



TERRAIN CLASSIFICATION SYSTEM FOR BRITISH COLUMBIA

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Fisheries Branch
Ministry of Environment
and Surveys and Resource Mapping Branch
Ministry of Crown Lands Province of British Columbia

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TERRAIN CLASSIFICATION SYSTEM FOR BRITISH COLUMBIA

(Version 2)
1997

A system for the classification of surficial materials, landforms and
geological processes of British Columbia

Contributing Editors

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PREFACE

This updated version of the terrain classification manual differs only slightly from the 1988 edition. The basic Terrain Classification System for British Columbia has not been modified. The only changes are the addition of several new symbols, and minor modifications to existing terms and symbols. These changes have come about as a result of discussions by the Terrain Data Working Committee of the Surficial Geology Task Group that is part of the Earth Sciences Task Force of the Resources Inventory Committee, British Columbia. They reflect the current widespread use of terrain mapping as the basis for ecosystem mapping and slope stability mapping. Additions and changes to symbols are indicated by footnotes where they first occur in the manual, and all modifications are summarized in a new Appendix III.

This manual is to be used in conjunction with "Guidelines and Standards for Terrain Mapping in British Columbia", Resources Inventory Committee, 1995, and "Terrain Database Manual: Standards for Digital Terrain Data Capture in British Columbia", Resources Inventory Committee, 1996.

PREFACE TO 1988 EDITION

The purpose of this manual is to provide an updated and revised edition of the Terrain Classification System produced by the British Columbia Ministry of Environment in 1976 (E.L.U.C.S., 1976). Since its introduction, this mapping scheme has been used extensively by various Provincial and Federal Government agencies, as well as by private companies. During this time period, the classification has been modified to improve its application for several kinds of land evaluations. This update incorporates these modifications and has been undertaken to ensure that terrain maps are uniformly prepared and of high quality. It also ensures that an empirically supported, qualitative, standard terrain database system for both terrain and multiple resource interpretations is available for the Province of British Columbia.

The Terrain Classification System is based upon a classification system designed for mountainous terrain originally introduced by R. J. Fulton of the Geological Survey of Canada and presented at the workshop, "Base Data Inventories for Canada's Northlands", held in Toronto in April, 1974. It formed the basis of British Columbia's 1976 edition of the classification (E.L.U.C.S., 1976). The latter document was prepared by the staff of the Resource Inventory and Analysis/Interpretation Divisions of the Resource Analysis Unit, Environment and Land Use Committee Secretariat, British Columbia Department of Environment. The authors of that published manual included: N. F. Alley, A. N. Boydell, J. M. Ryder, D. E. Howes, M. E. Walmsley, A. Pattison, B. Thomson, T. Vold and R. Beale.

This revision of the Terrain Classification System is based on, and draws heavily from, the following sources: (1) the original 1976 document, (2) an unpublished draft document of the terrain classification system prepared for the British Columbia Ministry of Environment by J. M. Ryder, (3) suggestions and ideas contributed by several terrain mappers within the Province of British Columbia (see Acknowledgments), and (4) material developed by the contributing editors. Revisions have been kept at a minimum, thus, users familiar with the 1976 version of the classification should have no problem adapting to the changes (see Appendix IV for summary of changes). The text does not provide information about mapping techniques and field sampling procedures. Further information about the classification, particularly for the non-specialist, is available in "A User's Guide to Terrain Maps in British Columbia" by Ryder and Howes (1984). Regional terrain reports and maps available in British Columbia are listed in a catalogue prepared by Maps BC, Surveys and Resource Mapping Branch, British Columbia Ministry of Crown Lands.

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1988 EDITION

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The final version of this classification was reviewed by H. A. Luttmerding of the British Columbia Ministry of Environment, S. C. Chatwin of the British Columbia Ministry of Forests, and T. P. Rollerson of MacMillan Bloedel Ltd.

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INTRODUCTION

The Terrain Classification System is a scheme designed for the classification of surficial materials, landforms and geomorphological processes. It has been specifically developed to provide an inventory of the terrain features in the landscape and to show their distribution, extent and location. The system is scale independent and provides base data applicable for a wide range of natural resource applications including planning, management, impact assessment and research. The data is conveyed in map form by the use of terrain symbols and is conducive to computer digital storage, management and processing.

This document (1997) includes updated terms and symbols which are found listed in Appendix III, and indicated throughout the manual. This update defines VERSION 2.

EXAMPLE TERRAIN SYMBOL

Information is portrayed on a terrain map by a terrain symbol which is composed of a group of letters. These letters provide information about the character of the terrain and are arranged in a manner such that each letter position represents a particular characteristic of the terrain. Information provided by a terrain symbol includes texture and type of surficial material, surface expression, geomorphologic processes, and qualifiers.

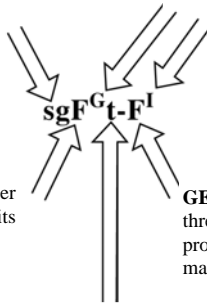
TEXTURE (one to three lower case letters) describes the size, roundness and sorting of particles in mineral sediments and the fiber content of organic materials (see p. 3-9).

QUALIFIERS (up to two superscript upper case letters) are used where appropriate to provide information about surficial materials and geomorphologic processes (see p. 60-62).

SURFICIAL MATERIAL one upper case letter) is classified according to its mode of deposition (see p. 10-25).

GEOMORPHOLOGICAL PROCESSES (one to three upper case letters) describes geomorphological processes that are modifying either surficial materials or landforms (see p. 42-59).

SURFACE EXPRESSION (one to three lower case letters) describes the form (shape) of the land surface or the thickness of the materials (see p. 26-41).



This symbol above indicates a glaciofluvial (F^G) terrace (t) composed of sandy gravel (sg) modified by slow downslope failures (F) that are no longer active (^I).

Note: Computer-drafted maps may present the superscripts in normal, inline fashion (e.g., FG, FI).

Note: Composite symbols, e.g., Mb/Cv-A, and stratigraphic symbols, e.g., $\frac{F^G v}{Mb}$, are commonly used. See pages 63-65.

CHAPTER 1

TEXTURE OF SURFICIAL MATERIALS

Texture refers to the size, shape and sorting of particles in clastic sediments, and the proportion and degree of decomposition of plant fibre in organic sediments.

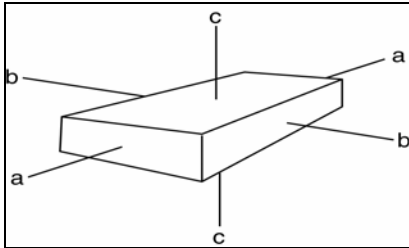


Figure 1. Model of the principal axes of a clast.

Particle size is considered to be the length of the intermediate (“b”) axis of a clast (Figure 1). For particles 2 mm in size or larger, this dimension can be measured by hand. Smaller particle sizes can be estimated in the field by hand texturing (see Appendix II) or measured by laboratory procedures. The proportion of sand particles may be determined in the field by sieving. The Wentworth Grade Scale (in Krumbein and Sloss, 1963, p. 96) is the basis of the particle size classification, with the exception that 0.002 mm has been adopted as the silt/clay boundary.

Particle shape refers to the degree of roundness of clasts greater than 2 mm. Roundness is the degree of rounding or smoothing (c.f. angularity) of the edges and corners (Figure 2).

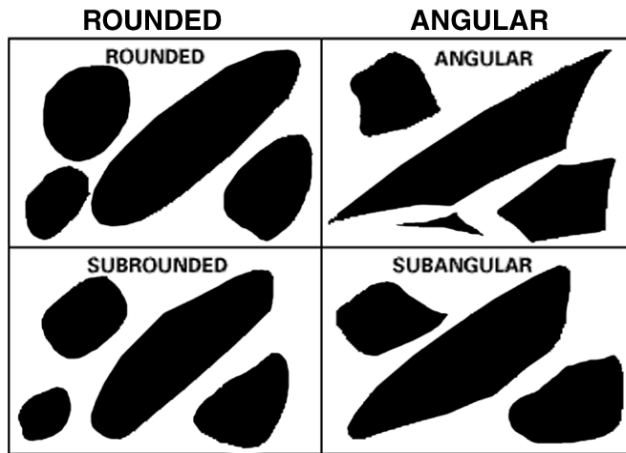


Figure 2. Particle roundness: two general classes are used in terrain mapping (rounded and angular).

The degree of sorting or particle size distribution refers to the range of particle sizes in a sediment. A “well-sorted” sediment, such as eolian dune sand, consists of a narrow size range, whereas a “poorly-sorted” sediment, such as ice-contact (glaciofluvial) material, encompasses a broad size range.

TEXTURAL TERMS AND SYMBOLS

<i>Specific Clastic Terms</i>		<i>Common Clastic Terms</i>		<i>Organic Terms</i>	
Name	Map Symbol	Name	Map Symbol	Name	Map Symbol
blocks	a	mixed fragments	d	fibric	e
boulders	b	angular fragments	x	mesic	u
cobbles	k	gravel	g	humic	h
pebbles	p	rubble	r		
sand	s	mud	m		
silt ¹	z	shells	y		
clay	c				

DEFINITION OF TEXTURAL TERMS

The definition of the specific and common clastic, and organic texture terms are provided below. Table 1.1 illustrates the relationship of size and roundness in the textural classification of the clastic sediments; example textures are presented in Figure 3.

Table 1.1. Relation of size and roundness, clastic textural terms.

roundness \ size mm		size mm				
		256	64	2	.062	.002
specific	rounded	boulder b	cobble k	pebble p		
	rounded/ angular			sand s	silt z	clay c
	angular	block a				
common	rounded	gravel g				
	rounded/ angular	mixed fragments d			mud m	
	angular		rubble r			
		angular fragments x				

¹ Silt is now (1997) represented by the symbol z (formerly s).

Specific Clastic Terms

Specific clastic textures have a narrow size range and an implication of clast shape (rounded versus angular) for particles greater than 2 mm in size.

<i>Name</i>	<i>Definition</i>
blocks	Angular particles greater than 256 mm in size.
boulders	Rounded particles greater than 256 mm in size.
cobbles	Rounded particles between 64 and 256 mm in size.
pebbles	Rounded particles between 2 and 64 mm in size.
sand	Particles between .0625 and 2 mm in size.
silt	Particles between 2 μ m and .0625 mm in size.
clay	Particles less than 2 μ m in size.

Common Clastic Terms

Common clastic terms refer to groupings of specific clastic size ranges and, in some cases, clast shape.

<i>Name</i>	<i>Definition</i>
mixed fragments	A mixture of rounded and angular particles greater than 2 mm in size.
angular fragments	A mixture of angular fragments greater than 2 mm in size (i.e., a mixture of blocks and rubble).
gravels	A mixture of two or more size ranges of rounded particles greater than 2 mm in size (e.g., a mixture of boulders, cobbles and pebbles); may include interstitial sand.
rubble	Angular particles between 2 and 256 mm; may include interstitial sand. Note: In general, little or no fine material will be visible on a rubble surface. At depth, sand and smaller particles may occupy the interstices between the coarser particles.
mud	A mixture of silt and clay; may also contain a minor fraction of fine sand.
shells	A sediment consisting dominantly of shells and/or shell fragments.



(a)



(b)



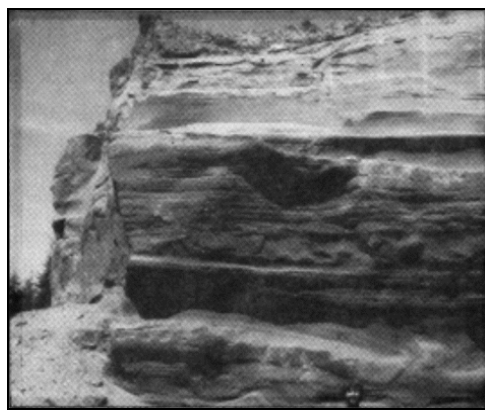
(c)



(d)



(e)



(f)

Figure 3. Examples of various textures: (a) blocky talus (colluvium); (b) cobbles and boulders on a beach; (c) well-bedded glaciofluvial sand and gravel; (d) till made up of rounded and angular particles (mixed fragments) in a silty sand matrix; (e) silty glaciolacustrine sediments; and (f) bedded glaciofluvial sands.

Organic Terms*

Organic terms are based on the proportion and degree of decomposition of the organic materials.

<i>Name</i>	<i>Definition</i>
fibric	The least decomposed of all organic materials. It contains amounts of well-preserved fibre (40% or more) that can be identified as to botanical origin upon rubbing.
mesic	Organic material at a stage of decomposition intermediate between fibric and humic.
humic	Organic material at an advanced stage of decomposition; it has the lowest amount of fibre, the highest bulk density, and the lowest saturated water-holding capacity of the organic materials; fibres that remain after rubbing constitute less than 10% of the volume of the material.
Note: Rubbed fibre is the fibre that remains after rubbing a sample about 10 times between the thumb and forefinger.	

*See Canada Soil Survey Committee (1978) for full definitions.

APPLICATION OF TEXTURAL TERMS

- Up to three textural terms can be used to describe the texture of a surficial material; textural term symbols are placed before the surficial material symbol; where two or three textural symbols are used, they are listed in reverse order of importance so that the symbology may be easily verbalized: a coarse textural component need not be shown if it constitutes less than 20% of the total volume of the deposit, but small proportions of silt and clay should be indicated because they have a significant effect on material properties. Table 2.2 shows the corresponding range in percent amount of each texture class when 1 to 3 textural terms are used.

Table 1.2. Percent composition for texture descriptions consisting of 1 to 3 symbols.

<i>Number of Symbols</i>	<i>Example</i>	<i>Subordinate 2</i>	<i>Subordinate 1</i>	<i>Dominant</i>
1	s (sand)	-	-	80-100 (sand)
2	gs (gravelly sand)	-	20-50 (gravel)	50-80 (sand)
3	bgs* (bouldery gravelly sand)	<30 (boulders)	25-40 (gravel*)	40-60 (sand)
*Note: In this example the gravel term indicates pebbles and cobbles (see p. 9).				

CHAPTER 2

SURFICIAL MATERIALS

Surficial materials are defined as non-lithified, unconsolidated sediments. They are produced by weathering, sediment deposition, biological accumulation, human and volcanic activity. They include residual materials weathered from rock in situ; transported materials composed of mineral, rock and organic fragments deposited by water, wind, ice, gravity, or any combination of these agents; accumulated materials of biological origin, materials moved and deposited by human actions; and unconsolidated pyroclastic sediments.

In general, surficial materials are of relatively young geological age and they constitute the parent material of most (pedological) soils. Other terms that are virtually synonymous with “surficial material” are the “Quaternary sediments” and “unconsolidated materials” of the geologist and the “soil” and “earth” of the engineer. Surficial materials are classified according to their mode of formation. Specific processes of erosion, transportation, deposition, mass wasting and weathering produce materials that have specific sets of physical characteristics. This is the single most useful descriptor of surficial materials.

Surficial materials are also described by the status of their formative process. *Each surficial material has an assumed status of activity.* The status is either active or inactive, and is indicated by a qualifier symbol: superscript “T” (inactive) or “A” (active)². Status of activity is indicated only when the actual state of formation is contrary to the assumed state defined for each material. Surficial materials displaying direct evidence that glacier ice exerted a strong, but secondary or indirect control, upon their mode of origin are indicated by a qualifier symbol, superscript “G”. For further details see “Qualifiers”, pages 60-62.

SURFICIAL MATERIAL TERMS AND SYMBOLS

<i>Material Name</i>	<i>Map Symbol³</i>	<i>Assumed Status of Formative Process</i>
Anthropogenic Material	A	active
Colluvium	C	active
Weathered Bedrock (in situ)	D	active
Eolian Material	E	inactive
Fluvial Material	F	inactive
Glaciofluvial Material	F^G	inactive
Ice	I	active
Lacustrine Material	L	inactive
Glaciolacustrine Material	L^G	inactive
Morainal Material (Till)	M	inactive
Organic Material	O	active
Bedrock	R	–
Undifferentiated Materials	U	–
Volcanic Material	V	inactive
Marine Material	W	inactive
Glaciomarine Material	W^G	inactive

² Computer-drafted maps may show normal in-line letters.

³ Computer-drafted maps may show FA, FG, LG, WG, etc.

DEFINITION OF SURFICIAL MATERIAL TERMS

Anthropogenic Material

Map Symbol: A

Status: active

Artificial materials, or geological materials so modified by human activities that their original physical properties (e.g., structure, cohesion, compaction) have been drastically altered.

General Description: Anthropogenic materials commonly have a wide range of textures. They are typically formed by the removal of material from an original site followed by deposition elsewhere. Also included are areas where topography and/or surface materials have been extensively changed due to removal of rock or unconsolidated deposits. These deposits are commonly associated with mineral exploitation, waste disposal and archaeological sites.

Application and Examples:

- Applied to landfills, spoil heaps, tailings, and artificial islands; also used to describe excavation areas such as open-pit mines.
- Applied to archaeological sites such as middens and historical whale rendering sites.

Example: a historic shelly midden yA^t

- On-site symbols should be used for anthropogenic sites where the area of disturbance is too small to be mapped (p. 78).
- Anthropogenic is not applied to urban areas where development has not modified the in situ material.

Colluvium

Map Symbol: C

Status: active

Materials that have reached their present positions as a result of direct, gravity-induced movement involving no agent of transportation such as water or ice, although the moving material may have contained water and/or ice.

General Description: Generally consist of massive to moderately well-stratified, non-sorted to poorly-sorted sediments with any range of particle sizes from clay to boulders and blocks. The character of any particular colluvial deposit depends upon the nature of the material from which it was derived and the specific process whereby it was deposited.

