A heavy rainfall that has occurred in 3–4 August 2011 caused many large debris flows which descended to the valley floor and made considerable destruction on the road which leading trough the valley. The largest debris flow deposits occurs 500 m north of Baumgartenalm. Its thick tongue of debris flow material reached Floitenbach stream channel and forced the stream to flow to the right-hand side of the valley.

Bericht 2012 über geologische Aufnahmen von quartären Sedimenten im Zillergrund, Sundergrund und Bodenbach auf Blatt 2230 Mayrhofen

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During 2012 Quaternary sediments and landforms were mapped over an area of ca. 40 km^2 in the western slope of the Zillergrund valley (in-between Nößlrain and In der Au settlements) in the western slope of the Sundergrund valley and in the area of the Bodenbach stream valley. All of these valleys are typical glacial troughs dissected in the Zentralgneiss crystalline rocks. Quaternary sediments mostly occur there in valley floors and in bottoms of hanging glacial cirques.

Evidence of the maximum ice extent (Last Glacial Maximum, LGM)

In the northern part of the investigated area the highest position of ice-moulded bedrock occurs in the spur descending to the north from the Trenker mountain at a level of 2,240 m. It indicates the ice-surface in the Zillergrund valley around location of the Nößlrain at a level of ca. 2,250 m. Trimmed facet of the spur which steeply running down from Äußere Gefallschneid towards Bodenbach stream valley point out maximum ice erosion in the middle section of this valley up to the level of 2,420 m. In the mouth of this valley, in the ridge which fencing the valley from the east, traces of ice erosion can be seen up to ca. 2,330 m. Two well-developed truncated spurs in the mouth of the Sundergrund valley: Stange and Grünkarlegg, mark trimline at the level of 2,400 and 2,440 m adequately. Further up the Sundergrund valley the former ice-surface has lifted up to 2,560 m in location of the spur which descends from the Vordere Stangenspitze towards the east and up to 2,620 m in the head of the Sundergrund valley in location of Roßkopf truncated spur (outside of reported map area). There are also traces of ice erosion (ice moulded bedrock, partially frost cracked) in the valley-head's watershed ridge around Hörndljoch cool (2,553 m). The ice moulded bedrock can be seen there over a distance of 600 m and up to 2,580 m. Also the north facing slope below this ridge bears traces of ice erosion, what is not common situation on a typical cirque back-wall. It might be considered that during the LGM some portion of ice accumulated in the Sundergrund valley head flowed over the Hörndljoch cool to the south, to the Ahrntal valley system (Italy), but the discharge of ice was there not enough large to effectively erode-down the ridge (ca. 20–30 m of ice thickness on the cool). The Hörndljoch cool in this respect can be considered as transfluence pass, but in the initial stage of development.

Lateglacial

In the study area two groups of Lateglacial moraines are distinguished basing on morphostratigraphic relations. Older moraines were most probably formed during the Eastern Alpine Gschnitz advance and the younger moraines ordered in multi-walled sequence were formed during the Egesen stadial advances.

Gschnitz age moraines occur only in the northern part of investigated area and in a lower altitude, below 1,850 m. The highest Gschnitz moraine wall (ca. 40 m high) occurs in the Hansenegg location, in the mouth of the Stadelbachalm valley, 2 km north of the Trenker mountain. It is a right-hand lateral moraine of glacier which occupied the Stadelbachalm valley. The highest position of this moraine reaches 1,850 m. The glacier, which formed this moraine, probably existed independently of the glacier which occupied the Zillergrund valley. Further up in the Stadelbachalm valley there is also well-developed and multi-walled Egesen moraine sequence (outside of map area). Very interesting moraine wall/terrace occur in the left-hand side of the Zillergrund valley, close to the mouth of the Bodenbach stream valley, 500 m east of Graßegg alp. This is the left-hand lateral moraine of the glacier which occupied the trough of the Zillergrund valley. The moraine extends parallel to the main valley axe on relatively low-sloped area of a glacial shoulder. The ridge of this moraine descends from 1,620 to 1,600 m. It indicates 580 m thick glacier in the Zillergrund valley (valley floor is at a level of 1,040 m in this location). Boulders which built this moraine are composed purely of Tuxer Kern gneiss lithology. A lack of well distinguishable Zillertaler Kern gneiss lithology in composition of this moraine implies relatively short glacial transport route from the tributary Bodenbach stream valley where this parent lithology does not occur in contrary to the upper catchment of the Zillergrund valley system (Zillergründl, Hundskehle and upper Sundergrund valleys). The highest position of moraine associated with the same glacial system can be considered in the mouth of the Bodenbach stream valley, in its right-hand side, 600 m NW of the Bärlahnerkopf mountain. This moraine descends from 1,730 to 1,660 m where it ends at the cliff of the Zillergrund trough edge. Presented moraine configuration indicates a large Gschnitz dendritic glacier system in the Zillergrund valley in which the glacier in the Bodenbach stream valley was the last large tributary affluent of the main trunk glacier.

