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DEVELOPMENT OF THE CARBONIFEROUS OF THE SW MARGIN OF THE EAST-EUROPEAN PLATFORM IN POLAND

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In Polish sector of the East-European Platform (EEP) margin, Carboniferous strata have been found by drillings in a wide zone. They occur at varying depths and are covered by Permian/Mesozoic and Cainozoic deposits of thickness from several hundred meters in the Podlasie-Lublin region to some thousand meters in Kujawy and Pomerania. The present extent of the cover was shaped by erosion in the Late Carboniferous and Early Permian in the major part of this area. The exception is here the south-eastern Lublin – Lvov part of the platform margin, where the strata were affected by erosion till the Late Jurassic (or even the end of Early Cretaceous in the Volhynia and Podolia region).

Large depth of burial of Carboniferous strata determined the succession in which they were recorded in individual regions. They have been found in Volhynia and Podole as early as the 1930's, in result of search for coal-bearing strata carried out by J. Samsonowicz. He continued these studies in the Lublin region in the 1950's, at first with H. Makowski and, thereafter K. Korejwo. Along with the progress in drilling works in this region, a large team of the Geological Institute, especially its Upper Silesian Branch (K. Bojkowski, A. Jachowicz, Z. Dembowski, J. Porzycki, T. Migier, and others including the Author) began to participate in these studies. Soon also H. Kmiecik, Ł. Musiał and M. Tabor and other researchers joined the team. The studies made it possible to state that the Carboniferous section comprises Visean-Westphalian rocks representing coal-bearing association, and to select area for more accurate works aimed at demonstration of a new coal basin.

Pomerania was the second area in which Carboniferous strata have been found, and along with increase in inflow of new data from the Geological Institute and oil industry drillings, the group of researchers studying the Carboniferous was growing to comprise K. Korejwo, H. Krawczyńska-Grocholska, H. Matyja, E. Turnau, B. Żbikowska, R. Dadlez, and others including the Author. The Carboniferous section of Pomerania was soon found to differ from that of the Lublin region and also those of Rügen and Mecklenburgia (10, 11). The Pomeranian Carboniferous is bipartite, comprising Dinantian strata overlain by the Middle and Upper Silesian with a gap.

In the last years Carboniferous rocks were also found in area stretching between Pomerania and Lublin region, where they are represented by Upper Silesian coal-bearing association.

It should be also noted that single drillings recorded the Carboniferous developed in associations different than the above (clay and Culm association) south-west of the Teisseyre-Tornquist Zone (TTZ) sensu stricto.

Together with K. Bojkowski and H. Żakowa, the Author analysed data for this zone and compiled lithofacies maps of the Carboniferous of Poland within the frame of the IGCP Project no. 86. The present paper is based on these and other Author's materials (20, 34–39) concerning geology and tectonic of the zone.

This paper presents development of the Carbonifeous in Polish sector of the East-European Platform margin, coinciding with TTZ (32).

TOURNAISIAN AND EARLY VISEAN

In the end of Late Devonian the area stretching along the East-European Platform margin in Poland was characterized by fairly uniform sedimentation. This area represented a marginal, eastern part of a large sedimentary basin. Sections of that part display with varying intensity some sedimentation changes related to a wide regression which started in the end of Devonian to continue in Dinantian. The advancement of that regression appeared different in individual parts of this zone. Some areas such as Pomerania remained within the extent of the basin till the end of Dinantian whereas the Lublin region became emerged and subjected to intensive denudation as early as Early Dinantian to be turned into a new sedimentary basin in Late Dinantian.

Despite of the above, mentioned regressive nature of the basin, Pomeranian sections display a continuity of sedimentation from the Devonian to Tournaisian and even Visean. However, in some places (e.g. vicinities of Koszalin) some sedimentary gaps (which increase towards the north) are recorded in Lower Tournaisian (30, 31, 36, 40) and tuffitic sandstones (Gozd complex) rest directly on Devonian limestones. In the remaining parts of that area (i.e., south and west of Koszalin) H. Matyja (unpub. mat.) recorded continuity of sedimentation from the Famennian to Tournaisian and the Devonian Carboniferous boundary. This change is connected by replacement of carbonate sedimentation prevailing in the Devonian by clay-marly one (40).

Several complexes are differentiated in the Dinantian of Pomerania (5, 36, 40) on the basis of marked differences in lithology. The section begins with a packet of clay or clay-marly rocks assigned to the Sąpólno complex. The strata are overlain by a packet (Kurowo complex) with increased share of limestones, usually oolitic and referable to the facies of oolitic limestones proper. The rocks laterally pass into those of the mixed oolitic facies, comprising both tuffitic sandstones with feldspars (Gozd Complex) and quartz sandstones (Trzebiechów complex). Carbonate-clay rocks with gypsum and anhydrites are assigned to the Grzybowo complex. The Kurów, Gozd, Grzybów and Trzebiechów complex are asigned to the Chmielno supercomplex, interpreted as comprising sediments formed in both littoral and sublittoral zones, i.e. at oolitic shoals and separating depressions. Moreover, some of these sediments originated in proximity of volcanic centres. The Chmielno supercomplex is overlain by, and passing laterally into quartz sandstones and claystones, sometimes with limestones intercalations (Drzewiany complex), also formed in littoral or, partly, sublittoral zone.

The paleontological record (16, 17, 21, 30, 31) makes

possible assignation of the above mentioned strata to the Tournaisian and Lower Visean.

In the southern Pomerania, complex identified in the section include the above mentioned as well as Łobżonka and Nadarzyce complex. The Łobżonka complex comprises clay-sandy and often tuffite rocks and dated at Tournaisian and Lower Visean, and the latter – a packet of claystones resting on the Kurowo complex and dated at the uppermost Visean (Fig. 1).

