



Supplement of

**Revisiting Late Pleistocene glacier dynamics north-west of the Feldberg,
southern Black Forest, Germany**

Felix Martin Hofmann et al.

Correspondence to: Felix Martin Hofmann (felix.martin.hofmann@geologie.uni-freiburg.de)

The copyright of individual parts of the supplement might differ from the CC BY 4.0 License.

Table S1: Ice-marginal positions in Sankt Wilhelmer Tal

Ice-marginal position (this study)	Location of terminal moraines (m a.s.l.)	Original reference	Description	Interpretation or comment (this study)
1	1030	-	ESE-WNW oriented sediment ridge on the eastern headwall of the Napf cirque	Terminal moraine
-	985	Zienert (1973)	Ridge on the eastern headwall of the cirque	Not identified in this study
2 & 3	910	Schreiner (1977b)	Two-crested sediment ridge with a steep northern flank and a gently sloping southern side; on the valley floor	Terminal moraine
-	850	Klute (1911)	Terrace-shaped accumulation of partly rounded boulders on the valley floor	Rockslide deposit
4	820	-	E-W oriented, subdued sediment ridge on the northern valley side	Terminal moraine
5	820	-	E-W oriented, subdued sediment ridge on the northern valley side	Terminal moraine
6	820	-	SE-NW oriented ridge composed of boulders on the southern valley side	Terminal moraine
7	780	Schreiner (1977b)	NE-SW oriented sediment ridge (oriented perpendicular to the orientation of the valley); on the valley floor	Terminal moraine

8	780	Schreiner (1977b)	NE-SW oriented sediment ridge (oriented perpendicular to the orientation of the valley); on the valley floor	Terminal moraine
9	780	-	Arc-shaped sediment ridge on the valley floor	Terminal moraine
10	780	-	Arc-shaped sediment ridge on the valley floor	Terminal moraine
11 & 12	700-760	Schreiner (1977b)	Two-crested sediment ridge with a SE-NW orientation on the valley floor	Terminal moraine
13	700	Klute (1911)	SW-NE oriented sediment ridge with a steep NW side and a gently sloping SE flank; on the valley floor	Terminal moraine
14	900	-	Arc-shaped sediment ridge with a strongly asymmetric cross-section (steep NE flank and gently sloping SW side); separated from the surrounding slope by a depression; on the southern valley side	Terminal moraine
15	910	-	NW-SE oriented sediment ridge with a steep NE side; separated from the surrounding slope by a depression; on the southern valley side	Terminal moraine

16	920	-	NW-SE oriented sediment ridge with a steep NE side; separated from the surrounding slope by a depression; on the southern valley side	Terminal moraine
17	930	-	NW-SE oriented sediment ridge with a steep NE side; separated from the surrounding slope by a depression; on the southern valley side	Terminal moraine
18	650	Hüttner (1967)	Terrace-shaped accumulation of partly rounded boulders on the valley floor	Medial moraine

Table S2: Ice-marginal positions in the Wittenbach cirque

Ice-marginal position (this study)	Location of terminal moraines (m a.s.l.)	Original reference	Description	Interpretation or comment (this study)
1	1210	-	N-S oriented, arc shaped sediment ridge in the SE corner of the cirque	Terminal moraine
2	1170	-	SW-NE oriented, arc shaped sediment ridge at the margin of the uppermost cirque floor	Terminal moraine
-	1120	Schreiner (1977b)	Arc shaped ridge at the northern end of the intermediate cirque floor	Not identified in this study
3	1100	-	N-S oriented sediment ridge NE of the intermediate cirque floor	Terminal moraine
4	1100	-	Sediment ridges NE and NW of the intermediate cirque floor	Terminal moraine
5	990	Schreiner (1977b)	Arc shaped sediment ridge with a smooth crest on the lowermost cirque floor	Overprinted terminal moraine
6	980	Schreiner (1977b)	Arc shaped sediment ridge with a smooth crest on the lowermost cirque floor	Overprinted terminal moraine
7	950	Schreiner (1977b)	Arc shaped sediment ridge with a smooth crest on the lowermost cirque floor	Overprinted terminal moraine

