nungen zeigen die Moränenreste in der Umgebung des Kars südöstlich vom Wildsee bis zur Hinterberger Alm.

Die Reste der pleistozänen Moränenüberdeckung zwischen Michelsberg und Gießgraben enthalten gerundete Quarz- und Kristallingerölle und besitzen Mächtigkeiten von wenigen Metern. Das Material führt besonders in steileren Bereichen zur Ausbildung von Rutschungen. Relikte von Verebnungsflächen finden sich in diesem Gebiet verbreitet.

Weite Bereiche der Vorderberger und Striedener Almen und der Umgebung des Wildsees zeigen eine postglaziale Bodenbildung mit Mächtigkeiten bis in den m-Bereich. Größere Vernässungsbereiche und Buckelwiesen sind auch hier verbreitet.

Die postglazialen Ereignisse spiegeln sich auch in intensiven Hangzerreißungen zwischen dem Langkofel und Damerkopf sowie in den Gipfelregionen von Kesselkopf und Sandfeldkopf. In Locker- und Festgesteinen sind Anbrüche in unterschiedlichsten Dimensionen zu beobachten. Unterhalb von Haßler- und Funderhütte, sowie in den Hängen nördlich von Strieden, findet man neben großen Schuttmassen sehr häufig eine über Gefügedaten dokumentierte Verstellung größerer Blöcke durch Hangtektonik.

Nahezu im gesamten Areal bildeten sich an übersteilten Hängen und Klippen zum Teil mächtige Hangschuttströme. Dies gilt insbesondere für die höher gelegenen Bereiche unterhalb der aufragenden Berggipfel (z.B. Damerkopf, Kesselkogel, Sandfeldkopf, Turneck, Mauereck), aber auch für Abschnitte der tiefer gelegenen, bewaldeten Gebiete. Als jüngste Bildungen wurden die Schwemmfächer von Nörsach und Nikolsdorf und die fluviatilen Schluffe, Sande und Schotter des Drautales in die Kartendarstellung übernommen.

Blatt 182 Spittal an der Drau

Bericht 1994 über geologische Aufnahmen auf Blatt 182 Spittal an der Drau

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PENNINIC BASEMENT COMPLEXES

Area N of Gössgraben (E of Hochalmspitz 3360 m)

Tectonostratigraphy and lithological composition of the crystalline complex are partly different from that of the Reißeck Massif (S of Gössgraben), especially due to the presence of migmatites to (diaphtoritic) micaschists, tonalitic orthogneisses to metatonalites, overlying the marker layer of amphibolites, which is usually present on the top of the Reißeck Massif tectonic structure.

The exposed basis of the structure N of Gössgraben is characterized by alternation of "porphyric Zentralgneis" and banded "gray gneisses", more or less schistose or porphyric (probably metaigneous protolith of the Zentralgneis), composed of quartz, plagioclase, biotite, sporadic amphibole and garnet. Thin granitoid layers, incl. porphyric Zentralgneis type, are present within the gray gneisses, which are cut by leucocratic granitoid veins. Granodiorite to granite showing less porphyric, but intensely deformed texture, underlies the amphibolites. The sequence is about 1000 m thick.

A distinct amphibolite layer, overlying the previous sequence, is composed of fine-grained amphibolites, biotite-amphibole gneisses and coarse grained metagabbros. All rocks are strongly biotitized. Amphibolites show banded, layered structure with alternating dark (amphibole, biotite-rich) and leucocratic (plagioclase, or plagioclase-quartz rich) layers with some content of epidote, scarcely K-feldspar, muscovite and garnet. The layering is concordant with metamorphic schistosity, indicating ductile deformation; leucocratic veins have been probably anatectic melts as deduced from the composition. The thickness of the marker amphibolite layer is about 100–150 m.

