ROCZNIK POLSKIEGO TOWARZYSTWA GEOLOGICZNEGO
ANNALES DE LA SOCIÉTÉ GÉOLOGIQUE DE POLOGNE

Tom (Volume) XLIII — 1973 Zeszyt (Fascicule) 3 Kraków 1973

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DEVELOPMENT OF THE LATE PALEOZOIC SEDIMENTARY BASIN OF THE KACZAWA MOUNTAINS

(14 Figs.)

Rozwój późnopaleozoicznego basenu sedymentacyjnego Gór Kaczawskich

(14 fig.,)

Abstract: The sedimentation of the uppermost Carboniferous and the Lower Permian deposits of the Kaczawa Mts (south-western Poland) was investigated using paleocurrents and basin analysis. The sediments investigated fall into two distinct lithostratigraphic units. The lower unit (Stephanian) is characterized by a considerable maturity of clastics and represents the deposits of extensive alluvial plains. The upper unit (Lower Rotliegendes) consists of immature sediments and represents the filling of relatively narrow tectonic depressions between uplifted ranges flanked by active faults. Both units are believed to have been deposited in continental basins corresponding the model distinguished by Potter and Pettijohn (1963) as the Newark Basin model.

INTRODUCTION

In the Kaczawa Mountains two structural units can be found: the lower unit — epimetamorphic and the upper one — non-metamorphic. The upper unit begins with red detritic deposits belonging to the Uppermost Carboniferous and the Lower Permian. These deposits rest in angular unconformity on the early Paleozoic, metamorphic basement. This basement, folded in the Late Caledonian phases during the variscian orogeny, was a rigid block faulted into horsts and grabens (H. Teisseyre, 1967, 1970). The main tectonic feature, mentioned above, was reflected in paleomorphology, and in consequence, it influenced the continental sedimentation. A more detailed characterization of sedimentary conditions of the Stephanian and of the Lowermost Permian will allow a reconstruction of the Kaczawa Mountains paleomorphology in closing variscian phases and its connection with tectonics.

The Stephanian and Lower Rotliegendes deposits in the Western Sudeten occur on the southern flank of a vast depression called the North

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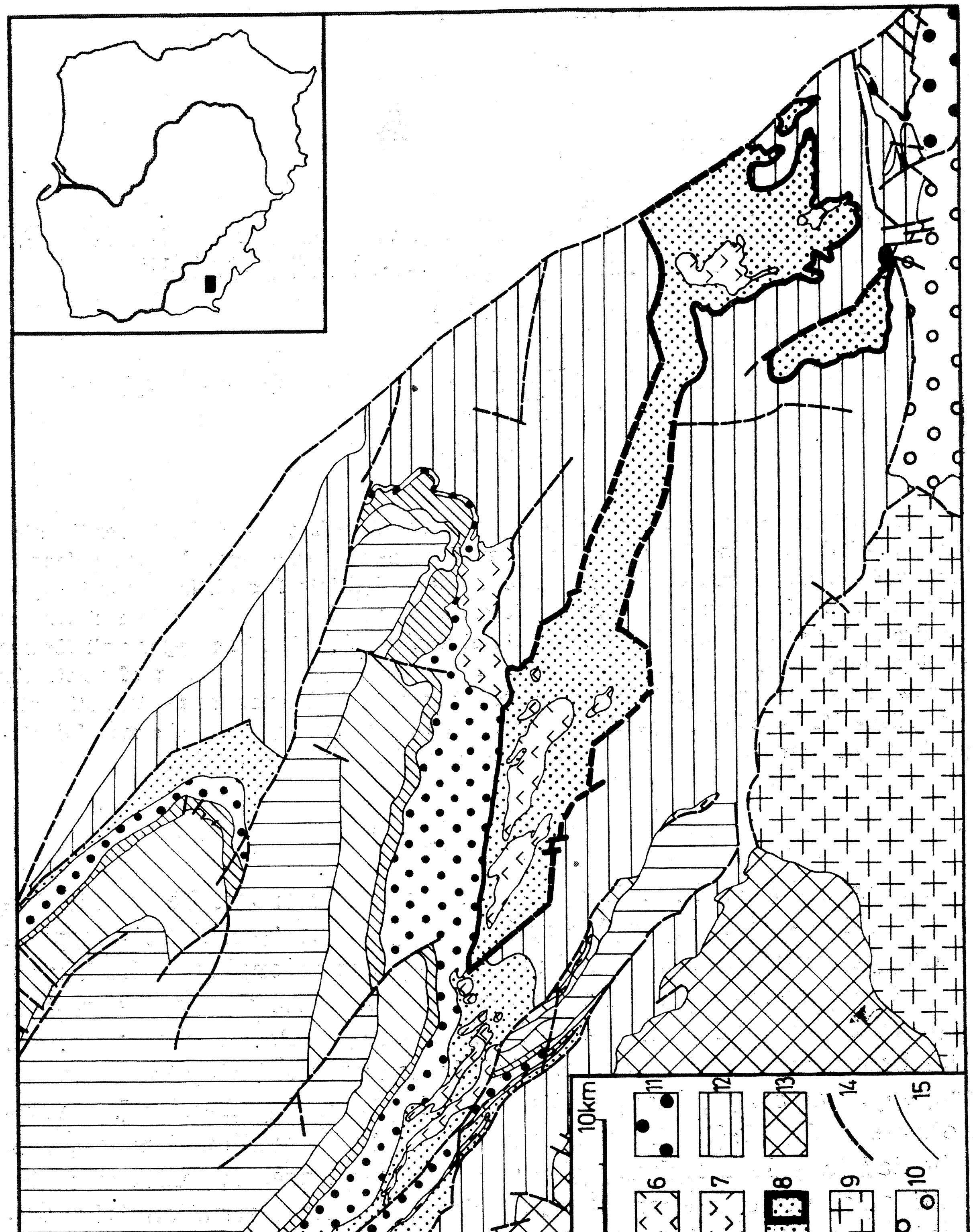
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Sudeten Trough (or depression — J. Milewicz, 1965 b) or, sometimes, — synclinorium. These names suggest a structural depression only giving no further information concerning the character of the region in the Upper Carboniferous and Lowermost Permian. The southern flank of the North Sudeten Trough extends eastwards to the Świerzawa graben; the latter passes south of Jawor into the Wolbromek trough (Fig. 1).

The continental, fluviatile character of red deposits in the described region has been beyond all question for tens of years (H. Scupin 1931, J. Milewicz 1965 a, 1966, K. Dziedzic, 1959).

The present paper aims at analysing the Stephanian and the Lower Permian basin, according to P. E. Potter's and F. J. Pettijohn's (1963) assumptions, and it will not discuss the sedimentary environment.

STRATIGRAPHY

Until 1962, clastic deposits beginning the upper structural unit of the Kaczawa Mountains had been commonly regarded as the Rotliegendes. This opinion had been based on macrofloral and macrofaunal designation, made still in the 19th century (S. Becker 1869, W. Haack 1912).

In the attempts to carry out a detailed classification, the presence of the Lower Rotliegendes, recognized by E. Zimmermann and B. Kühn (1919, 1936) became a matter of controversy. On the other hand, H. Scupin (1923, 1931) thought it was only the Middle and Upper Rotliegendes.

Since 1962 J. Milewicz has included the lowest part of these deposits among the Upper Carboniferous on the basis of microfloral studies (initially Westfalian D and Stephanian — J. Milewicz and T. Górecka, 1965, and later only Stephanian — T. Górecka, 1970). However, in his work of 1972, J. Milewicz confirms again Westfalian D.

Tables comparing age and lithological divisions, which have been used so far, were already published several times (E. Zimmermann

Fig. 1. Geological map of the Northsudetic Trough and localization of the area under consideration. According to a geological map of the Lower Silesia region, edited by L. Sawicki, 1967. 1 — Tertiary; 2 — Cretaceous; 3 — Triassic; 4 — Zechstein; 5 — Upper Rotliegendes; 6 — Trachybasalts; 7 — Rhyolites; 8 — Stephanian and Lower Rotliegendes and the area under consideration; 9 — The Karkonosze granite; 10 — Lower Carboniferous (Culm); 11 — Devon; 12 — Eocambrian, Cambrian, Silurian and Ordovician; 13 — Precambrian

Fig. 1. Mapa geologiczna niecki północnosudeckiej i położenie terenu badań. Według Mapy geologicznej regionu dolnośląskiego pod red. L. Sawickiego, 1967. 1 — trzeciorzęd; 2 — kreda; 3 — trias; 4 — cechsztyn; 5 — górny czerwony spągowiec; 6 — trachybazalty; 7 — riolity; 8 — stefan i dolny czerwony spągowiec oraz teren badań; 9 — granit karkonoski; 10 — dolny karbon (kulm); 11 — dewon; 12 — eokambr, kambr, ordowik i sylur; 13 — prekambr

and B. Kühn 1936, K. Dziedzic 1959, S. Kozłowski and W. Parâchoniak 1967, A. Ostrômęcki in press).

However, the indication of the Stephanian in the described area does not solve problems connected with the division of the Rotliegendes. So far, following division of the Rotliegendes into three parts in the North Sudeten Basin has been accepted in bibliography: the lower, the middle and the upper one (e. g. S. Sokołowski (Edit.) 1968), R. Osika (Edit. 1970). Still the recognition of the volcanic complex as an individual stratigraphic unit should not be taken into consideration. Volcanic activity had been taking place during the whole period of sedimentation of a, so called, subvolcanic member. In this situation the simplest way out is to accept the dichotomy of Rotliegendes with the boundary between the upper and the lower part at the top of the volcanic complex.

The Rotliegendes in the North Sudeten Basin had already been divided in a similar way by B. Kühn and E. Zimmermann (1936), and by H. Teisseyre (1957). Recently also J. Kłapciński (1971) distinguished only two substages in the Rotliegendes of the Fore-Sudeten monocline. Such a division has been commonly used by German authors (e. g. G. Ludwig 1955, H. Gallwitz 1956, W. Steiner 1966, E. Hoyningen-Huene 1960).

Table 1

Stratigraphical division used in present paper
Zastosowany podział stratygraficzny

Chronostratigraphical units			Lithostratigraphical units	
Permian	Rotliegendes	Lover	Complex	Volcanic
			Member	Upper Świerzawa
Carboniferous	Stephanien	C B A		Lower Świerzawa

It has not been a novelty, however, since Ch. Schuchert (1928) states in his monography of the Permian that the Rotliegendes in "the German facies has been lately divided into two parts".

The accepted division of deposits between the metamorphic basement and the Zechstein is presented in Table 1.

The terms: "Lower Świerzawa Member" and "Upper Świerzawa Member" are lithostratigraphic divisions and had been used in the author's previous work (A. Ostromęcki, 1972).

Lithostratigraphic profiles

Three profiles have been described from the region under consideration: 1) profile of the eastern margin (the Wolbromek trough), 2) profile of the middle part (the Świerzawa profile), 3) profile of the western margin of the investigated area (the vicinity of Bystrzyca). General descriptions of respective divisions in the profiles mentioned above will be presented below.

The Świerzawa Profile

Since the most complete of the described profiles, cropping out in the vicinity of Świerzawa, had been described before (A. Ostromęcki, 1972), only its shortened description will be given in the present work. The following lithostratigraphic units have been distinguished in this profile:

in the Lower Świerzawa Member (upwards):

— kaolinitic — micaceous mudstones — tuffaceous subgraywackes	} mudstones and tuffites

— orthoquartzitic conglomerates
— pebbly subgraywackes and protoquartzites
— calcareous subgraywackes and bituminous claystones

in the Upper Świerzawa Member (upwards):

— polimictic conglomerates
— flagstones intercalated with mudstones.

The latter are directly overlaid by a volcanic complex, then covered with sandy conglomerates of the Upper Rotliegendes. Typical exposures of the lithostratigraphic units mentioned above can be found in the Kaczawa and its tributaries valleys, in the vicinity of such localities as Świerzawa, Sędziszowa, Stara Kraśnica and Dobków.

Profile in the Wolbromek Trough

The Wolbromek Trough is a discrete unit of brachysyncline character, filled with deposits of the Stephanian and Rotliegendes. This unit is surrounded from N — E by epimetamorphic Cambro-sylurian formations and is cut by the Sudetic marginal fault. Westwards, it passes directly into the Świerzawa trough, but is separated from the formerly described Świerzawa profile by a region in which the Quaternary overlies the Rotliegendes formations on a considerable area. The Stephanian and Rotliegendes profile of the Wolbromek trough is similar to that of Świerzawa, but it shows a distinct reduction in thickness of the Lower Świerzawa Member (compare T. Górecka, 1970).

