Kleinen Gnasen (2.244 m) gelöst haben. Jedenfalls ist dort in 1.800 bis 1.900 m Seehöhe eine deutliche Abrisskante zu erkennen. Demnach wäre der Bergsturz von WNW nach ESE abgegangen und dann nach NNE entlang der Talachse umgelenkt worden. Über das Alter des Bergsturzes (spätglazial oder holozän) möchte ich kein abschließendes Urteil abgeben. Die sehr unregelmäßige Form der Tomalandschaft mit Hügeln und abflusslosen Hohlformen sowie die mit der Hauptmasse nicht zusammenhängenden Blockhaufen ganz im N sind möglicherweise darauf zurückzuführen, dass die Bergsturzmasse zunächst noch auf einem abschmelzenden Restgletscher zu liegen kam, und sich im Zuge der weiteren Abschmelzung Toteislöcher und fluvioglaziale Ausspülungen gebildet haben.

Blatt 136 Hartberg

Bericht 2011 über geologische Aufnahmen im Grobgneis- und Strallegg-Komplex auf Blatt 136 Hartberg

ALOIS MATURA

(Auswärtiger Mitarbeiter)

Im Berichtsjahr wurden die Aufnahmen im Bereich von Puchegg südlich Vorau gegen Osten bis zum unteren Steinbachgraben ausgedehnt.

Der leukokrate, ± deutlich porphyrische, weitgehend homogene **Puchegg-Orthogneis** (örtlich neben Muskovit mit ein wenig Biotit) zeigt gegen Norden zu stärker phyllonitische Ausbildung bis hin zum Auftreten von Leukophyllit. Vereinzelt ist Sericit-Quarzit mit idiomorphen Zirkonen eingelagert. Die Schieferung fällt im Allgemeinen flach gegen Westen bis Süden ein und stellt sich gegen Norden und Nordosten bis zu mittelsteilem Einfallen auf.

Von Südosten, vom Steinhöfviertel her, spitzt **Strallegg-Gneis** sichelförmig in den Puchegg-Orthogneis hinein. Daneben wurden noch einige weitere Einlagerungen von Strallegg-Gneis im Puchegg-Orthogneis gefunden. Beim Lechenbauer im Steinhöfviertel tritt innerhalb des Strallegg-Gneises an mehreren Stellen Leuchtenbergit-Sercit-Quarzphyllonit bis Sericitquarzit auf, der makroskopisch und auch durch den Gehalt an Leuchtenbergit an den Disthenquarzit aus dem Kernbereich des Strallegg-Komplexes erinnert.

Gegen Nordosten zu werden Puchegg-Orthogneis und Strallegg-Gneis mittelsteil von einer wechselvollen basischen bis intermediären **Metavulkanitserie** des **Waldbach-Komplexes** unterlagert. Dazu gehört ebenflächiger, plattig-lagiger Gneis oder Schiefer (? Metatuffit), Amphibolit, örtlich gebändert, Hornblendegneis, Hornblendegarbenschiefer, Chlorit-Hornblende-Epidotgneis, Granat-Chlorit-Muskovitquarzit und bis mehrere Dekameter mächtige Linsen und Walzen von grobkörnigem Pegmatoidgneis mit Gangquarz bzw. dickeren Quarzmobilisaten. Örtlich ist Amphibolit quergreifend von sulfidischen Erzen imprägniert, was sich nicht nur unter dem Mikroskop (Pyrit), sondern auch in weißlichen Ausblühungen (Steinbruch beim Ausgang des Steinbachgrabens) manifestiert. Ob die Stollenmundlöcher am Ausgang des Löffelgrabens in dieser Hinsicht auf ehemalige Abbaue hinweisen, habe ich noch nicht in Erfahrung gebracht.

