SEPTEMBER 6th

CRETACEOUS OF THE RHENODANUBIAN FLYSCH AND ULTRAHELVETICUM. CORE STORAGE DISPLAY OF ROCKS FROM THE MOLASSE BASEMENT AND THE MOLASSE

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with contributions by F. Rögl

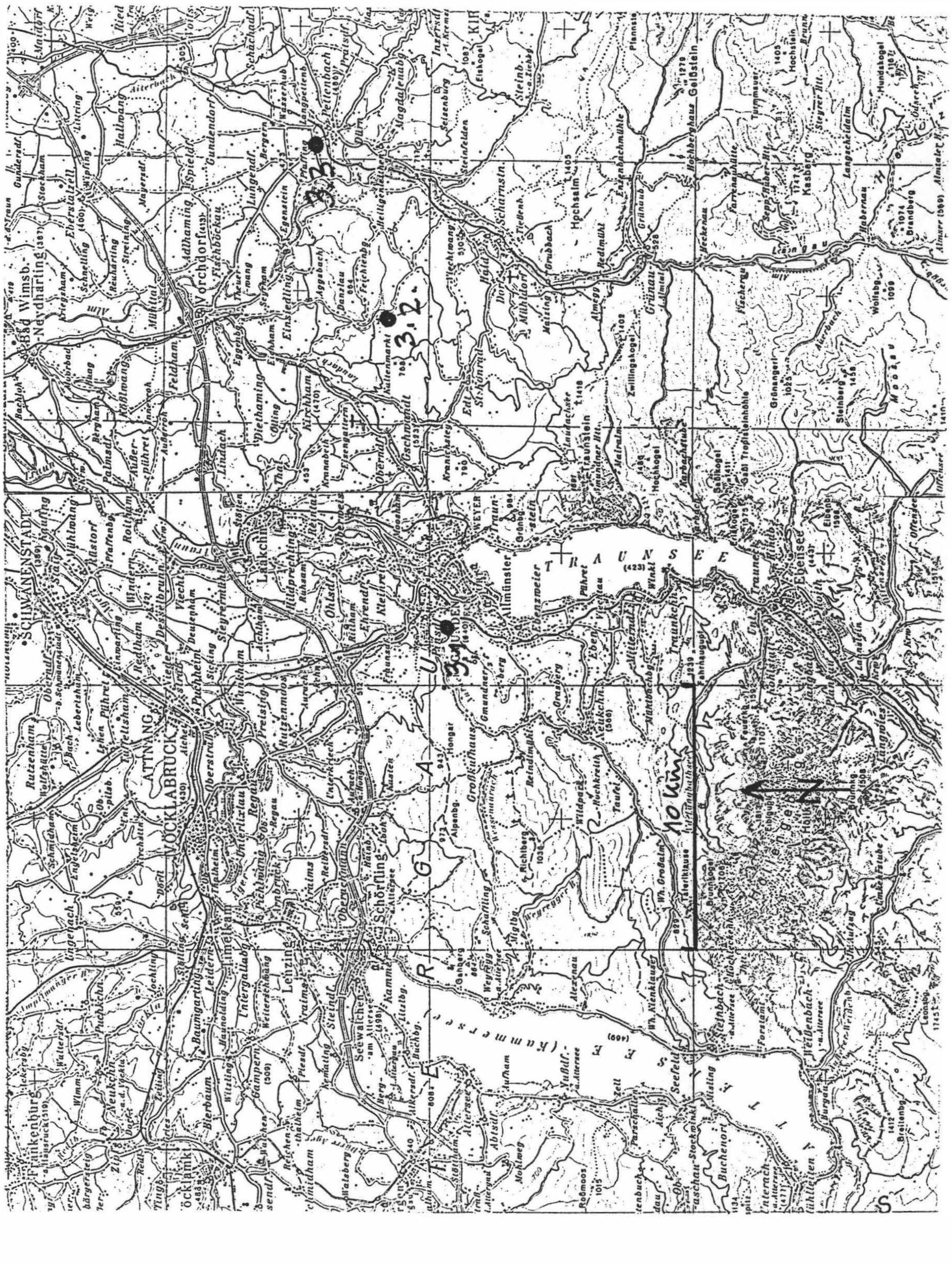


Fig. 34 Location of outcrops of the last field trip day

Stop 3.1: Hatschek quarry (cement plant) near Gmunden
Topic: Rhenodanubian flysch, Maastrichtian of the Altlengbach formation
(Ahornleiten member)

Within the Altlengbach formation (Maastrichtian - Late Paleocene) , which can reach a thickness of approximately 1500 m, four members can be distinguished: the psammitic Roßgraben member at the base, the Ahornleiten member with a lot of calcareous marls, the psammitic Kotgraben member and the Acharting member, which is rich in clayey marls. These members represent different source areas of the turbiditic material. As a general rule we can state that the material of the psammitic members was delivered from the east whereas turbidity currents dominated by calcareous material came from the west.

