Blatt 121 Neukirchen am Großvenediger

Bericht 2017 über geologische Aufnahmen quartärer Sedimente und Formen auf Blatt 121 Neukirchen am Großvenediger

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This report focuses on the Quaternary deposits and landforms in the Kelchsau Valley. A geological map made by Helmut Heinisch and Claudia Panwitz provided a basis for this study. While Heinisch and Panwitz did include Quaternary deposits on their map, they did not use a stratigraphic sequence for the Quaternary units. The climatostratigraphic subdivision was applied according to Reitner et al. (2016). The sequence is as follows: pre-Last Glacial Maximum (pre-LGM), the LGM, the phase of early Lateglacial ice-decay, the Gschnitz and the Egesen stadials.

General setting

The mapped area lies in the Kelchsau valley of the Kitzbüheler Alps in Tyrol, Austria. It encompasses the true right and left side of the Kelchsau Valley, which the Kelchsauer Ache drains. At the location of the Zwiesel hydroelectric power plant (*Kraftwerk Zwiesel*) the Kelchsau Valley forks into the western Langer Grund valley and the eastern Kurzer Grund valley. The true left side of the Langer Grund valley and the true right side of the Kurzer Grund valley were mapped, respectively. The true left side covers an area of 15 km^2 and the true right side an area of 21 km^2. The western limit of the map is the limit of map sheet 121. The Feldalphorn peak (1,923 m a.s.l.), the Höhenbrandalm and the Wurzenrain residence mark the northern limit of the mapped area. The eastern limit of the mapped area is the ridge separating the Kelchsau valley from the Windau Valley. This ridge, include the peaks of the Lodron (1,925 m a.s.l.) the Rahmkarkopf (2,026 m a.s.l.) and the Steinbergstein (2,215 m a.s.l.). The southern limit is a straight line from the Schneegrubenalm (1,780 m a.s.l.) to the Gasthof Wegscheid. In the Langer Grund valley, the Stubalm marks the southern point of the mapped area.

Geological setting

The mapped area contains two nappe-systems that are in contact in the southern half of the mapping area. A large portion of the map lies in the Tirolic-Noric nappe system that is informally referred to as the "Greywacke Zone", which comprises of two dominant formations in the study area. The Löhnersbach Formation is a sequence of fine-grained low-grade metamorphic rock consisting of predominant slate layers alternating with meta-sandstones. The Schattberg Formation consists of alternating course grained low-grade metamorphic sandstones with occasional course grained quartzite layers.

The Koralpe-Wölz nappe system covers the southern parts of the map, which is informally referred to as the "Innsbrucker Quartzphyllite Zone". It overlies the Tirolic-Noric nappe system. The Innsbrucker Quartzphyllite Zone consists of quartz phyllite that is rich in quartz and also contains quartzite bands (Heinisch & Panwitz, 2007, 2008).

Kehlbach bedrock geology

The Kehlbach area is found on the orographic left side of the Kelchsau Valley. It encompasses the side valley of the Kehlbach creek and the east-facing mountain flank (south of the creek), which includes the Alpmessaualm (1,222 m a.s.l.), the Unterschwaigbergalm and the Zwiesel power station. Löhnersbach formation dominates the bedrock geology whereas only a small part around the peak of the Schwaigberghorn (1,990 m a.s.l.) consists of Schattberg Formation. A few bands of augengneiss that vary in thickness are present in the Kehlbach area. The peak of the Feldalphorn is made-up of metatuff (pyroclastic vulcanite).