A migmatite-gneiss layer (100–200 m thick) appears above banded amphibolites. Biotite-garnet paragneisses to migmatites exhibit also banded and inhomogeneous texture characteristic for migmatites. They are intimately associated with layers of deformed leucocratic granitoids, often in the form of ptygmatitic folds of leucosome surrounded by melanosome concentrations, or layers of porphyric tonalites and granodiorites with assymetric tails due to dynamic recrystallization. The main mineral assemblage of gneisses comprises garnet, biotite, muscovite, plagioclase and quartz, indicating metapelitic lithology. In several places, kyanite, staurolite, newly formed garnet (smaller grains) and muscovite and chlorite represent most probably the products of Alpine metamorphic recrystallization, thus the rocks exhibit mica schist assemblages and texture. There are characteristic transitions from migmatites to mica schists, especially near the hangingwall of the layer or, along the internal shears. Thus the mica schists appear to be diaphtorites or migmatite paragneisses due to Alpine metamorphism.

The top of the tectonostratigraphic sequence is built of tonalitic gneisses, with transitions to massive metatonalites.

Area N of Gössgraben, Höhenock 2124 m

The upper part of the Höhenock (2124) ridge is built of metapelites (mainly mica schists with garnet, metagraywackes, biotite gneisses), rarely amphibolites. This complex is characterized by injections of white leucocratic granites, several tens of metres thick. Texturally, the metamorphism seems to be influenced by a periplutonic manifestation of the above mentioned granite: fresh garnet, randomly oriented phyllosilicates (muscovite, biotite, less chlorite), plagioclase and quartz forming common assemblage. If the underlying amphibolites representing the so called Innere Schieferhülle is considered to be as pre-Hercynian, then this rock pile may be envisaged as a Hercynian cover, or as a thrust sheet, "migmatitized" by syn- to postkinematic granite.

Eastern slopes of the Malta valley

The eastern slopes of the Malta valley at the northern edge of the map sheet are built by a "hybrid complex", comprising grey granites to gneisses, injected by the network of light-coloured granitic veins. This process, also manifested by superposed biotitization, is preliminarily designated as a postkinematic migmatitization. Primary magmatic-metamorphic layering and high grade deformation close to anatexis conditions is regarded to be older.

At the eastern slopes NE of Feistritz, marble bodies (of tens m of thickness) have been found, incorporated within the penninic crystalline. Some domains preserve primary bedding. In certain places, the adjacent variegated schists appear to be the lower metamorphosed complex, but the precise distinction from the mylonitized Innere Schieferhülle is usually obscure.

The top of the penninic basement in this area is built of coarse-porphyric biotite and biotite-muscovite metagranitoids (Zentralgneis of granodioritic to tonalitic composition).

PENNINIC MESOZOIC COMPLEXES

The Penninic Mesozoic rock sequence is built of two distinct complexes:

Volcano-sedimentary Complex

Stubeck (2370 m) area

The Penninic Mesozoic complex tectonically overlies the penninic crystalline basement. It starts with biotite-epidote-albite schists, with the low content of quartz. They might have been intermediary volcanics and volcanoclastics, with locally preserved banded structures. Coarse-grained mica schists like albite-muscovite-chlorite schists contain more quartz and white mica, less albite, chlorite and epidote-clinozoisite. They might represent tuffites to acid volcanics and volcanoclastics (with possibly recrystallized K-feldspars to white micas). The presence of greenschists and light-coloured orthoschists in the form of thin concordant layers is quite common. There was found the direct contact of a few dm thick layers of epidote amphibolite (albite, epidote, chlorite, $\text{hornblende}_{\text{blue-green}}$, $\text{biotite}_{\text{green-brown}}$) with light-coloured orthoschist (albite, muscovite-phengite?, epidote-clinozoisite, ±quartz, ±magnetite) within pearl albite-biotite schists.

The middle part of the sequence is characteristic by almost monotonous a few tens of m thick light-coloured homogeneous quartz-albite-muscovite orthoschists (±biotite). They usually have very low contents of quartz and some epidote-clinozoisite, chlorite or biotite, and magnetite. The original mineral composition might have been leuco-dacitic to rhyodacitic or dacito-andesitic.

The top of the sequence is built of actinolitic greenschists, epidote amphibolites and metagabbros. Epidote amphibolites are composed of albite, epidote, hornblende $1_{\text{(blue-green)}}$, hornblende $2_{\text{(act)}}$, magnetite, ilmenite, biotite. Metagabbros contain coarse-grained hornblende $1_{\text{(light-green)}}$, hornblende $2_{\text{(blue-green)}}$, hornblende $3_{\text{(act)}}$, chlorite, epidote-clinozoisite, biotite.