Application and Examples:

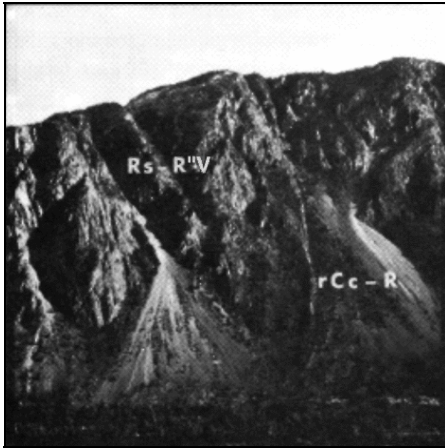
- Applied to unconsolidated materials that originate by disintegration of rock and have been moved by gravity. These include local, bedrock-derived colluvial mantles, and deposits from specific mass wastage processes (see Table 6.1). In general, these deposits are rubbly to blocky in texture and relatively easily identified (Figure 5).

Example: colluvial veneer derived from, and overlying, bedrock $\frac{rCv}{Rk}$

- Colluvial veneers and blankets derived from, and overlying, unconsolidated Quaternary sediments are only mapped if they are significantly dissimilar to the underlying material.

Examples: colluvium derived from bedrock overlying till blanket $\frac{rCv}{Mb}$

weathered mantle of till overlying unweathered till Mb



(a)



(b)



(c)

Figure 5. (a) Talus cones (map symbol: **rCc-R**) derived from the steep bedrock outcrops by rapid mass movement and gully processes (map symbol: **Rs-R''V**) (location of photo: Keremeos). (b) Fine-textured slump deposit (map symbol: **zCh**) derived from glaciolacustrine silts (location of photo: Spence's Bridge). (c) Angular, bedrock-derived colluvium deposited as a result of rapid mass movement processes in the form of a colluvial fan (map symbol: **srCf-R**) (location of photo: Port Alice, Vancouver Island).

- Clastic and/or organic deposits resulting from snow avalanches, landslide and rockfall debris, earthflows and debris–flows, are mapped as colluvium. These deposits typically occur as fans, cones, hummocks or irregular topography (Figure 5).

Examples:	talus slope	rCk
	debris–flow fan	mdCf
	slump–earthflow derived from glaciolacustrine silts	zChu

- Colluvium is considered to be a product of an active process unless there is evidence to the contrary. Most mass movement processes tend to be continuous or repetitive over time. Thus, it may be unwise to indicate a process has definitely ceased to occur. The map symbol “C^b” should only be used with great caution.

Weathered Bedrock

Map symbol: **D**

Status: **active**

Bedrock decomposed or disintegrated in situ by processes of mechanical and/or chemical weathering.

General Description: The character of weathered bedrock debris depends on the process of formation and the type of bedrock. Debris produced by mechanical weathering typically consists of angular fragments, although plutonic rock fragments may be converted in situ to subrounded forms by spheroidal weathering. In contrast, bedrock that has been altered by chemical weathering usually contains a high proportion of residual silts and clays.

Application and Examples:

- Applied only to rock that has been sufficiently weathered so that properties related to its strength are significantly different from those of the equivalent unweathered rock.
- Applied to weathered bedrock that has not been subject to downslope movement due to gravity. Weathered bedrock may be distinguished from colluvium on gently sloping surfaces by the absence of features that result from downslope movement such as solifluction lobes, stone stripes and boulder streams.
- Includes blockfields, grus, and saprolite (Figure 6).

Examples:	blockfield	aDb
	thin veneer of weathered shale (in situ)	zDx

- Blockfields too small to be mapped as a terrain polygon may be indicated by an on–site symbol (p. 76).

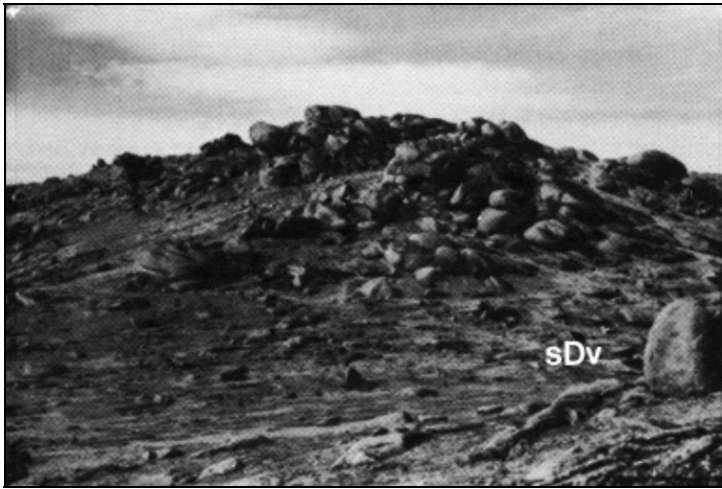


Figure 6. Weathering of granodiorite produced this grus-covered area with rounded boulders and tors. If slope processes are not apparent, this terrain is mapped as weathered bedrock (map symbol: **sDv**). (Location of photo: Okanagan Range, south central British Columbia).

Eolian Material	Map symbol: E	Status: inactive
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Materials transported and deposited by wind action.

General Description: Generally consists of medium to fine sand and coarse silt that is well-sorted, non-compacted, and may contain internal structures such as cross-bedding or ripple laminae, or may be massive. Individual grains may be rounded and exhibit frosting.

Application and Examples:

- Includes loess, dunes, and veneers and blankets of sand and coarse silt.

Examples:	veneer of sandy silt on a river terrace	$\frac{szEv}{Ft}$
	active sand dune	sE^A_r

- Inactive or active dunes too small to be mapped may be indicated by an on-site symbol (p. 76).

Materials transported and deposited by streams and rivers; synonymous with alluvial.

General Description: Deposits generally consist of gravel and/or sand and/or silt (and rarely, clay). Gravels are typically rounded and contain interstitial sand. Fluvial sediments are commonly moderately to well-sorted and display stratification, although massive, non-sorted fluvial deposits do occur.

Application and Examples:

- Applied to materials associated with floodplains, fluvial terraces and fans, and deltas.
- Floodplain deposits include channel deposits of relatively coarse gravel with weak to prominent stratification, and flood deposits (overbank sediments and levées) that may cover extensive areas away from the main channel and are composed of relatively finer sediments (commonly silt and sand).

Example:	floodplain consisting of channel gravels overlain by overbank silt and sand	$\frac{zsF^A v}{gFp}$
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- Fluvial terrace deposits consist of channel deposits that may include some overbank materials.

Example:	an inactive fluvial terrace composed of stratified sand and gravel	sgFt
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- Fluvial materials that are likely to be affected by inundation or channel processes are considered to be active. This is indicated by the “active” process qualifier denoted by the superscript “A” (see p. 61-62).

Example:	active floodplain made up of pebble sized gravel in sands ⁴	psF ^A p
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- Fans consisting of interbedded fluvial and colluvial sediments should be mapped as either fluvial “F” or colluvial “C” depending upon which type of material or process appears to be dominant.
- Deltas are mapped as fluvial materials because most delta surfaces are essentially the result of fluvial processes.

⁴ Computer-drafted maps may show psF^Ap.

Materials that exhibit clear evidence of having been deposited by glacial meltwater streams either directly in front of, or in contact with, glacier ice.

General Description: Glaciofluvial materials typically range from non-sorted and non-bedded gravel made up of a wide range of particle sizes, such as that resulting from very rapid aggradation at an ice front, to moderately- to well-sorted, stratified gravel; flow tills may occur in some deposits. Slump structures and/or their equivalent topographic expression, such as hummocky or irregular terrain may be present. These features are indicative of collapse of the material due to melting of supporting ice. Kettles may occur on the surface of these deposits; they result from the melting of buried or partially buried ice.

Application and Examples:

- Applied to materials that make up kettled or pitted outwash, kames and kame terraces, delta kames, eskers, and kame and kettle topography (Figure 7).

Examples:	kettled or pitted sandy gravel outwash plain	sgF^Gp-H
	eolian veneer of sandy silt overlying a gravel kame terrace	$\frac{szEv}{gF^Gt}$

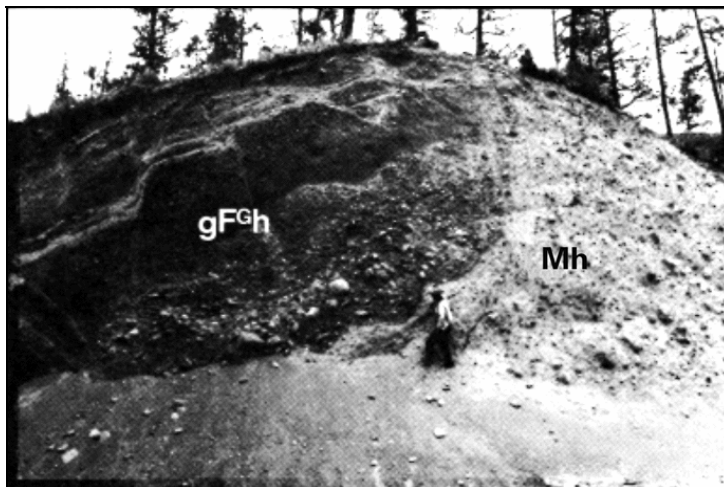


Figure 7. Cross-section through a hummock in kame and kettle topography that shows ice-contact gravels (map symbol: gF^Gh) (note: slump structures and rapid textural variations) and till (map symbol: Mh).

- Outwash deposits, such as plains and terraces displaying none of the ice contact features described above (e.g., kettles) may be mapped as glaciofluvial deposits if reconstruction of

the geological history indicates a glacial source; otherwise, these deposits are mapped as fluvial material (F).

- Eskers and kettles too small to be mapped can be indicated by on-site symbols (p. 75). Other glacial features that may be associated with glaciofluvial deposits and for which on-site symbols are available, are listed on pages 74-75.

Ice	Map Symbol: I	Status: active
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Areas of snow and ice where evidence of active glacier movement is present.

Application and Examples:

- Glacier movement is indicated by features such as crevasses, supraglacial moraines, icefalls and ogives.
- Applied to all types of glaciers and associated permanent snowfields such as cirque glaciers, mountain icefields, and valley and piedmont glaciers.

Examples:	a valley glacier overlain by coarse, angular ablation moraine	$\frac{arMb}{I}$
	an icefield with nunataks	I//Rs

Lacustrine Materials	Map Symbol: L	Status: inactive
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Sediments that have settled from suspension and underwater gravity flows, such as turbidity currents, in bodies of standing fresh water, or sediments that have accumulated at their margins through the action of waves.

General Description: Sediments commonly consist of stratified fine sand, silt and/or clay deposited on the lake bed from suspension, or moderately- to well-sorted, stratified sand and coarser materials that are beach and other littoral sediments transported and deposited by wave action.

Application and Examples:

- Applied to Holocene lake basins that have either drained or infilled, and active or “raised” (inactive) shoreline deposits.

Examples:	drained lake floor	zLp
	modern beach along a lakeshore	sgL ^A j

“raised” beach ridge

gLm

- May be applied to intermittently exposed sediments on the floors of seasonal lakes.

Example: floor of shallow lake periodically inundated zL^Ap-U

- Deltas are mapped as either fluvial or glaciofluvial materials.
- Raised shorelines too small to be mapped can be illustrated by the strandline on-site symbol (p. 76).
- Lacustrine materials of limited extent and overlain by younger surficial materials may be indicated by the on-site stratigraphic symbol (see p. 78). This is particularly useful because of the lacustrine materials’ potential effects on slope stability and groundwater movement.

Glaciolacustrine Materials	Map Symbol: L ^G	Status: inactive
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Lacustrine materials deposited in or along the margins of glacial (ice-dammed) lakes; includes sediments that were released by the melting of floating ice.

General Description: Glaciolacustrine sediments include: 1) lake bed sediments consisting of stratified fine sand, silt and/or clay; they commonly contain ice-rafted stones and lenses of till and/or glaciofluvial material; slump structures and/or their topographic expression, such as hummocky or irregular terrain, may be present and are indicative of collapse of the material due to melting of supporting ice; kettles may occur on the surface of these deposits, the result of the melting of buried or partially buried ice, and 2) moderately-sorted to well-sorted, stratified sand and coarser beach sediments transported and deposited by wave action along the margins of glacial lakes.

Application and Examples:

- Applied to lake sediments that display ice-contact features such as kettles, slump structures, and the inclusion of ice-rafted stones and other materials (Figure 8).

Examples: Pitted or kettled terrace of glaciolacustrine silt zL^Gt-H

Escarpment composed of glaciolacustrine sand overlain by till $\frac{Ms}{sL^Gs}$



Figure 8. Fine-textured glaciolacustrine sediments exposed in a terrace; note the drop stone (arrow) and contorted bedding (map symbol: zL^{Gt}) (location of photo: Gold River, Vancouver Island).

- Most lacustrine sediments in British Columbia that lie at elevations above present valley floors were deposited in glacial lakes that have subsequently drained. If reconstruction of the former lake (elevation, extent and outlet location) indicates it was ice-dammed or blocked by other means peculiar to glaciation, the deposits are mapped as glaciolacustrine. Otherwise, the deposit is mapped as lacustrine using the surficial material symbol “L”.
- Relict shoreline deposits may be mapped by the strandline on-site symbol; glaciolacustrine materials of limited extent or overlain by younger surficial materials may be indicated by the on-site stratigraphic symbol (see p. 78). This is particularly useful because of the glaciolacustrine materials’ potential effects on slope stability and groundwater movement. Other glacial features which may be associated with glaciolacustrine deposits and for which on-site symbols are available are listed on pages 75-76.

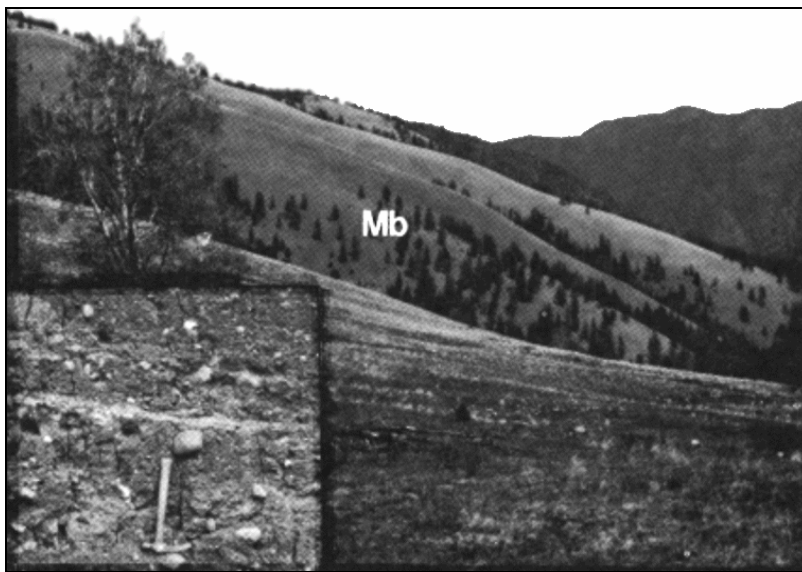
Morainal Material (Till)Map symbol: **M**Status: **inactive*****Material deposited directly by glacier ice without modification by any other agent of transportation.***

General Description: Morainal material can be transported beneath, beside, on, within and in front of a glacier. The mineralogical, textural, structural and topographic characteristics of till deposits are highly variable and depend upon both the source of material incorporated by the glacier and the mode of deposition. In general, till consists of well-compacted to non-compacted material that is non-stratified and contains a heterogeneous mixture of particle sizes, often in a matrix of sand, silt and clay.

Application and Examples:

- Applied to all varieties of till, including basal till (ground moraine), lateral and terminal moraines, moraines of cirque glaciers, hummocky ice-disintegration moraine, Neoglacial (recent) moraines and pre-existing unconsolidated sediments reworked by a glacier so that their original character (not necessarily texture) is largely or completely destroyed (Figure 9).

Examples:	rolling till plain	mdMm
	moraine at terminus of modern glacier ⁵	xM ^A r
	hummocky ice-disintegration moraine	zsgMh



*Figure 9. Bedrock slope mantled by till that is of uniform thickness greater than 1 metre (map symbol: **Mb**) and cross-section of a basal till (inset) illustrating a typical till texture made up of rock fragments of many sizes and shapes in a matrix of sand, silt and clay (location of photo: Ashnola River Valley).*

⁵ Computer-drafted maps may show xMAR.

till of variable thickness
overlying hummocky bedrock

$\frac{Mw}{Rh}$

- Bedrock escarpments of limited extent can be shown using the appropriate on-site symbol (see p. 76).
- Bedrock type can be indicated where necessary, see Bedrock Subclasses (p. 71-72).

Example: bedrock ridge consisting of quartzite qtRr

Undifferentiated Materials

Map symbol: U

Status: **not applicable**

A layered sequence of several types of surficial material outcropping on a steep, erosional (scarp) slope.

Application and Examples:

- Applied to steep slopes where linear bands (in plan view) of different materials are so closely juxtaposed that they cannot be delimited separately at the scale of mapping (Figure 10).

Example: scarp slope consisting of a layered sequence of several materials Us

- Texture symbols are not used to describe undifferentiated deposits.



Figure 10. Steep slope or escarpment consisting of layers of till, glaciofluvial gravel, marine silt and fluvial gravel is mapped as "Us" (location of photo: Cowichan Head, Victoria).

- The symbol “U” may be used as part of a composite unit where a mapper judges it is necessary to indicate the presence of a specific member of the undifferentiated group.

Example: as above, but the mapper wishes to indicate the presence of the glaciolacustrine silt and clay Us/zcL^Gs

- The stratigraphic sequence that is represented by the symbol “U” may be indicated using the stratigraphic on-site symbol (see p. 78).

