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# BIOSTRATINOMY AND SEDIMENTARY ENVIRONMENT OF THE ECHINODERM-SPONGE BIOSTROMES IN THE KARCHOWICE BEDS, MIDDLE TRIASSIC OF UPPER SILESIA

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Abstract: Echinoderm-sponge biostromes occur in the Karchowice Beds in the western part of Upper Silesia. The biostromes occur in pelitic limestones strongly burrowed by enteropneustans. Skeletal epifauna, represented mainly by hexactinellid sponges, crinoids and echinoids, accompanied by less numerous brachiopods, bivalves, gastropods and polychaetes, was living on marine shallows and formed small bioherms in the central parts of the biostromes. Sedimentation was strongly influenced by storms which destroyed the bioherms by covering them with sediments, and redistributed bioclastic material disintegrated earlier by microbial activity and dissolution. The material was sorted during the transport in this way that only carbonate mud was deposited in the low areas of the bottom between the biostromes. The mud was later colonized by enteropneustans. Episodic stroms decreased the sedimentation rate by removing carbonate mud and fine bioclastic fraction from the shallows. The narrow zone of bioherms, oriented NWW – SEE, was probably forming a barrier between a coastal lagoon to SSW and the open epicontinental sea to NNE. Coral bioherms are present inthis zone above the sponge bioherms, indicating the shallowing of the sedimentary basin.

Key words: Siliceous sponges, bioherms, biostromes, biostratinomy, Middle Triassic, Upper Silesia, southern Poland.
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## INTRODUCTION

Echinoderm-sponge biostromes were found at several places in the western part of Upper Silesia (Fig. 1):
– northern wall of quarry in Strzelce Opolskie,
– quarry in Tarnów Opolski,
– abandoned quarry in Szymiszów,
– eastern wall of abandoned quarry of basalt on the southern slope of the Góra Świętej Anny hill.

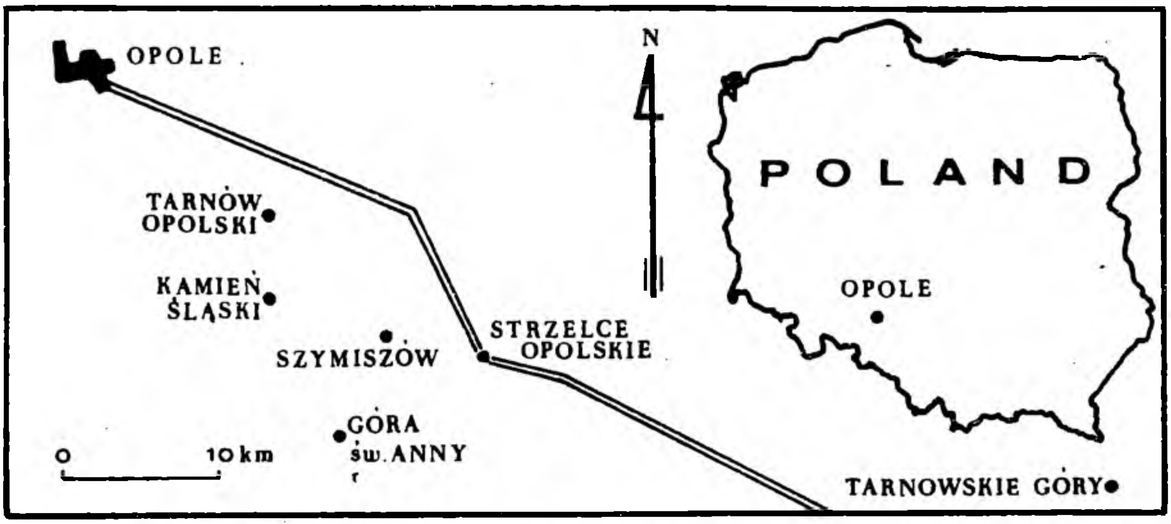


Fig. 1. Map showing localities with echinoderm-sponge biostromes

The biostromes probably occur also near Tarnowskie Góry from where sponges were described in old German papers (Eck, 1865; Assman, 1926; Rauff, 1937.

The biostromes occur in the middle and upper parts of the Karchowice Beds, the highest lithostratigraphic member of the Lower Muschelkalk in Upper Silesia, correlated with the Illyrian on the base of conodonts (Zawidzka, 1975; Table 1)

Table 1

Lithostratigraphical and chronostratigraphical units of the Middle Triassic in Upper Silesia Arrowed thick line marks stratigraphical interval in which occur echinoderm-sponge biostromes.

| Lithostratigraphical units | | | Chronostratigraphical units | |
|---|---|---|---|---|
| MUSCHELKALK | UPPER | Boruszowice Beds | FASSANIAN | MIDDLE TRIASSIC |
| | | Wilkowice Beds | | |
| | | Conglomerate of the Wilkowice Beds | | |
| | | Upper Tarnowice Beds | ILLYRIAN | |
| | | Lower Tarnowice Beds | | |
| | MID | Diplopora Dolomite | | |
| | LOWER | Karchowice Beds ← | | |
| | | Terebratula Beds | PELSONIAN | |
| | | Górażdże Beds | | |
| | | Gogolin Beds | LOWER ANISIAN | |

The biostromes occur as cream-yellow, locally dolomitized, silicified and strongly porous limestones with chert nodules (Fig. 2; Pl. I: 1). They form a characteristic lithostratigraphic horizon in the western part of Upper Silesia, so called the "Cidaris horizon" (Kotlicki, 1974).

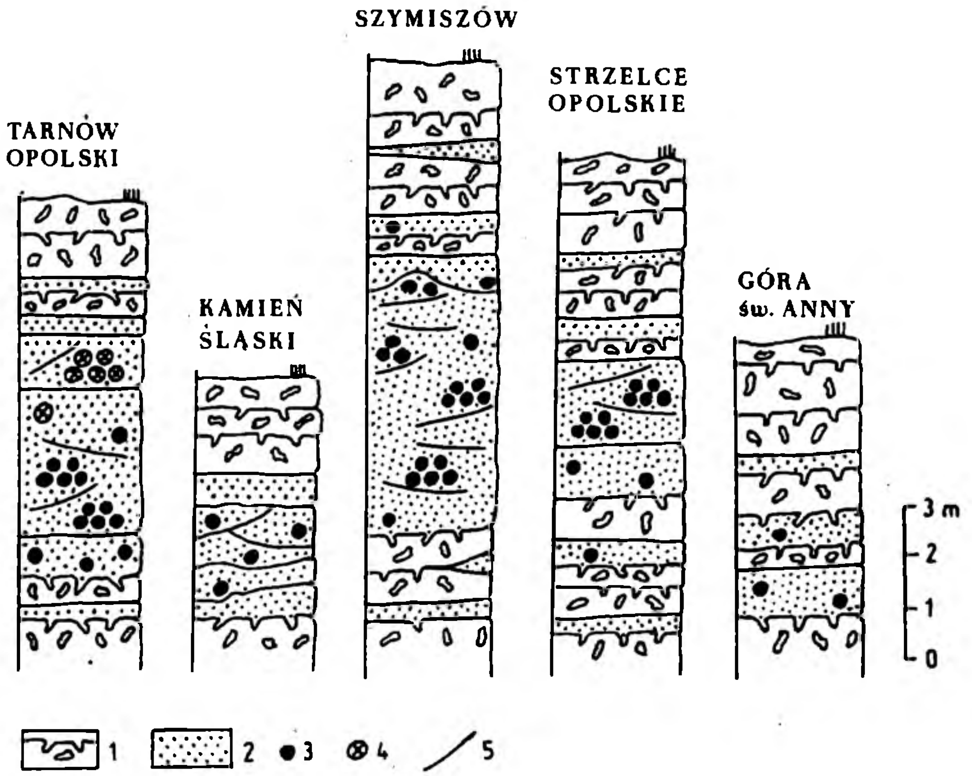


Fig. 2. Lithological columns of biostrome exposures. *1* — pelitic limestones strongly burrowed by enteropneustans; *2* — bioclastic limestones; *3* — sponges; *4* — corals; *5* — erosional surfaces

The main purpose of this paper is the reconstruction of sedimentary environment of the echinoderm-sponge biostromes. Biostratinomic approach was used for this purpose, mainly consisting in the classification and analysis of the accumulations of skeletal elements (Kidwell *et al.*, 1986; Bodzioch, 1986).

