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Petrographic and facies characteristics of coal from the Załęże and Ruda Beds (upper Namurian, Westphalian A) in the area of Zebrzydowice; Upper Silesian Coal Basin

Introduction

Currently, drillings in the Upper Silesian Coal Basin are performed sporadically and therefore, the possibility of carrying out tests on core samples is becoming increasingly rare. The advantage of these tests is the ability to describe long core sections representing the coal-bearing formations including multiple coal seams. This gives the opportunity to trace the vertical variation of the coal rank, petrographic composition and facies characteristics in the drilled formations. The disadvantage of research based on material derived from drilling is usually poor yield of the core (especially in case of coal), which to a large extent can alter the results. Therefore, this type of study, at least when it comes to coal petrology, should be considered as inaccurate, while the results should be regarded as approximate. In the period between 2011 and 2012, in the western part of the Upper Silesian Coal Basin in the area of Cieszyn, two boreholes were drilled by NWR KARBONIA S.A. They allowed to identify the geological structure of the area and to test the quality of numerous local hard coal seams. In the studied profiles, the occurrence of magmatic intrusions that led to formation of coked coal seams – in addition to coal and usually associated limno-fluvial formations – has been identified.

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1. The area of research

The Z-1/11 and Z-2/12 drillings are located north of the closed Morcinek coal mine – situated near Cieszyn, close to the Polish-Czech border (Fig. 1). The coal seams in the area are found in the Carboniferous coal-bearing formations within the north-western part of the main basin, which is the central part of the Upper Silesian Coal Basin. The overburden contains the Carpathian Foredeep formations and – locally – Carpathian Mountains formations. The discussed area is cut by numerous faults running in meridional and latitudinal directions, with stratigraphic throws of up to 300 m. Carboniferous formations are dipping to the north or north-west at an angle of 5–25 degrees (Ślaski 2001).

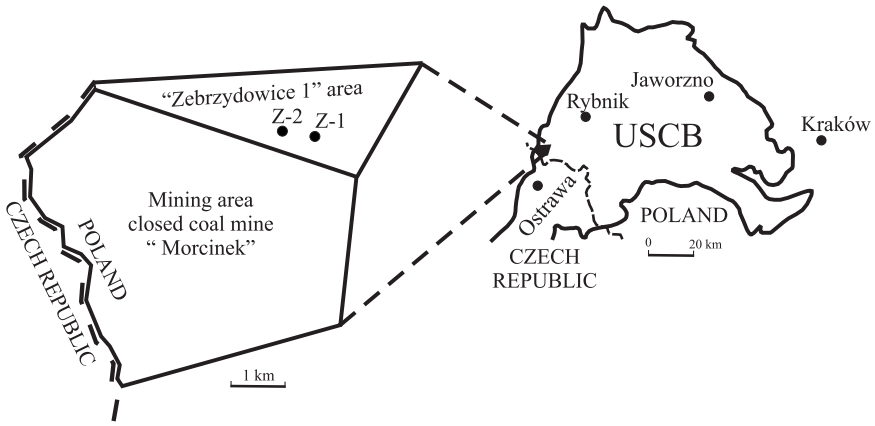

Fig. 1. Localization of The Z-1/11 and Z-2/12 drillings in the Upper Silesian Coal Basin (Ślaski 2001)

Rys. 1. Lokalizacja otworów wiertniczych Z-1/11 i Z-2/12 na terenie GZW (Ślaski 2001)

2. Materials and research methodology

The profiles of examined drillings included the samples of coal occurring in 11 intervals in the Z-1/11 drilling and 14 sections in the Z-2/12 drilling (Fig. 2). When it comes to the Z-1/11 drilling, coal seams indexed from 359/2 up to 405/1 have been found. They occur in the Upper Carboniferous formations, belonging to the mudstone series – the Załęże Beds (Westphalian A / Langsettian). The Z-2/12 drilling, which core is longer, includes coal seams No. 360–406/2 counted into the Załęże Beds accompanied by the seams No. 407/1–407/4 belonging to the Upper Silesian Sandstone Series – Ruda Beds. (Namurian C / Yeadonian). The drilled Carboniferous formations have a thickness of 255 m in the Z-1/11 drilling and 356 m in the Z-2/12 drilling. The coal seams occur among limno-fluvial clay-silty-sandstone sediments. The overburden of the Carboniferous formations includes overlying Miocene and Quaternary sediments. Lithostratigraphy of the Carboniferous formations and the over-

burden in the examined boreholes and the correlation of coal seams have been developed by I. Lipiarski in 2011–2012 – unpublished studies.

The condition of the core, from which the samples for petrographic studies were collected, was variable. In a few cases there were crumbs or coal pieces, while in most cases it was a continuous core, sometimes cracked. From each depth interval, which revealed the presence of coal, a representative coal seam sample has been taken. Each coal sample was crushed and averaged, while grain size fraction <0.1 mm was used to prepare polished

