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The nature of unconformities in the Upper Devonian–Lower Carboniferous condensed sequence in the Holy Cross Mts

ABSTRACT: Famennian-Tournaisian condensed sequence (up to anchoralis Zone) covering a carbonate platform shows the maximum condensation and the largest stratigraphic gaps in the southwestern part of the Holy Cross Mts, Central Poland. Disconformity between the Givetian (lowermost Frasnian?) and the Famennian is the only one caused by a tectonic uplift and abrasion. Other diastems were related to submarine nondeposition; their lateral extension is variable and rather limited, and their equivalent marine, often pelagic sediments occur in the neighborhood.

INTRODUCTION

The so-called Kadzielnia Reef, southwestern part of the Holy Cross Mts, Central Poland, is the easternmost Central European carbonate complex resembling closely the reef structures of the Rhenish Slate Mts and Harz. It is covered by the Famennian-Tournaisian sequence displaying stratigraphic condensation and forming neptunian dykes penetrating the substrate (cf. Szulczewski 1971, 1973). The sequence is extremely condensed in the environs of Gałęzice, southwestern margin of the Holy Cross Mts. Czarnocki (1928, 1933) recognized some stratigraphic gaps both below and within the sequence and referred them to epeirogenic movements assigned to the Bretonic subphase.

A new and vast quarry "Ostrówka" has recently been situated (Fig. 1) at the westernmost range of the Gałęzice Hills (southern limb of the Gałęzice syncline) making possible detailed investigations at the Devonian/ /Carboniferous boundary. Furthermore, the use of conodonts permitted much more precise stratigraphy than that existing previously. Then, one can further evaluate stratigraphy of the condensed sequence, causes for the stratigraphic gaps, and the Carboniferous/Devonian relationship.

The present paper deals only with a single selected problem involved in development of the condensed reef-cover, and only within a small part of its original geographic range. In all its bearings, the condensed sequence will be synthetically considered in a separate paper.

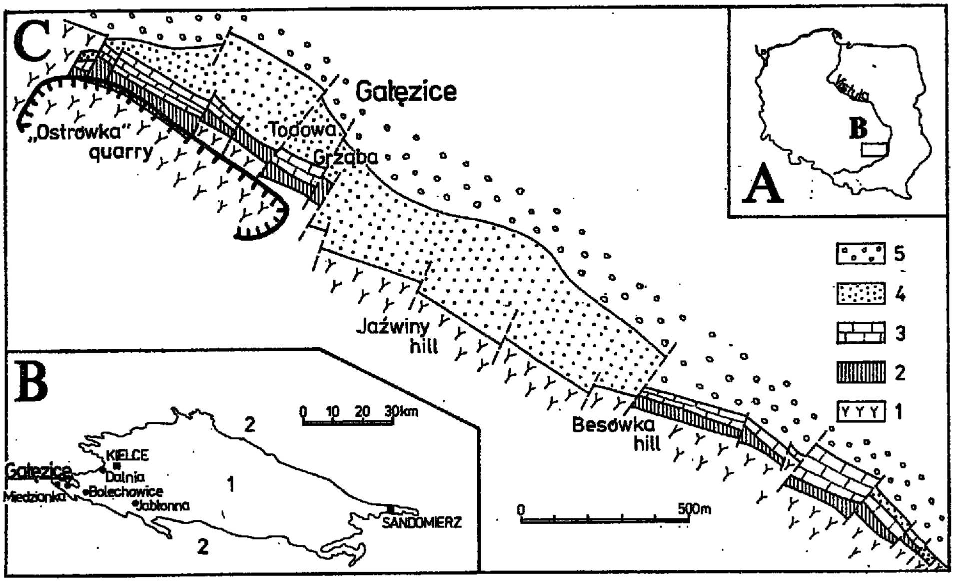


Fig. 1

A — General map of Poland; B — general outline of the Holy Cross Mts (*1* Paleozoic core, *2* Mesozoic margins; indicated are the discussed Upper Devonian/Lower Carboniferous localities)
C — geological sketch map of the Gałęzice Hills, southern limb of the Gałęzice syncline (*after* Żakowa 1974, Fig. 1; simplified and modified)

1 Amphiporoid Limestones (Givetian or lowermost Frasnian), 2 Famennian and „Lower Culm" (Tournaisian), 3 Carboniferous Limestone (Upper Viséan), 4 „Upper Culm" (Upper Viséan), 5 Permian

STRATIGRAPHIC FRAMEWORK

The Upper Devonian-Lower Carboniferous condensed sequence overlies bedded Amphiporoid Limestones (Fig. 2). The latter deposits are commonly attributed to the Givetian and sometimes, to the lowermost Frasnian. The Upper Devonian is represented by thin and laterally discontinuous cephalopod-bearing Famennian limestones.

