Geological Quarterly, Vol. 36, No. 1, 1992, p. 1 – 32

Maria CHOROWSKA, Jerzy FEDOROWSKI, Krzysztof RADLICZ

Famennian and Tournaisian deposits from the Zdanów IG 1 borehole (Sudetes)

The sandy-conglomeratic rocks and limestones, laying on the Góry Sowie Mts gneisses and covered with black claystones, belong to the Kłodzko limestones formation. They are deposits of transgressive cycle in which sea depth changes and short-therm regression occurred. They are dated for the Middle costatus Zone. Their sedimentation have been interrupted by periods of non-deposition of bottom sediments in marine conditions. Such period at the Devonian/Carboniferous boundary lasted from horizon with *Protognathodus* fauna up till lower part of the Upper crenulata Zone. It were stated lack of deposits of the Upper costatus Zone and index species for this horizon among conodonts found in neptunic dykes.

INTRODUCTION

Zdanów IG 1 borehole is located about 13 km northward from Kłodzko. The sandy-conglomeratic rocks and limestones, laying with sedimentary contact on the Góry Sowie Mts gneisses at the depth 1908.6 m, form here the next occurrence of deposits, known in literture as "Upper Devonian from Kłodzko vincinity" or "Kłodzko limestones formation" (J. Oberc, 1987) or "Wapnica sequence" (B. Wajsprych, 1986). These deposits belong to the lithostratigraphic unit of significant importance for geologic evolution of the Góry Bardzkie Mts and — indirectly — for the Middle Sudetes and due that it is valid to determine the age and sedimentary conditions of them. Such data, consequently, allow to explain reasons of deposit lack at Devonian/Carboniferous boundary, to state significant sea deepening in the Upper Tournaisian and dating the uplift of the Góry Sowie Mts gneiss massif for the Upper Devonian.

Conclusions of this study belied earlier suggestions (M. Chorowska et al., 1986) that in the Zdanów IG 1 borehole the Visean conglomerates have layed directly on the gneisses and later on them the older clastic rocks and limestones were overthrusted.

Paleontological dating based on foraminifers, described by R. Conil and K. Radlicz, and conodonts by M. Chorowska. Corals, studied by J. Fedorowski, gave some environmental remarks. Petrographic and microfacies characteristic and analysis of sedimentary conditions were done by K. Radlicz.

Bed sequence and macroscope rock characteristic based on core description were done by M. Chorowska, J. Milewicz and — partly — by K. Radlicz.

LITHOLOGICAL PROFILE

Studied rock sequence layes directly on the Góry Sowie Mts gneisses (Fig. 1). Large part of clastic material in its lower part orgined due erosion of that gneisses. Over gneisses occur upward such deposits:

1908.6–1900.6 m. Grey and grey-brown conglomeratic rock with the gneiss fragments, several mm up several dcm in size, and locally with fine particles of wackes, calcareous siltstones and recrystalized limestones containing relicts of unknown fauna. Matrix content is no more than 25% only locally rises up to 40%. Matrix is mainly fine- or coarse-grained, quartz-micaceous and sometimes it forms clay-silty laminae with densely placed stylolites, enriched also in organic and pyritic matter. Wavy clay-sandy laminae are visible in top part of section, separated by laminae consisted of the gneiss cataclasite. At the depth 1903.5–1902.6 m occur intercalation or block of kaolinized, carbonatized and brecciated diabase tuff with fissures infilled with quartz, chlorite and calcisparite.

1900.6–1900.15 m. Intensely broken rock. Quartz lithoclasts and grains are partly crushed. Zone of shearing.

1900.15–1898.0 m. Conglomeratic rock, composed of: 75% of the limestone lithoclasts and 25% of matrix. This matrix is of quartz-micaceous-bioclastic wacke type (sample 406). Lithoclasts are mainly bioclastic-sandy limestones with the calcisparite cement within algae and bryozoans dominate but also corals, echinus spines, crinoids, ostracods, foraminifers and micrite aggregates occur. Quartz grains, 0.06–0.45 mm in diameter, compose 20–25% of all limestone composition but 3–5% of it are muscovite and biotite plates, 0.3–0.75 mm long. Less abundant are lithoclasts of the biolithic and coral limestones, sometimes with stromatoporoidal covers (samples 405, 406). Lithoclasts are discoidal, densely packed and horizontaly oriented, often with sinusoidal deformations marked by later stylolitization. Components of matrix are: about 50% of quartz (0.03–0.6 mm in diameter), about 5% of biotite and muscovite, the rest are bioclasts of bryozoans, crinoids, *Kamaena* algae and indeterminate remains. Shreds of organic matter and silvery nodules of undistinguished ore minerals as well as irregular, mainly horizontal clay-micaceous strips and laminae occur also within wacke. All this rock is cutted by microstylolites and stylolites enriched in organic matter and pyrite.

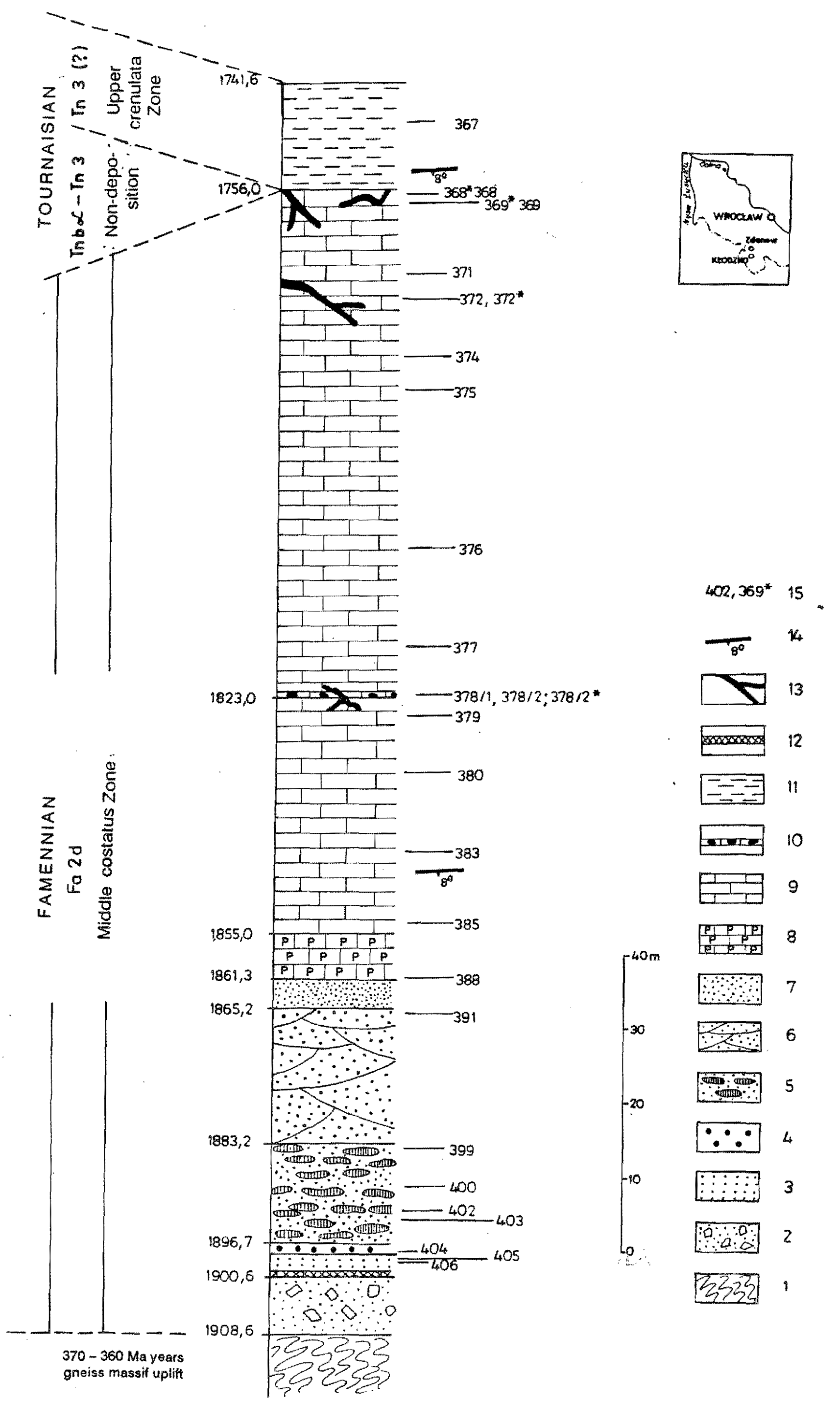
1898.0–1896.7 m. Calcareous lithic greywacke of arenite-rudite type (sample 404), distinctly vari-grained, with irregular, horizontal clay-sandy strips, enriched in micas.

Sharp-edged quartz grains, 0.1–4.2 mm in diameter, dominate within clastic material. Kalifeldspar grains, partly unclear and metasomatically replaced by calcite so as heavy minerals are rare. Frequently occur lithoclasts of sparitic limestones, 0.1–7.5 cm in diameter, with fauna remains and such bioclasts as: crinoids, pelecypods, bryozoans and algae, mainly of genus *Girvanella*. Single carbonate oncoids and large part of quartz grains have micritic carbonate covers. Cement of this lithic greywacke is of calcisparite type.

1896.7–1883.2 m. Grey and dark-grey, massive or locally stratified but mostly nodular limestones, with elongated nodules (protointraclasts), often of icicle shape. These nodules are horizontaly oriented. Intercalations of fine muscovite-biotite-quartz wacke occur between stratified and nodular parts as well as two 10 cm thick beds of such wacke, enriched in coarse quartz material. At the depth 1889.6–1889.4 m. occur brecciated dolomicrite with rare calcispheres, having rim of the organic matter, and with microstylolite relicts. This rock is cutted with several generations of fractures, some of them were infilled with the orthochemical calcite, other ones — with quartz (Pl. I, Fig. 1). Limestones, forming layers and nodules, contain: sandy biosparmicrite of mollusc-gastropod-foraminiferal microfacies with abundant algae, crinoids and bryozoans (sample 403); algal-crinoidal biomicrite with foraminifers, pelecypods, ostracods and corals (sample 402); sandy biomicrite of crinoidal-algal-foraminiferal microfacies with single corals, cephalopods, pelecypods, ostracods and bryozoans (sample 399). Carbonate nodules locally contact along series of wavy microstylolites of low amplitude. Thickness of such series, no less than of two generations, is up to 1.5 cm. They form suture-like surfaces (K. Radlicz, 1966).

