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THE CARBONIFEROUS AND PERMIAN OF HUNGARY

by

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I. STRATIGRAPHY

Lower Carboniferous

1. Safely-dated Lower Carboniferous in Hungary is known only in a narrow belt between the Velence granite mass and Lake Balaton, in the footwall of the Devonian crystalline limestone blocks of the Szabadbattyán—Polgárdi zone [A. FÖLDVÁRI 1952*a*, *b*; J. KISS 1951; G. KOLOSVÁRY 1951]. The base of this Lower Carboniferous has not been uncovered as of yet. The relevant statements of A. FÖLDVÁRI, however, have been confirmed by the careful analyses of recent drilling materials [CS. DETRE 1970, 1971; S. MIHÁLY 1971; M. MONOSTORI 1971]. This has to be emphasized because in recent years several workers, relying on erroneous determinations, have attempted to assign both the crystalline limestones and their tectonic footwall to the Upper Carboniferous [E. NAGY 1971; GY. MAJOROS 1971; M. SIDÓ 1971]. A starting point for the development of these ideas has been the isolated position of the Transdanubian occurrence, as the nearest, paleontologically dated Lower Carboniferous within the Carpathian arch can be found as far away as the Bihor Mountains and the Southern Carpathians [K. BALOGH 1964, pp. 602—603].

The Lower Carboniferous at Szabadbattyán consists of dark shales alternating with sandstones and limestones. The limestones show a purely marine facies, abunding in blue and green algae, crinoids and brachiopods. On the basis of their positive *(Table 1)* and negative features (e. g. the total absence of Westphalian *fusulinids* and Middle Visean *koninckopores)* they can be assigned convincingly to the Upper Visean [M. MONOSTORI 1971].

The normal stratigraphic hanging wall of these Upper Visean strata is not known either. For, the Upper Visean strata are in a tectonic contact with the partly ankeritized, crystalline limestones overlying them. Consequently, these should be annexed to the pre-Carboniferous phyllite sequence of the Balaton Region. In reality, in Borehole Sz-9 quartz-phyllites of 18 m thickness overlie the 167 m-thick crystalline limestones including, themselves, an interbedded breccia layer of quartz-phyllite.

2. On the basis of geological considerations, the author ascribed earlier [K. BALOGH 1964, pp. 561—565] a Lower Carboniferous age to the tripartite sequence of the Uppony block as well. As shown by J. ORAVECZ (1965), the microfossils of the siliceous schists of the uppermost member, however are reminiscent of the Silurian schists of the Balaton Highland. The presence of *acritarchs* has not been confirmed by F. GÓCZÁN'S informative investigations [1971]. M. HAJÓS' efforts [1971] to detect *conodonts* were similarly unsuccesful. Accordingly, though the Carboniferous age of the Uppony sequence has turned out to be uncertain, yet it has been impossible to warrant convincingly its assignment to the Silurian.

TABLE I

The biostratigraphically interpretable forms of the Upper Viséan at Szabadbattyán

Species	Tournaian	Viséan	Namurian	Middle Carboniferous
FORAMINIFERA*				
Parathurammina cf. *stellata* LIPOVA	—	—	—	
P. cf. *sulcimanovi* LIPOVA	—	—	—	
Tuberitina cf. *reitlingerae* (M.-MACLAY)		—	—	
Pachysphaera aff. *dervillei* CONIL et LYS		—		
Diplosphaerina aff. *inaequalis* (DERVILLE)		—		
Palaeotextularia cf. *consobrina* LIPOVA				
Tetrataxis aff. *pressulus* MALAKHOVA	—	—	—	
T. cf. *paraminimus* VISSARIONOVA	—	—	—	
Howchinia aff. *exilis* (VISSARIONOVA)	—	—	—	
H. aff. *declivis* (LEBED.)	—	—	—	
Archaediscus cf. *krestovniki* RAUSER		—	—	
A. cf. *krestovniki redita* CONIL et LYS				
A. cf. *karreri* BRADY		—	—	
A. cf. *moelleri* RAUSER		—	—	
A. cf. *convexus* GROZD. et LEBEDEVA		—	—	
A. cf. *kakjubensis* RAUSER		—	—	
Endothyra cf. *prisca* RAUSER et REITL.		—		
E. cf. *bradyi* MIKHAJLOV		—		
E. cf. *omphalota samarica* RAUSER		—		
E. cf. *amplis* SHLYKOVA		—		
E. cf. *similis* RAUSER et REITLINGER		—		
E. aff. *similis elegia* MALAKHOVA		—		
Janischewkina aff. *typica* MIKHAJLOV		—		
Bradyina cf. *rotula* (EICHWALD)		—	—	
B. ex gr. *cribrostomata* RAUSER et REITL.		—	—	
B. cf. *modica* LEBEDEVA				
Eostaffella cf. *vasta* ROZOVSKAJA		—		
E. cf. *ikensis* VISSARIONOVA		—	—	
E. cf. *mosquensis* VISSARIONOVA		—	—	
E. cf. *parastruvii* RAUSER		—	—	
Mediocris cf. *mediocris* (VISSARIONOVA)		—		
M. cf. *breviscula* (GAMELINA)		—		
Pseudoendothyra aff. *struvii supressa* (SHLYKOVA)		—		
TABULATA**				
Syringopora lata PHILLIPS	—	—	—	
Chaetetes sp.	—	—	—	—
RUGOSA**				
Hapsiphyllum battyánense KOLOSVÁRY	- - -	- - -	- - -	
Amplexus sp.	—	—	—	
Dibunophyllum turbinatum (M'COY)		—	—	
Palaeosmilia murchisoni M. EDWARDS et HAÎME		—	—	
HETEROCORALLA**				
Heterophyllia mirabilis (DUNCAN)		—		
BRACHIOPODA***				
Gigantoproductus ? *transdanubicus* (FÖLDVÁRI)		- - -	- - -	
Productus sp.	- - -	- - -	- - -	- - -
aff. *Unispirifer* sp.				
aff. *Dictyoclostus* sp.				

