



Designation: D7099 – 04 (Reapproved 2018)

## Standard Terminology Relating to Frozen Soil and Rock<sup>1</sup>

This standard is issued under the fixed designation D7099; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope

1.1 This terminology includes all of those terms which relate to frozen soils and rocks.

1.2 It is based on: a list of definitions drawn up by ASTM Sub-Committee D18.19; ASTM standards; a list of definitions drawn up by the Canadian Geomorphology Research Group (CGRG); the Glossary of Permafrost and Related Ground-Ice Terms developed by the National Snow and Ice Data Center (NSIDC), at the University of Colorado, at Boulder; the Keys to Soil Taxonomy of the United States Department of Agriculture (USDA); and contributions by a number of individuals.

1.3 For all of the terms included, the source is included in parentheses after the definition.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

### 2. Referenced Documents

2.1 *ASTM Standards:*<sup>2</sup>

D653 *Terminology Relating to Soil, Rock, and Contained Fluids*

D4083 *Practice for Description of Frozen Soils (Visual-Manual Procedure)*

2.2 *Other References:*

Harris, S. A., French, H. M., Heginbottom, J. A., Johnston, G. H., Ladanyi, B., Sego, D. C., and van Everdingen, R.

<sup>1</sup> This terminology is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.19 on Frozen Soils and Rock.

Current edition approved July 1, 2018. Published July 2018. Originally approved in 2004. Last previous edition approved in 2010 as D7099 – 04(2010). DOI: 10.1520/D7099-04R18.

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

O., 1988, *Glossary of Permafrost and Related Ground-Ice Terms*, Technical Memorandum, Associate Committee on Geotechnical Research, Ottawa, Canada

Everdingen, Robert van, ed., 1998, revised January, 2002, *Multi-Language Glossary of Permafrost and Related Ground-Ice Terms*, National Snow and Ice Data Center/World Data Center for Glaciology, Boulder, Colorado

National Snow and Ice Data Center, 2003, *English Language Glossary of Permafrost and Related Ground-Ice Terms*, Boulder, Colorado, <http://nsdic.org/fgdc/glossary/english.html>

Natural Resources Conservation Service, United States Department of Agriculture, *Keys to Soil Taxonomy*, Ninth Edition, 2003, 331 pp., [http://soils.usda.gov/technical/classification/tax\\_keys](http://soils.usda.gov/technical/classification/tax_keys)

Permafrost Map of the USSR (1:2,500,000), 1996, Department of Geocryology, Moscow State University, 16 sheets

### 3. Significance and Use

3.1 This terminology can be used to find the definitions of all of those terms which are used in association with frozen materials, including rocks, soils, and water.

### 4. Terminology

4.1 *Definitions:*

4.1.1 All of the definitions are consistent with those listed in Terminology D653.

**active layer**—the top layer of ground that is subject to annual freezing and thawing. (In the zone of discontinuous permafrost, the active layer is often underlain by unfrozen ground.)

**active layer failure**—any of several possible forms of slope failure in the active layer. **NSIDC**

**active layer thickness**—the thickness of the top layer of ground that is subject to annual freezing and thawing. **NSIDC**

**active rock glacier**—a mass of rock fragments and finer material, on a slope, that contains an ice core or interstitial ice, and which shows evidence of recent movement. **NSIDC**

