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UPPER PERMIAN-TRIASSIC FACIES ZONES IN THE TRANSDANUBIAN RANGE

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Key-words: Upper Permian-Triassic, facies pattern, paleogeographic reconstruction, Transdanubian Range, Hungary.

Riassunto. Viene analizzata in questo articolo la distribuzione delle facies del Permiano superiore e del Triassico nell'ambito della Catena Transdanubiana. Sono state compilate carte di facies per sei intervalli di tempo, sulla base di dati di superficie e sottosuolo, che sono state utilizzate per le ricostruzioni paleogeografiche. Considerando l'intervallo Permiano superiore-Triassico, le unità della Catena Transdanubiana mostrano una precisa polarità: la porzione a nordest rappresenta il lato verso il mare aperto, mentre la porzione a sudovest costituisce il lato in direzione della terraferma. Una parte importante delle facies può essere correlata con facies coeve del Sudalpino e delle falde dello Austroalpino superiore, fornendo un significativo strumento per la ricostruzione della posizione originale delle unità della Catena Transdanubiana.

Abstract. Facies patterns of the Upper Permian and Triassic formations within the Transdanubian Range are presented. Based on surface and subsurface data, facies maps were compiled for six time slices which served as a basis of the paleogeographic reconstructions. Considering the entire Late Permian - Triassic interval, the Transdanubian Range unit shows a definite polarity: its northeastern part represents the seaward (internal) side, whereas its southwestern part represents the landward (external) side. A remarkable part of facies units of the Transdanubian Range could be correlated with time equivalent facies in the Southern Alps and the Upper Austroalpine nappes, providing an effective tool for the reconstruction of the original position of the displaced Transdanubian Range Unit.

Introduction.

In the last decades, many studies have proved the heterogeneity of Paleozoic - Mesozoic - Early Tertiary sequences making up the basement of the Pannonian Basin. Based on these studies it has been shown that the present-day setting of the structural units of the basement (Fig. 1) is a result of complicated plate-tectonic rearrangements just prior to the beginning of the evolution of the Late Tertiary Pannonian Basin. Since the present-day setting does not reflect the original relationships of the structural units, reconstruction of their paleo-position became one of the key problems of the structural evolution and paleogeography of the entire Alpine-Carpathian-Dinarid region.

Alpine relationship of the Mesozoic section of the Transdanubian Range was noticed as early as the second half of the last century (Peters, 1859; Hauer, 1862; Hofmann, 1871; Böckh, 1873). Later on, at the beginning of this century, others (Taeger, 1912, 1913; Lóczy, 1916) confirmed these statements. In accordance with general contemporaneous concepts, the plausible relationship was explained by assuming narrow seaways between the Alpine sedimentary basins and the areas of the island mountains within the Pannonian Basin (Lóczy, 1916; Telegdi-Róth, 1929; Vadász, 1960).

General acceptance of the mobilistic plate tectonic concept established the idea that the Transdanubian Range Unit broke away from its original location and reached its present-day position as a result of considerable dislocations.

Based on the setting of the Upper Permian facies boundaries, Majoros (1980) suggested a large-scale strike-slip motion of the Transdanubian Range from the South Alpine region along the Periadriatic lineament. Later on, a great number of workers (Balla, 1982; Kázmér,

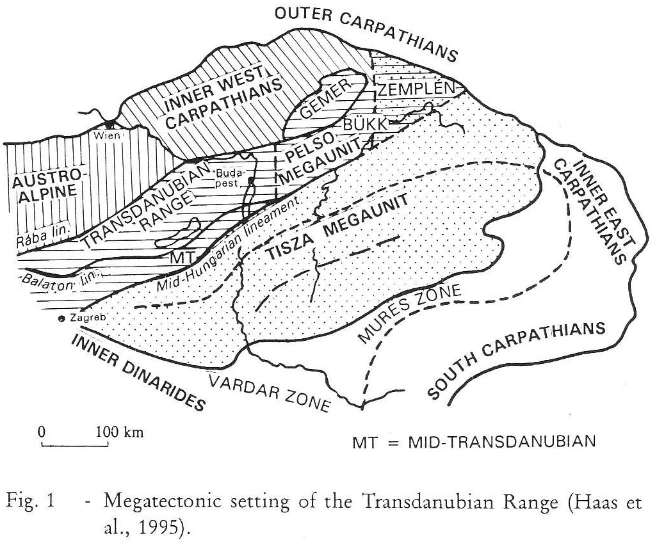

Fig. 1 - Megatectonic setting of the Transdanubian Range (Haas et al., 1995).

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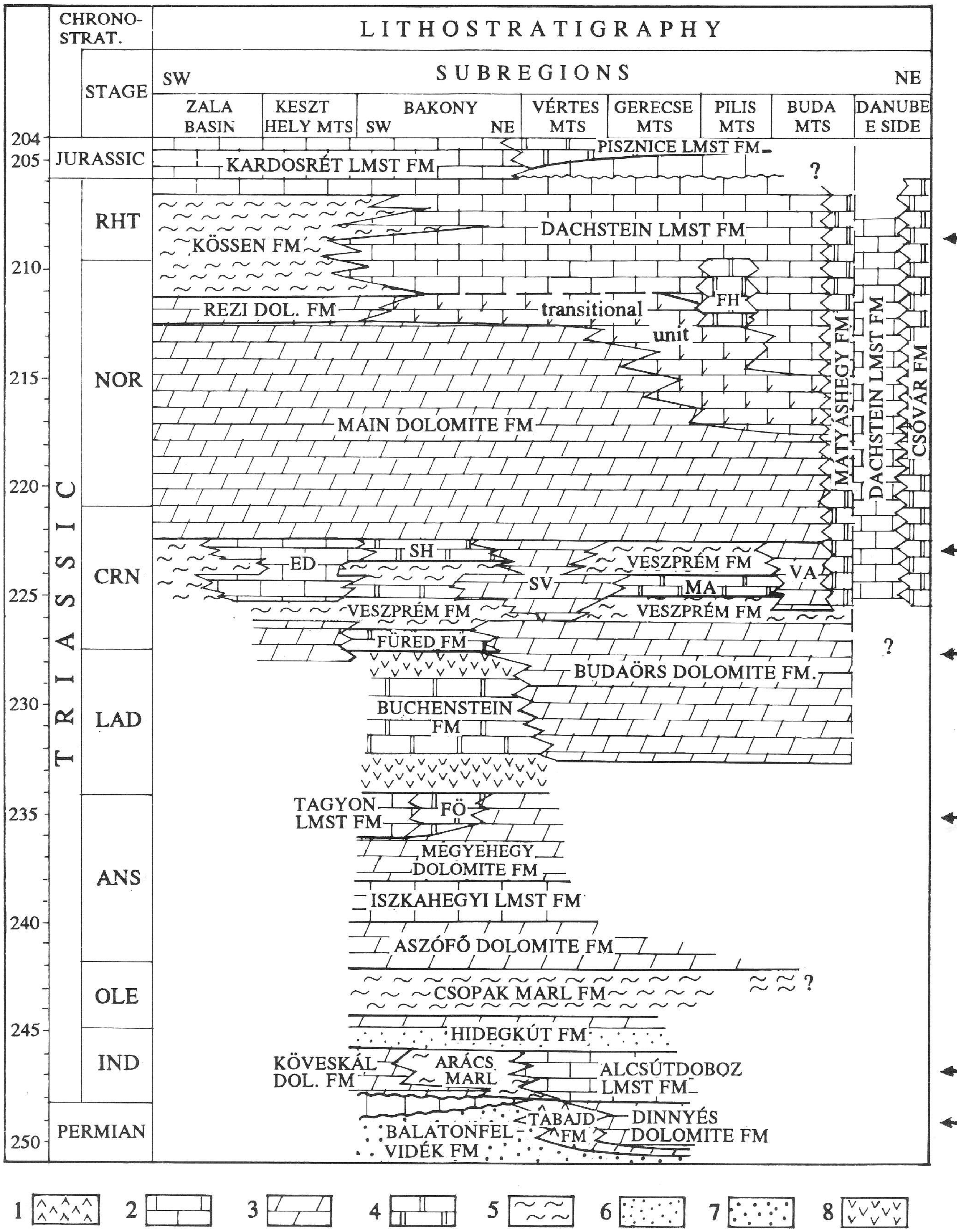

Fig. 2 - Stratigraphic chart of the Upper Permian-Triassic formations of the Transdanubian Range (chronostratigraphic scale after Gradstein et al., 1994). Arrows indicate the discussed stratigraphic horizons. Abbr.: FÖ - Felsöörs Limestone Fm.; MA - Mátyáshegy Fm.; ED - Ederics Limestone Mb.; SV - Sédvölgy Dolomite Mb.; VA - Vadaskert Dolomite Mb.; SH - Sándorhegy Fm.; FH - Feketehegy Fm. Legend: 1) shallow-water limestones; 2) dolomites; 3) deep-water limestones; 4) marls; 5) marine sandstones and siltstones; 6) continental sandstones; 7) evaporites; 8) volcanic tuffs.

1984; Kázmér & Kovács, 1985; Brezsnyánszky & Haas, 1986; Haas, 1987; Csontos et al., 1992) discussed this problem, generally accepting the concept that the Transdanubian Range Unit was located between the Southern and the Eastern Alps (Upper Austroalpine nappes) in the early period of the Alpine evolutionary phase; however, they differently explained the history and mechanism of the dislocations.

The reconstruction of the original setting of the Transdanubian Range (i.e. its setting prior to the major orogenic movements) is based fundamentally on the fitting of the Late Permian-Triassic facies zones of the dislocated units (Haas et al., 1995). However, in the paper of Haas et al. (1995) and also in other previous papers, the Late Permian and the Norian facies zones were mainly considered and constrains of facies boundaries were generally missing. This might be the reason, why distinction and limitation of the facies zones have been subject of many debates in the past years. Since outcome of these debates may profoundly influence the reconstructions and the interpretation of the structural evolution of the Pannonian Basin and the surrounding regions, more detailed studies on the facies setting and further evidences for the facies correlation seemed to be necessary.

Consequently, our paper has two main goals: a) to summarize data which may serve as a basis for distinction of the Late Permian-Triassic facies zones and to draft facies patterns for several relevant time levels within the Transdanubian Range Unit, and b) to discuss possibilities and problems of the reconstruction of the original position of the Transdanubian Range in the framework of the Alpine system based on correlation of the facies zones. In accordance with the main aim of our study, we selected stratigraphic intervals characterized by remarkable facies differences. They are indicated in Fig. 2, where time and space relationships of the Upper Permian-Triassic lithostratigraphic units of the study area are shown. In Fig. 3 lateral thickness-changes of the lithostratigraphic units are presented by a schematic cross section running along the strike of the Transdanubian Range. The reference line of the section is the base of the Main Dolomite Formation. Data to be displayed include results of the latest mapping project in the study area (Fig. 4), studies in the framework of the national key section project, and other important core data. Fig. 4 also shows localities referred in the text.

Facies pattern of the selected stratigraphic intervals.

Upper Permian (Fig. 5).