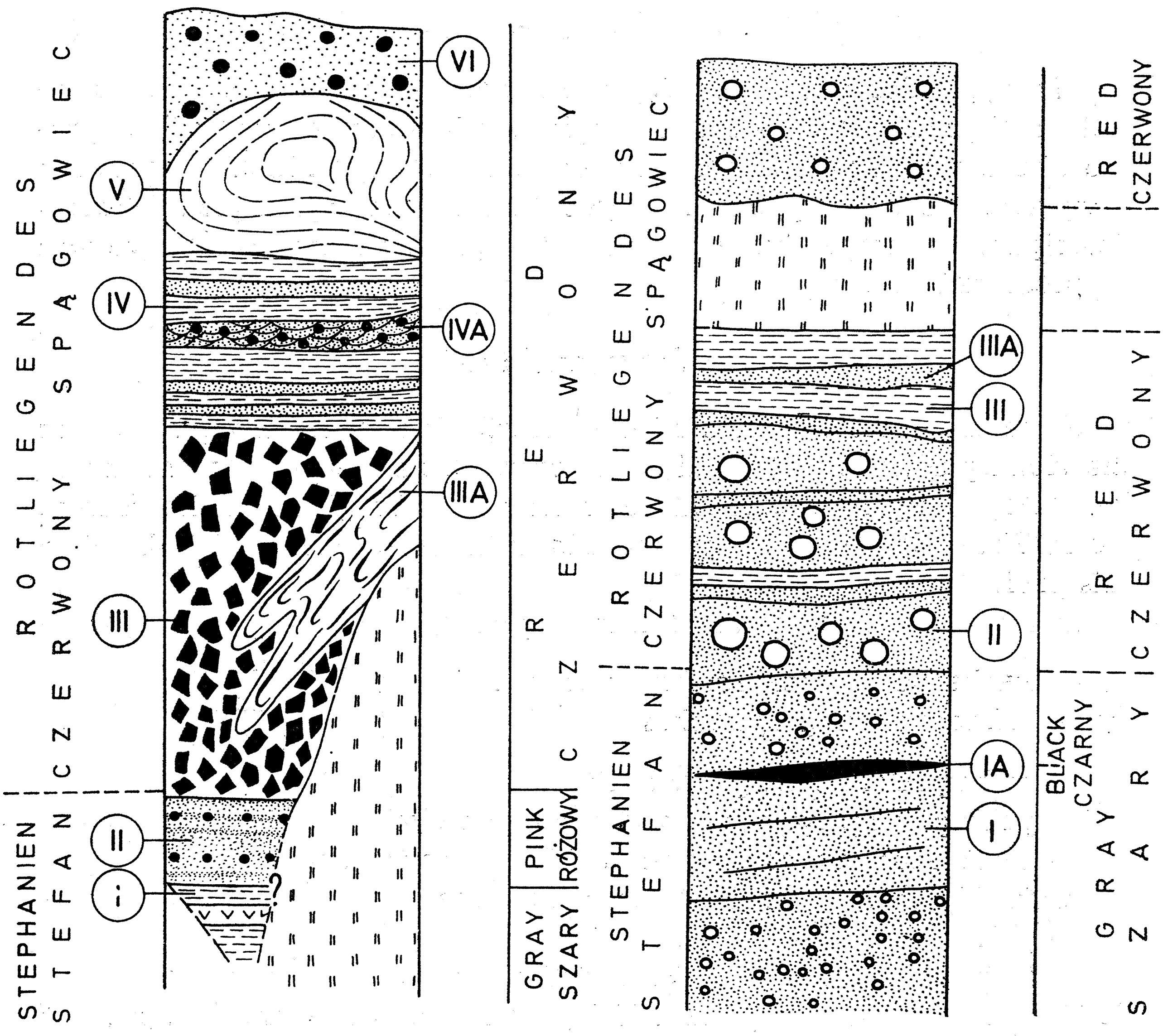

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Fig. 2. Synthetic profile of the Stephanian and Rotliegendes in the Wolbromek trough — for further explanations see the text

Fig. 2. Syntetyczny profil stefanu i czerwonego spągowca w obniżeniu Wolbromka — bliższe objaśnienia w tekście

Fig. 3. Synthetic profile of the Stephanian and Rotliegendes in the Bystrzyca region — for further explanation see the text

Fig. 3. Syntetyczny profil stefanu i czerwonego spągowca w okolicach Bystrzycy — bliższe objaśnienia w tekście

The lowest unit of this profile are gray kaolinitic mudstones (I — fig. 2). They undoubtedly correspond to gray mudstones from the Kamionka valley near Świerzawa (H. Scupin 1931, E. Zimmermann and B. Kühn 1936). Among these mudstones there are beds of gray sandstones, recurring several times. Their thickness considerably exceeds the thickness of tuffaceous beds, described from mudstones of the Kamionka valley. Observations of the northern margin of the Świerzawa Trough near Dobków showed that gray mudstones intercalate several times tuffaceous sandstones, previously described as tuffaceous subgraywackes. E. Zimmermann and B. Kühn's opinion (1936) confirms the fact that it is wrong to separate levels of mudstones and of tuffaceous subgraywackes, and that they constitute a complete interbedding complex.

Finegrained quartz conglomerates, known from a few exposures only (II — fig. 2) are the next link of the Lower Świerzawa Member in the Świny region (H. Teisseyre — oral information). These conglomerates should be regarded as corresponding to pebbly subgraywackes and protoquartzites from the Świerzawa profile (E. Zimmermann, 1935). Quartz finegrained conglomerates close the Lower Świerzawa Member (Stephanian) in the eastern part of the Świerzawa Trough and the Wolbromek Trough.

The Rotliegendes in this region begins with a level of monolitic greenstone breccias (III — fig. 2), well exposed at Świny. They overlie the previously mentioned quartz conglomerates of the Stephanian. However, in the region of Sady Górne they directly overlie Cambrian greenstones and are in some places replaced by mudflow deposits (A. Ostromęcki, 1971 a). The next link of the Rotliegendes in the Wolbromek Trough is a complex of thin-bedded, finegrained red sandstones, intercalated with mudstones (IV — fig. 2), which overlies monolitic breccias.

Among finegrained sandstones and mudstones there appears a characteristic horizon of sandy conglomerates (IV A — fig. 2). Pebbles which occur in great numbers are known in the surrounding regions only from the Culm of the intrasudetic basin (A. K. Teisseyre — oral information).

This conglomerate can be observed in an exposure of the Mała Nysa old meander, near the Sokola locality or in the railway cut-through, east of Świny.

Finegrained sandstones and mudstones are overlain by a volcanic complex, which consists of porphyries and pisolitic tuffs. The volcanic complex is covered with sandy conglomerates of the Upper Rotliegendes, which are not the subject of the present paper.

Profile of the Bystrzyca Region

This profile is characterized by a formation different from the previous ones. The Lower Świerzawa Member achieves here the thickness considerably exceeding the thickness of the Lower Rotliegendes. The lowest exposed horizon consists of gray layers with predominating unsorted sandy conglomerates (Fig. 3).

The conglomerates are usually fine- or medium-grained, and they consist mostly of powdered shaley material of the older Paleozoic rocks.

The coarsest, gravel fraction is usually composed of quartz and lydites. The quartz comes undoubtedly from the same source as the sand fraction, which is indicated by its common chlorite and sericite intergrowths. Upwards, the conglomerates pass into gray sandstones, which are overlain by intercalations of black or dark-brown coherent mudstones showing a bedding cleavage. (I A — Fig. 3). The microfloral determination of age by J. Milewicz and T. Górecka (1965) proved them to be Stephanian.

The next link of the profile are gray and red conglomerates. They are mostly coarse-grained sandstones and fine grained conglomerates. Among them there are stuck big, up to 20 cm in diameter, well-rounded cobbles of crystalline rocks (II — Fig. 3). Gneissic and granite-gneissic pebbles appear here for the first time in conglomerates in the region under consideration. Intercalations of finegrained, red sandstones are quite common here. These sandstones reveal various current structures. The position of conglomerates in the profile has not been cleared up, so far. The lithologic formation shows that they can correspond both to pebbly subgreywackes and protoquartzites and to polimictic conglomerates from the Świerzawa profile.

In the present work the conglomerates under consideration have been included in the Upper Świerzawa Member. Thus, they have been regarded as ones corresponding lithostratigraphically to polimictic conglomerates from Dobków.

Such a conclusion is evidenced by the fact that the conglomerates are directly overlain by finegrained sandstones and mudstones, which had been already overlain by the volcanic complex. The undervolcanic series of the Lower Rotliegendes is very poorly exposed. Gray and red mudstones (III — Fig. 3) with small beds of finegrained sandstones (III A — Fig. 3) can be observed in a small stream, N — E of the Bystrzyca. These sandstones are sometimes cross-laminated. Occasionally, there occur thicker beds of gray, coarse-grained feldspars. This series directly underlines trachybasalts. Unlike in the Świerzawa profile, the trachybasalts begin here volcanic activity.

LITHOLOGY OF CLASTIC SEDIMENTS

Up till now, clastic Stephanian and Rotliegendes sediments in the Northsudetic basic have not been systematically studied, as far as their lithology and petrography is concerned. However, some attention has been paid to the origin of some of the pebbles (H. Scupin 1931, E. Zimmermann and B. Kühn 1936, J. Milewicz 1965 a). The gravels from the Świerzawa section have already been dealt with in an earlier publication (A. Ostromęcki, 1972). The information presented here deals with pebbles from regions where no indentifications have been estiblished, so far.

Lower Świerzawa Member

This term has been used to determine precisely the complex of gray and pink sandy conglomerates and sandstones with characteristic horizons of gray and black calystones, which occurrs in the lower part of the Świerzawa profile. Presumably, this complex fully corresponds to the Stephanian (see J. Milewicz, 1965 b). The division based on lithological data, has proved more useful in the field than occasional identifications of microflora.

Conglomerates

Composition of the gravel fraction

Sandy conglomerates constitute the main lithological component of deposits of the Lower Świerzawa Member. High maturity is characteristic of the graval fraction, present in these conglomerates (J. Milewicz 1965 a, A. Ostromęcki 1972). The above characteristics of the main lithological varieties of pebbles concern the most common components first.

Quartz — in most cases it is vein quartz, usually milky, but sometimes also yellow. It occasionally occurs in intergrowths with pink feldspar or chlorite. The amount of quartz increases while the coarseness of fraction decreases. The quartz is usually poorly rounded, but occasionally well-rounded, quartzes can be found. Quartz or quartz-feldspathic veins, common in the Cambro-Silurian of the Kaczawa Mountains were, presumably, the primary source of quartz.

Quartzites — they are grey or pink, finegrained and very well rounded. These quartzites are particularly common in the coarsest gravel fraction. Medium-grained quartzites appear only occasionally. They are sometimes feldspathic. Two types of quartzites can be differentiated under the microscope: 1) typical metamorphic quartzites (more common) and 2) very hard orthoquartzites, composed of very well rounded quartz graines. These grains are cemented and enlarged by secondary growth and may acquire euhedral form. The origin of the quartzites under consideration has not been explained, so far. At present, quartzites never occur on the surface of this type in the Kaczawa Mountains. Only some more-coarse-grained types resemble the quartzites from Tarczyn or the ones from Sady Górne. It is then right to assume that the quartzites were derived from older rocks (Devonian, Culm).

Metalydites — the black variety with white quartz veins is the com-

Table 2

Lithological composition of the 16 - 32 mm class of the conglomerates from Lower Świerzawa Member in Świerzawa region

Skład frakcji 16 - 32 mm ze zlepieńców dolnej serii świerzawskiej w profilu świerzawskim

1	2	3	4	5	6	7	8	9	10	11	12
73,3	8,3	15,0	1,6	-	-	-	-	-	-	-	1,6
70,0	12,0	8,0	4,0	-	4,0	-	-	2,0	-	-	-
80,0	10,0	5,0	-	-	1,6	4,6	-	-	-	-	3,3
55,0	17,5	2,5	10,0	-	2,5	12,5	-	-	-	-	-
52,0	8,0	24,0	8,0	-	-	8,0	-	-	-	-	-
36,0	16,0	-	20,0	-	-	4,0	4,0	-	8,0	12,0	-

1 - quartz; 2 - lydite; 3 - quartzite; 4 - unmetamorphosed eruptive rocks; 5 - sericite schists; 6 - greenstones; 7 - phyllite; 8 - sandstones; 9 - quartz-sericite schists; 10 - keratophyre; 11 - mylonite; 12 - undetermined

1 - kwarc; 2 - lidyt; 3 - kwarcyt; 4 - niezmetamorfizowane skały wylewne; 5 - łupek serycytowy; 6 - zieleniec; 7 - fyllit; 8 - piaskowce; 9 - łupek kwarcowo-serycytowy; 10 - keratofir; 11 - mylonit; 12 - nieoznaczone.

monest one; it is characteristic of the Silurian of the Kaczawa Mountains. The pebbles are poorly rounded and, occasionally, well-rounded.

Unmetamorphosed volcanic rocks — pebbles of volcanic rocks are quite common among the coarsest fraction, always very well-rounded (A. Ostromęcki, 1972).

The lithological types under consideration constitue in all profiles above 75% of the gravel fraction of conglomerates of the Lower Świerzawa Member. The remaining rock types are, above all, epimetamorphic shales of the Kaczawa Cambro-Silurian, occuring in slight and changing amounts. In the Świerzawa profile the number of less durable rocks, especially effusive ones, increases towards the top of the formation (A. Ostromęcki, 1972). A special attention should be paid to occasionally occuring pebbles of cataclasites. They resemble the cataclasite forms from Cieszów (A. K. Teisseyre — oral information, Tab. 2).

In the Wolbromek profile there occur only finegrained conglomerates which consist mostly of quartz pebbles (Tab. 3). Fraction 16—32 mm is the coarsest one and therefore it is less mature than the whole gravel fraction (Tab. 4). In the Bystrzyca region conglomerates from the lowest part of the profile have also a highly mature composition, but the majority of quartz pebbles come from the close neighbourhood. In the source area vein quartz was the only material not easily crushed into sand fraction. Gravel fraction composition is shown in Table 5. Fraction 16—32 mm displays more advanced maturity (Tab. 6).

Table 3

Lithological composition of the conglomerates from the Lower Świerzawa Member in Wolbromek region
Skład frakcji żwirowej ze zlepieńców dolnej serii świerzawskiej w profilu Wolbromka

1	2	3	4	5	6	7	8	9	10	11	12
80,0	14,0	2,0	-	-	4,0	-	-	-	-	-	-

Explanation ses table 2
Objaśnienia jak w tabeli 2

Table 4

Lithological composition of the 16 - 32 mm class of the conglomerates from Lower Świerzawa Member in Wolbromek region
Skład frakcji 16 - 32 mm ze zlepieńców dolnej serii świerzawskiej w profilu Wolbromka

1	2	3	4	5	6	7	8	9	10	11	12	13
75,0	12,0	2,0	-	2,0	5,0	2,0	-	-	-	-	-	-

Explanation see table 2
Objaśnienia jak w tabeli 2

Table 5

Lithological composition of the conglomerates from the Lower Świerzawa Member in Bystrzyca region
Skład frakcji żwirowej ze zlepieńców dolnej serii świerzawskiej w profilu bystrzyckim

1	2	3	4	5	6	7	8	9	10	11	12
64,0	2,0	6,0	12,0	4,0	8,0	4,0	-	-	-	-	-

Explanation see table 6
Objaśnienia jak w tabeli 6

Grain Size and Roundness of the Gravel Fraction Components

As it has been already emphasized, sandy conglomerates are the main lithological type of the Lower Świerzawa Member. The sand fraction occurs in such quantity that pebbles are usually separated from one another.