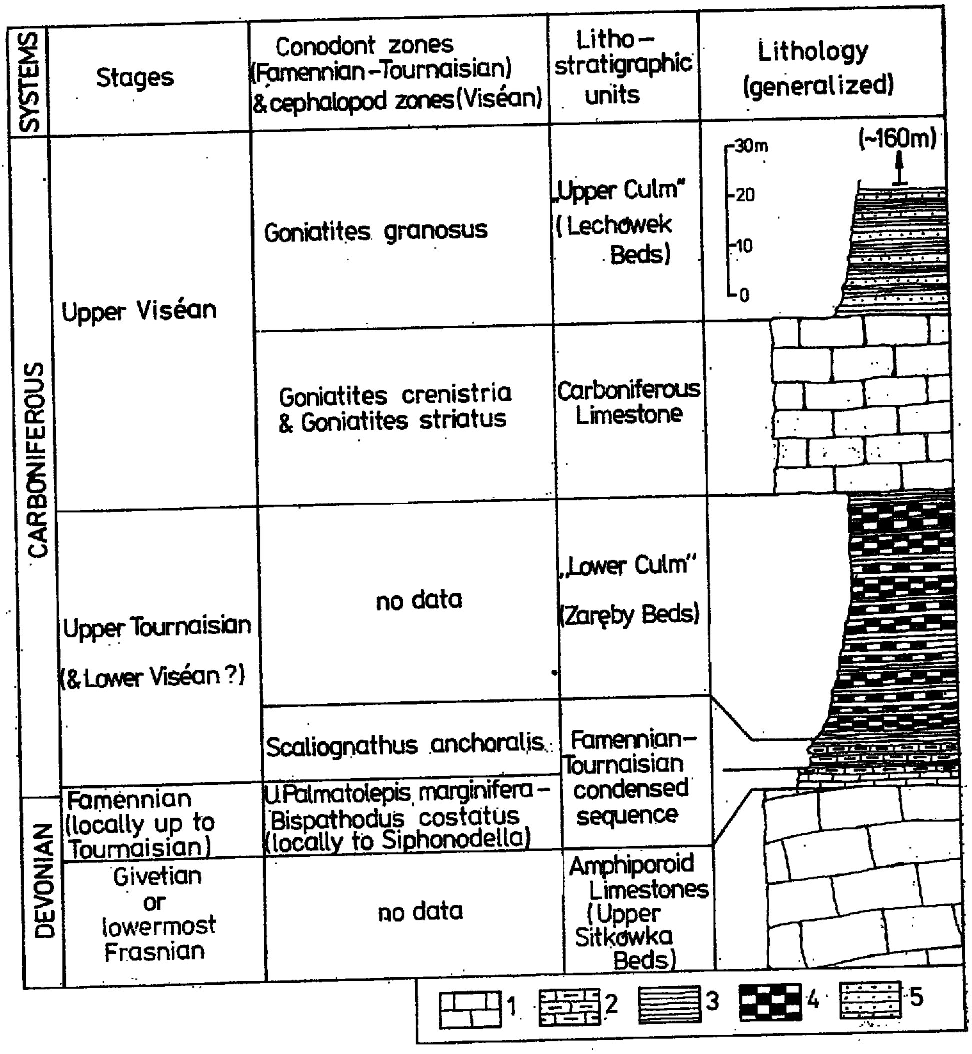


Fig. 2. Stratigraphy of the Devonian-Carboniferous sequence in the Gałęzice syncline
LITHOLOGY: *1* limestones, *2* marls and marly limestones, *3* shales, *4* radiolarian cherts, *5* siltstones and sandstones

In the environs of Gałęzice, the Lower Carboniferous is tripartite (Fig. 2); it consists of the so-called Lower Culm, Carboniferous Limestone, and Upper Culm. Only the lowermost part of the Lower Culm comprises limestone intercalations and shows a considerable stratigraphic condensation. Hence, this is the only Carboniferous member making part of the condensed sequence representing a clearly distinct stage of the facies-

-tectonic development of the area. The entire Lower Culm is assigned to the Tournaisian. The both overlying lithostratigraphic units belong already to the Viséan. The stratigraphy is, however, to be considered in more details in order to determine properly the position and nature of the stratigraphic gaps.

AMPHIPOROID LIMESTONES

The Amphiporoid Limestones underlying the Famennian or, locally, the Tournaisian were attributed by Czarnocki (1928, pp. 56, 59; 1933, p. 32; 1947, p. 14) to the Middle Devonian or more precisely to the Givetian. This interpretation is also generally accepted in geological mapping of the area.

However, judging from the stromatoporoids and associated corals (the latter fossils non-illustrated), Kaźmierczak (1971, p. 19) assigned the limestones of Ostrówka hill to his Upper Sitkówka Beds corresponding to the lowermost members of the Frasnian.

According to Kaźmierczak (1971), the stromatoporoid limestones exposed in the quarry "Panek" at Bolechowice do also represent the Upper Sitkówka Beds; whereas Różkowska (1953, p. 6) recorded the rugose corals *Pachyphyllum lacunosum* and *Tabulophyllum priscum* from those strata, regarded as indicative of "l'horizon supérieur du Frasnien". This casts into doubt the attribution of all the stromatoporoid limestones of the "Panek" quarry to the Upper Sitkówka Beds; or else the stratigraphic position of the latter unit is to be considered as at least partly higher than claimed by Kaźmierczak (1971).

Occurrence of any higher members of the Frasnian at Ostrówka seems improbable. Possibly, equivalents of the limestones with the Upper Frasnian corals from Bolechowice have been eroded here. On the other hand, the stratigraphic value of stromatoporoids studied by Kaźmierczak (1971) appears limited because those fossils have not been used to determine any of the recently proposed positions of the Givetian/Frasnian boundary.

Then, the stratigraphic position of the Amphiporoid Limestones of Ostrówka hill and other Gałęzice Hills remains unclear. In fact, the problem of the Givetian//Frasnian boundary is still to be finally solved in the Holy Cross Mts (*cf.* Kaźmierczak 1971, p. 21). The difficulties arise both from the scarcity of guide fossils due to the lithofacies at the Middle/Upper Devonian boundary, and from the lack of any generally accepted definition of the latter boundary (*cf.* also Szulczewski 1971).

FAMENNIAN

The Famennian thinness in the Gałęzice Hills (not more than 3—4 m) is its characteristic feature (Czarnocki 1916, 1928, 1947). Despite so strong condensation, the section is considered to be biostratigraphically continuous, as there is full succession of the standard biostratigraphic zones based upon both the cephalopods (Czarnocki 1928, 1947) and conodonts (Wolska 1967, Szulczewski & Żakowa 1976). In all the insofar investigated sections (Wolska 1967, Nasiłowski 1975, Szulczewski & Żakowa 1976), the Famennian starts in the Gałęzice Hills with the Upper Palmatolepis marginifera Zone corresponding to the zone *doIIIa* (*cf.* Szulczewski & Żakowa 1976, p. 65). In all the sections, a stratigraphic gap occurs in the underlying part of the Famennian, recorded already by Czarnocki (1928, 1947). The only significant within-Famennian gap occurs in the sections of the Besówka hill and Ostrówka hill investigated originally by Wolska (1967) and covers the Polygnathus styriacus Zones; the gap was discovered during the recent stratigraphic revision (Szulczewski & Żakowa 1976, p. 55, Tab. 1). Nevertheless, the Polygnathus styriacus

Zones occur locally in the eastern part of the Gałęzice Hills, developed not worse than the other zones (Szulczewski & Żakowa 1976, Fig. 3). Moreover, stratigraphic admixtures of the fauna of Polygnathus styriacus Zones occur commonly in the Lower Bispathodus costatus Zone (*cf.* Szulczewski & Żakowa 1976, p. 56, Tab. 1).

