GOSPODARKA SUROWCAMI MINERALNYMI – MINERAL RESOURCES MANAGEMENT

2020 Volume 36 Issue 1 Pages 105–122

DOI: 10.24425/gsm.2020.132546

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Possibilities of reclamation and using of large-surface coal mining dumping grounds in Poland

Introduction

The analysis of reclamation activity in Poland, considering coal mining dumping grounds allow to state that undertaken directions and activities changed with the reference to purposes. Observing the history of these changes, two directions can be observed. The first belongs to the reclamation in landscape direction, which allows described objects (dumps) to be transformed into widespread accepted parts of the landscape. The other direction shows a typical industrial tendency in the meaning of the economic depiction of the subject and considers the most effective recovery of any material from the dumps and their terminal liquidation and removal from the landscape (Gawor 2014; Gawor et al. 2014).

The development of mineral preparation technologies contributed to a significant (even intensive) increase of turn in the second of presented directions.

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Present possibilities and ways of recovery, processing, beneficiation etc. of raw material from anthropogenic deposits, which include investigated waste dumps, led to the increase of interest of different companies and institutions, both domestic and international. It seems to be that primary, landscape direction of reclamation already belongs to the past and is becoming a part of mining history in Poland.

Over 226 coal mining waste dumps are situated in the boundaries of the largest coal basin in Poland – the Upper Silesian Coal Basin (USCB), which in the Polish part of the USCB alone cover the surface of over $4000 \cdot 10^4$ m^2, and the volume of gathered wastes is estimated on ca. 700 million Mg (Gawor and Marcisz 2015). There is only one dump situated in the Lublin Coal Basin (LCB). A total of 116 waste dumps are localized in the area of Lower Silesian Coal Basin (LSCB), where the mining exploitation has been terminated as of 2000, but their relatively small surfaces of the objects and their thermal state have resulted in them not being analysed in detail. A full inventory of these dumps was elaborated by the State Geological Institute, and its results are presented on the website: https://cbdgportal.pgi.gov.pl/haldy/.

Not all dumps comprise objects of interest though. The conducting of any, widely understood, activity on the dump is preceded by obtaining a large amount of data, concerning potential facilities and is based on information gathered from a relevant economic analysis.

One of the main criteria defining the profitability of abovementioned activities is a surface of the dump and the following type, quantity, quality and distribution of the disposed material (Gawor and Marcisz 2014).

The investigations had a purpose of preparing an inventory and the valorisation of large-scale coal mining dumps in Poland, meaning facilities, the surface of which exceed $30 \cdot 10^4$ m^2, concerning possibilities of their reclamation and using and ultimately an evaluation of possibilities of recovery of coal from waste material. Established criteria of the surface $30 \cdot 10^4$ m^2 results from the analysis of the objects already exploited for the needs of recovery, where beyond central dumps, like e.g. Smolnica or Przezchlebie) preparation installations worked on the dumps with not smaller than mentioned surface. These criteria considering common access to geological databases, materials, digital maps as well as parameters of modern UAV (drones) is the easiest to define and verify.

1. Localization and geology of study area

The research was conducted in two domestic coal basins: USCB and LCB. The origination of mining wastes is strictly connected with the geological composition of these basins (Figs 1–2, Table 1).

The basement sediments occurring deeply in the lithostratigraphic profile of the USCB in the form of crystalline Precambrian rocks, Cambrian and Devonian as well as lower Carboniferous culm and coal limestone do not take of course part in the processes of disposing of wastes on the dumps (Probierz et al. 2012).

