Meeting 28.2. - 1.3.1977 in Salzburg

GEODYNAMICS AND GEOTRAVERSES AROUND THE ALPS

Abstracts

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Aric, K. und Gutdeutsch, R., Wien

Bemerkungen über die Krustenstruktur, erschlossen aus einigen Nachbeben der Friauler Erdbebenserie 1976

Die theoretischen Laufzeitkurven, gewonnen aus bisher publizierten Krustenmodellen der Ostalpen werden mit den Laufzeitkurven einiger Nachbeben von Friaul verglichen. Hierbei werden die Daten des ostalpinen Stationsnetzes, des Straßburger Ortsbebennetzes und der von Geophysikalischen Institut München betreuten Stationen verwendet.

Es stellt sich heraus, daß bis zu Epizentraldistanzen von Δ = 100 km mit Aufschluß bis ca. 15 km die meisten vorgeschlagenen Modelle die experimentellen Laufzeitkurven mit geringen Abweichungen bestätigen.

Die Ankunftszeitzeiten an den Stationen Molln und Mariazell in den nördlichen Kalkalpen und der Stationen am Ostalpenrand lassen sich jedoch nicht mit diesen Modellen in Einklang bringen.

Unter Berücksichtigung der bisherigen Ergebnissen des Alpenlängsprofiles wird eine Verteilung der Wellengeschwindigkeit vorgeschlagen, die die Widersprüche in den Ankunftszeiten beseitigt.

BECHSTÄDT, T.[x], BRANDNER, R.[xx], MOSTLER, H.[xx] & SCHMIDT, K.[x]:

Middle Triassic Paleotectonics of the Eastern and Southern Alps

Synsedimentary tectonic events seem to be responsible for the development of corresponding facies sequences of the Middle Triassic of the Eastern and Southern Alps. Taphrogenesis may have stimulated tectonic activity, the formation of simultaneous reef-basin systems, and the synchronous appearance of volcanism. The Middle Anisian, The Anisian-Ladinian boundary, and the Lower Carnian were periods of accelerated tectonic processes.

The sequences of the Alpine Triassic were deposited on an unstable shelf ("labile shelf"), which can be considered as an early stage of a geosynclinal development. With the end of the Triassic the shelf was finally transformed into a deep-sea-region. The deposits of the Alpine Triassic indicate a changing continental margin between the European platform and an opening ocean. The paleostructures examined follow approximately the E-W direction (rotations not included) and can be considered a post-Hercynian tectonic pattern persisting from Permian to Jurassic.

After the end of the mainly acidic magmatic activity (Bozner Quarzporphyr etc.) a basic alcaline (Na-rich) magmatism begins in the Upper Permian and continues until the base of the Middle Triassic (Reichenhall beds). A maximum of this magmatic activity was reached in the Ladinian. This principally alcali-basaltic volcanism takes place synchronously in the Southern Alps, the Drau Range and the Northern Calcareous Alps. This development of sodium-rich basic magmatites into alcalibasalts coincides with characteristics of rifting. Later, in the Jurassic, strong evidence of rifting is encountered in the north, in the Penninic area, but not in the Austroalpine region.

The general correspondance of facies sequences, synsedimentary tectonic events, and volcanism on both sides of the Periadriatic lineament is an important argument that a) the East- and Southalpine tectonic units were formerly in close vicinity, and b) the Periadriatic lineament had no great importance at that time.

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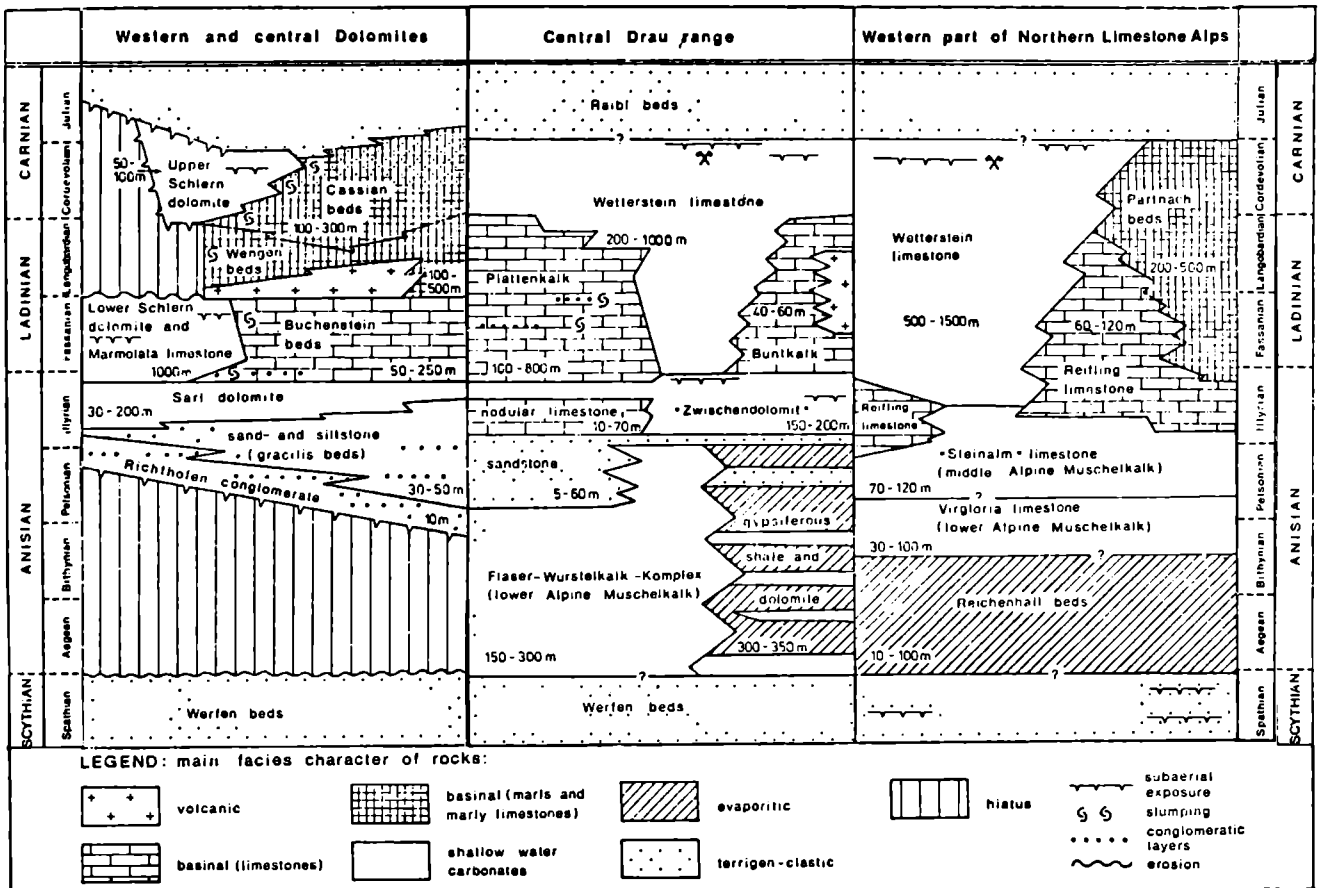
Western and central Dolomites
Central Drau range
Western part of Northern Limestone Alps
CARNIAN
LADINIAN
ANISIAN
SCYTHIAN
Julian
Cordevolian
Longobardian
Fassanian
Illyrian
Pelsonian
Bithynian
Aegean
Spathian
Raibl beds
50-100m
Upper Schlern dolomite
Cassian beds
100-300m
Wengen beds
100-500m
Lower Schlern dolomite and Marmolata limestone
1000m
Buchenstein beds
50-250m
Wetterstein limestone
200-1000m
Plattenkalk
100-800m
40-60m
Buntkalk
Wetterstein limestone
500-1500m
Partnach beds
200-500m
60-120m
Reifling limestone
Sarl dolomite
30-200m
sand- and siltstone (gracilis beds)
Richthofen conglomerate
30-50m
10m
nodular limestone
10-70m
Zwischendolomit
150-200m
Reifling limestone
sandstone
5-60m
Steinalm limestone (middle Alpine Muschelkalk)
70-120m
Virgloria limestone (lower Alpine Muschelkalk)
30-100m
gypsiferous shale and dolomite
Flaser-Wurstelkalk-Komplex (lower Alpine Muschelkalk)
150-300m
300-350m
Reichenhall beds
10-100m
Werfen beds
Werfen beds
LEGEND: main facies character of rocks:
volcanic
basinal (limestones)
basinal (marls and marly limestones)
shallow water carbonates
evaporitic
terrigen-clastic
hiatus
subaerial exposure
slumping
conglomeratic layers
erosion

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On the distribution of the electrical conductivity in the area of the Chiemgau (northern Calcareous Alps) and below the Eastern Alps

In the last years magnetotelluric measurements and geomagnetic depth sounding have been done along a profile Chiemsee - Hohe Tauern/Zillertaler Alpen - Drautal. In autumn 1976 further geomagnetic depth sounding has been done along an EW-profile Zell am See - Ennstal - Leoben - frontier Austria/Hungary (south of Sopron). From these registrations the distribution of rocks of different electrical conductivity in the uppermost 100 km may be deduced.

The results of magnetotellurics along the first profile across the morphological boundary of the Alps (Chiemsee - Tal der Tiroler Ache - Reit im Winkl) have been confirmed by new results from a profile, which is situated about 10 km further to the east: In the area of the Chiemgau the Calcareous Alps are underlain by well conducting sediments until about 10 km south of the morphological border of the Alps. The well conducting sediments below the Calcareous Alps are thicker (ca. 5 km) than the Calcareous Alps themselves (ca. 1 - 2 km). The thickness of the well conducting sediments (more exact: the integrated electrical conductivity) decreases within a short distance at the supposed southern border of the molasse basin. As confirmed by new borehole logging the tertiary and the mesocoic sediments in the molasse basin are well conducting.

In a special field program the strong distortion of the induced electric field in the Calcareous Alps has been investigated. This distortion is caused by the inhomogeneity of the electrical conductivity near the earth surface. The effect of field distortion has been eliminated as far as possible in the measurements along the profiles.

The amplitude of the geomagnetic variations is rather constant in the Eastern Alps. The vertical component Z of the variations is small in a wide period range. The amplitude of the horizontal components is somewhat increased in the area of the Hohe Tauern. Below the Eastern Alps no distinct anomaly of the electrical conductivity exists.

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Titl:
Pieniny Klippen Belt arc and major subduction zone in the West Carpathians

1. Deep seismic soundings indicate that the Moho discontinuity drops down close to the Pieniny Klippen Belt arc by about 15 km (down to about 50 km). This corresponds to a major break between the Inner and Outer Carpathians and has been interpreted by some authors as trace of a major subduction zone.

2. The peri-Pieniny subduction zone was located north of the Czorsztyn geanticlinal ridge which had formed a positive feature of the sea bottom along the northern rim of the Pieniny Klippen Belt basin for most of its Jurassic and Cretaceous history.

3. There is evidence of positive movements and tension within the Czorsztyn Ridge: (a) close to the boundary of Triassic and Jurassic, (b) at the boundary of Middle and Upper Jurassic, (c) close to the boundary of Jurassic and Cretaceous.

4. There is depositional and structural evidence for subduction in the zone adjoining the Czorsztyn Ridge from the north during the following stages: (a) Upper Toarcian (?) to Lower Aalenian, (b) Upper Senonian to Lower Palaeogene, (c) Early to Middle Miocene.

5. Vertical movements along the northern boundary of the Pieniny Klippen Belt arc, which affected the Late Miocene, Pliocene and Pleistocene sedimentation, are considered after-effects of earlier subduction.

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Geochronological investigations in the "Altkristallin" of Eastern Tyrol

In the area of Lake Wangenitz (12°43'E; 47°56'N) Rb-Sr isotopic age determinations from orthogneisses and paragneisses were carried out. Moreover, the Rb- and Sr-isotopes of two amphibolite samples and one eclogite sample were measured.

The obtained data give an isochrone for orthogneisses as well as for paragneisses indicating an age of 440 ± 13 (2σ) m.y. (Ordovician/Silurian). This is interpreted as an age of homogenization caused a "caledonian" metamorphism. The strontium initial isotope ratio is 0.7102 ± 0.0008 (2σ).

Two mineral isochrons (apatite-potassium feldspar - biotite and apatite - potassium feldspar - muscovite, respectively) yield an age of 79 ± 4 m.y. for biotite and of 79 ± 5 m.y. for muscovite in the area of Lake Wangenitz. Further muscovite ages from the Schobergruppe have also values of about 80 m.y.. These ages are considered to be cooling ages of a Cretaceous metamorphism.

Close to the margin of "Altkristallin" along to the zone of Kals - Matrei a muscovite age of ca. 44 m.y. was measured and is interpreted as a mixed age.