Kehlbach Quaternary geology

The lower reaches of this side valley are dominated by gravel-sand beds of varying thickness, which are interpreted as ice-marginal sediments attributed to the Phase of ice-decay. Certain outcrops show delta topset and forest deposits. The ice-marginal deposits reach the altitude of ca. 1,500 m a.s.l. The steep valley flanks are not conducive for the preservation of such loose sediments. This can result in pockets of ice-marginal sediments on the valley flanks that are surrounded by either subglacial traction till deposits, or bedrock outcrops, and in some cases a combination of both. In the higher reaches of the flanks, scree is found and often a mixture of scree and reworked (i.e. redeposited) subglacial traction till have formed. In the cirque below the Feldalphorn, a Dms (diamicton, matrix supported, stratified) lithofacies was identified that was one meter thick and contained the local lithological spectrum. Beneath the Dms, interpreted as a till, a fine-sand layer was identified that is of a fluviolacustrine origin. This would lead to the assumption that this cirque was ice-free before a cold period set in and a glacier deposited the subglacial traction till. The time constraints are difficult to judge here, because there is no clear sequence of moraine deposits as is described in the first paragraph. In the cirque below the Schwaigberghorn (a north-facing cirque), a latero-frontal moraine deposit was identified (1,750 m a.s.l.) and a rock glacier deposit (1,850 m a.s.l.). Just below the moraine system, a dump from a former copper mine is evident.

Kehlbach mass movements

Along the upper, outer edges of the tributary valley, scarps of mass movements are visible on both sides. On the southern side between the Neustattalm and the Alpmessaualm the detachment zone reaches a maximum vertical magnitude of ca. 20 m covering a length of 1 km. On the northern side in the area of the Höhenbrandalm a similar situation occurs. The scarp also reaches a maximum displacement of ca. 20–25 m and stretches over a length of ca 1.5 km. These rock slumps are highly likely to have occurred after the Phase of ice-decay as a result

of the Kehlbach creek destabilising the foot of the flanks. The fine-grained Löhnersbach formation is not (mechanically) competent and new rupture surfaces readily develop with increased stress. The slate dips at high, almost vertical, angles and strikes in a southwest direction (HEINISCH & PANWITZ, 2007), indicating that the foliation plane may have played a role on the southern mass movement but not along the northern rupture. Along the ruptured surface, the slate is highly fractured, disjointed but not dislodged. Along the riverbanks smaller secondary rock slumps formed.

Above the Trockenbachalm, there is a very sharp ridge that leads up to the Feldalphorn peak, is due to the formation of a scarp. The peak of the Feldalphorn has been shaped by mass movements. On the east-facing slope, a rock fall deposit consisting of a boulder field was identified.

An area separating the cirques of the Feldalphorn and of the Schwaigberghorn is characterised by a saw-tooth morphology. The antislope scarps (REITNER & LINNER, 2009) trend in a NNW–SSE direction without any link to the strike of the primary or secondary planar fabric (slaty cleavage). This deep-seated gravitational deformation of toppling type has been formed due to displacements along pre-existing joints and faults dipping steeply to Southwest.

Langer Grund bedrock geology

On the western flank of the Langer Grund (south of the Kehlbach area), the Wildkaralm (1,659 m a.s.l.) lies approximately on the boundary between the Löhnersbach and Schattberg Formations. A few bands of augengneiss occur between the two formations, and a few bands of the Löhnersbach Formation and metatuff lenses are found within the Schattberg Formation.

Langer Grund Quaternary geology

In the lower reaches of the valley, ice-marginal sediments dominate the setting and reach altitudes of 1,500 m a.s.l. In general, the ice-marginal sediments decrease in thickness as the altitude increases. In the Inner Wildgraben at an altitude of 1,400 m a.s.l. ice-marginal sediments, consisting of gravel and sand, no thicker than 2 m, overlie either subglacial traction till or bedrock. In certain areas, there is no loose rock cover. In the higher reaches of the area, the general loose rock cover (i.e. subglacial traction till or ice-marginal sediments) can be described as “patchy”, as is exemplified in the Inner Wildgraben. Above and below the Kühtalalm, ice-marginal sediments are missing. Here subglacial traction till deposits that in many cases have been superficially reworked i.e. redeposited, were identified. Just south of the Zwiesel power station, at an altitude of 910 m a.s.l., over-consolidated subglacial traction till was identified. In areas that are not on steep slopes, small bogs can often be found in areas underlain by impermeable subglacial traction till. This was often the case between the Lotterbichlalm and the Unterschwaigberghornalm. The time constraints for these deposits are difficult to judge but considering that during the LGM, ice masses reached altitudes of 2,000 m a.s.l. (VAN HUSEN, 1987) the subglacial traction till and overlying ice-marginal sediments are presumed to be from the LGM and Phase of ice-decay, respectively.

