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Frozen Ground

THE ANNUAL NEWS BULLETIN OF THE
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Once Upon the Permafrost: Knowing Culture and Climate Change in Siberia

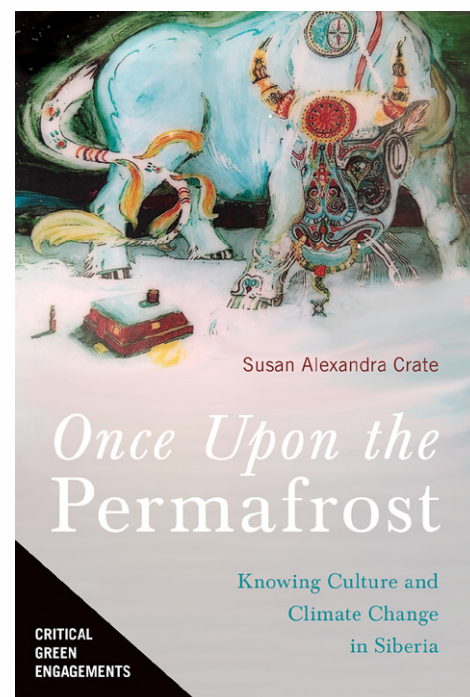
Words from the President

BY CHRIS BURN,
CARLETON UNIVERSITY, CANADA

I have taken the title of Susan Alexandra Crate's recent anthropological study of Sakha people and their encounter with cultural and climate change. I received a copy in February 2022, before the events in eastern Europe that will doubtless affect the IPA and which add another dimension to the existential challenges the 21st century has presented to us. We were aware of climate change, the proliferation of perspectives and information through the internet, and the permanent adjustments to working life that will be a consequence of the pandemic. Now we encounter in uncomfortable proximity aspects of our culture we thought had been banished from Europe.

Susan Crate's subject is the central significance of *alaas* – grassy drained

lake basins underlain by permafrost – in Sakha culture. It concerns connection to place as an essential part of Sakha's cultural identity. A Sakha person's birth *alaas* is their spiritual home to which they were tied seasonally as pastoralists and that remains the place where they belong. These fundamental connections are fraying as the ice wedges beneath the drained lake beds degrade and thermokarst mounds develop in the formerly flat terrain, making the area untrafficable. That is the principal geocryological element, driven by "milder" winters, no longer with weeks in the -50 and -60 °C range and more snow, hence, we must assume, warmer ground and a thicker active layer. *Alaas* landscapes are cultural landscapes because they are what Sakha have known since their Turkic ancestors arrived over 500 years ago. *Alaas* productivity depends on human intervention, especially with burning in spring to rid the surface of saplings invading from the forest surrounding the basins. They have been changed by canal ditching, more prevalent wildfires, and clear cutting. But there are other forces, largely socio-economic and particularly the next generation's



Crate, S.A. (2021). *Once Upon the Permafrost: Knowing culture and climate change in Siberia*. The University of Arizona Press: Tucson.

recognition of an easier life away from the animals at a desk or in a factory, the addictive magnetism of the internet and IT, and food supply through shops that distract Sakha from their birth *alaas*. Sakha's spiritual and cultural life is transforming, particularly for youth. This is perhaps seen in the West as lifestyle choice, but we will lose part of the intrinsic

connection between human society and the land, already commodified by the wilderness tourism industry that considers large tracts of the permafrost regions to be almost empty of human history or occupation, when these ties are no more. These places will then just be spaces.

Crate has uncomfortable words for scientists whose confidence in positivism as the epistemology for informing and managing climate change and its effects, including in the permafrost environment, may verge on hubris. We are so often pre-occupied with the general case that we relegate particular contexts to the error term in our modelling. She argues that progress in mitigating or adapting to climate effects will necessarily occur locally, hence the importance of geocryological anthropology, rather than anthropological geocryology. The collective inaction at global scale on carbon emissions

bears her critique out. In hopes of rallying more action globally, Crate leaves us with the understanding that 'We *all* live on permafrost,' considering the intrinsic connection that the cryosphere has to maintaining planetary climatic balance.

The Canadian Permafrost Association is involved in preparing for the 2024 ICOP in Whitehorse, where, we hope, Indigenous perspectives on the climate crisis and management of thawing permafrost landscapes will be an integral part of the meeting. Before then, we look forward next year to a regional conference in the Catalan Pyrenees, organized by Marc Oliva and his colleagues from Spain and Portugal. They have assembled a continent-wide treatise on *Periglacial Landscapes of Europe* that will be unveiled at the meeting. But looking back, the undoubted highlight of the IPA year 2021 was the RCOP organised and expertly transmitted online by the US Permafrost Associ-

ation. It was a magnificent production led by Tom Douglas, Anna Liljedahl, Kevin Schaefer, Peppi Croft, John Thornley, and Cathy Wilson. There were over 400 participants from around the circumpolar world, a *Proceedings* volume edited by Jon Zufelt, and now a thematic issue of *Environmental Research Letters* is open for submissions of papers developed from conference presentations. The RCOP format was a necessary response to pandemic conditions, but we shall see if it becomes an integral component of many meetings in the future as the carbon footprints of conferences begin to require management.

I hope that we enjoy a gradual return to greater connection with each other throughout 2022 and that Susan Crate's sensitive book expands our recognition of the dimensions of the challenges we face.

Chris Burn

IPA EXECUTIVE COMMITTEE, 2020-2022



PRESIDENT

Prof. Christopher R. Burn,
Carleton University,
Canada



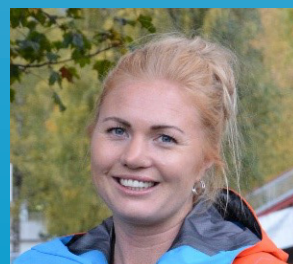
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CONFERENCE UPDATES

2021 Regional Conference on Permafrost (RCOP)

BY TOM DOUGLAS (U.S. ARMY CRREL), CONFERENCE CHAIR, KEVIN SCHAEFER (UNIVERSITY OF COLORADO) & FRITZ NELSON (MICHIGAN STATE UNIVERSITY)

The U.S. Permafrost Association (USPA) and American Society of Civil Engineers (ASCE) jointly held the Regional Conference on Permafrost (RCOP) and 19th International Conference on Cold Regions Engineering (ICCRE) from 24-29 October 2021. We met the conference goals of strengthening ties between the scientific, engineering, and local communities and promoting a diverse permafrost and cold regions engineering community.

Conference organizers spent two years planning the all-virtual meeting due to the ongoing COVID-19 pandemic. The virtual platform provided remote access to global participants, and registrants with access to presentations for three months after the conference. The event boasted 416 attendees with 280 plenary, oral, and poster presentations. The Permafrost Young Researchers Network (PYRN) held their annual meeting on 23 October (see p.12).

ASCE reviewed and edited 34 proceedings papers. Alaska Senator Lisa Murkowski opened the conference virtually, followed by Larry Hinzman

(White House Office of Science and Technology Policy). Other plenary presentations included the Eb Rice Lecture “*Tears of a Rapper: The Science and History behind the Art of Frozen Debris Lobe Rap Videos*” by Margaret Darrow (University of Alaska Fairbanks) and “*Perspectives on Climate Change: On-the-Ground Impacts of Climate Change in Arctic Communities*” by Darcy Peter (Woodwell Climate Research Center).

Jerry Brown received the [IPA Lifetime Achievement Award](#); Fritz Nelson provided a worthy tribute to his career accomplishments. The proceeding also included a tribute to Art Lachenbruch and acknowl-



edgement of others in the community that have passed.

The virtual platform provided some new ways of communicating and participating. The large number of registrants and presenters and the generous time and financial support of the permafrost research and engineering communities came together to develop a strong meeting. We appreciate the patience of our community during the planning process and send a much-deserved thank you to all that participated and helped with planning.



Dr. Jerry Brown (left) being awarded the IPA Lifetime Achievement Award by IPA President, Prof. Chris Burn (right) at RCOP2021.

CONFERENCE UPDATES

Cryosphere Transformation & Geotechnical Safety (CTGS'21)

BY DMITRY TURSUNOV & MARIA ATAMAS (YAMAL-NENETS DEPT. FOR EXTERNAL RELATIONS)

The International Conference: Cryosphere Transformation and Geotechnical Safety (CTGS'21) took place in Salekhard, Russia from 8-12 November 2021. It became a plat-

form for interdisciplinary dialogue to establish short- and long-term priorities for public authorities, science and business, which will provide a better level of enterprise ac-

tivities, life standards in the Arctic, and cryolithozone studies.

The Conference organizers include, Government of Yamal-Nenets autonomous okrug, IPA, Earth



Cryosphere Institute, Lomonosov Moscow State University, Melnikov Permafrost Institute, Arctic Research Center, and Russian Arctic Development Center. Specialists from nine countries and twenty Russian regions had the floor at the Conference both online and offline.

A special exhibition on permafrost-related issues was installed at the Conference venue. In addition, the Conference participants had an opportunity to take part in field trips to the Rai-Iz mountain massif and the Novoportovskiy merzlotnik (a warehouse made in permafrost).

The plenary session with the Governor of Yamal-Nenets autonomous okrug summarized the Con-

ference discussions. The experts in the fields of permafrost science and the real economy made proposals for a two-year program for developing Arctic territories in the face of climate change and permafrost degradation. The main conclusion

is that interdisciplinary joint work and cooperation of specialists from different fields are essential to solve the issues of adaptation to climate change. Experts in permafrost, social issues, and geotechnical problems should combine their efforts.



Panel discussion during CTGS'21 in Salekhard, Russia.

CONFERENCE UPDATES

16th International Circumpolar Remote Sensing Symposium (ICRSS)

BY BENJAMIN JONES (UNIVERSITY OF ALASKA FAIRBANKS, USA), LOCAL ORGANIZING COMMITTEE

The 16th International Circumpolar Remote Sensing Symposium (ICRSS) will be held at the University of Alaska Fairbanks from **16-20 May 2022**. Please submit your abstract to our updated Symposium email address (icrss2022@gmail.com) by 21 March 2022. The abstract template can be found [here](#). We are finalizing the registration portal and will share

the link shortly. We anticipate the Symposium will take place in-person with a virtual option for those unable to attend, including real-time and asynchronous interactive sessions. We have received support from the US National Science Foundation Office of Polar Programs and the International Arctic Science Committee (IASC) to increase participation among students

and early career researchers (ECRs) - contact the organizing committee if you need support.

For more information visit awi.de/en/science/geosciences/permafrost-research/conferences/icrss.html and sites.google.com/alaska.edu/coronavirus/uaf.



CONFERENCE UPDATES

6th European Conference on Permafrost (EUCOP6)

BY MARC OLIVA (UNIVERSITY OF BARCELONA, CATALONIA, SPAIN), LOCAL ORGANIZING COMMITTEE

The Spanish permafrost community is working on the organization of the 6th European Conference

on Permafrost (EUCOP6) to be held in Puigcerdà, Catalonia, Spain from **18-23 June 2023**. The conference



was postponed one year due to the COVID-19 pandemic. This event, promoted by IPA-Spain, will provide interdisciplinary collaboration and joint initiatives between periglacial and permafrost research groups. It will include three days of plenary lectures, oral presentations and posters, combined with several local field trips across the eastern Pyrenees (Cerdanya, Núria, Andorra, etc.). Two 3-day-long regional field

trips will be organized for before and after the conference.

The conference website will be available from early March.

Puigcerdà, in the valley floor of the Cerdanya basin.



CONFERENCE UPDATES

12th International Conference on Permafrost (ICOP2024)

BY LUKAS ARENSON (BGC ENGINEERING INC., CANADA), CONFERENCE CHAIR

The 12th International Conference on Permafrost (ICOP2024) will be held in Whitehorse, Yukon, Canada from **16-20 June 2024**. Whitehorse is situated on the banks of the historic Yukon River in the Traditional Territory of the Ta'an Kwäch'än Council and the Kwanlin Dün First Nation.

The conference will feature scientific sessions, public events, social gatherings, IPA council and executive meetings, PYRN meetings, a trade show, and local excursions. Pre- and post-conference excursions are being planned along the Alaska Highway, Dempster Highway, Inuvik to Tuktoyaktuk Highway, and to the

Dawson and Whitehorse areas. Field trips will last 1 to 6 days.

The National Conference Organizing Committee (NOC), with Brian Horton, Barb Fortin, Ryley Beddoe, Peter Morse, Kumari Karunaratne, Stephen Wolfe and Lukas Arenson are working towards offering a hybrid conference model with virtual access to selected elements of the conference. We expect the call for technical sessions to open on 1st January 2023, with a full-length paper submission deadline in August 2023. Extended abstracts will be accepted from the beginning of 2024. All full-length papers and abstracts



will be subject to peer review prior to be accepted.

For more information or if you want to volunteer, please contact Brian Horton (bhorton@yukonu.ca), chair of the Local Organizing Committee or Lukas Arenson (lar-enson@bgcengineering.ca), NOC Chair and Conference Chair. Additional information will soon be available on the conference website (icop2024.com).

