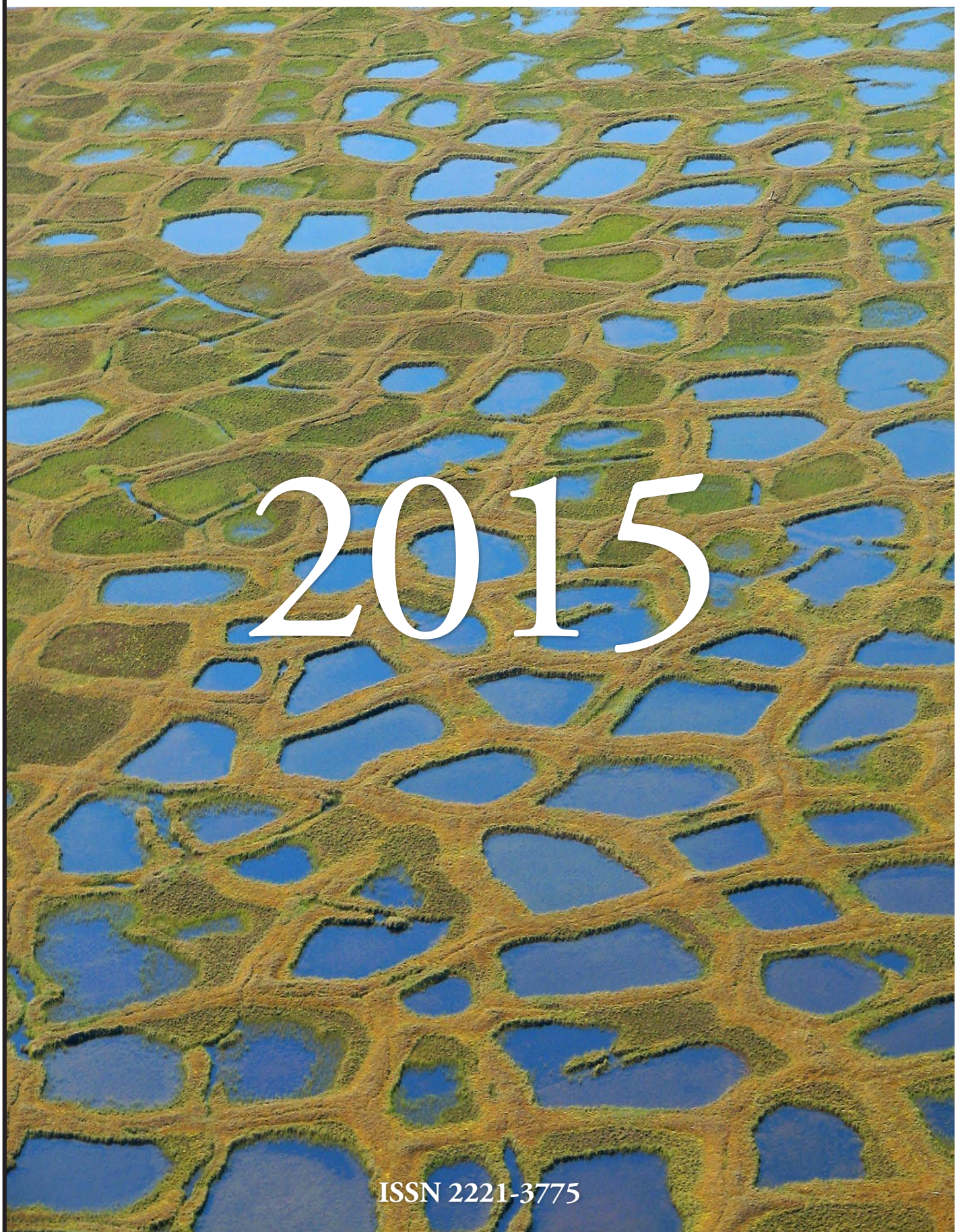
Country Reports

Reports from the Adhering Bodies of the International Permafrost Association



2015

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1 Argentina, South American Partners and Mexiko

In March 2015 an excursion to the Morenas Coloradas rock glacier in the Andes of Mendoza was made with the participation of 16 Students from the University of Bonn (Germany) under the direction of Dario Trombotto and Prof. Lothar Schrott (Bonn).

On behalf of the XIX Argentine Congress of Geology, held in Córdoba in 2014, and with the support of the Subcommittee of Cryospheric Sciences of the Argentine Republic (SAC) and the Argentine and South American Permafrost Association (AASP), a new special publication Lilloana (San Miguel de Tucumán) was edited by Trombotto and Ahumada. The chapters include periglacial and glacial topics like rock glaciers of the Tropical Andes of Argentina (Ana Lía Ahumada); ice studies of grain size evolution throughout the depth of a glacier (Carlos Di Prinzio, Córdoba); surface fluctuations of glaciers in the Nevado Cololo, Bolivia (Ana Maria Sanches, Centro Polar e Climático, Rio Grande do Sul, Brazil), among others.

Carla Tapia Baldis (PhD student, Universidad Nacional de San Juan) concluded with the periglacial and glacial geomorphology cartography at “Valle de los Glaciares de Escombros”, Rio Blanco basin (Central Andes, 31°50’S). First results concerning cryogenic altitudinal belts were already published. A regional approach about climatic parameters that control present permafrost distribution between 31°-32°S was made. Historic climatic series from spatial gridded data are used to elaborate regional maps of temperature, solar radiation and precipitation trends, validated with local meteorological stations registers. Landforms identified as probable active-layer detachments, among other mass movement deposits, were recognized and characterized using remote sensory imagery and digital elevation models.

Figure 1. Lizoite rock glacier in Salta, Argentina (M. Martini)

During 2015 Dr. Mateo Martini and co-workers from CICTERRA (Universidad Nacional de Córdoba) continued with the dynamic and thermal monitoring of the Varas rock glacier (initiated in 2010) and obtained the first results for the Lizoite rock glacier (initiated in 2014), both located in the Cordillera Oriental of NW Argentina (22-23˚S).

Figure 2. Active layer detachment at 4100 m asl in the province of San Juan, Argentina (Tapia Baldis)

During 2015 Noelia Sileo (Ciudad Autónoma de Buenos Aires) continued the water, ice and snow sampling in the Vallecitos river basin. New sampling points have been added to complete the whole basin monitoring program, to characterize different water origins and the hydrogeochemical composition of a typical cryogenic environment. The electric conductivity analysis in temporal series has revealed a characteristic behavior between the different sampling sites, depending mainly on their spatial and altitudinal distribution. The first isotopic results show that water samples in lower areas are enriched compared to those from higher zones indicating a dependence on values of δ18O y δ2H with altitude.

Xavier Bodin (Laboratoire EDYTEM, CNRS / Université de Savoie, Le Bourget-du-Lac, France) presented first conclusions of terrestrial photogrammetry for studying rock glacier dynamics and their interannual surface changes in the Andes at the meeting “Geomorphometry for Geosciences”, Adam Mickiewicz University in Poznań. At the same congress and to-

gether with Lucas Ruiz (Mendoza) Bodin analysed rock glaciers with the help of high resolution Pléiades images. Bodin has a collaboration project with the Research Group of Mendoza about Geocryology studying the rock glacier of “Quebrada del Medio” also called Hans Stepanek.

Throughout 2015, PhD Student Cristian Daniel Villarroel (CONICET-UNSJ) started with field measurements of hydrological and hydrogeological processes in the upper section of the river Santa Cruz basin. This area has lots of active and inactive rock glaciers, protalus lobes and few covered glaciers. We have obtained the first results on the hydrological behavior of different streams. It has also established the geometry of the groundwater basins. Geologist Ana Forte, of the same Universidad Nacional de San Juan, is mapping periglacial geomorphology with permafrost distribution in the Cordón de la Ramada of San Juan.

A collaboration work was initiated with the Universidad Nacional Autónoma of México, UNAM (Dr. Hugo Delgado Granados, Mexico City). Dario Trombotto is mentor in the PhD work of Víctor Hugo Soto Molina about permafrost at the Citlaltépetl volcano.

In 2015 Dario Trombotto was appointed member of the Climate and Cryosphere (CliC), Project Scientific Steering Group (SSG) by the Joint Scientific Committee (JSC) for the World Climate Research Program (WCRP) at the 35th session in Geneva, Switzerland.

Figure 3. Volcán Citlaltépetl, México (Víctor Hugo Soto Molina)

Report prepared by Dario Trombotto Liaudat, Geocryology, Mendoza (dtrombot@mendoza-conicet.gob.ar),

2 Austria

The year 2015 was another busy year for the Austrian permafrost community with national and international meetings and project activities. Similar to our national reports of the previous years, this report consists of two parts. The first part reports about general permafrost activities and events which happened this year in the country. The second part discusses permafrost and periglacial research activities carried out by the different research groups in Austria.

Part 1: General permafrost activities in Austria

The General Assembly 2015 of the European Geosciences Union (EGU) took place in Vienna during the period 12 to 17 April 2015. Almost 12.000 scientists from more than one hundred countries participated in this event (http://www.egu2015.eu). Permafrost-related research was presented and discussed in 22 different sessions.

Within the framework of a new nationwide project entitled permAT - Long-term monitoring of permafrost and periglacial processes and its role for natural hazard prevention: Possible strategies for Austria a workshop was held in Graz on 26-27 February 2015. The aim of this workshop was to discuss possible strategies, which allow the establishment of a long-term funded, maintained and efficiently working permafrost and periglacial monitoring network in Austria thereby considering also national hazard aspects (Fig. 1). The workshop was visited by some 40 colleagues from Austria and a neighbouring country (consisting of researcher, stakeholder and policy maker) and was supported by the Climate Change Centre Austria (CCCA). The project, which was jointly led by A. Kellerer-Pirklbauer (University of Graz) and A. Bartsch (Central Institute for Meteorology and Geodynamics/ZAMG) ended in 2015. The final report was written as a community white paper documenting the possible strategy of future permafrost monitoring in Austria. This paper was released in December 2015 (in German) and will be communicated to international colleagues in the near future. The compilation of this report was supported by more than 20 researcher in Austria. For more details on the project permAT see the national report of 2014.

A first official meeting of permafrost scientists from Austria and South Tyrol was held in 2010 in Obergurgl, Tyrol, Austria (see national report of 2010). Five years later, the Second Austrian Permafrost Workshop was successfully conducted in the federal province of Styria in the period 14-16 October 2015 with some 20 participants (Fig. 2). The workshop consisted of a presentation-and-discussion part (held in the Trautenfels Castle) and an excursion part (leading to the Hochreichart area, Seckauer Tauern Range). The excursion focused on present and past permafrost distribution and hydrogeological issues related to paleo-permafrost landforms. The workshop was jointly organized by the Department of Geography and Regional Science, University of Graz (represented by A. Kellerer-Pirklbauer), the Institute of Earth Sciences, University of Graz (G. Winkler), and the Universalmuseum Joanneum, Trautenfels and Graz (K. Krenn, I. Fritz).

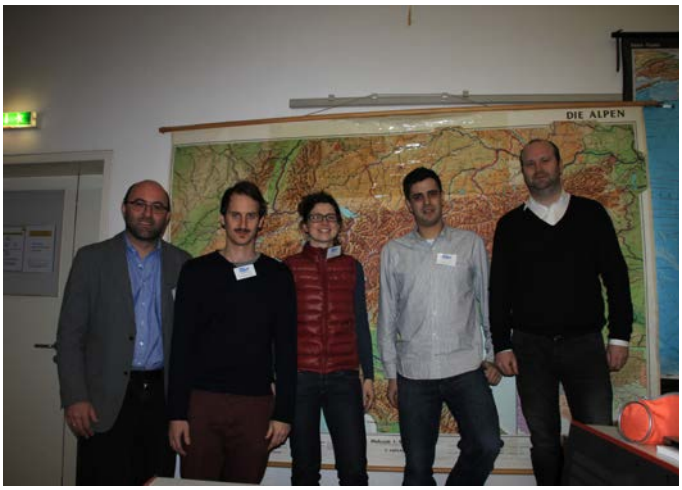

Figure 1. The organising committee of the permAT-permafrost workshop held in Graz on 26-27 February 2015 consisting of (from left to right) Andreas Kellerer-Pirklbauer, Christoph Gitschthaler (both University of Graz), Annett Bartsch (Central Institute for Meteorology and Geodynamics), Stefan Ropac and Matthias Themessl (both Climate Change Centre Austria(CCCA). Photograph provided by Andreas Kellerer-Pirklbauer.

Figure 2. Participants of the second Austrian Permafrost Workshop, held on 14-16 October 2015 at the Trautenfels Castle, Styria, Austria. The participants also visited a permafrost monitoring site in the Seckauer Tauern Range, (Hochreichart area) where permafrost and hydrogeological research related to paleo-permafrost landforms are carried out since more than a decade. Photograph provided by

Andreas Kellerer-Pirklbauer.
The Austrian Polar Research Institute has initiated and co-organized (jointly with the Committee on Polar Research, Poland, and the Centre for Polar Ecology, Czech Republic) the First Central European Polar Meeting which successfully took place between the 10 and 13 November 2015 at the Austrian Academy of Sciences in Vienna, Austria. W. Schöner (University of Graz) and A. Bartsch (ZAMG) were intensively involved in this meeting. The presentations included a range of permafrost related research. The abstracts can be found under the following link (http://www.polarresearch.at/conference/program/).

Finally, we report that I. Hartmeyer participated in the Second National Correspondents Workshop on GTN-P which took place on 19-20 September 2015 in Québec, Canada. Regarding GTN-P, the permafrost borehole Koppenkarstein North Face, Dachstein Massif, Austria was officially included in the GTN-P database. The drilling of the borehole was already accomplished in 2014 (see report of previous year). The monitoring data retrieved so far from the datalogger confirm permafrost existence at this site. Therefore, Austria now contributes with nine permafrost boreholes from three different monitoring sites (Hoher Sonnblick, Kitzsteinhorn and Dachstein) to the GTN-P network.

Part 2: Reports from the different Austrian permafrost research groups

The national permafrost project permAT (see above) was concluded in 2015 and the final report was released in December 2015. The final report is written in German and online accessible at http://www.startclim.at/startclim2014/. An English abstract of the final report is accessible at http://www.startclim.at/fileadmin/user_upload/StartClim2014_reports/StCl2014_en_final_report.pdf.

Salzburg

Research activities at the study site Kitzsteinhorn (3.203 m), Hohe Tauern Range, have been continued and intensified in 2015 within the MOREXPERT project (I. Hartmeyer, M. Keuschnig, J.-C. Otto). MOREXPERT is carried out by the University of Salzburg in cooperation with alpS (Centre for Climate Change Adaptation Technologies, Innsbruck) and investigates the long-term interaction of permafrost and rockfall in frozen rock walls (see also earlier reports). Monitoring activities in 2015 included (a) temperature measurements in deep (up to 30 m in depth) and shallow boreholes (up to 0.8 m in depth) that cover different aspects and elevations of the Kitzsteinhorn summit pyramid, (b) electrical resistivity measurements in unstable permafrost-affected bedrock, and (c) terrestrial laserscanning (TLS) surveys to identify rockfall release zones. In 2015 this combination of surface and subsurface measurements was expanded by seismic measurements. Within the SeisRockHT project, which is led by ZAMG (see below), geophones have been installed in three of the five boreholes at the Kitzsteinhorn in order to register acoustic emissions of rockfalls (Fig. 3).

Figure 3. Instrumentation of a borehole with temperature sensors and geophones in the summit area of the Kitzsteinhorn (3203 m a.s.l.) within the MOREXPERT project. Photograph provided by Markus Keuschnig.

The ZAMG Vienna (A. Bartsch, S. Reisenhofer) and ZAMG Salzburg (C. Riedl) intensified their research activities at Hoher Sonnblick (3106 m a.s.l.) in 2015. Since the beginning of the year 2015 the Sonnblick Observatory at Hoher Sonnblick is one of the 17 worldwide integrated CryoNet sites of the Global Cryosphere Watch (GCW) program, which is a young initiative of the WMO. The permafrost monitoring is a fundamental part of the instrumentation and thus also contributes to GCW. The permafrost related research activities in 2015 included rock fall activity monitoring (project SeisRockHT), a new permanently installed ERT (project PERSON-GCW and ATMOperm) and installation of further shallow boreholes (project PERSON-GCW). The two projects SeisRockHT and ATMOperm were launched in 2015 and are funded by the Austrian Academy of Science.

Within the project PERSON-GCW, funded by the Austrian Federal Ministry of Agriculture, the spatial distribution of permafrost is investigated by ZAMG (S. Reisenhofer) in the Hoher Sonnblick area. The aim of PERSON-GCW is to identify parameters affecting permafrost – geological, geomorphological, orographical and climatic factors – to determine its spatial-temporal behaviour under present day climate conditions and to estimate its possible future extension under a climate change scenario.

In cooperation with the Geological Survey of Austria (GBA; R. Supper, S. Pfeiler) the previously mentioned permanently installed electrical resistivity tomography (ERT) array was established in July 2015

in the upper summit area of Hoher Sonnblick (Fig. 4). To determine near-surface temperature conditions along the ERT profile two shallow boreholes were additionally installed with temperature sensor at depths of 80, 60, 40, 20 cm and at the surface. The ground surface temperature monitoring was continued and measurements of the bottom temperature of the winter snow cover (BTS) were accomplished in mid-March 2015.

Figure 4. Installation of an ERT array in the summit area of Hoher Sonnblick (3106 m asl.) on 14 July 2015. The Sonnblick Observatory and the summit hut Zittelhaus are visible in the background. Photograph provided by Stefan Reisenhofer.

ATMOperm is carried out by researchers from four different institutes: Department of Geodesy and Geoinformation, Uni. Vienna (A. Flores-Orozco), GBA (R. Supper, S. Pfeiler), Department of Geography and Regional Science, Uni. Graz (W. Schöner, G. Heinrich) and ZAMG (S. Reisenhofer). Within ATMOperm an intensive field week was held in the first week of August. The main emphasis lay on geophysical measurements such as active seismic and electromagnetic with planned replicate measurements in the following year.

Graz

Permafrost researcher in Graz continued their activities in the Hohe Tauern Range, Niedere Tauern Range and in the Northern Calcareous Alps. In 2015, scientists from three different institutes – the Department of Geography and Regional Science and the Institute of Earth Sciences (both University of Graz) as well as the Institute of Geodesy of the Graz, Graz University of Technology (A. Kellerer-Pirklbauer, G.K. Lieb, O. Sass, M. Rode, G. Winkler, M. Pauritsch, H. Schnepfleitner, M. Avian, V. Kaufmann, T. Wagner, C. Gitschthaler, W. Schöner, G. Heinrich) carried out permafrost/periglacial research. The main projects were, as in the previous year, Permafrost Monitoring Tauern Range, Water Resources of Relict Rock Glaciers, ROCKING ALPS, and permAT (see above for the latter). Additionally, the project ATMOperm was launched in 2015 (see above)

The project Permafrost Monitoring Tauern Range (A. Kellerer-Pirklbauer, M. Avian, V. Kaufmann, G.K. Lieb) continued and maintained the successfully operating permafrost and periglacial monitoring network in the Hohe and Niedere Tauern Range, Central Austria. Multidisciplinary monitoring at three active rock glacier sites (Dösen, Hinteres Langtalkar, Leibnitzkopf), one active rock fall site (Mittlerer and Hoher Burgstall, near Pasterze Glacier), and three marginally permafrost sites (Hochtor, Fallbichl, Hochreichart area) has been continued. ERT measurements have been carried out at several places in the Schober Mountains to study the glacier-permafrost relationship. Additionally, ERT measurements and relative surface dating of periglacial landforms were accomplished in the Hochreichart area, Niedere Tauern Range.

At Tschadinhorn rock glacier (Schober group, Hohe Tauern) the geodetic observation network installed last year by the Institute of Geodesy of the Graz University of Technology (V. Kaufmann) was re-visited and re-measured for the first time. Flow velocities between 2.6 and 4.5 m/year were observed. This year's flow velocities measured on all studied rock glaciers in the Hohe Tauern Range are the highest ones measured ever since. These activities were financed by the Hohe Tauern National Park Authority. For the moment, measurements at Weissenkar Rock Glacier have been discontinued. In summer 2015 a terrestrial photogrammetric survey of Äußeres Hochebenkar Rock Glacier, Northern Tyrol, was carried out additionally.

Research within the project Water Resources of Relict Rock Glaciers in the Styrian part of the Niedere Tauern Range) (led by G. Winkler) was finished at the end of 2014. Detailed findings of this project

are going to be published in different journals and a book. For instance, a conceptual hydrogeological model of a relict rock glacier (Schöneben Rock Glacier) has been developed. In addition, related to sloping aquifers in alpine catchments various analytic methods were explored to infer hydraulic properties of such aquifers. Furthermore, the hydrological impact of relict rock glaciers on downstream rivers at a more regional scale was quantified.

The two projects ROCKING ALPS and INFRAROCK were successfully continued in 2015 (O. Sass, M. Rode, H. Schnepfleitner, C. Gitschthaler) in the Dachstein Massif, Northern Calcareous Alps. For details see earlier reports. Additional ERT measurements were carried out at several locations. Two ERT-measurements at the north-exposed rock wall of the Koppenkarstein confirmed the measurements of earlier years regarding permafrost at the subsurface. Furthermore, a new ERT profile was installed at a NE exposed rock wall at the glacier forefield of the Schladminger Glacier to study also the relationship of glacier retreat and permafrost distribution. In 2015, some 40 shallow boreholes (10-100 cm) equipped with miniature temperature datalogger monitored successfully ground temperature data. The deep borehole (7m) at Koppenkarstein, which was drilled and instrumented in 2014, delivered valuable ground temperature data during the winter and spring season 2014/2015. This borehole is now integrated in the GTN-P network (see above).

As reported above, the project ATMOperm was launched this year. The Department of Geography and Regional Science, University of Graz (W. Schöner, G. Heinrich) is one of the four collaborating institutes. The four institutes are closely working together to set up a combined measurement and modeling approach as the basis for a long-term monitoring strategy at the summit of Hoher Sonnblick. The results of the geophysical measurements (see above) will form the evaluation basis for modeling and analyzing atmospheric energy fluxes over permafrost ground and their impact on the thermal state of permafrost and active layer thickness.

Innsbruck

The Interreg IV project PERMAQUA (Permafrost and its impacts on water resources and water ecology in high mountain areas) had finished in July 2015 (see earlier reports). The University of Innsbruck-group (U. Nickus, H. Thies, K.Krainer, M. Hirnsperger) focuses now on the evaluation and publication of results in collaboration with colleagues in Trentino and South Tyrol. At selected sites in North Tyrol (Austria) and South Tyrol (Italy) field work will be carried on for long-term data series also in the future. K. Krainer (University of Innsbruck) continued his research on the impact of climate change on permafrost hydrogeology, particularly on the discharge of rock glaciers and meltwater chemistry (particularly concentration of heavy metals) in the Eastern Alps thereby cooperating with G. Winkler (University of Graz).

Researchers at the Institute of Ecology of the University of Innsbruck (K. Koinig, B. Ilyashuk, E. Ilyashuk, G. Köck, R. Lackner, R. Psenner) continued to investigate high mountain water bodies affected by rock glacier melt water. B. Ilyashuk is currently compiling the analyses performed in a ca. 300 year old sediment core obtained from a lake affected by a rock glacier. Within a new project that will start in 2016 (PI K. Koinig and B. Ilyashuk), lakes with and without rock glacier influence located between 2500 and 3200 m a.s.l. will be monitored bi-annually in order to trace the impact of ongoing climate warming on rock glacier melt water inputs and to help the interpretation of changes observed in the sediment cores.

M. Luetscher from the Innsbruck Quaternary Research Group (University of Innsbruck) carried out paleo-permafrost research particularly in the Western European Alps. Several locations in different karst caves allow the identification of past permafrost thawing phases based on cryogenic cave calcite. At ten cave sites temperature monitoring was initiated in order to study permafrost changes in karst aquifers. One of these sites is the Jochloch cave, the highest cave in Austria at 3470 m a.s.l.

The time series of the measurements of flow velocities of the Äußeres Hochebenkar Rock Glacier in the Ötztal Alps have been continued in 2015. The campaign was carried out by the Verein Gletscher und Klima in cooperation with the Institute of Interdisciplinary Mountain Research of the Austrian Academy of Sciences (A. Fischer, L. Hartl). Also at this rock glacier very high flow velocites were measured; the highest values so far. These results are in accordance to the results from the Hohe Tauern Range (see above).

Vienna

Current research activities by the GBA, Department of Geophysics (R. Supper, S. Pfeiler) and the ZAMG group in Vienna (A. Bartsch, S. Reisenhofer) at Kitzsteinhorn and at Hoher Sonnblick were mentioned above. W. Schöner changed his position in 2014 and supports since September 2014 the permafrost/periglacial group at the Department of Geography and Regional Science at the University of Graz.

The Vienna University of Technology (A. Bartsch, E. Högström) as well as ZAMG (A. Bartsch, B. Wid-

halm) contributed to permafrost monitoring in the arctic by developing new methods for land surface characterization. These activities are part of to the FP7 project PAGE21. A method for correction satellite-derived near-surface soil moisture taking into account issues related to thaw lakes has been developed and published. A novel circum-arctic map describing wetlands for upscaling of fluxes has been published. Field measurements with focus on land-surface dynamics detectable with satellite data for linkage with GTN-P and CALM data in cooperation with the Russian Academy of Science were carried out by ZAMG on the Yamal peninsula in summer 2015.

Report prepared by Dr. Andreas Kellerer-Pirklbauer, Department of Geography and Regional Science, University of Graz (andreas.kellerer@uni-graz.at)

3 Canada

The Canadian Permafrost Community has much to report this year. A key highlight was the 7th Canadian Conference on Permafrost (CanCoP7) held jointly with the 68th Canadian Geotechnical Conference at GEOQuebec and was co-sponsored by the Canadian National Committee for the International Permafrost Association (CNC-IPA) and the Canadian Geotechnical Society. CanCoP7 was dedicated to the memory of J. Ross Mackay and also featured the inaugural Mackay lecture. An entire day was devoted to the Mackay Symposium which featured presentations by our international colleagues as well as Canadians. We were also pleased that a number of students were able to attend. An article in Frozen Ground provides more details on the conference. Other highlights from the past year including reports on a number of permafrost science and engineering projects are provided below.

News from the Cold Regions Geotechnology Division

The Cold Regions Geotechnology Division (CRGD) of the Canadian Geotechnical Society (CGS) has 87 first choice members and 235 second choice members this year. The Division's membership has had a steady increase since the last three years (66, 71 and 87 first choice members for 2013, 2014 and 2015 respectively).

CRGD provided strong support to the 68th CGS Conference and the 7th Canadian Permafrost Conference, Québec City, QC, Sept. 20 - 23, 2015. The Division actively participated in contacting the potential authors for contributions to the conference and the review of the abstracts and manuscripts.

CRGD is participating in the development of a National Standards of Canada on Geotechnical Site Investigations for Building Foundations in Permafrost (CAN/BNQ 2501-500) lead by BNQ, an initiative of the Standard Council of Canada. The document is planned to be published in 2017. The Division's executive members (Lukas Arenson and Baolin Wang) are on the board of the Technical Committee for the development of the Standards.

CRGD is currently working on sponsoring a young engineer/scientist/student to attend the 5th Canadian Young Geotechnical Engineers & Geoscientists Conference, Whistler, BC, September 29 – October 1, 2016. The Division is also planning on sponsoring a young engineer/scientist/student to attend the XI International Conference on Permafrost (ICOP 2016), Potsdam, Germany, June 20-24, 2016.

Contact: Baolin Wang, Geological Survey of Canada, Natural Resources Canada

News from the Territories

NWT Geological Survey

The NWT Geological Survey has been engaged in several mapping projects in northwestern NWT delineating both the broad and fine-scale distribution of thaw slump and thermokarst disturbance. The results indicate both significant increases in rates and magnitude of landscape change in ice-rich glaciogenic deposits, and a general association between slump impacted and glaciogenic terrain. Collaborators on this work include University of Victoria (T. Lantz), University of Ottawa (D. Lacelle) and University of Auckland (J. Tunnicliffe).

A project in partnership with Canada Centre for Remote Sensing researchers Rob Fraser and Ian Olthof is testing new image acquisition and processing techniques using UAV and structure for motion technologies to efficiently develop high resolution digital elevation models of permafrost features, including geomorphic disturbances such as thaw slumps. Promising results suggest that repeat surveys using this technique can resolve downslope movements of only a few cm.

The NWT Geological Survey is leading a Canadian Northern Economic Development Agency (CanNor) funded program in collaboration with Carleton University researcher Stephan Gruber that involves assessing ground ice conditions, geochemistry and ground temperatures in the Slave Geological Province. NWT Geological Survey is actively collaborating in the TRACS program led by the Geological Survey of Canada (S. Wolfe and P. Morse) with focus on improving the ground temperature data collection across treeline in this economically important region of the NWT.

The NWT Geological Survey is also working with the Geological Survey of Canada (P.Morse and S.Smith) to improve the reporting, organization and archiving of permafrost ground temperature data and metadata. The project has engaged several Canadian permafrost scientists and northern engineers, and once refined, it will provide a template to compile existing ground temperature data from the NWT and will be encouraged for future use by the Government of the Northwest Territories via government contracting, the regulatory process and scientific licensing.

Contact: Steve Kokelj, NWT Geological Survey

Yukon Research Centre (YRC)

Hazards mapping in Yukon communities

The Northern Climate ExChange (led by B. Benkert, YRC) and its partners, including the Yukon Geological Survey (J. Bond), U of Montreal (D. Fortier) and U of Ottawa (A. Lewkowicz), and Yukon communities and First Nations, continued hazard mapping activities for Yukon communities. Maps, which integrate permafrost vulnerability to thaw, have been completed for Mayo, Pelly, Destruction Bay, Burwash Landing, Dawson City, Faro and Ross River. A hazard map for Old Crow will be completed by March 2016. Reports and maps can be found at:
http://yukoncollege.yk.ca/research/project/hazard_mapping_in_yukon_communities
Funding for these projects is provided by Indigenous and Northern Affairs Canada.

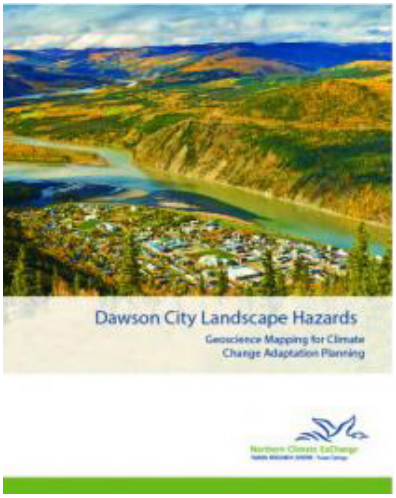

Figure 1.

Assessing Risks from Permafrost Thaw for Buildings in Ross River, Yukon

Using funding from Natural Resources Canada, Northern Climate ExChange (led by F. Calmels, YRC) has conducted a two-year study to evaluate the risks from permafrost thaw to key Yukon Government owned buildings in the community of Ross River. Part of this community is situated on warm, ice-rich permafrost. There is a history of substantial damage to buildings from thawing permafrost, and this damage is anticipated to increase in the context of climate change. The project has identified a range of adaptation measures that are intended to slow permafrost thaw and stabilize the foundations of the structures. Many of these practices will have relevance in other communities across the North. The project will be completed in January 2016.

Vulnerability of the North Alaska Highway to Permafrost Thaw

This project examined the potential sensitivity of permafrost along the northern 200 km of the Alaska Highway, from Destruction Bay to the Yukon/Alaska border, to present and future climate variability. The research team (led by F. Calmels, YRC) identified and characterized sensitive permafrost areas underlying the highway, and estimated the potential impacts of climate variability and change on thaw-sensitive permafrost. Findings culminated in the development of a permafrost thaw sensitivity vulnerability map and handbook (pictured below) for use by maintenance workers, engineers and decision-makers working on the highway. This report can be accessed at:
http://yukoncollege.yk.ca/research/abstracts/vulnerability_of_the_north_alaska_highway_to_permafrost_thaw
A fourth year of the project is devoted to collecting detailed information for specific sites along the highway in collaboration with Université Laval (G. Doré). The new acquired knowledge will allow design of adapted road sections that will contribute to maintenance of cold enough conditions underneath the highway to promote permafrost stability. The project, funded by Yukon Government and Indigenous and Northern Affairs Canada, will end in March 2016.

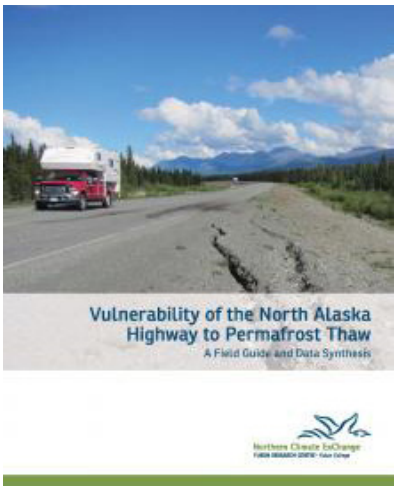

Figure 2.

Costing Adaptation for Community Infrastructure in Northern Canada

The Northern Climate ExChange (led by A. Perrin, YRC) is working with Memorial University (T. Bell), the International Institute for Sustainable Development (J. Dion), the Hamlet of Arviat and the Vuntut Gwitchin First Nation to create maps that reveal the financial costs and benefits of adaptation choices for community infrastructure, including housing, to climate change and permafrost thaw. The goal is to provide maps that aid northern communities affected by permafrost thaw in making effective and efficient infrastructure choices. The project will focus on two northern communities, Old Crow, YT and Arviat, NU, and will build on existing hazard maps to develop a

methodology and tools that can be applied throughout the Arctic and sub-Arctic. This project is funded by the Canadian Northern Economic Development Agency and will be completed by June 2016.

Human Dimensions of a Thawing Landscape

The Northern Climate ExChange (led by F. Calmels and A. Perrin, YRC) is working with the University of Saskatchewan (G. Strickert), the Yukon School of Visual Arts (C. Collins), the Jean Marie River First Nation and the Vuntut Gwitchin First Nation to study how traditional land uses are affected by climate change and permafrost thaw. The research will explore ways to combine biophysical and social science products to meet the needs of northern communities and identify adaptation strategies in response to a thawing landscape. This project is being conducted with funding from the Social Sciences and Humanities Research Council and will be completed in June 2018.

Contact: Bronwyn Benkert, Yukon Research Centre

Yukon Department of Transportation and Public Works

Collaborative research is continuing between the Yukon Dept. of Transportation and its academic partners and the Yukon Research Centre. Many of these projects are supported through the Transport Canada Northern Transportation Adaptation Initiative. Projects include assessments of vulnerability of highway infrastructure (including Alaska Highway) to climate change, a monitoring study at the Beaver Creek test site, assessment of the feasibility of remote sensing techniques to monitor ground movements and establishment of baseline data collection sites and assessment of permafrost response to climate warming.

Contact: Muhammed Idrees, Yukon Government, Dept. of Transportation and Public Works

Government of Nunavut

The Government of Nunavut's Climate Change Section is developing a centralized Permafrost Databank that will house permafrost data for Nunavut by 2016. This databank will make permafrost data, in its various forms, more accessible to practitioners. The major components of the project include collecting permafrost temperature data from various sources (including governments, academia, and industry) and integrating it into an online interface. This databank is being designed for user-friendly accessibility and is intended for Nunavut researchers, government and community decision makers, as well as the general public. Due to the varied formats and sources of data, the databank will be developed as a geo-referenced map, linking to other online forums that contain key permafrost data, publications, or references. It will be located on the Nunavut Climate Change Centre's website, www.climatechangenunavut.ca. This project is not intended to duplicate existing work or databases, but rather to compile and centralize these sources into one centralized location. If you have permafrost data for Nunavut that you would like to have included in the databank, please contact the Climate Change Section at climatechange@gov.nu.ca.

Contact: Sara Holzman, Department of Environment, Government of Nunavut

ARQULUK Engineering Research Program – Laval University

The ARQULUK engineering research program at Laval University, Québec, focuses on the development of cost-effective solutions to adapt the design and the management of transportation infrastructure built on permafrost. It aims to improve current adaptive capacities, by developing expertise for the mitigation of permafrost instability.

Until now, the program has provided a calculation tool to assess the effect of albedo on the surface temperatures of pavements, and a core-barrel that performs in-situ thaw consolidation tests. In the coming months, the program will also provide a gravimetric method to detect buried massive ice and ice-rich permafrost, a profile analysis tool to locate permafrost degradation under paved embankments, a better understanding of creep behavior in marginally frozen soils, a thermal stabilization procedure for paved structures using high albedo surfacing material, and a design tool that considers the accumulation of snow along an embankment.

