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Fundamental stratigraphic problem of the Cambrian in the Holy Cross Mts.

The only existing stratigraphic scheme of the Holy Cross Cambrian (S. Orłowski, 1975) and its later modifications (Figs. 1–7) are critically reviewed. Lithostratigraphic units in these subdivisions are informal because the majority of them do not meet the requirements of National Stratigraphic Code. Their biostratigraphic position is in most cases disputable. The author presents his own stratigraphic subdivision (Fig. 8). The Czarna Shales are of Holmia and Protolenus age. The Osiek Sandstones belong most probably to the lowest Middle Cambrian. The Góry Pieprzowe Shales represent not only the upper part of Middle Cambrian but are also the time equivalent of various Middle and Lower Cambrian units. Ichnozones in Middle and Upper Cambrian are of low stratigraphic value. The determinations of trilobites yielded by Middle and Upper Cambrian rocks must be revised.

INTRODUCTION

The main reason for preparation of this paper was a short note published recently in Polish (S. Orłowski, W. Mizerski, 1995). Several scientists — including myself — were fiercely attacked in this note. We were accused of the distribution of **false** information, misleading the participants of the international EUROPROBE meeting in Kielce, September 1994. Instead, the authors of that note promised to present a **true** picture of the Wiśniówka region geology which is a key area for understanding the stratigraphy and tectonics of the Cambrian in the Holy Cross Mts.

However, since the note did not contain any new arguments and referred only to earlier papers, a broader, more comprehensive discussion of all the scientific achievements of both authors became necessary. The following remarks concern only the stratigraphic views of S. Orłowski. The tectonic interpretations of W. Mizerski will be discussed in a separate paper.

Having read the mentioned note, we wanted to immediately correct some obvious misrepresentations of our thoughts. The editors of *Przegląd Geologiczny* have not accepted our short answer, because "...it does not contain a real scientific discussion...". Therefore, before we take up the main topic, we must begin with these corrections.

First, S. Orłowski and W. Mizerski (1995, p. 13) wrote: "...The statement that the rocks in the Wiśniówka Duża quarry may even belong to the Lower Cambrian results from either ill intention or unacquaintance of the discussed problems...". However, the questioned fragment (M. Studencki, 1994, p. 51) reads: "S. Orłowski (1968) documented Late Cambrian trilobites (*Olenus rarus* Orłowski and *Protopeltura olenosorum* Orłowski) in Wiśniówka. According to J. Bergström (1973) these determinations are controversial. Investigations of organisms *Corallicyathida* (W. Sedlak 1975) derived from quartzites of the Main Range even suggested a Lower Cambrian age (uppermost Lower Cambrian). An acritarch assemblage indicated the Middle Cambrian through Tremadoc (M. Moczyłowska in Z. Kowalczewski *et al.*, 1986). Investigations performed by Z. Szczepanik (unpublished data) seem to narrow this interval to the uppermost Middle Cambrian...". So, in the cited text several possibilities have been mentioned, **among them** the Lower Cambrian one. This is then neither ill intention nor a lack of knowledge, but rather an example of scientific impartiality. W. Sedlak had the right to express his opinion and M. Studencki was obliged to quote it.

Secondly, S. Orłowski and W. Mizerski (1995, p. 13) wrote: "...the conception that pre-Holmia rocks belong to the Precambrian is erroneous...". Of course it is! But in the cited paper the appropriate phrase is as follows: "In the Holy Cross Mts no pre-Lower Cambrian (pre-Holmia) rocks have been stratigraphically documented...". It is clear that the word in parentheses is nothing more than specification of the age (pre-Lower Cambrian, **more precisely** pre-Holmia). My opponents simply read this phrase with ill intention.

CAMBRIAN STRATIGRAPHY

INTRODUCTORY REMARKS

The fundamental arguments of S. Orłowski and W. Mizerski (1995, p. 13) are based on "...the only existing and documented stratigraphic model of the Cambrian..." which was created by S. Orłowski. This model was, in turn, the basis for tectonic reconstructions by W. Mizerski. Let us examine this cornerstone of Holy Cross Cambrian stratigraphy.

The lithostratigraphic subdivision of the Cambrian and its relation to biostratigraphy was first published by S. Orłowski (1975) and then modified several times (S. Orłowski, 1985a, 1987, 1988a, b, 1992a, b; W. Mizerski *et al.*, 1986; S. Orłowski, W. Mizerski, 1995).

Fig. 1. Lithostratigraphic units of the Cambrian and uppermost Precambrian in the Holy Cross Mts. and their correlation with biostratigraphic zones and subzones of the Cambrian in the Holy Cross Mts. and Scandinavia (after S. Orłowski, 1975)

Jednostki litostatygraficzne kambriu i najwyższego prekambriu Gór Świętokrzyskich oraz ich korelacje z poziomami i podpoziomami biostratygraficznymi kambriu Gór Świętokrzyskich i Skandynawii (według S. Orłowskiego, 1975)

S. Orłowski was convinced in 1975 that his lithostratigraphic units were formally correct and, subsequently, he also insisted on granting them a formal status because — as he claimed — they are congruent with the rules of Polish National Stratigraphic Code (*Zasady...*, 1975). However a thorough analysis of the problem shows that the requirements of the code are fully met in case of the Usarzów Sandstone Formation only. Remaining units **fulfil these requirements only partially**, because of inadequate documentation.

Major shortcomings of S. Orłowski's proposal are as follows:

- the boundaries between lithostratigraphic units were in most cases not properly described and defined (see paragraph 5c of the Code) with reference also to their tectonic character;

- lithological sequences of the majority of units were recognized in fragments only and their thicknesses were estimated inaccurately;

- detailed maps, lithologic columns, cross-sections illustrating the geology of the defined units, and especially the problem of boundaries, are lacking; the references in this respect to earlier papers where these units existed as informal is also insufficient since the illustrations are too general there;

- precise petrographical and lithological criteria are not given for the differentiation of various units of similar development (mainly sandstones) which frequently repeat in the sequence and sometimes are contiguous; this, as well as the description of regional aspects, are required by paragraphs 5c and 5f of the Code. Because of this defect the interrelations among the units and their geographic extent are still causing problems.

All these imperfections do not result from S. Orłowski's errors but rather from the fact that good Cambrian exposures are simply very scarce in the area. But it means only that in such circumstances the formal lithostratigraphic units **should not be created at any cost**.

As to the biostratigraphic position of lithostratigraphic units, S. Orłowski believes mainly in trilobites, overestimates the stratigraphic significance of trace fossils and completely ignores the acritarchs — a modern stratigraphic tool. He mentioned the acritarch assemblage from the Czarna Shales only once (S. Orłowski, 1975) but those data are out-dated now.

Consequently, the chronostratigraphic position of almost every lithostratigraphic unit is disputable. The following discussion is concentrated mainly on this problem. Figures 1 and 2 present, respectively, the earliest stratigraphic scheme and the geographic distribution of lithostratigraphic units, both according to S. Orłowski (1975). Figures 3–7 show successive changes of this scheme, Figures 6 and 7 being its latest version. Figure 8 illustrates the opinions of the present author.

THE AGE OF THE CZARNA SHALE FORMATION

In some of his works S. Orłowski (1975, 1987; S. Orłowski, W. Mizerski, 1995) believed that the Czarna Shales comprise the lower part of the Holmia-Schmidtellus Zone together with the following pre-Holmia zones: barren interzone, Coleoloides, and Hyolithes — Allathea (Figs. 1 and 6). In other papers (S. Orłowski, 1985a, 1988a, 1989, 1992a, b) he ascribed only a pre-Holmia age (down to the upper part of the Sabellidites Zone) to this formation (Fig. 5).

In fact, **rocks earlier than the Holmia age have been recorded nowhere** in the Holy Cross area (Z. Kowalczewski, 1990, 1994). This is clearly evidenced by the acritarch research of G. Vidal (W. Pożaryski *et al.*, 1981), M. Moczyłowska (Z. Kowalczewski *et al.*, 1987) and Z. Szczepanik (1993). More specifically, the acritarchs yielded by the Czarna Shales testify to their Holmia and Protolenus age. The Kotuszów Shale Member (Fig. 8) is of Lower Holmia age (not Precambrian as in S. Orłowski's scheme).

