VERSITA GOSPODARKA SUROWCAMI MINERALNYMI

Tom 28 2012 Zeszyt 4

DOI 10.2478/v10269-012-0034-y

JACEK MISIAK*

Quality of coal from exploited seams in LW "Bogdanka" S.A. (Lublin Coal Basin)

Introduction

Several hundred of boreholes were made on the territory of the Lublin Coal Basin (LCB), for the exploration and documentary purposes. Due to the different concentration of the boreholes resulted from the differentiated exploration works on the most prospective area and because of the possibility of the balanced coal seams occurrence, the state of the reconnaissance varied. The mining area of LW "Bogdanka" S.A. appeared to be the best examined and documented because of the opening –out work provided there, as well as the later exploitation of the coal seams. Numerous chemical and technical analysis have been conducted on the samples taken from the boreholes and excavations to determine the quality of coal. The obtained data allow to determine in a detailed way the quality of the coal and the variability of the some parameters in the analysed area.

1. The characteristic of the deposits exploitation area

The mine LW "Bogdanka" S.A. is located in the territory of the Bogdanka syncline which is an element of a platform part of the Lublin Coal Basin (Fig. 1A). Within the geology of this area there have been recognized the following formations: Quaternary, Paleogene, Cretaceous, Jurassic and Carboniferous. The Westphalian coal-bearing formations of the

* Ph.D. Eng., AGH University of Science and Technology, Faculty of Geology, Geophysics and Environmental Protection, Kraków, Poland; e-mail: misiak@agh.edu.pl

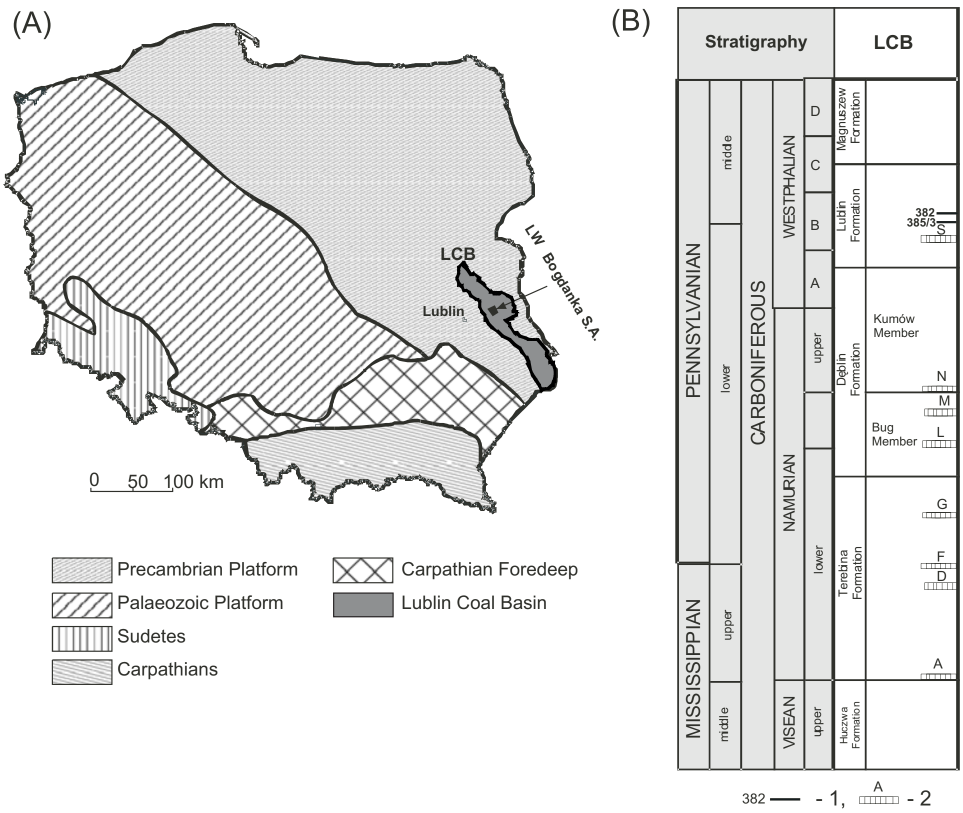

Fig. 1. The location of the research area (A) lithostratigraphy of Carboniferous formation LCB (B)
1 – exploited coal seams, 2 – the horizons of marine limestones

Rys. 1. Lokalizacja obszaru badań (A) i litostratygrafia utworów karbonu LZW (B)
1 – eksploatowane pokłady węgla, 2 – horyzonty wapieni morskich

Lublin Basin are exploited there (Fig. 1B). The thickness of this series is between 43.30 and 408.10 m, and the bottom goes to the depth 750–1115 m. The layers (indexed from 369 to 399) and the coal inserts, in amount between 2 and 49 appear among claystone-sandstone formations. The profile of the discussed above element is well formed in the area of the Bogdanka syncline, where the layers reached the thickness of about 400 m. The coal seams of Lublin formation shows the great variability – maximum 4.10 m of thickness but in the places of leaching and petering they disappear.

