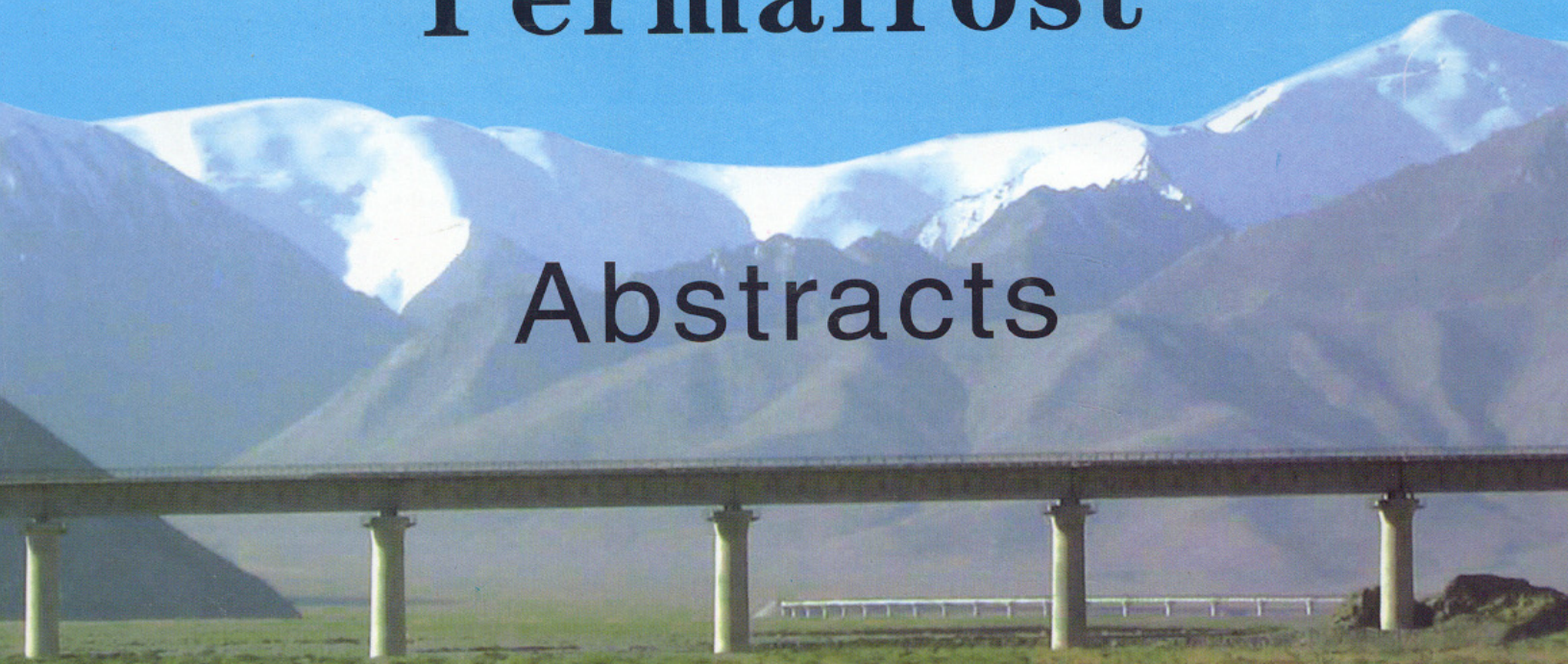
Asian Conference on Permafrost

Abstracts



Lanzhou, China
August 7–9, 2006

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Theme 1. Permafrost engineering, properties of frozen soils, model development, and their applications

Influence of snow meltwater infiltration on active layer movement in steep alpine scree slopes within the discontinuous mountain permafrost zone

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Abstract: The phenomenon of slow creep of seasonally and perennially frozen slopes has already been known for a long time. In the European Alps numerous researchers have studied creeping processes of slopes situated in the discontinuous permafrost zone. Profiles of downslope displacements have usually been measured in vertical boreholes, several tens of metres deep, using an inclinometer, with time intervals of at least several weeks between each measurement. In these studies the creep rate of scree for a given stress level was found to be mainly a function of ice content and temperature. However, the active layer is a special case: since its ice content can be quite low in mountain permafrost regions due to the well drained nature of coarse grained debris, infiltration of snow meltwater has to be considered as a cause for downslope movement. As the active layer is most susceptible to destabilization related to global warming, the influence of meltwater infiltration on the downslope displacement of the active layer has been investigated in the field.

The study site is situated in a 37° steep, NW exposed scree slope at a height of about 3000m a.s.l. in the Upper Engadin Valley, Eastern Swiss Alps. The existence of permafrost at this site had previously been proven by temperature measurements in boreholes. Meltwater infiltration rates were measured using a lysimeter with an area of $4m^2$. To observe the influence of water infiltration on volumetric soil water content and hence on slope deformations, TDR probes were buried at various depths in the active layer. The downslope displacements of the active layer were recorded with an in-place-inclinometer, which was installed in the middle of the active layer in a borehole. A measurement interval of two hours enabled a high temporal resolution monitoring of the three parameters. Data were collected over two snow melt periods (2004 and 2005).

The results show a clear correlation between the meltwater infiltration rate, water content and the downslope displacement of the active layer. As a consequence of the period of continuous meltwater infiltration at the beginning of June, the water content and the downslope displacement of the active layer increased sharply. Over the subsequent six months the average

curve of the accumulated displacement flattened out until displacement ceased during the following six winter months.

The field study has provided temporal benchmarks for displacement rates and therefore an indication of the highest disposition of slope failure. The next step will be to assess a threshold for the infiltration rate and water content necessary to trigger a plug-like hazardous mass movement using laboratory experiments.

Key words: Mountain permafrost, active layer, downslope displacement, slope stability, snow meltwater infiltration

Complex engineering – geocryological researches and laboratory researches of physico-mechanical properties soils the Pechora lowland (by the example of arrangement of an oil deposit of Varandei)

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Abstract: Engineering-geocryological researches in severe climatic conditions of Arctic regions (coast of Barents sea) at arrangement of oil and gas deposits are carried out with the purpose of studying the top part of geological sections. The main characteristic factor of territories of the Arctic coast is salinity soils. Such soils possess lowered durability, raised compressibility, high corrosion activity.

However methods of researches in territories of distribution salted frozen soils and researches of their physical and mechanical properties have not tested enough and found reflection in building rules and the technical literature.

The complex of works on research frozen soils at a predesign stage has consisted of the following sections:

Scientific support at drilling holes in salted frozen грунтах, including correct selection of monoliths for soil laboratory researches from preliminary allocated engineering - geological elements.

Recommendations on preservation of soil monoliths in a frozen condition during are their transportation developed.

The order of a monolith partition on blocks - preparations and separate samples, depending on a kind of tests, by the fulfilled technique with application of the special equipment is established.

The technique of tests salted frozen soils on durability and deformability (one axis compression, a ball stamp, a compression, shift of frozen soils) is developed

The being devices for tests salted plastic - frozen soils are advanced, the new ones are developed.

Installations, devices and techniques of frost heaving the beginning of freezing soil temperature definition, salinities, degrees of frost heaving are developed.

Key words: Frozen soils, engineering – geocryological researches, laboratory researches, physico-mechanical properties

The Features of Engineering and Geological Researches under Opening up of Permafrost of the High Mountains of Central Asia

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Abstract: In the last decade the opening up of the mountain territories in the countries of Central Asia have sharply increased. The governments of these countries began to give more attention to mountain problems, features of their sustainable development and environmental protection.

However, the main principles of economical planning not taking into account the real complexities and dangers under opening up of mountain territories. Among the natural exogenic processes inherent in all mountain territories there are a specific group of cryogenic processes and formations such as rock glaciers, rock streams (or kurum), solifluction, thermokarst subsidences, frost-susceptible, and cracked-polygonal grounds. It is necessary to take into account that they are in high seismicity regions that essentially complicates an economic activity in the mountain regions. Moreover, it should be noted that under action of local factors in mountains an extreme variability of geocryological conditions is observed on rather short distances. All of these make great, high demands of engineering-technical problems under design, construction and using automobile roads and railways, electricity transmission lines and other objects.

Till now in Kazakhstan, Kirghizia, Uzbekistan and Tajikistan the engineering and geocryological researches are not priority, regular and obligatory ones under opening up of mountain territories. It is best to China. Such researches have already received a wide range in connection with designing and construction automobile roads, railways and pipelines in Tibet.

One of the reasons of poor quality of engineering-geocryological researches is connected to absence of experts in general and engineering cryolithology. There is no special higher educational program for studying of cryolitologists at the universities of the upper-mentioned countries. All of this determines the numerous facts of destruction various engineering buildings constructed without considering permafrost. So, both periodic and casualty expensive repairs are ineffective and frequently do not reach positive results.

It is suffice to mention the absence of engineering and geocryological researches under the construction of highway connecting Almaty city with southern coast of the Issyk-Kul Lake in 1998-2000 years. This highway of length about 100 km crosses two mountain ridges, Zailiyiskiy and Kungey Alatau, rising up to a height of 3800 m a.s.l.. Already during the highway construction and in the first year after completion of the road it became unsuitable for operation. Significant parts of the road have been destroyed by mud-flows, blocked by rockslides and taluses. The frontal escarp of rock glacier cuts one part of the road, active moving ground masses from a body of rock glacier to the road occurs as a result.

The exploitation of the Kumtor golden deposits in Kirghizia at the heights more than 3800 m a.s.l. is periodically accompanied by rather negative consequences as a reason of the regional cryogenic features. As a whole, there are numerous violations of requirements for construction of various buildings and other engineering constructions on permafrost in the high-mountain

zone of Tien Shan.

Key words: Complexities and dangers, mountain territories, engineering-geocryological researches

Permafrost Issues in Route Choices for High-latitude Gas Pipelines in North America

Arlon R. Tussing, John Tichotsky & Philip L. Essley

Abstract: The largest accumulation of established[1] but undeveloped reserves of conventional natural gas in North America lies clustered on both sides of the Arctic shore,[2] and straddling the international boundary between the U.S. State of Alaska and Canada's Yukon Territory.[3]
Planning for a natural-gas pipeline from these reserves to southern markets started shortly after the 1968 discovery of the largest conventional oil and gas deposit in North America, at Prudhoe Bay in the onshore Alaskan sector. Construction began in 1974 on TAPS[4], an elevated, heated crude-oil pipeline from the Arctic Slope to an all-year tidewater port in southern Alaska, through which shipments commenced in 1977. Although reserves of natural gas in the Prudhoe Bay field alone are currently estimated at about 1 trillion cubic meters [TCM],[5] completion of any transport system to commercialize natural gas from Prudhoe Bay and other nearby field is unlikely for at least another ten years. Even after such a delay, anticipated growth in North American natural-gas markets might nevertheless be preempted by imports of liquefied natural gas [LNG], or by global emergence of alternative and possibly more abundant natural-gas resources, such as from deep offshore reserves in the Gulf of Mexico, or from disassociation of methane hydrates.[6]

The 1977 Decision

Since the early 1970s, shifting groups of oil-and-gas producing companies, pipeline builders and operators, and government authorities at federal, regional (state, provincial and territorial) and municipal levels, plus Native (Inuit and other aboriginal) landowner and advocacy groups, have periodically deliberated, negotiated, and litigated over the route, design, ownership, financing, construction and operation of such a pipeline or pipelines. These efforts came closest to fruition in 1977, when the U.S. Congress and Canada's Parliament, granted licenses[7] authorizing one of the competing pipeline coalitions to construct and operate an "Alaska Natural Gas Transportation System" [ANGTS].
ANGTS would have been a system of chilled and buried gas pipelines alongside the TAPS crude-oil pipeline from Prudhoe Bay southward to Fairbanks, Alaska, and thence southeast

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1 "Established reserves" = sum of proved and probable reserves.
2 At roughly the 70th Parallel N.
3 The international boundary at Longitude 141° W.
4 "TAPS" = The TransAlaska (crude-oil) Pipeline System, operated by the Alyeska Pipeline Service Company.
5 1 TCM of natural gas is the energy equivalent of about 1.1 billion tonnes of crude oil.
6 Methane hydrates—a form of natural gas bonded under high pressure in crystals of water ice, a potential resource that is widely distributed globally, but for which Arctic Alaska is current/y a major research and exploration frontier.
7 . . . after a series of competitive proceedings before the Energy Regulatory Boards of each nations.

across the Yukon Territory and British Columbia into Alberta, where it would connect with existing or newly built pipeline segments extending into the U.S. Midwest and California.[8]

Collapse of ANGTS project and recent revival of interest

However, in the 1980s restructuring of gas-market institutions in both the U.S. and Canada resulted in unanticipated increases in output from traditional gas-producing basins, deep reductions in market prices, and a collapse in the continent's perceived demand for natural gas from new or high-cost sources including the North American Arctic. By 1984 these events had caused an indefinite suspension of plans for Alaska and Yukon segments of the ANGTS pipeline project.[9]

Recent revival of interest

Since about 2003, however, retardation in replacement of conventional gas reserves in both the U.S. and Canada, and major increases in prices of crude oil and refined oil products, have revived active interest in gas-pipeline construction in North America's Arctic regions.
This paper will review a set of critical pipeline route and design issues which, as of this writing,[10] has received virtually no recognition in the ongoing public or official discourse.[11] The latter issues include the relevance of distinctive soil conditions that characterize the proposed pipeline routes, and implications of recent and anticipated of macro- and micro-climatic changes on the physical and commercial viability of the various potential pipeline routes.

Risk factors distinctive to pipeline viability.

All of the pipeline routes seriously considered either in the licensing contests of the 1970s, or in contemporary deliberations, share or appear to share a particularly vexing set of features:

> **Any pipeline route pointed south or southeast from the Central Alaskan Arctic or from the Beaufort-Yukon-Mackenzie gas-producing region tends to be richly endowed with permafrost of exceptionally high ice content, great depth, and frequent discontinuity. The foregoing generalization seems valid almost anywhere between the Arctic shore and the 60th Parallel or, in any event, for much of a pipeline system's most northerly thousand kilometers.**

It is also worth noting, inn addition, the specific zones characterized by these troublesome soil conditions are often also exposed to extraordinary seismic or volcanic activity.
The highest-profile instance of renewed activity involves heated and publicly controversial

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8 The 1977 plan also included a "Dempster cutoff" pipeline route directly south from the Beaufort/Mackenzie reserves, along the Dempster highway to join the ANGTS Alaska Highway main line in Yukon Territory;

9 Some of the southern segments of ANGTS (south of the permafrost regions) were completed in the 1980s and now operate profitably as conductors of Canadian gas exports to California or the United States Midwest.

10 March 2006.

11 Neither the implications of observed or projected changes of soil and ocean ice conditions, nor inferences from enhanced access to Russian experience with buried pipelines in permafrost, since the mid-1970s seems to be evident in the public record of current research or deliberations on high-latitude pipelines in North America.

negotiations currently under way among the three principal holders gas reserves[12] in Alaska's Arctic, and the governor of Alaska, regarding tax, royalty, and regulatory issues associated with a pipeline proposal that is very similar in route, scope, and design to the ANGTS project already approved by the two national governments in 1977.

Alternative pipeline route concepts, in addition to the ANGTS "Alaska Highway Route," that have been advanced in both periods by financially substantial parties, and which are particularly exposed to troublesome permafrost and possibly seismic risks include:

A "northern route" eastward from Prudhoe Bay to the Mackenzie Delta in order to pool ANS and Beaufort-Mackenzie gas, and thence southeast via the Mackenzie Valley into Alberta;[13]

1. A misnamed "All-Alaska Pipeline" to be laid parallel to the existing oil pipeline TAPS via Fairbanks to Big Delta, and thence directly south to a liquefaction terminal at Valdez, from which LNG would be exported to a receiving terminal in Canada or Mexico, for regasification preparatory to pipeline transshipment into the Western US;[14]
2. A "spur line" connecting Anchorage and Cook inlet with an outtake point on either the ANGTS or "All-Alaska" route; and

3. A "Cook Inlet bullet line" either directly from Prudhoe Bay through Fairbanks, or from a Fairbanks outtake facility of an Alaska Highway pipeline, and thence south alongside the Alaska Railroad to Anchorage, and possibly to an existing gas-liquefaction and LNG export terminal near Kenai.

This paper will also compare the likely merits and disadvantages of thus-far unsponsored alternative, namely a "Great Circle" alignment via the shortest geodesic alignment between the ANS/Beaufort/Mackenzie gas reserves and major northeastern destination markets such as Montreal, Boston and/or New York, which would traverse the relatively stable Canadian Shield and Hudson Bay.

On first consideration, this alternative would seem to combine minimal exposure to deep, wet or discontinuous permafrost or seismic activity with the shortest route into the highest gas-price markets in North America.

Finally, the Paper will review and compare the manifest and implied incentives of the various private and governmental entities in sponsoring or supporting, or opposing particular combinations of routing, design, financial or organizational features for high-latitude natural-gas pipelines in Alaska and the northwestern corner of Canada.

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[12] These three entities are ExxonMobil Corporation, BP plc, and ConocoPhillips, the world's largest, third and fourth largest investor-owned oil-and-gas companies respectively. in terms of both hydrocarbons production and capital value. They are also the three largest hydrocarbons producers in Alaska, but in a rank ordering opposite to the foregoing.

[13] Because of potential economies of scale in transmission, the gas-reserves holders have tended to favor a Northern route, but local interest groups in Alaska have successful pressed legislation at both the Federal and State levels to block authorization of such a system.

[14] The current sponsor of such a venture is a coalition of three Alaska municipalities that are located along the proposed route.

Numerical analysis for thickness of fractured-rock revetment layer on Qinghai-Tibet Railway

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Abstract: The non-dimensional governing equations for natural convection in variable permeability porous media are derived. Triggering and evolution of winter-time natural convection cooling effect in fractured-rock revetment embankments of Qinghai-Tibet Railway are investigated by means of an air-flow function. So as to evaluate the effectiveness of the cooling effect of winter-time natural convection in railway embankment with fractured-rock revetment, the mean Nusselt number representing heat transfer through unit length at the base of embankment was defined. The dependences of the average Nusselt number on thickness of fractured-rock layer and temperature amplitude of embankment surface are analyzed using a numerical representation of the non-dimensional governing equations for heat convection. The analysis shows that the mean Nusselt number in fractured-rock revetment embankments decreases early and then increases with increasing of temperature amplitude on the surface instead of increasing monotonically. This decrease-increase effect during increasing of the mean Nusselt number will rapidly weaken with increasing of temperature amplitude. The approach to evaluation of critical thickness of fractured-rock layer in revetment embankments was developed on the basis of the decrease-increase effect. Validity of estimating fractured-rock revetment layer thickness in the railway embankment was demonstrated both numerically and experimentally. Therefore, this evaluation approach in the present work is available for construction of Qinghai-Tibet Railway.

Key words: Qinghai-Tibet Railway, fractured-rock revetment, natural convection, winter-time cooling effect

Test and Analysis about the Development of Depth of Seasonal-Thawing of L Type Retaining Wall

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Abstract: In permafrost region, the key about the stability of earth structure is itself thermal stability. If retaining wall would be built in permafrost region, it would change the heat balance of ground layer and the upper limit of frozen soil or depth of seasonal-thawing would change. The stability of engineering structure would be affected by the heat balance change. So it is value to study the development of the upper limit of frozen soil or temperature field distribution according to the seasonal change. In this paper, considering the only retaining constructing - L type retaining wall in section from Golmud to Lhasa, Qinghai-Tibet railway, we test the temperature along the cross-section of retaining wall. We analyze the upper limit of frozen soil or depth of seasonal-thawing of typical backfill. The distribution shape of depth of seasonal-thawing in different cross-section has been obtained and the temperature field

distribution according to the seasonal change has been regressed also. From testing we know that the ground heat balance has been destroyed by excavation and construction. As an open area engineering structure, the ground heat balance could be recovered gradually if there is no new disturbance. In addition, the effect of freezing force or frozen-heave force shouldn't be neglected. In a word, the design idea and the engineering measure have been studied in this paper. All these work want to be benefit for future engineering application.

Key words: L type retaining wall, Permafrost, Thermal stability, depth of seasonal-thawing

Behavior Analysis of Adfreezing Force of Engineering Pile in Permafrost Regions of Mohe County*

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2.Heilongjiang Transportation Research Institute, Harbin 150080,China)

Abstract: In the construction of civil engineering in permafrost, cast-in-place concrete piles are widely adopted, because of the characteristics of big bearing capacity and easy to build. Concrete pile, surrounding frozen soil and pile-soil contact surface are simplified as FEM system in this paper. Contact elements of zero thickness imitating interface of pile and permafrost are inducted，and bi-linear constitutive relations are introduced as nonlinear constitutive relations of soil elements and interface elements in order to consider permanent displacement. An interaction work of layered frozen soil-pile model considering elastoplastic coupling is established, and a 3D non-linear FEM program is presented to compute this model.

Based on adfreezing force with frozen soil and cast-in-place model-pile test data, it is given that the variation laws and the model parameter between freezing strength and shear deformation, water content, temperature of frozen silt clay, sandy soil, gravelly soil. Through numerically calculating the adfreezing force distribution of pile, obtain the regularities of distribution, and all the peak values appear at the $1/3l$ of the embedded depth. Under the condition of the same load at pile block and different temperature of frozen soil around pile, in the family of curves of adfreezing force along pile body, the cross point occurs at $1/3l$, and the point is defined as "neutrality point" which is the cross-section not affected by the alteration of frozen soil temperature. Above the neutral point, i.e. in the $0\sim1/3l$ part of the pile body, as the temperature of frozen soil dropping the adfreezing force of pile increases, however below the neutral point, i.e. in the$1/3l\sim l$ part, the adfreezing force of pile reduces, on the whole, which indicates that with the lowering of temperature, the transfer of load along pile more generates in the upper part of pile, i.e. adfreezing force of upper part bears more load. The calculated load-settlement curve and that obtained from in-situ test of Mohe frozen soil are in well agreement, which verifies the model. The experimental results indicate that freezing strength

with frozen soil and concrete increases nonlinearly with decreasing of temperature under the different water content condition. After the freeze-thaw the data, acquired from refrozen shear test, shows the adfreezing force of the second loading distinctly reduces compared with the one of first, moreover to the sample of less water content, it reduces more distinctly.

Key words: permafrost; freezing strength; bearing capacity; neutrality point

Mechanical properties of Qinghai-Tibet clay subjected to closed-system freezing and thawing

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Abstract: A prerequisite for the pavement design, stability analysis and calculation is the availability of mechanical characteristic of subgrade soils. It is widely proved, however, that such factors as soil structure, water content and bulk density, grain size distribution, shape and mineralogy, the degrees of soil-grain interlocking, grain cementation and chemical weathering, the particle-bonding mechanisms in clay soils, and the presence of vegetation determine soil mechanical properties. In cold regions, a further dimension is added to soil mechanical properties through the introduction of freezing and thawing for the process of freeze–thaw changing the microcosmic structure of soil. In this case, the soil mechanics properties are also severely affected by ice bonding between particles during freezing and excess moisture during thawing. These effects may in turn substantially reduce the foundation capacity of structure.

A review of the published literature reveals that, although considerable research has been carried out on freezing and thawing of fine-grained soils and its effect on engineering properties, most research take it as hydraulic barriers in liners and covers for landfills or caps for remediation of contaminated sites, and emphasize freeze-thaw effects on the void ratio, permeability and hydraulic conductivity, only limited information is available regarding the effects of freeze-thaw on soils mechanical characteristic. However, fine-grained soils are often used as foundation soils. If soil undergoes internal fabric changes after freeze-thaw cycles, most likely the bearing capacity of foundation will be affected. An increased knowledge of the mechanical behavior of soils experienced freeze-thaw cycle is therefore needed.

This paper presents an experimental study performed on compacted Qinghai-Tibet clay at different initial confining pressure to investigate the effect of freeze-thaw on the mechanical properties such as stress-strain behavior, failure strength, resilient modulus, cohesive force and friction angle. The following conclusions are drawn based on this study:

(1) The height of specimen examined in this test program increased and the water content decreased with increasing numbers of freeze-thaw cycles during the first seven cycles. However, after seven cycles, they will keep constant with additional freeze-thaw cycles.

(2) Even though the magnitude of resilient modulus and failure strength were influenced by increasing the number of freeze-thaw cycles, the type of the stress-strain curve was only response to the variation of confining pressure and without regard to the increasing the

number of freeze-thaw cycles. With respect to resilient modulus, with the number of freeze-thaw cycles increasing, it shows decreasing gradually before seven cycles, and after seven cycles, it increases by degrees to a certain level and keeps constant with additional freeze-thaw cycles. The largest decreasing of resilient modulus took place after the first cycles, which indicated that a significant disturbance was happened during the first freeze-thaw process. In general, the magnitude of the resilient modulus decrease is about 18-27 % of unfrozen soil resilient modulus depending on confining pressure exerted on the triaxial tests. With respect to failure strength, it reaches the minimal point after the specimen exposed to about 3~7 freeze-thaw cycles, and subsequently it will increase with increasing the number of freeze-thaw cycles until the cycle number arrives at 10. When the numbers of cycle exceed 10, the failure strength of tested soil will keep constant and regardless of freeze-thaw cycles increasing. It is suggest that the mechanics index after the soil experienced seven freeze-thaw cycles could be applied to the process of cold region engineering design.

(3) The cohesion in the soils decrease with the increasing number of freeze-thaw cycle, while the angle of internal friction exhibits an increasing trend with the increasing number of freeze-thaw cycle.

Key words: freeze-thaw cycle; failure strength; elastic modulus; cohesion; friction angle

Estimation of cryogenic heave in the North of the Western Siberia and in the Central Siberia

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Abstract: The most widespread process in permafrost, and behind its borders is cryogenic heave.Area of Transbaikalia one of the first in Russia where regular researches of a frozen ground have started to be carried out. It is area where permafrost formation, its capacity and distribution has azonal character. Result of changes of these factors is mass development of deformations of industrial and civil objects. Therefore, despite of mainly rocky adjournment, here process of cryogenic heave can get catastrophic character. Site of a hollow of the Central Transbaikalia, is the most mastered, here the greatest population density and is located about 20 % of all industry of Transbaikalia. On a preliminary estimation cryogenic heave in this area can be provided in two basic types of determination of frost-heave, rather intensive and cryogenic heave in this conditions practically it is not shown. The forecast of size and intensity cryogenic heave is made on the basis of experimental data for the most adverse soil conditions. The maximal general cryogenic heave deformation occurs in sandy loams at soil temperature from-1 up to-2°C. The represented data can be compare to data on cryogenic heave in the north of Western Siberia, in conditions of more disperse breeds and more damp climate. The calculation of the general heave deformation has shown, that in this area they powerful enough 0,35 m. Special calculations on effort the side forces piles both in permafrost, and behind its borders have shown, that as much as possible negative influence of cryogenic heave are on the

bases of low-loaded objects along southern borders of permafrost and in areas with sporadic permafrost. It is necessary to spend the further studying spatially - time laws of development of processes cryogenic heave and search of opportunities of the correct numerical account of these processes.

Key words: Estimation, cryogenic heave,

Experimental Research on Cleavage Strength of a new Asphalt Mixture under Cyclic Frost Actions

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Abstract: Cleavage strength and modulus on an new asphalt mixture after cyclic frost actions were tested with a universal material test machine and with different temperatures, in which the cyclic temperature range was from -20□ to 25 □ and the cyclic number was from 0 cycle to 50 cycles, in particular, the asphalt mixture was applied on the road pavement in cold regions. The test results showed that the strength and modulus of the asphalt mixture had a good improvement, and their cleavage strength and modulus were obviously increased with the temperature decrease, but their values with a same temperature would nearly be stable under the different cyclic number of frost actions, so it was a good pavement material and had a good application foreground in cold regions.

Keywords: Cleavage strength, asphalt mixture, cyclic frost actions, Pavement materials.

The effect of Freeze-Thaw cycle on tensile characteristics of plastic geogrid

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Abstract: This article reported the tensile characteristics of polyethylene plastic geogrid after 50 Freeze-Thaw (FT) cycling, with the temperature range of -15~+15℃. The tensile experiment was proceeded in the conditions of 15℃, 0℃, -10℃, -20℃ and -35℃, respectively. Through which I obtained some parameters, such as limit strength, maximum tensile stretch, corresponding stress with different strain and elastic modular. And obtained the variation discipline of tensile characteristics of polyethylene plastic geogrid after FT cycling.

Key words: polyethylene plastic geogrid, Freeze-Thaw cycling, tensile characteristics, experiment research

The Technique of Geoinformation Modeling of Engineering Geocryological Conditions for Pipeline Construction in Mountain Regions

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Abstract: The technique of geoinformation modeling (mapping) of engineering geocryological conditions in mountain regions has been developed in order to design the Eastern Siberia - Pacific pipeline system. The designed pipeline route crosses the regions with different geological-structural, seismic, engineering geological, and geocryological conditions. A large volume and short duration of the works as well as the necessity of using many organizations and executors in mapping required the elaboration of a special mapping technique.

This technique is based on the combination of the structural geomorphological and formation map backgrounds and, on the other hand, on the typification of individual blocks of engineering geocryological conditions in the form of zoning matrix schemes. Matrix schemes are not only the information organization and generalization method but also the map legend that makes it possible to combine information completeness and map-reading simplicity. The application of these schemes makes it possible to most completely use the possibilities of GIS technologies and to correct map contents with the accumulation of new survey data.

The maps have the structural geomorphological background, which agrees with the geosystem approach conception and makes it possible to unify maps of the same scale. The relationships between the relief-forming factors and other components of the natural environment (such as vegetation, genesis, composition, and thickness of surface sediments; character and intensity of exogenous geological processes; geocryological characteristics; specific features of groundwater circulation; etc.), previously known and revealed during the survey, are used in this case.

The succession of geoinformation modeling used to construct the set of maps of scales 1:200000 and 1:25000 is considered in the paper. The mapping technology includes three main blocks: analysis of available data and creation of matrix schemes; construction of the main maps in the set (maps of engineering geocryological zoning); construction of additional maps (hydrogeological map, map of seismic soil conditions, etc.); and development of pipeline laying and engineering protection recommendations taking into account prediction of geocryological conditions and assessment of territory complexity based on construction conditions.

Key words: Permafrost, engineering-geocryological mapping, geoinformation modeling, matrix legend.

Deformation of permafrost embankment of Qinghai-Tibet railway

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Abstract: A good engineering effect has been achieved in Qinghai-Tibet railway engineering construction, based on controlling the deformation of permafrost embankment in the design stage. The embankment deformation in the permafrost region is related with construction, orientation effect of embankment slope, climate condition, moisture migration, the consolidation settlement of the frozen soil layer, and so on. Based on the observation and investigation of the field test section, measures taken in the design stage and construction stage are analyzed and evaluated in this paper, also the monitoring emphasis on embankment deformation during the operation stage are presented. The research results will further benefit the railway engineering activity in Qinghai-Tibet plateau.

Key words: Qinghai-Tibet railway, embankment, deformation

An Approximate analytical method for determining the Critical height of embankment in Fenghuoshan mountainous area along the Qinghai-Tibet Railway

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Abstract: The solutions to the heat transfer equation for quasi-steady periodic flow in a stratified semi-infinite medium were presented and used to determine the critical height of embankment in the Fenghuoshan mountainous area along the Qinghai-Tibet Railway. The analysis domain was assumed to consist of three soil types, based on the collected geological data and the standards for designing the Qinghai-Tibet Railway. The thermal and physical parameters of the soils were taken from experimental investigation results for the typical frozen and unfrozen soils in the Fenghuoshan mountainous area. Simulated results indicate that the critical height of embankment and temperature field of roadbed in permafrost regions are sensitive to the thermal properties of the gravel fill.

Keywords: Heat transfer equation; approximate analytical solution; Qinghai-Tibet Railway; critical height; temperature field

Monitoring Study on the Boundary Thermal Conditions and Temperature Fields of Duct-ventilated Embankment in Permafrost Regions

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Abstract: Duct-ventilated embankment is an available cooling method in roadbed constructions in permafrost regions. However, in the long-time effect prediction of the roadbed, there are difficulties in boundary condition selection, and the results are lack of being tested by real projects. In this paper, based on monitored data of field experimental embankments in Beiluhe section along the Qinghai-Tibet Railway, the air temperatures in the ducts and the wall temperatures were analyzed and simulated. The results indicated that the annual air temperatures in the ducts were higher than the environmental air temperature by a value of 1.6~1.8℃. This value was changed to be less than 1.0 ℃in thawing periods and to be 2.0 ℃ in freezing periods. Of the embankment, the ground temperature at a depth of 0.5m in south-facing slope was higher than that in north-facing slope with a value of 3.5~5.5℃. The ground temperature fields shown that, the common embankment uplifted the artificial permafrost table but increased temperature of the former frozen soils below it too. Furthermore, the temperature field of the common roadbed appeared serious transverse asymmetry. The ventilated embankment could efficiently cool the filled soils and the underlying permafrost, particularly when the ducts are installed near the nature ground surface. In case of the ducts are installed in middle of embankments, the transversely asymmetry of the temperature field is some limited but still penetrates into the primary ground surface. When the ducts are installed lower and near the ground surface, the asymmetry is totally limited with the zone above the ducts.

Key words： Permafrost; ventilation embankment; boundary condition; simulation; temperature field.

Experience of Designing, Construction and Repair of the Bases Buildings and Structures on Permafrost

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Abstract: By the basic areas of construction of buildings and structures on permafrost, in which NPO "Fundamentstroyarcos" (FSA) accepted direct participation in works on freezing and the bases ground temperature stabilization, were the fields Urengoyskoye, Medvejye, Harasavey, Bovanenkovo,Yamburgskoye, Yubileynoye, Zapolyarnoye, Sandibinskoye, Samburgskoye, and city in the Tyumen area-Salekhard, Labatnangy (including stations Obskaya,

Payuta, settlements Aksarka, Katrovraj, Yar-salie), Nadim, and also deposit Hakandjinskoye closely Okhots, Mirniy in Yakutia, the gas pipeline in Chukotka and oil pipeline Eastern Siberia - Pacific ocean.

Thus the amounts of works were distributed as follows. 40 % - were equaled at new construction with performance of design stages, construction and supervision. 60 % - were equaled at correction of mistakes of the designers and builders who are finding out in a course or upon termination of construction of buildings and structures, and also at elimination of emergencies on working objects arising for the different reasons. In all these cases grounds of the bases are used by a principle of preservation them frozen state or the transition to this principle is provided. As cooling tools the systems HNWP and system VNWP, used both in a combination with ventilating under-floor, and without it are applied the Plutonic working seasonal device (SCD) and individual working seasonal device (ISCD). All systems of grounds temperature stabilization of the bases and devices are vapor-liquid.

The system HNWP represents placed in embankment a network of horizontal cooling pipes of a small diameter filled with the heat-carrier and connected with aboveground by the condenser block. All system is completely tight, and the movement of the heat-carrier is carried out on classical without-pump method. At construction of buildings and structures (for example, tanks) the system HNWP is alternative to the ventilating under-floor. Thus it is much more effective, allowing to construct buildings with floors on a ground of width up to 100 м with significant economy of material inputs and territory. It is also perspective for roads and open platforms.

The VNWP system differs from HNWP system only by the fact, that placed in embankment horizontal pipes in certain places are additionally connected to vertical or inclined pipes, which in this case are cooling. Individual ISCD are applied all over the world and are produced in two types: filled and with of the heat-carrier in an underground part. We use both types: for building depths 10-12m is admitted (or is desirable) film currency. In case of large ISCD accommodation depths in a ground and under any corner to horizon are applied filled.

The combinations of these systems and ISCD are totaled many variants, that allows to solve any tasks of construction, repair and elimination of emergencies. The serious attention FSA pays on quality of installation works and maintenance of reliability of described systems. Through manufacturing process of all products the special attention we give to the quality of welding. In consequence with small diameters of used pipes we use an automatic rotating electric-arc welding (REAW) with the computer control of modes and results of welding, including field installations with the portable welding head, which can leave from the automobile on 50m and thus serve all territory of builded object.

Key words: Esigning, construction, repair, bases, buildings and structures, permafrost

The Calculation and Control Methods of the Ice-wall Thickness in Ground Freezing Construction

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Abstract: In this paper, the principle, merits and demerits of artificial ground freezing technology, as well as the thickness calculation and control of ice-wall which is very significant in ground freezing design and construction are introduced. The main methods and formulae along with their working conditions of the thickness calculation and control of ice-wall are presented and discussed. Furthermore, as an example, a secure and effective thickness calculation of ice-wall which is necessary for the proceeding of excavation, is conducted for the ground freezing construction on Tianhe passenger station reentry line of Guangzhou subway by selecting a proper formula based on the general situation, hydrogeologic condition and construction environment, etc. With the result of thickness calculation, the temperature of the monitoring holes preinstalled as the ice-wall reaches the design thickness or the excavation line is calculated by a formula deduced from Wei Yunbo's formula for the thickness calculation of ice-wall; thereby the length of Primary Freeze Period (PFP) can be put under control, moreover the construction period is shortened and the cost will be economized consequently.

Key words: freezing technology, ice-wall thickness, calculation and control, Lamé's formula, monitoring hole

The primary experiment study on the moisture and heat transferof soft rock material during its freezing and thawing

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Abstract: The policy of development in the west of China provides a good opportunity for us to study rock and soil engineering in cold region. The study on coupling moisture-heat of the frozen soil in cold region have made noteworthy achievements and have put forward many model of coupling moisture—heat at home and abroad in recent years, but the problem of mechanism of coupling moisture-heat have remained unaddressed as yet. The rock mass in cold region under the frost and thaw condition especially mechanism of coupled moisture-heat of soft rock is the core of the problem. Because the soft rock mass itself is a natural damage material and have high water content. Some moisture is solidified when soft rock is frozen, this will destroy the original damage balance of soft rock mass and cause moisture transfer to the freezing region meanwhile the rock become a multi-damage material containing water, ice, rock inside of it. The change in temperature will cause moisture transfer so as to change water content, variations in moisture will work a change to thermal conductivity and caloric receptivity, all this have exerted a major influence on heat-transfer process and temperature

distribution. Therefore it is necessary to study the mechanism of moisture-heat transfer. At present most study on the characteristics of rock and soil engineering in cold region focus on researching characteristics of frozen soil, the study which touch on rock especially soft rock is rare; the study which deal with frost and thaw is rare. But as for rock and soil engineering in cold regions, which coexist with rock mass and soil, deformation and strength property of rock and soil show two sides from strength property of friction materials of melted rock and soil at high temperatures to strength property of crystal lattice material of frozen rock and soil at low temperatures under the freeze – thaw cycles condition or during freezing-thawing process. We must therefore make an intensive study of moisture-heat transfer and phase transformation under frost and thaw condition.

In this paper, the experiment study on the moisture and heat transfer of soft rock material during its freezing and thawing is researched in the laboratory of our university. The soft rock material-concrete mortar is used during the moisture and heat transfer experiment. Two different kinds of soft rock material are experimented in the open system with temperature gradients. On the ground of experimental results and analysis we can reach some conclusions: the degree of the moisture and heat transfer is different between the different soft rock materials, the content of quartz mineral in the sample is higher, the redistributing time of the temperature field is longer; the gradient of temperature is the main driving power of the moisture transfer, the grads is higher and the moisture field redistributes quicker; the porosity ratio is higher and the process of freezing is longer.

Key words: freezing and thawing, moisture and heat transfer, the study of experiment

Artificial Freezing of Ground in the Base of Deformed Buildings in the North of Siberia

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Abstract: A problem of stability of buildings and structures in the permafrost zone has become essentially aggravated during the last decade. In cities of Northern Russia the tendency to develop mass-scale deformations of buildings and structures is observed. It was determined that the basic reasons of deformations are negative technogenic impact on the geocryological and geoecological environment while global warming has not shown detectable influence on the bearing capacity of frozen bases. A complex set of engineering-technical measures intended to stabilize the situation in large industrial centers of the Russian North as well as special methods for strengthening frozen bases has been developed and experimentally proved in Russia. The emphasis is made on the application of artificial cooling through the tapping of natural stocks of cold in rocks. Methods of cooling of boreholes by cold outer air by means of artificial and natural convection as well as by the use of spending cooling agents have been developed. "Liquid" and "steam-liquid" thermal piles demonstrated the most efficiency in operation. The positive as well as negative experience of 20-years term of operation thermal piles have been analysed. Results of geothermal

observations are presented.

Key words: Artificial freezing, deformed buildings, base

Simulation Study of Embankment Frost Damage Treatment by Cryogenic Refrigeration in Local

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Abstract: Based on Qinghai-Tibet railway engineering, global warming and artificial construction heat disturbance were taken in account, aiming at the problem of frost damage of embankment (frost and thawing settlement) in high temperature permafrost regions, short–term cryogenic refrigeration method was put forward for engineering emergency and maintenance. The changes of embankment temperature field, frozen soil table and melt belt were detaily studied, under the condition that the position of pipes, the angles of pipes, the lengths of pipes and refrigeration time were taken into account. The research indicates that: (1) cryogenic refrigeration is a high efficacious method of treatment for embankment frost damage; (2) the longer the pipe was, the shorter the circle crossing time was; (3) because of the high efficiency of cryogenic refrigeration, embankment can be frozen quickly, the bearing capacity will increase obviously. And the effect of horizontal pipe in the embankment was better than that of declining pipe in the stratum; (4) the permafrost table can be ascended 5~8m in short time, as well as the melt belt will decreasing evidently. Therefore, if the layout fashion of pipe was condign, the temperature field of embankment can achieve the station of below zero, and the bearing capacity of embankment can increase remarkably, so, the effect of engineering emergency will be very well.

Key words: high temperature permafrost; frost damage; cryogenic refrigeration, engineering emergency; temperature field

Study on the partition standard of frost force rank for tunnel in frozen earth

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Abstract: It is a discussing subject for both domestic and overseas to study the effect of frost force on tunnel lining. The volume of water would expand with a ratio of 9% when it was frozen and it’s phase changed from liquid to solid, in such instance, if the expansion was restricted, strong frost force would generate. The dimension of frost force could range from

several tenfold KPa to several tenfold MPa according to different constraint condition. The design of tunnel lining structure should be in accordance with different frost force for the sake of being both safe and economical. By FEM numerical simulation, the partition standard of frost force rank of tunnel in frozen earth could be found.
Key words: tunnel; frost force rank; FEM numerical simulation; frozen earth

Heat transfer characteristics of Qinghai-Tibet railway embankment with crushed-stone side slope in permafrost regions

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Abstract: The embankment with crushed-stone side slope in permafrost regions is an effective measure cooling subgrade and protecting permafrost. Considering the influence of the nocturnal cold air on the embankment with crushed-stone side slope in summer seasons in Plateau, the numerical analyses for the temperature field and thermal flow of the embankment at Beiluhe Test Base along Qinghai-Tibet railway were conducted on a full day in the present paper. The results show that the embankment with crushed-stone side slope releases less heat from the embankment in nighttime than that absorbed in daytime. This suggests that the embankment with crushed-stone side slope has cooling effect in nighttime. In addition, the present paper considered the difference of the heat transfer of the embankment between cold seasons and warm seasons and studied the change characters of the temperature field and thermal flow of the embankment. The results show that the embankment with crushed-stone side slope released more heat in cold seasons that that absorbed in warm seasons from the change of the thermal flow monitored. This is useful for protecting permafrost underlying railway embankment.
Key words: Qinghai-Tibet railway, embankment with crushed-stone side slope, thermal diode effect, thermal flow, cooling effect

Management and incident Analysis of Underground Gas Pipeline of Cities in Cold Area

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Abstract: Crack incidents of municipal underground gas pipeline occur quite frequently in cold regions in northern part of China, which could be attributed to the following causes: defective design, unregulated construction and lack of stringent management. With respect to design, there exists insufficient buried depth as well as effect of frost heaving force caused by freezing soil has not been taken into account while temperature shock happens. Crack of pipeline due to

frost heave is one typical case of freezing damage to engineering projects in cold regions. Designed depth of burial that must exceed local maximum depth of frost penetration might be a solution, or the effect of frost heave shall be well considered during design process. Another instance of defective design could be the stress originated by moving vehicles and transmitted via soil to the pipeline when it run through transportation roads, this issue happens when insufficient depth of burial exists. As to unregulated construction, criteria set forth for construction are not duly observed, situation could be aggravated if people performing the task are technically inadequately competent. With reference to management, lack of systematic and austere rules and regulations as well as monitoring measures is another blamable factor. For the purpose of above issues, this article recommends some ideas on design, management, and construction processes.

Key words: gas pipeline, crack incident analysis, frost heave

Laboratory Observation of Dynamic Frost Bulb and Frost Heave Development in Soil Surrounding Chilled Pipe Using Computerized Ultrasonic Tomography

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Abstract: Buried and chilled gas pipelines have been used to transport pressurized gas through permafrost regions to prevent thaw of permafrost through which the pipe traverses, as currently planned for the proposed Alaska gas pipeline. In preventing thaw of frozen ground, freezing of unfrozen frost susceptible soil creates a new problem – uneven frost heave along the buried pipeline. As a chilled pipeline cross a transition zone from frozen to unfrozen ground, a differential frost heave may develop and induce significant strains in the buried pipe causing concerns on the integrity of the pipe structure. A good understanding of frost heave development around chilled pipeline at various thermal and geotechnical conditions is essential for a reliable design and construction of buried and chilled gas pipelines. Studies including field and laboratory experimental studies have been conducted to investigate the behavioral characteristics of chilled gas pipelines buried in frozen and unfrozen ground. Progresses have been made to better understand the problems and address the concerns in dealing with chilled pipelines. However, many questions are still unanswered and problems unsolved. Continued studies are necessary for safe, reliable and economical development of buried and chilled gas pipelines through permafrost regions.

A previous study on a two-dimensional laboratory frost heave model was conducted by Akagawa (2006), in which the heave characteristics, thermal patterns and freezing front growing surrounding a chilled pipe was investigated by placing pressure gauges and thermal sensors in the soil. Following this 2-D laboratory model study, a multi-channel ultrasonic scanning system (MUSS) is developed and applied in the current study to observe the dynamic frost bulb and frost heave development surrounding a chilled pipe buried in soil. The MUSS

consists of 14 ultrasonic sensors working at a frequency of 400 kHz. Each sensor can serve as either a transmitter or a receiver. The ultrasonic scanning process starts by initiating a P-wave pulse from one ultrasonic senor serving as a transmitter and using the remaining 13 sensors as receivers. The scanning continues with one transmitter at a time until all 14 sensors are covered and a total of 14x13 = 182 ray paths are tested. The signal first arrival times are determined and the average sonic wave velocity for each ray path is computed. A sonic velocity tomogram is then generated by a computer program and displayed in color contour maps.

In the study, a frost heave test model is constructed with a 50 mm pipe buried in fully saturated artificial soil, as shown in Figure 1. Fourteen ultrasonic sensors are buried in the soil in circular pattern surrounding the chilled pipe to observe the frost bulb and freezing front development, and LVDT's are placed on top of the model to measure the frost heave. The test model is placed in a cold room with the temperature set at 2°C and chilled liquid with a temperature of -10°C is circulated through the buried pipe. Ultrasonic scans are conducted at preset time intervals and a P-wave velocity tomogram is constructed for each scanning. The dynamic process of frost bulb development and the freezing front movement are clearly observed in the experiments. The experiments are also conducted under various loading conditions to observe the relationship between loading pressure and the frost bulb and freezing front growing. Analyses are conducted to determine the dependency of frost bulb and frost heave development on various parameters.

Key words: Laboratory observation, dynamic frost bulb and frost heave, computerized ultrasonic tomography

General Systematics of Engineering Cryolithology

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Abstract: The paper presents the systematics of engineering cryolithology, a discipline dealing with the development of mechanical properties of perennially frozen ground. The focus of investigation is on perennially frozen, primarily sedimentary, materials of the lithosphere represented at various structural levels by rocks, genetic types of sediments and cryogenic formations. The latter are viewed as the result of cryolithogenesis in its specific varieties corresponding to the combined effect of various environmental factors. Three types of the factors – thermal, climatic and tectonic – in various combinations reproduce all possible kinds of lithogenesis and cryolithogenesis.

The concept *ground* is used following V.A. Obruchev's definition to designate any earth material with certain engineering properties which allows us to approach the development of various features of the ground as a single engineering superstratum at all structural levels of sediments, such as rocks, genetic types and cryogenic formations. At the level of rocks, mineral disintegration of rocks and universalization of grain size distribution and structure of the ground occurs. At the level of genetic types, cryogenic factors smooth the structure of the ground,

whose total water content and porosity become independent of initial origin and universalize too. As a result, at the level of cryogenic formations, perennially frozen soils attain a convergent structure corresponding to the sets of acting lithogenic factors and cryogenesis types.

The convergent structure of soils permits universal investigation of the stability of soil masses both within local limits under overburden pressure and below engineering structures. To this end, ultimate long-term strength parameters of permafrost soils are introduced which have been obtained by solving the analytical problem and which ensure the absolute stability of soil masses and supporting soils for a given formulation. These soil strength parameters can be considered as generalized characteristics of soil mass stability, i.e. as some regional parameters which make mapping possible.

The application of Boolean algebra techniques in all the constructions provides clearness and conclusiveness of the treatments.

Key words: General systematics, engineering cryolithology

Strength Parameters of Permafrost as Functional Characteristics of Foundation Soil Stability

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Abstract: Strength parameters of permafrost soils determined by laboratory and field methods are used for predicting the stability of soil masses and foundation materials. Data from field tests on foundation soils normally serve as a check on the validity of the estimates, including the reliability of both the parameters and the design procedures used for predicting the soil behaviour.

However, a reverse approach can be used when soil strength parameters are estimated based on field determinations of the bearing capacity of foundation material and correlated with laboratory strength values. In this case, the validity of design procedures is ensured automatically when the test and design values of the parameters coincide.

Based on the Coulomb-Mohr strength theory proven valid for various soils, including permafrost soils, we introduce the ultimate strength parameters: cohesion c, dimensional, and angle of internal friction φ, dimensionless. The c value, as a pure shear characteristics, is scale independent and can be determined by individual tests. In this case, with the known results of field tests on foundations soils, φ is a required parameter that completes the calculation.

From safety considerations, a function for the bearing capacity of foundation soils has been derived that expresses the minimum ultimate load ensuring the soil stability. Then for the design parameter φ at a given c value, the reliability of the foundation soil is ensured. The inverse φ function of the bearing capacity R for a known value of c is implicit, but is converging with a strict algorithm, i.e. it gives unique results.

Based on the comprehensive consideration of the design procedure used for predicting soil behaviour and the calculation algorithm for the parameters, it is demonstrated that the simultaneous determination of the strength parameters c and φ by back-analysing the actual

bearing capacity of the foundation soil is, in the general case, the most reliable method for determining soil strength.

It is of fundamental importance that the obtained *c* and φ values require no statistical averaging, because they characterize the studied soil mass as a whole.

Key words: Strength parameters, permafrost, functional characteristics, foundation soil stability

Influence of freeze-thaw on the strength of overconsolidated soils

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Abstract : It has become a common understanding that freeze-thaw cycling is a kind of weathering process which considerably changes the engineering properties of soils. Therefore, the influence of freeze-thaw must be taken into account when selecting soil parameters for stability and deformation analysis of slopes, embankments and cuts in cold regions, where newly exposed soil layers are to be submitted to freeze-thaw cycling. In this paper, freeze-thaw induced changes in strength of two overconsolidated soils are studied. The soil samples are subjected to one freeze-thaw cycle. Then mechanical testing and SEM micro-fabric scanning are carried out on both unfrozen and thawed samples. It has been found that the strength parameters of the soils, the cohesion and friction angle change in an opposite way. Novel explanations on the mechanism of the change are given both using SEM quantitative analysis and according to the deforming process during freeze-thaw.

Key Words: freeze-thaw, overconsolidation, strength, micro-fabric

Study on the Formation and Mechanisms of High Subgrade Diseases of the Qinghai-Tibet Highway

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Abstract: Since paving the black colored road surface in 1973, the subgrade diseases ,the majority of these is thaw settlement, in permafrost region are always chronic and stubborn disease, and have a long resistance to treatment. Before the mid-1990s, many researchers in frozen soil engineering field had researched into the characteristic and causes of subgrade thaw settlement in the permafrost region of Qinghai-Tibet highway. Their study showed that subgrade diseases was mainly caused by the formation and development of thaw bulb under embankment, and brought forward that higher embankment could protect the permafrost

effectively and restrain subgrade diseases from forming and developing. However, since the mid-1990s, with the construction of higher subgrade ,the large numbers of longitudinal crack have been detected in it. The current mainstream viewpoint is that excursion of thaw bulb, caused by the difference of solar radiant intensity between sunny side and shady side, is the cause of longitudinal crack disease. This paper, on the basis of a great deal of field investigations and the systemic analysis of mechanisms of high subgrade diseases of Qinghai-Tibet highway, put forward that the current view is partial and imperfect, and consider that high subgrade diseases is not only correlated with the thaw bulb, but also with thaw layer, frozen bulge and permafrost environment, and finally bring forward some design advice which is how to treat high subgrade diseases.

Key words: Qinghai-Tibet highway; High subgrade diseases; Formation mechanisms; Treatment advice

Sensitivity Analysis of Crack Evolution on Roadbed in Permafrost Zone

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Abstract: Cracks can be found in many places of the highways on Qinghai-Tibet permafrost distribution zone. To reveal the main reason of their occurrence, in this paper a sensitivity analysis was conducted based on numerical modeling of the thermal and stress state of the roadbed on permafrost. In conclusion, the possible contribution of many influencing factors such as the height of roadbed, the average annual air temperature, the heat conductivity, deformation properties, thermal expansion, the position of the permafrost table under the subgrade and so on were figured out.

Influence of initial thermal erosion on the long-term stability of high-filling embankment in cold regions

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Abstract: Under the influences of global warming and construction heat disturbance, the emergence of melt belt is unavoidable in cold region embankment. If any measures are taken, thermal erosion will induce frost damages of high-filling embankment (frost heave and thaw settlement), which will affect driving heavily. The high-filling embankment of bidirectional-four-lane expressway was used as an antetype in this paper, the evolutions of embankment temperature field, permafrost table and melt belt were studied under the condition of different

initial thermal erosion. The research indicates that: (1) melt belt would exist not less than ten years when the temperature of initial thermal erosion was positive temperature, which will become hidden trouble of embankment through the long-term working; (2) whereas, when the temperature of initial thermal erosion was negative temperature, permafrost table ascend 6~10m in the first three years, and the disappearance time of melt belt was 10 yeas ahead of scheduled comparing with the normal construction method; (3) the effect of initial thermal erosion of negative temperature did not linearly increase with the temperature descending, and the lower negative temperature was not easy realized, therefore, the suggestion best temperature during construction was -1℃. In conclusion, the temperature field of embankment under the conjunct effect of air temperature and ground temperature will come into beneficial circulation in the condition that initial thermal erosion was negative temperature; accordingly, long-term stability of high-filling embankment can be safeguarded effectively.

Key words: initial thermal erosion; high-filling embankment; permafrost table; melt belt

In-situ study on cooling effect of two-phase closed thermosyphon & insulation combinational roadbed

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Abstract: In 2003, a new testing roadbed—two-phase closed thermosyphon & insulation combinational roadbed was built in Beiluhe region, which lies in the hinterland of Qinghai-Tibet plateau. By analyzing the ground temperature of the testing roadbed, we make some conclusions below. Firstly, the thermosyphons worked consecutively from around October 10th to about March 1st in the first year, and they worked possibly at later proper time. Secondly, if we choose -2□ isotherm as the boundary of the cooling effect, the effective radius of these thermosyphons is 1.92m in the east slope and, 2.12m in the west slope. Finally, the combinational configuration makes the roadbed keep a very low ground temperature, so it is a very successful roadbed configuration for the high-temperature permafrost.

Key words: permafrost; two-phase closed thermosyphon; insulation

Selecting an Appropriate Type of Basement in Regions with Complicated Permafrost Conditions (an example for *north of Western Siberia)*

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Abstract: Western Siberia is a strategically important region of Russia. Analyzing natural conditions, 4 regions differing in permafrost conditions could be selected of oil-and-gas provinces, localized in permafrost area of Western Siberia. They are as follows: Yamal, Tar

Peninsula, Pur and Tar interfluve, Nadym and Pur interfluve. The most severe conditions are in Yamal. They are very low mean annual ground temperature about -7…-10°C, continuous and countrywide spread of permafrost, essentially consisted of clays. High salinity of grounds and unfrozen grounds having below temperature (cryopegs), high iciness of deposits as well as wedge-ice and massive ice sheets are typical.

There is anchored and mostly continuous permafrost on Tar Peninsula, but it southern part. There is also low mean annual ground temperature of -3…-7°C. Sandy-loamy and loamy grounds are mostly spread. High iciness deposits and wedge-ice are typical.

Pur and Tar interfluve has remarkably high variety of permafrost conditions. There is continuous mostly nonanchored permafrost. Higher ground temperature comparing with mentioned above, varying from -1 to -5°C are noticed. There are sandy-loams and sands mostly spread at North-West and East but loams and clays are in South and in Central Part of the region.

Nadym and Pur interfluve distinguishes by mild climate conditions as well as absence of continuous and anchored permafrost, the highest ground temperature from 0 to -5°C, essential spread of sands. However, sandy loams and loams are also observed.

The cryogenic processes following are spread in all regions: cryogenic cracking, seasonal and perennial frost heave, swamping, thermokarst and also active thermoerosion.

Both conditioning of bed techniques and ways of foundation preparation depend as on engineering-geocryological conditions so as on classes of constructions and their loads. 4 following classes of constructions could be distinguished: 1) constructions with high power and technogenic loadings; 2) buildings and constructions of low-rise building system; 3) pipelines (gas, oil and water pipelines); 4) Highways and railroads.

The principle of permafrost grounds use by keeping their frozen state during the building and exploitation periods is effective in Yamal and Tar Peninsula. There is an application of bored or composite piles with obligate corrosion proofing in aggressive medium are appropriate for the class 1 constructions. As an additional action the cold ventilated cellar (CVC) is used. For the classes 2 and 4 of constructions various surface types of basements including heaping are sufficiently used in Yamal. For the class 3 of constructions above-ground pipelining on drop piles is recommended. It is safely using pile foundations by bored dropped frozen technique and various surface basements for the class 2 constructions, including CVC and two-phase system thermosyphon contour on Tar Peninsula. For the class 3 it is better using above-ground pipelining as well as any type of surface basements for the class 4. The versatile combination of permafrost ground bed usage on isolated sections and maintaining of permafrost is sufficiently applicable on Pur and Tar interfluve. This requires taking actions on cooling the permafrost bed grounds. The most adequate melting permafrost grounds on the rest area. It requires the actions on melting the grounds before the building. For the both principles the basements should meet technological function of an object as well as intensity of its thermal input to the grounds. On Nadym and Pur interfluve the most effective is the use of melted grounds. For the classes 1, 2, and 3 of the constructions the application of various pile types of foundations is required depending on technological function of an object as well as intensity of its thermal input to the grounds combined with the use of seasonal coolers and CVC.

Key words: Appropriate type, basement, complicated permafrost conditions

Thermal and Seepage Modeling Analysis of a Lined, Rockfill Dam Founded on Marginal Permafrost

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Abstract: As a part of the engineering required for development of a new open-pit gold mine near Nome, Alaska, a thermal and seepage analysis was performed on the lined, tailing retention dam to assess the impact on the foundation permafrost and to determine the seepage water volume under the dam. The analysis included modeling the influence of thermosyphons, with the intention that the artificial passive freezing would limit seepage through and under the dam.

Modeling was completed using a coupled modeling package produced by Geo-Slope International, Ltd. Their Seep-W package was coupled with the Temp-W package to allow for analysis of the interaction between thermal changes and convective heat flow due to seepage. Physical parameters for the foundation and construction materials were determined. Environmental parameters were obtained from published data at nearby sites and adjusted such that the model reached thermal equilibrium matching the site subsurface conditions. Several scenarios were modeled to assess the influence of the physical and environmental parameters, the effect of thermosyphons, and global warming. To model the anticipated three phase development of the tailings dam, the model was split into five sets, with changes made to the modeling mesh at the end of each model set. A long-term model run was made at the end to assess the seepage and thermal performance of the development following closure of the mine site.

With the dam liner, the seepage flow was forced through a small zone. The flow rates were seasonally influenced by the thermosyphons, however the flow zone never completely froze. As such, the seepage flows were significantly reduced in the winter while the thermosyphons were active but summer flows were increased, effectively eroding the ice blockage created by the thermosyphons. On an annual basis, the seepage volumes were reduced slightly.

This paper presents a summary of the results of the modeling completed for the project and discusses the modeling techniques used to minimize the impact of the model constraints on the site conditions. The limitations of numerical modeling on this project are discussed and an assessment of the potential range of obtained results made.