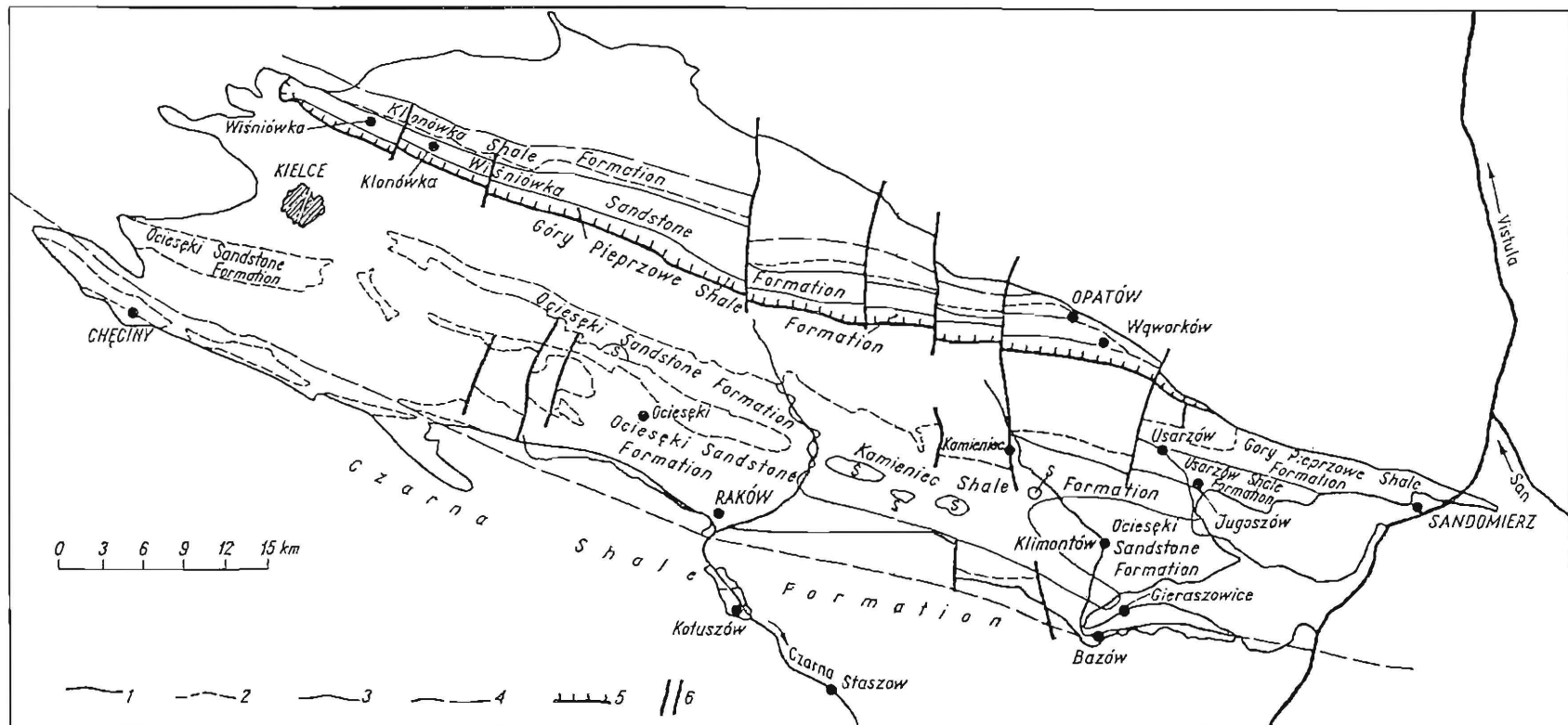
THE AGE OF THE OSIEK SANDSTONE MEMBER

The Osiek Sandstones are known from the Osiek 141 borehole (W. R. Kowalski, 1983, 1987; Z. Kowalczewski, 1990). According to S. Orłowski (1992*a, b*; W. Mizerski *et al.*, 1986; S. Orłowski, W. Mizerski, 1995) they underlie the Czarna Shales and belong to the pre-Holmia Sabellidites Zone, the oldest one in the Lower Cambrian, representing the entire zone or its lower part only (Figs. 4–6).

The trouble is that the quartz and sublithic arenites with quartz pebbles at the base encountered in the Osiek 141 borehole **contain neither any fossils nor organic matter at all** (Z. Kowalczewski, 1990). What then was the basis for assigning them to the Sabellidites biozone? Nevertheless, "...in shales below the Osiek Sandstones, Cambrian acritarchs (a.o. *Leiosphaeridia bicrura* Jank. and *Baltisphaeridia compressum* Volk.) have been identified by M. Moczyłowska. Therefore, the sediments which contain these fossils, cannot be older than the Holmia Cambrian ... " (Z. Kowalczewski, 1990, p. 16). Moreover, these shales belong to the Pliskowola Member (siltstones and shales), the older member of the Czarna Shales (Z. Kowalczewski, 1990, see also Fig. 8). In conclusion, the Osiek Sandstones **lie not below** (as S. Orłowski claims) but **above** the Czarna Shales. Their lithologic features may speak even for their Middle Cambrian age — according to Z. Kowalczewski (1990) the Osiek Sandstones are the lower member of the Middle Cambrian Słowiec Sandstones (Fig. 8).

THE CONTACT BETWEEN THE LOWER AND MIDDLE CAMBRIAN

The position of the Osiek Sandstones is important because in the Osiek 141 borehole there is an angular unconformity of 15–24° beneath them. This fact throws some light on the problem of conformity or non-conformity between the Lower and Middle Cambrian. If the views of W. R. Kowalski (1983, 1987) and S. Orłowski (1992*a*; S. Orłowski, W. Mizerski, 1995) are correct, this unconformity should be placed between the Cambrian and (?)Precambrian. According to my interpretation, in the Dyminy – Klimontów Anticlinorium (Fig. 8) the Słowiec Sandstones (and their part: the Osiek Sandstones) **overlie various members** of the Lower Cambrian: the Holmia Zone (its lower part in the Osiek 141 borehole) as well as the Protolenus Zone (vicinity of Widełki) which are developed either as sandstones (Ociesęki Sandstone) or as shales (Czarna Shales, Kamieniec Shales). The unconformity (and stratigraphic gap?) at this contact is estimated in the Bardo Syncline to be 5–10°. It becomes smaller northwards but is distinct in the entire area. R. Michniak (1962), investigating the discussed contact in the northeastern peripheries of the Klimontów



Anticlinorium, noted that the sediments of the Middle Cambrian are developed uniformly and overlie various deposits of the Protolenus Cambrian. S. Orłowski (1964a, 1975, p. 437) also notices the angular discordances along the top of Kamieniec Shales but he explains their origin by differences of competency between rocks of different lithology.

Full concordance, and possibly stratigraphic continuity, between the Lower and Middle Cambrian is to be expected in the Kielce – Łagów – Sandomierz Synclinorium (Fig. 8). There, the Lower Cambrian shales pass gradually upwards into similar sediments of the Middle Cambrian. The Góry Pieprzowe Shales contain (according to Z. Kowalczewski, 1990) rocks of both epochs (Fig. 8) developed in similar facies (see below and Fig. 8), while S. Orłowski (1975, 1985b, 1988a, b, 1992a, b; S. Orłowski, W. Mizerski, 1995) placed the Góry Pieprzowe Shales generally above the Usarzów Sandstones and Słowiec Sandstones, i.e. in the Middle Cambrian. Initially (S. Orłowski, 1975), the lower part of this unit was time-equivalent of upper portions of the Słowiec Sandstone Formation (Paradoxides polonicus Zone — comp. Figs. 1, 3, 5 and 6).