2. The type and quality of a mineral

Basing on the chemical and technical analysis of the coal carried out on the samples taken from boreholes and excavations in the area of Lublin Coal Basin there have been given some basic indicators which characterize the coal: W^r, Q_s^{daf}, H^{daf}, C^{daf}, V^{daf}, and RI.

The moisture content in the operating status (W^r) changes from below 2.0% in the south part of the LCB to over 12% in the northern part (Zdanowski 1999). The profiles of the boreholes reveal the variation of W^r values – the deeper the measurement is taken the smaller W^r value is shown.

The caloric value Q_s^{daf} vary from about 27 200 kJ/kg to 37 600 kJ/kg (average value – 33 000 kJ/kg). In the profile of Carboniferous formation Q_s^{daf} shows the increase in its value according to increase in the depth (Zdanowski 2010).

The changes in the carbon content C^{daf} and hydrogen content H^{daf} in the profile Carboniferous formation in the LCB do not show the visible trends (Zdanowski 2010).

The volatiles matter content V^{daf} varies between 27.89% and 45.50%. The variation of V^{daf} in the profile Carboniferous formation in the LCB increases according to the depth and is different than in the Upper Silesian Coal Basin (USCB), where the inverted process is observed – the value of V^{daf} decreases with the depth (Kotas et all. 1983).

Coking property of coal – Rogi index (RI) vary from zero value in the northern part of the LCB to over 85 in the bottom parts of the Carboniferous formation in the central and south areas of the LCB. The increase of the RI is observed according to the depth (Zdanowski 2010). In the area of the LCB there is observed a zone variability of coal occurrence in its different types according to the standard PN-82/G-97002: the zone of coal type 31 in the south part of the LCB, the zone of coal type 32 in the central part, and the zone of coal type 34 in the south-west part of the basin (Zdanowski, Shluga 2008).

The technological properties of coal are characterized by the following parameters: A^d, Q^r_i, S_t^r. The ash content A^d changes from 1.68% to 40.0% (average 13.12%). The main components of the ashes are: SiO_2, Al_2O_3 and Fe_2O_3 which make up about 89% of ash, and the remaining 11% consists of CaO, MgO, Na_2O, K_2O and SO_3. According to the content of the components mentioned above, ashes can be divided into three groups: siliceous, siliceous-ferruginous and ferruginous (Porzycki, Zdanowski 1988).

The calorific value (Q^r_i) depends on the rate of coal carbonification, ash content (A^d) and the total humidity (Porzycki, Zdanowski 1988). This changes within the limits 12 000 and 33 000 kJ/kg and the average value for the basin is 26 00kJ/kg.

The content of sulfur (S_t^r) changes from 0.25% to 13.65% (average 1.89%). The coals of the paralic series contain significantly more sulfur than the coals of the limnic series (Zdanowski 2010).

3. The characteristics of the seams exploited in LW "Bogdanka" S.A.

The seam 382

This is the seam with the same thickness in the south and central part of the area, characterized by a big amount of resources established on the basis of the data from the boreholes, shafts and horizontal mining pits. The coal from this seam shows the following parameters: the ash content (A^d) – 10.02 to 38.47 the average 21.71%, the calorific value ($Q^r{}_i$) – from 18 326 to 28 089 kJ/kg the average 23 826 kJ/kg, the total sulphur content ($S_t{}^r$) from 0.82 to 2.16% the average 1.27%, the types of the coal 31.2 , 32.1, 32.2, 33.

The thickness of this seam (Fig. 2) changes within the range 0,04 to 4,1 m. The biggest thicknesses are observed in the north part of this mining area, on the area of "Bogdanka" field, along the line W-E dividing the mining area into halves. To the south from this line the thickness of the seam drops almost to zero, and then rises reaching the thickness of 0.9 m in the area near the east border of the zone – in the field "Stefanów".

The similar picture shows the map (Fig. 3) picturing the thickness distribution of pure coal (without interlayers). The thickness of the coal is less there by the thickness of the interlayers occurring within the seam (Fig. 4). The total thickness of the interlayers reaching 0.8 m appears in the places where the seam reaches its biggest thickness in the south part of the area. The interlayers are thin or they do not occur in the south part of the area.

The biggest ash content (A^d), reaching 36% is observed in the central part of the seam (Fig. 5).

The content of total sulfur ($S_t{}^r$) in the coal from the 382 seam is changeable (Fig. 6) between the limits 0.7 to 2.3%. The smallest amount of sulfur are observed in the central part of this mining area, but the biggest are observed near its borders and outside the area.