Volcanic Material Map Symbol: **V** Status: **Inactive**

Unconsolidated pyroclastic sediments.

General Description: Volcanic sediments consisting of ash, cinder lapilli and/or volcanic bombs and blocks.

Application and Examples:

- Generally applied to tephra (volcanic ash) and cinder deposits (Figure 11).

Example: thick, sand-textured tephra over till $\frac{sVb}{Mu}$

- In British Columbia, thin layers of volcanic ash buried by younger, non-volcanic sediments are generally less than 10 cm thick, and are not considered mappable units. If necessary, they can be shown by an on-site stratigraphic symbol (see p. 78). Cinder cones of limited extent may be shown using the appropriate on-site symbol (see p. 77).

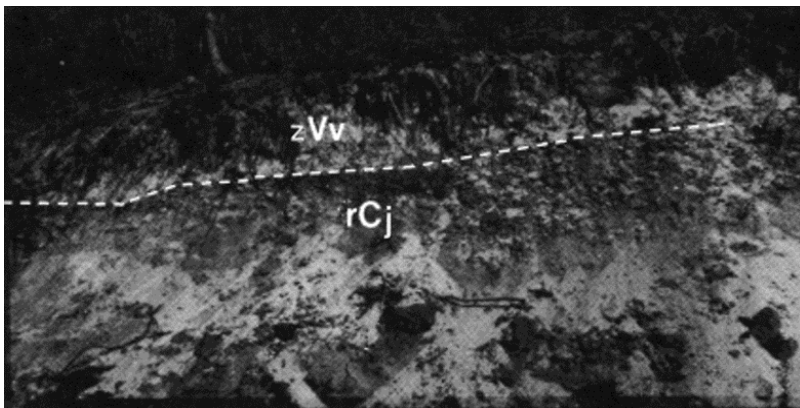


Figure 11. A veneer of silt-size volcanic ash overlying rubbly, bedrock-derived colluvium (map symbol: $\frac{zVv}{rCj}$) (location of photo: Bridge River near Lillooet).

Sediments deposited in salt or brackish water bodies by settling from suspension and submarine gravity flows, or sediments that have accumulated in the littoral zone through shoreline processes such as wave action and longshore drift.

General Description: Marine sediments deposited offshore generally consist of clay, silt, and sand that is well- to moderately well-sorted, and well-stratified to massive. Littoral marine sediments consist of well-sorted and well-rounded gravels and sand. Both sediments may contain shells and the remains of other marine organisms.

Application and Examples:

- Applied to all post-glacial marine sediments, including presently active shoreline deposits, and offshore and relict shoreline deposits which may have been elevated above present sea level due to isostatic or tectonic uplift (Figure 12).

Examples:	modern beach	gW^Aj
	elevated marine clay plain	cWp
	raised gravel beach overlying till	$\frac{gWr}{Mj}$

- Marine and lacustrine sediments have many characteristics in common. Deposits may be judged to be marine if they are located in an area that might reasonably have been covered by salt water at the time that the materials were formed. Shells or shell casts of marine origin may occur in these sediments; although their presence indicates marine origin, their absence cannot be interpreted to the contrary.



Figure 12. Raised, linear beach ridges made up of well-rounded pebble gravels (inset) with interstitial sand (map symbol: **pWr**) (location of photo: Queen Charlotte Islands).

- Deltas are mapped as fluvial materials, not marine sediments.

CHAPTER 3

SURFACE EXPRESSION

Surface expression refers to the form (assemblage of slopes) and pattern of forms expressed by a surficial material at the land surface. This three-dimensional shape of the material is equivalent to “landform” used in a non-genetic sense (e.g., ridges, plain). Surface expression symbols also describe the manner in which unconsolidated surficial materials relate to the underlying substrate (e.g., veneer).

It is assumed that a terrain map will be presented on a topographic base map. The function of the surface expression terms is to augment and highlight the information provided by the topographic base map. They may describe features that are not evident from the contours of the map or highlight the topographic information where necessary. It is recommended that data provided by contours (e.g., slope angle and configuration) be included on a terrain map that is presented on a planimetric base map and if a terrain map is stored in a computer database.

The surface expression of surficial materials is classified according to slope, geometric shape and spatial pattern. The surface expression terms have no genetic implication.

SURFACE EXPRESSION TERMS AND SYMBOLS

<i>Surface Expression Name</i>	<i>Map Symbol</i>
moderate slope	a
blanket	b
cone(s)	c
depression(s)	d
fan(s)	f
hummock(s)	h
gentle slope	j
moderately steep slope	k
rolling	m
plain	p
ridge(s)	r
steep slope	s
terrace(s)	t
undulating	u
veneer	v
mantle of variable thickness ⁶	w
thin veneer ⁷	x

⁶ Mantle of variable thickness is new (1997).

⁷ Thin veneer is new (1997).

KEY TO THE SELECTION OF SURFACE EXPRESSION SYMBOLS

- 1a. Topography of a surficial material is either bedrock-controlled or it reflects the surface configuration of the underlying surficial material; i.e., in either case, the surface material is draped over and owes its landform to the topography of an underlying substrate 2
- 2a. Thickness of the surficial material is relatively uniform over bedrock or surficial material 3
- 3a. Thickness of the surface material is less than about 1 m See VENEER (v) and THIN VENEER (x)
- 3b. Thickness of surface material is greater than 1 m See BLANKET (b)
- 2b. Thickness of surface material is variable, ranging from 0 to a few metres; surface material fills or partly fills depressions in an irregular substrate that may be either bedrock or surficial material See MANTLE OF VARIABLE THICKNESS (w)
- 1b. There is no apparent relation between the topography of the surficial material and that of underlying bedrock or older surficial material; depositional or erosional landforms are present 4
- 4a. Simple, constructional or erosional landforms are present, consisting primarily of planar surfaces 5
- 5a. Slopes are between 0 and 3° (0-5%) See PLAIN (p)
- 5b. Slopes are between 4 and 15° (6-26%) See GENTLE SLOPE (j)
- 5c. Slopes are between 16 and 26° (27-49%) See MODERATE SLOPE (a)
- 5d. Slopes are between 27 and 35° (50-70%) See MODERATELY STEEP SLOPE (k)
- 5e. Slopes are steeper than 35° (70%) See STEEP SLOPE (s)
- 4b. More complex depositional or erosional landforms are present, consisting mainly of multi-directional, non-planar surfaces 6
- 6a. Non-linear rises and hollows with slopes generally less than 15° (26%) See UNDULATING TOPOGRAPHY (u)
- 6b. Elongate rises and hollows with slopes generally less than 15° (26%) See ROLLING TOPOGRAPHY (m)
- 6c. Non-linear rises and hollows with many slopes steeper than 15° (26%) See HUMMOCKS (h)
- 6d. Elongate rises with many slopes steeper than 15° (26%) See RIDGES (r)
- 6e. Hollows, separated from an adjacent gentler surface by a marked break of slope See DEPRESSIONS (d)
- 6f. A fan shaped landform that is a sector of a cone: longitudinal gradient less than 15° (26%) See FAN (f)
- 6g. A fan shaped landform that is a sector of a cone; longitudinal gradient more than 15° (26%) See CONE (c)
- 6h. Level areas and scarps adjacent downslope; stepped topography See TERRACES (t)

Comment:

APPLICATION OF SURFACE EXPRESSION

- Up to three surface expression terms may be used to describe the surface expression of a surficial material and are placed immediately after the surficial material symbol.
- The use of two or three surface expression terms together implies that there is a mixing or juxtaposition of discrete forms and not a combination of intermediate forms.
- When more than one surface expression term is used, the symbols are written in order of decreasing importance based on their areal extent.

DEFINITION OF SURFACE EXPRESSION TERMS

Moderate Slope

Map Symbol: **a**

An unidirectional (planar) surface with a slope 16 to 26° (27 to 50%), and a smooth, longitudinal profile that is either straight, or slightly concave or convex; local surface irregularities generally have a relief of less than 1 metre.

Application and Examples:

- Does not include the surface expression cone (see CONE below).
- Applied to constructional and erosional slopes in unconsolidated materials, such as the foreset slopes of deltas, erosional slopes in weak materials, and some constructional slopes in till and colluvium.

Examples:	foreset slope of a delta	sgF ^G a
	erosional slope in glaciomarine sediments	zW ^G a

- Applied to inclined bedrock.

Example:	rock slope with alternating steeper and gentler sections	Ras
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- Not applied to till or colluvium or other material on bedrock-controlled slopes.

Example:	colluvial veneer overlying moderately sloping smooth bedrock	$\frac{rCv}{Ra}$
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A layer of unconsolidated material thick enough to mask minor irregularities of the surface of the underlying material, but still conforms to the general underlying topography. A blanket is greater than 1 metre thick and possesses no constructional forms typical of the material's genesis; outcrops of the underlying unit are rare.

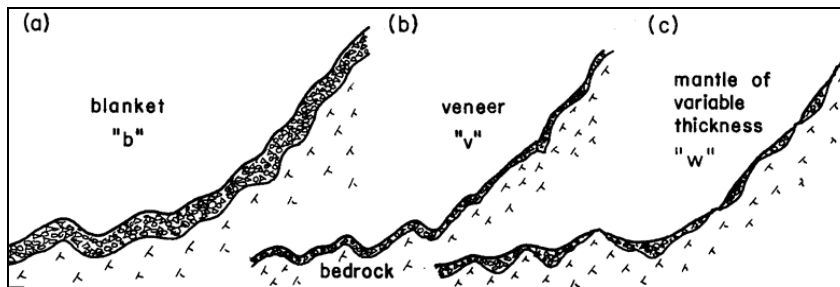


Figure 13. Schematic cross-sections that illustrate and distinguish the surface expression terms blanket, veneer, and mantle of variable thickness.

Application and Examples:

- The surface expression of the blanket is expressed by either the surface expression of the underlying unit, or by the contour lines of the topographic map (Figures 13 and 14).
- If the underlying unit is unconsolidated material, its presence is indicated in a stratigraphic symbol (see p. 64-65).

Example: till blanket overlying hummocky glaciofluvial gravels $\frac{Mb}{F^Gh}$

- If the underlying unit is bedrock, no stratigraphic information need be supplied, except where the contours of the topographic map do not adequately depict the land surface.

Examples: till blanket overlying bedrock with surface shape shown by contours (bedrock-controlled topography) Mb

till blanket overlying bedrock with surface shape not shown by contours (bedrock-controlled topography) $\frac{Mb}{Ru}$

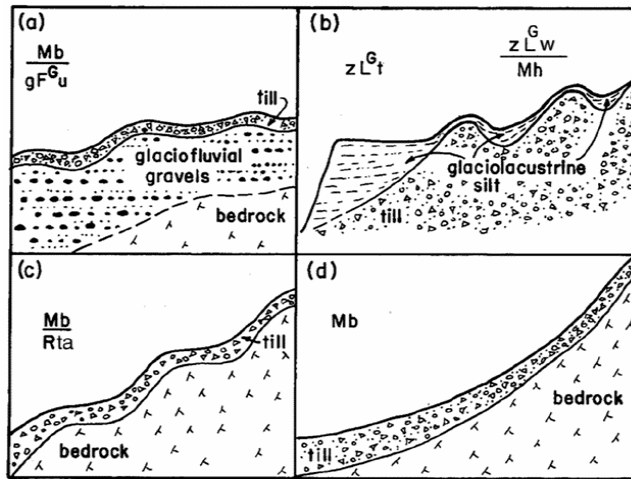


Figure 14. Schematic cross-sections to illustrate the use of stratigraphic symbols with the surface expression terms blanket, veneer, and mantle of variable thickness. In (d), "Mb" is used alone because contours indicate the long, convex hillside.

Cone(s)

Map Symbol: c

A cone or sector of a cone with a relatively smooth surface, and mostly steeper than 15° (26%), and a longitudinal profile that is either straight, or slightly concave or convex.

Application and Examples:

- A cone is distinguished from a fan on the basis of slope gradient (Figure 15). Refer to FAN.
- Typically applied to talus cones, avalanche cones, coalescing cones where individual cones can be distinguished and volcanic cones of pyroclastic materials.

Examples:	talus cones	rCc
	avalanche cones	arCc-A
	cinder cone	rVc

- Small volcanic cones may be indicated by on-site symbols (see p.77).

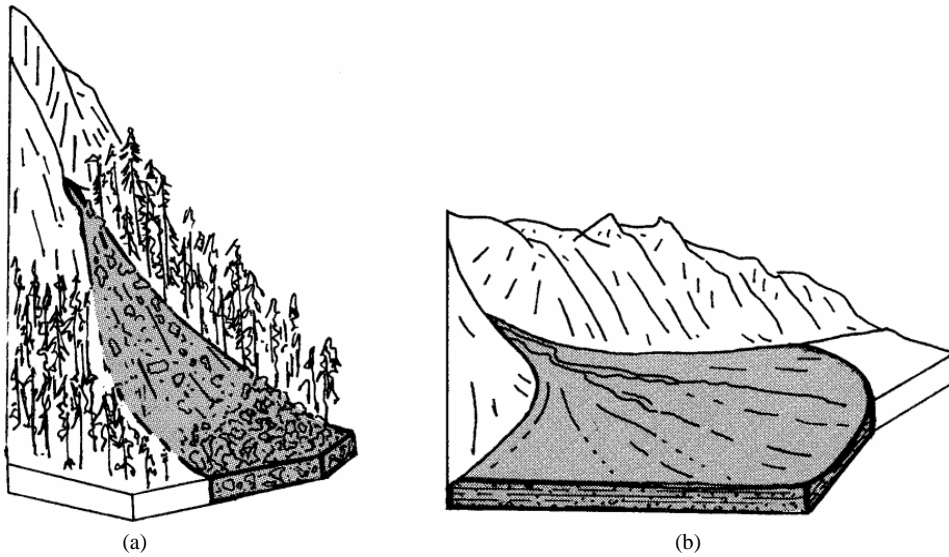


Figure 15. Block diagrams that illustrate the surface expression terms cone (a) and fan (b).

Depression(s)

Map Symbol: **d**

Circular or irregular area of lower elevation (hollow) than the surrounding terrain and delimited by an abrupt break in slope; side slopes within the depression are steeper than the surrounding terrain; depressions are two or more metres in depth.

Application and Examples:

- Typically used when mapping deposits containing kettle holes, karst depressions, or depressions caused by piping.
- If map scale permits, the term depression may be applied to a single enclosed depression.

Example: a large kettle in ice-contact materials gsF^Gd

- The origin of the depression, when known, should be indicated by the use of a “Geomorphological Process” symbol (see p. 42).

Examples:	a kettle hole	gsF ^G d-H
	pitted outwash plain	sgF ^G pd-H
	glaciolacustrine terrace with depressions caused by piping	mL ^G td-P

- On-site symbols for kettles, piping depressions, and karst depressions should be used instead of “d” where occurrence is of limited extent in relation to the whole map unit (p. 75-77)

Fan(s) Map Symbol: **f**

A fan is a relatively smooth sector of a cone with a slope gradient from apex to toe up to and including 15° (26%), and a longitudinal profile that is either straight, or slightly concave or convex.

Application and Examples:

- A fan is distinguished from a cone on the basis of slope gradient (Figure 15). Refer to CONE.
- Typically applied to fluvial (alluvial) fans, colluvial fans, or glaciofluvial fans.

Examples:	active colluvial fan	rCf
	“relict” fluvial fan	sgFf

- Applied to coalescing fans where individual fans are distinguishable.

Hummock(s) Map Symbol: **h**

Steep sided hillock(s) and hollow(s) with multidirectional slopes dominantly between 15 and 35° (26 to 70%) if composed of unconsolidated materials; bedrock slopes may be steeper. Local relief is greater than 1 metre. In plan, an assemblage of non-linear, generally chaotic forms that are rounded or irregular in cross-profile.

Application and Examples:

- Hummocky unconsolidated materials are sufficiently thick to mask the surface irregularities of the underlying material (Figure 16).
- Hummocky topography is distinguished from undulating topography on the basis of steeper slopes. Refer to UNDULATING TOPOGRAPHY.
- Commonly applied to knob-and-kettle topography, some landslide deposits, and hummocky bedrock.

Example:	kame-and-kettle glaciofluvial sediments	gsF ^G h-H
	landslide debris	mdCh
	till mantle of variable thickness overlying hummocky bedrock (till is thin on crests and thicker in depressions)	<u>Mw</u> Rh

Gentle Slope

Map Symbol: **j**

An unidirectional (planar) surface with slope gradient 4 to 15° (7 to 26%), and a smooth, longitudinal profile that is either straight, or slightly concave or convex; local surface irregularities generally have a relief of less than 1 metre.

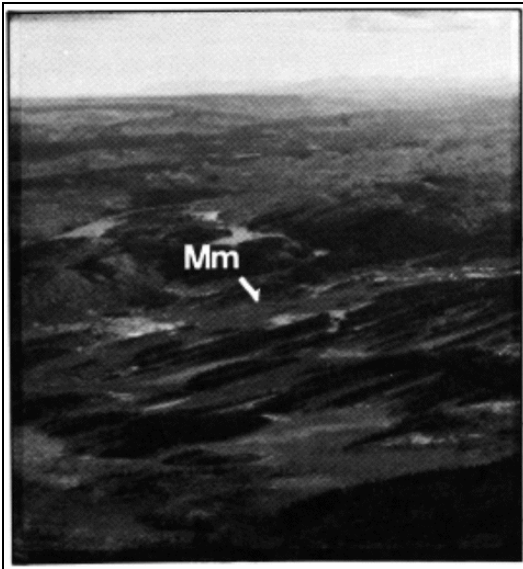
Application and Examples:

- Does not include the surface expression fan. Refer to FAN.
- Applied to gentle constructional slopes underlain by till or glaciofluvial materials, gently sloping beaches and the floodplains of steep creeks.