For more convenient reference to the old German literature, German synonims of the Polish geographical names, as used by Assman (1944), are given in Appendix 1.

## BIOSTRATINOMY

### TAXONOMICAL COMPOSITION

The described biostromes are polytypic (i.e. they comprise various skeletal elements of fauna) and at the same time polyspecific (i.e. the skeletal elements belong to different species). Echinoderm (mainly crinoid) fragments dominate, except for the central parts where hexactinellid sponges become dominant. The echinoderms and sponges are accompanied by subordinate brachiopods,

Table 2

Fauna of the echinoderm-sponge biostromes in the Karchowice Beds. Taxa are arranged in order of decreasing frequency. * incrusting organisms

1. Crinoidea:
   - *Entrochus silesiacus* Beyrich
   - *Encrinus aculeatus* Meyer
2. Echinoidea:
   - *Cidaris transversa* Meyer
   - *Cidaris longispina* Assmann
   - *Cidaris ecki* Assmann
3. Porifera:
   - *Tremadictyon roemeri* (Eck)
   - *Hexactinellida* sp.
4. Brachiopoda:
   - *Punctospirella fragilis* (Schlotheim)
   - *Hirsutella hirsuta* (Alberti)
   - *Mentzelia mentzeli* (Dunker)
   - *Decurtella decurtata* (Girard)
   - *Tetractinella trigonella* (Schlotheim)
   - *Waldheimia edlingeri* Assmann
   - *Coenothyris vulgaris* (Schlotheim)
5. Lamellibranchiata:
   - *Macrodon* sensu lato
   - *Lima* sensu lato
   - *Schafhautlia* sensu lato
   - *Prospondylus ernesti* Assmann
   - *Pleuromya* sensu lato
   - *Entolium discites* (Schlotheim)
   - *Pecten* sp.
   - *Placunopsis ostracina* Schlotheim*
6. Gastropoda:
   - *Trypanostylus* sensu lato
   - *Loxonema* sensu lato
7. Polychaeta:
   - *Serpûla schmischowiensis* Assmann*
   - *Salmacina incerta* Assmann*
   - *Spirorbis valvata* (Berger)*

bivalves, gastropods and polychaetes (Table 2). Epibionts (bivalves and polychaetes – marked with asterisks in Table 2) occur frequently on sponge walls and on shells. Moreover, small pores resembling algal and fungal borings, occur on shell surfaces.

## GEOMETRY

The biostromes are lens-shaped, up to 5 m thick and about 1.5–2 km in diameter as was estimated from a biostrome fragment exposed in Szymiszów.

They occur in pelitic limestones strongly burrowed by enteropneustans. A very complex internal structure of the biostromes is reflected in the vertical and horizontal differentiation of their biostratinomic characteristics.

## INTERNAL STRUCTURE OF BIOSTROMES

### Vertical differentiation of biostratinomic characteristics

In pelitic sediments beneath the biostromes, strongly burrowed by enteropneustans, the amount of skeletal elements is systematically increasing upwards. The concentration of faunal remains is greater within the biostromes, then it decreases to nearly zero at the biostrome tops and in the overlying layer. Moreover, bioclastic intercalations occur beneath and above the biostromes. They are thickening upwards beneath the biostromes, and thinning upwards above them (Fig. 3, explanation below).

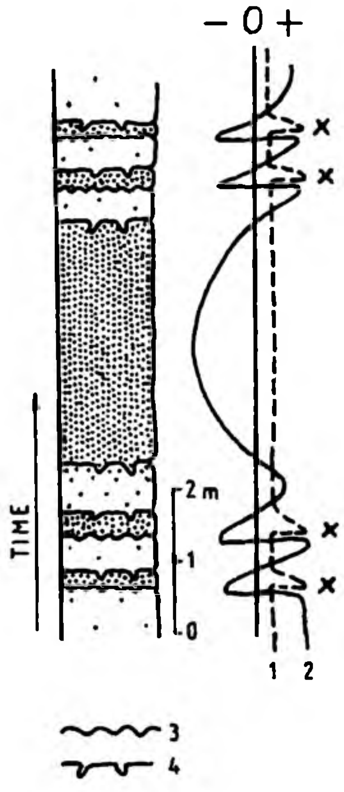


Fig. 3. Generalized section through biostrome, with sedimentological interpretation. *1* — rate of supply of skeletal elements; *2* — rate of supply of carbonate mud; *3* — erosional surfaces; *4* — enteropneustan burrows; *x* — episodes of rapid supply of skeletal elements during storms. Density of dots corresponds to concentration of faunal remains

The tops of most pelitic and bioclastic layers display numerous enteropneustan burrows (Pl. I:2). Erosional surfaces and large-scale cross-laminations are common within the biostromes (Pl. II: 1).

### Lateral differentiation of biostratinomic characteristics

The internal structure of biostromes is characterized by the distinction between the central parts built of sponge bioherms and peripheral parts (= bioherm taluses) built mainly of echinoderm and shell debris (Fig. 4).

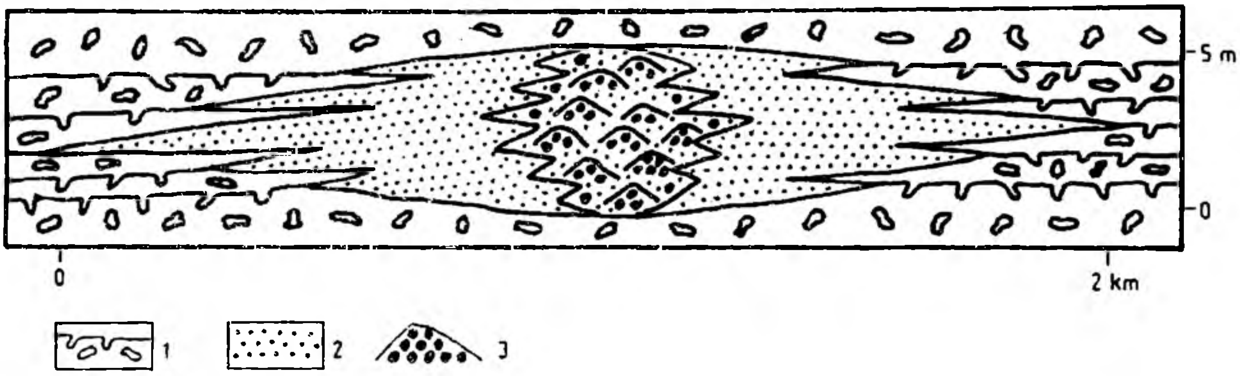


Fig. 4. Schematical cross-section through biostrome. *1* — pelitic limestones with enteropneustan burrows; *2* — bioherm talus, composed of echinoderm-sponge sediment; *3* — sponge bioherms

Small sponge bioherms, up to 1 m high and up to 3 m in diameter at base, are poorly visible in outcrops, due to the poor preservation of sponges. They are usually manifested as highly porous parts of the rock (Pl. II: 2). The pores are usually incompletely filled sponge paragasters, as may be easily ascertained by the presence of a wall (Pl. III; Pl. IV: 1), as well as loose hexactines and fragments of rigid skeleton (Pl. IV: 2).

