Glossary of Permafrost Science and Engineering

Permafrost Terminology Action Group
Canadian Permafrost Assocation

A.G. Lewkowicz, H.B. O'Neill, S.A. Wolfe, P. Roy-Léveillée, V. Roujanski, E. Hoeve, S. Gruber, H. Brooks, A.C.A Rudy, C.E.M Koenig, N. Brown, P.P. Bonnaventure

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CANADIAN PERMAFROST ASSOCIATION
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Front Cover: A megaslump thawing relict glacier ice on Gwich'in Lands in the foothills of the Richardson Mountains. This disturbance is one of the world's most rapidly growing retrogressive thaw slumps, with a headwall about 45 m high and a fill volume exceeding 5 million m^3. It generates enormous volumes of water and mud that flow downstream and impact water quality, ecosystems and traditional use. Note the helicopter for scale (bottom right). (Photo: J. van der Sluijs, Government of Northwest Territories)

Back cover (clockwise from top left): buried glacier ice of Pleistocene age exposed in the headwall of a very large retrogressive thaw slump on the Peel Plateau, NWT (photo: H.B. O'Neill); thermosyphons installed at the Iqaluit airport terminal, Nunavut (photo: Arctic Foundations of Canada); caribou crossing ice-wedge polygons, Richards Island, NWT (photo: B. Kennedy); hydraulic thawing of placer deposits, Quartz Creek, Yukon (photo: D. Froese); Ibyuk pingo near Tuktoyaktuk, NWT (photo: V. Roujanski); an air-cooled embankment and other experimental techniques in a test section of the Alaska Highway near Beaver Creek, Yukon (photo: A. Lewkowicz).

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CONTENTS

INTRODUCTION

The *Glossary of Permafrost Science and Engineering* is a wholesale revision of the *Glossary of Permafrost and Related Ground-Ice Terms* (Harris et al., 1988) and the International Permafrost Association's *Multilanguage Glossary of Permafrost and Related Ground-Ice Terms* (van Everdingen, 2005). The new title was chosen to better identify its content and to reflect the extent of the revisions.

The 1988 version of the *Glossary* was compiled by a working group of the Permafrost Subcommittee of the Associate Committee on Geotechnical Research of the National Research Council of Canada. The members were Stuart A. Harris (Chair), Hugh M. French, J. Alan Heginbottom, G. Hank Johnston, Branko Ladanyi, Dave C. Sego and Robert O. van Everdingen. This first edition was based in part on a previously published booklet entitled *Permafrost Terminology* (Brown and Kupsch, 1974). The working group met for three years to arrive at the published version, which also appeared in a French translation. The Introduction acknowledged the help of a further 17 individuals who provided feedback on the list of terms, their definitions and the references cited.

The list of entries and their definitions in the 1988 *Glossary* was subsequently revised by the Terminology Working Group of the International Permafrost Association and was translated into multiple languages. It appeared as the *Multilanguage Glossary of Permafrost and Related Ground-Ice Terms* (van Everdingen, 2005).

The current publication was developed by the Permafrost Terminology Action Group (PTAG) of the Canadian Permafrost Association. The Action Group members, working by consensus and composed of volunteer researchers and practitioners at all career stages, met more than 50 times over four years (2021–2025) to completely revise and update the *Glossary*. The process (Appendix A) involved identifying and adding 65 new terms adopted by the discipline over the past several decades and modifying the existing entries (term titles, definitions, comments and references) to clarify or update them. In addition, a hierarchy of entries was developed, to assist with discoverability. The process resulted in the elimination of 108 of the 398 entries in the 2005 version because the terms (1) could be included as sub-categories within another entry, (2) have fallen into desuetude, (3) are general scientific or engineering terms that do not relate strongly or exclusively to permafrost, or (4) were judged to be descriptive phrases rather than true terms. A further 49 new terms were considered for inclusion but ultimately were not chosen to be listed as individual entries. The result is a total of 355 entries, of which 261 are modified from the 2005 *Multilanguage Glossary* and 29 are unchanged in definition and comment but may include new references. Modifications ranged from one or two-word edits to the definition or comment with no change to the meaning, up to complete reformulation. Appendix B summarizes the origin of each entry.

The rapid growth of permafrost science and engineering since the start of the millennium means that relevant terminology is continually evolving. The criteria used for inclusion of a new entry were (1) that a definition or description exists in the literature and (2) that the term is broadly accepted by the international permafrost community as demonstrated by its use. Several potential terms that covered relevant concepts did not meet these criteria and instead are referred to within the comments of other entries (see Appendix C). We anticipate that a revision of the *Glossary of Permafrost Science and Engineering* in a few years may include some of these terms as they become better defined in the literature.

This glossary is a companion to *An Illustrated Permafrost Dictionary* (Lewkowicz et al., 2024) which was also developed by PTAG. The *Glossary of Permafrost Science and Engineering* is intended to provide technical definitions for use by researchers, practitioners and post-secondary students, while the *Illustrated Permafrost Dictionary* uses plain language and is primarily destined for non-experts.

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EXPLANATION OF ENTRIES

Glossary entries are ordered alphabetically, neglecting spaces and hyphens. All entries include:

(1) the term

About one quarter of the terms are shown in photos within the Illustrated Permafrost Dictionary (available for download from the Canadian Permafrost Association). These are identified by a camera icon .

(2) the term *en français*

The French versions of the terms were assembled by a group of six Canadian scientists and engineers (see Acknowledgments). Two possible translations are listed for some terms while a small number have no established French equivalents.

(3) a definition

The vast majority of entries include:

(4) a comment

This provides additional details regarding the use or derivation of the term.

Some concepts are referred to in the literature by more than one term. These are indicated as being:

(5) equivalent (i.e., equally acceptable), or
(6) non-preferred

Non-preferred terms are usually older and have not been widely adopted by the international permafrost community.

Relationships between entries are identified as follows:

(7) broader term

The entry is a category of the broader (parent) term shown. For example, *high-centred polygon* is a type of *ice-wedge polygon* so the latter is shown as the broader term. Entries have no more than one parent term and only the immediate broader term is shown. For example, *ice* is the broader term for *ground ice*, but a type of ground ice (e.g., *intrusive ice*) does not show *ice* as a broader term. In addition, the relationship is identified only if exclusive. *Thaw settlement*, for example, can be a *thermokarst* process, but the term also applies to small movements during thaw that do not induce thermokarst. For this reason, *thermokarst* is shown as a related term to *thaw settlement* and not as its broader term.

(8) narrower term(s)

The entry is the broader (parent) term for one or more types (child terms). The entry for *cryostructure*, for example, shows a list of eleven narrower terms, all of which are specific cryostructures. Equally, each of the entries for the narrower terms show *cryostructure* as the broader term. Some broad terms, such as *permafrost*, have a long list of narrower terms.

(9) related term(s)

Many entries are shown with related terms that help elucidate or differentiate their meaning. These can include terms that have the same broader term. For example, s*egregated ice* and *wedge ice* are shown as related terms; they each have *ground ice* as their broader term. They are related terms because comparison of their entries helps explain their essential differences. *Ice*, the broader term for *ground ice*, is also a related term.

Most entries in the *Glossary* include:

(10) references

The *Glossary* provides a limited review of the literature associated with each term. Efforts were made to include both seminal references and more recent reviews, and to select relatively accessible sources. In general, a maximum of five references are listed alphabetically. Given the make-up of PTAG, there is likely a bias favouring North American, and especially Canadian, sources.

Selected entries refer to figures which are included in numerical order before the appendices at the end of the *Glossary*.

ACKNOWLEDGMENTS

We thank the many Indigenous Peoples of northern Canada (First Nations, Inuit and Métis) and of other countries, for facilitating access to their lands and traditional territories to jointly develop our knowledge of permafrost environments. We acknowledge the funding agencies and other organizations that supported fieldwork carried out by members of PTAG over many years, especially NSERC, the Polar Continental Shelf Project and the Geological Survey of Canada.

We are grateful to the National Research Council of Canada for giving permission to reproduce the 14 entries that are unchanged from the original *Glossary of Permafrost and Related Ground-Ice Terms* (Harris et al., 1988). These terms are identified in Appendix B.

Michel Paquette was a member of PTAG from 2021–2022. We thank him for his important contributions during the first part of the process. We are also grateful to colleagues who generously shared their expertise and reviewed groups of terms that were new or substantially changed: Michel Allard, Lukas Arenson, Colin Ballantyne, Alex Bevington, Jim Bockheim, Chris Burn, Fabrice Calmels, Élise Devoie, Guy Doré, Tom Douglas, Caroline Duchesne, Igor Egorov, Louise Farquharson, Daniel Fortier, Samuel Gagnon, Madeleine Garibaldi, Jocelyn Hayley, Teddi Herring, Jean Holloway, Torre Jorgenson, Steve Kokelj, Denis Lacelle, Brian Moorman, Peter Morse, Julian Murton, Fritz Nelson, Marcia Phillips, Paul Sanborn, Greg Siemens, Wendy Sladen, Sharon Smith, Chris Spence, Dmitry Streletskiy, Richard Trimble, Yifeng Wang, Robert Way, Ed Yarmak, and Kathy Young. Four other colleagues gave feedback on specific terms: Margaret Darrow, Vladimir Romanovsky, Yuri Shur and Jef Vandenberghe. We also received suggestions for new terms from a number of CPA members following conference presentations. We thank all of these individuals for their guidance, although the responsibility for the entries lies with PTAG members.

The updated French equivalents of the terms are the work of Guy Doré, Simon Dumais, Daniel Fortier, Michelle Garneau and Anne-Marie Leblanc, under the leadership of Pascale Roy-Léveillée.

Production of the *Glossary* as an ebook was supported financially by the Canadian National Committee for the International Permafrost Association (CNC-IPA) and the Canadian Permafrost Association. Printing costs for an initial run of hard copies were supported by Natural Resources Canada through the Geological Survey of Canada, and by PermafrostNet. We thank these organizations for their generous assistance.

Finally, we acknowledge the essential contributions of all those who worked on publications relating to permafrost terminology during the past 50 years. We could not have completed this version of the *Glossary* without the foundations that they laid for the discipline.

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GLOSSARY ENTRIES

abrupt thaw

[fr] dégel abrupt

Definition: Permafrost thaw processes that lead to a substantial and persistent environmental change within a few decades.
Comment: Abrupt thaw commonly involves the development of thermokarst landforms in ice-rich terrain, but it can also be initiated in ice-poor permafrost by external factors such as wildfire or hydrologic change (e.g., increased streamflow, soil moisture fluctuations, altered groundwater recharge). Abrupt thaw may cause the permafrost system to cross an ecological or geomorphic tipping point and switch to a new state. The term is most useful for communicating to general audiences, describing multiple types of abrupt thaw processes (as distinct from gradual top-down thaw), or dealing with general concepts of abrupt permafrost change.
Related terms: permafrost degradation; thawing (of frozen ground); thermal erosion; thermokarst; thermokarst terrain
Reference: Webb et al., 2025

active layer 📷

[fr] couche active

Definition: 1. The layer of ground above permafrost whose temperature changes yearly from below 0°C to above 0°C (thermal active layer). 2. The layer of ground that freezes and thaws yearly at sites underlain by permafrost (phase-based active layer).
Comment: The thermal and phase-based definitions identify the active layer differently (Figure 1). 1. The thermal definition differentiates the active layer from permafrost (perennially cryotic), applies to all substrates, can be inferred from ground temperature measurements, and is most suitable for monitoring and modelling long-term change. 2. The phase-based definition recognizes that freezing and thawing of earth materials may occur at temperatures below 0°C, so

that fundamental geocryological, hydrological and ecological processes can take place within the lowermost portion of the active layer that thermally forms part of the permafrost (see seasonally active permafrost). This definition recognized the continuity of processes across the 0°C isotherm and appeared in the Glossary of Permafrost and Related Ground Ice Terms (Harris et al., 1988) and in the International Permafrost Association's Multilanguage Glossary (van Everdingen, 2005). Depending on substrate, the two definitions may delimit a near-identical layer with the same thickness (e.g., in coarse soils or peat), or layers with substantially different thicknesses (e.g., in fine-grained soils or saline permafrost where phase change occurs below 0°C, or dry permafrost where no phase change occurs). Which definition is preferable depends on the purpose of active layer identification and the method used to delimit it.
Non-preferred: active zone
Narrower term: relict active layer
Related terms: active layer thickness; freezing (of ground); one-sided freezing; seasonally-active permafrost; seasonally frozen layer; seasonally thawed ground; thawed ground; transient layer; two-sided freezing
References: Burn, 1998; Harris et al., 1988; Muller, 1943; van Everdingen, 2005; Yershov, 1990

active-layer detachment failure

[fr] décrochement de couche active

Definition: The rapid downslope movement of a thawing surface layer over frozen ground or the resulting shallow translational landslide.
Comment: Active-layer detachment failure generally occurs on low-angled to moderate slopes in fine-grained, ice-rich sediments. It is typically due to high rates of thaw caused, for example, by a particularly warm period in mid-summer, and/or to deep thaw that impacts the ice-rich transient layer caused, for example, by disturbance to the vegetation cover by fire or construction activity. High pore water pressures, generated during thaw consolidation or by rainfall, reduce the effective shear strength at the interface between the thawed and still-frozen ground. Failed blocks move downslope at rates in the order of metres per hour to metres per minute. The thawed mass may slide with little internal deformation, or at higher velocities, greater soil moisture contents or on steeper slopes, the materials can be subject to folding and flow in the toe zone of the landslide. Active-layer detachment failures that expose massive ice or icy sediments can develop into retrogressive thaw slumps.
Equivalents: active-layer detachment; active-layer detachment slide; cryogenic landslide; detachment failure
Non-preferred: skin flow; active-layer failure
Broader term: mass movement
Related term: thaw consolidation
References: Leibman, 1995; Lewkowicz, 2007; McRoberts and Morgenstern, 1974b

active layer thickness

[fr] épaisseur de couche active

Definition: The thickness of the surface layer of the ground that is subject to annual temperature cycling above and below 0°C (thermal active layer) or annual thawing and freezing (phase-based active layer) in areas underlain by permafrost.

Comment: Active layer thickness (ALT) depends on such factors as air temperature, vegetation, drainage, soil or rock type, total water content, snowcover, and degree and orientation of slope. In general, the active layer is thin in the High Arctic (it can be less than 15 cm) and becomes thicker farther south (1 m or more). The ALT varies annually with local environmental factors including annual air temperature and snowcover. The phase-based ALT includes the uppermost part of the permafrost wherever either the salinity or clay content of the permafrost allows it to thaw and refreeze annually (see seasonally-active permafrost), even though the material remains cryotic (T <0°C) and so is not part of the thermal active layer (see Figure 1). Providing there is not a supra-permafrost talik, the ALT is equivalent to the maximum thaw depth at the end of summer, a measure that is an essential climate variable according to the Global Climate Observing System.

Related terms: active layer; frost probe; seasonally-active permafrost; thaw depth; thaw penetration; thaw tube

References: Ballantyne, 2018; French, 2017; Muller, 1943

adfreeze/adfreezing

[fr] adhérence au gel

Definition: The process by which two objects are bonded together by the force formed between them when frozen.

Comment: Adfreezing is the process that connects objects buried in permafrost, and supports the loads associated with such infrastructure (i.e. structural loading, frost heave, etc.).

Related terms: adfreeze strength; adfreeze pile

References: Andersland and Ladanyi, 2004; Muller, 1943; Prakash and Sharma, 1990

adfreeze pile

[fr] pieu à adhérence au gel

Definition: A pile that derives its support from the bond between the pile surface area and the surrounding frozen soil.

Comment: An adfreeze pile is designed based on the velocity (creep) of the pile through the life of the structure using an assessment of permissible settlement.

Related terms: adfreeze/adfreezing; adfreeze strength; creep strength

References: CSA Group, 2019, 2021a

adfreeze strength

[fr] résistance d’adhérence au gel

Definition: The tensile or shear strength that has to be overcome to separate two objects that are bonded together by frozen soil or ice.

Comment: The term is usually used to describe the resistance to the force that is required to separate frozen ground or an ice mass from an object (frequently a foundation unit) to which it is frozen. The shear stress required to separate an object from frozen ground is frequently referred to as the *tangential adfreeze strength*. This strength is dependent on temperature, salinity and other site conditions. For permafrost engineering, adfreeze strength is considered to be the ultimate strength, independent of strain rate.

Related terms: adfreeze/adfreezing; adfreeze pile

References: Andersland and Ladanyi, 2004; Johnston, 1981; Prakash and Sharma, 1990

aggradational ice

[fr] glace d’aggradation

Definition: Segregated ice that accumulates in association with a rising permafrost table.

Comment: Aggradational ice develops due to (1) the net migration of moisture into the top of permafrost in summer and a rising permafrost table, and/or (2) incorporation of ice lenses, formed at the base of the active layer during freezeback, into permafrost that is aggrading upward.

Broader term: ground ice

Related terms: ice; segregated ice

References: Cheng, 1983; Mackay, 1972a, 1983

air-cooled embankment

[fr] remblai à convection

Definition: An embankment that extracts heat from the subsurface via air convection.

Comment: Air movement, and thus convective heat transfer, can be caused by density differences in the air due to temperature gradients, or forced by wind or engineered systems that move the air through the embankment. Types of natural convection-based air-cooled embankments include Air Convection Embankments (ACE) where natural convection develops in the winter within large pore spaces, and heat drain embankments in which a chimney effect develops in the winter. The extraction of heat convectively helps maintain permafrost beneath infrastructure.

Narrower term: heat drain

Related term: chimney effect

References: Andersland and Ladanyi, 2004; Doré et al., 2016

air freezing index

[fr] indice de gel de l'air

Definition: The cumulative number of degree-days below 0°C for the air temperature during a given time period.

Comment: The air freezing index differs from the surface freezing index at the same location (see n-factor).

Broader term: freezing index

Related terms: design freezing index; n-factor; nival offset; surface freezing index; Temperature at the Top of Permafrost (TTOP) model

References: Frauenfeld et al., 2007; Johnston, 1981

air thawing index

[fr] indice de dégel de l'air

Definition: The cumulative number of degree-days above 0°C for the air temperature during a given period.

Comment: The air thawing index differs from the surface thawing index at the same location (see n-factor).

Broader term: thawing index

Related terms: design thawing index; n-factor; surface thawing index; Temperature at the Top of Permafrost (TTOP) model

References: Frauenfeld et al., 2007; Johnston, 1981

alas

[fr] alass

Definition: A large ground surface depression produced by thawing of extensive areas of very thick, very ice-rich permafrost.

Comment: Alases range from 0.5 to >100 km^2 in area and from 5 to 30 m in depth. They are most commonly associated with the thaw of ice-rich yedoma deposits. In the early stages of formation, a shallow circular alas lake or several smaller lakes/depressions form(s) within part of the depression. Enlargement, migration, coalescence and drainage of such lakes may leave low inter-alas plateaus, sculpted by mass movement. Recently formed alas depressions are often underlain by taliks, whereas relict features are perennially frozen and may contain epigenetic ice wedges. Ultimately, the plateaus disappear and mass wasting produces gentle side slopes. The term is of Yakut origin.

Equivalents: alass; alas depression

Non-preferred: mezhalasye

Broader term: thermokarst

Related terms: permafrost degradation; talik; thermokarst lake; yedoma

References: Czudek and Demek, 1970; Dubikov et al., 2003; Morgenstern et al., 2011

albedo 📷

[fr] albédo

Definition: The ratio of reflected to incident solar radiation flux density at a surface.
Comment: The albedo determines how much sunlight is converted into heat at a surface. It varies seasonally as the vegetation cover changes and the snow cover forms and decays. High albedo surfaces have been used to help maintain permafrost beneath runways and roads. Strictly speaking, albedo is the broadband bihemispherical reflectance. Broadband means that it is integrated over the relevant part of the solar spectrum, usually 300 nm to 2500 nm. Because the albedo often depends on the local incidence angle of sunlight and on its spectral composition, the albedo of a surface can change diurnally and can vary depending on the instrument used for its measurement.
References: Bourgeois et al., 2006; Schaepman-Strub et al., 2006

anti-syngenetic ice wedge

[fr] coin de glace anti-syngénétique

Definition: An ice wedge that grows progressively downwards on an erosional surface, such as a receding slope, in a direction normal to the surface (Figure 2).
Comment: These wedges are commonly wide and shallow, with the youngest portions of the wedge extending farthest down. The downward rate of growth is a function of the rate of slope recession or surface erosion and the rate of formation of new ice veins.
Broader term: ice wedge
Related terms: epigenetic ice wedge; syngenetic ice wedge; wedge ice
References: Burn et al., 2021; Mackay, 1990

apparent heat capacity

[fr] chaleur spécifique apparente; capacité thermique massique apparente

Definition: The amount of heat required to change the temperature of a mixture, such as frozen soil, as one or more of its components undergoes phase change.
Comment: The apparent heat capacity is the sum of the heat capacities of the material components and a term that accounts for the latent heat released or absorbed due to phase change. It is commonly expressed in Joules per kg per degree K. Because phase change in frozen ground can occur over a range of temperatures, the apparent heat capacity may vary significantly with temperature.
Equivalent: effective heat capacity
Broader term: heat capacity
Related terms: latent heat of fusion; soil freezing characteristic curve; specific heat capacity
References: Anderson et al., 1973b; Mottaghy and Rath, 2006

artificial ground freezing

[fr] gel artificiel du sol

Definition: The process of converting soil water to ice by artificial means.
Comment: Freezing can be induced or maintained by natural convective movement of air, gases or liquids (e.g., in thermopiles and thermosyphons), or by mechanical circulation of cold air or a refrigerant through ducts or freeze pipes in the ground.
Broader term: freezing (of ground)
References: Alzoubi et al., 2020; Johnston, 1981

aufeis

[fr] aufeis

Definition: A sheetlike mass of layered ice formed on the ground surface, on river ice, or on engineered structures, by freezing of successive flows of water in winter.
Comment: Aufeis occurs in permafrost and non-permafrost areas. Flood ice, flood-plain icing, and overflow ice usually indicate aufeis formed on river ice and floodplains. Chrystocrene (or crystocrene), ground icing, groundwater icings and spring icing usually indicate aufeis formed by freezing of groundwater discharge. Icing is used as an equivalent to aufeis in North America, but it is preferable to restrict this term to the process (see icing) and use aufeis for the form (Ensom et al., 2020). Large, perennial aufeis in Yakutia are called *taryn*.
Equivalents: icing (North America); naled (Russia)
Non-preferred: glacier (Yukon and Alaska)
Related terms: icing; icing blister; icing glade; icing mound; intrapermafrost groundwater; suprapermafrost groundwater
References: Alekseev, 2007; Ensom et al., 2020

basal (glacier) ice cryostructures

[fr] cryostructures de la glace basale de glacier

Definition: Cryostructures, including structural characteristics and facies, associated with basal ice, formed at or near the bed of a glacier or ice sheet.
Comment: Basal glacier ice includes characteristic cryostructures which may provide a means to distinguish buried glacier ice preserved in permafrost from other types of ground ice.
Broader term: cryostructure
References: Fortier et al., 2012; Hubbard et al., 2009

basal temperature of snow (BTS) method

[fr] méthode basée sur la température à la base du couvert nival

Definition: A method to estimate the likelihood of the presence of permafrost, using measurements of the basal temperature of snow cover in mid- to late winter.

Comment: Ground surface temperatures in late winter correlate with mean annual ground temperatures in areas where the thickness of the snow cover is at least 0.8–1 m and snow surface melting is negligible. These basal temperature of snow (BTS) values remain virtually constant, mainly controlled by heat transfer from the upper ground layers, which in turn is strongly influenced by the presence or absence of permafrost. When the method has been locally calibrated, the BTS method can be used for estimating patterns of permafrost occurrence.
Equivalent: bottom temperature of snow method
References: Haeberli, 1973; Hoelzle, 1992; Lewkowicz and Ednie, 2004

beaded stream

[fr] cours d'eau en chapelet

Definition: A narrow stream characterized by short reaches that link a series of pools or small lakes in areas underlain by ice wedges.
Comment: A characteristic pattern of small streams in areas underlain by ice wedges. The course of the stream channel is controlled by the pattern of the wedges, with the beads (pools) occurring at the junctions of the ice wedges. When the intervening channels are dry, they may be called *beaded channels*.
Broader term: thermokarst
Related term: ice-wedge melt pond
References: Arp et al., 2015; Brown, 1970a; Péwé, 1954

blockfield

[fr] champ de blocs

Definition: A surficial accumulation of bouldery debris on plateaus and other low-gradient terrain in areas of present-day or past periglacial conditions and derived from *in situ* weathering of the underlying bedrock.
Comment: Processes responsible for the weathering of bedrock to form blockfields are believed to include frost shattering, frost wedging and differential thermal contraction of minerals leading to cracking of rock. Boulders are moved to the surface by frost heave.
Equivalents: felsenmeer; block field
Non-preferred: stone field; blockmeer
Broader term: periglacial phenomena
Related term: frost weathering
References: Ballantyne, 2010; Goodfellow et al., 2009; Washburn, 1973

buried ice

[fr] glace enfouie

Definition: Ice formed or deposited on the ground surface and later covered by sediments.
Comment: Buried ice originates as glacier ice, snow (in snowbanks), lake or pond ice, river ice, sea ice, or aufeis. Buried ice can be preserved for years to millennia in permafrost.

Broader term: ground ice
Related terms: ice; massive ice; relict ice; solid cryostructure
References: French, 2017; Harris and Murton, 2005; Mackay, 1973a

cave ice

[fr] glace de condensation solide

Definition: Ice in a cave or mine opening.
Comment: Cave ice can form and persist in an area where climatic conditions would not otherwise support permafrost but where the configuration of the cave system permits an influx of cold winter air by gravity flow and limits access of warm summer air.
Broader term: ground ice
Related term: ice
References: Harris, 1979; Luetscher and Jeannin, 2004

chimney effect

[fr] effet de cheminée

Definition: The ascending outflow of warmer lower-density air through voids in the ground surface and snow in winter when the ambient air temperature is lower than the ground temperature.
Comment: The chimney effect enhances winter heat loss from the lower parts of talus slopes and some rock glaciers because the outflow of warmer air upslope induces the inflow of colder air near the slope base. The effect is utilized in air-cooled embankments and heat drains to help maintain permafrost beneath linear infrastructure. The chimney effect is partly responsible for some occurrences of extra-zonal mountain permafrost.
Related terms: air-cooled embankment; extra-zonal permafrost; heat drain
References: Delaloye and Lambiel, 2005; Wicky and Hauck, 2020

climate-driven, ecosystem-modified permafrost

[fr] pergélisol contrôlé par le climat, modifié par l'écosystème

Definition: Permafrost occurring in a cold climate and formed as climate-driven, but with a thermal regime modified by ecological succession and organic-matter accumulation.
Comment: In the low arctic, climate-driven, ecosystem-modified permafrost may develop from climate-driven permafrost as vegetation accumulation reduces the direct control of climate on permafrost. This can lead to active layer thinning and the formation of aggradational ice above the original permafrost layer.
Broader term: permafrost
Related terms: climate-driven, ecosystem-protected permafrost; climate-driven permafrost; ecosystem-driven permafrost; ecosystem-protected permafrost
References: Ran et al., 2021; Shur and Jorgenson, 2007

climate-driven, ecosystem-protected permafrost

[fr] pergélisol contrôlé par le climat, protégé par l'écosystème

Definition: Permafrost that originally aggraded in a cold climate but persists under a warmer climate due to ecological succession.

Comment: This permafrost may contain unique cryostructures, including large inactive ice wedges or aggradational segregated ice formed under colder climatic conditions. If the permafrost thaws it cannot be re-established with its original characteristics.

Broader term: permafrost

Related terms: climate-driven, ecosystem-modified permafrost; climate-driven permafrost; ecosystem-driven permafrost; ecosystem-protected permafrost

References: Ran et al., 2021; Shur and Jorgenson, 2007

climate-driven permafrost

[fr] pergélisol contrôlé par le climat

Definition: Permafrost occurring in cold or very cold climates where it forms independent of surface cover.

Comment: Climate-driven permafrost occurs where only climatic, rather than ecological factors, are involved in either its initial formation or its persistence. It may form immediately after exposure of unfrozen soil on barren surfaces and is maintained primarily in the High Arctic.

Broader term: permafrost

Related terms: climate-driven, ecosystem-modified permafrost; climate-driven ecosystem-protected permafrost; ecosystem-driven permafrost; ecosystem-protected permafrost

References: Ran et al., 2021; Shur and Jorgenson, 2007

closed-cavity ice

[fr] glace de condensation solide (cavité fermée)

Definition: Ice formed from vapour in a closed space, cavity or cave in permafrost.

Comment: Along the western Arctic coast of Canada, for example, underground cavities, apparently formed by pockets of methane gas, have been found to contain ice crystals. The water from which the crystals have grown probably entered the cavities through vapour diffusion.

Non-preferred: sublimation ice

Broader term: ground ice

Related terms: ice; open-cavity ice

References: Mackay, 1965, 1972a

closed-system freezing

[fr] gel en système fermé

Definition: Freezing that occurs under conditions that preclude the gain or loss of any water by the system.

Comment: Closed-system freezing of water-saturated soil causes expansion equal to about 9 percent of the original pore volume of the unfrozen soil. Some redistribution of water may occur during freezing.
Equivalent: *in situ* freezing
Related term: freezing (of ground)

closed-system pingo

[fr] pingo en système fermé

Definition: A pingo formed by doming of frozen ground due to freezing of injected water supplied by expulsion of pore water during permafrost aggradation in the closed talik under a former water body (Figure 3).
Comment: Most closed-system pingos are found in flat, poorly-drained, sandy terrain in the zone of continuous permafrost. Repeated injections of expelled water into the overlying permafrost, followed by freezing of the injected water, cause progressive doming, and produce the massive ice forming the core of the pingo. Progressive formation of segregated ice and dilation crack ice can also contribute to the process.
Equivalent: hydrostatic pingo
Non-preferred: Mackenzie Delta pingo
Broader term: pingo
Related term: frost mound
References: French, 2017; Mackay, 1973, 1998

closed talik

[fr] talik fermé

Definition: A talik occupying a depression in the permafrost table (Figure 4).
Comment: Since frozen ground surrounds the talik, groundwater exchange is limited to that between the surface and the suprapermafrost ground, comprising the active layer and the talik.
Non-preferred: thaw basin
Broader term: talik
Related term: upward freezing
References: Dubikov et al., 2003; O’Neill et al., 2020; van Everdingen, 1976

collapsed pingo

[fr] pingo effondré

Definition: A pingo in a permafrost environment that has collapsed due to melting of some or all of its ice core.
Comment: In contemporary permafrost environments, a collapsed pingo is commonly represented by a low, circular or arcuate ridge of material resulting from the slumping of the sides of the pingo during thawing. The former centre is marked by a depression which may be filled with water.

Equivalent: pingo remnant
Broader term: thermokarst
Related term: pingo
References: Ballantyne, 2018; Mackay, 1998; Washburn, 1973

collapse scar

[fr] cicatrice d'effondrement

Definition: A portion of a permafrost peatland where part or all of a perennial frost mound or peat plateau has thawed and collapsed towards the level of the surrounding peatland.
Comment: Collapse scars include parts of bogs and fens that are marked by an absence of near-surface permafrost, and by vegetation that differs from that on both the remnant permafrost peatlands and previously unfrozen peatlands.
Related terms: thermokarst; thermokarst terrain
References: Jorgenson et al., 2001; Zoltai, 1971

composite wedge

[fr] coin à remplissage mixte

Definition: A wedge composed of both ice and soil (commonly sand) veins.
Related terms: ground wedge; ice wedge; ice-wedge pseudomorph; sand wedge
References: French, 2017; Murton, 1996; Romanovskii, 1977

condenser

[fr] paroi de condensation

Definition: The upper, above-ground part of a two-phase thermosyphon where the vapour of a working fluid, such as CO_2, rising from the underground evaporator section, loses heat in winter and condenses into a liquid.
Comment: Heat transfer in the condenser occurs by convection and radiation, so it is sometimes referred to as a radiator.
Equivalent: radiator
Related terms: evaporator; thermopile; thermosyphon
References: Andersland and Ladanyi, 2004; CSA Group, 2019

continuous permafrost

[fr] pergélisol continu

Definition: Permafrost occurring beneath all of the exposed land surface of a geographic region except for widely scattered sites, such as newly deposited or newly exposed unconsolidated sediments, where the climate has just begun to impose its influence on the ground thermal regime.

Comment: Isolated taliks may be present in regions with continuous permafrost where local anomalies occur in thermal, hydrological, hydrogeological, or hydrochemical conditions.
Broader term: permafrost
Related terms: continuous permafrost zone; permafrost region
References: Brown et al., 1997; Brown, 1970a; French, 2017

continuous permafrost zone

[fr] zone de pergélisol continu

Definition: A major subdivision of a permafrost region in which permafrost underlies 90% or more of the exposed land surface (Figure 5).
Comment: The continuous permafrost zone lies poleward of the discontinuous permafrost zone, or at higher elevations in the case of mountain permafrost. Transitions between continuous and discontinuous permafrost zones are conceptual and cannot be sharply delineated at a fine scale. Despite its formulation, the continuous permafrost zone can include isolated taliks, for example, associated with rivers, lakes or recent surface change.
Broader term: permafrost zone
Related terms: continuous permafrost; permafrost region
References: Brown et al., 1997; Heginbottom, 2002; Heginbottom et al., 1995

creep of frozen ground

[fr] fluage du sol gelé

Definition: The slow deformation (or time-dependent strain) that results from long-term application of a stress too small to produce immediate failure in the frozen material.
Comment: In frozen soils, creep deformations are mainly due to the creep of pore ice and the migration of unfrozen pore water. In ice-saturated frozen soils, most creep deformations are distortional with little or no volume change. In frozen soils with large unfrozen water contents or in unsaturated frozen soils, slow deformations due to consolidation, and creep due to volume change, may also occur. Usually, a large portion of the creep deformation is permanent.
Broader term: mass movement
Related term: rock glacier
References: Foriero et al., 1998; Ladanyi, 1972, 1981

creep strength

[fr] résistance au fluage

Definition: The failure strength of a material at a given, relatively low, strain rate or after a given period under deviatoric stress.
Comment: Under high confining stress and at relatively high freezing temperatures, most frozen soils creep and eventually fail in a plastic manner. For most buildings, permafrost engineers use strain rate to determine the creep strength of the adfreeze bond. The strain rate used is generally based on the allowable structural settlement of the foundation during its service life.