Langer Grund mass movements

The manifestation of mass movements in this area differs due to the differing rock formations. Slopes made up of the more competent Schattberg Formation display near-surface smaller mass movements whereas those of the Löhnersbach Formation show, larger and deep-seated mass movements, albeit they are initial. Within the Schattberg Formation, above the Wildkaralm, a mass movement with a width of 180 m that showed compressional ridges at its toe, and a scarp that was partly covered with boulders and scree, was identified. This mass movement has been interpreted as a translational slide with a rupture depth of a few meters. Southeast of the Wildkaralm in the Inner Wildgraben a rotational landslide was identified that spanned 200 m in width. The ruptured surface is no deeper than 10 m.

Within in the Löhnersbach Formation three major scarps were identified with a length ranging from 700 m to 1,400 m. The scarp depths do not surpass a magnitude of 80m and cease along the boundary of the two formations. The less competent Löhnersbach formation (towards the north) facilitates deep-seated gravitational deformations that are not structurally bounded, whereas the Schattberg Formation provides more resistance in this respect, as it is more competent. To the east and southeast of the Schwaigberghorn peak, extension cracks run in N–S and NE–SW direction. The slaty cleavage is not used here, because it strikes in a NW–SE direction. Southwest of the peak double-crested ridges have formed almost in parallel to the ridge.

Ofnergraben bedrock geology

Opposite the Kehlbach area, the Ofnergraben cuts into the mountain flank heading up to the Hartkaserjoch peak (1,639 m a.s.l.). The flank consists almost entirely of slate i.e. the Löhnersbach Formation. Very few bands of quartzite streak through the area.

Ofnergraben Quaternary geology

As was the case in the other areas of the map, ice-marginal sediments consisting of gravel and sand dominate the lower reaches of the flank. In the mid-reaches of the slopes, subglacial traction till with occasional indication of redeposition occurs partly in patches, especially in areas affected by mass movements. At an altitude of around 910 m a.s.l., north of the Ofnergraben subglacial traction till was identified that was high in silt content. South of the Vorderölbankalm (1,296 m a.s.l.) and in the surroundings of the Hinterölbankalm (1,439 m a.s.l.) patches of subglacial traction till with some indications of waterlogging cover the bedrock. The subglacial traction till is from the LGM as there are no morphological features to indicate younger glacial or periglacial activity. The ice-marginal deposits are therefore considered to be from the Phase of ice-decay.

Ofnergraben mass movements

On the northern flank of the Ofnergraben several mass movements have been recorded creating an overall complex mass movement. A prominent scarp west of the Vorderölbankalm extends over an altitude range of ca. 550 m that traverses in a north-easterly direction, before bending to the east (at an altitude of 1,350 m a.s.l.),

where it converges into a mountain ridge. The highest lying area has been identified as an area of mass creep (*Kriechmasse*), where initial slides were identified. The bedrock here is fragmented but not dislodged. A secondary scarp within the confines of the first scarp was identified. Here no bedrock outcrops were seen within the moved mass, but fragmented rock in a sandy to silty matrix. The toe of the mass movement has altered the course of the Ofnergraben creek leading to the conclusion that this mass, is a flow mass (*Fließmasse*).

South of the Ofnergraben a second large scale mass movement that surrounds the Fixern-Hochalm (1,636 m a.s.l.) and the Hinterölbankalm (1,439 m a.s.l.) was identified. The scarp of this mass movement stretches over a length of 1,600 m and is delimited by a creek to south that flows into the Ofnerbach creek. The height of the scarp increases from north to south i.e. from 30 to 100 m. Within the displaced mass extension, gaps (*Zerrgraben*) are evident in the northern half of the mass movement, which cease towards south half. This is a sign that the moved mass is more mature in the southern section, meaning that it shows some transition to a mass flow deposit (*Fließmasse*), whereas the northern half, with the extension gaps, it is still a mass creep (*Kriechmasse*).

On the west-facing slope south of the Steinergraben, extension gaps that strike in WNW–ESE direction occur. The extension gaps are very initial and are often hard to identify in the field but easily visible on laser scans.