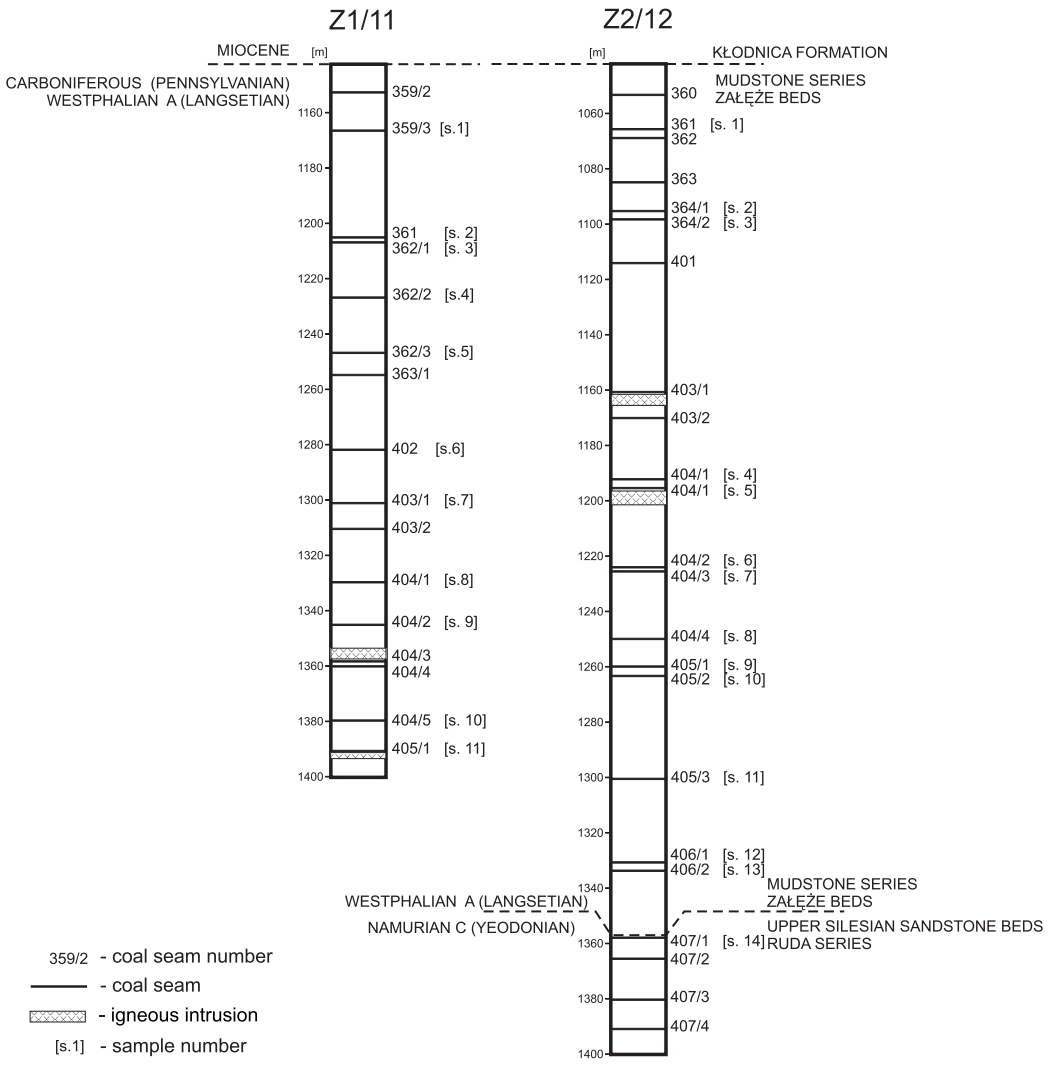

Fig. 2. Schematic profiles of the Z-1/11 and Z-2/12 drillings with the location of the samples used in the petrographic studies

Rys. 2. Schematyczne profile otworów wiertniczych Z-1/11 i Z-2/12 z lokalizacją pobranych próbek do badań petrograficznych

briquettes. Petrographic studies were performed using a polarizing microscope "Axioskop" (Opton) for incident-light fluorescence. What is more, oil immersion objective with a magnification of 50 times was used. On the basis of the classification of hard coal macerals, both qualitative and quantitative petrographic analysis have been done. The amounts of the petrographic components of coal were determined using an Eltinor point-counter, with 500 determinations for each sample, at a given deviation of 0.05 mm. It should be noted that random reflectance was determined for each sample (R_or).

3. Petrographic analyzes of coal and their interpretation

The Z-1/11 drilling

The results of petrographic (Table 1) studies of coal have shown, that the highest content of mineral matter – 53.4%, mainly in the form of clay with a small amount of sulfides, can be found in the No. 404/5 seam. Such a high content of mineral matter – over 50% – indicates carbonoceus shale seam. High content of mineral matter – 25.9% – can be found in the No. 404/1 seam. The No. 404/2 seam includes 17% clay and sulfides. The mineral matter content of the remaining seams is below 10%. When it comes to coal components, the dominant role is played by the macerals from the vitrinite group, ranging from 39.9% (The 404/5 carbonoceus shale seam) up to 71.2% (The 362/3 seam). Of this group, the most frequently occurring macerals are collodetrinite and collotelinite. Macerals from the inertinite group range from 6.3% (The 404/5 seam) to 35.6% (The 362/1 seam) while the most common include fusinite, semifusinite, funginite and inertodetrinite. The high content of inertinite in some of the tested samples is worth noting. In the samples from the No. 362/1 seam and 362/2 seam, inertinite content is above 30%. The lowest share, in the range from 0.4% (The 404/5 seam) to 7.1% (The 362/3 seam), belongs to the macerals from the liptinite group. The most common maceral in this group is microsporinite.

It should be noted, that the natural coke with melted porous substance has been found in the sample No. 11 from the seam No. 405/1. The coking mass has granular mosaic structure, while the pores are of oval shape and different sizes (usually in the range of 10–50 mm). Occasionally (in amounts up to a few percent), funginite and fusinite, which were not coked, can be observed in the samples.