Equivalent: creep resistance
Related terms: adfreeze pile; pore water salinity
References: Andersland and Ladanyi, 2004; Prakash and Sharma, 1990

crustal cryostructure

[fr] cryostructure crustale

Definition: A cryostructure in which frost-susceptible sediment or rock clasts are coated with a crust or rim of ice.
Comment: This cryostructure represents localized ice segregation around clasts or wood fragments and is commonly observed just beneath the permafrost table.
Equivalent: crust-like cryostructure
Broader term: cryostructure
References: French and Shur, 2010; Murton, 2022a

cryo-conditioning

[fr] cryo-conditionnement

Definition: The interaction of cryotic surface and subsurface thermal regimes and geomorphic processes.
Comment: Cryo-conditioning can occur in areas where the temperatures of earth materials are at or below 0°C diurnally, seasonally or perennially. The concept emphasizes the interconnectedness of periglacial, glacial and azonal processes (such as fluvial and coastal processes) and their associated landforms in the evolution of cold-climate landscapes.
Related terms: paraglacial; periglacial
Reference: Berthling and Etzelmüller, 2011

cryofacies

[fr] cryofaciès

Definition: Bodies of frozen ground that are relatively similar internally and distinguished from adjacent bodies in terms of characteristics such as volumetric ice content, sediment texture and cryostructure.
Comment: Cryofacies may be identified by patterns of sediment characterized by distinct ice lenses and layers, volumetric ice content and ice-crystal size. Two or more cryofacies that occur together as a distinctive cryostratigraphic unit and are thought to be genetically or environmentally related terms are referred to as a *cryofacies association*, and a group of cryofacies whose genetic relationship is unclear is referred to as a *cryofacies assemblage*.
Related terms: cryostratigraphy; cryostructure
References: French, 2017; French and Shur, 2010; Murton, 2022a

cryofront

[fr] isotherme de 0°C

Definition: The position of the 0°C isotherm in the ground.
Comment: The permafrost base is a cryofront. In the active layer, a cryofront advances from the surface downwards in the autumn, and over cold permafrost, a second cryofront advances upwards from the permafrost table. Cryofronts commonly do not correspond to the boundary between frozen and unfrozen ground due to the freezing-point depression.
Equivalent: 0°C isotherm
Related terms: cryotic; freezing front; permafrost base; thawing front
References: French, 2017; van Everdingen, 1976

cryogenesis

[fr] cryogenèse

Definition: The combination of thermophysical, physico-chemical, physico-mechanical, and mineralogical processes of transformation conditioned by the formation, existence, and melt of ice in earth materials.
Comment: The processes of cryogenesis occur at a variety of scales and include water migration during freezing and thawing of the ground, frost heave, thermal contraction cracking, heat and mass (moisture) exchange, regelation and solifluction.
Related terms: frost heave; solifluction
References: Dubikov et al., 2003; Poppe and Brown, 1976; Romanovskii, 1993

cryogenic aquiclude

[fr] aquiclude cryotique

Definition: A layer of ground which, because of its frozen state, has a low enough permeability to act as a confining bed for an aquifer.
Comment: Annual freezing can turn the active layer into a cryogenic aquiclude.
Related: suprapermafrost groundwater
References: Chesnokova et al., 2021; Fotiev, 1978; Romanovskii, 1983

cryogenic fabric

[fr] microtexture cryotique

Definition: A soil fabric with distinct micromorphology resulting from frost action and cryoturbation associated with cryosols.
Comment: Various fabrics can form in cryosols undergoing frost action depending on soil materials and cryotic processes. These include: *conglomeric* fabric of granular aggregates, mineral grains and organic material enclosed by dense fine mineral material; *orbiculic* fabric of roughly circular bands of silt grains around granular units of finer-grained materials; and *banded* and

isoband fabrics of platy and lenticular microstructures, formed by the accumulation of fine particles on coarse grains or aggregates from repetitive freeze-thaw cycles.
Broader term: periglacial phenomena
Reference: Brewer and Pawluk, 1975; Pawluk and Brewer, 1975; Van Vliet-Lanoë and Fox, 2018

cryolithology

[fr] cryolithologie

Definition: The study of cryogenic earth materials in the modern and relict cryolithosphere, and the conditions of cryogenic sediment accumulation and ground ice formation due to freezing and thawing.
Comment: Cryolithology is a branch of geocryology that deals with the specific lithogenesis that occurs in the cold regions of the Earth. It focuses on the lithological and geomorphic effects of freezing and thawing of earth materials, including ground ice formation and loss. Cryolithology is a Russian term and is not widely used in North America.
Broader term: geocryology
Related terms: cryostratigraphy; permafrost
References: Badu, 2010; Danilov, 1978; Popov, 1967; Popov et al., 1985

cryopedology

[fr] cryopédologie

Definition: The study of soils affected by ground temperatures equal to or less than 0°C, with particular reference to soils subject to intensive frost action, and soils overlying permafrost.
Comment: As originally defined (Bryan, 1946), the term comprised the entire science of geocryology, including the engineering methods used to overcome difficulties resulting from intensive frost action and the existence of permafrost. Current use focuses on pedology.
Broader term: geocryology
Related term: cryosol
References: Bockheim, 2015; Bryan, 1946

cryopeg

[fr] cryopeg

Definition: Perennially cryotic solute-rich groundwater.
Comment: Three types of cryopeg can be distinguished on the basis of their position with respect to permafrost: (1) a *basal* cryopeg occurs in the basal portion of the permafrost; (2) an *isolated* cryopeg is entirely surrounded by perennially frozen ground; (3) a *marine* cryopeg is found in coastal or subsea permafrost; marine cryopegs may also be basal and/or isolated. Cryopegs may be under pressure, up to and including artesian. In North America, cryopeg has been used to denote an unfrozen zone in the permafrost (i.e., a talik) in which cryotic solute-rich groundwater is present.
Broader term: talik (North America)

Related terms: intrapermafrost groundwater; isolated talik; pore water salinity
References: Dubikov et al., 2003; O'Neill et al., 2020; Tolstikhin and Tolstikhin, 1976

cryoplanation

[fr] cryoplanation

Definition: A suite of geomorphic processes causing erosion (bevelling) of upland terrain under cold non-glacial conditions.
Comment: Cryoplanation includes localized frost weathering and erosion of summit surfaces or hillside slopes by frost action, mass wasting at the edges of (and beneath) melting snowdrifts, and slopewash processes. Terrain elements relating to cryoplanation include flattened summits, stepped ridge crests, scalloped hillsides, and pediment-like surfaces.
Equivalent: altiplanation
Related terms: cryoplanation terrace; frost action; nivation; periglacial
References: Dubikov et al., 2003; Nyland et al., 2024, 2025; Washburn, 1973

cryoplanation terrace

[fr] replat de cryoplanation

Definition: A high-level terrace, often part of a staircase-like flight, cut in bedrock, and formed through nivation-induced scarp retreat in cold, unglaciated mountainous environments.
Comment: Cryoplanation terraces occur on a wide variety of lithologies and many truncate geological structure. Each terrace consists of a gentle tread and a steep riser immediately above.
Broader term: periglacial phenomena
Related term: cryoplanation
References: Demek, 1969; Eakin, 1916; Nyland et al., 2025; Reger and Péwé, 1976

cryosol

[fr] cryosol

Definition: Soil formed in either mineral or organic materials having permafrost either within 1 m below the surface or, if the soil is strongly cryoturbated, within 2 m below the surface, and having a mean annual ground temperature below 0°C.
Comment: This is a pedological term for a major soil order. Cryosols are divided into three groups: (1) organic cryosols developed in organic (peat) materials; (2) static cryosols developed in mineral soils and showing little or no evidence of cryoturbation; (3) turbic cryosols developed in mineral soils and showing strong evidence of cryoturbation.
Equivalent: gelisol
Non-preferred: cryosolic soil; pergelic soil
Narrower terms: organic cryosol; static cryosol; turbic cryosol
Related terms: cryopedology; cryoturbation
References: Bockheim, 2015; Canadian Society of Soil Science, 2020

cryosphere

[fr] cryosphère

Definition: The collective term for the components of the Earth's system that contain a substantial fraction of water in the frozen state.

Comment: The cryosphere includes solid precipitation, snow, glaciers and ice caps, ice sheets, ice shelves, icebergs, sea ice, lake ice, river ice, permafrost, and seasonally frozen ground. Permafrost is considered to be a part of the cryosphere in its entirety, including those parts that are dry or unfrozen. The cryosphere comprises elements on or beneath the Earth's surface or that are measured at the surface in the case of solid precipitation. Consequently, ice clouds are excluded.

Related terms: permafrost; permafrost region

Reference: Marshall, 2012

cryostratigraphy

[fr] cryostratigraphie

Definition: A field of study that examines rock and sediment bodies presently or previously frozen, and organizes them into distinctive, identifiable and mappable units (cryofacies) based on their inherent ground-ice properties, with the objectives of establishing the distribution and spatial relationships of these units, analyzing their succession in time, and interpreting the history of permafrost.

Comment: Cryostratigraphy differs from traditional stratigraphy by explicitly recognizing that structures present in perennially frozen sediments and rocks differ from those in unfrozen sediments and rocks.

Related terms: cryofacies; cryolithology; geocryology

References: French and Shur, 2010; Murton, 2022a

cryostructure

[fr] cryostructure

Definition: The macroscopic structural characteristics of frozen earth materials.

Comment: Cryostructure is determined by the amount and distribution of ice and soil materials. Various cryostructure classifications have been proposed. Differentiated cryostructures include crustal, layered, lenticular, organic-matrix, pore, porphyritic, reticulate, solid, suspended, vein and basal (glacier) ice. Cryostructures that are transitional between these major types, such as braided cryostructure, may also be recognized. For engineering purposes, the structure of frozen soil may be described as massive, layered or reticulate, based on the type and distribution of ice in the soil.

Broader term: periglacial phenomena

Narrower terms: basal (glacier) ice cryostructures; crustal cryostructure; layered cryostructure; lenticular cryostructure; organic-matrix cryostructure; pore cryostructure; porphyritic cryostructure; reticulate cryostructure; solid cryostructure; suspended cryostructure; vein cryostructure

Related terms: cryofacies; thaw unconformity
References: Gilbert et al., 2016; Murton, 2022a; Murton and French, 1994; Shur and Jorgenson, 1998

cryosuction

[fr] cryosuccion

Definition: The negative pressure gradient developed in freezing or partially frozen fine-grained materials as a result of temperature-dependent differences in unfrozen water content.
Comment: Cryosuction occurs when pore pressure gradients are sufficient to cause migration of water films toward areas of lower temperature. This process is responsible for ice segregation in fine-grained sediments.
Broader term: frost action
Related terms: ice segregation; unfrozen water content
References: Blanchard and Frémond, 1982; Williams and Smith, 1989

cryotexture

[fr] cryotexture

Definition: The microscopic textural characteristics of frozen earth materials, including sediment and ice crystal size and shape, and the nature of the contacts between sediments and ice crystals.
Comment: Cryotextures may be useful in determining the nature of the freezing process and the conditions under which the sediments accumulated. Differentiated cryotextures include *basal, contact, film, pore* and *needle-like.*
Broader term: periglacial phenomena
References: Dubikov et al., 2003; French, 2017; Murton, 2022b

cryotic

[fr] cryotique

Definition: Having a temperature of 0°C or lower.
Comment: The term *cryotic* and its counterpart *noncryotic* designate *below 0°C* and *above 0°C,* respectively, as opposed to *frozen* (containing ice) and *unfrozen* (not containing ice) (Figure 6). Perennially cryotic ground refers to ground that remains at or below 0°C continuously for two or more years and is therefore synonymous with permafrost, even if it contains no ice due to an absence of moisture (see dry permafrost) or because of a depressed freezing point.
Related terms: cryofront; frost; frozen ground; hydrochemical talik
Reference: van Everdingen, 1976

cryoturbation

[fr] cryoturbation

Definition: 1. A collective term used to describe soil movements due to frost action. 2. A non-sorted sedimentary deformation caused directly or indirectly by freezing or thawing in a periglacial environment.

Comment: 1. Cryoturbation, as a suite of processes, encompasses frost heave, thaw settlement and all differential soil movements, including expansion and contraction due to temperature changes and the growth and disappearance of ground ice bodies, whether perennial or seasonal. It results in disruption of soil horizons and structures, the formation of patterned ground, the growth of involutions, and the redistribution of organic-rich subsurface masses and layers (see turbic cryosol). 2. Disturbed, distorted and deformed structures with smooth boundaries and laminations occurring in mid-latitude Pleistocene periglacial deposits and attributable to frost action are commonly termed cryoturbations.
Equivalent: 2. periglacial involution
Non-preferred: 1. congeliturbation; frost churning; frost stirring; 2. cryoturbate
Broader term: periglacial phenomena
Related terms: cryosol; frost; frost action; frost sorting; periglacial processes; turbic cryosol
References: French, 2017; Vandenberghe, 2025; Washburn, 1979

debris flow

[fr] coulée de débris

Definition: A landslide linked to the rapid downslope flow of a mixture of poorly-sorted sediment and water.
Comment: Debris flows occur on steep open slopes and in gullies in areas with and without permafrost. They are commonly triggered by intense rainstorms, rapid snowmelt, or ground ice thaw. Failure is confined to the active layer on mountain slopes underlain by permafrost. These features comprise an eroded source area, an elongate track marked by lateral berms and a splayed deposition zone.
Related term: mass movement
References: Ballantyne, 2018; Lewkowicz and Hartshorn, 1998; Sattler et al., 2011; Zimmerman and Haeberli, 1992

degree-day

[fr] degré-jour

Definition: A derived unit of measurement defined as the departure of the mean temperature for one day from a given reference (or base) temperature.
Comment: Degree-days can be summed over a period of time to describe the cumulative departure from a reference temperature. The freezing index and the thawing index are expressed in degree-days with respect to a reference temperature of 0°C; units: degree-day Celsius.
Related terms: freezing index; thawing index
Reference: Boyd, 1979

depth of seasonal frost penetration

[fr] profondeur de gel saisonnier

Definition: The maximum thickness of the seasonally frozen layer.

Comment: This term is primarily used in areas without permafrost, but it also applies to permafrost sites where the active layer does not reach the permafrost table due to the presence of a talik.
Related terms: freezing front; freezing (of ground); frost penetration
References: Johnston, 1981; Lein et al., 2019

depth of zero annual amplitude

[fr] profondeur de l'amplitude annuelle nulle

Definition: The distance from the ground surface to the level at which the annual fluctuation in ground temperature becomes negligible (see Figure 1).
Comment: A temperature range of less than 0.1°C is commonly used as a threshold for negligible annual fluctuation. The depth of zero annual amplitude is typically between 10 and 20 m but can be less in permafrost with strong seasonal phase change. It varies spatially and temporally, depending on the amplitude of the annual surface temperature variation and the ground thermal diffusivity, including apparent effects from phase change.
Related term: ground thermal regime
References: Dubikov et al., 2003; French, 2017; Muller, 1943; Williams and Smith, 1989

design freezing index

[fr] indice de gel de conception

Definition: The freezing index for a particular site, that is projected to be exceeded once in a given period of time.
Comment: The appropriate return period for the design freezing index depends on the level of safety that is required for the building or structure in question. Parameters to consider are the expected lifetime of the structure, the sensitivity of the type of structure to frost heave, etc. For permanent buildings the period is normally chosen as 50 years or 100 years. Future climate change over this period should be taken into account when establishing the design freezing index.
Broader term: freezing index
Related terms: air freezing index; surface freezing index
Reference: International Organization for Standardization, 2001

design thawing index

[fr] indice de dégel de conception

Definition: The thawing index for a particular site that is projected to be exceeded once in a given period of time.
Comment: The appropriate return period for the design thawing index depends on the level of safety that is required for the building or structure in question. Parameters to consider are the expected lifetime of the structure, the sensitivity of the type of structure to thaw settlement, etc. For permanent buildings the period is normally chosen as 50 years or 100 years. Future climate change over this period should be considered when establishing the design thawing index.

Broader term: thawing index
Related terms: air thawing index; surface thawing index
Reference: Andersland and Ladanyi, 2004

dielectric constant (of ground)

[fr] constante diélectrique (du sol)

Definition: A measure of the ability of the ground to store electrical energy in the presence of an electrostatic field.
Comment: The dielectric constant is calculated as the ratio of the permittivity of the ground to the permittivity of a vacuum. It varies with unfrozen water content, soil properties (such as density and texture), temperature, pore water salinity, and frequency. It is an essential parameter for ground-penetrating radar investigations of the active layer or permafrost, and for microwave remote sensing of frozen ground.
Equivalent: relative permittivity
References: Du et al., 2020; Kneisel et al., 2008

dilation crack

[fr] fissure de dilatation

Definition: A tensile fracture in a frozen material due to surface extension caused by doming.
Comment: Dilation cracks typically develop during the growth of frost mounds or on the ridges of ice-wedge polygons.
Related terms: dilation crack ice; frost mound
References: Mackay, 1985; Matsuoka et al., 2018

dilation crack ice

[fr] glace de fissure de dilatation

Definition: Ice that forms in dilation cracks.
Comment: Dilation crack ice may form a significant component of the total ice content of features such as pingos. The ice is vertically banded and may be discoloured by inclusions of mineral soil and organic matter. Individual bands may be up to 20 cm wide.
Broader term: ground ice
Related terms: dilation crack; ice; ice vein; solid cryostructure; vein cryostructure; vein ice
References: Mackay, 1979; Murton, 2022b

discontinuous permafrost

[fr] pergélisol discontinu

Definition: Permafrost occurring beneath some parts of the exposed land surface of a geographic region while adjacent areas are permafrost-free.
Non-preferred: insular permafrost; island permafrost; scattered permafrost
Broader term: permafrost

Related terms: discontinuous permafrost zone; permafrost region
References: Brown, 1970a; Yershov, 1990

discontinuous permafrost zone

[fr] zone de pergélisol discontinu

Definition: A major subdivision of a permafrost region in which permafrost underlies 50–90% of the exposed land surface, whereas the remainder is permafrost-free (see Figure 5).
Comment: The zone of discontinuous permafrost lies between the continuous permafrost zone and the sporadic permafrost zone. Transitions between these zones are conceptual and cannot be sharply delineated at a fine scale.
Equivalent: extensive discontinuous permafrost zone (Canada)
Broader term: permafrost zone
Related terms: discontinuous permafrost; permafrost region
References: Brown, 1970a; Brown et al., 1997; Heginbottom, 2002; Heginbottom et al., 1995

disequilibrium permafrost

[fr] pergélisol en déséquilibre thermique

Definition: Permafrost that is not in thermal equilibrium with the current mean annual surface or sea-bottom temperature and the geothermal heat flux.
Comment: Disequilibrium permafrost will tend to aggrade or degrade over time.
Broader term: permafrost
Narrower term: relict permafrost
Related terms: equilibrium permafrost; permafrost aggradation; permafrost degradation
References: Halsey et al., 1995; Mackay, 1972b; Morse et al., 2016; Zhang et al., 2008

drunken forest

[fr] arbres inclinés

Definition: Trees leaning in differing directions.
Comment: A descriptive term for trees growing on terrain subject to frost heave or thermokarst subsidence. Forests present on active rock glaciers may also exhibit this characteristic.
References: Kokelj and Burn, 2003a; Muller, 1943; Zoltai, 1975

dry permafrost

[fr] pergélisol xérique

Definition: Permafrost that contains a negligible quantity of moisture and consequently, is not bonded by ice.
Comment: Dry permafrost is usually thaw-stable, but in bedrock, the effect of low total water content in fractures may be significant. Dry permafrost is a common near-surface layer in the Dry Valleys of Antarctica.
Broader term: permafrost

Related terms: friable permafrost; ice table
References: Bockheim and Tarnocai, 1998; McKay, 2009; Murton, 2022b; van Everdingen, 1976

earth hummock

[fr] butte minérale

Definition: A hummock with a core of fine-grained mineral soil.
Comment: Earth hummocks are a type of nonsorted circle (see patterned ground) commonly found in the zone of continuous permafrost. They develop in materials with high silt and clay contents and/or high ice contents and may show evidence of cryoturbation. Earth hummocks found outside the southern limit of present-day permafrost are believed to have formed during a previous period of cooler climate when the area was underlain by permafrost.
Non-preferred: mud hummock; earth mound; tundra hummock
Broader term: hummock
References: Kokelj et al., 2007; Luoto and Seppälä, 2002; Mackay, 1980

ecosystem-driven permafrost

[fr] pergélisol contrôlé par l'écosystème

Definition: Permafrost that develops at specific sites due to local ecological factors, where climate alone is insufficient to cause its formation.
Comment: Ecosystem-driven permafrost is formed through the complex interaction of biophysical factors on soil temperatures. It may establish under a comparatively warm climate due to ecological succession or evolve from degraded climate-driven, ecosystem-protected permafrost.
Broader term: permafrost
Related terms: climate-driven, ecosystem-modified permafrost; climate-driven, ecosystem-protected permafrost; climate-driven permafrost; ecosystem-protected permafrost
References: Ran et al., 2021; Shur and Jorgenson, 2007

ecosystem-protected permafrost

[fr] pergélisol protégé par l'écosystème

Definition: Permafrost that persists under a comparatively warm climate due to late-successional stages of ecosystem development and cannot re-form after disturbance.
Comment: Ecosytem-protected permafrost may evolve from climate-driven, ecosystem-protected permafrost or ecosystem-driven permafrost if the climate warms. It typically manifests as disconnected bodies of perennially frozen ground beneath thick accumulations of organic material in the isolated patches and sporadic permafrost zones.
Broader term: permafrost
Related terms: climate-driven, ecosystem-modified permafrost; climate-driven, ecosystem-protected permafrost; climate-driven permafrost; ecosystem-driven permafrost; relict permafrost
References: Ran et al., 2021; Shur and Jorgenson, 2007

electrical conductivity (of ground)

[fr] conductivité électrique (du sol)

Definition: A measure of the ease with which electrical current conducts through the ground.
Comment: The electrical conductivity of unfrozen soils decreases slightly with a decrease in temperature. A significant decrease occurs when a soil freezes which is directly related to the decreasing unfrozen water content of the frozen ground, and which may be affected by sediment type, pore water salinity and cryostructure. The electrical conductivity of frozen ground may be orders of magnitude lower than that of the same material when unfrozen. The conductivity of frozen soils decreases further with additional decreases in temperature. Electrical conductivity is the reciprocal of electrical resistivity.
Related terms: electrical resistivity (of ground); electrical resistivity tomography
Reference: Johnston, 1981

electrical resistivity (of ground)

[fr] résistivité électrique (du sol)

Definition: A measure of the resistance of the ground to the conduction of electrical current.
Comment: The electrical resistivity of unfrozen soils increases slightly with a decrease in temperature. A significant increase in resistivity occurs when a soil freezes which is directly related to the decreasing unfrozen water content of the frozen ground, and which may be affected by sediment type, pore water salinity, and cryostructure. The resistivity of frozen ground may be orders of magnitude greater than that of the same material when unfrozen. The resistivity of frozen soils increases further with additional decreases in temperature. Electrical resistivity is the reciprocal of electrical conductivity.
Related terms: electrical conductivity (of ground); electrical resistivity tomography
References: Hoekstra and McNeill, 1973; Johnston, 1981

electrical resistivity tomography (ERT)

[fr] tomographie de résistivité électrique

Definition: A geophysical technique that uses direct electrical current transmitted through the ground to develop a two- or three-dimensional model of its resistivity (Figure 7).
Comment: The contrasting electrical resistivities of frozen, ice-rich ground and ground that is unfrozen, allows interfaces between them, such as the top, base and lateral boundaries of permafrost, to be interpreted. This interpretation is aided by supplementary information along the ERT survey line, such as frost table depths, borehole logs, ground temperature profiles or other geophysical measurements. ERT has many other applications, such as in studies of groundwater and pollution.
Related terms: electrical conductivity (of ground); electrical resistivity (of ground)
References: Hauck, 2013; Herring et al., 2023; Kneisel et al., 2008

elevational zonation of permafrost

[fr] zonation altitudinale du pergélisol

Definition: The vertical subdivision of an area of mountain permafrost into permafrost zones, based on the estimated proportion of the land surface that is underlain by permafrost (Figure 8).
Comment: As mean annual temperatures typically decrease with increasing elevation, mountain permafrost can be expected to be more extensive, thicker and colder at higher elevations, although aspect, vegetation and snow cover also impact its distribution. Exceptions to this pattern can occur in areas with highly continental climates where cold air inversions develop in winter, such as parts of northwest Canada and Mongolia. There, permafrost is often more extensive, thicker and colder in valley bottoms than at mid-elevations.
Equivalent: altitudinal zonation of permafrost
Related terms: extra-zonal permafrost; mountain permafrost; permafrost extent; permafrost zone
References: Bonnaventure et al., 2012; Etzelmüller, 2013; Harris et al., 2009

epigenetic ice

[fr] glace épigénétique

Definition: Ground ice that develops beneath a stable ground surface (neither eroding nor aggrading) in epigenetic permafrost or in previously-formed syngenetic permafrost.
Comment: Examples of epigenetic ice include intrusive ice, segregated ice, and wedge ice.
Broader term: ground ice
Related terms: epigenetic ice wedge; epigenetic permafrost; ice; intrusive ice; segregated ice; wedge ice
Reference: Mackay, 1972a

epigenetic ice wedge

[fr] coin de glace épigénétique

Definition: An ice wedge that develops beneath a relatively stable ground surface in pre-existing permafrost (see Figure 2).
Comment: An epigenetic ice wedge grows under stable permafrost conditions beneath a surface that experiences no sediment accumulation or erosion. Epigenetic ice wedges grow progressively wider, rather than deeper, and are characteristically wedge-shaped.
Broader term: ice wedge
Related terms: anti-syngenetic ice wedge; epigenetic ice; syngenetic ice wedge; wedge ice
References: Mackay, 1990; Yershov, 1990

epigenetic permafrost

[fr] pergélisol épigénétique

Definition: Permafrost that forms beneath a relatively stable ground surface after deposition of the material in which it occurs.

Comment: Epigenetic permafrost typically forms through aggradation at its base into pre-existing ground materials.
Broader term: permafrost
Related terms: epigenetic ice; epigenetic ice wedge
References: Dubikov et al., 2003; French, 2017; Yershov, 1990

equilibrium permafrost

[fr] pergélisol en équilibre thermique

Definition: Permafrost that is in thermal equilibrium with the mean annual ground surface or the sea-bottom temperature and with the geothermal heat flux.
Comment: Equilibrium permafrost exhibits ground temperatures below the depth of zero annual amplitude that remain in a steady state, resulting in an unchanging permafrost thickness. Accelerated rates of climate warming over the last few decades and the lagged response of temperature changes at depth mean that little, if any, extant permafrost can be termed equilibrium permafrost.
Broader term: permafrost
Related term: disequilibrium permafrost
Reference: Mackay, 1972b

evaporator

[fr] évaporateur

Definition: The underground component of a two-phase thermosyphon in which a working fluid, such as CO_2, evaporates and in so doing, extracts heat from the surrounding soil.
Related terms: condenser; thermopile; thermosyphon
References: Andersland and Ladanyi, 2004; CSA Group 2019, 2021a, 2021b

excess ice

[fr] glace excédentaire

Definition: Ground ice in excess of the pore volume that the ground would have under natural unfrozen conditions (Figure 9).
Comment: Upon thawing, a soil containing excess ice will settle and consolidate under its own weight (see thaw strain).
Related terms: excess ice content; ground ice; ice-rich permafrost; thaw-sensitive permafrost; thaw settlement; thaw strain
References: French, 2017; Kokelj and Burn, 2003b, 2005; Linell and Kaplar, 1966; O'Neill and Burn, 2012

excess ice content

[fr] teneur en glace excédentaire

Definition: Volumetric proportion of excess ice.

Comment: The excess ice content can be estimated by thawing a frozen soil sample freely in a graduated glass beaker or under an applied load in the laboratory (see Figure 9). However, a thaw settlement test under projected applied load will provide a much better estimate of excess ice content and expected thaw settlement. Excess ice content is normally expressed as a percentage.
Related terms: excess ice; ice content; volumetric ice content; volumetric (total) water content
References: Andersland and Ladanyi, 2004; French, 2017; Johnston, 1981; Linell and Kaplar, 1966; Murton, 2022b

extra-zonal permafrost

[fr] pergélisol extrazonal

Definition: Permafrost that occurs outside mapped or modeled permafrost zones, including the isolated patches zone.
Comment: Extra-zonal permafrost can be produced by highly localized environmental conditions involving non-conductive processes, such as cooling by air convection in winter, or by long-term artificial freezing operations.
Non-preferred: azonal permafrost
Broader term: permafrost
Related terms: chimney effect; elevational zonation of permafrost; latitudinal zonation of permafrost; mountain permafrost; permafrost limit; permafrost zone
References: Bishop-Legowski and Burn, 2019; Sawada et al., 2003; Woodcock et al., 1970

food cellar

[fr] caveau à nourriture

Definition: A cavity excavated within permafrost that is traditionally employed by Indigenous peoples of the Arctic to refrigerate or freeze harvested meat or fish.
Comment: These cellars need to be cold enough to freeze food or to allow it to ferment safely. Consequently, they are usually constructed in tundra areas where permafrost is continuous. Climate warming and flooding are rendering some of these cellars unusable.
Equivalents: ice cellar; meat cellar; community freezer; ice house
Reference: Yoshikawa et al., 2022

freezeback

[fr] regel

Definition: Refreezing of thawed material.
Comment: This term describes: (1) seasonal refreezing of the phase-based active layer, or (2) refreezing of soil thawed as a result of construction activity or drilling, and of backfill or a slurry placed in frozen ground.
Broader term: freezing (of ground)
Reference: Johnston, 1981

freeze-thaw cycle

[fr] cycle de gel-dégel

Definition: Alternating freezing and thawing of the ground.
Comment: A freeze-thaw cycle may involve partial or complete phase change of water to ice. Natural freeze-thaw cycles can occur at frequencies that range from sub-diurnal to annual. In laboratory experiments and geotechnical testing, freeze-thaw cycles are usually controlled to be several days to a few months in duration.
Related terms: freezing (of ground); frost creep; frost action; thawing (of frozen ground)
References: Fraser, 1959; Qi et al., 2006

freezing front

[fr] front de gel

Definition: The boundary between frozen ground (containing some ice) and unfrozen ground during progressive freezing.
Comment: A freezing front advances from the surface downwards in the autumn (see one-sided freezing), and over cold permafrost, a second freezing front advances upwards from the permafrost table (see two-sided freezing). The freezing front position relates to the freezing point and typically does not coincide with the 0°C isotherm (see cryofront).
Non-preferred: freezing plane; frost front; freezing surface
Related terms: cryofront; depth of seasonal frost penetration; freezing (of ground); frost penetration
References: Corte, 1962; Mackay, 1974a; van Everdingen, 1976

freezing index

[fr] indice de gel

Definition: The cumulative number of degree-days below 0°C for a given time period.
Comment: A freezing index is usually calculated for the air or the ground surface, over a complete freezing season (starting when temperatures fall below 0°C in the autumn and ending when they rise above 0°C in the spring, sometimes referred to as the *seasonal freezing index*), or for a full calendar year.
Narrower terms: air freezing index; design freezing index; surface freezing index
Related terms: degree-day; Temperature at the Top of Permafrost (TTOP) model
References: Boyd, 1979; Frauenfeld et al., 2007; Johnston, 1981

freezing (of ground)

[fr] gel (du sol)

Definition: The changing of phase from water to ice in soil or rock.

Comment: The temperature at which freezing occurs may be lower than 0°C due to the effects of solutes, fine pores, particle surfaces, pressure, and delayed ice nucleation (see Figure 6). Ground freezing can occur naturally or due to artificial refrigeration.
Narrower terms: artificial ground freezing; freezeback; one-sided freezing; two-sided freezing; upward freezing
Related terms: active layer; closed-system freezing; depth of seasonal frost penetration; freeze-thaw cycle; freezing front; frost; frost penetration; open-system freezing; permafrost; seasonal frost; seasonally frozen ground; seasonally frozen layer; soil freezing characteristic curve
References: Brown, 1970a; Johnston, 1981; Williams and Smith, 1989

freezing point

[fr] point de congélation

Definition: In relation to soil or rock, the highest temperature at which ice and water can coexist in equilibrium.
Comment: Moisture in soil or rock is always unfrozen above the equilibrium freezing point. The freezing point temperature is commonly derived from experiments in which a sample of soil or rock first supercools to the ice-nucleation temperature and then rapidly warms to the equilibrium freezing point. This is followed by gradual further cooling. The equilibrium freezing point is equal to the melting temperature and commonly lower than 0°C (see freezing point depression).
Related terms: freezing-point depression; ice-nucleation temperature; supercooling
References: Kozlowski, 2009; Williams and Smith, 1989

freezing-point depression

[fr] abaissement du point de congélation

Definition: A collective term for the phenomena that lower the freezing point of water below 0°C in soil or rock. Alternatively, the absolute value of the freezing point.
Comment: The freezing point depression (see Figure 6) is controlled by the saturation, pore-size distribution, solute content, and mineral composition of the soil.
Related terms: freezing point; hydrochemical talik; ice-nucleation temperature; pore water; pore water salinity
References: Kozlowski, 2009; Yershov, 1990

freezing pressure

[fr] pression de gel

Definition: The positive pressure developed at ice-water interfaces in a soil as it freezes.
Comment: It results in a heaving pressure or frost-heave pressure that is responsible for the heaving of utilities, foundations and pavements. Ice-water interfaces occur at the contact between ice lenses and the frozen fringe.
Related terms: frost heave; frost jacking
References: Andersland and Ladanyi, 2004; Gilpin, 1982; Johnston, 1981

friable permafrost

[fr] pergélisol friable

Definition: Ice-bearing permafrost in which the soil particles are not bonded by the ice.
Broader term: ice-bearing permafrost
Related terms: dry permafrost; poorly-bonded permafrost; well-bonded permafrost
References: Linell and Kaplar, 1966; Pihlainen and Johnston, 1963

frost

[fr] gel

Definition: In relation to the ground, the occurrence of cryotic conditions in soil or rock.
Comment: The effects of frost can include processes such as cryoturbation, frost heave, and frost shattering. Frost can also refer to conditions in the air when the temperature declines to 0°C or lower.
Related terms: cryotic; cryoturbation; freezing (of ground); frost heave; frost shattering; frost wedging; permafrost; seasonal frost; seasonally frozen ground

frost action 📷

[fr] action du gel

Definition: A suite of processes linked to ground freezing/thawing and frozen ground, and the mechanical and geomorphic effects of these processes on materials and on structures placed on, or in, the ground.
Comment: Frost action is a collective term, used in the context of periglacial environments, that encompasses processes linked to the freezing and melting of water in soils and rocks. These processes include frost heave, thaw weakening, thaw settlement, mechanical weathering, and frost sorting. The term is also used to refer to the impacts of these processes on the ground, such as cryoturbation, the formation of patterned ground and frost mounds, as well as on infrastructure, such as frost heave of highways, and frost jacking of pile foundations. Frost action commonly refers to seasonal freezing and thawing processes and effects, but the term is also used to describe the long-term heaving effects that can occur when the ground is continuously subject to freezing temperatures over a period of years (e.g., under cold storage plants and buried chilled pipelines).
Broader term: periglacial processes
Narrower terms: cryosuction; frost heave; frost jacking; frost sorting; frost weathering
Related terms: cryoplanation; cryoturbation; freeze-thaw cycle; frost bulb; frost shattering; frost wedging; periglacial; periglacial phenomena
References: French, 2017; Hennion, 1955; Johnston, 1981; Washburn, 1979

frost blister 📷

[fr] butte saisonnière à noyau de glace

Definition: A seasonal frost mound that forms during the freezeback season when hydraulic pressures within a confined aquifer between the downward-freezing active layer and the permafrost table are sufficient to uplift the overlying frozen active layer materials.

Comment: Freezing of the accumulated subsurface water produces a domed layer of massive, mainly intrusive ice beneath the overlying frozen ground. Frost blisters are formed in a single winter but may take several years to decay. They are distinguished from icing blisters by the layer of seasonally frozen ground overlying the ice layer.
Non-preferred: cryolaccolith; hydrolaccolith; seasonal pingo; winter pingo
Broader term: seasonal frost mound
Related terms: icing blister; icing mound
References: Pollard and French, 1984; Pollard and van Everdingen, 1992

frost boil

[fr] ostiole

Definition: A small patch of bare soil with a slightly mounded central area, formed by frost action.
Comment: A type of nonsorted circle; frost boils are round to elongate bare soil patches, from less than 1 m to 3 m in diameter, that are commonly found in fine-grained sediments underlain by permafrost, but may also occur in non-permafrost areas.
Equivalent: mud boil, mud circle
Broader term: nonsorted circle
Related term: patterned ground
Reference: Shilts, 1978

frost bulb

[fr] bulbe de gel

Definition: A more or less symmetrical zone of frozen ground formed by infrastructure reducing temperatures below 0°C (Figure 10).
Comment: The sub-zero temperatures may be the result of purposeful design or an unintended consequence of design and construction. Infrastructure that could cause the formation of a frost bulb includes chilled pipelines, thermosyphons, and air-convection embankments. Heaving of the ground and/or of a structure or facility may occur as the frost bulb forms.
Related terms: frost action; frost heave
References: Andersland and Ladanyi, 2004; Johnston, 1981

frost creep

[fr] cryoreptation

Definition: The net downslope displacement of soil resulting from frost heave perpendicular to the slope and thaw settlement of the heaved soil in a nearly vertical direction.
Comment: Frost creep is a component of solifluction (Figure 11). Creep rates are influenced by slope gradient, freeze-thaw cycle frequency, and the amount of heave, which is a function of the frost-susceptibility of the soil, the depth of freezing, and moisture availability for ice-lens growth. Surface velocities typically range from 5 to 50 mm yr^{-1}.

Broader term: solifluction
Related terms: freeze-thaw cycle; frost heave; mass movement; thaw settlement
References: Ballantyne, 2018; Benedict, 1970; Matsuoka, 2001; Washburn, 1967

frost heave

[fr] soulèvement au gel; soulèvement gélival

Definition: The upward or outward movement of the ground surface (or objects on, or in, the ground) caused by the formation of ice in the soil.
Comment: Frost action in fine-grained soils increases the volume of the soil by freezing of *in situ* pore water (about 9% expansion) and by drawing water to the freezing front where ice lenses form. Soils that have undergone substantial heaving may consist of alternating layers of ice-saturated soil and relatively clear ice lenses. The lenses are formed normal to the direction of heat flow and when freezing penetrates from the ground surface (which may be horizontal, sloping or vertical), they form parallel to that surface. When unrestrained, the amount of surface heave may be almost as much as the total thickness of the ice lenses. Frost heave can occur seasonally or continuously if freezing of the ground proceeds without interruption over a period of years. Depending on the degree of restraint, large freezing pressures (up to 1 MPa) can develop as the ground freezes. These can be transmitted to a foundation, structure or other object placed on the ground surface, or embedded or buried in the ground, as basal (i.e., vertical) forces acting on their underside, or through adfreezing of the soil to the sides of the foundation, structure or object.
Broader term: frost action
Related terms: cryogenesis; freezing pressure; frost; frost bulb; frost creep; frost jacking; heaving pressure; periglacial processes; segregation potential
References: Chamberlain, 1981; Johnston, 1981; Penner, 1967, 1968; Washburn, 1979

frost jacking

[fr] éjection gélivale

Definition: Cumulative upward displacement of objects embedded in the ground, caused by frost heave.
Comment: Frost jacking results from basal or vertical freezing pressures acting on the underside of a foundation, structure or object, or from adfreezing of soil to the sides of these objects. The cumulative upward movement over a period of time (one or several freeze-thaw cycles) may result in the foundation unit or object being ejected from the ground. Fence posts and utility poles or towers are commonly affected and both deep (pile) and shallow (post) foundations (e.g., used for bridges, wharves, unheated or lightweight buildings) have been seriously impacted by frost jacking. Blocks of jointed or fractured bedrock can also be displaced upward by this process.
Broader term: frost action
Related terms: freezing pressure; frost heave; heaving pressure; periglacial processes
Reference: Linell and Lobacz, 1980

frost mound

[fr] butte cryogénique

Definition: Any mound-shaped landform produced by ground freezing combined with accumulation of ground ice due to groundwater movement or the migration of soil moisture.
Comment: Frost mounds are classified into perennial permafrost features, including pingos, palsas and lithalsas, and seasonal features, including frost blisters, icing mounds and icing blisters.
Non-preferred: bugor; bulgunniakh; cryogenic mound; earth mound; frost hummock; ground-ice mound; tundra hummock
Broader term: periglacial phenomena
Narrower terms: lithalsa; palsa; pingo; seasonal frost mound
Related terms: closed-system pingo; dilation crack; open-system pingo
References: Ballantyne, 2018; French, 2017; Muller, 1943; Porsild, 1938

frost penetration

[fr] pénétration du gel

Definition: The movement of the freezing front into the ground.
Related terms: depth of seasonal frost penetration; freezing front; freezing (of ground)
References: Doré and Zubeck, 2009; Johnston, 1981

frost probe 📷

[fr] sonde à gélisol

Definition: A metal rod that is pushed into the ground to the point of resistance in order to infer the depth of thaw.
Comment: Probing to obtain the thaw depth is generally straightforward in fine-grained soils and in peat, but can be problematic if soils are very cohesive, contain clasts or are coarse-grained. However, with experience, it may be possible to use the feel of the resisting layer and the sound that the probe makes to infer whether it has encountered frozen ground, a clast embedded in the soil, or bedrock. Probing at the end of the thaw season to obtain the maximum thaw depth is the primary method used in the Circumpolar Active Layer Monitoring network to monitor active layer thickness.
Related terms: active layer thickness; frost table; thaw depth; thawing front
References: Irrgang et al., 2024; Mackay, 1977; Nelson and Hinkel, 2003

frost shattering 📷

[fr] gélifraction

Definition: The mechanical disintegration of rock by the pressure of the freezing of water in pores and along grain boundaries, often through repeated freeze-thaw cycles.

