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Indications of Variscan nappe tectonics in the Aar Massif

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Abstract

In the Aar Massif a reinvestigation of the so called "quartzporphyre" dikes, the widespread sericite schists, and the psammitic layers occurring together with these rocks, show their vast extension within the complex. Many of these rock sequences have been recognized to represent meta-sedimentary volcanoclastic series and some of them have been dated as Carboniferous (Westphalian D-Stephanian). The Upper Paleozoic igneous rocks, volcanic and plutonic, belong to a calcalkaline suite and therefore relate to subduction processes. The deformation and the fact that these volcanoclastic sequences show contact metamorphic overprint due to the intrusion of the Upper Paleozoic granites can be explained by a compressional synsedimentary tectonic regime. While the molasse type volcanoclastic series were deposited, deeper parts of the same intramontane basins hade already been wedged into the basement, where they were intruded by syngenetic granites. This gives ample evidence for Variscan faulting and nappe tectonics.

Keywords: Aar massif, volcano-sedimentary sequences, compressive tectonics, Variscan nappes, Variscan basement.

Introduction

Up to now the Aar massif has been interpreted as a section of Variscan basement which has undergone Alpine metamorphism and deformation. Therefore attention was paid primarily to the deformation and recrystallization history due to Alpine orogenesis. The Aar massif has been subdivided into different Variscan batholiths and into several pre-Variscan polymetamorphic basement complexes. From the margins of the massif fossiliferous strata have been dated as Carboniferous (ROTHPLETZ, 1880; WEHRLI, 1925; CORSIN, 1946; JONGMANS, 1951, 1960; TAYLOR, 1976).

Volcanic and subvolcanic rocks as well as volcano-sedimentary sequences had already been recognized and mapped by many geologists: BAER (1959); BALTZER (1988); BRÜCKNER (1943); KAJEL (1973); FELLENBERG (1893); FISCHER (1905); FRANKS (1966, 1968a, b); HEIM (1878, 1891); HUBER (1948); HUGI (1923); HÜGI (1941); HÜGLY (1927); HUTTENLOCHER (1921, 1933, 1947); JENNY (1973); KOENIGSBERGER (1910); LABHART (1965, 1966, 1977); LIECHTLI (1933); PFLUGSHAUPT (1927); SCHMIDT (1886, 1891); SIGRIST (1947); STALDER (1964); STAUB (1911); STECK (1966, 1968, 1984); WEBER (1912, 1924); WEHRLI (1896); WIDMER (1949); WYSS (1932); ZBINDEN (1949). However, a geologic and magmatologic interpretation as well as the relationship to the large granitic plutons had not been worked out.

Today, modern petrogenetic theory allows an interpretation of the paleotectonic regime of an area from its magmatic assemblages. With this concept in mind, new emphasis has been given to the volcanoclastic sequences (SCHENKER, 1980, 1986, 1987; SCHENKER und ABRECHT, 1987; BÖHM, 1986, 1988 this volume; RIESEN, GNOS, VÖGELI, DOLLINGER, work in progress), to plutonic rocks (ABRECHT, 1975, 1980; KÜPFER, 1977; OBERHÄNSLI, 1985, 1987a, b; SEEMANN, 1975; SCHALTEGGER, 1984, 1986)

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and to the pre-Alpine deformation (KAMMER, 1985) in the eastern and central Aar massif.

The aim of this study is to present a new working hypothesis on nappe tectonics based on a reinvestigation of the volcanic and volcanoclastic sequences in the Aar massif. A map emphasizing the Upper Paleozoic volcanics and related sediments and the hitherto emerging ideas of Paleozoic tectonic events are presented.

Three major observations emerge from more recent investigations.

1) FRANKS (1968a, b) recognized two unconformable volcanoclastic sequences in the eastern Aar massif. The older volcanoclastic sequence shows a strong deformation and metamorphic overprint and is of probable Lower Carboniferous age. This sequence is overlain by a younger volcanic sequence which has been dated with plant remains as Westphalian D-Stephanian (ROTHPLETZ, 1880; JONGMANS, 1951, 1960) and is covered, with a marked unconformity, by parautochthonous Mesozoic rocks.

2) In contrast to the established opinion, SCHENKER (1986; SCHENKER und ABRECHT, 1987) demonstrated that the major pluton of the Central Aar granite (281 ma Rb/Sr, WÜTRICH, 1965; SCHALTEGGER, 1986) is intrusive into, and therefore younger than some of the volcanoclastic sequences. This is indicated by contact metamorphic phenomena.

3) The majority of the Upper Paleozoic magmatic rocks from the Aar massif belong to a calcalkaline rock series (SCHENKER, 1980, 1986; BÖHM, 1986, 1988 this volume).

These evidences led to the idea that the Aar massif was generated in a destructive continental margin, linked with subduction processes and underwent compressional tectonics rather than horst and graben tectonics during the Upper Paleozoic. An approach to this problem is the reevaluation of the volcanoclastic sequences, which represent Paleozoic surfaces. In analogy to the Alpine Pennine nappe system, where even minor and extremely thinned and deformed Mesozoic carbonaceous rocks are taken as Alpine nappe separators (overthrust horizons), the Paleozoic volcanoclastic sediments were taken to subdivide structural units within the Aar massif.