Figure 3. High albedo material test site, Alaska Highway, Yukon.

Figure 4. Core-barrel prototype for in-situ thaw consolidation testing.

Additional projects carried out by Arquluk consist of the development of a quantitative risk analysis tool for linear infrastructure on permafrost, a methodology for the design of low-impact drainage systems and a decision tool for mitigation and adaptation techniques.

ARQULUK is a Cooperative Research and Development Program, financed by NSERC and 12 partners from public and private sectors: Kativik Regional Government, Ouranos, Transports Québec, Yukon College Research Center and Cold Climate and Innovation Center, Yukon Highways and Public Works, Colas, GHD, Kryotek Arctic Innovation, Nippo, Tetra Tech EBA, WSP.

Contact: Guy Doré and Chantal Lemieux
Laval University, Department of Civil and Water Engineering, Québec

Carleton University

Chris Burn has maintained a field program in Yukon and western Arctic Canada, studying permafrost response to climate change in this region. Recent emphases have been on stability of transportation infrastructure underlain by permafrost, and carbon capture by soils in the western Arctic. Chris organized a symposium at the 7th Canadian Permafrost Conference to honour the work and memory of J. Ross Mackay. Eighteen papers were presented at the symposium, and are available upon request. A commemorative issue of PPP is also in preparation, to be published in 2017.

The Carleton permafrost group holds a weekly 1.5 hour seminar, regularly attended also by Geological Survey of Canada scientists. Contributions to the Canadian Permafrost Conference (6 to 8 page papers) by members of the seminar are available on the internet at: http://carleton.ca/permafrost/canadian-permafrost-conference/

Marcus Phillips (supervisor: C.R. Burn) is a Ph.D. student working to investigate organic matter in soils affected by the burial mechanisms of cryoturbation, alluvial sedimentation, and solifluction. His work will elucidate how these processes influence the depth distribution and bioavailability of organic matter in permafrost-affected soils of the Mackenzie Delta region.

Figure 5. Marcus Phillips and Chris Burn retrieve a core from Garry Island, NWT

Brendan O'Neill (supervisor: C.R. Burn) is a Ph.D. student studying the thermal regime of permafrost on Peel Plateau, Northwest Tertritories, and the effects of infrastructure on permafrost stability in the region.

Alice Wilson (supervisors: C.R. Burn, E. Humphreys) is working on her MSc thesis about the vegetation succession and subsequent carbon storage at Illisarvik, a drained thaw lake basin on Richards Island, western Arctic coast, NWT. This research will assess the vegetation productivity and soil carbon storage since drainage of the lake in 1978, to improve understanding of the Arctic carbon balance.

Andrée-Anne Laforce (supervisors: C. Burn, E. Humphreys) is working on her MSc thesis on the relevance of permafrost characteristics on summer carbon dioxide and methane emissions from an undisturbed tundra soil and a drained lake basin. Radiocarbon dating of the gas fluxes is planned to understand the source of carbon released from these soils.

Jeffrey Moore (supervisor: C.R. Burn) is in the third year of his M.Sc. degree in Geography at Carleton University in collaboration with Yukon College and Transportation Engineering – Yukon Government. His project revolves around modeling the magnitude of thermal change that will occur as a result of climate change along the Dempster Highway in the Yukon and Northwest Territories.

Wendy Sladen (Geological Survey of Canada) is completing an MSc thesis (supervisor: C. Burn) studying icings that occur near the Tibbitt to Contwoyto winter road, north of Yellowknife, NWT. The study uses time-lapse photography to record the timing and duration of overflows; geochemical analysis to determine the source of the icings; and measurements of snow and air and ground temperature to investigate controlling factors.

F*igure 6. a) Augering through lake ice to obtain a water sample for geochemical analysis. b) Measuring snow depth and snow water equivalent to obtain snow density.*

Figure 7. Photo of core showing overflow ice overlying frozen peat.

Together with the Northwest Territories Geological Survey, Carleton researchers established a permafrost measurement network in the tundra near Lac des Gras in the Slave Geological Province, N.W.T. in summer 2015. More than 40 sites, each with a borehole (2-12 m deep), have been established in differing terrain types. In many cases core was recovered to support analysis to characterize the contents of ice, organic material, and cation concentration in water. Boreholes were cased and instrumented with thermistor chains and data loggers. At the surface, plots of 15m x 15m have been described in detail, including laser scanning and surveying of terrain elevation as well as the measurement of soil and vegetation properties. More than 220 additional single channel data loggers were installed to characterise near-surface ground and air temperature variability.

Taylor McWade's Honours thesis (supervision: S. Gruber, P. Morse, S. Wolfe) describes new surficial features, tentatively termed "Eyeliner Slumps". Her work details a number of morphometric measures for 152 such features identified in the Slave Geological Province near the Ekati Diamond mine.

The MSc thesis of Julia Riddick (supervision: S. Gruber) analyses near-surface temperature variability and its drivers. One month of preliminary data from the Lac de Gras region of the Northwest Territories shows average temperatures within 15m x 15m plots to vary by up to 5ºC, similar in magnitude to the observed variability between plots in differing landscape elements. A full year data set is expected in 2016 and will form the basis of her thesis.

Nick Brown (supervision: S. Gruber) is working on his MSc thesis about methods to invert soil properties from a combination of measured temperature time series and models. The recovery of soil parameters will allow better estimates of the total heat gain and ice loss within the ground to be made for sites where this information is not available through direct observation.

Christian Peart (supervision: S. Gruber) is developing and testing methods for quantifying surface subsidence with terrestrial surveying and laser scanning. The work is focused on quantifying and increasing the accuracy with which the average surface elevation of man-made and natural surfaces can be determined. This is done to make repeated surveys suitable for detecting subsidence as a proxy for subsurface ice loss.

Rupesh Subedi (supervision: S. Gruber, C. Burn, S. Kokelj) is investigating the geochemistry and carbon content of permafrost and active layer soils in the Lac de Gras region, N.W.T. His work extends existing knowledge to a new environment and will contrast vertical geochemical profiles from aggrading and degrading parts of the landscape.

Nicola Colombo (supervision S. Gruber and M. Giardino, Torino, Italy) is pursuing a joint PhD between Carleton University and the University of Turin, Italy. His thesis work investigates the interactions between permafrost and physiochemical characteristics of surface water in the Western Italian Alps. Bin Cao is a visiting scholar from China working on a high-resolution (< 100m) permafrost map in Qilian Mountains focused on the upper reaches of Heihe River Basin, western China.
A laboratory device for the accurate measurement of temperature dependent dielectric spectra in frozen soil is being built by S. Gruber with the support of A. Adler. The instrument will enable better analysis of freezing characteristic curves as well as improved measurement of ice and water content in frozen or thawing soil.

S. Gruber is participating in a pilot study on permafrost in the Hindu-Kush Himalaya (HKH) conducted by the International Centre for Integrated Mountain

Development (ICIMOD), Nepal. Based on a systematic mapping of rock glaciers from Google Earth, a first-order evaluation of permafrost maps for the mountainous part of the HKH has been conducted. While large uncertainties remain in this data-sparse area, the study corroborates the existence of large, and mostly unstudied areas of permafrost in these mountains.

Contact: Chris Burn and Stephan Gruber, Carleton University

Deep Borehole Instrumentation in Nuvavik, QC

Raglan Mine, a Glencore company retained Amec Foster Wheeler Environmental & Infrastructure, a division of Amec Foster Wheeler Americas Ltd. to investigate deep permafrost conditions at the Raglan Mine, located at the northern tip of the Ungava Peninsula in the Province of Québec, about 1,800 kilometers north of Montréal.

F*igure 8. Diamond drill exploration rig, Raglan Mine, QC.*

The work was part of a combined geomechanical and hydrogeological program to support underground mining to depths of greater than 700 m. The specific objectives included: locating a potential lake talik near a crown pillar area; assessing the potential for groundwater inflows from isolated taliks along fracture zones within and below the permafrost; and an assessment of rock properties to support mining.

Figure 9.

The project was awarded in January 2015, and field work was completed in March 2015. To meet the project objectives Amec Foster Wheeler applied its experience in deep rock characterisation to work with Glencore and the equipment supplier (GKM Consultants Inc, Canadian affiliate of Geokon Inc) to develop a field program suitable for winter conditions at a fly in only site in Canada's subarctic. The executed program included in situ hydraulic permeability testing of the rock mass (packer testing) at the transition zone and below the permafrost, geomechanical characterisation of the rock mass and laboratory core strength testing, and the installations of thermistors and vibrating wire piezometers in two clusters of boreholes up to 750 m deep.

After overcoming some initial challenges, the packer testing and thermistor/vibrating wire installations were successfully completed in two short field campaigns of several weeks in early 2015. Follow-up measurements taken by Glencore show that the instruments continue to provide accurate data about the local ground conditions within and below the permafrost. Further measurements are planned which will provide a multi-year record of ground temperatures through and below the permafrost.

Contacts: Richard Caumartin, Glencore, Eliane Cabot, Amec Foster Wheeler, Stéphane-Éric Thivierge, GKM Consultants

New Publications from the Geological Survey of Canada, Natural Resources Canada

The Geological Survey of Canada, through its publication series, has produced maps, reports and data products that are of interest to the permafrost science and engineering community and also practitioners, governments and decision makers. These publications are available for free download at:
http://geoscan.nrcan.gc.ca/geoscan-index.html

Publications released in 2015 include:

Aden, A.A, Wolfe, S.A., Percival, J.B., Grenier, A. 2015. Characteristics of glacial Lake McConnell clay, Great Slave Lowland, Northwest Territories; Geological Survey of Canada, Current Research (Online) 2015-7.

Couture, N.J., Forbes, D.L., Fraser, P.R., Frobel, D., Jenner, K.A., Manson, G.K., Solomon, S.M., Szlavko, B., Taylor, R.B. 2015. A coastal information system for the southeastern Beaufort Sea, Yukon and Northwest Territories; Geological Survey of Canada, Open File 7778.

Duchesne, C., Smith, S., Ednie, M., and Chartrand, J. 2015. 20 years of active layer monitoring in the Mackenzie Valley, Northwest Territories Geological Survey of Canada, Scientific Presentation SP31.

Ednie, M., and Smith, S.L. 2015. Permafrost temperature data 2008-2014 from community based monitoring sites in Nunavut, Geological Survey of Canada Open File, 7784.

LeBlanc, A.-M., Short, N., Mathon-Dufour, V., Chartrand, J. 2015. DInSAR interannual seasonal surface displacement in permafrost terrain, Iqaluit, Nunavut, Geological Survey of Canada, Open File 7874.

Oldenborger, G.A., LeBlanc, A.-M., Stevens, C.W., Chartrand, J., and Loranger, B. 2015. Geophysical surveys, permafrost conditions and infrastructure damage along the northern Yukon Alaska Highway, Geological Survey of Canada Open File 7875.

Oldenborger, G.A., LeBlanc, A.-M., Sladen, W.E. 2015. Electrical and electromagnetic data for permafrost characterization at Iqaluit International Airport, Nunavut, Geological Survey of Canada, Open File 7750

Smith, S.L., and Ednie, M. 2015. Ground thermal data collection along the Alaska Highway easement (KP 1559-1895) Yukon, summer 2014, Geological Survey of Canada Open File 7762.

Smith, S.L., Chartrand, J., Duchesne, C., and Ednie, M. 2015. Report on 2014 field activities and collection of ground thermal and active layer data in the Mackenzie Corridor, Northwest Territories, Geological Survey of Canada Open File 7935.

Report prepared by Sharon Smith, Canadian National Committee for the International Permafrost Association and Geological Survey of Canada, Natural Resources Canada (Sharon.Smith@canada.ca)

4 China

High-speed railways on deep seasonally frozen ground in China

State Key Laboratory of Frozen Soils Engineering (SKLFSE), Cold and Arid Regions Environmental and Engineering Research Institute, Chinese Academy of Sciences (CAREERI), Chinese Academy of Sciences (CAS), Lanzhou 730000, China

China has built numerous high-speed railways(HSR) in the past decade (Figure 1). High-speed is defined here as a minimum travel speed of 250km/h. According to a report from the China Railway Co., Ltd., the total length of operating HSR will reach 18,000 km by the end of 2015. Among these HSR lines, the Harbin-Dalian High-Speed Railway, or Hada Railway (HDR), connects Harbin, the capital of Heilongjiang Province and Dalian, the southernmost seaport in Liaoning Province in northeast China. Construction work began on August 23, 2007 and the first commercial services began operating on December 1, 2012.The HDR is the first HSR in China to traverse deep seasonally frozen (>1.5 m) ground (Figure 2).

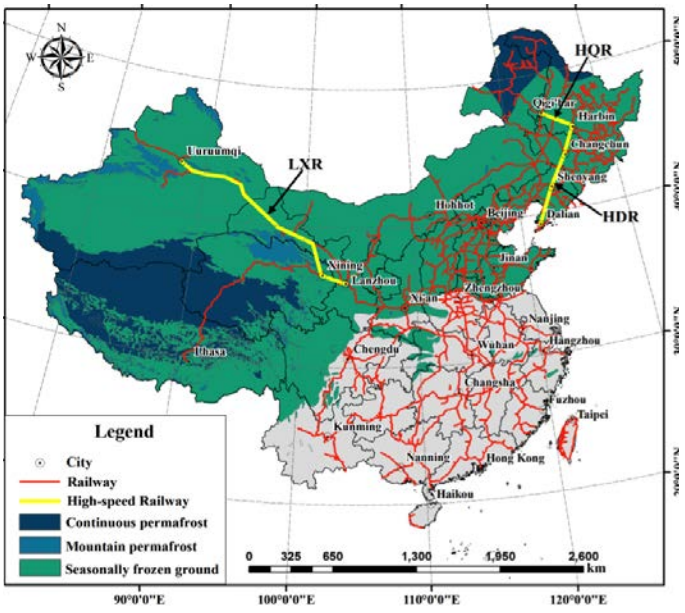

Figure 1. Railway networks and zones of frozen ground in China. Note: yellow lines are the recently built high-speed railways in regions affected by deep seasonally frozen ground. Red lines are conventional railways and HSR in regions affected by shallow seasonally frozen ground, or short-lived frozen ground, except for the railway crossing the Tibet Plateau which runs across permafrost.

Figure 2. A view of the HDR in winter (Photo provided by Shenku Liu)

The HDR winds across 909 km terrain affected by seasonally frozen ground, and about 25% of the line (231 km) is built on an embankment. The design speed is 350 km/hand the current operating speed is 300 km/h in all seasons. The line crosses terrain with a maximum depth of frost penetration ranging from 2.4 m in the north to 0.9 m in the south. The main challenge in the construction of the railway was how to mitigate frost heave of the railbed so that it stays within the acceptable vertical limit of±15 mm within a longitudinal distance of 200 m. This had to be achieved in spite of frequent and heavy dynamic loading due to high-speed trains, the huge range of ambient air temperatures (-40°C to+40°C; mean annual air temperature range from 3.5°C to 10°C), extensive frost susceptible soils and shallow ground water tables (1-3 m in many flat areas).

A typical embankment comprises three layers: an upper layer (0-0.4m from the roadbed surface) of well-graded gravels with cement; a middle layer (0.4-1.4m) of A and B group fills with cement, and; a lower layer (1.4-2.7m) of A and B group fills or mixed crushed gravels and sand. According to the China Railway Subgrade Construction Standard, A group is the highest quality fill, including block stone, well-graded soil, gravel with a fines content less than 15%; B group is high quality fill, including gravelly soils, gravels, coarse sand, and a fines content of15% to 30%). Underlying frost-susceptible clayey loess is treated by 20-meter long Cement Fly-ash Gravel piles placed at intervals of 1.5 m. The surface of the embankment is covered by China Railway Travel Service I track plate for supporting the tracks.

During construction, field tests were carried out by the research group from the State Key Laboratory of Frozen Soils Engineering (SKLFSE),to evaluate the effectiveness of mitigative measures for frost heave of foundation soils. These measures included refilling of the railbed with non-frost-susceptible soils, application of thermal insulation as a construction material, surface waterproofing and drainage con-

trol. Since the HDR was put to service at the end of 2012, the deformation of foundation soils along the whole line has been measured manually once a year. In addition, automatic monitoring devices were installed at 50 sections with complex geological conditions and prone to significant frost heave of the railbed (Figure 3). Three years of monitoring shows that deformation resulting from frost heave of foundation soils is less than 12mm at 97% of the 50 measured sections, i.e. less than the specified limit of 15mm.

Figure 3. A ground temperature and deformation monitoring site along the HDR. The yellow tube with temperature probes inside is for ground temperature monitoring; the concrete plates with white tubes are for deformation monitoring. The data are collected by datalogger and accessed remotely in Lanzhou.

During the first two years of operation (2013 to 2014), the HDR had a running speed of 200 km/h in winter and up to 300 km/h in summer. The running speed increased to 300 km/h year-round in 2015.

In the official design codes of China relating to frost heaving of foundation soils, they are considered to be free of frost action when the frost heave coefficient is less than 1%. This works well with traditional geotechnical engineering projects. However, for certain high-impact infrastructure such as airport runways and high-speed railbeds, this standard is not acceptable. For example, given that the HDR foundation soils are generally 2.7 m in thickness, deformation permitted by the current design code would exceed the allowable heave of the railbed. Consequently, the research team at SKLFSE, led by Professor Fujun Niu, proposed that the silt and clay contents in the A and B group fills must be less 5% in order to ensure the railbed would not experience excessive heave-induced deformation. This was based on intensive studies along the HDR embankment on processes and features of micro-frost-heaving (<1%), a new category of frost heaving proposed by Professor Niu, laboratory experiments and prototype testing, as well as from taking into account the thickness of railbed fills and maximum depths of frost penetration. The research results on the silt and clay contents suitable for high-speed railbeds will help modify future codes for designing high-speed railway and road foundations in cold regions in China and beyond.

Following the success of the HDR, another high-speed railway was built on seasonally frozen ground and began operating on August 17, 2015, running from Harbin west to Qigi'har (HQR) on the Songhua-Nen Rivers Plain (Figure 1). This 282-km-long railway traverses still colder terrain than the HDR, and the design speed is currently 250 km/h. In Northwest China, a new high-speed railway connecting Lanzhou (the Capital of Gansu Province) and Urumqi (the Capital of Xinjiang Uygur Autonomous Region), with a length of 1,776km and a design speed of 250 km/h (155 mph), was opened for service on December 26, 2014. Currently it is being monitored by the SKLFSE. China is building and is planning to build many more high-speed railways. Given that more than 70% of the area of the Chinese land territory is influenced by ground freezing and thawing (Figure 1), it is anticipated that more extensive and in-depth research will be conducted and more practical engineering experience will be obtained regarding high-speed railways in the near future. Such works will be beneficial to the construction of Moscow-Kazan High-speed Railway, which will be jointly designed by China and Russia, and the SKLFSE will be involved in that undertaking.

Report prepared by Huijun Jin and Fujun Niu, CAREERI, Lanzhou, CAS (hjjin@lzb.ac.cn)

5 Denmark

The Center for Permafrost (CENPERM) at Copenhagen University has continued the investigations at sites in Greenland, Svalbard, Siberia and Sweden. In 2015 a new snow fence experiment was established near Narsarsuaq in South Greenland. These additional snow fences will be used for exploring summer and winter warming effects on soil-plant interactions and should be seen in relation to the existing snow fence experiment established in Blæsedalen at Disko Island in West Greenland. Marked variations at contrasting altitudes and latitudes are expected which represent an uncertainty needed to be constrained before upscaling from plot to landscape and regional scales across sites in Greenland.

A national cooperation between CENPERM, the Department of Geoscience at Aarhus University and ARTEK has successfully resulted in shared publications on high temporal resolution electrical resistivity and induced polarization monitoring experiment at the Arctic Station research site in Central West Greenland. The co-operation is on-going.

Other important publications from CENPERM includes Hollesen et al., 2015 reporting in Nature Climate Change how permafrost thawing in organic Arctic soils can be accelerated by ground heat production. It was demonstrated that the impact of climate changes on organic soils could be enhanced compared to other soil types with crucial implications for the amounts of organic matter being decomposed and potentially emitted. This is particularly important for degradation of the uniquely well-preserved, organic archaeological artefacts in organic middens with the risk of losing evidence of human activity in the Arctic. Secondly, Westermann et al. (2015) reported in The Cryosphere on the future permafrost conditions along environmental gradients in Zackenberg, Greenland. The work was based on stepwise downscaling of future projections derived from a general circulation model using observational data, snow redistribution modelling, remote sensing data and a ground thermal model.

Currently, eighteen CENPERM PhD projects are ongoing and one completed in 2015. Hanna Valolahti successfully defended her PhD entitled ”Impacts of climate change induced vegetation responses on BVOC emissions from subarctic heath ecosystems” on November 27, 2015.

The Arctic Technology Centre (ARTEK) at the Technical University of Denmark has been involved in the evaluation of permafrost conditions at the main Greenlandic airport of Kangerlussuaq. A political process has been initiated to reorganize the Greenlandic airport infrastructure with the purpose of upgrading regional airports for international traffic and downgrading or closing the existing facilities at Kangerlussuaq. The present runway was constructed by the US Air Force in the 1950‘ies based on experiences from Alaska and Thule, and following extensive site investigations. Construction blueprints and site investigation reports indicate limited sensitivity to permafrost thaw in general, with a few local settlement problems. Major runway maintenance (repaving) has been neglected, and political prioritation is needed to ensure continued operability.

Report prepared by Thomas Ingeman-Nielsen (tin@byg.dtu.dk)

6 Finland

The Academy of Finland funded the INFRAHAZARD (Geomorphic sensitivity of the Arctic region: geohazards and infrastructure, 1/2015–12/2018) research consortium (J. Hjort, University of Oulu, and M. Luoto, University of Helsinki). The INFRAHAZARD focuses on the modelling of the Arctic Earth surface systems (ESSs) in a changing climate and production of geographic information system (GIS) -based infrastructure risk maps for decision making and land use planning. More precisely, the objectives are to: (i) investigate the environmental drivers of Arctic geomorphic processes across scales, (ii) forecast the geomorphic sensitivity of Arctic throughout the 21st Century, and (iii) identify threat spots of Arctic infrastructures in the face of climate warming. The research is based on comprehensive GIS and remote sensing based data at global, regional and local scales, and innovative modelling methodology. The research will provide new knowledge and insights regarding the (i) environmental drivers of Arctic ESSs and (ii) relations between ESSs changes and infrastructure. In addition to scientific publications, the results will be disseminated using existing spatial data infrastructures.
The Greenland Analogue Project (GAP) initiated by the Finnish (Posiva), Swedish (SKB) and Canadian (NWMO) nuclear waste management companies continued sampling and monitoring of the ~600 m deep bedrock drillhole in Kangerlussuaq, West Greenland. Otherwise the project has completed its work and the final reports are due to be published by the early 2016.

The Geological Survey of Finland (K. Korhonen, J. Lehtimäki, H. Vanhala, T. Ruskeeniemi and J. Engström) conducted geophysical studies using wide-band frequency-domain electromagnetic (EM) method in Kangerlussuaq, West Greenland. The study was done to test the applicability of the method for deep permafrost investigations in proglacial crystalline bedrock terrain and under the ice-sheet. Field work was done in 2012 and 2013 and the outcome will be published in 2016.

Geological Survey of Finland (R. Sutinen and P. Hänninen) has continued the temperature monitoring (2007–) of palsas at the Peera site in NW Finland. Moreover, temperature monitoring (J. Hjort, 2008–) of palsas in Kevo area, NE Finland, continued by installation of an automatic weather station in September. For the present, the Kevo site (Vaisjeaggi1) is the only Global Terrestrial Network for Permafrost (GTN-P) site in Finland.

Report prepared by Jan Hjort, Department of Geography, University of Oulu (Jan.Hjort@oulu.fi)

7 France

During 2015, the activities of the French permafrost community are going on Western Alps, Iceland and Central Yakutia (Russia). Permafrost studies in France are covering a wide range of different activities: e.g. geomorphological field study, field monitoring, laboratory simulation in cold rooms and numerical modelling of water/permafrost interactions.

Antoine Séjourné (GEOPS laboratory, Orsay, France) in collaboration with A. Fedorov (Permafrost Institute of Yakutsk) has continued their research on the dynamic retrogressive thaw slumps in Yakutia (figure 1). As observed in most regions in the Arctic, the thawing of ice-rich permafrost (thermokarst) is increasing in Central Yakutia (Eastern Siberia). In order to understand the current thermokarst dynamics, we studied retrogressive thaw slumps on the banks of thermokarst lakes in Yakutia, using high resolution satellite images taken in 2011–2013 and conducting field studies (Séjourné et al., 2015). However, meteorological parameters initiating each summer the thaw slumping remain unconstrained. In 2014, we sampled several larch (Larix sibirica) inside retrogressive thaw slumps. The aims are to reconstruct the development of this slump, his expansion rate and controlling meteorological parameters in CY during the last 100 years. The patterns of tree rings highlight growth disturbances and date uprooting, i.e. the tilting of trees and their death, demonstrating climatic changes and environmental transformations in ecosystems related to changes in air temperature, precipitation, and the dynamics of cryogenic processes. Tree-ring analyses have been commonly used to reconstruct landslides and snow avalanches in mountains but it has been little used for thermokarst lake development and not for RTS. Tree-ring disturbed by RTS can help studying the permafrost dynamics over a longer continuous period of time instead of snapshots with aerial and satellite images or field studies.

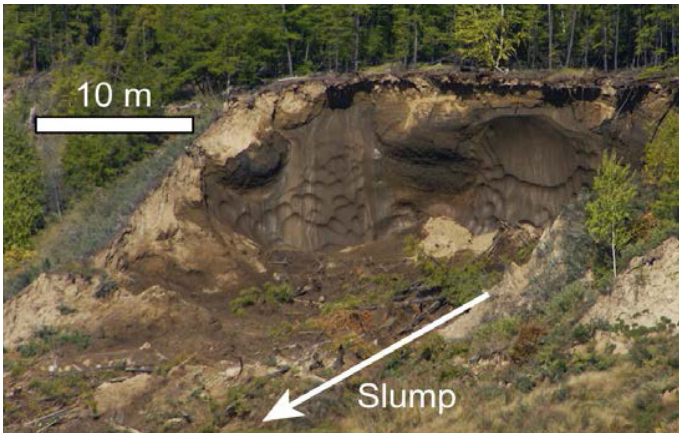

Figure 1. Retrogressive thaw slumping induces the destabilization and tilting of surrounding trees (tree of ~7 m high for scale).

Pursuing researches on the occurrence of paraglacial landslides in the fjords of Northern Iceland, a geophysical survey took place in September 2015 to highlight the part of landslides that is nowadays covered by the sea in the coastal area of Skagafjördur. Agnès Baltzer (University of Nantes and CNRS LETG UMR 6554) and Armelle Decaulne (CNRS LETG UMR 6554) took part in the research. The StrataBox used for the survey offered a high resolution marine sediment imaging of two landslides (figure 2) thanks to numerous survey lines, showing over 7 m thick landslide sediment with specific structures, tongue-like shaped.

Figure 2. The Hofdaholar landslide has the distal part eroded by the sea. The landslide extents in the sea more than 300 m offshore, with a thickness over 7 m (photo A. Decaulne, 2010).

Armelle Decaulne (CNRS LETG UMR 6554, Nantes, France) and Najat Bhiry (Centre d'Etudes Nordiques, University Laval, Canada) shared fieldwork in August 2015 to recognize active and inherited mass movements on slopes of the inner islands of Clearwater Lake (figure 3), in southern Nunavik, impulsing researches within the Tursujuq National Park. The study is part of Labex DRIIHM and OHMi NUNAVIK, and aims in the coming years at studying the postglacial evolution of slopes and potential risks for tourists and users of the Park.

Figure 3. The slopes of the inner islands of Clearwater Lake are dominated by screes, in some instances reworked by snow avalanches and debris flows; landslides are also common. Several generations of landforms are observed, with some very active slopes at present time (photo A. Decaulne, 2015).

These past years, researches conducted by EDY-

TEM Lab (X. Bodin, F. Magnin, L. Ravanel, Ph. Deline) and Institut de Géographie Alpine (Ph. Schoeneich) have been focus on the thermal regime of permafrost and on the rock fall activity in the Mont Blanc Massif.

The years 2014 and 2015 have shown extreme permafrost features in the Mont Blanc massif. The Summer 2014 was remarkably cold and directly impacted the active layers at the Aiguille du Midi (3842 m a.s.l) that experienced their minimum thickness since the beginning of the records in December 2009: 4.8-m-depth on the S face, 2-m-depth on the NE face and 1.3-m-depth on the NW face. The NW active layer was restricted to short-term (weeks) thawing cycles and no continuous seasonal thaw was observed contrary to the other years. In contrast, the summer 2015 was extremely hot and two boreholes have exceeded their previous active layer thickness by far: 3.6-m-depth at the NE and 6.3 m-depth at the S, whereas it reached 2.4-m-depth at the NW, similar than in 2012. Despite the cold summer of 2014, the permafrost temperature registered a warmer signal than the previous years corresponding to the warm season of 2014 (Figure 4) at 10-m-depth in December 2014. A warming trend is clearly visible in the NE borehole at 10-m-depth since the beginning of the records, and less clear in the NW borehole. However, the past two years registered remarkably warm winter signals at 10-m-depth. In the S-exposed borehole, no clear trend is detected. Although the bedrock is a relatively dry ground, some wet-detritic material was found when the borehole was drilled, suggesting that water-phase change may play a significant role in the thermal dynamics of this borehole. In consequence, the S borehole trend is possibly damped by the latent heat consumption since it is located on a warm permafrost area.

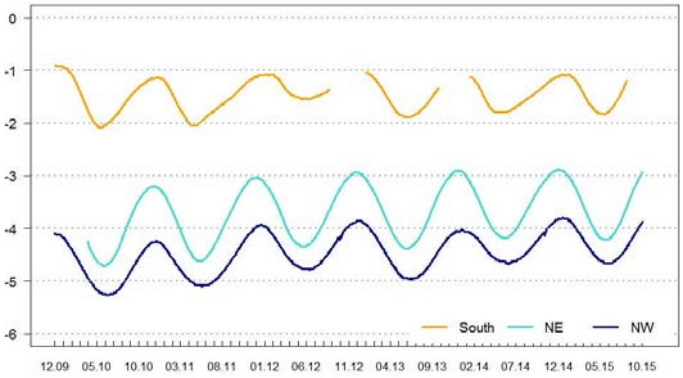

Figure 4. Daily temperature recorded at 10-m-depth in the three boreholes of the Aiguille du Midi since 2010.

Interestingly, only 17 rock falls were inventoried in 2014 by the network of observers (hut keepers and mountain guides) established since 2007 on the Mont Blanc massif, whereas > 160 rock falls were registered during the Summer 2015 (Figure 5). The comparison of the active layer dynamics and the rock fall inventory hints at a predominant role of the active layer thickening in the rock fall triggering; considerable efforts are lead today to clarify this relationship.

Figure 5. Rock fall at the "Tour Ronde" (Mont Blanc massif) that occurred the 27th August 2015 (picture: Gianluca Marra).

PermaFrance, the French monitoring network for mountain permafrost, continued its activities. It was recognized in 2014 as "Atelier d'observation" by the Observatoire des Sciences de l'Univers of Grenoble (OSUG), hopefully a first step towards the labelling as Observation System. A further step was the submission in spring 2015 of an application for an integrated national cryosphere observation system (including glaciers, snow and permafrost), which will be integrated in the Oscar research infrastructure on critical zone. The six boreholes of the network are integrated in the GTN-P database and a webpage has been created (permafrance.osug.fr).

During past years, Christophe Grenier, Nicolas Roux, Emmanuel Mouche from LSCE Gif sur Yvette, France) has been developing activities in numerical modeling for permafrost issues involving coupled thermal transfer with water flow in the Cast3M code (www-cast3m.cea.fr). This modeling activity was complemented by laboratory experiments and field work involving collaborations with François Costard at GEOPS (Univ. Paris Sud, Orsay) and the Permafrost Institute in Yakutsk (Yakutia, Russia). Nicolas Roux defended his PhD work this autumn on the topic of the evolution of the river's taliks in the context of climate change. The approach combines numerical simulation, analogical experiments in cold room at GEOPS lab and field study in Yakutia. So far the paper concerning the experiment in cold room has been accepted and will soon be published in PPP. The field study focuses on the evolution of the soil - river continuum in an Alas valley in Yakutia (figure 6). The site was equipped in 2012 with thermal, hydrological & hydrogeological sensors and the water properties and isotopic signatures were monitored.

The monitoring results already provided interesting results analyzed in terms of river and lake thermal and hydrological influence regions. The next phase on the site consisted in gathering the main monitoring equipment along a river transect. This was started in September 2014. Unfortunately some temperature monitoring devices were destroyed due to a large spring breakup event in 2015 strongly modifying the river shores. Thus the monitoring data remains uncomplete so far but the replacement of the devices should lead to full transect monitoring results by Sept. 2016 providing a unique monitoring case of a river transect thermal evolution.

Figure 6. Syrdakh site in Yakuita. Credit Photo: Nicolas Roux.

The other main activity concerns the development of coupled Thermo-Hydrological (TH) codes that face difficulties in the simulations of such a non-linear system of coupled equations with phase change effects providing steep fronts. Launched initially in 2014, April 2015 has seen the second meeting in Paris of the InterFrost TH code inter-comparison exercise. 13 codes competed corresponding to laboratories in America (USA, Canada) and Europe (France, UK, Sweden, The Netherlands, Germany). Some preliminary inter-comparison results were provided in (Rühaak et al. 2015, Energy Procedia) but the full exercise was closed and compiled recently with a publication in preparation for 2016. The main conclusion is that the inter-comparison results suggests that all codes modelling the exact equations and characteristic laws provide identical qualitative trends and even converge on a close quantitative basis. More information on test cases, actions, milestones and participants can be found on the InterFrost web site (https://wiki.lsce.ipsl.fr/interfrost).

Report prepared by François Costard (francois.costard@u-psud.fr)

8 Germany

PYRN Germany

On 24 October 2014, PYRN-DACH (Germany, Austria, Switzerland) held its meeting in the frame of the 7th AK Permafrost meeting in Wartaweil/ Lake Ammer with a professional workshop on ”10 steps how to write and publish a paper” chaired by Tress&Tress. Since then, various international meetings and activities were organized by PYRN international. Among them, a meeting was held and a presentation given at Arctic Change (Dec 2014) in Ottawa, a course on „The future of permafrost in a climate-changing world” was organized at EGU in Vienna (April 2015), a poster on “Perspectives and priorities of the next generation on permafrost research” was presented at ASSW in Toyama (April 2015), an excursion was organized at the PAST Gateways conference in Potsdam (May 2015), involvement of Young National Correspondents in GTN-P was decided at a GTN-P workshop in Québec (Sept 2015), a best presentation award was given at GeoQuébec (Sept 2015), PYRN`s 10th Birthday was celebrated in Pushchino (Sept 2015), and a student`s day was co-organized by PYRN at the ArcticNet meeting in Vancouver (Dec 2015) and AGU in San Francisco (both Dec 2015). PYRN initiated several outreach activities besides its quarterly newsletter, like printed Fflyers, improvement of the website and supporting the IPA Action Group on “Permafrost comics”. Further on, a 4-year strategy for PYRN was formulated and a PYRN member census was started which results will be published and presented at ICOP2016 in June in Potsdam. PYRN is actively involved in organizing ECR activities at ICOP2016, like a junior meets senior lounge, a soccer tournament and PYRN members co-chairing the sessions. During the past and coming month, we channel our energies in organizing a fruitful 2-day Permafrost Young Researcher Workshop prior the conference together with our partners from APECS, USPA and ADAPT. Since 2015, PYRN gratefully receives a yearly financial support by the IPA.

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Figure 1. Zugspitze excursion with PYRN-DACH and AK Permafrost members on Oct. 23., 2014 to the Eibsee rock avalanche deposits and the Zugspitze in the background.

