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Blatt NL 32-03-30 Mayrhofen

Bericht 2016 über geologische Aufnahmen quartärer Sedimente auf Blatt NL 32-03-30 Mayrhofen

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About 100 km² of Quaternary sediments and landforms in the northwestern corner of the UTM map sheet NL 32-03-30 Mayrhofen were geologically mapped during the field season of 2016. The investigated area belongs to the Tux Alps (German: Tuxer Alpen). It comprises the lower part of the Tux valley (German: Tuxertal), i.e. the section between the villages of Finkenberg and Lanersbach, the Nigglasbach catchment, the Penken massif and the valleys of Hoarbergbach and Sidanbach streams located to the north of the Penken massif. Elevations of the mapped area range from 650 m in the bottom of Ziller valley near the town of Mayrhofen to 2,762 m at the summit of Rastkogel. This corresponds to a difference in altitude of more than 2,100 m. The basement is mainly composed of metasedimentary and metavolcanic schists belonging to the upper Penninic nappe system (Tauern window) and the Innsbruck quartz phyllite Zone (Austroalpine nappe system). These lithologies are prone to weathering, erosion and mass movement processes, and exhibit a gentler relief than the neighbouring Central gneiss areas of the Zillertal Alps. The middle section of Tux valley around the village of Lanersbach, the Grüblspitze massif and most of the area of Nigglasbach catchment are built up of Bündner schist (phyllites, carbonate phyllites and quartzites), which has the least resistance to erosion. The highest summits bordering the area to the north and east (Torspitze, Hippoldspitze, Rastkogel, Pangert, Wanglspitze, Hoabergkarspitze) are built up of Innsbruck quartz phyllites. The lower Tux valley and the Penken massif are built up of Bündner schist, gneisses and greenschists (mostly belonging to Wustkogel nappe system). Within the mapped area, Central gneiss occurs only at the mouth of the Tux valley, in the village of Finkenberg.

Last Glacial Maximum (LGM)

In contrast to the Zillertal Alps, trim-line features recording the maximum extent of glaciers are poorly preserved in the Tux Alps. The maximum ice surface at the end of Ziller valley near the town of Mayrhofen reached to an altitude of about 2,150–2,250 m, what is well evidenced by trim-line data of the neighbouring Zillertal Alps (ZASADNI, 2014; WIRSIG et al., 2016). In the middle section of Tux valley, in the vicinity of Tettensjoch and Grüblspitze mountains, the ice surface reached to an altitude of about 2,300 m. At the Grüblspitz mountain, the transition from ice moulded bedrock to bedrock with no glacial overprint can be observed at elevations between 2,240 and 2,270 m. The Penken massif (2,095 m) bears clear evidence of ice moulding on the entire ridge between Wangalm (2,123 m) to Gschosberg (1,970 m). Elongation axes of bedrock streamlined features and measured striations on the Penken mountain ridge show direction of ice flow towards northeast. General ice flow directions recognized in the Ziller valley confluence zone, together with described evidence of ice flow directions on the Penken massif, indicate that during the LGM the ice stream originating from Tux valley was forced to overflow the Penken mountain ridge, because of the dominant role of the Zemm valley ice stream in the area of Mayrhofen confluence zone. Measured directions of glacial striation on the Ahorn gneiss near the village of Finkenberg (950–1,000 m altitude) and on the northern slope of Mount Gamsberg (up to 1,600 m altitude) support this conclusion for the ice confluence zone between Tux and Zemm valleys. Two generations of striation in this locality represent LGM and Gschnitz stages of ice flow. The older set of striation (LGM) shows divergent ice flow of Zemmtal ice stream towards north to northeast. The younger set of striation (Gschnitz stage) occurs only at lower elevations, below 1,000 m, and indicates ice flow towards northwest to the Tux valley. The divergent flow of the Zemm valley ice stream at the bottom of the Tux valley near the village of Finkenberg shows that the Tux valley ice stream did not reach this location during the LGM.

Till covers of the LGM occur in the Penken massif mostly below 1,800 m altitude, with the highest occurrence around 2,000 m altitude. Till covers of the Grüblspitze massif reach almost the same elevation. The vertical extent of till cover is not easily recognized in case of slaty lithology, which is not prone to develop rounded clasts by glacial transport. Even the slaty components of well-exposed glacial diamicton have an angular shape, quite similar to that of scree. On the slope, the till cover often shows an upward gradual transition into clay regolith with angular clasts, being the product of local bedrock weathering and colluvial processes. As a working hypothesis, it was adopted that till cover certainly occurs where any rounded clasts can be observed in the sediment. The thickest till cover (up to 4–5 m) occurs in the northeast slope of Penken massif (Larchwald, Grubenaste locations). LGM till entirely consists of local bedrock lithologies. No clasts of Central gneiss occur in till sediments on the left-hand slope of Tux valley, at some distance from the Gurbspitze mountain in the direction to the Penken massif. Central gneiss clasts occur sporadically in till covers of the Asteggertal valley (up to 0.5 m in diameter), and even 1 m big erratic boulders of Ahorn gneiss occur on the ice-moulded ridge separating this valley from Ziller valley (the mountain northeast of Asteg). Central gneiss components in tills of the mapped area are probably restricted to the influence zone of the Zemm valley ice stream, e.g. the area in the east, close to the Ziller valley near the town of Mayrhofen. Erratic fields with up to 4 m big blocks occur on the mountain slopes northeast from the village of Vorderlanersbach, at Lämmerbichlalm (1,900–2,100 m altitude), Schrofenalm (1,600–1,700 m altitude), and below Wanglalm (1,850–1,950 m altitude). However, the provenance of erratic lithologies is always local. For example, carbonate and quartzite lithologies of erratic boulders at the Wanglalm suggest about 2 km transport distance from the Graue Spitze mountain.