Surface character of the studied rock sequences

Because of the metamorphic overprint the original volcanoclastic nature of many sericite schists in the Aar massif is still a point of debate, although an intrusive origin has been suggested by former workers (cit. see p.). Therefore, the arguments for the surface character of these rocks shall be summarized:

- interlayering of pelitic, psammitic and conglomeratic rocks, often of epiclastic origin, with intermediate to acidic meta-volcanics.
- preserved sedimentary contacts of meta-volcanics and meta-volcanoclastics with eroded basement gneisses.
- relics of pyroclastic textures, including lapilli bearing strata.
- ignimbritic horizons ("quartzporphyric rocks") with preserved original structures like fiamme, glass shards, quartz shards (disintegrated, lobate, concave-shaped quartz fragments).

Since for a tectonic reconstruction the surface character of the studied rocks is of fundamental importance, in the following, we strictly refer to sequences which undoubtfully show surface characteristics.

Tectonic map of the Aar massif

In the eastern and central parts of the Aar massif volcanoclastic sequences are relatively well known and widespread. In the western part many of the so called "quartzporphyric dikes" have been identified as volcanoclastic sequences. They are shown in a simplified tectonic map (Fig. 1; based on previous investigations: OBERHÄNSLI, 1985, SCHENKER, 1986) together with major Alpine and Variscan lineaments (KAMMER, 1985).

Within the gneissic basement an alignment of amphibolites and serpentinites representing pre-Variscan (Caledonian?) protoliths (possibly ophiolitic) is evident. The outlines of the Upper Paleozoic volcanoclastic and plutonic rocks (281 ma, WÜTHRICH, 1965; SCHALTEGGER, 1986) as well as the Mesozoic sediment wedges are mostly parallel to the pre-Variscan directions. Generally where outcrop conditions are favourable, the northern contacts of the volcanoclastic sequences with the basement gneisses are observed to be primary (Trift, Diechtergletscher; Fig. 1, Tr, Di). The southern contacts

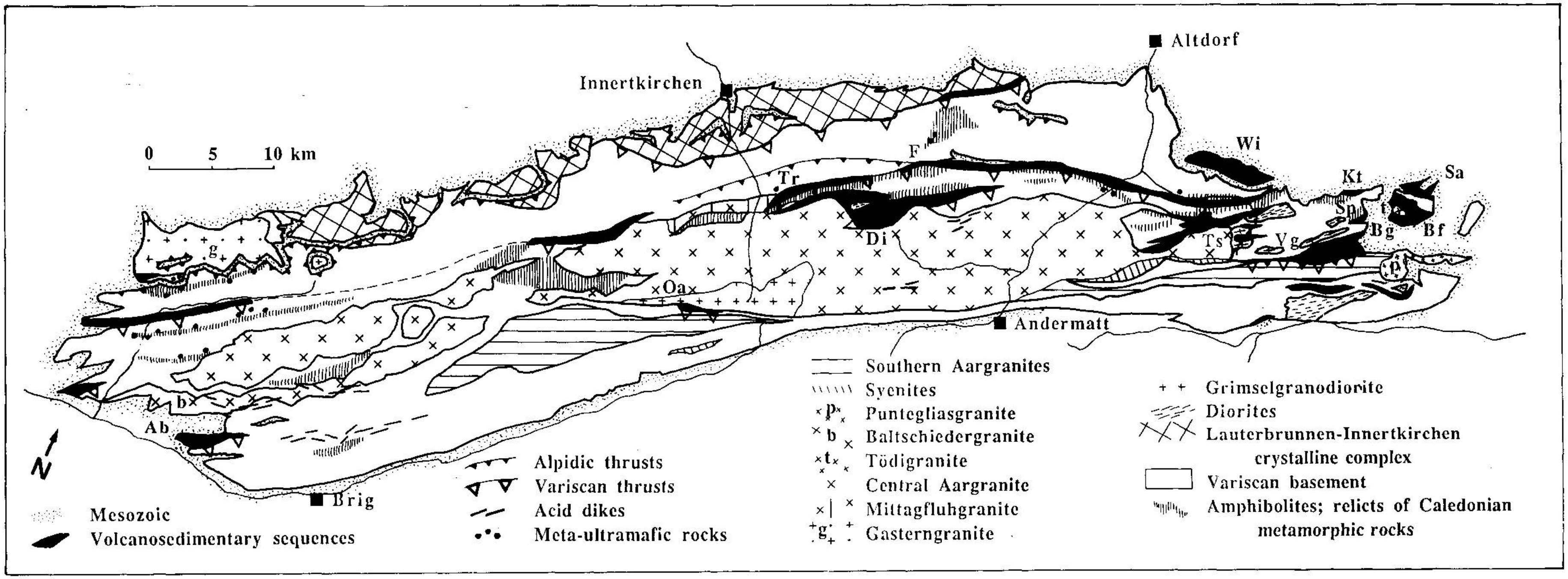

Fig. 1 Tectonic map of the Aar massif. Sa: Sandalp, Bf: Bifertenfirn, Bg: Bifertengrätli, Sp: Sandpass, Kt: Klein Tödi, Wi: Windgällen, Ts: Tscharren, Vg: Val Gliems, F: Furtwangsattel, Tr: Trift, Di: Diechtergletscher, Oa: Oberaar, Ab: Ausserberg.