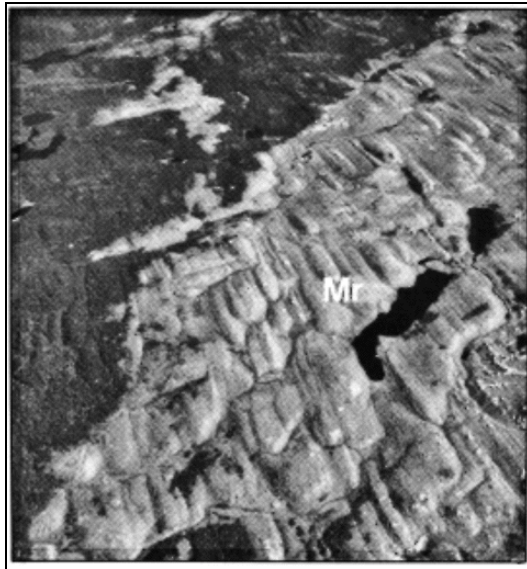
Examples:	floodplain of a steep creek	bgF ^A j
	thick till with gentle slopes and minor surface irregularities	dmMj

- Not applied to till or colluvium, or other material on bedrock-controlled slopes.

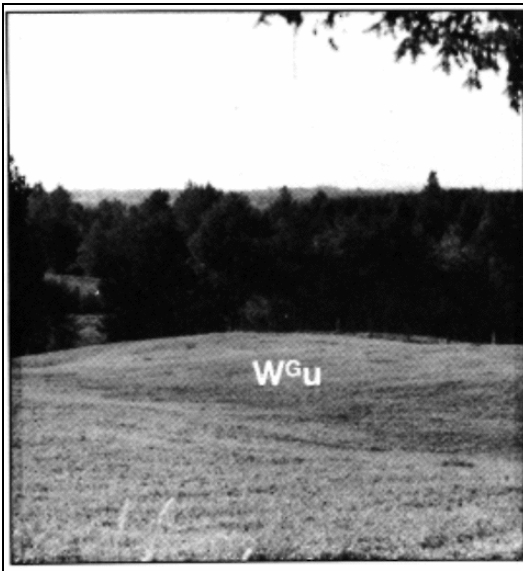
Example:	till 2-3 m thick covering gently sloping bedrock	<u>Mb</u> Rj
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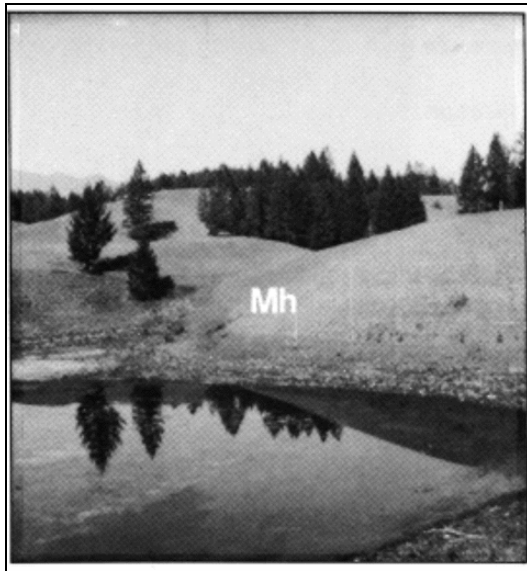
(a)



(b)



(c)



(d)

Figure 16. Examples of the surface expression terms rolling, ridged, undulating and hummocky. (a) Rolling till plain made up of low, gently sloping drumlinoid features on the Nahlin Plateau in the northwest corner of British Columbia (map symbol: **Mm**). (b) Drumlinized till plain on the McGregor Plateau; the drumlins are linear features characterized by steep slopes (map symbol: **Mr**). (c) Undulating glaciomarine deposit in the Fraser Valley characterized by gentle slopes and irregularly distributed swales (map symbol: **W^gu**). (d) Till hummocks with steep slopes in the Interior of British Columbia (map symbol: **Mh**).

Moderately Steep SlopeMap Symbol: **k**

An unidirectional (planar) surface with a slope gradient 27 to 35° (50 to 70%), and a smooth, longitudinal profile that is either straight, or slightly concave or convex; local surface irregularities generally have a relief of less than 1 metre.

Application and Examples:

- Does not include the surface expression cone. Refer to CONE.
- Applied to constructional and erosional slopes in unconsolidated materials, such as scarps resulting from stream erosion, gully side-scarps, ice-contact slopes and talus slopes.

Examples:	scarp of glaciofluvial terrace	gF ^G k
	side-slopes of gully eroded into till	Mk

- Applied to erosional slopes in bedrock, and to rock where rock-controlled slopes are covered by till, colluvium or other materials.

Examples:	moderately steep sloping bedrock	Rk
	colluvial veneer overlying moderately steep, smooth bedrock	$\frac{rCv}{Rk}$

Rolling TopographyMap Symbol: **m**

Elongate hillock(s) with slopes dominantly between 3 and 15° (5 to 26%) with local relief greater than 1 metre. In plan, an assemblage of parallel or sub-parallel linear forms with subdued relief.

Application and Examples:

- Rolling topography is distinguished from ridged topography on the basis of predominantly gentler slopes (Figure 16). Refer to RIDGE(S).
- Rolling unconsolidated materials are sufficiently thick to mask the surface irregularities of the underlying material.
- Commonly applied to fluted till plains, swell-and-swale topography, and subdued beach and bedrock ridges.

Examples:	“washboard” moraine	Mm
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beach strandlines

Wm

- Where rolling topography is the result of glaciation and reflects former ice-flow direction, the appropriate on-site symbols should be applied to the terrain map (e.g., drumlins, flutings, and roches moutonnées — p. 75).

Example: grooved till plain

Mm (with appropriate on-site symbol)

Plain

Map Symbol: **p**

A level or very gently sloping, unidirectional (planar) surface with gradients 0 to 3° (0 to 5%); local surface irregularities generally have a relief of less than 1 metre.

Application and Examples:

- Commonly applied to floodplains, organic deposits, lacustrine and marine plains, and the level portions of terraces and deltas (Figure 17).

Examples: active floodplain

sgF^Ap

organic deposit

Op

silty lacustrine plain

zLp

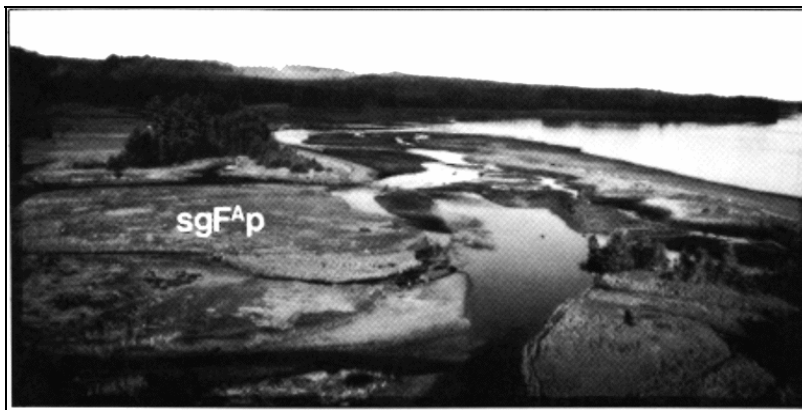


Figure 17. Level to very gently sloping (<3°) active delta deposit (map symbol: **sgF^Ap**) (location of photo: Port Hardy, Vancouver Island).

Ridge(s)

Map Symbol: **r**

Elongate hillock(s) with slopes dominantly between 15 and 35° (26 to 70%) if composed of unconsolidated materials; bedrock slopes may be steeper. Local relief is greater than 1 metre. In plan, an assemblage of parallel or sub-parallel linear forms.

Application and Examples:

- Ridged unconsolidated materials are sufficiently thick to mask the irregularities of the underlying material surface.
- Ridged topography is distinguished from rolling topography on the basis of predominantly steeper slopes (Figure 16). Refer to ROLLING.
- Commonly applied to drumlinized till plains, eskers, morainal ridges, crevasse fillings and ridged bedrock.

Examples:	sandy gravel esker	sgF ^G r
	till mantle of variable thickness	$\frac{Mw}{Rr}$
	overlying bedrock ridges	

- Where ridged topography is the result of glaciation and reflects former ice-flow direction, the appropriate on-site symbols should be applied to the terrain map (e.g., drumlins, flutings, and roches moutonnées — p. 75).

Example:	drumlinized till plain	Mr (with appropriate on-site symbol)
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Steep Slope

Map Symbol: s

An unidirectional (planar) surface with gradients greater than 35° (70%), and a smooth longitudinal profile that is either straight, or slightly concave or convex; local surface irregularities generally have a relief of less than 1 metre; bedrock slopes may be more irregular.

Application and Examples:

- Most commonly applied to steep erosional slopes of unconsolidated materials such as terrace scarps, river and lakeshore bluffs, gully side-slopes, steep bedrock slopes such as cliffs and steep slopes overlain by colluvium.

Examples:	cirque headwall	Rs
	lakeshore bluff	L ^G s
	escarpment of a river terrace	Fs
	steep-sided gully in thick till	Ms-V

(gully comprises entire polygon)

- Where the map scale does not permit the delineation of a scarp, an on-site symbol should be applied to indicate the scarp location and extent (see p. 76).

Example: multiple fluvial terraces with narrow scarps Ft (with scarp symbols)

Terrace(s) Map symbol: **t**

A single or assemblage of step-like forms where each step-like form consists of a scarp face and a horizontal or gently inclined surface (tread) above it.

Application and Examples:

- Terrace is applied to both the scarp and the flat tread, that is, to the whole feature in the landscape; includes river and lake terraces, kame terraces and structurally-controlled, stepped topography (Figure 18).

Examples: river terrace gsFt
stepped bedrock topography Rt

- In units consisting of more than one terrace, individual terrace scarps can be designated by a scarp on-site symbol (see p. 76).

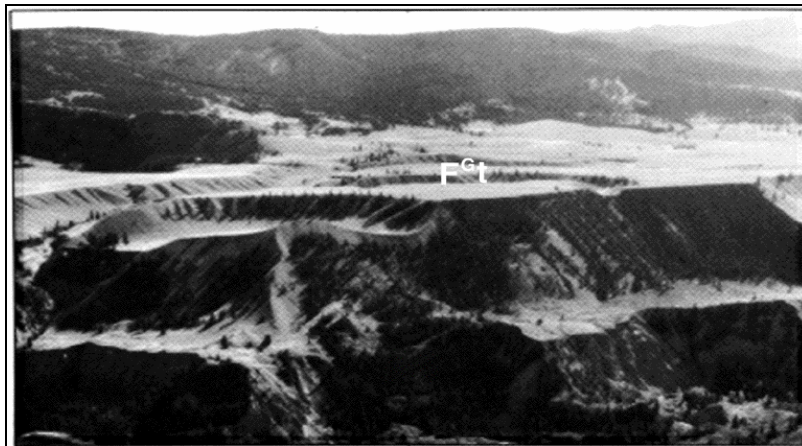


Figure 18. Terraces made up of thick Quaternary sediments (map symbol: **F^Gt**) (location of photo: Churn Creek near the Gang Ranch).

Undulating Topography Map symbol: **u**

Gently sloping hillock(s) and hollow(s) with multidirectional slopes generally up to 15° (26%); local relief is greater than 1 metre. In plan, an assemblage of non-linear, generally chaotic forms that are rounded or irregular in cross-profile.

Application and Examples:

- Undulating topography made up of unconsolidated materials sufficiently thick to mask the surface irregularities of the underlying material.
- Undulating topography is distinguished from hummocky topography on the basis of the predominantly gentler slopes (Figure 17). Refer to HUMMOCK(S).
- Commonly applied to undulating till plains, some landslide and dune deposits, and some ice-contact deposits.

Example:	undulating till plain	Mu
	dunes on river terrace	$\frac{Eu}{Ft}$
	discrete areas of kame hummocks and undulations	F ^G hu

Veneer

Map symbol: **v**

A layer of unconsolidated materials too thin to mask the minor irregularities of the surface of the underlying material. It is between about 10 cm and 1m in thickness, and possesses no constructional form typical of the material genesis.

Application and Examples:

- The surface topography of the veneer is indicated by either the surface expression of the underlying unit, or as expressed by the contour lines of the topographic map (Figures 13 and 14).
- When the underlying unit is unconsolidated material, its presence must be indicated by stratigraphic information (see p. 64-66).

Example: sandy eolian veneer overlying river terrace gravels $\frac{sEv}{gFt}$

- If the underlying unit is bedrock, no stratigraphic information need be supplied except where the contours of the topographic map do not adequately depict the land surface.

Examples: colluvial veneer overlying bedrock with surface shape shown by contours Cv

colluvial veneer overlying bedrock with surface shape not shown by contours $\frac{Cv}{Rh}$

- If veneer (v) and thin veneer (x) are used together, e.g., Cvx, then v indicates material 20 cm to 1 m thick, and x indicates material thinner than 20 cm.

Mantle Of Variable Thickness⁸

Map symbol: w

A layer or discontinuous layer of surficial material of variable thickness (typically 0 to 3 m) that fills or partly fills depressions in an irregular substrate. It is generally too thin to mask prominent irregularities in the underlying material.

Application and Examples:

- Similar to blanket and veneer.
- Mantle of variable thickness is draped over the underlying material and has no constructional form of its own.

Examples: mantle of variable thickness over hummocky rock (Figure 13c) $\frac{Mw}{Rh}$

mantle of glaciolacustrine sediments over hummocky till (Figure 14b) $\frac{zL^Gw}{Mh}$

⁸ This is a new term (1997).

A very thin layer of unconsolidated material about 2-20 cm in thickness.

Application and Examples:

- Similar to veneer. Intended primarily for terrain mapping that is to be used as the basis for ecosystem mapping.
- If veneer (v) and thin veneer (x) are used together, e.g., Cvx, then v indicates material 20 cm to 1 m thick, and x indicates material thinner than 20 cm.

⁹ This is a new term (1997).

CHAPTER 4

GEOMORPHOLOGICAL PROCESSES¹⁰

Geomorphological processes are natural mechanisms of weathering, erosion and deposition that result in the modification of the surficial materials and landforms at the earth's surface.

The status of all geomorphological processes in this classification is assumed to be “active”, except for the geomorphological processes “channeled by meltwater” and “kettled”, which have an assumed status of “inactive”. The status of activity of a geomorphological process is indicated only if it is contrary to the assumed state defined for each process. Status is indicated as “active” or “inactive” by the use of the qualifiers: superscript “T” (inactive) and “A” (active).¹¹ For further details refer to “Qualifiers”, p. 60-62.

GEOMORPHOLOGICAL PROCESS TERMS AND SYMBOLS

<i>Group</i>	<i>Geological Process Name</i>	<i>Map Symbol</i>	<i>Assumed Status of Geological Process</i>
Erosional Processes	Deflation	D	active
	Karst processes	K	active
	Piping	P	active
	Gully erosion	V	active
	Washing	W	active
Fluvial Processes	Braiding channel	B	active
	Irregularly sinuous channel	I	active
	Anastomosing channel	J	active
	Meandering channel	M	active
Mass Movement Processes	Snow avalanches	A	active
	Slow mass movements	F	active
	Rapid mass movements	R	active
Periglacial Processes	Cryoturbation	C	active
	Nivation	N	active
	Solifluction	S	active
	General periglacial processes	Z	active
	Permafrost processes	X	active
Deglacial Processes	Channeled by meltwater	E	inactive
	Kettled	H	inactive
Hydrologic Processes	Inundation	U	active
	Surface seepage ¹²	L	active

¹⁰ The term Geological (Modifying) Processes has been replaced with Geomorphological Processes.

¹¹ Computer-drafted maps can show normal upper-case letters, not superscript.

¹² This is a new term (1997).

Processes associated with the solution of carbonates (e.g., limestone, dolomite) and other soluble rocks; includes surface and underground weathering, and collapse and subsidence resulting from solution.

Application and Examples:

- Applied to carbonate and other rocks whose surfaces are marked by features such as sinkholes, uvalas, caves, surface etching, and limestone pavements.

Example: limestone outcrop with caves and sinkholes Ru-K

- Applied to depressions in surficial material that result from solution and subsidence in the underlying bedrock.

Example: till blanket with depressions due to collapse of underlying bedrock $\frac{Mb}{R} - K$

- Large and small karst depressions may be shown by on-site symbols.

Piping Map symbol: **P** Process status: **active**

Subterranean erosion of surficial materials by flowing water that results in the formation of tubular conduits due to the removal of particulate matter.

Application and Examples:

- Applied to surfaces exhibiting modification in the form of small hollows (collapse depressions) irregularly arranged, or aligned along routes of subsurface drainage (beaded gullies); these features occur most commonly in glaciolacustrine silts (Figure 19).

Example: piping in a glaciolacustrine terrace zL^Gt-P

- Piping may also occur in alluvium, volcanic ash, till, and colluvium, as evidenced by pipes in cross-sectional exposures.
- Depression resulting from piping may be shown by an on-site symbol.



Figure 19. Gullied terrace of glaciolacustrine silt undergoing modification by piping as indicated by the circular and semi-circular depressions (arrows) on the surface of the terrace (map symbol: zL^{Gt-VP}) (location of photo: Okanagan Valley, southern British Columbia).

Gully Erosion

Map symbol: **V**

Process status: **active**

The modification of unconsolidated and consolidated surfaces by various processes such as running water, mass movement and snow avalanching, resulting in the formation of parallel and sub-parallel long, narrow ravines.

