GEOLOGICKÝ ZBORNÍK — GEOLOGICA CARPATHICA, 35, 5, BRATISLAVA, OCTOBER 1984, PP. 559—581

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TO THE EARLY MID CRETACEOUS WEST CARPATHIAN DEVELOPMENT: THE AGE AND ENVIRONMENTAL POSITION OF THE "SKALICA BRECCIA"

(Figs. 8, Pl. 1, Tabs. 2)

A contribution to JGCP Project 58 „Mid Cretaceous Events"

A b s t r a c t: Biostratigraphy, lithology, paleogeographic and paleotectonic position of Skalica conglomerate breccias are interpreted in context with Aptian sequences in Strážovské vrchy Mts. tectonic units. Cephalopod macrofauna, indicating Mid Aptian age of the "lower fossiliferous horizon" and Aptian/Albian age of the "upper fossiliferous horizon" just below cherty limestone sequence, is revised. The Skalica breccia is interpreted to be produced by channelized debris flows on carbonate platform lower slope. Local erosion of the Lower Cretaceous sequence top members, often ascribed to subaerial exposure, was probable caused by an instability event of Aptian/Albian sedimentary regime.

Р е з ю м е: Биостратиграфия, литология, палеогеографическое и палеотектоническое положение среды происхождения конгломератных брекчий утеса Скалица интерпретируются в контексте аптских толщ в единицах Стражовских гор. Пересматриваются находки макрофауны головоногих моллюсков назначающих верхнеаптский возраст нижнего и аптско-альбский возраст верхнего горизонта содержащего окаменелости под толщей чертовых известняков. Конгломератные брекчии объясняются как продукты седиментации в течениях осыпей выходящих из каналов на подножии склона карбонатной платформы. Локальня эрозия высших членов нижнемеловой толщы, которая приписывается субаэральной эрозии, была вызвана аптско-альбским порушением равновесия осадочного режима.

Stratigraphical remarks to the Aptian sequence

Strážovské vrchy Mts. encover well preserved structure of the Centro-Carpathian nappe front. They consist mostly of Lower- and Mid-Cretaceous — the youngest members of Paleoalpine sedimentary cycle, which have slided down to the foreland of the upthrusting nappes. The Lower Cretaceous sequence forms important share of several digitations encovered in extensive area (chiefly Manín- and Krížna s. s. units). Thus, relatively limited Strážovské vrchy Mts. area allows a study of originally apart Lower- and Mid-Cretaceous sedimentary patterns, representing principally different environments.

Former authors who have worked in this area did not paid any attention on detailed Cretaceous stratigraphy. Their papers followed relation of Senonian complexes to their underlie, later also distribution of Albian sediments covering the "Neocomian". In the papers of A n d r u s o v (1943, 1945) the "Neocomian" has been already divided into "lower" and "upper" one, being di-

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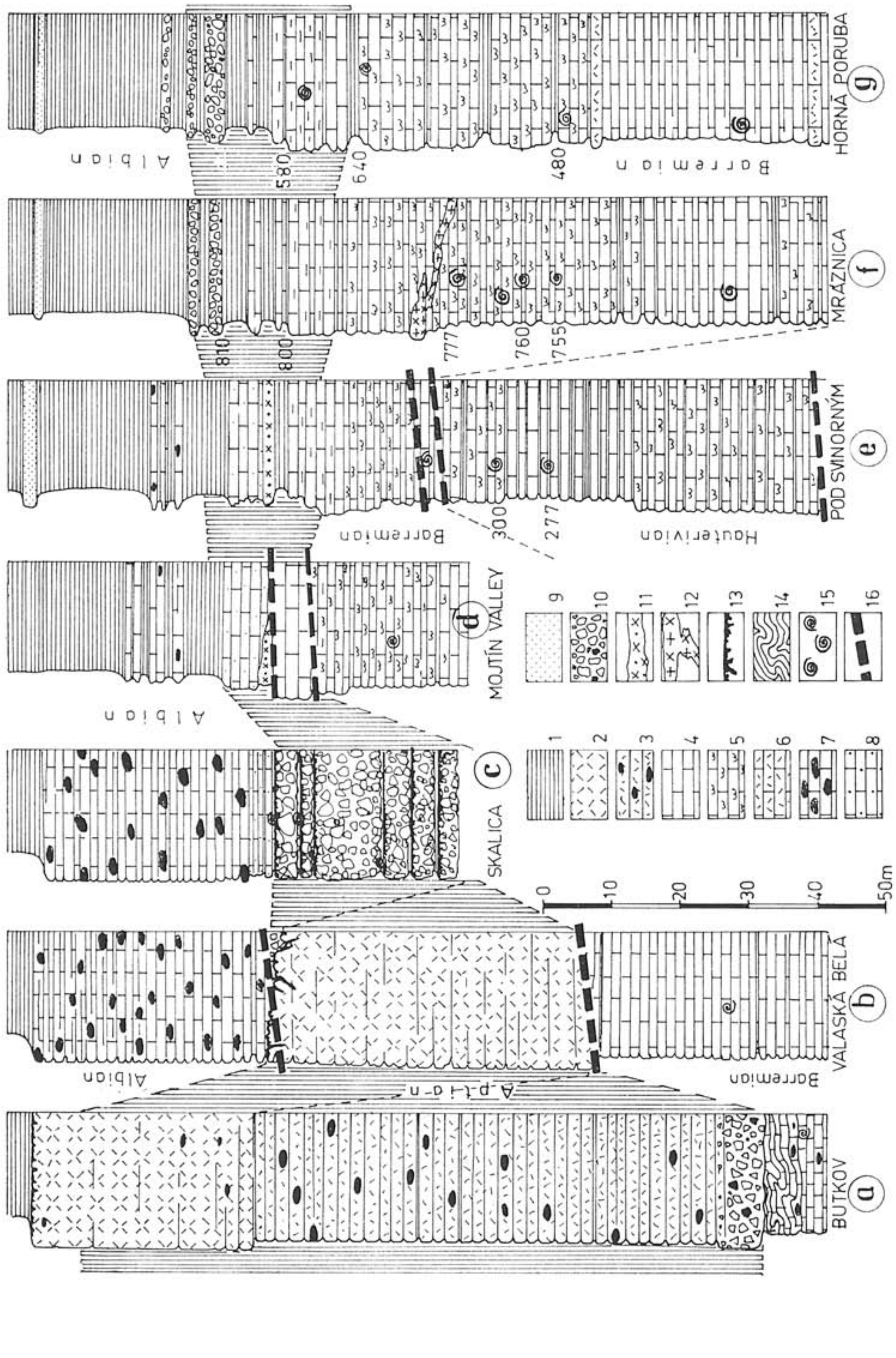
stinguished from the "Urgonian". More detailed age determinations have been mostly related to individual localities and documentation points. In the papers, which have been written after 1945 (M a h e ľ, 1946, 1948; A n d r u s o v, 1959) the range of "Neocomian" has been limited to Berriasian-Barremian interval and the Aptian stage problems have been dealt separately.