Paleogeography of the Permian in the Southern Alps

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FRIEDRICH LEITZ und GERD-FRIEDRICH TIETZ (Erlangen)

Sedimentological , paleontological and geochemical studies of the Permian sediments in South Tyrol , in the Carnic Alps and in the Karawanken (BUGGISCH 1976 , BUGGISCH et al. 1976 , E. FLÜGEL 1975 1977) indicate the following paleogeographical evolution

The basement of the Permian rocks are Variscean quartzphyllites in the Dolomites In the area between the western Carnic Alps and Slovenia Upper Carboniferous Auernig beds are exposed These cyclic deposits are overlained by the Lower Permian Rattendorf formation

In the western area (Dolomites) locally continental coarse-grained clastics (Waidbruck conglomerate resp. Verrucano alpino) are sedimented during the transition from the Carboniferous to the Permian Thick volcanic rocks (Bozener Quarzporphyr) are formed during the Lower Permian in South Tyrol

The Lower Permian Rattendorf and Trogkofel formations of the Carnic Alps and the Karawanken are characterized by a shelf- and shelf-edge sedimentation During the Rattendorf stage (Asselian) three lithological units can be recognized

The Lower Pseudoschwagerina limestones were deposited cyclically in a near-coast inner-shelf area by alternating transgressive and regressive phases

The erosion of metamorphic and acid volcanic rocks and the increasing sedimentation of clastics in a near-coast high-energy environment with intertidal to subtidal conditions is responsible for the genesis of the sandstones and silty shales of the Grenzland group For the upper part of this group an additional source area with acid plutonites is indicated by heavy mineral analysis (TIETZ 1975)

The Upper Pseudoschwagerina limestones show a regular recapitulation of microfacies sequences , which together with the medium to high biotic diversity give evidence to a repeated shifting of ecological zones from very shallow water areas to off-shore environments in an open-marine shelf lagoon with normal water circulation

This outer-shelf platform facies continues during the Trogkofel stage in the western parts of the Carnic Alps and in the western Karawanken In contrast ti these well-bedded Trogkofel limestones organic buildups with encrusting algea (Tubiphytes MASLOV) and with fenestellid bryozones , brachiopods and crinoids are developed in the Sexten Dolomites in the Carnic Alps (Trogkofel Tarvis) and in the Karawanken

Besides the Trogkofel area all the Tubiphytes limestones are known only from resedimentated Trogkofel components within the Tarvis beccia A shelf-edge position of some of these Trogkofel reefs is probable

The mobile inner-shelf developed in the Carnic Alps and in Slovenia and Croatia is characterized by the"Clastic Trogkofel formation" consisting of up to 2ooo m quartz-sandstones , conglomerates , and some limestones Lithoclastic limestones give hints to a long-lasting period of synsedimentary re-sedimentation (KOCHANSKY-DEVIDE et al. 1973)..

A widespread regression at the end of the Lower Permian is manifested by breccias and conglomerates (Tarvis breccia , Gröden conglomerate) These sediments have been formed in areas of intensive intra-Permian block-faults A tectonic uplift of some sedimentary regions seems to be responsible for an uniform submarine and subaerial destruction of the Trogkofel limestones in high-energy environments

The red bed facies of the Gröden formation (Middle Permian) known from South Tyrol to the Karawanken is superimposed discordantly to different Lower Permian or Variscean rocks

Within the sedimentation area of the Gröden formation two facies units have been observed

(A) Coarse-grained and ill-sorted conglomerates and sandstones consisting predominately of reworked material from basement Typical for this facies are authigene kaolinite formed by intensive in-situ weathering of feldspars and lack or low content of calcite (no dolomite)

(B) Fine-grained , medium- to well-sorted , interbedded silt- and sandstones , overlying the facies unit A in the area between the Karawanken and the river Etsch in South Tyrol Characteristics of this facies are the high feldspar contents (2o-3o %) high carbonate content (predominately dolomite) and the occurence of

chlorite together with the lack of kaolinite

The transition between these two facies is characterized by gyps , coals , enrichment of Pb and by typical clay minerals (montmorillonite , mixed-layers) . Representative sections are situated in the Gröden valley and in the Bletterbach gorge near Radein

A particular Middle Permian facies is exposed in the area of Bled , Julian Alps , consisting of high-energy reef-limestones (RAMOVS 1955)

The attributes of facies A correspond with a deposition in continental environments ; fresh-water algae (Kreuzberg pass Sexten Dolomites) support this interpretation

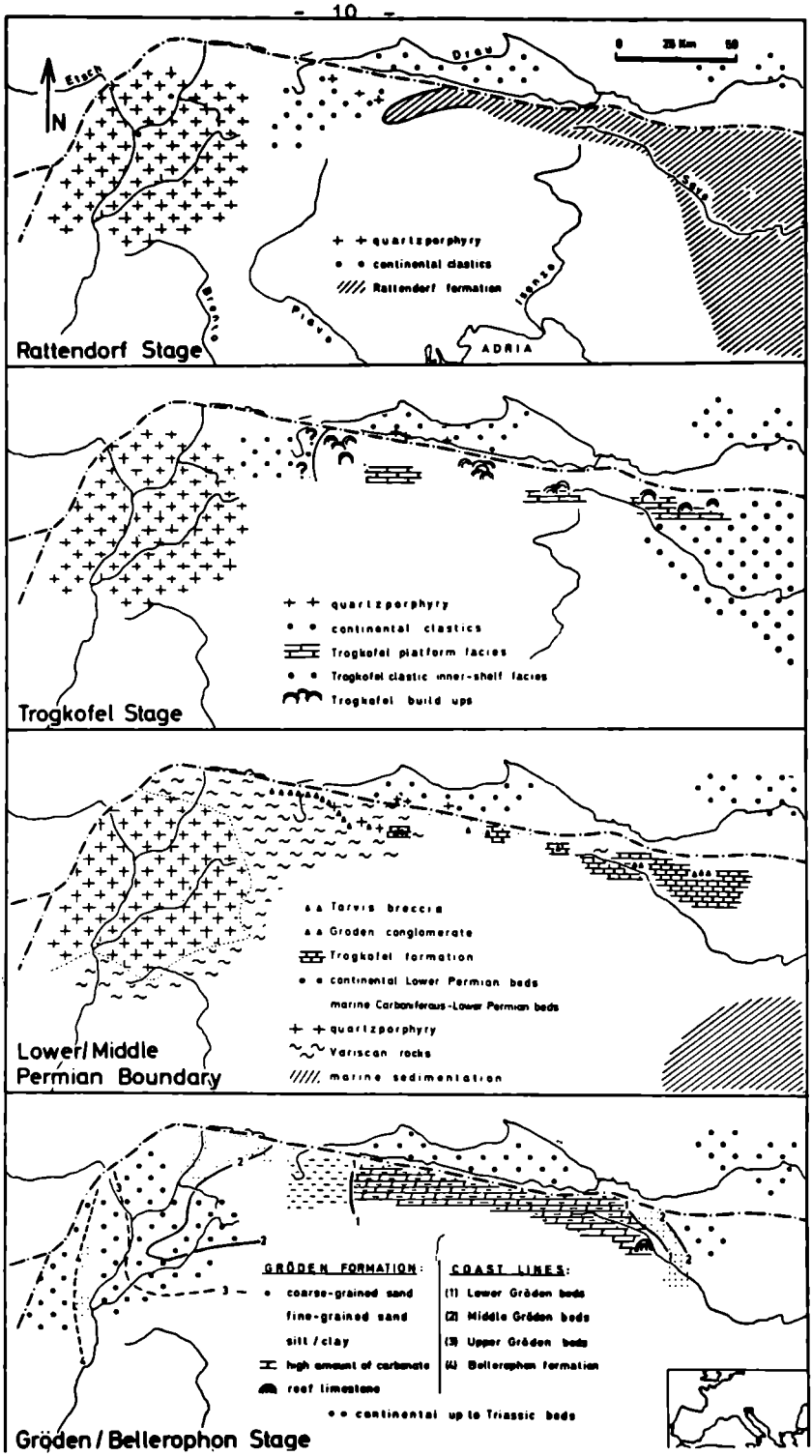
The transition facies shows characteristics of a coastal region with marginal lagoons . Paleontological data (tetrapod traces drifted cephalopods and foraminifera) are in accordance with this model

Facies Type B is deposited in marine environment (supply of Mg for dolomitization and formation of the chlorits ; enrichment of Mn ; scarce foraminifera , ostracods and gastropods)

In summary the paleogeographical development during the Middle Permian is as follows ;

Continental sedimentation at the basis
marine transgression in the western Carnic Alps and in the western Karawanken during the lower Gröden stage ;
progressive transgression during the middle Gröden stage to the west , with a coast line near the Gröden valley and the Bletterbach gorge and
a coastline near the river Etsch at the end of the Middle Permian

The increasing transgression during the Upper Permian resulted in the deposition of bituminous sediments and basal evaporites of the Bellerophon formation . In the southwestern near-coast area evaporites are dominating (facies fiammaza , ACCORDI 1958 , sabkha environment) whereas in northeastern South Tyrol gypsum with open marine carbonates prevails (facies badiotica) . The Bellerophon formation of the Carnic Alps indicates connections between the marine Zazar formation in the Save Folds area and with the limestones and dolomites of the Velebit Mountains


N
Etsch
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Save
Brenta
Piave
Isonzo
ADRIA
quartzporphyry
continental clastics
Rattendorf formation
Rattendorf Stage
quartzporphyry
continental clastics
Trogkofel platform facies
Trogkofel clastic inner-shelf facies
Trogkofel build ups
Trogkofel Stage
Tarvis breccia
Groden conglomerate
Trogkofel formation
continental Lower Permian beds
marine Carboniferous-Lower Permian beds
quartzporphyry
Variscan rocks
marine sedimentation
Lower/Middle
Permian Boundary
GRÖDEN FORMATION:
coarse-grained sand
fine-grained sand
silt / clay
high amount of carbonate
reef limestone
COAST LINES:
(1) Lower Grödon beds
(2) Middle Grödon beds
(3) Upper Grödon beds
(4) Bellerophon formation
continental up to Triassic beds
Gröden / Bellerophon Stage

J. DEBELMAS - Université de Grenoble - France

- Tectonic evolution of the French western Alps new data and consequences.

On the same plan as in the preceeding meetings, the communication is supported by the description of the evolution of two transverse sections accross the French Italian Western Alps.

The following are emphasized and discussed

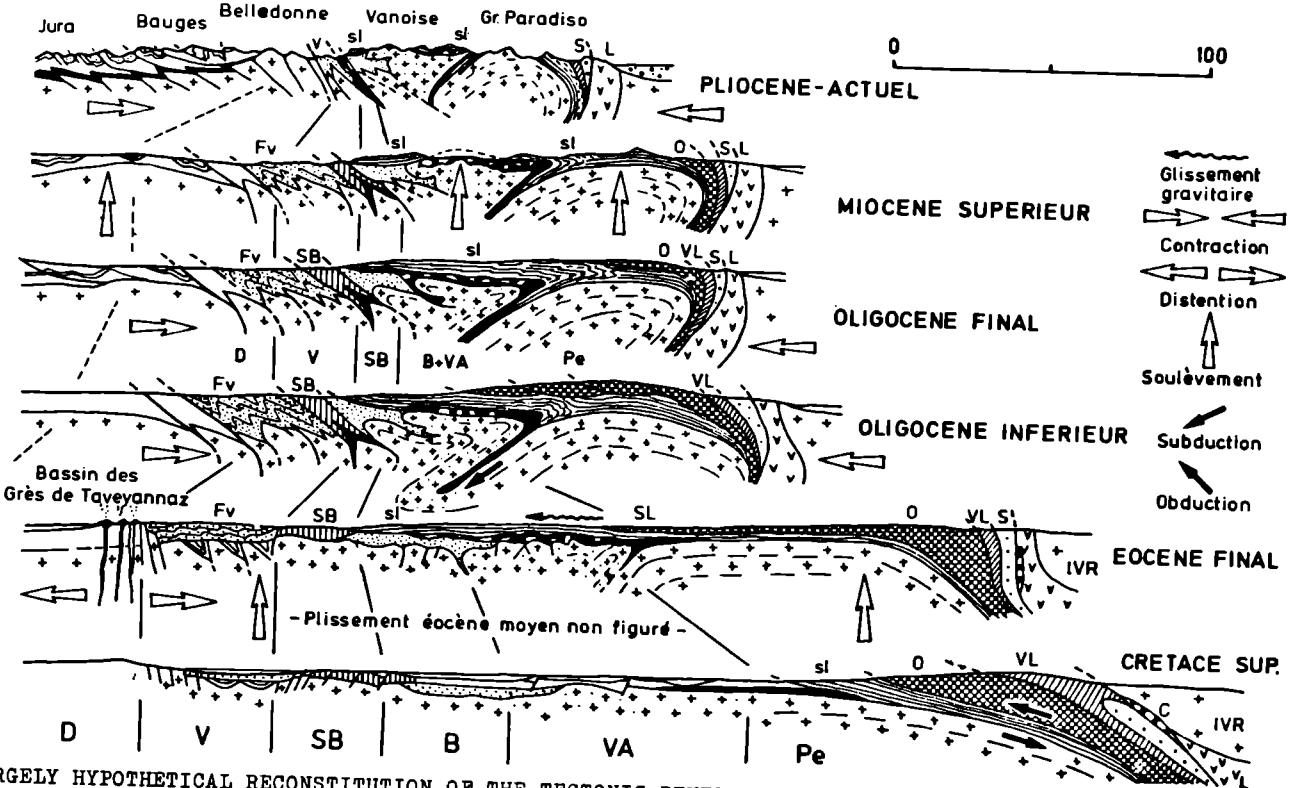
1 - Upper Jurassic and Lower Cretaceous paleogeographic pattern European continental margin (Briançonnais and external Piemontais zone) and Internal Piemontais ceanic domain.

2 - At the end of the Upper Cretaceous, disappearance of the oceanic basement of the Internal Piemontais zone, either by subduction, or by obduction of the subalpine margin (which implies a prior intraoceanic subduction). First phase of high-pressure metamorphism.

3 - At the Eocene-Oligocene boundary, flip of the suduction plane which is now located on the inner side of the Briançonnais zone, and controls synthetic and antithetic folding of the Briançonnais cover. First retrocharriage and second phase of high-pressure metamorphism.

4 - During the Neogène, last contraction phases, vertical motions and second retrocharriage.

Other problems are discussed, especially the origin of the andesitic material of the Upper Eocene sandstones of the external zones, the origine of the Helminthoïdic flysch nappes, etc.



LARGELY HYPOTHETICAL RECONSTITUTION OF THE TECTONIC DEVELOPMENT OF THE ALPINE FOLDING ON THE TRANSVERSE JURA - LANZO (FRENCH-ITALIAN WESTERN ALPS)

D Dauphinois zone; V Valais zone; Fv Valais flysch; SB Subbriançonnais zone; B Briançonnais zone; VA Vanoise-Ambin zone;(Inner Briançonnais); Pe Piemont zone; sl "Schistes lustrés"; O Ophiolites; VL Viù-Locana slices; S Sesia zone; C Canavese zone; L Lanzo massif; IVR Ivrea zone

J. Debelmas

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Hypabyssical rocks from the western Goldeck group

In the course of field work in the western part of the "Goldeck Gruppe" basic hypabyssical rocks have been newly found at five localities; large boulders at two other places point to further occurrences. Until now similar rocks have been reported from Drauhofen (at the mouth of the Möll river: ANGEL & KRAJICEK 1939) and from the outer Nigglaigraben (eastern Kreuzeck group; ANGEL 1930); today these outcrops are not longer exposed.