The Upper Permian sequence of the Transdanubian Range can be divided into three, coeval formations

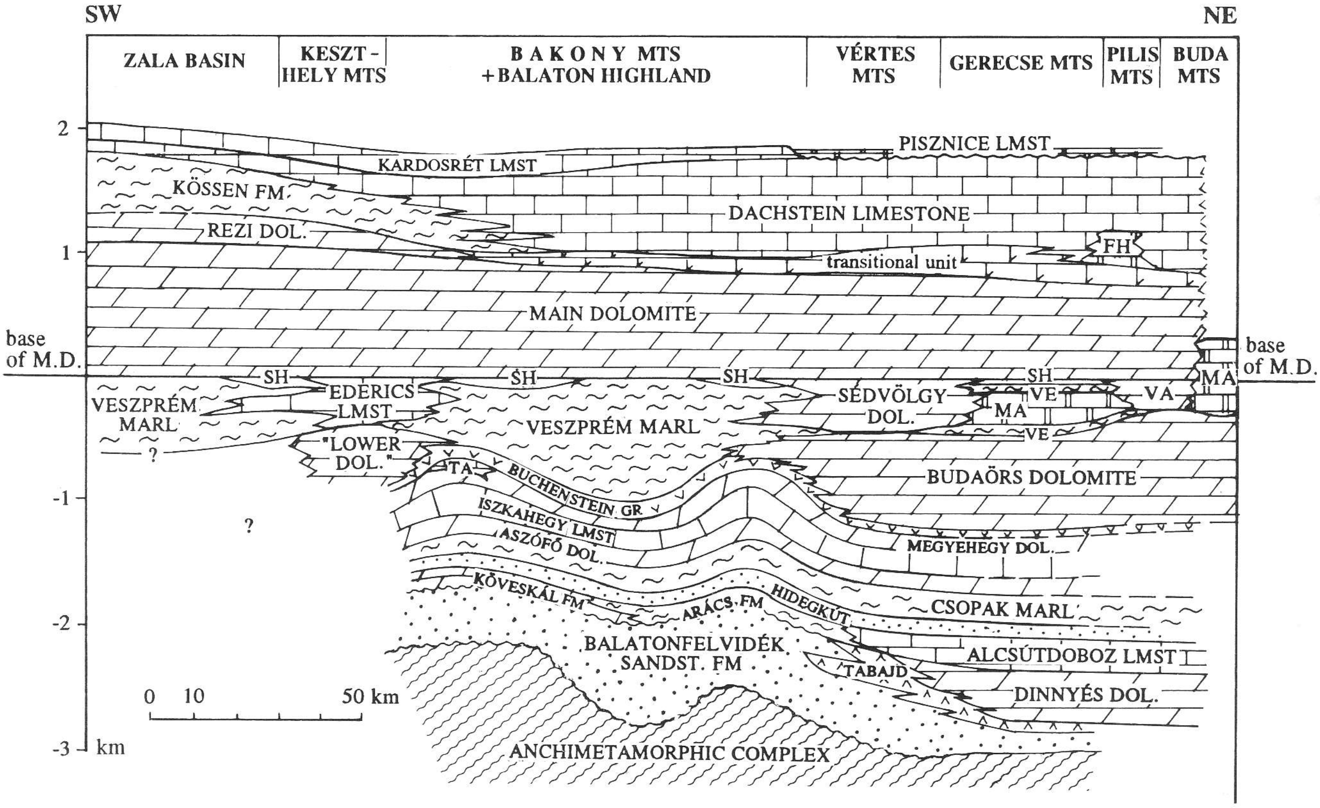

Fig. 3 - Schematic cross section along the strike of the Transdanubian Range unit from the Buda Hills to the Zala Basin. Reference line is the base of the Main Dolomite Formation. Abbr.: TA - Tagyon Fm.; MA - Mátyáshegy Fm.; VE - Veszprém Marl Fm.; SH - Sándorhegy Fm.; VA - Vadaskert Dolomite Mb.; FH - Feketehegy Fm. Buchenstein Gr. includes the Felsöörs, Buchenstein and Füred Formations. For legend see Fig. 2.

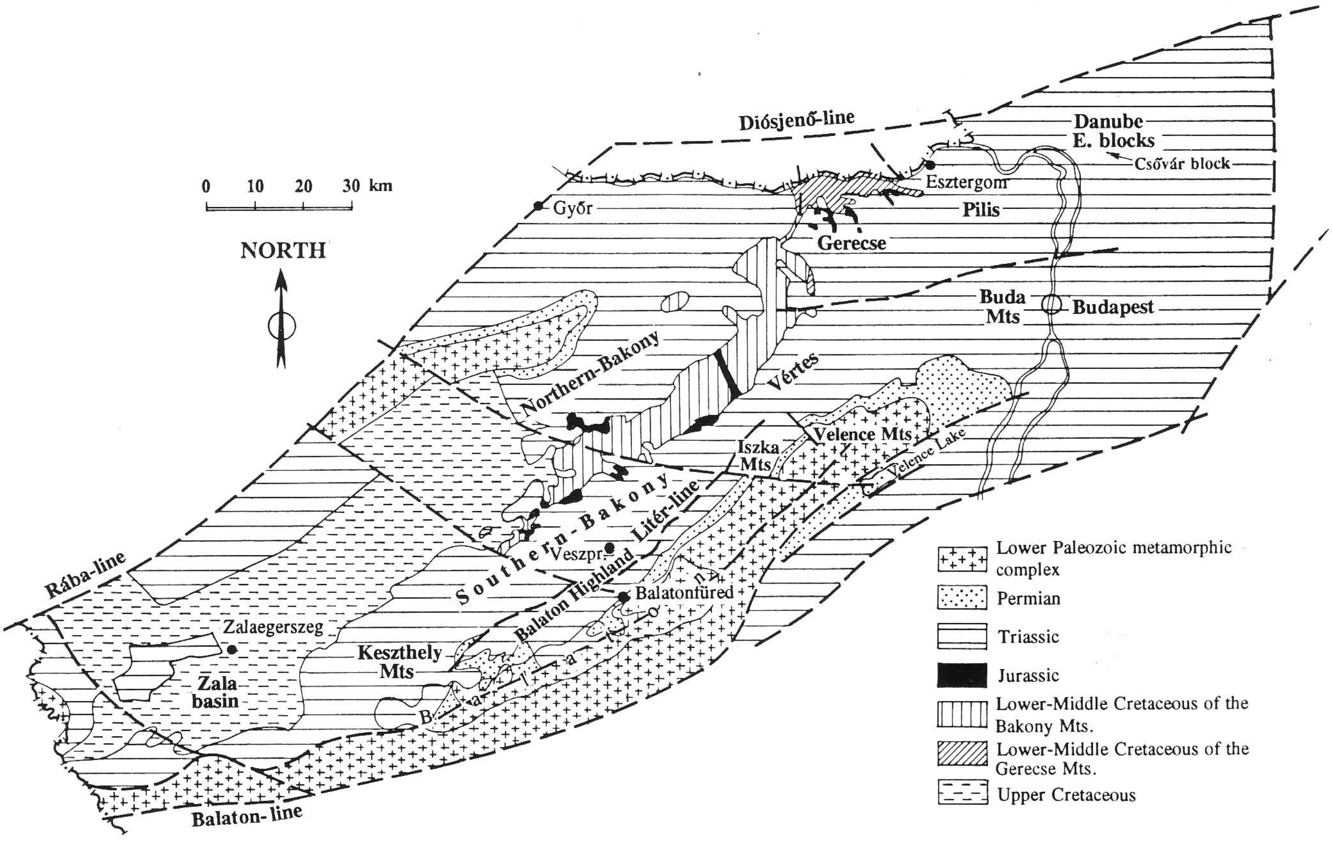

Fig. 4 - Simplified geological map of the Transdanubian Range (Haas et al., 1995) showing the referred locations.

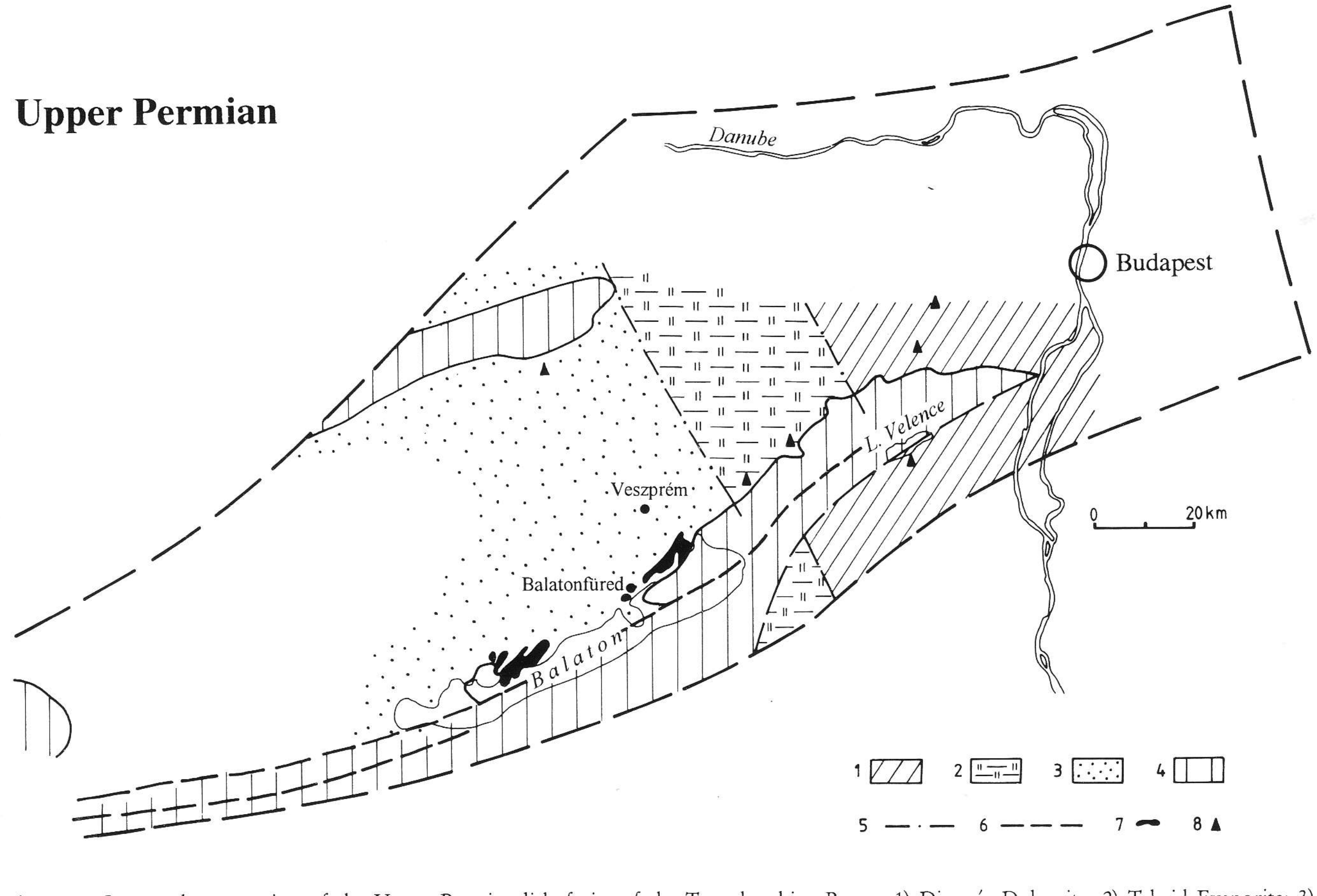

Fig. 5 - Present-day extension of the Upper Permian lithofacies of the Transdanubian Range. 1) Dinnyés Dolomite; 2) Tabajd Evaporite; 3) Balatonfelvidék Sandstone; 4) Pre-Permian formations; 5) facies boundary; 6) main tectonic line; 7) outcrop; 8) borehole.

(Fülöp, 1990) representing characteristic facies zones of the continental margin during the Late Permian transgression.

The Balatonfelvidék Sandstone Formation is a fluvial facies association made up by cyclic alternation of conglomerate, sandstone and siltstone layers. Thickness is 400-800 metres, and significantly decreases (to 150 m) northeastward (Fig. 3), where the unit is partially substituted by coastal (Tabajd Fm.) and marine facies (Dinnyés Fm.). Outcrops of the formation can be followed all along the Balaton Highland. It is also exposed by some drillings in the basement of the Kisalföld, which belongs to the northern limb of the synclinorium of the Transdanubian Range.

The Tabajd Evaporite Formation consists of red siltstones, with dolomite, anhydrite, and gypsum lenses, nodules and interlayers. It represents the coastal sabkha-salina facies belt. Its maximum thickness is 300 metres. Thickness decreases northeastward, where the unit is partially substituted by the Dinnyés Dolomite. This formation is known exclusively from boreholes in the SE foreland of the Vértes Mountains, NE to the Balaton Highland.

The Dinnyés Dolomite Formation is made up by algal dolomite with evaporite interlayers. This cyclic sequence represents periodically desiccated lagoon facies. The thickness of the formation may reach 400 m. The unit is unknown on the surface but reached by borehole in the eastern part of the SE foreland of the Vértes Mountains and S of Lake Velence, on the southern flank of the Velence anticline.

Exact drawing of the boundaries of the aforementioned units is not possible at present. However, lateral relations of the Upper Permian formations clearly indicate that transgression reached first the NE part of the Transdanubian Range (according to the present-day orientation), then it progressed toward SW, whereas a large part of the Transdanubian Range area was flooded only during the next significant transgression at the beginning of the Triassic (see Fig. 5 and Fig. 6).

Lowermost Triassic (Fig. 6).