ACTION GROUP REPORTS

Development of a pan-Arctic drained lake basin product

BY ACTION GROUP LEADERS, HELENA BERGSTEDT AND BENJAMIN JONES (UNIVERSITY OF ALASKA FAIRBANKS, USA)

Lakes and drained lake basins (DLB) are ubiquitous landforms in permafrost regions. Despite the recognition by local to regional studies of the long-term dynamics of lake formation and drainage evident in the abundance of DLBs in Arctic perma-

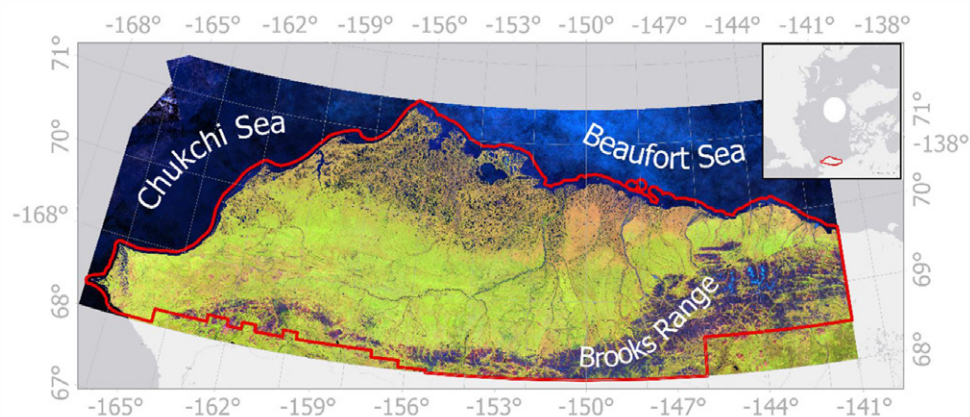
frost lowlands (e.g., Arctic Alaska, Russia, and Canada), a pan-Arctic assessment of DLB distribution and their carbon stores has never been attempted. A coordinated pan-Arctic scale effort is needed to better understand the importance of DLBs.

This Action Group has been focussing on the development of a pan-Arctic DLB product to fill this knowledge gap in permafrost-regions with implications for global-scale climate feedbacks. An extensive pan-Arctic DLB dataset

bringing together remote sensing-based mapping and field data will be of great interest to the scientific community and will benefit researchers working on projects from many different disciplines (e.g., hydrological modelling, wildlife and habitat studies, engineering, and carbon cycling).

This Action Group includes several early career researchers with multi-disciplinary skills in field studies, carbon science, permafrost science, and remote sensing. Helena Bergstedt, Benjamin Jones, Ingmar Nitze, and Alexandra Veremeeva are co-leading the DLB remote sensing effort. Guido Grosse is co-leading the basin age and carbon stock database development with Matthias Fuchs, Louise Farquharson, and Benjamin Gaglioti. Additional leadership of the Action Group is being provided by Mikhail Kanevskiy, Amy Breen, Anna Liljedahl, Annett Bartsch, Pascale Roy-Léveillé, Trevor Lantz, Frédéric Bouchard, and Gustaf Hugelius. Dr. Kenneth Hinkel is providing guidance based on his many years of research on DLBs in northern Alaska.

A remote sensing based DLB data product on the Alaska North Slope was published by multiple Action Group members. It forms the basis for developing this product across pan-Arctic lowland permafrost regions. A comprehensive review on lakes and DLB



Northslope of Alaska (red) in the Northern Hemisphere (insert) (Bergstedt *et al.*, 2021).

systems was also published by a multi-disciplinary team of experts in *Nature Reviews*. It contextualizes an extensive body of international research concerning L-DLB systems in the pan-Arctic, focusing primarily on research during the last decade. A progress update on the fusion of remote sensing-based mapping and field observations, focussing on vegetation surveys on the Alaskan North Slope, was presented during RCOP2021.

Current Action Group activities include the application of the DLB data product approach to the pan-Arctic lowland permafrost area. This will include a multisource remote sensing approach as well as a first attempt of fusing DLB field data with a DLB remote sensing data product on a circumpolar scale. Furthermore, the Action Group is hoping to hold at least one in-person meeting this year, which has so far been prevented by the global COVID situation.

We are aiming to hold a hybrid Action Group meeting in conjunction with the [International Circumpolar Remote Sensing Symposium \(ICRSS\)](#) in Fairbanks, Alaska during **16-20 May 2022**. In addition to the publication of the pan-Arctic mapping effort, we hope to conclude our Action Group with a specialized session at the [AGU Fall Meeting 2022](#).

For more information see:

Bergstedt, H., *et al.* (2021). Remote sensing-based statistical approach for defining drained lake basins in a continuous permafrost region, North Slope of Alaska. *Remote Sensing*, 13(13). DOI: [10.3390/rs13132539](https://doi.org/10.3390/rs13132539).

Jones, B.M., *et al.* (2022). [Lake and drained lake basin systems in lowland permafrost regions](#). *Nature Reviews Earth & Environment*, 3(1), 85-98.

ACTION GROUP REPORTS

Rock glacier inventories and kinematics (RGIK)

BY ACTION GROUP LEADER, REYNALD DELALOYE & RGIK OFFICER, SEBASTIÀN VIVERO (UNIVERSITY OF FRIBOURG, SWITZERLAND)

The Action Group 'Rock glacier inventories and kinematics' (RGIK) launched in 2018 at EUCOP5 in Chamonix, France. Its intended actions are to (1) coordinate the

definition of standard guidelines for inventorying rock glaciers globally, including refined indications on the activity rate, and (2) promote Rock Glacier Velocities (RGV) as a new



Tsarmine rock glacier, Swiss Alps (1 June 2021). Warmer temperatures in spring provoke intense erosion (about 4 cm/day) of the rock glacier front. A shear horizon is evident 20 m below the surface.

associated parameter of the GCOS ECV (Essential Climate Variable) Permafrost, representative of the evolution of mountain permafrost.

Following [Baseline concepts](#) for inventorying rock glaciers, illustrated [Practical concepts](#) were created and submitted to the Action Group subscribers for feedback in August 2021. The revised version of the latter document is almost ready to be launched for approval by Action Group participants.

A similar process has been undertaken to assign a semi-quantitative [Kinematic attribute](#) to inventoried rock glaciers. It has been supported by the [ESA CCI+ Permafrost](#) project, and partners from Argentina, France, Italy, Norway, UK, Switzerland and the USA have [tested the approach](#) in various mountain ranges.

Following the 2020 workshop in Fribourg, Switzerland, the baseline concepts of RGV as a new product of the ECV Permafrost were elaborated, submitted for approval by the Action Group members in late 2021. Practi-

cal guidelines regarding the setup of homogenized RGV time series will be prepared. The development of these practical guidelines is a key challenge of the Action Group in 2022.

For two years (starting in October 2021) GCOS-Switzerland are supporting the development of a service dedicated to the activities of RGIK. The purpose of this service is to formalize and consolidate the RGIK's main efforts, such as the implementation of a database and visualization platform for rock glacier inventories and RGV time-series, organizing workshops and training courses, and promoting the worldwide use of RGV as a climate indicator.

For more information and access to the released documents visit unifr.ch/geo/geomorphology/en/research/ipa-action-group-rock-glacier/. Anyone is welcome to participate in RGIK via its mailing list (bottom of webpage), which comprises 170 subscribers from 24 countries.



La Tolas rock glacier (4300-4600 m asl), Dry Andes of Chile. This talus-connected rock glacier is currently moving more than 1.5 m/yr at its central part. Photo: Sebastián Vivero.

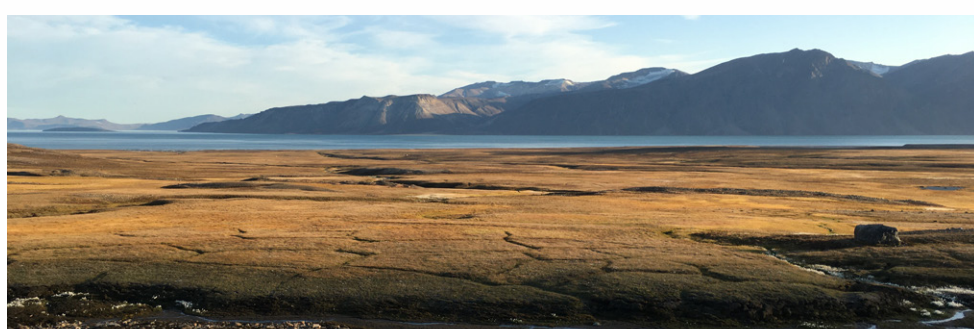
ACTION GROUP REPORTS

Standardized methods across Permafrost Landscapes: from Arctic Soils to Hydrosystems (SPLASH)

BY ACTION GROUP LEADER, FRÉDÉRIC BOUCHARD (UNIVERSITÉ PARIS-SACLAY, FRANCE)

Ongoing climate change across the northern permafrost region impacts Arctic hydrology and the mobilization of mineral and organic materials from formerly frozen soils to terrestrial ecosystems and surface water bodies. Mineral and organic components interact along the 'lateral continuum' (from soils to aquatic systems), affecting biogeochemical cycles with strong spatial and temporal heterogeneities. There is a need for a set of unified protocols to capture changes in the lateral transport of both mineral and organic matter across Arctic permafrost landscapes.

The main objective of the 'SPLASH' Action Group is to provide the permafrost community with a suite of



Near the Zackenberg research station (northeastern Greenland). Photo: Julien Fouché.

standardized field approaches for sampling soil, sediment, and water across different types of permafrost landscapes. SPLASH is a transdisciplinary initiative of early-career scientists and senior experts from 11 countries. We aim to coordinate sampling strategies along the lateral

continuum used by existing research initiatives and networks (e.g., T-MO-SAiC, Permafrost Carbon Network). This will contribute to the ongoing effort on standardizing sampling strategies, improving data comparison, synthesis, and upscaling of results.

SPLASH's progress has been im-

pacted by the COVID-19 pandemic. Nevertheless, some of us were able to collect samples from soils and aquatic systems (lakes, streams, and groundwater). Such as:

- Abisko scientific research station, northern Sweden, where the impacts of coupled carbon and nitrogen cycles are studied at sporadic permafrost sites spanning vegetation gradients (from boreal forest to tundra, including peatlands);

- Zackenberg research station, where the supra-permafrost groundwater is characterized to assess its residence time in proglacial landscapes and its contribution to river discharge and solute export;

Both teams developed and used a standardized protocol to collect vegetation and soils. Their project aims to study the hydrological and plant community controls on organic matter composition and stabilization.

We showcased SPLASH Eurosoil 2021 and EGU General Assembly. At

the EGU, we presented the results of an online survey prepared to collect basic input information from researchers who sample along the 'soil-to-hydrosystem continuum'. These results about the 'WHAT, WHERE, WHEN, and HOW' of field sampling identify relevant sampling strategies and current knowledge gaps.

We cross our fingers to be able to conduct fieldwork sampling in 2022. We are working on a synthesis manuscript, which we hope to submit by the end of 2022. Finally, we plan to gather the SPLASH 'community' (members and non-members) at the next AGU Conference.

For more information visit [splash.biogeochimie.fr](https://biogeochimie.fr).

For more information see:

Fouché, J., *et al.* (2021). The SPLASH Action Group - Towards standardized sampling strategies along the soil-to-hydrosystems continuum in permafrost landscapes. *EGU General Assembly*, online, 19-30 April 2021. DOI: [10.5194/egusphere-egu21-11184](https://doi.org/10.5194/egusphere-egu21-11184).



Near the Abisko scientific research station (northern Sweden). Photo: Antoine Séjourné.

ACTION GROUP REPORTS

The Yedoma Region: A Synthesis of Circum-Arctic Distribution and Thickness

BY ACTION GROUP MEMBERS JENS STRAUSS, GUIDO GROSSE, LOEKA JONGEJANS (AWI POTSDAM, GERMANY), AND YURI SHUR (UNIVERSITY OF ALASKA FAIRBANKS, USA)

The Yedoma Action Group aimed to synthesize existing information and generate new data products on the circum-arctic distribution of Yedoma permafrost. Due to their very high excess ice content, Yedoma deposits are especially prone to degradation under projected future climate scenarios in Siberia, Alaska and Yukon. Thawing of organic rich Yedoma releases greenhouse gases, which is contributing to climate change.

Recently, we finalised the last deliverables by guest editing a special issue in the open access journal *Frontiers in Earth Science* entitled “Yedoma Permafrost Landscapes as Past Archives, Present and Future Change Areas”. This collection features 26 papers highlighting various research findings and summarizing some current knowledge on Yedoma permafrost, including:

• Shur, Y., *et al.* (2021). Yedoma Permafrost Genesis: Over 150 Years of Mystery and Controversy. *Frontiers in Earth Science*. DOI: [10.3389/feart.2021.757891](https://doi.org/10.3389/feart.2021.757891).

