

RYSZARD UBERMAN¹

Mineral waste in light of the provisions of the Act on waste, the Act on extractive waste, and the Geological and mining law

Introduction

Economic and social development requires resources, among which a significant role is played by mineral raw materials produced practically from the beginning of humanity. However, their resources are non-renewable and largely exhaustible, especially taking the increasingly difficult conditions of occurrence and the limited possibilities of extraction and processing into account. A systematic increase in the demand for mineral raw materials, with limited possibilities of obtaining them from primary sources (mineral deposits), makes it necessary to use materials obtained from secondary sources. These may be waste stored in landfills, including waste from the current production, as well as raw materials that can be recovered e.g. by recycling of used equipment, products, etc. (Andersen 2007; Ellen 2012). Taking the insufficient supply of mineral resources from primary sources into account, especially in Europe, it is necessary to reach for secondary raw materials in order

✉ Corresponding Author: Ryszard Uberman; e-mail: uberman@min-pan.krakow.pl

¹ Mineral and Energy Economy Research Institute of the Polish Academy of Sciences, Kraków, Poland;
ORCID iD: 0000-0001-7273-3041; e-mail: uberman@min-pan.krakow.pl



© 2021. The Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution-ShareAlike International License (CC BY-SA 4.0, <http://creativecommons.org/licenses/by-sa/4.0/>), which permits use, distribution, and reproduction in any medium, provided that the Article is properly cited.

to balance the needs of the economy. An additional argument in favor of undertaking such activities is also the necessity to limit the negative impacts of the exploitation of mineral resources and waste disposal on the environment. Waste utilization eliminates the need to occupy large areas of land for the exploitation of new mineral deposits and restores areas used for landfills to alternative functions (after reclamation). The recovery of raw materials from stored waste allow for) the elimination, or at least a significant reduction, of waste from the current production, is in line with the principles of a circular economy, which corresponds to the idea of sustainable development ([Resolution CM 2019](#); [Transformation map 2019](#); [Kulczycka 2019](#)).

To achieve this goal, it is necessary to update the formal and legal aspects of waste management, which should, by definition, ensure the implementation of the circular economy model and waste hierarchy. Unfortunately, the current legal regulations do not take the specific conditions of mining industry in waste management into account. One of the main reasons for this is the fact that individual types of excavated materials are often classified as waste instead of products.

Improving the mining process and processing technologies using mineral raw materials should, apart from improving the formal and legal aspects, be among the priority tasks in implementing the principles of the circular economy.

Solutions for the exploitation of mineral deposits ensuring the comprehensive and rational use of mineral raw materials were presented on the example of opencast mining. On a side note, it should be noted that legal regulations were introduced relatively recently, but technical and organizational improvements to mining and processing activities, aimed at the comprehensive use of deposits and minimizing the amount of waste, were undertaken in Poland already in the 1980s ([SGGW 1990](#)).

The present work is focused on the above mentioned challenges.

1. Sources of mineral raw materials and the importance of mineral waste in the raw material balance of the country

Raw materials, including mineral raw materials, are an indispensable element of any production process and other forms of economic activity.

According to the *Principles of documenting solid mineral deposits* ([ME 2002](#)): “Mineral raw materials are excavated mineral intended for use and useful products of the processing (refining, enrichment) of minerals as well as useful by-products of processing mineral raw materials”.

Starting from the definition of a mineral raw materials, the concept of mineral waste can be formulated as follows:

“Mineral wastes are residues from the prospecting, exploration, extracting and processing of minerals, as well as wastes containing mineral substances from industries transforming mineral raw materials”.

The depletion of mineral deposits and difficulties in meeting the growing demand forced the search for other sources to satisfy the increasing demand.

The following should be mentioned here:

- ◆ minimizing the consumption of mineral raw materials per unit of finished product,
- ◆ substitution of mineral raw materials,
- ◆ extended use of mineral raw materials in continuous processes,
- ◆ preparation of a mineral raw materials for reuse,
- ◆ extending the durability of industrial products,
- ◆ recycling and other forms of recovery of mineral raw materials from waste.

Figure 1 presents mineral raw materials broken down by source. Waste is the main source of secondary mineral resources.

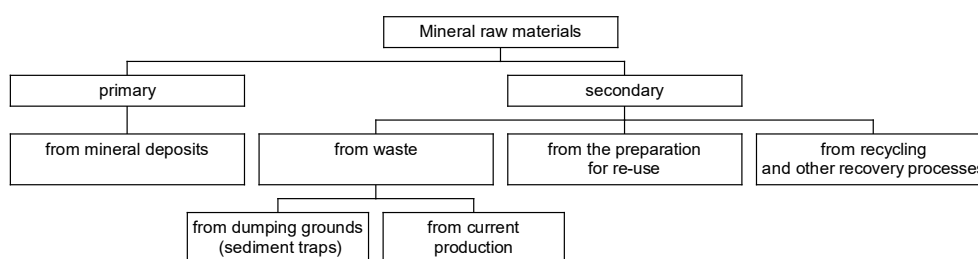


Fig. 1. Mineral resources by source
Source: own work

Rys. 1. Surowce mineralne wg źródeł pochodzenia

In 2019, 114.1 million tons of industrial waste was generated (CSO 2020). Compared to 2018, there was a 1% decrease in industrial waste. The main sources of industrial waste were:

- ◆ Mining: 63.7 million tons (55.8%),
- ◆ Industrial processing: 27.2 million tons (23.8%),
- ◆ Production and supply of electricity, gas, and steam: 14.0 million tons (12.3%),
- ◆ Others 9.2 million tons (8.1%).

In 2019, out of 114.1 million tons of industrial waste generated, 48.9% was recovered and the rest was sent to landfills.

At the end of 2019, there was 1,795 million tons of accumulated waste in landfills (excluding municipal waste). These landfills covered an area of 81 squared kilometers, of which 52.8% were spoil tips, and 47.2% lagoons. These landfills are not reclaimed.

The abovementioned data proves that presently slightly less than half of the industrial waste generated in current production is being recycled. Recent years have shown an increasing use of stored waste. These facts clearly confirm the great importance of using mineral waste in the management of mineral raw materials.

2. Legal regulations on waste management, including waste from mining activities

The problem of legal regulation of waste management resulted from the need to mitigate the effects of the rapid development of industry and consumption after World War II. In the first period of this development, the focus was on maximizing production, which required increasing amounts of raw materials (including mineral raw materials), without paying due attention to the rationality of their use. This resulted in overexploitation of natural resources, the generation of large amounts of post-production and post-consumer waste, and negative environmental impacts.

It was only in the 1970s that attempts were made to assess the effects of excessive industrialization and to include certain aspects of waste management in the legal framework. The starting point for the legal regulation of waste management were studies showing the effects of unlimited development ([Club of Rome 1972](#)). The first legal regulations referred to the effects of industry activity on the environment (air and water protection). Relatively late, only in the second half of the 20th century, the first and fragmentary legal regulations concerning waste management were introduced. The establishment of the European Union has intensified works on the large-scale rationalization of waste management, including the legal regulation of this activity. The following directives, among others, should be mentioned:

- ◆ Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste ([Directive 1999](#)),
- ◆ Council Directive 91/689/EEC of 12 December 1991 on hazardous waste ([Directive 1991b](#)),
- ◆ Council Directive 91/156/EEC of 18 March 1991 amending Directive 75/442/EEC on waste ([Directive 1991a](#)), used for the development of the European Waste Catalogue.

In Poland, some legal regulations on the waste management were introduced only in the 1980s. The Act on the Protection and Management of the Environment of January 31, 1980 ([Act 1980](#)) includes a section covering the issue of waste. For the sake of accuracy, it should be noted that according to Art. 2 of the decree of 6 May 1953 – Mining Law ([ML 1953](#)): “The provisions of the Mining Law apply accordingly to the exploration and extraction of minerals from post-mining dumping grounds”. These dumps were filled with unusable minerals, partings, and gangue (overburden), generally referred to as mining waste.

