ANTONI M. ŻELICHOWSKI

Geological Institute, Rakowiecka 4, 00-975 Warsaw

LITHOLOGICAL ASSOCIATIONS IN THE CARBONIFEROUS IN POLAND

UKD 551.735.1/.2.02:552.181:552.5(438)

Carboniferous rocks are widely distributed in Poland. They crop out in small areas in the Sudety Mts (1, 3, 8, 9, 14, 16, 28, 37, 38, 39, 41, 45), Upper Silesia and vicinities of Cracow (10, 11, 23–25, 32, 34, 35, 40) and Góry Świętokrzyskie Mts (43, 44), being evidenced elsewhere by boreholes only. The beginnings of studies on the Carboniferous were connected with coal mining and they may be dated at first decades of the XIX c. in the Upper and Lower Silesian Coal Basins, where they covered coal-bearing sequences. That is why strata without coals have been identified as the Carboniferous relatively early at the western margin of the Upper Silesian Coal Basin (Culm at Toszek) and the eastern Sudety Mts. In turn, the hypothesis of Lower Carboniferous age of limitestones from the vicinities of Dębnik near Cracow, put forward by J. Pusch, used to be questioned on account of large distances between that "Carboniferous Limestone island" and similar strata in Belgium or Russia, untill it has been proven correct by L. Zejszner in 1850. Lower Carboniferous rocks in the Góry Świętokrzyskie Mts, discovered in 1916 by J. Czarnocki, appeared to be represented by claystones, sometimes with cherts, different from coeval rocks known from the Upper Silesia and adjoining areas. Drillings made in the Polish Lowlands and Carpathian Foredeep showed that the Carboniferous is much wider distributed than hitherto assumed, being represented in some areas by strata similarly developed as those known from outcrops and different elsewhere (2, 4–7, 12, 15, 18–22, 26, 27, 33, 36, 46–48). The recent stratigraphic studies in the Sudety Mts showed Carboniferous age of some rocks formerly assigned to the Lower Paleozoic.

The available data make it possible to recognize several lithofacies groups of Carboniferous rocks in Poland, formed under similar sedimentary conditions but different tectonic setting. Such natural rock assemblages are termed as lithological associations, corresponding to formations as interpreted by Soviet and some other authors. Formations, originally used as lithological units of stratigraphic value, lost with time this meaning at the advantage of a genetic one. In the studies on the Carboniferous, there were traditionally differentiated Carboniferous Limestone, Culm and coal-bearing (Coal Measures) formations. The first two of these were treated as synonyms of the Lower Carboniferous, and the third (Coal Measures) as synonym of the Upper Carboniferous in western Europe. Because of differences in sedimentary conditions and imprecise definitions, the concepts are nowadays treated as historical and their interpretation may greatly differ from the original.

The Culm, in the meaning accepted by Murchinson and Sedgwick in the first half of the XIX c., was to comprise a complex of shales (claystones and siltstones) and sandstones with thin intercalations of limestones as well as coals. Nowadays such rocks used to be treated as belonging to coal-bearing association (formation) and the name Culm is given for both flysch and molasse Carboniferous rocks without coal layers, e.g. the Culm in the Hartz Mts, eastern Sudetes and Wałbrzych Basin. The term Carboniferous Limestone is also imprecise.

The developments in studies on the Carboniferous make it desirable to differentiate some new rock sequences, for which the term assocoation is used here*. This term is used for a sequence of rocks formed under similar sedimentary conditions, responsible for origin of specific rock types or at least one of their components. In differentiating coal-bearing association, the major criterion is the presence of coals or even conditions favourable for their origin whereas thickness of individual coal layers and facies features of coal-bearing strata are neglected. The latter are treated as the basis for differentiation of lower rank units, i.e. subassociations.

The criteria for differentiation of associations (formations) accepted in geological literature are still ununiform. Some authors prefer wide interpretation of the range of associations (formations) whereas others are trying to establish highly detailed subdivision, giving very narrow interpretation of the associations (formations) as homogeneous lithological beds. Names given for these units sometimes comprise only lithological terms varying in accuracy or both lithological notations and more or less precise references to the inferred sedimentary environment of a given unit. In studies on sedimentary cover in the Russian Platform (17), six formations were differentiated in the infill of the Pripets'-Donets aulacogen and five – for rocks present in the remaining areas.

The subdivision accepted in this paper is based on lithological composition of rocks whereas sedimentary conditions are treated as depending on interpretation and, therefore, derivative in relation to a given association. The subdivision of sedimentary complexes is generally consistent with proposition given by R. Gradziński et al. (13), with some modifications. The following associations of sedimentary rocks are differentiated in the Carboniferous of Poland: clay-marly, flysch, olistostrome, restricted clay, clay, greywacke-clay, limestone, evaporatic (salt), red beds, coal-bearing and alithic (aluminium-rich). The recorded igneous rocks are assigned to two associations: intrusive and volcanic rocks.

The paper presents material for discussions connected with further works carried out within the frame of the IGCP Project no. 166 on strata of coal-bearing associations (formations). Using the available data for the area of Poland, there are outlined interrelations of coal-bearing associations and the coeval ones and changes in the vertical.

The data concerning lithology of Carboniferous rocks in Poland were presented in several unpublished and published reports. The former mainly concern areas where Carboniferous rocks have been found by recent drilling works (Pomerania, Lublin region, Silesian Lowland, Wielkopolska region and Carpathian foreland). Figures 1 and 2 show extent of the Carboniferous after the recently compiled geological map of the Carboniferous in Poland and adjoining countries (Z. Dembowski and W. Pożaryski, eds., Geological Institute, in press), with some modifications.

* The term formation is widely used in Polish geological literature. However, it is applied here in original lithostratigraphic sense because of introduction of formal lithostratigraphic subdivision. Such terminological approach is in consistence with R. Gradziński et al. (13).

A REVIEW OF ASSOCIATIONS

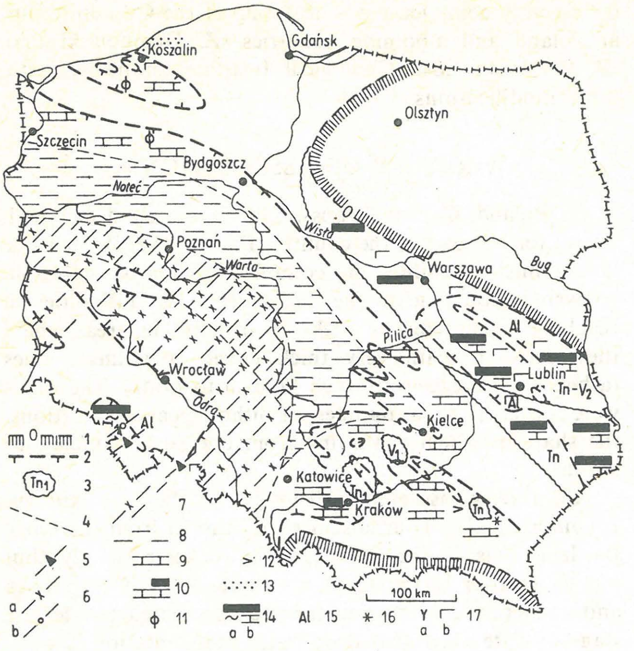
In Poland, Carboniferous rocks are widely distributed, except for NE part of the country (Fig. 1). Their knowledge is varying, depending on complications of structure in a given region (e.g. in the Sudety Mts) or difficulties in reaching Carboniferous rocks by drillings in areas where they occur beneath very thick cover of younger ones (a belt from Szczecin through Poznań to Łódź). The rocks were assigned to a number of lithological associations, the share of which is varying from one rock sequence to another.

