UNIL legend for geomorphological mapping

Instructions for use in QGIS 3.40 and later

2025-10-01

1 History and principles of the legend[1]

The geomorphological mapping legend of the University of Lausanne has been used for more than 30 years for detailed mapping especially in high and middle mountain regions. It is a morphogenetic mapping system built on the following principles:

- Colours represent process categories;
- Symbols have a genetic significance and are drawn in the colour of the related process;
- Morphodynamic differentiation of erosion and accumulation areas is achieved by white and coloured surfaces, respectively;
- Morphography, slope gradient and lithology are not represented.

The legend was initially developed for manual mapping in the field. It has since been adapted to ArcGIS and QGIS, and its symbology has been expanded to include aeolian, marine, lacustrine and anthropogenic processes.

2 QGIS implementation

In QGIS, the UNIL geomorphological legend is distributed directly inside a GeoPackage, as an independent style database, as QML files and as SLD files (Styled layer descriptor in XML).
The QGIS symbology is rule-based: each object has three attributes `FORM`, `PROCESS` and `ANGLE` used to define the symbology.

- `FORM`: drop-down menu. Always used, stores the name of the landform. Several options may correspond to the same symbology, but are proposed separately for clarity;
- `PROCESS`: drop-down menu. Only necessary to distinguish between two processes producing similar landforms, e.g. scars (gravitational erosion edges) and fluvial erosion edges. Can also be useful to extract statistics about the dominant processes in the study area;
- `ANGLE`: integer. Used to rotate directional symbols (points and polygons). Usually corresponds to the slope direction.

3 Load data structure and styles

Choose reference scale (bottom of the window) (1:5'000 or 1:10'000) and lock the scale.
Load `geomorpho_mapping.gpkg` (3 tables) in a group.
Styles are included in the geopackage and should load automatically. Check by opening layer *Properties* > *Symbology*. See the appendices of this document for the complete list of symbols and rules.

[1] See Lambiel C., Maillard B., Martin S., Pellitero Ondicol R., Schoeneich P., Reynard E. (2013). Adaptation of the geomorphological mapping system of the University of Lausanne for ArcGIS. *8th International Conference on Geomorphology (IAG)*, Paris, 27-31 Aug. 2013.

4 Mapping

4.1 Setup

View / Toolbars: activate *Digitizing toolbar*, *Advanced digitizing tools* and *Snapping toolbar*.
Enable *Snapping* to avoid overlapping features.
Select the layers and toggle *Editing* on. Then select the layer where you want to create a feature and start mapping.
If you are not familiar with editing with QGIS, first have a look at the manual: https://docs.qgis.org/2.18/en/docs/user_manual/working_with_vector/editing_geometry_attributes.html

Note: Some lines and polygons are *directional*, i.e. they must be drawn in a particular direction to represent the feature correctly (e.g. terrace edges and scarps). If you have drawn the line the wrong way around, you can simply flip it by selecting *Reverse line* in the *Advanced digitizing* toolbar and clicking on the object.

4.2 Attribute form

A form opens upon completion of an object. You can directly fill in all the attributes, or only `FORM` by selecting the appropriate name in the dropdown menu. If you are mapping several of the same landforms, you can also digitize a series of forms without using the form (leave all blank) and then use the *Field calculator* to populate the attributes all at once.
For directional symbols that cannot be determined by drawing direction (such as landslides, ploughed ground, or solifluction), the azimuth of the displacement must be provided in the `ANGLE` attribute. You can manually change a symbol's orientation by editing the `ANGLE` field in the attribute table.
Some symbols depend not only on the `FORM` attribute, but also on `PROCESS` to differentiate between similar landforms originating from different morphogenetic processes. Please refer to the symbology rules in the appendix to find which symbols require supplying `PROCESS`. In these cases, select the corresponding process domain from the dropdown menu.