The bioherms are irregularly distributed in echinoderm-shell sediment with numerous erosional surfaces (Fig. 5; Pl. II: 2) which can be traced horizontally for several hundred metres (Szymiszów).

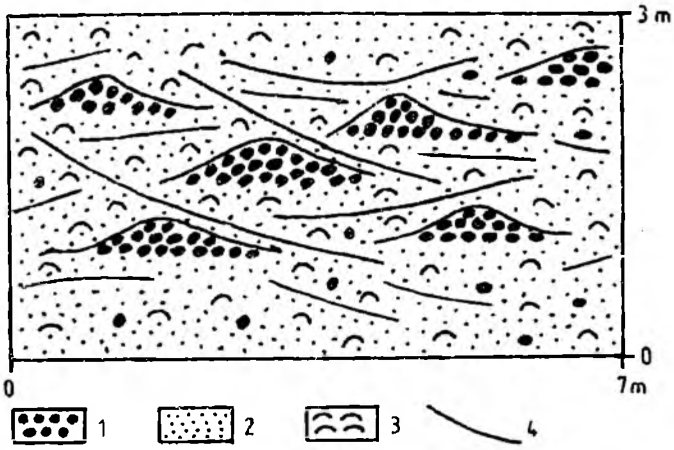


Fig. 5. Schematic drawing of a fragment of central part of biostrome. Szymiszów. *1* — sponge bioherms; *2* — echinoderm-shell sediment between bioherms; *3* — shells; *4* — erosional surfaces

The peripheral parts of biostromes consist of bioclastic limestone layers, only a few centimetres thick, embedded in pelitic limestone strongly burrowed by enteropneustans (Pl. IV: 3; Fig. 4).

## ORIENTATION

Most sponges within the bioherms are in life positions, while the remains of accompanying fauna are oriented chaotically. Within the talus, with increasing distance from the bioherms, the elongated skeletal elements are oriented more concordantly (i.e. parallel to stratification – see Kidwell, *et al.*, 1986) and shells become oriented convex side up.

## DISARTICULATION AND CRUSHING

The lowest degree of disarticulation and crushing of skeletal elements is observed within the sponge bioherms. It increases systematically with the increasing distance from the bioherms, so that in the peripheral parts of the biostromes there are almost exclusively disarticulated and crushed skeletal elements (Tables 3 and 4).

## SORTING

No evident shape or size sorting of bioclastic material has been observed in bioherms (Table 3). The sorting becomes better and better visible with the increasing distance from the bioherms and is expressed by: (1) rapid decrease in

Table 3

Biostratinomic features of bioherms

| Major taxa | Disarticulation [%] | Skeletal elements | Crushing [%] | Dominant orientation | Dimensions [cm] |
|---|---|---|---|---|---|
| Porifera | – | adults and fragments | roots only | life position | > 3 |
| Crinoidea | 100 | crowns | – | concordant | < 4 |
| | | columnals | – | concordant | < 5 |
| | | stems | – | no data | < 0.5 |
| | | roots | – | random | < 1 |
| | | other | – | random | < 1 |
| Echinoidea | 100 | interambulacral plates | 40 | no data | < 0.5 |
| | | spines | 5 | concordant | < 1 |
| Brachiopoda | 20 | adults | 5 | random | < 3 |
| | | shells | 30 | random | < 3 |
| Lamelli–branchiata | 70 | adults | 5 | random | < 4 |
| | | shells | 20 | random | < 4 |

$$\text{Disarticulation ratio} = \frac{\text{number of skeletal elements} \times 100}{\text{number of skeletal elements} + \text{adults}}$$

$$\text{Crushing ratio} = \frac{\text{number of crushed skeletal elements} \times 100}{\text{number of skeletal elements} + \text{adults}}$$

Table 4

Biostratinomic features of the peripheric parts of biostromes

| Major taxa | Disarticulation [%] | Skeletal elements | Crushing [%] | Dominant orientation | Dimensions [cm] |
|---|---|---|---|---|---|
| Porifera | – | – | – | – | – |
| Crinoidea | 100 | crowns | – | concordant | < 4 |
| | | columnals | – | concordant | < 2 |
| | | stems | – | no data | < 0.5 |
| | | roots | 100 | random | < 1 |
| | | other | – | random | < 0.5 |
| Echinoidea | 100 | interambulacral plates | 80 | no data | < 0.5 |
| | | spines | – | concordant | < 0.5 |
| Brachiopoda | 90 | adults | – | no data | < 0.5 |
| | | shells and fragments | 70 | convex-up | < 2 |
| Lamellibranchiata | 100 | shells and fragments | 70 | convex-up | < 2 |

Disarticulation and crushing ratios as in Table 3.

number of sponges, completely preserved brachiopods and bivalves, and larger fragments of crinoids; (2) fining of the bioclastic fraction, so that the peripheral parts of the biostromes are dominated by debris of echinoderms and shells, finer than 5 mm (Table 4).

## OTHER FEATURES

The fabric of skeletal elements is usually bioclastic supported, i.e. individual skeletal fragments are in contact with one another.

No abrasion of skeletal elements was observed. Even very fine appendages on echinoid spines are completely preserved.

Macroscopic identification of sponges is rather difficult due to almost complete obliteration of their original structure. Silicification of sponges together with the surrounding sediment is commonly observed (Pl. IV: 1), as well as sponge fragments preserved in siliceous nodules (Pl. IV: 4). These features indicate, in the author's opinion, that the loss of original structure occurred due to dissolution and removal of silica which was building the sponge skeletons (Fig. 6) during the early diagenesis.

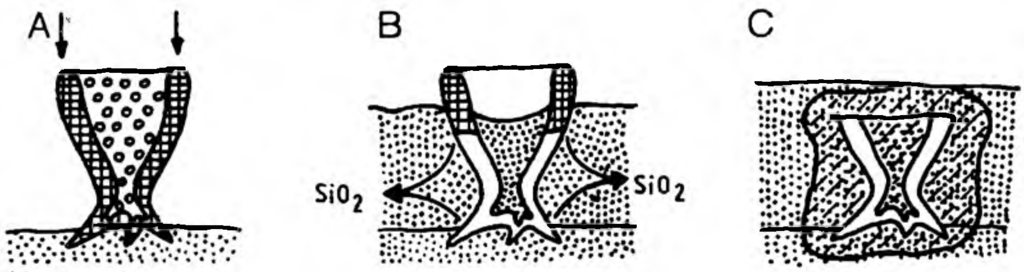


Fig. 6. Silicification of sedimental around sponges. *A* — filling of intraskeletal space with carbonate mud; *B* — burial of sponge with bioclastic sediment, dissolution and removal of silica; *C* — pelitic mummification within silicified sediment

## DISCUSSION

The vertical sequence of biostratinomical features may be well compared with the model of fossil accumulation proposed by Kidwell (1986). The increase in number of skeletal elements may be explained as the result of the decrease in the rate of carbonate mud deposition relative to the supply rate of skeletal elements (Johnson, 1960). The enteropneustan burrows indicate that the bed tops were firm surfaces of sedimentation discontinuities (*cf.* Kaźmierczak and Pszczółkowski, 1968, 1969) which could also be the result of the decrease in the rate of carbonate mud deposition. Breaks in sedimentation are also suggested by the traces of encrusting and boring organisms (e.g. Driscoll, 1970; Warme, 1975). A strong decrease in the sedimentation rate, even to the negative values indicated by the presence of the erosional surfaces may be thus considered the main cause of the biostrome growth.