THE AGE OF THE OCIESEKI SANDSTONES AND THE SŁOWIEC SANDSTONES

In the original stratigraphic scheme of S. Orłowski (1975) the sandy-silty Ociesęki Sandstone Formation belonged only to the Lower Cambrian (Holmia and Protolenus Zones), whereas the Słowiec Sandstone Formation was assigned to the Middle Cambrian (Paradoxides insularis, P. pinus Zones within the Eccaparadoxides oelandicus Stage and the lower part of the P. polonicus Zone within the P. paradoxissimus Stage — Fig. 1). In one of his later papers (W. Mizerski *et al.*, 1986) the upper part of the Ociesęki Sandstones was included in the Paradoxides insularis Zone (Fig. 4) and this opinion was subsequently maintained (Fig. 5). Consequently, the problem of sedimentary non-conformity (or unconformity) at the Lower/Middle Cambrian boundary was eliminated.

Strangely enough, in S. Orłowski's recent synthesis of lithostratigraphic units (S. Orłowski, W. Mizerski, 1995) the Słowiec Sandstones have again returned to the P. insularis Zone (Fig. 6) and along with younger deposits of the P. pinus Zone make up the major part of this unit. The sediments of the P. polonicus Zone have nearly completely disappeared. **So what is the truth?** For what reasons are the same sandstones alternately or simultaneously assigned to both these formations? Why have these displacements been done without any geological justification? Neither a real lithological sequence of the boundary beds has been described nor a direct contact between the Słowiec and Ociesęki Sandstones has been

Fig. 2. Geographic distribution of lithostratigraphic formations of the Cambrian and uppermost Precambrian in the Holy Cross Mts. (after S. Orłowski, 1975)

1 — limits of Palaeozoic core of the Holy Cross massif, 2 — limits of Cambrian exposures, 3 — boundaries of formations, stated, 4 — boundaries of formations, supposed, 5 — the Holy Cross thrust, 6 — important faults, S — the Słowiec Sandstone Formation

Geograficzne rozprzestrzenienie formacji litostratigraficznych kambru i najwyższego prekambru Gór Świętokrzyskich (według S. Orłowskiego, 1975)

1 — granice masywu Gór Świętokrzyskich, 2 — granice odsłoneń kambru, 3 — granice formacji pewne, 4 — granice formacji prawdopodobne, 5 — nasunięcie świętokrzyskie, 6 — ważniejsze uskoki, S — formacja piaskowców ze Słowca

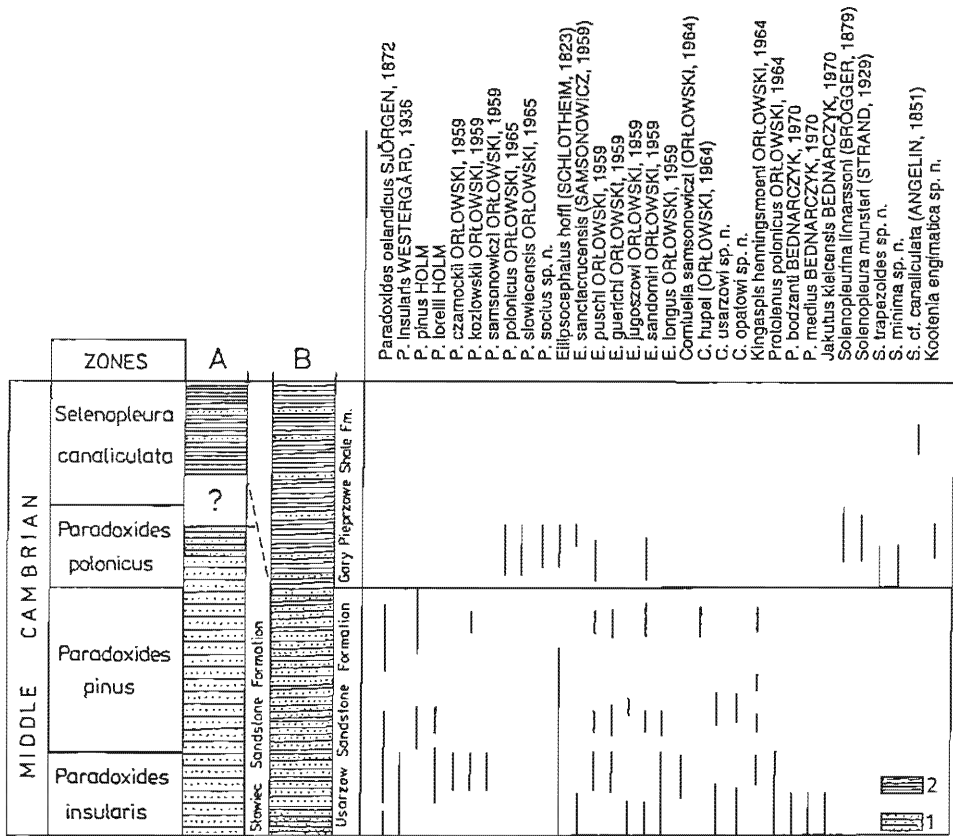


Fig. 3. Stratigraphy and trilobites of the Middle Cambrian in the Holy Cross Mts. (after S. Orłowski, 1985b): A — sections of Słowiec Hill and the Main Ridge in the middle part of the Holy Cross Mts., B — sections Jugoszwów — Usarzew and Góry Pieprzowe in the eastern part of the Holy Cross Mts.

1 — sandstones, 2 — shales

Stratygrafia i trylobity środkowego kambru w Górach Świętokrzyskich (według S. Orłowskiego, 1985b): A — profile góry Słowiec i Pasma Głównego w środkowej części Gór Świętokrzyskich, B — profile Jugoszwowa — Usarzewa i Gór Pieprzowych we wschodniej części Gór Świętokrzyskich

1 — piaskowce, 2 — łupki

indicated. It is well known, however, that the development of rocks in these both units is markedly different.

One of the key points in this discussion are the trilobites collected from the northern slopes of Zamczysko Hill where the rocks were included into the Middle Cambrian. We again meet a controversy here. Namely, it is doubtful whether these trilobites are really indicative of the Middle Cambrian — *P. insularis* Zone (W. Mizerski *et al.*, 1986; S. Orłowski, 1988a — see Fig. 4). J. Czarnocki (1927, 1933), whose collection from the same area was greater and who had excellent experience of the position of characteristic lithotypes

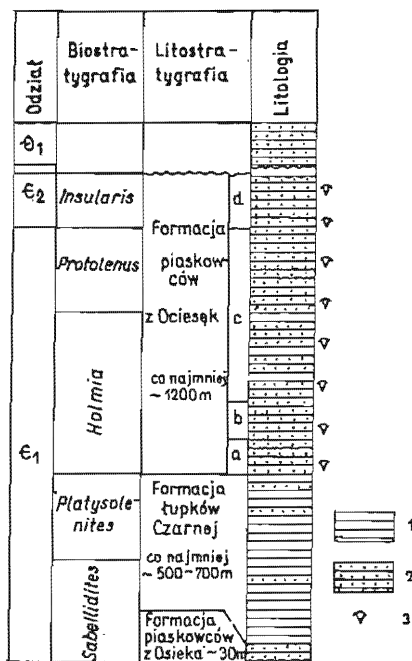
in the Cambrian sequence, assigned his trilobites and their containing rocks to the Lower Cambrian (upper part of the Protolenus Zone). Unfortunately, this collection was destroyed during the war. S. Orłowski (W. Mizerski *et al.*, 1986) listed only the endemic species in his collection: *Ellipsocephalus puschi* Orłowski, *E. guerichi* Orłowski, *Comluella opatovi* Orłowski, *C. usarzowi* Orłowski. In view of existing controversies about the description and determination of fossils, it would be necessary to revise them. After

Fig. 4. Lithological-stratigraphic section of the Cambrian in the Pasma Ociesęckie and Pasma Zamczyńska Ranges (after W. Mizerski *et al.*, 1986)