to the basement gneisses are always of tectonic nature. The volcanoclastic sequences, therefore, can be taken as indicators of Variscan dislocation zones, represented in Fig. 1 as Variscan thrusts. The deformation zones indicated as Alpine thrusts are marked by Mesozoic sediment wedges and can be followed as mylonitic zones into the basement gneisses. The main Variscan and Alpine thrusts are oriented subparallel and spatially follow each other closely. In the Furtwangsattel area (Fig. 1, F), however, the Variscan and Alpine trends diverge and the Alpine deformation zone splits off into the basement gneisses. In this area, definite distinction between Variscan and Alpine structures is possible.

In the north one major volcanoclastic sequence, together with Mesozoic sediments, roots in the basement gneisses. In its eastern part this sequence is thrust northwards over the parautochthonous Mesozoic cover to form the Alpine Windgällen fold (Fig. 1, Wi). A second southerly lying volcano-sedimentary sequence shows complex folding (Fig. 1, Ts) together with the enclosing basement gneisses. Along this structure small dioritic intrusive bodies occur. In the southeastern part the intrusive bodies forming the Central Aar batholith obliterate the relationships between several other volcanoclastic sequences cropping out at the eastern (Fig. 1, Ab, Oa) and western (Fig. 1, Vg) ends of the Aar massif.

Volcanoclastic formations

The different volcanoclastic formations are heterochronous and differ in their lithostratigraphic compositions as well as their contact relationships.

SOUTHEASTERN AAR MASSIF

In the southeastern Aar massif, BÖHM (1986; 1988 this volume) distinguishes two volcanoclastic sequences of differing age. The older one, the *Val Gliems Formation* (Fig. 1, Vg) consists of meta-sediments and meta-volcanoclastic rocks. The meta-sediments can be subdivided into 1) banded psammitic schists, derived from sandy turbiditic protoliths and 2) black pelitic schists representing metamorphosed equivalents of marine or limnic argillites. These meta-sediments contain lithic components of the surrounding basement. Some of the meta-pelites show contact metamorphic overprint and form "Knotenschiefer" and chiastolite-schists. This metamorphism seems to be related to the intrusion of Upper Paleozoic granitoids, as delineated by crosscutting granodioritic dikes (BÖHM, 1986; 1988 this volume). Volcanoclastic rocks and welded tuffs are intercalated in these meta-sediments. This typical volcanic sequence (conglomeratic beds, rhyolites) occur repeatedly (BÖHM, 1986; 1988 this volume). The chemical composition of the metamorphosed volcanic extrusive rocks is calc-alkaline and varies from dacitic to rhyodacitic (BÖHM, 1986; 1988 this volume). Layering of the meta-sedimentary and meta-volcanic complex delineates a megascopic fold with a steeply plunging foldaxis, indicating Hercynian directions.

The younger *Sandpass-Formation* (Fig. 1, Sp), described by BÖHM (1986; 1988 this volume) belongs to the Permian Verrucano-sequences and is composed of green and black schists of volcanic origin. These rocks, in part strongly mylonitized, contain pebbles of the crystalline basement gneisses and plutonic rocks. The chemical composition of the volcanic rocks is rhyolitic, with a slight enrichment in potassium (BÖHM, 1986; 1988 this volume) and therefore, differs from the older typically calc-alkaline volcanics. They could be termed G-type rhyolites after IZETT (1981). This formation is conformably overlain by the base of parautochthonous Triassic rocks. BÖHM considers the "Klein Tödi-Formation" of FRANKS (1968a) to be identical to the Sandpass-Formation.

EASTERN AAR MASSIF

From the eastern part of the Aar massif FRANKS (1968a, b) described four formations, which are partly meta-volcanic.

FRANKS (1968b) defined the *Bifertenfirn-Formation* (Fig. 1, Bf) as a meta-sedimentary sequence of hornfelses derived from argillaceous siltstones and fine grained sandstones. Banded hornfelses show poikiloblastic flakes of muscovite and quartz phenocrysts. This formation contains spotted slates ("Knotenschiefer"; "Knoten" consist of muscovite, quartz and opaques), which are products of contact metamorphism due to the intrusion of the Tödigranite (Hügi, 1941). Dioritic dikes crosscut the meta-sediments. Franks correlated these rocks with the Val Gliems-Formation. However, he did not recognize the volcanic/volcanoclastic character of some of the layers neither in the Biferten- nor in the Val Gliems-Formation.