Calcschist-volcano-sedimentary Complex (Periphere Schieferhülle)

Stubeck (2370 m) area

The Penninic Mesozoic marble complex overlying the volcano-sedimentary one is present just few metres behind the northern map-sheet (182) boundary, approx. 800 m N of Stubeck. Only one tectonic slice of the marly marble is cropping out (like a small tectonic window) on the NW slope of Stubeck, within the frontal part of the Austroalpine Nappe Unit.

The mylonitic marble is composed of strongly deformed calcite grains (bent e-lamellae), alternating with calcite-phengite (phlogopite?), albite or quartz-phengite (phlogopite)-albite±calcite bands.

Mölltal valley area

The rock complexes of the Periphere Schieferhülle are formed by low to medium grade metasedimentary and metavolcanic rocks distinguishable from the Innere Schieferhülle by the lack of granitic intrusive bodies or dykes and by the widespread presence of carbonate-rich lithologies (Bündnerschiefer). They occupy a position between the Penninic Göss crystalline core and Austroalpine basement complexes. Most of the Periphere Schieferhülle rocks are probably allochthonous with respect to the Zentralgneis – Innere Schieferhülle substratum, especially in the SW part of the mapped area along the Mölltal valley. However, their basal parts in the Bartelmann area are lacking calcareous rocks and rather resemble some Permoscythian sedimentary cover.

The following principal rock types have been mapped:

- Calcareous phyllites and mica schists (Kalzitschiefer) are the dominant Schieferhülle constituents in the Mölltal area. Their calcite content varies so the rocks range from impure marbles to calcite-poor mica schists. White mica and quartz aggregates are concentrated in flakes or small lenses, sometimes arranged in bands and elongated clusters defining schistosity and stretching lineation. Marly limestones and/or calciturbidites were probably the sedimentary precursors of calcschists.
- Black phyllites and mica schists (Schwarzschiefer) form intercalations in calcschists and usually contain some calcite as well. In some places (the ridge between Taborgraben and Metnitzergraben) black phyllites contain several 10–30 cm thick beds of white pinkish quartzites, possibly original radiolarites. On the SW slopes of Burgstallberg the dark mica schists are garnetiferous.
- At the contact with the Austroalpine basement (near Edling in the Mölltal valley) upper parts of the Bündnerschiefer complex are composed of dark calcareous phyllites and crystalline limestones with clastic admixture (quartz, muscovite, carbonates, crinoid ossicles). Isometric bodies of yellowish dolomites are probably olistolites. This unit could represent the "Tauernflysch Group" terminating the Cretaceous Penninic sedimentation in the Matrei zone (Frisch et al., 1987). Large bodies of calcite and dolomite marbles also occur in a similar position on the eastern slopes of Bartelmann.
- The metavolcanic complex is built up by chlorite-rich greenschists, massive amphibolites, hornblende-bearing gneisses, albitic gneisses and metagabbros. These rock types show complex internal relationships and gradual transitions and were probably derived from an oceanic ophiolitic basement.
- Serpentinites form separate bodies. One small lens surrounded by calcschists is in the Mühldorf valley (Oxburgh et al., 1971), a large sheet is exposed on the eastern slopes of Bartelmann.
- Locally garnetiferous mica schists form elongated slices (Burgstallberg).
- Quartzose and arcosic metasandstones occur in two large slices on the NE slopes of the Mölltal valley (Plankogel, In Öden). Both calcite-free mica schists and metasandstones might be tectonic slivers

of Austroalpine (Upper Paleozoic?) rocks incorporated in the Periphere Schieferhülle complexes.
– In the Mölltal valley near Mühldorf, augen-gneisses of the Zentralgneis type are exposed, interpreted as the "Sonnblick-Lamelle" by EXNER (1962, 1980) and OXBURGH et al. (1971) – a strongly sheared antiformal "tail" of the Sonnblick dome.