Note: As the dropdown menu for the `FORM` attribute cannot be filtered or searched, landforms are alphabetically sorted by the most relevant term, i.e. "ephemeral lake" is registered as "lake, ephemeral", but "kettle lake" is registered as is.

5 Export map

First, in the layer list, uncheck all layers that you do not want to show on your map.
Secondly, for readability, your map has to include topographic information. You can use e.g.:

- a mix of hillshade and vector layers for hydrography, main summits, buildings and roads;
- a black and white map in the background.

In both cases, you have to adapt the transparency of your geomorphological map layers to make the base layer visible. Create your layout with *Project / New print layout*.

6 Appendices

Appendix I: Symbology

Line features

Note: Indicated attribute values are those that appear in the dropdown menu interface. For the internal values assigned to these terms in the symbology rules, refer to the Attribute Form section of the layer properties.

The baseline is vertically centered with the text. Symbol elements appearing above this baseline are drawn to the left of the baseline in direction of drawing, elements appearing below are drawn to the right. This means they are directional (cf. §4.1).

Symbol	Legend label	Dropdown menu value(s)
	fault	`FORM = 'fault'`
	supposed fault	`FORM = 'fault, supposed'`
	rock scarp (> 20 m)	`FORM = 'rock scarp, large'`
	rock scarp (5 - 20 m)	`FORM = 'rock scarp, small'`
	covered scarp (> 20 m)	`FORM = 'covered scarp, large'`
	covered scarp (5 - 20 m)	`FORM = 'covered scarp, small'`
	rock step (< 5 m)	`FORM = 'rock step'`
	covered rock step (< 5 m)	`FORM = 'rock step, covered'`
	fault escarpment	`FORM = 'fault escarpment'`
	stream	`FORM = 'stream'`
	intermittent stream	`FORM = 'stream, intermittent'`
	crevasse, serac	`FORM = 'crevasse' OR FORM = 'serac'`
	ice fall	`FORM = 'ice fall'`
	rimaye	`FORM = 'rimaye'`
	gorge	`FORM = 'gorge'`

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Table 1: (Continued)

fluvial erosion edge (< 5 m)	`FORM = 'edge/scar' AND PROCESS = 'fluvial'`
fluvial erosion edge (> 5 m)	`FORM = 'edge/scar, large' AND PROCESS = 'fluvial'`
fluvial terrace edge	`FORM = 'terrace' AND PROCESS = 'fluvial'`
debris flow channel	`FORM = 'channel' AND PROCESS = 'fluvial'`
palaeochannel	`FORM = 'paleochannel'`
alluvial fan direction	`FORM = 'direction, alluvial fan'`
gully	`FORM = 'gully'`
scar	`FORM = 'edge/scar' AND PROCESS = 'gravitational'`
debris channel	`FORM = 'channel' AND PROCESS = 'gravitational'`
glacial corrie, glacial edge	`FORM = 'edge/scar' AND PROCESS = 'glacial'`
trimline	`FORM = 'trimline'`
 riegel	`FORM = 'riegel'`
striae direction	`FORM = 'direction, striae'`
moraine crest (main)	`FORM = 'moraine crest, main'`
moraine crest (secondary)	`FORM = 'moraine crest, secondary'`
kame terrace	`FORM = 'terrace' AND PROCESS = 'glacial'`
esker	`FORM = 'esker'`
Nye channel	`FORM = 'Nye channel'`
rock glacier front	`FORM = 'rock glacier front'`
gelifluction deposit	`FORM = 'gelifluction'`

