ROCZNIK POLSKIEGO TOWARZYSTWA GEOLOGICZNEGO
ANNALES DE LA SOCIÉTÉ GÉOLOGIQUE DE POLOGNE

Vol. XLV — 1: 3—20 Kraków, 1975

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INTRAFORMATIONAL CONGLOMERATES IN THE GOGOLIN BEDS (MIDDLE TRIASSIC, SOUTHERN POLAND)

(Pl. I—IV and 7 Figs.)

Śródformacyjne zlepieńce w warstwach gogolińskich

(Tabl. I—IV i 7 fig.)

Abstract. In the limestones of the Gogolin beds intraformational conglomerates have been recorded. The layers of conglomerates consist of organodetrital matrix in which are embedded limestone pebbles. Pebbles are made up chiefly of micrite, rarely of detrital or detrital-skeletal limestone. There is a substantial similarity between this material and that of some layers in the profile of the Gogolin beds. Pebbles are flat and discoidal.

The origin of pebbles is connected with submarine erosion. During erosion, the bottom sediment was more or less consolidated. The lowering of the wave base during periodically recurring storms or the action of bottom currents may have been responsible for the erosion. It seems that the pebbles reached the area of deposition together with the material making up their matrix. Such transport may have been in the form of flow of calcareous mud with a great amount of organic detritus.

INTRODUCTION

The Gogolin beds constitute the lowermost part of the Lower Muschelkalk (Middle Triassic), where they overlie the dolomitic Roethian deposits. Their thickness ranges from 20 to 50 m, increasing to the west. Lithological heterogeneity of the Gogolin beds has made it possible to distinguish several minor units of great geographical extent. A division of the Lower Muschelkalk was made by Assmann (1944) for the region of Upper Silesia and applied by Siedlecki (1949) to the region of Cracow (Fig. 1). The two regions lie within the same regional geological unit, the so-called Silesian-Cracovian Monocline. Some of the units distinguished in the Gogolin beds may be defined as members (conglomerate horizon, "cavernous limestone"). The traditional name "beds", which has been used so far, has, strictly speaking, the status of formation.

The Gogolin beds appear as limestones, which in the eastern and

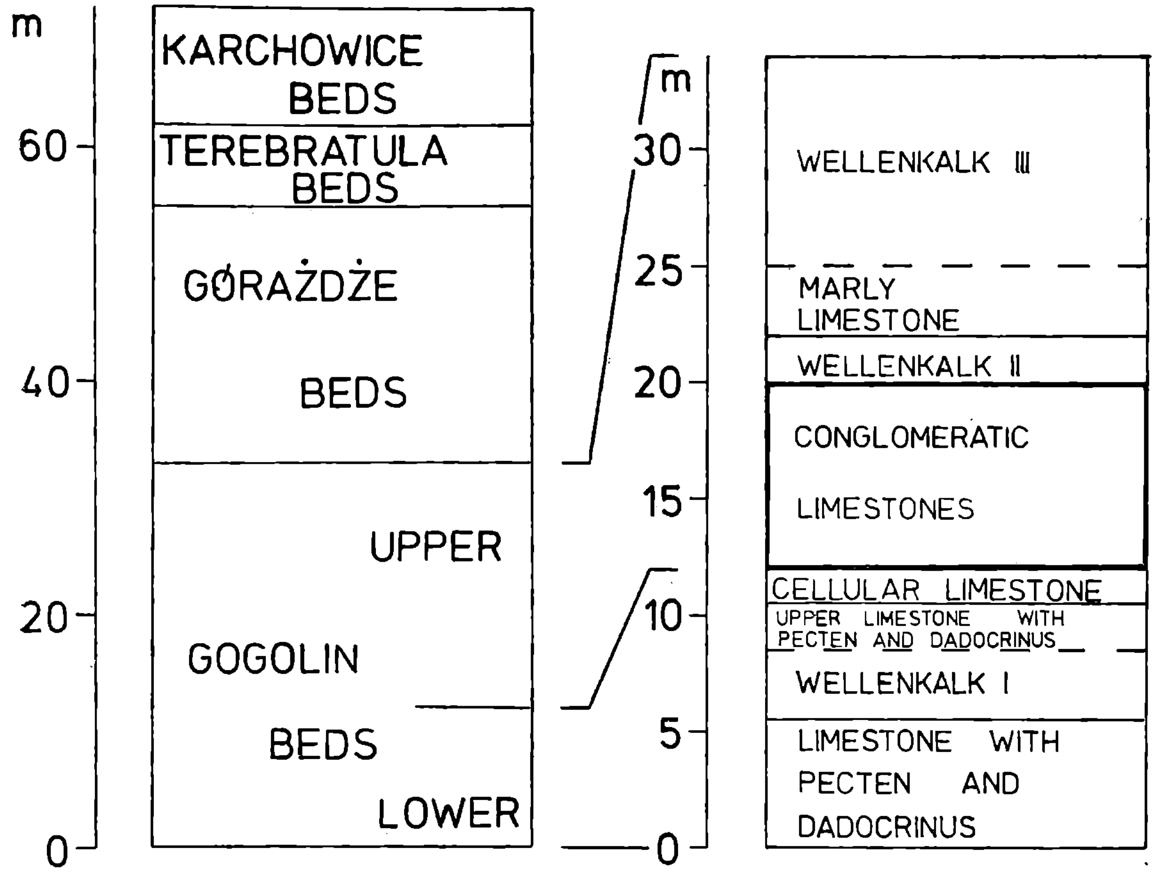

Fig. 1. Stratigraphic profile of the Lower Muschelkalk and lithostratigraphic horizons of the Gogolin beds according to Siedlecki (1952)

Fig. 1. Profil stratygraficzny dolnego wapienia muszlowego i poziomy litostratygraficzne warstw gogolińskich według Siedleckiego (1952)

north-eastern parts of the area of their occurrence are replaced by dolomites. These are ore-bearing dolomites. They owe their origin to the transformation of the primary calcareous deposits under the influence of dolomitizing solutions (e. g. Bogacz et al., 1972). Lithostratigraphic division cannot be applied in these areas because sedimentary structures occurring primarily in calcareous deposits were partly or totally obliterated due to dolomitization.

In the calcareous deposits of the Gogolin beds numerous sedimentary structures are present. Horizontal, cross and wavy stratification, crumpled structures, ripple-marks, erosional surfaces, intraformational conglomerates and biosedimentary structures may be distinguished. Their form and origin have been so far discussed by Siedlecki (1964) and Bogacz et al. (1968).

Opinions regarding the origin of calcareous intraformational conglomerates in the Gogolin beds were expressed in the papers dealing with their lithology and stratigraphy (Doktorowicz-Hrebnicki, 1935; Assmann, 1944; Siedlecki, 1949, 1952, 1955, 1964; Śliwiński, 1964; Alexandrowicz and Alexandrowicz, 1966; Wyczółkowski; 1971). All these papers are concerned with the deposits of the

Lower Muschelkalk formed in the Silesian-Cracovian facies. Calcareous intraformational conglomerates have been also recorded in other parts of the Lower Muschelkalk basin. They were described by Kłapciński (1959) in the area situated to NE of the Fore-Sudetic Block. This author correlates the observed conglomerates with the conglomerate horizon of the Cracow-silesian Region. Intraformational conglomerates appear as intercalations in crumpled limestones of the Lower Muschelkalk in the Holy Cross Mts. (Bialik et al., 1971).

This type of conglomerates has been found as well in the Lower Muschelkalk in Germany (Vossmerbäumer and Vossmerbäumer, 1969; Schüller, 1969; Schwarz, 1970).