The erosional surfaces and large-scale cross- laminations, mentioned above, indicate high energy of environment. The degree of disarticulation and crushing is not a certain criterion in this case, because the encrusting and boring organisms contribute to the breakdown of faunal remains. However, the lack of abrasion suggests a rather low degree of bottom water turbulence, insufficient for sediment movement. These apparently contradictional observations may be explained by accepting that the episodes of increased energy of environment were relatively short. The same is suggested by the lateral differentiation of biostratinomic characteristics (Fig. 7). The most important characteristic with this respect is the fining of the bioclastic fraction from the central parts of the biostromes outwards, reflecting the decrease in the energy of environment. The increase in the degree of disarticulation and crushing is here dependent on the grain-size only (the lower the energy — the lower the grain-size, and consequently — the higher the number of fragmented skeletal elements). The source of bioclasts were the bioherms in the central parts of biostromes. The listed features, as well as the high concentration of skeletal elements in the areas occupied by bioherms, indicate that bioclasts and the carbonate mud were being removed from the areas of bioherms outwards and

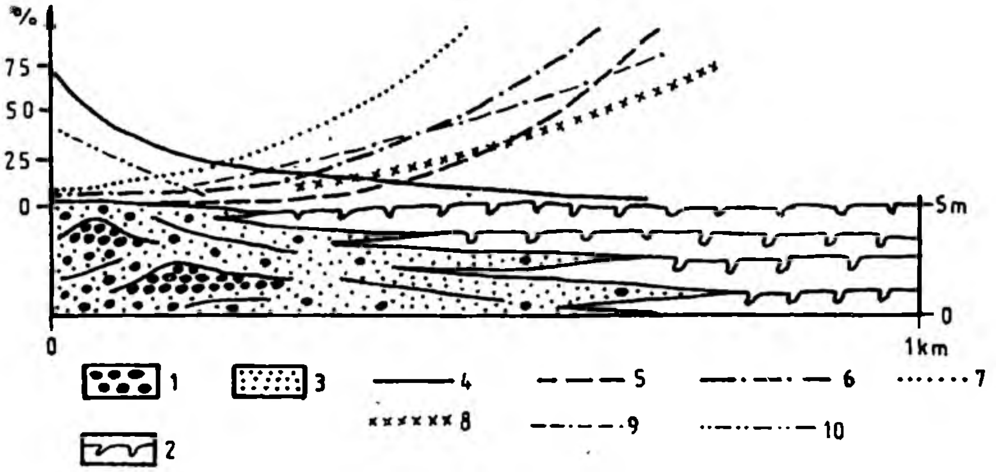


Fig. 7. Lateral variation of biostratinomic characteristics of biostromes. *1* — sponges; *2* — pelitic sediment with enteropneustan burrows; *3* — echinoderm-shell material; *4* — percentage of sponges; *5* — percentage of skeletal elements smaller than 0.5 cm; *6* — percentage of disarticulated shells; *7* — percentage of crushed skeletal elements; *8* — percentage of shells lying convex side up; *9* — percentage of concordantly arranged skeletal elements; *10* — number of sponges in life position

that they were sorted during the transport. The removal occurred episodically in conditions of increased energy of environment, as is indicated by the presence of bioclastic intercalations in the pelitic sediments.

Such short episodes of increase in energy of environment, resulting in erosion of substratum, transport and selection of sediment in shallow-water environments are related mainly to storms (Aigner, 1985, and references therein). The lateral variability of biostratinomic features, discussed above, indicates that the increase in the energy of environment during the storms was greatest in the areas occupied by bioherms, so the bioherms may be envisaged as local bottom highs.

It may be concluded that the described biostromes were formed in conditions of strong decrease in the rate of deposition due to removal of carbonate mud and fine bioclastic fraction during storms. The bioclastic material was supplied from the bioherms. Hence, the discussed deposits are a kind of tempestite condensation horizon, much alike the crinoid-shell and placunopsis bioherms in SW Germany (*cf.* Hagdorn, 1978, 1982).

## INTERPRETATION

A model presenting the evolution of the described echinoderm-sponge biostromes is shown in Fig. 8. It includes the following stages:

A — Skeletal epifauna is growing on shallows situated probably beneath the mean wave-base.

B — During storms the wave-base reached the bottom on the shallows, disturbing the surface sediment, burying the bioherms and forming suspension of chaotically mixed skeletal elements and carbonate mud. Waves and local

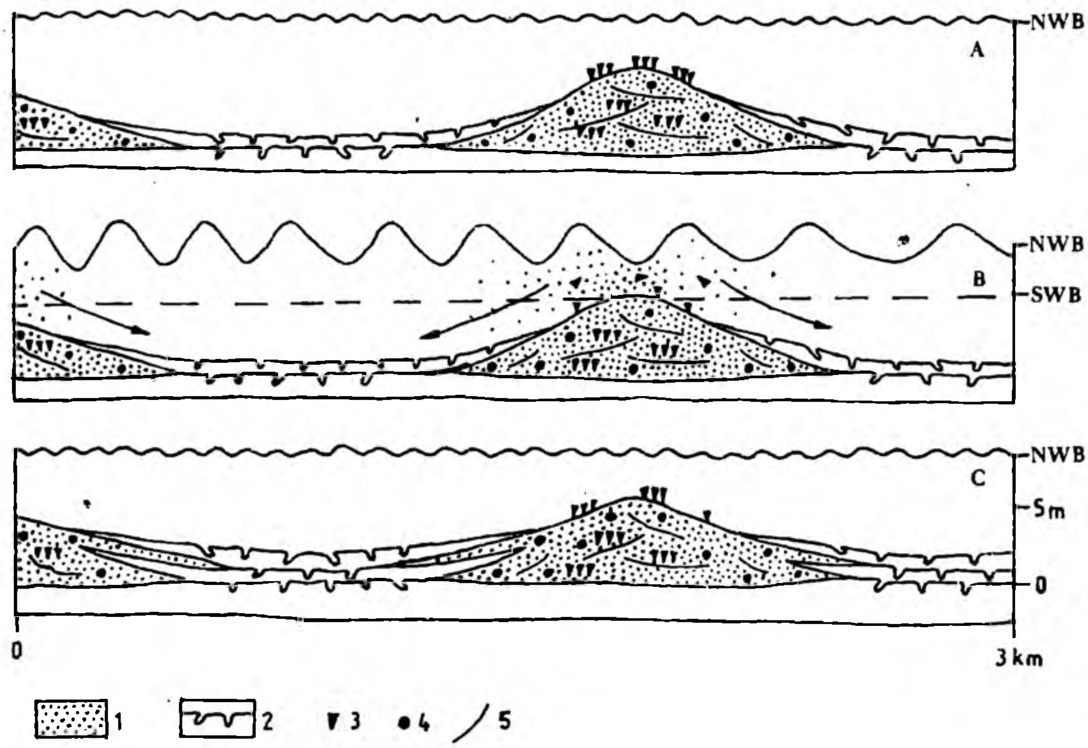


Fig. 8. Model of biostrome evolution (explanation in text). *1* — biolastic material; *2* — pelitic sediment with enteropneustan burrows, separating biostromes; *3* — sponges in life position (bioherms); *4* — sponges in other positions; *5* — erosional surfaces; *NWB* — normal wave base; *SWB* — storm wave base

storm currents redistributed and sorted the suspension during the transport (with increasing distance from the shallows, the amount and size of transported bioclasts was decreasing). In consequence, only carbonate mud was deposited in the low areas of the bottom, between the biostromes.

C — After cessation of a storm, the bioherms revived on the hard, coarse-grained substrate of the shoals. The first settlers were larvae which survived due to their planktonic mode of life. Pelitic sediment laid down in the low areas of the bottom was colonized by soft-bodied infauna, mainly enteropneustans.

