The studied soils differ mainly in winter temperatures. The mean coldest month temperatures of loam soils measured at 20 cm below the surface are 10 °C higher in northern taiga than in southern tundra. However, the mean annual temperatures at this depth vary from –4.3 to –9.7 °C in tundra and from –1.2 to –4.9 °C in taiga. This discrepancy is primarily due to the effect of the snow cover which is thicker, less dense, and more stable in the forest landscapes. Sandy podburs have larger thawing degree-day sums and deeper 0 °C, 5 °C, and 10 °C isotherms than the loamy soils of tundra or taiga zones. Xeromorphic soils of steppe ecosystems in the northern taiga subzone have the warmest summer temperatures and are most responsive to temperature change.

5. In the profiles of cryozems (Oxyaquic Turbic Cryosols) developing in tundra of northern Yakutia under conditions of shallow active layer, suprapermafrost horizons of the accumulation of raw organic matter are formed. Taking into account their genesis, stable and regular position in the soil profile, paragenetic links with the overlying horizons and neighboring soil profiles, and a set of diagnostic features and properties, these horizons can be separated as a new type of genetic soil horizons—the organomineral accumulative suprapermafrost horizon (CRO). Its qualitative composition (the ratio of organic and mineral matter in the material) can be reflected at a lower level. In relation to the separation of the new genetic horizon within the framework of the new Russian soil classification system, a new genetic types of soils—cryozem with suprapermafrost accumulation of raw organic matter (suprapermafrost organo-accumulative cryozem)—can be established. Its diagnostic profile has the following horizonation: (O, AO, T)–CR–CRO–┬C.

Most important publications – 2018:

Rivkina E., Abramov A., Spirina E., Petrovskaya L., Shatilovich A., Shmakova L., Scherbakova V., Vishnivetskaya T. Earth's perennially frozen environments as a model of cryogenic planet ecosystems. Permafrost and Periglacial Processes. 2018, 4: 246-256. https://doi.org/10.1002/ppp.1987

Shatilovich A.V., Tchesunov A.V., Neretina T.V., Grabarnik I.P., Gubin S.V., Vishnivetskaya T.A., Onstott T.C., Rivkina E.M. Viable Nematodes from Late Pleistocene Permafrost of the Kolyma River Lowland. In Doklady Biological Sciences 2018 May 1 (Vol. 480, No. 1, pp. 100-102).

Vishnivetskaya T.A., Buongiorno J., Bird J., Krivushin K., Spirina E.V., Oshurkova V., Shcherbakova V.A., Wilson G., Lloyd K.G., Rivkina E.M. Methanogens in the Antarctic Dry Valley Permafrost. FEMS microbiology ecology. 2018 Jun https://doi.org/10.1093/femsec/fiy109

Fedorov-Davydovs D.G., Davydov S.P., Davydova A.I., Shmelev D.G., Ostroumov V.E., Kholodov A.L., Sorokovikov V.A. Northern Yakutia, tundra soils, northern taiga soils, soil cover heterogeneity, temperature regime of soil, active layer, seasonal thaw. Earth`s Cryosphere, 2018; 22(3):47-58. DOI: 10.21782/EC2541-9994-2018-3(47-58)

Gubin S.V., Lupachev A.V. Suprapermafrost Horizons of the Accumulation of Raw Organic Matter in Tundra Cryozems of Northern Yakutia. Eurasian Soil Science. 2018 Jul 1; 51(7):772-81. DOI: 10.1134/S1064229318070049

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http://www.irigs.irk.ru/

A database of soil temperatures has been created from monitoring data of the climatic characteristics of landscapes at the Tunkinskaya depression ((south-west part of the Baikal Rift Zone in the South Siberia). The study area is located at the junction of the Tunkinskiy Goltsy and Khamar-Daban ridges, belongs to the island distribution zone of permafrost and is characterized by a sharp continental climate, a variety of landforms, soil-forming rocks, landscape conditions (from steppe to mountain-taiga and bald mountains in the height range of 700-3500 m a.s.l.). The data of year-round observations of the soil temperature and moisture (from the underlying surface to 10 m) were collected. Since October 2011, observations are carried out automatically in 1 hour at 21 sites. Observation sites are located on plots with seasonally thawing soils (wetland) and seasonally freezing soils (sandy massifs, taiga and forest-steppe areas). For monitoring, the atmospheric-soil measuring complex developed and manufactured at IMCES SB RAS is used. Soil sampling at pits and boreholes on various underlying rocks were made to assess the influence of the physicochemical properties of soils on the features of the hydrothermal regime. More than 200 soil samples were collected. The moisture content, particle size, texture, bulk weight (density), the content of organic matter, etc. were analyzed. Fluctuations in average daily air temperatures at the sites are synchronous during the year. However, due to differences in vegetation cover, microclimatic differences in daily air temperatures reach 4-5 oC. The differences between average daily temperatures are slightly higher (7–9°C) on the soil surface.