1 — shales, 2 — sandstones, 3 — trilobites

Profil litologiczno-stratygraficzny kambru Pasma Ociesęckiego i Pasma Zamczyńska (według W. Mizerskiego i in., 1986)

1 — łupki, 2 — piaskowce, 3 — trylobity

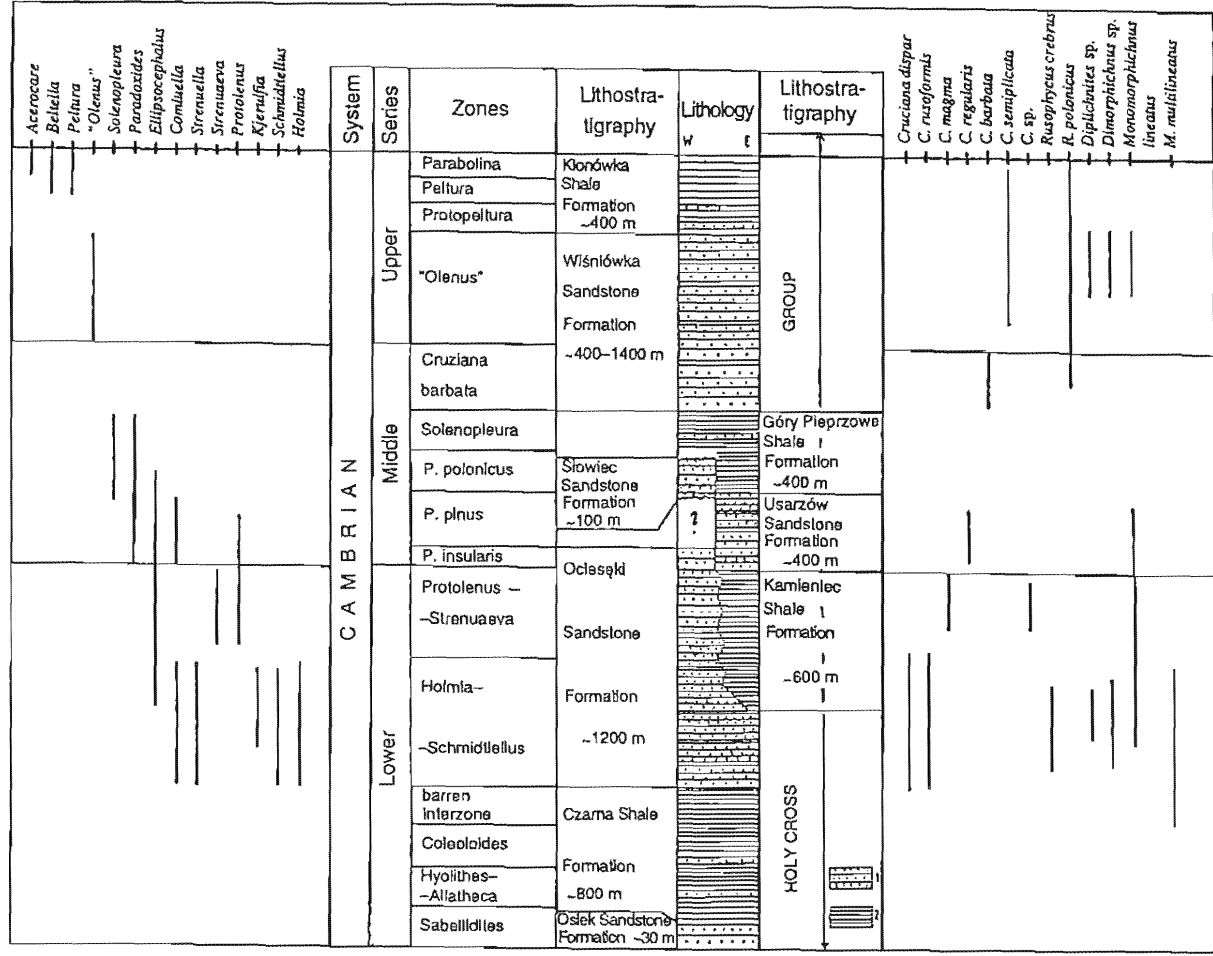


that the lower members of the Słowiec Sandstones would perhaps stop wandering in the stratigraphic scheme.

In addition, a view about the ubiquitous sedimentary continuity and full tectonic concordance between the rocks of supposed *P. insularis* through *Solenopleura* ages should be thoroughly examined. S. Orłowski, although accepts such a continuity, cannot prove it. The Komorna Conglomerate Bed in Kamień Łukawski (S. Orłowski, 1975) marks an erosional break in the otherwise monotonous sedimentation of the Góry Pieprzowe Formation (see below). The components of these conglomerates were derived from the adjacent area which seemed to be uplifted at that time. We can discuss whether the uplifted terrains were situated in the Klimontów or Łysogóry area. The discordance occurs at the contact between the Słowiec Sandstones and the Ociesęki Sandstones. If the sandstones with *P. insularis* happened to be part of the Ociesęki Sandstone Formation, then the discordance should be located higher in the sequence, i.e. within the Middle Cambrian, at the base of the *P. pinus* or *P. polonicus* Zones. S. Orłowski (1988a, b, 1992a, b) tacitly assumed a sedimentary and stratigraphic hiatus here (Fig. 2).

THE AGE OF THE GÓRY PIEPRZOWE SHALE FORMATION

The Góry Pieprzowe (Pepper Mts.) Shale Formation (S. Orłowski, 1975) is about 600 m thick. In the stratotype sequence near Sandomierz it is distinctly tripartite (Fig. 8). Its lower part, built of shales weathering "into pepper", is exposed in the southwestern segment of the Vistula River bank. The middle part consists of the Komorna conglomerates and sandstones. It is the Komorna Member *sensu* Z. Kowalczewski (1990), a small part of which



was earlier separated as the Komorna Conglomerate Bed by S. Orłowski (1975). These rocks, not more than 20–30 m thick, were once accessible in the Kamień Łukawski quarry. The upper part of the Góry Pieprzowe Shales is composed of shaly siltstones, poorly exposed in the northeastern segment of the Vistula River bank.

Trilobites characteristic of the *Paradoxides polonicus* and *Solenopleura* Zones (S. Orłowski, 1964*b*, 1985*b*, 1988*a*) have been found only in the quarry, i.e. in the Komorna Member, and on the opposite side of the Vistula River in Gorzyce (Mount Pączek). S. Orłowski extended this age upwards and downwards, into both the lower and upper parts of the Góry Pieprzowe Formation which are several hundred metres thick and are biostratigraphically barren. The *Solenopleura canaliculata* Zone, established by S. Orłowski (1985*b*) on the basis of poorly preserved cranidia of *S. cf. canaliculata* (Angelin) from Mount Pączek, was originally to represent the very top of the Middle Cambrian (equivalent of the *P. forchhammeri* Stage — Figs. 1 and 3). It was then “pushed down” (Fig. 5) by the *Cruziana barbata* Zone (S. Orłowski, 1992*b*). Since he has created the latter zone in Łysogóry, it is necessary to discuss if the siltstones of upper part of the Góry Pieprzowe Formation do not represent the younger zones of the *P. paradoxissimus* Stage together with the *P. forchhammeri* Stage.

Z. Kowalczewski (1990) claims that the lithological features of the lower part of the Góry Pieprzowe Shales speak for its Lower Cambrian age while the upper part belongs most probably to the *P. forchhammeri* Stage (Fig. 8).

GÓRY PIEPRZOWE SHALES ON THE SOUTHERN FORELAND OF THE MAIN RANGE

According to S. Orłowski (1975, 1992*a, b*) the southern slopes of the Holy Cross Main Range along their entire length are built exclusively of the Middle Cambrian Góry Pieprzowe Shale Formation (Fig. 2) which remains in sedimentary continuity with the overlying Wiśniówka Sandstones. The lower portion of the latter is of Middle Cambrian age (*Cruziana barbata* Zone = *P. forchhammeri* Stage in Scandinavia).