Comment: Frost shattering is the process of grain loosening and rock disintegration by the freezing pressure of water in films of varying thickness on the surfaces of individual mineral grains. Freezing of the water drawn between the grains by various particle surface forces exerts sufficient differential pressure to loosen and separate the grains.
Broader term: frost weathering
Related terms: frost; frost action; frost wedging
Reference: French, 2017

frost sorting

[fr] triage gélival

Definition: The differential movement of soil particles of different size ranges as a result of frost action.
Comment: Frost sorting often accompanies cryoturbation.
Broader term: frost action
Related terms: cryoturbation; patterned ground; periglacial processes; sorted circle; sorted net; sorted polygon; sorted step; sorted stripe
Reference: Washburn, 1979

frost-stable ground

[fr] sol non gélif

Definition: Ground (soil or rock) in which little or no segregated ice forms during seasonal freezing.
Comment: The properties of frost-stable soil are specified in some building codes; generally, they are defined by the gravimetric percentage of soil particles less than 0.02 mm in diameter. Significant ice accumulation and frost heave may occur even in seasonally frost-stable ground (e.g., gravels and rock) under conditions of continuous freezing and plentiful water supply.
Narrower term: non-frost-susceptible soil
References: Chamberlain, 1981; Konrad and Morgenstern, 1983; van Everdingen, 1976

frost-susceptible ground

[fr] sol gélif

Definition: Ground (soil or rock) in which segregated ice may form (causing frost heave) given appropriate moisture supply and temperature conditions.
Comment: Frost-susceptible ground may eventually become ice-rich, regardless of its initial total water content, if the appropriate moisture supply and temperature conditions persist. By implication, frost-susceptible ground may also be susceptible to thaw weakening effects when it thaws. Frost-susceptible soil is a classification of soil that meets this definition.
Related terms: segregated ice; thaw weakening
References: Chamberlain, 1981; Konrad and Morgenstern, 1983; van Everdingen, 1976

frost table

[fr] sommet du gélisol

Definition: The boundary between seasonally unfrozen ground and underlying perennially or seasonally frozen ground.
Comment: The frost table descends from the ground surface during the thaw season. Its position is referred to as the *frost table depth* or thaw depth. The maximum depth of the frost table attained at a permafrost site corresponds to the thickness of the phase-based active layer, unless a supra-permafrost talik is present. Two-sided freezing over cold permafrost can cause the frost table at the base of the active layer to rise at the end of the thaw season. The depth to the frost table is often determined using a frost probe.
Related terms: frost probe; thaw depth; thawing front
Reference: Irrgang et al., 2024

frost weathering

[fr] météorisation gélivale

Definition: The disintegration and break-up of soil or rock by the combined action of frost shattering, frost wedging and hydration shattering, often through repeated freeze-thaw cycles.
Comment: Hydration shattering is the process of grain loosening and soil or rock disintegration by the wedging pressure of water in films of varying thickness on the surfaces of silicate minerals. Water is drawn between the grains by various particle surface forces and exerts sufficient differential pressure to loosen and separate the grains. The process can act in all climates without the aid of freezing and thawing. When combined with freezing and thawing (frost shattering and frost wedging), however, the resulting process of frost weathering can be a very efficient mechanism for the break-up of soil or rock.
Broader term: frost action
Narrower terms: frost shattering; frost wedging
Related term: blockfield
References: French, 2017; Washburn, 1979

frost wedging

[fr] gélifraction

Definition: The mechanical disintegration, splitting or break-up of rock by the pressure of the freezing of water in cracks, crevices, pores, joints or bedding planes, often through repeated freeze-thaw cycles.
Comment: A wide variety of terms has been used to describe what appears to be a single process.
Equivalents: congelifraction; frost bursting; frost prying; frost riving; frost splitting; gelifraction
Non-preferred: frost comminution
Broader term: frost weathering
Related terms: frost; frost action; frost shattering; periglacial processes
References: Harris et al., 2017; Washburn, 1979

frozen debris lobe

French equivalent not established.

Definition: A slow-moving landslide occurring in permafrost regions comprising an ice-poor mixture of coarse-grained to fine-grained debris and organic material, moving continuously by shear in zones near its base and/or by creep within the landslide body.
Comment: Frozen debris lobes have been recognized in the southern Brooks Range in Alaska where they move at variable rates up to 20 m yr^{-1} and are covered by trees and shrubs. They have an elongated lobate shape. Massive ice may be present as infiltration ice within cracks that have opened to the surface.
Related terms: infiltration ice; mass movement; rock glacier
References: Daanen et al., 2012; Darrow et al., 2016

frozen fringe

[fr] frange gelée

Definition: The partially frozen layer between the freezing front and the location of the isotherm at which the warmest ice lens is growing.
Comment: The temperature at the growing ice lens in frost-susceptible soil is slightly below 0°C. Moisture migration through the frozen fringe results in ice lens formation and frost heave.
Related terms: ice lens; ice segregation; segregated ice
References: Konrad and Morgenstern, 1983; Miller, 1972

frozen ground

[fr] gélisol; sol gelé

Definition: Soil or rock in which part or all of the pore water has changed into ice.
Comment: Perennially and seasonally frozen ground can vary from being partially to extensively frozen depending on the degree of phase change. The ground may be described as hard frozen, plastic frozen or dry frozen, depending on the pore ice and unfrozen water contents and its compressibility under load. Hard-frozen soils are firmly cemented by ice, are subject to brittle failure, and exhibit practically no consolidation under load. Plastic-frozen soils are cemented by ice but have viscous properties due to their high unfrozen water content and therefore compress under load. Dry-frozen or friable-frozen soils have a very low total water content and are not cemented by ice; their compressibility is the same as for unfrozen soils having the same composition, total water content and density.
Related terms: cryotic; permafrost; seasonally frozen ground
References: U.S.S.R., 1969, 1973; van Everdingen, 1976

gas-emission crater

[fr] cratère d'éjection de gaz

Definition: A crater produced by the sudden release of pressurized methane-rich gases accumulated beneath or within permafrost.

Comment: Gas outbursts have been observed in areas where both continuous permafrost and shallow gas deposits are present. Near-surface permafrost confines gas release, resulting in high gas pressure and the development of a rounded perennial mound. The subsequent and sudden gas outburst at the mound location creates a crater surrounded by blocks of frozen ejecta. Gas-emission craters are short-lived features as they become filled by water from ground ice melt and surface drainage, eventually transforming into ponds or lakes. To date, gas-emission craters have been observed only in western Siberia.
Equivalent: gas blowout crater
Non-preferred: methane crater
References: Bogoyavlensky et al., 2020; Dvornikov et al., 2019

gas hydrate

[fr] hydrate gazeux

Definition: A form of solid clathrate compound in which crystal lattice cages or chambers, consisting of host molecules, enclose guest molecules.
Comment: Gas hydrates are formed and preserved under specific conditions of temperature and pressure that can occur in some permafrost areas, especially in offshore permafrost. The host molecules are water, and the guest molecules may be a variety of gases, including methane (methane hydrate). Gas hydrates are commonly found near the base of permafrost and have been investigated as a potential source of energy. They may be released to the atmosphere by climate warming, thereby raising atmospheric greenhouse gas concentrations.
References: Bily and Dick, 1974; Collett et al., 2011; Judge, 1982; Mestdagh et al., 2017

gelifluction

[fr] gélifluxion

Definition: The slow downslope plastic deformation of unfrozen earth materials over a frozen substrate.
Comment: Gelifluction is a component of solifluction that occurs during the thaw period as a result of saturation by precipitation or snowmelt and/or high pore water pressures generated at the thaw front (see Figure 11). Gelifluction is associated with both seasonally-frozen and permafrost slopes.
Broader term: solifluction
Related term: plug-like flow
References: Ballantyne, 2018; Matsuoka, 2001; Washburn, 1979

geocryology

[fr] géocryologie

Definition: The study of permafrost and seasonally frozen ground development in time and space, including the processes of formation and the landforms that result from ground freezing and thawing.

Comment: According to Sumgin et al. (1940), Geocryology can be divided into General Geocryology and Applied or Engineering Geocryology. General Geocryology is the study of the composition, structure, texture, genesis, properties and thermal regime of cryotic ground and ground ice. Engineering Geocryology develops engineering methods to control cryogenic processes in support of industrial development and construction in permafrost regions.
Narrower terms: cryolithology; cryopedology
Related terms: cryostratigraphy; permafrost
References: French, 2017; Sumgin et al., 1940; Williams and Smith, 1989; Yershov, 1990

geothermal gradient

[fr] gradient géothermique

Definition: The rate of temperature change with depth in the subsurface (see Figure 1).
Comment: The geothermal gradient is affected by the local geothermal heat flux, the thermal conductivity of earth materials and the climatic history of a site. Near the surface, the gradient may vary, but beneath 200 m it is generally positive with depth. The geothermal gradient is used to estimate the depth of the permafrost base (e.g., for mining operations).
Related terms: geothermal heat flux; ground thermal regime
References: French, 2017; Judge, 1973; Lachenbruch et al., 1982

geothermal heat flux

[fr] flux géothermique

Definition: The amount of heat moving steadily outward from the interior of the Earth through a unit area in unit time.
Comment: The geothermal heat flux is commonly expressed in units of Watts per metre squared ($W\ m^{-2}$). All else being equal, a greater geothermal heat flux results in thinner permafrost under equilibrium conditions.
Related terms: geothermal gradient; ground thermal regime
Reference: Judge, 1973

gravimetric water content

[fr] teneur en eau gravimétrique

Definition: The ratio of the mass of water and ice in a sample to either the dry mass of the sample (dry basis) or less commonly, the total mass of the sample (wet basis).
Comment: Because of the way it is defined, the dry basis gravimetric total water content of an ice-rich permafrost sample can greatly exceed 100 percent, potentially making interpretation or graphical representation a challenge. Wet basis measurements are not subject to the same drawbacks. The gravimetric water content remains constant during thawing of a sample of frozen ground, unless excess water is allowed to drain.
Equivalent: gravimetric moisture content

Related terms: ice content; unfrozen water content; volumetric (total) water content
References: Anderson and Morgenstern, 1973; Murton, 2022b; Phillips et al., 2015

ground ice

[fr] glace de sol

Definition: All types of ice contained in the ground, including buried ice (see Figure 12).
Broader term: ice
Narrower terms: aggradational ice; buried ice; cave ice; closed-cavity ice; dilation crack ice; epigenetic ice; intrusive ice; lens ice; massive ice; needle ice; open-cavity ice; pore ice; relict ice; reticulate ice; segregated ice; syngenetic ice; thermokarst-cave ice; vein ice; wedge ice
Related terms: excess ice; ice-cored topography; ice lens; infiltration ice
References: French, 2017; Mackay, 1972a, 1973a; Murton, 2022b; Pollard and French, 1980

ground temperature profile

[fr] profil thermique du sol

Definition: The graphical or analytical expression of ground temperature values, typically with depth relative to the ground surface.
Comment: The ground temperature profile varies throughout the year (Figure 13). It may represent discrete measurements at a particular time or multiple observations made regularly through the year (see trumpet curve) from which a mean may be calculated.
Related terms: ground thermal regime; mean annual ground temperature (MAGT); trumpet curve
Reference: Irrgang et al., 2024

ground thermal regime

[fr] régime thermique du sol

Definition: The pattern of temperature and heat flow variations with depth below the ground surface, summarized for a specific period of time.
Comment: The ground thermal regime is usually assessed for a particular depth range and for one or more complete years. It may be a summary of temperature only, or it may include descriptions of other variables such as heat fluxes, heat storage or the phase state of water. The ground thermal regime of a permafrost site characteristically includes: (1) near-surface temperatures that fluctuate from above to below 0°C during the year, resulting in soil freezing and thawing and associated use and release of latent heat; (2) temperatures at depth that remain at or below 0°C for the entire year; (3) seasonal temperature fluctuations that decrease with depth until they become negligible; (4) a temperature gradient below the depth of zero annual amplitude that may be positive due to the geothermal heat flux, negative in warming permafrost, or negligible where permafrost is thawing and isothermal; and (5) heat flows that take place primarily by conduction. Exceptions to these generalisations can exist, such as at sites where groundwater transports significant heat by convection.

Equivalent: ground temperature regime
Related terms: depth of zero annual amplitude; geothermal gradient; geothermal heat flux; ground temperature profile; mean annual ground surface temperature (MAGST); mean annual ground temperature (MAGT); permafrost table; permafrost thickness; thermal offset; trumpet curve; upward freezing; zero curtain
References: French, 2017; Williams and Smith, 1989

ground wedge

[fr] coin de sol

Definition: A downward-tapering wedge of soil that differs in structure and texture from the surrounding soil.
Comment: A ground wedge may be an ice-wedge pseudomorph (i.e., a feature of secondary filling), or a sand wedge (i.e., a feature of primary filling), or it may be produced by repeated thermal contraction cracking in seasonally frozen ground or permafrost, followed by filling of the crack with soil.
Equivalent: soil wedge
Narrower terms: ice-wedge pseudomorph; sand wedge
Related terms: composite wedge; thermal contraction crack
References: Black, 1976; Murton et al., 2000; Romanovskii, 1977; Washburn, 1979

heat capacity

[fr] capacité thermique

Definition: A measure of the ability of a material to store heat, defined as the amount of heat energy (J) required to raise the temperature of a fixed amount of material by one degree Kelvin.
Comment: Heat capacity partially controls active layer thickness. This term is sometimes used erroneously to refer to specific heat capacity, which is heat capacity per unit mass.
Equivalent: thermal capacity
Narrower terms: apparent heat capacity; specific heat capacity
Related term: thermal diffusivity
References: Farouki, 1981; Williams and Smith, 1989

heat drain

[fr] drain de chaleur

Definition: A highly air-permeable geocomposite ventilation layer installed in an embankment to facilitate convective air flow.
Comment: A heat drain is designed to work during winter when the air temperature is lower than the subgrade soil temperature. Heat is transferred from the soil to the air in the drainage layer by conduction. The warm air generates an upward movement in the drain, drawing cold air into the system through the air intake.
Broader term: air-cooled embankment

Related term: chimney effect
References: Doré et al., 2016; Kong and Doré, 2024

heaving pressure
[fr] pression de soulèvement gélival; pression de soulèvement au gel

Definition: Upward or lateral pressure developed during freezing of ground.
Related terms: frost heave; frost jacking
Reference: Johnston, 1981

high-centred polygon
[fr] polygone à centre bombé

Definition: An ice-wedge polygon in which melting of the surrounding ice wedges has left the central area in a relatively elevated position.
Comment: This type of patterned ground often manifests on well-drained uplands or elevated surfaces where preferential melt of ice wedges leads to its formation.
Broader term: ice-wedge polygon
Related terms: low-centred polygon; patterned ground; polygon; polygon trough; thermokarst mound
References: French, 2017; Washburn, 1973

hummock
[fr] butte

Definition: A small, low-relief mound composed of various earth materials.
Comment: Most hummocks are roughly circular, with diameters between 0.5–2 m. They often occur in large groups that cover the ground surface in areas with permafrost or deep seasonal freezing. Several types are recognized based on their composition.
Broader term: nonsorted circle
Narrower terms: earth hummock; thufa; turf hummock
Related term: patterned ground
References: Goudie, 2014; Kokelj et al., 2007; Mackay, 1980

hydraulic thawing
[fr] dégel hydraulique

Definition: Artificial thawing (and removal) of frozen ground undertaken with a stream or jet of water under high pressure.
Comment: Hydraulic thawing (hydraulicking) is a common method of working frozen placer deposits in North America and Siberia.
Equivalent: hydraulicking (North America)
Related term: thermal erosion
Reference: Brown, 1970b

hydrochemical talik

[fr] talik hydrochimique

Definition: A cryotic talik maintained by moving mineralized groundwater (see Figure 4).

Comment: Freezing is prevented by the high dissolved solids content of mineralized groundwater moving through the talik.

Broader term: talik

Related terms: cryotic; freezing-point depression; lateral talik; open talik

References: O'Neill et al., 2020; van Everdingen, 1976

hydrothermal talik

[fr] talik hydrothermique

Definition: A noncryotic talik maintained by moving groundwater (see Figure 4).

Comment: The temperature in a hydrothermal talik is maintained above 0°C by heat supplied by moving groundwater.

Broader term: talik

Related terms: lateral talik; noncryotic ground; open talik

References: O'Neill et al., 2020; van Everdingen, 1976

ice

[fr] glace

Definition: Water in its solid state.

Comment: In permafrost, ice may occupy voids in soils and rocks and may develop in a variety of forms. Ice may be colourless to pale blue or greenish-blue. It may appear white due to included gas bubbles. In exposures, ground ice may also appear black.

Narrower term: ground ice

Related terms: aggradational ice; buried ice; cave ice; closed-cavity ice; dilation crack ice; epigenetic ice; infiltration ice; intrusive ice; lens ice; massive ice; needle ice; open-cavity ice; pore ice; relict ice; reticulate ice; segregated ice; syngenetic ice; thermokarst-cave ice; vein ice; wedge ice

Reference: Murton, 2022b

ice-bearing permafrost

[fr] pergélisol contenant de la glace

Definition: Permafrost that contains ice.

Broader term: permafrost

Narrower terms: friable permafrost; ice-bonded permafrost; ice-poor permafrost; ice-rich permafrost

Related terms: ice table; poorly-bonded permafrost; well-bonded permafrost

Reference: Osterkamp, 2001

ice-bonded permafrost

[fr] pergélisol lié par la glace

Definition: Ice-bearing permafrost in which the particles are cemented by ice to some degree, resulting in a measurable increase in stiffness and/or strength properties compared to otherwise similar unfrozen material.

Comment: Ice-bearing permafrost may be well-bonded if the ice-bonding is strong, or poorly-bonded if particles are weakly held together (cemented) by the ice. The distinction between ice-bonded permafrost and ice-bearing permafrost in which the ice does not act as a cement, is particularly important in subsea permafrost, where the dissolved-solids content of the pore water affects the ability of ice to act as a cement. Acoustic geophysical methods can be used to delineate ice-bonded permafrost, but use of the term *acoustically-defined permafrost* is not recommended except as a modifier to describe the method used to determine the permafrost conditions.

Broader term: ice-bearing permafrost

Narrower terms: poorly-bonded permafrost; well-bonded permafrost

Related term: permafrost

References: Hunter, 1984; Linell and Kaplar, 1966; Pihlainen and Johnston, 1963

ice content

[fr] teneur en glace

Definition: The amount of ice contained in frozen or partially frozen soil or rock.

Comment: Ice contents can be assessed qualitatively as *visible ice content* or quantitatively in three different ways: (1) as the ratio of the mass of the ice in a sample to the mass of the dry sample (gravimetric water content); (2) as the ratio of the volume of ice in a sample to the volume of the whole sample (volumetric ice content); and (3) as the ratio of the volume of ice that exceeds the total pore volume of the ground when unfrozen to the volume of the whole sample (excess ice content). The volumetric ice content and excess ice content cannot exceed unity whereas the gravimetric ice content can greatly exceed 100 percent.

Related terms: excess ice content; gravimetric water content; massive ice; unfrozen water content; volumetric ice content; volumetric (total) water content

References: Andersland and Ladanyi, 2004; Ballantyne, 2018; Kokelj and Burn, 2005; Murton, 2022b

ice-cored topography

[fr] relief à coeur de glace

Definition: Topography that is due almost solely to differences in the amount of excess ice underlying its surface.

Comment: The relief is due to irregular occurrence of ground ice, for instance intrusive ice, segregated ice, or buried glacier ice. The pingos near Tuktoyaktuk, Canada, represent an example.

Equivalent: ice-cored terrain

Related terms: ground ice; pingo

References: Rampton and Walcott, 1974; Rudy et al., 2017

ice lens

[fr] lentille de glace

Definition: A lens-shaped body of ice of any size.
Comment: The term is commonly used for segregated ice bodies. Ice lenses may range in thickness from hairline to metres.
Related terms: frozen fringe; ground ice; ice segregation; lens ice; lenticular cryostructure; segregated ice
References: Gilbert et al., 2016; Mackay, 1971

ice nucleation temperature

[fr] température de nucléation de la glace

Definition: The temperature at which ice first forms during freezing of a particular soil and water system that does not initially contain ice (see Figure 6).
Comment: The ice-nucleation temperature is usually lower than the equilibrium freezing point, sometimes by several degrees Celsius. This is because nucleation, the formation and growth of the first ice crystals, occurs in supercooled water.
Related terms: freezing point; freezing point depression; supercooling
References: Kozlowski, 2009; Williams and Smith, 1989

ice-poor permafrost

[fr] pergélisol pauvre en glace

Definition: Permafrost containing a volume of ice smaller than the pore space available in the host material under unfrozen, *in situ* stress conditions.
Comment: A qualitative term. Upon thawing of ice-poor permafrost, water from melt of ground ice is entirely accommodated within the thawed soil pore space.
Broader term: ice-bearing permafrost
Related terms: permafrost; pore ice
References: Kenner et al., 2019; Romanovskii, 1977

ice-rich permafrost

[fr] pergélisol riche en glace

Definition: Permafrost containing a volume of ice in excess of the pore space available in the host material under natural unfrozen conditions.
Comment: A qualitative term. Ice-rich permafrost is thaw-sensitive.
Broader term: ice-bearing permafrost
Related terms: excess ice; permafrost; thaw-sensitive permafrost; thermokarst; thermokarst terrain
References: Williams and Smith, 1989; Woo, 2012

ice segregation

[fr] ségrégation de la glace

Definition: The process of formation of discrete layers or lenses of segregated ice in soils as a result of the migration (and subsequent freezing) of pore water.
Comment: The migration of pore water to the growing ice lens is caused by cryosuction.
Related terms: cryosuction; frozen fringe; ice lens; layered cryostructure; lens ice; lenticular cryostructure; needle ice; segregated ice
References: Miller, 1972; Murton et al., 2001

ice table

[fr] sommet de la glace de sol

Definition: The boundary between a layer of dry permafrost and an underlying layer of ice-bearing permafrost.
Comment: The ice table represents a sublimation unconformity in hyper-arid parts of Antarctica. An ice table has also been observed on Mars.
Related terms: dry permafrost; ice-bearing permafrost
References: Fisher et al., 2016; Lapalme et al., 2017; Mellon et al., 2009

ice vein

[fr] veine de glace

Definition: Ice occurring within a crack or fissure in the ground.
Comment: An ice vein commonly refers to ice within a single contraction crack of an ice wedge but may include ice filling any crack or fissure in the ground.
Related terms: dilation crack ice; ice wedge; infiltration ice; thermal contraction crack; vein ice
References: Ballantyne, 2018; Romanovskii, 1977

ice wedge

[fr] coin de glace

Definition: A body of massive ice in permafrost that is generally wedge-shaped, with its apex pointing downward, and composed of foliated or vertically banded, commonly white, ice veins.
Comment: Ice wedges vary in width at their tops from less than 10 cm to more than 3 m, and they commonly taper downward to a feather edge at a depth of 1 m to more than 10 m. Some ice wedges may extend vertically downward as much as 25 m with little or no tapering. Ice wedges are formed in thermal contraction cracks which are filled by water from melting snow in the spring. Repeated seasonal contraction cracking of the ice in the wedge, followed by freezing of water in the crack, gradually increases the width (and possibly the depth) of the wedge and causes vertical banding of the ice mass (see Figure 2). Ice wedges that are growing because of repeated (but not necessarily annual) winter cracking are called active ice wedges. Inactive ice wedges can be stable and remain preserved unchanged in the permafrost for

many centuries. This conceptual binary classification of ice wedges may be difficult to apply in practice, however, because a minimum cracking frequency to classify an ice wedge as active has not been defined.
Narrower terms: anti-syngenetic ice wedge; epigenetic ice wedge; syngenetic ice wedge
Related terms: composite wedge; ice vein; ice wedge polygon; thermal contraction crack; vein ice; wedge ice
References: Lachenbruch, 1962; Mackay, 1972a, 1990; Murton, 2022b; Romanovskii, 1977

ice-wedge melt pond

[fr] mare de fonte de coin de glace

Definition: A body of water occupying a depression formed by thaw settlement due to melt of the top of an ice wedge.
Comment: Ice-wedge melt ponds develop in polygon troughs on hillcrests and slopes, as well as in flat terrain. They are increasingly common thermokarst features caused by thaw settlement due to melt of the tops of ice wedges and of ground ice in adjacent sediments. Water often accumulates in polygon troughs but such bodies are not ice-wedge melt ponds unless there is evidence of recent thaw settlement. The latter includes tension cracks running parallel to a pond edge, dead woody vegetation within a pond and an expanding network of ponds. Ice-wedge melt ponds differ from the pools of a beaded stream by being still bodies of water without a connecting channel.
Broader term: thermokarst lake
Related terms: beaded stream; thermokarst
References: Burn et al., 2021; Fraser et al., 2018; Liljedahl et al., 2016

ice-wedge polygon

[fr] polygone à coins de glace

Definition: A polygonal relief feature outlined by the intersecting troughs of ice wedges that underlie its boundaries.
Comment: Ice-wedge polygons occur in both mineral terrain and peatlands. They may be high-centred or low-centred.
Broader term: polygon
Narrower terms: high-centred polygon; low-centred polygon
Related terms: ice wedge; patterned ground; polygonal peat plateau; polygon trough; thermal contraction crack
References: French, 2017; Romanovskii, 1977; Washburn, 1979; Williams and Smith, 1989

ice-wedge pseudomorph

[fr] pseudomorphe de coin de glace

Definition: A secondary infilling of part or all of a cavity in the ground that was originally created and occupied by an ice wedge.

Comment: With wedge ice melt, sediment, organic materials, or water may fill the resulting void through cavity infilling or collapse of the sidewalls and of the overlying sediment. In permafrost areas, refreezing of water may form thermokarst-cave (pool) ice. In non-permafrost areas an ice-wedge pseudomorph is a definitive indicator of the previous presence of permafrost.
Non-preferred: ice-wedge cast; fossil ice wedge
Broader term: ground wedge
Related terms: composite wedge; thermokarst; thermokarst mound
References: French, 2017; Gagnon et al., 2024; Harry and Gozdzik, 1988; Romanovskii, 1977; Washburn, 1980

icing

[fr] glaçage

Definition: The process of water emerging from subsurface or surface sources and freezing in winter to form aufeis and icing mounds.
Comment: Water may seep from the ground, flow from a spring, or emerge from below river or lake ice through fractures and open leads. In a permafrost area, this water can originate from above or beneath the permafrost. In North America, *icing* is also used to describe the sheetlike mass of ice that forms from this process (see aufeis).
Related terms: aufeis; icing blister; icing glade; icing mound
References: Alekseev, 2007, 2015; Ensom et al., 2020; Morse and Wolfe, 2017

icing blister

[fr] cloque de glaçage

Definition: A seasonal frost mound composed entirely of ice and formed at least in part through lifting of one or more layers of aufeis by injected water.
Comment: Freezing of the injected water produces a layer of clear ice, contrasting with the overlying thinly layered ice of the aufeis. Rupture and draining of an icing blister may leave an empty cavity. Icing blisters are distinguished from frost blisters by the absence of a covering layer of seasonally frozen ground. They are distinguished from icing mounds by the layer of clear ice, and in some cases by the presence of an empty cavity.
Non-preferred: ice blister
Broader term: seasonal frost mound
Related terms: aufeis; frost blister; icing
References: Pollard and French, 1984; van Everdingen, 1978

icing glade

[fr] clairière de glaçage

Definition: An area kept clear of trees and shrubs by the annual occurrence of aufeis.
Comment: Icing glades along streams may also show the effects of lateral erosion occurring along the edges of the aufeis during and after snowmelt.
Equivalent: aufeis glade

Related terms: aufeis; icing
References: Alekseev, 2007, 2015

icing mound

[fr] butte de glaçage

Definition: A seasonal frost mound consisting exclusively of thinly layered ice, formed by freezing of successive flows of water issuing from the ground or from below river ice.
Comment: Icing mounds may incorporate snow.
Non-preferred: ice mound
Broader term: seasonal frost mound
Related terms: aufeis; frost blister; icing
References: Alekseev, 2007, 2015; Muller, 1943; Pollard and French, 1984; van Everdingen, 1978

infiltration ice

[fr] glace d'infiltration

Definition: Ground ice formed from surface runoff that enters ground movement-related tension and shearing cracks on slopes and freezes within them.
Comment: Infiltration ice is a type of vein ice and is differentiated from wedge ice by the genesis of the cracks in which it forms.
Broader term: vein ice
Related terms: frozen debris lobe; ground ice; ice; ice vein
Reference: Darrow et al., 2016

interfacial water

[fr] eau interfaciale

Definition: A film of liquid water that separates mineral surfaces from ice.
Comment: Interfacial water is one component of the unfrozen water content and affects phenomena such as frost heave and temperature-dependent soil characteristics. The thickness of the interfacial water layer depends on temperature, the mineral properties, and solute content. It is typically on the order of a nanometre, the length of several water molecules. In unfrozen soil, a similar phenomenon exists where a thin layer of adsorbed water is tightly held on mineral surfaces.
Broader term: pore water
References: Anderson and Morgenstern, 1973; Anderson and Tice, 1973; Rempel et al., 2004

intrapermafrost groundwater

[fr] eau intrapergélisol

Definition: Water occurring in an unfrozen zone within permafrost (see talik).
Comment: Intrapermafrost groundwater includes water in open, lateral and transient taliks. It comprises basal, isolated and marine cryopegs. Sometimes erroneously called interpermafrost water.

Related terms: aufeis; cryopeg; subpermafrost groundwater; suprapermafrost groundwater; talik
References: Tolstikhin and Tolstikhin, 1976; Williams, 1970

intrusive ice

[fr] glace d'intrusion

Definition: Ice formed from water injected into soils or rocks.
Comment: Intrusive ice is often clear at its sharp contact with enclosing sediments, but it may be cloudy elsewhere. Freezing of injected water will normally lift the ground above it, producing topographic forms. Intrusive ice masses can be tabular or dome-shaped and may develop in porous unconsolidated sediments or in jointed or fractured bedrock. Fractures may become enlarged by hydraulic fracturing or frost wedging processes. For the greatest effect, water must become trapped in the joints or fractures and be subjected to relatively rapid freezing.
Non-preferred: injection ice; sill ice
Broader term: ground ice
Related terms: epigenetic ice; ice; solid cryostructure
References: Dyke, 1984; Mackay, 1972a; Murton, 2022b

isolated patches permafrost zone

[fr] zone d'ilots de pergélisol dispersés

Definition: A major subdivision of a permafrost region in which permafrost underlies less than 10% of the exposed land surface (see Figure 5).
Comment: The isolated patches zone lies between the sporadic permafrost zone and the distal latitudinal limit of permafrost occurrence. Individual bodies of permafrost in this zone are widely separated, of limited areal extent, and are surrounded by seasonally frozen ground or water. The transition to the sporadic permafrost zone is conceptual and cannot be sharply delineated at a fine scale.
Non-preferred: insular permafrost; island permafrost; scattered permafrost
Broader term: permafrost zone
Related term: permafrost region
References: Brown et al., 1997; Heginbottom, 2002

isolated talik

[fr] talik isolé

Definition: A talik entirely surrounded by perennially frozen ground (see Figure 4).
Comment: Isolated taliks are commonly cryotic (see cryopeg), but they may be noncryotic (see transient talik).
Broader term: talik
Related term: cryopeg
References: O'Neill et al., 2020; van Everdingen, 1976

isotherm

[fr] isotherme

Definition: A line on a map or diagram connecting points having the same temperature at a given moment or on average over a given period.
Reference: Hock et al., 2019

kurum

[fr] kurum

Definition: An accumulation of coarse angular blocks of rock on slopes with angles not exceeding 40°, moving slowly downslope over fractured bedrock in areas of mountain permafrost.
Comment: This Russian term covers Western terms such as *block slopes*, *stone streams*, *block streams*, *rock streams*, *rock covers*, and *rock fields*. Vertically, kurums are characterized by a two-layered structure: the upper layer is within the active layer and the lower one extends below the permafrost table and is underlain by a layer of ground ice of interstitial or segregation-interstitial origin. Kurums move slowly downslope, mainly due to creep, but their movement rates may suddenly increase due to earthquakes, precipitation, or road construction involving cut slopes.
Equivalent: block stream
Related term: mass movement
References: Dubikov et al., 2003; Harris et al., 1998; Tyurin et al., 1982; Wilson et al., 2008

lake talik

[fr] talik lacustre

Definition: A talik beneath a lake (see Figure 4).
Comment: The temperature of a lake talik generally remains above 0°C due to the heat storage effect of the lake water, although talik margins may be cryotic if the pore water is subject to freezing point depression. Depending on the permafrost thickness and the size of the water body, a lake talik may be open or closed.
Broader term: talik
Related term: open talik
References: Burn, 2002; O'Neill et al., 2020

latent heat of fusion

[fr] chaleur latente de fusion

Definition: The amount of heat required to change the phase of a material between solid and liquid.