- Strauss, J. *et al.* (2021). Circum-Arctic Map of the Yedoma Permafrost Domain. *Frontiers in Earth Science*. DOI: [10.3389/feart.2021.758360](https://doi.org/10.3389/feart.2021.758360).

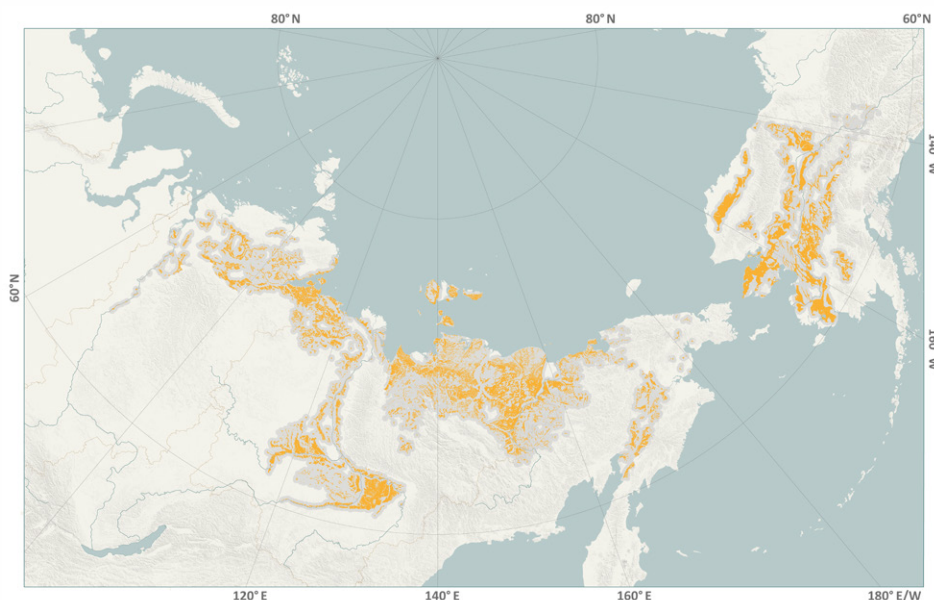
The first paper summarizes the long history of Yedoma research to explain the phenomenon, starting from the early 1800 until today's accepted hypotheses. The second paper outlined the substantial spatial extent of late Pleistocene Yedoma deposits in our paper. Moreover,

The first paper summarizes the long history of Yedoma research to explain the phenomenon, starting from the early 1800 until today's accepted hypotheses. The second paper outlined the substantial spatial extent of late Pleistocene Yedoma deposits in our paper. Moreover,



we created a unique pan-Arctic dataset including confidence estimates. We found that the current pan-Arctic Yedoma domain covers approximately 2,587,000 km², from which 480,000 km² are covered by undisturbed Yedoma deposits. All datasets are freely available and downloadable from the [Arctic Permafrost Geospatial Centre \(APGC\)](#) in GIS-ready shapefile format and can also be directly viewed and interacted with online in a [webGIS](#).

We want to thank all the Action Group members for making this effort a great success.



Yedoma Northern Hemisphere Distribution (Strauss *et al.*, 2021).

ACTION GROUP REPORTS

Towards an International Database of Geoelectrical Surveys on Permafrost (IDGSP)

BY ACTION GROUP LEADERS CHRISTIAN HAUCK AND COLINE MOLLARET (UNIVERSITY OF FRIBOURG, SWITZERLAND)

The action group launched in 2021 with the main objective to bring together the international community interested in geoelectrical measurements on permafrost and laying the foundations for an operational International Database of Geoelectrical Surveys on Permafrost (IDGSP). We aim to initiate a database for geoelectrical data and develop guidelines for Electrical Resistivity Tomography (ERT) survey

repetition and data processing. We promote and support the repetition of existing legacy geoelectrical measurements to yield the resistivity evolution over time and detect temperature and ground ice/water changes in response to climate changes. By archiving geoelectrical data on permafrost, the long-term goal is the reanalysis of the full database and its climatic interpretation.

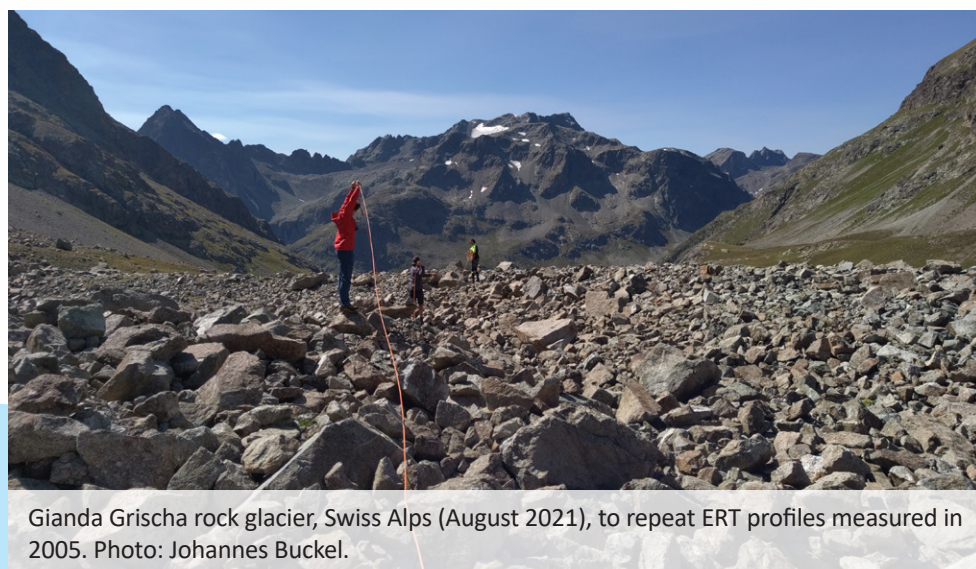
IDGSP is composed of 10 scientists

(6 early career scientists). The kick-off meeting took place online in April 2021 with 29 attendees, during which 7 working groups were created. We have used the communication platform Slack to better channelize the discussions. In spring 2021, the list of necessary ERT survey metadata was extensively discussed and finally compiled. A call of metadata was sent to all action group members in early summer 2021; since then IDGSP has received metadata from 230 profiles from 10 scientists/research groups.

IDGSP also financially supported two field campaigns in summer 2021 and will open a new call for financial support in 2022.

IDGSP published two papers to the 2021 Regional Conference on Permafrost (RCOP), available through the American Society of Civil Engineers (ASCE) soon:

- Herring, T., *et al.* (2021). [Standardized processing of geoelectrical data for perma-](#)



Gianda Grischia rock glacier, Swiss Alps (August 2021), to repeat ERT profiles measured in 2005. Photo: Johannes Buckel.

frost applications: Initial findings from a new IPA action group. *Regional Conference on Permafrost*, online, 24-29 October 2021, Session: Geophysical and Remote Sensing Investigations of Changing Permafrost Landscapes p. 8.

- Mollaret, C., et al. (2021). *International database of geo-electrical surveys on permafrost: a new IPA Action group. Regional Conference on Permafrost*, online, 24-29 October 2021, Session: Permafrost Data Systems, p. 3.

The new IDGSP database is currently set up on a virtual machine hosted by the University of Fribourg, Switzerland. The advanced open-source relational database system PostgreSQL is used to program the database. Homogenization and standardization of a large number of data and metadata sets are among the greatest challenges, yet are essential to a structured relational database.

The call for ERT metadata is still open and data are continuously added to the metadata database. In 2022, we plan to (1) make the full metadata open access and initiate a user-friendly webmap to access the

metadata; (2) send a call for electrical resistivity data (as the open metadata call only address metadata), which will then be entered into the new IDGSP; and (3) continue to work on the challenges of the automatic processing of large data sets as well as on strategies how to analyze ERT repetition surveys over different time periods in a joint climatic context.

IDGSP is open to everyone interested on the topic. For more information contact ertdb@unifr.ch or visit unifr.ch/geo/cryosphere/en/projects/permafrost-monitoring-and-dynamics/idgsp.html.

NEW ACTION GROUP UPDATE

RTS InTrain: Retrogressive thaw slump inventory and machine learning training-data development

BY ACTION GROUP LEADER ANNA LILJEDAHN (WOODWELL CLIMATE RESEARCH CENTER, USA)

Our new Action Group aims to bring the permafrost science community together to address the challenges and opportunities in machine learning (ML) training data development for remote sensing (RS) analyses. Specifically, we aim to identify the resources, common interests and needs required to apply RS-ML approaches to identify and characterize retrogressive thaw slumps (RTS).

The Action Group (>20 people) will develop a map of active RTS research sites, training data creation protocols, pooling and standardization of existing training datasets (inc. addressing the time-dependent nature of RTS). It will further expand the Permafrost Discovery Gateway cyberinfrastructure to support a col-laboratory of community-scale training data development (see p.20). The long-term products from the working group will allow for pan-Arctic assessments of permafrost thaw at societally-relevant spatial and tem-



RTS on the edge of a lake near Inuvik, NT (September 2021). Photo: Emma Stockton.

poral scales allowing stakeholders to identify and mitigate permafrost-related problems. We will bring together those interested in data creation, analysis, or application of the information at regular intervals to share knowledge and exchange experiences. The proposed effort will be undertaken by a core group of researchers representing five coun-

tries (Canada, China, Germany, Russia, and USA) with the greatest area affected by RTS, and a broad range of career levels (students to professors and institute directors) and expertise (field, RS, ML, and software engineering). We will broadly advertise our new Action Group and invite the larger science community to join and contribute.

The Permafrost-Agroecosystems Action Group

BY ACTION GROUP MEMBERS MELISSA WARD JONES (UNIVERSITY OF ALASKA FAIRBANKS, USA) AND MATHIAS ULRICH (UNIVERSITY OF LEIPZIG, GERMANY)



Climate change is driving an increase in permafrost degradation while simultaneously benefiting agriculture by increasing the suitable growing conditions for globally important crops in high-latitude and altitude regions. Permafrost-agroecosystems (e.g., crop production, animal husbandry and reindeer herding) is a critical and emergent topic affecting food security, livelihoods, and culture in permafrost regions. The heterogeneity of permafrost-agroecosystems must be accounted for due to a range of potential thaw responses depending on type and ground-ice content, and differences

in agricultural activities.

The Permafrost-Agroecosystems Action Group: developing and setting up a global map product, brings together experts from permafrost and agricultural systems, including social and physical scientists from 7 countries (USA, Canada, Russia, Germany, Nepal, Switzerland, and Finland) to develop a global map of permafrost-agroecosystems and provide a venue where an international network of scientists can exchange data and ideas through webinars and workshops. We invite anyone from the scientific community (particularly from geographic areas not currently

represented) with interest in permafrost-agroecosystems, regardless of career stage, to join the Action Group and participate in our networking activities to provide guidance between more established and emerging research programs and the creation of the global map product. Our understanding of permafrost-agroecosystems is limited and furthering our knowledge is essential for the predicted climate-driven agricultural expansion to occur sustainably in high-latitude and -altitude regions.

STANDING COMMITTEE REPORTS

The Global Terrestrial Network for Permafrost (GTN-P)

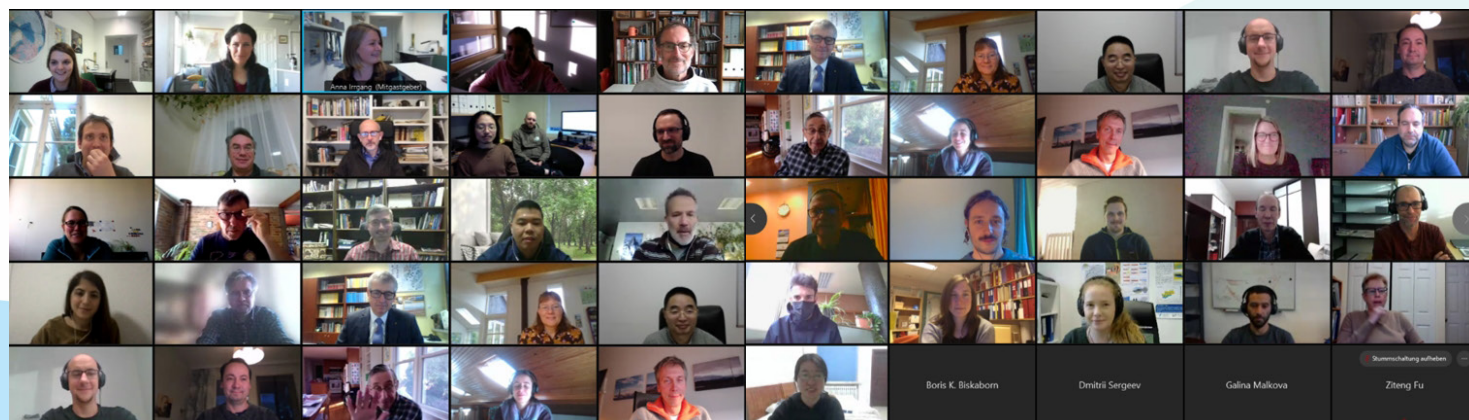
BY CHAIR DMITRY STRELETSKIY (GEORGE WASHINGTON UNIVERSITY, USA) AND EXECUTIVE DIRECTOR, ANNA IRRGANG (AWI POTSDAM, GERMANY)



The 1st virtual GTN-P General Assembly was held in November 2021, with 42 participants from all over the World! The GTN-P warmly welcomes 9 new Young National

Correspondents and two new National Correspondents. The country reports, presented the National Correspondents allowed the GTN-P community to gain insight into the

state of permafrost in 15 countries. The Steering Committee (SC) decided to make the virtual GTN-P GA an annual event; the next GA will take place 17 November 2022.