Key Words: Coupled Numerical Analysis, Seepage, Convective Heat Flow, Thermosyphons, Permafrost Foundation

1-D Numerical Analysis to Predict a Buried Chilled Gas Pipeline in Alaska, Fairbanks

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Abstract: An experiment on a full-scale 105m long, 0.914m diameter chilled pipeline was conducted in Fairbanks to evaluate the pipe-permafrost interaction at the boundary between shallow upper permafrost and deep upper permafrost area from December 1999 to August 2004. The pipeline was buried with 0.9m backfills. The first 30 m of the pipes are in the shallow upper permafrost area and the remaining 75m in the deep upper permafrost area.

This paper presents the results of an on-going research entitled "2-D Analytical modeling for pipe – permafrost interaction", funded by Alaska EPSCoR. Although the ultimate goal of this research is to develop a two-dimensional finite element model for pipe movement simulating heat and mass transfer induced water migration due to frost heaving, the objective of this paper is to show one dimensional finite element analysis result preliminarily.

First, this paper outlines a one-dimensional finite element model for heat and mass transfer using segregation potential theory (SP). SP is dependent Konrad and Morgenstern (1982) showed the governing equation for the SP as follows:

$$\mathrm{SP}_0 = a\exp\left(-bP_e\right)$$
$$v(t) = \mathrm{SP}_0\left(P_e\right)\mathrm{grad}T(t)$$

where a and b = soil constants determined from laboratory tests, Pe = confining pressure, v = water intake flux, and grad$T$ = temperature gradient in the frozen fringe. The freezing of soil surrounding a chilled pipeline is not purely one-dimensional. In multi-dimensional frost action simulations, the SP approach must be considered with the interaction between stress and SP on one hand and the capability between stresses and strains at the frozen–unfrozen interface as a resisting force on the other hand. At this stage of this research, one-dimensional frost heave simulations using the SP are performed so that the confining pressure to frost heaving is simply equal to the overburden pressure, that is to say, the stresses and strains at the frozen–unfrozen interface so that resisting forces are ignored. The above simplification is based on the assumption that the overburden pressure is more dominative factor of confining pressure than that of the resisting force at the frozen–unfrozen interface. The one-dimensional semi-analytical solution could be worth to conduct to determine a quick estimation of heave displacement for a period of time. FLAC Ver5.00.346 code is used for these analyses.

Second the paper discusses modifications to conventional heat flow models in order to determine the accurate temperature gradient in frozen fringe with using deforming mesh. We applied temporary rectangular element method with modifying the temporary triangular

element method to eliminate the oscillation of thermal gradient in the frozen fringe reported by Shen and Konrad (1993).

Third, the one-dimensional model will be validated and verified using the field data on pipe movement in the deep permafrost section of the Fairbanks pipeline test facility. Finally the model will also be used to predict pipe movement for a life period when the major portion of the total heave occurs.

Key words: Numerical analysis, predict, buried chilled gas pipeline

Test Research on Frost-Heave Amount by Artificial Ground Freezing with Different Freezing Directions

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Abstract: As following merits, more flexible adaptability to complicated hydro-geologic condition, high intensity, well water-resisting property, non-contamination to environment and so on, artificial ground freezing is more and more recognized in subterranean works recent years. As for present technology, there are certain environmental hazards, frost heave and thaw collapse. Though excessive either of them will result in surficial inhomogeneous deformation, destruction of structures, even grave engineering accidents, which and the influence on the surrounding buildings, those problems don't receive systemic research all along.

The paper studies the frost-heave amount generated by artificial ground freezing with different freezing directions through combination of indoor test and finite-element numerical simulation; estimating and analyzing by test, engineering certificating by numerical simulation, analyzing and summarizing both results through correlated theories. To begin with, according to Standard for Soil Test Method of frost-heave amount, adopt standard frost-heave-amount test apparatus, ST5405 type high-low temperature freezing and thawing cycle testing box and DT615 data taker system; carry out the frost-heave test on the samples of disturbed clay soil under the condition of different moisture content, density, soil temperature, ambient temperature; by varying the upside, downside, surrounding temperature, separately test and research on the change features of frost heave, frost depth, temperature field with distinct freezing modes as follows: from top to bottom, from bottom to top, from lateral to center simulating the freezing course of construction program with artificial ground freezing method. Test results reveal, under the same test conditions, the minimal frost-heave amount occurs in the from-bottom-to-top freezing mode, the maximal in the from-top-to-bottom freezing mode, consequently the from-bottom-to-top freezing mode can effectively reduce the frost-heave amount in the practical engineering; when the frost heave happens, both the temperature filed and the frost-heave factor of frozen soil are nearly stable, furthermore, the distribution of the temperature field approximately linear. As the distance increasing between the freezing end and each part of the samples, the alteration of the temperature field shows the rules of gradual decay. According as the initial and boundary conditions, which on the basis of test research, apply giant F. E. M. program to analyzing the practical engineering. The outcome indicates the results

of the two simulation-analysis methods are basically consistent, what's more, manifests the reliability of the test result.

Key words: frost-heave amount; freezing mode; temperature field; coupled transfer of soil water and heat; numerical simulation

Estimation of thermophysical properties of rocks cryolithozone

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Abstract: The massive of frozen rocks is the firm body, taking place in a natural temperature regime, and represents multiphase system. Thermophysical properties of a rock massive is formed from a relationship of separate phases, including unfrozen water, gaseous substances in rock, ice and mineral particles of rocks. Research of change thermophysical properties in space is of great importance at the forecast of a temperature field of a rock massive. Therefore, direct carry of results of laboratory experiments thermophysical properties on a rock massive is not quite correct.

As a first approximation thermophysical properties of a rock massive can be estimated, proceeding from physical reasons. The major factors, influencing on thermophysical of properties of rocks, it is necessary to count porosity and humidity of rocks in a natural condition. That we shall estimate thermal properties in a thawed state to consider, that humidity of rocks is determined from necessity of filling of all jointing by water (the limiting characteristic of humidity of rocks). That also thermal properties in a frozen state we shall estimate to consider, that the accepted humidity of rocks in a thawed state has passed in the relative ice content of rocks (the limiting characteristic ice in rocks). It enables to estimate limiting values thermophysical properties of rocks in a thawed and frozen state, which can be accepted as accounted parameters.

Keywords: Thermophysical properties, frozen rocks, temperature.

Analysis of Temperature-control Effect on Particle Improved Roadbed in Permafrost

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Abstract: The total length of the Qinghai-Tibet railway is 1,118km. 632km of the railway must build on the permafrost. Therefore, it is the primary task for many researchers to provide right measures for the stabilization of the roadbed during its construction and operation. Because of the warming of global climate, the average air temperatures in Qinghai-Tibet plateau keep rising annually, which results from the degeneration of frozen soil. So these researchers have to face the great challenge to protect the frozen soil from thawing. Based on large amount of practical engineering experiences, they adopt some design principles and provide the design theory of active cooling roadbed, thus promote the development of the frozen soil protection.

For the Qinghai-Tibet railway, one of the important tasks is to keep the stabilization of the roadbed, and the thermal stability is one of the key factors. It has become the main task of engineering construction in permafrost to select the right engineering measures and proper roadbed structure for the prevention of harmful effects caused by the thermal conditions change of the frozen soil. Today there are many measures for the protection of permafrost roadbed. These measures could be generally classified into two groups. One is the passive measures such as laying the insulation materials into the roadbed or simply raising the roadbed itself. The other is the active measures, such as burying ventilation pipe, using ballast, block-stone roadbed or revetment, adopting thermal rod, and so on. In this paper, the measure of particle improved roadbed is presented. It is mainly through the filtering and restructuring of the roadbed-filling granules to change the original structure of the roadbed, thus to create the physically improved layer of combined particles for different requirements, which change the mutual heat-exchange of the roadbed and the atmosphere for the protection of the frozen soil. Theoretically speaking, this measure belongs to the scope of convection adjustment and control. In cold season this measure with the big inner pore space could form the strong free convection with the change of density differences of the atmosphere, which enable the continuous coldness exchanges. While in warm season this measure could shield heat because of the difference of the conductive coefficient between the air and the soil.

Based on the ground-temperature observation on the particle improved roadbed in Beiluhe test field of Qinghai-Tibet railway, this paper makes an analysis of the characteristics of the ground temperature changes and the temperature-control effect of the particle improved roadbed, comparing with other similar protection measures. The result indicates that in certain range of depth the ground temperature of the particle improved roadbed changes in different seasons, depicting a sinusoidal curve. With the increment of the depth, the changes of ground temperature lag behind the changes of the outside surroundings. Compared with the normal roadbed, the particle improved roadbed has a generally lower ground temperature whether in cold or warm seasons. To some extent, the upper limit of the frozen soil rises and from the annual average ground temperature curve it shows the effect of cooling roadbed and protecting

frozen soil. While compared with the normal duct-ventilation roadbed, the cooling effect of the particle improved roadbed in cold seasons is worse, but the thermal shield effect in warm seasons is better. Considering the annual average ground temperature, it shows that this measure is better potential effect on the protection of frozen soil. It proves to be an active measure for the protection of frozen soil.
Key words: permafrost, the particle improved roadbed, temperature-control effect

Laboratory investigation on cooling effect of crushed-rock slope under wind action in permafrost regions

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Abstract: A series of experiments were constructed for the cooling effect of crushed-rock slopes with different particle sizes under wind action in this study. The crushed-rock particle sizes include four kinds: 6～8、14～16、21～23、28～30 cm. The experimental result indicates that, under the windward and leeward conditions, the crushed-rock slopes with the four particle sizes all have good cooling effect and can effectively decrease the temperatures of the underlying soil layers; furthermore, the mean periodic temperatures of soil slope surfaces under crushed-rock slopes can be lowed down below 0 □ after two experimental cycles. Under windward condition, with the increase of particle size, the cooling effect of crushed-rock slope becomes better when its particle size ranges between 6 and 30 cm; under leeward condition, the cooling effect of crushed-rock slope with a particle size range of 21～23 cm is best. Besides, we also find that, under the experimental condition, the periodic range of temperature at the bottom of crushed-rock slope is mainly dominated by windward/leeward condition, not crushed-rock particle size; namely, the periodic range of temperature at the bottom of windward crushed-rock slope is far larger than that of leeward one; and the maximum positive temperature at the bottom of crushed-rock slope in every cycle under windward condition is far higher than that under leeward condition, furthermore, the time of the positive temperature is longer under windward condition, and it will be disadvantageous to the stability of permafrost embankment. At the same time, by analyzing the temperature distributions of the crushed-rock slopes, we find that the cooling mechanism of the leeward side is more complicated than that of windward side.
Key words： cooling effect; crushed-rock slope; windward and leeward conditions; wind action; particle size

Dynamics of the Baydaratskaya Bay Coasts (Kara Sea) in the Area of the Gas Pipeline Underwater Crossing Design

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Abstract: Coastal zone of the sea is an area of interaction between lithosphere, hydrosphere and atmosphere and an extraordinary high dynamic activity. Morpholithodynamic conditions in the coastal zone are one of the factors to select the site of pipelines crossing from the offshore slope to the land and a value of pipeline deepening.

More than a half of the Baydaratskaya Bay of Kara Sea coastline extent is exposed by the erosion process; moreover, at some sites, the coast destruction rate achieves up to 1-3 meters a year in natural conditions. Taking into account the technological impacts on the environment that result from new areas development and global warming forecast for the XXI Century, the coastal destruction rate must essentially increase.

In the case of pipeline deepening through rapidly retreating parts of the shore a risk of its injury arises as a result of possible uncovering, whipping and mechanical deformations. Pipeline deepening, landfilling and other protective measures are often ineffective, since not only coastal bluff retreat towards the land, but also erosion of beach and offshore slope are typical for rapidly destructing coastal sections. Besides, parts of the pipeline uncovered as a result of erosion process may become subjected to direct dynamic impact of sea ice. Extrusion of fast-ice on the shore results in ice bulk forming may be a cause of costal infrastructure and pipeline destruction.

Thus, environmental safety of a pipeline may be provided by both a proper selection of the most dynamically stable coastal zone and a design value of pipe deepening taking into account forecasted coastal dynamics for the period of pipeline construction and exploitation.

Since 1988 Laboratory of Geoecology of the North, Faculty of Geography, MSU is carrying out monitoring observations on the coastal dynamics in the area of the gas pipeline underwater crossing. In the summer-autumn of 2005 regular cycle of coastal dynamics research was performed. As a result reliable values of long-term erosion rates over a 17-years observations period have been derived on Yamal as on Ural crossing sections.

In spite of short dynamic activity period coastal zone of Baydaratskaya Bay is characterized by quite intensive lithodynamic processes, which is connected with relative wide outlet to the south-western sector of Kara Sea on the one hand, and with low stability of the coasts, composed of frozen dispersive sediments on the other hand.

Field investigations allow to estimate coastal stability of Yamal as on Ural sections in the area of pipeline crossing. It was determined that the least stability is typical for coasts, composed by clay sediments with high ice content and massive ice beds. Such coasts are wide spread on the Ural section, including a coast directly within northern segment of cross-section. Long-term erosion rates for these coasts can reach 2.0-2.5 m a year. Thereupon it is expedient to shift cross-section on the Ural coast on 300-500 m to the east to the dynamically more stable section. On the contrary, Yamal section is chosen correctly in respect to pipeline safety.

Values of coastal dynamics, achieved as a result of long-term monitoring, enabled to estimate vertical deformation of the coastal zone profile for 30 years of the pipeline exploitation.

The maximum vertical deformations are expecting on Ural section, up to 5 m at the current frontal part of the onshore slope and up to 0.5-1.2 m within the beach and the tide flat. Yamal section is characterized by minor deformations.

In 2005 the coastal monitoring network were renewed. Now it can serve as a reliable base for well-timed revealing unfavorable trends in the coastal processes (e.g. under changes in temperature regime and sea-level rise due to climate warming) and taking appropriate engineering protection measures.

This work was supported by Russian Foundation of Basic Research grant no. 05-05-64258.
Key words: Arctic coastal dynamics, pipeline safety

Discussion on some design principles for cold region engineering

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Abstract：Based on construction experience and numerical simulation test, 5 important considerations in the design of the frost foundations are discussed and the new design concepts are proposed:①the dominative factor for the cube duct design is the controlled gate; the cube should be lain as lower as possible;②the real cooling mechanism of the crushed rock slope for frozen foundation depends on the difference of the wind velocity in summer and winter, and the differences of the temperature in night and day;③it is a misunderstanding for the crushed rock as a foundation embankment;④designing ideas for tunnels in frozen soil is to prevent frozen pressure instead of thaw;⑤the pile foundation design principle in frozen soil is to prevent negative friction, cooling tension effect on pile and to reduce the refrozen time.
Key Words：Frozen foundation design；ventilated duct；Crushed rock slope；Pile；Tunneling

Thermal Conductivity Measurements of Road Construction Materials in Frozen and Unfrozen State

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Abstract: Construction and maintenance of road and railway routes in high altitude areas like the Qinghai-Tibet-Plateau is complicated by frequent melting and freezing processes of the used

building materials and the underground soil. A key parameter which may undergo significant changes as a consequence of temperature variations is the thermal conductivity of the materials. We report on a series of experiments performed in summer 2005, using a big climate chamber at the CAREERI in Lanzhou. The size of the chamber allowed the preparation of relatively big samples (70cm x 70cm x 35cm) in a controlled thermal environment. Three types of sensors were used to determine the thermal conductivity and/or diffusivity:

1. A grid of PT1000 temperature sensors, evenly distributed inside the sample, supplied by CAREERI.
2. Two thermal conductivity sensors of the type HUKSEFLUX TP02, supplied by IWF. They allowed a direct measurement of the local thermal conductivity value.
3. Two "EXTASE" thermal diffusivity sensors, provided by IfP. These sensors are actually a spin-off from the space experiment MUPUS, which has been built for the ESA comet mission Rosetta (*http://ifp.uni-muenster.de/pp/MUPUS/*). They consist of a series of individual temperature sensors integrated into a glass fibre rod, which both can be used for passive temperature sensing and can be actively heated in order to determine the thermal diffusivity more directly.

The general set-up of the experiments is illustrated in the figures below. The following sample materials were used: fine-grained reddish sand from the Gansu area, coarse-grained moist sand, gravels with various grain size distributions from <1cm up to about 6cm, and for comparison and calibration pure water (with convection suppressed by adding agar-agar), compact water ice, and compact granite. Of particular interest are the measurements with composite samples, like stones embedded in an agar-agar matrix. The results of these measurements may also contribute to a better theoretical description of thermal conduction in multi-component materials generally. We give an overview on the experiments performed and present their results as far as they are relevant in support of road engineering and maintenance.

Key words: Laboratory experiments – thermal conductivity – permafrost – engineering

Problem of operation of hydraulic engineering constructions in Norilsk an industrial district

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Abstract: Specificity of development of any mountain metallurgical base of region it is connected to the inevitable device dump (ash dump, tailings, tailing dump etc.) for warehousing dead rock - waste products from concentration non-ferrous metal. For normal modern economic development permafrost it is necessary erection and operation hydraulic structures.

Norilsk industrial district (NID) is one of the largest industrial areas of the world and the world's largest center located in permafrost, in a zone of forest-tundra, in conditions of a subarctic climate (compare year t =-9,50C).

Safe operation of hydraulic engineering constructions in conditions of Far North is actual engineering-cryopedology and an environmental problem. The tailing dumps contain

dangerous pollutants, including heavy metals, radioactive nuclides and others which in case of possible failures will put the most serious loss to an environment and safety of ability to live of the person.

In rather small territory on area of NID one of the most world's largest tailing dumps have settled down at once some: "Lebjge", the last two years ago began the world's largest after its expansion and opening of the second field. The tailing dumps №1, №5 and "Nadegdinskoe" are erected on first principle of construction of constructions on permafrost, i.e. with a condition of preservation always frozen barrier the screen inside the dam. The tailing dump " Lebjge " it is constructed on thawed and frozen type.

The basic complexity of similar constructions in permafrost is that they inevitably are in a close contact with water which is the manifest enemy of a frozen ground.

On a background of the general global warming of a climate or at negative local man-caused influences formations through taliks in a body of a dam are possible. Outflow of waters can occur both on a surface of a dam, and through underground waters. Besides it because of the strongest defrost effect of hardly salted waters, occurs thaw through always frozen breeds of a protecting dam. Goes permafrost thaw directed as vertically (on depth), and in a horizontal direction (in area extent). In NID this moment is most important, since the territory in a geological structure is submitted lake and is high icy earth thicknesses peat loams, loam having mesh cryotexture and sand with sandy loams with massive cryotexture, and as ice-borne sediments adjournment submitted by loams, pebbles, boulder bed. The defrosting it is high icy ground leads to to formation thermokarst subsidence, especially dangerous to a steady status of a dam. Not smaller danger to stability of a dam represent frost bursting, etc. dangerous cryogenic processes.

Most frequently meeting process is erosion of a body of a dam as a result of infiltration of water on talik in watertight diaphragm. The dam of tailing dump " Nadegdinskoe " is constructed on first principle of construction with preservation frozen antifiltering screen inside a body of a dam. Complexity of its structure consists that it is erected directly on a channel concerning the large river. Through tailing dump " Nadegdinskoe " proceeds r. Burovaja for which tap of waters have been constructed a line of water-elevating dams. The having hitwater the pond - sediment bowl - water-turnaround also is used constantly for the purpose economy of water resources and avoiding of ecological pollution. Water is pumped out by special pumps from a pond-sediment bowl and leaves back on " Nadegdinskoe " combine.

The hydraulic structure are the most complex engineering objects. The small hydraulic engineering is characterized as one of the most emergency. For increase of reliability of the dams providing in quality antifiltering barrier veils - frozen ground the screen, it is necessary special measures are applied to cooling grounds. Among those it is possible to allocate as cleaning of a snow into the cold period from a surface of a dam. Most effectual measures would become at application of special seasonal and all-the-year-round cooling installations special seasonal deep freezing dams. Has well recommended itself the cementation of fissures.

The hydraulic engineering service of Norilsk mountain combine applies a series of special meliorative actions which allow to maintain hydraulic engineering objects with a sufficient degree of reliability. Into structure of such actions enter: cementation of dams, freezing antifiltering screens the special cooling installations, a regulated alluvium of tail waste products

with their subsequent freezing and other actions.

Effective monitoring of a status of the protecting dam, carried out by experts of Polar branch GMK "Nornikel", allows to accept in an operative mode actions necessary engineering - cryopedology on increase of stability of hydraulic engineering constructions of region.

Key words: Hydraulic engineering constructions, frozen ground

Investigation of Laboratory Experiment on Cooling Effect of Embankment with Perforated Ventilation Pipe

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Abstract: A technique of laboratory experiment modeling for the cooling mechanism in perforated ventilation pipe embankments was introduced. Various ventilated-embankment samples with dimensions of 100×60×100cm under cyclically fluctuating upper-surface temperature were studied experimentally. The analysis shows that the ventilated embankment with perforated ventilation pipe can enhance the cooling effectiveness of the embankment base. The cooling effect of perforated ventilation pipe embankment only ventilating during negative temperature is strongest. Temperature change amplitudes and distribution ranges of negative temperature in the vicinity of air inlet of ventilation pipe are larger than that in the vicinity of air outlet of ventilation pipe. This is a direct consequence of unsymmetrical temperature distribution along a wind direction parallel to the ventilation pipe. Under the same cyclically fluctuating temperatures, the cooling effects of ventilation pipe embankment are increased with increasing wind velocity in the ventilation pipe.

Key words: permafrost; ventilation pipe embankment; cooling effect; self-windward vent; perforated ventilation pipe

Analysis of Cooling Effect for Block-Stone Embankment of Qinghai-Xizang Railway

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Abstract：Block-stone embankment is one of techniques for protecting permafrost of Qinghai-Xizang Railway, and has been used in about 60% of the sections overlying warm permafrost with high ice content. In order to evaluate the cooling effectiveness of the BSE, seven monitoring sites of the soil temperature beneath the block-stone embankment were set up in Qinghai-Xizang Railway. According to analysis of monitoring in recent three year, it is concluded that it is advantage to cooling roadbed for block stone embankment, but the different

fact of the rising of artificial permafrost table, thermal regime, variation of soil temperature with time, and thermal offset between upper and bottom of block stone layer is indicative of some difference of cooling effectiveness for cold and warm permafrost regions. For cold permafrost, block-stone embankment is effective for raising permafrost table and lowering the soil temperature and a cool energy can be accumulated to makes the raising permafrost table be gradually stabilized and thermal stability of permafrost beneath the BSE be gradually enforced. For warm permafrost, block-stone embankment is effective for raising permafrost table but not all effective for lowering the temperature. Soil temperature and thermal regime is basically unchangeable with the application of block stone layer. The thermal offset between upper and bottom of block stone layer shows that there is only a process of heat conduction in block stone layer. Once raising permafrost table is affected by external thermal disturbance, artificial permafrost table will be gradually dropped since the temperature near raising permafrost table approaching to 0oC.Thus, a block stone embankment can be widely applied in cold permafrost regions, but the application of block-stone embankment is worth discussing in warm permafrost regions.

Keywords: Qinghai-Xizang Railway, Block stone embankment, cooling effect, monitoring.

Numerical Experiment and Analysis of Tensile Failure Process on Steel Fiber Reinforced Concrete in low Temperature

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Abstract: In light of the tensile experiment of the SFRC at 0□, -5□, -10□, -15□, -20□, it was discovered that the tensile strength of SFRC elevated as the temperature fell. Numerical tensile model was established by means of the experiment result, and numerical simulation on tensile failure process of the SFRC was prosecuted using RFPA2D, which was based on the finite element theory and material failure arithmetic. The relationship curves of load force-load pace and acoustic emission energy-load pace were gained and the numerical simulation result resembles the experiment result.

Key words: Steel fiber reinforced concrete, Negative temperature, Tensile failure, Numerical simulation, Acoustic emission

Thermal Stabilization of Soils in Permafrost Engineering and the New Techniques for its Realization

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Abstract: Two-phase heat pipes also called seasonal thermo-stabilizers (STS) are widely used in construction. They are known to be the effective techniques providing stable support for buildings and structures in cold regions. A STS transfers heat from its underground part (evaporator) to the aboveground part (condenser) owing to natural temperature difference between them during a cold season. Active deep cooling of soils results in great increase of their strength, bearing capacity, resistance to thermal fluxes producing by engineering structures, and it also protects foundations against frost heave. These well known features characterize only one aspect of soils thermal stabilization.

The other (not so evident) aspect concerned with foundations reliability has probabilistic origin. Random variations of natural factors (air temperature and snow cover at first) effect soils temperature, bearing capacity and stability. Considering this problem in terms of probabilistic approach and the theory of reliability we have shown that STS application sharply decreases these negative effects and rises foundations reliability. It permits to decrease safety factor and foundations cost. The paper presents the numerical results proving the importance of soils thermal stabilization in this aspect.

We have been working out, manufacturing and applying different types of STS (since 1993). Some of them were presented in our paper for the 6th Symposium in Lanzhou (2004): vertical thermo-stabilizers with minor diameter (28-54 mm) from steel (TMD-4) and aluminum alloy (TMD-5); thermo-stabilizers with a flexible bond (crimped metal tube) between evaporator and condenser (TSF); thermo-stabilizers with horizontal or slightly inclined (1-2 degrees to horizon) evaporators (TSI). The experience has shown that in many cases (e.g. for engineering structures with high heat release) a soil cooling by those STS is not sufficient. More powerful cooling units are needed to prevent negative cryological processes and provide the stability of foundations. For this purpose we have developed new devices – TIP – thermo-stabilizers with improved productivity (or with increased power). Their technical parameters and test results are given in this paper, and their operation in the North of Western Siberia and further applications are discussed. We mean new thermo-stabilizers TIP (as well as previous STS types) would be useful for the new railway in Tibet.

Key words: permafrost, bases of structures, stability, reliability, thermo-stabilizers.

The Thermal Conductivity of Segregated Ground Ice

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Abstract: In order to estimate the thermal conductivity of segregated ground ice, the model of porous ice with closed bubbles of spherical shape can be used, taking into account additional convective heat transfer by vapour diffusion in bubbles. Calculations can be made on the basis of the Maxwell-Rayleigh theory using Schwerdtfeger's equation. It is shown that the measured values of the thermal conductivity for segregated ice in Grechishchev et al. (2002, 2003) are obviously underestimated because of the incorrect application of the temperature wave method to layered bodies.

Laboratory and Numerical Modeling of Rock and Concrete Fracture Due to Thermally-Induced Water Migration

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Abstract: Thermally-induced water migration in porous media is a common phenomenon in arctic and subarctic regions where water saturation levels are high, time periods of freeze/thaw are long, and thermal gradients are strong. Ice accumulation at the freezing front leads to ice lensing and frost heave in soils, and can cause fracture in rigid, elastic materials such as bedrock and concrete foundations. The damage to roadways, pipelines, buildings and other infrastructure is costly and often difficult to repair. However, mitigation techniques such as thermosiphon installation or gravel backfilling are also expensive and should be instituted judiciously. We are studying the thermodynamic and mechanical processes involved through both physical and numerical modeling to improve engineering techniques and reduce costs in arctic regions.

The fundamental water migration process occurs due to a gradient in thermomolecular pressure, also known as a 'disjoining' pressure, caused by thin liquid water films at subfreezing temperatures. We have utilized previous theoretical models of soil frost heave in a thermo-mechanical model that describes temperature, pressure, water saturation, and mechanical stress in elastic materials. When tiny cracks/flaws exist in freezing rock or concrete, ice can collect and eventually cause fracture. Our numerical model describes this process in material containing an initial distribution of very small microcracks. The pattern of macroscopic fracture that develops depends on the thermal regime. For boundary conditions of cyclic freeze/thaw on top and thermally insulated, unfrozen on bottom, maximum fracturing occurs just slightly below the top surface. However, when the bottom boundary is constrained to remain frozen (simulating permafrost), maximum fracturing occurs just slightly below the depth of maximum thaw. The degree of saturation strongly influences the tendency to fracture

due to its effect on hydraulic conductivity. Without a sufficient supply rate of water, growing microcracks tend to become engulfed by the freezing front before the increasing internal pressure can cause further fracture. This behavior is generally analogous to the conditions necessary for ice lens formation in soils and particle trapping at an advancing solidification front.

We have also conducted laboratory experiments by simulating the thermal regime associated with (a) one-sided freezing in non-permafrost regions and (b) two-sided freezing of an active-layer above permafrost. Crack development, rock surface heave, temperature and pore pressure have been monitored in 10 blocks of siliceous chalk 45 cm high during the course of more than 20 freeze-thaw cycles. The location of cracking varies according to the rock thermal regime and generally agrees with the numerical model predictions. With two-sided freezing of the active layer, cracking commenced at a depth determined by the permafrost table, and significant ice segregation occurred during thaw cycles. By contrast, in seasonally frozen rock (1-sided freezing), the location of cracking was more variable and closer to the rock surface. We are now applying the same laboratory techniques to cylinders of cement and concrete. By preparing the samples using different frost-prevention techniques such as air entrainment, we will better understand the environmental conditions that can lead to concrete foundation fracture and eventual failure.

Keywords: Frost heave, ice segregation, concrete, modeling, fracture.

Permafrost Thaw Settlement and Embankment Stability

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Abstract: Permafrost degradation resulting from climatic warming or regional warming has been observed in areas from Arctic to Qingzang plateau, and from cold to warm permafrost in the past decades. One of the main consequences of permafrost degradation is thaw settlement which can be significant for ice-rich permafrost. Permafrost thaw settlement is one of the most important considerations in design, operation and maintenance of buildings, embankments and other infrastructures in permafrost areas. Permafrost thaw settlement was discussed in this paper in terms of thaw settlement susceptibility, settlement estimation, porewater pressure variation and thawed soil effective strength, with respect to permafrost geotechnical and hydrogeological properties.

Stability of embankment subject to thaw settlement was assessed in a few different scenarios. Settlement occurs along with thawing under a free drain condition. In this condition, embankment instability generally attributes to uneven settlements. For fine-grained low permeability soils or under a condition with drainage problems, excess pore water pressure can accumulate in the thawing layer to form a low shear strength soft layer, which can result in sliding failure of the embankment. Measures to ensure a well-drained condition in the thawing process to prevent formation of such soft soil layer and for slope supporting were

discussed in view of geotechnical and hydrogeology. Thaw settlement mitigation measures were also evaluated based on soil geotechnical and hydrogeology properties.
Keywords: permafrost, thaw settlement, embankment stability

Cryogenic physical and chemical technologies ore dressing and processings of minerals of natural and technogenic deposits of gold

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Abstract: Last decades the heap gold leaching is widely applied in Russia, including areas with wide development of permafrost. Applied world technologies of heap leaching are not considering the climate conditions of Russia. It decreases the efficiency of heap leaching and sometimes and conducts to the fail. The Laboratory of the General Cryology Institute of Natural Resources, Ecology and Cryology of the Siberian Branch of the Russian Academy of Science (INREC SB RAS) develops the approaches of using the natural sources of energy in permafrost for optimization of efficiency of technology ore dressing and processings of minerals of natural and technogenic gold deposits.

The goal of experiments was to reveal and to quantitatively describe the influence of nival and subaeral cryogenic weathering on ore dressing and heap leaching. We offer the algorithm of ore dressing technology with using the natural source of energy for increasing of they efficiency.

We developed the complex researches method to checking the efficiency of cryogenesis on ore dressing with application of thermal loading. This method included the estimation and the forecast of decomposition processes and change of geotechnical properties of rocks. Also it included an estimation of cryogenic weathering (cryogenesis) role in a strength decreasing and partial destruction of structural communications auric ores and leaching of them.

The cryogenesis results in ore shattering with desired size. The change of a strength of ores and of their open porosity leads to significant reduction of power inputs. The power inputs on ore dressing after influence cryogenesis were reduced to 7.5 %. Also it was established, that the efficiency of leaching ore gold depends on the weathering in subaeral and nival conditions and increases accordingly on 20 and 40 %, than at non transformed ore.

The received results have allowed to offer the new technological scheme of heap leaching that includes the intensification of physical and chemical processes in a ore stack with using the natural sources of energy, that allows to essentially accelerate the technology of ore leaching that decreases the deterioration of the crushing equipment in cold regions. This technological scheme can be use as basic for the heap leaching in permafrost.

This work is executed in according with the program of basic governmental researches "Kinetics and mechanics of cryogenic processes in permafrost".

Key words: heap leaching, permafrost, cryogenesis, geotechnology, ore dressing.

The Effect of Freeze-thaw Processes on Soil Properties in Earth Dam Embankments on Permafrost

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Abstract: The paper discusses soil expansion at the base of the seasonally frozen layer (SFL) that occurs during the first years after the construction of thawed dams on permafrost. This phenomenon has been found to be caused by the difference in settlement between the unfrozen embankment soils and the seasonally frozen ground.

Investigations on the physicomechanical properties of the embankment soils in the Arkagalinskaya electric power plant dam conducted in 2005 indicate that at the dam crest the soil moisture content, density and porosity at a depth of 3.0 to 4.5 m from the surface are 10-25% different from those of the overlying and underlying soils. No changes were observed in the soils of the downstream face. The comparison of the results of investigations carried out in 1954 during the thawed embankment placement and in 2005 shows deterioration of the soil engineering properties at the depth of the SFL. At a depth of 3.5 m from the surface, the soil moisture content has increased by 13%, the soil density has decreased by 12%, and the porosity has increased by 28%. For a depth of 1.5 m, the 2005 and 1954 values are absolutely identical. Below the layer of seasonal freeze-thaw (at depths of 4.5 to 5.5 m), the engineering properties of the soils, on the contrary, have improved: the moisture content has decreased by 50%, the density has increased by 6%, and the porosity has decreased by 26%. Changes in the soil physicomechanical properties within the SFL base are thus evident.

Based on the investigations, the following conclusions have been made.

1. The main cause of soil expansion at the SFL base is the different settlement rate of the frozen soils within the SFL compared to the unfrozen soils of the dam embankment. The arching effect is strongest during the first years of the dam construction.
2. The higher is the dam height and the longer is the frozen condition of the SFL, the greater is soil expansion at the SFL base.
3. The arching effect at the SFL boundary affects soil expansion not only during the first year after dam construction. If a dam is constructed during several years and only during the summer season, there may be several zones of soil expansion in the dam. Further on, increased seepage areas may develop in these zones during the dam operation.
4. Analysis of the soil physicomechanical properties in the dams constructed of unfrozen silty soils indicates that they experience no such significant changes at the SFL boundary as do those in the dams constructed of unfrozen sandy soils.

Key words: Seasonally frozen layer, hydraulic structure, settlement, soil expansion

Numerical modeLling of thawing railway embankments constructed on permafrost soils

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Abstract： Recently geotechnical engineers have had new geotechnical technologies added to their arsenals of instrumentation allowing to conduct site investigation and construct railways on permafrost soils with reasonable quality and reliability. One of the most promising methods of strengthening and winterization of railway subgrades is application of state-of-the-art geomaterials allowing to implement various strengthening structures. The results of numerical modelling of thus strengthened subgrade structures on thawing permafrost soils are presented.

Bending Properties Monitored in Full-scale Child Gas Pipeline Experiment in Discontinuous Permafrost

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Abstract: Gas pipeline projects are starting in permafrost regions. New design concepts for these pipelines are urgent for planning, construction and maintenance.
Chilled gas pipeline is a one promising concept to secure the stability of pipelines in permafrost regions. However, the concept may arise a new difficulty. The bending moment will develop at the interface of permafrost and non-permafrost due to the growth of frost bulb around chilled gas pipeline in non-permafrost section.

The authors had conducted full scale experiment in discontinuous permafrost in Fairbanks Alaska from 1999 to 2004. The test pipeline has the dimension of 0.9m in diameter and 105m in length. The temperature of circulating air was –10 ^{o}C. Three thermal fences were established with 200 thermistors for 2D temperature profile monitoring. Thirty nine heave rods were installed for vertical movement of test pipeline. Forty strain gauges were attached at the surface of the pipeline for strain monitoring. Five in-ground deformation gauges were placed below the pipe in non-permafrost section for heave amount monitoring due to frost bulb growth. Other minor monitoring such as surface level survey were conducted.

The clear bending behavior of test pipeline was confirmed at the boundary. Maximum up-lift of the test pipeline was 18cm in non-permafrost section. Growth behavior of frost bulb was also confirmed. The details of these behaviors will be shown in presentation.
Key words: Chilled gas pipeline, permafrost, bending moment, frost bulb

Laboratory Study on the Dynamic Strength Characteristic on Frozen Silty Clay

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Abstract: Using triaxial cycle tests with constant stress amplitude under confining pressures between 0.3MPa and 16.0MPa at a temperature of -4℃ and at a frequency 2Hz, dynamic strength characteristics of frozen silty clay were studied. The results showed that the dynamic strength depended not only on the confining pressure and the number of vibration, but also on maximum loading stress at constant minimum loading stress. Additionally, pressure melting of pore ice and growth of micro-cracks also influence dynamic stress response. The critical number of vibrations and the critical confining pressure were put forward. Finally, the dynamic and static strength tests were conducted to assess the design of foundation base in permafrost regions.

Key words: Frozen silty clay, dynamic strength characteristic, vibrating number, confining pressure

Practical Modeling for Frost Heave Estimation of Chilled Gas Pipeline Buried in Frost Susceptible Soil

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Abstract: It has been known that chilled gas pipeline buried through a boundary between permafrost and non-permafrost is likely to suffer bending deflection due to frost heave since the pipeline is held tightly in permafrost whereas the other end in non permafrost is surrounded by growing frost bulb and is subjected to frost heaving. As a result, large deflection of pipeline is expected to occur near the boundary and it may cause fatal damage to the pipeline.

For the frost heave estimation of structure buried in frost susceptible soil, various methods have been proposed so far. However, most of those require many parameters to explain this complicated phenomenon as a numerical model since the frost heave depends on freezing rate, permeability of the soil, amount of water migration and etc. The authors, then, propose to adopt Takashi's equation for the frost heave estimation. Introducing only three parameters obtained through indoor experiment, Takashi's equation relates the frost heave ratio with the constraint pressure at the freezing front and its freezing rate. This equation has been confirmed to give satisfactory estimation for one-dimensional frost heave so that the procedure of the indoor

experiment for obtaining those parameters has been regulated by Japan's geotechnical society.

In order to utilize this equation for two-dimensional frost heaving problem, the authors conducted a time dependent heat transfer analysis in two dimensions to predict the temperature distribution in the ground. At the beginning right after the pipeline is buried, the temperature distribution in the ground is same with that of annual temperature change. When the air inside of the pipe becomes colder such as –10 degrees, frost bulb forms around the pipe and gradually grows in size with time elapsing. Applying two-dimensional heat transfer analysis, the authors evaluate the growth of the frost bulb. The effect of latent heat of water involved in the soil is taken into consideration by adopting the equivalent heat capacity of soil and the temperature distribution in the ground is successfully simulated.

Based on the simulation result, the depth of freezing front below the pipeline can be expressed as a function of time and the freezing rate is also calculated. If it is assumed that the constraint pressure at the freezing front is estimated as an overburden pressure due to the growth of frost bulb, the frost heave ratio in vertical direction can be calculated by Takashi's equation with three experimental parameters. The amount of frost heaving is obtained by multiplying the thickness of frost soil layer to the frost heave ratio. The estimation result by this method shows good coincidence with the observed data in the real scale experiment.

Key words: Chilled Gas Pipeline, frost heave, estimation

Comparison of the creep characteristic on frozen silt under dynamic loading with different amplitudes

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Abstract：The creep characteristics of frozen silt are studied based on creep tests, which added dynamic loading on static loading. Two groups of tests are performed (test I and test II). The static loadings of both are same and the dynamic loading of test II is twice as much as that of test I . The dynamic creep strain curves including three stages (initial creep stage, steady creep stage and tertiary stage), and the strain of test II is larger than that of test I . The tests results also show there are similar change trends of creep failure characteristics, but with different values. The minimum creep strain rate of test II is greater than that of test I, and failure time is smaller. Even if same vehicle pass, the dynamic loading stress in roadbed, influenced by the irregularity condition of road and speed of vehicle, is different. These tests proof the roadbed will undertake more strain and is easier to be destroyed with worse irregularity condition of road and higher speed of vehicle.

Key Words: frozen silt; dynamic load; different amplitudes; creep strain; creep failure characteristics

Soil Insulation by STYROFOAM Extruded Polystyrene Foam

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Abstract: After invented by Dow Chemical Company about 60 years ago, STYROFOAM™ extruded polystyrene foam board has, because of its excellent mechanical strength, high resistance to water and water vapor, long-term high thermal resistance, been widely used for insulating various construction facilities in the seasonally freezing regions, sometimes in the permafrost regions as well.

This paper introduces some of the typical insulation applications and a basic insulation procedure of pavement roads.

keywords: freezing, soil, pavement, road, insulation, XPS

Spatial-Temporary Changing of Electric Resistance in Period of Freezing and Thawing

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Abstract: The laboratory of Permafrost the Institute of Geography, Mongolian Academy of Sciences has executed several dynamic research study of the seasonal and long standing permafrost rocks and in 2005-2006 is implementing the serial work named as “Study of temperature regime of the seasonal freezing and thawing”. In today’s condition of market economy have expended a lot of running costs to equip and drilling bore holes for studying of temperature regime, to set an measuring equipment up ready for use.

So, in purpose to provide the no drilling technology were used tools AE-72 for geo-physical prospecting and in assistance of firstly repeated methodology of micro-electric regional measurement has economized great financial expenditure, labor and materials that began to give its efficiency.

The first measurements in study of regime for the personal electric resistance were made along the central road in the East-South of Ulaanbaatar city located in 45 km, in Bus lake on territory of Coal mining of Nalaikh district with 15-40 m thick permafrost. The muddy water of this lake has treatment significance so the people amenable to diseases use it as spring of mineral water that was protected in its wind character. But in last years in using water of this lake was disturbed the ecological balance and most of the natural difficulties is occupied the seasonal thawing.

Under the negative influence of Human activity the water of lake is contaminated and due to climatic warming water is drying up, its hump is thawing that forms collapse and as a result of this action has begun to dominate the permafrost disturbing.

Here were determined the spatial-temporary changing of the permafrost disturbing in Bus

lake and in purpose to protect surround area were made measurement on selected physical point in March of 2005 by the equipment with equal temperature of Slumbered during six months of spring, summer and autumn, where repeatedly installed all curves and made interesting figures explanation.

In our conclusion the deep changing of seasonal thawing made by this method is equal to studying of temperature changing. Therefore we are planning to continue our research work on five physical points as Bus lake until 2007.

Key words: Spatial-Temporary Changing, electric resistance, freezing and thawing

The Active Methods of Stabilization of a Roadbed and Contact-line and Air Line Supports on Permafrost

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(TransEGEM)

Abstract: Reasons of deformations of a roadbed and contact-line and air line supports on permafrost are analyzed. For example deformations of embankment have long character and are usually connected to degradation of a permafrost in the basis of roadbed under influence of increase in amount of solar radiation absorbed by roadbed in comparison with a natural surface, infiltration on warm summer precipitation through a body of an embankment, increase in thickness of a snow cover at the basis of an embankment and in adjoining territory. On slope this is promoted also by a filtration of surface and underground waters in a body and the basis of an embankment.

The active methods of strengthening of the foundation of a railway roadbed on ice-rich permafrost by ratio control cooling and warming factors for conservation of the foundation in constantly frozen state (by the help of a snow removal and painting, sun-precipitation protective shed, cross-section cooling pipes, the film shield, a longitudinal refrigerator) or preventive excision of icy blocks of soils (ice lenses) from the foundation with simultaneous filling-up of generating concavities with non-subsiding soil mass (on the basis of a spray process engineering) are defined.

Experience of development anti-deformation measures for the Russian railroads (Berkakit-Yakut railway, Transbaikalian railroad, access railway track Ulak-Elga) with utilization active methods of strengthening of the foundation of a railway roadbed on ice-rich permafrost is illuminated.

New technical solutions anti-frost heaving devices for contact-line and air line supports on permafrost and a deep seasonal freezing of the soils, providing decrease of forces of a regulation seasonally-thawed soils with a lateral area of a support and reduction of their power and humidity are defined also at simultaneous magnifying of pinching down action of the transmission tower footing by upheaval of a roofing of permafrost by means of the taken out a patent for modes; experience of design and the installation new anti-frost heaving devices is featured at renovation of an overhead contact system Transbaikalian railroad; the first outcomes monitoring probing of their efficiency are illuminated.

Problems of the further probing for a solution of a problem of stabilization of a roadbed and contact-line supports on permafrost are stated.

Key words: permafrost, stabilization of a roadbed and contact-line supports

Skilled-experimental Check New Anti-frost Heaving Devices for Supports of Contact Net and Aerial Lines on the Transbaikalian Railway

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Abstract: Supports of contact net and aerial lines of railways in the field of permafrost and deep seasonal freezing of soil under impact frost heaving of soil are often deformed and lose sustainability. It is necessary to repair them regularly. So, on the Transbaikalian railway for 10 years after end of electrification of the Trans-Siberian Railway it has been corrected and fixed 14676 and 3294 supports of contact net - 16,5% all supports on railroad are replaced. Only in 2004 it is corrected and fixed 2415 and 335 supports of contact net are replaced, on what 1196 windows in movement of trains by the general duration 2631,2 hours - 30% from duration of year were required. In 2005 the amount of unstable supports again has essentially increased.
TransEGEM within 2001-2005 has executed development of technical decisions on provision of sustainability of supports of contact net on permafrost, their skilled-experimental check on Transbaikalian railway, also has developed recommendations on application anti-frost heaving devices for supports of contact net on permafrost.

Anti-frost heaving device is executed in the form of built in a support thermosyphon, heat and hydro insulation and anti-frost heaving bandage. The heat and hydro insulation is imposed on soil surface around a support, covered from above by soil or turf. The anti-frost heaving bandage consists of a protective sheath and nonfreezing lubricating grease. The elevated part of a support is painted in reflective color.

At joint action thermosyphon and heat and hydro insulation in soil around support the roof covering of a permafrost rises and thickness of seasonally-thawed soil is reduced. The anti-frost heaving bandage protects a support from impact frost heaving in seasonally-thawed soil, and painting of an elevated part of a support in reflective color reduces heating by solar rays and corresponding transfer of heat to a soil, that also promotes reduction of depth of its seasonal thawing. Forces of a bulging of a support in a seasonally-thawed soil as a result decrease and its jamming in permafrost increases more thickly, that as a whole provides sustainability of the support erected on permafrost.

In case of installation of a support with the anti-frost heaving devices on lots deep seasonal freezing of soil in the beginning the long-term frozen ground, a layer seasonal freezing is formed turns to a seasonally-thawed layer, and in the further interaction of a support with soil occurs how is described above.

Key words: Permafrost, frost heaving, anti-frost heaving devices, thermosyphon, contact net support, heat and hydro insulation

The Concept of an Engineering-geocryological Monitoring System of the Federal Highway "amur" Chita-khabarovsk

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Abstract: The federal highway "Amur" Chita - Khabarovsk is one of the largest modern construction in Russia. Its construction has been begun in 1978, completion is planned on 2008. Road has length of 2165 km and intersects from the west on the east Transbaikalia and Priamurie - terrains with rather non-uniform geomorphologic, geology-tectonic and climatic conditions, that in turn predetermines significant dissimilarity engineering-geocryological conditions of a trace. On a trace there are neighboring communes with very complex, complex, rather complex and rather simple engineering-geocryological conditions. And complexity of conditions basically is determined by presence and ice content permafrost, them thawing settlement, and also frost heaving at a freezing of seasonally-thawed and seasonally-frozen soils. At construction and exploitation of road there are essential alterations cryogenic processes and phenomena.

The highway "Amur" develops for security of resistance and reliability during its exploitation TransEGEM under the order of Federal Road Agency of Russia the methodical document «Recommendations on engineering-geocryological justification of exploitation of a federal highway "Amur". The basis of «Recommendations … » is compounded with the concept of system engineering-geocryological monitoring of highway "Amur" (SEGMA "Amur"). In it are in detail described: the frame the SEGMA"Amur" which is powering up blocks: observation; the collecting, handling, analysis, an estimation and storage of the information; the forecast and preparing of protective measures; realization of protective measures; the scheme of operation in time the SEGMA "Amur" providing series of sequenced procedures, organized in cycles of data acquisition of observation, estimations of hazard engineering-geocryological processes, the forecast of their further development, control of unfavorable processes; the functional frame the SEGMA "Amur" consisting of several subsystems of different purpose and functions: hierarchical, plants of monitoring, functional, industrial operations, is scientific-methodical security and a hardware; a plant engineering-geocryological probes in the SEGMA "Amur" consisting of three interdependent parts: geology-geographical conditions of a trace, permafrost circumstances, road; the complex program of architecture the SEGMA "Amur" called determine an optimum compound and sequence of practical operations on architecture and operation the SEGMA "Amur"; the plan of realization of the complex program of architecture the SEGMA "Amur" providing three stages: a preparatory stage, informational database stage, a stage of operation the SEGMA "Amur"; offers on organizational security of operation the SEGMA "Amur".

Key words: Permafrost, highway “Amur”, engineering-geocryological monitoring

The experience of designing and construction of road water-carrying metal goffered pipes on the icing places

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Abstract: Among set of scientific and technical problems of construction of highways in cryolithozone the special place is occupied with a problem of a construction of their transitions through temporary and small water-currents. Until recently it is usual on lots of permafrost and icings the preference was given construction of small and average bridges. Even in that case when icings were only assumed, it is frequent without a sufficient substantiation. Water-carrying pipes were applied only on waterless valleys and is usual in traditional performance: reinforced-concrete round in diameter 1,5 m from lengthy parts, one-, two-, three- and four opening or rectangular with an aperture of 2,0 m x 2,0 m. The metal goffered pipes were applied a little.

In 2003 the situation has cardinally changed, when became obvious, that universal application of small and average bridges on temporary and small water-currents Chita-Khabarovsk highway detains rates of construction of a federal highway and not always is justified technically and economically.

So, absence appropriate geocryological to the information on lots of transitions of a highway through water-currents with width of a channel 5 and 4 m on lots of a line of km 1008 and km 1020 have led to that originally, from fears of development icings, there were designed four and three flying bridges in length of 97 and 55 m accordingly. The additional researches executed by us have allowed to estimate real icing danger on water-currents and to develop actions on its decrease that has allowed to apply on the specified water-currents more effective technically and economically decisions with application of the goffered metal tubings of the big diameter.

In total per 2003-2005 forces of Joint-Stock Company «CPE-Ecoterra» for a Chita-Khabarovsk highway were designed 138 and 15 water-carrying constructions are constructed of the metal goffered structures in the form of round pipes in diameter from 1,5 up to 4,30 m and pipes-arches in width from 1,94 up to 10,72 m, by height from 1,6 up to 7,81 m and equivalent diameter from 1,72 up to 7,5 m. Length of pipes thus, changed from 21 up to 70 m, a downgrade on a channel - from 0,0006 up to 0,05, thickness of a wall of a pipe - from 2,75 up to 7 mm. The height of embankment above pipes has made from 1,1 up to 16,09 m. Water-currents had the charge from 1,07 up to 147 $м^3$/sec.

In the report saved experience is analyzed and the to a focus is brought to problems of designing and construction of water-carrying constructions from the metal goffered structures in neighboring communes of distribution of a permafrost and deep seasonal freezing soils.

Key wods: Frame of Permanent Mai, designing and construction, water-carrying metal, goffered pipes

Effect of seismic events on the stability of buildings on permafrost: a case study

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Abstract: The paper discusses a special case of building failure in Susuman, the Magadan Province, north-eastern Russia. The area is in the zone of continuous permafrost and high seismic activity. Scientific and practical interest was caused by the fact that the building, which was designed to accept thawing of frozen ground (Principle II in the Russian Building Code 2.02.04-88), had been stable for about 30 years and, then, suddenly began to experience progressive damage threatening its integrity since the spring of 1998. It should be stressed that the building had a substantial footing foundation of box type, i.e. with cross strapping by reinforced concrete strips on the top and bottom.

Investigations found that the cause and specific development of distress were related to the changes in permafrost conditions on the site after major flooding in 1995. Extensive suprapermafrost taliks developed which were further enlarged by leaks from water and heat lines. Resulting seepage flows caused the steady-state thaw bulbs beneath the buildings to coalesce. This impaired the performance of the supporting soils and foundations. The sensitivity threshold of the warming and saturated soils to seismic loads increased. At present, the majority of the buildings that were in the flood zone show signs of settlement-related distortions typical for dynamic impacts. Several earthquakes with magnitudes 3-4.5 occurred in the region after the 1995 flood. The results of the macroseismic survey by the Geophysical Service of the Russian Academy of Sciences indicate that the part of the town where the studied building is located was often within the epicentral region of these earthquakes. In all these cases, local residents reported that they heard booming and crackling sounds and felt shaking of the houses with the walls cracking. According to the Geophysical Service data, the intensity of quakes was one point higher in those parts of the town where the soils warmed by the flood became hydraulically connected with the river.

The studied building suffered the greatest settlement and structural damage. Although the cracks in the walls were repaired they used to appear again after next shocks with the cracks progressively increasing in width. By the time of inspection in 2004, the building had a cross crack from the foundation and its end tilted and settled significantly. This caused structural responses and damages in other supporting members and walls due to excessive soil deformations. The building was recognized to be in emergency requiring stabilization of the weakened soils beneath the foundation over the entire depth of thawing. A grouting method was offered.

Key words: permafrost, degradation of foundation soils, seismic impacts, building damage.

Geocryological Aspects of Unsuccessful Construction in a Mountainous Area of the Permafrost Zone

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Abstract: The paper presents the results of permafrost monitoring on the site of numerous damages to buildings in the Dukat Silver Mine camp.

The site is typical for the mountainous areas of the Magadan Province, north-eastern Russia, which is situated in the zone of transition from discontinuous to continuous permafrost. It is characterized by extremely complicated geological and permafrost conditions. Tectonic disruptions with faults and steeply dipping bedrock are responsible for the highly variable thickness of soil deposits (5 to 30 m). The upper bedrock is heavily weathered and consists of fissured tuff, andesite, siltstone and mudstone that have reduced strengths and are saturated with water. The overlying coarse colluvial-alluvial and residual deposits are ice-poor to 3 m. Below this depth, the deposits have high ice contents and their thawing results in settlement of 8-12 cm/m (up to 32 cm/m in some localities and horizons). Large suprapermafrost and open taliks occur in the area. For such conditions, the active construction method, or Principle II in the Russian Building Code 2.02.04-88, was selected and the superstructures were designed to handle differential settlements. This approach however failed to ensure the stability of many of the buildings. Greater damage occurred to the buildings located in the transition zone from the unfrozen ground to thawing permafrost. These buildings had to be demolished because of the danger of collapse. The unsatisfactory performance of the foundations resulted from inadequate consideration for the permafrost and groundwater conditions on the construction sites with complex topography where leveling was made by filling the lows. Filling does not provide, in most cases, thermal protection to the permafrost between heat-generating buildings. Instead, it promotes the formation of rapidly deepening and widening suprapermafrost taliks due to infiltration of surface water and leakage from water and heat lines. Seepage flows in the talik zones intensify thermokarst and lead to subsurface thermal erosion extending into the soils below the existing buildings. The thaw bulbs under the buildings attain an unsteady state with chaotic outlines. This causes dangerous unevenness of soil settlement and, consequently, unacceptable foundation distortions.

Investigations confirm that the reliability of the “structural” method is highly limited. Experience shows that it is virtually impossible to provide the stability of buildings on permafrost only by increasing structural strength. For the given conditions, engineering preparation of the foundation material involving pre-thaw of course soils would have been more expedient.

Key words: Perennially frozen coarse soils, differential thaw settlement, building damage.

Electrical Conductivity of Rocks in Freezing-thawing Cycle

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Abstract: Let us consider rocks electrical conductivity in a freezing-thawing cycle. A quantity of unfrozen water in them is supposed to be less than that of a percolation treshold.

1. Rocks are saturated by fresh water and do not change after freezing-thawing cycle.

1.1. A specimen of a rock to be slowly cooled from one side till some –t. At $t=0^0$C free water usually falls in a metastable state and only after some delay begins to freeze. From this moment conductivity of rock is decreasing. Temperature of the rock returnes to 0^0C and till freezing almost all the free water remains constant. Farther the bound water begins to freeze. On this stage temperature and conductivity of the rock decrease, last one in a small degree, depending from temperature and specific quantity of the bound water.

1.2. When thawing this rock its conductivity will rise up exactly the same way down when freezing except a stage of a metastable state of water which takes no place.

2. A rock, saturated by fresh water, changes after freezing-thawing: owing to brittle fracturing of rock, coagulation or to ice inclusions formation in case of deposits. These processes change a pore volume, a pore space structure and decrease a part of the bound water in rocks.

2.1.A change of a conductivity when rock is cooling will be the same as in p. 1.1. but final meaning of conductivity after the completion of the freezing process will be less and its decreasement on the stage of the bound water freezing will be more.

2.2. The curve of the rocks conductivity change during its thawing will repeat one when freezing except a stage of the metastable state of free water which takes no place. Conductivity of fully thawed rocks depend from a change of their tortuosity in a freezing-thawing cycle. If this change will be small the final meaning of thawed rocks conductivity will be less owing to decreasing of a surface conductivity contribution.

3. Rocks are saturated by saline water.

Specimen of a rock is to be cooled slowly, as before, from one side. A rock porous water in the rear of the frost boundary becomes freshened, because last one drives admixtures before it. If final temperature of the cooling will be higher than eutectic one, in the base of a specimen will be formed an unfrozen layer saturated by saline water. If final temperature of the cooling will be below than eutectic one, in the base of a specimen will be formed a layer with porous space filled by eutectic. Conductivity of it will be almost the same as above it because crystals of salts are dielectric. In real conditions a change of rocks in a freezing-thawing cycle will be asymmetric owing to a change of rocks volume and its pore space structure.

Key words: Electrical conductivity, rocks, freezing-thawing cycle

Model of Horisontally Layered Cryolithozone

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Abstract: Cryolithozone boundaries, formed in rocks, saturated by fresh water, by freezing coinside with temperature ($t=0^0C$) and petrophysical ones if relating physical properties change owing to freezing-thawing. Other boundaries in a cryolithozone are formed on lithological and cryolithological ones in syngenetically frozen part of deposits. Degradation of frozen strata from the beneath is followed, after levelling its temperature to $t=0^0C$, by forming a few new boundaries relating frost boundaries on, from below: 1) temperature $t=0^0C$; 2) seismic velocity, sometimes; 3) rocks constant electrical conductivity and close to it by position dielectric permeability; 4) rocks high-frequency conductivity. They move up with different velocities increasing in enumerated order and in time they diverge more and more- on tens and hundreds meters. Knowing their mutual disposition it is possible to find all base parameters of a degradation process: a time of its beginning, a thickness of its thawed part, velocities of frost boundaries owing to different physical mechanisms of their formation.

Freezing of rocks strata, saturated by saline water, from above, is followed by freshening porous water in the rear of the frost boundary. Cryolithozone boundaries can be determined only by temperature measurments. Boundaries of frozen part of cryolithozone and boundaries in it, as in p.1, responce to frozen-thawed and lithological ones. Over solt-watertight layers taliks are forming. Their thickness depends from temperature, porosity of rocks and a quantity of solts, brought to them by a frost boundary. During a degradation of such frozen strata from below in the base of it new boundaries appear in a mentioned above order and of the same origin. In solts-watertight layers they disappear and in taliks over them they start again, simultaneously, but with different velocities.

Formation of permafrost is often accompanied by appearing under it of a fractured zone, always water bearing, and therefore deserves to be mentioned. It is natural to suppose that formation of these zones is a result of many times repeated processes of underlaying rocks freezing-thawing as a responce to long-period changes of climate.

Key words: Model, horisontally Layered Cryolithozone

The research on computing method of frozen-heave force existed in frozen ground tunnel

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Abstract：The research on computing method of frozen-heave force existed in frozen ground tunnel has been carried out by two different methods of model test and numerical analysis used the same scale of model. The results indicate that the semi-empirical and semi-theoretical computing method of frozen-heave force, with low temperature test determining surrounding rock freezing circle area, original sample mechanical test defining surrounding rock physics and

mechanics parameters both in frozen and non-frozen condition, and taking indoor test to confirm constitutive curve of frozen soil, then coupling deadweight stress field and temperature stress field, is feasible.