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Table 1: (Continued)

	nivation hole	`FORM = 'edge/scar' AND PROCESS = 'nival'`
	snow moraine	`FORM = 'snow moraine'`
	bedrock step	`FORM = 'edge/scar' AND PROCESS = 'karstic'`
	underground channel	`FORM = 'underground channel, certain'`
	possible underground channel	`FORM = 'underground channel, possible'`
	lacustrine terrace	`FORM = 'terrace' AND PROCESS = 'lacustrine'`
	marine terrace	`FORM = 'terrace' AND PROCESS = 'marine'`
	relict lacustrine terrace	`FORM = 'terrace, relict' AND PROCESS = 'lacustrine'`
	relict marine terrace	`FORM = 'terrace, relict' AND PROCESS = 'marine'`
	cliff	`FORM = 'cliff'`
	dead cliff	`FORM = 'dead cliff'`
	coastal bench	`FORM = 'coastal bench'`
	berm	`FORM = 'berm'`
	longshore drift	`FORM = 'direction, longshore drift'`
	tidal channel	`FORM = 'channel' AND PROCESS = 'marine'`
	delta direction	`FORM = 'direction, delta'`
	perched delta front	`FORM = 'perched delta front'`
	dune crest	`FORM = 'dune crest'`
	wind direction	`FORM = 'direction, wind'`
	slope (backfilled or excavated)	`FORM = 'edge/scar' AND PROCESS = 'anthropic'`

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Table 1: (Continued)

	anthropic ridge	`FORM = 'ridge, anthropic'`
	agricultural terrace	`FORM = 'terrace' AND PROCESS = 'anthropic'`
	drainage	`FORM = 'drainage'`
	concrete dyke	`FORM = 'dyke, concrete'`
	stone dyke	`FORM = 'dyke, stone'`
	earth dyke	`FORM = 'dyke, earth'`
	weir	`FORM = 'weir'`
	irrigation channel	`FORM = 'irrigation channel'`
	abandoned irrigation channel	`FORM = 'irrigation channel, abandoned'`
	drainage channel	`FORM = 'drainage channel'`
	abandoned drainage channel	`FORM = 'drainage channel, abandoned'`
	undefined	`FORM = NULL`

Point features

Note: Indicated attribute values are those that appear in the dropdown menu interface. For the internal values assigned to these terms in the Value Map, refer to the Attribute Form section of the layer properties.

The centroid of the point feature is vertically aligned with the text.

Symbol	Legend label	Dropdown menu value(s)
	dipslope	`FORM = 'fault'`
	witness butte direction	`FORM = 'direction, witness butte'`
	source	`FORM = 'source'`
	waterfall	`FORM = 'waterfall'`
	fallen block	`FORM = 'fallen block'`
	erratic boulder	`FORM = 'erratic boulder'`
	thermokarst	`FORM = 'thermokarst'`
	ploughed ground	`FORM = 'ploughed ground'`
	pinnacle, monolith	`FORM = 'pinnacle' OR 'monolith'`
	cave, hole	`FORM = 'cave' OR 'hole, karstic'`
	karst spring	`FORM = 'karst spring'`
	sinkhole	`FORM = 'sinkhole'`
	ponor	`FORM = 'ponor'`
	doline	`FORM = 'doline'`
	nebkha	`FORM = 'nebkha'`
	micro-nebkha	`FORM = 'micro-nebkha'`
	mine	`FORM = 'mine'`

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Table 2: (Continued)

○	foggara, khettara, qanat	`FORM = 'foggara' OR 'khettara' OR 'qanat'`
▲	avalanche defence	`FORM = 'avalanche defence'`
●	undefined	`FORM = NULL`

Polygon features

Note: Indicated attribute values are those that appear in the dropdown menu interface. For the internal values assigned to these terms, refer to the Attribute Form section of the layer properties.