Größere linsenförmige Massen von grobschuppigem **Granatglimmerschiefer** und **Paragneis** sind der Metavulkanitserie nicht nur eingelagert (Vorauleiten, Mündung Steinbach in Voraubach), sondern auch an der Grenze zum hangenden Puchegg-Orthogneis südlich des Stiftes Vorau zwischengeschaltet, sodass es noch offen ist, ob diese auch zum Waldbach-Komplex oder aber zum Grobgneis-Komplex („Tommerschiefer“) zu stellen sind. Dieser Granatglimmerschiefer oder Paragneis ist örtlich ausgestattet mit gefülltem Oligoklas, frischen Granatblasten, frischem braunem Biotit, Disthen, Staurolith-Resten und Chloritoid.

Die **tertiären Erosionsfluren** im Vorauer Talkessel setzen sich auch weiter gegen Osten fort.

Blatt 154 Rauris

Bericht 2012 über geologische Aufnahmen auf den Blättern 154 Rauris und 181 Obervellach

SILVIA FAVARO

(Auswärtige Mitarbeiterin)

The Mallnitz synform is a structure affecting the Subpenninic and Penninic nappes in the eastern part of the Tauern Window (Salzburg/Carinthia, Austria). This report describes the structure of the Malnitz synform along three sections. Two are located in the Sonnblick area close to Kolm-Saigurn (sheet 154 Rauris) and the third is situated close to Obervellach (sheet 181 Obervellach). The sections are based on structural investigations in combination with geological mapping of a larger area in scale 1:10.000, which is reported in FAVARO & SCHUSTER (2012, this volume).

The Tauern Window is the most prominent tectonic window of the Eastern Alps. Within Subpenninic derived from the European continental margin and Penninic nappes derived from the Alpine Tethys Ocean are exposed under the Austroalpine nappes. In the investigated area from bottom to the top the following tectonic is present (according to the tectonic nomenclature by SCHMID et al., Eclog. Geol. Helv, 97/1, 2004; PESTAL & HELLERSCHMIDT-ALBER, Jb. Geol. B.-A., 151/1+2, 2011; SCHMID et al., Swiss J. Geosc., in review):

- Hochalm-Ankogel nappe (Venediger nappe system of Subpenninic nappes).

- Romate nappe (Venediger nappe system of Subpenninic nappes).
- Sonnblick nappe (Venediger nappe system of Subpenninic nappes).
- Kolm nappe (lower element of Glockner nappe system of Penninic nappes).
- Modereck nappe system (Subpenninic nappes).
- Geißel nappe (upper element of Glockner nappe system of Penninic nappes).

The Mallnitz symform is a km-sized fold structure with a northwest-southeast trending fold axis. It affects mainly elements of the Glockner and Modereck nappe system and has been interpreted as being the continuation of a stretching fault by KURZ & NEUBAUER (J. Struct. Geol., 18/11, 1996). To the southwest of the Mallnitz synform the Sonnblick nappe is located, whereas to the northeast a nappe stack including the Hochalm-Ankogel and Romate nappe appears.

According to FAVARO et al. (Geophy. Res. Abstracts, 14, EGU2012-10371, 2012) simplified deformation history within Tauern Window´s units starts with nappe stacking in the Penninic (D1) and Subpenninic nappes (D2), followed by duplex formation (D3), doming (D4) and brittle exhumation (D5). In this nomenclature the Mallnitz synform is a D4 structure showing different structural domains along strike. In the northwest it is an open fold dominated by S2 foliations. Further to the south S2 dips to the northeast and it is cut by a SW dipping axial plane foliation S4. Intensity of S4 increases southeastward until it becomes the main foliation. In the lower nappes of the northeastern limb (Kolm and Romate nappe) SW–NE directed structures D3 are overprinted by D4. From Obervellach until Pusaritz, still within the Tauern Window, the synform is rotated and the southwestern limb dips to the northeast. In this area a sinistral shear bands pattern related to the ductile Katschberg Shear Zone (D4) is present (SCHARF et al., Int. J. Earth Sc., in review).

Description of the sections

In the following the structures and the lithostratigraphic succession of the two sections in the Rauris valley and the one close to Obervellach are described.