Clay-marly association belongs to the less known. It comprises clay Tournaisian rocks known from the Góry Bardzkie Mts in the Sudetes. The rocks, relatively thin (not much over 100 m thick), are represented by claystones and, sometimes, marls and limestones, related to the last stage of Late Devonian deep-water sedimentation. However, tectonic complications displayed by the rocks preclude their unequivocal interpretation. In the Sudety Mts, some metamorphic rocks are assigned to the Dinantian. Of these, phyllites with lydites from Niemcza (10) may belong to the clay-marly association or a transitional to the chert-limestone one. The presence of the clay-marly association may be expected in the Góry Kaczawskie Mts and at northern margin of the Fore-Sudetic Block, where siliceous claystones of the Upper Devonian age has been found. Younger rock associations are dated at upper Visean on the basis of paleontological premises in these areas.

The Upper Devonian-Lower Carboniferous (Upper Frasnian-Lower Visean) age of rocks of the clay-marly association (Ponikiev Beds) has been proven in the Jesenik area, Eastern Sudetes (40).

Flysch and olistostrome associations are treated as a unity as they are interrelated and difficult to separate in highly disturbed sequences or on the basis of borehole data. The associations were recognized in the Sudety Mts and their foreland. Very thick conglomerate beds of the Góry Kaczawskie Mts and Świebodzice Depression may represent the olistostrome association. Similar nature is inferred by some authors (41) in the case of "Silurian-Devonian shaly series" of the Góry Bardzkie Mts. This point of view is, however, seriously questioned (30, 31). Taking into account advanced development of the flysch association in the Góry Bardzkie Mts, where olistoliths are fairly common, Silurian and Devonian rocks and conglomerates built of Sowie Góry Mts gneisses may be also assumed to be allochtoneous in character. Flysch rocks are here several hundred meters thick.

Outside the Góry Bardzkie Mts, the olistostrome association was found in the Góry Kaczawskie Mts by M. Chorowska (8, 9). There, rocks of that and the flysch association are dated at upper Dinantian. In the Eastern Sudetes, the range of the flysch association comprises the whole Dinantian and beginning of its sedimentation is dated at the Late Devonian (45). The Culm complex is some thousand meters thick in the latter area. It is built of a number of lithological complexes which may be treated as separate formations. Despite of marked differences in lithology, the whole complex displays clearly flysch character of rocks, including typical flysch sequences and numerous sedimentary structures. The Culm rocks

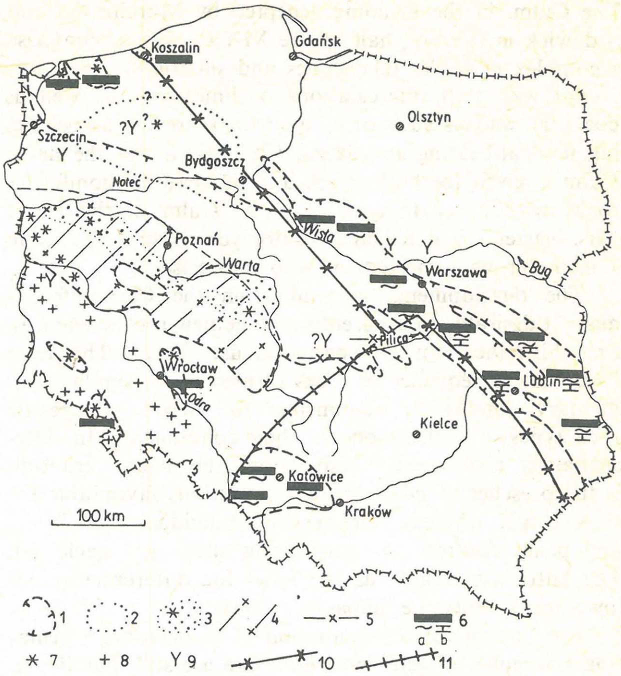


Ryc. 1. Rozmieszczenie asocjacji dinantu.

1 – maksymalny pierwotny zasięg utworów dinantu, 2 – współczesny zasięg osadów dinantu, 3 – granice obszarów o niepełnym profilu z podanym indeksem stratygraficznym luk stratygraficznych, 4 – granice asocjacji litologicznych; asocjacje: 5 – ilasto-marglowa, 6a – fliszowa, 6b – olistostromowa, 7 – ilasta, przechodząca w górze we fliszową, 8 – iłowa i ilastoszarogłazowa, 9 – wapienna, 10 – wapienna w stropie zastąpiona węglonośną, 11 – subasocjacja wapieni oolitowych, 12 – asocjacja solna ewaporatowa, 13 – asocjacja piaskowców kwarcowych, 14 – asocjacja węglonośna: a – bezwapienna terygeniczna subasocjacja, b – wapienna subasocjacja, 15 – asocjacja alitowa, 16 – asocjacja skał czerwonych, 17 – asocjacja wulkaniczna: a – porfirowa, b – diabazowa.

Fig. 1. Distribution of Dinantian associations.

1 – maximum original extent of Dinantian rocks, 2 – present extent of Dinantian rocks, 3 – boundaries of areas with incomplete section and index of stratigraphic gaps, 4 – boundaries of lithological associations; associations: 5 – clay-marly, 6a – flysch, 6b – olistostrome, 7 – clay, passing upwards into the flysch, 8 – clay and clay-greywacke, 9 – limestone, 10 – limestone, replaced by the coal-bearing at the top, 11 – oolitic limestone subassociation, 12 – salt evaporatic subassociation, 13 – quartz sandstone association, 14 – coal-bearing association: a – non-calcareous terrigenous subassociation, b – calcareous subassociation, 15 – alithic association, 16 – red bed association, 17 – volcanic association: a – porphyry, b – diabase.



Ryc. 2. Rozmieszczenie asocjacji silezu.