Application and Examples:

- Gullies may have either steep or gently sloping sides, and either steep or gently sloping longitudinal profiles. They are much smaller than valleys but larger than rills, and occur on various types of terrain such as steep mountain slopes, escarpments and terraces (Figure 20).

Examples:	till overlying steep bedrock dissected by gullies	$\frac{M_{bv}}{R_s} - V$
	glaciolacustrine terrace dissected by gullies	L^{Gt-V}

- Individual gullies may be indicated by on-site symbols.

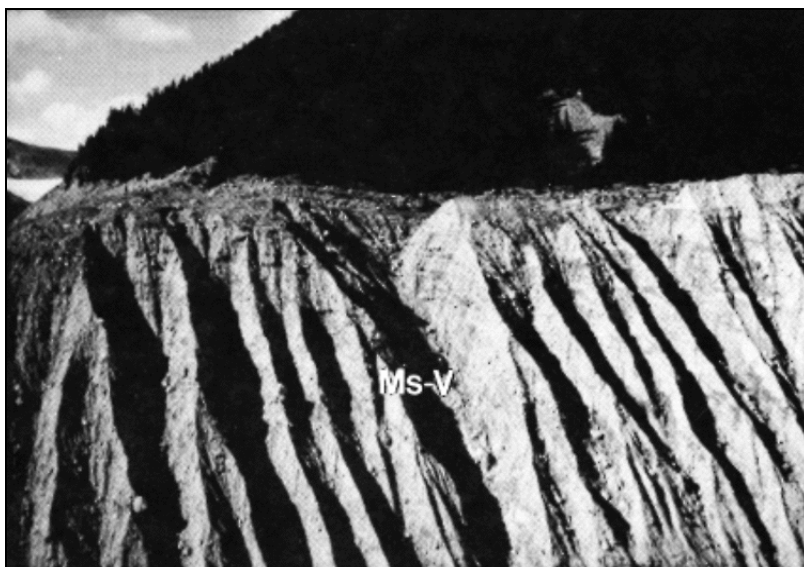


Figure 20. Gullied till in the Coast Mountains of British Columbia (map symbol: Ms-V).

Washing

Map Symbol: **W**

Process status: **active**

The modification of a surficial material by wave action or, occasionally, by running water (e.g., meltwater), resulting in lag deposits formed by the removal of fines from a mixture of coarse and fine particles.

Application and Examples:

- Commonly applied in areas of former glacial lakes, marine inundation, or areas of meltwater runoff. Active washing occurs along present shorelines.
- The process generally results in the formation of a thin lag gravel; thicker, water-deposited gravels (e.g., beaches) should be mapped as discrete units of surficial material.

Examples:	gravel pavement (lag) on till plain due to wave action in an ancient lake	Mp-W ^l
	marine beach gravels overlying a till plain (no process needed)	<u>gWj</u> Mp

DEFINITIONS FOR FLUVIAL PROCESSES

The behaviour of a river is a complex function of its discharge, sediment load and gradient. Analysis of these parameters is beyond the scope of terrain mapping, however over time, a particular kind of river behaviour results in a characteristic set of features, such as the type and distribution of floodplain sediments and floodplain vegetation, floodplain and channel zone morphology, and channel pattern. These features are amenable to air photo interpretation and can be mapped and interpreted as part of terrain analysis. The classification of fluvial processes is based primarily on channel patterns as these provide a useful basis for the interpretation of fluvial hazards and other river characteristics. The following symbols apply only to rivers on floodplains. See also Subclasses for Fluvial Processes (p. 47)¹³.

Braiding Channel

Map Symbol: **B**

Process status: **active**

Active channel zone is characterized by many diverging and converging channels separated by unvegetated bars. Many channels are dry at moderate and low flows, but during major floods, the entire channel zone may be occupied by flowing water.

Application and Examples:

- Most commonly applied to active floodplains and fluvial fans, and to distributary channels on deltas (Figure 21).

Example: braiding channel on active floodplain

sgF^Ap-B

- Braided channels on abandoned fluvial surfaces are classified as inactive.

Example: braided channel on former outwash plain

sgF^Gp-B^I



Figure 21. An example of a braiding channel at moderate to low flow (map symbol: sgF^Ap-B) (location of photo: Southgate River).

¹³ Fluvial Subclasses are new (1997).

Irregularly Sinuous ChannelMap Symbol: **I**Process status: **active**

A clearly defined main channel displaying irregular turns and bends without repetition of similar features; backchannels may be common, and minor side channels and a few bars and islands may be present, but regular and irregular meanders are absent.

Application and Examples:

- Applicable only to active floodplains and fluvial fans (Figure 22).

Example: fluvial fan with irregularly sinuous channel

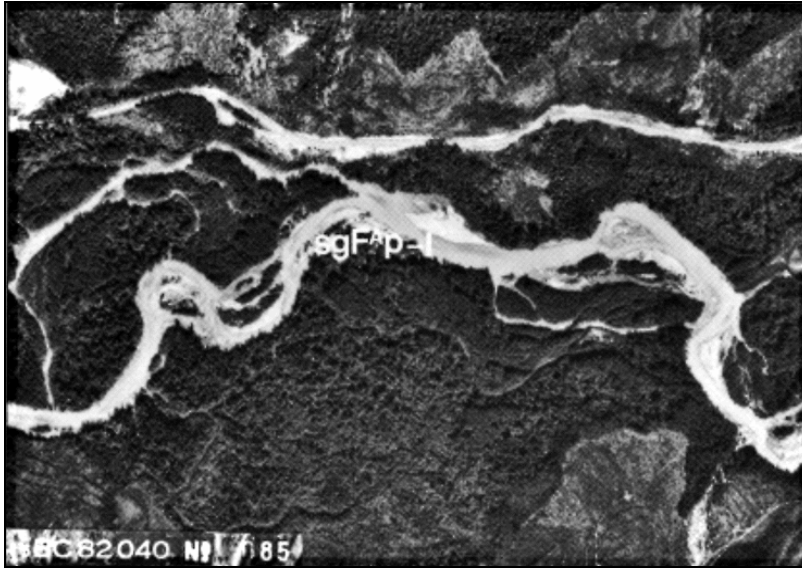
gF^Af-I

Figure 22. An irregularly sinuous channel; note there is a single, clearly defined main channel, although there are many back channels (map symbol: sgF^Ap-I) (location of photo: Bella Colla River).

Anastomosing ChannelMap Symbol: **J**Process status: **active**

A channel zone where channels diverge and converge around many islands. The islands are vegetated and have surfaces that are relatively far above mean maximum discharge levels. Some channels are dry at moderate or low flows.

Application and Examples:

- Applicable only to active floodplains and fluvial fans (Figure 23).
- Most anastomosing rivers occupy gravel channels; islands consist of relatively thick sequences of overbank silt and sand which overlie gravel at low-water level.

Example: gravel channel with islands of silty sand overlying gravel

$$gF^A p / \frac{zF^A b v}{gF^A p} - J$$



Figure 23. The Stikine River in the Coast Mountains, an example of anastomosing channel (map symbol: $F^A p - J$).

Meandering Channel

Map Symbol: **M**

Process status: **active**

A clearly defined channel characterized by a regular and repeated pattern of bends with relatively uniform amplitude and wave length.

Application and Examples:

- Applied to active floodplains that display features ranging from meander scars and cut-offs (ox-bow lakes) to regular scroll patterns (Figure 24). Zoned (i.e., linear pattern) successional vegetation may be present on point bars. Channel may be bounded by levées.

Example: floodplain with a meandering channel

$$sF^A p - M$$

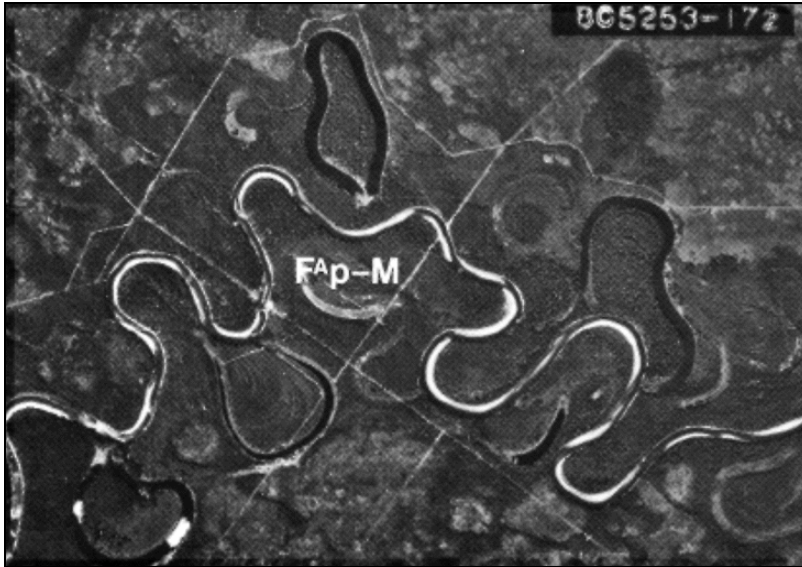


Figure 24. A meandering channel; note uniform size of meanders (and cutoffs) (map symbol: $F^A p-M$) (location of photo: Kahntah River).

DEFINITIONS FOR MASS MOVEMENT PROCESSES

Mass movement processes involve the downslope movement, due to gravity, of surficial materials, bedrock fragments, and snow and ice, often mixed with vegetation debris. This classification distinguishes three types of mass movement based on the rate of movement and the presence of snow and/or ice. Subclass symbols may be used with these categories in order to indicate specific processes (see Subclasses for Mass Movement Processes¹⁴, p. 50).

Snow Avalanches

Map Symbol: A

Process status: **active**

Rapid downslope movement of snow and ice, as well as incorporated rock, surficial material and vegetation debris, by flowing or sliding.

Application and Examples:

- Applied to terrain with snow avalanche initiation zones, tracks, and runout zones (Figure 25).

Example: avalanche cone

Cc-A

- Commonly associated with areas of high local relief and moderate to heavy snowfall. Below timberline, slopes modified by snow avalanches are characterized by linear vegetation patterns: avalanche tracks with deciduous shrubs and young conifers are demarcated from mature forest by a sharp trimline. Above the treeline avalanche paths are not well marked.

¹⁴ Subclasses for snow avalanches are new (1997).

Example: steep rocky slope modified by avalanches

Rs-A

- Applied to terrain affected by falling ice from glaciers.
- Specific avalanche paths can be indicated by on-site symbols (p. 77).

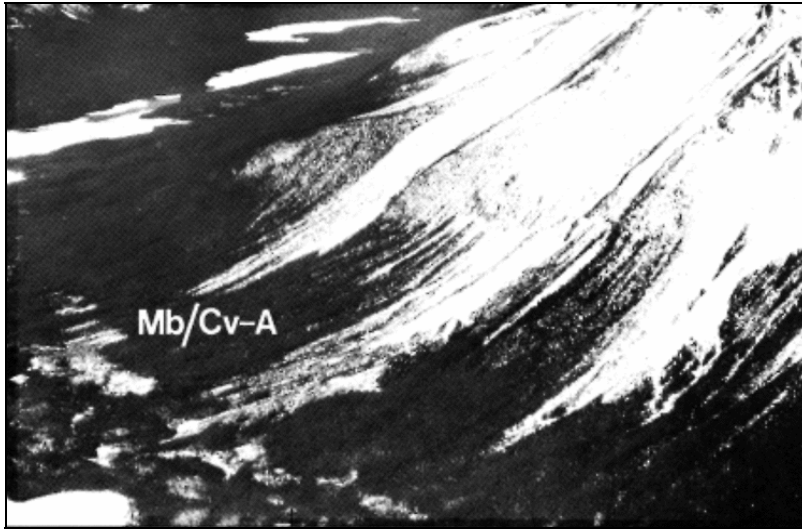


Figure 25. A valley side of till and colluvium subject to snow avalanches; note the varying length of the runout zones (map symbol: *Mb/Cv-A*).

Slow Mass Movement

Map Symbol: **F**

Process status: **active**

Slow downslope movement of masses of cohesive or non-cohesive surficial material and/or bedrock by creeping, flowing or sliding.

Application and Examples:

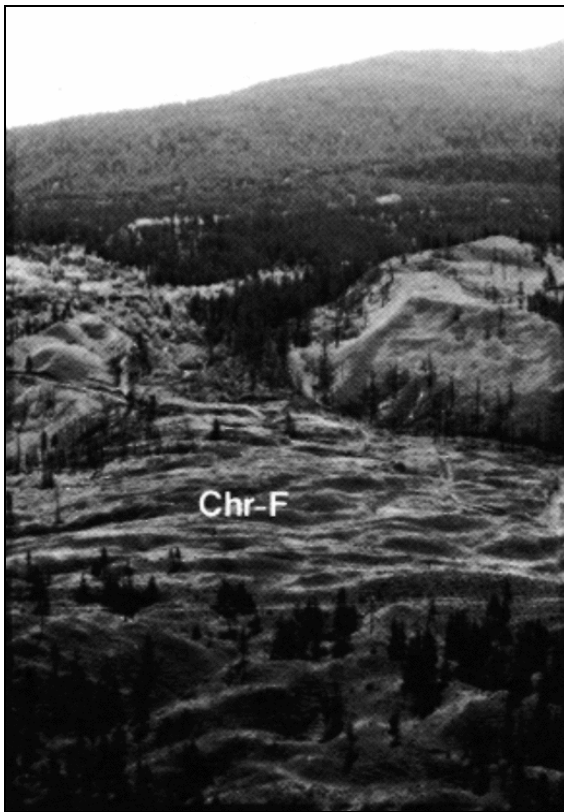
- Applied to terrain that includes the initiation, transportation, and depositional zones of slow mass movements. Includes slow earthflows, rotational slumps, rock glaciers, and lateral spreads. Terrain affected by slow mass movement usually displays irregular, chaotic or hummocky topography bounded upslope by an arcuate headscarp; lateral margins may be marked by levée-like ridges, and seepage or small ponds may be present (Figure 26). Also includes soil creep; in steep mountainous terrain where soil creep is a common process, the symbol should only be applied to sites showing significant alteration by creep processes.
- Applied to terrain units that consist entirely of unstable material, or to terrain units which include small areas where failure is occurring.

Examples: earthflow dmChr-F
 scarp of glaciolacustrine terrace zL^Gt-F
 with several small slumps

- Slow movement may be indicated by the presence of tension cracks, tilted or jackstrawed trees, and displacement of man-made features such as roads and fence lines.

Example: tension cracks indicating incipient failure of bedrock Rst-F

- On-site symbols can be used to delineate specific failure headwall scars and paths (see p. 77).
- Additional information regarding specific slow mass movement processes can be indicated by subclass symbols (see p. 66-70).



*Figure 26. Hummocky and irregular topography of lower portion of the Pavilion earthflow - an example of slow mass movement (map symbol: **Chr-F**) (location of photo: near Pavilion, central British Columbia).*

Rapid Mass Movement

Map Symbol: **R**

Process status: **active**

Rapid downslope movement by falling, rolling, sliding or flowing of dry, moist or saturated debris derived from surficial material and/or bedrock.

Application and Examples:

- Applied to terrain that includes the initiation, transportation, and depositional zones of rapid mass movement (Figure 27). Includes rock and earth falls, rock slides, debris slides, flows and torrents. These processes result in features that range from small linear tracks (bare or vegetated) that terminate at fans or cones (e.g., debris flow) to large accumulations of debris characterized by lobate, hummocky or ridged topography with an arcuate slide scar upslope (e.g., rockslide).

Examples:	till slope modified by debris slides	Mbv-R
	talus slope derived from rockfall	arCa-R
	large rockslide deposit	aChr-R ¹

- On-site symbols can be used to delineate specific failure headwall scars and paths (see p. 77).
- Additional information regarding specific rapid mass movement processes can be indicated by subclass symbols (see p. 66-70).

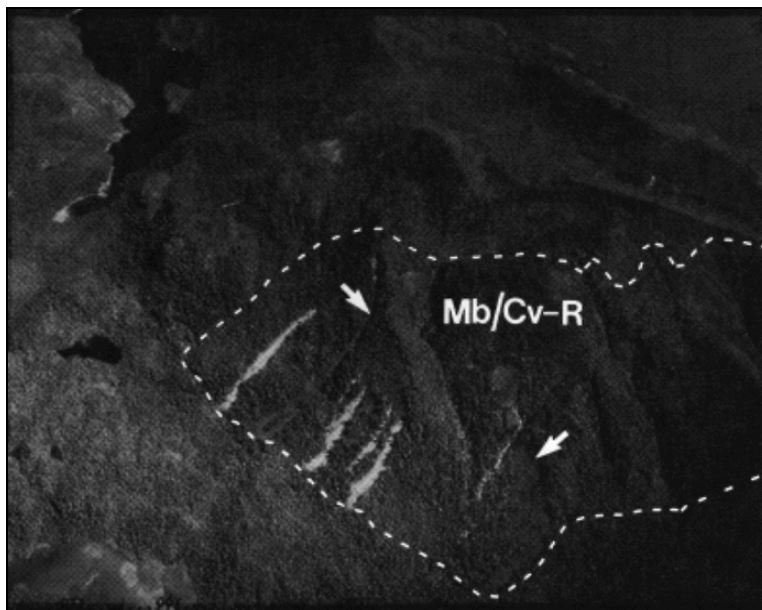


Figure 27. Recent debris slides and flows (rapid mass movements) on steep slopes made up of till and colluvium; recent failures appear as white linear scars whereas older failures can be identified by their uniform revegetation pattern (arrow) (map symbol: **Mb/Cv-R**) (location of photo: west coast of Vancouver Island).

DEFINITIONS FOR PERIGLACIAL PROCESSES

Periglacial processes refer to non-glacial phenomena of cold climates, such as permafrost and frost-related processes. They affect alpine and subalpine areas.