Comment: Latent heat is responsible for the zero-curtain effect whereby ground temperatures remain at or just below 0°C as moisture in the ground freezes or thaws.
Related terms: apparent heat capacity; zero curtain
References: Farouki, 1981; Romanovsky and Osterkamp, 2000; Williams and Smith, 1989

lateral talik

[fr] talik latéral

Definition: A talik oriented roughly horizontally that provides a pathway for lateral groundwater flow (see Figure 4).
Comment: Lateral taliks may be cryotic (see hydrochemical talik) or noncryotic (see hydrothermal talik). They may be both underlain and overlain by perennially frozen ground or comprise a layer of thawed ground between the active layer and underlying permafrost.
Broader term: talik
Related terms: hydrochemical talik; hydrothermal talik
References: O'Neill et al., 2020; van Everdingen, 1976

latitudinal zonation of permafrost

[fr] zonation latitudinale du pergélisol

Definition: The subdivision of a permafrost region into permafrost zones, based on the estimated percentage of the area that is underlain by permafrost.
Comment: The concept of latitudinal zonation of permafrost is useful for communicating continental-scale spatial trends in permafrost coverage through maps (see Figure 5) which are largely based on patterns of mean annual air temperature. It cannot be relied upon to estimate how much permafrost may be present locally as this depends on environmental factors such as snow depth and vegetation cover which can vary greatly over short distances.
Related terms: extra-zonal permafrost; permafrost extent; permafrost zone
References: Heginbottom, 2002; Nelson and Outcalt, 1987; Obu et al., 2019

layered cryostructure

[fr] cryostructure en couches

Definition: A cryostructure with alternating, continuous layers of ice and sediment or rock.
Comment: A layered cryostructure is commonly produced by ice segregation in frost-susceptible sediments, and it may also form in syngenetic permafrost with soil accumulation (e.g., yedoma), or by injection and freezing of pressurized water. Ice layers are commonly between 2 and 5 cm thick.
Equivalent: bedded cryostructure
Broader term: cryostructure
Related terms: ice segregation; segregated ice
References: French and Shur, 2010; Gilbert et al., 2016; Murton, 2022a

lens ice

[fr] glace en lentille

Definition: Ground ice occurring as ice lenses.
Comment: Lens ice is commonly produced by ice segregation in fine-grained sediments.
Broader term: ground ice
Related terms: ice; ice lens; ice segregation; lenticular cryostructure; segregated ice
Reference: Murton, 2022b

lenticular cryostructure

[fr] cryostructure lenticulaire

Definition: A cryostructure in which numerous ice lenses are present in frost-susceptible soil, organic material or bedrock.
Comment: A lenticular cryostructure is produced by ice segregation. The orientation of the ice lenses typically reflects the orientation of the freezing front and/or the structural properties of the sediment. When ice lenses are <0.5 mm thick, the term *micro-lenticular* can be used.
Equivalent: lens-type cryostructure
Broader term: cryostructure
Related terms: ice lens; ice segregation; lens ice; segregated ice
References: French and Shur, 2010; Gilbert et al., 2016; Murton, 2022a; Murton and French, 1994

lithalsa

[fr] lithalse

Definition: A mound, dome or ridge, with a perennially frozen core composed of fine-grained mineral soil and layers or lenses of segregated ice.
Comment: Lithalsas are typically one to a few metres high and tens of metres long or wide, and are formed by the growth of segregated ice lenses in fine-grained sediments (fine sand, silt, or clay). Most are located in wetlands where permafrost is discontinuous. An organic layer may be present on the surface of the lithalsa but peat is absent from its perennially frozen core. Some lithalsas may evolve from palsas through erosion of the surface peat layer.
Non-preferred: minerogenic palsa, mineral palsa
Broader term: frost mound
Related terms: palsa; segregated ice
References: Calmels et al., 2008; Harris, 1993; Wolfe et al., 2014

long-term strength

[fr] résistance à long terme

Definition: The failure strength of a material after a long period of creep deformation.
Comment: It is sometimes defined in practice as the creep strength (or the delayed strength) related to the service life of a structure, but its general definition is the failure strength

attained when the strain rate tends to zero or time tends to infinity. Long-term strength is relevant in design to sustained loads.
Reference: Andersland and Ladanyi, 2004

low-centred polygon

[fr] polygone à centre déprimé

Definition: An ice-wedge polygon with a slightly depressed central area.
Comment: Low-centred polygons are common in poorly drained, ice-rich permafrost terrain. They generally possess a raised rim, or rampart, on each side of the ice-wedge trough. The raised rims result from lateral thermal expansion within the active layer moving material from the polygon centre to the periphery.
Broader term: ice-wedge polygon
Related terms: high-centred polygon; patterned ground; polygon; polygon trough
References: French, 2017; Mackay, 2000

massive ice

[fr] glace massive

Definition: A general term used to denote masses of relatively pure ground ice.
Comment: Massive ice can be formed in various ways, including thermal contraction cracking (wedge ice), ice segregation (segregated ice), injection of water (intrusive ice) and burial (buried ice). Some authors have suggested that a body of ice must have a minimum ice content of 250% (on an ice-to-dry-soil weight basis) and be at least 0.3 m in thickness to be termed massive ice but there is no internationally agreed-upon minimum set of dimensions. Identification of a body of massive ice in a core is particularly difficult as true thickness and lateral extent are typically unknown. Massive ice beds can exceed 40 m in thickness and can extend up to 2 km horizontally. Some massive ice bodies are responsible for prominent topographic rises (e.g., pingos) whereas others have no surface expression (e.g., tabular sheets of massive ice). Some massive ice bodies are deformed, dislocated and folded.
Broader term: ground ice
Related terms: buried ice; ice; ice content; intrusive ice; segregated ice; wedge ice
References: French, 2017; Mackay, 1971; Murton, 2022b; Rampton and Mackay, 1971; Yershov, 1990

mass movement

[fr] mouvement de masse

Definition: The downslope movement of soil or rock under the influence of gravity.
Comment: Mass movement can occur as a flow, slide, fall or topple, or as a combination of these movements. In the periglacial context, displacements that occur slowly include permafrost creep and solifluction, while more rapid mass movements include active-layer detachment, block collapse and rockfall. Mass movement does not include crustal displacements resulting

from tectonic activity or processes where material is carried directly by an active transporting medium, such as glacial ice, snow, water or air. Mass movement gives rise to numerous periglacial landforms including active layer detachment failures, debris flows, frozen debris lobes, solifluction features and some rock glaciers.
Narrower terms: active-layer detachment failure; creep of frozen ground; solifluction
Related terms: debris flow; frost creep; frozen debris lobe; kurum; multiple retrogressive slide; retrogressive thaw slump; rock glacier; thaw slumping
Reference: Ballantyne, 2018

mean annual ground surface temperature (MAGST)

[fr] température annuelle moyenne de la surface

Definition: Mean annual temperature of the surface of the ground.
Comment: The MAGST is calculated by averaging ground surface temperatures measured at equal intervals (generally multiple times per day) throughout one full year (or several years). It can exhibit significant inter-annual variability. Permafrost exists if the mean annual ground surface temperature is perennially below 0°C. Permafrost can also be present if the MAGST regularly exceeds 0°C and the thermal offset is sufficiently large or if the permafrost is degrading and at the point of thaw. Field measurements of MAGST are usually made a few centimetres below the surface to prevent solar heating of the temperature sensor.
Related terms: ground thermal regime; surface offset
Reference: Williams and Smith, 1989

mean annual ground temperature (MAGT)

[fr] température annuelle moyenne du sol

Definition: Mean annual temperature of the ground at a particular depth.
Comment: The MAGT at any given depth is calculated by averaging values measured at equal intervals (generally multiple times per day at shallow depths) throughout one full year (or several years), or it can be represented by a single measurement if this is collected at or below the depth of zero annual amplitude. The MAGT at the depth of zero annual amplitude is used as a standard for assessing the ground thermal regime at a specific location. The MAGT is regarded as an essential climate variable for permafrost within the Global Climate Observing System and values in permafrost areas around the globe are housed in the Global Terrestrial Network for Permafrost.
Related terms: ground temperature profile; ground thermal regime; trumpet curve
References: Biskaborn et al., 2019; Smith et al., 2022; Williams and Smith, 1989

megaslump

French equivalent not established.

Definition: A very large retrogessive thaw slump.

Comment: Megaslump headwalls are commonly >10 m high and can be hundreds of metres wide. A minimum affected area of 5 ha has been used to distinguish between megaslumps and other retrogressive thaw slumps (Kokelj et al. 2015). Debris evacuation from megaslumps results in significant downstream geomorphic and environmental consequences. Megaslumps develop in thick sequences of ice-rich permafrost, such as yedoma or sediments hosting buried glacier ice. The largest megaslump globally is the Batagaika Crater in Siberia.
Broader term: retrogressive thaw slump
References: Kokelj et al., 2013, 2015; Murton et al., 2023

mountain permafrost

[fr] pergélisol de montagne

Definition: Permafrost in mountainous regions.
Comment: Mountain permafrost is particularly heterogeneous in its properties, including temperature and ice content, due to the influence of topography on climate and on the redistribution of snow, water, soil and rock. Mountain permafrost may be continuous in polar regions, even at sea level, whereas a vertical zonation typically exists in lower latitudes (see elevational zonation of permafrost).
Equivalents: alpine permafrost; plateau permafrost
Non-preferred: high-altitude permafrost
Broader term: permafrost
Related terms: elevational zonation of permafrost; extra-zonal permafrost; permafrost limit
References: Arenson et al., 2022; Cheng and Dramis, 1992; Gruber et al., 2015; Gruber and Haeberli, 2009; Péwé, 1983

mud ejection

[fr] éjection boueuse

Definition: A slurry of fine-grained sediment expelled from the base of the active layer onto the ground surface during periods of rapid active layer thaw.
Comment: The development of new mud ejections on slopes is an indication of high pore water pressures and potential instability.
Related term: thaw consolidation
References: Holloway et al., 2016; Lewkowicz, 2007

multiple retrogressive slide

[fr] glissement rétrogressif multiple

Definition: A type of mass movement associated with shear failure in unfrozen sediments underlying permafrost, leading to detachment of blocks of frozen ground that move downslope.
Comment: This type of landslide appears as a series of arcuate, concave-towards-the toe blocks that step upward tens of metres towards the headscarp. The blocks may be rotated or back-tilted.
Related term: mass movement
References: Johnston, 1981; McRoberts and Morgenstern, 1974a

near-surface permafrost

[fr] pergélisol près de la surface

Definition: 1. The uppermost layers of permafrost above a prescribed depth. 2. Less commonly, perennially frozen ground where the permafrost table is shallower than 1 m.
Comment: 1. The IPCC (2021) defines near-surface permafrost as extending to depths of about 3–4 m below the ground surface but other publications have used a greater range of values and there is no universally agreed-upon maximum depth. Near-surface permafrost is first- and most-affected by surface temperature change, is most frequently represented in global-scale permafrost models, generally includes the horizons with the highest ice contents and is highly relevant to people and ecosystems. The complete thaw of near-surface permafrost at a given site does not preclude its persistence for many years at greater depths beneath a supra-permafrost talik.
Broader term: permafrost
Related terms: permafrost carbon-climate feedbacks
References: IPCC, 2021; Lawrence and Slater, 2005; Nguyen et al., 2009; Pastick et al., 2015

needle ice

[fr] pipkrake

Definition: Long, thin, ice crystals that form perpendicular to the ground surface.
Comment: Needle ice can form nocturnally when extensive radiative cooling results in ice segregation in the surface layer of the soil. The needles can form under stones, soil peds, mosses or other surface vegetation and commonly develop in mountains with silty or organic soils.
Equivalent: pipkrake (Sweden)
Broader term: ground ice
Related terms: ice; ice segregation
References: Mackay and Mathews, 1974; Washburn, 1979

n-factor

[fr] facteur n

Definition: An empirically-derived transfer function relating ground surface temperature to air temperature, calculated for the freezing period as the ratio of the surface freezing index to the air freezing index and for the thawing period as the ratio of the surface thawing index to the air thawing index.
Comment: N-factors were originally developed for engineering purposes to estimate surface boundary conditions from readily available air temperature data, in order to permit ground thermal modelling. However, they have also been used to model vegetated surfaces over large areas using methods such as the TTOP model. The difference between air and surface temperatures at any specific time and location is influenced by climatic, surface and subsurface conditions (e.g., latitude, cloud cover, time of day or year, relative humidity, wind speed, type of surface (wet, dry, moss, snow, natural vegetated terrain, mineral soil, pavement) and thermal properties of the ground). Freezing n-factors are highly variable spatially and

temporally due to the insulating effect of snow, varying from almost zero to 1.0 (for a wind-scoured bare surface). Thawing n-factors exhibit less variation, ranging from typical values of about 0.7 for forested sites to 1.0 or slightly higher for bare surfaces or tundra sites. Direct determination of the n-factor for a specific location requires concurrent observation of air and surface temperatures throughout at least one and preferably several complete freezing and thawing seasons.

Related terms: air freezing index; air thawing index; surface freezing index; surface offset; surface thawing index; Temperature at the Top of Permafrost (TTOP) model

References: Carlson and Kersten, 1953; Karunaratne and Burn, 2004; Klene et al., 2001; Lunardini, 1978

nival offset

[fr] décalage thermique nival

Definition: That part of the difference between the mean annual ground surface temperature and the mean annual air temperature at a site attributable to the insulating effect of the snow cover.

Comment: The nival offset is a measure of the warming impact of snow on average ground surface temperature. It is calculated from the air and ground surface freezing indices.

Related terms: air freezing index; surface freezing index; surface offset; Temperature at the Top of Permafrost (TTOP) model

References: Hasler et al., 2015; Smith and Riseborough, 2002

nivation

[fr] nivation

Definition: Umbrella term for intensified physical and chemical weathering, erosion and sediment transport in the vicinity of late-lying snow patches.

Comment: Shallow hillslope concavities, known as nivation hollows, are produced by nivation processes. Nivation is not limited to permafrost areas.

Related term: cryoplanation

References: French, 2017; Mitchell et al., 2023, 2021; Nyland et al., 2025; Thorn, 1976

noncryotic ground

[fr] sol non cryotique

Definition: Soil or rock at temperatures above 0°C.

Comment: Noncryotic ground is not synonymous with thawed ground (which implies an earlier frozen state), nor with unfrozen ground (the temperature of which may be below 0°C).

Related terms: hydrothermal talik; unfrozen ground

Reference: O'Neill et al., 2020

non-frost-susceptible soil

[fr] sol non gélif

Definition: Soil in which little or no frost heave occurs during seasonal freezing or permafrost aggradation.

Comment: The properties of non-frost-susceptible soil are specified in some building codes. Generally, they are defined by an upper limit on the gravimetric percentage of soil particles less than 0.02 mm in diameter. This type of soil meets the classification of frost-stable ground.

Equivalent: frost-stable soil

Broader term: frost-stable ground

Related term: pore cryostructure

References: Andersland and Ladanyi, 2004; Johnston, 1981

nonsorted circle

[fr] cercle non trié

Definition: A patterned ground form that is equidimensional in several directions, with a dominantly circular outline and without a border of stones.

Comment: Nonsorted circles characteristically have margins of vegetation. They occur singly or in groups. Their diameters are commonly between 0.5 and 3.0 m. Their central areas tend to be slightly dome-shaped and may be cracked into small nonsorted polygons. In places, the long axes of stones and sand particles tend toward vertical. The term covers frost boils and mud circles, developed in fine-grained materials, and stony earth circles, developed in gravelly materials.

Broader term: patterned ground

Narrower terms: frost boil; hummock

References: Washburn, 1956, 1979

nonsorted net

[fr] réseau non trié

Definition: A type of patterned ground with cells that are equidimensional in several directions, neither dominantly circular nor polygonal, and without borders of stones.

Comment: Nonsorted nets occur on nearly horizontal surfaces. Diameters of individual cells range from 0.5 to as much as 10 m. Where vegetation is sparse, it is generally concentrated in furrows bordering the individual cells of the net, emphasizing the pattern.

Broader term: patterned ground

References: Washburn, 1956, 1979

nonsorted polygon

[fr] polygone non trié

Definition: A patterned ground form that is equidimensional in several directions, with a dominantly polygonal outline and without a border of stones.

Comment: Nonsorted polygons commonly occur in extensive groups, most frequently on nearly horizontal surfaces (although small forms have been found on slopes up to 27°; large ones have been found on slopes as steep as 31° in polar regions). Micro-scale polygons range in size from 5 cm to about 1 m; macro-scale polygons may be more than 100 m in diameter. Where vegetation is sparse, it is generally concentrated in furrows along the borders between the polygons, emphasizing the pattern. The mineral soil can be well-sorted fines, sand, gravel, or a mixture.
Broader term: polygon
Related term: patterned ground
References: Washburn, 1956, 1979

nonsorted step

[fr] replat non trié

Definition: A patterned ground feature with a step-like form and a downslope border of vegetation embanking an area of relatively bare ground upslope.
Comment: Nonsorted steps are only found on slopes, commonly ranging from 5° to 15°. Their downslope border forms a low riser fronting a tread whose slope is less than the general slope. Nonsorted steps are assumed to be derived from nonsorted nets or hummocks or nonsorted polygons, rather than to have developed independently.
Broader term: patterned ground
Related term: solifluction
References: Washburn, 1956, 1979

nonsorted stripe

[fr] sol strié non trié

Definition: Patterned ground with a striped and nonsorted appearance, due to parallel strips of vegetation-covered ground and intervening strips of relatively bare ground, oriented down the steepest available slope.
Comment: Nonsorted stripes, both large and small, occur on slopes of 5° to 6°, downslope from nonsorted polygons or nonsorted nets. In some places the vegetated and non-vegetated strips are equally wide; in other places vegetated strips of 0.3–0.6 m are spaced from 3 to 4.5 m apart. They can be several hundred metres long.
Broader term: patterned ground
Related term: solifluction
References: Washburn, 1956, 1979

one-sided freezing

[fr] gel unidirectionel

Definition: Seasonal freezing of the ground that progresses exclusively from the ground surface downwards.

Comment: One-sided freezing predominates where permafrost is discontinuous and in areas of seasonally frozen ground. In frost-susceptible soil, it results in ice lensing in the near surface that diminishes with depth.
Broader term: freezing (of ground)
Related terms: active layer; seasonally frozen ground; seasonally frozen layer; two-sided freezing
References: Kern-Luetschg and Harris, 2008; Lewkowicz, 1988; Matsuoka, 2001

onshore permafrost

[fr] pergélisol terrestre

Definition: Permafrost occurring beneath exposed land surfaces.
Comment: Typically used to indicate permafrost in coastal land areas, as contrasted with subsea permafrost.
Non-preferred: continental permafrost
Broader term: permafrost
Related term: subsea permafrost
References: Angelopoulos et al., 2021; Osterkamp, 1975

open-cavity ice

[fr] glace de condensation solide (cavité ouverte)

Definition: Ice formed in an open cavity or crack in the ground by reverse sublimation of water vapour.
Comment: Open-cavity ice is similar to hoar frost, except that the ice crystals grow in cavities rather than on the surface. It is common in thermal contraction cracks, mine workings, ice caves and food cellars in permafrost.
Non-preferred: sublimation ice
Broader term: ground ice
Related terms: closed-cavity ice; ice
Reference: Mackay, 1972a

open-system freezing

[fr] gel en système ouvert

Definition: Freezing that occurs under conditions that allow gain or loss of water by the system.
Comment: The effects of open-system freezing vary for different soil materials. During freezing of clean, medium- to coarse-grained materials, some pore water may be expelled ahead of the freezing front, compensating for the volume increase during phase change and reducing frost heave. During freezing of fine-grained materials, water typically migrates to the freezing front, contributing to the formation of segregated ice and frost heave.
Related term: freezing (of ground)
Reference: Williams and Smith, 1989

open-system pingo

[fr] pingo en système ouvert

Definition: A pingo formed by groundwater flowing under hydraulic pressure through taliks and towards the surface, where it freezes to form intrusive ice (see Figure 3).

Comment: Most open-system pingos are found in or near areas of marked relief, both in areas of continuous permafrost, such as Greenland and Svalbard, and in areas of discontinuous permafrost, such as Alaska. High hydraulic potential, typically due to water originating in elevated areas, causes injection of water into a thin layer of the permafrost, followed by freezing. Some open-system pingos in continuous permafrost form where water flow is accompanied by the upward migration of methane gas through open taliks.

Equivalent: hydraulic pingo

Non-preferred: East Greenland pingo

Broader term: pingo

Related term: frost mound

References: French, 2017; Hughes, 1969; Mackay and Stager, 1966; Müller, 1963; Yoshikawa, 1993

open talik

[fr] talik ouvert

Definition: A talik that penetrates completely through permafrost, connecting suprapermafrost and subpermafrost water (see Figure 4).

Comment: Open taliks can be found below large rivers (see river talik) and lakes (see lake talik). They may be noncryotic (see hydrothermal talik) or cryotic (see hydrochemical talik).

Equivalents: through talik; throughgoing talik

Non-preferred: penetrating talik; perforating talik; piercing talik

Broader term: talik

Related terms: hydrochemical talik; hydrothermal talik; lake talik; river talik

References: Dubikov et al., 2003; O'Neill et al., 2020; van Everdingen, 1976; Washburn, 1973

organic cryosol

[fr] cryosol organique

Definition: An organic soil having a surface layer containing more than 17% organic carbon by weight, with permafrost within 1 m of the surface and a mean annual ground temperature below 0°C.

Comment: The organic material is more than 40 cm thick, or more than 10 cm thick over either a lithic contact, or an ice layer that is at least 30 cm thick. Subgroups within the Organic Cryosol Great Group are differentiated on the basis of the depth and degree of decomposition of the organic material. Organic cryosols are the prevailing soil type in permafrost-affected peatlands and are commonly present on landforms such as palsas, peat plateaus and polygonal peat plateaus. Large amounts of organic carbon are stored in both the active layer and permafrost where these soils are present (see permafrost carbon).

Broader term: cryosol
Related terms: permafrost carbon; permafrost carbon-climate feedbacks
References: Soil Classification Working Group, 1998; Tarnocai and Bockheim, 2011

organic-matrix cryostructure

[fr] cryostructure de matrice organique

Definition: A cryostructure developed in an organic-rich material with the ice disseminated throughout and larger crystals or lenses typically visible to the unaided eye.
Comment: Organic-matrix cryostructure develops where water freezes in wet or saturated peat or organic-rich soil, resulting in ice filling the voids. It is common in peaty terrain. The ice morphology and visible ice content of this cryostructure are highly variable, but the gravimetric and volumetric moisture contents are consistently high due to the low density and high porosity of the organic matter. The modifiers *nonvisible, uniform,* and *irregular* can be used to differentiate ice abundance and morphology.
Broader term: cryostructure
Related term: porphyritic cryostructure
References: Jorgenson and Shur, 2009; Kanevskiy et al., 2013; Murton, 2022a

oriented lake

[fr] lac orienté

Definition: One of a group of lakes possessing a common, preferred, long-axis orientation.
Comment: Oriented lakes appear to develop by differential erosion of permafrost shorelines formed in fine-grained, homogeneous sediments under the influence of predominant winds. In some cases, bedrock structural control may also determine lake orientation. Oriented lakes also occur in non-permafrost environments.
References: Black and Barksdale, 1949; Harry and French, 1983; Jorgenson and Shur, 2007; Roy-Léveillée and Burn, 2016; Wolfe et al., 2020

palsa

[fr] palse

Definition: A mound, dome or ridge, with a perennially frozen core comprising peat, typically underlain by fine-grained sediments incorporating layers of segregated ice.
Comment: Palsas are typically 1 to 10 m high and a few metres to 100 m long or wide. They usually develop in wetlands and are widely distributed within areas of discontinuous permafrost. The term *palsa* is of Fennoscandian origin, meaning “a hummock rising out of a bog with a core of ice” (Seppälä, 1972).
Non-preferred: peat hummock; peat mound
Broader term: frost mound
Related terms: lithalsa; palsa bog; peat; peatland; peat plateau
References: Allard and Rousseau, 2002; Laberge and Payette, 1995; Seppälä, 1972, 2011

palsa bog
[fr] tourbière à palse

Definition: A poorly-drained lowland underlain by organic-rich sediments and containing perennially frozen peat plateaus and/or palsas.
Comment: Palsa bogs occur in subarctic lowlands and are characteristic of areas where permafrost is discontinuous.
Equivalent: palsa mire
Related terms: palsa; peat; peatland
References: Seppälä, 2011; Zoltai and Tarnocai, 1975

paraglacial
[fr] paraglaciaire

Definition: Non-glacial earth-surface processes, sediment accumulations, landforms, land-systems and landscapes that are directly conditioned by glaciation and deglaciation.
Comment: Paraglacial processes are those that modify landscapes following deglaciation, and include rock-slope failure, modification of sediment-mantled slopes by streams and mass-wasting, enhanced fluvial sediment transport and lacustrine sedimentation, and reworking of coastal glacigenic deposits. Paraglacial landscape modification occurs within decades to millennia after deglaciation, often on terrain that is underlain by permafrost. The occurrence of permafrost may slow the rate of paraglacial adjustment compared to non-permafrost environments.
Related terms: cryo-conditioning; periglacial
References: Ballantyne, 2018; Church and Ryder, 1972; Kokelj et al., 2017; Murton, 2021

patterned ground
[fr] sol structuré

Definition: Any ground surface exhibiting a discernibly ordered, more or less symmetrical, morphological pattern of ground and, where present, vegetation.
Comment: Patterned ground features are not confined to permafrost regions but they are best developed in regions of present or past frost action. Patterned ground includes such features as nonsorted and sorted circles, nets, polygons, steps and stripes, and other solifluction features. In permafrost regions, the most ubiquitous macro-form is the ice-wedge polygon, and common micro-forms are circles, hummocks and mud boils. Some patterned ground may also form in seasonally frozen ground. Patterned ground also occurs in peatland in the form of string fens and other peatland features.
Broader term: periglacial phenomena
Narrower terms: nonsorted circle; nonsorted net; nonsorted step; nonsorted stripe; polygon; sorted circle; sorted net; sorted step; sorted stripe; string fen
Related terms: frost boil; frost sorting; high-centred polygon; hummock; ice-wedge polygon; low-centred polygon; nonsorted polygon; stone garland; turbic cryosol
References: French, 2017; Romanovskii, 1977; Washburn, 1979, 1956

peat

[fr] tourbe

Definition: A deposit consisting of decayed or partially decayed humified plant remains.
Comment: Peat is commonly formed by the slow decay of successive layers of aquatic and semi-aquatic plants in swampy or water-logged areas, where oxygen is absent.
Related terms: palsa; palsa bog; peatland; peat plateau; polygonal peat plateau
References: Lourenco et al., 2023; MacFarlane, 1969

peatland

[fr] tourbière

Definition: Wetland terrain with a surficial layer of peat.
Comment: Peatland is most commonly a bog or a fen where peat is forming or has formed by the accumulation of plant remains with negligible decomposition, but there is no internationally agreed-upon minimum thickness of peat required for the term to be applied. Peatland is often associated with permafrost where the latter is discontinuous, reflecting the thermal insulating qualities of peat. Palsas, peat plateaus and polygonal peat plateaus are permafrost-related peatland features. In North America, peatland is also known as muskeg, a word that has its roots in Algonquian languages.
Equivalents: muskeg (North America); organic terrain
Related terms: palsa; palsa bog; peat; peat plateau; permafrost carbon; permafrost carbon-climate feedbacks; polygonal peat plateau; string fen
References: Hugelius et al., 2020; Lourenco et al., 2023; Zoltai and Tarnocai, 1975

peat plateau

[fr] plateau palsique

Definition: A generally flat-topped expanse of perennially frozen peat, elevated above the general surface of a peatland, and containing segregated ice that may or may not extend downward into underlying mineral soil or bedrock.
Comment: Peat plateaus typically occur as patches of permafrost and are commonly 1–3 m high and several tens to hundreds of metres wide. Some controversy exists as to whether peat plateaus and palsas are morphological variations of the same features or are genetically different. Layers or lenses of segregated ice occur especially in the mineral soil but they are thinner and less extensive in peat plateaus than in palsas. Raised peatlands without permafrost are not peat plateaus.
Non-preferred: palsa plateau; raised peatland
Narrower term: polygonal peat plateau
Related terms: palsa; palsa bog; peat; peatland
References: Brown, 1970b; Quinton and Baltzer, 2013; Sannel and Kuhry, 2011; Zoltai, 1972

pereletok

[fr] pereletok

Definition: A layer of short-lived permafrost which forms by particularly deep winter freezing in areas free of permafrost or with a lowered permafrost table, remains cryotic for at least two consecutive years, and then thaws.

Comment: Pereletok is a Russian term that underlines the potential dynamics of permafrost at sites where inter-annual variability in climate, drainage or other conditions can result in the formation of a layer of cryotic ground that persists through at least the following summer. The maximum duration for newly-formed permafrost to be termed pereletok varies in the literature from 2–5 years.

Non-preferred: climafrost

Broader term: permafrost

Related term: permafrost aggradation

References: Brown, 1966; Dubikov et al., 2003; Yershov, 1990

periglacial

[fr] périglaciaire

Definition: A broad term used to describe the climatic conditions, environments, processes, landforms, landscapes, sediments and soil structures associated with cold, non-glacial environments.

Comment: The term was originally used to describe the climatic and geomorphic conditions of areas peripheral to Pleistocene ice sheets and glaciers. Modern usage refers to a wider range of cold climatic conditions regardless of their proximity to a glacier, either in space or time. Many, but not all, periglacial environments possess permafrost. All are impacted by frost action processes.

Related terms: cryo-conditioning; cryoplanation; frost action; paraglacial; periglacial phenomena; periglacial processes

References: Ballantyne, 2018; Dylik, 1964; French, 2017; Murton, 2021

periglacial phenomena

[fr] phénomènes périglaciaires

Definition: Landforms and soil characteristics produced by periglacial processes.

Comment: Periglacial phenomena include landforms, such as frost mounds (seasonal and perennial) and patterned ground, and the cryotextures, cryostructures and cryogenic fabrics found in soils.

Narrower terms: blockfield; cryogenic fabric; cryoplanation terrace; cryostructure; cryotexture; cryoturbation; frost mound; patterned ground

Related terms: frost action; periglacial; periglacial processes

References: Ballantyne, 2018; French, 2017; Washburn, 1973

periglacial processes

[fr] processus périglaciaires

Definition: Processes associated with frost action in cold, nonglacial environments.

Comment: Periglacial processes include frost jacking, frost sorting, frost wedging, cryoturbation, and the development of cryotextures, cryostructures and cryogenic fabrics in soils.

Narrower term: frost action

Related terms: cryoturbation; frost jacking; frost sorting; frost wedging; periglacial; periglacial phenomena

References: Ballantyne, 2018; French, 2017; Washburn, 1973

permafrost

[fr] pergélisol

Definition: Earth materials (soil or rock and included moisture, gases and organic material) that remain at or below 0°C for at least two consecutive years.

Comment: Permafrost is defined as perennially cryotic (≤0°C) on the basis of the most easily monitored parameter: ground temperature (see Figure 1). It is not necessarily frozen, because included water may freeze or thaw over a range of temperatures below 0°C and in some substrates, moisture may be absent altogether. Permafrost includes perennial ground ice, but not glacier ice, aufeis, or bodies of surface water with temperatures perennially below 0°C. Cold permafrost is generally considered to have a mean ground temperature ≤-4°C while warm permafrost has a mean ground temperature between -2°C and 0°C.

Equivalent: perennially cryotic ground

Non-preferred: biennially frozen ground; climafrost; cryic layer; permanently frozen ground

Narrower terms: climate-driven, ecosystem-modified permafrost; climate-driven, ecosystem-protected permafrost; climate-driven permafrost; continuous permafrost; discontinuous permafrost; disequilibrium permafrost; dry permafrost; ecosystem-driven permafrost; ecosystem-protected permafrost; epigenetic permafrost; equilibrium permafrost; extra-zonal permafrost; ice-bearing permafrost; mountain permafrost; near-surface permafrost; onshore permafrost; pereletok; planetary permafrost; saline permafrost; seasonally-active permafrost; subglacial permafrost; subsea permafrost; syngenetic permafrost; thaw-sensitive permafrost

Related terms: cryolithology; cryosphere; freezing (of ground); friable permafrost; frost; frozen ground; geocryology; ice-bonded permafrost; ice-poor permafrost; ice-rich permafrost; permafrost aggradation; permafrost base; permafrost boundary; permafrost degradation; permafrost extent; permafrost limit; permafrost region; permafrost table; permafrost thickness; permafrost zone; poorly-bonded permafrost; transient layer; well-bonded permafrost

References: French, 2017; Muller, 1943; van Everdingen, 1976; Yershov, 1990

permafrost aggradation

[fr] aggradation du pergélisol

Definition: An increase in the thickness and/or area underlain by permafrost.

Comment: Permafrost aggradation may occur following climatic cooling, a decrease in snow cover, vegetation succession, or changes in terrain conditions, including exposure of surfaces previously covered by water bodies or glaciers. It can also occur under ice arenas, road and airfield embankments, etc. It may manifest as a thinning of the active layer and a thickening of the permafrost, or the development of permafrost at a location where none previously existed.
Related terms: disequilibrium permafrost; pereletok; permafrost
References: French, 2017; Hunter, 1988; Mackay, 1997; Treat and Jones, 2018

permafrost base

[fr] base du pergélisol

Definition: The lower boundary surface of permafrost (see Figure 1).
Comment: It represents the boundary between perennially cryotic and non-cryotic ground. The depth of the permafrost base is measured vertically below the ground surface. It varies with climate, typically being greatest in cold areas with continuous permafrost and less in warmer discontinuous permafrost. It also depends on local factors such as topography, the geothermal gradient, substrate properties and the presence of water bodies.
Related terms: cryofront; permafrost; permafrost thickness
References: Brown, 1970a; French, 2017

permafrost boundary

[fr] limite du pergélisol

Definition: The margin of a discrete body of permafrost.
Equivalent: permafrost edge
Related term: permafrost

permafrost carbon

[fr] carbone du pergélisol

Definition: Organic carbon present in permafrost.
Comment: This term specifically relates to organic carbon stored in permafrost (Figure 14) and does not include carbon stored in the active layer, or in permafrost regions in general. Changes in permafrost carbon storage due to permafrost degradation caused by climate change affect permafrost carbon-climate feedbacks.
Related terms: organic cryosol; peatland; permafrost carbon-climate feedbacks; permafrost degradation; turbic cryosol; yedoma
References: Ping et al., 2015; Strauss et al., 2013; Tarnocai et al., 2009

permafrost carbon-climate feedbacks

[fr] rétroactions entre le carbone du pergélisol et le climat

Definition: The feedback loops between a warming global climate and permafrost-affected carbon stores.

Comment: Vast quantities of carbon are stored in various forms within permafrost zones. Permafrost thaw can make soil organic carbon that was previously perennially frozen available for decomposition. Thaw-related changes in vegetation and hydrological conditions can initially create conditions favourable for the mineralization of near-surface organic carbon constituting a positive feedback to warming, or may result in plant growth and accelerated accumulation of organic matter, potentially constituting a negative feedback to warming. Increasing ground temperatures can also cause changes in the storage of gas hydrates at depth.

Equivalent: permafrost carbon feedbacks

Related terms: near-surface permafrost; organic cryosol; peatland; permafrost carbon; permafrost degradation; turbic cryosol; yedoma

References: Chaudhary et al., 2020; Heffernan et al., 2020; Koven et al., 2015; Manasypov et al., 2022; Schuur et al., 2015

permafrost degradation

[fr] dégradation du pergélisol

Definition: A decrease in the thickness and/or area underlain by permafrost, or a decrease in ice bonding caused by an increase in unfrozen water content.

Comment: Permafrost degradation may be caused by climatic warming or by changes in terrain conditions, such as disturbance or removal of an insulating vegetation layer by fire, flooding, or human activity. It may manifest as one or more of: (1) thickening of the active layer, (2) lowering of the permafrost table, (3) ground warming leading to increasing unfrozen water content accompanied by loss of bearing capacity, (4) raising of the permafrost base, (5) disappearance of permafrost at a location where it previously existed, and (6) the development of thermokarst. The phrase *abrupt thaw* has been used by some authors to refer to relatively rapid permafrost degradation that leads to a change in environmental state.

Equivalent: permafrost thaw

Related terms: abrupt thaw; alas; disequilibrium permafrost; permafrost; permafrost carbon; permafrost carbon-climate feedbacks; talik; thaw bulb; thermal erosion; thermokarst

References: Hjort et al., 2021; O’Neill et al., 2023; Vasiliev et al., 2020; Zoltai, 1971

permafrost extent

[fr] étendue du pergélisol

Definition: 1. The area of the permafrost region. 2. The proportion of a specified area that is underlain by permafrost.

Comment: 1. Permafrost extent and permafrost area are sometimes used synonymously, but this is incorrect. The former is the total area (in km^2) of the permafrost region. The latter is the more limited area actually underlain by permafrost, taking into account that permafrost is not ubiquitous where it is discontinuous. 2. The extent of permafrost (i.e., percentage of the terrain) is used by some authors, including on the International Permafrost Association map (see Figure 5) and the Canada Permafrost map, to classify the permafrost region into zones.
Equivalents: permafrost area; permafrost distribution
Related terms: elevational zonation of permafrost; latitudinal zonation of permafrost; permafrost; permafrost limit
References: Brown et al., 1997; Gruber, 2012; Obu et al., 2019; Vandenberghe et al., 2014; Zhang et al., 2000

permafrost limit

[fr] limite du pergélisol

Definition: The inferred or modelled outermost (latitudinal) or lowest (elevational) limit of permafrost occurrence.
Comment: The permafrost limit is coincident with the outer boundary of the isolated patches permafrost zone (see Figure 5), either latitudinally or in relation to elevation. The coarse scale at which this term is applied means that extra-zonal permafrost can occur at sites outside the permafrost limit.
Non-preferred: permafrost boundary
Related terms: extra-zonal permafrost; mountain permafrost; permafrost; permafrost extent; permafrost region
References: Brown et al., 1997; Gruber, 2012; Péwé, 1983; Smith and Riseborough, 2002

permafrost region

[fr] région du pergélisol

Definition: A geographic region in which permafrost is present beneath some or all of the Earth's surface.
Comment: The permafrost region is commonly subdivided into permafrost zones (see Figure 5).
Narrower term: permafrost zone
Related terms: continuous permafrost; continuous permafrost zone; cryosphere; discontinuous permafrost; discontinuous permafrost zone; isolated patches permafrost zone; permafrost; permafrost limit; sporadic permafrost zone
References: Brown et al., 1997; Obu et al., 2019; Zhang et al., 2000

permafrost table

[fr] sommet du pergélisol

Definition: The upper boundary surface of permafrost (see Figure 1).