It is considered to be of importance that one of the dikes unconformably cuts the epimetamorphic sericite-chlorite-phyllites of Lower Paleozoic age (southern slope of "Siflitzgraben", 1 km E Schwandlhtt., ÖK 1 50.000, sheet 182) but itself displays no features of cleavage. From a comparable rock in the "Kreueck-Gruppe" (ridge between Salzkofel and Kreuzeck, ÖK 1 50.000, sheet 181) a radiometric K/Ar-biotite-age of 35$\pm$ 2 my (HAWKESWORTH 1974) is published. Thus it is determined that the deformation of the Goldeck group has been finished mainly not later than Oligocene.

All the other localities are situated along the road from Sachsenburg via Bärnbad to the End of the Siflitzklamm. Here the lamprophyres cut across the structures of the underlying garnet-mica-schists which are, at least, for a good part of Lower Paleozoic age. This age determination of the country rock is confirmed by stem plates of crinoids found in light coulored, banded calcareous marbles of the "Altkristallin", and by lithostratigraphical comparisons (intercalations of graphitic calcareous marbles).

ANGEL & KRAJICEK 1939 consider these lamprophyres which occur frequently in the Kreuzeck- and -Schober groups and with the Rieserferner tonalite to be related with the dike swarms of this tonalite.

Petrologically these greyish green massiv rocks range from "spessartites" to "malchites". More than 50 vol% of the mode consists of hornblende-phenocrysts accompanied by biotite; feldspars (plagioclase, very seldom orthoclase), quartz,

apatite and opaque minerals form a fine-grained groundmass. To the margins of the 1-4m thick dikes, the size of the phenocrysts (here mainly biotite increases considerably. ANGEL & KRAJICEK 1939 gave to these rocks the local name "Lurnfeldit". Two chemical analysis have been performed until now; the following data have been obtained:

	HACKL & FABICH 1952	DEUTSCH 1976
SiO_2	46.12	44.89
TiO_2	2.16	2.41
Al_2O_3	13.96	17.24
Fe_2O_3	2.95	
FeO	6.26	10.07
MnO	0.15	0.11
CaO	8.60	7.92
MgO	9.31	8.06
K_2O	3.04	1.53
Na_2O	2.82	2.87
H_2O	2.52	3.19
P_2O_5	0.56	0.33

An exact petrographical treatment, more chemical analyses, and investigations of single phases by the means of microprobe (Dr.F.KOLLER, Univ.Wien) are in progress. Results are to be displayed in February 1977.

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Titel

Temperatures of fissure mineralization in the western Hohe Tauern area.

Fissure mineralization took place in the western Hohe Tauern area (Tyrol, Austria) during a phase of tensional tectonism caused by the uplift of the penninic rocks, following the main period of tectonic activity associated with alpine metamorphism

Oxygen isotope fractionations between coexisting minerals (e. g. quartz and biotite) in the fissures did no differ from fractionations determined between the same minerals in surrounding rocks. The fissure minerals must therefore have formed at similar temperatures as the minerals which recrystallized during the last phase of alpine metamorphism. The temperature maximum and the tectonic activity were not contemporaneous, however as the main phase of tectonic acitivity occured before temperature climax of metamorphism. There is no isotopic evidence to indicate that fissure mineralization occured during a late, hydrothermal event.

During the cooling of the Hohe Tauern area ankeritic dolomite exolved from high magnesium calcite. An estimated temperature of 425 to 570 ^{o}C for this exolution was derived by Hörmann and Morteani (1972) from the iron and magnesium partitioning among the carbonates. Oxygen isotope measurements indicate that no measurable reequilibration of the anionic framework occurred during the rearrangement of cations.

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On the Alpidic structures in the Venediger nappe system of the western Tauern Window

The Alpidic structures of the Venediger nappe system in the western Tauern Window are controlled by the different plasticity of the Hercynian basement; the gneiss cores (Zentralgneis) act as relatively rigid blocks, and the synclines of Hercynian metavolcanic and metasedimentary series are zones of strong compression. The Mesozoic, and parts of the Paleozoic cover are squeezed out and thrusted some distance over the bordering gneiss cores to the north (see "Geologischer Tiefbau der Ostalpen", 3. Bericht).

In recent studies, emphasis has been placed on the sedimentary cover of the Venediger nappe system south, east, and north of the Venediger massif. If the quartzites and calcareous quartzites within the Paleozoic rock sequences in the area between the Venediger and the Granatspitz gneiss cores were of Mesozoic age as suggested by CORNELIUS (1941) and FUCHS (1958), this would have important bearing on the structure of the cover of the gneiss cores in Alpidic time. The same is valid for the black (graphitic) schists in the upper part of the Maurer Tal if they were of Mesozoic age.

The results are that neither the black schists nor the quartzites can be considered to be of Mesozoic age because all these rocks are intimately related to the encountering Paleozoic rock sequences.

The black schists of the Maurer Tal and the bordering metablastic gneisses show mutual inclusion of screens and, in places, transitional borders. The schists are considered to be the equivalent to the Habach phyllites but display a higher degree of metamorphism.

The quartzites and calcareous quartzites mentioned above are related to the bordering Paleozoic sequences by alternating layering of the different rock types. Bands of schists intercalated within the quartzites display the same metamorphic history as do the surrounding rocks. This is true for the occurrences both within the "injected schists" (FUCHS, 1958) of the Riffl Decken (connected with the Venediger gneiss core), and within the cover of the Granatspitz gneiss core.

From this it can be deduced that the partly calcareous quartzites in the area between the Venediger and the Granatspitz gneiss cores are part of the Paleozoic sequence of metavolcanics and metasediments and do not mark a thrust fault in Alpidic time. In this light it seems doubtful whether there is forcing evidence for the Alpidic age of the thrusting of the Riffl Decken over the Granatspitz gneiss c re and its Hercynian cover. Intercalations of Bündner Schiefer east of the Granatspitz gneiss core are not controlled by the fault plane and can be interpreted as slices between digitations of the entire Hercynian system.

H.-J. Götze und O. Rosenbach, Clausthal

Gravimetric measurements on three N-S profiles through the East Alps - observational results and preliminary modelling

1. Introduction

We describe gravity and vertical gradient measurements on two north-south profiles through the alpine foreland und the east Alps, together with preliminary interpretive model calculations.

The lines of the profiles are

Profile I: Landshut - Wasserburg- Reit i.Winkl - Kitzbühel - Mittersill - Lienz - Plöckenpaß

Profile II: Altötting - Zell a.See - Großglockner - Lienz

Profile III: Freistadt - Linz - Steyer - Liezen - Judenburg - Klagenfurt

2. Field Measurements

On three profiles the measurements are spaced

at about 3 km in the alpine foreland
at about 2.5 km in the alpine margins
at 1.5 - 2.0 km in the central Alps

Our field results are presented as

Bouguer anomaly profiles
profiles of modified Bouguer anomalies

The techniques are as described by Ehrismann et al. in (1973) for gravity measurements in mountaineous terrain. Terrain correctings for the innermost zone were made by the method developed by Schöler (1976). Götze et al. (1976) describe the procedure for measuring the vertical gradient, with special emphasis on the reproductivity of readings.

Remarks

(1) The terrain correction for the most distant zones is made by the method of Ehrismann et al. (1966, 1971).

(2) The accuracy of the gravity anomalies is about ± 0.5 mgal. This error is larger than in flat lands owing to the difficulties of levelling and of estimating the terrain corrections in rough terrain. The standard density of 2.67/gr/cm^3 is used in the Bouguer slab and terrain corrections.

3. Model calculations

Model calculations in connection with the results of earlier field measurements are in progress. Three of these models appropriate for the profiles I, II, III are shown in slides. The structures of these two-dimensional models are based on the following publications:

in geophysics: Closs (1957), Harcke (1972), Angenheister et al. (1972)

in geology: Geologische Karte von Österreich nach Exner (1964), Tollmann (1963)

The gravity profiles computed using the method of Talwani (1959), and the densities shown in the models are given too. They are in good agreement with the modified Bouguer anomaly profiles.

In contrast with earlier work the models contain much detail in the crustal structure down to 10 km. - Further conclusions will be possible when the model calculations, now in progress for the adjacent areas, have been completed. This is especially true for the deeper structure between 10 and 50 km.

This preliminary report is part of the larger scale gravimetrical investigations of the Alps. This work is supported financially by the German Research Society (Deutsche Forschungsgemeinschaft) to whom the authors are greatly indebted.

Equilibrium and nonequilibrium relationships of oxygen isotopes in rocks from the Swiss Central Alps

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Previous oxygen isotope investigations in the Eastern Alps have yielded a relatively clear picture concerning isotopic equilibria during regional metamorphism.
Oxygen isotope equilibrium was reached and retained among coexisting mineral phases in these rocks near the temperature maximum of metamorphism. Retrograde processes, such as the chloritisation of biotites, did not affect the oxygen isotope equilibria between prograde minerals. Reequilibration of the oxygen isotopes in a previously metamorphosed rock are clearly associated with recrystallisation of the minerals.

Samples of ortho- and paragneisses were collected along a north - south profile from Disentis to the Insubric line, and also along an east - west profile from Bergell to the Simplon area.
Oxygen isotope data were collected of about 150 minerals. The oxygen isotope ratios were measured in at least two coexisting phases of each of the samples.
Oxygen isotope equilibrium was attained in rocks from peripheral areas of the Swiss Central Alps. Quartz - biotite and quartz - muscovite and also quartz - magnetite (ilmenite) isotope fractionations yield temperatures (e.g. 450 ^{o}C - 550 ^{o}C), which are in good agreement with well accepted temperatures for the mineral zones of this area.
In the central part of the studied area, on the other hand, non-equilibrium conditions are preserved in many samples. For example, quartz - biotite fractionations yield a tempetrature of only 550 - 500 ^{o}C, or about 50 - 100 ^{o}C below the metamorphic temperatures expected for the Swiss Cental Alps. Quartz - magnetite fractionations in the same samples, on the other hand, yielded quite reasonable temperatures, ranging from 560 ^{o}C in the Simplon area to 700 ^{o}C near the Bergell granite.

These isotopic relationships suggest that mica crystallised at temperatures near 500 to 550 ^{o}C during early stages of Alpine metamorphism and did not exchange their oxygen isotopes during later, higher grade stages. The quartz-magnetite fractionations would then reflect the temperature conditions of the later stages of Alpine metamorphism.

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Titel: UNTERSUCHUNGEN ZUR MINERALCHEMIE UND METAMORPHOSE IM SW-ENDE DES SCHNEEBERGERZUGES, ÖTZTALER ALPEN, TIROL

Marmore des Pfossentales, die in die voralpine Schlingentektonik miteinbezogen sind, enthalten cm- bis dm-mächtige, tonige und mergelige Zwischenlagen die nach einer mehrphasigen, metamorphen Überprägung als Granatglimmerschiefer, Hornblendeschiefer und Granathornblendefelse vorliegen. Die Mineralphasen solcher Zwischenlagen eines Profiles wurden mit der Elektronenstrahlmikrosonde untersucht.
Charakteristische Minerale sind Granat, Hornblende, Biotit, Muskovit, Paragonit, Margarit, Chlorit, Plagioklas und Karbonat. Die koexistierenden Mineralphasen zeigen mikroskopisch Reaktionsbeziehungen und Zerfallerscheinungen und sind chemisch auffallend variabel zusammengesetzt. Der Zonarbau der Granaten gliedert diese in eine ältere und eine jüngere Generation. Die jüngeren bilden idiomorphe Anwachssäume um die älteren, xenomorphen Körner oder kommen als idiomorphe Einzelkristalle vor. Sie sind in der Mitte reicher an CaO und FeO und ärmer an MgO und MnO. Die älteren dagegen sind in der Mitte reicher an CaO und MnO und ärmer an MgO und FeO. Das Verhältnis Mg/Fe der beiden Granatgenerationen ist etwa gleich groß und nimmt von der Mitte zum Rand hin zu.

In den karbonatfreien Granatglimmerschieferlagen des untersuchten Profils koexistiert Paragonit mit Quarz ohne Zerfallsanzeichen zu einer Al_2SiO_5-Modifikation. Die Maximaltemperaturen der metamorphen Überprägung kann daher 550 - 580°C (Chatterjee, 1972) nicht überschritten haben, wenn man als Maximalüberlagerung des Schneebergerzuges 15 km (3-4 kb) annimmt.
In den karbonatführenden Hornblendegesteinen kommt die Paragenese Muskovit + Calcit + Quarz vor. Diese kann bei P_t = 3 - 4 kb und einem X_{CO_2} von 0.5 maximal bis 510 - 530°C existieren (Hewitt, 1972). Bei Änderung des X_{CO_2} und Beteiligung von Na_2O in den beteiligten Mineralphasen kann sich diese Maximaltemperatur nur noch verringern. Aus diesen und weiteren Beobachtungen lassen sich folgende petrogenetisch bedeutende Schlüsse für das SW-Ende des Schneebergerzuges ableiten:

1.) Die Metamorphose war mindestens zweiphasig (Granatprofile)
2.) Die letzte Metamorphose ist nicht vollständig abgelaufen (Ungleichgewicht koexistierender Phasen)
3.) Die Temperaturen der beiden Metamophosen waren etwa gleich hoch (Mg/Fe in Granat) und nicht über 500°C (3-4 kb vorausgesetzt) (Paragenese Ms + Cc + Qu)

Für die Entwicklungsgeschichte des Schneebergerzuges wird daher folgende Möglichkeit zur Diskussion gestellt:
Die ältere Phase wird der variszischen Metamorphose zugeordnet (Beeinflußung des W-Endes des Schneebergerzuges durch die voralpine Schlingentektonik).
Die jüngere Phase hat ein frühalpines Alter mit einem Temperaturhöhepunkt von ~ 500° (3-4 kb) vor ca. 110 - 90 Millionen Jahren (Satir, 1975). In benachbarten Marmoren wurde von Hoinkes und Purtscheller (1975) eine Mindesttemperatur der alpinen Metamorphose von~480°C ermittelt und eine Maximaltemperatur von ~ 580°C.
Die in dieser Arbeit bestimmten Temperaturen fallen in diesen Rahmen und präzisieren die Temperaturbedingungen der frühalpinen Metamorphose auf 500 ± 30°C (3-4 kb).