As a consequence of the above mentioned fast transgression, an oolite horizon was formed at the base of the Lowermost Triassic sequences. Based on palynological data, oolitic beds are somewhat older in the northeastern region, where the P/T boundary is within the oolite horizon, whereas in the Balaton Highland the basal beds are lowermost Induan (Haas et al., 1986; Góczán et al., 1987). After the oolite event, three sedimentary environments were established in the area of the Transdanubian Range. In the southwestern part of the area, in a lagoon of periodically hypersaline water frequently affected by terrigenous influx, the Köveskál Formation was

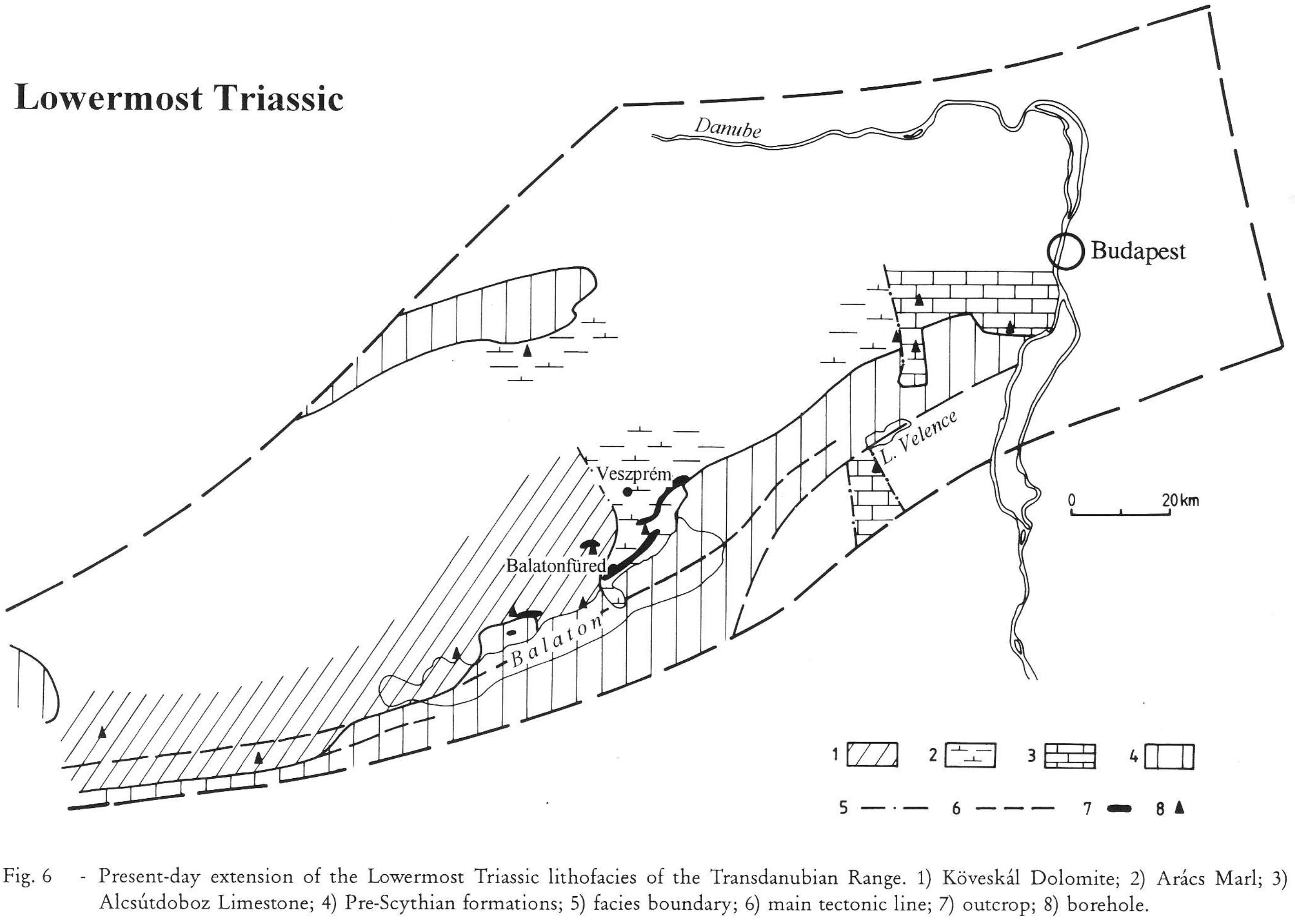

Fig. 6 - Present-day extension of the Lowermost Triassic lithofacies of the Transdanubian Range. 1) Köveskál Dolomite; 2) Arács Marl; 3) Alcsútdoboz Limestone; 4) Pre-Scythian formations; 5) facies boundary; 6) main tectonic line; 7) outcrop; 8) borehole.

deposited. Northeastward, it passes into the predominantly shaly Arács Formation of intertidal- subtidal facies which further to NE is partly substituted by shallow marine carbonate facies of the Alcsútdoboz Formation.

The Köveskál Dolomite Formation consists of grey, porous, and in the basal layers oolitic dolomites, dolomitic siltstones and sandstones. Upwards in the sequence, the dolomite content increases whereas the amount of siliciclastics decreases. In the southwestern part of the Balaton Highland, this lithofacies represents all of the Lower Scythian. In this region, its thickness is about 100 m. Further to NW, it occurs between the Permian Balatonfelvidék Sandstone and the Arács Formation in a significantly reduced thickness.

The Arács Marl Formation is made up predominantly by greenish-grey and brownish-red marls with siltstone and "gastropod oolite" intercalations. Bioturbation is common. In its type locality on the Balaton Highland, it is not thicker than 120 m. Based on core data, the formation can be followed along the SE limb of the Bakony. It is also known from boreholes in the Northern Bakony and in the southern foreland of the Vértes and the Velence Mountains although in the latter areas the sequences show transitional features towards the Alcsútdoboz Formation.

The Alcsútdoboz Formation consists of grey limestones, calcareous marls and silty marls; in the latter "gastropod oolite" interlayers occur. It is known exclusively from boreholes in the southern foreland of the Vértes and the Velence Mountains. The thickness of the formation is about 150-200 m.

The only lateral facies boundary that can be satisfactorily drawn between the above-mentioned three units is that between the Köveskál and Arács Formations. Its direction is roughly N-S in the Balaton Highland area. The lateral boundary between the Arács and Alcsútdoboz Formations might be parallel to this. Based on available data, a right-lateral displacement of this boundary of 10-15 km amplitude may be assumed along the Balaton Line.

Middle Anisian (Fig. 7).

Olenekian to Lower Anisian sequences are fairly uniform all over the exposed parts of the study area. In the Middle Anisian, differentiation of the facies pattern is visible as a response to initiation of tectonism (Budai & Vörös, 1992). Platform carbonates (Megyehegy Dolomite, Tagyon Limestone) and pelagic limestones were formed (Felsöörs Limestone) coevally.

The Megyehegy Dolomite consists predominantly of grey, thick-bedded sparitic, lithologically rather monotonous dolomites. Its thickness is markedly variable: 10-30 m in the SW margin of the Balaton Highland and

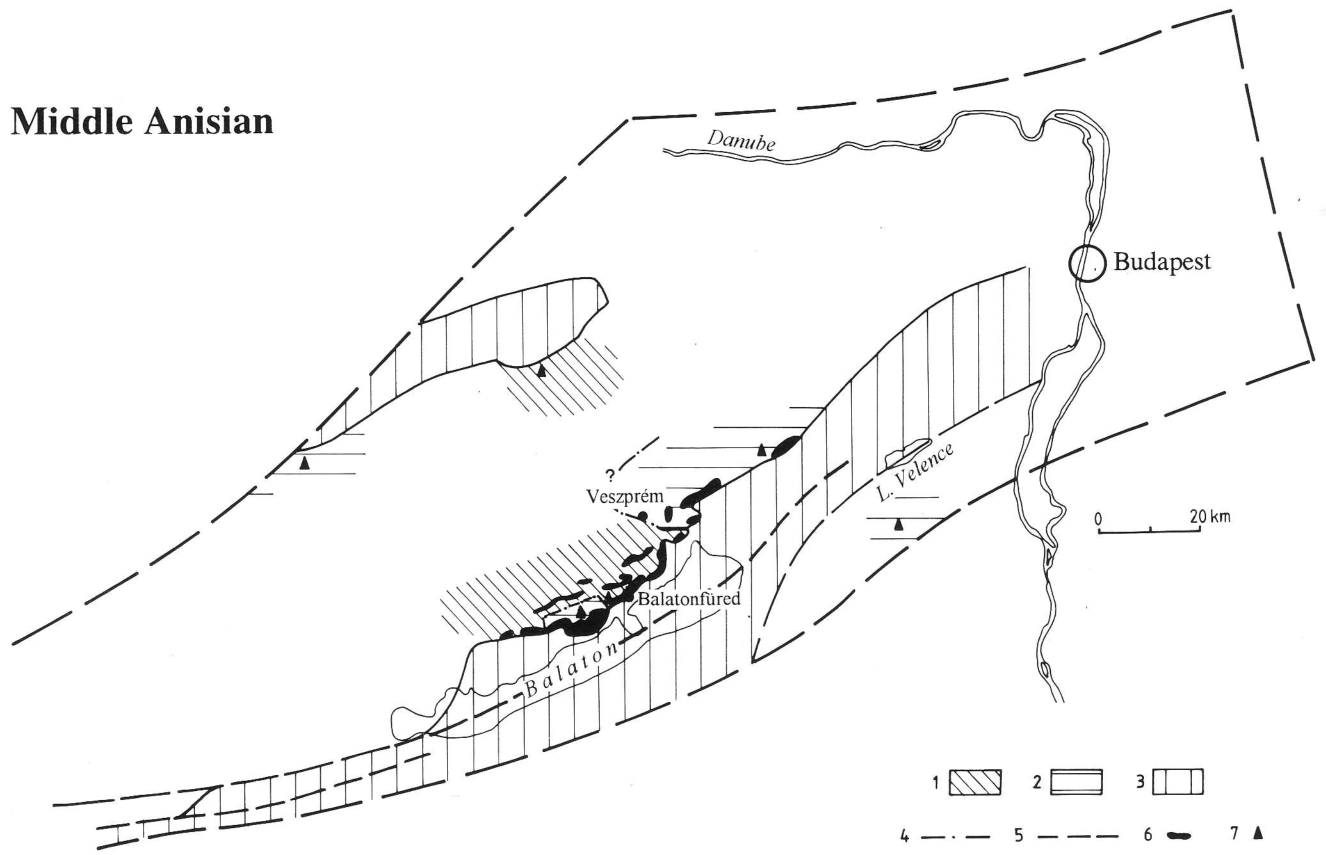

Fig. 7 - Present-day extension of the Middle Anisian lithofacies of the Transdanubian Range. 1) Felsöörs Limestone; 2) Megyehegy Dolomite + Tagyon Limestone; 3) Pre-Anisian formations; 4) facies boundary; 5) main tectonic line; 6) outcrop; 7) borehole.

in a zone north of the Litér Line (Fig. 3), whereas in the middle part of the Balaton Highland, at the rim of the Veszprém plateau and in the eastern Bakony it is more than 250 m. In the former areas, dolomites are slightly bituminous and bioclasts are common. In the latter ones, the bituminous facies occurs only in the lower part of the formation. In the Northern Bakony and in the area south of Lake Velence, the formation is known only from boreholes.

The Tagyon Limestone Formation occurs only in a small part of the Balaton Highland. The sequence is made up by cyclic alternation of light brown to yellowish-white, thick-bedded, subtidal limestones and brownish-yellow, thin-bedded, peritidal limestones showing fenestral lamination. Its maximum thickness is about 80 m.

The Felsöörs Formation locally overlaps and locally replaces the Anisian platform facies. It consists of thick-bedded cherty limestones; brachiopodal-crinoidal limestones; ammonite-bearing bituminous, laminitic limestones, marls and dolomitic marls. The maximum thickness of the Felsöörs Limestone (150 m) occurs in the middle part of the Balaton Highland (in the surroundings of Balatonfüred), from where the unit pinches out towards NE. Surface exposures are restricted to the area of the Balaton Highland. NE of this area, in a few isolated outcrops, brachiopodal limestones of extremely reduced thickness (a few metres) represent the formation. It is also known from cores in the Northern Bakony.

The relationships of the basin and platform formations are satisfactorily known only in the Balaton Highland area. Based on available data, we assume the continuation of the basins NW and SW of this area, whereas shallow platforms might be located northeastward.

Upper Ladinian-Lower Carnian (Fig. 8).