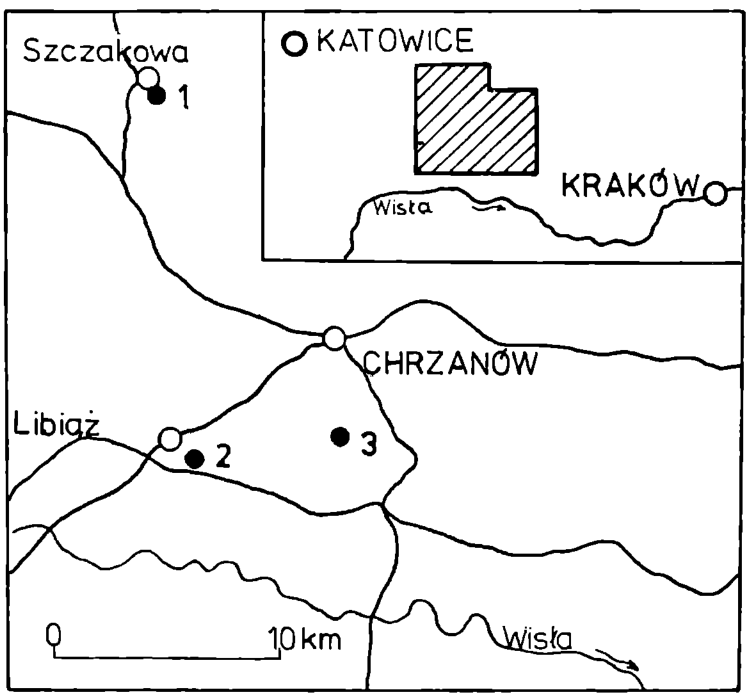

Fig. 2. Localization of outcrops: 1 — Szczakowa; 2 — Moczydło; 3 — Pogorzyce
Fig. 2. Lokalizacja odsłonięć: 1 — Szczakowa; 2 — Moczydło; 3 — Pogorzyce

Field works were conducted in the eastern part of the Silesian-Cracovian Monocline, mainly near Chrzanów (Fig. 2). Observations were made on polished and thin sections. Size measurements of pebbles were performed on the walls of outcrops as their separation was not possible.

CONGLOMERATE HORIZON

Intraformational conglomerates form intercalations in limestone-marly deposits. In this horizon micrite, detrital and organodetrital limestones, marls, and marly shales have been recorded. Various sedimentary types of limestones may be distinguished in the profile, i.e. limestones with

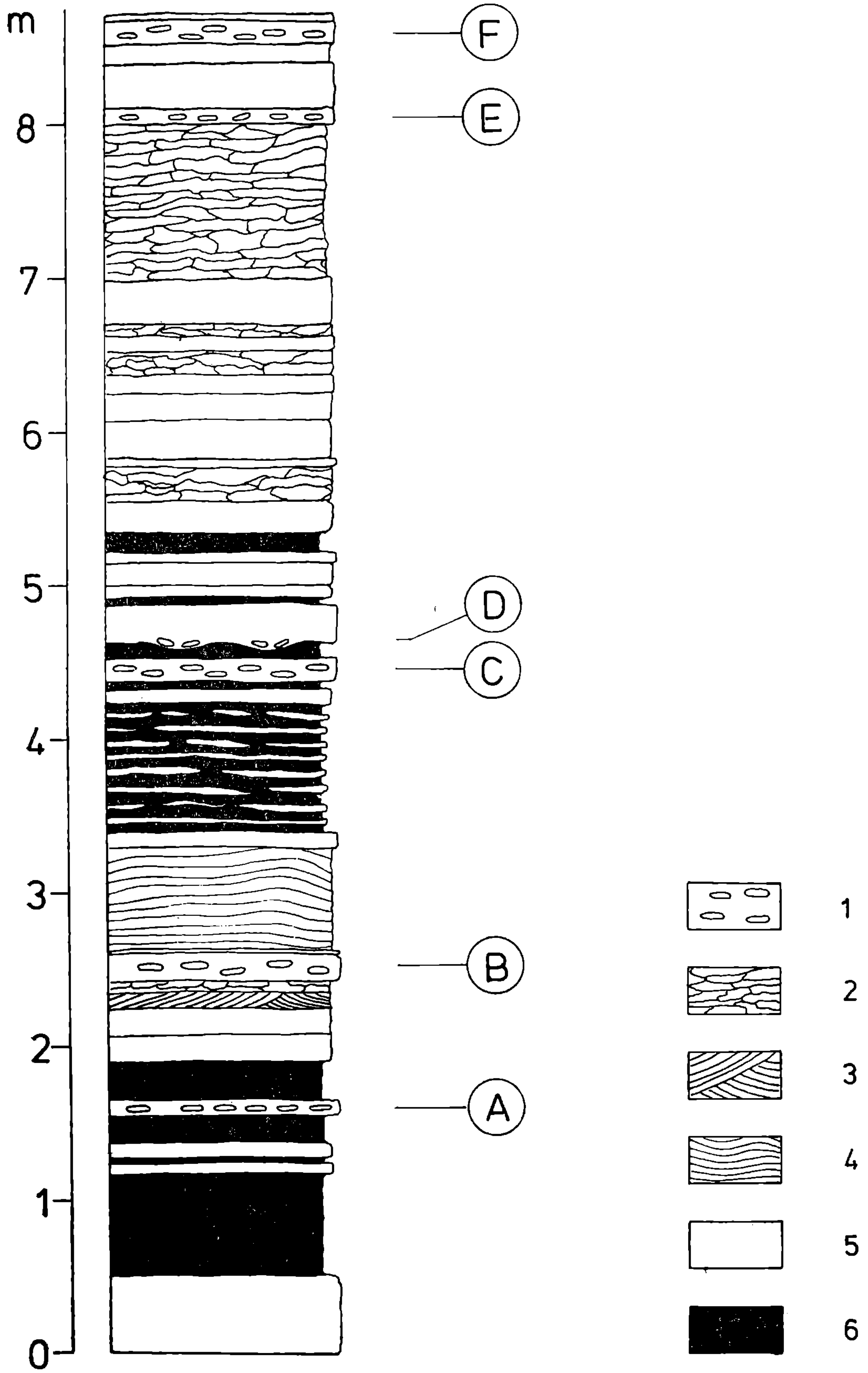

Fig. 3. Profile of the outcrop at Moczydło: 1 — intraformational conglomerates; 2 — crumpled limestones; 3 — cross-bedded limestones; 4 — limestones with indistinct wavy structure; 5 — massive limestones; 6 — marls and marly shales

Fig. 3. Profil odsłonięcia w Moczydle: 1 — zlepieńce śródformacyjne; 2 — wapienie gruzłowe; 3 — wapienie skośne warstwowane; 4 — wapienie z słabo zaznaczoną strukturą falistą; 5 — wapienie bez wyraźnych struktur; 6 — margle i łupki margliste

horizontal, cross and wavy stratification, crumpled limestones and ones lacking distinct structures.

Thickness of the conglomerate horizon varies from 7 to 16 m, increasing to the west. It is 7 to 9 m near Chrzanów (Siedlecki, 1949), 8 to 10 m near Szczakowa (Bojkowski, 1955), ca 15 m in the eastern part of Upper Silesia (Assmann, 1944), ca 15 m near Grodziec (Doktorowicz-Hrebnicki, 1935), ca 16 m in the region of Siewierz (Śliwiński, 1964). Wyczółkowski (1971) noticed that there are two types of conglomerate sediments in the Gogolin beds: 1. limestones and dolomites with fragments of Palaeozoic rocks, of inconsiderable horizontal extent; 2. conglomeratic limestones containing fragments of the Lower Muschelkalk rocks, of large geographical extent. According to this author, the occurrence of the former is confined to the most elevated areas, and they owe their origin to the erosion of a cliff shore. An attempt at elucidating the origin of the other type of conglomerates has been undertaken in the present paper.

The number of conglomerate intercalations in the profile of the conglomerate horizon is variable. In the outcrops under study it varies from 3 to 5 (Fig. 3). The number of conglomerate layers decreases to the north and west (Gruszczyk, 1956). Conglomerates are not confined to the conglomerate horizon since they have been encountered in the under- and overlying deposits. Vertical distances between the layers of conglomerates are from about 20 cm to several metres. The conglomerates are usually interbedded between marly layers of various thickness. Sometimes marls are replaced by limestones. In the outcrops at Moczydło and Szczakowa layers of conglomerates overlying directly a 1-m thick layer of crumpled limestone have been encountered.

The conglomerate layers are from 10 to 30 cm thick. Within the investigated outcrops their thickness is, as a rule, constant. Only in rare instances local thinning or complete pinching of a layer may be noted. Pebbles are found not only in typical conglomerate layers. Fig. 5 C shows a fragment of a micrite layer in which pebbles are very rare. They accumulate in the bottom part of the layer, in a furrow that is about 0.5 m wide and about 10 cm deep.