This provision was clarified in the Act of February 4, 1994, the Geological and Mining Law ([GML 1994](#)). Article 2 of the Act stated that “Unless the Act provides otherwise, its provisions: Art. 2 point 2 “concerning common minerals shall apply respectively to prospecting, exploration, and extraction of mineral resources in waste from mining works and mineral enrichment processes”.

The first Act on Waste was passed only in 1997, excluding the section of provisions relating to waste management from the Act on Protection and Management of the Environment of January 31, 1980. Pursuant to this Act, on December 24, 1997, the Minister of

Environmental Protection, Natural Resources and Forestry issued the Regulation on Waste Classification ([Regulation MEP 1997](#)).

The Act on Waste of June 27, 1997 ([Act 1997](#)) contained the following provisions regarding mining waste:

Article 2 (1). The provisions of the Act also apply to:

Art. 2 (1), point 3. “earth or rock masses, if they are moved or displaced in connection with the implementation of investments or exploitation of minerals”.

Art. 2 (2), point 1: The provisions of the Act do not apply to: “earth or rock masses moved or displaced in connection with the implementation of the investment or the exploitation of minerals, if the local spatial development plan or the decision on building conditions and land development determine the conditions and method of their development”.

The quoted provisions introduced the concepts of “removal” or “displacement of earth or rock masses”. In the case of mining operations, the term “displacement” referred to the implementation of this activity within the mining excavation. On the other hand, “removal of earth or rock masses” referred to activities beyond the boundaries of the mining excavation.

After the first Act on Waste was in force for four years, a new Act on Waste was passed on April 22, 2001 ([Act 2001](#)), which amended the Art. 2, sections 1 and 2 to “Art. 2 (1). The provisions of the Act also apply to the handling of earth and rock masses if they are moved or displaced in connection with the implementation of an investment or exploitation of minerals”. Art. 2 (2) “The provisions of the Act do not apply to earth or rock masses moved or displaced in connection with the implementation of an investment or exploitation of minerals along with their processing, if a local spatial development plan, decision on land development and management conditions, or a building permit specify the conditions and the way of their management”.

The amendment to the Act on Waste of April 27, 2001 changed Art. 2 (2) additionally introducing point 1a, which states that “The provisions of the Act do not apply to earth or rock masses moved or displaced in connection with the extraction of minerals from deposits along with their processing, if a concession for the extraction of minerals from deposits and their processing is granted under the Geological and Mining Law ([GML 1994](#)) or a local spatial development plan for the mining area defines the conditions and the manner of their management”. As a result of further amendments to the Act on Waste status of rock and earth masses was more precisely defined in the Act on Mining Waste of July 10, 2008 ([Act 2008](#)). The current legal status of mining waste is as follows ([Act 2008](#) and [Act 2012](#)).

“The regulations of the Act shall not apply to:

- ◆ Art. 2 (2), point 1: 4: “to earth or rock masses transferred as result of mining activities if the mining license or the mine operations plan approved by a decision based on GML 2011 the local spatial development plan for the mining area defines the conditions and the manner of their management,
- ◆ Art. 2 (2), point 1: 5: The provisions of the Act shall not apply to the overburden, i.e. earth or rock mass removed from the deposit in order to enable the extraction of a useful mineral and dumped in the mining area, as long as it is not classified as waste

within the meaning of the provisions of the Act on Waste of April 27, 2001, and the date and manner of its management are determined in accordance with the provisions of the GML 2011”.

Based on the mentioned regulations it can be concluded that in open-pit mining, earth or rock masses (overburden) displaced and moved from the excavation site are not classified as waste because conducting mining activities requires meeting the conditions specified in Article 2(1) point 1: 4 and 5 of this Act.

Currently, the management of waste, including waste from mineral resources, is regulated by the three following acts:

- 1) a general act, i.e. the Act on Waste of December 14, 2012 ([Act 2012](#)),
- 2) *lex specialis*, i.e. the Act on Mining Waste of July 10, 2008 ([Act 2008](#)),
- 3) the Act regulating the basis of activity constituting the source of extractive waste, i.e. the Geological and Mining Law of June 9, 2011 ([GML 2011](#)), hereinafter referred to as GML.

The above-mentioned acts complement EU regulations and directives that have been implemented in the Polish legal system ([Directive 1991a](#); [Directive 1991b](#); [Directive 2006](#)).

3. Classifications and categories of mining waste and waste from mineral resources

The current regulations governing waste management define basic concepts, classify waste, introduce formal and legal procedures for waste management, and define economic and financial instruments. With regard to terminology and classification, it can be observed that the same terms are defined differently in each act, that the definitions introduced in the three acts are not compatible, and that the definitions are not unambiguous and that there is no general classification of waste. The inconsistent terminology regarding the management of mineral resources in the literature on mining geology is also worth noting ([Glapa and Korzeniowski 2005](#); [Góralczyk ed. 2011](#); [Hausner ed. 2015](#); [Kicki and Sobczyk eds. 2016](#); [Ney ed. 2009](#)).

Therefore, there is an urgent need to review the existing concepts, clarify their definitions, the equivalents of definitions appearing in these acts, and, consequently, make them more precise and systematized. It is necessary to formally legitimize new concepts used in practice and in scientific works, and not included in legal regulations. It is especially urgent to organize the terminology used in the Act on Waste and the Act on Mining Waste in the context of the provisions of the updated Geological and Mining Law ([GML 2011](#)).

The starting point for the verification of regulations is to define the basic elements of the production process, as a result of which products and by-products are generated. The mentioned acts lack definitions of the production process and the product itself. According to a popular encyclopedia ([Encyclopedia 1974](#)) a product is a good resulting from a production process, which is a set of activities aimed at processing raw materials, materials, or semi-finished products into finished products”. As follows from this definition, the concepts

of the production process and the product were defined at the same time. On the other hand, the Act on Waste defines the concept of waste. According to Art. 3(1) point 6, “waste” shall mean any substance or object which the holder discards or intends or is required to discard.

The original definition of waste was formulated in 1980 in the Act on the Protection and Management of the Environment (Act 1980) and was amended several times. The evolution of the legal definition of waste in the context of its application and interpretation in the extraction process, including overburden classification is particularly interesting. In 1985, the Supreme Administrative Court asked the Supreme Court how to qualify the overburden in the light of the provisions of the 1980 Act. The Resolution of the Supreme Court of April 16, 1985 (III AZP2 / 85) adopted the following position (SC 1985): “The Art. 86 (2), point 5 of the Act on the Protection and Management of the Environment shall not apply to a coal gangue landfill created from an overburden removed during the development of a lignite open-cast mine which is a mining plant structure”. The Supreme Administrative Court, bound by the Supreme Court’s decision, issued the following judgment (SAC 1985) on July 16, 1985: “The overburden removed during the construction and operation of a lignite open-cast mine is not a waste for which fees are determined in accordance with Art. 86(2), point 5 of the Act on the Protection and Management of the Environment”.

From the point of view of subsequent changes to the definition of waste, the justification of the judgment is especially interesting: “The concept of waste is far from being precisely defined in physical, technological, and legal terms. There are far-reaching exceptions from the rule that industrial waste is any material that is rendered useless during a manufacturing process and is not used in the economy. The term ‘waste’ is precisely defined in Art. 54 of the Act on the Protection and Management of the Environment. This provision implies that the legislator distinguishes between ‘waste’ and ‘other materials not useful for economic use’. The latter concept includes, among others, overburden in opencast mining”.

The first definition of waste was made more precise in the Act on Waste of June 27, 1997 (Act 1997). According to Art. 3, section 1 of the Act “All objects, solid substances and liquid substances that are not sewage, which are a result of business or human activity and are useless in a place or time in which they arise are considered as waste”. There were some critical comments on this definition. According to A. Lipiński (2000): “The criterion of usefulness or lack of it, however, is extremely important”. The usefulness may be of a technical or economic nature. Determining the boundaries between what is and what is not waste may lead to extremely varied assessments.