The Famennian exposed in the "Ostrówka" quarry is largely different from the above characteristics. In fact, only the easternmost section of the quarry, situated near Todowa Grząba hill, resembles somewhat the pattern typical of the Gałęzice Hills, as it starts with the Upper Palmatolepis marginifera Zone. The Famennian disappears westwards and the Amphiporoid Limestones border directly with the Carboniferous. In the westernmost part of the quarry, the Famennian appears once more but it is only 25 cm thick. This extreme thinness could result from either a uniform reduction in thickness of particular zones (be this associated with occurrence of mixed faunas or not), a diastem factor, or else an erosion or corrosion from above acting before the Culm sedimentation. Actually, the considered Famennian section consists of but two limestone beds separated with a shale intercalation. The lower bed comprises conodonts indicative of the Upper Scaphignathus velifer Zone, while the upper one is to be assigned to an unidentified Bispathodus costatus Zone (Fig. 3). None of the beds comprises stratigraphically mixed conodonts. Then, the striking reduction in thickness reflects: (*i*) sedimentation onset in the Upper Scaphignathus velifer Zone, that is later than elsewhere in the Gałęzice Hills, (*ii*) internal stratigraphic gap comprising the Polygnathus styriacus Zones, and (*iii*) decreased thickness of those zones represented in the section. One may conclude that the reduction in thickness did not result from any subsequent pre-Carboniferous degradation; it is due to the increased condensation and diastem factor.

TOURNAISIAN

Recent observations on the exposed Devonian/Carboniferous boundary confirm the results of Czarnocki (1928, p. 56) who conceived the Lower Culm (= Tournaisian) sequence as bipartite. The lower part of the sequence consists of green and cherrish clayey shales intercalated with compact limestones comprising a poor but characteristic fauna, namely "*Glyphioceras* (cf. *fasciculatum*), *Phillipsia* (ex gr. *aequalis*), and *Cyrtosymbole (Varibole)*". Those strata are overlaid by black clayey shales intercalated with lydites. Czarnocki (1928, p. 55) found also a stratigraphic gap above the beds with *Wocklumeria*, comprising the Gattendorfia Stage ("Stufe"); he followed O. Schindewolf in assigning the latter unit to the Famennian. Czarnocki (1928, p. 55) did certainly regard the gap as a local phenomenon not necessarily implying the Gattendorfia Stage to be lacking also in the neighborhood.

Subsequent investigations did not significantly contribute to the Tournaisian stratigraphy in Gałęzice area. The lower part of the Lower Culm, that is the green and cherrish clayey shales intercalated with limestones, was not observed and became forgotten (Żakowa 1970, 1971). Additional fossils found in those strata (*Orbiculoidea tornacensis* Demanet and undescribed spores) lack any considerable stratigraphic value eventhough Żakowa (1970, p. 9; 1971, p. 12) considered them as indicative of the Upper Tournaisian, higher than the Gattendorfia Stage. More recent investigations at the Devonian/Carboniferous boundary, conodont studies including (Wolska 1967, Szulczewski & Żakowa 1976), did also not record the Gattendorfia Stage.

However, Nasiłowski (1975) documented recently with conodonts the Gattendorfia Stage in the western part of the Gałęzice Hills, by Todowa Grząba, that is just in close neighborhood of the "Ostrówka" quarry. The stage is represented by marly limestones with thin shale intercalations; it is 60 cm thick. It makes a direct continuation of the underlying condensed Famennian from which deposits the considered strata differ but in their more marly nature. The conodont fauna is poor and does not allow to recognize precisely the zonation. Nevertheless, any considerable stratigraphic gaps can hardly be expected at the Devonian/Carboniferous boundary, as the conodonts of the Upper Bispathodus costatus Zone are mixed with the "Protognathodus-Fauna", while the upper part of the section (*cf.* Fig. 3) comprises *Siphonodella*.

The Gattendorfia Stage has not been found in the course of the recent conodont-based biostratigraphic study in the "Ostrówka" quarry. In that quarry, the Amphiporoid Limestones are overlaid directly by the mottled clayey shales intercalated with limestones, that is the lower lithostratigraphic unit of the Tournaisian of the Gałęzice area (*cf.* Czarnocki 1928). It is noteworthy, however, that the unit comprises large amounts of pyroclastic matter unknown from equivalent strata of the area; in fact, Czarnocki (1928, p. 55) observed tuffites at Gałęzice but lower in the section, namely in the Wocklumeria Stage. In the "Ostrówka" quarry, the unit is variable in thickness but never exceeds 6 meters. It is usually tripartite with the middle part represented by yellow and rose limestones intercalated with shales, whereas limestones are absent from both the lower and upper parts. Locally, singular thin calcareous layers or nodules may, however, occur at the base of the section. The lower part of the unit decreases considerably in thickness in places and the limestone-shale member may even border directly upon the Devonian (Amphiporoid Limestones). The middle part of the unit approximates 150 cm in thickness and comprises a few limestone intercalations.

The mottled clayey shales intercalated with limestones overlie usually the thin (25 cm) Famennian, bordering upon the top of the Bispathodus costatus Zones. However, they locally overlie directly the Amphiporoid Limestones just as it was already recorded by Czarnocki (1928, p. 58; 1933, p. 32). The conodonts come exclusively from a few Tournaisian calcareous intercalations. The most significant stratigraphically fauna derived from intercalations close to the top of the Devonian, namely from 70 cm and 20 cm above the latter boundary in two sections, respectively. In both the cases, the fauna comes from the second lowermost Tournaisian intercalation and indicates the Scaliognathus anchoralis Zone. When compared to the conodont succession of Belgium (Groessens 1974), the investigated fauna corresponds to the Doliognathus latus Subzone, that is the lowermost subzone in the tripartite subdivision of the Scaliognathus anchoralis Zone. The more diverse of the two samples comprises all the forms typical of the Subzone, including:

Doliognathus latus Branson & Mehl
Dollymae bouckaerti Groessens → *Scaliognathus anchoralis* Branson & Mehl
Hindeodella segaformis Bischoff
Gnathodus antetexanus Rexroad & Scott
G. delicatus Branson & Mehl
G. semiglaber Bischoff
Polygnathus communis communis Branson & Mehl
Pseudopolygnathus triangulus triangulus Voges
P. triangulus pinnatus Voges
Scaliognathus anchoralis Branson & Mehl

One may then conclude that the base of the lower lithostratigraphic unit of the Tournaisian of Gałęzice area occurs most probably within the Scaliognathus anchoralis Zone corresponding to the zone *Tn3c* of the Belgian zonation scheme and hence, rather closely to the top of the Tournaisian. Thus, the stratigraphic gap below the Tournaisian comprises at its maximum (Fig. 3) the entire Frasnian (or its large part), entire Famennian, strata with the "Protognathodus-Fauna" (approximate equivalent of the zone *Tn1a*), and most of the Tournaisian. This is the largest gap found in the condensed sequence above the Devonian carbonate platform of the Holy Cross Mts.

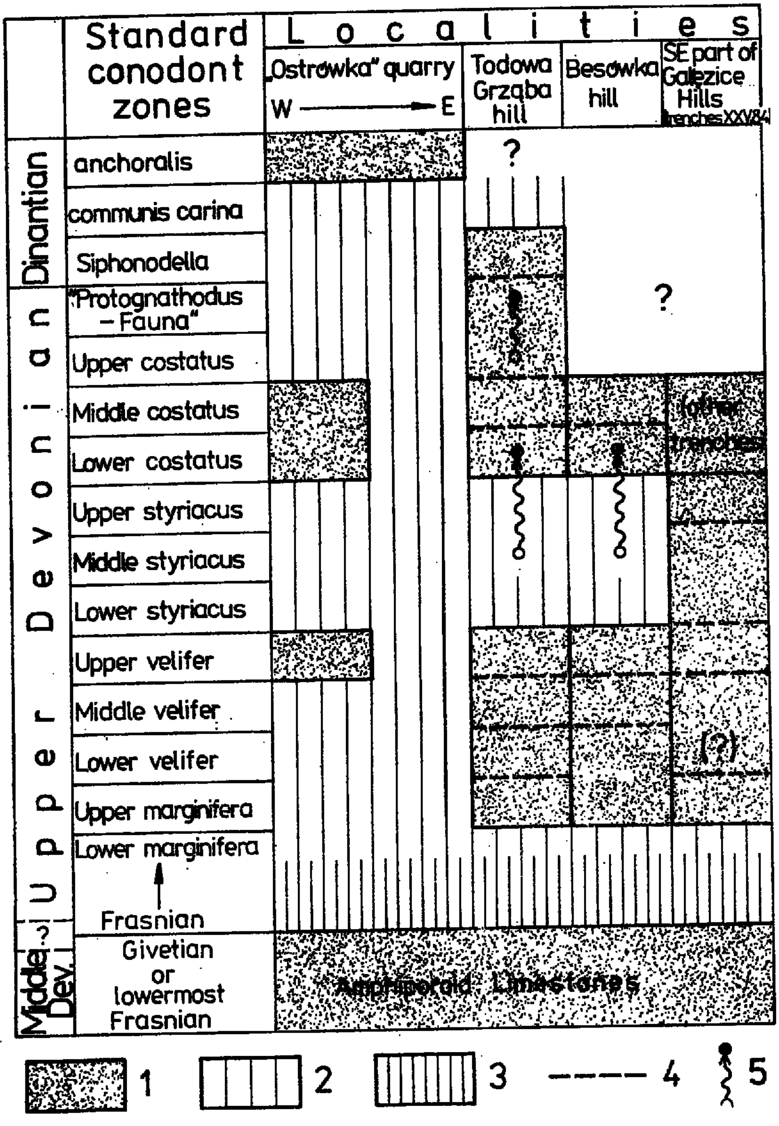


Fig. 3. Hiatuses in some selected profiles of the Upper Devonian — Lower Carboniferous condensed sequence in the Gałęzice syncline

Data from Todowa-Grząba hill based on Nasiłowski (1975, reinterpreted), from Besówka hill on Wolska (1967, reinterpreted by Szulczewski & Żakowa, 1976), and from the south-east part of the Gałęzice Hills on Szulczewski & Żakowa (1976)

1 deposits, 2 non-deposition, 3 abrasion, 4 determinable biostratigraphic boundaries, 5 conodont admixtures derived from older zones

SEDIMENTARY DISCONTINUITIES AND THEIR PHYSICAL MANIFESTATION

Czarnocki (1928, 1933) found two main stratigraphic gaps in the considered sequence in Gałęzice area, namely (*i*) between the Middle Devonian and the Famennian beds with *Prolobites*, and (*ii*) between the upper beds with *Laevigites* or even the Middle Devonian and the Lower Culm. Originally, Czarnocki (1928) conceived the latter gap as occurring above the Wocklumeria Stage; however, he reinterpreted subsequently the local stratigraphy basing upon the cephalopod fauna (Czarnocki 1933, p. 31) and transferred to the Laevigites Stage ($doV\beta$) the strata assigned previously to the Wocklumeria Stage. The gaps were interpreted as reflecting transgressions of the overlying deposits, and referred to epeirogenic uplifts corresponding to the Bretonic orogenic subphases.

The present conodont-based biostratigraphic investigations result in making the image of the geological structure more complex (Fig. 3) but nevertheless, not in changing its fundamental characteristics.