Roundness

Roundness of components of the conglomerate gravel fraction was defined by means of visual comparison with Pettijohn's (1957) roundness

Table 6

Lithological composition of the 16 - 32 mm class of the conglomerates from Lower Świerzawa Member in Bystrzyca region
Skład frakcji 16 - 32 mm ze zlepieńców dolnej serii świerzawskiej w profilu bystrzyckim

1	2	3	4	5	6	7	8	9	10	11	12
68,0	8,0	8,0	8,0	4,0	-	4,0	-	-	-	-	-

1 - quartz; 2 - lydite; 3 - quartzite; 4 - quartz-chlorite schists; 5 - quartzite schists; 6 - sericite-chlorite schists; 7 - chlorite schists

1 - kwarc; 2 - lidyt; 3 - kwarcyt; 4 - łupek kwarcowo-chlorytowy, 5 - łupek krzemionkowy; 6 - łupek serycytowo-chlorytowy; 7 - łupek chlorytowy

classes. Conglomerates of the Lower Świerzawa Member display a wide range of the roundness values.

Although the lowest classes predominate, well rounded pebbles are of common occurrence. It is important that the well rounded components are usually quartzites and, somewhat more seldom, lydites and quartz. In the presented tables there have been given average roundness values from respective profiles. The results show the percentage of pebble quantity. Roundness values of the fraction 16—32 mm have been given separately, which allows a study of the dispersal pattern of this characteristic. In most tables the roundness values for the whole gravel fraction do not very much differ from the values for the fraction 16—32 mm (Tab. 7, 8). It is due to the fact that this fraction usually occurs in the greatest quantities.

Table 7

Average roundness of 4 - 256 mm class of the conglomerate from Lower Świerzawa Member
Średnie wartości obtoczenia składników frakcji żwirowej zlepieńców dolnej serii świerzawskiej

	0,00 - 0,15	0,15 - 0,25	0,25 - 0,40	0,40 - 0,60	0,60 - 1,00
Wolbromek	4,0	66,0	24,0	6,0	-
Świerzawa	20,0	42,3	22,0	10,80	4,9
Bystrzyca	-	50,0	44,0	6,0	-

Size of Pebbles

In the present work all values concerning the size of pebbles refer to their average axis (axis b).

Conglomerates of the Lower Świerzawa Member can be described as medium-grained, according to the predominance of the fraction 16—32 mm. Finer conglomerates occur in the Świny region (the Wolbromek

Table 8

Average roundness of 16 - 32 mm class of the conglomerates from Lower Świerzawa Member

Średnie wartości obtoczenia składników frakcji 16 - 32 mm zlepieńców dolnej serii świerzawskiej

	0,00 - 0,15	0,15 - 0,25	0,25 - 0,40	0,40 - 0,60	0,60 - 1,00
Wolbromek	-	50,9	17,0	33,0	-
Świerzawa	17,2	50,3	21,8	4,7	5,8
Bystrzyca	-	54,0	37,5	8,5	-

Table 9

Grain size distribution in 4 - 256 mm class of the conglomerates from Lower Świerzawa Member in Wolbromek region

Rozkład wielkości otoczaków w zlepieńcach dolnej serii świerzawskiej w profilu Wolbromka

4-8	8-16	16-32	32-64	64-128	128-256	256
26,0	62,0	12,0	-	-	-	-

Table 10

Grain size distribution in 4 - 256 mm class of the conglomerates from Lower Świerzawa Member in Bystrzyca region

Rozkład wielkości otoczaków w zlepieńcach dolnej serii świerzawskiej w profilu bystrzyckim

4-8	8-16	16-32	32-64	64-128	128-256	256
6,0	44,0	44,0	6,0	-	-	-

Table 11

Comparison of content of different pebble classes in conglomerates of Lower Świerzawa Member in the three regions

Porównanie zawartości różnych frakcji otoczaków w zlepieńcach dolnej serii świerzawskiej w trzech profilach

	frakcja 4-8 mm	frakcja 16-32 mm	frakcja 64-128 mm
Wolbromek	26,0	12,0	0,0
Świerzawa	10,0	42,5	8,0
Bystrzyca	6,0	44,0	0,0

profile) only. The biggest observed pebbles are made up of volcanic rocks. Tables 9 and 10 show size characteristics of pebbles (per cent).

Table 11 shows the contents of the fractions 4—8, 16—32 and 64—128, in order to get dispersal pattern by means of comparison of these values in individual profiles.

Dispersal Pattern of Conglomerates of the Lower Świerzawa Member

In addition to directional structures, the dispersal pattern of clastic structures gives information about paleocurrents (see P. E. Potter and F. J. Pettijohn, 1963). As it has already been mentioned, the measurements of directional structures permitted a fairly clear picture of paleocurrents in both basins. Studies of the dispersal pattern are to prove the hypothesis. In both basins transport southwards, northwards and from the east to the west have been observed. However, the directional structures do not permit an evaluation which of the mentioned directions are of fundamental and which of only secondary importance for transportation of clastic material. This problem can also be solved on the basis of studies of the dispersal pattern of pebble composition and texture. Linear changes of scalar propetries from the east to the

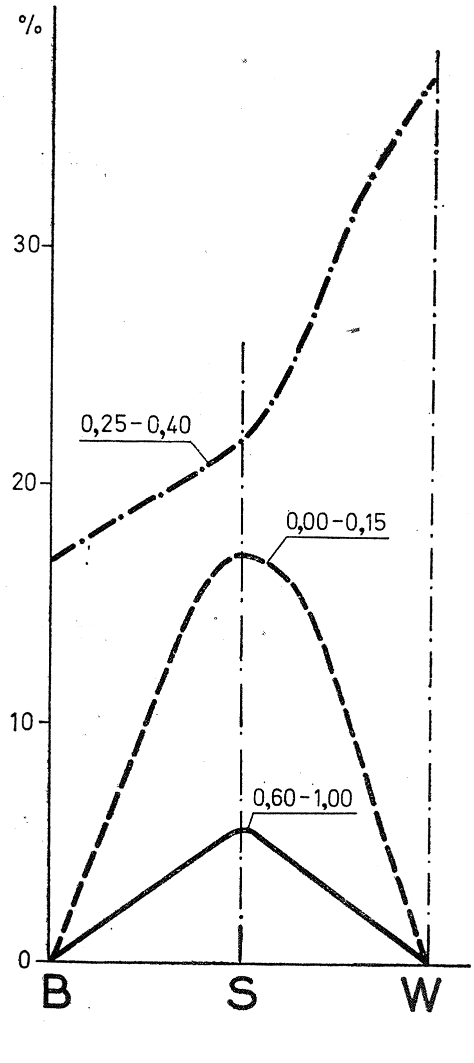

Fig. 4. Content changes of various roundness classes in conglomerates of the Lower Świerzawa Member: W — Wolbromek; S — Świerzawa; B — Bystrzyca

Fig. 4. Zawartość ziarn o różnych stopniach obtoczenia w zlepieńcach dolnej serii świerzawskiej. W — Wolbromek; S — Świerzawa; B — Bystrzyca

west point to predominance of parallel transportation between the described profiles and, on the contrary, the step differences of properties under consideration point to feeding from meridional directions. The dispersal pattern of conglomerates has been established on the basis of studies of properties of the fraction 16—32 mm. It is to eliminate other than regional factors, e. g. such as roundness increase (accompanying) grain size increase or maturity decrease with grain size decrease. Drawn curves are of a semi-quantitative character, since distances

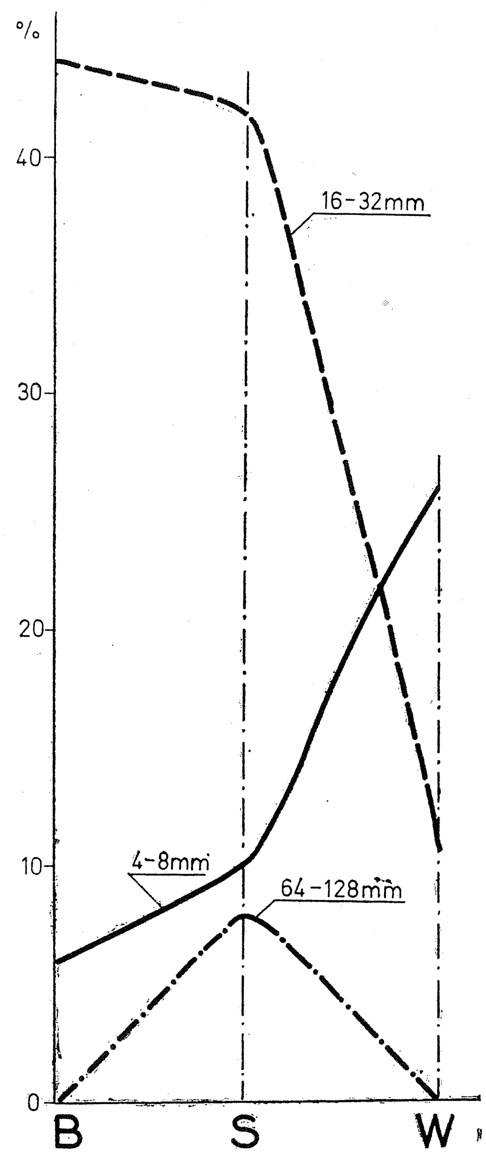

Fig. 5. Content changes of different fractions in conglomerates of the Lower Świerzawa Member: W — Wolbromek; S — Świerzawa; B — Bystrzyca

Fig. 5. Zawartość ziarn wydzielonych frakcji w zlepieńcach dolnej serii świerzawskiej: W — Wolbromek; S — Świerzawa; B — Bystrzyca

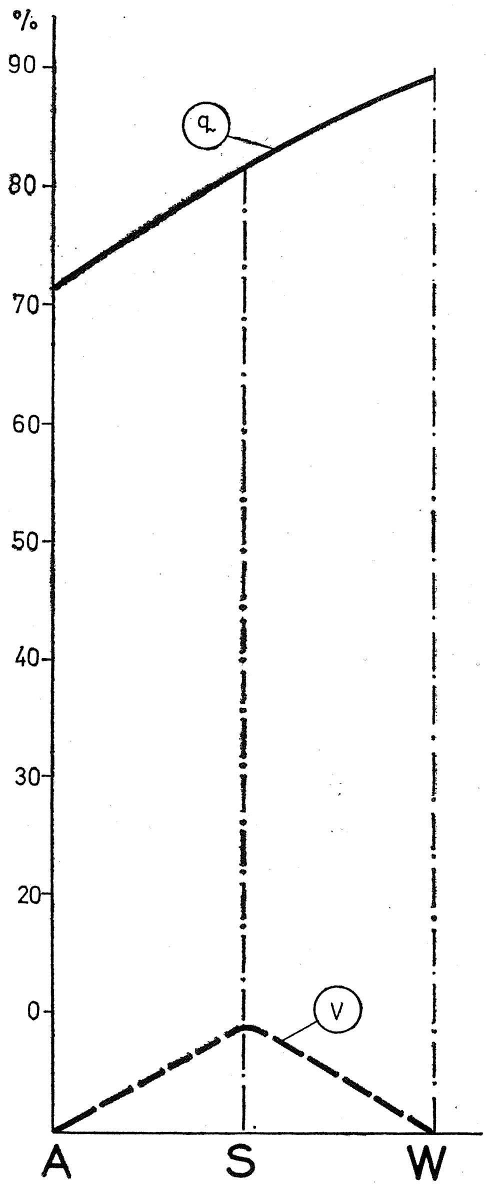

Fig. 6. Content changes of resistant (Q) and less resistant (V) components in conglomerates of the Lower Świerzawa Member: W — Wolbromek; S — Świerzawa; B — Bystrzyca

Fig. 6. Zmiany zawartości składników odpornych (Q) i nieodpornych (V) w zlepieńcach dolnej serii świerzawskiej: W — Wolbromek; S — Świerzawa; B — Bystrzyca

between profiles in diagrams have been presented with no regard to appropriate proportions. The content of respective roundness classes in the fraction 16—32 mm changes in a non-linear way (Fig. 4). It concerns both the lowest, the highest and the medium roundness class. Content changes of respective fractions are also of a non-linear character (Fig. 5). Only the diagram showing changes of lithological content of the fraction 16—32 mm pointed to a linear decrease of durable components content towards the west (Fig. 6). The phenomenon of quartz content westwards decrease in conglomerates was also observed by J. Milewicz (1965a).

A non-linear course of curves pointing to textural changes and to changes of the gravel fraction content from the east to the west prove that the basin material was carried from meridional directions, while the parallel transport did not much influence its displacement. Linear maturity decrease of the gravel fraction towards the west should thus be explained by a diminishing occurrence of deposits older than the Stephanian in the source area.

Sandstones

Components

In the Świerzawa profile two types of sandstones of the Lower Świerzawa Member have been distinguished. In the lowest horizons there occur tuffaceous sandstones, which can be described as tuffaceous subgraywackes. Higher in the sequence, highly matured subgraywacks and sometimes protoquartzites can be found (F. J. Pettijohn's terminology, 1957). A detailed description of components and types of tuffaceous subgraywacke cement had been previously given (A. Ostromęcki, 1972). A similar situation can be found in the Wolbromek profile. In this paper, however, tuffites have not been taken into consideration, since their dispersal pattern depends on too many factors (paleocurrents, as well as eruption force and wind directions, of we consider precipitation of pyroclastic material from the air).

Sandstones of the Lower Świerzawa member from the Wolbromek profile do not much differ in composition from the corresponding sandstones from the Świerzawa vicinity. The detrital components here are: polycrystalline and undulatory quartz, monocrystalline quartz, feldspars, quartzites, eruptive rocks, phyllites, quartzsericite slates, sericite slates, greenstones and diabases, sandstones, muscovite, biotite, heavy minerals. The cement is most often formed from calcite as well as from kaolinite or, less often, from quartz. Their quantitative composition is shown in Table 12.