The 1st virtual GTN-P General Assembly (November 2021).

GTN-P STRATEGY AND IMPLEMENTATION PLAN (SIP) 2021-2024

The SC released the GTN-P SIP 2021-2024 and GTN-P Measurement and Monitoring Guidelines.

GTN-P DATA SERVICE

The [GTN-P Database](#) continued to provide users with up-to-date information on permafrost temperature and active layer thickness. GTN-P website had over 3,000 visitors in 2020, mainly from USA, Canada, Germany, Russia, China, Norway and Spain, the top cities being Moscow, Beijing, St. Petersburg, Berlin, Ottawa, Potsdam, London and Toronto. We thank all field investigators and national correspondents for collecting and submitting of observational data. We also thank the staff of Arctic Portal for their ongoing work on the GTN-P webpage and database.

GTN-P OFFICE

The GTN-P office will be funded until November 2024 by the EU-Horizon 2020 project [Arctic PASSION](#), led by AWI. The GTN-P is part of the Pan-Arctic requirements-driven Permafrost Service.

GTN-P & GCW

Several SC members participate in the [Permafrost Best Practice Task Team \(GCW\)](#) - established to define best practices for permafrost measurements which will be included in the next [WMO Guide no. 8](#). The team made progress in 2021 by setting the naming conventions and definitions of the three Permafrost ECV products being Permafrost Temperature (PT), Active Layer Thickness (ALT) and Rock Glacier Velocity (RGV). The permafrost community will have the opportunity to contribute edit suggestions before the Permafrost Best Practice-

es will be submitted to the WMO.

GTN-P & GCOS

The SC reviewed and formally approved the Permafrost Essential Climate Variables (ECVs) requirements which will be part of the next GCOS implementation plan. To comply with the naming convention of the WMO, which was set by the Permafrost Best Practice Task Team, the 3 Permafrost ECV products were re-named (see above).

GTN-P AT RCOP

GTN-P had a very productive session at the [2021 RCOP](#), with more than 50 people attending the session. We sincerely thank all presenters and the organizing committee for making this conference a success.

For more information visit gtnp.org/
or contact GTNP-Secretariat@awi.de.

STANDING COMMITTEE REPORTS

Permafrost Young Researchers Network (PYRN)

BY VICE-PRESIDENT, ADAM KIRKWOOD (LAURENTIAN UNIVERSITY, CANADA), ON
BEHALF OF THE PYRN EXCOM

2021 was still predominantly online, but the Permafrost Young Researchers (PYRN) ExCom and members continued to work their hardest. The year was filled with many opportunities to network at online conferences and virtual hang-

outs. PYRN is proud of the many great events organized and hosted throughout the year, including:

PYRN SEMINAR SERIES

Starting in early 2021, we organized a monthly seminar series where



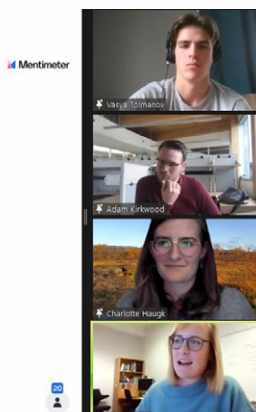
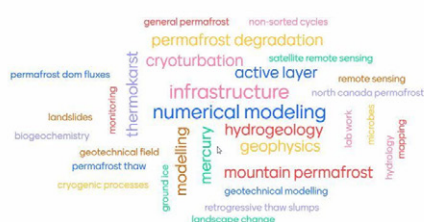
early career researchers (ECRs) within PYRN could present their research to virtual audiences, and then field questions from the audience. PYRN hosted several of these seminars, with over 10 great speakers sharing their research, ranging from ice-wedge polygons on the surface of Mars to rock glaciers in Banff National Park, Canada.

PERMAFROST SCIENCE & ENGINEERING SHORT COURSE

Leading up to the 9th Regional Conference on Permafrost (RCOP) and the 19th International Conference on Cold Regions Engineering (ICCRE), PYRN decided this joint conference would be a great opportunity for

Go to www.menti.com and use the code 4281 6868

What is the main focus of your work?



A mentimeter on the focus of PYRN members work (RCOP2021 student day).

people to learn more about both Permafrost Science and Cold Regions Engineering. So, we created an online 'short course' with 4 amazing and respected researchers: Dr. Ashley Rudy, Dr. Simon Dumais, Dr. Christopher Burn, and Dr. Guy Doré. Each lecturer provided background on their respective disciplines, followed by a thrilling discussion with the audience on how permafrost scientists and engineers can better work together in the future to address issues posed by future permafrost thaw.

RCOP2021 STUDENT DAY

Though many of us were disap-

pointed to learn the RCOP had been moved to fully online, PYRN was determined to make sure that the RCOP experience was still fun and fruitful for all of its members. To kick-off the conference, PYRN organized a student day filled with workshops and networking events. Starting with a presentation on '*How to visualize your science*' by Dr. Andreas Dahlin, attendees learned some great new skills to help them be more engaging presenters. At the conference itself, PYRN hosted a 'Best Presentation and Poster Award', where PYRN members signed up to have their presentations and posters assessed by the PYRN ExCom for the chance to win a prize! It was a hard decision,

but the winners were Julius Kunz and Tabea Rettelback for 1st and 2nd best presentations, and Alexandra Hamm and Alexandre Chiasson for 1st and 2nd best poster presentations.

Congratulations!

Finally, it's 2022, the last year of this ExCom's term. We're looking forward to planning more events and workshops for young permafrost researchers, and are excited to arrange elections for the next PYRN ExCom who will continue supporting its members. Wishing everyone a happy and healthy 2022! For more information visit pyrn.arcticportal.org/ or email contact@pyrn.org.

STANDING COMMITTEE REPORTS

Education & Outreach

BY CO-CHAIRS ANNA KLENE (UNIVERSITY OF MONTANA, USA) AND YLVA SJÖBERG (UNIVERSITY OF COPENHAGEN, DENMARK)

Our Standing Committee coordinates and promotes permafrost education and outreach to all generations across the globe. The SC is also coordinated with the University of the Arctic [Thematic Network for Permafrost \(TNP\)](#). Please contact us if you would like to know more about the committee.

During another pandemic year, educators continued physically-distance permafrost education and outreach activities. Our members continued to use to web-based education platforms and activities (i.e., *Skype a Scientist*). For more information visit permafrost.org/group/education-and-outreach/.

PERMAFROST FIELD SCHOOL

At the University Centre in Svalbard (UNIS), one of the first short courses starting after the COVID-19 lockdown was the '*International Bachelor Permafrost Summer Field School*' 10 ECTS course in June-July 2021. The course, which was orig-

inally developed as a TNP activity by Kenji Yoshikawa and Hanne H. Christiansen and later taken over by UNIS as a legacy of the TNP activity, was cancelled due to COVID-19 in 2020. A group of 16 international students (participation limit due to COVID-19) participated in the five-week course in 2021.

FROZEN-GROUND CARTOONS

The project began as an IPA Action Group (2016-2018) and has now evolved into '*Permafrost on All Channels*'. Cartoons have been released in nine languages (Danish, French, German, English, Greenlandic/Kalaallisut, Inuktitut, Luxembourgish, Russian, and Swedish) so far. The materials also include an augmented reality app for smartphones and tablets, a board game, and videos on permafrost topics. In 2021, the team presented the project at the '*Ice (St) Ages: Experiencing Environments in Science, Arts and Spectacle*' international online seminar series, and

wrote an "Our Earth" piece for the *Nature Reviews Earth & Environment* special issue on permafrost.

- Bouchard, F., *et al.* (2022). Redrawing permafrost outreach. *Nature Reviews Earth & Environment*, 3. DOI: [10.1038/s43017-021-00255-8](https://doi.org/10.1038/s43017-021-00255-8).

Frozen-Ground Cartoons were also used by the [Aurora Research Institute \(ARI\)](#) during an on-the-land STEM Camp to teach grade 7 and 8 students from Fort McPherson, NT, Canada about permafrost and climate change in their region (e.g., retrogressive thaw slumps) (see p.25).

For more information contact frozengroundcartoon@gmail.com.

2021 RCOP & ICCRE SESSION

At the virtual 2021 Regional Con-



ference on Permafrost (RCOP) and 19th International Conference on Cold Regions Engineering (ICCRE), a session was held titled “*Permafrost Dialogue: New Avenues of Communication for Permafrost Science, Outreach, & Education*”. Brendan Rogers and Jennifer Watts organized this session with 6 posters and 3 oral presentations and a discussion.

GLOBE Activities

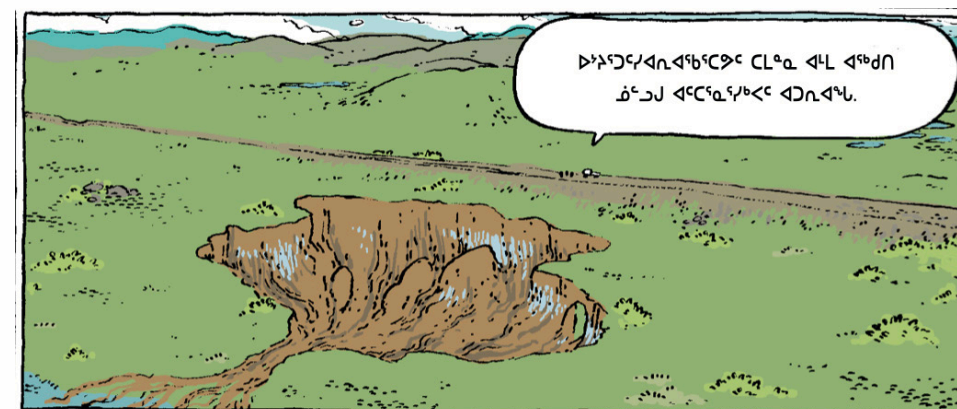
Those living in areas with permafrost or frozen ground may want to check out the [Frost Tube Protocol](#) designed to be implemented by students and teachers. This can be a physically distanced hands-on learning activity. Additional data-collection and analysis activities for all climates are available from the [GLOBE program](#) as well.

STANDING COMMITTEE REPORTS

Glacier and Permafrost Hazards in Mountains (GAPHAZ)

BY CHAIR MARTA CHIARLE (CNR-IRPI, ITALY), VICE-CHAIR MICHELE KOPPE (UNIVERSITY OF BRITISH COLUMBIA, CANADA), AND SECRETARY HOLGER FREY (UNIVERSITY OF ZURICH, SWITZERLAND)

2021 was marked by the Chamoli disaster on 7 February in Uttarakhand, India. This rare and complex event drew attention to glacier and permafrost hazards in mountains, offering the opportunity to reflect on process chains and the possible role of climate change. GAPHAZ immediately provided a preliminary report of the event, which was forwarded to and appreciated by governmental institutions in India. Further, GAPHAZ activated a Slack working space, where over 70 scientists, practitioners and decision-makers met and exchanged information and analyses. In this way, GAPHAZ fulfilled its mission of facilitating communication within the international scientific



Frozen Ground Cartoon of a retrogressive thaw slump threatening a road. Used by the Aurora Research Institute (ARI) for their on-the-land STEM Camp.

ONLINE TEXTBOOKS

There are two permafrost books written for high school and university students:

- [Permafrost in Our Time](#) by Kenji Yoshikawa (available in English and Russian)
- [Permafrost and Culture: Global Warming and Sakha Republic \(Yakutia\), Russian Federa-](#)

[tion](#) edited by Hiroki Takakura et al. (available in Russian).

UPCOMING OPPORTUNITIES

Educational sessions are planned for EUCOP6 in June 2023, in Puigcerdà, Spain (see p.4). Session proposals are due in mid-April 2022. We look forward to seeing you all virtually until we can be in-person again.



community and towards governmental communities, serving as a focal point of information for international media. The GAPHAZ community effort on the reconstruction of the Chamoli disaster resulted in a Science publication with 40+ authors.

- Shugar, D.H., et al. (2021). A massive rock and ice avalanche caused the 2021 disaster at Chamoli, Indian Himalaya. *Science*, 373. DOI: [10.1126/science.abh4455](https://doi.org/10.1126/science.abh4455).