AUSTROALPINE BASEMENT COMPLEXES

The Austroalpine Nappe Unit (A.N.U.) predominates at the eastern edge of the map-sheet. In the Stubeck (2370 m) area the A.N.U. is built of two different nappes:

Micaschist Nappe

The lower nappe is composed of coarse-grained garnet micaschists (quartz, garnet, muscovite, biotite, ±plagioclase – albite, ±rutile, chlorite) with nice examples of synkinematically grown garnets (with rotated internal inclusion fabrics). The thrust zone of the L.A.N. is accompanied by mylonitic to ultramylonitic dark-gray fine grained garnet schists with a dark to black lyditic type of metaquartzite layer (20–30 m thick). Diaphthoritized mica schists contain regenerated $garnet_1$ with a rim of new tiny grains of $garnet_2$, chlorite, sericite-muscovite, quartz, albite. Rare tiny amphibolite bodies (metagabbros) are composed of $hornblende_{(blue-green)}$, garnet, zoisite, plagioclase, ±quartz. Retrograde minerals are: epidote, clinozoisite, calcite, biotite, chlorite, ±quartz.

Similar quartzphyllites and garnet micaschists overlie penninic Mesozoic calcschist and volcano-sedimentary complexes in the Möll valley and the Eckberg area.

Gneiss Nappe

The upper nappe, overlying the mica schists of the lower nappe is composed of gneisses (garnet, plagioclase, quartz, muscovite, biotite, ±rutile, ±ilmenite) which have comparable mineral assemblage with those of the mica schists, but gneisses have lower content of quartz and higher contents of feldspars, as well as gneissous structure and texture. Also retrograde minerals are the same: quartz, sericite-muscovite, chlorite, garnet 2 (often grown within plagioclase), albite.

TECTONIC STRUCTURES

Area N of Gössgraben

The oldest (Pre-Alpine, probably Variscan) tectonic structures are characterized by metamorphic to anatectic layering e.g. within gray gneisses and within gneisses to migmatites. Superposed (top-to-ESE) ductile shearing in mid-crustal conditions left biotite-amphibole mineral lineation of E–W direction, combined with N–S compressional synmetamorphic folding (a part of biotite flakes grew in axial-plane clevage) with N–S B-axes.

The mylonitic (alpine) stretching lineation in Zentralgneis is predominantly striking NNW–SSE. Metamorphic foliation is dipping 10–40° to the N–NNW.

The Alpine remobilization is the most distinct in the hangingwall of the gneiss-migmatite layer (nappe?) accompanied by a huge diaphthoritic micaschist. It can indicate an Alpine thrust of the gneiss-migmatite and metatonalite sheet over the marker amphibolite layer.

Stubeck (2370 m) area

The eastern edge of the Tauern window relatively escaped from intensive strike-slip movements, known e.g. in the Mölltal area.

The thrust plane of the Penninic Mesozoic volcano-sedimentary (island-arc? complex) over the penninic crystalline basement is dipping 20–40° to the SE. It bears distinctly superimposed extensional asymmetric S-C fabrics indicating top-to-SE sliding along the distinct stretching lineation striking NW–SE, to WNW–ESE.

The same extensional fabrics have been observed along the thrust planes of the Austroalpine Nappes.

Mölltal valley area

In the Mölltal valley, the rock complexes of the Periphere Schieferhülle, including the Sonnblick-Lamelle and possible Austroalpine slices, form a generally subvertically dipping, NW–SE-striking tightly folded and imbricated system separated from both the Austroalpine basement and from the Penninic Göss crystalline core by large-scale strike-slip faults (Mölltal-Linie) interpreted as the Tertiary dextral wrench zone by RATSCHBACHER et al. (1991). At the SE corner of the Tauern window, in the NE direction, both the Göss core/Periphere Schieferhülle and the Schieferhülle/Austroalpine contact faults flatten and dip moderately SE to E. In the area of Hummelkopf and Kolm hills, the contact between the steeply dipping, tightly folded Mesozoic Schieferhülle complexes following the Mölltal valley and monoclinal, gently to moderately S to SE dipping complexes further to the NE is rather sharp, indicating the northern boundary of the WNW–ESE-trending Mölltal shear zone. The internal sedimentary and tectonic boundaries, as well as the metamorphic foliation and locally detectable bedding follow this trend, while the penetrative stretching lineation plunges constantly SE to E. In the Mölltal valley, the lineation parallels axes of tight to isoclinal passive flow folds with subvertical axial planes. Along the eastern periphery of the Tauern window, this lineation is interpreted as a stretching direction of the Tertiary unroofing of the Penninic Tauern metamorphic core complex along low-angle normal faults (GENSER & NEUBAUER, 1989). This indicates that the ductile transpression along the Mölltal line and eastward tectonic unroofing occured simultaneously in the overall N–S-oriented compressional setting.