The current definition of waste in the Act on Waste, characterized by a high degree of generality, also raises doubts in the context of other terms and definitions related to production processes in mining.

The Act on Waste does not define the concept of a by-product, but pursuant to Art. 10 of this Act “there are established conditions, the fulfillment of which allows us to recognize an object or substance as a by-product”. Recently, in the Act of 20 July 2018, amending the Environmental Protection Law and the Waste Act (Act 2018), the procedure for recognizing an object or substance as a by-product has been changed. As a side note, it should be men-

tioned that the literature on the management of mineral resources provides a definition of a by-product. According to the Encyclopedia of mineral resources, ed. Bolewski A. (1993) “A by-product is a secondary product derived from a production process”. This term underestimated their economic importance. It was replaced by the term “accompanying product” or “co-product”.

Recently, some publications and studies aimed at the analysis of production processes, e.g. in the Opinion of the European Economic and Social Committee on “The processing and exploitation, for economic and environmental purposes, of industrial and mining waste deposits in the European Union” (Opinion EU 2012), postulated to introduce the term co-product. Co-products would be goods with similar utility and economic values, produced in the same production process. These issues, i.e. waste, by-products and co-products, are discussed in detail in the section on the analysis of the mining and processing process in the mining industry.

3.1. Proposal for a general classification of waste by source of origin

The general classification of waste is not provided in any of the analyzed legal acts. In the glossaries of these acts and in their content, the types of waste are listed according to their source. In some cases, a waste catalog can be found in annexes to laws or regulations. For the sake of accuracy, it should be stated that pursuant to Art. 4 of the Act of April 27, 2001 on Waste, the Minister of the Environment issued the Regulation on the Waste Catalogue (Regulation MEP 2001) transposing the Polish law to the so-called European List of Waste (Decision 2000). According to this list, waste, depending on the source of its generation, is divided into 20 groups (two-digit code), subgroups (four-digit code) and types (six-digit code). The criteria for division and some cases of specific classification of waste to individual groups (subgroups) are debatable (Ney ed. 2009), which often results in the limited transparency of statistics and difficulties in data analysis.

When it comes to the general classification of waste in the applicable legal acts, e.g. the Act on Waste mentions municipal, medical, veterinary, green waste, etc. The Act on Mining Waste breaks down waste from mineral resources into waste from prospecting and exploration, extraction, processing, and storage of mineral raw materials. The EU documents mention industrial, mining, metallurgical waste, etc. The above-mentioned examples show that the usage of terminology is inconsistent and, above all, that the classification of waste is not precise and logically structured. For example, in one of the documents, industrial waste is presented as a parallel concept to metallurgical waste. Waste groups such as waste from the energy and chemical industries, etc. are not listed. It is therefore suggested that waste from the energy industry, chemical processing, metallurgy, and the extraction and processing of minerals should be included into a single group of industrial waste within the general classification of waste. At this level, municipal, medical, veterinary, green waste, etc. should be listed next to industrial waste.

An important group of industrial waste, both in terms of the amount and value of secondary mineral resources to be obtained, comprises waste from the demolition of machinery and structures (scrap), construction and road materials and elements, and electrical and electronic equipment.

The source of waste generation would be more determined more precisely at a lower level of classification (Figure 2).

As a side note, it should be mentioned that waste from minerals is a broader term encompassing waste from the prospecting, exploration, and exploitation of deposits, as well as processing and storage of minerals. To avoid terminological dualism, it would be advisable to refer to the extraction waste as a component of mining waste resulting solely from extraction activities, thus not including ones from prospecting, exploration and processing activities. All four types indicated are to be covered by a notion of mining waste.

4. Mining waste in terms of the Geological and Mining Law, the Act on Waste, and the Act on Mining Waste

The extraction and processing processes, the aim of which is to obtain finished products and mineral raw materials for further processing, is illustrated in Figure 3.

When interpreting the definitions of waste from the Act on Waste, it can be concluded that everything that is extracted during the exploitation of the deposit, except for the main and accompanying minerals, may be waste. However, the provisions of the Act on Waste (Article 2) and Act on Mining Waste of July 10, 2008 ([Act 2008](#)) (Article 2(1)) exclude certain types of excavated geological materials, provided that certain conditions are met. Otherwise, excavated geological formations are considered waste. For the sake of accuracy, it should be noted that in order for the exploitation to be legal, the necessary conditions must be met for excluding these geological formations, defined as earth or rock masses, from the provisions of the Act on Waste. Without meeting these conditions, the exploitation of the deposits would not be possible ([Dyka 2011](#); [Radecki 2009, 2012](#)). As a consequence, if certain earth or rock masses are treated as waste, they should be stored in waste treatment facilities. Otherwise, they are considered as overburden, stockpiled in spoil tips or lagoons at mine sites.

The problem of managing mineral deposits is a multifaceted problem due to the diverse geological structure of deposits, specificity of mining exploitation methods, and different classifications of deposit components used in the GML 2011, the Act on Waste and the Act on Mining Waste of July 10, 2008 ([Act 2008](#)).

Figure 4 shows three types of mineral deposits, using simplified lithological cross-sections, and the terminology used to describe deposit parameters, in light of the provisions of the Geological and Mining Law, the Waste Act, and the Act on Mining Waste.

In the process of obtaining mineral resources, two production processes are implemented: mining and processing, consisting of many elementary component activities. Each of the activities of the mining process ends with obtaining various types of mining material, and

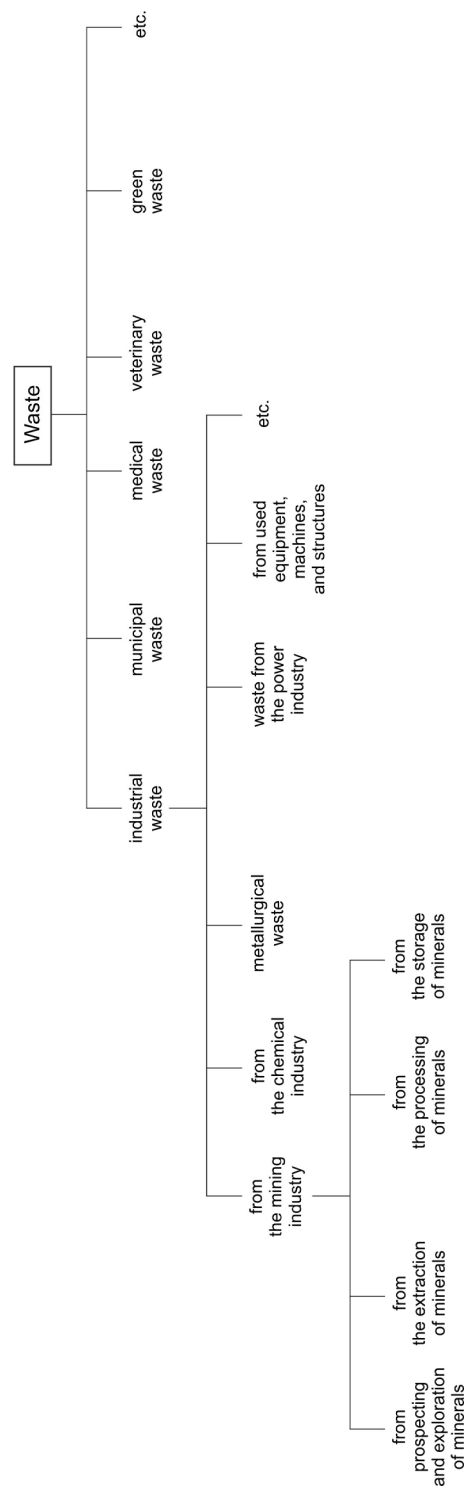


Fig. 2. The proposed general classification of waste
Source: own study

Rys. 2. Propozycja klasyfikacji ogólnej odpadów

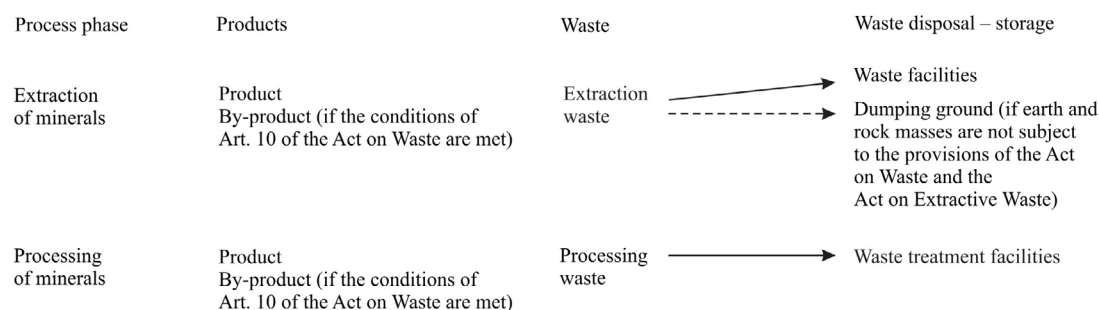


Fig. 3. Scheme of the production process in the mining sector in the light of the provisions of the Act on Waste and the Act on Extractive Waste