Cryoturbation

Map Symbol: **C**

Process status: **active**

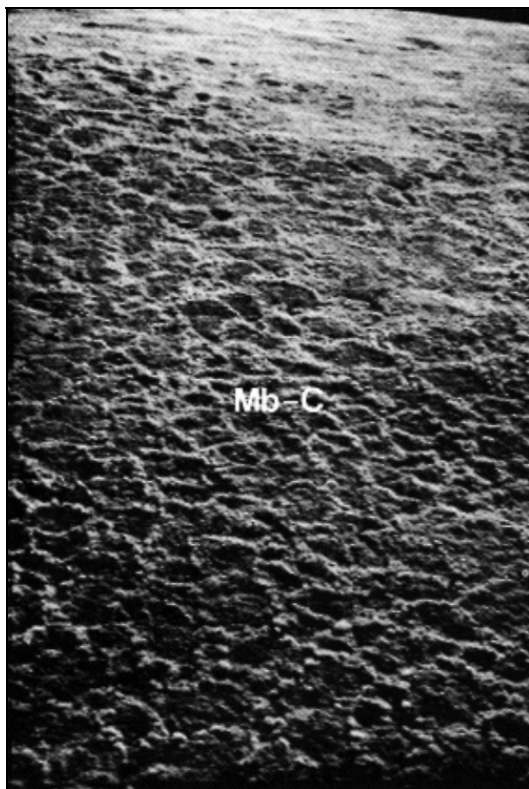
Movement of surficial materials by heaving and/or churning due to frost action (repeated freezing and thawing).

Application and Examples:

- Applied to areas of patterned ground where features such as sorted circles, earth hummocks, and recurring permafrost result from freeze-thaw processes (Figure 28).

Example: stone polygons on morainal blanket

Mb-C



*Figure 28. Patterned ground: evidence of cryoturbation in till (map symbol: **Mb-C**) (location of photo: northern British Columbia).*

Nivation

Map Symbol: N

Process status: **active**

Erosion of bedrock or surficial materials beneath and along the margin of snow patches by freeze-thaw processes (frost shattering and heave), meltwater action and snow creep.

Application and Examples:

- Applied to areas where transverse, longitudinal, circular and/or irregular nivation hollows occur.

Example: nivation hollows on rolling till plain

Mm-N

Solifluction

Map Symbol: S

Process status: **active**

Slow gravitational downslope movement of saturated non-frozen overburden across a frozen or otherwise impermeable substrate.

Application and Examples:

- Applied to areas where solifluction lobes, sheets and terraces are widespread (Figure 29).

Example: solifluction lobes in a colluvial blanket

zrCb-S

- Material transported by solifluction is classified according to its source material, although technically solifluction material is colluvium.

Example: solifluction lobes on till

Mb-S



Figure 29. Solifluction lobes (highlighted by the dark tones) in till in the alpine zone (map symbol: Mb-S) (location of photo: Omineca Mountains).

General Periglacial ProcessesMap Symbol: **Z**Process status: **active***Solifluction, cryoturbation and nivation occurring together within a single terrain unit.**Application and Examples:*

- Commonly used for small scale and generalized mapping instead of “-CNS”.

Example:	moderately sloping alpine area of till on small scale map	Mb-Z
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Permafrost ProcessesMap Symbol: **X**Process status: **active***Processes controlled by the presence of permafrost, and permafrost aggradation or degradation. “Permafrost” is earth material whose temperature remains below 0°C continuously for two years or longer.**Application and Examples:*

- Applied to terrain where any of the following features are present: ice-wedge polygons; thaw lakes or other thermokarst features; surficial materials containing interstitial or segregated ice (ice lenses); palsas and pingos.

Examples:	bog with palsas	Op-X
	lacustrine plain with ice wedge polygons	Lp-X

- Permafrost cannot be identified on the basis of a single (at one point in time) observation. If during field work, frozen ground is encountered during late summer or fall, it may be permafrost, however, if no permafrost landforms are present the permafrost symbol should not be used. Instead, the site should be identified with the frozen ground on-site symbol (p. 76)
- See also Subclasses for Permafrost Processes¹⁵, p.70.

¹⁵ Subclasses for Permafrost Processes are new (1997).

DEFINITIONS FOR DEGLACIAL PROCESSES

Processes resulting from melting ice and meltwater during deglaciation.

Channeled By Meltwater

Map Symbol: **E**

Process status: **inactive**

Erosion and channel formation by meltwater alongside, beneath, or in front of a glacier or ice sheet.

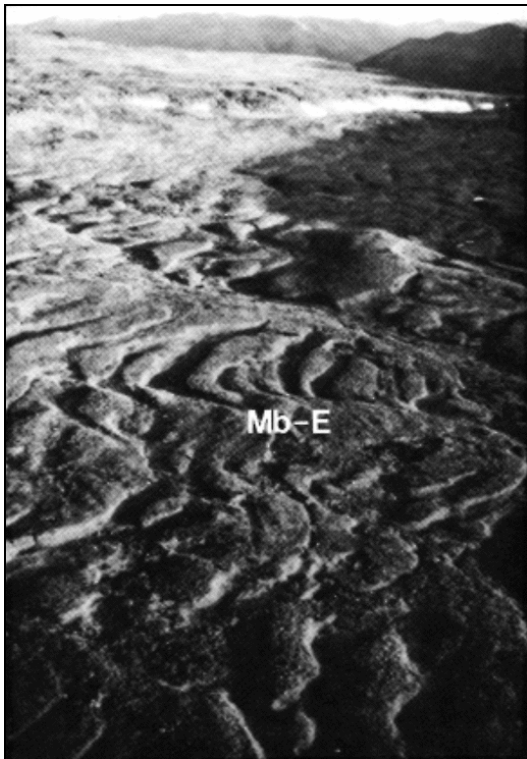
Application and Examples:

- Applied to terrain dissected by meltwater channels (Figure 30); channels vary in length and range from broad, shallow channels to deeply-incised, steep-sided, flat-bottomed valleys. Channels may run across or along slope contours and presently may be dry, poorly drained or contain a stream (often a misfit stream) or small lake.

Example: till-covered slope dissected by several lateral meltwater channels

Mbv-E

- Specific small and large meltwater channels may be indicated by on-site symbols (see pg. 75).



*Figure 30. Lateral meltwater channels developed on a slope made up of till; the channels formed during the last deglaciation (map symbol: **Mb-E**) (location of photo: Spatzizi Plateau, northwest British Columbia).*

KettledMap Symbol: **H** Process status: **inactive***Depressions in surficial materials resulting from the melting of buried or partially buried glacier ice.**Application and Examples:*

- Kettles are depressions characterized by steep sides bounded by abrupt, convex breaks in slope. They occur in a variety of shapes from round to irregular forms (Figure 31).

Example: pitted outwash terrace sgF^Gt-H

- Individual small and large kettle holes can be indicated by on-site symbols (pg. 75).

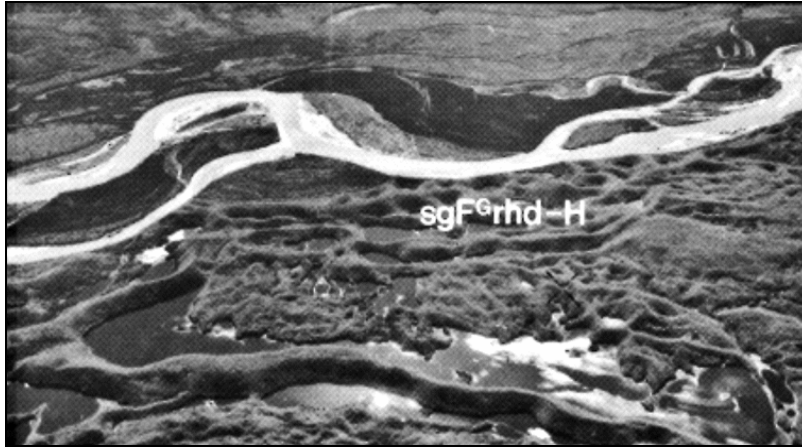


Figure 31. Pitted or kettled topography made up sandy gravel glaciofluvial eskers and kames (map symbol: sgF^Grhd-H) (location of photo: Liard Plain, northeast British Columbia).

DEFINITIONS FOR HYDROLOGIC PROCESSES**Inundation**Map Symbol: **U** Process status: **active***Terrain seasonally under standing water which results from high watertable.**Application and Examples:*

- Commonly applied to ephemeral lakes whose floors are mapped as terrain units, and to surficial materials with seasonally high watertables that result in local flooding for a continuous and significant time period (greater than one month).

Example: ephemeral lake on lacustrine plain Lp-U

CHAPTER 5

QUALIFIERS

Qualifier symbols provide additional information about the mode of formation and/or the depositional environment of surficial materials and the status of activity of geomorphological processes.

APPLICATION TO SURFICIAL MATERIALS

Qualifiers are used to provide additional information about surficial materials. These are denoted by an upper case superscript that follows the surficial material symbol¹⁶. Two distinct types of qualifiers are available: (1) glacial qualifiers, and (2) activity qualifiers.

Glacial Qualifiers

The “glacial” descriptor “G” is used to qualify surficial materials where there is direct evidence that glacier ice exerted a strong although secondary control upon the mode of origin of the material. The use of this qualifier implies that glacier ice was close to the site of deposition of the material. The most common types of glacially–modified materials are included in the surficial material classes (listed on pg. 10). However, the “glacial” modifier may be used with other materials where necessary, in which case appropriate descriptions should be added to the map legend and terrain report.

Application and Examples:

- Applied to surficial materials that exhibit any of the following: kettled or irregular (hummocky or ridged) surfaces that result from the melting of buried or partially buried ice; slump structures indicating partial collapse of a landform due to melting of supporting ice; ice–contact and moulded forms such as crevasse fillings and eskers; non–sorted and non–bedded gravel with a wide range of particle sizes resulting from very rapid aggradation at an ice front; the presence of flowtills; and the presence of ice–rafted stones in glaciolacustrine or glaciomarine deposits.

Examples:	kettled outwash plain	sgF ^G p-H
	silty lacustrine terrace with ice–rafted stones	zL ^G t

¹⁶ Computer maps may show LG, FA, etc.

- Surficial materials that display none of the ice–contact features described above can be qualified by the “glacial” term if reconstruction of geomorphological history indicates a glacial source.

Activity Qualifiers

The “activity” qualifiers “I” and “A” are used to indicate whether a surficial material is undergoing formation (or deposition) at the present time.

Application and Examples:

- By definition, each surficial material has an assumed status of activity (as discussed on p. 10). If the actual state of activity of the surficial material is contrary to the assumed state, then the actual state is indicated by attaching the appropriate superscript to the surficial material symbol. If the actual state is the same as the assumed state, no superscript is used.

Examples:	fluvial terrace high above river level (<i>actual state and assumed state are the same</i>)	Ft (<i>qualifier is not shown</i>)
	floodplain subject to shifting channels (<i>actual state is active, contrary to assumed state</i>)	F ^A p (<i>qualifier is shown</i>)
	outwash in front of a modern glacier (<i>actual state is active, contrary to assumed state</i>)	gF ^A g ^p (<i>qualifier is shown</i>)

- A surficial material is “active” if there is evidence of its recent deposition. The nature of the evidence varies with the type of depositional process, but will include some of the following:
 - i) Absence of vegetation or presence of immature or successional vegetation; recently disturbed or damaged vegetation.
 - ii) Lack of soil development (immature soil); recently deposited sediment overlying soil or litter layers (cumulic soil horizons).
 - iii) Fresh, unweathered surface with no lichen or moss cover.
 - iv) Historical records and air photographs; eyewitness accounts.
 - v) Indications of an active sediment supply.

APPLICATION TO GEOMORPHOLOGICAL PROCESSES

Only “activity” qualifiers are applied to the geomorphological process terms.

Activity Qualifiers

The “activity” qualifiers “I” and “A” are used to indicate the status of activity of the geomorphological process at the present time.

Application and Examples:

- By definition all geomorphological processes are assumed to be active except for deglacial processes which are assumed to be inactive (see pg. 42). If the actual state of activity of the geomorphological process is contrary to the assumed state, then the actual state is indicated by attaching the appropriate superscript to the geomorphological process symbol. If the actual state is the same as the assumed state, no superscript is attached.

Examples:	active sand dunes and deflation hollows (actual and assumed states are the same)	$sE^A r-D$ (<i>process qualifier is not shown</i>)
	vegetated sand dunes and deflation hollows (actual state is inactive, contrary to assumed state)	$sEr-D^I$ (<i>process qualifier is shown</i>)

- Geomorphological processes should be considered active for terrain mapping purposes if there is evidence of current or recent occurrence, or likely future occurrence. Indicators of present or future activity include freshly deposited sediments, visible slope instability, soil and vegetation characteristics or other features in the landscape (refer to Activity Qualifiers for surficial materials).
- The use of the “activity” qualifiers is not defined in quantitative terms (e.g., once every hundred years) because the assessment of the frequency of most geomorphological processes (e.g., floods, snow avalanches) is beyond the scope of this terrain classification system.

CHAPTER 6

TERRAIN SYMBOLS

Many terrain polygons include more than one kind of material, and so the simple terrain symbol (p. 2) commonly must be modified in order to:

- *Describe more than one type of terrain (composite symbols).*
- *Provide subsurface information (stratigraphic symbols).*
- *Provide additional information (often project specific) about surficial materials and/or geomorphological processes (subclasses and subtypes).*

COMPOSITE SYMBOLS

Areas of uniform terrain are commonly so small that they cannot be delimited individually at the scale of mapping. Consequently, a system of composite symbols is employed whereby up to three types of surficial material may be designated within a terrain unit boundary. A composite symbol is made up of two or three simple symbols, each referred to as a component of the composite symbol, with the geomorphological process symbols placed last after a dash (hyphen). The components are arranged in decreasing order of areal extent, and the relative proportions of the components are indicated by delimiters or deciles. At present, delimiters are used for most purposes, including terrain stability mapping, but deciles are used for ecosystem terrain mapping. Surficial material that occupies less than 10% of a polygon is generally not indicated in the terrain unit symbol.

Delimiters

Delimiters indicate the relative amount of each surficial material type represented in a composite symbol. The delimiter symbols are a point sign (·) and a single or double slash (/, //).¹⁷

<i>Map Symbol</i>	<i>Definition</i>
·	components on either side of the symbol are of approximately equal proportion; (see "Terrain Database Manual").
/	the component in front of the symbol is more extensive than the one that follows; can also be used to indicate a discontinuous covering of material, see Stratigraphic Symbols, Example 3.
//	the component in front of the symbol is considerably more extensive than the component that follows.

¹⁷ Symbol references for the delimiter (=) are now represented on air photo maps by the symbol (·). See Terrain Database Manual for data entry requirements.

Examples of all possible combinations of delimiter symbols and their interpretation follow:

Mb•R	Mb and R are roughly equal
Mb/R	R is less than Mb
Mb//R	R is considerably less than Mb
Mb•R•Cv	Mb, R and Cv are all roughly equal
Mb•R/Cv	Mb and R are roughly equal; Cv is less than each of Mb and R
Mb•R//Cv	Mb and R are roughly equal; Cv is considerably less than each of Mb and R
Mb/R•Cv	R is less than Mb; R and Cv are roughly equal
Mb/R/Cv	R is less than Mb; Cv is less than R
Mb/R//Cv	R is less than Mb; Cv is considerably less than R
Mb//R•Cv	Mb is considerably more extensive than each of R and Cv; R and Cv are roughly equal
Mb//R/Cv	R is considerably less than Mb; Cv is less than R
Mb//R//Cv	R is considerably less than Mb; Cv is considerably less than R

Deciles

Where appropriate, e.g., for ecosystem terrain mapping, deciles instead of delimiters may be used to indicate the proportion of each terrain type. The decile, a superscript¹⁸, immediately precedes the component described. The reliability of the decile estimates should be noted in the map legend and/or report.

Examples:	Mb and Rh each occupy about 50% of the terrain unit area	⁵ Mb ⁵ Rh
	The unit consists of 60% Mb, 30% rock, and 10% colluvium	⁶ Mb ³ Rh ¹ Cv

STRATIGRAPHIC SYMBOLS

Stratigraphic symbols are used when two or more kinds of surficial materials are superimposed (Figure 32). They are commonly applied to terrain where the thickness of the surface material is such that the nature of the underlying material(s) may be important, and/or where it is necessary to show the character of the underlying material(s). Superimposed materials are indicated by a vertical alignment of symbols, which are arranged in stratigraphic order, with materials separated by a horizontal line as indicated in the examples below. Surface expression must be indicated for the underlying material(s), and texture should be indicated if known. Commonly, only two or three superimposed materials are indicated in this manner. Specific conventions apply to materials draped over bedrock; see surface expression terms: veneer, thin veneer, and mantle of various thickness. Stratigraphic symbols may be simple terrain symbols or component(s) of composite symbols.

¹⁸ Computer-drafted maps and databases can use regular numbers, e.g., 5Mb5Rh.