Random reflectance (R_or) of collotelinite ranges from 0.78% (The No. 359/3 and 362/3 seams) up to 0.84% (The 404/5 seam). However, random reflectance of all of the tested samples is 0.81%. Measured values indicate the coal rank equivalent to gas coal type 33.

The Z-2/12 drilling

The highest content of mineral matter, 50.2%, mainly in form of clay with a small amount of sulfides (Table 2), can be found in the No. 407/1 seam. Such a high content of mineral matter – over 50% – indicates carbonoceus shale seam. High content of mineral matter – amounting to 30% – can also be found in the No. 405/3 seam. The seams No. 364/2, 404/4

TABLE 1

The results of petrographic analysis of coal from the Załęże beds and vitrinite reflectance measurements in the Z-1/11 drilling

TABELA 1

Wyniki analiz petrograficznych i wartości wskaźnika refleksyjności witrynitu węgla z warstw załęskich w otworze Z-1/11

Sample number	The depth of the seams floor [m]	Thickness of the coal seams [m]	Coal seam number	Vitrinite						Liptinite					Inertinite							Mineral matter			Total				Reflectance ($R_o r$)
				telinite	colotelinite	colodetrinite	vitrodetrinite	corpogelinite	gelinite	microsporinite	macrosporinite	cutinite	resinite	liptodetrinite	fusinite	semifusinite	macrinite	micrinite	funginite	secretinite	inertodetrinite	clay minerals	sulphides	carbonates	vitrinite	liptinite	inertinite	mineral matter	
1.	1 167.8	1.85	359/3	1.0	43.9	20.2	2.2	1.9	1.0	3.2	0.3	0.6	0.3	0.3	5.4	2.6	1.6	0.0	3.5	0.0	5.8	5.8	0.3	0.0	70.2	4.8	18.9	6.1	0.79
2.	1 205.2	2.10	361	0.9	40.9	22.6	3.0	0.4	0.0	2.6	0.0	0.9	0.9	0.4	4.3	3.4	3.8	0.0	4.3	0.0	5.1	5.5	1.3	0.0	67.7	4.7	20.9	6.8	0.80
3.	1 207.3	1.26	362/1	0.0	24.4	28.3	0.0	2.2	1.7	3.3	0.0	0.6	0.6	0.6	6.7	13.3	3.9	0.0	5.0	0.0	6.7	2.8	0.0	0.0	56.7	5.0	35.6	2.8	0.80
4.	1 227.0	1.32	362/2	2.7	29.1	23.2	1.4	1.4	0.9	4.1	0.0	0.0	0.5	0.5	3.6	7.7	3.6	0.0	8.2	0.0	10.0	3.2	0.0	0.0	58.6	5.0	33.3	3.2	0.82
5.	1 247.5	1.06	362/3	0.9	25.2	43.4	0.4	0.9	0.4	3.5	0.4	0.4	2.2	0.4	2.7	2.7	0.4	0.0	3.1	0.0	8.0	3.1	1.8	0.0	71.2	7.1	16.8	4.9	0.79
6.	1 282.9	1.35	402	0.0	19.7	42.6	1.1	0.5	1.1	3.3	0.0	0.0	0.5	0.0	8.2	1.6	0.5	0.0	7.1	0.0	7.1	4.4	2.2	0.0	65.0	3.8	24.6	6.6	0.80
7.	1 301.6	2.38	403/1	0.7	19.9	42.9	0.3	0.3	0.7	2.0	0.3	0.3	2.0	0.3	5.1	3.7	2.4	0.7	3.0	0.0	9.5	4.7	1.0	0.0	64.9	5.1	24.3	5.7	0.81
8.	1 329.5	2.74	404/1	0.3	17.6	34.8	3.1	0.3	0.0	1.4	0.0	0.3	1.7	0.0	3.4	2.8	2.4	0.7	1.4	0.0	3.8	23.8	2.1	0.0	56.2	3.4	14.5	25.9	0.81
9.	1 345.4	1.60	404/2	0.0	21.5	39.5	5.5	2.0	2.0	1.5	0.5	0.0	1.0	0.5	3.0	2.0	1.0	0.0	1.5	0.0	1.5	16.5	0.5	0.0	70.5	3.5	9.0	17.0	0.82
10.	1 379.0	2.00	404/5	0.0	10.3	22.1	5.1	1.2	1.2	0.4	0.0	0.0	0.0	0.0	0.8	0.8	0.4	0.0	1.2	0.0	3.2	51.4	2.0	0.0	39.9	0.4	6.3	53.4	0.84
11.	1 391.7	2.54	405/1	Natural coke: – 94,5 %, fuzinite + funginite – 5,5%																									

TABLE. 2

The results of petrographic analysis of coal from the Załęże and Ruda Beds, and vitrinite random reflectance measurements in the Z-2/12 drilling

TABELA 2

Wyniki analiz petrograficznych i wartości wskaźnika refleksyjności witrynitu węgla z warstw załęskich i rudzkich *s.s.* w otworze Z-2/12