The top surface of conglomerate layers is usually even, which is due to the deposition of a micrite lamina directly on the conglomerate. If this lamina is not present, protruding pebbles and accumulations of organic detritus, which is one of the components of the matrix, may be observed on the top surface. Pelecypods shells are sometimes crushed due to compaction. Pebbles lying near the top surface are truncated, which points to the action of erosional factors. The bottom surface of the layers is either even or, more frequently, uneven and erosional. In several layers that have been investigated the conglomerate is underlain by a micrite lamina. Thickness of this lamina is variable and ranges

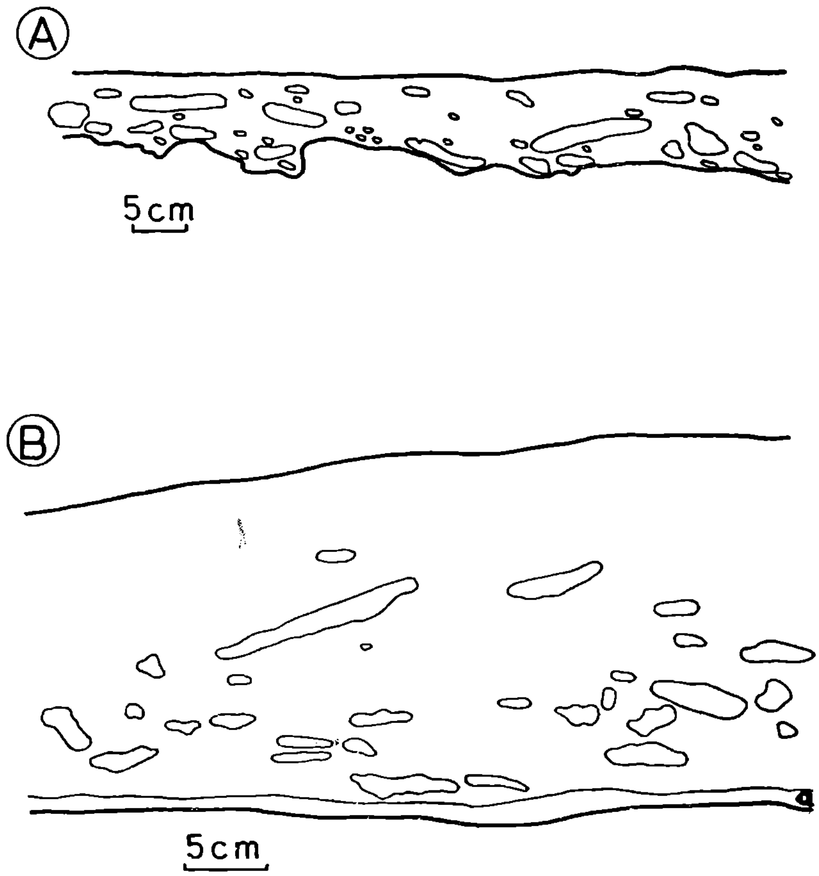

Fig. 4. Conglomerate layers. A — the conglomerate overlies the eroded top of a layer of crumpled limestone; B — the conglomerate with scattered pebbles horizontally and cross-bedded (a — limina of micrite)

Fig. 4. Ławice zlepieńców. A — zlepieniec spoczywa na wyerodowanym stropie ławicy wapienia o strukturze gruzłowej; B — zlepieniec z rzadko rozmieszczonymi otoczakami ułożonymi skośnie i horyzontalnie (a — warstewka wapienia mikrytowego)

from 1 to 5 cm (Fig. 4 B and 5 A, Pl. III fig. 2). Locally it is preserved only in fragments (Pl. I fig. 2). Its bottom is usually even, the top shows a more or less diversified relief (Pl. III fig. 2). This lamina, at any rate in some layers, was not completely consolidated during the deposition of the conglomerate layer. This is indicated by pebbles being sometimes sunk in it.

In the conglomerate horizon there is a set of interbedded limestone and marly laminae (Fig. 3). The limestone laminae are 2 to 5 cm thick. Sometimes they pinch out within the range of several metres, and sometimes they form lenticular bodies in marls. Thickness of the marly laminae is from some mm to 5 cm. According to B o g a c z et al. (1968), this type of sediment corresponds to the primary stage of formation of crumpled limestones. Cross bedded limestones in the conglomerate horizon are exceptional. They are unquestionable evidence of the existence, at any rate periodical, of bottom currents.

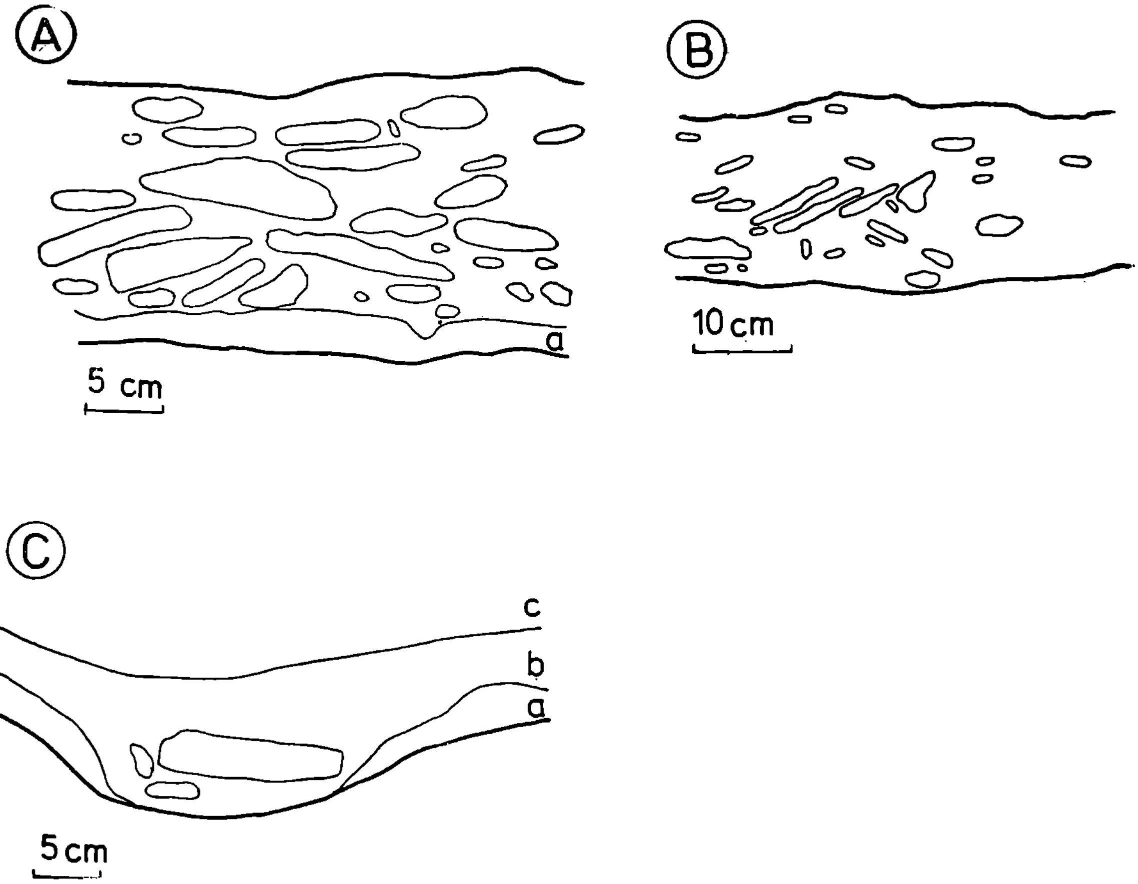

Fig. 5. Distribution of pebbles in the conglomerate layers. A — densely packed pebbles displaying horizontal and cross bedding (a — lamina of micrite); B —variable packing of pebbles, horizontal bedding and imbrication; C — accumulation of pebbles in depressions of the bottom (a — micrite, b — limestone with organic detritus, c — micrite)

Fig. 5. Rozmieszczenie i ułożenie otoczaków w ławicach zlepieńców, A — ciasno upakowane otoczaki ułożone skośnie i horyzontalnie (a — warstewka wapienia mikrytowego); B — zmienne upakowanie otoczaków, ułożenie dachówkowate i horyzontalne; C — fragment ławicy wapiennej, w której otoczaki występują w miejscach obniżania się spągu ławicy (a — wapień mikrytowy, b — wapień ze szczątkami organicznymi, c — wapień mikrytowy)

FEATURES OF THE PEBBLES

The conglomerate is made up of organodetrital matrix in which flat limestone pebbles are embedded. As it was impossible to separate the pebbles, the data on their shape and size were chiefly obtained from the measurements and observations made directly in the outcrops or on polished sections.