Alfred Wegener Institute

Within the ERC project “Rapid Permafrost Thaw in a Warming Arctic and Impacts on the Soil Organic Carbon Pool” (PETA-CARB), led by Guido Grosse, three field campaigns were conducted in Siberia and Alaska in 2015. During March and April, Guido Grosse and Jens Strauss participated in a joint drilling expedition with colleagues from the Melnikov Permafrost Institute (PI) in Yakutsk and Mathias Ulrich from the University of Leipzig. This two-week expedition was conducted in the Yukechi Alas in Central Yakutia. The aim was to core permafrost and talik sites in thermokarst lake basins and on surrounding Yedoma uplands. During July, with US-based colleagues from United Stated Geological Survey (USGS) and the University Alaska Fairbanks (UAF), the PETA-CARB team consisting of Guido Grosse, Frank Günther, Matthias Fuchs and Ingmar Nitze collected permafrost cores along transects in Arctic river deltas and thermokarst-affected terrains. The aim of this expedition was to sample for carbon stock analysis on the Alaska Northslope. Starting from the Teshekpuk Lake Observatory, floatplane-based ground-truthing and validation of trends in landcover changes observed in super-temporal Landsat-time series datasets were conducted south of Teshekpuk Lake and along the Beaufort sea coast between Cape Halkett and Drew Point. Across an upland between two thermokarst lakes, an extensive land elevation survey grid was installed for repeat measurements using laser scanning to detect and quantify thaw subsidence. During a follow-up expedition in August, permafrost thaw survey grids that have been instrumented in the preceding year with long-term reference markers were resurveyed on Sobo-Sise Island in the eastern Lena Delta and on the Bykovsky Peninsula. Frank Günther from the PETA-CARB project and colleagues from PI Yakutsk, Russian Academy of Science, Pushchino, and Hamburg University took part. The goal for this expedition was to study past

and current thermokarst landscape dynamics. Several data loggers in shallow boreholes in ice-rich permafrost and in thermokarst lakes and ponds have been recovered and read-out for monitoring purposes of water and soil temperatures.

Many Russian-German permafrost research teams used the new Research Station Samoylov Island, operated by the Trofimuk Institute of Petroleum Geology and Geophysics, Siberian Branch of the Russian Academy of Science (IPGG) since 2013, during spring, summer, and fall covering several disciplines and topics. These included carbon storage and turnover, trace gas emissions, permafrost degradation by thermokarst and thermal erosion, surface subsidence, water and energy balance, and long term observational studies. In June 2015 the directors of AWI, Prof. Karin Lochte and Dr. Karsten Wurr, together with other delegates from AWI and University of Hamburg, visited several Siberian partner institutions including IPGG and the Research Station Samoylov Island in order to discuss further deepening of the Russian-German cooperation in the field of permafrost research. During the visit to the station, the delegation was able to gain a personal impression of the excellent working and living conditions on site. In Yakutsk, Prof. Hans-Wolfgang Hubberten received the honour of being awarded membership of the Academy of Sciences of the Republic of Sakha as the first non-Russian member for his past achievements and long years of promoting Russian-German scientific collaboration.

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The Global Terrestrial Network for Permafrost (GTN-P) developed a Data Management System (www.gtnpdatabase.org) collecting permafrost temperatures and active layer thickness data from all permafrost regions of the Earth. The GTN-P Secretariat is coordinated and managed by the AWI (GTN-P Director Boris Biskaborn). GTN-P is currently working on an international data collecting effort to establish global datasets on permafrost Essential Climate Variables. The new snapshot on the thermal state of permafrost and active layer thickness is planned for presentation at the ICOP2016 and for publication in a high-ranking journal.

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Helmholtz Young Investigator Group COPER (Coastal Permafrost erosion, organic carbon and nutrient release to the Arctic nearshore zone; https://www.awi.de/forschung/nachwuchsgruppen/coper.html) led by Hugues Lantuit has arrived at half-time of the project. At the same time, this year's expedition was the tenth of the AWI in the area and took place from 15 July until 23 August on Herschel Island (NW Canada). The expedition was conducted in cooperation between the AWI (H. Lantuit), the Geological Survey of Canada (Gavin Manson) and the University of Edinburgh (Isla Myers-Smith). Monitoring efforts were continued for micro-meteorology and lateral transfer of sediment, organic matter and nutrients in the land-ocean continuum (http://dx.doi.org/10.1002/ppp.1881). Weather station and a cutthroat flume, already used since 2010, were deployed at the outlet of retrogressive thaw slumps and thaw streams. Water samples from creeks, lakes, ponds and sea water were taken for Michael Fritz to characterize the geochemical composition and the fate of organic matter in freshwater ecosystems and in the nearshore zone (http://www.the-cryosphere.net/9/737/2015/). Extensive active-layer sampling and moisture measurements will help Samuel Stettner as ground-truth datasets for remote sensing of moisture conditions on large scales. Additionally, vegetation surveys were conducted by I. Myers-Smith to help characterizing the role of shrub growth on the ground thermal regime and they can assess greening of the Arctic. AWI boat FS „Christine" was used as platform to conduct sampling of the seafloor sediments and oceanographic monitoring under supervision of Michael Fritz and George Tanski. In cooperation with the Geological Survey of Canada (G. Manson), Anna Konopczak performed DGPS surveys along the Yukon mainland to monitor coastal erosion rates since sea ice had retreated dramatically in the last years (http://dx.doi.org/10.1007/s12237-015-0046-0).

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University of Bonn

The working group of Richard Dikau (Richard Dikau, Jana Eichel, Karoline Messenzehl, Katharina Eibisch) of the University of Bonn continued its fieldwork in the Turtmann Valley (Valais Alps, Switzerland). The BIMODAL project (‚Biogeomor¬phic dynamics on lateral moraines in the Turtmann glacier forefield, Switzerland') with PhD student Jana Eichel, supervised by R. Dikau (University of Bonn) and Sebastian Schmidtlein (Karlsruhe Institute of Technology), proceeded with its work on feedbacks between geomorphic and vegetation dynamics on alpine late¬ral moraine slopes. In cooperation with Nele Meyer (Institute of Crop Science and Resource Conservation, University of Bonn), soil samples were taken and iButton temperature loggers were read out at established permanent plots to investigate interactions between vegetation, soil, snow and geomorphic processes. Field investigations of turf-banked solifluction lobes were continued in cooperation with Daniel Draebing (Bonn, TU Munich) and Lasse Klingbeil and Markus Wieland (Institute of Geodesy and Geoinfor-

mation, University of Bonn). This included geomorphological and vegetation mapping, repeated 2D and 3D Electrical resistivity tomographies, an octocopter mission and terrestrial laserscanning to identify solifluction movement and its controlling factors. The findings on conditions for feedbacks between vegetation and geomorphic processes on lateral moraine slopes were published by Eichel, Corenblit and Dikau in a paper about a 'biogeomorphic feedback window' (www.dx.doi.org/10.1002/esp.3859).

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Figure 2. Geophysical measurement in the Turtmann Glacier Forefield performed for the BIMODAL Project and rock glacier Morenas Coloradas, Mendoza, Argentina investigated in the PermArg Project.

PhD student Ka¬roline Messenzehl, supervised by Richard Dikau (University of Bonn) focuses on major controls on rock slope instability and talus slope evolution in the hanging valleys of the Turtmann Valley affected by glacier retreat and permafrost degradation. The multidisciplinary investigations on coupled rockwall-talus-systems, performed in cooperation with Daniel Draebing (Bonn, TU Munich) during the 2014 field campaign, were honoured with the Outstanding Poster Award 2015 of the European Geoscience Union. In summer 2015, the third field season of the PhD project "Rock slope instability in alpine geomorphic systems, Switzerland" comprised extensive geotechnical rockwall surveys as well as mapping of rockfall blocks along corresponding talus slopes in three hanging valleys. Additionally, first data of more than 25 rock temperature iButtons, financed by a PhD Research Grant of the British Society for Geomorphology, were read out. The data will provide valuable insights into near-surface rock temperature fluctuations during the last year. Besides the local-scale field surveys, a regional-scale modelling study on the relative role of permafrost degradation, paraglacial bedrock reaction and rock mechanical factors for rockfall initiation have been recently published by Messenzehl et al. in the journal Geomorphology.

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At the end of August, the working group of Richard Dikau also organised the 3rd geomorphological workshop „Turtmann-Talks". During field trips into the Turtmann Valley and into the Val d'Annivier, members of the working group of Stuart Lane (University of Lausanne), as well as Bachelor and PhD-students of Richard Dikau, came together to discuss about geomorphic and cryospheric topics including rock slope instabilities, glacier retreat and solifluction processes.

In the Research Group Geomorphology and Environmental systems (Prof. Lothar Schrott, Bonn) a new DFG (Deutsche Forschungsgemeinschaft) funded project on "Rock glacier permafrost in the Central Andes of Argentina (PermArg)" has been started in November 2015. The project focuses on the spatial distribution, the ice content and hydrological significance of rock glaciers in the semi-arid to arid Argentinian Andes (30-33°S). We will use a combination of field geophysics (electrical resistivity tomography (ERT), refraction seismic tomography (RST), ground penetrating radar (GPR)) and four phase modeling to estimate the volumetric ice contents of the active layer and the permafrost bodies in rock glaciers. Local investigations in the "Morenas Coloradas" and the "Agua Negra" basins will be complemented by direct observations of sediment properties, thermal monitoring, and field based mapping. Regional controls of the rock glacier distribution will be investigated by compiling and analyzing a remote sensing/ GIS based inventory that further serves as basis for a first order quantification of the water storage capacities of rock glaciers based on empirical field data. The first field work campaign will be conducted in February and March 2016. The three-year project will be carried out by Lothar Schrott's working group and includes the project-integrated PhD-thesis of Christian Halla as well as several national and international cooperations, among others Dario Trombotto (IANIGLA, Mendoza, Argentina), Christian Hauck and Christin Hilbich (University of Fribourg, Switzerland).

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University of Cologne

Continuing our efforts to understand carbon dynamics in Siberian permafrost soils, the Organic Geochemistry and Radiocarbon group at the University of Cologne (Institute of Geology and Mineralogy) also joined the 2015 Lena Expedition to Samoylov Island. The group, headed by Janet Rethemeyer, focuses on the elucidation of organic carbon quality, microbial feedbacks, and organo-mineral interactions as revealed by the radiocarbon signature of microbial and vascular plant lipids, pore-water dissolved and particulate organic carbon (DOC and POC), carbon dioxide, and soil density fractions. This year, we aimed at sampling soil and pore-water DOC and

POC on Samoylov and Kurungnakh with a seasonal resolution. Senior researcher Stephanie Kusch obtained samples at the beginning of the season in June, when the Lena River ice broke and permafrost began to thaw, while master student Jannik Martens performed sampling during the last campaign of the season in August, when permafrost had thawed to its maximum depth. Furthermore, we sampled Lena River POC to analyze microbial lipids exported from permafrost into the Lena River. Here we closely collaborate with Gesine Mollenhauer's group at AWI Bremerhaven to integrate our knowledge of carbon cycling in the Lena Delta, the Lena River, and the Laptev Sea. After arrival of the permafrost cores drilled on Bol'shoy Lyakhovsky Island in 2014, our group and Gesine Mollenhauer's group at AWI Bremerhaven are now also collaborating to analyze plant-derived, bacterial, and archaeal lipid biomarkers in these deposits to obtain paleoenvironmental information dating back to the Eemian. Postdoctoral researcher Silke Höfle and Jannik Martens will analyze the samples from Samoylov, Kurungnakh, and Bol'shoy Lyakhovsky Island to complement our work within the German-Russian research project „CarboPerm" funded by the German Ministry of Education and Research (BMBF).

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University of Giessen

Lorenz King (Justus Liebig university, Giessen) continued his rock temperature measurements in permafrost drill holes at Matterhorn glacier paradise (3820 m a.s.l.) in cooperation with Bergbahnen Zermatt. Ina Keggenhoff finished her PhD thesis on "Temperature Extremes over Georgia: Changes, Patterns and Driving Forces" in the Caucasus mountains (published online)."

University of Heidelberg

Since April 2015 the Heidelberg University (Bernhard Höfle and Inga Beck) and the Alfred-Wegener Institute (Julia Boike) are working together for the PermaSAR project, a project funded by the German Space Agency and the German Ministry of Economics. The idea of the project is a multi-source approach (TanDEM-X data, LiDAR data, ground truth data) in order to detect vertical movement in a Canadian permafrost region. As test site serves Trail Valley Creek, a watershed 50 km North of Inuvik, in the North-Western Territories. This site is operated by our Canadian partners, Phil Marsh, Aron Berg and Jennifer Baltzer. Already this year 2 campaigns in the test site have been conducted in cooperation with them: One in early June and one in late August. Subsidence stations and ground temperature loggers have been installed and the high-performance terrestrial LiDAR system Riegl VZ-400 and a Leica GNSS RTK GS10/GS15 system have been used to measure the microtopography and potential movements of the ground.

University of Hamburg

The CARBOPERM project funded by the German Ministry of Education and Research (BMBF) and coordinated by the Universität Hamburg and AWI Potsdam intensively continued the multidisciplinary studies running between 2013 and 2016. In spring more than 60 scientists met in Hamburg to discuss the results of the first year of active investigations as well as to coordinate joint laboratory work and to prepare for next field expeditions. The early season field program focused on pre-site surveys of thermokarst basins in the central Lena River Delta. Colleagues from AWI Potsdam and Univ. Potsdam used a GPR system to detect sediment distribution in thaw lakes and on alluvial slopes of river branches. Furthermore it has helped defining talik occurrence below water bodies and localizing future coring sites. Using the GPR data two coring sites in the Tumatskaya Channel were selected. Drilling provided cores of a total length of 43 m of high quality material for investigations of both, the permanently frozen sediments as well as the unfrozen layers. Core analysis is shared between the Permafrost Institute Yakutsk and Univ. Hamburg. In summer several expeditions lead CARBOPERM scientists (Univ. Hamburg, Univ. Cologne, AWI Bremerhaven, Max Planck Institute Jena) to the Lena River Delta and to Cherskiy and for further description of the landscapes, additional sampling and maintenance of running systems for data collection. In Cherskiy the investigations of the effect of drainage on greenhouse gases and the global warming potential were continued. On Samoylov Island a winter flux dataset was collected for further detailed analyses from the eddy tower on the annually flooded plains. Climate data collections show that over the last 50 years both sites got warmer by ca. 2 °C with increasing temperature differences over the past decade. With the new available data future projections of the pan-Arctic permafrost soils' physical state including snow depth, temperature profiles, active-layer thickness and hydrology can be modelled. Furthermore, ecosystem carbon dynamics as well as climate-carbon cycle feedback mechanisms due to permafrost dynamics can be modelled using a combination of models (JSBACH, CBALANCE, HAMOCC, MPIOM, OASIS3 and ECHAM6). In the frame of the CARBOPERM project a workshop was held in Gülpe (near Rathenow, E Germany) in late autumn, where 16 students from Germany and Russia met to autonomously discuss their scientific topics. Next to presenting their results they considered the potential of innovative cooperative efforts. Their

outcomes will be considered in discussions of future project designs.

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University of Leipzig

During the third year of the Postdoc project "Short and long-term thermokarst dynamics due to climate changes and human impacts in Central Yakutia, Siberia" (DFG UL426/1-1) lead by Mathias Ulrich (University of Leipzig, Institute for Geography) two field campaigns were conducted at our thermokarst key sites in the Lena-Aldan-Amga region east of Yakutsk. In March 2015, a drilling campaign was jointly organized together with Russian scientist from the Melnikov Permafrost Institute and under the leadership of the ERC project PETA-CARB (Rapid Permafrost Thaw in a Warming Arctic and Impacts on the Soil Organic Carbon Pool) led by G. Grosse to drill four 20m permafrost cores in thermokarst lakes as well as alas and Yedoma deposits and to install temperature and environmental dataloggers. During a second short campaign in July 2015, the field work included bathymetrical measurements of thermokarst and alas lakes, geodetic measurements of alas topography as well as readout of environmental dataloggers.

As an activity of the IPA Action Group "Permafrost and Culture (PaC)", Mathias Ulrich and J. Otto Habeck (University of Hamburg, Institute for Social Anthropology) together with the Melnikov Permafrost Institute (Alexander N. Fedorov) and the Institute for Biological Problems of the Cryolithozone (Roman V. Desyatkin) in Yakutsk, organized a five-days workshop from 20 to 24 July 2015 in the city of Yakutsk as a forum for intensive interdisciplinary debate among social and natural scientists about human-nature interaction in the Central Yakutian thermokarst landscapes. Two days of which were spent on a field trip to several alas sites and local communities east of the River Lena.

Senckenberg Research Station and Institute

In the frame of the DFG funded project TUNDRA-STEPPE, going on the second year in cooperation of the Senckenberg Research Station of Quaternary Palaeontology Weimar (F. Kienast) and the Senckenberg Natural History Museum Görlitz (K. Wesche), another field campaign to Yakutia (Sakha Republic, Russian Federation) was conducted together with partners from the Institute for Biological Problems of the Cryolithozone in Yakutsk (E. Troeva). After last year's expedition into the Yana Highlands, where Permafrost outcrops close to Batagai and at the Adycha River were studied, the 2015 expedition involved works in Central and Northeast Yakutia (the lower course of Kolyma River). As crucial part of the expeditions in 2014 and 2015, modern vegetation was recorded in the transition zone from northern taiga to tundra (Cherskii to Pokhodsk area) as well as in relict steppes in the continental part of Northern (Verkhoyansk) and Central Yakutia (Yakutsk, Buotama). The studies aimed at gradients along transects from South to North and from the continental interior part of Yakutia to the more maritime coastal lowlands as well as at the response of vegetation on grazing by large herbivores in different intensities. For that, vegetation surveys in the Pleistocene Park (lower Kolyma, coastal lowlands) operated by the Northeast Science Station Cherskii (N. Zimov) and in a so-called Bisonarium at the Buotama River (Central Yakutia, interior part) were compared with natural or less intensely grazed vegetation in the Pokhodsk tundra area and in Central Yakutia. Special focus was given to vegetation grazed by (Pleistocene) keystone herbivores such as bison. To reconstruct changes of ancient vegetation in Northern Yakutia in the course of the late Quaternary, sediment samples from continuous permafrost sequences in Batagai and Duvanny Yar were taken for palaeobotanical studies. Two PhD candidates are involved in this project: Kseniia Ashastina, who made her Master of Science for Applied Polar and Marine Sciences in the frame of the joint Russian-German POMOR Master Program (Universities of St.Petersburg and Hamburg) and Jennifer Reinecke (M.Sc. In Ecology, Evolution and Conservation, University of Potsdam) who covers the part of modern vegetation studies. The scientific processing of the sediment samples is carried out in close cooperation with partners from the Alfred Wegener Institute for Polar and Marine Research Potsdam (sedimentology, L. Schirrmeister, B. Diekmann) and from the Institute of Archaeology & Ethnography at the Centre of Cenozoic Geochronology (RAS SB) Novosibirsk (pollen, N. Rudaya).

Figure 3. ERT measurements across and LiDAR measurements in ice-filled crevasses in rock slopes above the Lyngenfjord as part of the starting Cryowall Project (Norway, Photos: M. Krautblatter, TUM).

Technical University of Munich

Researchers at the chair of landslide research (Prof. M. Krautblatter, https://www.landslides.geo.tum.de/news/) performed research on unstable permafrost rock slopes in the laboratory and in the Alps and in Norway. The German-Swiss ISPR-Project (Influences of snow cover on thermal and mechanical processes in steep permafrost rock walls, D-A-CH, SNF/DFG) in cooperation with Dr. M. Phillips (SLF) went into its final year and the synoptic outcome was condensed into two synoptic publications on snow influence on permafrost rocks which are presently in review. In July the Norwegian Project „CryoWall – Permafrost rock walls in Norway“ started where the TUM is involved as CO-PI and Michael Krautblatter and Benjamin Jacobs, the new TUM-based PhD student, performed field work in permafrost-affected rock slopes above the Lyngenfjord in Norther Norway (http://www.mn.uio.no/geo/english/research/projects/cryowall/). In Novemeber a new project started on “Real time monitoring of fracture initiation in natural stones induced by environmental stresses (StoneMon).” PhD candidate Philip Mamot continued working on mechanical components of permafrost rock wall destabilisation at the Zugspitze. PhD candidate Markus Keuschnig is about to finish his PhD on Temperature related destabilization of alpine rock walls at the Kitzsteinhorn and submitted a paper on continuous ERT-measurements to record changes in rockwall stability relevant for cable car infrastructure. The TUM landslides group contributed to recent papers in which we compare paraglacial rock weathering rates on Earth with paracratering rates on Mars (http://dx.doi.org/10.1002/2015JE004915), develop a model to quantify rock fatigue after repeated freeze-thaw cycles (http://dx.doi.org/10.1002/ppp.1857), use ERT to validate permafrost models in the Mont-Blanc-Region (http://dx.doi.org/10.1002/2014JF003351), challenge the predictability of rockfalls (http://dx.doi.org/10.1007/s10346-015-0605-2) and in a recent book chapter we tried to find a way to combine the mechanical understanding of glacier- and permafrost-related slope instabilities (http://dx.doi.org/10.1017/CBO9781107588653.009).

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University of Würzburg

The investigation of the three-dimensional internal structure and characteristics of different periglacial permafrost-affected landforms has been continued. The research approach is based on the assessment of heterogeneities in surface and subsurface parameters and to correlate these with subsurface hydrological conditions and geomorphic process dynamics. A further borehole was drilled and instrumented with temperature loggers. Adrian Emmert has continued his Phd within the framework of this project.

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9 Iceland

On the 12th of October 2015, Akureyri, Iceland's second city, has hosted the last General Assembly of the European Commission's FP7 programme (EC-FP7) project: Changing Permafrost in the Arctic and its Global Effects in the 21st Century (Page21). Participants have engaged and secured future initiatives and challenges for permafrost disciplines. Understanding the dynamics of the permafrost carbon and nitrogen pools and their vulnerability to climate change, producing and assessing high-quality datasets, improving models and reducing uncertainties, disseminating widespread results and discussing scenarios are work in progress. The Page21's successes laid the basis of a continuous integration of the network, while connecting international programmes and projects, and involving the best people and resources in the discipline. The General Assembly was followed soon after by the Arctic Circle conference in Reykjavik. On the 18th October, a plenary session: „Permafrost in the 21st Century" was organized by the Alfred Wegener Institute (AWI).

Over the year 2015, Arctic Portal (AP) has continued its efforts toward developing the Global Terrestrial Network for Permafrost Data Management System (GTN-P DMS). The official release of the system took place in September 2015 and numerous outcomes were achieved this year. A new interface using OpenLayer replaced the Google Maps which was not accessible in some countries. This generalizes the use of Open Source technologies within the system. On-the-fly visualization of active layer thickness grid measurements was updated in order to meet the requirements of the scientists (Figure 1). All functions and algorithms aggregating the data and computing the trends of the time series have been implemented, achieving the primary purpose of GTN-P, which is to establish an early warning system for the consequences of climate change in permafrost regions. A first range of Web Services are distributed, enabling dissemination of the GTN-P DMS over several remote catalogues and Earth Sciences platforms. Data dissemination of Permafrost temperature and Active layer thickness data toward World Climate Research Programme (WCRP) is in progress for these Essential Climate variables (ECVs). Several products have been formatted in NetCDF 4 by the Arctic Portal and the Alfred Wegener Institute. Discussions are undertaken with the Obs4MIPs group in order to register our variables to a data node as well as to standardize our products in compliance with the Climate and Forecast convention (CF 1.7). Due to the great heterogeneity of the data, Data Quality Assurance and Control (QA/QC) parameters are of foremost importance in order to describe our resources. An IPA Action Group on data quality was created for the 2-year period, 2015-2016. The group establishes these quality parameters for Permafrost temperature and active layer thawing variables, building a standard reference for the discipline. Flags will be implemented into the GTN-P DMS and distributed along with the global products.

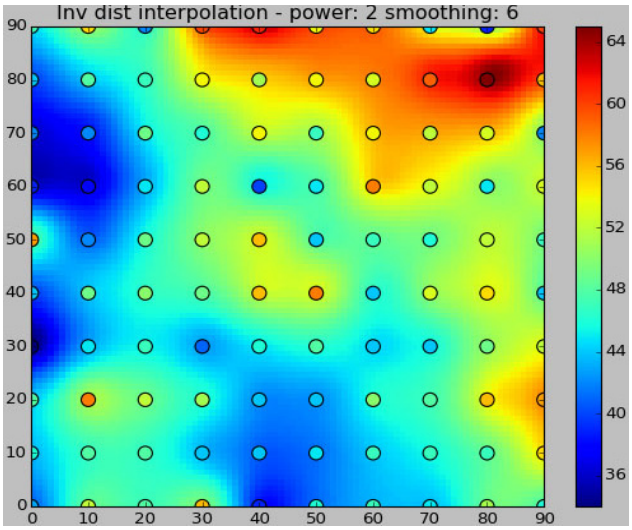

Figure 1. GTN-P DMS visualization of Active layer thickness with IDW interpolation.

A close work between AP and the National Snow and Ice Data Centre (NSIDC) allowed the retrieval of, in a bulk submission, Russian Historical time series on ground temperature from 103 boreholes. The data range from 1913 to 1990 (Figure 2). Several other rounds of bulk submissions will take place in the years to come. All data are available for free download. Visit also our website in order to be updated about GTN-P: *www.gtnp.org*

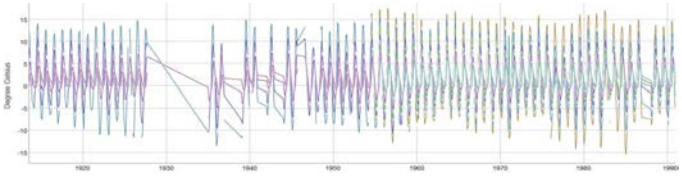

Figure 2. GTN-P DMS visualization of ground temperature from Russian Historical data (Bayandai borehole: http://gtnpdatabase.org/boreholes/view/1674).

Furthermore, the book from Arnalds Olafur The Soils of Iceland has been published this year, and it is the only comprehensive book about Icelandic soils currently available. Very few updates about permafrost in Iceland have been made recently but we inserted into the GTN-P DMS permafrost temperature time series from the four Icelandic boreholes, parts of the Thermal State of Permafrost (TSP) and of the GTN-P. They will be included as parts of the global products distributed to the Climate modellers community.

Report prepared by Jean-Pierre Lanckman (jean@arcticportal.org)

10 Italy

The Italian research in the permafrost and periglacial environments was focused on the entire Alpine arch and in the Antarctic region.
It is worth to be noted that since 2012 the Italian permafrost community is self-organized within the PermaItaly initiative with the aim of aggregate, coordinate and promote the mountain permafrost research at national level. In 2015, a first workshop focused on the monitoring and study of rock glaciers has been held in Valle d'Aosta (October 13-15th). For three days more than 20 researchers with very diverse background (geologists, biologists, hydrologists, ...) have presented their ongoing researches, discussed and planned future common initiatives at community level. Participation, aggregation and sharing (of skills and data) have been the keywords of this nice workshop (Figure 1).

Figure 1. Workshop on Rock Glaciers Monitoring and Dynamics (Aosta, 13-15th October 2015).

Eastern Alps

In the northeastern most part of the Italian Alpine chain, in Friuli Venezia Giulia (FVG) high altitude karstic environments, preserving permanent ice deposits within caves, are under investigation since 2011. Since their main characteristics is to have ground ice older than 2 years, many authors are prone to consider ice caves as sporadic permafrost phenomena (e.g. Holmlund et al., 2005; Luetscher et al. 2005, Hausmann and Behm, 2011; Kern et al., 2011). As part of the cryosphere such ice masses are linked to the climate and respond to climate change, thus several rock and air temperature monitoring stations are still active in the Leupa ice caves, located at 2,300 m of elevation. This cave was identified in 2011 as the most suitable for a long monitoring campaign. A complete FVG-inventory of ice-caves and cryo-caves has been also established during 2015. This year the Automatic Weather Stations of Canin (2,200 m a.s.l.) was implemented with 7 ground thermistors at different depths in the recently deglaciated sector of the Eastern Canin glacier. Geophysical investigations aiming at characterize the presence of possible ground-ice patches are also ongoing over the mountain sectors of the Region (R. Colucci, E. Forte, M. Guglielmin)

Central Alps

The following institutions are currently working on permafrost and periglacial environments in Trentino and in the Mount Ortles area:

- University of Padova, Department of Geosciences and Department of Land, Environment, Agriculture and Forestry (G. Dalla Fontana, A. Bondesan, A. Carton, L. Carturan, T. Zanoner, G. Zuecco);
- University of Pavia, Department of Earth and Environmental Sciences (R. Seppi);
- Autonomous Province of Trento, Geological Service (S. Cocco, M. Zumiani);
- Autonomous Province of Bolzano, Geological Service (V. Mair, D. Tonidandel) and Hydrographic Office (R. Dinale);
- Ohio State University, Byrd Polar Research Centre (P. Gabrielli)
- IASMA-Research & Innovation Centre, Fondazione E. Mach (M. Tolotti)

In Val de la Mare (Ortles Cevedale massif), GST measurements from monitoring sites located on bedrock and various landforms (active and inactive rock glaciers, scree slopes, glacial deposits) were continued, along with hydrological investigations in a small permafrost-dominated catchment. In the same area, the monitoring station established in 2010 at Cavaion site (~2900 m asl) during the PermaNET project was equipped with a new thermistor chain for measuring the temperature in a 50 m borehole drilled in bedrock. Here, the climatic variables are also under measurement.

The surface displacement of two active rock glaciers in the Adamello Presanella massif, in progress since 2001, was measured also in 2015, along with GST measurements which are carried out since 2004 (Figure 2). On these rock glaciers, the data from the monitoring stations installed in 2013 for measuring the snow cover thickness and the air and ground temperature were retrieved. In this area, the data from the monitoring station established close to the Lobbie Hut (~3000 m asl) during the PermaNET project (temperature from a 20 m borehole drilled in bedrock and air temperature) were retrieved.

In the Dolomites, surface displacement and ground surface temperature measurements continued on a

composite permafrost landform located in Val San Nicolò, in order to understand the current processes driving its evolution. In addition, the data on snow cover evolution were retrieved from the monitoring station installed in the 2013.

Preliminary investigations on the hydrochemistry and the biology of lakes and streams affected by permafrost and active rock glaciers were conducted in the Ortles Cevedale and the Presanella massifs.
In the Mount Ortles area, the activities focused on the recovery of temperature data from several sites, including GST, temperature of rock faces at three depths (10, 30 and 55 cm from the surface), and englacial temperature of the Alto dell'Ortles glacier and of a small ice-cap located on the "Hintergrat" ridge of Mount Ortles (Figure 2).

Figure 2. Measurements of the surface displacement of the Maroccaro rock glacier in the Adamello Presanella area (on the left) and monitoring of englacial temperature of a small ice-cap located on the "Hintergrat" ridge of Mount Ortles (on the right).

The main activities in South Tyrol have been carried out by the Provincial Office for Geology and Building materials testing (V. Mair, K. Lang, D. Tonidandel), Autonomous Province of Bolzano. All the permafrost monitoring stations, which were installed during the Alpine Space project PermaNET, the Interreg IV Italy-Austria project Permaqua and the Ortles Ice Core project are operant and are still collecting data of internal temperatures of three rock glaciers and several rock faces.

Western Alps

In July 2015, Environmental Protection Agency of Valle d'Aosta (ARPA VdA) (E. Cremonese, U. Morra di Cella, P. Pogliotti) hosted in Cervinia the Field Course of the Applied Geophysical Methods organized by Prof. Christian Hauck (Uni. Fribourg, CH). During the 4-days field works, repeated electrical (ERT) and seismic (RST) tomography have been realized in the permafrost monitoring sites of Cime Bianche (http://dx.doi.org/10.5194/tc-9-647-2015) and Gran Sommetta rock glacier. On this last site, have been equipped two 15m deep boreholes, drilled in 2014, with thermistor chains and TDR-cable for deformation detecting. On the same site, repeated UAV and GNSS campaigns have been carried on throughout the summer for studying the surface dynamics over time (http://dx.doi.org/10.5194/isprsarchives-XL-3-W3-391-2015), in collaboration with Prof. Reynald Delaloye (Uni. Fribourg, CH).

NATRISK-LNSA (M. Freppaz, M. Isabellon, M. D'Amico) and ARPA VdA are carrying out the monitoring of low-elevation permafrost in two talus-slope sites in the Lys valley (Monte Rosa Massif). In the South-Eastern sector of the Aosta Valley, pedological investigations are being performed on selected patterned ground areas associated with permafrost with the aims of understanding the effect of lithology on patterned ground morphology and plant ecology in cold high altitude environments.
- Nicola Colombo pursues a joint PhD between Carleton University - Canada (supervision S. Gruber) and the University of Turin (supervision S. Fratianni, M. Giardino, M. Freppaz). His thesis work investigates the interactions between permafrost and physiochemical characteristics of surface water in the Western Italian Alps (LTER site Istituto Mosso), in collaboration with IRSA-CNR (F. Salerno, R. Balestrini, G. Viviano).

Arpa Piemonte (Dept. "Geology and Natural Hazards", Ref. Luca Paro), with the contribution of Insubria University (Mauro Guglielmin), continued the activities developed during the European project "PermaNet" finished in September 2011. Since 2010, all the activities are included in a specific institutional topic named B3.19 "Permafrost monitoring" and new activities and collaborations have been carried out on the Piedmont Alps.

Synthetically, during the 2015 Arpa Piemonte carried out the following activities:

- Management of the regional network for permafrost monitoring. Maintenance of the permafrost monitoring stations in Piedmont Alps and analysis of monitoring data related to climate conditions. The regional network is constituted by 5 sites with vertical boreholes: 2 stations in Southern Cottian Alps (Gardetta Pass and Colletta Pass, boreholes 30 m deep each), 1 station in the Northern Cottian Alps (Sommeiller Pass key site, 3 borehole with 5, 10 and 100 m deep), 2 stations in the Pennine Alps (Salati Pass, two boreholes of 5 and 30 m deep; Mt. Moro Pass, 30 m deep). A new temporary weather station has been installed at the Salati Pass on the roof of the cableway station.

- Management of GST monitoring sites. Maintenance and improving of the GST sites installed since 2013; download and analysis of GST data. The GST network is constituted by 5 sites: Sabbione Lake basin – Lepontine Alps (8 sensors: 1 for air temperature,

3 in the same site at 2, 10 and 50 cm underground, and 4 sensors at 2 cm underground in the moraine rock glacier); Corno del Camoscio – Pennine Alps (2 sensors at 2 and 10 cm undersoil); Sommeiller Pass - Cottian Alps (4 sensors: 2 under the nivometer at 2 and 10 cm underground and 2 sensors at 2 cm underground at 5 and 10 m far from the weather station towards N); Mt. Rocciamelone – Cottian Alps (6 sensors: 2 sensors at 2 cm in the rockwall near the extensimeter, 4 sensors in two wide open fractures at 2, 10 and 60 cm in the rockwall); Prato Ciorliero – Cottian Alps (2 sensors: 1 for air temperature and 1 at 2 cm undersoil). The latter, has been installed in December 2015 to improve the waterspring monitoring site already installed.

- Surveys. BTS surveys in different sites of Piedmont Alps (Salati Pass - Pennine Alps, Sommeiller Pass and Prato Ciorliero – Cottian Alps, and Mt. Argentera site – Maritime Alps) in order to evaluate the permafrost distribution and to validate empirical and physical models.

- Project and Agreement. Arpa Piemonte is partner in approved European project (ALCOTRA Programme 2014+) named “PrevRiskHauteMontagne” that it will start on January 2016. The main aim of the project is to analyze new risks in glacial and periglacial areas due to climate change. Arpa Piemonte will establish a new monitoring site (inclinometers and thermometers) on the Southern watershed of the Mt. Rocciamelone that highlighted an active landslide at 3200 m of high. A new biennial agreement has been activated between Arpa Piemonte and Pisa University (A. Ribolini) in order to analyze and improve monitoring and surveys activities in periglacial areas of Maritime Alps.

- Dissemination and education. Teaching activities in Schools, University and PhD School (lessons on permafrost and periglacial environment of Piedmont Alps). Popularizing activities addressed to the population, updating of institutional webpages, publication of videoclip and no-scientific articles on Arpa Piemonte’s activities on cryosphere topics and Antarctica expedition (further information at the webpage http://www.arpa.piemonte.it/approfondimenti/temi-ambientali/geologia-e-dissesto/monitoraggio/monitoraggio-permafrost/monitoraggio-permafrost).

Antarctica

Rossana Raffi (Sapienza University of Roma) continued the activities focused on the monitoring of the permafrost thermal regime at three ice-wedge polygon sites (Figure 3). The research, started on 2004 in the framework of the Italian Antarctic Research Program (PNRA), is based on data-logger measurements of hourly temperatures of the air, the ground surface, ice-wedge top and bottom and of 160 cm depth.