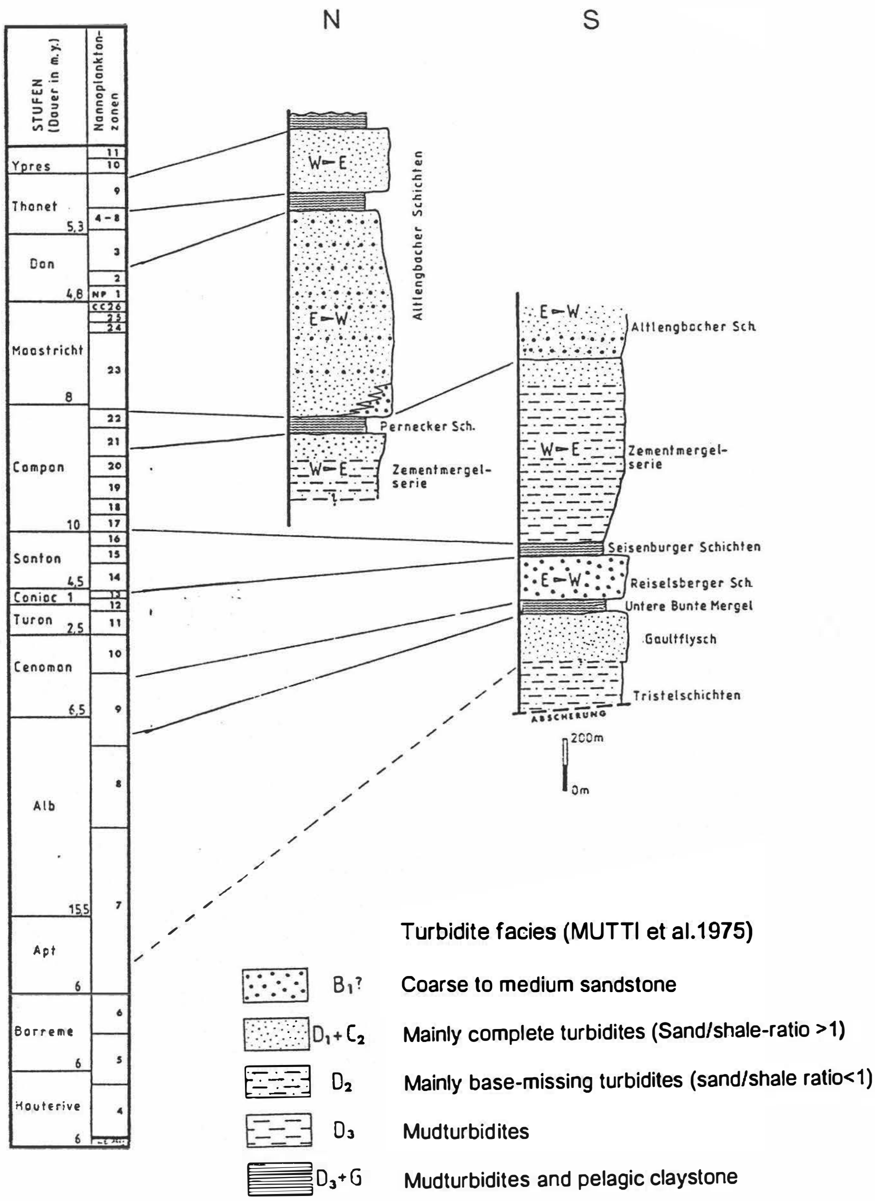


Fig 35 Stratigraphy and facies of the Rhenodanubian Flysch

Typical for the Ahornleiten member are grey calcareous marls which represent Bouma T_d . These layers can reach thicknesses up to 8m. Together with sandy to silty hardbeds at their base isolated complete turbidites are up to 10m thick. These are the thickest turbidites known from the Rhenodanubian Flysch. Beside of them very often incomplete (base missing) layers can be observed. The sand/shale ratio is generally low. According to MUTTI et al 1975 C2 and D2 are the dominating turbidite facies.

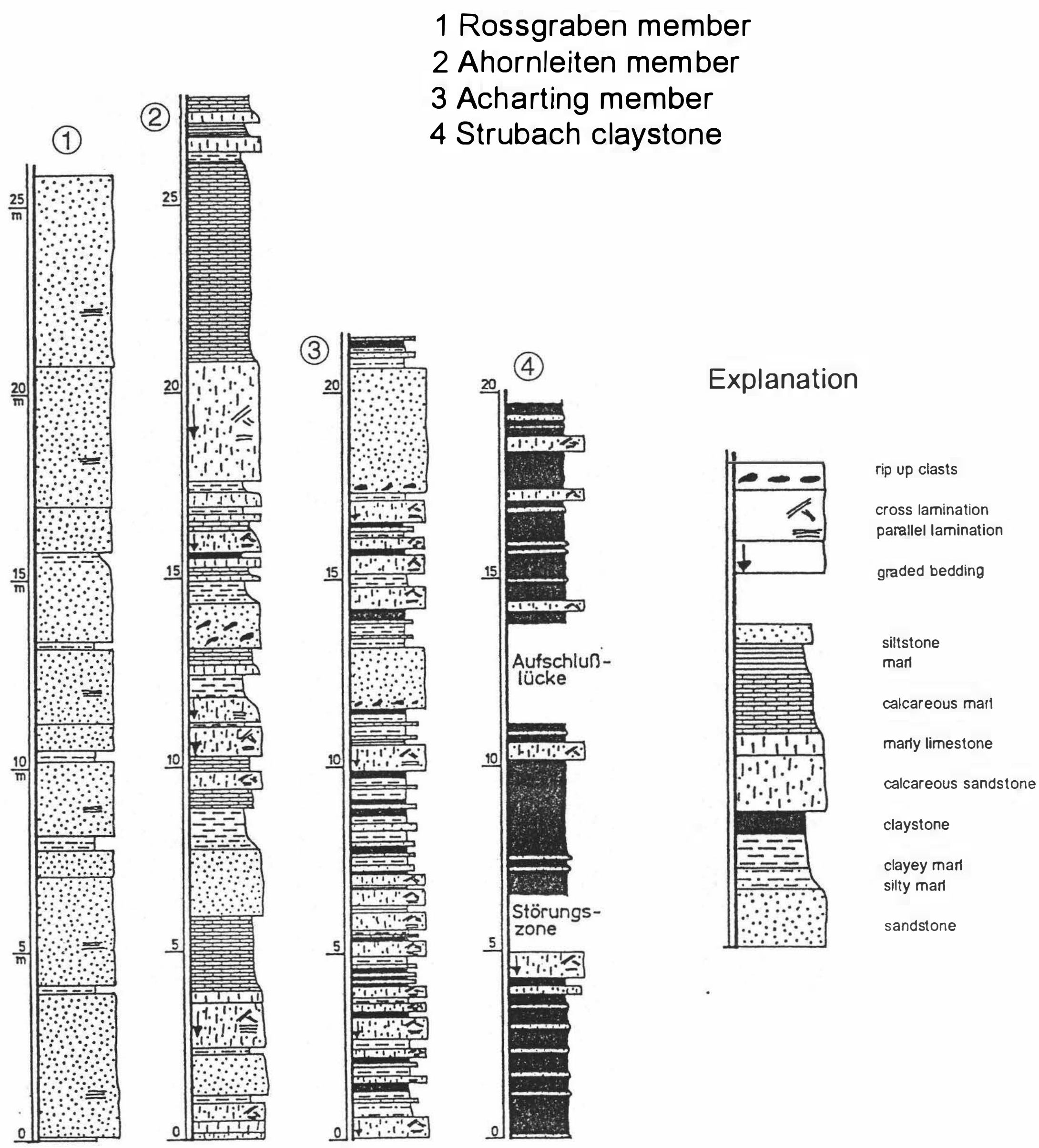


Fig 36 Detailed sections from part of the members of the Altlengbach formation

Stop 3.2: Rehkogelgraben section S of Hagenmühle
Topic: Middle to upper Cretaceous marls of the "Buntmergelserie" (Ultrahelvetic)

