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Jurassic of Silicicum

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Abstract: The paper describes the particular occurrences of Jurassic of Muráň and Stratená nappes; and Silicicum nappe itself. The aim of the paper is to provide the complete information about lithostratigraphy, paleogeography and geodynamic development of Silicicum in the Jurassic time.

Unlike the surface distribution of the Triassic rocks, the Jurassic sediments are preserved only rudimentarily due to of long-term erosion. Despite of that fact the Jurassic sediments provided valuable information in understanding of the geodynamic development of Silicicum during Jurassic.

Unlike the majority of paleogeographic regions in the Western Carpathians, the Jurassic cycle is transgressive and lies with bigger or smaller hiatus on the Norian limestones (Tesná skala rock, Geravy, Bleskový Prameň, etc.). The basal members of Liassic are characterized by various facial developments of limestones that often included clasts of Triassic limestones. The other typical mark of the Silicicum Jurassic is the presence of neptunian dikes that can reach deep underlying Norian limestones (Biele Vody, Bleskový Prameň). The breccia development continues till the Middle Liassic, the clastic material is represented not only by the Triassic limestones, but by the proper Liassic limestones as well (Bleskový Prameň).

In the basinal parts (Bohúňovo) the Jurassic cycle is gradually developed from the late Triassic and unlike the elevated regions the basinal sediments of the Allgäu formation where calci-turbidite intercalations are also present.

The lower part of Middle Jurassic is characterized by the last important deposition of coarse clastics (Bohúňovo formation) and is represented by olistostrome, which material originates mainly from the Liassic limestones. Clasts of dark radiolarites are occasionally present as well (Bleskový Prameň). The upper Middle Jurassic consists mainly of radiolarites, that represent the maximal deeping. The overlying Oxfordian/ Kimmeridgian sediments are rarely presented and they have pelagic character. The deposition cycle ends by these sediments and because of closing the neighbouring Meliaticum domain the area of Silicicum is structured into a system of nappes. The new one and simultaneously the last sedimentation cycle is Tithonian (limestones with Clypeina jurassica) that definitely ends the Jurassic sedimentation in Silicicum.

The paper describes the fauna of ammonites that enabled precise stratigraphic classification of several facies of the Silicicum Jurassic.

Key words: Western Carpathians, Jurassic, lithostratigraphy, ammonites

Introduction

In comparison with other tectonic units of the Western Carpathians, the Jurassic sediments of the rear part of the Inner Carpathians are preserved only rudimentarily (with respect to the superficial distribution of the Triassic sediments). This so-called general lack of the Jurassic sediments is due to the long-term erosion (minimally from the lower Cretaceous) and to originally smaller thickness of the Jurassic sediments.

Dominant presence of Paleozoic and Triassic in this region led to obvious polarisation of the investigation effort and Jurassic was studied only marginally, what is confirmed by the little number of papers. Insufficient information about Jurassic of this region caused insurmountable obstacles in reconstruction of its paleogeographic and geodynamic development. The fact that Jurassic is the last stratigraphic record of the layer succession of strata connected to the Triassic stage of development was underestimated. As we can find in the following, the Jurassic sediments end the sedimentary cycle in this part of the Western Carpathians, what has special importance in evaluation of the geodynamic development of the region.

We can state that the last few years brought turnover. The widespread utilisation of micropaleontologic methods (mainly radiolarians and palynomorphs) enabled stratigraphic dating of deep water sediments, particularly of the Meliaticum, and their attribution to Jurassic, what has great importance in understanding of the geology of the region.

Considering the sufficient reviewing of the Jurassic history of this region in the past (Bystrický, 1960, 1964,

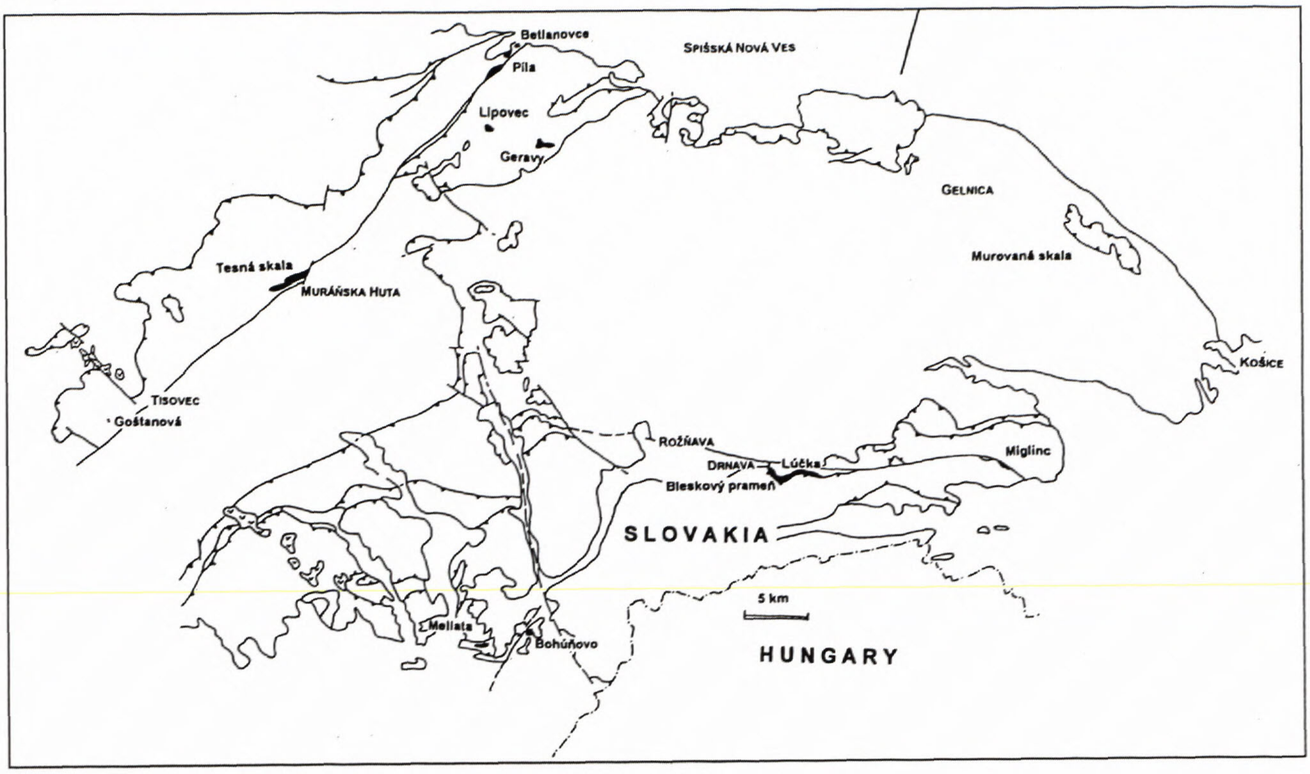

Fig. 1 Schematic map of Jurassic outcrops of Silicicum in the Inner Carpathians

1973, Kollárová-Andrusovová, 1966 and Rakús, 1967), we shall not deal with it in detail.

The aim of this paper is to provide summarizing information about lithostratigraphy, paleogeography, and geodynamic development of Jurassic in rear parts of the inner Carpathians taking into account all the present knowledge.

LOCALITIES AND LITOFACIES DESCRIPTION

Jurassic of Muránska planina plateau

Jurassic of the Muráň nappe was discovered by Bystrický in 1959 during the compilation of general map. In 1952 Biely refined its lithostratigraphy and stated that Jurassic is represented only by Lias. Jurassic of the Muráň nappe occurs at narrow belt in core of Tesná Skala syncline, northward of Muránska Huta (fig. 1).

Locality Tesná Skala, northward of Muránska Huta (fig. 1, 2)

The Jurassic or Liassic rocks are only poorly resistant against weathering, therefore their exposures are insufficient and the tracking of their lithological succession is very restricted. The best exposures occur in the forest path cut near the forest nursery where the following profile can be observed (from bottom to top) (fig. 2):

1) Light grey, occasionally brownish, fine-grained, thick-banked limestones are well correlated with the Dachstein formation. Microfacially they are grainstones – biointrasparitic limestones, where micrite intraclasts of irregular shapes are the dominant component. Then there were found pelsparites, with an amount of spheroidal bodies (about 0,1 mm) probably of bioclastic origin.

Biocomponent is represented by „glomospiroid“ foraminifers, fragments of lamellibranchiates and punctate brachiopods, echinoid spines and rare coprolites (*Parafavreina sp.*). Compared to other localities in the Muráň nappe we consider these limestones as Norian.

The Skalka limestones (Michalík, 1977; Michalík and Gaždzicki, 1983) considered as Rhaetian, were not found here. Similarly, the Kössens member described by Biely (1962) was not found in this profile, although its occurrences are nearby (about 300 m NW from profile on northern edge of the syncline). Missing of the facies mentioned above can be explained by erosion during the lowest Liassic-Hettangian. This explanation is confirmed by the fact that the top parts of the Dachstein limestones bear distinct traces of alteration, and small neptunian dikes filled by brownish-red laminated micrite limestone occur there. The surface of the Dachstein limestones on the contact with the Liassic crinoidal limestones is covered by thin haematite crusts with flat chlorite concretions and it has hardground character. Absence of the Skalka limestones as well as Kössen memberlayers emphasizes the transgressive character of Liassic.

2) Grey to greyish-brown, sometimes pink crinoidal limestones – crinoidal biomicrites – **Hierlatz limestones** directly overlying the Dachstein limestones. Lithologically they are grey, mostly light grey, or brown, in upper parts pinkish, fine crinoidal sometimes banked (up to 20 cm) limestones.

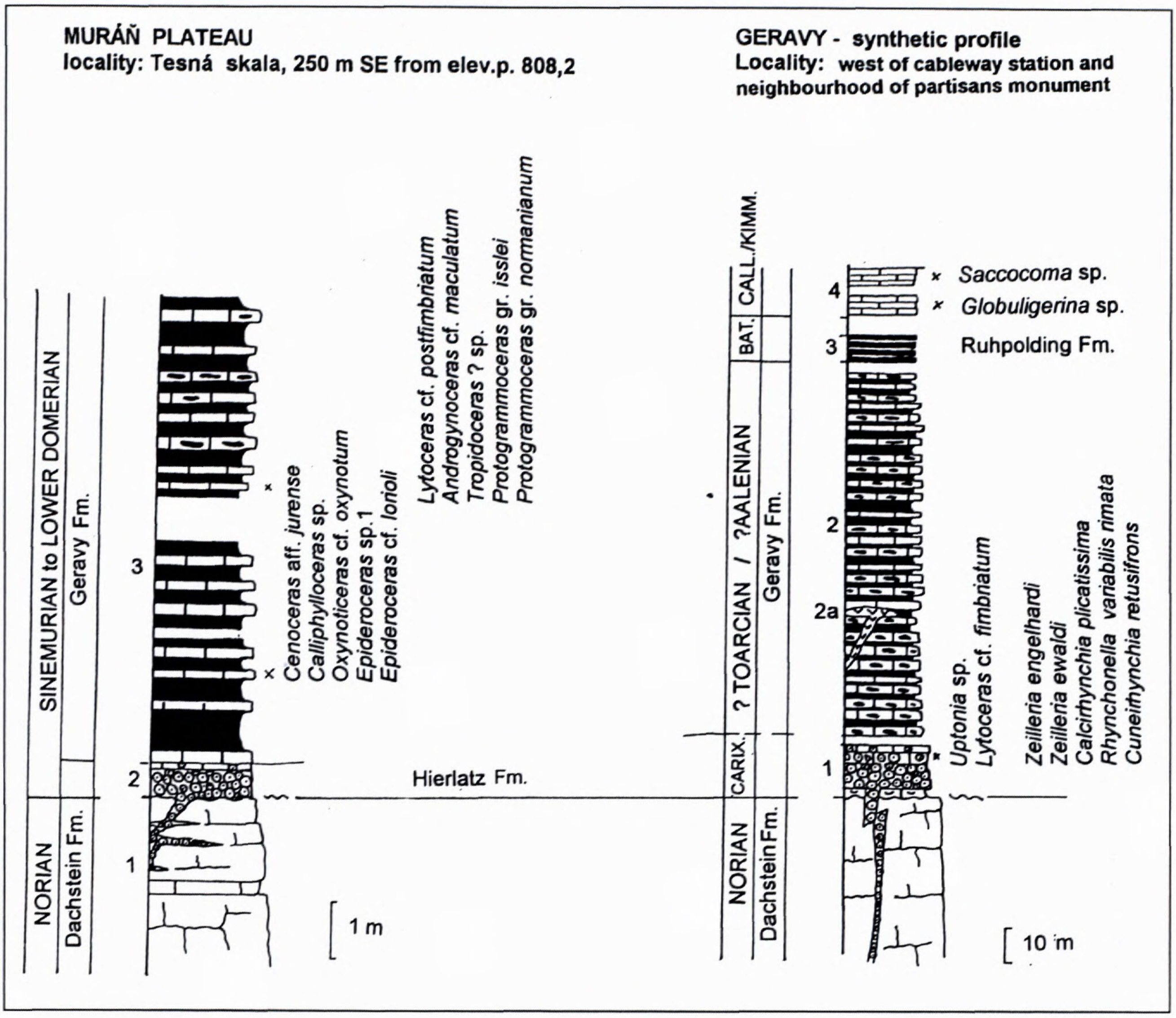

Fig. 2

Micrite matrix contains the segments of crinoids, slightly rounded fragments of punctate brachiopods („*Terebratula*"), fragments of lamellibranchiates, ostracods and Bryozoa. Rarely there occur foraminifers: *Lenticulina* sp., *Nodosaria* sp. Moreover, there are lithoclasts of Triassic carbonates – pelsparites , as well as foraminifer limestones. At Geravy, where these limestones have a some what more varied development, Maheľ described presence of cherts (l.c.: 65); however we were not successful in finding them.

Thickness: The measurable thickness is very low and it varies from 30–50 cm to about 5 m (near the forest nursery). At Geravy and Lipovec it could reach up to 10 m (estimation).

Stratigraphic range: up to now it has not been determined directly. Based on the brachiopod fauna (Geravy site) and position in basement of the Geravy formation, we assign these limestones to Sinnemurian s.l., most probably to Lotharingian.

3) Grey fine-grained limestones are directly overlying of crinoidal limestones. Microfacially they are micrites with rare fine admixture of clastic quartz and fine scales of mica. Relatively abundant occurrences of authigenic plagioclases are observed. Biocomponent is represented by silicisponge spicules; spherical calcified radiolarians and sporadical small (less than 0,1 mm) peloid grains. Authigenic pyrite is abundant.

In overlying direction these limestones gradually pass into several tens metres thick complex of dark-grey non-spotted marlstones with intercalations of grey banked (5-10-18 cm) biomicrite limestones – the Geravy formation (see description of Jurassic in Geravy). In debris (towards the well intercepted on the lower meadow) black silicites occur as well (spongolites). (Note: the term „Allgäu formation" we use in quotation marks because we want to emphasize certain difference from the typical facies. This difference consists in non-spotted character and higher content of intercalations of more or less crinoidal limestones.)

Amidst of the Liassic strip, near by the elevation point 808,2 m, Biely found (ex-situ) a cephalopod fauna in grey more or less crinoidal limestones. The limestones are bio-

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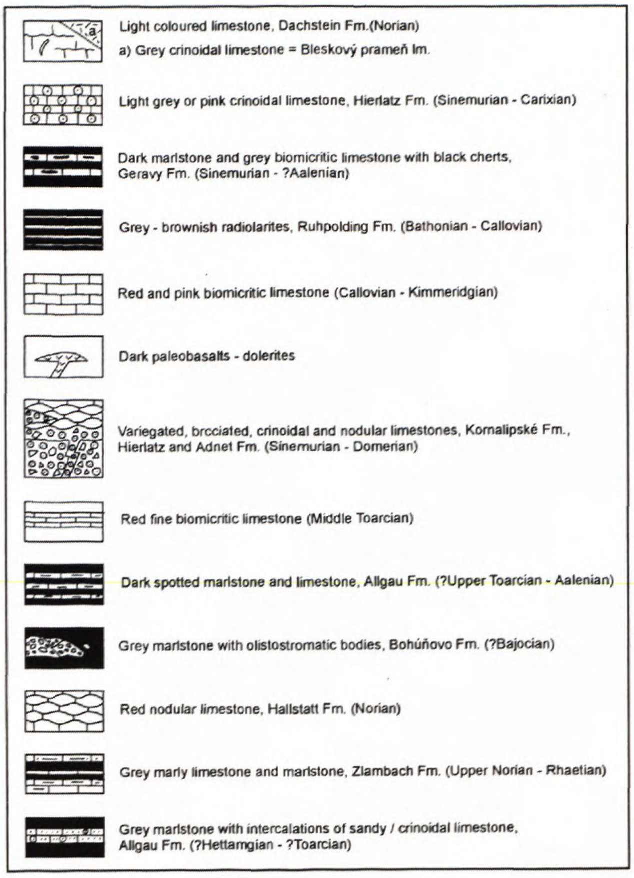

Explanations to text-figures 2, 5, 8, and 9

sparites with a plenty of crinoid segments, sea urchin spines, fragments of brachiopods and pelecypods and spicules of silicisponges (Pl. 8, Fig. 3). Foraminifers are represented by *Dentalina* sp., *Lenticulina* sp., *Nodosaria* sp. *and Involutina liassica* Jones. Intraclasts and clastic silty quartz were identified less often.

We have determined these Cephalopoda:

Cenoceras aff. jurense (QUENSTEDT), *Calliphylloceras* sp., *Lytoceras* cf. *postfimbriatum* PRINZ, *Oxynoticeras* cf. *oxynotum* (QUENSTEDT), *Epideroceras* sp.1, *E.* cf. *lorioli* (HUG), *Tropidoceras* ? sp., *Androgynoceras* cf. *maculatum* (YOUNG & BIRD), *Protogrammoceras* gr. *isslei* (FUCINI), *P. gr. normanianum* (d´ORB.).

This association indicates Lotharingian (zone Oxynotum /Raricostatum Zone), Carixian (Davoei Zone), up to Lower Domerian (Stokesi Zone). Upper members of Jurassic formation have not been found yet at the Tesná Skala locality.

Jurassic in Gošťanová (fig. 1)

The Jurassic sediments were plotted for the first time in the map of the Slovenské Rudohorie Mts. (Klinec, 1976). However, the rocks ranged here to Jurassic, actually belong to Late Triassic. Lately this area was investigated by Vojtko (1999), who confirmed the occurrence of Jurassic in Goštanová, which form here filling of neptunian dikes and does not form superficially bigger occurrences.