1883.2–1865.2 m. Calcareous arenitic greywacke, in top and bottom — ruditic with clasts up to several cm in diameter. They are densely packed, with sink structures and often stylolitic contacts. Clasts of such rudites are: gneisses, blastomylonites, greywackes, sandy limestones with abundant bioclasts of crinoids, bryozoans, algae and siliceous shales. Arenitic greywacke is medium- and fine-grained, has two types of bedding: parallel one, often fractional and trough cross bedding of medium scale, marked with laminae and streaks enriched in micas or leucoxenized minerals (Pl. I, Fig. 3). Greywacke contains: monocrystalline and aggregatic quartz, quartz-chloritic grains, kalifeldspar, albite, grains of leucoxene, leucoxenized pyroxene or amphibole and diabase (Pl. I, Fig. 4) and fragments of blastomylonites, gneisses, unknown weathered rocks, chloritized and calcitized effusive rocks, siliceous shales, sparitic and biosparitic limestones with fauna (sample 391). Rarely were found mostly recrystalized bioclasts of algae *Solenopora* sp., crinoids, echinoderms, bryozoans and pelecypods. Grains are of variable shapes, from isometric to discoidal, mainly well or partially rounded, rarely sharp-edged. Cement is of calcisparite or calcimicrite type. Locally such arenites pass into wackes which differ from them mainly with presence of argillic matrix and higher content of micas.

1865.2–1861.3 m. Arenitic greywacke with the calcisparite cement, in upper part passing into quartz-micaceous wacke with argillaceous matrix and concentrations of pyrite, pyrrhotite and carbonaceous matter. Wacke contains 50% of quartz grains, 0.07–0.45 mm in diameter, chlorite, biotite, muscovite and rare bioclasts of crinoids and bryozoans. Greywacke contains quartz grains, 0.15–0.2 mm in diameter and albite


TOURNAISIAN
Tn 3 (?)
Upper crenulata Zone
Non-deposition
FAMENNIAN
Fa 2d
Middle costatus Zone
370 – 360 Ma years gneiss massif uplift
1741,6
1756,0
1823,0
1855,0
1861,3
1865,2
1883,2
1896,7
1900,6
1908,6
367
368* 368
369* 369
371
372, 372*
374
375
376
377
378/1, 378/2; 378/2*
379
380
383
385
388
391
399
400
402
403
404
405
406
8°
40m
30
20
10
0
WROCŁAW
KŁODZKO
402, 369* 15
14
13
12
11
10
9
8
7
6
5
4
3
2
1

ones as well as clasts of blastomylonites, gneisses, diabases and intensely weathered unknown rocks.

1861.3–1855.0 m. Dark-grey pelbiosparitic limestone with calcisparite cement (Pl. II, Fig. 1), containing in its lower part about 5% quartz and muscovite grains and quartz-muscovite aggregates. It is composed mainly of peloids, surficial ooids with bioclasts in nucleus, bioclasts and intraclasts of biomicritic limestones. Among bioclasts were found pelecypods, foraminifers, echinoderms, ostracods and strongly recrystalized unidentified remains. This limestone is cutted by stylolites enriched in quartz-muscovite sand and pyrite.

1855.0–1836.0 m. Biosparitic and partly biosparmicritic limestone of algal-foraminiferal microfacies, with bioclasts of crinoids, pelecypods, echinoderms, ostracods, corals and sometimes with frequent styliolinids like forms (sample 383). Limestone is of nodular type, cutted by microstylolites and stylolites enriched in pyrite. Locally along such structures occur concentrations of fibrous calcite, perpendicular to stylolite seams. This limestone is cutted by stylolites and calcisparitic veins.

1836.0–1823.0 m. Nodular, strongly recrystalized limestone of foraminiferal-algal microfacies with crinoids and ostracods. There occur zones with microstylolites enriched in carbonaceous matter, frequent veins of coarse- and medium-crystalline calcite and 20 cm thick anhydrite vein (depth 1833.2–1833.0 m), composed of the anhydrite blades, idiomorphic quartz (Pl. III, Fig. 2) and porphyroblasts of anhydrite, polyhalite and calcisparite (Pl. III, Fig. 1).

1823.0–1822.3 m. Nodular deposit with nodules size from several mm up to 20 cm, composed of grey bioarenitic-ruditic limestone, crinoidal-plagioclase in type, with foraminifers, algae and pelecypods (sample 378/1; Pl. II, Fig. 2), and of grey biosparmicritic, partly algal-foraminiferal limestone with echinoderms, gastropods,

←

Fig. 1. Profile of the Famennian and Tournaisian deposits in the Zdanów IG 1 borehole

1 — gneiss; 2 — gneiss-lithoclastic ruditic breccia; 3 — quartz-micaceous-bioclastic wacke with limestone lithoclasts; 4 — carbonaceous lithic greywacke; 5 — micaceous-quartzose wacke with layers and nodules (protointraclasts) of limestones; 6 — carbonaceous greywacke with large amount of leucoxene, mainly with cross, trough bedding; 7 — quartz-micaceous wacke and arenitic greywacke; 8 — pelbiosparitic limestone with frequent surficial ooids; 9 — biosparitic and biomicritic nodular limestones of algal-foraminiferal microfacies, in upper part — with large fragments of coral colonies; 10 — nodules of bioarenitic-ruditic, crinoidal-plagioclase limestone and of biomicritic, algal-foraminiferal limestone with rare plagioclases; 11 — black claystone, partly siltstone with 2 cm radiolarite intercalation; 12 — tectonic zone; 13 — neptunic dykes; 14 — bed dip; 15 — sample numbers (* fragments of neptunic dykes)

Profile utworów famenu i turneju w otworze Zdanów IG 1

1 — gnejs; 2 — brekcja rudytowa, gnejsowo-litoklastyczna; 3 — waka kwarcowo-łyszczykowo-bioklastyczna z litoklastami wapieni; 4 — szarogłaz wapnisty, lityczny; 5 — waka łyszczykowo-kwarcowa z warstewkami i gruzłami (protointraklastami) wapieni; 6 — szarogłaz wapnisty z dużą ilością leukoksenu, przeważnie warstwowany skośnie, rynnowo; 7 — waka kwarcowo-łyszczykowa i szarogłaz arenitowy; 8 — wapień pelbiosparytowy z licznymi ooidami powierzchniowymi; 9 — wapienie gruzłowe biosparytowe i biomikrytowe mikrofacji glonowo-otwornicowej, w górnej części z dużymi fragmentami kolonii koralowców; 10 — gruzły wapienia bioarenitowo-rudytowego, liliowcowo-plagioklazowego oraz wapienia biomikrytowego, glonowo--otwornicowego z nielicznymi plagioklazami; 11 — czarny iłowiec, częściowo mułowiec z dwucentymetrową wkładką radiolarytu; 12 — strefa tektoniczna; 13 — żyły neptuniczne; 14 — upad warstw; 15 — numery próbek (* fragmenty żył neptunicznych)

bryozoans of *Fenestrella* group, ostracods, single plagioclase plates, fine autigenic quartz and oncoids (sample 378/2). Nodules contact along microstylolite and stylolite systems, riched in pyrite. *Cone in cone* structures in form of veins of fibrous calcite with autigenic quartz occur within these stylolites (Pl. II, Fig. 3). Besides of mentioned limestones this rock has streaks of various shape and thickness, consisted of light-grey micritic limestone, locally laminated, with calcisparite concentrations, single ostracods of *Entomozoidae* group and other undiscerned organic remains (sample 378/2*). Also abundant crystals of autigenic quartz occur locally there. These streaks are interpreted as neptunic dykes.

1822.3–1756.0 m. Grey, nodular, biosparmicritic and partly biomicritic limestone of algal-foraminiferal microfacies with large amount of crinoids, with bioclasts of bryozoans from *Fenestrella* group, ostracods, pelecypods, tentaculites (sample 372; Pl. III, Fig. 3), less of brachiopods and with bush-like fragments of colonial corals up to 80 cm in size. In lower section of limestone the part of bioclasts have relict micritic covers.

Within described core section streaks and fine intercalations were found, differing in microfacies type and bioclasts composition from surrounding rocks: at the depth 1770.5–1770.3 m occur (sample 372*) irregular streak of the micritic limestone with bioclasts of pelecypods, cephalopods, ostracods, trylobites,conodonts, plagioclase plates, single biotite scales and autigenic quartz grains; at the depth 1757.5–1757.3 m was found (sample 369*) nest-like structure of carbonate micrite with abundant, broken, strongly recrystallized bioclasts, conodonts, plates of calcitized plagioclases, bar-shape crystals of autigenic quartz, veins and nests of autigenic calcite with pyrite concentrations; at the depth 1756.6–1756.5 m (sample 368*) occur the streak of the micritic limestone with numerous organic remains (Pl. III, Fig. 4) and of pelitic claystone with rare grains of detrital quartz, muscovite plates, fine fragments of limestones and organic relicts (Pl. II, Fig. 4).

Boundaries between biosparmicrite and micritic limestone or pelitic claystone, forming these streaks, are sharp, irregular, mostly of microstylolitic type. There are no less than two generations of microstylolites and stylolites, occurring within all carbonate sequence.

1756.0–1741.6 m. Black claystone with large amount of micas, nests and strips of pyrite. At the depth 1747.2 m occur 2 cm thick radiolarite layer, strongly impregnated with carbonaceous matter. This radiolarite is cutted by fractures, infilled with quartz or calcisparite (sample 367).

SEDIMENTARY CONDITIONS

Analysis of described above lithological profile indicated that clastic and carbonate deposits build a trangressive cycle with characteristic basin shallowing and deepening, interrupted by short-term regression. The period of non-deposition was strongly pronounced, after which considerable deepening of sedimentary basin took place.

The transgressive cycle began with ruditic breccia (depth 1908.6–1900.15 m), composed of chaoticaly placed large fragments of gneisses and less abundant, finer clasts of metamorphic and sedimentary rocks. Within this breccia occurred carbonitized diabase tuff in form of block or intercalation 0.8 m thick. Regarding it as intercalation it is supposed that volcanic activity has accompanied beginning of transgressions.

Finer detrital deposit, found at the depth 1900.15–1898.0 m confirmed further transgression development. It was quartz-micaceous-bioclastic wacke, containing fragments of bioclastic limestones with large amount of quartz and micas and of biolithic coral limestones. These limestones have origined on shoals, limiting the supply of coarser gneiss material to deeper basin parts, where wacke has accumulated. Due intensive submarine erosion the pieces of limestones have been transported into that deeper zone and deposited in bottom sediments, forming within wacke beds of densely packed discoidal lithoclasts. Observed sinusoidal deformations of large number of lithoclasts have resulted from sink processes, acting under overburden in conditions of unstable density stratification of sediments. Later stylolization marked such sink structures.

The lithic, arenitic-ruditic greywacke, found at the depth 1898.0–1896.7 m, indicated more intensive supply of coarser gneiss material due to expanding marine transgression. This greywacke has origined in environment with hydrodynamic conditions. Periodical diminishing of its energy was documented with clay-micaceous streaks. Energy vanishing could be connected with separation of the deposition place of clay-micaceous material from open basin by sandy long-shore bars.