## PALAEOGEOGRAPHICAL REMARKS

A very interesting phenomenon is the presence of coral bioherms, described by Morycowa (1974), above the described biostromes in the vicinities of Kamień Śląski, Tarnów Opolski and, as may be inferred from old German papers, Tarnowskie Góry. This phenomenon, analogous to those similar widely known from the Upper Jurassic strata of Europe (Gwinner, 1976), indicates in the author's opinion the shallowing of the sedimentary basin, and it was apparently related to the tectonic remake whose end result was the closure of the Silesian-Moravian Gate shortly after the end of the Karchowice Beds deposition (*cf.* Senkowiczowa, 1962).

The sponge bioherms, together with the coral bioherms above them, form a narrow zone extending in the NWW–SEE direction between Tarnów Opolski and Tarnowskie Góry. The facies of the Karchowice Beds south of this zone are not known, because of their complete removal by erosion. As for the areas situated to the north, the borehole data permit one to suppose (Kłapciński, 1959; Kotlicki, 1968; Senkowiczowa *et al.*, 1975; Pawłowska, 1985) that the sponge-coral facies disappears rapidly and is laterally substituted by deposits of somewhat deeper sea. This indicates that the described biostromes formed a shallow barrier between a coastal lagoon on the south and the open sea on the north (see Fig. 9).

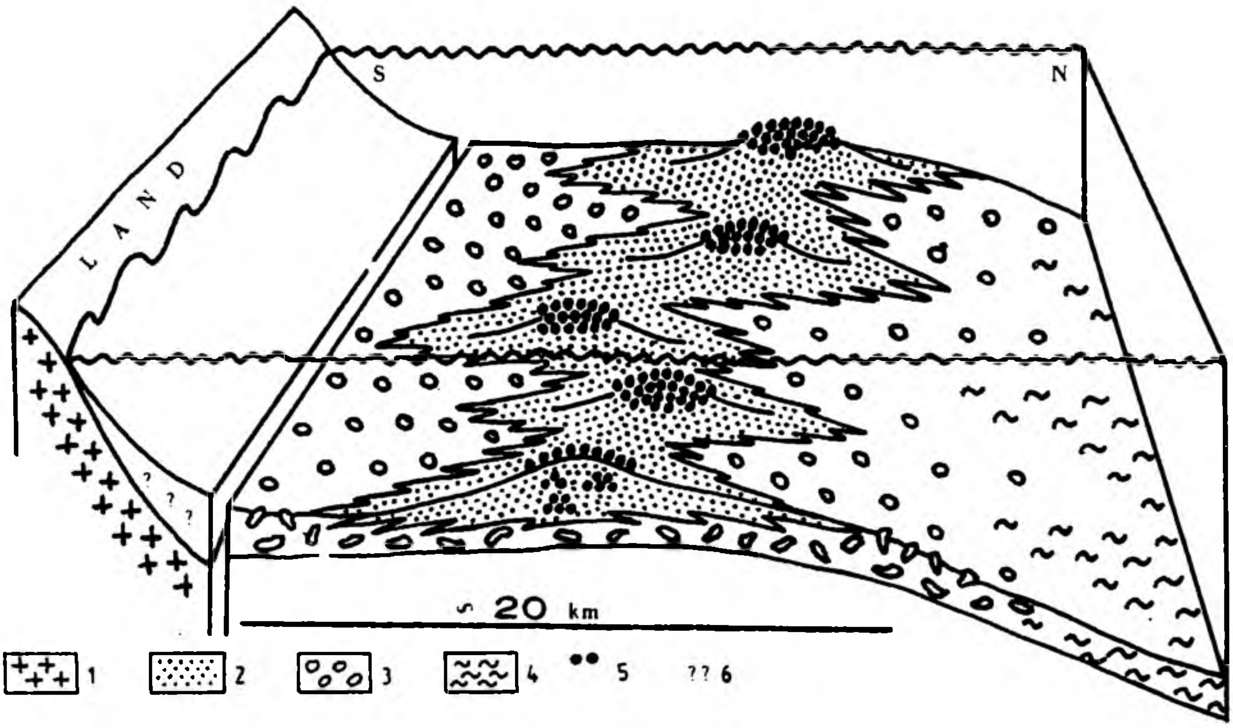


Fig. 9. Palaeogeographical model of Karchowice Beds sedimentation. *1* — pre-Triassic basement; *2* — echinoderm-sponge barrier facies, passing upwards to echinoderm-coral facies; *3* — lagoonal facies, pelitic limestone with enteropneustan burrows and bioclastic intercalations; *4* — facies of open epicontinental sea, limestone; *5* — sponge bioherms; *6* — unknown facies of the Triassic

## CONCLUSIONS

1. Echinoderm-sponge biostromes from the Karchowice Beds of the western part of Upper Silesia were formed in conditions of strong decrease in sedimentation rate which was due to a shallowing of sedimentary basin.

2. The fauna that built the bioherms which supplied bioclastic material was dwelling on shallows which probably formed a barrier between the coastal lagoon and the open epicontinental sea.

3. Storms played important role in the biostrome formation; they resulted in the death of bioherms buried with sediment and in the redistribution of the bioclastic material.

4. Siliceous sponges that built the bioherms were growing at depths of a few to not more than a hundred metres, within the reach of storm waves.

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## Streszczenie

# BIOSTRATINOMIA I ŚRODOWISKO SEDYMENTACJI BIOSTROM SZKARŁUPNIOWO-GĄBKOWYCH Z WARSTW KARCHOWICKICH (ŚRODKOWY TRIAS) GÓRNEGO ŚLĄSKA

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W zachodniej części Górnego Śląska (Fig. 1) znaleziono biostromy szkarłupniowo-gąbkowe (Pl. I: 1), występujące w obrębie warstw karchowickich (Tab. 1; Fig. 2). Biostromy tworzą soczewy o średnicy około 1,5–2 km i miąższości do 5 m (Fig. 4), rozmieszczone w obrębie wapieni pelitycznych przepełnionych kanałami po jelitodysznych (Pl. I: 2).

W biostromach dominują elementy szkieletowe liliowców i gąbek krzemionkowych, którym towarzyszą jeżowce, ramienionogi, małże, ślimaki i wieloszczety (Tab. 2).

W profilach pionowych obserwuje się stopniowy wzrost zawartości elementów szkieletowych oraz liczby i miąższości wkładek bioklastycznych, co zinterpretowano jako spadek tempa sedymentacji (Fig. 3), wywołany czynnikami hydrodynamicznymi, na co wskazują liczne rozmycia erozyjne i warstwowania przekątne (Pl. II: 1).

Centralne partie biostrom wykształcone są w postaci bioherm gąbkowych (Pl. II: 2; Fig. 5), zbudowanych przez przedstawicieli rzędu Dictyida (Pl. III; Pl. IV: 1,2). Gąbki te są często trudne do identyfikacji z powodu utraty pierwotnej struktury wskutek rozpuszczania i usuwania krzemionki budującej ich szkielety (Fig. 6; Pl. IV: 4).

W miarę oddalania się od bioherm następuje spadek liczby gąbek, drobnienie frakcji bioklastycznej, zmiana ułożenia elementów szkieletowych z bezładnego na konkordantne (zgodne z uławiceniem), wzrost stopnia dysartykulacji i pokruszenia muszli oraz dominacja muszli ułożonych wypukłą stroną ku górze (Tab. 3, 4). Peryferyjne części biostrom wykształcone są jako cienkie wkładki bioklastyczne w obrębie wapieni pelitycznych przepełnionych kanałami jelitodysznych (Pl. IV:3).

