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Underground Mining Heritage Sites: Preservation and Safeguarding

Podziemne dziedzictwo górnicze – zarys problematyki ochrony

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Introduction

The history of the mining industry in Poland bears witness to human creativity, being an empirical example of linear civilizational development as evidenced by advancements in mining and extraction techniques, roof stabilization and support methods and implementation of technologies for the maintenance of engineering infrastructure and sites. Mining has become the driving force behind the development of towns, villages and entire regions, enriching local communities and entire states, ensuring their prosperity. In well-preserved underground excavations we can still recognize retrospective values, such as integrity, authenticity, uniqueness as well as historical, symbolic and aesthetic values; in some cases prospective aspects are present as well, related to educational and economic features when these sites are still adaptable and can be put to commercial, use thus promoting the social development of the entire region.[1]

Studies and programs developed with a view to restore and bring to a new use the underground sites in the Wieliczka salt mine are of primary importance to present-day interdisciplinary research projects and development of conservation principles and schemes. Collaboration between the conservation officers and experts on roof stabilization and support of the rock strata has resulted in the development of an intervention model by mining methods yet in consideration of the conservation principles. In the period 1984–1986, the team of experts: Jerzy Grzesiowski, Antoni Jodłowski, Roman Kędra, Robert Kurowski, Ignacy Markowski, Józef Piotrowicz, Janusz Wiewiórka, Janusz Wójcik and Andrzej Gaczoł, recalling the expertise of the Mining and Conservation Council headed by Professor Aleksander Garlicki,[2] developed the "Fundamental Principles of Conservation,"[3] which summarize formal and legal aspects of restoration works and the methodology and procedures to be implemented during mining, technical and restoring intervention projects. Of primary importance is the fact that a red line for mining interventions has been established, postulating the respect for heritage values and adoption of the major principle whereby "the excavations ought to be preserved in their original and authentic form."[4] These problems were also addressed during regular international and national-level Conferences of Mining and Underground Open-Air Museums held by the Cracow Saltworks Museum. It is worthwhile to mention that the UNESCO World Heritage Sites List in Poland, grouping sites and landmarks considered to be of outstanding "value to humanity,"[5] with world-

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wide significance and, unique features, includes four old mines:

- The Royal Salt Mines in Wieliczka and Bochnia (Ref. No. 32, 1978, 2008, 2013), World Heritage Listing criterion IV,
- Tarnowskie Góry Lead, Silver and Zinc Mine and its Underground Water management System (Ref. No. 1539, 2017), World Heritage Listing criterion IV,
- Krzemionki Prehistoric Striped Flint Mining Region (Ref No. 1599, 2019), World Heritage Listing criterion III and IV.[6]

It is not a haphazard selection, instead it illustrates well the significance of mining heritage on the regional level and world-wide.

Presently in Poland that are 22 old coal, salt or metal mines (including 3 open-pit mines) that have been put to a new use. In addition, 24 old excavations of historic interest have been identified and penetrated; depending on their condition they too should be open to public, or, if it is not possible, should be exhibited in the form of artefacts either in the natural landscape or in the urban settings.

Legal aspects

The interest in safeguarding of industrial heritage, including old mining sites, dates back to the early 1990s. The significance of this heritage, as the driving force behind social and economic transformations in the history of communities and societies, was emphasized in official documents issued by international institutions, such as: The Council of Europe, European Committee and UNESCO (ICOMOS, TCICH). The first document having relevance to mining heritage was the recommendation of 1990 by the Council of Europe: On the Protection and Conservation of the Industrial, Technical and Civil Engineering Heritage in Europe[7] which states in the preamble that "the technical industrial and civil engineering heritage constitutes an integral part of the historic heritage of Europe."[8] This document (section II) emphasizes the need for the identification, survey and academic analysis of the technical, industrial and civil engineering heritage,[9] focusing our attention on "significant sites and places whose geographical situation makes access difficult (small hydraulic works, small dams, disused mines etc.), which are harder to protect."[10] One of the key aspects is "the protection of not only archives which retrace their history, but also plans and other data concerning the construction of technical and industrial buildings, civil engineering works and production processes."[11] This postulate is of key importance in the context of the protection of underground mining heritage. The lack of archival documentation, excavation plans, as well as business documents of disused mines (production levels) adds to the difficulties involved in restoration works aimed as adaptation of old excavation to be used either for research purposes or as tourist attractions.