Comment: The depth of the permafrost table varies with climate, typically being shallowest in cold areas with continuous permafrost and deeper at warmer discontinuous permafrost sites. It also depends on local factors such as topography, aspect, insulation by vegetation and snow, drainage, grain size and the thermal properties of soil and rock.
Related terms: ground thermal regime; permafrost; permafrost thickness
References: Ballantyne, 2018; Brown, 1970a; Muller, 1943; Stearns, 1966

permafrost thickness

[fr] épaisseur du pergélisol

Definition: The difference between the depth of the permafrost table and the depth of the permafrost base (see Figure 1).
Comment: Permafrost thickness can range from less than 1 m to more than 1000 m.
Related terms: ground thermal regime; permafrost; permafrost base; permafrost table
References: Brown, 1970a; French, 2017; Smith and Burgess, 2002; Wu et al., 2010

permafrost zone

[fr] zone de pergélisol

Definition: A major subdivision of a permafrost region based on estimated permafrost extent (see Figure 5).
Comment: The permafrost region is commonly subdivided into permafrost zones based on the estimated percentage of the ground surface that is underlain by permafrost. The International Permafrost Association's circumarctic map recognizes four permafrost zones: continuous, discontinuous, sporadic and isolated patches.
Broader term: permafrost region
Narrower terms: continuous permafrost zone; discontinuous permafrost zone; isolated patches permafrost zone; sporadic permafrost zone
Related terms: elevational zonation of permafrost; extra-zonal permafrost; latitudinal zonation of permafrost; permafrost
References: Brown et al., 1997; Gruber, 2012; Heginbottom et al., 1995; Obu et al., 2019

pingo

[fr] pingo

Definition: A perennial frost mound with a core of massive ice formed by freezing of pressurized groundwater with resultant updoming of overlying earth materials and vegetation (see Figure 3).
Comment: Pingos occur in both continuous and discontinuous permafrost zones. The term is derived from an Inuvialuktun word used in the Mackenzie Delta, Canada. Pingos are typically dome-shaped or conical, with a circular or oval base. They may have a fissured and cratered top, resulting from rupturing of the surface materials caused by progressive growth of the ice core (see dilation crack). Pingos can grow to exceed 40 m in height and several hundred metres in

diameter. Pingos are commonly differentiated into closed-system (hydrostatic) and open-system (hydraulic) types.
Equivalent: bulgunniakh (Yakutia)
Non-preferred: hydrolaccolith
Broader term: frost mound
Narrower terms: closed-system pingo; open-system pingo
Related terms: collapsed pingo; dilation crack; ice-cored topography; relict pingo
References: Demidov et al., 2022; Grosse and Jones, 2011; Mackay, 1998; Porsild, 1938; Wolfe et al., 2023

planetary permafrost

[fr] pergélisol planétaire

Definition: Permafrost occurring on planetary bodies (planets, moons, asteroids) other than Earth.
Comment: Most of the moons and asteroids of the solar system are characterized by permafrost (temperature perennially below 0°C), but in the absence of any water, they are cryotic but unfrozen. In addition to meeting the temperature criteria, large volumes of ice exist beneath the surface of Mars which exhibits an extensive suite of planetary permafrost-related features. Water ice has been detected in shaded craters on the Moon, and alone, or in combination with gas hydrates, it is also believed to occur on the moons of Jupiter (Callisto, Ganymede and Europa) and Saturn (Titan).
Equivalent: extraterrestrial permafrost
Broader term: permafrost
References: Anderson et al., 1973a; Deutsch et al., 2020; Dundas et al., 2018; Yershov, 1990

plug-like flow

[fr] solifluxion en masse

Definition: A component of solifluction that involves almost the whole active layer moving downslope as a plug.
Comment: Plug-like flow occurs in areas of cold permafrost where two-sided freezing results in the formation of ice lenses near the base of the active layer. These lenses melt in mid- to late-summer, resulting in plastic deformation and/or sliding at depth. The overlying soil is carried downslope as a plug with little internal deformation (see Figure 11).
Broader term: solifluction
Related term: gelifluction
References: French, 2017; Mackay, 1981; Matsuoka, 2001

polygon

[fr] polygone

Definition: A closed, multi-sided, roughly equidimensional patterned-ground feature, bounded by more or less straight sides; some of the sides may be irregular.

Comment: Macro-scale polygons, typically 15 to 30 m across, result from thermal contraction cracking of the ground and form random or oriented polygonal patterns. They occur in both mineral terrain and peatland (see polygonal peat plateau). Ice-wedge polygons are common in poorly drained areas and may be either high-centred or low-centred. Sand-wedge polygons occur where wedges of primary mineral infill underlie the polygon boundaries. Some polygons may be formed by thermal contraction cracking in areas of deep seasonal frost. Micro-scale polygonal patterns, usually less than 2 m in diameter, are normally caused by desiccation cracking.
Broader term: patterned ground
Narrower terms: ice-wedge polygon; nonsorted polygon; sand-wedge polygon; sorted polygon
Related terms: high-centred polygon; low-centred polygon; polygonal peat plateau; polygon trough; thermal contraction crack
References: French, 2017; Rapp and Clark, 1971; Romanovskii, 1977; Washburn, 1979

polygonal peat plateau

[fr] plateau palsique à polygones

Definition: A peat plateau with ice-wedge polygons.
Comment: Polygonal peat plateaus commonly occur in the vicinity, and on both sides, of the boundary between the discontinuous and continuous permafrost zones.
Broader term: peat plateau
Related terms: ice-wedge polygon; peat; peatland; polygon; polygon trough
References: Olefeldt et al., 2021; Sannel and Kuhry, 2008; Zoltai and Tarnocai, 1975

polygon trough

[fr] sillon de polygone

Definition: A furrow or trench-like feature over a wedge or wedge cast that marks the perimeter of a polygon.
Comment: High-centred and low-centred polygons are distinguished by the relative elevations of the trough and the polygon centre. Raised ridges may bound polygon troughs due to the volume increase from growing wedges. Deep troughs may develop due to partial or complete melting of wedge ice.
Equivalents: ice-wedge polygon trough; ice-wedge trough
Related terms: high-centred polygon; ice-wedge polygon; low-centred polygon; polygon; polygonal peat plateau
References: Burn et al., 2021; Haltigin et al., 2012; Mackay, 2000, 1974b

poorly-bonded permafrost

[fr] pergélisol faiblement lié

Definition: Ice-bearing permafrost in which some particles are not held together by ice.
Comment: Some authors distinguish qualitatively between poorly-bonded permafrost, having a lower proportion of particles bonded by ice, and partially-bonded permafrost, having a higher proportion.

Equivalent: partially-bonded permafrost
Broader term: ice-bonded permafrost
Related terms: friable permafrost; ice-bearing permafrost; permafrost; well-bonded permafrost
Reference: Pihlainen and Johnston, 1963

pore cryostructure

[fr] cryostructure de glace interstitielle

Definition: A cryostructure in which pore ice cements the mineral soil particles without excess ice being present.
Comment: This cryostructure is typical of non-frost-susceptible materials where liquid water freezes and/or water vapour is deposited directly as ice. The pore ice may be visible to the unaided eye in sands or gravels but is usually not discernible when this cryostructure, less commonly, develops in fine-grained soils.
Equivalent: structureless cryostructure
Non-preferred: massive cryostructure
Broader term: cryostructure
Related terms: non-frost-susceptible soil; porphyritic cryostructure
References: Gilbert et al., 2016; Murton, 2022a

pore ice

[fr] glace interstitielle

Definition: Ice occurring in the pores of soils and rocks and formed by *in situ* freezing of pore water.
Comment: Pore ice does not include segregated ice.
Equivalent: interstitial ice
Broader term: ground ice
Related terms: ice; ice-poor permafrost
References: Brown and Kupsch, 1974; Johnston, 1981; Murton, 2022b

pore water

[fr] eau interstitielle

Definition: Water occurring in the pores of soils and rocks.
Comment: Pore water includes free water and interfacial (adsorbed) water. Free water is that portion of the pore water that is free to move between interconnected pores under the influence of gravity, as well as within fissures, solution channels and other openings in soils or rocks. The temperature at which free water changes phase, from which the freezing point depression is derived, depends mainly on its dissolved solids content. Interfacial water forms transition layers at mineral/water and mineral/water/ice interfaces. The intermolecular forces involved are such that this water does not move under the influence of gravity. The temperature at which any fraction of the interfacial water changes phase depends on the total energy of the various adsorption forces,

which in turn depends on distance from the mineral surface, type of mineral and solute content of the water. As a consequence, significant amounts of interfacial water can exist in fine-grained permafrost at temperatures well below 0°C, resulting in numerous frost heave phenomena.
Narrower term: interfacial water
Related term: freezing point depression
References: Anderson and Morgenstern, 1973; Chuvilin et al., 2022

pore water salinity

[fr] salinité de l'eau interstitielle

Definition: The concentration of dissolved salts in soil pore water.
Comment: Saline pore water in permafrost can affect creep rate, creep strength, unfrozen moisture content and freezing point changes. Predominant ions include chloride, calcium, magnesium, potassium and sulfate.
Related terms: creep strength; cryopeg; freezing point depression; saline permafrost; unfrozen water content
References: Hivon and Sego, 1993; Shah and Mir, 2022

porphyritic cryostructure

[fr] cryostructure de glace interstitielle visible

Definition: A cryostructure with visible ice inclusions within the soil.
Comment: Porphyritic cryostructure can develop where liquid water freezes or water vapour is deposited within large pores. Visible ice inclusions are commonly 1–10 mm in diameter. In mineral soils, porphyritic cryostructure can be distinguished from pore cryostructure by ice inclusions distinctly larger than the individual sand or silt particles between them. In organic soils, porphyritic cryostructure exhibits ice inclusions distinctly larger than the disseminated ice, but classification as organic-matrix cryostructure may be preferable because of the large differences in physical properties between mineral and organic soils.
Broader term: cryostructure
Related terms: organic-matrix cryostructure; pore cryostructure
References: Gilbert et al., 2018; Murton, 2022b

pressure-melting

[fr] fonte par pression

Definition: Lowering the melting point of ice by applying pressure.
Comment: Application of pressure increases the unfrozen water content by a small amount in frozen soils at a given temperature. Ice in soils is more easily melted by this process than bulk ice, because of stress concentrations at the soil intergranular contacts.
Reference: Anderson and Morgenstern, 1973

relict active layer

[fr] couche active relique

Definition: A layer of permafrost, located immediately below the modern active layer, that formed the basal part of a previously thicker active layer.
Comment: The base of the relict active layer is a thaw unconformity, which may be recognized by differences in cryostructures, ice contents and stable isotopes, and by the truncation of ice bodies. The relict active layer does not include previously thawed ground that may have been part of a former talik.
Non-preferred: paleo-active layer
Broader term: active layer
Related term: thaw unconformity
References: Burn et al., 1986; French, 2017; Lacelle et al., 2019

relict ice

[fr] glace relique

Definition: Ground ice that formed in a past environment and could not develop in its stratigraphic position under current environmental conditions.
Comment: Relict ice includes buried ice and ice wedges preserved in relict permafrost. It also includes ice wedges that have been truncated by a relict active layer.
Broader term: ground ice
Related terms: buried ice; ice; relict permafrost
References: Froese et al., 2008; Mackay, 1975; O'Neill et al., 2019

relict permafrost

[fr] pergélisol relique

Definition: Permafrost that persists at sites where it is in disequilibrium with the existing surface temperatures; it cannot form under current environmental conditions.
Comment: The presence of relict permafrost may reflect past climatic conditions that were colder, a historical period with decreased snow cover, or a change in surface conditions.
Non-preferred: fossil permafrost
Broader term: disequilibrium permafrost
Related terms: ecosystem-protected permafrost; relict ice; subsea permafrost
References: French, 2008; Mackay et al., 1972; Szewczyk and Nawrocki, 2011

relict pingo

[fr] pingo relique

Definition: The morphological expression of a pingo in a contemporary non-permafrost environment after all of its ice core has melted.

Comment: A relict pingo is evidence of former permafrost conditions. It can be difficult to distinguish between relict pingos and the remnants of other frost mounds.
Equivalent: pingo scar
Non-preferred: fossil pingo
Broader term: thermokarst
Related term: pingo
References: Ballantyne, 2018; Flemal, 1976; Mackay, 1988a

residual stress

[fr] contrainte résiduelle

Definition: The initial effective stress in soil thawed under undrained conditions.
Comment: Only deviations from the residual stress will result in volume changes from consolidation. If two soils with the same compressibility are exposed to the same additional loading post-thaw, the one with the lower residual stress will experience more consolidation settlement than the one with a higher residual stress.
References: Andersland and Ladanyi, 2004; Morgenstern and Nixon, 1971; Nixon and Morgenstern, 1973

residual thaw layer

[fr] couche dégelée résiduelle

Definition: A layer of thawed ground between the maximum depth of seasonal freezing and the permafrost table.
Comment: This layer, which constitutes a supra-permafrost talik, may result from lowering of the permafrost table due to deep thaw, or from incomplete refreezing of the active layer. The latter may occur during a mild winter after a very warm summer, or during a winter in which an unusually heavy snowfall occurs before extreme cold sets in (providing a thick insulating cover on the ground surface). A residual thaw layer may exist for one year or for several years, and it may persist or thicken during periods of climatic warming or changes in terrain conditions resulting from natural or human disturbance or activity. This layer does not exist where seasonally frozen ground extends to the permafrost table.
Equivalent: supra-permafrost talik
Broader term: talik
References: French, 1999, 2017; Linell and Kaplar, 1966

reticulate cryostructure

[fr] cryostructure réticulée

Definition: A cryostructure comprising a three-dimensional network of vertical ice veins and horizontal ice lenses that commonly form a rectangular or square lattice.

Comment: Reticulate cryostructure is typical of fine-grained sediments and forms as a result of hydraulic fractures combined with ice segregation or ice infilling shrinkage cracks. It is typically associated with volumetric ice contents <50%.
Broader term: cryostructure
Related terms: reticulate ice; segregated ice
References: French and Shur, 2010; Gilbert et al., 2016; Murton, 2022a

reticulate ice

[fr] glace réticulée

Definition: A network of horizontal and vertical ice veins forming a three-dimensional, often rectangular or square lattice.
Comment: Field observations suggest that reticulate ice veins grow in horizontal and vertical shrinkage cracks with much of the water coming from the adjacent material in a semi-closed freezing system, rather than from migration of water in an open system.
Broader term: ground ice
Related terms: ice; reticulate cryostructure
References: Fortier et al., 2008; Mackay, 1974c

retrogressive thaw slump

[fr] glissement rétrogressif dû au dégel

Definition: A slope failure in permafrost terrain that enlarges progressively due to ablation of exposed massive ice or ice-rich sediments.
Comment: A retrogressive thaw slump is a thermokarst landform comprising a steep (often near-vertical) headwall that retreats in a retrogressive fashion due to thawing, and a lower-gradient slump floor formed from the mixture of meltwater and thawed sediment that slides, falls or flows down the headwall face. Material in the slump floor may build up progressively or periodically evacuate by debris flow or sliding. Retrogressive thaw slumps stop enlarging each autumn when ablation of the exposed icy headwall ceases, but they can reactivate each thaw season for many years or decades, stabilizing only when the ice-rich sediment or massive ice is no longer exposed. Some particularly large retrogressive thaw slumps have developed in northwest North America and Siberia over the past few decades (see megaslump).
Equivalent: thaw slump
Non-preferred: ground ice slump; bimodal flow; thermocirque; retrogressive thaw flow slide
Broader term: thermokarst
Narrower term: megaslump
Related terms: mass movement; thaw slumping; thermokarst terrain
References: Burn and Lewkowicz, 1990; Lewkowicz and Way, 2019; Li et al., 2024; Mackay, 1966; Nesterova et al., 2024

river talik

[fr] talik fluvial

Definition: A talik beneath a river (see Figure 4).
Comment: The temperature of a river talik generally remains above 0°C due to the heat storage effect of the river water, although the talik margins can be cryotic if the pore water is subject to freezing point depression. Depending on the permafrost thickness and the width of the channel, a river talik may be either open or closed.
Broader term: talik
Related term: open talik
References: Liu et al., 2022; O'Neill et al., 2020; van Everdingen, 1976

rock glacier

[fr] glacier rocheux

Definition: A thick lobate or tongue-shaped mass of rock, finer-grained sediments and ice on a slope showing evidence of past or present slow downslope movement and deformation.
Comment: Rock glaciers are characterized by the movement of rocky debris that is facilitated by interstitial ice or an ice core. Some are formed, at least in part, by burial of glacier ice. Others originate from deposition by snow avalanches or rockfall and talus accumulation. Most rock glaciers have transverse ridges and furrows on their surface. Intact rock glaciers are commonly sub-divided into active and inactive types. Active rock glaciers move at velocities of centimetres to decametres per year and possess steep fronts with slope angles greater than the angle of repose. Rock glaciers are said to be inactive when the main body ceases to move. In contrast, relict rock glaciers no longer include an ice core, interstitial ice or permafrost.
Related terms: creep of frozen ground; frozen debris lobe; mass movement
References: Anderson et al., 2018; Berthling, 2011; Capps, 1910; Haeberli et al., 2006

saline permafrost

[fr] pergélisol salin

Definition: Permafrost in which part or all of the total water content is unfrozen because of freezing-point depression due to an elevated dissolved solids content.
Comment: Saline permafrost is found in a variety of surficial materials (especially marine deposits) and where cryopegs exist. At temperatures below the ice-nucleation temperature, a higher than normal unfrozen water content is present due to the increased dissolved solids content of the remaining pore water. Unfrozen water in saline permafrost can occupy the bulk pore space in addition to occurring as surface-bound water and thin water films in the vicinity of soil grains. A value of 5 parts per thousand of pore-fluid salinity has been used to differentiate between permafrost with low and high salinity (Hivon and Sego, 1993).
Broader term: permafrost
Related term: pore water salinity
References: Hivon and Sego, 1993; Wu et al., 2017

sand wedge

[fr] coin de sable

Definition: A downward-tapering wedge-shaped body of sand consisting of individual sand veins that have successively infilled a thermal contraction crack.
Comment: Sand wedges are wedges of primary filling since, at the time of their formation, they are filled with mineral soil, usually of aeolian origin. Upon thawing of the permafrost, there is little or no void space formed, and any subsequent downward movement of material into the wedge is negligible. A sand wedge is not a replacement feature (or ice-wedge pseudomorph) associated with the melting of an ice wedge. It is a type of ground wedge showing marked vertical fabric and laminations. Unlike an ice wedge, a sand wedge may extend upwards into the active layer because seasonal thawing does not affect its presence.
Non-preferred: tesselations
Broader term: ground wedge
Related terms: composite wedge; thermal contraction crack; sand wedge polygon
References: Berg and Black, 1966; Mackay and Matthews, 1983; Murton et al., 2000; Romanovskii, 1977; Wolfe et al., 2018

sand-wedge polygon

[fr] polygone à coins de sable

Definition: A polygon outlined by sand wedges underlying its boundaries.
Comment: Sand-wedge polygons may be formed by thermal contraction cracking in permafrost environments and in areas of deep seasonal frost.
Broader term: polygon
Related terms: sand wedge; thermal contraction crack
References: Berg and Black, 1966; Murton et al., 2000; Romanovskii, 1977; Wolfe et al., 2018

seasonal frost

[fr] gel saisonnier

Definition: The occurrence of ground temperatures below 0°C for only part of the year.
Comment: This term is sometimes used synonymously with seasonally frozen ground.
Related terms: freezing (of ground); frost; seasonally frozen ground
References: Andersland and Ladanyi, 2004; Johnston, 1981

seasonal frost mound

[fr] hydrolaccolithe saisonnier

Definition: A localized area of raised ground surface, produced by the formation of ground ice during winter freezing, that collapses during thaw the following summer.
Comment: The three types of seasonal frost mounds (frost blisters, icing blisters and icing mounds) are differentiated based on the location where the water freezes (on the surface or in the

ground), and whether or not hydraulic pressure causes uplift. In rare cases, frost blisters may not thaw entirely during the summer following their formation.
Non-preferred: ephemeral frost mound
Broader term: frost mound
Narrower terms: frost blister; icing blister; icing mound
References: Ballantyne, 2018; Pollard and French, 1984; Pollard and van Everdingen, 1992

seasonally-active permafrost

[fr] pergélisol à dégel saisonnier

Definition: Permafrost within the phase-based active layer (see Figure 1).
Comment: Seasonally-active permafrost occurs wherever substrate salinity or fines content allows thawing and refreezing annually, even though the ground remains cryotic ($T < 0°C$) throughout the year. It is the layer of permafrost between the base of the thermal active layer and that of the phase-based active layer.
Broader term: permafrost
Related terms: active layer; active layer thickness; seasonally thawed ground
References: Devoie et al., 2024; van Everdingen, 1985

seasonally frozen ground

[fr] sol à gel saisonnier

Definition: Ground that freezes and thaws annually.
Comment: An additional criterion used by some authors (Zhang et al., 2003) is that seasonally frozen ground must be frozen for more than 15 days per year but thaws annually. In Russian and Chinese literature, seasonally frozen ground is termed the active layer in areas without permafrost or with a deep permafrost table. Ground that freezes between one and 15 days per year has been referred to as *intermittently frozen ground*.
Related terms: freezing (of ground); frost; frozen ground; one-sided freezing; seasonal frost; seasonally frozen layer
References: Dubikov et al., 2003; French, 2017; Yershov, 1990; Zhang et al., 2003

seasonally frozen layer

[fr] couche de sol à gel saisonnier

Definition: A layer of ground that freezes and thaws annually and is underlain by unfrozen ground.
Comment: In Chinese and Russian literature, the seasonally frozen layer is synonymous with the active layer in areas without permafrost or where a supra-permafrost talik is present. Freezing progresses from the surface downward, whereas thawing progresses both downward from the surface and upward from the bottom of the seasonally frozen layer.
Related terms: active layer; freezing (of ground); one-sided freezing; seasonally frozen ground
References: Dubikov et al., 2003; Wang and Chen, 2024; Yershov, 1990

seasonally thawed ground

[fr] sol à dégel saisonnier

Definition: Ground that thaws and refreezes annually.

Comment: In areas with permafrost, seasonally thawed ground forms the phase-based active layer. The uppermost part of the permafrost can also constitute seasonally thawed ground at sites where annual thawing takes place at temperatures slightly below 0°C, due to high salinity or a high clay content (see seasonally-active permafrost).

Broader term: thawed ground

Related terms: active layer; seasonally-active permafrost

References: Frauenfeld et al., 2004; van Everdingen, 1985

segregated ice

[fr] glace de ségrégation

Definition: Ice formed by the migration of pore water due to cryosuction and its subsequent freezing.

Comment: Segregated ice forms lenses or layers that can range from hairline to metres in thickness. It is associated with lenticular, layered, reticulate and solid cryostructures. Some massive ice bodies may have formed due to a combination of cryosuction and hydraulic pressure.

Equivalent: segregation ice

Broader term: ground ice

Related terms: aggradational ice; epigenetic ice; frost-susceptible ground; frozen fringe; ice; ice segregation; ice lens; layered cryostructure; lens ice; lenticular cryostructure; lithalsa; massive ice; reticulate cryostructure; solid cryostructure

References: Calmels and Allard, 2008; Fu et al., 2022; Mackay, 1972a; Murton, 2022b; Taber, 1929

segregation potential

[fr] potentiel de ségrégation

Definition: The ratio of the rate of moisture migration to the temperature gradient in a frozen soil near the 0°C isotherm.

Comment: An engineering parameter that couples mass (water) flow and heat flow in a freezing soil. It can be used to predict amounts of frost heave.

Related term: frost heave

References: Konrad, 2005; Konrad and Morgenstern, 1981, 1984; Nixon, 1982

short-term strength

[fr] résistance à court terme

Definition: The failure strength of a material under short-term loading.

Comment: In the simplest case, the short-term loading would be a uniaxial compression test, e.g., of up to about 10 minutes. In design practice, short-term loading can be taken to represent various non-sustained loads, such as seismic loads, wind loads or even snow loads.
Reference: Andersland and Ladanyi, 2004

soil freezing characteristic curve

[fr] courbe de teneur en eau non gelée; courbe caractéristique de gel du sol

Definition: The relation between temperature below 0°C and unfrozen water content in earth materials (see Figure 6).
Comment: Soil freezing characteristics, represented by the curve, control the apparent heat capacity of a soil by determining how much phase change occurs over an incremental temperature change below 0°C, and influence the soil thermal conductivity at freezing temperatures.
Related terms: apparent heat capacity; freezing (of ground); thermal conductivity; unfrozen water content
References: Anderson et al., 1973b; Azmatch et al., 2012; Koopmans and Miller, 1966

solid cryostructure

[fr] cryostructure de glace massive

Definition: A cryostructure with bodies of ice that are more than 10 cm thick and that may be clear to dirty and stratified or unstratified.
Comment: Solid cryostructures can develop within sediment or bedrock and may comprise wedge, segregated, intrusive, thermokarst-cave, dilation crack or buried ice. This cryostructure is commonly described as massive ice.
Equivalent: massive ice
Broader term: cryostructure
Related terms: buried ice; dilation-crack ice; intrusive ice; segregated ice; thermokarst-cave ice; wedge ice
References: Gilbert et al., 2016; Murton, 2022a

solifluction

[fr] solifluxion

Definition: The slow downslope movement of earth materials due to cyclical freezing and thawing of the ground.
Comment: The term is commonly applied to processes operating on both seasonally frozen and permafrost slopes (see Figure 11). Depending on soil characteristics, frequency of freeze-thaw, and the location and thickness of the resultant ice lenses, the components of solifluction can include needle ice creep, diurnal frost creep, annual frost creep, gelifluction, and plug-like flow. Resultant landforms include solifluction aprons, lobes, terraces and sheets.
Broader term: mass movement

Narrower terms: frost creep; gelifluction; plug-like flow
Related terms: cryogenesis; nonsorted step; nonsorted stripe; solifluction apron; solifluction lobe; solifluction sheet; solifluction terrace; sorted step; sorted stripe; stone-banked solifluction lobe; stone-banked solifluction terrace; stone garland; turf-banked solifluction lobe; turf-banked solifluction terrace
References: Ballantyne, 2018; French, 2017; Harris et al., 2011; Matsuoka, 2001

solifluction apron

[fr] talus de solifluxion

Definition: A fan-like deposit at the base of a slope, produced by solifluction.
Related term: solifluction
References: Benedict, 1970; Washburn, 1979

solifluction lobe

[fr] lobe de solifluxion

Definition: An isolated, tongue-shaped solifluction feature, formed by more rapid downslope movement on certain sections of a slope.
Comment: Solifluction lobes typically have steep (15°- 60°) frontal risers and relatively smooth, more gently sloping, upper surfaces. Surface movement rates are typically one to a few centimetres per year. Solifluction lobes with fronts covered by a vegetation mat are called turf-banked lobes whereas those that are stony are called stone-banked lobes.
Narrower terms: stone-banked solifluction lobe; turf-banked solifluction lobe
Related term: solifluction
References: Ballantyne, 2018; Benedict, 1970; French, 2017; Matsuoka, 2001; Washburn, 1979

solifluction sheet

[fr] nappe de solifluxion

Definition: A broad solifluction feature that has moved uniformly downslope without riser development except at its downslope terminus.
Comment: Solifluction sheets are best developed in areas of sparse vegetation. The downslope edge is typically characterized by numerous small lobate forms. Sorted and/or nonsorted stripes are commonly associated with solifluction sheets.
Non-preferred: solifluction mantle
Related terms: nonsorted stripe; solifluction; sorted stripe
References: Ballantyne, 2018; French, 2017; Harrison et al., 2021; Washburn, 1979

solifluction terrace

[fr] replat de solifluxion

Definition: A broad, low step, or bench-like solifluction feature with a straight or lobate front extending approximately parallel to the contour of the slope.

Comment: A solifluction terrace may have bare mineral soil on its upslope part and folded-under organic matter in both the seasonally thawed ground and frozen ground. These features are commonly divided into turf-banked and stone-banked solifluction terraces. Terraces may occur in step-like sequences on a slope and may be tens to hundreds of metres in width.
Equivalents: solifluction bench; solifluction step
Non-preferred: soliflual garland terrace
Narrower terms: stone-banked solifluction terrace; turf-banked solifluction terrace
Related term: solifluction
References: Ballantyne, 2013, 2018; Benedict, 1970; Washburn, 1979

sorted circle

[fr] cercle trié

Definition: A sorted circle is a patterned ground form that is equidimensional in several directions, with a dominantly circular outline, and a sorted appearance commonly due to a border of stones surrounding a central area of finer material.
Comment: Sorted circles occur singly or in groups; their diameter is commonly between 0.5 and 3.0 m. Their central areas have a concentration of fines, with or without stones. The stones of the borders surrounding the central areas tend to increase in size with the size of the circles. Tabular stones tend to stand on edge, with their long axes in the vertical plane parallel to the border.
Broader term: patterned ground
Related term: frost sorting
References: Kääb et al., 2014; Kessler and Werner, 2003; Washburn, 1956; Williams and Smith, 1989

sorted net

[fr] réseau trié

Definition: A sorted net is a type of patterned ground with cells that are equidimensional in several directions, neither dominantly circular nor polygonal, with a sorted appearance commonly due to borders of stones surrounding central areas of finer material.
Comment: Sorted nets occur most frequently on nearly horizontal surfaces. Diameters of individual cells range from 0.5 to as much as 10 m. Central areas have a concentration of fines, with or without stones. The bordering stones tend to increase in size with the size of the net.
Broader term: patterned ground
Related term: frost sorting
References: French, 2017; Washburn, 1956, 1972, 1979; Williams and Smith, 1989

sorted polygon

[fr] polygone trié

Definition: A sorted polygon is a patterned ground form that is equidimensional in several directions, with a dominantly polygonal outline, and a sorted appearance commonly due to a border of stones surrounding a central area of finer material.

Comment: Sorted polygons commonly occur in extensive patterns, most frequently on nearly horizontal surfaces, and on slopes of less than 20°. They range in size from 10 cm to about 10 m. In places, small, sorted polygons occur in the central areas of larger polygons. Central areas have a concentration of fines, with or without stones. The bordering stones tend to increase in size with the size of the polygons, but to decrease with depth, regardless of the size of the polygons.
Broader term: polygon
Related term: frost sorting
References: Kessler and Werner, 2003; Romanovskii, 1977; Washburn, 1956, 1979; Williams and Smith, 1989

sorted step

[fr] gradin trié

Definition: A sorted step is a patterned ground feature with a step-like form and a downslope border of stones embanking an area of relatively fine-grained bare ground upslope.
Comment: Sorted steps are only found on slopes ranging from 5° to 15°; their downslope border forms a low riser fronting a tread whose slope is less than the general slope. Sorted steps are presumed to be derived either from sorted circles or from sorted polygons, rather than developing independently. Some sorted steps clearly form an intermediate stage between sorted polygons and sorted stripes.
Broader term: patterned ground
Related terms: frost sorting; solifluction; stone garland
References: Washburn, 1956, 1979; Williams and Smith, 1989

sorted stripe

[fr] sol strié trié

Definition: Sorted stripes form patterned ground with a striped and sorted appearance, due to parallel strips of stones and intervening strips of finer material, oriented down the steepest available slope.
Comment: Sorted stripes, both large and small, occur on slopes of more than 3°, downslope from sorted polygons or sorted nets; they are derived by downslope extension of sorted polygons or sorted nets. They can be several hundred metres long. The stones of the coarse stripes can range from pebbles to boulders, depending on the size of the stripes. The intervening finer material can be stone-free or contain stones and be a diamicton.
Broader term: patterned ground
Related terms: frost sorting; solifluction
References: Kessler and Werner, 2003; Washburn, 1973, 1979; Williams and Smith, 1989

space frame foundation

[fr] fondation à armature spatiale

Definition: A surface foundation system that uses a three-dimensional network of prefabricated trusses to support the building or structure on a rigid platform, which sits on top of a prepared granular foundation pad.
Comment: The premise is that if the ground under the foundation moves differentially, the truss system will move as a plane so that building elements are not distorted.
References: CSA Group, 2021a; Vangool, 2015

specific heat capacity

[fr] chaleur spécifique; capacité thermique massique

Definition: A measure of the ability of a material to store heat, defined as the amount of heat energy required to raise the temperature of a unit mass of that material by one degree.
Comment: The specific heat capacity of soil is calculated based on the proportions and specific heat capacities of its constituent parts. It partially controls the active layer thickness. Specific heat capacity is commonly expressed in Joules per kg per degree K.
Equivalents: specific heat; mass heat capacity; specific thermal capacity
Broader term: heat capacity
Related term: apparent heat capacity
References: Anderson et al., 1973b; Farouki, 1981; Williams and Smith, 1989

sporadic permafrost zone

[fr] zone de pergélisol sporadique

Definition: A major division of a permafrost region in which permafrost underlies 10–50% of the exposed land surface whereas the remainder is permafrost-free (see Figure 5).
Comment: The sporadic permafrost zone lies between the zone of discontinuous permafrost and the isolated patches permafrost zone. Transitions between these zones are conceptual and cannot be sharply delineated at a fine scale. In the sporadic permafrost zone, individual areas of permafrost are typically surrounded by seasonally frozen ground or water.
Equivalent: sporadic discontinuous permafrost zone (Canada)
Non-preferred: insular permafrost; island permafrost; scattered permafrost.
Broader term: permafrost zone
Related term: permafrost region
References: Brown et al., 1997; Heginbottom, 2002

static cryosol

[fr] cryosol statique

Definition: A mineral soil showing little or no evidence of cryoturbation, with permafrost within 1 m of the surface and a mean annual ground temperature below 0°C.

Comment: Static cryosols occur most commonly in coarse-textured materials, and patterned ground features may or may not be present. Subgroups within the Static Cryosol Great Group are differentiated on the basis of the type and sequence of horizons.
Broader term: cryosol
References: Soil Classification Working Group, 1998; Tarnocai and Bockheim, 2011

stone-banked solifluction lobe

[fr] lobe de solifluxion à front pierreux

Definition: A solifluction lobe with a stony front.
Comment: These solifluction features usually occur on higher-elevation slopes where coarse colluvial debris is present.
Non-preferred: mud-debris tongue
Broader term: solifluction lobe
Related terms: solifluction; turf-banked solifluction lobe
References: Benedict, 1970; Washburn, 1979

stone-banked solifluction terrace

[fr] replat de solifluxion à front pierreux

Definition: A solifluction terrace with a stony front.
Comment: These solifluction features usually occur on higher-elevation slopes where coarse colluvial debris is present.
Broader term: solifluction terrace
Related terms: solifluction; turf-banked solifluction terrace
References: Benedict, 1970; Washburn, 1979

stone garland

[fr] guirlande de pierre

Definition: The downslope border of stones along a sorted step, embanking an area of relatively fine-grained bare ground upslope.
Related terms: patterned ground; solifluction; sorted step
References: Washburn, 1956, 1979

string fen

[fr] tourbière réticulée

Definition: A peatland with roughly parallel narrow ridges of peat interspersed with slight depressions, many of which contain shallow pools.
Comment: String fens are best developed in discontinuous permafrost and immediately to the south of the permafrost region. The ridges are typically perennially frozen in the discontinuous

permafrost zone but are typically perennially unfrozen in the sporadic permafrost and isolated patches permafrost zones.
Equivalents: ribbed fen; string bog
Broader term: patterned ground
Related term: peatland
References: Treat et al., 2016; Zoltai, 1971; Zoltai and Tarnocai, 1975

subglacial permafrost

[fr] pergélisol sous-glaciaire

Definition: Permafrost beneath a glacier or an ice sheet.
Comment: Subglacial permafrost is present beneath glacial ice that is frozen to its bed and potentially beneath ice that remains at a sub-zero pressure melting point year-round. Subglacial permafrost is extensive beneath the Antarctic ice sheet.
Broader term: permafrost
References: Alexander et al., 2020; Waller et al., 2012

subglacial talik

[fr] talik sous-glaciaire

Definition: A talik beneath a glacier or ice sheet.
Comment: Subglacial taliks occur where glaciers are polythermal and may be associated with aufeis and open-system pingos.
Broader term: talik
References: Melvold et al., 2003; Moorman, 2003

subpermafrost groundwater

[fr] eau infrapergélisol

Definition: Water occurring in noncryotic ground below permafrost.
Comment: Subpermafrost groundwater does not include basal cryopegs, i.e., solute-rich water in unfrozen zones that may occur in the basal portion of the permafrost, although the two may be hydrologically connected.
Related term: intrapermafrost groundwater
References: Tolstikhin and Tolstikhin, 1976; Williams, 1970

subsea permafrost

[fr] pergélisol sous-marin

Definition: Permafrost occurring beneath the seabed.
Comment: Subsea permafrost can develop in response to negative sea-bottom temperatures, or it formed in coastal areas that were previously exposed to cold atmospheric conditions but are now

submerged (see relict permafrost). Subsea permafrost is known to be extensive in the Beaufort, Laptev and East Siberian Seas.
Equivalent: offshore permafrost
Non-preferred: sea-bed permafrost; submarine permafrost; sub-seabed permafrost
Broader term: permafrost
Related terms: onshore permafrost; relict permafrost
References: Hunter et al., 1976; Rachold et al., 2007; Shakhova et al., 2017

supercooling
[fr] surfusion

Definition: Cooling of a liquid to a temperature below its equilibrium freezing point, without causing solidification (see Figure 6).
Comment: Supercooling of water is mostly identifiable in laboratory measurements. It occurs before the onset of crystallization and is influenced by the volume, saturation, pore-size distribution, solute content, and mineral composition of the soil.
Related terms: freezing point; ice nucleation temperature
References: Kozlowski, 2009; Williams and Smith, 1989

suprapermafrost groundwater
[fr] eau suprapergélisol

Definition: Water occurring in noncryotic ground above permafrost.
Comment: Suprapermafrost groundwater occurs in the active layer, and in suprapermafrost taliks, including below rivers and lakes. It is replenished by infiltration of rain, snowmelt or surface waters, or by intrapermafrost or subpermafrost water via open taliks. Much of the suprapermafrost water in the active layer may freeze in the winter; some can temporarily become confined and be subject to increasing pressure during progressive freezing (see cryogenic aquiclude). Suprapermafrost groundwater can be extruded to the ground surface during the cold season to form aufeis.
Related terms: aufeis; cryogenic aquiclude; intrapermafrost groundwater; subpermafrost groundwater; water track
References: Tolstikhin and Tolstikhin, 1976; Williams, 1970

surface freezing index
[fr] indice de gel de surface

Definition: The cumulative number of degree-days below 0°C for the surface temperature (of the ground, pavement, etc.) during a given time period.
Comment: The surface freezing index differs from the air freezing index at the same location, mainly due to the influence of snow cover (see n-factor and nival offset). The index is usually calculated for a full freezing season or a calendar year.
Broader term: freezing index

Related terms: air freezing index; design freezing index; n-factor; nival offset; Temperature at the Top of Permafrost (TTOP) model
Reference: Johnston, 1981

surface offset

[fr] décalage thermique de surface

Definition: The numerical difference between the mean annual ground surface temperature and the mean annual air temperature (Figure 15).
Comment: The mean annual ground surface temperature is usually warmer than the mean annual air temperature, resulting in a positive surface offset. This is because the magnitude of the warming of the surface (relative to the air) by the insulating snow cover in winter exceeds the magnitude of the cooling of the surface in summer by vegetation shading.
Related terms: mean annual ground surface temperature (MAGST); n-factor; nival offset; Temperature at the Top of Permafrost (TTOP) model
References: Hasler et al., 2015; Smith and Riseborough, 2002

surface thawing index

[fr] indice de dégel de surface

Definition: The cumulative number of degree-days above 0°C for the surface temperature (of the ground, pavement, etc.) during a given time period.
Comment: The surface thawing index differs from the air thawing index at the same location, mainly due to surface albedo and shading (see n-factor). The index is usually calculated for a full thawing season or a calendar year.
Broader term: thawing index
Related terms: air thawing index; design thawing index; n-factor; Temperature at the Top of Permafrost (TTOP) model
Reference: Johnston, 1981

suspended cryostructure

[fr] cryostructure suspendue

Definition: A cryostructure in which grains, aggregates and rock clasts appear suspended in ice.
Comment: A suspended cryostructure is common within part of the transient layer, often some tens of centimetres below the permafrost table. The term *ataxitic cryostructure* has also been used to emphasize the irregular or chaotic nature of the ice morphology, as opposed to the nature of the suspended soil inclusions. Suspended sediment aggregates have been observed in segregated ice, intrusive ice, vein ice and buried ice.
Non-preferred: ataxitic cryostructure
Broader term: cryostructure
References: French and Shur, 2010; Murton, 2022a

syngenetic ice

[fr] glace syngénétique

Definition: Ground ice developed during the formation of syngenetic permafrost.
Broader term: ground ice
Related terms: ice; syngenetic ice wedge; syngenetic permafrost

syngenetic ice wedge

[fr] coin de glace syngénétique

Definition: An ice wedge developed during the formation of syngenetic permafrost.
Comment: Syngenetic ice wedges grow in width and height more or less simultaneously with the deposition of sediment or other earth material on the ground surface (see Figure 2). Hence the ice on the outside edges decreases in age from bottom to top. Syngenetic ice wedges are generally wedge-shaped but with more irregular sides than epigenetic ice wedges.
Broader term: ice wedge
Related terms: anti-syngenetic ice wedge; epigenetic ice wedge; syngenetic ice; syngenetic permafrost; wedge ice; yedoma
References: French, 2017; Harry and Gozdzik, 1988; Mackay, 1990; Morse and Burn, 2013

syngenetic permafrost

[fr] pergélisol syngénétique

Definition: Permafrost formed by a rise in the permafrost table due to the deposition of sediment or other earth materials onto the ground surface.
Comment: At a geologic time-scale, syngenetic permafrost is considered to be contemporaneous with the deposition of the materials in which it forms.
Broader term: permafrost
Related terms: syngenetic ice; syngenetic ice wedge; yedoma
References: Dubikov et al., 2003; French, 2017; Kanevskiy et al., 2011; Shur et al., 2004

talik 📷

[fr] talik

Definition: A layer or body of perennially unfrozen ground occurring in association with permafrost due to local thermal, hydrological, hydrogeological, or hydrochemical conditions (see Figure 4).
Comment: Taliks may have temperatures above 0°C (noncryotic) or below 0°C (cryotic, forming part of the permafrost). They can be described based on a number of characteristics: (1) relationship to permafrost (e.g., suprapermafrost talik, intrapermafrost talik, through talik); (2) hydraulic connectivity or geometry (e.g., lateral talik, closed talik, isolated talik, open talik); (3) processes leading to their formation (e.g., hydrothermal talik, hydrochemical talik); (4) associated landscape features (e.g., lake talik, river talik, subglacial talik); and (5) temporal dynamics (e.g., transient talik).