Jurassic is represented by dark-grey organo-detritic limestones (packstones). They are composed mainly of segments of echinoderms (crinoids, sea urchins), fragments of lamellibranchiates and brachiopods. The ostracods (with thin and thick tests) occur very often. Uniserial foraminifers of genus *Nodosaria* and planispirals of genus *Ammodiscus* are presented seldom. Dr. Soták in Vojtko (1999) determined the following species here: *Ammodiscus incertus* (d´ORB.), *A. multiinvolutus* REITLINGER and *Nodosaria nitidana* BRAND. Some tests of lamellibranchiate are drilled by algae. Limestone contains rarely plastically deformed intraclasts of mudstones – micrites and peloids. Clastic quartz of fine - grained sand size is also one of the components present (less than 1 %). Beside the primary components, authigenic plagioclase and pyrite occur and some of the bioclasts are silicified.

According to the lithofacial character the limestones described above can be classified as Liassic.

Jurassic of the Vernár belt (fig.1)

At the beginning it should be stated that majority of the Jurassic occurrences in so-called Vernár belt (only with one exception) have a unclear structural position with respect to the older members of the bed sequence. In reality, there are block occurrences that can represent megaclasts of Pre-Eocene sedimentary cycle - ? Late Cretaceous.

In the northern vicinity of the Píla village near Hrabušice Mahel' (1957) described two Jurassic occurrences. In both cases there are small, isolated occurrences formed by red to redish-violet more or less crinoidal limestones with abundant tiny lithoclasts (up to 3 mm) of yellow carbonates.

The first occurrence is situated NW from the elevation point 676,2 m where light coloured to whitish thick-banked Dachstein limestones are present in small exposure. Microfacially there are packstones – grainstones with *Tetrataxis* cf. *nana* KRISTAN-TOLLMANN, *Permodiscus* sp. and *Angulodiscus* sp.

Overlying and in overlain and lateral continuation, red, partly re-crystallised fine-grained more or less clayey limestones are present in debris. Microfacially they are micrites with seldom and poorly preserved radiolarians and intrapelsparite with rare bioclasts – ostracods and little lamellibranchiates.

The second occurrence is situated about 650 m SE from the elev. p. 654,8 m. In small discontinuous exposures (block debris) grey fine-grained limestones with small dikes composed of red micrite carbonates occur.

Overlying them there is debris consisting of greyish-red, redish-violet crinoidal limestones with abundant, unrounded lithoclasts (up to 3 mm) of yellow carbonates (Pl. 8, Fig. 1, 2). They contain lithoclasts, fragments (usually of micrite limestones and clastic quartz). Bioclasts are represented mainly by fragments of crinoidal segments and echinoderms, fragments of punctate brachiopods, as well as fragments of hydrozoans. Rarely *Nodosaria* sp. and fish teeth were found. Among lithoclasts-pelmicrites, pelsparites, biosparites and oosparites were identified that are probably of Triassic age. Quartz is monocrystallic and undulate. Clasts are rounded and unsorted. According to the particle size the rock is at psephite-psammite boundary and it can be considered as residual sediment (lag deposits). Maheľ (1957:92) described a fauna of brachiopods in them, which indicates a Lotharingian age:

Calcirhynchia plicatissima (QU.), *Rhynchonella deffneri* OPP., *Spiriferina alpina* OPP., *Spiriferina obtusa* OPP., *Spiriferina pinguis* ZIET., *Zeilleria engelhardti* (OPP.).

A finding (ex situ) by one of the authors (M.S.) in the Betlanovce neighbourhood showed the brown-red fine-grained limestones – packstones with fibrous microfacies. The majority of the packstone consists of fragments of thin-walled shells tests of lamellibranchiates. Except of them there are fragments of massive tests that are leached off and replaced by calcite crystals coloured by Fe-hydroxides. Further there were found: *Lenticulina* sp., segments of echinoderms, aptychi, *Globochaete alpina* LOMBARD, calcified radiolarians, ostracods and representatives of *Globuligerinidae.* A terrigenic admixture – quartz of silt size content of which is bellow 1 % occur here as well. Rarely grains of chlorite as well as bright mica were found here. Considering the presence of globuligerinids we range these limestones to Callovian-Oxfordian.

Red bioclastic limestones are the next lithotype. The most abundant components are segments of planktonic echinoderms of genus *Saccocoma*, columnaria of crinoids (seldom *Pentacrinus* type), aptychi, fragments of lamellibranchiates and brachiopod shells, ostracods (seldom) and *Cadosina* sp. Rarely clastic quartz occurs there. Clasts of re-crystallised bacterial Fe/Mn stromatolites and metha-colloid grains are one of the limestone components. Irregular cavities– fenestrae with polarity textures occur in sediments. This type is ranged to Kimmeridgian.

Jurassic of the Stratenská hornatina Mts.

As in previous regions, Jurassic occurrences are preserved only rudimentarily, and were unknown for a long time. The first information is by Maheľ (1957) who briefly described and stratigraphically classified them. In fact there are two occurrences, which despite of their relatively larger areal extension, are poorly exposed, regarding their lithology and structural position. The research of the last years enabled us to range the known facial types into a bed sequence that can be correlated, for instance, with the Muráňska Planina plateau.

Locality Geravy (fig.1, 2)

Similarly as in the Muráňska Planina plateau, the Jurassic lies transgressively on various facies of the late Triassic – Dachstein limestones, Norian in age. Transgressive relation of the Liassic crinoidal limestones can be observed in NW neighbourhood of the monument in Geravy. The crinoidal limestones occur directly overlying by light - grey to white massive limestones of the Norian Dachstein formation. In places (approximately 500 m eastward of the top station of the cableway at the forest border), the top parts of the late Triassic limestones are, on the contrary, formed by grey thick-banked grapestones (SMF 17) with *Aulotortus* sp., which would indicate Norian age.

1) As the lowest member of the Jurassic layer succession the **Hierlatz limestones** are considered. They are grey, light-grey, occasionally greyish-brown to redish biomicrites with varying share of crinoidal segments, thus locally they are crinoidal sparites. These limestones lie directly on Dachstein limestones (westward of the monument in Geravy) or they penetrate deeply (up to 120 m) through a system of neptunian dike into late Triassic limestones (gamekeeper´s cottage eastward of Biele Vody, personal information from Dr. Havrila, 1995). Microfacially there are mainly biomicrites - packstones, and also crinoidal sparites. There are relatively abundant cross sections of foraminifers – *Lenticulina* sp., *Frondicularia* sp., *Trocholina* sp. *and Neoangulodiscus carinatus* LEISCHNER (in Kullmanová 1963).

From redish varieties of the limestone in the vicinity of the memorial Maheľ (1957:65) mentioned the following brachiopods:

Zeilleria engelhardti (OPP.), *Zeilleria ewaldi* (OPP.), *Calcirhynchia plicatissima* (QU.), *Rhynchonella variabilis rimata* GEYER, *Cuneirhynchia retusifrons* (OPP.), (revised by Dr. J. Pevný). The stratigraphic range is Lotharingian – Domerian.

Poorly preserved ammonites originate from greyish varieties of the limestones:

Lytoceras sp. (*Lytoceras* gr. *fimbriatum* (SOW.), *Uptonia* ? sp., which would indicate the Carixian, probably Jamesoni Zone.

2) As the next member of strata there is the formation of the dark-grey to black, clayey-calcareous shales with banks (5-10-15 cm) of fine sandy slightly-crinoidal limestones of the same colour and with nodules of black silicites = **Geravy formation – new name**.

Type locality: Geravy, gorge under the bottom station of the ski lift.

Informal names: black and dark-grey clayey shales (Maheľ, 1957: 64).

Lithology: formation of black clayey calcareous shales with layers - banks of fine-sandy slightly-crinoidal limestones of the same colour. Limestones contain nodules of black cherts.

Microfacially they can be characterized as biomicrites -packstones. Fine grain sand to silt size bioclasts consist of fragments of echinoderm segments, chambers of nodosarid and planispiral foraminifers, ostracods, tiny calcified spicules of porifera and radiolarians. Silt size clastic quartz is also present. Except of this type, there occur also more marly varieties resembling "fleckenmergel" with low bioturbation (? *Chondrites*).

As particularity we mention finding of pieces of paleobasalt – dolerites affected by chloritisation of mafic minerals! Because of their scattered occurrences, we did not succeed in finding out the relation to neighbouring environment.

Thickness: it is very hard to determine the thickness because of their poor exposure. It is estimated to several tens metres.

Stratigraphic range: the attribution of this formation at type locality is not yet known, although there is no doubt about its Liassic age. Maheľ (1957 : 64) described in black shales: *Spiriferina alpina* OPP., which is known from Early and Middle Liassic. In Muránska Planina plateau the association of ammonites comes from this formation which age is Lotharingian - Carixian, what is in good harmony with occurrence of *Sp. alpina* in Geravy. With respect to the fauna content we prefer Middle/Late Liassic age, but it is not excluded that the formation of black shales reaches into Early Dogger as well.

3) About 100 m SE from the monument in the forest road cut the thin lens (observable thickness 0,5 – 1 m) of grey-brown radiolarian rocks occurs, from which we obtained only indeterminable radiolarians ranged to Dogger (?Bajocian – Bathonian).

4) As the stratigraphically highest proved member of the Jurassic succession the red biomicrites can be assigned, which occur in debries, eastward of the monument. Microfacially there are packstones with fibrous-echinoderm microfacies. Foraminifers occur there relatively often: *Tetrataxis* sp., *Lenticulina* sp., *Nodosaria* sp., *Ophtalmidium* sp. *and Globuligerina* sp. (Pl. 8, Fig. 4). Clastic quartz and small oncoides occur quite rarely. Based on the presence of genus *Globuligerina* (and absence of genus *Cadosina*) we range the limestones to Callovian.

Kullmanová (1963) mentions the occurrence of pink fine-grained massive limestones with *Saccocoma sp.* what suggests presence of Kimmeridgian sediments. We point out that we were not successful in repeating this finding.

Locality Lipovec (fig.1)

According to Maheľ (1957:64) the situation here is similar to that in Geravy. The present terrain exposure does not enable direct determination of the bed sequence. It seems that similarly as in Geravy the bulk rock mass is formed by dark-grey to black clayey-calcareous shales with layers of limestones containing cherts. Bigger clastic admixture can be observed macroscopically in limestones. It consists of lithoclasts of carbonates and quartz (up to 2 – 3 mm).

At this locality Kullmanová (1963) described the presence of grey more or less crinoidal and compact limestones with nodules of brownish-grey cherts. She mentions the presence of *Involutina liassica* (JONES) *and Trocholina* sp. in limestones what indicates Lias age. Stratigraphically higher members as Lias were not found here.

Jurassic of Slovenský Kras

In comparing with the Jurassic occurrences that were described in the previous part, the Jurassic of Slovenský Kras is much better known, thanks to more complete and better preserved succession.

The Jurassic sediments occur mainly in SE neighbourhood of Drnava, on southern foothills of Drienkova Hora near by the well-known Late Triassic locality Bleskový Prameň (fig. 3, 5). From this place, they can be traced from the upper part of Vrbovy Potok brook towards Kornalipske Sedlo pass, from which they stretch in a narrow strip to Kováčová and Lúčka villages.

The second, smaller Jurassic occurrence is in the Miglinc valley, where the exposure is very poor and succession is incomplete.

Except of these localities, the last known Jurassic occurrences in our territory are close to Bohúňovo and southward of Meliata near the northern margin of the Muráň River canyon.

Jurassic near Bleskový Prameň (figs 1, 3, 4, 5)

This locality is known from the past by its abundance of the Late Triassic fauna of Norian age, which is described in several monographs (Sturzenbaum, 1879, Bittner, 1890, Mojsisovics, 1896, Kollárová & Kochanová, 1973 and Siblík, 1967).

The first reference about the Jurassic red crinoidal limestones is by Sturzenbaum (1879). Although this locality was later several times mentioned, these written references did not bring a contribution to knowledge of the succession and Jurassic stratigraphy. However, we should mention the contributions of Andrusov & Šuf (1936) and Andrusov (1953) in which the authors described and figured the first fossils confirming the Liassic age.

Remarkable change is dated to 60-ies, when Bystricky (1960 a 1964) published important papers, in which he defined not only the succession, but he also identified the transgressive character of Jurassic on Drienkova Hora Mt. The following two papers from that time have paleontological character and specify the stratigraphic range of some facies (Kollárová-Andrusovová, 1966 and Rakús, 1967).

The papers published in 70-ies summarized only information known so far (Bystrický, 1970 and Mello in Bystrický, 1973). The last publication about this locality was recently issued and has dealt with stratigraphy of lithoclasts of Middle Jurassic (Sýkora & Ožvoldová, 1996).

Despite of undoubted increase information about Jurassic of this locality the question of succession as well as stratigraphic range of particular lithofacies was not solved. These problems result mainly from varied quickly changing lithology of limestones in short distance, plenty of little faults and in insufficient precision of the stratigraphy. The profile that we present in this paper was elaborated after several years-lasting research and it consist of several partial profiles (Roman figures in column) that were adjusted on the basis of detailed microfacial correlation and stratigraphic range of particular lithofacial

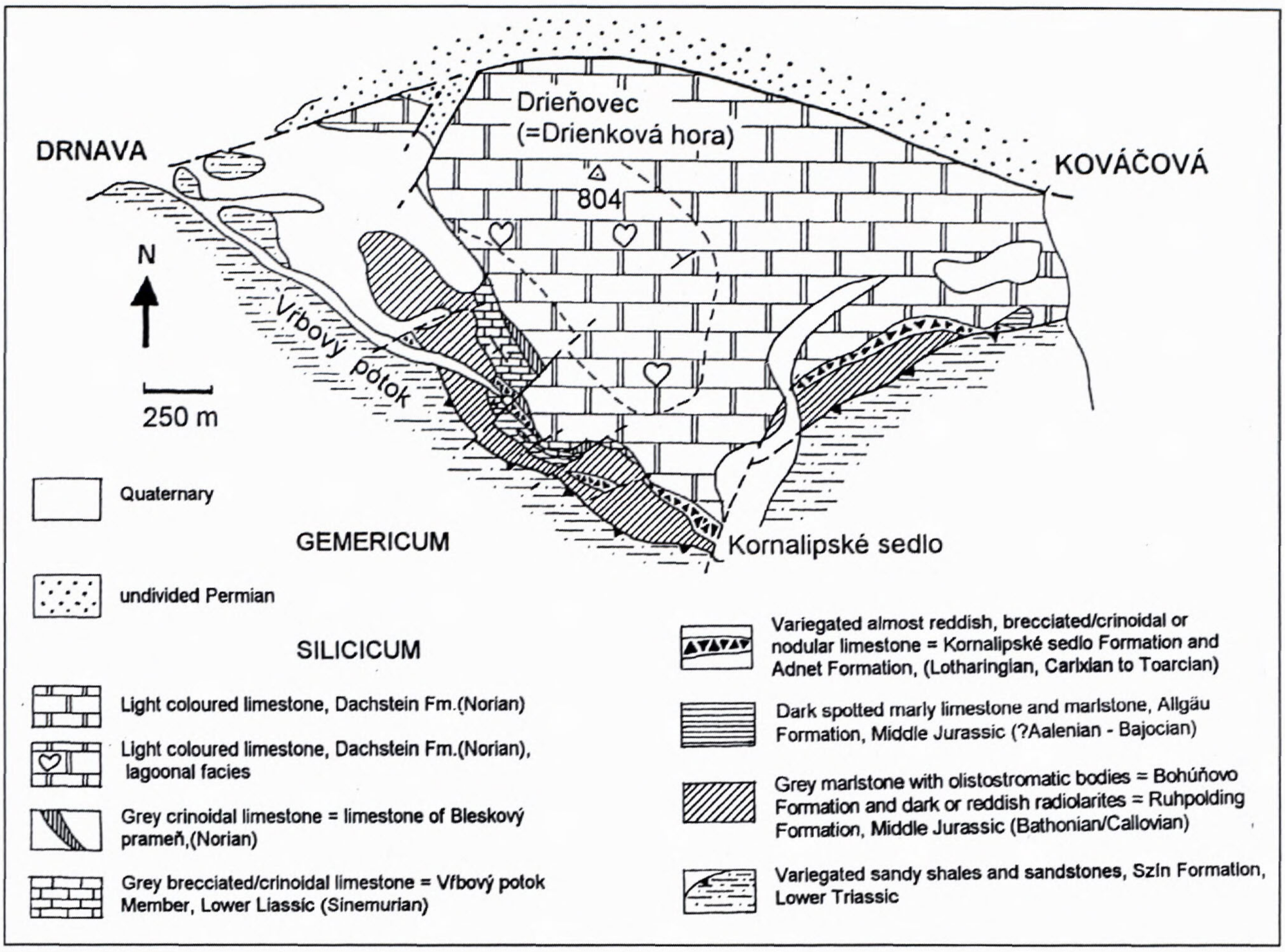

Fig. 3 Geological sketch map of Drienkova hora (after Mello, 1996 completed by author)

types. We could establish there this bed sequence of Jurassic (fig. 4).

The Jurassic basement is formed by limestones of Bleskový Prameň (= grey crinoidal biosparites with rich fauna of brachiopods, bivalves, gastropods, nautiloids (rarely) and ammonites (cf. Kollárová-Andrusovová & Kochanová, 1973, Siblík, 1967) or by **reef coral-sponge** limestones of Drienkova Hora Mt. The first type represents fore-reef facies where fauna is re-deposited and represents thanatocoenosis (Kollárová-Andrusovová & Kochanová, 1973). The above mentioned limestone types are of Norian age (Sevatian). The presence of Rhaetian stage was not confirmed! From the geological situation it is obvious that (cf. Text-fig. 3) the basal crinoidal - brecciated limestones of Liassic (= Kornalipké sedlo formation) rest on various lithofacial types of Late Triassic what emphasizes their transgressive character.

1) The oldest sediments of the Jurassic sedimentary cycle are formed by a variegated formation of crinoidal-brecciated limestones, for which we introduce a new name: Kornalipské sedlo formation (see next).

The base of the Kornalipské sedlo formation is formed by greyish-brown massive to thick-banked brecciated limestones = **limestones of Vŕbový Potok – new name.**

Limestones of Vŕbový Potok

Type locality: Vŕbový Potok near Bleskový Prameň, southward of Drienkova Hora Mt. (fig. 3).
Informal names: grey limestones (Bystrický, 1960:41); light brown to greyish brecciated weakly-crinoidal limestones (Rakús, 1967: 6).

Lithology: greyish-brown massive, occasionally thick banked brecciated limestones with variable content of detritus of crinoidal segments and lithoclasts. Lithoclasts form by various facies of Triassic carbonates, from which were identified: pelsparites with ostracods, dolomites, micrite with *Trochammina* cf. *almtalensis* KOEHN-ZANINETTI and ?*Cayeuxia* sp., grainstone with *Aulotortus* sp., mudstone-biomicrite with fibrous microfacies (similar to „Reifling type"), peloidal grainstones impregnated by hydroxides of Fe, micrite with calcified spicules of silicisponges. In the parts of the breccia there are fragments of echinoderm segments, fragments of lamellibranchiate shells and rarely Hydrozoa.