* Determined by MONOSTORI, M. [1971].
** Determined by MIHÁLY, S. [1971].
*** Determined by DETRE, Cs. [1970, 1971].

Middle and Upper Carboniferous

The higher members of the Carboniferous in Hungary are represented by continental and marine facies.

a) Continental facies

At present the continental facies is known to occur in three places: *1.* the Tokaji Mountains, *2.* between Lake Balaton and the Velence Mountains (at Füle village) and *3.* the northern foreland of the Villány Mountains.

i. The Tokaj's Upper Carboniferous is exposed at Vilyvitány and it has been cut through in 226 m thickness in Borehole Felsőregmec-1. It joins the 500- to 600-m-thick Permo-Carboniferous sequence of the Czechoslovak Zemplin Mountains comprising meta-anthracite seams and Ottweilian floral elements and, in the upper part, some ash-flow-tuff-like quartz-porphyry intercalations as well. According to the data of drilling, this coarse-detrital Carboniferous sequence overlies crystalline schists or their Lower Paleozoic mantle, respectively. The meta-anthracitic lenses and vegetal remnants (fossil plant remnants) of the intersected sandstones and of the upper part of the schists represent certainly the Stephanian Stage [G. Pantó 1965, 1966, pp. 25—28].

ii. As discovered recently, the so-called "conglomerate-and-phyllite sequence of Füle" belongs to the Westfalian Stage [Á. B.-Stuhl 1971; E. Nagy 1971; Gy. Majoros 1971] rather than to the Upper Permian or the Lower Carboniferous [Gy. Wein 1969, p. 410]. Unfortunately, the rocks underlying this sequence of some 600 m thickness, uncovered by Borehole Polgárdi-2, has not been explored as of yet. Consequently, the relation of the sequence to the Visean of Szabadbattyán has remained unsettled.

The sequence consists of 15 microcycles of red breccias, conglomerates and sandstones which, however, turn grey in depth. Claystones and phyllites, if any, occur very seldom even in the upper strata. At 250 m depth Á. B.-Stuhl [1971] found a sporomorph assemblage of Westfalian age *(Table 2)*. Most of the pebbles of the sequence are consituted by quartzite, quartz- and sericite-phyllites [G. Teleki 1941, p. 314]. Accordingly, they indicate a continental formation accumulated on the denuded surface (paleorelief) of overwhelmingly Upper Paleozoic roks as a result of Sudetic overthrusts.

iii. The exploration of the continental Upper Carboniferous of the Villány and Mecsek Mountains is also a new discovery. Phytofossiliferous Upper Carboniferous sandstone pebbles were first shown to occur in the Miocene basal conglomerates of the northern margin of the Mecsek Mountains [G. Andreánszky in: I. Soós—Á. Jámbor 1960] *(Table 3)*. The mother rock of the pebbles was identified first in Borehole Téseny-2 [I. Baranyi—Á. Jámbor 1962], then it was explosed by five more boreholes in a SE dipping position [Á. Jámbor 1969]. The sequence was found to be in contact with crystalline schists along a tectonic line in the north and to consist of light grey sandstones partly gravelly and of black sericitic schists partly sandy. Its facies is identical with that of the South Carpathian and Croatian Upper Carboniferous (Baia Noua, Secul, Lupac, resp. Slemenski Jarak, Ruc, Cipluh). Thereafter two additional boreholes were sunk at the foot of the Villány Mountains [E. Nagy 1971, p. 654]. According to L. R.-Baranyai [in: R. Hetényi—M. Földi—L. R.-Baranyai 1971], these represent two different parts of the Middle and Upper Carboniferous without the hiatus between the two parts of profile being precisely definable. The footwall of the sequence has not been reached here either, yet the material of Borehole Bogádmindszent-1 with its 1105 m thickness represents the deeper, Borehole Siklósbodony-1 (round 630 m) the higher parts of the profile.

TABLE 2

The Middle Carboniferous Sporomorpha in Hungary

Forms	Continental facies			Marine facies
	Polg. —2* 230 m	Bmsz. —1** 509—514 m	Sbod. —1** 779—798 m	Nagyvisnyó Railway 1**
Calamospora liquida f. major KOSANKE	+			
C. liquida f. *minor* KOSANKE	+			
C. breviradiata KOSANKE	+			
C. pallida (LOOSE) S. W. & B.			+	
Punctatisporites sabulosus IBRAHIM	+			
P. punctatus IBRAHIM	+			
P. obscurus KOSANKE	+			
Granulatisporites piriformis LOOSE	+			
G. micrograni[er IBRAHIM	+			+
G. parvus IBRAHIM	+			
G. sp.				+
Laevigatisporites giganteus DYB. & JACH.	+			
Verrucosisporites sp.				+
Crassispora (Planisporites) kosankei (R. POT. & KREMP) BHARDVAJ				+
C. (P.) ovalis BHARDVAJ				+
Raistrickia aculeata KOSANKE				+
R. superba (IBRAHIM) S. W. & B.				+
R. sp.				+
Reticulatisporites sp.				+
Apiculatisporites raistricki DYB. & JACH.	+			
Anapiculatisporites spinosus (KOSANKE)			+	
Tuberculatisporites regularis DYB. & JACH.	+			
T. gigantomodatus DYB. & JACH.	+			
Conbaculatisporites sp.			+	
Canaliculatisporites spongiatus DYB. & JACH.	+	?		
Cristatisporites n. sp.		+	+	
Leiotriletes sphaerotriangulus R. POT. & KREMP	+			
L. adnatus KOSANKE	+			
Converrucosisporites sp.			+	
Converrucitriletes armatus DYB. & JACH.	+			
C. verrucosus DYB. & JACH.	+			
Triquitrites tribullatus (IBRAHIM) R. POT. & KREMP				+
T. trigallerus (NEVES) nov. comb.				+
T. tricuspis R. POT. & KREMP	+			
Tripartites cf. *confragosus* JACH. var. *cumareus* GÓCZÁN				+
cf. Neoraistrickia drybrookensis SULLIVAN				+
Savitrisporites asperatus SULLIVAN				+
S. concavus MARSHALL & SMITH				+