Source: own study

Rys. 3. Schemat procesu produkcyjnego w sektorze wydobywczym, w świetle przepisów ustaw o odpadach i o odpadach wydobywczych

in the case of a processing process, with a commercial product or raw material for further processing and waste.

The output obtained in the mining process is classified according to its suitability (economic usefulness), and the terminology used is specific to the industry, different from other types of activity. The specificity of mining terminology is especially visible when compared with the definitions used in the Act on Waste and the Act on Mining Waste. The use of different terms, often describing similar or even the same concepts, makes it difficult not only to explicitly classify the individual types of mining material, but also has legal and financial consequences. In order to address the terminological discrepancies and criteria for qualifying mining output, it is necessary to confront them with the equivalents used in the Act on Waste and the Act on Mining Waste. The scheme, shown in Figure 4, illustrating three lithological profiles of various deposit exploited using opencast mining techniques is helpful in achieving this goal: a) a profile with intrusion, b) a profile with accompanying mineral, c) a profile with two co-occurring minerals.

In the extraction process, the following activities are performed during the exploitation of the deposit:

- a)
 - ◆ soil, if contaminated (i.e. exceeds the soil and ground quality standards referred to in the regulations issued on the basis of Art. 101a p. 5 of the Act of April 27, 2001 – Environmental Protection Law – [Regulation MEP 2016](#)), is disposed of and stored in a landfill; if it is not contaminated, it is used for reclamation, which is regulated by the provisions of the Act on the Protection of Agricultural and Forest Land,
 - ◆ the overburden with partings (if present) is directed to spoil tips and valley fills. If the overburden rocks are suitable for use, they can be placed in the so-called anthropogenic deposits. It should be noted that the Geological and Mining Law, amended in 2014, introduced the definitions of overburden dump and mining area and created

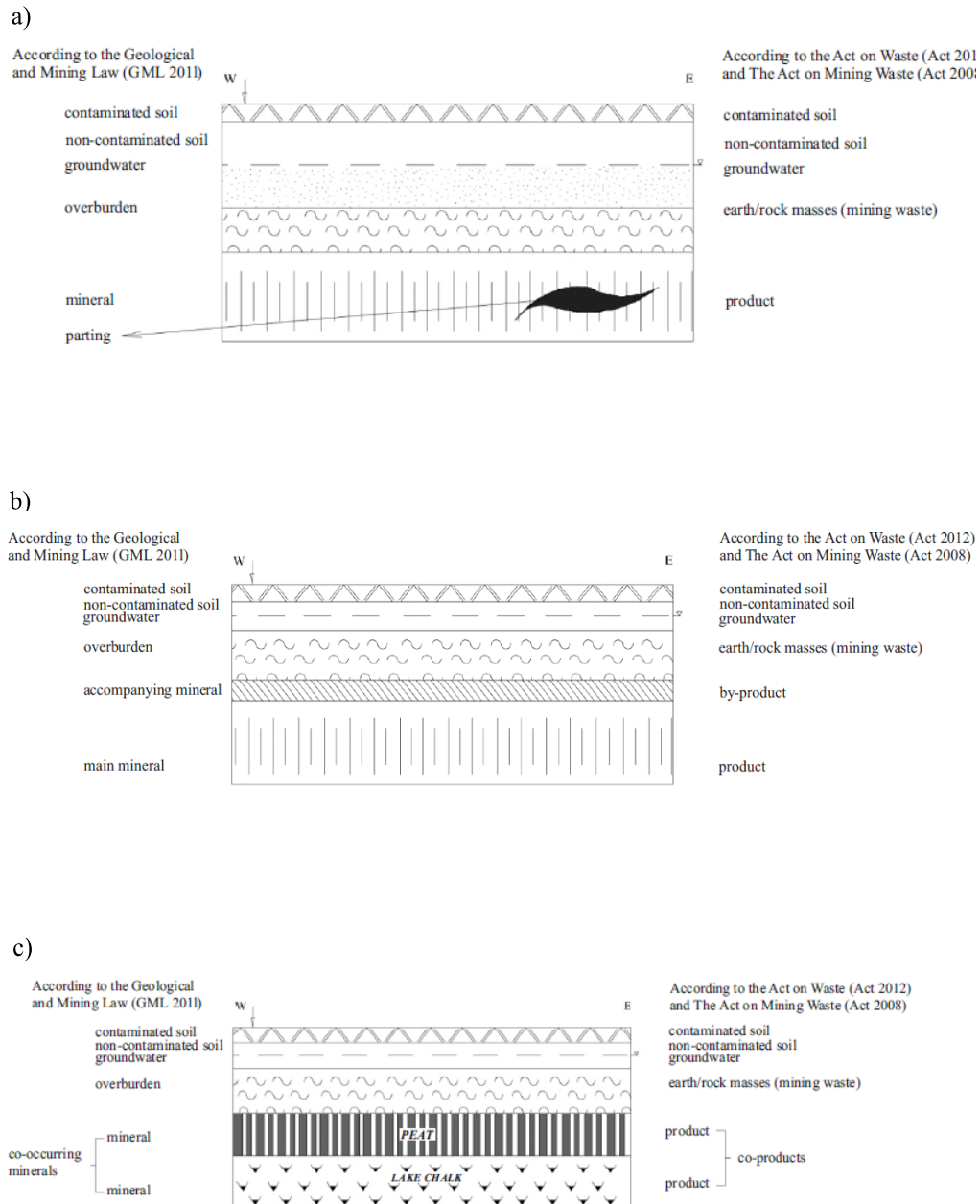


Fig. 4. Management of a mineral deposit in light of the provisions of the GML 2011, the Act on Waste, and the Act on Extractive Waste

Source: own study

Rys. 4. Gospodarka złożem kopaliny w świetle przepisów Prawa geologicznego, ustawy o odpadach i ustawy o odpadach wydobywczych

prerequisites for not qualifying overburden and coal partings as mining waste. In underground mining, the overburden above the deposit is not removed, while the overburden rocks excavated during mine development are stockpiled in spoil tips; waste rocks, excavated during exploitation, are stored in mining excavations.

b) a mineral deposit is exploited, which may contain:

- ◆ only one mineral (main mineral),
- ◆ main mineral and accompanying mineral,
- ◆ co-occurring minerals.

The extracted minerals may be a ready-to-use commercial product, but they are usually processed.

c) Groundwater, which is not a mineral according to Art. 5 of the Geological and Mining Law (e.g. not classified as curative, thermal and brine waters) is pumped. These waters, however, are used for technical or technological purposes in the processing of minerals. Sometimes they are used for the production of drinking water or discharged into surface watercourses. Only a part of chemically contaminated groundwater is treated as sewage.