Broader term: unfrozen ground
Narrower terms: closed talik; cryopeg (North America); hydrochemical talik; hydrothermal talik; isolated talik; lake talik; lateral talik; open talik; river talik; subglacial talik; residual thaw layer; thaw bulb; transient talik
Related terms: alas; intrapermafrost groundwater; permafrost degradation
References: Dubikov et al., 2003; O'Neill et al., 2020; Yershov, 1990

Temperature at the Top of Permafrost (TTOP) model

[fr] modèle de température au sommet du pergélisol

Definition: An equilibrium ground temperature model for permafrost areas that relates the mean annual ground temperature at the top of permafrost (TTOP) to the mean annual air temperature using scaling factors related to the properties of the surface and subsurface.
Comment: The TTOP model requires limited inputs to arrive at a prediction of ground temperature. TTOP is equal to the mean annual air temperature plus the surface offset and the thermal offset (see Figure 15). N-factors can be used to calculate the surface offset. The thermal offset is obtained from the ratio of frozen to thawed ground thermal conductivity. The accuracy of these calculations may be affected by the model's basic assumption of thermal equilibrium (i.e., that climatic and ground conditions remain unchanged for an extended period) which can be violated by a progressively warming climate.
Related terms: air freezing index; air thawing index; freezing index; n-factor; nival offset; surface freezing index; surface offset; surface thawing index; thawing index; thermal offset
References: Obu et al., 2019; Smith and Riseborough, 2002

thaw bulb

[fr] bulbe de dégel

Definition: A talik surrounding or below a man-made structure maintained at temperatures above 0°C.
Comment: Construction and operation of structures usually lead to alterations of the ground thermal regime. Where permitted, the development of a thaw bulb under a structure (see Figure 10) is taken into account and controlled as part of the engineering design. It is frequently nearly symmetrical in form and limited in size under structures such as buildings. However, it may be asymmetrical if the heat load from the structure is not uniform. A thaw bulb may extend beneath the full length of a linear structure or facility built in a permafrost area, such as a road embankment or a buried warm pipeline. Settlement of the ground and the structure or facility may occur as the thaw bulb forms. A thaw bulb may also form when a structure or facility, around which a frost bulb has developed, is abandoned and the ground is no longer maintained at a temperature below 0°C.
Broader term: talik
Related term: permafrost degradation
References: Andersland and Ladanyi, 2004; Johnston, 1981; Lai et al., 2004

thaw consolidation

[fr] consolidation au dégel

Definition: Time-dependent compression resulting from thawing of frozen ground and subsequent expulsion of excess water.

Comment: The rate of settlement with time at a given pressure is controlled by the permeability and compressibility of the thawed ground. In the case of fine-grained soils, if the rate of thaw is sufficiently rapid, ice changes to water faster than it can flow from the soil, and pore pressures in excess of hydrostatic will be generated. The excess pore pressures may cause severe instability in slopes and foundation soils. The magnitude of excess pore pressures and the degree of consolidation in thawing soils depend principally on the thaw consolidation ratio.

Related terms: active-layer detachment failure; mud ejection; thaw consolidation ratio; thawed ground; thawing (of frozen ground); thaw settlement; thaw weakening

References: Andersland and Ladanyi, 2004; Johnston, 1981; Morgenstern and Nixon, 1971

thaw consolidation ratio

[fr] rapport de consolidation au dégel

Definition: A dimensionless ratio describing the relation between the rate of thaw and the rate of consolidation of a thawing soil.

Comment: This ratio is considered to be a measure of the relative rates of generation and expulsion of excess water during thaw.

Related terms: thaw consolidation; thaw settlement

References: Andersland and Ladanyi, 2004; Johnston, 1981; Morgenstern and Nixon, 1971

thaw depth

[fr] profondeur de dégel

Definition: The instantaneous minimum distance between the ground surface and frozen ground at any time during the thawing season in an area with permafrost or seasonally frozen ground.

Comment: The thaw depth at the end of the thawing season is used as an approximation of active layer thickness where permafrost is present. In an area with seasonally frozen ground, thawing is complete when no frozen ground remains, and the thaw depth cannot be determined.

Equivalents: depth of thaw; frost table depth

Related terms: active layer thickness; frost probe; frost table; thawed ground; thawing front; thawing (of frozen ground); thaw tube

References: Brown et al., 2000; Irrgang et al., 2024; O'Neill et al., 2023

thawed ground

[fr] sol dégelé

Definition: Previously frozen ground in which all ice has melted.

Comment: Thawed ground is typically noncryotic, but may be cryotic due to salinity, pressure, or fine grain-size.

Broader term: unfrozen ground
Narrower term: seasonally thawed ground
Related terms: active layer; thaw consolidation; thaw depth; thawing front; thawing (of frozen ground); thaw penetration; thaw weakening
Reference: van Everdingen, 1976

thawing front

[fr] front de dégel

Definition: The advancing boundary between thawed and frozen ground.
Comment: The thawing front may advance into either seasonally frozen ground or permafrost. In non-permafrost areas, two thawing fronts exist during the annual thawing period, one moving downward from the surface, the other moving upward from the base of the seasonally frozen ground. The thawing front usually coincides more closely with the position of the 0°C isotherm than does the freezing front, except in saline permafrost.
Equivalent: thaw front
Related terms: cryofront; frost probe; frost table; thaw depth; thawed ground; thawing (of frozen ground)

thawing index

[fr] indice de dégel

Definition: The cumulative number of degree-days above 0°C for a given time period.
Comment: A thawing index is usually calculated for the air or the ground surface, over a complete thawing season (beginning when temperatures rise above 0°C in the spring and ending when they fall below 0°C in the autumn, sometimes referred to as the *seasonal thawing index*), or for a full calendar year.
Narrower terms: air thawing index; design thawing index; surface thawing index
Related terms: degree-day; Temperature at the Top of Permafrost (TTOP) model
References: Frauenfeld et al., 2007; Johnston, 1981

thawing (of frozen ground)

[fr] dégel (du sol gelé)

Definition: The progressive melting of ice in frozen ground, usually as a result of a rise in temperature.
Comment: Thawing of frozen ground may occur at temperatures below 0°C where salinity, pressure, or fine-grained sediments reduce the melting point of ice. The use of *melting* in relation to frozen ground and permafrost is not recommended because the soil and rocks do not melt; only the ice does.
Non-preferred: melting (of frozen ground)

Related terms: abrupt thaw; freeze-thaw cycle; thaw consolidation; thaw depth; thawed ground; thawing front; thaw penetration; thaw penetration rate; thaw settlement; thaw strain; thaw weakening
Reference: Grosse et al., 2010

thaw penetration

[fr] pénétration du dégel

Definition: The downward movement of the thawing front into frozen ground.
Comment: When measured using a thaw tube, thaw penetration commonly refers to the distance between the thawing front and a fixed datum. Maximum annual thaw penetration differs from active layer thickness when the melt of excess ice and thaw consolidation result in subsidence of the ground surface.
Related terms: active layer thickness; thawed ground; thawing (of frozen ground); thaw penetration rate; thaw tube
Reference: O'Neill et al., 2023

thaw penetration rate

[fr] taux de pénétration du dégel

Definition: The rate of downward movement of the thawing front relative to a fixed datum during thawing of frozen ground.
Comment: The thaw penetration rate depends mainly on the heat flux and the ice content of the ground. Units are mm/day.
Related terms: thawing (of frozen ground); thaw penetration

thaw-sensitive permafrost 📷

[fr] pergélisol sensible au dégel

Definition: Permafrost that contains excess ice and which would experience significant thaw strain or loss of strength, or both, upon thawing.
Comment: Thaw-sensitivity relates mainly to moisture content rather than particle size or mineral composition. Ice-rich permafrost is thaw-sensitive.
Non-preferred: thaw-unstable permafrost
Broader term: permafrost
Related terms: excess ice; ice-rich permafrost; thaw settlement; thaw strain; thaw weakening
References: Kokelj et al., 2023; Linell and Kaplar, 1966; van Everdingen, 1976

thaw settlement 📷

[fr] tassement au dégel

Definition: The downward vertical movement of the ground surface due to the volume change from ice to water and the compression of the ground as a result of thaw consolidation.

Comment: In rock, and coarse-grained and dense soils, the amount of thaw settlement is usually small because it is governed mainly by the melting of joint or pore ice. In ice-rich permafrost and seasonally frozen ground containing excess ice, however, the amount of thaw settlement may be substantial. In general, on thawing, any frozen ground will settle both under its own weight and under applied stress. The settlement will continue as long as the thawing front advances and until the pore pressures generated during thawing are dissipated. The rate of thaw settlement will be based on the rate of thaw and the thaw consolidation properties of the material.
Related terms: excess ice; frost creep; thaw consolidation; thaw consolidation ratio; thawing (of frozen ground); thaw-sensitive permafrost; thaw strain; thermokarst; thermokarst lake
References: Andersland and Ladanyi, 2004; Johnston, 1981; Pullman et al., 2007

thaw slumping

[fr] effondrement au dégel

Definition: A slope failure mechanism characterized by the melting of ground ice and the collapse of thawed sediments.
Comment: Thaw slumping can only occur where permafrost is ice-rich. Slumping is followed either by the downslope sliding and flowing of the resulting debris, or at some lakeshores and coasts, in bank or cliff retreat as debris falls directly into the water. The resulting landform on slopes is commonly a retrogressive thaw slump, while near-vertical faces may develop on lakeshores or at coasts. Thaw slumping is a common mechanism for thermokarst lake expansion.
Broader term: thermokarst
Related terms: mass movement; retrogressive thaw slump; thermokarst lake
References: Burn and Lewkowicz, 1990; Mackay, 1966; McRoberts and Morgenstern, 1974b

thaw-stable material

[fr] sols (et matériaux) stables au dégel

Definition: Perennially or seasonally frozen soil or rock that does not typically experience either significant thaw strain or loss of strength upon thawing.
Comment: Thaw stability relates mainly to moisture content rather than particle size or mineral composition.
Reference: Linell and Kaplar, 1966

thaw strain

[fr] déformation au dégel

Definition: The proportion of the thickness of frozen ground that is lost to compression upon thawing.
Comment: Thaw strain is equal to thaw settlement divided by the original thickness of the frozen ground before thawing. It includes the immediate volume change from ice melting, the strain due to drainage of excess water, and compression associated with thaw consolidation.

Related terms: excess ice; thaw consolidation; thawing (of frozen ground); thaw-sensitive permafrost; thaw settlement
References: Andersland and Ladanyi, 2004; Johnston, 1981

thaw tube

[fr] tube de mesure du dégel

Definition: A clear liquid-filled tube installed vertically through the active layer that is used to measure the maximum annual thaw depth over permafrost.
Comment: The clear tube is housed within a larger opaque tube that is anchored in the underlying permafrost. A coloured marker bead placed in the inner tube during the summer settles to the interface between water and ice so that the maximum thaw depth can be determined during a site visit the following year. A scriber may be attached to the outer tube to measure seasonal frost heave. Some designs employ methylene blue as the liquid and can also be used to measure maximum frost penetration in seasonally frozen ground.
Equivalent: frost tube
Related terms: active layer thickness; thaw depth; thaw penetration
References: Irrgang et al., 2024; Mackay, 1973b; Nixon et al., 1995; O'Neill et al., 2023; Rickard and Brown, 1972

thaw unconformity

[fr] discordance de dégel

Definition: A boundary representing the present-day or paleo-environmental contact between thawed and frozen ground.
Comment: A primary thaw unconformity is a present-day thaw contact. A paleo-thaw unconformity represents a previous location of the permafrost table, such as the base of a relict active layer or the boundary of a former talik. A paleo-thaw unconformity may be recognized by differences in ice contents, cryostructures, stable isotope contents, and heavy mineral and pollen assemblages above and below the unconformity, and by the truncation of ice bodies.
Equivalent: thaw contact
Related terms: cryostructure; relict active layer
References: Burn et al., 1986; French, 2017; French and Shur, 2010; Murton, 2022a

thaw weakening

[fr] affaiblissement au dégel

Definition: The reduction in shear strength due to the decrease in effective stresses resulting from the generation and slow dissipation of excess pore pressures when frozen soils containing ice are thawing.
Comment: The usual effects of thaw weakening are a significant decrease in bearing capacity and an increase in stability problems (e.g., on road embankments, natural slopes, etc.).
Equivalent: thaw softening

Related terms: frost-susceptible ground; thaw consolidation; thawed ground; thawing (of frozen ground); thaw-sensitive permafrost
References: Andersland and Ladanyi, 2004; Johnston, 1981

thermal conductivity

[fr] conductivité thermique

Definition: A measure of the ability of a material to conduct heat, defined as the heat flux through a unit area in response to a unit temperature gradient.
Comment: The thermal conductivity of a soil depends on the conductivity of its individual components: solids, ice, water and air. The thermal conductivity of a soil is higher when it is frozen. This affects both the thermal offset and the distribution of permafrost. Thermal conductivity is commonly expressed in units of watts per metre per degree K.
Related terms: soil freezing characteristic curve; thermal diffusivity
References: Côté and Konrad, 2005; Farouki, 1981; Williams and Smith, 1989

thermal contraction coefficient

[fr] coefficient de contraction thermique

Definition: The strain (fractional change in size) of a substance due to a one degree Celsius change in temperature.
Comment: When not specified, the coefficient could be linear or volumetric. When a material is isotropic, the linear coefficient is 1/3 of the volumetric coefficient.
Equivalent: thermal expansion coefficient
Related term: thermal contraction crack
References: Andersland and Ladanyi, 2004; Lachenbruch, 1962; Williams and Smith, 1989

thermal contraction crack

[fr] fissure de contraction thermique

Definition: A tensile fracture resulting from thermal stresses in frozen ground
Comment: Tensile (fracture) stresses developed in winter during periods of ground cooling cause thermal contraction cracking when they exceed the tensile (fracture) strength of the frozen material. These thermal contraction cracks often form polygonal networks (*thermal contraction-crack polygons*). Ice wedges, sand wedges, soil wedges and ice veins form in thermal contraction cracks.
Equivalents: frost crack; frost fissure
Related terms: ground wedge; ice vein; ice wedge; ice-wedge polygon; polygon; sand wedge; sand wedge polygon; thermal contraction coefficient; vein ice; wedge ice
References: Kokelj et al., 2014; Lachenbruch, 1962; Mackay, 1993; Matsuoka et al., 2018; O'Neill and Christiansen, 2018

thermal diffusivity

[fr] diffusivité thermique

Definition: A measure of how readily a temperature change propagates through a material, defined as the ratio of the thermal conductivity to the volumetric heat capacity.
Comment: A larger thermal diffusivity increases the magnitude and decreases the delay of ground temperature changes at depth in response to changes in the ground surface temperature.
Related terms: thermal conductivity; heat capacity
Reference: Farouki, 1981

thermal erosion

[fr] érosion thermique

Definition: The erosion of ice-bearing permafrost by the combined thermal and mechanical action of moving water.
Comment: Thermal erosion is a dynamic process that involves the wearing away of frozen ground by both thermal means (i.e., the melting of ice by heat transfer) and mechanical means (i.e., fluvial transport or wave action). The formation of thermo-erosional niches and thermo-erosional gullies are examples of thermal erosion.
Equivalents: thermo-erosion; thermoerosion
Non-preferred: fluvial-thermal erosion
Broader term: thermokarst
Related terms: abrupt thaw; hydraulic thawing; permafrost degradation; thermo-erosional gully; thermo-erosional niche; thermokarst-cave ice; thermokarst lake
References: Dupeyrat et al., 2011; Fortier et al., 2007; Walker and Arnborg, 1966; Yershov, 1990

thermal offset

[fr] décalage thermique dans la couche active

Definition: The numerical difference between the mean annual temperature at the top of permafrost and the mean annual ground surface temperature.
Comment: The thermal offset is controlled by seasonal variation in soil thermal conductivity due to varying proportions of water, ice, and air in the soil. In moist, fine-grained soils, the mean annual surface temperature is typically higher than the mean annual temperature at the top of permafrost (see Figure 15). The opposite may be true for very dry soils.
Related terms: ground thermal regime; Temperature at the Top of Permafrost (TTOP) model
References: Burn, 2004; Burn and Smith, 1988; Smith and Riseborough, 2002

thermo-erosional gully

[fr] ravin de thermo-érosion

Definition: A steep-sided channel, often several metres deep, that is cut into ice-rich permafrost terrain by thermal erosion.

Comment: Thermo-erosional gullies are caused by heat transfer melting ground ice and by running water causing mechanical erosion. They are triggered and develop rapidly from runoff flowing over a network of ice wedges, for example, during lake drainage. Sinkholes develop in the wedge ice and evolve into underground tunnels that progressively widen until subsidence and collapse of the remaining overburden results in gullies.
Broader term: thermokarst
Related term: thermal erosion
References: Dubikov et al., 2003; Fortier et al., 2007; Godin and Fortier, 2012; Mackay, 1988b; Yershov, 1990

thermo-erosional niche

[fr] niche d'érosion thermique

Definition: A recess at the base of a coastal bluff, riverbank or lakeshore, produced by thermal erosion of ice-bonded permafrost.
Comment: A niche may extend more than 10 m into a coastal bluff, riverbank or lakeshore. Subsequently, the undercut sediments may collapse as block failures along lines of weakness, such as ice wedges, destroying the niche. Niche development and block failures are unique erosional mechanisms in permafrost regions. Very rapid bluff or bank retreat can occur if collapsed debris is removed by waves or water currents.
Broader term: thermokarst
Related terms: thermal erosion; thermokarst lake
References: Are, 1978; Hoque and Pollard, 2009; Kobayashi, 1985; Rowland et al., 2023; Walker and Arnborg, 1966

thermokarst

[fr] thermokarst

Definition: Processes and landforms that result from the thaw of ice-rich permafrost.
Comment: Thermokarst processes are initiated by disturbance of the ground thermal regime. This may be caused by diverse factors such as climate variation or change, destruction of the insulating vegetation cover by fire, animals or human activity, or alterations of surface drainage. Thermokarst processes may trigger feedbacks causing additional or accelerated ground ice melt, particularly where thaw settlement results in ponding or promotes sediment removal by gravity or water. Thermokarst processes, including thaw settlement, thaw slumping, and thermal erosion, result in the development of characteristic landforms that contribute to irregular surface topography (see thermokarst terrain). These landforms include alasses, ice-wedge melt ponds, retrogressive thaw slumps, thermo-erosional gullies and niches, thermokarst lakes and thermokarst mounds. In the Russian literature, thermokarst is generally used more restrictively to refer only to the process of thaw settlement (i.e., subsidence) and the resulting landforms.

Narrower terms: alas; beaded stream; collapsed pingo; collapse scar; relict pingo; retrogressive thaw slump; thaw slumping; thermal erosion; thermo-erosional gully; thermo-erosional niche; thermokarst lake; thermokarst mound
Related terms: abrupt thaw; ice-rich permafrost; ice-wedge melt pond; ice-wedge pseudomorph; permafrost degradation; thaw settlement; thermokarst terrain
References: Czudek and Demek, 1970; French, 2017; Kokelj et al., 2023; Kokelj and Jorgenson, 2013; Sumgin et al., 1940; Yershov, 1990

thermokarst-cave ice

[fr] glace de cavité

Definition: Ice formed by water freezing in cavities, conduits and tunnels that were previously excavated within the permafrost by thermal erosion.
Comment: This type of ice is frequently present in ice-rich permafrost that has been affected by thermal erosion.
Equivalent: pool ice
Broader term: ground ice
Related terms: ice; solid cryostructure; thermal erosion
References: Douglas et al., 2011; Kanevskiy et al., 2017; Murton, 2022b; Shur et al., 2004

thermokarst lake

[fr] lac de thermokarst

Definition: A body of water occupying a depression that formed, at least in part, by thermokarst processes, including ground settlement or expansion due to the thaw of ice-rich permafrost.
Comment: A thermokarst lake may expand by thermal erosion, thaw slumping or thaw subsidence of its banks. A body of water meeting the genetic definition, but with an area smaller than 1 ha or a mid-basin depth less than 2 m, is generally referred to as a thermokarst pond. A body of water that is not a thermokarst lake but which is modified by thermokarst processes (e.g., an oxbow lake impacted by a retrogressive thaw slump), can be described as thermokarst-affected.
Equivalents: thaw lake; thaw pond; thermokarst pond
Broader term: thermokarst
Narrower term: ice-wedge melt pond
Related terms: alas; thaw settlement; thaw slumping; thermal erosion; thermo-erosional niche; thermokarst terrain
References: Grosse et al., 2013; Hopkins, 1949; Roy-Léveillée and Burn, 2016

thermokarst mound

[fr] butte de thermokarst

Definition: A mound formed by the melting of wedge ice surrounding an ice-wedge polygon.
Comment: Thermokarst mounds occur in groups that exhibit a distinctive patterned ground network of regularly shaped mounds separated by troughs formed by the melting of ice wedges.

These features may result from subsidence, thermal erosion, or slope processes, and are best developed in areas where high-centred polygons are underlain by syngenetic permafrost. Troughs separating thermokarst mounds are commonly underlain by ice-wedge pseudomorphs.
Equivalent: baydzherakh (Yakutian language, the Sakha Republic, the Russian Federation)
Non-preferred: cemetery mound; graveyard mound
Broader term: thermokarst
Related terms: ice-wedge pseudomorph; thermokarst terrain
References: Ballantyne, 2018; Brown, 1967; Czudek and Demek, 1970; French, 2017; Péwé, 1954

thermokarst terrain

[fr] modelé thermokarstique

Definition: Irregular topography resulting from the thaw of ice-rich permafrost and associated thaw settlement, slumping, erosion or ponding.
Comment: Thermokarst features are the surface expression of thaw-driven processes and combine to form thermokarst terrain, which varies across the landscape. Features include depressions, pits, slumps, mounds, lakes and ponds. Thermokarst terrain can be active if excess ice is continuing to melt or inactive if this has ceased. Thermokarst terrain was so named because of its superficial resemblance to the karst topography typical of limestone regions.
Related terms: abrupt thaw; collapse scar; ice-rich permafrost; retrogressive thaw slump; thermokarst; thermokarst lake; thermokarst mound
References: Ballantyne, 2018; Czudek and Demek, 1970; French, 2017; Hopkins, 1949; Kokelj et al., 2023

thermopile

[fr] pieu à extraction de chaleur

Definition: A pile that incorporates thermosyphon technology to cool adjacent soil in winter and thereby increase its ability to carry axial or lateral structural loads.
Comment: This term was previously, or more generically, referred to as thermal pile but thermopile is now conventionally used for the prevalent passive variant of the technology. The condensers are typically integral to the pile and located within the air space between the ground and the building, but could be external to the pile. Condensate circulation occurs by gravity in thermopiles. Thermopiles directly support structural loads, so the design process requires consideration of these foundation loads. Thermopiles cause radial, outward cooling/freezing, so they do not mobilize significant frost-jacking stresses.
Equivalent: thermal pile
Related terms: condenser; evaporator; thermosyphon
References: CSA Group, 2021b; Heuer, 1979; Johnston, 1981

thermosyphon

[fr] thermosiphon

Definition: A passive heat transfer device installed to remove heat from the ground.
Comment: The most used variant of this technology consists of a two-phase system in a sealed tube, with a condenser above ground and an evaporator below ground, containing a pressurized working fluid (liquid and gas). When the air temperature falls below the ground temperature, the vapour condenses in the condenser section of the tube, the pressure in the tube is reduced and the liquid in the evaporator starts to boil. The resulting cycle of boiling, vapour moving up the tube, condensation, and return of the condensate by gravity flow extracts heat from the ground and transfers it to the air, thus cooling the ground. The system may be coupled with an active refrigeration (freezing) system to extract heat from the circulating fluid when air temperatures are warmer than ground temperatures, or to provide supplemental cooling. A coupled passive/active system is referred to as a hybrid thermosyphon. Single-phase variants of the concept also exist in which the working fluid may be a gas (typically air) or a liquid that transfers heat passively by convection.
Equivalents: heat pipe; thermosiphon
Related terms: condenser; evaporator; thermopile
References: Andersland and Ladanyi, 2004; Hayley et al., 1983; Heuer, 1979; Johnston, 1981; Long, 1966

thufa

[fr] thufa

Definition: A perennial cryogenic mound formed in seasonally frozen ground.
Comment: Thufur (an Icelandic term; singular is thufa) are found in maritime areas with seasonal frost and at warmer locations in areas of discontinuous permafrost. These hummocks may be up to 50 cm high and 160 cm in diameter and can reform within 20 years following destruction.
Broader term: hummock
References: Grab, 1994; Schunke and Zoltai, 1988; Scotter and Zoltai, 1982; Thorarinsson, 1951; Van Vliet-Lanoë et al., 1998

transient layer

[fr] couche transitoire

Definition: A layer of permafrost that thaws episodically on sub-decadal to centennial time scales due to interannual variation in the depth of seasonal thaw.
Comment: In years of shallow thaw, the transient layer remains frozen, comprising the uppermost horizons of permafrost. In years of deep thaw, most or all of the transient layer becomes part of the active layer. The transient layer is part of a *transition zone* which includes a lower, often ice-rich, *intermediate layer*.
Related terms: active layer; permafrost
References: Shur 1988; Shur et al., 2005

transient talik

[fr] talik transitoire

Definition: A talik that is gradually refreezing.

Comment: A closed talik under a lake that transitions to an isolated talik following lake drainage is an example of a transient talik (see Figure 4).

Broader term: talik

References: O'Neill et al., 2020; van Everdingen, 1976

trumpet curve

[fr] courbe en trompette

Definition: A line graph showing maximum, minimum, and often mean ground temperatures, against depth, measured or modelled over a period of at least one year (see Figure 1).

Comment: The convergence of the maximum and minimum lines with depth, representing the reduction of annual temperature variation down to the depth of zero annual amplitude, may resemble a cross-section of the bell of a trumpet.

Related terms: ground temperature profile; ground thermal regime; mean annual ground temperature (MAGT)

Reference: Changwei et al., 2015

tundra

[fr] toundra

Definition: A treeless region, with a continuous vegetation cover, found at high latitudes and high elevations.

Comment: Tundra vegetation comprises lichens, mosses, sedges, grasses, forbs and low shrubs. This vegetation cover occurs most widely as Arctic tundra in the zone north of the boreal forest, including the treeless parts of the forest-tundra ecotone adjacent to the treeline. At high elevations, alpine tundra occurs immediately above the forest zone or timberline. The term *tundra* is used to refer to both the region and the vegetation growing in the region.

Reference: Polunin, 1951

turbic cryosol

[fr] cryosol géliturbé

Definition: A mineral soil that has permafrost within 2 m of the surface, a mean annual ground temperature below 0°C, and marked evidence of cryoturbation within the active layer.

Comment: Turbic cryosols are generally associated with patterned ground. Cryoturbation is indicated by disrupted, mixed or broken horizons, and/or displaced material, or a combination of these. The subgroups within the Turbic Cryosol Great Group are differentiated on the basis of the type and sequence of horizons. Large amounts of organic carbon are stored in both the active layer and permafrost where these soils are present (see permafrost carbon).

Broader term: cryosol
Related terms: cryoturbation; patterned ground; permafrost carbon; permafrost carbon-climate feedbacks
References: Soil Classification Working Group, 1998; Tarnocai and Bockheim, 2011

turf-banked solifluction lobe

[fr] lobe de solifluxion à front végétalisé

Definition: A solifluction lobe with a front covered by a vegetation mat.
Comment: These solifluction features usually occur on mid-level and lower-elevation slopes where fine-grained colluvial sediment is present.
Broader term: solifluction lobe
Related terms: solifluction; stone-banked solifluction lobe
References: Ballantyne, 2018; Benedict, 1970; Washburn, 1979

turf-banked solifluction terrace

[fr] replat de solifluxion à front végétalisé

Definition: A solifluction terrace with a front covered by a vegetation mat.
Comment: These solifluction features usually occur on mid-level and lower-elevation slopes where fine-grained colluvial sediment is present.
Broader term: solifluction terrace
Related terms: solifluction; stone-banked solifluction terrace
References: Ballantyne, 2018; Benedict, 1970; Washburn, 1979

turf hummock

[fr] butte organique

Definition: A hummock consisting of vegetation and organic matter with or without a core of mineral soil or stones.
Broader term: hummock
References: Raup, 1966; Washburn, 1979

two-sided freezing

[fr] gel bidirectionel

Definition: Seasonal freezing of the ground that progresses from the base of the active layer upwards as well as from the ground surface downwards (Figure 16).
Comment: Two-sided freezing occurs in areas of cold (and generally continuous) permafrost where significant negative temperature gradients into the top of permafrost exist at the end of the thaw season. In frost-susceptible soils, it results in most ice lensing at the base of the active layer with lesser amounts in the near-surface.
Broader term: freezing (of ground)

Related terms: active layer; one-sided freezing; upward freezing
References: French, 2017; Lewkowicz, 1988; Mackay, 1981; Matsuoka, 2001

undisturbed permafrost sample

[fr] échantillon de pergélisol non remanié

Definition: A sample of frozen ground from the permafrost preserved in a near *in situ* condition.
Comment: Undisturbed samples of perennially frozen ground can be collected using a range of tools, including portable drilling systems. The emphasis is usually on maintaining geotechnical properties, including cryostructure, during sampling, transportation and storage. Depending on the extraction method used, undisturbed permafrost samples can be subject to other types of disturbance and are not necessarily uncontaminated from a chemical or microbial perspective. When access to undisturbed permafrost samples is not feasible, samples for testing may be reconstituted or remoulded with desired physical properties and subsequently frozen under controlled conditions.
Equivalents: undisturbed core sample; natural permafrost core sample; intact sample
Reference: Andersland and Ladanyi, 2004

unfrozen ground

[fr] sol non gelé

Definition: Soil or rock that does not contain any ice.
Comment: Unfrozen ground can be cryotic (T ≤ 0°C) if a freezing-point depression prevents freezing of the pore water, or if no water is available to freeze (e.g., in dry permafrost). It should not be called thawed ground, unless it is known that the ground previously contained ice.
Narrower terms: talik; thawed ground
Related term: noncryotic ground
Reference: van Everdingen, 1976

unfrozen water content

[fr] teneur en eau non gelée

Definition: The amount of water that remains unfrozen in earth materials below 0°C (Figure 17), expressed as a ratio of either (1) the weight of unfrozen water to the weight of dry soil, or (2) the volume of the unfrozen water to the total volume of the sample.
Comment: The main factors controlling the unfrozen water content of cryotic ground are temperature, water saturation of the pore space, specific surface area of mineral particles, pore size distribution, and solute content of the pore water. Cryotic soils exhibit direct relationships between unfrozen water content and temperature or solute content, and an inverse relationship between unfrozen water content and particle size.
Equivalent: unfrozen moisture content
Non-preferred: liquid water content

Related terms: cryosuction; gravimetric water content; ice content; pore water salinity; soil freezing characteristic curve; volumetric (total) water content

References: Anderson and Morgenstern, 1973; Watanabe and Mizoguchi, 2002; Williams and Smith, 1989

upward freezing

[fr] gel ascendant

Definition: The advance of a freezing front upwards from the permafrost table.

Comment: Upward freezing takes place due to heat flow from unfrozen ground downward into the underlying permafrost. Seasonal upward freezing of the active layer occurs over cold permafrost (see Figure 16). Perennial upward freezing can occur at the bottom of a closed talik as it refreezes following a change in surface conditions, such as lake drainage.

Broader term: freezing (of ground)

Related terms: closed talik; ground thermal regime; two-sided freezing

References: Mackay, 1980, 1983

vein cryostructure

[fr] cryostructure à veines de glace

Definition: A cryostructure with vertically oriented to inclined ice veins.

Comment: A vein cryostructure can develop by ice infilling a thermal-contraction crack, a dilation crack or a joint in bedrock, as well as by ice segregation associated with a steeply inclined freezing front.

Broader term: cryostructure

Related terms: dilation crack ice; vein ice

Reference: Murton, 2022a

vein ice

[fr] glace de fissure

Definition: A comprehensive term for ice occupying cracks in permafrost.

Comment: Vein ice occurs, for example, within thermal-contraction cracks and in reticulate ice veins.

Broader term: ground ice

Narrower term: infiltration ice

Related terms: dilation crack ice; ice; ice vein; ice wedge; thermal contraction crack; vein cryostructure; wedge ice

References: Fan et al., 2021; Mackay, 1972a, 1974c

volumetric ice content

[fr] teneur en glace volumique

Definition: The ratio of the volume of ice in a sample to the volume of the whole sample, expressed as a fraction, or as a percentage.

Comment: The volumetric ice content of an ice-rich sample includes both pore ice and excess ice. Because of the way it is defined, the measure cannot exceed unity (or 100%). The volumetric ice content of a frozen sample can be accurately estimated from high-resolution computer images (CT scans) of ice lenses, soil layers, and cryostructures, obtained using a tomodensitometric scanner.

Related terms: excess ice content; gravimetric water content; ice content; volumetric (total) water content

References: Calmels and Allard, 2004; Fan et al., 2021; O'Neill et al., 2025

volumetric (total) water content

[fr] teneur en eau volumique

Definition: The ratio of the volume of water and ice in a sample to the volume of the whole sample, expressed as a fraction, or as a percentage.

Comment: The volumetric (total) water content of an ice-rich sample includes water in all its phases. Because of the way it is defined, the measure cannot exceed unity (or 100%). The term can also be applied to an *in situ* mass of frozen ground.

Related terms: excess ice content; gravimetric water content; ice content; unfrozen water content; volumetric ice content

References: Anderson and Morgenstern, 1973; Kokelj and Burn, 2005; Linell and Kaplar, 1966; Murton, 2022b

water track

[fr] chenal d'écoulement de surface préférentiel

Definition: Shallow, parallel or sub-parallel, linear surface depressions delineating subsurface pathways of suprapermafrost groundwater movement on gentle slopes.

Comment: The principal hydrological role of water tracks is to carry runoff downslope as subsurface flow. They act as preferential pathways and are often associated with enhanced hydraulic conductivity compared to adjacent hillslope locations.

Related terms: suprapermafrost groundwater

References: Del Vecchio and Evans, 2025; Evans et al., 2020; Gooseff et al., 2013; McNamara et al., 1999

wedge ice

[fr] glace de fente en coin

Definition: Ice occurring in an ice wedge.