Sample number	The depth of the seams floor [m]	Thickness of the coal seams [m]	Coal seam number	Vitrinite						Liptinite					Inertinite							Mineral matter			Total				Reflectance (R_or)
				telinite	colotelinite	colodetrinite	vitrodetrinite	corpogelinite	gelinite	microsporinite	macrosporinite	cutinite	resinite	liptodetrinite	fusinite	semifusinite	macrinite	micrinite	funginite	secretinite	inertodetrinite	clay minerals	sulphides	carbonates	vitrinite	liptinite	inertinite	mineral matter	
pr.1	1 066.90	1.35	361	2.3	25.0	25.8	2.7	2.3	1.5	6.1	0.1	0.8	0.8	0.1	6.4	4.2	1.1	0.8	4.9	0.1	7.2	6.8	1.1	0.0	59.5	7.8	24.7	8.0	0.8
pr.2	1 095.78	1.13	364/1	0.0	25.0	39.2	1.6	2.2	1.6	6.5	0.0	0.2	1.1	0.2	4.4	2.7	0.2	1.6	7.1	0.0	2.2	4.4	0.0	0.0	69.6	7.9	18.1	4.4	0.8
pr.3	1 097.29	1.04	364/2	1.7	18.4	25.6	2.5	2.5	5.0	4.2	0.8	0.0	0.0	0.1	4.2	4.6	2.1	1.7	3.8	0.1	5.4	15.5	0.8	0.8	55.7	5.2	21.9	17.2	0.82
pr.4	1 192.00	1.00	404/1	Natural coke: – 96 %, fuzinite + funginite – 4%																									
pr.5	1 194.00	1.10	404/1	Natural coke: – 94 %, fuzinite + funginite – 6%																									
pr.6	1 223.00	1.10	404/2	0.2	39.4	34.7	0.0	0.2	1.1	1.6	0.2	0.0	0.2	0.2	4.7	5.3	0.2	0.2	4.2	0.2	5.8	1.1	1.1	0.0	75.4	2.0	20.4	2.1	0.84
pr.7	1 226.15	1.74	404/3	0.9	23.4	40.5	0.1	0.1	0.9	4.1	0.1	0.0	0.0	0.1	3.7	7.8	0.1	0.9	4.1	0.0	10.6	2.3	0.0	0.0	66.0	4.4	27.3	2.3	0.79
pr.8	1 249.64	2.05	404/4	0.2	12.7	37.4	1.2	1.7	3.5	1.2	0.0	0.0	0.0	0.2	6.9	8.1	1.2	1.7	4.6	0.0	9.2	10.4	0.2	0.0	56.5	1.3	31.6	10.5	0.82
pr.9	1 259.00	1.75	405/1	0.2	19.7	50.2	0.2	1.9	3.2	3.2	0.0	0.2	1.3	0.2	3.2	2.5	0.6	0.2	4.4	0.0	5.7	1.9	0.0	1.3	75.3	4.8	16.7	3.2	0.84
pr.10	1 263.27	0.90	405/2	0.0	21.4	31.0	3.4	3.4	2.8	2.8	0.2	0.0	0.0	0.2	6.8	6.2	1.1	0.2	1.7	0.0	4.0	14.7	0.0	0.2	62.1	3.2	19.9	14.8	0.87
pr.11	1 310.48	1.43	405/3	1.8	19.3	24.2	3.1	1.0	1.3	0.5	0.0	0.0	0.1	0.1	4.9	5.4	0.1	0.0	3.3	0.0	4.9	26.3	0.1	3.6	50.7	0.7	18.6	30.0	0.86
pr.12	1 329.75	2.31	406/1	1.7	19.3	31.5	1.1	1.7	2.8	3.9	0.2	0.0	0.2	0.0	5.0	14.4	0.2	1.1	3.9	0.0	10.0	3.3	0.0	0.0	58.0	4.2	34.4	3.3	0.90
pr.13	1 333.67	1.25	406/2	0.2	9.3	36.0	1.9	1.9	1.2	3.7	0.2	0.0	0.0	0.0	7.5	13.1	1.2	1.2	6.8	0.6	11.2	2.5	1.2	0.2	50.5	3.9	41.6	3.9	0.90
pr.14	1 357.00	1.33	407/1	0.0	5.9	22.7	4.9	2.7	0.2	1.1	0.2	0.0	0.2	0.0	3.8	3.2	1.6	0.2	1.6	0.0	1.6	45.4	2.2	2.7	36.3	1.4	12.0	50.2	0.91

and 405/2 include 17.2%, 10.5% and 14.8% clay and sulfides, respectively. The mineral matter content of the remaining seams is below 10%. When it comes to coal components, the dominant role is played by the macerals from the vitrinite group, ranging from 36.3% (the No. 407/1 seam) to 75.4% (the No. 404/2 seam). The most common macerals in this group include collotelinite and collodetrinite. The macerals from the inertinite group, most strongly represented by fusinite, semifusinite, funginite and inertodetrinite, range from 12% (the No. 407/1 seam) to 41.6% (the No. 406/2 seam). Inertinite content in the samples from the 406/2, 406/1 and 404/4 seams is above 30%. The macerals from the liptinite group are the least represented in the tested coal, ranging from 0.7 % (the No. 405/3 seam) to 7.9% (the No. 364/1 seam). The most common maceral of this group is microsporinite.

The natural coke (Fig. 3) with melted porous substance has been found in the samples no. 4 and 5 from the No. 404/1 seam. The coking mass has granular mosaic structure, while the pores are of oval shape and different sizes (usually in the range of 10–50 mm). Occasionally (in amounts up to a few percent), funginite and fusinite , which were not coked, can be observed.

Random reflectance ($R_o r$) of collotelinite ranges from 0.79% (the No. 404/3) to 0.91% (the No. 407/1). Meanwhile, random reflectance of all of the tested samples is 0.84%. Measured values indicate the coal rank corresponding to gas coal type 33.