The Tournaisian comprises strata formed in sublittoral zones of a shallow shelf and, partly, those of neritic zone. The former are characterized by large share of terrigenous material (especially in the vicinities of Koszalin – Ustronie) and often red colour which indicates high intensity of processes of laterization in neighbouring land area. The red colour disappears along with increase in distance from the coast and sediments attain gray to dark-gray colour.

Sediments identical as those of the Kurów complex are found far to the south, at northern margin of the Świętokrzyskie Mts. In that area the borehole Przysucha 1, recorded rocks of the oolitic limestone facies proper with high share of crystoclastic feldspars (38). This indicates similar sedimentary conditions as in Pomerania – a shallow zone with oolitic shoals, situated in proximity of volcanic center.

In the Lublin – Lvov area, SW part of EEP margin was characterized by development different than in Pomerania. In that area the Late Devonian regression resulted in marked narrowing of the basin. In the Late Famennian, margins of the basin were related to the Kock and, along which the sedimentation of terrigenous complexes of red beds with admixture of evaporites (Hulcze Fm.) took place in the latest Famennian (33). West and south of zones of sedimentation of the red beds we find marine sediments of the offshore zone, assigned to the Niedrzwica Fm. and dated at the Upper Devonian (including the Tn_1a zone).

A thin cover of gray limestones and claystones of the Chorevsk suite, found south of the Vladimir Fault, is dated at the Tournaisian (8, 22). The cover evidences an incomplate regression of the Tournaisian sea in that area. A regressive basin with carbonate, and, partly, evaporitic-terrigenous sedimentation existed in the Lublin – Lvov area in the Tournaisian. The basin was presumably smaller than the Late Devonian. It disappeared by the end of this epoch and the area became a land. This was followed by initiation of denudation processes and retreat of the sea from marginal part of EEP far into its foreland. The Lublin – Lvov area became faulted and subjected to erosion varying in intensity from one block to another, but resulting in complete removal of the Tournaisian. It should be also noted that a number of depressions and horsts originated along individual fault zones generally parallel to the platform margin and locally entering into platform areas. Some of these structures are arranged, obliquely to the platform margin (37, 39). The block movements were accompanied by intense volcanic activity, responsible for origin of numerous basaltic dykes and covers dated at the Lower Dinantian.

Paleogeographic reconstructions for the Tournaisian

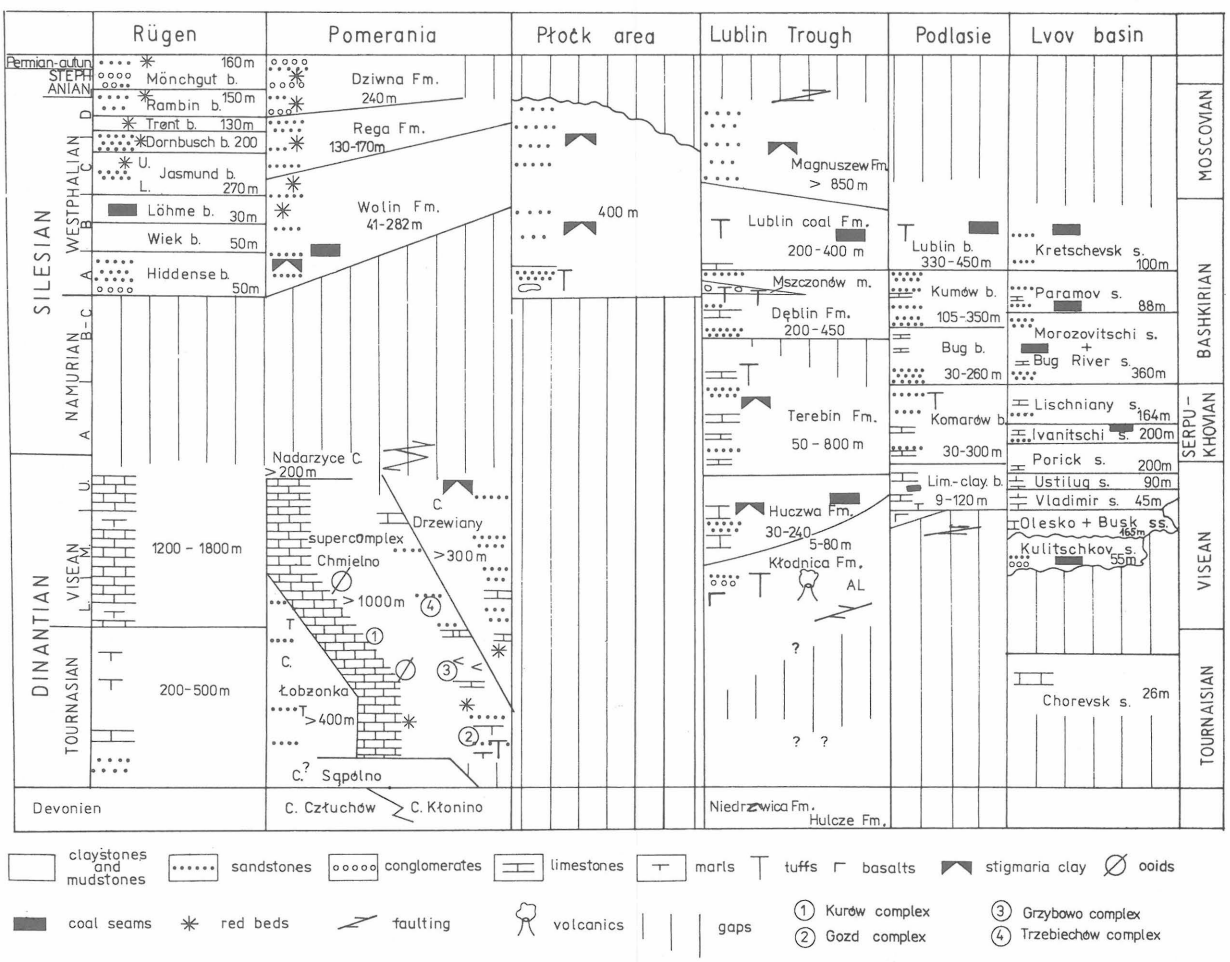

Fig. 1. Correlations of the Carboniferous in SW margin of the East-European Platform