As it can be seen from the above comparison, they are sandstones of subgraywacke composition with average quartz content. Their com-

Table 12

Mineral composition of the sandstones from Lower Świerzawa Member in Wolbromek region

Skład mineralny piaskowców dolnej serii świerzawskiej w profilu Wolbromka·

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1,4	0,9	3,3	18,4	47,6	14,6	-	0,6	-	5,8	-	0,4	-	7,0	-	-
34,0	13,7	16,3	12,4	4,7	3,2	1,5	-	4,0	9,2	-	0,2	-	-	0,4	0,4
37,7	7,1	5,8	14,8	2,7	4,2	5,5	5,4	-	-	-	-	-	-	-	16,8
45,5	3,5	12,8	23,0	-	1,4	0,9	5,2	6,6	-	0,2	-	-	-	-	0,9
18,7	12,4	25,1	7,9	5,2	1,2	6,3	7,9	2,4	-	0,7	0,5	0,5	0,5	-	10,0
30,0	15,0	8,5	11,6	4,7	12,8	1,2	3,9	0,5	-	-	-	-	-	-	11,8
26,0	16,2	6,5	19,4	6,0	2,3	0,6	3,8	-	-	-	-	-	-	-	19,2

1 - policrystalline quartz; 2 - monocrystalline quartz; 3 - feldspars; 4-quartzite; 5 - eruptive rocks; 6 - phyllite; 7 - quartz-sericite schists; 8 - sericite schists; 9 - greenstones and diabases; 10 - sandstones; 11 - muscovite; 12 - biotite; 13 - heavy minerals; 14 - kaolinite; 15 - secondary quartz; 16 - calcite

1 - kwarc polikrystaliczny; 2 - kwarc monokrystaliczny; 3 - skalenie; 4 - kwarcyty; 5 - skały wylewne; 6 - fyllity; 7 - łupki serycytowe; 8 - łupki serycytowe; 9 - zieleńce i diabazy; 10 - piaskowce; 11 - muskowit; 12 - biotyt; 13 - minerały ciężkie; 14 - kaolinit; 15 wtórny kwarc; 16 - kalcyt

Table 13

Mineral composition of the sandstones from Lower Świerzawa Member in Bystrzyca region

Skład mineralny piaskowców dolnej serii świerzawskiej w profilu bystrzyckim

1	2	3	4	5	6	7	8
21,6	1,2	9,2	56,0	12,0	-	-	-
13,2	1,6	-	41,5	20,0	-	23,7	-
22,0	3,4	2,8	52,5	8,5	-	10,8	-
5,6	5,6	12,4	28,0	11,2	-	37,2	-
30,4	1,3	21,0	34,4	7,4	-	5,5	-
25,3	-	11,2	21,2	3,5	-	24,3	14,0
18,5	-	13,2	27,0	2,4	-	26,0	11,9

1 - policrystalline quartz; 2 - monocrystalline quartz; 3 - feldspars; 4 - quartzite; 5 - sericite schists; 6 - quartz-sericite schists; 7 - chlorite schists; 8 - calcite

1 - kwarc polikrystaliczny; 2 - kwarc monokrystaliczny; 3 - skalenie; 4 - kwarcyty; 5 - łupki serycytowe; 6 - łupki kwarcowo-serycytowe; 7 - łupki chlorytowe; 8 - kalcyt

position reflects erosion of the epimetamorphic members of the Cambro-Silurian and also of older deposits (sandstones). No detritus of the Wojcieszów limestones (early Cambrian) can be observed here.

Sandstones of the Lower Świerzawa Member in the Bystrzyca vicinity have a somewhat poorer composition. Polycrystalline quartz, monocrystalline quartz, feldspars, quartzites, sericite slates, quartz-sericite slates, chlorite slates and calcite forming the cement have been distinguished here.

Quantitative composition of these sandstones is shown in Table 13. As it can be seen from the Table, the main component here is quartz detritus. This phenomenon should be explained by the direct neighbourhood of the Ordovician quartzites from Tarczyn. A small content of both quartz types makes these sandstones to be defined as poorly mature subgraywacks.

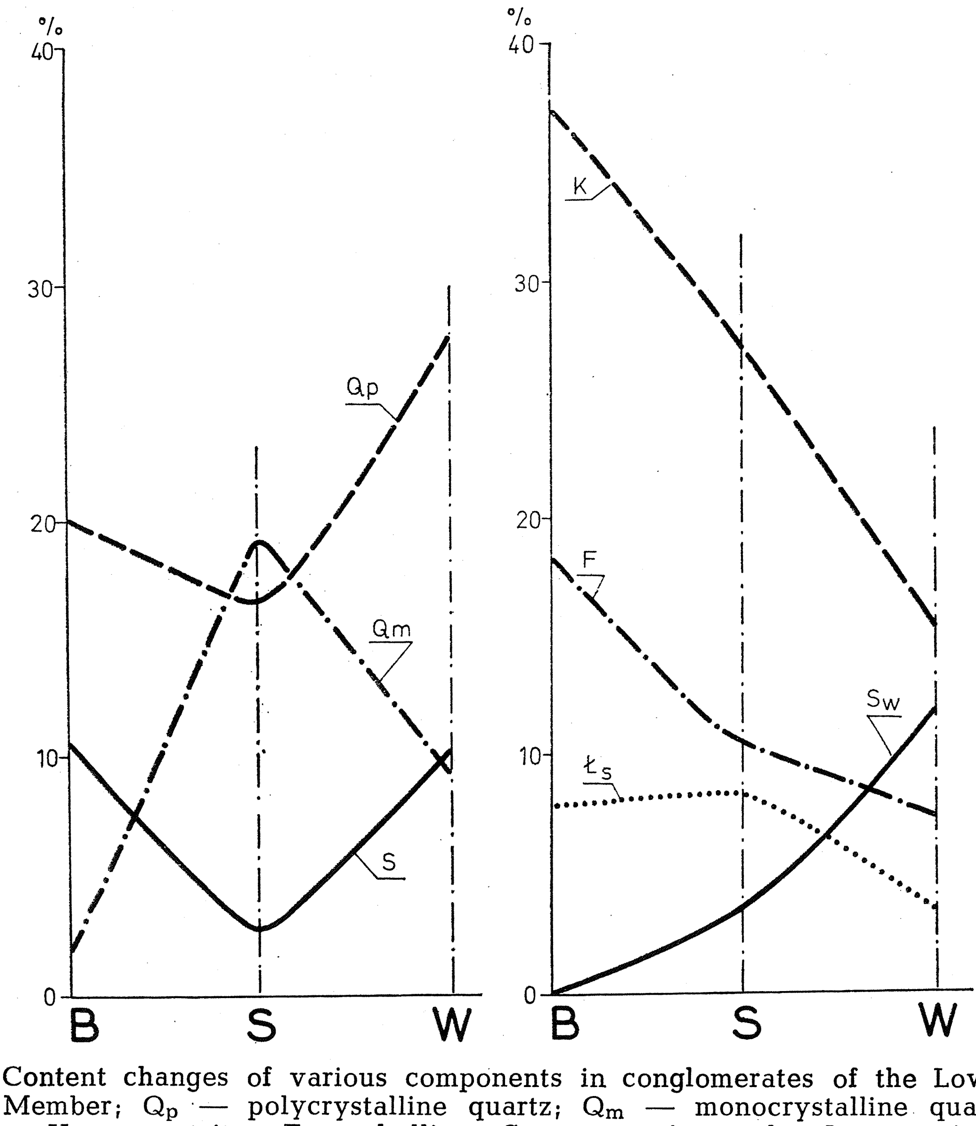

Fig. 7. Content changes of various components in conglomerates of the Lower Świerzawa Member; Q_p — polycrystalline quartz; Q_m — monocrystalline quartz; S — feldspars; K — quartzites; F — phyllites; S_w — eruptive rocks; $Ł_s$ — sericite slates; W — Wolbromek; S —Świerzawa; B — Bystrzyca

Fig. 7. Zawartości różnych składników w piaskowcach dolnej serii świerzawskiej: Q_p — kwarc polikrystaliczny; Q_m — kwarc monokrystaliczny; S — skalenie; K — kwarcyty; F — fyllity; S_w — skały wylewne; $Ł_s$ — łupki serycytowe; W — Wolbromek; S — Świerzawa; B — Bystrzyca

Dispersal Pattern of Sandstones

Studies of the dispersal pattern of the Lower Świerzawa Member sandstones have been carried out to the same purpose and according to the same rules as the studies of dispersal pattern of conglomerates. Changes in content of the most common components (monocrystalline quartz, polycrystalline quartz, quartzites, eruptive rocks, phyllites, sericite slates and feldspars) have been taken into consideration. The following facts can be observed from the course of curves (Fig. 7):

— consequent increase of the quartz grains quantity to the west (K)

— similar increase of the phyllite grains content

— decrease of the grain content of non-metamorphosed eruptive rocks (Ws) (Table 14).

Increase of the quartzite and phyllite quantities towards the west gives evidence to the fact that epimetomorphic members of the Cambro-silurian prevailed in the structure of source areas towards the west. It can be proved by means of a previously obtained conclusion about the decreasing participation of sedimentary members towards the west. The conclusion was drawn from studies of the dispersal pattern of conglomerates. The highes monocrystalline quartz content in the Świerzawa profile can be probably explained by the occurrence of sedimentary acid volcanism in this region. The course of curves showing content variations of the remaining components is somewhat ambiguous.

Upper Świerzawa Member

The series of red conglomerates and sandstones intercalated with mudstones, occurring between the Lower Świerzawa Member and the

Table 14

Average contents of some components of sandstones of Lower Świerzawa Member

Średnie zawartości niektórych składników w piaskowcach dolnej serii świerzawskiej

	Bystrzyca	Świerzawa	Wolbromek
policrystalline quartz	19,5	16,4	27,6
monocrystalline quartz	1,8	19,4	9,8
quartzite and lydite	37,2	27,2	15,3
eruptive rocks	-	3,2	11,6
phyllite and quartz-sericite schists	18,2	10,5	7,9
sericite schists	7,8	8,3	3,8
feldspars	10,1	2,3	9,7

volcanic complex of the Lower Permian, has been described as the Upper Świerzawa Member in the Świerzawa profile.

Conglomerates

Composition of Gravel Fraction

Macroclastic deposits of the Upper Świerzawa Member appear to have more differentiated composition than the Stephanian conglomerates. Shaly sediments of the Kaczawa Cambro-Silurian frequently pass into the sand fraction. In consequence, a certain "enrichment" of the deposit in pebbles of mostly eruptive rocks and crystalline limestones can be observed.

Table 15

Lithological composition of the 16-32 mm class of the conglomerates from Upper Świerzawa Member in Świerzawa region
Skład frakcji 16-32 mm zlepieńców górnej serii świerzawskiej w profilu świerzawskim

1	2	3	4	5	6	7	8
14,3	7,1	7,1	43,0	7,1	-	21,4	-
-	12,4	12,6	12,4	12,5	-	37,5	12,6
10,2	13,1	5,4	27,1	5,4	5,4	25,1	9,3

1 - quartz; 2 - lydite; 3 - quartzite; 4 - rhyolite; 5 - phyllite; 6 - quartz-sericite schists; 7 - chlorite schistsę 8 - various breccias
1 - kwarc; 2 - lidyt; 3 - kwarcyt; 4 - ryolit?; 5 - fyllit; 6 - łupek serycytowo-kwarcytowy; 7 - łupek chlorytowy; 8 - różne brekcje

In the Świerzawa profile the following lithological types are the most common ones among pebbles (Table 15):

— rhyolites? and, perhaps, also paleorhyolites, fully aphanitic, pink or greenish and also dark-violet with phenocrystals of pink feldspar or biotite, or pink ones with mica flakes and a great amount of pink feldspar, sometimes resembling microgranite;
— various volcanic breccias;
— fragments of quartz-feldspar-hematic veins;
— crystalline limestones, white coarse-grained or gray finegrained ones;
— greenstone slates.

The pebble complex under consideration shows that the units of Świerzawa and Bolków, closely adjoining from the south, were their source area. A rich pebble content of acid volcanic rocks allows a hypothesis, that the Żeleźniak massif had already been exposed at that time.

Thus the volcanism in the area of the Bolków—Wojcieszów anticline derives from the period proceeding the Lower Rotliegendes. Pebbles and crystalline limestone cobbles in conglomerates at Dobków seem to come from the intermediate of three lithological horizons, distinguished by H. Teisseyre (1967) in the Wojcieszów limestones. Towards the west, however, dark-gray limestone pebbles, characteristic of the lower horizon, occur in great numbers. In the Wolbrom profile macroclastic sedimentation in the Upper Świerzawa member appears twice: at the base of the whole sequence a greenstone breccia horizon can be found. Cobbles building the sediment are, above all, massive, non-slaty greenstones where fragments of lava "pillows" can sometimes be recognized. Monolitic greenstone breccias from Świny have been recognized as talus deposits transported by mudstones and formed at a tectonically active scarp (A. Ostromęcki, 1971 a).

The greenstone material comes from the adjoining regions, and then from the Dobromierz unit. The other coarseclastic horizon is a conglomerate intercalation which occurs above breccias among mudstones and sandstones. The gravel fraction of these conglomerates has an entirely different composition than gravel fractions of conglomerates hitherto described (Tables 16, 17).