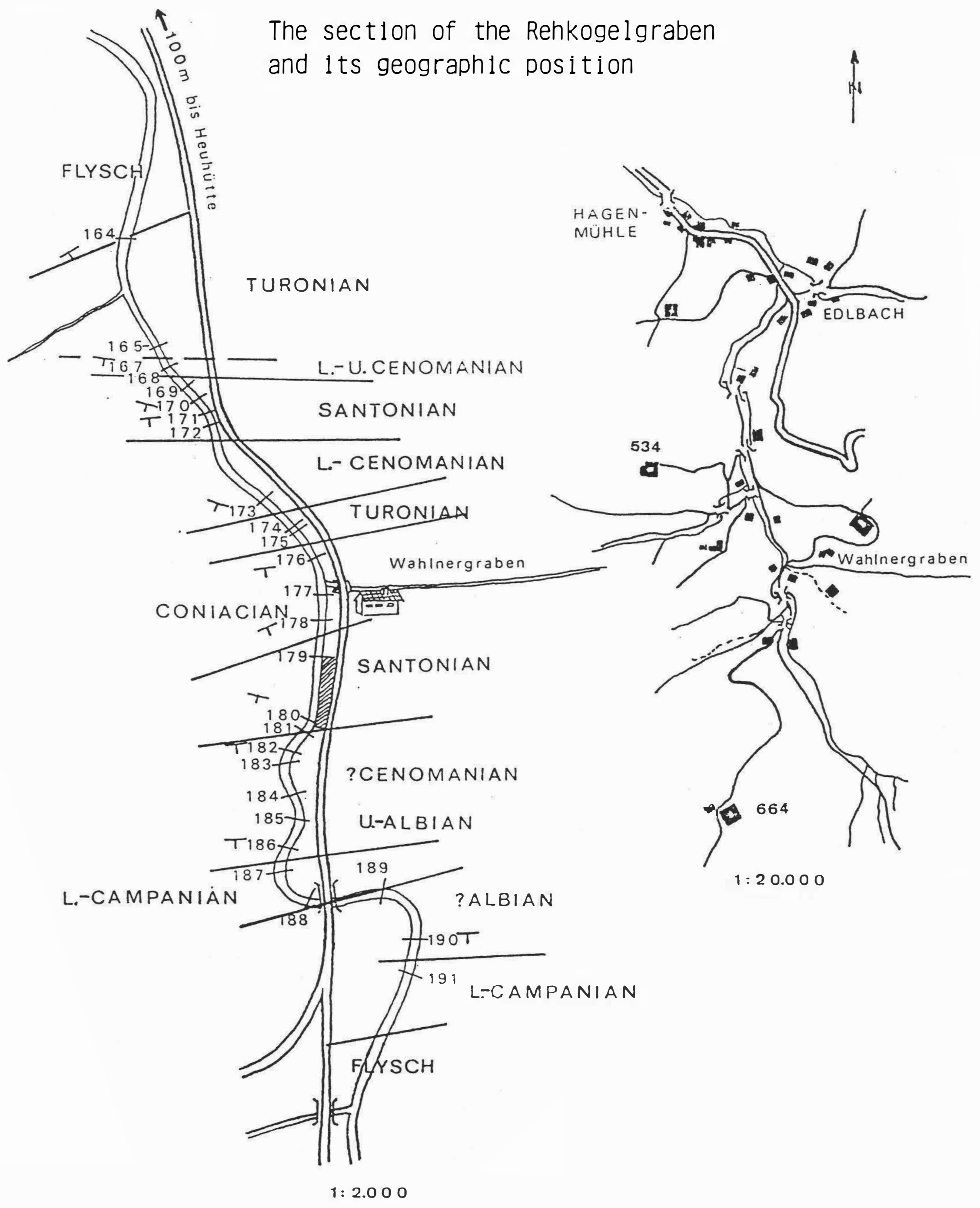


Fig 37 Location of outcrops of the Rehkogelgraben section (from KOLLMANN & SUMMESBERGER, 1982)

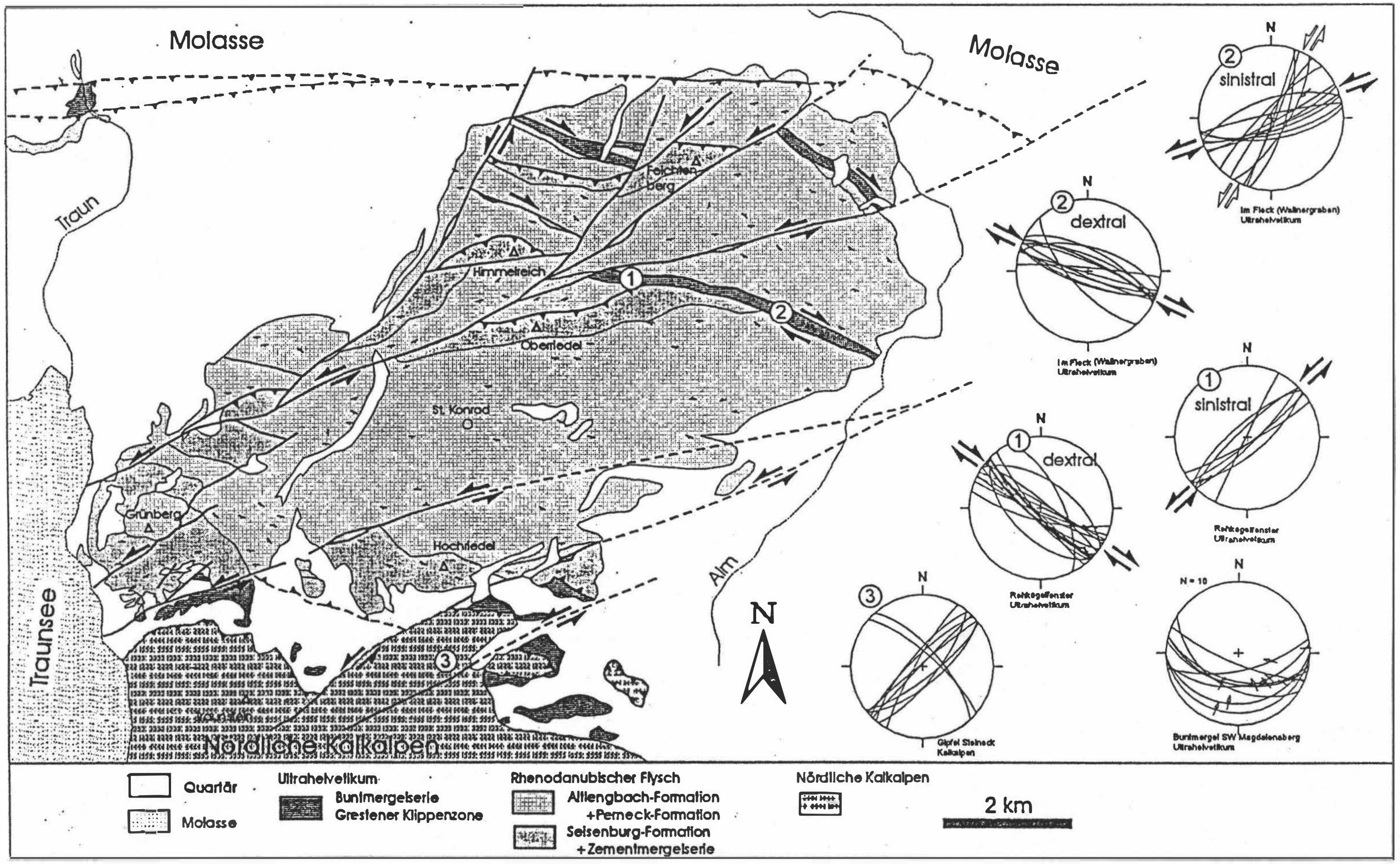


Fig 38 Geological sketch map of the Flyschzone E of Lake Traun

PREY (1952) has introduced the name "Buntmergelserie" (variegated coloured marls) for the pelitic rocks of the Ultrahelvetic continental slope. These rocks were deposited from the Albian to the Eocene. Due to increasing water depths to the south the marls were replaced by claystones and might interfinger with thinbedded turbidites and variegated shales of the Rhenodanubian flysch (EGGER, 1995). Within the Rhenodanubian flysch a number of tectonic windows with Ultrahelvetic rocks exist. Some of these structures are bound to internal overthrusts within the flysch nappe, the rest of them cuts diagonally the flysch units. The Rehkogelgraben window (fig. 38) belongs to this latter type of structures which were created along huge dextral strike-slip faults. The age of these faults is estimated as Oligocene. In the Miocene ENE-striking sinistral strike-slip faults cut the older NW-striking dextral strike-slip faults (fig.38). These younger faults terminate the Rehkogelgraben window to the west and to the east (EGGER, 1996).

From the narrow road beside the farmhouse (fig.37) one can get a good view to steeply south-dipping reddish marls and grey marly limestones of Coniacian to Santonian age. The samples (180 and 181) from the outcrop at the outer bend of the small creek contained well preserved planktonic foraminifera of Santonian age. *Marginotruncana coronata* (BOLLI), *Marginotruncana sinuosa* PORTHAULT, *Marginotruncana marginata* (REUSS), *Marginotruncana paraconcavata* PORTHAULT and *Globotruncana lapparenti* BROTZEN are the most important species (RÖGL ,1982).The Santonian rocks border tectonically to grey marls and highly bioturbated spotted marly limestones of Cenomanian age. Sample 182 contained only badly preserved and small foraminifera: *Hedbergella cf. planispira* (TAPPAN), *Hedbergella cf. delrioensis* (CARSEY) and *Globigerinelloides sp.* . In sample 185 *Biticinella breggensis* (GANDOLFI), *Hedbergella planispira* (TAPPAN), *Clavihedbergella subcretacea* (TAPPAN) and *Globigerinelloides sp.* prove the late Albian (RÖGL, 1982).