Ladinian and lowermost Carnian are represented by thick platform carbonate sequences in the NE part and most probably also in the SW part of the Transdanubian Range (Budaörs Dolomite). However, in the area of the Balaton Highland and the rim of the Veszprém plateau, pelagic basin sedimentation was continued (Füred Limestone).

Volcanic activity initiated in the Late Anisian and reaching its climax in the Early Ladinian shows a gradual decline during the Late Ladinian (Budai & Vörös, 1993). This trend is reflected by the transition of the tuffaceous Buchenstein Formation into the light-grey, well-bedded, slightly cherty Füred Limestone. In the lower part of the Füred Formation, limestones are thick-bedded. Progressing upward, the thickness of beds decreases and the limestone succession is punctuated by

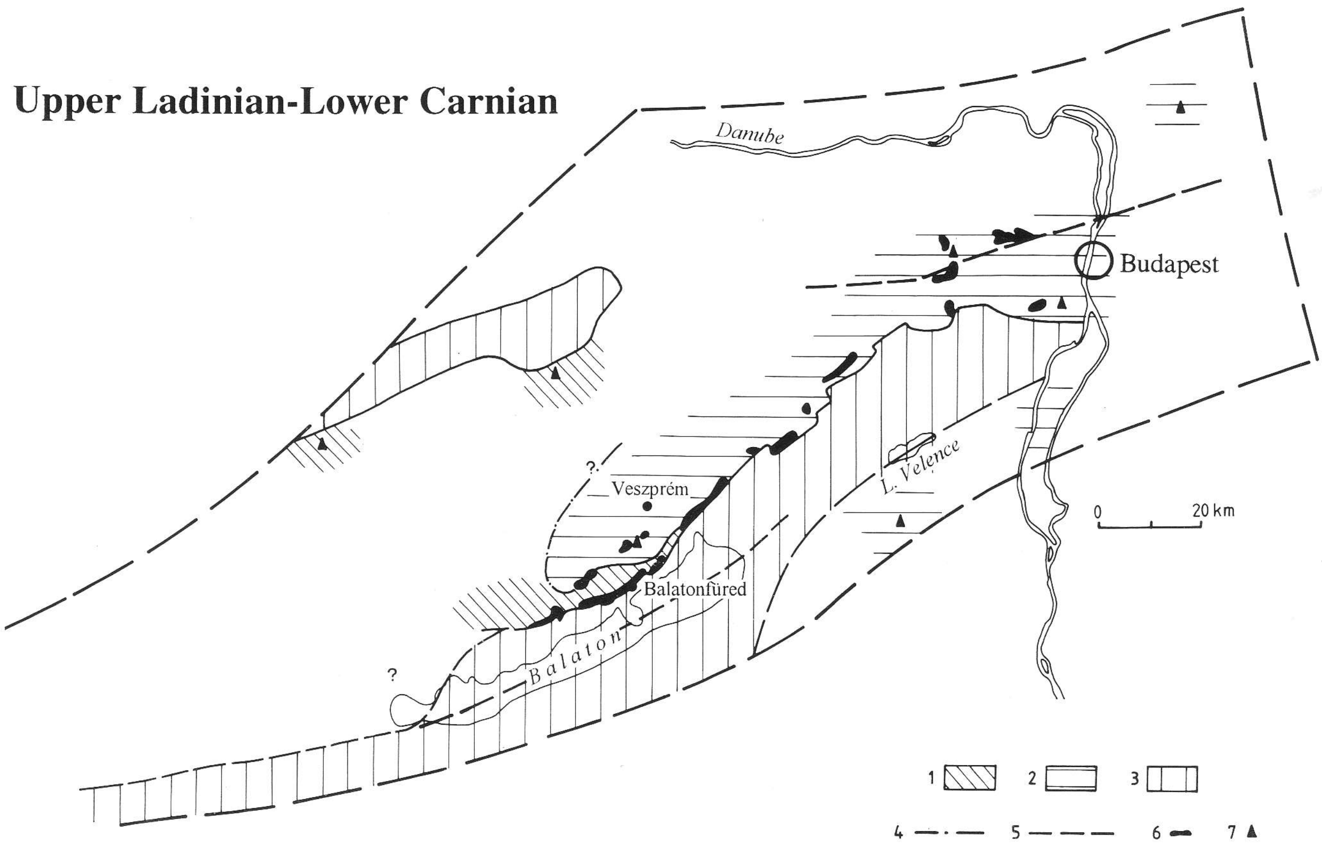

Fig 8 - Present-day extension of the Upper Ladinian-Lower Carnian lithofacies of the Transdanubian Range. 1) Buchenstein + Füred Limestone; 2) Budaörs Dolomite; 3) Pre-Ladinian formations; 4) facies boundary; 5) main tectonic line; 6) outcrop; 7) borehole.

marl interlayers. The Füred Limestone can be followed all along the Triassic zone of the Balaton Highland south of the Litér Line, whereas to the north only a few data are available. The formation attains its maximum thickness (60 m) in the middle part of the Balaton Highland in the vicinity of Balatonfüred and shows gradual thinning both toward SW and NE. In the Northern Bakony, it is exposed only in cores and its thickness is highly reduced (not more than 5 m).

Upper Ladinian dark-grey volcanoclastics with plant remnants showing similarities with the Wengen facies, are known only from a few cores in a small area in the eastern part of the Bakony Mts.

At the southern rim of the Veszprém plateau and in the northern range of the Balaton Highland, the Budaörs Formation of carbonate platform facies appears above the gradually outpinching Füred Limestone or, where it is totally missing, directly above the Buchenstein Formation.

The Budaörs Dolomite is made up by thin- to thick-bedded dolomites. Cyclic alternation of dasycladacean dolomites of subtidal logoon facies and peritidal beds of algal mat facies is generally characteristic. The thickness of the formation is about 1000 m in the northeastern part of the Transdanubian Range (in the vicinity of Budapest) and gradually decreases southwestward. The unit pinches out in the NE part of the Balaton Highland. Apart from its surficial extension area, the Budaörs Dolomite was also reported from a borehole, south of the Lake Velence.

Platform dolomites were exposed by drill cores below the Carnian shales in the Keszthely Mts., but there is no biostratigraphic evidence for their age.

Middle-Upper Carnian (Fig. 9).

In the Middle Carnian (Julian), the significantly increased terrigenous influx resulted in the infilling of the intraplatform basin of the Balaton Highland-Bakony area, while new basins came into being in the NE part of the Transdanubian Range (in the area between the Vértes and the Buda Mountains) above the previous carbonate platforms. By the Late Carnian, gradual infilling of the basins attained an advanced stage and the Balaton Highland - Bakony area became a restricted basin showing further shallowing-upward trend (Sándorhegy Formation). However, in some places evolution of carbonate platforms continued or they were affected only by incipient drowning. Consequently, isolated platforms emerged in the area of the Keszthely Mountains (Ederics Limestone), in the eastern part of the Bakony (Sédvölgy Dolomite) in the Buda Mountains (Vadaskert Do-

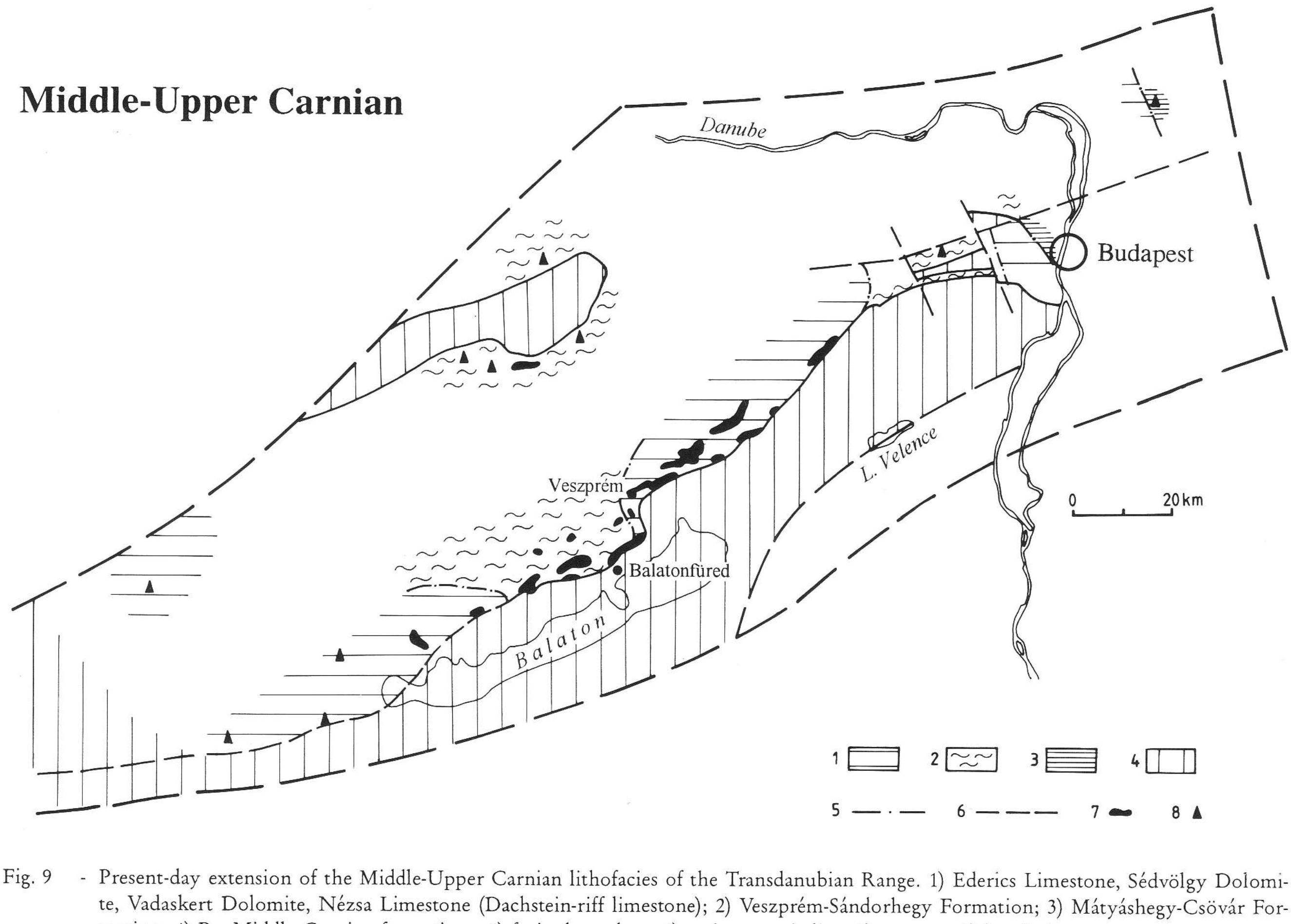

Fig. 9 - Present-day extension of the Middle-Upper Carnian lithofacies of the Transdanubian Range. 1) Ederics Limestone, Sédvölgy Dolomite, Vadaskert Dolomite, Nézsa Limestone (Dachstein-riff limestone); 2) Veszprém-Sándorhegy Formation; 3) Mátyáshegy-Csövár Formation; 4) Pre-Middle Carnian formations; 5) facies boundary; 6) main tectonic line; 7) outcrop; 8) borehole.

lomite), and even in the Csövár block ("Carnian reef limestone").

The Sándorhegy Formation is made up by three members. The lower member consists of light-grey, thin-bedded, laminitic, bituminous limestones with slump folds. Its thickness is 30-70 m. The middle member consists of light-grey, commonly intraclastic dolomites. Its thickness is variable, increasing towards the coeval carbonate platforms. The 30-50 m thick upper member is made up by well-stratified, nodular, locally cherty limestones, marly limestones with large oncolites, megalodontids and brachiopods. Extension of the Sándorhegy Formation is restricted to the Balaton Highland.

Platform carbonates may be either practically undolomitized or pervasively dolomitized. The only locally and slightly dolomitized Ederics Limestone is known from the Keszthely Mountains and the surrounding area and from a few boreholes also in the southern and northern parts of the Northern Zala Basin. It is made of massive biogenic and ooidic-oncoidal limestones. Its thickness is 200-300 m.

The Sédvölgy Dolomite consists of thick-bedded dolomitized biogenic carbonates. Microbial encrustations are common and characteristic. This unit is known in the eastern part of the Bakony and in the Vértes Mountains. It is separated from the underlying Budaörs Dolomite and from the overlying Main Dolomite only by thin marly intervals; consequently, distinction of the three platform dolomite units is not easy.