This papers have already shown different character of the Aptian/Albian sedimentation if compared with more uniform pelagic carbonate development during the former Early Cretaceous stages. This sedimentation appeared to be characteristic with great facial variability, facial instability, frequent sedimentary gaps, decreasing role of carbonates in sedimentary record, submarine basic volcanism, synsedimentary movements and re-building of sedimentary environment (M a h e ľ, 1958, 1959, 1961, 1962; M a h e ľ et al., 1964, 1966). Submarine basic volcanism was especially specific feature of Aptian/Albian developmental stage of Fatric area (= sedimentary basin of Krížna nappe s. l. sequences). Basic extrusives and volcanoclastics derived from decomposed hyaloclastite lavas of alcaline olivine basalts character are widespread not only in Strážovské vrchy Mts. (Z o r k o v s k ý, 1949; H o v o r k a, 1976), but also in Malá Fatra Mts. (Z o r k o v s k ý, 1953), Veľká Fatra Mts. (H o v o r k a — S ý k o r a, 1979), in the Považský Inovec Mts. and Biele Karpaty Mts. foothills (K u l m a n o v á — V o z á r, 1980) and Nízke Tatry Mts. (B u j n o v s k ý et al., 1981). Although the basic extrusions were by various authors attributed to different age intervals (Hauterivian to Albian) the microfauna of adjacent sediments (*Hedbergella trocoidea* etc., cf. B o r z a et al., 1979) proves that the volcanic activity maximum peaked in short Aptian/Albian period of Fatric sedimentary basin re-building.

Substantial changes of paleogeographic and paleotectonic situation at this time affected extensive area between Mediterranean Tethys and adjacent Submediterranean (West European) province to the Pacific (A. A r n a u d — H. A r n a u d, 1976; F e r r y, 1978, 1979; F e r r y — F l a u d r i n, 1979; F e r r y — S c h a a f, 1981; G e l a t i and others 1982; M i c h a l í k — K o v á č, 1982 etc.). All these facts indicate that the first changes heralding the Paleoalpine (Austrian) rebuilding of Tethyan domain happened in the Aptian already (in some regions even in the Barremian). In consequence, much greater attention must be paid to the study of Aptian sequences in the Western Carpathians.

Fig. 1. The correlation of Barremian-Albian interval in seven lithostratigraphical sequences of Strážovské vrchy Mts. (Manín-?, Belá-, Zliechov units). Aptian sediments are indicated by vertical hatching.

Explanations: 1 — claystones; 2 — massive organogene limestones; 3 — bituminous organodetrital cherty limestones; 4 — pelagic micrital limestones; 5 — spotted limestones; 6 — turbiditic graded detrital limestones; 7 — pelagic cherty limestones; 8 — micritic limestones with detrite and silt; 9 — sandstones; 10 — conglomerate breccia; 11 — volcanoclastics, tuffs, tuffites; 12 — basic volcanites; 13 — hard ground and erosive contacts; 14 — slumping textures; 15 — stratigraphically important macrofaunal findings; 16 — faults.


HORNÁ PORUBA g
MRÁZNICA f
POD SVINORNÝM e
MOJTÍN VALLEY d
SKALICA c
VALASKÁ BELÁ b
BUTKOV a
Albian
Aptian
Barremian
Hauterivian
580
640
480
810
800
777
760
755
300
277
0
10
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40
50m
1
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16

Position of Aptian sequence in the Strážovské vrchy Mts.

a) Manín narrows

Although the first commences about Lower Cretaceous members of this imposingly encovered sequence comes from beginning of the last century (fide in Andrusov, 1945), the stratigraphic division has been unclear for long time. Stur (1860) parallelized thick light-gray biogene limestone complex capping the pelagic limestone sequence with the Tithonian Stramberg limestone. On the base of rudist fauna, Andrusov (1929) attributed this complex to the "Urgonian". This Lower Cretaceous section has been studied by several authors up to present (cf. Michalík et al., 1980). However, the age of the "Urgonian" complex is poorly documented, still. According to Borza (1980 b) this light-gray organogene-, gravel-, and rudist limestones is Barremian to Lower Aptian in age. The surface of Urgonian limestone complex is covered by Albian to Cenomanian brown-gray marls. Salaj and Gašparíková (in Borza l. c.) dated its base even as Late Aptian in age. However, Borza ascertained erosive contact of Upper Albian claystone base with Barremian limestones on Mt. Manín southern slope. Thus, it is possible that substantial part of the Aptian sequence has been eroded before Late Albian.

b) Mt. Butkov

Von Telegd (1917) has distinguished Hauterivian-Barremian cherty limestones and marls above Jurassic sequence of Mt. Butkov near Ladce in Middle Váh valley. Andrusov (1945) recognized a sequence of Tithonian-Valanginian "sublithographic" limestone underlying those cherty limestones, and "Urgonian" organodetrital limestone complex overlying them. Mentioned complex starts with breccia layer composed of Barremian micritic limestones-, Lower Aptian organodetrital limestones-, chert nodule- and volcanic clasts (Michalík et al., in prep.). The breccia along with higher-lying well bedded gray bituminous organodetrital limestones with dark-gray cherts represent slope debris of prograding carbonate platform. Loading of mobile detrital slope complex has deformed underlying Barremian marly limestones and caused the origin of submarine slumping (Michalík et al., in prep.) (Fig. 1 a). Nearly 75 m thick cherty limestone sequence is followed by 35–40 metres of massive pale gray organogene limestones. The latter type contains beds formed by gravel-, orbitolinid-, bryozoan-, and other microfacies (Borza, 1980 b). The uppermost layers consist of micritic and microsparitic limestones containing fine organic debris, glauconite grains, phosphate clasts, sparse chert nodules and Lower Albian microfauna *Colomiella mexicana* and *C. recta* (Borza in Michalík et al., 1980). The surface of topmost limestone layer is corroded and bored by benthic organisms (Rakús, 1977). Andrusov (1945) has introduced mass-occurrence of *Neohibolites minimus* rostra in surficial limonite--stromatolitic crust. However, this finding could not be confirmed, till now. Overlying dark marls contain plant debris, limonitic concretions and Late Albian microfauna (Samuel in Michalík et al., 1980). Rakús (l. c.) justified the hard-ground surface to be caused by Early Albian emersion of lime bottom, what according to him, enabled its colonization and boring. However, in fact, the diversity of domichnia presented is rather low (boring bivalves and sponges, while cementing epifauna is missing). This fact indicate rapid subsidence of carbonate platform below photic zone, enabling penetration of cold upwelling stream into area (Michalík – Kováč, 1982).

c) „Nad mlynom" narrows – Valaská Belá

Mahel' (1958) described dark-gray cherty limestones in Albian claystone complex regarding them as a member of shallow-water sequence. Later (1961) he designated this development as "Belá-series", characterized by sedimentary gap between Tithonian-Berriasian pelagic limestones and basal breccia of the "Urgonian" organodetritial limestone complex (Mahel', 1961, 1962).

On the other hand, Borza (1980 a) has ascertained that the limestones underlying the organodetrital complex are Barremian in age. Thus, the "Urgonian complex" of biointrasparitic, pelsparitic and biomicritic limestones is in position similar to the Butkov sequence, its Aptian age being indicated by microfossil association (Borza l. c.). The uppermost part of the complex contains clasts of older limestones, pellets and *Colomiella mexicana*. The top layer is penetrated by Albian neptunic dykes, being covered locally by thin breccia bed (Fig. 1 b). Dark fine-detritic and cherty limestones in its overlie contain echinoid fauna (Szörényi, 1957) and Lower Albian microfauna (Borza l. c.).

d) Skalica rock by Dolný Moštenec

Began et al. (1963) have introduced limestone breccia intercalations in "Urgonian" complex in the area with typical development of the Manín succession, They have parallelized them with Upohlav conglomerates. Andrusov – Kollárová-Andrusovová (1971) observed crevices filled up by glauconitic marls with Late Lower Albian ammonites in the "Urgonian limestones" in this locality. They interpreted the observed conditions as arguments which had proved "Early Albian transgression through emerged zones of Czorsztyn and Manín sedimentary areas". Rakús (1977) followed conditions on the locality more in detail. He noticed that the surface of the "Urgonian limestone crevices filled up with marl" is corroded, covered by Fe and Mn oxides and accompanied by "pseudobreccia", and that the glauconite marl bodies penetrate practically through all the "Urgonian limestone complex". He concluded that the crevice infilling has been preceeded by folding, which has caused the origin of deep dilatation cracks. Consequently, its surface has weathered and has been covered by oxide crusts.