Later phases of brittle extension are recorded by steepening of the Penninic/Austroalpine boundary fault (Maltaberg) and by high-angle normal faults causing gravity sliding of serpentinite and dolomitic marble blocks on the NE slopes of the Bartelmann ridge. Mesoscopic ductile/brittle shear zones with ecc fabric in calcschists, revealing top-to-the south extension, have been observed also along the Möll valley (east of Plankogel).

According to the field experience, the metavolcanic complexes and the inferred Austroalpine slices generally occur in synformal structures of the upright system of tight macrofolds. This might indicate that not only Austroalpine rocks, but also at least part of ophiolitic complexes formed originally an overthrust nappe sheet overriding the Bündnerschiefer complexes rich in calcschists. To prove this opinion, a more thorough petrological and structural analysis of the Penninic complexes in the Mölltal valley are necessary.

QUATERNARY DEPOSITS AND STRUCTURES

Practically all genetic types of Alpine mountainous-type Quaternary deposits are present in the mapped area. Deluvial sediments are the areally most widespread, formed mostly by loamy-stony debris fields and cones. Pure stony and boulder debris sheets, together with rock avalanches occur on steep slopes below rock cliffs at higher altitudes.

The very dynamic morphology causes instability of slope deposits in many places (north of Lendorf, southern slopes of Böse Nase). Slope sliding of rocky blocks on the NE slopes of the Bartelmann hill is brought about by the near parallelism of foliation and the slope dips. Near the top of Hummelkopf hill, approximately N–S-striking, several meters wide breakoffs were observed in calcschists. These document recent subsurface creeping along metamorphic foliation generated by gravitational instability of the mountain ridge and still active E–W-trending extension.

Fluvial sediments are common in the present-day river beds and alluvial plains, as well as in terraces of several generations, e.g. in the Malta and Gmünd areas. Sometimes terraces reach considerable thickness and occasionally are mined for gravel. In some places terraces are preserved in relatively high elevations with respect to the valley bottoms. On the left side of the Mölltal valley the Quaternary fluvial deposits are represented by alluvial gravels, sands and clays of the valley bed, forming also an alluvial terrace near Lendorf. SE of Lendorf huge accumulations of alluvial fan-related gravels are preserved.

Proluvial cones of several generations typically occur in front of the lateral valley mouths, where they sometimes destroy fluvioglacial parts of Pleistocene frontal morraines (e.g. the Klinzerschlucht mouth near Mühldorf).

Glacial sediments are mostly reworked by fluviatile processes, remnants of original morraines are preserved only in high-altitude kars. Here also the mountain-type fens are quite common. Considerably thick fluvioglacial deposits occur on the left side of the Mölltal glacial valley, destroyed by progressive scouring of the Möll river in the lower part of the valley.

In many places (e.g. the Eckberg and Hummelkopf hills, slopes north of Karlsdorf), the erratic blocks of mostly Zentralgneis-type rocks indicate the originally more widespread occurrence of glacial sediments.