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Titel

Fluid inclusion study on quartz from fissures in the penninic rocks of the western "Tauern Fenster", the Austrian Alps.

From geochemical data Hörmann and Morteani (1972) and Lausch, Möller and Morteani (1974) deduced that there is a close relationship between the metamorphic grade of the country rock and the crystallisation temperatures of the carbonates in the alpine fissures of the penninic rocks of the western "Tauern Fenster" (Tyrol, Austria).

From oxygen isotope data on biotite, quartz and carbonates Friedrichsen and Morteani (unpubl.) deduced that these minerals crystallizes in the fissures at the same temperature as the surrounding rocks during a phase of tensional tectonics following the main period of alpine tectonic activity.

A fluid inclusion study by microthermometric method on quartz from fissures gives therefor an information on the composition of the fluid phase during the temperature maximum of the alpine metamorphism. It is obvious that only primary inclusions should be examined.
In the studied quartz crystals there are many fluid inclusions of apparently secondary origin, but it can be shown that these inclusions are real primary inclusions formed in syncrystalline ruptures.

Depending upon the composition of the fluid inclusions the whole western "Tauern Fenster" could be subdivided into two areas:
a) An area corresponding to the Zillertaler and Tuxer Alps in which the inclusions are characterized by high CO_2-contents (ranging from 10 to 80 vol. %).

The inclusions formed early showed high CO_2-contents. However this was found to decrease gradually in the inclusions formed later the youngest inclusions were found to be nearly free of CO_2. As for the salt content in these inclusions, those with very high CO_2-content (50 vol. %) were generally found to contain about 6 % by weight of the total salts. Furthermore the salt contents increased very steeply thereafter as the CO_2 started decreasing. The maximum salt content was found to be about 18 wt. % corresponding to 15 - 30 vol. % CO_2. The younger inclusions were low in their salt contents, and exhibited almost the same trend as the CO_2. The time of formation of the inclusions can be qualitativly established by the density of the CO_2 phase; earliest inclusions are characterized by high density CO_2 inclusions, whereas late inclusions have a low density CO_2 phase.

b) In the area of the Grossvenediger and in the south of it generally no CO_2 content could be detected in the fluid inclusions by microthermometric methods. The salt content of the aqueous phase was about 5 to 7 % by weight. The only CO_2-rich fluid inclusions are found in the quartz veins within the eclogites collected from the area south of the Grossvenediger.

From the temperature of homogenisation (determined by microthermometry in the present study) and the temperature of metamorphism (determined by oxygen isotope geothermometry by Hoernes and Friedrichsen (1974)) the pressure during the mineralization in the fissures of the Grossvenediger area was about 3 kb. As compared to the pressure estimated from the solid phases in the surrounding rocks the pressure deduced from fluid inclusions is lower by about 1 - 3 kb.
In the area of the Tuxer and Zillertaler Alps the pressure as deduced from the fluid inclusions is about 6 kb. This value is in good agreement with that deduced from the mineral parageneses in the surrounding rocks.

Paleomagnetic Results from the Paleozoic Area near Graz.

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In the paleozoic area W of the Mur river, 46 sites were sampled. The idea was, to try, if it is possible to find with paleomagnetic methods new indications, wether the paleozoic material is autochtonous-paraautochtonous or allochtonous. The area is tectonical very strong influenced and the stratigraphic control is in some sampling areas not sure, so that the auspicious for getting good results, have not been to hopeful. The materials, which were sampled, were dolomitic sandstones and limestones from Devonian age. On a number of pilotsamples rockmagnetic studies were undertaken, to find the carrier of the remanence, the stability of the intensity and of the direction of the remance-vector. These studies showed the mainly multidomain magnetite as the carrier of the remance.

The results of the paleomagnetic investigation show a grouping in the form of a bend with a mean direction of Dec. 55^{o}; Inc. 43^{o}; (k = 16,5; COFC 19,3).

This bend structure is very interesting, because there are two possibilities of explanation: firstly there are some not cleaned remagnetisation effects and secoundly tectonic reasons. Partial demagnetisation on a number of pilotsamples were carried out to find an answer to the first possibility and one can be sure that these structures can not be a remagnetisation effect.

A comparison with the tectonic structure (B-axis-measurements H. Flügel 1954) shows a good agreement of the B-axis orientation and the pole, which was found by a large circle reconstruction of the paleomagnetic bending structure. The reason for that could be the uplift of the Gleinalmmassiv after the implacement of the material. The overall mean of the area shows, that the paleozoic material which was investigated was rotated over at least 15o to $16o^{o}$ clockwise.

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Titel: ÜBER DIE POLYPHASE ALPINMETAMORPHE ENTWICKLUNG DER EKLOGITE IM PENNINIKUM DES TAUERNFENSTERS, ÖSTERREICH

Das Tauernfenster ist eines der Gebiete in den Ostalpen, in denen Gesteine des Penninikums neben altkristallinem Basement und dessen Schieferhüllen aufgeschlossen sind. Das Vorkommen von Eklogiten und Glaukophanschiefern in diesem Bereich ist auf eine schmale, ca. 35 km lange, EW-streichende und intensiv verformte Zone im S der Zentralgneiskerne und ihrer Hüllen beschränkt. Sie sind als Lagen und Linsen mit Gesteinen verknüpft, welche den tektonischen Einheiten der Seidlwinkldecke (Frank, 1969) und der Glocknerdecke (Frisch, 1976) angehören. Frank (1976) konnte in dieser Zone vereinzelt Relikte einer Gefügeprägung nachweisen, die älter als jene ist, welche mit der Kristallisation am thermischen Höhepunkt der Tauernmetamorphose im Tertiär interferierte und dabei auch die Hochdruckparagenesen in besonders intensiv beanspruchten Bereichen völlig zerstörte.
Die Eklogite lassen sich auf Grund von chemischen und Gefügemerkmalen als Metaophiolite deuten, welche einer Hochdruckmetamorphose unterworfen waren und anschließend zumindest teilweise weiter metamorph überprägt wurden. Die große Anzahl der Phasen, der Zonarbau vieler Minerale, Verdrängungsgefüge und die kristallchemische Entwicklung der Mineralarten, die in zwei oder mehr Generationen auftreten, ermöglichen eine schematische Rekonstruktion des Metamorphoseverlaufes mit folgenden sechs Phasen:

1.) Die erste Phase läßt sich durch folgende Einschlüsse in den Granatkernen vieler Eklogite belegen: Ep + Fe-Barroisit + Chl + Pg $\pm$ Phengit + Qz $\pm$ Ab + Ilm $\pm$ Mt $\pm$ Pyrit.
2.) Das zweite Stadium ist am besten in den grobkörnigen, als Metagabbros gedeuteten Eklogiten dokumentiert, deren Omphacite I eine mittlere Zusammensetzung von $Jd_{34}Ac_{12}Ts_3$ haben. Der Rand der zonaren Ga enthält $Py_{33}Gross_{20}Spess_{0.5}$. Weitere Phasen sind Ky, Tc, Qz, Rt, Pyrit.
3.) Eine spätere intensive Druckbewegung führte zur Bildung kataklastischer Eklogite mit Omphacit II ($Jd_{47}Ac_4Ts_{1.5}$), Granat (Rand: $Py_{38}Gross_{18}Spess_{0.7}$), Ky Tc, Qz, Rt, Pyrit.

4.) Feinkörniger Glaukophan oder Crossit verdrängt Omphacit II. Ky wird von Paragonit ersetzt und findet sich so als Einschluß in großen, zonaren Glc/Barr-Hornblendeblasten.

5.) Barroisitische und andere subcalzische Hornblenden werden zu Hauptgemengteilen. Ky fehlt, Ga, Rt und Omphacit sind instabil.

6.) Prasinitstadium

Eine Abschätzung der Bildungsbedingungen für das Stadium 3 ergibt durch Vergleich mit experimentellen Daten (bes. Kushiro, 1969; Råheim & Green, 1974) Temperaturen von 500 - 550°C bei einem Überlagerungsdruck von mindestens 10 kb ($P_{H_2O} < P$ total) und damit einen sehr niedrigen geothermischen Gradienten, wie er für Subduktionszonen charakteristisch ist. Diese Hochdruckphase ist nicht nur durch Eklogite, sondern auch durch die weite Verbreitung von Pseudomorphosen nach Lawsonit, Granat und Disthen in vielen Prasiniten, durch das Vorkommen von Omphacit (+ Qz) in Marmor und durch Lawsonitpseudomorphosen in Kalkglimmerschiefern (Höck, 1974) belegt. Ein deutliches Absinken des Druckes (dokumentiert durch die aus Omphacit entstandenen (Ab + Di)-Symplektite, verbunden mit einem Ansteigen von H_2O führte später - während der "Tauernmetamorphose" - zur Bildung der prasinitischen Paragenesen bei Temperaturen um 500° und Drucken von 4 - 5.4 kb (entsprechend der Überlagerung durch ostalpine Einheiten).

Alpine Explosion Seismology Group: Reporter Heinz Miller
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Alpine Longitudinal Profile, 1975 - The Experiment and first Results

From September 8th to 20th, 1975 refraction seismic measurements were carried out in close European cooperation on a long range profile along the strike of the Alps between Hungary and France. 20 shots from 9 different shotpoints were recorded along a main line 850 km long as well as on a number of fans and additional shorter profiles. Figure 1 shows the location of shotpoints and profiles of ALP,1975 within a simplified map of Bouguer gravity. With 193 recording stations and over 200 persons participating ALP 1975 was the largest experiment of that kind ever to be undertaken in the Alps.

The aim of the experiment was twofold: to determine the velocity depth structure of the crust beneath the axis of the Alps from data essentially free of the influence of strong horizontal velocity variations and to probe the structure of the lower lithosphere.

First results will be presented in the form of velocity-depth functions, which are generally characterized by a marked velocity inversion at depths varying between some 18 to 30 km. In some areas a second velocity inversion seems to exist in the lower crust.

Furthermore, long range data indicate a fine structure of the lower lithosphere, which at the present time cannot yet be resolved in any detail, since crustal structure and accordingly crustal traveltimes have not yet been determined accurately enough over the whole length of the profile.

The newly determined velocity-depth-distributions form a good basis for reinterpretations of earlier measurements. As an example of such a reinterpretation a crustal cross section will be presented for the line Eschenlohe - Trieste.

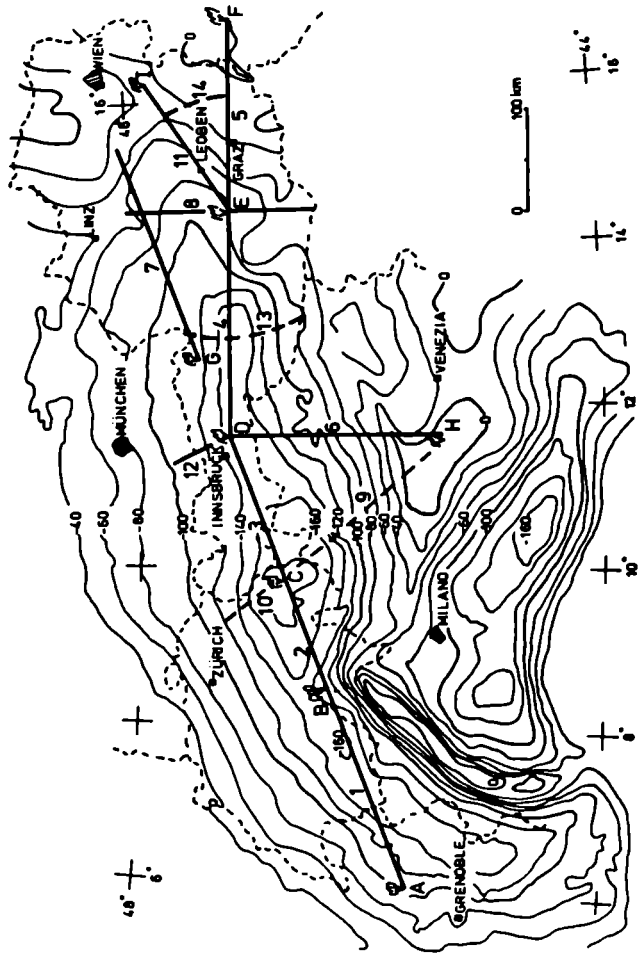

Fig.1. ALP 1975: Location of shotpoints and recording lines within a simplified map of Bouguer gravity. Note how the main line between shotpoints A and F follows the gravity minimum.