On the other hand, Borza et al. (1979) have found that the hitherto supposed "Urgonian complex" consisted in fact of conglomerate breccia with intercalation of glauconite limestones. This rock body, containing Aptian microfauna, is followed by Lower Albian cherty limestone sequence (Fig. 1 c). The authors explained the breccia origin as a consequence of accumulation and sliding of a rough carbonate slope debris. They regarded both the Aptian glauconitic rocks and the Albian cherty limestones to be of shallow water

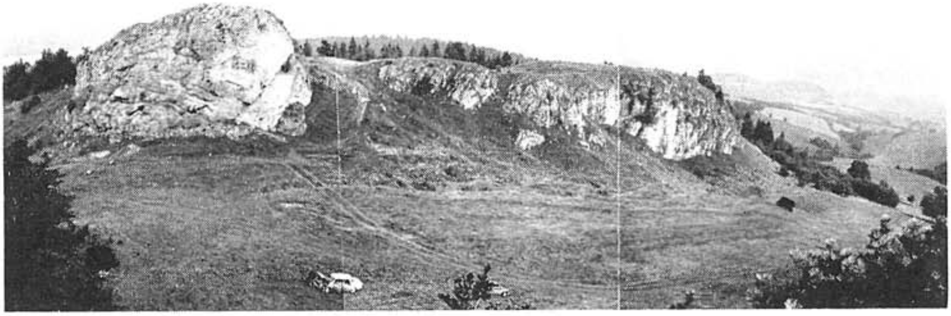

Fig. 2. Skalica klippe viewed from SSE. The base of the sequence (western foot of the klippe on the left margin of photo) is formed by conglomerate breccia. Its overlie (rock wall and tne eastern, right part of the klippe) consists of micritic cherty limestone. The faunistic levels are denoted by arrows (cf. Fig. 3, 5).

origin: In contrast with Rakús (l. c.) they interpreted the effect of "Manín-phase" as sedimentary break between beds No 16 and 17, connected with hard-ground formation (Borza in Michalík et al., 1980). In contrary, Marschalko and Kysela (1980) studying an equivalent breccia in Podmanín vicinity (accompanied by basic volcanic extrusions) concluded that the material of this megabreccia belt has been derived from rocks of Early Albian nappe front. Thus, the formation of breccias could have been made dependent upon tectonic movements of a rapidly rising mobile belt on the foot of steep basinal margins. However, the uniform composition of clasts and basic character of volcanics do not confirm this supposition.

The opinions, former introduced are substantially different each of other in many aspects. Moreover, our field observations compel us to somewhat different conclusions, which will be formulated in following text.

e) Mráznické lúky meadow belt by Košeca

A characteristic sequence of Lower Cretaceous spotted and marly limestones and marls has been described by Michalík and Vašíček (1980), Vašíček and Michalík (1982) and Vašíček et al. (1983). The Aptian sediments are preserved inconsistent, like in other parts of Strážovské vrchy Mts. (Maheľ, 1962). They are represented by dark gray organodetrital bituminous limestones with quartz silt admixture. Weathered tuffite layer is encovered in several sections, one of them (Pod Mráznicou) encovers small basic volcanite body. Higher part of the sequence consists of gray marls with conglomerate intercalations. Black detritic limestone pebbles yielded Late Albian orbitolinid foraminifers (det. by Köhler in Vašíček and Michalík, l. c.).

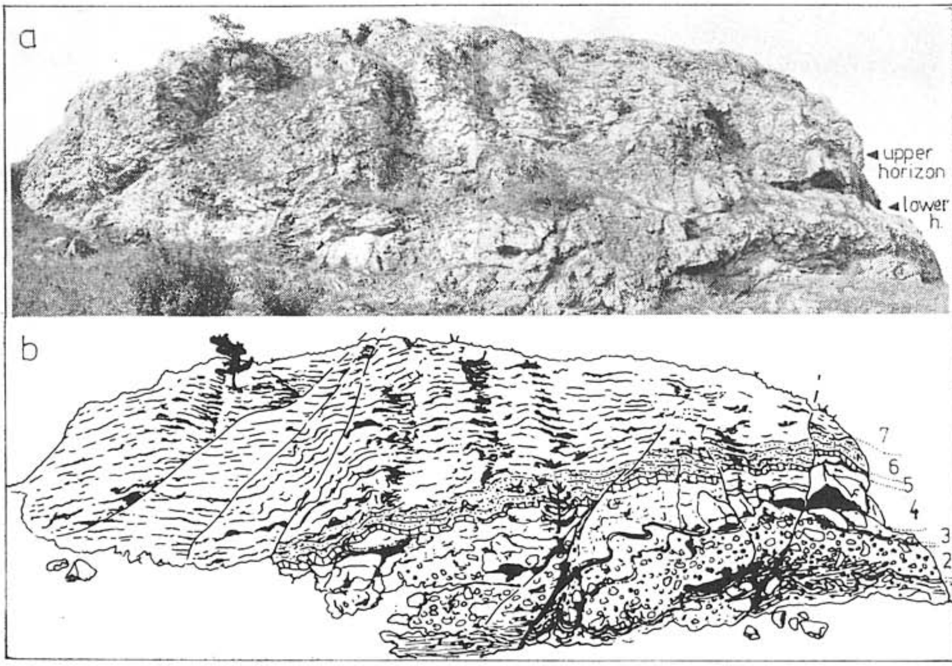

Fig. 3. Western part of the Skalica klippe viewed from SW and the interpretational sketch of geological situation (b). The faunistic levels are denoted by arrows. Numbers 1–4 in the Figure b denote conglomerate breccia cycles, terminated by glauconitic marl beds; 5 – black limestones with echinoid fauna; 6 – fine detritic limestones with chert nodules; 7 – dark gray fine-grained limestones with large loaf-like chert nodules.

f) Horná Poruba area

Thick sequence of spotted- and marly limestones, maiolica-type limestones and graded detritic limestone intercalations has been interpreted as calcareous distal turbidites (Vašíček et al., 1983). The ammonite *Deshayesites sp.*, (figured in the mentioned paper) indicating Early Aptian age has been found in violetish marly micritic limestones, capping the carbonate sequence, These limestones are followed by characteristic "silky-shining" dark-gray sericitic marls with sole belemnite rostra and conglomerate intercalations in the uppermost part (Fig. 1 g). The sequence has been interpreted (Michalík and Vašíček 1980) as a product of distal turbidites below submarine slope base.

Lithological, stratigraphical and taxonomical study of the Skalica section and its ammonite fauna

1. Lithostratigraphy

The locality lies in the NW of Strážovské vrchy Mts., one kilometer SSE of Dolný Moštenec-village, 3.5 km southern of Považská Bystrica (Fig. 2).

