water masses (sensu Schopf 1980). According to this interpretation, the transgression would procede from the Mediterranean region (comp. Rögl et Steiniger 1983) from the SW.The intrusion of the lower waters of the open sea (from the oxygen minimum zone) penetrated permanently into this basin near the bottom, propagated on it and caused low-oxygen conditions. The evaporation was evidently lower than the influence and the surface streams led away the warmer, and possibly even less salty water from the basin into the open sea. A sufficient dotation in organic matter from the dry land contributed to a relatively long-term regimen that was poor in oxygen. This concept is also supported by the character of microfauna of the Karpatian (relatively low diversity of assemblages, relatively great individual frequency, an indistinct and often dwarfish plankton, frequent occurrence of groups of benthic foraminifera or of elements tolerant with respect to low oxygen contents, which has, compared with the Badenian, a higher content of organic substance and a lower content of $CaCo_3$ in the sediments and a considerable content of laminated sediments. To the NE, the basin became generally more shallow and the influence of the open sea became less prominent.

In the Lower Badenian, the deep-sea component of the fish fauna became substantially more diversified and had a different composition. Over 20 genera of mesopelagic and archibenthic fishes occur in them which not only with respect to their composition, but also with respect to the frequency of their representatives correspond to the ecologically related ichthyocoenoses of the recent Mediterranean Sea. It may thus be assumed, that in the Lower Badenian the water regimen significantly changed compared with the Karpatian. The substantially more extensive Paratethys communicated in the W with the Mediterranean and in the SE with the Indopacific region. The communications between this region and the open sea did not necessarily attain greater depths than 300 m, the communication in the W, however, was decidedly deeper than in the SE. Inside the basin, however, partial basins must have existed with a depth reaching up to 1000 m. From the point of view of water circulation, the Central Paratethys became a Mediterranean type basin in the sense of Schopf (1980). Above all surface water of the free sea penetrated into them, partly they evaporated, subsided to the depth and flew out near the bottom. The supply of organic matter was evidently lower than in the Karpatian and the waters had a high oxygen content. In favour of this type of circulation of water witnesses not only the homogenized character of sediments generally rich in $CaCO_3$ and poor in organic matter, but also rich and highly diversified biotes of the bottom of various depths, considerably diversified plancton and evidently the most populated pelagial from all levels of the Central Paratethys.

In the Middle Badenian, the deep-sea component of the fish fauna is distinctly reduced and delimited above all to the western region of the Central Paratethys. The presence of some of the archibenthic fishes, however, still witnesses in favour of the considerable depth of the sedimentary region and of the communication paths into the Mediterranean region. The occurrence of otoliths of mesopelagic fishes in the Czechoslovak part of the Vienna Basin, the Dráva-Depresion, in the Polish Foredeep, belongs exclusively to the juvenile stages of fishes which are transported by streams over enormous distances.

In the Upper Badenian, the mesopelagic elements appear only sporadically in the otolith faunas of Roumania, in the western part of the Central Paratethys they are practically missing. This fact is controversary to the interpretation offered by Kókay (1984) on the communication of the Upper Badenian sedimentary region and they explain rather the interpretation offered by Rögl et Steininger (1983)-

More detailed data on the discussed problems are in the paper by Brzobohatý (1987).

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Abstrakt

Autochtonní asociace otolitů mezopelagických a archibentálních ryb byly v centrální Paratethydě prokázány dosud pouze v sedimentech karpatu a spodního a středního badenu. Jejich složení v konfrontaci s údaji mikrobiofaciálními, sedimentologickými a geochemickými umožňuje interpretovat hydrodynamický režim jednotlivých pánví. Během karpatu převládal estuáriový typ cirkulace vod s relativně nízkým stupněm prokysličení. Ve spodním a středním badenu převládal mediteránní typ cirkulace vod s vysokými obsahy kyslíku a výbornou komunikací s volným mořem.