Key words: frozen ground tunnel; frozen-heave force; model test; numerical computing

Investigation of the Awning Effect on the Roadbed Slope in High-Temperature Permafrost Regions

——For Example of the Huashixia Valley Filed Test Section at Qing-Kang Road

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Abstract：With the warming of the globe is coming, all kinds of active protecting permafrost methods were accepted, and the awning protecting the embankment slope is one of them, also was adopted at the Qinghai-Tibet road and railway and QingKang road. From the weather data analysis, we found the mean annual air temperature(MAAT) was -3.80□ at Huashixia valley, but the MAAT was -5.3□ at Beiluhe regions. Along with the trend of globe warming up, the QingKang road certainly will be the premonitory of the Qinghai-Tibet road and railway. It is very important and necessary to make clear the awning active protecting permafrost methods for high-temperature permafrost, and all of these are important meaning for the Qinghai-Tibet road and railway future run, the protecting permafrost and the maintenance of all kinds methods along with the Qinghai-Tibet lines.

Key words：high-temperature permafrost; awning；Qing-Kang road; permafrost table；Huashixia valley

The analysis of the anti-frozen effect of the heat preservation foundation of the hydraulic buildings in the seasonal cold region

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Abstract: This paper mainly aims at the defects which exposed in popularizing and applying the anti-frozen method for heat preservation foundation of hydraulic structure. Through adopting the field spot simulation method and observing the EPS heat preservation foundation in four winter and springs, we obtained the spot observation data and results, given the variation characteristics of temperature field and variation discipline of humidity field for heat preservation foundation.

Through the information of the temperature fields under the EPS thermal insulation boards with different thickness and density, the frost heaving variation orderliness of the temperature fields, and the testing results of the correlative physical mechanics' parameter of EPS, the conception that EPS heat preservation foundation can restrain frost heaving has been validated,

which offers the referrence for further perfecting the anti-frozen and anti-seepage theories and applied experience of EPS.

Key words: hydraulic structure, frost heaving, EPS, heat preservation foundation, temperature field

Study on the Thermal Regime of Frozen Ground after Construction of Large-diameter Cast-in-place Piles in Permafrost Regions

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Abstract: The results obtained from 2 typical sites of pile test alone Qinghai-Tibet Highway in permafrost regions indicate that the thermal regime and the refreezing process of frozen soil around the large-diameter cast-in-situ piles dependent on such factors as the engineering geology characteristics of frozen ground, the construction methods, the heat carried by the concrete and released during cement hydration period and the seasons of construction.

1) The factors of engineering geology characteristics of frozen ground

After the thermal disturbance of construction the low-temperature frozen ground can gradually refreezes in the short construction period. The temperature of side surface of test piles (diameter=1.2m, length=15m) in Kunlun Mountains pass test site (the mean annul ground temperature=-2℃) drops to freezing temperature 15 days after concrete casting; then reduces to -1~-2℃ 50 days after casting. But the high-temperature frozen ground of large-diameter piles can't refreeze in the limited construction period. The temperature of side surface of test piles (diameter=1m, length=12.5m) in Beiluhe test site (the mean annul ground temperature=-0.8℃) decreases to freeing temperature 90 days after concrete pouring, and remains around -0.1℃ even 270 days after concrete pouring.

The regression analysis result shows that the period (t) from concrete pouring to the temperature of the pile side surface decreasing to freezing temperature is inverse proportion to the initial temperature (θ) of the frozen soil around the piles.

$$t = -\frac{28}{\theta} - 2.5, \quad (R^2 = 0.98)$$

After dropping to freezing point the temperature decreasing rate of low-temperature frozen ground slows down and this process can be express as followed according to regression analysis result:

$$\theta = -a \ln t + b, \quad (R^2 = 0.8\sim0.9)$$

where parameter a=0.6, and b=1.4~1.6.

The temperature of high-temperature frozen ground around the large-diameter piles remains to freezing temperature and temperature dropping process ceases.

The thermal physical properties such as ice content and thermal conductivity of frozen ground

influence its temperature change process. The temperature increase and decrease process in the layer of high ice content is relatively slow.

2) The factors of drilling methods

Drilling in different methods disturbs the frozen ground to varying degrees. In the process of percussion boring, the circulation of slurry carries a great quantity of heat into the ground and brings about great heat exchange with the frozen ground and causes the increase of the frozen ground. For instance, after 2 months of the boring process the temperature of frozen ground at the center of piles group increases about 0.5℃.

For the rotary drilling, the frozen ground temperature increase caused by the friction heat is too small to be neglected comparing with the percussion boring.

3) The factors of volume and thermal physical properties of concrete

The bigger the concrete pile is, the greater thermal disturbance to the frozen soil foundation will be. Especially for the piles group, the influence between the piles will lead to superimposed effect, and causes the temperature of the frozen soil rising obviously.

The concrete mix proportion, the cement hydration heat and the concrete temperature before pouring influence the temperature of frozen soil and the refreezing process of the foundation greatly. The greater the cement hydration heat and the higher temperature of concrete, the larger quantity heat will be carried into the ground and the more difficult for foundation to refreeze.

The adfreezing force between large-diameter cast-in-situ pile and the frozen soil dependents on the temperature of frozen soil around the pile. The regression analysis result of pile load in-situ tests shows that the adfreezing force increases 0.08~0.1MPa while the temperature of frozen soil around the pile decreasing 1℃ in the range from –0.3 to –2.5℃.

Strength Behavior and Unfrozen Water Content of Saline Fine-grained Frozen Soils

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Abstract: The influence of soil type, initial water content, temperature, strain rate and salinity on strength of three different fine-grained saline frozen soil under conditions of unconfined constant strain rate tests is studied in this paper. The soils include silt, silty clay and clay which were taken from the sites along the Qinghai-Xizhang railway in construction. The range of initial water content is from 4% to 50%, and the salinity varies from 0 to 40 parts per thousand (ppt). The range of temperature of strength test is from –2 to –10℃, and the range of strain rate is from $1.1*10^{-3}$ to $1.1*10^{-6}s^{-1}$.

The effects of temperature and salinity can be normalized through unfrozen water content in frozen soil, so the measurement of unfrozen water content at different temperature corresponding to the strength test condition were carried out using pulsed nuclear magnetic

resonance (NMR) method.

Results indicate that the increase in temperature and salinity (unfrozen water content) causes a significant loss of strength. The dependence of yield stress, peak stress, initial modulus and hardening modulus on salinity can be expressed as simple exponential law. The strength of frozen silty is the most sensitive to the change of salinity among the three type of soil, and then that of silty clay and clay. Comparing with NaCl, the effect of salinity of Na_2SO_4 on the strength of frozen soil is not quite obvious.

The law of the effect of salinity on the strength of frozen soil can be explained by the law of the effect of salinity on the unfrozen water content of frozen soil. The change of salinity behaves the strongest effect on unfrozen water content of frozen silty among the three type of soil. The effect of salinity of Na_2SO_4 on unfrozen water content of frozen soil is not quite obvious comparing with that of NaCl. The unfrozen water content even decrease with the increase of salinity at some temperature and salinity of Na_2SO_4.

The failure mode of frozen unsaturated soil is brittle type at some dry weight condition. When the total water content exceeds saturate water content almost all samples behave ductile mode But brittle failure mode is only observed at low temperature and high water content. Therefore the unfrozen water content also affects the failure mode of frozen unsaturated soil.

The strength of frozen soil decreases with the increase of unfrozen water content and this relation can be expressed as a power law. At the condition of same dry weight, the strength of frozen soil increases with the increase of ice content in frozen soil. The unfrozen water content affects the mechanical behavior of soil-ice interface, hence, the mechanical properties of frozen soil. As a consequence, unfrozen water content provides an excellent means for express mechanical properties in term of such variables as temperature, salinity and surface area.

Key words: frozen fine-grained soil, saline, unfrozen water, strength.

The research status and prospect of frozen protection technology in Heilongjiang province

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Abstract: The total area of Heilongjiang province is 454 thousand ha, and the plantation area is 9265 thousand km^2, and distributes four water systems including the Heilongjiang river, songhuajiang river, wusulijiang and suifenhe in Heilongjiang province. The cold environment bring up many problem for the water conservancy, the frozen destroy of hydraulic structure induced by the soil frost heaving spread all over. Through the research over 30 years, obtained tremendous achievements in the theory of engineering frozen soil and the technology of frozen protection, solved many problems primarily occurred in the construction of water conservancy. This paper summarized briefly the research status of frozen protection technology of water conservancy in Heilongjiang province, and make a prospect of the research of frozen protection technology in Heilongjiang province, based on the present theory status、methods of research on engineering frozen soil and the development level of new material.

Keywords: engineering frozen soil, water conservancy, frozen protection technology

Experimental and numerical simulation study on the relation between the freezing mode and frost heave

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Abstract: Since frost heave in frozen soil is depended directly on the freezing mode, it can be controlled in a relative small range by adjusting freezing modes. This paper aims at revealing the relation between freezing mode and frost heave and finding out an efficient freezing mode, which gets a light frost heave after reaching the same design frost depth as other modes. The variable characteristics of the frost depth, the frost heave and the temperature field of the Tibetan Clay under the different freezing modes including continuous mode, stepwise mode and continuous-intermissive mode were studied by means of experiment and numerical simulation. The continuous mode and stepwise mode's test results show that when the frost heave is happened, the temperature field of soil is basically stable and the distribution of the temperature field is almost linear. The stepwise and continuous-intermissive mode's test result show that, as the distance away from the cooling end is increasing, the hysteresis of the response to the temperature changing of the cooling end is more and more prominent. According to the aforementioned conclusions, the continuous-intermissive mode may be an efficient freezing mode because it can easily destroy the linear temperature distribution and make it unstable. The test results have proved this point, that is to say, continuous-intermissive mode can control frost heave effectively. This paper exposed that continuous-intermissive freezing mode of high frequency, the number of cooling end's temperature change cycles of a periodic process occurring per unit time, is more efficient than that of low frequency to restrain the development of the frost heave, and the extent of the cooling end's temperature change has some effect on the frost heave. Based on the improved algorithm of heat and moisture coupled model, a self-made finite difference program was made to simulate the frost heave. On the whole, the result of simulation is quite consistent with the test result, which indicates that the conclusions obtained in the article are credible. Two test not be done in practice were then simulated, which concludes that if continuous-intermissive mode's variable frequency of cold end is too high, effectiveness of the mode's restraining frost heave can be decreased.

Key words: frozen soil; frost heave; freezing mode; experiment; numerical simulation

Experimental Study on Solute Transport During Soil Freezing Process

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Abstract: With the development and utilization of cold regions with high latitude or high elevation, some special engineering problem appeared. For example, structure damage by frost heave; ground and road subsidence due to the ablation of permafrost layer; the fracture, crash, ponding, and base damage of road due to frost heave; the pull and rise of bridge pier by frost heave and the foundation damage of runway and standing apron of airport. In addition, with the development of modern technology construction, artificial freezing technology have been widely used in mine shaft digging, tunnel excavation and subway construction, this respect need us to know more about the frost soil as well.

In the aspect of agriculture and ecological environment: when the soil is frozen, the pore is plugged by ice，the soil temperature is low, so not only the root of plant can't growth, but also the root can be damaged by pull of frost heave. In spring, after the top layer of frozen soil began thawing, for the sub soil layer is still frozen, the permeability is very low, the thawed water can't infiltrate through it, the surface runoff will be easily formed, the soil loss and slop wash will occur, especially because of the shearing strength of soil has been weaken by freezing and thawing function, erodibility of soil is strong, therefore serious freeze-thaw erosion of soil will appear. In the other hand, the solute will be carried by the transport of water from the lower layer to the up layer during soil freezing, and take a secondarily rising to the soil surface due to the strong water evaporation of surface soil in spring, so the secondary salinization or alkalization will be caused by freeze-thaw action. In addition, the atmospheric change and human activity make the very weak ecological environment change rapidly of the regions with frost soil permanently, seasonally, or instantaneously, such as vegetation degeneration and desertification. Consequently the existence, change of frost soil have important influence on the living environment, productive activity and sustainable development of human being as a kind of territory resources, low temperature environment of engineering foundation, and constructive material.

In order to solve these problem related to frost soil, the mechanism of freeze and thaw of soil must be studied in detail, and the heat, water and solute transport regularity during freezing and thawing is a important content in it, because the frost heave or thawing subsidence problem substantially belong to the heat and mass transport problem. The former researches are mainly conducted about the normal solutes appeared in saline or alkaline soils. With the increase of the amount of fertilizer used in agriculture, the study on the transport rule of plant nutrients during freezing and thawing became necessary and important in frost soil field. Therefore, in this paper, the transport rule of plant nutrients including $(NH_4)_2SO_4$, KH_2PO_4 and KCl during freezing of Brown soil is studied experimentally.

(1) For the specimens put with $(NH_4)_2SO_4$ solution: the redistribution extent of NH_4^+ after freeze is low, this suggested that the kept amount of it by brown soil is big. The NO_3^- increase from the cold side to the warm side obviously，reversing to the direction of water transport, this

signifies that the diffusion action of solute movement prevail against the convection. The redistribution of SO_4^{2-} after freeze is not apparent, mainly due to the high amount of fixation by soil through static electricity adsorption or exchange adsorption of ligand. The redistribution extent shows light increase with the increase of the concentration of solution input, but the moving direction of SO_4^{2-} is not certain for the specimen with a high concentration of 50‰, this can be explained by the comprehensive action of convection and diffusion.

(2) For the specimens put with KH_2PO_4 solution: water soluble phosphorus show obvious transport after freeze in the direction of the water transport when the input concentration is higher (35‰ and 50‰), but no apparent trans port for lower concentration, imply that high amount of phosphorus is adsorbed or fixed by soil through chemical action with calcium, magnesium, iron, aluminium and manganese etc. and becoming unsolvable matter. The redistribution of total phosphorus is not obvious either, means a big portion of it is in fixation. A big amount of water soluble kalium is adsorbed by the soil too, because only in the specimen with high concentration of 50‰ there exist obvious transport of it toward the cold side same as the water transport direction. The redistribution of total kalium show no certain tendency, the reason is not clear, can be preliminary estimated as the different temperature, ice content and unfrozen content etc. make the amount of fixed K^+ different along the soil column.

(3) For the specimens put with KCl solution: the redistribution Cl^- is obvious for any specimen with different input concentration, the movement direction of Cl^- is same to the transport direction of water during freezing, implies that the fixed portion of Cl^- is small, and the convection is prevailing. The redistribution of K^+ is obvious for any specimen with different input concentration too, the movement direction of K^+ is same to the transport direction of water during freezing, implies that the fixed portion of K^+ is small too, and the convection is prevailing. Compared to the specimens input with KH_2PO_4, KCl has a smaller molecular weight, at the same gravity percentage, the equivalent concentration or mole concentration of KCl is much higher than KH_2PO_4, therefore even at a low gravity concentration, the amount of K^+ may pass maximum fixation amount of it by the brown soil used in this study, and there exist much dissolved K^+ in the soil solution. The redistribution of total kalium show no certain tendency either, and the reason is not clear, can be preliminary estimated as the different temperature, ice content and unfrozen content etc. make the amount of fixed K^+ different along the soil column too.

Analytically study on the rising temperature of freezing soil zone Compared to FEM

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Abstract: Using graphical chart tool of Maple and the analytics theory, this paper studied the procedure of transit rising temperature fields of the infinite long column and infinite plain wall of frozen soil. Compared with the results of FEM, the analytics answer is much consistent with the numerical, this reveal that when stopping freezing, the rising temperature field characterized evidently, which can be surveyed in the center of freeze hole and usefully applied to supervising the ground freezing process.

Keyword: freezing wall, analytics analysis, and frozen soil structure.

Experimental and mechanical study on the Coupled action to seepage field applied by both stress and temperature fields

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Abstract: This paper firstly summarized the coupled field theory of temperature and stress applied to the seepage field, and then studied the function of parameter of permeability coefficient, so argued the monotonically changes with the varies of temperature. Experiment has been set and carried out, and the result data were regressed in the form of exponential function, in which the convergence of nonlinear numeral calculation surely is benefit.

Research on mode and criterion of frozen soil fracture under compressive loading

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Abstract In order to explain the mode l and ll of frozen soil fracture under compressive loading, a stress model of micro-cracking element is presented on the basis of damage properties in the tip of main crack.. Through studying the distribution law of stress intensity factors of branching cracks in various orientation, a new criterion of fracture mode and failure of mixed crack of frozen soil subjected to compressive loading, expressed by rations of stress intensity factors and fracture toughness, is obtained, which can predict not only mode l, but also mode ll of fracture. Based on it, the geometrical and loading conditions of mode ll of fracture are given and discussed in detail. The results are in good consistent with experiments.

Key words: compressive loading, frozen soil crack, fracture mode, fracture criterion

Experimental Study on the Influence of Paving Location and Diameter on the Cooling Effect of Ballast Embankment

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Abstract: To study the influence of paving location and diameter on the cooling effect of ballast embankment, the one dimensional tests were carried out on the three materials of ballast, cobble and sandy gravel with single, compound and mixed structures in an insulated box of 50 cm in length and width and 65cm in height under the periodic fluctuation of air temperature at the top of the specimen. Results show that for single structure, the natural convection is appeared respectively in the ballast with the diameter of 2-4cm, 4-6cm, 6-8cm and in the cobble with diameter of 10-15cm,among with the ballast with diameter of 4-6 cm provides the best cooling effect. For the compound and mixed structures, the cooling effects are weakened. The mean temperature of ballast is deceased with increasing its thickness. To use the mechanism of natural convection sufficiently we suggest that the ballast with diameter of 4-6 cm could be used as filling material for the embankment in permafrost regions and the paving location should be at the top of the embankment. The compound and mixed structures of different materials, such as ballast, cobble and sandy gravel, should not be used in permafrost regions.
Key words: diameter of ballast, paving location, embankment, cooling effect

The elementary study on the chain-styled mechanism and the new-typed method to the chain breakage of the water leakage hazard in Kunlun mountain tunnel

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Abstract：The hazard of the water leakage is the most familiar one in the several hazards in the cold region tunnels. This hazard could bring on other hazards, such as frost heave, because the water leakage is frost in spring, autumn or winter. In this paper, after the geologic status and the design general situation of Kunlun mountain tunnel in Qing-Tibet railway are represented, the hazards of water leakage of the tunnel are introduced by the time step based on the measured data in-situ. From the viewpoint of the chain-styled rule, the chain-styled mechanisms of the water leakage hazard in Kunlun mountain tunnel are open out. According to the principle to the chain breakage and the chain-styled mechanisms of the water leakage hazard, a new-typed method to the chain breakage, using the ripped-stone method, is presented based on the principle of protecting the frozen soil layer from thawing. The design of the ripped-stone is made, and matters needing attention during designing and constructing the ripped-stone are put forward. So the new analysis method and the new prevention and cure measure are offered for

the water leakage hazard in cold region tunnels.

Key words：The cold region tunnel, Water leakage, Hazard chain, the chain breakage using the ripped stone

Study on the ripped-stone method to the chain breakage of the water leakage hazard in Kunlun mountain tunnel

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Abstract：The paper whose title is *The elementary study on the chain-styled mechanism and the new-typed method to the chain breakage of the water leakage hazard in Kunlun mountain tunnel* presents a new-typed method，using the ripped stone, to the chain breakage of the water leakage hazard in cold region tunnels. And the design of the method is shown. But the theoretic foundation and the feasibility of the method are not analyzed in that paper. In allusion to these problems, according to the essential theories of heat transfer and seepage, considering the coupled effects of seepage field and temperature field, a three-dimensional computational model of the coupled problem is given. The finite element formulae of this problem are obtained by Galerkin's method. And the computer program of the finite element is written. Using this model and the computer program, three-dimensional nonlinear analysises for the coupled problem of seepage field and temperature field of the flat segment DK977+578～DK977+682 in Kunlun mountain tunnel on Qinghai-Tibet Railway are made under the two conditions of using the ripped-stone method and not using the ripped-stone method. The results show that it is feasible that the ripped-stone method is used for breaking the chain of the water leakage hazard in the permafrost tunnels. So, the theoretic foundation of the ripped-stone method is provided for its application and design in cold region tunnels.

Key words：The permafrost tunnels, Seepage field, The coupled problem, The chain breakage using the ripped stone method, Three-dimensional nonlinear analysis.

Analysis of the Combined Effect of Thermal Insulation and Thermosyphon for Embankment Cooling in Qinghai-Tibet Railway

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Abstract: The thermosyphon and the thermal insulation layer are widely used in the roadbed engineering of Qinghai-Tibet railway separately. The measure protecting permafrost using thermal insulation layer is a passive way, which has limitations. The insulation can prevent outer thermal energy from penetrating the embankment in warm season, while in cold season it

does not spread the energy in the foundation soils below the embankment. Because of that, when the thermal insulation is used to keep the permafrost table, the ground temperature below the embankment rises gradually, and this will lead to heat accumulation under the insulation. For the warm permafrost region the long-term effect of the thermal insulation layer is not good. The thermosyphon method is a active approach and can cool the soil surrounding it by exporting inner thermal energy in cold season, but the thermosyphon does not function in warm season and the extension of its effect which is effective radius is limited. In some cases the thermal insulation and the thermosyphon are used as a combination to achieve better cooling effect so as to maintain stability of the embankment, in this way their respective advantages can be utilized in the different season and the more accumulated "cold" can be kept in the embankment.

In the paper, according to the observation data of the climate and geological conditions at test site of Qinghai-Tibet railway, finite element analysis of 3-D temperature field with phase change is conducted to study the cooling effect of 4 kinds of embankment, namely, traditional thermosyphon embankment , 3 kinds of combined thermosyphon and insulation embankment in which the thicknesses of the insulation are 6 , 8, and 10cm, respectively, and the position of 3 kinds of insulation in embankment is 0.4m up the natural ground surface. In term of the analyzing and comparing temperature characteristics of each embankments in future 40 years, the cooling effect of different embankment is given and the most rational spacing between the thermosyphons in above 4 kinds of embankment is obtained, respectively.

Key words: permafrost, insulation, thermosyphon, temperature field, embankment

Study on Frame of Permanent Maintenance Decision Support System for Permafrost Embankments of Qinghai-Tibet Railway

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Abstract：Formidable nature conditions and the problem of permafrost makes the maintenance work of permafrost embankments more difficult than that of others. Based on the GIS platform, this paper established frame architecture of permanent maintenance Decision Support System (DSS) for permafrost embankments of Qinghai-Tibet railway, and studied the function implementation of system integrated specific maintenance work and information technology. Based on the different network, this paper established the topology structure used by different employee. Meanwhile, the design of the database contents of distributed database, treatment and integration of various data, different form of data flow were studied. Based on these studies, this paper put forward the architecture design of the database on the basis of the system function, and suggested the design platform of the system. Integrating the technology of MIS, GIS and DDS, the technology routes this paper gives realizing information management on permafrost embankments of Qinghai-Tibet railway can fulfill the safe running demands of the

railway, and can collect and aggregate the transportation resource relatively isolate distributed in diverse professional works so as to realize the central supervisory and management and get up to scientific decision ultimately.

Key words： Qinghai-Tibet railway, embankment disasters, permanent maintenance, database, system design

Numerical Simulation of Nonlinear Fracture Failure Process in Frozen Soil

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Abstract: This paper presents a semi-analytical finite element method for the numerical simulation of nonlinear fracture failure process in frozen soil. The fracture failure process of frozen soil is nonlinearity and it exist the crack damage zone (MDZ), simplified MDZ as fictitious crack and assumed there is cementation force on the crack face; the frozen soil cementation force crack model of nonlinear fracture failure is presented. According to the Paris displacement formula, the expressions of crack tip opening displacement especially for three-point band beam (3PB) model and compress model of frozen soil are proposed under the loading of nonlinear cementation force on the crack face, besides some parameters are provided for calculating the nonlinear failure process of the frozen soil. Finally the numerical simulation of 3PB model and compress model of frozen soil is presented. Semi-analytical finite element method is adopted in the numerical simulation. For 3PB model, the failure process curve at different temperature and crack tip opening displacement (CTOD) critical value for different types of frozen soil are given. For compress model, the relation curve CTOD vs. loading and CTOD critical value for different types of frozen soil are given, too. Compare with the experimental value in the frozen soil experiment, the result value is accord well.

Key words: frozen soil; nonlinear failure cementation model; numerical simulation

Effects of Seasonal Frozen Soil on Soil-Foundation-Structure Interaction

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Abstract: It has been observed that the environmental variables including temperature and seasonal frozen soil could significantly influence the soil-foundation-structure interaction (SFSI)

and seismic response of infrastructures in cold regions. However, there is little literature documenting systematic studies of the effects of environmental variables on the dynamic properties of civil structures. This paper presents the detailed results of more than one year's monitoring and analysis of the effects of environmental variables on the dynamic properties of a selected bridge system.

First the seismic instrumentation of the selected bridge is described in details. Using these instruments, the ambient noises, traffic induced vibrations, and earthquake ground motions has been recorded and processed for a time period spanning from November 1, 2004 to December 27, 2005. Based upon the collected field data, the dynamic properties of the bridge, including modal frequencies, mode shapes and damping ratios are identified by using System Identification tools. The fundamental frequency of the bridge is found to change by as much as 15% due to environmental impacts within one year, implying about 30% change in the stiffness of the bridge foundation system. A three-dimensional finite element model of a typical bridge pier is built and the analysis results show that the seasonal frozen soil can contribute as much as 10% change to the fundamental frequency.

In the mean time, the environmental variables recorded from a nearby meteorological station are gathered to provide temperature and frozen soil depth for modeling purpose. The seasonal frozen soil depth was evaluated by Stefan Equation, which is calibrated by using data obtained by a Ground Penetrating Radar (GPR). In the end, a multiple-input ARX model is built with the temperature and frozen soil depth as the input and the fundamental frequencies as the output for structural health monitoring. The model is then used to predict the dynamic properties changes for two scenario cases.

In conclusion, the environmental variables including air temperature and seasonal frozen soil can have significant impact on the dynamic properties and hence the seismic behavior of a bridge structure. The findings suggest that seasonal frozen soil can significantly change the stiffness of the bridge foundation system and soil-foundation-structure interaction. Further investigation is needed to better understand soil-foundation-structure interaction considering the effects of seasonal frozen soil and provide input to design code provision.

Key Words: Seasonal Frozen Ground, Soil-Foundation-Structure Interaction, GPR, ARX

Study on the Influence of Artificial Frozen Soil Layer to the Temperature Field and Displacement Field of the Frozen Wall

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Abstract: Frozen wall has been widely used in civil engineering; foundation pit supported by plane frozen wall is attracting increasing attention of the researchers. In cold seasonal frozen soil area, the thickness of seasonal soil is large and the strength of the seasonal soil is high. It is necessary to consider the interaction between the seasonal frozen soil and the artificial frozen wall. This paper presents a model which based on 2D heat conduction, and calculates the temperature distribution in the frozen wall. The frozen soil layer provides an initial and

boundary condition which have a lower temperature. The results show that the freezing speed of the frozen wall under the circumstances of seasonal frozen soil is higher than that of a frozen wall which not in this circumstances. The author studies the influence of the space between frozen pipes on the thickness and average temperature of the frozen wall, also studies the influence on the time to complete the freezing. The optimum spacing interval is about 1 meter to 1.5 meter. The seasonal frozen soil and the frozen wall adhesively bond each other, forming a spatially integral structure, improving the integrity of the frozen wall. The frozen soil layer constrains the horizontal movement of the frozen wall; the curves of deformation of deep foundation pit with the existence and the non-existence of frozen soil layer are obtained, horizontal displacements of the frozen wall are compared. The results show that there is variation in horizontal displacement from excavation stage to stage for the excavation. Under the circumstances of seasonal frozen soil layer, the horizontal displacement of frozen wall is limited by 48% maximum on the top of the frozen wall, and meanly cut down by nearly 30%. In cold region the frozen wall is economical and steady for pit excavations; the application potential of frozen wall is huge in cold seasonal frozen soil area.

Key words: seasonal frozen soil layer; frozen wall; temperature; deformation

Experimental research on thermal conductivity of undisturbed frozen samples from permafrost regions on Qinghai-Tibetan plateau

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Abstract: Thermal conductivity is an important parameter for engineering design to estimate thermal regime of permafrost regions. Using a thermophysical instrument, the thermal conductivity of undisturbed frozen samples from Beiluhe in Qinghai-Tibetan plateau was tested. Experimental data showed that there was significant difference in thermal conductivity between undisturbed frozen samples from the permafrost regions and their remoulded frozen samples. We found that volumetric ice content controlled the thermal conductivity of shallow permafrost layers. As for shallow permafrost layers with the same soil texture, structure and consolidation condition, results indicated that their thermal conductivity had negative correlativity with volumetric air content and positive correlativity with natural density, respectively. On the other hand, volumetric air content was a dominant factor for the thermal conductivity of ground ice and deep permafrost layers. At the same time, ground ice in Qinghai-Tibetan plateau had equivalent thermal conductivity with pure ice, and volumetric air content affected the magnitude of its thermal conductivity. The study will be helpful for thermal calculation on permafrost regions of Qinghai-Tibetan plateau.

Key words: Permafrost; Beiluhe; Qinghai-Tibetan plateau; Thermal conductivity

Cooling effect of crushed rock revetment in permafrost regions

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Abstract: During the year of 2003-2005, an experimental embankment was constructed in Beiluhe, the Qinghai-Tibet Plateau, using coarse (7-12cm), poorly graded crushed rock fill material on the slope of the conventional embankment with thick ground ice permafrost foundation, which should be called the crushed rock revetment embankment (CRRE). The highly permeable CRRE installation was designed to test the cooling effect of CRRE concept with conventional control embankment in an actual railway project. Using thermistor sensor strings, ground temperature data were collected from test sections. At present study, based on the ground temperature data measured in the boreholes within the CRSPE and conventional embankments, it is found that crushed rock layer can take effect of reducing slope surface annual mean temperature and slope surface annual range of temperature. Comparing with the conventional embankment, crushed rock revetment has mainly the effect of heat insulation in summer but is disadvantageous to heat losing in winter. According to rising of artificial permafrost table and decreasing range of ground temperature and difference of deformation, the heat stability of CRRE is better than that of the conventional embankment. It will be a long term process for crushed rock revetment to adjust the interior temperature field of embankment, so it is careful when using the measure in the Qinghai-Tibet Railway.

Key words: Qinghai-Tibet Railway, permafrost; cooling effect, crushed rock revetment

Theme 2. Frost hazards and periglacial environments in mountain/plateau regions

Thermodynamic conditions of the cryopegs formation in the coastal zone of Russian Arctic

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Abstract: Cryopegs are mineralized groundwater lenses existing at bellow 0^oC temperatures, which are widespread in the coastal area of west Yamal, for example. They occur at different depths as isolated lenses, which are not connected with each other or to ground or surface waters, and have different pressure heads (depending on the depth of location). An examination of a cross-sectional profile shows that cryopeg lenses occur in multiple layers. Cryopeg water has a rather constant chloride-sodium composition, however concentrations of SO_4^{-2}, Mg^{+2}, Ca^{+2} ions can differ among occurrences, as can salinity.

The process of formation of cryopegs is followed by heat-mass transfer. Physical model of freezing of a salt dispersed sediments is much more difficult than model of unsalt sediments. Process of freezing is followed by: a – displacement of ions to the layer of unfrozen water; b – water and ions migration, caused by diffusion; c – salt crystallization with formation of minerals; d – adsorption of pore solution on mineral surface of sediments; e – ion exchange and chemical reactions; f – origin of mechanical stress, caused by moisture phase changes. During freezing in the body appears mobile border between two zones, and pore solution undergoes differentiation: small portion of salt stays in the frozen area, but the main part squashed to the liquid area. As the result of squashing salt by phase border there is a formation of liquid high-mineralized zones, concentration of their solution can be 200gr/litre or higher, it means these zones don't freeze at temperatures bellow 0^oC.

The goal of the investigation is to determine specific features associated with the occurrence and formation of cryopegs, mainly focusing on those shallowly lying in the coastal zone of the west Yamal. Cryopegs in this region have been drilled through by boreholes on several occasions, to different geomorphological levels at depths ranging from 2-3 m to 10-12 m during explorations in the oil- and gas fields of this region, along the lines of trenches planned for gas utilities and railways. The deep parametric boreholes drilled in the areas of Kharasavej and Bovanenkovo have detected cryopeg lenses at depths ranging from 30-50 m to 200-250 m.

The analysis of the data concerning the conditions of the occurrence and the chemical composition of cryopegs, obtained during these investigations and taken from literature, enabled us to identify landscape indicators of the cryopegs that are situated near the surface.

The origin of those cryopegs, which possess both a salinity that is considerably lower than that of the sea water and a chemical composition that is devoid of sulphates but has increased magnesium ion content, cannot be considered to be completely understood. Association on the cryopegs with hasyreys and riverbeds suggests that their formation is connected with cryogenic metamorphosis during deep freezing of the lake (surface) and under-lake (under-riverbed) groundwater in very severe climatic conditions (about 20000-18000 years ago). In this case, the depth of cryopegs of this type is determined by the depth of paleo-lake. A promising direction for ongoing investigations of cryopegs is the greater application of isotopic method.

The presence of cryopegs in the ground poses several challenges to infrastructure: they considerably reduce the bearing capacity of the ground and the brine solution aggressively attacks concrete and is corrosive to metals, which also renders surface water unusable for water supply. Temperature conditions of formation of cryopegs needs to be studied in future.

Influence of Morphological Structure of Soils on the Depth of Seasonal Thawing

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Abstract: In order to assess the role of soil morphological structure on the thawing depth during the the growing season in cryolithozone, measurements of soil temperatures were carried out on four sites of the Central Yakutia. Observed sites are located close from each other and developing in identical bioclimatic conditions. For comparison two meadow and two forest sites were selected. Meadow sites located on the belts of optimum moisture at Tungulu (site 1) and Ulakhan Sukkhan alases (site 2) and were developed under the presence of *Puccine11ia tenuif1ora (Griseb.) Scribn, et Merr.* meadows. The maximum height of a grass cover reached 40-50 cm, productivity of meadows 15 c/ha in dry weight. Characteristics of forest sites are as follows: site 3 – cow berried larch forest (*Larix gmelinii (rupr). Rupr.*) with low density (0,4-0,5), middle productive capacity (about 90 m^3/ha); 4 - *Pinus sylvestris L.* pine forest with foxberry, has low density (0,4-0,5), and also has middle productivity (about 90 m^3/ha). Thus, characteristics of vegetation cover of sites are close, but each site differs by morphological structure and granulometric structure of soils.

Capacity of the top humus-accumulative horizon in forest sites, and sod-humus layer in grassland soils is the basic difference in a morphological structure of soils. Therefore, capacity of sod humus horizon of grassland soil of site 1 amounts 10-15 cm, but at the site 2 - up to 40-45 cm, middle clay loam horizons located below. In forest soils of site 3 the structure of the top part of soil profile is as follows: 6 (8) - 0 cm – over surface cover of cowberry, 0-2 (4) cm – tree litter from weakly decomposed plant remains, from 2 to 5 (8) cm humus-accumulative horizon. And lower located middle clay loam horizons. A morphological structure of the top

part of soil profile in pine forest following: 4 (6) - 0 cm – over surface cover from a foxberry, 0-2 (3) cm – litter from weakly decomposed plant remains and clay sandy and sandy horizons are below.

The summer of 2002 is characterized as dry and warm. During the period from May to October, precipitation was only 90.2 mm (out of a mean of 174.9 mm for the same period), the average temperature of the season was equal to 12.3 degC. (with at long-term mean value of 12.2 degC. The summer season of 2003 was close to the mean. During the period from May to October, precipitation was 153 mm, the season was warmer than the mean and averaged 13 degC. At almost identical conditions of warming and moisture the compared sites appreciably differed on depth of seasonal thawing.

The maximum depth of seasonal thawing of the grassland soil on site 1 in 2002 reached 3m, on site 2 – 2.1 m. For the summer of 2003, depth of seasonal thawing of grassland soils reached, 2.4 and 1.0 meters respectively. The depth of active layer of forest soils at 2002 summer reached on site 3 – 1.4 m, on site 4 – 2.1 m, corresponding parameters for 2003 were equal to 1.6 and 2,3 m. Such difference in soil thawing depth is caused by structure of the soil profile. It is known, that the soil horizons enriched with organic substance, possess increased moisture capacity and low heat conductivity. Due to these properties in grassland soil on site 2 and forest soil of site 4, depending on weather conditions of summer season, the depth of seasonal soil thawing reached only 50-70 % those of on sites 1 and 3.

Thus, the morphological structure of soils plays an essential role on seasonal soil thawing depth in cryolithozone.

Key words: Central Yakutia, cryolithozone, soil structure, thawing depth, umus-accumulative horizon, sod humus horizon

Rock Temperature Regimes in Northern Norway and on Svalbard: Implications for Cryogenic Weathering

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Abstract: The study of cryogenic rock weathering features and the monitoring of rock temperature have been carried out in Longyearbyen, Svalbard (78º N, 15º E) since 2001 and along a West-East gradient across the Troms county, Norway (69-70° N, 16-21° E) since 2004. Temperatures are monitored in blocks and in rockwalls at depths of 40 cm, 10 cm, 1 cm and at the rock surface.

On Svalbard, the monitored sandstone rockwall is experiencing considerable temperature fluctuations, even during the polar winter. The freezing of the rockwall in the autumn and particularly its thawing in the spring bring along several freeze / thaw cycles at the rock surface. 40 centimeters into the rockwall, the rock freezes once in the autumn and remains frozen until May. On Svalbard, conditions favourable to cryogenic weathering (i.e. freezing of the rock when its moisture content is high) are met only rarely. But when these conditions are met, frost action can be very aggressive, because of the high rock moisture content, the quick cooling or

the extended duration of freezing periods. Only very few thermal shocks (i.e. temperature changes of at least 2º C/minute) were observed and could not cause any weathering. Dynamic Young's modulus measurements indicate a very low weathering rate after 4 years of exposure. This poorly porous sandstone is not weathered by microgelivation, but by wedging of its well-developed crack system.

The Troms transect includes three sites exposed to maritime climate (Kvaløya) and two sites located in a much colder and drier region (Skibotndalen); sites are spread between sea level and 530 m a.s.l. Both on Kvaløya and at in Skibotndalen, at around 500 meters a.s.l., frost can occur at the rock surface from around mid-September until mid-May. At all elevations, a large number of freeze / thaw cycles are observed at the rock surface over a one-year period: between 35 and more than 60. This is considerable, and much larger than on Svalbard (about 20-25 per year); this reflects the fact that, in Troms, air temperature can fluctuate a lot also during the winter, particularly in maritime locations. This parameter is important in the context of the efficiency of cryogenic weathering, which is supposed to be higher at the Troms subarctic sites than in the Svalbard high-arctic sites.

Characteristics of Cryogenic Soils in the Qinghai-Xizang Plateau, China

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Abstract: The objectives of this study are (1): to investigate the soil-landscape relationship and vegetation of Qinghai-Tibetan Plateau, (2): to find modern analog of Beringia environment, and (3) to set up soil monitoring sites to study the effects of climate change on the soil environment of the Plateau. Soil-vegetation sites were chosen along a N-S transect from 31 to 35^{o} N. Of all the eight sites studied, 6 exhibit calcareous reactions and had pH values >8.2 (water). Free carbonates, mostly pedogenic, were detected in 7 of the 8 sites. Soil morphological features suggest the segregation, hence redistribution of carbonates in the profiles. The unusually high carbonate contents in the buried organic horizons in the Qingxuehe site are marl formations associated with a shallow lake sequences that frequently flooding produced stratified sedge layers and fine sand layers. Each time the water level dropped a marl layer formed. In Kokexili site, the carbonates are evenly distributed in the matrix without segregation due to the carbonate-rich parent materials. On sites south of Tangula Pass where MAP increased to 350 mm and there are loamy soils overlying gravelly substratum, carbonates undercoatings on gravel is common, indicating the movement of percolating water indicative of the semiaridic environment. At the Liangdohe sites there is evidence of carbonates-leaching in a semihumid (MAP~ 400 mm) environment. Permafrost presented in 4 of the 8 sites investigated with active layers ranging from 50 to over 200 cm. Generally poorly drained organic soils have shallow active layers.

Keywords: Cryogenic soils, alpine soils, soil property, Tibet Plateau, Cryosols

Permafrost – affected Soils in Oil and Gas Exploiting Regions (Bolshezemelskaya Tundra)

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Abstract: In the connection with the exploitation of oil and gas deposits in the Barents region, negative influence is made on the unique soil cover of the tundra. The most widespread types of destructions are: 1) chemical pollution with crude oil and other organic liquids, 2) physical-mechanical degradation, 3) damages consequent to the strengthening of exogenous processes (deflation, solifluction, degradation of permafrost), deterioration in this or that degree of their qualities. The contents of oil products in contaminated soils 10-20 time exceeds the maximally allowable coefficient. The studies of oil hydrocarbons (OH) in the soils of the background ecosystems was carried out. The highest indexes were found in the soils of low level landscape – geochemical position, which have sorption biogenic, lithogenic, cryogenic, oxidation reduction barriers. The low contents of OH and a high activity of migration into the surface waters were revealed for the soils on loose-sandy deposits (Gelic Cambic and Haplic Podzols), which accumulate OH in the OA, BHF horizons, as well as above the permafrost, The soils of morainic loams and underlayed by loams are characterized by an increased contents of OH in comparison with the sands. The increase of OH contents deeply evidences a weak lateral migration and the inclination for conservation in these soils.

Optical microscope observations carried out on polluted and background soils. The distinctive from the background features of microfabric of the oil polluted soils serving as indicators of pollution are found: 1) Gelic Cambic and Haplic Podzols: a) fragmentation of vegetative remains, b) black thick films and double-layer coatings on mineral grains, c) dark-brown aggregations of fine dispersed mass between grains. 2) Gelic gleyic Podzols: fragmentation and chaotic location of plant residues, b) accumulations of coagulated black aggregates, c) large brown accumulations of fine dispersed mass. 3) Gelic Histosols: a) strong fragmentation of plant remains, destruction, b) black large clots with cracks of shrinkage. The possibility and availability of the use of the micromorphological method for the control of changes of soils at their pollution with oil products are revealed. The effects of hydrocarbons on the development of cryogenic microfabric is an important factor in designing appropriate responces to oil spills and other contamination in soils subjected to freezing.

Keywords: Bolshezemelskaya tundra, oil contaminated soils, microfabric.

Distribution of Rock Glaciers in the Nepal Himalaya

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Abstract: Permafrost in Nepal has received very little scientific attention, despite the fact that Nepal is a country known for the Himalaya. Even the distribution of permafrost in Nepal has not been clarified yet. This study deals with the distribution of rock glaciers and permafrost in five high Himal areas of the Nepal Himalaya: Kangchenjunga, Khumbu, Langtang, Annapurna, and Sisne.

Permafrost is an invisible phenomenon and its presence is difficult to identify. Therefore, an indicator landform of rock glaciers was used for aerial photograph interpretation to identify the present distribution of permafrost in five areas. Field observations were also made in order to check the rock glaciers in three areas of Kangchenjunga, Khumbu, and Langtang. First, rock glaciers of periglacial-origin and those of glacial-origin were mapped; and then size, altitude, and aspect of each periglacial-origin rock glaciers were analyzed by GIS. The results show that: (1) High amount of precipitation in eastern Nepal leads to the development of glacier-origin rock glaciers; (2) the size of the rock glaciers tends to decrease from the east (Kangchenjunga) to the west (Sisne); (3) the mean altitude of rock glaciers decreases towards the west; and (4) the aspects of the rock glaciers are variable, but southerly directions are most common.

The rock glacier development is strongly related to the debris supply, such as rockfall. Rockfall activities and exposed bedrock thermal regime were monitored and evaluated at altitudes between 4,600 m and 6,000 m in Kangchenjunga Himal. Effective freeze-thaw cycles were first calculated from measured rockwall temperatures at different altitudes, and then, the exposed rockwall area was analyzed by GIS. The results show that: (1) the south-facing rockwalls experience frequent diurnal freeze-thaw cycles, while the north-facing rockwalls are characterized by seasonal freeze-thaw cycles; (2) the south-facing rockwalls have greater number and amount of rockfall than the north-facing rockwalls; and (3) the altitudinal belt responsible for the rockfall activities ranges from 5,400 m to 6,000 m on the south-facing rockwalls, and from 5,000 m to 5,600 m on the north-facing rockwalls.

Finally, factors responsible for deciding the size, altitude, and aspect of the rock glaciers in the Nepal Himalaya were discussed focusing mainly on the debris supply regimes from adjacent rockwalls. Summer precipitation water experiences freezing and thawing to expand cracks of the rockwall surface, so that more rockfall debris is produced; therefore, the concurrence of the effective freeze-thaw cycles and the large exposed rockwall area, especially of southerly directions, is considered as the major controlling factor for the development of the permafrost including rock glaciers.

Key words: rock glacier, permafrost, Nepal Himalaya, rockfall, freeze-thaw cycles

Relict Gas Hydrate as Possible Form of Shallow Intrapermafrost Gas Existence

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Abstract: Investigation of gas releases from frozen sediments, carried out for different regions of the North of Siberia, particularly of Yamal and Tar peninsulas, let talk about high gas saturation of some horizons of permafrost within depth of 40-130 meters (Chuvilin et al.1998, Yakushev, Chuvilin, 2000). Accumulations of intrapermafrost gas at shallow depth are mainly presented by methane of biogenic genesis with small contents of the other gases (carbon dioxide, nitrogen, rarer others).

Detailed analysis of gas releases from these horizons allows suggest that evidently a part of these accumulations are in relict gas hydrate state. It is pointed at several indirect evidences of presence of gas hydrates in the frozen sediments above hydrate stability zone, as well as available data of anomalous behavior of gas hydrates at negative temperatures.

The opportunity of existence of gas hydrate accumulation on shallow depth represents special interest as they are at non-equilibrium conditions and can be serious geological hazard at development of these areas, and also at global warming a climate due to emission of greenhouse gases.

For research of existence conditions of relict gas hydrate formations in frozen sediments it is important to carry out experimental investigation.

For experimental study of gas hydrate metastability (self-preservation) in frozen sediments at negative temperature we used core samples taken from horizons of gas releases as well as model sediment samples. These samples were placed in special pressure chamber, where they were artificially saturated with methane hydrate and were cooled to negative temperatures close to natural. Then non-equilibrium conditions in frozen artificially gas hydrate saturated samples were set up by means of pressure release below equilibrium and kinetics of dissociation of porous methane hydrate was studied at negative temperatures.

On the base of study of hydrate dissociation in time quantitative parameters of self-preservation effect of gas hydrates in frozen samples at non-equilibrium conditions were obtained. It was experimentally received that the increase of ice content of frozen hydrate containing samples reduces dissociation intensity of porous hydrate and favours its self-preservation. The increase of content of fine clay part of samples causes the increase of decomposition intensity of gas hydrate formations and the decrease of its self-preservation coefficient.

Generally experimental investigation of self-preservation effect of gas hydrate in frozen sediments at non-equilibrium conditions make possible to substantiate relict gas hydrate form existence within permafrost.

These investigations were supported by grants INTAS Nr03-51-4259 and RFBR Nr04-05-64757.

Key words: Intrapermafrost gas, methane, gas hydrate, frozen sediment, hydrate dissociation, self-preservation effect

Methods of Theoretical and Experimental Definition of Phase Equilibrium Parameters for Saline Soils and Cryopegs

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Abstract: The problem of the determination of the thermodynamic characteristics for frozen salted soils are called attention.

From many experimental methods using for getting the phase balance parameters the cryoscopic method as one of most informative was chosen. The thermogramms handling was permitted to find freezing points of soils.

Computation were carried out by means of the program «FREZCHEM2». The point calculation reliability of the program was improved by applying the Gibbs energy minimization approach to computing equilibrium in CRREL laboratory, used for calculation of phase diagrams, of freezing point temperature and other parameters of phase equilibrium for solutions with any composition and concentration, and especially for high concentrated solutions in frozen soils – cryopegs. But it is applicable only for free solutions in volume.

There are submitted data of calculating and experimental results in this report. The findings of modeling on «FREZCHEM2» were used for construction of phase graphs and determination of freezing point temperatures. The experimental operation was made for kaolin clay and quartz rock samples containing following ions of soluble salts: NaCl, KCl, $CaCl_2$, $MgSO_4$ in different percentage. The results were compared to each other and the satisfactorily convergence has been achieved.

Estimation of phase balance parameters for cryopegs is very hard according to their high mineralization and chemical reactions. The program «FREZCHEM2» allowed to get computational data and to create dot chart. It's using enables to appreciate the freezing point temperature for cryopeg and the temperature of cryopeg's formation by finding the starting point of the sulfate precipitation.

Key words: cryoscopic method, phase equilibrium parameters, cryopegs.

Influence of Petroleum Pollution on Seasonal Thawing and Freezing Depth of Soils

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Abstract: The oil recovery, its storage and transportation is inevitably accompanied by hydrocarbon environmental contamination. Passages of petroleum annually make millions tons. The environmental problem arising at it has global character. This problem completely concerns to a zone of distribution of frozen and freezing grounds. According to "Hydrospecgeology", in Western Siberia in places of an oil recovery thickness of petroleum layer exceeds some cm. The temperature mode and depth of seasonal thawing (freezing) of soils depend on many factors, including from their structure, humidity, thermal properties, albedo of surfaces, influences of a

vegetative and snow cover etc. Occurrence of petroleum on surfaces of soils changes the albedo of surfaces and has oppressing an effect on a vegetative cover. Oil penetration into grounds affects their thermal characteristics. It is necessary to note, that thermal characteristics of oil contaminated soils change in time that is connected to change of structure and properties of the petroleum. After its transformation contents of more dense and low-heating fractions in oil increases that result in decrease heat conductivity on 30-40 %.

Therefore the purpose of the given research was to estimate influence of petroleum pollution on depth of seasonal thawing (freezing) and mid-annual temperature of soils in view of change of albedo of surfaces and their thermal properties caused by such pollution.

As objects of research the area of city of Urengoj and area of city Tarco-Sale were chosen. At a choice of studying platforms that fact was taken into account, that both areas concern to Jamalo-Nenetskiy autonomous region on which share it is necessary over 10 % of stocks of the Russian petroleum and 12 % of volume of its extraction. Also through this area passes a main oil pipeline.

The estimation was carried out on the basis of calculations under the program "Heat", developed under the direction of the professor L.N. Hrustalevs. The task for one-dimensional model was solved. The size of settlement area was set equal 30 m. Calculation was made for two types of a ground: loam and sand at the big values of their water-saturation and pollution.

The data on change albedo and temperatures of a blacked surfaces, received earlier E.D. Ershov, and thermal characteristics of soils, polluted and unpolluted with petroleum, received earlier R.G. Motenko and etc., were used in calculations.

Calculations have shown that for both objects depth of seasonal thawing at rise in temperature of a surface of soils on 2˚C in summer months due to decrease albedo will increase on 16-18 %. At rise in temperature of a surface of soils on 4˚C in area of Urengoj depths of seasonal thawing will make 40 %. And in area of Tarco-Sale the mid-annual temperature of grounds becomes positive, that will cause development from a surface of a layer of thawed soils. Accompanying removal of a vegetative cover causes development from a surface of a layer of thawed soils in the both regions too. Influence of change thermal properties of frozen soils at their pollution by petroleum (for example, thermal conductivity) has an effect to a lesser degree and is directed aside reduction of depth of seasonal thawing.

Key words: Seasonal thawing depth, mid-annual temperature, oil contamination, thermal properties, albedo

Behavior of Oil Contamination in a Low-positive and Negative Temperature Diapason

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Abstract: the modelling and forecast of oil contamination transfer in cryolithozone soils is a very important and difficult problem. The main part of oil volume in contaminated soils is presented by non-aqueous phase liquids, that are characterized by different from water

properties, and is able to move both with water flow and by itself. in this system water as a polar liquid appears to be a wetting phase. Being combined with mineral particles, water possesses lower mobility than oil. The oil-contamination distribution in cryolithozone soils has its peculiarities. They are concerned with the climatic conditions and cryogenic factors, i.e. permafrost and seasonal freezing of the upper soil horizons. In cryolithozone soils, oil contaminations are under conditions of low-positive and negative temperature diapason – that means close to or lower than hardening temperature of the majority of oils. at present properties of oil in these conditions are scantily investigated.

This study takes up the aspects of oil behavior in a low-positive and negative temperature diapason and physicochemical interactions of the components of freezing and frozen soils.

An investigation of oil viscosity in low-positive and negative temperature diapason (from +20 to -15°c) has been carried out. oils with different compositions and properties (hardening temperature from +5 to –27°c) were used. Tests were made on apparatus of rotary model with measuring instrument of "cylinder-cylinder" type. The lowering of temperature was gradual. During the test the values of transverse strain (τ, pa) and dynamical viscosity of oil (η, mpa*s) were obtained. The dependence of structural strength of oil on its hardening temperature was observed.

The study of migration and cryogenic transformation of oil pollution in permafrost and seasonal freezing and thawing soils has been carried out.

Permafrost is permeable to oil pollution. Sufficiently high accumulations of oil hydrocarbons, and their long-term intact there are possible in permafrost soils. Oil redistribution in freezing soils (mainly cryogenic expulsion), and migration of oil components into frozen soils are accompanied by cryogenic transformation of oil – that means isolation from its bulk the most active fractions and components. This process is determined by temperature conditions, oil consistence, composition of oil components, composition and structure of soils. Naphthenes - saturated hydrocarbons which do not reveal associative properties with temperature lowering - are most likely to have the greatest mobility within this system.

Key words: Permafrost, frozen soils, oil contamination, migration, cryogenic transformation

The kind and distribution periglacial features and alpine permafrost in eastern tibet and mongolia

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Abstract: Comprehensive studies concerning the distribution of periglacial features and alpine permafrost for Central and High Asia are still rare. In the humid Eastern Tibet two sub belts of periglacial phenomena can distinguished: the lower limit of bound solifluction (occurs roughly above the timberline) and the zone of unbound solifluction, dominated by blockfields, patterned ground, and bare bedrock. The upper limit of the periglacial belt results from steep high mountain topography or from the extent of perennial snow and ice in the higher altitudes (glacial belt). Alpine permafrost is present in all these mountains, but is very small in the humid

zone of mountain ranges on the eastern margin of the Tibetan Plateau due to the lower elevation of the snowline (equilibrium line of glaciers = ELA). In contrast, in the more continental regions of Mongolia this zone is much broader due to the high elevation of the ELA. In these mountains periglacial features and permafrost are also widespread within the forest zone. Periglacial phenomena are generally controlled by cold climatic conditions, where the mean annual air temperature (MAAT) as well as the duration and depth of snow cover are low. The distribution of discontinuous permafrost is generally associated with an MAAT of about -2°C. On the other hand, the upper timber line is related to the mean air temperature of 10°C in July. Modern climatic condition of different lower limits of periglacial phenomena can help to reconstruct the palaeoclimate environments.

Key words: periglacial phenomena, permafrost, Tibet, Mongolia, paleaoclimate

CH_4 emission from a Siberian Alas ecosystem near Yakutsk, Russia

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Abstract: Alas is a circular grassland area with a pond at the center, formed by subsidence associated with permafrost thawing in taiga forests in the eastern Siberia. The pond area reaches its maximum in spring owing to the inflow of snowmelt water from the surrounding grassland and forest. However, the amount of evapotranspiration exceeds the amount of precipitation during the summer, leading to reduced water levels in the pond and a decrease in pond area.

Temporal measurements of methane (CH_4) emission were carried out in the Alas ecosystem near Yakutsk, Russia (62°N, 129°E) from June to September 2004. A transect line was set up from the forest to the pond through the grassland. Six sampling sites were set up for various vegetation type along the transect: Larch forest (F), dry grassland (DG-1 and DG-2), wet grassland (WG-1 and WG-2: the temporarily flooded grassland) and pond surface (P: continuous flooded). CH_4 fluxes were measured by a closed chamber method, for two treatments (with and without plants) in each site except for forest and pond site (F and P were only measured without plant).

CH_4 (cumulative value, Unit: kg C ha^{-1}) uptake constantly occurred in the forest (-0.13). Both CH_4 uptake and emission occurred in individual measurements, however, cumulative flux was the low uptake (-0.1 to -0.04) in dry grassland. CH_4 emission from the water surface of the pond (238) showed a maximum value in the beginning of July, and then decreased gradually. In wet grassland (17 to 174), high CH_4 emissions were found during the flooding period. After flooded water disappeared, CH_4 emission decreased immediately. A positive relationship between flooding period and total CH_4 emission were found in wet area (temporal or consistently flooding zone). Our results showed that the vegetation zone around the pond was the important sources of CH_4. These results also indicated that the soil moisture condition,

especially water flooding, could be an important factor for controlling CH_4 emission in the Alas ecosystem.

Key words: CH_4, closed chamber method, alas, scaling up.

Carbon and nitrogen accumulation by invertebrate biomass in permafrost soil of Enisey region

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Abstract: Permafrost determine the peculiarity of the processes of accumulation and transformation of substance and energy in the north ecosystems. The questions of secondary productivity and participation of soil animals in these processes are of particular significance for understanding peculiarity of biogeochemical cycle in forests of permafrost region.

The aim of our investigation is to estimate soil invertebrates biomass and accumulating carbon and nitrogen in permafrost soil of forest ecosystems of Enisey region.

Our researches have been carried out in forest-tundra rare stands formed on typical cryozems (Chantaika river region), in northern taiga larch stands on ochre podburs (Nignaya Tunguska river region) and south taiga forests on sandy podzols (Kass flat).

The biomass of large invertebrates in cryozems of larch and spruce stands of forest-tundra is 1690 and 587-1280 t/ha x 10^{-2}, respectively, in of larch stands of northern taiga is 60-1240, in podsol soils of pine stands of south taiga is 50-80. The minimum of biodiversity is characteristic of south taiga subzone podsol and it correlates with the minimum of biomass value in this habitat.

The concentrations of carbon, nitrogen in absolutely dry biomass of individual taxonomic groups make up 27-60 % C, 5-11 % N. Soil invertebrate biomass of forest-tundra cryozems makes up 5.9-17.0 kg/ha, north taiga podburs – 0.1-20.4, south taiga podzols makes up 0.3-0.8 kg/ha.

On base of obtained data the estimation of balk share of large invertebrates in biogenic element accumulation depending on climatic and soil condition has been carried out. The minimum of C (0.2 kg/ha), N (0.05 kg/ha) are accumulated by invertebrate biomass of sandy podzols in south taiga. In typical cryozems of forest-tundra and podburs of north taiga are accumulated accordingly 6.0 and 2.2 kg C/ha, 1.2 and 0.4 N and 0.8 and 0.4 kg P/ha.

Podsol soils distinct by extreme low water keeping capacity and low concentration of light available organic matter. Solar radiation and periodic drying of duff and upper soil layers limit both fauna biomass and biogenic element accumulations. The short vegetation period (69-89 days) and closed to surface permafrost (20-50 cm) are main limit factors in forest-tundra and northern taiga zones. However, the quality consistent of plant residues, accumulation of organic matter being at the different stages of decomposition and favorable combination of heat and moisture regimes during no frost period result in sufficiently high level of invertebrates biomass and carbon (0,04-0,85 t/ha x 10^{-2}) and nitrogen accumulation (0,01-0,15 t/ha x 10^{-2}).

Despite of the fact that available data on carbon and nitrogen accumulation values of pedobionts much less then overall organic matter load in forest permafrost soils (0,001-0,02 % of carbon and 0,005-0,06 % of nitrogen from overall stocks in the soils of Yenisey region), it reflects the increasing of role of invertebrates in accumulation of main biogenic element under soil-climatic condition improvement.

Key words: Permafrost soils, invertebrate biomass, accumulation, carbon, nitrogen

Contribution of Thermo-mechanical Ratchetting to the Formation of Periglacial Environments

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Abstract: It is widely recognised that when lake-ice or sea-ice becomes grounded any increase in temperature is in certain circumstances capable of developing massive compressive forces. These forces constitute major threats to any man made structure which might restrain the free expansion of the ice. And of course where the restraints are sufficiently massive the ice sheet itself can undergo many forms of crushing, folding and uplift buckling, associated with compression induced failures. If during this warming cycle the compression failures have absorbed much of the thermally induced strain energy within the ice sheet, any subsequent cooling will fairly quickly result in tensile stresses being developed. With the ice being relatively weak in tension these stresses will at an early stage start to induce tension cracking. Water and snow getting into these cracks will be turned to ice so that by the end of the cooling period a relatively continuous ice sheet, containing low levels of tensile strain energy, will present itself for the next cycle of thermal warming and compressive action. For sea-ice and lake-ice the result of this, essentially thermal ratchet, process will be a gradual outward movement of ice that accumulates at the grounded boundaries. There is evidence that similar processes are at work in the formation of many geomorphic features in periglacial environments.