Just beside of the small road bridge red marls are exposed along the creek. They are of early Campanian age (*Marginotruncana coronata* (BOLLI), *Marginotruncana marginata* (REUSS), *Globotruncana lapparenti* BROTZEN, *Globotruncana bulloides* VOGLER; *Globotruncana elevata* (BROTZEN)).

Stop 3.3: Core storage Pettenbach

Lithostratigraphy of the Molasse basement and the Tertiary Molasse basin.
(core # and wellnames of displayed examples in corehouse of RAG at Pettenbach. (HP figure index stands for figure in booklet "Hydrocarbon potential and exploration opportunities").

PALAEOZOIC

In the subsurface of Upper Austria, the late Palaeozoic (Permo- Carboniferous) sediments are limited to graben structures in the south-western margin of Central Swell Zone which forms the south-eastern extension of the Landshut-Neuötting High in Bavaria. From the light grey fluvial sand- and siltstones with coal seams in the

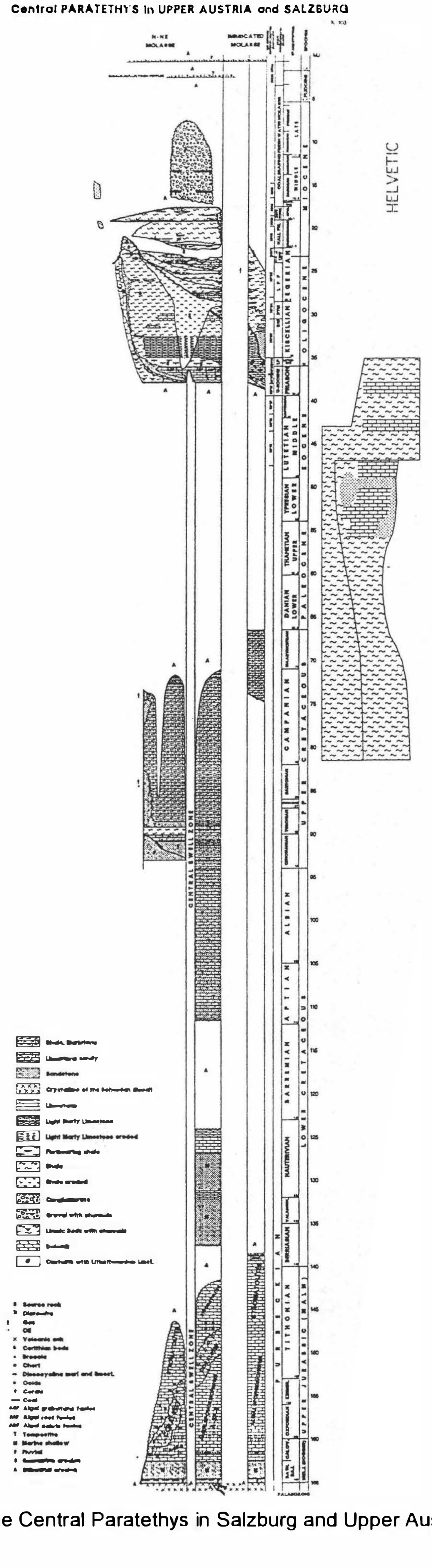


Fig 39 Section through the Central Paratethys in Salzburg and Upper Austria

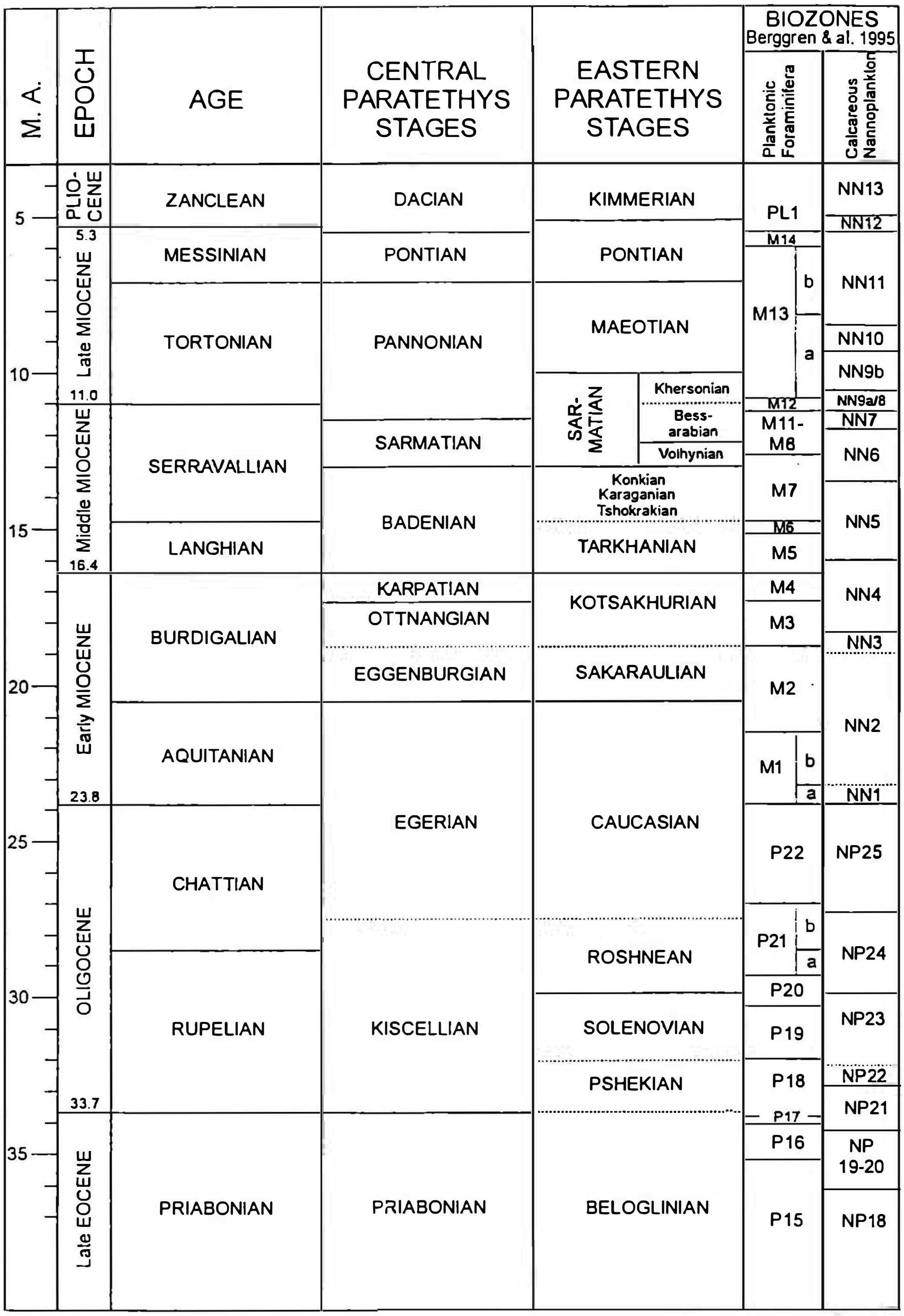
well Hochburg 1 (core#7) were determined by Permo-Carboniferous spores (Stephanian-lower Permian; I. Draxler, pers. commun., 1981).Autochthonous Triassic sediments are not preserved below the western Molasse in Austria.