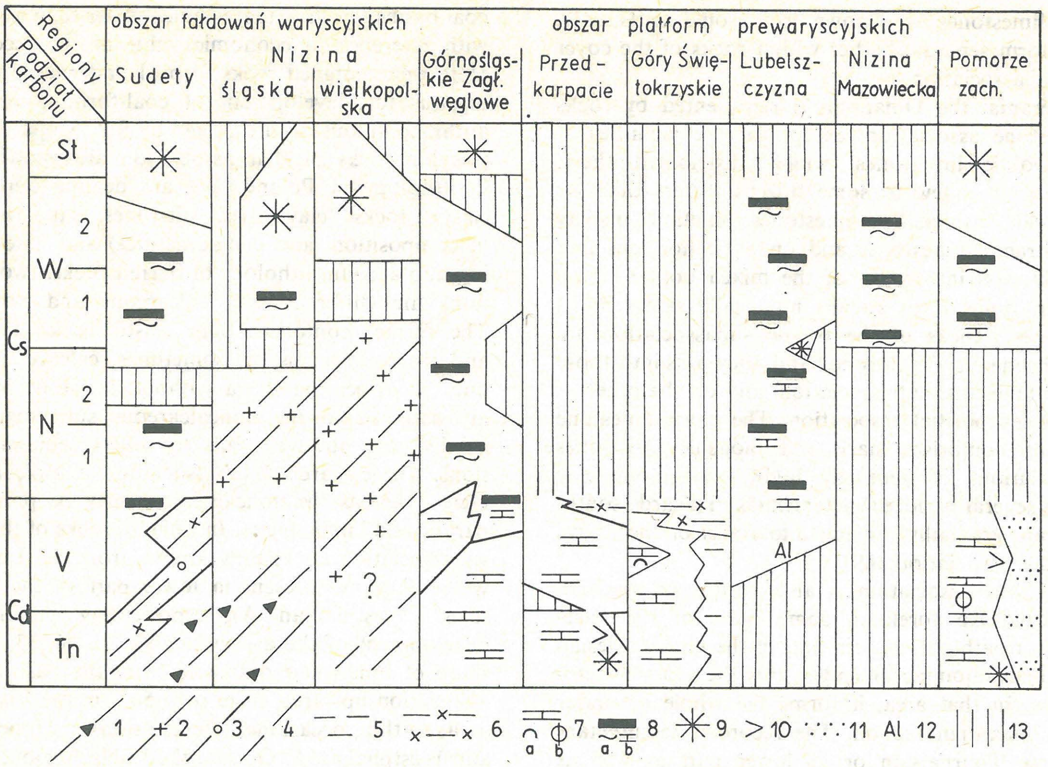
1 – współczesne rozprzestrzenienie osadów silezu, 2 – zasięg występowania asocjacji skał czerwonych czerwonego spągowca, mogących należeć do wyższego silezu, 3 – rozprzestrzenienie pokryw piaskowców kwarcowych asocjacji skał czerwonych nad sfałdowanymi utworami karbonu, 4 – asocjacja fliszowa, 5 – asocjacja ilasto-szarogłazowa, 6 – asocjacja węglonośna: a – subasocjacja bezwapienna terygeniczna, b – subasocjacja wapienna, 7 – asocjacja skał czerwonych, 8 – asocjacja skał intruzywnych, 9 – asocjacja skał wulkanicznych, 10 – linia wyznaczająca przebieg strefy Teisseyre'a-Tornquista, 11 – strefa głębokiego rozłamu Pilicy.

Fig. 2. Distribution of Silesian associations.

1 – present extent of Silesian rocks, 2 – extent of Rotliegendes rocks of red bed association which may belong to upper Silesian, 3 – extent of covers of quartz sandstones of red bed associations resting on folded Carboniferous, 4 – flysch association, 5 – clay-greywacke association, 6 – coal-bearing association: a – non-calcareous terrigenous subassociation, b – calcareous subassociation, 7 – red bed association, 8 – association of intrusive rocks, 9 – association of volcanic rocks, 10 – line showing the course of Teisseyre-Tornquist zone, 11 – Pilica depp fracture zone.

of the Eastern Sudetes are represented by alternating claystone-siltstone layers and greywacke sandstone intercalations and conglomeratic horizons. Sandstones often show various types of graded bedding as well as plant remains, locally abundant and clearly allochtoneous in character. The analysis of directions of transport of clastic material showed both transport along the axis of sedimentary basin (S–N) and, on much smaller scale, from the west to east (45). Similar rocks were encountered by drillings north of the Moravo-Silesian Zone. Carboniferous rocks found there in numerous drillings show similar sedimentary features as well as alternations of claystone-siltstone packets and greywackes or, sometimes, conglomeratic sandstones with pebbly mudstone intercalations. Sandstones are usually represented by lithic wackes, sometimes with graded bedding. Rocks of the flysch association from area NE of the Sudety Mts are dated at the Upper Dinantian and Lower Silesian (fig. 3). I assume that the extent of that association was migrating in time outside the Variscan geosyncline.

Rocks similar in lithology were also found NE of the above area, beyond the extent of the flysch association. Borehole data are still poor but they show presence of clay sediments, presumably quite thin and assignable to the **restricted clay association**, representative of deep-water zone, beyond the reach of coarse clastic admixture. Similar clay sediments with greywacke sandstone intercalations were found in drillings in northern foreland of the Góry Świętokrzyskie Mts and assigned to the **clay-greywacke association**. The latter differs from the flysch in the lack of graded bedding and other features typical of the flysch sequences. However, it is not excluded that the clay-greywacke association represents a distal flysch variety but the available borehole data are too scarce to solve



Ryc. 3. Schemat asocjacji litologicznych karbonu w Polsce.

Asocjacje: 1 – ilasto-marglowa, 2 – fliszowa, 3 – olistostromowa, 4 – ilasta, 5 – iłowa, 6 – ilasto-szarogłazowa, 7 – wapienna: a – subasocjacja rafowo-biohermowa, b – subasocjacja oolitowa, 8 – węglonośna: a – subasocjacja węglonośna bezwapienna, b – subasocjacja węglonośna wapienna, 9 – asocjacja skał czerwonych, 10 – solna (ewaporatowa), 11 – piaskowców kwarcowych, 12 – alitowa, 13 – braki osadów i luki (brak linii ciągłej poniżej zaznaczonego braku osadów zaznaczono w obszarach o nie ustalonym zakończeniu sedymentacji). Cd – dinant, Cs – silez, Tn – turnej, V – wizen, N – namur: 1 – dolny, 2 – górny; W – westfal, St – stefan.

Fig. 3. Scheme of distribution of lithological associations in the Carboniferous of Poland.

Associations: 1 – clay-marly, 2 – flysch, 3 – olistostrome, 4 – restricted clay, 5 – clay, 6 – clay-greywacke, 7 – limestone: a – reef-biohermal subassociation, b – oolitic limestone subassociation, 8 – coal-bearing: a – non-calcareous terrigenous subassociation, b – calcareous subassociation, 9 – red bed association, 10 – salt (evaporatic) association, 11 – quartz sandstone association, 12 – alithic association, 13 – lack of deposits and gaps (the lack of continuous line beneath the symbol of lack of deposits means undefined end of sedimentation in a given area). Cd – Dinantian, Cs – Silesian, Tn – Tournaisian, V – Visean, N – Namurian: 1 – Lower, 2 – Upper; W – Westphalian, St – Stephanian.

this problem. It is also very similar to the clay association, comprising claystones with radiolarites.