Of particular interest in the context of heritage safeguarding and protection was the protocol to the The Nizny Tagil Charter for the Industrial Heritage of July 2003,[12] published by The International Committee for the Conservation of Industrial Heritage (TICCIH), where the definition of industrial heritage is expanded to include "places used for social activities related to industry such as housing, religious worship or education"[13] and it is suggested that industrial archaeology ought to incorporate historical research on manufacturing technologies and techniques.

In the context of the preservation of underground mining heritage, of particular importance is protection of local communities in industrial areas "threatened by sudden structural transformations."[14] This postulate is of key importance in Poland in the light of the continuing process of reducing coal production, resulting in closures of old mines. In response, programs should be developed to "preserve and safeguard the industrial heritage, which ought to be incorporated in an overall strategy of economic development and economic plans, both on the regional and national level,"[15] to prevent uncontrolled and irreplaceable loss of material objects of mining heritage as well as of non-material (intangible) aspects—local dialects, family relations, personal and social attitudes, literature etc. In the document entitled The Industrial Heritage in Europe issued in 2013, the Standing Committee of the Council of Europe reaffirmed the significance of industrial heritage protection, as an integral element of the common European background.[16]

In the above mentioned paper discussing the fundamental types of preservation and safeguarding activities, the authors included the following points:

- the need to develop social awareness;
- the need to define clearly the elements of the heritage—administrative aspects;
- introduction of preservation and safeguarding programs to the land development plans for the given regions;
- creations of multiple and variable options as to the functional use of the social heritage sites;
- applying new models of funding—private financing, state subsidies, others (crowdfunding, revolving funds, public guarantee schemes, tax break schemes);
- introduction of informative policies—presenting the inventory of resources in the context of exchange of the international information using digital platforms;
- developing education while cooperating with specialists from different fields, artistic schools and schools of design;
- supporting interdisciplinary cooperation with the volunteer organizations participating in the process of the preservation of the cultural and natural heritage.[17]

One of the consequences of starting the process aimed at preservation of the post-industrial heritage in

Europe, referring mainly to the preservation of mines of the post-industrial heritage, is the need to incorporate proper legal regulations in the Polish legislation. In the Regulation on the Preservation and Safeguarding of Historic Monuments and Heritage Sites, in Article 6, the authors formulated a catalogue of objects that could be referred to as monuments and heritage sites. In the catalogue being open in its character, the authors enumerated monuments and relics of industrial culture that are: "technical objects, especially mines, steel-making companies, power plants and other industrial plants" (immovable monuments);[18] "technical (engineering) creations especially technical devices, means of transport / machines / and tools giving a picture of the material culture characteristic of the old and the new forms of state-controlled economy documenting the level of science and civilization" (immovable monuments).[19]

In the process of preservation of the underground heritage, legal acts and regulations referred to as The Geological and Mining Laws[20] as well as the Act having relevance to the operation plan of the mining plants, have some significant meaning.[21] First of all, the problem of mine closures is addressed.[22] This aspect is raised in the regulation of the Ministry of the Environment of 2017 referring to operation of mining plants introducing a regulation whereby the mine operators are obligated to define the ways of "safeguarding objects, machines, installations or excavations regarded as archaeological heritage, as well as other objects of historic interest."[23]

The issue of preservation of the geological heritage was addressed for the first time in 1988 by the European Association for Conservation of Geological Heritage-ProGeo. In 1996, the project "Global Geosites was launched,"[24] under the auspices of UNESCO, as the Global Geosites Work Group (GGWG) and the detailed criteria were defined to support the assessment and evaluation of geological heritage.

The most fundamental criteria of the assessment of the geological heritage are the characteristic features of geosites, their usefulness for interdisciplinary studies, scientific and practical usefulness in relation to geodiversity of the analyzed area. The representativeness of geosites and usefulness for interdisciplinary studies are connected with geological exposure and the preservation of the most important lithological, geomorphological and hydrological features that constitute an element of evaluation of geodiversity in the given geological.[25]

The Act referring to the Preservation of Natural Resources defines the scope and range of resources and sites to be preserved and safeguarded, providing for ex situ preservation of the species of plants, animals and fungi being separated from the place of origin, preservation of rocks, fossil and minerals in places of their natural occurrence and protection in situ of species of plants in places of their natural occurrence.[26] That means that protection of underground excavations is of a synergetic character representing the existing cultural and natural resources regarded as equivalent.

Resources to be preserved – evaluation and valorization

This process should be understood as the defined program of the so-called synchronic presentation.[27] These are mining and geological procedures coordinated at various levels with the methodology of preservation.