In the central part of the Buda Mountains, massive platform dolomites of Upper Carnian age occur (Vadaskert Dolomite), showing features similar to the Sédvölgy Dolomite. In the northeastern and southern part of the Buda Mountains, cherty limestones and dolomites of basin facies are exposed in outcrops and cores. Based on conodonts and radiolarians, Middle Carnian, Lower and Upper Norian, and Rhaetian ages have been reported from the pelagic succession (Kozur & Mock, 1991; Dosztály pers. com.). According to these data, accumulation of basin sediments may have been continuous from the Carnian to the Norian in the intraplatform basins, while on the surrounding platforms the Vadaskert Dolomite was formed.

A similar relationship can be assumed in the Csovár block (NE of Budapest), where the "Upper Carnian reef limestone" deposited coevally with the lower part of the Csovár Formation of basin and slope facies, is exposed in core (Detre, 1970; Kozur & Mostler, 1973).

Upper Norian-Rhaetian (Fig. 10).

In the latest Carnian, huge carbonate platforms came into being on the Tethyan shelf of levelled topo-

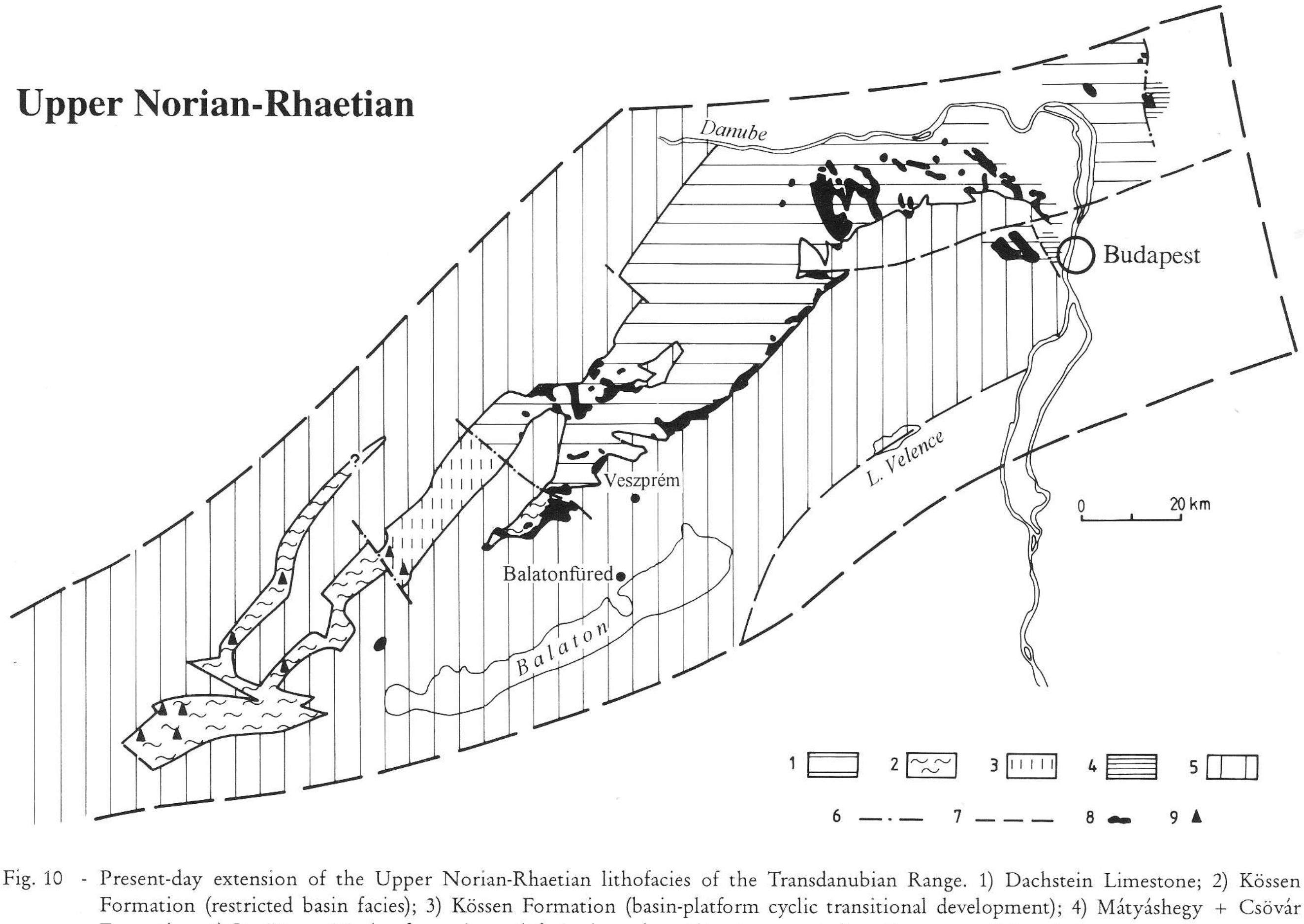

Fig. 10 - Present-day extension of the Upper Norian-Rhaetian lithofacies of the Transdanubian Range. 1) Dachstein Limestone; 2) Kössen Formation (restricted basin facies); 3) Kössen Formation (basin-platform cyclic transitional development); 4) Mátyáshegy + Csövár Formation; 5) Pre-Upper Norian formations; 6) facies boundary; 7) main tectonic line; 8) outcrop; 9) borehole.

graphy, extending over most of the Transdanubian Range. Pervasively dolomitized cyclic shallow subtidal-peritidal carbonate succession of about 1,000 m was formed till the Middle Norian (Main Dolomite Formation). In the Late Norian-Rhaetian, the Dachstein Limestone was deposited on the platform, while the shaly Kössen Formation was accumulated in a newly formed back-platform basin in the NW part of the Transdanubian Range.

The Kössen Formation consists of dark grey, black marls and shales with limestone interlayers - a restricted basin facies. Its thickness is 300-500 m (Fig. 3). The thickness of the formation significantly decreases northeastward, where it interfingers with the Dachstein Limestone and finally it pinches out. Three subunits can be differentiated. In the SW part of the Transdanubian Range, the formation is thick and predominantly shaly. Present-day extension of the formation was controlled by Middle Cretaceous tectonism and subsequent denudation. In the western part of the Southern Bakony, sequences are cyclic; they actually represent a wide interfingering zone between the Kössen and Dachstein Formations. In the middle part of the Southern Bakony and in the Northern Bakony, the Upper Norian-Rhaetian is represented by the Dachstein Limestone, still with a few meters thick grey pelitic interlayers of the Kössen Formation.

The Dachstein Limestone is a carbonate platform sequence made up predominantly by cyclic alternation of peritidal and lagoonal facies. However, non-cyclic predominantly subtidal oncoidal development of the Dachstein Limestone occurs in the NE part of the Transdanubian Range (Buda Mountains, blocks E of the Danube) which began to accumulate probably in the Early Norian (Balogh, 1981; Végh-Neubrandt, 1982). In the largest part of the Transdanubian Range, the Dachstein Limestone began to deposit somewhat later, in the Middle Norian; more exactly, this was the time when pervasive dolomitization of the platform carbonates (i.e. formation of the Main Dolomite) came to an end. In the SW part of the Transdanubian Range, in the area of the Kössen Basin, the platform prograded only after the infilling of the basin in the latest Rhaetian. In the NE part of the Transdanubian Range, in the Buda Mountains and in the blocks east of the Danube (in the Csövár block), cherty limestone and dolomite sequences occur from the Carnian to the top of the Triassic and even in the Lower Jurassic (Kozur & Mock, 1991; Kozur & Mostler, 1973). These sequences (Mátyáshegy Formation, Csövár Formation) may have accumulated in restricted intraplatform basins, as well as on the slopes between the platforms and the basins.

Similarities in development of the oncoidal Dachstein Limestone, the coeval basin facies (Mátyáshegy and Csövár Formations) in the Buda Mountains, and in the blocks east of the Danube, respectively suggest intimate genetic relation of the two areas. They present-day setting is probably a result of significant right-lateral displacements (Fig. 10).

In the Upper Norian-Rhaetian, a fairly definite paleogeographic boundary can be drawn between the shaly inner basin facies of the Kössen Formation and the transition zone of the Kössen and Dachstein Formations. Non-cyclic, oncoidal facies of the Dachstein Limestone probably indicates the offshore marginal zone of the platform.

Discussion.

Based on the presented data and the outlined facies trends, we have attempted to sketch the paleogeography of the area of the Transdanubian Range unit for the selected time slices. Palaeogeographic sketch maps are shown in Fig. 11 a-f. They also demonstrate the changes of the facies patterns through time. Possibility of fitting the Transdanubian facies trends in a wider palaeogeographic frame, that is in the Alpine domain, is also discussed below.

Late Permian (Fig. 11a).

Facies pattern came into being as a consequence of the Late Permian transgression represents a complete series of facies from shallow subtidal lagoon through tidal flat to alluvial paleoenvironments (Majoros, 1980; Haas et al., 1988). Within the unit, facies boundaries are fairly well defined and oriented in a NW- SE direction.

Upper Permian facies and their relations in the Transdanubian Range show conspicuous similarities with facies pattern in the Southern Alps (Majoros, 1980). Close genetic relationships of the continental red-bed facies (Balatonfelvidék Sandstone and Val Gardena Formation resp.) are very likely. The Dinnyés Dolomite may correspond to the Fiamazza facies of the Bellerophon Formation (based on observed facies trends, corresponding facies of the calcareous Badiota facies of the Southern Alps might be located in the vicinity of Budapest, but they has not yet been encountered). The orientation of facies boundaries, taking also into consideration post-Triassic rotations, is N-S roughly coinciding with South Alpine directions. The boundary between marine and continental facies can be drawn between the Balaton Highland and the southern foreland of the Vértes Mountains in the Transdanubian Range; it is recognizable approximately at the Adige valley in the Southern Alps (Assereto et al., 1973; Wopfner, 1984).

Early Triassic (Fig. 11b).

Akin to the Late Permian, three coeval facies zones characterize the Induan in the Transdanubian Range unit and the orientation of their boundaries are similar to the Permian directions. The facies pattern is shown in Fig 12.