The calorific value ($Q^r{}_i$) depends on the rates of coalification and the content of ashes (A^d), that is why the close link between the distribution of the calorific value and the ash content is visible (Fig.7). The calorific value reaches the biggest values – 29 000 kJ/kg in the areas where the ash content in the lowest while in the areas where this parameter is high, the calorific value drops even to 18 000kJ/kg.

The seam 385/2

This is one of the most regular and the richest seam occurring in the mining area of the LW "Bogdanka" S.A. It is the second seam, where the exploitation is being carried now. The coal from this seam is characterized by the following parameters: the ash content (A^d) 6.36–32.32 the average 18.99%, the calorific value ($Q^r{}_i$) 19 881–30 135 kJ/kg the average 24 661 kJ/kg, the amount of total sulfur ($S_t{}^r$) 0.58–1.83% the average 0.99%, the types of coal – 32.1, 32.2, 33, 34.1, 34.2.

The thickness of this seam (Fig. 8) changes between the limits 0.9 to 2.5 m the biggest thicknesses are reached in the center of the mining area. The thickness decreases in the direction to the borders of the area. The similar view is shown in the map (Fig. 9) showing the distribution of thicknesses of pure coal (without interlayers). The thickness of the coal is less there by the thickness of the interlayers occurring within the seam (Fig.10). The total thickness of the interlayers in the significant part of the area is rather small and reaches 0.2 m. The interlayers are thicker along the west border of the coal deposit.

The biggest ash content (A^d) reaching 36% is observed in the east part of the deposit (Fig. 11).

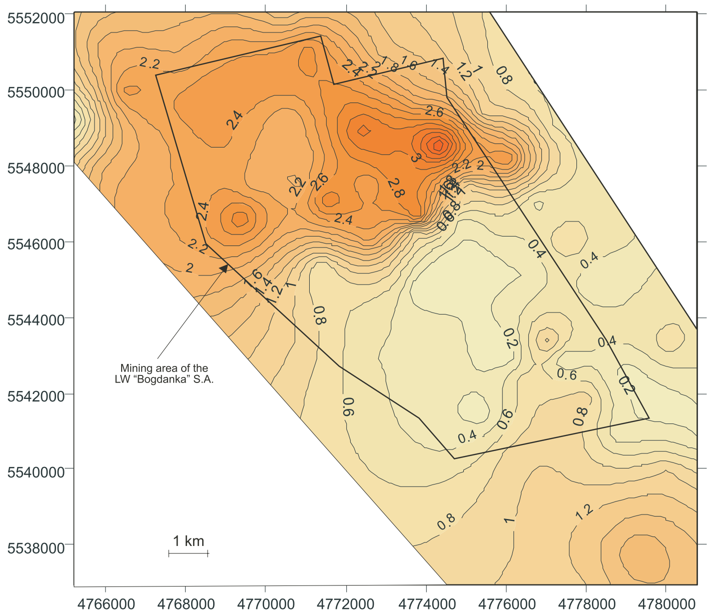

Fig. 2. The thickness of a coal seam 382 in the mining area of LW "Bogdanka", LCB

Rys. 2. Miąższość pokładu węgla kamiennego 382 w obszarze górniczym LW „Bogdanka", LZW

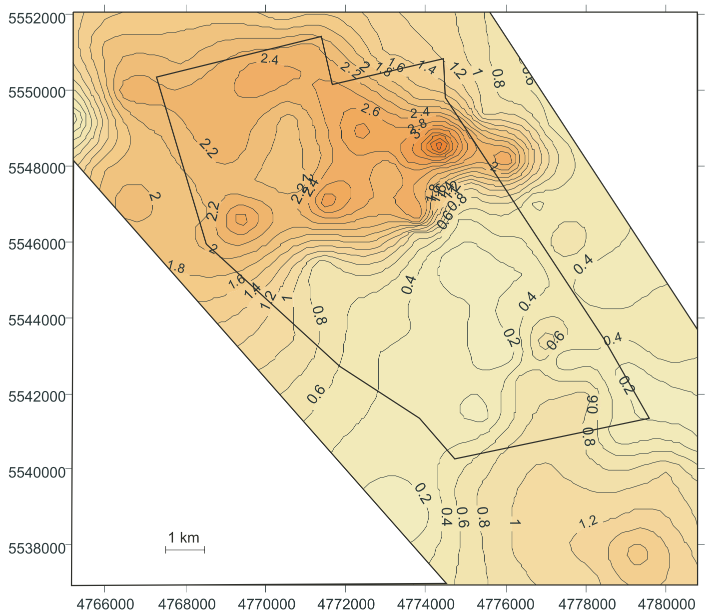

Fig. 3. The thickness of pure coal (without interlayers) in the seam 382 in the mining area of LW "Bogdanka", LCB

Rys. 3. Miąższość czystego węgla (bez przerostów) w pokładzie 382 w obszarze górniczym LW „Bogdanka", LZW