This system allows us to define the elements of the heritage representative of the given underground object or site and provides the analysis of the retrospective resources not only referring in the strict sense to underground excavation but also to complex cultural heritage (containing architectural, urban, landscape, cultural, non- materials elements).

Evaluation in the aspect of preservation and adaption is a cognitive process "comprising of real values involving analytical sequence of identification, research, interpretation, defining, redefining and evaluation of separate individual values."[28] It should be emphasized that underground structures display the features that are characteristic of the given architectural areas; not only because of their geometrical form, but also because of the presence of architectural and engineering structures implemented in the excavations and integrated with their interior. These include systems of safeguards protecting the integrated part of the production process, representing not only a progressive character of the production process in this branch, but they are also an example of high quality woodwork (framework and door lining systems, chock systems).

Evaluation of the mining heritage evaluation ought to rely on the following criteria: technology of creation (exploration of geological works); forms and geometry of space; stabilization of galleries, entries, caverns, drifts, shafts; systems of linings—the support structures, egress routes—the evacuation plan; methods of elimination of environmental hazards (dehydration, ventilation, primitive and traditional systems of warning: *Serinus canarius* and mobile objects (lighting, mining and haulage equipment, transport). It is worthwhile to mention the paper by Professor Antoni Jodłowski which addresses these issues in the context of the need to systemize the analysis and evaluation of man-made heritage geodiversity in the Wieliczka Salt Mine. Basing on these criteria, the maximum amount of information and observations can be registered that have relevance to a particular heritage site in the given region.[29] The author postulates "that historical and conservation studies of the old excavations in the salt mine in Wieliczka"[30] are fully merited and should be supported by technical and economic analysis to ensure the implementation of preservation and conservation works with the use of state-of-the-art technologies.[31]

This evaluation should be complemented by the analysis of the cultural heritage, its functional use and its historical background (economical, cultural and social aspects), of artistic heritage (sculpture, small archi-

tecture, interior decorations) as well as non-material aspects (traditions, habits, literature).[32] These are values of social identity. In the context of natural heritage, the evaluation should comprise: rock types, tectonic features, geodiversity and new biological environments that came into being in the process of exploration.

Particular underground excavations may exhibit features corresponding to several criteria listed above, which further highlights their significance as historical sites. While selecting the underground heritage sites for preservation and safeguarding, it is suggested that their informative, educational and marketing aspects should be taken into account as well.

Intervention by mining methods

Depending on their stability, underground excavations can be categorized into two groups: sites in continuous use, where rock strata and ground surface are either naturally stable or stabilized and reinforced by supporting or bolting structures; sites that have suffered damage, are buried under rubble or partly collapsed as a result of man-mad and natural processes involved in mining exploitation, leading to disintegration and physical transformations of the surrounding rock media.[33] The key aspect of interventions in underground excavations by mining methods is maintaining their stability, i.e. the ability to retain shape geometry and spatial configuration within the rock strata. Identification of the primary state of stress, i.e., stress concentration and de-concentration zones within the surrounding geological settings is the top priority task. The state of stress is determined by factors associated with mining exploitation, such as the adopted mining method or implemented support systems. One has to emphasize the role of environmental degradation, revealed by chemical, electromechanical, microbiological or physical processes. This negative aspect is of key importance particularly in old salt mines whilst in mines where metal ores or coal were extracted it is of less significance. Another aspect to be considered, though often neglected in analyses and studies, is the way the surroundings interact with and impact on the behavior of the rock strata, particularly in the context of the existing civil engineering structures, infrastructure or agricultural production (presence of chemical substances). As a result, the state of stress within the rock strata can be changed and the suffusion effect will be observed (leaching the components from construction materials and the existing stabilizing structures by inflow of penetrating water). In interpretation of interactions between the rock strata and stabilizing systems of particular importance is the assessment of the working condition of the existing old structures, their mining and conservation stratigraphy profile, evidencing the back history of stabilization and rock support technology. These structures exhibit a variety of geometric configurations, are made of various materials and represent a diversity of engineering components, yet from the standpoint of conservation officers, they constitute a homogeneous structure.