Forms	Continental			Marine
	facies			
	Polg. —2* 230 m	Bmsz. —1** 509—514 m	Sbod. —1** 779—798 m	Nagyvisnyó Railway 1**
S. nux (BUTTERWORTH & WILLIAMS) SULLIVAN				+
Lycospora punctata KOSANKE	+			
L. parva KOSANKE	+			
L. spinosa BOHÁCOVÁ	+			
L. pellucida (WICHER) S. W. & B.				+
L. pusilla (IBRAHIM) S. W. & B.				+
L. torquifer (LOOSE) R. POT. & KREMP				+
L. triangulata BHARDVAJ				+
Densosporites granulosus KOSANKE				+
D. loricatus (LOOSE) S. W. & B.				+
D. parvus HOFFM., STAPL. & MALL.				+
D. rufus KOSANKE				+
D. sinuosus KOSANKE				+
D. sp.	+			+
Verrucososporites obscurus R. POT. & KREMP	+			
V. verrucosus ALPERN	+			
Granulatosporites fabaeformis DYB. & JACH.	+			
G. granulatus DYB. & JACH.	+			
Latosporites latus R. POT. & KREMP	+			
Cirratriradiates arcuatus GUENNEL				+
Florinites ovatus DYB. & JACH.	+			+
F. sp. 1				+
F. sp. 2				+
Alisporites sp.	+			
Potonieisporites sp.				+

* Determined by BARABÁS-STUHL, Á. [1971].
** Determined by GÓCZÁN, F. [1971].

The Bogádmindszent sequence is constituted by coarse and fine conglomerates, coarse and fine sandstones, arcoses, siltstones and sandy, silty and calcareous shales. The grain size of the strata, as a rule, decreases down the profile and it is only in the lowermost 40 m that a coarsening is observable again. The sequence consists of 30 microcycles grading into one another without any sharp boundary. Between 648 and 1290 m several seams and stringers of freshwater meta-anthracite of 20 to 60 cm thickness can be observed. The presence of carbonaceous shale pebbles in the higher-seated coarse conglomerate material testifies to occasional interruptions of the sedimentation by erosional episodes. According to its sporomorphs *(Table 2)* and the macroflora recovered from 20 levels *(Table 3)*, the sequence can be dated as Westfalian. The same can be said about the topmost strata, where, at 310 m depth, poorly preserved representatives of *Licospora, Savitrisporites, Cirratriradiates* and *Florinites* could still be observed.

The detrital rocks of Borehole Siklósbodony-I differ in composition from those of Bogádmindszent. The pebbles are overwhelmingly metamorphites. No granite pebble is present, the pebbles of quartz-porphyry are scarce. The strata below 980 m are of greyish-green colour. Between 980 and 570 m, however, more and more red-brown intercalations are observable, so that this 410 m-thick member grades into the red Lower Permian strata conformably overlying it. The scant sporomorphs deriving from the middle of this interval *(Table 2)* do not exclude the possibility of a Stephanian age.

Otherwise, the Bogádmindszent sequence includes, at 784.5—785 m depth, a carbodiabase sill and, at 1100—1200 m, it is intervowen by a netlace of quartz, quartz-feldspar and quartz-carbonate streaks.

TABLE 3

Macroflora of the Middle Carboniferous in Hungary

Species	Boulders from North-Mecsek*	Bmsz—1 502—1195 m**
EQUISETINAE		
Sphenophyllum erosum LINDL & HUTT.	?	
S. schlotheimi BRONGN.	+	
Annularia sp.		+
Calamites sp.	+	+
FILICINAE		
Pecopteris volkmanni SAUVEUR		+
P. pennaeformis BRONGN.		+
P. (Daclitykitheca) dentata BRONGN.		+
P. cf. *miltoni* ARTIS		+
P. cf. *punctata* CORSIN		+
P. sp.	+	+
Neuropteris cf. *schlehani* STUR		+
N. microphylla BRONGN.	+	
N. gigantea STERNBERG	+	
N. articulata BRONGN.	+	
N. sp.		+
Alethopteris grandini BORNGN.		+
A. davreuxi (BRONGN.) GOEPP.		+
A. cf. *friedeli* BERTR.		+
A. sp.		+
PTERIDOSPERMAE		
Lepidopteris cf. *rigida* (KURZ) SCH.	+	

* Determinated by ANDREÁNSZKY, G. [in SOÓS, I.—JÁMBOR, Á. 1960].
** Determinated by FÖLDI, M. [1971].

b) Marine facies

Marine Middle to Upper Carboniferous sediments have for a long time been known to occur in the northern Bükk Mountains and were last described in detail by K. BALOGH [1964]. Unfortunately, the formations underlying this continuous geosynclinal-type sequence explored in about 1500 m thickness are unknown. If the Uppony sequence, which was earlier considered to be a representative of the Lower Carboniferous, was assigned, in accordance with J. ORAVECZ [1965] to the Silurian, a Lower Carboniferous of Szabadbattyán facies had to be supposed to be hidden in depths. The possibility of a Sudetic unconformity, however, cannot be completely rejected in this case, either.