Zusammenfassung

Autochthone Assoziationen der Otolithen mesopelagischer und archibenthaler Fische wurden in der zentralen Paratethys bisher nur in Sedimenten des Karpatiens sowie des unteren und mittleren Badeniens nachgewiesen. Der Vergleich ihrer Zusammensetzung mit mikrobiofaziellen, sedimentologischen und geochemischen Angaben ermöglicht eine Interpretation des hydrodynamischen Regimes in einzelnen Becken. Im Karpatien überwog der Ästuartyp des Wasserkreislaufs mit einem verhältnismäßig niedrigen Durchlüftungsgrad. Im unteren und mittleren Badenien überwog der mediterrane Typ des Wasserkreislaufs mit hohen Gehalten an Sauerstoff und einer ausgezeichneten Verbindung mit der hohen See.

NEW STUDIES OF THE OTOLITHS FROM THE MARINE OTTNANGIAN (LOWER MIOCENE, UPPER AUSTRIA)

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Preface

From the end of the 1970's onward, some coal cuttings were found in hydrocarbon wells, particularly north and west of the Hausruck region in Upper Austria. All of these coal occurrences are located in sandy beds of the predominantly muddy Robulus Schlier s.l. (Innviertel Group, Ottnangian) at depths ranging between 150 and 500 m.

In 1982, a cored hole (Kemating K 1) was drilled by the Geological Survey of Austria to explore the potential for coal occurrences; well logging was also done. Intensive sedimentological investigations were subsequently carried out; the total floral and faunal assemblage was examined by specialists for the purpose of environmental analysis. The fossil content of cuttings of hydrocarbon wells in the distant surroundings was also determined; field work on

Brief description of discussed wells (from the terrain surface to the top of Hall Formation, Eggenburgian)	
Pfaffstätt 4 (Pfaf 4, Rohöl-Aufsuchungs G. m. b. H = RAG, 1979): **—20,5 m : Quaternary** **—67,0 m : Coal-Bearing Freshwater Beds** **—103,5 m : Ried Beds** **—591,5 m : Robulus Schlier s. l.**	**Kemating K 1 (Ktg K 1, Geological Survey of Austria, 1982):** **—0,5 m : Mehrbach Sands** **—142,0 m : Ried Beds** **—447,6 m (total depth): Robulus Schlier s. l.**
Hocheck 4 (He 4, RAG, 1974): **—3,0 m : Quaternary** **—185,0 : Coal-Bearing Freshwater Beds** **—235,0 m : Ried Beds** **—739,0 m : Robulus Schlier s. l**	**Pattigham Süd 1 (Pa S 1, RAG, 1979):** **—2,0 m : Quaternary** **—81,0 m : Ried Beds** **—620,0 m : Robulus Schlier s. l.**
Kemating 1 (Ktg 1, RAG, 1979): **—1,0 m : Quaternary** **—97,0 m : Ried Beds** **—615,2 m : Robulus Schlier s. l.**	**Eberschwang 1 (Esw 1, RAG, 1979):** **—1,0 m : Quaternary** **—108,0 m : Ried Beds** **—572,0 m : Robulus Schlier s. l.**
Kemating 3 (Ktg 3, RAG, 1979): **—0,3 m : Quaternary** **—88,0 m : Ried Beds** **—608,0 m : Robulus Schlier s. l.**	**Haag 2 (Hg 2, RAG, 1982):** **—8,0 m : Coal-Bearing Freshwater Beds** **—90,3 m : Ried Beds** **—549,0 m : Robulus Schlier s. l.**
Kemating 7 (Ktg 7, RAG, 1983): **—2,0 m : Quaternary** **—110,0 m : Ried Beds** **—620,0 m : Robulus Schlier s. l.**	**Wolf segg-Litzlfeld M 1/83 (Wolfsegg-Traunthaller Kohlenwerks AG, 1983):** **—0,5 m : Quaternary** **—50,4 m (total depth): Atzbach Sands**
Kemating Nord 1 (Ktg N 1, RAG, 1981/82): **—5,0 m : Mehrnbach Sands** **—42,0 m : Ried Beds** **—661,0 m : Robulus Schlier s. l.**	

the sedimentology of outcropping Atzbach Sands south and east of Hausruck was done (Heinrich et al. 1984).

