GOSPODARKA SUROWCAMI MINERALNYMI – MINERAL RESOURCES MANAGEMENT

2020 Volume 36 Issue 4 Pages 127–144

DOI: 10.24425/gsm.2020.133943

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Rock raw materials from the Mesozoic–Neogene contact zone in the Bełchatów Lignite Deposit – recognition and evaluation of their utility

Introduction

The Bełchatów lignite deposit is located in central Poland in the area of the Polish Lowland, in the Szczecin–Łódź–Miechów synclinorium zone. It was formed in a ditch limited by tectonic lines, 1–2 km wide and about 35 km long. The average thickness of the graben zone is 150–200 m, it reaches a maximum of 390 m. Its extent in the WE is 72 km (Ciuk and Piwocki 1980). The Kleszczów Graben, also called the Bełchatów trench, is filled with younger Neogene deposits. From the south, it is limited by the main fault. From the north, its limitations are complementary faults. Mesozoic sediments make the basis for lignite deposits belong to the Jurassic and Cretaceous. Permian deposits build the Zechstein salt dome Dębina. Three resource fields were separated in the Bełchatów lignite deposit, from the west the Szczerców Field, the Bełchatów Field and the Kamieńsk non-industrial Field in the east (Figure 1). The Szczerców Field is separated from the Bełchatów Field with the salt dome Dębina. It is an ellipsoidal form reaching from the surface of the land to depth of 170 m.

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Fig. 1. Location of the Bełchatów lignite deposit

Rys. 1. Lokalizacja złoża węgla brunatnego Bełchatów

The Kamieńsk Field is separated on the Bełchatów Field by fault zone – the so-called Widawka fault. It both the depth of occurrence of the lignite seam as well as its thickness and the way of forming different than in the Fields of Bełchatów and Szczerców.

Lignite exploitation in the Bełchatów deposit belongs to the largest in Poland, and the mining area is one of the largest excavations in Europe. Over 34,644 thousand tons were extracted from the Bełchatów–Szczerców Field, which accounted for 56.66% of the total domestic extraction, while extraction from the Bełchatów–Bełchatów Field amounted to 12 180 thousand tons (19.92% of domestic extraction).

Industrial resources of lignite of the Bełchatów deposit as at December 2018 amounted to 1,047.60 million tons. Compared to 2017, they increased by 55.02 million tons. This is related to the preparation of additions to the development projects for the Bełchatów–Bełchatów Field and Bełchatów–Szczerców Field, which resulted in an increase in industrial resources,

Table 1. Technological parameters of individual deposits

Tabela 1. Parametry technologiczne poszczególnych złóż

Deposit name	Thickness of lignite		Thickness of overburden		Depth of bottom	
	min.–max.	med.	min.–max.	med.	min.–max.	med.
Bełchatów (Bełchatów Field)	3–230.5	55.1	0–159	24.3	3–245.5	79.5
Bełchatów (Szczerców Field)	8.9–196.1	50.3	7.6–240	119.5	65–351.7	171.1
Złoczew	12.1–127.8	51.4	138.4–281	215.1	150.5–354.3	266.6

despite the exploitation of 75.58 million tons (Balance of mineral resources in Poland 2019). The gradual increase in extraction from the Szczerców Field compensates for extraction in the Bełchatów Field and allows stable production for the Bełchatów power plant to be maintained. Due to the depletion of geological balance resources in the Bełchatów Field, lignite mining is to be completed here by the end of 2020, while the main resource is to be the Szczerców Field and the recognized Złoczew deposit located 50 km from the Kleszczów Graben (Kasztelewicz et al. 2007). The main technological parameters for individual deposits are presented in Table 1.

1. Rock raw materials accompanying lignite in the Bełchatów deposit

During lignite mining by the open-cast method, the removal of the rocks laying in the lignite overburden is necessary. We often find rocks of economic importance in the vicinity of the main rocks (Figure 2). Therefore, the mine services also conduct selective recognition and documentation of the rocks accompanying the main rocks-lignite.