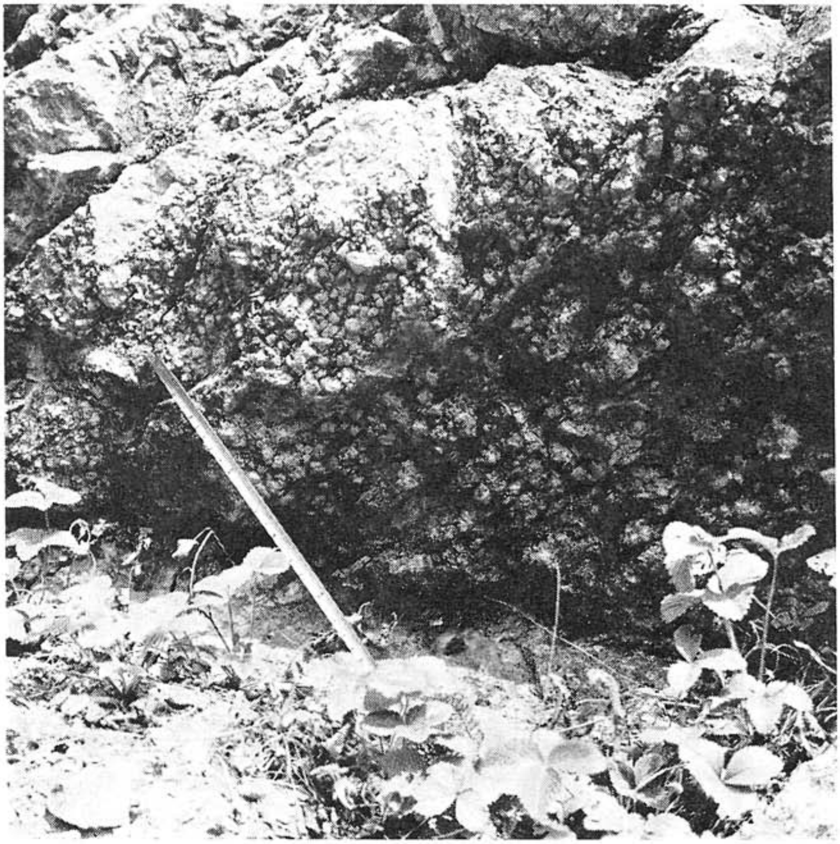

Fig. 4. Lower surface of breccia layer with graded angular more-or-less isometric clasts. The scale in centimetres.

According to M a r s c h a l k o and K y s e l a (1980), it forms a part of megabreccia structure in the Manín-belt, containing variegated rock bodies of Central-Carpathian affinity, which have been derived (cf. B o r z a et al., 1979) from the Belá unit of Krížna nappe front. We used B o r z a 's et al. (l. c.) detailed section in our study. In difference with these authors, we concluded that certain regularity can be stated in the arrangement of clasts in conglomerate breccia horizons (Fig. 3). Glauconite marl horizons do not form accidental intercalations in the chaotic breccia mass; they finish rough sedimentary cycles. Each breccia cycle starts with rather homogeneous material consisting of angular more-or-less isometric "Urgonian" limestone clasts 1 to 5 cm in diameter. The interstitial space is filled up with pyrite- and glauconite containing marl (Fig. 4). Frequent belemnite rostra fragments, more seldom bivalve shells and ammonite mold fragments occur between the clasts. Clast size increases upward up to 7.5 m, roundness becomes better in the same direction. In the higher part of breccia layer's marly matrix share diminishes, being

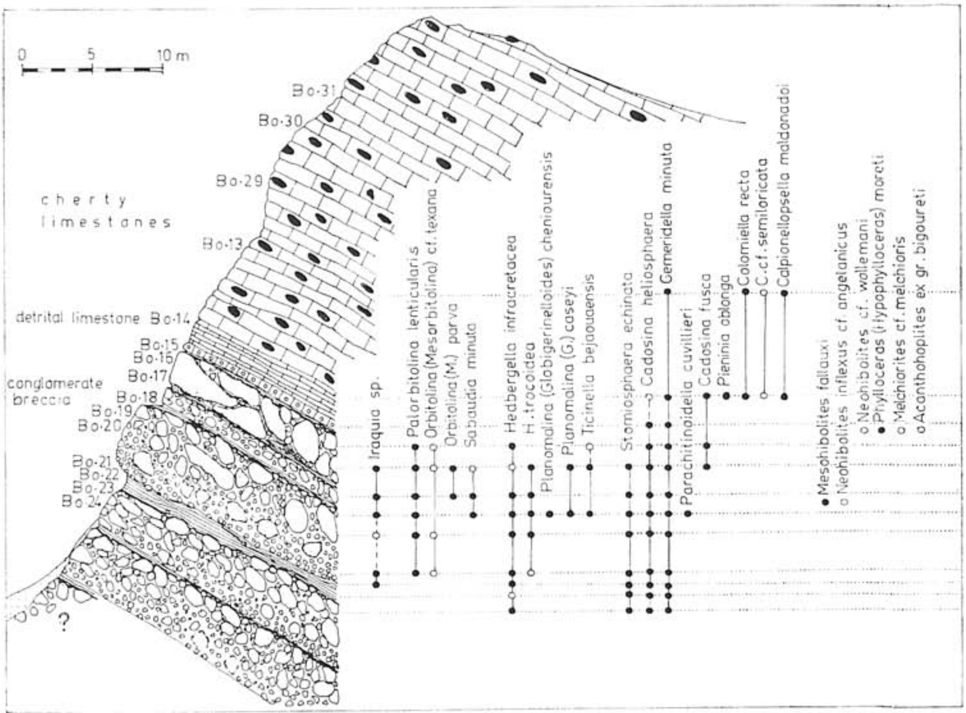

Fig. 5. Lithostratigraphy and vertical distribution of stratigraphically important organic remnants in Skalica klippe sequence. Sample site numbering and distribution of microfossils according to B o r z a et al. (1979).

substituted by carbonatic cement. The upper part of breccia layers consists of smaller, firmly cemented clasts. This is because the top surfaces of layers are usually more even than the lower ones. Corrosion marks and Fe – Mn crusts, distinct here and there on these surfaces (not only Bed 17, introduced by B o r z a et al., 1979) indicate retardation of accumulation and early lithification of limestone breccia (prior- or synchroneous with glauconite marl sedimentation). Breccia layers are 70–700 cm thick. Glauconite marl (passing into marlstone to marly limestone) contains an amount of variously preserved belemnite rostra, less frequent: reworked limestone clasts, or redeposed macrofaunal remnants (Fig. 5).

The highest glauconite marl horizon (between beds No. 15 and 16, Fig. 4) contains fairly abundant ammonite mold remnants. The fauna described by A n d r u s o v – K o l l á r o v á - A n d r u s o v o v á (1971) has been probably collected in this level. Each new breccia bed accumulation has been preceeded by erosion, which has removed a great part of marl, topping the foregoing breccia cycle. It could be proved by erosive grooves, marlstone clasts and dominant character of matrix in basal parts of breccia layers. The uppermost marly horizon (No. 15–16) is covered by 15–20 cm thick layer of black gray fine organodetrical limestone containing glauconite and dispersed marly admixture.