Among entirely new components occuring here are, above all:

— dark, sometimes also red, finegrained graywackes, always very coherent and, at the same time, very well-rounded;

— gray and red quartzites. Some transitional types can also be found

Table 16

Lithological composition of the conglomerates from the Upper Świerzawa Member in Wolbromek region

Skład frakcji żwirowej zlepieńca górnej serii świerzawskiej w profilu Wolbromka

1	2	3	4	5	6	7	8	9	10	11	12	13	14
14,0	10,0	14,0	4,0	6,0	4,0	10,0	20,0	8,0	2,0	6,0	-	2,0	-
2,0	12,0	8,0	-	52,0	2,0	-	2,0	-	-	-	22,0	-	-
10,0	15,0	2,0	-	37,0	2,0	8,0	3,0	-	1,0[a]	1,0	11,0	-	10,0
24,0	12,0	34,0	-	11,0	6,0	1,0	2,0	2,0	1,0[a]	-	-	-	7,0

1 - quartz; 2 - graywackes; 3 - gray and pink quartzites; 4 - conglomerates; 5 - greenstones; 6 - adinol; 7 - mylonite and cataclasite; 8 - lydite; 9 - jasper; 10 - sericite schists; 11 - eruptive rocks; 12 - limestone; 13 - undetermined; 14 - keratophyre; a - phyllite

1 - kwarc; 2 - szarogłazy; 3 - szare i różowe kwarcyty; 4 - zlepieńce; 5- zieleńce i łupki zieleńcowe; 6 - adinol; 7 - mylonity i kataklazyty; 8 - lidyty; 9 - jaspis; 10 - łupek serycytowy; 11 - skały wylewne młodsze ; 12 - wapień krystaliczny; 13 - nieoznaczone; 14 - keratofir; a - fyllit

Table 17

Lithological composition of the 16-32 mm class of the conglomerate from Upper Świerzawa Member in Wolbromek region
Skład frakcji 16-32 mm zlepieńca górnej serii świerzawskiej w profilu Wolbromka

1	2	3	4	5	6	7	8	9	10	11	12	13	14
20,0	4,0	4,0	-	8,0	4,0	12,0	28,0	12,0	-	8,0	-	-	-
3,8	7,8	7,7	-	50,0	3,8	-	3,8	-	-	-	23,1	-	-
25,4	12,8	38,2	-	9,1	3,6	-	-	3,6	-	-	-	-	7,3

Explanation see table 16
Objaśnienia jak w tabeli 16

Table 18

Lithological composition of the conglomerates from Upper Świerzawa Member in Bystrzyca region
Skład frakcji żwirowej zlepieńców górnej serii świerzawskiej w profilu bystrzyckim

1	2	3	4	5	6	7	8	9	10
28,0	6,0	10,0	4,0	4,0	34,0	4,0	6,0	4,0	-
32,0	10,0	6,0	-	8,0	28,0	10,0	3,0	3,0	-

1 - quartz; 2 - lydite; 3 - quartzite; 4 - chlorite schists; 5 - quartz-sericite schists; 6 - gneisses; 7 - rhyolite; 8 - amphibolite; 9 - mica schists
1 - kwarc; 2 - lidyt; 3 - kwarcyt; 4 - łupek chlorytowy; 5 - łupek serycytowo-kwarcytowy; 6 - gnejs i granitognejs; 7 - ryolit?; 8 - amfibolit; 9 - łupek łyszczykowy

Table 19

Lithological composition of the 16-32 mm class of the conglomerates from Upper Świerzawa Member in Bystrzyca region
Skład frakcji 16-32 mm zlepieńców górnej serii świerzawskiej w profilu bystrzyckim

1	2	3	4	5	6	7	8	9	10
30,0	2,8	13,2	5,6	4,6	33,4	2,8	8,0	-	-
33,0	3,0	11,0	6,5	5,5	28,0	4,0	9,0	-	-

Explanation see table 18
Oznaczenia jak w tabeli 18

among graywackes and quartzites. Some quartzites are, however, distinctly more coarse-grained than graywackes;
— adinoles;
— jaspers.

Besides them, the following have been found: quartz conglomerates, greenstones and greenstone slates, mylonites and cataclasites, lydites, sericite slates, younger eruptive rocks, crystalline limestones, keratophyres and phyllites. This complex shows that older deposits (probably the Lower Corboniferous) of the Intersudetic basin were the initial material for conglomerates. Especially adinoles seem to confirm this opinion (A. K. Teisseyre — oral information). Also conglomerates from the Bystrzyca profile are characterized by a different pebble complex. Besides common quartzes, lydites and quartzites and also various shale rocks, pebbles from deeper metamorphic facies than in the Kaczawa Mountains occur here in great numbers (Tables 18, 19).

The following have been distinguished here:
— pink, coarsegrained microperthititic granite gneisses with megascopically gray quartz, plagioclases and chlorite which forms big single flakes;
— granite-gneisses of similar colour and composition, yet finegrained;
— pink, thinly-laminated gneisses, initially biotite but now chlorite;
— amphibolites,
— dark vein rocks,
— gray, pink or green quartz volcanic rocks with pink feldspar.

The origin of granite-gneisses and gneisses mentioned above cannot be explicitly defined. It would be easiest to assume that they come from rocks covering the Karkonosze granite. Such an assumption may seem doubtful, however, if we consider the fact that in the pebble complex under consideration typical Izera granite-gneisses are absent. Also measurements of directional structures give no explicit solution to the problem. The pebbles, mentioned above; may come both from the south — from some local, long-forgotten types of the Izera granite-gneisses, and from the north — from now covered massifs of the Northsudetic Basin bed rock or from the foresudetic massif.

Size and Roundness of the Gravel Fraction Components

In the Upper Świerzawa Member, similarly as in the Lower one, rewashed conglomerates, in which the gravel fraction would predominate over the sand one, never occur. Most frequently the two fractions are in equilibrium, but sometimes the sand fraction or the coarse-sandy one prevails.

Roundness

Roundness of the gravel fraction components of the Upper Świerzawa Member conglomerates varies very widely. Besides detritus and distinctly sharp-edged cobbles, e. g. in fanglomerates, there also occur very well-rounded fragments of graywackes and quartzites and, sometimes, of vein quartz. The latter have probably undergone a few sedimentary cycles. Bigger environmental inhomogeneity than in the Lower Świerzawa Member is, on the one hand, caused by a richer lithological composition of pebbles and, on the other, by a difference in length of transport. In general, however, low and medium classes of roundness prevail. In the inserted tables roundness values are presented separately for the whole gravel fraction and for the fraction 16—32 mm. The latter values have been used to study the dispersal pattern (Tables 20, 21).

Table 20

Average roundness of 4 - 256 mm class of the conglomerate from Upper Świerzawa Member
Średnie wartości obtoczenia składników frakcji żwirowej zlepieńców górnej serii świerzawskiej

	0,00 - 0,15	0,15 - 0,25	0,25 - 0,40	0,40 - 0,60	0,60 - 1,00
Wolbromek	4,3	34,3	15,3	20,6	18,6
Świerzawa	23,2	45,7	23,5	7,5	-
Bystrzyca	2,0	34,0	38,0	18,0	8,0

Table 21

Average roundness of 16-32 mm class of the conglomerates from Upper Świerzawa Member
Średnie wartości obtoczenia frakcji 16-32 mm zlepieńców górnej serii świerzawskiej

	0,00 - 0,15	0,15 - 0,25	0,25 - 0,40	0,40 - 0,60	0,60 - 1,00
Wolbromek	5,7	33,1	21,5	19,9	19,7
Świerzawa	24,0	43,3	24,8	7,8	-
Bystrzyca	-	40,5	34,5	15,6	9,4

Size of Pebbles

Lithological inhomogeneity of the source areas has also influenced the non-homogeneity of granulometric composition of conglomerates. Also the transport was relatively short. Therefore, maximum pebble sizes in conglomerates of the Upper Świerzawa Member usually exceed pebble sizes of the Lower Świerzawa Member. The biggest pebbles were

Table 22

Grain size distribution of 4 - 256 mm class of the conglomerates of Upper Świerzawa Member in Wolbromek region
Rozkład wielkości otoczaków w zlepieńcach górnej serii świerzawskiej w profilu Wolbromka

mm	4–8	8–16	16–32	32–64	64–128	128–256	256
%	1,0	18,3	50,3	34,3	-	-	-

Table 23

Grain size distribution of 4 - 256 mm class of the conglomerates of Upper Świerzawa Member in Bystrzyca region
Rozkład wielkości otoczaków w zlepieńcach górnej serii świerzawskiej w profilu bystrzyckim

mm	4–8	8–16	16–32	32–64	64–128	128–256	256
%	22,0	66,0	12,0	-	-	-	-

Table 24

Comparison of content of different pebble classes in conglomerates of Upper Świerzawa Member in the three regions
Porównanie wielkości otoczaków w zlepieńcach górnej serii świerzawskiej w trzech profilach

	4–8 mm	16–32 mm	64–128 mm
Wolbromek	1,5	50,0	0,0
Świerzawa	4,3	32,0	18,6
Bystrzyca	0,0	66,0	0,0

formed by eruptive rocks (rhyolites?) or by crystalline limestones (in the Świerzawa vicinity), and also by greenstones (in the Wolbrom profile) and granite-gneisses (the Bystrzyca profile).

Dispersal Pattern of Conglomerates of the Upper Świerzawa Member

General rules concerning the drawing and interpretation of diagrams have been already presented, while discussing the dispersal pattern of coarseclastic sediments of the Lower Świerzawa Member. The presented diagrams (Fig. 8) show that the characteristics under consideration change in a non-linear way even in the Upper Świerzawa Member. It is worth noticing that the curves showing changes in content of the most poorly rounded material have a similar course in diagrams for the Lower and for Upper Świerzawa Members. Also the curves of changes of the fraction 64—128 mm content look very much alike.

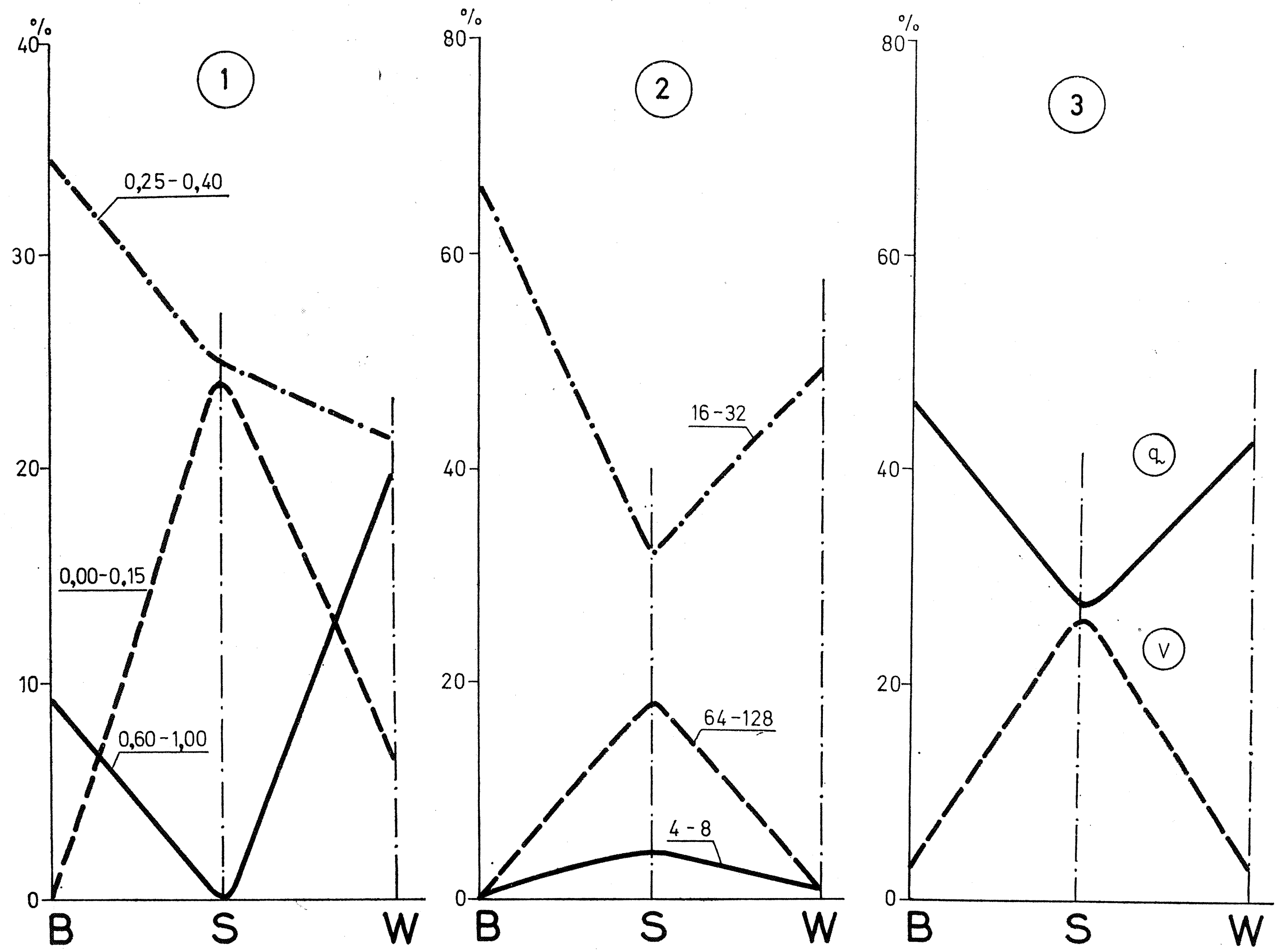

Fig. 8. Content changes of: 1 — various roundness classes; 2 — different fractions and 3 — resistant (Q) and less resistant (V) components in conglomerates of the Upper Świerzawa Member: W — Wolbromek; S — Świerzawa; B — Bystrzyca

Fig. 8. Zawartości ziarn: 1 — o różnym stopniu obtoczenia: 2 — różnych frakcji (w mm); 3 — oraz składników odpornych (Q) i nieodpornych (V) w zlepieńcach górnej serii świerzawskiej: W — Wolbromek; S — Świerzawa; B — Bystrzyca

In general, the presented diagrams allow an assumption that the material brought to the basin from the meridian directions in the Upper Świerzawa Member did not undergo further rounding and shifting which would prove the existance of distinct fluting in the parallel direction.

Sandstones

Components

Sandstones of the Upper Świerzawa Member display a much richer composition than the ones of the Lower Świerzawa Member. Sandstones of the Lower Rotliegendes are always characterized by a marked predominance of lithic components over quartz and feldspar grains. It has enabled their determination as poorly mature subgraywackes. However, a distinct differentiation in their composition according to sedimentary environment can be observed. Sandstones of the flood plain always display greater maturity than the subgraywackes, mentioned above, characteristic of channel deposits. In the Wolbrom profile sandstones of the Upper Świerzawa Member have a poorer composition and they rather correspond to deposits of flood plain from the Świerzawa profile. In composition of the sandstones, the following components have been distinguished: polycrystalline quartz, monocrystalline quartz, feldspars (also microcline), quartzites, sericite slates, quartz-sericite slates,

Table 25.