8	860	Klute (1911)	Sediment ridge at the entrance to the cirque extending up to the eastern headwall of the cirque	Terminal moraine
---	-----	--------------	---	------------------

Table S3: Ice-marginal positions in the Katzensteig cirque

Ice-marginal position (this study)	Location of terminal moraines (m a.s.l.)	Original reference	Description	Interpretation or comment (this study)
1	1040; 1080	Schreiner (1977b)	W-E oriented, asymmetric sediment ridges	Terminal moraine
2	1020; 1030	Klute (1911)	SW-NE to W-E oriented, asymmetric sediment ridges; partly separated from the surrounding slope	Terminal moraine
3	1020	Klute (1911)	W-E oriented, asymmetric sediment ridges; partly separated from the surrounding slope	Terminal moraine
4	900; 980; 1030	Schreiner (1977b)	SW-NE and N-S oriented, asymmetric sediment ridges; separated from the surrounding slope	Terminal moraine
5	890; 980; 1060	Schreiner (1977b)	N-S and SW-NE oriented, asymmetric sediment ridges; not separated from the surrounding slope	Terminal moraine
6	890; 1110	-	Arc-shaped, asymmetric sediment ridge on the eastern headwall of the cirque and SW-NE oriented sediment ridge north of the entrance to the cirque	Terminal moraine

7	1110	-	Arc-shaped, asymmetric sediment ridge on the eastern headwall of the cirque	Terminal moraine
---	------	---	---	------------------

Table S4: Ice-marginal positions in Zastler Tal

Ice-marginal position (this study)	Location of terminal moraines (m a.s.l.)	Original reference	Description	Interpretation or comment (this study)
1	1400-1420	-	Set of short sediment ridges on the uppermost cirque floor	Terminal moraine
	1340-1360	Zienert (1973)	Set of sediment ridges in the SE corner of the cirque	Terminal moraine
2	1400-1430	-	Arcuate sediment ridge at the NW margin of the uppermost cirque floor	Terminal moraine
	1320-1340	Zienert (1973)	Set of sediment ridges in the SE corner of the cirque	Terminal moraine
3	1340-1350	-	Sediment ridges with a SW-NE and a SE-NW orientation in the SE corner of the cirque	Terminal moraine
4	1260	Steinmann (1902)	Arcuate sediment ridge separated from the eastern headwall of the cirque by a depression; at the margin of the lowermost cirque floor	Terminal moraine
5	1270	Schreiner (1981)	Arcuate sediment ridge on the eastern headwall of the cirque	Terminal moraine

6	1200-1290	Schreiner (1981)	Two SE-NE oriented sediment ridges on the eastern headwall of the cirque, a S-N oriented sediment ridge on the centre of the valley and a S-N oriented sediment ridge on the western headwall of the cirque	Terminal moraine
7	1200	Schreiner (1981)	S-N oriented sediment ridge on the eastern headwall of the cirque	Terminal moraine
8 & 9	1030	Steinmann (1902)	Two-crested, arcuate sediment ridge on the centre of the valley floor	Terminal moraine
10	980	-	Short sediment ridge on the centre of the valley floor	Terminal moraine
11	970	-	Short sediment ridge on the centre of the valley floor	Terminal moraine
12	970	-	SE-NE oriented sediment ridge on the western valley side	Terminal moraine
13	980	-	SE-NE oriented sediment ridge on the western valley side	Terminal moraine
-	860	Zienert (1973)	Ridge on the centre of the valley floor	Not identified in this study
14	720	-	Small sediment ridge on the centre of the valley floor	Terminal moraine
-	720	Steinmann (1910)	Prominent ridge oriented perpendicular to the valley floor	<i>Riegel</i>
15	640	Schreiner (1977a)	Arcuate sediment ridge on the valley floor	Terminal moraine