The results of the programme of investigations indicate that the potential for finding in situ coal deposits in Ottnangian sediments of western Upper Austria is not large. However, the core drilling of Kemating K 1 meant the initiation of modern scientific investigations and geological mapping of Ottnangian sediments in the Innviertel (Faupl et Roetzel 1987).

This paper is concerned with otoliths and their ecological characteristics; the results of other fossil determinations (nannoplankton, spores, pollen, dinoflagellate cysts, lignite, Foraminifera, Anthozoa, Mollusca, Crustacea, Annelida, Echinoidea, Chondrichthyes) on Kemating K 1 have not been published yet.

Geological Review

The Molasse Zone of Upper Austria forms part of the Cenozoic foredeep that accompanies the Alpine and Carpathian ranges along their northern edge from the Rhône Basin to the Caspian Sea (Malzer 1980, Rögl et Steininger 1983). In Upper Austria, the Molasse Basin contains Late Eocene to Quaternary largely detrital sediments of predominantly alpine origin, overlying Mesozoic series and the crystalline basement of the Bohemian Massif (Malzer 1980, Nachtmann et Wagner 1986).

The marine sediments of Ottnangian stage in Upper Austria correspond to the younger part of Lower Miocene Paratethys transgression (Faupl et Roetzel 1987). Ottnangian deposits (Table 1) are showing almost uniform pelitic facies (Robulus Schlier s.s.) in the eastern part of Upper Austrian Molasse Zone, whereas in the western part the sedimentary record shows a more variable pattern. The fan — delta system of the Sand-Schottergruppe with coarse clastic deposits interfingers with the sandy and muddy sediments of a marine regime (Traub 1948, Aberer et Braumüller 1949, Aberer 1958, Faupl et Roetzel 1987). The plant- and coal-detritus bearing sand facies of Robulus Schlier s.l., shown by the wells north and west of Hausruck, especially in the Kemating region, is presumed to correspond with the outcropping Atzbach Sands (Fig. 1). The Atzbach Sands were deposited in a sand-rich subtidal shallow marine environment under strong tidal influences (Faupl et Roetzel 1987). They form a transitional contact with the underlying Vöckla Beds and are overlain by muddy shelf sediments of Ottnang Schlier.

Otoliths

The studied otolith fauna of the Ottnangian sediments of Upper Austria was obtained only from the sand facies of the Robulus Schlier s.l. (the first ten boreholes in table 2), or from its stratigraphic equivalent, the Atzbach Sands (borehole Wolfsegg-Litzlfeld M 1/83). It is an assemblage that is relatively poor in individuals and without exception composed of quite incompletely preserved otoliths (fragments, strongly corroded specimens). The systematic assignment of individual taxons is hence frequently incomplete or approximative. The assemblage, however, significantly extends the scope of our knowledge of the fish fauna of this time interval. It shows, that the Ottnangian fauna of the marine bony fishes was much richer and more diversified than hitherto published; the papers on these subjects had been mainly based on studies of brackish and freshwater facies (Schubert 1906, Brzobohatý et Schultz 1973). The identified taxons and their frequency in the sand facies of the Robulus Schlier s.l. in individual boreholes are listed in table 2.