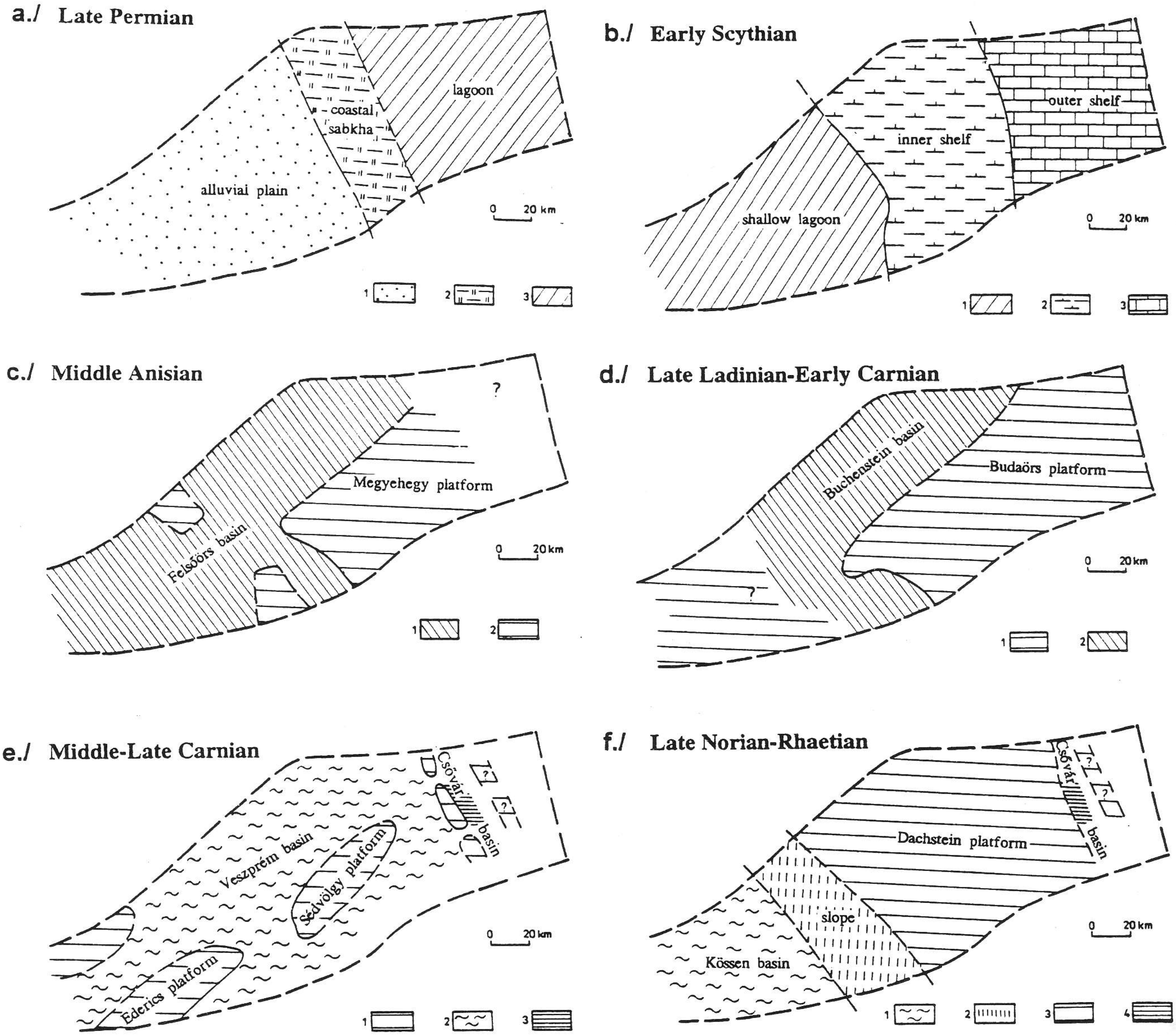

Fig. 11 - Paleogeographic sketch of the relevant time slices: 11a Late Permian: 1) Balatonfelvidék Sandstone; 2) Tabajd Evaporite; 3) Dinnyés Dolomite. 11b Early Triassic: 1) Köveskál Dolomite; 2) Arács Marl; 3) Alcsútdoboz Limestone. 11c Middle Anisian: 1) Felsöörs Limestone; 2) Megyehegy Dolomite + Tagyon Limestone. 11d Late Ladinian - Early Carnian: 1) Budaörs Dolomite; 2) Buchenstein + Füred Limestone. 11e Middle-Late Carnian: 1) Ederics Limestone, Sédvölgy Dolomite, Vadaskert Dolomite, Nézsa Limestone; 2) Veszprém-Sándorhegy Formation; 3) Mátyáshegy-Csövár Formation. 11f Late Norian - Rhaetian: 1) Kössen Formation (restricted basin facies); 2) Kössen Formation (basin-platform cyclic transitional development); 3) Dachstein Limestone; 4) Mátyáshegy + Csövár Formation.

The Arács Formation was deposited in a very shallow mud-shoal area, where a major part of the terrigenous material was trapped. Southwestward, behind the shoals, in a restricted lagoon dolomites were formed (Köveskál Dolomite), however input of fine siliciclastics was remarkable during the early phase of accumulation of the formation. Northeastward from the mud-shoal zone, an inner ramp environment with ooidic shoals can be assumed. Existence of ooidic shoals is proved by the frequent oolite interlayers in the shallow subtidal carbonate sequences (Alcsútdoboz Formation).

A thin oolite horizon is recognizable at the base of every Induan formation, onlapping the transgression surface both in the Transdanubian Range and the Southern Alps (Haas et al., 1988; Broglio Loriga et al., 1990; De Zanche et al., 1993).

Facies pattern of the Transdanubian Range shows definite similarities to that of the Southern Alps, where a western and an eastern facies area can be distinguished. Pasini et al. (1986, p. 8 and Fig. 3) assumed a paleohigh located in the vicinity of the Brenta Dolomites to explain this facies setting. The dolomitic and sandy Lombardian-type Induan sequence (Servino Formation) can be correlated with the Köveskál Dolomite, whereas the Mazzin Member in the Dolomites may correspond to the Arács Marl and the Alcsútdoboz Limestone, re-

Early Triassic

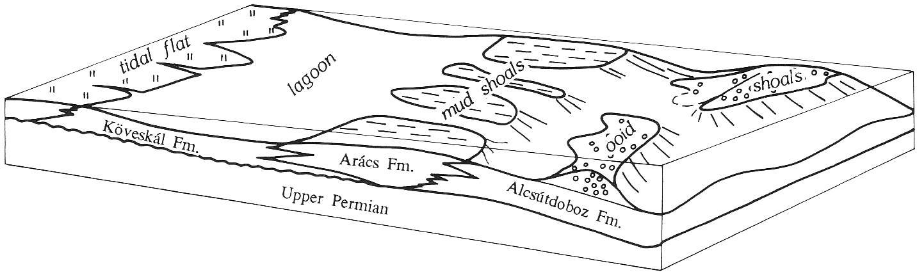

Fig. 12 - General facies model for the Early Triassic.

spectively, or more precisely, it represents the transition zone between them. The oolitic basal member of the Köveskál Formation and the Praso Horizon (Neri in Pasini et al., 1986, p. 163), as well as the lowermost oolitic beds of the Alcsútdoboz Formation and the Tesero Horizon are comparable with each other (Broglio Loriga et al., 1990).

Middle Anisian (Fig. 11c).

In the Early Anisian, before the Pelsonian tectonic activity, a shallow carbonate ramp came into being in the area of the Transdanubian Range (Budai et al., 1993). In the Pelsonian, the ramp evolved to platform. Later on this platform became dissected by normal faults (Budai & Vörös, 1992). On the Balaton Highland the paleofaults show a NW-SE orientation, as a rule. As a consequence of tilting of some blocks, narrow restricted basins were formed (Felsöörs Formation). Coevally,

Middle Anisian

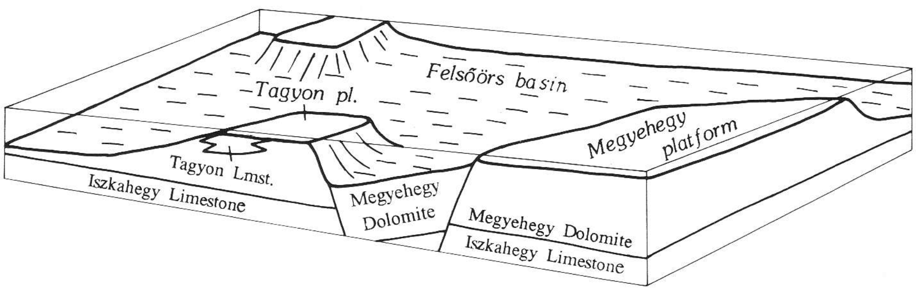

Fig. 13 - General facies model for the Middle Anisian.

in the areas remaining in uplifted position, shallow-marine carbonate accumulation was continued (Fig. 13).

A similar tectonically-controlled facies pattern characterizes the Drau Range and the Southern Alps (Bechstädt, 1978; Bechstädt et al., 1978; Farabegoli & Guasti, 1980; Blendinger, 1983 etc.). Correlation of Middle Anisian facies zones, however, is difficult and ambiguous. As compared with the Southern Alps, the following statements can be made (Budai, 1992):

- equivalent facies of the Lowermost Anisian Aszófö Dolomite are known both in Lombardy (Carniola di Bovegno) and the Dolomites (Lower Serla Formation);

- a formation akin to the Lower Anisian Iszkahegy Limestone is known only from Lombardy (Lower Angolo Limestone).

Middle Anisian platform carbonate equivalents of the Megyehegy Dolomite (e.g. Dosso dei Morti Limestone, Upper Serla Formation) can be found in many parts of the Southern Alps (Gaetani, 1969; Gaetani et al., 1970; Pisa, 1974; Gaetani & Gorza, 1989; Jadoul et al., 1992b; Senowbary-Daryan et al., 1993) but the intraplatform basin facies of the Felsöörs Limestone shows closer affinity with the Lombardian basin facies only (Upper Angolo ?, Prezzo Limestone).

Late Ladinian-Early Carnian (Fig. 11d).

After the Middle Anisian tectonic activity, and most probably in relation with this, acidic volcanism began at the end of the Illyrian. Subsequently, dissected topography controlled the sedimentation for a short period until a large pelagic basin ("Buchenstein Basin") was formed in the area of the southwestern and central parts of the Bakony Mts. at the beginning of the Ladinian. Basin sequences are characterized by nodular, cherty limestones and radiolarites with tuff interbeds, showing close relationships and indicating paleogeographic connections with time-equivalent formations in the Southern Alps. In the area of the Eastern Bakony, Vértes, and Buda Mts., a platform was formed at the same time ("Budaörs platform") and carbonate accumulation was interrupted by events of volcanic ash falls only. Another platform can be assumed in the area of the Keszthely Mts., but its extension is unknown.

In contrast with the Southern Alps, the facies pattern of the Transdanubian Range described above did not change considerably during the Ladinian. Other differences between the two domains are summarized below:

- In the Transdanubian Range, the "Buchenstein-type" pelagic sedimentation lasted until the end of the Ladinian in starved basins, producing a condensed sequence of very reduced thickness during this period.

- The volcanoclastic Wengen facies, characteristic in the Upper Ladinian of the Southern Alps is missing in the Transdanubian Range, except for a small area at the northeastern end of the Bakony (Budai, 1992). This can be explained by the different paleogeographic settings of the two areas. Volcanoclastics trapped in "Wengen-type" basins of the Southern Alps were transported from the south (Cros & Szabó, 1984; Pisa et al., 1980 etc.), consequently influx of volcanoclastic material could not reach the basins of the Transdanubian Range located further to the north.

- Pelagic carbonate sedimentation was continued even after the end of the volcanic activity during the Cordevolian. In contrast with the volcanoclastic Wengen-St. Cassian sequence of the Southern Alps, pelagic carbonates (Füred Limestone) represent the lowermost Carnian in the Transdanubian Range.

The platform progradation in the Early Carnian is a common feature both in the Dolomites and the Bakony - Balaton Highland area, resulted in step-by-step reduction of the extension of the intraplatform basins (Budai & Vörös, 1993).

Middle-Late Carnian

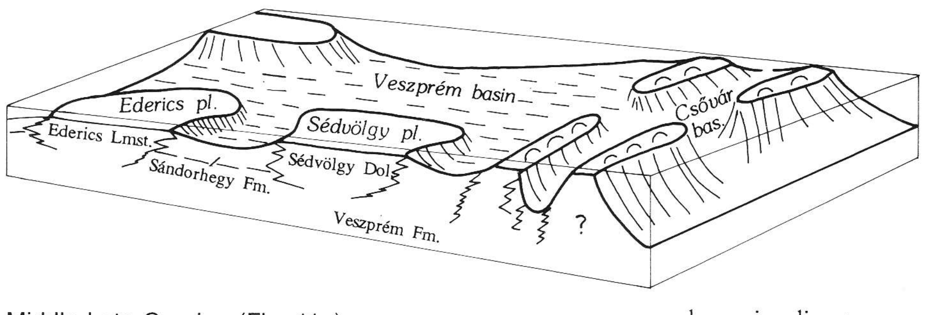

Fig. 14 - General facies model for the Middle-Late Carnian.

Middle-Late Carnian (Fig. 11e).

At the end of the Early Carnian, as a consequence of increased terrigenous influx and a penecontemporaneous sea level rise, carbonates were replaced by argillaceous sediments (Veszprém Marl Formation - Julian-Early Tuvalian, Oravecz-Scheffer, 1987; Góczán et al., 1991) both in the basins and on the platforms. Extension of the platforms became markedly reduced, small isolated platforms (or ramps) came into being. In the middle part of the Carnian, a sea level drop may have resulted in an expansion of the incipiently drowned platforms, and even in the basins carbonate sedimentation prevailed. Later on, due to a new sea level rise, fine terrigenous sedimentation became prevalent again (Haas, 1994).

By the beginning of the Late Carnian (Fig. 14) the basin in the area of the Balaton Highland filled up to a large extent. In the shallow basin, carbonate accumulation became prevalent and the upward shallowing trend continued (Sándorhegy Formation). At the same time, platforms began to prograde (Ederics Limestone, Sédvölgy Dolomite, Vadaskert Dolomite). Joint effect of upfilling of the basins and progradation of the platforms led to the elimination of the topographic differences by the end of the Late Carnian. This was the fundamental prerequisite of the initiation of the evolution of the huge Dachstein Platform.

Upfilling of the basins did not take place in the intraplatform basins of the Buda Mountains and the Csövár block, where the terrigenous input was very restricted and marginal slopes of the basins were probably too steep for significant platform progradation.