	940	Schreiner (1977a)	Ridge-shaped accumulation of boulders parallel to the valley floor; on the southern valley side south of Schweizerhof	Terminal moraine
16	620	Zienert (1973)	Arcuate sediment ridge on the valley floor and both valley sides	Terminal moraine
	770-780	Hüttner (1967)	Ridge-shaped accumulation of boulders parallel to the valley floor; on the southern valley side between the entrance to Stollenbach and Angelsbach	Terminal moraine
17	560	Erb (1948)	Short sediment ridge on the southern and the northern valley side near Jockelehof	Terminal moraine
18	550	Erb (1948)	Short sediment ridge on the southern and the northern valley side near Jockelehof	Terminal moraine

Establishment of the digital surface model of the upper Katzensteig

Due to the presence of well-preserved terminal moraines, the rugged terrain and the lack of vegetation, an additional drone survey was conducted in the Katzensteig valley to derive a more precise digital surface model (DSM) based on structure-from motion photogrammetry (Westoby et al., 2012). 470 photos of the unforested area in the upper Katzensteig were obtained using a DJI Mavic quadcopter equipped with a FC220 camera (12 megapixel). The internal GPS of the quadcopter enabled the coordinates of the locations from which the photos were taken to be recorded. The photos were subsequently imported in Agisoft Photoscan. The photos were first aligned using the highest quality setting. The application of the ‘dense point cloud’ command resulted in the identification of c. 540,000,000 points, whereby the ultra-high-quality setting was chosen. A mesh was subsequently created from the dense point cloud using the ‘height field’ mode. Lastly, an orthomosaic and a DSM were derived from the mesh and dense point cloud, respectively. The orthophoto has a x- and y-cell size of 5.4 and 3.7 cm, respectively, whereas the DSM has a pixel size of 3.7 cm. Due to the sheltered location of Katzensteig, the total error of the georeferencing was 2.67 m. Due to this high error with respect to the pixel size of the DSM, the DSM and an existing DTM of the area were compared. Since the DSM and the DTM agreed well, the georeferencing error of the DSM was deemed acceptable. To correct the DSM for trees, trees were digitised in ArcMap. The resulting shapefile was then subtracted from the DEM using the ‘clip’ tool. The application of the ‘Elevation void fill function’ enabled the subtracted areas to be filled.

References

- Erb, L.: Die Geologie des Feldbergs, in: Der Feldberg im Schwarzwald, edited by: Müller, K., L. Bielefelds Verlag KG, Freiburg i. Br., 22-96, 1948.
- Hüttner, R.: Das Quartär, in: Geologische Karte von Baden-Württemberg 1:25 000, Erläuterungen zu Blatt 8013 Freiburg-Südost, edited by: Geologisches Landesamt Baden-Württemberg, Landesvermessungsamt Baden-Württemberg, Stuttgart, 69-105, 1967.
- Klute, F.: Die Schneereste des Schwarzwaldes im Frühsommer und die Beziehungen ihrer Lage zu den Stellen ehemaliger Vergletscherung, Ber. Naturf. Ges. Freiburg i. Br., 19, 61-116, 1911.
- Schreiner, A.: Geologische Karte von Freiburg i. Br. und Umgebung 1:50000, 1st ed., Geologisches Landesamt Baden-Württemberg, Freiburg i. Br., 1977a.
- Schreiner, A.: Quartär, in: Erläuterungen zur Geologischen Karte von Freiburg i. Br. und Umgebung 1:50 000, 1st ed., edited by: Geologisches Landesamt Baden-Württemberg, Landesvermessungsamt Baden-Württemberg, Stuttgart, 174-198, 1977b.
- Schreiner, A.: Quartär, in: Geologische Karte von Baden-Württemberg 1:25 000. Erläuterungen zu Blatt 8114 Feldberg, 1st ed., edited by: Geologisches Landesamt Baden-Württemberg, Landesvermessungsamt Baden-Württemberg, Stuttgart, 67-95, 1981.
- Steinmann, G.: Die Bildungen der letzten Eiszeit im Bereiche des alten Wutachgebiets, Ber. d. Oberrhein. Geol. Ver., 35, 1-8, 1902.
- Steinmann, G.: Die Eiszeit und der vorgeschichtliche Mensch, Aus Natur und Geisteswelt, 302, B. G. Teubner, Leipzig, 1910.
- Westoby, M. J., Brasington, J., Glasser, N. F., Hambrey, M. J., and Reynolds, J. M.: 'Structure-from-Motion' photogrammetry: A low-cost, effective tool for geoscience applications, *Geomorphology*, 179, 300-314, <https://doi.org/10.1016/j.geomorph.2012.08.021>, 2012.
- Zienert, A.: Die Würm-Vereisung und ihre Rückzugsstadien im Westteil des Hochschwarzwaldes, *Z. Geomorphol.*, 17, 359-366, 1973.