From the paleoecologic point of view, the otolith assemblage of the studied boreholes is very clear. It is composed of purely marine species which require a stable normal salinity. The only exception might be the problematically evidenced gobiid in the borehole Pattigham Süd 1. A substantial part of the otoliths is constituted by representatives of the family Myctophidae (genera *Diaphus, Myctophum, Symbolophorus*), which can live mostly in the mesopelagic environment (200—1 000 m below water level) of tropical and subtropical oceans. They form the most important component of ichthyoplankton and therefore the basic component of the food chain of fish. They also migrate regularly in great shoals into the epipelagic environment, or up to the sea level. It is generally accepted that their mode of life in the Tertiary was analogous. The other groups of fishes are represented in the studied assemblage only sporadically. Macrouridae (genera *Coelorhynchus, Bathygadus*) are benthopelagic (archibenthal) fishes that occur preferably in the deeper region of the sublittoral and in the upper part of the continental slope. Gadidae (the genera *Raniceps* and *Palaeogadus*) and Ophidiidae (genus *Hoplobrotula*) also belong to the fishes which tend to live rather in open or deeper waters. Only the Gobiidae represent here distinctly shallow-water fishes that can live under both brackish and freshwater conditions.

A direct paleoenvironmental interpretation of this assemblage, however, would lead to false conclusions. The strong corrosion of the otoliths, a fragmentary preservance and composition of the fauna (prevalence of juvenile myctophids) together with the hitherto accomplished paleogeographic interpretations of the Ottnangian sedimentary area point to a typically allochthonous origin. The transport of the otoliths of various fish groups over relatively great distance by predators (other fishes, birds, sea mammals, etc.) is quite usual. Physical factors such as currents are not considered. Many recent assemblages of otoliths have passed through the digestive system of predators. The presence of a great number of sharks in the Ottnangian sediments of Upper Austria (Schultz 1969, Brzobohatý et Schultz 1973) is also in favour of this explanation of the assemblage studied.

In any case, the otolith Robulus-Schlier fauna points to a very good connection between the Upper Austrian region and the open sea as late as during the Lower Ottnangian. This connection was oriented to the W (besides cosmopoli-