These rocks are characterized by great diversity in terms of both age and lithology. Among them, sediments from the Holocene represented by peats to the Lower Jurassic quartz sands can be distinguished. Accompanying rocks in the Bełchatów deposit were

Fig. 2. The opencast nature of mining in the Bełchatów lignite deposit

Rys. 2. Odkrywkowy charakter eksploatacji złoża węgla brunatnego Bełchatów partially documented in 1983 and 1989 (Comprehensive Geological Documentation of the Belchatów… 1983, 1989). They were clayey rocks, lake chalk, sands and sand gravel. In later documentary and research works to Bełchatów accompanying rocks with raw material importance were joined by Jurassic limestone, marl and halite (Stryszewski 1995). The work done so far has allowed to separate such accompanying rocks as peats, erratic boulders, sands and sand gravel, flints, beidellite clay, lake chalk, limestone and quartz sands in the Szczerców Field.

Peat

Peat in the Szczerców Field was identified in 7 deposits in which agricultural peats, mixed-agricultural and non-normative peats were distinguished. Primary peat resources amounted to 380 thousands m^3, but as a result of drainage works and the formation of depressive funnels, their prosperity decreased. In 2018, 0.042 million tons of this mineral was extracted from the Bełchatów (Szczerców Field) (Balance of mineral resources in Poland 2019).

The use of peats for gardening seems to be varied. The value of some parameters, e.g. humidity, allow them to be included in the first quality class. On the other hand, the bulk density parameter, especially the ash content is sometimes outside of the limit. Therefore, there are doubts in the case of such a direction of their development. Some varieties can be used to produce mixed peat varieties used in agriculture. Others meet the criteria for compost peat. Such directions of use are also confirmed by moisture values and to a lesser extent, by ash. Some of them are suitable for the direct fertilization of soil. This direction of development is demonstrated by the high values of ion exchange capacity – from 153 to 338 mval/kg. As a result, it will be possible to modify the soil quality properties. They can also be used for the reclamation of agricultural heaps, waste dumps or the development of degraded and devastated mining activities. The high content of CH_4 and petroleum substances was found in some peat cultivars. The increased content of heavy metals in peats means that each "agricultural" use of this raw material requires testing in this direction (Ratajczak 2014).

Erratic boulders

Erratic boulders have been identified around almost the entire Szczerców Field excavation. In 2017, 2.97 thousand tons of erratic boulders were mined and in 2018, 1.93 thousand tons (Balance of mineral resources in Poland 2019). They are characterized by large sizes reaching up to 3 m in diameter (Figure 3). They are used for the production of stonemasonry and aggregates.

Sandy and sand-gravel sediments

The exploitation serviceability of sandy and sand-gravel sediments for construction was found in the resources of 4.9 million m^3 for sands and 6.4 million m^3 for gravel and sandy gravel. These formations occur in the form of lenses surrounded by sandy sediments (comprehensive geological deposit documentation of "Bełchatów" lignite deposit in category

Fig. 3. Erratic boulders in the Bełchatów lignite deposit

Rys. 3. Głazy narzutowe w złożu węgla brunatnego Bełchatów

C + B Szczerców Field 1983). The resources of natural sand and gravel aggregate with an average sand point of 59.6% were estimated at 750 thousand tons, while natural sand aggregate with an average sand point 59.6% per 708.9 thousand tons. The silt fraction content was 3.4%. The use of sandy and sand-gravel sediments is diverse. They are used in the glass and ceramics industry, abrasives, paints and varnishes, building ceramics and leveling works, for the production of sand-lime bricks. They can also be used in water treatment and purification processes. Experimental works have shown the possibility of neutralizing groundwater with the use of this type of sediments for the construction of backfill in well filters (Stryszewski 1995; Marek 2003).

Flints

Flints are also determined in the lithostratigraphic profile as accompanying rocks. They occur in the form of flinty cobblestones on the carbonaceous clay of the clay-sand complex or on lignite productive complex (Figure 4). They are often described as flinty-calcareous pavements with numerous inserts of silicified formations, mainly limestone and sandstone. These deposits are also classified as hard-to-cut rocks (Jończyk et al. 2003). The thickness of these layers varies considerably and ranges from a few centimeters to even about 20 m. As a result of diverse geological and mining conditions, these resources are difficult to estimate: in 2017 – 5.33 thousand tons of quartzites, in 2018 – 12.12 thousand tons of quartzites. In 2018 113.65 thousand tons of limestone, classified as broken and block stones was extracted (Balance of mineral resources in Poland 2019). It was used in construction, as a grinder in ball mills, for the production of dusting in sandpaper (Stryszewski 1995).