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Die Nordrand-Zone des Tauernfensters zwischen Zillertal und Hippold-Spitz (Tuxer Voralpen, Tirol)

Es wird eine Übersichtsskizze vorgelegt, die auf einer Kartierung 1:10 000 aufbaut. Es ergaben sich wesentlich neue Auffassungen in zwei Bereichen:

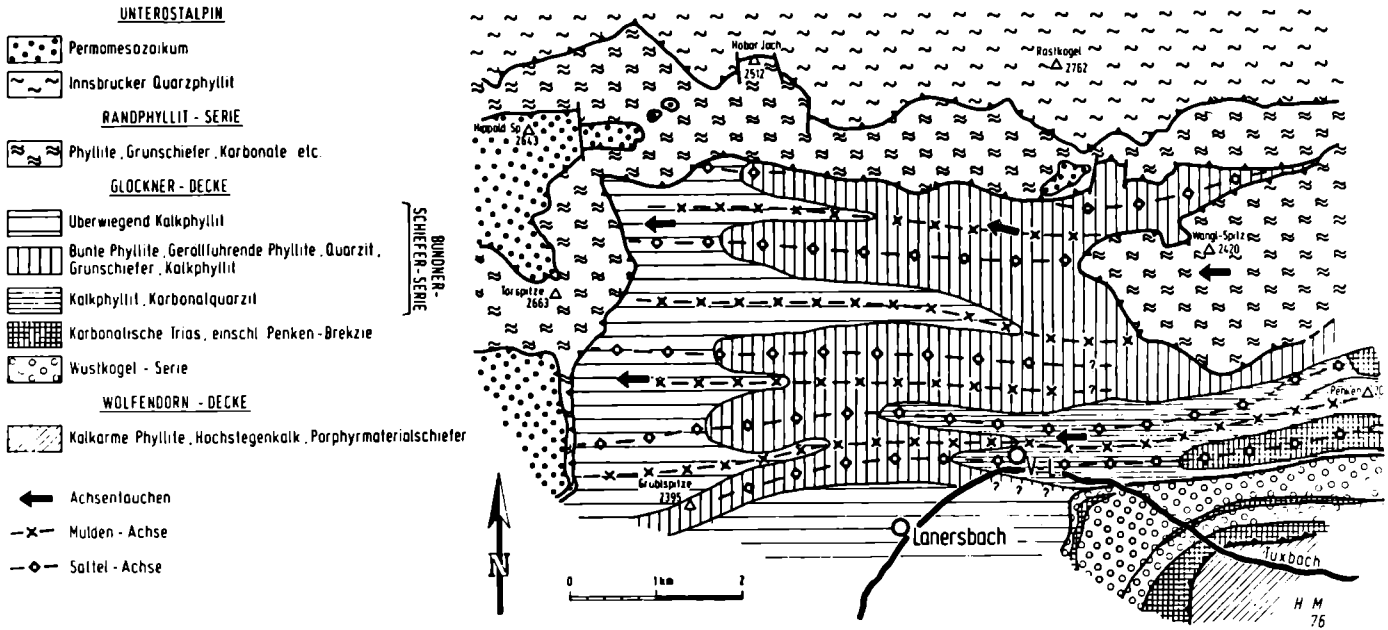
1. Paläozoische Quarzphyllite. Vom Innsbrucker Quarzphyllit (I.Qu.) wird an seinem Südrand die sog. "Randphyllit-Serie" abgetrennt. Sie besteht überwiegend aus Quarzphylliten verschiedenen Serizit/Quarz-Verhältnisses, die im Durchschnitt dunkler und quarzärmer sind als der typische I. Qu. am Südrand seiner Hauptverbreitung. Dazu treten Einschaltungen von Grünschiefer, Marmor, Dolomit, Ankerit, Graphitphyllit und Quarzit. Der Magnesit und die Scheelitvererzung des Bergbaues Tux gehören zu dieser Serie, ebenso die Kupfer-Vererzung der Knappenkuchl (Westrand der Tarntaler Berge) und des Mühlwaldes (Sidantal). Typisch als Unterscheidungsmerkmal gegenüber dem I. Qu. ist auch die häufig rotbraune Farbe der Quarzknauern im Phyllit. Das Alter der Randphyllit-Serie ist durch Conodontenfunde (Höll & Maucher, Mostler) als Silur/Devon bestimmt. Kleintektonische Untersuchungen zeigten, daß der Internbau der Randphyllit-Serie tektonisch dem der penninischen Bündner-Schiefer-Serie wesentlich näher steht als dem des unterostalpinen I.Qu.. Von diesem ist die Randphyllit-Serie oft deutlich durch eine Überschiebungsfläche getrennt. Die permomesozoischen unterostalpinen Schollen des Arbeitsgebietes (Hippold, Graue Spitz) liegen nicht auf I. Qu., sondern auf Randphyllit-Serie. Sie wird nicht als stratigraphisch Hangendes oder Liegendes der Hauptmasse des I.Qu. aufgefaßt, sondern ist von ihm tektonisch abzutrennen und möglicherweise ins Penninikum statt ins Unterostalpin zu stellen.

2. Bündner-Schiefer-Serie. Die Penkenbrekzie bildet das stratigraphisch Liegende der Bündner-Schiefer-Serie; sie ist mit dem gesamten Penkengipfel ins Penninikum zu stellen. Die tiefsten Teile der Bündner-Schiefer-Serie sind durch die Einschaltung von Karbonatquarziten und kompakten Kalkbänken charakterisiert. Darüber folgt eine stark klastisch betonte Fazies mit Quarzi-

ten, geröllführenden Phylliten, kalkarmen Phylliten, Grünschiefern, Kalk- und Dolomitschollen sowie Kalkphylliten. In den höheren Teilen der Serie kommen fast ausschließlich die üblichen Kalkphyllite vor. Diese Dreigliederung wurde im Längsprofil auf Grund der stetig W-fallenden Faltenachsen erkannt. Davon ausgehend war es möglich, einen engen Sattel-Mulden-Bau innerhalb der Glockner-Decke nachzuweisen. Der stark klastische Einschlag in den tieferen und mittleren Horizonten der Bündner-Schiefer-Serie läßt darauf schließen, daß das Untersuchungsgebiet ursprünglich knapp südlich des Ablagerungsraumes der Wolfendorn-Decke (Trias bis Dogger fehlend oder verkümmert) anschloß. Somit wäre auch für die Richbergkogel-Serie des Gerlosgebietes, die in östlicher Fortsetzung liegt, eine Zuordnung ins Penninikum (Nordrand der Glockner-Decke) anzunehmen.

GEOLOGISCHE ÜBERSICHTSKARTE DES

TAUERNFENSTER - NORDRANDES ZWISCHEN HIPPOLD - SPITZ UND PENKEN



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Titel

Preliminary report on the age of the early alpine metamorphism in the western Tauern Fenster as deduced from K/Ar dating on actinolite from the Greiner Schiefer series (Zillertaler Alpen, Tyrol, Austria).

The Greiner Schiefer series are intercalated in the western part of the Tauern Fenster between the Zentralgneis series of the Tuxer Alpen and that of the Zillertaler Alpen. The Greiner Schiefer Series belongs to the tectonic unit of the lower Schieferhülle (Angenheister et al. 1975). The age of the Greiner Schiefer series is still a matter of discussion; according to Frasl and Frank (1966) they are of early Paleozoic age, according to Baggio and De Vecchi (1966) of late Paleozoic one. The Greiner Schiefer series consists mainly of thick amphibolite series partly developed as the so called Garbenschiefer. The amphibolites show partly a layering due to intercalations of biotite-plagioclase-schists. In the amphibolite there are several serpentinite bodies.

The texture and the mineral assemblages of the Greiner Schiefer series are mainly the result of the alpine metamorphism. According to Morteani (1971), Raase (1972), Ackermand and Morteani (1973) and Morteani and Raase (1974) at least two alpine metamorphic events occured; a low grade (eoalpine?) metamorphism was followed later on by a medium graded event. According to radiometric dating on white micas the mineral parageneses of the younger alpine metamorphic event are formed 35 (as well as at about 20) m. y. ago. The age of the earlier alpine metamorphic event (or events?) is not known as yet.

In the Greiner Schiefer series actinolite -talc-, actinolite - chlorite- and actinolite -chlorite-biotite-schists are observed at the contact between the banded amphibolites and gneisses and the serpentinite bodies. From microscopical study it could be deduced that probably the actinolite crystallised during an early metamorphic event. Furthermore crystallisation of this actinolites took place at high pressures as inferred by Hörmann and Morteani (unpubl.) from their unusual high alumina content. As actinolites are supposed to retain argon rather tenaciously (Gerling et al. 1965) this is a suitable mineral for the $^{40}K/^{40}Ar$ dating of the early events.

Ten actinolites and seven tschermakitic amphiboles originating from the area around the mountains of the Totenkopf (Schlegeis valley) and the Geier (Zamser valley) were separated for $^{40}K/^{40}Ar$ dating. One sample originate from below the Grosser Greiner. The distance between the Totenkopf and the Geier is about 5 km. The amphibole bearing samples from the Totenkopf are collected from an area of about 50 m^2, that of the Geier cover an area of about 100 m^2. All actinolites from the above mentioned actinolite-bearing schists originate from the contact between the serpentinite bodies and the surrounding gneisses and amphibolites. The tschermaktic amphiboles originate from the amphibolites near the serpentinites.

The work presented here reports the $^{40}K/^{40}Ar$ ages on three samples each collected from three different locations (Totenkopf, Geier and Grosser Greiner) mentioned above. The conventional model ages (constants of the phanerozoic time scale 1964) are 70, 80, and 110 m. y. The model ages are obviously discordant. In the plot of $^{40}Ar/^{36}Ar$ versus $^{40}K/^{36}Ar$ of our analytical data, we find that the values fall on a straight line. This line can be interpreted as an isochron with slightly increased $^{40}Ar/^{36}Ar$ initial ratio. From this isochron an early alpine metamorphic event at 55 m. y. ago can be assessed.

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"Crustal Structure along the Swiss Geotraverse"

New seismic refraction and reflection results indicate that the crustal structure along the Swiss geotraverse from Basel to Chiasso is made up of five segments:

(1) The northernmost part of the geotraverse between the southern Rhinegraben and the southern limit of the Jura Mountains is characterized by the influence of a pronounced mantle upwarp in that region.

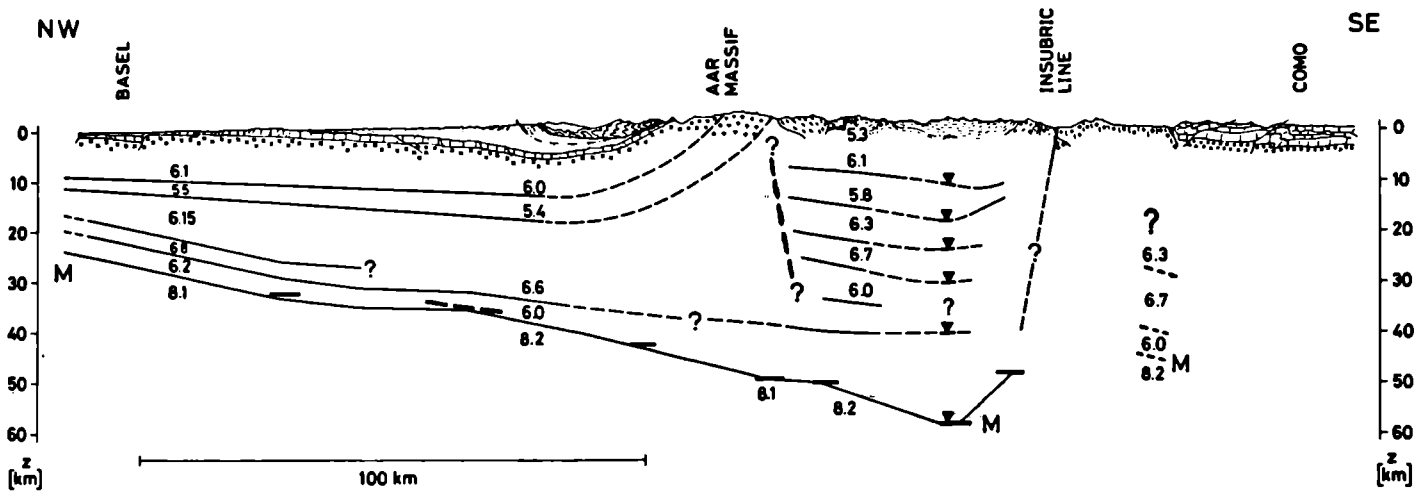
(2) Under the Molasse Basin the thickness of the southward dipping crustal slab bounded by the top of the crystalline basement and the crust-mantle boundary is remarkably constant (~32 km).

(3) Between the northern margin of the Alps and the southern border of the Aar Massif the crustal structure is rather complex. There are indications that the Aar Massif must be considered as a "flake" of the upper crust which has been sheared off at the level of a first zone of velocity inversion, and then has been bent upward.

(4) The adjacent segment to the south comprising the Gotthard Massif and the Lepontine Alps is associated with the largest crustal thickness and the highest rate of recent uplift. There supposedly two crustal slabs - once overthrust - are still superimposed. Towards the south this segment is bounded by the "Insubric Line", which seems to be a deep-reaching fault zone cutting through the entire crust.

(5) In the Southern Alps not much is known about the crustal structure. It is suggested that a flake-type structure prevails in that region, where the whole crust has been sheared off just above the crust-mantle boundary and then has been pushed upward, analogous to the structure of the Ivrea body.

The present-day stress field in the upper part of the crust along the geotraverse is characterized by a considerable horizontal pressure, which reaches its maximum where the measured crustal uplift is also greatest. Under these circumstances concave structures will be dominant as is actually observed.


NW
SE
BASEL
AAR MASSIF
INSUBRIC LINE
COMO
0
10
20
30
40
50
60
z [km]
6.1
5.5
6.15
6.8
6.2
8.1
6.0
5.4
6.6
6.0
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M
?
5.3
6.1
5.8
6.3
6.7
6.0
8.1
8.2
M
6.3
6.7
6.0
8.2
M
100 km

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Seismik und Schwere entlang der Schweizer Geotraverse

Es wird ein Modell für die Erdkruste und den oberen Erdmantel entlang der Schweizer Geotraverse (Basel - Chiasso) vorgestellt, welches kompatibel mit der Seismik und Gravimetrie ist. Die gefundenen seismischen Kompressionswellengeschwindigkeiten werden mit Hilfe der neuen, überarbeiteten WOOLLARDschen Geschwindigkeits-Dichterelation in Dichtewerte umgerechnet und anschliessend die theoretischen Schwereanomalien des seismischen Modells bestimmt. Dabei wird versucht, eine Normalkruste zu definieren, welche als "Referenzkruste" für die Alpenkruste angesehen werden kann. Aus den Unterschieden zwischen den theoretischen Schwerewerten des seismischen Modells und den beobachteten Schwereanomalien ergeben sich Implikationen für die Dichteverteilung des oberen Erdmantels. Es wird ausserdem versucht die aus Oberflächenwellen bestimmte Tiefenverteilung der Lithosphären - Asthenosphärengrenze in Rechnung zu setzen. Die Ergebnisse unserer Untersuchungen werden in Zusammenhang gebracht mit einem kinematischen Modell für die gegenwärtige Hebung der Alpen.