The Slack working space has proven to be an effective tool for promoting quick and inclusive interaction, and could therefore be provided by GAPHAZ for future events as well. It enabled the GAPHAZ community

to expand, with the involvement of many colleagues from East Asia, a previously underrepresented region.

In early 2021, GAPHAZ completed its two-year rotation of Officers, which now includes Marta Chiarle (CNR-IRPI) as Chair, Michele Koppes (University of British Columbia) as vice-Chair, and Holger Frey (University of Zurich) as Secretary. The mailing list has been migrated to listserv@lists.ubc.ca. A “GAPHAZ experts list” on our [website](#) is under construction, aiming at providing a platform for expert members.

GAPHAZ members have made major contributions to EGU Online

(in particular to session CR5.4 *"Risks from a changing cryosphere, and mountains under global change"*, co-sponsored by IACS and IPA), and in the GLOF conference & workshop from 7-9 July 2021 in Graz and on-line. A focus session on *"Glaciers and permafrost risks in a changing climate"* has been accepted for IMC22 in Innsbruck (call for abstracts is open until 16 February 2022). In fact, in the coming years we intend to devote particular attention to the relations between climate change

and glaciers and permafrost risks, given the lack of data on the subject, on the one hand, and the potentially catastrophic outcomes of environmental changes taking place in high mountains, on the other hand.

To further promote the dissemination of the *"Technical Guidance document on the assessment of Glacier and Permafrost Hazards in Mountain Regions"*, the reference document for GAPHAZ, hard copies of the English version have been printed and distributed in the Cryosphere pavilion at COP26 in Glasgow in November. The *"Global database of glacier*

and permafrost hazard events and disasters", managed by GAPHAZ, continues to attract interest, and was an opportunity for new interactions (e.g. with GEO-Mountains).

The number of GAPHAZ members increased by more than 50% in the last year; 189 people are signed up to the new listserv. Particular attention in the coming years will be devoted to increase diversity in the GAPHAZ community, mainly in terms of gender and geographic representation, but also in thematic competences.

For more information visit gap-haz.org/.

STANDING COMMITTEE REPORTS

Antarctic Permafrost, Periglacial Environments and Soils (ANTPAS)

BY CO-CHAIRS MARC OLIVA (UNIVERSITY OF BARCELONA, CATALONIA, SPAIN) AND MAURO GUGLIELMIN (UNIVERSITÀ DEGLI STUDI DELL'INSUBRIA, ITALY)

ANTPAS activities were very restricted by the pandemic situation in 2021. Some ANTPAS members conduct-

ed research during the first months of the year in Maritime Antarctica and in December in Victoria Land, basically performing the monitoring

activities of permafrost and active layer boreholes. Research was very limited as field activities were cancelled in the frozen continent.

We expect that in 2022 the situation will go back to normality and ANTPAS can continue to foster permafrost research in Antarctica promoting sessions and seminars in regional and international meetings.

For more information visit antpas.org/.

STANDING COMMITTEE REPORTS

Nomination and Awards Committee (NAC)

BY CHAIR, JULIAN MURTON (UNIVERSITY OF SUSSEX, UK)

Below is a report of activities of the IPA Nomination & Awards Committee (NAC). The report sets out the membership of the Committee, the processes and the results of the deliberations and recommendations.

2019-2023 NAC COMPOSITION
Chair: Julian Murton (UK)
Members: Megan Balks (New Zealand), Toni Lewkowicz (Canada), Marcia Phillips (Switzerland), Dmitrii Sergeev (Russia), Cathy Wilson (USA) and Tingjun Zhang (China).

BACKGROUND

Two new members of the IPA Execu-

tive Committee (EC) must be elected in June 2022 to replace current mem-

bers Prof. Michael Krautblatter and Prof. Frederick Nelson, who will com-

Composition of the current EC for 2020–2022.

Position	Holder	Country	Period in office	Comments
President	Prof. Chris Burn	Canada	2020-2024	
Vice-President	Dr. Isabelle Gärtner-Roer	Switzerland	2020-2024	
Vice-President	Assoc. Prof. Dr. Gonçalo Vieira	Portugal	2020-2024	
Member	Prof. Michael Krautblatter	Germany	2018-2022	Term ends June 2022
Member	Prof. Frederick "Fritz" Nelson	USA	2018-2022	Term ends June 2022
Member	Dr. Kjersti Gisnås	Norway	2020-2024	
Member	Prof. Dr. Yangming Lai	China	2020-2022	Appointed

plete their terms at that time. Nominations are needed for two 4-year positions, to ensure that turnover of the EC occurs every two years, normally at regional and international permafrost conferences.

Dr Gärtner-Roer or Dr Vieira will become Senior VP in 2022 and then succeed to the Presidency in 2024. Three people will leave in 2024: either Dr Gärtner-Roer or Dr Vieira, in addition to Dr Gisnås and Prof. Burn.

NOMINATIONS

In November 2021, the NAC received nominations from four countries (Canada, China, Russia, USA) for three people:

- Mr. Ed Yarmak (USA): President, Arctic Foundations, Inc., Anchorage, Alaska;
- Prof. Fujun Niu (China): Professor & Executive Director of the State Key Laboratory of Frozen Soil En-

Composition of the EC for 2022–2024.

Position	Holder	Country	Period in office
President	Prof. Chris Burn	Canada	2020-2024
Vice-President	Dr. Isabelle Gärtner-Roer	Switzerland	2020-2024
Vice-President	Assoc. Prof. Dr. Gonalo Vieira	Portugal	2020-2024
Member	Dr. Kjersti Gisnås	Norway	2020-2024
Member	To be appointed		2022-2026
Member	To be appointed		2022-2026

gineering in Lanzhou & Professor in the School of Civil Engineering and Transportation at South China University of Technology;

- Dr. Vladislav Sergeyevich Isaev (Russia): Senior researcher, Head of the international projects, Department of Geology, Moscow State University, Russian Federation, Moscow.

The NAC screened and approved these nominations in January 2022.

All three of the nominees accepted their nominations. The IPA Council will vote in June 2022 to decide which two of the three nominees will be elected to the EC.

The NAC expresses its thanks to the Council members and national adhering groups, national permafrost associations and national societies for making their nominations for the EC positions.

PROJECT UPDATES

NSERC PermafrostNet

BY TRISTAN MACLEAN (CARLETON UNIVERSITY, CANADA)

NSERC PermafrostNet has grown considerably over the last year, and the network now hosts 30 graduate students and 4 postdoctoral research fellows conducting projects across Canada.

Two projects have already been completed and we’d like to congratulate Maria Shaposhnikova (University of Waterloo) and Patrick Jardine (Carleton University) on their work. Maria carried out her Master’s degree under the supervision of Prof. Claude Duguay (*"Temporal Deep Learning Approach to Bedfast and Floating Thermokarst Lake Ice Mapping using SAR imagery: Old Crow Flats, Yukon, Canada"*). Patrick has been working under the supervision of Prof. Chris Burn. He presented his work Investigating *"Snowpack*

Compaction as a Method of Preserving Permafrost beside Highway Embankments" at the 2021 joint Canadian Permafrost Association (CPA) and NSERC PermafrostNet Annual General Meeting (AGM).

AGM

Our virtual 2021 AGM was held 15-17 November. It consisted of presentations on recent permafrost science and engineering research, mentoring and career development for early career researchers, permafrost strategy consultation, the annual policy panel, and community engagement. Take a closer look at the Network News and Theme News online and sign up to our newsletter for more in-depth reports on the progress of the theme research. Thank you to Ryley



PermafrostNet
NSERC | CRSNG

Beddoe and Teddi Herring for leading the organization of the meeting.

FIELDWORK

Despite the majority of in-person activities continuing to be on hold, summer 2021 saw some network members making a cautious return to fieldwork. You can see photos and read more about one trip that took place near Kelvin Camp (NT) in Chief Drygeese territory. Other research was conducted in the Norman Wells area in the MacKenzie valley, NT (Alexandre Chiasson), along the Alasaka Highway from Beaver Creek, YT to Fort Nelson, BC (Teddi Herring), MacKenzie Mountains, NT (Joseph Young), on the Dempster highway near Dawson City and areas around Mayo, YT

(Patrick Jardine) and in the Hudson Bay Lowlands, QC (Adam Kirkwood).

STRATEGY

Since July 2021, an initial Strategy Committee supports the NSERC PermafrostNet Board of Directors in leading or catalyzing an open and inclusive strategic thinking ex-

ercise for the future of Canadian permafrost research and services. Continuing the arc of engagement started at the [2017 permafrost workshop](#), this will connect with a wide range of organizations and initiatives and foster new conversations and increased awareness.

DATA

Nick Brown and Michel Paquette

added additional permafrost-relevant terms to the CF standard names list. This is a controlled vocabulary used to standardize metadata for datasets. We will use these terms as part of their initiative to publish interoperable datasets on its [ERDDAP server](#). These standards and technologies contribute to interoperability with the atmospheric science and modelling communities. We hosted a [Data Systems Workshop](#) at the RCOP 2021 conference.

We are looking to get expert feedback and validation from the Canadian permafrost community on the Ground Ice Map of Canada (GIMC) particularly expert opinion on the accuracy of the current GIMC.

For more information visit permafrostnet.ca/.

Fieldwork near Kelvin Camp (NT) during the summer 2021. Photo: Galina Jonat.



PROJECT UPDATES

Permafrost Carbon Network

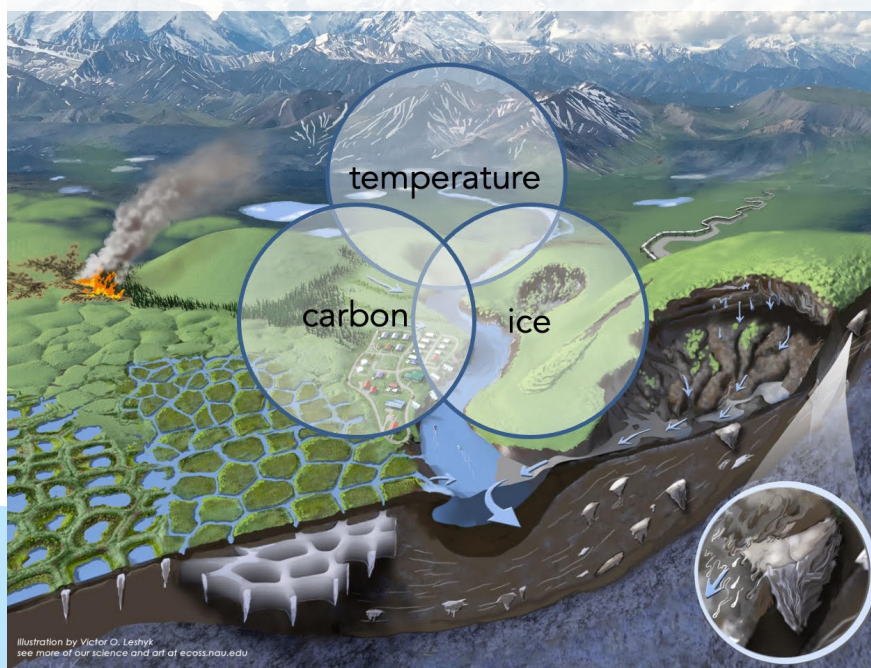
BY TED SCHUUR AND CHRISTINA SCHÄDEL (NORTHERN ARIZONA UNIVERSITY, USA)

The Permafrost Carbon Network hosted its [11th Annual Meeting](#) in a virtual format on 16-17 November 2021. We welcomed over 200 par-

ticipants from around the globe and discussed the representation of permafrost carbon in the [6th Assessment report of the IPCC](#) and the commu-



Permafrost landscape with 3 components of frozen ground (temperature, ice, carbon) that comprise key ecosystem services to people.



nication of permafrost carbon in the media and to decision makers. We also had breakout discussions on:

- Remote permafrost change detection
- Model intercomparisons
- Paleo carbon evidence
- Carbon flux timeseries and up-scaling
- Ground ice across spatial scales
- Nutrient interactions with carbon and climate.

These breakout discussions will lead to several smaller workshops on some of these topics (e.g., modeling, carbon fluxes) in 2022. Contact the [Permafrost Carbon Network](#) if you have an interest in participating.

Major science synthesis high-

lights co-sponsored by the Permafrost Carbon Network in 2021 include a synthesized Arctic-Boreal carbon flux database (ABCflux) that includes historic and contemporary CO₂ flux measurements from tundra and boreal forest sites located across the northern high latitudes. This database builds upon several previous workshops held at the National Center for Ecological Analysis and Synthesis in coordination with the Arctic Data Center. The cur-

rent manuscript was led by Anna Virkkala at the Woodwell Climate Research Center. The database synthesizes whole-ecosystem CO₂ fluxes from both clear chamber and eddy tower measurements along with site meta-data. In the future, the database is intended to be updated on an annual basis in order to place new CO₂ flux measurements from the region into perspective alongside historic time series. If you are making whole-ecosystem CO₂ flux measurements that can be aggregated monthly or seasonally

and wish to contribute to database updates, please contact the [Permafrost Carbon Network](#).

