

Title of proposed Action Group

Action Group on Permafrost-Associated Gas Hydrates

Action Group Principal Investigators (PIs)

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Objectives and scope of the Action Group

Background and Motivation:

High latitude permafrost regions are warming faster than the rest of the planet leading to drastic and cascading environmental impacts including ice sheet and glacier melting, sea ice decline, and permafrost thawing (Angelopoulos et al., 2020; Rantanen et al., 2022 and references within). Permafrost hosts methane (CH₄) as free gas, dissolved in water, and stored in gas hydrates - an ice-like substance composed of water and predominantly methane gas. The stability of these gas hydrates requires low-temperature and high-pressure conditions; therefore, gas hydrates occur within or below terrestrial and subsea permafrost, as well as beneath large ice sheets (Figure 1).

Current estimates of the methane in gas hydrates occurring in permafrost are highly uncertain, ranging from as low as 27 gigatons (Ruppel, 2015) of methane to at least 540 gigatons of methane as estimated in subsea permafrost for the East Siberian Arctic Shelf (Shakhova et al., 2010). The large variability in these values is based on numerous assumptions in key parameters required to define the inventory. These include pressure/temperature conditions defining the maximum size of the container that could host hydrate, *in situ* gas hydrate concentration levels, composition of hydrocarbons and associated hydrate structures, and porosity of host-sediments. Despite the potentially large carbon stores, **permafrost-associated gas hydrates (PAGH)** have been undervalued in global carbon budgets and policy discussions. Such assessments typically focus on marine gas hydrates and often do not include onshore and subsea PAGH. While the latest IPCC report indicates that methane hydrates are not currently a significant source of emissions, climate change has the potential to destabilize these deposits, increasing their contribution in the future.

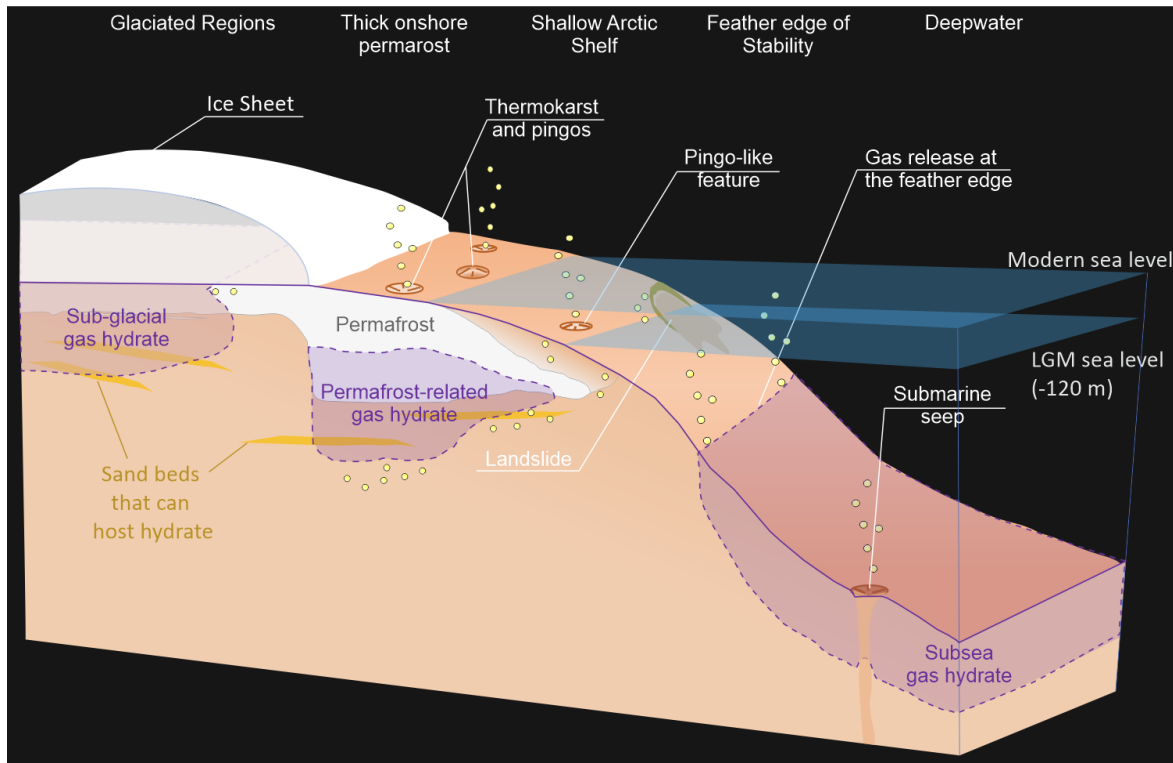


Figure 1: Sketch of sub-glacial and permafrost-associated gas hydrates, including onshore and subsea regions. Sea-level rise leads to warming at the surface, inundation and thawing of permafrost, and potentially, destabilization of gas hydrates. Likewise, atmospheric warming may lead to terrestrial permafrost thaw and gas hydrate decomposition. Modified from Ruppel and Kessler (2017).