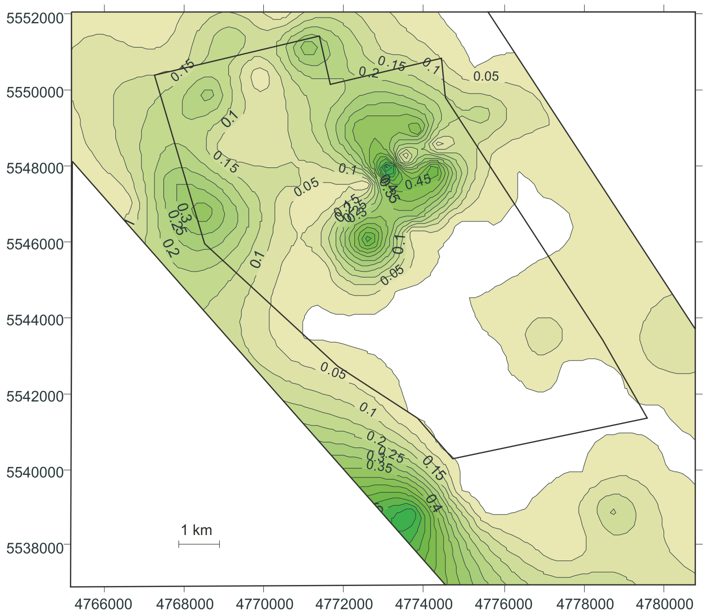

Fig. 4. The thickness of interlayers in the coal seam 382 in the mining area of LW "Bogdanka", LCB

Rys. 4. Miąższość przerostów płonnych w pokładzie węgla kamiennego 382 w obszarze górniczym LW „Bogdanka", LZW

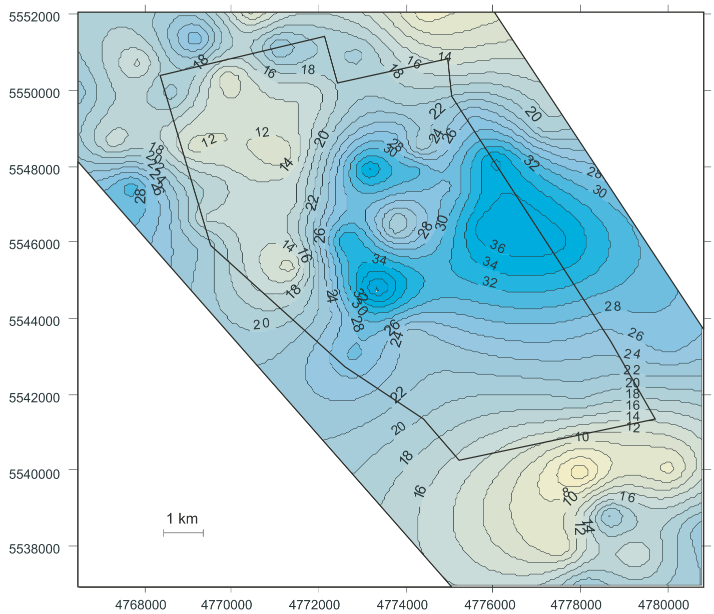

Fig. 5. The ash content of coal in the coal seam 382 in the mining area of LW "Bogdanka", LCB

Rys. 5. Popielność węgla kamiennego w pokładzie 382 w obszarze górniczym LW „Bogdanka", LZW

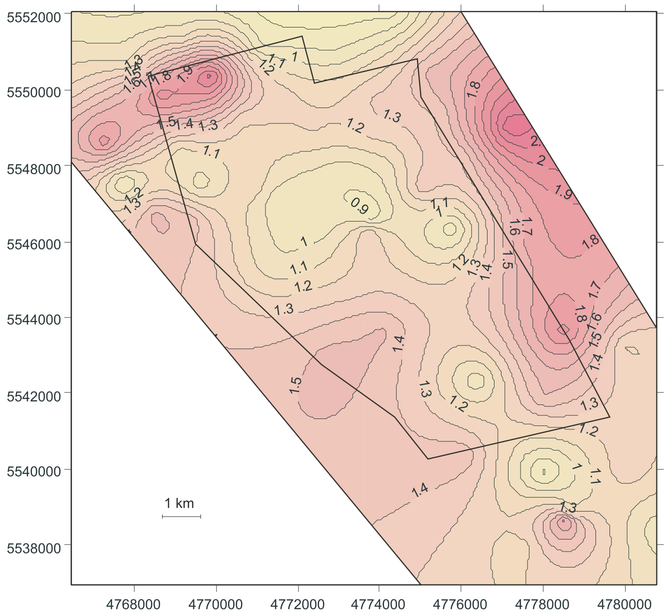

Fig. 6. The content of total sulfur in the coal seam 382 in the mining area of LW "Bogdanka", LCB