Ryc. 1. Korelacja utworów w SW obrzeżeniu platformy wschodnioeuropejskiej

show vast areas of eastern and north-eastern Poland emerged and subjected to denudation. Karst processes were developing in areas of outcrops of Devonian limestones. The extent of the land was wider than in the latest Devonian. In the Early Tournaisian the Kock and Vladimir fault zones were delineating extent of the sedimentary basin in the south but the subsequent, Late Tournaisian displacements of individual blocks resulted in widening of the land comprising some areas south-west of TTZ. In the north-western part of the country the marginal zone of EEP was overstepped by the Tournaisian embayment which extended through the Peribaltic Syneclise. It became isolated and subsequently the area was affected by uplifting movements (Fig. 2). Coastal line of that basin was oriented obliquely to TTZ, running across southern Baltic and north of Rügen Island towards to Jylland. The intensity of subsiding movements of the basin floor was markedly varying, from high in north-western Poland to almost none in south-eastern Poland and Volhynia, where we may rather speak about predominance of uplifting movements.

The increase in intensity of faulting in the Early Dinantian was accompanied by intense volcanic and subvolcanic phenomena. The latter are evidenced by the record of numerous occurrences of pyroclastic rocks, mainly of the rhyolite type, and lava covers and basaltic dykes or sills. Small microsyenite intrusions also originated at that time (Fig. 2).

Continuation of diastrophic processes resulted in further narrowing of the sedimentary basin from the EEP margin in the Early Visean. Sediments formed at that time in Pomerania represent a continuation of the Tournaisian, reflecting at the same time further shrinkage of the basin throughout the area, except for some places (e.g. Sarbinowo), where there is found an increase in extent of continental sediments. In the Early Visean the sedimentary

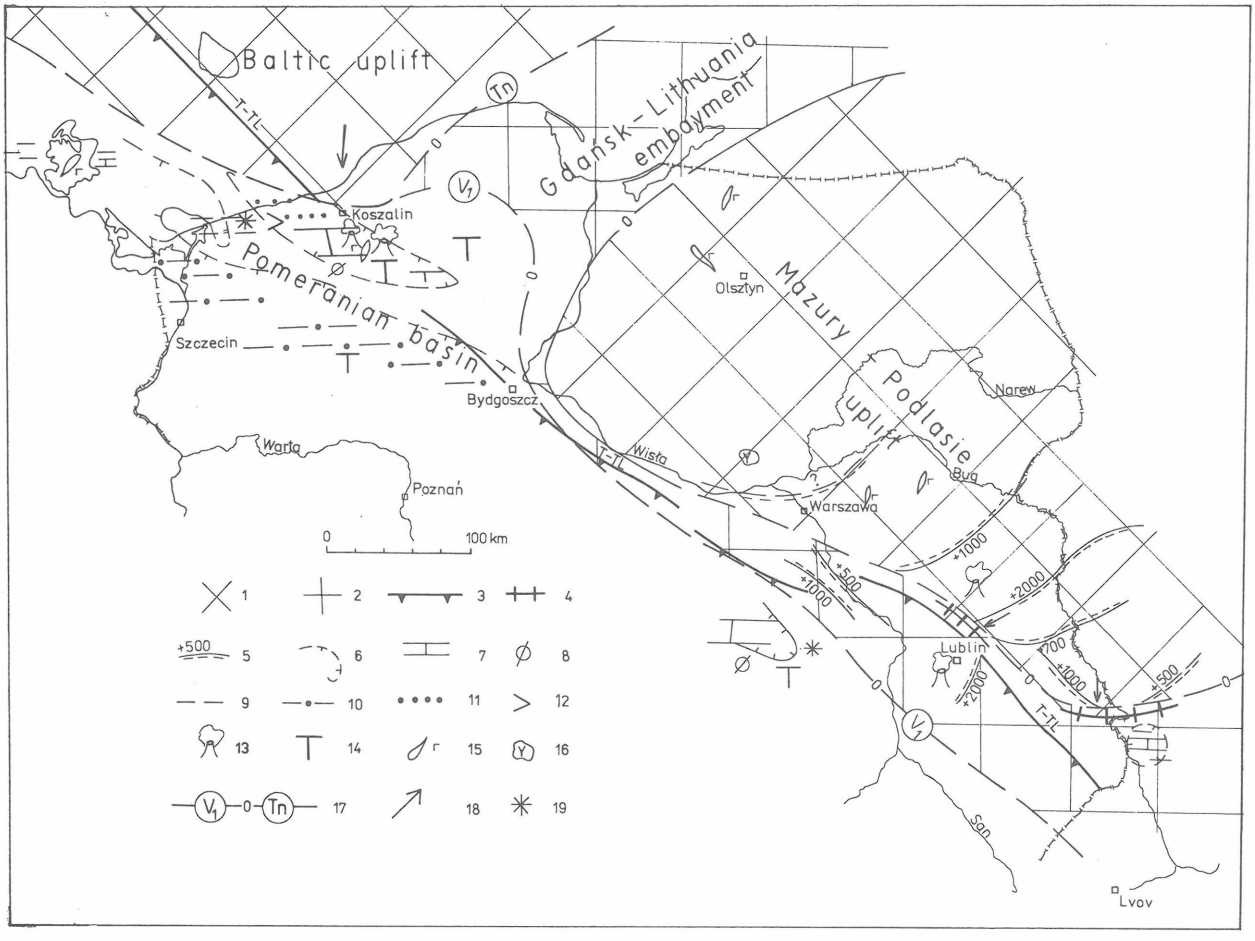

Fig. 2. Paleogeography of the margin of the East-European Platform in the Tournaisian and Early Visean