Name and address: Rudolf OBERHAUSER (Wien, Geol.Bundesanstalt)

Title: Contribution to the geology of the boundary between the Eastern and Western Alps between Upper Swabia and Northern Graubünden with respect to paleogeodynamic processes.

Sections from Upper Swabia through Vorarlberg and westernmost Tyrol into the Prättigau and the Lower Engadine (enclosed) are used to demonstrate the paleogeodynamical development of the alpine edifice. Hereby the northern prolongation of the Chur-Lineament, the contacts between the Alps and the Molasse, the inversion of the southern frame of Calcareous Alps and the correlation between the Rhenodanubic Flysch and metamorphised sediments in the Engadine Window are importance.

For the timing of the relative movements facts of biostratigraphy and heavy mineral analysis are used. New fossil records (ammonites and foraminifers) in the "Fimbertal" prove for the S o u t h e r n P e n n i n i c realm of the Lower Engadine Window a stratigraphic sequence as: Variegated Keuper, Kössen beds, Steinsberger Liassic from Sinemurian to Toarcian, flyschoid beds of Middle Jurassic, Lower Cretaceous and Cenomanian-Turonian ages. The ophiolites of the Bürkel-Kopf-Massiv situated beside them, may have been extruded in Middle Jurassic to Cenomanian times.

If wie try to generalize this age-theory (and paleogeographic position?) for all the alpidic ophiolites of the Lower Engadine Window, we have to assume a tectonic or olistostromatic origin for occurrences in other sequences of this window. This idea and its consequences enable to consider all paleozoic and early mesozoic lenses in different levels of the Engadine Window and in the "Feuerstätter Decke" far in the north also as olistoliths in younger beds and not in any case as tectonic slices inside a basal sequence of an overlying tectonic unit. It facilitates palinspastic reconstructions and encourages a connection of the "Stammerspitz"-Sequence and the "Feuerstätter-Decke".

In the N o r t h e r n P e n n i n i c realm, in the central part of the Engadine Window Maastrichtian-foraminifers (Raschvella = Saderer Joch Serie?) are known long ago. These sequences can be connected beneath the Silvretta-Massiv with the Prättigau-

flysch and beneath the Ötztal-Massiv with the "Kalkphyllit" of the Tauern Window. Feuerstätter Zone and Rhenodanubic Flysch of the northernmost alps have to be situated immediately north of a seamount area in a M i d d l e P e n n i n i c position. This longitudinal height is characterised in the Lower Engadin and in the Prättigau (Falknis-Sulzfluh-Tasna) by "Couches rouges" of Upper Cretaceous to Paleocene ages. It consequently has not to be connected with the "Hochstegen-Kalk", which we consider as foreland, but is getting lost in the "Kalkphyllit"-Bassin of the western Tauern Window.

We try to connect the Engadine Dolomites beneath the Silvretta-Verwall-Cristalline-Massiv and the southern Northern Calcareous-Alps with northernmost elements of Northern Calcareous Alps. The "Krabach-Joch"-Nappe and the "Hasenfluh"-Block can be derived from an inversion of their southern frame. The contact plane between the allochthonous "Faltenmolasse" and the alpine edifice is not of greater structural importance than other tectonic boundary-planes inside the "Faltenmolasse", and that one toward the Not-Foulded-Molasse.

Name and address: Dr.Benno Plöchinger
Geologische Bundesanstalt, Wien

Titl:

On the Problem of Intermalmian Gravitational Sliding in the area of Hallein-Berchtesgaden

Clays of Upper Permian Haselgebirge, exposed in the area of the cement-quarry St.Leonhard-Gartenau south of Salzburg, form the core of a N-S striking anticline in a length of one kilometer. Because of its position it can be co-ordinated with the salt-bearing clays of the zone Hallein-Berchtesgaden of Hallstatt facies. Above the sedimentary contact between the Haselgebirge and the clayey, pelagic Oberalm beds (Tithonian-Berriassian), building up the flanks of the anticline, there are rhythmically intercalated breccias rich in components of Upper Permian Haselgebirge clay together with allodapic limestones. That the Haselgebirge of the anticline-core, underlying these sediments of mudflow, grainflow and turbidity currents, was brought in synsedimentarily by an Inter-Malmian gliding, was confirmed by the results of a drilling sunk for salt in the mentioned anticline (Fig.1). The drilling showed, that a sedimentary Klippe slided into the Malmian Oberalm beds, consists of Upper Permian Haselgebirge, Upper Triassic dolomite, dark Carnian shales and spotted Liassic marls, -rocks, which are known in the area of Hallstatt facies.

The components of Hallstatt facies in the clastic intercalations of the Oberalm beds and Roßfeld beds (Hauterivian) as well as the olistholiths of Hallstatt facies overriding these Roßfeld beds show, that during the Jurassic and Lower Cretaceous a submarine elevetion was formed by salt-diapirism and caused the rhytmic sliding into the basin sediments (Fig.2). This diapirism might be related with Late-Kimmeridgian movements. Such movements are indicated by tilting of the southern marginal parts of the Osterhorn group and on the Göll massif. Besides the known transgression of Oberalm beds on the zone mentioned, E of Kuchl a silicious, limy Roßfeld sandstone unconformably overlying Oberalm beds was observed and a discordance between Oberalm beds and Schrambach marls on the Mehlweg road in the Berchtesgaden area.

The Tirolian Oberalm beds surrounding the Hallstatt facies zone of Hallein-Berchtesgaden are equivalent to Oberalm

beds containing Haselgebirge S St. Leonhard. As the components of the clastic intercalations (Haselgebirge, Malmian reef limestone ecc.) were moved to a certain degree also there, it seems possible, that the whole Hallstatt mass of the Hallein-Berchtesgaden zone was brought in by Intermalmian gravitational sliding too (Fig.3). A drilling in the Nesseltal anticline ("A" in the section of Fig.3) could easely clear the problem, whether this Hallstatt mass was brought into the Tirolicum like the Klippe S St.Leonhard by sliding or whether a Hallstatt facies belt within the Tirolicum caused elevetion by salt diapirism. Independent of these two possibilities the Limestone Alps as a whole were thrust en block over Flysch and Helvetikum in the Lower Tertiary. At any case there are several facts, which tell in favour of a Malmian gliding mass.

Name and address: Siegmund PREY (Wien, Geol.Bundesanstalt)

Titel: Outline of the geological structure of the easternmost Alps.

In this report the author tries to explain the structure of the easternmost Alps by means of some Profils. One of them ist for this purpose elected.

The lowermost tectonical unit comprising mesozoic rocks and ophiolites of penninic type can be seen in the tectonical windows of Rechnitz-Bernstein. Their basement is unknown. This Penninicum is overthrusted by two nappes the lower of which consists of Wechsel Crystalline while the upper one is composed of Grobgneis Crystalline, combined with some mesozoic, belonging to the lower austroalpine group. Generally a very big middle austroalpine crystalline builds up the frame of the large Semmering Window. Mesozoic rocks imposing the crystalline are known as Stangalm Mesozoic, Raasbergfolge on the border of the Graz Paleozoic, Tattermann Mesozoic north of Semmering, Rannach Series and others. The Rechnitz overthrust is supposed to be young alpidic whereas the lower austroalpine nappes might have been layed out in the older alpidic age and moved on up to the young alpidic time.

This unit comprising the remnants of mesozoic rocks above mentioned has been overthrusted by the lower and upper nappe of the Grauwacken Zone, the lower one being characterised by younger and the upper one by older paleozoic. Behind remaining parts of these units are the Gurktal Nappe and the Graz Paleozoic. All these units once have been parts of an early cretaceous (oldalpidic) nappe system including the Limestone Alps.

Still today we can perceive a sedimentary connection between the Grauwacken Zone and the southernmost respectively highest units of Limestone Alps. But both of them about during oligocene time moved by sliding from the core of austroalpine crystalline into the Molasse trough during a late phase of Tauern overthrust. This way the Limestone Alps have overthrusted and pushed foreward flysch and helveticum over molasse. These movements finally came to a standstill in later ottnangien time. Comparing with Western Carpathians we are able for interpreting the lower Grauwacken Nappe as a former basement belonging to one of the lower nappes of the Limestone Alps and the Noric Thrust Plane as an alpidic event.

The attempt to see the Rheno-Danubian Flysch Trough as a wide opening rift valley south of the ultrahelvetic region consequently leeds to assuming a second subduction zone situated more northerly beside

the big penninic subduction. Possibly the young lineament established in the Mur-Muerz valley and the southeastern Vienna Basin have a certain connection with the refered to above tectonical structure.

At any rate an important structure is the Raab Line which, striking northeastwards, is situated between the strongly deformed Eastern Alps and the much less deformed Bakony Region. Probably the Raab Line is rather a fault than the continuation of the gemeric overthrust in the Western Carpathians.

Events of young geological history are the marine transgression bordering the Eastern Alps as well as the young basins breaking down in miocene time. Some geologists assume the miocene andesitic volcanism of eastern Styria and southern Western Carpathians to be effected by the big alpine subduction.

Contributions to the geodynamic interpretations in the Eastern Alps

by F.P.SASSI[+], S.BORSI[++], A.DEL MORO[++], A.ZANFERRARI[+] & G.ZIRPOLI[+]

Every Alpine geodynamic model concerning the Eastern Alps must take into account and explain the following points, mostly demonstrated by the writers in the area between Mules (Mauls) and Iseltal.

1) An intermediate to acid plutonism took place certainly during the Alpine cycle. It has a calcalkaline character, and occurs both in the Vedrette di Ries (Rieserferner) pluton and in numerous dykes crosscutting the austridic schists throughout the whole region. In the Vedrette di Ries pluton a Rb-Sr whole rock isochron has been obtained, displaying an age of 30 m.y.

2)The Deferegger - Anterselva - Valles tectonic line ("DAV line") is exceedingly important as regards the dynamic and thermic Alpine history. It is the only line in our area which can be detected by means of radiometric methods, i.e. which has a paleogeothermic meaning. In fact, by means of numerous radiometric NS sections, it has been ascertained that the Rb-Sr cooling ages of biotites range systematically between 16 and 32 m.y. in the area north of the DAV line, between 286 and 302 m.y. to the south. Along these cross - sections, any main change in the above described pattern of the biotite cooling ages has been detected both at the Periadriatisch Naht and the Pennides - Austrides boundary.

3) Three metamorphic Alpine events have been recognized in the Eastern Alps. Besides the well known paired metamorphic events (HP metamorphism of Cretaceous age; barrovian-type metamorphism of Oligocenic age = "Tauernkristallisation"), a third, younger metamorphism can be recognized at least locally; we are dealing with the low grade metamorphic effects occuring in the dykes considered above, under point 1.

4) a) The age and the pressure character of the metamorphism in the "Brennermesozoikum" (and consequently also in the "Schneebergerzug") are essentially indistinguishable from those of the Cretaceous metamorphism in the Tauern Window.
b) On the other hand, during Oligocene any subducted plate in con-

sumption can be assumed underneath the Brennermesozoikum - Schneebergerzug area; or, at least, it did not induce thermic disturbances in the presently outcropping levels of the assumed overlying plate.
c) Finally, upper Cretaceous biotite cooling ages occur in the Austrides also to the east of the Tauern Window. These points represent on one hand some important constraints to the geodynamic models in the Eastern Alps on the other, the starting-points for speculations.

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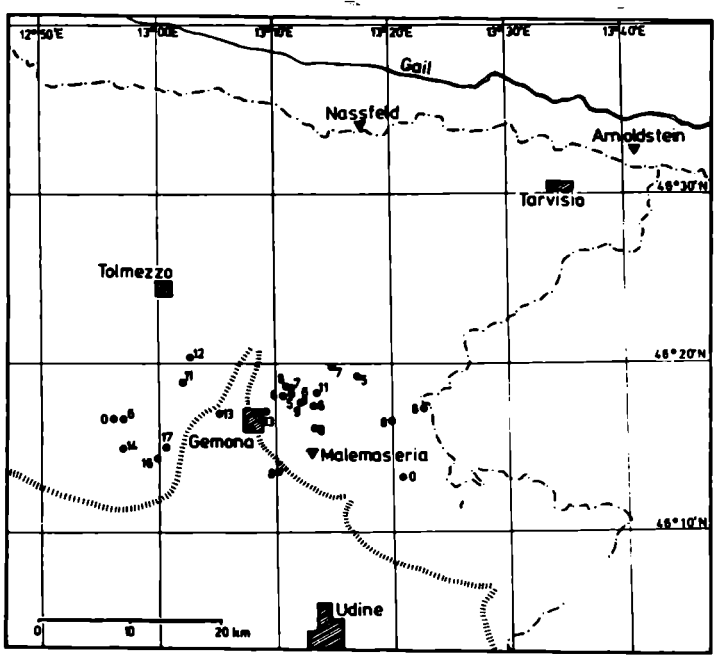
Some Results of Aftershock Investigations of the Friuli Earthquake of May 6th, 1976.

Aftershocks of the Friuli earthquake were recorded during the period of May 8th to June 14th 1976 by up to four selftriggering three component seismic stations which have been installed in addition to the italien and austrian seismic networks.
A marked high value of 1.9 for the v_p/v_s ratio was found within and surrounding the epicentral area. Origintimes and hypocenters for about 25 aftershocks were calculated (see figure). It turned out that focal depths calculated with the standard value of v_p/v_s = 1.72 are too large as opposed to focal depths calculated with the true value of 1.9.
Recently a new crustal model for the Eschenlohe SE profile crossing the Eastern and Southern Alps had been determined from refraction seismic measurements. To check the validity of this model, theoretical traveltime curves were calculated for some selected aftershocks with different focal depth and compared with observations. Thus the Eschenlohe SE profile can be reversed and crustal structure can be determined still more accurately.



Outline map showing location of stations and epicenters. Triangles: seismic stations, closed circles: epicenters. Numbers indicate focal depth.