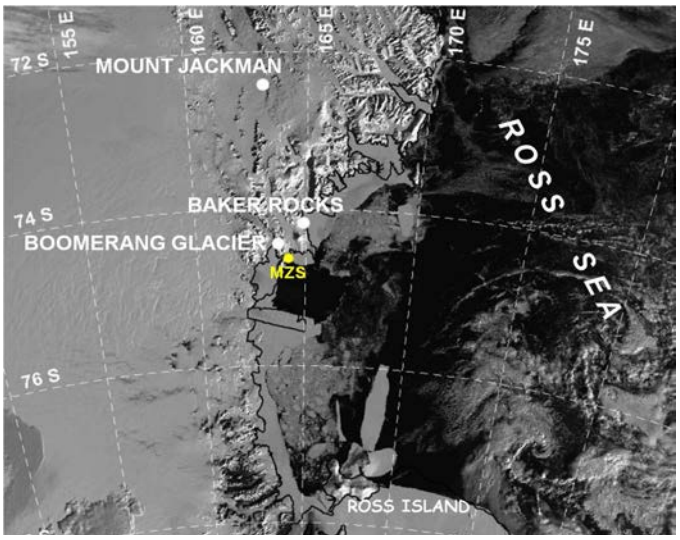

Figure 3. Location of the ice-wedge thermometric stations. MZS: PNRA Mario Zucchelli Station.

Report prepared by Andreas Ribolini (ribolini@dst.unipi.it)

11 Japan

During the Argentinean Antarctic expedition of the summer 2014-2015, T. Sone and S. Tanabe (Hokkaido Univ., Japan) investigated permafrost temperatures on Seymour (Marambio) Island and James Ross Island (Antarctic Peninsula). Geodesic surveys on rock glaciers, solifluction lobes, protalus lobes were conducted on James Ross Island.

In Svalbard, a long-term monitoring campaign by N. Matsuoka (Univ. of Tsukuba), T. Watanabe (Kitami Institute of Technology, Japan) and H.H. Christiansen (UNIS, Norway) has continued since 2005, targeting the dynamics of patterned ground (ice-wedge polygons, mudboils and hummocks) and a polar rock glacier. UAV mapping was conducted to produce 3D images of these features in August 2015.

In 2014 an international collaboration, called the UV-project, has started between two Japanese universities (N. Matsuoka and A. Ikeda, Univ. of Tsukuba; F. Imaizumi, Shizuoka Univ.) and University of Bern (M. Stoffel and D. Trappmann) in an attempt to compare geomorphic dynamics between U-shaped valleys in the Swiss Alps and V-shaped valleys in the Japanese Alps. Monitoring and dendrochronological techniques combine to evaluate current and historical dynamics of steep slopes, including permafrost creep, rock creep, slope failure, rockfall and debris flow, contributing to valley-slope evolution in both situations. A. Ikeda has maintained the 10 m-deep borehole on the summit of Mt. Fuji. The borehole temperatures were successfully monitored since the summer of 2011.

A voluntary committee (K. Saito, JAMSTEC; T. Sueyoshi, NIPR; K. Watanabe, Mie Univ., Japan; K. Takeda, Obihiro Univ. of Agriculture and Veterinary Medicine) for the open-access database for Japanese historical domestic ground temperature and frost depth data has digitized the image-based observational data from 27 sites of the Japan Meteorological Agency (from as early as 1888), and for 5 sites of the Prefectural Agricultural Institute of Hokkaido (from the early 1900s).

In eastern Siberia, active layer and thermokarst monitoring at Tiksi and central Yakutia was conducted by Y. Iijima and H. Park (JAMSTEC) with Russian colleague Dr. A. N. Fedorov (Permafrost Institute). 1x1 km CALM grid and temperature at deep boreholes (30 and 60 m depth) were measured and revealed continuous increases in permafrost temperature since 2000s. Thermokarst development at natural dry grassland and boreal forest damaged from insects were investigated by measuring land surface terrain and active layer thickness at Churapcha in central Yakutia. According to the thermokarst depression in the dry grassland, the depression rate is ca. 15 mm/year in average since 1990.

3D topographic mapping was conducted by using UAV mounted camera at several thermokarst sites of Hentei, Hovsgol and Hangai regions, Mongolia (M. Ishikawa Hokkaido Univ.; A. Dashtseren, Institute of Geography and Geoecology, Mongolia). T. Hiyama (Nagoya Univ., Japan), M. Ishikawa and A. Dashtseren collected water sample from many spring, river and lakes in order to analyze tritium and CFCs concentrations, which would be hydrological indicators of permafrost thawing.

Within the GRENE Arctic Climate Change Research Project, a modeling group in the terrestrial research sub-project (GRENE-TEA) has been conducting an intercomparison project for land surface process models (encompassing from physical to biogeochemical and ecological) for the Arctic region. Twenty-one models (domestic and abroad) participated the stage 1 (site simulations for four sites: Kevo, Finland; Tiksi and Yakutsuk, Russian; Fairbanks, Alaska, for 1980-2013), and 7 models are participating the stage 2 (circum-polar simulations for 0.5 degree land areas north of 50N, for 1850-2100). The analysis and documentation are now on going (the project ends in March 2016).

In early March 2015, advanced course in modelling of the permafrost and cryosphere entitled “CryoEAST” has been conducted in Sapporo, Japan (B.Etzelmüller and S. Westermann, UiO, Norway; M. Ishikawa and T. Sato, Hokkaido Univ.; N. Matsuoka; Y. Sawada, Fukuyama City Univ., Japan). About 20 of Bs, Ms. phD students and young researchers from Japan, Norway, Mongolia, USA and Denmark) have attended to learn numerical and statistical modelling, and geoinformatic skills for permafrost researches.

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12 Kyrgyzstan

Engineering geonomic forecast model of glacial-permafrost georisks in mountainous countries on the example of Kyrgyz Tien Shan

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Usupaev Sh.E., Usubaliev R.A, Erokhin S.A, Atakanov U., Azisov E.

Researchers of global warming, not fully use data on rhythmic change of glacial to the interglacial periods, and moreover do not consider indicators of the glaciers formation which include inertia-resistant permafrost environment on the Earth [1-4].

With the growth of annual temperature according to the scenarios on the 1,3 - 1,7 °C by 2050 and 2,5 - 3,0 °C by 2100 in Central Asia and Kyrgyzstan, the amount of precipitation will increase by 5 - 7 and 10 - 15% respectively, which will lead to a shift in the thermal zones from 200 to 600 m, up the altitudinal zones.

In Holocene time there are four periods: two cold with minimums in 2900 - 2300 and 330 - 125 years ago and warm with cycle peaks. The latest cold period of paleoclimate lasted for 425 years, and dated 1435 - 1860 C.E., and the latest warm period lasted 200 years (985 - 1185 years C.E.)

Cryolithozine in the territory of mountain countries including Kyrgyz Tien Shan is extremely rich with geohazards induced by frozen water: 1. pulsations of the parts of glacier tongue; 2. ice collapses; 3. firn avalanches; 4. Intraglacial breakthrough closed lacustrine cavities; 5. moraine glacial outburst mountain lakes; 6. Breakdown of the masses of ice and / or avalanche materials creating dam of outburst mountain lakes; 7. glaciological-tectonic faults, resulting in ice sliding and avalanches; 8. loss of sources of fresh clean drinking water; 9. geocryogenic hazardous processes and phenomenas.

In the Kyrgyz Tien Shan the permafrost ground covers more than 34% of the mountainous country. The most developed are the permafrost environments in syrts (local name for high mountain valley) holding (36,400 km2), and stretched on the heights from 2.6 to 7.4 km. Approximately 54% (4350 km2) of area consists from permafrost syrts (local name for high mountain valley) of Kyrgyz Tien Shan.

The temperature of frozen ground with increasing altitude is changed to 5 km (-10, -11 °C.), 7 km (-25, -26 °C). Maximum depth of permafrost soils is more than 1 km. The temperature of frozen soil varies from - 0.7 °C to - 7.9 °C.

The depth of continuous distribution of permafrost soil excess 100 m and has an average temperature of - 3 °C. Zones of interrupted development of permafrost have depth from 30 to 100 m, and the soil temperature from -1 to -3 °C. The areas occupied by the insular permafrost have depth less than 30 m and temperature from 0 to -1 °C. [1]

Ice content of frozen soil varies from 0 (frost thickness single storey formations and massive structure without visible ice discharge), up to 40 or more in coditions of schliere cryogenic textures of segregation type with development of rock-forming injection ice and massive cryogenic textures with widespread development of buried ice.

In case of violation of the surface conditions and melting, the following dangerous cryogenic processes and phenomena occur: differential settlement with the development of thermokarst, thermal erosion, cryogenic landslides, structural solifluction, slipouts, hydrolaccolith, heaving, thufur, polygons, icefield.

The EGN model by Usupaev Sh.E. (Fig 1.) shows the distribution of the lateral pattern, typification and forcats of geonoms of : a)permafrost spread b) glaciation on the territory of Kyrgyzstan.

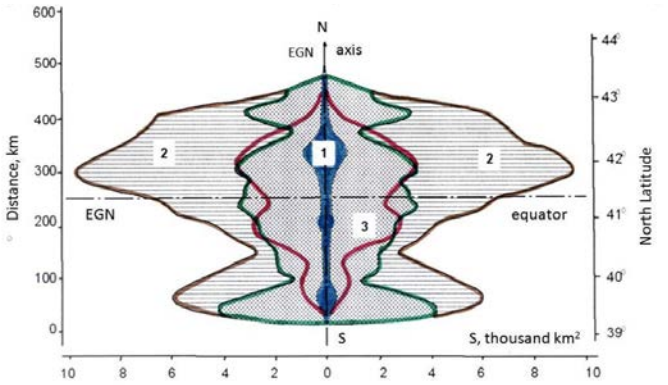

Figure 1. EGN model of lateral for latitudinal patterns of geonom distribution areas: red line marked permafrost areas, 1. glaciation; 2. orogeny; 3. valleys for the territory of Kyrgyz Tien Shan.

The engineering geonomic model of lateral patterns of distribution and forecast of glacial permafrost geohazards of Kyrgyzstan shows that the permafrost geonom have three highest peaks of development when integral unification of all glaciers by northern latitude.

The greatest peak of permafrost geonom by the area of development is at a latitude of 42 degrees, then

when moving from north to south, is the second largest peak by the area of development from 40 degrees 40 minutes to 40 degrees 50 minutes.
The third peak of permafrost geonom is smaller by the area than listed above and is at a latitude of 39 degrees 45 minutes.

The pattern of integral distribution of permafrost areas indicates that the degradation of glaciation in Kyrgyzstan will take place in three stages, in the direction from south to north.
The first will degrade the permafrost of the smallest peak of permafrost geonom, then two peaks of permafrost located toward north.

Permafrost degradation forms three islands of permafrost geonom.
From EGN models it is known that the glaciation geonom closely correlated with permafrost geonom. The mechanism of glaciation degradation is similar to the scenario with permafrost geonom.

The figure of EGN model of risk assessment of glaciers degradation shows that the modern integrated areas of glaciers in Kyrgyzstan form by latitude from north to south the three peaks of glaciation geonoms. Since moving to the south the temperature increase with climate change, and the risk of degradation of glaciers also increases.

Conclusion

1. EGN methodology allows to transform the thematic maps of the distribution of long-term permafrost rocks, glaciation, orogens and valleys in mountainous countries into geonom models of the lateral distribution of permafrost, glaciation, orogenic and plain with a forecast of their variability.
2. Modeling of climate change requires the conducting the applied research with drilling and core sampling of ice massive, of deep bottom sediments of large lakes and as a result construction of EGN models.

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Report prepared by Ryskul Usubaliev (r.usubaliev@caiag.kg)

13 Mongolia

For last years as an increase of economic growth of Mongolia the infrastructures such as roads, power plants and others have been built in Mongolia. Some of these infrastructures will be built in permafrost areas. Within conception agreement between Mongolian government and an international team of companies (QDF SUEZ Energy Asia, Sojitz Corporation, POSCO Energy, and NEWCOM) new combined heat and power plant is planning to construct near the Ulaanbaatar city. There is sparsely insular permafrost distribution at the site of this power plant. Permafrost team of our laboratory have completed the permafrost distribution map of this site using the ERT method and temperature measurements in boreholes. The site of power plant has a patchy permafrost.

Our young staff, A.Dashtseren, has completed a PhD course in Hokkaido University in 2015. He got PhD degree within the framework of long-term corporation between our institute and Hokkaido University. Prof M.Ishikawa from Hokkaido University and Prof T.Hiyama from Nagoya University have participated in field work through Hovsgol and Hangai mountain regions in this summer.

Figure 1. Field trip 2015 in Hangai and Hovsgol mountain regions, from left T.Hiyama, Kh.Temuujin, M.Ishikawa, A.Dashtseren, D.Renchindamba, T.Nara, Ch.Sukhbaatar, Ts.Undrakhtsetseg, 2015.08.12

Within new agreement of our institute and Oslo University we have installed 100 button data loggers in Terelj observation area, about 70 km to south-east from Ulaanbaatar. In end of this year, we have been to upstream site of Sugnugur River, where we installed the sensors of moisture and temperature for study interactions between permafrost and surface water within agreement with Prof Lucas Menzel from Heidelberg University, Germany.

Figure 2. Upstream area of Sugnugur River, 2015.12.01

Within 2015, we have been completing the new permafrost map of Mongolia within the national project of spatial and temporal modelling of permafrost in Mongolia. We have used the TTOP modelling approach for this map and used the data from investigations on permafrost for Mongolia. During 2014-2015, we drilled several shallow boreholes to determine the lower limits of permafrost distribution in Altay, Hangai and Eastern Mongolia. We have several permafrost map of Mongolia with different scales all over the Mongolia since 1950-1960s. Firstly, N.Lonjid, senior scientist and founder of permafrost laboratory in Mongolia, had established the permafrost map based on data from that time. In 1971 newly permafrost map was completed as results of joint Mongolian and Soviet Union expedition. This map is familiar as a Gravis map. After these maps, several maps with different scales were completed by national scientists, usually N.Sharkhuu completed these maps. All of these maps were completed based on data from temperature measurement in boreholes and regulations of ground temperatures.

Figure 3. During the drilling work, Hangai mountain region, 2014.10.15

Report prepared by Jambaljav Yamkhin (jambaljav@gmail.com)

14 New Zealand

We continue to maintain our Antarctic soil-permafrost monitoring network in the Ross Sea Region, which now comprises 9 soil climate monitoring stations that monitor to depths of about 1.2 m, along with 2 boreholes, each 30 m deep (Figure 1). This work is undertaken with continuing collaboration between Landcare Research (Fraser Morgan), the University of Waikato (Megan Balks) and USDA (Cathy Seybold). The boreholes are managed also in collaboration with Prof Mauro Guglielmin from Italy. Megan Balks and Dean Sandwell undertook the climate station maintenance and download in January 2015 and this summer Dean Sandwell will be returning to Antarctica and training a new tech support, Chris Morcom, so we have some back-up expertise.

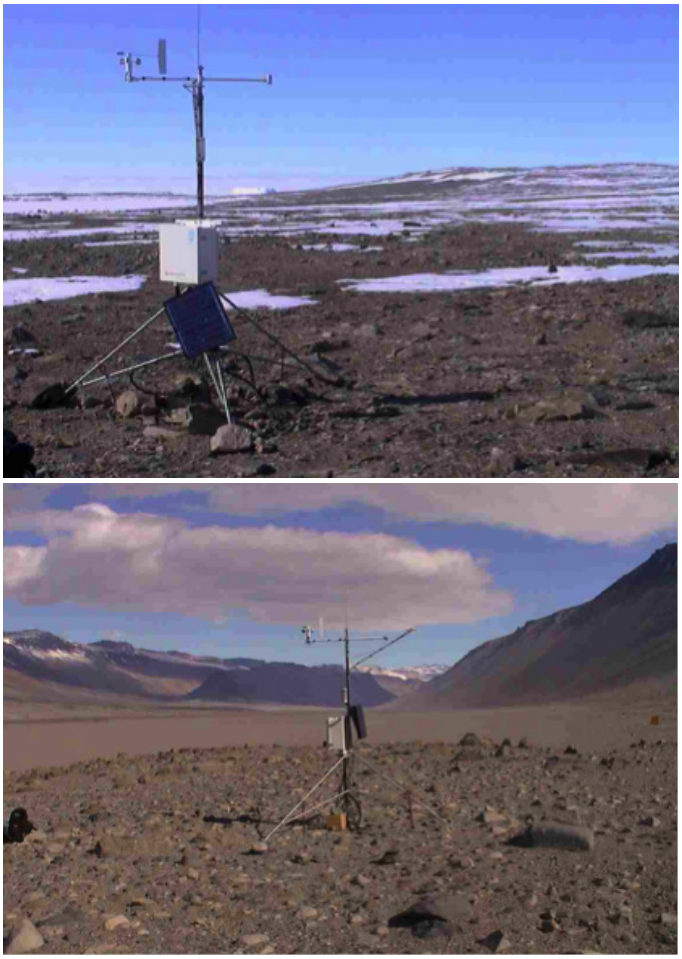

Figure 1. Two of our 9 soil climate stations. Left: Marble Point, Right: Wright Valley floor.

Congratulations to Dr Fiona Shanhun who has successfully completed her PhD on soil CO2 dynamics in Antarctic soils and is now working supporting the science programme for Antarctica New Zealand. Fiona's PhD research (at Lincoln University) investigated soil CO2 dynamics in Taylor Valley (Figure 2), and focused on understanding biological and non-biological processes associated with CO2 fluxes from soils. The ultimate aim was to provide a platform for using soil CO2 emissions as a way of detecting and monitoring changes in ecosystem behaviour as the Dry Valleys respond to global change. Prior to taking up her role at Antarctica New Zealand, Fiona was on a SCAR Science Fellowship to St Francis Xavier University in Nova Scotia, Canada, collaborating on research which built on aspects of her PhD.

Figure 2. Fiona Shanhun installing soil temperature and moisture sensors in Eastern Taylor Valley.

Tanya O'Neill had a proposal funded by the British Antarctic Survey receiving a small grant to support her research on temperature dependence of soil respiration in cold soils. She hopes to present at the SCAR Open Science Conference in Malaysia 2016.

Report prepared by Megan Balks (m.balks@waikato.ac.nz)

15 Norway

Engineering aspects

The SamCot program continues with 6 focus areas one being Coastal Technology where the objective is to develop knowledge and analytical and numerical models of coastal erosion in the Arctic. The Samcot program is organised as a Center for Reaserch-based Innovation (CRI) running until 2019 with NTNU, UNIS and Sintef as main contributors. The Moscow State University was also a significant contributor. Field work has been carried out both in Russia and Svalbard as can be seen below:

Figure 1.

During 2015 temperature and erosion measurements were continued at Vestpynten, Svalbard and work on analytical modelling was intensified. The analytical work included both Thermo-Hydraulic-Mechanical modelling, effect of Thermo Denudation and sediment transport in water. In December Emilie Guegan defended her PhD with a dissertation titled: Erosion of permafrost affected coasts: rates, mechanisms and modelling at NTNU. Further information can be found through the Samcot webpage www.ntnu.edu/web/samcot

Use of crushed rock

A research program on "Frost Protection of Roads and Railways" was started with the primary objective of building knowledge on behavior of crushed rock and subgrade under cold climate conditions resulting in upgraded design methods for frost protection layers for roads and railways. The project is managed by Elena Kuznetsova at NTNU and collaborates with the Laval University in Canada. The work will continue for several years and include two PhD programs. Preliminary results were presented in September 2015 during the 68th Canadian Geotechnical Conference and the 7th Canadian Permafrost Conference in Quebec, Canada. Further work will be presented at the XI. International Conference on Permafrost in Postdam.

Additional engineering news related to Svalbard

Infrastructure development and permafrost engineering activities in Svalbard has to a large extent been dependent on the mining industry.

The recent decline in coal prices on the world market has seriously affected the mining industry in Svalbard. It is likely that the coal mine in Sveagruva will be (temporarily?) closed from the summer of 2016.

However, it is possible that the research infrastructure facilities in Longyearbyen will be extended in the coming years. There are also plans being made for a major port development to serve increased tourism and other industry in the Barents region.

These projects represents interesting challenges for permafrost engineers as the soil conditions are characterized by saline, relative warm permafrost (marine silty clay) and unstable submarine slopes.

In the future it is possible that research, education and tourism will take over for the traditional coal mining industry as the main activities on Svalbard.

Report by the CRYONOR group

Geology Department, UNIS

In 2015 the periglacial research group in the Geology Department of The University Centre in Svalbard, UNIS, did a winter permafrost drilling campaign in Ny Ålesund (Svalbard), using the UNIS permafrost drill rig. A permafrost borehole down to 40 m were drilled, cores were partially collected, the boreholes cased to be later instrumented for continuous ground thermal monitoring by Italian colleagues. Kings Bay (Ny Ålesund) was also involved in this project.

In June-July 2015 the second of two planned AG-218/219 'International Bachelor Permafrost Summer Field Schools' as part of the University of the Arctic Thematic Network on Permafrost was held at UNIS in close cooperation with University of Alaska Fairbanks and other partners in this network. 20 students from eleven different countries took this 5 or

10 ECTS course, which had as the main aim to provide an overview of how diverse permafrost studies are in modern Earth System Science, from potential carbon release due to increased permafrost thawing to conditions for infrastructure on permafrost.

PhD student Graham Gilbert has continued working in our group in the DEFROST Nordic Center of Excellence Project on ground thermal analyses, but also on cryostratigraphy. He has been fieldworking at Zackenberg in NE Greenland summer 2015. Our Page21 PhD student Stefanie Cable continue working on the last part of her PhD thesis on geomorphological and geocryological mapping of the Adventdalen and Zackenberg area for her PhD thesis.

Department of Geography, Norwegian University of Science and Technology (NTNU)

By Ivar Berthling and Radmil Popovic work was continued on sorted circle dynamics on Kvadehuksletta, Svalbard. The work was done in collaboration with University of Oslo (Luc Girod/Andreas Kääb - close-range aerial photos using structure-from-motion) and University of Zürich (Alexander Bast, Isabelle Gärtner-Roer - 2,5 D ERT imaging and soil moisture/temperature monitoring). On the same occasion, the Brøggerbreen rock glacier was remeasured for displacement monitoring, providing a series of measurements that goes back to 1998 - although not at annual intervals. The rock glacier was also investigated with 2,5 D ERT and GPR measurements, and surface topography mapped with terrestrial LiDAR. The ERT measurements were performed along length profiles of 10 m spacing covering the main part of the rock glacier. All the fieldwork was carried out during a Norwegian Research School in Geography summer field course.

Department of Geosciences, University of Oslo (UiO)

2005 marked the final year of the project period in CryoMET (Bridging scales for the terrestrial Cryosphere, PI: Etzelmuller, funded by the Research Council of Norway (RCN)), where we this year mainly focused on including the subgrid variability of snow in permafrost models and down-scaled climate models (Gisnås, Schanke Aas, Westermann, Schuler). The field areas were sites in southern Norway and Ny-Ålesund in Svalbard. The work resulted in a permafrost model approach which includes the subgrid variability of snow, which has been applied and validated for Norway.

This year started the COUP project (Constraining uncertainties in the permafrost-carbon feedback, funded by JPI-CLIMATE/RCN) led by the University of Stockholm, with WP leadership at UiO (Westermann). Here, we instrumented some palsa mires at several sites in the Finnmark county, northern Norway, and took high-resolutions images by UAV at different sites in northern Norway and northern Sweden (Etzelmuller, Westermann, Eiken).

We also started the SATPERM project (Satellite-based Permafrost Modeling across a Range of Scales, funded by RCN), with Westermann as applicant and project leader, where we use satellite-based products to force permafrost models from global to more local scales. Within this project several sites are or will be instrumented for validation, such as sites in Finnmark/northern Norway, Svalbard/Ny-Ålesund, Russia, Greenland and Mongolia.

In 2005 we also started the RCN-funded project Cryowall (Steep rock walls in Norway, PI Etzelmuller, co-operation with TU Munich (Kreautblatter), Met Norway (Isaksen) and NGU (Herrmanns)), where we systematic assess the distribution, thermal regime and stability parameters of steep slopes in permafrost in Norway. This summer we implemented 15 new rockwall data loggers in 5 different localities both in southern (Romsdalen, Loen-area) and northern Norway (Lyngen-Kåfjord area), a.o. with the help of French partners (Magnin). The TU Munich (Krautblatter, Jakobs) prepared and took samples for rock stability analysis and modeling from sites in the Kåfjord area, while the NGU (Herrmanns, Hilger) took samples for CN dating, trying to decipher the evolution of rock slope movement during Holocene. In 2015 we compiled a first map of rock walls in permafrost (Steiger), and worked on a systematic assessment of the thermal regime in steep slope setting using 2D numerical modeling (Myhra).

In terms of student and Faculty exchange, we started the small activity CRYOEAST (funded by SIU – Center for internationalizing education), which is a cooperation between UiO (PI Etzelmuller, with Westermann, Dunse, Schuler, Hagen, Lilleøren) and Hokkaido University in Sapporo (PI Ishikawa, with Sugiyama, Greve). In 2005 we offered a permafrost modeling course in Sapporo for Norwegian and Japanese students and Faculty.

Other activities from UiO are related to finalizing a new Nordic Permafrost Map (Gisnås and Nordic partners), evaluating our Norwegian rock glacial inventory especially in sites in northern Norway (Lilleøren), complete a full palsa inventory for the county of Finnmark (Frogner Borge, Solheim), re-instrument the permafrost boreholes in Iceland (Westermann, Dunse) and read-out and maintain our 15 boreholes in both southern and northern Norway (Etzelmuller). We have continued also our intense co-operations

with other partners in 2015, such with Finland (Prediction modeling of palsa and rock glaciers, transfer of models, Etzelmuller/Lilleøren/Hjort), France (energy balance modeling of rock walls, Westermann/Magnin) and Germany (AWI, process modeling of thermo-karst in Russia, Westermann/Boike/Overduin/Langer).

Figure 2. Ice-cored moraines and steep rock walls at Gjuvbreen glacier, Juvvasshøe, central southern Norway, August 31, 2015. Photo: Ole Humlum.

Report prepared by Gisle Hâland (GISH@Statoil.com) and Ole Humlum (Ole.Humlum@geo.uio.no)

16 Poland

*I*n 2015, Polish scientists investigated different aspects of permafrost on Spitsbergen and in the Polish mountains.

In 2015, scientists from the Adam Mickiewicz University in Poznań relocated the University Polar Station from the area of Petunia Bay to a new location in the area of Pyramiden. The main direction of work in the scope of permafrost and periglacial research was the continuation of already initiated observations of active layer temperature and thickness according to CALM guidelines at two sites differing in ground humidity conditions ('dry' – on a raised marine terrace and 'wet – on the surface of a river terrace). Both sites in the test area of Ebba Valley were furnished with temperature sensors placed down to 1.4 m b.g.l. and sub-surface humidity measurements were carried out. The programme of aeolian processes activity in the conditions of a dry polar climate was also continued, and so were observations of the development of active layer detachments. More attention was paid to the observation of frost weathering and slope processes in periglacial conditions. Systems of sediment collecting traps at the foot of exposed rockwalls and on talus/alluvial fans were mounted (Fig. 1) and supplied with a system of wheels to measure suprapermafrost ground-water circulation. An additional attempt was made to perform deeper drilling in the permafrost (Fig. 2), however under the 1.5-m deep active layer only 0.7 m in frozen substrate was reached, yet seven temperature sensors were arranged from the surface to a depth of 2.2 m. The drilling system is prepared to be used to a depth of 20 m during the next season.

Figure 1. Sediment traps to measure rock fall activity on limestone cliffs in Ebba Valley (Photo by Liliana Siekacz)

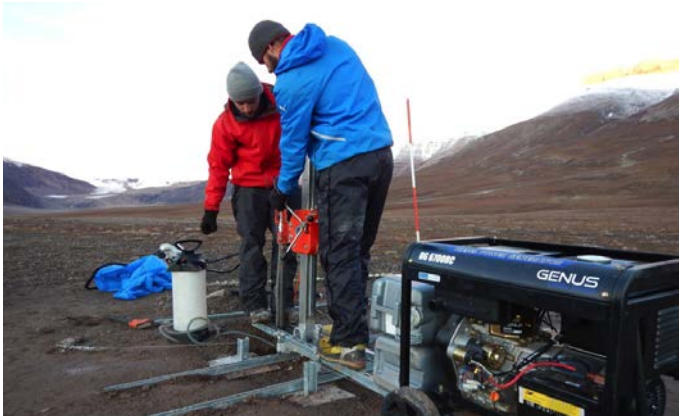

Figure 2. Permafrost drilling equipment on a raised marine terrace 30 m a.s.l. on the eastern coast of Petunia Bay (Photo by Grzegorz Rachlewicz)

In 2015, measurements of the active layer depth of permafrost, its thermal conditions, as well as its dynamics were continued at the CALM project Site P2 (A-C) – located near the Nicolaus Copernicus University station (Fig. 3) in Kaffiøyra.

Figure 3. The location of the Nicolaus Copernicus University Polar Station in Kaffiøyra (NW Spitsbergen) and the CALM Site P2, where active layer depth and ground temperature measurements were carried out. P2A – beach, P2B – tundra, and P2C – moraine (Photo by A. Araźny)

Furthermore, these investigations were also performed at two independent test sites (100x100 m) arranged according to the CALM project rules. At each of the test sites a set of temperature and humidity sensors was installed at various depths (1, 5, 10, 20, 50 and 100 cm for temperature, and 5 and 10 cm for humidity) connected to data-loggers. The measurements of the rate of ground thawing and the thickness of the permafrost active layer at the sites were performed every 7-10 days in July and August. The ground temperature at Site P2 was measured at standard depths up to 1-2 m in the same three different ecotopes as it was in the case of the active layer depth measurements, i.e. the beach (P-2A), the tundra (P2-B), and the moraine (P-2C) (see Fig. 3). Continuous series of ground temperature measurements are available for the moraine and tundra

(since 2006) and for the beach (since 2012). For this purpose, both mercury thermometers (readings taken every 6 hours, only in summer) and automatic temperature loggers (registration every 10 minutes, year-round) were installed at the measurement sites. In 2015, studies on permafrost were conducted by the team of Dr. W. Dobiński (University of Silesia) in two directions. The first was focused on a detailed investigation of glacier-permafrost relationships. Relevant fieldwork research was done in the forefield of the Hans Glacier in Hornsund, Spitsbergen. Thirty one electroresistivity profiles from 20 to 1500-m long were made. The depth range from a few meters to almost 100 meters indicates the presence of permafrost between the coast and the mountain slopes and across the entire glacier foreland.

The second direction was a search for the lower limit of permafrost occurrence in Western Carpathians. For this purpose 3 electroresistivity profiles were made at the top of Babia Gora, 1725 m a.s.l. The results will be published in 2016 in the Polish journal „The Geographical Review".

Report prepared by Rajmund Przybylak (rp11@umk.pl)

17 Portugal

Portuguese research on permafrost and periglacial environments in 2015 was conducted within the following projects:

- Permafrost and climate change in the Antarctic Peninsula. Long-term permafrost and active layer monitoring and modelling (PERMANTAR-3, PI: Gonçalo Vieira, Univ. Lisbon) continued in 2015, with field parties in Livingston Island, King George Island, Deception Island, Cierva Cove and Palmer archipelago. Cooperation with Spain, Brazil, Bulgaria, Argentina, Chile, South Korea and the USA. Alice Ferreira and João Branco conducting PhD theses.

- Arctic development and adaptation to permafrost in transition – Portuguese branch (ADAPT-PT2, PI: João Canário, Univ. Lisbon), with field activities on thaw lake chemistry and UAV surveying in the region of Kuujjuarapik-Whapmagoostui and Umiujaq, Northern Quebec, Canada. Cooperation with Canada.

- Integrated geological, geochemical and permafrost studies in Fildes Peninsula, King George Island, Antarctica (GEOPERM, PI: Pedro Ferreira, LNEG), focusing on high resolution geological characterization and mapping. Cooperation with Brazil.

- Holocene environmental change in the Maritime Antarctic: Interactions between permafrost and the lacustrine environment (HOLOANTAR, PI: Marc Oliva, Univ. Lisbon). The field activities continued in Byers Peninsula, Livingston Island with extensive laboratory work conducted along the year. Cooperation with Spain, UK, Canada, Brazil, Uruguay and the Czech Republic.

- Very high resolution imaging for detailed surface mapping in ice-free areas of Maritime Antarctica – Part 3 (HISURF-3, PI: Pedro Pina, Univ. Lisbon), focused on high resolution UAV surveying for vegetation and geomorphological mapping in the ice-free areas of Barton Peninsula. Cooperation with South Korea.

- Reaction of permafrost and landforms to climate in the Maritime Antarctic and risk for the infrastructure and environment. (CO-PIs: Gonçalo Vieira and Gabriel Goyanes). Surveying of Antarctic infrastructures using UAV and implementation of new permafrost boreholes near infrastructure in Dundee Island, Northern Antarctic Peninsula. Bilateral cooperation Portugal-Argentina.

- Does permafrost exist in the High Atlas mountains? Morocco. (PI: Gonçalo Vieira and Ali Faleh). Installation of a network of air and ground surface temperature loggers in the Middle and High Atlas, up to the Djebel Toubkal (4167 m) in order to assess the potential for permafrost occurrence. Collaboration between Universities of Lisbon and Université Sidi Mohammed Ben Abdellah of Fès (Morocco).

- Paleoenvironmental reconstruction of periglacial environments in the serra da Estrela, Central Portugal. Alexandre Nieuwendam continues his PhD dissertation research under supervision of G. Vieira. Focus on sedimentological analysis of slope deposits.

- Marc Oliva continued cooperative research with Spanish universities on mountain periglacial environments of the mountains of the Iberian Peninsula, with field research in the Sierra Nevada, Picos de Europa and the Pyrenees.

Portuguese scientists continued participation in the Expert Group on Antarctic Permafrost and Soils (ANTPAS - SCAR/IPA, co-chair G. Vieira), and have joined IASC with national representatives at the Terrestrial (J. Canário) and Cryosphere (G. Vieira) Working Groups.

Report prepared by Gonçalo Vieira (vieira@campus.ul.pt)

18 Romania

In 2015 three groups were engaged in periglacial geomorphology and permafrost researches, of the West University of Timişoara, Bucharest University and University ,,Babeş-Bolyai" Cluj-Napoca. The group of periglacial researchers from West University of Timişoara (P. Urdea, A. Onaca, F. Ardelean, A. C. Ardelean, R. Şerban, R. Puţan, F. Sîrbu, B. Magori) continued to study permafrost distribution and other significant periglacial landforms in Southern Carpathians. The main goal of the approach was to capture the current amplitude of periglacial processes from Southern Carpathians, taking into account the complex relationship between the detailed morphology of analyzed landforms, their internal structure and their thermal regime and actual movement. To achieve this goal, several test sites were chosen for detailed analysis of selected periglacial phenomena – e.g. frost effect and needle ice (Fig. 1) and structures like earth hummocks, solifluction lobes, ploughing blocks, rock streams (Fig. 2), rock glaciers and fossil soil stripes (Fig. 3) etc. Investigations were conducted on ERT, GPR, thermal conductivity, magnetic susceptibility, particle size analysis, water content, mineralogical and geochemical analysis.

Figure 1. Needles ice on Ștevia Valley, (Retezat Mountains, 04.10.2015 (Photo P. Urdea).

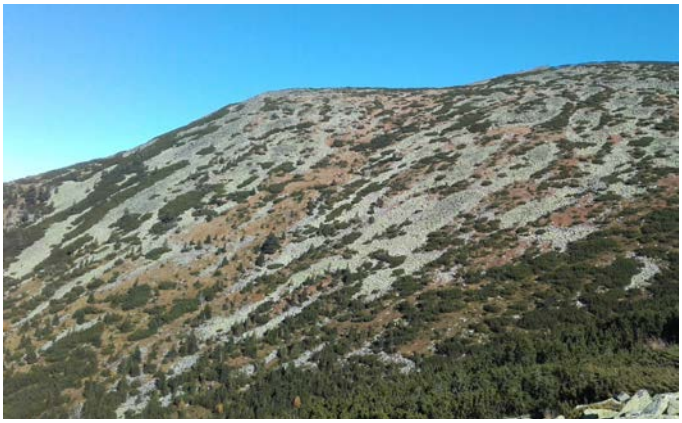

Figure 2. Rock streams on the Western slope on Valereasa Mountain, Retezat Mountains (Photo P. Urdea).

Figure 3. Fossil soil stripes cross-section on Paltina Mountain, Făgăraş Mountains (Photo P. Urdea).