This paper will explore how thermo-mechanical ratchetting could be influencing the formation of many seasonal features within the active layers and perennial features extending well into the permafrost layers. While fluctuations in solar energy provide the driving force for these ratchet processes they will be shown to be made possible by one or other form of differential property of materials during the tension and compression phase. The gradual outward movement of relatively dense particles, such as stones and rocks, within or above relatively compliant soil materials to form sorted and unsorted stone circles, polygons etc will be reasoned to partly result from differences in visco-plastic creep characteristics when warm soil and ice is subject to compression compared with that occurring when cold soil and ice is subject to tension. The gradual upward deformation of frozen and unfrozen soil to form perennial hummocks, frost mounds, palsas and pingos, etc, will be argued to also be partially the result of similarly temperature sensitive creep within the material. But additionally in these cases a major causal factor is suggested to be the differences in the nature of the failure

mechanisms during the compression and tension cycles. In a similar and perhaps even more explicit form, a thermo-mechanical ratchet process will be suggested to provide a major input into the formation of ice wedges, ice polygons etc. The paper will attempt to provide an alternative classification framework for these and other periglacial features in accordance with the nature of the thermo-mechanical process involved in their formation.

Key words: Contribution, thermo-mechanical ratchetting, periglacial environments

Impact of Degrading Permafrost on Impounded Tailings at Mount Nansen, Yukon Territory, Canada

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Abstract: Mining in the Canadian North has often taken advantage of the presence of permafrost to manage reactive mine wastes such as potentially acid-generating tailings and waste rock. However, the wisdom of such practice is recently in doubt due to concerns about climatic warming, which may result in permafrost degradation. To elucidate the potential impacts of climatic warming on tailings management in mountainous terrains with discontinuous permafrost, the stability of impounded tailings at the abandoned Mount Nansen mine in the Yukon Territory is reviewed.

The Mount Nansen gold mine is located in the Dawson Range at an elevation of about 1300 m. Discontinuous permafrost ranging from 30 to 60 m thick occurs in the area at a depth varying from 0.4 to 5.0 m. The mine operated for 15 months in 1997-1999, extracting gold from oxidized ores associated with arsenic mineralization by cyanidation. The operation generated 250,000 tonnes of As- and CN-bearing tailings impounded in a valley at 1150 m elevation behind a compacted earth dam keyed into the underlying frozen ground. Improper initial tailings placement led to partial thawing of permafrost beneath the dam, casting doubt on its physical stability. Systematic coring in the tailings impoundment in 2001 showed that whereas permafrost still persisted at the bottom of the impoundment, the depth to permafrost increased from north to south and from west to east in the direction of the tailings dam. Permafrost thawing was particularly evident in the vicinity of the seepage pipe located upstream of the tailings dam near its centre.

The results of detailed physical and chemical characterization of the ponded water in the impoundment, of the tailings solids and porewater as well as seepage down-gradient of the containment dam suggest that the prevalent cold temperature and strong sorption with the fine tailings particles have slowed down the natural degradation of CN-containing species and the efflux of potentially detrimental trace elements. Column testing and sequential batch leach testing of sampled tailings indicate that, under thawed conditions, significant releases of As, Sb, thiocyanate and ammonia may occur with continual flushing. Partial sequential extraction analyses also suggest that As and Zn are susceptible to remobilization under mildly acidic or reducing conditions.

Given the risks of potential deterioration in the integrity of containment structures and enhanced metal leaching associated with permafrost thawing, great caution must be taken in devising mine waste management schemes that rely heavily on the persistence of frozen ground. The possibility of a warming climate leading to permafrost degradation must be duly considered in developing a proper strategy for a particular site, especially those located in terrains with discontinuous or scattered permafrost.

Key Words： Thawing permafrost, tailings stability, metal leaching, mine waste management

Cryosphere and permafrost change resulting in slope instability in Hindu Kush and Western Himalaya

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Abstract: Manifold climate changes in Quaternary time are well known to have influenced landform stability. In the Hindu Kush and western Himalaya GLIMS researchers are identifying past and present-day examples of slope instabilities resulting from combinations of monsoon fluctuation and ancient and modern permafrost degradation in bedrock and regolith-covered slopes, as well as downwasting glaciers that debuttress valley walls, and increased melt-water breakout floods that undercut valley walls. Increased global warming may be causing monsoon fluctuations and multiple instabilities in cryospheric/permafrost systems in high mountain regions that will result in many more natural hazards for residents and adventure tourists to deal with, while at the same time providing opportunities to study such dangerous phenomena. In the Afghanistan Hindu Kush, because of ongoing political uncertainties significant fieldwork is limited. Landsat and ASTER imagery, however, coupled with older topographic maps from Soviet and Anerican government sources, plus prior field assessments, enable GLIMS researchers to pinpoint cryospheric changes that are indicative of the overall condition of ice resources that control downstream water resources in a chronically arid area. In the Pakistani Karakoram Himalaya we are especially interested in cryospheric controls of slope stability and instability, as well as in measurable fluctuations of debris-covered glacial ice that we can detect in satellite imagery, coupled with field assessments. In summer 2005 in the Shigar, Braldu, and Baltoro valleys we investigated four major mass-movement complexes (Ghoro Choh rock avalanche complex, Busper sackung, Gomboro slope failure complex, Urdokas rockslide complex) that are associated with canyon-wall debuttressing, undercutting, and permafrost degradation resulting in reduced rock strength. The 3-4 km of relief, coupled with steep slopes, and high to intermediate magnitude and frequency snow and rain storms provide considerable potential, gravitational, kinetic, and thermal energy sources that drive the varied mass-movement processes. The products of such mass movement are ubiquitous, including failure of massive crystalline rock (gneisses, metasediments, granites) to depths of hundreds of m, piling up considerable mass on valley floors and sidewalls, causing

inundations and catastrophic breakout floods, as well as forming the extensive supraglacial debris covers so characteristic of the region. Quantitative evaluations of change detection are key to assessing the spatial and temporal dimensions of landform evolution of the region, as well as deriving necessary predictive and protective development measures for these regions.
Keywords: cryosphere change, permafrost degradation, landslides, Afghanistan, Pakistan,

About Some Features of Organic Profiles Formation in Soils of Tundra-taiga Ecosystems of the West Siberia North

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Abstract: Organic matter transformation processes, which are formed in cryogenic conditions, were studied in Long-Ugan river basin (north of Western Siberia, N65° E72°). Variants of organic matter transformation are very diverse there. Different groups of ecosystems are formed according to soilforming factors combination, where the most important is the level (depth) of perennial frozen stratum deposition. Some of them reflect modern tendencies very well and adequate to existing bioclimatic conditions. Above all these are forest ecosystems with well developed podzols in conditions of paleocryogenesis. Thin forest litter with low differentiated profile is formed there. It consists of lichen remains and tree fall. The fast ejection of decomposition products is characteristic property of organic matter transformation in such conditions.

Swamp ecosystems are another group, which is the opposite side of drainage classes. They are situated on swamp floodplain and lacustrain-alluvial plains. Vegetation remains transformation in conditions of poor drainage and tendency to intensive peatformation are common features for these ecosystems. The upper part of organic profile reflects modern ecological conditions and type of organic matter accumulation.

These two groups are opposite sides of drainage classes. Permafrost is situated on depth more than 1m or defaults. There are series of ecosystems between them, which differ in organic matter transformation trend. It involves, on the one hand, modern tendency of bog ecosystem transformation according to its topography and, on the other hand, various cryogenic processes presentations. Permafrost is on the depth of 0,5-1 meter. Swell processes causes considerable variety of region elevation over modern level of swamp ecosystems. There are large-scale-hilly and plain-hilly peatbogs, and cryohills in flood-plains and lacustrain-alluvial plains. The special rule is for degraded peatbogs. Ridges, specific surface free of vegetation and small depth of permafrost are the characteristic features for it. Degraded peatbogs could be as high (absolute altitudes over lacustrain-alluvial plains) as large cryohills.

Within the problem of organic matter transformation one of the most important thing is the high oligotrophic characteristics of all investigated ecosystems. Low value of ash level, low base saturation, high acidity and natural waters poorness verifies it.

Total carbon and nitrogen ratio is one of the most important integrated criterions of

transformation degree, relative soil resources and even organic matter origin. As our investigation shows, nitrogen content varies to high extent in studied samples– from one hundredth to 1-2 %. The reasons of it are not only modern bioclimatic conditions, main peat formators (vegetation types peat consists of) and peat decaying degree but also peat stratum origin. Low nitrogen values correlate with mosses (Sphagnum sp.) or lichen coverage. According to this parameter upper horizons, consists of modern vegetation, differs from lower peat stratum. Increasing or maximum and minimum alternations of nitrogen values are typical for organic profile. It depends on different types of vegetation remains. We note that extreme values and maximum varying of studied parameters are typical for central part of the soil profile (25cm depth). It is the center of organic matter transformation. It could be indirectly checked out by temperature data (maximum freezing-melting frequency is situated on the same depth). It's significant that various peatbogs and swamp ecosystems make one group by total nitrogen (<=0,5–1%) and carbon (45–50%).

Degraded peatbogs are absolutely specific group with high values of nitrogen (>2%), low values of carbon (35-40%) and low carbon-nitrogen ratio (15-20). It's the evidence of organic matter decaying high degree (close to values in humic horizons). Also it could mark that there is the other set of peat formators in degraded peatbogs in comparison with other ecosystems.

According to this degraded peatbogs should be examined as independent phenomenon. They appeared evidently in Holocene climatic optimum, when the other type of vegetation (with higher degree of ash content) existed. At the present time the degradation process take place. It's accompanied by involving again organic material in the process of peat forming. It causes increasing total ash level of bog ecosystems. Thus, degraded peatbogs are relic phenomenon, which carry information about territory development in the past.

Thus complicated and various complex of ecosystems origins in the north of western Siberia. Ecosystems differ not only in time of entrance into automorphic development phase influenced by cryogenesis. Cryogenic processes are one of the most important one. They cause both ecosystem geomorphologic variety, and rate and organic matter transformation trend. We can see simultaneous development of different soil types (oligotrophic swamp soils, peat cryosols, peat gleic soils, peat mucky gleic soils, peat podzolic gleic soils, humus-ferric illuvial podzols in forest ecosystems (Russia, 1977); Sphagnic Cryofibrists, Pergelic Cryorthents, Histic Pergelic Cryaquepts, Humic Pergelic Cryaquepts, Oxyaquic Haplorthods, Typic Haplocryods (USA, 1994).

Key words: Soil, organic matter, permafrost, cryopedology

An Influence of Salinity on the Kinetics of Frozen Ground Destruction

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Abstract: An experimental and theoretical research of long strength of frozen ground proves thermal fluctuations physical nature of their destruction process. So it deals with energy of heat fluctuations of atoms. External load only adds the load to atomic bonds resulting in increasing

of quantity of neglected interactions with time. Such point of view explains appearing of flow properties of frozen ground, reduction of strength with time in particular.

After study of this process from the position of kinetic theory of solid strength (this theory was developed by academician S.A. Jurkov) and taking into account the influence many-components character of frozen ground and changes of phase Roman L.T. found the equation of long strength of frozen ground in 2002 year: $\sigma_t = \sigma_0 / (t/t_0)^{\beta_\theta}$ (where: σ_t - long-time strength of frozen soil in moment of time t; t_0 – kinetic parameter oscillation period of atoms, it is equal 10^{-13} sec; σ_0 – experimental parameter, independents of the soil temperature; β_θ. - parameter depends on ground temperature) The given equation takes possibility to predict .the long- strength using experimental data on the period exploitation of buildings

Further researches resulted in statement that the influence on the decreasing of strength of frozen salt grounds is analogical to the influence of increasing of temperature. It allows to recive the family of dependences of strength from the time in wide range of salinity of grounds that were tested for constant temperature. It give possibility to determine experimental parameters of predicted equation of long strength, that time the parameter β is depending only from salinity and of it symbol is β_{sal} Results of given researches presented in this report. The method of determination of activation energy of destruction process is developed, also method is given for determination of coefficient that characterize concentration of tension in soil components which are destructed under load.

Findings confirm supposition that lose of strength of frozen ground results from destruction of hydrogenous connections either in the ice or on the contact of ice with pore solution of soil. In the report is showed the relation between processes of the disintegration and warping. Both processes are based on the break of elementary bonding. In contrast to warping break of elementary bonding is irreversible in process of disintegration. The numbers of broken bonds are constantly increased. During of destruction appear and grow defects. Elementary acts of warping are dislocation of defects which transfer to the stage of broken bonds. The data of experimental determination of creep's velocity suggest the existence of functional dependence between durability of frozen salt ground and tension and salinity.

The work was supported by the Russian Foundation for Basic Research, grant 05 – 05 – 64310

Key words: frozen salt ground, strength of frozen ground

Structure of Organic Matter in Permafrost Soils of Forest Ecosystems in Central Siberia

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Abstract: The first step to estimate biological cycling of chemical elements is assessment of storage and structure of organic matter in soil.

The soil organic matter is a complex multicomponent system, parts of which are different in terms of genesis and structure. It causes their different resistance to the microbial decomposition. Generally, the soil organic matter is united in two fractions: light-mineralized organic matter and stable organic matter [Jenkinson and Rainer, 1977; Sauerbeck, 1978]. Stable organic matter consists of humified substances that are closely connected with mineral soil particles. It has a significant resistance to the mineralization and therefore has very long turnover time (from hundreds to thousands years) [Dushofur, 1998]. Forest litter, dead root material, microbial biomass, zoomass and soluble part of humus are the main components of light-mineralized organic matter in forest ecosystems. It is the main source of the mineralized carbon flow into the atmosphere and for the synthesis of new humus. Only this fraction, but not resistant humus of soil, determines the response of soil to any changes of the ecological conditions

Our research was carried out in forest ecosystems of forest-tundra zone in Central Siberia. Stock and composition of soil organic matter was studied on 17 sample areas. Tree stands on these plots are presented by larch, spruce and birch.

Soils in forest-tundra zone are developing under the direct and indirect influence of permafrost. Depth of thawing out during the warm period makes up 20-60cm in dependence on their position in relief.

Total carbon stock in soil of forest ecosystems in forest-tundra zone ranges from 31 to 125 $tC*ha^{-1}$. Plant residues at different stage of decomposition present about 13-80% of this stock.

These plant residues are distributed in two pools – on the soil surface as forest litter layer, and in mineral soil profile as stock of dead root material. Plant residues stock in soil profile is in 1.2-8.0 times less than on the soil surface. Total stock of live roots in soil system makes up from 0.12 to 65.2 $t*ha^{-1}$.

Light-mineralized organic matter makes up in average 57% of total carbon stock in soil. It is in two times greater than in soil system under the forests of southern taiga of Central Siberia [Mukhortova,2001], where only seasonal freezing of soils take place. Mobile organic matter in soil system ranges from 14 to 41% of total carbon stock, while in southern taiga it does not exceed 22%. Stable humus contribute in average only 43% of total organic carbon stock in the soil of forest-tundra zone and from 63 to 76% in forest ecosystems of southern taiga.

In the northern taiga, where permafrost take place during whole year distribution of carbon storage between main soil organic matter pools is like that one in forest-tundra: 72% of carbon is in the light-mineralized organic matter, 17-25% - in mobile organic compounds and 25% - in stable soil humus [Vedrova et al.,2002]. Larger amount of light-mineralized organic matter in northern taiga forests is due to higher density of tree stands in this region in comparison with forest-tundra zone.

Thus, total carbon stock in soil of forest ecosystems of forest-tundra is almost similar to this one in soil of northern taiga and southern taiga (in average 66.5, 62.0 and 72.4 $tC*ha^{-1}$, accordingly). The main differences are observed in structure of soil organic matter pool. The share of soil humus in total carbon stock decreases from south to north. Contribution of light-mineralized organic matter in the total carbon stock increases more than two times in this direction.

Key words: Forest ecosystems, forest-tundra, soil organic matter, carbon stock

Past and present salinization in natural ecosystems in Central Yakutia , Eastern Siberia

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Abstract: Recent evidence suggests that the drastic climatic changes that occurred during the early Holocene, mainly snowfall, caused due to its insulating effect, degradation of the permafrost. Snow depth increase is the major phenomenon that can thus explain the level of organization of alas (thermokarst depressions) distribution in Central Yakutia. However, the water released by ice wedges thawing that contributed to the development of ponds, tree toppling and consequent formation of alases is not the factor controlling their existence at present but rather the high levels of salinity found in the soil. In the past, salt originally trapped in the permafrost that lied below the active layer where larch forest grows was released during thermokarst formation.

At present, salinization can occur through two main mechanisms: 1. climatic warming which in this region is not translated in higher summer temperatures or rainfall increase but rather higher temperatures and higher snowfall in winter and 2. human-caused disturbances (fire and clear-cutting) that in its initial state accelerate the process of thermal disruption. In this study, we focus on the second mechanism. Sixteen sites (intact forest (4), burnt site (3), clear-cut (6) and thermokarst depression (3)) were surveyed and their chemical characteristics were analyzed. Increases in ions content in the active layer of the burnt and clear-cut sites was found but not to the extent that will limit revegetation of trees. These results suggest that soil thawing because of these disturbances have not deepened enough to set in motion the process of thermokarst depression, despite the fact of early accumulation of water. Slight salinization increase observed in this study is the result of salt trapped in the upper permafrost (EC_e, 1.8 mS cm^{-1} at 1.1m depth) below the intact forest, that thawed (approximately 40 to 50 cm) after the above vegetation disappeared. However, soil layers with higher salt concentration found e.g. at 2 meters (EC_e, 4.6 mS cm^{-1}) was not affected because the thawing depths never reached the depth of ice wedges location (approximately, 2m) which otherwise would have accelerated their release. Furthermore, our results allowed us to propose salinity measurements as a useful tool to indicate the extent of the disturbance since the deeper the thawed layer the higher the salt concentration that is released at different locations.

Permafrost creation in Kuparuk oil field Alaska and its effects on gas hydrate formation

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Abstract: Use of methane hydrates or gas hydrates may play a significant role as a part of the world’s energy resources. Significant effort has been spent in research into how the gas hydrates

are formed and where they are located. This paper investigates gas hydrate accumulation in a permafrost area of the Prudhoe Bay-Kuparuk River oil field in Alaska, USA by approaching the gas hydrate formation using a thermal analysis and the methane hydrate stability curves.

Ground thermal regime for the duration of the formation of permafrost in the area was modeled using a finite element method, TEMP/W 2004. Ground thermal properties were estimated using information from well bore data and logs including deposit characteristics such as rock type and water content. Latent heat of fusion was considered using an unfrozen water content function. Assumed values for the past average ground surface temperature was used for several analysis runs. The value that yielded conditions reflecting current thermal gradient and depth of permafrost was used in the final analysis.

The modeled thermal regime as a function of depth and time was then compared with the appropriate methane hydrate phase boundary curve. As a result, depth zones for stable methane hydrates were obtained with time. Further, the formed layer of methane hydrates, and the penetration of the 0°C isotherm and their trapping effects on the free flow of water and gas to the stable zone were considered to explain the logged layers of methane hydrates in the Kuparuk Oil Field. The created model can be used as an example to create similar models in other locations to be used in methane hydrate exploration and field evaluation.

Key words: Permafrost formation, Alaska-North Slope, paleoclimate, methane hydrates

The influence of frozen ground on dynamics in geomorphic processes and sediment rates: case studies from N-Sweden and Svalbard

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Abstract: Dynamics in geomorphic processes and sediment transfer rates are controlled by the existence of frozen ground, among other factors. In this respect, not only permafrost, but also seasonally frozen ground plays an important role.

The geomorphic dynamics in the investigated periglacial mountain landscapes in N-Sweden (Abisko Mountains) and in NW-Svalbard (Liefdefjord) are characterized by a variety of processes. In both areas, the major geomorphic processes and their sediment transfer rates were measured and monitored in several field campaigns. Furthermore, an elaborate data set from intensive field studies since the 1950th is available for the catchment Kärkevagge in the Abisko Mountains.

Based on these data sets a comparative study of sediment transfer rates in relation to the processes is undertaken. The results demonstrate that (1) high magnitude and low frequency processes like big rockfalls or slushflows significantly contribute to total sediment rates and (2) the frozen ground is likely to influence especially the distribution and occurrence of these extreme events.

Key words: geomorphic processes, dynamics, sediment rates, geomorphic events

Temperature Regime of Atmosphere and Upper Rock Layers on High Latitudes on Mars

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Abstract: The study represents analysis of average diurnal, seasonal, annual atmosphere and surface temperatures and their amplitudes.

Global Mars Climate Data Base (GMCDB) founded on the climate modeling and Global Circulation Model (GCM) has been used for evaluation of the temporal and spatial inconstancy of the surface atmosphere and radiation-thermal balance for the high latitude areas of Mars.

The work focused on the summary of sample processed maps dealing with the distribution of main components of the surface radiation-thermal balance and a number of parameters having an influence on it along the meridian and latitudinal strike for the high latitude areas where intensive manifestation of frost cracking processes were marked. These processes include complete radiation-heat flux to the surface and its separate part for IR spectrum; heat flow from the surface and its component for IR spectrum; albedo and emissivity coefficient of the surface; atmosphere pressure and density for the heights from 5 m to 3 km above the surface; in near-surface layers of atmosphere towards the latitude and longitude directions.

An attention was paid to analysis of the temperature conditions on the surface and near-surface atmospheric layers. In particular, next features are characteristic for the dynamics of seasonal surface temperature: temperature comes up to the highest values at the end of summer that leads to the warm autumn. This is changed into the strict ceasing of the average winter temperature with the different distribution of the lowest values on selected areas.

The dynamic of temperature differentiation within the meridian and latitudinal range shows the character of the temperature changes and its relation to the location and the forming time of the temperature mode.

Variability of average diurnal, seasonal, annual atmosphere and surface temperatures and their amplitudes were evaluated. These are characterized by peculiar zoning distribution on Mars.

This work is supported by fund of RFFI (# 04-05-65110).

Key words: Temperature regime, albedo, radiation heat flux, emmisivity, zoning

Thermophisycal characteristics of dispersion soils in a wide range of negative temperatures

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Abstract: In the report the generalization of experimental data on thermophisycal properties of dispersion soils for the range of temperatures from -125 to +100^{o}C is presented. The knowledge of these properties in a wide range of negative temperatures is useful for understanding the

nature of ground properties formation and an estimation of these properties for the temperature mode of Mars, Moon and some other planets.

Frozen grounds are multi-component and multi-phase systems. The main components are rock skeleton, water, ice and pore gas. Theoretical aspects of solid physics, solution and surface thermodynamics were applied for the theoretical analysis of thermophisical characteristics (heat capacity and thermal conductivity) of main components of dispersed soils and water in it at different temperature conditions. Experimental approbation was carried out with the use of adiabatic and differential-scanning calorimeter. Results of theoretical knowledge and experimental data comparison are presented.

Concluded, that temperature dependence of heat capacity of rock skeleton, ice and unfrozen water (pore solutions) of experimental data is in the good correspondence with theoretical one. It is need to take into account components temperature for a high accuracy of calculated heat capacity of rocks. In an interval of temperatures from + 20 up to - 20^0C the heat capacity of a rock skeleton it is possible to consider constant (mistake + 10 %).

The thermal conductivity of a mineral skeleton insignificantly depends on temperature, having the small tendency to its decrease at downturn up to -200 K, and at ice has extreme character - essentially raising from 273 K till 70-80 K and then sharply falling. The thermal conductivity of pore solution decreases with temperature pulldown. The thermal conductivity is a dynamic characteristic as depends on speed and direction of process of freezing-thawing; the structural transformations result in occurrence of a hysteresis at alternation of cycles of heating of cooling.

The effects of heterogeneity of structure, in a potent degree are shown at low temperatures. The distinction in factors of linear expansion of minerals composing a skeleton and crystals in defective structure of ice, results in occurrence of pressure and formation of microcracks, both in ice, and in a rock skeleton.

Key words: Thermal conductivity, heat capacity, hysteresis, multiphase and multiple systems, negative temperatures

Cryoturbation in Permafrost Soils and NortherAgricultural-landscape Ecology under Global Climatic Change

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Abstract: The paper discusses the basic types of cryoturbation in permafrost-affected soils within the North Taiga and Middle Taiga subzones of Yakutia.

Under contemporary rapid climate change, permafrost-affected soils, the active layer and the upper part of an ice-rich substrate, especially that of frozen ground containing thick ice wedges, are subject to exogenous processes. Anomalously extreme cryogenic and hydrothermal processes are accompanied by cryoturbation in soils of the active layer.

Cryoturbations are diverse and include:

1) cryoturbated permafrost soils with polygonal-wedge structures that result in three levels of

disturbance: conflicting, critical and crisis-level ecological conditions in the North Taiga subzone;

2) cryoturbated profile-deformed permafrost soils with modified structures and properties, involutions and irregular horizons. They result from three initial stages of thermokarst and small polygon development in the Middle Taiga subzone (rudimentary ‘bylar’ and subsidence trough, mature ‘bylar’, and ‘eeyo’ stages);

3) shallow cryoturbated profile-destructed permafrost soils where approximately one-half of the upper soil profile (A and B) is fully or partially destructed or thermally eroded on gently sloping areas (2-4o) of the agricultural landscapes over short periods of time (1-3 wet summers or repeated prolonged rain events). They lead to critical and crisis-level ecological conditions at a local level;

4) cryoturbated permafrost soils showing cryogenic destruction of the lower genetic horizons of the soil profile above the permafrost table and disturbances in the middle part of the active layer. They are estimated to be the sources of ecological stress;

5) cryogenic disruptions of the active layer with complete destruction of the soil profile (A, B and BC horizons) and the underlying active layer which are the net result of frost action. Associated with these features is the disastrous ecological condition of agricultural landscapes.

It has been found that under global climate change the permafrost soils are transformed into cryoturbated profile-deformed and cryoturbated profile-destructed soils (cryozems) over a relatively short period of time (7-10 years). These soils occur in the areas of intensive cryogenesis, especially in Central and Subarctic Yakutia. Deep cryoturbation of the active layer and rapid thawing of the ice-rich substrate, especially that containing ice wedges, cause numerous adverse processes and phenomena in hydrothermal, pedological and ecological aspects. The results of investigations on soil cryoturbation will be useful in developing scientific and methodological basis for classification and diagnostics of permafrost soils, in developing indicators (criteria) for state and stability assessment of natural and agricultural landscapes, and in addressing land resource management problems.

Key words: Ice-rich permafrost, cryoturbation, permafrost-affected soils, permafrost-landscape ecology

Mapping and monitoring strategies for detecting air circulation Processes in blocky terrain (Swiss Alps)

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Abstract: The so-called “chimney effect” or “wind-tube effect” is a seasonally reversible mechanism of air circulation which controls for instance the thermal regime of dynamic ice caves. But the process is also known to occur throughout talus slopes and even throughout relict or inactive rock glaciers.

The circulation of air is driven by the contrast in air temperature between the interior of the porous terrain and the surroundings. Indeed, the ventilating flow is ascending when the inside air is warmer – and thus lighter – than the surrounding air. The air stream is descending when the inside air is colder than the outer. As a consequence, the lower part of the ventilated terrain experiences a strong negative thermal anomaly comparing to the mean annual air temperature. The process is thus generating the occurrence of sporadic islands of permafrost at the bottom of talus slopes and in relict rock glaciers located far below the regional lower limit of mountain permafrost. Simultaneously, it may conduct to the absence of permafrost in the upper part of many talus slopes located within the discontinuous permafrost belt in a mountain environment.

The proposed communication will focus on the measurement strategy – especially based on ground surface temperature mapping and monitoring – that has been developed and applied a) to detect the occurrence of the mechanism, b) to map the areas affected by the ventilation process, c) to improve the comprehension of the mechanism and the controlling factors. About thirty sites have been investigated in the Swiss mountains since 1995.

Main contributions obtained by means of mapping and monitoring techniques will be presented, as for instance:

- BTS (bottom temperature of the snow cover) mapping has revealed to be a performing tool – especially on talus slopes and relict rock glaciers, and if performed during or after a period of cold weather – to detect areas with abnormally warm or cold temperatures that may be related to the effect of an efficient ventilation process.
- On a 300 m long inactive rock glacier, an 11-year BTS series has allowed to evidence the occurrence of a probable ventilation mechanism between the frontal part of the landform and its rooting zone.
- Year-round continuous ground surface temperature monitoring along a longitudinal transect has permitted on the one hand to define a typology of typical thermal “signature” for ventilated talus slopes (with 5 main types) and, on another hand, to evidence the spatial dissymmetry that may occurred between the ascending and descending modes of air circulation in talus slopes.
- An electrical resistivity monitoring permitted to evidence, by relating seasonal changes in ground resistivity to variations in temperature, that the air circulation process may induce rapid temperature changes in the deeper layers of a talus slope by cold weather in winter time.

More generally, the importance of repeating measurements in time (monitoring) is underlined in this study about internal air circulation. Indeed, many original results arise from measurements that were repeated occasionally or acquired in an uninterrupted way during several years. Unlike a simple prospection, monitoring has not only given a fixed image of the investigated situation, but also an evolutionary insight, which has allowed a better appreciation of it.

Keywords: air circulation, talus slope, rock glacier, ground surface temperature, BTS mapping, monitoring

Application of ERS InSAR for detecting slope movement in a periglacial mountain environment (western Valais Alps, Switzerland)

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Abstract: Available data on slope movements in mountain periglacial areas is to date only restricted to punctual sites. Regional overviews on landslide and permafrost creep (rock glacier) activity in such areas are often lacking. InSAR (space-borne synthetic aperture radar interferometry) appears to be a potential tool to fill in, at least partially, this gap. In addition to the ESA (European Space Agency) SLAM (Service for Landslide Monitoring) program, the Swiss Federal Office for the Environment (FOEN) intended to test the capability of the ERS (European Remote Sensing Satellites) InSAR technique for detecting and inventorying both location and magnitude of slope instabilities in a mountain periglacial environment, namely the western part of the Swiss Alps. The reliability of the results was evaluated by comparison with existing and newly acquired field data such as rock glacier inventories, GPS measurements, air-borne photogrammetry, etc.

ERS-InSAR is sensitive to changes in surface topography in the satellite radar line of sight, which is inclined at 23° to the east or to the west. InSAR processing generates 2D "displacement" maps for cm to dm range displacements at cm to sub-cm accuracy. For this project, 34 interferograms available between 1995 and 2000 have been computed by Gamma Remote Sensing. Time lapse varies between 1 and 1085 days (only multiples of 35 days +/- 1 day, time necessary for the satellites to be approximately at the same position). Coherent results can be obtained between early summer and mid fall (the snow free period) and, for daily time lapse, also in winter when the snow surface still remains cold. They are moreover restricted to areas located above the tree line or sparsely vegetated. Due to the mountain topography (deep valleys, steep rock walls, etc.), many gaps occur in image covering.

The major obstacle limiting the potential of InSAR is the presence of wet snow (fresh and/or old) which strongly disturbs the radar signal. To prevent any misinterpretation of SAR interferograms, estimating the snow conditions at SAR image dates is necessary in a previous step. A second significant limitation of the ERS-InSAR technique is that north and south slopes are not favourably illuminated by the ERS SAR, what decreases the capacity for detecting slope instabilities in such orientations.

The comparison of InSAR data with "terrestrial" data (air-borne photogrammetry and GPS survey) showed an encouraging and often excellent fitting of the results in both magnitude order and spatial pattern of slope motion. The combined use of interferograms with various time lags (1 day, 1-2 months, 1-3 years) appeared to be a useful step for obtaining a complete overview of potential slope instabilities in a given area of interest. This systematic method permitted moreover to identify not only the location and spatial extent of instable zones but also the magnitude order of the 3D displacement velocities. It was also possible to define typical ERS-InSAR signature depending on the activity and/or type of different geomorphic landform. Indeed, more than 600 polygons were identified as ERS-InSAR-dectected slope instabilities

within the tested area. The inventory was not an exhaustive list of all the slope instabilities in the area, but an inventory of all areas showing any kind of signal on ERS-SAR interferograms, that can be interpreted as a possible slope movement.

The resulting inventory of ERS-InSAR-detected instabilities can be seen as a preliminary tool compiled at regional scale which can be useful for further investigations to be carried out (if required) at local scale. It appears to be an attractive perspective both for early natural hazard management and process understanding of slope movement in permafrost areas.

Keywords: SAR interferometry, permafrost, slope instabilities, rock glacier

Active Lag Block Streams in the Chinese Tian Shan

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Abstract: Active lag block streams are forming today in the mountains of the Chinese Tian Shan above treeline near cold-based glaciers. Mean annual air temperatures are below –5.4°C while the mean annual precipitation exceeds 420mm. This paper describes the three main types of situation in which they occur (drainage from a hanging valley, gullies on a steeply sloping valley wall, and in front of an end moraine), together with their characteristics. Conditions favoring their formation include continuous permafrost, sediments with abundant large blocks, incipient sorted patterned ground, a discontinuous vegetation cover, steep slopes, high precipitation and a fairly thick winter snow cover. Once started, washing out of the finer interstitial material leaving behind the blocks will occur with every spring snow melt and heavy precipitation event. These results are important since they appear to provide the first description of active lag block streams being formed. Lag block streams are rather common in many parts of the world, but their conditions of formation have been the subject of considerable debate in the absence of any known modern analogues.

Key words: Active lag block streams, Tian Shan, continuous permafrost, sorted patterned ground, end moraines, permafrost hydrology.

Exposed glacial and debris-covered ice in the Hindu Kush, Afghanistan.

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Abstract: Snow, glacier ice, and debris-covered glacial and ground ice in Afghanistan are

critical to melt-water irrigation in the late summer months of the chronically drought-affected region. Kabul City, capital of Afghanistan, has long had a dominant surface water source from melting ground ice from the Paghman rock glacier in the Hindu Kush mountains northwest of the capital. Assessments of the ice and water resources of the country are especially important in the reconstruction and redevelopment of the country after two decades of war, environmental problems and political uncertainty. The GLIMS (Global Land Ice Measurements from Space) Regional Center for Southwest Asia (Afghanistan and Pakistan) was established under the auspices of the US Geological Survey and National Aeronautics and Space Administration to study ice resources because of their importance to the water budgets of the region and the world. Long-term ice change detection in the country is facilitated by access to multiple data sets of varying quality, resolution and precision of fabrication, including: (1) previously classified large-scale Soviet and US DOD topographic maps derived from aerial photographs taken in the 1950-60s; (2) lost or still restricted or classified aerial photographs or digital elevation data; (3) declassified Corona and Keyhole satellite photographs and images; (4) multi-temporal Landsat MSS and TM, SPOT, and ASTER imagery; and (5) ground survey and geomorphologic mapping. As far as is known, except for a few water temperatures of flowing springs and photographs of rock-glacier ground ice, true observational or instrumental temperature data of permafrost conditions in Afghanistan never were available anywhere in the country. On the other hand, the well-known high seismicity of Afghanistan and the steep mountain slopes have generated very large debris loads that in many cases nearly or completely cover glacier ice. Rock glaciers are ubiquitous, some the result of talus mobilization through ground-ice development, but most the result of downwasting and debris-accumulation over glacier ice. Our assessments of these features are confounded by: (1) unsafe or impossible field-observation conditions; (2) originally errant photogrammetric or cartographic interpretations, (3) ongoing political restrictions denying access to key data sets; (4) limited local interpretive expertise; and, (5) variable satellite sensory capabilities. Preliminary results indicate diminution of some glaciers with probable decreased downstream meltwater discharges; and enigmatic ground-ice conditions in need of fresh assessments. New digital elevation model capabilities and remote sensing offer the only possible capability at present.

Keywords: Glaciers, , debris-covered ice, ground ice, irrigation melt water

Karst Processes and Phenomena in Frozen Carbonate Rocks of the Middle Lena River Basin

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Abstract: A study of karst processes and phenomena in the basin of the Middle Lena River was induced in connection with start up of railroad and pipeline construction in this area. Karst processes have a considerable negative effect on linear engineering constructions, inducing subsidence phenomena in basement ground, embankment flooding, and icing phenomena.

Investigation results showed that the Prilensko'e plateau is an area of wide karst formation linked with Lower Cambrian carbonaceous strata. Wide distribution of karst processes and phenomena are determined by the following conditions: low (up to 200 m a.s.l.) location of local basis of erosion, big thickness (up to 300 m) of aeration zone, intensive physical weathering and discontinuity of permafrost. The thickness of frozen strata is ranged between 0 to 200 m, and in single cases reaches 700 m. The temperature at the depth of zero annual amplitude comprises in most cases -2°C.

By character of exposure, the karst is related to the type of mantled karst, bedding under a cover of disperse, 1-3 m in thickness, ground. By geomorphologic position, an under-river bed and river bed karst is observed here. By time of development, modern, ancient and renewed karst is separated. Primary development of vertically-orientated channels of discharge and limited development of horizontal channels of discharge is character for the karst of the region. By type of permeability, this karst may be named crevassed. The forms of surface-exposed karst are divided into micro-, meso-, and macroforms. For the first time, sink holes are separated among the karst microforms of the region. By form, sink holes are divided into crevasses, furrows, grooves, rills, etc. Karst mesoforms are presented by corrosion, corrosion-suffosion, corrosion-erosion cones and cup-like depressions. Karst megaforms are presented by large (many hundreds of meters in diameter) karst-erosion and karst-subsidence depressions.

Hydrodynamic zonation, peculiar to karst areas of the Earth, expressed in interval of influation (aeration) and interval of intensive underground discharge is clearly presented in the region limits. Surface waters bear a big heat supply in the depth of the carbonate rocks massive and destroy cryolithozone. A zone of surface circulation is spatially coincides with a thermoactive cryogenic zone, the thickness of which reaches 4 meters. Intensive cryogenic weathering, and in particular frost cracking, occurs here, that is also favourable for development of surface karst phenomena. The zone of vertical descending circulation in the region limits is, probably, linked by subvertical or inclined lots of thawed ground. Small, by their debit, hanging springs located in the upper parts of slopes are linked with this zone. The zone of periodical fluctuation of karst water level and horizontal circulation is linked with lateral taliks. The surface of horizontal circulation zone crosses different age layers, including salt-bearing ones. In this connection, the salt content of ground waters and their mineralization are considerably changing by area. An important peculiarity of the region karst waters is the presence of a siphon circulation zone. Of big importance for appearance of this zone are the character and form of the lower cryolithozone surface. Investigations were conducted in the scopes of the Integration program #13, SB RAS.

Key words: karst, permafrost, cryolithozone, cryogenic processes

Features of hydrothermal conditions and cryogenic structure of kurums in the Udokan Range (Northern Transbaikalia)

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Abstract: During 5 years the Geocryology Department of the Moscow State University carried out complex investigations of kurums, which were formed in the Udokan Range on mountain slopes with an inclination less than an angle of repose under determining action of cryohypergene processes and represented by coarse deposits.

In conditions of continuous distribution of permafrost with thickness from 40-50 up to 800-900 m, kurums occupy the area up to 40-60 % in different parts of the range.

Formation of radiation-heat, temperature, and water content conditions of kurums, their cryogenic structure has a number of differences in comparison with fine-grained perennially frozen deposits of this region.

1. The smallest evaporation and corresponding heat losses are observed in the structure of radiation-heat balance of a kurum surface during the summer period. The radiation index of dryness is about 0,1 at factor of humidification 0,45 that corresponds to the value of these factors for a semidesert zone.
2. In the bottom part of a layer of seasonal thawing a process of water vapor condensation occurs permanently during the warm period of year. The annual volume of condensation is about 75 - 100 mm and its warming influence on formation of mean annual ground temperature (t_{mean}) is from +1.9 to +2.7^{o}C.
3. Air porosity of kurums reaches 30-35 %, therefore one of main factors of t_{mean} formation is autumn - winter convection cooling. The value of cooling convection influence changes from -2,5 to -6^{o}C depending on a kurum type and the features of snow cover occurrence.
4. Taking into account all factors of the natural environment (radiation-heat balance, snow, atmospheric precipitation infiltration, condensation, convection, *etc*.), the t_{mean} values in coarse air-penetrable kurums are formed on 2,5-4,5 ^{o}C below, than on coarse deposits with full pore filling by a fine-grained material located alongside. The estimated analysis of t_{mean} formation is verified by temperature observation in specially drilled holes of 15 - 25 m in depth.
5. Different types of ice-formation take part in formation of kurums cryogenic structure: infiltration-crust, ablimation, snow-firn, and migration-segregation (in case of filling of porous space by a fine-grained material) ones. The horizons of basal cryogenic structure and increased volumetric ice content (up to 40-50 %) with thickness up to the first meters are formed in separate facieses of kurums below the seasonally thawing layer bottom, if it does not reach a bedrock roof.
6. The base of a seasonally thawing layer of kurums is characterized by high ice content and also a roundness and a smoothness of the form of debris due to active cryohypergenesis. It can be the serious reason of development of subsidence, deformations, and displacement of linear constructions on slope deposits – kurums. Such processes and phenomena are observed now on the building railway from a route of BAM to the Udokan copper deposit.

Key words: kurum, temperature, evaporation, convection, ice content

Hazard Assessment Criteria for Development of Engineering Geological Processes during Construction in the Area with Perennially Frozen Ground

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Abstract: During development of the territory, disturbances of the state of the geocryological environment are mainly related to removal of topsoil, draining and swamping of territories, surface leveling, construction of artificial coatings, and erection of engineering structures. The character of disturbances and interaction between engineering structures and perennially frozen ground is responsible for the degree of development and intensification of cryogenic processes.

The criteria for assessing the degree of hazard of such cryogenic processes as thermokarst, frost heaving, thermal erosion, and earth flow have been determined taking into account the development of the regions with perennially frozen ground. Based on the quantitative estimates, we classified the manifestation of these processes as not hazardous, slightly hazardous, hazardous, and very hazardous.

The degree of hazard of cryogenic heaving is characterized by the total value of heaving. The risk of development of thermokarst depends on the total thermal settlement. The predicted earth flow area and slope steepness are taken into account when hazard assessment is performed for cryogenic earth flow. The hydrothermal potential, which is used to determine the maximal depth of downward cutting in frozen rock, is accepted as a quantitative indicator of thermal erosion hazard.

The performed studies of the manifestation of the most hazardous cryogenic processes made it possible to determine the possible permissibility of technogenic load during the development of the territory:

Processes	Technogenic load
Not hazardous	Permissible
Slightly hazardous	Permissible after certain protective measures
Hazardous	Permissible after the complex of protective measures
Very hazardous	Impossible

Key words: Cryogenic processes, degree of hazard, technogenic load.

Rock glaciers and mountain permafrost in Zanskar, NW Indian Himalaya

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Abstract: Rock glaciers form an important landform associated with the interaction of permafrost and the coarse sediment system within high mountains. In Zanskar, rock glaciers are widely distributed north of latitude 32º N where there is a marked decline in precipitation

associated with the southwest summer monsoon across the main topographic divide of the High Himalaya, leading to the high altitude desert environment of Zanskar with an annual precipitation of c. 250 mma^{-1}. Both talus-derived and glacier-derived forms have been observed and mapped at a range of altitudes above 3200 m. Many of these rock glaciers appear to have stable frontal scarps with a well developed rock varnish on the exposed surfaces of clasts.

The presence of active talus-derived rock glaciers reflects high rates of rock weathering forming large talus cones that are subsequently deformed into rock glaciers in areas underlain by permafrost. The rock glacier initiation line (RILA) has been defined as the elevation of the commencement of creep in the rock glacier and used to determine altitudinal trends of such rock glaciers across the area, giving a range of values from 4500 to 5000m. There are also a number of glacier-derived rock glaciers found within recent moraine systems reflecting recent on-going glacier retreat from the Little Ice Age which appears to have reached a maximum extent in the late-nineteenth century. Transformation of the surface morphology to one typical of a rock glacier may reflect climate change to drier conditions related to a reduction on snowfall.

Field observations have also recorded a number of landforms associated with a major gravel aggradation within an abandoned valley. There is clear evidence of slope failure within valleys incised into these gravels with clear evidence of flow and creep as the major mechanisms. However, because the clasts are generally much finer than those usually associated with the coarse angular clasts that characterise talus rock glaciers, they have not been considered as rock glaciers. Their occurrence at an elevation of 4500 m would suggest that they could well relate to the presence of permafrost and its degradation to form extensive slope failures.

There is little evidence of a geographic trend within the limited data so far determined for this high mountain desert. This is particularly the case for talus-derived rock glaciers which are the more relevant landforms with respect to permafrost distribution. The range of values do not indicate increasing rock glacier distribution with increased aridity northwards but appear to indicate that rock glacier distribution may also be related to a lithological control which is determining the rate of talus generation.

Stimulation of N_2O Production and Reduction in Soil under Frozen Condition

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Abstract: Melting of permafrost is one of the biggest concerns corresponding to the progress of global warming. In addition, a change in soil freeze-thaw patterns in boreal and temperate

regions can also arise. For the seasonally frozen soil, soil freezing and thawing is known to be one of the significant events that cause high N_2O emission from soil, together with after the rainfall, compaction and application of N fertilization in arable land. N_2O is a climate relevant trace gas and produced in soils mainly through microbial N transformation processes as a byproduct and an intermediate product during nitrification and denitrification, respectively. Denitrification is considered to be highly involved in high N_2O emission on seasonally frozen soil. Field observations suggest that the N_2O emission occurs under not frozen but thawing or diurnal freeze-thaw conditions. Among them, high N_2O emission under thawing condition has been interpreted as a release of accumulated N_2O that was entrapped by the frozen surface layer. However, the origin of the accumulated N_2O remained uncertain, whether it was produced in and diffused from the unfrozen subsurface layer or produced in the frozen surface layer. In our previous field observations, the highest N_2O concentration was observed in the frozen surface layer, rather than below the frozen surface layer. Therefore, we conducted a laboratory incubation experiment to determine which part (surface or subsurface) is more responsible for the production of N_2O under the frozen condition of surface soil. Soil samples were collected from two depths (0-10 cm, 50-70 cm) of three different arable fields (S4, W4S, W8) in the Shizunai Experimental Livestock farm in Southern Hokkaido, Japan, on May 2005. A sieved (4 mm) and field moist soil sample (7 to 15 g) was placed in eight pieces of test tubes sealed with rubber stoppers and incubated at +4□. Four of them were subjected to freeze (-3□)-thaw (+4□) cycle and the others were kept at constant temperature of +4□ as unfrozen control. Changes in N_2O concentration in the headspace of the test tubes were monitored throughout the incubation, which was divided into five periods: initial (+4□), freezing (+4□ to -3□), frozen (-3□), thawing (-3□ to +4□) and thawed (+4□). Apparent N_2O production was not observed in two subsurface soil samples (W4S and W8) in spite of the incubation temperature, while it was observed in the other one subsurface (S4) and all three surface soil samples. Two surface soil samples (S4, W8) produced N_2O even in the frozen period, but the N_2O production rate decreased to 56 and 64% of that of each unfrozen control, respectively. In one surface soil sample (W4S), which had the highest N_2O production rate among the samples in the unfrozen control, the N_2O production rate was 13 to 26 times higher in the frozen period than that in the unfrozen control. In one subsurface soil sample (S4), the N_2O production rate decreased to 38% of that of the unfrozen control in the frozen period. Moreover, negative N_2O production (consumption) was observed in the thawing period, while the unfrozen control showed apparent N_2O production. Collectively, our observation indicated that soil freezing may not terminate N_2O production in surface soils, suggesting that N_2O can accumulate in surface frozen soil layer depending on the condition of the ground surface. In addition, since denitrification is a sequential reductive reaction from NO_3^- to NO_2^-, NO, N_2O and to N_2, the accumulation of N_2O in any given closed space depends on enzymatic activity associated with N_2O reduction. Thus, both apparent N_2O consumption and significant increase in apparent N_2O production suggested that denitrification process may be stimulated under frozen condition of soil, in which the ice formation creates O_2 depleted condition into microsite of soil and unfrozen water film on soil surface that accumulates substrates (NO_3^- and dissolved organic C) for denitrifying communities.

Key words: Trace gas, denitrification, unfrozen water, ice formation, anoxic microsite

Significance of Microtopography and Cryoturbation in Mature Larch Forest near Yakutsk, Eastern Siberia, Russia

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Abstract: The microtopography (earth hummocks) and cryoturbation structures are measured and described by digital photogrammetry and sketch on pit sections. A study plot was established in mature larch forest near Yakutsk, eastern Siberia. The 1cm DEM and contour map of 2cm interval of a 4m^2 quadrat revealed the existence of a number of small mounds and surrounding troughs on the mineral soil surface, which was covered with an organic soil layer. Mean diameter of the mounds and mean intervals are approximately 30-50cm, and relative height is 10-20cm. Sidewalls of the troughs have an apparent straight shape. The dead root and funnels were found within the troughs, indicating the root expansion into the troughs, and it forced trough edges being straight.

Cryoturbation structures were appeared in the sidewalls on the quadrat pit. Upper and lower boundaries of the mixed layer have a wave-like form. The concave, bowl-shaped depressions in the lower boundary are located under the convex mounds on the mineral soil surface. The wave length of the lower boundary is approximately 1m. Black mineral soils are deposited in the troughs, and they had an extension down to the large pools of the black mineral soil. These structures indicate that the surficial mineral soil darkened with organic matter submerged into the active layer, and these finally stored in the pools of black mineral soil within the active layer. Large amount of organic-affected black soils can be stored within the active layer.

The soil movements can be explained by the circulation model, which is proposed for earth hummock growth by Mackay (1980). He demonstrated that the cell-like soil circulation occurs if there are bowl-shaped frozen table, because of the upward and downward movement of melting soil with the driving force of the gravity. Bowl-shaped lower boundaries appeared in the sections were probably associated with the frost table when soil circulation occurred.

Key words: Siberia, Continuous permafrost, microtopography, cryoturbation, soil carbon pool, digital photogrammetry

Theme 3. Climatic, environmental and cryospheric changes

Evaluation of permafrost seasonal variations at several Asian sites in 21st century

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Abstract: Several series of numerical experiments has been carried out using a detailed soil-snow-vegetation-atmosphere transfer (SVAT) model involved in PILPS and alike international projects. Input meteorological variables were specified for some possible scenarios of future climate change in Eurasia. The meteorological time series combine both contemporary variability on daily to annual basis, and interdecadal trends of the parameters. The SVAT model allowed us to evaluate changes in snow cover features, temperature regime of snow and soil, and permafrost thawing depth under climate change conditions at several locations tested for the study. The experimental sites are located in permafrost areas of Siberia and Tibet, and are characterized with different natural conditions.

Under various warming scenarios, the snow parameters on permafrost sites don't change considerably, although the snow season shortens to some extent. At the same time, at some sites the snow depth increases due to larger precipitation in winter, which results in slightly higher permafrost temperatures in winter. Average depth of permafrost seasonal thawing for tested sites is examined. Its change under warming scenarios strongly depends on local landscape features: presence and depth of peat and/or moss layer on the top of the soil profile, specifics of thaw water dynamics in the soil, etc. The peat/moss layer acts as insulator and prevents fast thawing, which is typical for some Siberian sites, and rather rare for Tibet. The thaw water can re-freeze on the top of the frozen ground, thus making deeper thaw more difficult. This process, however, depends on the local hydrological regime in the soil, and plays important role not everywhere.

The study was supported by the Russian Foundation for Basic Research (grant 04-05-64745) and by INTAS (grant No. 03-51-5296).

Key words: Permafrost, numerical modeling, Asia, land cover features

Reconstruction of paleocryogenic strata through micromorphological indications

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Abstract: Relicts of cryogenic strata are known in Central Asia on the territory of Mongolia and northern China. In order to reconstruct permafrost formation and degradation the data of the changes of cryostructure and maximum thickness during climate fluctuations and sedimentation dynamics are necessary.

The information about cryogenic events is contained in buried permafrost and thaw strata of the intermountain depressions. According to Baikal paleoclimatic scale the seasonal and perennially frozen ground of the Cenozoic downwarps and intermountain depressions of the southern Siberia could be formed from the Late Pliocene (2.8 Ma ago).

Evidences of the deep ground freezing (up to 118 m) have been received on the example of downwarps of the southern Siberian platform. Cryolithozone consisted of two layers: the upper syngenetic strata from the surface and the lower epigenetic strata of the Miocene and Paleogene. On the exposures of the Quaternary deposits the direct cryoindications are distinguished such as polygonal wedge structures, cryogenic and postcryogenic textures, ctyoturbations, traces of the frost heave and solifluction ground flows, seasonal and perennial frost heave mounds testifying about repeated degradation of permafrost and partial thawing from the surface.

By studying the core samples it is possible to distinguish only the fragments of these formations less changed by modern exogenic processes. The researches have proved that the ancient cryogenic processes caused by phase transitions of water/ice, have left the influence traces of the different scale: seen deformations of sedimentation and postcryogenic structures.

Micromorphological analyses of the thin soil sections have shown that cryogenic processes also caused the irreversible changes of the microstructure. The deformed relicts of the syngenetic microstructure similar to an Ice Complex are kept in the thawed and subsided in situ sincryogenic strata. They are formed by different combinations of sedimentary, soil and cryogenic features of the microstructure. These attributes allow to distinguish the horizons of syngenetic and seasonal freezing in a paleocryogenic strata. Micromorphological evidences of syngenesis are absent in the lower strata. Presence of postcryogenic textures and deformations together with good safety of sedimentary microstructure testify only about epigenetic freezing.

Thus the former syncriogenic and seasonal freezing horizons and also lower epicryogenic strata can be distinguished in the sections of the layered sandy-clayish sediments using cryoindications. The bottom border of the maximal epigenetic freezing can be established in the closed depressions filled by the Cenozoic weakly consolidated sediments.

The revealed attributes of the structures of paleocryogenic strata in shallow intermountain depressions of Central Asia can be used for reconstruction of the thawed out and buried permafrost in the continental freshwater basins (for example, Baikal and Khubsugul), also for the studying of Arctic shelf permafrost.

Key words: Cryogenic strata, syngenetic and epigenetic permafrost, micromorphological cryoindications

Present-day Thermokarst Development in Central Yakutia

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Abstract: As part of the joint Russian-Japanese projects, investigations on post-disturbance permafrost dynamics are being conducted. Thermokarst research is a major component in these investigations. Thermokarst studies are carried out at the Yukechi, Neleger, Kerdyugen and Umaibyt sites near Yakutsk. The sites are heavily underlain by ground ice and contain numerous alases.

Geographically, thermokarst development occurs primarily on level surfaces with gradients up to 1-2^{o} and on gentle slopes of 2-3^{o} at the border between open sites and forest stands where a frozen barrier resulting from the difference in thaw depth between these landscapes promotes the accumulation of surface water.

In Central Yakutia, high thermokarst activity is observed at present in previously disturbed and treeless landscapes related to the regional increase in air temperature. The development of young thermokarst features is especially intensive. Dry thaw depressions are becoming wet, young thermokarst lakes are enlarging, taliks are growing below the lakes, and ground subsidence is occurring in the surrounding terrain.

The results of monitoring observations of thermokarst development indicate that the largest rates of surface subsidence over the period of 1992 to 2005 occurred in depressions with incipient thermokarst lakes (up to 25 cm/yr). In the central parts of wet thaw depressions with relative depths of 2 to 2.5 m, the average rates of subsidence were 5-10 cm/yr, in some of which incipient lakes tend to develop. No or very little surface subsidence was observed in dry gently sloped depressions with relative depths of up to 1m.

At present, conditions for thermokarst development do exist. In treeless landscapes with the dry active layer, the depth of seasonal thaw frequently reaches the top of ice wedges, resulting in ground subsidence. Ground subsidence is significant where hummocky polygonal topography has begun to develop, having the average rates of up to 5 cm/yr. Flat areas that were not previously subject to thermokarst are also subsiding with the rates of up to 1 cm/yr.

Current disturbances, primarily tree cutting and fire, are the major causes of thermokarst development. Our observation at the Neleger site indicate, however, that the rapid thawing of ground ice and ensuing ground subsidence up to 10-15cm may cease during the first few years after disturbance. This is related to the active layer properties and winter meteorological conditions. This is a common phenomenon, since polygonal features, evidence of the early stages of thermokarst, are frequently encountered in the recovered landscapes.

Observations on the dynamics of initial thermokarst forms in Central Yakutia indicate that the process has intensified during the last decades when the increase in air temperature has been the greatest. However, the initiation of thermokarst under present-day conditions depends on many factors, in addition to geocryological ones. The self-restoration mechanism in permafrost landscapes is strong, so thermokarst development is limited in area and is confined to sensitive sites.

Key words: Thermokarst, surface subsidence, depression, permafrost.

Dendroclimatic investigations of forests on permafrost, Central Yakutia, North-Eastern Russia

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Abstract: The Republic of Sakha (Yakutia) occupies a huge area in north-eastern Russia situated within the permafrost zone. The region has a sharply continental climate. The response of dominant tree species to large seasonal temperature variations, from extremely low temperatures in winter (up to -70°C) to high temperatures in summer (up to 30°C), is of considerable interest. Climate is known to be a primary control on the distribution of forest types, as well as on growth and dynamics of woody vegetation. Trees record the evidence of climatic change in the varying widths of their annual rings.

In the permafrost zone, larch and pine, the dominant forest species, require different ecological and soil hydrothermal conditions. Larch is more tolerant to cryogenic processes and grows on the major portion of Yakutia. This is because its root system is normally within 50 cm depth from the surface. Pine is less tolerant to permafrost conditions. It occupies dry soils with deep seasonal thawing.

The correlation analysis of tree-ring chronologies from larch and pine growing in different forest types has revealed relationships between tree growth and soil hydrothermal regime in the forest type. Tree-ring growth has been found to be significantly correlated with mean monthly soil temperatures.

The correlation analysis of tree-ring chronologies developed from larch from the Spasskaya Pad site shows the best correlation with soil temperature conditions at different depths in the winter season. The higher is the soil temperature, the faster is soil warming, which promotes timely onset of active tree growth in the beginning of the growing season. Summer temperatures impose no limitations on radial tree growth. There is a sufficient amount of heat for rapid tree growth during this period.

The response function of pine growth indicates that it is positively correlated with winter soil temperatures (until late May) at the upper and lower boundaries of the active layer at depths of 20 cm and 120 cm. In the depth interval 40-80 cm, the positive effect of temperature is observed during the spring months. It leads to early thawing of soil and causes growth processes to begin. In contrast to larch, however, a considerable negative effect of summer temperatures on pine growth is observed at some depths. This may be explained by significant moisture deficit in drier soils where warm temperatures have a desiccating effect.

Permafrost, Climate Change and the Coupled Climate System

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Abstract: Observations of changes in the state of permafrost in recent times are many and varied. Appearance and disappearance of lakes, degradation of ice wedges and changes in river channel morphology are several of the processes that have been linked to thawing of permafrost and warming of soil temperatures. Thus there is a need for assessing the effect of climate change frozen ground and permafrost. For example, knowledge of the state of the ground is important for assessing likely impacts to human infrastructure such as pipelines or railroads. Further, altering the state of the below ground system can have a large influence upon ecology, hydrology and trace gas emissions from high latitude regions.

In this research, we examine the advantages and disadvantages of analyzing permafrost under climate change within a fully coupled system. Some of the advantages that coupled system models have to offer include the ability to account for interactive hydrology and its associated feedbacks to the atmosphere. For example, a coupled model will capture the influence of additional snow cover and its associated infiltration patterns upon the thermal regime of the ground, which in turn can affect circulation patterns in later seasons. Conversely, a potential disadvantage of direct assessment of the state of permafrost from a climate model is that the land surface model component of coupled climate system models may not be as sophisticated as dedicated permafrost models with respect to resolving the thermal regime of freeze-thaw processes. While land surface models have recently been increasing in complexity, they may still be deficient in some areas.

Using a hierarchy of models, ranging from temperature index models, through to analytic steady-state models, soil diffusion models and full energy balance land surface models we explore both the strengths and weaknesses of particular strategies for diagnosing changes in permafrost as well as determining the interdependent relationship between climate change and permafrost. Some of these matters will be explored within a coupled land-atmosphere general circulation model (CCSM3).

Key words: Permafrost, climate change, modeling

Comparison of Tibetan Plateau Rainfall to Permafrost Distribution

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Abstract: Permafrost plays an essential role in high-latitude and high-altitude environments. Many environmental parameters have been shown to contribute to the formation and degradation of permafrost, such as air temperature, snow depth, vegetation canopy, soil moisture and texture, organic matter accumulation, hydrologic movement, as well as

anthropogenic disturbance. Despite the reported accelerated climate change that has occurred in high latitudes as well as high altitudes, a fundamental problem exists: climate warming has been shown to have occurred disproportionately during the cold season; however, permafrost degradation tends to occur at the end of the warm season, via, *e.g.*, a deepened active layer.