More frequent occurrence of limestone protointraclasts and later the layers of massive or partly stratified limestones (see — depth 1896.7–1883.2 m) indicated more distant deposition from basin margin. In this core section are important nodules (protointraclasts), composed of algal-crinoidal biomicrite with foraminifers, pelecypods, ostracods and corals of the new genus and species *Sudetiphyllia aphroides* Fedorowski (sample 402; Pl. V, Figs 1,2). Occurrence of dolomicrite here was also characteristic (sample 400; Pl. I, Fig. 1).

Deposits, noticed at the depth 1883.2–1865.2 m, documented short regression period. They were carbonaceous greywackes with two types of stratification: parallel, often fractional and through cross bedding marked with laminae enriched in micaceous material but in upper part of section — in leucoxene grains (sample 391; Pl. I, Fig. 3). Mineral and structural maturity of these deposits as well as calcisparitic cement indicated that such sediments have origined in beach zone.

The quartz-micaceous wacke with rare bioclasts, found at the depth 1865.2–1861.3 m, denoted next transgression stage. This deposit reflected back-barrier facies and have accumulated in low energy environment. Similar character have overlaying biopelsparitic limestones of the bahamite type (depth 1861.3–1855.0 m), containing surficial ooids (sample 388; Pl. II, Fig. 1).

During next transgression stages biosparitic limestones of algal-foraminiferal microfacies have origined (depth 1855.0–1823.0 m). These carbonates, rich in chlorophyta of *Kamaena* and cyanophyta of *Girvanella* genera, indicated sedimentation within photic, litoral zone. They were distinctly nodular, variably recrystalized. Calcite and anhydrite veins of unknown origin, up to 30 cm thick, occurred within them (samples 380 and 379). Such veins contained typical evaporitic paragenesis of anhydrite together with polyhalite, quartz and calcite (Pl. III, Figs 1, 2).

Most of the nodules, occurring within the rock, found at the depth 1823.0–1822.3 m, consisted of limestone, the main components of which were: crinoidal bioclasts and idio- and hipidiomorphic plates of pyroclastic (sample 378/1; Pl. II, Fig. 2). Other nodules were composed of algal-foraminiferal limestone with small amount of plagioclases. It could be suspected that during deposition of mentioned limestones were some changes in itensity of supply of pyroclastic material. Occurrence there of the neptunic dyke, infilled with carbonaceous micrite, locally laminated, with rare ostracods of *Entomozoidae* group and indeterminable organic remains (sample 372/2*; Table 1), was particulary important. Such ostracods indicated pelagic sedimentary environment (*vide* M. Narkiewicz, 1978). This dyke was the only one proof that in described sedimentary zone have existed for some time the deep sea conditions with non-deposition of bottom sediments.

After period of sea deepening and — as was supposed — non-deposition of bottom sediments (term "non-deposition" after M. Szulczewski, 1978), was the next phase of accumulation of biosparmicritic and biomicritic limestones (sequence from the depth 1823.0–1756.0 m). They were algal-foraminiferal limestones, partly nodular. There were frequent fragments of colonial coralls, from 20 to 80 cm in size, representing species *Stylostrotion sudeticum* Fedorowski (Pl. IV, Figs 6, 7). These corals prooved that limestone deposition has taken place in more stagnant waters of open sea. Almost undamaged coral colonies with good preserved corallites and complete or slightly damaged epithecas and with incorporated within colonies broken branches indicated that they have been rapidly detached from basement, probably during strong storms, transported for short distance and quickly buried. Stromatoporoidal covers have formed on the unburied branches (Pl. V, Fig. 3), suggesting the water depth no more than 40 m.

In upper part of biosparmicritic and biomicritic limestones occurred streaks of micritic limestones with bioclasts of trilobites, cephalopods and conodonts. Facies differences between biomicritic limestones with fauna and algae typical for shallow litoral zone and micritic carbonates with pelagic fauna of open sea suggested that the last ones infilled the neptunic dykes and were relicts of other marine environment in conditions of non-deposition. The found neptunic dykes were of two generations. Older were carbonaceous-micritic (samples 369* and 368*; Pl. III, Fig. 4) but younger ones were infilled with clay-pelitic material, enriched in organic matter and sulphides (sample 368*; Pl. II, Fig. 4).

These two dyke generations indicated no less than two phases of long-term non-deposition of bottom sediments for their origin. The second phase was related with significant deepening of marine basin and change of geochemical environment. Accumulation of black claystones, partly pelitic, with radiolaritic intercalations, which occurred over biosparmicritic limestones of algal-foraminiferal microfacies after non--deposition break, has documented further basin depth growth. The suspected water depth during that time could reach no less than several hundreds meters.

BIOSTRATIGRAPHIC POSITION

Biostratigraphic position of studied deposits was possible to define only basing on foraminifers and conodonts (Table 1). Better preserved section of stratigraphically important foraminifer species were shown on Plate IV but photos of most of conodonts — on Plates VI, VII. Table 2 contained correlation of foraminiferal and conodont zones with relations to the Famennian and Tournaisian division according cephalopods. Letter symbols, used to mark stratigraphic units in Table 1 and in profile description (Fig. 1), were after similar ones for the Famennian/Tournaisian boundary in the French-Belgian Basin.

Organic remains were not found in ruditic, gneiss-lithoclastic breccia, laying directly on gneiss at the depth 1908.6–1900.6 m. Firstly authors regarded this rock as equivalent of the Upper Visean gneiss conglomerates, occurring in Nowa Wieś (M. Chorowska et al., 1986). M. Paszkowski suggested that this breccia had sedimentary transition with overlaying deposits. Later studies documented that this rock, with variable composition and large size of gneiss clasts but smaller of sedimentary rocks, has began transgressive cycle. Next unit of such cycle was quartz-micaceous-bioclastic wacke, containing muscovite-argillic streaks and laminae. Similar ones also occurred in upper parts of breccia. Tectonic zone, found at the depth 1900.6–1900.15 m, was not the overthrust of older sequence on younger one but was only displacement along the interbed weakness planes.

First biostratigraphic indicators were found at the depth 1893.0 m (sample 403). They were foraminifers, which — similary as ones from upper part of studied sequence (samples 372 and 371) — documented the uppermost Famennian age. The foraminifers assemblages with species *Quasiendothyra regularis, Q. regularis radiata, Q. communis radiata, Q.* cf. *kobeitusana, Q. parakosvensis, Q. parakosvensis struniana* documented the zones from Q. regularis to Q. radiata eventuel Q. kobeitusana. These zones are the equivalent of the Middle costatus Zone of the conodont ones.

Conodonts occurred in carbonaceous micrite of neptunic dykes. At the depth 1770.3 m (sample 372*; Table 1) there were only conodont remains, undistinguished even to genus. They did not allow to define the time period of carbonate micrite accumulation. Fragments of cephalopods and other fauna, found also there, were unuseful for biostratigraphic dating. They indicated pelagic environment. Fractures, forming in this zone of marine basin, have infilled with carbonate mud during periods of non-deposition of bottom sediments.

Conodonts, found in carbonate micrite at the depth 1757.3 m (sample 369*; Table 1), documented the Tournaisian age. Occurrence of both species: *Pseudopolygnathus fusiformis* Branson et Mehl and *Siphonodella obsoleta* Hass suggested that this limestone origined in time period from the S. – triangulus inaequalis Zone up to lower part of the Upper crenulata Zone. *Siphonodella obsoleta* Hass occurred firstly in S. – triangulus inaequalis Zone; in turn species *Pseudopolygnathus fusiformis* Branson et Mehl disappeared in lower part of the Upper crenulata Zone.

Conodont assemblage, noticed in micritic limestone from the depth 1756.5 m (sample 368*; Table 1) had mixed character. Beside species *Protognathodus meischneri* Ziegler and *Pseudopolygnathus dentilineathus* Branson, of which the first one disap-

Fauna and algae from clastic

Algae, Foraminifers, Corals, various fauna, Conodonts	Famennian Fa2d							
	406**	405	403	402	399	391	388	385
	1898.3***	1898.0	1893.0	1891.7	1883.2	1865.5	1861.0	1853.5
1	2	3	4	5	6	7	8	9
Girvanella problematica Nicholson et Etheridge	x		x	x	x		x	x
Girvanella wetheredi Chapman			x		x			
Rodophyta			x		x			
Solenoporaceae						x	cf.	
Issinella sp.								
Kamaena sp.	x			x	x			x
Vermiporella sp.	x							
Quasiumbella sp.					x			
Diplosphaerina inaequalis (Derville)				x	x		x	x
Radiosphaera basilica Reitlinger								
Bisphaera irregularis Birina,	cf.		x	cf.			x	x
Earlandia elegans (Rauser et Reitlinger)								
Septabrunsiina sp.			x	x				
Baelenia sp.								
Endochernella sp.								
Endothyra concavacamerata (Lipina)								
Endothyra parakosvensis Lipina			x					
Endothyra parakosvensis struniana (Conil et Lys)								
Endothyra sp.				x	x		?	x
Quasiendothyra regularis regularis (Lipina)								x
Quasiendothyra regularis radiata (Lipina)					cf.			
Quasiendothyra communis communis (Rauser)			x		x			x
Quasiendothyra communis radiata (Reitlinger)				x	x			x
Quasiendothyra kobeitusana (Rauser)								
Quasiendothyra sp.					x		cf.	x
Dividocorallia: Stylostrotion sudeticum Fedorowski								
Dividocorallia: Sudetiphyllia aphroides Fedorowski	x	x		x		x		
cf. Guerichiphyllum Różkowska					x			
Bryozoans of *Fenestrella* group	x		x		x			
Pelecypods			x	x	x	x	x	
Gastropods			x		x			
Styliolinids like forms								
Tentaculites								
Cephalopods					x			
Trylobites								
Ostracods	x		x	x	x		x	x
Crinoids	x		x	x	x	x	x	x
Echinoids								
Echinoderms							x	
Brachiopods								
Ostracods of *Entomozoidae* group								

* fragment of neptunic dykes; ** sample number; *** depth in metres

Table 1

and carbonate deposits and claystones

Famennian Fa2d											?	Tournaisian Tn1bα–Tn3		Tournaisian Tn3(?)
383	378/1	378/2	378/2*	377	376	375	374	372	371	368	372*	369*	368*	367
1843.9	1822.5	1822.5	1822.5	1816.6	1803.2	1782.4	1778.0	1770.3	1767.2	1756.5	1770.3	1757.3	1756.5	1747.2
10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
x		x		x	x	x	x	x	x	x				
		x								x				
x	x	x		x		x		x	x	x				
x		x		x	x	x	x	x	x	x				
x														
		x		x				x		x				
				x						x				
		x					cf.	x	x	x				
								cf.	cf.					
									x					
x									x					
x		x		x		x				cf.				
								cf.	aff					
x		x		x	x	x	x	x	x	x				
x						x			x	x				
x														
x	x	x			cf.	x	cf.	x	x	x				
x	x			cf.	x	x			x	x				
cf.														
x	x			x		x		x	x	x				
					x		x							
x		x		x	x	x	x		x	x				
x	x			x				x	x	x	x			
		x												
x														
						x		x						
											x			
											x			
x		x		x	x	x		x	x	x	x			
x		x		x	x	x	x	x	x	x				
		x									x			
					x		x							
			x											