In general, along the banks of the creek small-scale slide and flow masses are present.

Kurzer Grund bedrock geology

The Kurzer Grund area (on the eastern side of the valley) is south of the Ofnergraben. Its northern border extends from the Urschla farmhouse to the Lodronalm (1,700 m a.s.l.) and in the southern border forms at Neualmtrettl (1,950 m a.s.l.) and the Faulaschlagalm (1,533 m a.s.l.). The northern half of the area consists of the Löhnersbach Formation. Towards the south, the Schattberg formation makes up the bedrock. The boundary between the two formations lies between the Hocheggalm and the Hochegger Graben. In the valley reaches, a band of augengneiss lies between the two formations. The augengneiss is the dominate lithology between the Hintingerschlagalm and the Hocheggalm.

Kurzer Grund Quaternary geology

In the vicinity of the valley floor ice-marginal sediments are found, that consist of gravel and sand. South of the Hintingerschalgalm (1,196 m a.s.l.) partly reworked subglacial traction till covers the hard rock until the Niederkaseralm is reached (1,116 m a.s.l.). Towards the upper reaches of the flank (approximately 1,800 m a.s.l.) only scree deposits are present. Just south of the Niederkaseralm (1,108 m a.s.l.) a small area between alluvial fans, stretching over ca. 300 m in length and 120 m in width, consists of ice-marginal sediments with a local lithological spectrum. 250 m north of Gasthof Wegscheid lateral moraine deposits, which consists of boulder-sized clast-supported scree (bSCc) and a secondary lithofacies of gravel-sand with no fine sand content was identified. It is a matter of discussion whether these moraines are deposits of the Phase of ice-decay, where local valley glaciers oscillated (Reitner, 2007), or if these features were formed by the Kurzer Grund Kelchsau Glacier during the Gschnitz stadial. Considering the results of the Manzenkar cirque in the upstream area (Dippenaar, 2017), the latter case seems to be more likely.

Kurzer Grund mass movements

A major scarp that stretches over a distance of 2.2 km and shows a maximum vertical displacement of 100 m occurs between the Wiesboden and the Rahmkarkopf peak. This entire west-facing flank (that lies between the Wiesboden and the Rahmkarkopf); from the ridge to the valley floor extension gaps are evident indicating that the whole flank is affected by a deep-seated gravitational slope deformation. Double-crest ridges are also evident in the ridge area of the Wiesboden. The augen gneiss forms a large part of the flank, which is more competent than the slate to the north and the Schattberg formation to the south. This is very likely to be the reason why extension gaps (possibly due to toppling) have formed over the whole flank, which is not the case in the Ofnergraben area, despite the presence of scarps of a similar magnitude.

A few minor scarps were identified that are a result of either slumping (*Hangsackung*), sliding (*Gleiten*) and or flowing (*Fließen*). Directly west of the Wiesboden compressional ridges were identified at the toe of slump masses (*Hangsackungen*). The slump masses comprised of loose rock that reached boulder size. The mass movement east of the Hocheggalm has been identified as a translational slide mass (*Gleitmasse*). The slide mass itself is covered in scree and small boulders that are all very angular to angular and lie in a sandy matrix.

The southwest-facing flank between the Ramkarkopf and the Steinbergstein shows one distinct type of mass movement over the whole flank. In the vicinity of Neutrettl a series of prominent antislope scarps span a vertical distance from 1,920–2,020 m a.s.l. and have a maximum length of 400 m. The extension gaps curve up into the slope towards their ends. 300 m below these extension gaps at 1,635 m a.s.l. a more subtle extension gap is visible that stretches over a length of 550 m. At 1,400 m a.s.l. prominent ridges that reach a maximum height of 8 m were identified. These ridges trend in the same direction as those at higher altitudes. The ridges are different in that they are developed in an area covered by gravel-sand deposits. This could lead to the assumption that these ridges are lateral moraine deposits. Considering that, there are smaller single extension gaps on this slope that trend in the same direction as the above described, it seems more likely that the ridges at an altitude of 1,400 m a.s.l. are a result of extension gaps in the bedrock that affected as well the cover of ice-marginal sediments. Further structural data will have to be collected to constrain this model.