The system of the Carnian basins and isolated platforms fits well into the paleogeographic picture of the Southern Alps, the Drauzug, and the Northern Calcareous Alps, as was discussed in detail by Haas (1994). The essence of this reconstruction is as follows. The deep basin of the Northern Bakony was probably connected with the basin assumed to be located offshore the shallow shelf of the Drauzug and the Northern Calcareous Alps (Hagemeister, 1988). The basin of the Balaton Highland, which was separated from the Northern Bakony basin by a range of isolated platforms, may have been in direct communication with the South Alpine Raibl Basin.

Essential elements of paleogeographic setting discussed above came into being already in the Middle Triassic, as a consequence of tectonic segmentation of the Anisian platforms. Total upfilling of the basins led to the re-establishment of a levelled topography by the Late Carnian and to establishment of the large Late Triassic Dachstein Platform, showing definite zonal facies pattern. This setting is particularly favourable for determinating the paleoposition of the displaced domains of the Alpine-Carpathian-Dinarid system, as it was discussed by Kázmér & Kovács (1985), and Haas et al. (1995).

Late Norian-Rhaetian

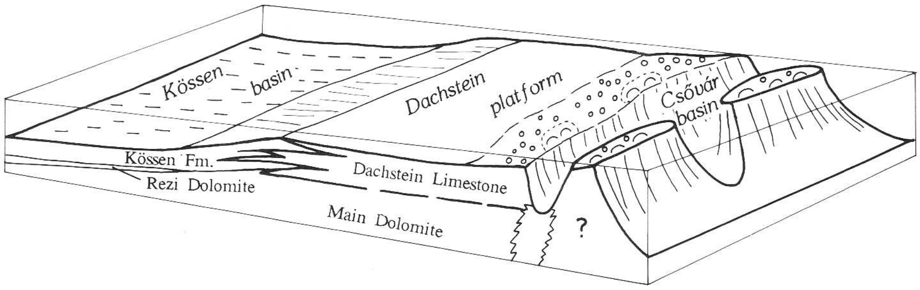

Fig. 15 - General facies model for the Late Norian-Rhaetian.

Late Norian-Rhaetian (Fig. 11f).

At the end of the Middle Norian, most probably due to joint effect of extensional tectonic motions and a eustatic sea level rise, basins were formed, which resulted in the segmentation of the previously uniform carbonate platform (Fig. 15). In the background of the remnant Dachstein platform, the large Kössen Basin began to evolve, whereas a small intraplatform basin came into existance in the inner zone of the previous platform (Feketehegy Basin), in addition to the surviving intraplatform basins near to the offshore platform margin (Csövár Basin).

In the Late Norian, basically due to a climatically-controlled increase in the terrigenous input (Kössen event), pattern of sedimentation significantly changed in the back-platform basin; carbonate sedimentation was substituted by argillaceous deposits and anoxic conditions became prevalent.

A low-angle slope was formed between the Dachstein platform and the Kössen Basin where, controlled by changes of the sea level, progradations and retrogradations of the platform resulted in an alternation of the shaly basinal and calcareous platform facies (4th order Kössen cycles - Haas, 1993). The location of this wide transitional zone and its boundary towards the inner basin facies are fairly easily recognizable. The inner part of the Kössen Basin was located in the area between the Zala Basin and the Keszthely Mountains, whereas the transitional zone may be recognized in the western part of the Southern Bakony. In the Northern Bakony area, platform accretion was interrupted for short episodes only during intervals of maximal flooding (intercalations of the Kössen Formation), whereas in the area of the Gerecse and Pilis Mountains the evolution of the platforms was continuous during the Late Norian - Rhaetian interval.

In the Buda Mountains and in the blocks on the east side of the Danube, the topmost part of the platform carbonate sequence is missing due to subsequent erosion. In the same region, the predominantly carbonate sedimentation continued in the intraplatform basins (Mátyáshegy and Csövár Formation). Resedimented bioclasts and lithoclasts of platform origin in these basinal formations suggest coeval existence of platforms in the vicinity.

The discussed facies setting confirmed our previous conclusion on the general paleogeographic position of the Transdanubian Range unit. Its northeastern part represents the offshore shelf margin, whereas its southwestern part should be located in the external (landward) zone of the shelf. This relationship of the facies fits well into the Late Norian-Rhaetian paleogeographic scheme of the Alpine domain.

In the Southern Alps, a dolomitized platform carbonate series, the Dolomia Principale was formed from the latest Carnian onward. In Lombardy, small intraplatform basins began to form in the Middle Norian, the sites of accumulation of carbonates of the Aralalta Group (Jadoul et al., 1992a), while on the platform deposition of the Dolomia Principale continued coevally. In the Late Norian, shales rich in organic matter began to be deposited in large areas of Lombardy, the Riva di Solto Shale (Masetti et al., 1989; Jadoul et al., 1992a) showing great similarity to the Kössen Formation. The Riva di Solto Shale grades upward and eastward into the Zu Limestone made up by cyclic alternation of the deeper-water shales and limestones of shallower facies. The zone of lateral transition between the restricted basin and the platform can be drawn between the Adige valley and Lake Idro (Masetti et al., 1989). East of this zone, platform carbonates accumulated coevally and are pervasively dolomitized, as a rule (Dolomia Principale). In the Late Rhaetian, the shallow-water carbonates extended over the area of the former basins in Lombardy (Conchodon Dolomite).

In the Northern Calcareous Alps, due to downfaulting of the platform margin the pelagic facies zone (Hallstatt zone) significantly expanded during the Norian (Lein, 1987). In the Late Norian, an increase of the terrigenous influx resulted in change in the sedimentary pattern (Zlambach Marl).

In the Dachstein facies zone of the platform (in the sense of Prey, 1978) located in the southern part of the Northern Calcareous Alps, as far as near Salzburg, deposition of the Dachstein Limestone was continued until the end of the Triassic, except for sequences in the

Tirolikum unit, paleogeographically representing the most external parts of the Dachstein facies zone (Golebiowsky, 1990). In this unit, the Kössen Formation appears as a thin intercalation within the Dachstein Limestone.

In the Hauptdolomit facies zone (some parts of the Tirolikum and the Bajuvarikum), bituminous dolomites are overlain by the Upper Norian Plattenkalk, which can be considered as a transitional formation between the platform facies and the Kössen basin facies (Fruth & Scherreiks, 1975). The lower part of the Kössen Formation is made up by cyclic alternation of shales with bivalve coquina interlayers and shallow-water carbonates. The upper part of the formation consists of bioclastic limestones and shales (Golebiowsky, 1990). By the Late Rhaetian large parts of the basin were filled up, and carbonate platforms were re-established ("Oberrhät" Limestone).

The outpinching zone of the Kössen Formation towards the Dachstein platform carbonates, located in the middle part of the Southern Bakony in the Transdanubian Range, can be fitted to nappes of the Tirolikum in the Northern Calcareous Alps and to the zone between the Adige valley and Lake Idro in the Southern Alps.

Conclusions.

1. Facies patterns of the Upper Permian and Triassic formations within the Transdanubian Range Unit may provide a base for the reconstruction of the original structural and paleogeographical setting of this unit. An improved, more precise reconstruction can be attained by paleogeographic analysis of a series of time slices.

2. In the Late Permian, a complete tract of facies is known from a continental alluvial to a coastal sabkha - shallow lagoon environment, and the fitting with the South Alpine facies zones (Val Gardena - Bellerophon Formation) is good.

3. The Lowermost Triassic is also characterized by definite facies zonation: a restricted ramp (lagoon), a mud-shoal zone and an ooidic outer ramp environment can be distinguished. These zones are also correlatable with the South Alpine zones - the mud-shoal zone may correspond with the "threshold" facies of the Brenta Dolomites.

4. In the Induan to the Early Anisian, the facies differentiation was the least definite. On the uniformly and moderately subsiding shelf, open ramp then restricted ramp environments came into being, followed by establishment of the first carbonate platforms in the Middle Anisian.

5. In the Middle Anisian, intraplatform basins were formed by normal faulting in the Transdanubian Range. They were probably related to basins of similar origin in the Southern Alps. However, complicated geometry and small size of the basins and platforms do not allow exact reconstructions.

6. In the Ladinian, the facies pattern is simpler. A large platform ("Budaörs Platform") and a large basin ("Buchenstein Basin") came into existence in the Transdanubian Range area. The latter can be correlated with the largest intraplatform basin in the central sector of the Southern Alps, although numerous smaller platforms make the picture more complicated.

7. In the Transdanubian Range only local and subordinate occurrence of Wengen-type volcanoclastics is consistent with the assumed paleogeographic position of this unit north to the Southern Alps.

8. In the Carnian, the extension and position of platforms and basins significantly changed. The formation of a northern and a southern subbasin, separated by a belt of carbonate platforms, can be assumed. This picture easily fits into the formerly published paleogeographic reconstructions for the Drauzug - Northern Calcareous Alps and the Southern Alps, respectively.

9. The Early - Middle Norian was the era of the largest extension of the "Dachstein platform". Facies zonation described in the Northern Calcareous Alps could also be recognized in the Transdanubian Range. Oncoidal outer platform, Lofer-cyclic, partly dolomitized inner platform and organic rich, dolomitic back-platform facies zones were recognizable in both areas (Haas et al., 1995) and a similar trend was also detected in the Southern Alps, although dolomitization was much more extensive in the latter area.

10. In the Late Norian - Rhaetian, the "Kössen Basin", the "Dachstein Platform" and the transitional zone between them can be followed both in the Northern Calcareous Alps and the Southern Alps, offering another opportunity for fitting the facies zones.

11. Considering the entire 40 Ma Late Permian - Triassic interval, the Transdanubian Range unit shows a definite paleogeographic polarity: its northeastern part represents the seaward (internal) side, whereas its southwestern part represents the landward (external) side.

12. The Transdanubian Range seems to be the "missing link" between the Southern Alps and the Upper Austroalpine nappes. Based on the correlation of the facies zones, the fitting of the Transdanubian Range to the Southern Alps may be accomplished with a fairly good approximation (with an error of 10-20 km). As to the Northern Calcareous Alps, due to its complicated nappe structure, less favourable orientation of the facies zones, and more limited data, the uncertainty is greater (50-150 km).

13. The essence of the reconstruction for the studied interval is as follows:

- the Zala basin and the western part of the Southern Bakony may have been located between the Northern Karawanken Range, as well as the Bajuvarikum, and the Bergamo Alps (Lombardy), respectively;

- the eastern part of the Southern Bakony, the Northern Bakony, and the Vértes Mts. may have been situated between the western part of the Tirolikum and the Dolomites;

- the Buda Mts. and the blocks on the east side of the Danube may have been located between the eastern part of the Tirolikum and the Carnic Alps, Southern Karawanken Range, and the Julian Alps.

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REFERENCES

Assereto R., Bosellini A., Fantini Sestini N. & Sweet W. C. (1973) - The Permian-Triassic boundary in the Southern Alps (Italy). In Logan A. & Hills L. V. (Eds.) - The Permian and Triassic systems and their mutual boundary. *Alberta Soc. Petrol. Geol. Mem.*, v. 2, pp. 176-199, Calgary.

Balla Z. (1982) - Development of the Pannonian basin basement through the Cretaceous-Cenozoic collision: A new synthesis. *Tectonophysics*, v. 88, pp. 61-102, Amsterdam.

Balogh K. (1981) - Correlation of the Hungarian Triassic. *Acta Geol. Hung.*, v. 24, n. 1, pp. 3-48, Budapest.

Bechstädt Th. (1978) - Faziesanalyse permischer und triadischer sedimente des Drauzuges als Hinweis auf eine grossraumige Lateralverschiebung innerhalb des Ostalpins. *Jb. Geol. B.-A.*, v. 121, n. 1, pp. 1-121, Wien.

Bechstädt Th., Brandner R., Mostler H. & Schmidt K. (1978) - Aborted rifting in the Triassic of the Eastern and Southern Alps. *N. Jb. Geol. Paläont. Abh.*, v. 156, n. 2, pp. 157-178, Stuttgart.

Blendinger W. (1983) - Anisian sedimentation and tectonics on the M. Pore-M. Cernera area (Dolomites). *Riv. It. Paleont. Strat.*, v. 89, n. 2, pp. 175-208, Milano.

Böckh J. (1873) - Die geologischen Verhältnisse des südlichen Theiles des Bakony (I. Theil). *Mitt. Jahrb. Kön. Ung. Geol. Anstalt*, v. 2, pp. 27-182, Budapest.