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Review of pre-Variscan events in the Eastern Alps (Fig.1,2)

During the last years progress in biostratigraphy, geochronology and detailed petrography/experimental petrology has led to a modified concept regarding age and nature of geodynamic processes in basement rocks of the Eastern Alps. Thus, according to various authors, pre-Alpidic series are built up of at least two metamorphic complexes which are assumed to represent pre-Variscan, mostly Caledonian, and the long known Variscan orogenic events respectively. The older metamorphic complex, if at all separated from the overlying Variscan greenschist facies rocks by a more or less obliterated unconformity, is commonly recognized - among other distinct features - on the basis of different b_0-values of white micas; in turn these data are supposed as a useful "stratigraphic" tool in the wide and misty field of crystalline rocks (SASSI 1972, SASSI & SCOLARI 1974, SASSI et al.1974a,b,c, PURTSCHELLER & SASSI 1975, KLEINSCHMIDT et al.1976, SASSI et al.in press).

However, as far as published data are concerned, we have serious arguments against the general application of that model which originated in the Puster-valley but in the meantime was also transformed on rocks of the Ötztal-crystalline complex and recently on rocks of the Kor- and Saualpe. Additionally to the criticism of SATIR 1975,1976 and HEINISCH & SCHMIDT 1976 our reasons against the "pressure model" of Italian geologists mostly are derived from disagreement of used stratigraphic data which not only characterize a certain geodynamic process but also divide the Lower Paleozoic history into phases of rock formation and epochs of erosion. Very briefly, we would like to make the following remarks:

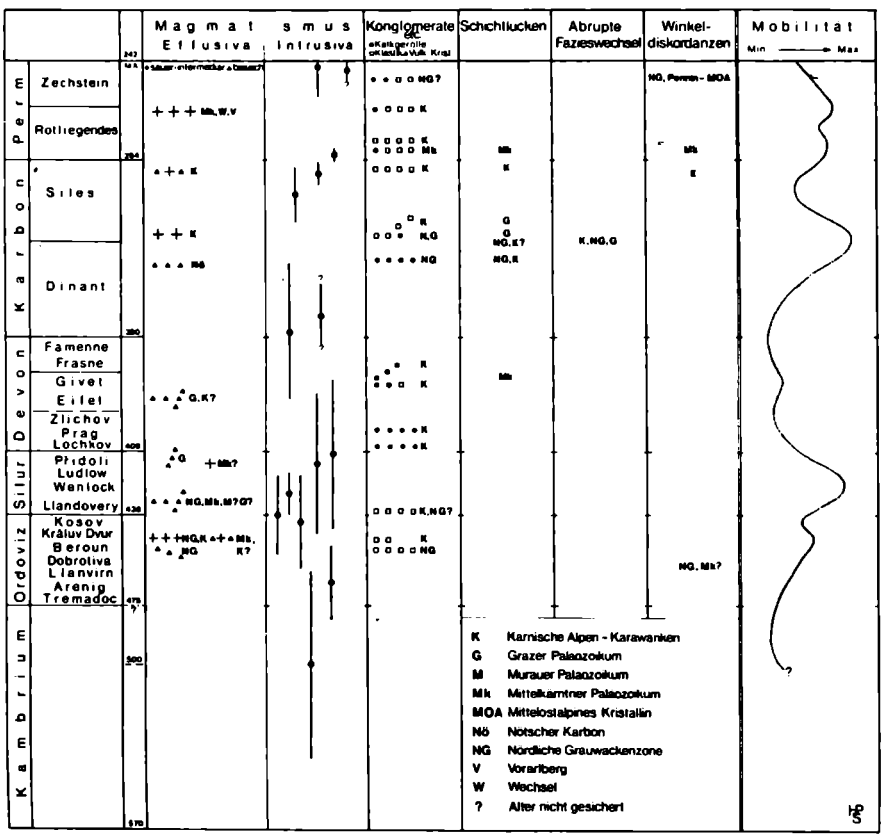
1) As yet there is no satisfying explanation about the relationship between the Antholz granite (434 m.y.) and the overlying (?) coeval Turntal quartzphyllite-complex.
2) Several microfossil-findings indicate an Upper Ordovician (?) to Silurian and Devonian (?) age for parts of the Eastern Alps quartzphyllites. These data, however, are still too insufficient to cover the total mass of these rocks, i.e. the stratigraphic base and their top.
3) The same may be said about the "Phyllitgruppe" of the Saualpe: So far one fossil-proof suggests a Lower Paleozoic age only for the fossil-bearing layer but not for the "Phyllitgruppe" as a whole. Beside this fact several authors noted that the transgressive unmetamorphosed Lower Permian of the Christophberg does not overly the "Phyllitgruppe" which implies that a pre-Alpine metamorphism of the phyllites neither can be proved at this locality nor can it be concluded for the greenschist facies rocks of the Saualpe as illustrated in fig.1 of KLEINSCHMIDT et al.1976.
4) Considering both the uncertain age of the above quoted greenschist facies complex and the climate during the Ordovician an interpretation of the "Großgranatglimmerschiefer" as lateritic horizon on top of pre-Variscan crystalline rocks becomes highly speculative (FLÜGEL 1976, KLEINSCHMIDT et al.1976). Apparently more probable seems the explanation of the "Großgranatglimmerschiefer" by PILGER & WEISSENBACH 1970 or KLEINSCHMIDT 1971.

In short, we believe that b_0-values of white micas may give additional evidence about pressure phenomena during metamorphism. As far as stratigraphic information and stratigraphic value are concerned,

however, further pre-Variscan and Variscan complexes must be analysed.

Our concept of pre-Variscan rocks and pre-Variscan events is derived from combined data which we have partly summarized in fig.1 and fig.2. Heavy mineral analysis (SCHNABEL 1976), metamorphic components of volcanic breccias (MOSTLER 1970), and the Upper Ordovician "Kalwanger Gneiskonglomerat" enable additional information about a source-area. Nevertheless it is still a fundamental problem to trace pre-Variscan metamorphic rocks ("Altkristallin s.str.") in those areas of the Eastern Alps in which younger Variscan and/or Alpine overprinting occured. From all data available we conclude a widespread and intense pre-Upper Ordovician, i.e. "pre-Sardinian" rock formation and metamorphism as can be demonstrated in parts of the Northern Graywacke Zone (Vöstenhof, Stübming, Kaintaleck, Rittino) or in the Gleinalpe (FRANK et al.1976, cf. fig.2). Further, regardino isotope data there seems no doubt that in the Ötztal-,Silvretta-, and other regions of the Muralpen-complex also pre-Upper Ordovician rocks are incorporated. From the Upper Ordovician to Devonian/Carboniferous times temporarily magmatism was responsible for a locally very mobile sedimentary basin. As yet two geodynamic climaxes best fit to characterize the pre-Variscan history of the Eastern Alps (fig.1).

Geodynamische Faktoren im Paläozoikum der Ost- und Südalpen Fig. 1



Korrelation zwischen mediterranem und alpinem Prä-Variszikum

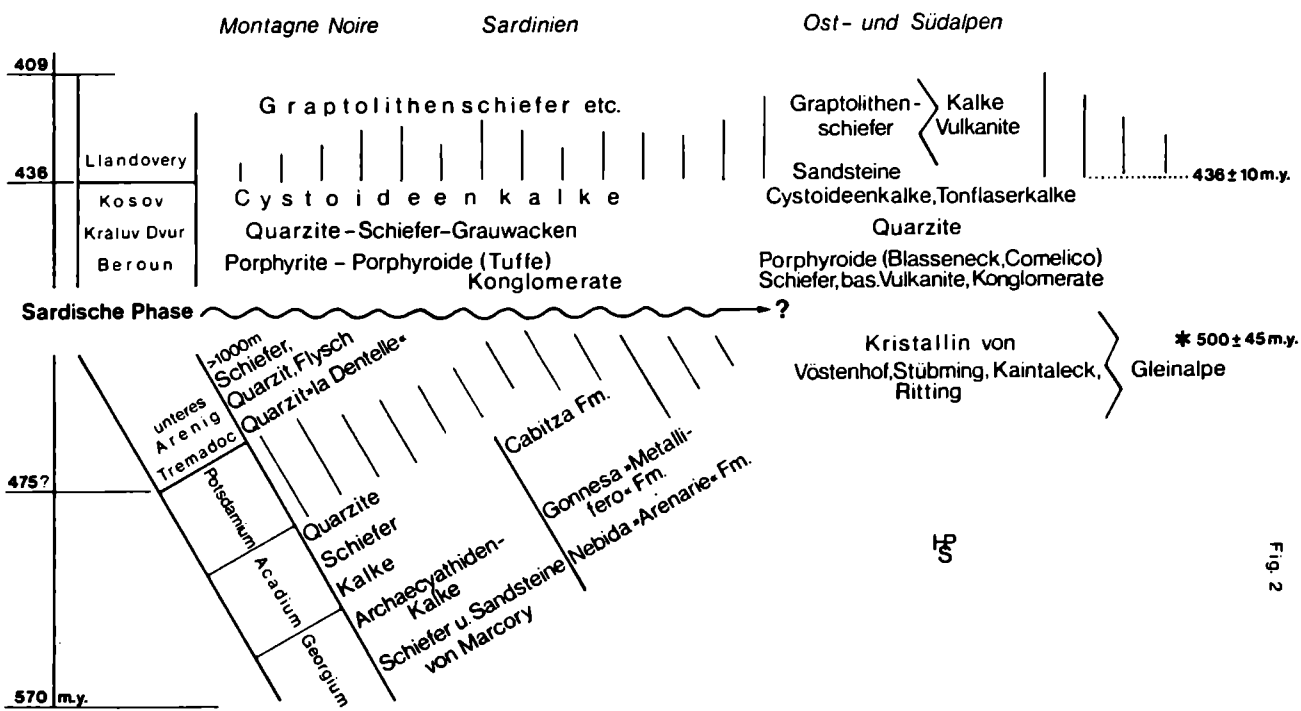


Fig. 2

Bericht über weitere paläomagnetische Testmessungen an Gesteinen aus den Ost- und Südalpen

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Zur Erweiterung der bisherigen paläomagnetischen Daten für die Ost- und Südalpen wurden die Messungen auf eine Reihe von zuvor noch nicht untersuchten Vorkommen erweitert. Der überwiegende Teil der Messungen ist als Test anzusehen und wurde unter dem Aspekt der Suche nach weiteren paläomagnetisch geeigneten Gesteinstypen durchgeführt. Beim überwiegenden Teil der neu untersuchten Vorkommen konnte auch nach mehrfacher Entmagnetisierung mit Feldstärken bis zu 2000 Oe keine stabile Remanenz festgestellt werden. Bei einigen Vorkommen ergaben sich jedoch stabile Remanenzen, die Rückschlüsse auf die Geodynamik des Gebiets und das Alter der Gesteine bzw. Metamorphosen zulassen.

In den paläomagnetisch geeignet erscheinenden Serien sind weitere Probenentnahmen geplant, um die bisherigen vorläufigen Resultate besser untermauern zu können.

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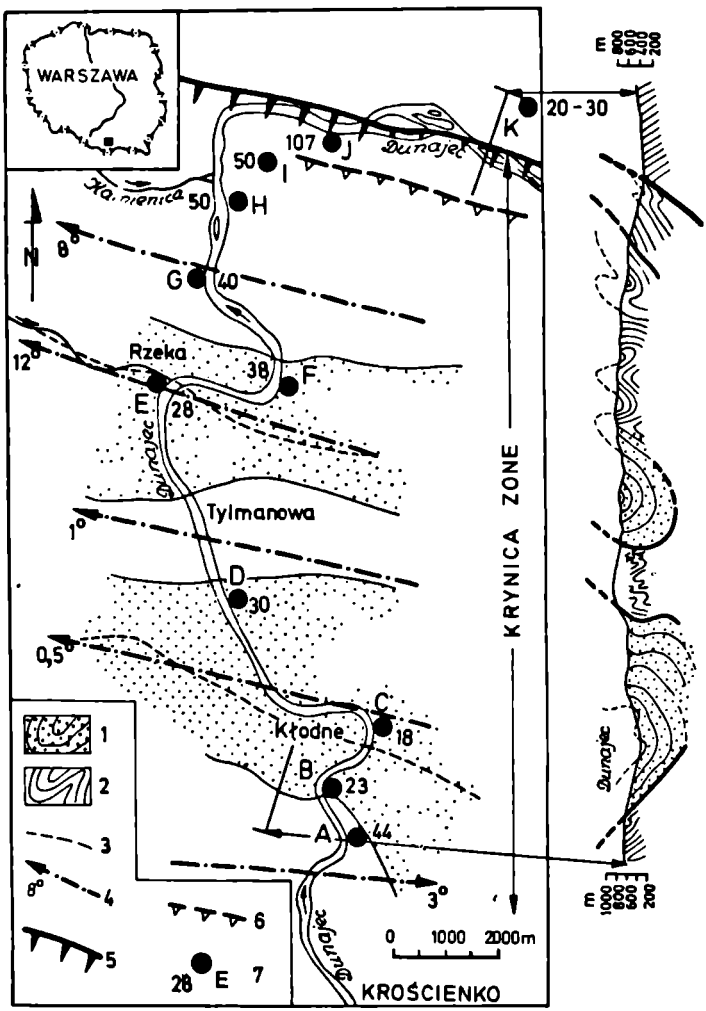
Possible Significance of Jointing for Palinspastic Reconstructions

The present observations were made in the valley of the Dunajec in the Palaeogene flysch of the Krynica Zone/fig./, i.e. the southern facies zone of the Magura Nappe, the innermost one in the Outer Carpathians in Poland. East of the Dunajec, the Krynica Zone forms a separate tectonic unit.

There occur two pre-folding transverse complementary joint sets of shear-extension origin. Joints were measured in sandstone beds in outcrops of monoclinal layers. The values of angle between transverse complementary joint sets were calculated on measurements of at least 50 joint surfaces /fig./. It may be seen that: a/ in analogous elements, e.g. syncline cores, the angles gradually grow northwards /C-E/; b/ the angles gradually grow downwards /C-B-A and C-D/; besides, an overall gradual increase of angles towards the N occurs/ B-I/. Angles abruptly change near the overthrust surface.