Blatt 185 Straßburg

Bericht 1994 über geologische Aufnahmen im Gurktaler Deckensystem auf Blatt 185 Straßburg

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(Auswärtige Mitarbeiter)

Die Aufnahmen des Geologischen Instituts Frankfurt auf Blatt Straßburg betreffen einen zwei bis drei Kilometer breiten Streifen nördlich der Wimitz zwischen Bachergraben im Westen und Geesgraben im Osten, dazu ein kleines Gebiet zwischen Schneßnitz und Hausdorf. Die Gesamtaufnahme umfaßt gut 30 km² mit folgenden sieben Teilgebieten:

1) Edling – Lind – Dolz (A. Mann)
2) Bacher-/Frischengraben (J. Kolb)
3) Frischen-/Jägergraben (C. Irle)
4) Jägergraben – Hundsdorf (M. Gudo)
5) Hundsdorf – Gruska (I. Steyer)
6) Sutsch – Zedroß – Niederdorf (A. Menz)
7) Schneßnitz – Hausdorf (G. Kleinschmidt)

Die Gebiete Nr. 2 bis Nr. 6 sind innerhalb des Berichtszeitraumes begonnene und fertiggestellte Diplomkartierungen.

Im Aufnahmsgebiet sind alle wesentlichen Gesteinseinheiten des gesamten Kartenblattes auf kleinstem Raum vertreten: Im (N)W liegen schwach metamorphe Gesteine vor, die nach ihrer Geländeansprache der Stolzalpendekke (SD) zugerechnet werden können. Im S, SE und NE gehören die Gesteine der Glimmerschiefergruppe an (Altkristallin [AK] bzw. Mittelostalpin). Dazwischen erstrecken sich als erstaunlich schmales Band zwischen Bachergraben im W und Zedroß/Niederdorf im E Gesteine der Phyllitgruppe (sensu Saualpe [1975]) bzw. der Murauer Decke (MD). Zusammengefaßt ergibt sich für alle Gebiete etwa folgende Gesteinsabfolge:

– Tonschiefrige Phyllite (SD)
– Phyllite (SD und/oder MD)
– Biotitschiefer (MD)
– Biotit-Glimmerschiefer bzw. Biotit-Feldspat-Glimmerschiefer (AK)
– Granatglimmerschiefer (AK)

In den Gebieten Nr. 2 bis Nr. 7 liegt zwischen den Arealen, die einerseits den Glimmerschiefern und andererseits der Murauer Decke klar zuzuordnen sind, eine Übergangszone mit stark gescherten, diaphthoritischen Gesteinen. Die Grenzen zwischen den übrigen Einheiten zeigen ähnliche Strukturen. In Gebiet Nr. 1 ist die Grenze zwischen den Phylliten und den tonschiefrigen Phylliten ebenfalls als Bewegungszone ausgebildet.

1. Edling – Lind – Dolz (Mann)

In dem mit mächtigem Hangschutt bedeckten und daher nur sehr schlecht aufgeschlossenen Kartiergebiet konnte die Hangendgrenze der Phyllite (s. dazu Gebiete Nr. 2 bis Nr. 6) auskartiert werden. Diese Grenze verläuft etwa parallel zur 900 m-Isohypse. Sie streicht im W des Aufnahmsgebietes ca. 500 m S des Wiesenbauer im Bachergraber aus und läßt sich über Lind und Dolz bis zum Grat, der in SW Richtung von der Höhe 975 S Kohlgruber herunterläuft, verfolgen.

Das Hangende der Phyllite wird von einer Gesteinsassoziation aus tonschiefrigen Phylliten s. str. und Eisendolomiten, in die einzelne Grüngesteinslinsen eingeschaltet sind, gebildet. Diese Einheit wurde auch schon aus den im W (Klingel) und N (Lenser) anschließenden Gebieten (Berichte 1990, 1991 und 1992/93) beschrieben. Diese Gesteine werden aufgrund ihres geringen Metamorphosegrades in die SD gestellt, zudem ähneln sie in der Geländeansprache stark der Magdalensbergserie (Kahler, 1953). Im W des Kartiergebietes herrschen Eisendolomite vor, die sich durch eine charakteristische Braunfärbung und einen meist grob krenulierten weitständigen Lagenbau auszeichnen. Der W-Teil wird dagegen hauptsächlich von tonschiefrigen Phylliten s. str. aufgebaut. In diesen sehr feinkörnigen Phylliten ist durch psammitische Einschaltungen noch ein älterer, wahrscheinlich sedimentär vorgegebener, Materialwechsel auszumachen. Die Grenze zwischen den beiden Gesteinen läßt sich aufgrund der