Sections in the Rauris valley

Along the profiles, between Niedersachsen Haus, Neuerkogel, Bockhartscharte and Neubau respectively, the Mallnitz synform is highly asymmetric. From bottom to the top three different nappes built up the Mallnitz synform:

- lower nappe of the Glockner nappe system (Penninic nappes).
- element of the Modereck nappe system (Subpenninic nappes).
- upper nappe of the Glockner nappe that forms the core of the synform (Penninic nappes).

There are two possible interpretations for the tectonostratigraphy of the Mallnitz synform in this area: there might be only one element of the Glockner nappe system whereby the lower element is the inverted limb of the upper one, or there might be two nappes of the Glockner nappe system. Accepting the first solution, this nappe could be connected with the crustal-scale, N-facing, sheath fold to the west of the Sonnblick dome. This fold displays an isoclinals folding of the Modereck nappe system and Glockner nappe and it brings the Glockner nappe into the inverted limb of an antiform whose core comprises the normal and inverse stratigraphic sequences of the Modereck nappe system (KURZ & NEUBAUER, 1996). The second solution connects the lower element of the Glockner nappe system with the Kolm nappe and the upper one with the Geißel nappe, both outcropping in the Mallnitz area. Several arguments argue for the second possibility: directly at Mallnitz, the Kolm nappe gets very thin, but can be traced as slices below the element of the Modereck nape system until the Hagener hut and further to the northwest. Also the lower nappe of the Glockner nappe system in the Rauris valley is not more than few meters thick and highly sheared. It consists of calcareous micaschists, mica bearing marbles and prasenites. Remarkably garnet is present in this unit, which is missing in the upper nappe. This indicates a slightly higher metamorphic grade in the lower element of the Glockner nappe system than in the upper one. This reflects the situation in the Mallnitz area where also the Kolm nappe shows a slightly higher metamorphic grade than the Geißel nappe.

The element of the Modereck nappe system consists mainly of the Brennkogel formation. Additionally in the southwestern limb of the synform arkoses and whitish Brennkogel quartzites are intercalated. Further slices of whitish to grayish marble occur. These marbles might be interpreted as equivalents to the “Angertal marble” (PESTAL, pers. com.), but the age and the tectonic position is still unclear.

At the base of the lower Glockner nappe, a layer with a mix of highly sheared lithologies is present. It consists of retrogressed amphibolites, calcareous micaschist, black schist and quartzites. This layer is interpreted as the roof thrust of the Venediger nappe duplex.

The structures within the Mallnitz synform can be described as follows: In the northeastern limb only a single, almost horizontal or slightly southwest dipping foliation is present. In the core of the synform, where the upper element of the Glockner nappe system occurs, an overprinting foliation can be identified. Both foliations diverge slightly in angle and create an intersection lineation striking approximately N130E. Further towards southwest an axial plane foliation appear and becomes more frequent until the southwestern limb is ending. This axial plane foliation dips approximately 200/25. The older foliation will have formed during the nappe stacking event (D2), whereas the axial plane foliation is due to the doming event of the Sonnblick nappe (D4).

Underneath the roof thrust a distinct lithological association occurs: a mix of bright colored, Quartz-rich gneisses intercalated with carbonate-bearing chlorite-schists, biotite-porphyroblasts schists and dark graphitic schist with albite-porphyroblasts crops out for several meters. This sequence is interpreted as the shear zone that developed between two horses during the duplex formation in the Venediger nappe system (D3). In our case it divides the Sonnblick nappe and the Romate nappe. The lithological association and the style of deformation support this interpretation: the lithological association reminds to highly hydrated lithologies of the old roof (paragneisses, amphibolites and dark micaschists) of the Venediger nappe system. For what concerns the structures, in this shear zone two folding events can be recognized. The younger one, affecting the overall area, is the folding event due to

the doming (D4). F4 fold axis always strike approximately N140E, the folds are NE-verging and the orientation of the axial surfaces is orientated from recumbent to horizontal inclined. Features of an older deformational event are upright folds, with fold axis that turned from strike values of approximately N100E into the doming fold axis direction of N140E. The older fold axis and lineation formed during the duplex formation event (D3). They were re-aligned during the doming event (D4).