Basing on the results of the analysis of coal from the Z-2/12 and Z-1/11 boreholes, the projection of the basic parameters characterizing the quality of coal according to the International Classification of In-Seams Coal (International 1998) has been shown in the diagram (Fig. 4). On the basis of petrographic composition, the tested coal is defined as

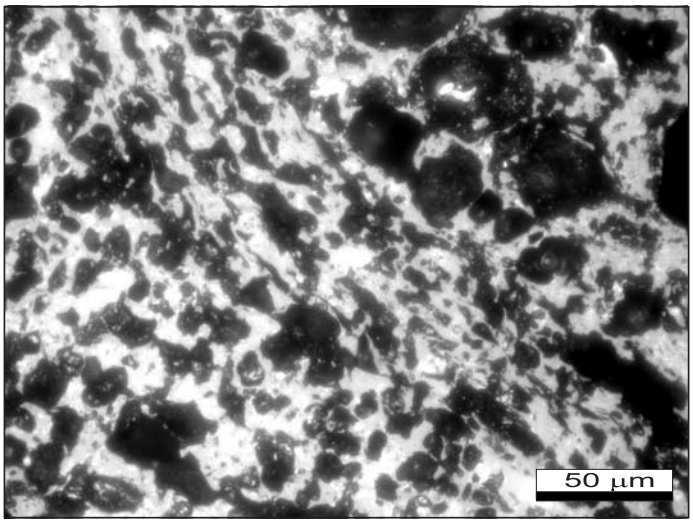

Fig. 3. Natural coke from the No. 404/1 seam, the Z-2/12 drilling
(immersion objective, polarized light – reflected)

Rys. 3. Koks naturalny z pokładu 404/1, otwór Z-2/12
(obiektyw immersyjny, światło spolaryzowane – odbite)

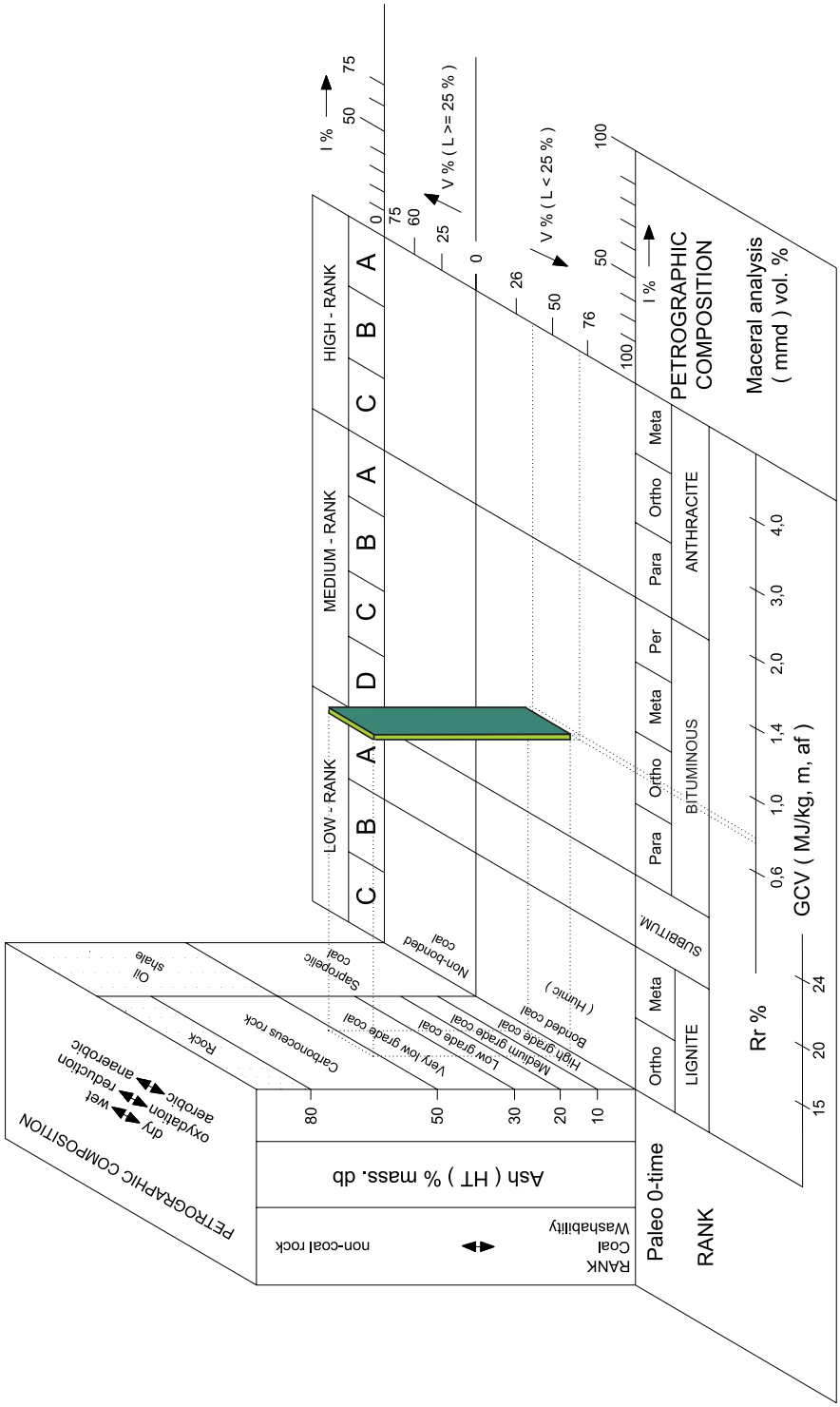

Fig. 4. The quality of coal from the seams in the Z-1/11 and Z-2/12 drillings according to the ECE-UN In Seam Coal Classification