GIVETIAN?/FAMENNIAN DISCONFORMITY

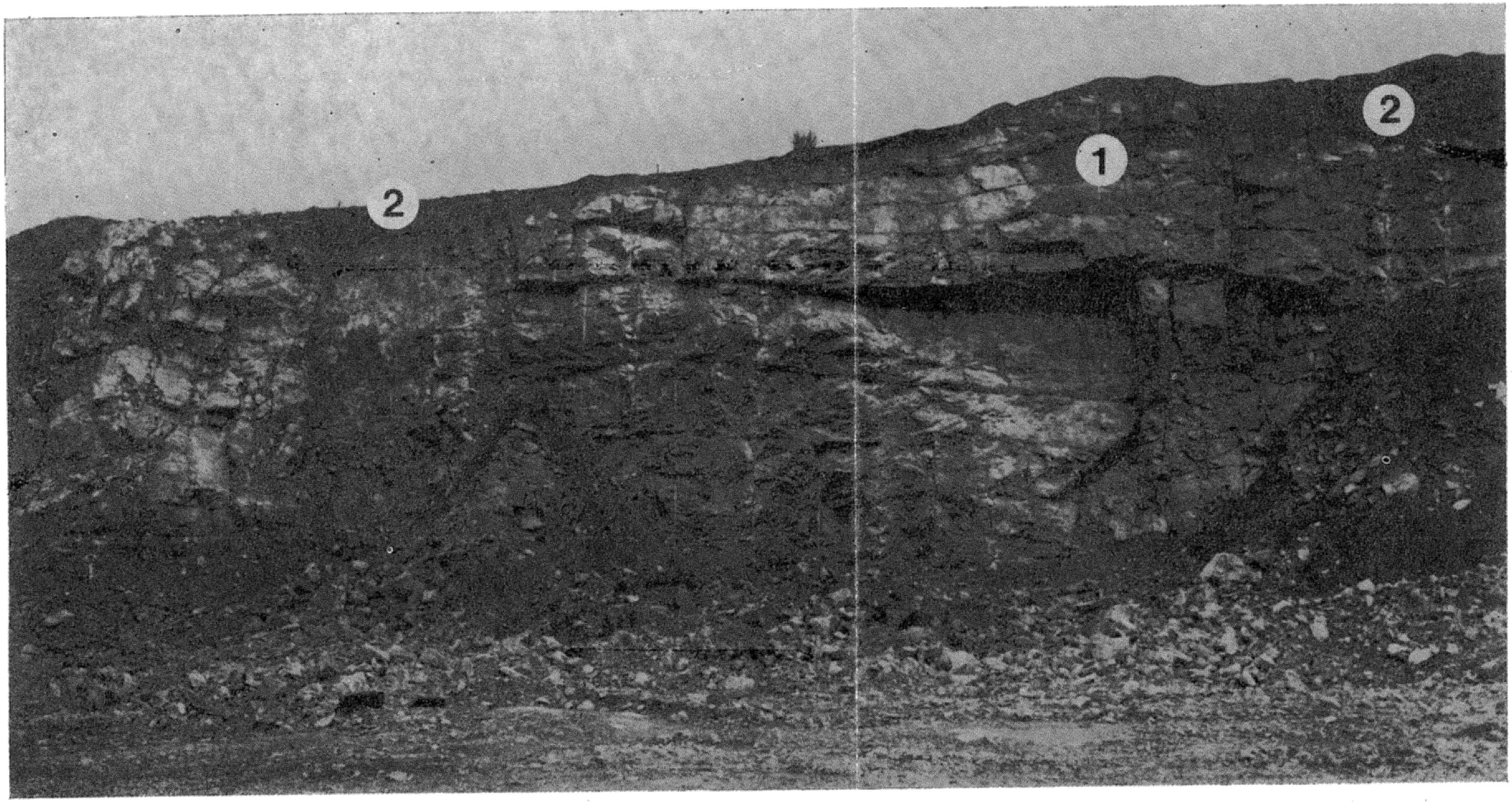
The Famennian to Givetian relationship in the Gałęzice Hills was variously interpreted in the geological literature. Czarnocki (1928, 1947) regarded the contact as sedimentary, whereas Kwiatkowski (1959) claimed it to be of tectonic nature. The present author supported the former opinion because of the following reasons: Firstly, the Famennian starts with the same conodont zone (Upper Palmatolepis marginifera Zone) attaining but some tens centimeters in thickness, over a distance of some 2 km; one can hardly expect that a longitudinal fault cuts down the Frasnian and lower part of the Famennian so precisely (Szulczewski 1971, p. 77). Secondly, the deposits of the Palmatolepis marginifera Zone form in places small neptunian dykes penetrating the Amphiporoid Limestones (Szulczewski & Żakowa 1976, p. 65).

The contact of the Amphiporoid Limestones with the Famennian, as exposed in the "Ostrówka" quarry, does not only confirm that opinion but also it throws much light on the causes for the stratigraphic gap between the Givetian and the upper part of the Famennian.

There is no angular conformity between the Amphiporoid Limestones and the overlying Famennian and/or Lower Carboniferous (Fig. 4). The well bedded Amphiporoid Limestones are slightly bent and cut by a flat even surface. The Famennian and Culm are bedded parallel to the unconformity surface. Then, the relationship of the Famennian — Lower Carboniferous sequence to the underlying Amphiporoid Limestones is of disconformity type. The Givetian top surface does usually not display any peculiarities. In places, however, corrosion cavities coated with ferrum oxides and filled with Famennian limestones penetrate the bedrock down to 15 centimeters. The smooth surface separating the Famennian from the Givetian is also sometimes covered with brownish ferroxides. Neptunian dykes occur but exceptionally; however, small cavities filled with internal sediments occur locally down to some 25 cm below and hence appear related to the unconformity surface. Eventhough both the Givetian and Famennian deposits are marine limestones, they are clearly different in facies.

The uppermost portion of the Amphiporoid Limestones takes appearance of micritic limestones with inabundant fossils. Some amphiporoids may occur up to

Western part of the quarry "Ostrówka" at the Gałęzice Hills



Visible is disconformity between (1) the Amphiporoid Limestones (Givetian or lowermost Frasnian) and (2) the uppermost Tournaisian (Scaliognathus anchoralis Zone). In other places, the lenses of the Famennian overlie the disconformity surface below the Tournaisian the disconformity surface. There are some intercalations of calcareous laminites among the micritic limestones and fine calcarenites, passing in places into fine stromatolites. Thus, the Amphiporoid Limestones underlying the unconformity surface are certainly of shallow-water origin; actually, the sedimentary environment could even be intertidal zone.

In contrast, the Famennian is represented by dark-grey micritic limestones with abundant crinoid detritus and clymenid shells. The large amounts of crinoid matter make the rock different from the typical pelagic "Cephalopoden-Kalk".