An important additional variable that has not been studied extensively in regard to its effect on permafrost is warm-season precipitation. For instance, it has been found that in spite of increased summer surface air temperatures, summer soil temperatures actually decreased due to abundant precipitation. Different hypotheses can be made regarding the relationship between precipitation and permafrost: increased precipitation can increase soil moisture, which results in a higher thermal conductivity than for dry soil. Therefore, increased precipitation could cause higher soil temperatures. Conversely, increased precipitation can result in increased evaporation from the soil, thereby resulting in lower soil temperatures. Additionally, increased soil moisture from increased precipitation will increase the specific heat of the soil, requiring more energy to increase soil temperature.

There is thus a potentially missing link in our understanding of permafrost dynamics: warm season precipitation. This is partly due to a lack of reliable precipitation observations in the traditionally data-sparse high latitudes. However, the Tibetan Plateau presents a unique region to study the impacts of precipitation on permafrost. Because of its high elevation, large parts of the plateau are underlain by permafrost. Furthermore, because of its subtropical location, precipitation measurements are available for the last nine years (1997–present) from the Tropical Rainfall Measurement Mission (TRMM) satellite. While there are several methods of retrieving rainfall from satellite observations, many of these suffer from various inherent problems, especially in snow-covered terrain. For example, microwave measurements are commonly used to retrieve precipitation, however they require specific knowledge of the background surface emissivity. In a snow-covered region such as the Tibetan Plateau, characterization of the background scene is extremely difficult. The first spaceborne precipitation radar (PR) on TRMM, therefore allows a direct measurement of precipitation that will not suffer from the problems inherent in other precipitation retrieval schemes.

The PR footprint is approximately 4 km at nadir, however as the data are not temporally continuous and the footprint size increases as the instruments scans away from nadir, monthly average rain rates are calculated on $0.1° \times 0.1°$ grid for the Tibetan Plateau. The PR data are used to develop a rainfall climatology for the Tibetan Plateau from 1997–present. A comparison between the PR data and a surface rain gauge network is performed to validate the satellite retrievals. The rain gauge data from the Chinese Meteorological Administration provides daily precipitation totals for approximately 200 stations in and around the Tibetan Plateau. While we do not expect a one-to-one relationship between the data because of sampling differences, the comparison allows us to validate that the PR captures the spatial variability of the rainfall on the Tibetan Plateau. Since rain gauge data have sparse spatial coverage, the PR offers a high-resolution dataset with a previously unavailable spatial coverage for a permafrost region. A principal components analysis is also performed on the rainfall climatology to examine the dominant modes of precipitation variability on the Tibetan Plateau. In addition to developing a satellite rainfall climatology, the rainfall climatology and dominant patterns of precipitation variability are compared to the distribution of permafrost on the Tibetan Plateau using the

Circum-Arctic Map of Permafrost and Ground-Ice Conditions and the Maps of Geocryological Regions and Classifications in China. While there are many other variables that influence the permafrost distribution, this comparison could reveal potential systematic relationship between rainfall and permafrost.

Palaeoenvironmental Changes on the South-eastern Margin of the Tibetan Plateau:a Pollen-data Based Analysis

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Abstract: An 18 m long sediment core from Lake Naleng in the south-eastern part of the Qinghai-Xizang Plateau (present-day precipitation:~ 800mm) was examined to reconstruct the vegetation and climate history of the region, considering the composition of fossil pollen. To retrace precipitation patterns quantitatively, a pollen-precipitation transfer function was applied. The region is influenced by the Indian Monsoon; a shift in the intensity of the monsoon circulation is therefore detectable.

The age of the core base was determinate by means of AMS-Dating to 16.5 ka cal BP.

Findings from qualitative and quantitative analysis show a periglacial vegetation, composed of alpine cushion plants and species which indicate perturbed conditions, for the beginning of the Late Glacial.

The reconstructed precipitation shows an annual amount of ca. 300-400 mm. Climate conditions stabilised and alpine meadows established around the lake during the later Late Glacial. The Pleistocene/Holocene transition is marked by a rise of arboreal pollen (mainly *Abies* and *Betula)*.

Forests were reconstructed for the first half of the Holocene, pointing to an enhanced summer monsoon for this period with annual rainfall of about 800 mm. An increase in alpine herb and shrub taxa and a decrease of arboreal taxa during the Late Holocene indicate a decrease of the forest vegetation in the area.

Key words: Tibetan Plateau, Pollen Analysis, palaeoclimate, transfer-functions, Monsoon

Cryolithological features of Quaternary sediments on the Lena-Kénkémé interfluve, Central Yakutia

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Abstract: Central Yakutia has an extreme continental climate with an annual range of temperature of more than 100°C. In Yakutsk, temperature extremes can reach –64°C in winter

and +38°C in summer. Continuous permafrost distribution is evident in this region at least since the middle Pleistocene. The study area is situated on the denudation plain to the west of the Lena River. Quaternary deposits cover interfluve areas, slopes, and the bottoms of small river valleys and runoff rills, and fill thermokarst depressions. Cryogenic eluvium, loess-like silts, and peaty deposits are widespread. Jurassic sedimentary rocks underlie the Quaternary cover.

This presentation deals with cryolithological features of Quaternary deposits formed at the headwaters of the Ulaakh River, a left tributary of the Lena. Intermittent streams in small dry valleys drain this kettle or cirque-like depression, which is a typical morphological structure of the denudation plain to the west of the Lena River. More than ten core profiles, as well as related pits in the active layer, were investigated using a complex cryolithological approach including study of cryostructure, ice content, grain size, and the mineralogical and chemical composition of sediments. The results show that ice-saturated loess-like deposits with polygonal ice wedges fill a dendritic system of runoff rills, which dissect slopes of the modern Ulaakh valley. Orientation and morphological features of the rills give evidence that they are ancient valleys of small rivers – the pre-Ulaakh‘s tributaries. The thickness of Quaternary cover deposits depends on the size and maturity of the runoff rill and can reach 20-25 m. The composition, fabric and cryostructure indicate that slope processes have played a significant role in the accumulation of sediments. These deposits consist mainly of loess-like silts interrupted by layers of sands and fragmental plant remains. Pebbles and stones are contained in the basal layers. An average segregation ice content of 25-45% and the deep penetration of ice wedges down to 15 m characterize these “Ice Complex” deposits. Granulometry and heavy mineral composition of the investigated sediments suggest an aeolian origin of a great part of silt-sized material, carried under varying wind strengths from the Lena valley. However, this silt in most places was affected by slope processes and mixed with local weathering products.

Keywords: Central Yakutia, cryolithology, headwaters, loess-like deposits

Thermodynamic and Morphometric Permafrost Characteristics Dynamics in Transbaikalia in Pleistocene and Holocene: the Fundamental and Applied Results

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Abstract: The problem of reconstructing the permafrost characteristics in connection with cyclic character of climate changes was formulated by M.I.Sumgin in the beginning of XX century. This problem stays topical now because the practical needs. It is connected with the thermodynamic and morphometric permafrost characteristics change and also with the activation of negative cryogenic processes that affect the engineering constructions and make a danger for human life. For example, only in Transbaikalia within last 5 years, the permafrost temperatures increasing, the reduction of the ground bearing capacity and the permafrost area

reducing were the reasons of more than 50 percent of extreme situations. Especially this circumstance is important for the areas near the southern periphery of permafrost.

The Laboratory of the General Cryology of Institute of Natural Resources, Ecology and Cryology of the Siberian Branch of the Russian Academy of Science developed the model of Transbaikalia permafrost dynamics for the last 500000 years. The basic results include the following:

We developed the complex approach to the definition of initial and boundary model conditions;

We got the principal morphometric characteristics and worked out the maps of permafrost distribution for different cold and warm past periods in Transbaikalia;

We found that the periods of degradation and forming of permafrost were repeatedly proceeded in Pleistocene and Holocene times. The increasing and reduction oscillations of the permafrost thickness had the similar intensity;

We got the evaluation of the lateral dynamics of the permafrost southern border in Transbaikalia during Pleistocene and Holocene times;

We found that the most active degradation of permafrost under influence of global warming is linked with the technogenesis.

Field researches as a whole confirm the above-mentioned results. Within last 100 years in Southern Transbaikalia the permafrost bodies with thickness up to 20-30 m were completely degraded. In the same time in the North of Transbaikalia the active layer depth were increased to 20-30 % along with the destruction of glaciers and long-term icing bodies.

The executed researches showed a high importance of the combination of scientific and applied research for maintaining the effective management in Subarctic areas in conditions of global climate change.

Key words: Transbaikalia, pleistocene, climate change, permafrost degradation.

Periglacial Lake Environments in Eastern Siberia

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Abstract: Research work during the last decades highlighted the role of the northern high-latitude regions for global climate variability. The climatic influence arising from the vast periglacial regions of eastern Eurasia is poorly understood. Those regions were only affected by regional mountain glaciations, are covered by Taiga and Tundra vegetation and are characterized by deep-reaching frozen ground. In particular, Yakutia in the northeastern part of Eurasia represents one of Earth's most extreme climate regions with semiarid continental climate and coldest winter temperatures on the northern hemisphere. The landscape of Yakutia is occupied by widespread lake districts. Lacustrine sediment records of these lakes provide the

basis for palaeolimnological reconstructions of former environmental and climate conditions of the periglacial realm in eastern Siberia. By using sedimentological, geochemical, and micropalaeontological proxy records, including the application of ecological transfer functions, an interdisciplinary approach is followed to characterize the dynamics of lacustrine systems related to Holocene climate variability.

Few lakes of tectonic-glacial origin are located at the Verkhoyansk Mountain margin. These mostly oligotrophic lakes are dominated by siliciclastic muds with low abundances of organic matter. Changes in grain-size characteristics indicate variations in fluvial sediment runoff, possibly related to spring snow melt. The majority of Yakutian lakes are eutrophic and occur in shallow closed to semiclosed thermokarst depressions and in deep alass basins. Because of the semiarid climate setting, the lakes respond very sensitively to perturbations in the hydrological balance, driven by summer precipitation and evaporation. On longer time scale, pollen and chironomid records in the lacustrine sediments document an early Holocene climate optimum between 8.0 and 4.5 ka BP with generally warm and wet summer conditions. For the same time, a marked variability in the proportions of pelagic and litoral compounds of organic matter point to cyclic lake-level fluctuations at centennial time scales, possibly related to climate seesaws of summer Arctic Oscillation. As for the sub-Recent development of lake status, the cycles show affinities to variations in sun-spot activity.

Key words: East Siberia, holocene climate, limnogeology, thermokarst, alass, lake status

Change on permafrost on northerneastern Antarctic Peninsula under climate warming

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Abstract: In the Antarctic Peninsula, from the time meteorological measurements began in the middle twentieth century, the air temperature was characterized by a general decrease. The main and particular effects of the present climatic changes on periglacial environment in the permafrost regions are summarized. The different geocryogenic conditions produce the divergent relationship between climatic change and frozen ground. Our field survey was carried out systematically during the last four years on Seymour (Marambio) and Vega Islands on the ice-free areas. The drypolar climatic conditions of the area, with a mean temperature around -8.5 °C ÷ -5.5 °C, are for the existence of continuous permafrost with a thickness that is probably greater than 150 m. on ice-free ground surface.

The previous studies have been determined two most important cryoformations, epigenetic y syngenetic observed in this region. Epigenetic cryoformation presents the dry frozen ground and occupies the greater part of Seymour Island consists of Tertiary marine sediments, and high volcanic plateau on Vega Island. Syngenetic cryoformation consists of ice-rich frozen ground developed under permafrost environment during degradation of Last Pleistocene Glaciation. Ice-rich permafrost zone on Seymour Island occupies comparatively isolated small areas such

as alluvium on Gross and Dias Valley or niveo-aeolian deposits with the buried snow and icing. In Vega Island syngenetic cryoformation consists to different types of Quaternary deposits. The most prevalent are terminal moraines with buried glacial ice and fluvioglacial deposits which occupy more 90% ice-free area on north part and around 60% of south sector of the island.

The meteorological data and the ground thermal records in the active layer and upper section of permafrost show the greater fluctuations of ground thermal regime in summer with the general trend increase ground-surface temperatures. Account the long term climatic warming may determinate the seasonal thawing to 20-30 % higher what last three decades. Thinning of seasonally thawed layer with an increase in depth of the permafrost table would create a large near-surface modification of ice-coved topography. The dominant processes in the frozen Quaternary deposits with buried massive ice such as lateral and terminal moraine and are the lowering of the surface of the frozen ground, extend of areas and increased rates of the thermokarst and thermoerosion processes produced better drainage patterns and the formation of thermokarst lakes. The increase of extensive transformation of the fluvioglacial surface due to thermoerosion activity. Indirect effect of change in the ground thermal regime of ice-rich permafrost would include in the movement of groundwater in unfrozen ground on the thermokarst areas, increase in magnitude and extend of icing activity as a result of an increased groundwater discharge.

Key words: Antarctic Peninsula, permafrost, climate change

Investigation of seasonal freezing dynamics in the central part of the Russian Plane

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Abstract: During two winter seasons (2004-2005 and 2005-2006), in the vicinity of Zvenigorod (Central Russia) special geocryological and glaciological research was held in order to study the depth and dynamics of seasonal freezing. Basic reasons causing the dynamics of a seasonally freezing layer (SFL) have been evaluated. A forecast of spring flood level and the rate of the SFL influence on the agriculture have been worked out. To study the dynamics of seasonal freezing, two expeditions were held in the beginning and the end of the freezing period. The first stage of investigations revealed the ground freezing on 10% of the study area (December, 2004) while in December, 2005 about 80% of the area was frozen. In the end of the freezing period (February, 2005), frozen ground was found on 95% of flood-plains and terraces area. At the same time, in the forest on the watershed, 50% of the area was frozen. The ground on felling areas, due to the thick (about 40 cm) snow cover as well as soil water saturation in the autumn, remained unfrozen. Another reason hindering ground freezing is the warming effect of plant residues decay. In the end of cold winter 2005-2006, the area was frozen entirely. The SFL thickness after the first month of freezing, in 2004, was 15 cm on snow-free sites while at the same period of 2005 – 10 cm. In the end of winter, 2005, maximum freezing was marked

beneath a path (34 cm.) In the end of winter, 2006, the depth of freezing increased significantly. The ground freezing in loamy sand and sand deposits (massive cryostructure) was much deeper than in loamy and peat ones. Snow cover thickness was: early winter, 2004 – from 27 cm up to 70 cm (felling area), February, 2005 – from 40 cm (mean) up to 140 cm (gully). The two-level composition of the river ice was found on the flood-plane and the river coast. The SFL dynamics is caused mainly by the climate parameters, e. g.: the amount of negative degrees during the winter 2004-2005 was 5800 deg.-hours while during 12 coldest days of January, 2006, it was 6100 deg.-hours, so the rate of freezing and the SFL depth has significantly increased by the end of the freezing period. Investigations showed that the SFL dynamics is strongly influenced by the rate of ground freezing, snow cover thickness, structure and distribution depending on wind, relief and vegetation as well as landscape peculiarities and ground properties.

Five year record on the progressing degradationof a lithalsa in the Canadian Arctic

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Abstract: Numerous lithalsas have formed in marine clays which in the past have been exposed to subaerial conditions in consequence of glacial rebound effects. Lithalsas are a valuable indicator of past climate, since they are suspected to develop within a narrow band width of mean annual air temperatures of between -4 to -6°C. A large population of lithalsas exists east of the village Umiujaq near the eastern shoreline of the Hudson Bay. The structure and thermal decay of one lithalsa due to climatic warming in the Canadian Arctic has been investigated and monitored since the year 2000 jointly by teams of Laval University, Quebec, Canada, and of the Bundesanstalt für Geowissenschaften und Rohstoffe (BGR), Hannover, Germany. The investigated structure has a diameter of about 50 m and rises on average by about 2.5 m above the surrounding wetlands. A continuous record of thermal data from six bore holes, the results of borehole investigations and on drill cores from within the lithalsa are now available.

The temperatures in the main mass of the lithalsa are between -0.8°C to -0.2°C. Nevertheless, a highly complex image of the internal temperature field has emerged from the temperature records. An estimated volume of 200 m³ of ice was lost from the interior of the palsa during the last three years. The volume loss expresses itself by subsidence of the lithalsa surface. A crescent-shaped pond has started to develop and the outline of a future thermokarst lake surrounded by a rim has begun to show up. Ground subsidence actually affects about one half of the lithalsa, creating a hollow that traps snow and water, therefore making the depressed area a very effective heat source throughout the year which will speed up the thermal decay of the lithalsa.

The rate of climatic warming in the area of investigation has slightly slowed down from measured rates of 0.4°C per decade from 2000 to 2002 to currently about 0.2°C per decade

(based on the ground temperature record at 10 m depth). Nevertheless, the degradation of the lithalsa was accelerated in recent years through subsurface warming by heat carrying groundwater flow across the surrounding unfrozen terrain. Indeed, the collapsing half of the lithalsa is on the upstream side of the regional slope and surface water flow, a pattern that is apparent also in other degrading palsas and lithalsas in the same wetland.

A numerical model simulating the current thermal degradation of this lithalsa will be presented with an estimate on the relative amounts of heat carried into the lithalsa by heat conduction and, eventually, heat advection. It will be argued that warming of the permafrost core by heat carrying groundwater might well be the dominant process responsible for degradation of shallow permafrost layers.

Key words: Lithalsa, permafrost degradation, numerical model

Negative Consequences of Permafrost Degradation

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Abstract: Permafrost occupies about a fifth part of Earth's surface. Modern observations assess permafrost condition as unstable due to the global climate warming and human impact. A result of climate change in fact influences the cryosphere elements: permafrost, glaciers, marine ice. The influence is taken exaggerated or understated very often as positive and negative parts of it are discussed. The oldest permafrost is dated 3 million years. Climate has been changing multiple times until our days. The presence of humanity with the economical demands on the environment corrects the natural processes. At first human just explored the surrounding environment extensively in agricultural matters like natives do so today and the centuries before. As society develop the more areas become used in any purposes. Human impact on this areas exists anyway, was it a survey information collection or mining or factory work. An observation of cryosphere response to a clear climate change nowadays is possible only on always unsuitable for humanity localized areas such as high-mountainous ones. Mountain permafrost behavior is very complicated depending on multiple factors, basically climatic and geographical ones. Though the most convenient and more observed cryospheric element for clear climate change is glacier response.

The amount of urbanized in various extent sites in cryolithozone growing for centuries, reached maximum during industrialization era and stabilized last decades. Permafrost investigations at number of the sites are held. It is difficult to separate local microclimatic changes from urbanized center work energy and mass incomes into atmosphere at any of these sites. However the biosphere separates lithosphere from atmosphere. That means any changes of landscape lead to changes in permafrost conditions with the impact of climatic change on or without it.

Self-restoration of cryolithozone landscapes leads to not identical environment. So on the route of climate influence on permafrost the landscape stays whether it anthropogenic modified or not. Results are different. Permafrost condition change on sites of anthropogenic landscape

can lead to a global ecological catastrophe with problems of dangerous engineering-cryogenic processes activation, frozen nowadays pollutants are to melt and join the food chain. The sea transgression is expected as so as glacial and permafrost disasters occur also in not urbanized areas but they are lesser-observed and not contacting directly with society. Degradation and regeneration of permafrost at various sites show the strict localization of these processes. Permafrost destabilization often leads to negative for settlers results but the process is natural at all. At urbanized sites of cryolithozone the human risk occurs. Social interest is to save the environment directly surrounding it. That is why human unobjectively enlarges the local problems to the scale of Earth. The only problem then is controlling the permafrost conditions to use it.

Key words: Negative consequences, permafrost degradation

Late-pleistocene Permafrost Events in Southern New Jersey, Eastern U.S.A.

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Abstract: Recent field studies in the Pine Barrens of Southern New Jersey have documented the occurrence of relict sand wedges and numerous deformational structures. This area lay beyond the maximum southern limits of the Late-Pleistocene ice sheets in North America. The wedge structures are the result of thermal-contraction cracking and indicate the previous existence of permafrost. Modern analogs suggest mean annual air temperatures of at least -3.0ºC to -4.0ºC for their formation. Wedge infill material has been dated by optically-stimulated luminescence (OSL). The dates obtained suggest at least two, probably three, periods of thermal-contraction cracking during the last 150,000 to 200,000 years.

The deformational structures are interpreted to reflect thermokarst activity when permafrost degraded, icy layers melted, and density-controlled mass displacements occurred in water-saturated sediments. The most common deformations extend for several tens of metres in horizontal extent and affect sediments at depths as great as 3-4 m below the ground surface. For this reason, they cannot be interpreted as either cryoturbation within the active layer or the result of deep seasonal frost. Others take the form of deformed wedge-like structures, and bulbous ‘sediment pots’ or kettles. These structures are thought to have formed when gullying and fluvio-thermal erosion operated preferentially along fissures and sand wedges as permafrost degraded. Other non-diastrophic structures are associated with layers of bog ironstone, 1-2 m thick. These are broken and disrupted. They are thought to have ‘foundered’, or sank, in water-saturated sediments that had lost inter-granular cohesion when icy beds melted.

A number of OSL ages now permit construction of a tentative permafrost chronology for Southern New Jersey. We attach most significance to the age determinations made upon the coarse-grained (150-250 μm) quartz fraction.

A number of age determinations are derived from the highly wind-abraded sand from within the wedges. These vary from >55 ka to >146 ka. Because these ages span the duration of the last interglacial (Eemian, or OIS-5), they may indicate two distinct periods (i.e. ~50-70 ka or Early Wisconsinan, and ~140-200 ka or OIS-6) when cold-climate (permafrost) conditions prevailed. However, we are unsure of an OIS-6 interpretation and prefer, at this point, to discuss the evidence for permafrost that is associated with the climatic deterioration that occurred at the transition from the Eemian interglacial to the Wisconsinan glacial. This allows a better interpretation of the thermokarst structures that we have observed.

At the end of the Eemian interglacial, global sea level and the regional groundwater table in Southern new Jersey would have been relatively high. Thus, as climate progressively deteriorated and as permafrost aggraded, water would have migrated, by cryosuction, through the permeable sand and gravel substrate towards the downward-advancing freezing plane. Icy beds might also have formed immediately beneath the relatively impermeable bog ironstone beds. Permafrost was probably continuous in nature.

A second group of ages concentrate around ~30 ka. They have been obtained from the sandy material that infills sediment-pots and deformed wedge-like structures. If our thermokarstic interpretation of these phenomena is correct, the dates suggest an amelioration of climate between ~40-30 ka led to their formation by fluvio-thermal erosion processes. At the same time, degradation of permafrost would have led to mass displacements and disturbed bedding. The ‘foundering' of bog-ironstone beds would also have occurred in response to the melt of icy beds.

A third group of age determinations of ~13 ka to ~17 ka relate to the more heterogeneous and loosely-packed sandy infill of a number of wedges that have been studied near the southern extremity of the Pine Barrens. Here, the fine sand fraction is much less highly wind abraded and more local in origin, suggesting less wind action. These wedges suggest thermal-contraction cracking occurred when the regional climate deteriorated during the LGM. At one locality, near Newtonville, Atlantic County, a sand-wedge infill that was dated at ~ 16ka was observed to penetrate a sediment-pot, the infill of which was dated at ~30 ka. The type locality for these younger wedges is near Port Elizabeth, Cumberland County. Geomorphological considerations indicate it was probably an exposed, snow-free site. This suggests that permafrost may have been thin and discontinuous in nature. However, we cannot exclude the possibility that these wedges are ‘ground’ wedges and reflect deep seasonal frost. There is little evidence of any thermokarst activity associated with this period of permafrost conditions.

This sequence of permafrost-related events in Southern New Jersey appears to mirror the large-scale climatic changes that have been deduced from the paleoecologic and paleoenvironmental record from the eastern and mid-continental USA. These are based on inferences from the loess depositional record and from well-dated cave carbonates. They indicate climatic cooling post OIS-5a, at about 70 ka, followed by warming between 40-35 ka (OIS-3), with cooling commencing at 30-35 ka, a slight warming between 30-25 ka, and then the onset of the LGM.

Key words: Relict sand wedges, relict thermokarst, OSL dating

Assessment of Frozen Soils Environmental Geological Conditions along the Qinghai-Tibet Engineering Corridor from Xidatan, Qinghai to Nagqu, Tibet, China

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Abstract: The Qinghai-Tibet Engineering Corridor (QTEC) traverses 670 km of permafrost and seasonally frozen ground from Xidatan in the north to Nagqu in the south in the interior of the Qinghai-Tibet Plateau (QTP). The QTEC lies in a belt of several hundred of meters to several kilometers in width that is sensitive to natural and engineering disturbances and in the cold regions ecotones susceptible to climatic and environmental changes. The major engineering infrastructures within the QTEC include the Qinghai-Tibet Highway (QTH), Qinghai-Tibet Railway (QTR), Golmud to Lhasa Ambient Temperature Product Oils Pipeline (GLATPOP), Lanzhou-Xi'ning-Lhasa Fiber-Optic Cables (LXLFOC), and 110kV Power Transmissions Line (110kVPTL), and associated maintenance stations/squads. These engineering structures and frozen ground eco-environments intensively interact each other, resulting in constant environmental changes. Along the QTEC, there are large expanse of continuous permafrost, and significant amount of island-sporadic permafrost in the middle section, and deep seasonally frozen ground on the northern and southern edges and along or at the large river valleys. The QTEC is characterized by high elevations, arid, cold and windy climate, active tectonics, and resultant distinct conditions in frozen ground environmental engineering geology. High elevations, relatively low latitudes, and distinct division of large geomorphological units control the regional distribution of frozen ground and ground ice. However, local differentiations in frozen ground environmental engineering geology occur due to the variations and their changes in soils and lithology, water and ice contents, thicknesses of the active layer, ground temperatures, surface vegetation, and periglacial hazards. Three engineering geology zones, 20 engineering geology subzones, and 51 engineering geology sections are divided based on the regionalization at three levels. The division in engineering geological conditions at the first level takes account of regional distribution of various frozen ground types and resultant differences in frozen ground engineering geology, resulting in three categories of frozen ground zones: large expanse of continuous permafrost, island-sporadic permafrost, and deep seasonally frozen ground. Based on the division of the three zones, the subdivisions at the second level reflect the thermal stability characterized by mean annual ground temperatures and other basic features of frozen ground. The next level divisions, engineering geology sections, which are the most basic units in frozen ground engineering geology, are mainly based on the ground ice contents and aim at reflecting present conditions in frozen ground engineering geology and cold regions ecological environments. Each zones, subzones and sections are concisely evaluated for engineering design and hazards mitigation.

Key words: Qinghai-Tibet Engineering Corridor (QTEC), frozen ground environmental engineering geology (FGEEG), assessment, mean annual ground temperatures (MAGTs), ground ice contents (GICs).

Comparison of Climatology and Trends of Air temperature from EAR-40 and Meteorological Station Data in China

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Abstract: Air temperature is one of primary parameters to evaluate climate conditions at local, regional, and global scales. However, ground-based measurements are usually limited spatially and temporally. Reanalysis grid data set can be used because of its higher spatial resolution and more continuous and uniform if it is verified to be reliable over various spatial and temporal scales. In this paper, we examine the accuracy of ERA-40 air temperature from ECMWF by comparing with the corresponding measurements from meteorological stations in China. The time series of data cover the period from January, 1958 through December, 2001. We focused on ERA-40 grid cells that contain at least one meteorological observation station. Results indicate that, in general, ERA-40 data can properly track the means and trends of air temperature in China but with some difference compared to ground-based observed data.

Mean annual air temperature across China from ERA-40 data has a positive bias in the 1960s comparing with meteorological station data. The biggest positive bias was up to 0.74 °C in 1966. Air temperature difference between ERA-40 and measured data became smaller since the mid 1970s, with difference generally within +/-0.1°C. Furthermore, ERA-40 air temperature had cold bias since the late of 1980s. Further study indicates that warm bias happened almost every season during 1960s, while for the negative bias since late 1980s, the winter that cold bias was stronger than the other seasons. ERA-40 can well predict the pattern and gradient of air temperature in China. There are some cold bias mainly existing around the Tibetan Plateau where local elevation difference is large. Warm bias mainly occurs in Northeast China and West China. This warm bias may be due to local elevation difference between ERA-40 grid cells and meteorological stations. The variations of annual and monthly air temperature indicate that air temperature increases in most of China. Increase in air temperature is greater in the North than in the South. Temporally, air temperature increased more in winter and spring than in summer and autumn. Air temperature increase from ERA-40 is smaller than that from observations.

Key words: air temperature ERA-40 correlation elevation DEM

No Thawing of the Cold Permafrost Has Occurred in North ALASKA During the Last One-half Century

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Abstract: Climatic warming has not resulted in measurable thawing of the cold (-6 to -10°C) permafrost in Northern Alaska during the last one-half century. The maximum depths of summer thaw at five locations near Barrow, Alaska, in 2005 were within the ranges of the depths obtained at those exact same locations during the early 1950s. However, there has been a net warming of about 2°C at the upper depths of the permafrost column at two of the locations. Thawing of permafrost (increase in active layer thickness) is determined by the summer thawing index for the specific year, while any warming, or cooling, of the upper permafrost column results from the cumulative effect of changes in the average annual air temperatures over a period of years, assuming no change in surface conditions. The reported shoreline erosion along the Northern Alaskan coast is a secondary result from changes in the nearby ocean ice coverage during the fall stormy period, and not directly because of any climatic warming of the permafrost.

Key words: cold permafrost, climatic warming, thawing index, Northern Alaska.

Relationship between Permafrost and Past Ice Cover on the Qinghai-Tibet Plateau

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Abstract: The degree to which the Qinghai-Tibet Plateau was covered by ice during the last Ice Age is still debated. The evidence for complete glaciation competes with that for only relatively minor mountain glaciation, where vast regions of the plateau remain ice-free. The argument is primarily based on the geomorphic record. However, we anticipate that the present distribution and depth of permafrost could further elucidate the problem.

Permafrost is a sensitive responder to surface temperature forcing. This has been seen during the past century with the rapid degradation of permafrost due to climate warming across the Tibetan Plateau as well as other permafrost regions. Ground temperature profiles have proven to be valuable archives of surface temperature and may provide one of the most robust indicators of surface warming. In addition to using temperatures, permafrost distribution is likely to integrate past changes in surface conditions.

During a cold period the depth of permafrost will increase due to colder conditions; however, permafrost growth is typically considered separate from the growth of ice sheets during glacial periods. In reality, permafrost and ice sheets commonly coexist, generating a single thermal regime. We produce thermal scenarios of a permafrost system with and without an overlying ice cover. We compare the modeled vertical temperature profiles and permafrost thickness estimates with available observations to provide constraints on the most likely scenario of ice extent for the Qinghai-Tibet Plateau.

Our numerical representation of permafrost evolution treats the problem of 1-D advection and diffusion with a logarithmic grid transformation that concentrates grid cells at boundary interfaces. This more appropriately treats the thermal discontinuity between sediment, permafrost, air, and/or ice. Geothermal heat flux into the base and overlying air or basal ice temperatures serve as boundary conditions for the coupled domain. At steady state, the depth of permafrost is determined by the heat flux at the permafrost-sediment interface, the surface temperature, and the thermal conductivity of the permafrost. A temperature change at the surface boundary decreases in amplitude as it propagates within the permafrost, and ultimately affects the permafrost depth.

While permafrost will grow in response to cooler air temperatures, ice cover during a cold period will insulate the permafrost and can lead to its degradation. The ice cover caps the permafrost, shielding it from changing surface air temperature, and influencing the temperature gradient through the permafrost. If enough time ensues, the temperature profile through permafrost with an overlying ice cover and without an overlying ice cover will differ significantly.We expect the current permafrost temperatures and resulting thickness distributions to contain a memory of the bulk past surface conditions. The present existence of permafrost is significant and allows for a comparison between our model results and scenarios based on field observations, though we acknowledge that dry conditions and relatively shallow permafrost in this area will limit our ability to decipher accurate details of surface temperature conditions in the distant past. By comparing recent temperature profiles with generated temperature profiles from different model scenarios we hope to add new constraints to the extent of ice on the Qinghai-Tibet Plateau during the last glacial period.

In addition to this study of ice cover on the Qinghai-Tibet Plateau, these reconstructions may shed light on the timing and extent of Last Glacial Maximum glaciation in Antarctica. One region where past ice cover remains contentious is in the Dry Valleys; deciphering the permafrost signatures there may support or rule out possible past surface temperature scenarios.

Key words: Permafrost, Qinghai-Tibet Plateau, Ice Sheet, Temperature

Cryospheric changes in the West Siberia northern taiga

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Abstract: The monitoring of landscape and permafrost conditions in natural ecosystems and on sites disturbed by a lining of linear structures will be carried out since 1971 till the present time in northern taiga of West Siberia. The observations over a soil-vegetation cover, thickness and moisture of an active layer, soil and ground temperature, engineering geological processes are carried out on constant profiles and plots. Repeated (with an interval 3 years) landscape mapping of a gas pipeline route and the adjacent not disturbed territory and repeated leveling of a constant profile surface, have allowed to lead inventory of ethnogeny disturbances and forms of engineering geological process displays.

Carried out monitoring observations have revealed the changes of landscape and permafrost conditions caused by climatic changes and influence of the anthropogenic factor. Air temperature steadily rose from a beginning 70 years. For example, trend of increase of mean annual air temperature has made on the data of Nadym weather station for 1972-2004 years $0,03^0$C per one year. The increase of air temperature has caused increase of frequency both covering by shrubs and occurrence of wood plants in tundra ecosystems. The steady increase of seasonal thaw depth in all natural complexes, behind exception flat peat land, also is connected to increase of air temperature in the summer period. The increase of variation amplitude of the maximal seasonal thaw depth on years is appreciable expressed for last 10-15 years.

The removal of a vegetation cover on a gas pipeline route has resulted in increase of an active layer thickness in all investigated ecosystems. However size and character of these changes essentially differ in time in different landscape conditions. So for example, on frost mounds, composed with a surface by sands underlain by ice-rich silty and clayey deposits, the active layer thickness has increased in 2 times per the first years after disturbance (from 110 up to 230cm). The next years the increase of seasonal thaw depth was small (10 % from average size of the maximal active layer thickness. Last decade the increase of the maximal active layer thickness as in disturbed (up to 370cm), and in natural conditions (up to 180cm), caused by increase of air temperature was marked.

On the contrary, on flat peat land per first five years after removal of a vegetation cover the seasonal thaw depth has increased slightly (with 57cm up to 64cm, i.e. by 13 % from initial size). However further in connection with a surface subsidence of the disturbed plot and development of water pools the appreciable increase of seasonal thaw depth up to 120cm in 11 years after disturbance was marked. Through 18 years the maximal active layer thickness becoming 190cm has exceeded initial size in 3 times. Stabilization of the maximal active layer thickness is not observed on disturbed peat land for the investigated 33-year's period.

The observable increase of ground temperature in various landscape conditions also is caused by increase of air temperature. The maximal changes of ground temperature are marked on big palsa peat land. The ground temperatures at the depth of a layer with annual temperature fluctuations (10m) on these peat lands for the period of research have increased from $-1,8^0$ up to $-0,5^0$C. Trend of ground temperature increase has made $0,03^0$C per one year.

Key words: Monitoring, permafrost, landscape, vegetation, climate.

The Influence of Freezeback Duration on Permafrost Temperatures in Central Yakutia

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Abstract: In the context of global climate change it is of practical importance to study changes in the thermal state of upper permafrost. Upper permafrost temperatures are significantly influenced by active-layer freezeback whose duration varies from year to year. The later is complete freezing of the active layer, the shorter is the period of winter heat losses from the ground and the higher is its mean annual temperature, and vice versa.

Investigations have been conducted since 1996 in the watershed between the Lena and Kenkeme Rivers, 30 km north-west of Yakutsk. The study area is situated within the zone of continuous permafrost with temperatures of –2.5 to –3.5°C.

In Central Yakutia, duration of active-layer freezing primarily depends on two environmental factors: pre-winter soil moisture content and early-winter snow depth.

Winters with low pre-winter soil moisture contents and thin snow covers have higher freezing rates and shorter duration of the freezeback period. In such winters during the observation period, the rates of freezing and the lengths of the freezeback period were, respectively, 1.0-3.8 cm/day and 60-110 days for the forest landscapes on sandy soils, 1.3-3.5 cm/day and 40-75 days for the forest landscapes on silty soils, and 0.8-3.7 cm/day and 70-110 days for the meadows on silty soils.

Winters with high pre-winter soil moisture contents and thick snow covers are characterized by lower freezing rates and by longer duration of the freezeback period. During the observation period, the rates of freezing and the lengths of the freezeback period in these winters were, respectively, 0.4-2.5 cm/day and 83-145 days for the forest landscapes on sandy soils, 0.5-2.1 cm/day and 80-130 days for the forest landscapes on silty soils, and 0.6-2.6 cm/day and 95-155 days for the meadows on silty soils.

Based on the results of investigations at the experimental sites, empirical relationships between mean annual permafrost temperature and duration of active-layer freezing have been obtained. Lengthening of the freezeback period by one month results in a warming of mean annual permafrost temperatures by 0.8°C for sands and by 1°C for silty soils.

Key words: Permafrost, soil freezing, freezeback period, permafrost temperature

Response of Ice-rich Permafrost to Contemporary Climate Warming and Surface Disturbance

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Abstract: Based on the data from integrated monitoring investigations over the period of 1989 to 2005, the parameters of the active layer over the ice-rich permafrost containing thick wedge ice (the ice-wedge complex) changed little, within the range of natural variation, in the natural (undisturbed) landscapes. These observations add support to the views of a number of well-known scientists who believe that, firstly, permafrost degradation in response to moderate climatic warming is weak and, secondly, the permafrost in Central Yakutia shows thermal stability to moderate climate warming.

In the areas of surface, soil and vegetation disturbances, however, a degradational situation developed in the upper part of the ice-rich permafrost (upper 10-15 m) with the 5 to 35% loss of cold resources and ground ice volumes over a short period of time (1989-2005) in response to an increase in air temperature of 1.5 to 2.6°C. In places, permafrost temperatures at a depth of 10 m have warmed by 1-2°C.

In the disturbed landscapes located on the VI-VII terraces of the Lena River, the upper part of the ice-rich permafrost thawed at a rate of 0.3-0.6 m in the years with anomalously warm winters and warm, rainy summers (1996-1999 and 2005). Where the surface was disturbed, a thawing trend of the ice-wedge complex ranged on average from 0.03 to 0.20 m/yr . At the Dyrgabai site, the table of the permafrost with ice wedges lowered rapidly from 1.8 m in 1991 to 4.5 m in 2005. This triggered thermokarst, thermal erosion and other frost-related processes.

The influence of cryogenic processes on the response and inertia of the ice-wedge complex is estimated to be high (m_{ec}=1.3-3 or greater) for typical geothermal conditions: mean annual temperatures t_m=-1° to -3°C and high ice contents (i=0.5-0.8). At some disturbed inter-alas sites, a thawing trend of the ice-rich permafrost (Δh_{ip}) may exceed an increasing trend of seasonal thaw (Δh) in natural (undisturbed) analogues by a factor of 3-15 or greater. This is explained by a 1.5-3 times increase in snow accumulation in thaw settlements relative the background norm and by the additional effect of intensified cryogenic processes. If thermokarst develops, degradation of the ice-rich permafrost occurs at a faster rate under moderate climate warming.

These observations indicate that the response of permafrost to contemporary climate warming and surface disturbance is not uniform. The problems requiring further research are discussed.

Key words: Climate, ice-rich permafrost, landscapes, thermokarst

Primary Thermokarst on Agricultural Lands, Central Yakutia

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Abstract: The early stage of thermokarst development has been monitored in Central Yakutia since 1992. The main monitoring site is a 157 ha unirrigated field at Dyrgabai. It is an inter-alas area on the right bank of the Lena River which was cleared of tree vegetation and ploughed in 1956. Six plots were established at the site to monitor thermokarst development, and soil temperature and moisture. The field was abandoned in 1996 and is now used for livestock grazing.

Soon after clearing shallow thaw pits began to form on the field surface and along its margins. Within the field, they used to disappear during spring and autumn tillage. On the field margins and around the slash piles, cryogenic processes progressed. A lake 28 m long, 19 m wide and 1.85 m deep formed in the northern part. Thaw troughs developed in places along the field margins.

In 1992, little surface disturbance was observed in the ploughfield. Small thaw pits occurred on the ground surface. However borings and pits frequently encountered subsurface cavities at a depth of 0.4 to 0.6 m. Rapid changes in the cryogenic conditions occurred in 1993. Numerous new frost cracks, thaw pits and troughs, and collapse pits were detected and investigated throughout the field.

In 1994, most thaw pits were leveled by spring tillage. A small surface subsidence, 4 by 5 m in size and up to 0.4 m in depth, formed on plot 2. It continued to expand during the following years and now is a mature depression measuring 91 m in length, 50 m in width and 1.71 m in maximum depth relative the field surface. Meltwater persists here into late June and even throughout July in a rainy summer season. The gravimetric soil moisture contents in the active layer did not drop below 20-25% during the last three years. The active layer depth increased to 4.5 m in the thermokarst hummock and 2.05 m in the hollow. Soil temperature at 3.2 m depth warmed due to high moisture contents. It varied from –0.2 to 2.0°C in the hummock and from –0.4 to -0,2°C in the hollow over the year 2005.

At present, much of the field surface is heavily disturbed. Hummock-and-hollow microdepressions, 20 to 60 m in size, occur throughout the field.

These results confirm that cryogenic processes and phenomena are highly variable. Moreover, they indicate that these processes develop rapidly in ice-rich agricultural landscapes in response to regional climate warming and increasing human impact. This is especially the case in the areas where destabilized zones, such as subsurface cavities and loose soils in the active layer, are present and primary thermokarst is extensive.

Key words: Thermokarst, agricultural landscape, thaw depression, soil moisture content, active layer

About Role of Thermokarst in Global Balance of Carbon

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Abstract: It is considered that one of the primary factors in global changes of climate is increasing of greenhouse gases concentration in atmosphere, among which the dominating role is taken by carbonic gas. At calculations of balance of carbon along with a vegetative biomass should be considered a role of a soil cover, as the reservoir influencing natural fluxes streams of CO2 and its concentration in an atmosphere. Calculations of carbon balance have approximate character and are far from a real estimation of its dynamics, constantly there is a search on improving the methods of calculation and specification of gases emission. In this article carried out the attempt of the estimation of role of thermokarst processes in global balance of carbon.

It is considered, that in a permafrost thickness there are preserved significant stocks of carbon compounds which being gradually released from a long captivity during thawing process of frozen grounds and increase the concentration of greenhouse gases in an atmosphere. For today the role of cryolithozone and cryogenic processes in balance of carbon is limited. But in our opinion, such prevalent phenomenon as thermokarst has the essential role on carbon balance.

On the flat territories of cryolithozone ice complex is widely developed. In the boreal zone ice wedges takes up to 40-50 % of ice complex volume. On the lowlands of northern latitudes the arctic type of ice complex (edoma) is distributed. The volumetric content of ice in it takes up to 90 %. The fluctuations of thermal conditions during holocene have led to the partial degradation of underground ice and formation of depressed forms of relief called alases. At present, on the plains of boreal zone with ice complex alases occupy about 20-30 % of total area. In circumpolar territories of Arctic regions within of northern taiga zone, forest-tundras and tundras the thermokarst occupies huge area. For example, only about 25 % of Yana-Indigirka and Kolyma lowlands territory represents plain with an ice complex, the other part of lowland was processed by thermokarst.

We determined that under influence of alas process the change of contents and structure of organic matter goes in soils of alas depressions. The deposition of organic matter in the bottoms of periodically appearing and disappearing alas lakes, the formation of peat in low locations of depressions lead to the accumulation of organic material in the thermokarst depressions. Fast dynamics of alas relief promotes to re-deposition of grounds and to formation of buried humus, peat and sapropel horizons in soil profile. As a result of such enrichment of alas soils by organic material the stocks of carbon in soils of alas considerably exceed those than in zonal soils. Carbon stocks of alas soils in boreal zone are 7-10 times higher than in zonal forest soils. In northern taiga zone, alas soils contain 3-4 times more, and in tundra zone up to 2 times more stocks of carbon, than zonal soils. The age of alas soils of boreal zones is estimated 8-12 thousand years, on exposures of Seaside lowland are found out buried soils of Karginskiy age (25-50 thousand years). Consequently, the thermokarst influence on global carbon balance consists in removing a part of carbon from active circulation and its preservation as buried

organogenic horizons of soils for the long period. Taking into account the scales of thermokarst distribution and high carbon content in buried horizons this influence is rather essential.
Key words: Role, thermokarst, global balance of carbon

Origin and Stability of Ground Ice in the Dry Valleys, Antarctica

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Abstract: Subsurface ice occurs with one meter in most soils in the McMurdo Dry Valleys, Antarctica. The ground ice exists as massive ice or as pore ice. The existence and persistence of this ice is of interest since ablation models suggests the ice should be absent in all but the youngest soils (or in all soils older than 10,000 yrs) and yet ice is ubiquitous under much older surfaces. Since ground ice drives development of many landscape features, understanding the factors that lead to its formation and stability are of interest for understanding polar landscapes and the history of ice sheet advance and retreat. Furthermore, the Dry Valleys provide our best analog for understanding the presence of ground ice on Mars. This presentation highlights various types of ground ice in the Dry Valleys as well as their chemical and physical characteristics.

Ground ice can be broadly classified as: (1) pore ice cementing soil/sediment; (2) modern or remnant buried glacial ice; and (3) syngenetic ice. Buried lake ice may also exist but is not presented here. Each of these types display considerable variation in physical and chemical characteristics; the origin of the ice may be difficult to determine. Pore ice is the most common form of subsurface ice. Typically it is present within a few decimeters of the soil surface in areas displaying contraction cracks and polygonal patterned ground. Our data on air and soil temperature and humidity together with our model of sublimation, as well as published models, suggest that this ice should have sublimated long ago given the age of the soils. The persistence of ice-cement reveals that the models are incomplete. We are investigating the potential role of snow-cover and episodic meltwater recharge in the long-term occurrence of subsurface ice in cold hyper-arid soils.

One of the most debated aspects of ground ice is the age of buried glacial ice, which is found in numerous locations at elevations of 400 m and higher. Three distinct assemblages have been identified: moraines cored with ice from a former polar glacier, deposits from temperate glaciers of unknown age, and active debris-covered glaciers. The surface of all three forms displays polygonal patterned ground; however, relative to this form of patterned ground found in sediments, the micro-morphology is distinct, consisting of low-relief central domains bordered by deeper troughs, presumably due to the near-surface ablation of ice sublimating along the contraction cracks.

The third type of ground ice is syngenetic ice. This type of ice is least common and its

presence may be debated since there is limited unfrozen water in the soils/sediments to feed ice growth. Unlike in the Arctic where contraction cracks infill with water and from ice-wedge polygons, virtually all contraction cracks are in-filled with local and wind blown sand/silt, thereby forming sand-wedges. Ice-wedges have been noted, however, at a few coastal locations. Also, massive ice-lenses may have formed at one location near a seasonal flowing river. The flowing water would provide a source for both heat, which would increase the amount of unfrozen water in the soil, and water to fuel the growth of syngenetic ice.

Examples of each type of ground ice will be presented together with ice chemistry, including stable isotopes, and physical characteristics. These characteristics are useful for understanding the mechanism of formation and for parameterizing our models of sublimation and ice condensation. Generalization of ice source may be made based on these data; however, these do not always suffice to distinguish between the potential ice sources. We present our most recent findings about the origin, nature and chronology of the subsurface ice, and consider the implications for the distribution and stability of ground ice on Mars.

Key words: Permafrost, ground ice, dry valleys, antarctica

Quaternary Sediments of Kara Sea Coast and Their Cryogenic Structure

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Abstract: The Eastern coast of the Galf of Yenisey and the western coast of the Yamal peninsula are the key sites for studying Quaternary sediments of Russian Arctic. There, coastal cliffs contain most representative sedimentary strata: continental sands and sandy loams with syngenetical and epigenetical ice wedges underlined by clayey marine saline sediments with massive ground ice. The volumetric ice content of the coastal sediments varies from 30% to 80%, which is one of the major factors of thermal erosion. The widest distribution of massive ground ice is linked to the lowland areas of several Pleistocene marine transgressions. Sediments, inclosing ground ice are often have ice wedges of various ages indicating a change of sedimentary and thermal regimes after the ground ice of marine lowlands was formed.

During the last four years detailed investigations of the sedimentary strata have being conducted. Field and laboratory work included chemical, isotope, mineralogical, granulometric analysis as well as absolute dating of sediments. It was found that the relict lithological and thermal processes occurred on the marine shelf are presently reflected in the modern coastal lowlands. As a result, relict Pleistocene marine shelf, which constitutes present-day coastal plains, can be considered as the analogy with modern shelf. We have developed a new offshore/onshore classification of permafrost. This study can lead to the developing of several criteria for age gradation of modern shelf. Continuation of this work is important for understanding temporal evolution of costal landscapes of Russian Arctic and for paleoreconstructions.

Key words: Ground ice, ice wedges, thermal erosion, Quaternary sediments

Temporal and Spatial Changes of Permafrost Distribution in the Tien Shan Mountains During the Last Millennia

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Abstract: During the Late Holocene there were numerous periods of warming and cooling in the Tien Shan Mountains, Central Asia. The dynamics of air and ground surface temperature changes that occurred in the Tien Shan at an altitude of 2500 m a.s.l. during the last millennium has been obtained by correlating the data from radiocarbon dates, tree-rings indexes, and limnological, archeological and historical data. During the last millennium, the most significant periods of cooling occurred during 1150-1350 and 1600-1850.

Ground temperatures and permafrost area in the Northern Tien Shan have been subject to repeated fluctuations during the Late Holocene. During the maximum warming, the ground temperatures rose by approximately 1.0-1.5°C. The altitude oscillations of the permafrost lower boundary had amplitude of about 200-300 m. The result of numerical simulations shows that the permafrost formation at an altitude of 2500 m a.s.l. has developed at least two times during the last millennia.

At the lover boundary of permafrost distribution the permafrost temperatures now are close to 0°C and at some sites permafrost degradation has already started. Analysis of measured active layer and permafrost temperatures coupled with numerical thermal modeling (permafrost temperature reanalysis) shows that most of the recently thawed permafrost was formed during the Little Ice Age. Since the second part of the nineteenth century, permafrost in the Tien Shan Mountains is experiencing a warming period, which continues up to the present. The geothermal observations and modeling indicate that in the Tien Shan more favorable conditions of permafrost occurrences and preservation exist in the coarse blocky material where the mean annual temperatures are typically 2.5-4.0°C colder than the mean annual air temperature.
Key words: Climate variability, alpine permafrost, modeling, Tien Shan.

Natural Processes Trend in Russian Permafrost Regions

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Abstract: The author of this report believes that naturally and anthropogenic disturbed habitats (waterside slopes, baidzherakhs, quarries, steep mountain slopes with mobile grounds, ground roads, open cuts, industrial workings, cutting slopes, embankment and dirt roads, and roadsides, streets of populated localities, etc.) are the most convenient objects for studying trend of recent natural processes – successions and fluctuations of vegetation, soil forming processes, etc.

Researches have been conducted in Yakutia, in northern territories of Zabaikalye and Amur regions, near Vorkuta (Komi Republic), Labytnangi – Salechard (Yamal region), Khatanga (Taymyr region). These are zones of tundra, forest-tundra and taiga. Disturbed habitats of these

territories have natural and anthropogenic origin.

Eventually, all disturbed habitats with well drainage in the permafrost areas of strong continental climate with small precipitations (tundra, forest-tundra, taiga) are grown over by steppe plants (almost all Yakutia, Zabaikalie). The projective cover of these plants is small. Soil similar to steppe ones are also formed: humus is accumulated but not peat, soil reaction is about neutral, and the amount of exchangeable calcium and magnesium increases. The humus content accounts for 1 – 1,5 % in upper horizons of minor soils and about 3 - 8 % in fine earth from grass tussock. All investigated soils have neutral or close to neutral reaction. This process was not market in Tynda (Amur region) because of the influence of Far East monsoon climate on this region. This process was not market too in northern-western seaside part of Yakutia with frequent drizzling rains (Tiksi, Chokhurdakh, Khroma bay) where disturbed habitats are grown over by pioneer and apophyte vegetation. Such situation is near Vorkuta (tundra), Labytnangi and Salechard (Yamal, forest-tundra), Khatanga (tundra) where the climate is more humid then in north-east of Russia. We known from scientific publication that analogical situation exist in north of European part of Russia too.

It is necessary to tell separately about pine forests. The pine forests are wide-spread in Zabaikalye and in neighbouring territories. They grow on sandy sediment in intermountain valleys. These forests penetrated into a steppe zone of Mongolia through high sandy ridge. They were investigated in Verhnyeangarskaya depression during 2004 year (around Novy Uoyan settlement, northwest of Buryatia).

The area is located in Moscow latitude. True altitude is more than 500 m. These pine forests are "classical" types. Litter or lichen pine forests grow on high sandy ridge, grass-cowberry-lichen forests distributed on flat surface. Soils here are sandy weakly podzolic and podburs. The permafrost is deeply and does not affect the pedogenesis.

Forests around of settlement are under strong anthropogenic stress: unpaved roads, groove, wood dumps and other. Light sands are formed here too. Disturbed sites slowly obliterate with pioneer plants, and then steppe ones: wormwoods, thyme, steppe grasses and etc. Lawns in settlement have steppe aspect also. Pioneer and steppe plants cover roadsides from railway station to northwest.

The pine forests will be replaced by steppe as it takes place in south Buryatia without application of special security measures.

Key words: Disturbed habitats, permafrost regions, pioneer plants, apophyte plants, steppe plants and soils

Paleoglaciology of the Bayan Har Mountain Area, Eastern Tibetan Plateau

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Abstract: The glacial history of the Tibetan Plateau is a topic of considerable interest because of its significance for regional and global environmental reconstructions, and its interaction with variations in monsoon strength and plateau uplift. Published glacial reconstructions for the last glaciation range from a large ice sheet covering the entire Tibetan Plateau to extended valley glaciation forming discrete glaciated mountain blocks. Although current chronologies appear to underpin the restricted glaciation model, there appears to be enough regional variation to motivate further study, especially the glacial history predating the last glaciation. We therefore study the glacial history of a large upland section of the eastern Tibetan Plateau centered on the currently unglaciated Bayan Har Mountains (BHM), partly because chronological constraints are entirely absent, and partly because the area may once have been covered by an ice sheet of intermediate proportions. The BHM area, which houses the headwaters of the Huang He (Yellow River), contains a wide array of glacial deposits and morphologies. Moreover, it appears that superseding glaciations were ever limiting in extent and the area therefore presents optimal conditions to investigate glaciations over long time periods.

We report from an on-going investigation into the extent and chronology of Quaternary glaciers in this region, manifested in glacial deposits and landforms (e.g., erratics, end moraines, tills and trough valleys). Previous studies have indicated the occurrence of two phases of mountain glaciation during the last glaciation (OIS 2-4), with mountain glaciers distributed around the highest summits, and two prior glaciations of ice sheet glaciation character (the penultimate glaciation, OIS 6, and the Huang He ice sheet, OIS 12).

We mapped the glacial morphology of the area using satellite images and a DEM of 90 m resolution. Large-scale glacial landforms such as cirques, glacial troughs and U-shaped valleys indicate repeated glaciations, and so do series of moraine ridges and meltwater channels. The abundance of glacial traces detectable through remote sensing techniques diminish with decreasing elevation, and it appears that evidence for former ice sheets are based mainly on sedimentary evidence.

In an introductory field work in 2005, surface boulders (including erratics) and boulders in till profiles have been sampled for dating using terrestrial cosmogenic nuclide (TCN) concentrations in quartz. Sampling was carried out along a 300 km stretch of the Qingkang highway, crossing the 80,000 km^2 area of the Huang He ice sheet. We intend to present these first TCN results at the meeting.

Our study will present new data for the paleoglaciology of the eastern Tibetan Plateau, and

will contribute to the resolution of questions such as:

- What glacial fluctuations occurred in the BHM area throughout the last glaciation?
- When did glaciation pre-dating the last glaciation occur?
- Was the area ever covered by an ice sheet?
- What is the relation Tibetan glaciation – uplift – climate variations?

These are questions of special significance also for former periglacial conditions, as reconstructed glaciers and ice sheets had a fundamental effect on regional paleoenvironmental conditions.

Keywords: paleoglaciology, glacial morphology, cosmogenic nuclides, Bayan Har

Theme 4. Permafrost hydrology and cold regions water resources and land use

Impacts of an Arctic Reservoir's Regulation on Downstream Thermal Regime in Open-Water Season

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Abstract: In this study, based on the long-term (1950-1990/1992) stream temperature and discharge data, we investigated the impacts of the Vilui reservoir's regulation on the downstream thermal regime in the open-water season. Results show that in the early open-water season (before June 30), the reservoir's regulation has enhanced the downstream water temperature in a length through the mid Vilui River (maximum 4.7 ^{o}C) and down to the river mouth (maximum 2.3 ^{o}C). The decrease of discharge due to reservoir's regulation is mainly responsible for the downstream water temperature increase in June, which was defined as the "indirect impact" of the reservoir. Analysis shows that the "direct (positive or negative) impact" of the reservoir, which usually causes continuous temperature increase or decrease along a distance of the downstream from the dam, could be possible in a distance from the dam, though much likely shorter than the mid Vilui River in the early open-water season. Results reveal that part of water temperature increase (around 1 ^{o}C) at the Vilui River mouth in June is caused by natural factors. In the mid open-water season (from July 10 to August 10), the reservoir's regulation has reduced the downstream water temperature in a length through the mid Vilui River (about -2.7 to -0.6 ^{o}C), but not down to the river mouth. The "direct (negative) impact" is primarily responsible for the water temperature decrease in the mid open-water season in the mid Vilui River as the discharge increase is small compared to the pre-dam period. It is important to note that the water temperature in July at the Vilui River mouth is significantly associated with the reservoir's regulation (discharge variation), although the long-term mean water temperature doesn't show big change compared to that in the pre-dam period. In the late open water season (after August 20), the impact of the reservoir's regulation cannot be through the mid Vilui River; thus the water temperature increase at the river mouth shows a local warming (maximum 1.9 ^{o}C), which is probably due to the reduction of influx from the non-regulated area.

Key words: Vilui River, Reservoir Impacts, Thermal Regime, Long-term Change

Impact of Frozen Ground Change on Streamflow Hydrology over the Siberian Lena basin

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Abstract: Climate, permafrost, and hydrology are the dynamic components of the arctic system. They closely interact in many ways. Our current knowledge of permafrost effects on arctic hydrologic changes is incomplete, and this limits our capability to understand the long-term changes observed in the arctic hydrologic system. Recently we have integrated and analyzed long-term climate, permafrost and hydrology data over the Lena basin in Siberia. This presentation will review the preliminary results. It will define basin and sub-basin climate, permafrost, and hydrology regimes, variations and trends, with an emphasis on frozen ground changes over the upper Lena basin and quantitatively assess their impacts on basin streamflow characteristics. Special focus will be placed on examining the changes in streamflow seasonal cycle due to changes in seasonally frozen ground. Our ongoing and future efforts will use physically based permafrost and hydrology models to examine the linkage between climate, frozen ground, and streamflow changes over selected sub-basins with sufficient input and validation data. We will apply hydrochemistry models to determine subsurface flow component and its change over space and time. These analyses will allow us quantify the linkage and interaction between the arctic hydrological regime and the dynamics of permafrost and freeze-thaw cycle, and advance our understanding of arctic hydrological system and its change related with climate and permafrost variations. The result of this study will advance our understanding of the functions, interactions, and changes in the Arctic system and benefit national and international programs, such as the IPY and WCRP CLIC.

Key words: Impact, Frozen Ground Change, Streamflow Hydrology

Arctic hydrological feedbacks associated with a global climate model projection of severe degradation of near-surface permafrost

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Abstract: The representation of near-surface permafrost and projections of future near-surface permafrost under climate change as well as its relationship with changes to Arctic hydrology are examined in a fully coupled climate model, the Community Climate System Model version 3 (CCSM3). Present-day and future near-surface permafrost distributions are analyzed based on data from five member ensembles of CCSM3 integrations, conducted at NCAR in support of

the fourth IPCC assessment report (AR4), of 20th and 21st century climate based on IPCC SRES emission scenarios. The sensitivity of the CCSM3 projections to the depth of the soil column, the insulating capacity of the upper soil organic layer, and vegetation type are analyzed through a series of transient 1% CO_2-to-doubling experiments.

The impact of the projected severe degradation of near-surface permafrost in CCSM3 on surface fluxes of energy and moisture as well as runoff to the Arctic Ocean is assessed. In particular, the interrelationship between abrupt decreases in September sea-ice extent and relatively sharp changes in near-surface permafrost extent and related increases in freshwater fluxes to the Arctic Ocean are investigated.