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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.

1. ***D.G. Fedoryov-Davydov, S.P. Davydov, A.I. Davydova, D.G. Shmelev, V.E. Ostroymov, A.L. Kholodov, V.A. Sorokovikov*.** THE THERMAL STATE OF SOILS IN NORTHERN YAKUTIA (№3, 2018, p. 52-66)

Soil profile temperatures in Northern Yakutia depend on their location in tundra or taiga zones and subzones, water content (drainage conditions), ice content in the underlying permafrost, vegetation cover, as well as soil particle size (texture) and thickness of organic horizons. The studied soils differ mainly in winter temperatures. The mean coldest month temperatures of loam soils measured at 20 cm below the surface are 10 °C higher in northern taiga than in southern tundra. However, the mean annual temperatures at this depth vary from -4.3 to -9.7 °C in tundra and from -1.2 to -4.9 °C in taiga. This discrepancy is primarily due to the effect of the snow cover which is thicker, less dense, and more stable in the forest landscapes. Sandy podburs have larger thawing degree-day sums and deeper 0 °C, 5 °C, and 10 °C isotherms than the loamy soils of tundra or taiga zones. Xeromorphic soils of steppe

ecosystems in the northern taiga subzone have the warmest summer temperatures and are most responsive to temperature change.

2. ***D.G. Fedoryov-Davydov, S.P. Davydov, A.I. Davydova, V.E. Ostroymov, A.L. Kholodov, V.A. Sorokovikov, D.G. Shmelev***. THE TEMPERATURE REGIME OF SOILS IN NORTHERN YAKUTIA (№4, 2018, p. 15-24)

Soils in Northern Yakutia differ in average duration of the season of positive temperatures, the difference being 2.3 times between soil types and 1.8 between zonal loam soils, at a depth of 20 cm. The seasons of > 0 °C and > 5 °C soil temperatures may be shorter in wetter boggy areas with thicker organic horizons. The durations of fall freezing and persistent near-zero temperatures vary from 1-2 months for tundra cryozems and gleyzem (Turbic Glacic Cryosols) to 2.5-3.5 months for taiga cryometamorphic soils (Cambic Turbic Cryosols), peat-cryozem (Folic Cryosol), and tundra podburs (Spodic Turbic Cryosols). The active layer freezes mostly from above (top to base), except some years of cool summers mainly in the tundra zone when it freezes partly from below. The tundra and taiga soils show a warming trend of the soil climate since the late 1990s according to dynamics of annual freezing degree-day sums. The soils of Northern Yakutia vary in total heat spent on the active layer warming Q > 0, the difference reaching 10 times.

3. ***D.V. Yakovlev, A.G. Yakovlev, O.A. Valyasina.*** PERMAFROST STUDY IN THE NORTHERN MARGIN OF THE SIBERIAN PLATFORM BASED ON REGIONAL GEOELECTRIC SURVEY DATA (№5, 2018, p. 77-95)

The article presents results of permafrost study within northern margins of the Siberian Platform, obtained during regional geoelectric surveys by magnetotelluric and transient electromagnetic methods. The surveys aimed to identify areas perspective for oil and gas within the entire sedimentary cover. From 2005 to 2016, more than 30,000 soundings were performed with a total survey line length of more than 20,000 km. A large amount of factual data acquired in the Yenisei-Khatanga and the Anabar-Lena regional troughs allowed mapping the depth of permafrost base and provided insights about other structural features of the permafrost interval, along with the information on permafrost distribution beneath the Khatanga bay. High-resistivity anomalies identified over hydrocarbon reservoirs capped by the permafrost strata can be associated with accumulations of gas-hydrates.