1 – areas emerged and eroded in Tournaisian, 2 – areas emerged and eroded in Early Visean, 3 – T-TL – Teisseyre-Tornquist Zone, 4 – active fault zones influencing sedimentation in Late Devonian and Tournaisian, 5 – fault lines active in Early Dinantian and the maximum amplitude of downthrow (in m), broken line – downthrown limb, 6 – present extent of Tournaisian and Lower Visean; predominating lithofacies: 7 – limestones, 8 – presence of calcareous oolites, 9 – claystones and mudstones, 10 – sandy-clay rocks, 11 – quartz sandstones, 12 – anhydrites and gypsum, 13 – volcanoes, 14 – tuffs and tuffites, 15 – basaltic dykes, 16 – microsyenite intrusion, 17 – original extent of basin: V_1 – in Early Visean, Tn – in Tournaisian, 18 – direction of transport of terrigenous material from erosion of pre-Carboniferous rocks, 19 – red beds

Ryc. 2. Paleogeografia brzegu platformy wschodnioeuropejskiej w turneju i wczesnym wizenie

1 – wypiętrzony w turneju obszar, stanowiący ląd podlegający denudacji, 2 – wypiętrzone obszary we wczesnym wizenie, powiększające ląd podlegający denudacji, 3 – T-TL przebieg strefy Teisseyre'a-Tornquista, 4 – czynne strefy rozłamowe, wpływające na sedymentację w późnym dewonie i turneju, 5 – linie uskokowe czynne we wczesnym dinancie z podaną maksymalną amplitudą w metrach (linia przerywana oznacza skrzydło zrzucone), 6 – zasięg współcześnie zachowanych osadów turneju i dolnego wizenu, 7 – wapienie, 8 – obecność oolitów wapiennych, 9 – iłowce i mułowce, 10 – skały piaszczysto-ilaste, 11 – piaskowce kwarcowe, 12 – anhydryty i gipsy, 13 – wulkany, 14 – tufy i tufity, 15 – dajki bazaltowe, 16 – intruzja mikrosyjenitu, 17 – pierwotny zasięg basenu: V_1 – we wczesnym wizenie, Tn – w turneju, 18 – kierunek transportu materiału terygenicznego, pochodzącego z erozji skał prekarbońskich, 19 – czerwona barwa osadu

zones of the oolite shoal type became shifted from the vicinities of Chmielno and Karlino southwards as far as the Kamień Pomorski – Czaplinek line. Migration of these zones was accompanied by an onset of formation of a wedge of regressive sandy sediments (Drzewiany complex). The accompanying volcanic activity resulted in origin of basaltic dykes (12, 25). In the remaining parts of the Polish sector of EEP, Visean sediments remain unknown as the areas were emerged and affected by denudation and volcanic processes. The area of the Świętokrzyskie Mts probably belonged to hemipelagic zone and the section comprises a thin packet of clay sediments.

The Early Visean paleogeography was close to the Tournaisian, so it is shown at the same Figure (Fig. 2). A regressive epicontinental basin still existed in NW Poland, acting as a place of sedimentation of littoral and sublittoral sediments. The infill of the basin well displays the regressive stage by southward migration of the wedge of sandy sediments of the Drzewiany complex. The basin extended eastwards beyond TTZ, entering the area of EEP, whereas in SE land area widened beyond TTZ, and form a single Mazury – Podlasie Uplift.

MIDDLE AND LATE VISEAN

A marked change of paleogeographic conditions took place in the Middle Visean. Upper and Middle Visean strata are known from Pomerania and GDR (11, 21, 36). In Pomerania the section comprises strata similar to those of the Lower Visean as sedimentation of oolitic limestones of the Kurów complex and sandy ones of the Drzewiany complex was continuing in these times. In central Pomerania the limestones of the Kurów complex are overlain by claystone packet of Nadarzyce complex. The latter are the youngest rocks of the Dinantian regressive cycle in that region and their deposition was followed in the Namurian by an uplift of the Pomeranian area and denudation.

In SE part of the Polish sector of EEP margin, the area previously affected by uplifting movements gradually began to be comprised by a new sedimentary basin. Margin of that basin was oriented obliquely to TTL. The strongly faulted Lublin – Lvov area became completely peneplenized as early as the Middle Visean although original amplitude of vertical displacements is estimated at 500 to 2000 m. I regard this faulting as due to strike-slip movements along faults parallel to TTL. In the Middle Visean a downwarp of the area began progressively from the south-west and sedimentation of the coal-bearing association began.

In central Lublin area and Podlasie, the Carboniferous section begins with the rocks of Kłodnica volcanogenic formation. The formation comprises basalt lava covers and volcanic agglomerates as well as tuffs and tuffites, characterized by predominance of rocks of the rhyolite type. Lava covers are sometimes intercalated by sandstones and claystones. Basalts, especially basalt tuffs, also display effects of lateritization and a small bauxite deposit has been found (3).

The lithostratigraphy of the Lublin – Lvov Carboniferous was discussed in several papers (4, 8, 20, 22, 27, 28, 38, 39). Table I shows comparisons of the subdivisions.