For more information visit permafrostcarbon.org/news.html.

For more information see:

Virkkala, A-M., *et al.* (2022). The ABC flux database: Arctic-Boreal CO₂ flux observations and ancillary information aggregated to monthly time steps across terrestrial ecosystems. *Earth System Science Data*, 14. DOI: [10.5194/essd-14-179-2022](https://doi.org/10.5194/essd-14-179-2022).

PROJECT UPDATES

ESA CCI+ Permafrost

BY ANNETT BARTSCH (B.GEOS, AUSTRIA) AND TAZIO STROZZI (GAMMA REMOTE SENSING, SWITZERLAND)



permafrost
cci

The 3rd version of the climate records of Mean Annual Ground Temperature as well as Active Layer Thickness for the northern hemisphere (1997-2019) was released in 2021. An additional dataset for permafrost extent following the IPA class descriptions has been derived from 2 m ground temperatures. In 2021, data were downloaded about 100 times for each parameter. Data interest has increased following COP26 and the publication of a use case for infrastructure assessment. All datasets have undergone a third round of detailed validation based on GTN-P, CALM, PERMOS, ROSHYDROMET, records stored on PANGAEA, Nordicana D & the Arctic Data Centre as well as direct provisions by colleagues maintaining some of the boreholes. The new validation report (v3) is accessible on the [project webpage](#).

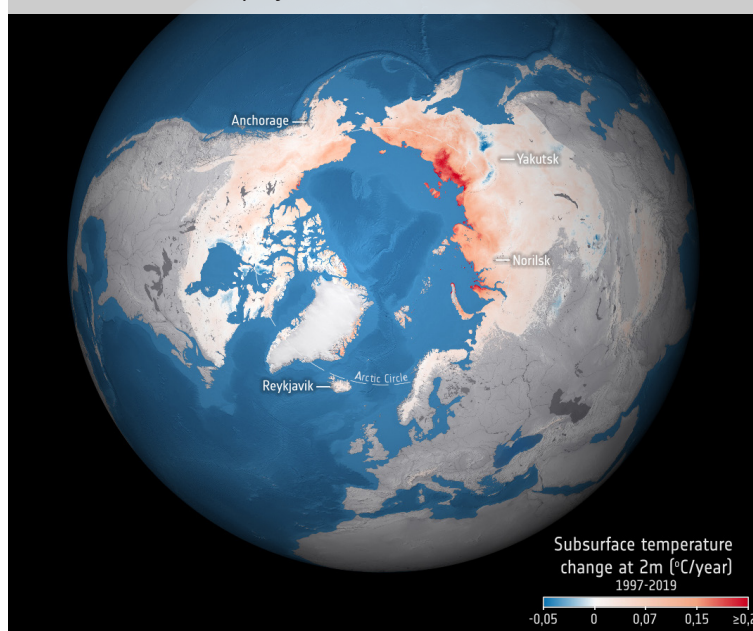
The 1st CCI+ Permafrost User Workshop was held on 27 September 2021 with 66 participants. All presentations by the project team are available on the project webpage. This includes a review of the evolution of satellite data use in ESA funded activities starting from 2009

with DUE Permafrost, followed by DUE GlobPermafrost in 2016 and eventually CCI+ Permafrost from 2018 onwards. A workshop summary is available on p.29 in the latest [Climate Assessment Report \(CAR\)](#).

The CCI+ Permafrost project extension “*Rock glacier kinematics as a new associated parameter of the ECV permafrost*” was completed in 2021. The close cooperation with

the IPA action group ‘*Rockglacier inventories and kinematics*’ permitted the definition of standard guidelines to integrate kinematic information in rock glacier inventories, exploiting spaceborne interferometric synthetic aperture radar (InSAR) data. The feasibility to apply the guidelines in 11 different periglacial regions of the world was tested in an international cooperation with 9 institutes.

Ground temperature trend from v3 of Permafrost_cci datasets © ESA/CCI Permafrost project.



Frozen Canoes

FROZEN CANOES (*Landscape & infrastructure dynamics of frozen environments undergoing climate change in Canada, Norway, and Svalbard*) started in 2018 and is funded by the INTPART program of the Norwegian Research Council. Due to the COVID-19 pandemic, FROZEN CANOES didn't have any activity in 2021 other than project meetings. International travel was not possible between Norway/Svalbard and Canada which prevented both exchanges and physical course participation. The project was planned to end in 2020 but has been prolonged into 2022. due to the pandemic. To finish the project as planned,

we have now planned an intensive course package for 2022 consisting of 3 masters courses and 1 bachelors course. The bachelors course and one masters courses will be given at UNIS, Svalbard, while the other masters courses will be given at Yukon University, Whitehorse, Canada, and the Norwegian University of Science and Technology (NTNU), Trondheim, Norway. The project will not be prolonged any further than 2022, we hope the pandemic does not prevent our ambitious final year of activity.

For more information visit ntnu.edu/ibm/frozen-canoes.

- *AG-352 Geohazards and geotechnics in high Arctic permafrost regions (10 ECTS)*
 - Continuous permafrost
 - 5 weeks masters course
 - Loneybyen, Svalbard
 - 1 June – 7 July
- *AG-218 International Bachelor Permafrost Summer Field School (10 ECTS)*
 - Continuous permafrost
 - 5 weeks bachelors course
 - Loneybyen, Svalbard
 - 7 June – 8 July
- *Advanced Permafrost Engineering Applied to Transportation Infrastructure (3 Canadian credit course)*
 - Discontinuous permafrost
 - 1 online module: Numerical modelling
 - 2 weeks masters course
 - Whitehorse, Yukon, Canada
 - 18 August – 2 September
- *Design of roads and railways in cold climate (7.5 ECTS)*
 - Seasonal frost
 - 2 online modules: Heat transfer
 - Freezing & thawing soil mechanics
 - 2 weeks masters course
 - Trondheim, Norway
 - 17-28 October

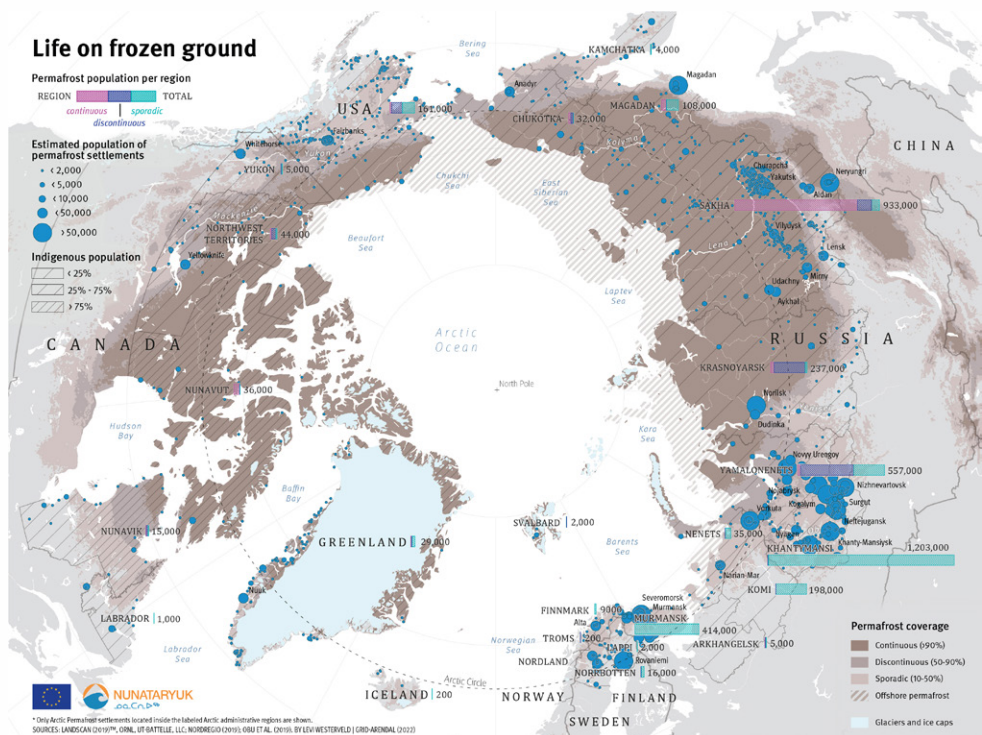
Nunataryuk

NUNATARYUK

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Since November 2017, AWI in Potsdam has coordinated the Horizon2020 EU-project “*NUNATARYUK: Permafrost thaw and the changing Arctic coast; science for socioeconomic adaptation*”. The six-year project (2017-2023) has a budget of €11.5 million and unites 26 partners from 11 countries. Nunataryuk studies:

- What happens to the fluxes and organic matter released from thawing coastal and subsea permafrost;
- What risks are posed by thawing coastal permafrost to infrastructure, indigenous and local communities and people's health;
- What are the long-term impacts of permafrost thaw to global climate and the economy.



4.9 million people lived in 1,162 permafrost settlements across eight Arctic countries in 2017.
Nunataryuk © Levi Westerveld / Grid Arendal.

Major results in 2021 include (1) a risk framework for Arctic coastal communities, which builds on the notion of dual dimension of risk, as both physically and socially constructed, with co-production of risk management solutions with local stakeholders as a central component; (2) a novel AI enhanced Arctic Coastal Human Impact (SACHI) dataset from the Copernicus Sentinel-1 and Sentinel-2 missions that offers a complete overview of the Arctic to identify communities and infrastructure that will be at risk over the next 30 years; and (3) a study that

examines the adaptive capacity for managing permafrost degradation in Northwest Greenland.

Nunataryuk results, together with results from other projects and scientists, will be compiled into the first ever [Arctic Permafrost Atlas](#), to be released in 2023 (see p.21). This print and digital publication will be a highly visual product, covering over 150 pages of maps, illustrations, drone imagery, and photographs, as well as engaging text on the latest permafrost science.

For more information visit nunataryuk.org/ or contact Hugues.Lantuit@awi.de.

For more information see:

Larsen, J.N., *et al.* (2021). Thawing Permafrost in Arctic Coastal Communities: A Framework for Studying Risks from Climate Change. *Sustainability*, 13(5). DOI: [10.3390/su13052651](https://doi.org/10.3390/su13052651).

Bartsch, A., *et al.* (2021). Expanding infrastructure and growing anthropogenic impacts along Arctic coasts. *Environ. Res. Lett.*, 16. DOI: [10.1088/1748-9326/ac3176](https://doi.org/10.1088/1748-9326/ac3176).

Jungsberg, L., *et al.* (2021). Adaptive capacity to manage permafrost degradation in Northwest Greenland. *Polar Geography*. DOI: [10.1080/1088937X.2021.1995067](https://doi.org/10.1080/1088937X.2021.1995067).

PROJECT UPDATES

Permafrost Discovery Gateway

BY ANNA LILJEDAHN (WOODWELL CLIMATE RESEARCH CENTER, USA)

The vision of the [Permafrost Discovery Gateway \(PDG\)](#) is to create an online resource to enable big data creation and discovery, primarily for the international permafrost science community and secondly for the public. About two years into the development process of the PDG we have mapped over one billion ice-wedge polygons from WorldView imagery (led by Dr. Witharana, University of Connecticut), established initial pipelines for increased automatization in processing public imagery stored on Google Earth Engine (led by Dr. Nitze and the [National Center for Supercomputing Applications, NCSA](#)), established an optimized workflow for process-

ing the big imagery archives of the [Polar Geospatial Center](#) (Dr. Witharana and NCSA), and provided a sneak-peak online access to two of the three visualization tools: The Fluid Earth Viewer, which is already a well-established tool (led by Dr. Cervenec), allows for fast viewing of spatially coarse (> 15km) and temporally fine (3-hourly) climate and weather datasets at the global scale and it is being populated with permafrost data. The Imagery Viewer will support a similar map-view experience but at much finer spatial scales covering the entire Arctic (a limited sample of the ice-wedge polygon data is currently available), while the Plot Viewer will support 2



to 4-D graphing of new big datasets and published geospatial information (ArcticDEM, soil carbon etc.) as well as climate and weather data (led by the [Arctic Data Center](#)). The PDG is hosting monthly webinars aimed to connect the community interested in big imagery permafrost science and is contributing to the new IPA Action Group RTS InTrain (see p.10). The Permafrost Discovery Gateway is funded by the [NSF Navigating the New Arctic](#) program.