The value of the dihedral angle between complementary shear planes is positively correlated with confining pressure. In gently folded regions, the value of the angle between complementary transverse joint sets diminishes both horizontally - towards the element initiating jointing, and vertically - namely upwards. The pattern in the Krynica Zone is more complex. This is a result of a rotation of the joint surfaces due to diverse shortenings during flexural-flow folding superposed on the original increase of the angle northwards and downwards. The greatest shortening was in the normal limb of the fold from which the overthrust developed /J/. The smallest shortening, or even a lenghtening, occurred in the overturned limb of this fold /K/. The abrupt northward increase of the angle value in the immediate vicinity of the overthrust surface allows to calculate the amount of shortening. It is 26 per cent for a

zone 2 km wide situated immediately S of the Krynica Unit overthrust, and for the entire Outer Carpathians it may be tentatively calculated as 5 to 10 per cent.



1. Magura beds, mostly thick bedded sandstones; 2.Magura flysch, mostly thin bedded;3.Axial surfaces of synclines;4.B-axes of folds;5.Krynica overthrust;6.Secondary overthrust;7.Joint measurement station with the value of angle between transverse joint sets

Geophysikalische Arbeiten im Gebiet des Nordostsporns der Zentralalpen

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Seit 1972 werden im Gebiet des Nordostsporns der Zentralalpen im Rahmen der österreichischen Beteiligung am IGP geophysikalische Messungen durchgeführt. Mit dem Problem des Wechselfensters und seines Intern- bzw. Tiefbaues, sowie der Stellung der geologisch-tektonischen Einheiten Grobgneisserie, Wechselserie und Rechnitzserie zueinander, stehen in diesem Gebiet wesentliche Fragen des ostalpinen Deckenbaus an. Das Gebiet war bisher geophysikalisch unerforscht, auch geologische Tiefenaufschlüsse fehlten bis vor kurzem.

Die geophysikalischen Arbeiten wurden mit Messungen der magnetischen Vertikalkomponente und der Bestimmung gesteinsphysikalischer Parameter (Dichte, Longitudinalwellengeschwindigkeit, Suszeptibilität) begonnen. Die Übersichtsmessungen auf zwei je 4 - 8 km breiten und 65 km langen magnetischen Traversen (mittlerer Stationsabstand 500 m - 5000 Stationen - 700 km^2 Gesamtfläche) wurden 1976 abgeschlossen, gravimetrische und refraktionsseismische Testmessungen dienten der Planung größerer Meßprogramme im Zeitraum 1977 1978.

Die etwa NS verlaufende magnetische Traverse 1 verbindet den Südrand des Wiener Beckens mit dem Oststeirischen Becken. Neben einigen für lokale tekto-

nische und stratigraphische Fragen bedeutsamen Ergebnissen - dazu zählt zum Beispiel die Bestätigung des von der Geologie vermuteten Verlaufes der Südgrenze des Wechselfensters - ergab sich als für den Tiefbau wichtigstes Resultat, eine im Gebiet der Wechsel-Südflanke über etwa 1o km NW streichende Anomalie mit Störwerten bis über 15o γ, deren Ursachen nach überschlägigen Störkörperberechnungen im tieferen Untergrund des Wechselfensters liegen. Mit der an der Wechsel-Südflanke WE verlaufenden Traverse 2 wurden dann 3 weitere, ebenfalls N-NW streichende Anomalien erfaßt, wobei die Teufenlage der zugehörigen Störkörper nach E zu immer näher an die Oberfläche heranrückt, und deren östlichste schließlich durch die bekannten, an der Oberfläche anstehenden Ultrabasite im Raum Bernstein verursacht wird.

Nach den Ergebnissen der gesteinsphysikalischen Untersuchungen, kommen von den aus der Oberflächengeologie bekannten Gesteinen nur die Serpentine ($\varkappa \sim 6o.1o^{-3}$ SI) als Ursache dieser Anomalien in Frage. Diese nehmen im Raum Bernstein die höchste Position einer Schichtfolge ein, die nach jüngsten geologischen Ergebnissen gesichertes Penninikum repräsentiert.

Nimmt man nun als erste Modellvorstellung an, daß die beschriebenen Anomalien tatsächlich durch Ultrabasite vom Typ Bernstein hervorgerufen werden, was mit den magnetischen Messungen gut in Einklang zu bringen ist, so ergibt sich ein Abtauchen des Penninikums mit etwa 3-4° unter die Gesteine des Wechselfensters, das sich aus dem Raum Bernstein etwa 4o km nach W verfolgen läßt.

Diese Modellvorstellung wird heuer durch gesteinsmagnetische, gravimetrische und ergänzende magnetische Messungen überprüft.

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Ergebnisse magnetischer Messungen im Ostteil der Niederen Tauern.

Es wurde eine breite magnetische Traverse (Vertikalintensität) im Ostteil der Niederen Tauern gemessen, die nunmehr in einer Länge von 35 km und einer Breite von mindestens 2o km mehrere wichtige geologische Baueinheiten quert: im Süden die Zone des Wölzer Kristallins, sodann das Fohnsdorfer Tertiärbecken, das Seckauer Kristallin, einschließlich des Seckauer Tertiärbeckens und die Rannachserie. Überdies wurde im Jahre 1976 von diesem Hauptprofil eine Erweiterung nach E gemessen, um den einen wichtigen tektonischen Baustein bildenden Serpentinkörper von Kraubath und das umgebende Gleinalmkristallin einzubeziehen. Insgesamt wurden in den Jahren 1973 - 1976 632o Stationen gemessen und an die Basispunkte Nr. 59 (Trofaiach) und Nr. 83 (Feistritz), Epoche 197o der magnetischen Landesvermessung angeschlossen.

Grundlage der Anwendung der Magnetik bildete die bereits bei einer übersichtsmäßigen Probennahme bestätigte Voraussetzung, daß im Meßgebiet Gesteinskomplexe mit beträchtlich erhöhter Suszeptibilität auftreten, so daß aus der Magnetik letztlich geologisch-tektonisch bedeutungsvolle Aussagen ermöglicht werden. Die wichtigsten magnetischen "Leitgesteine" und deren durch Labor- und in situ-Messungen ermittelten Suszeptibilitätswerte sind:

	$K.1o^{-6}$ cgs
Serpentin	15oo - 6ooo
Serpentinit	bis 45oo
Amphibolit	5o - 4oo
Rannachkonglomerat	bis 2ooo

Die tertiären Sedimente (Tone, Sandsteine, Brekzien) zeigen in den obertags und im Bergbau Fohnsdorf entnommenen Proben nur geringe Suszeptibilitäten.
Im N tritt die der Ausdehnung und Amplitude nach größte Anomalie am N-Hang des Seitnerberges (SE Kalwang) auf. Diese zeigt zwar ein generelles NW-Streichen in Übereinstimmung mit den Quarzitschiefern und Quarziten der Rannachserie, durch die Auflösung in mehreren Teilanomalien mit Störwerten bis 500 γ kommt jedoch auch ein N-NNE gerichteter Trend zum Ausdruck, der mit Querstörungen in Zusammenhang stehen könnte. S und SE davon bis etwa zur Linie Stubenbach-Brennstein treten eine Reihe von kleineren Anomalien (0,5 – 1,0 km Länge) auf, deren Amplitude im Bereich von 100 - 300 γ liegt. Der geometrischen Form nach könnten diese am besten durch das Modell der dicken Platte angenähert werden. Das Streichen der Isanomalen variiert, neben einer anscheinend bestimmenden NW-Tendenz ist nördlich vom Oberlauf des Stubenbachs eine ENE-Richtung vorherrschend. Weiters findet sich auch eine N-NNE-Richtung, die mitunter besonders klar in den negativen Begleitanomalien zum Ausdruck kommt.

Eine bedeutende Anomalie ca. 2,5 km von Mautern zeigt bei stark asymmetrischer Form generell WNW-Streichen, wobei die Störkörperberechnung eine dicke, 50°N fallende Platte ergab, deren Oberkante in ca. 100 m Tiefe unter dem Gelände liegt. Nach S schließt eine breite Zone mit mäßig negativen Störwerten (meist -10 bis -30 γ) an, die den Gneisen und Gneisgraniten der Seckauer Alpen entspricht. Lediglich am W-Rand der Traverse gegen den Ingeringbach zu treten einige räumlich eng begrenzte, schwach positive Anomalien auf.
Im Flatschacher Zug, der nach K. Metz aus Orthogneisen vom Gleinalmtypus, Amphiboliten und Glimmerschiefern besteht, gibt die Magnetik eine recht detaillierte Information über die lithologischen und tektonischen Verhältnisse. Eine Reihe bedeutender Anomalien mit Amplituden bis über 300 γ markieren am Tremmelberg den Verlauf von eingeschuppten Serpentiniten. Die Zerlegung in Teilmaxima, Scharungen und Richtungsänderungen der Isanomalen machen die Annahme von NW und NE verlaufenden Störungen wahr-

scheinlich. Gegen W zu (Hölzlberg) nimmt der Betrag der Störwerte anscheinend generell ab, die Anomalien dürften hauptsächlich von Amphiboliten verursacht sein. Als hangende Einheit folgt das Kristallin der Wölzer Tauern mit dominierenden Glimmerschiefern, daneben Marmoren und Amphiboliten. Die Überschiebung selbst findet in der Magnetik keinen Ausdruck, über den Internbau geben jedoch einige positive Anomalien Hinweise, die vermutlich den Amphiboliten entsprechen. Ein NW gerichteter Trend ist in der Anordnung der Anomalien und Isolinienverlauf erkennbar, daneben macht sich über kürzere Distanz auch eine N-S-Richtung bemerkbar. Die tektonisch wichtige Pölslinie, die generell NW-SE streicht, könnte nach der Magnetik durch N und NE streichende Querstrukturen unterbrochen oder versetzt sein.

Im Fohnsdorfer Tertiärbecken treten mehrere flache positive Anomalien geringen Störwerts auf, die von tiefliegenden, jedenfalls aus dem Beckenuntergrund stammenden Störkörpern (Amphibolitzüge ?) herrühren dürften. Eine stark asymmetrische Anomalie N Judenburg streicht im Zentrum NNW, wobei eine auffallende Parallelität mit einer von Metz (1973) untertags festgestellten Störungszone besteht. Eine Reihe flacher Anomalien (Störwert +1o bis +2o γ) verläuft im zentralen Becken in NW-SE-Richtung und dürfte einer Schwellenzone entsprechen, die das tiefere Fohnsdorfer Becken vom östlich anschließenden seichteren Knittelfelder Teilbecken trennt.
Im Seckauer Becken tritt eine langgestreckte E-W streichende markante Anomalie auf, die als sich verschmälernde westliche Fortsetzung des Kraubather Serpentinstocks angesehen wird. Obertags endet dieser beim Feistritzbach, wo er an einem NW streichenden Bruch abgesenkt wird. Östlich von Knittelfeld dürfte im Zentrum einer negativen Anomalie eine N-S streichende Muldenzone ausgebildet sein, die das Seckauer mit dem Knittelfelder Becken verbindet.

Rock formations and metamorphism in the Eastern Part of the Austrian Central Alps (Geotraverse East)

by WIESENEDER, H. and SCHARBERT, S. *)

In the Eastern Part of the Austrian Alps deeper elements of the Central zone are exposed forming the Semmering-Wechselfenster. The deeper elements consist of the "grobgneiss formation, "its Permo-Triassic cover and of the "Wechsel formation" whereas the "Rechnitz formation" belongs according to petrographic and paleontologic (SCHÖNLAUB) datas to the Penninic zone. The praealpidic metasediments of the grobgneiss formation consist of metasediments rich on Fe and Al, kyanite-quartzites, arkose gneisses and phyllitic micaschists of considerable thickness with rare intercalations of amphibolites. The first proved metamorphism and a migmatitisation is restricted to the Fe- und Al-rich metasediments with staurolith andalusite and sillimanite. A second cycle of metamorphism includes the whole sequence. The next event is the "intrusion" of a coarse grained granite. Small lenses of spinel and corundum bearing metagabbros are in local and genetic connection with the granite.
The "Wechselschiefer" are supposed to be of postgranitic age, the "Wechselgneisses" in contrary are derived mainly from phyllitic micaschists which have undergone a para- till postkinematic albitisation.
After a phase of deep erosion the sedimentation of the Permian-Triassic sequence began. The alpidic revolution led to a progressive low grade metamorphism in the granite and in the postgranitic rocks whereas the country rocks of the granite have suffered a more or less complete diaphthoreses. The alpidic metamorphism took place in two phases, which is easely to be demonstrated on the fact that the first phase led to the "gneissification" of the granite, and the second to the development of "leucophyllites" on stress-zones. The most reasonable explanation for the young metamorphism in the considered area seems to be the rising of temperature and pressure during the alpine revolution.
From radiometric dating by SCHARBERT (Rb/Sr) on granite gneisses (grobgneis) a total rock age of 350 m.y. is probable. To confirm this data additional dating will be done this year. According to K/Ar dating on micas "altalpidische" metamorphism (approximately 70 m.y., t 380°C) has been proved. Older rocks have not been tested up till now because of the lack of unweathered samples.

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THE GEOMAGNETIC BASEL-CHIASSO PROFILE

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A survey of the earth's magnetic field is presently in progress in Switzerland. From the data so far collected, profiles of the geomagnetic elements on the line from Basel to Chiasso have been derived and presented at the recent Geneva Meeting devoted to this geotraverse[1].

The outstanding feature of all these profiles is the large peak at Locarno, associated with the north-eastern tail of the Ivrea body, as seen in figs. 1 to 3. While, of course, this is not new, we should like to draw attention to the steepness of the D and F anomaly profiles to the north of the peak. Since the inclination anomaly is rather symmetric, the horizontal and vertical components must both behave rather like the total intensity F. These findings by themselves do not allow to reconstruct the exact structural profile of the Ivrea body, but an asymmetric model, as for example the well-known "bird head" proposed by Berkhemer[2] and others, could certainly be made to account for the observations.

Further to the north our profiles show some oscillations, but the profiles alone do not reveal the features of interest. These are far more evident in the new declination map represented in fig. 4. Apparent on this map is a series of weak anomalies, typically of 10 km radius, strewn along the axis Simplon-Furka-Oberalp. It is tempting to associate these anomalies with basic and ultrabasic rocks occuring along the northern margin of the Gotthard Massif in a complicated and not yet fully resolved pattern.

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