1	2	3	4	5	6	7	8	9
Polygnathus cf. *bardensis* Chorowska								
Polygnathus communis communis Branson et Mehl								
Polygnathus inornatus s. l. Branson								
Polygnathus purus purus Voges								
Polygnathus symmetricus Branson								
Polygnathus sp.7 Chorowska								
Protognathodus meischneri Ziegler								
Pseudopolygnathus dentilineatus Branson								
Pseudopolygnathus fusiformis Branson et Mehl								
Pseudopolygnathus cf. *fusiformis* Branson et Mehl								
Pseudopolygnathus multistriatus Mehl et Thomas								
Pseudopolygnathus triangulus pinnatus Voges								
Siphonodella isosticha (Cooper): → *S. obsoleta* Hass								
Siphonodella obsoleta Hass								
Siphonodella quadruplicata (Branson et Mehl)								
Siphonodella var. sp. – pieces								
Spathognathodus cf. *campbelli* Rexroad								
Conodonts in thin plate, unidentified								

peared in the kockeli-dentilineatus Zone but second one — in the Siphonodella – triangulus triangulus Zone, were also *Pseudopolygnathus triangulus pinnatus* Voges, which occurred firstly just above bottom part of the Lower crenulata Zone, and *Siphonodella isosticha* (Cooper) → *S. obsoleta* Hass, also unknown from lower sections than from the Lower crenulata Zone. Species *Siphonodella quadruplicata* (Branson et Mehl), found in that assemblage, was known from the Siphonodella triangulus triangulus Zone up to the Siphonodella crenulata one. Species *Protognathodus meischneri* Ziegler and *Polygnathus purus purus* Voges, very abundant in the horizon with *Protognathodus* fauna, indicated that fracture infilling with carbonate mud could begin at transition between the Famennian and Tournaisian. Accumulation in this fracture probably had finished in the Upper crenulata Zone, above of which was unknown species *Siphonodella quadruplicata* (Branson et Mehl), also occurring in described conodont assemblages.

It was impossible to define in which part of the crenulata Zone has finished the sedimentation of carbonate mud in fractures of sea bottom and that these fractures have been infilled gradually or they have been opened and closed several times.

Studies of the clay-pelite infilling of the neptunic dyke, cutting at the depth 1756.5 m (sample 368*) the older micritic-carbonate vein, did not supplied the palaeontological data. This dyke resulted from infilling of fracture in conditions of deeper sea but without accumulation of deposit on all bottom surface. The black claystones, laying in lithostratigraphic profile directly on biosparmicritic limestones of algal-foraminiferal microfacies, indicated remarkable marine basin deepening and return to

c. d. tab. 1

10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
												x		
													x	
													x	
												x	x	
												x		
												x	x	
													x	
													x	
												x		
												x		
													x	
													x	
													x	
												x	x	
													x	
														x
												x		
											x			

bottom deposit sedimentation. It is not unlikely that black claystones could accumulate as early as in the Upper crenulata Zone. They didn't accumulate later than in Tournaisian. Conodont fragments of genus *Siphonodella* were found in radiolarite, occurring as intercalation within these claystones at the depth 1747.2 m (sample 367). The representatives of genus *Siphonodella* disappear at the end of Tournaisian.

The discussed results of palaeontological dating indicated that sedimentation of transgressive coarse clastic deposits has began in the Upper Famennian, no earlier than in the Middle costatus Zone (Fa2d). In the Upper costatus Zone the general conditions were of such kind that prevented accumulation of bottom sediments. It was unlikely that during the length of this Zone has began the accumulation of carbonate muds within fractures, cutting then sea bottom. Lack of characteristic conodonts for the Upper costatus Zone in carbonate micrites forming neptunic dykes suggested that such fracture infilling has began during Zone with *Protognathodus* fauna. Non-deposition period has lasted no less than up to lower part of the Upper crenulata Zone. In upper part of this horizon, due to remarkable deepening of marine basin, has began probably sedimentation of black claystones with radiolarite intercalations.

Rocks of lower part of analysed sequence, sedimentation of which — according mentioned palaeontological data — has taken place in the Upper Famennian, detaily during the Middle costatus Zone, were composed of clasts of the lowerlaying gneisses of the Góry Sowie Massif. During the Upper Famennian this massif should be uplifted and intensively eroded. That conclusion agreed with results of last isotopic studies, documented age of the end of progressive metamorphism, magmatic activity and

Table 2

Correlation of foraminifer, conodont and cephalopod zones of the Famennian and Tournaisian

Stage	Zone and genus of ammonites	Conodont zones (W. Ziegler, 1962, 1971; C.A. Sandberg, W. Ziegler 1973)	Conodont zones (A. Voges, 1960; W. Ziegler, 1962, 1969)	Conodont zones (C.A. Sandberg et al., 1978)	Foraminiferal zones French-Belgian Basin (R. Conil, R. Dreesen et M. Streel, 1985, unpublished)			
Tournaisian	Pericyclus stage	P. com. carina; bouck.; bult.; cf. bult.; D. hassi	Upper crenulata	isosticha — Upper crenulata	Gran. Im. Par.	Tn3	Ivor.	Tournaisian
		Gn. delic.			Spinobruns.	Tn2c	Hastar.	
		S. crenulata	Lower crenulata	Lower crenulata	Pal. tchern.; Chern. giom.	Tn2b; Tn2a		
	Zone crassa	S. sandbergi	Siphonodella triangulus triangulus	sandbergi		Tn1b β		
	westfalicus; dorsoplanus	S. duplicata	Siphonodella triangulus inaequalis	U; L duplicata	Aresn.	Tn1b α		
	subinvoluta; acutum	Pr. kuehni; S. sulcata	* kockeli – dentilineatus; Górna fauna Protognathodus	sulcata				
Famennian	Imitoceras; Cyrtoclymenia	Pr. kockeli; ?; S. praesulcata U	Lower fauna Protognathodus	praesulcata	? ?	?	Strun.	Famennian
	Wocklumeria	B. costatus U; S. praesulcata M, L	Upper costatus; Middle costatus		Qu. konensis; Qu. kobeitus.	Tn1a		
	Clymenia	B. costatus M, L; P. expansa U, M	Lower costatus		Qu. radiata; Qu. regularis	Fa2d; Fa2c		
		P. styriacus; P. postera U, L	U, M, L styriacus		?			
	Platyclymenia	Sc. velifer; P. trachytera U, L	U, M, L velifer		Qu. communis; ?	Fa2b		
		P. marginifera; P. margin. U, L	marginifera		Qu. bella; ?	Fa2a		
	Cheiloceras	P. rhomboidea	rhomboidea					
		P. crepida	crepida			Fa1b		
		U, M, L P. triangularis	U, M, L triangularis			Fa1a		
Frasnian	Manticoceras	P. gigas	gigas			"F3"		
		A. triangularis	A. triangularis		Nanic.	"F2ij"		

* sulcata – kockeli Zone

and uplifting of the Góry Sowie Mts complex respectively for 381±2, 370±4 and 370–360 Ma (O. van Breemen et al., 1988). Period of gneiss complex uplift, related to the Frasnian or Lower Famennian, was marked in mln years on profile of the Zdanów IG 1 borehole (Fig. 2).

CONCLUSIONS

Studies of character and age of clastic and carbonate rocks, occurring in the Zdanów IG 1 borehole directly on gneisses and covered with black claystones, enlarged recent knowledge about development and age of the Kłodzko Limestones Formation. Beach deposits, up till now unknown in this formation, were found in studied profile. From limestones of shallow-water sedimentation zone were noticed new species *Stylostrotion sudeticum* Fedorowski and new genus and species *Sudetiphyllia aphroides* Fedorowski, which allowed to distinguish new subgenus *Dividocorallia* Fedorowski and new order *Calyxocorallia* Fedorowski.

The coarse clastic deposits, laying directly on gneisses, were typically transgressive. Transgression has began in the Upper Famennian, in the Middle costatus Zone. At its beginning small water depth changes in basin have existed accompanied with seaward and inland movements of the shoreline up to short-time regression phenomena, during which beach deposits have origined. During the next transgression phase deposits of bahamite facies have formed in the back-barrier zone and later — limestones of algal-foraminiferal microfacies in litoral zone at depths up to 40 m. Accumulation of these limestones have been broken by periods of sea deepening and non-deposition of bottom sediments, documented by neptunic dykes with pelagic fauna (noticed in profile at the depths 1822.5 and 1770.3 m). Feldspars and pyroclastic quartz grains, found in limestones from the depth 1823.0–1822.3 m, indicated seasonal supply of volcanogenic material.

Sedimentation of limestones of algal-foraminiferal microfacies have taken place in period, including foraminiferal zones from *Quasiendothyra regularis* up to *Quasieendothyra radiata* or *Quasiendothyra kobeitusana,* which corresponds to conodont horizon of the Middle costatus Zone.

Deposits of the Upper costatus Zone was absent in studied sequence. Probably during this time in regarded part of marine basin have existed conditions unfavourable for bottom sedimentation. Neptunic dykes, composed of carbonate micrite with cephalopod remains, indicated that during period from horizon with *Protognathodus* fauna up to lower part of the Upper crenulata Zone the pelagic conditions have dominated in discussed basin zone. Neptunic dykes of younger generation, infilled with clay-pelitic material, indicated the deepening of this area. Further deepening, probably up to several hundreds meters, finishing period of non-deposition of bottom sediments, was marked by accumulation of black claystones with radiolarite intercalations. Such claystones have began to origin no earlier than in upper part of the Upper crenulata Zone but it was not unlikely that in the Lower Visean.

Non-deposition of bottom sediments have lasted for a long time. It was impossible — according studies results — to define that bottom fractures have been infilled with carbonate micrite gradually from horizon with *Protognathus* fauna up to lower part of the Upper crenulata Zone or they have opened and closed several times. It was sure that later fracture generation, infilled with clay-pelitic material, have origined during period of sea deepening.

The Góry Sowie Mts gneisses, on which these transgressive deposits layed, have been intensely eroded in the Middle costatus Zone. It suggested that the Góry Sowie Mts gneiss massif should be uplifted before the Upper Famennian. This conclusion agreed with results of isotopic studies according which the Góry Sowie Massif has been uplifted 370–360 Ma years, that means — in the Frasnian or in the Lower Famennian.

The clastic deposits, beginning the transgressive cycle, layed with sedimentary contact on gneisses. The dislocation zone, marked at the depth 1900.6–1900.15 m with broken and crushed rocks, resulted from displacement along the interbed loosening planes.