A thick complex (some thousand meters thick) of clastic rocks is also known in the Central Sudetic Depression. It comprises conglomeratic-sandstone rocks with siltstone intercalations. Sedimentological studies (37, 38) showed that these are mainly continental deposits of alluvial fans, which may be generally treated as the Culm. They were subdivided into a number of formations by A. Grocholski. Upper lithostratigraphic units, comprising intercalations of marine sediments and single coal layers may present basal part of the coal-bearing association. The lower ones – Figlów, Bogaczów and Lubomin formations – do nor display any features of embryonal coal-bearing formation, deposited in the form of alluvial fans (38). Therefore, there are no premises for assigning them to that association. Taking into account the fact that the rocks are closely related to those of a higher part of the section, i.e. coal-bearing association (Szczawno Fm.), the "older Culm" may be interpreted as representing praeanthracogenic stage of this association. The above described rocks, related to different sedimentary conditions and stages in diastrophic development and assignable to different lithological associations, were given the same name Culm in the geological literature which leads to marked differences in opinion. In discussing some problems of lithology and sedimentation of the Lower Carboniferous, the present author suggested elsewhere the necessity to restrict the meaning of Culm to flysch deposits. The works carried out within the frame of the IGCP Project no. 166 should result in more uniform use of that and other terms.

Limestone associations. Rocks widely distributed beyond the area occupied by the above discussed association are characterized by varying share of limestones. In the majority of the studied borehole columns their extent is smaller that of the Dinnantian so the term Coal Limestone refers to some occurrences only. In vast areas, the rocks usually predominate in lower part of the section or they form packets varying in thickness. They display intercalations of claystones, sandstones and, sometimes, conglomerates. Both facies transitions between these components and natural sequences, consistent with the principle of facies succession, are found. The rocks belong to several varieties of the limestone association. The association, limited to the Dinantian, is known from the Pomerania, Silesian-Cracow region, Góry Świętokrzyskie Mts and Carpathian foreland. The recorded marked differences in the mode of development of the association make possible differentiation of some subassociations. The most widely distributed of the latter is subassociation of cover limestones. Rocks of subassociations of oolitic and reef-

-biohermal limestones are known from some areas only, where they form separate bodies within rocks of the cover limestone subassociation.

In Pomerania, the Dinantian is represented by rocks of the limestone association, except for the vicinities of Koszalin. Oolitic limestones, widely distributed there, form layers from a few to some dozens meters thick or even almost 400 m thick. The limestones sometimes display lenses of ostracod limestones and oncolitic horizons and they laterally pass into rocks of the mixed oolitic facies. In the latter, ooids form streaks in usually sandy marls and claystones. Rocks of the oolitic subassociation are usually diachroneous. On the one hand, they pass into those of the cover limestone subassociation, and on the other – into the salt (evaporitic) association. The cover limestone subassociation comprises marls and biogenic limestones with intercalations of generally highly calcareous clay rocks, up to several hundred meters thick. Towards south-west, they are gradually passing into rocks of the above discussed clay association (49).

The limestone association is also known in southern Poland: Carpathian foreland, some parts of the basement in the Carpathians, eastern part of the Upper Silesian Coal Basin and adjoining areas towards the Góry Świętokrzyskie Mts. In that area, it forms the whole or major part of the Dinantian section. The recorded sedimentary gaps comprise Tournaisian or its lower part as well as some parts of Lower Visean (18, 42). The association is several hundred meters thick, generally close to 500 m and locally more (close to 1,000 m). Most often we are dealing here with rocks referable to the cover limestone subassociation: various biogenic, mainly crinoidal and foraminiferal limestones, accompanied by sandstones and claystones. Claystones sometimes display intercalations of cherts. Coal-bearing packets appear in top part of this association in area west of Cracow, Upper Silesian Coal Basin (so-called clay series; 40), and rocks of the clay-greywacke association – in the east. The rocks contact clay ones, often with cherts, in the north in the Góry Świętokrzyskie Mts. In the latter area, biogenic limestones with high share of corals and referable to the reef-biohermal subassociation are locally found. Rocks of the limestone association (oolitic limestone subassociation) have been also found by drillings north of Kielce (Fig. 1). The extent of the limestone association in southern Poland is delineated mainly on the basis of borehole data. East of Cracow (Fig. 1), some scarce borehole data show the presence of rocks unassignable to that association in the Dinantian.

At eastern margin of area occupied by the Dinantian, there were found rocks resembling those of the salt and red beds associations: sandstones and siltstones, mottled and intercalated by dolomites and anhydrites. In the map of the Dinantian (Fig. 1), they are shown as occurrences of rocks of the latter associations but it should be noted that this is a simplification and they should be treated as rocks transitional to those of the limestone association.

Quartz sandstone association has been differentiated in the Dinantian in the Koszalin area, northern Poland (Fig. 1). It comprises quartz and sometimes calcareous sandstones with siltstone and limestone intercalations. Similarly as in the case of the salt and red beds association in southern Poland, it represents a transitional type between quartz sandstone and limestone associations. Some clay intercalations are brown and red in colour.

Coal-bearing association comprises rocks typical of the Carboniferous in Poland, known from both the Silesian and Dinantian (Figs. 1–2). It is best developed in coal basins but its extent is much wider than that delineated with reference to economic value of the recorded coals. Here were assigned rocks formed under conditions advantageous for development of coal-forming processes, i.e. anthracophilous as interpreted by S.Z. Stopa. Coal-accompanying rocks of that association are markedly varying in lithology in Poland. We are dealing here with both clastic rocks (claystones, siltstones, sandstones varying in composition, and conglomerates) and limestones. Taking into account lithology of barren rocks, two subassociations are differentiated: calcareous and noncalcareous. The former comprises both clastic rocks and limestone and marly horizons or, sometimes, calcareous claystones only. Coal-bearing strata without limestone intercalations are assigned to the noncalcareous subassociation. Such subdivision, however, fails to reflect sedimentary conditions. The calcareous subassociation is typical for paralic facies whereas the noncalcareous may be present in both paralic and limnic facies. In Poland, rocks of the calcareous subassociation are mainly known from the Lublin region, where they are present in lower part of the section (Visean – Westphalian A), representing paralic stage in development of the association (7, 10, 26, 33, 46, 48). The share of limestones decreases from the base of that subassociation upwards, from over 50% in the Visean in some areas to thin, occasional intercalations in Upper Namurian and Westphalian A. Outside the Lublin region, the calcareous coal-bearing subassociation has been recorded at eastern margin of the Upper Silesian Coal Basin, where it comprises the Zalas Beds (Upper Visean). In that area, a change from the limestone association of the Dinantian to the coal-bearing has taken place when conditions advantageous for limestone sedimentation were still prevailing in the east. The calcareous coal-bearing subassociation is relatively thin there, some dozens meters thick only. It is also known to form a packet less than 100 m thick at the base of the coal-bearing association in Pomerania (lower part of the Westphalian; 49).

The noncalcareous coal-bearing subassociation forms the whole section of coal-bearing rocks in the Upper and Lower Silesian Coal Basins and the bulk in the Lublin Coal Basin. In the Lublin and Lower Silesian Basins, it corresponds to a limnic stage in their development and in the Upper Silesian Basin – to paralic stage in lower part of the section and the limnic – in the upper part. As it was stated above, so-called Culm of the Central Sudetic Depression corresponds to a preliminary stage in development of the coal-bearing association. The noncalcareous coal-bearing association also began to develop in depressions NE of the Sudety Mts, i.e. in area of the buried Variscan orogen. However, coal layers found in these depressions are without economic value.

In the Lower Silesian Basin and western Pomerania, rocks of the above association pass upwards but also laterally into those of the red beds association.