The *Biferten-Formation* (Fig. 1, Bg) of Franks (1968a) is divided into three members. The lowermost Volcanic member contains a basal conglomerate with reworked metamorphic rocks from the uncomformably underlying Bifertenfirn-Formation. Above the basal conglomerate, epiclastic and rarely pyroclastic material was deposited: e.g. volcanic breccias, tuffaceous sandstones, lithic tuffs, crystal tuffs and ashes. In the epiclastic breccias andesitic, dactitic and rhyodacitic components occur. The volcanic member is overlain by the Estuarian member consisting of conglomerates, sandstones and mudstones. The latter containing the plant bearing beds dated as Westphalian D-Stephanian (Rothpletz, 1880; Jongmans, 1960). At the top of the formation, the Lacustrine member is composed of mudstones, siltstones and sandstones.

The *Klein Tödi-Formation* (Fig. 1, Kt) underlies the Mesozoic rocks in the Sandpass area (Franks, 1968a) and contains coarse epiclastic breccias with reworked basement gneisses, granites and granodiorites alternating with lapilli tuffs and banded rhyolites. The volcanic sequence contains porphyritic microdiorites and is cut by acid porphyric dikes. East of the Sandpass the formation changes its character and pyroclastic rocks and bedded tuffs predominate. In epiclastic sequences, metamorphosed rocks similar to the Val Gliems-Formation or Bifertenfirn-Formation occur.

The *Tscharren-Formation* (Fig. 1, Ts) after Franks (1968a) can be divided into three units. A tuffaceous member with dark vitric and lithic tuffs, a conglomeratic member and an ignimbritic member with light coloured acid tuffs and ignimbrites. The first unit consists of discontinuous beds of black carbonaceous mudstones and siltstones intercalated with banded tuffs, crystal tuffs and lapilli tuffs. The conglomerates and breccias are composed of fragments of the surrounding beds and represent epiclastic deposits. The ignimbritic member consists of rhyolitic flows, interbedded with tuffs and sediments. In some places this formation is cut by the younger Aar granite and the tuffaceous strata contain chlorite and biotite, possibly produced through contact metamorphism.

CENTRAL AAR MASSIF

From the central as well as the eastern Aar massif Schenker (1986) has described several sequences of sedimentary and volcanic rocks.

The *Windgällen-Formation* (Fig. 1, Wi; Fig. 2) after Schenker (1986) consists of a porphyric microgranite, which intrudes the overlaying sequence of ignimbritic, calcalkaline rhyolites, pyroclastic tuffs and epiclastic sediments (lahars, pelitic schists). It is interpreted as subvolcanic equivalent to the rhyolites. Dogger sediments transgressively overlay the volcanoclastic sequence with a marked unconformity. The volcanoclastic rocks are only weakly metamorphosed and exhibit ample primary structures, such as cooling columns, fluidal textures and fiamme. This formation is thrust over the parautochthonous sediments in a mega fold and roots together with Mesozoic rocks in the basement gneisses of the Maderanertal.

The *Trift-Formation* (Fig. 1, Tr; Fig. 3) can be considered as an extension of the Windgällen-Formation (Schenker, 1986). The Mesozoic rocks are absent. In the area of the Klein Griessenhorn, (Furtwangsattel, Fig. 1, F) Variscan and Alpine lineaments diverge. The Upper Paleozoic volcanoclastic sequence and the Variscan thrusts turn towards southwest. The Alpine thrust can be traced further westward. The Trift-Formation is composed of ignimbritic and epiclastic volcanic series as well as clastic, conglomeratic sediments. The metarhyolites are strongly deformed but generally not mylonitized. In the north the meta-volcanic sequence overlies the basement with a sharp contact, considered to be sedimentary, whereas the southern contact is marked by a thin mylonitic zone. The volcanic components show dacite to rhyolitic compositions belonging to a calcalkaline suite.

The *Diechtergletscher-Formation* (Fig. 1, Di; Fig. 4) can be divided into a pyroclastic and an epiclastic unit (Schenker, 1986). The epiclastic unit contains meta-greywackes and fanglomeratic, argilleous meta-sandstones which are intercalated with pyroclastic meta-volcanics. The