Translated by Grzegorz Czapowski

Oddział Dolnośląski
Państwowego Instytutu Geologicznego
Wrocław, al. Jaworowa 19
Received: 25.07.1991

REFERENCES

BREEMEN VAN O., BOWES D.R., AFTALION M., ŻELAŹNIEWICZ A. (1988) — Devonian tectonothermal activity in the Sowie Góry gneissic block, Sudetes, Southwestern Poland: evidence from Rb-Sr and U-Pb isotopic studies. Ann. Soc. Geol. Pol., **58**, p. 3–19.

CHOROWSKA M., MILEWICZ J., RADLICZ K. (1986) — Wstępne wyniki otworu wiertniczego Zdanów IG 1. Prz. Geol., **34**, p. 596–597, nr 10.

FEDOROWSKI J. (1991) — Dividocorallia, a new subclass of the Palaeozoic Anthozoa. Bull. Inst. Roy. Sci. Nat. Belg., **61**, p.21–105.

NARKIEWICZ M. (1978) — Stratygrafia i rozwój facjalny górnego dewonu między Olkuszem i Zawierciem. Acta Geol. Pol., **28**, p. 415–470, nr 4.

OBERC J. (1987) — Struktura bardzka jako reper rozwoju waryscydów wschodniej części Sudetów Zachodnich i ich przedpola. Przew. 58 Zjazdu Pol. Tow. Geol., p. 163–185.

RADLICZ K. (1966) — Tekstury stylolitowe. Kwart. Geol., **10**, p. 367–381, nr 2.

SANDBERG Ch.A., ZIEGLER W. (1973) — Refinement of standard Upper Devonian conodont zonation based on sections in Nevada and West Germany. Geol. Paleontol., **7**, p. 92–122.

SANDBERG Ch.A., ZIEGLER W., LEUTERITZ K., BRILL S. (1978) — Phylogeny, speciation, and zonation of Siphonodella (Conodonta, Upper Devonian and Lower Carboniferous). Newsl. Stratigr., **7**(**2**), p. 102–120.

SZULCZEWSKI M. (1978) — The nature of unconformities in the Upper Devonian — Lower Carboniferous condensed sequence in the Holy Cross Mts. Acta Geol. Pol., **28**, p. 283–298, nr 3.

VOGES A. (1960) — Die Bedeutung der Conodonten für die Stratigraphie des Unterkarbons I und II (Gattendorfia — und Pericyclusstufe) im Sauerland. Fortschr. Geol. Rheinl. Westfalen, **3**, p. 197–228.

WAJSPRYCH B. (1986) — Sedimentary record of tectonic activity on a Devonian-Carboniferous continental margin (Sudetes). Excursion Guide No B-8. In: IAS 7th European Regional Meeting, p. 140–164. Ossolineum, Wrocław.

ZIEGLER W. (1962) — Taxonomie und Phylogenie Oberdevonischer Conodonten und ihre stratigraphische Bedeutung. Hess. Landesamt Bodenforsch. Abh., **38**.

ZIEGLER W. (1969) — Eine neue Conodontenfauna aus dem höchsten Oberdevon. Fortschr. Geol. Rheinl. Westfalen 17, p. 343–360.

ZIEGLER W. (1971) — Conodont stratigraphy of the European Devonian. In: W.C. Sweet, S.M. Bergström, eds — Symposium on conodont biostratigraphy. Geol. Soc. Amer. Mem., **127**, p. 227–284.

Maria CHOROWSKA, Jerzy FEDOROWSKI, Krzysztof RADLICZ

UTWORY FAMENU I TURNEJU W PROFILU OTWORU WIERTNICZEGO ZDANÓW IG 1 (SUDETY)

Streszczenie

W profilu otworu Zdanów IG 1 (fig. 1) na gnejsach masywu Gór Sowich leżą w kontakcie sedymentacyjnym wapniste skały piaszczysto-zlepieńcowe i wapienie, które tworzą kolejne stanowisko utworów określanych jako "dewon górny okolic Kłodzka", "formacja wapieni kłodzkich" lub "sekwencja Wapnicy". Sedymentacyjny nadkład wapieni stanowią czarne iłowce.

Analizowany profil poszerza w znacznej mierze dotychczasową znajomość rozwoju formacji wapieni kłodzkich. W profilu tym rozpoznano np. nie znane dotychczas w składzie tej formacji osady plażowe. Stwierdzono też nowe taksony koralowców *Stylostrotion sudeticum* Fedorowski i *Sudetiphyllia aphroides* Fedorowski należące do świeżo wyodrębnionej przez J. Fedorowskiego (1991) podgromady *Dividocorallia* i rzędu *Calyxocorallia* gromady *Anthozoa* (tabl. IV i V). Koralowce te dostarczyły cennych wskazówek środowiskowych. Wiek omawianej sekwencji skalnej został udokumentowany na podstawie otwornic oraz konodontów (tab. 1; tabl. IV, VI i VII).

Osady klastyczne grubookruchowe, które występują bezpośrednio na gnejsie, są typowo transgresywne. Transgresja rozpoczęła się w famenie górnym w poziomie środkowym costatus. Początkom transgresji towarzyszyły niewielkie wahania głębokości zbiornika połączone z przesuwaniem się na zewnątrz i cofaniem linii brzegowej aż do krótkotrwałej regresji, w czasie której powstały w rozpatrywanej strefie sedymentacyjnej osady plażowe. W kolejnym etapie transgresji powstały początkowo osady facji bahamitowej (w strefie zabarierowej), a następnie wapienie mikrofacji glonowo-otwornicowej strefy litoralnej (głębokość sedymentacji do 40 m). Sedymentację tych wapieni przerywały okresy pogłębienia morza i niedepozycji osadów dennych, o czym świadczą żyły neptuniczne z fauną pelagiczną stwierdzone na głębokościach 1822.5 m oraz 1770.3 m. Skalenie i kwarce piroklastyczne występujące w wapieniach z głębokości 1823.0–1822.3 m wskazują na okresowy dopływ materiału wulkanogenicznego.

Sedymentacja wapieni mikrofacji glonowo-otwornicowej odbywała się w famenie górnym, w przedziale czasu obejmującym otwornicowe poziomy od Quasiendothyra regularis do Q. radiata ewentualnie Q. kobeiusana, co odpowiada konodontowemu środkowemu poziomowi costatus.

W analizowanej sekwencji skalnej brak utworów górnego poziomu costatus. Najprawdopodobniej w tym czasie panowały w rozpatrywanej części zbiornika morskiego warunki uniemożliwiające tworzenie się osadów na dnie. Żyły neptuniczne utworzone z mikrytu wapiennego ze szczątkami głowonogów dowodzą, że od poziomu z fauną protognathodusową do dolnej części poziomu górnego crenulata panowały w rozpatrywanej części morza warunki pelagiczne. Żyły neptuniczne młodszej generacji, wypełnione materiałem ilastopylastym, wskazują na zwiększenie się głębokości tej części zbiornika sedymentacyjnego. Dalsze pogłębienie (przypuszczalnie co najmniej do kilkuset metrów), kończące okres niedepozycji osadów dennych, zaznaczone jest sedymentacją iłowców czarnych z wkładkami radiolarytów. Iłowce te powstały w turneju nie wcześniej niż w wyższej części poziomu górnego crenulata.

Niedepozycja osadów dennych objęła długi przedział czasu. Na podstawie poczynionych obserwacji nie można określić czy szczeliny w dnie morskim zapełnione mikrytem wapiennym wypełniane były stopniowo od poziomu z fauną protognathodusową do dolnej części poziomu górnego crenulata, czy też były kilkakrotnie otwierane i zamykane. Pewne jest natomiast, że późniejsza generacja szczelin wypełnionych materiałem ilasto-pylastym utworzyła się w okresie pogłębienia morza.

Gnejsy sowiogórskie, na których leżą utwory transgresywne, były w poziomie środkowym costatus intensywnie erodowane. Masyw gnejsowy Gór Sowich musiał być zatem wydźwignięty przed famenem górnym. Wniosek ten pokrywa się z wynikami badań izotopowych, według których podniesienie masywu sowiogórskiego nastąpiło 370–360 milionów lat temu, a więc we franie, ewentualnie w niższym famenie.

Utwory klastyczne rozpoczynające cykl transgresywny graniczą z gnejsami sedymentacyjnie. Strefa dyslokacyjna, która na głębokości 1900,6–1900,15 m zaznaczona jest rozkruszeniem i zmieleniem skał, jest wynikiem przesunięcia wykorzystującego zluźnienie międzywarstwowe.

PLATE I

Fig. 1. Brecciated dolomicrite with fissures of several generations, infilled with quartz and calcisparite; sample 440, depth 1889.4 m; crossed nicols, x 9

Zbrekcjowany dolomikryt ze szczelinami kilku generacji, wypełnionymi kwarcem oraz kalcysparytem; próbka 440, głęb. 1889,4 m; nikole skrzyżowane, pow. 9 x

Fig. 2. Set of microstylolites and calcisparitic concentrations with relicts of bioclastic micrite and crinoids; sample 399, depth 1883.2 m; without analyser, x 24

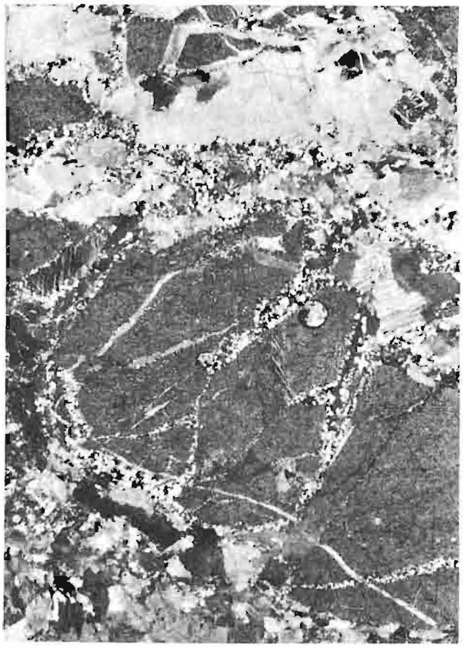
Zespół mikrostylolitów i skupienia kalcysparytowe z reliktami mikrytu bioklastycznego i liliowcami; próbka 399, głęb. 1883,2 m; bez analizatora, pow. 24 x

Fig. 3. Leucoxenic strips in quartzose carbonaceous arenite; sample 391, depth 1865.5 m; without analyser, x 10