In Poland, rocks of the coal-bearing association are highly varying in thickness. Their summative thickness is the greatest (up to several kilometers, presumably over 7 km) in the Upper Silesian Coal Basin, being much smaller in the Lublin (below 2,5 km) and Lower Silesian (below 1.0 km when so-called older Culm is neglected) Basins, and the smallest in Pomerania and areas NW of Warsaw (a few hundred meters) and depressions in the vicinities of Wrocław.

Red beds association is mainly connected with the Silesian, being also developed but on much smaller scale in the Lower Carboniferous, in the limestone association. Thick packets of its rocks are known in Pomerania, Silesian – Wielkopolska Lowland and Central and North-Sudetic Depressions. The Kwaczała Arcose represents its small occurrences at eastern margin of the Upper Silesian Coal Basin (35). Borehole data show that it is also locally present in the vicinities of Warsaw (Lublin region), at the base of the coal-bearing association.

In Pomerania, the red beds association is represented by covers of sandstones with intercalations of conglomerates and claystone-siltstone rocks. It comprises rocks of the Dziwna and Rega Formations and top parts of the Wolin Fm., dated at the higher Westphalian and Stephanian. Figure 2 shows inferred distribution of these strata in central Pomerania. I assume that some sequence with volcanic covers, assigned to the Rotliegendes in this region, may represent upper parts of the Silesian (49).

In the Polish Lowlands, thick covers of red beds were also found in the Silesian and Wielkopolska Lowlands. Incomplete borehole columns preclude accurate evaluation of thickness but they seem to be several hundred meters thick. They are built of quartz sandstones with claystone-siltstone intercalations. Red and brown colours predominate but some claystones are grey. Innumerous palynological datings make possible assignation of these rocks to Upper Westphalian and Stephanian. In depressions from the vicinities of Wrocław, the association is characterized by high share of conglomerates and it rests on rocks of the coal-bearing association. In the Lower Silesian Coal Basin, Upper Silesian rocks of the Glinnik and Ludwikowice Formations – coarse clastic rocks with mottled claystone intercalations – correspond to that associations. They laterally replace or interfinge with those of the coal-bearing association (Žacler Fm.) and they are varying from below 200 m to over 600 m in thickness. In the North-Sudetic Basin, similar rocks were formerly regarded as the Rotliegendes to be recently assigned to Upper Westphalian and Stephanian by J. Milewicz (29).

Alithic association is occupying a separate position. It comprises small weathering covers or loams enriched in aluminium or, sometimes, even bauxites. The covers are developed in areas of occurrence of volcanic and igneous rocks. Here are assigned weathering covers from the vicinities of Nowa Ruda and north-eastern part of the Lublin region. In the latter, the covers are found at the base of the coal-bearing association (Visean). Moreover, karst deposits are developed in places where the Carboniferous directly rests on mostly carbonate Devonian. In the vicinities of Nowa Ruda (Lower Silesian Coal Basin), alithic rocks also occur at the base of the coal-bearing association. In both cases they are of the Lower Carboniferous age.

Besides distribution of associations of sedimentary rocks, the maps show some data concerning igneous rocks. Both basic and acid volcanic rocks are known from the Dinantian. Diabase dykes and veins were found in Pomerania and Lublin region, and porphyries – in the Silesian Lowland. Granitoid intrusions of the Sudety Mts and their foreland and rhyolite and dacite volcanism are dated at the Silesian.

EVOLUTION OF THE BASIN

The maps (Figs. 1 – 2) show distribution of the above discussed lithological association in the Carboniferous of Poland. Figure 1 shows distribution of the associations in the Dinantian as well as inferred southern and north-eastern boundaries of the sedimentary basin. The Silesian map (Fig. 2) does not show extent of individual basins because of their marked shifts in time. The present extent, given in that figure, is the maximum for individual epochs structural stages of the Carboniferous, except for the Early Namurian. The actual extent of the latter is wider than that shown in this figure both in the case of marginal part of the Upper Silesian Coal Basin and Sudetic foreland. Figure 3 shows distribution and time changes of individual associations in the Carboniferous.

The lithological associations have no direct genetic notations but, nevertheless, they make possible some regionalization and reconstruction of diastrophic conditions responsible for their origin. For appropriate reconstruction of evolution of the Carboniferous basin in Poland it would be desirable to superimpose thickness data on distribution of association. However, the resulting image would be hardly readable because of overlap of individual associations and time changes in their extent so paleoisopachs are not given in the maps.

The associations are related to definite diastrophic conditions and some of them may be treated as unequivocal indices of conditions under which they have originated. This is especially the case of the flysch, olistostrome as well as clay-marly associations. The remaining associations, although comprising rocks formed in areas unaffected by geosynclinal regime, depended on a wider array of geotectonic agents.

The presence of the flysch, olistostrome and clay--marly associations delineates course and extent of the Variscan orogen in SE Poland. The associations also show that the Carboniferous stage was the final one in evolution of this geosyncline. Area of flysch sedimentation migrated in time towards NW, being represented in that direction by progressively younger strata (up to Westphalian A – Figs. 1, 2, 3). This reflects migration of geosynclinal furrow into its foreland and drawing the latter into zone of flysch sedimentation under geosynclinal conditions. On the basis of results of studies on migrations of lithological associations and intensity of tectonic disturbances, I made an attempt to identify major zones of foldings. From SW to NE, the zones include: areas affected by foldings in the Sudetic phase, comprising the Sudety Mts, those affected by Erzgebirgian foldings – SW part of the Silesian Lowland (Lower Silesian zone), and Asturian foldings – the Wielkopolska Lowland (Poznań zone). Boundary between the two latter zones is drawn along the Dolsk deep fracture. So wide Variscan fold zones are delineated by the Pilica deep fracture line, south of which the external zone of the Variscides is limited to the Moravo-Silesian zone only. The Pilica line at the same time delineates distribution of the limestone association of the Dinantian of the Góry Świętokrzyskie, Upper Silesian Coal Basin and Carpathian foreland.

Intramontane depressions started to form in the Sudety Mts in the time of flysch sedimentation in external zones of the Variscan orogen. The became the site of sedimentation of the coal-bearing and subsequently red beds associations. In the Westphalian, such depressions began to form in the Lower Silesian zone (vicinities of Wrocław). In the latter area, molasse deposits are represented by the coal--bearing and red beds associations.

There remains the question of lithological associations originating in foreland of the Poznań fold zone as it may be overthrusted on the foreland.

The Poznań fold zone and some parts of the Lower Silesian are covered with rocks of the red beds association, representing basal parts of the young platform cover.

That epiplatform cover is connected with sedimentary cover of Pomerania, built of rocks of the same and coal-bearing associations.

The associations occurring in the Teisseyre-Tornquist Zone and NE of it were originating under platform conditions, on old; Caledonian and Precambrian platforms. They belong to the limestone and coal-bearing associations. In Pomerania and Góry Świętokrzyskie Mts, the former association is related to a regressive stage in development of the Devono-Dinantian basin, and the Dinantian coal-bearing association in the Lublin region – with a transgressive one. There is no direct correlation between associations from SW and NE Poland. This, according to the present author, may be explained in terms of wrench character of the Teisseyre-Tornquist Zone.