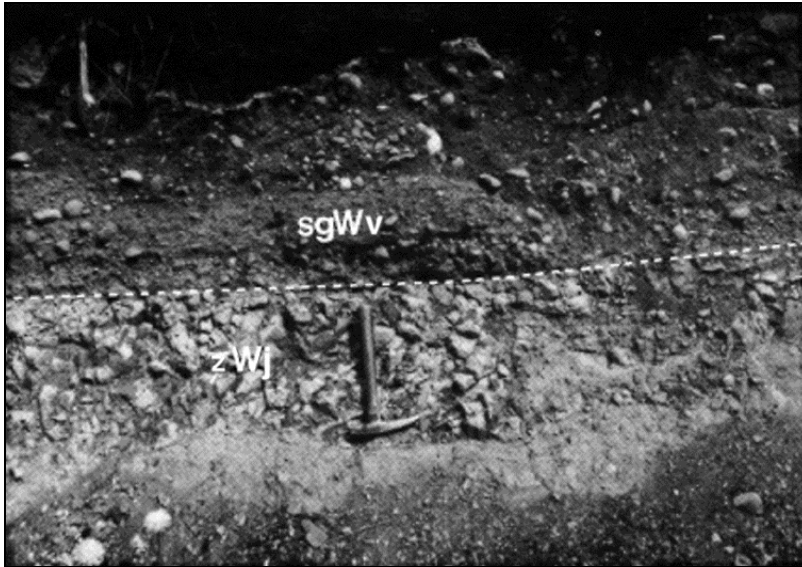


Figure 32. An example of a stratigraphic symbol; sandy gravel beach materials on a gentle slope overlying silty marine sediments (map symbol $\frac{sgWv}{zWj}$) (location of photo: Vancouver Island).

Examples:	veneer of eolian silt overlying terraced fluvial gravels	$\frac{zEv}{gFt}$
	hummocky morainal materials overlying glaciofluvial gravels	$\frac{Mh}{gF^Gp}$
	a moderately extensive, but discontinuous, eolian veneer on a river terrace ¹⁹	$\frac{/sEv}{gFt}$

¹⁹ The use of a slash in a stratigraphic symbol to indicate a discontinuous layer is new (1997).

CHAPTER 7

SUBCLASSES AND SUBTYPES

Subclasses²⁰ and subtypes²¹ can be incorporated in terrain symbols to provide further information about a surficial material or a geomorphological process.

SUBCLASSES FOR GEOMORPHOLOGICAL PROCESSES

For some purposes, it is useful to be able to map the specific types of geomorphological processes that are grouped together in the general classification presented in Chapter 4. For example, in the general classification, rockfall, debris flows, etc., are grouped together as “rapid mass movement” (symbol: R). The use of subclass symbols enables these specific processes to be shown on the map. *Subclasses are defined as subdivisions of the general categories of the Geomorphological Processes classification; symbols and definitions of process subclasses are specified within the Terrain Classification System* (see: Subclasses for Mass Movement, Subclasses for Snow Avalanches, Subclasses for Fluvial Processes, and Subclasses for Permafrost Processes in this chapter). In some cases, features that result from a particular process and thus indicate that the process is (or has been) active, are used to define the process. For example, “type of backchannel” (in subclasses for fluvial processes) implies certain physical and biological conditions and processes.

Application and Examples

Subclasses are represented by a lower case letter that is placed after the related general geomorphological process symbol. Up to three subclasses can be attached to each general geomorphological process. It is recommended that subclasses be used for relatively detailed, large scale mapping, especially where the objective of the mapping is slope stability assessment or identification of slope hazards.

Examples:	a meandering river with backchannels containing flowing or standing water year-round ²²	F ^A p-Mp
	gullied bedrock cliffs where rockfall (b) and debris flows (d) start (“”) ²²	Rs/Cv-VR”bd
	talus slope receiving rockfall ²²	xrCk-Rb
	bedrock and colluvium slope with major avalanche tracks	Rsk/Cv-Af

²⁰ Subclasses have been redefined (1997).

²¹ Subtypes were previously included in subclasses.

²² See subclass tables for definitions of new (1997) symbols.

Subclasses for Mass Movement Processes²³

The following subclasses can be used, where appropriate, with the symbols -F (slow mass movement), -R (rapid mass movement) and -A (snow avalanches).

Table 6.1. Subclasses for mass movement processes.

<i>Subclass Name</i>	<i>Map Symbol</i>	<i>Definitions</i>
<i>Initiation Zone</i>	”	polygon includes sites or zones of instability, such as the headscarps of debris slides or earthflows and source areas for rockfall and debris flows; use with -F and -R to distinguish initiation zones from runoff zones; (see example on previous page).
<i>Slow Mass Movement: use the following symbols with -F</i>		
soil creep	c	slow movement of soil.
rock creep	g	slow movement of angular debris under periglacial conditions (e.g., rock glaciers)
tension cracks	k	open fissures, commonly near crest of slope.
lateral spread		
–in bedrock	p	lateral extension of a fractured mass of bedrock or surficial material; movement is predominantly horizontal.
–in surficial material	j	
<i>Rapid Mass Movement: use the following symbols with -R</i>		
debris fall	f	descent of a mass of surficial material by falling, bouncing and rolling.
rockfall	b	descent of masses of bedrock by falling, bouncing and rolling.
debris flow	d	rapid flow of saturated debris.
debris torrent	t	rapid flow of a mixture of water, earth and vegetation debris down a steep, well-defined stream channel.
		Table continues on next page. Table continued from previous page.

²³ This table contains some new (1997) symbols.

<i>Subclass Name</i>	<i>Map Symbol</i>	<i>Definitions*</i>
<i>Slow or Rapid Mass Movement: use the following symbols with -F or -R</i>		
earthflow	e	slow viscous flow of material containing a high proportion of silt and clay.
slump –in bedrock	m	sliding of internally cohesive masses of bedrock or surficial material along a slip plane that is concave upward or planar.
–in surficial material	u	
slump–earthflow	x	combined slump (upper part) and earthflow (lower part).
debris slide	s	sliding of disintegrating mass of surficial material.
rockslide	r	descent of large masses of disintegrating bedrock by sliding.
<i>Snow Avalanches: use the following symbols with -A</i>		
major avalanche tracks; active	f	in zones of coniferous forest: broad avalanche track(s) occupied by predominantly shrubby, deciduous vegetation; conifers are largely absent.
minor avalanche tracks; active	m	similar to above, but relatively narrow; generally narrower than the height of adjacent trees.
mixed major and minor tracks; active	w	polygon includes both major and minor avalanche tracks.
old avalanche tracks	o	tracks are clearly visible on air photos but are less well defined than active avalanche tracks because they are partly or completely occupied by young conifers.
* Mass movement definitions after Fairbridge, 1968; Swanston, 1974; Swanston and Swanson, 1976; Varnes, 1978; White, 1981.		

Subclasses for Fluvial Processes²⁴

The following subclasses can, where appropriate, be used with the process symbols -B (braided channel), -I (irregularly sinuous channel), -J (anastomosing channel) and -M (meandering channel). They are intended for use primarily with ecosystem terrain mapping, and with detailed mapping of riparian zones and fish habitat.

Table 6.2. Subclasses for fluvial processes.

<i>Subclass Name</i>	<i>Map Symbol</i>	<i>Definitions</i>
progressive bank erosion	u	persistent bank erosion indicated by the presence of undercut banks, overhanging and fallen trees, and much timber in the channel; old air photos and historical information can also be used as evidence. Example: sF ^A p-Mu
abrupt channel diversion; avulsion	a	the present channel has recently shifted abruptly to a previously vegetated area; the former channel can be identified on air photos or on the ground. Examples: gF ^A p-Ja gF ^A f-Ba
backchannels (undivided)	b	small channels which may or may not be connected to the main channel. Example: sgF ^A p-Ib
permanent river-fed backchannels	p	backchannels joined to the main channel at the upstream end, allowing flowing or standing water all year. Example: sgF ^A p-Jp
ephemeral river-fed backchannels	e	backchannels joined to the main channel at the upstream end, but dry during late summer. Examples: sgF ^A p-Je sgF ^A p-Jpe gF ^A f-Be
spring-fed backchannels	s	backchannels in which water is maintained during the late summer by the emergence of floodplain groundwater. Examples: sF ^A p-Ms sF ^A p-Msu
permanent tributary-fed backchannels	t	either flowing or standing water from tributaries is present in the backchannel all year. Example: sgF ^A p-Jt
ephemeral tributary-fed backchannels	d	backchannels normally fed by tributaries, but dry during late summer. Example: sgF ^A p-Jtr

Subclasses for Permafrost Processes²⁵

²⁴ This table contains new (1997) symbols.

The following subclasses can be used, where appropriate, with the process symbols -X (permafrost processes) and -Z (periglacial processes).

Table 6.3. Subclasses for permafrost processes.

<i>Subclass Name</i>	<i>Map Symbol</i>	<i>Definitions</i>
palsas, peat plateaus	p	flat-topped or rounded mounds and ridges of peat or peaty earth formed by differential frost-heaving; contain perennial ice lenses and a core of permafrost. Example: Op-Xp
thermokarst: subsidence	t	ground-surface depressions created by the thawing of ice-rich permafrost and associated soil subsidence. Example: zLpd-Xt
thermokarst: thermal erosion by water	e	gullies and depressions created by melting of ice-rich permafrost due to heat transfer from water bodies, either streams or lakes. Example: mWj-XeV
thaw flow slides	f	slope failures caused by the thawing of permafrost. Example: dzsMb-Xf
ice-wedge polygons	w	intersecting narrow cracks that contain ice-wedges comprise polygonal patterns on ground underlain by permafrost. Example: sFt-Xw
patterned ground	r	a collective term for the regular surface features, such as stone polygons, frost boils, and stone stripes, that are characteristic of ground that is subject to intensive frost (freeze-thaw) action. Examples: rCv-Xr rCv-Zr

²⁵ This table contains new (1997) symbols.

Table 6.5. Subclasses for igneous rocks.

Intrusive	<i>EITHER</i>		<i>OR</i>	
	acid (felsic)	ia	syenite granite quartz monzonite granodiorite	sy gr qm gd
intermediate	ii	quartz diorite diorite	qd di	
basic	ib	quartz gabbro gabbro pyroxenite peridotite dunite	qg gb py pd du	
Extrusive	acid (felsic)	ea	trachyte rhyolite dacite	tr rh da
	intermediate	ei	andesite	an
	basic	eb	quartz basalt basalt	qb bs
	recent lava flow	la		
	pyroclastic	ep	tuff volcanic breccia agglomerate	tu vb ag

Table 6.6. Subclasses for metamorphic rocks.

Foliated	<i>EITHER</i>		<i>OR</i>	
	fine grained	ff	slate phyllite	sl ph
medium to coarse grained	fm	schist gneiss granite gneiss diorite gneiss	sc gn gg dg	
coarse grained	fc	migmatite	mi	
Non-Foliated	fine grained	nf	argillite serpentinite	ar sp
	medium to coarse grained	nm	granulite quartzite hornfels	gl qt hf
	coarse grained	nc	amphibolite hornblendite	am hb
	calcareous	nk	marble dolomite marble serpentine marble	mb dm sm

SUBTYPES FOR SURFICIAL MATERIALS AND GEOMORPHOLOGICAL PROCESSES

For some purposes, it is useful to be able to map specific subcategories of surficial materials and geomorphological processes that are, at present, *undefined* in the Terrain Classification System. For example, within the context of project objectives, it may be useful to distinguish subcategories of till according to their mineralogy, or subcategories of gullies according to their morphology. *Subtypes are defined as subdivisions of the classes defined for Surficial Materials and Geomorphological Processes that are NOT specified within the Terrain Classification System.*

Application and Examples

Subtypes should be defined only where their use is of direct relevance to project objectives. Symbols and definitions are the responsibility of the mapper. Symbols must be clearly defined in the map legend, and subtypes should be clearly defined in the project report.

Subtypes should not be defined where equivalent information can be indicated by pre-defined symbols, for example, to show differences in surficial material texture, or to define processes that can be described by the use of subclasses or qualifiers.

Subtypes are represented by a number that is placed immediately after the symbols defined in Geomorphological Processes (Chapter 4) or Surficial Materials (Chapter 2). Only one subtype can be attached to a surficial material or process symbol.

Examples:	blanket of calcareous till	M1b
	blanket of non-calcareous till	M2b
	mineralogy of till unspecified	Mb
	till blanket with steep-sided, deeply incised gullies	Mb-V1
	till blanket with shallow, rounded gullies	Mb-V2
	till blanket with gully morphology unspecified	Mb-V

When subtypes are used, a short (<1 page) statement including: name of project; project area; name and contract numbers for senior mapper; symbol(s) used; definition(s); and justification should be forwarded to the curator of the provincial database.

CHAPTER 8

ON-SITE SYMBOLS

On-site symbols are graphic representations used to describe landforms, features or geomorphological processes not portrayed by terrain symbols.

The on-site symbols can be used to indicate linear features such as eskers or moraine ridges; provide site specific information such as gravel locations or kettle holes; and add details of Quaternary history such as striae, glacial meltwater channels or abandoned shorelines. The size of the on-site symbols varies with the type of symbol. For example, those symbols connotating areal extent, such as blockfields or large kettles, vary in size because they conform to the shape of the feature on the ground. Those that are point observations are presented as a standard symbol having no relation to areal extent (e.g., fossil locality or observation of frozen ground). Symbols which have linear connotations such as eskers, gullies, or end moraines will vary in length but will be of standard width and may also indicate direction of deposition or process activity.

APPLICATION OF ON-SITE SYMBOLS








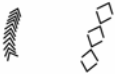


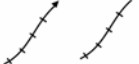

On-site symbols are usually depicted on the basic terrain map, however, a separate “Features Map” may be produced to meet specific mapping objectives. On-site symbols should be applied where:

- Landforms, features or geomorphological processes are of insufficient areal extent, or too few in number, to be delineated as terrain units or to be represented in the terrain symbol at the scale of mapping.
- It is desirable to indicate the precise location of a landform, feature or geomorphological process whose presence is already identified by the terrain symbol.
- The landform or feature cannot be indicated by the terrain symbol.


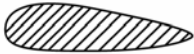


LIST OF ON-SITE SYMBOLS

On-site symbols used with this classification system are outlined below. An upper case letter in the notes column indicates if the symbol is standard in terms of shape and size (S), or drawn to actual map scale shape or length (R).

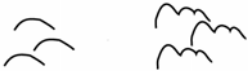







Glacial Features




<i>Name</i>	<i>Symbol</i>	<i>Notes</i>
Drumlin		ice flow is in the direction of the arrow; symbol is placed in the center of the feature (S)
Crag and tail		ice flow is in the direction of the arrow; symbol is placed in the center of the feature (S)
Roches moutonnées		ice flow is in the direction of the arrow; symbol is placed in the center of the feature (S)
Striae, grooves (ice flow direction known; unknown)		ice flow is in the direction of the arrow; symbol is placed in the center of the feature (S)
Undifferentiated lineations and flutings		symbol is placed in the center of the feature (S)
Moraine ridge (major)		line drawn along ridge crest (R)
Moraine ridge (minor)		lines drawn along ridge crests (R)
Esker (flow direction known; unknown)		drawn along ridge crest (R)
Kettle holes (large; small)		(R; S)
Meltwater channel (large)		arrow shown if flow direction known (R)
Meltwater channel (small)		arrowhead shown if flow direction known (R)
Cirques		line drawn along ridge crest (R)

Periglacial Features



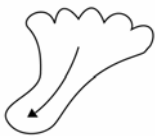




<i>Name</i>	<i>Symbol</i>	<i>Notes</i>
Blockfield		(R)
Rock Glaciers		(R)
Tors		(S)
Observation of frozen ground		(S)

Other Landforms and Features

<i>Name</i>	<i>Symbol</i>	<i>Notes</i>
Dunes (active; inactive)		(S)
Escarpment		hachures extend to base of slope (R)
Strandline		(R)
Piping depression		(S)
Karst depression (large; small)		(R; S)
Gully		symbol follows gully path downslope (R)
Spring		(S)
Gravel pit (active; abandoned)		(S)

Quarry or mine (active; abandoned)		(S)
Gravel occurrence		(S)
Cinder cone		(S)

Mass Movement Symbols

<i>Name</i>	<i>Symbol</i>	<i>Notes</i>
Snow avalanche		symbol follows track downslope and continues to furthest point of runout (R)
Large Landslide: headwall scar only		(R)
headwall scar and area affected		terrain symbol should be added to polygons (R)
Small Landslide: headwall scar only		(S)
headwall scar and track		symbol follows track downslope to the furthest point of runout (R)
Tension cracks		(S)
Sackung (sagging slopes)		(S)

Point Observations

<i>Name</i>	<i>Symbol</i>	<i>Notes</i>				
Quaternary fossil site	ⓕ	(S)				
Observation site (ground, visual)	⊙ ₄₅ ⑦	(S)				
Stratigraphic section site	11 ⊕ Ft M R	(S)				
¹⁴ C dated site	19 ⊕ <table border="1" style="display: inline-table; vertical-align: middle;"> <tr> <td>date</td> <td>material</td> </tr> <tr> <td>lab no.</td> <td>alt.</td> </tr> </table> 20 ⊕	date	material	lab no.	alt.	location on map with data recorded in legend (S)
date	material					
lab no.	alt.					
Anthropogenic site	ⓐ	(S)				

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APPENDIX I

GLOSSARY OF TERMS

The following definitions draw heavily from “The Glossary of Geology” by The American Geological Institute (1980).

BEDDING: Collective term for the existence of beds or laminae. A bed is separated by a more or less well-defined divisional plane from its neighbours above and below. 1) Well-bedded — when beds are immediately apparent, clearly defined and can be easily traced across the deposit. 2) Moderately-bedded — intermediate between 1) and 3). 3) Poorly-bedded — when beds are only discerned after careful scrutiny, or bedding planes are discontinuous.

BLOCKFIELDS: (syn. Felsenmeer) A level or gently sloping area covered with moderate sized or large blocks of rock that have been derived from the underlying bedrock by frost shattering.

BOG: An area covered or filled with peat material which generally consists of undecomposed to moderately decomposed sphagnum mosses.

CARBONATE ROCKS: A rock composed of carbonate minerals; most commonly limestone or dolomite; a sedimentary rock composed of more than 50% by weight of carbonate minerals.