Symbol	Legend label	Dropdown menu value(s)
	witness butte	`FORM = 'witness butte'`
	outlier	`FORM = 'outlier'`
	lake	`FORM = 'lake'`
	ephemeral lake	`FORM = 'lake, ephemeral'`
	marsh	`FORM = 'marsh'`
	glacier	`FORM = 'glacier'`
	debris-covered glacier	`FORM = 'glacier, debris-covered'`
	permanent snow patch	`FORM = 'permanent snow patch'`
	sabkha	`FORM = 'sabkha'`
	alluvial fan	`FORM = 'alluvial fan'`
	pediment	`FORM = 'pediment'`
	fluvial accumulation area	`FORM = 'accumulation' AND PROCESS = 'fluvial'`
	rockslide	`FORM = 'rockslide'`
	rockslide with dislocation	`FORM = 'rockslide with dislocation'`
	landslide	`FORM = 'landslide'`
	translational landslide	`FORM = 'landslide, translational'`
	shallow landslide	`FORM = 'landslide, shallow'`
	talus slope	`FORM = 'talus slope'`

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Table 3: (Continued)

	vegetated talus slope	`FORM = 'talus slope, vegetated'`
	rockfall deposit	`FORM = 'deposit, rockfall'`
	colluvium	`FORM = 'colluvium'`
	gravitational accumulation area	`FORM = 'accumulation' AND PROCESS = 'gravitational'`
	glacial basin	`FORM = 'glacial basin'`
	roches moutonnées	`FORM = 'roches moutonnées'`
	drumlin	`FORM = 'drumlin'`
	moraine	`FORM = 'moraine'`
	deplaced moraine	`FORM = 'moraine, deplaced'`
	hummocky moraine	`FORM = 'moraine, hummocky'`
	fluvio-glacial deposit	`FORM = 'accumulation' AND PROCESS = 'fluvio-glacial'`
	till	`FORM = 'accumulation' AND PROCESS = 'glacial'`
	rockfall deposit on glacier	`FORM = 'deposit, rockfall on glacier'`
	rock glacier	`FORM = 'rock glacier'`
	relict rock glacier	`FORM = 'rock glacier, relict'`
	push moraine	`FORM = 'push moraine'`
	solifluction lobe	`FORM = 'solifluction lobe'`
	creeping scree	`FORM = 'creeping scree'`
	small terrace	`FORM = 'small terrace'`
	patterned ground	`FORM = 'ground, patterned'`

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Table 3: (Continued)

	sorted ground	`FORM = 'ground, sorted'`
	paved ground	`FORM = 'ground, paved'`
	gelifraction deposits	`FORM = 'deposit, gelifraction'`
	thermokarst	`FORM = 'thermokarst'`
	thufurs	`FORM = 'thufurs'`
	kettle lake	`FORM = 'kettle lake'`
	periglacial accumulation area	`FORM = 'accumulation' AND PROCESS = 'periglacial'`
	avalanche deposit area	`FORM = 'avalanche deposit area'`
	avalanche erosion area	`FORM = 'avalanche erosion area'`
	avalanche impact zone	`FORM = 'avalanche impact zone'`
	exposed karren	`FORM = 'karren, exposed'`
	buried karren	`FORM = 'karren, buried'`
	gelifracted karren	`FORM = 'karren, gelifracted'`
	eroded karren	`FORM = 'karren, eroded'`
	gypsum karst	`FORM = 'gypsum karst'`
	ouvala	`FORM = 'ouvala'`
	closed basin	`FORM = 'closed basin'`
	karstic accumulation area	`FORM = 'accumulation' AND PROCESS = 'karstic'`
	sandy beach	`FORM = 'beach, sandy'`
	cobble beach	`FORM = 'beach, cobble'`

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Table 3: (Continued)