In the Lublin – Podlasie area, the lowermost part of the section is assigned to the Huczwa Formation. Rocks of that formation are Upper Visean in age, except for the basal ones in south-western part of the area, dated at the Middle Visean. They are overlain by those of the Terebin Fm., Namurian in age in eastern and north-eastern parts of the area or, in the case of the two lower cyclotems, the uppermost Visean in the south-western part. The Huczwa Fm. displays sedimentary cyclicity, reflected by alternations of marine and nonmarine deposits. The former are represented by organogenic and organodetrital limestones of various types, marls, and claystones and mudstones. Limestones predominate along north-eastern boundary of distribution of the formation. Nonmarine parts of cyclothems mainly include claystone-mudstone rocks with stigmari, sometimes with intercalations of quartz sandstones. A few layers of humus coals with summative thickness up to 2 to 3 m were found at north-eastern boundary. Cyclothems of the Terebin Fm. are characterized by strong development of their nonmarine parts (comprising fluvial claystone-sandy sediments) at the expense of the marine ones, mainly built of claystones and with subordinate share of limestones. The strata are traced throughout the Lublin – Lvov area as far as the vicinities of Warsaw, to the Grójec Fault Zone. Further to the north-west they are missing possibly due to pre-Westphalian erosion.

Rocks different than above described were found south of Łódź. They represent flysch association (Culm): alternating sandstones and claystones that are dated at the turn of the Visean and Namurian. The sequence is several hundred metres thick but was not drilled through. Sandstones are poorly sorted and are lithic wackes. Graded bedding is common, and the bottom surfaces of sandstone beds are sharp, often with hieroglyphs. Rare Goniatites indicate marine sedimentary environment. Altogether, these deposits are similar to those of the Fore-Sudetic area.

The above review shows that Upper (and Middle) Visean rocks are highly varying in lithological composition. Carbonate rocks, including organodetrital and oolitic limestones, are fairly common, being accompanied by clay and sandy rocks as well as volcanic ones (lavas and tuffs). A marked decrease in share of limestones in the Upper Visean appears typical for both Pomerania and Lublin – Lvov region, that is areas of origin of limestone associations and carbonate coal-bearing associations, respectively. A similar phenomenon was also found at eastern margin of the Upper Silesian Coal Basin and basement of the Fore-Carpathian Depression. This indicates that a crisis in carbonate sedimentation affected both marginal zone of EEP and areas situated in front of it. The Late Visean was also the time of onset of sedimentation of coal-bearing series, including also one of the most important events of coal-bearing sedimentation in marginal zone of EEP.

All the above described strata are traceable in a zone from the Rügen Island through Pomerania as far as Lvov. They originated beyond the Variscan orogenic zone, in a basin developed in marginal zone of EEP and, partly, areas of the Lower Paleozoic Platform. Deep faults related to TTZ markedly influenced sedimentation and outline of the basin in the Lvov – Lublin area in the Early Dinantian. However they appear untraceable in sedimentary pattern of the Visean, characterized by the course of sedimentary zones oblique to TTZ, i.e. similar as in Pomerania.

The Late Visean paleogeography markedly differed from the Early Visean. NE Poland became turned into a land area and subjected to erosion, and a sedimentary basin with varying rates of subsidence of floor developed at the margin of that land. In NW Poland, where regressive sediments were accumulating, the Late Visean was the time when subsidence gradually began to cease. This

resulted in withdrawal of sea and widening of land area subjected to erosion. In turn, subsidence began to be intensified in the south-east, which resulted in origin of a new sedimentary basin. The subsidence was compensated by sedimentation and under conditions of the environment of coastal plains flooded by sea from time to time.

NAMURIAN

Both the type of sedimentary conditions and paleogeography from the Early Namurian remained similar as above. Land areas subjected to erosion are traced in both NW and NE Poland whereas in the south-east we trace continuation of alternating continental and marine sedimentation, taking place in coastal plains flooded by sea from time to time. Rocks formed under such conditions in the Podlasie – Lublin area are assigned to the Terebin Fm., and in the Lvov part of the basin – to the Porick, Ivanitschi and Lischniany suites. The section mainly comprises clay-mudstone rocks with intercalations of sandstones and, occasionally, limestones. The latter are especially characteristic for eastern Lublin and Lvov areas where they mark margin of sedimentary basin from that time. Thin coal layers are also found in that zone, whereas clay sediments predominate and phytogenic sedimentation appears limited to the stigmaria horizons in western part of the basin.

The whole packet of the Lower Namurian represents rocks formed in a belt of coastal plains. Such sedimentary conditions persisted till the end of Early Namurian, when sedimentation began to be broken. Rocks assignable to the Alportian are missing here (15, 24), which may be due to a break in connections with western European seas. The isolation of the Lublin – Lvov basin may be explained as due to widening of the north-western Polish landmass. The connections became reestablished already in early Late Namurian, which is evidenced by appearance of Goniatites in the Lublin area (15, 18, 19). Lands surrounding the Lublin – Lvov basin were affected by uplifting movements so there took place an increase in supply of terrigenous material. The land situated in NE Poland, i.e. in area of the Baltic-Mazury Elevation, acted as the major source of the material. Rocks formed at that time, mainly fluvial in character, are characterized by a high share of sandstones and conglomerates, and are assigned to the Kumów member of the Dęblin Fm. Their origin was preceded by a stage of strong erosion, which resulted in more or less advanced truncation of those of the Terebin Fm. The erosion was especially intense in NW part of the Lublin area, where older strata became completely removed. The rocks of the channel facies are accompanied by clay-mudstone ones of the flood plain facies, with numerous coal layers especially in the Lvov area. Scarce marine ingressions are reflected by intercalations of clay sediments and thin limestone layers (1, 2).

The Namurian paleogeographic image remained very similar to the Late Visean, despite of marked changes in sedimentation. Large areas of NE Poland were emerged and subjected to erosion and the sedimentary basin with sedimentation of the continental type (except for scarce and short-lasting marine ingressions) was developing obliquely to the platform area.