The size of limestone fragments ranges from some tenth of mm to several cm. Typical discoidal pebbles are from ca 1—2 cm to several cm in size. The measurements were limited to pebbles having more than 1 cm in diameter. The size of pebbles was estimated on the basis of measurements of their length. Its frequency in size classes is shown on histograms (Fig. 6). The first three histograms (I, II, III) were made basing on the measurements in the conglomerate layer C (Fig. 3), histogram

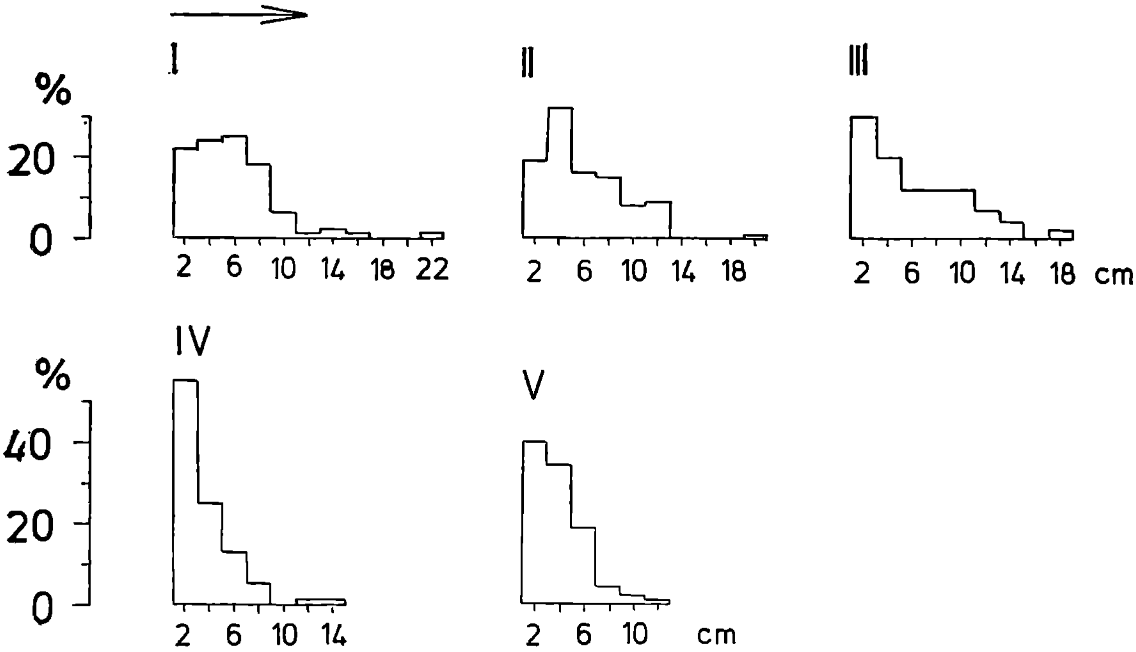

Fig. 6. Histograms of the size of pebbles. I, II, III — a layer of conglomerate C (Fig. 3). The arrow indicates the direction of its pinching; IV — a layer of conglomerate B (Fig. 3); V — a layer of conglomerate E (Fig. 3)

Fig. 6. Histogramy wielkości otoczaków. I, II, III — ławica zlepieńca C (fig. 3). Strzałka wskazuje kierunek wyklinowania się ławicy; IV — ławica zlepieńca B (fig. 3); V — ławica zlepieńca E (fig. 3)

III being nearest to the lateral limit of the layer where a slight increase in the content of finer material and a decrease in the number of pebbles have been noted. It appears that the mean size of pebbles is about 4.5 cm. Large pebbles, above several cm in diameter, have been recorded only in isolated cases. The detrital material is poorly sorted. The pebbles are from some mm to 3—4 cm thick, the thickness increasing with an increase in diameter. Sometimes, however, pebbles with a diameter above several cm whose thickness does not exceed 1 cm may be found.

The pebbles are, as a rule, discoidal. Their edges are usually well rounded. In sections parallel to the long axes the shape of pebbles approximates that of a rectangle or an ellipse. They rarely assume the form of micrite "stains" that merge gradually in the organodetrital matrix. Some pebbles are bent (Pl. III fig. 1). Those lying on the uneven top surface of the micrite lamina bend following the surface irregularities or else they become fractured (Pl. III fig. 2). The fractures do not cause a complete disruption of a pebble; even in the case of strong fracturing all the fragments remain in place. Fissures formed in the pebbles are filled with the material of the matrix.

Pebbles are for the most part made up of micrite. Occasionally this limestone contains a slight admixture of quartz grains, the size of which does not exceed 1 mm. The surfaces of pebbles made up of such material are usually even and well polished (Pl. IV fig. 4). Pebbles made up of organodetrital limestone are rare (Pl. IV fig. 2). In the matrix, consisting of fine-crystalline calcite, are embedded numerous fragments of shells or complete shells of pelecypods and gastropods. In some instances the organic fragments show parallel orientation. Their long axes are almost parallel to those of a pebble. More frequently however, random distribution of organic detritus may be observed. Besides skeletal material intraclasts have been recorded. They are nearly circular, with a diameter about 0.1 mm, 0.2 mm being the maximum. The surface of pebbles made up of this limestone is not so well polished as that of pebbles built of micrite. It displays numerous cavities into which squeezes the matrix. Occasionally pebbles made up of laminated detrital limestone are found (Pl. IV fig. 3). Thin laminae are conspicuous by the presence or absence of quartz grains, the size of which varies from 0.1 to 0.2 mm. Apart from quartz there are limestone intraclasts. The laminae are parallel to the long axes of a pebble.

The pebbles are embedded in the organodetrital matrix, which usually consists of micrite with a large quantity of detrital material. Broken or complete shells of pelecypods and gastropods as well as crinoid ossicles are randomly distributed in the matrix. There are also limestone intraclasts and, sporadically, quartz grains in the matrix. Sometimes a visible change in the arrangement of organic detritus may be observed within one and the same layer. In the lower part there are larger fragments of shells, randomly disseminated, whereas higher, small broken fragments are lying with their long axes parallel to the bedding.

The distribution and orientation of pebbles were determined basing on observations on the walls of outcrops and on polished sections. Fig. 4, Fig. 5, Pl. I fig. 1 and 2, Pl. II fig. 1 and 2 present various types of distribution and orientation of pebbles in the layers. In thin layers, up to several cm thick, the pebbles are distributed rather uniformly throughout the thickness of the layer. They lie, as a rule, horizontally. In thicker layers pebbles sometimes accumulate in the bottom parts. It also happens that in the bottom part they are imbricated whereas near the top they take a horizontal position. Random arrangement of pebbles is fairly common, too. It seems that imbrication results from the transportation of pebbles together with the material that constitutes their matrix. It is possible that differences in the friction forces in this shifting mass resulted in such an arrangement of pebbles. The direction of the dip of pebbles is sometimes quite different in the neighbouring conglomerate layers. This may be due to a change in the direction of the current by which the material was transported.

BORINGS IN THE PEBBLES

In the pebbles traces of the activity of boring organisms have been ascertained. The borings however are not present on pebbles of all the conglomerate layers or in all the pebbles within a single layer.