**adfreeze shear strength**—the shear stress required to separate two objects that are bonded together by ice.

- adfreeze tensile strength**—the tensile stress required to separate two objects that are bonded together by ice. **NSIDC**
- adfreezing**—the process by which objects are bonded together by the ice formed between them. **NSIDC**
- aggradation of permafrost**—see **permafrost aggradation**.
- aggradational ice**—newly formed ice lenses, especially in the lower part of the active layer, which become incorporated into the permafrost due to a raising of the permafrost table or a lowering of the permafrost base.
- air freezing index**—see **freezing index**.
- air thawing index**—see **thawing index**.
- albedo**—the fraction of the total solar radiation incident on a body that is reflected by it.
- alpine permafrost**—permafrost developed in temperate climate mountainous areas.
- altitudinal permafrost limit**—the lowest altitude at which mountain permafrost occurs in a highland area outside of the general permafrost region. **NSIDC**
- altitudinal permafrost zonation**—the vertical subdivision of mountain permafrost into zones based on mean annual temperatures. **NSIDC**
- apparent heat capacity**—the amount of heat required to raise the temperature of a unit mass of frozen ground by one degree. It is expressed in Joules per kg per degree K. **NSIDC**
- approximate freezing index**—the cumulative number of degree-days below 0°C for a given period, calculated from the mean monthly temperatures for a given station without making corrections for positive degree-days in the spring and fall. **NSIDC**
- approximate thawing index**—the cumulative number of degree-days above 0°C for a given period, calculated from the mean monthly temperatures for a given station without making corrections for negative degree-days in the spring and fall.
- artificial ground freezing**—the process of freezing earth materials by artificial means.
- banded cryogenic fabric**—a distinct soil morphology in which soil particles form subhorizontal layers as the result of freezing and thawing. **NSIDC**
- barrens**—areas of discontinuous vegetation cover in the polar semi-desert of the High Arctic. **NSIDC**
- basal cryopeg**—a layer of unfrozen ground, forming the basal portion of permafrost, in which the temperature is perennially below 0°C (32°F). **NSIDC**
- basal cryostructure**—the structural characteristics of a frozen deposit of boulders that is saturated with ice. **NSIDC**
- basal-layered cryostructure**—the structural characteristics of a frozen layered deposit of gravel and boulders that is saturated with ice. **NSIDC**
- beaded stream**—a characteristic pattern of small streams underlain by ice wedges. “Beads,” or pools, occur at junctions of wedges. The pools are linked by narrow channels. **NSIDC**
- bottom temperature of snow cover**—temperature measured at the base of the snow cover during mid- to late-winter (February/March). The measurements are used in the BTS method to predict the presence or absence of permafrost. **NSIDC**
- BTS method**—a method to predict the presence or absence of permafrost in a mountainous area, using measurements of the bottom temperature of the snow in mid- to late-winter. **NSIDC**
- buried ice**—ice formed on the ground surface and later covered by sediments.
- candled ice**—ice that has rotted or otherwise formed, by melting during the spring, into long columnar crystals which are very loosely bonded together. A distinctive “chiming” sound accompanies movement during “ice-out.”
- cave ice**—ice formed in an open or closed cave. **NSIDC**
- clear ice**—ice that is transparent and contains only a moderate number of air bubbles.
- closed-cavity ice**—ice formed in a closed space, cavity, or cave, in permafrost. **NSIDC**
- closed-system freezing**—freezing that occurs under conditions that preclude the gain or loss of water by the system. **NSIDC**
- closed-system pingo**—a pingo formed by the doming of frozen ground due to the freezing of injected water. The water is provided by the expulsion of pore water during the growth of permafrost. Closed-system pingos are found in poorly-drained terrain in the continuous permafrost zone. **NSIDC**
- closed talik**—a body of unfrozen ground occupying a depression in the permafrost table below a lake or river. **NSIDC**
- cloudy ice**—ice that is translucent or relatively opaque due to the content of air or for other reasons, but which is essentially sound and nonpervious.
- coefficient of compressibility**—the change in volume per unit volume of a substance per unit increase in effective compressive stress, under isothermal conditions. **NSIDC**
- collapse scar**—that part of a peatland where the whole, or part, of a peat plateau has thawed and collapsed to the level of the surrounding land. Collapses scars are not depressions but are marked by vegetation different from the peatland that was not underlain by permafrost. **NSIDC**
- composite wedge**—a wedge, containing both soil and ice, that shows evidence of both primary and secondary filling. **NSIDC**
- compressive strength**—the load per unit area at which an unconfined cylindrical specimen of soil or rock will fail in a

simple compression test. Commonly the failure load is the maximum that the specimen can withstand in the test. **D653**

**conglomeric cryogenic fabric**—a distinct soil micromorphology resulting from the effects of freezing and thawing, in which coarser soil particles form compound arrangements. **NSIDC**

**construction methods in permafrost**—special procedures of design and construction that are required when engineering works are undertaken in areas of permafrost.