Key words: climate change, global climate model, Arctic hydrology, feedbacks

Hydrological characteristics of Seabee Hook, Cape Hallett, Antarctica

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Abstract: The hydrology of the Seabee Hook area of Cape Hallett, Antarctica, was investigated and characterized. Seabee Hook is a low lying spit formed from deposits of basalt boulders, gravel, and sand, carried by tidal currents from an adjacent cliff face. Seabee Hook is the location of a large Adelie penguin (*Pygoscelis adeliae)* colony. The Seabee Hook area has been divided into four main hydrological areas based on slope and sources of meltwater. Dipwells were inserted to monitor changes in depth to, and volume of, groundwater in Seabee Hook. Tracer tests were conducted to estimate aquifer hydraulic conductivity and groundwater velocity.

Considerable spatial and temporal variations in groundwater were found. During the 2004/05 summer the depth to ice cement increased and groundwater was observed perched above the ice cement, as a shallow unconfined aquifer, from early December until early February. At the end of summer groundwater refroze in some dipwells. On Seabee Hook groundwater was sourced from melting snow drifts and ground ice on Seabee Hook Therefore, the volume of groundwater was largely determined by the amount of snowfall. During the 2003-04 summer, snowfall was relatively high and groundwater was found throughout Seabee Hook and surface water commonly occurred as ephemeral streams and shallow ponds. During the 2004-05 summer, which had a lower incidence of snowfall than the previous year, groundwater was confined within topographic low areas and surface water was less common. Groundwater velocity through the permeable gravel and sand (porosity 23 – 33%) of up to 7.8 m day^{-1}, and hydraulic conductivities of 4.7×10^{-4} m s^{-1} to 3.7×10^{-5} m s^{-1} were measured.

Groundwater chemistry was influenced by the presence of the Adelie penguin colony on Seabee Hook and the close proximity of the sea. Groundwater from within the penguin colony had elevated concentrations of salt (1205 mg L^{-1} sodium, 332 mg L^{-1} potassium), and nutrients (193 mg L^{-1} nitrate, 833 mg L^{-1} ammonia 10 mg L^{-1} total phosphorus) compared to groundwater sourced away from the penguin colony on Seabee Hook, and other terrestrial waters in

Antarctica.

Key words: Cape Hallett, Antarctica, groundwater, groundwater chemistry, ice cement, permafrost.

Sustainability of the Transport Sector in Norwegian Arctic to Climate Change

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Abstract: The annual average temperature in the Norwegian Arctic is expected to increase between 1,2° C and 5.0° C next hundred years. The precipitation is expected to increase with up to 35 % together with higher storm activity. Slides and floods are a threat to traffic safety and regularity on roads and railways, and in Norway we have in average 2000 slide events on roads during the year. As there is a close connection between weather and slide/flood activity we expect higher frequency of these events. Regularity on our wind exposed roads will also be reduced with increasing storm frequency and intensity.

Another consequence of a warmer climate is higher frequency of slush avalanches and debris slides in the Norwegian Arctic where dry snow avalanches are predominant today.

Change in slide and flood pattern can together with increasing traffic enlarge the risk for fatalities and reduced regularity in the future. To meet this challenge we have made plans for mitigation and physical protection which will be adjusted to the climate in the future.

Key words: Sustainability, climate change

Historical Variability of the Icing (aufeis) in the Brooks Range, Alaska and Kunlun Mountain, China

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Abstract: Different remote sensing sensors were employed to obtain the characteristics of icing (aufeis) in the Brooks Range, Alaska and the Kunlun Mountains, China. Ground truth results support remote sensing observations and led to the development of techniques to determine ice formation and spring water interactions. Icing creates an important water storage, and an engineering hazard in the permafrost region. The Synthetic Aperture Radar (SAR) is a powerful and sensitive sensor for ice detection, estimating volume of the ice, and freeze/thaw conditions. The 27-30% of winter baseflow contributes to the icing at the Kuparuk Aufeis Field. Landsat imagery from the Brooks Range indicates many of the high discharge springs are

located less than 500m a.s.l. in limestone areas with glacial morphology. Many springs have survived at least through the last glaciation. However, the size of these icing deposits was similar to those found recently by identifying ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer) shortwave infrared (SWIR) data.
Key words: Historical variability, icing, china

Permafrost Condition After Tundra Fire in Seward Peninsula, Alaska

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Abstract: Thermal, water and electrical conditions of permafrost after the tundra fire were observed in Seward Peninsula, southwest Alaska, in order to evaluate the effect of fire on permafrost conditions. Field observations were made in 2005 and four sites were established where the slope direction and surface disturbance condition are different; south- or north-facing, and burned or unburned. At each site ground temperature and water content were measured by pit survey, and the seasonal thawed depth measurements were also conducted by using the steel rod from the ground surface. Transient electromagnetic surveys were carried out along profiles with the length of 140-180m to compare the permafrost condition using a transmitter loop of 60 x 60m.

The temperatures of 20-40cm deep at the burned sites were 4-5 ºC higher than that at the unburned sites. The soil water contents at the burned sites showed the high condition. The measured thawed depths are significantly different between the burned and unburned sites, which were more than 20cm deeper in the burned sites than that in the unburned sites.

The obtained apparent resistivity curves and estimated resistivity models showed that a significant difference was observed between south- and north-facing slopes. At the north-facing sites, high resistivity layers were estimated near the ground surface with the thickness of 20-26m, which represents permafrost. The permafrost base could not be detected at the south-facing sites by the transient electromagnetic surveys because the permafrost base may be located in bedrock. There is no significant difference of the curves and models between burned and unburned sites. However, only at the burned south-facing site, stable data could be obtained by using the standard central induction configuration, which means that this site has a relative low resistivity condition near the ground surface. Thus, the burned south-facing site may have a different permafrost condition near the surface.
Key words: Tundra fire, resistivity, Alaska

The sensitivity of Tibetan Plateau climate to changes in NDVI-derived vegetation properties

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Abstract: The spatial distribution of vegetation properties strongly influences the energy, water, and carbon exchanges at the land-atmosphere interface. Recent studies have shown that there are noticeable trends over Tibetan Plateau in surface-meteorology-station observed screen-height air temperatures and precipitation (Frauenfeld et al, 2005), and in the satellite remotely sensed land-cover features such as NDVI (Chu et al., 2006; Fan et al, 2006), and surface skin temperatures (Oku et al., 2006). These observational evidences indicate the possible amplified climate change signals over the elevated plateau-region.

To understand the mechanisms driven Plateau-wise climate variations and monsoon dominated moisture balance, year-long simulations are performed using Colorado State University Regional Atmospheric Modeling System (CSU RAMS) for 1995. Our coarse grid covers entire China, and part of Japan, Mongolia, and southern Asian countries at 100-km grid-spacing, and finer-grid focuses on the Tibetan Plateau region at 25-km grid-increment. The year 1995 is chosen because it is an average year in terms of screen-height air temperatures and precipiations. ECMWF reanalysis product is used to provide atmosphericinitial and lateral boundary conditions for our simulations. The GIMMS 8-km NDVI products are processed to describe vegetation growth states. The sensivitiy experiments are performed by increasing and decreasing the NDVI value to 25% of their original values. At the first glance, our model is doing a reasonable job in reproducing 2-m air temperature observed at local met-stations. The preliminary results also indicate that the penetration of monsoon moisture is sensitive to vegetationdescription, and thereby the biosphere-atmosphere feedbacks.

Further numerical experiments will be performed to evaluate the impact of land use and land cover change to Tibetan Plateau climate.Sensitivities of simulated climate to perturbations of vegetation spatial distribution, topography, and sea surface temperatures will also be evaluated.

Key words: Sensitivity, climate , NDVI-derived vegetation properties

Hydrogeochemistry of the Ak-shirak Range glacier waterflows (Central Tien Shan)

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Abstract: Processes of chemical composition formation of mountain rivers are still rather unexplored. Various chemical composition of glaciers ice, various degree of their contamination with morainic material and uneven ratio of demineralization activity and concentration hinder the geochemistry studies of glaciers waterflows. The results of geochemical studies of surface waterflows that spring from under the Ak-shirak Range glacier are given in the paper.

The Ak-shirak Range is one of the centers of modern mountain glaciation of Tien Shan. It separates the upper courses of 2 large river systems of Middle Asia – the Tarim and the Syr Daria. The range is a slightly separated elevation with an average altitude in central parts about 4600 km. The region is characterized by continuous permafrost of 90-370 m thick. Taliks are found only under large valley glaciers. Annual ice mounds formation that are fed by thawed waters from outwash plains at the valleys of Lysy, Davidov's, Sarytor, Boordu glaciers is an indirect confirmation of it.

The thickest glaciers are in the west of the Ak-shirak; they are mainly characterized by vast snowfields and rather small morainic deposits. Average thickness of ice at the firn line is 120-140 m.

The content of fresh snow that was taken at the Ak-shirak mountain range (actual elevation of 3600 m) is of low mineralization and of subacid reaction.

The content of the majority of microelements in fresh snow is very low. Cobalt, molybdenum and aurum were found in those samples that were taken at the end of continuous snowfall. Those metals are typical for metallogenic specification of the region and they are an evidence of considerable role of the earth surface chemical composition in formation of precipitations geochemistry.

Ice mineralization of the glaciers varies from 7.5 to 73.9 mg/l and is 22 mg/l in average. Chemically ices are sulphate- or chloride- hydrocarbonate with a compound set of cations, but with natrium prevalence and in general are close to chemical composition of snow. The following ratio of cations ($Na^+ > Ca^{2+} > Mg^{2+}$) and anions ($HCO_3^- > SO_4^{2-} > Cl^-$) is typical for the glaciers. The content of almost all the ions in ice increases comparing to that of snow. Natural waters of those streams that run out right under the glaciers are of various chemical composition. The closest to snow chemical composition is chemical composition of a stream in the southern part of Petrov's glacier - at the contact of the glacier and lateral moraine so the chemical composition formation of this waterflow is virtually due to glacier melting. Boordu stream chemical composition differs from the one of Boordu glacier because of considerable role of the subglacial flows that are present at the contact of the glacier and basal moraine in formation of chemical composition of the stream. Chemical composition of the majority of the streams that start under the glaciers (Sarytor, Davidov's, Lysy, № 121) differs greatly from those of glaciers. This is caused by various reasons. For example, formation of chemical composition of the stream from the glacier № 121 is due to anthropogenic processes – interaction of precipitations and thawed glaciers waters with dumps from mine working rich in sulphide minerals that oxidize quickly. However anthropogenic factor is very slight in formation of chemical composition of flows from the other glaciers. Similarity in chemical composition of the streams from Syrator, Davidov's and Lysy glaciers with the one of underground waters of the region that are revealed by mining works and reveal themselves as springs at the Kumtor river valley is conspicuous.

The above-mentioned glaciers are warm ones; there are taliks at their beds through which underground waters are discharged. Considerable difference in chemical composition of a glacier and a waterflow evidences the presence of infrapermafrost discharge and its rather considerable role in formation of surface discharge. Similarity of chemical composition of

infrapermafrost waters that are discharged through taliks at the beds of glaciers confirms the role of underground waters in formation of surface flow. Waters that comprise periglacial ice mounds during the cold period of year and that influence the flow of some of the left tributaries of the Kumtor river is of mixed origin and are formed due to snow and glaciers thawing and infrapermafrost waters discharge.

Glaciers waterflows contain a large complex of microelements that are grouped according to decrease of concentration: Zn > V > Cu > Mo > Co, Cr > Pb, Y > W, Sn > Tl, Bi, Au

Key words: Hydrogeochemistry, glacier waterflows

Hydraulic conditions of Mongolian frozen ground deduced from monthly DC resistivity prospecting

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Abstract: Mongolian frozen grounds occupy the southern boundary of Eurasian permafrost, possibly displaying large spatial and hydraulic variations even over small areas. We investigated these variations by means of DC resistivity prospecting, ground temperature and total soil water (ice plus water) measurements. They were applied monthly from August 2003 to May 2004 at three representative sites: northern forested slope (NFS), flat pasture plain (FPP) and southern pasture slope (SPS). We found the annually-subzero soil layers (i.e. permafrost) at NFS and FPP. Greater DC resistivity values of permafrost at NFS indicate this permafrost to be frozen, allowing lateral downward flow of subsurface water and developing dense forests. DC resistivity values of permafrost at FPP remained low over the observation, indicating this permafrost to be unfrozen. We quantified seasonality of the ratio of frozen and unfrozen water involved in the active layer and upper permafrost. For this, Archie's empirical model, which relates DC resistivity values to soil water contents, was improved to cover frozen soils, considering soil property that represents exponential coefficient between subzero soil temperatures and unfrozen water contents.

Key words: DC resistivity, Mongolia, unfrozen permafrost, unfrozen water contents

Applying the Adaptive Cycle to Modelling Environmental and Anthropogenic Cryospheric Changes and Linking Problems of Human Adaptation and Mitigation

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Abstract: The earth's cold regions are experiencing accelerated rates of change, and the associated effects on land forms and land use raise many concerns for the health and well-being of those who live in cold regions, and also for sustainability for those living elsewhere (Gude et al., 2005). Interconnectivity and complexity characterise social-environmental systems. Although the changes being observed may be related to the physical environment and to climate in the first instance, contingent or related changes such as shifts in land use may be less obvious. However changes in land use also have consequences for key factors influencing processes of environmental change for example, in changes in albedo. The sphere of influence of the cold regions extends far beyond its geographical limits. There are many examples of changes with impacts at a global scale, such as the possibility of an ice-free shipping route across the Arctic Ocean. Similarly, while north ward shifts in frost-free season length may be very useful to farmers in certain regions, but if the longer frost-free season is also accompanied by drought, from an agricultural perspective one limiting factor has simply been replaced by another. If warming temperatures also lead to increases in sea-level rise, many ocean island states face grave danger. Clearly these are potentially massive and complex problems extending beyond the cold regions.

The scientific issues related to defining both the mechanisms and possible consequences of cryospheric change are subjects of debate but there is general agreement among scientific experts in many fields that more sophisticated and inclusive models for conceptualising change in complex systems are needed. Further it is recognised that there is a need to find methods to describe both anthropogenic factors and natural environments as interconnected systems. Such methods must also be able to address very practical problems of integrating knowledge from many different scientific fields.

Recognising that cryospheric change is likely to demand a long-term human response through environmental management based on adaptation as well as on mitigation means that it is important to develop conceptual models capable of addressing complexity as well as allowing for uncertainty. Using a systems approach that emphasises the linking of human and natural systems in an adaptive management model (Gunderson and Holling, 2002), and building on previous work (Doubleday 2005), this paper extends the model of the adaptive cycle as understood in the natural and social sciences, to include adaptation to and mitigation of environmental change in cold regions. Implicit in this approach is the understanding that human societies and their future health and well-being will be determined by many complex environmental, social and economic factors, and that in some cases, positive forces for adaptation or mitigation at one scale may produce negative or positive feedbacks at other scales.

Keywords: cryosphere, anthropogenic change, environment, adaptation, mitigation

Dynamics of cryogeological systems in river valley of northern Russia

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Abstract: The influence of superpermafrost waters on geocryological conditions were studied at near-talik zones of the rivers Berelekh and Debin, in Susuman and Jagodnoye settlements. The upper part of loose deposits composed of finely permeable alluvial, fragmentarily, eluvial-deluvial coarse-grained soil with sandy filler, sparsely, with clay and sand. At 10-15 m loose soil underlying by sandy-clay slates. According to previous research (30^{th} -60^{th} years), building sites were located at flood-plain terrace, in permanently frozen soil condition. Detailed geological engineering survey was held at deformated Central Bank building area (Susuman-city, near-talik zone of the Berelekh river). Three main phases of superpermafrost waters drainage development and, corresponding to these phases, types of engineering-geocryological conditions were detected. The first phase: formation of separate thawing zones in foundation basis; the second phase: enlargement of thawing basins and connecting of those with thawed soil gutters, developed under the service lines; the third: connecting of man-caused and natural river taliks. Their thickness varies from several meters outside the thawing bowls up to 9-15m thick under the buildings. It is typical, in winter period, at the low level of ground waters, natural and man-caused taliks function practically independently. In high water period cold river water penetrate into thawing basin of building basis.

It is necessary to mention that due of soil thawing under the building's basis and due the natural-man-caused talik formation, considerable surface subsidence and flooding of the building basements with superpermafrost and surface waters take place. As a result, during the flood period peculiar geocryological environment occurs. In case of abrupt abatement of water level the seepage of subsoil waters takes place only under the buildings, in thawed bottom soil "windows" (because of watertight seasonally frozen soil layer). According to calculations, bottom soils may be classified as piped. The possible head gradients of subvertical water filtration (seepage) were compared with critical. It was shown that in bottom soils offset of fine particles (3-5% of the whole bulk) is possible. Thus, peculiar geocryologica! conditions at near-talik zone heighten the possibility of bottom soil piping subsidence and building deformation.

Key words: drainage of suprapermafrost water, hydrothermal conditions, taliks.

Frost Penetration Beneath Snow Cover

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Abstract: In civil engineering, frost penetration is normally estimated for a snow-free ground or pavement. In a natural terrain a layer of snow decreases strongly cooling, and thus also frost penetration. In seasonal freezing and thawing, the length of thaw depends on the frost penetration during the previous winter. Thus, the snow cover dramatically reduces the length of thaw-weakening period.

In this study, frost penetration in a ground covered with a layer of snow is studied. The approaches include modeling of frost penetration in a ground, and air temperatures are varied in the course of time. The snow cover can be given as constant or varying with time. Some examples are presented, verifying the approach.

Key words: frost penetration, modeling, snow cover

The Effect of Ad Hoc Management on Alaska's North Slope Winter Oil Exploration Season

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Abstract: Over the last 30 years, the length of the winter tundra travel season allowing oil exploration on Alaska's North Slope has declined from 200 days in the early 1970's to 100 days in 2003. The narrowing operating window, attributed to climate change, poses a threat to the fiscal stability of the State of Alaska and the energy security of the United States. The implications to Alaska's economy from declining oil revenues are profound since oil royalties and taxes account for 84 percent of the State's general fund revenues. Furthermore, with 19 percent of U.S. production, Alaska's oil reduces the nation's dependency on unstable foreign oil sources. The shortened season has been prolifically cited as an indicator of climate change in publications, climate change conferences, and news media.

The Department of Natural Resources (DNR) has responsibility for making the yearly determination of when tundra conditions are suitable to declare a "general opening" for winter exploration. DNR has roughly followed a heuristic "12 & 6" standard which requires 12 inches of frost to be present in the active layer and 6 inches of snow coverage for vegetation protection. The standard was incorporated into the environmental impact statement (EIS) prepared in 1975 for the Navy's exploration of what is now the National Petroleum Reserve of Alaska (NPR-A). The objective of this research was to review DNR's management history in conjunction with statistical analysis of available scientific data to determine how much of the declining season can be attributed to climate change as compared to management choice. The results suggest that ad hoc management has been responsible for 85% of Alaska's shortened oil exploration season.

Key words: Alaska, oil exploration, climate change, tundra, natural resource decision making, active layer

The new radio wave technology for researches and 3D-geoelectrical mapping of underground inter-well space in permafrost massif

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Abstract: As many problems in the geophysical studies require the reliable values of frozen formation electric characteristics, the suitable methods giving a possibility to determine these properties in situ are of considerable interest. The radio wave geo-introscopy (RWGI) performed in boreholes is one of such method developed in Russia. It permits to obtain the effective (i.e. characterizing the electromagnetic wave propagation in real geological situation) values of electric resistivity and dielectric permittivity as well as the regularities in theirs spatial changes within the massif under study. The paper contains the main principles of RWGI, a brief description of the modern special borehole equipment, procedures of the measurements, principles of data special processing and some results of RWGI application in several sites of monitoring of Western Yakutia cryolithozone.

Sufficiently high resistivity of frozen massifs allows inter-borehole radiowave investigations at the high frequencies 1 – 31 MHz to a range up to hundred meters (in continuous permafrost,). The frozen - thawed sediment boundaries are clearly detectible and may be confidently localized due to contrasts of their electrical properties. The same is also true for inhomogeneities of geological structure and lithology.

3-D geoelectric survey of cross-hole space was performed using radio waves with two parameters found complementing each other when interpreted from geological position: resistivity and dielectric permittivity.

Such a survey shows a high resolution, it permits a comprehensive differentiation of geological sequence and provides reliable information on the rock and soil electrical characteristics *in situ*.

The considered methods are an effective way to solve various problems of geocryology, engineering geology and hydrogeology, including those related to ecological-geophysical monitoring of permafrost state changes result to technogenic impact.

Keywords: electrical prospecting, radiowave, crosshole tomography, permafrost.

The Strategy of Developing the Gold Ore Reserves under Permafrost Conditions of the Vitim Tableland

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Abstract: Vitim tableland is located at the Zabaikalia territory. The region is at all times known with its gold-bearing placers. Until recently ore deposits were poorly prospected and not exploited. Nowadays their industrial mining starts. This is very important for social and economical development of the region.

Rational strategy of the nature management is to be based upon modern concept of the cryolithozone nature-technical systems. This notion combines: 1) the character of the key economics; 2) the features of geocryological conditions having decisive impact on the local economy and the population life support. It is worth to note that some technical solutions may fit in conditions of cryolithozone nature-technical systems very successfully.

The region under consideration is characterized with thick crust of weathering including a zone of cryogenic disintegration. Location near southern boundary of permafrost area has predetermined the frozen ground unsteadiness during Pleistocene that was favorable for cryogenic weathering and loss of initial rocks' strength. It is essential that in Cenozoic the central part of Zabaikalia was not the subject to glaciations and therefore there was no exaration of fissured rocks. Taking this into account the technical mine leadership has decided to use hydraulic hammers instead of conventional drilling and blasting operations. It helps to improve the environment protection, the works' safety and in the same time to reduce the excavation cost. Besides such a method let remove the rocks by thin (up to 0.5 m) layers. This heightens many times a selection ability of the high grade ore.

Long and frosty winters impel to apply a frozen core in the dams of water reservoirs and tailings disposal facilities. Also the natural cold is planned to use for constructing the ice food depots of M.Krylov's system.

In spite of hard frosts, Vitim tableland has significant sources of renewable atmospheric heat, first of all in the insolation form. It was established that during daylight hours the heat flux more than 1κW/m^2 comes from atmosphere onto the surface with temperature 0^{o}C (for example naked frozen ground). It allows to organize the heat water supply using the simplest water heaters made of synthetic hooves.

Prospecting and experimental-industrial mining of gold ore deposits give wonderful ability to studying the thermal regime, composition and cryogenic structure of perennially frozen ground. In this connection the geocryological station is organized at one of the new mines. It will serve as the base for geoecological monitoring and a part of international program "Thermal State of Permafrost" led by IPA president J.Brown.

In conclusion it should be referred to the usage of centuries-old experience of the native people.

The dwellings for the mine shift teams was fitted out in the Mongolian yurtas (nomad's tents), where all the year round the comfortable conditions are supported.

Key words: permafrost, developing gold ore deposits, nature-technical system, cryogenic disintegration, geoecological monitoring.

Possible Change of Runoff in the Upper Yellow River Basin under Global Warming Scenarios

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Abstract: Global surface's average temperature has increased all the time since 1861, and it has increased by 0.6±0.2□ according to the 3rd science evaluation report on climatic change of 20th century by IPCC[1]. The report also showed that two periods of the most increased ranges in 20th century are from 1910 to 1945 and from 1976 to 2000. Among the changes, climatic change in the Qinghai-Tibet Plateau located at Northern Hemispherical high elevation area is stupendous especially[2].The different heated condition and the changed atmospheric circulation inevitably cause acceleration of water cycle and redistributing of water resources in space and time, they then affect ecological environment and the social economy development in the basin. The recent 10 years have the highest Global average temperature since 1861 when there are meteorological records and the lowest mean runoff in the upper Yellow Rive (at the Tangnag Hydrologic Station) since 1956 when there are hydrology observation records), and the runoff measured value in 2002 also is lowest since 1956. Durative decrease of runoff from the upper Yellow River basin not only has influenced waterpower in the northwest China, but also has influenced irrigation in the basin, and the ecological environment and national economy development in the whole Yellow River basin. It is estimated that Global warming will continue in 21st century, and the global average surface temperature will rise 1.5~4.5 □[3], which will inevitably causes the more inconsistency between supply and demand on water resources in the Yellow River basin. Therefore, the study on the possible changes of runoff in the upper Yellow river basin under the Global warming condition have the vital significance for constituting the regional social and economic developmental plan and sustainable empoldering and using water resources in the upper Yellow River basin. Therefore, the characteristics, possible causes and variations trends on temperature, precipitation and runoff in the upper Yellow River basin above Tangnag are analyzed according to hydrological and meteorological data for recent about 50 years at the observation stations, and the evolvement trend of runoff in the basin in the future decades is forecasted based on the suppositional climate scenes combination in this paper. The results indicate variation of temperature in the basin has an obvious corresponding relationship with Global warming and it all rises differently, and it variation of precipitation has the larger difference in every region in the basin because difference of located geography position since the recent about 50. Runoff in the basin has been decreasing continually since the end of 1980s because mean temperature in the basin rises and precipitation in the main areas of runoff formation in the basin decreases. Runoff will largely decrease if precipitation decreases largely and temperature rises continuously , whereas runoff will increase if temperature is immovable and precipitation increases largely, well than the increase range of runoff may be more than that of precipitation because of the supply of melt-water from snow, glacier and frozen soils in future several decades.

Key words: global warming; upper Yellow River; runoff variation; circumfluence

Influence of alpine meadow land cover change on runoff precipitation of the Qinghai-Tibet Plain, China

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Abstract: There are many permafrost and alpine meadows covers in the Beiluhe basin within Fenghuo Mountain area of Qinghai-Tibet Plain. The small Zuomaoxikongqu River in the Fenghuo Mountain area, where vegetation is simple and dominated by alpine cold meadows and alpine steppe meadows, are selected as typical catchments to study contrastively the impacts of alpine meadow land cover change on rainfall-runoff processes and soil erosion. The relationship between frozen soil together with its precipitation-runoff process and vegetation growing environment is discussed according to the monitored data of precipitation-runoff on active layers in the Tibet Plateau. The precipitation-runoff process in slop land is compared with that in permafrost. Influence of alpine meadow land cover change on rainfall-runoff discussed. Analysis result shows that vegetation ecology vegetation ecology in cold region has an interactive relationship with alpine meadow land cover change and its rainfall-runoff process. Vegetation land cover change and its rainfall-runoff process not only control the change of Surface state, but also affect the vegetation-growing extent. The result indicates that on the 30^{o} slope in alpine meadow and under the same condition of precipitation, the runoff in the meadow which holds 30% land-cover is apparently more than that in the meadows which hold 92% and 68% land-cover; at the same time, sediment yield is also more than that of the later two, and the average amount of sediment per precipitation is twice to four times as that of them. The corroding amount in the earth's surface is 3-10 times of the last two kinds of situations on average to arise from this. Cover degree high two place is it miscarry sand result is it find to compare with to produce relatively, under the same precipitation terms, 92% high to overlay place of degree runoff that produce overlay flow heavy foot-path producing in the place of degree than 68%, sand yield is just opposite. The results support the concept of vegetation as a major control upon runoff and sediment production.

Key words: alpine meadow, land cover change, precipitation-runoff, Qinghai-Tibet Plain

Theme 5. Monitoring, mapping and modeling of mountain and high-elevation permafrost

Sounding Permafrost in the Source Area of the Yellow River (Northeastern Tibet): Degrading or Already Disappeared?

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Abstract: The present status of frozen ground in the source area of the Yellow River, located at the northeastern margin of the Tibetan Plateau, was investigated to evaluate permafrost degradation and its impacts on groundwater hydrology. The fieldwork involved monitoring of temporal variations in ground thermal and hydrological regimes at an observatory and sounding of seismic and electrical stratigraphies.

The observatory was placed at the Madoi meteorological station (98°13'E, 34°55'N, 4273 m ASL) in mid-August 2004. The site lies at an elevation representative of the surrounding plateau area (4200-4300 m ASL). A data logger has automatically recorded air temperature; ground temperature at 0.03, 0.3, 1.3, 2.3, 4.3, 6.3 and 7.8 m depth; snow depth; soil moisture at 0.3, 0.6 and 0.9 m depth; and thermal properties (conductivity, diffusivity and heat capacity) at 0.1 m depth. Daily precipitation and weekly groundwater level have also been observed manually. The first year's data showed a large seasonal range with a mean annual temperature close to 0°C at the ground surface, which resulted in deep seasonal frost despite the low thermal conductivity of the topsoil. The seasonal frost penetration reached a maximum depth of 2.6 m in late April. Lack of precipitation in winter (15 mm from November to February) resulted in intermittent and very shallow snow cover, which favored frost penetration. The ground between 4 m and 8 m in depth was kept at slightly positive temperatures (0–4°C) throughout the year. Extrapolating isotherms suggest the absence of permafrost within the upper 10 m of the surface, although previous studies have reported the presence of permafrost at least until 1980s. Thus, permafrost at Madoi may have significantly degraded during the last few decades.

Distribution of permafrost was examined by refraction seismic soundings and/or electrical DC resistivity soundings at twelve sites between 3800 m and 4600 m ASL. All sites are located on alluvial plains or terraces underlain by thick fluvial sediments. High P-wave velocities (>2 km s^{-1}) and relatively high DC resistivities (650–1100 Ωm) below the thin uppermost layer (2–4 m thick) at three sites show that stable permafrost occurs above 4300 m ASL. In contrast, low P-wave velocities (<1 km s^{-1}) throughout the sediments at two sites indicate that permafrost is absent below 4000 m ASL. At three sites (including the observatory) on alluvial

plains between 4200 m and 4300 m ASL, subsurface low resistivities (30–140 Ωm) indicate the absence of permafrost below the groundwater level detected by intermediate P-wave velocities (1.5–1.7 km s^{-1}). The presence of permafrost is unclear at the other four sites between 4200 m and 4300 m by the resistivity sounding alone. A geocryological map edited in early 1990s included the whole plain area in a permafrost region, with exceptions of lakes, streams and nearby swamps. Recent climatic warming, however, would have induced significant deepening of permafrost table or even completely melted permafrost. Thus, the source area of the Yellow river currently faces a rapid loss of the permafrost area, since the elevations mostly belong to a transitional condition between permafrost and seasonal frost environments. Such rapid permafrost degradation may also significantly affect the groundwater circulation within the source area.

Key words: Permafrost, global warming, ground temperature, geophysical soundings, Tibet

Monitoring and modeling the permafrost dynamics under climate changes

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Abstract: Monitoring of cryolithozone behavior under climate changes requires a rise in precision, duration and completeness of the ground temperature and cryogenic processes observations.

The monitoring net in Russia has 15-20 permafrost stations (Vorkuta, Marre-Sale, Nadym et al.) with observational series duration upward of 20-30 years. Obtained data together with the results of meteorological observations are used for estimating cryolithozone thermal state and forecasting its dynamics in XXI century.

In the Russian North contemporary rise in the air temperature has started since the middle sixties of past century. It averages 1.1 ºC whereas the global one is essentially less, about 0.5 ºC. The climate warming is pronounced in the continental regions of cryolithozone where it may be as much as 1.4-2.5 ºC. Over Arctic plains the climate warming does not exceed 0.5-0.7 ºC. The maximum warming rate was observed in 1980-ies. The values of the air temperatures' local trends range from 0.01 to 0.08 ºC/year. The climate warming rate reduces since the middle of 1990-ies.

The permafrost thermal state is usually considered as a sensible detector of contemporary climate changes. According to monitoring data rise in the ground temperature was observed in a number of northern regions of Russia between late seventies and middle nineties. For example, in the north of Western Siberia the rise in frozen ground temperature can be estimated as 0.9 ºC for continuous cryolithozone and 0.9-1.4 ºC for the regions with discontinuous and sporadic permafrost. In Central Yakutia, in spite of high climate warming, the increasing of ground temperature manifests poorly and far from everywhere. If the rase in frozen ground temperature (at the depth of 3-10 m) occurred its relation to the rise of the air temperature ranged from 0.3 to 0.75.

Mathematical model for quantitative prognoses of permafrost evolution is well known “Stefan’s problem”. To ensure reliable results it is necessary to preset the upper boundary condition in modern form of the earth surface thermal balance (Perlshtein, 2002) including such factors as short- and long-wave radiation, convective heat flux into atmosphere, evaporation and thermal resistance of the surface covers. Due to uncertainty of climate dynamics it is expedient to use some spectrum of expected changes of climatic characteristics. Also it is important to calibrate the model. It allows to establish more exactly the thermal properties of ground and snow cover, to bring into accord the starting distribution of temperature with boundary conditions (usually it requires preliminary calculations for the period no less than 5 years).

An example of similar forecast is given for conditions of Yakutsk region. Numerical modeling was performed with the air temperature trends equal to 0.04 and 0.08 ºC/year. The obtained results show that as applied to Central Yakutia it should be anticipated insignificant rise in the temperature of permafrost upper layers, without any degradation signs. The active layer thickness remains practically unchanged. Relationship between the rise in the ground and the air temperatures was about 0.3 (the climatic parameters except the air temperature were set up invariable). When calculations are based on the air temperatures only this value is close to 0.8 (Kaurkin, 2005).

The modeling data testify that for correct prognoses it is necessary to use all available data on the changes of so-called “non-temperature” factors and especially the thermal resistance of snow cover.

The work was supported by Russian Foundation for Basic Research (grants 05-05-64215 and 05-05-64390).

Key words: climate changes, monitoring of cryolithozone evolution, ground temperature, mathematical modeling, upper boundary condition.

Influence of Upper Soil Horizons on Thermal Regime of the Active Layer of Eastern Siberia

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Abstract: Whereas permafrost is ultimately a climatic phenomenon, the thermal conductivity of the surface vegetation and snow cover via the surface offset, the thermal conductivity of the upper soil layers and the ground thermal conductivity ratio via the thermal offset, are critical in determining the regime of permafrost. In Eastern Siberia, the O soil horizon, primarily composed of organic matter, is only 1 - 2 cm thick. The A horizon, typically a dark colored layer due to the presence organic matter, reaches 5 – 15 cm in thickness. In spite of their small depths, these horizons affect significantly the heat balance of the active layer due to their low thermal conductivity and diffusivity. In addition, soil thermal properties differ in the thawed and frozen states. As a result, the mean annual temperature at the surface and in the O and A horizons, and the active layer depth vary; offsets of the mean annual temperature are formed.

A non-steady-state technique used to test soils in field and in laboratory has given a possibility to study thermal conductivity of soil horizons in landscapes of the Eastern Siberia and established variation of its values. Value of the thermal conductivity depends on water content, organic content and density of the mineral samples. Temperature dependence was established for frozen soil as well as for the ancient ice. Calculations based on Kudryavtsev's model and experimental data show a high sensitivity of the thermal mode of the active layer to the surface disturbance. Enriched by organic material, soil horizon A has a low thermal conductivity that differs in frozen and thawed states; it creates a negative thermal offset decreasing the temperature of permafrost about 1.5 ÷ 2ºC and up.

Forest fires modify ground surface conditions and cause deepening of the active layer. The subsequent disturbance of surface vegetation and organic layer changes the energy budget of soil. Thermal conductivity of the soil horizon A increases significantly after a forest fire. Values of the thermal conductivity of both organic (horizon A) and mineral soil are also enlarged in surface depressions at swamp and alas sites; therefore, a process of warming of permafrost once started could be accelerated as a result of the alteration of thermal properties of soil.

About 19% of the total land surface in the Eastern Siberia has been affected by thermokarst. However, wide distribution of alases in the Central Yakutia is not an evidence of its modern growth. Though thermal conductivity of upper soil horizons increase after fire, changes of thermal mode of soil induced by fires alone are not enough to cause ice wedges thawing. Nevertheless, climatic change followed by surface disturbance (forest fires and clearances) causes significant transformation of soil temperature mode and thermokarst appearance. In spite of obvious climatic warming in the area there are no noticeable changes of surface development on undisturbed landscapes yet, and upper soils horizons still protect permafrost.

Key words: Thermal conductivity, active layer, forest fires, thermokarst

The Simulated Current and Future Soil Thermal Regime of the Tibetan Plateau

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Abstract: The Tibetan Plateau encompasses about 7.5 % of the permafrost regions of the Northern Hemisphere, with permafrost underlying an area of about 1.8 mio. km^2. It is the southernmost permafrost region of the Northern Hemisphere where low air temperatures allow its existence at altitudes mostly between 3500m and 6000 m. The northeastern parts of the Plateau have recently been subject to considerable attention in context with the construction of the Qinghai-Tibet Railroad Line that leads over the Plateau for more than 950km at altitudes of over 4000m. Melting permafrost within the 21st century in response to increasing air temperatures and changing snow insulation represents a serious threat for constructions.

The soil thermal regime of the Tibetan Plateau is modeled by applying a one-dimensional

heat transfer model with phase change. The two main forcing parameters are surface air temperature and snow height taken from NCAR Community Climate System Model (CCSM3) output. Additionally, soil type, bulk density, and moisture content are from the NCAR-CCSM3. Simulations are performed globally for the time period 1870 to 2100 with T85 resolution of about 1.4 degrees.

We present a trend analysis for soil surface temperature and 15 further layers down to 14 m depth. In the first study we calculate linear trends for the whole 231-year time period, and for the three permafrost regions continuous, discontinuous, and sporadic/isolated permafrost (according to the IPA permafrost classification), as well as for seasonally frozen ground. We then subdivide our results into four decadal time slabs, namely 1995 to 2005 (for present-day conditions), 2020 to 2030, 2055 to 2065, and 2090 to 2100. The increase in soil temperatures and the deepening of the active layer (seasonally thawing top soil layer during the thawing season) for these three near-future time periods are discussed in detail, both for the northern-hemisphere and for the Tibetan Plateau permafrost regions. As regions near topographic features are not covered well at this spatial resolution, we put emphasis on results obtained for large and relatively t areas. Differences in soil temperature and active-layer depth in response to climate change scenarios A2 and B2 are discussed for the Tibetan Plateau in comparison to the regions Western Siberia, Eastern Siberia, Alaska/Mackenzie Basin, and Northeastern Canada.

Keywords: Soil modeling, soil temperature, active-layer depth, Tibetan Plateau, climate scenario

Permafrost in Mongolia

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Abstract: This paper presents a summary of existing permafrost study as well as permafrost condition in Mongolia.

Permafrost study in Mongolia officially began in the end of 1950 years. At the first time, our senior researchers concentrated on the regional characteristics of permafrost distribution and on the engineering geocryological problems. At present, we concentrate on permafrost mapping using the GIS and Remote sensing, on permafrost monitoring based on the temperature measurements in boreholes, on permafrost phenomena monitoring in same permafrost regions and on engineering geocryological problems.

The permafrost area covers about 63 percent of Mongolian's total territory. Monographs and papers have been published, including Permafrost of Mongolia (N.Lonjid. 1969), Basic Features of Permafrost in Mongolia (N.Sharkhuu. 1975), Seosnal Freezing and Thawing of ground in Mongolia (D.Tumurbaatar. 1975), Geocryological Conditions of Mongolia (V.F.Gravis et al., 1974) and Permafrost in the Hangay and Hovosgol Mountain Region (D.Luvsandagva). We have the map of seasonally frozen ground and permafrost distribution at

a scale of 1:1500000. This map was compiled by the results of Soviet – Mongolian geocryological expedition in 1967 – 1971. After this period our senior researchers, doctor D.Tumurbaatar, N.Sharkhuu, compiled the series of permafrost distribution map at a different scale. On these maps, permafrost is classified into seven categories: Continuous, discontinuous, widespread island, rear island, sporadic, without permafrost and seasonal.

At the present, we are carrying out the permafrost investigation in the several areas. For example, the permafrost area covers about 22.4 percent of total territory of Ulaanbaatar area.

Permafrost phenomena such as frost crack, frost heaving, stone polygons, kurum, thermokarst, solifluction, icing area developed everywhere in permafrost zone of Mongolia.

Mongolia is situated in the southern boundary of Eurasian permafrost region in which permafrost distribution is mosaic-lake, being strongly affected not only by landscape conditions but also by global climate.

Permafrost in Mongolia is degrading at various, but considerable rates depending on the local natural conditions. Permafrost, especially sporadic and isolated, is very sensitive to climate change and human actives.

In future, we need to complete the complex observation of permafrost condition in same selected areas. For this complex observation, we invite the scientists of this field to co-operation.

Key words: permafrost, geocryology, phenomena, mapping, GIS,

Long-term permafrost observatory on the block slope in the Northern Zabaykaliye

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Abstract: Practically all sectors of Arctic are bordered by the mountain systems. Mountainous regions are very complex in terms of permafrost conditions due to high variability of landscapes. We still don’t have enough information and scientific descriptions of the climate reactions on the mountain permafrost dynamics. We have to make clear the principal factors that cause the mean annual permafrost temperatures changes at diverse altitude intervals in mountains.

The Northern Zabaykalye region (South-Eastern Siberia, Russia) is very known by geologists and geographers. In 60-th–80-th of XX century the industrial development of this region was intensified. There initiated the regular permafrost investigation as interdisciplinary cooperation of different academic, educational and industrial science organizations (Chitageologia, ZabTISIZ, Permafrost Institute SB AS USSR, Moscow State University, Chita Institute of Natural Resources etc.). Now the IEG RAS (Moscow) with PI SB RAS and INREC SB RAS (Chita) recommence the long-term permafrost observation.

In 1986-1988 author participated in the investigation when the special isolated pit-camera (mine) inside the kurum (block slope) was constructed. That was destined for detailed observation of thermal and hydrologic condition in the active layer on the block slope (1170 m

e.s.l.). In 2005 this mine was equipped by modern system of temperature sensors. We obtained short-term regime information for summer condition and we expect getting out new extensive data after fieldwork 2006. The temperature measurements in 4 adjacent boreholes characterize the mean annual ground temperatures at 20 m depth. These data characterize the basic permafrost condition and show the 1-degree warming during 19-year observation period.

We continued to analyze an array of geotemperature and active layer depths data (Romanovskii et al., 1991). The geotemperature conditions in Zabaykalye are extremely variable. The average permafrost temperature at 20 m depth varies from -9 to +1.5°C. The maximal permafrost depth amounts to 900 m. The kurums, which are extremely expanded in Eastern Siberia's mountains, are cooler factor for permafrost conditions. Usually kurums cool the underlying rocks up to 1.5 ÷ 2.5 degrees (average temperature at 20 m depth). There is linked with intensive air convection, the seasonal wandering ("goltzoviy") ice forming and the water condensation in the summer time in the active layer. Extremely low temperature (up to -20°C at 3 m depth in January) in the kurum active layer results in the possibility of the active ice wedges developing under coarse debris layer.

Key words: mountain permafrost, kurum, block slope, temperature observation.

Air and Ground Surface Temperature Monitoring in Arctic Foothills of Alaska

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Abstract: The dearth of standard meteorological and ground temperature data from high-elevation locations is well known. This problem is exacerbated in the remote areas of Alaska where logistical constraints and topoclimatic effects complicate the construction of reliable air-temperature fields. Hydrologic and permafrost models rely on baseline climate data, yet weather stations in northern Alaska are concentrated along the arctic coastline leaving remote higher-elevation inland regions largely underrepresented. To improve existing air temperature fields and to establish baseline air and soil surface temperature data from representative upland locations, air and soil temperature was continuously monitored from 1995-2005 at nine sites distributed along the primary climatic gradient across Northern Arctic Foothills of Alaska. The Arctic Foothills occupy an extensive swath of rolling hills and dissected plateaus between the Arctic Coastal Plain and the Brooks Range. Fluvial drainage networks are well developed, however complex soil/vegetation communities exist owing to the effects of permafrost on local hydrology. Tussock tundra and assemblages of shrubby plant species occupy extensive water tracks characterized by acidic soils. Nonacidic soils are predominantly covered by sedges, forbs, and mosses. Standardized air and soil temperature measurements were collected using miniature automated data loggers (Onset®). The data were used to examine spatial and temporal trends in air and ground surface temperature, and their relations to varying vegetation and terrain conditions. The effects of topography on air

temperature are apparent in observed near-surface lapse rates and inversions. To evaluate the effect of vegetation on ground surface temperature, several heat-transfer coefficients were estimated, including land cover specific thermal diffusivity and empirical n-factors. The results of this study will be used to refine spatial temperature fields in complex terrain and to improve land cover parameterizations currently used in permafrost and climate models.
Key words: air temperature, soil temperature, Alaska, tundra vegetation, permafrost

Modeling the surface energy fluxes and ground thermal regime at Lhasa, Tibet

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Abstract: Ground surface energy balance in cold regions is a complex function of seasonal snow cover, vegetation, atmospheric radiation, surface moisture content, and atmosphere temperature. Thus, the accurate approach for describing ground surface temperature and ground thermal regime should be through the physically-based models which account for the relevant processes occurring within, and at the boundaries of permafrost, snow, and atmospheric components of the natural system. This study models the surface energy balance components and ground temperature at different depths at Lhasa, Tibet, by using a surface energy balance approach based heat transfer model. The influence of unfrozen water on the ground thermal regime was considered, and the effect of snow was included in the model by extending the heat conduction solution into the snow layer and computing the surface heat balance and the snow surface temperature. The baseline inputs for the meteorological characteristics are observed data at a weather station at Lhasa on the Tibetan Plateau during 1998. The net solar radiation, net longwave radiation, sensitive heat flux, latent heat flux and conductive heat flux were simulated. The surface and ground soil temperature at different depths also were calculated.
Key words: Surface energy balance; ground thermal regime; finite difference method; Qinghai-Tibet Plateau

Surface- coupled 3-D Permafrost Model for Impact Assessment on Building Foundations in Northern Canada due to Permafrost Degradation

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Abstract: In many Canadian northern communities, the stability of building foundation systems relies on the strength of the underlying permafrost. Building deterioration due to the loss of this strength/stability would profoundly affect human well-being and economic activities in the communities. The effects of permafrost degradation due to climate warming observed in recent decades are of major concern in northern Canada, both to the public and to decision makers. The Intergovernmental Panel on Climate Change (IPCC) projects that by 2100, air temperature will increase globally by 1.4°-5.8°C based on a range of greenhouse gas emission scenarios. Moreover, temperature increases in the North will be greater than the global average. There is consensus among earth scientists that air temperature increases in this century will accelerate permafrost degradation, thereby exacerbating impacts on foundation systems with serious socio-economic consequences for northern communities.

In order for public and decision makers to take adequate and timely adaptation actions to minimize potential damages, the following scientific and social questions need to be addressed: (1) How much permafrost degradation will take place due to climate change under different greenhouse gas emission scenarios and in different northern communities in Canada? (2) What will be the impacts of permafrost degradation on community foundation systems? (3) What will be the costs of the impacts with or without adaptation? (4) What are the timeframes within which adaptation action is required in order to minimize the costs?

To improve our understanding of future permafrost degradation, of the associated vulnerability of community infrastructure, and of the timeframes, options and potential costs for adaptation, a surface- coupled 3-Dimensional geothermal model has been developed.

The model has two integrated components. One component is the surface model which deals with energy and water balances of the ground surface, including snow dynamics, and the other component is the ground model which manages the coupled heat and water transfers under the ground surface. The two components are fully coupled through heat and water flux.

The model uses Finite Element Method and is three– dimensional to take account of building's effects on energy and water balances. In particular, the model modifies incoming solar radiation and precipitation distributions surrounding and underneath a building by modeling building's dimensions and orientation as part of the energy and water balance processes, and the model is purely driven by climate variables.

The model has been used for simulation of geothermal dynamics with climate change scenarios at Inuvik community of the Northwest Territories of Canada. Assessment of the permafrost degradation and its impacts on and costs to community building foundation systems for adaptation is under investigation. The paper will present the theory and validation of the model, and some geothermal simulation results.

Keywords: Climate Warming, Permafrost Degradation, 3-D Geothermal Modeling, Impact

The main regularities of permafrost extent in the Southern Siberia and in Mongolia

(In connection with small-scale mapping of permafrost in the Central Asia)

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Abstract: In the Asian region, on N.A.Marinov (1968), there are two largest permafrost massifs: Northern-Asian and Southern-Asian. The southern part of the Northern-Asian massif and the Southern-Asian massif were formed and exist only due to severe climatic conditions of mountains, highlands and plateaus.

The mountain relief causes complex permafrost distribution. There are no enough boreholes and excavations for exact mapping of mountain permafrost. Therefore with a view of small-scale geocryological mapping with scope of vast territories exclusively great value get the general regularities of permafrost distribution. These regularities allow to interpolate and extrapolate of individual geocryological data on mountain territories correctly. Revealing of these regularities is carried out with the help direct and indirect cryoindicators. The direct cryoindicators are carried out on the cryogenic forms studying of a relief which can be formed only at permafrost presence: pingos, cementry mounds and the some kinds (but not all) of solifluction forms. The indirect cryoindication is carried out by landscape methods.

The analysis of results Russian, Russian-Mongolian and Mongolian geocryological researches shows, that within the limits of mountains of the Southern Siberia and Mongolia regularities of permafrost distribution are identical. It has allowed to compare geocryological maps of Russia and Mongolia by compiling Circum-Arctic Map of Permafrost and Ground Ice Conditions (1997).

There are three directions of increase of permafrost extent:

- in a direction from the south on the north;
- in a direction from below upwards;
- in a direction from the west on the east (separately for each mountain massifs).

In a direction on the south the massif of continuous permafrost separates up to islands and isolated patches. In a direction from below upwards permafrost extent grows - first of all in the north of region, and then in the south. In both cases the predominating role belongs to thermal factors. In a direction from the west on the east of mountain massifs the extent of permafrost is depending on an exposition of slopes, on changes atmospheric precipitation caused by the western air transfer. On the western slopes of mountains because of a high snow cover permafrost distribution is less than on east ones (Altai, Saiany, Khangai, Khentei).

With a view of engineering practice on a small-scale map of the Central Asia it is expedient to show two types of territories:

- the territories where the permafrost is absent because of a high snow cover (removal or compression of a snow causes aggradation of permafrost);

- the territories where the permafrost is absent because of low ground humidity (permafrost forms after inevitable increasing of ground humidity by engineering of such sites; this process is accompanied by formation of icings and pingos).

Key words: permafrost extent, cryoindicators, small-scale mapping of permafrost.

Local-level processes associated with progressive permafrost thaw as examplified by data from a CALM grid

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Abstract: Active layer depths in the permafrost area of the European Russian North have been demonstrating clear increasing trend during the recent three decade covered with geological and CALM (Circumpolar Active Layer Monitoring) records (Oberman & Mazhitova, 2001; Mazhitova et al., 2004). In a non-linear way, the trend corresponds to climate dynamics during the same period, first of all, to the increasing trend in thaw degree days in air.

Local-level processes related to the progressive permafrost thaw are often landscape-specific and not yet well studied. CALM design allows for statistical studies on these processes with further upscaling to the regional level. The paper discusses such studies examplified with data from the 100x100 m Ayach-Yakha CALM grid located in the discontinuous permafrost zone of the European Russian North ($67^0$35.4'N; $64^0$09.9'E). The deposit is silty loam, vegetation is dwarf shrub/moss tundra, and frost boils occupy 3% of the site area.

General Linear Model analyses were used to find landscape predictors of thaw depth and to assess their relative input to thaw variability. Examined factors were the conventionally defined “macro-“ and “meso-“ topography (within-grid ranges of 5 m and 1.1 m, respectively), volumetric soil water content (14-73%), snow depth (0-70 cm), vegetation (dwarf shrub/moss class and tall shrub class) and soil organic layer thickness (5-23 cm). In different years the examined factors explained in total 5-35% of the end-of-season thaw depth variability. Effect of organic layer was most sensitive to thaw depth showing logarithmical trend (R^2=0.18).

Long-term increase in thaw depth thickness in permafrost regions causes surface subsidence, which is one of potentially hazardous consequences of climate warming. In the termokarst-prone terrain types, i.e. those with high ice content in permafrost, subsidence combined with other processes can lead to catastrophic changes of surface topography. Terrains with smaller ice contents in the ground still experience subsidence. Subsidence measurements were conducted annually in 1999-2005 at the end of warm season. Site-averaged retreat of permafrost table totaled 33 cm during this period. Accompanied with site-averaged subsidence of 17 cm, it resulted in a 16 cm increase in active layer depth. Subsidence (or heave at few grid nodes) values were well correlated with node-specific amounts of downward or upward shift of the permafrost table (R^2=0.76). Normalized subsidence index (a ratio of subsidence to permafrost retreat) approximating the ice content in the ground averaged 0.52 for the observation period. It was found that the differential subsidence changed the site surface

topography rather quickly, with some concave sub-areas turned to level and vice versa by the end of the observation period.

Permafrost surface topography in the studied landscape closely, though in an amplified manner, reproduces topography of the soil surface. Range of the altitudes is 30 to 40% larger for permafrost as compared to soil surface. Deviations from an approximating linear slope used to quantify topography are well correlated for the soil and permafrost surfaces (correlation coefficient 0.91). Such pattern can only exist in the absence of well developed pattern grounds which is characteristic for mineral sites of the area. Pattern grounds with frost cracks filled with organic material and concave frost boils usually demonstrate the inverse picture with the permafrost surface topography reflecting the soil surface topography in a mirror manner.

Use of the described analyses to assess a monitoring site representativeness of a particular landscape will be discussed, as well as upscaling problems.

The CALM project is funded by NSF (OPP-9732051 and OPP-0225603).

Key words: Permafrost, active layer, surface subsidence, upscaling.

Mapping High-Resolution Snow Depths, Soil Surface Temperatures, and Thaw Depths over the Tibetan Plateau

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Lixin Lu， Lijuan Ma

Abstract： A combined high-resolution micrometeorological and snow distribution modeling system (MicroMet/SnowModel; Liston and Elder 2006a, b) was used to simulate snow depth, snow density, snow thermal properties, soil surface temperature, and soil thaw depth evolution across the Tibetan Plateau. Our simulation domain covered a 5 degree latitude by 5 degree longitude area centered at 32.5 degrees N latitude, 92.5 degrees E longitude. Simulations were performed on a 200-m model grid increment, and included relevant processes related to snow precipitation, blowing and drifting snow, precipitation enhanced by orographic mechanisms, and snow insulating ability. Snow-ground interface temperatures were defined following the model of Taras et al. (2002), and thaw depths were calculated using a simple degree-day model. Our simulations spanned two years: 2002-2003 and 2003-2004. Meteorological forcing was provided by a combination of Tibetan Plateau meteorological stations and European Centre for Medium-Range Weather Forecasts (ECMWF) reanalysis (ERA-40) datasets. Topographic data (90-m grid increment) were provided by the NASA Shuttle Radar Topography Mission (SRTM) (http://edc.usgs.gov/products/elevation/ srtmdted.html). Vegetation data were obtained by re-sampling global International Geosphere-Biosphere Programme (IGBP), 30 arc-second (approximately 1-km) latitude-longitude vegetation/land-cover classification data to our simulation grid. As part of the model simulations, MicroMet/SnowModel was run in data assimilation mode, where AMSR-E snow-water-equivalent distributions were used to define the regional snow-distribution variations. In this presentation we outline various components of our modeling system and the model configuration required for the simulations. In addition, we provide spatial maps of our simulated snow-depth and snow-property datasets, and the

associated soil surface temperature and thaw-depth evolution and distributions.
Key words: snow, permafrost, model, soil temperature, thaw

Micrometeorological measurements of mountain permafrost in the Daisetsu Mountains, Hokkaido, Japan: the state of the art

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Abstract: Mountain permafrost is distributed in a complex manner over a large area of the upper approximately 1700m of the Daisetsu Mountains (43°N, 142°E). Numerous periglacial landforms were identified in the 1960's suggesting the occurrence of perennially cryotic ground in this area. In recent years, basic meteorological measurements and geophysical surveys of mountain permafrost have been performed in this range. However, information is still insufficient to discuss environmental controls of the occurrence and temporal variation of the mountain permafrost. This paper summarizes the history of the micrometeorological study of mountain permafrost in the Daisetsu Mountain. Second, it presents a micrometeorological station, where a 4m tower with micrometeorological measuring instruments was newly installed at a representative point of the mountain permafrost zone (2038m a.s.l.) in July 2005.
Preliminary results show that consecutive northwesterly winds prevent snow accumulation in the mountain permafrost site and enhance the energy exchange between ground and atmosphere. Summer precipitation easily penetrates through the highly permeable active layer and significantly affects the thermal regime of the layer.
Key words: Mountain permafrost, Micrometeorology, Active layer, Daisetsu Mountains

Mountain permafrost distribution and ground temperatures in Iceland and northern Norway

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Abstract: Permafrost in high-mountain environments is extremely heterogeneous, and its distribution depends on topo-climatic factors in addition to snow and vegetation cover. Iceland is governed by an oceanic climate type with low annual range of temperature (generally below 11°C along the coast), mean annual air temperature (MAAT) of 3-4°C along the coast, high

temperature variability throughout the year and high precipitation. Simple air temperature modelling and continuous ground temperature measurements in four boreholes (up to 22 m depth) combined with DC resistivity tomography document warm, thin, but wide-spread mountain permafrost at altitudes above 850 to 900 m a.s.l., at least in wind-blown areas. Numerical modelling of ground temperatures indicates that the permafrost is highly sensitive to climate variations, and modelled permafrost variations based on empirical derived time series back to the 1950ies are presented.

At Banak airport (5 m a.s.l.) close to our field area in Gaissane mountains, Finnmark, northern Norway, MAAT is 0.6°C, annual range of temperature 22°C and mean annual precipitation 345 mm. The field area constitutes a range of periglacial landforms, which includes rock glaciers, palsas, fossile ice wedge polygons, patterned ground, ploughing boulders and solifluction lobes. Bottom Tempereature of Snow cover (BTS) measurements, a network of ground surface temperature data loggers and extensive geophysical soundings indicate lower permafrost limit of nearly 400 m a.s.l. in north facing slopes, and permafrost distribution seems to be more dependent on incoming solar radiation than what is known from southern Norway.

In both areas, the investigations indicate more wide-spread permafrost than anticipated earlier, which has wider implications on geomorphological processes, landscape development and responses to present climate change.

Keywords: Permafrost; Thermal regime; Periglacial geomorphology; DC resistivity tomography; Iceland; Norway

Degradation of Permafrost in the Da- and Xiao-Xing'anling Mountains, Northeastern China and Assessment of Its Trends

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Abstract: Permafrost in the Xing'anling Mountains in northeastern China is warm, thin, thermally unstable and subsequently sensitive to climatic warming. During the past 40 years, permafrost has been degrading as evidenced by the deepening active layer, thinning of permafrost, rising ground temperatures, expansion of taliks, and disappearance of permafrost islands. Detailed analyses indicate that climatic warming and sharp reduction of forest coverage during the past century are the general and basic reasons for the degradation of permafrost, and increasing human activities have been accelerating the retreat of permafrost. Based on the close correlations between the southern limit of permafrost (SLP) and multi-year average air temperatures (MYAAT), present positions of the SLP are delineated using the MYAAT isotherms of -1.0 to +1.0ºC during the 1999-2000 decade. The SLP would shift northwards upon a warming of 1.0 to 1.5ºC during the next 40~50 years, but with significant uneven

variations in different parts.

Keywords: Xing'anling Mountains, SLP, permafrost degradation, climatic warming, deforestation

Main Features of Soil Seasonal Thawing and Freezing in the Timan-Pechora Oil-and-Gas Province

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Abstract: Soil seasonal thawing and freezing is the most important parameter used to assess the engineering geocryological conditions of developed territories. Seasonally thawing (STL) and freezing (SFL) layers regulate thermal and mass exchange between the perennially frozen ground (PFG) and the atmosphere. The large-scale engineering geocryological survey, performed by PNIIIS in the Timan-Pechora oil-and-gas province in 2000-2004, made it possible to characterize in detail STL and SFL under different landscape conditions, to estimate the effect of the zonal and regional factors of the natural environment on the processes of soil thawing and freezing, to predict technogenic changes in the STL and SFL thickness and temperature, and to estimate the permissible technogenic load (which does not initiate cryogenic hazards) during different types of industrial development of the territory. The specific features of soil seasonal thawing and freezing are as follows. (1) STL is predominant in tundra and is local in forest-tundra (is confined only to peat bogs and mounds). SFL occupies about 20% of the tundra zone and is confined to the areas with deep PFG and thawed zones. In forest-tundra SFL is predominant (occupies up to 90% of the area). (2) The depth of soil seasonal thawing and freezing varies from 0.3 to 3.0 m. The most typical STL thickness is 0.8-1.8 m in tundra and 1.0-2.2 m in forest-tundra; the SFL typical thickness is 1.0-2.0 m. (3) Transient ($t_{av.s.}$ varies from 0 to ± 1°C) and semitransient ($t_{av.s.}$ varies from ± 1 to ± 2°C) types of soil seasonal thawing and freezing are observed in the most part of the territory, which characterizes the natural environment as very dynamic. The technogenic impact can principally change the STL and SFL thickness and temperature, which provokes development of cryogenic hazards that cause deformations of engineering structures and irreversible changes in the ecosystems. Therefore, it is necessary to take complex engineering protection measures on developed territories.