One might wonder whether the unconformity does occur between the Givetian and the Famennian, or higher in the section, that is between the Famennian and the Culm. In fact, the Culm overlies in places directly the Amphiporoid Limestones (Fig. 4), the contact being sedimentary. Nevertheless, one may recall the occurrence of a thin Famennian cover also in areas where the Amphiporoid Limestones are degraded more considerably than usually, which indicates clearly that the unconformity surface is, indeed, below the Famennian. Furthermore, there is the largest stratigraphic gap in the sequence associated with the most dramatic change in facies at the Givetian?/Famennian boundary.

One may claim that the disconformity resulted from an uplift following the shallow-water sedimentation of the Amphiporoid Limestones. This would be a local block-type uplift causing but a slight tilting of the Amphiporoid Limestones. An emersion could take place although a possibility of shallow submarine origin of the disconformity cannot be rejected.

The thickness of abraded deposits can hardly be estimated. As judged from a geometric reconstruction of the folded Amphiporoid Limestones, at least 10 meters of the rocks have been taken off in places. However, the uplift is not precisely situated in time. In some sections (Fig. 3), the gap is at least partly related to nondeposition instead of abrasion. This is evidenced by the onset of the Famennian sedimentation in the Upper Scaphignathus velifer Zone here and there, whereas in a close neighborhood the sedimentation of similar cephalopod limestones started at the same flat depositional surface much earlier, namely in the Upper Palmatolepis marginifera Zone. Thus, some areas (Fig. 3) of the unconformity surface represented nondepositional surfaces at least since the Upper Palmatolepis marginifera Zone through the Upper Scaphignathus velifer Zone. Possibly, such conditions extended earlier, just after the "inundation" of the unconformity surface, all over the investigated area. If not, the Upper Frasnian could be stratigraphically condensed, as it is at the adjacent hill of Miedzianka. Thus, the extent of the pre-Famennian degradation might actually be much less than it appears, owing to stratigraphic condensation and nondeposition preceding the possible emersion.

FAMENNIAN DIASTEM AND RELATED PHENOMENA

The Famennian diastem occurs in the Polygnathus styriacus Zones. In fact, there is a continuous succession of the biostratigraphic zones in the eastern Gałęzice Hills (Szulczewski & Żakowa 1976); at Besówka and Ostrówka, the conodonts of the Polygnathus styriacus Zones occur only as a stratigraphic admixture in the Bispathodus costatus Zones (cf. Wolska 1967, as reinterpreted by Szulczewski & Żakowa 1976), although a possibility of sampling the zonal boundaries cannot be rejected (cf. Szulczewski & Żakowa 1976, p. 66); there is a hiatus or shaly parting in the westernmost part of the "Ostrówka" quarry, as indicated above. The phenomenon is not manifested physically and hence, it can be demonstrated exclusively with the biostratigraphic method. In particular, the hiatus comprising at least three standard conodont zones is represented physically by a mere bedding plane and/or shaly intercalation. When considered in dynamic terms, this is a completely *hidden hiatus* of Hadding (1958).

The argillaceous layer separating the limestone beds attributed to the Upper Scaphignathus velifer and the Bispathodus costatus Zones respectively, might also be regarded as a calm-water residuum after a submarine-corroded calcareous sediment (*cf.* Hadding 1958, p. 61); or even more plausibly as an effect of a near-cessation of lime mud production for a long time, representing thus *near-diastemic conditions* (cf. Heckel 1972, p. 26). However, the conodont absence from the layer would then be hardly explainable, since conodonts might be expected to occur more abundantly in the clay than in the adjacent limestones due to the lower accumulation rate of clay. In fact, the considerable chemical resistance of phosphatic conodonts makes implausible a hypothesis of corrosion-induced dissolution. On the other hand, conodonts could also be mechanically washed off to some contemporaneous or slightly younger areas of calcareous sedimentation. This hypothesis is, indeed, supported by the occurrence of the conodonts of that age admixtured to younger zones in some sections (Fig. 3).

Be it one way or another, the restricted geographical spread of the within-Famennian diastem indicates that it resulted from a pattern of some chemical or mechanical factors instead of tectonical uplift. Then, this is a submarine nondeposition gap (Fig. 3).

DEVONIAN/TOURNAISIAN DISCONFORMITY

Geometrically, the boundary between the Devonian and the Tournaisian (starting with the Scaliognathus anchoralis Zone) is of disconformity type. In fact, the Tournaisian is bedded parallel to the boundary, while it borders upon either the Amphiporoid Limestones, or the Bispathodus costatus Zone of the Famennian.

Czarnocki (1928) referred the hiatus between the Famennian or Middle Devonian and the Lower Culm to epeirogenic Bretonic movements of the Nassau subphase and to the Culm transgression.

Actually, however, it appears improbable that the disconformity resulted from a typical succession of emersion, abrasion, and transgression. The variability in thickness of the underlying Famennian is not caused by any subsequent degradation but by a variation in condensation and diastem factor intensity. The Culm rests upon either the Amphiporoid Limestones, or the Famennian Bispathodus costatus Zones but never upon any lower zone of the Famennian. There is no evidence of any pre-anchoralis abrasion affecting the Famennian; whereas the local sedimentary contacts between the Tournaisian and the Amphiporoid Limestones are probably related to some pre-Famennian abrasion and to the original absence of Famennian deposits from some areas. In fact, those places with Famennian rocks lacking at all do not make any elevations of the pre-Tournaisian substrate; the unconformity surface is flat. One may conclude that these are nondeposition areas persisting at least throughout the entire Famennian (Fig. 3).

The only physical manifestation of the nondeposition before the Scaliognathus anchoralis Age is in the form of ferrugineous pavements covering the top surface of the Givetian, and red hematitic impregnations in the top part of the Amphiporoid Limestones. There is no peculiar microrelief at the unconformity surface to evidence any corrosion.

The universal in the Gałęzice Hills (except of the section by Todowa Grząba) absence of strata with the "Protognathodus-Fauna" and of the lower part of the Tournaisian (all the zones below the Scaliognathus anchoralis Zone; *cf.* Groessens 1974) does also appear related to submarine nondeposition.