JURASSIC (fig. 39, HP fig.12, p.25)
In Middle Jurassic (Bathonian-Bajocian) braided fluvial to shallow marine sandstones with coal layers of the **Gresten Group** are the earliest encountered Mesozoic series (Mayersdorf 1, core#1). From Callovian through upper Jurassic-Malm and into lower Cretaceous, carbonates were produced on the tropical shelf along the Bohemian landmass. The Jurassic shelf reached its greatest water depth in the west of the craton in Callovian in the south-west below the Alps of Salzburg. The vertical section of the carbonates starts with dark brown and light grey arenaceous nodular micrits of the **Höflein Formation**. They contain lumachelles, ammonites, belemnites and sponge spicules with abundant chert nodules and grade upward into biostromal limestones.The dolomitized, leached and partly fractured chert nodules are excellent oil producers (Haindorf1,core# 2).Oxfordian and Kimmeridgian algal and sponge banks are capped by coral reefs and their debris, surrounded by the high energy environment with oolites and grainstones. The salt lagoon and tidal flat deposits of the **"Purbeck"** Facies (from Tithonian to early Berriassian) consist of thin bedded fine crystalline dolomites, cherty limestones, breccias and stromatolites (Oberhofen1, core# 16).

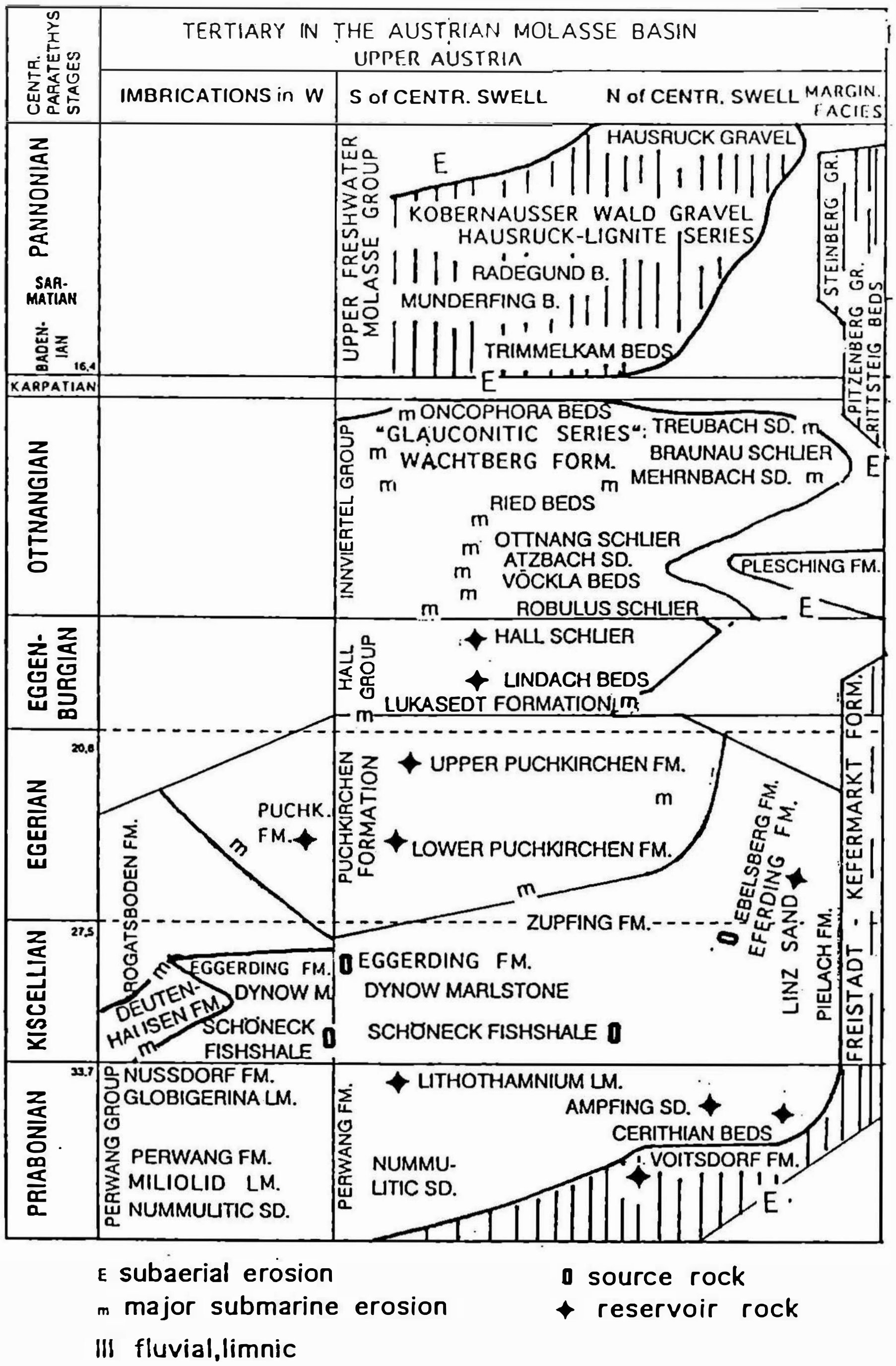
CRETACEOUS (fig. 39, HP fig.12, p.25)
During the Early Cretaceous the area of Salzburg and Upper Austria becam,e uplifted and subjected to erosion and karstification. South of the Central Swell Zone two pulses of transgressions in Lower Cretaceous are recorded in one well in Upper Austria (WAGNER, 1996) and from Bavaria (LANGE AND PAULUS, 1971).To the northeast of the Central Swell Zone non fossiliferous fluvial sandstones, which infill Jurassic karst, are overlain by the marine Cenomanian sandstones and shales. The Cenomanian sandstones are deposited by storms and reach thicknesses of 15 to 70 metres. In a complete sequence, the basal beds have a silicious cement, whereas the middle beds, have calcitic cements. Both are characterised by the rhythmical successions of thinly laminated storm layers with hummocky cross bedding and escape burrows and heavily burrowed fair weather layers with burrows mainly of the ophyomorpha and skolithos type and from molluscs (Bachmanning1, core#2 &3). The upper beds start with a tight, calcareous glauconitic sandstone with red zones and spots caused by flushed-in oxidised clay minerals. This marker bed is easy to identify by the high resistivity on logs, the large (up to 4 cm) thick single quartz and feldspar grains and the abundant large Echinoid burrows. The top section is a succession of porous and tight calcareous glauconitic sandstones and spiculitic limestone nodules and layers. The basal and middle beds were deposited on the inner shelf below normal wave base. With the marker bed, the Cretaceous sea transgressed further across the massif and most of the preserved upper layers represent outer shelf sediments. The maximum drilled thickness of Cretaceous sediments with a stratigraphic range from Cenomanian to Upper Campanian is 800 metres. Oil and thermal gas from Mesozoic reservoirs is produced mainly from the Cenomanian sandstones.

TERTIARY

EOCENE (fig.39, tab.4 & 5)



Tab.4 Cenozoic geochronologic and chronostratigraphic correlation (F. RÖGL 1996).



Tab. 5 Tertiary in the Austrian Molasse Basin

In the upper Eocene the Tethys Sea progressively encroached across the Mesozoic and Crystalline fault blocks (HP fig.7, p. 20). The present Foreland Molasse is only a narrow remnant of the original basin. In late Eocene time, the Central Swell Zone was the high zone which separated the lagoon from the slope to the open marine realm (L. Wagner, 1980). The different facies zones (fig. 32)started in the north with fluvial floodplain white, yellow earth, olive green and red clays with roots traversed by meandering channels of the limnic series of the **Voitsdorf Formation** (Eberstallzell 14, core#1 &2). They are underlain locally in graben structures by accumulated channel sands of the braided stream system. In the top section occur locally already strongly bioturbated estuarine channel sands. The fluvial and limnic Voitsdorf Formation was transgressed by upper Eocene in the S and progressively younger Oligocene sediments to the **N** and **NE**. The subsiding floodplain is capped by a swamp coal bed which is overlain by dark grey, soft shale of the paralic **Cerithian Beds** (Eberstallzell 13, core# 1&2)**.** The shales are cut by tidal channels and merge into inundated sandflats. Finally shallow marine sands of the **Ampfing Formation** were deposited along the shoreline of the lagoon. The red algae (corallinaceae) and coral reefs of the **Lithothamnium Limestone** are centred on top of the Central Swell Zone and shed their debris to the north into the lagoon and to the south into the high energy open marine shelf edge.