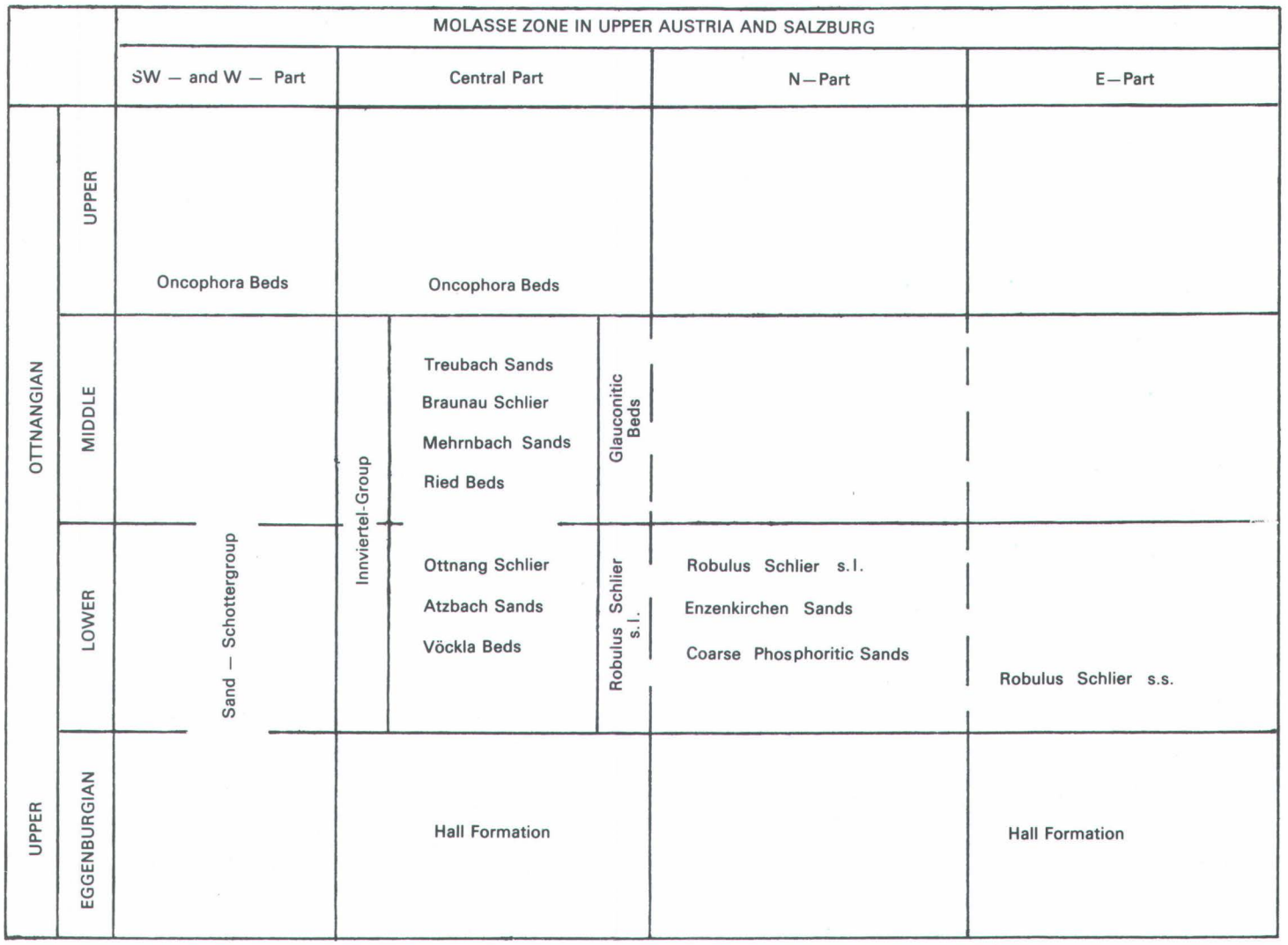

Table 1: Stratigraphic table of Upper Eggenburgian and Ottnangian deposits of Molasse Zone in Upper Austria and Salzburg (by Faupl et Roetzel 1987).

tan and Mediterranean elements and/or even boreal elements — *Hoplobrotula, Raniceps?, Bathygadus, Palaeogadus* — are present there). This conclusion is in harmony with the present-day paleogeographic interpretations (Rögl et Steininger 1983) and with the detailedly evaluated otolith fauna of the Lower Miocene of Aquitania (Steurbaut 1979). The studied otolith assemblage is not competent to prove connection of the Bavarian-Austrian Molasse with the Mainz Basin and probably with the boreal region, which is considered by Martini (1981, 1983) based on the evaluation of shallow water and brackish fish.

The otolith fauna of the sand facies of the Robulus Schlier s.l. is stratigraphically almost indifferent. Apart from taxonomic problems, the identified or at least approximately determined species are currently present in the Miocene and show a considerable geographic distribution (*Diaphus debilis, D. austriacus, D. cahuzaci, Coelorhynchus toulai*). *Symbolophorus meridionalis* has occurred since the upper part of the Lower Miocene. A comparison with the Eggenburgian fish fauna of the Central Paratethys is not possible, because from the Eggenburgian deposits only very shallow and brackish assemblages not containing deeper water elements have been known. But the composition of the deep-water assemblages of the Karpatian differs already significantly in the dominant occurrence of otoliths of the species *Triphoturus carpaticus* (Brz.) and *Hygophum weileri* (Brz.), which seem to be specific for the Karpatian deposits of the Central Paratethys and which have not been established in the Ottnangian.