The sample BP/2 is rudstone formed by rounded bioclasts (lamellibranchiata, segments of echinoderms, *Cayeuxia sp.,* seldom foraminifers, lithoclasts of micrites and pelsparite with ostracods). In the upper part (sample BP/3) there are rather grey limestones (grainstones-

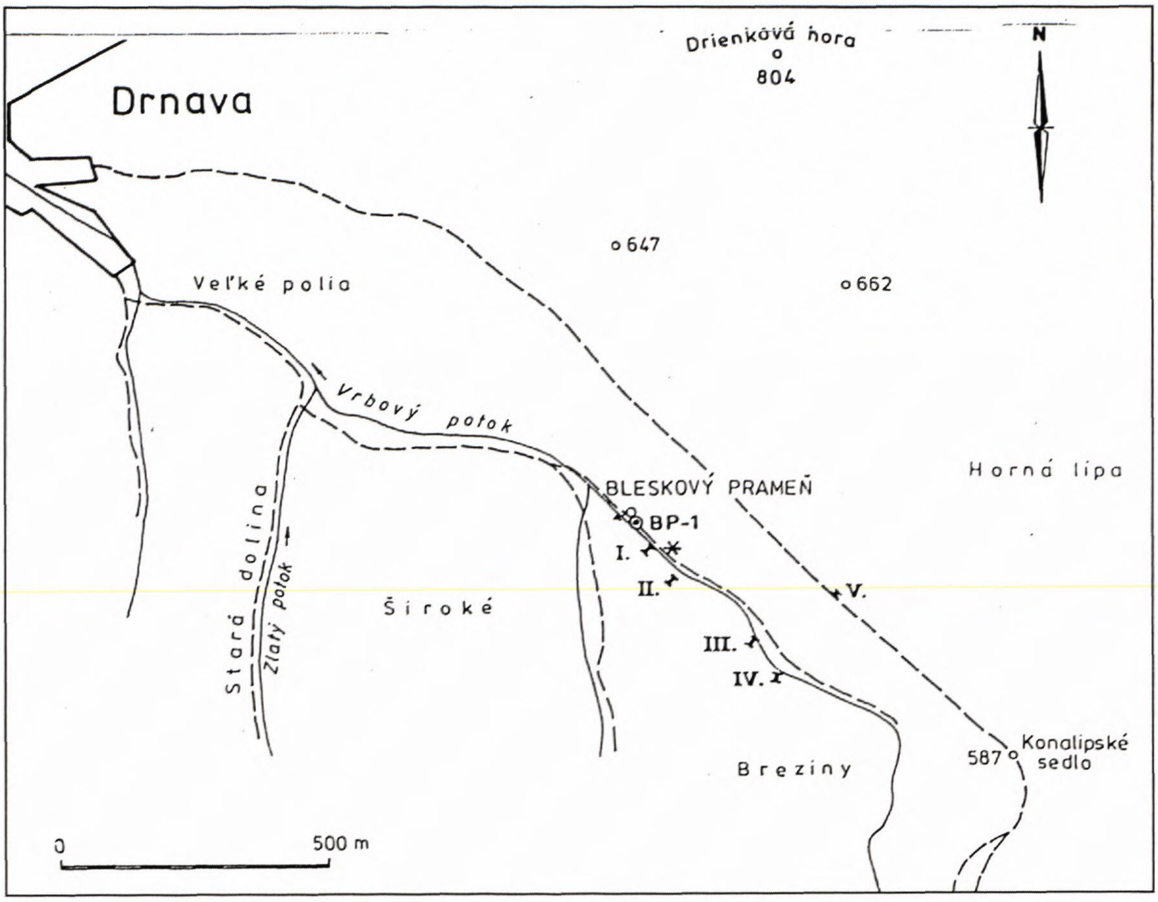

Fig. 4 Location of the partiale profiles in the vicinity of Bleskový prameň near Drnava. BP – 1 borehole, I.– V. partiale profiles.

intrabiosparites) cemented by A and B types cement. There are often fragments of cyanophycean coatings, micrite bioclasts and pellets. Abundant sediment components are lithoclasts with foraminifers: *Triasina hantkeni* MAJZON, *Permodiscus* sp., *Aulotortus* sp., *Auloconus* sp., *Variostoma* sp., *Planiinvolutina* sp. (Pl. 4, Fig. 1)

(Note: in the groove that does not exist now – a - days, on contact of limestones Norian in age with limestones described above existed a thin (up to 10 cm) layer of dark-grey marly slightly-crinoidal limestones, however their age was not determined).

Thickness: 4 m

Stratigraphic range: direct dating based on fossils has not been carried out till now. Incomplete belemnite rostra do not enable precise dating. According to their position we range them to Sinemurian.

Variegated (greyish-green, beige, pinkish and red) crinoidal-brecciated limestones with lithoclasts = **Kornalipské sedlo formation – new name.**

Kornalipské sedlo formation

Type locality: Kornalipské Sedlo pass, SE from Drienkova Hora Mt., Vŕbovy Potok brook (fig. 3).

Informal names: crinoidal and massive limestones, usually of red colour (Andrusov, 1953 : 119); grey, but mostly red crinoidal limestones and limestone breccias (Bystrický, 1960 : 41); red brecciated limestones (Rakús, 1967: 7).

Lithology: facial variety is typical for this formation. However, its bottom parts are formed mostly by greyish-green limestones, occasionally by redish-brown varieties with dark-grey limestone lithoclasts (10 x 30 cm) with silicifications. Towards the overlying parts, but laterally as well, there are transitions changes into pink to red thick coarse-crinoidal limestones of Hierlatz type with lithoclasts of grey grained limestones (Pl. 5, Fig. 1).

Thickness: up to 10 m.

Stratigraphic range: it is not confirmed directly yet. Based on its position bellow the Adnether formation of Carixian age we consider it as Lotharingian /Carixian.

Red nodular Adneth limestones: this formation is gradually developed from underlying formation, what makes difficult its strict distinction from the Kornalipské sedlo limestones. As the whole it can be designated here as „Hierlatz/Adneth formation", where several transitions exist between marginal varieties, cartographic distinction of which is not possible. We can often observe „nodules" formed by fine biomicrites, which are „drowned" in coarse-crinoidal varieties (Pl. 3, Fig. 1). Except of intraclasts, there are present also lithoclasts (10 x 20 cm) of grey fine-grained limestones where the biodetritus is formed by minute crinoidal as well as echinoderm segments. The ostracods are less presented, foraminifers of genus *Nodosaria* and *Textularia* are very rarely found. Further, minute grains of clastic quartz, flakes of light - coloured mica, authigenic pyrite and plagioklase are present.

The following fauna comes from the red limestones (Rakús, 1967):

Zetoceras zetes (d'ORB.), *Juraphyllites* sp., *Androgynoceras* sp., *Acanthopleuroceras* ? sp., *Fuciniceras* sp., *Chlamys (Velata)* sp., *Securithyris adnethensis* (SUESS), *Pentacrinus* sp. (segments, stalks and calyxes), *Passalotheutis* sp.

This fauna association refers to Carixian. The fauna found in these limestones by Andrusov & Šuf (1936) and Andrusov (1953) refers to the same age . The exception is genus *"Vermiceras"*, which belongs to Lower Sinemurian. Andrusov (cf. 1953, pl. 15, fig. A) re-determined it later to *Paltechioceras* that occurs in the Upper Lotharingian. From the Andrusov's depiction it is obvious that its preservation is very poor and we cannot exclude that it is an *acanthopleuroceratoid* form. The rich fauna that was described by Kollárová-Andrusovová (1966) at Miglinc locality in the same limestones shows almost the same age – Carixian and Early Domerian.

The above described limestone types form the filling of neptunian dikes that intersect not only the underlying brecciated limestones, but reach also deep into the Late Triassic limestones. Hydrogeological well drilled directly in Bleskový Prameň reached them in 30 m depth! Bystricky (1964) states that this type of limestones in the Kornalipské sedlo rests directly on light coloured limestones of Late Triassic.

Note: the real Adneth formation of Carixian age occurs on the Miglinc locality (see next).

4) The top parts of the Hierlatz-Adneth facies are formed by red, banked, fine-grained biomicrites with indistinct nodularity. Limestones belong to biomicrites – wackestones with fragments of Lamellibranchiata, ammonites, segments of Echinodermata and ostracods. Biodetritus is often drilled by Algae and Porifera (sample BP/6; Pl. 4, Fig. 2). The following ammonite fauna comes from these limestones (finding of Dr. J. Soták):

Dactylioceras sp., *Hildoceras sublevisoni* FUCINI.

This points to Middle Toarcian, Bifrons Zone. Although the direct contact with overlying spotted limestones is not exposed, the deposition conditions show without doubt that the "fleckenmergel" formation is overlying it normally.

5) Alteration of dark-grey calcareous claystones and banked (8, 13, 15, 18 cm) spotted limestones - "fleckenmergel" = **Allgäu formation.** Microfacially, there are mudstones with rare bioclasts of minute fragments of echinoderm segments, ostracods and pellets. In small amount the clastic quartz (silt) is present as well as aggregates of epigenetic pyrite (samples BP/7 and BP/8). Measurable thickness up to 10 m is in valley of the Vŕbový potok brook. In top parts of the formation there are stratiform nodules of dark silicites or dark aphanitic silicified limestones (Mello, 1973).

The opinions about the age of this formation were quite different (Bystrický, 1960). The last named, (l.c.: 44) based on superposition above Liassic, considered them ? as Doggerian. The finding of the nautiloid cephalopod (most probably *Cenoceras*) in this formation in the Miglinc valley is unfortunately not sufficient. Based on the investigated age of underlying limestones (Toarcian) this assignment seems to be reasonable.

6) As the next lithostratigraphic member there is the formation of calcareous claystones with irregular accumulations of carbonate breccias of debris flow type (fig. 5, Pl. 2, Fig. 2, 3) = **Bohúňovo formation – new name.**

Type locality: Bohúňovo village area, near the gas transit pipeline.

Appendix profiles: Vŕbový Potok.

Informal names: endostratigraphic breccia (Bystrický, 1964 : 78), carbonated breccia (Sýkora & Ožvoldová, 1996 : 21).

Lithology: The bulk mass of debris flow breccias is situated overlying the spotted limestones and underlying black radiolarites. Thin intercalations of breccias occur in the radiolarites as stated by Mello (1973).

The olistostrome itself consists of blocks of various sizes (from several cm3 to 3–4 m^3). Blocks and lithoclasts are usually formed by various types of limestones (Pl.4, Fig. 3 ; Pl. 5, Fig. 2), but mainly by crinoidal-brecciated limestones. They are varyously rounded, sometimes with alteration rim. Matrix of these debris flow deposits (see Sykora & Ožvoldová, 1996) is formed by calcareous claystones to clayey limestones in which lithoclasts of various sizes occur (Pl. 5, Fig. 4). There were identified the segments of echinoderms (crinoids, ophiurians, sea urchin spines). Sclerites of holothurians, fragments of lamellibranchiates (also filaments) and brachiopod are rare. Ostracods and radiolarians were found rarely. The biodetritus is not sorted according to the size. Part of the matrix is clastic quartz (silt) and mica and epigenetic pyrite. The characteristic mark of the breccia is the albitisation of lithoclasts margins. In smaller grains the albitisation usually obscures their original structure. Some of grains are not affected by this metamorphose (for instance Late Triassic grainstones). The formation of albite in carbonates is a characteristic indication of brine – carbonate interactions at temperatures of high – grade diagenesis (? 150 – 200 °C) to lower greenschist facies (? 300 – 350 °C), see Spötl et al., 1999.

The Triassic and Jurassic rocks were identified in the lithoclasts, mainly limestones, less often fragments of calcareous claystones. In the upper parts of the formation the angular lithoclasts of dark-grey radiolarites are part of the breccia!

Lithoclasts of the Triassic rocks are usually the Late Triassic limestones of Drienkova Hora Mt. type with foraminifers, lamellibranchiates, fragments of corals, gastropods and peloids. More often there are Liassic greyish to grey-pink limestones (biomicrites–wackestones) with abundant segments of echinoderms, calcified spicules of silicisponges, ostracods, foraminifers: *Ophtalmidium leischneri* KRISTAN-TOLLMANN, Ophtalmidium sp., *Involutina liassica* JONES, *Nodosaria* sp., *Lenticulina sp.* Seldom lithoclasts of spotted limestones were found. Calcareous claystones are more rare. They contain silty quartz, mica and fine organic detritus. Often

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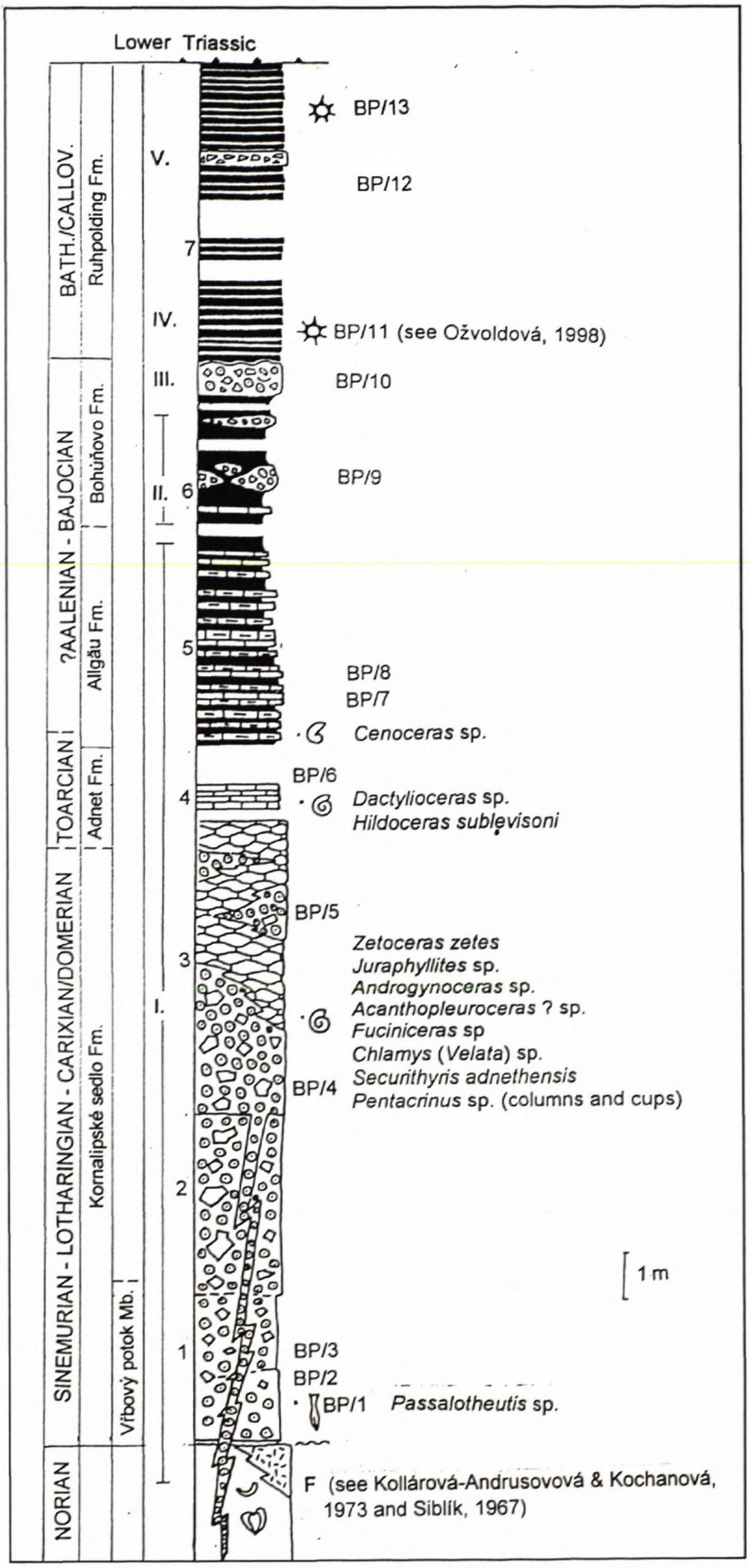

Fig 5 Bleskový prameň composite lithostratigraphic profile. Rakús, 1993

we can observe plastic synsedimentary deformations (Pl. 3, Fig. 2).

As mentioned above, the lithoclasts of blackish-grey radiolarites are also part of the breccia, although their occurrence is sporadic (Pl. 3, Fig. 3; Pl. 5, Fig. 3). In clasts of radiolarites the radiolarians were identified that are according to Sýkora & Ožvoldova (1996) (l.c. 23) of Bathonian-early Kellovian age.

In the top part of the Olistostrome formation there is a thin (0,5 – 1 m) layer of green crinoidal limestones (? calciturbidite) with clasts of biomicritic limestones (Pl. 2, Fig. 1). Matrix is formed by fine-grained biomicrite with echinoderm-fibrous microfacies. In upper part there are several millimetres thin layers, irregular laminas of black claystones that „flow round" (copy) the clast surface (Pl. 2, Fig. 1). The layer ends by black siliceous shales to silicites that form transition into dark-grey to black radiolarites overlying them.

Thickness: 12 m

Stratigraphic range: The age of the Olistostrome formation is estimated only indirectly by radiolaria from lithoclasts of radiolarites (see above) and by the position below dark radiolarites, which has been recently dated as „Late Bathonian and Early Callovian" (Ožvoldová 1998). Considering the fact that of radiolarians are from lithoclasts the age of the formation should be younger.

7) Ruhpoldin radiolarites occur as the known topmost member of the Jurassic succession at locality Bleskový Prameň. Their colour can be different, however the dark colour prevails, mainly dark-grey to black. There are also reddish, brownish or greenish shades (slopes of Drienkova Hora Mt.). The dark colour is considered to be original, while variegated colouring is the consequence of the weathering.

In radiolarites, except of radiolarians there are also clastic quartz and light – coloured mica, however, their contents do not exceed 1 %. Immediately overlying crinoidal limestones there are dark to black, banked radiolarites (10–15 cm, which are formed by thin beds 1-3-5 cm). Individual layers are separated by thin interlayers of black clayey shales. The fauna Late „Bathonian to Early Callovian" radiolarians is derived from these radiolarites (Ožvoldová, 1998). This age is identical with age of radiolarites lithoclast form underlying olistostrome formation, causing difficulties in age determination of the radiolarites. Considering the superposition, the Ruhpoldin radiolarites should be younger in age.