In the transversal section the borings are circular. Their diameters attain a maximum of 1 mm and their length 3—4 cm. In the longitudinal section they are straight, only sporadically slightly bent. On polished sections parallel and perpendicular to the long axis of a pebble, sections of the borings are as a rule circular or elliptical (Fig. 7). Most

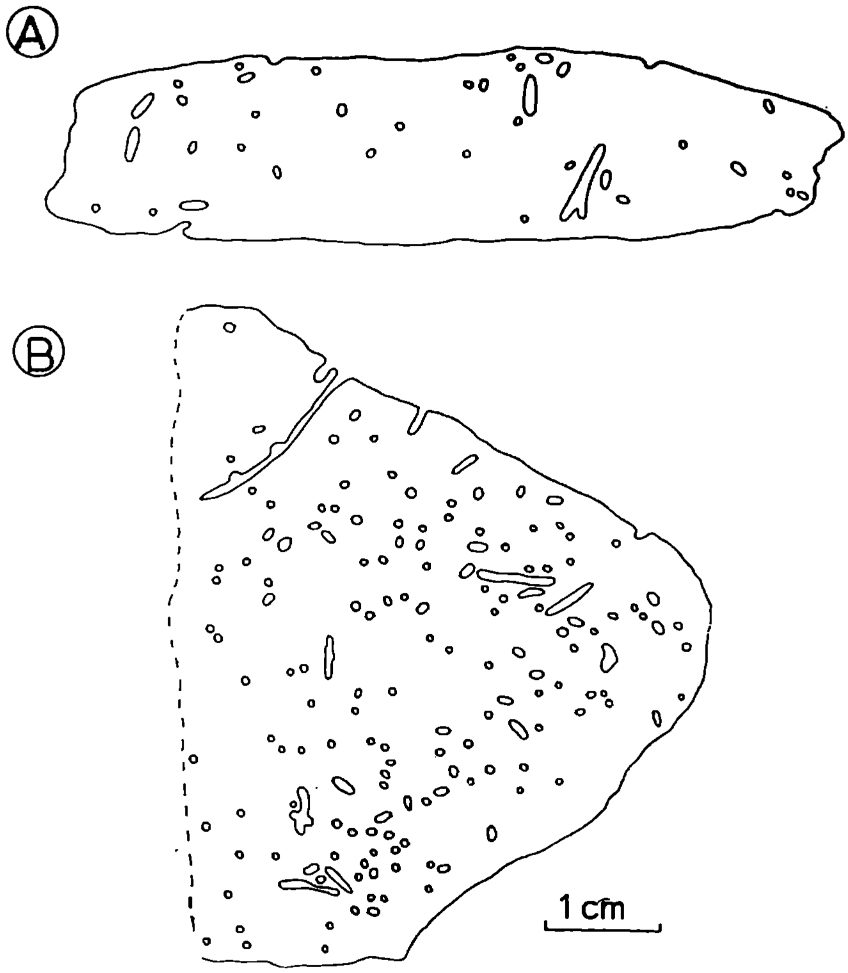

Fig. 7. *Trypanites* borings. A — section perpendicular to the long axis of the pebble; B — section parallel to the long axis of the pebble

Fig. 7. Ślady drążenia *Trypanites*. A — przekrój prostopadły do dłuższych osi otoczaka; B — przekrój równoległy do dłuższych osi otoczaka

of the borings run perpendicularly to the top and bottom surfaces of a pebble (Fig. 7 B). The exits of borings are sometimes on the side edges of a pebble. Now and then the borings converge or intersect. Their number in a pebble is highly variable, ranging from a few in one pebble to 13—15 in 1 cm² of the surface of the section parallel to the long axis of a pebble. The investigations failed to show an explicit dependence between the size of pebbles and the presence of borings. The borings are always filled with fine- or medium-crystalline calcite. In some instances, a differentiation in the filling material in a single boring has been noted.

S i e d l e c k i (1964) presumed that the traces may have been made by sponges. This, however, seems rather unlikely. The shape and size of the borings are very similar to those of *Trypanites* (*Cirripeds*). The Trypanites traces were described for the first time by Mägdefrau (1932) in the sediments of the Lower Muschelkalk in Germany. They were also discussed by Hecker (1960, 1970), Bromley (1972), Kaźmierczak and Pszczółkowski (1969), and Vossmerbäumer and Vossmerbäumer (1969). The latter investigated the borings of this type in pebbles of intraformational conglomerates of the Lower Muschelkalk.

The present author believes that borings found in the pebbles are a consequence of the activity of boring organisms in the hardening bottom sediment. This interpretation is supported by the fact that the predominant number of borings run perpendicularly to the top and bottom surfaces of the pebbles. Some observations (the exits of borings on the side edges of the pebbles, different arrangement of borings) testify to the boring of the material that was torn away from the basement. Intersecting and converging of the borings may be indicative of several stages of boring. It is therefore feasible that boring took place both in the primary rock and in the pebbles.

THE ORIGIN OF INTRAFORMATIONAL CONGLOMERATES

The origin of intraformational conglomerates in the Gogolin beds has not been so far satisfactorily accounted for. Stappenbeck (1928, vide Śliwiński, 1964) and Assmann (1944) maintained that the origin of the conglomerates may be sought in the periodical uplifting of the sea-bottom, sometimes even above the sea level, which was accompanied by intensive waving. It seems unlikely however, as pointed out also by Śliwiński (1964), that the bottom would have emerged above the water table since there are no surfaces of discontinuity evidencing such an emergence. A considerable content of crinoids in the matrix as well as the conglomerates passing into the over- and underlying marls would also testify against this interpretation. It seems therefore pertinent to accept the hypothesis that the conglomerates originated under submarine conditions.

The conglomerates under study are certainly intraformational. Their characteristic features wholly correspond to the standard definition of Walcott (1894).

Explanation of the origin of the conglomerates requires an interpretation of the following problems:

1. degree of consolidation of the sediment subject to destruction,
2. type of sediment,
3. factors responsible for the origin, of pebbles,
4. determination of the type and length of the way of transport and conditions of deposition.

The sediment that was subject to destruction must have been consolidated to a high or, at any rate, certain degree, otherwise limestone fragments could not have been formed. Their shapes may be different depending on the degree of consolidation of the material being destroyed. In the conglomerates under study the shape of the majority of pebbles is discoidal. This would point to the primary deposit, laminated to some extent, which is confirmed by lamination observed in some pebbles that is parallel to the top and bottom surfaces of the pebble. The action of erosion may result not only in the formation of surfaces of the "hard ground" type but also in the destruction of the consolidated material. H e c k e r (1960) studied Devonian sediments in which he found surfaces of the "hard ground" type and calcareous intraformational conglomerates. He stated that with an increase in the distance from the shore, the effects of the action of submarine erosion change. In the farthermost area "hard ground" is formed. The distance from the shore decreasing, erosion of thin-layered sediments occurs and flat pebble conglomerates are formed. In the area nearest to the shore, erosion of the unconsolidated sediment occurs. Synaeresis cracks may have very likely favoured the formation of such pebbles (F e n t o n and F e n t o n, 1937; S z u l c z e w s k i, 1968). The shapes of pebbles found in the conglomerates of the Gogolin beds permit to assume that the original material of the pebbles was consolidated to a various degree. Contorted pebbles are indicative of semi-consolidated primary material, whereas those of discoidal shape with numerous fractures point to a much better consolidated material. Also pebbles with borings testify to a high degree of consolidation of the primary sediment.

Pebbles are made up of limestones that show a substantial similarity to the material of some layers occurring in the profile of the Gogolin beds. It is conceivable that, in some cases, the pebbles are derived from a limestone lamina recorded in the bottom of the conglomerate layers. Uneven top surface of this lamina as well as the similarity of its material to that of pebbles seem to indicate that the pebbles originate from this lamina. B i a l i k et al. (1972) arrived at the same conclusion investigating a similar type of sediment in the Muschelkalk in the Holy Cross Mts. In the case of other layers investigated they conclude that the pebbles should be considered as allochthonous. S z u l c z e w s k i (1968) studied a similar limestone lamina with eroded top surface, overlain by fragments of pelitic limestones. The fragments fill the irregularities in the top of the lamina. Szulczewski is of opinion that the pebbles in question were formed in the initial stage of intraformational erosion, this being suggested by rod shape of the pebbles. This shape permits to assume that the lamina subject to destruction was incompletely consolidated. The pebbles were transported over a very short distance.

Two processes may be regarded as responsible for the origin of pebbles. One is submarine erosion, the other — erosion of the drying sediments in the tidal zone. The action of submarine erosion causes the bottom sediment to be destroyed and included in the sediment being formed. Such erosion may be due to the destructive action of waving in the shallow sea or to the action of tidal, turbidity or other bottom currents. Kotański (1954) thinks that the lowering of the wave base may follow an increase in the amplitude of waves during storms or may be due to tsunami waves. It seems that pebbles in the conglomerates under study were formed in the entirely submarine conditions. It is very unlikely, on the other hand, that they should have formed in subaerial conditions. Fagerstrom (1967) assumes that the decisive criterion permitting to ascertain that pebbles originated in precisely this way is the occurrence of mud cracks on the top surfaces of the underlying layers. If the fragments are transported to the parts of the basin where deposition is continuous and there are no indications of an emergence of the bottom, a determination of the origin of the pebbles meets with certain difficulties.