In fact, beneath the so-called “Łysogóry Quartzite” (thick-bedded quartzitic sandstones which are the lower, main part of S. Orłowski’s (1975, 1992*a, b*) Wiśniówka Sandstone Formation) the rocks are **variably developed and are probably of various ages** (Z. Kowalczewski *et al.*, 1976, 1986). Among them there are shales similar to Góry Pieprzowe Shales, but also thick sandstone/siltstone beds (Z. Kowalczewski *et al.*, 1976, their Fig. 1). There is no unequivocal evidence of the age of these rocks.

The results of mapping and observation of contacts between the Wiśniówka Sandstones and their underlying rocks testify to their mutual discordant tectonic relation (Z. Kowalczewski *et al.*, 1976, 1986). In the Jeleniów Range and in the area of Opatów, the Łysogóry Quartzites and younger rocks overlap to the east the various folded complexes of the Middle

Fig. 5. Stratigraphy of Cambrian sequence with selected trilobite genera (on the left) and trilobite trace fossils (on the right) (after S. Orłowski, 1992*b*)

1 — sandstones, 2 — shales

Stratygrafia profilu kambry z wybranymi rodzajami trylobitów (po lewej) i trylobitowych skamieniałości śladowych (po prawej) (według S. Orłowskiego, 1992*b*)

1 — piaskowce, 2 — łupki

and (?) Lower Cambrian (Z. Kowalczewski *et al.*, 1976). The mutual stratigraphic relation between the Góry Pieprzowe Formation (and, more precisely, the Komorna Member with index fossils) and the Łysogóry Quartzites remains disputable. As in both units *Paradoxides* trilobites, even of the same species, have been found (J. Czarnocki, 1929, 1936, 1950; J. Samsonowicz, 1934), so it is quite possible that they are coeval. Consequently, the upper part of the Góry Pieprzowe Shales (above the Komorna Member) may be assumed to be the facies equivalent (Fig. 8) not only of the Usarzów Sandstones and the Słowiec Sandstones but also of the Łysogóry Quartzites in the Wiśniówka Sandstone Formation *sensu* S. Orłowski (1992a).

THE AGE OF ROCKS IN THE WIŚNÍÓWKA AND WĄWÓRKÓW QUARRIES

Two lithostratigraphic units have been distinguished by S. Orłowski (1975, 1992a, b; S. Orłowski, W. Mizerski, 1995) in the vicinities of Wiśniówka (Figs. 1 and 5–7). They remain in stratigraphic continuity and tectonic concordance. The lower unit — Wiśniówka Sandstone Formation — was assigned earlier (S. Orłowski, 1975) to the lowermost Upper Cambrian (“*Olenus*” zone — the equivalent of the biozones I and II in Scandinavia). Earlier, S. Orłowski (1968b) admitted the Wiśniówka Sandstones to represent also the lower part of the biozone III but later he did not confirm this view. In turn, the lower part of this formation was later included by him in the so-called *Cruziana barbata* Zone which is supposed to be the equivalent of the *P. forchhammeri* Stage (S. Orłowski, 1992a, b). The upper unit — Kłonówka Shale Formation — is of Upper Cambrian and Lower Ordovician age (Protopeltura, Peltura, Parabolina and Dictyonema Zones — equivalents of biozones III through VI + Dictyonema in Scandinavia).

S. Orłowski and W. Mizerski (1995, p. 11) wrote: “...The most important for Cambrian stratigraphy ... are trilobites. They are scarce in the rocks of the Wiśniówka quarries — there are 10 specimens in the collection of S. Orłowski — but their significance is increased by ... the more abundant findings in Wąwórków near Opatów ...”. Let us consider this evidence.

S. Orłowski (1968a) identified the trilobites *Olenus rarus* n. sp. and *Protopeltura olenusorum* n. sp. from the quarries in Wiśniówka Duża and Wąwórków. He mentioned also the brachiopods *Orusia* cf. *lenticularis* Wahlenberg.

However, J. Bergström (1973, p. 57) questioned the correctness of S. Orłowski’s determinations. He wrote: “...The pleurae of “*Olenus*” *rarus* as well as of “*Protopeltura*” *olenusorum* indicate that these trilobites belong to the *Ptychoparida* ... The cephalitic characters including the blunt anterior end of the glabella, indicate that “*O.*” *rarus* belongs to the *Acrocephalitinae*, probably to one of the Upper Cambrian genera *Pesaia*, *Clifia* or *Paraorocephalites*. Also “*P.*” *olenusorum* seems to be a *solenopleuracean*...”.

S. Orłowski never discussed these objections. It is true that in his later works (1988a, 1992a, b; S. Orłowski, W. Mizerski, 1995) he placed the genus name in quotation marks (“*Olenus*” *rarus*). He has also used quotation marks for the “*Olenus*” Zone when putting it in the stratigraphic tables — especially those published abroad (S. Orłowski, 1992a, b). In Polish journals he is not so consistent: even in the same paper this horizon is sometimes put in quotation marks and sometimes is not (S. Orłowski, W. Mizerski, 1995, comp. Figs. 6 and 7).

Two conclusions may be drawn from J. Bergström’s opinion quoted above:

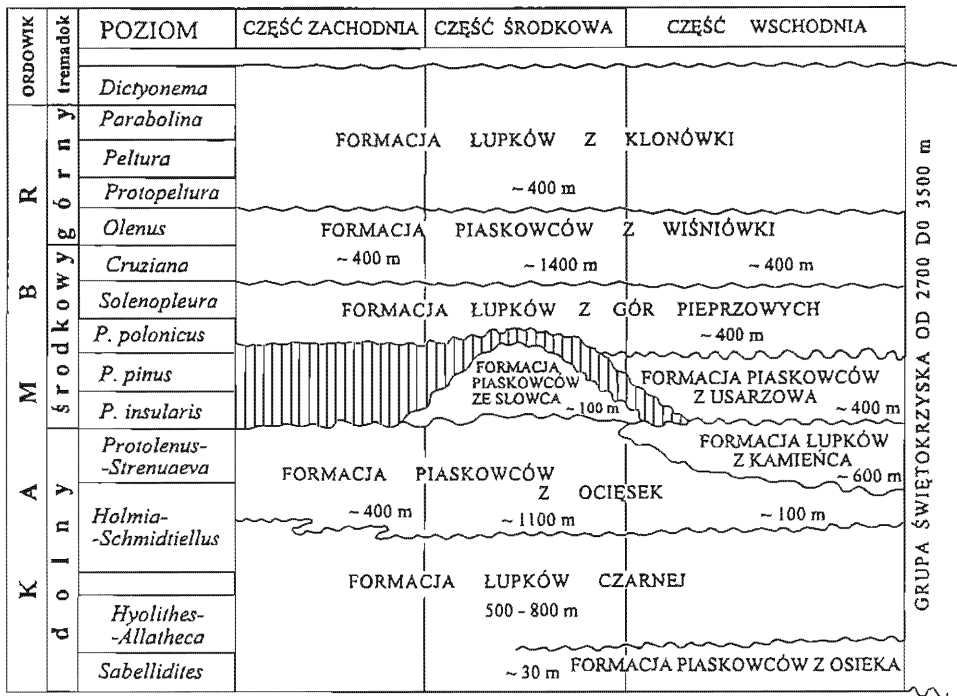


Fig. 6. Cambrian subdivision in the Holy Cross Mts. (after S. Orłowski, W. Mizerski, 1995)

Podział stratygraficzny kambru Gór Świętokrzyskich (według S. Orłowskiego, W. Mizerskiego, 1995)

— no index taxa of *Olenides* from Zones I to II in Scandinavia have been found in the Holy Cross region; only representatives of *Solenopleuraceae* seem to occur here;

— if "*Olenus*" *rarus* Orłowski and "*Protopeltura*" *olenusorum* Orłowski are really of Upper Cambrian age, they are rather characteristic of zones younger than the *Olenus* Zone; as will be indicated below, they might be the equivalent of Zone III.