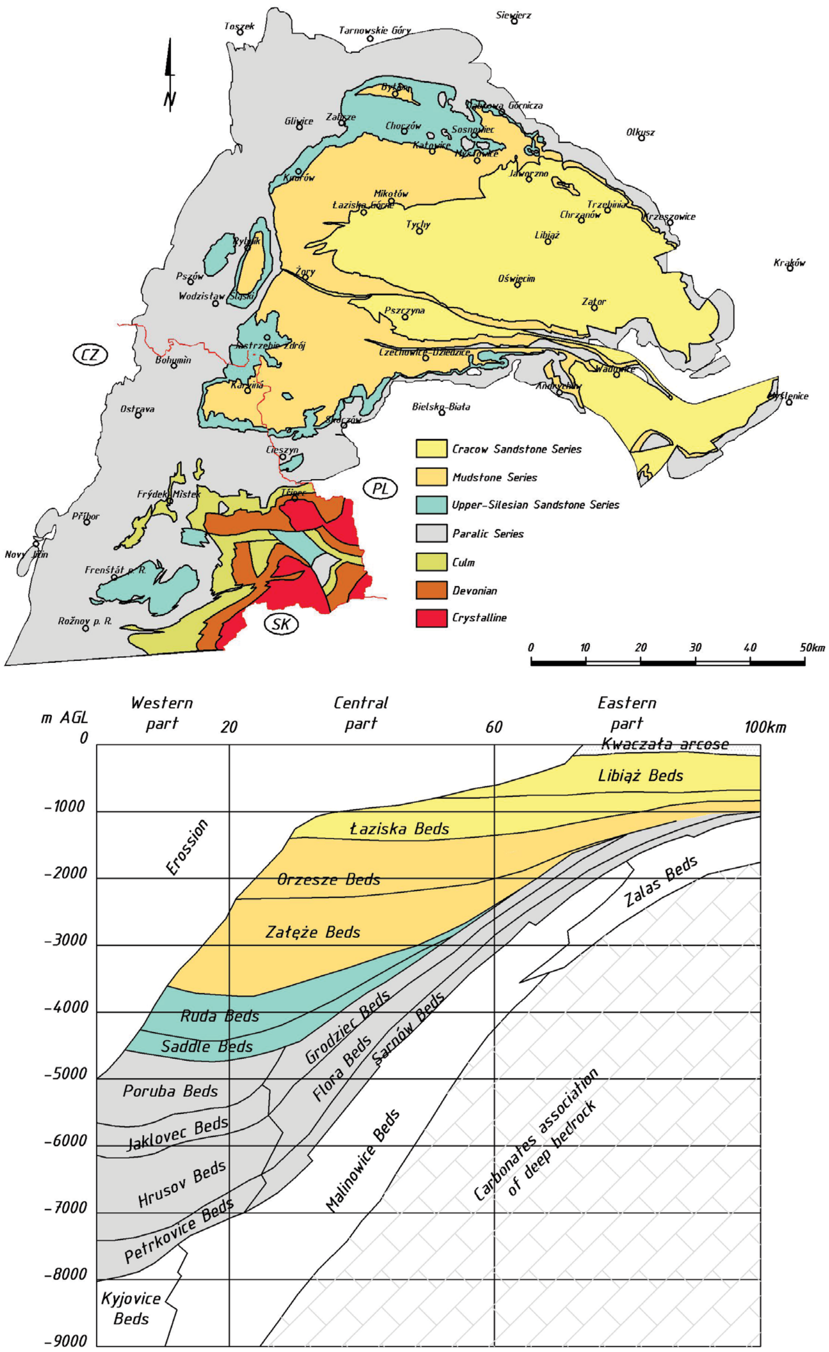

Fig. 1. Sketch of geological composition of the USCB (A) and litho-stratigraphic series of productive Carboniferous layers of the USCB (B) (Probierz et al. 2012)

Rys. 1. Szkic budowy geologicznej GZW (A) i serie litostratygraficzne karbonu produktywnego GZW (B)

Table 1. Stratigraphy of Upper Silesian Coal Basin (Probierz et al. 2012)

Tabela 1. Stratygrafia Górnośląskiego Zagłębia Węglowego

Eonothem/Eon (ICS 2013)	Erathem/Era	System/Period	Series/Epoch	Stage/Age	Heerlen 1935: Eonothem/Eon	Erathem/Era	System/Period	Series/Epoch	Stage/Age	Substage	Orogenesis	Complex	Lithostratigraphic division (series)	Lithostratigraphic division (beds)	Limiting horizons	after T. Bocheński and S. Doktorowicz-Hrebnicki (1952)	for continental sediments after S. Stopa (1957, 1967, 1977)	for Czech part of basin after M. Dopita (1967)
Phanerozoic	Paleozoic	Carboniferous	Pennsylvanian – Upper	Gzhelian	Phanerozoic	Paleozoic	Carboniferous	Upper (Siles, Silesian)	Stephanian	C							Stratigraphic gap	
				Kasimovian						B				Kwaczała arcose				
										A				Stratigraphic gap				
			Middle	Moscovian					Westphalian	D	Astrurias	Coal Ortomolasse	Cracow Sandstone Series	Libiąż Beds	seam 119	Libiąż Beds	Libiąż Beds	
										C	Leon			Łaziska Beds	seam 209	Łaziska Beds	Chełm Beds; Łaziska Beds	
			Lower	Bashkirian						B	?		Mudstone Series	Orzesze Beds	tuff horizon	Orzesze Beds	Orzesze Beds	
										A				Załęże Beds	seam 401; seam 406, 407		Załęże Beds: Dębieńsko com., Żory complex, Świerklany com., Boryna complex	Doubrava Beds; Sucha Beds – Upper
									Namurian	C			Upper Silesian Sandstone Series	Ruda Beds sensu stricto	seam 501	Ruda Beds	Ruda Beds sensu stricto	Sucha Beds – Lower
										B				Zabrze Beds	seam 510	Saddle Beds	Zabrze Beds	Saddle Beds
			Mississippian – Upper	Serpukhovian						A	Ore Mountains			Jejkowice Beds	Gaebler	Poruba Beds	for Dąbrowa region*	Stratigraphic gap
												Coal Paramolasse	Paralic Series	Poruba Beds	Barbara		Grodziec Beds	Poruba Beds
														Jaklovec Beds	Enna	Jaklovec Beds		Jaklovec Beds
														Hrusov Beds	polishing slate hor.	Hrusov Beds	Flora Beds	Hrusov Beds
														Petrkovice Beds	Stur	Petrkovice Beds	Sarnów Beds	Petrkovice Beds
											Sudeten	Flysch		Zalas Beds			Malinowice Beds	Kyjovice Beds; Hradec Beds
			Middle	Visean				Lower (Dinant)	Upper Visean									Moravice Beds
			Lower	Tournaisian														

* after S. Doktorowicz-Hrebnicki (1935); 117–920 (PL) and 009–962 (CZ) – coal seams numbers; ● – sea horizons