Fig. 4. Flint pavement in the outcrop in the Bełchatów lignite deposit

Rys. 4. Bruk krzemienny w odkrywce złoża węgla brunatnego Bełchatów

Clay rocks

Clay rocks with raw material importance in the Szczerców Field are: beidellite clay and sub-lignite clay. Pliocene clay of the clayey-sandy complex belong to the most promising minerals. They form several layers with a thickness of 1–2 m to 17–25 m. Their thickness increases in the marginal fault zones from 40 to 50 m. The resources of these minerals for the ceramics industry were estimated at 10 million m^3, and the estimated resources at 45 million m^3. Their resources for the production of agloporyte are 14.3 million m^3 and estimated at 71 million m^3. The works on clay rocks accompanying the Bełchatów deposit were carried out for years, allowing their use in the building ceramics industry (Wyrwicki 1993; Wiśniewski 2000a; Sałaciński and Gąsiński 2012) as mineral sorbents (Bajda and Ratajczak 2005; Kozioł et al. 2006). For the production of ceramic fertilizer composites (Sałacinski and Puff 2007), waterproofing screens (Ratajczak et al. 2015).

The main directions of use of these deposits confirmed by the Geological Department of the Bełchatów Mine (2015) are:

- building ceramics,
- production of light expanded clay aggregate,
- mineral sorbents,
- soil remediation,
- construction of waterproofing screens.

Lake chalk

Lake chalk, which is found in the marginal zones of the Kleszczowa Graben, is another rock of raw material importance. Its occurrence was found in 6 areas, in the lignite, over--lignite and sub-lignite complex. Its estimated resources are 20.9 million tons, of which approximately 7.1 million tons will be recoverable. Out of six areas of occurrence of lake chalk, exploitation includes area 2 lying at the southern dislocation. The lake chalk in this area is located in the top parts of the lignite complex and has a thickness of 14.4 m, and its resources are 5.8 million tons. The possible exploitation of lake chalk is also in the area of 3, 4, 5 where it lies in the southern part of the excavation. It was found in the upper part of the lignite complex in the form of single layers. Its resources were estimated at 144 thousand tons in the area of 3,361 thousand tons, in the area of 4 and 832 thousand tons in area 5. In 2018, 0.042 million tons of this mineral was extracted from the Bełchatów–Szczerców Field (Balance of mineral resources in Poland 2019). The lake chalk in Bełchatów comes in two varieties: with a minimal degree of carbonation and as carbonaceous. It is a natural ecological fertilizer, which is a source of calcium easily absorbed by plants. The possibility of its use for the production of mineral – organic fertilizer with the main purpose for the reclamation of acidic soils rich in heavy metals (Grabiński 1993). Its use outside agriculture is mainly the directions of production of painting chalk, technical chalk, white cement, quicklime as well as in the glass and ceramics industry (Wyrwicki 1999). It is also used for the synthesis of wollastonite (Sałaciński and Puff 2003) and as a sorbent for reducing SO_2 emissions (Hycnar et al. 2013).

2. Raw material analysis of rocks from the Mesozoic–Neogene contact zone

The wide group of Bełchatów accompanying rocks also contains rocks recognized in the Mesozoic–Neogene contact zone in the Bełchatów lignite deposit (Ratajczak and Hycnar 2017).

The rocks discussed in this article were identified in post-lignite deposits on the contact of Mesozoic and Neogene formations. Their occurrence shows a certain regularity. They were identified on the Mesozoic bedrocks (Jurassic and Cretaceous) in contact with green smectite clay. These rocks are formed by decalcified and synthesized rocks of the Mesozoic substrate, weathered clay and erosion rubble of local rocks. Their lithology is strictly conditioned by the lithological character of the substrate deposits lying in direct contact with it. In the Lower and Middle Jurassic, the weathered deposits are sandy or clayey – sandy, sometimes with small crumbs of slates, siderites, sandstone and occasionally flints. Rubble covers built of sharp-edged, weathered flints and fractions of fossilized local rocks are found on the Upper Jurassic (oxford) formations. The rubble is usually a mixture of sands and clay, often forming a kind of breccia or conglomerate cemented with clay or silica, less often ferrous. Detailed mineralogical and petrographic analysis has allowed the following to be distinguished among them:

- carbonate rocks: limestone,
- transitional rocks: opoka-rock, gaize and marl,
- silica rocks: diatomites, flints,
- medium-grained clastic rocks: wackes and arenites,
- weathered deposits: kaolin clay, decalcified opoka- rocks and poly and monomictic breccias (Pękala 2017).