Rys. 4. Jakość węgla z pokładów nawierconych w otworach Z-1/11 i Z-2/12 według klasyfikacji węgla w pokładzie (ECE-UN In Seam Coal Classification)

humic coal, as the macerals from the liptinite group do not exceed 25%. The content of the macerals from the vitrinite group is between 36.3 and 75.4%, while for the macerals from the vitrinite group this value ranges from 6.3 up to 41.6%. On the basis of the rank of coal, measured using the random reflectance (R_or), between 0.78 and 0.84% for coal from the seams from the Z-1/11 drilling and between 0.79 and 0.91% for coal from the seams from the Z-2/12 drilling, the coal has been identified as medium-rank C (ortho-bituminous). The content of mineral matter, transformed into ash after coal combustion, is highly variable. In the seams from the Z-1/11 drilling, this content ranges from 2.8 to 53.4%, while in case of the seams from the Z-2/12 drilling it is between 2.1 and 50.2%.The amount of ash after the combustion of coal is approximately double that of the mineral matter content found in the petrographic studies when this amount is up to several percent (Ward 2002). Ash content and mineral matter content measured under the microscope are similar when their content is several dozen %. Therefore, in terms of ash content, coal from the individual seams has a very high variability (Mucha, Wasilewska 2005), ranging from high grade coal through medium-low-very low grade coal up to carbonoceus rock.

4. Facies characteristics of coal seams

Facies analysis of coal from the seams in the tested interval of the Załęże Beds in the Z-1/11 drilling and both the Załęże and Ruda Beds in the Z-2/12 drilling was done on the basis of petrographic studies. Maceral composition analysis was performed on the basis of the formulas and facies diagrams as suggested by Diessel (1986). The calculated parameters presented in facies diagrams (Fig. 5, 6) allow to formulate the following conclusions.

The Z-1/11 drilling

The paleo-peat-bogs of the coal seams No. 404/5, 404/2 and 404/1 (sample 10, 9 and 8) were located between swamp forest and lake environment. The peat accumulated under high floods, as indicated by high values (around 10) of gelification index GI. The high content of clay in the No. 404/5 seam suggests periodic peat lands flooding. The plant material was derived mainly from herbaceous plants, as evidenced by the low amount of telovitrinite in petrographic composition of coal, which also translates into low (below 1) preservation of plant tissue (TPI). The paleo-peat-bogs of the coal seams No. 403/1, 402, and 362/3 (sample 7, 6 and 5) were located between swamp forest and lake environment according to the Diessel's diagram (1986). Peat accumulated under high floods, as indicated by high values (between 4 and 5) of gelification index GI. The plant material was derived mainly from herbaceous plants, as evidenced by the low amount of telovitrinite in petrographic composition of coal, which also translates into low (below 1) preservation of plant tissue (TPI). The paleo-peat-bog of the coal seams No. 362/2, 362/1, 361 and 359/3 (sample 4, 3, 2, and 1) was located in the swamp forest environment according to the Diessel's diagram

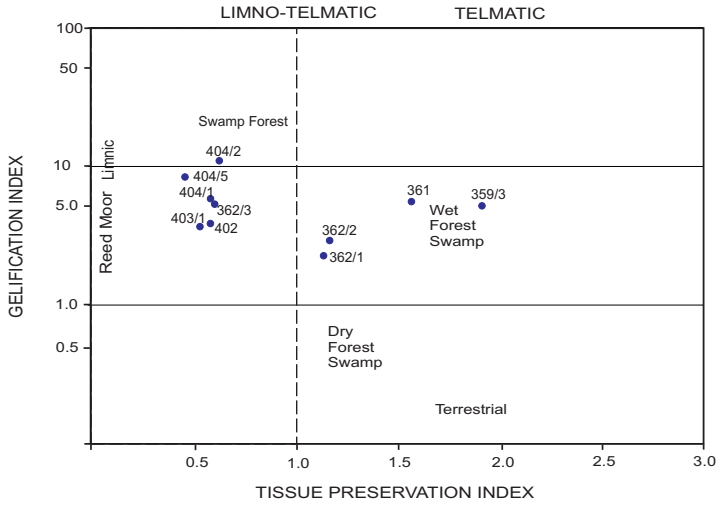

Fig. 5. Facies characteristics of the examined coal seams from the Z-1/11 drilling in the Diessel's diagram (1986)

Rys. 5. Wskaźniki facjalne badanych pokładów węgla z otworu Z-1/11 na diagramie Diessel'a (1986)

(1986). This suggests, that the peat accumulated under high floods – as evidenced by high values (between 3 and 5) of gelification index GI. The plant material was derived mainly from the ligneous plants, as evidenced by the high content of telovitrinte in petrographic composition of coal, which also translates into low (below 1) preservation of plant tissue (TPI).