The shear zone described above rests on the cover of the Romate nappe below the northeastern limb of the Mallnitz synform and on the old roof of the Sonnblick Dome below its southwestern limb. The post-Variscan cover of the Romate nappe is very typical and can be found on top of the Romate orthogneiss in the whole area. It is greenish, bright colored garnet and chloritoid-bearing muscovite-chlorite schist. As the deformation event leading to the doming of the Sonnblick nappe does not affect strongly the Romate nappe several pre-doming structures are still preserved in the post-Variscan cover of the Romate nappe. The strike of stretching and mineral lineation is scattering from N110E to N150E. The crenulation is mostly due to the doming event (D4) (strike around N140E), but sometimes also a N–S oriented crenulation has been found. It is associated with N–S oriented fold axis of kink bands. Shear bands are oriented N290E with a dip between 30 and 50 degrees.

Normal to the direction of the Mallnitz synform a set of fractures filled by quartz occur in the whole area. These veins are well known as they are gold-bearing (Golden Tauern).

Section Obervellach – Kaponig Graben

In the section close to Obervellach the Mallnitz synform is much broader and shows a much more complicated internal structure than in the Rauris valley. According to mapping more than one synform and antiform is present and the whole structure is highly sheared. However, the internal part of the synform is again built up by three nappes:

- Kolm nappe of the Glockner nappe system (Penninic nappes).
- element of the Modereck nappe system (Subpenninic nappes).
- Geißel nappe of the Glockner nappe that forms the core of the synform (Penninic nappes).

The Kolm nappe is interpreted to be the lower nappe of the Glockner nappe system. Typical lithologies are greyish-bluish, thick bedded, mica-bearing marble intercalated with dark, greyish, brownish calcareous mica schist of the Bündnerschiefer-Group. Further large ophiolite bodies with prasenites, amphibolites and serpentinites occur. For this reason the Kolm nappe is characterized by the "Glockner facies". This lithological association is similar to that of the Glockner nappe sensu stricto (Pestal & Hellerschmidt-Alber, 2011), but in contrast to the Glockner nappe sensu stricto of the Glockner area, no relics of a high pressure imprint have been reported from the Kolm nappe until now. The Geißel nappe is interpreted to be the upper nappe of the Glockner nappe system. It is different because of different primary lithologies and a weaker metamorphic imprint: The Bündnerschiefer-Group of the Geißel nappe consists of brownish calcareous micaschists with intercalated greenish chlorite schist with albite-porphyroblasts. Serpentinites are present just as tiny bodies. Therefore the Geißel nappe can be attributed to the "Fuscher Facies" (Pestal & Hellerschmidt-Alber, 2011).

The Modereck-nappe system in between the Kolm and Geißel nappe shows the following succession along the crest between Häusleralm and Lonzaköpfl: Its lowermost part is built up by the Brennkogel Formation. Above some slices of Schwarzkopf Formation, Piffkar Formation and Wustkogel Formation occur. After a thick pile of Brennkogel Formation a sequence starting with Lower-Triassic quartzites (Lantschfeld quartzite), Seidelwinkel Formation, Piffkar Formation, Schwarzkopf Formation and Brennkogel Formation continues. It is not totally clear, but this succession can be interpreted as an isoclinally folded and contemporaneously sheared nappe. The lower part up to the Wustkogel Formation might be the inverted limb, whereas the succession starting with the Lower Triassic quartzites represents the upright limb. The Brennkogel Formation interval in between can be interpreted as an intercalated sheared slice.

Based on mapping the hinge of the synform coming from the Rauris valley continues within the Geißel nappe to Lonzaköpfl and Lassacher Höhe. Here the synform is tight and the axial plane is dipping steeply towards southwest. Close to Mallnitz, at Auernig a second synform develops. It is open, the hinge is located in the Kolm nappe and the axial plane is dipping parallel to that of the other synform. Towards the south, this synform gets also narrower and intensely sheared. In this synform the Kolm nappe is underlain by a thin tectonic zone including highly sheared lithologies of the Kolm nappe, garnet and chloritoid-bearing schists of the Romate nappe and schists of the Brennkogel Formation from the underlying Hochalm-Ankogel nappe. This zone represents the roof thrust on top of the Venediger nappe system.