Key words: Seasonal thawing, freezing, technogenic impact.

Permafrost Terrain Analysis along the Tommot-Yakutsk Railway

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Abstract: The Tommot-Yakutsk Railway now under construction is 454 km long and passes through the area between latitude 59° and 62°N and longitude 127° and 130°E. Elevations range from 100 to 600 m a.s.l. The railway route traverses the terrain with extremely difficult geocryological conditions. The difficulty is related to the development of adverse processes and phenomena, especially those associated with frost action. Their distribution, in combination with environmental factors, is differentiated into seven physiographic regions.

1. The Lena stepped outcrop, dolomite region is characterized by distinctly stepped relief and by discontinuous occurrence of permafrost. The high amounts of solar radiation and precipitation in the most southerly region determine the occurrence of unfrozen ground on elevated well-drained interfluves and warm slopes. Permafrost up to 30 m thick occurs on the shadowed north-facing slopes, and on the lower slopes and bottoms of small valleys (Figure). The northern limit of unfrozen ground is indicated by the range of cedar pine and mixed forest of pine, larch, aspen, birch and occasional cedar pine with undergrowth of mountain-ash. Ground temperatures (T_g) vary from +1.0 to –2.0°C, depths of seasonal freezing (ξ_{fr}) are 2.0 to 3.5 m, and depths of seasonal thawing (ξ_{th}) range from 0.8 to 2.5 m. The railway route passes along the foot of slopes and crosses the bottoms of small valleys, where surface disturbance would trigger solifluction, movement of rock fields, frost heaving and thaw settlement.

2. The Lena-Aldan rolling watershed, dolomite region is also characterized by dissected relief, but permafrost with thicknesses of 50 m in the south to 650 m in the north is continuous. T_g varies from +0.5 to –3.5°C, ξ_{fr} from 2.3 to 3.5 m and ξ_{th} from 1.2 to 3.0 m. Shallow taliks are encountered locally on interfluves, warm slopes, burns and forest cuts. Because of the dominance of surficial clayey silts on the slopes, percolation of suprapermafrost water is impeded resulting in downslope flow. This leads to accumulation and ponding of suprapermafrost water on the footslopes and small valley bottoms, causing peat accumulation, heaving and ice saturation in proluvial-alluvial deposits that are crossed by the railway route. Surface disturbance will inevitably result in solifluction, mud flows, slumping, thaw subsidence, and sheet and rill wash.

3. The Lena-Amga rolling, karsted limestone region has less dissected relief and continuous permafrost with an estimated thickness of 650 to 720 m. T_g varies from +0.5 to –3.5°, ξ_{fr} is 2.5 to 3.2 m and ξ_{th} is 0.8 to 2.5 m. Both surface and subsurface karst is developed throughout the region. Surface disturbance in the areas crossed by the railway route causes slumping, mud flows, solifluction, thaw subsidence, frost heaving, and sheet and rill wash.

4. The Lena-Aldan undulating, sandstone region has continuous permafrost with an estimated thickness of 400 to 620 m, T_g of +0.2 to –4.0°C and ξ_{th} of 0.7 to 2.3 m. The region is a slightly dissected plateau of the Jurassic mantle of planation blanketed by polygenetic clayey silts which contain ice wedges in the north and highly kaolinized silty sands derived from sandstones in the south. Shallow infiltration-radiation taliks are encountered on formerly burned areas on the interfluves. Poor surface drainage keeps them wet due to infiltration of precipitation. Solifluction, thermokarst, slope and valley karst are widespread in the region. In

disturbed landscapes, thaw subsidence, mud flows, and sheet and rill wash are common.

5. The Lutenga-Lena alas, silt region consists of high terraces of the Lena River. It is dominated by Quaternary deposits, which contain large amounts of massive and structure-forming ice and highly thaw-sensitive permafrost. Permafrost has a thickness of 300 to 420 m, T_g varies from 0 to –4.0°C, ξ_{th} from 0.7 to 2.9 m, and ξ_{fr} in alas deposits is 2.5 to 3.0 m. Surface disturbance could result in lake thermokarst. The region of the so-called "ice-wedge complex" poses the most serious problems for railway construction.

6. The Bestyakh sand-ridge region consists of middle-height terraces of the Lena River. It arbitrarily includes a fragment of the V terrace of the Lena River covered by eolian sands. The thickness of uniform permafrost is 150 m. In general, the region is characterized by complicated groundwater and permafrost conditions. Supra- and intra-permafrost water-bearing taliks are widespread which dictate the complex patchy and layered structure of permafrost. T_g varies from +0.5 to –6.5°, ξ_{th} is from 0.4 to 4.0 m, and ξ_{fr} is locally 2.5 to 4.0 m. Landforms produced by piping and thermal erosion occur on the sand ridges, and seasonal and perennial frost mounds are present on the bottoms of small valleys and on the inter-ridge depressions.

7. The Lena valley and forest-steppe, sandy silt–sand region covers the floodplain and low terraces of the Lena River. Unfrozen ground masses, transient and irreversible frozen and thawed layers, as well as 'aprons' and 'islands' of frozen ground determined by the hydrologic regime of the Lena River are widespread in the region. Permafrost thickness increases with increasing distance from the river channel from a few meters to 300 m. T_g varies from –0.1 to –3.5°C, ξ_{th} from 1.2 to 3.5 м, and ξ_{fr} ranges locally from 2.5 to 4.0 m.

Key words: Physiographic region, permafrost landscape, engineering geocryological condition

Preliminary Permafrost Maps of Antarctica

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Abstract: Only 0.33% of the 14 million km^2 Antarctic region (>60ºS) is ice-free. Ice-free areas, which include exposed bedrock as well as unconsolidated materials, can be divided into eight subregions. The Transantarctic Mountains (TAM), which bisect the continent, contain about 45% (20,000 km^2) of the ice-free area. The Antarctic Peninsula and its offshore islands constitute the second largest ice-free area at 13,600 km^2 (35% of area). The other ice-free regions, including the Vestfold Hills, Queen Maud Land, the Pensacola Mountains, the Ellsworth Mountains, Marie Byrd Land, Enderby Land, and Wilkes Land, contain the remaining 20% of the ice-free area. The McMurdo Dry Valleys (MDV, 4,800 km^2) in the central

TAM constitute the single largest ice-free area in Antarctica. In this study we provide preliminary permafrost maps for each of the key ice-free subregions, the MDV, and individual valleys within the MDV, including the Victoria Valley system, Wright Valley, and Taylor Valley. Based on our analysis, continuous permafrost occurs throughout the continent from the interior to about 67ºS along the Antarctic Peninsula. Discontinuous permafrost occurs along the Antarctic Peninsula (>67ºS) but is continuous at elevations above 50 m. Sporadic permafrost occurs in the Antarctic and subantarctic islands (ca. 60-62ºS), primarily at the higher elevations. Ice-cemented permafrost is dominant in all subregions, but dry-frozen permafrost occurs in the Sør Rondane Mountains, the Prince Charles Mountains, and the TAM. In the TAM about 35% of total area of permafrost is dry-frozen. Permafrost form is related to climatic zone, age of sediments, and local site factors. Ground ice is present in ice-cored alpine moraines and pyroclastic materials, coastal tills of Holocene age, and hummocky drifts of late Quaternary age (ca. <115 ka). Ice-cemented permafrost is present not only in coastal areas and in sediments of late Quaternary age, but also occurs in soils of pre-Quaternary-age along the Polar Plateau. Dry-frozen permafrost occurs in interiors of larger ice-free valleys on sediments of pre-late Quaternary age. Dry-frozen permafrost, which may be unique to Antarctica, appears to form from sublimation of moisture in ice-cemented permafrost over time.

The physical mechanism in freezing processes of soil and the constitutive model of frozen soil

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Abstract: By explained of the physical process of freezing processes and studied conservation equations and constitutive equations, material characteristics of frozen soil is studied from the viewpoint of meso-mechanics mechanism of the composite materials. Frozen soil is firstly regarded as compound body unit which is composed of soil and ice. Secondary, for the coupling problem of soil and ice, the soil grain which had the big composition is taken as framework but ice was regarded as filler, which is coupled to constitutive relation of frozen soil by using classical mixture law idea in composite material theory. And the influence of the damage factor is finally considered. The equivalent modulus of elasticity E and equivalent Poisson's ratio ν of frozen soil by an expression of modulus of elasticity and Poisson's ratio of soil and ice are gained. According to damage mechanics, and then the damaged constitutive relation in frozen soil material is: $\sigma = (1-D)E\varepsilon$. The Weibull distribution with double parameters can express damage of frozen soil. So the damaged constitutive relation of frozen soil is shown as follows:

$$\sigma = E\varepsilon \exp\left(-\frac{1}{n}\left(\frac{\varepsilon}{\varepsilon_f} \right)^n \right)$$

Based on this constitutive model, stress-strain curves of the frozen sand soil with different volumetric percentage of ice at different temperatures are calculates. The results look highly consistent with the experimental data, which indicates that this model can well describe the mechanical characters of frozen soil.

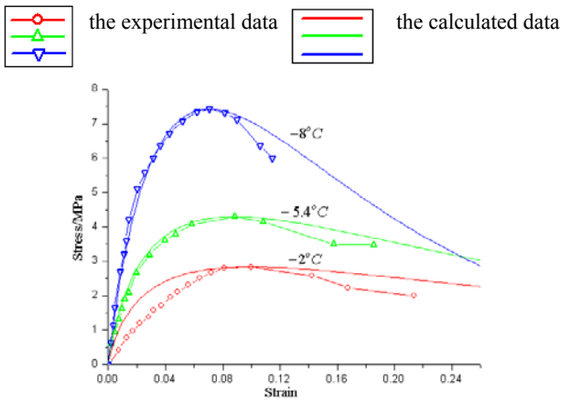

Fig.1 Compared curve of stress-strain of frozen sand soil under different temperature (K_i =0.05)

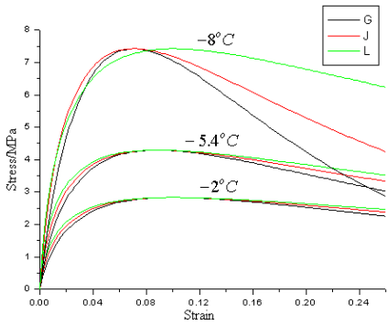

Fig.2 Curve of stress-strain under different temperature

Key words: frozen soil, constitutive model, frozen fringe, moisture migration, damage

Mixed Environment Developing Research on the Distributed Qinghai-Tibet Railroad GIS

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Abstract: A distributed GIS system, which is the base of the Qinghai-Tibet railroad model platform (named 'Digital Roadbed'), has been built presently by developing with IDL(Interactive Data Language), C# and SDE(Spatial Data Engine) environment. This application system is used to support the construction and research activities of Qinghai-Tibet railroad which is the highest plateau railroad in the world.

A number of approaches can be adopted to implement distributed GIS applications. But it's difficult to strike a proper balance between the performance, developing difficulty and developing cost due to the special requirements of the Qinghai-Tibet Railroad GIS application on the spatial data manipulation, security, and so on.

IDL is a kind of new type object-oriented interactive data manipulating language base on matrix, and it has powerful matrix-based computing abilities and is with a big function library.

The IDL is a proper tradeoff between flexibility, developing difficulty and cost. The SDE is a ‘midware’ between RDBMS database and spatial data users. Users can manage and access their spatial data stored in a RDBMS database such as Oracle, SQL Server and so on. In the developing solution C# is used as a ‘glue’ to integrate IDL and SDE into the object system because of the shortcoming of IDL on GUI (Graphical User Interface) programming and SDE accessing.

To achieve the developing goal above, two key problems were solved. The first one is accessing interface between ArcSDE, which is a kind of SDE, and .Net environment (C# routine). As IDL can’t access ArcSDE database directly, a set of ArcSDE APIs was reclassified, encapsulated and reused in C# shell program to support spatial data access. The second one is communicating between C# and IDL. The communicating mechanism between C# and IDL, found in the initial stage test of development, is very different from the mechanism between VB and IDL mentioned in the official document of IDL. A new communicating method named ‘matrix dividing transfers’ was set up and improved to support the data exchange between C# and IDL.

Mixing IDL and SDE to construct distributed GIS applications is a cost-effective and feasible developing way in which the object GIS system not only benefits from the strongpoint of IDL on spatial data manipulation and three-dimensional visualization, but also is enhanced by the spatial data management and data security of SDE. In addition, the developer need not pay lots of money for the costly GIS developing component license.

In this way, after the light-weight version of the ‘Digital Roadbed’ for the Qinghai-Tibet railroad was built successfully in the end of 2003, a heavy-weight version of the ‘Digital Roadbed’ is now being beta tested.

Key Words: GIS, IDL, SDE, Distributed Application, Qinghai-Tibet railroad

Distribution of permafrost in Middle-East Section of Mt. Qilian

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Abstract：The Qilian-mountain lies in northeast edge of Qinghai-Tibetan Plateau, where permafrost distributes widely. Research about permafrost has nearly been done in previous time. In 2004, a drilling investigation that served for several roads in Qinghai province of China was carried out. Based on the information of drilling investigation, the distribution characteristics of permafrost in this area were described. With the increase of altitude, the type of frozen soil varied from seasonally frozen ground zone, patchy permafrost zone to continuous permafrost zone. Altitude limit of permafrost descends from west to east along latitude. In the same time, slope face, seasonally snow cover and vegetation evidently affect the distribution of permafrost. Compared with the former result of investigation, it can be concluded that permafrost is degenerating in this region.

Keywords: Qilian-mountain, permafrost, distribution

Mountain permafrost study in the Russia Altai Mountains

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Abstract: The Russia Altai Mountains are located in the boundary between the West Siberia Plain and the central Asian Mountains. Because little permafrost studies had been performed in this region, the jointed research group of National Institute of Polar Research (Japan) and Altai State University (Russia) has researched the mountain permafrost in the Russia Altai Mountains since 2003. The intensive field works have been performed in the South Chuyskiy Range (49°N, 87°E) located in the northern part of the Russia Altai Mountains. Here we present the primary report of the air and ground temperature regime and the distributions of the rock glaciers, pingos and ice-wage polygons in and around the South Chuyskiy Range.

We have monitored the air and ground temperatures (0, 0.5, 1.0, 1.5, 2.0 m in depth) in the north-facing slope of the Akkol valley located in the central part of the South Chuyskiy Range. The altitude of the monitoring site is 2560 m Above Sea Level (ASL). Mean annual air temperature was –4.7°C. The monthly mean air temperatures in July that is the warmest month and February that is the coldest month were 11 and –23°C, respectively. The mean annual ground surface temperature was –5°C. The large diurnal ground surface temperature variations throughout the winter indicated that the winter snow falls were negligible small on the measurement site. The active layer thickness was estimated approximately 2.5 m based on the yearly maximum ground temperatures gradient.

Numerous active rock glaciers are distributed on the north- and west-facing slope of the Akkol valley and the Tardura valley in the South Chuyskiy Range. The altitudinal range of the distribution of the rock glaciers is between 1700 m and 2600 m ASL. Many pingos exist in the bottom of the Akkol valley and Kosh-Agach basin. The altitudinal range of the pingos is between 1700 m and 2300 m ASL. Ice-wedge polygons were observed on the bottom of the Akkol valley. The distributions of these features indicate that the present mountain permafrost lower limit in the South Chuyskiy Range is approximately 1700 m ASL.

Keywords: Mountain permafrost, The Russia Altai Mountains, Rock glacier, Pingo

Change in hydro-thermal regimes in the soil-freezing regions in the Global Warming simulation by a CGCM of moderate- and high-resolution

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Abstract: The land cryosphere, mostly underlain by permanently or seasonally frozen ground, is projected to experience a largest increase of near-surface temperatures under the Global Warming at the end of this century. Degradation of permafrost, or changes in the active layer depths and seasonally-frozen layers will exert a large impact both on the socio-economy and on the eco-climate system in the regions. Such changes, however, may not be contained at a local scale but will affect other regions through several physiochemical and biological pathways. Therefore, the changes in the soil-freezing regions cannot be neglected for an adequate estimation of the impacts due to the Global Warming. As a first step for such estimation, change in hydro-thermal regimes was examined by a global land-ocean-atmosphere coupled model (CGCM) of a moderate (T42) and high (T106) horizontal resolutions, including soil-freezing processes.

The model was developed by CCSR/NIES/FRCGC, and run at the Earth Simulator at JAMSTEC. The 200-year integration from 1900 to 2100 followed the IPCC AR4 specification; climate of the 20th century (**20c3m**) and 720 ppm stabilization experiment (**SRES A1B**). The land surface scheme includes ground heat and water transfer, and canopy structure and vegetation biophysical processes. Typical land grid interval is about 50 km and 250 km for T106 and T42, respectively, and the ground down to 4 m was divided into five layers of different depths. Two 20-year periods (1980 to 1999, and 2080 to 2099) were selected as the reference periods for present-day and projected climatology, respectively. 200-year times series was also used for the analysis.

Due to the limitation in the horizontal dimensions and the resolved depth, we employed a new classification of the frozen ground. The area is classified as a multi-year frozen ground (MFG) when soil temperatures at any depth are kept below the freezing point during the analyzed period. Similarly, it is seasonally frozen ground (SFG) if a soil layer at any depth is frozen at some time of year. The geographical mapping of present-day MFG and SFG showed reasonably good correspondence with the respective current distribution of continuous permafrost and seasonally-frozen ground. The former occupied about 17% of the Northern Hemisphere open land surface. MFG were found only in eastern Siberia and Arctic Canada (about 6% of the open surface) at the end of the 21st century, implying of the deepening of the active layers and/or degradation to SFG in large areas. Changes in the hydro-climate of the high-latitude will be discussed in the presentation. Impact of the horizontal resolution difference in the simulated distribution of the frozen soil and the hydro-thermal regimes will also be reported.

Key words: climate change; permafrost; seasonally-frozen ground; global climate model; thermal regime; hydroclimate

Permafrost Distribution and Thickness in Mesozoic Basins of the Aldan Shield

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Abstract: A series of Mesozoic basins occur in the junction zone of the Aldan shield and the Stanovoy fold system situated in north-eastern Eurasia, of which the largest are the Chulman, Tokarikan-Konerkit, Guvilgra, Ytymdzha, Upper Gynym and Toko basins. Southern Yakutia is one of the major industrial areas in Yakutia which has a rich variety of minerals. Most mineral resources occur within or below permafrost. Exploration and development of mineral deposits require a knowledge of permafrost and groundwater conditions for the construction of engineering structures, utilities and mines.

Because of little geothermal research in the area, a very general characterization of the permafrost conditions is available in the literature. Mapping and description of the permafrost in the Mesozoic basins rest on information obtained for the Chulman basin. Recent observations indicate that this is not true.

The climate in the Mesozoic basins is characterized by a strong temperature inversion and the west-east decreasing trend in mean annual air temperature, from –9.5°C in the Chulman basin to –11.4°C in the Toko basin. Permafrost in the basins is discontinuous and varies in thickness from a few meters to 250 m. The geothermal heat flux is from 45-47 (the Chulman, Tokarikan and Guvilgra basins) to 65 mW/m^2 (the Toko basin).

The temperature field and permafrost in the Mesozoic basins within the Stanovoy foreland develop under the combined effect of air temperature inversion, meridional climate variation and increased geothermal heat flux relative to the surrounding geological structures. Low mean annual air temperatures in combination with high precipitation result in a great diversity of ground temperature conditions, while variations in the geothermal heat flow determine permafrost thickness in these structures. Permafrost has been found to be discontinuous with a thickness of 190 m only in the Chulman basin. In the basins located to the east, permafrost is continuous and ranges 120 to 240 m in thickness (Tokarikan, Guvilgra, Toko and others). Important features of permafrost in the basins are the presence of open taliks (extensive or localized) and the decrease in thickness at the contacts with ancient crystalline massif. They are related to fracture tectonics of these zones and to groundwater dynamics.

Mountain permafrost in Japan: reviews and perspectives

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Abstract： In 1970’s Japanese mountain permafrost was found at volcanic high mountain ranges, Mt. Fuji and Daisetsu Mountains. Thereafter the lower limit of permafrost distribution was evaluated by annual air temperature monitoring and mapping the permafrost-related landforms. Intensive geophysical prospecting and ground temperature monitoring conducted at numerous

sites from late 1990's to early 2000's showed that permafrost is present in two contrasting situations: wind-blown, thinly snow-covered terrain and thick blocky sediments covered with late-lying snow. The former situation occurs in the summit areas of the Daisetsu Mountains and Mt. Fuji, where thin snow cover permits deep frost penetration in winter. The latter involves talus-derived rock glaciers in deglaciated cirques in the Japanese Alps and Hidaka Mountains, where the permafrost is possibly preserved by both intensive cooling through matrix-free boulders and the thermal insulation effect of thick snow cover lying until late summer. Intensive cold air ventilation also allows perennial ground ice to develop in some block slopes and lava tubes below the timberline, even where the mean annual air temperature is considerably above 0 °C. Above mountain permafrost are situated on far south of zonal boundary of Eurasian continental permafrost and thus might degrade significantly due to climate change. Prediction of this change needs more understanding of modern energy balance over permafrost and thermal stability of permafrost.

Key words: Japanese mountain permafrost, rock glaciers, ventilation, wind-blown ground

Spatial Rules of Dynamics of Geocryological Conditions in Mountainous Regions of Russian Asia

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Abstract：Long-term geocryological researches in mountain systems of the Sayan and the Altai let us draw a number of fundamental conclusions that serve as a basis for the main theses of the paper.

1. A combination of various natural conditions in mountainous regions of the Altai and the Sayan determines quite considerable distribution of seasonally and perennially frozen soils. Perennially frozen soils occupy about 20% of the region and are found at the majority of mountain geosystems.
2. Changes in nature of permafrost development, its thickness and temperature are mainly due to two geographic patterns of altitudinal zonality and meridional sectors. At the same time an increase of permafrost area and its thickness, as well as a decrease of its temperature, are not of linear dependence. General tendency of increase in severity of geocryological conditions depending on altitude and from west to east is of complex nature.
3. Specific combination of natural-permafrost parameters within a single geosystem of the region allows making geocryological mapping.
4. Large-scale development of mountainous regions of the Altai and the Sayan, including industrial, civil, transportation development and engineering, mineral resource industry etc., should be carried out taking into consideration permafrost conditions of the region.

Permafrost Distribution and Thickness in the South-Eastern Siberian Platform

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Abstract: The primary factors controlling the development and distribution of permafrost are mean annual temperature at the active layer base or at the depth of zero annual amplitude (t), ground thermal conductivity (λ) and geothermal heat flow (q).

The existence and evolution of permafrost in the south-eastern part of the Siberian Platform is determined by climatic, geologic and geomorphic conditions. Despite the low negative mean annual air temperatures (–6.3°C to –11.4°C), the permafrost temperatures, distribution and thickness are highly variable over the region. This is attributed to spatial variations in the heat exchange conditions between the atmosphere, soil and lithosphere, as well as to variations in λ and q.

The southern part of the Siberian Platform is one of the most intensively studied regions in Asia with respect to permafrost. Numerous studies conducted since the 1950s revealed the basic patterns of permafrost distribution. However, lack of sufficient information on permafrost thickness and position of the permafrost base makes it difficult to comprehensively assess the present-day permafrost and, hence, to develop reliable paleoreconstructions or predictions of its future evolution.

During the last twenty years, staff members of the Permafrost Institute, including the present author, have carried out geothermal measurements in 1,800 boreholes, of which 850 boreholes are deeper than 100 m. These investigations included single, repeated and intensive geothermal observations. Permafrost thicknesses were determined from ground temperature measurements in 210 boreholes penetrating through the entire permafrost. This enabled us to characterize the geothermal field to 3,000 m depth, to compile maps of geothermal heat flow, permafrost distribution and permafrost thickness, and to construct geothermal profiles of permafrost 650 to 900 km in extent.

In the study region, ground temperatures at the depth of zero annual amplitude vary from +2.0 to – 8.0°C, the geothermal heat flux ranges from 20 to 65 mW/m^2, and the thermal conductivity varies from 2.3 to 8.6 W/m·K in metamorphic rocks, from 2.2 to 3.7 W/m·K in igneous rocks and from 1.9 to 6.6 W/m·K in sedimentary rocks. These parameters in combination control the development of permafrost in the region. Based on measurements, the maximum permafrost thicknesses occur in the northern Lena-Aldan Plateau (Ulu site) and in the Olekma-Chara Upland (Udokan Ridge) at 1,900 m elevation, being 720 and 616 m respectively. The estimated permafrost thickness in the Kodar Range having elevations of 2900-3000 m a.s.l. can reach 1,050 m.

According to permafrost distribution, three hypsometric levels have been distinguished in the region. The lower level lies between 200 and 600 m isohypses and has continuous permafrost. The middle level, between 600 and 1,300 m isohypses, is the zone of transition from the shield to the platform and has discontinuous, frequently thin (50-100 m) permafrost. The upper level lies above 1,300 m; the permafrost distribution is continuous here. There is a clear altitudinal trend in permafrost temperature and distribution. Each of these levels has been

found to have distinctive permafrost landscapes.

The thermal regime of permafrost in the region is normally in a quasi-steady-state. However, an unsteady state exists in the Baikal-type basins where permafrost has anomalously large thicknesses and is degrading. The thickness of permafrost varies from 200 to 475 m in the Chara basin and from 150 to 250 m in the Upper Tokko basin. The maximum permafrost thickness in these basins is observed where basement rocks occur at greatest depths.

The obtained data have been compiled into a geocryological database of the south-eastern Siberian Platform. From analysis of these data, one- and multi-dimensional regression equations have been derived which relate permafrost thickness and temperature to elevation, surface slope angle and slope aspect.

The permafrost temperature changes at D105, northern Tangula Mts. and the climate warming on Tibetan Plateau

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Abstract: Climatic change is one of the important problems in the high latitude. The climatic warming is amplified and occurs rapidly in the polar regions. This is especially true in the permafrost regions. As one of the highest and complex plateau, Tibetan Plateau also experiences the fast warming. And therefore the ground temperature is increasing and the permafrost is degrading. In this paper, based on the 16 years ground temperature observation at site D105, northern Tanggular Mts on the Tibetan Plateau, the soil thawing/freezing processes and their variations were analyzed. The results showed that the ground temperature is increasing, corresponded to the climate warming significantly.

KeyVwords: permafrost, temperature, climate warming, Tibetan Plateau

Monitoring of Permafrost in Mongolia

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Abstract: Permafrost zones occupy almost two thirds of Mongolia, predominantly in the Khentei, Hovsgol, Khangai and Altai Mountains and surrounding areas. The territory is characterized by mountain and arid-land permafrost, sporadic to continuous in its extent, and underlain the southern fringe of the Siberian permafrost zones. Most of the permafrost is at temperatures close to 0°C, and thus, thermally unstable. According to the climate change

studies (Natsagdorj et al. 2000), the mean annual air temperature in Mongolia has increased by 1.56°C during the last 60 years.

Monitoring of permafrost in Mongolia is started since 1996. Main purpose of the permafrost monitoring is to estimate values of recent changes in permafrost under influence of climate warming and human activities, such as land use in Mongolia. The monitoring is carried out within the framework of the Circumpolar Active Layer Monitoring (CALM) and Global Terrestrial Network for Permafrost (GTN-P) programs. In addition, some cryogenic processes and phenomena are monitored at different monitoring sites.

The main criteria of permafrost monitoring are active layer depth and mean annual permafrost temperature at the level of the zero annual amplitude. Long-term CALM and GTN-P programs are based on ground temperature measurements in shallow to deep boreholes. Each borehole for monitoring is installed by certain instrumentation in order to protect air convection in them. Temperature measurements in the boreholes are made using the same thermistors at the corresponding depths, and carried out on the same dates of any year. In addition, temperature data loggers and thaw tubes are installed in some of the boreholes. Monitoring of frost heaving, thermokarst and icing is based on leveling measurements.

At present, we have 14 sites of permafrost monitoring in Mongolia. There are five (Baganuur, Nalaikh, Argalant, Terelj and Gurvanturuu) sites in Khentei, two (Terkh and Chuluut) sites in Khangai, six (Sharga, Burenkhan, Hatgal, Ardag, Hovsgol Project and Darhad) sites in Hovsgol, and Tsengel site in Altai mountain regions. Each site has one or several monitoring boreholes with depth of 5 to 15 m. A depth of six boreholes reaches 50-80 m. At present, there are 37 both CALM and GTN-P active boreholes in Mongolia. Most of 5-15 m deep boreholes are redrilled during last 10 years in the points where old closed deep ones were investigated well (in a detail) 15-35 years ago. Therefore, the monitoring of permafrost in Mongolia is long-term.

The initial results of permafrost monitoring show that permafrost under influence of recent climate warming and human activities in Mongolia is degrading with different rates depending on regional and local character of changes in climate and natural conditions. The rates of increase in active layer depth and mean annual permafrost temperatures vary 3-30 cm and 0.1-0.4^{o}C, respectively. A rate of permafrost degradation in bedrock is more than that in unsolidated sediments, in ice-poor substrates more than in ice-rich ones, on south-facing slopes higher than on north-facing ones, and at sites with human activities more than at those without them. A temperature gradient of permafrost is increasing with depth. For example, permafrost temperature gradient in Darhad depression was 0.025^{o}C/m at 20-50 m depth and 0.038^{o}C/m at 50-80 m depth. In generally, permafrost degradation during last 15-20 years was more intensively than during previous 15-20 years (1970-1990s). Meanwhile, the permafrost in the Hovsgol Mountain Region is degrading more intensively than that in the Khentei, Khangai Mountain Regions.

Dynamics of thermokarst thermoerosion, frost heaving, solifluction, kurum and icing are monitored at seven sites of the Hovsgol, Khangai and Khentei Regions. Especially, the thermokarst and the thermoerosion are direct indicators of ancient and recent degradation of permafrost under climate warming. By visual observation during last 30 years, a rate of settling due to thermokarst processes (lake and sink) at Chuluut (in Khangai) and Nalaikh (in Khentei)

sites is estimated to be 3-10 cm per year. Maximum subsidence of up to 20-40 cm per year was observed during the formation of incipient thermokarst pond at Chuluut site. During such events, spring water discharges in thaw pond were 0.2-1.0 liter per second. In late August 2004, one and half m thick active layer landslide on pingo ice table occurred on southeastern steep slope of the degrading 5 m high pingo at Nalaikh thermokarst site. Small subsurface cavities on the permafrost table are formed because of melting ice wedges in Darhad depression, Hovsgol Region. Large cattle (yaks and horses) fell into deep (3 m) surface cavities and died there. Although the vertical extent of some thermokarst depression and thermoerosional riverbanks in Darhad depression reaches 15-25 m, the average is 3-7 m. In the 1970-s, Choiden Lake (in Darhad degression), water body about 2 km in diameter disappeared due to thermoerosional changes in the river channel leading to the lake. The lake depression dried gradually over the last 15 years. In addition, a rate of thermo-erosion, based on the collapsing 6-8 m high Chuluut River banks (composed of ice-rich lacustrine clays) is estimated to be in the range of 15 to 30 cm per year.

The recent degradation of permafrost under influence of climate warming leads to some changes in natural and ecological balance. In particular, there are observed some processes of desertification in steppe zone and deforestation in taiga zone of Mongolia.

Key words: active layer, permafrost temperature, thermokarst and thermoerosion

Mapping of Mountain Permafrost in Mongolia and Central Asia

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Abstract: According to the first recommendation of the International Symposium on Mountain and Arid Land Permafrost (Ulaanbaatar, 2001), an international team experts from China, Kazakhstan, Mongolia and Russia are required to prepare a uniform map of Central Asian permafrost. Main tasks of the IPA working group on mapping and modeling of mountain permafrost (ICOP, 2003) are to analyze the experience of permafrost map in the different countries and to develop uniform legend for compiling Central Asian permafrost map. Different principles and methods of permafrost classification and mapping in China, Kazakhstan, Mongolia and Russia lead to some difficulties in compiling the uniform map. Moreover, initial data for the map are very different in every mountain regions of Central Asia. The objectives of this paper are to analyze present state of permafrost mapping in Mongolia and to put forward for discussion the proposed draft of unified legend for compiling Central Asian permafrost map.

Present state of permafrost mapping in Mongolia. As a result of Joint Russian and Mongolian geocryological expedition in 1967-1971, G. F. Gravis et al. compiled permafrost map of Mongolia (1:1500000), which shows distribution of permafrost and cryogenic phenomena. Based on latitudinal zones and altitudinal belts of permafrost distribution, the permafrost zone of Mongolia is divided into geocryological areas of sporadic (<1%), scattered islands (1-5%), islands (5-40%), discontinuous (40-80%) and continuous (>80%) permafrost by its extent. Subsequent mapping of permafrost in Mongolia has been carried out by N. Sharkhuu

on the basis of determining temperature regime of permafrost formation.

Basic parameters of ground temperature regime are mean annual ground temperature and geothermal gradient. In order to obtain the parameters, the author carried out geotemperature measurements in more than 400 boreholes with depths of 10-200 m which are located mainly in Hovsgol, Burenkhan, Erdenet, Argalant, Nalaikh and Baganuur areas. Based on factor analysis and approximate calculation for the obtained data, the author established a number of quantitative parameters of changing mean annual ground temperature depending on major factors of natural condition such as on altitudinal and latitudinal zonation, ground composition and moisture content, slope aspect, vegetation and snow covers, air and water convection in ground and other factors.

As a result of the above established parameters, the author compiled more than 20 permafrost maps of Mongolia and its regions and areas on various scales. The maps show distribution, thickness, temperature and ice content of permafrost and distribution of cryogenic phenomena. In accordance with the maps, permafrost conditions in the Selenge river basin, embracing most territories of the Hovsgol, Khangai and Khentei mountain regions have been relatively well studied and mapped. However, permafrost conditions in the Altai mountain region and southern boundary of permafrost zone in Mongolia have been studied insufficiently.

Permafrost zone occupies almost two thirds of Mongolia, predominantly in the Khentei, Hovsgol, Khangai and Altai Mountains and surrounding areas. The territory is characterized by mountain and arid-land permafrost, sporadic to continuous in its extent, and occupies the southern fringe of the Siberian permafrost zones.

Proposed draft of unified legend for compiling Central Asian permafrost map is developed based on analyzing circumarctic map of permafrost and ground ice conditions and permafrost maps of China, Kazakhstan, Mongolia and Russia. There are the following five components on the legend: 1) Main component of the legend is distribution of permafrost, seasonal frost and glaciers, which are shown by numbered colors from cold to warm tone. Permafrost zone is divided into 11 areas in relationships between extent and geomorphologic types of frozen ground. Alpine permafrost areas are generalized (unified) due to difficulties to show their altitudinal zonation on the map. Seasonal frost zone is divided into three areas depending on seasonal freezing depths of ground. (2) There has relationship between temperature and thickness of permafrost. Therefore, we show the five (numbered) gradations of permafrost temperature and thickness by white lines with different directions. Mean while, these lines combined with three column gradations of permafrost ice content (l, m, h), which is reflected by differences in distance between lines. White lines in the legend are superimposed on dark-gray background of the table. These lines used in the sample map are superimposed on different colors of permafrost distribution. (3) Dominant composition of permafrost within the upper 10-20 m of the ground is classified by geomorphologic types of frozen ground. In particular, accumulative types of frozen ground are divided into glacial (g), alluvial (a), lacustrine (l) and eolian (v) deposits. Denudation and alpine types of frozen ground are divided into deluvial (d) and coluvial (c) deposits, exposed bedrock (b) and soluble rock (k). We show genesis of the deposits and bedrocks on the maps by appreciated letters. (4) Distribution of main cryogenic processes and phenomena is reflected by out-off scaled symbols, which are required to prepare newly on computer. Some of symbols on the legend might be changed. The symbols on the map

are placed so that the main cryogenic processes and phenomena had regional character are depending on permafrost and geomorphologic conditions. (5) Distribution, ice content and thickness of permafrost on the map are also reflected by combined appreciate numbers and letters of color and line. There are borehole locations, data on mean annual temperature and thickness of permafrost, and five boundaries of permafrost on the map.

Key words: permafrost map, ground temperature and mountain permafrost

Multiscale, Hierarchical Approach to Validation of Spatial Permafrost Models

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Abstract: Permafrost is a central element of the cryospheric system. Its importance has become increasingly recognized in both scientific literature and popular media, especially in the last few years. The past two decades have seen a dramatic rise in the number of permafrost models used to evaluate permafrost parameters over geographic space, as well as spatial changes in permafrost-related phenomena that may follow from global climate change. Despite the importance of its roles in the geological, ecological, engineering, and climate-change sciences, modeling of permafrost has, for the most part, remained the domain of individuals and small groups of scientists, each utilizing its own methodological approach, resulting in a wide range of results. This situation has made it difficult to incorporate generated data sets and modelling products into the larger global-change research enterprise. Consequently, there has been little effort to develop an explicit hierarchy of permafrost models, to evaluate their performance using standardized validation tools and data sets and to explicitly link results of models operating at different spatial scales.

At present, spatial permafrost models operating at small geographic scales (circumarctic, continental) are usually evaluated at sets of point locations. Often, such approaches to validation do not correspond to the resolution at which models are applied. The high spatial variability of permafrost parameters requires careful selection of validation points. However, observation locations rarely correspond well with generalized conditions prescribed for the model's grid cells. Correspondence between the scale of observations and modeling resolution is necessary to compare observed and simulated patterns of permafrost parameters.

We addressed this problem by developing a hierarchical scheme for evaluating spatial permafrost models. This scheme includes empirical data from point locations and observational plots provided by current permafrost observation networks, regional characterization of permafrost conditions, and circumpolar-scale models. This approach was applied to evaluate results from two models operating at circumpolar scale and representing dynamic and equilibrium classes of permafrost modeling. The National Snow and Ice Data Center and State Hydrological Institute/University of Delaware permafrost models were used for analysis. The

models were run using standardized climatic forcing and the models' outputs were compared with permafrost parameters observed at a range of Circumpolar Active Layer Monitoring (CALM) sites. To evaluate circumarctic-scale models on the basis of their ability to represent the spatial behavior of the permafrost system and to quantitatively estimate uncertainties introduced by such representations the models outputs were compared with regional, high-resolution spatial data sets of permafrost parameters developed for representative regions of North-Central Alaska and North-Central Siberia. The results of such a comprehensive evaluation of permafrost models provide incite into performance and applicability of currently available circumarctic-models and discern important differences in modeling approaches.
Key words: permafrost, active layer, spatial modelling

The role of land surface processes and permafrost on temperature variability in the Tibetan Plateau

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Abstract: The Tibetan Plateau (TP), with an average elevation of >4000 m and a size of 629,500 km^2 (roughly the size of France), is a semi-arid region occupied by montane grass- and shrublands. Over 62% of this temperature and moisture limited environment is used for agriculture: farmlands, forests, and a majority (80%) for livestock grazing. Since the early–late 1950s, and accelerated since the 1980s, significant urban expansion and changes in agricultural and industrial practices have shaped this part of the world, resulting in a substantially altered landscape. Because of the plateau's role in the Asian Monsoon system, the water resources of most of the Asian continent and therefore the livelihoods of over 3.7 billion people, the extensive changes to the land surface in this part of the world are arguably of heightened importance to local–global resources and the climate system.

We hypothesize that land-atmosphere interactions play a major role in driving climate change on the TP. As socio-economic changes have caused a net reduction in vegetation, this has resulted in significantly reduced soil moisture which feeds back to further decrease vegetation, but also increase sensible (versus latent) heat fluxes, and hence increase temperatures. Our previous work has already demonstrated that, indeed, reported warming on the TP seems to be confined to low-lying populated regions but is absent in temperature data free of surface biases. Furthermore, the existence of permafrost on the TP provides additional complexity for the land-atmosphere system as surface heat fluxes, soil moisture, and vegetation changes are all significantly impacted by permafrost (and *vice versa*).

To quantify temperature changes on the plateau we employ long-term *in situ* temperature records for 187 locations (1950–2004). We also make use of 2-meter temperatures from the European Centre for Medium-Range Weather Forecasts (ECMWF) 40+ year reanalysis (ERA-40) which, as we have shown in our previous work, provide a remarkably realistic depiction of temperature variability on the plateau. Unlike point-measurements provided by station observations, ERA-40 provides long-term fields of surface temperatures, continuous in

both time and space.

We next categorize the TP according to land cover type based on the global *International Geosphere-Biosphere Programme* (IGBP) 30 arc-second (approximately 1 km × 1 km) latitude-longitude vegetation/land-cover classification data consisting of 16 land types, and quantify temporal changes in vegetation based on the 8 km × 8 km *Global Inventory Modeling and Mapping Studies* (GIMMS) Normalized Difference Vegetation Index (NDVI). The TP is also classified according to the distribution of permafrost using the *Circum-Arctic Map of Permafrost and Ground-Ice Conditions* and the *Maps of Geocryological Regions and Classifications in China*. We assess *in situ* and reanalysis temperature trends according to land cover type, disturbed versus undisturbed regions, and permafrost distribution, and quantify the corresponding warming trends related to land cover types and changes.

Preliminary results suggest that statistically significant vegetation decreases have occurred over the last 20 years in the central and eastern TP. Based on this geographic distribution of vegetation changes as well as the land cover type classification, we indeed find different temperature trends based on disturbed versus undisturbed regions. The seasonality of these changes plays an important role; however, vegetation changes alone do not account for observed temperature increases. Surface temperature trends are likely also affected by the reported general warming of the atmosphere in recent decades. However, the distribution of permafrost also accounts for differences in observed temperature variability on the TP. We hypothesize that as permafrost affects soil moisture and hence vegetation and heat fluxes, reported surface temperature changes and analogous changes in land cover are partly driven by the distribution of permafrost.

Key words: Tibetan Plateau, climate change, land-use change, permafrost

Volume Rendering of Qinghai-Tibet Railway Borehole Data

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Abstract: Qinghai-Tibet railway geographical information system and digital roadbed is a platform for sharing data, running models and displaying research result. Three dimension (3D) visualization techniques were applied in the system. In this paper a method of borehole data volume rendering was discussed.

Borehole is a main way to know circumstance under ground. Borehole data include lithology data and normal property data such as temperature, pressure etc. Through the lithology data the stratigraphic unit can be constructed. Through normal property data the physical field under ground can be constructed.

Voxel modeling is used to build 3D model. The regular voxel data are created from discrete borehole data with kriging algorithm.

A geology space is separated into different stratigraphic units. An approach called horizons method was used to build contact surface of different stratigraphic units. Borehole data are

organized into segments and contacts. A contact is defined as the interface between two adjacent stratigraphic units. Segments occur between contacts and are associated with a material. Each contact has a location(x,y,z) , a horizon id, and two segment ids (one for the material above and one for the material below). A series horizon surfaces were defined by interpolating the horizon elevations with kriging algorithm from the borehole contacts which have the same id. The horizon surfaces divide the whole space into separated regions. Each region is a kind of stratigraphic unit. From the top horizon surface to the bottom, calculate voxel belong which stratigraphic unit and assign a lithology code. Finally, map the codes to special color for rendering.

The fields create from normal property data are uniform. That is, there are not clearly contacted surface. The whole space is partitioned evenly by a series of parallel horizontal planes at different depth. From the borehole database, the property values at different depth can be got. In the vertical direction, liner interpolation algorithm was used to calculate the values along borehole. In the horizontal direction, kriging interpolation algorithm was used to calculate the values on the location where has not borehole at a given depth. Each depth forms a plane. Based on the series planes voxel model was created.

The parameters of kriging algorithm– the range, nugget, and sill – are determined by analysis borehole data.

A method using voxel modeling to generate solid models via different borehole data was presented. Based on the solid models, the different borehole data was rendering in the same way. It can be applied as an assistant tool for engineering design and science research.

Keywords: 3DGIS; Borehole data; solid modeling; kriging algorithm

Decision Tree to Classify the Surface Frozen/Thaw Using SSM/I Brightness Temperature

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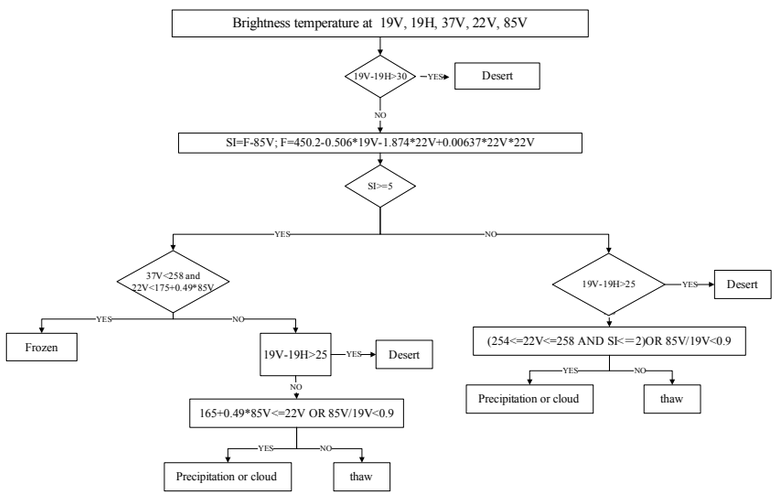
Abstract: The frozen ground, which occupied about 75% terrestrial of the northern hemisphere, is distributed extensively on the earth. The frozen/thaw status of soil has profound impact on the surface runoff, exchange of water and energy between the surface and the atmosphere, the crop growth, engineering and so on. The freeze/thaw cycle has been defined as one of the important parameters for monitoring and change detection of the permafrost and the seasonally-frozen ground in the EOS Science Plan. A decision tree was developed to classify the frozen/thaw status based on SSM/I brightness temperature at 19V, 19H, 37V, 22V, 85V GHz.

The basic theory is (1) obviously different in the dielectric constant between thaw soil and frozen soil. With the temperature decreasing below ºC, the liquid moisture changed into ice and the dielectric constant of the soil mixture decreased from about 20 to 4, which led to the

increased emissivity; (2) the negative spectral gradient ($\Delta T/\Delta f < 0$) was due to the volume scatter darkening.

The decision tree was set up based on the sample analysis and statistics. The key classification filters were the Scatter Index (SI) and the 37V GHz brightness temperature with vertical polarization. The SI was used to distinguish the stronger scatter and the weak one. And the 37V was used to distinguish the cold scatter and the warm one due to the highly correlation between 37V and the surface temperature. In order to improve the accuracy of classification, the other filters were introduced to identify the desert, the precipitation or the cloud which has the similar negative spectral gradient as the frozen soil.

The soil temperature data at 4cm depth from GEWEX/Game-Tibet CEOP 2002 representing the ground truth were used to validate the decision tree. The result shows that the total accuracy of the classification can be more than 90%.



Key Words: frozen/thaw, SSM/I, brightness temperature, decision tree

Specific Features of Distribution of the Perennially and Seasonally Frozen Ground in Transbaikalia

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Abstract: The considered region is located east of Lake Baikal (53^0 ~49^0 N, 105^0 ~121^0 E) in the southern part of the cryolithozone with discontinuous permafrost. Middle and low mounts are widespread in the region. The climate is continental and dry, the average annual air temperatures are -0.5~ -4^{o}C, the precipitation is 300-400 mm/yr, and the snow depth is 8-10 cm. Under such conditions, the soil temperature, along with the presence or absence of permafrost,

depends on the microclimate of specific landscapes and heat exchange between the soil and atmosphere. The known equation of the annual heat balance for the soil surface

$$R + LE + P + A = 0 \quad (1)$$

can be written as

$$T_S = \frac{1}{a}(R + LE + A) + T_A \quad (2)$$

Here R is the radiation balance; LE is the heat loss by evaporation; P is the turbulent heat exchange between the surface and atmosphere; A is the heat exchange between the surface and underlying soils; T_S and T_A are the average annual temperature of the soil surface and air, respectively; and a is the constant of proportionality.

An analysis of equation (2) for the conditions of Transbaikalia indicated that topography is the leading natural factor in the distribution of the main heat balance components (R and LE) on the Earth's surface. Topography is responsible for variegated landscapes in Transbaikalia and different microclimates within the region and, as a consequence, for discontinuous permafrost. Permafrost with the lowest temperature and maximal thickness is always encountered at bottoms of valleys and depressions (where the moisture content is higher and the LE value is therefore larger). A change in soil temperature follows here a change in soil moisture content: temperature decreases with increasing moisture and vice versa. On slopes, T_S is usually higher. It is formed here due to R and, therefore, depends on slope exposure and steepness. The highest T_S is typical of slopes facing southward, and permafrost is usually absent here. Slopes facing northward are the coldest. Permafrost occurs here in the most part of Transbaikalia, and its thickness (H_M) is always larger than on slopes of different exposure.

The considered regularities in the permafrost distribution are typical of the entire Transbaikalia and are observed within each valley regardless of absolute T_S values which are variable in the region.

One more regularity observed in Transbaikalia---alternation of the regions with discontinuous (~90% of the total area) and sporadic (< 20% of the area) permafrost---is related to the leading role of topography. Such an alternation is independent of the zonal climate changes and is related to a change in the geomorphological conditions and, mainly, to the degree of relief dissection. The Map, which shows five areas (**I-V**) with different types of permafrost, has been constructed. The most «severe» permafrost (T_S= -3 ÷ -1.5^{0}C, H_p ≤ 130 m) occurs in the strongly dissected areas of central Transbaikalia with the highest elevations (areas **I-II**). With decreasing surface dissection, T_S becomes higher, and the number of thawed zones (taliks) increases. In the areas located east and west of central Transbaikalia (areas **III**) with less dissected relief and lower elevations, T_S = -0,5 ÷ -1.3^{o}C and H_p ≤ 35-40 m. The area with low elevations in easternmost Transbaikalia (area **IV**) is even warmer. Permafrost is encountered here only at bottoms of depressions and on very steep slopes facing northward (T_S = -0,2 ÷ -0.5^{o}C, H_p ≤ 10-15 m). Wide depressions **(**areas **V)** in southwestern and southeastern Transbaikalia are the warmest areas in this region**.** Permafrost is encountered here only in the most moistened and swamped deep depressions and salinized soils (T_S = -0.2 ÷ -0.3^{o}C, H_p = 2-3 ÷ 15-20 m).

Such a specific regularity is related to topography, which plays the leading role in the distribution of heat and moisture on the Earth's surface and, thereby, in the formation of the heat balance structure. In the areas with dissected topography, many slopes are oriented unfavorably,

and the radiation coming to their surface (R) is insufficient; therefore, negative T_S are formed here. The radiation input (R) is high, and positive T_S are formed only on slopes facing southward. However, the number of such slopes is insignificant. In narrow valleys and deep depressions moisture is increased, LE is high, and negative T_S are therefore formed. As a result, the surface conditions facilitates the formation of negative temperatures in the most part of such an area. In the areas with slightly dissected smoothed topography, the distribution of R and LE on the Earth's surface is more uniform, as a result of which the heat input to the Earth's surface is higher and soils are warmer.

Since the leading role of topography in the T_S distribution in Transbaikalia is the established fact, the principle of cryogenic-temperature zoning of the region is as follows: the boundaries of geothermal zones should coincide with those of geomorphological areas distinguished based on the degree of relief dissection.

Seasonal freezing and thawing in Transbaikalia are characterized by large depths (to 5-7 m) and clearly defined dependence on topography and lithology: the depth of seasonal freezing and thawing is 3-5 m in loose grounds on slopes and increases in bedrock due to the absence of phase processes. Such a depth is not more than 0.5 m in swamped valleys and depressions composed of a frozen soil with peat. A characteristic feature of the region is that the depth of thawing of frozen soils is always less than that of freezing of unfrozen rocks. One more specific feature consists in that the layer of seasonal thawing- freezing joins to permafrost in winter. This means that the temperature state of the permafrost in Transbaikalia is in agreement with the recent climate.

Keywords: Permafrost, seasonal frost, microclimate, heat-balance, topography

Permafrost studies in the Hovsgol Mountain Region, Mongolia

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Abstract: The Hovsgol Mountain Region is located between coordination of N 49^o – 102^o in territory of Hovsgol Province, Mongolia. The region embraces the Darhad depression, which is located in northwest of the region and surrounded by high mountain ranges, and has mountain forest steppe plateau in the southwest, mountain taiga in the northeast and Eg-Delger river basin in southwest. The territory is characterized by mountain permafrost, sporadic to continuous in its distribution, and underlied the southern fringe of the Siberian continuous permafrost zones. Permafrost studies in the region can be divided into four stages with different objectives.

The objectives of investigations (1967-1973) in the first stage were to study regional distribution patterns of permafrost and cryogenic phenomena. Field investigations in the stage were as follows: (1) description of cryogenic texture in Darhad lacustrine sediments (Gravis and Tumurbaatar, 1967), (2) several 15-55 m deep borehole drillings, 33 vertical electric

soundings, borehole temperature measurements and field analysis for ice content and density of more than 150 samplings along the Sharga valley transect in the southwest of the region (Gravis and Sharkhuu, 1968), (3) observations for distribution of cryogenic phenomena in the northeastern part of the region (Sharkhuu) and (4) shallow borehole drillings in the central part of the region (Sharkhuu, 1973). The results of the above studies are published in a number of scientific papers and used for compiling geocryological map of Mongolia (Gravis, 1974., and Sharkhuu, 1976)

The objective of the investigations (1983-1987) in the second stage was to study temperature regime of mountain permafrost in the central part of the region. According to the investigations, Sharkhuu (1983-1987) made ground temperature measurements in more than 100 deep boreholes, located in the Burenkhan and Hovsgol phosphorite deposit areas. Using the result of measurements, we estimated values of changes in mean annual temperatures of mountain permafrost depending on altitudes, slope aspect, geological and landscape conditions. Based on the estimation, permafrost maps of the Hovsgol deposit areas (1:100000) and Hovsgol Province (1:1000000) (by Sharkhuu) are compiled in 1989 for specific purposes.

The third stage of the studies, since 1996, is related to long-term monitoring of permafrost in the region. The monitoring is carried out by Sharkhuu within the framework of the international CALM and GTN-P projects in Mongolia. Main parameters of the monitoring are values of changes in active layer thickness and mean annual permafrost temperatures, which are estimated by measuring or recording ground temperatures in the monitoring 5-15 m and deeper boreholes. At present, there are 19 boreholes of both CALM and GTN-P in the region. Some of the boreholes are redrilled in last years in the same points where old closed ones were investigated very well 15-35 years ago. In addition, dynamics of some cryogenic phenomena are monitored at the certain sites. Initial results of the monitoring show that permafrost in the Hovsgol Mountain Region is degrading more intensively under influence of recent climate warming than in the Khangai and Khentei Mountain Regions. Meanwhile, permafrost degradation during last 15-20 years was more intensive than during previous 15-20 years (1970-1990). Average rates of increase in active layer thickness and mean annual permafrost temperatures in the region are 3-30 cm and 0.2-0.4^{o}C, respectively. Relatively deep thermokarst lake and hollow, and active thermoerosion process are characteristic of Darhad depression.

Permafrost studies in the fourth stage, starting since 2002 are conducted in six valleys along the northeastern shore of Lake Hovsgol. The new studies are carried out within the framework of international project “Impacts of nomadic pasture use and climate change on watershed ecosystems, biodiversity and permafrost of the boreal forest and steppe of northern Mongolia” (Goulden, 2002). The project is funded by a five-year grant from the Global Environmental Facility to the Mongolian Academy of Sciences, implemented by the World Bank. The main purpose of the studies are (1) to study permafrost conditions and (2) to monitor recent degradation of permafrost under influence of climate warming and human activities, such as nomadic pasture, forest cutting and fire in the project area. During last four years Mongolian and Norwegian permafrost researchers carried out the following field investigations: 19 borehole drilling with depth of 5 to 10 m, borehole temperature measurements by movable thermistor strings, leveling measurements of frost heaving and thaw settlement at 6 sites (Sharkhuu, 2002-2005), resistivity tomography soundings at 18 sites (Etzelmuller, 2002 and

2005), three years recordings of surface and soil temperatures by more than 20 mini data loggers (Heggem, 2002-2004), round year surface temperature recordings under different vegetation and snow covers by 15 mini data loggers (Anarmaa, 2005). From a result of the studies, we determined and mapped permafrost distribution, active layer thickness and cryogenic phenomena depending on slope aspect, vegetation and snow covers, surface wetness, soil and hydrologic conditions in the study area. It is proved that vegetation cover with dead plant tissue, moss, peat and forest are natural insulator for maintaining low ground temperatures and protecting soil moisture from high evaporation. Consequently, this insulator leads to decreasing of active layer thickness and permafrost degradation. Active layer thickness varies from 1.4 m in Borsog in the south, to 4.8 m in Turag in the north, apparently in relation to livestock grazing manner.

We think that Darhad depression and Mountain taiga zone of the region are very suitable areas for international studies on mapping and monitoring of permafrost under the combined influences of climate warming and human activities in Central Asia.

Key words: Active layer, permafrost distribution, vegetation cover

The Permafrost Temperature Dynamics in the Subarctic zone of Kodar-Udokan Fold Mountain Region.

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Abstract: Now we can observe a lot of different global climate models. They are calibrated by meteorological data that was obtained mainly in valley or plain located observing centers. In result we can see the different opinions and forecast in the question of climate change in the mountains. This problem can be solve with helping of the data from permafrost mountain observatories. The high mountain Kodar-Udokan permafrost observatories helps us getting various data during 20 years. It is located at 53°E and 118°N and presents the set of sites on the altitudes from 630 m a.s.l. (bottom of Chara tectonic depression) to 3000 m a.s.l. (Kodar Range).

Since 1987 the thermal observations in the many boreholes in Chara Region were made. We got the result that the permafrost temperature at 20 m depth increased during last 18 years up to 1 °C (at different sites on the altitude from 1440 to 1710 m a.s.l.). This warming is synchronous and unidirectional with one in the tectonic depression and valleys (at different sites on the altitude from 630 to 900 m a.s.l.).

The mountain glaciers are good indicators of climate warming also. The depth of glaciers in Kodar Range decreased during last 30 years. From 1957 to now the Geograph Azarova Glacier reduced in volume and in area. The ice depth decreased from 20-30 to 15-20 m.

In high mountain regions, as well as in the depressions, we described the activation of natural and human-induced processes that result in damages of consructions. We suppose that the destruction of several section of Chara-China and BAM railway is linked with increasing of permafrost temperature, change of permafrost geometry and its pecularities. Now we see here the frost heaving, thaw settlement, cryogenic weathering, icing, etc..

Key words: Mountain permafrost, temperature observation, glacier, railway stability.

Structure and physical state of the permafrost in Western coastal planes of Russian Arctic

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Abstract: Coastal planes of Russian European North and West Siberia were under transgression most of the Pleistocene. Quaternary deposits found in this area are up to 300-350 m thick. Deposits presented mostly by marine and coastal-marine clay and sandy-clay sediments. Sediments of continental geneses are rare in these areas. During the regression stage the sediments started to freeze up quickly enough to save the primary chemical composition (sodium chloride). That is why marine sediments below the active-layer have high salinity. Salinity of clay sediments is relatively constant through depth and corresponds with salinity of contemporary marine sediments (0.7-0.9%). Salinity of sandy sediments is below 0.3%, but it contain lenses mineralize water (cryopegs) very often. The upper layer of permafrost characterized by high ice content, ice content reduces significantly with depth. Continental part of coastal zone, with exception of Kanin Nos Peninsula, is completely underlined by permafrost. Temperature at the depth of maximum annual temperature variation ranges from -1 to -10 ^{0}C depending on climatic zone and local landscape features. Depth of permafrost bottom ranges from 50 to 300 m. Geothermal gradient is 2.5-3.5 ^{0}C/100 m in West Siberia and 0.8-2.0 ^{0}C/100 m in European North. Because of its high salinity the permafrost has multiple-layer structure. Well known that physical state of the ground depends on the ratio of its real temperature (t_n) and the temperature of the pore water freezing point (t_f). Hence the main criteria of physical state of the ground can be characterized by temperature difference (Δt), where $\Delta t = t_n - t_f$. If $\Delta t < 0^0$C the ground can be considered frozen, if $\Delta t > 0^0$C the ground is cooled ground without ice, and if $\Delta t = 0^0$C the ground is in physically unstable condition. Interaction of frozen and cooled sediments both horizontally and vertically creates multiple layering conditions of offshore permafrost in studied region. In cooled sub-littoral sediments of Barents and Kara seas the layers of frozen ground were found. In the littoral zone, beach and laida underlined by frozen ground the cooled layers were found together with lenses of cryopegs. Analysis of functional dependence between temperature of freezing point and salinity was carried out for typical saline sediments of West Siberia based on salinity and mechanical properties of the ground. Presented the diagram which can be applied for the determination of permafrost thickness with ice content and without ice content based only on mean annual temperature of ground. The results can be

used for construction on permafrost in the regions with high salinity. It is important at calculations and design decisions at the choice of places of drilling of oil and gas wells.
Key words: Frozen ground, cooled ground, salinity, physical state of permafrost

Questions Regarding the Recent Warming of Permafrost in Alaska

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Abstract: Permafrost has warmed significantly throughout much of Alaska over the past quarter century. There are a number of questions that arise for any systematic warming of permafrost. These include questions regarding the timing, magnitude, spatial distribution, seasonal distribution, effects on the active layer, thawing effects, thermokarst, and cause(s) of the warming. This paper reviews permafrost research conducted over this time period and attempts to provide at least partial answers to these questions.