4. ***A.A. Galanin, M.R. Pavlova, I.V. Klimova*****.** THE NEW KEY SECTION OF THE DOLKUMINSKAYA FORMATION IN THE VILUY RIVER BASIN AND THE HISTORY OF THE LATE QUATERNARY DUNE FORMATION IN CENTRAL YAKUTIA (PART 1) (№6, 2018)

The facial features, details of the structure and absolute age of cross-layered sandy-loam sediments, widely distributed in the region in a wide hypsometric range, are discussed on the base of the new Kysyl-Syrsky key-section in the basin of the Viluy river in Central Yakutia. These deposits are related to the Dyolkuminskaya Formation, which was formed from through the Last Cryochrone (MIS 2) till the beginning of the Holocene under conditions of severe desiccation and desertification of the territory. During the Boreal optimum of the Holocene (12-6 kyr), the dune cover was stabilized with soil-vegetation cover. The modern dune massifs have been originated no more than 1 thousand years ago and associated with the climatic events of the Small Ice Age.

5. ***V.Ya. Lipenkov*****.** HOW AIR BUBBLES FORM IN POLAR ICE (№2, 2018, p. 16-28)

Experimental results for 22 ice cores from Antarctica and Greenland provide insights into principal mechanisms that govern the formation and evolution of air bubble systems in polar ice. A semi-empirical model has been suggested to relate the size and number of bubbles in ice with snow accumulation rate and temperature during ice formation. Air bubble sizes and number concentrations can be used for refining paleoclimate reconstructions based on ice core data.

6. ***A.A. Zhang, E.S. Ashpiz, L.N. Khrustalev, D.M. Shesternev.*** A NEW WAY FOR THERMAL STABILIZATION OF PERMAFROST UNDER RAILWAY EMBANKMENT (№3, 2018, p. 67-71)

It is suggested to prevent permafrost thawing under railroad embankments by laying a geosynthetic heat insulator on the slopes. The insulation creates a cooling effect whereby the permafrost table moves upward from the embankment base to its body. The thaw depth reduction is confirmed by geophysical surveys at a test segment of a railway operated in a permafrost area. The new method has better economic performance than other known ways of thermal stabilization.

7. ***E.M. Chuvilin, S.I. Grebenkin.*** DISSOCIATION OF GAS HYDRATES IN FROZEN SANDS: EFFECT ON GAS PERMEABILITY (№1, 2018, p. 44-50)

Special experiments have been carried out to assess gas permeability variations associated with dissociation of pore hydrate in frozen sand samples at negative temperatures. The experiments were run on an originally designed system using frozen samples artificially saturated with methane hydrate which either remained stable or dissociated upon pressure drop. The measurements under different pressures and temperatures showed that the sand samples became more permeable to gas as pore hydrate dissociated at a pressure below equilibrium (0.1 MPa) and temperatures of -5 to -3 °C. The magnitude of the gas permeability increase varied depending on initial hydrate and ice saturation of the samples.

8. ***A.K. Saraev, K.M. Antashchuk, I.S. Eremin.*** AUDIO-FREQUENCY MAGNETOTELLURIC SURVEYS WITH NON-GROUNDED LINES FOR IMAGING THE RESISTIVITY STRUCTURE OF THE RYBACHIY PENINSULA (MURMANSK REGION) (№5, 2018, p. 65-76).

The resistivity structure of the Rybachiy Peninsula (Murmansk region) was studied in winter by audiofrequency magnetotelluric (AMT) surveys using long non-grounded lines and a preamplifier with a high input resistance. The acquired data were processed by robust techniques. Reliable measurements were provided in an audio-frequency range of 7-8 to hundreds of hertz. The results collected in winter with non-grounded lines were no worse than summer measurements with grounded lines. The AMT surveys can resolve the basement top under 5-6 km of low-conductive sediments. The obtained resistivity section of the area represents the transition between the Fennoscandian shield and the Barents shelf and comprises highly permeable water-saturated conductors. The basement depth estimate by inversion of AMT curves was proven valid by subsequent drilling. The AMT surveys have provided updates for the local crust structure inferred from seismic data. The method is applicable to surveys in the Arctic areas of Russia and other permafrost territories.