Attaining a thickness of about 1100 m, the member of the Bükk's Carboniferous seems to span the Namurian-Bashkirian-Lower Moscovian interval. It consists of a monotonous sequence of dark shales and sandstones containing at the top both *brachiopods* and the fusulinid *Hemifusulina moelleri* RAUSER. The Upper Moscovian and Uralian are characterized by the alternation of dark limestone lenses with shales including sporadically interbedded massive quartz-conglomerates and sandstones. At the top the dark shales are replaced by variegated ones, so that the grading into a lagoonal Lower Permian of variegated facies locks very plausible. The facies reminds of the Hochwipfel and Auernig Beds of the Carnian Alps, it spans the interval Upper Moscovian — Uralian distinguished with the aid of *fusulinids*. In addition, the Upper Moscovian contains hosts of *calcareous algae, smaller foraminifera, corals, brachiopods, molluscs* and *trilobites* [K. BALOGH 1961, 1964, M. HERAK—V. DEVIDÉ 1963, SZ. E. ROZOVSZKAJA 1962, 1963, GY. RAKUSZ 1932, Z. SCHRÉTER 1948, 1963]. Let us admit, however, that the Uralian has so far been rather poorly identified and only in the southern limb of the northern Bükk anticline *(Pseudofusulina pseudojaponica* DUTKEVICH, *Quasifusulina, Triticites.)*

The continuation of the Bükk's marine Middle and Upper Carboniferous in the Carpathian Region may be searched for mainly in the magnesitic Carboniferous of the Slovak Metalliferous Mountains. Farther south, traces of marine facies are allegedly known to occur in the eastern Great Hungarian Plain, being represented there by dark shales and sandstones recovered from some boreholes [K. SZEPESHÁZY]. They appear, however, in form of yellowish-white limestone pebbles in the 956.5—959.5 m interval of Borehole Karád-1 south of Lake Balaton [K. BALOGH 1964. p. 339]. Although these seem to belong to Tertiary conglomerates, yet they form an important link, proved by *Triticides* and *Daixina*, with the Middle and Upper Carboniferous of the Southern Alps and Dinarides.

Permian

The Permian of Hungary is similarly represented by both continental and marine facies.

a) Continental Permian

The thickest sequence, including the Rotliegend, is known to occur in the western Mecsek and at the northern margin of the Villány Mountains. Elsewhere, sedimentation was restricted to the Late Permian time only. The sediments are accompained by eruptions of quartz-porphyry whose erosion products play a considerable role in both parts of the Permian. The individual sequences are characterized by a recurring rhythmicity of varying size.

1. The almost 2.5-km-thick red Lower Permian of the Mecsek Mountains *(Fig. 1)* begins — above Precambrian granitoids rejuvenated in Early Carboniferous time — with 340 m of coarse sediment. The pebbles of these consist of granite, crystalline schist, Carboniferous sandstone, Silurian shale and porphyrite. Above the talus-like basal strata follow four microcycles which can be divided into a number of rhythms. The top of this member contains, beside *Pecopteris* sp. and *Voltzites* sp., Lower Permian *sporomorphs (Table 4, Column 1).*

These presumably fluviatile sediments are overlain by 30 to 150 m of quartz-porphyry lava. Above this, the fluviatile facies reappears, though with torrential features this time. This member can be split up into two cycles separated by erosion surface from each other. Most of the pebbles consist of porphyrites and quartz-porphyry. The grain size, however, shows a gradual decrease within the second cycle.

The upper part of the Mecsek's Lower Permian is constituted by lacustrial sediments linked through the medium of 150 of transitional sediment with the older fluviatile ones. The transitional member consists of an alternation of sandstones of graded bedding with thinly laminated (foliaceous) siltstones cemented by dolomite. One limestone intercalation could also be identified. The finer-grained strata contain the phyllopod *Lioestheria lallyensis* DEPÉRET et MAZAREN.

The transitional member is overlain by 700 to 900 m of red-brown siltstone with locally associated red dolomitic marls. Characterized by fine bedding, micro-crossbedding ripple marks, bioglyphs and dessication marks and cycles of 10 to 30 m thickness, the sequence appears to have been deposited in a non-agitated environment. Because of the absence of common salt accumulations, a shallowwater sea environment is hardly conceivable. In this respect, the phyllopods (*Limnadia* sp.) recovered from the sedimentary sequence do not give any information.