In radiolarites thin (maximum several dm) layers of carbonate sedimentary breccias to calcarenites occur, which were described by Mello (1973) for the first time. The breccias (fig. 5 a Pl. 1, Fig. 3) lie on positively graded sediments of distal turbidites. The turbidite

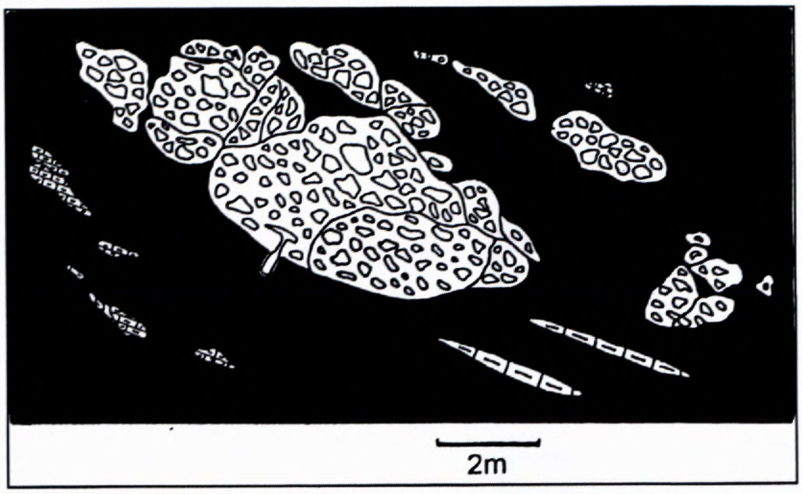

Fig. 6 Olistostromatic body in the Bohúňovo formation at the locality Bleskový prameň

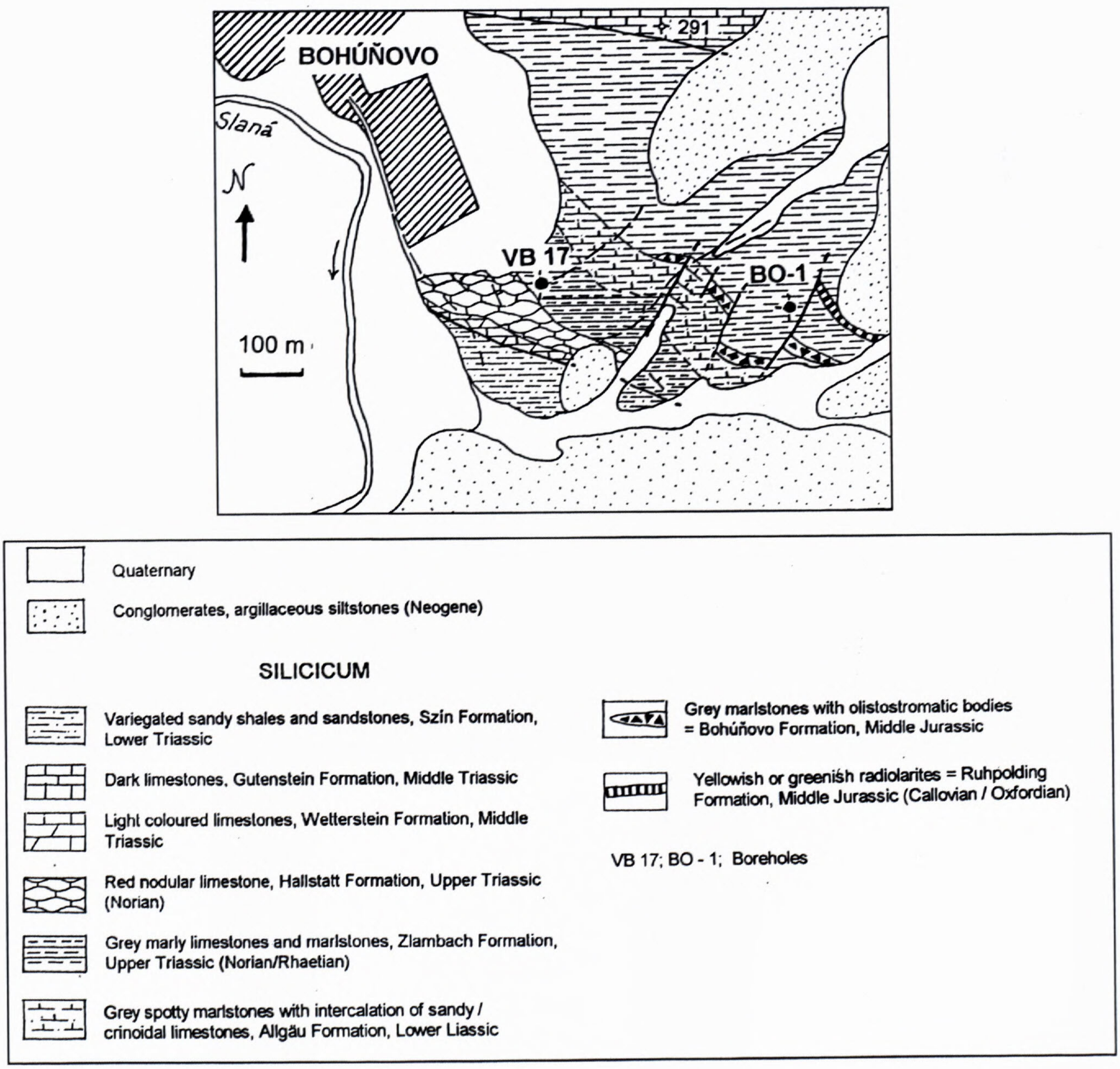

Fig. 7 Geological sketch map of the Bohúňovo vicinity (after Bystrický, 1962, completed by author)

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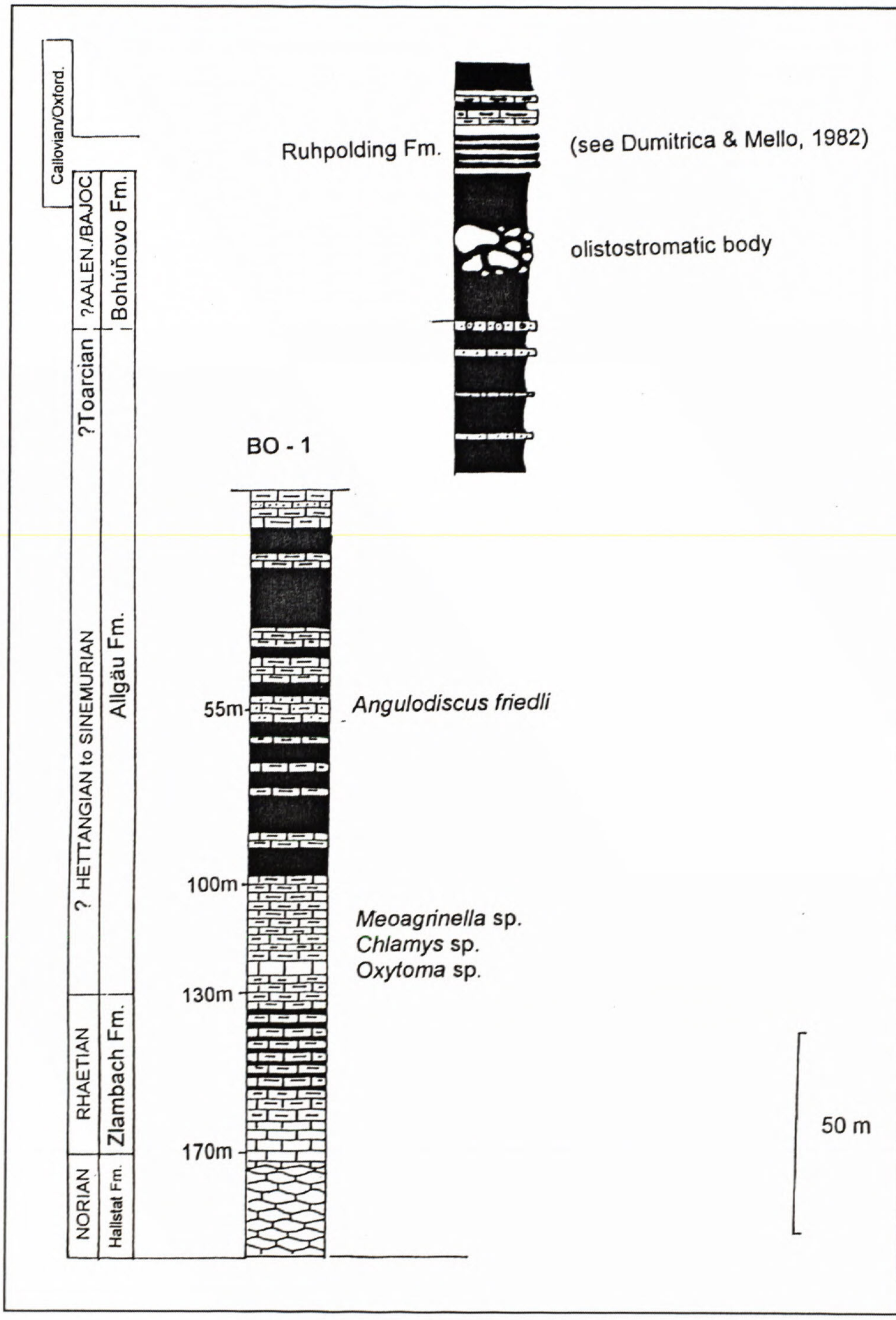

Fig. 8 Lithostratigraphic composite profile of Jurassic near Bohúňovo

laminas are thick 3–10 mm and formed by graded-bedded calcarenite (Pl. 4, Fig. 4), to everlying parts gradually passes into radiolarites. The grains in calarenite are bioclasts (fragments of echinoderms, uniserial foraminifers, tubes of worms, brachiopods, lamellibranchiates and zoospores). A cosiderable part of sediment is formed by micrite grains, in which the majority are formed by small fragments of micrites, some of them are Triassic (*Trochammina* sp. a *Semiinvoluta* sp.). Only seldom calcite ooides and lithoclasts of chloritised and calcitised volcanic rock (originally it contained thin phenocrysts of plagioklase) were found. Clastic quartz and mica occur only seldom in sandstone. In radiolarites in which calcarenite is present, Bathonian–Early Callovian radiolarians were determined (Dumitrica - Mello, 1982). Because of bad exposure, the thickness is only estimated to 10–15 m.

The succession of this locality is ended by the formation of the radiolarites. Overlying it the early Triassic – Bodvaszilas and Szin members are present in tectonic position (Bystrický, 1964 a Mello, 1994).

Jurassic near by Lúčka village

The Jurassic sediments from these localities were described by Andrusov (1953) and Bystrický (1964). The Liassic part of the succession is less exposed in comparison with the previous locality. On the other hand, the Middle Jurassic – radiolarites are more abundant and form the majority of exposures. However, their present uncovering is quite poor in comparison with the later past, so the continuous profile cannot be studied here. However, parts of its sections.

On the south-western margin of Lúčka there is the exposure of the radiolarites in the road cut where Ondrejičková (1990) described the rich association of radiolarites: stratigraphic range of radiolarian association (based on two samples) is according to the authoress wide: uppermost Middle Jurassic (Callovian) to earlier part of Late Jurassic (Oxfordian).

Radiolarites are dark-grey, poorly spotted and weathering into brownish-yellow or rusty yellow colour. They are thin layered and platy and are characterised by clastic admixture (Pl. 6, Fig. 3) that is formed by quartz, muscovite, biotite and rarely zircon, rutile and tourmaline. The grains are of silt to fine-sand size. The content of terrigenous component is 1 – 2 %, seldom to 10 % (in bioturbated parts). There are rhombohedrons of disintegrated carbonates. New sampling for radiolarians was not successful and provided only poorly preserved associations of radiolarians that do not enable precise stratigraphic assignment.

Jurassic in the Miglinc valley (fig. 9)

This locality represents the most eastern occurrence of the Jurassic in the Silica nappe on Slovak territory. It was discovered by Bystricky (1960 and 1964) and in comparison with Bleskový Prameň, often the red nodular limestones and marls of "Ammonitico rosso" type – Adneth formation occur (fig. 9). In these limestones, there is rich association of Carixian to Early Domerian ammonites (Jamesoni/Ibex to Margaritatus Zones) Kollárová-Andrusovová, 1966). The lower part of the red nodular limestones consists of biomicrite (wackestone to packstone) and contains abundant fragments of lamellibranchiate shells, segments of echinodermates (mostly crinoids, sea urchins and ophiurians). There are often spicules of calcified silicispongies as well as foraminifers: *Lenticulina, Nodosaria, Ophtalmidium and Involutina.* Less frequent there are ostracods, gastropods, zoospores (*Globochaete alpina* LOMBARD) and bryozoans. Clastic quartz is observed very seldom, however, there are frequent findings of autigenic plagioklase of silt size.

In comparison with the previous limestones, the upper parts of the nodular limestones contain in the first place juvenile shells of lamellibranchiates (filaments) and ammonites (Pl. 6, Fig. 1). Foraminifers as *Ophtalmidium* and *Involutina* are missing in them. Calcified spicules of silicisponges are found rarely.

Overlying the red nodular limestones there is a formation of more or less grey to dark-grey clayey limeones that alternate with calcareous claystones (Fleckenmergel - Allgäu formation), from which Bystricky (1964) described the finding of the nautiloid *Cenoceras* cf. *intermedium* (SOW.). Unfortunately, stratigraphic value of this finding is not sufficient. Microfacially they are biomicrites – wackestones with relatively rich fragments of biodetritus (Pl. 6, Fig. 2), in which ostracods, echinoderm segments and less frequent uniserial foraminifers are present. The sediment is bioturbated and contains only low admixture of clastic quartz and micas of silt grain size. Some bigger bioclasts are „replaced„ by plagioclase (probably albite).

Jurassic in the Muráň river canyon (fig. 10)

The first reference to these occurrences can be found in works by Bystricky (1960, 1964) who has described small occurrences of crinoidal limestones that were classified as Jurassic, in the Muráň river valley, on both embankments, about 1 km southward of Meliata village on northern ending of the canyon. However, detailed information about these southernmost occurrences was missing.

Our research has shown that Jurassic limestones occur here as fillings of neptunian dikes, on northern end of the Muréň river canyon (on both sides) in the Late Triassic light - coloured limestones. Dikes are about 25 – 100 m long, the range of their width is from 5 to 8 m. Observable depth is at least 10 – 15 m. The strike dip is 110°, dipping 30° to 80°.

The lithological filling is variegated and variously grained types of limestones (from micrites to crinoidal sparites) red with transition to beige and grey colours occur there. The grey parts of the sediment consist of shells of juvenile ammonites, brachiopods and calcite cement. The voids in the mentioned bioclasts and original pores between the grains are often geopetally filled with the red wackestone (Pl. 6, Fig. 4). This consists of the micrite matrix, bioclasts from sporadical authigenic plagioclases and quartz. Bioclasts consist of fragments of juvenile ammonite shells, segments of crinoids (sporadically ophiura) and fragments of thin – walled lamellibranchiates (filaments). Gastropods and nodosaride foraminifers are there rare. The internal sediments are frequent, as well as RFC calcites (=„evinesponge structures“). The contact with the Late Triassic limestones is sharp and in the red Jurassic limestones angular fragments of light - coloured Triassic limestones can be found, what would point to activity of theses synsedimentary faults. In a small dike on the left-bank the fauna of ammonites in red biomicritic limestones was found:

Phylloceras sp., *Hildoceras* gr. *sublevisoni* FUC., *Hildoceras* cf. *lusitanicum* MEISTER, *Harpoceratinae* ex gr., *Dactylioceras* sp.

This association suggests the Middle Toarcian age, Bifrons Zone.

Because there are not any other rocks between the red Toarcien limestones and the light- coloured Late Triassic limestones, they represent the oldest known member of the Jurassic succession on this locality. This fact emphasizes the transgressive character of Jurassic in this part of Silicicum.

Jurassic near Bohúňovo (fig. 1, 7)

Unlike the previous locality the Jurassic near Bohúňovo is developed in more complete profile. This fact is probably caused by various positions in deposition area and it reflects the dynamics of the basin of the future Silicicum nappe.