Mineral composition of the sandstones from Upper Świerzawa Member in Wolbromek region

Skład mineralny piaskowców górnej serii świerzawskiej w profilu wolbromskim

1	2	3	4	5	6	7	8	9	10
32,0	7,6	18,0	3,2	19,4	-	3,2	1,3	0,6	14,7
37,0	7,9	13,2	5,3	26,4	-	1,0	1,0	0,5	7,9
49,9	12,2	5,3	3,2	15,7	-	5,4	2,0	1,0	5,3
25,4	10,5	4,8	10,8	39,3	-	4,8	2,2	2,2	-
30,2	8,7	15,3	2,5	28,8	-	7,2	4,0	3,3	-
19,5	15,3	20,0	7,4	25,1	-	4,2	4,2	4,3	-
32,4	6,8	17,0	5,5	20,1	-	2,3	3,2	2,5	10,2
40,2	13,3	8,2	5,1	17,3	-	4,5	4,7	-	6,7
28,3	7,9	19,2	4,4	28,3	10,5	1,4	-	-	-

1 – policrystalline quartz; 2 – monocrystalline quartz; 3 – feldspars; 4 – sericite schists; 5 – quartzite; 6 – greenstones; 7 – quartz-sericite schists; 8 – microfelzite; 9 – micas; 10 – calcite

1 – kwarc polikrystaliczny; 2 – kwarc monokrystaliczny; 3 – skalenie; 4 – łupki serycytowe; 5 – kwarcyty; 6 – zieleńce; 7 – łupki kwarcowo-serycytowe; 8 – mikrofelzyt; 9 – miki; 10 – kalcyt

greenstones, lydites, microfelsite and calcite in the form of cement. Quantitative composition of these sandstones is shown in table 25.

Sandstones of the Upper Świerzawa Member in the Bystrzyca profile, which accompany macroclastic sediments and are thus deposited in channel facies, are characterized by a considerably poorer composition. The following have been distinguished here: polycrystalline quartz, monocrystalline quartz, feldspar, quartzites gneisses, chlorite slates and sericite slates. Cement is formed of calcite; sometimes some recrystallized kaolinite also occurs here. The quantitative composition is shown in table 26.

Table 26

Mineral composition of the sandstones of Upper Świerzawa Member in Bystrzyca region

Skład mineralny piaskowców górnej serii świerzawskiej w profilu bystrzyckim

1	2	3	4	5	6	7	8
22,0	1,2	12,2	38,3	-	-	2,0	24,3
22,9	2,2	11,0	28,5	34,5	-	0,9	-
25,0	-	16,4	55,0	-	-	3,6	-
25,7	3,2	10,0	31,1	29,0	-	1,0	-
21,6	2,8	15,0	30,1	10,2	6,3	14,0	-

1 - policrystalline quartz; 2 - monocrystalline quartz; 3 - feldspars ; 4 - quartzite; 5 - gneisses; 6 - chlorite schists; 7 - sericite schists; 8 - calcite

1 - kwarc polikrystaliczny; 2 - kwarc monokrystaliczny; 3 - skaleń; 4 - kwarcyty; 5 - gnejsy; 6 - łupki chlorytowe; 7 - łupki serycytowe; 8 - kalcyt

Dispersal Pattern of Sandstones Composition

Comparison of sandstone composition of the Upper Świerzawa Member in the three profiles under consideration allows an assumption that it is changed in a non-linear way from the east towards the west (Fig. 9). Only the monocrystalline quartz content displays a constant decreasing tendency in this direction. A similar decrease can be observed in the curve course of detritus content in volcanic rocks (microfelsite).

In all the three profiles two different lithological members can be found. Sandy conglomerates and sandstones predominate in both members. In the lower member there occur highly mature conglomerates and subgraywacke sandstones, which also contain a great number of resistant components. Conglomerates of the upper member are oligomictic, while in sandstones lithic components distinctly prevail over

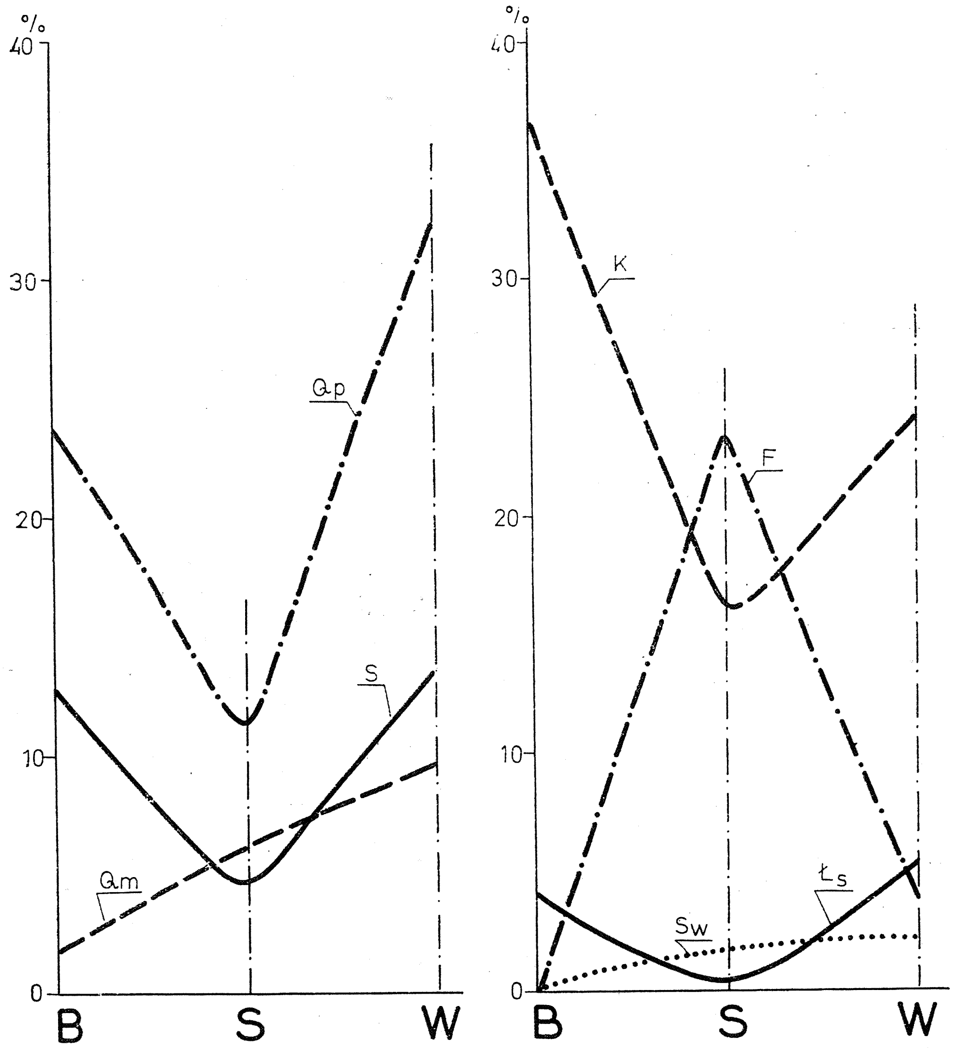

Fig. 9. Content changes of various components in sandstones of the Upper Świerzawa Member: Q_p — polycrystalline quartz; Q_m — monocrystalline quartz; S — Feldspars; K — quartzites; F — phyllites; S_w — eruptive rocks; $Ł_s$ — sericite slates; W — Wolbromek; S — Świerzawa; B — Bystrzyca

Fig. 9. Zawartość składników w piaskowcach górnej serii świerzawskiej: Q_p — kwarc polikrystaliczny; Q_m — kwarc monokrystaliczny; S — skalenie; K — kwarcyty; F — fyllity; S_w — skały wylewne; $Ł_s$ — łupki serycytowe; W — Wolbromek; S — Świerzawa; B — Bystrzyca

quartz. Both members differ mostly in maturity. On the other hand, dispersal pattern of deposits in both members is very much alike and proves that the basic model of alimentation and transport within the basin has not undergone any bigger changes on the boundary of the Lower and Upper Świerzawa Members.

DIRECTIONAL STRUCTURE IN THE STEPHANIAN AND LOWER ROTLIEGENDES

The system of paleocurrents in the Stephanian and Rotliegendes of the southern limb of the Nordsudetic Basin has been determined according to measurements of directional structures.

Table 27

Average contents of some components of sandstones of Upper Świerzawa Member
Średnie zawartości niektórych składników klastycznych w piaskowcach górnej serii świerzawskiej

	Bystrzyca	Świerzawa	Wolbromek
policrystalline quartz	23,4	11,2	32,7
monocrystalline quartz	1,8	6,3	10,0
quartzite and lydite	36,6	15,3	24,5
phyllite and quartz-sericite schists	–	23,7	3,7
sericite schists	4,3	–	5,2
feldspars	12,9	4,5	13,4
eruptive rocks	–	1,7	2,5

Directional structures, their shaping and orientation

Occurrence od current structures in clastic deposits of the Stephanian and Rotliegendes depends upon sedimentary environment. The cyclic development of coarse channel deposits did not permit preservation of structures on the bed surface. Various types of cross-bedding are, however, more common than current marks. Erosional channels are also quite frequent, but they are of little importance in defining the direction of transport, as usually only one cross-section is visible. Imbrication is pretty rare in poorly washed conglomerates. Parting lineation is common in adjacent sandstones and different types of ripplemarks occur on top surfaces of beds. A better stock of directional structures have been preserved, however, in complexes of finegrained sandstones, intercalated with mudstones and claystones, which probably represent the flood plain environment. The most common directional structures are:

— cross bedding in minor scale
— scours and flute-casts
— current crescents
— sand shadows
— groove-casts
— parting lineation
— prod-marks
— ripplemarks.

1. Cross bedding: both in the Lower and in the Upper Świerzawa Member cross bedding is not very often found and is poorly shaped. In the Lower Member cross bedding in minor scale has rather

been found, where cross-bedded units always point to rough, erosional lower surface. Cross bedding in major scale has not been observed here, as imbrication in a few metres thick, so called Świerzawa Index Conglomerate is, presumably, only pseudoimbrication. This phenomenon will be described in a more detailed way, together with interpretation of directional structures. In the Upper Świerzawa Member only cross bedding in major scale has been observed.

2. Imbrication: directional orientation of flat pebbels occurs only occasionally in poorly washed conglomerates both in the Lower and in the Upper Świerzawa Members.

3. Scours: they belong to the most frequently found structures on bed bases. They usually reveal symmetrical, longitudinal section which does not allow a determination of transport direction. They may come up to considerable sizes and have an irregular course. In other cases they resemble typical flute casts and occur on erosional lower surfaces of cross laminated units. Typical flute casts with unsymmetrical longitudinal section occur occasionally and always individually.

4. Current crescents: they belong to the most common directional structures in the Stephanian and Rotliegendes deposits. They most frequently occur around pebbles, but also on top bed surfaces, where they had been presumably formed round better cemented fragments of the deposit (A. Ostromęcki, 1971 b).

5. Sand shadows: they occur together with current crescents but also independently as, e. g., in finegrained sandstones with a slight admixture of gravel fraction in the Kaczawa exposure at Stara Kraśnica.

6. Groove casts: they are found as moulds of long, thin, single or joint scratches on lower surfaces of platy sandstones, intercalated with mudstones and exposed in left-bank tributaries of the Kaczawa near Świerzawa. However, in any groove ends no objects, which might have caused them, have been found.

7. Prod-marks: they occur together with groove casts.

8. Parting lineation: it is common in platy sandstones of the Upper Świerzawa Member, where it occurs on intrastratal surfaces of discontinuity.

9. Ripplemarks: they are always irregularly shaped (linguoid ripples) — more common in the Upper than in the Lower Świerzawa Member. They occur on top surfaces of sandstones intercalated with mudstones. Parting lineation sometimes occurs within the same beds.

The above survey has been limited to structures important for the determination of paleocurrents. It is a common phenomenon that in respective exposures at least two groups of directions can be found. In the diagram concerning the Lower Świerzawa Member three groups can be distinguished (Fig. 10 A). The primary one is placed within the sector 180—290°, the two following ones, more poorly marked, point to currents

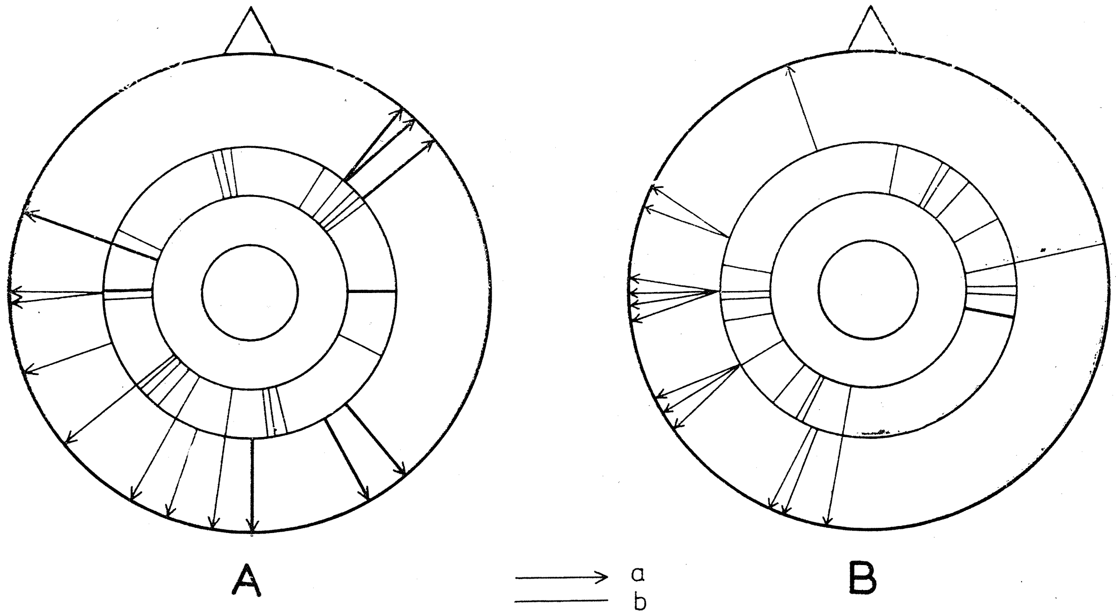

Fig. 10. Comprehensive diagrams of current marks from the Lower (A) and Upper (B) Świerzawa Members; a — flute, b — groove marks
Fig. 10. Zbiorcze diagramy hieroglifów prądowych z dolnej (A) i górnej (B) serii świerzawskiej

towards SE and NE. In this presentation there is a striking absence of measurements pointing to NW, N, and E directions. The picture of dispersion of directions in the diagram for the Upper Świerzawa Member is entirely similar; however only individual measurements occur beyond the SW sector (Fig. 10 B). A comprehensive survey of dip directions of cross bedding from the Lower Świarzawa Member gave results resembling the ones obtained in diagrams of linear structures. Besides the main maximum directed towards W and SW, there occur weak maxima directed towards NE and N. Two diagrams of cross bedding directions have been made for the Upper Świerzawa Member. In the Świerzawa region the main maximum is directed towards W, and besides it there occur two weaker, symmetrical maxima towards NE and SW, and an individual group of measurements towards S. In the Wolbrom area the main maximum is directed towards SE, and the weak sub-maximum towards SW.