Comment: Wedge ice comprises a series of ice veins formed at the same location over multiple winters due to thermal contraction cracking of the ground. The ice is vertically to subvertically banded. It may contain air bubbles and may be discoloured by sediments. Individual bands of ice (foliations) are a few millimetres to about a centimetre in width.
Broader term: ground ice
Related terms: anti-syngenetic ice wedge; epigenetic ice; epigenetic ice wedge; ice; ice wedge; solid cryostructure; syngenetic ice wedge; thermal contraction crack; vein ice
References: Gell, 1978; Murton, 2022b; O'Neill et al., 2024; Opel et al., 2018; Romanovskii, 1977

well-bonded permafrost

[fr] pergélisol complètement lié

Definition: Ice-bearing permafrost in which all the particles are held together by ice.
Broader term: ice-bonded permafrost
Related terms: friable permafrost; ice-bearing permafrost; permafrost; poorly-bonded permafrost
Reference: Pihlainen and Johnston, 1963

yedoma

[fr] yedoma

Definition: Extremely ice-rich syngenetic permafrost that formed in unglaciated areas during the Late Pleistocene, containing large ice wedges that penetrate its entire thickness.
Comment: Yedoma is mainly composed of loess-like silt or silty sand, with organics, and can be up to 50 m thick. Volumetric ice contents may exceed 80% due to the presence of tall and wide syngenetic ice wedges, which formed during sedimentation. The moisture content of the soil between the ice wedges can also be high. Yedoma deposits are extensive in Siberia, Alaska and in some unglaciated parts of the Yukon. Their thaw creates yedoma landscapes, characterized by flat residual uplands with large syngenetic ice wedges, separated by thermokarst basins, some containing lakes.
Equivalents: Ice Complex (Russia); muck (Yukon, Canada).
Related terms: alas; permafrost carbon; permafrost carbon-climate feedbacks; syngenetic ice wedge; syngenetic permafrost
References: Kanevskiy et al., 2011; Schirrmeister et al., 2025; Strauss et al., 2021

zero curtain

[fr] période de latence thermique

Definition: The persistence of a nearly constant temperature, very close to the freezing point, during freezing or thawing of the ground, that results from latent heat effects (Figure 18).
Comment: The zero curtain results from the dissipation of the latent heat of fusion of water during freezing or thawing of the ground. It can persist for several hours to several weeks depending mainly on the total water content, thermal conductivity and thermal diffusivity of the ground, air temperatures and snow cover. The zero curtain is commonly observed during freezing

of the active layer and is an important consideration in the re-freezing of backfill and slurry materials.

Related terms: ground thermal regime; latent heat of fusion

References: Brewer, 1958; French, 2017; Outcalt et al., 1990

FIGURES

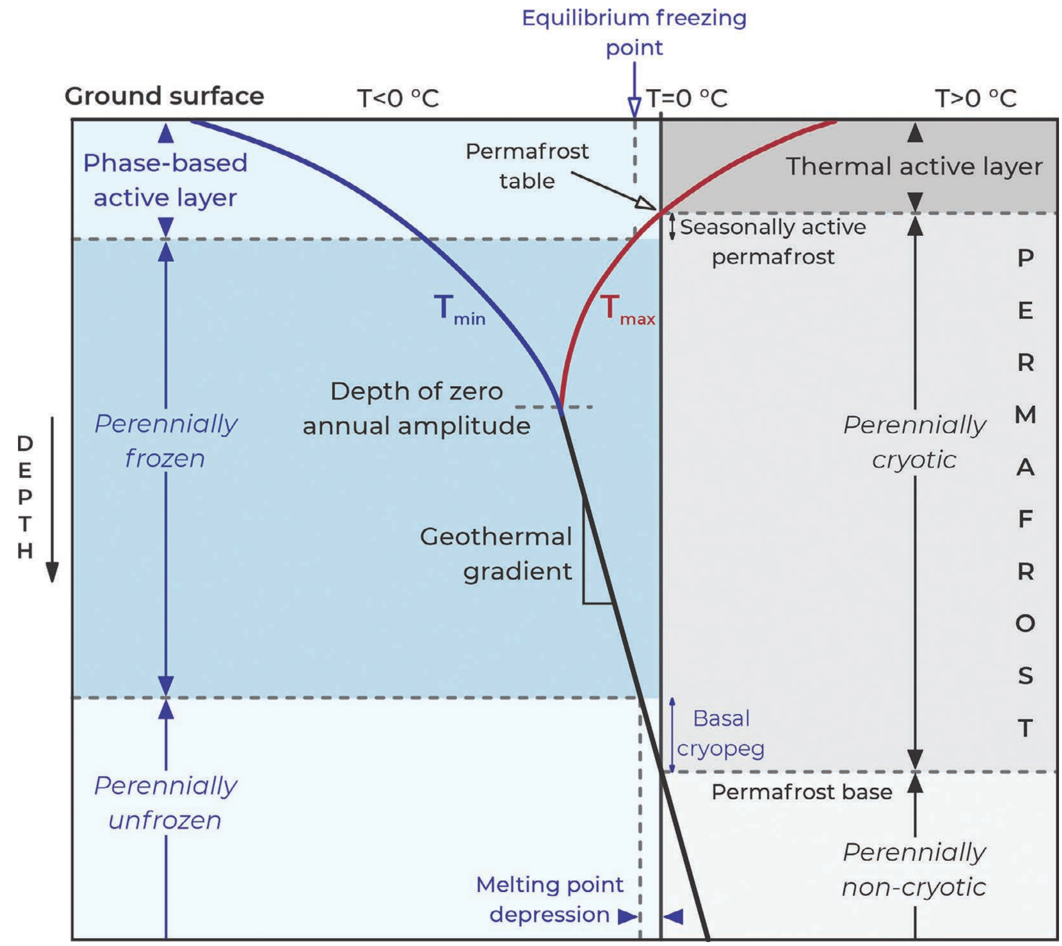

Figure 1. Key terms to describe the ground thermal regime and the state of water in permafrost environments.

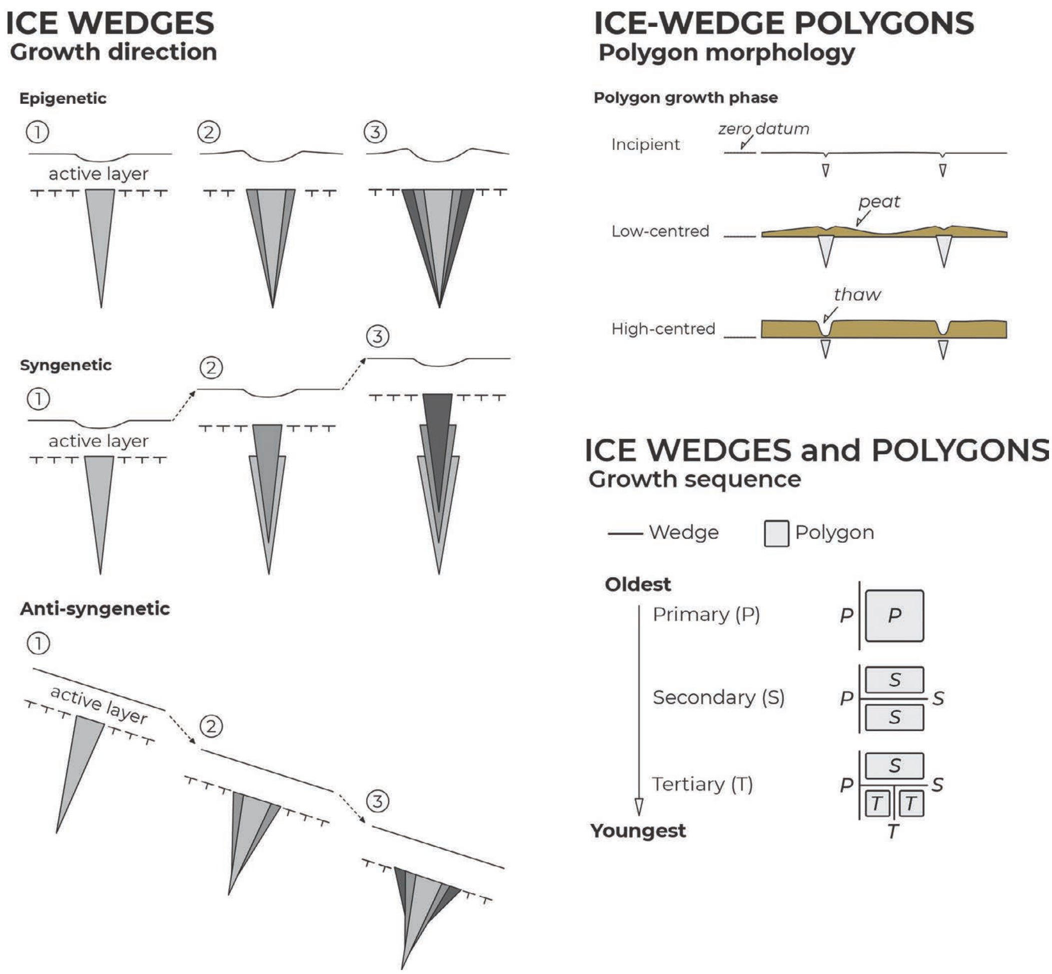

Figure 2. Growth direction of epigenetic, syngenetic and anti-syngenetic ice wedges during: 1—early, 2—intermediate and 3—late stages of development (left); common polygon morphologies in flattish areas with peat accumulation (upper right); growth sequence of ice wedges and ice-wedge polygons (lower right) (modified from Mackay, 2000; van Everdingen, 2005).

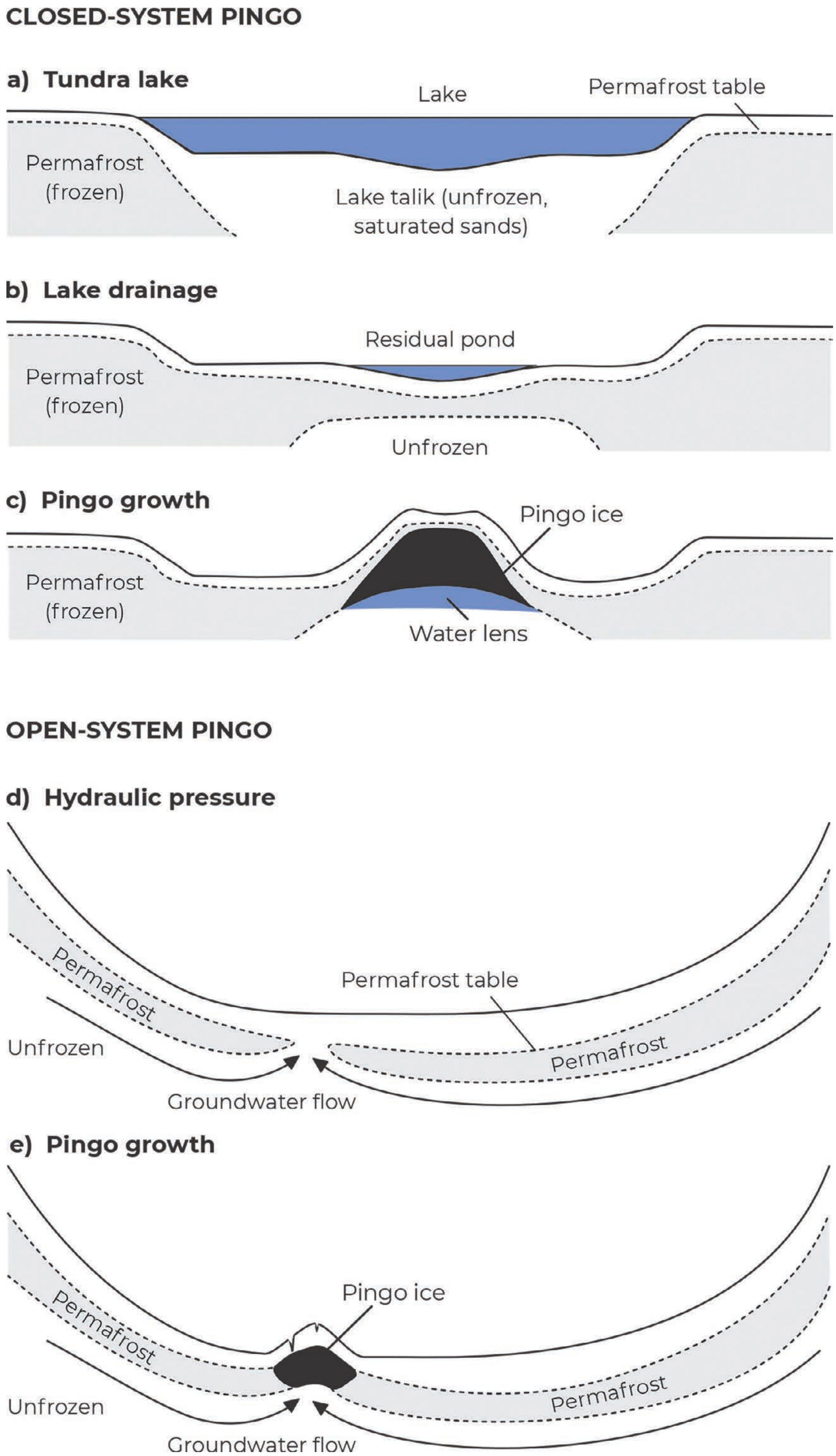

Figure 3. The formation of closed- and open-system pingos. Closed system pingos form when (a) a tundra lake overlying saturated sands drains and (b) permafrost aggrades into the lake talik. As freezeback progresses, the pingo grows as (c) water is expelled from the freezing sands. Open-system pingos form as hydraulic pressure (d) forces groundwater toward the ground surface and freezes (e).

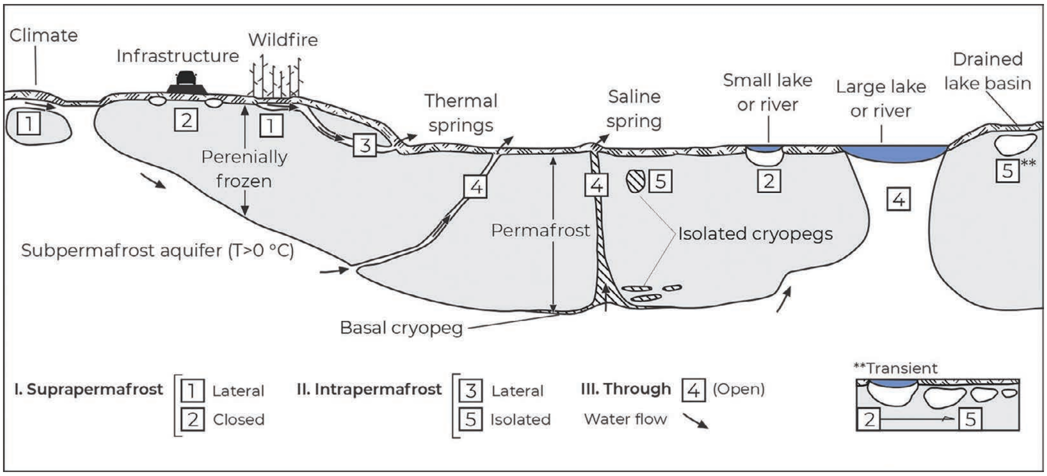

Figure 4. Diagram depicting talik configurations (suprapermafrost, intrapermafrost, through), their hydraulic connectivity (lateral, closed, open, isolated), and different mechanisms and features associated with talik development (modified from O'Neill et al., 2020 Figure 2).

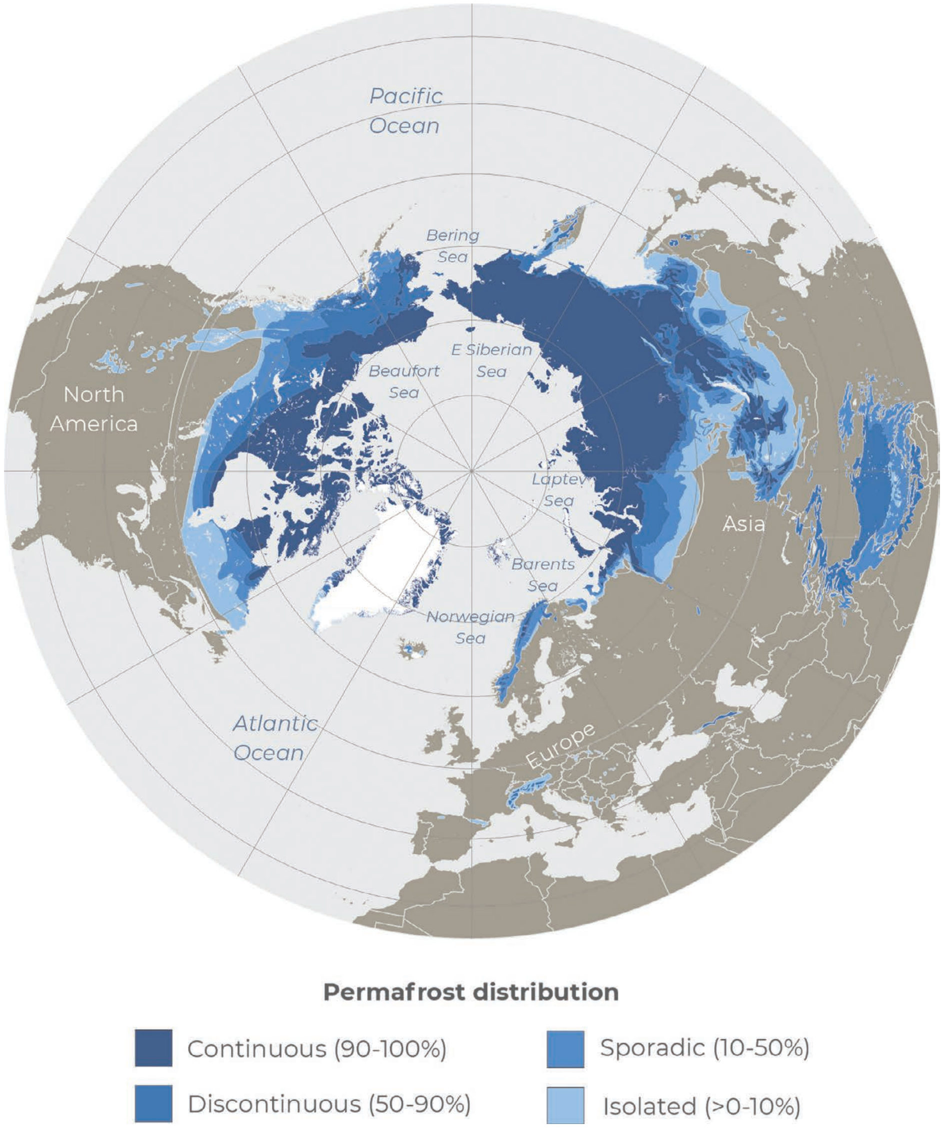

Figure 5. Map of permafrost zones in the Northern Hemisphere (Brown et al., 2002). Note: permafrost in the Southern Hemisphere and subsea permafrost are not depicted.

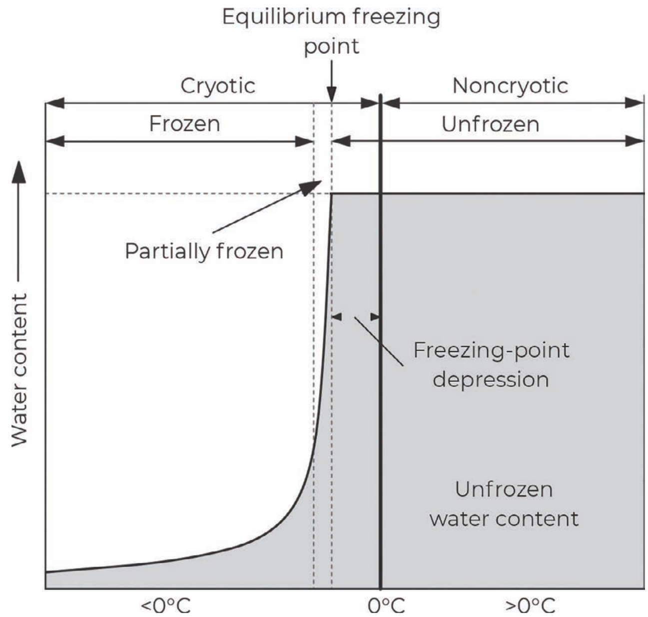

Figure 6. Terms used to describe the state of the water relative to ground temperature in soil materials subjected to freezing temperatures (modified from Harris et al., 1988).

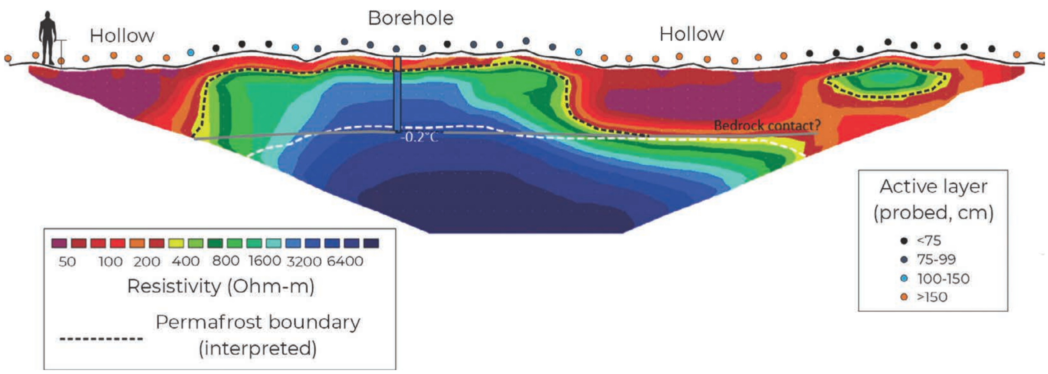

Figure 7. An electrical resistivity tomography (ERT) survey from a peatland burned by wildfire in 2023 near Yellowknife, Northwest Territories, Canada (unpublished data: Geological Survey of Canada and Northwest Territories Geological Survey).

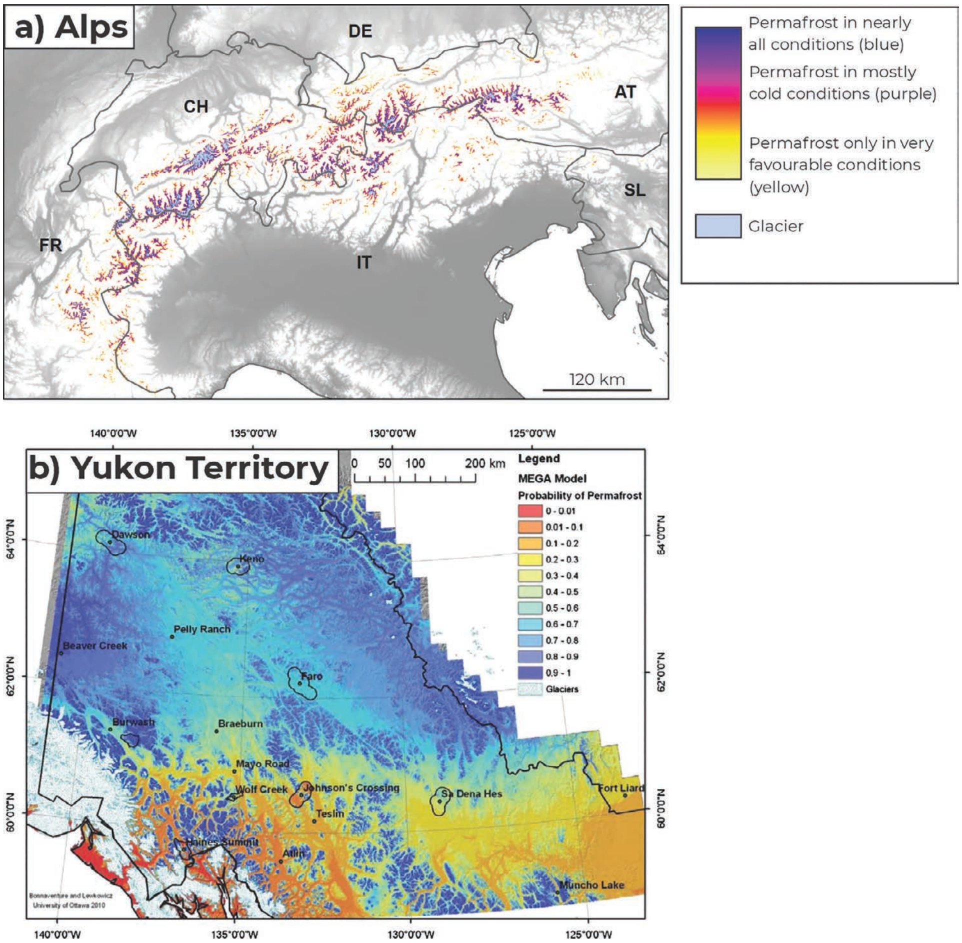

Figure 8. Elevational patterns of permafrost probability for (a) the European Alps (Boeckli et al., 2012), and (b) Yukon Territory (Bonnaventure et al., 2012).

Figure 9. a) Photograph of an ice-rich core from a lithalsa near Kangiqsualujjuaq, QC; b) a classified image of an ice-rich core cross section; and c) supernatant water overlying saturated sediment from a thawed sample of permafrost with excess ice. The volume of supernatant water is used to calculate excess ice content (photos: a) P. Roy-Léveillée, b) and c) Geological Survey of Canada).

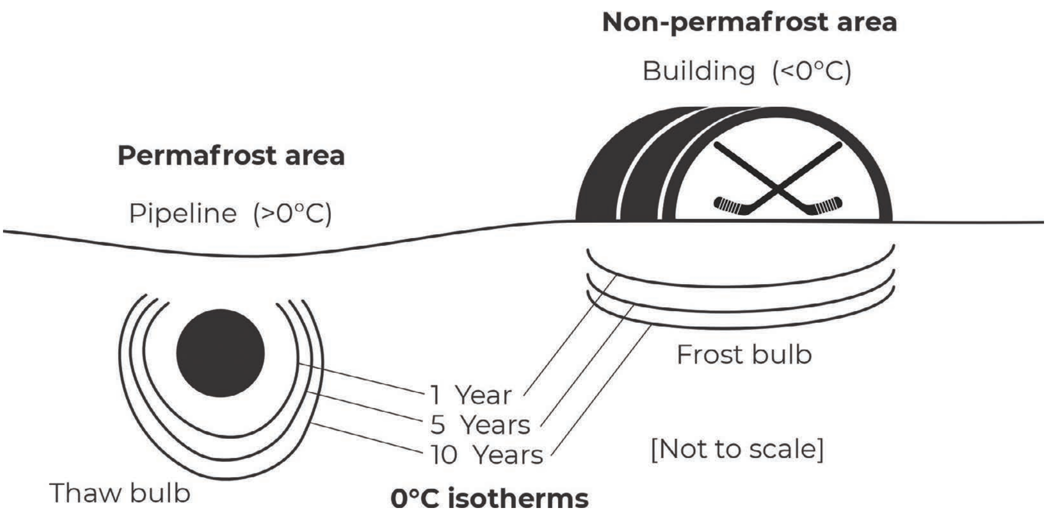

Figure 10. Example of the progression of a thaw bulb around a pipeline (left) and a frost bulb underneath a refrigerated arena (right) (modified from Harris et al., 1988).

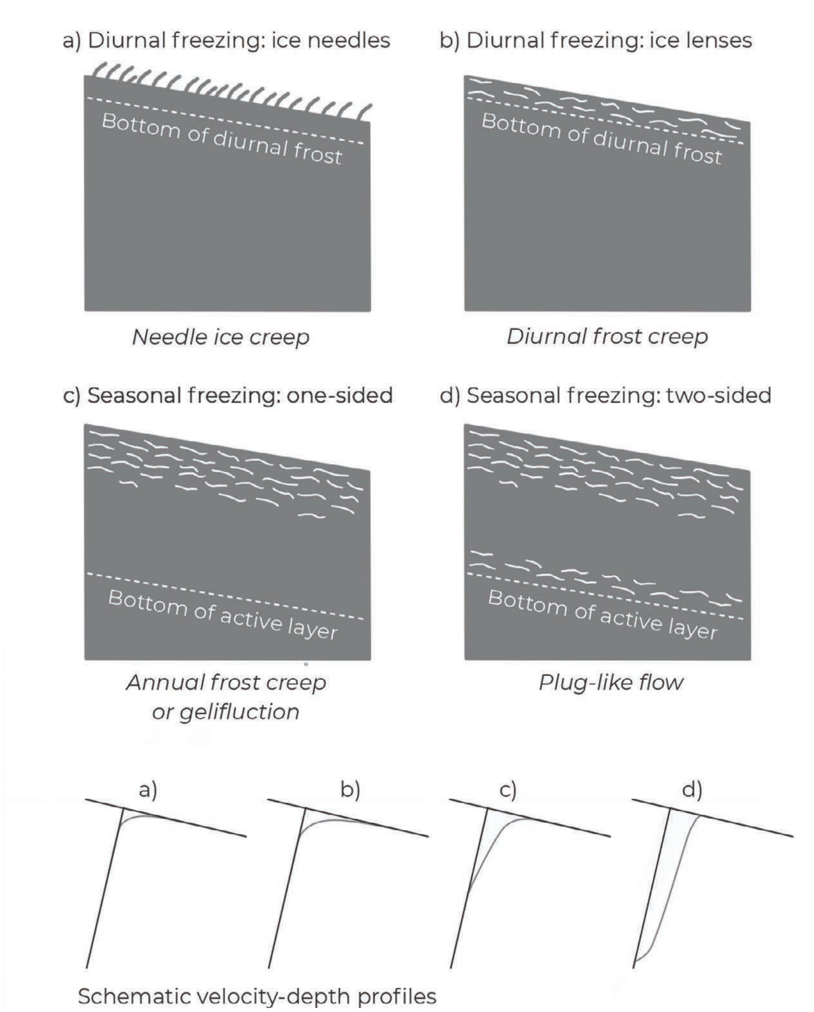

Figure 11. Different types of frost heave and solifluction, and simplified velocity-depth profiles for each (modified from Matsuoka, 2001).

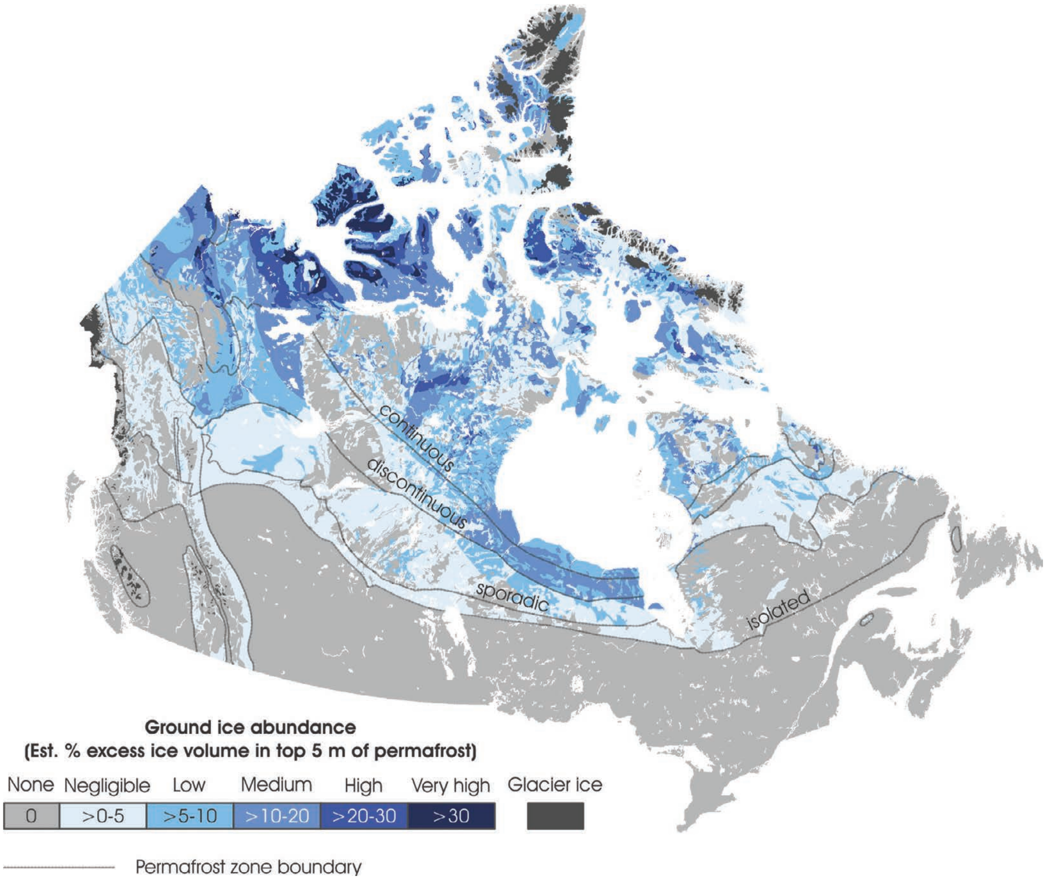

Figure 12. The Ground Ice Map of Canada, depicting a generalized, modelled distribution of excess ice content in upper permafrost from buried glacial ice, ice wedges, and segregated ice (O'Neill et al., 2019, 2022).

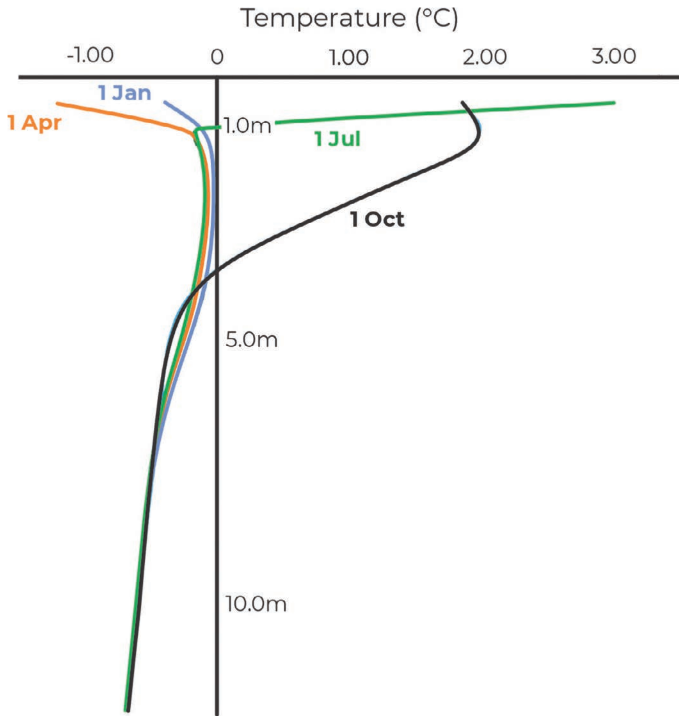

Figure 13. Ground temperature profiles for four different dates from a temperature cable at Reindeer Station, Northwest Territories, in the Mackenzie Delta, Canada (unpublished data: Geological Survey of Canada).

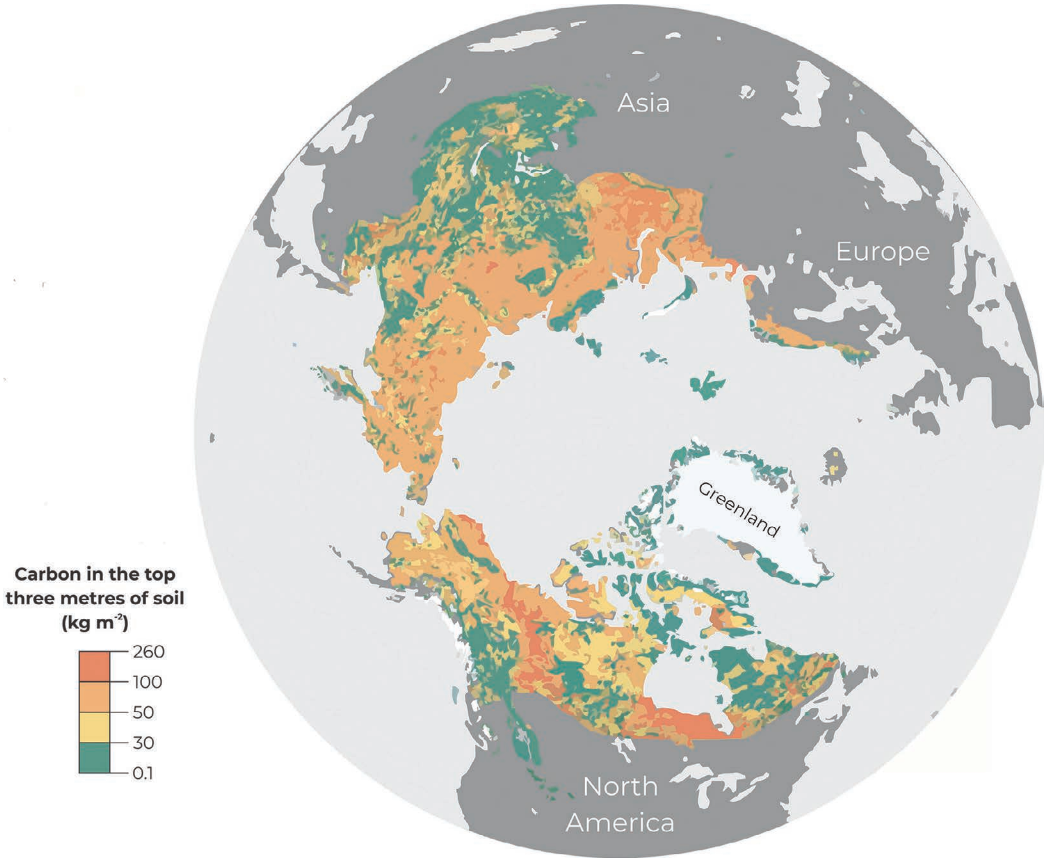

Figure 14. Estimated carbon in the top three metres of soil in the Northern Hemisphere permafrost region. Note: the amounts shown include carbon in permafrost, in the active layer, and at sites without permafrost. Permafrost carbon can also be present at depths greater than 3 m (modified from Schuur, 2016, based on Schuur et al., 2015).