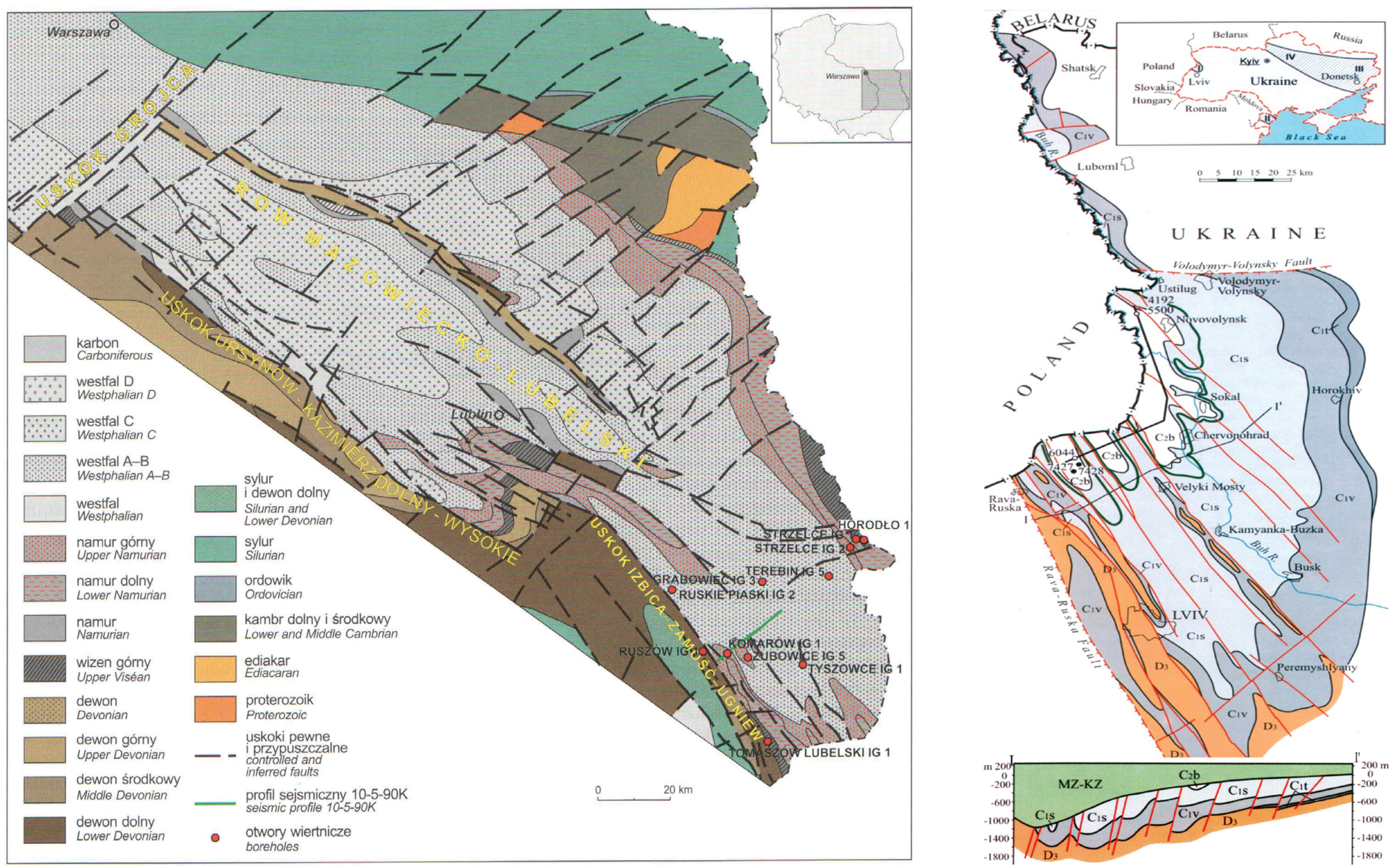

Fig. 2. Sketch of geological composition of the Polish and Ukrainian part of the basin: Lublin Coal Basin (A), Lvov-Volyn Coal Basin (B), after (Paczesna 2014; Shulga et al. 2007)

Rys. 2. Szkic budowy geologicznej polskiej (A) oraz ukraińskiej (B) części zagłębia: Lubelskie Zagłębie Węglowe (A), Lwowsko-Wołyńskie Zagłębie Węglowe (B)

The basement series occurring deeply in the litho-stratigraphic profile of Upper Silesian Coal Basin in the form of crystalline Precambrian rocks as well as Cambrian, Devonian, lower Carboniferous Kulm and coal limestone formations do not take part in the process of wastes disposal in the dumps. The oldest rocks occurring in the Upper Silesian waste dumps are represented by upper Carboniferous paralic series (Namur A) including following layers: pietrzkowickie, gruszowskie, jaklowieckie and porębskie. They represent mostly sandstones, siltstones and claystones deposited mostly on dumping grounds in western part of the USCB (Gawor 2008; Probierz et al. 2017).

The younger litho-stratigraphic series in USCB is limnic Upper Silesian sandstone series (Namur B and C), where saddle layers (Zabrze layers) and Ruda layers may be counted.

Predominant waste material in this case is represented by sandstones disposed mainly in the dumps of central and northern part of the USCB. Another series in the profile of upper Carboniferous of the USCB belong to the limnic siltstone series (Westphal A and B), comprising załęskie and orzeskie layers.

Rocks of these series are represented by sandstones, siltstones and claystones disposed on the surface of the entire basin excluding its eastern part.

The youngest part of Upper Carboniferous productive formation of the USCB is made up of the limnic Krakow sandstone series, which occurs generally in the Eastern part of the basin (in the other part it has been eroded) and the łaziskie and libiąskie layers belong to this formation. Waste rock are represented in this case mainly by sandstones, disposed in the dumps in the central and eastern part of the USCB. Rocks of overburden, created by layers of Permian, Triassic, Jurassic, Paleogene, Neogene and Quaternary may occur in the dumps.

On in the only dump in Lublin Coal Basin – Bogdanka – is it hard to find the rocks of a Carboniferous basement, as it is built of different age rocks, from Proterozoic granites to Upper Devonian rocks and Upper wizen sediments (e.g. diabases, tuffs, limestones) occurring above them. There are no Upper Carboniferous sediments and waste rocks disposed in Bogdanka waste dump, which represent the youngest layers of Carboniferous profile which consists of: sandstones, mudstones, siltstones and limestones, including siderites. The presence of overburden rocks e.g. *Rotliegendes* and *Zechstein* Permian sediments, Middle and Upper Jurassic (sandstones, limestones, dolomites, marls), Upper Cretaceous (sandstones with phosphorites, marls, chalk), Paleogene, Neogene and Quaternary may be observed (Shulga et al. 2007; Paczesna 2014; Probierz and Marcisz 2010).

2. Data and methodology

The source material for the research included statistical data within the localization of particular dumps, obtained from both archival materials as well as available printed materials e.g. books, research papers (Gawor and Kwaśny 2015; Probierz et al. 2017, 2018; Sikorska-Maykowska 2001).

The first stage comprised cameral works, where an inventory of 38 waste dumps, coming from 27 mines and 32 deposits, was conducted on the basis of analysis and verification of gathered data Table 2).

The situation of particular dumps was verified at the beginning on the basis of available topographic maps, orthophotomaps and actual aerial photographs and then during field works (making of low-level aerial photographs using UAV).

The result of this stage is a map of a coal mining waste dump (Fig. 3).

Another stage of the research regarded the valorization of the dumps with the use of the repeatedly presented method, comprising: the name of the dump, coal mine from where the disposed wastes originate, state of the dump, surface of the dump, art of technical and biological reclamation, accessibility of the object and possibilities of coal recovery (Table 2). The results of valorization have been placed on the map (Fig. 3 and 4).

An attempt of defining potential possibilities of recovery of coal from the dumps and connecting of quality of coal in the deposit and in waste material was taken on the basis of the obtained and elaborated data.