The Geological and Mining Law does not precisely define the terms “product” and “waste”. This question is covered by the Act on Waste and the Act on Mining Waste. According to the Act on Waste, products and by-products are generated as a result of the production process. This is due to the fact that the by-product is not an independent element of the process, but a “reclassified” waste that meets the conditions specified in the Act. When interpreting the definitions of mining waste and tailings included in the above-mentioned acts, it can be concluded that the earth or rock masses correspond to the concepts of overburden and gangue, which are commonly used in mining. The main mineral is the basic product of the mining process. The accompanying mineral, due to its lower economic value and efficiency, is considered a by-product. Some mineral deposits contain two equivalent minerals (co-occurring minerals, [Wyrwicki 2002](#)). Due to their similar economic parameters, two main products are obtained. This would justify the introduction of an additional product class, i.e. a co-product. As a consequence, depending on the structure of the deposit, basic products, co-products, and by-products are obtained. As far as waste is concerned, the exclusion of earth and rock masses and overburden from the provisions of the Act on Waste and the Act on Mining Waste is the reason why there is no problem of waste from open-cast mining.

The status of groundwater still needs to be solved (therefore, in Figure 4a, b, and c their status, as undetermined, is marked with a question mark). Groundwater used for technical, technological, and consumption purposes should be considered as a by-product. However, there are doubts as to how to classify non-contaminated groundwater discharged into surface watercourses. They are not classified as useless, because their discharge improves the quantity and quality of watercourses. There is no doubt about the classification of contaminated water as waste.

On the basis of the analysis of legal provisions regulating mining activities and waste regulations, the management of mineral deposits exploited using opencast mining can be

illustrated with the following scheme (Figure 5). It shows the structure of the mining and processing processes, their results (products, waste), and sites (deposits, dumping grounds, and anthropogenic deposits). The concept of “anthropogenic deposit” will be discussed in more detail in Section 6.

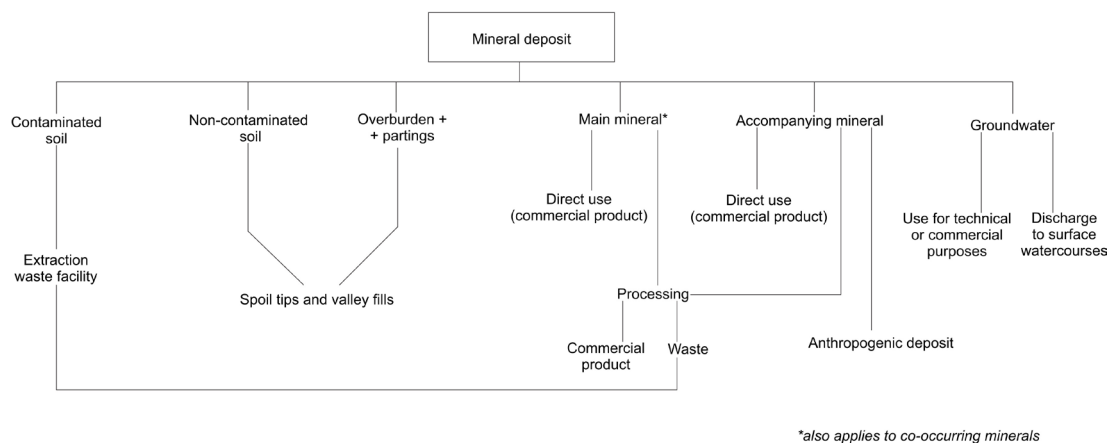


Fig. 5. Management of mineral deposits in opencast mines
Source: own study

Rys. 5. Gospodarka złożem kopaliny w kopalniach odkrywkowych

5. Technical and organizational solutions for the comprehensive use of mineral deposits and the minimization of waste

The scheme (Figure 5) shows a situation that takes into account the possibility of securing the extracted and unused accompanying minerals in the future by storing them in anthropogenic deposits. The reason justifying the need to develop anthropogenic deposits is that the accompanying minerals, for logistic and technical reasons, must be excavated in order to exploit the main mineral. As a side note, it should be noted that the term “anthropogenic deposit” is not legally defined. However, it is used in geological and mining sciences. This problem is discussed in detail in the work Uberman (2017); the definition of an anthropogenic deposit is included in the “Principles of documenting solid mineral deposits” published by the Ministry of Environment (ME 2002).

Anthropogenic deposits can be documented by examining the suitability of mining and industrial waste stored in landfills. Another possibility is to consciously build these deposits from waste from current production, if they meet the requirements of secondary mineral raw materials (Figure 1).

Examples of landfills in open-pit mining classified as anthropogenic deposits are presented in the paper by Uberman (2017). The possibility of entering anthropogenic deposits into the balance sheet of mineral resources was only available for a few years, e.g. from 1994 to 2001. Figure 6 shows an example of the development of anthropogenic deposits outside rock mining (brown coal mining). Extracted accompanying minerals and synthetic gypsum from flue gas desulfurization in a coal-fired power plant are also stored in anthropogenic mineral deposits, although without any formal basis for their development.

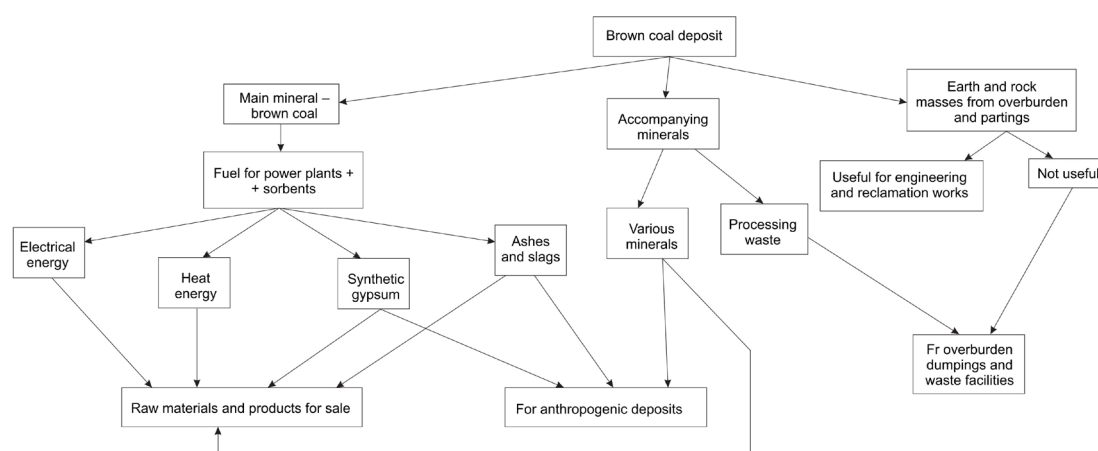


Fig. 6. Scheme of electricity production from brown coal
Source: Uberman 2017

Rys. 6. Schemat produkcji energii elektrycznej z węgla brunatnego

Since landfills contain huge amounts of waste from mining and other industries using mineral resources and the current production generates additional waste, it becomes necessary to analyze the management of mineral resources in a wider scope than the mining process, i.e. in combination with the their subsequent use. Solving this problem, not only in the formal and legal aspect, but also while ensuring economic and financial conditions stimulating the development and exploitation of anthropogenic deposits, will contribute to increasing the share of secondary mineral resources in the national balance of mineral resources.

Opencast mining covers many sectors that extract various minerals using different techniques and technologies of extraction and processing. The main mineral can be used to produce one or several raw materials.