The above data on distribution of lithological associations in the Carboniferous of Poland suggest polygenic nature of conditions responsible for origin of the coal-bearing association. Favourable conditions for origin of the latter appear related to both regressive stage) in the Upper Silesian Coal Basin) and the transgressive (Lublin Coal Basin and Pomerania). It should be also noted that this association was developing in areas of both old and young platforms, in foredeeps and intramontane basins.

LITERATURA

1. Augustyniak K. – Geological Atlas of the Lower Silesian Coal Basin. Part II, Inst. Geol. 1970.
2. Bojkowski K. – Geological Atlas of Poland. Stratigraphic and facial problems. Fasc. 6 Carboniferous. Inst. Geol. 1960.
3. Baranowski Z., Haydukiewicz A. et al. – Aktualne kierunki badań stratygraficznych, sedymentologicznych i tektonicznych metamorfiku Gór Kaczawskich. (Engl. sum.) Present directions of stratigraphic, sedimentologic and tectonic studies over the metamorphic zone of the Góry Kaczawskie Mts. Biul. Inst. Geol. 1982 t. 341.
4. Bojkowski K., Dembowski Z. – Die Paleogeographie und Lithofazies des Karbons in Polen. Septième Congres Inter. Strat. Geol. Carbonifère Krefeld. 1973 Bd 2.
5. Bojkowski K., Żelichowski A.M. – An outline of paleogeography of the Namurian B–C and Westphalian of Poland. Biul. Inst. Geol. 1980 t. 328.
6. Cebulak S. – Surowce boksytowe i kaolinowe występujące w karbonie Lubelskiego Zagłębia Węglowego. (Engl. sum.) Bauxite and kaolinite raw materials in the Lublin Coal Basin. Prz. Geol. 1978 nr 9.
7. Cebulak S., Porzycki J. – Charakterystyka litologiczno-petrograficzna osadów karbonu lubelskiego. (Engl. sum.) Lithological-petrographic characteristics of the deposits of the Lublin Carboniferous. Pr. Inst. Geol. 1966 t. 44.
8. Chorowska M. – Wizeńskie wapienie w epimetamorficznym kompleksie Gór Kaczawskich. (Engl. sum.) Visean limestones in the metamorphic complex of the Kaczawa Mts Sudetes. Ann. Soc. Geol. Pol. 1978 no. 48, f. 2.
9. Chorowska M. – Badania stratygraficzne formacji metamorficznych Sudetów (Engl. sum.) Stratigraphic investigations of metamorphic formations of the Sudetes. Biul. Inst. Geol. 1982 t. 341.
10. Czekaj A., Dembowski Z. et all. – Upper Silesian Region. Upper Carboniferous deposits. Maps of thickness and of the content of coarse-clastic and of phytogenic material. Inst. Geol. 1964.
11. Dembowski Z. – Krakowska seria piaskowcowa Górnośląskiego Zagłębia Węglowego. (Engl. sum.) The Cracow sandstone series of the Upper Silesian Coal Basin. Pr. Inst. Geol. 1972 t. 61.
12. Górecka T. et all. – Utwory skalne podłoża permu zachodniej części monokliny przedsudeckiej i perykliny Żar oraz przyległej części bloku przedsudeckiego. (Engl. sum.) The crystalline and Carboniferous deposits of the Foresudetic Monocline, the Żary Pericline and adjacent part of the Foresudetic Block. Pr. Nauk. Inst. Górn. P. Wroc. t. 22 nr 9.
13. Gradziński R., Kostecka A. et all. – Sedymentologia. Wyd. Geol. 1976.
14. Grocholski A. – Problemy stratygrafii silezu w Dolnośląskim Zagłębiu Węglowym. (Engl. sum.) Stratigraphical problems of the Silesian in the Lower Silesian Coal Basin. Kwart. Geol. 1975 nr 1.
15. Grocholski A. – Serie krystaliczne bloku przedsudeckiego i związane z nimi perspektywy surowcowe. (Engl. sum.) Crystaline series of the Fore-Sudetic Block and the connected prospects for mineral resources. Biul. Inst. Geol. 1982 nr 341.
16. Haydukiewicz A. – Litostratygrafia i rozwój strukturalny kompleksu kaczawskiego w jednostce Rzechówka i w zachodniej części jednostki Jakuszowej. Geol. Sudetica 1977 nr 1.
17. Igołkina N.S. (red.) – Gieołogiczeskije formacii osadocznogo czechła russkoj płatformy. Tr. WNIGNI now. sier. 1981 t. 296.
18. Jurkiewicz H., Żakowa H. – Rozwój litologiczno-paleogeograficzny dewonu i dolnego karbonu w Niecce Nidziańskiej. (Engl. sum.) Lithologic-paleogeographic development of the Devonian and Lover Carboniferous in the Nida Trough. Kwart. Geol. 1972 nr 4.
19. Korejwo K. – Stratigraphy and paleogeography of the Namurian in the Polish Lowland. Acta Geol. Pol. 1969 no. 4.
20. Korejwo K. – The Carboniferous of the Chojnice area (Western Pomerania). Ibidem 1976 no. 4.
21. Korejwo K. – Charakterystyka litologiczna i rozwój paleotektoniczny karbonu w rejonie Wierzchowa (Pomorze Zachodnie). (Engl. sum.) Lithology and paleotectonic development of the Carboniferous in the Wierzchowo Area (Western Pomerania). Ibidem 1977 no. 4.
22. Korejwo K., Teller L. – Stratygrafia karbonu z wierceń Marszowice 1 i Koniusza 1 (niecka miechowska). (Engl. sum.) Stratigraphy of the Carboniferous from boreholes Marszowice 1 and Koniusza 1 (Miechów Trough, S. Poland). Ibidem 1968 no. 4.
23. Kotas A. – Osady morskie karbonu górnego i ich przejście w utwory produktywne Górnośląskiego Zagłębia Węglowego. (Engl. sum.) The marine sediments of the Upper Carboniferous and their transition into the productive deposits in the Upper Silesian Coal Basin. Pr. Inst. Geol. 1972 t. 61.
24. Kotas A., Malczyk W. – Seria paraliczna piętra namuru dolnego Górnośląskiego Zagłębia Węglowego. (Engl. sum.) The paralic series of the Lower Namurian stage of the Upper Silesian Coal Basin. Ibidem.
25. Kotas A., Malczyk W. – Górnośląska seria piaskowcowa piętra namuru górnego Górnośląskiego Zagłębia Węglowego. (Engl. sum.) The Upper Silesian