The hypothesis recalling submarine nondeposition without any emersion and abrasion to explain the disconformity between the Devonian and the Scaliognathus anchoralis Zone is also additionally supported by the pelagic or almost pelagic nature of both the Famennian and Tournaisian deposits accumulated probably in deeper parts of the photic zone, and by the pelagic nature of the strata equivalent to the gap as observed in adjacent sections.

Then, some misunderstanding may follow from the term *Lower Culm transgression* over the Wocklumeria Stage or the Middle Devonian, as introduced by Czarnocki (1928, p. 58; 1933, p. 32). Actually, the term recalls the Culm to Devonian relationship and it is meant to designate but the hiatus separating them. What is meant is only the appearance of deposits. It does not reflect any actual marine transgression, since the Famennian sedimentation, the nonsedimentation resulting in the hiatus, and the Culm sedimentation took all of them place under submarine conditions; and moreover, the hiatus itself did not result from any regression.

The causal relationship of the hiatus and Lower Culm "transgression" to epeirogenic movements, as claimed by Czarnocki (1928, p. 58), does also appear doubtful. One must not recall any uplift to account for a disconformity. In contrast, the lithology at both the sides of the considered disconformity surface indicates successive deepening of the basin, while the Tournaisian facies development lead eventually to the formation of radiolarian cherts and the replacement of carbonate sedimentation with clayey one. The problem of a considerable change in facies at the Devonian/Carboniferous boundary broadly meant appears to be a regional one and hence, caused by much more universal processes than local epeirogenic movements.

With the above argument taken into account, one may also consider the Devonian/Carboniferous boundary at Gałęzice; in fact, the latter problem appears somewhat cloudy and is usually treated in terms of "transition of the Devonian into the Carboniferous" or the ocurrence of "transitional beds". Actually, three basic points are to be considered: (*i*) presence or absence of full succession of the standard biostratigraphic units at the Devonian/Carboniferous boundary (problem of biostratigraphic continuity); (*ii*) presence or absence of a considerable change in facies at the boundary (problem of facies continuity); and (*iii*) relationship of possible discontinuities to subsequent tectonics.

In most sections, continuous succession of the conodont zones ranges up to the Middle Bispathodus costatus Zone; whereas higher zones, up to the Siphonodella Zones, are usually considerably condensed or absent at all due to local diastems. The taxa indicative of the "Protognathodus-Fauna" interval occur in but a single sample taken at Todowa Grząba and comprising also conodonts of the Bispathodus costatus Zone. There are also the Siphonodella Zones at Todowa Grząba.

At the Devonian/Carboniferous boundary, a sharp change in lithology occurs exclusively in sections where it is accentuated by a hiatus. In more complete sections, there is but an increase in marly matter content at the boundary. Over the carbonate platform (Fig. 1), limestone intercalations range commonly up to the Siphonodella triangula inaequalis Zone (Bolechowice, Dalnia, Miedzianka, Jabłonna) and even to the Scaliognathus anchoralis Zone at Ostrówka hill; while radiolarian cherts appear but higher in the section.

The stratigraphic gaps at the boundary resulted from subaqueous nondeposition. Then, the replacement of calcareous sedimentation typical of the Upper Devonian with clayey-siliceous sedimentation in the upper part of the Tournaisian was not caused directly by any tectonic uplift; in contrast, it resulted from a renewed subsidence following previous long-term tectonic stability. In the Tournaisian, the submarine threshold formed at the basement of the carbonate platform had drowned; thereafter, the Lower Culm fine-grained clastic sedimentation started in the area due to an increase in morphological gradient in marginal portions of the basin.

LOWER CULM/CARBONIFEROUS LIMESTONE BOUNDARY

Czarnocki (1928) regarded the Lower Culm as the Tournaisian higher than the Gattendorfia Stage, and the Carboniferous Limestone and Upper Culm as the Viséan. Later investigations of various fossil groups of the Carboniferous Limestone demonstrated that the unit represents but the upper part of the Viséan (*cf.* Czarniecki & *al.* 1965; Fedorowski 1971; Żakowa 1971, 1974; Czarniecki 1973), eventhough there is no unanimity as to its precise age.

The new stratigraphic attribution of the Carboniferous Limestone and at the same time, the persistence of the opinion assigning the Lower Culm to the Tournaisian implied a hiatus between both the units, comprising the lower part of the Viséan. As judged from the goniatites (Czarniecki 1973, Żakowa 1974), the Carboniferous Limestones starts with the Goniatites crenistria Zone (*Goα*) equivalent to the Belgian zone *V3b*. If so, the hiatus comprises the zones *V1* through *V2a*. According to Żakowa (1970, p. 20), the hiatus resulted from the tectonic nature of the contact between the Lower Culm and the Carboniferous Limestone.

The age attribution of the Carboniferous Limestone is, indeed, documented with diverse fossils; in contrast, the assignment of the Lower Culm of Gałęzice area to the Tournaisian is substantiated with but a few fossils derived almost entirely from the base part of the unit. And yet the Lower Culm attains at least 60 m in its maximum thickness (Żakowa 1971, p. 12). One can hardly accept any stratigraphic attribution of the unit based upon fossils coming exclusively from its lower part.

The present study does not supply any data finally solving the problem of the geological age of the top part of the Lower Culm. One may but claim that since the Lower Culm starts with the Scaliognathus anchoralis Zone (*i.e.*, the uppermost Tournaisian), the upper part of the Lower Culm (*i.e.*, that one with the radiolarian cherts) is already to be attributed to the Viséan and therefore, there is no significant hiatus between the Lower Culm and the Carboniferous Limestone. Slight tectonical reductions can, of course, be expected at the Lower Culm/Carboniferous Limestone boundary because of their differential competence; nevertheless, those reductions should not be so considerable as they are commonly thought to be.