It yielded echinoid fauna, pyrite concretions and belemnite rostra fragments. Following, about 2 m thick layer of dark-gray limestone with marly admixture and small cherty concretions (5—10 cm in diameter) contains echinoderm fragments and organic debris. Thick (30—40 m) dark-gray fine grained limestones with great (20—50 cm in diameter) concentric black chert concretions, overlying the sequence before mentioned, do not contain any macrofaunal remnants.

2. Cephalopod fauna of the Skalica locality

Although the macrofaunal remnants occur practically elsewhere in fine-grained parts of breccia, more completely preserved fossils could have been collected in two glauconite marl horizons (Fig. 5.). The composition of this two faunal collections and the difference between them will be described here.

Order *Ammonoidea* ZITTEL, 1884
Suborder *Phylloceratina* ARKELL, 1950
Superfamily *Phylloceratacea* ZITTEL, 1884
Family *Phylloceratidae* ZITTEL, 1884
Genus *Phylloceras* SUESS, 1865
Subgenus *Hypophylloceras* SALFELD, 1924

Phylloceras (Hypophylloceras) moreti (MAHMOUD, 1956)
Pl. 1., Fig. 3; Text-fig. 6 c.

1964 *Phylloceras (H.) moreti* MAHM.; Wiedmann p. 200, Pl. 19, Fig. 2, Text-fig. 46 (cum. syn.)
1968 *Phyll. (H.) moreti* MAHM.; Wiedmann and Dieni p. 23, Pl. 3., Fig. 6

Material: Half of one slightly corroded stone-mold representig phragmocone.

Description: Involute shell. Umbilical half of the last whorl is relatively flat, slightly inclined to umbilicus. In the close proximity of umbilicus a narrow funnel-like depression arises, leaving no edge. Maximal bending approximately in the half of whorl height. Outer half of the whorl surface runs streamingly to the rounded narrow outer whorl side. The sculpture consists of dense fine ribs, visible on outer half of the whorl surface. The ribs begin with slight concave arc, then form a shallow arc convex to the mouth. Very shallow dense furrows are visible in oblique light on the outer half of whorl surface. They are approximately parallel with ribs: however, they never reach the outer whorl side. A striking stripe answering the course of siphonal tube is visible in the middle of outer side.

The suture is identical with Wiedmann's (1964, text-fig. 46) description: E/L sattle is diphylloid, U_2/U_1 sattle triphylloid. Phylloid sattle extremities are rounded, indifferentiated in their terminal parts. The lobes are clearly assymmetrical (Fig. 6).

Measurements: see Tab. 1.

Remarks: shell shape, sculpture and sutural development resembles less developed representatives of the subgenus. The absence of tetraphylloid sattles indicates that our specimen belongs to *Phylloceras (H.) thetys* (D'ORBIGNY)

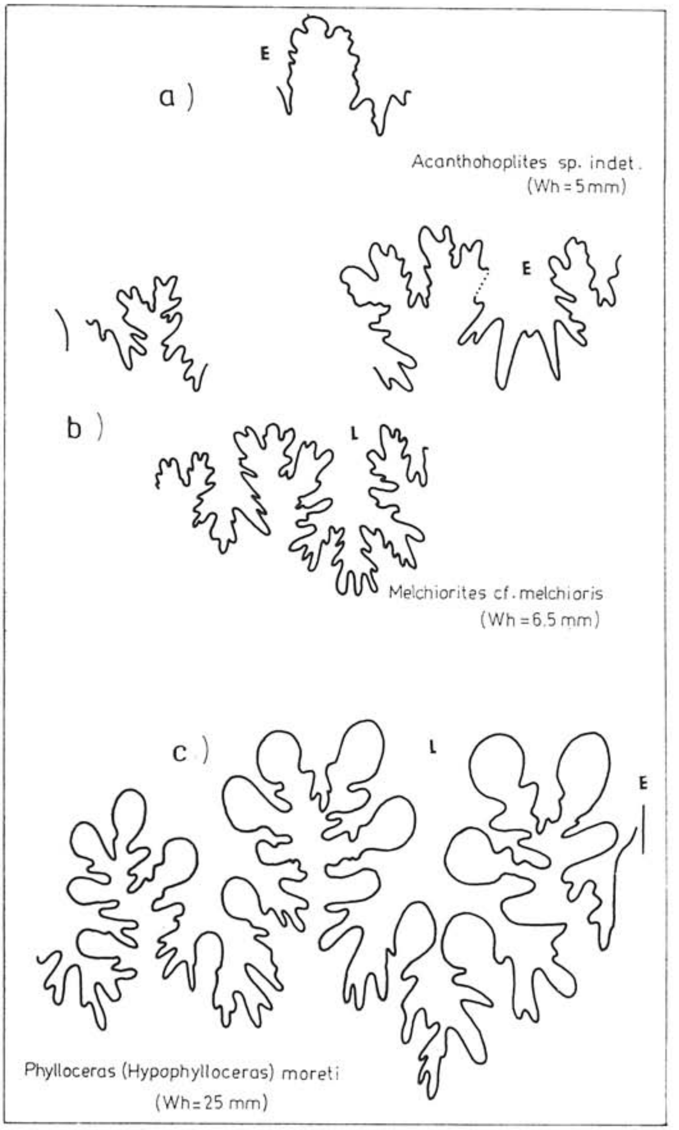

Fig. 6. Suture lines of ammonites founded in the "upper faunistic level" of Skalica klippe. a) – *Acanthohoplites* sp. indet. A fragment of outer suture line between outer and lateral lobe. Whorl height 5 mm; b) – *Melchiorites* cf. *melchioris* (TIETZE). Almost complete external suture combined of two final sections of subsequent suture trial (the middle suture is ommited). Suture height 6,5 mm; c) – *Phylloceras (Hypophylloceras) moreti* (MAHMOUD). Incomplete external suture with height 25 mm.

Table 1
Statistic parameters measured on ammonite shells of "upper faunistic level" of Skalica locality.

Species	D	H	U	W	H/D	U/D	W/D
Phyll. (H.) moreti	48.0	27.5	3	22.0	0.56	0.06	0.45
Ac. ex gr. *bigoureti*	28.5	10.0	10.0	11.0	0.35	0.39	0.39
Melch. cf. *melchioris*	22.0						
	21.0	8.0	7.1	–	0.37	0.34	–
	19.5	7.2	6.5	6.5	0.37	0.33	0.30

Abbreviations used: D – shell diameter; H – whorl height; U – umbilicus width; W – whorl width

group. However, considerable width of whorls, suture and overall sculpture pattern are closest to *P. (H.) moreti.*

Distribution: Wiedmann and Dieni (1968) introduced this recently described species to be distributed in Albian deposits (according to Wiedmann 1964: Lower and Middle Albian) of England, Italy, Mallorca and Sinai Peninsula.

Occurrence: our specimen comes from "upper faunistic level" at 58 m (see scheme in Michalík et al., 1980), Skalica locality.

Suborder *Ancyloceratina* WIEDMANN, 1933
Superfamily *Douvilleiceratаceae* PARONA and BONARELLI, 1897
Family *Parahoplitidae* SPATH, 1922
Subfamily *Acanthohoplitinae* STOYANOW, 1949
Genus *Acanthohoplites* SINZOW, 1907

Acanthohoplites ex gr. *bigoureti* (SEUNES, 1887)
Pl. 1., Fig. 5.