The antiform located between the two synformes is situated directly west of Mallnitz. On the path up to the Häusleralm (at 1.800 m altitude) amphibolites and calcareous micaschist of the Kolm nappe are dipping below the element of the Modereck nappe system. Further to the south the Kolm nappe disappears, because the fold axis of the anticline is dipping towards southeast and it is truncated by a shear zone. Therefore the anticline affecting the Kolm and Romate nappe is visible only in the subsurface. The southwestern limb of the Mallnitz synform shows different features: The Kolm nappe is not present and the stratigraphy doesn´t follow a clear succession, because it is more sheared and folded. The southwestern limb is overturned and the Sonnblick nappe is therefore overlying. The contact between the elements of the Glockner and Modereck nappe system with the Sonnblick nappe is in most cases a shear zone dipping steeply toward the southwest and subparallel to the fault planes of the Mallnitz synform. This shear zone is several meters wide and formed by mixed up lithologies of the bordering units. The Sonnblick nappe forms an antiform with a southwest dipping axial plane, which gets narrower towards the southeast.

Also the structural inventory across the Mallnitz symform is changing: In the northeastern limb of the synform at Auernig the foliation of the nappe stacking event (D2) is always visible. The foliation formed during the doming event (D4) occurs as an incipient axial plane foliation that infolds the nappe stacking foliation. The orientation of the axial plane foliation is approximately 220/40. A crenulation due

to the doming event (D4) with southeast dipping fold axis is also present. As in the Rauris valley, the post-Variscan cover of the Romate nappe is folded by axis perpendicular to those of the Mallnitz synform. These folds are related to the D3 event.

In contrast, in the main part of the synform and on the southwestern limb the main foliation is a composed foliation formed during the nappe stacking event (D2) and the doming event (D4). In the more competent lithologies (e.g., quartzites of the Piffkar Formation) the nappe stacking foliation is still visible, but isoclinally folded. Both foliations are steep, almost vertical and parallel to each other (dipping of foliation c. 210/70-80).

Towards the southwest, south of Obervellach the Mallnitz synform is rotated and the axial plane is dipping to the northeast (c. 040/30). Also the Sonnblick nappe, forming a narrow lamella is rotated and dipping towards northeast. This rotation is pre-brittle deformation (D5) as brittle planes measured in the rotated and un-rotated part are fitting perfectly to the strike of the brittle Mölltal fault. Along the slopes of the Möll valley an intense pattern of transpressive sinistral shear bands occurs within the nappes of the Glockner and Modereck nappe system. This pattern is interpreted as the continuation of the Katschberg Shear Zone System that swings around the gneisses of the Hochalm dome in the southeastern corner of the Tauern Window (SCHARF et al., in review). In contrast, the Sonnblick lamella disappears below the Austroalpine nappes.

Bericht 2012 über geologische Aufnahmen auf den Blättern 154 Rauris, 155 Bad Hofgastein und 181 Obervellach

SILVIA FAVARO

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& RALF SCHUSTER

In this report results from geological mapping in the Sonnblick area near to Kolm-Saigurn (ÖK154), from the Tauerntal near to Mallnitz (ÖK 155) and from the south-western slopes of the Mölltal near to Obervellach (ÖK 181) are documented. The geological maps improve the manuscript of ÖK 154 Rauris by PESTAL (Manuskript zur Geol. Karte 1:50.000, Blatt 154 Rauris, Geol. B.-A., 2011) and give additional information for the south-western part of map sheet ÖK 155 Bad Gastein. The mapping was focused on the north-western end of the Mallnitz synform and on the subdivision of pre-Mesozoic and Mesozoic rocks of the Subpenninic nappes. Additional structural investigations are reported in FAVARO, 2012 (this volume).