Rys. 6. Zawartość siarki całkowitej w pokładzie węgla kamiennego 382 w obszarze górniczym LW „Bogdanka", LZW

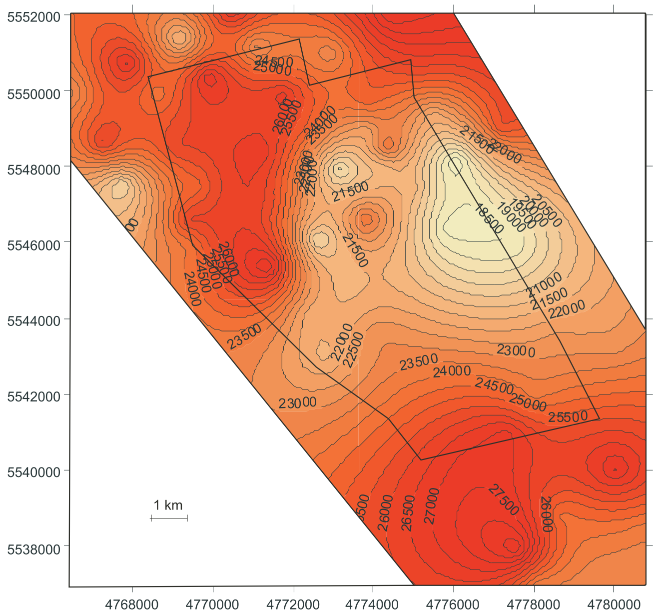

Fig. 7. The calorific value in the coal seam 382 in the mining area of LW "Bogdanka", LCB

Rys. 7. Wartość opałowa węgla kamiennego w pokładzie 382 w obszarze górniczym LW „Bogdanka", LZW

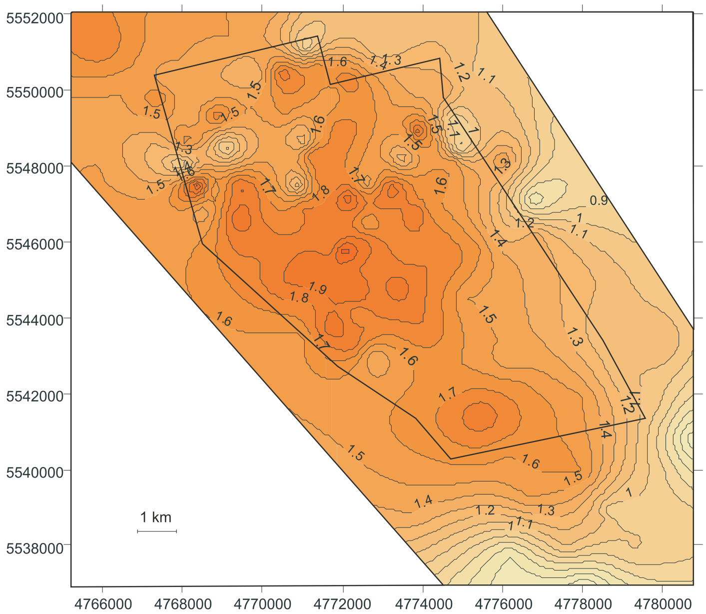

Fig. 8. The thickness of a coal seam 385/2 in the mining area of LW “Bogdanka”, LCB

Rys. 8. Miąższość pokładu węgla kamiennego 382 w obszarze górniczym LW „Bogdanka”, LZW

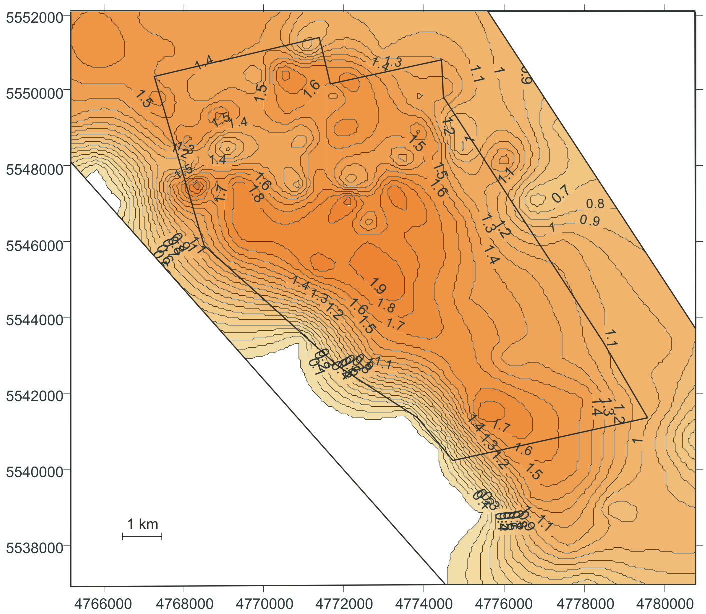

Fig. 9. The thickness of pure coal (without interlayers) in the seam 385/2 in the mining area of LW “Bogdanka”, LCB