3. Results

An analysis of source materials, their verification and an inventory made it possible to valorize 38 coal mining waste dumps belonging to 27 mines: Anna, Bobrek-Miechowice, Bolesław Śmiały, Borynia, Brzeszcze, Chwałowice, Dębieńsko, Halemba, Jan Kanty,

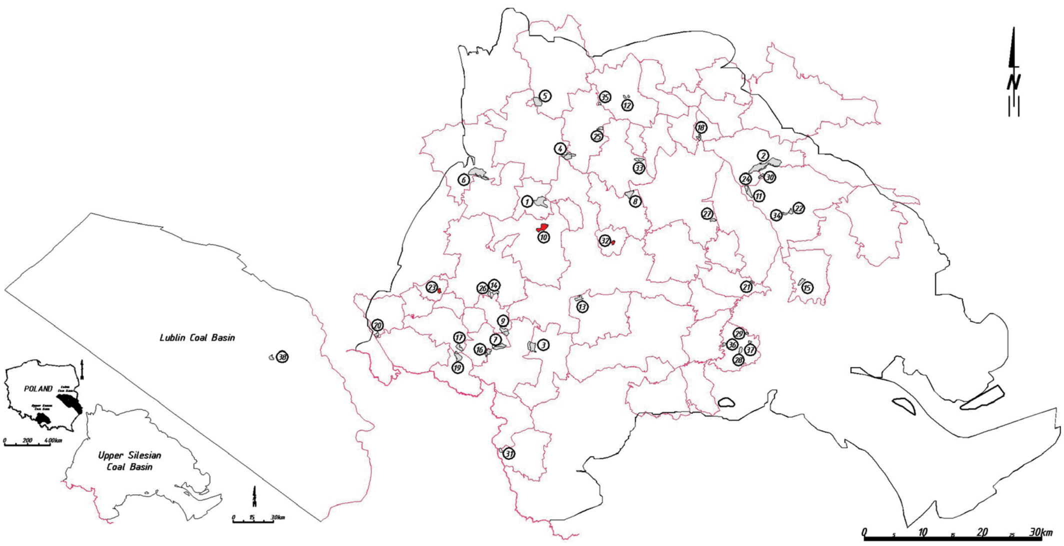

Fig. 3. Distribution of valorized dumping grounds within Upper Silesian Coal Basin (USCB) and Lublin Coal Basin

Rys. 3. Rozmieszczenie zwaloryzowanych zwałowisk w granicach Górnośląskiego i Lubelskiego Zagłębia Węglowego

Table 2. Coal mining waste dumps after valorization

Tabela 2. Zwaloryzowane zwałowiska odpadów pogórniczych

L.p.	Name	Localization	Coal mine	State	Surface $m^2 \cdot 10^4$	Technical reclamation	Biological reclamation	Accessibility	Possibility of coal recovery
1.	CZOG	Knurów	Different mines	NZP	255,1	ST	M	++	+
2.	Maczki-Bór	Sosnowiec-Jaworzno	Different mines	NZP	211,0	P	B	++	+
3.	Kościelniok	Pawłowice--Jastrzębie-Zdrój	Pniówek	NZP	193,6	ST	M	++	+
4.	No. 1	Gliwice-Zabrze	Sośnica-Makoszowy	NZP	108,8	ST	M	++	+
5.	Przezchlebie	Zbrosławice	Different mines	NZP	141,0	K	M	++	+
6.	Smolnica	Sośnicowice-Pilchowice	Different mines	NZP	138,8	ST	M	++	-
7.	Pochwacie	Mszana--Jastrzębie-Zdrój	Zofiówka	NZP	137,1	K	Z	++	+
8.	Panewniki	Mikołów	Halemba	NZP	118,4	ST	M	+	+
9.	Borynia-Jar	Świerklany--Jastrzębie-Zdrój	Borynia	NZP	97,0	K	Z	++	+
10.	Mine dump	Czerwionka-Leszczyny	Debieńsko	ZP	97,0	S	M	++	+
11.	Wysoki Brzeg	Jaworzno	Sobieski	NZP	78,8	K	M	++	+
12.	1–4 on Ruch I	Bytom	Bobrek-Miechowice	NZP	73,2	K	M	++	+
13.	At the plant	Suszec	Krupiński	NZP	70,7	ST	M	++	+
14.	A area	Rybnik	Jankowice	NZP	69,0	K	M	++	+
15.	At Krakowska street	Libiąż	Janina	NZP	66,0	ST	M	++	+
16.	Jas-Mos	Mszana-Jastrzębie-Zdrój	Jas-Mos	NZP	62,7	ST	M	++	+
17.	Reclamation facility	Wodzisław Śląski	Marcel	NZP	56,2	ST	M	++	+
18.	At Węglowa street I and II	Czeladź	Saturn	NZP	47,0	K	M	++	+
19.	Krostoszowice	Godów-Wodzisław Śląski	Marcel	NZP	45,0	K	M	++	+

Table 2. cont.

Tabela 2. cd.

L.p.	Name	Localization	Coal mine	State	Surface $m^2 \cdot 10^4$	Technical reclamation	Biological reclamation	Accessibility	Possibility of coal recovery
20.	Buków	Lubomia-Gorzyce	Anna	NZP	44,0	ST	M	++	-
21.	Paciorkowce	Bieruń	Piast	NZP	40,0	K	M	++	+
22.	Piłsudski area	Jaworzno	Jaworzno	NZP	38,0	ST	B	++	+
23.	Szarlota	Rydułtowy	Rydułtowy	ZP	37,8	S	M	++	-
24.	Zdzicha	Jaworzno	Jaworzno	NZP	35,5	K	M	++	+
25.	Ruda	Zabrze	Zabrze-Bielszowice	NZP	39,6	K	M	++	+
26.	Mud settlement area	Rybnik	Chwałowice	NZP	37,0	ST	B	++	+
27.	KWK Wesoła	Katowice	Wesoła	NZP	34,8	K	M	++	-
28.	E	Brzeszcze	Brzeszcze	NZP	34,7	ST	M	++	+
29.	Buczaki	Brzeszcze	Brzeszcze	NZP	34,2	R	B	++	-
30.	Marian Wschód	Sosnowiec-Jaworzno	Jan Kanty	NZP	33,9	K	Z	++	+
31.	Pogwizdów	Hażlach	Morcinek	NZP	33,4	ST	M	+	+
32.	Skalny	Łaziska Górne	Bolesław Śmiały	ZP	32,0	K	Z	++	-
33.	1–5	Ruda Śląska	Polska-Wirek	NZP	32,0	ST	M	++	+
34.	H field	Jaworzno	Jaworzno	NZP	31,5	K	M	++	+
35.	F-1 field	Bytom	Bobrek-Miechowice	NZP	30,9	ST	B	++	+
36.	F	Brzeszcze	Brzeszcze	NZP	30,4	ST	Z	++	+
37.	G	Brzeszcze	Brzeszcze	NZP	30,0	ST	M	++	+
38.	Bogdanka	Puchaczów	LW Bogdanka SA	NZP	88,0	K	M	++	+