Trattenbach bedrock geology

The Trattenbach area extends from Gasthof Wegscheid (1,148 m a.s.l.) to Neutrettl (1,950 m a.s.l.) in the north and includes the cirque formed by the Steinbergstein peak (2,215 m a.s.l.), the Haldenstein peak (2,074 m a.s.l.) and the Schneegrubenalm (1,780 m a.s.l.). The northern half

of the area consists of the Schattberg Formation and the southern half of Innsbrucker Quartzphyllite. The boundary between the two-nappe systems is just north of the Trattenbach creek. A band of augengneiss that is considered to be part of the Tirolic nappe system (Heinisch & Panwitz, 2008) occurs occasionally at the boundary.

Trattenbach Quaternary geology

SSE of the Gasthof Wegscheid a double ridge structure consisting of a Dmm (diamicton matrix-supported massive) lithofacies with boulders on the crests was identified. The morphology and the lithofacies leads to the assumption that this is a lateral moraine deposit. Considering the lateral moraine deposit 250 m north of Gasthof Wegscheid this deposit could belong to the same system or be of a younger age. This means that this deposit is either from the Phase of ice-decay or, more likely, from the Gschnitz stadial.

A latero-frontal moraine deposit was identified (at ca. 1,500 m a.s.l.) on the southern side of the Trattenbach creek (the partnering deposit on the right side is missing due to a mass movement). The age of this latero-frontal moraine is difficult to estimate as reference points like moraines undoubtedly attributed to a stadial are missing in the vicinity. Considering the lateral moraine deposit just north of Gasthof Wegscheid (Kurzer Grund area) and the presence of terminal moraines of the Egesen stadial close to Schneegrubenalm (1,780 m a.s.l.), a Gschnitz age of the latero-frontal moraine is assumed.

Outside the bounds of the latero-frontal moraine deposits, the flanks are covered by patches of subglacial traction till up to an altitude of ca. 1,800 m a.s.l. Beyond this, bedrock and scree deposits cover the flanks.

Trattenbach mass movements

Multiple double-crested ridges strike in a NNE–SSW direction just below the saddle of the Schneegrubenscharte. These features have been interpreted as extension gaps (*Zerrspalten*). On the southwest-facing flank, directly below the peak of the Steinbergstein, a mass movement that spans 400 m across in the crown area and 700 m in the foot area was identified. The scarps vary in depth from north to south, with the scarps on the northern side not surpassing 10 m whereas the southern scarps reach depths of 100 m. Extension gaps occur also in the displaced mass that are comparable to those described in the Kurzer Grund area. These features cease in the lower half of the moved mass and bedrock outcrops become rare. The rock in the lower area is fractured and loose. This indicates slope creep (*Hangkriechen*) is the dominate process here. The mass movements are generally of post-LGM age according to the relation between glacial and gravitational features. Glacial erosion i.e. oversteepening of the valley flanks is regarded as the major cause of the large-scale mass movements.

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Blatt 126 Radstadt

Bericht 2018 über geologische Aufnahmen und stratigrafische Untersuchungen im Bereich der Werfener Schuppenzone westlich St. Martin am Tennengebirge (Salzburg) auf Blatt 126 Radstadt

Michael Moser

Ziel der im Rahmen des Projektes „Gebietskartierung ÖK-Blatt 126 Radstadt“ durchgeführten Geländearbeiten war eine stratigrafische Bearbeitung und teilweise Neukartierung der Werfen-St. Martiner Schuppenzone (Nördliche Kalkalpen, Tirolikum) zwischen St. Martin/Tennengebirge–Lungötz–Oberes Lammertal–Korein–Naßberg–Helferalm.

Die bereits von Rossner (1972) im Detail durchaus richtig erkannte und auskartierte Mitteltrias-Schichtfolge des „St. Martiner Schuppenlandes“ bedarf noch zusätzlich einer biostratigrafischen Fundierung der einzelnen Schichtglieder, einer mikrofaziellen Analyse der leider ausgesprochen stark dolomitisierten Karbonate sowie eine daraus resultierende Zuordnung zu einzelnen Formationen der kalkalpinen Mitteltrias.