1971 *Acanthohoplites bigoureti* (SEUN.); Kvantaliani, p. 42, Pl. 4, Fig. 3 (cum syn.)

Material: Incomplete fragment of one half-whorl. Inner whorls densely covered by sediment.

Description: Evolutely coiled shell consists of relatively low whorls. Whorl height is somewhat lower that its width. Outer whorl surface is little arched, being rather distinctly separated from the lateral whorl side. Imperfectly incovered umbilical wall is probably low, well separated from the lateral shell surface.

The sculpture consists of relatively strong ribs, moderately inclined to the mouth. Some ribs are simple, the other bifurcate in longitudinal elongated tubercles near to umbilicus, while the third type bifurcates twice: by umbilicus and near to the outer side. Also the latter bifurcation is sometimes accompanied by thickening or tubercle. Bifurcation pattern, tubercle development and rib thickness are strong variable. The stronger ribs are divided by two weaker ones, as usually. The twice-bifurcated ribs are sometimes accompanied by wider furrows.

M e a s u r e m e n t s: see Table 1. All the data presented are of orientational character owing to shell incompletness. Outer side of the half-whorl has approximately 22 ribs, 18 of them reaching up to the umbilicus.

R e m a r k s: Relatively low ribs density and whorl width exceeding their heigh parallelize our specimen with morphologically variable *A. bigoureti* group. Described whorl belongs to juvenile ontogenetical stage, being very close to S i n z o w 's (1907, Pl. 6., Fig. 5) specimen.

D i s t r i b u t i o n: According to K v a n t a l i a n i (1971) *A. bigoureti* occurs in Clansayan (Upper Aptian) sediments of southeastern France, Georgia, Caucasus, Madagascar etc. This species has been introduced by L i e b u s (L i e- b u s and U h l i g, 1902) from the Krásná locality in Silesian unit of Western Carpathians.

O c c u r r e n c e: scree of "upper faunistic horizon" of Skalica locality, 60. metres.

Acanthohoplites sp. indet.
Text-fig. 6 a.

M a t e r i a l: imperfectly preserved specimen with partially preserved suture on the outer shell side. Non measurable.

D e s c r i p t i o n: Weakly vaulted outer side and whorl flanks. Outer side sculpture consists of relatively equal thick ribs. The ribs bifurcate in tubercles lining the passage between flanks and outer side. Some of bifurcated ribs pass into subparallel simple ribs on the opposite whorl side. The bifurcated ribs are separated by two inserted simple ribs having no tubercles. The half--whorl bears approximately 18—20 ribs.

S u t u r e: Rests of several sutures which are visible on outer whorl side are relatively low differentiated, having incomplete outer lobe, first lateral lobe and the sattle between them. The outer lobe is probably narrow, with low secondary sattle. Trifid lateral lobe is somewhat deeper than the outer one. The lateral sattle is two-armed, low articulated.

R e m a r k s: The suture preserved agrees with the pattern characteristic of the genus Acanthohoplites as figured by D r u š č i c and K u d r j a v c e v (1960), or K v a n t a l i a n i (1971). Shell morphology and character of ribs are also typical of this genus. However, the incompleteness of our specimen does not allow more exact determination.

D i s t r i b u t i o n: According to K v a n t a l i a n i (1971) the genus is characteristic of Gargasian (Middle Aptian) and Clansayan (Upper Aptian) deposits of the Mediterranean province.

Occurrence: "upper faunistic level" of Skalica locality, 65. metres.

Subordo *Ammonitina* HYATT, 1889
Superfamily *Hoplitaceae* DOUVILLÉ, 1890
Family *Desmoceratidae* ZITTEL, 1895
Subfamily *Puzosiinae* SPATH, 1922
Genus *Melchiorites* SPATH, 1923

Melchiorites cf. *melchioris* (TIETZE, 1872)
Pl. 1., Fig. 4., Text-fig. 6 b.

1872 *Ammonites Melchioris* TIETZE; p. 135, Pl. 9., Figs. 9–10.
1972 *Melchiorites melchioris* (TIETZE); Vašíček, Pl. 16., Figs. 1–3.
1978 *Melch. melchioris* (TIETZE); Avram, p. 11, Pl. 1., Figs. 1–2, 4–7, Text-fig. 1 (cum syn.)

Material: Stone mold of phragmocone forming a part of the last whorl.

Description: Semievolute shell with relatively flat and narrow whorls. Whorl flanks are flat, moderately inclined to rather narrow, rounded outer side. A distinct edge determines the boundary between whorl flanks and funnel--like low umbilical wall.

Smooth mold surface bears six shallow and indistinctive constrictions (the seventh one could has been in the missing part). Their course is stright, slightly inclined to mouth, with subangular bending on the outer side.

Suture: The outer lobe (E) is situated assymetrically to symmetry plane of the shell. It is shallower than the distinctively trifid almost symmetrical first lateral lobe. The second lateral lobe is also trifid, but asymmetric.

Measurements: see Tab. 1.

Remarks: The suture development, coiling pattern and relatively narrow whorls answer to diagnosis of the Late Barremian-Aptian genus *Melchiorites* SPATH. Morphologically similar Albian-Cenomanian *Puzosia* BAYLE, 1878 differs in having intensively diversificated suture (mainly in outer lobe region), usually higher and wider whorls. The outer part of whorl surface (also on the sculptural molds) bears relics of sculpture.

Whorl shape of our specimen is similar to Tietze's (1872) holotype of *Melchiorites melchioris*. However, the mentioned constrictions are missing on Tietze's type material, which has similar shell diameter. The suture resembles the specimens designated by Fallot (1920) as *Puzosia melchioris;* however, their shell parameters (whorl heigh etc.) are somewhat different. *Melchiorites emerici* (RASPAIL, 1831) having wider coils and wide outer side, bears also similarly developed suture.

Distribution: According to *Avram* (1978) the Tietze's *Melchiorites melchioris* type material has been collected in Roumanian Upper Barremian deposits. Fallot (1920) has described somewhat different French Aptian forms, which could also belong to variability spectrum of mentioned species. Related *M. emerici* and the majority of other representatives of this genus are Aptian in age.

Occurrence: The sole specimen has been collected in the "upper faunistic level" of Skalica locality, 65. metres.

Order *Decapoda* LEACH, 1818
Suborder *Belemnitida* NAEF, 1912
Family *Belemnopsidae* NAEF, 1922
Genus *Mesohibolites* STOLLEY, 1919

Mesohibolites fallauxi (UHLIG, 1883)
Pl. 1., Fig. 2 a–b

1978 *Mesohibolites fallauxi* (UHLIG). Vašíček, p. 13., Pl. 2., Fig. 4 (cum syn.)

Material: Rostrum with complete postalveolar part has locally corroded surface. Alveolar region incomplete: 8–10 mm of the terminal part and the longitudinal half of alveolar part are missing.

Description: Fairly robust medium-sized rostrum is slightly spindle--shaped both in ventral and lateral views, the postalveolar region being expressively conical, the alveolar one is subcylindrical to slightly conical. Ventral furrow reach almost to alveola termination. Alveolar length is approximately equal to half-length of the rostrum. Rostrum cross-section is circular in alveolar region, but dorsoventrally flattened in postalveolar region. Ventral side of the rostrum is relatively flat. The vaulting reach its maximum close below alveola termination.

Measurements: see Tab. 2.