 tidal flat	`FORM = 'tidal flat'`
 salt marsh	`FORM = 'salt marsh'`
 delta	`FORM = 'delta'`
 lacustrine/marine accumulation area	`FORM = 'accumulation' AND PROCESS = 'lacustrine' OR 'marine'`
dune construction	`FORM = 'dune construction'`
 vegetated dune construction	`FORM = 'dune construction, vegetated'`
nebkha field	`FORM = 'nebkha field'`
micro-nebkha field	`FORM = 'micro-nebkha field'`
reg	`FORM = 'reg'`
tafoni	`FORM = 'tafoni'`
mushroom rock	`FORM = 'mushroom rock'`
deflation basin	`FORM = 'deflation basin'`
yardang	`FORM = 'yardang'`
aeolian accumulation area	`FORM = 'accumulation' AND PROCESS = 'aeolian'`
 vegetated aeolian accumulation area	`FORM = 'accumulation, vegetated' AND PROCESS = 'aeolian'`
 active quarry	`FORM = 'quarry'`
 abandoned quarry	`FORM = 'quarry, abandoned'`
 dump	`FORM = 'dump'`
 embankment	`FORM = 'embankment'`
 ditch, trench	`FORM = 'ditch' OR 'trench'`

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Table 3: (Continued)

	ski run	`FORM = 'ski run'`
	anthropic accumulation area	`FORM = 'accumulation' AND PROCESS = 'anthropic'`
	anthropic hill	`FORM = 'anthropic hill'`
	agricultural terrace	`FORM = 'agricultural terrace'`
	soil on bedrock	`FORM = 'soil on bedrock'`
	organogeneous accumulation area	`FORM = 'accumulation' AND PROCESS = 'organic'`
	undefined	`FORM = NULL`

Appendix II: Additional information for symbology development

II.1: Codes for `PROCESS` field

AEO	aeolian
ANT	anthropic
FGL	fluvio-glacial
FLU	fluvial
GLA	glacial
GRA	gravitative
HYD	hydrography
KAR	karstic
LAC	lacustrine
NIV	nival
ORG	organic
PGL	periglacial
STR	structural

II.2: Colour codes

Landform type	CMYK colour				HTML colour	RGB colour			Use case
Structural	0	100	100	0	`#ff0000`	255	0	0	All
Hydrography	80	10	00	05	`#30daf2`	48	218	242	Lines, points, borders
	40	00	00	00	`#99ffff`	153	255	255	Surfaces (except glaciers)
	15	00	00	00	`#d9ffff`	217	255	255	Glaciers
Fluvial	100	0	100	20	`#00cc00`	0	204	0	Lines, points, borders
	55	00	55	15	`#62d962`	98	217	98	Surfaces
Gravitative	10	50	100	5	`#da7900`	218	121	0	Lines, points, borders
	0	15	50	5	`#f2ce79`	242	206	121	Surfaces
Glacial	80	100	0	10	`#2e00e6`	46	0	230	Lines, points, borders
	30	35	0	5	`#aa9df2`	170	157	242	Surfaces
Periglacial	10	100	0	10	`#cf00e6`	207	0	230	Lines, points, borders
	5	50	0	5	`#e679f2`	230	121	242	Surfaces
Nival	10	100	80	10	`#cf002e`	207	0	46	Lines, points, borders
	10	50	40	10	`#cf738a`	207	115	138	Surfaces
Karstic	100	0	40	0	`#00ff99`	0	255	153	Lines, points, borders
	0	60	100	0	`#ff6600`	255	102	0	Underground structures
	60	0	25	0	`#66ffbf`	102	255	191	Surfaces (except below)
	5	50	0	5	`#e679f2`	230	121	242	Gelifracted karren
	0	0	45	10	`#e6e67e`	230	230	126	Covered karren
Lacustrine/marine	100	40	0	40	`#005c99`	0	92	153	Lines, points, borders
	50	20	0	30	`#598fb3`	89	143	179	Surfaces
Anthropic	0	0	0	50	`#808080`	128	128	128	Lines, points, borders
	0	0	0	25	`#bfbfbf`	191	191	191	Surfaces
Aeolian	0	11	79	0	`#ffe336`	255	227	54	Lines, points, borders
	0	0	25	0	`#ffffbf`	255	255	191	Surfaces
Organic	0	0	40	10	`#e6e68a`	230	230	138	Soil on bedrock
	50	30	100	0	`#80b300`	128	179	0	Organogenous accumulation