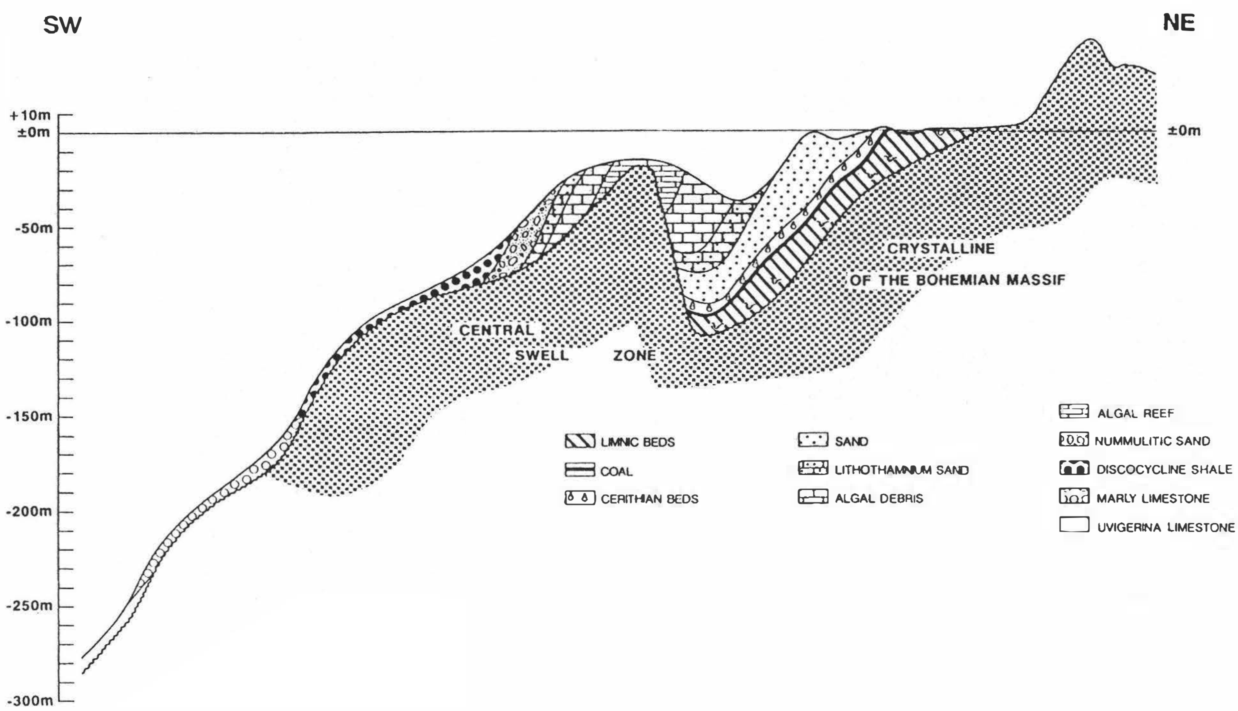
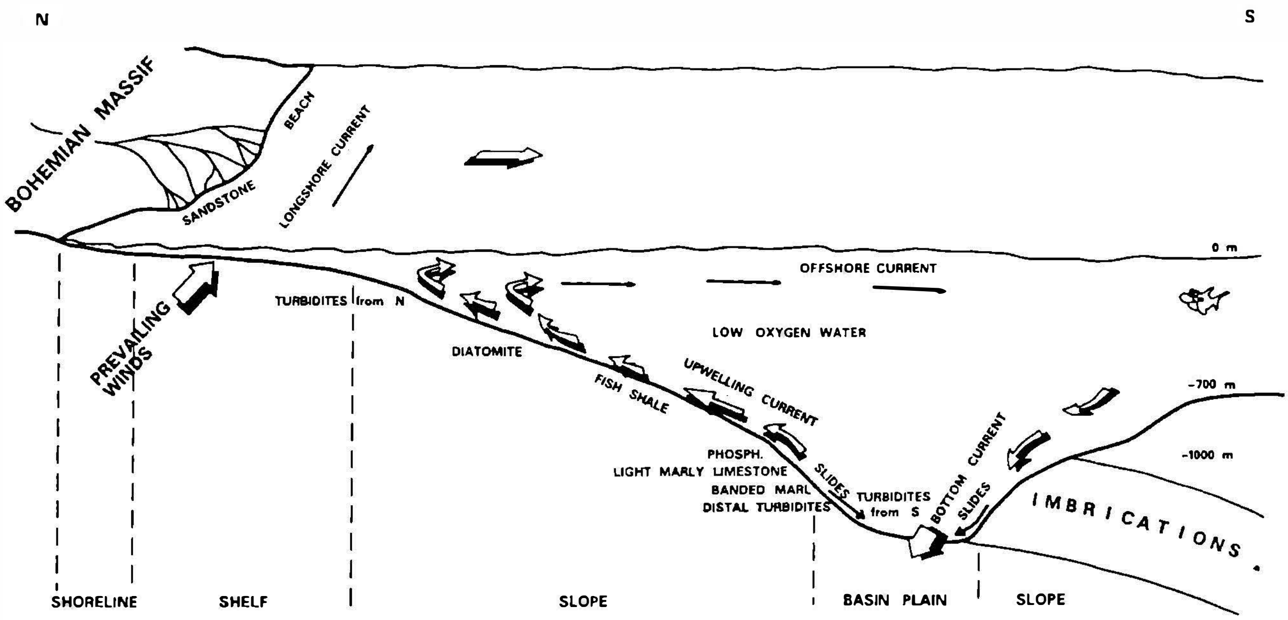


Fig. 40 Facies cross-section through the Upper Austrian Molasse basin at the Eocene-Oligocene boundary

On the slope, successively deeper environments were developed characterised by foraminifera. A zone with the larger foraminifera nummulites and discocyclines, is followed by sediments deposited on the deeper slope bearing ornamented uvigerinas and globigerinas. The Discocyclina limestone and marl is limited to the southwestern autochthonous Eocene (Helmberg1, core#1) and to the Molasse Imbrications.Oil and thermal gas are produced from the fluvial sands of the Voitsdorf Formation, the tidal channel sands of the Cerithian beds, the shallow marine sands of the Ampfing Formation and from the Lithothamnium Limestone

FACIES DISTRIBUTION IN THE OLIGOCENE AND LOWER MIOCENE.
<u>MODEL FOR THE DEEP MARINE OLIGOCENE-EARLY MIOCENE BASIN.</u>

After restoring the tectonic units to their original depositional position the reconstructed distance at the end of Eocene from the floodplain deposits in the north to the more than 3000 m deep Flysch trough was approximately 250 km (L. WAGNER, 1996). With the deepening of the Molasse ocean in early Oligocene time the interactive process between cold deep water currents and the upwelling on the slope. Warm longshore and offshore currents at the surface and a low oxygen zone in the middle in medium water depth (J. PARISH, 1982) was established (fig.41).



Sketch of the upwelling model for marine currents and facies, after Parish (1982) & Armentrout (pers. comm.).