sandstone series of the Upper Namurian stage of the Upper Silesian Coal Basin. Ibidem.
26. Kowalski W., Chlebowski R., Żelichowski A.M. – Charakterystyka mineralogiczno-petrograficzna utworów karbonu rowu mazowiecko-lubelskiego. (Engl. sum.) Mineralogical-petrographical characteristic of the Carboniferous of the Masovian-Lublin trough. Bull. of Geology Warsaw Univer. 1982 t. 25.
27. Krawczyńska-Grocholska H., Grocholski W. – Uwagi o karbonie północno-zachodniego obrzeżenia bloku przedsudeckiego. (Engl. sum.) Some remarks on the Carboniferous occurring on the north-western margin of the Fore-Sudetic Block. Kwart. Geol. 1976 nr 1.
28. Lipiarski I. – Osady warstw żaclerskich (dolny westfal) w niecce Słupca (depresja śródsudecka) oraz morfologia pokładów węgla. Pr. Geol. Kom. Nauk Geol. PAN Oddz. Kraków 1976 nr 101.
29. Milewicz J. – Nowe dane o górnym karbonie w depresji północnosudeckiej. (Engl. sum.) New facts about the Upper Carboniferous in the North Sudetic Depression. Biul. Inst. Geol. 1972 nr 259.
30. Oberc J. – O faktach przemawiających przeciw poglądowi o allochtonizmie sedymentacyjnym wielkich mas skał przedkarbońskich w strukturze bardzkiej. (Engl. sum.) On facts speaking against hypothesis of sedimentary allochtonous nature of great pre-Carboniferous rock masses of the Bardo structure. Prz. Geol. 1979 nr 10.
31. Oberc J. – Rozwój waryscydów południowej części strefy kaczawskiej. (Engl. sum.) Evolution of the Variscides in the southern part of the Kaczawskie (Mts) Zone. Biul. Inst. Geol. 1982 nr 341.
32. Porzycki J. – Seria mułowcowa piętra westfalu dolnego Górnośląskiego Zagłębia Węglowego. (Engl. sum.) The siltstone series of the Lower Westphalian stage of the Upper Silesian Coal Basin. Pr. Inst. Geol. 1972 t. 61.
33. Porzycki J. – Fundamental properties of the geological structure and evolution of the deposits of the Lublin Coal Basin. Biul. Inst. Geol. 1980 nr 328.
34. Radomski A., Gradziński R. – Lithologic sequences in the Upper Silesian Coal-Measures (Upper Carboniferous, Poland). Rocz. Pol. Tow. Geol. 1978 t. 48 z. 2.
35. Rutkowski J. – Osady stefanu Górnośląskiego Zagłębia Węglowego. (Engl. sum.) The Stephanian sediments of the Upper Silesian Coal Basin. Pr. Inst. Geol. 1972 t. 61.
36. Sawicki L. – Rozwój poglądów na tektonikę utworów paleozoicznych regionu dolnośląskiego. (Engl. sum) Evolution of opinions on the tectonics of the Paleozoic rocks in the Lower Silesia Area. Biul. Inst. Geol. 1982 nr 341.
37. Teisseyre A.K. – Charakterystyka sedymentologiczna kulmu z Ciechanowic i paleogeografia najniższego kulmu niecki śródsudeckiej. (Engl. sum.) Sedimentology of the Kulm of Ciechanowice and palaeogeography of the Lowest Kulm of the Intrasudetic Basin. Geol. Sudet. 1971 no. 3.
38. Teisseyre A.K. – Sedymentologia i paleogeografia kulmu starszego w zachodniej części śródsudeckiej. (Engl. sum.) Sedymentology and palaeogeography of the older Kulm Alluvial Fans in the Western Intrasudetic Basin (Central Sudetes, SW Poland). Ibidem 1975 no. 2.
39. Unrug R. – Turbidites and fluxoturbidites in the Moravia-Silesia Kulm zone. Bull. Acad. Pol. Sc. Sér. Sc. Géol. Géogr. 1964 no. 3.
40. Unrug R., Dembowski Z. – Rozwój diastroficzno-sedymentacyjny basenu morawsko-śląskiego. (Engl. sum.) Diastrophic and sedimentary evolution of the Moravia-Silesia Basin. Rocz. Pol. Tow. Geol. 1971 t. 41 z. 1.
41. Wajsprych B. – Allochtoniczne skały paleozoiczne w osadach wizeńskich Gór Bardzkich (Sudety). (Engl. sum.) Allochtonous Paleozoic rocks in the Visean of the Bardzkie Mts (Sudetes). Ibidem 1978 t. 48 z. 1.
42. Zając R. – Nowe dane o utworach dewonu i karbonu w rejonie Grobli. Kwart. Geol. 1975 nr 4.
43. Żakowa H. – The present state of the stratigraphy and paleogeography of the Carboniferous in the Holy Cross Mts. Acta Geol. Pol. 1970 no. 1.
44. Żakowa H. – Dolny karbon w okolicy Bolechowic (Góry Świętokrzyskie). (Engl. sum.) The Lower Carboniferous from the vicinity of Bolechowice (Holy Cross Mts). Prz. Geol. 1967 nr 1.
45. Żelichowski A.M. – Cechy sedymentacji utworów dolnego karbonu okolic Głubczyc. (Engl. sum.) Characteristics of sedimentation of the Lower Carboniferous in the vicinity of Głubczyce (Eastern Sudeten). Ibidem 1964 no. 1.
46. Żelichowski A.M. – Rozwój budowy geologicznej obszaru między Górami Świętokrzyskimi a Bugiem. (Engl. sum.) Evolution of the geological structure of the area between the Góry Świętokrzyskie and the River Bug. Biul. Inst. Geol. 1972 nr 263.
47. Żelichowski A.M., Juskowiak M. et all. – Pokrywy dolnokarbońskich glin zwietrzelinowych w centralnej Lubelszczyźnie. (Engl. sum.) Covers of the Lower Carboniferous weathered loams in the central area of the Lublin Region (SE Poland). Kwart. Geol. 1974 nr 3.
48. Żelichowski A.M. et all. – Utwory karbonu w strefie uskoku Grójca. (Engl. sum.) The Carboniferous deposits in the Grójec fault zone – Central Poland. Biul. Inst. Geol. nr 344 (in press).
49. Żelichowski A.M. – Karbon Pomorza Zachodniego. The Carboniferous in western Pomerania. Prz. Geol. 1983 nr 6.

STRESZCZENIE

W artykule omówiono stwierdzone asocjacje skalne karbonu na terenie Polski. Pod mianem asocjacji rozumiany jest zgodnie z propozycją (13), zespół skał utworzonych w zbliżonych warunkach sedymentacji, które przyczyniły się do powstania określonych skał lub warunkowały obecność w nim jednego składnika. W polskiej literaturze stosowany jest zazwyczaj termin – formacja, z uwagi jednak na wprowadzany obecnie podział litostratygraficzny na formalne jednostki, wydaje się celowe pozostawienie terminu formacja w sensie litostratygraficznym. Jest to nawiązane zresztą do historycznych uwarunkowań tego terminu.

Wśród osadów karbonu Polski wydzielono wiele asocjacji. Część z nich ma szeroki zasięg, niektóre natomiast mają mały zasięg terytorialny jak i wąski przedział czasu, w którym się tworzyły. Rozmieszczenie ich na obszarze Polski przedstawiono na ryc. 1 i 2, osobno dla dinantu i silez, a następstwo pionowe obrazuje ryc. 3.

Szeroki zasięg wśród osadów dinantu mają asocjacje: wapienna, ilasto-marglowa, fliszowa i olistostromowa, ilasta, ilasto-szarogłazowa, iłowa. Podrzędne znaczenie natomiast mają asocjacje: węglonośna, solna (ewaporatowa), skał czerwonych, piasków kwarcowych oraz alitowa. W obrębie osadów silezu dominują asocjacje węglonośna i skał czerwonych, natomiast mniejszy udział ma asocjacja fliszowa.