Of the rocks mentioned, the Upper Jurassic limestone, opoka-rock, kaolinite clay and marl are the best recognized and listed as prospective in terms of the raw material base. The economic significance of the remaining rocks seems small.

Upper Jurassic limestone

Upper Jurassic limestone has been extracted by the Bełchatów mines since the beginning of the 1990. It was exposed during mining works on the southern slope of the "Bełchatów" opencast. Its extraction is around 100,000 m^3/year (Wiśniewski 2000a; 2000b). In 2018, a total of 113.65 thousand tons was extracted. It is converted into road aggregates in the place of occurrence as limestone aggregate, limestone rubble and as the mine's own needs. The mineralogical and chemical results indicated directions its use as mineral sorbents relative to SO_2 in dry methods of reducing sulfur dioxide emissions in both grate, dust and fluid furnaces. The value of the reactivity coefficient (RI), which determines the ratio of calcium

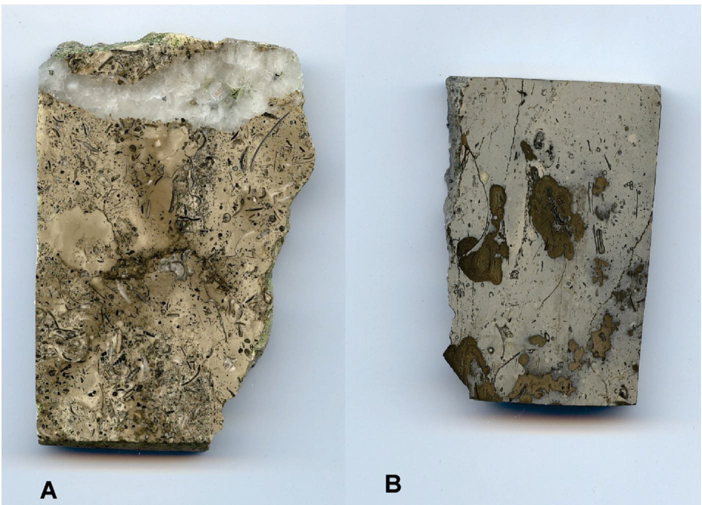

Fig. 5. Symptoms of mineralization
A) Organogenic limestone with crystallized quartz in rocky crevices,
B) Micritic limestone with crystallized iron sulphides

Rys. 5. Przejawy mineralizacji
A) wapien organogeniczny z wykrystalizowanym kwarcem w szczelinach skalnych,
B) wapień mikrytowy z wykrystalizowanymi siarczkami żelaza

in the sample to the amount of sulfur after sorption [mol Ca/mol S] is 4.47–1.55, while the value of absolute sorption coefficient (CI), which determines the amount of sulfur absorbed by 1000 g sorbent [g S/1000 g sorbent] is in the range 62–150. The presented values of the coefficients allow to assess the sorption capacity of limestone at the level from excellent to sufficient. Studies have also shown that the sorption abilities of limestone are mainly affected by the porosity of the rock, to a lesser extent the CaO content in it, whose content ranges within a wide range from 48.67 to 98.61% wt. and is 70.90% wt. (Hycnar 2015) on average. The diversity in the chemical composition of Upper Jurassic limestone from the contact zone is associated with the mineralization processes that the zone covered. The most important of them include pyritization and silification. The manifestations of these phenomena are visible in the examples presented below (Figure 5A, B).

Opoka-rock

According to the (Balance of mineral resources in Poland from 2017), opoka-rock was included in the group of stones that meet the relevant requirements for the production of broken aggregate and stone elements for road and construction, production of blocks, slabs and as stone wall. The total balanced resources of these rocks in Poland amount to 13,192 thousand tons (Balance of mineral resources in Poland 2019). The estimated and mining resources from the Bełchatów lignite deposit for the opoka-rock is 100–150 thousands m^3/year, and decalcified opoka-rock amounts to several million m^3 (Pękala 2019). It should be mentioned that the Bełchatów opoka-rock from 1994 is mentioned in the (Balances of Mineral and Groundwater Resources in Poland 1994) as a perspective area in the context of the possibility of increasing the national resource base, including diatomaceous earth.