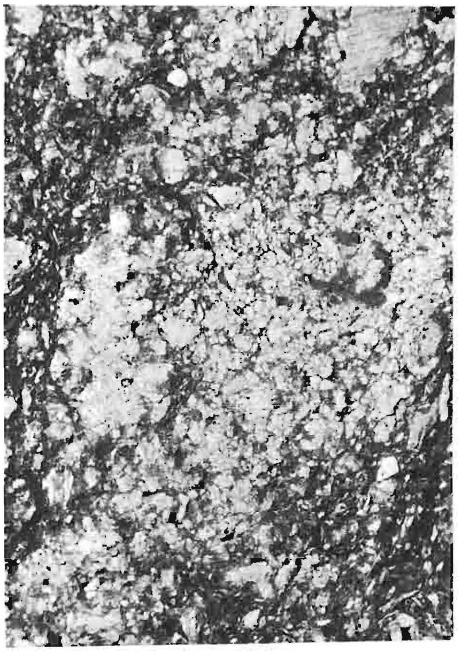
Smugi leukoksenowe w kwarcowym arenicie wapnistym; próbka 391, głęb. 1865,5 m; bez analizatora, pow. 10 x

Fig. 4. Piece of leucoxenized amphibole and diabase in calcisparite; sample 391, depth 1865.5 m; without analyser, x 37

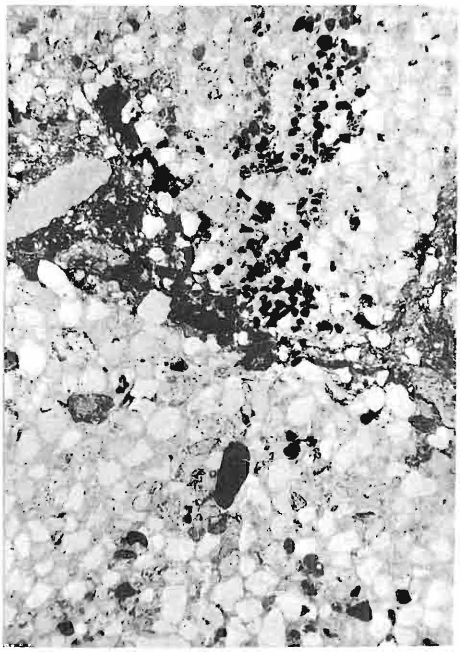
Okruch zleukoksenizowanego amfibolu i diabazu w kalcysparycie; próbka 391, głęb. 1865,5 m; bez analizatora, pow. 37 x



1



2



3

4

Maria CHOROWSKA, Jerzy FEDOROWSKI, Krzysztof RADLICZ — Famennian and Tournaisian deposits from the Zdanów IG 1 borehole (Sudetes)

PLATE II

Fig. 1. Pelbiosparitic sandy limestone. Among bioclasts — crinoid fragments and foraminifers; sample 388, depth 1861.0 m; without analyser, x 16

Wapień pelbiosparytowy, piaszczysty. Wśród bioklastów człony liliowców i otwornice; próbka 388, głęb. 1861,0 m; bez analizatora, pow. 16 x

Fig. 2. Crinoidal bioarenite with plagioclase plates and microstylolites; sample 378/1, depth 1822.5; crossed nicols, x 16

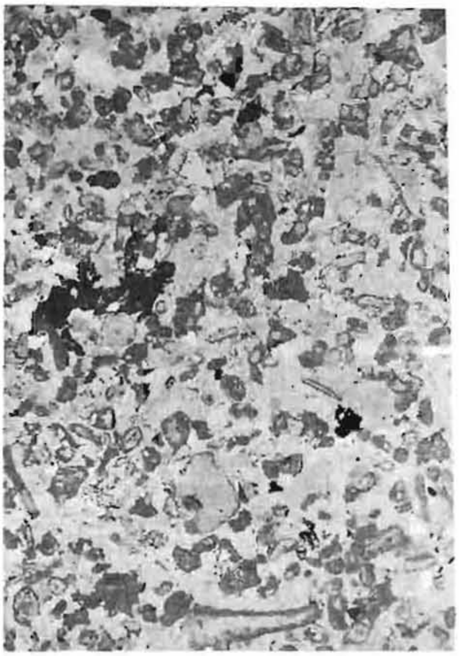
Bioarenit liliowcowy z tabliczkami plagioklazów, z mikrostylolitami; próbka 378/1, głęb. 1822,5 m; nikole skrzyżowane, pow. 16 x

Fig. 3. Calcitic veins of *cone in cone* type in stylolitization zone between limestone fragments; sample 378/2, depth 1822.5 m; without analyser, x 10

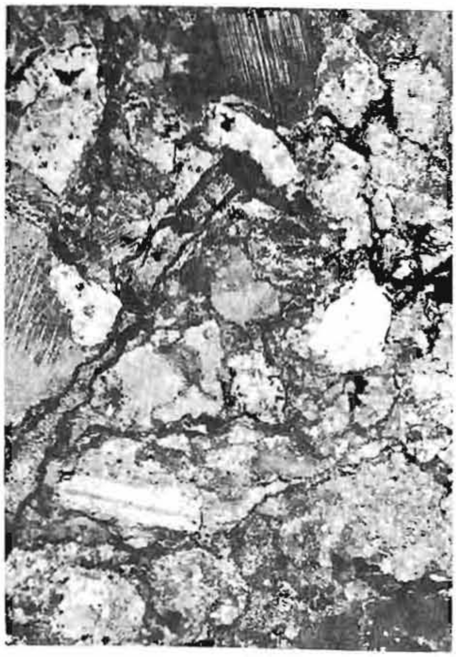
Żyłki kalcytowe *cone in cone* w strefie stylolityzacji między okruchami wapieni; próbka 378/2, głęb. 1822,5 m; bez analizatora, pow. 10 x

Fig. 4. Calcisparite of *cone in cone* type at boundary with neptunic dyke infilled with pelitic claystone; sample 368*, depth 1756.5 m; crossed nicols, x 16

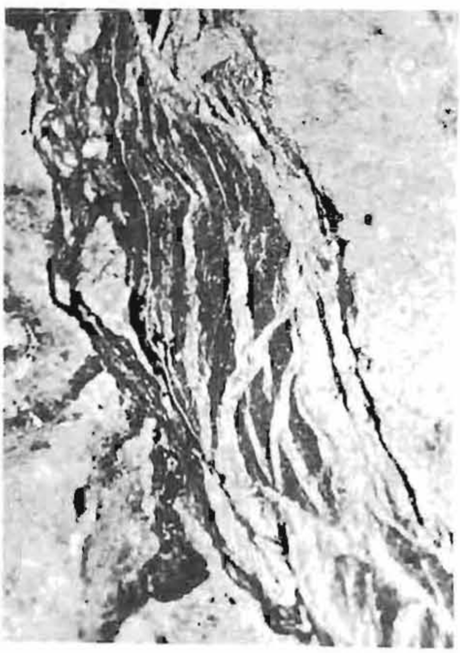
Kalcysparyt *cone in cone* na granicy z żyłą neptuniczną wypełnioną iłowcem pylastym; próbka 368*, głęb. 1756,5 m; nikole skrzyżowane, pow. 16 x



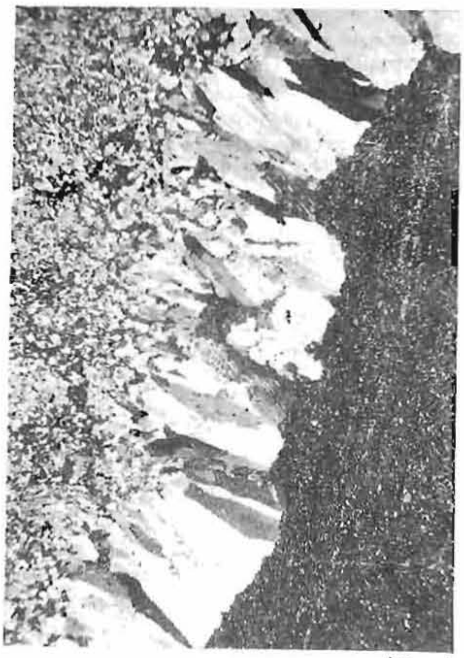
1



2



3



4

Maria CHOROWSKA, Jerzy FEDOROWSKI, Krzysztof RADLICZ — Famennian and Tournaisian deposits from the Zdanów IG 1 borehole (Sudetes)

PLATE III

Fig. 1. Polyhalite porphyroblast in anhydrite; sample 379, depth 1825.3 m; crossed nicols, x 16

Porfiroblast polihalitu w anhydrycie; próbka 379, głęb. 1825,3 m; nikole skrzy- żowane, pow. 16 x

Fig. 2. Idiomorphic quartz in fine crystalline anhydrite; sample 379, depth 1825.3 m; crossed nicols, x 37

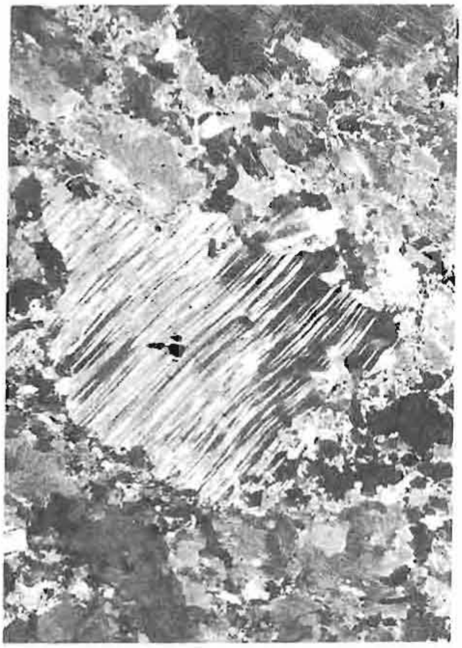
Idiomorficzny kwarc w anhydrycie drobnokrystalicznym; próbka 379, głęb. 1825,3 m; nikole skrzyżowane, pow. 37 x

Fig. 3. Tentaculit (oblique section) in algal-foraminiferal biosparmicrite; sample 372, depth 1770.3 m; crossed nicols, x 16

Tentakulit (przekrój skośny) w biosparmikrycie glonowo-otwornicowym; próbka 372, głęb. 1770,3 m; nikole skrzyżowane, pow. 16 x

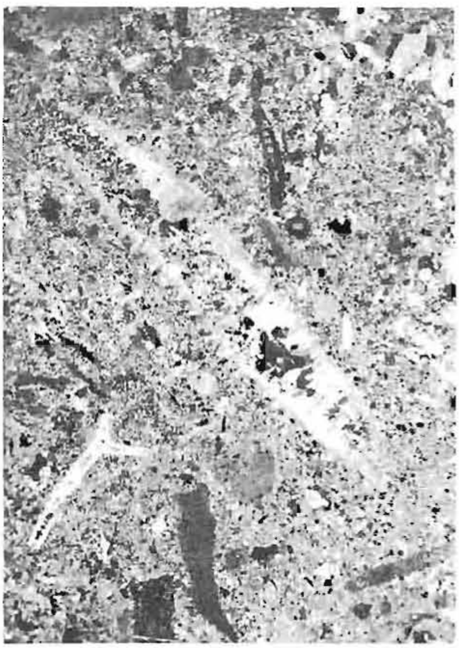
Fig. 4. Biomicritic limestone with fissure infilled with calcisparite, cutted at limestone boundary with carbonaceous-micritic neptunic dyke, with microstylolite relicts and numerous organic fragments; sample 368*, depth 1756.5 m; crossed nicols, x 7