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species \ wells	Pfaffstät 4	Hocheck 4	Kemating N 1	Kemating 1	Kemating 3	Kemating 7	Kemating K 1	Pattigham Süd 1	Eberschwang 1	Haag 2	Wolfsegg-Litzlfeld M 1/83
Myctophidae											
Diaphus debilis (Koken, 1891)		+	+			+				+	+
Diaphus austriacus (Koken, 1891)		+		+							
Diaphus sp.		+			+	+	+		+	+	
Diaphus cf. cahuzaci Steurbaut, 1979								+			
Myctophum sp.							+				
Symbolophorus cf. meridionalis Steurb., 1979				+	+					+	
Symbolophorus? sp.			+	+						+	
Myctophidae gen. et sp. indet.		+	+	+	+	+	+	+	+	+	
Macrouridae											
Coelorhynchus aff. toulai (Schubert, 1905)										+	
Coelorhynchus sp.			+	+						+	
Bathygadus sp.										+	
Macrouridae gen. et sp. indet.			+								
Gadidae											
Palaeogadus sp.										+	
Raniceps? sp.										+	
Gadidae gen. et sp. indet.	+							+			
Ophidiidae											
Hoplobrotula sp.										+	
Gobiidae											
Gobiidae gen. et sp. indet.								+			

Table 2: Distribution of otolith species in sand facies of Robulus Schlier s. l. of discussed wells.