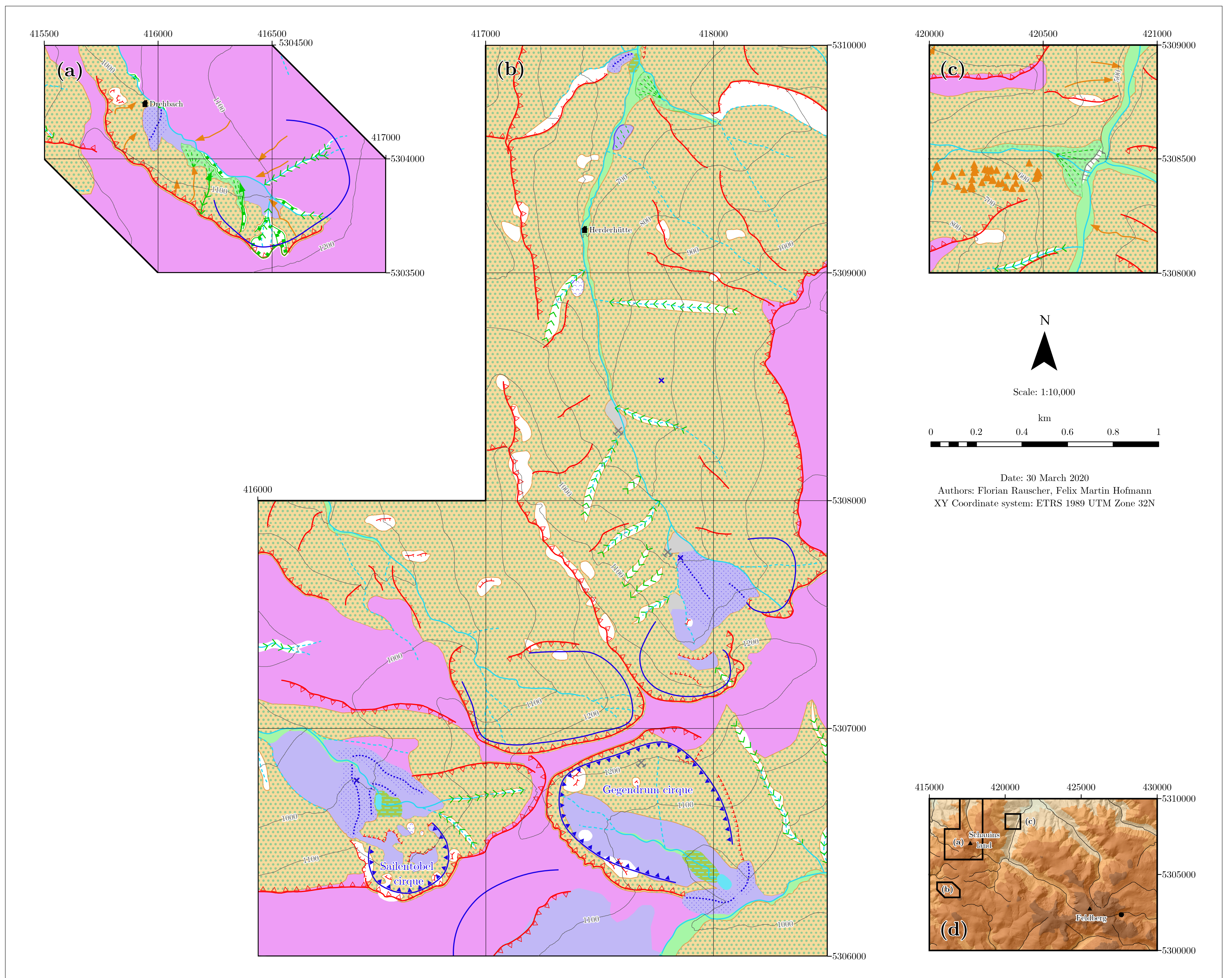


Figure S1. Geomorphological map of (a) Drehbach, (b) Kappeler Tal, the Sailendobel cirque and the Gegendrum cirque and of the entrance to (c) Hörnegrund. The legend of the geomorphological maps is given in Figure S4. The location of the mapped areas is shown in (d). The legend for (d) is given in Figure 2.