9. ***V.M. Fedorov.*** FORECASTING GLACIER MASS BALANCE VARIATIONS IN GLACIATED REGIONS OF THE NORTHERN HEMISPHERE (№4, 2018, p. 55-64).

Correlation analysis revealing a relationship between regionally averaged mass balance series for 9 glacial regions in the Northern hemisphere and insolation contrast has been carried out. According to the regression equation, the forecast of the changes in the regionally averaged total mass balance of ice has been performed for these regions until 2050. It has been determined that the degradation of the contemporary mountain glaciation is associated with the enhancement of the inter-latitudinal heat transfer caused primarily by a decrease in the inclination angle of the Earth's rotation axis increasing thereby the meridional gradient of insolation (insolation contrast).

10. ***S.V. Popov, V.L. Kuznetsov, S.S. Pryakhin, M.P. Kashkevich.*** RESULTS OF GROUND-PENETRATING RADAR INVESTIGATIONS ON THE NELLA FIORD SEA ICE (PROGRESS STATION AREA, EAST ANTARCTICA) IN THE 2016/17 AUSTRAL SUMMER FIELD SEASON (№3, 2018, p. 18-26).

The paper presents the main results of the field investigations using multi-frequency (150 MHz, 270 MHz, 400 MHz and 900 MHz) ground-penetrating radar profiling and georadar sensing by the common depth point method. The investigations have been carried out on the fast sea ice of Nella Fiord (Eastern Antarctica) during the 2016/17 austral summer field season. The studies have included the seawater salinity measurements. The sounding of about 1 m thick sea ice have proved to be most effective at the radar frequencies which correspond to the wavelengths in a meter range. Besides the intensive reflections from the lower edge of sea ice, the ground-penetrating radar data have revealed a boundary between fresh and salt water whose position has been corroborated by salinity measurements. The ground-penetrating radar common depth point technique has served as a basis for the subsurface velocity model showing that effective dielectric constant for sea ice equals 10, which is accounted for intense near-surface internal melting and for the ice being exceedingly saturated with fresh water. The effective dielectric permittivity of the fresh water layer is found to be 75 that may have been prompted by roughness of the lower ice boundary.

11. S.N. ***Buldovich, E.N. Ospennikov, V.Z. Khilimonyuk.*** PHENOMENON OF GEOCRYOLOGICAL CONDITIONS IN THE EASTERN PART OF THE OLEKMA-CHARA UPLANDS (№3, 2018, p. 3-17).

The paper discusses results of the study on geocryological (permafrost) conditions in the eastern part of the Olekma-Chara Upland at the watershed of the Tokko river and its tributary, the Choruoda River, carried out within the framework of field research at the sites of mineral showings whose permafrost conditions are extremely contrasting. The combined impact of hydrogeological factors acting in the middle altitude environment is found to be largely responsible for the unique permafrost conditions in the study area.

12. ***A.P. Gorbunov, M.N. Zhelezniak, E.V. Severskiy.*** ESTIMATING THE VOLUME OF GROUND ICE IN THE TIEN SHAN (№6, 2018).

This article presents the estimates of evident ground ice in permafrost of the Tien Shan obtained from the available geocryological maps of various scales. The maps are based on the patterns of permafrost distribution reflected in the regional structures depending on geocryological zonality. Using the data on areal extent, thickness and ice content of permafrost, the volumes of permafrost and ground ice were determined. The study has shown that the largest volumes of ground ice occur in active rock glaciers and recent moraines. The volume of glaciers relative to that of ground ice has significantly decreased due to glacial degradation.

13. ***E.A. Novikov, V.L. Shkuratnik, M.G. Zaytsev, R.O. Oshkin.*** CHANGES IN PROPERTIES AND STATE OF COAL EXPOSED TO FREEZE-THAW WEATHERING: EVIDENCE FROM THERMALLY INDUCED ACOUSTIC EMISSION (№4, 2018, p. 76-85).

Acoustic emission responses of water-saturated lignite and hard coal samples exposed to cyclic freezing and thawing have been studied as a function of the number of loading cycles, at different stages of freeze-thaw weathering, including prefailure. It is suggested to use an acoustic emission ratio to track the weathering history of coal and to assess the dependence of the weathering rate on pore water pH. The revealed acoustic emission patterns are applicable to predict the effect of weathering on the oxidation of coal which reduces its calorific value and poses risks of spontaneous combustion.