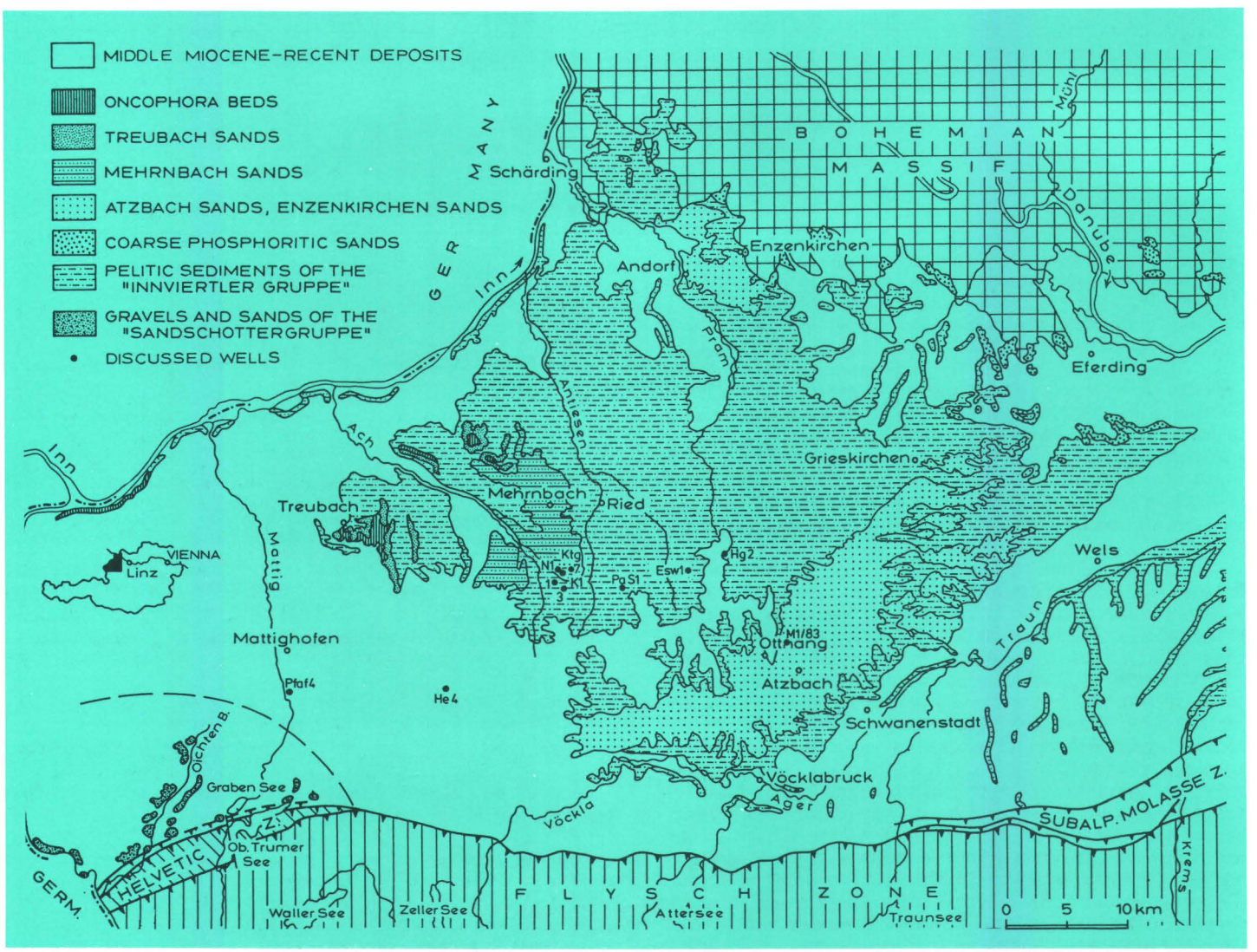

Fig. 1: The Ottnangian sediments in Upper Austria and Salzburg (compiled by Faupl, Rohrlich et Roetzel, 1988) with the situation of discussed wells.

Schultz O.(1969): Die Selachierfauna (Pisces, Elasmobranchii) aus den Phosphoritsanden (Untermiozän) von Plesching bei Linz, Oberösterreich. — Naturkundl. Jb. Stadt Linz 14, 61—102, Linz.
Steurbaut E. (1979): Les otolites de Téléostéens des marnes de Saubrigues (Miocène d'Aquitaine méridionale, France). — Paleontogr., A 166, 50—91, Stuttgart.
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Abstrakt

Otolitová fauna písčité facie robulových šlírů s.l. Horního Rakouska (spodní ottnang) je složena z čistě mořských druhů indikujících relativně značné hloubky původního životního prostředí. Silná koroze otolitů a úlomkovité zachování spolu s převahou juvenilních exemplářů ukazují na primárně allochtonní původ studované asociace, která však každopádně dokumentuje dobré spojení sedimentačního prostředí s otevřeným mořem. S touto představou je v souladu i přítomnost četných druhů žraloků (predátorů) i prokázaná existence relativně silných proudů a silné tidální aktivity během ukládání písčité facie robulových šlírů s.l.

Většina zjištěných druhů kostnatých ryb je ze sedimentů ottnangu uváděna poprvé.

Zusammenfassung

Die Otolithenfauna der Sandfazies des Robulus-Schliers s.l. in Oberösterreich (unteres Ottnangien) ist ausschließlich aus marinen Arten zusammengesetzt, die verhältnismäßig beträchtliche Tiefen des ursprünglichen Lebensmilieus indizieren. Eine starke Korrosion und bruchstückartige Erhaltung der Otolithen sowie ein Übergewicht juveniler Exemplare weisen auf einen primär allochthonen Ursprung der untersuchten Assoziation hin, durch die jedenfalls eine gute Verbindung des Sedimentationsraums mit der hohen See dokumentiert wird. Mit dieser Vorstellung stehen auch das Vorkommen zahlreicher Haifischarten (Raubfische) sowie die nachgewiesene Existenz verhältnismäßig starker Ströme und Gezeiten während der Ablagerung der Sandfazies des Robulus-Schliers s.l. im Einklang.

Die meisten ermittelten Arten der Knochenfische werden aus den Ablagerungen des Ottnangiens zum erstenmal angeführt.

CARBONIFEROUS CONODONTS FROM BRUSNÍK ANTICLINE (SOUTH SLOVAKIA)

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Geologic structure

The geologic structure and tectonic interpretation of the eastern part of the Slovenské rudohorie Mts. (Spišsko-gemerské rudohorie) are at present widely discussed in Czechoslovakia and abroad, especially in Hungary and Austria.