Microscopic examinations of these rocks have shown that opoka-rocks in the Tertiary and Mesozoic contact zone are distinguished by the presence of silica in opal-chalcedony form. The analyses carried out showed that the sites covered by silification are associated with the presence of partially ordered varieties, opal – CT (cristobalite – trydimite) relative to opal – C (cristobalite). It has been observed that this mineral phase often has an affinity for minerals from the smectite group (Figure 6). Cathodoluminescent analyses (CL) confirmed the presence of the different generations of silica. The youngest generation of silica was opal – CT with pink – blue luminescence, which builds the rocky background of the opoka-rock, most likely indicating the interaction of hydrothermal solutions. In the observed rocky groundmass, the primary calcite cement with red luminescence was visible. Opal – a the bioclast builder showed blue luminescence in the CL image. Chalcedony did not show luminescence. Furthermore, observations at CL have revealed the original rock components previously not visible in the microscopic image (Figure 7). They were mainly primary carbonate bioclasts and feldspars (Pękala 2020).

The opoka-rock is characterized by higher mechanical strength above 50MP and an apparent density of 1.97 g/cm^3. However, it has a lower total porosity of 24.3% vol. and water absorption 10.92% wt. The specific value of the silicate module for these rocks was in the range of 44.3–8.2. Chemical analyses of the opoka-rock confirmed that the silica was in

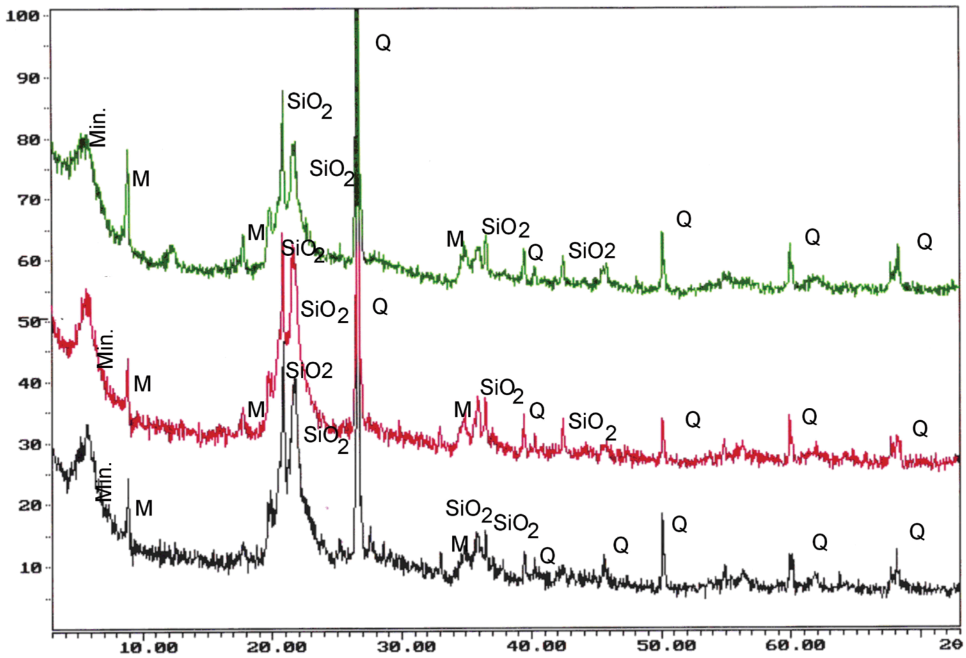

Fig. 6. Example diffractometric curves.
SiO_2 – silica phases in the form of opal (CT varieties relative to C), Q – quartz, M – mica,
Min. – clayey minerals (Pękala 2020)

Rys. 6. Przykładowe krzywe dyfraktometryczne
SiO_2 – fazy krzemionki w formie opalu (odmiany CT względem C), Q – kwarc, M – miki, Min. – minerały ilaste