REMARKS ON REGIONAL CORRELATION

Other serious difficulties arise when correlating the section of the Gałęzice Hills with other sections of the Holy Cross Mts. According to Żakowa (1970, Tab. 1; 1974, p. 7), the Tournaisian of the Gałęzice Hills is represented entirely by the Zaręby Beds comprising radiolarian cherts. As shown both by Czarnocki (1928) and the present study, the lower part of the Lower Culm is actually represented by mottled clayey shales intercalated with limestones and hence, it resembles in lithology the Radlin Beds rather than the Zaręby Beds. The Radlin Beds have been distinguished by Żakowa (1970, Tab. 1) at Bolechowice where they comprise the conodont fauna indicative of the Siphonodella

Zones (cf. Freyer & Żakowa 1967); whereas the possible Radlin Beds in the western Gałęzice Hills start usually with the Scaliognathus anchoralis Zone. The base boundary of the Zaręby Beds is then to be traced much higher than it was claimed by Żakowa (1970, Tab. 1); maybe, the unit should be at least partly transferred to the Viséan.

The precise stratigraphic position of the so-called Tournaisian in other sections of the Holy Cross Mts appears uncertain, as no conodonts or goniatites have been found. Then, any stratigraphic correlation is but tentative.

CONCLUSIONS

New observations made at Ostrówka, Gałęzice Hills, do generally confirm the Upper Devonian-Tournaisian lithological sequence as claimed by Czarnocki (1928). However, the better exposures and the use of conodonts permitted more precise general stratigraphy; on this basis, the hiatuses are more precisely determined and new interpretations of the disconformities are presented.

A few meters thick condensed sequence covering the Amphiporoid Limestones ranges at its maximum since the Upper Palmatolepis marginifera through the Scaliognathus anchoralis Zones. Its top marks the ultimate disappearance of carbonate sedimentation replaced with the deposition of clays and radiolarian cherts.

There are stratigraphic gaps (three at maximum) within the sequence, varying in both the lateral and vertical range. The first gap occurs always at the base of the Famennian; it ranges since the Givetian (or lowermost Frasnian ?) through the Upper Palmatolepis marginifera Zone and locally, even up to the Upper Scaphignathus velifer Zone. The second gap occurs within the Famennian and comprises the Polygnathus styriacus Zones; this is completely hidden hiatus recognizable only biostratigraphically. The third gap occurs at the base of the Scaliognathus anchoralis Zone; it ranges down to the Bispathodus costatus Zones or even to the top of the Amphiporoid Limestones.

All the gaps resulted from processes contemporaneous to the Devonian--Carboniferous sedimentation, not from subsequent tectonics. The variability in thickness of the Famennian ranging between 3—4 m and 25 cm (or even total reduction) resulted from internal diastems rather than from post-Famennian degradation.

The gaps have insofar been interpreted as a reflection of epeirogenic uplifts related to the Bretonic tectonics. However, such a nature can be, indeed, ascribed only to the disconformity between the Amphiporoid Limestones and the Upper Palmatolepis marginifera Zone, displaying effects of successive uplift resulting in a slight tilting, emersion (?), and abrasion.

The gaps above the Upper Palmatolepis marginifera Zone do not show any direct relationship to tectonics. Almost all the standard conodont zones are locally present in one or another part of the Gałęzice Hills. The usually absent Polygnathus styriacus Zones appear nevertheless as stratigraphic admixtures in higher zones. Only those zones (or the Polygnathus communis carinus Zone) comprised between the Siphonodella Zones and the Scaliognathus anchoralis Zone have not been found in the Gałęzice Hills. Possibly, however, the latter interval is equivalent to that part of the section lacking limestone intercalations. There is a change in facies in the condensed sequence, the cephalopod-crinoid limestones being successively replaced with true pelagic limestones.

One may conclude that subaqueous regime persisted in the area continuously since the Palmatolepis marginifera Age through the Scaliognathus anchoralis Age and later on. There was a variable, mosaic pattern of sedimentation and nonsedimentation. The nonsedimentation was prevalent during some time-spans, as *e.g.* the Polygnathus styriacus or Siphonodella Ages.

The present study of the Upper Devonian and Lower Carboniferous of the Gałęzice Hills shows clearly that the simple model "gap means uplift" and "sedimentation means subsidence" cannot be uncritically applied, especially to condensed sequences. In fact, a stratigraphic gap appears in such sequences as a normal although extreme reflection of a decrease in sedimentation rate down to its cessation. The latter process is expressed in a sequence of biostratigraphic phenomena: condensation with normal fossil succession, mixed fauna, and finally local diastem.

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NIECIĄGŁOŚCI SEDYMENTACYJNE I ICH GENEZA W PROFILU POGRANICZA DEWONU I KARBONU GAŁĘZIC

(Streszczenie)

Przedmiotem pracy jest ścisłe określenie pozycji, zakresu i przyczyn powstania luk stratygraficznych w profilu górnego dewonu i dolnego karbonu wzgórz gałęzickich w Górach Świętokrzyskich (*patrz* fig. 1—4). Profil ten wykazuje znaczną kondensację stratygraficzną i zawiera kilka luk (*patrz* fig. 2), z których ważniejsze były już znane Czarnockiemu (1928, 1933); luki pomiędzy wapieniem amfiporowym a famenem, oraz między famenem a wyższym turnejem, Czarnocki wiązał z epejrogenicznymi ruchami bretońskimi.

Nowe odsłonięcia w obrębie kamieniołomu „Ostrówka" ujawniły, że tylko famen od wapieni amfiporowych (żywet lub najniższy fran) dzieli nieznaczna niezgodność kątowa, związana z bretońskim wydźwignięciem tektonicznym i abrazją (*patrz* fig. 4). Wyższe luki stratygraficzne (*patrz* fig. 3) nie wykazują bezpośredniego związku z ruchami tektonicznymi, lecz spowodowane są okresami lokalnej niedepozycji w środowisku podmorskim. Luki te są niemal w całości zastąpione obocznie przez osady wapienne wykształcone w facji pelagicznej, lub zawierające skamieniałości pochodzenia pelagicznego. Lokalnie i jako kontynuacja facji właściwej famenowi występują osady piętra Gattendorfia oraz „fauna Protognathodus" wymieszana z konodontami z poziomów Bispathodus costatus. Kolejna luka występuje poniżej poziomu Scaliognathus anchoralis, rozpoczynającego najwyższy turnej, a wykształconego jeszcze w facji ilasto-wapiennej. Wydaje się zatem prawdopodobne, że tzw. turnej w Gałęzicach może zawierać w wyższej partii także część wizenu, a zatem nie musi być znacznie starszy od górnowizeńskiego wapienia węglowego.