Some of the results formed the basis for five papers, important for Romanian geomorphological community, by the novelty of the approach: 1. Onaca, A., Ardelean, A.C., Urdea, P., Ardelean, F., Sîrbu, F., (2015) Detection of mountain permafrost by combining conventional geophysical methods and thermal monitoring in the Retezat Mountains, Romania, Cold Regions Science and Technology 119, 111–123; 2. Șerban,R.D., Onaca, A., Urdea, P., Popescu, M. (2015), Multivariate prediction model for block streams occurrence in Retezat mountains (Southern Carpathians), Carpathian Journal of Earth and Environmental Sciences, 10, 1, 263 – 272; 3. Șerban, R.D., Sipos, G., Popescu, M.,Urdea, P., Onaca, A., Ladányi, Z. (2015) Comparative grain-size measurements for validating sampling and pretreatment techniques in terms of solifluction landforms, Southern Carpathians, Romania, Journal of Environmental Geography, 8, 1–2, 39–47; 4. Ardelean, A.C., Onaca, A., Urdea, P., Șerban, R.D., Sîrbu, F. (2015), A first estimate of permafrost distribution from BTS measurements in the Romanian Carpathians (Retezat Mountains), Géomorphologie, Relief, Processus, Environnement, 21, 4, 297-312; 5. Chiroiu, P., Stoffel, M., Onaca, A., Urdea, P., 2015, Testing dendrogeomorphic approaches and thresholds to reconstruct snow avalanche activity in the Făgăraş Mountains (Romanian Carpathians), Quaternary Geochronology, 27, 1-10.
Also, the undersigned made field investigations on the periglacial forms în Latoriţei Mountains (Southern Carpathians) and on relict periglacial forms in a middle mountain area of the Romanian Carpathians, like Poiana Rusca.

With excellent qualificatives, under the coordination of the undersigned, in the last year was sustained three PhD theses by R. Putan ,,Periglacial processes and forms in Capra basin, Făgărăs Mountains" (201 p.), P. Chiroiu ,,Dendrogeomorfological study on the slope processes in Northern-central area of Făgăraş Mountains" (235 p.), and A.C. Ardelean ,,Sediment budget quantification and denudation rate in Doam-

nei Valley (Făgăraş Mountains),(166 p.).

In 2015 the periglacial research team from Faculty of Geography, University of Bucharest (Răzvan Popescu, Mirela Vasile, Alfred Vespremeanu-Stroe, Nicolae Cruceru) performed a comparative study of low altitude permafrost sites from Central Europe and Romania with the aim to assess the role of slope, morphology and grain size of the deposits upon the efficiency of the chimney circulation and ground overcooling. Another goal was to evaluate the relation between chimney circulation and tree ring annual growth rates. Thus, several field measurements were applied including topographic survey, grain size quantification and dendrogeomorphologic investigations. New experiments using smoke generators were performed at Detunata Goală low altitude permafrost scree (Apuseni Mountains, Romania) in order to detect the underground air circulation paths during the cold. Frost weathering monitoring within the periglacial belt of the Romanian Carpathians continued in 2015. Hourly near-surface rock temperatures were continuously registered in about 20 locations, in order to obtain a multi-annual behavior of rock thermal regime and to assess the control factors that act on freeze-thaw magnitude.

Also, A. Munteanu (Bucharest University) and O. Pop (University ,,Babeş-Bolyai" Cluj-Napoca) analyzed the phenomenon of avalanches and falling rocks by means dendrogeomorfological and dendrochronological techniques in Piatra Craiului Mountains.
In September, at the University of Bucharest, was sustained two PhD theses by Mirela Vasile "Processes and forms of rock thermal weathering in areas from the Southern Carpathians and Măcin Mountains" and Răzvan Popescu ,,Phenomenology of permafrost in the Romanian Carpathians" and at University ,,Babeş-Bolyai" Cluj-Napoca, Roxana Văidean presented his PhD thesis ,,Middle and upper basin of Râu Mare, dendrogeopmorphological study'', focused on the debris flow phenomenon in three basins of Retezat Mountains.
Members of the West University of Timişoara teams attended with papers in a special sessions, P. 38 ,,Periglacial processes in high mountain environments" held at the European Geographical Conference EUGEO 2015 (Budapest, 30.08-02.09.2015. On the other hand a team from our university, Mircea Voiculescu, Marcel Török –Oance and Florina Ardelean, attend, together with four other institutions in Bucharest in the grant ,,Remote sensing, model and in-situ data fusion for snowpack parameters and related hazards in a climate change perspective (SnowBall)''

Report prepared by Petru Urdea (petru.urdea@e-uvt.ro)

19 Russia

Geocryological monitoring in undisturbed condition was continued. The 2015-results were submitted in the GTN-P Database. The 298 observatories contain several boreholes or soil temperature measurements. The 61 CALM-sites present different landscape condition.

Earth Cryosphere Institute

(ECI SB RAS) (Earth Cryosphere Institute, Siberian Branch, Russian Academy of Science, Tyumen) publishes the journal “Earth’s Cryosphere” (“Kriosfera Zemli”): http://www.izdatgeo.ru

The results of the most fundamental and advanced investigations, important results on the programs of the Earth Cryosphere Institute (ECI SB RAS) and of the many others Institutes and organizations specializing on permafrost/cryosphere researches are presented in the journal “Earth’s Cryosphere” (“Kriosfera Zemli”). The abstracts of the most interesting papers are submitted for the consideration of readers.

1) V.N. Golubev, D.M. Frolov. Pecularities of water vapor migration at snow cover–atmosphere and snow cover–ground boundaries

Lomonosov Moscow State University, Laboratory of Snow Avalanches and Mudflows, Department of Geography, 119991, Moscow, Leninskie Gory, 1, Russia; golubev@geol.msu.ru

Concentration gradient of water vapor in snow cover is determined by the presence of temperature gradient. The formation of water vapor concentration gradient on the boundaries of contacting media (snow cover– atmosphere and snow cover–underlying ground) is conditioned by the difference between water vapor content in pore spaces of snow and in boundary layers of atmosphere and ground. The result is the sublimation of ice grains and the migration of forming vapor. It has been demonstrated that the snow sublimation intensity under isothermal conditions depends on microstructure and varies from 42*10–8 kg/(m2*s) at –8 °C for ice and 40*10–8 kg/(m2*s) for snow with density 500 kg/m3 to 32*10–8 kg/(m2*s) for snow with density 160 kg/m3. Water vapor content in pore space of snow amounts to 1.08 at –22 °C and 1.045 at –5 °C in regard to its concentration defined by Clapeyron–Clausius equation. Consideration of water vapor transfer on the snow-ground boundary for isothermal conditions and at the presence of temperature gradient for sand and clay models has demonstrated that flux values range (8.0–39.3)*10–8 kg/(m2*s) (from ground to snow) and (1.0–2.5)× 10–8 kg/(m2*s) (from snow to ground).

2) S.M. Fotiev. Genesis and mechanism of formation of the layers of the repeatedly-injective ice

Earth Cryosphere Institute, SB RAS, 625000, Tyumen, P/O box 1230, Russia; kriozem@gmail.com

The typical features of the ice layers occurring in situ in the full sections of the marine sediments have been specified. The comparison of the mineralization and the chemical composition of the ice of the lacustrine and marine waters have proved that the ice layers had been saturated by the lacustrine waters. It was determined that the ice layers began forming only after the full sea regression and considerably later than the perennial freezing of the surrounding deposits. It has been ascertained that thick ice layers cannot be formed during the process of segregational accumulation. The leading role of the process of injective ice accumulation during the formation of the thick layers of the ultrafresh ice inside the strata of the frozen deposits have been proved. The source “feeding” the ice layer occurred to be not inside but outside the surrounding deposits. The conditions of penetration of the lacustrine waters into the strata of the frozen deposits and the layerwise formation of the ice layers have been examined. It was revealed that the delivery of the water from lake to ice layer and its transportation to enormous distances was provided by the huge cryogenic pressure occurring during ice freezing inside the closed lake depression.

3) D.G. Shmelev. Role of cryogenese in the formation of composition of the Late Quaternary deposits in Antarctic oasis and North East Yakutia

Lomonosov Moscow State University, Department of Geography, 119991, Moscow, Leninskie Gory, 1, Russia; shmelevdenis_msu@mail.ru ; Institute of Physicochemical and Biological Issues in Soil Science, RAS, 142290, Moscow region, Puschino, Russia

The pioneer data obtained by the Cryology Laboratory of the Institute of Physicochemical and Biological Issues in Soil Science from Antarctic oasis and North East Yakutia are analyzed in the paper. Two different types of cryogenic weathering have been distinguished on the basis of analyzes of current temperature regime of active layer and features of deposit composition. The detailed investigations of the Late Quaternary deposits of North East Yakutia and Larsemann Oasis (Antarctica) have ascertained the cyclic structure of cryolithogenic strata caused by the changes in the environmental conditions during sedimentation. It was established that the most favorable conditions for cryogenic weathering had occurred at the Late Pleistocene–Holocene terms for the examined regions.

4) S.S. Kutuzov, I.I. Lavrentiev, E.V. Vasilenko*, Y.Y. Macheret, D.A. Petrakov, G.V. Popov**** Estimation of the Greater Caucasus glaciers volume, using radio-echo sounding data and modelling

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* Institute "Academpribor" NAN Uzbekistan, 100125, Tashkent, Durmon Yuli str., 28, Uzbekistan
** Lomonosov Moscow State University, Department of Geography, 119991, Moscow, Leninskie Gory, 1, Russia

The results of ice-thickness measurements and modelling of the Greater Caucasus glaciers, using radio-echo sounding data, GlabTop model and satellite imagery, are presented and discussed. Ground and airborne radioecho sounding measurements were conducted at selected Caucasus glaciers, including the biggest Bezengi glacier, reference glaciers Djankuat and Marukh as well as glaciers of the southern and eastern slopes of Mt. Elbrus in 2011–2013. The GlabTop model was calibrated using the measured ice-thickness data and ice-thickness and bedrock topography maps were completed for 224 glaciers (13 %) which cover 719 km2 or 64 % of the total glacier area in Caucasus. New dataset of the Caucasus glaciers outlines was completed using available satellite imagery. There were 1713 glaciers with the surface area of (1121 ± 30) km2 in Caucasus in 2010–2013. Obtained data were used to calibrate volume-area scaling relationship and to calculate the total volume of Greater Caucasus glaciers which is (43.5 ± 5.0) km3.

5) J.B. Gorelik, P.V. Soldatov, A.A. Seleznev. Engineering and geocriological conditions of the Yamburg gas and condensate reservoir and dynamics of the ground state of boreholes

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Engineering and geocriological conditions of the Yamburg gas and condensate field are considered from the point of view of their impact on the operational reliability of the production wells and on the state of the soil near the wellhead area. The results of the previous permafrost's researches have been significantly supplemented after the drilling of special permafrost parametric wells of 250 m depth and the permafrost core examination, custom-made by NTF "Krios" in the period from 2004 to 2005 (the customer is CoLtd "Gazpromdobycha Yamburg"). According to its construction characteristics (ice content, thaw factor) the field ground occurring below than 10–15 m has a low coefficient of subsidence during thawing and is favorable for building. Nevertheless, regardless of the exploitation time of wells, disorders occur on the well pads due to the ground subsidence and atypical loss of stability of individual wells. The nature and dynamics of these disorders are discussed in the article in relation to the properties of deposit frozen ground.

6) V.P. Melnikov, A.V. Brouchkov*, A.N. Khimenkov** On the development of fundamentals of geocryology

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** Sergeev Institute of Geoecology, RAS, 101000, Moscow, Ulansky per., 13, build. 2, Russia; cryo@geoenv.ru

There is an objective requirement of further improvement of the cryolithozone formation theory. Some methodological approaches to studing of the bases of cryostratigraphy, including the development of criteria for definition of the cryostratigraphical horizons and techniques for allocation of local and territorial cryostratypes, are considered. Need for further development of the permafrost-facial analysis in relation to epigenetical permafrost offered by E.M. Katasonov is proved. The importance of studying live substance in cryolithozone is designated.

7) A.I. Kizyakov*, A.V. Sonyushkin, M.O. Leibman***, M.V. Zimin**, A.V. Khomutov***.** Geomorphological conditions of the gas-emission crater and its dynamics in Central Yamal

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**ScanEx Research and Development Center, 119021, Moscow, Berezhkovskaya embank., 20/10, Russia
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This paper presents the characteristics of the relief within the area of crater formation in Central Yamal, based on the analysis of remote sensing data, including stereo-pair very high resolution data as well as field observations. Time interval of the crater formation was defined as late fall 2013. Data on the morphology of the studied area before and after the crater formation were obtained. The existence of the bulge with the base diameter 45–58 m and height of about 5–6 m in place of the crater was documented. Analysis of multi-temporal digital elevation models

allowed calculating the volume of the crater and the parapet formed around it. The volume of discharged material is almost 6 times larger than the volume of material found in the parapet. The difference is due to a significant amount of ice that, according to the results of field observations, is exposed in the walls of the cylindrical portion of the crater, and, apparently, comprised a major part of bulge material that thawed after ejection. The rate of the crater increase in diameter due to melting of its ice walls and the rate of its filling with water over the summer period were determined.

8) A.S. Victorov, V.N. Kapralova, O.N. Trapeznikova. Mathematical model of the lacustrine-thermokarst plain morphostructure under the changing climatic conditions

Sergeev Institute of Environmental Geoscience, RAS, 101000, Moscow, Ulansky per., 13, build. 2, Russia; dist@geoenv.ru

The aim of the paper is theoretical and empirical substantiation for a new model of developing the morphological pattern for thermokarst lacustrine plains taking into account the climatic changes. The model is based on the approach of the mathematical morphology of landscape, using the random process theory. The researches have resulted in the mathematical model for the morphological pattern of uniform thermokarst lake plains changing under climatic changes in case of isometric lakes. It has been demonstrated analytically that under the climatic changes the distribution of thermokarst lake areas should obey the lognormal distribution at any time, and their spatial distribution should obey the Poisson distribution for the different physiography and permafrost conditions. These conclusions agree with empirical testing of key areas with different physiography, geology and permafrost conditions.

9) I.D. Streletskaya*, A.A.Vasiliev, G.E. Oblogov**, I.V. Tokarev*****. Reconstruction of paleoclimate of Russian Arctic in Late Pleistocene–Holocene on the basis of isotope study of ice wedges

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*** Resources center “Geomodel” of Sankt-Petersburg State University, 198504, St.-Petersburg, Ulyanovskaya str., 1, Russia
Paleoclimate of the Russian Arctic has been reconstructed based on the isotope composition (δ18O) of ice wedges. All available data on isotope composition of syngenetic ice wedges with determined geologic age have been analyzed. Spatial distribution of δ18O values has been analyzed by the present time, as well as MIS 1, MIS 2, MIS 3, and MIS 4. Trend lines of spatial distribution of δ18O for different time periods are almost parallel. Based on the data on isotope composition of ice wedges of different age, winter paleotemperatures have been reconstructed for the Russian Arctic and their spatial distribution has been characterized.

10) Yu.B. Badu. Ice content of cryogenic strata in gas-bearing structures on the Northern Yamal

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Investigation of the ice content of the ground in the cryogenic sections of the gas¬bearing structures (Northern Yamal) has been carried out. The differences in salinity due to the conditions of accumulation and freezing of the sediments in Late Pleistocene have been revealed. The value of the pore water mineralization, at which ice-segregation occurs in disperse ground, has been determined.

11) G.Z. Perlshtein, G.S. Tipenko, A.V. Levashov*
Prospect of the atmospheric heat utilization on permafrost territory

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Effects of the film water heater is analyzed theoretically. Calculation researches were accomplished on the basis of generally accepted design equations. unique dependence has been established between the water heating rate and the temperature on its surface. This important conclusion allows us to significantly simplify the numerical modelling procedures. Accomplished calculations show high prospects of the simplest water heater on the russian permafrost territory.

12) V.A. Dubrovin, L.N. Kritsuk, E.I. Polyakova*
Temperature, composition and age of the Kara Sea shelf sediments in the area of the geocryological station Marre-Sale

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The results of studying the upper 20 m-thick Near-Yamal bottom shelf sediments, stripped in May 2014 by two boreholes of VSEGINGEO, have been presented. The boreholes were equipped with the loggers LPC for monitoring observations of temperature regime dynamics in the bottom sediments. This was necessary in connection with the prospective development of hydrocarbon deposits in the shelf. The results of the temperature change for three summer months of 2014 have been obtained. It has been revealed that the marine aleurolitous clays and aleurolites represent relict frozen strata subjected to cryogenic metamorphization in the subaerial conditions. The diatomic complexes of clayey soils consist exclusively of marine extinct species typical of the Early Eocene Pyxila gracilis diatom zone. A complex of modern marine sublittoral diatoms has been found in the sands of the near-shore borehole upper part.

13) V.V. Olenchenko, A.I. Sinitsky*, E.Y. Antonov, I.N. Eltsov, O.N. Kushnarenko, A.E. Plotnikov, V.V. Potapov, M.I. Epov. Results of geophysical researches of the area of new geological formation "Yamal crater"

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Results of the field survey and geophysical observations on the area of the rare geological objects known as "Yamal crater" have been presented and discussed. The purpose of the research was to determine the origin of the crater. In 2014, permafrost and geomorphological observations, sampling of soil, water, geodetic and geophysical surveys were carried out. As a result, the absence of radiation anomalies has been revealed. It has been demonstrated that the crater is situated within the limits of the circular negative anomalies of the magnetic field, nearby the intersection of the linear negative anomalies of the magnetic field. It was found that the crater occurs at the junction of geoelectrical structures, and the geophysical showings of the horizon saturated with gas-hydrates have been detected at a depth of 60–80 m. It is suggested that both the abyssal migratory gas and the gas-hydrate decomposition could be the source of the gas. It was shown that the pingo existed on the place of the crater. The problem of identification of the hazardous pingo has been stated. This problem can be solved by complex investigations, including permafrost and geophysical surveys as well as drilling. Yamal crater, pingo, permafrost, gas, gas hydrate, fault, geophysical methods, geoelectric section, electrical resistivity tomography, electromagnetic sounding.

14) L.T. Shirshova, D.A. Gilichinsky, N.V. Ostroumova, A.M. Yermolayev. Application of spectrophotometry for quantification of humic substances in the permafrost sediments

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The application of spectrophotometry for determining the chromophoric humic substances content in permafrost sediments has been discussed. Strong linear correlation between the content of chromophoric humic substances and the content of organic carbon in the humic fractions isolated by the sequential resin-alkali extraction procedure has been revealed. Rapid non-destructive spectrophotometric method can be used when monitoring the state of humic substances stored in frozen strata.

15) E.A. Bondarev, I.I. Rozhin, V.V. Popov*, K.K. Argunova. Assessment of possibility of natural gas hydrates underground storage in permafrost regions

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*Ammosov North-Eastern Federal University, 677000, Yakutsk, Belinskogo str., 58, Russia

An approach to assessment of possibility of the construction of natural gas hydrate underground storage in appropriate geological structures has been proposed. It is based on the mathematical model of multiphase real gas and water flow in porous media. The model takes into account the transformation of gas and water into hydrate at certain temperature which depends on gas flow pressure. The dynamics of hydrate and water saturation as well as the pressure and temperature fields in a reservoir with given porosity, permeability and initial values of pressure, temperature and water saturation has been studied. An implicit finite-difference scheme is used to approximate the original boundary-value problem. The finite-difference equations have been solved using simple iteration and sweeping algorithms. Some examples of calculations corresponding to real cases are given. Calculations have revealed that the final result strongly depends on the porosity and permeability of a reservoir. Further efforts are needed to estimate the role of heat exchange with surrounding rocks.

CONFERENCE

Earth Cryosphere Institute (ECI SB RAS) in the period July 02-05, 2015 (Tyumen, Russia) has successfully held the International conference «Arctic, Subarctic: mosaic, contrast, variability of the Cryosphere», which was attended by 170 scientists representing the leading scientific organizations from Russia, Europe: http://www.ikz.ru/conference2015

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

1. Main research results 2015

1. Studies by the MPI Laboratory of General Geocryology and Kazakhstan Alpine Permafrost Laboratory established a new genetic type of dynamic periglacial landforms – partially thawed ice-rubble-silt rock glaciers widespread within the mountain permafrost zone of Europe and Central Asia (Fig. 1). An integrated study of the Gorodetsky glacial-periglacial complex in northern Tian-Shan, employing ERT, GPR, thermometry and meltwater isotopic analysis, has shown that this rock glacier has a thawed bed and consists of blocks of metamorphic ice separated by thaw zones of intense seepage flow.

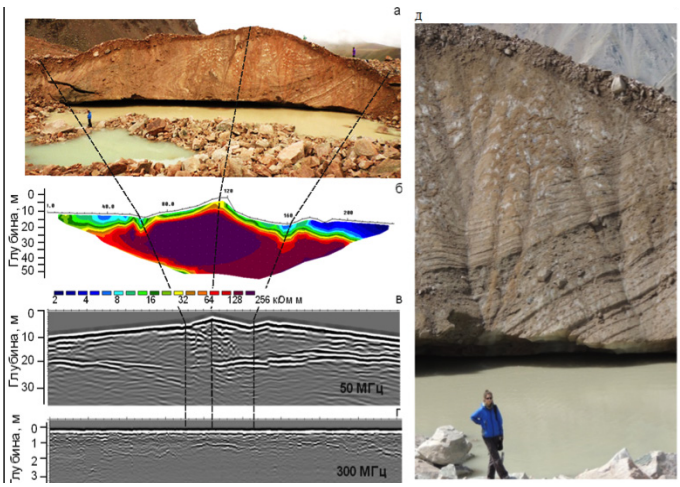
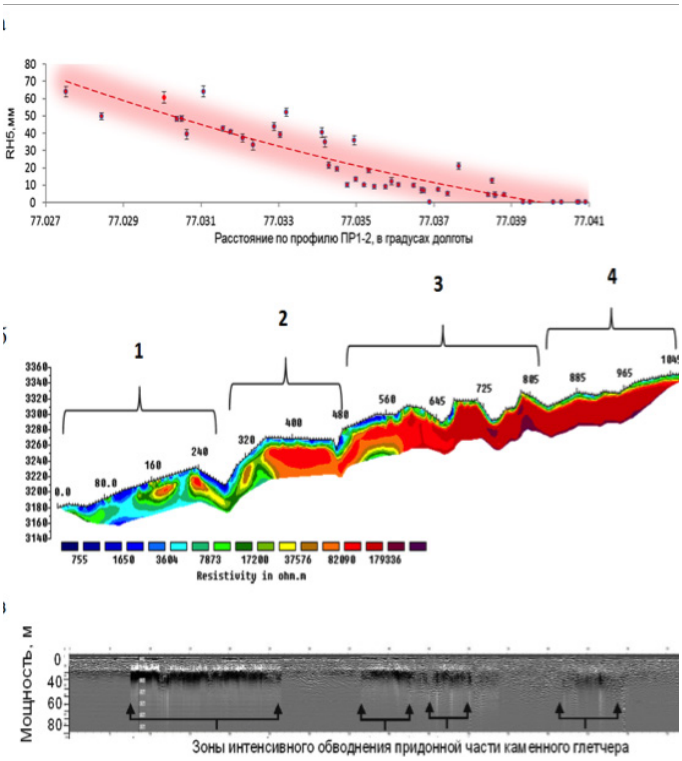


Figure 1. Results of the Gorodetsky rock glacier study (northern Tian-Shan):
A) Block of fossil metamorphic ice; b) resistivity profile; c-d) radar sections obtained at different frequencies; e) metamorphic folding of the ice block.



B): a, b, c) 1-km-long integrated profile along the rock glacier axis; a) relative age in RH5, b) resistivity (formations of different age: 1-2- active, thawed, 1-4 – passive, young); c) radar section.

2. Monitoring studies conducted by the Laboratory of General Geocryology and the Laboratory of Groundwater and Geochemistry indicate an increase in upper permafrost temperatures due to climate warming. In Yakutsk, permafrost temperatures have warmed by 3°C over the last 80 years (Fig. 2). As a result, significant changes in geocryological conditions are taking place in near-surface permafrost. The formation of multi-layered cryopegs has been observed in Yakutsk (Fig. 3). The dynamics of cryopeg levels and chemical composition suggest that frozen soils separating the cryopeg layers have transformed into a thawed state. Such transformation of the geocryological conditions in northern cities of Russia significantly reduces the bearing capacity of frozen foundations, increasing damage and accident rates.

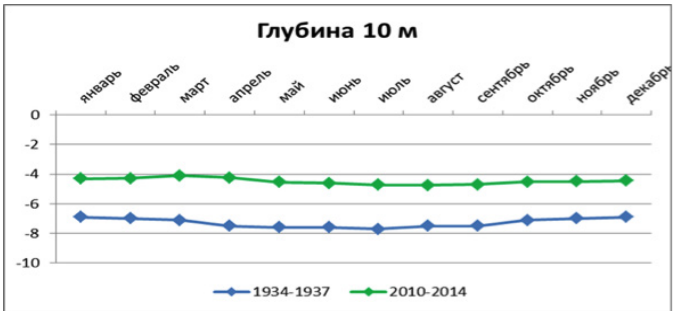


Figure 2. Curves of permafrost temperature at 10 m depth for the periods 1934-1937 and 2010-2014 for an urban site, Yakutsk.

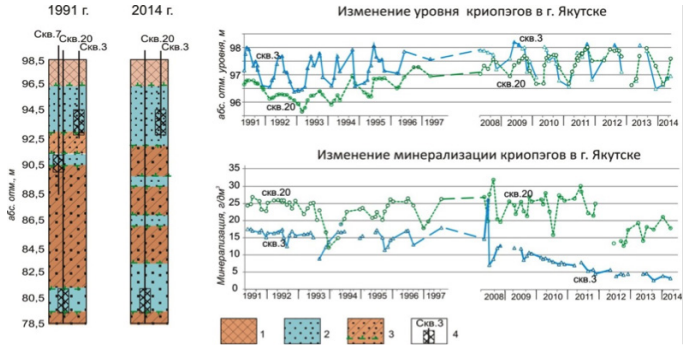


Figure 3. Logs showing the position of cryopeg layers and curves demonstrating the dynamics of cryopeg levels and dissolved-solids content.
1 – active layer consisting of sandy silt and silt; 2 – cryotic sands saturated with saline water (cryopegs); 3 – perennially frozen sands; 4 – observation well and filter interval.

3. Based on data about the structure of subsea permafrost in the Laptev Sea shelf, two-dimensional physical-mathematical models were developed by the Laboratory of General Geocryology simulating the geocryological conditions in the shelf for different time slices of the Late Pleistocene.
During the Late Neopleistocene and Holocene, permafrost degradation occurred mainly from below. Maximum subaerial freezing of the sediments reached 800 m, while upper permafrost temperatures were as slow as –18 to –19°C (Fig. 4a).
The postglacial marine transgression caused a further reduction of permafrost thickness, by 150–200 m in its lower horizons and by 30–60 m from the top, due to increased temperatures in the near-bottom sediments and diffusion of sea salts (Fig. 4b).

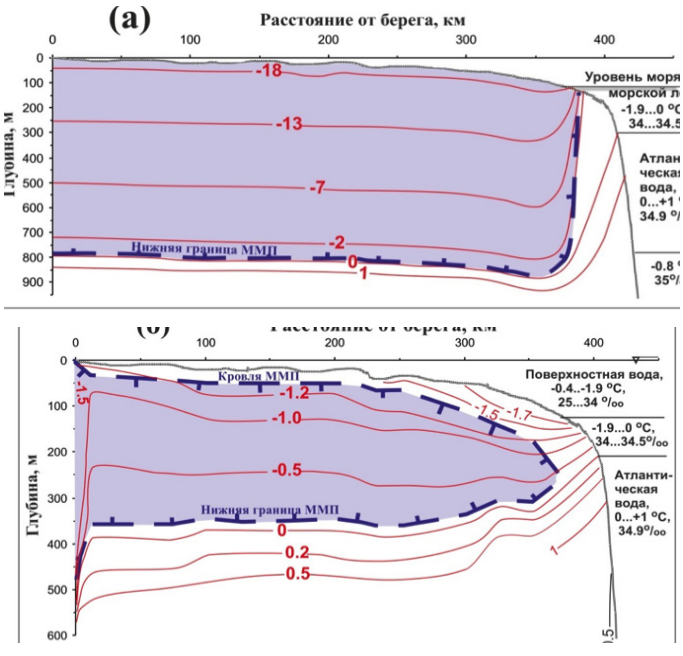


Figure 4. Physical-mathematical models of Laptev subsea permafrost evolution
(a) – subaerial freezing stage which lasted from 117 kya to 50 kya. Permafrost conditions are shown for the end of this freezing stage; (b) – end of the last regression-transgression cycle in the Arctic basin.

2. Meetings and expeditions

1. An important event in 2015 was the XXI Conference on Groundwater in Siberia and Far East held in Yakutsk from 22-28 June. The conference hosted by MPI was organized as part of the Federal Target Program 2010-2015: Clean Water and marked the 60th year since the first forum of Siberian hydrogeologists was organized. In all, 122 papers were submitted to the conference, authored and co-authored by 267 researchers and practitioners from St. Petersburg, Moscow, Perm, Yekaterinburg, Tyumen, Novosibirsk, Tomsk, Krasnoyarsk, Irkutsk, Chita, Khabarovsk, Vladivostok, Petropavlovsk-Kamchatsky, Anadyr, Yakutsk, Neryungri, Mirny, Khandyga, and Deputatsky. Foreign participants represented Japan, Republic of Korea, and China.
The plenary and oral sessions were attended by 120 delegates. All papers submitted to the conference were published in: Alekseev S.V. and Shepelev V.V. (eds.). 2015. Fundamental and Applied Problems in Hydrogeology, Proceedings of the National Conference on Groundwater in Eastern Russia (XXI Conference on Groundwater in Siberia and Far East with International Participation), Yakutsk, June 22 – 28, 2015. Yakutsk: Melnikov Permafrost Institute SB RAS Press, 552 pp.

Figure 5. Plenary session, XXI Conference on Groundwater in Siberia and Far East, June 2015,

Yakutsk.

2. Several field campaigns were undertaken by MPI in 2015, some of them in cooperation with foreign partners. An expedition was organized to Makhatta Tukulan, a large active dune massif on the Vilyui River, 20 km upstream from the town of Kysyl-Syr, central Yakutia. The program of the Kysyl-Syr expedition included geomorphological and landscape investigations. Twelve key sections were described and about 400 samples collected for grain-size, mineralogical, spore pollen, geochemical, radiocarbon dating and micromorphological analyses. A full-length documentary film, "Tukulans – Pleistocene Cryodeserts in Yakutia", was shot during the expedition.

Figure 6. Shooting a documentary film about tukulans, July 2015, Kysyl-Syr.

3. Another highlight of the last summer season was the Fourth Forum for Young Permafrost Scientists organized by MPI from 29 June to 12 July. This event commemorated the 200th birthday of Alexander von Middendorff, a Russian naturalist and explorer who pioneered scientific research on permafrost. The Forum included a three-day conference in Yakutsk attended by early career scientists and students from Moscow, Novosibirsk, Tyumen, St. Petersburg, Vladivostok, Chernyshevsky, and Seoul. The conference was followed by a field workshop which focused on frost-related forms and processes along federal roads in Central Yakutia, with special emphasis on the causes and dynamics of slope processes at KP 450 of the Lena Federal Road.

Figure 7. Field workshop participants at Buluus icing, central Yakutia.

3. Publications

Theoretical, experimental and field investigations carried out by MPI researchers resulted in 280 publications, including four monographs:
- Makarov V.N. (2015). Arsenic in the Biosphere of Yakutia. Novosibirsk: Academic Publishing House "Geo", 93 pp.
- Makarov V.N., Sedelnikova A.L. (2015). Environmental Geochemistry of Yakutsk Urban Lakes. Yakutsk: Melnikov Permafrost Institute Press, 232 pp.
- Medeu A.R., Akiianova F.Zh., Beisenova A.S., Blagoveshchenskii V.P., Kunaev M.S., Malkovskii I.M., Nurmambetov E.I. (2015). Atlas Mapping in the Republic of Kazakhstan. Almaty: Institute of Geography Press, 261 pp.
- Shesternev D.M., Verkhoturov A.G. (2015). The Geological Medium of Mineral Resources in Trans-Baikalia Under Changing Climate. Chita: Trans-Baikal University Press, 227 pp.

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

In 2015 Cryolithology and Glaciology Department fundamental studies on the impact of natural and technogenic factors on cryolithozone and glaciosphere been conducted.

New approach to the analysis of mineral loess substance genetic nature was proposed. Its distribution is almost identical to the area of cryolithozone in the Pleistocene. The map of distribution of loess, loess-like minerals in modern and Pleistocene cryolithozone was made for the first time (authors – V.N. Konishchev, N.A. Koroleva).

Field and laboratory researches determined the spatial distribution of the content of O18 isotopes in modern and more ancient ice wedges that were formed in the Russian Arctic during MIS 1, MIS 2, MIS 3, MIS 4. The research showed that, since 60,000 ye-

ars ago until the present time, features of atmospheric transfer in the north of Eurasia, in general, has not changed (I.D. Streletskaya et al.). The isotopic composition of methane and massive ice bed in Yamal clearly indicated its bacterial origins and formation in situ.

Features of cryogenic strata such as geocryological structure, thickness, temperature and ice content above gas-bearing deposits of the Yamal Peninsula (north of Western Siberia) were analyzed. Geocryological classification for these gas-bearing structures was developed for the first time (Yu.B. Badu).

Concept of geo-ecological parameters for the sustainability of permafrost landscapes to the mechanical loads was established. Map on a scale of 1: 20 000 000 called „Seasonal thawing and freezing of the territory of Russia“ was compiled to assess the impact of natural factors on the geo-ecological state of cryolithozone (N.V. Tumel', L.I. Zotova, N.A. Koroleva, S.Yu. Dedyusova).

For example, the Norilsk region, one of the largest industrial region in the cryolithozone. After analyzing temperature fields of around 800 permafrost basements having cold ventilated cellars, it was found out that 55% of the besaments tend to experience permafrost degradation, 25% - permafrost buildup, 20% preserved preconstruction thermal state (V.I. Grebenets). Map on a scale of 1: 15 000 000 called "Activization of dangerous engineering cryogenic processes in cities and settlements of cryolithozone of Russia" (V.I. Grebenets).

Geographic information system was developed for Kolka glacier and Karmadon Basin, where in 2002 there was a famous catastrophe with human losses and massive destruction. It was determined that from 2004 to 2014, against the background of unfavorable climate conditions (for the Caucasus glaciation), about 30 million m3 of ice accumulated in the cirque of Kolka glacier. As a result, the glacier front has advanced by 800 meters (D.A. Petrakov et al.). This is the only case of significant advance of glaciers in the Caucasus in the XXI century.

Regime investigation of the dynamics of seasonal thawing (International Program CALM – Circumpolar Active Layer Monitoring), that began in 2004, continued on the experimental site near Talnakh (south of the Taimyr peninsula) and in Lorino (settlement on Chukotka) (V.I. Grebenets, A.A. Maslakov). The data on the reaction of permafrost to a very cold but abnormally long summer of 2015 was obtained. This year average depth of soil thawing in Talnakh region will exceed by 15 % compared to the average value of many years.

In July 2015 in Igarka and Norilsk region were held regular International field student's courses on permafrost, which was attended by younglings from Russia, USA, Germany and France (courses are conducted by docent of Lomonosov Moscow State University V. Grebenets and master of The George Washington University K.E. Nyland).

******* Geocryology Department, Geology Faculty, Lomonosov Moscow State University**

Geocryology department of the Lomonosov Moscow State University in 2015 has been developing the revised digital edition of the permafrost map for Russia 1:2 500 000. The studies have been focused on the European North, Western Siberia and Yakutia. The original 3D software for thermal calculations was tested. A possibility for simultaneous numeral modeling of heat and water flows during freezing is now considered. Arctic shelf permafrost was studied by geophysical methods for Laptev and Kara seas. A new data on underground ice on the Arctic islands have been received. Monitoring site on Baydara bay was used to study thermal mode of permafrost, coastal erosion rates and properties of frozen soils. Methane content of permafrost deposits has been studied in Western Siberia and Central Yakutia, as well as microbial communities in samples of permafrost deposits. Mechanical and thermal properties of frozen grounds was studied for major pipelined projected in the country. A new and revised edition of the Permafrost Forecast textbook (1974) has been completed for publishing. A master program in English on permafrost studies for foreigners is announced for 2016.

******* Sergeev Institute of Environmental Geoscience RAS (Moscow)**

Geocryological monitoring in undisturbed condition was continued. The 2015-year data were submitted to the GTN-P database. Sergeev Institute of Environmental Geoscience RAS supports 11 monitoring TSP-sites and 2 CALM-sites in Northern Transbaicalia Region (Chara). Also the activity of geocryological processes in Olkhon Island was estimated in cooperation with Institute of Earth Crust SB RAS, Irkutsk (Fig.1). IEG RAS participated in Moscow State University post-graduate student training combined with permafrost monitoring in Vorkuta Region (Fig. 2, 3). The cooperation with Melnikov Permafrost Institute SB RAS opened new horizons of long term permafrost investigation in Igarka (Middle Siberia).
The new program of common investigations of Arctic surface (rivers) and underground water discharge with Institute of Water Problems RAS was drawn up. The comparative analysis of Yamal Craters formation hypotheses with future investigation plan was

developed.