CAST: A structure formed when the external, skeletal or other organic structural part of an organism has been dissolved and the resulting space is replaced by a secondary material, producing a replica of the original form.

CINDER CONE: A conical hill formed by the accumulation of cinders and other pyroclastic sediments, normally of basaltic or andesitic composition.

CIRQUE: A step-walled, half bowl-like recess, horseshoe or semi-circular in plan, situated high on the side of a mountain and produced by the erosive activity of a mountain glacier.

CLAST: An individual constituent or particle of a detrital sediment or sedimentary rock initially produced by the disintegration of a larger mass.

COHESION: The capacity of particles to stick or adhere together. In effect, all of the shear strength of a material not due to friction.

COMPACTION: The degree of packing of the individual particles of detrital sediments.

CRAG AND TAIL: A hill of bedrock having a steep face of ice-smoothed resistant bedrock (the crag) with a long sloping tail of drift streaming behind it.

CREEP: The imperceptibly slow, more or less continuous, downward and outward movement of soil or rock on slopes. The movement is essentially viscous, under shear stresses

sufficient to produce permanent deformation but too small to produce shear failure as in a landslide.

CREVASSE: A fissure in the ice formed under the influence of various strains.

CREVASSE FILLING: Generally, a short, straight ridge made up of unconsolidated sediments (till or sand and gravel) that were initially deposited in a crevasse and subsequently deposited on the earth's surface as the ice melted.

CROSSBEDDING: The arrangement of laminations or beds transverse or oblique to the main planes of stratification of the deposit concerned; included are often lenticular beds between the main bedding planes; found only in granular sediments.

DELTA: A landform that is commonly nearly flat and triangular or fan-shaped, made up of gravel, sand and/or finer sediments that are deposited by a river discharging into a sea or lake.

DIAMICTON: Applied to non-sorted or poorly-sorted, heterogeneous sediments containing a wide range of particle sizes in a muddy matrix.

DRIFT: Any material, such as boulders, till, gravel, sand or clay, transported by a glacier, and subsequently deposited by ice or meltwater.

DRUMLIN: A streamlined hill or ridge of till with the long axis paralleling direction of flow of a former glacier; generally it has an elliptical base and arched profile with a long gentle slope pointing in the downstream direction.

EPHEMERAL: Used here in association with streams and lakes to indicate seasonal or short term in occurrence.

ESKER: A sinuous low ridge composed of sand and gravel formed by deposition from meltwater running through a channel beneath or within glacier ice.

FEN: An area covered or filled with peat material which generally consists of well to moderately decomposed sedge (*Carex* spp.) species.

FLOODPLAIN: Flat land that is subject to flooding bordering a river; consists of unconsolidated depositional material transported by the related river.

FLOWTILL: Superglacial debris (ablation till) that moved laterally as a mudflow from glacier ice to an adjacent lower surface.

FLUTED SURFACE: A surface made of parallel gutter-like furrows with intervening ridges that are developed in bedrock, till or stratified drift.

FROSTING: A lusterless, ground-glass, or mat surface imposed on the surface of rounded quartz grains because of innumerable close contacts with other similar grains.

GRUS: The fragmental products of in situ granular disintegration of granite and granitic rocks by chemical processes (e.g., hydrolysis).

HOLOCENE EPOCH: An interval of geologic time extending from approximately 10,000 years ago to present.

HYDROPHYTIC VEGETATION: Vegetation with an affinity to wet sites.

ICE-RAFTED STONES: Stones deposited in glaciolacustrine or glaciomarine sediments from the melting of floating ice.

INTERSTITIAL: Occurring within the pore spaces of a particulate sediment; of, pertaining to, existing in, or forming an interstice or interstices.

KAME: A steep sided hill or short ridge of stratified drift, formed in contact with glacier ice.

KAME TERRACE: A remnant terrace of stratified drift deposited between a valley ice lobe and the bounding side slope of the valley.

KAME-AND-KETTLE TOPOGRAPHY: Surface formed of a kame complex interspersed with kettles.

KNOB-AND-KETTLE TOPOGRAPHY: Irregular surface formed of hillocks and scattered kettles; may refer to either morainal or kame topography.

LAG DEPOSIT (syn. lag gravel): Residual deposit of coarse material that has had the finer fraction removed by a transporting agent, usually wind or water.

LAPILLI: Volcanic ejecta; typically small broken fragments or cinders ranging mostly from 2 mm to 64 mm in diameter.

LEVEES (natural): A low, wide ridge immediately adjacent to a river channel.

LIMESTONE PAVEMENT: An exposure of bare limestone consisting of flat or ridged irregularly sized and shaped blocks separated by clefts formed by the widening of joints by solution.

LITTORAL: Belonging to, inhabiting or taking place on or near the shore.

LOBES (solifluction lobes): Tongue-like mass of solifluction debris commonly with steep front and sides and relatively gentle upper surface.

LOESS: Largely homogeneous, nonstratified silt and fine sand of eolian origin.

MARL: Soft, unconsolidated calcium carbonate, usually mixed with varying amounts of clay and other impurities.

MASSIVE: A homogeneous structure, without stratification, flow-banding, foliation, or bedding.

MASS WASTING: A general term for a variety of processes by which large masses of earth material are moved by gravity, either slowly or quickly, from one place to another.

MATRIX: In a rock or deposit made up of small and larger sized grains, the grains of the smaller size comprise the matrix.

MICRORELIEF: Small, or relatively small elevations or inequalities, collectively, of a land surface; generally less than 1 metre amplitude.

MIDDEN: A heap or stratum of refuse (broken tools, shells, ashes, etc.) normally found on the site of an ancient settlement.

MUDFLOW: A flow comprised of heterogeneous debris (including much silt–clay matrix), lubricated with a large amount of water, usually flowing in a former stream course.

NEOGLACIAL MORaine: Moraines formed by the re–advance of mountain glaciers during the relatively cool periods of the late Holocene, including the Little Ice Age.

NON–SORTED: See sorting.

OGIVES: Curved dark and light bands that are convex downslope and visible on a glacier surface.

OUTWASH: Stratified drift transported and deposited by meltwater streams beyond the glacier.

PYROCLASTIC SEDIMENTS: A general term applied to detrital volcanic materials that have been explosively or aeri ally ejected from a volcanic vent.

QUATERNARY PERIOD: The most recent geological time interval; subdivided into the Pleistocene and Holocene (Recent) Epochs.

ROCK GLACIER: A lobe–shaped accumulation of angular fragments resembling a small glacier. The motion is the result of flow of interstitial or buried ice.

ROCHES MOUTONNÉES (stoss–and–lee): Bedrock outcrops that have a gentle abraded slope on the upstream (stoss side) and a somewhat steeper, quarried lee slope formed by glacial erosion.

SAPROLITE: Weathered bedrock decomposed in situ by processes of chemical weathering.

SLUMP STRUCTURES: Disturbed bedding or stratification within a deposit, which indicates material has moved downslope due to gravity since its deposition.

SHEETS (solifluction sheets): Broad deposit of non–sorted, water saturated, locally derived material which has moved or is moving downslope.

SINKHOLE (doline): A funnel shaped depression in the land surface generally in a limestone region communicating with a subterranean passage developed by solution.

SOLUTION: The process whereby solid matter dissolves in a liquid; commonly used to refer to the dissolving of limestone (calcium carbonate) in rain and ground water.

SORTING: Refers to the variation of particle sizes within a sedimentary unit; statistically it is a measure of the spread of the particle size distribution on either side of the mean. Well-sorted — particles of uniform size; non-sorted — a wide variation of particle size.

STRATIFICATION: Horizontal or inclined structure in a sedimentary unit that results from its mode of deposition; includes beds, laminae, abrupt and gradational textural changes, and orientation of particles.

STRIAE: Fine cut lines on the surface of bedrock or a clast surface formed by glacial abrasion.

STRUCTURE: The arrangement of particles and beds within a deposit; ie., bedding structures, stratification, laminations, faults and folds.

SUPRAGLACIAL MORAINE: Ablation till on the surface of glacier ice; a consequence of debris melting out from the ice and/or falling from the valley sides.

SWAMP: A level or slightly concave area covered or filled with peat material which generally consists of decomposed sedge or feathermoss species. The watertable is generally at or above the peat surface. The vegetation is usually characterized by a tree cover of cedar and spruce.

SWELL AND SWALE TOPOGRAPHY: A low-relief, undulating landscape exhibiting gentle slopes and well-rounded hills interspersed with shallow depressions.

TALUS (scree) SLOPE: An accumulation of sharp angular rock fragments at the base of a cliff; produced by frost action and other processes from an exposed bedrock slope.

TEPHRA: A general term for all pyroclastic sediments of a volcano.

UVALA: A large collapse feature in a limestone region formed when the supporting wall between sinkholes breaks down.

VOLCANIC ASH: Fine pyroclastic material less than 2 mm in size.

WASHBOARD MORAINE: A series of small parallel or subparallel moraines that form a ridged topography orientated transverse to ice movement.

WELL-SORTED: See sorting.

WENTWORTH PARTICLE SIZE SCALE: A logarithmic grade scale for size classification of sediment particles.

APPENDIX II

FIELD DETERMINATION OF TEXTURE FOR SAND, SILT AND CLAY

The texture of sand and finer textured materials can be determined in the field by “feel” (hand texturing). Comparisons of the results from both field examinations and laboratory analysis should be made whenever possible. A number of tests can be done in the field to establish the texture of a sediment, including: (1) moist cast test; (2) ribbon test; (3) feel tests; (4) taste test; and (5) shine test.

Moist Cast Test: Involves squeezing (compressing) a moist soil sample in your hand. If the soil holds together (i.e., forms a cast), then toss from hand to hand to test strength of cast. The more durable the cast is the more clay present.

Ribbon Test: Roll moist soil into cigarette–shape between palms of hands, then roll out between thumb and forefinger forming the longest, thinnest ribbon possible.

Feel Tests: Includes graininess test, dry feel test, and stickiness test.

Graininess Test: Soil is rubbed between thumb and fingers to assess the percent sand by the grainy feel of the sample.

Dry Feel Test: Start with moist soil samples with more than 50% sand. Sample is rubbed in the palm of the hand to dry it, and to separate and estimate, the size of the individual sand particles. The sand particles will then fall out of the hand and the amount of finer material (silt and clay) remaining can be noted.

Stickiness Test: Knead a saturated soil sample until the stickiest point is reached. Then compress between the thumb and forefinger. The degree of stickiness is determined by noting how strongly it adheres to the thumb and forefinger upon release of pressure and how much it stretches.

Taste Test: Work a small amount of soil between front teeth. Sand is distinguished as individual grains against the teeth. Silt particles, as a group, have a general fine grittiness, but individual grains cannot be identified. Clay particles have no grittiness (smooth).

Shine Test: A small amount of moderately dry soil is rolled into a ball and rubbed once or twice against a hard, smooth object such as a knife blade or thumb nail. A shine on the ball indicates clay in the soil.

GUIDE TO THE IDENTIFICATION OF THE MAIN TYPES OF FINE SEDIMENTS

This section describes some of the characteristics for certain classes of fine textured sediments. It is intended to be a guide that is not all inclusive. Additional combinations of sand, silt, and clay may occur.

Sand: Material made up of sand has a grainy feel and individual sand particles can be readily seen, felt or tasted. Dry sand, when squeezed in the hand, will fall apart when the pressure is released. Moist sand will form a weak cast when squeezed that falls apart when touched.

Silt: Material made up of silt feels like flour when pulverized and dry, and has a soapy, non-sticky feel when the sediment is very moist. Silt has a gritty taste when chewed between the teeth. Dry or moist, this material will form a weak cast that can be carefully handled. When moist, silt flakes rather than forming a ribbon.

Clay: Material made up of clay has a smooth feel (no graininess) and is plastic and usually very sticky when wet. It has a smooth taste when chewed. Moist sediment will form a very strong cast when pressure is applied, a roll will bear its own weight when flexed and it will form a very thin, long, flexible ribbon (>7.5 cm). It produces a strong shine when rolled into a ball and rubbed once or twice against a hard surface.

Silty Sand: Material that is made up of sand, with a lesser amount of silt (20 to 49%) and that may contain from 0 to 19% clay. There is sufficient finer material (silt and clay) to make it somewhat coherent. Individual sand grains can be seen, felt or tasted. The material feels very grainy with a secondary strong floury feel and may be slightly sticky. If squeezed it will form a weak to moderate cast (depending on the amount of silt/clay present) that will bear careful handling without breaking. No shine is evident. (A silty sand is roughly equivalent to the sandy loam to “light” loam soil textures).

Sandy Silt: Material that is made up of silt with lesser amount of sand (20 to 49%) and that may contain from 0 to 19% clay. It has a floury with slight graininess feel and may be slightly sticky when wet. When chewed, it has a silt grittiness with some sand graininess. It forms a weak to moderate cast that allows for careful handling and it flakes rather than forming a coherent ribbon or barely forms a ribbon. No shine is produced. (A sandy silt is roughly equivalent to the silt loam to loam soil texture).

Clayey Sand: Material that is made up of sand with a lesser amount of clay (20 to 49%) and that may contain from 0 to 19% silt. It has a grainy feel (individual sand grains are evident) that is slightly to moderately sticky. The sediment forms a moderate to strong cast; a short (<3 cm), thick to a long (5 to 7.5 cm), thin ribbon that holds its own weight; and the sediment has a slight to moderate shine. (A clayey sand is roughly equivalent to sandy clay loam and sandy clay soil textures).

Clayey Silt: Material made up of silt with a lesser amount of clay (20 to 49%) and that may contain from 0 to 19% sand. It has a smooth to smooth with floury feel depending on the amount of silt present and silt grittiness when chewed. The material is sticky to very sticky; forms a strong to very strong cast; produces a slight to moderate shine; and forms fairly thin ribbons barely able to support their own weight, to thin, long (5 to 7.5cm) ribbons which readily support their own weight. (A clayey silt is roughly equivalent to a silty clay loam to silty clay soil texture).

Sand/Silt/Clay (in any order): Sediments made up of at least 20% sand, 20% silt and 20% clay should display the following characteristics: (1) some to moderate graininess with sand grains evident and should be slightly sticky to sticky when moist, (2) barely forms ribbons to thin ribbons that barely support their own weight, (3) forms a moderate to strong cast when clenched, and (4) may produce a slight shine when rolled and rubbed. (A mixture of sand/silt/clay is roughly equivalent to a clay loam to “heavy” loam soil texture).

APPENDIX III

SUMMARY OF CHANGES MADE TO 1988 TERRAIN MANUAL

CHANGES AND ADDITIONS TO SYMBOLS

Texture: The symbol (\$), silt, has been changed to (z).

Surface Expression: Symbols have been added for mantle of variable thickness (w) and thin veneer (x).

Geomorphological Processes: A symbol has been added for surface seepage (L).

Stratigraphic Symbol: The symbol (/) can now be used to denote discontinuous coverage of the uppermost surficial material in a stratigraphic symbol, e.g., /Cv

Mb

Subclasses for Slope Processes: Subclasses that may be used with mass movement and snow avalanche symbols (-F, -R, and -A) have been added:

initiation zone for mass movement	(")	e.g., Rs-R"b
major avalanche tracks	(f)	e.g., Cv-Af
minor avalanche tracks	(m)	e.g., Cv-Am
mixed major and minor avalanche tracks	(w)	e.g., Cv-Aw
old avalanche tracks	(o)	e.g., Cv-Ao

Subclasses for Fluvial Processes: Subclasses that may be used with the fluvial process symbols (-B, -I, -J, and -M) have been added:

progressive bank erosion	(u)	e.g., F ^A p-Mu
abrupt channel diversion; avulsion	(a)	e.g., F ^A p-Ba
backchannels	(b)	e.g., F ^A p-Ib
permanent, river-fed backchannels	(p)	e.g., F ^A p-Jp
ephemeral, river-fed backchannels	(e)	e.g., F ^A p-Je
spring-fed backchannels	(s)	e.g., F ^A p-Ms
permanent, tributary-fed backchannels	(t)	e.g., F ^A p-Mt
ephemeral, tributary-fed backchannels	(r)	e.g., F ^A p-Mr

Subclasses for Permafrost Processes: Subclasses that may be used with the permafrost and periglacial symbols (-X, and -Z) have been added:

palsas and peat plateaus	(p)	e.g., Op-Xp
thermokarst: subsidence	(t)	e.g., Lu-Xt
thermokarst: thermal erosion by water	(e)	e.g., Lu-Xe
thaw flow sides	(f)	e.g., zCv-Xf

ice-wedge polygons	(w)	e.g., mWp-Xw
patterned ground	(r)	e.g., Cvb-Zr

Subclasses for Bedrock: See bedrock subclass tables in Chapter 7.

Use of Superscripts: Normal uppercase letters and normal numbers can be used instead of superscripts for computer-drafted maps and data-bases.

Examples: F^Ap is equivalent to FAp
F^Gh is equivalent to FGh
6Mb⁴Cv is equivalent to 6Mb4Cv

CHANGES IN TERMINOLOGY

The changes listed below have been made to update terrain terminology and minimize the length of the terms.

Surficial Materials replaces Surficial (Genetic) Materials.

Geomorphological Processes replaces Geological (Modifying) Processes.

Qualifiers replaces Qualifying Descriptors.

Subclass replaces Subclass Modifier for processes that have standard definitions within the Terrain Classification System, such as subclasses for slope processes and fluvial processes (Chapter 7).

Subtypes: Replaces Subclass Modifier for processes and materials that do not have standard definitions within the Terrain Classification System, such as subdivisions of surficial materials (e.g., till subtypes: M1, M2...) (Chapter 7).

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