Wapień biomikrytowy ze szczeliną zabliźnioną kalcysparytem, ściętą na granicy tego wapienia z wapienno-mikrytową żyłą neptuniczną z reliktami mikrostylolitów, z licznymi szczątkami organicznymi; próbka 368*, głęb. 1756,5 m; nikole skrzyżowane, pow. 7 x

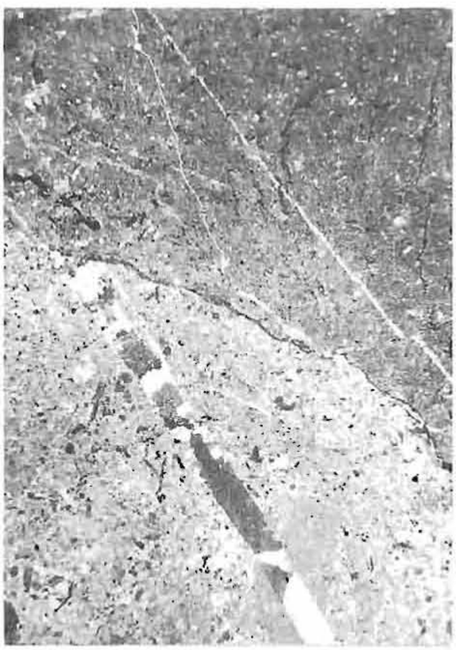


1

2



3

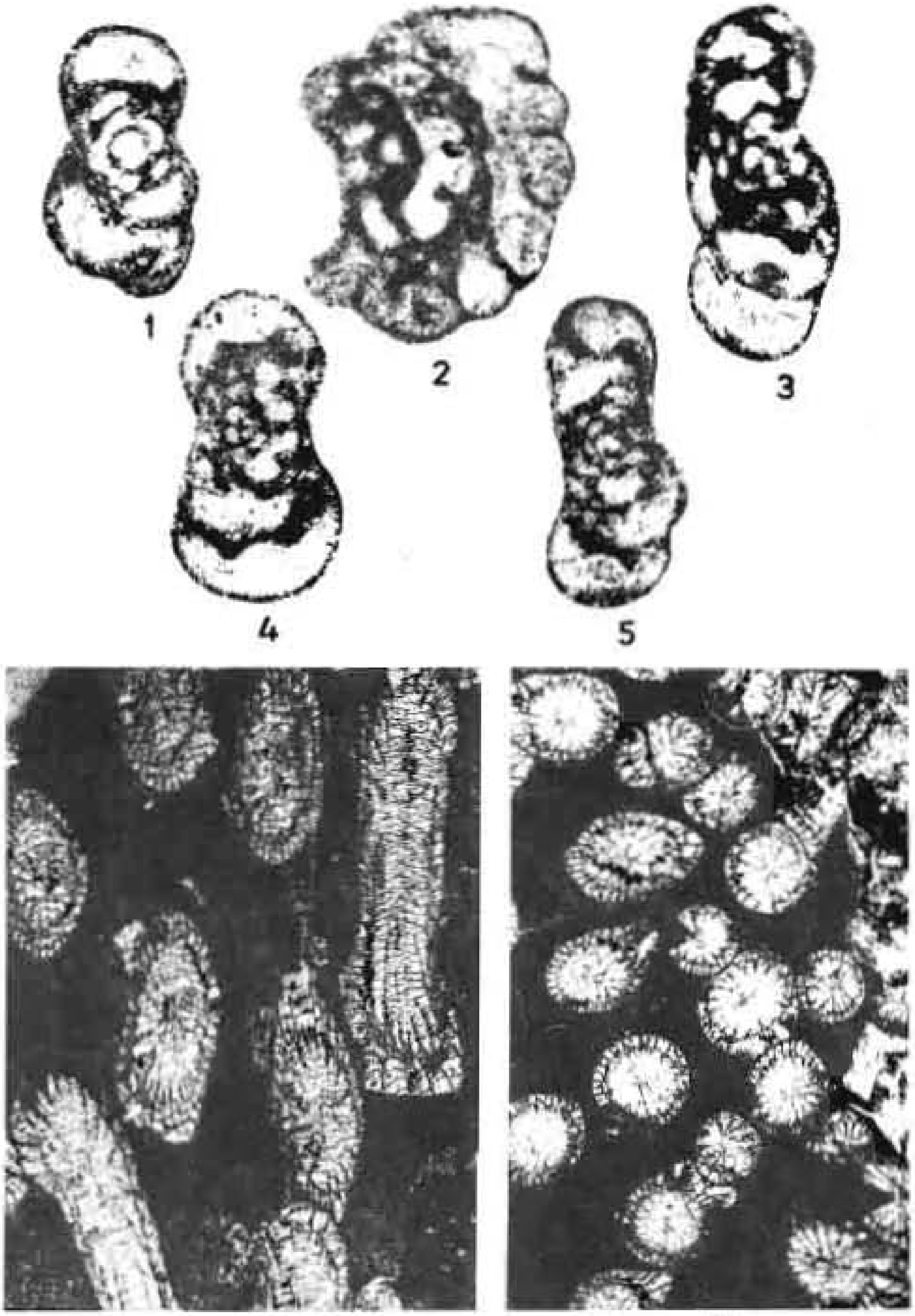


4

Maria CHOROWSKA, Jerzy FEDOROWSKI, Krzysztof RADLICZ — Famennian and Tournaisian deposits from the Zdanów IG 1 borehole (Sudetes)

PLATE IV

Fig. 1. *Endochernella* sp.
Sample 371, depth 1767.2 m; x 45
Próbka 371, głęb. 1767,2 m; pow. 45 x
Fig. 2. *Quasiendothyra* cf. *kobeitusana* (Rauser)
Sample 383, depth 1843.9 m; x 45
Próbka 383, głęb. 1843,9 m, pow. 45 x
Fig. 3. *Quasiendothyra communis communis*(Rauser)
Sample 384, depth 1850.2 m; x 45
Próbka 384, głęb. 1850,2 m; pow. 45 x
Fig. 4. *Quasiendothyra communis radiata* (Reitlinger)
Sample 375, depth 1782.4 m; x 45
Próbka 375, głęb. 1782,4 m; pow. 45 x
Fig. 5. *Quasiendothyra regularis regularis* (Lipina)
Sample 381, depth 1837.8 m; x 45
Próbka 381, głęb. 1837,8 n; pow. 45 x
Figs 6, 7. *Stylostrotion sudeticum* Fedorowski
6 — longitudinal, oblique section, 7 — cross section; sample 374, depth 1778.2 m; x 3
6 — przekrój podłużny, skośny, 7 — przekrój poprzeczny; próbka 374, głęb. 1778,2 m; pow. 3 x



Maria CHOROWSKA, Jerzy FEDOROWSKI, Krzysztof RADLICZ — Famennian and Tournaisian deposits from the Zdanów IG 1 borehole (Sudetes)

PLATE V

Figs 1, 2. *Sudetiphyllia aphroides* Fedorowski

1 — longitudinal section, 2 — cross section; sample 402, depth 1891.7 m; x 3

1 — przekrój podłużny, 2 — przekrój poprzeczny; próbka 402, głęb. 1891,7 m; pow. 3 x

Fig. 3. *Stylostrotion sudeticum* Fedorowski

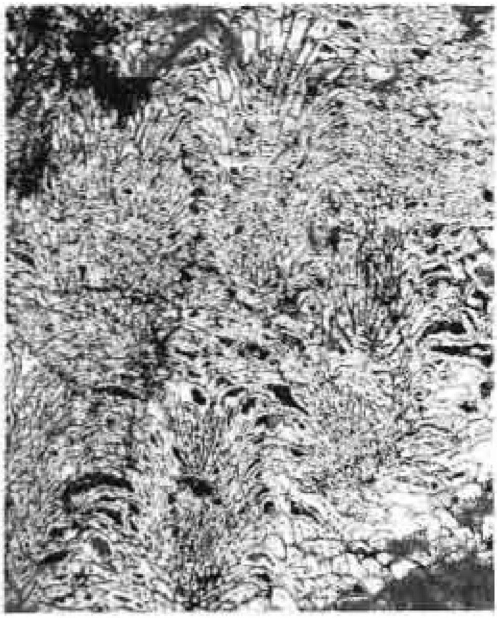
Stromatoporoidal cover on coral colony; sample 374, depth 1778.2 m; x 3

Powłoka stromatoporoidowa na kolonii koralowca; próbka 374, głęb. 1778,2 m; pow. 3 x

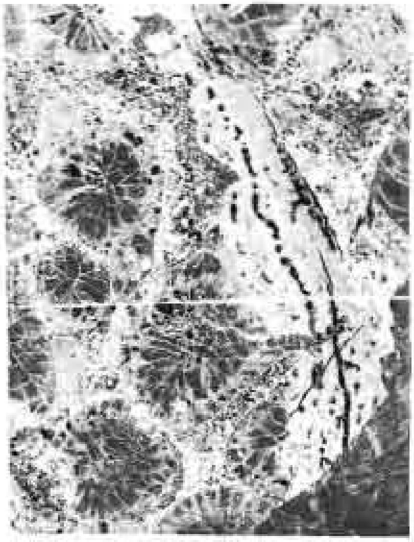
Fig. 4. cf. *Guerichiphyllum* Różkowska

Amplexoidal stage; sample 399, depth 1883.5 m; x 5

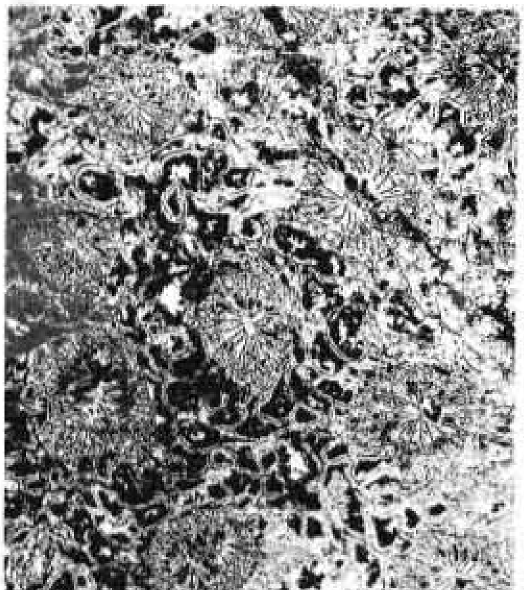
Stadium ampleksoidalne; próbka 399, głęb. 1883,5 m; pow. 5 x