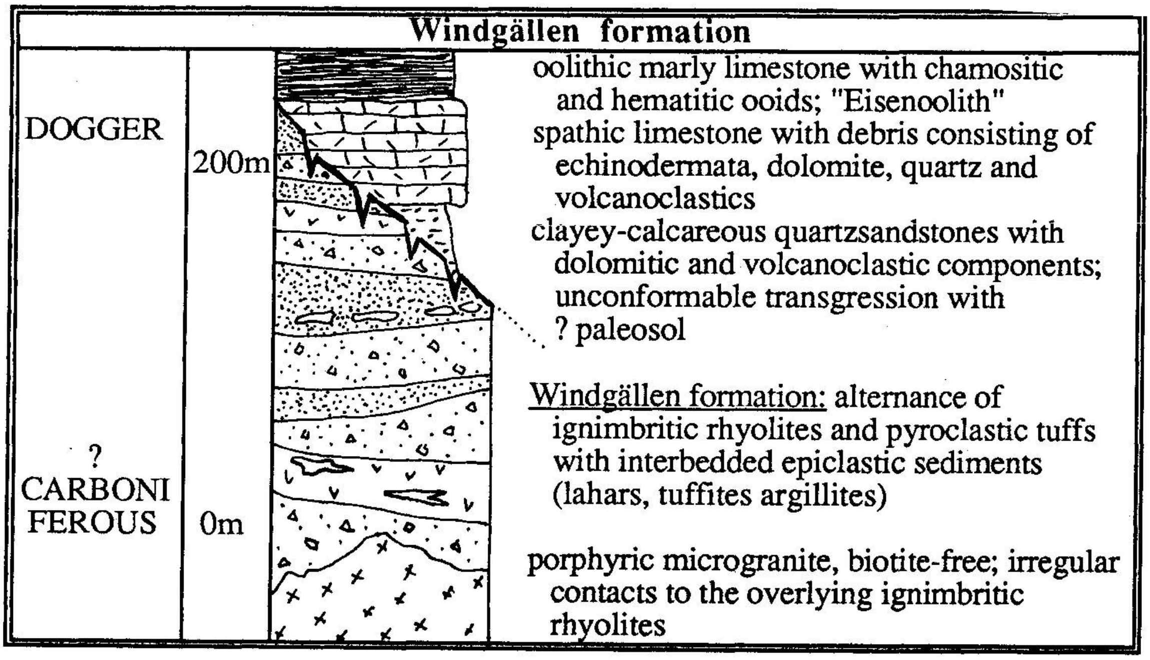

Fig. 2 Idealized section of the Windgällen formation. Location of the base of this section: 698.080/184.240/2710.

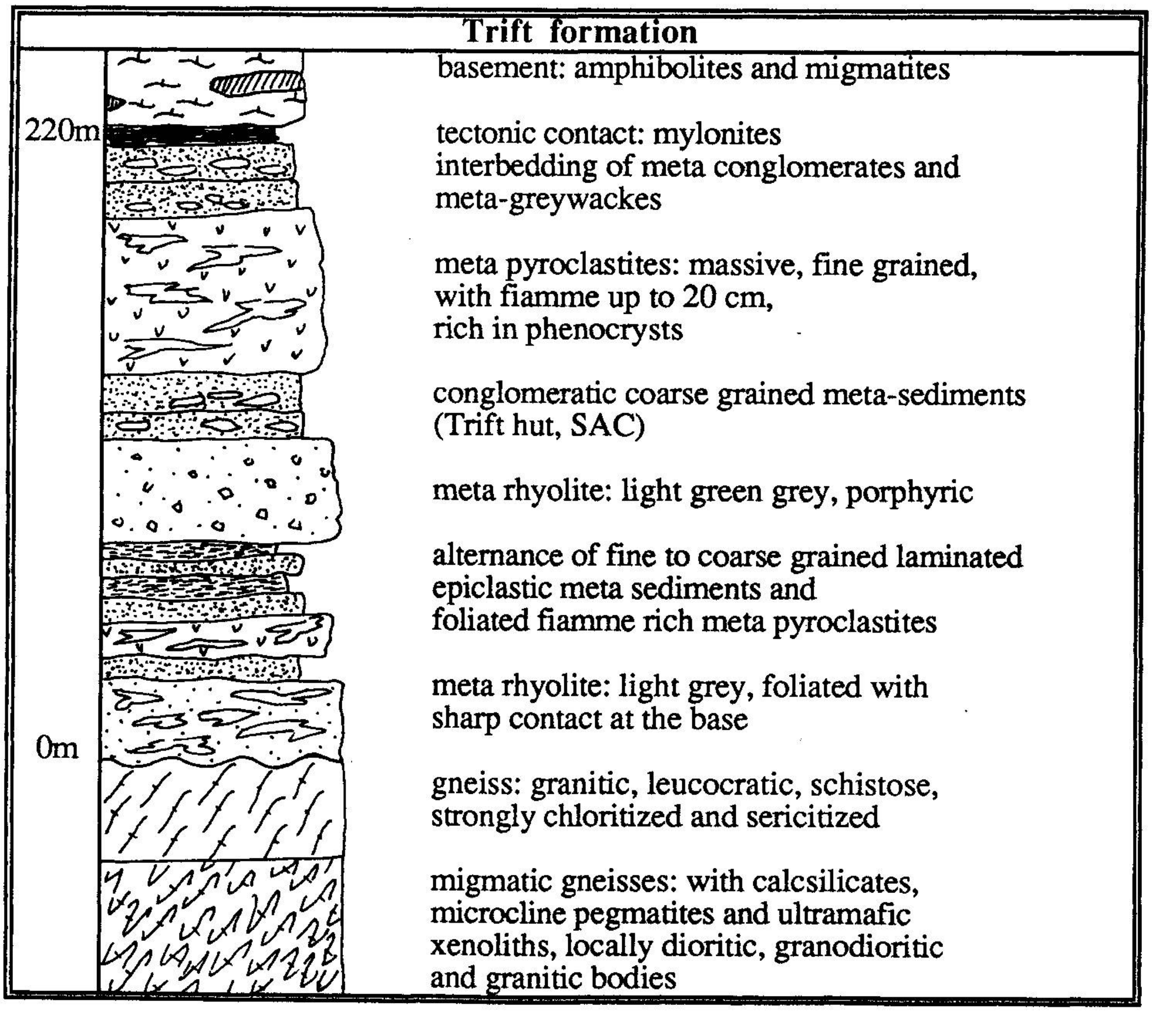

Fig. 3 Idealized section (profile) of the Trift formation modified after SCHENKER and ABRECHT (1987). Location of the base of this section: 671.500/170.075/2300.