Gschnitz stadial

According to Penck & Brückner (1901/09), Gschnitz moraine of the Tuxertal glacier occurs at the village of Vorderlanersbach. These authors have also suggested that a moraine of the Zemmtal glacier in the village of Finkenberg was deposited during the Gschnitz stadial. The Lanersbach moraine is located on the left-hand side of the valley (1,285–1,320 m altitude) close to the stream confluence of Nigglasbach and Tuxbach. This moraine is 300 m long and its external slope is 2–3 m high. Superficial boulders of the moraine were removed by human activity because of its location in a settlement area; only the largest boulders of several meters in diameter are still in place. This stadial moraine is unique in the trunk valley of Tuxertal. Position and elevation of the moraine indicate that during the Gschnitz stadial the trunk glacier of the Tux valley dammed up the stream of Nigglasbach. In the upper part of Nigglasbach valley, Gschnitz moraine occurs at Geislhofer (1,580 m). Thus, the lowermost 1.4 km long section of the valley was ice-free during the Gschnitz stadial. In this section, several meters to several tens of meters thick gravels and sands occur above a deeply incised bedrock gorge. These sediments are particularly well preserved on the right-hand slope of the valley, 500 m northwest of the Gemais settlement. They build a terrace 100 m above the present-day stream channel. At least two stages of terrace formation can be recognized in the topography. There are also traces of palaeochannels with discharge form Nigglasbach stream to the south, through the Gemais location. In outcrops along the rim of steep fluvial undercutting, the terrace sediments reveal rounded gravels with sandy matrix, and up to 2–3 m thick beds of homogeneous sand.

The existence of a moraine from the Zemmtal glacier in the village of Finkenberg, as described by Penck & Brückner (1901/09), cannot be confirmed. During the Gschnitz stadial, the Zemmtal and Stillupgrund glaciers merged and flowed together toward Ziller valley bottom at the market town of Mayrhofen. Glacial striations around the village of Finkenberg provide clear evidence that the ice tongue from Zemm valley diverged and flowed up into Tux valley, as described above. Kame terraces occur near the village of Finkenberg, on both sides of the Tux valley. They mark the position of the invaded tongue of Zemmtal glacier. Such kame terrace is best preserved near the location of Persal (Magiera, 2008). It stretches over a distance of 550 m and its slope is 50–60 m high. Kame terrace also occurs in the Zellberger Siedlung settlements on the opposite side of the valley. It shows at least two stages of development. Top surfaces of both kame terraces reach the same elevation of about 1,000 m. Gravels and sands related to these terraces occur on the southern rim of the Tuxbach gorge and can be followed in upstream direction to the Brunnhaus settlement (1,050 m altitude). Locally these sediments are cemented.

The Tux valley between the villages of Finkenberg and Vorderlanersbach was ice-free during the Gschnitz stadial. Therefore, moraines of smaller tributary valley glaciers are exceptionally well-preserved at the bottom of this valley section. Best developed are latero-frontal moraines of Grinbergalm valley glacier, which reach the bottom of Tux valley (1,050 m) near the Brunnhaus settlement. This moraine consists of Ahorn gneiss components. Close to the bottom of the trunk valley, also moraines of the Elsalm valley glacier (at Elsegg, 1,200 m altitude), and right-hand lateral moraine descending to 1,400 m altitude, above the village of Vorderlanersbach near the Berg settlement are preserved. The last one was formed by a glacier from the Rötlbach stream catchment. Gschnitz moraines also occur in the Hoarbergbach valley, outside the catchment of the Tux stream. There are two lateral moraines located 500 m to the north of Hintertrettalm. They descend to an elevation of 1,800 m. Within the mapped area, maximum elevation of Gschnitz lateral moraines reaches 1,750 m altitude in the Rötlbach catchment and 2,075 m altitude in the Hoarbergbach valley. Both glaciers had a southern exposition.