Wszystkie te cechy, podsumowane na Fig. 7, wskazują, że biostromy tworzyły się w sposób przedstawiony na Fig. 8: szkieletowa epifauna rozwijała się na mieliznach, w zasięgu oddziaływania falowania sztormowego; podczas sztormów następowało niszczenie bioherm wskutek zasypania osadem oraz dystrybucja materiału bioklastycznego, podczas której ulegał on selekcji, tak że w obszarach pomiędzy biostromami deponowany był głównie muł wapienny, kolonizowany później przez bezszkieletową infaunę.

Opisane biostromy ograniczone są do wąskiej strefy o kierunku NWW–SEE; stanowiły one najprawdopodobniej barierę pomiędzy przybrzeżną laguną i otwartym morzem epikontynentalnym (Fig. 9), na co wskazuje także pojawienie się w ich górnej części bioherm koralowcowych.

Appendix 1

## GERMAN SYNONYMS OF POLISH STRATIGRAPHICAL AND GEOGRAPHICAL NAMES USED

| Polish names in English translation | German synonyms |
|---|---|
| Gogolin Beds | Gogoliner Schichten |
| Górażdże Beds | Gorasdzer Schichten |
| Terebratula Beds | Terebratelschichten |
| Karchowice Beds | Karchowitzer Schichten |
| Diplopora Dolomite | Diploporendolomit |
| Tarnowice Beds | Alt Tarnowitzer Schichten |
| Conglomerate of the Wilkowice Beds | Gross Wilkowitzer Konglomerat-Schichten |
| Wilkowice Beds | Georgendorfer Schichten |
| Boruszowice Beds | Boruschowitzer Mergelschiefer |
| Opole | Oppeln |
| Tarnów Opolski | Tarnau |
| Kamień Śląski | Gross Stein |
| Szymiszów | Schimischow |
| Góra Św. Anny | Annaberg |
| Strzelce Opolskie | Gross Strehlitz |
| Tarnowskie Góry | Tarnowitz |

## EXPLANATIONS OF PLATES

### Plate I

1 — Fragment of enchinoderm-sponge biostrome. At bottom, strongly burrowed pelitic sediment (lighter spots) mixed with bioclastic material (dark spots). Strzelce Opolskie
2 — Enteropneustan burrows on top of pelitic layer. Szymiszów

### Plate II

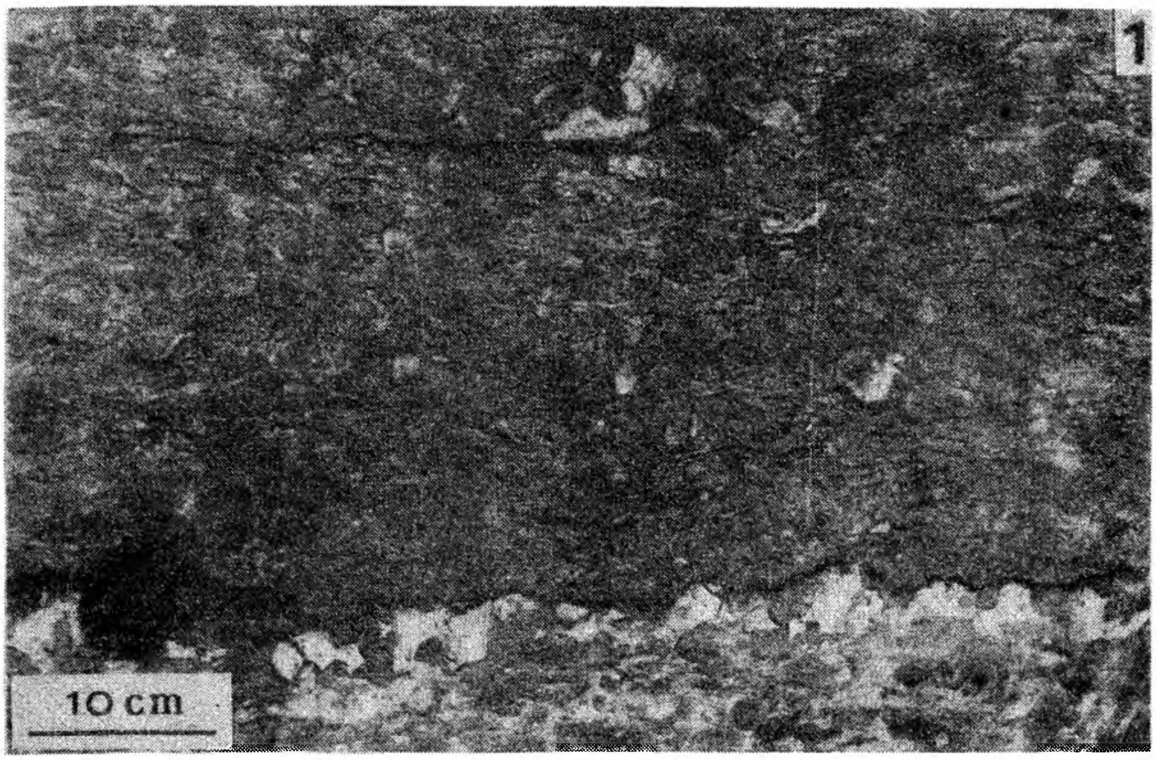
1 — Erosional surface and cross-lamination in biostrome. Kamień Śląski
2 — Sponge bioherms (arrows) in central part of biostrome. Szymiszów