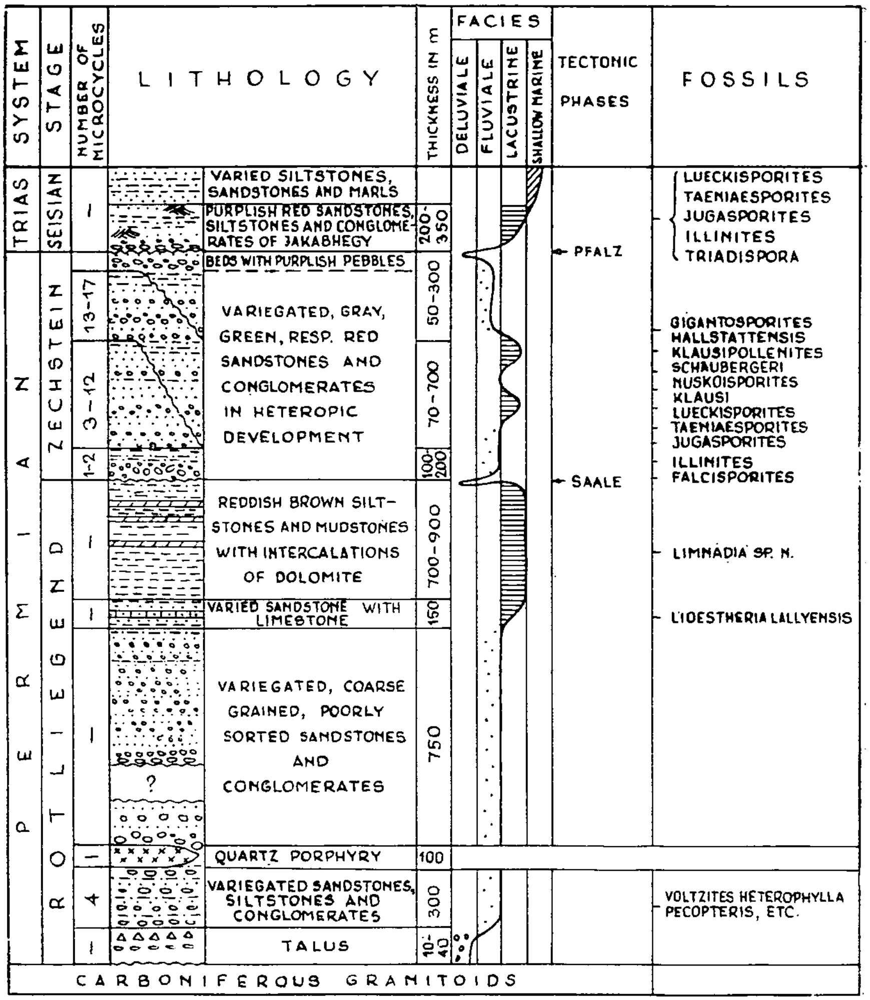

Fig. 1. Ideal profile of the Permian of the Western Mecsek.
Compiled by Mr. and Mrs. Barabás, Á. Jámbor and O. Tőzsér

As opposed to this asymmetrical megacycle, the Mecsek's Upper Permian exhibits a new and symmetrical megacycle of fluviatile nature. The total thickness of its four members increases from 200 m in the west up to 1200 m in the east (i.e. towards the centre of the basin). The merit of deciphering the intricate facial conditions belongs to Á. B.-Stuhl [1969].

At the base, the Lower Permian siltstone sequence is overlain with a sharp unconformity by a very diversified, though overwhelmingly red-coloured, sequence of coarse- to fine-grained sediments. The second member consists of finer, fluviatile and lacustrial sediments which on the basin margins are variegated, in the basin centre grey. The third member shows the same development, but the colour is inversely distributed: turning red towards the centre of the basin. This member

TABLE 4

Sporomorpha from the Permian and Early Trias of the Mecsek Mountains after BARABÁS-STUHL, Á. [1967]

Species	Early Permian	Later Permian			Early Trias
	Sandstone				
	underlaying the quartz-porphyry	of			of Jakabhegy
		varied	gray	green and red	
		colour			
Nuskoisporites klausi GREBE		+	+	+	
Jugasporites schaubergeroides KLAUS		+	+	+	
J. delasaucei LESCHIK	+	+	+	+	+
Limitisporites sp.	+	+	+	+	+
Gigantosporites hallstattensis KLAUS		+			
Gardenasporites sp.	+	+	+	+	
Lueckisporites virkkiae POT. & KLAUS				+	
L. microgranulatus KLAUS	+	+	+	+	+
Taeniaesporites alatus KLAUS	+	+	+	+	
T. labdacus KLAUS		+	+	+	
T. sp.					+
Klausipollenites schaubergeri (POT. et KLAUS) JANSONIUS		+	+	+	
Falcisporites zapfei LESCHIK		+	+	+	+
Platysaccus papilionis POT. & KLAUS			+	+	+
Converrusisporites eggeri KLAUS	+	+	+	+	
Cordaitina sp.	+				
Lophotriletes sp.	+				
Illinites melanocorpus KLAUS					+
Triadispora sp.					+
Allisporites sp.					+

is rich in *silicified wood trunks [Baiera digitata* HEER, *Baieroxylon implexum* (ZIMMERMANN) GREGUSS, *Dadoxylon schrollianum* (GOEPPERT), *D. transdanubicum* SIMONCSICS, *D. rhodeanum* (GOEPPERT), *Araucarioxylon* sp., *Platyspiroxylon parenchymatosum* GREGUSS, *Voltzites hungarica* HEER, *V. boeckhiana* HEER, *Carpolithes geinitzi* HEER*]* and *phyllopods [Eoestheria dawsoni* (JONES), *Eoleaia leaiformis* RAYMOND [in VÁRSZEGI K. 1961]. The afore-mentioned "horizons", repeatedly intertonguing, are overlain by a relatively thin final layer of "sandstone with purple gravels" showing, again, a coarser grain size. This formation is undoubtedly separated by an unconformity from the Jakabhegy Sandstone Formation assigned recently to the Lower Trias, on account of its sporomorphs *(Table 4)*, lithological characteristics and overlapping transgression. The presence of an unconformity is emphasized by the basal conglomerates of the Jakabhegy Formation.

2. The Permian of the Villány Mountains is similar to that of the Mecsek, but is known only from boreholes (as a result of drilling). From the Lower Permian so far only the coarse-grained basal member developing gradually from the Stephanian (Siklósbodony-1) and the top of the siltstone sequence (Turony-1) are known. No trace of Lower Permian volcanism is available *(Fig. 2)*.

In the Upper Permian two heteropical facies occur in a juxtaposition. For, the purely sedimentary, Mecsek-type sequences of the western basin portion (Turony-1) show an intertonguing with the products of the large quartz-porphyry volcano of Bisse-Vokány in the east. And it is then that the Jakabhegy Sandstone