Figure 8. Cryogenic landslides at Olkhon Island (Baical Lake). The photo was taken by using the radio-control quadrocopter.

Figure 9. Boring in Vorkuta Tundra.

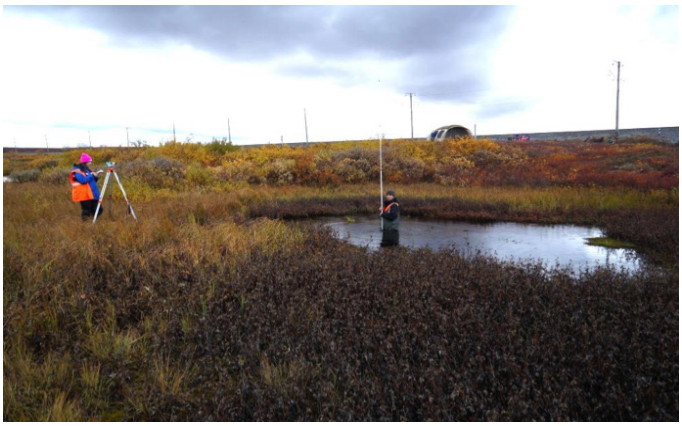


Figure 10. Measurements of the thermokarst lake's depth in Vorkuta Tundra.

******* Institute of Physicochemical and Biological Problems in Soil Science, RAS (Soil Cryology Laboratory)(Pushchino, Russia)**

Permafrost Microbiology

1. It was announced that the Mollivirus sibericum, a fourth type of giant virus isolated from the permafrost sample where last year another giant virus Pithovirus sibericum was discovered. These four types of giant virus exhibit different virion structures, sizes (0.6–1.5 μm), genome length (0.6–2.8 Mb), and replication cycles. Their origin and mode of evolution are the subject of conflicting hypotheses. The fact that two different viruses could be easily revived from prehistoric permafrost should be of concern in a context of global warming. This is the result of joint work of the Soil Cryology laboratory and our french colleagues from Institut de Microbiologie de la Méditerranée.

2. Viable amoeboid protists were isolated from the Arctic Late Pleistocene and Holocene permafrost sediments many of them belong to new species. The diversity of amoebae in the permafrost is rather low in comparison with that of modern tundra soils. The genus Acanthamoeba appears most widespread in the permafrost sediments under study. The amoebae under study are stable with reference to stressful effects; the cysts of fossil amoebae examined successfully survived under conditions of the free space.It is shown that, in the permafrost, along with viable prokaryotes, eukaryotic microorganisms are also preserved and, like remains of rigid skeletal structures, provide evidence of the existence of ancient ecosystems. Although the taxonomic diversity of amoebae in the permafrost is relatively low, they include not only new species of known genera, but also new taxa of higher rank. The resistance of cysts of protists from permafrost makes them a promising model for the study of the cryptobiosis in eukaryotic organisms and for further experiments both in the space and on the Earth.

3. We performed a result of comparative analysis of the two permafrost samples isolated from lake sediments and ice complex with utilization of metagenomic sequencing approach. We have shown that the presence of methane in one sample and its absence in the second are associated with the prevalence of the certain groups of microorganisms and their corresponding genes. The possible scenario of the development of both Yedoma and lake sediments can be proposed on the basis of these findings. Analysis of metagenome from IC4, a sample of the lake sediments, demonstrated occurrence of many physicochemical reactions such as denitrification, iron reduction and sulfate reduction, which could reduce environmental redox potential and ultimately create favorable conditions for development of methanogenic community and methanogenesis. As reflected from the composition of IC8 metagenome, the sporadic occurrence of such physicochemical reactions brought to deficiency of methanogenic activity and lack of biogenic methane in the late Pleistocene ice complex on Kolyma-Indigirka lowland. The obtained results demonstrate that the metagenomic analysis of permafrost microbial communities can represent a valuable instrument for paleo-reconstruction of conditions under which the permafrost sediments were

formed in geological perspective.

Permafrost Astrobiology

4. The permanently frozen volcanic sediment is one of the most promising geological objects for searching life on Mars. On Earth, volcanic intrusions into permafrost result in formation of the unique microbial communities. We propose several terrestrial analogues of Martian polar volcanoes, such as the permanently frozen volcanic sediments on the Kamchatka peninsula and in Antarctica. The present study shows applicability of the morphometric analysis for demonstration of the morphological similarity between the terrestrial and Martian cinder cones. In the present work, the morphometric analysis of young Martian landforms is based on the assumption that the conical structures identified on digital terrain model (DTM) are volcanic cinder cones. Morphometric analysis of the studied cones showed a range of degradation. The extent of degradation may be an indicator of age based on comparison with volcanic cinder cones on Earth. A morphometric analysis of potentially young volcanic cones in the North Polar Region of Mars was performed to estimate their relative age. The 14 potential cinder cones were identified using the DTM provided by Mars Express High Resolution Stereo Camera (HRSC), allowing for the basic morphometric calculations. The majority of the cinder cones are localized in the Chasma Boreale region within the area 79°–81°N and 261°–295°E. The calculated morphometric parameters showed that the cone average steepness varied from 3.4° to 11.8°, cone height-to-width ratio varied from 0.025 to 0.12, and the ratio between surface and basal area of the cone varied from 1.005 to 1.131. The studied cinder cones were classified with respect to the morphometric ratios assuming that larger values correspond to the younger structures. Employing the terrestrial analogy of morphometric ratios as a proxy for relative geological age, we suggest that existing microorganisms may be found in permafrost of young Martian cinder cones.

Permafrost Soil science

5. For the first time the soil mapping of 29% the ice-free area of Antarctica carried out. It was characterized the soil taxa . The leading role of the factors of area drainage, nanorelief formation, activity cryoturbation in the formation and development of the tundra CRYOSOL was found.

Conference

In the period from September 27 to October 1, 2015 Soil Cryology laboratory has successfully held the International conference «Permafrost in XXI century: basic and applied researches», which was attended by 90 scientists representing the leading scientific organizations from Russia, USA, Germany: http://cryosol.ru/news/163-permafrost-conference-is-over.html

Most important publications 2015:

Legendre, Matthieu, Lartigue, Audrey, Bertaux, Lionel, Jeudy, Sandra, Bartoli, Julia, Lescot, Magali, Alempic, Jean-Marie, Ramus, Claire, Bruley, Christophe, Labadie, Karine, Shmakova, Lyubov, Rivkina Elizaveta, Coute, Yohann, Abergel, Chantal, Claverie, Jean-Michel. In-depth study of Mollivirus sibericum, a new 30,000-y-old giant virus infecting Acanthamoeba, // PNAS, 2015, 112 (38): E5327-E5335.

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Gilichinsky, Michael; Demidov, Nikita; Rivkina, Elizaveta. Morphometry of volcanic cones on Mars in perspective of Astrobiological Research // INTERNATIONAL JOURNAL OF ASTROBIOLOGY, 2015, 14(4): 537-545.

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Krivushin K, Kondrashov F, Shmakova L, Tutukina M, Petrovskaya L, Rivkina E. Two metagenomes from Late Pleistocene northeast Siberian permafrost. GENOME ANNOUNCEMENTS, 2015, 3(1), 1-2.

Rivkina E. , L. Petrovskaya, T. Vishnivetskaya , K. Krivushin, L. Shmakova , M. Tutukina, A. Meyers, F. Kondrashov. Metagenomic analyses of the late Pleistocene permafrost – additional tools for reconstruction of environmental conditions // BIOGEOSCIENCES DISCUSS., 2015, 12: 12091–12119.

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Report prepared by Elena Andreeva (kriozem@gmail.com)

20 South Korea

CAPEC Project (PI: Bang Yong Lee)

The CAPEC (Circum Arctic Permafrost Environment Change Monitoring) Project, supported by Korea Ministry of Science, ICT and Future Planning, has been continued since 2011. Through this project, we plan to establish Arctic monitoring nodes to study environmental changes and develop the state-of-the-art observation techniques for terrestrial permafrost region. This monitoring project includes atmosphere-pedosphere-biosphere monitoring system with Ubiquitous Sensor Network (USN) and GPS monitoring. The research aims of this project are (1) to understand the correlation between carbon dioxide (CO2) fluxes and soil properties; (2) to estimate the contribution of microbial respiration, and plant photosynthesis and respiration to the CO2 production from soil; (3) to understand the geophysical and mechanical behavior of frozen ground correlated with environmental change. On the basis of the CAPEC project, we had two Arctic explorations this spring and summer: Council, Alaska; and Cambridge Bay, Canada.

CAPEC project in Council, Alaska

We have operated the eddy-covariance flux system and 4-component radiometer at the Council site, during the summer period to monitor NEE (Net Ecosystem Exchange of CO2) over Alaskan permafrost region. Spatial variation of NEE was also measured using a manual chamber system with 9×9 grids on a monthly basis from July to September. In addition, thaw depths at multiple points were manually measured using a probe once in July, August, and September. Likewise, plant activity was monitored using a camera and NDVI sensors throughout the year. Researchers from Seoul National University joined the field campaign to measure physical properties and photosynthetic characteristics of permafrost vegetation.

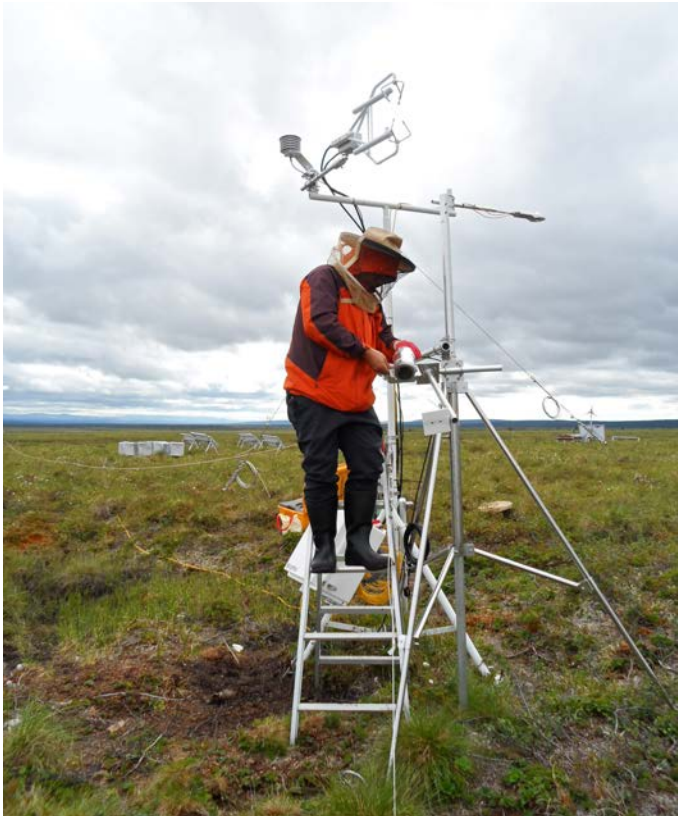

Figure 1. Eddy-covariance system for green-house-gas (CO2, H2O) flux measurement at Council, Alaska

Figure 2. In-situ measurement of photosynthetic activity of permafrost vegetation at Council, Alaska in July, 2015

CAPEC project in Cambridge Bay, Canada

The Arctic ecosystem is undergoing dramatic changes due to climate change. Since 2012, through long-term monitoring of the Canadian Arctic tundra, changes in ecosystem structure and function have been examined. The study aims to observe the effects of climate warming and increased precipitation on the structure and functioning of plant and soil microbes.

The study site is Cambridge Bay (69°07′48″N and 105°03′36″W) which is located on the southeast coast of Victoria Island, Nunavut, Canada. Aver-

age temperature is 4.2°C and -23.8°C in summer and winter, respectively. Precipitation is low with an average precipitation of 140 mm annually. This area is classified as prostrate dwarf-shrub, herb tundra (CAVM Team, 2003) with vegetation dominated by small prostrate shrubs (Dryas spp.) and sedges (Carex spp.). The climate manipulation experiment was conducted with summer warming and increased precipitation both separately and combined. Hexagonal 2 m-diameter open-top chambers (OTCs) were established to increase air temperature of 1-2°C and 2 L of water was added to sites every week to manipulate the increased precipitation of additional 4 mm per year. The manipulation experiment was conducted during summer season from late June to early October each year. Changes in plant and soil microbial community structure as well as soil ecosystem functioning such as microbial biomass, soil respiration and extracellular enzyme activity were monitored on a biennial basis.

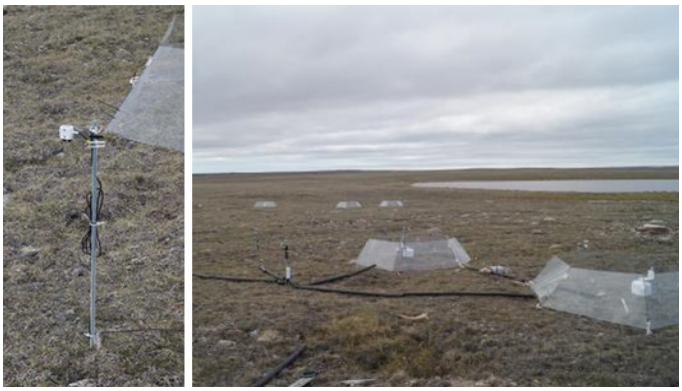

Figure 3. NDVI sensor installation in July 2015

Figure 4. Soil and soil-derived gas sampling in August 2015

CAPEC project in Ny-Ålesund

The overall main research objective of KOPRI aerosol research team is to address the question: will future changes of the Arctic climate induce positive or negative feedbacks with respect to DMS-aerosol-cloud interactions? To improve knowledge gaps regarding these issues, KOPRI aerosol research team has focused on the three research themes in collaboration with Pohang University of Science and Technology (POSTECH), Stockholm University, Norwegian Polar Research Institute (NPI) and Norwegian Institute for Air research (NILU):

- Long-term observation of DMS and aerosol physics in the atmosphere at an Zeppelin observatory
- Evaluating the linkage between oceanic biological activities and the formation of Arctic aerosol
- Examining climate feedback roles of DMS-aerosol in Arctic environment under global warming event

The Zeppelin observatory is located in the Arctic on Zeppelin Mountain on the island archipelago of Svalbard (79oN, 12oE). The observatory is located in an undisturbed Arctic environment, away from major pollution sources. The unique location of the observatory makes it an ideal platform for the monitoring of global atmospheric change. Korea aerosol research team has been carrying out the aerosol research program since 2007. Currently, we are observing numerous aerosol parameters (e.g., CCN, DMS, number of nano-size particles, and size distribution of aerosol particles) at an observation site. To assure quality and continuity of measurements, we make frequent visits to the observation site and provide necessary support for routine maintenance and calibration.

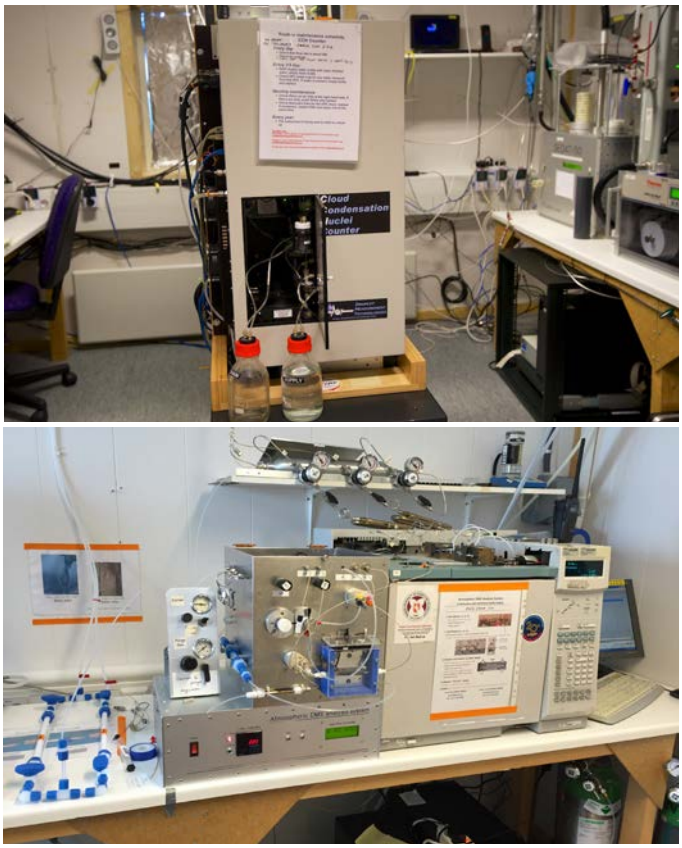

Figure 5. (a) CCN counter, (b) DMS analyzer installed in Zeppelin obsrevatory, (c) high volume sampler installed on the roof of Gruvebadet laboratory

After glacier retreat in Svalbard (PI: Yoo Kyung Lee) A research project based on the Arctic Dasan Station in Svalbard has been initiated in 2014 by Korea Polar Research Institute. KOPRI research groups and other teams from several universities and institutes studied the glacier foreland ecosystem of Midtre Lovénbreen. The plant community in the glacier foreland was surveyed by the French team 10 years ago. We repeated vegetation survey in the same sampling sites, studied by the French team, with the French and Norwegian groups in the same manner. In addition, soil samples were collected to study soil organic carbon, microbial community, plants metabolites, and fatty acids composition in the glacier foreland in 2014. We preliminarily produced a vegetation map by calculating the probability of vegetation distribution in the entire glacier foreland from using some available environmental parameters (topography, age of surface, etc.). This showed that most of the glacier foreland was lack of plants or very low coverage of plants. We are currently working on producing maps through many combinations of classification and estimation methods. In addition, we are planning to produce a soil organic carbon stock map in the foreland and to find the microbial distribution pattern with a relationship with soil environmental features.

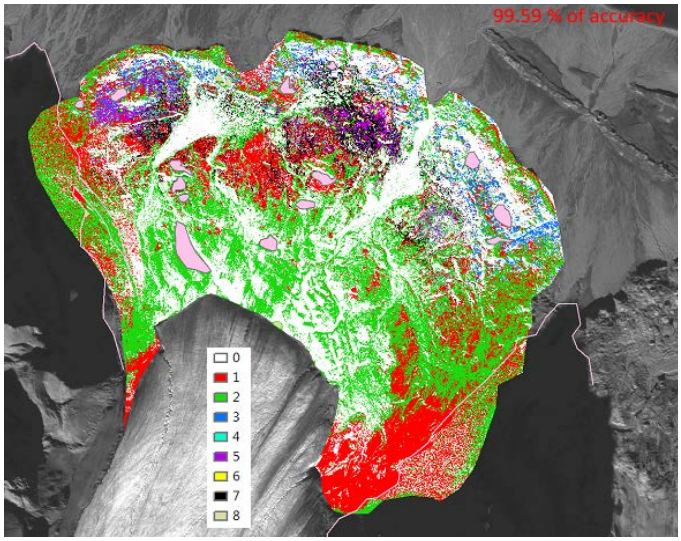

Figure 6. A vegetation map in Midtre Lovénbreen glacier foreland.

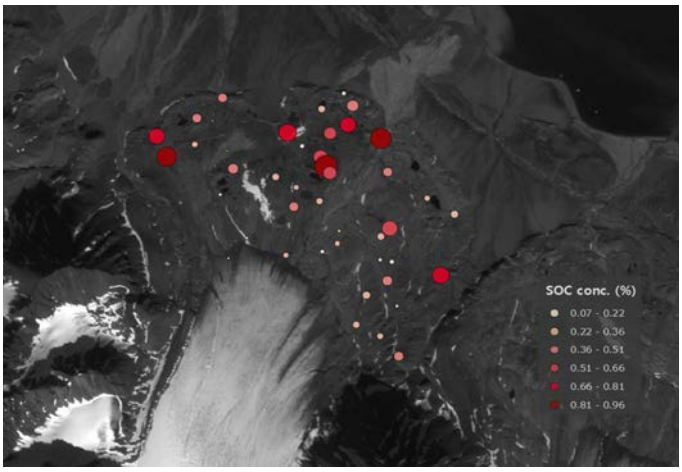

Figure 7. Soil organic carbon concentration in the surface soil (0-5 cm depth).

Public Relations

Korea Polar Research Institute has operated the web page, <Arctic Knowledge Center> (http://www.arctic.or.kr), to provide all sorts of arctic related information in Korean. The webpage introduces organizations and groups involved in arctic activities as well as scientific activities.

KOPRI published a book <Story of Tundra> written by Yoo Kyung Lee and Ji Young Jung. This book explains where the Arctic tundra is, what kind of organisms live there, how tundra is changing with climate change, and how Korean scientists are researching Tundra. Specifically with a total of 80 pictures comprising of a diverse set of photographs taken in the Arctic, images that explain scientific principles in a clear and accessible way, this book makes Arctic Tundra understandable to all kinds of readers.

Report prepared by Yoo Kyung Lee (yklee@kopri.re.kr)

21 Spain

Research Groups working on permafrost

During 2015 the Spanish research groups working in periglacial landforms and permafrost have continued his works in different geographic sites. During this year the research of Universidad Autónoma de Madrid, leaded by Jerónimo López-Martinez, and the University of Alcalá de Henares, leaded by Miguel Ángel de Pablo, have get financial support for research in Antarctica on periglacial and permafrost from different techniques and methodologies, according with his previous research trajectories. It is important news because allows the permanence of permafrost researchs in Antarctica, during a crisis period with very low funding for research in Spain.

The first one, the GEA research Group, applying remote sensing and RADARSAT-2 data in the ultra-fine and fine quad polarization mode to identify periglacial features and permafrost within the South Shetland Island and Antarctic Peninsula region. The GEA research Group (UAM) organized a meeting on "Researcher on geodynamic processes in the North of Antarctic Peninsula", on 19th December, 19, attended by 25 researchers. Jerónimo López-Martínez (UAM), Thomas Schmid (CIEMAT) and Stéphane Guillaso (TUB, Germany) talked about geomorphology, data acquisition from field, satellites and Radar Remote Sensing in Antarctica: Issues and Challenges.

The second one, the GIFA research group of Alcalá de Henares, continues working on the study of the thermal state of permafrost, the maintenance of CALM-S sites in South Shetland Island, and the collaboration with Portuguese groups. The GIFA group finished the last field work in the Antarctic Spanish Station Juan Carlos I (Figure 1) in March 2015, working on CALM-s sites of Livingston and Deception Island.

Figure 1. Participants in the 2015 campaign in the ASS Juan Carlos I.

Works on periglacial and permafrost

Marc Oliva (UL) has coordinated eleven researchers of eight universities, in relation with the Iberian group of the IPA, to make a synthesis on "The periglaciation of the Iberian Peninsula". It has been presented in several national and international meeting, finishing as a paper. Joint to Marc Oliva (UL), the authors Enrique Serrano (UVA), Antonio Gómez-Ortiz (UBA), María José González-Amuchastegui (UPV), Alexandre Nieuwendam (UL); David Palacios (UCM); Ramón Pellitero (Aberdeen University); Augusto Pérez-Alberti (USC); Jesús Ruiz-Fernández (UNIOVI), Marcos Valcárcel (USC) and Gonçalo T. Vieira (UL) have examined the past periods with periglacial activity in the different massifs and highlands of Iberian Peninsula (Pyrenees, Cantabrian Range, Galician mountains, Portuguese ranges, Central Iberian Range, Iberian Range, Sierra Nevada and the central Iberian Meseta).

Although nowadays, active periglacial processes in the Iberian Peninsula are only restricted to the highest mountain environments, in the past periglacial deposits and landforms had a wide spatial distribution, suggesting the existence of past periods with enhanced periglacial activity. Over the last decades significant advances have been made regarding the geochronology of past periglacial activity. Whilst periglacial research until the 80's and 90's was mostly focus on the study of the distribution of geomorphological features, description and relative dating of inactive landforms and deposits, this approach has been complemented during the last decades with the monitoring of present-day processes as well as in establishing the age of periglacial phenomena through different absolute datings techniques. During the Last Glaciation the periglacial environment extended to elevations between 800 and 1000 m lower than today, even down to sea level in the NW corner of the Iberian Peninsula. A wide range of geomorphological landforms and sedimentary records is indicative of very active periglacial processes, in some cases related to permafrost conditions. Most of the inactive landforms and deposits in low- and mid- elevations in Iberia are related to these phase.

During postglacial times periglacial processes prevailed in the formerly glaciated areas, with very intense periglacial dynamics during colder periods (e.g. Late Glacial). During the Holocene periglacial processes have been only active in the highest mountain ranges, shifting in altitude according to the regime of temperature and moisture conditions. The Little Ice Age saw the reactivation of periglacial activity in lower elevations than today. Currently, periglacial processes are only active in elevations exceeding 2200-2400 m in the southern ranges and above

2000-2200 m in the northern massifs (Figure 2).

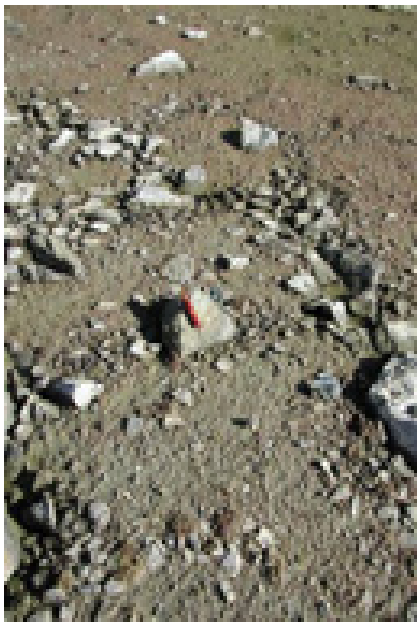

Figure 2. Patterned ground in Tucarroya cirque and La Paúl rock glacier (Pyrenees).

During 2015 have been presented at least two Doctoral thesis related to cold environments and permafrost. Dr. Manuel Gómez-Lende made the doctoral dissertation and lecture on “Ice caves in the Picos de Europa: climate, geomorphologies and dynamics” (in Spanish, Picture 3, up) in the University of Valladolid, in October 2015. Dr. Miguel Ángel de Pablos made the public defence of the Doctoral Thesis on “Glacial geomorphology in the Hecates Tholus, Mars” (in Spanish, Figure 3, down) in the University of Alcalá de Henares in November 2015.

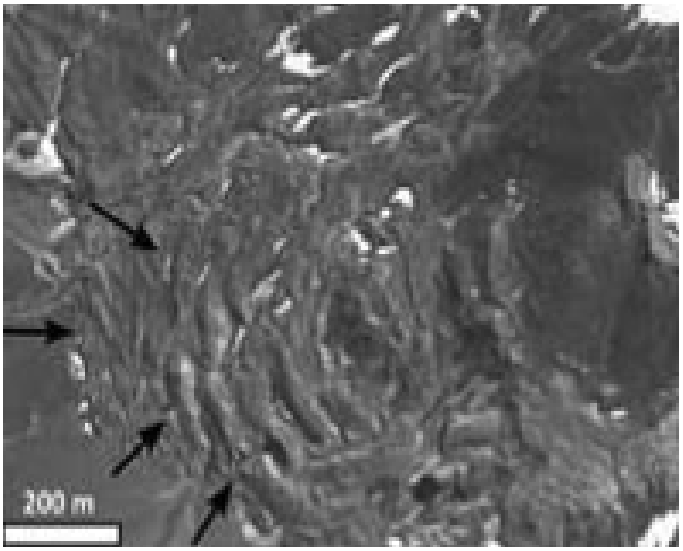

Figure 3. View of the ice cave in the Picos de Europa (Spain) and the cold movement of Hecates Tholus in Mars.

Course on EXTREM COLD. From Iberia to Poles and Mars. Science and research around permafrost.

During three days was developed a course oriented to the study of permafrost in the University of Valladolid. Funding by Buendía Centre (UVa) and boosting by PANGEA Research Group and the International Permafrost Association (IPA), took part as lecturers the mostly of Iberian IPA group leaders. Coordinating by Enrique Serrano the course dealt the permafrost as an environment and as a physical fact, the related problems to the past and present changes at different geographic areas, including polar, mountain and Iberian Peninsula and from different point of view, scientific and cultural. The course was imparted by twelve experimented lecturers in Polar, periglacial and permafrost issues and planned in

three parts, Permafrost environment, explained by Eduardo Martinez de Pisón (UAM), Miguel Ramos (UAH, IPA), Francesc Bailon (UAB), David Palacios (UCM, IPA), Gonzalo T. Vieira (UL, IPA) and Miguel Ángel de Pablo (UAH, IPA); Researching permafrost, explained by Jerónimo López-Martínez (UAM, SCAR), Marc Oliva (UL, IPA), Augusto Pérez-Alberti (USC, IPA) and Thomas Schmid (CIEMAT); and Permafrost in the Iberian Peninsula, attended by Marc Oliva (UL, IPA), Enrique Serrano (UVa, IPA) and Antonio Gómez-Ortiz (UAM). Recipients were students and young researchers interested in cold environments. 25 students from Spain and Portugal, coming from nine universities attended to the sessions and shared discussion and knowledge on human and physical subjects around permafrost. Reduced taxes were applied to UVa students and IPA members. The appraisal of Buendía Centre showed the interest to students and the high level of presentations. It has been the first course in Spain on Permafrost.

5th. Iberian Congress IPA 2015.

The 5Th Iberian meeting was held with success in Valladolid, between 24 and 26 June, organized by the PANGEA Research Group and Department of Geography and funded by the University of Valladolid. During three days we meet in the Philosophy and Letters Faculty to discuss and present 46 presentations. The participation (Figure 4) was quite high with 34 inscriptions, 20 oral communications and 26 in poster format. Researchers from nineteen Universities and research centers of Spain and Portugal talked about periglacial and permafrost processes and environments.

Figure 4. Participants in Santa Cruz Palace (XVI century building, rectorate of the university).

The Organization Committee (Research Group PANGEA, University of Valladolid) was formed by Enrique Serrano, Alfonso Pisabarro, Alberto Merino and Manuel Gómez-Lende. We had the pleasure of having the assistance of Prof. Dr. Hans-Wolfgang Hubberten in the opening conference (Figure 5), speaking on “Arctic warming and its impact on permafrost”.

Figure 5. Sessions in Valladolid (up) and Prof. Antonio Gómez Ortiz in Sierra Nevada (bottom).

Four scientific sessions was proposed:
-Research advances and techniques in the study of permafrost and periglacial polar and high mountain areas (10 orals & 8 posters)
-Current periglacial processes and quaternary heritages in the Iberian Peninsula. (4 orals & 10 posters)
-Planetary cryospheres: researches and cartography about permafrost in Mars. (1 oral)
-Snowfall, periglaciarism and snow cover: new contributions. (5 orals & 8 posters)

During the congress had place the homage to Prof. Dr. Antonio Gómez-Ortiz retired after lots of years working for IPA in Spain and on periglacial and cold subjects in the Iberian Peninsula. Prof. Dr. Antornio Gómez Ortiz made his first works on periglacial processes in the seventies on the Eastern Pyrenees of Catalonia and Andorra. Also have worked on glacial and periglacial environments in Sierra Nevada (Figure 5) during the last 25 years, and he promoted the IPA-Spain leaded joint to Prof. Dr. David Palacios the first ten years of our association, and organizing important meeting on periglacial and permafrost subjects in 1994, 1998 and 2013.

Figure 6. Participants in the field trip (Alto Campoo valley, Cantabrian Mountain).

The fieldwork was into the Cantabrian Mountains (North of Spain) where we saw periglacial landforms like rock glaciers, debris flows and another slope processes into a landscape full of glacier heritage. The field trip was leaded by Enrique Serrano and Manuel Gómez-Lende, visiting the valley and two cirque glaciares where the inherited and active periglacial features, mainly nival and solifluction ones. In the fieldwork participated 25 persons (Figure 6) that studied the present day periglacial processes and landforms in an atlantics mountain, and the interesting glacial landforms inherence from several cold periods since the Last Glacial Maximum. A field guide on Alto Campoo Mountains was edited (in Spanish, http://www5.uva.es/gir_pangea/?page_id=578) including geomorphological features and periglacial and nival processes. The work during these three days was developed into an excellent environment with high participation and great knowledge exchange.

Report prepared by Enrique Serrano (serranoe@fyl.uva.es) and Alfonso Pisabarro

22 Sweden

The studies of periglacial geomorphology focusing on traces from the terminal periods of the last glaciation was for a long period a main subject in Sweden. This research which studied fossil traces of permafrost and ground ice, (mainly ice wedges in south Sweden) has more or less “stopped” even though the subject still attain some interest by sedimentologist now also in northern regions of Sweden. Early the interest was focused to the palsas of the subarctic peatbogs and their distribution, localisation in the terrain, morphology and genetics. The first main study of palsas (and Swedish permafrost) in a climatic context appeared in 1977 (Richard Åhman). The palsas of Sweden are basically found at the edge of the distribution area of permafrost (in the sporadic permafrost zone) mainly at elevations between 500 and 700 m. a. s. l. These areas and the palsas are found very sensitive to changes in climate. For Sweden, palsas are recently detailed mapped in the EU report , Kartering av Sveriges palsmyrar‘; http://www.lansstyrelsen.se/norrbotten/Sv/publikationer/2014/Pages/kartering-av-sveriges-palsmyrar.aspx

The main input from Sweden for the reporting period is the new Nordic Permafrost map and Data. The work has been performed by a Nordic working group coordinated by Kjersti Gisnäs (kjersti.gisnas@geo.uio.no) from Norway. This will be reported in detail separately.

Sweden has permafrost only in the northernmost parts – at lower elevations in peatbogs and at elevations from 700 m.a.sl. in the northernmost mountains. In the southernmost part of the mountains remnants of permafrost are mainly found above 1000 m.a.s.l. There is a long history of research on the stability of permafrost etc. regarding the palsas in the subarctic peatbogs. The permafrost in palsas has been studied from geomorphological, ecological and climatological aspects since the early 1900. All major Universities has been active in these studies but during the last decades Lund, Stockholm and Uppsala Universities have been the most active. In cooperation with other Nordic and international departments a lot of comparative field studies has been launched in mainly the Nordic countries, Greenland, Svalbard, Russia, Canada and the USA. A clear and natural change from process orientated geomorphological to ecological, climatological and climate change aspects of permafrost research questions has been seen. Very early it was observed that the “borderline” very fragile permafrost in Sweden started to react upon environmental changes caused by the climatic change.

Palsa mires constitute a so called priority habitat in the Habitats Directive of the EU. This means that they are considered to be one of the most threatened habitat types within the EU. Every six years, Sweden have to report to the EU on the conservation status of palsa mires. The reporting shall include distribution, area, quality, prospects and an overall assessment. The previous reporting, in 2007, was based on a vegetation map which was produced in the 1980s. This map only shows symbols of palsas in mire vegetation areas. The symbols accordingly only showed cartographically where palsas were found. The map was therefore not suitable for area estimates. Because it is 25 years since the vegetation map was made and the climate has changed in a “negative way” for palsa mires, the need for a new mapping of palsa mires emerged. Commissioned by the Swedish Environmental Protection Agency, a mapping of palsa mires in Sweden was made in 2013. The mapping was performed by aerial photo interpretation in a grid of squares (100 m x 100 m). In each square, the percentage of palsas and water related to palsas was specified. A total of about 250 000 squares were mapped. 12 960 of these squares contain palsas. The total palsa area is 1977,30 hectares. 99,9 % of the Swedish palsa area is situated in the County of Norrbotten and the remaining 0,1 % in the County of Västerbotten. 47 % of the palsa area is situated within protected areas, e.g. national parks, nature reserves and Natura 2000 sites. Vissátvuopmi, the largest contiguous palsa region in Sweden, containing 13,8 % of its palsa area, is not protected. Ongoing climate change with higher temperature and increased precipitation means that palsa mires generally develop in a negative direction. However, some areas with local conditions favouring palsa growth have also been found during the mapping.