Fig 41 Upwelling model for marine currents and facies

With cold deep oceanwide circulating bottom currents boreal fauna immistated into the Molasse sea (L. DOHMANN, 1991) from the Kiscellian throughout Oligocene into the lower Miocene.The palaeoecological conditions in the Paratethys, with wide spread areas with under low oxygen conditions deposited fish shales from the western Alps to the Crimea, are the cause for the occurence of aberrant foraminiferal species (F. RÖGL, 1994). At the same time, a tropical to subtropical fauna and flora existed on land and in the surface water of the Molasse basin.
The bottom currents eroded deeply in front of the north-ward moving Alpine nappe system into older sediments. This erosion immediately was followed by rapid sedimentation of gravity deposits and turbidites and reworking of sediments. The deepest erosion took place during early Miocene time.

The gravel in the Oligocene conglomerates was derived from the Central Alp mountains. The conglomerates contain crystalline, gneiss, granite, porphyrite, phyllite, quartzite, quartz, chert, dark grey and light grey and brownish dolomites and limestones. The pebbles were transported across the shelf of the drowned

Northern Calcareous Alps and the southern slope, composed of Flysch and Helveticum, into the southern Molasse Basin. The Crystalline pebbles belonged to hills or a mountain range which was sitting above the presently outcropping Crystalline in the Central Alps. Olistoliths of Helveticum material slid into the basin. They are abundant in the uppermost Molasse Imbrications which were set down at the southern edge of the Molasse basin at the foot of the slope.

OLIGOCENE

Basin and slopes.

The cold dense deep marine bottom currents were forced to deviate from their former main flow due to the tectonically northward moving slope. Therefore the current cuts deeper into the seafloor further to the north. The south slope as well as the north slope were undercut by erosion. Massflows from north and south filled the lows in periods of less energetic bottom currents (L. WAGNER, 1996).

The "flysch - like" sedimentation in front of the Flysch and Helveticum nappes was shifted in the Kiscellian to the Molasse trough. The early Kiscellian **Deutenhausen Formation** sand turbidites outcrop in the allochthonous Molasse in Bavaria. The sandstones are predominantly cemented by calcite and exhibit complete Bouma sequences with thin pelitic layers. They contain besides reworked fauna nanno fossils and exclusively agglutinating foraminifera. In the well Aurach1 (close to the quarry Hatschek, stop 3.1), approx. 100 m of Deutenhausen sandstones were encountered in the autochthonous Molasse below the Flysch.

The **Rogatsboden Formation** is characterised by calcareous, pelitic and distal parts of the turbidites and contourites with dark and light grey, micaceous sandstone layers, lenses and ripples with deep water foraminifera. Excellent outcrops with slumps and contourites can be studied in the allochthonous Molasse of Bavaria e.g. in the riverbeds Ammer (locality Scheibum) and Traun at Siegsdorf (stop 2.7). The term contourite means bottom currents reworked deposits (G. SHANMUGAM et al., 1993). The terminologies for the gravity driven deep marine sediments - turbidite, slump and slide - are used in the meaning suggested by SHANMUGAM et al (1994).

The Rogatsboden Formation in the uppermost Molasse imbrications, which have been sedimented in the farthest to the south, contains high amounts of massflows of almost exclusively Helveticum olistoliths. In middle Kiscellian to early Egerian time, the distal calcareous and pelitic parts of turbidites from the S extent further up on the slope of the Bohemian Massif and interfinger with local turbidites from the N in the **Zupfing Formation**. The Zupfing Formation consists of pelites with fish remnants and of limestones with exclusively nanno fossils (nanno blooms) to the S and in the stratigraphic older portions. These sediments are the preserved distal parts of the turbidites from the S, which have not been eroded before the sedimentation of the younger Puchkirchen clastics. Intercalated are slides and slumps from the northern slope of soft pelites of the Ebelsberg Formation. The sandstones of the turbidites from the N are accumulated at faults.The axis of the deep part of the Molasse basin was shifted to the N by the northward movement of the Alpine thrust system. The Zupfing and Ebelsberg Formations became subject to intensive submarine erosion.

Subsequently, with the movement of a slice of the Molasse Imbrications and erosion, the lows were filled by the Egerian to early Eggenburgian sediments of the **Puchkirchen Formation.** The infill of the Puchkirchen Formation is composed of more than 80 percent of slide and contorted slump material from both sides of the basin. Slides and slumps of Zupfing and Ebelsberg deposits from the **N** interchange with slides and slumps of Rogatsboden Formation and by the imbrications uplifted and again moved downslope Puchkirchen sediments and of the new turbidites from the S and of contourites. The bottom currents transported the fine material from the mass flows and turbidites in E-W - direction and along the erosional lows in front of the Molasse Imbrications and parallel to the faults. In the resulting muddy and sandy all reworked sediments can be recognised in the alternating laminae. The Puchkirchen Formation turbidites comprise micaceous sandstones and conglomerates with Bouma sequences. The well rounded pebbles are often coated with a black film and reach more than 30 centimetres in diameter. The matrix of the sandstones are angular to subrounded lithic arenites. The mass flows of light and dark grey and brown micaceous pelites, silts, sands, sandy and muddy conglomerates reproduce the lithology from the active and passive slope. The contourites contain the reworked fine grained material of the pelitic, silty, sandy and conglomeratic slumps and turbidites (Friedburg 5,core#6, Friedburg13, core#2, Sankt Georgen 1, core#1 & 2, Atzbach 23, core#1, Puchkirchen 23, core#5).The microfossil assemblage of the autochthonous sediments contains only deep water agglutinating foraminifera (in the lower portion: Rhabdammina linearis), besides intensively reworked fauna from **N** and S Molasse and Helveticum and excellent preserved single fossils from Cretaceous and Eocene The stratigraphic range of the Puchkirchen Formation comprises Egerian to early Eggenburgian.

All diagnostic sedimentary structures described from the Ewing Bank in the Gulf of Mexico (G. SHANMUGAM et al., 1993) can be studied in the cored contourite sediments. At the core display in Pettenbach are predominantly fine-grained thin-bedded to laminated sands and silts in deep-water mud with numerous layers per metre and with sharp upper contacts and bottom contacts, internal erosional surfaces, horizontal lamination and low angle cross-lamination cross-bedding, lenticular bedding, starved ripples, mud offshoots, flaser bedding flame structures and sand dykes. Also the shale layers in between are predominantely reworked by bottom currents. They are laminated or folded (slumps). They are composed of the fine material from several different slides and turbidites (Sankt Georgen 1, core#2, Atzbach 23, core#1, Friedburg 5, core#6, Friedburg 13, core#2).

In late Oligocene time, Puchkirchen conglomerates, trachy-andesitic volcanic ash was recovered in cores from several wells. These ashes are probably related to the Oligocene intrusives along the Periadriatic line (MAIR et al. 1993 &1996). The bentonite beds (KURZWEIL, 1973) in the Ebelsberg Formation are equivalent to volcanic ashes in the Egerian of Hungary and Slovakia. From the rise of the basin to the north and up the slope the sequence of sediments is characterised by the upwelling system. It starts with distal turbidites from the south and local turbidites from the north, merging into a zone with blooming of nannoplancton, the Kiscellian "Banded Marl" of the **Eggerding Formation** (Eggerding W1, core#3) and the pure nanno ooze of the light coloured middle Kiscellian **Dynow Marlstone**, and below the low oxygen zone fish shales. The middle Kiscellian Eggerding Formation is composed of dark grey laminated pelites with thin white layers of nanno plancton (nanno blooms) and is often tectonized. The banded marl contains breccia of submarine reworked lithothamnium limestone (Oberhofen1, core# 12) and Schšneck Formation and has a high tendency to slide (L. WAGNER, 1996). Some layers within the Eggerding Formation yielded similar TOC (total organic content) values as in the Schöneck shales.The early Kiscellian **Schöneck Formation** is the source rock for the Molasse oil and contains phosphorite nodules (Eberstallzell13, core#1). The dark grey or brown, shaly, thin-bedded limestones and shales of the early Kiscellian Schöneck Formation contain abundant fish remnants and medium to deep-water calcareous and agglutinating foraminifera.