The first published information about Jurassic near Bohúňovo is by Bystricky (1964: 78), who described it already in 1962 (manuscript). He classified as Jurassic the formation of dark clayey limestones, more or less spotted, endostratic breccias composed of red crinoidal limestones and radiolarites. The relation of the mentioned facial types was owing to their bad exposure very problematic. This lack was partly diminished by geological drilling BO-1 that was located (by Dr. Bystricky and one of authors M.R.) 600 m SE from Bohúňovo. The following profile was recorded in the drilling (Mello, 1973, appendix 9):

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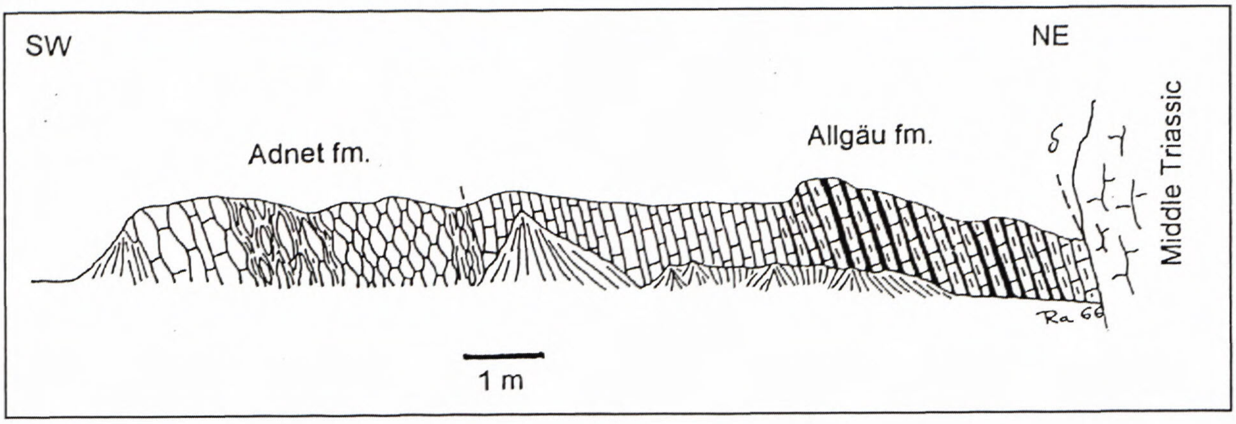


Fig. 9 Lithostratigraphic section through the Jurassic

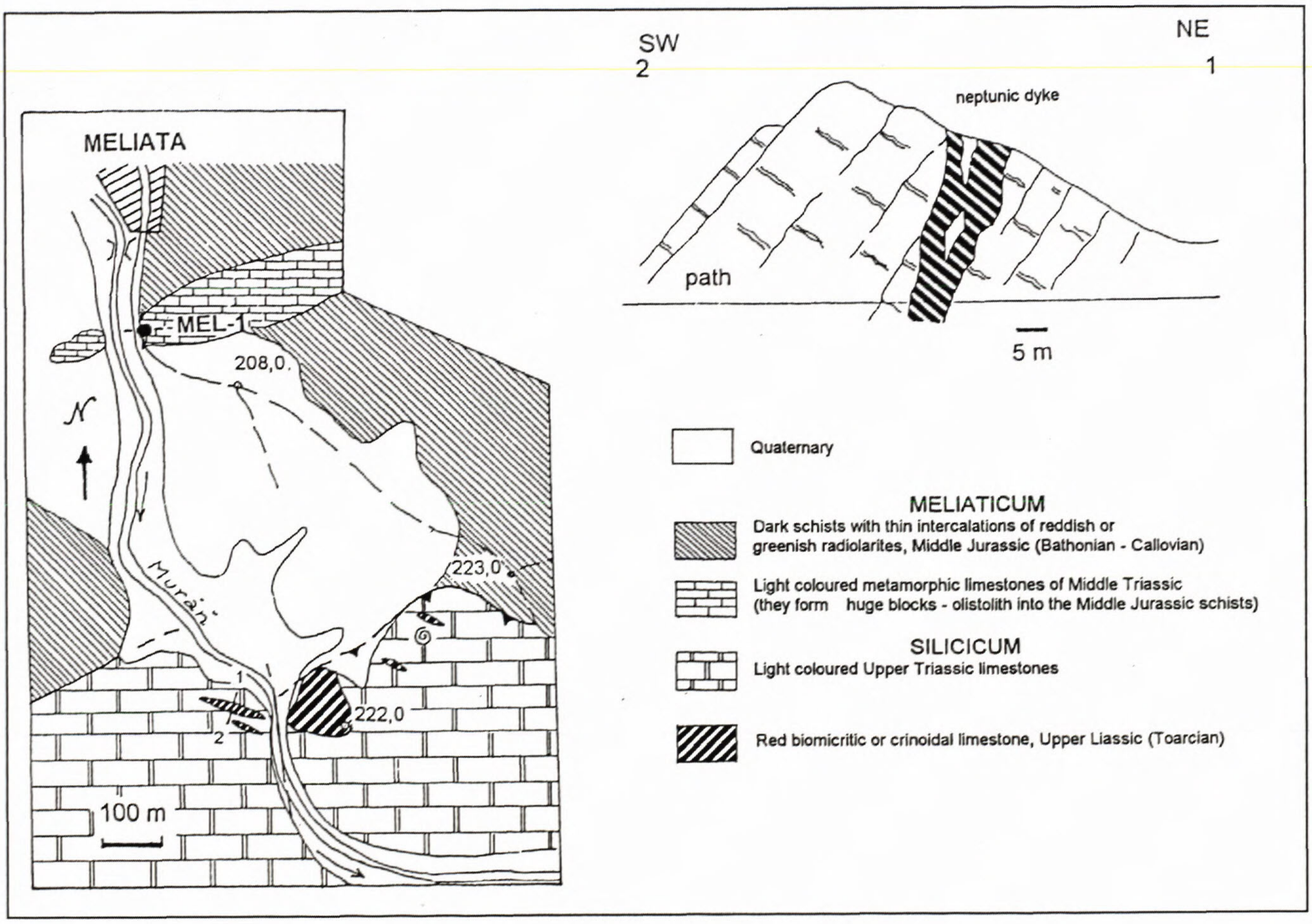


Fig. 10 Geological sketch map southern vicinity of Meliata village (after Mello, 1996, completed by author)

0–2 m	Quaternary,
2–12 m	dark-grey organodetritic, limestone layers (10, 20, 40 cm) with bed of calcareous sandstones (depth 9-10 m),
12–55 m	dark-grey calcareous claystones (prevailing) with layers of spotted clayey limestones - "Fleckenmergel" (=Allgäu formation)
55–61 m	dark-grey organodetritic limestones with sandy admixture and *Angulodiscus friedli* KRISTAN-TOLLMANN
61–100 m	dark-grey calcicareous claystones with layers of spotted clayey limestones ("Fleckenmergel"), in depth 88–92 m there is a layer of sandy–crinoidal limestones – calciturbidite
100–130 m	clayey spotted limestones with *Meoagrinella* sp., *Chlamys* sp. and *Oxytoma* sp. In interval 120 to 130 m passages of crinoidal-pellet at to oolitic biomicrites occur, which could correspond the turbidites. All layers mentioned above we includ into Early Liassic, but without detailed subdivision.
130–170 m	dark-grey clayey limestones and calcareous marls, locally spotted. The content of clayey limestones increases towards underlying parts. Facially these layers are well correlated with the

Zlambach formation at Malý Mlynský Vrch Mt., from which the fauna of ammonites of Norian-Rhaetian age is known.

170–200 m at the beginning there are pinkish, then red massive and nodular Hallstatt limestones (Norian).

The layer succession described above partly occurs on the surface in the gorge SE from the Bohúňovo village, from which similarly as in drilling, it is seen that in „Fleckenmergel" occur scattered beds (from 20 cm up to 1 m) of organodetritic weakly-sandy limestones. In upper part of the calcareous claystones formation (near the curve of the field path) there is a remarkable layer (about 5 m) of crinoidal limestones with intraclasts (up to 5 cm), which can have turbidite character.

Overlying these limestones the grey calcareous claystones occur again, in which Bystrický (1962) mapped endostratic breccias. The relation of these breccias to claystone formation was not known. Thanks to excavation works on gas transit pipeline (in neighbourhood of BO-1 drilling) the body of olistostrome formation was uncovered (= intraformational breccia of Bystricky) that is very similar to that one described in previous text on the Bleskový Prameň locality.

Bohúňovo formation: is an olistostrome composed of blocks of various sizes (several m^3 metres) and smaller clasts (20-30 cm^3 and less), of red crinoidal limestones, brecciated-crinoidal limestones and carcareous breccias (Pl. 1, Figs 1, 2, Pl. 7, Fig. 1). Further there are grey lumachelle limestones as well as limestones with Fe/Mn crusts. Blocks and lithoclasts laying in grey to yellowish-brown weathering clayey limestones to calcareous claystones.

The matrix of the breccia is calcareous-clayey with scattered minute lithoclasts spread in it (Pl. 7, Fig.2) and fragments of echinoderm segmants, foraminifers, ostracods, lamellibranchiates, brachiopods and seldom calcified radiolarians. Clastic quartz can be found rarely. The age of matrix is not reliably determined. In one sample Dr. POTFAJ determined the following nannoplankton association: *Ellipsagelosphaera fossacinata* BLACK, *Cyclagelosphaera deflandrei* (MANIVIT), *C. margerelii* NOEL, *? Biscutum* sp.. In case that this association is original, then its stratigraphic range is Middle Jurassic (? Bathonian) and younger.

The unsorted clasts in the breccia consist of grey, yellowish, pink and red limestones (Pl. 7, Figs 3, 4). Most ftequently there are biomicrites – wackestones and they have an association resembling biodetritus. They contain echinoderm segments, fragments of lamellibranchiates, foraminifers (*Involutina* sp., *Nodosaria* sp., *Lenticulina* sp. and *Ophtalmidium* sp.). The juvenile ammonites, gastropods, bryozoans, *Globochaete alpina* LOMB. and tubes of worms occur rarely. The crinoidal sparites of Liassic age were found rarely. Except of the limestones, the lithoclasts of claystones containing silty quartz are present. The ratio of matrix and lithoclasts (limestone-claystone) is very variable and changes in different parts of the exposure.

As mentioned above, the breccia near Bohúňovo resembles olistostrome sediments at the Bleskový Prameň locality. We did not find lithoclasts of demonstrably Triassic rocks as well as radiolarites that were mentioned by Bystricky. Moreover, the lithoclasts are not albitised.

The age of the Olistostrome formation has not been yet directly and reliably dated. However, if we consider the results of nannoplankton and position in the basement of the Callovian-Oxfordian radiolarites, then we can think about ? Bajocian – Bathonian age. The thickness of the formation is estimated to several tens metres.

Overlying of the olistostrome there are greenish-grey to yellowish-green weathering radiolarites (Ruhpolding radiolarites) with poorly observable thickness (poor exposure), in which rich association of radiolaria of Callovian-Oxfordian age was described (Dumitrica & Mello, 1982 and Ondrejičková, 1990). Younger members were not found because being covered by Neogene sediments.

Comments regarding the age of ruhpolding radiolarites of the Silicica nappe

Although the radiolarites of Silicicum do not reach remarkable thickness, they form a well distinguished and important regional correlation horizon. Moreover, in the Silicica nappe itself they can be the last known lithological member of the succession (Bleskový Prameň), preserved on the surface.

In the Bleskový Prameň locality above the radiolarites in tectonic position there is the Szin formation of Early Triassic of upper partial structure of the Silicicum nappe (Mello, 1993). Considering the age of closing and following structuration of sedimentary basin of Silicicum, this fact is very important. As we have stated above (l.c.), their stratigraphic assignment is understood variously. At the localities Lúčka and Bleskový Prameň they are stratigraphically ranged mainly to Late Bajocian-Bathonian up to Early Callovian (Goričan & Dogherty 1998 written announcement, Sýkora & Ožvoldová, 1995, Ožvoldová, 1998). In contrast to previous authors, only Ondrejičková (1990) considers their possible ranging to Callovian-Oxfordian. Regarding the radiolarites from Bohúňovo, these are dated as to Callovian-Oxfordian (Dumitrica & Mello, 1982 a Ondrejičková, 1990).

Although there are only three localities within Silicicum unit, considering their basinal and deep wather character, we suppose, that there should be one radiolarites horizon, stratigraphic range of which should be ? Late Bajocian to Oxfordian. However, the age determination of the radiolarites in Bleskový Prameň remains a problem. According to Ožvoldova (l.c.) the age of radiolaria clasts in the Bohúňovo formation and radiolarites overlying them is the same i.e. Bathonian-Early Callovian. As we have already stated, the age of radiolarites (in position above breccias) should be younger. From this viewpoint the age of radiolarites as mentioned by Dumitrica & Mello (1982) is more probable.

Cephalopoda fauna and its stratigraphic evaluation

With respect to the fact that Liassic ammonites of Juhoslovenský Kras were in detail described in publication by Andrusovová-Kollárová (1966), in following we would be focused only on species that have not been described in this area up to now. The paleontologic material is deposited in collections of the **D. Štúrs´ State Geological Institute in Bratislava.**

NAUTILIDAE de BLAINVILLE, 1825
Cenoceras HYATT, 1883

***Cenoceras* aff. *jurense* (QUENSTEDT, 1846)**
Fig.11

Material: one incomplete stone cast, ex situ.
Remarks: our specimen is characterised by ventraly compressed cross´section of the whorl (fig. 11), what makes it most resemble to species *C. aratum* (QUENSTEDT, 1846). However it differs from that species by shallow internal lobe (fig.11).
Stratigraphic range and occurrence: the species occurs mainly in Early Liassic, but it can be found in Upper Liassic as well. Our specimen was found together with the Middle Liassic ammonites on the locality northward from Muráňska Huta (Muranska Planina plateau) at margin of meadow near the elevation point 808,2 m.

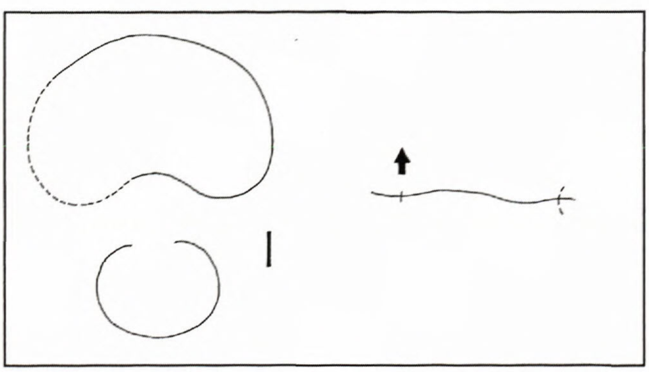


Fig. 11

JURAPHYLLITIDAE ARKELL, 1950
***Juraphyllites* MÜLLER, 1939**

***Juraphyllites* cf. *planispira* (REYNES, 1868)**

Material: three incomplete stone casts drill cores of red weakly-crinoidal limestone
Remarks: Specimens from Bleskový Prameň locality are similar to species *J. planispira* (REYNČS) considering their laterally compressed crossection of whorl, smooth and flat sides and stratigraphic position.
Stratigraphic range and occurrence: Carixian – Early Domerian, locality Bleskový Prameň, layer No.3 (see profile, text. -fig. 5).

PHYLLOCERATIDAE ZITTEL, 1884
***Phylloceras* SUESS, 1865**
***Phylloceras* sp.**

Material: one incomplete stone cast
Remarks: our specimen represents a juvenile specimen that cannot be reliably determined. It occurs together with *Hildoceras.*
Stratigraphic range and occurrence: Toarcian, zone Bifrons, left bank of the Muráň river, southward of Meliata, NE from the elevation point 220,0 m.

CALLIPHYLLOCERATINAE SPATH, 1926
Calliphylloceras SPATH, 1927

***Calliphylloceras* sp.**

Material: one incomplete stone core, ex situ

Dimensions: D	Wh	Ww	O
78,0	42,0	-	10,5

Notes: because of its poor preservation nearer its determination was not possible. According to the total proportions and relatively wide umbilicles our specimen is similar to species *C. liasicum* GÉCZY, 1967.
Stratigraphic range and occurrence: Middle Liassic – Pliensbachian, northward from Muránska Huta (Muránska Planina plateau), at margin of the meadow near the elev. point 808,2 m.

LYTOCERATIDAE NEUMAYR, 1875
Lytoceras SUESS, 1865

***Lytoceras* cf. *postfimbriatum* PRINZ, 1904**

Material: two incomplete, partly preserved stone cores, ex situ

Parameters:	D	Wh	Ww	O
	105,0	37,0	26,0	57,0

Note: in the level degree of coiling and laterally compressed – elliptical cross of whorl our specimens are similar to species L. postfimbriatum PRINZ, 1904.
Stratigraphic range and occurrence: the species is known from Middle Liassic – Pliensbachian of the Western Carpathians (localities Borišov and Rovne pod Krížnou), where it occurs together with *Uptonia.* Our specimens were found northward of Muránska Huta (Muránska Planina plateau), at margin of the meadow near the elev. point 808,2 m.

***Lytoceras* cf. *fimbriatum* (SOWERBY, 1817)**

Material: one incomplete imprint, ex situ
Notes: our specimen represents incomplete imprint of whorl in greyish-green weakly-crinoidal limestone with distinct traces of collars with typical crenulate margin. Although there is only an imprint, on the basis of collars we could range our specimen to *L. gr. fimbriatum* (Sow.).
Stratigraphic range and occurrence: the species was found in Geravy near the monument and it is ranged to Middle Liassic – Pliensbachian.

OXYNOTICERATIDAE HYATT, 1875
Oxynoticeras HYATT, 1875

***Oxynoticeras* cf. *oxynotum* (QUENSTEDT, 1845)**
Pl. 10, Fig. 4

Material: one partly preserved stone core, ex situ

Dimensions:	D	Wh	Ww	O
	62,0	32,4	-	6,5

Notes: Regarding the cross section of the whorl, sharp keel and degreelevel of involution our specimen resembles *Ox. oxynotum* (QU.), which is common species of Carpathians´ Lotharingian,.

Stratigraphic range and occurrence: Early Liassic – Lotharingian. Zone Oxynotum, northward of Muránska Huta (Muránska Planina plateau) at the margin of the meadow near the elev. point 808,2 m.

EODEROCERATIDAE SPATH, 1929

***Epideroceras* SPATH, 1923**

***Epideroceras* sp. 1**

Material: one partly preserved stone core, ex situ

Notes: In the degree of the involution, radial and relatively wide flat ribs and highly oval cross section of whorl our specimen is close to species *Epideroceras roberti* (HAUER, 1854) or *E. steinmanni* (HUG,1899).

Stratigraphic range and occurrence: The species mentioned above occur in Lotharingian in the Raricostatum zone, northward of Muránska Huta (Muránska Planina plateau). Margin of the meadow near the elev. point 808,2 m.

***Epideroceras* cf. *lorioli* (HUG, 1899)**

Fig. 12

Material: one partly corroded rock stone core, ex situ

Dimensions:	D	Wh	Ww	O
	225,0	68,6	47,0	105,6

Notes: This big form is characterized by laterally compressed, oval cross section of whorl (fig.12). Its immature stage is characterized by radiate rounded ribs with obscure tubercles. Overall appearance, but mainly the degree of volution and ribbing of our specimen resemble *Epideroceras lorioli* (Hug).

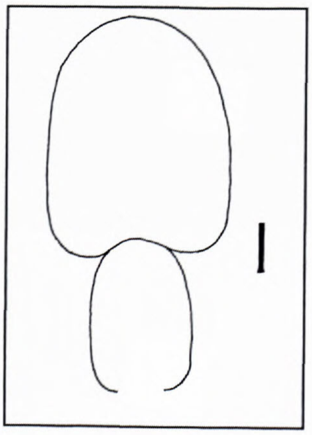


Fig. 12

Stratigraphic range and occurrence: this species occurs in Lotharingian, Raricostatun zone, northward of Muránska Huta (Muránska planina plateau), the margin of the meadow near the elev. point 808,2 m.

POLYMORPHITIDAE SPATH, 1929

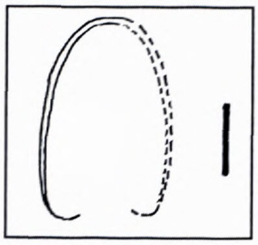
***Uptonia* BUCKMAN, 1898**

***Uptonia* sp.**

Fig. 13

Material: part of the whorl of the middle sized specimen, ex situ

Notes: our specimen has laterally compressed whorl section of whorl (fig.13) with remarkable prorsiradiate ribs, which cross up the ventrum forming „chevrons“. The ribbing type range our specimen to genus Uptonia, but the species could not be determined due to more precisely poor preservation.



Stratigraphic range and occurrence: Early Carixian, zone with Uptonia jamesoni, Geravy (Stratenská Dolina valley), northward of cableway, near the monument.

Fig. 13

ACANTHOPLEUROCERATINAE Arkell, 1950

Tropidoceras Hyatt, 1867

***Tropidoceras* ? sp.**

Material: one incomplete stone core, ex situ

Notes: Although the specimen is poorly preserved, the whorl section of whorl as well as degree of volution indicates the genus *Tropidoceras.*

Stratigraphic range and occurrence: Carixian, Ibex Zone, northward of Muránska Huta, the margin of the meadow near the elev. point 808,2 m.