State of the dump: NZP – not endangered by fires, ZP – endangered by fires; Technical reclamation: K – landscape, P – sublevel, R – dismounted, ST – tabular; Biological reclamation: L – forest direction (afforestation), M – mixed reclamation (grass areas and trees), Z – grass areas, B – lack of reclamation; Accessibility of the object: – – fenced, + – dirt road, ++ – hardened road; Possibility of coal recovery: – – burned dump, + – non-burned dump.

Janina, Jankowice, Jas-Mos, Jaworzno, Krupiński, Marcel, Morcinek, Piast, Pniówek, Polska-Wirek, Rydułtowy, Saturn, Sobieski, Sośnica-Makoszowy, Wesoła, Zabrze-Bielszowice, Zofiówka and LW Bogdanka SA and situated within the administarative boundaries of 28 municipalities belonging to the Silesian Province: Bieruń, Brzeszcze, Bytom, Czeladź, Czerwionka-Leszczyny, Gliwice, Gorzyce, Hażlach, Jastrzębie-Zdrój, Jaworzno, Katowice, Libiąż, Lubomia, Łaziska Górne, Mikołów, Mszana, Pawłowice, Pilchowice, Ruda Śląska, Rybnik, Rydułtowy, Skrzyszów, Sosnowiec, Sośnicowice, Suszec, Świerklany, Zabrze, Zbrosławice as well as one Lublin Province municipality (Puchaczów). The results are presented in Table 2, Figs 3–4.

Twenty seven mines disposed of their waste on 38 dumping grounds located within the boundaries of 29 municipalities. Only three of the mining waste dumps in question come under threat of fire, namely Czerwionka-Leszczyny, Szarlota and Skalny dumps.

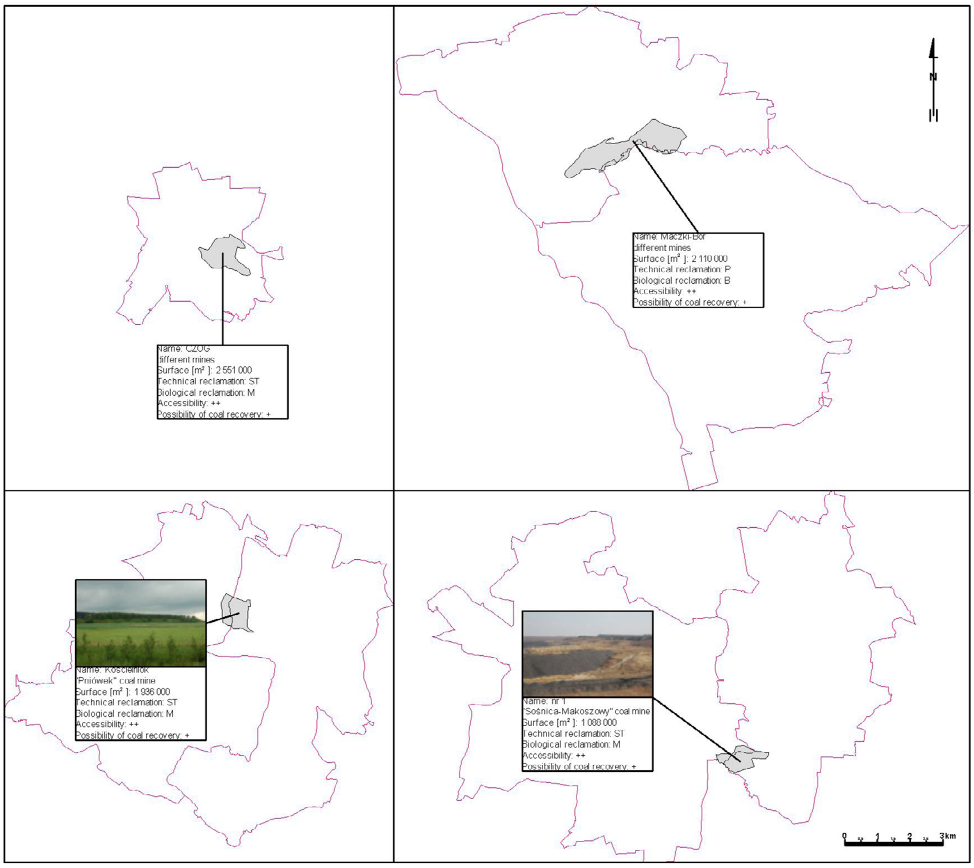

Fig. 4. Maps of selected coal mining waste dumps with the surface of over $100 \cdot 10^4$ m^2

Rys. 4. Mapy wybranych zwałowisk po górnictwie węgla kamiennego o powierzchni ponad $100 \cdot 10^4$ m^2

The surface of analyzed facilities ranges from 300,000 (the dump in Brzeszcze) to 2,551,000 m^2 (CZOG in Knurów). There are tabular dumps in the majority of the facilities (17). Fourteen represent the category of landscape dumps, two belong to conical type (the aforementioned Czerwionka-Leszczyny mine dump and Szarlota), one represents the sub-level type (Maczki-Bór), and one has already been dismantled (Buczaki dump).

25 of the analyzed dumps represent mixed type of biological reclamation (including afforestation and sodding), five have been reclaimed as grass areas, while five haven't been reclaimed at all (lack of reclamation). The majority of the dumps are easily accessible thanks to hardened roads leading to them.