Egesen stadial

Moraines of the Egesen stadial and corresponding rock glacier deposits occur only in the highest part of the mapped area. Well-developed latero-frontal moraines of four small glaciers (500–700 m long) are found in glacial cirques of the upper part of the Hobarbach valley between the summits of Torspitze and Hipoldspitze. Terminal moraines are located there between 2,190 and 2,400 m altitude. The largest Egesen glacier occurred in the Torseen cirque to the northeast of the Torwand summit (2,771 m). The moraine sequence of this cirque suggests at least a two-fold advance during the Egesen stadial. Moraines consist of large metacarbonate blocks and are situated at elevation between 2,250 and 2,350 m. It should be noted that Penck & Brückner (1901/09) described this moraine as an evidence of Daun stadial advance in the upper Ziller valley. But in the modern sense of East Alpine late glacial chronology it corresponds to the Egesen stadial. Moraines of this stadial also occur near Rastkogel (2,762 m) and Harbergjoch summits (2,590 m). Distinct latero-frontal moraines, with 20–40 m high external slopes occur in the cirque to the south of Rastkogel summit, above Lämmerbichlalm. They are located at relatively high altitudes between 2,460 and 2,500 m. Moraine in the Hoaberg cirque, to the southeast of the Hoarbergjoch summit are less pronounced. There, a terminal moraine occurs on a bedrock threshold at an elevation of 2,260 m. The bedrock depression on the inner side of the moraine is filled with alluvial sediments and peat. An interesting relation between moraines and rock glacier deposits can be observed in the area of Graue Spitze summit, located to the southwest of the Hoarbergjoch summit. The Graue Spitze summit is built of white quartzites, which produce more blocky material than the neighbouring lithologies. Directly below these summits, two large rock glacier deposits were formed by quartzite material supply form the summit. Rock glacier deposit in the cirque southwest of Graue Spitze is connected with latero-frontal moraine of the glacier which flowed along the cirque bottom axis from the Hoabergjoch summit towards the Rotkopf rock (2,006 m). The left-hand lateral moraine is partially destroyed by the main scarp of Rötlbach landslide, which has affected the slope below the cirque. This situation implies that the landslide is younger than the moraine. If this moraine has indeed an Egesen age (Younger Dryas), the landslide cannot be older than Holocene. Shapes of the rock glacier deposits and Egesen moraines located south of the Graue Spitze summit are strongly modified by anthropogeneous earthmoving along ski pistes and lift trails. An artificial lake has been built in the body of the rock glacier deposit. In the mapped area, rock glacier deposits around the Graue Spitze summits are the largest. They clearly demonstrate that bedrock lithologies are crucial for development and shaping of rock glaciers. Most rock glaciers of the mapped area are rather indistinct because of schistose bedrock lithology.

Holocene intact rock glaciers

Holocene/Little Ice Age moraines do not occur in the mapped area. Holocene permafrost is represented by two small (100 and 240 m long) still active rock glaciers developed on the northeast flank of the Torspitze summit (2,663 m). Their fronts are located at altitudes of 2,425 and 2,490 m.

Landforms and sediments related to mass movements

Slopes of the mapped area are strongly affected by deep-seated gravitational deformation and by toppling. Such mass movements often occur in Bündner schists. Almost entire slopes are affected by mass movements in the upper part of the Nigglasbach catchment, in the lower section of Hobarbach and Torbach valleys. Most of these landslide masses are not active, but small and shallow landslides can be activated along deeply incised gorges in the landslide mass. Large deep-seated and complex landslide bodies occur in all tributary catchments on the northern slope of Tux valley, between Schöneben near Vorderlanersbach and Freithof, 2.5 km west of the village of Finkenberg. These landslides are located in the stream catchments of Bruchbach, Rötlbach, Hoserbach, and Tuxxegbach. All of them have well-developed main scarps reaching heights of up to 100 m. The Tuxxegbach landslide is the largest. It has an area of 2.7 km^2, its main scarp is located near Wanglalm (2,123 m altitude), and it reaches the bottom of the Tux valley (1,060 m altitude). The landslide mass is built of strongly deformed Bündner schist, partially exposed as an alternating sequence of dark or grey clay, blocks, and undissected, quite solid portions of basement rock. The landslide is highly active. Most of the farm buildings on the landside (Obere Naudisalm) are slightly tilted, showing deviation of their walls and floors from vertical and horizontal, respectively. Secondary scarps in the landslide mass indicate fresh activity, with many new gravitational faults and fractures. The most active part of the landslide is at lower altitude, close to the Tuxbach stream near the alpine pastures of Bärdille and Moslau. Two parts of the landslide mass with relatively fast motion towards Tuxbach stream can be recognized. They are separated by a less deformed "island" which is located 300 m west of Moslau. Interviews with local farmers, and comparison of older and present-day orthophoto maps, lead us to conclude that the most active part of the landslide has a flow velocity of about 1 m per year. The landslide is active, at least, since 35 years. It represents a risk potential for the infrastructure, i.e. for the farms on the landslide, and for the road to the village of Hintertux.

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