Interpretation of Directorial Structures — System of Paleocurrents and Framework of Basins

Both in diagrams of current marks and of cross bedding three main groups of directions can be distinguished. They correspond to three regional transport directions: from N towards S, from S towards N, and from E towards W. This pattern is to be found both in the Lower and in the Upper Świerzawa Member and is interpretted as transports feeding

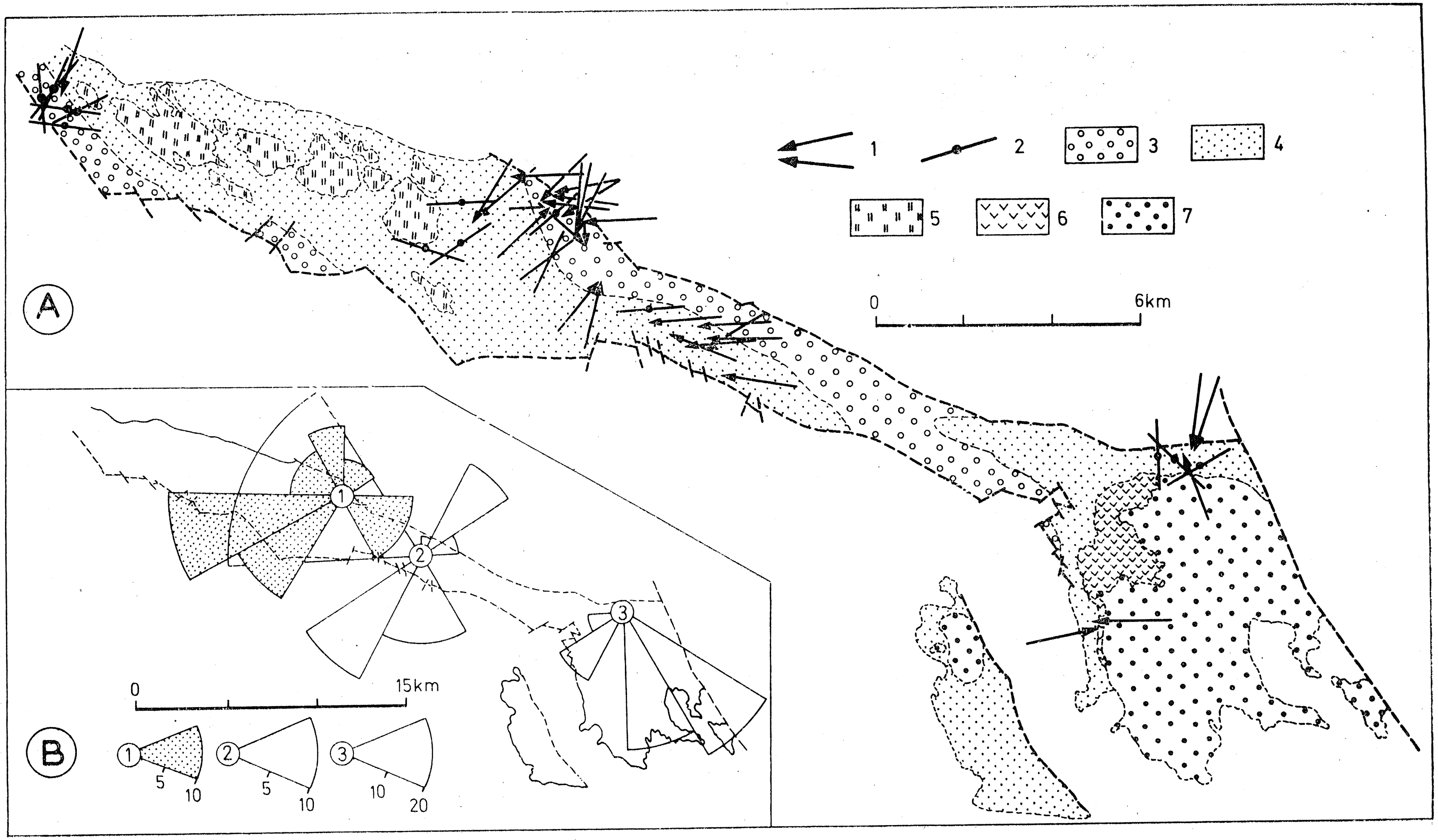

Fig. 11. Transport directions in the Stephanian and Rotliegendes. A — Current marks. 1 — univocally definnig the direction; 2 — ununivocally defining the direction; 3 — Stephanian; 4 — Lower Rotliegendes; 5 — Trachybasalts; 6 — Rhyolites; 7 — Upper Rotliegendes. B — Cross bedding. 1 — Lower Świerzawa Member; 2—3 — Upper Świerzawa Member

Fig. 11. Kierunki transportu w stefanie i dolnym czerwonym spągowcu. A — hieroglify prądowe. 1 — jednoznacznie określające kierunek; 2 — niejednoznacznie określające kierunek; 3 — stefan; 4 — dolny czerwony spągowiec; 5 — trachybazalty; 6 — riolity; 7 — górny czerwony spągowiec. B — skośne warstwowania. 1 — dolna seria świerzawska; 2—3 — górna seria świerzawska

the basin from margins e. g. from N and S (also from E in the Wolbrom area), and also as an additional flow from E towards W. The latter direction is of the smallest importance, which has already been emphasized in the description of lithological dispersal pattern. Small effectiveness of parallel transport results from distribution of structures according to lithology. Directions from E towards W usually occur in the finest deposits (sandstones intercalated with mudstones), so they correspond with the weakest currents. It should be emphasized that transport from N occur under the same conditions. This phenomenon is reflected graphically in diagrams as maximum in the SW sector where directions from N and E overlap. Transport from S towards N are definitely less distinct in the diagrams. Alimentation of the basin from S is still quite obvious, considering, the coarse clastics lithology. Especially composition and formation of conglomerates of the Upper Świerzawa Member points quite explicitly to direct transport from S. Therefore, we come to a general conclusion that currents carrying clastic material from S had a bigger traction force than the ones from N.

Comprehensive diagrams of cross bedding must be interpretted much more carefully. Formation of cross bedding does not always allow a determination whether they have resulted from lateral migration of channels or from frontal dumping. The system of maxima seems to point to the fact that both possibilities occur. In the diagram of cross bedding both from the Lower and from the Upper Świerzawa Member, besides the main maximum generally directed W, symmetrically placed submaxima can be observed. The latter represent, especially in the Upper Świerzawa Member, directions of cross bedding on large scale in conglomerates. Structures of this type are presumably the result of lateral migration of channels. Also in the Lower Świerzawa Member rather lateral sedimentation predominated in conglomerates. Measurements of flat pebble orientation in a, so called, Świerzawa Index Conglomerate from the vicinity of the Świerzawa dam showed that their dipping occurs mainly in the direction almost perpendicular to big current marks, common at the base of this bed (Fig. 12). The lower surface, exposed in a considerable area, reveals characteristics of a large, flat, scoured surface which can also be explained only by lateral migration of current. The orientation of pebbles should thus be regarded as pseudoimbrication without a distinct formation of the cross bedding surface.

The remaining small maxima in diagrams point to transport towards N or S. Thus the interpretation of diagrams of cross bedding resembles the interpretations of diagrams of current marks. Especially a flow towards W is marked in both members, while directions from N and S are less distinct. In the Wolbrom vicinity the direction from N predominates: it is possible that the flow towards W has not been of any importance here, so far.

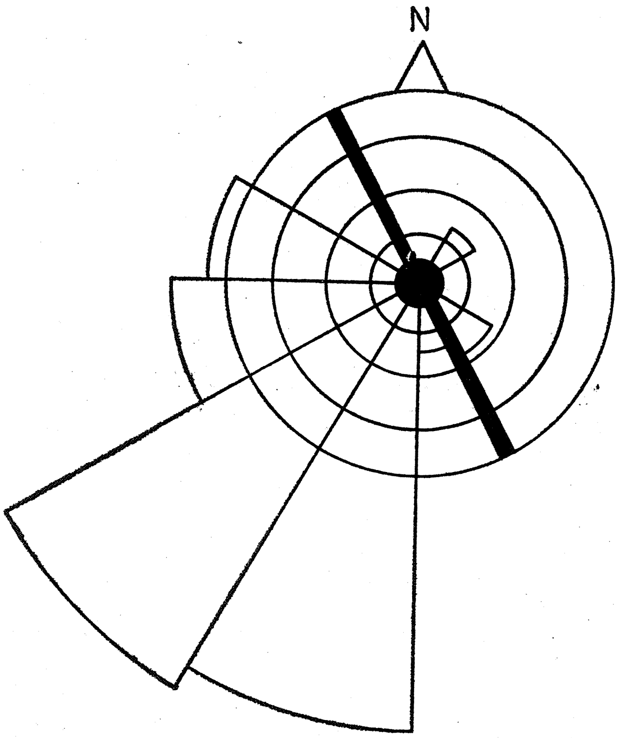

Fig. 12. Imbrication and current marks orientation (thick line) in the exposure near the Świerzawa dam
Fig. 12. Orientacja imbrykacji i hieroglifów prądowych (gruba linia) w odsłonięciu koło zapory w Świerzawie

A tentative general pattern of paleogeography may be presented as follows: The present Świerzawa Trough was situated in the direct neighborhood of the southern margin of the basin. The northern margin was far more far away. There have been no direct proofs of its localisation, yet it seems quite obvious, according to J. Milewicz's (1966) and J. Krasoń's (1967) opinion, that a ridge in the area of the present Grodzisk syncline constituted the northern boundaries of the basin.

However, the character of this margin will remain unknown. Fault tectonics has chiefly influenced morphology of the southern margin. Monolithic greenstone breccias, described from the Świny vicinity, were formed at the active fault escrapment and then transported by mudflows (A. Ostromęcki, 1971 a). However, breccias of this type have not been observed further on towards W.

Deposits bearing undoubtful characteristics of water transport occur in a similar lithostratigraphical position in the central and western part of the Świerzawa Trough. The southern margin of the basin has not presumably been a regular line. Thus deposits differing from one another in the lenght of transport occur along the present faults separating the Northsudetic Basin from the trunk of the Kaczawa Mountains. The escarpment cutting the elevated massif of the Bolków—Wojcieszów anticline from N must have been of a complex character. There were active, steep escrapments in some sections and gentle slopes in others. Respective sections were separated from one another by transversal valleys, probably also following the faults. These faults were active at the time of sedimentation and they had mainly contributed the material which was then deposited in the form of fans at valley mouths. It corresponds to H. Teisseyre's opinions (1967) of regeneration of older faults in younger variscian phases. It is probable that these faults, active again during the Late Saxonian orogeny (ibid. p. 20) have outlasted until now. It seems then right to fix the course of the southern margin of the basin on the basis of a cartographic picture of faults observed today. The basin of the Upper Świerzawa Member was an intermontane trough, elongated according to the Sudetic direction. In certain sections it was limited by active fault escrapments.

The character of the northern margin of the trough still remains an open question. Directions of transport from N towards S confirm the existence of a ridge, buried here today. The present Świerzawa Trough is situated closer to the southern margin of the described basin. There are also no deposits which would allow a description of morphology of the northern ridge. From E the basin of Lower Rotliegendes was closed by an elevated massif which had been built from sedimentary members of the western part of the Intrasudetic Trough and, may be, of the Świebodzice Depression.

The basin probably changed its direction to meridional at the foot of this massif; however we have had no information about the farther course of the northern and southern branches (Fig. 13).

There have been considerably fewer data on paleomorphology of the

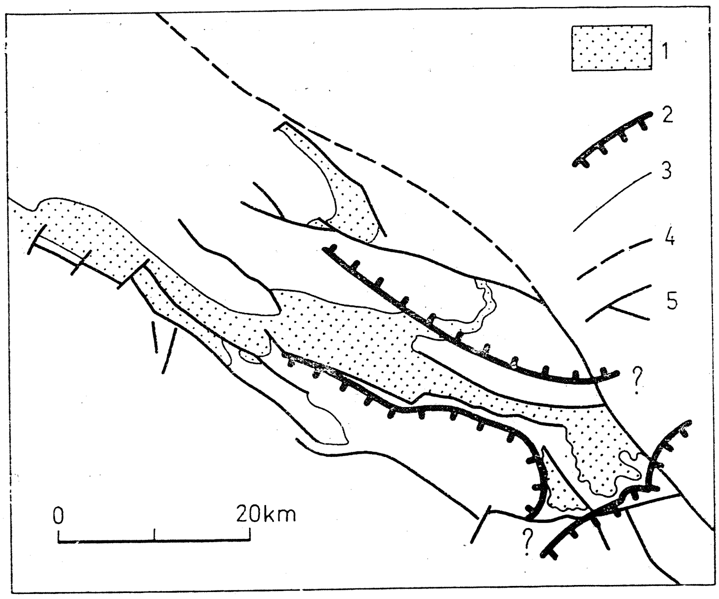

Fig. 13. General paleogeographic situation in the Stephanian and Lower Rotliegendes of the Kaczawa Mountains: 1 — Carboniferous and Lower Permian deposits; 2 — basin margins; 3 — geological boundaries; 4 — supposed faults; 5 — proved faults

Fig. 13. Ogólny zarys paleogeograficzny w stefanie i dolnym czerwonym spągowcu w górach Kaczawskich: 1 — osady karbonu i dolnego permu; 2 — brzegi basenu; 3 — granice geologiczne; 4 — uskoki przypuszczalne; 5 — uskoki stwierdzone

basin of the Lower Świerzawa Member. Although the picture of paleocurrents very much resembles the Upper Świerzawa Member, no deposits pointing to the vicinity of a margin have been found here (may be besides the vicinity of the Bystrzyca village). The further characteristics of the Stephanian Basin will thus be presented only after the analysis of sedimentation environment.