The simplest, in terms of technology, is the exploitation of a mineral aimed at the preparation of a specific commercial product or a mineral raw material intended for a specific use (Figure 7). The extraction of this type of minerals is carried out on a mass scale (mass exploitation). If a deposit contains more than one mineral or even one but that can be used for various purposes, its extraction is carried out selectively; depending on the structure of the deposit

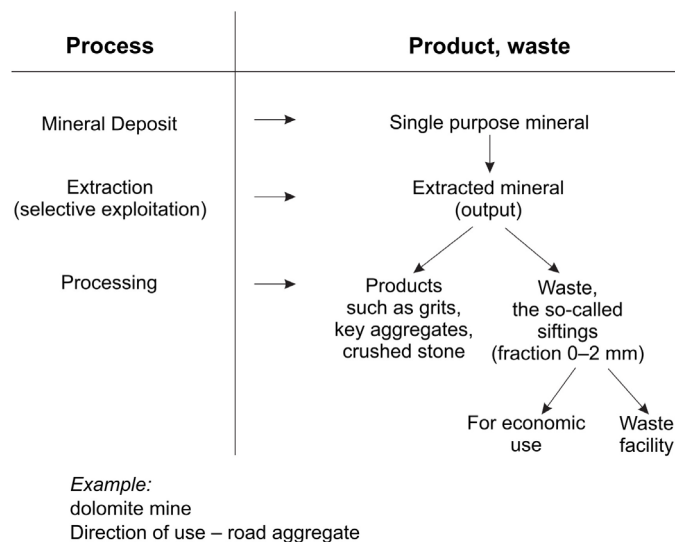


Fig. 7. Opencast mining. Scheme of the mining and processing of a single purpose raw material
Source: own study

Rys. 7. Górnictwo odkrywkowe. Schemat procesu wydobywczo-przeróbczego kopaliny jednosurowcowej

and the quality characteristics of the mineral, it may be a differentiating or homogenizing exploitation (Figure 8). Selective exploitation ensures the rational use of the properties of a given mineral and the comprehensive use of the entire deposit with accompanying minerals. It is important to articulate the need for the rational and comprehensive use of deposits and minerals because this is the easiest way to increase the production of mineral resources without the need to develop new deposits.

Research work on the comprehensive use of mineral deposits was undertaken in Poland in the 1980s as part of the Central Program of Basic Research 04.10: Protection and Development of the Natural Environment (SGGW 1990).

The site at which the research was conducted was an opencast limestone mine; the excavated limestone is used to produce building, road, and other materials and various products and raw materials, e.g. in cement, chemical, limestone, and cellulose industries. In addition, accompanying minerals (sand, clay), groundwater, and tailings are also used for various purposes.

The results are presented in the work (SGGW 1990), among others in the form of a scheme: “The flow of raw materials, products, and waste”, which is one of the sheets of the Atlas of the Kujawy District of Exploitation of Carbonate Raw Materials (Kujawski Okręg Eksploatacji Surowców Węglanowych).

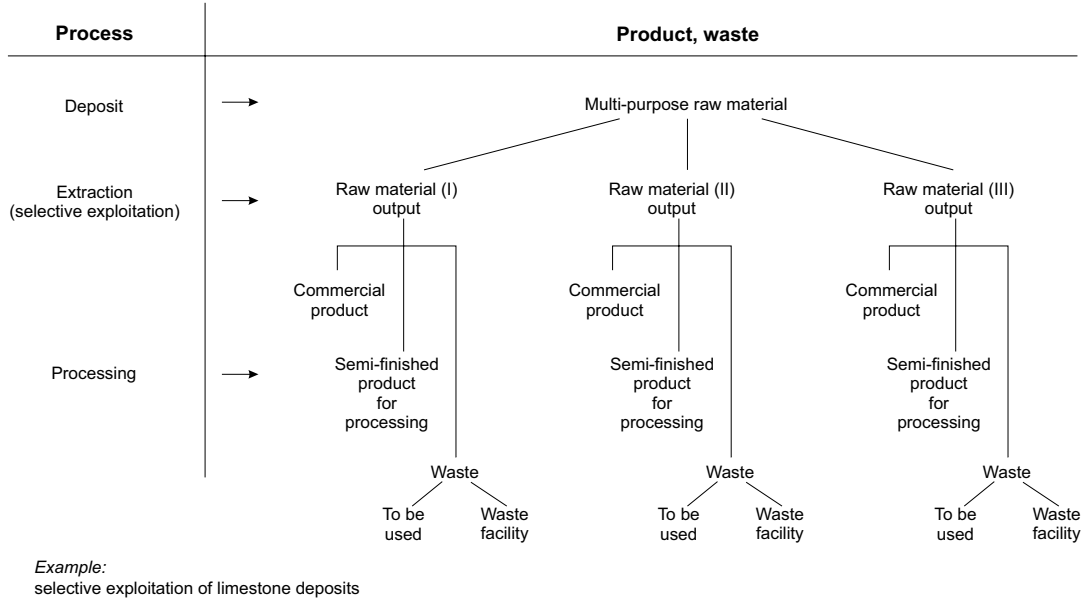


Fig. 8. Opencast mining – scheme of the mining and processing of multi-mineral raw materials
Source: own study

Rys. 8. Górnictwo odkrywkowe – schemat procesu wydobywczo-przeróbczego kopaliny wielosurowcowej

6. Certain comments on mineral waste in the provisions of the Act on Waste, the Act on Mining Waste, and Geological and Mining Law

The Act on Waste, passed at the end of the last century and the Act on Mining Waste, passed at the beginning of the 21st century, regulate the management of waste, including waste generated during the extraction of minerals and the management of mineral resources. The aforementioned acts are in line with the general tendency to implement circular economy, which is of paramount importance for ensuring the sustainable development of countries and environmental protection. They should also motivate to minimize the amount of waste generated and to use the waste accumulated in the past, as secondary mineral resources.

Since the main source of mining waste is the process of mineral extraction, the regulations concerning waste from this process should be compatible with the regulations concerning its exploitation and therefore with the then binding geological and mining law. The analysis of the provisions of the Act on Waste, the Act on Mining Waste and the provisions of the Geological and Mining Law allowed us to observe a clear and consistent terminology regarding the basic directions of development. However, with regard to specific regulations, there are significant gaps and ambiguities in the interpretation of definitions and regulations.

They do not take the specificity of mining industry and the fact that extraction and processing processes are complex and differ from the simple production process adopted in the Act on Waste into account, taking only product and waste into consideration.

The basic shortcomings of the analyzed acts on waste include the lack of a general classification of waste according to its source. This is accompanied by inconsistent usage of terminology, e.g. the terms mining, extraction, and metallurgical waste are used interchangeably, which is also the case in EU regulations.

It is therefore necessary and urgent to organize the nomenclature and to determine the overall classification of waste by origin.

There is also a need to organize the structure and nomenclature used in the production process. The current regulations assume the simplest model of the production process resulting in product and waste. It should be noted that only the later term is defined in the legislation. In practice, production processes are more complex, as exemplified by the mining industry. The result of the mining process can be two or sometimes more main products, equivalent in terms of use and economic efficiency. In the mining process, the by-products, which are accompanying minerals, are legitimized from the very beginning, in contrast to the provisions of the Act on Waste, according to which substances and objects that were previously classified as waste have to meet the conditions specified in the regulations in order to be recognized as by-products.

Therefore, it is justified to include the term “co-product” in the provisions of the Act on Waste and legitimize “by-product” as an effect of the production process.

The current waste legislation does not sufficiently take the fact that different industries consume and process mineral raw materials at various stages into account, which is reflected in the significant integration of mining, processing and manufacturing processes. The examples cited in the study, concerning the generation of electricity from lignite (integration of mines and power plants) and multi-mineral limestone deposits (involving mines, processing plants and various industries, e.g. cement or power plants) showed that the production model adopted in the assumptions to the acts on waste does not properly cover many significant activities creating or using waste.

The integration of the extraction and processing process with the manufacturing processes is beneficial as it ensures the comprehensiveness and rational use of the developed deposits and minerals, and this model should be preferred in the economy.

The demonstrated dissimilarities between extraction and processing activities and manufacturing processes in other industries need to be taken into account through a *lex specialis*, i.e. the Act on Extractive Waste.