In the context of technical aspects of research investigations, a specific feature of support systems in underground excavations is that they accessible on one side only, that applies to both brick and wooden structures. Obviously, that restricts the scope of works and a range of available research methods because of the one-way system of penetrating the studied structure and material (from the interior of an excavation towards the rock surface). Of particular interest is the fact that present-day mining interventions in the context of rock strata stabilization are often implemented by traditional methods, providing wooden supports though using modern-day technologies (Fig. 1, 2).[34] Selection and implementation of state-of-the-art mining technologies, such as adhesive and injection systems, anchoring systems or industrial steel supports is determined on one hand by the condition of the underground site, on the other-by the need to preserve original artefacts found in the existing supports. In such cases proper anchoring should be considered top priority so as to minimize the extent of interference with the structure and spatial configuration of the excavation and to better display its biodiversity. It is worthwhile to mention that stabilizing and safeguarding the old excavations using state-of-the-art technologies has become a subsequent step in the existing structure of man-made mining constructions, thus maintaining the historical continuity of technological advancements (Fig. 3).

Conservatorial intervention

Old excavations of historic interest exhibit the natural and cultural attributes giving a coherent image of underground sites. It is required, therefore, that at the stage of research analyses, the diagnostic methods should be coordinated with the conservators' practices, taking into account the synergy effect. It means that the heritage studies-based evaluation analysis is just one element in the process of formulating conclusions and establishing conservation priorities in the light of safeguarding the retrospective values. In this case the major consideration is a hierarchically superior conclusion resulting from technical diagnostics of stability of mining excavations. Underlying all programs prompting the natural and man-made heritage preservation is the collaboration between engineering and conservation experts at the stage of preliminary and final diagnostic procedures. Generally, the concept of intervention by mining and conservation methods should incorporate a strategy for safeguarding of an underground site taking into account the projected changes of its functional features and adaptation requirements based on prospective values of the site before it can be open to the public.

The account of profits and losses involved in restoration of underground sites reveals that there are three main categories of sites:

Fig. 1. Sandstone mine in Nagórzyce (Nagórzyckie Grottos)—an example of a modern support structure based on traditional props with cross binding; photo by T. Wieja.
Ryc. 1 Kopalnia piaskowca w Nagórzycach (Groty Nagórzyckie) – przykład nowoczesnej konstrukcji wsporczej opartej na tradycyjnych podporach z wiązaniem krzyżowym; fot. T. Wieja.

Fig. 2. Podgórze uranium mine in Kowary—conservation works inside the shaft through implementation of polygonal wooden support to the space reinforced and secured with a concrete arched support; photo by T. Wieja.
Ryc. 2. Kopalnia uranu „Podgórze" w Kowarach – prace konserwatorskie wewnątrz szybu w postaci zastosowania poligonalnego podparcia przestrzeni wzmocnionej i zabezpieczonej łukową podporą betonową; fot. T. Wieja.

- unique objects with outstanding natural and cultural values—limited accessibility—adaptation works for the purpose of preservation and safeguarding;
- objects which may profit by providing continuity of use or by bringing them back to use after it was discontinued—individually tailored scope of intervention works;
- objects which, unless adapted, would deteriorate, leading to annihilation of natural and cultural features and structures.

The top priority in heritage evaluation analyses should be retaining the original function of the building or site. Retaining the original function of heritage sites is recommended in the reports issued by the Ministry of Culture and National Heritage in Poland, whereby buildings and sites are classified into several categories.[35] A similar approach was adopted in the documents issued under the National Program for Heritage Conservation and Preservation of Historic Monuments for the years 2013-2016, providing the list of thus categorized objects and sites.[36] Alas, these documents make no direct reference to old underground excavations, so they have to be included in the "Other sites" category.

Preservation of the natural and cultural heritage sites as a top priority ought to be subject to clear-cut conservation principles, such as: maintenance or restoration of their original condition and function; maintaining the spatial and structural authenticity; maintaining the integrity of the building or sites; preservation of aesthetic integrity and of the period character; non-intrusive interventions, without destroying the heritage fabric and disturbing original strata profiles; reversibility of implemented alterations being the result of intervention by mining methods; highlighting the historic and symbolic aspects; maintaining the artefacts of technical infrastructure and geo-diversity in the form of in-situ exhibitions; evaluation of the proposed functional project, in the context of preserving the retrospective values; evaluation of artificial lighting provided in underground sites.

The issue associated with artificial lighting in natural and man-made heritage sites is of key importance in the context of preserving their character (smell or micro-climate or acoustic phenomena), exhibiting

Fig. 3. Wieliczka Salt Mine—reconstruction of truss support in the "Gołuchowski" cavern, using modern anchoring support; photo by AMC.
Ryc. 3. Kopalnia Soli w Wieliczce – rekonstrukcja podparcia kratownicowego w grocie „Gołuchowski" przy użyciu współczesnego podparcia kotwionego; fot. AMC.