Two (the Panewniki dump in Mikołów and Pogwizdów dump in the Hażlach municipality) can be approached only via dirt roads, which does not make them less accessible though. All the facilities have the surface of over $30 \cdot 10^4$ m^2 and only six of them are burned dumps.

Field research results in the form of photographic material presenting various genetic types of waste dumps as well as different reclamation and management methods are shown in Fig. 5.

Reclamation activities characterizing the studied waste dumps are both technical – including standard earthworks i.e. shaping the dumps, draining, densification of the waste material, agrotechnical treatment etc. and biological – consisting in soil preparation i.e. fertilization as well as a proper choice of plants and their growth (sodding in particular).

Initial soils_originating on waste rocks are characterized by fast disintegration (weathering) and a change of granulation within the surface layer, which results mainly from (Patrzałek 2006; Patrzałek and Gawor 2008):

- the presence of coal substance,
- leaching of alkaline ions,
- predominance of kaolinite and illite in the mineral composition and ensuing a small sorptive complex,
- pirite decomposition and high acidity accompanied by dynamically changing reaction over a wide pH range 7.0–2.5,
- deficiency of nutritive elements, such as phosphorus and nitrogen, that are necessary for plants.

What poses a considerable threat to the environment is waste dump fires which make the use and management of such areas difficult or even impossible.

Waste dumps used to or/and still start burning if sulphur content is higher than 3.0–3.5% and that of coal exceeds 10%.

Burning waste dumps cannot be further used. However, the rock material which has undergone burning processes is a valuable raw material and can be used, inter alia, in road and hydrotechnical construction works.

Coal mining waste can also be used in industry, either directly (without prior processing) – as a material in road and hydrotechnical construction works, underground mining technologies as well as in land levelling and the reclamation of degraded areas, or after mechanical preparation in road construction and thermic preparation for the purposes of construction materials production (Ostręga and Uberman 2005, 2010).

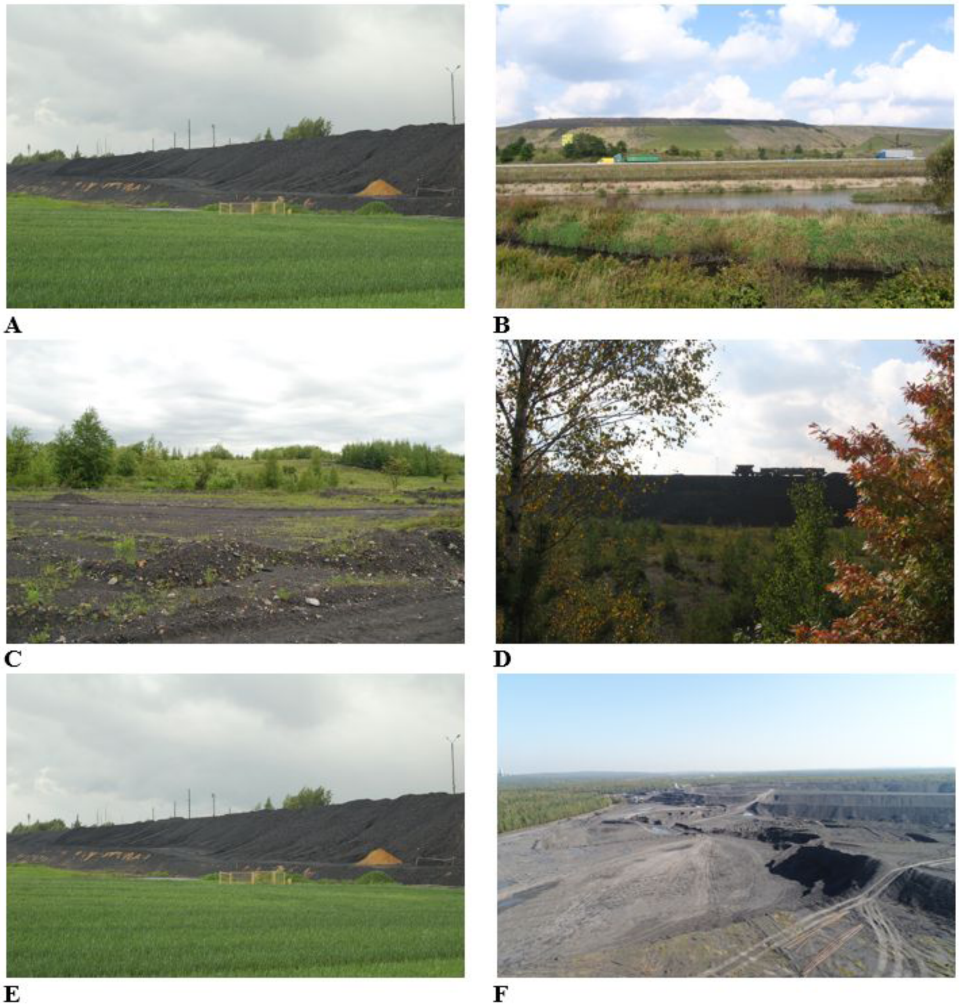

Fig. 5. Photographs of selected waste dumps with the surface of over $100 \cdot 10^4$ m^2
A – Kościelniok (Pawłowice), B – No. 1 (Zabrze), C – Przezchlebie (Zbrosławice), D – Smolnica (Sośnicowice), E – Pochwacie (Jastrzębie-Zdrój), F – Panewniki (Mikołów). Photos by Ł. Gawor

Rys. 5. Fotografie wybranych zwałowisk o powierzchni ponad $100 \cdot 10^4$ m^2
A – Kościelniok (Pawłowice), B – Nr 1 (Zabrze), C – Przezchlebie (Zbrosławice), D – Smolnica (Sośnicowice), E – Pochwacie (Jastrzębie-Zdrój), F – Panewniki (Mikołów). Fot. Ł. Gawor

Such parameters of the studied facilities as: their surface, state of waste material (burned/ /not burned) and quality of coal contained in the waste material need to be taken into consideration when establishing the potential possibilities of coal recovery from the waste material.

Rocks, including coal, encountered on the dumps are usually weathered material, affected by changeable or even extreme weather conditions (from insolation to frost wedging).