Well-developed moraine sequences of the Egesen stadial can be observed especially in the Bodenbach stream valley and in the Rachkaralm cirque (the northernmost left-hand tributary cirque of Sundergrund valley). Moraines assigned in this report to the Egesen stadial moraines occur below 2,300–2,400 m. The exception is blocky, south exposed, rock glacier like moraine in the Rachkar cirque which reaches ca. 2,500 m. In the Bodenbach stream valley two morphological fresh, latero-frontal moraine walls stretch subparallel in the mouth of this valley, in its right-hand side, between 1,580 and 1,700 m. They mark positions of Bodenbach glacier tongue probably during the Egesen I and II advance. Several meters high terminal

moraine of the Egesen III advance occurs exactly in the Bodenalm alp location at a level of 1,680 m. Further up the valley talus and debris flow cone deposits entirely cover the valley floor. Some rest of the left-hand lateral moraines (Egesen I and III) and several meters thick till cover, however, occur on the slope running down to the valley floor form the Lahnkar cirque. In the bottom of the Lahnkar cirque distinct sequence of 5–6 fresh in shape and boulder-rich moraine ridges occurs which probably represent full Egesen sequence (I–III). These latero-frontal moraines are arranged into two independent moraine lobes. Frontal moraines of these lobes occur at elevation 2,050–2,160 m, are up to 5 m high and are composed of till with large, angular boulders up to 2–3 m in diameter. Less distinct, a third morainic lobe, composed of schistose material (Schönach zone lithology) occurs in the northern part of this cirque (2,200–2,300 m). In the Rachkaralm cirque distinct terminal moraines occur at 2,100–2,140 m (Egesen I?). They surround cirque overdeepening. Further up the cirque bottom (up to 2,400–2,460 m), these moraines are continued in lateral moraines which bend to form secondary latero-frontal lobe with distinct, high proximal slope (at 2,260 m). In the remaining area of the Sundergrund valley, Lateglacial moraines are poorly developed and are confined to the lower parts of cirques bottoms and areas of the Sundergrund trough shoulders. Steeply descending lateral moraines of glaciers which flowed from Kainzenkar and Hasenkar cirques can be traced close to the Rinderschneid spur (ca. 2,100–2,340 m). A lateral moraine occurs also north of the Mannlschneid spur (2,080–2,280 m) and a blocky till cover and poorly developed moraine walls can be observed in Grasleite site, 1,600 m east of the Vordere Stangenspitze mountain.

In valley floor of the Zillergrund and Sundergrund valley trough lacks of glacial deposits. They are entirely covered with talus, rock avalanche and debris flow deposits. The most of large debris cones are built of angular boulders very often up to 10 m in diameter with finer material matrix.

Holocene

The Holocene glacial landsystem and present-day glaciers occur in the head part of the Bodenbach stream valley and in the Sundergrund valley tributary cirques with exception of the Rachkar cirque. In the Bodenbach stream valley well-developed, high morainic ramps of small cirque/niche glaciers occur in the northern face of Grundschartner mountain (Roβkar cirque). In inner side of the most prominent latero-frontal moraine ramp which surrounds the easternmost glacial niche (north of Kainzenkarscharte cool), close-spaced recessional moraines and debris covers on glacier surface can be observed. A remnant of the most extensive Holocene terminal moraine (older than 1850 advance) is preserved on the high, distal slope of this ramp. Indistinct Holocene moraine systems occur also near small niche glaciers located north of Wilhelmer mountain and west of Pobergscharte cool. A complicated configuration of multilobate latero-frontal moraines of the Holocene system occur in left-hand Sundergrund tributary cirques, mostly above 2,200–2,300 m and below 2,500–2,600 m. The lowermost position of frontal moraine occurs in the trough end, in the Grieslaub site at 2,000 m. This is also an older than 1850 advance moraine, which is considerable rewashed and partially buried by debris flows. A fresh and prominent latero-frontal moraine occurs 80 m higher up slope (1850 advance). In most of the glacier forefields two recessional moraines which were formed during 1920 and 1970/1980 advances, can be distinguished. The best developed sequence of this moraine set occurs in the Schafkarkees glacier forefield. Recessional moraines in glacier forefields are commonly composed with passively transported angular blocks. In areas inside a glacier forefield where thicker till cover occurs, fluted moraines are also developed. They are clear visible, especially in the Schafkarkees glacier forefield, in the northern part of Kainzenkarkees glacier forefield and inside the northern morainic lobes in Hassenkarkees glacier and Grasleitenkees glacier forefields. Some small active rock glacier feature is also developed with association with right-hand lateral moraine of the 1850 advance in the Schafkarkees glacier forefield in Schafleite location (2,340 m). It has fresh looking, 40 m high frontal slope. An active rock glacier also occurs in the head of the Sundergrund valley, 500 m NW of the Hollenzkofel mountain. The front of this rock glacier descends to 2,370 m. There are no other intact (Holocene) rock glaciers in the mapped area.

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During 2013 Quaternary sediments and landforms were mapped over an area of ca. 40 km^2 in the lower section of Zillergrund valley, east from Mayrhofen. The major part of mapping area covers north facing slope of Ahornspitze (2,973 m) massif dissected with Arbesseitbach, Fellenbergbach, Ahornachbach and Stadelbach valleys. Remaining part of mapping area is located in vicinity of Brandberg village, on the 1,400–1,700 m high, south facing slope of Zillergrund valley descending from crest which runs between Hollenzberg, Hochfeld, Torhelm and Brandberger Kolm summits. In this area only one small valley occur. It stretches between location of Kolmhaus inn (1,845 m) and Brandberger Joch pass (2,307 m).

Evidence of the maximum ice extent (Last Glacial Maximum, LGM)

One of the best evidence of the highest position of ice erosion – glacial trimline – in the study area occurs in the spur descending westward from Ahornspitze summit toward Hauser Berg slope above Mayrhofen town. Glacially flattened topography of this spur can be observed up to ca. 2,200 m, close to Filzenkogel summit (2,227 m). Higher part of this spur has sharp, periglacially modeled form (arête). The highest location of roche moutonnées occurs at the level of 2,100 m on the flat ridge, 300 m west from Filzenkogel summit. Flat surface around Filzenalm alp is dominated with ice-moulded bedrock knobs surrounded with thin and patchy cover of till. Continues till cover composed of local Ahorn gneiss boulders occurs on the slope of Hauser Berg, below 1,600 m. Around Filzenalm alp (ca.