The question should be settled whether the pebbles were deposited on the spot or were transported to the area of deposition. If they are allochthonous, what factors caused their transportation and how long was the way of transport? The mode of distribution of pebbles in the layers and sometimes their arrangement evidence that they were brought to the area of deposition in the body of calcareous mud containing a great quantity of organic detritus. This kind of transport is confirmed by loose distribution of pebbles in the matrix. Dense accumulations of pebbles have not been recorded, the pebbles being rather uniformly distributed throughout the thickness of a layer. Occasionally the number of pebbles decreases towards the top of the layer, and so it does in the direction of its pinching. The lack of internal structures in the layers seems to testify to their rapid deposition. It is possible that the pebbles were transported in the mass of mud flow type. Such flow could have been a consequence of a loss of the equilibrium of the sediment as a result of sedimentary processes or movements of the sea bottom. Bull (1972) describes mud flow in alluvial fan deposits. Obviously, the phenomena discussed by this author occurred in entirely different conditions; nevertheless, an attempt may be made to compare them with the processes leading to the formation of calcareous intraformational conglomerates. Bull maintains that such flows are characterized by poor sorting of the material, well defined boundaries, constant thickness (when observed in outcrops), and distribution of clasts dependent on the flow density. Graded bedding, horizontal position of clasts as well as imbrication indicate liquid mud flow, whereas their uniform distribution throughout the thickness of the bed is characteristic of a denser flow. Very dense flow is characterized by uniform distribution of clasts and their vertical orientation, perpendicular to the direction of the current. The distribution of pebbles in the conglomerates of the Gogolin beds would point to their having been transported in the body of calcareous mud of medium density. The way of transport of limestone fragments was not very long. This is demonstrated by pebbles that are several cm long but not more than 1 cm thick. Detrital material in the layers is poorly sorted. Apart from typical discoidal pebbles, small limestone fragments can be noted.

Abundance of organic detritus in the matrix of the conglomerate indicates that the conditions were favourable for the development of benthonic fauna, which abounds in individuals but is poor in species. Siedlecki (1952) determined a few species of pelecypods from the conglomerate horizon, in which also fragments of crinoids and gastropods have been found. The shells are either complete or broken. They are sometimes in horizontal position, but more frequently are randomly distributed in the matrix. Organic detritus was brought to the area of deposition together with the matrix and the pebbles.

In the present author's opinion, intraformational conglomerates in the Gogolin beds were formed under submarine conditions in shallow sea. The pebbles owe their origin to the eroding action of currents or waving on the more or less consolidated and laminated bottom sediment. Detrital material was very likely brought to the area of deposition in the form of mud flow.

CONCLUSIONS

Basing on the foregoing observations, the following conclusions may be drawn:

1. The pebbles are derived from the Gogolin beds; the primary sediment was bedded and partly well, partly weakly consolidated;
2. *Trypanites* borings were made both in the primary sediment and in the pebbles;
3. The pebbles were formed by erosion on a shallow sea bottom;
4. The pebbles were probably transported by a mud flow;
5. The process of deposition of the intraformational conglomerates was very rapid.

Acknowledgements. The author wishes to express his gratitude to assistant professors Ryszard Gradziński and Stanisław Kwiatkowski for valuable advice and suggestion during the investigations and preparation of the manuscript.

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STRESZCZENIE

W utworach dolnego wapienia muszlowego wykształconego w facji śląsko-krakowskiej występują wapienne zlepieńce śródformacyjne. Utwory te były obserwowane przez autora w warstwach gogolińskich we wschodniej części basenu dolnego wapienia muszlowego w okolicach Chrzanowa. Zasięg geograficzny zlepieńców jest dość znaczny. Występują one we wschodniej i centralnej części triasowego zbiornika. Ilość wkładek zlepieńców zmniejsza się ku zachodowi (Gruszczyk, 1956). Utwory takie obserwowane były również w dolnym wapieniu muszlowym w obszarze położonym na NE od wału przedsudeckiego (Kłapciński, 1959) oraz w dolnym wapieniu muszlowym wykształconym w facji świętokrzyskiej (Bialik et. al., 1972). Znane są również z obszaru Niemiec (Schüller, 1967; Vossmerbäumer i Vossmerbäumer, 1969; Schwarz, 1970).

Zlepieńce śródformacyjne występują głównie w tzw. „poziomie zlepieńcowym" stanowiącym spąg górnych warstw gogolińskich (fig. 1). Tworzą one wkładki w osadach wapiennych i marglistych tego poziomu (fig. 3). W osadach tych można obserwować liczne struktury sedymentacyjne takie jak: warstwowania horyzontalne, skośne i faliste, struktury gruzłowe, riplemarki oraz struktury biosedymentacyjne.

Ilość wkładek zlepieńców w obserwowanych odsłonięciach wynosi od 3 do 5. Odległości pionowe między tymi ławicami są rzędu kilkunastu cm do kilku metrów. Miąższość ławic waha się od ok. 10 cm do ok. 30 cm. Górna powierzchnia ławic jest najczęściej równa. Powierzchnia dolna jest równa albo erozyjna. W tym drugim przypadku zlepieniec spoczywa

zwykle na warstewce wapienia mikrytowego (fig. 4A i 4B, pl. III fig. 2). Otoczaki zbudowane są przeważnie z wapienia mikrytowego (pl. IV fig. 1), a czasem z wapienia organodetrytycznego (pl. IV fig. 2) lub laminowanego wapienia detrytycznego (pl. II fig. 2, Pl. IV fig 3). Kształty niektórych otoczaków wskazują na niecałkowicie skonsolidowany materiał pierwotny (pl. III fig. 1). Dyskoidalny kształt większości otoczaków wskazuje jednak, że niszczony materiał był przeważnie dobrze skonsolidowany i wykazywał pewne warstwowanie. Spękania w niektórych otoczakach (pl. III fig. 2) powstały w wyniku pionowych nacisków na sztywne otoczaki. Spękaniu temu sprzyjało w niektórych przypadkach ułożenie otoczaków na nierównym podłożu. Wielkość otoczaków zmienia się w dość szerokich granicach (fig. 6). Maksymalnie osiągają one ok. 25 cm średnicy. Materiał okruchowy jest źle wysortowany. Otoczaki tkwią rzadziej lub gęściej rozmieszczone w organodetrytycznym spoiwie. Składa się ono z licznych fragmentów organicznych najczęściej chaotycznie rozmieszczonych w wapiennym materiale. Czasem otoczaki są równomiernie rozłożone w całej miąższości ławicy, a czasem obserwuje się ich większe nagromadzenie w części dolnej. Otoczaki rzadko stykają się ze sobą, a odległości między nimi wynoszą od kilku do kilkudziesięciu cm. Fig. 4 i fig. 5 pokazują różne typy ławic zlepieńców oraz rozmieszczenie i ułożenie otoczaków. Otoczaki ułożone są najczęściej horyzontalnie, rzadziej chaotycznie, a sporadycznie można obserwować ułożenie dachówkowate. Otoczaki występują także sporadycznie w innych ławicach wapiennych (fig. 5 C).

W otoczakach obserwowano ślady drążenia w postaci kanalików wypełnionych drobno- lub średniokrystalicznym kalcytem. Kanaliki osiągają długość 3 do 4 cm. W przekroju prostopadłym do przebiegu mają one kształt kolisty. Średnica ich nie przekracza 1 mm. Autor uważa, że są to ślady typu *Trypanites*. Wydaje się, że kanaliki były drążone zarówno w otoczakach, jak i w skale pierwotnej, zanim uległa ona erozji.

Zdaniem autora wapienne zlepieńce śródformacyjne w warstwach gogolińskich powstały w warunkach całkowicie podmorskich. Erodowany z dna materiał, przeważnie dobrze skonsolidowany i warstwowany, był przenoszony do miejsca depozycji. Czynnikiem powodującym niszczenie materiału dna było falowanie lub prądy podmorskie. Transport materiału odbywał się w masie szlamu wapiennego z dużą ilością szczątków organicznych w warunkach przypominających spływ błotny.