As far as quality is concerned, it is essential to remember that there is a close connection between such an environment and the nature of waste rocks, properties of which significantly differ from those of rocks occurring in deposits.

The intensity of changes varies, depending mainly on the type of rock (lithology), original depth of occurrence and stratigraphic belonging (i.e. layer). What matters above all else though, is the exposure time on the dump and the weather conditions.

In terms of the potential use, coal can be divided into two groups:

- power coal used for the purposes of energy market: types 31, 32, 33, 38, 41, 42, 43, according to PN-82/G-97002;
- coal used in chemical processing: types 33-37.

As regards waste material it is only the power coal that counts, as it can be used in combustion processes and could therefore be processed and adapted for such purposes. Power coal, understood in that sense, can be found in the studied facilities in various quantities and proportion (Fig. 6).

The lowest coal type, i.e. 31.1-32.2, can be encountered in such dumps as (e.g.): Paciorkowce in Bieruń as well as in Czeladź (ul. Węglowa I and II). Types 32-33 are to be

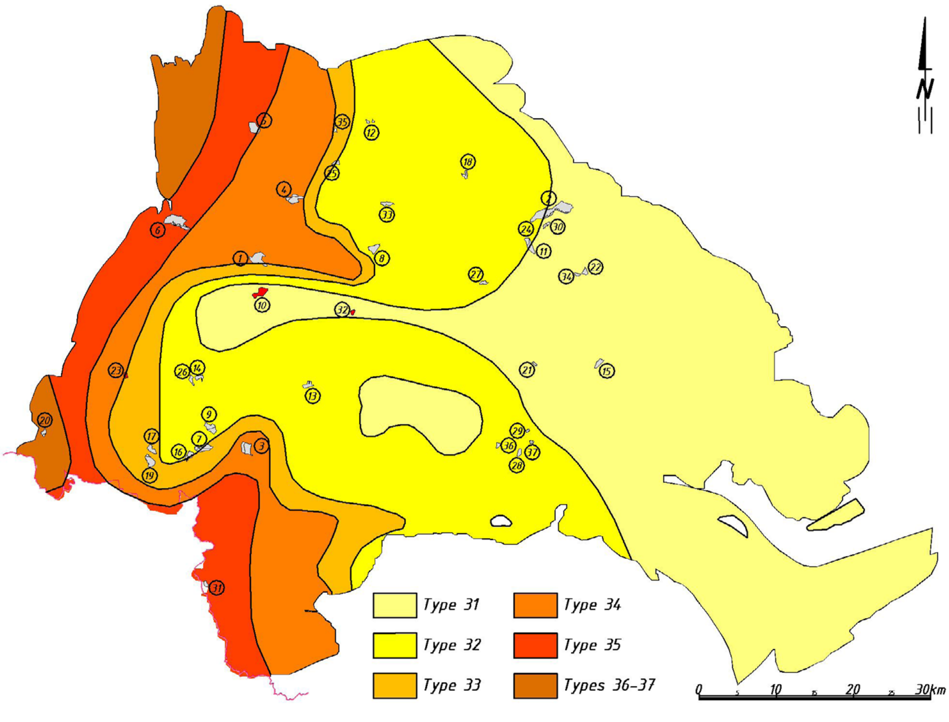

Fig. 6. Location of the investigated dumps against the background of coal types distribution in accordance with PN-82/G-97002 and within the boundaries of the USCB (Probierz et al. 2012)

Rys. 6. Lokalizacja analizowanych zwałowisk na tle rozmieszczenia typów węgla kamiennego według PN-82/G-97002 w granicach GZW found in Bytom: dumps 1-4 in Ruch I and Pole F-1. A wider range of types: 31.1-33, can be observed, i.a., in the KWK Wesoła dump in Katowice, and wider still (types 31.1-34.2), in the following dumps: Buków in Lubomia-Gorzyce, Świerklany in Świerklany, district A and shaft VI area in Rybnik, Szarlota in Rydułtowy (Gawor and Kwaśny 2015).

Coking coal is getting more common within such dumps as: company dump in Suszec (types 32.2-35.1), Ruda in Zabrze (types 31.1-35.2B), No 1 in Gliwice-Zabrze (types 32.2--35.2B), Kościelniok in Pawłowice-Jastrzębie-Zdrój (types 33-35.2B), Pochwacie in Mszana--Jastrzębie-Zdrój (types 34.2-37.1). Proper coking coal representing type 35.1-37.2 can be found on waste dumps in Jastrzębie i.e. Borynia-Jar (in Świerklany-Jastrzębie-Zdrój) and Jas-Mos (in Mszana-Jastrzębie-Zdrój).

Answering questions concerning the quantity and location of waste material (including coal) within particular coal mining waste dumps can be problematic, due to technical issues.

To comply with geological and mining rules, a borehole should be made, the specific profile of which would encompass all the layers of the dump, from the top to the low-lying area (or even several meters of subsoil), and that would result in the aeration of the facility and the ensuing fire or self-ignition hazard (Nieć 1999; Radwanek-Bąk 2002, 2015).

Consequently, if safety is to be taken into consideration (which is the case), the drilling of the recommended number of exploratory boreholes (i.e. 1 hole/10^2 m^2) without permission (obtaining of which would require providing fair justification for taking such an action) has become virtually impossible (not to mention the financial aspect related to drilling works).

Reclamation and management of coal mining waste dumps is a long-lasting process that requires considerable capital expenditure. All the dumps with the surface of over $30 \cdot 10^4$ m^2 are suitable for interesting or even spectacular reclamation. What may pose a problem though, is common lack of financial resources that could be spent on reclamation projects. The aspects that are even more problematic are: difficulties in ensuring continuity of financing and facility management as well as lack of proper host. The "Wrzosy" waste dump in Pszów is a good example of the aforementioned problems. After an interesting and costly transformation into sports facilities (courts, pitches) the area was not properly managed or supervised and quickly degraded.

Overly complicated site development plans which have to include facility location and potential users may also be a problem. There is no doubt that large infrastructure projects could be carried out and financed mainly with the use of part of the profit generated from the coal recovery processes. Money coming from that source should be provided for at the investment feasibility study stage (Kudełko et al. 2005).