PROJECT UPDATES

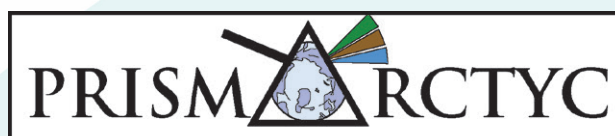
PRISMARCTYC

BY ANTOINE SÉJOURNÉ (UNIVERSITÉ PARIS-SACLAY, FRANCE)

PRISMARCTYC is a four year project (2021-2024) funded by the [Belmont Forum](#) organization. The

aim is to better understand the impacts of permafrost thaw on soils, surface/groundwater fluxes (critical

zone) and carbon cycle, as well as their controlling factors. The project has a multidisciplinary approach



includes geomorphology, social sciences, hydrology-hydrogeology, microbiology and geochemistry. Our study will focus on the near-surface permafrost-hydrosystem continuum in small Arctic watersheds where localized and rapid thermokarst occurrences remain under-studied. This goal will be achieved by comparing different sites in Siberia and Alaska with different permafrost settings, climate-sensitivity, vegetation, permafrost degradation types along a latitudinal and longitudinal gradient.

Due to travel restrictions, no extensive field studies were possible during summer 2021 but some ex-

ploratory sampling of different lakes and rivers in Central Yakutia and Kolyma area were fortunately possible. These data are being analyzed and discussed via videoconference to prepare the 2022 summer field campaigns. At the same time, out-

reach activities about permafrost and climate change with primary schools in France and in Yakutia are continuing. These tested activities will serve to build a handbook for teachers with DIY activities which is one of the outcomes of the project.



Outreach activities about greenhouse warming with the school of Syrdakh (Sakha Republic). Photo: Antoine Séjourné.

ASSOCIATED ORGANIZATIONS

Arctic Permafrost Atlas

BY LEVI WESTERVELD (GRID-ARENDAL)

The [Arctic Permafrost Atlas](#) is a key outcome of the [Nunataryuk](#) project, an [EU H2020](#) funded project. Edited by [GRID-Arendal](#) together with all Nunataryuk project partners, it will present state-of-the-art knowledge about permafrost and the impacts of permafrost thaw on human communities in the Arctic.

The print and digital publication will be a highly visual product. Covering over 150 pages, it will include maps, illustrations, drone imagery,

and photographs, as well engaging text based on the latest permafrost science. As an interdisciplinary publication, it will both focus on the natural sciences of permafrost and the Arctic communities and people whose lives revolve around permafrost and explore strategies they can use to adapt to permafrost thaw (see p.19).

To ensure the highest quality of the design, GRID-Arendal set up an Advisory Board for Cartography

Design. The board includes of five skilled cartographers and graphic designers with expertise in the world of map making, publishing, and communicating science and stories to broad audiences. A workshop with the board will be held in Arendal in May 2022, with supporting funds from the IPA.

The atlas is due for release in April 2023, and the team behind the publication is in full production mode. A full first draft will be completed by the summer, leaving us the second half of 2022 to review, edit, and polish all the text and graphics of the publication.

Follow [@nunataryuk](#) on Twitter to read about the development of

ASSOCIATED ORGANIZATIONS

Canadian Permafrost Association (CPA)

BY KUMARI KARUNARATNE (NORTHWEST TERRITORIES GEOLOGICAL SURVEY, CANADA), CPA PRESIDENT

The Canadian Permafrost Association (CPA) is now well established with 173 members and 40 volunteers. Though the pandemic inhibited in-person events, CPA members from across Canada engaged virtually and made progress

on several initiatives. The CPA's Standing Committees initiated a foundation to fund permafrost initiatives; organized webinars; communicated on social media platforms; and collaborated with NSERC PermafrostNet to host a 3-day virtu-

al meeting in November 2021.

The CPA contributed to initiatives of International and National importance. Extreme heat, wildfires, landslides, and flooding killed



and endangered thousands of Canadians and damaged communities and critical transportation corridors in 2021. To emphasize the scientific evidence and implications of climate change collectively, the CPA joined the [Canadian Federation of Earth Sciences](#) and endorsed their Climate Change statement published in *Geoscience Canada*.

- Burn, C.R., *et al.* (2021). The Canadian Federation of Earth Sciences Scientific Statement on Climate Change – Its Impacts in Canada, and the Critical Role of Earth Scientists in Mitigation and Adaptation. *Geoscience Canada*, 48(2). DOI: [10.12789/geocanj.2021.48.173](https://doi.org/10.12789/geocanj.2021.48.173).

The CPA's [Permafrost Carbon Feedback \(PCF\) Action Group](#) convened four dialogues with scientists, Indigenous Northerners, and administrators and transferred this initiative to the Cascade Institute. The CPA strengthened collaboration with our Russian colleagues through a MOU with the Roscongress Foun-

dation and participating in the Eastern Economic Forum in Vladivostok, Russia and online events organized by the Northern Forum.

The identification of unmarked graves at former residential schools in 2021 was a painful reminder of the horrors experienced by First Nations, Métis and Inuit children at these institutions across Canada. The CPA joined an alliance of orga-

nizations to support investigations into missing Indigenous children since up to 40 residential schools lie within permafrost regions. The CPA will continue its mission of bringing communities, researchers, and practitioners together to understand permafrost – hopefully in person this year.

For more information visit canadianpermafrostassociation.ca/.



Sharon Smith (left) and Don Hayley (right) presented with the 2021 [Hugh M. French Award](#) and the inaugural [Don W. Hayley Award](#), respectively.

ASSOCIATED ORGANIZATIONS

Chinese Academy of Sciences (CAS)

BY NIU FUJUN (CAS, CHINA)

China launched its [Second Tibet-Can Plateau Scientific Expedition and Research \(STEP\)](#) in 2017. STEP focusses on earth system changes on the Qinghai-Tibetan Plateau (QTP) and their impact. Scientific issues include plateau uplift and resource and environmental effects, resource and environmental carrying capacity, Asian water tower change and impact, westerly and monsoon synergy and impact, ecological barrier optimization, impact and adaptation of human activities on the environment, and disaster risk prevention and control. STEP has 66 teams belonging to 10 main

projects. A synthesis dataset of permafrost thermal state on the QTP, including observational data from 6 automatic weather stations, 12 active layers and 84 long-term drill holes in the permafrost regions was published by Prof. Zhao Lin's team.

- Zhao, L., *et al.* (2021). A synthesis dataset of permafrost thermal state for the Qinghai-Tibet (Xizang) Plateau, China. *Earth Systems Science*, 13. DOI: [10.5194/essd-13-4207-2021](https://doi.org/10.5194/essd-13-4207-2021).

Within STEP, Prof. Fujun Niu leads the special subject "*Freeze-thaw Related Disaster and Damages to Engineering Infrastructure in Permafrost*

Environment". In 2021, three research teams conducted field work for over 110 days on the QTP. Two teams investigated permafrost environments and damages to engineering infrastructures along the northwestern and western parts of the QTP. The last team went deep into the interior of the Hoh Xil region and explored freeze-thaw related disasters in this no-man's land. The teams travelled over 20,000 km and collected large amounts of data, photos and videos.



In 2021, three important national conferences related to permafrost community were held in-person in Xuzhou (Jiangsu Province, April 23-25), Nanchang (Jiangxi Province, May 14-16), and Zhuhai (Guangdong Province, December 10-12, also online). Over 1200 researchers from Chinese universities, institutes, and companies attended the conferences. Conference topics included hydro-thermo-mechanical properties of freeze-thaw soils, cold regions engineering, climate chang-

es and the permafrost environment, and carbon emissions and carbon neutrality. Meanwhile, researchers from Japan, Canada, USA, Russia,

and Norway attended the Zhuhai conference online.

For more information visit english.cas.cn/.

STEP teams conducting fieldwork on the QTP in 2021.



ASSOCIATED ORGANIZATIONS

United States Permafrost Association (USPA)

BY JOHN THORNLEY (WSP & GOLDER, USA), USPA PRESIDENT

The U.S. Permafrost Association (USPA) held its 2021 Annual Meeting virtually in December. The election results of new [Board members](#) were announced: Anna Wagner, President Elect; Eva Stephani, Treasurer, and Michael Lilly and Peppi Croft, Board Members. John Thornley assumed the Presidency from Past President Cathy Wilson.

The USPA planned and convened the highly successful 2021 Regional Conference on Permafrost (RCOP), held in conjunction with 19th International Conference on Cold Regions Engineering (ICCRe) of the

American Society of the Civil Engineers (ASCE) (see p.3). Tom Douglas, Cathy Wilson, Peppi Croft, Kevin Schaefer, Anna Liljedahl, and John Thornley lead conference planning, supported by the USPA Board of Directors, the IPA, the Canadian Permafrost Association (CPA), and many volunteers from the permafrost and engineering communities.

USPA membership increased from a mid-summer level of approximately 200 paid members to the end-of-year total 352 members. This increase was in large part due to the reduced RCOP registration fee offered by becoming



a member. Of this latter total, 104 are student members and 99 identify as PYRN members. 275 members are from the USA, representing over 50 universities, 10 federal and state agencies, and 20 private organizations from 36 states. International membership is represented by 16 countries, including 55 Canadians and 13 Germans.

The [Permafrost Monthly Alert](#) produced 561 accessions in 2021 with the November Alert including 34 abstracts from the RCOP ASCE proceedings.

The original USPA website was redesigned, and major portions moved to a new domain in conjunction with the MemberClicks management system. The more detailed current and recent [USPA Annual Reports](#), based on research and related activities of member organizations and individuals, are posted on the web.

For more information visit uspermafrost.org/.



CRREL Permafrost Tunnel, Fox, Alaska. The re-conditioned 'Old Tunnel' and Gravel Room. All passages are full height and width allowing ample room for viewing and sampling.

ASSOCIATED ORGANIZATIONS

Melnikov Permafrost Institute (MPI)

BY OLGA ALEKSEEVA (MPI, RUSSIA)

Starting from 2008, the MPI (Yakutsk, Russia) holds Forums for Young Permafrost Scientists (FYPS), each consisting of a conference and a field trip. These events are intended to strengthen international and interregional cooperation between young researchers, and to generate interest and develop skills in making field observations. In 2021, the FYPS convened for the 6th time (previous events took place in 2008, 2010,

2015 and 2018) and commemorated 100th birthday of two prominent figures in Russian permafrost science, Evgeny M. Katasonov (1921-1988) whose pioneering research laid the foundation for cryolithology and Nina P. Anisimova (1921-2011) who developed cryohydrogeochemistry as a new subdiscipline in permafrost science. The Forum program included a four-day conference (29 June to 2 July, 2021), with in-person and



online attendance of about 140 people from Russian and foreign universities, research centers and companies. The conference was followed by a field trip (3-13 July) featuring the cold deserts of central Yakutia. The trip participants took part in field studies of the D'Olkuma Formation exposure at Ust-Buotama, the active Saamys-Kumaga Dune Field and the Lena Dune. In the Makhatta and Kysyl-Syr sand fields, ground and surface water sampling and groundwater discharge measurements were conducted. Results will be compared with historical data taken in 1974-1975 to assess water resource changes over the last 50 years.

For more information visit mpi.ysn.ru/en/.

Examining cover sand stratigraphy, Makhatta Tukuran dune field, July 2021.



ASSOCIATED ORGANIZATIONS

University Centre in Svalbard (UNIS)

BY HANNE CHRISTIANSEN (UNIVERSITY CENTRE IN SVALBARD, UNIS)

The COVID-19 pandemic continued to affect research and educational activities at UNIS in 2021, but in June intensive courses started again. This included AG-218 'International Bachelor Permafrost Summer Field School' which was run with reduced student capacity (see p.19). We also carried out a permafrost winter drilling campaign, as part of the Svalbard Integrated Observing System (SIOS) in spring 2021. In this campaign a 100 m deep borehole was established in the lowlands 4 km from UNIS, and two 22 m boreholes at different el-

evations on mountain tops in the same area. Instrumentation for permafrost thermal monitoring was put into the 100 m borehole in autumn,



while the two other boreholes will be instrumented in spring 2022.

Permafrost drilling operation for the SIOS InfraNOR project at Breinosa, 29 April 2021. Photo: Kolibri Geo Services.



ASSOCIATED ORGANIZATIONS

Aurora Research Institute (ARI)

BY JEN HUMPHRIES (ARI, CANADA)

ARI continued to adapt to the evolving public health crisis to meet both our commitments and mitigate the risks and spread of COVID-19 to protect our staff and communities across the Northwest Territories. Following Chief Public Health Officer (CPHO) approved protocols, ARI implemented and supported permafrost research programs in the western Arctic. Research led by the ARI includes:

- The 3rd year of a snow manipulation project;
- Using water geochemistry to study the effects of permafrost degradation on the hydrology of Arctic watersheds;

- A monitoring and mitigation project with the Inuvik Community Corporation assessing the land around Reindeer Station;
- Monitoring the feasibility of using local vegetation to stabilize key sites identified by the Tuktoyaktuk Hunters and Trappers Committee.

Routine ground temperature monitoring along the Dempster Highway and Inuvik to Tuktoyaktuk Highway (ITH) continued. ARI also co-delivered a youth STEM camp for the students of Chief Julius School in Fort McPherson, NT (with Emma Stockton, Carleton University) (see p.13).