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EXPLANATION OF PLATES
OBJAŚNIENIA TABLIC

Plate — Tablica I

Fig. 1. Imbrication in the conglomerate

Fig. 1. Ławica zlepieńca z widocznym dachówkowatym ułożeniem otoczaków

Fig. 2. Conglomerate layer with pebbles lying horizontally. In the bottom fragments of a micrite lamina. Moczydło

Fig. 2. Fragment ławicy zlepieńca z horyzontalnie ułożonymi otoczakami. W spągu widoczne fragmenty warstewki wapienia mikrytowego. Fragment pieca wapienniczego w odsłonięciu w Moczydle

Plate — Tablica II

Fig. 1. Conglomerate layer. In the bottom part pebbles show imbrication, in the top part they lie horizontally. On the rightside a pebble with *Trypanites* borings. Moczydło

Fig. 1. Ławica zlepieńca. W części dolnej dachówkowate, a w górnej horyzontalne ułożenie otoczaków. Z prawej strony widoczny otoczak ze śladami *Trypanites*. Fragment pieca wapienniczego w Moczydle

Fig. 2. Conglomerate layer. Pebble with horizontal lamination. Limestone underlying the conglomerate is horizontally laminated. The top and bottom unknown. Moczydło

Fig. 2. Ławica zlepieńca. Otoczak laminowany horyzontalnie. Wapień pod zlepieńcem laminowany horyzontalnie. Strop i spąg nieznane. Fragment pieca wapienniczego w Moczydle

Plate — Tablica III

Fig. 1. Bent pebble

Fig. 1. Wygięty otoczak. Wskazuje on na niezupełnie skonsolidowany materiał pierwotny

Fig. 2. Fractured pebbles. Uneven top surface of the micrite lamina is visible

Fig. 2. Spękane otoczaki. Wskazują one na dobrze skonsolidowany materiał pierwotny. Widoczna nierówna powierzchnia stropu warstewki wapienia mikrytowego

Plate — Tablica IV

Fig. 1. Matrix of the conglomerate with fine micrite clasts. Negative photograph of a thin section

Fig. 1. Zdjęcia negatywowe płytki cienkiej. Spoiwo zlepieńca z drobnymi okruchami wapieni mikrytowych

Fig. 2. Fragment of a pebble made up of organodetrital limestone. Negative photograph of a thin section

Fig. 2. Zdjęcia negatywowe płytki cienkiej. Fragment otoczaka zbudowanego z wapienia organodetrytycznego

Fig. 3. Fragment of a pebble made up of laminated limestone. Laminae are conspicuous by the presence of quartz grains. Negative photograph of a thin section

Fig. 3. Zdjęcie negatywowe płytki cienkiej. Fragment otoczaka zbudowanego z wapienia laminowanego. Laminy zaznaczone obecnością ziarn kwarcu

Fig. 4. Fragment of a pebble with *Trypanites* borings. In the right-hand lower corner a fragment of organodetrital limestone is visible. In the matrix are numerous limestone intraclasts. Negative photograph of a thin section

Fig. 4. Zdjęcia negotywowe płytki cienkiej. Fragment otoczaka z widocznymi śladami drążenia *Trypanites*. W prawym dolnym rogu widoczny okruch wapienia organodetrycznego. W spoiwie liczne intraklasty wapienne


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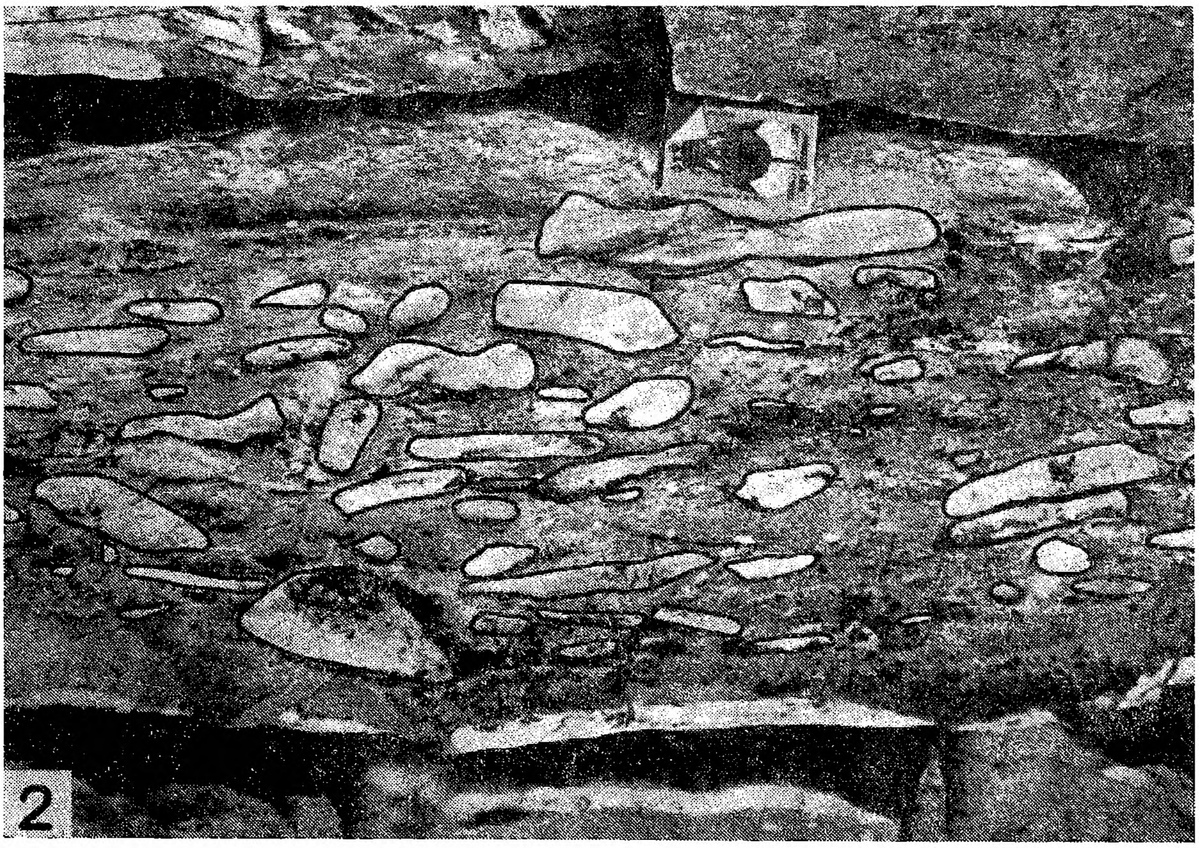
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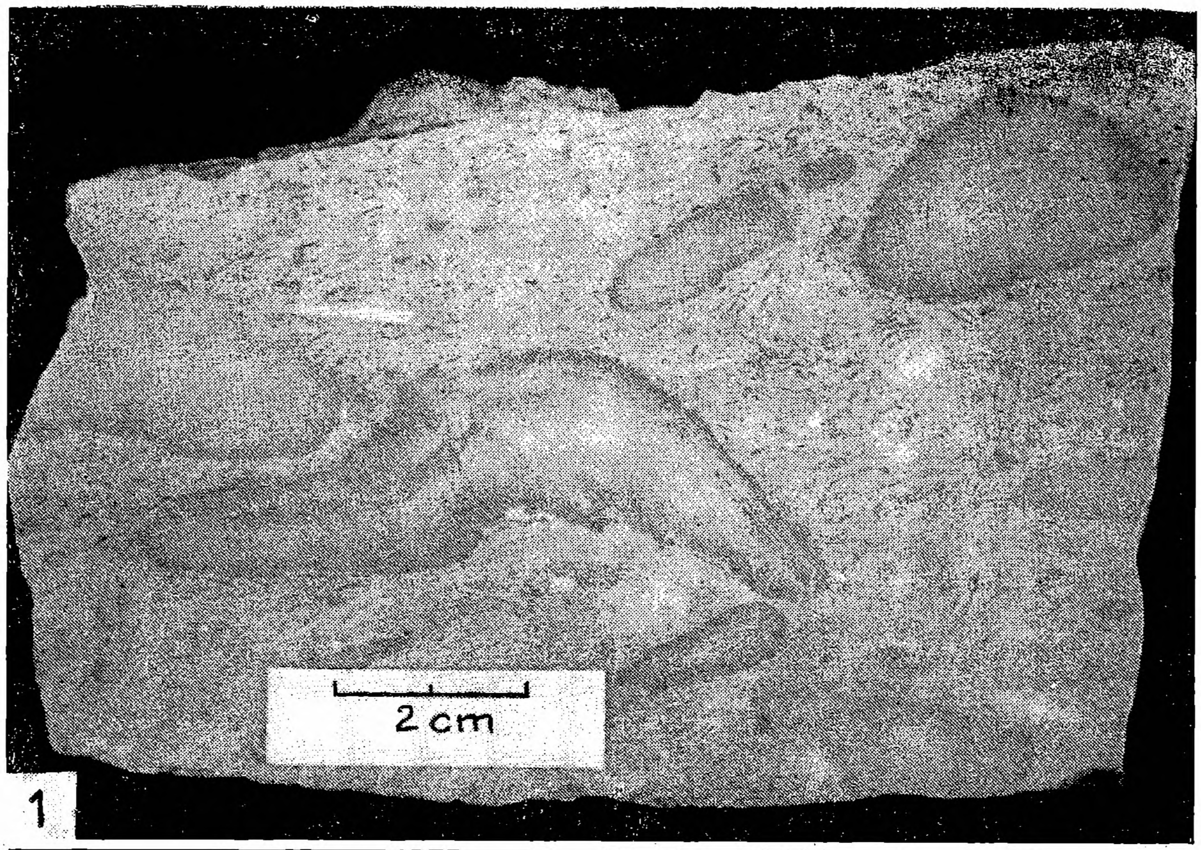