At present, there are no implemented big coal mining waste dumps management plans or projects within the USCB and Lublin Coal Basin, although certain steps were taken e.g., in the case of the Szarlota or Przezchlebie dumps. In their case, design contests were organized as regards development plans.

When taking the trends in recultivation and management of coal mining waste dumps prevailing in the European coal basins into account, it is worth paying attention to the educational aspect e.g., creating educational trails, information boards and different types of geotourist infrastructure. Projects of that type have been carried out in the Ruhr district in Germany (Grosses Holz dump in Kamen) or in Ostrava-Karvina Basin in the Czech Republic (Ema waste dump). Projects of this type are much less expensive and easier to maintain in comparison to such spectacular projects as ski slopes. Moreover, their educational values make access to various EU funds possible.

Summary

The research results have shown that in spite of the initial information proving that the majority of the studied coal mining waste dumps are potentially suitable for coal recovery from waste material, it may be economically justified in only approximately half of the cases (coal types 32-34, with the exception of coking coal).

Other limiting factors, which may be observed in such dumps as Smolnica, Przezchlebie, Panewniki, Czerwionka or Buków, are the present (or past) recovery attempts as well as the fact that some waste material is of burned type.

Having excluded the above-mentioned facilities, we are left with 13 in the case of which recovery processes seem to be economically justified. These waste dumps are situated in: Bytom, Brzeszcze, Czeladź, Godów, Gliwice, Hażlach, Knurów, Ruda Śląska, Rybnik, Suszec, Wodzisław Śląski and Zabrze.

In some of the largest facilities (Jastrzębie region), the main factor limiting recovery is the coking coal content. Nevertheless, the large surfaces of these dumps will possibly make them subjects of further investigation.

What is crucial, is the fact that none of the studied dumps have undergone self-ignition or fires.

Coal mining waste dumps should be subject to reclamation processes, with the aim of diminishing their inconvenience for the surroundings and creating facilities that could be used for either generating profit or the benefit of the society.

It is a complicated process and should be carried out simultaneously with recovery processes, or even financed from the profit generated by such recovery.

Reclaimed and managed waste dumps, just as the other post-mining areas, can and should be transformed not only into attractive recreation facilities but also landmarks being elements of the cultural landscape.

It should be emphasized that the financing of waste dumps reclamation and management processes should be provided for at the stage of the investment feasibility study and from the coal recovered from the waste material deposited on a given dump.

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POSSIBILITIES OF RECLAMATION AND USING OF LARGE-SURFACE COAL MINING DUMPING GROUNDS IN POLAND

Keywords

hard coal mining, coal waste dumping ground, reclamation, waste management

Abstract

There was done an inventarization of 41 coal mining dumping grounds, gathering waste material from 27 mines. Considering the fact, that five mines belong to multi-motion plants the research comprised 32 hard coal deposits. Source data with localization of particular dumps have been obtained from archival materials from the mines and municipalities, in the boundaries where the dumps occur as well as free accessible published materials (books, scientific papers). The data have been verified, in the beginning on the basis of topographical maps, orthophotomaps and aerial photographs and then, after vision done during field works they have been drawn on the topographic base, what resulted in creating the map of post-mining dumping grounds. Valorisation of coal mining waste dumps, using already repeatedly presented method, included defining of: name of the dump, coal mine from where the wastes come from, state of the dump, surface of the dump, type of technical and biological reclamation, accessibility of the object, possibilities of recovery of coal and the results have been drawn on the map. On the basis of collected and elaborated data there was done an attempt of defining of potential possibilities of recovery of coal from the dumps and connecting of coal quality in exploited deposits and coal content in waste material. The results showed that in spite of initial information that the majority of the dumps comprise potential objects of coal recovery of coal from waste material, eventually only in some cases (thirteen objects) the recovery seems to be economically justified.

MOŻLIWOŚCI REKULTYWACJI I ZAGOSPODAROWANIA WIELKOOBSZAROWYCH ZWAŁOWISK PO GÓRNICTWIE WĘGLA KAMIENNEGO W POLSCE

Słowa kluczowe

górnictwo węgla kamiennego, zwałowisko odpadów powęglowych, rekultywacja, zagospodarowanie odpadów

Streszczenie

Dokonano inwentaryzacji 41 zwałowisk odpadów pogórniczych pochodzących z 27 kopalń. Z uwagi na fakt, że pięć kopalń są kopalniami wieloruchowymi, badania objęły swoim zasięgiem aż 32 złoża węgla kamiennego. Dane źródłowe (wraz z miejscami lokalizacji poszczególnych zwałowisk) pozyskano, zarówno z materiałów archiwalnych, jakimi dysponują zakłady górnicze i urzędy miast (w granicach których występują te zwałowiska), jak również z powszechnie dostępnych materiałów opublikowanych (tj. książek, monografii, artykułów naukowych). Zweryfikowane, początkowo na podstawie dostępnych map topograficznych, ortofotomap oraz aktualnych zdjęć lotniczych, a następnie na podstawie wizji w ramach prac terenowych, dane zostały naniesione na podkład topograficzny, czego rezultatem jest mapa zwałowisk odpadów pogórniczych. Waloryzacja zwałowisk, wykorzystująca wielokrotnie już zaprezentowaną metodę, obejmowała określenie: nazwy zwałowiska, kopalni, z której pochodzą zwałowane odpady, stanu zwałowiska, powierzchni zwałowiska, rodzaju rekultywacji technicznej i biologicznej, dostępności obiektu oraz możliwości odzysku węgla, zaś jej wyniki zostały naniesione na wykonaną uprzednio mapę. Na podstawie zebranych i opracowanych danych podjęto próbę określenia potencjalnych możliwości odzysku węgla ze zwałowisk oraz powiązania jakości węgla w złożach eksploatowanych i węgla w materiale odpadowym. Wyniki badań wykazały, iż pomimo wstępnej informacji, że większość badanych zwałowisk stanowi potencjalne obiekty odzysku węgla z materiału odpadowego, ostatecznie tylko w kilkunastu przypadkach (trzynaście obiektów) odzysk ten wydaje się ekonomicznie uzasadniony.