LIPAROCERATIDAE HYATT, 1867

***Androgynoceras* HYATT, 1867**

***Androgynoceras* cf. *maculatum* (YOUNG & BIRD, 1822)**

Material: one incomplete stone core, ex situ

Notes: despite of partial preservation of our specimen, by its robust and strong ribs distant from each other mostly resembles *A. maculatum* (Y. & B.).

Stratigraphic range and occurrence: Carixian, Davoei Zone, northward of Muránska Huta (Muránska Planina plateau), the margin of the meadow near elev. point 808,2 m.

***Androgynoceras* sp. juv.**

Material: four incomplete stone cores

Notes: on locality Bleskový Prameň there occur several not adult specimens belonging to genus Androgynoceras. These pieces resemble mostly species *A. capricornum* (SCHLOTH.) the general rib type. However, due to preservation as well as the size of the specimens (max. diameter is 25 cm) their closser determination is practically impossible.

Stratigraphic range and occurrence: Carixian, Ibex/ Davoei Zone, locality Bleskový Prameň, layers no.3 (see profile).

DACTYLIOCERATIDAE HYATT, 1867
***Dactylioceras* HYATT, 1867**

***Dactylioceras* sp.**

Material: two fragments of whorls
Notes: On locality Bleskový Prameň and southward of Meliata two fragments of whorl parts were found, which undoubtedly belong to this genus. Due to the poor preservation, their specific determination was not possible.
Stratigraphic range and occurrence: Middle Toarcian, Bifrons Zone, locality: Bleskový Prameň, layer 4 (together with H. sublevisoni) and southward of Meliata, NE of elev. point 220,0 m, left bank of the Muráň river.

HILDOCERATIDAE HYATT, 1867
HARPOCERATINAE NEUMAYR, 1875
***Protogrammoceras* SPATH, 1913**

***Protogrammoceras* gr. *isslei* (FUCINI, 1900)**
Pl. 10, Fig. 2

Material: one incomplete stone core, ex situ
Notes: the specimen from Muránska Planina plateau mostly resembles *"P." isslei* (FUC.) by its densely spaced sigmoidal ribs, which are more distinct towards the ventrum. Other mark that makes the specimen resembling to this species is that ribs practically have not ventral projection and end on the strip accompanying the keel.
Stratigraphic range and occurrence: ? Late Carixian – Early Domerian (Stokesi Zone), northward of Muránska Huta (Muránska Planina plateau), the margin of the meadow, near the elev. point 808,2 m.

***Protogrammoceras* cf. *normanianum* (d´ORBIGNY, 1844)**
Pl. 10, Fig. 1

Material: one partly deformed stone core, ex situ
Notes: the subadult stages are characterized by laterally compressed whorl section.The ornamentation is represented by dense, distinct strong, rursiradiate and bifurcate ribs. The branching occurs near umbilicum, in the place of branching there are indications of slight swelling sometimes. The last preserved whorl keeps the same style of branching, but the ribs are remarkably less distinct, without ventral projection.

Due to the overall volution as well as character of ribs our specimen approximates to the species *P. normanianum* (d´ORB.). It is necessary to say that in the Early Domerian of Tethys realm a plenty of species have been described, but their reliable distinction is often very problematic (cf. Dommergues et al., 1987)
Stratigraphic range and occurrence: ? Late Carixian – Early Domerian, Stockesi Zone, northward of Muránska Huta (Muránska Planina plateau), the margin of the meadow near the elev. point 808,2 m.

***Hildoceras* HYATT, 1867**

***Hildoceras sublevisoni* FUCINI, 1919**
Fig. 14, Pl. 9, Figs. 1, 2

1919 *Hildoceras sublevisoni* nov. sp.- FUCINI: 182 pars
1976 *Hildoceras sublevisoni* FUCINI, 1919 - GYBILLY: 128-135, Pl. 20, Figs. 6-7, Pl. 21, Fig. 5, Pl. 22, Figs. 1,2 (cum syn.)

Material: eight incomplete specimens (parts of whorls in various growth stages)
Remarks: our specimens are owing to their cross section of whorl and type of ribbing of the subadult whorls well correlated with descriptions and figures of species described by Gabilly (1976) in his monograph.
Stratigraphic range and occurrence: Middle Toarcian, Bifrons Zone, locality Bleskový Prameň, layer 4 (sample BP/6).

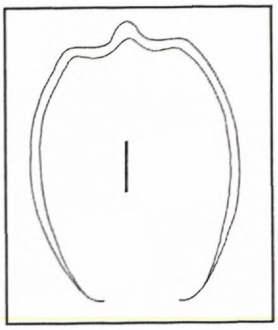


Fig. 14

***Hildoceras* gr. *sublevisoni* FUCINI, 1919**
Pl. 9, Fig. 4

Material: eight more or less complete stone cores
Notes: several subadult stages (total average is about 30 mm) come from the locality southward of Meliata, which resemble species *H. laticosta* Bellini, 1900 by their type of rib distribution. However, GABILLY (1976: 132) considered this species as synonym of species *H. sublevisoni.* Due to the quality of preservation as well as due to the subadult stage of our specimens it is not possible to determine their precise attribution.
Stratigraphic range and occurrence: Middle Toarcian, Bifrons Zone, southward of Meliata, left bank of the Muráň river, NE from the elev. point 220,0 m.

***Hildoceras* cf. *lusitanicum* MEISTER, 1913**
Pl. 9, Fig. 3

Material: two stone cores
Notes: Considering the type and density of ribbing our specimens, although in subadult stage, mostly resemble species *H. lusitanicum* MEIST.
Stratigraphic range and occurrence: Middle Toarcian, Bifrons Zone, left bank of the Muráň river, NE from the elev. point 220,0 m.

Paleogeographic and geodynamic development of Jurassic in Silicicum

Although the reconstruction of the Jurassic history of Silicicum is risky, we suppose that it is an inevitable step for understanding of its own geodynamic development as well as neighbouring palaeographic regions. First of all the main risk is in the incomplete and poorly preserved Jurassic succession, which does not enable to create a relatively realistic picture of the distribution of facies in this area. On the other hand, Jurassic sediments form the last preserved sedimentary record of Silicicum, which is connected (at least in its basin parts) to Triassic cycle and it provides good information about the conditions in this area before its closing. This moment seems to be very important in reconstruction of the geodynamic development of the Silicicum.

It is obvious from the general paleogeographic picture of the inner most units of the Western Carpathians, that the leading element in this region during Jurassic period, there was the oceanic domain of Meliaticum. Its geodynamic development and its consequent Late Jurassic closing had a direct influence on the development and character of the Jurassic sediments in Silicicum (Rakús, 1996).

During Late Triassic and Early Jurassic era the paleogeographic domain of Silicicum was divided by system of normal synsedimentary faults into elevations (horst) and basin areas. This basic paleogeographic element controlled the distribution and character of the Liassic facies of Silicicum. In elevated zones (for instance, Muránska Plošina plateau, Goštanová near Tisovec, Geravy - Stratenská hornatina Mts.), Drienková hora Mt., the Muráň river canyon southward of Meliata village), the Liassic limestones lie with bigger or smaller hiatus on the Norian Dachstein limestones and they are in transgressive position. The transgressive development of Liassic is underlined not only by the brecciated development of basal members with a plenty of late Triassic limestones clasts (Bleskový Prameň), but also by the fact that nowhere the sediments of Rhaetian, Hettangian and lowest Sinemurian were found! The continuing rifting accompanyed with extension caused also the development of new opened faults in subjacent Late Triassic limestones that were consequently filled with the Liasssic limestones. The depth reach of these faults can be very deep and can reach more than 100 m (the wall of Geravy near gamekeeper´s Biele Vody or drilling close to Bleskoý Prameň). The filling of the neptunian dikes consists mostly of variegated red biomicrite, probably Middle Liassic, or of red Toarcian biomicrites (the Muráň river canyon, southward of Meliata village). On the last mentioned locality there is very distinct transgressive character of Liassic in horst zones. The presence of neptunian dikes in elevated areas of Silicicum seems to be characteristic for this region unlike, for instance in Hronicum.

In basin parts of Silicicum (Bohúňovo, Tiba) Liassic sediments develop continuously from the Zlambach formation (Late Norian/Rhaetian) and they are represented by development of spotted calcareous claystones and clayey limestones "Fleckenmergel" (Allgäu formation) with beds of sandy-crinoidal limestones to calcareous sandstones of calciturbidite character. In Geravy the formation of dark shales and biomicritic limestones with spongolites can correspond to Late Liassic. A rare phenomenon in this area is the presence of basaltic volcanism, which occurs locally only (locality Geravy).

In Muránska planina localities the slope-basinal character of sediments can be defined since Lotharingian and it is probable that it lasted during Late Liassic as well. From total facial regime of Liassic in Silicicum we can state the distinctive trend of deepening – „pelagisation" of its area, which reached its maximum later, by the end of Middle Jurassic only.

At the beginning of Dogger (?Aalenian/Bajocian) the debris flow type olistostromes occurred (Bohúňovo formation), which had enigmatic origin. Although the material composition indicates its intra-Silicicum origin, but the location of the elevations (escarpment) in the basin itself is unknown. We could assume that the olistostromes reflect the tectonic activity in the Silicicum area itself due to starting subduction of the Meliaticum domain.

The Silicicum area reached the maximum deepening at the end of Bathonian/Callovian up to Oxfordian, when the deep wather, typically basinal deposition of non-calcareous radiolarites existed here. Despite of deep wather basinal conditions, the calciturbidites with thin layers of synsedimentary breccias (Bleskový Prameň) occurred, which clearly demonstrate dissection of the basin.

The Late Jurassic (Kimmeridgian), in case that it is preserved in situ (data of Kullmanová, 1963 from Geravy) or from the secondary occurrence (Mišík & Sýkora, 1980) is characterized by shallower although pelagic development. The latest Jurassic – Tithonian does not occur anywhere in situ in our territory. However it is known from secondary occurrences in facies of algal-Clypeina limestones (Mišík & Sýkora, 1980).

In Kimmeridgian era (about 153 Ma) there was closing followed by subduction of the Meliaticum oceanic domain (Malouski et al., 1993, Dalmayer et al., 1996, Rakús, 1996 and Faryad, 1997). This event was manifested in the Silicicum area by closing of the space, what caused the formation of the nappe structure with outward vergency (northward in the present-day co-ordinates). This situation is indicated also by tectonic superposition of Early Triassic on the radiolarites of Middle Jurassic, as it can be seen at locality Bleskový Prameň (Mello, 1996).

Facies of uppermost Jurassic – Tithonian, even they are known only from secondary occurrences in our area, were deposited in extremely shallow water environment. This points to great facial contrast between Dogger – Early Malm and Tithonian! This phenomenon cannot be explained by gradual shallowing of the Silicicum area. It seems that the only logic explanation of this facial contrast is development of the nappe structure from the rock complexes of the „Pre-Tithonian" Silicicum. The shallow-water Tithonian algal limestones should rest on this structure as the new and last Jurassic cycle that closes the sedimentary record in Silicicum area. With regard to the chronic missing of Early Cretaceous sediments in Silicicum we could think about it as the area without deposition in contrary to Hronicum, for instance, where the deposition lasted to Late Hauterivian. The new deposition cycle begins in Late Cretaceous – Senonian with lagoonal-marine sediments only.

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Explanations to photo-plates

Plate 1.

1, 2 Carbonate sedimentary breccia (debris flow) of Dogger. Clasts are formed by various varieties of crinoidal biomicrites, reddish-violet, red and grey colours. Clasts are poorly rounded, the matrix consists of grey to beige, more or less consolidated marlstone. Locality Bohúňovo. Gas transit pipeline.

3 Black radiolarite (lower part) with graded laminae and thin bed of carbonate sedimentary breccia (upper part). Locality Bleskový Prameň, ex situ, lgt. M. Havrila.

Plate 2

1 Grey-green crinoidal biomicrites with lithoclasts (intraclasts) of lighter - coloured varieties, which are replaced by darker layer with rounded lithoclasts of grey crinoidal biomicrites that „flow round" the dark claystones with light coloured laminae of biomicrites towards overlying parts. On this part the thin bed of black siliceous consolidated claystones (? silcretes) rests. Overlying them occurs the first bed of black radiolarite. Locality Bleskový Prameň, ?Bajocian, sample BP/10.

2,3 Types of the Dogger breccias (debris flow) with lithoclasts of light-grey biomicrite , fragments of megalodonts (me) and lithoclast of greyish-green radiolarite (ra). Matrix consists of grey calcareous claystone with transitions into clayey limestone. Locality Bleskový Prameň, ? Bajocian, sample 9a.

Plate 3

1 Red "Hierlatz-Adneth" limestones with irregular disseminated segments of crinoids (co = columnaria, ba = basalia), rostra of belemnites (= b ? Passaloteuthis sp.), ammonites (genera Phylloceras, Juraphyllites and ?Tropidoceras) and intraclasts with dark hematite coat. Locality Bleskový Prameň, Carixian, the sample position between BP/5 a BP/6, lgt. J. Mello.

2 Synsedimentary fold (size about 5 cm) in Dogger olistostrome. Locality Bleskový Prameň, ex situ, probably near the sample BP/9.

3 Lithoclasts of the greyish-green to dark-grey radiolarite in Dogger breccia (debris flow). Locality Bleskový Prameň, ex situ, sample BP/12 - 13.

Plate 4

1 Grey grainstone with bioclasts and intraclasts, lithoclast of Dachstein limestone (Late Triassic – Norian)) in basal parts of Liassic, locality Bleskový Prameň, sample BP/3, magnified 10 times.

2 Wackestone- red fine-grained limestone of Adneth type with fragmentary biodetritus of thin-walled lamellibranchiates, ammonites and spicules of silicisponges, Late Liassic – Middle Toarcian, Bifrons Zone, locality Bleskový Prameň, sample BP/6 (thin section 22 640), magnified 10 times.

3 Lithoclast of the grey limestone of Dogger olistostrome, wackestone / packstone with fine biodetritus of juvenile ammonites shells, foraminifers, segments of echinoderms, spicules of silicisponges and ostracods, Dogger, locality Bleskový Prameň, sample BP/9 (thin section 22 822), magnified 26 times.

4 Laminae of the graded bedded clastic limestone in radiolarite, Late Bathonian – Early Callovian, locality Bleskový Prameň, ex situ, (thin section 22 637), magnified 10 times.

Plate 5

1 Coarse-clastic limestone with lithoclasts of limestones and bioclasts mainly of crinoidal segments in the micrite matrix, Lias, locality Bleskový Prameň, (thin section 9405), magnified 7,7 times.

2 Lithoclast of Liassic limestone in the Dogger carbonate breccia – olistostrome, wackestone with spicules of silicisponges, fragments of lamellibranchiate shells and segments of echinodermats, locality Bleskový Prameň, sample BP/9, magnified 26 times.

3 Lithoclast of the radiolarite in the Dogger olistostrome, Dogger, locality Bleskový Prameň, ex situ, length of the line is 2 cm.

4 Unsorted clastic limestone with lithoclasts and bioclasts of various size in top part of the Dogger olistostrome, Dogger, locality Bleskový Prameň, sample BP/10, (thin section 22 679), magnified 7,7 times.

Plate 6

1 Adnet limestone, packstone with many fragments of lamellibranchiate shells, segments of echinodermates and juvenile ammonites, Late Liassic – Toarcian, locality Miglinc valley, (thin section 9414), magnified 26 times.

2 Wackestone with fragmentary detritus composed of ostracods and lamellibranchiate shells, segments of echinodermates, Late Liassic, locality Miglinc valley, (thin section 24 153), magnified 44 times.

3 Lenticle of siltstone (clastic quartz and mica) in the radiolarite, Dogger, locality Lúčka (thin section 23 476), magnified 44 times.

4 Bioclastic rudstone (filling of dike in the Dachstein limestone) contains shells of ammonites and segments of crinoids, in voids there are often geopetal structures (the picture is negative!), Middle Toarcian, (thin section 25259), magnified 5 times.

Plate 7

1 Bioclastic limestone – breccia with large limestones lithoclats, Dogger, locality Bohúňovo, gas transit pipeline, (thin section 22 737), magnified 7 times.

2 Claystone lithoclasts , limestones and bioclasts as part of olistostrome sediments, matrix is clayey-calcareous, Dogger, locality Bohúňovo, gas transit pipeline, (thin section 22 639), magnified 26 times.

3 Wackestone/packstone lithoclast with Liassic microfossils , also *Involutina liassica* in the Dogger olistostrome, locality Bohúňovo, gas transit pipeline, (thin section 22 732), magnified 26 times.

4 Liassic limestones lithoclast in the Dogger olistostrome, packstone with echinoderm segments, foraminifers, brachiopods and worm tubes, locality Bohúňovo, (thin section 22 729), magnified 26 times.

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Plate 8

1 Rudstone with rounded limestone lithoclasts, shells of thick-walled lamellibranchiates hydrozoans, segments of echinoderms, Liassic, locality northward of Pila near Hrabušice village, (thin section 22 644), magnified 7x times.
2 The Same thin section, magnified 26 times.
3 Wackestone with cross of gastropods, juvenile ammonite and crinoid segments, Middle Liassic – Carixian, locality northward of Muránska Huta near the elev. point 808,2m (thin section 22 638), magnified 26 times.
4 Packstone with foraminifers *Globuligerina* sp. *Lenticulina* sp. *Tetrataxis* sp, fragments of thin walled lamellibranchiate shells and segments of echinoderms, Middle Jurassic – Callovian, locality Geravy, sample G-1, magnified 26 times.