The younger Oligocene black to brown silty, soft fish shale of the Kiscellian and Egerian **Ebelsberg Formation** has locally interbedded high amounts of diatomites and menilites, stratified and laminated nanno blooms. The pelites are partially bituminous and non calcareous and contain also phosphorite nodules and bentonites, abundant fish remnants and agglutinating and rare calcareous foraminifera. On the shallow shelf, abundant terrigenous material was shed into the dark grey, silty pelites of the Kiscellian and Egerian. Calcareous foraminifera are the dominant microfauna in the Eferding Formation.

At the northern coast is a narrow belt of Kiscellian and Egerian shoreline pelites (Eferding Formation) and sands of the **Linz Formation**, paralic pelites and floodplain and swamp deposits developed (HP fig.7, p. 20).

MIOCENE - Eggenburgian
An Eggenburgian microfauna was determined in the upper few hundred metres of the **Puchkirchen Formation** in the W (F. RÖGL, pers. commun. 1994). Above the most prominent submarine erosion across the Molasse basin, a new fauna immigrated in the **Hall Group** from the Indian Ocean (F. Steininger & F. Rögl 1979, F. Rögl & F. Steininger, 1983). The oldest deposits of the Hall Group is the **Lukasedt Formation** (stop 2.3). At the time of the deposition of the overlying **Hall Formation** the whole Molasse basin was filled with light grey to green-grey, micaceous, sandy pelites the so-called "Hall Schlier", which are the distal parts of turbidites and contourites. The centre of the Hall basin accumulated the turbiditic and contouritic sandstones and slides in erosional lows (Heitzing G5, core#3). The pelitic caprock of the gas reservoirs contains slumps and coquinas of holoplanctonic living gastropods, the pteropods (Zell am Pettenfirst1, core# 1). The pattern of the lows is delineated by the fault-systems. The turbidites and contourites of the Hall Group and the Puchkirchen Formation are the reservoirs for the biogenic gas.

TECTONIC SETTING

The Crystalline basement has been stretched in the Mesozoic and early Tertiary to the SW and SE and in the early Oligocene to the S. From Miocene on it has been transpressed, which means compressed and partly pulled apart between strike - slip systems. The system is relatively locked by the spur of the Bohemian Massif on the west flank

The Bohemian Massif is dissected by a system of conjugate NW-SE - and NE-SW-trending faults and secondary fault systems running approximately N - S and E - W. The NW- and NE-trending fault systems already existed in Palaeozoic times (B. SCHRÖDER, 1987, WALLBRECHER, E. et al., 1996). The faults became reactivated in early Jurassic, early Cretaceous and early Tertiary. Through these periods of tectonic activity the Crystalline basement and its cover were pulled apart using the old fault planes

During the latest Eocene and earliest Oligocene the area of the Central Paratethys subsided rapidly to deepwater conditions. This was accompanied by the development of a dense network of WE -trending antithetic and synthetic extensional faults (L. WAGNER, 1996 & 1997). The resulting structure of the basin parallel fault system contain most of the Mesozoic and Tertiary oil bearing reservoirs. Almost all of the early Oligocene extensional faults in Upper Austria were integrated in the transpressional stress in the Miocene. The sediments were further displaced laterally either to the NW or to the NE along the post Eocene faults. Locally the soft sediment on top of the competent Eocene rock started to overthrust at sharp bends in the fault pattern. Through this compression, many of the extensional faults became seals. On the other hand the NW- and NE -fault system acted in Miocene as drainage for the oil migration from below the thrust sheets.

Oil and gas fields in the Upper Austrian Molasse Foredeep

By Heinrich Polesny

The first gas and oil in present Austria was found in the Upper Austrian Molasse Basin (1892 gas in Wels and 1906 heavy oil in Leoprechting). Both discoveries were accidentally encountered by water wells in the shallow northern part of the Molasse Foredeep.

Many years passed by without any other hydrocarbon finds.In 1956 RAG (Rohöl - Aufsuchungs Aktiengesellschaft), Austrias oldest oil company (founded 1935), encountered oil by drilling its first exploration well in Upper Austria. The well Puchkirchen 1 hit oil in Eocene sandstones (Cerithian beds).

Meanwhile, many oil and gas fields have been discovered. The largest oil field so far is Voitsdorf (1962/63), located a few kilometres NE of the core lab Pettenbach. Some 40 wells have been drilled in this field, which is a E-W trending monocline with a major fault in the N. Erosional processes made a joint reservoir with Eocene sandstones (fluvial and marin) overlaying the Cenomanian sandstones (tempestites) which rest on Jurassic sandstones. This field is crowned by a gas cap. 3.1 MM tonnes (23 MM BBL) of oil have been produced in Voitsdorf up to the end of 1996.

The last important oil discovery was Kemating (1979) where the oil is trapped in shallow marine Eocene sandstones of a fault block.

The oil fields are controlled by faults and the south dipping beds. Sometimes in addition the shale-out of the reservoir playes an important role.

The Schöneck Fishshale (early Oligocene) is the source rock for the Upper Austrian Oil. Generation took place below the Alpine nappes starting in Miocene.
The first commercial gasfind of RAG happened 1962 (Schwanenstadt 2, in Miocene Hall Formation). Most of the gas (bacterial gas) is found in Oligocene and Miocene coarse clastics (turbiditic sandstones and sandy conglomerates). The gas is trapped in compaction anticlines, stratigraphic traps or in a combination of both.

In the last few years prospects in the area of the rather complex imbricated molasse have been drilled. So far only one significant gas field has been discovered in these imbricates.

Several gas fields were found by drilling deeper oil prospects.

In most of the deeper horizons there is condensate associated with the biogenic gas.

The largest gas field is Atzbach - Schwanenstadt with gas in the deep marin coarse clastics of Puchkirchen Formation and partially in Hall Formation (cumulative production to end of 1996 3.25 B Ncbm(121 BSCF)).
Thermal gas is found in the Eastern part of Upper Austria in Upper Cretaceous and Eocene sandstones. Some reservoirs contain a mixture of thermal and biogenic gas.

Since 1965 OMV has been sucessfully exploring in parts of Upper Austria.

Deep prospects S of the Alpine thrustfront encountered only marginal oil and gas accumulations.

One well in the imbricated zone had a good oil influx but due to a later high water cut the well was uncommercial.

The low oil price has compelled RAG to concentrate on gas prospects during the last 11 years. This caused a decline in the oil production. The gas sales have been supplied by new discoveries and development drilling.

Though the big compaction structures have been drilled for many years more complicated, but smaller, gas accumulations are being found.

The fault pattern is important for the occurence of the reservoirs and the traps.

The Molasse foredeep of Upper Austria and Salzburg is the second most important hydrocarbon province of Austria.

At the end of 1996, RAG had produced 8.1 MM tonnes (60 MM BBL) of oil and
15.8 B Ncbm (588 BSCF) of gas.

RAG installed an underground gas storage in the Puchkirchen gas field (Upper Puchkirchen Fm.). Six horizontal wells (horizontal length in the reservoir > 1000 m) have been drilled. Another gas storage project is handled by OMV.

RAG has drilled some 600 wells in the Molasse Foredeep.The basin is covered by a dense grid of 2 D-seismic lines and relative large area by 3 D- seismic.

High temperatures (> 100° C) and appropriate reservoir rocks (karstic Jurassic carbonates) offer good geothermal potential. Some geothermal projects are already operating partially using old RAG wells. Even electric power will be generated.

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