Conclusions and proposals

There is an urgent need to:

- ◆ organize the terminology by replacing the term “extraction waste” with the term “mining waste” and, therefore, classify mining waste according to the proposal presented in the study,
- ◆ establish unequivocally that:
 - ◆ overburden with partings in opencast mines and gangue excavated from underground mines and dumped in mining areas are not considered as waste,
 - ◆ the extracted accompanying minerals are by-products,
 - ◆ the extracted and not used accompanying minerals should be stored for the future, which requires us to reconsider the concept of “anthropogenic deposit” and legalizing its status,
 - ◆ co-occurring minerals extracted from multi-mineral deposits are considered as co-products,
 - ◆ pumped groundwater the drainage of mineral deposits and used for technological purposes in mines, processing and manufacturing facilities, and for the production of drinking water are by-products.

Taking the above-mentioned proposals into account will allow us to organize the terminology, simplify the regulations, and ensure the transparency and compatibility of acts.

Financing: The publishing of this work was supported by MEERI statutory work and by National Center for Research and Development as a part of the oto-GOZ project.

REFERENCES

- Act 1980. The Act of January 31, 1980 on the Protection and Management of the Environment (*Ustawa z dnia 31 stycznia 1980 r. o ochronie i kształtowaniu środowiska*). Consolidated text, Journal of Laws 1994.49.196 (*in Polish*).
- Act 1997. The Act of 27 June 1997 on waste (*Ustawa z dnia 27 czerwca 1997 r. o odpadach*). Journal of Laws 1997.96.592 (*in Polish*).
- Act 2001. The Act on Waste of April 27, 2001 (*Ustawa z dnia 27 kwietnia 2001 r. o odpadach*). Journal of Laws 2001.62.628 (*in Polish*).
- Act 2008. Act of July 10, 2008 on Mining Waste with Amendments (*Ustawa z dnia 10 lipca 2008 r. o odpadach wydobywczych z poprawkami*). Uniformed version in Journal of Laws 2020. 2018 (*in Polish*).
- Act 2012. Act of December 14, 2012 on Waste with Amendments (*Ustawa z dnia 14 grudnia 2012 r. o odpadach z poprawkami*). Uniformed version in Journal of Laws 2020, 787,875 (*in Polish*).
- Act 2018. Act of 20 July 2018 amending the Environmental Protection Law and the Waste Act (*Ustawa z dnia 20 lipca 2018 r. o zmianie ustawy Prawo ochrony środowiska oraz ustawy o odpadach*). Journal of Laws 2018.1564 (*in Polish*).
- Andersen, M.S. 2007. An introductory note on the environmental economics of the circular economy. *Sustainability Science* 2(1).

- Bolewski, A. ed. 1993. *Encyclopedia of mineral resources (Encyklopedia surowców mineralnych)*. Kraków: Publishing house CPPGSMiE PAN (in Polish).
- Club of Rome 1972. The Limits to Growth, a 1972 report commissioned by the Club of Rome.
- CSO 2020. *Environmental Protection at the Central Statistical Office. News 2019. (Ochrona Środowiska w GUS. Informacje sygnałowe 2019)*. Warszawa: Główny Urząd Statystyczny (Central Statistical Office (CSO)). [Online] <https://stat.gov.pl/obszary-tematyczne/srodowisko-energia> [Accessed: 2020-09-13] (in Polish).
- Decision 2000. 2000/532/EC: Commission Decision of 3 May 2000 replacing Decision 94/3/EC establishing a list of wastes pursuant to Article 1(a) of Council Directive 75/442/EEC on waste and Council Decision 94/904/EC establishing a list of hazardous waste pursuant to Article 1(4) of Council Directive 91/689/EEC on hazardous waste (notified under document number C(2000) 1147).
- Directive 1991a. Council Directive of 18 March 1991 amending Directive 75/442/EEC on waste (91/156/EEC). (Official Journal L 78, 26.03.1991).
- Directive 1991b. Council Directive 91/689/EEC of 12 December 1991 on hazardous waste (Official Journal L 377, 31.12.1991).
- Directive 1999. Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste (Official Journal L. 182, 16/07/1999).
- Directive 2006. Directive 2006/21/EC of the European Parliament and of the Council of 15 March 2006 on the management of waste from extractive industries and amending Directive 2004/35/EC (Official Journal L 102, 11.4.2006).
- Dyka, M. 2011. Mining waste management – selected issues in the light of regulations (*Gospodarowanie odpadami wydobywczymi – wybrane zagadnienia w świetle przepisów*). [In:] Materials of the 4th Regional Meeting of the MIN-Novation Project Network (*Materiały IV Regionalnego spotkania Sieci Projektu MIN – Novation*). Katowice (in Polish).
- Ellen MacArthur Foundation 2012. Towards the circular economy: Economic and business rationale for an accelerated transition. [Online] <https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Ellen-MacArthur-Foundation-Towards-the-Circular-Economy-vol.1.pdf> [Accessed: 2020-09-13].
- Encyclopedia 1974. *A popular encyclopaedia (Encyklopedia powszechna)*. PWN (in Polish).
- GML 1994. Act of February 4, 1994 Geological and Mining Law (*Ustawa z dnia 4 lutego 1994 r. Prawo geologiczne i górnicze*). Journal of Laws 1994.27.96 (in Polish).
- GML 2011. Act of June 9, 2011, Geological and Mining Law (*Ustawa z dnia 9 czerwca 2011 r. Prawo geologiczne i górnicze*). Journal of Laws 2011.63.981, as amended (in Polish).
- Głapa, W. and Korzeniowski, J.I. 2005. *A small lexicon of opencast mining (Mały leksykon górnictwa odkrywkowego)*. Wrocław: Wydawnictwa i Szkolenia Górnicze Burnat and Korzeniowski, pp.140 (in Polish).
- Góralczyk, S. ed. 2011. *Hard coal waste management (Gospodarka surowcami odpadowymi z węgla kamiennego)*. Warszawa: Publishing house Instytutu Mechanizacji Budownictwa i Górnictwa Skalnego, pp. 324 (in Polish).
- Hausner, J. ed. 2015. *Poland's raw material policy. It is a matter of what is not there and is very necessary (Polityka surowcowa Polski. Rzecz o tym, czego nie ma, a jest bardzo potrzebne)*. Kraków: Fundacja Gospodarki i Administracji Publicznej, pp. 130 (in Polish).
- Kicki, J. and Sobczyk, J. eds 2016. *Legal, technical, economic and environmental aspects of waste rock management in hard coal mines (Prawne, techniczne, ekonomiczne i środowiskowe aspekty gospodarki skalą płonną w kopalniach węgla kamiennego)*. Kraków: Publishing house IGSMiE PAN, pp. 186 (in Polish).
- Kulczycka, J. 2019. *Circular economy in politics and scientific research (Gospodarka o obiegu zamkniętym w polityce i badaniach naukowych)*. Kraków: Publishing house IGSMiE PAN pp. 201 (in Polish).
- Lipiński, A. 2000. Handling waste and maintaining cleanliness and order (*Postępowanie z odpadami oraz utrzymanie czystości i porządku*) [In:] Elements of environmental protection law (*Elementy prawa ochrony środowiska*). Kraków: Wyd. Zakamycze, pp. 290 (in Polish).
- ME 2002. Principles of documenting solid mineral deposits (*Zasady dokumentowania złóż kopalin stałych*). Warszawa: Ministerstwo Środowiska (Ministry of the Environment – ME) (in Polish).
- ML 1953. Decree of May 6, 1953. Mining Law (*Dekret z 6 maja 1953 r. Prawo górnicze*). Journal of Laws 1953.29.113 (in Polish).