The reporting to the EU 2013 on palsa mires, according to Article 17 of the Habitats Directive, was based on results of this mapping. These results provide an excellent basis for continued monitoring of palsa mires, in particular as regards the development of their conservation status. In the report a methodology for bio-geographical follow up of palsa mires is proposed. It can be used both for reporting to the EU and for monitoring and evaluation of the national environmental objective “Thriving wetlands”; http://www.lansstyrelsen.se/norrbotten/Sv/publikationer/2014/Pages/kartering-av-sveriges-palsmyrar.aspx

Stockholm University

At Stockholm University, Department of Physical Geography, monitoring of ground temperatures have continued at Tarfala Research Station (PACE12, 100 m depth, 1550 m a.s.l.) and in Tavvavuoma (<6 m depth, 550 m a.s.l.). In Tavvavuoma, a project funded by the Swedish Research Council for Environ-

ment, Agricultural Sciences and Spatial Planning (2015-2018) will allow continued permafrost monitoring as well as projections of hydrological responses and future permafrost-carbon feedbacks from subarctic peat plateau ecosystems under future warmer scenarios. Within the framework of the ESF CryoCarb (2010-2014), the EU FP7 PAGE21 (2011-2015), the Nordforsk DEFROST (2010-2016) and the JPI COUP (2015-2017) projects, we have updated the current estimate of the northern circumpolar permafrost region soil organic carbon (SOC) pool. We have also carried out detailed SOC inventories in field sites across the permafrost region (Canada, Greenland, Svalbard, Sweden and Russia) in order to further improve the estimates of the permafrost SOC pool and, through simple geochemical indicators, to assess its potential decomposability upon thaw. Furthermore, this information provides important benchmarking for the improvement of Earth System Models (ESMs) developed by other partners in these consortia. We are currently also assessing the northern permafrost region extent and SOC pool at the time of the Last Glacial Maximum (French-Swedish cooperation program, 2013-2016). A new Swedish Research Council (VR) project (2015-2017) will investigate the role of permafrost soils in ESMs, with a special emphasis on surface organic soil layers and cryoturbation processes. An ongoing project with the Geological Survey of Sweden (2014-2016) involves model development and analysis of permafrost change, where a particular focus is on improving the understanding of coupled effects between permafrost and heat fluxes with hydrological and hydrogeological flows and its impact on carbon transport. The modelling efforts make use of available field data including sites in Sweden, Greenland and Svalbard.
The Trace Gas Biogeochemistry (TGB) Laboratory at the Department of Geological Sciences of Stockholm University focuses on how the changing Arctic impacts low molecular weight carbon gas emissions. The VR and the Nordforsk DEFROST projects have supported work on terrestrial organic matter and emissions of carbon trace gases from Arctic surface waters as determined by isotopes and micrometeorology. The Lab work on role of lakes and ponds Arctic carbon is placed into a global context within the process modelling framework of the US NSF Macrosystems project and the EU GHG-Lake program. The main research site has been the Stordalen Mire where an automated methane (CH4) and carbon dioxide (CO2) chamber flux station across a thawing permafrost gradient was first established in 2003, with the support from the STINT foundation and VR. The TGB has played a role in the establishment of the Stordalen Mire as an ecosystem site in the VR supported Integrated Carbon Observation Network (ICOS-SE), an EU continental wide effort to monitor greenhouse gases. Most recently, with the support of the US DOE and VR, we have been able to obtain the first complete genomic sequence of an archeon extracted from peat that has led to the description of Candidatus 'Methanoflorens stordalenmirensis' gen. nov., sp. nov. as the first representative of a new family of methanogens. TGB also participated in the SWERUS-C3 Arctic Ocean crossing in 2014 by making continuous, high precision measurements of ambient CH4 and CO2 and the isotopologues of CH4. The Swedish Polar Research Secretariat supported the deployment of the technology for the Petermann Cruise of the I/B Oden in 2015. This allowed us to develop a circum-Greenland dataset that will be used with observations of land based stations to investigate the continental scale flow of greenhouse gases off North America. As part of that effort, there is now a French Swedish project to use high frequency, high precision isotope measurements to test inversion models of Arctic methane fluxes.

Lund University

The research group from Lund University has carried out active layer monitoring in the Abisko area measuring the active layer at initially ten mires at the end of September. This project started measuring the active layer depths in 1978 at 10 sites in a 150km east west transect by the Dep. of Physical Geography and Ecosystem Sciences, Lund. For the 37th year in a row now, the research group from Lund University has carried out this active layer monitoring programme. The correlations between the warmer summer temperatures and the depths of the active layer is evident and permafrost has completely disappeared from 4 of the ten mires. The last summer was very warm and especially in the degraded peat plateaus the warm summer was directly reflected in a thicker active layer. The active layer data is submitted to the CALM database. In addition, ground temperatures from five boreholes have been downloaded and submitted to the GTN-P database.
A snow manipulation experiment has been running for 9 years now in the same areas. In 2010, PAR sensors were added to the monitoring and data from these measurements have now been compiled and published in Bosiö, J., C. Stiegler, M. Johansson, H.N. Mbufong and T.R. Christensen 2014. Increased photosynthesis compensates for shorter growing season in subarctic tundra - eight years of snow accumulation manipulations. Climatic Change 127 (2): 321-334. DOI 10.1007/s10584-014-1247-4. Results showed higher PAR absorption, together with almost 35 % higher light use efficiency, in treated plots (with added snow) compared to untreated plots. Estimations of GPP suggested that the loss in early season photosynthesis, due to the shortening of the growing season in the treatment plots, was well compensated for by the increased absorption of PAR and hig-

her light use efficiency throughout the whole growing seasons, most likely due to increased soil moisture and nutrients together with a shift in vegetation composition associated with the accelerated permafrost thaw in the treated plots. In addition to the active layer measurements ground temperatures from three boreholes is and submitted to the GTN-P database.
Dep. of Physical Geography and Ecosystem Sciences from Lund University has carried out two PhD courses with international students in the Kapp Linne' area on Svalbard in 2012 and 2015 in order to maintain the geomorphological and ecological studies within this area that started in 1972. The active layer monitoring in this area that started with initially 20 CALM sites in 1972 measuring the active layer at various material and levels has been reduced to one site (AL3) which has been maintained with only a minor gap in the series. For the 43rd year in a row now, the research group from Lund University has carried out this active layer monitoring programme also at Kapp Linne', Svalbard. The correlations between the warmer summer temperatures and the depths of the active layer is evident also here (Fig 1).

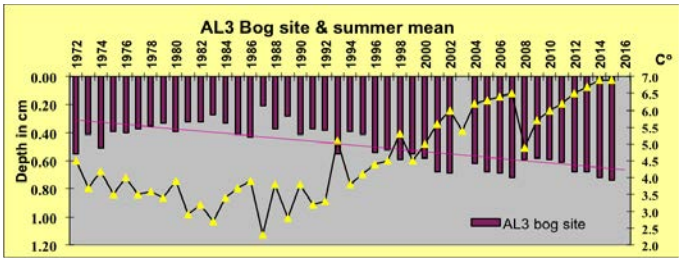

Figure 1. Depth of the active layer compared with the summer temperature at a bog site (AL3) near Kapp Linne' Svalbard, 1972-2015.

The Dep. of Physical Geography and Ecosystem Sciences participated in the following projects that deal partly with permafrost or problems in permafrost environments;

AMAP Prof. Torben Christenson has been active in the Arctic Monitoring and Assessment Program, which is one of six Working Groups of the Arctic Council. AMAP's work is directed by the Ministers of the Arctic Council and their Senior Arctic Officials, who have requested AMAP to support international processes that work to reduce the global threats from contaminants and climate change. These include the UN Framework Convention on Climate Change, UNEP's Stockholm Convention on Persistent Organic Pollutants and Minimata Convention on mercury, and the United Nation's Economic Commission for Europe (UN ECE) Convention on Long-range Transboundary Air Pollution. Since its establishment in 1991, AMAP has produced a series of high quality reports and related communication products that detail the status of the Arctic with respect to climate and pollution issues and that include policy-relevant science-based advice to the Arctic Council and governments.

DEFROST (Impact of a changing cryosphere - Depicting ecosystem-climate feedbacks from permafrost, snow and ice) is to understand how climate change induced changes in the cryosphere influence the ecosystem/geosphere processes which directly affect climate. We will focus on key terrestrial, lacustrine and marine cryospheric components that have the potential for giving rise to substantial changes in climate feedback mechanisms both in terms of surface-atmosphere energy exchange and exchanges of greenhouse gases. DEFROST seeks to bridge existing gaps between climate modelling, cryospheric science, and Arctic

ICOS - Integrated Carbon Observation System - is a European research infrastructure to quantify and understand the greenhouse gas balance of the European continent and of adjacent regions. ICOS Sweden is the Swedish contribution to this European effort and is a cooperation of several research institutes. ICOS Sweden has their head office Lund.

ICOS Carbon Portal offers access to research data from ICOS scientists all over Europe, as well as easily accessible and understandable science and education products. All measurement data available in the portal is quality controlled through the three thematic centres, Ecosystem, Atmospheric and Ocean Thematic Centres and a Central Analytical laboratory.

LPJ-GUESS is a process-based dynamic vegetation-terrestrial ecosystem model designed for regional or global studies. Models of this kind are commonly known as dynamic global vegetation models (DGVMs). Given data on regional climate conditions and atmospheric carbon dioxide concentrations, it can predict structural, compositional and functional properties of the native ecosystems of major climate zones of the Earth.

LUCCI is a research centre at Lund University devoted to studies of the carbon cycle and how it interacts with the climate system. The centre involves about 120 researchers from four Lund university departments: Physical Geography and Ecosystem Science, Geology, Biology and Physics.

Figure 2. Students from the Dep. of Physical Geography and Ecosystem Sciences during the year 2015 PhD course in the Kapp Linne' area on Svalbard. Here investigating new land surfaces and its colonisation of vegetation after the retreat of the glacial cover in the inner Trygghamna fjord. (photo J. Åkerman)

Gothenburg University

The Latnjajaure catchment in northernmost Swedish Lapland, spanning from mid to high alpine (950-1500 m a.s.l.) is situated in an area of marginal and patchy permafrost. The area has undergone drastic changes during the last 25 years. Most prominently, an area of tussock tundra at the outlet of the lake faced final permafrost thaw in between 1992 and 2002; the plant community was mapped in detail in 1995 (before) and 2012 (after final thaw), with drastic changes on hydrology (desiccation) and plant community change (Molau 2010). At present, the remaining permafrost in the Latnjajaure catchment is "dry permafrost" in bedrock and moraines from above 1300 m a.s.l. As a proxy for dry permafrost degradation we monitor shallow lakes on moraines at various altitudes since 2011. A lake at 1000 m a.s.l. is drained since about 2010 (Callaghan et al., 2013; Cramer et al. 2014). At higher altitudes, a small lake was drained in 2013 at 1250 m alt. In the area of remaining permafrost, a shallow lake at 1350 m on Mt Latnjatjårro was provided with permanent metal shore-line stakes in 2013; this lake still shows no signs of change after the 2015 season (Molau, unpubl.).

Swedish Polar Research Secretariat

The Secretariat has not specifically reported to the Swedish IPA in time for the deadline but it is important that this government agency, the Swedish Polar Research Secretariat that is mandated to coordinate and promote Swedish polar research is noted in this Swedish report to the IPA. The agency's primary mission is to organise and support research expeditions to the polar regions and manage research infrastructure. The Secretariat also helps to create favourable conditions for polar research that does not involve fieldwork.

An important fact to note for permafrost researchers is that the Swedish Polar Research Secretariat has taken over the running of the Abisko Scientific Research Station. This is a unique, modern and comprehensive station situated about 200 km north of the Arctic Circle in Sweden (68º21'N, 18º49'E) which most permafrost researchers know and have used for many decades. For more information, please contact http://polar.se/

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23 Switzerland

Swiss Permafrost Monitoring

The Swiss Permafrost Monitoring initiative PERMOS (http://www.permos.ch) maintains a network of 28 high alpine sites in order to document the state and changes of permafrost in Switzerland based on three main observation elements (ground temperatures, changes in subsurface ice and water content, and permafrost creep velocities). PERMOS is funded by the Federal Office for the Environment (FOEN), the Swiss GCOS Office at MeteoSwiss, and the Swiss Academy of Sciences (SCNAT). The PERMOS Office (J. Noetzli) coordinates observation and reporting activities undertaken by the six partner institutions ETH Zurich (ETHZ, S.M. Springman, T. Buchli), the Universities of Fribourg (UNIFR, R. Delaloye, C. Hauck, C. Hilbich, M. Hoelzle, B. Staub), Lausanne (UNIL, C. Lambiel), Zurich (UZH, J. Noetzli, I. Gärtner-Roer, A. Vieli, A. Bast), the WSL Institute for Snow and Avalanche Research (SLF, M. Phillips, J. Noetzli) and the University of Applied Sciences and Arts of Southern Switzerland (SUPSI, C. Scapozza). A new 4-year contract period has started in 2015 for which the PERMOS Office has officially moved to the Department of Geosciences at the University of Fribourg and a second 50% position has been funded (B. Staub). A new 60 m borehole has been drilled in the Murtèl rock glacier on Corvatsch in the Upper Engiadine in order to secure the longest available temperature time series in mountain permafrost from the borehole drilled here in 1987, which is very likely to shear off in the next years. The project was funded by FOEN and carried by UZH.

Ongoing research projects and activities

Permafrost research activities at the Institute of Earth Sciences of the SUPSI University of Applied Sciences and Arts of Southern Switzerland (C. Scapozza, C. Ambrosi) continued after their beginning in 2013 with the affiliation to the PERMOS network. During this year research focused mainly on the assessment of rock glacier kinematics and ground surface temperatures. These local investigations were coupled with a regional climate analysis performed in collaboration with the University of Turin (S. Fratianni, E. Giaccone), for understanding the influence on permafrost conditions of the Southern Swiss Alps climate evolution. Within this framework, a research project based on Schmidt hammer exposure-age dating and historical analysis (Fig. 1) allows assessing the kinematics of the Splügenpass rock glacier in the last two millennia by comparison with climate evolution.

Figure 1. The Splügenpass rock glacier with the two historical mule tracks crossing its frontal part. The arched shape of the RP mule track is probably related to ground ice degradation between the Roman Period and the Late Middle Ages (Photo: C. Scapozza).

In parallel to its long-term monitoring of borehole temperatures and deformation in cooperation with PERMOS (J. Noetzli), the WSL Institute for Snow and Avalanche Research SLF investigated the impact of the snow cover on the thermal regime and stability of steep rock walls (A. Haberkorn, M. Phillips) with German project partners (D. Draebing, M. Krautblatter). Rock wall dynamics were monitored using terrestrial laserscanning and numerous rock slope failures were registered in the SLF rockfall database in the course of the summer 2015 heat wave - with information obtained via crowd sourcing (Fig. 2). The stability and thermal regime of high mountain infrastructure was monitored (M. Phillips) with various partners and record displacements of snow nets in the Matter valley which have been monitored since 1999 were registered. These displacements were confirmed by an in-situ GPS installed by the ETH Zurich (J. Beutel, S. Weber). A novel combination of time-lapse photography and terrestrial laser scanning is currently being applied to monitor the dynamics of the Ritigraben rock glacier (R. Kenner).

Figure 2. One of many rock fall events in the Swiss Alps during the summer 2015 heat wave: Spannort, September 2015 (Photograph Christian Schindler, Swiss Helicopter).

The Department of Geography at the University of Zurich (A. Vieli, A. Bast, I. Gärtner-Roer, J. Müller, S. Weber, V. Wirz) is announcing that part of the PERMOS monitoring program, a replacement 60 m borehole has been drilled and instrumented at Murtel rock glacier to continue the time series of the 1987 borehole. The PermaSense project has finished the new experiment setup to capture micro-seismic activity as an indicator for damage in steep bedrock permafrost. The continuous data get streamed in real time and is planned to be continued over the next year. Additional, initial datasets for repeat of terrestrial laser scanning, radar interferometry as well as drone-based orthophotos have been undertaken at Matterhorn and Dirru rockglacier in order to assess spatio-temporal changes.

The SNSF-Sinergia project «The evolution of Mountain Permafrost in Switzerland» (TEMPS, 2011-2015), which was led by the University of Fribourg and regrouping scientists from several institutions (ETH Zurich, Universities of Fribourg, Lausanne, and Zurich, SLF) finished in spring 2015. A particular aim of this project was combining observation and model-based research approaches to obtain an integrative view of the current state of mountain permafrost in the Swiss Alps and the governing processes for its recent and future evolution. A concluding TEMPS symposium (www.temps-symposium.ch) was held in the heart of Swiss mountains in Sion in February 2015 and was attended by more than 100 scientists and practitioners (Fig. 3).

Figure 3. Some of the TEMPS-Symposium participants took part to a ski touring 2-day excursion and visited in particular the Becs-de-Bosson/Réchy rock glacier.

Members of the Alpine Cryosphere and Geomorphology research group at the University of Fribourg, Department of Geosciences (C. Hauck, M. Hoelzle, R. Delaloye, N. Salzmann, C. Barboux, L. Braillard, C. Hilbich, A. Hasler, M. Kummert, S. Mari, A. Marmy, C. Mollaret, S. Nussbaumer, C. Pellet, B. Rick, P.-O. Schmid, B. Staub, J. Wicky) have deployed their activities on a wide range of topics including the analysis of rock mechanics and rock glacier dynamics (Fig. 4), sediment transport, geomorphology, geophysics, subsurface modelling and remote sensing related to permafrost essentially in the Alps, but also in other mountain regions over the world (e.g. Brooks Range – Alaska, Argentinean and Chilean Andes, Himalaya). A close collaboration has also been set up with ARPA (Regional Agency for Environment Protection) Aosta Valley in Italy. In 2015 Stefano Mari, Antoine Marmy and Benno Staub finished their PhDs on the

regional pattern of rock glacier distribution and local hydrology, modelling of Alpine permafrost time series and integrative analysis of permafrost-related monitored data in the Swiss Alps, respectively.

Figure 4. 4-year time series of webcam images on the active eroding front of the 100 m wide Tsarmine rock glacier. As for many monitored sites in the Swiss Alps, the creep velocity of rock glaciers has dramatically increased over the last decades, and especially over the last years. The mean annual velocity of the Tsarmine rock glacier has for instance jumped from 1 to 4.5 m/year between 2011 and 2015. The availability of loose sediments downwards of the rock glacier front may be strongly enhanced. Survey activities are undertaken by the Universities of Fribourg and Lausanne with the support of the local community (Evolène) and regional services (Forest and Landscape Service, Canton of Valais). http://bigweb.unifr.ch/Science/Geosciences/Geomorphology/Pub/Website/_Sites/Tsarmine/Tsarmine_GIF.gif

At the University of Lausanne, the current main activities of the small group formed by C. Lambiel, J.-B. Bosson, N. Deluigi and Master students focus on permafrost mapping and modelling and ground ice related movements. The repartition of subsurface ice was investigated in post LIA proglacial margins located in permafrost environment and on solifluction slopes. These data are used as input variables for predicting the occurrence of mountain permafrost with machine learning algorithms. Within this project, three different algorithms were tested this year: Artificial neural networks (ANN), Support Vector Machines (SVM) and Random Forest (RF). They have demonstrated to be efficient for permafrost distribution modelling with consistent results compared to the field reality. A new project started on mountain solifluction with the aim of understanding the factors controlling the process activity and of investigating the role of permafrost in the movements. More generally, studies have continued on the decadal and current evolution of rock glaciers with digital photogrammetry, Lidar and GPS surveys, as well as the use of automatic cameras. Schmidt Hammer was used on rock glaciers to obtain surface exposure age data with the aim of reconstructing the past activity of rock glaciers. Finally, a funding was obtained from the Swiss National Foundation (SNF) for an interdisciplinary project called „Integrating spatial predictions of vegetation, soils, geomorphology and hydrology for improved assessment of ecosystem services under climate change“ (INTEGRALP). The project will investigate the influence of permafrost conditions on the vegetation. Many of the data collected in monitoring projects carried out by the University of Lausanne (Fig. 5) (borehole and surface temperatures, rock glacier velocities, electrical resistivities) are integrated in the PERMOS network.

Figure 5. Location of the new Mont Fort borehole, 3300 m a.s.l. (Swiss Alps). The borehole was drilled in October 2014. Temperatures at 20 m are -2°C. (Photo: Christophe Lambiel, University of Lausanne)

Report prepared by Reynald Delaloye (reynald.delaloye@unifr.ch)

24 The Netherlands

The Carbon Cycle research group of VU University in Amsterdam participated in the EU FP7 research programme PAGE21 on vulnerability of permafrost carbon in the 21st century. With the last general assembly in Aukureyri, Iceland in October 2015, this research programme has come to an end. The focus of research activities of VU was the Kytalyk reaseach station near Chokurdagh in the Indigirka Lowlands in Northeast Yakutia. In close cooperation with the Russian Academy of Science institute IBPC in Yakutsk and Wageningen, University research on carbon cycle of and ecology of permafrost soils is done.

In 2015, the eddy covariance observations on CO2 and CH4 fluxes were continued at the station, for the first time the spring and autumn seasons were included succesfully. A new research programme in the framework of the Netherlands Earth System Science Centre funded by Dutch science funding organization NWO (‚Gravity' programme), was started with extensive sampling of thaw lake water and sediment. The aim of this research programme is to quantify the carbon cycle of thaw lakes.

In 2015, the Wageningen University team continued the measurements in the long-term Betula nana shrub removal experiment at the Kytalyk tundra research station in North-eastern Siberia. We measured surface elevations, as in 2012 (Nauta et al. 2015), to examine whether the permafrost in the removal plots had degraded further, resulting in more soil subsidence, or shows stabilisation. In addition we started a litter decomposition experiment and sampled Betula nana stems for dendrochronology. The sampling included dead and drowning shrubs from thaw ponds (Figure 1) to explore whether it is possible to see the onset of small-scale permafrost collapse, resulting in soil subsidence and increasing wetness, and how the shrubs, based on the annual ring growth pattern, responded to the increasing wetness.

The research focus at Utrecht University (Jorien Vonk) has been the effect of permafrost thaw on aquatic systems; both on land via slumping and release of organic matter from thawing permafrost into streams, lakes and rivers, but also on the continental shelf via coastal erosion and river input. Her research aim is to quantify the input, transport, and degradation pathways, as well as to qualitatively assess organic matter composition and underlying processes that drive these pathways. Ongoing research takes place in Northeast Siberia in the Kolyma River region, and the East Siberian Arctic Shelf.

As part of the work in the present Task Group, Vandenberghe particpated in a joint expedition with Hugh French and organized by a team of CAREERI, Lanzhou (prof. Huijun Jin) on the Ordos Plateau (north China) to further explore the southern boundary of permafrost extent in that region during the Last Permafrost Maximum.

Report prepared by J. van Huissteden (j.van.huissteden@vu.nl)

25 United Kingdom

NERC Arctic Research Programme

Lakes and Arctic Climate cycle (LAC)
The NERC-funded project LAC [https://arcticlakes.wordpress.com/] involves researchers from Geography departments at Southampton, UCL, Loughborough and Nottingham, plus partners in Alaska, Russia and Greenland, who together are bringing a state-of-the-art approach to understanding the interactions between vegetation changes in arctic catchments and biogeochemical cycling in lakes. Our focus is on changes in carbon (C) cycling over a range of time scales (from decades to centuries and millennia). Study sites are representative of major permafrost-affected, pan-Arctic biomes (vegetation types), past and present, e.g., moist shrub tundra, boreal forest (European Russia, Norway, Alaska), dry shrub tundra (W. Greenland); these are characterized by different dominant plant functional types and nutrient regimes. As vegetation and permafrost regimes respond to climate change, the distribution of C on the landscape and its delivery to lakes changes, which in turn affects C-processing in lakes. We are testing the hypothesis that increasing biomass and a switch toward biomes dominated by woody vegetation (for example, the current phenomenon of arctic greening) increases lake processing of terrestrial C and, in turn, C emissions as greenhouse gases to the atmosphere. To do this, we are using data on Holocene environments and lake-ecosystem dynamics derived from a suite of proxies in radiocarbon-dated lake sediments to understand how lakes responded to previous episodes of arctic greening. In an extension of the project, researchers at Southampton are developing a pan-arctic assessment of lake methane emissions using new remote sensing tools. Participants: John Anderson (PI), Mary Edwards, Viv Jones, Pete Langdon, Suzanne McGowan, Maarten van Hardenbroek.

Because of their dynamic erosion and sedimentation regimes, thaw lakes contribute disproportionally to lacustrine methane emissions in permafrost regions. Kim Davies (Southampton) has been studying the spatial patterns of methane oxidation across small thaw lakes in Alaska using a compound-specific isotope approach. The larger goal is to understand what drives down-core patterns of such methane proxies in palaeo studies. Findings are now in press in Biogeosciences [http://www.biogeosciences-discuss.net/12/12157/2015/bgd-12-12157-2015-discussion.html]. Collaborators include Rich Pancost (Bristol), Katey Walter Anthony (UAF) and Mary Edwards and Pete Langdon (Southampton). The work was partially supported by NERC (isoptope analysis) and NSF (fieldwork).

Carbon Cycling Linkages of Permafrost Systems (CYCLOPS)
A second NERC-funded project, CYCLOPS, involves researchers from the universities of Edinburgh, Exeter, Sheffield and Sussex with Canadian collaborators at the Geological Survey of Canada, the University of Ottawa and the Northwest Territories Geological Survey. With two field seasons successfully carried out in Whitehorse (2013) and Yellowknife (2014), CYCLOPS is now focussed on data analysis and publications. Current foci involve analysis of vegetation and soil influences on active-layer thickness; methane and carbon dioxide fluxes under different vegetation, thermokarst and burn areas; and process-based modelling of soil-plant-atmosphere (SPA) interactions.
http://arp.arctic.ac.uk/projects/carbon-cycling-linkages-permafrost-systems-cyclops/

Ancient DNA

A Norway-UK collaboration funded by NFR has made considerable advances in the use of ancient, sediment-derived DNA to reconstruct vegetation changes in a lake catchment on Svalbard. The cold climate and continuous permafrost mean that DNA is preserved particularly well in soils and sediments. The data are highly promising and show that new molecular methods can contribute to understanding floristic and vegetation change in the Arctic. Collaborators include Inger Alsos (PI) and Per Sjøgren (Tromso University Museum) and Mary Edwards and Tony Brown (Southampton, Geography and Environment). Further information from Mary Edwards (m.e.edwards@soton.ac.uk).

UK-Russian collaboration on Pleistocene permafrost
Collaboration on Pleistocene permafrost continues between the University of Sussex (Julian Murton), the University of Southampton (Mary Edwards) and a Russian team led by Grigoriy Savvinov at the Science Research Institute of Applied Ecology of the North of North-East Federal University, Yakutsk. This led to the publication of a monograph on the palaeoenvironmental significance of the yedoma at Duvanny Yar (Murton et al., 2015). Currently the team is finishing a preliminary palaeoenvironmental analysis of 90 m of permafrost deposits at Batagaika megaslump, in the Yana Uplands of northern Siberia. This is based on reconnaissance sampling of the site in 2011 and 2013. A follow-up systematic study of this remarkable sedimentary sequence is being planned.

Rock micro- to macrocracking

PhD student Vikram Maji of the University of Sussex has been preparing for experiments investigating the transition from micro- to macrocracking of rock du-

ring freezing. This will involve imaging with micro-CT scanning at Queen Mary University of London and sensing by electric field potential, acoustic emissions and miniature strain gauges in the Sussex Permafrost Laboratory. Pilot work on cracking of chalk and sandstone has been conducted in collaboration with Civil Engineering at the University of Brighton.

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26 United States of America

US Permafrost Association

The annual meeting of the US Permafrost Association (USPA) Board of Directors and a general member meeting was held at the 2014 Fall Meeting of the American Geophysical Union. Tom Krzewinski as elected as the new President; other election results were: Mark Waldrop as President-Elect, Molly McGraw as Secretary, and Margaret Darrow as Member-at-large.

Current USPA membership includes 34 student members, 48 regular members, and 13 corporate/non-profits/lifetime members, for a total of 95 members and includes several non US members. The Board of Directors initiated a survey to determine the best means to enhance membership.

Meeting and Workshops

American Geophysical Union (AGU): The Fall 2015 meeting of the American Geophysical Union will be held December 14-18, 2015 in San Francisco. The meeting is scheduled to have 36 permafrost related regular sessions and 33 permafrost related poster sessions.

Association of American Geographers (AAG): The Annual 2015 meeting of the Association of American Geographers was held April 21-15, 2015 in Chicago. Twenty-four permafrost related sessions were held at this meeting.

Institution Member Activities

Geophysical Institute Permafrost Laboratory, University of Alaska Fairbanks

The Geophysical Institute Permafrost Laboratory (GIPL) research team led by Prof. Vladimir Romanovsky continued the development of the observation borehole network for the thermal state of permafrost (TSP) monitoring in Alaska, Russia, and Central Asia as part of the Arctic Observing Network project "Development of sustainable observations of thermal state of permafrost in North America and Russia: The U.S. contribution to the GTNP". The work included data collection and maintenance of existing boreholes, instrumentation of new or recovered boreholes, and gathering of historical data.

As part of a project involving approximately 120 shallow boreholes that were donated to GIPL by ExxonMobil, in 2015, nine additional shallow (10 m) boreholes were instrumented which brings the total number of shallow boreholes instrument so far to 24. The transect of boreholes follows the Alaska Highway from the US/Canada border to Delta Junction and then follows the Trans-Alaska Pipeline System (TAPS) corridor north to Prudhoe Bay. GIPL will continue to instrument and collect data from the selected boreholes for the next 3 years.

Use of AIEM permafrost module output to assess the permafrost changes in the 21st century: During the first year of this project, the GIPL team modeled the permafrost dynamics of North Slope of Alaska through 2100. The second year of the project will be focused on modeling the effects of surface disturbances, both natural and anthropogenic, on permafrost thermal dynamics over the entire North Slope of Alaska. It is a two year project funded by the USGS Alaska Climate Science Center.

Community based permafrost and climate monitoring in rural Alaska: The GIPL team secured 3 years of funding (2015-2018) from the National Science Foundation for this project. The overarching goal of this project is to help build the tribal capacity to monitor changes in local climate and permafrost. The GIPL team will establish new permafrost observatory system in the Upper Kuskokwim region as part of this project.

Dr. Reginald Muskett continues satellite-based investigations of changes within the permafrost and periglacial regions of Earth. This year Dr. Muskett had two publications: one an investigation of soil moisture retrieval algorithms with soil moisture measurements (Muskett et al., 2015a, Int. J. Geosciences) and the other an investigation of Alaska's North Slope using the NASA Ice, Cloud and land Elevation Satellite (ICESat) Geoscience Laser Altimeter System (GLAS) and the JAXA Advanced Land Observation Satellite (ALOS) Phased Array type L-band Synthetic Aperture Radar (PALSAR) to further our understanding of radar scattering (surface and volume) by the active-layer, snow cover and tundra vegetation (Muskett et al., 2015b, Int. J. Geosciences). Dr. Muskett is working with other members of the Lab and other institutes on new funding proposals to for the coming year. Dr. Muskett continues to convene and chair permafrost science sessions at the European Geoscience Union General Assembly in Vienna, Austria and the American Geophysical Union Fall Meeting in San Francisco. This year JPL and NASA convened the second annual workshop for developing the dual-band satellite radar mission NASA - Indian Space Research Organization (NISAR). The workshop was held at the NASA Ames Research Center, Moffet Field, California. At the workshop Dr. Muskett gave a poster presentation of his newest paper about interferometric synthetic aperture radar (InSAR) scattering properties

on the tundra of the North Slope, Alaska. There he also shared information and insights with the mission working groups and science teams.

Dr. Alexander Kholodov continued to conduct his long-term observations of permafrost temperature in Yakutia. In collaboration with colleagues from Melnikov Permafrost Institute 3 more boreholes were instrumented for continuous temperature monitoring around Yakutsk. As part of a NSF funded project "Vegetation and ecosystem impacts on permafrost vulnerability" he took part in an ecological survey at the GIPL permafrost observation sites in collaboration with Woods Hole Research Center and Colgate University. Also Dr. Kholodov conducted permafrost coring near Healy, Alaska; 3 short (2.5 meters) and one long (5.3 meters) cores were described and subsampled for cryolithological, biogeochemical and paleoenvironmental analyses. A previously existing deeper borehole (5 m deep) was instrumented for continuous measurement in order to extend and improve monitoring system at the Healy research site. He served as a lead mentor in 2015 International Arctic Research Center summer school "Arctic in a warming climate: connection to vegetation, permafrost and hydrology".

Dr. Santosh Panda continued his work on a National Park Service (NPS) funded permafrost modeling project focused on developing high-resolution (30 m) maps of near-surface permafrost temperature and active-layer thickness for national parks in Alaska. High-resolution permafrost modeling for the five Arctic national parks has been completed recently. The modeling products and the report will be available by spring 2016 on GIPL website. As part of a permafrost outreach project entitled "Hot Times in Cold Places: The Hidden World of Permafrost" funded by NSF, Dr. Panda travelled to seven communities in interior Alaska and help conduct community science night on permafrost. One of the goals of this project is to improve the delivery and effectiveness of STEM learning related to climate change. He participated in New Generation of Polar Researchers Leadership Symposium held at University of Southern California Wrigley/Boone Center for Environmental Leadership during May 2-9, 2015. He served as a mentor in 2015 International Arctic Research Center summer school "Arctic in a warming climate: connection to vegetation, permafrost and hydrology". He is editor of Changing Ice, a newsletter of cryosphere research in Alaska.

William Cable continues to pursue his master's degree (finishing summer 2016), studying the spatial variation in permafrost thermal regime at both regional and local scales, while working part- time as a Research Professional in the GIPL. In April, he attended the EGU General Assembly in Vienna and presented a poster, "Evaluating Ecotypes as a means of Scaling-up Permafrost Thermal Measurements in Western Alaska" (http://goo.gl/ME694z). William spent most of the summer traveling around Alaska, visiting permafrost observatories to collect data and make repairs. He continues to serve as a GTN-P National Correspondent and on the Secretariat as the Technical Assistant for GTN-P.

PhD student Prajna Regmi Lindgren, together with other project members of the NASA funded project on North American lake methane emissions, published a research paper on "Detecting and Spatio-Temporal Analysis of Methane Ebullition on Thermokarst Lake Ice Using High Resolution Optical Aerial Imagery" (Lindgren et al., 2015, Biogeosciences Disc.). Lindgren continues research on remote sensing-based detection and classification of methane ebullition bubbles in thermokarst lake ice and as well as mapping of lake distribution and changes in Western Alaska. The Western Alaska Landscape Conservation Cooperative (WALCC) funded the research on lake mapping and change analysis with a focus to assess the dynamics of lake habitat change in major lake districts of the WALCC region in relation to permafrost change. Lindgren presented the preliminary outcome of this research in two village communities (Selawik and Kotzebue) in November 2014, and in a webinar in May 2015 organized by the WALCC. Lindgren and Guido Grosse are involved in a new NASA ABoVE project on scaling local thermokarst lake methane emissions to larger regions using remote sensing data.

Visit Geophysical Institute Permafrost Laboratory website for further details on the current and past projects, data, reports, publications of all GIPL members, and latest permafrost news, www.permafrostwatch.org. GIPL Team: Vladimir Romanovsky, Sergey Marchenko, Alexander Kholodov, Reginald Muskett, Dmitry Nicolsky, William Cable, Santosh Panda, Prajna Regmi Lindgren, Louise Farquharson and Viacheslav Garayshin, Lily Cohen.

The George Washington University

Permafrost research at GWU is focused on three thematic areas: long-term monitoring and dynamics of the active-layer and near-surface permafrost (CALM); interactions between permafrost and hydrologic regimes in the Russian Arctic; and socio-economic development in Russian permafrost regions. Field activities for the Circumpolar Active Layer Monitoring (CALM) project were conducted in Alaska and Russia during the summer of 2015 under the CALM IV program. CALM IV is funded by the U.S. National Science Foundation's Arctic Obser-

ving Network program for the 2014-2019 period, and provides support for field operations at permafrost observatories in northern and western Alaska and at numerous Russian sites. The project is headquartered at GWU, with subcontracts to the University of Montana and Northern Michigan University. The 2015 Alaska field team consisted of Nikolay Shiklomanov (GWU), Anna Klene (University of Montana), Fritz Nelson (Northern Michigan University and Michigan State University), and four students (K. Nyland (MSU), S. Ross (GWU), Z. Li (GWU) and C. Queen (NMU). Annual active-layer and ground-temperature observations were conducted at a series of CALM sites representative of the diverse climatic and landscape conditions on the North Slope of Alaska and Seward Peninsula. Ground-subsidence monitoring by means of differential GPS was conducted at several sites. All data generated under CALM‘s programs are available through the CALM webpage.