Remarks: Described specimen is shorter in postalveolar region and more dorsoventrally flattened than *M. fallauxi* holotype. *M. uhligi* (SCHWETZOFF, 1913) differs from it having shallower alveola, considerably longer postalveolar region (the rostrum length being comparable, = 80 mm), less spindle-like shape, while the maximum vaulting is about 15 mm in front of alveola beginning. *M. ekimbontshevi* STOYANOVA-VERGILOVA, 1965 has shallower alveola, longer postalveolar region and subcylindrical shape.

Distribution: According to Stoyanova-Vergilova (1970) this species occurs in Barremian to Lower Aptian deposits of Bulgaria and Georgia, in Aptian deposits of Caucasus, Crimea and southeastern France. It has been described also from the Silesian unit of the Western Carpathians (Moravia, Czechoslovakia).

Occurrence: the "lower faunistic horizon" of Skalica locality, 25. metres.

Genus *Neohibolites* STOLLEY, 1911

Neohibolites inflexus cf. *angelanicus* AK. ALI-ZADE, 1961
Pl. 1., Fig. 1 a–b.

1972 *Neohibolites inflexus angelanica* AK. ALI-ZADE: p. 167., Pl. 12, Figs. 5–8 (cum syn.)

Material: A sole incomplete rostrum, secondary deformed. The alveola is missing.

Description: The slender rostrum is of moderately spindleshape both in ventral and lateral views. Postalveolar region of the rostrum is slightly dorsoventrally flattened, indication of lateral flattening is visible at the beginning of alveola. Although the ventral furrow is probably short, it reach to the alveolar region. Maximum vaulting of the rostrum (respecting the missing alveolar region) lies in the centre of postalveolar region, thus approximately in the half of the whole rostrum length. Alveola probably shallow, accompanied by lateral furrows (?).

Remarks: The character of this slender rostrum is identical with *N. inflexus* STOLLEY diagnosis. The statistic analysis shows inexpressive spindle-shape with the maximal width out of postalveolar region centre (if compared rostra of similar size), which indicates that our specimen is closest to *N. inflexus angelanicus*.

Distribution: *N. inflexus* has been described from Aptian deposits, the subspecies angelanicus has to be a characteristic element of Late Aptian fauna (Ali-Zade 1972).

Occurrence: the "lower faunistic level" of Skalica locality, 25. metres.

3. Stratigraphical and environmental conclusions

Because of fragmentation of most macrofaunal remnants, our stratigraphical conclusions could have been supported by the best preserved and biometrically evaluable specimens only. The results of biostratigraphical study indicate some mutual differences in age of both the faunistic levels studied.

The "lower faunistic level" yielded sparse findings of *Mesohibolites fallauxi*, occurring in Aptian deposits, and *Neohibolites inflexus* cf. *angelanicus* considered to be Late Aptian. The age determination of this level as Mid/Late Aptian well agrees with the microbiostratigraphical conclusions of Borza et al. (1979) (Fig. 5).

The "upper faunistic level" yielded ammonite *Acathohoplites* ex gr. *bigoureti*, a characteristic Late Aptian (Clansayan) species. Similar age is indicated also by *Melchiorites* cf. *melchioris*, which has been found together with *Neohibolites* rostra fragments. However, the majority of ammonite molds and alveolae infilling of the belemnites derived from this level consist of material contrasting

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Plate 1

Fig. 1. *Neohibolites inflexus* cf. *angelanicus* AK. ALI-ZADE, magnification 1,57 x. Slightly deformed specimen Sc-2, "lower faunistic level" (a — ventral side of postalveolar region, b — lateral side with inexpressive lateral groove). Skalica, 25 m.
Fig. 2. *Mesohibolites fallauxi* (UHLIG), x 1. Specimen Sc-3, "lower faunistc level" (a — ventral view, b — lateral view). Skalica, 52 m.
Fig. 3. *Phylloceras (Hypophylloceras) moreti* (MAHMOUD), x 1,57. The "upper faunistic level", specimen Sc-5, Skalica, 58 m.
Fig. 4. *Melchiorites* cf. *melchioris* (TIETZE), x 2. Specimen Sc-1, the "upper faunistic level", Skalica, 65 m.
Fig. 5. *Acathohoplites* ex gr. *bigoureti* (SEUNES), x 1. Specimen Sc-6, scree of the "upper faunistic level".

All the above mentioned metres are related to the scheme figured in Michalík et al., 1980. Whitened by ammonium chloride. Photo by M. Grmelová, DMG MU Ostrava.

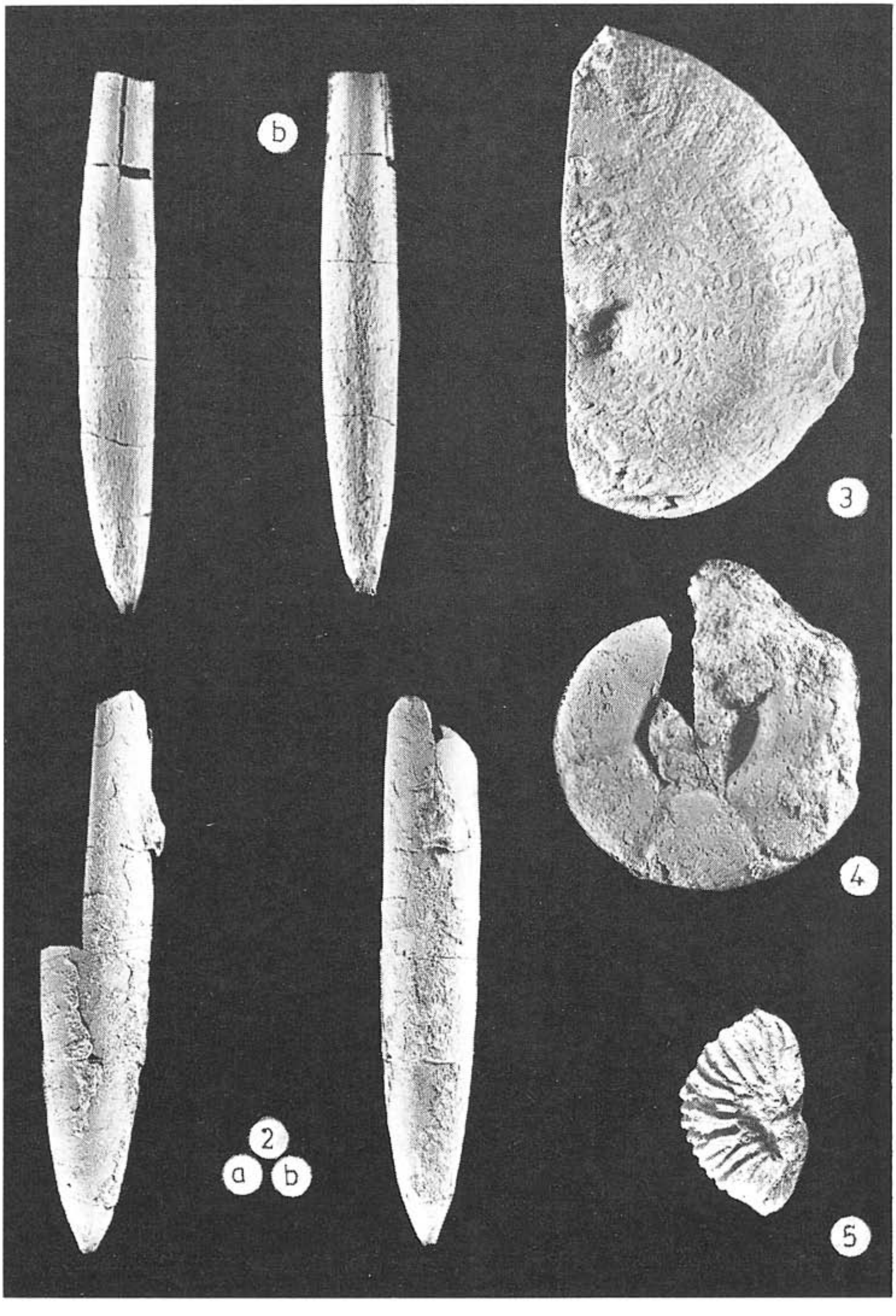
b
3
4
2
a b
5

Table 2
Statistic parameters measured on belemnite rostra of Skalica locality.