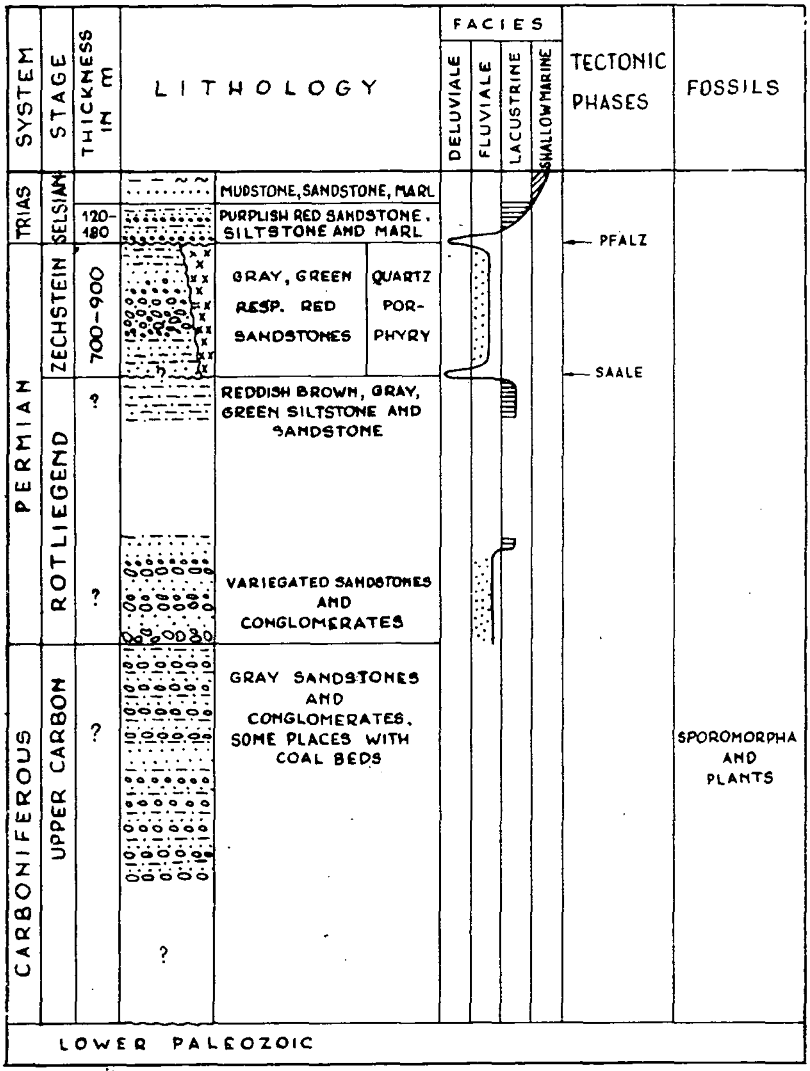

Fig. 2. Ideal profile of the Later Palaeozoic of the Villány Mountains.
Compiled by Mrs. Barabás, M. Kassai, Mrs. M. Kovács and T. Szederkényi

transgresses over both facies, extending eastwards beyond the limit of the Upper Permian area similarly way as in the Mecsek Mountains.

3. On the southeastern side of the Balaton Highland a continental Upper Permian is exposed in several places, being further traceable along the strike underground as shown by drilling *(Fig. 3).*

The basal conglomerates rest on a Silurian quartzphyllite sequence, being overlain by a rhythmical alternation of red, grey and variegated sandstones, siltstones and clays. The pebbles of the basal conglomerates are constituted by quartz, quartz-porphyry, phyllite and metamorphic sandstones. The sandstones contain, beside quartz and muscovite, some rock debris and feldspar as well. The coarser fluviatile deposits turn upwards gradually finer, grading into lacustrial sediments partly green in colour. These last-mentioned rocks include thin coal stringers, red dolomite lenses and even traces of gypsum.

The total thickness increases from 200 in the SW to 800 m in the NE. In a close connection with this the Upper Permian is separated by a slight angular disconformity and basal conglomerates from the purely marine Lower Trias transgressing over the SW part of the area (Kővágóőrs-Zánka). However, farther NE, i.e. closer to the basin centre, there is a transition in lithology between the two systems. Finally, the continental facies in the southern foreland of the Vértes Mountains grades into a gypsum-bearing, lagoonal-marine facies which was connected with the sea trough to the south of it.

However, the Upper Permian of the northern margin of the Bakony Mountains is again of purely continental facies. In Borehole Alsószalmavár-1, between the Lower Triassic and slightly metamorphosed Devonian (?) schists, it attains round

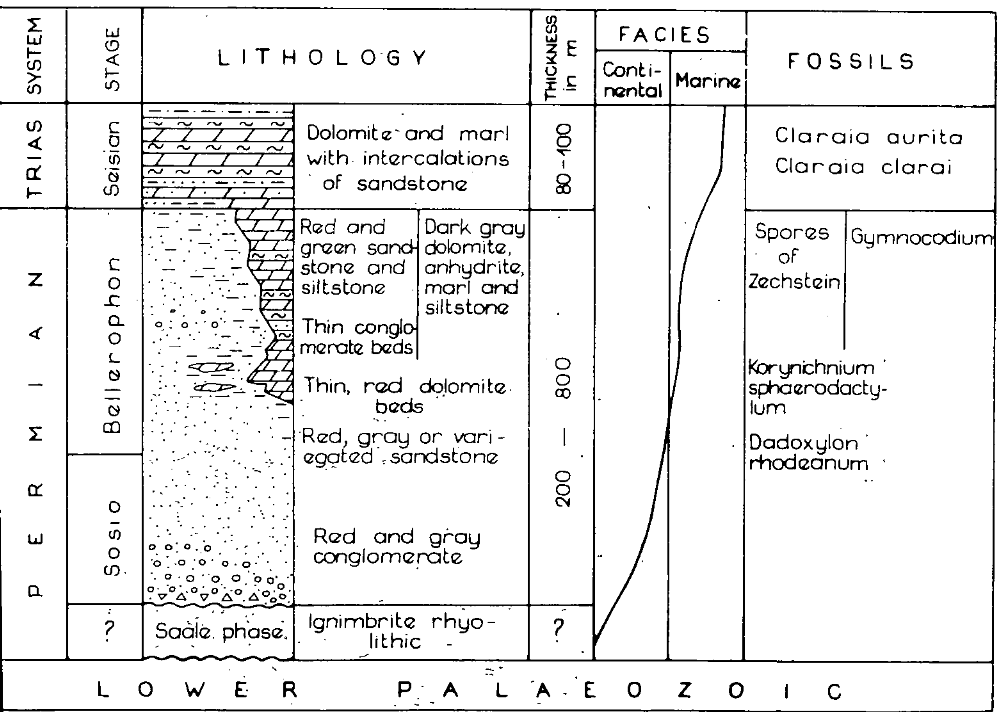

Fig. 3. Ideal profile of the Permian of the Balaton Region. Compiled by GY. MAJOROS

400 m in thickness [E. KORPÁS—Á. JÁMBOR—E. NAGY 1970; CS. DETRE—E. NAGY 1971].