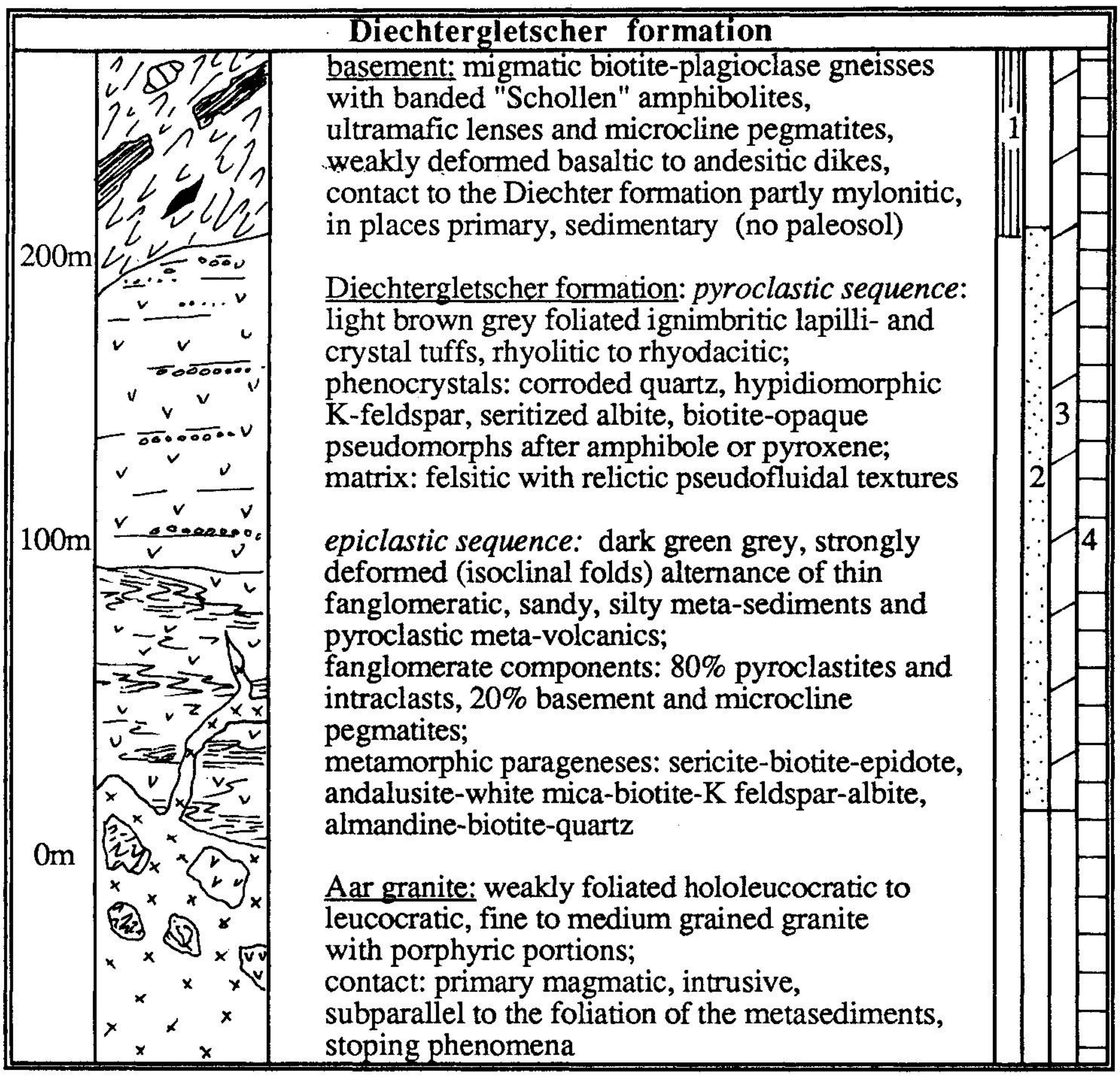

Fig. 4 Idealized cross section (N-S) of the Diechtergletscher formation modified after SCHENKER and ABRECHT (1987). 1. pre-Variscan amphibolite-facies metamorphism with subsequent anatexis; 2. syn-volcanic hydrothermal alteration; 3. syn-granitic contact metamorphism; 4. Alpine greenschist facies metamorphism; Location of the base of this section: 669.175/166.950/2690.

pyroclastic unit is built up by ignimbritic crystal tuffs and lapilli tuffs. Additionally shoshonitic andesites forming subvolcanic bodies (?necks) and dikes are observed. Rocks of this formation are strongly deformed and isoclinally folded. The northern contacts to gneisses and amphibolites of the basement are partly stratigraphic. The southern contact is intrusive: the Aar granite cutting the meta-sedimentary unit produced stoping phenomena and developed a contact aureole (SCHENKER, 1986; SCHENKER AND ABRECHT, 1987). The effects of contact metamorphism are recorded in pelitic layers by garnet-biotite as well as andalusite-muscovite-biotite parageneses.