14. ***A.V. Baranskaya, F.A. Romanenko, H.A. Arslanov, F.E. Maksimov, A.A. Starikova, Z.V. Pushina.*** PERENNIALLY FROZEN DEPOSITS OF BELY ISLAND: STRATIGRAPHY, AGE, DEPOSITIONAL ENVIRONMENTS (№2, 2018, p. 3-15).

This paper is an overview of the study of perennially frozen deposits outcropping in the coastal cliffs of the western and eastern parts of Bely Island. The obtained results provide information about the composition, structure, stratigraphy, origin and age of Quaternary deposits. It has been established that the cross-section consists of three main units: the lower silts and clays formed during MIS 3 in the marine conditions; the middle sandy unit accumulated between 9 and 5 kA BP as a result of small-scale local relative sea level rise; the upper unit consisting of clays, loam, peat and aeolian sands of terrestrial origin formed in the Late Holocene.

15. ***Yu.K. Vasil'chuk, A.C. Vasil'chuk.*** WINTER AIR PALEOTEMPERATURES AT 30-12 KA BP IN THE LOWER KOLYMA RIVER, PLAKHINSKII YAR YEDOMA: EVIDENCE FROM STABLE ISOTOPES (№5, 2018, p. 3-19).

A continuous 15-18 m long sequence of permafrost with ice wedges at the Plakhinskii Yar site (Karetovo yedoma, left side of the Stadukhin Channel, lower Kolyma River) has been studied in terms of structure, stable isotopes, radiocarbon ages, major ion chemistry, and spore-pollen spectra. The obtained data allow quantitative estimates of Late Pleistocene permafrost and climate conditions in the area between 30 and 12 ka BP. The study confirms the previous inference that local winters at 30-28 ka BP were much colder than at present.

16. ***E.A. Slagoda, G.V. Simonova, Ya.V. Tikhonravova, A.O. Kuznetsova, K.A. Popov, P.T. Orekhov.*** RADIOCARBON DATING OF PERMAFROST IN BELY ISLAND, THE KARA SEA (№4, 2018, p. 3-14).

Twenty radiocarbon ages have been obtained for permafrost sections on Bely Island (Kara Sea) sampled in 2015-2016. The results make basis for sketch maps of Late Pleistocene (Karginian and Sartanian) and Holocene deposits of marine terraces I and II, the laida, and the floodplain of the Rogozin tidal channel. The Karginian shelf sediments make up terrace II and the uneven base of terrace I, and lie below the sea level under the laida; the Sartan shelf and subaerial deposits are widespread on terrace I. The new radiocarbon ages place the first time constraints on the Sartan sediments and record the northward sea retreat within the island at the Karga/Sartan boundary. The laida and the Rogozin Channel floodplain formed during the Atlantic, Subboreal, and Little Ice Age deposition in the Holocene simultaneously with peat deposition in drained lakes (hasyreys) on terraces.

17. ***D.A. Petrakov, K.A. Aristov, A.A. Aleynikov, E.S. Boyko, V.N. Drobyshev, N.V. Kovalenko, O.V. Tutubalina, S.S. Chernomorets.*** RAPID REGENERATION OF THE KOLKA GLACIER (CAUCASUS) AFTER THE 2002 GLACIAL DISASTER (№1, 2018, p. 58-71).

We have analysed changes in the Kolka glacier cirque and in the Karmadon depression after the glacial disaster of September 20, 2002 in the Republic of North Ossetia-Alania (Russia). We have estimated the rates of Kolka glacier regeneration and the rates of the ice dam decay in the Karmadon depression, on the basis of the field observations of 2002-2016, the topographical surveys of 2002-2004, 2009 and 2014,