The *sporomorphs* of the Upper Permian of the Balaton Highland are for the most part identical with those of the Mecsek's Upper Permian [Á. B.-STUHL 1961]. In addition, however, *Araucarioxylon* sp., *Platyspiroxylon* sp., *Dadoxylon rhodeanum* (GOEPPERT), tracks and burrows of *worms* and *crustaceans* as well as foot-prints of *reptiles* [*Korynichnium sphaerodactylum* (PABST)] can also be observed [GY. MAJOROS, 1964; GY. MAJOROS in: J. FÜLÖP 1969. p. 8; A. KASZAP, 1968; P. GREGUSS, 1967].

4. The continental Upper Permian occupies large areas other than the Zemplén-Tokaj and Bihar Mountains in the southern Great Hungarian Plain as well. Overlying crystalline schists and Carboniferous granitoids, its strata have been uncovered by drilling in the vicinity of Érsekcsanád, Kunbaja, Ásotthalom and Nagykőrös [G. CSIKY, 1963; K. SZEPESHÁZY, 1962; A. BÉRCZI—MAKK, 1971]. The red conglomerates and arcoses at Nagykőrös grade upwards into gypsum-bearing beds which are difficult to separate from the Lower Trias. In the Zemplén Mountains and at Battonya and Kelebia the red sediments are accompained by quartz-porphyry tuffs and intrusions whose radiometric age at the last two localities is estimated at 250 ± 20 M. Y. and 230 ± 20 M. Y., respectively.

b) Marine Permian

Marine Permian deposits occur amidst the afore-listed continental occurrences in the Bükk Mountains. The basal member of their sequence attaining a total thickness of 400 to 500 m begins above the Uralian Stage with variegated sandstones, shales and lagoonal dolomites. These grade up in the profils into dark, bituminous limestone and dolomite facies abunding in Indo-Armenian to Dinarian microfloral elements and micro- and macrofossils [K. BALOGH 1961, 1964]. The continuation of this facies is still uncertain. Its connection with the South Alpine and Dinarian occurrences, however, can be supposed to be traceable, as shown by I. SZABÓ's observations, via the Boreholes of Bugyi, Tabajd-5, Táska, Dinnyés and Dióskál, i.e. virtually along the southern side of Lake Balaton.

Nota bene, at Bugyi, Gymnocodium-bearing Permian limestones occur in Eocene conglomerates. In the lithological log of Borehole Tabajd-5 the Lower Paleozoic schists are overlain by red conglomerates, sandstones and siltsones totalling 300 to 400 m in thickness. These agree in lithology and facies with the continental Permian of the Balaton Highland. The red siltstones, however, are overlain by yet another 350-m-thick sequence consisting of grey gypsum- an anhydrite-bearing sandstones, marls, siltstones and dolomites. According to Á. B.-STUHL, among the *sporomorphs* there are genuine Upper Permian forms such as *Nuskoisporites dulhuntyi* (POT et KLAUS), *Pityisporites zapfei* POT. et KLAUS, *P. delasaucei* (POT. et KLAUS), and *Klausipollenites schaubergeri* (POT. et KLAUS) JANSONIUS. The massive dolomite beds contain calcareous algae *(Gymnocodium bellerophontis* (ROTHPLETZ) PIA, *Permocalculus tenellus* (PIA)) and smaller foraminifera *(Glomospira* sp., *Climacammina* sp., *Ammodiscus* sp.). The transition into the Lower Trias is indicated by the appearance of sandy, marly and, finally, pure limestones. The last-mentioned member of 68 m thickness already contains small *gastropods, pseudomonotids, pectinids* and *lingulae.* At Táska, the Upper Permian is constituted by a thick dolomite complex.

II. MAGMATISM, TECTONIC PHASES, PALEOGEOGRAPHY

1. In addition to the already-mentioned Lower and Upper Permian quartz-porphyry bodies whose removed detrital material is so largely involved in the construction of sedimentary sequences, those granite bodies should also be referred which on the basis of their features and radiometric data may be assigned, with good reason, to the Carboniferous. Among them the granites of migmatic nature, seemingly synorogenic, should be considered older, the batholitic, i.e. post-orogenic, ones younger.

The former, which are known to occur in Transdanubia and in the more southern part of the Great Hungarian Plain (Mágocs, Nyugat-Szenterzsébet, Pécs, Mórágy—Fazekasboda, Soltvadkert, Kecskemét, Cegléd, Algyő and Battonya), seem to be connected with the Breton phase. The latter occurring in the Velence Mountains in exposure and at Ságvár, Buzsák and Gelse underground, can be brought into connection with the Sudetic phase. It should be emphasized, however, that long-lasting magmatic processes are dealt with, as manifested by both the fluctuation of radiometric data and the occurrence of subsequent quartz-porphyry volcanism. At any rate, the frequency of igneous bodies testifies to vivid crustal activities to have taken place in Variscan time in what is now Hungary.

2. Because of the deficiency of information, intra-Carboniferous sedimentation breaks and unconformities cannot be located with complete accuracy as of yet. Nonetheless, the heaviest tectonic movements should be placed at the boundary between the Devonian and Carboniferous and Lower and Middle Carboniferous, respectively. This is confirmed, on the one hand, by the suddently increasing epi-metamorphism of the pre-Carboniferous formations, on the other hand, by the retrograde metamorphism (315—330 M. Y. old) of Precambrian crystalline rocks along planes of subsequent movements. The period of these northerly overthrustings, however, died with the Sudetic phase. (Movements of northerly trend can be observed in the SE dipping Lower Paleozoic of the Szendrő-Uppony Mountains as well as at Szabadbattyán, where the Visean shales are tectonically "overridden" by the Devonian crystalline limestones.) The post-Sudetic phases, however, brought about only synorogenic uplifts and subsidences. The resulting fractures, however, have not caused any considerable change in the original arrangement of the strata. This is the reason why both the main facies of Hungary's Upper Paleozoic are connected with the Alpide structures rather than Variscide ones (e.g. the Bükk's Upper Paleozoic was folded together with the Trias).