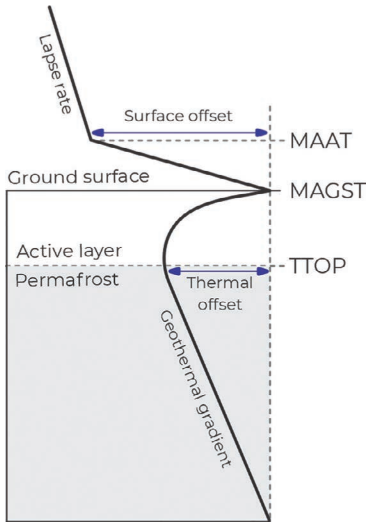

Figure 15. **The annual temperature profile through the boundary layer and the uppermost layers of the ground in permafrost regions. MAAT = mean annual air temperature, MAGST = mean annual ground surface temperature, TTOP = temperature at the top of permafrost (modified from French, 2017).**

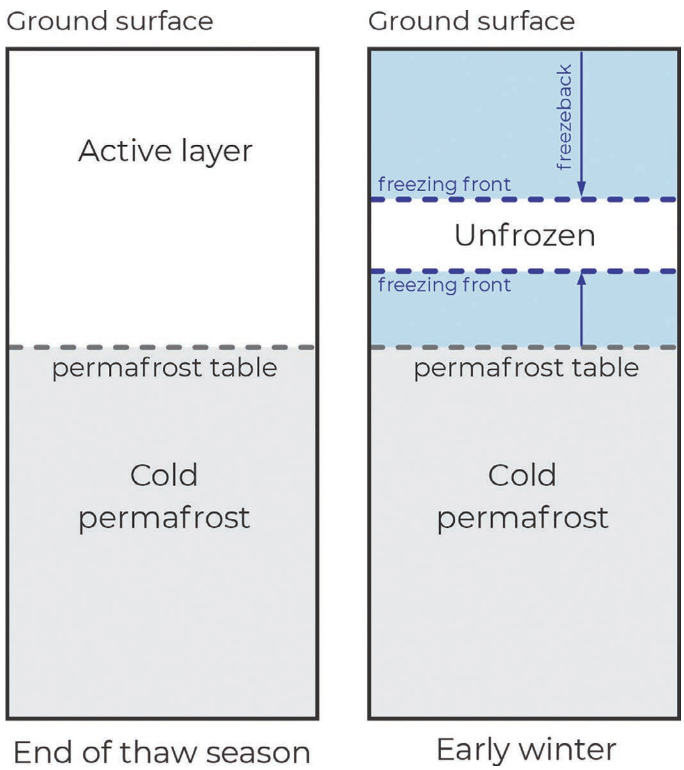

Figure 16. **The progression of two-sided freezeback of the active layer above cold permafrost.**

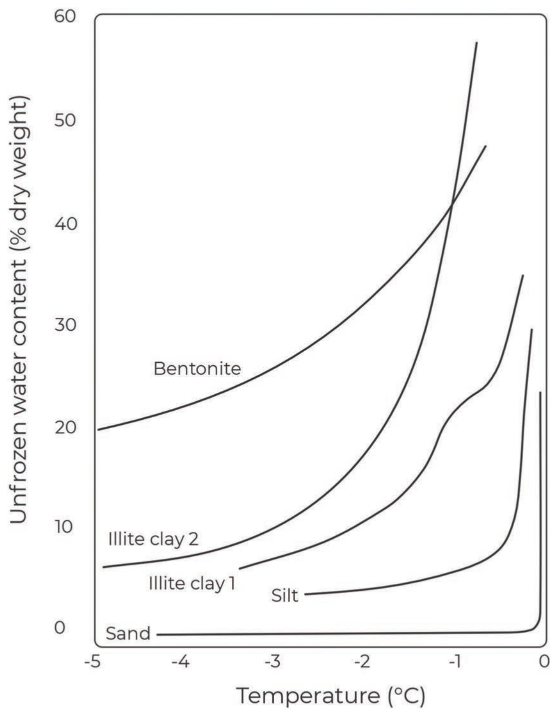

Figure 17. Unfrozen water contents in different materials at temperatures below 0°C (modified from Williams and Smith, 1989)

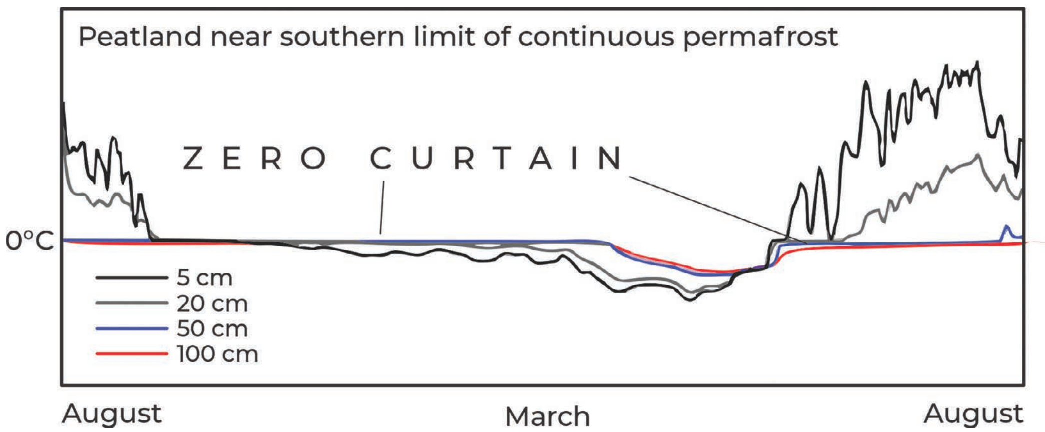

Figure 18. Time series from a shallow thermistor array on Peel Plateau, Northwest Territories, Canada (O'Neill et al., 2015).

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APPENDIX A. SUMMARY OF TIMELINES AND METHODOLOGY USED BY PTAG

The project to revise and update the International Permafrost Association's *Multi-Language Glossary of Permafrost and Related Ground-Ice Terms* was discussed several times within board meetings of the Canadian Permafrost Association (CPA) during 2019–2020. The formalization of Action Groups at the CPA's Annual Meeting in November 2020 provided a structure to organize this task. An announcement was made at that meeting that the project was planned and a call made for volunteers to participate.

The proposal for the Permafrost Terminology Action Group (PTAG) was submitted by A.G. Lewkowicz (Chair) in December 2020. PTAG's main goals were to update previous versions of the *Glossary* and to develop a plain-language illustrated version (subsequently entitled *An Illustrated Permafrost Dictionary*) for broader use. The proposal was approved by the CPA board in February 2021. The 13 members of PTAG had either volunteered during the 2020 Annual Meeting or were asked to join to provide subject balance. Members included scientists and engineers at all career stages and with one exception, they remained active in PTAG throughout the process.

It was decided early on that the group would work by consensus, an objective that was met throughout. Documents were made available in CPA space on-line which allowed sharing and comments between and during meetings. Although individuals met with each other over the years at conferences and elsewhere, all 55 meetings were held on-line.

The starting point was the list of terms in the 2005 *Glossary*. Each was reviewed by two members for aspects such as the formulation and uniqueness of the term, its thematic relevance, and the consistency of its use. The reviewers made recommendations regarding amendment and retention and included their rationale. All members of PTAG were then given the opportunity to vote and provide further comments on retention, change or removal.

The same process was followed for a list of new terms that was developed in parallel. The potential entries originated from PTAG members themselves, the ASTM Standard D7099–04 (2018) *Standard Terminology Relating to Frozen Soil and Rock*, and from individuals who communicated suggestions in response to poster presentations at conferences (see list below).

Terms that had received broad support for inclusion in the initial stage or where opinions differed, were examined in detail. PTAG divided into four groups of three members to draft the wording of each term, its definition, comment, hierarchical relationships, and references and to recommend whether it should be an entry in the *Illustrated Permafrost Dictionary* as well as the *Glossary*. Proposed entries were then voted on and subsequently discussed one by one in PTAG meetings and accepted or amended.

Accepted terms which had undergone more than editorial modification from the 2005 *Multi-Language Glossary* or were new terms, were sent out in thematic groups for external review by two or three experts (see list in Acknowledgments). Reviewer comments were transformed into proposals for amendments by the original drafters or arguments made for not following all suggestions (e.g., conflicting comments from the reviewers).

Substantively changed entries were again reviewed one by one. In some cases, multiple cycles of amendments and discussions were needed before consensus was reached and a term was accepted. During this stage, a small number of new terms were added. The final term in the list was accepted in July 2025.

French language equivalents were prepared by a group of francophone scientists and engineers led by Pascale Roy-Léveillée. The group used the definitions to find the best equivalent term in French (rather than focusing on the translation of terms). When terminology differed between engineering and geomorphology, two French equivalents were provided.

The figures were drafted by Brendan O'Neill.

The finalized manuscript was assembled and reviewed by members of PTAG in August 2025 prior to submission to UTP Press.

List of conference poster presentations by PTAG

Lewkowicz, A.G., Bonnaventure, P., Brooks, H., Brown, N., Gruber, S., Hoeve, E., Koenig, C., O'Neill, B., Paquette, M., Roy-Léveillée, P., Rudy, A., Wolfe, S. (2021). Towards a revised version of the *Glossary of Permafrost and Related Ground-Ice Terms*. 2021 Regional Conference on Permafrost—19th International Conference on Cold Regions Engineering, October 2021.

Lewkowicz, A.G., Bonnaventure, P., Brooks, H., Brown, N., Gruber, S., Hoeve, E., Koenig, C., O'Neill, B., Paquette, M., Roy-Léveillée, P., Roujanski, V., Rudy, A., Wolfe, S. (2021). Revising and updating the *Glossary of Permafrost and Related Ground-Ice Terms*: a CPA project. NSERC PermafrostNet and Canadian Permafrost Association Joint Virtual Annual General Meeting, November 2021.

Lewkowicz, A.G., Wolfe, S., Rudy, A., Roujanski, V., Roy-Léveillée, P., O'Neill, B, Koenig, C., Hoeve, E., Gruber, S., Brown, N., Brooks, H., Bonnaventure, P. (2022). Development of an illustrated plain-language version of the *Glossary of Permafrost and Related Ground-Ice Terms*. Canadian Permafrost Association North Yukon Permafrost Conference, Dawson, August 2022.

Lewkowicz, A.G., Wolfe, S., Rudy, A., Roujanski, V., Roy-Léveillée, P., O'Neill, B, Koenig, C., Hoeve, E., Gruber, S., Brown, N., Brooks, H., Bonnaventure, P. (2023). Progress in the development of an illustrated plain-language version of the *Glossary of Permafrost and Related Ground-Ice Terms*. Sixth European Conference on Permafrost, Puigcerdà, Spain, June 2023.

APPENDIX B. SOURCE OF ENTRIES

Term title (completely new entries in bold)	Term title: new (n), unchanged (u) or revised (r: previous entry) from previous versions of the Glossary		Definition: new (n), unchanged (u) or revised (r) from previous versions of the Glossary		Comment: new (n), unchanged (u) or revised (r) from previous versions of the Glossary. Dash indicates that there is no comment in current or past versions.	
	1988	2005	1988	2005	1988	2005
abrupt thaw	n	n	n	n	n	n
active layer	u	u	r	r	r	r
active-layer detachment failure	r: active-layer failure	r: active-layer failure	r	r	r	r
active layer thickness	n	u	n	r	n	r
adfreeze/adfreezing	u	u	r	r	r	r
adfreeze pile	n	n	n	n	n	n
adfreeze strength	r: strength, adfreeze	u	r	u	r	r
aggradational ice	r: ice, aggradational	u	r	r	r	r
air-cooled embankment	n	n	n	n	n	n
air freezing index	n	u	n	u	n	r
air thawing index	n	u	n	u	n	r
alas	r: alas/alass	r: alas/alass	r	r	r	r
albedo	n	u	n	r	n	r
anti-syngenetic ice wedge	n	u	n	r	n	r
apparent heat capacity	n	u	n	r	n	r
artificial ground freezing	r: ground freezing, artificial	u	r	r	r	r
aufeis	r: icing	r: icing	r	r	r	r
basal (glacier) ice cryostructures	n	basal cryostructure	n	r	n	r
basal temperature of snow method	n	r: BTS method	n	r	n	r
beaded stream	u	u	r	r	u	u
blockfield	r: block field	r: block field	r	r	r	r

Term title (completely new entries in bold)	Term title: new (n), unchanged (u) or revised (r: previous entry) from previous versions of the Glossary		Definition: new (n), unchanged (u) or revised (r) from previous versions of the Glossary		Comment: new (n), unchanged (u) or revised (r) from previous versions of the Glossary. Dash indicates that there is no comment in current or past versions.	
buried ice	r: ice, buried	u	u	u	r	r
cave ice	r: ice, cave	u	r	r	r	r
chimney effect	n	n	n	n	n	n
climate-driven, ecosystem-modified permafrost	n	n	n	n	n	n
climate-driven, ecosystem-protected permafrost	n	n	n	n	n	n
climate-driven permafrost	n	n	n	n	n	n
closed-cavity ice	r: ice, closed-cavity	u	u	u	u	u
closed-system freezing	r: freezing, closed-system	u	u	u	r	r
closed-system pingo	r: pingo, closed-system	u	u	u	r	r
closed talik	n	u	n	r	n	r
collapsed pingo	r: pingo remnant	r: pingo remnant	r	r	r	r
collapse scar	u	u	r	r	r	r
composite wedge	u	u	r	r	r	r
condenser	n	n	n	n	n	n
continuous permafrost	r: permafrost, continuous	u	r	r	r	r
continuous permafrost zone	n	u	n	r	n	r
creep of frozen ground	u	u	r	r	r	u
creep strength	n	u	n	r	n	u
crustal cryostructure	n	r: crust-like cryostructure	n	r	n	r
cryo-conditioning	n	n	n	n	n	n
cryofacies	n	n	n	n	n	n
cryofront	u	u	r	r	r	r
cryogenesis	u	u	r	r	r	r
cryogenic aquiclude	u	u	u	u	u	u
cryogenic fabric	u	u	r	r	r	r
cryolithology	u	u	r	r	r	r
cryopedology	u	u	r	r	r	r

(Continued)

Term title (completely new entries in bold)	Term title: new (n), unchanged (u) or revised (r: previous entry) from previous versions of the Glossary		Definition: new (n), unchanged (u) or revised (r) from previous versions of the Glossary		Comment: new (n), unchanged (u) or revised (r) from previous versions of the Glossary. Dash indicates that there is no comment in current or past versions.	
cryopeg	u	u	r	r	r	r
cryoplanation	n	u	n	r	n	r
cryoplanation terrace	u	u	r	r	r	r
cryosol	u	u	u	u	u	u
cryosphere	u	u	r	r	r	r
cryostratigraphy	n	n	n	n	n	n
cryostructure	u	u	r	r	r	r
cryosuction	u	u	r	r	r	r
cryotexture	u	u	r	r	r	r
cryotic	r: cryotic ground	r: cryotic ground	r	r	r	r
cryoturbation	u	u	r	r	r	r
debris flow	n	u	n	r	n	r
degree-day	u	r: degree-day (C or F)	r	r	r	r
depth of seasonal frost penetration	n	u	n	u	n	r
depth of zero annual amplitude	u	u	r	r	r	r
design freezing index	n	u	n	r	n	r
design thawing index	n	u	n	r	n	r
dielectric constant (of ground)	n	r: dielectric constant	n	r	n	r
dilation crack	u	u	u	u	r	r
dilation crack ice	r: ice, dilation crack	u	u	u	u	u
discontinuous permafrost	r: permafrost, discontinuous	u	r	r	r	r
discontinuous permafrost zone	n	u	n	r	n	r
disequilibrium permafrost	r: permafrost, disequilibrium	u	u	u	n	r
drunken forest	u	u	r	r	r	r
dry permafrost	r: permafrost, dry	u	r	r	r	r
earth hummock	hummock, earth	u	r	r	r	r

Term title (completely new entries in bold)	Term title: new (n), unchanged (u) or revised (r: previous entry) from previous versions of the Glossary		Definition: new (n), unchanged (u) or revised (r) from previous versions of the Glossary		Comment: new (n), unchanged (u) or revised (r) from previous versions of the Glossary. Dash indicates that there is no comment in current or past versions.	
ecosystem-driven permafrost	n	n	n	n	n	n
ecosystem-protected permafrost	n	n	n	n	n	n
electrical conductivity (of ground)	n	r: electrical conductivity	n	r	n	r
electrical resistivity (of ground)	n	r: electrical resistivity	n	r	n	r
electrical resistivity tomography (ERT)	n	n	n	n	n	n
elevational zonation of permafrost	n	r: altitudinal zonation of permafrost	n	r	n	r
epigenetic ice	r: ice, epigenetic	u	r	r	r	r
epigenetic ice wedge	n	u	n	r	n	r
epigenetic permafrost	r: permafrost, epigenetic	u	r	r	n	n
equilibrium permafrost	r: permafrost, equilibrium	u	r	r	n	n
evaporator	n	n	n	n	n	n
excess ice	r: ice, excess	u	r	r	r	r
excess ice content	n	n	n	n	n	n
extra-zonal permafrost	n	n	n	n	n	n
food cellar	n	n	n	n	n	n
freezeback	u	u	u	u	r	r
freeze-thaw cycle	n	u	n	r	n	r
freezing front	u	u	r	r	r	r
freezing index	u	u	u	u	r	r
freezing (of ground)	u	u	u	u	r	r
freezing point	n	u	n	r	n	n
freezing-point depression	u	u	r	r	r	r
freezing pressure	u	u	u	u	r	r
friable permafrost	n	u	n	r	-	-

(Continued)

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frost	n	u	n	r	n	r
frost action	u	u	r	r	r	r
frost blister	u	u	r	r	r	r
frost boil	u	u	r	r	r	r
frost bulb	u	u	r	r	r	r
frost creep	u	u	r	r	n	n
frost heave	u	u	u	u	r	r
frost jacking	u	u	r	r	u	u
frost mound	u	u	r	u	r	r
frost penetration	u	u	r	r	-	-
frost probe	n	n	n	n	n	n
frost shattering	n	u	n	r	n	u
frost sorting	u	u	r	u	n	u
frost-stable ground	u	u	u	u	r	r
frost-susceptible ground	u	u	r	r	r	r
frost table	n	n	n	n	n	n
frost weathering	u	u	r	r	u	u
frost wedging	u	u	r	r	u	u
frozen debris lobe	n	n	n	n	n	n
frozen fringe	u	u	r	r	u	u
frozen ground	u	u	r	r	r	r
gas-emission crater	n	n	n	n	n	n
gas hydrate	u	u	r	r	r	r
gelifluction	u	u	r	r	r	r
geocryology	u	u	r	r	r	r
geothermal gradient	n	u	n	r	n	r
geothermal heat flux	n	u	n	u	n	r
gravimetric water content	n	r: gravimetric (total) water content	n	r	n	r
ground ice	r: ice, ground	u	r	r	r	r
ground temperature profile	n	r: temperature profile	n	r	n	n

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ground thermal regime	u	r: thermal regime of the ground	r	r	r	r
ground wedge	r: soil wedge	r: soil wedge	r	r	r	r
heat capacity	n	u	n	r	n	r
heat drain	n	n	n	n	n	n
heaving pressure	n	u	n	r	n	r
high-centred polygon	n	r: high-centre polygon	n	r	n	r
hummock	n	n	n	n	n	n
hydraulic thawing	u	u	u	u	r	r
hydrochemical talik	n	u	n	r	n	r
hydrothermal talik	n	u	n	r	n	u
ice	u	u	r	r	r	r
ice-bearing permafrost	r: permafrost, ice-bearing	u	u	u	-	-
ice-bonded permafrost	r: permafrost, ice-bonded	u	r	r	r	r
ice content	u	u	u	u	r	r
ice-cored topography	u	u	u	u	r	r
ice lens	u	u	r	r	r	r
ice nucleation temperature	u	u	u	u	n	r
ice-poor permafrost	n	n	n	n	n	n
ice-rich permafrost	r: permafrost, ice-rich	u	r	r	u	u
ice segregation	u	u	r	r	r	r
ice table	n	n	n	n	n	n
ice vein	u	u	r	r	n	n
ice wedge	u	u	r	r	r	r
ice-wedge melt pond	n	n	n	n	n	n
ice-wedge polygon	n	u	n	r	n	r
ice-wedge pseudomorph	r: ice-wedge cast	r: ice-wedge cast	r	r	r	r
icing	n (as a process)	n	n	n	n	n
icing blister	u	u	r	r	r	r

(Continued)

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icing glade	n	u	n	r	n	r
icing mound	u	u	u	u	u	u
infiltration ice	n	n	n	n	n	n
interfacial water	n	u	n	r	n	r
intrapermafrost groundwater	r: intrapermafrost water	r: intrapermafrost water	r	r	u	u
intrusive ice	r: ice, intrusive	u	u	u	r	r
isolated patches of permafrost zone	n	r: isolated patches of permafrost	n	r	n	r
isolated talik	n	u	n	r	n	u
isotherm	n	n	n	n	n	n
kurum	n	u	n	r	n	r
lake talik	n	u	n	r	n	r
latent heat (of fusion)	n	u	n	r	n	r
lateral talik	n	u	n	r	n	r
latitudinal zonation of permafrost	n	u	n	r	n	r
layered cryostructure	n	u	n	r	n	r
lens ice	n	u	n	u	n	n
lenticular cryostructure	n	r: lens-type cryostructure	n	r	n	r
lithalsa	n	n	n	n	n	n
long-term strength	n	u	n	u	n	r
low-centred polygon	n	r: low-centre polygon	n	r	n	n
massive ice	r: ice, massive	u	r	r	r	r
mass movement	r: mass wasting	r: mass wasting	r	r	r	r
mean annual ground surface temperature (MAGST)	n	u	n	u	n	r
mean annual ground temperature (MAGT)	n	u	n	u	n	u
megaslump	n	n	n	n	n	n

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mountain permafrost	r: permafrost, alpine	u	r	r	r	r
mud ejection	n	n	n	n	n	n
multiple retrogressive slide	u	u	u	u	r	r
near-surface permafrost	n	n	n	n	n	n
needle ice	r: ice, needle	u	r	r	r	r
n-factor	u	u	r	r	r	r
nival offset	n	n	n	n	n	n
nivation	n	n	n	n	n	n
noncryotic ground	u	u	u	u	u	u
non-frost-susceptible soil	n	n	n	n	n	n
nonsorted circle	n	u	n	u	n	u
nonsorted net	n	u	n	u	n	u
nonsorted polygon	n	u	n	u	n	u
nonsorted step	n	u	n	u	n	u
nonsorted stripe	n	u	n	u	n	u
one-sided freezing	n	n	n	n	n	n
onshore permafrost	n	u	n	u	n	r
open-cavity ice	r: ice, open-cavity	u	r	u	r	r
open-system freezing	r: freezing, open-system	u	r	u	r	r
open-system pingo	r: pingo, open-system	u	r	r	r	r
open talik	n	u	n	r	n	r
organic cryosol	n	u	n	r	n	r
organic-matrix cryostructure	n	n	n	n	n	n
oriented lake	u	u	u	u	u	u
palsa	u	u	r	r	r	r
palsa bog	n	u	n	r	n	r
paraglacial	n	n	n	n	n	n
patterned ground	u	u	r	r	r	r
peat	n	u	n	u	n	u

(Continued)

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peatland	u	u	r	r	r	r
peat plateau	u	u	r	r	r	r
pereletok	u	u	r	r	r	r
periglacial	u	u	r	r	r	r
periglacial phenomena	n	u	n	u	n	r
periglacial processes	n	u	n	u	n	u
permafrost	u	u	r	r	r	r
permafrost aggradation	u	u	r	r	r	r
permafrost base	u	u	r	r	n	n
permafrost boundary	u	u	r	r	-	-
permafrost carbon	n	n	n	n	n	n
permafrost carbon-climate feedbacks	n	n	n	n	n	n
permafrost degradation	u	u	r	r	r	r
permafrost extent	n	n	n	n	n	n
permafrost limit	u	u	r	r	n	n
permafrost region	u	u	r	r	u	u
permafrost table	u	u	r	u	r	r
permafrost thickness	u	u	r	r	r	r
permafrost zone	u	u	r	r	r	r
pingo	u	u	r	r	r	r
planetary permafrost	r: permafrost, planetary	u	r	r	r	r
plug-like flow	n	n	n	n	n	n
polygon	u	u	r	r	u	u
polygonal peat plateau	u	u	u	u	r	r
polygon trough	n	u	n	r	n	r
poorly-bonded permafrost	n	u	n	r	n	r
pore cryostructure	n	r: massive cryostructure	n	r	n	r
pore ice	r: ice, pore	u	r	r	r	r
pore water	r: water, pore	u	u	u	r	r
pore water salinity	n	r: salinity	n	r	n	r

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porphyritic cryostructure	n	n	n	n	n	n
pressure-melting	u	u	u	u	u	u
relict active layer	r: active layer, relict	u	r	r	r	r
relict ice	r: ice, relict	u	r	r	r	r
relict permafrost	r: permafrost, relict	u	r	r	r	r
relict pingo	r: pingo scar	r: pingo scar	r	r	r	r
residual stress	u	u	r	r	n	n
residual thaw layer	u	u	r	r	r	r
reticulate cryostructure	n	u	n	r	n	r
reticulate ice	r: ice, reticulate	u	r	u	r	r
retrogressive thaw slump	u	u	r	r	r	r
river talik	n	u	n	r	n	r
rock glacier	u	u	r	r	r	r
saline permafrost	r: permafrost, saline	u	r	r	r	r
sand wedge	u	u	r	r	r	r
sand-wedge polygon	n	u	n	u	n	r
seasonal frost	r: frost, seasonal	u	u	u	n	n
seasonal frost mound	n	n	n	n	n	n
seasonally-active permafrost	r: permafrost, seasonally-active	u	r	r	r	r
seasonally frozen ground	u	u	r	u	r	r
seasonally frozen layer (SFL)	n	u	n	r	n	r
seasonally thawed ground	u	u	r	u	r	r
segregated ice	r: ice, segregated	u	r	r	r	r
segregation potential	u	u	u	u	r	r
short-term strength	n	u	n	r	n	n
soil freezing characteristic curve	n	n	n	n	n	n
solid cryostructure	n	n	n	n	n	n
solifluction	u	u	r	r	r	r

(Continued)

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solifluction apron	n	u	n	u	-	-
solifluction lobe	n	u	n	r	n	r
solifluction sheet	n	u	n	r	n	r
solifluction terrace	n	u	n	r	n	r
sorted circle	n	u	n	u	n	u
sorted net	n	u	n	u	n	u
sorted polygon	n	u	n	u	n	u
sorted step	n	u	n	u	n	u
sorted stripe	n	u	n	u	n	u
space frame foundation	n	n	n	n	n	n
specific heat capacity	n	u	n	r	n	r
sporadic discontinuous permafrost zone	n	r: sporadic discontinuous permafrost	n	r	n	r
static cryosol	n	u	n	r	n	r
stone-banked (solifluction) lobe	n	u	n	u	n	n
stone-banked (solifluction) terrace	n	u	n	u	n	n
stone garland	n	u	n	r	-	-
string fen	u	u	r	r	r	r
subglacial permafrost	n	u	n	r	n	n
subglacial talik	n	u	n	r	n	n
subpermafrost groundwater	r: subpermafrost water	r: subpermafrost water	u	u	r	r
subsea permafrost	n	u	n	r	n	r
supercooling	n	u	n	r	n	n
suprapermafrost groundwater	r: suprapermafrost water	r: suprapermafrost water	u	u	r	r
surface freezing index	n	u	n	r	n	r
surface offset	n	n	n	n	n	n
surface thawing index	n	u	n	u	n	r
suspended cryostructure	n	n	n	n	n	n

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syngenetic ice	r: ice, syngenetic	u	r	u	-	-
syngenetic ice wedge	n	u	n	u	n	r
syngenetic permafrost	r: permafrost, syngenetic	u	r	r	n	n
talik	u	u	r	r	r	r
Temperature at the Top of Permafrost model (TTOP)	n	n	n	n	n	n
thaw bulb	u	u	r	r	r	r
thaw consolidation	u	u	r	r	r	r
thaw consolidation ratio	u	u	r	r	r	r
thaw depth	r: depth of thaw	r: depth of thaw	r	r	n	r
thawed ground	u	u	u	u	r	r
thawing front	u	u	u	u	u	u
thawing index	u	u	u	u	u	u
thawing (of frozen ground)	u	u	r	r	r	r
thaw penetration	n	u	n	r	n	r
thaw penetration rate	n	n	n	n	n	n
thaw-sensitive permafrost	r: permafrost, thaw-sensitive	u	r	r	r	r
thaw settlement	u	u	r	r	r	r
thaw slumping	u	u	r	r	r	r
thaw-stable materials	r: permafrost, thaw-stable	thaw-stable permafrost	r	r	r	r
thaw strain	u	u	r	r	r	r
thaw tube	n	n	n	n	n	n
thaw unconformity	n	u	n	r	n	r
thaw weakening	u	u	u	u	r	r
thermal conductivity	n	u	n	r	n	r
thermal contraction coefficient	n	r: thermal expansion (or contraction) coefficient	n	r	n	n
thermal-contraction crack	u	u	u	u	r	r

(Continued)

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thermal diffusivity	n	u	n	r	n	r
thermal erosion	u	u	r	u	r	r
thermal offset	n	n	n	n	n	n
thermo-erosional gully	n	n	n	n	n	n
thermo-erosional niche	u	u	r	r	r	r
thermokarst	u	u	r	r	n	r
thermokarst-cave ice	n	n	n	n	n	n
thermokarst lake	u	u	r	r	r	r
thermokarst mound	r: mound, thermokarst	u	r	r	r	r
thermokarst terrain	u	u	r	r	r	r
thermopile	r: thermal pile	r: thermal pile	r	r	r	r
thermosyphon	u	u	u	u	r	r
thufa	r: thufur	r: thufur	r	r	r	r
transient layer	n	n	n	n	n	n
transient talik	n	u	n	r	n	r
trumpet curve	n	n	n	n	n	n
tundra	u	u	r	r	r	r
turbic cryosol	n	u	n	r	n	r
turf-banked solifluction lobe	n	r: turf-banked (solifluction) lobe	n	u	n	n
turf-banked solifluction terrace	n	r: turf-banked (solifluction) terrace	n	u	n	n
turf hummock	r: hummock, turf	u	u	u	-	-
two-sided freezing	n	n	n	n	n	n
undisturbed permafrost sample	n	n	n	n	n	n
unfrozen ground	u	u	u	u	u	u
unfrozen water content	r: water content, unfrozen	u	r	r	r	r
upward freezing	n	u	n	r	n	r

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vein cryostructure	n	n	n	n	n	n
vein ice	r: ice, vein	u	u	u	r	r
volumetric ice content	n	n	n	n	n	n
volumetric (total) water content	n	u	n	r	n	r
water track	n	n	n	n	n	n
wedge ice	n	u	n	u	n	r
well-bonded permafrost	n	u	n	u	-	-
Yedoma	n	n	n	n	n	n
zero curtain	u	u	r	r	r	r

APPENDIX C. TERMS CONSIDERED FOR INCLUSION BUT NOT RETAINED

Term title	**Action: c: considered for inclusion as a new term but not retained as a separate entry; e: existing term in 2005 Multilanguage Glossary that was eliminated.**	**Referred to within the entry shown**
active air-cooled thermal pile	e	
active construction methods in permafrost	e	
active ice wedge	e	ice wedge
active liquid refrigerant pile	e	
active rock glacier	e	rock glacier
active thermokarst	e	
adfreeze shear strength	c	
adfreeze tensile strength	c	
alternative pingo	c	
altitudinal limit of permafrost	e	permafrost limit
approximate freezing index	e	
approximate thawing index	e	
banded cryogenic fabric	e	cryogenic fabric
barrens	e	
basal cryopeg	e	cryopeg
basal-layered cryostructure	e	
bottom temperature of snow cover (BTS)	e	basal temperature of snow (BTS) method
chi'juudii	c	
clear ice	c	
cloudy ice	c	
coefficient of compressibility	e	
cold permafrost	c	permafrost
congeliturbate	c	
conglomeric cryogenic fabric	e	cryogenic fabric
construction methods in permafrost	e	
cryogenic temperature	e	
cryoturbate	e	

(Continued)

Term title	Action: c: considered for inclusion as a new term but not retained as a separate entry; e: existing term in 2005 Multilanguage Glossary that was eliminated.	Referred to within the entry shown
deformability	e	
degree of saturation	e	
delayed strength	e	
density of frozen ground	e	
desiccation crack	e	
desiccation polygon	e	
design depth of frost penetration	e	
design ground temperature	c	
detachment failure	e	active-layer detachment failure
disturbed sample	c	
dry density	e	
dry frozen ground	e	frozen ground
dynamic modulus of elasticity	e	
dynamic Poisson's ratio	e	
electrical properties of frozen ground	e	
extensive discontinuous permafrost	e	discontinuous permafrost zone
fabric	e	
fragmic cryogenic fabric	e	
fragmoidal cryogenic fabric	e	
frazil ice	c	
free water	e	
friable	c	
frost cracking	c	
frost-heave extent	e	
frost phenomena	e	
frost-stable soil	e	frost-stable ground
frost-susceptible soil	e	frost-susceptible ground
gelisol	e	
glacial till	c	
glaciolacustrine deposits	c	
granic cryogenic fabric	e	
granoidic cryogenic fabric	e	
granular ice	c	
ground settlement	c	
hard frozen ground	e	frozen ground
histel	c	
hydraulic conductivity	e	
hydraulic diffusivity	e	
ice-poor cryostructure	c	
iciness	e	
inactive ice wedge	e	ice wedge
inactive rock glacier	e	rock glacier
intermediate discontinuous permafrost	e	
intermediate layer	c	transient layer
Interstitial ice/cryostructure	c	pore ice

(Continued)

Term title	Action: c: considered for inclusion as a new term but not retained as a separate entry; e: existing term in 2005 Multilanguage Glossary that was eliminated.	Referred to within the entry shown
involuted terrain	c	
isoband cryogenic fabric	e	cryogenic fabric
isolated cryopeg	e	cryopeg
latitudinal limit of permafrost	e	permafrost limit
loess	c	
macro-scale polygons	e	polygon
marine cryopeg	e	cryopeg
massive-agglomerate cryostructure	e	
massive cryostructure	e	
massive-porous cryostructure	e	
mass movement landforms	c	
mass movement processes	c	
mechanical properties of frozen ground	e	
mechanical strength	e	
methane crater	c	gas-emission crater
micro-lenticular cryostructure	c	lenticular cryostructure
micro-scale polygon	e	polygon
minerogenic palsa	e	lithalsa
mud circle	e	nonsorted circle
offshore pingo	c	
orbiculic cryogenic fabric	e	cryogenic fabric
orthel	c	
paleosol	c	
partially-bonded permafrost	e	poorly-bonded permafrost
passive construction methods in permafrost	e	
passive single-phase thermal pile	e	
passive two-phase thermal pile	e	
peat hummock	e	
pergelic soil temperature regime	c	
permacrete	e	
pingo ice	e	
plastic frozen ground	e	frozen ground
Poisson's ratio	e	
polar desert	c	
polygonal pattern	e	
pool ice	c	thermokarst-cave ice
reconstituted sample	c	
relative permittivity	e	
reticulate-blocky cryostructure	e	
saturation ratio	c	
seasonal freezing index	e	freezing index
seasonal thawing index	e	thawing index
seasonally thawed layer (STL)	e	
shear strength	c	
single-phase thermosyphon	e	thermosyphon
snow	e	
snowcover	e	

(Continued)

Term title	Action: c: considered for inclusion as a new term but not retained as a separate entry; e: existing term in 2005 Multilanguage Glossary that was eliminated.	Referred to within the entry shown
snowdrift	e	
snowline	e	
snowmelt	e	
snowpatch	e	
solifluction features	e	patterned ground
stony earth circle	e	nonsorted circle
sublimation	c	
sublimation ice	e	open-cavity ice
subsea talik	e	
surface lapse rate	c	
suscitic cryogenic fabric	e	
talus slope	c	
tension cracked ice	c	
thaw basin	e	closed talik
thaw sink	e	
thermal disequilibrium	c	disequilibrium permafrost
thermal equilibrium	c	equilibrium permafrost
thermal properties of frozen ground	e	
thermal-contraction crack ice	e	
thermal talik	e	
thermo-erosional cirque	e	
thermokarst landforms	c	thermokarst
thermokarst processes	c	thermokarst
total annual freezing index	e	
total annual thawing index	e	
total water content (of frozen ground)	e	
transition zone	c	transient layer
turbel	c	
two-layer permafrost	e	
two-phase thermosyphon	e	thermosyphon
vadose zone	c	
volumetric heat capacity	e	
volumetric latent heat of fusion	e	
warm permafrost	c	permafrost
waterbody encircling a palsa	e	
Young's modulus	e	
zero-degree isotherm	c	cryofront
zone of gas-hydrate stability	e	

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PermafrostNet
NSERC | CRSNG

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