However, neither the one nor the other basin can be presented as an oval depression, as it was done by Milewicz (1965 b, 1966). It should be stressed that especially the basin of the Upper Świerzawa Member resembled in outline the present occurrences of this member on the surface.

COMPARISON OF SEDIMENTATION ENVIRONMENTS

Types of Bedding

In the clastics of both the Lower and the Upper Świerzawa Members alteration of sand and conglomerate deposits with horizontally bedded mudstones and claystones has been a frequent phenomenon. They are finning upwards cycles, commonly known from outwashes. A report on mechanisms of sedimentation of this type was recently compiled by Z. Dembowski and R. Unrug (1970). Thus a, so called, "simple" cycle is composed of coarse-grained deposits of a river channel, covered with finegrained material deposited in the flood plain area. Thickness of such cycles in the Lower Świerzawa Member is variable. A course--grained element of the cycle can be 5 m thick in the lowest part of the second of four cyclothems, distinguished by K. Dziedzic (1959). Higher, in the middle of cyclothem, the thickness of coarse-grained elements drops to 2 m, and to several tens of cm in the highest part. The thickness of mudstone interbeds is variable as a result of erosion caused by appearance of a stronger current carrying coarser material of the next cycle. The pattern of a "simple" cycle from the Lower Świerzawa member was presented in Fig. 14 A a. There are, however, deviations from the presented principle. It is shown in Fig. 14 A *b, c, d* and *e*. The deviations lie in the fact that coarser material appears in the middle or even in the upper part of the coarse-grained element; also streaks of coarser material, not seperated by erosional surfaces, occur several times. Bedding of this type is probably of different origin than of finning upward cycles. Possibly, the latter were caused by sudden rain-storms. The uppermost part of cyclothem is composed of finegrained deposits, initially sand and then black, bituminous, fine-clivaged pelitic rocks with organic remains, pirite and fine coal lenses.

The Upper Świerzawa Member is characterized by the same mechanism of sedimentation as the Lower one. However, cycles come up here

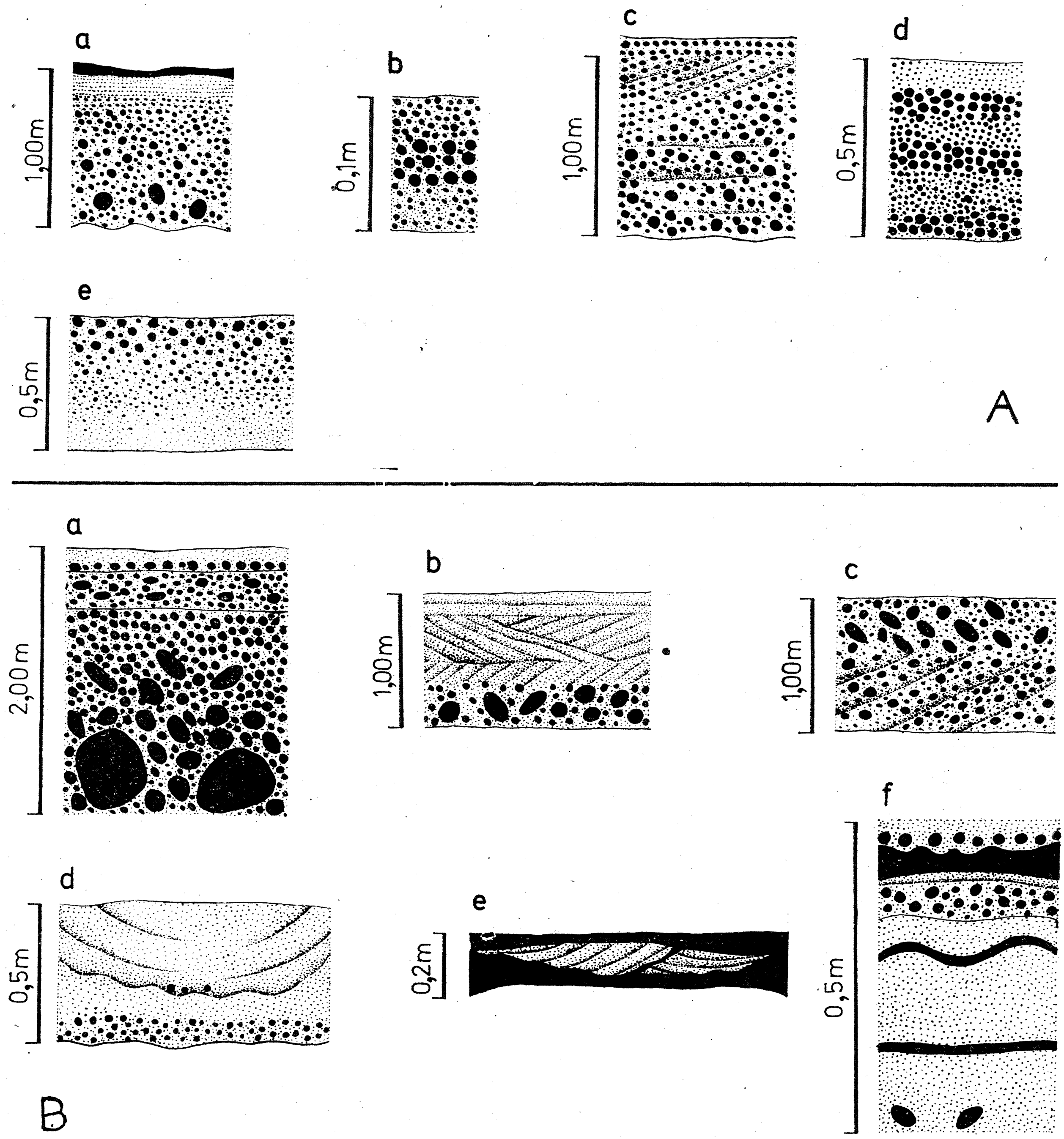

Fig. 14. Types of bedding in the Lower (A) and Upper (B) Świerzawa Member
Fig. 14. Typy warstwowań w dolnej (A) i górnej (B) serii świerzawskiej

to a greater thickness than previously. Examples of coarse clastic structure are presented in Fig. 14 B, *a, b, c.* Sometimes interdigitating processes of erosion and accumulation produce much more complicated bedding types than it was shown in Fig. 14 B, *e* and *f*. Both series constitute a complex of deposits with a cyclic mechanism of sedimentation. This type of sedimentation has been interpreted in literature as a result of migration of river channels. The channel migration, however, is characteristic both of vast and flat areas of the middle part of alluvial plain and of the piedmont area, where individual fans can also be distinguished (C. B. Leopold, M. C. Wolman, J. P. Miller 1964;

Thornbury 1969; S. A. Schum 1968). Therefore the occurrence of finning upward cycles cannot indicate environment. An attempt to interpret detailed environments will then be based on comparison of indicatory complex, mainly inorganic.

Interpretation of Inorganic Indicators of the Environment

Lithology	Directional Structures	Bedding	Environment Interpretation
	Upper Świerzawa Member		
Weakly matured, red conglomerates, also fanglomerates. Red sandstones, weakly matured with poorly rounded grain. No sorting. Small quantity of calcite cement. Red mudstones and claystones without organic remains.	Cross bedding in major scale. Current marks. Ripplemarks. Parting lineation. Increase crescents.	Finning upward cycles.	Escrapment area-piedmont part of alluvial plain — fans.
	Lower Świerzawa Member		
Mature gray and pink conglomerates and sandstones. Poor or sometimes very good rounding. Complex polymineral cement, common siderite. Gray mudstones and black bituminous claystones with pyrite. Bituminous limestones?	Cross bedding in minor scale. Rare current marks.	Finning upward cycles.	Middle part of alluvian plain. Local lakes (oxbows?) of reductive character.

COMPARISON OF THE STEPHANIAN AND THE LOWER PERMIAN BASIN

Recapitulation of data concerning elements of the basins model (Potter, Pettijohn, 1963) is presented in the form of tables, separately for the Stephanian Basin and also separately for its temporary prolongation in the Lowermost Permian.

The Stephanian Basin

Geometry	Filling	Distribution of lithofacies	Tectonic fundations
Position of margins not precisely defined; source area-mainly eastern margin, where older sedimentary members are eroded. Position of basin axis not precisely defined; probably present occurrences constitute the axial part of basin. The basin axis dipping westwards.	Gray and pink sand conglomerates and sandstones; red mudstones; red black bituminous claystones. Tuffites. Mature clastic deposits, which result from revorking of older deposits Cyclic sedimentation, poorly shaped cross bedding, small number of current marks-erosional channels.	No detailed data. Presumably vast alluvial covers; flat, wide accumulative forms.	Not precisely defined. Presumably a rising massif in the eastern margin. Small activity of the southern and northern margins.

Basin During the Lower Rotliegendes

Geometry	Filling	Distribution of lithofacies	Tectonic foundations
Elongated basin of W-E direction Margins partly on active faults Southern margin on active faults. of the elevated Bolków-Wojcieszów anticline. Position of northern margin not precisely defined. Basin axis north of the present Świerzawa Trough. Possible asymmetry of margins.	Sand conglomerates and red sandstones, red mudstones. Fanglomerates and deposits of mud flows. Distinct lack of maturity. Cyclic sedimentation. Poorly shaped cross bedding in major scale. Frequent ripplemarks and parting lineation.	No detailed data. Presumably flat accumulative forms resulting from channel migration in lower parts of fans.	Small influencess of an elevated massif at eastern margin. High activity of southern margin founded on faults.

No greater importance can be ascribed to lithological differences. They result mainly from erosion developing inward in sources areas, where sedimentary cover overlying the Kaczawa sediments had been initially destroyed. Lake horizons within the Lower Świerzawa Member point to longer periods of detention of the basin outlet. It might have been caused by local blocking or by sinking of the basin bottom. It seems that uplifting of basin margins was of a greater importance in sedimentation of the Upper Świerzawa Member. Common occurrence of parting lineation in sandstones of the Lower Rotliegendes betokens greater slopes and also stronger currents depositing clastic material. It appears most frequently in the upper parts of cycles, where mudstones and platy sandstones were alternately deposited. As it already been mentioned, the upper parts of cycles are regarded as flood plain deposits. In the case under consideration, however, it is difficult to assume that such strong currents might have occured under conditions of quiet sedimentation in the flood plain environment.

Co-occurrence of finning upward cycles and parting lineation points to the fact that sedimentation must have taken place in the environment of braided channels with very strong flows. Such conditions might have presumably existed only in the piedmont area on fan surfaces, yet in their lower part. Also occurrence of fanglomerates and mudflows points to visible regeneration of margin of the basin existing before. The Lower Świerzawa Member was undoubtedly deposited under conditions of greater tectonic quietness. Influence of the southern and northern margin was much weaker. Therefore, the tectonic foundations of sedimentation in the Stephanian and Lower Permian Basin can be characterized in the following terms:

1. Bottom uplifting in the N—W part of the Intrasudetic Basin. According to H. Teisseyre (1968), it had already occurred in the Sudetic phase.

2. Formation of vast alluvial plain with unknown northern and southern rim in the western foreland of this massif.

3. Further uplifting of the massif, mentioned above, causes stresses in the Kaczawa region. The latter breaks up into blocks and troughs of general direction W—E. Local stresses are relieved by the already existing fault system of the course NE—SW and NW—SE.

4. Narrow basins are formed between uplifted ranges.

The greatest differentation in paleomorphology in the Kaczawa region occured in the Lowermost Permian. Narrow uplifted ranges were seperated by basins of a trough character, which were being strongly buried from margins. These basins underwent further modifications in the Uppermost Lower Rotliegendes in connection with appearance of lava covers and domes, which must have undoubtedly changed the system of rivers. Compensation of paleomorphology of the Kaczawa Mountains and sedimentary unification in large areas occur in the Upper Rotliegendes.

Both basins, i. e. the Stephanian and the Lower Permian one, correspond presumably to the model distinguished by P. E. Potter and

F. J. Pettijohn (1963) as the Nevark Basin model, on the basis of the Deep River coal field in North Carolina, described by J. A. Reinemund (1955). A few years later it was found out that this model corresponded to a great number of other land basins. Recently S. Sengupta (1970) mentioned it in connection with the Gondwana Basin in North India. Paleomorphology of the Kaczawa region in the lowermost Permian can be compared with the Basin and Range Province in the western part of the United States.

The author wished to thank sincerely prof. dr H. Teisseyre for introducing him to the subject of the Stephanian and Rotliegendes sedimentation in the Kaczawa Mountains. He is also indebted to dr A. K. Teisseyre, dr T. Jerzykiewicz, dr J. Mroczkowski, and dr S. Dżułyński for fruitful discussions and excursions to the field.

He also thanks docent dr Jerzy Don for reading the text and criticism, and dr (assistant professor) Lech Teller for his remarks on lithostratigraphical division.

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STRESZCZENIE

Przedmiotem pracy jest analiza sedymentologiczna basenu i kierunków transportu materiału w osadach najwyższego karbonu i dolnego permu Gór Kaczawskich. Wyróżniono dwie jednostki litostratygraficzne. Jednostka dolna (stefan) odznacza się zaawansowaną dojrzałością materiału okruchowego, który był odkładany na rozległych równinach aluwialnych. Jednostka górna (dolny czerwony spągowiec) składa się z osadów o niskim stopniu dojrzałości materiału klastycznego i wypełnia stosunkowo wąski rów tektoniczny leżący pomiędzy skrzydłami uskoków czynnych w czasie sedymentacji. Obie jednostki litostratygraficzne utworzyły się zapewne w zbiorniku kontynentalnym odpowiadającym typowi wyróżnionemu przez Pottera i Pettijohna (1963) jako typ "Newark".

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