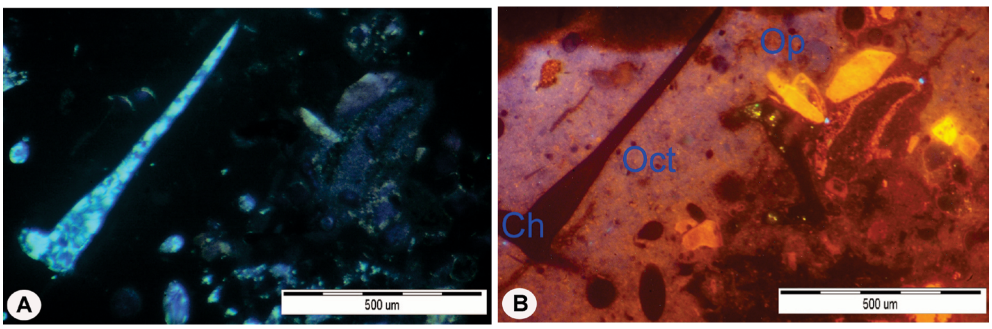

Fig. 7. Silificated opoka-rock: A – polarizing microscope, 2P;
B – CL image revealing an opal rocky background–pink luminescence, and relics of feldspar and carbonate
CL – cathodoluminescence, Ch – microcrystalline chalcedony, Oct – opal cristobalite-tridymite, Op – opal
(Pękala 2020)

Rys. 7. Zsylifikowana opoka: A – mikroskop polaryzacyjny, 2P;
B – 2 obrazie CL widoczne opalowe tło skalne – różowa luminescencja oraz relikty skaleni i węglanów
CL – katodoluminescencja, Ch – chalcedon, Oct – opal krystobalitowo-trydymitowy, Op – opal

the range from 40.20 to 66.90 wt. and averages 49.23% wt. The CaO content ranges from 16.00 to 30.50% wt. with an average share of 25.14% wt. (Pękala 2017). Specific surface area (BET) was determined at 39 m^2/g, sorption (CEC): 63 mval/100 g. Transformed oil sorption: 46.7% (at pH 4) and 38.7% (at pH 8) for fraction 0–12 mm and 32.16% (at pH 4) and 24.3% (at pH 8) for the fraction 1–3 mm. In addition, the low CaO content in relation to the requirements for limestone fertilizers, eliminates them in the agricultural area. They can be used, among others, for the production of Portland cement as a clinker component. The opoka-rock studied, due to low strength parameters, are not suitable for the construction of roads and engineering facilities with a long service life. Nevertheless, crushed rocky material could be used to harden roads and repair grounds operating for a few months at most (Hycnar and Pękala 2011).

Marl

The group of transitional rocks with carbonate character in the Mesozoic-Neogene contact zone is represented by Upper Cretaceous marl. They are rocks with an organogenic structure. Their texture is compact, sometimes directional. Groundmass has a carbonate – clayey composition. Calcite that builds it is microcrystalline. These rocks are built by numerous bioclasts and grains of terrigenous material. Most of them are strongly crushed.