Brezsnyánszky K. & Haas J. (1986) - Main features of the Pre-tertiary basement of Hungary. *Geol. Zbornik - Geol. Carpathica*, v. 37, n. 3, pp. 297-303, Bratislava.

Broglio Loriga C., Góczán F., Haas J., Lenner K., Neri C., Oravecz - Scheffer A., Posenato R., Szabó I. & Tóth Makk Á. (1990) - The Lower Triassic of the Dolomites (Italy) and Transdanubian Mid Mountains (Hungary) and their correlation. *Mem. Sc. Geol.*, v. 42, pp. 61-113, Padova.

Budai T. (1992) - Middle Triassic formations of the Balaton Highland and of the Southern Alps. Stratigraphic correlation. *Acta Geol. Hung.*, v. 35, n. 3, pp. 217-236, Budapest.

Budai T. & Vörös A. (1992) - Middle Triassic history of the Balaton Highland: extensional tectonics and basin evolution. *Acta Geol. Hung.*, v. 35, n. 3, pp. 237-250, Budapest.

Budai T. & Vörös A. (1993) - The Middle Triassic events of the Transdanubian Central Range in the frame of the Alpine evolution. *Acta Geol. Hung.*, v. 36, n. 1, pp. 3-13, Budapest.

Budai T., Lelkes Gy. & Piros O. (1993) - Evolution of Middle Triassic shallow marine carbonates in the Balaton Highland (Hungary). *Acta Geol. Hung.*, v. 36, n. 1, pp. 145-165, Budapest.

Cros P. & Szabó I. (1984) - Comparison of the Triassic volcanogenic formations in Hungary and in the Alps. Paleogeographic criteria. *Acta Geol. Hung.*, v. 27, n. 3-4, pp. 265-276, Budapest.

Csontos L., Nagymarosy A., Horváth F. & Kovác M. (1992) - Tertiary evolution of the Intra-Carpathian area: a model. *Tectonophysics*, v. 208, pp. 221-241, Amsterdam.

De Zanche V., Gianolla P., Mietto P. & Siorpaes Ch. (1993) - Triassic sequence stratigraphy in the Dolomites (Italy). *Mem. Sc. Geol.*, v. 45, pp. 1-27, Padova.

Detre Cs. (1970) - Paläontologische und sedimentologische Untersuchungen über die Triasschollen in der Umgebung von Csövár, Nézsa und Keszeg. *Bull. Hung. Geol. Soc.*, v. 100, pp. 173-184, Budapest.

Farabegoli E. & Guasti M. (1980) - Anisian lithostratigraphy and paleogeography of M. Rite (Cadore, Southeastern Dolomites). *Riv. It. Paleont. Strat.*, v. 85 (1979), n. 3-4, pp. 909-930, Milano.

Fülöp J. (1990) - Magyarország geológiája. Paleozoikum I. V. of 325 pp, Hungarian Geol. Inst., Budapest.

Fruth J. & Scherreiks R. (1975) - Facies and geochemical correlation in the Upper Hauptdolomit (Norian) of the eastern Lechtaler Alps. *Sediment. Geol.*, v. 13, pp. 27-45, Amsterdam.

Gaetani M. (1969) - Osservazioni paleontologiche e stratigrafiche sull'Anisico delle Giudicarie (Trento). *Riv. It. Paleont. Strat*, v. 75, n. 3, pp. 469-546, Milano.

Gaetani M. & Gorza M. (1989) - The Anisian (Middle Triassic) carbonate bank of Camorelli (Lombardy, Southern Alps). *Facies*, v. 21, pp. 41-56, Erlangen.

Gaetani M., Premoli Silva I. & Zanin Buri C. (1970) - Calcare di Dosso dei Morti. In Formazioni geologiche, fasc. IV. *Studi illustr. Carta Geol. Italia*, pp. 21-32, Roma.

Góczán F., Oravecz-Scheffer A. & Csillag G. (1991) - The stratigraphic characterization of the Cordevolian and Julian Formations of the Csukrét Ravine, Balatoncsicsó. *Ann. Rep. Hung. Geol. Inst. 1989*, pp. 241-325, Budapest.

Góczán F., Oravecz-Scheffer A. & Haas J. (1987) - Permian-Triassic boundary in the Transdanubian Central Range. *Acta Geol. Hung.*, v. 30, n. 1-2, pp. 35-58, Budapest.

Golebiowsky R. (1990) - The Alpine Kössen Formation, a key for European topmost Triassic correlations. *Albertiana*, v. 8, pp. 25-35, Utrecht.

Gradstein F.M., Agterberg F.P., Ogg J.G., Hardenbol J., van Veen P., Thierry J. & Huang Z. (1994) - A Mesozoic time scale. *Journ. Geoph. Res.*, v. 99 (B12), pp. 24,051-24,074, Washington.

Haas J. (1987) - Position of the Transdanubian Central Range structural unit in the Alpine evolution phase. *Acta Geol. Hung.*, v. 30, n. 3-4, pp. 243-256, Budapest.

Haas J. (1993) - Formation and evolution of the Kössen Basin in the Transdanubian Range. *Bull. Hung. Geol. Soc.*, v. 123, n. 1, pp. 9-54, Budapest.

Haas J. (1994) - Carnian basin evolution in the Transdanubian Central Range, Hungary. *Zbl. Geol. Paläont.*, Teil 1. 1992 H. 11/12, pp. 1233-1252, Stuttgart.

Haas J., Góczán F., Oravecz-Scheffer A., Barabás-Stuhl A., Majoros Gy. & Bérczi-Makk A. (1986) - Permian-Triassic boundary in Hungary. *Mem. Soc. Geol. It.*, v. 34, pp. 221-241, Roma.

Haas J., Kovács S., Krystyn L. & Lein R. (1995) - Significance of Late Permian-Triassic facies zones in terrane reconstructions in the Alpine-North Pannonian domain. *Tectonophysics*, v. 242, pp. 19-40, Amsterdam.

Haas J., Tóthné Makk Á., Oravecz-Scheffer A., Góczán F., Oravecz J. & Szabó I. (1988) - Alsó-triász alapszelvények a Dunántúli- Középhegységben (Lower Triassic key sections in the Transdanubian Mid-Mountains). *Ann. Inst. Geol. Publ. Hung.*, v. 65, n. 2, 356 pp., Budapest.

Hagemeister A. (1988) - Cyclic Sedimentation on a Stable Carbonate Platform: The Raibl Beds (Carnian) of the Drau Range/Carinthia (Austria). *Facies*, v. 18, pp. 83-122, Erlangen.

Hauer F. (1862) - Über die Petrefacten der Kreideformation des Bakonyer Waldes. *Verhandl. k.k. Geol. Reichsanst. Sitzb.*, v. 44, pp. 631-659, Wien.

Hofmann K. (1871) - Die geologischen Verhältnisse des Ofen-Kovácsier Gebirges. *Mitt. Jahrb. Kön. Ung. Geol. Anstalt*, v. 1, pp. 149-235, Budapest.

Jadoul F., Berra F. & Frisia S. (1992a) - Stratigraphic and paleogeographic evolution of a carbonate platform in an extensional tectonic regime: the example of the Dolomia Principale in Lombardy (Italy). *Riv. It. Paleont. Strat.*, v. 98, n. 1, pp. 29-44, Milano.

Jadoul F., Gervasutti M. & Fantini Sestini N. (1992b) - The Middle Triassic of the Brembana Valley: preliminary study of the Esino Platform (Bergamasc Alps). *Riv. It. Paleont. Strat.*, v. 98, n. 3, pp. 299-324, Milano.

Kázmér M. (1984) - Lateral displacement of the Bakony in the Paleocene. *General Geol. Rev.*, v. 20, pp. 53-101, Budapest.

Kázmér M. & Kovács S. (1985) - Permian-Paleogene paleogeography along the eastern part of the Insubric-Periadriatic lineament system: Evidence for continental escape of the Bakony-Drauzug Unit. *Acta Geol. Hung.*, v. 28, n. 1-2, pp. 71- 84, Budapest.

Kozur H. & Mock R. (1991) - New Middle Carnian and Rhaetian Conodonts from Hungary and the Alps. Stratigraphic Importance and Tectonic Implications for the Buda Mountains and Adjacent Areas. *Jb. Geol. B.-A.*, v. 134, pp. 271-297, Wien.

Kozur H. & Mostler H. (1973) - Mikrofaunistische Untersuchungen der Triasschollen im Raume Csovár, Ungarn. *Verh. Geol. B.-A.*, v. 973, n. 2, pp. 291-325, Wien.

Lein R. (1987) - Evolution of the Northern Calcareous Alps during Triassic times. In Flügel H.W. & Faupl P. (Eds.) - Geodynamics of the Eastern Alps, pp. 85-102, Franz Deuticke, Wien.

Lóczy L. sen. (1916) - Die geologischen Formationen der Balatongegend und ihre regionale Tektonik. *Result. wissenschaft. Erforschung Balatonsees*, v. 1, n. 1, 716 pp., Wien.

Majoros Gy. (1980) - Problems of Permian sedimentation in the Transdanubian Central Mountains: a paleogeographic model and some conclusions. *Bull. Hung. Geol. Soc.*, v. 110, n. 3-4, pp. 323-341, Budapest.

Masetti D., Stefani M. & Burchell M. (1989) - Asymmetric cycles in the Rhaetic facies of the Southern Alps: platform-basin interactions governed by eustatic and climatic oscillations. *Riv. It. Paleont. Strat.*, v. 94, n. 3, pp. 401-424, Milano.

Oravecz-Scheffer A. (1987) - Triassic Foraminifers of the Transdanubian Central Range. *Geol. Hung. ser. Paleont.*, v. 50, 331 pp., Budapest.

Pasini M., Conti M. A., Mariotti N., Nicosia U., Cassinis G., Oddone M., Vannucci R., Massari F., Fontana D., Giobbi E., Ramovs A., Broglio Loriga C., Neri C., Posenato R., Flügel E., Noe S., Demelia Pittau P., Amico C. D., Farabegoli E., Gabriele Ori G., Perri C. & Venturini C. (1986) - Permian and Permian-Triassic boundary in the South-Alpine segment of the Western Tethys. Excursion Guidebook, pp. 1-158, Brescia.

Peters K.F. (1859) - Geologische Studien aus Ungarn II. Die Umgebung von Visegrád, Gran. Totis und Zsámbék. *Jb. Geol. R.-A.*, v. 10, pp. 485-521, Wien.

Pisa G. (1974) - Tentativo di ricostruzione paleoambientale e paleostrutturale dei depositi di piattaforma carbonatica medio-triassica delle Alpi Carniche sud-occidentali. *Mem. Sc. Geol. Ital.*, v. 13, n. 1, pp. 35-83, Padova.

Pisa G., Castellarin A., Lucchini F., Rossi P.L., Simboli G., Bosellini A. & Sommavilla E. (1980) - Middle Triassic magmatism in the Southern Alps. I.: A review of general data in the Dolomites. *Riv. It. Paleont. Strat.*, v. 85 (1979), n. 3-4, pp. 1093-1110, Milano.

Prey S. (1978) - Rekonstruktionversuch der alpidischen Entwicklung der Ostalpen. *Mitt. Österr. Geol. Ges.*, v. 69, pp. 1-25, Wien.

Senowbary-Daryan B., Zühlke R., Bechstädt Th. & Flügel E. (1993) - Anisian (Middle Triassic) Buildups of the Northern Dolomites (Italy): The Recovery of Reef Communities after the Permian/Triassic Crisis. *Facies*, v. 28, pp. 181-256, Erlangen.

Taeger H. (1912) - További adatok a Bakony földtani viszonyaihoz. *Ann. Rep. Hung. Geol. Inst. 1911*, pp. 61-66, Budapest.

Taeger H. (1913) - A tulajdonképpeni Bakony délkeleti részének szerkezeti alapvonásai. *Ann. Rep. Hung. Geol. Inst. 1912*, pp. 156-170, Budapest.

Telegdi-Róth L. (1929) - Magyarország geologiája I. rész (Geology of Hungary), Pécs.

Vadász E. (1960) - Magyarország földtana (Geology of Hungary), Budapest.

Végh-Neubrandt E. (1982) - Triassische Megalodontaceae. Entwicklung, Stratigraphie und Palaontologie. V. of 526 pp., Budapest.

Wopfner H. (1984) - Permian deposits of the Southern Alps as product of initial alpidic taphrogenesis. *Geol. Rund.*, v. 73, n. 1, pp. 259-277, Stuttgart.

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