Objectives:

The Gas Hydrate Community Scoping Workshop *Permafrost Gas Hydrates in Climate Change: Risks and Chances*, as convened in Hannover, Germany over July 3-5, 2024, identified a series of integrated gas hydrate science and technical challenges relevant to the International Permafrost Association (IPA) and its mission. These include: (1) Quantifying the methane stored in the global permafrost-associated gas hydrate (PAGH) systems, and (2) Assessing what portion of the global PAGH is at risk of dissociation. We propose a two-year interdisciplinary Action Group that will catalogue available data on permafrost and gas hydrate occurrence (surface and borehole temperature data, geophysical well logs, seismic and electromagnetic survey data, etc.) for the Arctic and Antarctic. Furthermore, we will compile subsea permafrost datasets as they will be crucial for describing boundary conditions for PAGH. Our specific objectives are the following: (1) create a digital geospatial directory of existing field data on PAGH in the Arctic and Antarctic (sediment temperature and pressure, porewater salinity, acoustic velocity, electrical resistivity, gas chemistry, gas sources, etc.), (2) define regional extents of the gas hydrate stability zone (GHSZ) in the Arctic and Antarctic, with a special focus for the Beaufort and Svalbard regions, and (3) identify targets for a proposed land-to-sea drilling campaign. Our focus regions reflect one transgressive system (Beaufort) and one deglacial system (Svalbard).

Significance:

One of the missions of the IPA is to disseminate findings on permafrost to decision-makers, the public, and educators. Addressing the role of PAGH in the global climate system represents a critical knowledge gap, essential for determining whether PAGH are important for policy discussions about methane emissions. Our deliverables will directly support ongoing efforts to develop state-of-the-art circum-Arctic maps of permafrost conditions. For instance, Miesner et al. (2023) present the most up-to-date model of subsea permafrost organic carbon in the Northern Hemisphere but does not account yet for PAGH. This action group will also benefit the IPA community by integrating expertise from hydrate specialists who work within the cryosphere but are typically not involved in mainstream permafrost events. Our IPA action group will bridge these two communities, fostering collaboration and advancing shared goals.

Team Members:

This IPA action group proposal was inspired by the Hannover workshop, providing a solid foundation of researchers who are already well-acquainted with each other and committed to achieving the outlined deliverables. As an initial step, we will invite all 26 participants from the hydrate workshop and build upon this network. To kick-start this work, we plan to organize an online workshop in April 2025.

Timeline:

Our deliverables are scheduled around major international conferences, such as the American Geophysical Union (AGU) and the International Conference on Gas Hydrates (ICGH), to facilitate in-person meetings among group members. Online meetings will be held between these events to track progress on the group's activities. The following schedule provides a starting point, but we anticipate that additional informal meetings and workshops will take place as the action group grows and scientific activities advance.

April 2025: Online kick-off meeting.

September 2025: Online workshop to discuss progress on geospatial data directory.

December 2025: First draft of geospatial data directory (hybrid meeting at American Geophysical Union in New Orleans, United States).

July 2026: Finalize geospatial data directory and begin data interpretation to delineate the gas hydrate stability zone (GHSZ) (hybrid meeting at the 11th International Conference on Gas Hydrates - ICGH in Lyon, France).

September 2026: Online workshop (progress update).

December 2026: Publish geospatial data directory online in user-friendly Google Earth format in the open-access PANGAEA platform.

April 2027: Submit scientific article to an open access, peer-reviewed journal that interprets the compiled geospatial data (i.e., GHSZ delineation) and suggest sites for future land-to-sea drilling activities for the Beaufort and Svalbard regions.

Note: In January 2025, several of our group members submitted a pre-proposal to the International Continental Drilling Project (ICDP) entitled "THAW - Thawing of permafrost and cryosphere-associated gas hydrates by Arctic warming". If successful, we will combine an ICDP

full proposal writing workshop with an IPA action group meeting. We will also take advantage of the Ninth Canadian Permafrost Conference (September 2025 in Winnipeg, Manitoba, Canada), the Fourth International Conference on Arctic Research Planning (March 2025 in Boulder, Colorado, United States), and the 10th International Conference on Arctic Margins (March 2025, in Bremen, Germany) to advertise our action group and its activities.

Deliverables:

Anticipated deliverables include:

1. Digital public geospatial directory of field surveys indicating permafrost-associated gas hydrates (PAGH) in onshore and submarine settings for the Arctic and Antarctic, available in Google Earth format. This directory will also serve as an educational resource for researchers and students interested in permafrost and gas hydrates.
2. Regional maps of the gas hydrate stability zone in the Arctic and Antarctic, with a special focus for the Beaufort and Svalbard regions, developed using existing publications and refined interpretations from our action group members.
3. Recommendations for land-to-sea drilling campaign transects in the Beaufort and Svalbard regions.
4. Publish the findings from (2) and (3) in a peer-reviewed, open-access scientific journal, focusing on the geospatial directory (1). The publication should also provide insights into the evolution of the gas hydrate stability zone beneath shallow shelf seas, including the extensive Siberian shelves, where most subsea permafrost lies. We will ensure public outreach by including plain language summaries, infographics, and online visualizations.