3. After the Breton phase the Hungarian territory of the Variscicum became a denudation area, except for a small central belt pointing towards Nötsch in the Gailtal (Austria). After the Sudetic phase, however, larger intramontane basins were formed here. At the same time, the sea transgressed in the central, "Dinaric", sea-trough in NE direction as far away as the Gemerides.

Essentially, the same conditions persisted in post-Carboniferous time as well. Of course, the boundaries of certain basins were changed and also new areas of sedimentation were brought about. The sedimentation of the "Dinaric" sea-trough had not been interrupted since the beginning of the Middle Carboniferous and it was not until the Carboniferous-Permian boundary that lagoons could develop. The continental realm proved to be much more sensitive to crustal movements. There are two continental areas (Villány and western Mecsek Mountains), where sedimentation began in the Middle Carboniferous and the earliest Permian, respectively. In other places sedimentation was restricted to Late Permian time. The boundaries of the megacycles of Southern Transdanubia's Permian coincide with the Saale and Pfalz phases. This should be emphasized, as these phases are just slightly manifested or totally absent in the more northern areas or the Great Hungarian Plain. In the central, "Dinaric", belt the Upper Permian grades directly into the Lower Trias.

Consequantly, the paleogeographic setting *(Fig. 4)* must have been totally different from that proposed earlier [1963] by V. I. Slavin.

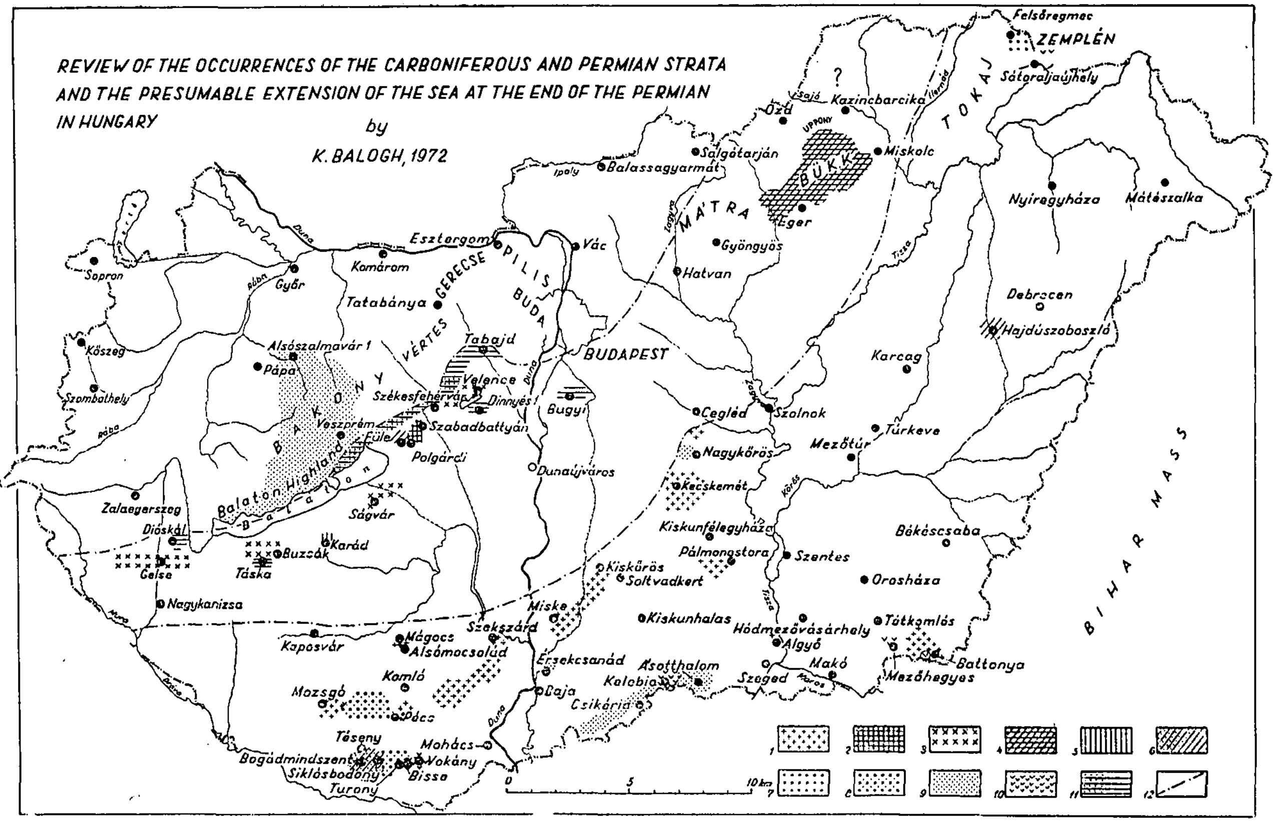

Fig. 4.

1: Migmatic granites (Breton phase?). — *2:* Early Carboniferous in marine facies. — *3:* Granite plutons (Sudetic phase?). — *4:* Marine sedimentary series, uninterrupted from the earliest Middle Carboniferous to the Latest Permian. — *5:* Later Carboniferous, purely marine. — *6:* Middle and Later Carboniferous in continental and marine facies. — *7:* Continental „Permocarboniferous". — *8:* Continental Early and Later Permian. — *9:* Later Permian, transgressing over Early Palaeozoic. *10:* Quartz porphyry and quartz porphyry tuff. *11:* Later Permian in continental—lagoonal, respective in continental—marine facies. — *12:* Later Permian shoreline

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