Moreover, S. Orłowski (1968a, b, 1975, 1992a) completely ignored the results of research by J. Samsonowicz who found the Late Cambrian trilobites in the Wąworków quarry. He wrote (J. Samsonowicz, 1934, p. 7): "...The genera *Parabolina*, *Peltura* and *Ctenopyge* can be distinguished among the numerous fragments of trilobites ... This fauna is not older than that of zone III in the Swedish stratigraphic scheme ... because the representatives of the genus *Olenus* (*sensu stricto*) do not occur here. On the other hand it seems to be not younger than zone V of this scheme....". S. Orłowski tacitly rejected this opinion and continues to believe that only the Wiśniówka Sandstone Formation (earlier Late Cambrian) occurs in the Wąworków region.

However, the detailed geological and geophysical survey proved that the Łysogóry Quartzites, so characteristic of the Main Range (including the Wiśniówka area) are absent in the Opatów area (Wąworków). Instead, in Wąworków and Jałoweszy — among alternating sandstones, and varicoloured siltstones and shales — numerous interlayers of bentonites, tuffites and tuffitic siltstones have been recorded (Z. Kowalczewski *et al.*, 1976). Pyroclastic

rocks of similar type are also known above the Łysogóry Quartzites in the Wiśniówka area (Z. Kowalczewski *et al.*, 1986).

In recent years the Late Cambrian brachiopods from the Łysogóry region have been investigated by B. Jendryka-Fuglewicz (1992). Her results indicate that the brachiopods from Wąworków (Opatów area) and Mąchocice (Wiśniówka area) are strikingly similar, and that they should most probably be linked to the *Parabolina spinulosa* Zone (biozone III) in Scandinavia.

THE AGE OF THE "ŁYSOGÓRY QUARTZITES"

Acritarch assemblage, composed mainly of numerous *Timofeevia lancarae* (Cramer et Diez) Vanguetaine and *Timofeevia phosphoritica* Vanguetaine, characteristic of the interval: Middle Cambrian-Tremadocian, has been identified in the Łysogóry Quartzites by M. Moczyłowska (Z. Kowalczewski *et al.*, 1986). On this basis an opinion has been put forward that: "...the sandstone complex from Wiśniówka is built of Middle Cambrian rocks in the lower part and the Upper Cambrian rocks in the top part..." (Z. Kowalczewski *et al.*, 1986, p. 356). S. Orłowski also lately modified his earlier scheme (S. Orłowski, 1975) where the Wiśniówka quartzites were placed entirely in the Upper Cambrian. Because of *Cruziana barbata* finds in the lower part of the quartzites he distinguished the *Cruziana barbata* biozone — an equivalent of the P. forchhammeri Stage (S. Orłowski, 1992a, b). In this case my views are coincident with that of S. Orłowski though they are based on different evidence.

The stratigraphical value of trace fossils must be treated with extreme caution. They have been investigated in the Wiśniówka area for many years (A. Radwański, P. Roniewicz, 1963; S. Orłowski *et al.*, 1970, 1971; S. Orłowski, 1992b) but they are in no case decisive of the age of rocks.

S. Orłowski and W. Mizerski (1995, p. 12) wrote: "...*Cruziana barbata* determines the top of the Middle Cambrian all over the world and ... *Cruziana semiplicata* since more than a hundred years has indicated the Upper Cambrian...". Both statements are **evident oversimplifications**. What is the real value of these taxa?

Cruziana barbata Seilacher was created by A. Seilacher (1970). Formal documentation of this new species was, however, rather poor — it contained only drawings without any holotype photographs. The creator wrote only generally about the occurrence of *Cruziana barbata* Seilacher in the Middle Cambrian without referring to any stratigraphic zone. The opinion by S. Orłowski (1992b, p. 23) that: "...According to Seilacher (1970) *Cruziana barbata* is characteristic of the upper part of the Middle Cambrian of Spain, Turkey and the USA (Montana)..." is **nothing more than wishful thinking**. In Turkey and the USA the age of rocks containing *Cruziana barbata* Seilacher has been defined on the basis of this species alone — it has not been documented by any other index fossils. In Spain *Cruziana barbata* Seilacher occurs in the Cantabrian Mts. in the La Barca Member of the Oville Formation. This member is believed to be an equivalent of the P. forchhammeri Stage (C. Aramburu *et al.*, 1992). However, macrofossils in the La Barca Member are represented only by *Lingulella herberti* Barrois and *L. sp.* Trilobites have not been found in this member but only in the underlying rocks which correspond to the P. paradoxissimus Stage. It is interesting that the La Barca Member also contains acritarchs, among others *Timofeevia*

lancarae (Cramer et Diez) Vanguetaine. The La Barca Member attains 620 m in thickness in the western part of the Cantabrian Mts. and also comprises the Upper Cambrian and Lower Tremadoc sediments there — thus, generally speaking, the situation is somewhat similar to that in the Holy Cross Mts.

S. Orłowski, judging from the documentation in his paper, was working with poorly preserved specimens of *Cruziana barbata* Seilacher. If they really looked like those on the photographs (S. Orłowski, 1992b, his Fig. 7) how could he compare them with the drawings of A. Seilacher (1970, his Figs. 1a, b and 7 — 6, 7)? S. Jensen, a Swedish expert, characterized S. Orłowski's discovery as follows (authorized information in the files of the Holy Cross Mts. Branch, Polish Geological Institute, Kielce): "...*Cruziana barbata* has been considered indicative of late Middle Cambrian (Seilacher 1970), but the control of this is weak and the identification of this ichnospecies is far from straightforward. S. Orłowski (1992b) listed *Rusophycus polonicus* with *Cruziana barbata* from the base of the Wiśniówka Formation and therefore extended the range of *Rusophycus polonicus* to the upper Middle Cambrian. This stratigraphic procedure can at best be described as doubtful and in connection with forming the upper part of a proposed new stage-division (S. Orłowski, 1992b, p. 471) it is outright unsuitable...".

The same problem occurs with *Cruziana semiplicata* Salter which is thought by S. Orłowski to determine the Upper Cambrian age of the upper part of the Wiśniówka Sandstones. In Wales, the type area of this ichnospecies, trilobites are absent again. The Upper Cambrian age of sediments containing this species is only interpolated from the stratigraphic succession and not documented by other fossils. In Spain, *Cruziana semiplicata* Salter is known from the Cantabrian Mts. in the La Matosa Member of the Barrios Formation representing (according to C. Aramburu *et al.*, 1992) Upper Cambrian-Lower Tremadoc age. A. Seilacher (1970) gave the vertical extent of this species as Upper Cambrian-Tremadoc. S. Orłowski limited this extent to Upper Cambrian only referring wrongly to ... A. Seilacher!

In conclusion, there are no solid grounds for the reliable creation of both ichnozones and especially of that with *Cruziana barbata*. This does not mean, however, that I reject the hypothesis of the Middle Cambrian age of the Łysogóry Quartzites or at least of their lower part (Z. Kowalczewski *et al.*, 1986). Recently, Z. Szczepanik (1993) proposed the idea of the Middle Cambrian age of the entire series. He thinks that the older acritarch assemblage of this site, dominated by two species: *Timofeevia lancarae* (Cramer et Diez) Vanguetaine and *T. phosphoritica* Vanguetaine, is most closely related to that which is known from the SK-2 Zone in the East European Platform (N. A. Volkova, 1990) and from the lower part of the A-2 Zone in New Foundland (F. Martin, W. T. Dean, 1981), as well as from Belgium and France (M. Vanguetaine, 1974). The rocks of those zones contain Middle Cambrian trilobites with index species of the upper part of the P. paradoxissimus Stage and of the P. forchhammeri Stage. The weak point of this concept is that both *Timofeevia* species also occur — though more scarcely — in the Upper Cambrian and Tremadoc.

One problem is worth mentioning here. In the quartzitic sandstones with wavelite in Wiśniówka there are also the organic remnants similar to Corallicyathida described by W. Sedlak (1975 — see Z. Kowalczewski *et al.*, 1986). Coral-like fossils were found in many places in the Main Range. It seems that sandstones with Corallicyathida and wavelite are an index stratigraphic zone. This important problem should be examined in detail.