The Z-2/12 drilling

The paleo-peat-bogs of the coal seams No. 405/1 and 364/1 (sample 9 and 2) were located between swamp forest and lake environment. Peat accumulated under high floods, as indicated by high values (around 10) of gelification index GI. The plant material was derived mainly from herbaceous plants, as evidenced by the low amount of telovitrinite in petrographic composition of coal, which also translates into low (below 1) preservation of plant tissue (TPI). The paleo-peat-bogs of the coal seams No. 407/1, 406/2, 406/1, 405/2, 404/4, 404/3 and 364/2 (sample 14, 13, 12, 10, 8, 7 and 3) were located between swamp forest and lake environment according to the Diessel's diagram (1986). Peat accumulated under high floods, as indicated by high values (in range between 2–5) of gelification index GI. The high content of clay in the seams 407/1, 405/3 405/2, and 364/2 indicates periodic flooding of peat lands. The plant material was derived mainly from herbaceous plants, as evidenced by the low amount of telovitrinite in petrographic composition of coal, which also translates into low (below 1) preservation of plant tissue (TPI). The paleo-peat-bog of the coal seams No. 405/3, 404/2 and 360 (sample 11, 6 and 1) was located in the wet forest swamp environment according to the Diessel's diagram (1986). It suggests, that the peat accumulated under high floods – as evidenced by high values (between 3 and 5) of

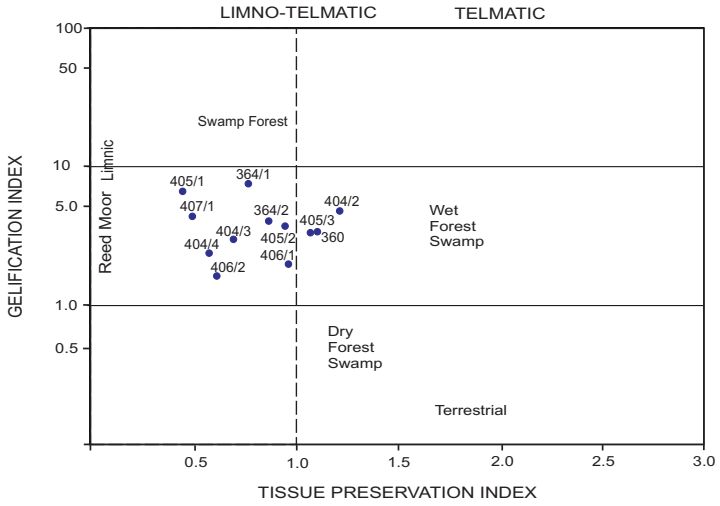

Fig. 6. Facies characteristics of the studied coal seams from the Z-2/12 drilling in the Diessel's diagram (1986)

Rys. 6. Wskaźniki facjalne badanych pokładów węgla z otworu Z-2/12 na diagramie Diessel'a (1986)

gelification index GI. The plant material was derived mainly from the ligneous plants, as evidenced by the high content of telovitrinte in petrographic composition of coal, which also translates into low (below 1) preservation of plant tissue (TPI).

Summary

Petrographic studies of coal seams from the Z-1/11 and Z-2/12 drillings allowed to identify the rank of coal on the basis of reflectance measurements. Random reflectance (R_or) of collotelinite in the Z-1/11 drilling ranges from 0.79% to 0.84%. Random reflectance of all of the tested samples is 0.81%. Random reflectance (R_or) in the Z-2/12 drilling ranges from 0.79% up to 0.91%. Random reflectance of all of the tested samples is 0.84%. Measured values indicate the coal rank which corresponds to – according to Polish standard PN-82/G-97002 – gas coal type 33.

According to the International Classification of In-Seam Coal, and therefore on the basis of petrographic composition, the coal from both boreholes has been identified as humic coal. The content of the macerals from the liptinite group does not exceed 25%. The content of the macerals from the vitrinite group varies between 36.3–75.4%, while the macerals from the inertinite group are between 6.3–41.6%. On the basis of the rank of coal, measured using the random reflectance (R_or), the coal has been identified as medium-rank C (ortho--bituminous). In terms of ash content, coal from the individual seams has a very high variability, ranging from high grade coal through medium-low-very low grade coal up to carbonoceus rock.

The natural coke with melted porous substance has been identified in the No. 405/1 (the Z-1/11 drilling) and the 404/1 m (the-2/12 drilling) seams. The coking mass has granular mosaic structure, while the pores are of oval shape and different sizes (usually in the range of 10–50 μm). Occasionally (in amounts up to a few percent), funginite and fusinite, which were not coked, can be observed in the samples. The conversion of coal to coke is the result of contact metamorphism at the contact zones between igneous intrusions in the form of microtonalities with a thickness of 2–5 m. The impact of the intrusions on the rank of coal of other coal seams several meters away is not noticeable. The magmatism in this region of Upper Silesian Coal Basin can be observed in the nearby " Morcinek" coal mine (Probierz et al. 1988).

On the basis of the facies analysis, it can be concluded that the paleo-peat-bogs of the coal seams were located between peatland environment and lake environment. The peats accumulated under high floods in the area of Swamp Forest and Wet Forest Swamp environment. The high content of clay in some of the seams suggests periodic peat lands flooding. Facies analysis for the intervals corresponding to the thickness of the individual, thin coal seams is general and can only determine the prevailing environment, which likely was the subject of numerous fluctuations during the process of formation of the seam (Misiak 2006). A detailed facies analysis of the coal seam can be performed only on the samples representing the entire thickness of the deposit (Misiak 2011).

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CHARAKTERYSTYKA PETROGRAFICZNA I FACJALNA WĘGLA Z WARSTW ZAŁĘSKICH I RUDZKICH S.S. (NAMUR GÓRNY, WESTFAL A) W REJONIE ZEBRZYDOWIC; GZW

Słowa kluczowe

Górnośląskie Zagłębie Węglowe, karbon, petrologia węgla, facje

Streszczenie

Odwierty Z-1/11 i Z-2/12 zlokalizowane są na północ od obszaru górniczego zlikwidowanej kopalni Morcinek – usytuowanej koło Cieszyna, przy granicy Polsko-Czeskiej (rys. 1). Pokłady węgla, w tym rejonie, występują w utworach węglonośnych karbonu w obrębie północno-zachodniej części niecki głównej Górnośląskiego Zagłębia Węglowego. W profilach badanych odwiertów opróbowano ławice węgla występujące w 11 interwałach w otworze Z-1/11 i 14 odcinkach w otworze Z-2/12 (rys. 2).