### Plate III

1—4 — Sponges. Strzelce Opolskie

### Plate IV

1 — Longitudinal cross-section through the sponge from Pl. III: 4. Bioclastic fill and silicification of surrounding sediment may be observed. Strzelce Opolskie
2 — Fragment of sponge rigid skeleton. Szymiszów
3 — Peripheral part of biostrome. Note intercalations of strongly burrowed pelitic sediment and bioclastic intercalations (arrows). Szymiszów
4 — Sponge fragment (arrowed) preserved in siliceous nodule. Szymiszów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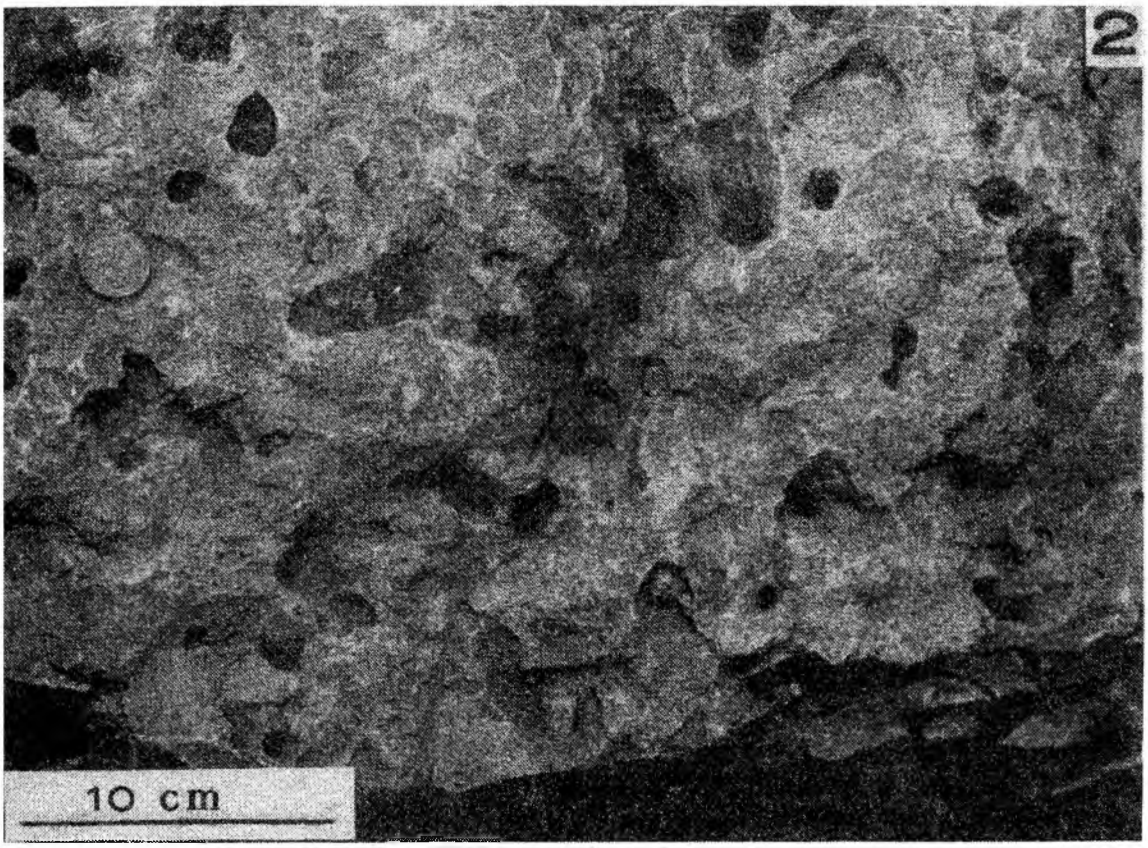