	LITOSTRATYGRAFIA	BIOSTRATYGRAFIA	TRYLOBITY	ŚLADY ORGANICZNE	
θ_1		<i>Dictyonema</i>			θ_1
ϵ_3	FORMACJA ŁUPKÓW Z KLONÓWKI -400m	<i>Parabolina</i> <i>Peltura</i> <i>Protopeltura</i>	" <i>Olenus</i> " <i>rarus</i> — <i>Protopeltura olenusorum</i> <i>Peltura scarabeoides</i> <i>Sphaerophthalmus alatus</i> <i>Beltella irae</i> <i>Acerocare klonowkae</i> <i>Agnostus pseudobesius</i> <i>Parabolina acanthura</i> <i>Beltella rotundata</i>	<i>Cruziana barbata</i> <i>Ruzophycus polonicus</i> <i>Bergaueria parata</i> <i>Phycodes pedum</i> <i>Planolites beverleyensis</i>	ϵ_3
	FORMACJA ④ PIASKOWCÓW Z	" <i>Olenus</i> "	①		
ϵ_2	WIŚNIÓWKI -400m	<i>Cruziana barbata</i>		<i>C. semiplicata</i> <i>Ruzophycus polonicus</i> <i>Bergaueria parata</i> <i>Phycodes pedum</i> <i>Planolites beverleyensis</i>	ϵ_2
	FORMACJA ŁUPKÓW Z GÓR PIEPRZOWYCH -400m	<i>Solenopleura</i>			

Fig. 7. Lithology, trilobite, trace fossils and Cambrian subdivision in the Wiśniówka Duża quarry and neighbouring area (after S. Orłowski, W. Mizerski, 1995)

1 — Wiśniówka Duża quarry, 2 — Lubrzanka river valley — Chabowe Doły outcrop, 3 — Wilków Valley, 4 — rocks exposed inside the Wiśniówka Duża quarry

Litologia, podział stratygraficzny oraz trylobity przewodnie i wybrane ślady organiczne w kambrze Wiśniówki i innych części bloku łysogórskiego

1 — kamieniołom Wiśniówka Duża, 2 — przełom Lubrzanki — Chabowe Doły, 3 — Dolina Wilkowska, 4 — profil utworów odsłaniających się w kamieniołomie Wiśniówka Duża

THE AGE OF THE UPPER PART OF THE KLONÓWKI SHALE FORMATION

The uppermost lithostratigraphic unit of the Łysogóry Cambrian is — in S. Orłowski's scheme — the Klonówka Shale Formation (Figs. 1 and 5–7). Trilobites from the middle part of it have been found in Chabowe Doły, 7 km east of Wiśniówka (Chabowe Doły Sandstone Bed — S. Orłowski, 1968a, b, 1975; S. Orłowski, W. Mizerski, 1995, see also Figs. 1 and 7). They are index fossils for the *Peltura* zone: *Peltura scarabeoides scarabeoides* Wahlenberg, *P. ?protopeltorum* Orłowski, *Sphaerophthalmus alatus* (Boeck), *Beltella irae* Orłowski, *Acerocare ?klonowkae* Orłowski, *Parabolina bella* Orłowski and *Agnostus (Homagnostus) pseudobesius* Orłowski. The youngest Upper Cambrian as well as Tremadoc (according to S. Orłowski the *Parabolina* Zone and *Dictyonema* Zone) have been identified in outcrops and shallow boreholes in the Wilków Valley (J. Czarnocki, J. Dembowska, 1950; E. Tomczykowa, 1968; S. Orłowski, 1968a, b). In these so-called "Łysogóry Beds" (*sensu* E. Tomczykowa) *Peltura scarabeoides scarabeoides* (Wahlenberg), *P. scarabeoides cf. westergaardi* Henningsmoen, *Parabolina acanthura* (Angelin)

and *Beltella rotundata* Tomczykowa have been found among others. Graptolites pointing to the Dictyonema Zone have come from the Brzezinki 1 borehole near Wiśniówka in the Wilków Valley.

While defining the Wiśniówka Sandstone Formation and the Klonówka Shale Formation, S. Orłowski (1975) distinguished the Wiśniówka Duża Shale Member as the lowermost unit of the latter (Fig. 1). He stated that (*op. cit.*, p. 443): "...the stratotype of the lower boundary of this member coincides with the lower boundary of the (Klonówka Shale — my remark) Formation. The stratotype of the upper boundary of this member is located in the northern end ..." of the western road cut leading to the quarry. The Wiśniówka Duża Shale Member was thought by this author to represent the Protopenetula Zone (biozone III in Sweden).

However, M. Moczydłowska (Z. Kowalczewski *et al.*, 1986) found acritarch assemblage with *Peteinosphaeridium trifurcatum typicum* (Eisenack) Eisenack, Cramer et Diez, *Vulcanisphaerae nebulosa* Deunff, *V. frequens* Górka and *Croniosphaeridium cf. mochtiensis* (Górka) which are index fossils for the Lower Tremadoc, **both below and above** the presumed boundary between these formations. Thus, the Wiśniówka Duża Shales are not **the lowermost** but rather **the uppermost** part of the Klonówka Shale Formation. The Łysogóry Quartzites in Wiśniówka Duża quarry are separated from the Klonówka Shales by a fault zone with tectonic breccias (M. Studencki, 1994, Fig. 22).

INFORMAL LITHOSTRATIGRAPHIC SUBDIVISION OF THE YOUNGER ROCKS OF ŁYSOGÓRY CAMBRIAN

Based on the research of J. Czarnocki (1927, 1929, 1950), J. Samsonowicz (1934), E. Tomczykowa (1968) and Z. Kowalczewski *et al.* (1986), the existence of the following informal lithostratigraphic units (in ascending order) seems to be justifiable (Fig. 8):

1. Thick bedded quartzitic sandstones intercalated with siltstones and shales, mainly dark grey, subordinately red or variegated. These are the so-called **Łysogóry Quartzites** or "Holy Cross Quartzites" which resemble the lower part of the Wiśniówka Sandstone Formation *sensu* S. Orłowski.

2. Sandstones, partly quartzitic, varicoloured siltstones and shales with pyroclastic interlayers. These are the **Wąworków Sandstones** or "Jałowęsy Sandstones" of J. Samsonowicz (1934). In S. Orłowski's scheme they are equivalent to the upper part of the Wiśniówka Sandstone Formation and the lower part of the Klonówka Shale Formation.

3. Siltstones and shales, mainly varicoloured, interbedded with sandstones, partly ferruginous. These are the so-called **Mąchocice Beds** (E. Tomczykowa, 1968) which resemble the middle part of the Klonówka Shale Formation in S. Orłowski's subdivision. The Chabowe Doły Sandstone Bed (S. Orłowski, 1968a, b, 1975) belongs to this unit.

4. Black and dark grey shales and siltstones, occasionally with sandstone intercalations. These are the **Łysogóry Beds** (E. Tomczykowa, 1968), the "Beltella Shales" (J. Czarnocki, 1950) and Wiśniówka Duża Shales in the scheme of S. Orłowski.

In the Wiśniówka Duża quarry only three out of these four units have been encountered: unit 3 is lacking. In the Wąworków area only the strongly tectonically involved fragments of units 2, 3 and 4 occur, unit 1 disappears. In all cases the gaps are caused by tectonic squeezing out.

CONCLUSIONS

The stratigraphy of the Cambrian in the Holy Cross Mts. is still poorly examined. Our knowledge is incomplete. The age of the major Cambrian stratigraphic unit has not been exactly determined so far. The distinguished lithostratigraphic units do not meet the requirements of formal and essential correctness. The sampling sites of many fossils as well as the places of geological observations were often not exactly located in the profiles which in a region of complicated tectonics seriously diminishes their value and may result in excessively subjective geological interpretation. Important biostratigraphic diagnoses are impaired because the correctness of determinations is doubtful. Generally, the fundamental biostratigraphic and lithostratigraphic problems still remain unsolved. However, this does not mean that nothing has been and still is being done, though the progress is too slow relative to the possibilities of the modern stratigraphy.