Regional comparison

Despite the lithological similarities in the formations described above, three types can be soundly distinguished based on lithology, age and structure:

1) Units with volcanic rocks of intermediate to acid calc-alkaline compositions; their associated conglomerates contain basement detritus; intense isoclinal folding has affected these units.
2) Units with volcanic rocks consisting of calc-alkaline ignimbritic lavas and tuffs; the epiclastic sediments contain few or no basement material; these units may unconform-

Tab. 1 Comparison and compilation of different volcano-sedimentary sequences in the Aar massif.

	FRANKS (1968)	SCHENKER (1986)	BÖHM (1986)	THIS WORK	
Mesozoic					
Permian			Sandpass F.	Sandpass F.	
Westphalian D	Bifertengrätli F. Tscharren F. Sandalp F. Windgällen F. Kleintödi F.	Windgällen F. Trift F. Tscharren F. Diechtergl. F.		Windgällen F. Sandalp Bifertengrätli F. Tscharren F. Brunnital Oberaar 2 Ausserberg	MADERANER GROUP
pre Westphalian	Bifertenfirn F. Val Gliems F.		Val Gliems F.	Bifertenfirn F. Val Gliems F. Diechtergl. F. Oberaar 1	CAVADIRAS GROUP

ably top and underlay the former units and the Mesozoic respectively.

3) Units revealing no or a minor hiatus at the Paleozoic–Mesozoic transition; volcanic rocks are mildly alkali-rhyolitic (G-type). These units could correspond to the Permian Verrucano spilite and keratophyre volcanics.

Based on their lithological aspects, associations and deformations, the Upper Paleozoic formations can be grouped as follows (Tab. 1): We propose CAVADIRAS GROUP for the intensely folded, basement component bearing, intermediate to acid and to our opinion older formations and MADERANER GROUP for the less deformed, mainly rhyolitic younger formations devoid of basement components.

We shall compare further volcanic sequences found elsewhere in the Aar massif to the three types of formations discussed above.

EASTERN AAR MASSIF

North of Disentis WEBER (1924) mapped "quartzporphyres". A closer investigation showed that they can be interpreted as volcanoclastic sequences folded into the basement revealing affinities to the Windgällen- or Tscharren-Formation. Furthermore, we found rhyolitic volcanoclastic rocks underlying Triassic sediments in this area. Their stratigraphic position and lithology show affinities to the Sandpass-Formation. From the Brunnital transsect several intercalations of volcanoclastic sediments of the Tscharren type have been identified by RIESEN and GNOS (diploma work in progress, OBERHÄNSLI et al., 1987).

CENTRAL AAR MASSIF

From the Grimsel area near to the Oberaar power-dam (Fig. 1, Oa), two volcanic sequences can be observed over a short distance (DOLLINGER, diploma work in progress). One is isoclinally folded (Tab. 1, Oberaar 1), shows chlorite- and sericite-rich schists and can be interpreted as corresponding to the Bifertenfirn / Val Gliems type. The other (Tab. 1, Oberaar 2), less deformed ignimbritic sequence is equivalent to the younger formations (Windgällen, Tscharren).

WESTERN AARMASSIF

From the Lötschenpass area a volcanic sequence intruded by the Gasterngranite has been identified by ZAUGG and ARNOLD (pers. comm).

The "quartzporphyres" of Ausserberg (Fig. 1, Ab) have already been compared to the Tscharren-Formation by HUTTENLOCHER in 1933; an observation which we can fully confirm.

Paleotectonic frame

Indications of a compressional tectonic setting during Variscan orogeny of the Central Alps can be deduced from FRANKS work (1968a, b). Comparing the different lithostratigraphic volcanoclastic sequences from Lower Carboniferous to Permian, he distinguished two pre-Alpine (pre-Mesozoic) unconformities between Bifertenfirn-, Bifertengrätli-Formations and the Mesozoic sedimentary cover. Further arguments for compressional tectonics are:

1) Thrust-faults (Fig. 1) which separate different parts of the basement (KAMMER, 1985).
2) Strong isoclinal folding in the older pre-Westphalian formations and less intensive folding in the uppermost Carboniferous formations, indicating a continuous shortening of the crustal segment connected with igneous activity.
3) Surface rocks must have been brought to a considerable depth in order to be intruded and metamorphosed by the syngenetic Aar granite.
4) The calcalkaline chemistry of the igneous rocks suggests crustal thickening.

The old volcanic sequences today lie subvertically or show a slight southward vergence. This position is doubtless due to the later Alpine compression, which incorporated the parautochthonous Mesozoic cover along deep reaching south vergent thrust planes. Thus the original vergence and inclination of the Variscan nappes can not yet be established soundly. In the Variscan belt in Central Europe which was not affected by later Alpine tectonic events, nappe transport directions are to the north (BEHR et al., 1984). We therefore infer similar transport directions for the Variscan nappes in the Aar massif.