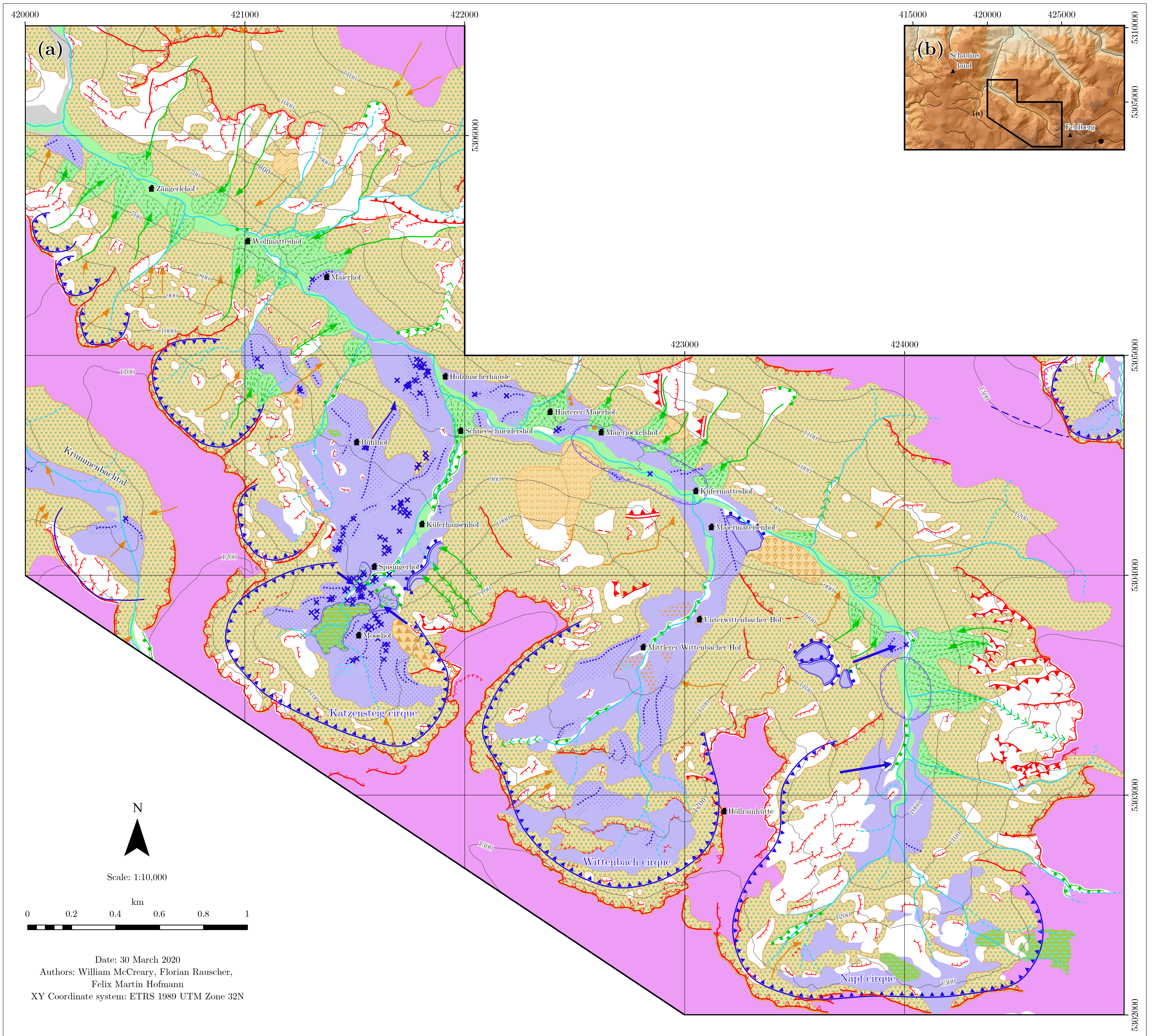


Fig. S2: Geomorphological map of (a) Sankt Wilhelmer Tal including the Katzensteig, Wittenbach and Napf cirques as well as of Krummenbachtal. The legend of the geomorphological maps is given in Figure S4. See (b) for the location of the mapped area. The legend for (b) is given in Figure 2.