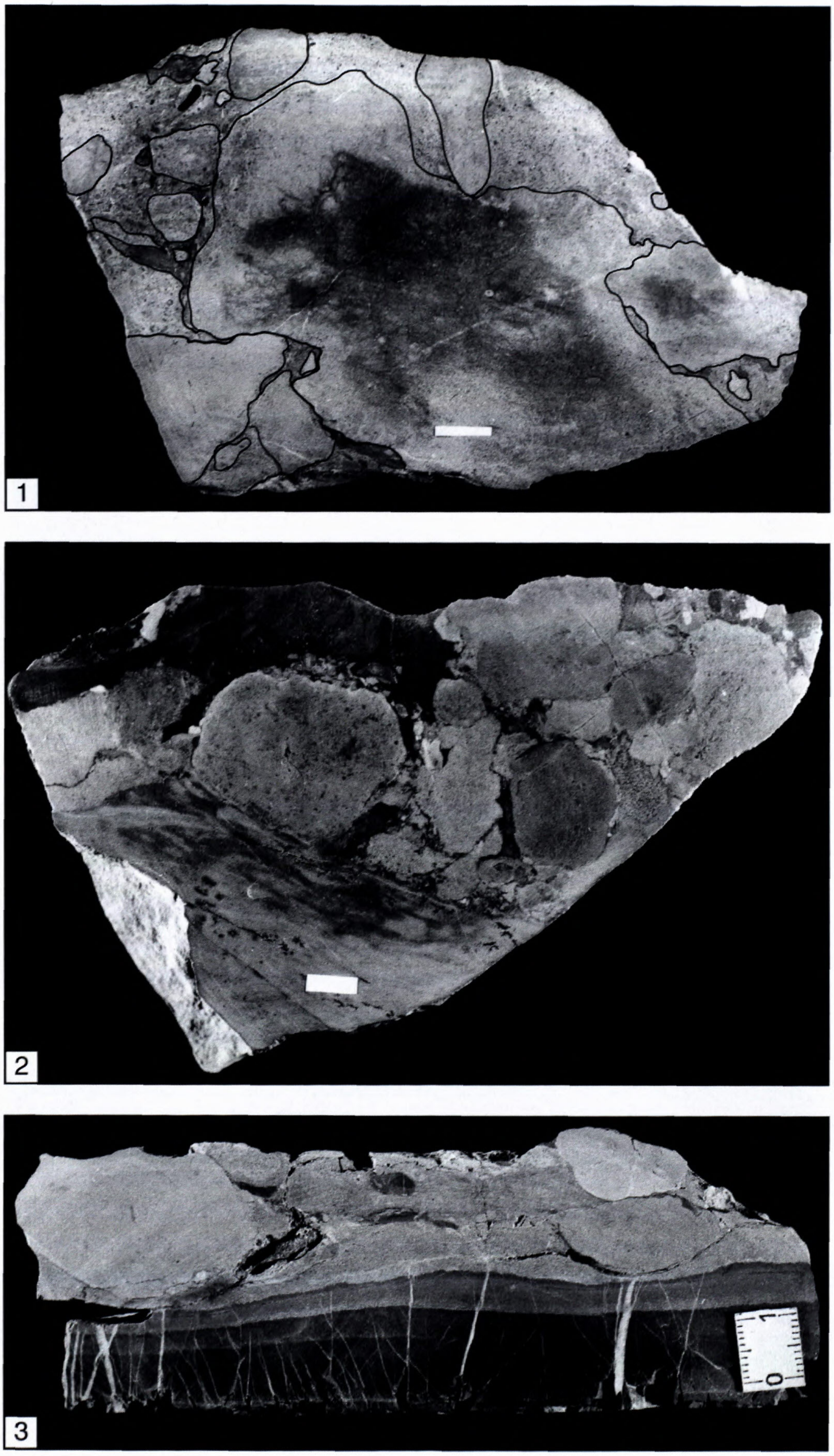
Plate 9

1 *Hildoceras sublevisoni* FUCINI, 1919, Middle Toarcian, Bifrons Zone, locality Bleskový Prameň, sample BP/6, slightly magnified.
2 *Hildoceras sublevisoni* FUCINI, 1919, part of the whorl of the immature specimen, Middle Toarcian, Bifrons Zone, locality Bleskový Prameň, sample BP/6, magnified 2 times.
3 *Hildoceras cf. lusitanicum* MEISTER, 1913, Middle Toarcian, Bifrons Zone , locality: the left-bank side of the Muráň river canyon, near the elev. point 222,0m, southward of Meliata village, magnified one time.
4 *Hildoceras* gr. *sublevisoni* FUCINI, 1919, Middle Toarcian, Bifrons Zone , locality: the left-bank side of the Muráň river canyon , near the elev. point 222,0m, southward of Meliata village, magnified one time.
5 ? *Pseudogrammoceras* sp., Middle Toarcian, Bifrons Zone, locality: the left-bank side of the Muráň river canyon , near the elev. point 222,0m, southward of Meliata village, magnified 0,5 times.
6 bottom part of calyx of crinoid with basalias, Middle Liassic, locality Bleskový Prameň, ex situ, natural size.

Plate 10

1 *Protogrammoceras* cf. *normanianum* (d'ORBIGNY, 1844), Middle Liassic, ? Late Carixian – Early Domerian, ex situ, locality northward of Muránska Huta, near the elev. point 808,2m, magnified 0,5 times.
2 *Protogrammoceras* gr. *isslei* FUCINI, 1900, Middle Liassic, ? Late Carixian – Early Domerian, ex situ, locality northern of Muránska Huta, near the elev. point 808,2m, magnified one time.
3 Bottom part of the crinoidal calyx with basalia and columnalia, Middle Liassic, locality Bleskový Prameň, ex situ, slightly magnified.
4 *Oxynoticeras* cf. *oxynotum* (QUENSTEDT, 1845), Lotharingian, Oxynotum Zone, locality northward of Muránska Huta, near the elev. point 808,2m, ex situ, slightly magnified.
5 *Androgynoceras* sp. juv., Middle Liassic, Carixian, locality Bleskový Prameň (text. - fig. 5), magnified 2,2 times.
6 *Hildoceras* cf. *sublevisoni* Fucini, 1919, Middle Toarcian, Bifrons Zone, locality Bleskový Prameň, sample BP/6, natural size.

The paper was worked out within the project „Geodynamic Development of the Western Carpathians" and the authors devote it in to the honour of RNDr. JÁN BYSTRICKÝ DrSc., excellent geologist and specialist of Mesozoic of the Western Carpathians.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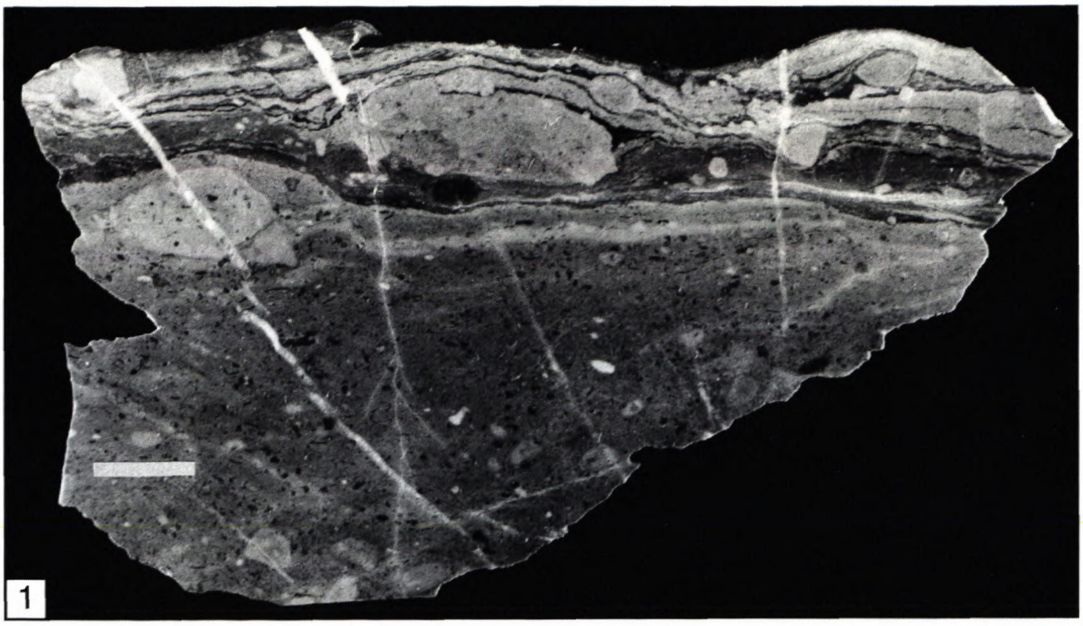

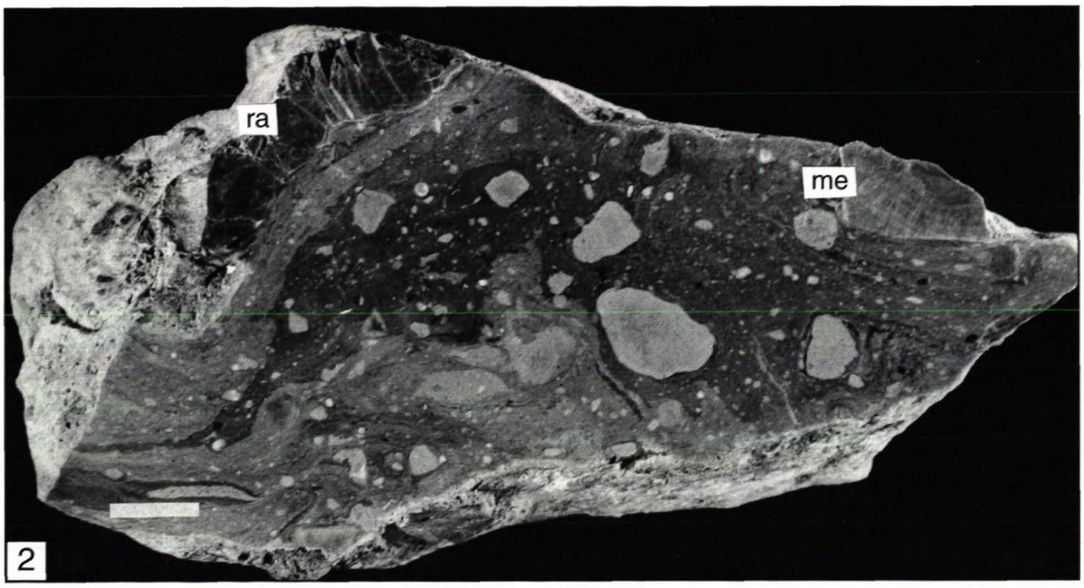

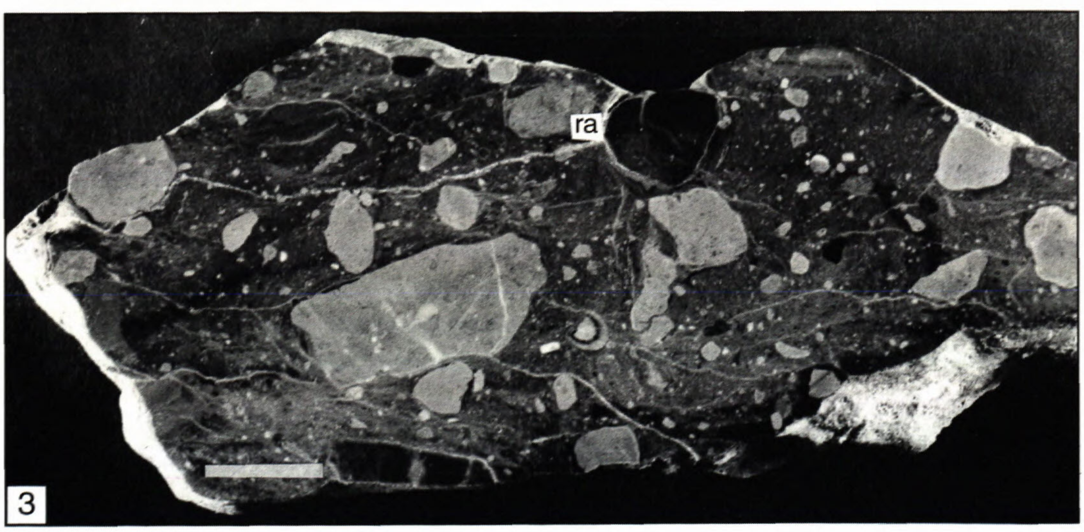

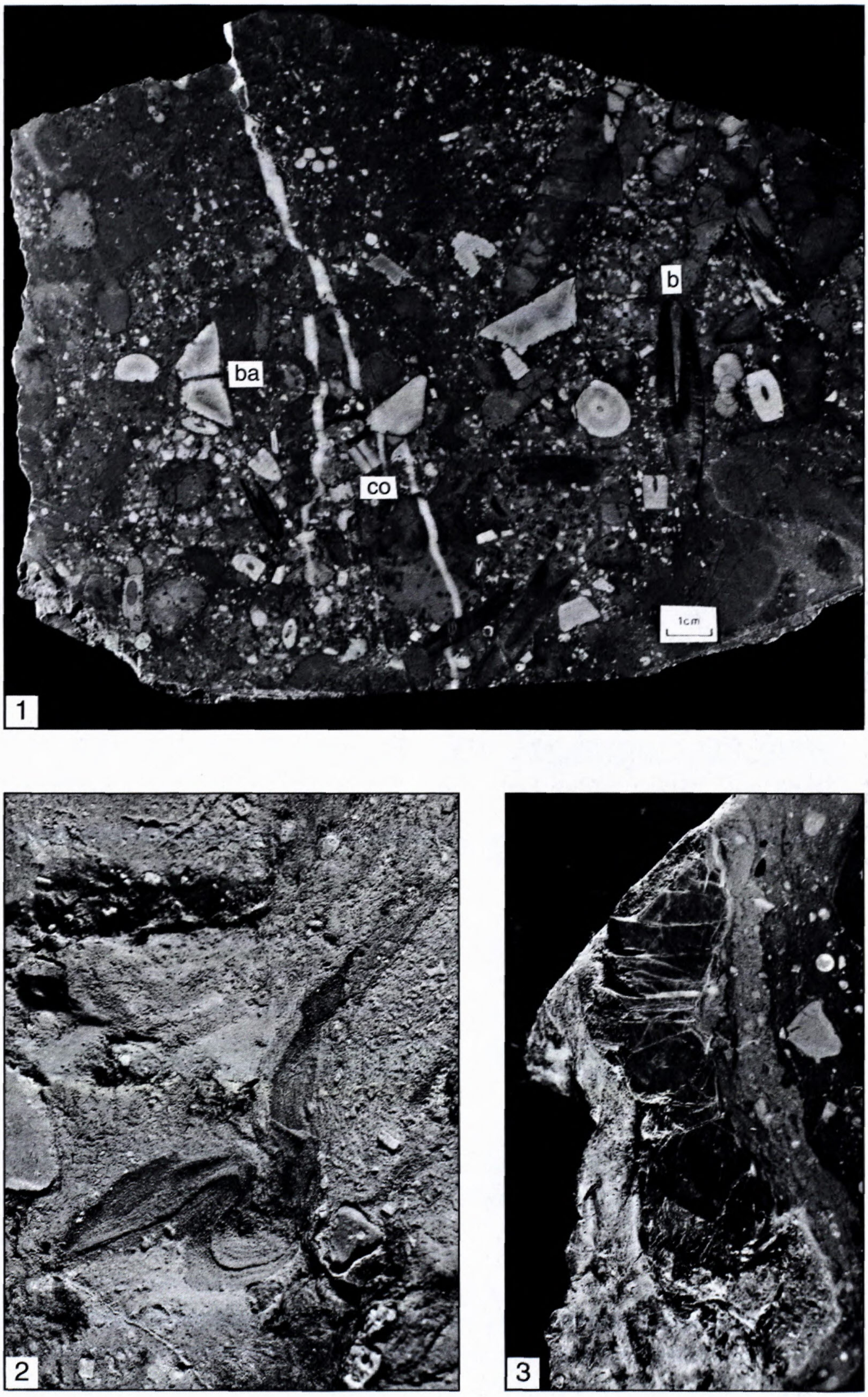
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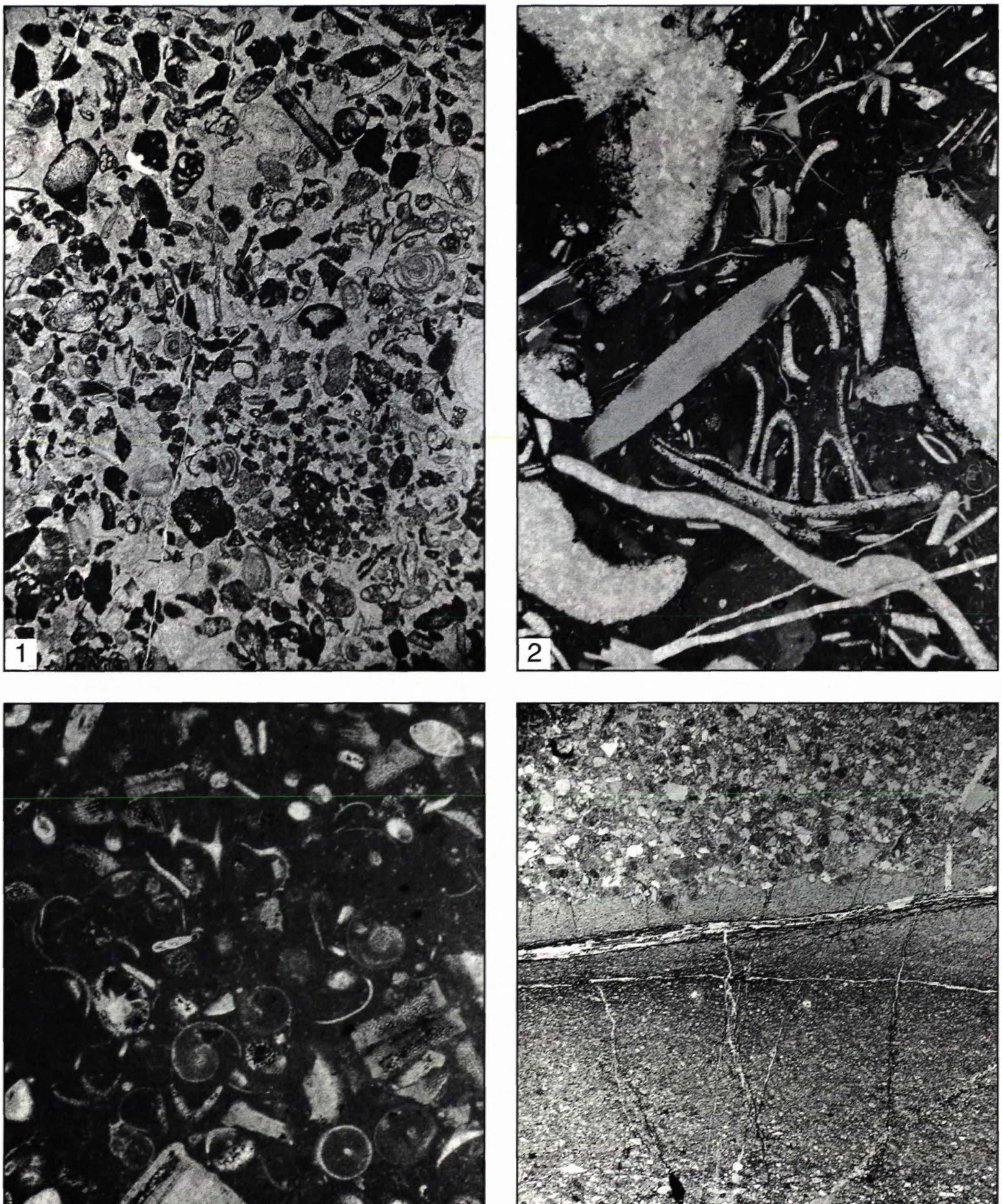