A structure test hole in the southern part of the Slovenské rudohorie Mts. on the periphery of the Rimavská kotlina basin (Vozár et al. 1986) had to solve the problem concerning the geologic structure of the Inner West Carpathians, i.e. the Silicicum as a nappe unit and its relation to the Gemericum s.s. The structure test hole was situated in the Brusník anticline consisting according to earlier ideas (Fusán 1957, Chmelík — Jablonský 1964, Snopko et al. 1970, Varga et al.1971, Mello et al. 1976, Vass et al. 1983) — of Early-Paleozoic complexes. These are lithologically correlated with the Gelnica Group, in the upper part — with Permian and Lower Triassic terrigencus complexes, and higher up with Lower-Middle Triassic limestones. The core of the anticline is ranged to the Devonian on the basis of lithological correlation with the data by Snopková — Snopko (1979). Mello (in Mello et al. 1976) regards the Early-Paleozoic complexes as the Gelnica Group, i.e. as the Gemericum, but he ranges the Late Paleozoic and the Mesozoic to the Silica nappe. According to the new interpretation by Mello — Vozárová (1984) the entire Brusník anticline is part of the Silicicum nappe unit, presumably underlain by the Meliata Group (Meliaticum). Later on (Vozárová — Vozár 1988) the presence of an Alpine granite intrusion in deeper parts of the anticline was presumed. All the opinions were, however, based on the idea of the Gelnica Group as the oldest member in the core of the Brusník anticline, and the anticline was regarded as part of the units in the eastern part of the Slovenské rudohorie Mts. and in the Slovak Karst, i.e. the Gemericum and Silicicum comprising Paleozoic complexes in their structure.

The structure test hole at Brusník (BRU-1) was situated in the core of the anticline. The lithological section of the 1 043 m deep hole offered new data enabling the new interpretation of the anticline, particularly in the relation of Paleozoic occurrences in Hungary.

Following are most significant data from the borehole BRU-1:

1. The borehole penetrated two tectonically related rock complexes as indicated by a prominent fault at the depth of about 600 m;
2. conodonts from the interval of 75—116 m of the upper rock complex were determined by Ebner and Straka and ranged to the Namurian B-C to Westphalian A;
3. the rock complex from the interval 0—598.8 m with its lithologic character and stratigraphic position is best correlatable with the Szendrö Fm. (described from the Szendrö Mts. in Hungary, Kovács — Péró 1983, Kovács 1987);
4. the lower rock complex below the fault sole has so far not been dated biostratigraphically but it may lithologically correspond to olistostromes of the Rudabánya Mts., described by Kovács (1987).

Lithological characteristics

The upper part of the borehole BRU-1 to the depth of 598.8 m consists of grey and black phyllites, metasiltstones, and intercalations of line-grained metasandstones, mostly refolded, showing a distinct cleavage. Metasediments display typical features of flysch sedimentation, including graded- and laminar bedding. Graded-bedded intraformation breccia appear amid the metasediments in the interval of about 497—541 m. Structures in the breccia correspond to the gravity current sediments. The fragments are angular ranging from 1 cm to 10 cm in size. They consist of shales, siltstones, acid volcanics, less lydites, and sporadical crystalline carbonates. Clastic detritus with quartz grains in metasandstones has the same composition. Metasandstones contain small amounts of plagioclase-, microperthite- and clastic mica grains. There are also metamorphosed volcanoclastic sandstones and rhyolite tuffs (maximum in the interval of 250—350 m). The volcanoclastic sediments consist of fragments of quartz-, microperthite-, plagioclase phenocrysts, of occasional K-feldspar and decomposed biotite. The microcrystalline volcanogenic matrix is recrystallized to quartz, sericite, ore pigment, tourmaline and rutile.

Layers of grey to black, bluish-grey carbonates are in the interval of 75—116 m. They are divided from one another by dark shale layers. The carbonates are either crystalline and contain fragments of organic detritus, or they are slightly recrystallized with a micrite or microsparite texture, formerly enriched with clay material and organic matter. In the same interval (75—116 m) conodonts were found, determined by Ebner.

The complex of metasediments from the interval 0—598.8 m underwent regional metamorphism to the initial degree of the green schist facies (the approximate temperature 370—400 °C).