Rys. 9. Miąższość czystego węgla (bez przerostów) w pokładzie 382 w obszarze górniczym LW „Bogdanka”, LZW

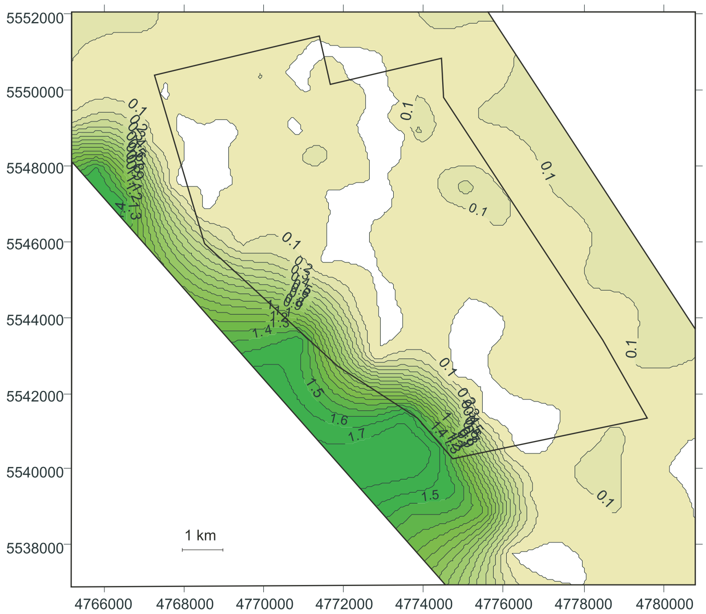

Fig. 10. The thickness of interlayers in the coal seam 385/2 in the mining area of LW "Bogdanka", LCB

Rys. 10. Miąższość przerostów płonnych w pokładzie węgla kamiennego 382 w obszarze górniczym LW „Bogdanka", LZW

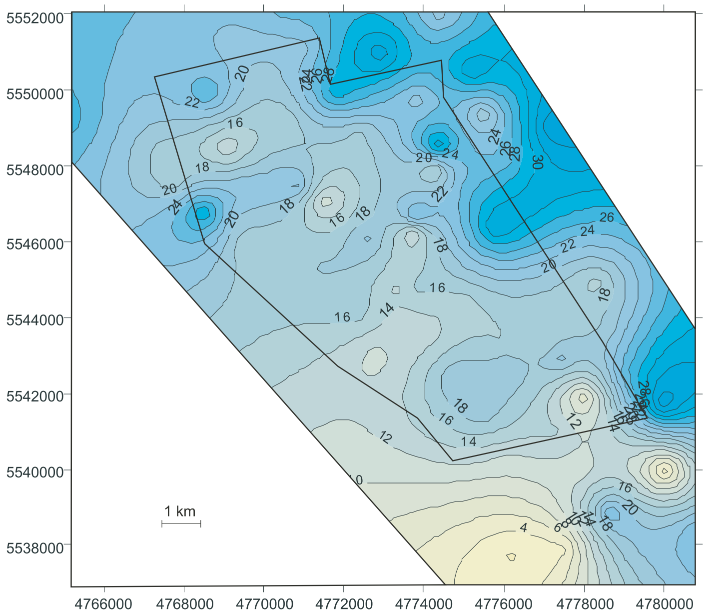

Fig. 11. The ash content of coal in the coal seam 385/2 in the mining area of LW "Bogdanka", LCB

Rys. 11. Popielność węgla kamiennego w pokładzie 382 w obszarze górniczym LW „Bogdanka", LZW

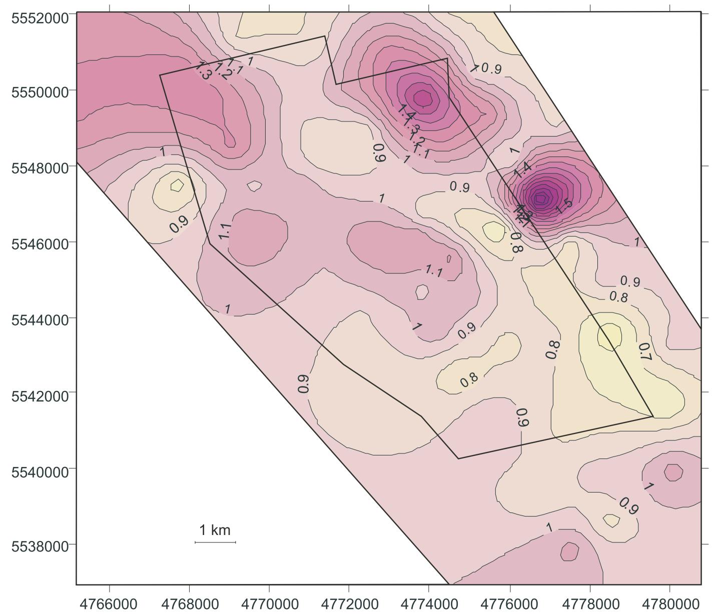

Fig. 12. The content of total sulfur in the coal seam 385/2 in the mining area of LW "Bogdanka", LCB