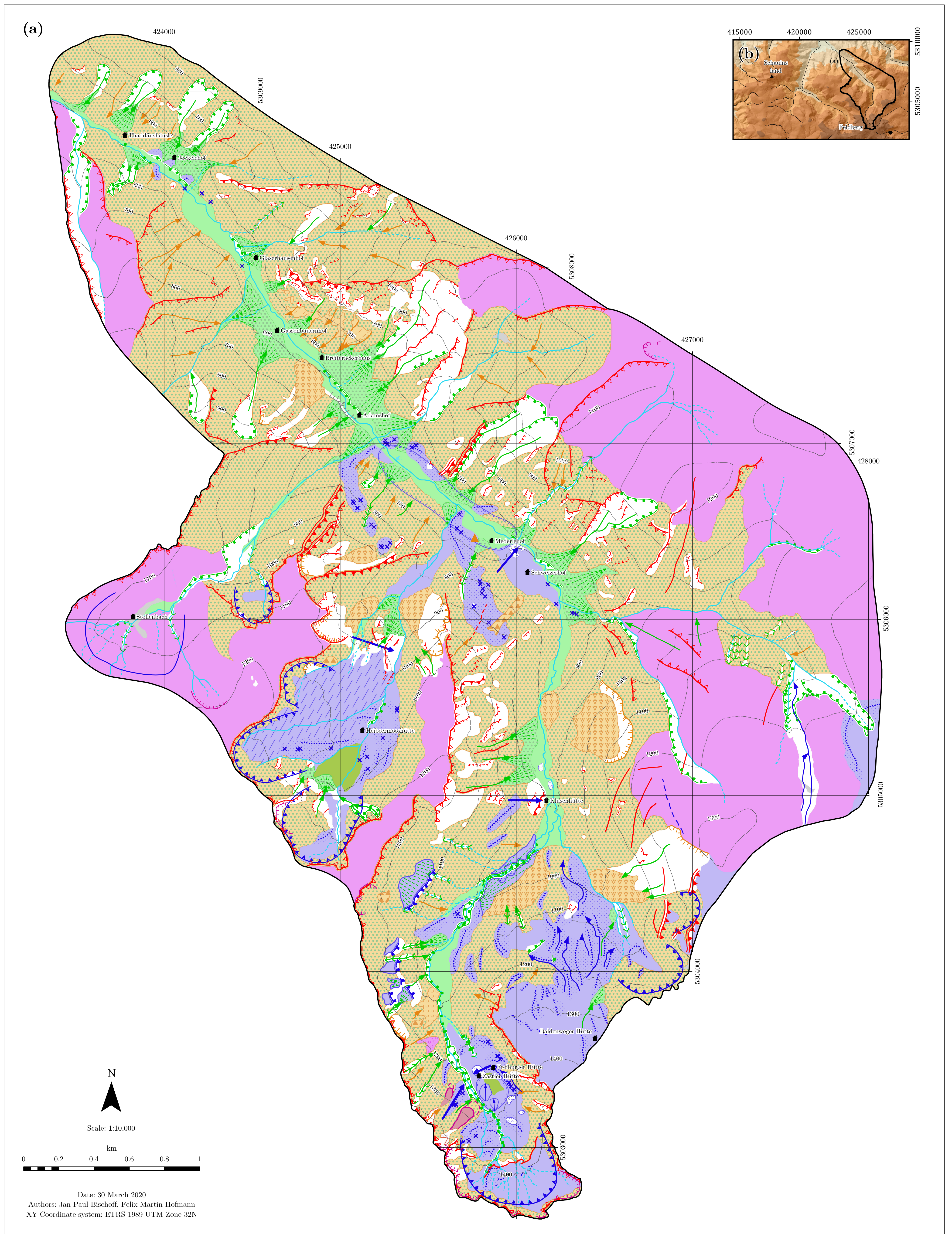















Fig. S3: Geomorphological map of (a) Zastler Tal and its tributary valleys. See (b) for the location of the mapped area. See Figure S4 for the legend of the geomorphological maps. The legend for (b) is given in Figure 2.








Structural landforms

-  Covered scarp (5-20 m)
-  Covered scarp
-  Covered step
-  Fault
-  Fault escarpment
-  Rock scarp
-  Rock scarp(5-20 m)
-  Rock step
-  Supposed fault









Hydrography

-  Intermittent stream
-  Stream
-  Marsh
-  Lake








Fluvial landforms










-  Alluvial fan (direction)
-  Debris flow
-  Erosion or terrace edge >5 m
-  Glaciofluvial terrace (direction)
-  Gully
-  Fluvial accumulation area
-  Vegetation-covered alluvial fan

Gravitational landforms



-  Fallen boulder
-  Debris channel
-  Scar
-  Screes lope/talus slope
-  Rockfall deposit
-  Landslide
-  Rockslide with dislocation
-  Vegetation-covered scree

Glacial landforms






-  Erratic boulder
-  Glacial cirque (poorly developed)
-  Glacial cirque
-  Kame terrace (edge)
-  Glacial meltwater channel
-  Moraine crest
-  Riegel

-  Trimline
-  Drumlin
-  Overprinted moraine
-  Glacial basin
-  Glacial deposition area/till plain
-  Glaciofluvial deposition area
-  Moraine
-  Roches moutonnées
-  Streamlined till plain





Periglacial landforms

-  Periglacial deposition area (periglacial cover beds)
-  Solifluction lobe

Nival landforms

-  Avalanche deposit
-  Avalanche impact zone
-  Nivation hole
-  Avalanche erosion zone
-  Nival deposition area

Other landforms

-  Mine
-  Slope (backfilled or excavated)
-  Anthropic deposition area
-  Mire

Other objects



-  Hamlet, farm or hut
-  Contour line (m a.s.l.), interval: 100 m

Figure S4. Legend of the geomorphological maps of the Schauinsland area (Fig. S1), Sankt Wilhelmer Tal (Fig. S2) and of Zastler Tal (Fig. S3).