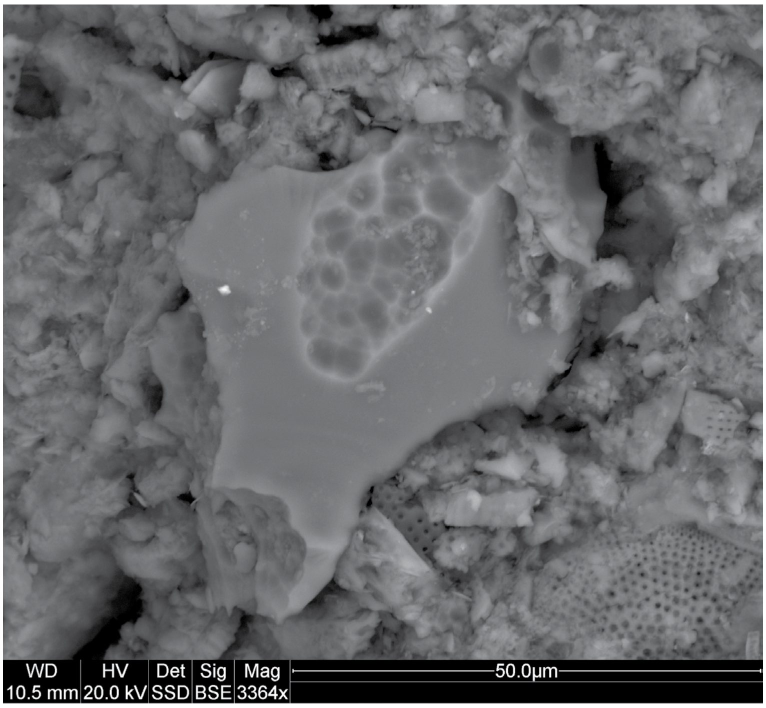

Fig. 8. Marl with diatom shells in the groundmass. Image SEM

Rys. 8. Margiel z zachowanymi w tle skorupkami okrzemek. SEM

Only a few, such as foraminifera shells, have remained intact. Among the organic carbonate debris, shells of molluscs and fragments of echinoderms can also be distinguished. Their sizes reach up to several millimeters. Slightly less well-preserved organic remnants made of silica are found. These are mainly sponge needles, radiolars, sea urchin spines. Scanning microscope studies also revealed the presence of diatoms (Figure 8). Some of the carbonate-type bioclasts are impregnated with a poorly translucent brownish substance. The presence of iron oxides and hydroxides has been documented in the chemical composition (EDX) of this type of bioclasts. Chemical analyses for marl showed that the CaO content is from 27.34 to 43.87% wt. The Al_2O_3 content ranges from 1.78 to 7.52% wt. The Fe_2O_3 level is in the range of 0.81 to 9.42% wt (Pękala 2012).

Marl from the Mesozoic-Neogene contact zone is to be used in agriculture for the production of calcium mixtures and fertilizer mixtures, it can also be used as a low raw material to cement.

Decalcified gaizes

Decalcified gaizes are macroscopically like sandstone or mudstones. They usually accompany the opoka-rock. The texture of these rocks is random, slightly porous and the structure is organodetritic. Cryptocrystalline silica as well as clay minerals are rocky cement in these rocks. It is slightly pigmented in part with brown organic matter. The detritic material is represented by silica organic skeletal elements, mainly sponge needles, radiolar shells or diatoms. The silica that builds them mainly assumes chalcedony. Chalcedony also creates a secondary filling of rock pores. In this type of occurrence, the chalcedony fibers are arranged in a concentric-radial manner, creating characteristic "rosette" forms. Muscovite and hydromusovite plates, partially chlorinated biotite and quartz grains are also found within the detritic material. Chemical tests carried out in the case of gaizes have shown that they are composed mainly of silica which constitutes over 93% wt. quantitative composition. The CaO content ranges from 0.50 to 19.82% wt. with an average proportion of 5.85% wt. A characteristic feature of gaizes is a low volumetric weight of 1.2 to 1.8 g/cm^3, a high total porosity of up to 50% by volume and compressive strength from 9.71 to 35.30 MPa (Pękala 2012). The presence of active silica in their composition indicates the possibility of using them as a cement raw material. Gaizes have been shown to be a highly active cement additive, enabling the production of Portland sulfate-resistant cements and pozzulan cements. In addition, these rocks are suitable for the production of concrete and reinforced concrete elements.

Kaolinite clay

The occurrence of kaolinite clay was recorded in three mining levels (IV–VI), in direct contact with rocks of the Mesozoic substrate (carbonate rocks) and the Neogene sediments. The Neogene sediments were represented by quartz sands. Sediments of a clay and coal complex formed in the form of alternating layers of sand, silts, carbonaceous clay and lignite were below them. They are slightly compact rocks, whose main mineral component are columnar aggregates of kaolinite with a characteristic habit: worm-shaped or fan-shaped, resulting from kaolinization of feldspars, volcanic glass and muscovite. X-ray analysis allowed to assess the quantitative content of individual minerals. It showed that kaolinite is present in an amount of 43–58% wt., quartz 19–32% wt., feldspar 10–18% wt., illite 2–15% wt., muscovite 0–1% wt. A feature of kaolinite clay from the contact zone is the presence of very fine-grained quartz, not exceeding 0.1 mm. In addition, iron sulphides and siderite were not found in the investigated deposits (Pękala 2014).

The analysis of the grain composition of kaolinite clay showed that the clay fraction with a grain size below 2 µm on average represents 56% wt. The fraction above 60 µm is present in an amount of about 6.5% wt. and the rest 37.5% wt. it is a fraction with a grain size of 60 to 2 µm. A significant amount of Al_2O_3, reaching a maximum of about 30% wt. and low Na_2O content (max. 0.15% wt.). The SiO_2 content ranges from 33% wt. up to 65% wt. Fe_2O_3 ranges from 1.20% wt. up to 2.98% wt. CaO was less than 1% wt. (Pękala 2012).