Rys. 12. Zawartość siarki całkowitej w pokładzie węgla kamiennego 382 w obszarze górniczym LW „Bogdanka", LZW

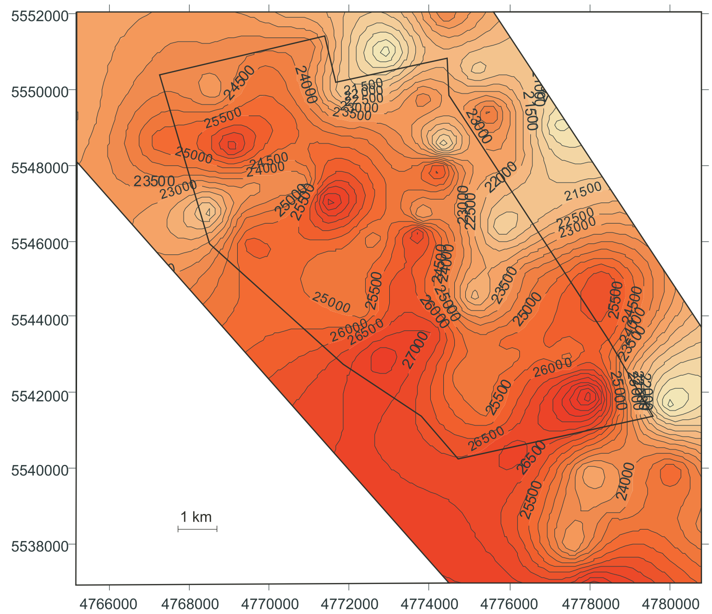

Fig. 13. The calorific value in the coal seam 385/2 in the mining area of LW "Bogdanka", LCB

Rys. 13. Wartość opałowa węgla kamiennego w pokładzie 382 w obszarze górniczym LW „Bogdanka", LZW

The content of total sulfur (S_t^r) in the coal from the 385/2 is changeable (Fig. 12), between the limits 0.5 to 2.3%. The smallest amount of sulfur are observed in the west and central parts of the mining area and the lowest are observed near its borders and outside the area.

The calorific value (Q^r_i) depends on the rates of coalification and the content of ashes (A^d), that is why the close link between the distribution of the calorific value and the ash content is visible (Fig. 11 and 13). The calorific value is biggest – 30 000 kJ/kg in the areas where the ash content in the lowest while in the areas where this parameter is high, the calorific value drops even to 18 000 kJ/kg.

Summary

The seams indexed as 382 and 385/2 show a changeable morphology because of the coal beds thickness and mullocky interlayers. The other parameters, such as the ash content or the calorific value show also a great variability on the analyzed area and are strongly linked with the non-coal rock interlayers, which presence causes the decrease in the calorific value and increase in the amount of after-burning ash (Bielowicz 2010). These parameters are less dependable on the sedimentation environment of the coal formation in the phase of peat. That means the level of water in the moor, the vegetation in the moor and biochemical processes occurring during the transformation of the embedded material, both in the phase of peat and after covering it by an overlay.

The content of total sulfur in the analyzed seams reaches on average 1.27% in the seam 382 and 0.99% in the seam 385/2. The content of total sulfur in the discussed area changes within the rage 0.82–2.16% in the seam 382 and 0.58–1.83% in the seam 385/2. This variability does not show any link to the values of the parameters analyzed before. The total sulfur is made up from sulphide gathered in coal and sulphates deriving from the decomposition of plants and supplied by deposit waters in different phases of coal seam formation. The obtained results could be useful in the exploration of the prospective seams lying below the currently exploited ones (e.g. 389) and the seams in the neighboring areas and increase the resource base LCB (Kulczycki, Sowa 2008).

The researches were supported financially by AGH – statutory research no. 11 11 140 562

REFERENCES

Bielowicz B., 2010 – New technological classification of lignite as a basis for balanced energy management. Gospodarka Surowcami Mineralnymi t. 26, z. 2, s. 25–39.

Kotas A., Buła Z. (red.), Gądek S., Kwarciński J., Malicki R., 1983 – Atlas Geologiczny Górnośląskiego Zagłębia Węglowego; część II – Mapy jakości węgla. Wyd. Geol. Warszawa.