The stratigraphic scheme by S. Orłowski is not an exception to this rule. The majority of his lithostratigraphic units should remain in informal status (as do the units of the Łysogóry Cambrian proposed here) until the moment when more detailed description of their boundaries and their profiles can be prepared. Concerning the biostratigraphic position of these units, the main mistakes are as follows (Fig. 8):

- the Czarna Shales are not of pre-Holmia and Lower Holmia age but of Holmia and *Protolenus* age;

- the Osiek Sandstones do not belong to the *Sabellidites* Zone but are younger than the Holmia Cambrian and should be placed rather in the lower part of the Middle Cambrian Słowiec Sandstones;

- the boundary between the Słowiec Sandstones and the Ociesęki Sandstones and its relation to the boundary between the Lower and Middle Cambrian must be verified;

- the age of the Góry Pieprzowe Shales is doubtful; the possibility that they are facies equivalents of various units (Czarna Shales, Kamieniec Shales, Usarzów Sandstones, Słowiec Sandstones, Łysogóry Quartzites) must be taken into consideration;

- both ichnozones (*Cruziana barbata* and *C. semiplicata*) are of low stratigraphic value;

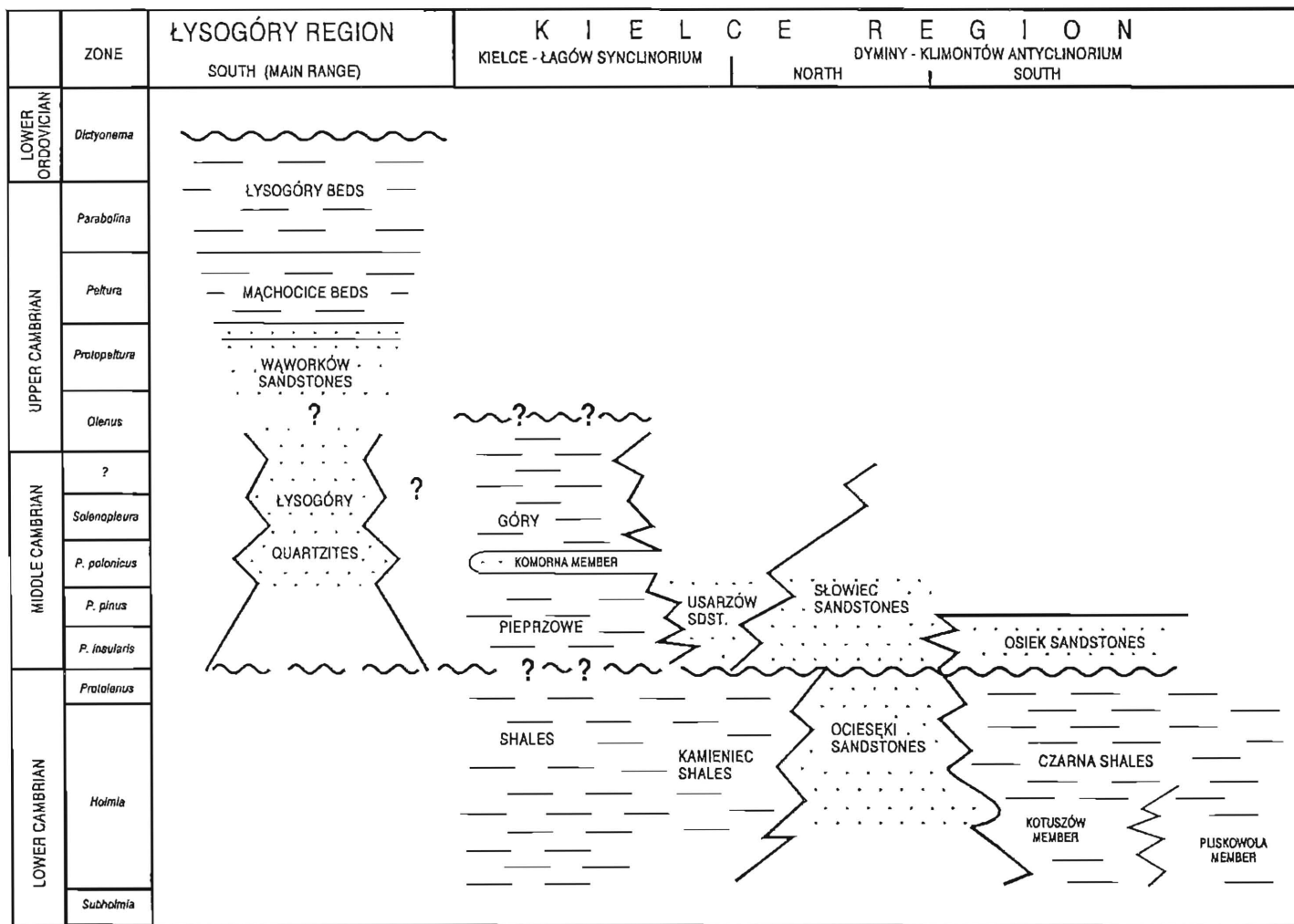
- the trilobite documentation of the oldest rocks of Upper Cambrian must be revised;

- the age of the Łysogóry Quartzites is not yet precisely defined.

In such circumstances the reason for which this subdivision has not been presented to the participants of the EUROPROBE meeting seems to be quite obvious. It is always better in science (and not only in science) to admit frankly that our knowledge is incomplete, than to pretend that all is clear and correct.

Fig. 8. Lithofacies and lithostratigraphic units of the Cambrian in the Holy Cross Mts.

Litofacje i jednostki litostratigraficzne kambru w Górach Świętokrzyskich



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Zbigniew KOWALCZEWSKI

PODSTAWOWE PROBLEMY STRATYGRAFICZNE KAMBRU
W GÓRACH ŚWIĘTOKRZYSKICH

Streszczenie

Wobec zarzutów dotyczących niekompetencji naukowej, rozpowszechniania fałszów i dezinformacji międzynarodowej społeczności geologicznej (S. Orłowski, W. Mizerski, 1995) przeprowadzono szczegółową analizę podziału stratygraficznego kambru, dokonanego przez S. Orłowskiego (1975) i później kilkakrotnie modyfikowanego (przede wszystkim S. Orłowski, 1985*b*, 1992*b*; W. Mizerski i in., 1986; S. Orłowski, W. Mizerski, 1995 — patrz również fig. 1–7). Wykazano znaczne niedostatki wydzieleni litostratygraficznych w stosunku do wymagań *Zasad polskiej klasyfikacji, terminologii i nomenklatury stratygraficznej* (1975). Skoncentrowano się na biostratygraficznych zasadach podziału, stwierdzając m. in., że:

- łupki z Czarnej nie są wieku preholmiowego i holmiowego, lecz holmiowego i protolenusowego;
- piaskowce z Osieka nie należą do poziomu Sabelidites, lecz są młodsze od kambru holmiowego i powinny być raczej umieszczone w dolnej części środkowokambryjskich piaskowców ze Słowca;
- granica między piaskowcami z Ociesek i piaskowcami ze Słowca, a także jej relacja do granicy między dolnym a środkowym kambrem powinny być zweryfikowane;
- wiek łupków z Gór Pieprzowych jest wątpliwy — należy brać pod uwagę możliwość, że są one odpowiednikami facjalnymi różnych jednostek: łupków z Czarnej i Kamieńca, piaskowców z Usarzowa i Słowca, kwarcytów łysogórskich;
- obydwie ichnopoziomy: *Cruziana barbata* i *C. semiplicata* mają niską wartość stratygraficzną;
- dokumentacja trylobitowa najstarszych skał górnego kambru musi być zrewidowana;
- wiek kwarcytów łysogórskich nie jest dokładnie zdefiniowany.