and analysis of digital elevation models generated from satellite image stereo pairs (Terra ASTER of 2002 and 2004; and SPOT-6 of 2014). The combination of four methods used in 2014 to survey the surface of Kolka Glacier has helped to clarify the rate of recovery of the glacier in the past and provides a reliable benchmark for the future. Remote and terrestrial survey methods have demonstrated good agreement. We established that in 2002-2014 about (40 ± 11) million m3 of ice accumulated in the Kolka Glacier cirque, which is about 40 % of the volume of this glacier before the collapse in 2002. The forecasted slowdown of the glacier mass recruitment is not yet happening: in 2009-2014 as much ice has accumulated in the cirque, as in 2004-2009. The regeneration of Kolka Glacier comes amid adverse weather conditions for glaciation of the Caucasus, and in sharp contrast with the behaviour of other Caucasian glaciers experiencing rapid decline. The volume of the ice dam in the Karmadon depression decreased by 75 % in 2002-2014. The progressive decrease in the melting rate, which we noted before, continued in 2009-2014. In comparison with the first year after the disaster, the rate of melting decreased by almost 50 times. In the following ten years, the repetition of events similar to the disaster in 2002 is unlikely, but by 2025 Kolka Glacier can accumulate 60-70 % of its pre-disaster volume. It is necessary to continue monitoring the recovery of the glacier and to measure the volume of accumulated ice every 5-10 years.

18. ***A.P. Nevecherja, O.O. Rybak.*** PARAMETERIZATION OF DAILY AMPLITUDES OF SURFACE AIR TEMPERATURE IN GREENLAND FOR APPLICATION IN MASS BALANCE CALCULATIONS (№4, 2018, p. 31-41).

Mathematical modeling of melting (ablation) on the surface of the Greenland ice sheet is one of the challenging tasks of the modern glaciology. Normally, the ablation rate is evaluated by using one of the two methods - either by the index-temperature method or by the energy balance method (or by combination of both). The pitfall of either method is realistic approximation of the daily amplitudes of surface air temperatures and of the mean square errors of surface air temperatures. In the paper, an approach is proposed for approximating the equations of both characteristics. Final approximating models allowed us to establish the dependence of surface air temperatures daily amplitudes on time and on the absolute height above the sea level.

19. ***N.G. Koronatova, N.P. Mironycheva-Tokareva, Ya.R. Solomin.*** TEMPERATURE REGIMES OF PEAT DEPOSIT OF PALSAS AND HOLLOWS IN FLAT PALSA COMPLEXES OF WESTERN SIBERIA (№6, 2018).

The study is focused on temperature regime of fibrist histosols of flat palsa complexes located in the north of Western Siberia. Automatic loggers recorded temperature for 343 days every hour up to a depth of 60 cm in palsas and 120 cm in hollows (pools, lawns) in four mire ecosystems: in a hollow and a palsa of forest tundra, as well as in a hollow and a palsa of northern taiga. There are data on the mean daily temperature, mean annual temperature, extremes, annual amplitude, seasonally frozen layer dynamics, the sum of positive and negative temperatures at different depths. It was found out that the distinctions in the temperature regime were rather due to the differences in mire ecosystems than to the differences in bioclimatic zones. Hollows are characterized by milder thermal conditions. The location of mires in a higher latitude affected mainly to the annual amplitude and to temperature parameters obtained in the cold period.

20. ***G.P. Pustovoit, E.S. Grechishcheva, S.I. Golubin, A.V. Avramov.*** HOW THE TYPE OF INPUT DATA AFFECTS PROGNOSTIC TEMPERATURE CALCULATIONS FOR DESIGN IN PERMAFROST (№1, 2018, p. 51-57).

The design of oil and gas facilities on permafrost commonly includes several geotechnical tasks. One of them is providing operational stability of buildings and structures by project solutions based on prognostic calculations. The behavior of soils is simulated proceeding from their thermal and other physical properties. Designers and researchers most often estimate the respective parameters by calculations and use tabular data from national design standards instead of laboratory testing. We have calculated and compared several variants of input data obtained by laboratory testing and retrieved from national design standards. The results demonstrate that laboratory determination of some thermal properties of soils is indispensable for design in permafrost.

21. ***N.A. Pavlova, M.V. Danzanova.*** INTER-ANNUAL VARIABILITY OF THE CHEMICAL COMPOSITION OF THE ANTHROPOGENIC CRYOPEGS IN THE YAKUTSK CITY (№6, 2018).