WESTPHALIAN AND STEPHANIAN

The structural framework of the sedimentary basin from marginal zone of EEP became also changed in the Early Westphalian. The basin widened once more to comprise the area of Pomerania as well as a part of EEP in the south. This resulted in origin of a wide marginal sedimentary zone extending from Rügen Island (10) through Pomerania, Mazowsze and Lublin area as far as the vicinities of Lvov.

In Pomerania, the Westphalian rests on various members of the Devonian and Dinantian. Rocks of the coal-bearing association were found beneath a cover of those of the red beds association in western part of the area. The former are assigned to two formations with reference to differences in shares of sandstones and clay-mudstone rocks. The lower of these formations, Wolin Fm., mainly comprises clay rocks with sandstone intercalations and oversteps older strata to the east and north. The upper, Rega Fm., appears characterized by marked share of sandstones and disappearance of clay-mudstone rocks. The age of these packets still remains poorly known. The Author (36) assigned the two formations to the Westphalian on the basis of palynological data of H. Kmiecik, whereas S. Jachowiczowa (7) assumes that only lower part of the Wolin Fm. belongs to the Westphalian and all the younger strata – to the Stephanian. Westphalian rocks with paleontological record are also known from the vicinities of Koszalin, where they are represented by quartz sandstone with thin intercalations of mudstones with coals, dated at the Westphalian B (30, 31).

The youngest strata known from that region are assigned to the Dziwna Fm. The strata, known from the vicinities of Kamień Pomorski, represent a 240 m complex of red

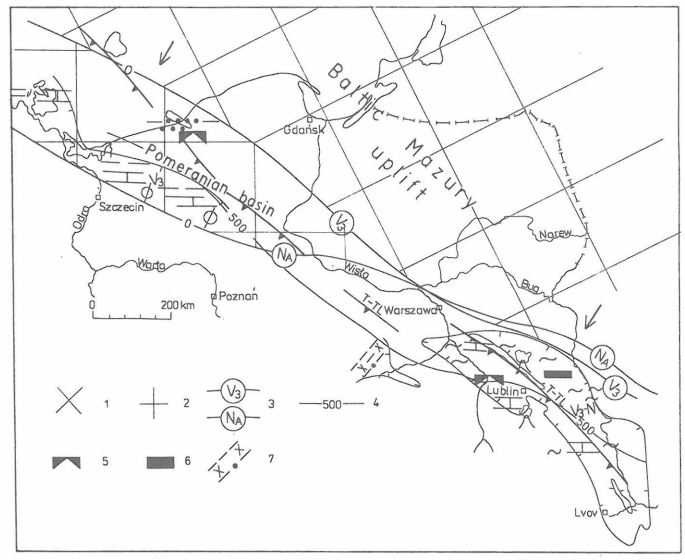

Fig. 3. Paleogeography of the margin of the East-European Platform in the Late Visean and Early Namurian

1 – areas emerged and eroded in Late Visean, 2 – areas emerged and eroded in Early Namurian, 3 – original extent of basin: V_3 – in Late Visean, N_A – in Early Namurian, 4 – paleoisopachytes, 5 – presence of stigmaria horizons, 6 – coals, 7 – flyschoid rocks; other explanations as given in Fig. 2

Ryc. 3. Paleogeografia brzegu platformy wschodnioeuropejskiej w późnym wizenie i wczesnym namurze

1 – obszary wypiętrzone w późnym wizenie, stanowiące ląd podlegający denudacji, 2 – obszar wypiętrzony we wczesnym namurze i powiększający ląd podlegający denudacji, 3 – pierwotny zasięg basenu w: V_3 – w późnym wizenie, N_A – we wczesnym namurze, 4 – paleoizopachyta, 5 – obecność poziomów stygmariowych, 6 – węgle, 7 – utwory fliszoidalne, inne objaśnienia jak na ryc. 2

mudstones with intercalations of sandstones and conglomerates and with fragments of volcanic rocks. They are dated at the Stephanian and, with reservation, Autunian.

Westphalian rocks are also known from area between Toruń and Warsaw (34). In that area they are represented by sandy-conglomeratic rocks with silty-clay intercalations and with numerous fragments of coals and plant remains (including stigmaria). Tuffs and tuffites and conglomerates built of rhyolite and dacite pebbles, known as the Mszczonów Conglomerates Mb. (26), occur at the base of that sequence. The sequence was found to be the thickest (up to 50 m thick) south-west of Warsaw, Both its thickness and size of pebbles of volcanic rocks decrease to the north-east which shows that the source of that material should be looked for outside the area of EEP, in the Variscan orogen. Palynological data show that terrigenous material was also coming from destruction of older Carboniferous rocks (9, 14). A similar phenomenon is also known from the Westphalian of north--western Europe (2).

The Westphalian usually rests directly on the Lower Paleozoic in area from Toruń to the Grójec Fault south of Warsaw (38) and on the Upper Namurian to south-east of that fault. In the latter case the Westphalian/Namurian boundary is drawn within the Kumów member (Beds) of the Dęblin Fm. (23, 24).

Rocks of the Dęblin Fm. are overlain by clay-mudstone ones of the Lublin Fm. (Beds), representing the major coal-bearing formation in the Lublin Coal Basin (6, 27, 28). The latter comprises the uppermost marine horizon, delineating the Westphalian A/B boundary. Higher parts of the section do not comprise any marine intercalations but some horizons with fresh-water fauna only.

No fossiliferous horizons were found in rocks of the Magnuszew Fm., directly overlaying those of the Lublin Fm.