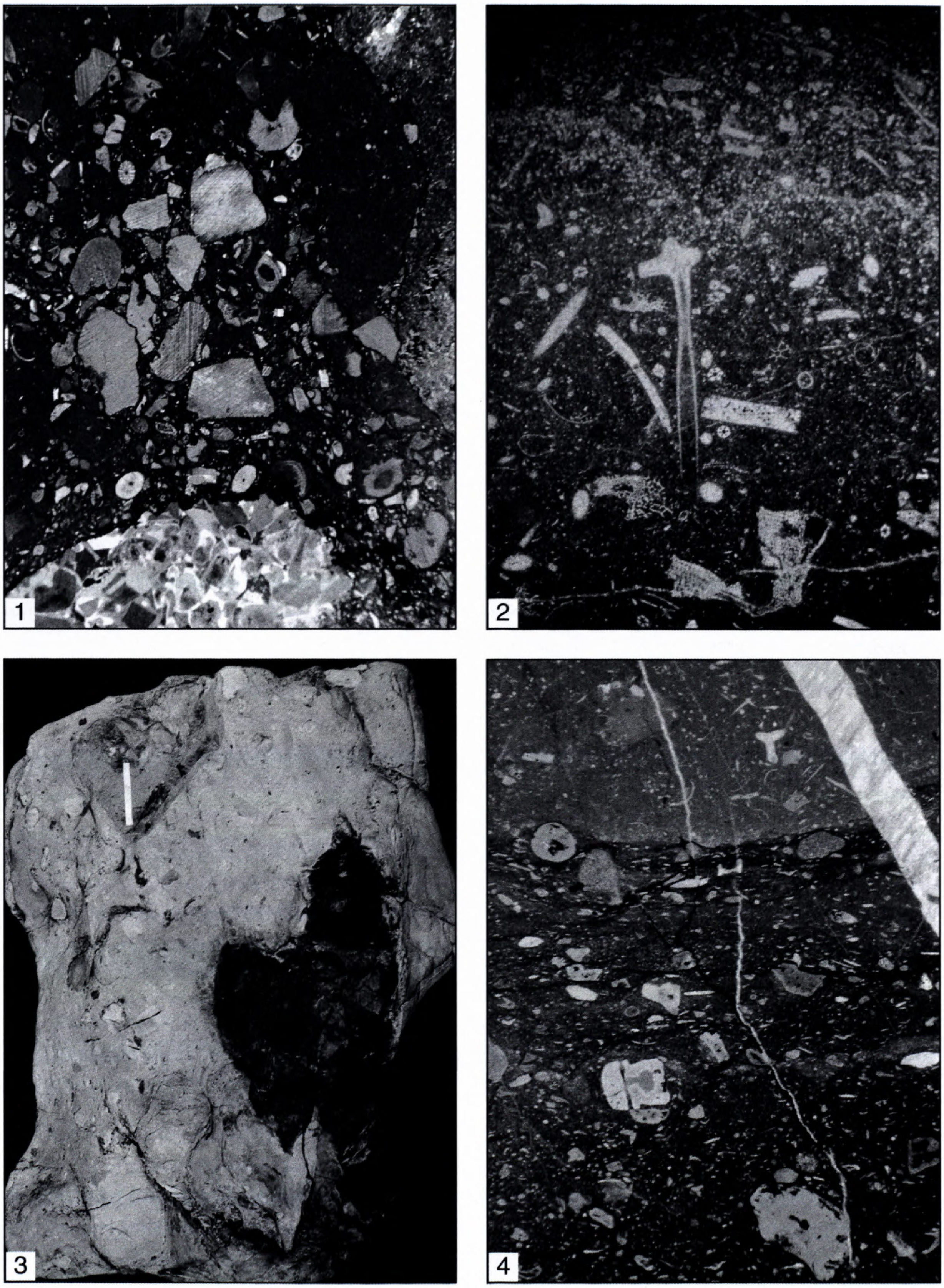
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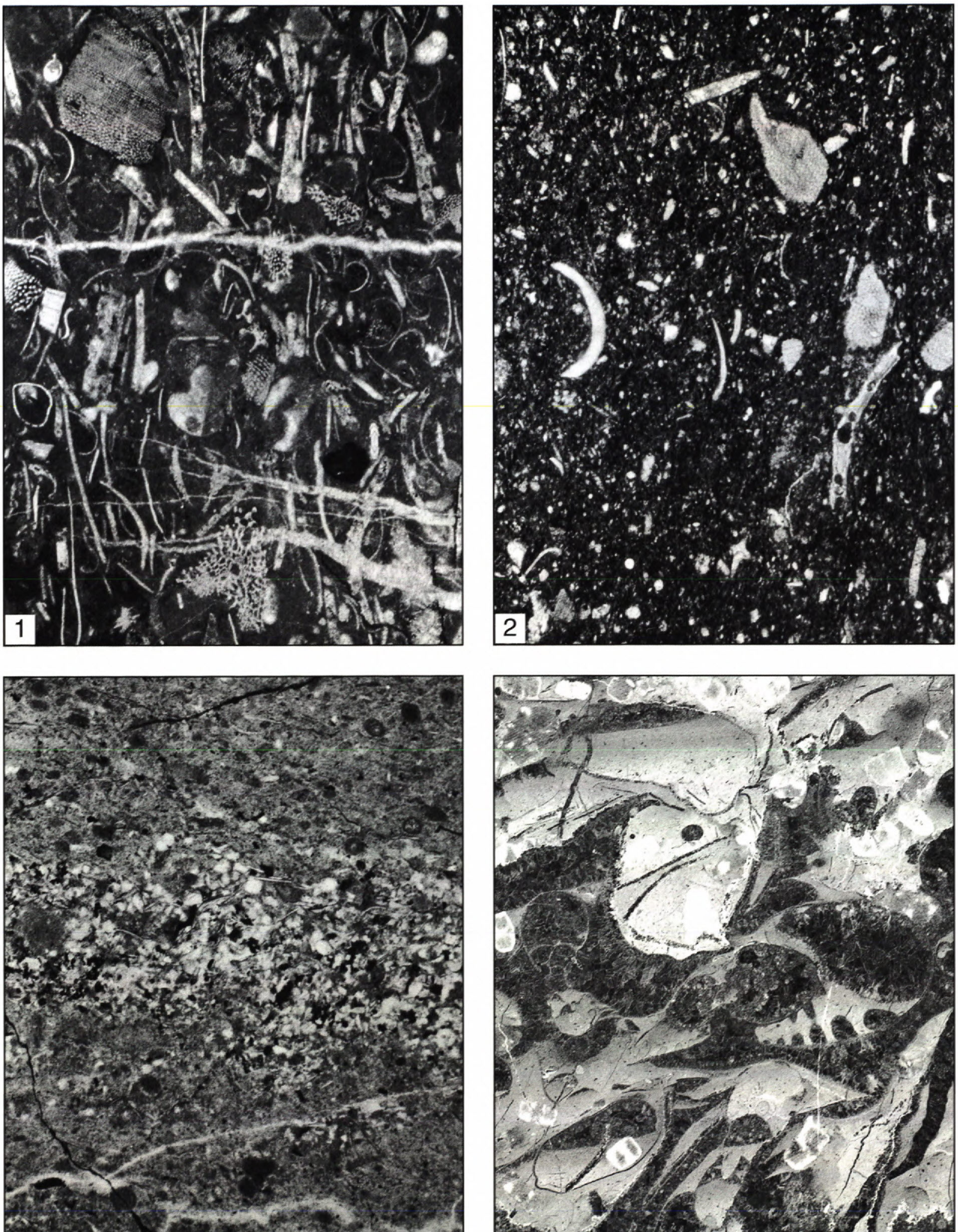
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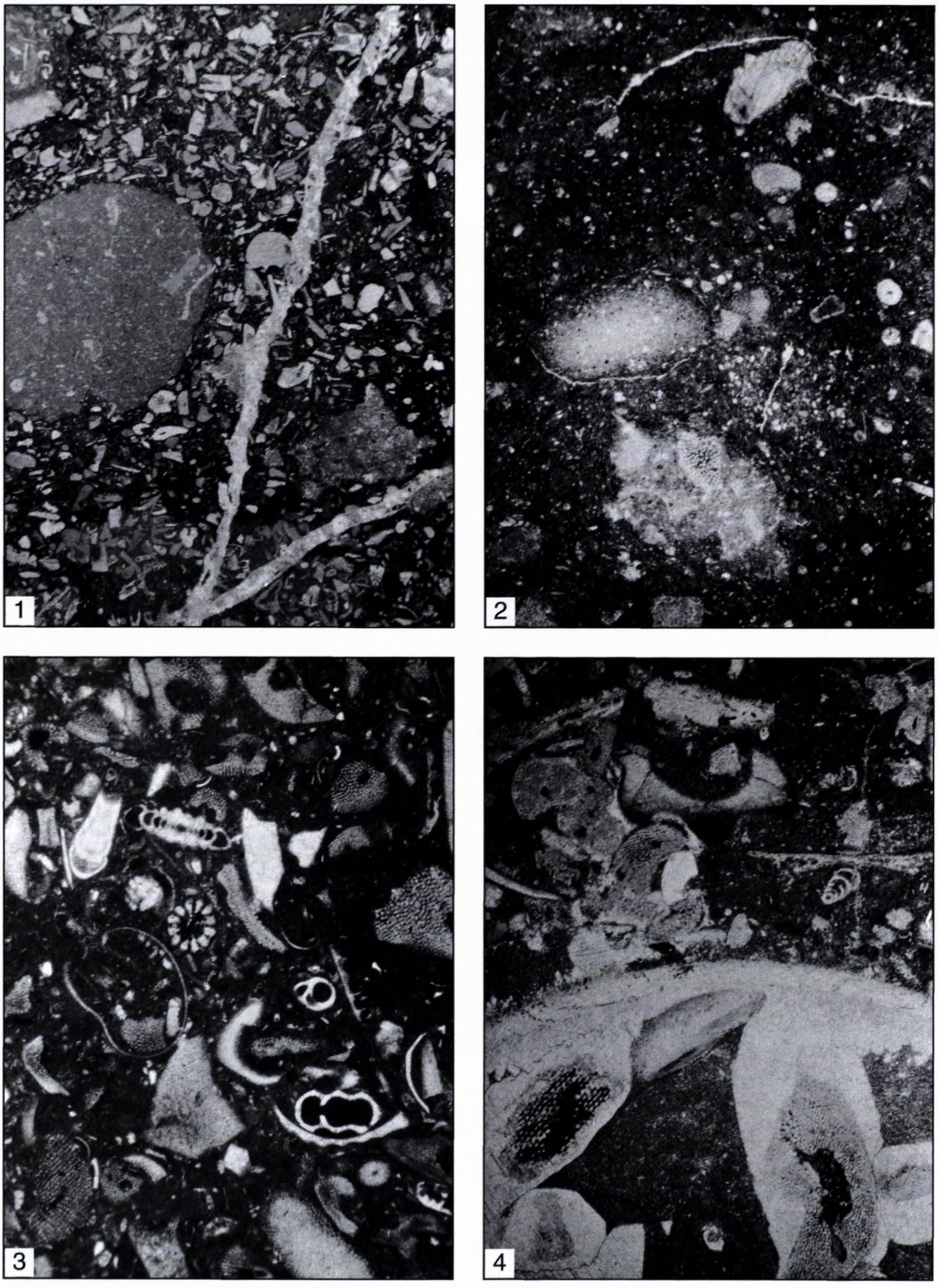
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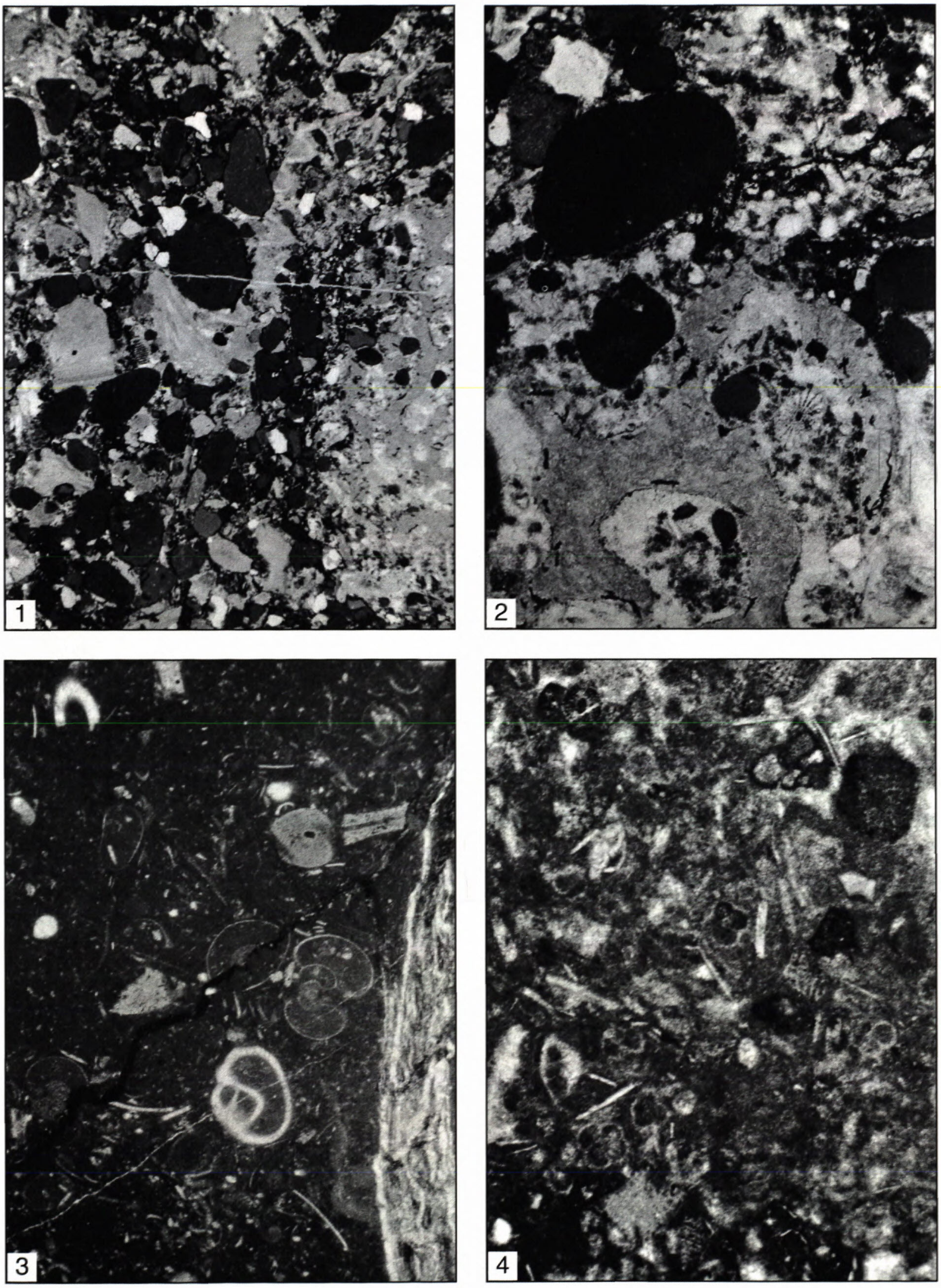

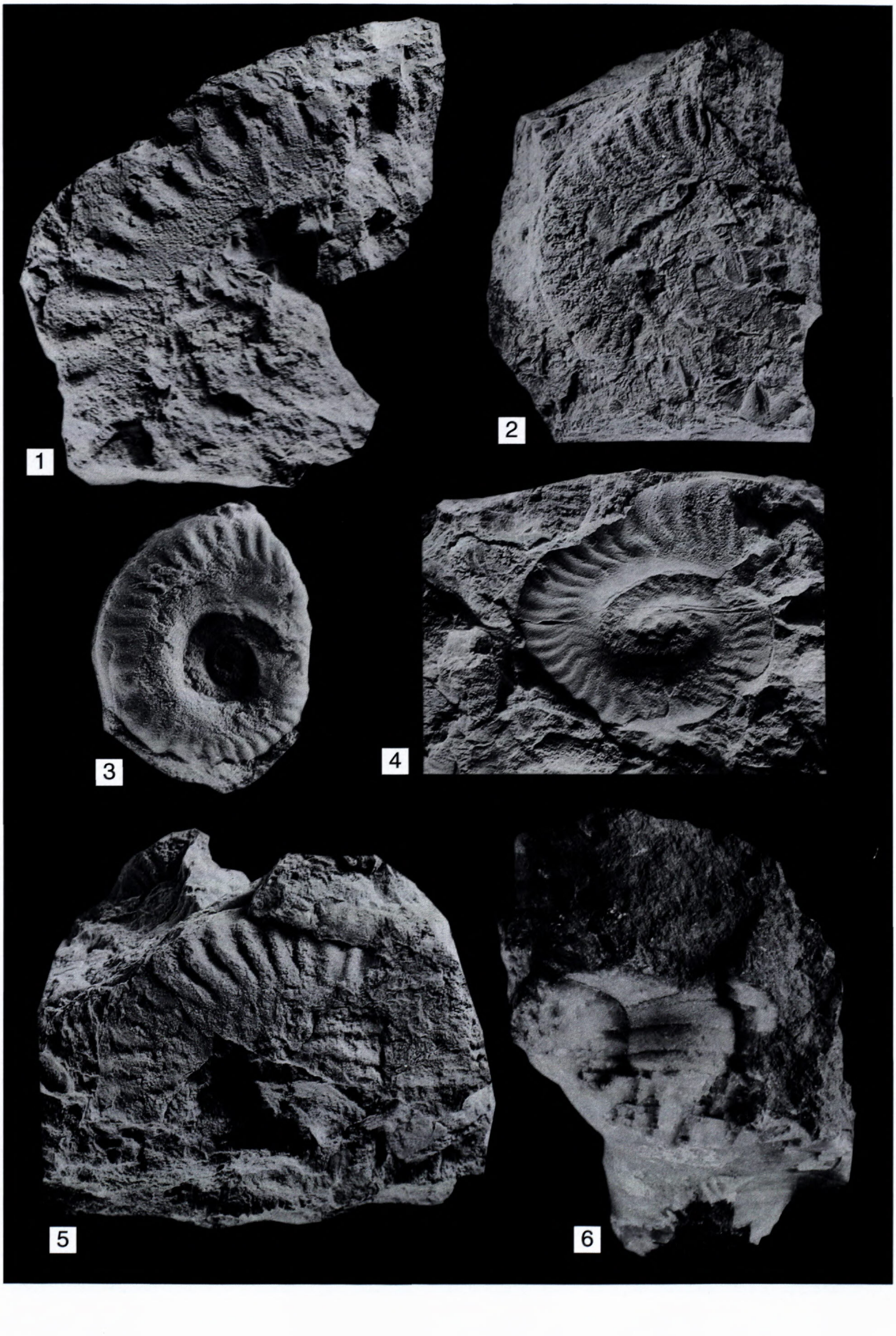
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