Fig. 4. Gold and arsenic mine in Złoty Stok—application of color light system (LED RGB diodes) in line with the guidelines relating to exposing rocks rich in iron compounds (ochre) in the Ochre Shaft open to the public; photo by T. Wieja.
Ryc. 4. Kopalnia złota i arszeniku w Złotym Stoku – zastosowanie systemu oświetlenia kolorowego (diody LED RGV), według wytycznych ekspozycji kamieni bogatych w związki żelaza (ochra), w Sztolni Ochrowej otwartej dla publiczności; fot. T. Wieja.

the structure of stabilizing systems (multiplication of doors in galleries, 3D truss structures and the fiber and material of brick wall sections) as well as artefacts of technical infrastructure. This applies also to presentation of litho-diversity (texture and structure of minerals, tectonic features, flora and fauna specimens) or the formation process (diastrophism, magmatism, metamorphism) (Fig. 3). The selection of artificial lighting systems (spot lighting, flood lighting or mix light systems) and physical parameters of light (luminance or chrominance) is in the domain of light engineering. Yet these aspects ought to be coordinated under the supervision of conservation officers, with the main focus on reintegration of lighting systems within underground sites (Fig. 4). Conservation intervention is of primary importance in the context of adaptation of underground sites when they are to be brought to a new use. In many cases the only chance to preserve the site is through opening them to the public as underground tourist routes coordinated with the functions of a museum, or a spa center that would utilize available natural resources for therapeutic purposes (Fig. 5, 6).

Social and economic aspects

Revitalization projects of underground heritage sites, launched by local communities, should incorporate the plan of introducing the new functional use, in line with the land development plans in a city or rural area, or in entire regions, protecting the interests of local communities.[37] The risk involved in such approach is that new functions of the objects and sites being made open are

Fig. 5. Liczyrzepa uranium mine in Kowary—present-day view of the spa hotel; photo by T. Wieja.
Ryc. 5. Kopalnia uranu „Liczyrzepa" w Kowarach – obecny widok hotelu uzdrowiskowego; fot. T. Wieja.

imposed *a priori*, neglecting the entire spectrum of urban development, architectural, technological or aesthetic considerations, which came to light in its entire history. Obviously, making accessible the spaces or sites which hitherto remained inaccessible for majority of inhabitants will enhance the landscape quality, through clearing up the grounds, creation of architectural aesthetic features in the town and also through changing the social attitudes when inhabitants begin to identify themselves with the region and its back history. A change in the functional use of underground excavation sometimes appears to be the only chance to preserve and retain the natural and cultural values. Professor J. Zachwatowicz stated that "Each historic building or site has to find the new role, more appropriate and such as to ensure its further existence and protection."[38] The current expertise allows this postulate to be expanded to incorporate aspects associated with the public awareness of the value and history of the site.[39] The preservation and opening of old underground excavations to the public encourages inhabitants to identify themselves with the history of their region.

"Acquainting the readers with the history of their region, highlighting the links between the historic events and present-day natural and cultural landscape has become a vital component of 3D communication involving knowledge, images, feelings and emotions and based on exposing unique features of the region, which furthers the development of its specific and unique image."[40] This means that mining heritage structures and sites should become the moving force behind land development and economic growth, promoting urban and regional development and growth. Basing on studies conducted by the induction method,[41] natural and man-made heritage sites to be adapted and re-opened as tourist routes may be regarded as a counterpoint to other natural, architectural or urban attractions, generating natural-cultural settings which interact with the visitors utilizing the synergy effect.[42] One excellent example of revitalization is the old arsenic and gold mine in Złoty Stok, Poland. A project was undertaken

Fig. 6. Gold and arsenic mine in Złoty Stok—contemporary sandstone portal completed when the Ochre Shaft was opened; photo by T. Wieja.
Ryc. 6. Kopalnia złota i arszeniku w Złotym Stoku – współczesny portal z piaskowca wykonany w chwili otwarcia Sztolni Ochrowej; fot. T. Wieja.

Fig. 7. Gold and arsenic mine in Złoty Stok—open-air exhibition of reconstructed traditional mining equipment; photo by T. Wieja.
Ryc. 7. Kopalnia złota i arszeniku w Złotym Stoku – wystawa zrekonstruowanego tradycyjnego sprzętu górniczego na wolnym powietrzu; fot. T. Wieja.

and successfully completed, resulting in revitalization of the system of underground excavations, the old disused mine buildings and its immediate surroundings where a medieval mining settlement was built and furnished (Park of Medieval Technology) (Fig. 7).