Conclusions

The analysis carried out of lignite accompanying rocks in the Bełchatów deposit allows for the recognition of rocks of application importance. Rocks from the Mesozoic–Neogene contact zone in the Bełchatów lignite deposit are potential rocky raw materials. Upper Jurassic limestone, opoka-rock and kaolinite clay can be used in practical applications. The use and management of these rocks in opencast lignite mining is very important in many economic aspects. It protects natural resources by limiting the surface of the mining areas. It has economic significance by increasing the supply of minerals and materials made from them. This increases the profit of economic entities exploiting lignite deposits. This is an important aspect in environmental protection through the use of some of the obtained raw materials for the production of ecological materials (Pękala 2019). In the analyzed work, attention should be paid to the need to study raw materials extracted even in small quantities and occurring in relatively small accumulations. With proper recognition and detailed research, they can have raw material importance. Examples of this are white-burning kaolinite clay, the opoka-rock and Jurassic limestone.

This research was supported by a Polish Ministry of Science and Higher Education grant to maintain research potential.

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ROCK RAW MATERIALS FROM THE MESOZOIC–NEOGENE CONTACT ZONE IN THE BEŁCHATÓW LIGNITE DEPOSIT – RECOGNITION AND EVALUATION OF THEIR UTILITY

Keywords

brown coal, rocks accompanying, mineral resources, mining, resource balance

Abstract

The open-cast nature of deposit exploitation means that apart from the extraction of the main mineral, rocks are also found in its vicinity. Their nature, raw material quality and geological and mining conditions allow them to be used in various branches of the economy. Hence, it seems that more attention should now be given to these rocks. However, the long-term, open-cast mining operations involving Bełchatów lignite ultimately necessitated basic, raw-material-related research on the deposits accompanying the lignite as the main mineral. The presented work shows the state of the recognition of rocks lying in the Mesozoic–Neogene contact zone in the Bełchatów lignite deposit as well as their petrographic nature and possible directions of their use. Attention was drawn to the lithological diversity of the studied rocks and diagenetic processes that contributed to the impact on their physical and mechanical characteristics. Based on the analysis of the literature, the current state of utilization and development as well as the balance of accompanying rock resources in the Bełchatów lignite deposit are presented.

Today, it would seem very important from various economic points of view for utilization and management of the aforementioned rocks encountered as open-cast lignite mining to take place. Natural resources are protected where the area mined is kept in check, and there is economic significance to any increasing in the supply of minerals, or materials made from them. The level of profitability for economic entities that exploit lignite deposits may obviously be raised in this way, and environmental goals can also be served if some of what is extracted can be transformed into environment-friendly materials.

SUROWCE SKALNE ZE STREFY KONTAKTU MEZOZOIK–NEOGEN ZE ZŁOŻA WĘGLA BRUNATNEGO BEŁCHATÓW – ROZPOZNANIE I OCENA ICH PRZYDATNOŚCI

Słowa kluczowe

węgiel brunatny, kopalnia, zasoby mineralne, skały towarzyszace

Streszczenie

Odkrywkowy charakter eksploatacji złóż sprawia, że poza wydobyciem kopaliny głównej pozyskiwane są również skały występujące w jej sąsiedztwie. Ich charakter, jakość surowcowa oraz geologiczno-górnicze warunki zalegania sprawiają, że mogą być one wykorzystane w różnych gałęziach gospodarki. Jednak wieloletni, odkrywkowy charakter eksploatacyjny węgla brunatnego, m.in. w Bełchatowie, przyczynił się do konieczności wykonywania badań podstawowych, jak i surowco-

wych dla utworów towarzyszących kopalinie głównej, jaką jest węgiel brunatny. W prezentowanej pracy przestawiono stan rozpoznania skał zalęgających w strefie kontaktu mezozoik– neogen w złożu węgla brunatnego Bełchatów ich charakter petrograficzny oraz aktualne i ewentualne kierunki ich wykorzystania. Zwrócono uwagę na zróżnicowanie litologiczne omawianych skał oraz procesy diagenetyczne, które przyczyniły się do wpływu na ich cechy fizyko-mechaniczne. W oparciu o analizę literatury przedstawiono ponadto dotychczasowy stan wykorzystania i zagospodarowania oraz bilans zasobów skał towarzyszących w złożu węgla brunatnego Bełchatów.

Wykorzystanie i zagospodarowanie skał podłoża serii burowęglowej przy odkrywkowej eksploatacji węgla brunatnego jest bardzo istotne w wielu aspektach gospodarczych. Stanowi ochronę zasobów naturalnych poprzez ograniczenia powierzchni obszarów górniczych. Ma znaczenie ekonomiczne, jak i w ochronie środowiska, poprzez wykorzystanie niektórych z pozyskanych surowców do produkcji materiałów proekologicznych.