Other Action Group Members:

Our proposed action group includes permafrost and gas hydrate experts from seven IPA member countries, representing a range of career stages from ECRs to senior scientists. As part of our proposed budget, we will allocate funding for international conference travel for both a co-PI and an ECR. We are committed to expanding our membership, fostering diversity, and strengthening integration within PYRN. Therefore, this list is not fixed but rather a starting point for the development of the action group.

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International dimension:

Our proposed action group builds upon previously funded IPA action groups, including the Subsea Permafrost Mapping Action Group (SuPerMAG). The SuPerMAG action group strongly contributed to the creation of the state-of-the-art map of subsea permafrost in the Northern Hemisphere (published in [Arctic Permafrost Atlas | GRID-Arendal](#)). Our IPA action group will further add to this subsea permafrost effort by compiling relevant gas hydrate and GHSZ information in key regions. We are also committed to working closely together with the proposed IPA Action Group on saline permafrost (support letter attached). Saline permafrost influences the distribution and stability of PAGH, as well as gas migration pathways that may develop when permafrost warms. Several members of our action group have also contributed to a pre-proposal for an International Continental Drilling Proposal (ICDP), with potential land-to-sea transects in the Beaufort or Svalbard regions. Beyond our deliverables, our action group is a key network uniting international permafrost and hydrate specialists (including ECRs) and will have great benefits for joint fieldwork, modeling, conferences, and publications. Members of the action group also intend to develop and submit a proposal to the COST funding organization (European Cooperation in Science and Technology, <https://www.cost.eu/>) in October 2025 with a specific aim in updating the algorithms in predicting the response of the GHSZ to various warming trends. If funded, the COST action runs from 2026-2030. Outcomes of this Action Group within the IPA on specifics of the PAGH systems would feed into the COST action workflow and deliverables.

Budget:

The proposed working group asks for an annual 3,000€ budget for a total of 6,000€ to successfully execute its tasks and complete all the planned deliverables within the two-year timeline. This budget is broken down as follows:

- 1500€: Travel money for a co-PI to attend the American Geophysical Union (AGU) in December 2025 (New Orleans, United States)
- 1500€: Travel money for an Early Career Researcher (ECR) to attend AGU in December 2025 (New Orleans, United States)
- 1500€: Travel money for a co-PI to attend the International Conference on Gas Hydrates (ICGH) in July 2026 (Lyon, France)
- 1500€: Travel money for an ECR to attend the ICGH in July 2026 (Lyon, France)

By providing equal travel funding between senior researchers and ECRs, we demonstrate our commitment to developing young researchers who are or will be a part of the Permafrost Young Researchers Network (PYRN).

Frozen Ground Newsletter:

The Action Group recognizes its responsibility to prepare a 500-word progress report for inclusion in the IPA's annual Frozen Ground Newsletter. The group is committed to drafting and submitting this report by the specified deadline.

Secretarial support:

The proposed action group requests limited support from the IPA secretariat. We request aid in

disseminating our action group activities and products through the IPA listserv and social media accounts.

Reference List:

Angelopoulos, M., Overduin, P. P., Miesner, F., Grigoriev, M. N., & Vasiliev, A. A. (2020). Recent advances in the study of Arctic submarine permafrost. *Permafrost and Periglacial Processes*, 31(3), 442-453. <https://doi.org/10.1002/ppp.2061>

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International Permafrost Association

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28 January 2025

Dear International Permafrost Association,

On behalf of the Saline Permafrost Action Group, I am pleased to extend our support for the proposed Permafrost-Associated Gas Hydrates (PAGH) action group under the International Permafrost Association (IPA). We recognize the immense research potential and collaborative opportunities that this group brings to the study of gas hydrates and their interactions with permafrost systems.

While our groups have distinct yet complementary goals, our shared focus on Arctic and coastal permafrost environments forms a strong foundation for collaboration. As saline permafrost plays a critical role in influencing the stability and distribution of PAGH, our work naturally aligns with the objectives of your action group. By working together, we aim to advance the understanding of processes such as gas migration pathways and the dynamic interplay between saline permafrost and hydrate systems.

The Saline Permafrost Action Group is committed to contributing resources, expertise, and materials, including geospatial data, mapping initiatives, and collaborative scientific outputs. We look forward to continuing our work together on the updated Northern Hemisphere saline permafrost map and other joint endeavors.

In full support of the PAGH group's efforts, we remain eager to strengthen our partnership and further our collective research on permafrost systems.

Sincerely,

A handwritten signature in black ink, appearing to read 'Ben M. Jones', is written over a light blue horizontal line.

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