The preservation and safeguarding of natural and man-made heritage is in line with the principles of sustainable development. On the intentional level, the principles of sustainable development promote certain human behaviors and activities as the basis for interdisciplinary and equivalent social, economic and ecological processes. They require a thorough understanding of the links between retaining the retrospective values for the future generations, and initiating prospective values by those living here and now. Consequently, aesthetic, social, economic, ecologic processes are thus maintained, and developed, at the same time land and urban development is promoted. Thus initiated ecological processes, such as reclamation of degraded land and substance and their utilization as well as urban development and land development processes through clearing up the surroundings with the view of making them accessible to the public, foster the economic development of local communities. Thus, local communities tend to engage in grassroots initiatives and activities, particularly in areas affected by economic restructuring, resulting in increased unemployment levels. The utilization of the locally available human and material resources helps the local communities maintain their identity, for example through arousing the awareness of the uniqueness of the site, recreation of old crafts and technologies, recovery of traditional social relations, etc.

Conclusions

Old underground excavations are an immanent component of cultural and natural heritage, an non-transferrable value added during the transformations of geological structures and impacting on the process of formation of architectural space, urban development and natural land features in the neighborhood of underground sites. Many of these sites used to become starting points for mining settlements, or towns which, in consequence, furthered the development of the entire regions and sometimes ensured the prosperity of the states. It is worthwhile to mention the significant contribution of conservation and mining organizations in Poland to preservation, safeguarding and opening the old underground excavations to the public. Synergic programs developed by the conservation and mining agencies to protect the retrospective values and expanded to incorporate the prospective values give credit to achievements of Polish specialists as a model of interdisciplinary collaboration, in the light of legal, educational and economic considerations.

On account of the vast scope of analytical studies on technical and conservation intervention works undertaken to safeguard and preserve underground heritage sites, it is suggested that multi-criterial methods should be used to support decision-making. On this basis, a master plan should be created at the preliminary stage, to define the adopted strategy of preserving the sites and opening them to the public that would account for the social and economic effects of this process.

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[20] Ustawa z 9 czerwca 2011 prawo geologiczne i górnicze, Dz.U. 163, item 981.
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[22] Mining plant—a technically and organizationally autonomous complex of means used directly to perform activity regulated in the Act in terms of the extraction of minerals from deposits, and underground mining plants that extract coal, and the preparation of the mined materials for sale, which remain in a technological relationship of mineral mining, and an underground mining plant without tank-based substance storage, or the underground storage of waste, including mining excavations, buildings and installation machinery (art. 5, section 1, point 18, Geological and Mning Law Act).
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[41] It is based on an analysis of individual facts and on this basis, general conclusions are drawn.
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Abstract

Old underground excavations are an immanent component of cultural and natural heritage. Bearing in mind the fact that each space formed as an underground excavation has unique features, the author of this study explores the fundamental principles having relevance to retrospective values represented by mining heritage created through formation and exploration of underground excavations, and recognizes the priorities for modern intervention schemes in the context of heritage preservation and safeguarding. Revitalization of old disused underground excavations gives rise to social, economic and ecological mechanisms at the stage of investment planning, implementation and operation and maintenance. That determines the continuation and development of aesthetic, social, economic and ecological processes, as well as land and urban growth being inherent components of sustainable development of towns and entire regions.

Streszczenie

Podziemne wyrobiska górnicze są immanentnym składnikiem dziedzictwa kulturowego i naturalnego, niezbywalną wartością dodaną w procesie przekształcania struktur geologicznych; mają także wpływ na kształtowanie przestrzeni architektonicznej, urbanistyki i krajobrazu naturalnego wokół realizowanych podziemnych obiektów. Mając świadomość, że każda przestrzeń uformowana jako wyrobisko podziemne ma indywidualne i niepowtarzalne cechy, w artykule sformułowano podstawowe zasady odnoszące się do oceny wartości retrospektywnych reprezentowanych przez dziedzictwo górnicze. Określono również priorytety dla współczesnej interwencji antropogenicznej w procesie jego ochrony i adaptacji. Rewitalizacja podziemnych nieczynnych wyrobisk generuje zachowanie i rozwój procesów estetycznych, społecznych, ekonomicznych, ekologicznych, krajobrazowych i urbanistycznych będących immanentnym składnikiem zrównoważonego rozwoju miast i regionów.