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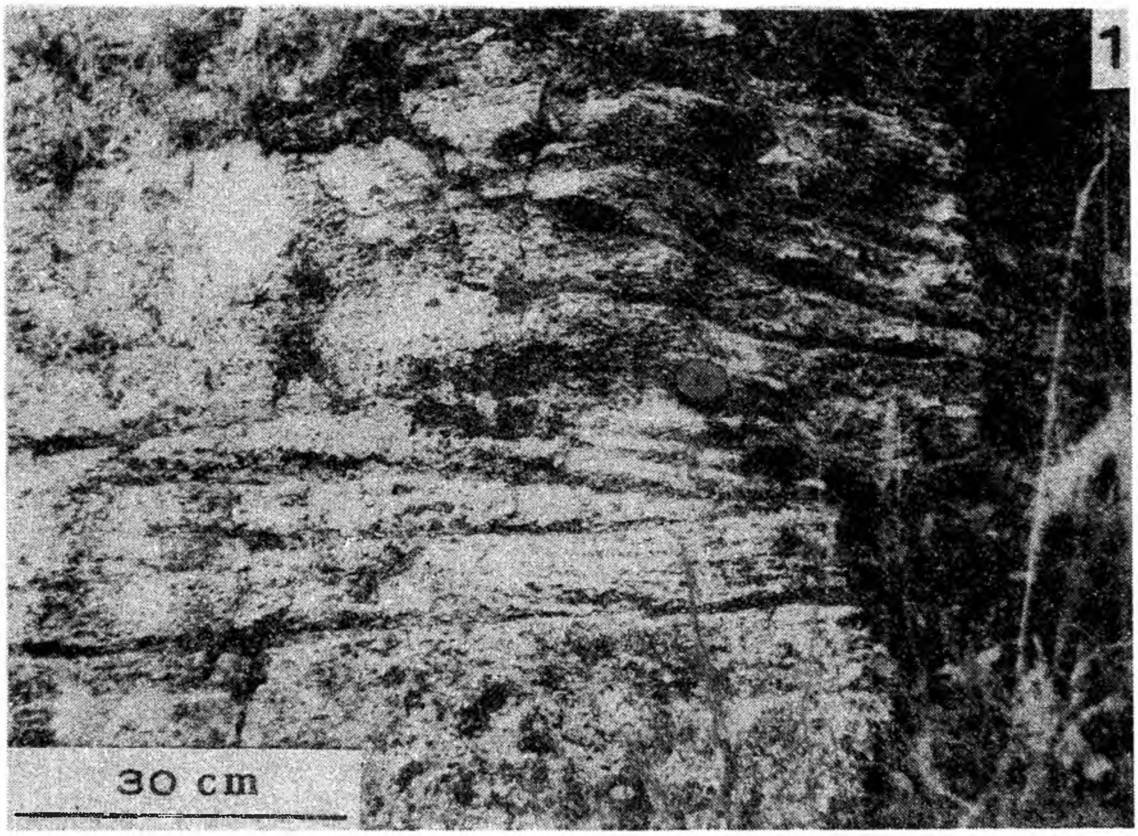
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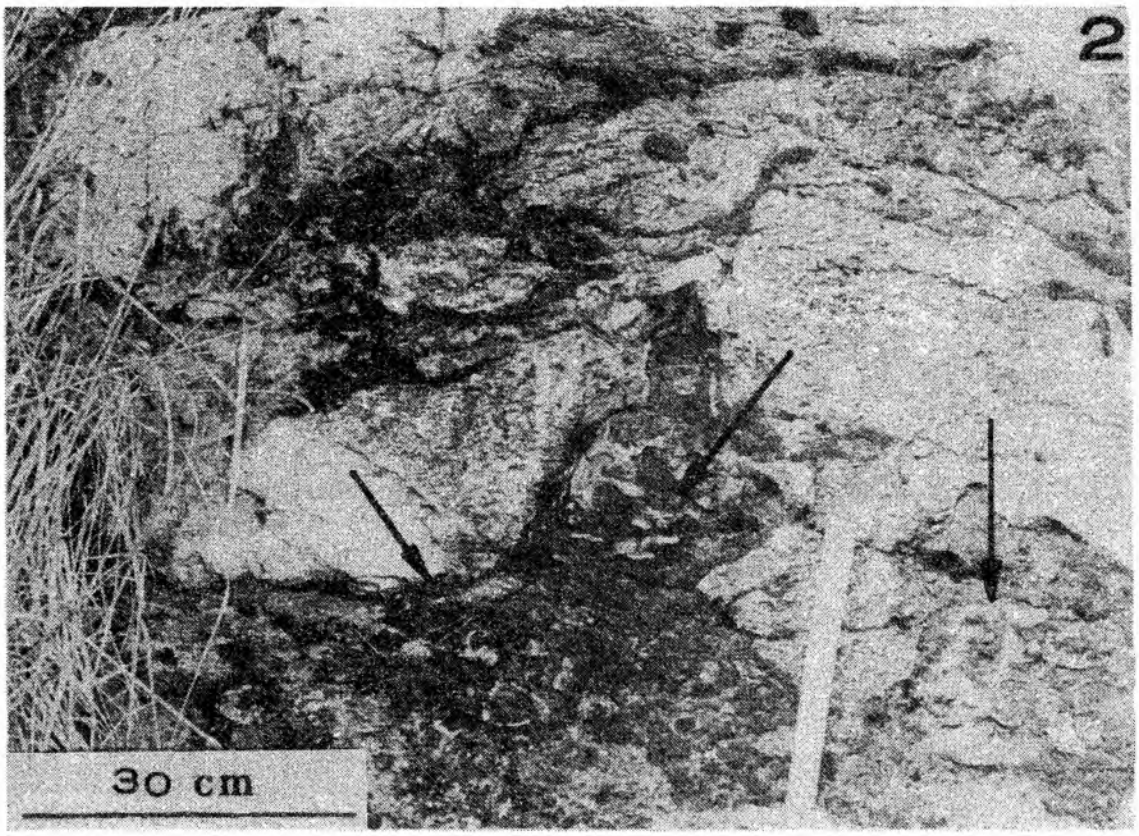
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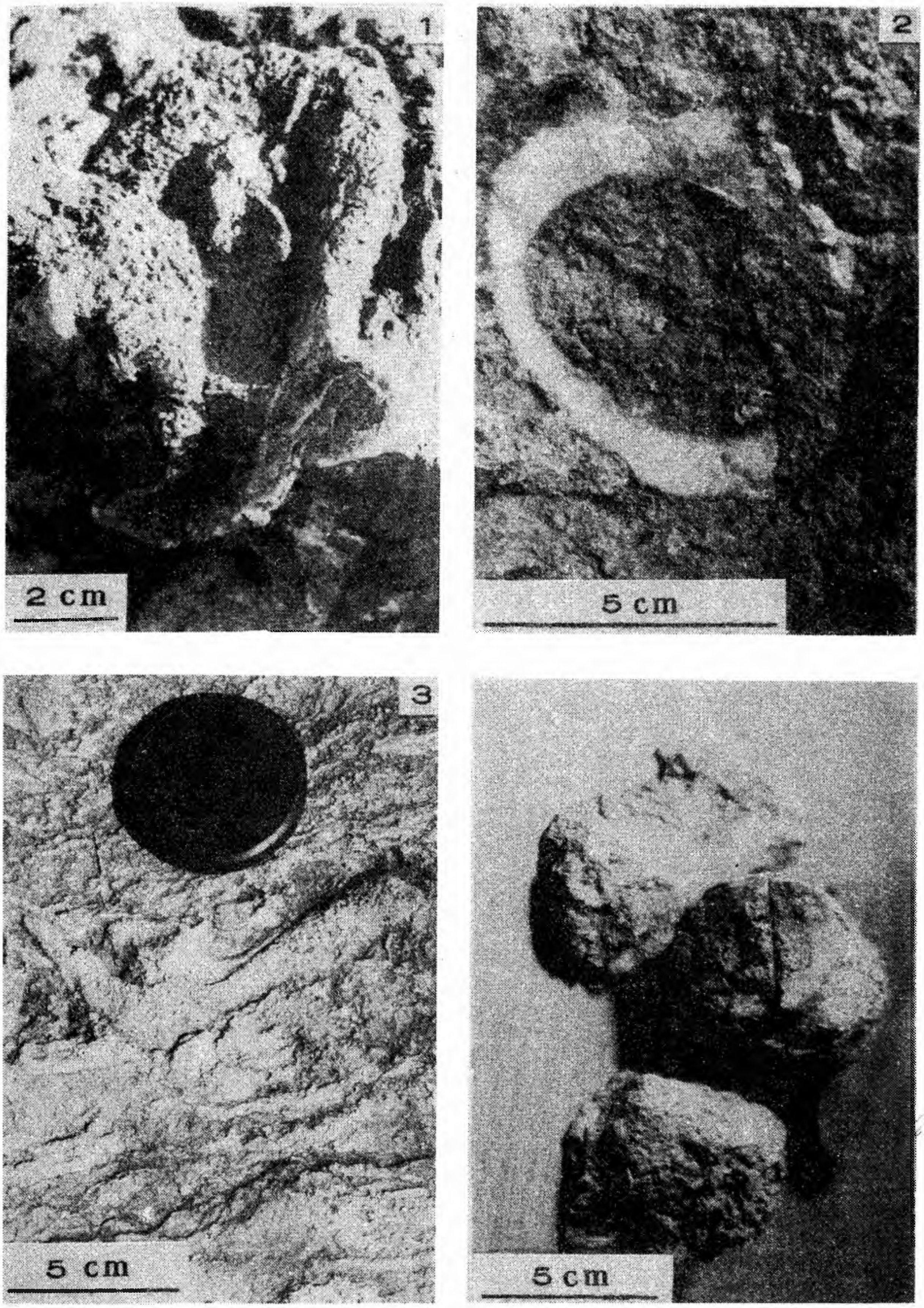
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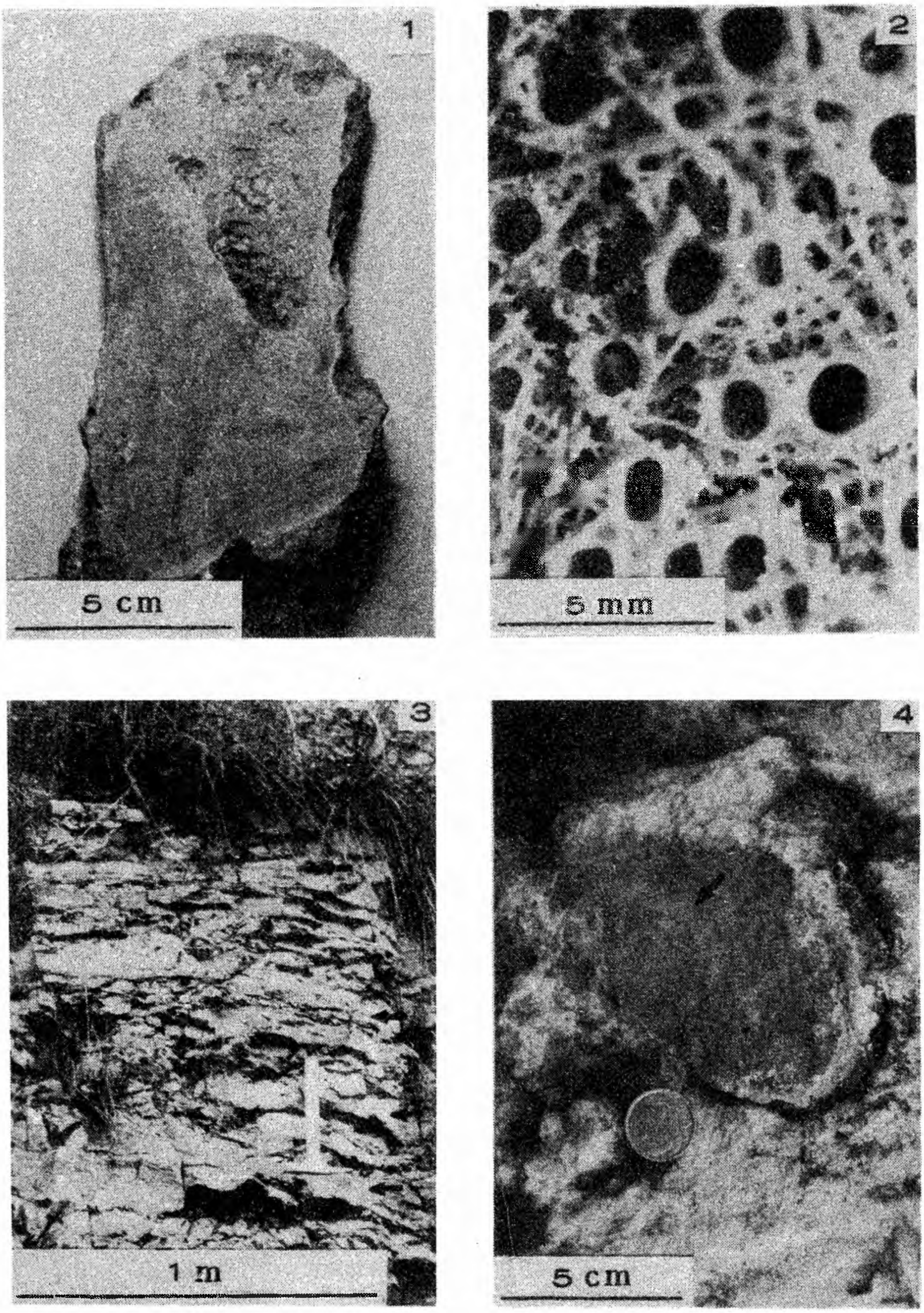
2 cm
2
5 cm
3
5 cm
5 cm


1
5 cm
2
5 mm
3
1 m
4
5 cm