Variscan nappe structures

To "individualize" Variscan nappes, we propose a speculative solution by combining the different supracrustal sequences as given in Fig. 5. Three prominent zones of volcanoclastic sediments and pre-Alpine deformation zones can be correlated (1, 2, 3; Fig. 5). Several smaller lineaments are considered to represent minor deformation zones (1a, 2a, b, 3a, b, c; Fig. 5). In the central parts of the Aar massif the thrusts are crosscut by the Upper Paleozoic plutons. While in the northern part of the Aar massif the Variscan structures can be distinguished from the Alpine structures, in the southern part the increasing intensity of Alpine deformation obliterates their distinction. Despite the Alpine overprint, Variscan sutures delineated in some parts by volcano-sedimentary sequences, can be followed in the basement gneisses.

The three major alignments (1, 2, 3; Fig. 5) subdivide four portions of the Aarmassiv. "Nappe 1", the northernmost portion consists

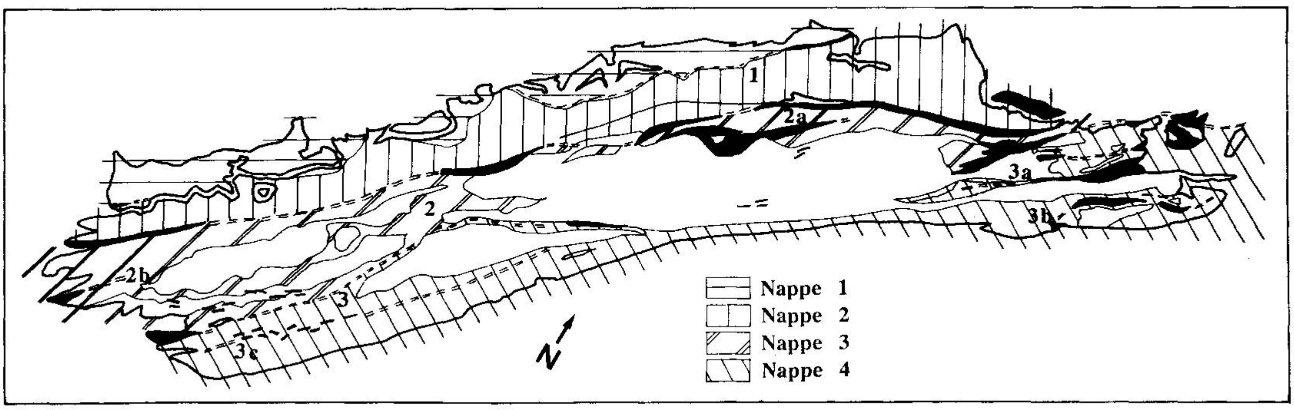

Fig. 5 Interpretative correlation of Upper Paleozoic surface rocks to delineate four possible Variscan nappes.

of the anatectic Lauterbrunnen-Innertkirchen complex and the Gasterngranite (Fig. 1) and contains very little basement gneisses.

"Nappe 2" contains the biotite-plagioclase gneisses and magmatites of the Erstfeldergneiss Zone, the Guttannen unit (ABRECHT and SCHALTEGGER, 1988) and the muscovite chlorite schists and gneisses in the northern part of the Lötschental. Lenses of calcsilicate felses, garnet amphibolites, banded amphibolites with muscovite-chlorite layers are common (HÜGI et al., 1985).

"Nappe 3" is composed of biotite-plagioclase gneisses of the Stampfhorn-Ofenhorn unit (ABRECHT and SCHALTEGGER, 1988) which contains conspicuous meta-ultramafic lenses and microcline pegmatites. Biotite-sericrite gneisses with intercalations of meta-pelitic schists as well as chlorite schists and gneisses are associated with dioritic amphibolites and amphibolite-rich migmatites (Schollenamphibolite).

"Nappe 4" is essentially composed of the augengneisses, biotite gneisses and sericite schists of the southern Aarmassiv. Within this section of the basement syenitic to monzonitic rocks occur. All these rocks are strongly foliated and show Alpine metamorphic overprint.

Conclusions

During Upper Paleozoic the Aar massif formed as a part of a cordillera at the southern margin of the proto-European continent (MERCOLLI and OBERHÄNSLI, 1988 this volume). In the Aar massif, epiclastic sediments; coarse grained alluvial deposits, lahars, and lacustrine sediments are intercalated with intermediate to acid volcanics. The volcanoclastic sequences were deposited into intramontane basins during the Upper Paleozoic. These molasse type basins were continuously deformed and overthrusted by basement wedges. Their sedimentary infill was draged to depth, folded and subsequently intruded by granitic rocks. The calcalkaline compositions of volcanic as well as plutonic rocks indicate a generation by subduction related processes. This implies convergent plate boundaries and therefore a compressional tectonic regime. The fact that supracrustal rocks occur between diverse basement blocks suggests major thrust faults and nappe structures.

The striking feature of parallelism of Kimmeric and Alpidic structures throughout the Alpine orogenic belt from the Alps to Asia has been discussed by SENGÖR (1985). A similar pattern of parallelism of Caledonian, Variscan and Alpine structures can be found within a small basement complex, the Aar massif.

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