Wykonane badania petrograficzne węgla pozwoliły na oznaczenie stopnia uwęglenia na podstawie pomiarów refleksyjności. Pomierzona refleksyjność średnia ($R_o r$) w otworze Z-1/11 wynosi 0,81%, a w otworze Z-2/12 – 0,84% i wskazuje na zbliżony stopień uwęglenia w obydwu badanych odwiertach, który odpowiada zgodnie z polską normą PN-82/G-97002 węglowi gazowemu o wyróżniku 33.

Zgodnie z *International Classification of In-Seam Coal* na podstawie składu petrograficznego węgiel w obu badanych odwiertach określono jako humusowy. Ze względu na stopień uwęglenia, mierzony wskaźnikiem refleksyjności ($R_o r$) węgiel określono jako *medium-rank C* (orto-bituminous). Pod względem zawartości popiołu węgiel z poszczególnych pokładów lokuje się w bardzo szerokim zakresie zmienności od *high grade coal* poprzez *medium-low-very low grade coal* aż do *carbonoceus rock*.

W pokładach 405/1 (otwór Z-1/11) i 404/1 m (otwórz-2/12) , stwierdzono koks naturalny, w którym obserwuje się stopioną substancję porowatą. Masa koksowa jest o strukturze ziarnistej, mozaikowej, a pory wykazują kształt owalny i zróżnicowane wymiary (najczęściej w przedziale 10–50 μm). Miejscami (w ilości kilu procent) w próbkach obserwuje się fuzynit i funginit, które nie uległy skoksowaniu. Przeobrażenie węgla w koks jest efektem metamorfizmu kontaktowego na styku intruzji magmowych w postaci mikrotonalitów o miąższości 2–5 m

Na podstawie wykonanych badań facjalnych można stwierdzić, że paleotorfowiska pokładów węgla usytuowane były na pograniczu środowisk torfowiskowego i jeziornego. Torfy tworzyły się w warunkach silnego podtopienia w strefie środowisk „Swamp Forest" i „Wet Forest Swamp". Duża zawartość iłu w niektórych pokładach węgla wiąże się z okresowymi (powodziowymi) zalewami torfowisk. Analiza facjalna w odniesieniu do interwałów odpowiadających miąższości poszczególnych ławic węgla ma charakter ogólny i pozwala jedynie określić dominujące środowisko, które prawdopodobnie w trakcie tworzenia się pokładu ulegało licznym fluktuacjom.

PETROGRAPHIC AND FACIES CHARACTERISTICS OF COAL FROM THE ZAŁĘŻE AND RUDA BEDS (UPPER NAMURIAN, WESTPHALIAN A) IN THE AREA OF ZEBRZYDOWICE; UPPER SILESIAN COAL BASIN

Key words

Upper Silesian Coal Basin, Carboniferous, coal petrology, facies

Abstract

The Z-1/11 and Z-2/12 drillings are located north of the closed „Morcinek" coal mine – situated near Cieszyn, close to the Polish-Czech border (Fig. 1). The coal seams in the area are found in Carboniferous coal-bearing formations within the north-western part of the main basin, which is the central part of the Upper Silesian Coal Basin. The profiles of examined drillings included the samples of coal occurring in 11 intervals in the Z-1/11 drilling and 14 sections in the Z-2/12 drilling (Fig. 2).

Petrographic studies of coal seams from the Z-1/11 and Z-2/12 drillings allowed to identify the rank of coal on the basis of reflectance measurements. Random reflectance ($R_o r$) of collotelinite in the Z-1/11 drilling is 0.81%, while in the Z-2/12 drilling it is 0.84%. Measured values indicate similar coal rank in both drillings, which corresponds to – according to Polish standard PN-82/G-97002 – gas coal type 33.

According to the International Classification of In-Seam Coal, and therefore on the basis of petrographic composition, the coal from both boreholes has been identified as humic coal. On the basis of the rank of coal, measured using the random reflectance ($R_o r$), the coal has been identified as medium-rank C (ortho- bituminous). In terms of ash content, coal from the individual seams has a very high variability, ranging from high grade coal through medium-low-very low grade coal up to carbonoceus rock.

The conversion of coal to coke is the result of contact metamorphism at the contact zones between igneous intrusions in the form of microtonalities with a thickness of 2–5 m. The natural coke (Fig. 3) with melted porous substance has been found in the No. 405/1 (The Z-1/11) and No. 404/1 seam (Z-2/12 drillings). The coking mass has granular mosaic structure, while the pores are of oval shape and different sizes (usually in the range of 10–50 μm). Occasionally (in amounts up to a few percent), funginite and fusinite, which were not coked, can be observed. The conversion of coal to coke is the result of contact metamorphism at the contact zones between igneous intrusions in the form of microtonalities with a thickness of 2–5 m.

On the basis of the facies analysis, it can be concluded that the paleo peat-bogs of the coal seams were located between between peatland environment and lake environment. The peats accumulated under high floods in the area of Swamp Forest and Wet Forest Swamp environment. The high content of clay in some of the seams suggests periodic peat lands flooding. Facies analysis for the intervals corresponding to the thickness of the individual, thin coal seams is general and can only determine the prevailing environment, which likely was the subject of numerous fluctuations during the process of formation of the seam.