The authors present an analysis of the 30-year observations of chemical composition dynamics of the anthropogenic cryopegs intersected at different depths in the loose alluvial deposits at one of the sites in

Yakutsk. Features of long-term and seasonal variability of major and trace elements composition of groundwater are considered. It is defined that the desalination of the suprapermafrost cryopegs observed during the last 5-7 years is due to the climatic features of the preceding period. Based on the results of hydrochemical and hydrodynamic studies, the conclusion about the increase of the hydraulic connectivity of cryopegs occurred in the layer of zero annual amplitude is justified. In conditions of rising ground temperatures, an increase of the concentration of trace elements in pore solutions is projected along with a general decrease of the highly-soluble salts content in the suprapermafrost waters.

22. ***V.N. Golubev, A.V. Vlakhova, G.A. Rzhanitsin, I.V. Semyonova.*** WATER CRYSTALLIZATION UPON FREEZING OF SOILS (№1, 2018, p. 20-26).

Changes in the amount of unfrozen water remaining in frozen wet soils are estimated theoretically for two possible cases of ice nucleation: within bulk pore water and on the surface of mineral particles. The process in the latter case is considered with regard to the composition, physical properties, and surface roughness of soil particles.

23. ***J.B. Gorelik, P.V. Soldatov.*** METHOD OF CALCULATION OF AXIAL LOAD ON THE WELL'S CASING DURING THAWING OF FROZEN HOST SEDIMENTS (№2, 2018, p. 50-60).

The paper presents data on casing deformations reported from high-latitude hydrocarbon production fields, and results of their comparison with laboratory simulations of a casing subjected to axial compression leading to deformations, such as buckling, similar to those occurring under operation conditions. The frozen soils in regions of well placements with reported buckled casings include epigenetically frozen clayey layers. In the thawed state, such layers have better mechanical properties and may retain their integrity under significant loads. As such, the thawed part of the layer comprises three supporting elements: casing; its own extension into the frozen soils; and the underlying thawed soils. A method for calculating axial loads on the casing depending on the thawed area size and thawing soils properties is proposed. The axial load exerted on casing tends to grow reaching its maximum at the initial stages of well operation, and then decreases to the asymptotically constant value (regardless of thaw radius). Early years of well operations appear to be most hazardous for the constructions, which agrees well with the known practical results.

24. ***S.S. Volokhov****.* ON THE NATURE OF MECHANOCALORICAL EFFECT IN FROZEN SOILS UNDER UNIAXIAL COMPRESSION (№1, 2018, p. 14-19).

The paper provides the results of experimental verification of the author's earlier hypothesis about the crack formation playing a major role in the appearance of mechanocalorical effect in the frozen soils, which is underpinned by the data obtained.

25. ***A.A. Vasiliev, G.E. Oblogov, I.D. Streletskaya, R.S. Shirokov.*** PERMAFROST AGGRADATION IN TIDAL FLATS OF THE KARA SEA (№5, 2018, p. 39-46).

The low accumulative laidas (tidal flats) are the areas of the permafrost aggradation. Long-term observations of the thermal regime of upper permafrost have been carried out at the two sites - Marre-Sale (western coast of the Yamal peninsula), and Sopochnaya Karga (western coast of the Taymyr peninsula). Mean annual ground temperature is -3.5...-4.5 °C at Marre-Sale, and -4.8...-7.7 °C at Sopochnaya Karga. Heat flow from atmosphere to the upper permafrost can reach 3.4 W/m2. A high correlation between the heat flows and the average annual air temperature anomalies has been established.

26. ***A.A. Semernya, L.A. Gagarin, K.I. Bazhin.*** CRYOHYDROGEOLOGICAL FEATURES OF THE SITE OF INTRAPERMAFROST AQUIFER DISTRIBUTION AT THE ERUU SPRING AREA (CENTRAL YAKUTIA) (№2, 2018, p. 29-38).

The paper presents the results of long-term permafrost and hydrogeological research conducted by Melnikov Permafrost Institute in the area of one of the perennial intrapermafrost springs residing in the territory of Central Yakutia. Spatial boundaries of the intrapermafrost aquifer recharging Eruu spring are determined from the drilling and geophysical survey data. Results of the groundwater level monitoring data processing allowed to define conditions of groundwater accumulation and discharge, as well as to determine the major role of icings (aufeis) in the hydrodynamic regime of intrapermafrost waters. The revealed specific geothermal characteristics of the upper rock layers may serve as indicators of groundwater presence on the fourth (Bestyakhskaya) terrace of the Lena River, which is evidenced by the maximum thaw depth coinciding with the depth of zero annual amplitude.