- Ney, R. ed. 2009. *Mineral waste raw materials (Mineralne surowce odpadowe)*. Kraków: Publishing house IGSMiE PAN, pp. 264 (in Polish).
- Opinion EU 2012. Opinion of the European Economic and Social Committee on ‘The processing and exploitation, for economic and environmental purposes, of industrial and mining waste deposits in the European Union’ (own-initiative opinion). (OJ C 24, 28.1.2012, p. 11–17).
- Radecki, W. 2009. Extractive waste charges (*Oplaty za odpady wydobywcze*). *Aura* 3, pp. 35–37 (in Polish).
- Radecki, W. 2012. Legal aspects of overburden management in the light of the Extractive Waste Act (*Prawne aspekty gospodarowania nadkładem w świetle ustawy o odpadach wydobywczych*). *Węgiel Brunatny* 2/79, pp. 18–24 (in Polish).
- Regulation MEP 1997. Regulation of the Minister of Environmental Protection, Natural Resources and Forestry of December 24, 1997 on waste classification (*Rozporządzenie Ministra Ochrony Środowiska Zasobów Naturalnych i Leśnictwa z dnia 24 grudnia 1997 r. w sprawie klasyfikacji odpadów*). *Journal of Laws* 1997.162.1135 (in Polish).
- Regulation MEP 2001. Regulation of the Minister of the Environment of 27 April 2001 on the Waste Catalog (*Rozporządzenie Ministra Środowiska z dnia 27 kwietnia 2001 r. w sprawie klasyfikacji odpadów*). *Journal of Laws* 2001.112.1206 (in Polish).
- Regulation MEP 2016. Regulation of the Minister of the Environment of 1 September 2001 on evaluation modes of earth surface pollution Waste Catalog (*Rozporządzenie Ministra Środowiska z dnia 1 września 2016 r. w sprawie sposobu prowadzenia oceny zanieczyszczenia powierzchni ziemi*). *Journal of Laws* 2016.1395 (in Polish).
- Resolution CM 2019. Resolution of Council of Ministers No. 67 of July 16, 2019 on the approval of the “State Environmental Policy 2030 – Development strategy in areas of environmental protection and water policy” (*Uchwała nr 67 Rady Ministrów z dnia 16 lipca 2019 r. w sprawie przyjęcia „Polityki ekologicznej Państwa 2030 – Strategii rozwoju w obszarze środowiska i gospodarki wodnej*). *Journal of Laws*, item 794 of 6 September 2019 (in Polish).
- SAC 1985. Judgment of the Supreme Administrative Court of July 16, 1985 on the qualification of the overburden (*Wyrok NSA z dnia 16 lipca 1985 r. w sprawie kwalifikacji nadkładu*) (in Polish).
- SC 1985. Resolution of the Supreme Court of April 16, 1985 on the qualification of the overburden – IIIAZP2/85 (*Uchwała Sądu Najwyższego z dnia 16 kwietnia 1985 r. w sprawie kwalifikacji nadkładu – IIIAZP2/85*) (in Polish).
- SGGW 1990. The management of mineral resources in the context of shaping natural conditions in the Kujawy District of Carbonate Exploitation (*Gospodarka surowcami mineralnymi na tle kształtowania warunków przyrodniczych w Kujawskim Okręgu Eksploatacji Surowców Węglanowych*). Materials of the Central Program for Fundamental Research 04.10 Protection and Management of the Natural Environment. Issue 45 together with the Atlas of the Kujawy District of Exploitation of Carbonate Raw Materials (scale 1: 50,000). [In:] Materials of the Central Program for Fundamental Research 04.10 Protection and Management of the Natural Environment. Issue 45 together with the Atlas of the Kujawy District of Exploitation of Carbonate Raw Materials (scale 1: 50,000). (*Materiały Centralnego Programu Badań Podstawowych 04.10 Ochrona i Kształtowanie Środowiska Przyrodniczego. Zeszyt 45 wraz z Atlasem Kujawskiego Okręgu Eksploatacji Surowców Węglanowych (skala 1:50 000)*). Warszawa: Szkoła Główna Gospodarstwa Wiejskiego – Akademia Rolnicza (SGGW) (in Polish).
- Transformation map 2019. Transformation map towards a circular economy. [Online] <https://www.gov.pl/web/rozwoj/rada-ministrow-przyjela-projekt-mapy-drogowej-goz> [Accessed: 2020-09-13].
- Uberman, R. 2017. *Accompanying minerals in lignite deposits. Volume II. Legal, economic and mining aspects of the development of accompanying minerals (Kopaliny towarzyszące w złożach węgla brunatnego. Tom II. Prawno – ekonomiczne oraz górnicze aspekty zagospodarowania kopaliny towarzyszących)*. Kraków: Publishing house IGSMiE PAN, pp. 128 (in Polish).
- Wyrwicki, R. 2002. Main, accompanying and co-minerals (*Kopalina główna, towarzysząca a współkopalina*). *Górnictwo Odkrywkowe* 2/3, pp. 32–33 (in Polish).

**MINERAL WASTE IN THE LIGHT OF THE PROVISIONS OF THE ACT ON WASTE,
THE ACT ON EXTRACTIVE WASTE, AND THE GEOLOGICAL AND MINING LAW**

Key words

mineral resources, mineral raw materials, mineral waste, waste from extractive industry, terminology and classifications, legal regulations, mining and processing of raw materials

Abstract

A systematic increase in the demand for mineral raw materials combined with the difficulty of obtaining them from primary sources, made it necessary to use secondary ones including mineral waste. The effectiveness of the management of mineral waste stored in landfills and from current production depends on many factors. The most important ones include the legal regulations of this activity and the technical and organizational determinants of deposit exploitation, processing, and refining of minerals.

The paper analyzes the current waste (including mining waste) management regulations. The technological discrepancies in these regulations, as well as missing or inaccurate classifications, were demonstrated. The interchangeable use of notions: mining/mine and extractive/extraction is a primary source of problems. It also has to be noted that accompanying and joint minerals are not defined in appropriate legislation. Attention was also paid to the omission of important issues in these regulations, e.g. product structure, construction of anthropogenic deposits, etc. It was emphasized and demonstrated with examples that the comprehensive and rational exploitation of mineral deposits, combined with processing and refining of mineral raw materials is an effective way of using mineral waste. The obtained results allowed for formulating proposals regarding legal provisions regulating waste management and the recommendation of technical and organizational solutions for the activities of mining, processing, and refining of mineral raw materials.

**ODPADY MINERALNE W ŚWIELE PRZEPISÓW USTAW O ODPADACH,
O ODPADACH WYDOBYWCZYCH ORAZ PRAWA GEOLOGICZNEGO I GÓRNICZEGO**

Słowa kluczowe

zasoby złóż kopalin, surowce ze złóż kopalin, odpady wydobywcze,
odpady z przemysłu górniczego, terminologie i klasyfikacje stosowane w regulacjach prawnych,
wydobycie i przeróbka kopalin

Streszczenie

Systematyczny wzrost zapotrzebowania na surowce mineralne spowodował, wobec trudności z ich pozyskaniem ze źródeł naturalnych, konieczność wykorzystania odpadów mineralnych.

Efektywność zagospodarowania odpadów mineralnych nagromadzonych w przeszłości na składowiskach oraz pochodzących z bieżącej produkcji zależy od wielu czynników. Szczególny wpływ

wywierają uregulowania prawne tej działalności oraz czynniki techniczno-organizacyjne eksploatacji złóż, przeróbki i przetwórstwa kopalin.

W artykule przeprowadzono analizę obowiązujących przepisów gospodarowania odpadami, w tym odpadami wydobywczymi. Wykazano występujące w tych przepisach rozbieżności technologiczne, brak lub nieadekwatność klasyfikacji. Podstawowym źródłem problemów jest wymienne używanie pojęć: górnictwo i wydobywcze/wydobycie. Brakuje również w odpowiednich ustawach odpowiedników pojęć: kopaliny towarzyszące oraz równoległe. Zwrócono też uwagę na pominięcie w tych przepisach istotnych zagadnień, np. struktury produktów, budowy złóż antropogenicznych itp.

Podkreślono i wykazano na przykładach, że skutecznym sposobem wykorzystania odpadów mineralnych jest kompleksowa i racjonalna eksploatacja złóż kopalin, w powiązaniu z procesami przeróbki i przetwórstwa surowców mineralnych.

W podsumowaniu sformułowano propozycje i postulaty dotyczące przepisów prawnych regulujących gospodarkę odpadami, a także upowszechnienie rozwiązań techniczno-organizacyjnych procesów wydobywania, przeróbki i przetwórstwa surowców mineralnych.