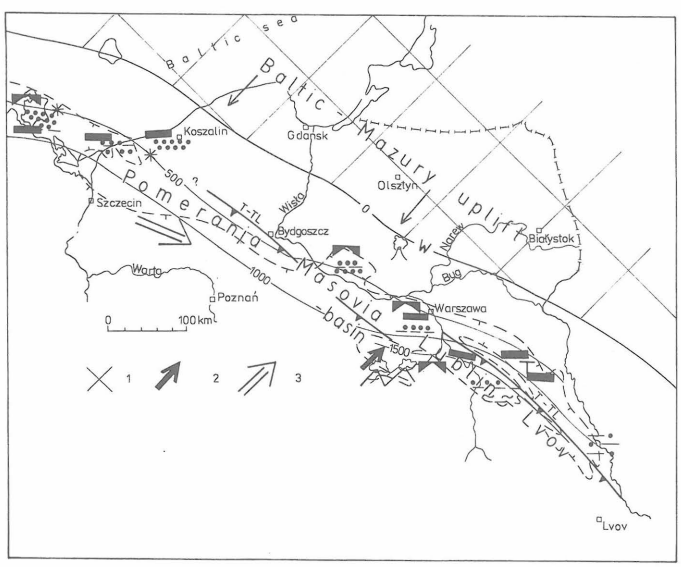

Fig. 4. Paleogeography of the margin of the East-European Platform in the Westphalian

1 – areas emerged and eroded in Westphalian, 2 – direction of transport of volcanic material and material from erosion of Carboniferous rocks older than Westphalian, 3 – direction of fauna' ingression

Ryc. 4. Paleogeografia brzegu platformy wschodnioeuropejskiej w westfalu

1 – obszar wypiętrzony w westfalu, ląd podlegający denudacji, 2 – kierunek transportu materiału wulkanicznego i pochodzącego z niszczonych utworów karbońskich starszych od westfalu, 3 – kierunek ingresji fauny.

The Magnuszew Fm. comprises top part of the Carboniferous section in the Lublin area, i.e. a series with high share of sandstones, often conglomeratic and several hundred m in thickness. The strata, dated at the Westphalian B–C and D, yield numerous older Carboniferous miospores which evidences reworking of the relevant material (38). Distribution of the Westphalian indicates that the sedimentary basin became shifted into the area of EEP.

Rocks of the Magnuszew Fm. represent the youngest Carboniferous in this part of EEP. Their top surface is eroded and overlain by the Permian or Mesozoic. Stephanian strata remain so far unknown here.

Carboniferous rocks found in the borehole Przysucha at northern margin of the Holy Cross Mts are represented by sandstones and mudstones rich in plant remains and dated at the Silesian.

The above discussed Westphalian rocks mark a wide belt of sedimentation of the coal type along SW margin of EEP (see 2, 41) and also NE margin of the sedimentary basin. Material for their origin was supplied from both the area of EEP and orogenic zone. Therefore, it may be expected that a large part of the material was derived from destruction of older Carboniferous sedimentary and volcanic rocks.

In the Lublin region, Westphalian strata were originating in result of fluvial and, partly, limnic sedimentation. The sedimentary basin was still affected by some marine ingressions in the Early Westphalian (A) from the west. Towards the end of the Westphalian denudation of land areas surrounding the basin became intensified, which resulted in increase of rates of sedimentation and isolation of the basin. The basin existed somewhat longer i.e. till the Stephanian in NW Poland. In that area the sedimentation of coal-bearing association became replaced by that of red beds association by the end of the Westphalian.

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The Carboniferous strata nowadays recorded at the margin of EEP represent relics of originally much wider cover. They escaped erosion in depressed zones separated by horsts at which erosion removed them already before the Permian (33, 35, 40). In my analysis of geological structure of the Lublin–Radom area, I arrived at the conclusion that marginal part of the EEP has been affected by strike-slip movements and the origin of the Masovian--Lublin Trough infilled with Carboniferous strata may be best explained in terms of these movements (35, 37, 39).

It also seems that the remaining parts of the EEP margin may be explained in similar way. However, the currently used methods of studies appear insufficient for detail analysis of tectonics of the Permian basement. Nevertheless, the available data clearly show the presence of troughs and horsts built of pre-Permian rocks also outside the Lublin part of the EEP margin (40).

Strike-slip movements along the EEP margin continued with varying intensity from the end of Devonian through Carboniferous (33, 35, 37, 39), resulting in origin of depressions oriented transversally to the margin. Dextral sense of these movements indicates that the Lublin–Lvov basin could have been displaced beyond the front of the Variscan orogen after deposition of Carboniferous infill and a marked part of infill originated from destruction of the orogen. This sense of movements is opposite to large-scale strike--slip movements which took place along the platform margin in Early Paleozoic according to some authors (29). It is possible, that sinistral movements were still taking place in Early Carboniferous, when a number of

depressions and horsts originated at the platform margin. A change in sense of movements could have taken place after collision of Gondvanian and Laurasian continents, i.e. during major Variscan tectonic phases.

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STRESZCZENIE

W szerokim pasie wzdłuż brzegu platformy wschodnioeuropejskiej, który na odcinku polskim przebiega zgodnie

z linią T – T, stwierdzono wierceniami występowanie utworów karbonu. Leżą one na różnych głębokościach. Grubość utworów nadległych waha się od kilkuset metrów, na obszarze podlasko-lubelskim, do kilku tysięcy metrów na Pomorzu i Kujawach.

W turneju i wczesnym wizenie Polska wschodnia i północno-wschodnia stanowiła ląd podlegający denudacji. Maksymalny zasięg zbiornika we wczesnym turneju ograniczony był na południowym wschodzie przez czynne strefy uskokowe Kocka i Włodzimierza Wołyńskiego. W ciągu turneju w wyniku przemieszczeń poszczególnych bloków – obszar lądowy ulegał poszerzeniu. Zjawiskom tym towarzyszył silny wulkanizm – utworzone zostały pokrywy law bazaltowych i tufy ryolitowe. W Polsce północno-zachodniej istniało morze z sedymentacją ilasto-wapienną. Zbiornik wkraczał dość głęboko na obszar starej platformy, sięgając na obszar Litwy i Łotwy. Również na Pomorzu miała miejsce w turneju silna działalność wulkaniczna (skały tufitowe kompleksu z Gozdu).