Species	R	Pa	DV′	LL′	DV	LL	dv	11	Ic	Ic′	Id′	S	M
Mesohib. fallauxi	78	45	13.6	13.5	13	15	13	15	84	84	424	—	—
Neohibol. inflexus cf. *angel.*	53	53	—	—	6.2	6	7.2	7.6	95	103	722	14	30

Abbreviations used: R — rostrum length preserved; Pa — length of postalveolar region; DV — dorso-ventral rostrum diameter at beginning of alveola; LL — lateral rostrum diameter at the beginning of alveola; DV' — dorso-ventral rostrum diameter in front of alv. termination; LL' — lateral diameter of rostrum in front of alveola termination; dv — dorso-ventral diameter at rostrum maximal width; ll — lateral diameter at the rostrum maximal width; Ic — index of compression; Ic' — index of compression at alveola beginning; Id' — index of dilatation (cf. Vašíček, 1978); S — length of ventral furrow; M — distance between apex and the maximum of vaulting

Fig. 7. Flute cast on the base of breccia layer No. 22. (The exact localisation and current direction figured in Michalík et al., 1980).

with the rock surrounding them. The finding of Early Albian (?) ammonite *Phylloceras (Hypophylloceras) moreti* also calls for younger age of this faunistic level. This facts allow to attribute this level close to Aptian/Albian boundary. We failed to repeate the findings of ammonite taxa introduced (but never figured) by Andrusov and Andrusovová-Kollárová (1971). Despite of it, the composition of theirs ammonite collection derived probably from the layer No. 15/16 is not in contradiction with our stratigraphical conclusions.

The majority of fossils bears marks of allochtonous deposition. This fact forces the environmental interpretation to be based on sedimentological arguments. Distribution and composition of clasts in conglomerate breccia has lead Borza et al. (1979) to convince that the sediment had arisen by sliding of material on submarine slopes. Size distribution pattern (great blocks pushed out the base) characterizes debris flows in channels on the foot of steep submarine elevations (Ing. R. Marschalko, pers. comm.). The supposition of distinctive linear transport of blocks together with small fragments and marly matrix could be confirmed by symptomatic imbrication and by the presence of flute casts on the base of some breccia cycles (Fig. 7., cf. also Michalík et al., 1980).

The data obtained resemble the situation in the Vocontian through margin (Ferry, 1979; Ferry and Flaudrin, 1979), where turbidite cal-

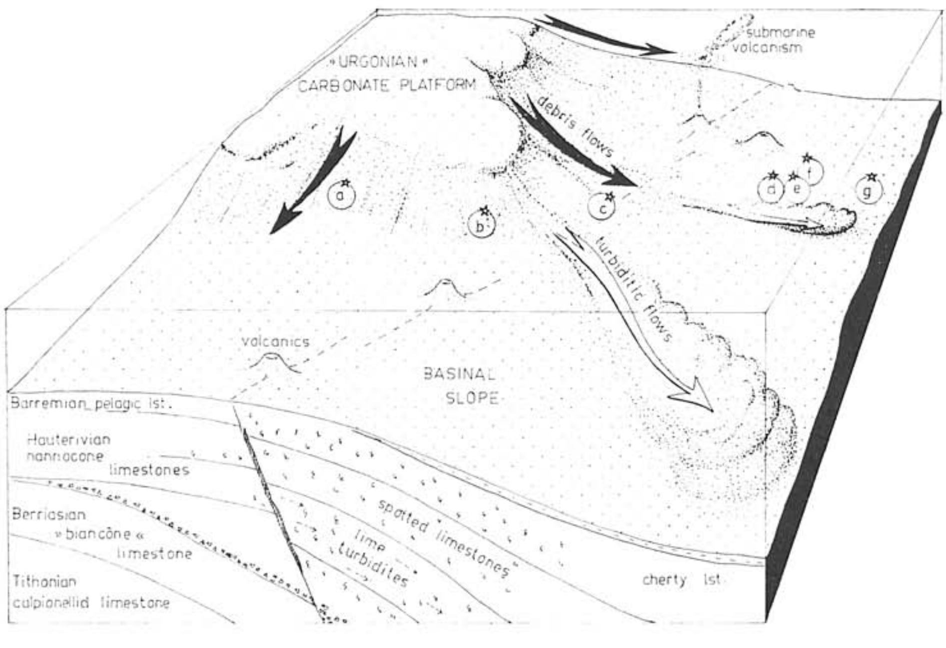

Fig. 8. A model of paleogeographic situation influencing the sedimentary regime in the area studied, during Aptian time. The letters in circles (a–g) denote approximate environmental positions of the sections figured on Fig. 1 (not their palinspatic localisation!).

carenites and breccia- to megabreccia deposits are widespread. Mentioned authors interpreted them as products of channelized transport in submarine valleys on outer deep platform slopes (slope inclination being estimated to be 8–10 °). The break in sediment stability in filled valleys produced debris flows and origin of turbidites, which rapidly transported the material to great depth. The turbiditic sedimentary regime has been accompanied by origin of extensive sedimentary gaps and hard-grounds in the area more than 150 km^2.

Results

1. Environmental and paleotectonic changes in West Carpathian sedimentary basins heralded Paleoalpine (Austrian) event in the Tethyan history already in Aptian.

2. This changes have caused expressive lithological differences in followed Strážovské vrchy Mts. sequences. The influence of basic volcanism, activity of synsedimentary tectonic movements and increased substrate mobility belong to the most remarkable features of the Aptian sedimentation.

3. Re-interpreting the stratigraphic and paleogeographic position of the Skalica locality, we have evaluated two fossiliferous levels in the conglomerate breccia body, which have yielded remnants of six cephalopod taxa. The "lover" level is Aptian, the upper one Albian/Aptian in age.

4. We regard the conglomerate breccia of Skalica locality to be produced by debris flow sedimentation in channels of a deep carbonate platform slope. It originated during Aptian/Albian reorganization of paleogeographic situation (Fig. 8).

Acknowledgments: The authors would like to express sincere thanks to Dr. M. Rakús, CSc. and to Dr. K. Borza, DrSc. for introducing into Skalica locality field problematics; they are also indebted to Dr. E. Köhler, CSc. and to Ing. R. Marschalko, CSc. for helpful discussion and for inspiring comments.

Translated by J. Vitko

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Note of reviewer: The reviewer consider the Manín-zone to has been independent paleotectonic element, which has been situated north of the Tatric, thus far apart of Fatric (Krížna) area. This is why some of the section illustrated on the Figs. 1 and 8 could be hardly mutually correlated.

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Review by M. RAKÚS

Manuscript received April 17, 1984