1



3



2

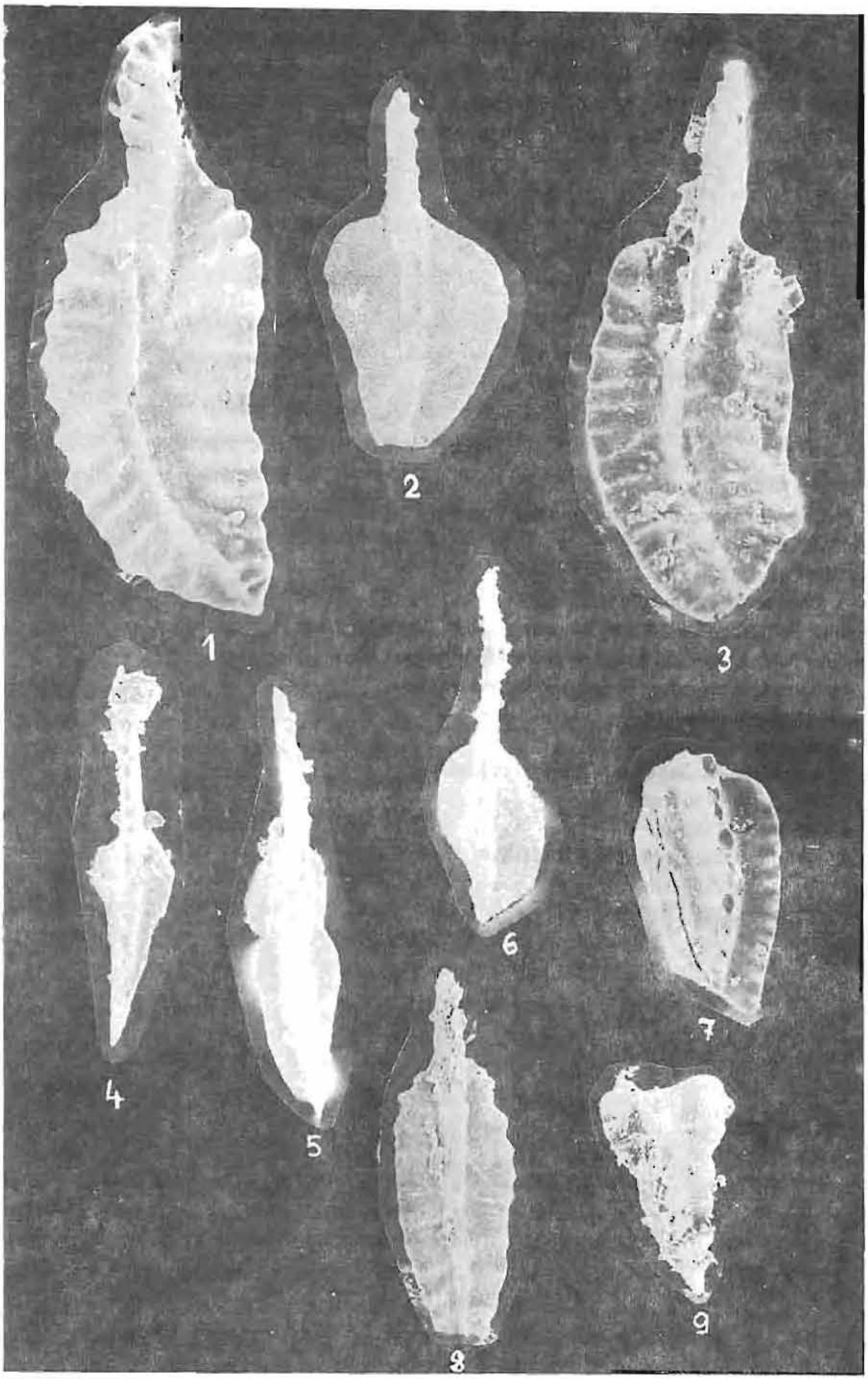
4

Maria CHOROWSKA, Jerzy FEDOROWSKI, Krzysztof RADLICZ — Famennian and Tournaisian deposits from the Zdanów IG 1 borehole (Sudetes)

PLATE VI

Fig. 1. *Polygnathus* cf. *bardensis* Chorowska
Sample 368*, depth 1756.5 m
Próbka 368*, głęb. 1756,5 m
Fig. 2. *Polygnathus purus purus* Voges
Sample 368*, depth 1756.5 m
Próbka 368*, głęb. 1756,5 m
Fig. 3. *Polygnathus symmetricus* Branson
Sample 369*, depth 1757.3 m
Próbka 369*, głęb. 1757,3 m
Figs 4, 5. *Polygnathus* sp. 7 Chorowska
4 — sample 368*, depth 1756.5 m; 5 — sample 369*, depth 1757.3 m
4 — próbka 368*, głęb.1756,5 m; 5 — próbka 369*, głęb.1757,3 m
Fig. 6. *Protognathodus meischneri* Ziegler
Sample 369*, depth 1757.3 m
Próbka 369*, głęb. 1757,3 m
Fig. 7. *Pseudopolygnathus fusiformis* Branson et Mehl
Sample 369*, depth 1757.3 m
Próbka 369*, głęb. 1757,3 m
Fig. 8. *Pseudopolygnathus* cf. *fusiformis* Branson et Mehl
Sample 369*, depth 1757.3 m
Próbka 369*, głęb. 1757,3 m
Fig. 9. *Pseudopolygnathus multistriatus* Mehl et Thomas
Sample 368*, depth 1756.5 m
Próbka 368*, głęb. 1756,5 m

Enl. x 120; pow.120 x

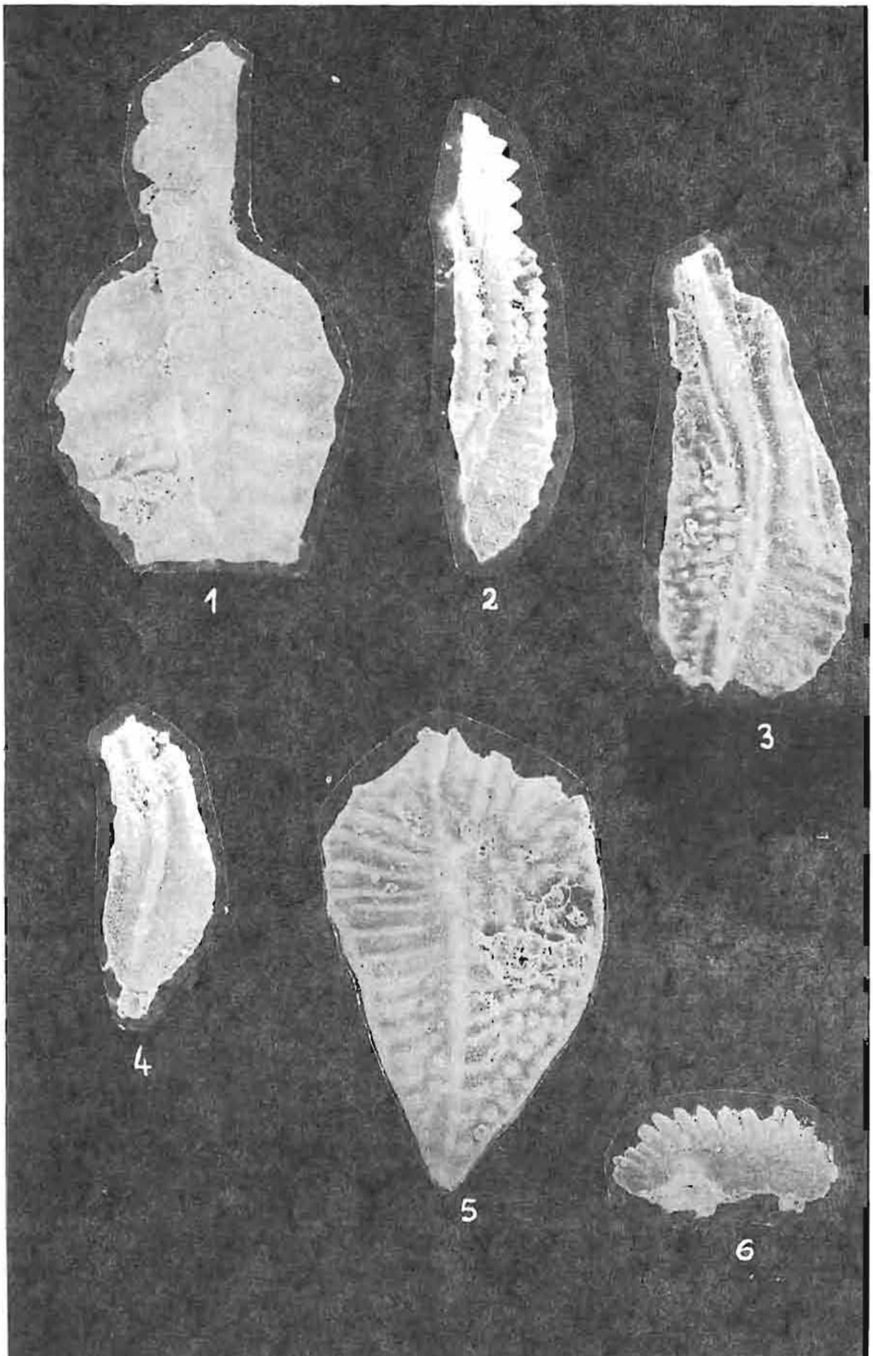


Maria CHOROWSKA, Jerzy FEDOROWSKI, Krzysztof RADLICZ — Famennian and Tournaisian deposits from the Zdanów IG 1 borehole (Sudetes)

PLATE VII

Fig. 1. *Pseudopolygnathus triangulus pinnatus* Voges
Sample 368*, depth 1756.5 m
Próbka 368*, głęb. 1756,5 m
Figs 2, 3. *Siphonodella obsoleta* Hass
2 — sample 368*, depth 1756.5 m; 3 — sample 369*, depth 1757.3 m
2 — próbka 368*, głęb. 1756,5 m; 3 — próbka 369*, głęb. 1757,3
Fig. 4. *Siphonodella isosticha* (Cooper) → *S. obsoleta* Hass
Sample 368*, depth 1756.5 m
Próbka 368*, głęb. 1756,5 m
Fig. 5. *Siphonodella quadruplicata* (Branson et Mehl)
Sample 368*, depth 1756.5 m
Próbka 368*, głęb. 1756,5 m
Fig. 6. *Spathognathodus* cf. *campbelli* Rexroad
Sample 369*, depth 1757.3 m
Próbka 369*, głęb. 1757,3 m

Enl. x 120; pow.120 x



Maria CHOROWSKA, Jerzy FEDOROWSKI, Krzysztof RADLICZ — Famennian and Tournaisian deposits from the Zdanów IG 1 borehole (Sudetes)