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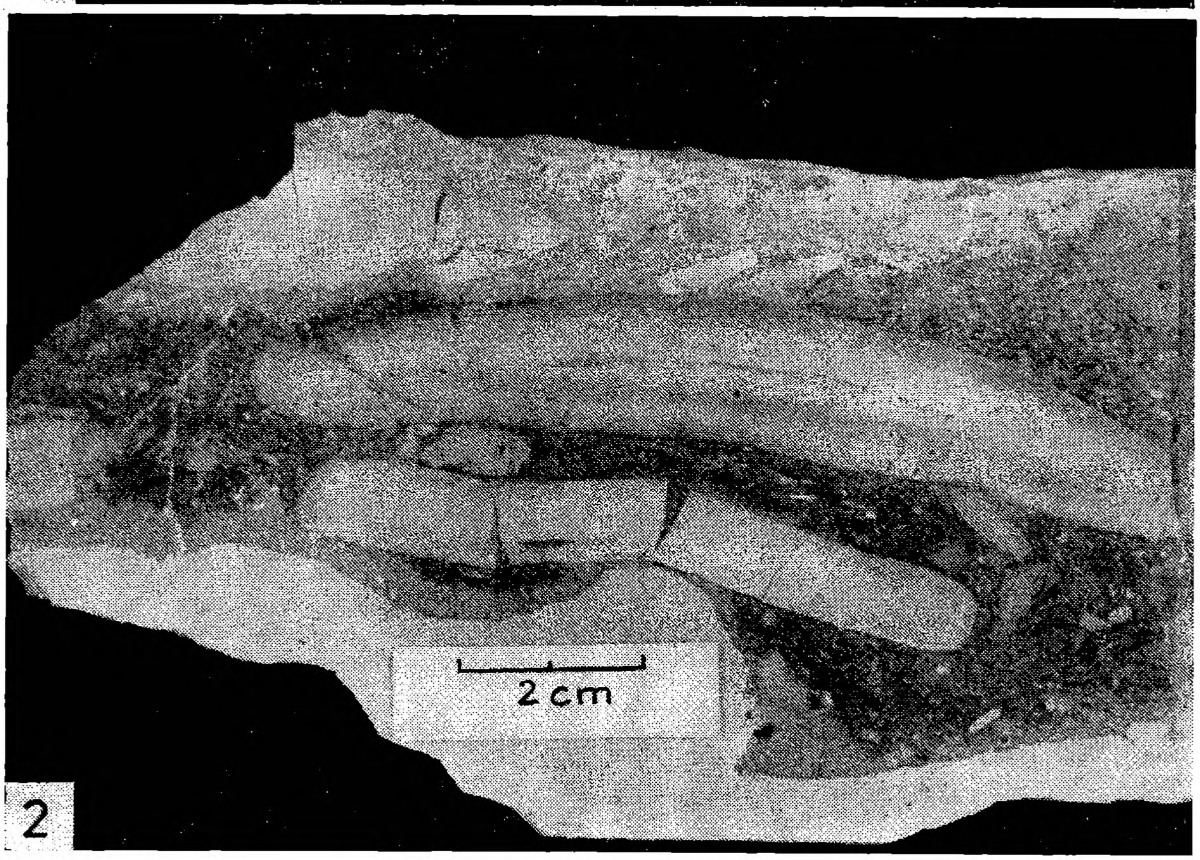

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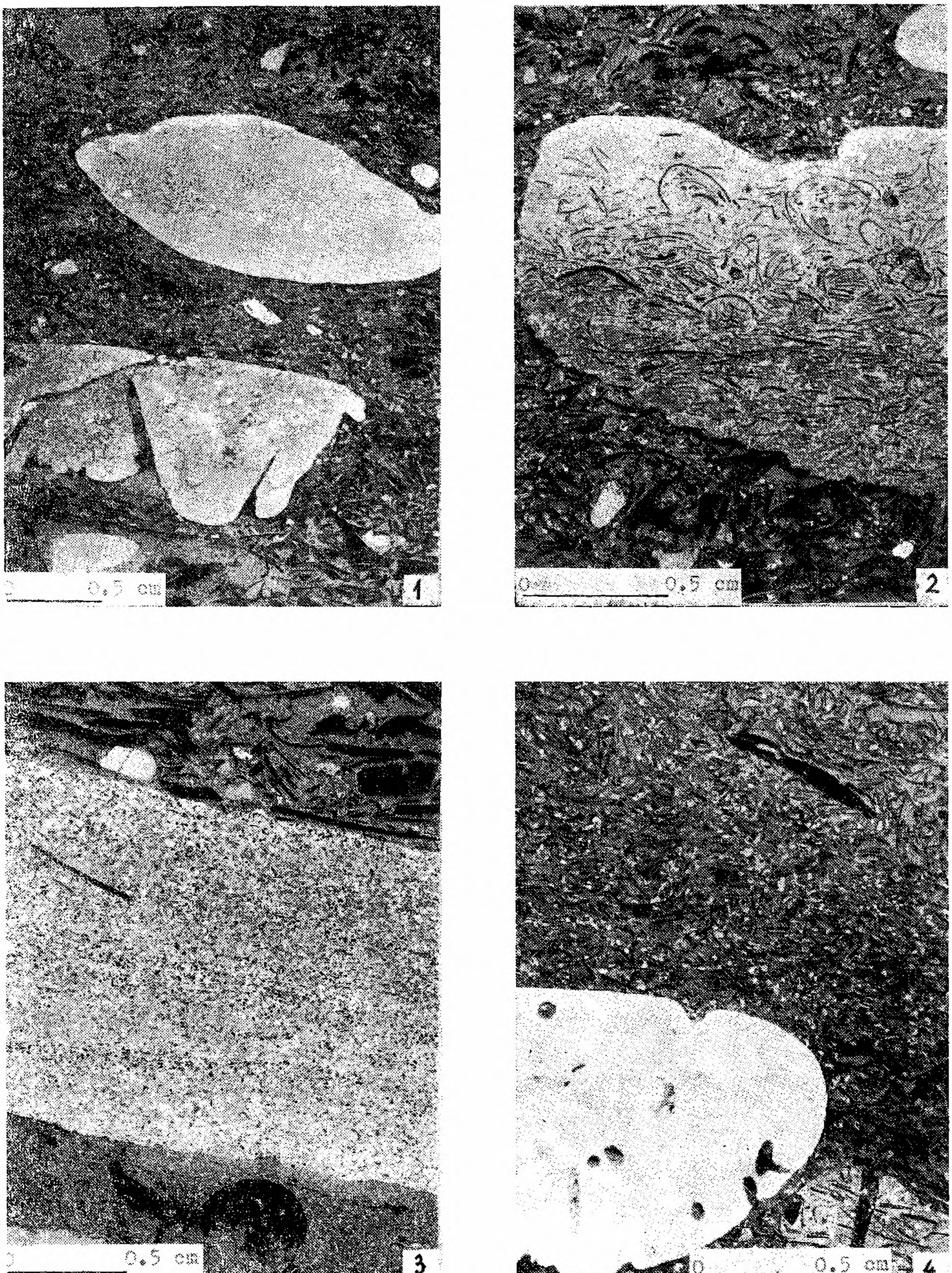
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