W środkowym wizenie nastąpiła zmiana warunków sedymentacji. Na północnym zachodzie kontynuowana była sedymentacja kompleksów znanych z turneju i wizenu niższego. Następowało stopniowe przesuwanie się ku południowi strefy brzegowej, wzdłuż której pojawiały się osady lądowe.

Na odcinku południowo-wschodnim brzegu platformy wschodnioeuropejskiej wypiętrzony dotychczas obszar dostał się stopniowo w zasięg nowego basenu sedymentacyjnego. Silnie zuskokowany obszar lubelsko-lwowski już w wizenie środkowym był całkowicie speneplenizowany. Rozpoczął się okres sedymentacji węglonośnej. W wizenie i wczesnym namurze istniały znaczne wpływy morskie, a od namuru późnego przewagę miała sedymentacja lądowa.

W namurze nastąpiła kolejna zmiana warunków sedymentacji na brzegu platformy. W Polsce północno-zachodniej zapanowały warunki lądowe. Na wypiętrzonym obszarze panowała erozja. Po okresie przerwy w sedymentacji, na początku późnego namuru, basen sedymentacyjny lubelsko-lwowski poszerzył się ku platformie wschodnioeuropejskiej.

W westfalu, obszar Polski północno-zachodniej ponownie znalazł się w zasięgu sedymentacji. Powstawały początkowo utwory asocjacji węglonośnej, w późnym westfalu zastąpione przez skały czerwone. Na obszarze tym utrzymywał się basen sedymentacyjny do stefanu, w którym powstawały utwory asocjacji skał czerwonych. Na południowym wschodzie sedymentacja asocjacji węglonośnej utrzymywała się do końca westfalu. Dopływ materiału terygenicznego w późnym westfalu doprowadził do zakończenia tworzenia węgli.

W westfalu obok platformy wschodnioeuropejskiej, źródłem materiału terygenicznego był także wypiętrzony orogen waryscyjski. W westfalu nastąpił kolejny epizod wulkanizmu kwaśnego. Obecny zasięg utworów karbonu w strefie brzeżnej platformy wschodnioeuropejskiej, na znacznym obszarze, ukształtowany został przed sedymentacją permską. W tym czasie powstały na brzegu platformy rowy tektoniczne wypełnione osadami karbonu. Jednym z nich jest rów mazowiecko-lubelski. Genezę tych rowów wiąże autor z prawostronnymi ruchami przesuwczymi, przypadającymi na późny karbon i wczesny perm.

РЕЗЮМЕ

В широком поясе вдаль берега Восточно-Европейской платформы, который в польском участке расположен вдоль линии Т—Т, буровыми скважинами были обнаружены карбонские отложения. Они находятся на разных глубинах. Мощность покрова колебется с нескольких сот (в подляско-люблинском районе) до нескольких тысяч метров (на Поморье и Куявии).

В турнее и раннем визе восточная и северо-восточная Польша составляла собой континент подвергающийся денудации. Максимальная дальность бассейна в раннем визейском веке была ограничена с юго-востока действующими зонами Коцка и Владимира Волынского. В турнейском ярусе, в результате перемещений отдельных блоков, континент становился всё шире. Этим явлениям сопутствовал сильный вулканизм — образовались покровы базальтовых лав и риолитовые туфы. В северо-западной Польше существовало море с глинисто-известковой седиментацией. Бассейн входил довольно глубоко на территорию древней платформы — на Литву и Латвию. Также на Поморье в турнейском ярусе имела место сильная вулканическая деятельность (комплекс туфогенных пород из Гозда).

В среднем визе изменились условия седиментации. На северо-западе продолжалась седиментация известная из турнейского и нижневизейского веков. Постепенно перемещалась к югу береговая зона, вдоль которой появились континентальные осадки. На юго-восточном участке берега Восточноевропейской платформы выдвинутая до сих пор территория вошла постепенно в пределы нового седиментационного бассейна. Пересеченный многими сбросами люблинско-львовский район уже в среднем визе совсем пенепленизированный. Начался период угленосной седиментации. В визе и раннем намюре наблюдается значительное влияние моря, но с позднего намюра берёт верх континентальная седиментация.

В намюре произошло очередное изменение условий седиментации на берегу платформы. В северо-западной Польше господствовали континентальные условия. На выдвинутой территории происходила эррозия. После седиментационного перерыва, в начале позднего намюра, люблинско-львовский седиментационный бассейн расширялся к Восточно-Европейской платформе.

В вестфальском веке район северо-западной Польши вновь нашёлся в радиусе действия седиментации. Сначала образовались отложения угленосной ассоциации, а в поздном вестфале — красные породы. На этой территории до стефанского века существовал седиментационный бассейн, в котором образовались отложения ассоциации красных пород. На юго-востоке седиментация угленосной ассоциации удерживалась до конца вестфаля. Приток теригенного материала в поздном вестфале стал причиной окончения образования углей.

В вестфале источником теригенного материала был, кроме Восточно-Европейской платформы, также выдвигнутый варисцийский ороген. В вестфале наблюдается очередный эпизод кислого вулканизма.

Современная дальность карбонских отложений в береговой зоне Восточноевропейской платформы на большом участке сформировалась перед пермской седиментацией. На берегу платформы образовались в это время тектонические впадины заполненные карбонскими осадками. Одной из этих впадин является мазовецко-люблинская впадина. Автор связывает генезис этих впадин с правосторонними перемещающими движениями, которые происходили в поздном карбоне и в раннем перме.