Asocjacja ilasto-marglowa i ilasta obejmuje utwory ilaste, niekiedy z rogowcami oraz z przewarstwieniami skał wulkanicznych, występujące w Sudetach i ich przedpolu. Są to osady o niewielkiej miąższości, silnie zaburzone tektonicznie, często w znacznym stopniu zmetamorfizowane. Asocjacja fliszowa i olistostromowa również wydzielone są w Sudetach i na ich przedpolu. Zaliczono tutaj utwory dinantu i niższego silezu. Powyższe asocjacje związane są z etapem rozwoju geosynklinalnego i wykazują znaczny stopień zaburzeń tektonicznych.

Poza obszarem geosynklinalnym (na NE) rozwinięte są asocjacje iłowa i ilasto-szarogłazowa. Powyższe asocjacje określane są często jako kulm. Należy podkreślić, że część osadów „kulmu" należy do asocjacji węglonośnej – kulm depresji środkowosudeckiej (formacja ze Szczawna).

Asocjacja wapienna zajmuje znaczne obszary Polski, w całości należąc do dinantu. Reprezentuje ona różne odmiany należące do subasocjacji wapieni pokrywowych, subasocjacji wapieni oolitowych i sporadycznie rafowo-biohermowej. Osady asocjacji wapiennej przechodzą lokalnie w asocjację solną (ewaporatową) i skał czerwonych.

Asocjacja węglonośna obejmuje różnorodne zespoły skalne, charakteryzujące się obecnością złogów węglowych. Z uwagi na występowanie lub brak wapieni podzielono je na dwie subasocjacje: wapienną i bezwapienną. Subasocjacja węglonośna wapienna występuje na granicy asocjacji wapiennej i węglonośnej w cyklu regresywnym (GZW) lub u podstawy asocjacji węglonośnej w cyklu transgresywnym (LZW, Pomorze Zachodnie). Osady subasocjacji węglonośnej bezwapiennej pojawiają się zazwyczaj ponad subasocjacją wapienną w basenach paralicznych, a typowe są dla basenów węglowych limnicznych.

Asocjacja skał czerwonych związana jest głównie z osadami silezu, a tylko niewielkie jej wystąpienia notowane są w dinancie. Reprezentowana jest ta asocjacja przez osady klastyczne piaszczysto-zlepieńcowate z przewarstwieniami ilasto-mułowcowymi o barwach czerwonych lub pstrych. Na Pomorzu i nizinie wielkopolskiej w utworach tej asocjacji znaczny udział mają piaskowce kwarcowe, tworzące rozległe pokrywy. Występujące w dinancie Pomorza okrywy piaskowców kwarcowych, zaliczono do asocjacji piaskowców kwarcowych, zdając sobie sprawę z odrębności ich od typowych utworów zaliczanych do tej asocjacji.

Ostatnią wydzieloną asocjacją jest asocjacja alitowa. Umieszczono w niej pokrywy glin zwietrzelinowych na Lubelszczyźnie i okolic Nowej Rudy, podścielające osady asocjacji węglonośnej.

Obok asocjacji skał osadowych w karbonie Polski mamy do czynienia z asocjacjami skał wulkanicznych i intruzywnych (ryc. 1 i 2).

Asocjacje reprezentujące etap geosynklinalny stwierdzone zostały w SW Polsce. Na podstawie przemieszczania się w czasie i przestrzeni asocjacji fliszowej i olistostromowej, uwzględniając stopień zaburzeń tektonicznych, wydzielone zostały w strefie fałdowań waryscyjskich trzy strefy. Położona najbardziej na SW strefa fałdowań sudeckich, obejmująca Sudety, graniczy ze strefą dolnośląską (sfałdowaną w fazie kruszcogórskiej), do której z kolei od NE przylega strefa poznańska sfałdowana asturyjsko (po dolnym westfalu A). Przebieg orogenu waryscyjskiego modelowany jest przez rozłam wgłębny Pilicy (ryc. 2), który wymusił jego przegięcie i zwężenie. Na strefę orogenu waryscyjskiego nałożone są zapadliska śródgórskie wypełnione osadami asocjacji węglonośnej i skał czerwonych. Poza orogenem, na NE i E, na obszarach platform prekambryjskiej i staropaleozoicznej rozwijały się asocjacje: wapienna, węglonośna oraz skał czerwonych. Lokalnie powstały asocjacje: solonośna, piaskowców kwarcowych i alitowa. Wzajemne stosunki pomiędzy asocjacjami powstałymi na starszej platformie i geosynklinie waryscyjskiej zaburzone są przez strefę Teisseyre'a-Tornquista i rozłam Pilicy. Strefy te mają charakter przesuwczy.

Asocjacja węglonośna karbonu w Polsce reprezentuje etap transgresywny (Pomorze Zachodnie, Lubelszczyzna) oraz regresywny (Zagłębie Górnośląskie i częściowo Zagłębie Dolnośląskie). Stanowi ona składnik utworzony zarówno w warunkach pokrywy epiplatformowej (Pomorze, Lubelszczyzna), zapadlisk śródgórskich (Zagłębie Dolnośląskie, okolice Wrocławia), jak i zapadliska przedgórskiego (Zagłębie Górnośląskie).

РЕЗЮМЕ

В статье представлены скальные ассоциации карбона обнаруженные на территории Польши. Выделены следующие литологические ассоциации: глинисто-мергелевая, флишевая и олигостромовая (представляющая этапы геосинклинального развития), а также ассоциации: глинистая, глинисто-граувакковая, известковая, кварцевых песчаников, угленосная, красных пород и алитовая (фиг. 1, 2, 3). Ассоциации представляющие геосинклинальный осадок были обнаружены в юго-западной Польше (Фиг. 1, 2). На основании перемещения флишевой ассоциации, учётывая степень тектонических наружений, в зоне варисцийской складчатости были выделены три зоны. Находящеяся наиболее на ЮЗ зона судетской складчатости включает Судеты, с СВ к ней прилегает нижнесилезская зона (район горнорудной складчатости) и внешняя зона, имеющая астурийскую складчатость. Форма варисцийской геосинклинали была моделированная глубинным разломом Пилицы (фиг. 2). В зоне варисцийского орогена накладываются межгорные прогибы, отложения угленосной ассоциации и красных пород. На территории докембрийской и древнепалеозойской платформ развивались ассоциации: известковая, угленосная и красных пород. Взаимные отношения между ассоциациями образовавшимися на платформе и в варисцийской геосинклинали нарушены перемещающим характером зоны Тейсера-Торнквиста. Угленосная ассоциация в карбоне Польши представляет трансгрессивный этап (Поморье и Любельский угольный бассейн), а также регрессивный (Верхнесилезский угольныи бассейн). Она образовалась как в условиях эпиплатформенного покрова так и межгорных прогибов (Нижнесилезский угольный бассейн, окрестности Вроцлавя), а также предгорных впадин (Верхнесилезский угольный бассейн). Добавочно были выделены: солевая ассоциация (которая является переходным этапом от известковой ассоциации). Магматические породы карбона Польши представлены интрузивными ассоциациями (гранитоиды Судетов и предполья), а также ассоциациями вулканических пород.