Permafrost temperatures have warmed throughout much of the state coincident with a statewide warming of air temperatures that began in 1977. The permafrost temperatures peaked in the early 1980s and then decreased in response to slightly cooler air temperatures and thinner snow covers. Arctic sites began warming again typically about 1986 and Interior Alaska sites about 1988. Gulkana, the southernmost site, has been warming slowly since it was drilled in 1983. Air temperatures were relatively warm and snow covers were thicker-than-normal from the late 1980s into the late 1990s allowing permafrost temperatures to continue to warm. Temperatures at some sites leveled off or cooled slightly at the turn of the century. Two sites (Yukon River Bridge and Livengood) cooled during the period of observations.

The magnitude of the total warming at the surface of the permafrost (through 2003) was 3 to 4 °C for the Arctic Coastal Plain, 1 to 2 °C for the Brooks Range including its northern and southern foothills, and 0.3 to 1 °C south of the Yukon River.

Sparse data indicates that permafrost is warming throughout the region north of the Brooks Range from the Chukchi Sea to the Canadian border, southward along a north-south transect from the Brooks Range to the Chugach Mountains (except for Yukon River and Livengood), in Interior Alaska throughout the Tanana River region, and southward through the Alaska Range in a broad band to Anchorage in the west and Tok in the east including the Copper River Valley and the Wrangell Mountains.

At two sites on the Arctic Coastal Plain, the warming was seasonal, greatest during "winter" months (October through May) and least during "summer" months (June through September).

Active layer thicknesses depend largely on the thermal history of the ground surface during the summer thaw period. This explains why the observed winter warming of air, ground and permafrost temperatures has produced little change in annual maximum active layer thicknesses.

Near Healy, permafrost has been thawing at the top since the late 1980s at about 10 cm/year. Maximum settlement is about 1 ½ m. At Gulkana, permafrost was thawing from the

bottom at a rate of 4 cm/year and accelerated to 9 cm/year after 2000.

Thermokarst investigations have shown that new thermokarst is forming in undisturbed areas of the Tanana River, Little Tok River, and Slana River (a tributary of the Copper River) valleys, and in the Wrangell Mountains indicating warming and thawing of the permafrost in these areas.

Massive ice wedges on Alaska's North Slope that have been stable for thousands of years have been thawing during the recent warming.

The primary causes of the recent permafrost warming appear to be increased air temperatures, and increased snow covers with snow cover the dominant factor during the late 1980s and 1990s In some parts of the state.

Key words: Permafrost, borehole temperatures, climate warming, thawing, thermokarst, monitoring.

Thermal State of Degrading Permafrost in the Source Region of Yellow River, Qinghai Province, China: Numerical Approach

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Abstract: A large part of the source area of the Yellow River (Hunag He), in the northeastern margin of the Tibetan Plateau, is underlain by perennially or seasonally frozen ground, which faces a rapid warming in the past decades. Since 2002, we have investigated the permafrost distribution in the area to evaluate permafrost degradation and its impacts on groundwater hydrology. In this study, based on the data obtained during the first two years (Ikeda et al, 2006), involving the temperature profile from the 8m-depth borehole, the surface temperatures from distributed small loggers and the geophysical soundings, thermal history of the permafrost in the area was investigated through parameter studies using the numerical model.

The problem was defined as the one-dimensional thermal conduction with phase change under the forcing of the surface boundary condition, which was given as ground surface temperature variations. Stable geothermal heat flux and homogeneous physical soil properties were assumed. Starting from various initial conditions, the rate of permafrost degradation was calculated under the different surface temperature history. Giving the same surface temperature conditions, the rate of degradation could vary even for the identical-thickness permafrost, depending on the initial temperature profile. Hence, several initial conditions as well as surface temperature scenarios are examined in the calculations to estimate the rate of degradation in the source area.

In the previous studies, permafrost thicknesses in the source area in 1980s are reported as ca.10m or even less depending on the sites, which must have been already warm permafrost. Therefore, the reasonable initial temperature profile would be zero degree (or freezing point)

throughout the whole frozen part, showing “zero curtain”. This is the most sensitive condition for permafrost to respond the surface warming, and numerical experiments showed that such permafrost could degrade in the time scale of ten to several tens of years. Considering the time scale of the global warming, there is a high possibility that the relict permafrost (perennially frozen part beneath the supra-permafrost talik) has widely degraded during 1990s, which is considered to be related with the desertification of the grassland or lowering of the ground water level. Further analysis of borehole temperature data may provide more constraints for ground surface temperature history.

Keywords: Permafrost, global warming, ground temperature, numerical modelling, Tibet

Permafrost distribution in the vicinity of Esso, central Kamchatka, Russia

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Abstract: It has been reported that the limit of discontinuous permafrost lies in the Kamchatka Peninsula, Russia. However, the information on permafrost in Kamchatka is very limited. We conducted the year round ground temperature measurements in the vicinity of Esso village, central Kamchatka.

Esso village is situated at 158°40’E, 55°56’N, 500 m above sea level and is surrounded by lava plateaus of around 1000m a.s.l. We measured the ground temperatures of 0-2m deep at 1-hour interval with thermistor temperature recorders (T and D corp., Tr.52) along the Uksichan River. The river is one of tributary of the Bystraya River and flows west of Esso village. MAAT in Esso is around –2°C.

Larch trees (*Larix cajanderi)* and creeping pines (*Pinus pumila*) are developing mainly on the right bank of the Uksichan River (north-facing slope). An intact forest of larch trees upstream looks like a “drunken forest”, suggesting the existence of permafrost. Permafrost occurs in the larch forest with a thick litter layer. A forest fire occurred on moraines near the village in 1995. Permafrost develops even in a burned place under the sphagnum layer. A slope failure occurred on the right side slope of the Uksichan River in 1997. It is possibly related to the forest fire and climatic warming. Permafrost does not develop on the place with thin litter layer or without sphagnum.

There are several mounds of 60-80 cm high and 2 to 10 m wide on the burned gentle slope of 2-3° (650 m a.s.l.). The shape of the mounds is oval to circular. They consist of peat layer. Around the mound the peat layer become thin and the thickness of the seasonal thaw layer become larger. The frozen mounds are covered with the peat layer of 40-60 cm thick. The peat layer is underlain by humus layer of 10cm thick, which overlies the volcanic ash soil. They are defined as degradation palsas. The temperature profiles show that the thickness of permafrost seems to be only several meters.

Birch trees (*Betula ermanii)* are dominant vegetation on the left bank of the Uksichan River (south-facing slope). The ground temperature measurements do not show the existence of permafrost. The thickness of the seasonal freeze-thaw layer on the south-facing slope is deeper than that on the north-facing slope.

Periglacial landforms such as rock glaciers, solifluction lobes, avalanche boulder tongues are observed on the western mountain slopes of Esso above 1000m a.s.l.

Permafrost in the vicinity of Esso is distributed mainly on the north-facing slope of the Uksichan River. The occurrence of permafrost depends on thermal conductivity of the ground surface layers. Permafrost seems unstable. It is affected by the environmental changes such as forest fire and climatic warming.

Key words： Permafrost, Ground temperature observation, Forest fire, Palsas, Kamchatka

Characteristics and Significance of the Active Layer in Permafrost Affected Soils (Dasan Station, Svalbard and Sejong Station, Antarctica)

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Abstract: Geochemical properties of active layers between the Arctic and the Antarctic were analyzed. Soil samples were collected from Sejong Station (62º17´S, 58º47´W) located in King George Island, west Antarctica and Dasan Station (78º55´N, 11º56´E) located in the Spitsbergern Island, Svalbard. Soil samples were analyzed for major, trace, and rare earth elements using ICP techniques at Korea Basic Science Institute. Organic and inorganic carbon contents of soil samples and water contents of active layer at Sejong Station were also measured.

The soil samples from the Antarctic showed relatively low SiO_2, and similar K_2O contents with those from the Arctic. The element composition results of the Antarctic soils were similar to those of previous studies; it might be derived from the weathering of Ca-plagioclase and olivine which has high Fe/Mg ratio. Contents of total carbon (TC) and total organic carbon (TOC) of the Antarctic soils were 0.20% and 0.18%, respectively, and less than those of the Arctic soils. The ratio of TOC to TC of the Antarctic soils was higher than those of the Arctic soils. The water contents of active layer soils of the Antarctic were increased with depth. The water contents of surface soils were about 5% and those of 60 cm depth were about 35%, respectively. It indicates that water in surface soils was lost by evaporation and water losses were decreased with depth. Further studies on the properties of organic carbon are recommended to comprehend the geochemical changes of active layer by global warming.

Key words: active layer, total carbon(TC), total organic carbon(TOC), water content

Climate Factors of Permafrost Regime and Their Change in Northern Eurasia During Recent Decades

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Abstract: Low-frequency variations of the surface air temperature (SAT) and snow accumulation are recognized as major climate factors of permafrost regime changes. Daily data of SAT and February snow depth for 1950-2001 in Northern Eurasia are examined in order to study the response of permafrost thawing depth on recent changes of SAT and snow accumulation. The listed parameters are calculated for the reference period of 1951-1980, as well as for the period of contemporary warming (1989-2001). The periods were chosen according to the variations of average annual air temperature in Russia, which has increased by about 1°C, and its rise is statistically significant.

The spatial fields of the seasonal and annual SAT for the mentioned time periods are plotted. Regions with its different trends during the contemporary warming are revealed. The number of days with extremely strong frosts in winter decreases significantly in a large part of Siberia. Analyses of snow depth principal components (PCs) indicate that within the Northern Eurasia, there are several regions spatially homogeneous with respect to snow depth interannual variations, respondent to certain atmospheric circulation modes. Temporal variability of snow accumulation in each of the revealed regions differs by the share of low- and high-frequency variations, as well as by the relation with recent global warming. First of all, it touches upon the region between the White Sea and river Lena basin, where the snow depth variations are described by PC1. Snow accumulation in that region is revealed to be associated with circulation modes, also responsible for the recent changes of surface air temperature over the Northern Eurasia. Strengthening of cyclonic activity, linked to positive phase of North Atlantic Oscillation and enhanced westerlies, has to be considered as a major circulation factor of positive trend of both temperature and snow accumulation since 1970s. Thus, over the major portion of Siberia both increased SAT and snow accumulation seem to be affecting the permafrost thawing depth. At the same time, relation of the anomalies of the annual SAT and snow depth on one hand, and permafrost thawing depth on the other hand, demonstrates its strong dependence on the types of landscape.

The study was supported by the Russian Foundation for Basic Research (grant 04-05-64745) and by INTAS (grant No. 03-51-5296).

Key words: permafrost, climate change, Northern Eurasia, atmospheric circulation, land cover features

Monitoring of the snow cover in the north Asia

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Abstract: The snow cover as a planetary phenomenon and cryogenic resource is one of the most important natural processes and economic activities of a man. This annual recycled resource has no stable characteristics. It appears seas only and affects industrial and residential objects, as well as the condition of the upper lithosphere horizons and other Earth s crusts. At the sometime the difference of peculiarities and the conditions of its formation in time and in space is characteristic of it. It is influenced by the regularities of the climatic formation which can both have similar average meanings of the meteorological indicators and rare sharp changes. These changes are different in the regions and climatic zones in a year and interyearly cycles.

In the large areas cultivated by a man the formation of snow cover is a significant factor, limiting many types of activity. The industrial activity of a man also influences on snow cover distribution which leads to the heterogeneity and unevenness of the technogenic accumulation snow. The lack of snow cover or the presence of it is sometimes dangerous and unfavorable. So, to study the regularities of the formation of snow cover in the large regions during different climatic tendencies (warming or coldsnap) has an important and practical significance. The influence of the formation of the atmosphere, hydrological, geological biological, coldsnap is defined by the depth of the snow cover and the conditions its density time and conditions of deposits and some other characteristics of snow cover.

Monitoring and studying of the peculiarities of snow accumulation an actual research problem for the vast territory of the north of Asia. It is not necessary only to use the data of the state meteorological stations but also to organize localities for monitoring observations.

For example, the investigation of the snow cover in different climatic zones of western Siberia and the analysis of the observation materials at the monitoring localities (Kharasavey, Tarko-sale, Tyumen) showed that the regional peculiarities together wit the zone conditions greatly influence on the distribution of permafrost minerals. These localities are situated in tundra, taiga and forest-steppe zones.

The route investigations were done in different landscape conditions of snow cover accumulations. The snow survey data are done in the lines of 250-300 meters in 5 meters from each other. Besides the depth of snow cover is measured at the localities where the points of survey are located in the chess order in the distance of 10 metros from each other (programmer CALM).

For example, accordly to the results of long observations of the meteorological stations, the deepest snow cove was painted out in the taiga zone (0,5m). The depth of snow cover is similar to that in tundra and forest steppe zones (0,34-0,35m). The peculates of snow cover density are also evidently seen. In tundra and forest steppe zones the snow cover density is the biggest, in taiga it is less. However, at the large areas of taiga zones, occupied by marshes, the snow cover density is also similar to that in tundra and forest-steppe zones.

To study the peculiarities of snow cover accumulation is the actual research problem for vast territory of the north of Asia. To use the data of the state meteorological stations is not enough in the studying of the variety of the problems of the snow. To create the net of the

monitoring observation locality will allow solving a great number of tasks which define the influence and functionary of coldness on other crusts of the Earth, including the activity of a man.

Key words: The monitoring, the snow cover, Earth s crusts, the meteorological stations.

Towards the Satellite Monitoring of Methane Emission from Permafrost

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Abstract: Atmospheric methane (CH_4) is the second most important greenhouse after carbon dioxide (CO_2). Its concentration has increased in the past several decades; however, the growth rate has a considerable inter-annual variation, particularly in the northern hemisphere. An international research partnership known as the Global Carbon Project identified melting permafrost as a major source of climate feedback that could accelerate climate change by releasing greenhouse gases into the atmosphere. Current ground-based measurements are sparse, especially in the sub-arctic region, and are not representative at large scales. Global space-borne measurements will play an important role to improve our understanding of the emission and atmospheric transport of CH_4, and the exchange of CH_4 between lower stratosphere and upper troposphere.

NOAA plans to exploit operational sounders to derive atmospheric CH_4 simultaneously with cloud products, temperature, moisture, ozone, carbon monoxide, and carbon dioxide using the Atmospheric Infrared Sounder (*AIRS)*, the Infrared Atmospheric Sounding Interferometer (*IASI*) (2006-2021) and the Cross-track Infrared Sounder (*CrIS*) (2009-2023). Each of these thermal sounders will make 324,000 soundings per day in clear and partially cloudy scenes. Here we present a summary of the retrieval methodology, preliminary validation of the AIRS methane product, and examples of the retrieved CH_4 from globally gridded AIRS measurements from August 2003 through May 2006. Regional variation of the retrieved CH_4 in the high northern hemisphere will be shown in detail.

Probabilistic prediction of the permafrost distribution on the Qinghai-Tibet Plateau according to a warming climate scenario

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Abstract: The permafrost is an indicator of the environmental change. The global warming will change the top position of the permafrost (the depth of summer thaw, i.e. the permafrost table) and the distribution of warm permafrost closes to its southern/lower limit. In this study, the

deterministic model combined with probabilistic methods has been adopted to predict the distribution of the permafrost according to the warming scenario predicted by GCM at grid-scale.

The altitude model has been used to calculate the lower limit of altitudinal permafrost distribution. The assumption is that if the air temperature increases by 1ºC, the vertical zone of permafrost will move upward according to the lapse rate of the air temperature.

We take the air temperature from HADCM3 – GCM Model of the Hadley-Center surface climate output. The original digital elevation model (DEM) and the air temperature were resampled to $0.5^{o} \times 0.5^{o}$ grids; the Qinghai-Tibet Plateau was divided into 30×60 grids eventually. We use the annual mean temperature in 1980 as a baseline to calculate the air temperature rise for 2049 and 2099.

Because of uncertainty in the GCM, it is reasonable to consider the global climate change probabilistically. The Monte Carlo methods were specially employed to simulate probabilistic distribution of the air temperature and to assume that the GCM predict error is Gauss-distributed. The samples of the air temperature rise noise were selected from Gauss distribution truncated to [-1, 1] interval with 0 as a mean, variance 0.5k. A great quantity of random samples was selected to deal with uncertainties in GCM. According to the altitude model assumption, we can determine the changed lower limit of the altitudinal permafrost; if the grid altitude is greater than the lower limit of the altitudinal permafrost, there will be the permafrost; otherwise there will be none. The result in each grid looks like a Bernoulli trial, so we can calculate the probability of the permafrost existence for each grid for 2049 and 2099.

We present a probabilistic approach to evaluate the effects of uncertainties, and the purpose of this study is to: ⑴investigate the variability of air temperatures predicted with GCM ⑵develop a probabilistic approach that will support the determination of the impact of climate on distribution of the Qinghai-Tibet Plateau permafrost.

Key words: global warming, permafrost degradation, probabilistic methods

Study on Land Surface Heat Fluxes over the Tibetan Plateau Area

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Abstract: As the most prominent and complicated terrain on the global, the Tibetan Plateau, with an elevation of more than 4000 m on average above mean sea leave makes up approximately one fourth of the land area of China. Long-term operation and research on the

Tibetan Plateau have shown that the giant prominence expert thermal effects on the atmosphere, thus greatly influencing atmospheric circulations over China, Asia and even the global. Due to its topographic character, the plateau surface absorbs a large amount of solar radiation energy and undergoes dramatic seasonal changes of surface heat and water fluxes. The lack of quantitative understanding of interactions between the land surface and atmosphere makes it difficult to understand the complete energy and water cycles over the Tibetan Plateau and their effects on the Asian Monsoon system by numerical models. Therefore, the study on energy exchange and water cycle are regarded as the main task in the GEWEX (Global Energy and Water cycle Experiment) Asian Monsoon Experiment on the Tibetan Plateau (GAME/Tibet, 1996-2000) and CEOP (Coordinated Enhanced Observing Period) Asia-Australia Monsoon Project (CAMP) on the Tibetan Plateau (CAMP/Tibet, 2001-2005). The intensive observation and long-term observation of the GAME/Tibet and the CAMP/Tibet have been done successfully in the past 8 years. A large amount of data has been collected, which is the best data set so far for the study of land surface heat flux and water cycle over the Tibetan Plateau. Firstly, the field experiments and some results on the local land surface fluxes partitioning ("imbalance", diurnal variation, inter-monthly variation, inter-yearly variation and vertical variation etc) will be presented.

The study on the regional distribution of land surface heat fluxes is of paramount importance over heterogeneous landscape of the Tibetan Plateau and it is also one of the main scientific objectives of GAME/Tibet and CAMP/Tibet. Therefore, the derived regional distribution and seasonal variation of surface variables (surface reflectance and surface temperature), vegetation variables (*NDVI*, *MSAVI*, vegetation coverage and *LAI*) and surface heat fluxes (net radiation flux, soil heat flux, sensible and latent heat flux) are also presented by combining 5 Landsat-7 ETM images with field observations.

In order to upscale the land surface heat fluxes to the whole Tibetan Plateau area, the Institute of Tibetan Plateau Research (ITP) of the Chinese Academy of Sciences (CAS) is establishing a Monitoring and Research Platform (MORP) for land surface and atmospheric processes on the Tibetan Plateau. The establishing and monitoring plan of long-term scale (5-10 years) of the MORP and three new comprehensive observation and study stations (Mt.Qomolangma, Nam Cuo and Linzhi) will also be introduced here.

Modelling and Mapping of Mountain Permafrost Occurrence and Distribution in Ulaanbaatar area using GIS and Remote Sensing

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Abstract: Mongolia is situated in the southern boundary of Eurasian permafrost region in which permafrost distribution is mosaic-lake, being strongly affected not only by landscape conditions but by global climate (1).

We have the map of seasonally frozen ground and permafrost distribution at a scale of 1:1500000. This map was compiled by the results of Soviet – Mongolian geocryological expedition in 1967 – 1971. After this period our senior researchers, doctor D.Tumurbaatar, N.Sharkhuu, compiled the series of permafrost distribution map at a different scale. The main methodology of these maps is the geographical elevation belts.

Two thirds of the population of Mongolia lives in the region with permafrost distribution. With the increasing activity of infrastructure networks, knowledge about the distribution patterns of mountain permafrost helps reducing installation costs, and improves life safety of people in such area.

At the present, we concentrate on the modelling and mapping of mountain permafrost distribution patterns using GIS applications and Remote Sensing.

The occurrence of mountain permafrost depends on many parameters, which have direct and indirect relationships between each other, such as solar radiation, elevation, sloppiness, aspect, mean annual temperature on permafrost table.

The modelling is based on the mean annual temperature on permafrost table. The mean annual temperature on permafrost table depends on energy flux in an active layer and the ground parameters (ground moisture, heat capacity, and etc).

The energy flux in an active layer depends on a solar radiation and landscape conditions. The rate of solar radiation varies in mountainous area. The minimum mean annual temperature on permafrost table is one of the criteria of permafrost occurrence.

In valleys and depressions with same solar radiation rate, the permafrost occurrence depends on ground moisture. The permafrost distributes in an area with more moisture along the valley and in the depression.

Based on the modelling results, we compiled the map of permafrost distribution in Ulaanbaatar area using GIS applications and Remote Sensing.

Key words: permafrost, GIS, Remote Sensing, modelling, mapping, mountain

Land surface condition on warm-permafrost region in Mongolia and its impact to evapotranspiration processes

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Abstract: Mongolia is located at the periphery of the sub-Arctic permafrost region. Permafrost covers about 63% of Mongolia, at the southern fringe of Siberian permafrost. Relating to climatic condition, a thick active layer and higher ground surface temperatures characterize this permafrost region. This situation can be classified as “warm permafrost”. Observations of ground temperature from the surface to a depth of 3 m showed that the surface temperature was continuously below 0^{o}C at the beginning of October. The downward frost front moved from the surface to 3 m in the following 85–90 days. After the snowcover disappeared at the beginning of April, the surface started to melt. The downward-moving thawing front reached 3 m at the

end of April. Seasonal variation of the permafrost active layer suggests that the thaw–frost cycle may not affect biological processes of the grass, because the thaw depth exceeded 3 m during the growth period (May to September), even though the study site was underlain by permafrost.

Vegetation was uniformly sparse grass with coverage of 38-60% during the maximum growth period. Over the pasture, plant type and species did not vary. Artemisia frigita dominated (~60%) and other species included Arenaria and Leymus chinensis. The maximum grass height in mid-July was less than 20 cm. Figure 4 shows the vertical distribution of grass root density (dry biomass) measured in April and June 2003. Grass roots develop mainly in the surface ground layer (the top 50 cm). Differences in root biomass between April and June also occurred only in the ground surface layer.

Eco-hydrological observations since July 2002 and June 2004 at a sparse grassland site in Mongolia suggest that variability of evapotranspiration shows temporal decline processes response to precipitation events or snow melting. The effect of vegetation cover on evapotranspiration was insignificant comparing to that of surface soil moisture. Changes in soil evaporation, related to precipitation, mainly caused the very large inter-annual differences in evapotranspiration. The transpiration partition was 22%. Evapotranspiration was sensitive to precipitation (ground surface moisture) and influenced by seasonal heat fluxes. The partition of transpiration was small during wetter grass-growing periods but large in drier periods. The growing period is short along the periphery of the cryosphere, but water fluxes during the growing period contribute significantly to the annual water cycle.

Key words: Mongolia, permafrost, surface condition, evapotranspiration

Cryomorphogenesis in the mountains of North-Eastern Russia

Yuri. V. Mudro

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Abstract: Permafrost, perennially frozen ground, occupies over 11 million km^2 or 65 per cent of Russian territory. The permafrost zone (cryolithozone) extends from the Arctic islands and the Arctic coast at 80-82°N across the continent to the Mongolian border at 49°N in Transbaikalia. The Arctic shelf is occupied by subsea permafrost. The distribution of permafrost in the mountains varies with altitude, latitude and longitude. North-eastern Russia, which includes Eastern Siberia and the northern Pacific, is a predominantly mountainous region which extends from the river Lena to the Bering Strait and occupies about 1.5 million km^2.

It is difficult to analyse the climate of the north-eastern mountains in detail, first, because of the sheer size and diversity of the region: and second, because observations are still sparse. The most severe weather is associated with locally transformed air masses, while the advection of the fresh arctic air rises temperature by about 10ºC. Temperature inversion are frequent and elevated regions often exhibit higher temperatures. Ameliorating effects of the Bering Sea and the North Pacific are mostly limited to the narrow coastal mountains prevent the advection of the maritime air landwards. The southern limit of the continuous permafrost coincides

approximately with the -5°C mean annual air temperature isotherm in Eastern Siberia. The lowest temperatures of mountainous permafrost (between -13°C and -15°C) occur in the subarctic mountains of north-eastern Siberia. Most of the north-east is occupied by the continuous cryolithozone and only in a limited area on the Okhotsk coast does discontinuous permafrost occur. In the mountains of north-eastern Asia permafrost exceeds 1000 m in thickness. The extreme thickness of permafrost is caused by a number of factors, such as high thermal conductivity of bedrock and paleoclimatic conditions.

The depth of the active layer varies strongly as a function of altitude, aspect, microclimatic, and hydrological conditions, and vegetation. The maximum depth of the active layer (about 1.5 m) is observed in the low and middle mountains on the southern slopes with poor vegetation cover, while in peatlands the active layer is no more than 0.5 m deep.

The whole spectrum of cryogenic and slope processes typical of cold climates, such as frost weathering, sorting, wedging, and solifluction which play an important role in the formation of landscapes particularly in the upper mountains, is represented in north-eastern Russia. The extent and intensity of these processes are controlled by various factors including the type of rocks, presence and .thickness of unconsolidated deposits, and steepness of slopes. Frost or thermal contraction cracking creates the most typical cryogenic landforms: ice wedge polygon relief, also known as tundra polygons or fissure polygons.

Ice-wedge formation is ubiquitous in the Chersky-Moma region and the northern Verkhoyansk mountains while in the southern Verkhoyansk their occurrence is mostly limited to the northern macroslope of the Suntar-Khayata. The largest ice wedges, which exceed 3 m in surface diameter and 5-8 m in depth, develop in the Verkhoyansk region in wide valleys and where mountains merge with plateaux. In the southern Verkhoyansk mountains, northern Chukchi peninsula, and the Koryak highland thawing of ice wedges has led to the widespread development of thermokarst.

Thermokarst is among the most important processes shaping permafrost landscapes. It develops in response to the disruption of the thermal equilibrium of permafrost and is controlled by such changes in the environment as climatic warming, increase in snow cover, and an increase in seasonal variation of temperature, deforestation or destruction of vegetation, presence of standing water, and anthropogenic impacts. Thus in the Koryak highland the maximum surface subsidence reaches 10-12 m and in the Main basin thermokarst destroys a layer of ground up to 6-8 m in thick per year. This phenomenon seldom occurs naturally in the northern Verkhoyansk and Chersky mountains where it is mainly limited to the moraines of modern glaciers that have a high ground ice content.

Patterned ground is the most common cryogenic form of microrelief. Different varieties of patterned ground such as spot-medallions, polygonal and hummocky forms, stone circles and rings occur in the tundra environment. Sorted and unsorted patterned ground can form nets of circles on flat surfaces and steps or stripes on hillslopes. They are created by different processes in the active layer: frost cracking, contraction, heave resulting from cryostatic pressure and ice segregation in winter: ice-melting and dilation subsidence in summer; and frost sorting around the ear. Patterned ground most often has the following morphology: spot-medallions which may be surrounded tussocks, flat, curved or convex heaves (which have a size range between 0.5 m and 2.0 m) and hummocks. Sorted patterned ground (circles, garlands, nets. and polygons) is

found on ground rich in coarse-grained material which is located close to the surface.

Solifluction is regarded as one of the most widespread processes of soil movement in periglacial areas. The following conditions favour the development of solifluction: a slope angle of 8-12°, (although it is often observed within a much wider range of 2-25°); the presence of tine-grained soils, deposits, and ground, transformed by cryogenic weathering; and availability of water-saturated thawing soils. The major influence upon solifluction is vegetation. Solifluction in mountains is characteristic of the lowest belt of the Arctic and subarctic mountains. The typical solifluction regions are the Chukchi and Taymyr peninsulas where alternating stripes of fine-grained and coarse stony deposits (sorted solifluction) are found. Another type is the block field or block streams (also termed kurum), formed by frost weathering of exposed rocks. Solifluction terraces with treads reaching 5 m in width and 1.5 m in depth, tongue-shaped lobes and ramparts about 0.5 m high are a distinct feature of the landscape. On the steeper (15-25°) slopes, these forms have larger dimensions: terraces have a width of 50-100 m and a height of 1.5-3 m and the ramparts are about 3 m high.

Key words: cryolithozone, thickness of permafrost, cryogenic processes, ice wedges, thermokarst, patterned ground, solifluction.

Theme 6. Others

Developing an Online GIS Repository for Permafrost Data

Christopher W. Helm

(University of Colorado, Boulder, National Snow and Ice Data Center)

Abstract: Much of the permafrost data available over the Internet is hard to retrieve and difficult to convert into formats that allow users to efficiently distribute and manipulate the data. I am proposing to promote the development of an online Open Geospatial Consortium (OGC) Compliant Web Mapping Service (WMS) and Web Feature Service (WFS) that will act as the prototype for the possible creation of a long-term site for housing permafrost data. The prototype will be an online tool that allows users to view available permafrost data in a spatial context, and will allow users of permafrost data to explore, query, and download data in a number of GIS-compatible formats. Data housed at the National Snow and Ice Data Center (NSIDC) will be converted and ingested into a spatially compatible database (PostgreSQL/PostGIS) and served over the Internet via the open source mapping software MapServer. MapServer allows for the development of user-friendly and intuitive mapping interfaces that take advantage of OGC protocols for sharing data. Being OGC compliant means that other OGC compliant services can easily integrate data provided by this prototype service into their own services. It is important that an intuitive interface be developed to enable the distribution and sharing of permafrost data and to provide a place for those searching for, and creating, such data to have a convenient place to share information.

This Web Interface will be developed as a prototype to be showcased at the Asian Conference on Permafrost. It is the hope of the author that by attending the conference users of permafrost data will contribute important feedback on the feasibility and need for such a utility. The major benefit for the author to attend the Asian Conference on Permafrost is the prospect that more scientists will become interested in such a site and may be willing to contribute to the development of such a service.

To the knowledge of the author, this interface is the first GIS web-based application that integrates permafrost data from the Frozen Ground Data Center (FGDC) at NSIDC. This conference is an excellent opportunity to support the Frozen Ground Data Center, while promoting GIS applications and the distribution of permafrost data.

Keywords: GIS, Permafrost Data, Mapping

Facilitating International Scientific Exchange, the Development of Effective Pre- and Post-Conference Websites

Gary Whitton

(Engineering and Environmental Internet Solutions, LLC)

Abstract: With the emergence of the Internet in the 1990's, the world was opened to a new and broad reaching medium that allowed geographically dispersed groups of scientists to share information, and collaborate like never before. The Internet, like the electronic document revolution before it, also offered a mechanism to reduce the costs of developing, reviewing and distributing information. These developments opened a door for universities, associations, and conference organizers to fulfill their missions like never before.

However, along with its benefits, the Internet presents many challenges. The Internet is a continuously changing medium, with many different user groups whose computing environments, cultural backgrounds, and technical know-how vary greatly. To build an effective conference website requires an understanding of the needs of its potential audience, so as to avoid mistakes that may limit a site's effectiveness.

This presentation shall discuss the author's experience developing conference websites, and electronic proceedings for the American Water Resources Association and the United States Permafrost Association, as well as the numerous International standards, and techniques that have been developed over time to maximize website usability and accessibility.

Frozen Ground Data Management for the International Polar Year and Beyond

Mark A. Parsons

(World Data Center for Glaciology, Boulder/IPY Data Policy and Management Subcommittee)

Abstract: Data and information on frozen ground collected over many decades and in the future are critical for fundamental process understanding, environmental change detection and impact assessment, model validation, and engineering application in seasonal frost and permafrost regions. However, many of these data sets and information remain widely dispersed and relatively unavailable to the national and international science and engineering community, and some are in danger of being lost permanently.

The International Permafrost Association (IPA) has long recognized the inherent and lasting value of data and information and has worked to prioritize and assess frozen ground data requirements and to identify critical data sets for scientific and engineering purposes. In 1996, a working group of the IPA established the Global Geocryological Data (GGD) system to facilitate the availability of permafrost and related data. In 2002, the World Data Center (WDC) for Glaciology, Boulder in collaboration with the International Arctic Research Center (IARC) enhanced the GGD system by establishing the Frozen Ground Data Center (FGDC) to continue the IPA strategy for data and information management and to meet the requirements by cold regions science, engineering, and modeling community.

The FGDC identifies, archives, documents, and distributes data related to permafrost and seasonally frozen ground. The FGDC currently holds over 100 data sets and information products and contains detailed metadata records describing over 100 additional data sets available at other GGD nodes around the world. The data center has improved access to these data through an online search and order system, and by publishing Version 2.0 of the Circumpolar Active-Layer Permafrost System (CAPS) CD-ROM set.

The International Polar Year (IPY) now presents an opportunity to take the IPA data strategy to a new level. The IPY will involve an unprecedented number of geophysical, biological, and social science projects in the Polar Regions, and IPA projects will integrate closely with many of these projects through shared data and other affiliations. Integrated data management will be necessary to realize the full scientific and interdisciplinary potential of these projects and the IPA is positioned to take a lead in this area.

This presentation will present an array of high level data management considerations for the IPY including cross-disciplinary data access, essential documentation, system guidance, and long-term data archiving and how the IPY has begun to address these issues. The primary means by which IPY is addressing data management is through the creation of a Data Policy and Management Subcommittee and by endorsing an IPY Data and Information Service as described in the IPY Framework document. I will review the initial work and future plans of these groups and describe how they fit into existing international data structures. I will further highlight how existing and planned IPA efforts can fit into and lead broader IPY efforts.

Permafrost Young Researchers Network (PYRN): An international effort to encourage the involvement of young researchers for the International Polar Year (2007–2008)

Oliver W. Frauenfeld[1], Lisa Ballagh[2], Hugues Lantuit[3]

(1.CIRES/NSIDC, University of Colorado, Boulder, Colorado, USA;

2. Alfred Wegener Institute for Polar and Marine Research, Potsdam, Germany)

Abstract: The newly created Permafrost Young Researchers Network (PYRN) envisions spreading permafrost science and information among young researchers looking at permafrost environments around the globe. PYRN aims at gathering information, redistributing it, furthering international cooperation, and promoting the ideas and results emanating from permafrost research.

The imminence of the International Polar Year (IPY) prompted the need for a visible representation of the young permafrost community at the newly formed Youth Steering Committee of the IPY. PYRN will be an active member of IPY projects as well as the Youth Steering Committee within IPY, investigating the effects of changing environmental conditions on permafrost.

PYRN is formally established under the patronage of the International Permafrost Association (IPA). Its role is to create and maintain means of communication among young researchers involved in permafrost research. It reports on the activities of young permafrost

scientists and engineers within broader international or national young researcher assemblies (*e.g.*, WAYS, AGU, SEDIFLUX, *etc.*). PYRN has implemented a website (http://www.pyrn.org/) to report on conferences, events, employment opportunities, research and other topics related to permafrost science, and distributes a newsletter related to these topics. This new network attempts to raise the public's attention to permafrost research and its relevance to global environmental issues.
Key words: Permafrost, IPY, students, young researchers

Final Revised Program (August 28, 2006)
Asian Conference On Permafrost
Lanzhou, China August 7-9, 2006

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State Key Laboratory of Frozen Soil Engineering， Cold and Arid Regions Environmental and Engineering Research Institute, China Academy of Sciences

Saturday, Aug 5, 2006

Pre-conference Workshop on Central Asian Permafrost
Location: Ningwozhuang Hotel, Meeting room of South Building

Sunday, Aug 6, 2006

Pre-conference Workshop on Central Asian Permafrost
Location: Ningwozhuang Hotel, Meeting room of South Building

Registration (8:00-18:00)
Location: Ningwozhuang Hotel, VIP Building Hall

Reception (18:00-20:30)
Location: Ningwozhuang Hotel Great Hall
(Muslim foods are available. Please contact the Local Organizing Committee members in advance, if you need.)

Aug 10-16, 2006

Field Excursion

Organizer: Fujun Niu, Yongping Shen
Please read the Field Excursion Guide to gain more information.

Monday, Aug 7, 2006

Location: Ningwozhuang Hotel Great Hall

8:30–9:30 ***Opening Ceremony***
Chairs Wei Ma

Opening Speech
Jerry Brown
Guodong Cheng

9:30–10:30 ***Coffee Break***

10:30–12:00 ***Keynote Speech***
Chairs Guodong Cheng, H.-W. Hubberten

Guodong Cheng
Applications of the roadbed-cooling techniques in building the Qinghai-Tibet Railway
Jerry Brown
Status of international permafrost projects
Douglas L. Kane, Larry D. Hinzman and Robert E. Gieck
Extreme high and low streamflow in permafrost catchments

12:00–14:30 ***Lunch***

14:30–16:00 ***Keynote Speech***
Chairs Jerry Brown, Huijun Jin

Jef Vandenberghe
Permafrost extension in north-central China during the Last Glacial Maximum
Wei Ma, Guang-li Feng, Qing-bai Wu, Guo-dong Cheng
Analyses of temperature fields under the air convective embankment of the crushed rocks structures along Qinghai-Xizang Railway

16:00–16:30 ***Coffee Break***

16:30–18:00 ***Keynote Speech***
Chairs Jerry Brown, Huijun Jin

H.-W. Hubberten, N. N. Romanovskii
The evolution of permafrost during the last climatic cycle in the coastal lowlands and shelf areas of eastern Eurasia
Tingjun Zhang, Mark A. Parsons, and Roger G. Barry
Statistics of global permafrost distribution
Douglas J. Goering, Jianfeng Xu
Title to be decided

18:00-20:30 ***Dinner***
Attendees lodging in VIP Building have your dinner in VIP Building Dining-room.
Attendees Lodging in North Building and South building have your dinner in North Building Dining-room.
Attendees not lodging in Ningwozhuang Hotel have your dinner in VIP Building Dining-room.
(Muslim foods are available. Please contact the Local Organizing Committee members in advance if you need.)

Tuesday, Aug 8, 2006

8:00–8:30 ***Keynote Speech*** **(Location:** Small **Hall of North Building)**
Chairs: Gang Chen
M.C.R. Davies
Geotechnical centrifuge experimental studies related to frost heave and slope deformation

8:30–10:10 ***Oral session***
Theme 1-1: Engineering: Pipeline design and performance (Location: Small Hall of North Building)
Chairs: Gang Chen
Koui Kim, Wendy Zhou, and Scott L. Huang
One-D numerical analysis to predict a buried chilled gas pipeline in Alaska, Fairbanks
Hui Li, Gang Chen*
Laboratory observation of dynamic frost bulb and frost heave development in soil surrounding chilled pipe using computerized ultrasonic tomography
Arlon R. Tussing, John Tichotsky & Philip L. Essley
Permafrost issues in route choices for high-latitude gas pipelines in North America
Shunji Kanie, Satoshi Akagawa and Takashi Mikami
Practical modeling for frost heave estimation of chilled gas pipeline buried in frost susceptible soil
Satoshi AKAGAWA, Scott HUANG, Kohi KIM, Syunji KANIE, Takashi MIKAMI, Masami FUKUDA

Bending properties monitored in full-scale childed gas pipeline experiment in discontinuous permafrost

Theme 3-1: Climate and environmental controls of the cryosphere (Location: No.1 Conference-room of Zhongxiaolou Building)

Chairs: Jef Vandenberghe, Xiaoping Yang

Diekmann, B., Andreev, A.A., Gerasimova, M., Lüpfert, H., Nazarova, L., Pestryakova, L., Popp, S., Siegert, C., Subetto, D.A.
Periglacial lake environments in eastern Siberia

Xiaoping Yang
Ice wedge landforms as indicators for quantitative reconstruction of palaeoclimates in desert regions of China

Sergei Marchenko, Vladimir Romanovsky
Temporal and spatial changes of permafrost distribution in the Tien Shan Mountains during the Last Millennia

Ronald S. Sletten, Birgit Hagedorn, Warren W. Dickinson, Bernard Hallet
Origin and stability of ground ice in the Dry Valleys, Antarctica

Michelle Koutnik, Ronald S. Sletten, Bernard Hallet, and Shawn Marshall
Relationship between permafrost and past ice cover on the Qinghai-Tibet Platea

Theme 4-1: Permafrost hydrology (Location: Multifunctional-hall of VIP Building)

Chairs: Daqing Yang, Oliver Frauenfeld

David M. Lawrence Andrew G. Slater
Arctic hydrological feedbacks associated with a global climate model projection of severe degradation of near-surface permafrost

Daqing Yang, Tingjun Zhang, Baozhong Liu, Baisheng Ye
Impact of frozen ground change on stream flow hydrology over the Siberian Lena basin

Yong-chao Lan, Zhi Wei*, Hui-jun Jin, Jun-jie Chang, Xiao-hu Huo, Ye-xin Xu
Possible change of runoff in the Upper Yellow River Basin under global warming scenarios

Erica H. Hofstee, Megan R. Balks*, David I. Campbell, Jackie Aislabie
Hydrological characteristics of Seabee Hook, Cape Hallett, Antarctica

10:10–10:30 ***Coffee Break***

10:30–12:10 ***Oral session***

Theme 1-2: Engineering: Frozen ground properties and models (Location: Small Hall of North Building)

Chairs: Douglas Kane, Wei Ma

Norbert I. Kömle, Roman Wawrzaszek, He Ping, Bing Hui, Feng Wenjie
Thermal conductivity measurements of road construction material in frozen and unfrozen states

S.B.Tataurov, Petrikey A.L.

Cryogenic physical and chemical technologies of ore dressing and processing of minerals of natural and technogenic deposits of gold

Simon Wang, Osamu Sano

Soil insulation by styrofoam extruded polystyrene foam

Fujun Niu, Guodong Cheng, Jianjun Li, Wei Ma

Monitoring study on the boundary thermal conditions and temperature fields of duct-ventilated embankment in permafrost regions

Keli **Wang, Guodong Cheng, Hao Jiang, Dayong Wang***

Thermodynamic Model of the Ground Surface and Embankment Surface along the Qinghai-Tibet Railway: Results in the Cloud-Free Condition

Theme 3-2: Climate and environmental controls of the cryosphere (Location: No.1 Conference-room of Zhongxiaolou Building)

Chairs: Hans-W. Hubberten, Thomas Osterkamp

Bernd Wuennemann

Periglacial and glacial processes in Ladakh, India - Influences on the Holocene history of the Tso Kar lake basin.

Max C. Brewer, Huijun Jin

No thawing of the cold permafrost has occurred in northern Alaska during the last one-half century

Alexander Fedorov, Masami Fukuda, Pavel Konstantinov, Nikolai Bosikov, Go Iwahana

Present-day thermokarst development in Central Yakutia

R. Shirokov, I. Streletskaya

Quaternary sediments of Kara Sea coast and their cryogenic structure

Andrey Shmakin

Evaluation of permafrost seasonal variations at several Asian sites in 21st century

Theme: 4-2: Land use and management (Location: Multifunctional-hall of VIP Building)

Chairs:N.C. Doubleday, Arlan Tussing

N.C. Doubleday

Applying the adaptive cycle to modeling environmental and anthropogenic cryospheric changes and linking problems of human adaptation and mitigation

Jan Otto Larsen

Sustainability of the transport sector in Norwegain Arctic to climate change

Zhaohui Yang

Transportion infrastructure on degrading permafrost

Anna Kurchatova

West Serbia permafrost observatories and educations activities

12:10–14:20 ***Lunch***

14:20–16:00 ***Oral session***

Theme 1-3: Engineering: Frozen ground interactions and models (Location: Small Hall of North Building)

Chairs: Luxin Zhang, Aldar Gorbunov

Zhaohui (Joey) Yang, Tpal Dutta
Effects of seasonal frozen soil on soil-foundation-structure interaction

Aldar P.Gorbunov, Edward V.Seversky
The features of engineering and geological researches under opening up of permafrost of the high mountains of Central Asia

Yue-dong Wang, Li Hongsheng
Numerical simulation of nonlinear fracture failure process in frozen soil

Rorik A Peterson, Julian B Murton
Laboratory and numerical modeling of rock and concrete fracture due to thermally-induced water migration

Jian-bing Chen, Shuang-jie Wang, Jin-zhao Zhang, Wei Ma
Study on the formation and mechanisms of high subgrade diseases of the Qinghai-Tibet Highway

Theme 5-1: Mapping: Monitoring and modeling (Location: No.1 Conference-room of Zhongxiaolou Building)

Chairs: Sergey Marchenko, Tingjun Zhang

Xiaozhen Xiong, Chris Barnet, Eric Maddy, Xingpin Liu, Lihang Zhou, Walter Wolf, Mitch Goldberg
Towards the satellite monitoring of methane emission from permafrost

N. Sharkhuu, Sh. Anarmaa
Monitoring of permafrost in Mongolia

Tonghua Wu, Shuxun Li, Guodong Cheng, Lin Zhao, Qinxue Wang, Masataka Watanabe
Application of GPR in permafrost detection and field survey design in Mongolia

Nikolay I. Shiklomanov, Oleg A. Amisimov, Tingjun Zhang, Vladimir E. Romanovsky
Multiscale, hierarchical approach to validation of spatial permafrost models

Fuqun Zhou, Aining Zhang, Robert Li
Surface-coupled 3-D permafrost model for impact assessment on building foundations in Northern Canada due to permafrost degradation

Theme 2-1: Slope processes, rock glaciers, and planetary (Location: Multifunctional-hall of VIP Building)

Chairs: W A Mitchell, Stuart Harris

V.N. Zaitsev
Features of hydrothermal conditions and cryogenic structure of kurums in the Udokan Range

W A Mitchell
Rock glaciers and mountain permafrost in Zanskar, NW Indian Himalaya

Reynald DELALOYE, Christophe LAMBIEL, Jonathan DORTHE, Sébastien MORARD
Mapping and monitoring strategies for detecting air circulation processes in blocky terrain
Stuart A. Harris, Guodong Cheng, Cui Zhijiu
Active lag block streams in the Chinese Tian Shan

16:00–16:20 *Coffee Break*

16:20–18:00 *Oral session*

Theme 1-4: Engineering: Construction methods and results (Location: Small Hall of North Building)

Chairs: Bo Liang, Zhaohui Yang

Vladimir Petroveth Vlasov
Effect of seismic events on the stability of buildings on permafrost: a case study
Bo Liang, Yuan-ping Cao, Jian-jun Ge , Cheng Wang
Test and analysis about the development of depth of seasonal-thawing of L-type retaining wall
Xue-fu Zhang
The elementary study on the chain-styled mechanism and the new-typed method to the chain breakage of the water leakage hazard in Kunlun mountain tunnel
Zhi-qiang Ji, Xue-yan Xu, Lin-lin Yu
Study on the influence of artificial frozen soil layer to the temperature field and displacement field of the frozen wall

Theme 5-2: Mapping: Land surface processes (Location: No.1 Conference-room of Zhongxiaolou Building)

Chairs: Xiaozhen Xiong

Tingjun Zhang
Modeled Changes in Active-Layer Depth over the Tibetan Plateau
Oliver W. Frauenfeld, Tingjun Zhang
The role of land surface processes and permafrost on temperature variability in the Tibetan Plateau
Rui Jin, Xin Li, Tao Che
Decision tree to classify the surface frozen/thaw using SSM/I brightness temperature
Dmitry A. Streletskiy, Nikolay I. Shiklomanov, Anna E. Klene, and Frederick E. Nelson
Air and ground surface temperature monitoring in Arctic Foothills of Alaska
Galina Mazhitova, Dmitry Kaverin*
Local-level processes associated with progressive permafrost thaw as exemplified by data from a CALM grid
Y. Ma, Y. Wang, W. Ma, Z.Su, M.Menenti, Z. Hu, J. Wang, H.Ishikawa, T.Koike
Progress on the Study of Land Surface Processes over the Tibetan Plateau Area

Theme 2-2: Frost hazards: Permafrost chemistry (Location: Multifunctional-hall of VIP Building)

Chairs: Bernhard Diekman, Ron Sletten

V.B. Spektor, V.V. Spektor, V.A. Nikolaev, A.B. Kolesnikov
Karst processes and phenomena in frozen carbonate rocks of the Middle Lena River basin

John Kwong Y.T.
Impact of degrading permafrost on impounded tailings at Mount Nansen, Yukon Territory, Canada

18:00-20:30 ***Dinner***
Attendees lodging in VIP Building have your dinner in VIP Building Dining-room.
Attendees Lodging in North Building and South building have your dinner in North Building Dining-room.
Attendees not lodging in Ningwozhuang Hotel have your dinner in VIP Building Dining-room.
(Muslim foods are available. Please contact the Local Organizing Committee members in advance if you need.)

Wednesday, Aug 9, 2006

8:00–10:00 ***Oral session***
Theme 1-5: Engineering: Embankment investigations (Location: Small Hall of North Building)
Chairs: Valentin Kondratiev, Jilin Qi

Douglas J. Goering, Jianfeng Xu*
Experimental Validation of Passive Permafrost Cooling Systems

Ning Li, Guoyu Li, Jiamei Kang
Discussion on some design principles for cold region engineering

A. Rist, M. Phillips, W. Haeberli
Influence of snow meltwater infiltration on active layer movement in steep alpine scree slopes within the discontinuous mountain permafrost zone

Zhi-zhong Sun, Wei Ma, Dong-qing Li
Cooling effect of crushed rock revetment in permafrost regions

Junjie Wu, Wei Ma
In-situ study on cooling effect of two-phase closed thermosyphon & insulation combinational roadbed

Theme 3-3: Climate and environmental controls of the cryosphere (Location: No.1 Conference-room of Zhongxiaolou Building)
Chairs: Oliver W. Frauenfeld, Fuqun Zhou

Richard Armstrong

Snow cover mapping on the Tibetan Plateau using NASA EOS optical (MODIS) and passive, microwave (AMSR-E) remote sensing data

Anita D. Rapp, Oliver W. Frauenfeld, Tingjun Zhang, Lijuan Ma

Comparison of Tibetan Plateau rainfall to permafrost distribution

T. Sueyoshi, A. Ikeda, N. Matsuoka and T. Ishii

Thermal State of Degrading Permafrost in the Source Region of Yellow River, Qinghai Province, China: Numerical Approach

Andrew G. Slater, David M. Lawrence

Permafrost, climate change and the coupled climate system

Kenji Yoshikawa, ZHAO Lin, and Baisheng YE

Historical variability of the icing (aufeis) in the Brooks Range, Alaska and Kunlun Mountain, China

Theme 1-6: Engineering: Embankment investigations (Location: Multifunctional-hall of VIP Building)

Chairs: Xiaozu Xu, Nikolay Shiklomanov

Sheng-sheng Li

Exerimental study on the relation between the freezing mode and frost heave

Xiao-zu Xu, Bin-xiang Sun, Qi Liu, Shuang-jie Wang, Jin-zhao Zhang

Experimental study on the influence of paving location and diameter on the cooling ffect of ballast embankment

Guoyu Li, Ning Li, Jiamei Kang

Heat transfer characteristics of Qinghai-Tibet railway embankment with crushed-stone side slope in permafrost regions

10:00–10:20 ***Coffee Break***

Theme 1-7: Engineering: Freeze-thaw processes(Location: Small Hall of North Building)

Chairs: Ruijie Chen, Fujun Niu

V.G. Kondratiev, Z.B. Dashinimaev*, A.P. Balagansky, V.V. Hananov

Skilled-experimental check new anti-frost heaving devices for supports of contact net and aerial lines on the Transbaikalian railway

Ruijie Chen, Wei Ma

Permafrost thaw settlement and embankment stability

Da-yan Wang, Wei Ma, Xiao-xiao Chang, Wen-jie Feng

Mechanical properties of Qinghai-Tibet clay subjected to closed-system freezing and thawing

Xiao-fei Chen, Wei Ma, You-sheng Deng, Xue-zu Xu

Experimental study on solute transport during soil freezing Process

Jilin Qi, Pieter A. Vermeer

Influence of freeze-thaw on the strength of overconsolidated soils

Theme 5-3: Mapping: Permafrost and active layer trends (Location: No.1 Conference-Room of Zhongxiaolou Building)

Chairs: Aldar Gorbunov, Xin Li

Hui-jun Jin, Shao-peng Yu, Rui-xia He, Yan-jun Ji, Si-zhong Yang, Zhi Wei, Dong-xin Guo, and Ying-wu Li

Degradation of permafrost in the Da- and Xiao-Xing'anling Mountains, Northeastern China and assessment of its trends

V.V.Popova, A.B. Shmakin

Climate factors of permafrost regime and their change in Northern Eurasia during recent decades

Xujun Han, Rui Jin, Xin Li

Probabilistic prediction of the permafrost distribution on the Qinghai-Tibet Plateau according to a warming climate scenario

Thomas Osterkamp

Questions regarding the recent warming of permafrost in Alaska

H. Farbrot, B. Etzelmüller, Á. Guðmundsson, O. Humlum, K. Isaksen, L. Sørbel

Mountain permafrost distribution and ground temperatures in Iceland and northern Norway

Theme 1-8: Engineering: Design concepts (Location: Multifunctional-hall of VIP Building)

Chairs: Doug Goering, Ning Li

Valentin Kondratiev

The active methods of stabilization of a roadbed and contact-line and air line supports on permafrost

V.G. Kondratiev, L.S. Garagulya, S.V. Soboleva*, S.U. Potapov

The concept of an engineering-geocryological monitoring system of the federal highway "Amur" Chita-Khabarovsk

Xiao-min Zhou, Long-ge Xiao, Yun-chen Zhao

Experimental and mechanical study on the Coupled action to seepage field applied by both stress and temperature fields

Keith F. Mobley, P.E., Andy R. Smith, Edward Yarmak, Jr., P.E.

Thermal and seepage modeling analysis of a lined rockfill dam founded on marginal permafrost

12:00–14:30 ***Lunch***

14:30–19:00 ***Visit the State Key Laboratory of Frozen Soil Engineering，CAREERI,CAS and Yellow River.***

19:00–21:00 ***Closing Ceremony and Banquet*** **(Location: Small Hall of North Building)**

Jerry Brown (USA) Closing Comments

Oliver Frauenfeld (Austrian) PRYN awards

Hans Hubberten (Germany) Closing Comments

Jef Vanderberghe (Netherland) Closing Comments

Michael Davies (UK) Closing Comments
Stuart Harris (Canada) Closing Comments
Doug Kane(USA) Invitation to NICOP, Fairbanks, Alaska
Huijun Jin(China) Submission and Publication of Papers
Fujun Niu(China) Introduction of Field Excursion
Guodong Cheng (China) Final Presentation

Posters:

- **Posters belonging to Theme 1 will be shown at *Small Hall of North Building* on August 8-9.**
- **Posters belonging to Theme 3 and Theme 5 will be shown at *No.1 Conference-room* of Zhongxiaolou Building on August 8-9.**
- **Posters belonging to Theme 2 and Theme 4 will be shown at *Multifunctional-hall of VIP Building* on August 8-9.**

Theme 1. Permafrost engineering, properties of frozen soils, model development, and their applications

Rev I. Gavriliev
The thermal conductivity of segregated ground ice
Ya-hu Tian
Analysis of the combined effect of thermal insulation and thermosyphon for embankment cooling in Qing hai-Tibet Railway
Jian-kun Liu
Sensitivity analysis of crack evolution on roadbed in permafrost zone
Gao-feng Man
The calculation and control methods of the ice-wall thickness in ground freezing construction
Qi Liu
Investigation of laboratory experiment on cooling effect of embankment with perforated ventilation pipe
Bin-xiang Sun
Numerical analysis for thickness of fractured-rock revetment layer on Qinghai-Tibet Railway
Yue-dong Wang
Numerical simulation of nonlinear fracture failure process IN frozen soil
Xi-zhong Yuan
Study on the thermal regime of frozen ground after construction of large-diameter Cast-in-place piles in permafrost regions
Xi-zhong Yuan
Strength behavior and unfrozen water content of saline fine-grained frozen soils
Zhi Wen

Experimental research on thermal conductivity of undisturbed frozen samples from permafrost regions on Qinghai-Tibetan plateau

Theme 2. Frost hazards and periglacial environments in mountain/plateau regions

Yosuke Yanai

Stimulation of N2O production and reduction in soil under frozen condition

Vladimir Chernyad´ev

Hazard assessement criteria for development of engineering geological processes during construction in the area occupied by perennially frozen ground

Evgeny Chuvilin

Relict gas hydrate as possible form of shallow intra permafrost gas existence

Reynald Delaloye

Application of ERS InSAR for detecting slope movement in a periglacial mountain environment

Fumiaki Takakai

CH4 emission from a Siberian alas ecosystem near Yakutsk, Russia

Theme 3. Climatic, environmental and cryospheric changes

Christine Siegert

Cryolithological features of Quaternary sediments on the Lena-Kénkémé interfluve,Central Yakutia

Anna Kurchatova

Reconstruction of paleocryogenic strata through micromorphological indications

Roman Desyatkin

About role of thermolarst in global balance of carbon

Jakob Heyman

Paleoglaciology of the Bayan Har Mountain area, eastern Tibetan Plateau

Hui-jun Jin

Assessment of frozen soils environmental geological conditions along the Qinghai-Tibet engineering corridor from Xidatan, Qinghai to Naqu, Tibet, China

Theme 4. Permafrost hydrology and cold regions water resources and land use

Nataliya Moskalenko

Cryospheric changes in the West Siberia northern taiga

Koichiro Harada

Permafrost condition after tundra fire in Seward Peninsula, Alaska

Baozhong Liu

Impacts of an Arctic reservoir’s regulation on downstream thermal regime in open-water Season

Christopher Warren Helm
Developing an Online GIS repository for permafrost data
Oliver W. Frauenfeld
Permafrost Young Researchers Network (PYRN): An international effort to encourage the involvement of young researchers for the International Polar Year (2007–2008)

M.Gude
The international geographical union (IGU) commission on "Cold Region Environments" within the context of changing land use effects in northern permafrost areas

Theme 5. Monitoring, mapping and modeling of mountain and high-elevation permafrost

Atsushi Ikeda
Sounding permafrost in the source area of the Yellow River (Northeastern Tibet): degrading or already disappeared?
Uk Han
Characteristics and significance of the active layer in permafrost affected soils (Dasan Station, Svalbard and Sejong Station, Antarctica)
Petru Urdea
Patterned ground and permafrost in the southern carpathians (Romania)
Inga Shamanova
Main features of soil seasonal freezing and thawing in the Timan – Pechora Oil – and –Gas Province
Oleg Streletskiy
1. Structure and physical state of the permafrost in western coastal planes of Russian Arctic 2. Thermophisycal characteristics of dispersion soils in a wide range of negative temperatures
Nella Shpolyanskaya
Specific features of distribution of the perennially and seasonally frozen ground in Transbaikalia
Sharkhuu Natsagdorj
Mapping of mountain permafrost in Mongolia and Central Asia
Kyung Ho Chung
Characteristics and significance of the active layer in permafrost affected soils (Dasan Station, Svalbard and Sejong Station, Antarctica)
Kazuyuki Saito
Change in hydro-thermal regimes in the soil-freezing regions in the Global Warming simulation by a CGCM of moderate- and high-resolution
Zhi-wu Zhu
The physical mechanism in freezing processes of soil and the constitutive model of frozen soil
Jian-wen Guo
Mixed environment developing research on the distributed Qinghai-Tibet Railroad GIS
J. G. Bockheim

A Preliminary Permafrost and Ground Ice Map of Antarctica

Author Index (08-28-06)