Kulczycki Z., Sowa A., 2008 – Struktura i zagospodarowanie zasobów węgla kamiennego w Polsce. Gospodarka Surowcami Mineralnymi t. 24, z. 4/4, s. 219–234.

P o r z y c k i J., Z d a n o w s k i A., 1988 – Jakość węgla [W:] Dembowski Z., Porzycki J., (red.) – Karbon Lubelskiego Zagłębia Węglowego. Prace Instytutu Geologicznego CXXII, Warszawa, s. 184–92.

Z d a n o w s k i A., 2010 – Zróżnicowanie jakości węgla w Lubelskim Zagłębiu Węglowym. Mat. XXXIII Symp. nt. Geologia formacji węglonośnych Polski. Wyd. AGH, Kraków, s. 101–103.

Z d a n o w s k i A. (red.), 1999 – Atlas geologiczny Lubelskiego Zagłębia Węglowego. MOŚZNiL i PIG Warszawa.

Z d a n o w s k i A., S h u l g a V.F., 2008 – Złoża węgla kamiennego w strefie przygranicznej Polski i Ukrainy. Materiały I Polskiego Kongresu Geologicznego. PTG Kraków.

JAKOŚĆ WĘGLA EKSPLOATOWANYCH POKŁADÓW W LW „BOGDANKA" S.A. (LUBELSKIE ZAGŁĘBIE WĘGLOWE)

S ł o w a k l u c z o w e

Lubelskie Zagłębie Węglowe, karbon, jakość węgla

S t r e s z c z e n i e

Jakość węgla została przeanalizowana na podstawie danych z rozpoznania geologicznego i analiz chemiczno-technologicznych węgla wykonanych na próbach pobranych z otworów wiertniczych oraz wyrobisk górniczych. Eksploatowane pokłady węgla o indeksach 382 i 385/2 wykazują zmienną morfologię ze względu na grubość ławic węglowych oraz występujące w nich przerosty płonne.

Węgiel z pokładu 382 posiada następujące parametry: popielność (A^d) – 10,02–38,47 średnio 21,71%, wartość opałowa (Q_i^r) – 18 326–28 089 kJ/kg średnio 23 826 kJ/kg, zawartość siarki całkowitej (S_t^r) – 0,82–2,16% średnio 1,27%, typy węgla – 31.2, 32.1, 32.2, 33.

Węgiel z pokładu 385/2 posiada następujące parametry: popielność (A^d)– 6,36–32,32 średnio 18,99%, wartość opałowa (Q_i^r) – 19 881–30 135 kJ/kg średnio 24 661 kJ/kg, zawartość siarki całkowitej (S_t^r) – 0,58–1,83% średnio 0,99%, typy węgla – 32.1, 32.2, 33, 34.1, 34.2.

Parametry takie jak popielność czy wartość opałowa są silnie skorelowane z występującymi w pokładzie przerostami skał niewęglowych, których obecność w węglu powoduje obniżenie wartości opałowej i wzrost ilości popiołu po spaleniu węgla. W mniejszym stopniu te parametry będą zależne od środowiska sedymentacji materiału węglotwórczego. Zawartość siarki całkowitej w analizowanych pokładach nie wykazuje związku z wartościami wcześniej analizowanych parametrów. Siarka całkowita stanowi sumę nagromadzonych w węglu siarczków i siarczanów pochodzących z rozkładu materii roślinnej oraz dostarczonych przez wody złożowe na różnych etapach tworzenia się pokładów węgla. Uzyskane wyniki i wnioski dotyczące zmienności parametrów obecnie eksploatowanych pokładów węgla mogą być przydatne przy rozpoznaniu planowanych do eksploatacji niżej leżących pokładów np. 389, 391 lub pokładów w obszarach sąsiednich.

QUALITY OF COAL FROM EXPLOITED SEAMS IN LW "BOGDANKA" S.A. (LUBLIN COAL BASIN)

K e y w o r d s

Lublin Coal Basin, Carboniferous, coal quality

A b s t r a c t

The quality of coal has been analyzed basing on the data from geological exploration and chemical – geological analyses of coal carried out on the samples obtained from the boreholes and mining pits. The operated coal seams indexed as 382 and 385/2 reveals the changeable morphology due to the thickness of carbon shoals and

stent intergrowths. The other parameters, such as the ash content or the calorific value are strongly linked with the non-coal rock interlayers, which presence causes the decrease in the calorific value and increase in the amount of after-burning ash. These parameters are less dependable on the sedimentation environment of the coal formation material. The content of total sulfur in the analyzed seams does not show any link with the values of the parameters analyzed before. The total sulfur is made up from sulphide gathered in coal and sulphates deriving from the decomposition of plants and supplied by deposit waters in different phases of coal seam formation. The obtained results could be useful in the reconnaissance of the prospective seams lying below the currently exploited ones (e.g. 389) and the seams in the neighboring areas.