Tectonic subdivision of the investigated area

The area is situated in the Subpenninic and Penninic nappes of the Tauern Window. From bottom to the top the following tectonic succession occur (according to the tectonic nomenclature by SCHMID et al., Eclog. Geol. Helv., 97/1, 2004; PESTAL & HELLERSCHMIDT-ALBER, Jb. Geol. B.-A., 151/1+2, 2011; SCHMID et al., Tauern Window (Eastern Alps, Austria): new tectonic map, cross-sections and tectonometamorphic evolution. – Swiss J. Geosciences, in review):

- Hochalm-Ankogel nappe (Venediger nappe system of Subpenninic nappes).
- Romate nappe (Venediger nappe system of Subpenninic nappes).
- Sonnblick nappe (Venediger nappe system of Subpenninic nappes).
- Kolm nappe (lower element of Glockner nappe system of Penninic nappes).
- Modereck nappe system (Subpenninic nappes).
- Geißel nappe (upper element of Glockner nappe system of Penninic nappes).

The area is characterized by a km-sized fold structure with a northwest-southeast trending fold axes. It is termed Mallnitz synform and consists of elements of the Glockner and Modereck nappe system infolded between Subpenninc nappes. The Mallnitz Synform is bordered to the northwest by the Hochalm-Ankogel nappe with the overlying Romate nappe and to the southwest by the Sonnblick nappe. The nappe stack forming the Mallnitz Synform has been interpreted as a stretching fold by KURZ & NEUBAUER (J. Struc. Geol., 18/11, 1996) in the area southeast of Obervellach.

Description of the Subpenninic and Penninic nappes in the Rauris and Mallnitz valley

In this chapter the lithostratigraphy and the lithological content of the Subpenninic and Penninic units is described.

Subpenninic nappes

The Subpenninic nappes, derived from the Helvetic shelf, representing the southern European margin after the opening of the Penninic ocean in the Middle Jurassic. According to the older nomenclature (e.g. KOBER, Sitzber. Akad. Wiss., Math.-Naturw. Kl., 98, 1920; STAUB, Beitr. Geol. Kt. Schweiz, 52 (N.F. 82), 1924; EXNER, Erläuterungen zur Geol. Karte der Sonnblickgruppe. – Geol. B.-A., 1964) the "Venediger Nappe" comprises Permo-Carboniferous plutonites ("Zentralgneise"), intruding an old roof ("Altes Dach"). The old roof consists of pre-Carboniferous "Altkristallin" and Permocarboniferous schists belonging to the "Untere Schieferhülle". In 1962, Exner mentioned that due to insufficient knowledge also some Mesozoic rocks might be included in the "Untere Schieferhülle".

Maps of the area produced in the last Century are mostly lithological maps, but in the past years the lithostratigraphy of the Permomesozoic rocks of the Subpenninic nappes has been improved significantly (e.g. PESTAL et al., Erläuterungen zur Geologischen Karte von Salzburg 1:200.000. – 162 S., Geol. B.-A., 2009). The newly established lithostratigraphy constrained specifying quartzites or blackish schists in different stratigraphic positions. This leads to a better understanding of the tectonic style of the area. Equally important for the definition of individual nappes are different orthogneisses and the old roof lithologies.

A problematic lithological unit in the eastern part of the Tauern Window comprises the Permocarboniferous schists of the "Untere Schieferhülle". In the area between Mallnitz and Gastein KOBER (1920) summarized them as "Woisgenschiefer" based on their occurrence in the Woisgen valley. For the same rock association EXNER (Erläuterungen Geol. Karte 1:50.000 – Umgebung Gastein. Geol. B.-A., 1957) uses the term basal and central schist series ("Basale und Zentrale Schieferserie") and in the maps of the Sonnblick area by EXNER, Geol. Karte Umgebung Gastein 1:50.000. – Geol. B.-A, 1956; Geol. Karte Sonnblickgruppe 1:50.000.