**contemporary permafrost**—(1) newly formed permafrost in an area where surface temperatures have fallen below 0°C (32°F); (2) permafrost that is in thermal equilibrium with the existing mean annual surface or sea-bottom temperature and the geothermal heat flux.

**continuous permafrost**—permafrost occurring everywhere beneath the exposed land surface throughout a geographic region, with the exception of widely scattered sites, such as newly-deposited unconsolidated sediments, where the climate has just begun to impose its influence on the ground thermal regime and will cause the formation of continuous permafrost.

**continuous permafrost zone**—a major subdivision of a permafrost region, in which permafrost occurs everywhere beneath the land surface, with the possible exception of widely scattered sites; both in North American (GPRGIT) and in Russian (Permafrost Map of the USSR) usage: >80 % of area underlain by permafrost.

**convection tube**—a closed single-phase heat transfer device that removes heat from the ground whenever conditions are appropriate to drive the internal convection cell.

**creep of frozen ground**—the slow deformation that results from long-term application of a stress too small to produce failure in the frozen material.

**creep strength**—the failure strength of a material at a given rate of strain or after a given period under deviatoric stress. **NSIDC**

**crust-like cryostructure**—the structural properties of a frozen deposit of angular blocks that are coated with ice, while large spaces between the blocks are not filled with ice. **NSIDC**

**cryofront**—the boundary between frozen and unfrozen ground, as indicated by the position of the 0°C isotherm in the ground. **NSIDC**

**cryogenesis**—the combination of thermophysical, physico-chemical, and physico-mechanical processes that occur in freezing, frozen, and thawing earth materials. **NSIDC**

**cryogenic aquiclude**—a frozen layer of ground with sufficiently low permeability as to act as a confining bed for an aquifer. **NSIDC**

**cryogenic fabric**—the distinct soil micromorphology which results from the effects of freezing and thawing processes. **NSIDC**

**cryogenic temperature**—the term can apply to temperatures below -50°C but is usually used for those temperatures close to absolute zero (-273°C). **NSIDC**

**cryolithology**—the study of the genesis, structure, and lithology of frozen earth materials. **NSIDC**

**cryopedology**—the study of soils at temperatures below 0°C.

**cryopeg**—a layer of unfrozen ground in which the temperature is perennially below 0°C. In general, the freezing of such layers is prevented due to the depression of the freezing point by solids dissolved in the pore water.

**cryoplanation**—the process through which cryoplanation terraces form. **NSIDC**

**cryoplanation terraces**—hillside benches or table-like summit surfaces which are thought to have resulted from intense frost wedging associated with snowbanks. These are usually underlain by permafrost and are considered by some as diagnostic landforms of permafrost terrain. **NSIDC**

**cryosol**—soil within 1 to 2 m of the surface in which the mean annual ground temperature is below 0°C. **NSIDC**

**cryosphere**—that part of the Earth's crust, hydrosphere, and atmosphere subject, for at least a part of each year, to temperatures below 0°C (32°F). **NSIDC**

**cryostructure**—the structural characteristics of frozen earth materials. **NSIDC**

**cryosuction**—a suction which develops in freezing or partially-frozen fine-grained materials due to temperature-dependent differences in unfrozen water content. **NSIDC**

**cryotexture**—the textural characteristics of frozen earth materials cemented together with ice. **NSIDC**

**cryotic ground**—soil or rock in which the temperatures are 0°C, or below. **NSIDC**

**cryoturbate**—a body of earth material moved or disturbed by the action of frost. **NSIDC**

**cryoturbation**—(1) a collective term to describe all soil movements due to frost action; (2) irregular structures formed in earth materials by deep frost penetration and frost action processes. **NSIDC**

**debris flow**—a sudden and destructive form of landslide, in which loose materials on a slope, with at least half of the particles being larger than sand, are mobilized by saturation and flow downwards. **NSIDC**

**deformability**—the ability of a material to change its shape or size under the influence of an external or internal agency. **NSIDC**

**degree-day**—a unit of heat measurement equal to one degree of the variation of the mean temperature for a day from a given reference (or, base) temperature.

**degree of saturation**—(1) the total degree of saturation of frozen soil is the ratio, expressed as a percentage, of the