Territorial CPHO guidelines pre-

vented many external partners from travelling to the western Arctic for fieldwork. ARI delivered a range of support to partners, such as deploying and retrieving equipment, collecting data, assisting with fieldwork, and shipping samples. Support was provided to southern academic institutions, Parks Canada, the Geological Survey of Canada, the Northwest Territories Geological Survey, Northwest Territories Department of Lands, Department of Fisheries and Oceans, and the Joint Secretariat. Examples of ARI contributions in 2021 include monthly thaw depth, snow depth, and vegetation data to the Terrestrial Multidisciplinary Distributed Observatories for the Study of Arctic Connections (T-MOSAIC), as well as mapping for the [NWT Thermokarst Mapping Collective](#).

For more information see:

Wilson, M.A., *et al.* (2021). [Snow compaction and the influence on ground temperatures at sites along the Inuvik-Tuktoyaktuk Highway](#). *Yellowknife Geoscience Forum*, online, 15-17 November 2021.

Hille, E. (2022). Using river geochemistry to monitor the hydrology of Arctic watersheds. *Nature Reviews Earth & Environment*, 3(5). DOI: [10.1038/s43017-021-00257-6](#).



Students from Fort McPherson, NT, learning to conduct snow surveys from Emma Stockton (in orange) along the Dempster Highway. Photo: Celtie Ferguson.

ASSOCIATED ORGANIZATIONS

Yukon University (YukonU)

BY FABRICE CALMELS, FANNY AMYOT, LOUIS-PHILIPPE ROY, CYRIELLE LAURENT & CATHY KOOT (YUKONU RESEARCH CENTRE, CANADA)

In 2021, while finalizing projects in the greater Whitehorse area and along the Yukon Dempster Highway,

the Permafrost & Geoscience Research teams (PGR) continued to investigate a [Retrogressive Thaw Slump](#)

located at km 1456, Alaska Highway, with geotechnical and UAV methods. As a result the team organized a work-



shop in partnership with Yukon Dept. of Highways & Public Works, Carleton University and Université Laval to develop a remediation strategy to be implemented during winter 2022.

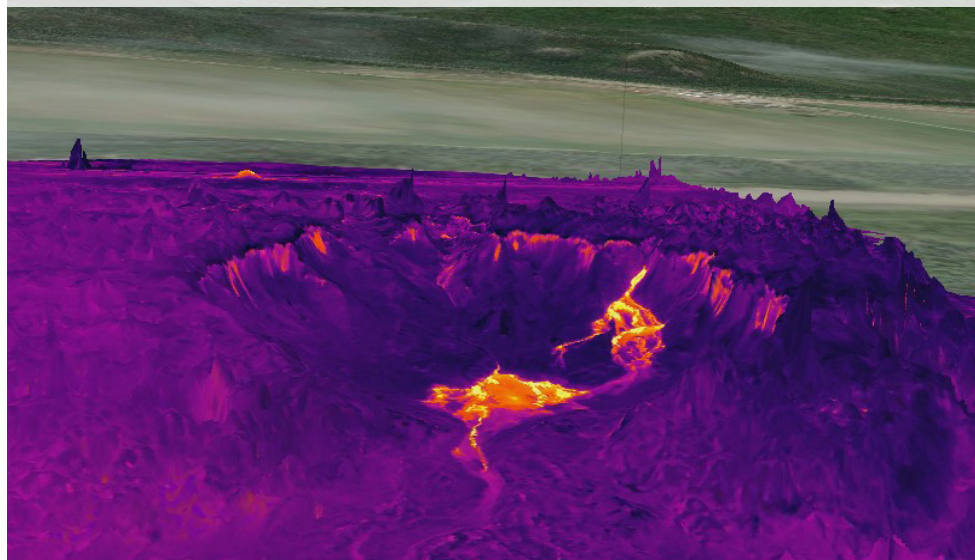
Prof. Michel Allard (Université Laval) and PGR collaborated to develop innovative early warning alarm systems for infrastructure impacted by permafrost-related hazards. They were implemented at three Nunavik Airports, and will soon be

deployed at critical sites along Yukon highways.

Research in Yukon communities continued. In the Old Crow Flats, the PGR participated in a project led by Prof. Pascale Roy-Léveillé (Université Laval) which aims to assess the impact of climate changes in the Vuntut Gwitchin First Nation traditional territories. The assessment of potential landscape changes resulting of climate change continued in the Champagne & Aishihik First Nation's traditional territory with the participation of the community. PGR partnered with the Ross River community to lead a permafrost and hydrological vulnerability assessment of the road linking the community to their gathering hall.

Those activities benefitted from the support of ArcticNet & Northx-North programs, the CCPN program, Polar Knowledge, and Transport Canada.

Tridimensional thermal aerial imagery capturing groundwater flow from the headwall of the km 1456 Retrogressive Thaw Slump along the Alaska Highway.



ASSOCIATED ORGANIZATIONS

T-MOSAiC permafrost thaw Action Group

BY JULIA BOIKE (ALFRED WEGNER INSTITUTE, AWI, GERMANY)

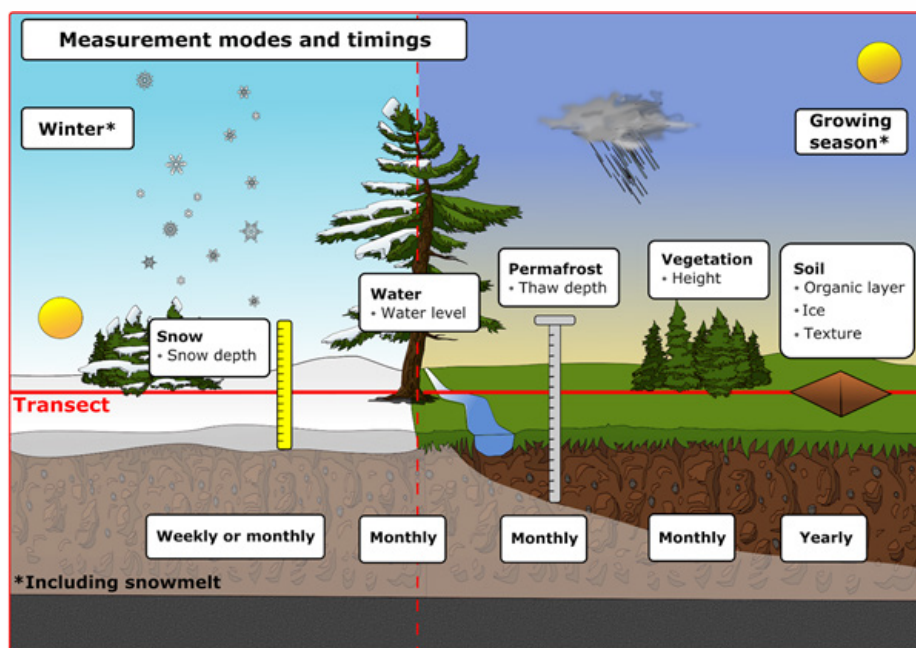
In 2021, the T-MOSAiC permafrost thaw Action Group published a protocol for standardized collection of field data for quantifying permafrost thaw. It addresses the need for integrated observations of multiple connected components of permafrost landscapes, including soils, snow and vegetation. Multi-parameter observations are necessary to understand and predict permafrost thaw, which is increasingly affecting infrastructure, ecosystems and human livelihoods.

- Boike, J., *et al.* (2021). Standardized monitoring of permafrost thaw: a user-friendly, multiparameter protocol. *Arctic Science*, 8(1). DOI: [10.1139/as-2021-0007](https://doi.org/10.1139/as-2021-0007).

We established a growing database from several pan-arctic sites

with many more to join. Based on our protocol we produced a mobile

app [myThaw](#) (iOS and Android) with several [YouTube video tutorials](#).



Multiparameter field observations with their recommended methods and frequency for data collection between winter and summer.

IN MEMORIAM

Geoffrey "Graeme" Carré Claridge

(1931-2021)

BY MEGAN BALKS (UNIVERSITY OF WAIKATO, NEW ZEALAND) & IAIN CAMPBELL

Graeme was born and educated in New Zealand and commenced work at DSIR Soil Bureau in 1953. He made a major contribution to study of soils in the Ross Sea Region of Antarctica. Graeme first travelled to Antarctica in 1959-60 with J.D. McCraw to study:

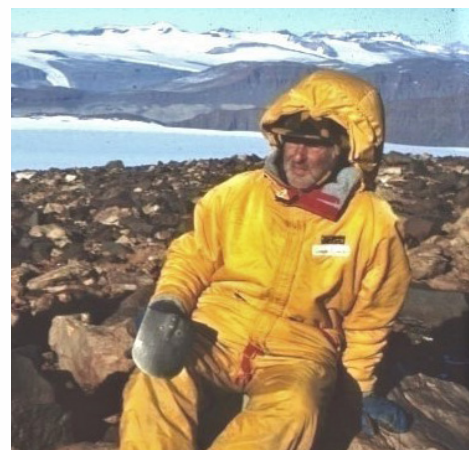
- Antarctic soil processes and produce a small-scale soil map of the Ross Dependency (450,000 km²);
- Buried soils and evidence of changes in climate;
- Past and present chemical and physical weathering;
- The relationship of the per-

mafrost-table to topography;

- The organic cycle under polar conditions and make geological and botanical observations.

While McCraw never returned to Antarctica, Graeme continued the work in partnership with Iain Campbell, commencing in 1964. Claridge and Campbell were a successful team, co-authoring 84 Antarctic scientific publications, including their 1987 book which remains a widely cited classic text on Antarctic Soils.

During the 1970s Graeme taught himself Russian and visited Russia to better understand their work on Cryosols. In 1991, Graeme was award-



ed the Polar Medal. Graeme hated to waste anything - he wore the same boots on his last Antarctic trip as on his first, constantly repairing them.

Graeme was a humble, stoic and practical man with a great love of wilderness areas and an ironic sense of humour. He was a careful, thorough, scientist who had an encyclopaedic knowledge of all things Antarctic and contributed greatly to our understanding of Antarctic soils.

Campbell, I.B. and Claridge, G.G.C. (1987). *Antartica: Soils, Weathering Processes and Environment*. Developments in Soil Science 16. Elsevier Science Publishers, Amsterdam & New York, 406 p.

IN MEMORIAM

Arthur H. Lachenbruch

(1925-2021)

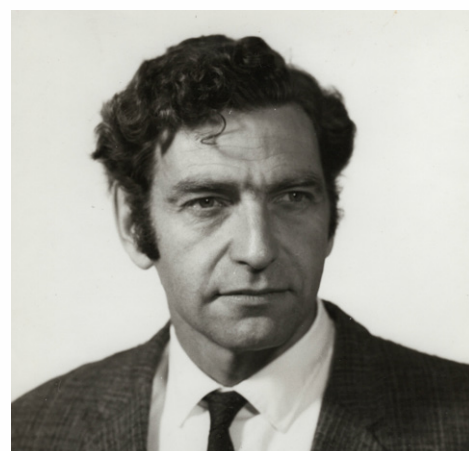
BY CHRIS BURN (CARLETON UNIVERSITY, CANADA)

Art Lachenbruch was a giant of North American permafrost science. He produced consistently stimulating and innovative papers during a career with the United States Geological Survey (USGS), which he joined after high school. His contributions to permafrost science sprang from extensive fieldwork on the Alaskan North Slope, an innate interest in terrestrial heat flow, and a remarkable facility with quantitative analysis. An early achievement was the Geological Society of America Special Paper for which he received the Kirk Bryan Award.

When the Trans-Alaska pipeline

was originally designed to be buried throughout its entire length, Art knew it was untenable and prepared a short USGS Circular, Some estimates of the thermal effects of a heated pipeline in permafrost. It averted environmental disaster. In terms of societal consequences, it is the most important report on permafrost published in North America.

Exploration for oil in Alaska led to wells that penetrated deep permafrost and provided access to its entire temperature profile. Art reconciled warming of the upper permafrost with post-Neoglacial climate warming. This way he made a



critical contribution to understanding permafrost and climate.

Art was elected a Fellow of the National Academy of Sciences in 1975 and he received the Bucher Medal of the American Geophysical Union in 1989. He was a gentle and gracious man, devoted to his family. We will remain astonished by his contributions and will remember him with our utmost respect.

Lachenbruch, A.H (1962). *Mechanics of thermal contraction cracks and ice-wedge polygons in permafrost*. Geological Society of America, Special Paper 70. 69 p. DOI: 10.1130/SPE70.

Photography CONTEST

After two restrictive years due to the COVID-19 pandemic, many permafrost researchers are returning to fieldwork in 2022. To celebrate this, the IPA will run its **2nd Photo Contest** in Autumn.

We hope you have a safe and productive field season!
STAY TUNED FOR MORE UPDATES!

THEME:
Return to
Fieldwork



www.permafrost.org



THE INTERNATIONAL PERMAFROST ASSOCIATION

The mission of the International Permafrost Association is to promote research in permafrost and permafrost-related fields within the global scientific and engineering communities, to support the activities of researchers in these disciplines, and to disseminate findings concerning permafrost to decision-makers, the general public, and educators.

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