Dima Streletskiy (GWU) was appointed the Chair of the GTN-P Steering Committee during the Second GTN-P National Correspondents Workshop in Quebec, Canada, September 19-20, 2015. The 2nd GTN-P National Correspondents Workshop, funded by IASC and supported by the IPA and the AWI, was visited by 28 participants involved in the GTN-P Steering Committee, the Secretariat, Advisory Board, as National Correspondent or as invited external collaborator (e.g. IASC, IPA, NSIDC and NORDICANA-D) representing 16 countries. The involvement of Early Career Scientists in GTN-P was discussed in order to sustain and excel GTN-P in the future. The decision was made for a wide call for “Young National Correspondents” of GTN-P (YNC) through PYRN. YNC will work closely with their national correspondents and be exposed to all aspects of the GTN-P from data collection and management to participation in scientific reports, meetings and publications. GTN-P will present the results of the new state of permafrost report at the ICOP2016 in Potsdam and will give a data management course for Young National Correspondents in association with the PYRN workshop at ICOP.

Our research on socio-economic impacts on permafrost degradation has continued. Over the past three years we have collaborated with the GWU Institute for European, Russian and Eurasian Studies (IERES) on NSF-funded Research Coordination Network (RCN) project on Arctic Urban Sustainability. It is a multi-disciplinary, international effort examining the interconnections among resource development, climate change, and evolving demographic patterns with the goal of providing advice to U.S., Russian, and other policy-makers on how to develop Arctic and related infrastructure in a way that produces minimal impact on the environment. The permafrost component of the project involves participants from the US and Russia representing geography, permafrost engineering, architecture, and climatology. In 2015 GWU housed an RCN meeting with 40 participants from the US, Russia, Canada, and Europe. Building on the NSF RCN in 2015 we have developed a successful NSF Partnership in International Research and Education (PIRE) project on Promoting Urban Sustainability in the Arctic. The project will start in April 2016 and has a substantial permafrost-related research and educational components. The 2015 funded ARCTIC-ERA (ARCTIC climate change and its impact on Environment, infrastructures and Resource Availability) Belmont project is collaborative effort between Laboratoire de Glaciologie et Géophysique de l‘Environnement (France), The GWU (USA), Shirshov Institute of Oceanology (Russia), the Institute of Economic Forecasting (Russia), and HS&S Corp. (USA) are working to forecast and provide estimates of the magnitude of environmental changes in the Arctic and their impact on the communities’ well being and infrastructure. Within the framework of the ARCTIC-ERA project the GWU team is responsible for geographic assessment of the effect of permafrost changes on human infrastructure.

The project “Collaborative Research: Interactions Between Air Temperature, Permafrost, and Hydrology in the High Latitudes of Eurasia” has completed its fieldwork component. Stable isotope composition of rain, snow, and various types of ground ice was used to determine various inputs and pathways to river flow in several watersheds. More than 500 samples were collected over the three year period at Igarka, Russia in collaboration with the Igarka Geocyology Lab of the Melnikov Permafrost Institute SB RAS, and University of New Hampshire.

Kelsey Nyland has completed a master‘s degree in geography at GWU with a thesis entitled Climate- and Human-Induced Land Cover Change and its Effects on the Permafrost System in the Lower Yenisei River of the Russian Arctic. Kelsey has moved to Michigan State University to pursue a Ph.D. in Geography. She will continue to be actively involved in the CALM IV and Arctic Urban sustainability projects. Fritz Nelson has been named Professor Emeritus at the University of Delaware, and now holds academic appointments as Adjunct Professor at Northern Michigan University (NMU) and Michigan State University (MSU). He maintains involvement in CALM IV through NMU and is developing a program of research and graduate education in periglacial geomorphology at MSU. After 1 January 2016 Nelson’s email address will be fnelson@msu.edu.

Institute of Northern Engineering (INE), University of Alaska Fairbanks (UAF)

A research group led by Prof. Yuri Shur continued working on the NSF-funded project "Dynamics and consequences of increasing ice-wedge degradation". During these studies, which started in 2010, the team has performed field work to assess ice-wedge degradation and stabilization at six intensive study sites, including the Jago River, Prudhoe Bay, Barrow, and Itkillik sites in northern Alaska and the Creamers Field and Horseshoe Lake sites in central Alaska. Five stages of ice-wedge degradation and stabilization, including undegraded wedges (UD), degradation-initial (DI), degradation-advanced (DA), stabilization-initial (SI), and stabilization-advanced (SA), and processes of ice-wedge thermokarst and thermoerosion have been characterized have been characterized. The field efforts included measurements of surface microtopography with ground-based LIDAR, descriptions of soil stratigraphy and ground ice, estimations of ground-ice content, monitoring water levels with pressure transducers and time-lapse cameras, logging soil temperatures, and vegetation sampling. In 2015, two peer-reviewed papers were published (Jorgenson et al., 2015; Kanevskiy et al., 2015).

Team: Yuri Shur (INE), Torre Jorgenson (Alaska Ecoscience), Mikhail Kanevskiy (INE), Nataliya Moskalenko (Earth Cryosphere Institute, Russia), Dana Nossov Brown (UAF), Kim Wickland (USGS), Josh Koch (USGS).

Jorgenson, T., Kanevskiy, M.Z., Shur, Y., Moskalenko, N.G., Brown, D.R.N., Wickland, K., Striegl, R., and Koch, J. (2015) Ground ice dynamics and ecological feedbacks control ice-wedge degradation and stabilization. JGR Earth Surface 120, doi:10.1002/2015JF003602.

Kanevskiy, M., Shur, Y., Strauss, J., Jorgenson, M.T., Fortier, D., Stephani, E., and Vasiliev, A. (2015, in press) Patterns and rates of riverbank erosion involving ice-rich permafrost (yedoma) in northern Alaska. Geomorphology, doi:10.1016/j.geomorph.2015.10.023.

A research group led by Dr. Margaret Darrow continues to monitor the movement and analyze the morphology of frozen debris lobes (FDLs) in the southern Brooks Range, Alaska. This project uses remotely sensed data from multiple acquisition methods (e.g., LiDAR, InSAR, historic aerial imagery, data gathered by unmanned aircraft system (UAS), and DGPS measurements in the field) to study FDLs, which are slow-moving landslides on permafrost-affected slopes. Large advances have been made in understanding the rates and episodes of movement of these geohazards by analyzing these features at different temporal scales using the various methods. The effectiveness of each method will be discussed in an upcoming paper in summation of the research project. Additional slope stability and GIS analysis of FDL-A, the closest FDL to the Dalton Highway, will be presented in a forth-coming paper "Investigating Movement and Characteristics of a Frozen Debris Lobe, South-Central Brooks Range, Alaska" (Simpson et al., in press).

Team: Margaret Darrow (INE), Franz Meyer (UAF), Wenyu Gong (UAF), Keith Cunningham (UAF), Ronald Daanen (DGGS), Nora Gyswyt (INE)

Simpson, J. M., Darrow, M. M., Huang, S. L., Daanen, R. P., Hubbard, T. D. "Investigating movement and characteristics of a frozen debris lobe, south-central Brooks Range, Alaska." Environmental & Engineering Geoscience, (in press).

The Next-Generation Ecosystem Experiments (NGEE Arctic)

Investigating linkages between surface and subsurface properties is critical for understanding the fate of terrestrial ecosystems in a changing climate. Near-surface soil hydrological and biogeochemical processes are widely known to be influenced by strong surface and subsurface interactions in ice-rich landscapes, but seldom are studies designed to examine co-variation in active layer and permafrost properties at scales appropriate for inclusion into Earth System Models. In this study, researchers in the NGEE Arctic project investigated linkages between soil and landscape property dynamics in the Arctic tundra in Barrow, AK. This was done along transects that traverse a range of geomorphological conditions, including ice-wedge polygons, interstitial tundra, and drained-haw lake basins. Landscape characteristics were inferred from topographic, multi-spectral and thermal-infrared imaging measurements using either a kite-, pole- and tram-based platform at various temporal and spatial scales from continuous monitoring along a 35 m long transect to occasional campaigns along 500x40 m corridors (see Figure). Soil properties are inferred using electrical resistivity tomography, time- domain reflectometry, temperature measurements, and soil sample analysis. Overall, scientists were able to identify the spatiotemporal linkages between various soil and landscape properties, including water inundation, vegetation, topography, thaw layer thickness, soil water content, temperature, electrical conductivity, and snow thickness. This research confirms the complementary nature of various ground- and aerial-based approaches and proxies to estimate soil

properties within a framework that considers uncertainty, resolution, and spatial coverage. Among other results, a relatively strong relationship was observed between changes in soil electrical conductivity, water content, active layer thickness, and vegetation state. These associations reinforce the importance of water distribution on various processes including vegetation dynamics, thermal conductivity, surface- subsurface energy exchange, redox reactions, and biogeochemical mechanisms. Identifying such linkages is crucial if we are to extrapolate knowledge from point-scale and core-based biogeochemical measurements at specific sites over larger scales to ultimately improve parameterization of models simulating ecosystem feedbacks to climate. Results from this study will be presented at the Fall AGU meeting in San Francisco (Dafflon et al., B41D-0469).

Figure 1.The picture on the left shows the co-acquisition of electrical resistivity tomography (ERT) along transects on the Barrow Environmental Observatory. Geophysical data acquired using the ERT arrays are collocated with point-scale measurements of various soil properties and landscape images using a kite-based platform equipped with a multi-spectral camera. Landscape images (such as the ones shown on the right) are involved in the reconstruction of geo-referenced mosaic and digital surface model, which are further used to investigate co-interactions between subsurface and surface properties.

University of Alaska Fairbanks

D.A. (Skip) Walker, Yuri Shur, Gary Kofinas, Mikhail Kanevskiy, Marcel Buchhorn, Martha Raynolds, Lisa Wirth, Jana Peirce, Tracie Curry, Michael Willis

Following the discovery of oil at Prudhoe Bay, Alaska, a series of environmental studies documented the landscape changes resulting from the rapidly expanding network of roads and oilfield facilities (Walker et al., 1987; National Research Council (NRC), 2003; Raynolds et al., 2014). The latest studies noted a steep increase in the abundance of thermokarst features within the oilfield since 1990 (Fig. 1). A full description of the landscape and permafrost changes in the Prudhoe Bay Oilfield, derived mainly from regional- and landscape-scale mapping studies, is in Walker et al. (2014). In- depth field studies of thermokarst within the Prudhoe Bay Oilfield have been recently conducted (Jorgenson et al. 2015, Walker et al. 2015).

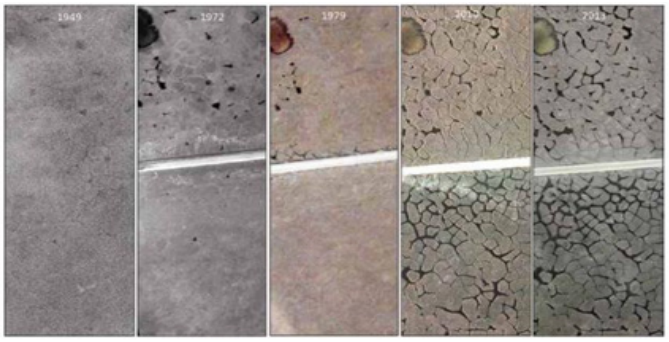

Figure 2. Colleen Site A study area time series 1949-2013, showing progression of change. Imagery and original scales: Jul 1, 1949, U.S. Navy, BAR, black & white, 1:20,000; July 15, 1972, U.S Army Cold Regions Research and Engi- neering Laboratory (CRREL), black & white, 1:6,000; July 13, 1979, Prudhoe Bay Unit, color,1:18,000; 2010 BP Alaska, digital, color, 1-foot resolutions; 2013 BP Alaska, digital, color, 0.75-foot resolution. Notes: The Spine Road was constructed in 1969 so it does not appear on the 1949 image. The 1949 image is degraded, but most of the thermokarst pits that are present in 1972 are still visible.

During August 2014 and 2015, we examined road-related thermokarst features that were accessible near the Deadhorse airport. The main objective of the field program was to document the extent and effects of road dust and road-related flooding to the topography, landforms, permafrost, soils, and vegetation. We were particularly interested in changes to the permafrost and ice-wedges. We chose two main study sites: (1) Colleen Site A, which is located along the Spine Road, the oldest most heavily traveled road in the region, and (2) the Airport Study Site. The Colleen Site has extensive thermokarst that formed deep troughs over degrading ice wedges on the surface with low- centered ice-wedge polygons. Historical changes to thermokarst at this site are documented in annual aerial photographs taken by the U.S. Navy (1949) and oil industry every year since discovery of the field in 1968. The Airport Site is located adjacent to the Sagavanirktok River on better-drained terrain, where thermal erosion has deeply eroded the polygonal ice-wedge troughs forming high- centered polygons with over a meter of center-trough micro-relief. Field studies at both sites include measurements of topography, active layer, vegetation, dust, flooding, snow, soil temperatures, and spectral reflectance along transects on both sides of the road. Shallow permafrost boreholes with depths from 50 to 257 cm were drilled in ice-wedge troughs and centers of polygons (57 boreholes at Colleen Site A and 28 boreholes at the Airport Site). A full data report is available for the 2014 field studies (Walker et al. 2015), and another is in preparation for the 2015 studies. Interviews of oil- industry personnel and local residents are being conducted

to examine the various perspectives of the effects of roads to help in developing adaptive management methods. The U.S. National Science Foundation's Arctic Science Engineering and Education for Sustainability (ArcSEES) initiative is funding the study. Early results will be presented at the 2015 AGU meeting.

Jorgenson, T., Kanevskiy, M.Z., Shur, Y., Moskalenko, N.G., Brown, D.R.N., Wickland, K., Striegl, R., and Koch, J. (2015) Ground ice dynamics and ecological feedbacks control ice-wedge Degradation and Stabilization. JGR Earth Surface. (In press)

National Research Council (NRC). (2003). Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope (pp. 1–305). Washington, D.C.: National Academy Press.

Raynolds, M. K., Walker, D. A., Ambrosius, K. J., Brown, J., Everett, K. R., Kanevskiy, M., et al. (2014). Cumulative geoecological effects of 62 years of infrastructure and climate change in ice-rich permafrost landscapes, Prudhoe Bay Oilfield, Alaska. Global Change Biology, (20),
1211–1224. http://doi.org/10.1111/gcb.12500

Walker, D. A., Webber, P. J., Binnian, E. F., Everett, K. R., Lederer, N. D., Nordstrand, E. A., & Walker, M. D. (1987). Cumulative impacts of oil fields on northern Alaskan landscapes. Science, 238(4828), 757–761.

Walker, D A, Raynolds, M. K., Buchhorn, M., & Peirce, J. L. (Eds.). (2014). Landscape and permafrost change in the Prudhoe Bay Oilfield, Alaska (pp. 1–84). Fairbanks, AK: Alaska Geobotany Center, University of Alaska, AGC Publication 14-01.

Walker, D. A., Buchhorn, M., Kanevskiy, M., Matyshak, G. V., Raynolds, M. K., Shur, Y. L., & Peirce, J. L. (2015). Infrastructure-Thermokarst-Soil-Vegetation Interactions at Lake Colleen Site A, Prudhoe Bay, Alaska (No. AGC 15-01). (D. A. Walker, M. K. Raynolds, M. Buchhorn, & J. L. Peirce, Eds.)AGC Data Report (pp. 1–100). Fairbanks.

Walter Anthony, K. M., S. A. Zimov, G. Grosse, M. C. Jones, P. Anthony, F. S. Chapin III, J. C. Finlay, M. C. Mack, S. Davydov, P. Frenzel, S. Frolking

Shift of thermokarst lakes from methane source to climate-cooling carbon sink

Our recent efforts have focused on understanding the dual role thermokarst lakes play in the climate system by emitting greenhouse gases and sequestering atmospheric carbon. Walter Anthony et al. 2014 compiled basal dates of thermokarst lake initiation in the Arctic; quantified carbon stocks in undisturbed permafrost soil profiles and in thermokarst lake basins; and estimated past and present methane and carbon dioxide emissions from thermokarst lakes using both flux measurements and carbon mass balance approaches.

Thermokarst lakes formed across vast regions of Siberia and Alaska during the last deglaciation and are thought to be a net source of atmospheric methane and carbon dioxide during the Holocene. However, the same thermokarst lakes can also sequester carbon, and until recently it was uncertain whether carbon uptake by thermokarst lakes can offset their greenhouse gas emissions. Walter Anthony et al. (2014) used field observations of Siberian permafrost exposures, radiocarbon dating and spatial analyses to quantify Holocene carbon stocks and fluxes in lake sediments overlying thawed Pleistocene-aged permafrost. We find that carbon accumulation in deep thermokarst-lake sediments since the last deglaciation is about 1.6 times larger than the mass of Pleistocene-aged permafrost carbon released as greenhouse gases when the lakes first formed. While methane and carbon dioxide emissions following thaw lead to immediate radiative warming, carbon uptake in peat-rich sediments occurs over millennial time scales. With the help of an atmospheric perturbation model we assess thermokarst-lake carbon feedbacks to climate and find that thermokarst basins switched from a net radiative warming to a net cooling climate effect about
5000 years ago. High rates of Holocene carbon accumulation in lake sediments (47 ± 10 g C m-2 a-1, mean ± SE, n=20 lakes) were driven by thermokarst erosion and deposition of terrestrial organic matter, by nutrient release from thawing permafrost that stimulated lake productivity and by slow decomposition in cold, anoxic lake bottoms. When lakes eventually drained, permafrost formation rapidly sequestered sediment carbon. Our estimate of about 160 Pg of Holocene organic carbon in
deep lake basins of Siberia and Alaska increases the circumpolar peat carbon pool estimate for permafrost regions by over 50 percent. The carbon in perennially-frozen drained lake sediments may become vulnerable to mineralization as permafrost disappears, potentially negating the climate stabilization provided by thermokarst lakes during the late Holocene.

Walter Anthony, K. M., S. A. Zimov, G. Grosse, M. C. Jones, P. Anthony, F. S. Chapin III, J. C. Finlay, M. C. Mack, S.Davydov, P. Frenzel, S. Frolking. 2014. A shift of thermokarst lakes from carbon sources to sinks during the Holocene epoch. Nature, 511, 452-456, DOI 10.1038/nature13560

United States Army Cold Regions Research and Engineering Laboratory (CRREL)

The U.S. Army Cold Regions Research and Engineering Laboratory (CRREL) continues to expand detailed permafrost characterization studies at their Permafrost Tunnel and Farmer's Loop Research sites near Fairbanks, Alaska. This includes intensive drilling and sampling along transects, repeat geophysical surveys, and repeat active layer probing, vegetation analysis, soil thermal measurements, and snow characterization. We are also maintaining a growing network of sites around Fairbanks where hyperspectral imagery, airborne LiDAR, snow depth, seasonal thaw, and vegetation spectral measurements are being made. New projects include work on the hydrogeology of Tanana Flats, soil microbiologic and bacterial measurements of permafrost of varying ages, and hydrochemistry of permafrost terrains across Alaska. Large scale permafrost characterization studies are ongoing for the North Slope Borough, the State of Alaska Department of Transportation, and the U.S. Navy. A suite of research projects in Greenland includes refining methods for delineating, sampling and characterizing ground ice conditions of glacio-fluvial/weathered bedrock for infrastructure and developing rehabilitation methodologies for active infrastructure suffering from thaw-degradation in Greenland.

U.S. Geological Survey

Permafrost-related research at the USGS spans multiple disciplines and regional science centers. Broad research themes include permafrost thermal regime measurements, soil microbiology and biogeochemistry, hydrologic modeling and aquatic biogeochemistry, geophysical investigations, and remote sensing and landscape change. A selection of the USGS personnel involved, specific project goals, and outcomes during 2015 are provided below.

Permafrost Thermal Regime Measurements: Gary Clow and Frank Urban with the USGS Geosciences and Environmental Change Science Center (GECSC) oversee the DOI/GTN-P USGS Permafrost and Climate Monitoring Network located on federal lands in northern Alaska. In 2015, the annual data series update from the team was released and a subsequent release with data through July 2014 will be published before the end of the calendar year. In addition, network station maintenance, snow surveys and instrument retrievals/deployments were conducted during the spring and summer of 2015. Gary Clow is constructing mathematical models to extract the climate signal from the borehole temperature measurements collected during the past 40 years. Frank Urban represented the United States as a correspondent at the annual GTN-P workshop in Quebec City.

Soil Microbiology and Biogeochemistry: Mark Waldrop is the Principal Investigator of the USGS Soil Biogeochemistry Group which seeks to understand the forms, causes, and consequences of soil carbon gains and losses in response to permafrost thaw in northern latitude ecosystems. His team includes Jack McFarland, Jennifer Harden, Kristen Manies, Miriam Jones, and Monica Haw. The team works in close collaboration with the Bonanza Creek LTER and university colleagues Rachel Machelprang at CSU Northridge on microbial metagenomics and Rebecca Neumann at U. Washington on measurement and modeling of methane cycling. In Alaska, this team focuses primarily on permafrost thaw and its effects on soil C storage and greenhouse gas fluxes in lowland thermokarst environments. During 2015, the team published findings related to the phylogenetic composition of microbial communities in permafrost, the active layer, and a thermokarst bog located in Interior Alaska and demonstrated the potential linkage between molecular data and ecosystem level process rates. These microbial community relationships may help explain the processes involved with findings by the group showing that permafrost carbon is rapidly lost following permafrost thaw in boreal permafrost peatlands. A new NASA astrobiology project will focus on microbial strategies for survival and activity in permafrost. Miriam Jones is also co-Principal Investigator on an NSF-funded project to examine the role of peatlands and thermokarst lakes on the atmospheric methane concentrations over the Deglacial and the Holocene. Synthesis work included identifying peatland properties specific to permafrost peatlands, and using plant macrofossils and peat properties to identify the timing of permafrost aggradation in existing permafrost peatlands.

Hydrologic Modeling and Aquatic Biogeochemistry: Michelle Walvoord, with the USGS National Research Program (NRP), led a USGS team that completed a four year integrated field and model based study to investigate permafrost influence on hydrologic processes and fluxes in interior Alaska.

The research was done in collaboration with scientists from the US Army CRREL office and resulted in methodological advances in geophysical measurements as well as concerted efforts focused on widespread Interior Alaska lake surface area changes and feedbacks. In addition, Cliff Voss is finalizing the public release of a computer simulation code (USGS-SUTRA code) that represents the flow of groundwater, subsurface energy transport (temperature change), and subsurface freeze/thaw. Kim

Wickland and Rob Striegl of the USGS NRP also recently published a paper that describes the rapid conversion of ancient permafrost soil-derived dissolved organic carbon (DOC) to carbon dioxide (CO2), and implications for detection of aged DOC in aquatic systems from permafrost thaw. Kim Wickland and Dave Krabbenhoft (USGS Wisconsin Water Science Center) launched a field study in 2015 focused on the effects of permafrost thaw on mercury and carbon cycling in cooperation with Denali National Park. The project will continue in 2016. In addition, Rob Striegl will lead a recently funded NASA ABoVE Project to assess the vulnerability of inland waters and the aquatic carbon cycle to changing permafrost and climate across boreal northwestern North America.

Geophysical Investigations: Burke Minsley and other research scientists from the USGS Crustal Geophysics and Geochemistry Science Center (CGGSC) as well as the USGS Office of Groundwater Branch of Geophysics (OWG BG) used geophysical methods to map permafrost characteristics. Permafrost geophysical measurement efforts focused on collecting electrical resistivity tomography (ERT) data in Interior Alaska to characterize the impact of fire on permafrost. In addition, a nuclear magnetic resonance (NMR) probe was tested for applications of quantifying in situ unfrozen water content in shallow soils and permafrost. The team published a recent numerical hydrogeophysical modeling study showing the utility of airborne electromagnetic data for better understanding the state of sublacustrine permafrost thaw. In August 2015, Bruce Richmond, Peter Swarzenski, Tom Lorenson and Cordell Johnson from the USGS Pacific Coastal and Marine Science Center in Santa Cruz, CA, surveyed rapidly eroding permafrost bluffs on Barter Island, a barrier island on Alaska's Arctic coast. The researchers aim to document seasonal to decadal coastal-bluff change and associated hydrogeologic processes along a 3-kilometer stretch of permafrost coastline on Barter Island.

Remote Sensing and Landscape Change: Bruce Wylie and Jennifer Rover of the USGS Earth Resources and Observation and Science (EROS) center and Neal Pastick (SGT contractor to USGS EROS) are involved in a collaborative partnership with other scientists to map permafrost, water dynamics in lakes, and soil organic layer thickness in mainland Alaska. Machine learning, data fusion, remotely-sensed Landsat data, and other digital map products are used to extend field observations of permafrost related attributes. The EROS team recently published a study that focused on developing binary and probabilistic maps of near-surface permafrost distributions at a 30 m resolution by employing decision tree models, field measurements, and remotely sensed (Landsat) and mapped biophysical data. The team also has an in press publication related to soil carbon and permafrost estimates and susceptibility in Alaska. Ann Gibbs and Bruce Richmond from the USGS Pacific Coastal and Marine Science Center in Santa Cruz, CA, recently released a comprehensive report covering more than 1000 miles of the Alaskan coast between the U.S. Canadian border and Icy Cape. Benjamin Jones, with the USGS Alaska Science Center (ASC), is involved in a number of studies related to northern high latitude landscape and ecosystem dynamics and change. The ASC team, that also includes Carson Baughman and Benjamin Gaglioti, focuses on the use of remote sensing, GIS, field surveys, laboratory analyses, and model development in Arctic and Boreal regions to better understand short-term and long-term changes occurring in permafrost-influenced landscapes. In 2015, the team published findings related to post-fire thermokarst development in arctic tundra, the role of beaded streams in arctic permafrost landscapes, observing a catastrophic thermokarst lake drainage, and the role of lake ice regimes on the hydrologic response of arctic lakes. The team is currently working on developing a remote sensing based Permafrost Essential Climate Variable (ECV) program and they are contributing to the recently funded NSF-Arctic Lake Ice Systems Science project, which focuses on winter lake dynamics and interactions with permafrost, hydrology, and climate to predict future Arctic system responses.

Individual Member Activities

Mark Demitroff: USPA-board member Mark Demitroff (Stockton University) has been working on evidence of strong Pleistocene wind-action, and its effects to land-surface processes and palaeohydrology in the ice marginal Pinelands National Reserve, New Jersey. He now collaborates with Franklin & Marshall College on the cold climate landscapes and sediments of unglaciated Pennsylvania and Maryland (thermal- contraction polygons, gelifluction features, pingo- like structures, thermokarst).

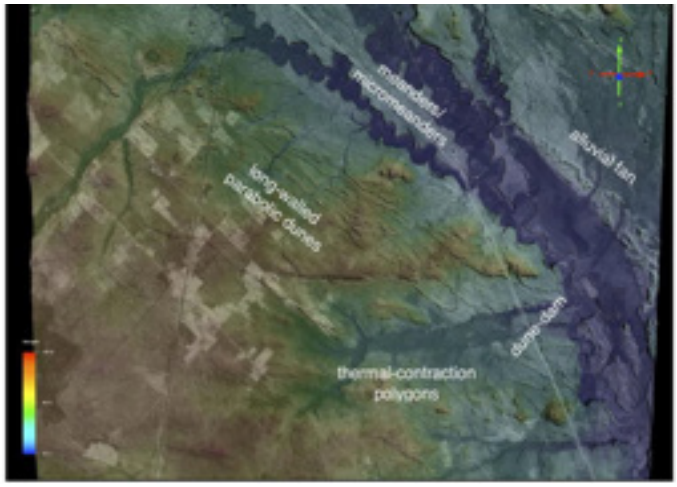

Figure 3. LiDAR-image of the true bare-earth ground showing relict periglacial features in the Great Egg Harbor National Wild and Scenic River watershed, Newtonville, NJ (M. Cicali & M. Demitroff). Stockton University).

Reginald Muskett (Ph.D., Research Associate, Geophysical Institute Permafrost Lab University of Alaska Fairbanks) continues research investigations into the changes of the permafrost regions of the Northern Hemisphere with measurements from the joint mission NASA-DLR Gravity Recovery and Climate Experiment (GRACE), the JAXA Advanced Land Observing Satellite (ALOS) Phased Array L-band Synthetic Aperture Radar (PALSAR) and other satellite remote measurement and sensing systems. This year he published papers on Arctic active-layer soil moisture retrievals (satellite-based algorithms) and measurements and their spatial-temporal variations (Muskett, 2015a) and the North Slope, Alaska, with emphasis on the Anaktovuk wildfire and Barrow regions using measurements from the NASA Ice, Cloud and land Elevation Satellite (ICESat) Geoscience Laser Altimeter System (GLAS) and the JAXA ALOS PALSAR for comparison of the backscatter properties of the tundra at two far- separated electromagnetic wavelengths (Muskett, 2015b).

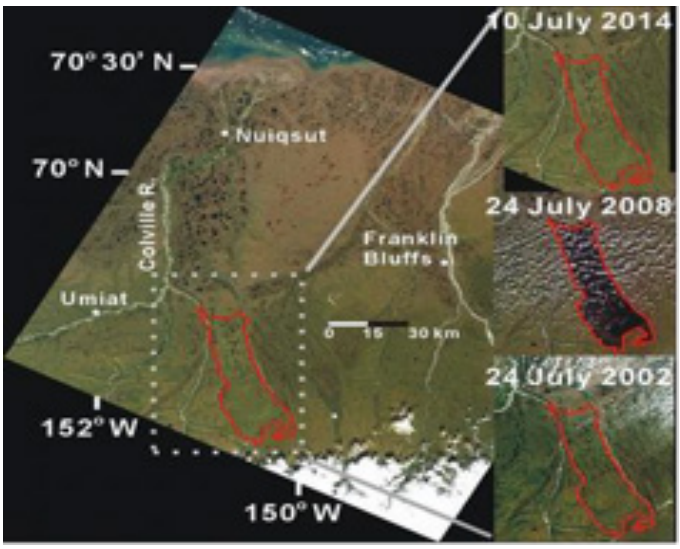

Figure 4. A region of interest on the North Slope, Alaska: The Anaktovuk Wildfire scar, as observed in LANDSAT7 and 8 images from 24 July 2002 (before the wildfire), 24 July 2008 (one year after the wildfire) and 10 July 2014 (showing vegetation recovery seven years after the wildfire) (Muskett, 2015b). For more on tundra vegetation recovery see Bret-Harte et al. (2013).

In 2015 Reginald continued his activity of convening and chairing permafrost science sessions at the European Geoscience Union (EGU) General Assembly, Vienna, Austria, and at the American Geophysical Union Fall Meeting in San Francisco, Califronia. At the EGU Reginald co-convened and co-shared again the session „Permafrost Open Session.“ At the AGU he was co-convener and co- chair of the session „Applications of Near Surface Geophysics in Periglacial Regions Posters.“

This year JPL and NASA convened the second annual workshop for dual-band satellite radar mission NASA - Indian Space Research Organization (NISAR). The workshop was held at the NASA Ames Research Center, Moffet Field, California. At the workshop Reginald gave a poster presentation of his newest paper about interferometric synthetic aperture radar (InSAR) scattering properties on the tundra of the North Slope, Alaska. There he also shared information and insights with the mission working groups and science teams.

Muskett, R.R., Romanovsky, V.E., Cable, W.L. and Kholodov, A.L. (2015a) Active-Layer Soil Moisture Content Regional Variations in Alaska and Russia by Ground-Based and Satellite-Based Methods, 2002 through 2014. International Journal of Geosciences, 6, 12-41. http://dx.doi.org/10.4236/ijg.2015.61002

Muskett, R.R. (2015b) ICESat GLAS Elevation Changes and ALOS PALSAR InSAR Line-of-Sight Changes on the Continuous Permafrost Zone of the North Slope, Alaska. International Journal of Geosciences, 6, 1101-1115. http://dx.doi.org/10.4236/ijg.2015.610086

Bret-Harte, M.S., Mack, M.C., Shaver, G.R., Huebner, D.C., Johnston, M., Mojica, C.A., Pizano, C., Reiskind, J.A. (2013) The response of Arctic vegetation and soils following an unusually severe tundra fire. Phil Trans R Soc B 368: 20120490. http://dx.doi.org/10.1098/rstb.2012.0490

Deaths

A.V. Pavlov (1930-2015)

Aleksandr V. Pavlov, one of the most accomplished permafrost scientists in permafrost history, passed away on November 4, 2015. Born in January 1930, he lost his parents while he was a boy and he and his sister had spent several years in an orphanage. He was in Leningrad during the Leningrad Siege. Before attending open university, he spent 4 years in a technical school. He graduated from Leningrad Polytech University and soon became a PhD student of the Academy of Sciences with residence at the Obruchev Permafrost Institute. He always remembered that period with great pleasure. He had a room in a dormitory of the Academy of Sciences and could attend the Moscow Chess Club. He was a very talented chess player and had high ranking in the chess hierarchy. His Ph.D. study was under M.M. Krylov on winter irrigation and he received his PhD in agricultural science. At that time, the Soviet Union started a program of Development of Virgin Lands and every institution, business, and industrial enterprise were to send their employees there even against their will. The Obruchev Permafrost Institute had only one candidate to send and this was Pavlov. Only health problems inherited during the WWII saved him from this adventure. He did not have a place to live in Moscow and for about 6 years he lived 100 km from Moscow at the small Zagorsk scientific station of the Permafrost Institute. Fortunately, it was the best time for the station.

It was chosen as one of the experimental sites of the International Geophysical Year 1957-1958 (IGY) and Pavlov lead, unique for that time, the thermal balance studies under several typical landscapes. His first book "Thermal exchange of freezing and thawing soils with the atmosphere" was based on his work during the IGY. He was an extremely hard worker and colleagues joked that he would never find time to have a family, but he did find his future wife Nina and they have two wonderful children Lena and Sergey.

In the beginning of 1960s Academician P.F. Shvetsov started the permafrost program at VSEGINGEO (USSR Institute of Hydrogeology and Engineering Geology) and Pavlov was invited to join it. After working at the VSEGINGEO for a few years he went to the Yakutsk Permafrost Institute. Many international scientists met him and visited his experimental sites during 2nd International Permafrost Conference. In 1974 he became a Doctor of Science in Geography. After 15 years work in Yakutsk, he returned to VSEGINGEO and led investigations on the monitoring of the thermal regime of permafrost at numerous sites. He continued his non-stopped work and only during lunches did he take time off to play fast chess games with two other well-known permafrost scientists, Grechishchev and Chistotinov, and not leaving them many chances for victory. I began my work at the Obruchev Permafrost Institute as his assistant. We spent three winter months together in the field in a very remote area where he tried to teach me heat transfer and without success to play cards and chess.

He wrote more than 15 books during his lifetime in permafrost science. He has left a long lasting memory in his numerous publications and with the people who worked with him. Maybe he can rest now for first time in his life.
Prepared by his friend Yuri Shur, University of Alaska Fairbanks.

H. Jesse Walker (1921-2015)

H. Jesse Walker died peacefully on May 10, 2015 at his home in Baton Rouge Louisiana at the age of 92. He was born in Michigan in 1921. He lived briefly in Colorado as a child, before the family finally settled at Morro Bay, California. He attended the University of California, Berkeley until World War II interrupted his studies. He enlisted after the bombing of Pearl Harbor and became a pilot in the Marine Corps, flying countless supply missions in the Pacific Theater. He returned to his studies at the end of the war, completing both a BS and a MS degree in geography. Carl Sauer was his Master's thesis advisor.

Dr. Walker began working in the North American

Arctic in the 1950s during his PhD research (1960 Louisiana State University). He flew over the Colville River delta, Alaska toward the end of his dissertation fieldwork. Looking down from the airplane, he became intrigued by this large Arctic river making it the focus of much of his research for the rest of his long life. During the 1950s through the 1980s, he spent many of his summers in the delta conducting fieldwork and mentoring graduate students. The result is a massive body of work that has laid the foundation for Alaskan Arctic research. His other research interests led him to coastlines throughout the world, most notably, Taiwan, Japan, Mauritius and Louisiana.

He was a humble and unassuming man, who had a passion for science and learning. Meeting him, one would never guess that he was a highly regarded scientist. Counted among his numerous awards and honors are the Patron's Medal from the Royal Geographical Society (2008), the Mathes Award from the American Association of Geographers (2009), the First Richard J. Russell Award in Coastal Geography - Association of American Geographers, Fellow of the American Academy of Science (1990), the First Honorary Fellow of the International Association of Geomorphologists (1989), a Doctor of Philosophy Honoris Causa degree from the University of Uppsala, Sweden (1986), Fellow of the Arctic Institute of North America (1979) and a Boyd Professorship at LSU (1977).

Jesse worked at Louisiana State University for over 50 years and was actively writing and publishing until his death. Fittingly, his last journal article was about the Arctic and was published several months after his passing.

Written by his friend and colleague Molly McGraw, Southeastern Louisiana University.

Report prepared by Molly McGraw, Secretary US Permafrost Association (4 December 2015) (molly.mcgraw@selu.edu)